

LoadLeveler for AIX 5L and Linux



Using and Administering

Version 3 Release 3.1

LoadLeveler for AIX 5L and Linux



Using and Administering

Version 3 Release 3.1

Note

Before using this information and the product it supports, read the information in "Notices" on page 615.

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This edition applies to version 3, release 3, modification 1 of IBM LoadLeveler for AIX 5L™ (product number 5765-E69) and Linux (product number 5724-I23), and to all subsequent releases and modifications until otherwise indicated in new editions. This edition replaces SA22-7881-03. Significant changes or additions to the text and illustrations are indicated by a vertical line (|) to the left of the change.

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About this book

IBM LoadLeveler for AIX 5L and Linux provides various ways of scheduling and managing applications for best performance and most efficient use of resources. LoadLeveler manages both serial and parallel jobs over a cluster of machines or servers, which may be desktop workstations, dedicated servers, or parallel machines. This book describes how to configure and administer this LoadLeveler cluster environment, and to submit and manage jobs that run on machines in the cluster.

Who should use this book

This book is intended for two separate audiences:

- Personnel who are responsible for installing, configuring and managing the LoadLeveler cluster environment. These people are called LoadLeveler administrators. LoadLeveler administrative tasks include:
 - Setting up configuration and administration files.
 - Maintaining the LoadLeveler product.
 - Setting up the distributed environment for allocating batch jobs.
- Users who submit and manage serial and parallel jobs to run in the LoadLeveler cluster.

Both LoadLeveler administrators and general users should be experienced with the UNIX commands. Administrators also should be familiar with:

- Cluster system management techniques such as SMIT, as it is used in the AIX® environment.
- Networking and NFS or AFS® protocols.

Conventions and terminology used in this book

Throughout the LoadLeveler product documentation:

- LoadLeveler for Linux® on xSeries® and LoadLeveler for Linux on IBM® @server® with AMD Opteron or Intel® EM64T processors are referred to as LoadLeveler® for Linux on Multiplatform. LoadLeveler for Linux on Multiplatform includes:
 - IBM @server 325
 - IBM @server 326
 - IBM @server xSeries
 - IBM @server Cluster 1350
 - IBM @server BladeCenter™ HS20
- Note that in this document Switch_Network_Interface_For_HPS is also referred to as HPS or High Performance Switch.
- Note that in this document, the IBM RS/6000® SP™ systems hardware platform is referred to as the “SP.” References to RS/6000 SP or SP should be read to also include currently supported IBM @server Cluster 1600 hardware.

Table 1 describes the typographic conventions used in this book.

Table 1. Summary of typographic conventions

Typographic	Usage
Bold	<ul style="list-style-type: none">• Bold words or characters represent system elements that you must use literally, such as commands, flags, and path names.• Bold words also indicate the first use of a term included in the glossary.
<i>Italic</i>	<ul style="list-style-type: none">• <i>Italic</i> words or characters represent variable values that you must supply.• <i>Italics</i> are also used for book titles and for general emphasis in text.
Constant width	Examples and information that the system displays appear in constant width typeface.
[]	Brackets enclose optional items in format and syntax descriptions.
{ }	Braces enclose a list from which you must choose an item in format and syntax descriptions.
	A vertical bar separates items in a list of choices. (In other words, it means “or.”)
< >	Angle brackets (less-than and greater-than) enclose the name of a key on the keyboard. For example, <Enter> refers to the key on your terminal or workstation that is labeled with the word Enter.
...	An ellipsis indicates that you can repeat the preceding item one or more times.
<Ctrl-x>	The notation <Ctrl-x> indicates a control character sequence. For example, <Ctrl-c> means that you hold down the control key while pressing <c>.
\	The continuation character is used in coding examples in this book for formatting purposes.

Prerequisite and related information

The LoadLeveler publications are:

- *Installation Guide*, GI10-0763
- *Using and Administering*, SA22-7881
- *Diagnosis and Messages Guide*, GA22-7882

To access all LoadLeveler documentation, refer to the **IBM @server Cluster Information Center**, which contains the most recent LoadLeveler documentation in PDF and HTML formats. This Web site is located at:

<http://publib.boulder.ibm.com/infocenter/clresctr/index.jsp>

A **LoadLeveler Documentation Updates** file also is maintained on this Web site. The **LoadLeveler Documentation Updates** file contains updates to the LoadLeveler documentation. These updates include documentation corrections and clarifications that were discovered after the LoadLeveler books were published.

Both the current LoadLeveler books and earlier versions of the library are also available in PDF format from the IBM Publications Center Web site located at:

<http://www.ibm.com/shop/publications/order>

To easily locate a book in the IBM Publications Center, supply the book's publication number. The publication number for each of the LoadLeveler books is listed after the book title in the preceding list.

Blue Gene documentation

The Blue Gene publications are available from the IBM Redbooks Web site at the following URLs:

Publication Name	URL
<i>Blue Gene/L: System Administration</i>	http://www.redbooks.ibm.com/abstracts/sg247178.html
<i>Blue Gene/L: Hardware Overview and Planning</i>	http://www.redbooks.ibm.com/abstracts/sg246796.html
<i>Blue Gene/L: Application Development</i>	http://www.redbooks.ibm.com/abstracts/sg247179.html
<i>Unfolding the IBM eServer Blue Gene Solution</i>	http://www.redbooks.ibm.com/abstracts/sg246686.html

Using LookAt to look up message explanations

LookAt is an online facility that lets you look up explanations for most of the IBM messages you encounter, as well as for some system abends and codes. You can use LookAt from the following locations to find IBM message explanations for Clusters for AIX and Linux:

- The Internet. You can access IBM message explanations directly from the LookAt Web site:
<http://www.ibm.com/eserver/zseries/zos/bkserv/lookat/>
- Your wireless handheld device. You can use the LookAt Mobile Edition with a handheld device that has wireless access and an Internet browser (for example, Internet Explorer for Pocket PCs, Blazer, or Eudora for Palm OS, or Opera for Linux handheld devices). Link to the LookAt Mobile Edition from the LookAt Web site.

Accessibility information

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To request accessibility information, click **Product accessibility information**.

How to send your comments

Your feedback is important in helping us to produce accurate, high-quality information. If you have any comments about this book or any other LoadLeveler documentation:

- Send your comments by e-mail to: mhvrfs@us.ibm.com
Include the book title and order number, and, if applicable, the specific location of the information you have comments on (for example, a page number or a table number).
- Fill out one of the forms at the back of this book and return it by mail, by fax, or by giving it to an IBM representative.

To contact the IBM cluster development organization, send your comments by e-mail to: cluster@us.ibm.com

Summary of changes

The following sections summarize changes to the LoadLeveler product and LoadLeveler library for each new release or major service update for a given product version. Within each book in the library, a vertical line to the left of text and illustrations indicates technical changes or additions made to the previous edition of the book.

Changes to LoadLeveler for this release or update include:

- **New information:**

- LoadLeveler allows administrators the ability to create a multicluster environment supporting both AIX and Linux LoadLeveler clusters. LoadLeveler provides load distribution of jobs among multiple clusters at submit time, easy access to multiple cluster resources by users, manual transfer of an idle job from one cluster to another, and copying user input and output files between clusters. For more information, see “LoadLeveler multicluster support” on page 139 and “Submitting and monitoring jobs in a LoadLeveler multicluster” on page 193.
- In an environment where a firewall is used to secure communications between clusters, LoadLeveler can be configured to use the OpenSSL library to enable LoadLeveler to operate in the secure environment.
- The LoadLeveler backfill scheduler supports the scheduling of jobs on Blue Gene hardware. LoadLeveler also provides APIs that enable other programs to access the state of the LoadLeveler-Blue Gene interaction. For more information, see “LoadLeveler Blue Gene support” on page 143 and “Submitting and monitoring Blue Gene jobs” on page 195.
- LoadLeveler supports scheduling affinity on AIX, allowing jobs to utilize the memory and adapter affinity features available in IBM servers with IBM @server POWER5 or IBM @server POWER4 CPU architecture. LoadLeveler allows jobs to utilize the Resource Set (RSet) function available in AIX 5L. For more information, see “LoadLeveler scheduling affinity support” on page 137.
- LoadLeveler supports remote direct memory access (RDMA) remote context blocks (rCxt blocks) by managing rCxt blocks as an adapter resource. Support for rCxt blocks is an extension of the existing RDMA infrastructure used for bulk data transfer operations.
- LoadLeveler provides a way to cancel jobs from a list of machines that have gone down. The new **llcancel -f *hostlist*** option vacates all jobs from a list of specified host names and then marks those hosts as “Down”.
- LoadLeveler provides a way to determine which jobs have been favored by the **llfavorjob** command. The **llq -l** command and Data Access API provide a favored job indicator.
- LoadLeveler provides an interface to the Globus Toolkit 4.0 (GT4.0). This interface allows users and processes on a GT4.0 machine that is not part of the LoadLeveler cluster to interact with the LoadLeveler cluster and also provides a mechanism through which selected information about the state of the LoadLeveler cluster is made available to GT4.0 enabled systems. The interface is shipped in the tar file `RELEASEDIR/full/lib/llgrid.tar`. Documentation for the interface, **LoadLeveler-GT4.0_Users_Guide.pdf**, can also be found in the tar file.

- **Changed information:**

- A new appendix for sample output of long listings has been created. Long listings have been moved from the command documentation to this new appendix.
- This release of LoadLeveler no longer supports switches other than the SP Switch2 and the High Performance Switch.
- LoadLeveler 3.3 is the last release that will support gang preemption. The method used for preemption has been replaced with the new backfill scheduling preemption capability.
- LoadLeveler 3.3 is the last release that will support the Parallel Job API, consisting of **ll_get_hostlist** and **ll_start_host**.
- LoadLeveler 3.3 is the last release that will provide support for submitting NQS scripts to LoadLeveler and routing them to a machine outside of the LoadLeveler cluster that runs NQS.

Part 1. Overview of LoadLeveler concepts and operation

Setting up LoadLeveler involves defining machines, users, jobs, and how they interact, in such a way that LoadLeveler is able to run jobs quickly and efficiently. If you are unfamiliar with the LoadLeveler product, consider reading one or more of the introductory topics listed in Table 2.

Table 2. Topics in the LoadLeveler overview

To learn about:	Read the following:
LoadLeveler interfaces, operations, and the lifecycle of a job	Chapter 1, "What is LoadLeveler?," on page 3
Specific products and features that are required for or available through the LoadLeveler environment	Chapter 2, "What operating systems are supported by LoadLeveler?," on page 25

Once you have a basic understanding of the LoadLeveler product and its interfaces, you can find more details in the topics listed in Table 3.

Table 3. Major topics in LoadLeveler "Using and Administering"

To learn about:	Read the following:
Performing administrator tasks	Part 2, "Configuring and managing the LoadLeveler environment," on page 29
Performing general user tasks	Part 3, "Submitting and managing LoadLeveler jobs," on page 155
Using LoadLeveler interfaces	Part 4, "LoadLeveler interfaces reference," on page 229

Chapter 1. What is LoadLeveler?

LoadLeveler is a job management system that allows users to run more jobs in less time by matching the jobs' processing needs with the available resources. LoadLeveler schedules jobs, and provides functions for building, submitting, and processing jobs quickly and efficiently in a dynamic environment.

Figure 1 shows the different environments to which LoadLeveler can schedule jobs. Together, these environments comprise the *LoadLeveler cluster*. An environment can include heterogeneous clusters, dedicated nodes, and the RS/6000 SP.

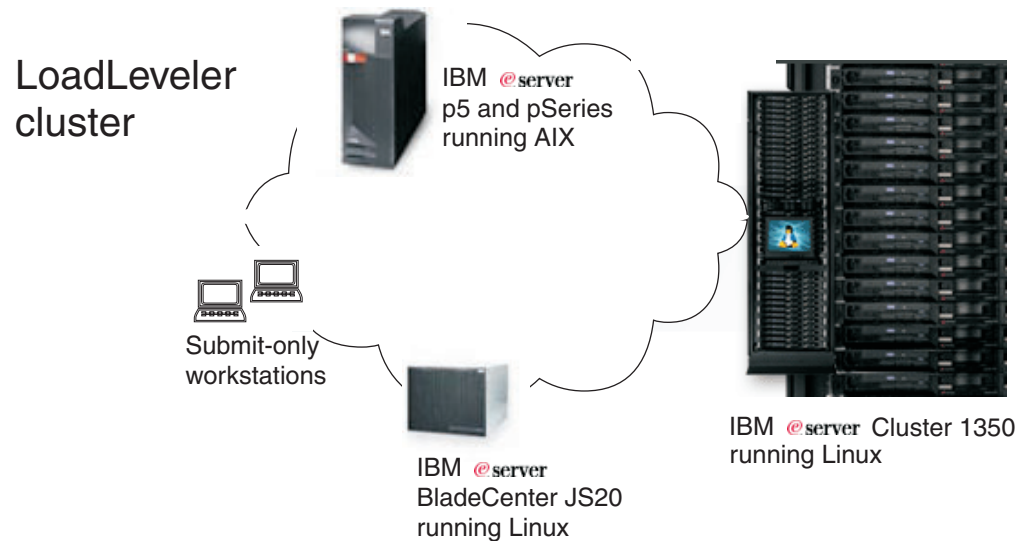


Figure 1. Example of a LoadLeveler cluster

In addition, LoadLeveler can schedule jobs written for NQS to run on machines outside of the LoadLeveler cluster. As Figure 1 also illustrates, a LoadLeveler cluster can include *submit-only* machines, which allow users to have access to a limited number of LoadLeveler features.

Throughout this book, the terms *workstation*, *machine*, *node*, and *operating system instance (OSI)* refer to the machines in your cluster. In LoadLeveler, an OSI is treated as a single instance of an operating system image.

LoadLeveler basics

LoadLeveler has various types of interfaces that enable users to create and submit jobs and allow system administrators to configure the system and control running jobs. These interfaces include:

- Control files that define the elements, characteristics, and policies of LoadLeveler and the jobs it manages. These files are the configuration file, the administration file, and job command file.
- The command line interface, which gives you access to basic job and administrative functions.

LoadLeveler basics

- A graphical user interface (GUI), which provides system access similar to the command line interface. Experienced users and administrators may find the command line interface more efficient than the GUI for job and administrative functions.
- An application programming interface (API), which allows application programs written by users and administrators to interact with the LoadLeveler environment.

The commands, GUI, and APIs permit different levels of access to administrators and users. User access is typically restricted to submitting and managing individual jobs, while administrative access allows setting up system configurations, job scheduling, and accounting.

Using either the command line or the GUI, users create job command files that instruct the system on how to process information. Each job command file consists of keywords followed by the user defined association for that keyword. For example, the keyword **executable** tells LoadLeveler that you are about to define the name of a program you want to run. Therefore, **executable = longjob** tells LoadLeveler to run the program called *longjob*.

After creating the job command file, you invoke LoadLeveler commands to monitor and control the job as it moves through the system. LoadLeveler monitors each job as it moves through the system using process control daemons. However, the administrator maintains ultimate control over all LoadLeveler jobs by defining job classes that control how and when LoadLeveler will run a job.

In addition to setting up job classes, the administrator can also control how jobs move through the system by specifying the type of scheduler. LoadLeveler has several different scheduler options that start jobs using specific algorithms to balance job priority with available machine resources.

When LoadLeveler administrators are configuring clusters and when users are planning jobs, they need to be aware of the machine resources available in the cluster. These resources include items like the number of CPUs and the amount of memory available for each job. Because resource availability will vary over time, LoadLeveler defines them as consumable resources.

LoadLeveler: A network job management and scheduling system

A network job management and job scheduling system, such as LoadLeveler, is a software program that schedules and manages jobs that you submit to one or more machines under its control. LoadLeveler accepts jobs that users submit and reviews the job requirements. LoadLeveler then examines the machines under its control to determine which machines are best suited to run each job.

Job definition

LoadLeveler schedules your jobs on one or more machines for processing. The definition of a **job**, in this context, is a set of **job steps**. For each job step, you can specify a different executable (the executable is the part of the job that gets processed). You can use LoadLeveler to submit jobs which are made up of one or more job steps, where each job step depends upon the completion status of a previous job step. For example, Figure 2 on page 5 illustrates a stream of job steps:

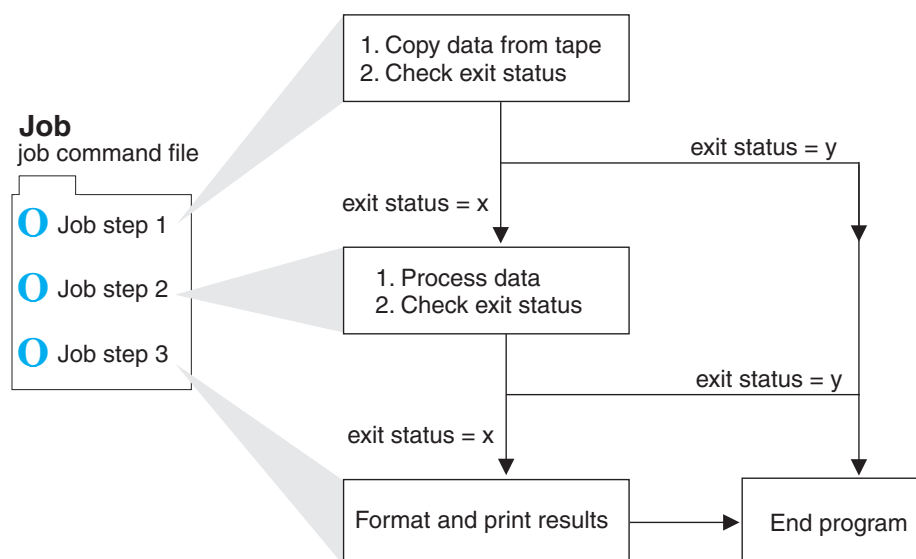


Figure 2. LoadLeveler job steps

Each of these job steps is defined in a single **job command file**. A job command file specifies the name of the job, as well as the job steps that you want to submit, and can contain other LoadLeveler statements.

LoadLeveler tries to execute each of your job steps on a machine that has enough resources to support executing and checkpointing each step. If your job command file has multiple job steps, the job steps will not necessarily run on the same machine, unless you explicitly request that they do.

You can submit batch jobs to LoadLeveler for scheduling. Batch jobs run in the background and generally do not require any input from the user. Batch jobs can either be **serial** or **parallel**. A serial job runs on a single machine. A parallel job is a program designed to execute as a number of individual, but related, processes on one or more of your system's nodes. When executed, these related processes can communicate with each other (through message passing or shared memory) to exchange data or synchronize their execution.

For parallel jobs, LoadLeveler interacts with Parallel Operating Environment (POE) to allocate nodes, assign tasks to nodes, and launch tasks. LoadLeveler also supports MPICH parallel jobs.

Machine definition

For LoadLeveler to schedule a job on a machine, the machine must be a valid member of the LoadLeveler cluster. A cluster is the combination of all of the different types of machines that use LoadLeveler.

To make a machine a member of the LoadLeveler cluster, the administrator has to install the LoadLeveler software onto the machine and identify the central manager (described in "Roles of machines"). Once a machine becomes a valid member of the cluster, LoadLeveler can schedule jobs to it.

Roles of machines

Each machine in the LoadLeveler cluster performs one or more roles in scheduling jobs. These roles are described below:

LoadLeveler basics

- **Scheduling Machine:** When a job is submitted, it gets placed in a queue managed by a scheduling machine. This machine contacts another machine that serves as the central manager for the entire LoadLeveler cluster. (This role is described below). This scheduling machine asks the central manager to find a machine that can run the job, and also keeps persistent information about the job. Some scheduling machines are known as *public scheduling machines*, meaning that any LoadLeveler user can access them. These machines schedule jobs submitted from submit-only machines, which are described below.
- **Central Manager Machine:** The role of the Central Manager is to examine the job's requirements and find one or more machines in the LoadLeveler cluster that will run the job. Once it finds the machine(s), it notifies the scheduling machine.
- **Executing Machine:** The machine that runs the job is known as the executing machine.
- **Submitting Machine:** This type of machine is known as a *submit-only* machine. It participates in the LoadLeveler cluster on a limited basis. Although the name implies that users of these machines can only submit jobs, they can also query and cancel jobs. Users of these machines also have their own Graphical User Interface (GUI) that provides them with the submit-only subset of functions. The submit-only machine feature allows workstations that are not part of the LoadLeveler cluster to submit jobs to the cluster.

Keep in mind that one machine can assume multiple roles, as shown in Figure 3.

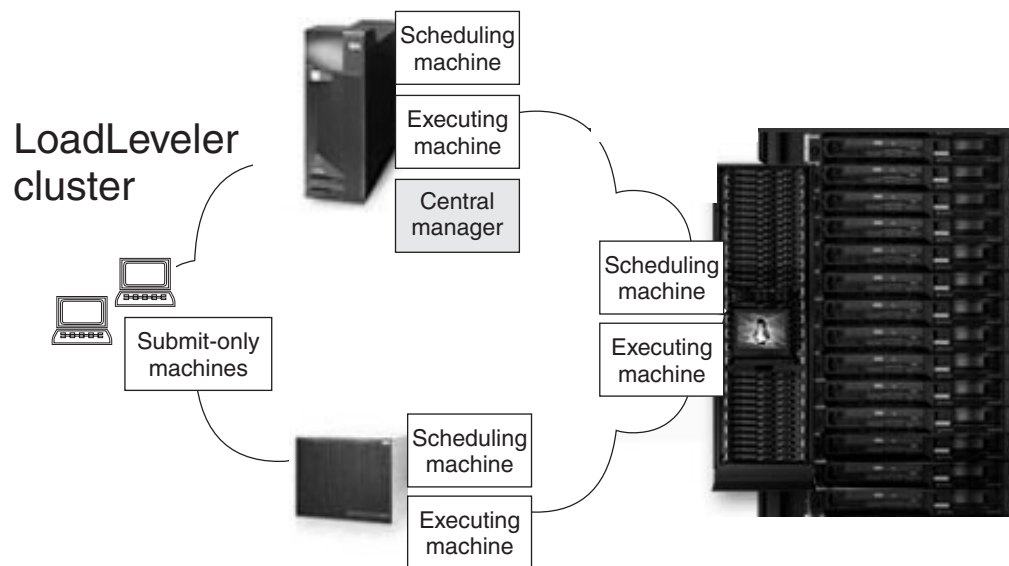


Figure 3. Multiple roles of machines

Machine availability

There may be times when some of the machines in the LoadLeveler cluster are not available to process jobs; for instance, when the owners of the machines have decided to make them unavailable. This ability of LoadLeveler to allow users to restrict the use of their machines provides flexibility and control over the resources.

Machine owners can make their personal workstations available to other LoadLeveler users in several ways. For example, you can specify that:

- The machine will always be available
- The machine will be available only between certain hours

- The machine will be available when the keyboard and mouse are not being used interactively.

Owners can also specify that their personal workstations never be made available to other LoadLeveler users.

How LoadLeveler schedules jobs

When a user submits a job, LoadLeveler examines the job command file to determine what resources the job will need. LoadLeveler determines which machine, or group of machines, is best suited to provide these resources, then LoadLeveler dispatches the job to the appropriate machines. To aid this process, LoadLeveler uses queues. A **job queue** is a list of jobs that are waiting to be processed. When a user submits a job to LoadLeveler, the job is entered into an internal database— which resides on one of the machines in the LoadLeveler cluster— until it is ready to be dispatched to run on another machine.

Once LoadLeveler examines a job to determine its required resources, the job is dispatched to a machine to be processed. A job can be dispatched to either one machine, or— in the case of parallel jobs— to multiple machines. Once the job reaches the executing machine, the job runs.

Jobs do not necessarily get dispatched to machines in the cluster on a first-come, first-serve basis. Instead, LoadLeveler examines the requirements and characteristics of the job and the availability of machines, and then determines the best time for the job to be dispatched.

LoadLeveler also uses **job classes** to schedule jobs to run on machines. A job class is a classification to which a job can belong. For example, short running jobs may belong to a job class called `short_jobs`. Similarly, jobs that are only allowed to run on the weekends may belong to a class called `weekend`. The system administrator can define these job classes and select the users that are authorized to submit jobs of these classes.

You can specify which types of jobs will run on a machine by specifying the types of job classes the machine will support. LoadLeveler also examines a job's **priority** to determine when to schedule the job on a machine. A priority of a job is used to determine its position among a list of all jobs waiting to be dispatched.

“The LoadLeveler job cycle” on page 14 describes job flow in the LoadLeveler environment in more detail.

How LoadLeveler daemons process jobs

LoadLeveler has its own set of daemons that control the processes moving jobs through the LoadLeveler cluster. The LoadLeveler daemons are programs that run continuously and control the processes that move jobs through the LoadLeveler cluster. A master daemon (**LoadL_master**) runs on all machines in the LoadLeveler cluster and manages other daemons.

Table 4 on page 8 summarizes these daemons, which are described in further detail in topics immediately following the table.

LoadLeveler daemons

Table 4. LoadLeveler daemons

Daemon	Description
LoadL_master	Referred to as the master daemon. Runs on all machines in the LoadLeveler cluster and manages other daemons.
LoadL_schedd	Referred to as the schedd daemon. Receives jobs from the llsubmit command and manages them on machines selected by the negotiator daemon (as defined by the administrator).
LoadL_startd	Referred to as the startd daemon. Monitors job and machine resources on local machines and forwards information to the negotiator daemon. The startd daemon spawns the starter process (LoadL_starter) which manages running jobs on the executing machine.
LoadL_negotiator	Referred to as the negotiator daemon. Monitors the status of each job and machine in the cluster. Responds to queries from llstatus and llq commands. Runs on the central manager machine.
LoadL_kbdd	Referred to as the keyboard daemon. Monitors keyboard and mouse activity.
LoadL_GSmonitor	Referred to as the gsmonitor daemon. Monitors for down machines based on the heartbeat responses of the MACHINE_UPDATE_INTERVAL time period.

The master daemon

The **master** daemon runs on every machine in the LoadLeveler cluster, except the submit-only machines. The real and effective user ID of this daemon must be root.

The master daemon determines whether to start any other daemons by checking the **START_DAEMONS** keyword in the global or local configuration file. If the keyword is set to **true**, the daemons are started. If the keyword is set to **false**, the master daemon terminates and generates a message.

The master daemon will not start on a Linux machine if **DCE_ENABLEMENT** is **TRUE**, **SEC_ENABLEMENT** is set to **DCE** or **CTSEC**, **SCHEDULER_TYPE** is set to **GANG**, or **NQS_DIR** is specified. If the master daemon does not start, no other daemons will start.

On the machine designated as the central manager, the master runs the **negotiator** daemon. The master also controls the central manager backup function. The negotiator runs on either the primary or an alternate central manager. If a central manager failure is detected, one of the alternate central managers becomes the primary central manager by starting the negotiator.

The master daemon starts and if necessary, restarts all the LoadLeveler daemons that the machine it resides on is configured to run. As part of its startup procedure, this daemon executes the **.llrc** file (a dummy file is provided in the **bin** subdirectory of the release directory). You can use this script to customize your local configuration file, specifying what particular data is stored locally. This daemon also runs the **kbdd** daemon, which monitors keyboard and mouse activity.

When the master daemon detects a failure on one of the daemons that it is monitoring, it attempts to restart it. Because this daemon recognizes that certain

situations may prevent a daemon from running, it limits its restart attempts to the number defined for the **RESTARTS_PER_HOUR** keyword in the configuration file. If this limit is exceeded, the master daemon forces all daemons including itself to exit.

When a daemon must be restarted, the master sends mail to the administrators identified by the **LOADL_ADMIN** keyword in the configuration file. The mail contains the name of the failing daemon, its termination status, and a section of the daemon's most recent log file. If the master aborts after exceeding **RESTARTS_PER_HOUR**, it will also send that mail before exiting.

The master daemon may perform the following actions in response to an **llctl** command:

- Kill all daemons and exit (**stop** keyword)
- Kill all daemons and execute a new master (**recycle** keyword)
- Rerun the **.llrc** file, reread the configuration files, stop or start daemons as appropriate for the new configuration files (**reconfig** keyword)
- Send drain request to startd and schedd (**drain** keyword)
- Send flush request to startd and send result to caller (**flush** keyword)
- Send suspend request to startd and send result to caller (**suspend** keyword)
- Send resume request to startd and schedd, and send result to caller (**resume** keyword)

The schedd daemon

The **schedd** daemon receives jobs sent by the **llsubmit** command and manages those jobs to machines selected by the negotiator daemon. The schedd daemon is started, restarted, signalled, and stopped by the master daemon.

The schedd daemon can be in any one of the following activity states:

Available	This machine is available to schedule jobs.
Drained	The schedd machine accepts no more jobs. There are no jobs in starting or running state. Jobs in the Idle state are drained, meaning they will not get dispatched.
Draining	The schedd daemon is being drained by the administrator but some jobs are still running. The state of the machine remains Draining until all running jobs complete. At that time, the machine status changes to Drained.
Down	The daemon is not running on this machine. The schedd daemon enters this state when it has not reported its status to the negotiator. This can occur when the machine is actually down, or because there is a network failure.

The schedd daemon performs the following functions:

- Assigns new job identifiers when requested by the job submission process (for example, by the **llsubmit** command).
- Receives new jobs from the **llsubmit** command. A new job is received as a *job object* for each job step. A job object is the data structure in memory containing all the information about a job step. The schedd forwards the job object to the negotiator daemon as soon as it is received from the submit command.
- Maintains on disk copies of jobs submitted locally (on this machine) that are either waiting or running on a remote (different) machine. The central manager can use this information to reconstruct the job information in the event of a failure. This information is also used for accounting purposes.

LoadLeveler daemons

- Responds to directives sent by the administrator through the negotiator daemon. The directives include:
 - Run a job.
 - Change the priority of a job.
 - Remove a job.
 - Hold or release a job.
 - Send information about all jobs.
- Sends job events to the negotiator daemon when:
 - schedd is restarting.
 - A new series of job objects are arriving.
 - A job is started.
 - A job was rejected, completed, removed, or vacated. schedd determines the status by examining the exit status returned by the startd.
- Communicates with the Parallel Operating Environment (POE) when you run an interactive POE job.
- Requests that a remote startd daemon end a job.
- Receives accounting information from startd.
- Receives requests for reservations.

The startd daemon

The **startd** daemon monitors the status of each job, reservation, and machine in the cluster, and forwards this information to the negotiator daemon. The startd also receives and executes job requests originating from remote machines. The master daemon starts, restarts, signals, and stops the startd daemon.

Checkpoint/restart is not supported in LoadLeveler for Linux. If a checkpointed job is sent to a Linux node, the Linux node will reject the job.

The startd daemon can be in any one of the following states:

Busy	The maximum number of jobs are running on this machine as specified by the MAX_STARTERS configuration keyword.
Down	The daemon is not running on this machine. The startd daemon enters this state when it has not reported its status to the negotiator. This can occur when the machine is actually down, or because there is a network failure.
Drained	The startd machine will not accept any new jobs. No jobs are running when startd is in the drained state.
Draining	The startd daemon is being drained by the administrator, but some jobs are still running. The machine remains in the draining state until all of the running jobs have completed, at which time the machine status changes to drained. The startd daemon will not accept any new jobs while in the draining state.
Flush	Any running jobs have been vacated (terminated and returned to the queue to be redispached). The startd daemon will not accept any new jobs.
Idle	The machine is not running any jobs.
None	LoadLeveler is running on this machine, but no jobs can run here.
Running	The machine is running one or more jobs and is capable of running more.

Suspend All LoadLeveler jobs running on this machine are stopped (cease processing), but remain in virtual memory. The startd daemon will not accept any new jobs.

The startd daemon performs these functions:

- Runs a time-out procedure that includes building a snapshot of the state of the machine that includes static and dynamic data. This time-out procedure is run at the following times:
 - After a job completes.
 - According to the definition of the **POLLING_FREQUENCY** keyword in the configuration file.
- Records the following information in LoadLeveler variables and sends the information to the negotiator.
 - State (of the startd daemon)
 - EnteredCurrentState
 - Memory
 - Disk
 - KeyboardIdle
 - Cpus
 - LoadAvg
 - Machine
 - Adapter
 - AvailableClasses
- Calculates the SUSPEND, RESUME, CONTINUE, and VACATE expressions through which you can manage job status.
- Receives job requests from the schedd daemon to:
 - Start a job
 - Preempt or resume a job
 - Vacate a job
 - Cancel

When the schedd daemon tells the startd daemon to start a job, the startd determines whether its own state permits a new job to run:

If:	Then this happens:
Yes, it can start a new job	The startd forks a starter process.
No, it cannot start a new job	The startd rejects the request for one of the following reasons: <ul style="list-style-type: none"> • Jobs have been suspended, flushed, or drained • The job limit set for the MAX_STARTERS keyword has been reached • There are not enough classes available for the designated job class

- Receives requests from the master (through the **llctl** command) to do one of the following:
 - Drain (**drain** keyword)
 - Flush (**flush** keyword)
 - Suspend (**suspend** keyword)
 - Resume (**resume** keyword)
- For each request, startd marks its own new state, forwards its new state to the negotiator daemon, and then performs the appropriate action for any jobs that are active.
- Receives notification of keyboard and mouse activity from the kbdd daemon

LoadLeveler daemons

- Periodically examines the process table for LoadLeveler jobs and accumulates resources consumed by those jobs. This resource data is used to determine if a job has exceeded its job limit and for recording in the history file.
- Send accounting information to schedd.

The starter process

The startd daemon spawns a **starter** process after the schedd daemon tells the startd daemon to start a job. The starter process manages all the processes associated with a job step. The starter process is responsible for running the job and reporting status back to the startd daemon.

The starter process performs these functions:

- Processes the prolog and epilog programs as defined by the **JOB_PROLOG** and **JOB_EPILOG** keywords in the configuration file. The job will not run if the prolog program exits with a return code other than zero.
- Handles authentication. This includes:
 - Authenticates AFS, if necessary
 - Verifies that the submitting user is *not* root
 - Verifies that the submitting user has access to the appropriate directories in the local file system.
- Runs the job by forking a child process that runs with the user ID and all groups of the submitting user. That child process creates a new process group of which it is the process group leader, and executes the user's program or a shell.

The starter process is responsible for detecting the termination of any process that it forks. To ensure that all processes associated with a job are terminated after the process forked by the starter terminates, process tracking must be enabled. To configure LoadLeveler for process tracking, see "Tracking job processes" on page 64.

- Responds to vacate and suspend orders from the startd.

The negotiator daemon

The **negotiator** daemon maintains status of each job and machine in the cluster and responds to queries from the **llstatus** and **llq** commands. The negotiator daemon runs on a single machine in the cluster (the central manager machine). This daemon is started, restarted, signalled, and stopped by the master daemon.

In a mixed cluster, the negotiator daemon must run on an AIX node.

The negotiator daemon receives status messages from each schedd and startd daemon running in the cluster. The negotiator daemon tracks:

- Which schedd daemons are running
- Which startd daemons are running, and the status of each startd machine.

If the negotiator does not receive an update from any machine within the time period defined by the **MACHINE_UPDATE_INTERVAL** keyword, then the negotiator assumes that the machine is down, and therefore the schedd and startd daemons are also down.

The negotiator also maintains in its memory several queues and tables which determine where the job should run.

The negotiator performs the following functions:

- Receives and records job status changes from the schedd daemon.

- Schedules jobs based on a variety of scheduling criteria and policy options. Once a job is selected, the negotiator contacts the schedd that originally created the job.
- Handles requests to:
 - Set priorities
 - Query about jobs, machines, classes, and reservations
 - Change reservation attributes
 - Bind jobs to reservations
 - Remove a reservation
 - Remove a job
 - Hold or release a job
 - Favor or unfavor a user or a job.
- Receives notification of schedd resets indicating that a schedd has restarted.

The kbdd daemon

The kbdd daemon monitors keyboard and mouse activity. The kbdd daemon is spawned by the master daemon if the **X_RUNS_HERE** keyword in the configuration file is set to **true**.

The kbdd daemon notifies the startd daemon when it detects keyboard or mouse activity; however, kbdd is *not* interrupt driven. It sleeps for the number of seconds defined by the **POLLING_FREQUENCY** keyword in the LoadLeveler configuration file, and then determines if X events, in the form of mouse or keyboard activity, have occurred. For more information on the configuration file, see Chapter 4, “Defining LoadLeveler resources to administer,” on page 77.

The gsmonitor daemon

The gsmonitor daemon is not available in LoadLeveler for Linux.

The negotiator daemon monitors for down machines based on the heartbeat responses of the **MACHINE_UPDATE_INTERVAL** time period. If the negotiator has not received an update after two **MACHINE_UPDATE_INTERVAL** periods, then it marks the machine as down, and notifies the schedd to remove any jobs running on that machine. The gsmonitor daemon (LoadL_GSmonitor) allows this cleanup to occur more reliably. The gsmonitor daemon uses the Group Services Application Programming Interface (GSAPI) to monitor machine availability on PSSP and peer domains and notify the negotiator quickly when a machine is no longer reachable.

If the **GSMONITOR_DOMAIN** keyword was not specified in the LoadLeveler configuration file then LoadLeveler will try to determine if the machine is running in a peer (cluster) domain or a PSSP domain. If the gsmonitor daemon is running in an active peer domain then it will use the RMC API to determine the node numbers and names of machines running in the cluster, otherwise it will assume it is running in a PSSP domain and attempt to use the SDR access routines to gather information. If the administrator restricted where the gsmonitor daemon can run by specifying the **GSMONITOR_DOMAIN** as either **PSSP** or **PEER**, then the daemon will start only if it is in a valid domain corresponding to what was specified in the configuration file.

If the administrator sets up a LoadLeveler administration file that contains OSIs spanning several PSSP or peer domains then a gsmonitor daemon must be started in each domain. A gsmonitor daemon can monitor only the OSIs contained in the domain within which it is running. The administrator specifies which OSIs run the

LoadLeveler daemons

gsmonitor daemon by specifying `GSMONITOR_RUNS_HERE=TRUE` in the local configuration file for that OSI. The default for `GSMONITOR_RUNS_HERE` is False.

The gsmonitor daemon should be run on one or two nodes in each domain (PSSP, peer, or both). By running LoadL_GSmonitor on more than one node in a domain you will have a backup in case one of the nodes that the monitor is running on goes down. LoadL_GSmonitor subscribes to the Group Services system-defined host membership group, which is represented by the **HA_GS_HOST_MEMBERSHIP** Group Services keyword. This group monitors every configured node in the system partition (when running in a PSSP domain) and every node in the active peer domain.

Notes:

1. The Group Services routines need to be run as root, so the LoadL_GSmonitor executable must be owned by root and have the setuid permission bit enabled.
2. It will not cause a problem to run more than one LoadL_GSmonitor daemon per SP System Partition, this will just cause the negotiator to be notified by each running daemon.
3. For more information about the Group Services subsystem, see *PSSP: Administration Guide*, SA22-7348 for **PSSP** domains or *RSCT Administration Guide*, SA22-7889 for **PEER** domains.
4. For more information about GSAPI, see *Group Services Programming Guide and Reference*, SA22-7355.

The LoadLeveler job cycle

The following description and sequence of diagrams illustrate the flow of job information through the LoadLeveler cluster.

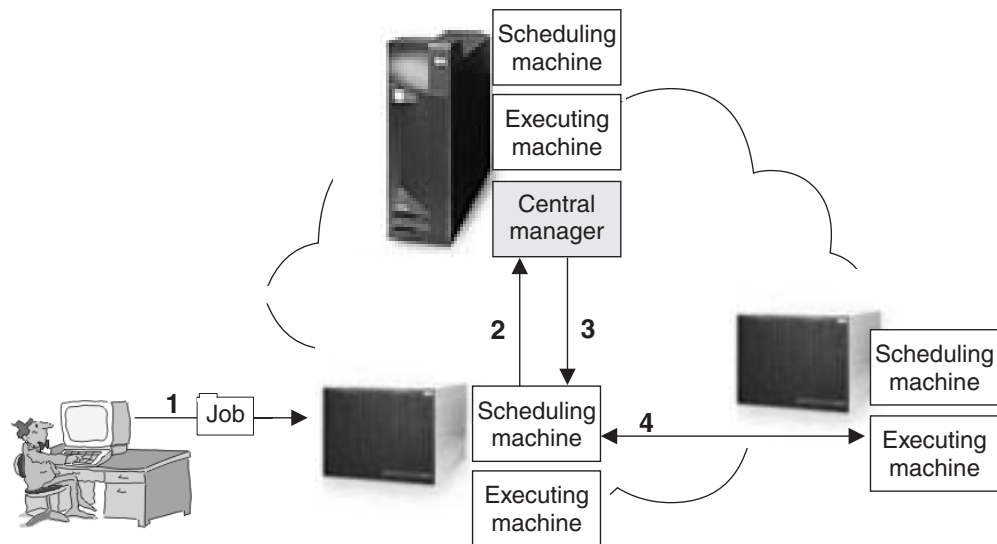


Figure 4. High-level job flow

The managing machine in a LoadLeveler cluster is known as the **central manager**. There are also machines that act as schedulers, and machines that serve as the executing machines. The arrows in Figure 4 illustrate the following:

- Arrow 1 indicates that a job has been submitted to LoadLeveler.

- Arrow 2 indicates that the scheduling machine contacts the central manager to inform it that a job has been submitted, and to find out if a machine exists that matches the job requirements.
- Arrow 3 indicates that the central manager checks to determine if a machine exists that is capable of running the job. Once a machine is found, the central manager informs the scheduling machine which machine is available.
- Arrow 4 indicates that the scheduling machine contacts the executing machine and provides it with information regarding the job. In this case, the scheduling and executing machines are different machines in the cluster, but they do not have to be different; the scheduling and executing machines may be the same physical machine.

Figure 4 on page 14 is broken down into the following more detailed diagrams illustrating how LoadLeveler processes a job. The diagrams indicate specific job states for this example, but do not list all of the possible states for LoadLeveler jobs. A complete list of job states appears in “LoadLeveler job states” on page 18.

1. Submit a LoadLeveler job:

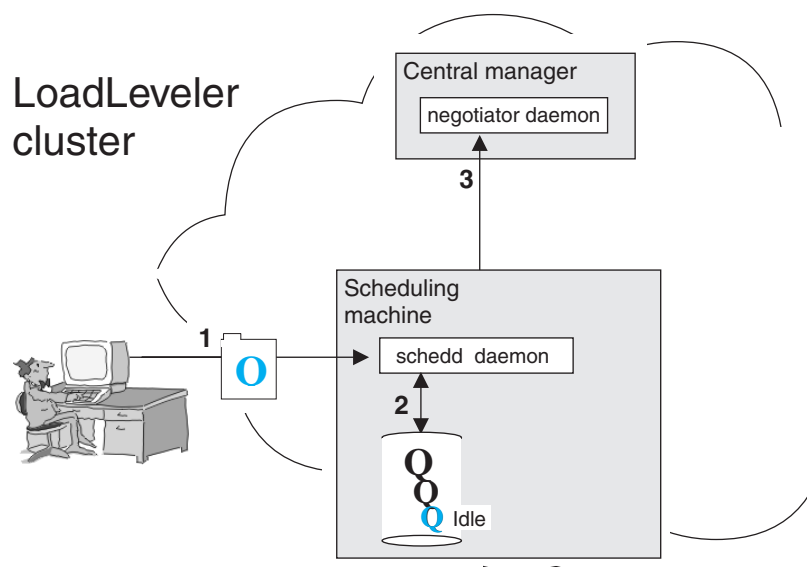


Figure 5. Job is submitted to LoadLeveler

Figure 5 illustrates that the schedd daemon runs on the scheduling machine. This machine can also have the startd daemon running on it. The negotiator daemon resides on the central manager machine. The arrows in Figure 5 illustrate the following:

- Arrow 1 indicates that a job has been submitted to the scheduling machine.
 - Arrow 2 indicates that the schedd daemon, on the scheduling machine, stores all of the relevant job information on local disk.
 - Arrow 3 indicates that the schedd daemon sends job description information to the negotiator daemon. At this point, the submitted job is in the Idle state.
2. Permit to run:

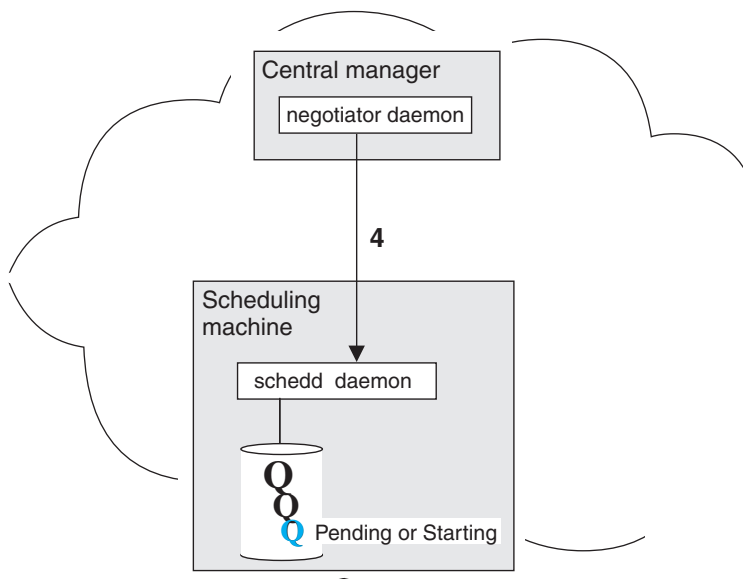


Figure 6. LoadLeveler authorizes the job

In Figure 6, arrow 4 indicates that the negotiator daemon authorizes the schedd daemon to begin taking steps to run the job. This authorization is called a *permit to run*. Once this is done, the job is considered Pending or Starting.

3. Prepare to run:

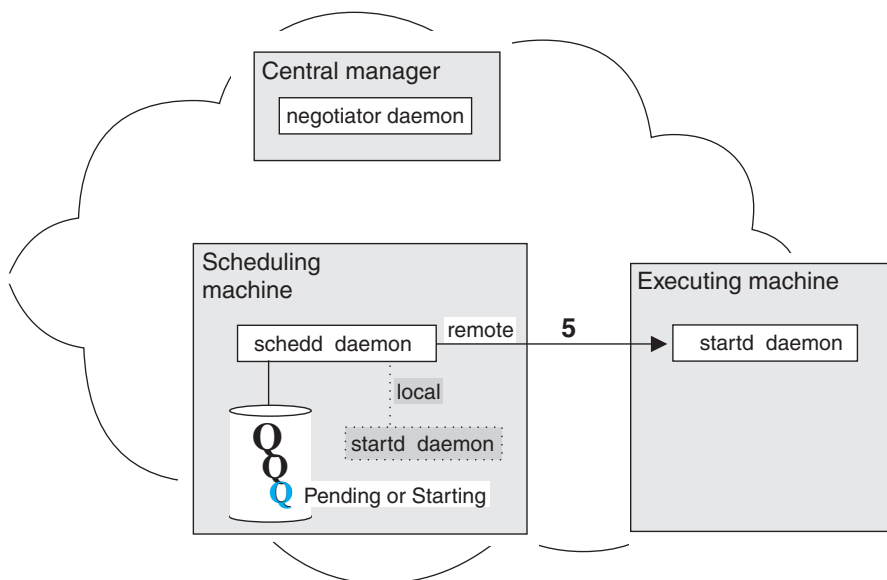


Figure 7. LoadLeveler prepares to run the job

In Figure 7, arrow 5 illustrates that the schedd daemon contacts the startd daemon on the executing machine and requests that it start the job. The executing machine can either be a local machine (the machine to which the job was submitted) or another machine in the cluster. In this example, the local machine is **not** the executing machine.

4. Initiate job:

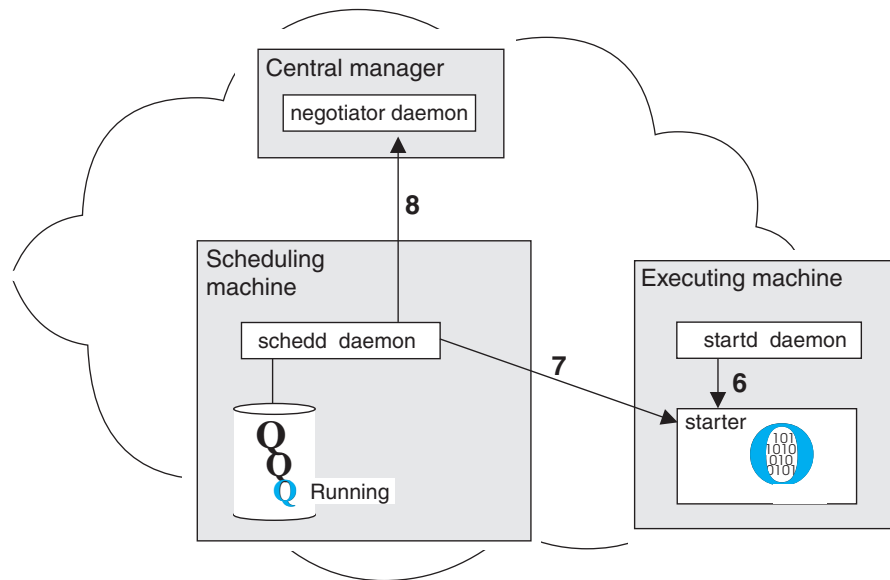


Figure 8. LoadLeveler starts the job

The arrows in Figure 8 illustrate the following:

- Arrow 6 indicates that the **startd** daemon on the executing machine spawns a **starter** process for the job.
- Arrow 7 indicates that the **schedd** daemon sends the starter process the job information and the executable.
- Arrow 8 indicates that the **schedd** daemon notifies the negotiator daemon that the job has been started and the negotiator daemon marks the job as Running.

The starter forks and executes the user's job, and the starter parent waits for the child to complete.

5. Complete job:

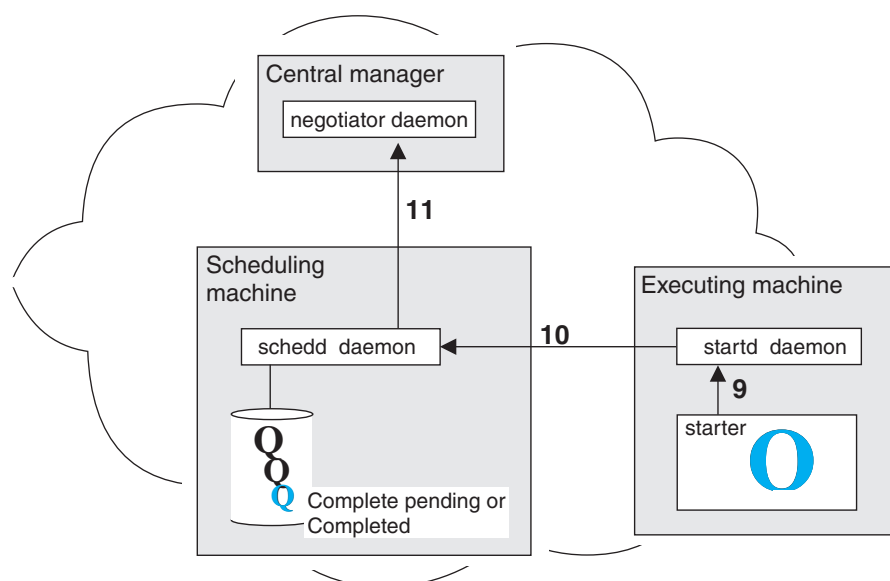


Figure 9. LoadLeveler completes the job

LoadLeveler job cycle

The arrows in Figure 9 on page 17 illustrate the following:

- Arrow 9 indicates that when the job completes, the starter process notifies the startd daemon.
- Arrow 10 indicates that the startd daemon notifies the schedd daemon.
- Arrow 11 indicates that the schedd daemon examines the information it has received, and forwards it to the negotiator daemon. At this point, the job is in Completed or Complete Pending state.

LoadLeveler job states

As LoadLeveler processes a job, the job moves through various states, which are listed in Table 5. Job states that include “Pending,” such as Complete Pending and Vacate Pending, are intermediate, temporary states.

Some options on LoadLeveler interfaces are valid only for jobs in certain states. For example, the **llmodify** command has options that apply only to jobs that are in the Idle state, or in states that are similar to it. To determine which job states are similar to the Idle state, use the “Similar to...” column in Table 5, which indicates whether a particular job state is similar to the Idle, Running, or Terminating state. A dash (—) indicates that the state is not similar to an Idle, Running, or Terminating state.

Table 5. Job state descriptions and abbreviations

Job state	Similar to Idle or Running state?	Abbreviation in displays / output	Description
Canceled	Terminating	CA	The job was canceled either by a user or by an administrator.
Checkpointing	Running	CK	Indicates that a checkpoint has been initiated.
Completed	Terminating	C	The job has completed.
Complete Pending	Terminating	CP	The job is in the process of being completed.
Deferred	Idle	D	The job will not be assigned to a machine until a specified date. This date may have been specified by the user in the job command file, or may have been generated by the negotiator because a parallel job did not accumulate enough machines to run the job. Only the negotiator places a job in the Deferred state.
Idle	Idle	I	The job is being considered to run on a machine, though no machine has been selected.

Table 5. Job state descriptions and abbreviations (continued)

Job state	Similar to Idle or Running state?	Abbreviation in displays / output	Description
Not Queued	Idle	NQ	The job is not being considered to run on a machine. A job can enter this state because the associated schedd is down, the user or group associated with the job is at its maximum maxqueued or maxidle value, or because the job has a dependency which cannot be determined. For more information on these keywords, see “Controlling the mix of idle and running jobs” on page 599. (Only the negotiator places a job in the NotQueued state.)
Not Run	—	NR	The job will never be run because a dependency associated with the job was found to be false.
Pending	Running	P	The job is in the process of starting on one or more machines. (The negotiator indicates this state until the schedd acknowledges that it has received the request to start the job. Then the negotiator changes the state of the job to Starting. The schedd indicates the Pending state until all startd machines have acknowledged receipt of the start request. The schedd then changes the state of the job to Starting.)
Preempted	Running	E	The job is preempted. This state applies only when LoadLeveler uses the suspend method to preempt the job.
Preempt Pending	Running	EP	The job is in the process of being preempted. This state applies only when LoadLeveler uses the suspend method to preempt the job.
Rejected	Idle	X	The job is rejected.
Reject Pending	Idle	XP	The job did not start. Possible reasons why a job is rejected are: job requirements were not met on the target machine, or the user ID of the person running the job is not valid on the target machine. After a job leaves the Reject Pending state, it is moved into one of the following states: Idle, User Hold, or Removed.
Removed	Terminating	RM	The job was stopped by LoadLeveler.
Remove Pending	Terminating	RP	The job is in the process of being removed, but not all associated machines have acknowledged the removal of the job.
Resume Pending	Running	MP	The job is in the process of being resumed.

Table 5. Job state descriptions and abbreviations (continued)

Job state	Similar to Idle or Running state?	Abbreviation in displays / output	Description
Running	Running	R	The job is running: the job was dispatched and has started on the designated machine.
Starting	Running	ST	The job is starting: the job was dispatched, was received by the target machine, and LoadLeveler is setting up the environment in which to run the job. For a parallel job, LoadLeveler sets up the environment on all required nodes. See the description of the “Pending” state for more information on when the negotiator or the schedd daemon moves a job into the Starting state.
System Hold	Idle	S	The job has been put in system hold.
Terminated	Terminating	TX	If the negotiator and schedd daemons experience communication problems, they may be temporarily unable to exchange information concerning the status of jobs in the system. During this period of time, some of the jobs may actually complete and therefore be removed from the schedd’s list of active jobs. When communication resumes between the two daemons, the negotiator will move such jobs to the Terminated state, where they will remain for a set period of time (specified by the <code>NEGOTIATOR_REMOVE_COMPLETED</code> keyword in the configuration file). When this time has passed, the negotiator will remove the jobs from its active list.
User & System Hold	Idle	HS	The job has been put in both system hold and user hold.
User Hold	Idle	H	The job has been put in user hold.
Vacated	Idle	V	The job started but did not complete. The negotiator will reschedule the job (provided the job is allowed to be rescheduled). Possible reasons why a job moves to the Vacated state are: the machine where the job was running was flushed, the <code>VACATE</code> expression in the configuration file evaluated to True, or LoadLeveler detected a condition indicating the job needed to be vacated. For more information on the <code>VACATE</code> expression, see “Managing job status through control expressions” on page 63.
Vacate Pending	Idle	VP	The job is in the process of being vacated.

Consumable resources

Consumable resources are assets available on machines in your LoadLeveler cluster. They are called "resources" because they model the commodities or services available on machines (including CPUs, real memory, virtual memory, software licenses, disk space). They are considered "consumable" because job steps use specified amounts of these commodities when the step is running. Once the step finishes, the resource becomes available for another job step.

Consumable resources which model the characteristics of a specific machine (such as the number of CPUs or the number of specific software licenses available only on that machine) are called machine resources. Consumable resources which model resources that are available across the LoadLeveler cluster (such as floating software licenses) are called floating resources. For example, consider a configuration with 10 licenses for a given program (which can be used on any machine in the cluster). If these licenses are defined as floating resources, all 10 can be used on one machine, or they can be spread across as many as 10 different machines.

The LoadLeveler administrator can specify:

- Consumable resources to be considered by LoadLeveler's scheduling algorithms
- Quantity of resources available on specific machines
- Quantity of floating resources available on machines in the cluster
- Consumable resources to be considered in determining the priority of executing machines
- Default amount of resources consumed by a job step of a specified job class
- Whether CPU and real memory resources should be enforced using AIX WLM
- Whether all jobs submitted need to specify resources

Users submitting jobs can specify the resources consumed by each task of a job step.

LoadLeveler for AIX supports memory and I/O adapter affinity options for improving IBM POWER5™ and POWER4™ machine performance. Memory and adapter affinity are phenomena where performance gains occur when jobs are limited to a specific multiple chip module (MCM). LoadLeveler makes use of the Resource Set (RSet) APIs available in AIX5.2 for this purpose, attaching a task's processes to run only on CPUs of a single MCM. On an affinity enabled system the administrator can configure LoadLeveler to use RSets for tasks, based on consumable CPUs or based on the RSets specified in the job command file. For more information on scheduling affinity, see "LoadLeveler scheduling affinity support" on page 137

Notes:

1. When software licenses are used as a consumable resource, LoadLeveler does not attempt to obtain software licenses or to verify that software licenses have been obtained. However, by providing a user exit that can be invoked as a submit filter, the LoadLeveler administrator can provide code to first obtain the required license and then allow the job step to run. For more information on filtering job scripts, see "Filtering a job script" on page 70.
2. LoadLeveler scheduling algorithms use the availability of requested consumable resources to determine the machine or machines on which a job will run. Consumable resources (except for CPU and real memory) are used only for scheduling purposes and are not enforced. Instead, LoadLeveler's negotiator daemon keeps track of the consumable resources available by

Consumable resources

reducing them by the amount requested when a job step is scheduled, and increasing them when a consuming job step completes.

3. If a job is preempted, the job continues to use all consumable resources except for ConsumableCpus and ConsumableMemory (real memory) which are made available to other jobs.
4. When the network adapters on a machine support RDMA, the machine is automatically given a consumable resource called RDMA with an available quantity defined by the limit on the number of concurrent jobs that use RDMA. For machines with "Switch Network Interface for HPS" network adapters, this limit is 4.
5. When steps require RDMA, either because they request bulkxfer or because they request rcxtblocks on at least one network statement, the job is automatically given a resource requirement for 1 RDMA.

Consumable resources and AIX Workload Manager

If the administrator has indicated that resources should be enforced, LoadLeveler uses AIX Workload Manager (WLM) to give greater control over CPU and real memory resource allocation. WLM monitors system resources and regulates their allocation to processes running on AIX. These actions prevent jobs from interfering with each other when they have conflicting resource requirements. WLM achieves this control by creating different classes of service and allowing attributes to be specified for those classes.

LoadLeveler dynamically generates WLM classes with specific resource entitlements. A single WLM class is created for each job step and the process id of that job step is assigned to that class. This is done for each node that a job step is assigned to execute on. LoadLeveler then defines resource shares or limits for that class depending on the LoadLeveler enforcement policy defined. These resource shares or limits represent the job's requested resource usage in relation to the amount of resources available on the machine.

When the enforcement policy is shares, LoadLeveler assigns a share value to the class based on the resources requested for the job step (one unit of resource equals one share). When the job step process is executing, AIX WLM dynamically calculates a desired resource entitlement based on the WLM class share value of the job step and the total number of shares requested by all active WLM classes. It is important to note that AIX WLM will only enforce these target percentages when the resource is under contention.

When the enforcement policy is limits (soft or hard), LoadLeveler assigns a percentage value to the class based on the resources requested for the job step and the total machine resources. This resource percentage is enforced regardless of any other active WLM classes. A soft limit indicates the maximum amount of the resource that can be made available when there is contention for the resources. This maximum can be exceeded if no one else requires the resource. A hard limit indicates the maximum amount of the resource that can be made available even if there is no contention for the resources.

Note: A WLM class is active for the duration of a job step's execution and is deleted when the job step completes. There is a limit of 27 active WLM classes per machine. Therefore, when resources are being enforced, only 27 job steps can be executing on one machine.

For more information on integrating LoadLeveler with AIX Workload Manager, see "Steps for integrating LoadLeveler with AIX Workload Manager" on page 126.

Overview of reservations

Under the backfill scheduler only, LoadLeveler allows authorized users to make reservations, which specify a time period during which specific node resources are reserved for exclusive use by particular users or groups. This capability is known in the computing industry as advance reservation. Normally, jobs wait to be dispatched until the resources they require become available. Through the use of reservations, wait time can be reduced because the jobs have exclusive use of the node resources (CPUs, memory, disk drives, communication adapters, and so on) as soon as the reservation period begins.

In addition to reducing wait time, reservations also are useful for:

- Running a workload that needs to start or finish at a particular time. The job steps must be associated with, or bound to, the reservation before LoadLeveler can run them during the reservation period.
- Setting aside a set of nodes for maintenance purposes. In this case, job steps are not bound to the reservation.

Only bound job steps may run on the reserved nodes, which means that a bound job step competes for reserved resources only with other job steps that are bound to the same reservation.

The following sequence of events describes, in general terms, how you can set up and use reservations in the LoadLeveler environment. It also describes how LoadLeveler manages activities related to the use of reservations.

1. Configuring LoadLeveler to support reservations

An administrator uses specific keywords in the configuration and administration files to define general reservation policies. These keywords include:

- **max_reservations**, which defines both:
 - The users or groups that will be allowed to create reservations. To be authorized to create reservations, LoadLeveler administrators also must have the **max_reservations** keyword set in their own user or group stanzas.
 - How many reservations users may own.
- **max_reservation_duration**, which defines the maximum duration for reservations.
- **reservation_permitted**, which defines the nodes that may be used for reservations.

Administrators also may configure LoadLeveler to collect accounting data about reservations when the reservations complete or are canceled.

2. Creating reservations

After LoadLeveler is configured for reservations, an administrator or authorized user may create specific reservations, defining reservation attributes that include:

- The start time and the duration of the reservation. The start and end times for a reservation are based on the time-of-day (TOD) clock on the central manager machine.
- The nodes to be reserved. Until the reservation period actually begins, the selected nodes are available to run any jobs; when the reservation starts, only jobs bound to the reservation may run on the reserved nodes.
- The users or groups that may use the reservation.

LoadLeveler assigns a unique ID to the reservation, and returns that ID to the owner.

Overview of reservations

After the reservation is successfully created:

- Reservation owners may:
 - Modify, query, and cancel their reservations.
 - Allow other LoadLeveler users or groups to submit jobs to run during a reservation period.
 - Submit jobs to run during a reservation period.
- Users or groups that are allowed to use the reservation also may query reservations, and submit jobs to run during a reservation period. To run jobs during a reservation period, users must bind job steps to the reservation. You may bind both batch and interactive POE job steps to a reservation.

3. Preparing for the start of a reservation

During the preparation time for a reservation, LoadLeveler:

- Preempts any jobs that are still running on the reserved nodes.
- Checks the condition of reserved nodes, and notifies the reservation owner and LoadLeveler administrators by e-mail of any situations that might require the reservation owner or an administrator to take corrective action. Such conditions include:
 - Reserved nodes that are down, suspended, no longer in the LoadLeveler cluster, or otherwise unavailable for use.
 - Non-preemptable job steps that cannot finish running before the reservation start time.

During this time, reservation owners may modify, cancel, and add users or groups to their reservations. Owners and users or groups that are allowed to use the reservation may query the reservation or bind job steps to it.

4. Starting the reservation

When the reservation period begins, LoadLeveler dispatches job steps that are bound to the reservation.

After the reservation period begins, reservation owners may modify, cancel, and add users or groups to their reservations. Owners and users or groups that are allowed to use the reservation may query the reservation or bind job steps to it.

During the reservation period, LoadLeveler ignores system preemption rules for bound job steps; however, LoadLeveler administrators may use the **llpreempt** command to manually preempt bound job steps.

When the reservation ends or is canceled:

- LoadLeveler unbinds all job steps from the reservation. At this point, the unbound job steps compete with all other LoadLeveler jobs for available resources.
- If accounting data is being collected for the reservation, LoadLeveler also updates the reservation history file.

For more detailed information and instructions for setting up and using reservations, see:

- “Configuring LoadLeveler to support reservations” on page 120.
- “Working with reservations” on page 184.

Chapter 2. What operating systems are supported by LoadLeveler?

LoadLeveler supports three operating systems:

- **AIX 5L**

IBM's AIX 5L is an open UNIX operating environment that conforms to The Open Group UNIX 98 Base Brand industry standard. It provides high levels of integration, flexibility, and reliability and operates on IBM @server pSeries®, IBM @server Cluster 1600, and IBM RS/6000 servers and workstations.

AIX 5L supports the concurrent operation of 32- and 64-bit applications, with key internet technologies such as Java and XML parser for Java included as part of the base operating system.

A strong affinity between AIX and Linux permits popular applications developed on Linux to run on AIX 5L with a simple recompilation.

- **Linux**

LoadLeveler supports the following distributions of Linux:

- Red Hat® Enterprise Linux (RHEL) 3 and RHEL 4 on IA-32 xSeries servers
- RHEL 3 and RHEL 4 for an IBM @server with AMD Opteron processors or Intel EM64T processors
- RHEL 4 on IBM POWER™ servers
- SUSE LINUX Enterprise Server (SLES) 9 on IA-32 xSeries servers
- SLES 9 on IBM POWER servers
- SLES 9 for an IBM @server with AMD Opteron processors or Intel EM64T processors

- **IBM @server Blue Gene® Solution**

While no LoadLeveler processes actually run on the Blue Gene machine, LoadLeveler can interact with the Blue Gene machine and supports the scheduling of jobs to the machine.

AIX and Linux compatibility

LoadLeveler 3.3.1 for Linux is compatible with LoadLeveler 3.3.1 for AIX. Its command line interfaces, graphical user interfaces, and application programming interfaces (APIs) are the same as they have been for AIX. The formats of the job command file, configuration file, and administration file also remain the same.

System administrators can set up and maintain a LoadLeveler cluster consisting of some machines running LoadLeveler for AIX and some machines running LoadLeveler for Linux. This is called a mixed cluster. In this mixed cluster jobs can be submitted from either AIX or Linux machines. Jobs submitted to a Linux job queue can be dispatched to an AIX machine for execution, and jobs submitted to an AIX job queue can be dispatched to a Linux machine for execution.

Although the LoadLeveler products for AIX and Linux are compatible, they do have some differences in the level of support for specific features. For further details, see the following topics:

- “Restrictions for LoadLeveler for Linux” on page 26.
- “Features not supported in Linux” on page 26.
- “Restrictions for LoadLeveler AIX and Linux mixed clusters” on page 28.

Restrictions for LoadLeveler for Linux

LoadLeveler for Linux supports a subset of the features that are available in the LoadLeveler for AIX product. The following features are available, but are subject to restrictions:

- 32-bit applications using the LoadLeveler APIs

LoadLeveler for Linux supports only the 32-bit LoadLeveler API library (libllapi.so) on the following platforms:

- RHEL 3 and RHEL 4 on IBM IA-32 xSeries servers
- SLES 9 on IBM IA-32 xSeries servers

Applications linked to the LoadLeveler APIs on these platforms must be 32-bit applications.

- 64-bit applications using the LoadLeveler APIs

LoadLeveler for Linux supports only the 64-bit LoadLeveler API library (libllapi.so) on the following platforms:

- RHEL 3 and RHEL 4 on IBM xSeries servers with AMD Opteron or Intel EM64T processors
- RHEL 4 on POWER servers
- SLES 9 on IBM xSeries servers with AMD Opteron or Intel EM64T processors
- SLES 9 on POWER servers

Applications linked to the LoadLeveler APIs on these platforms must be 64-bit applications.

- Support for AFS file systems

LoadLeveler for Linux support for authenticated access to AFS file systems is limited to RHEL 3 on xSeries servers and IBM xSeries servers with AMD Opteron or Intel EM64T processors. It is not available on systems running SLES 9 or RHEL 4.

- Support for preempting jobs under the backfill scheduler

LoadLeveler for Linux support for backfill preemption is limited. In LoadLeveler for AIX, you may use several methods for preempting jobs under the backfill scheduler; LoadLeveler for Linux supports all of these methods except for one: suspend. If you request preemption through the suspend method on LoadLeveler for Linux, preemption will not occur.

Features not supported in Linux

LoadLeveler 3.3.1 for Linux supports a subset of the features that are available in the LoadLeveler 3.3.1 for AIX product. The following features are not supported:

- MCM scheduling affinity
MCM scheduling affinity is not supported by LoadLeveler for Linux.
- RDMA consumable resource
RDMA consumable resources are not supported by LoadLeveler for Linux.
- User context RDMA blocks
User context RDMA blocks are not supported by LoadLeveler for Linux.
- Checkpoint/restart
LoadLeveler for AIX uses a number of features that are specific to the AIX kernel to provide support for checkpoint/restart of user applications running under LoadLeveler. Checkpoint/restart is not available in this release of LoadLeveler for Linux.
- Process tracking

On AIX, the process tracking feature is implemented as a kernel extension. Using this feature, LoadLeveler for AIX is able to ensure that when a job managed by LoadLeveler has terminated no processes or threads associated with this job are left behind and continue to consume or hold resources. Process tracking is not supported in this release of LoadLeveler for Linux.

- Gang scheduler

Gang scheduling is not supported by LoadLeveler for Linux.

- AIX Workload management (WLM)

WLM can strictly control use of system resources. LoadLeveler for AIX uses WLM to enforce the use of a number of consumable resources defined by LoadLeveler (such as **ConsumableCpus** and **ConsumableMemory**). This enforcement of consumable resources usage through WLM is not available in this release of LoadLeveler for Linux.

- CtSec and DCE security

LoadLeveler for AIX can exploit CtSec (Cluster Security Services) or DCE (Distributed Computing Environment) security functions. These functions authenticate the identity of users and programs interacting with LoadLeveler. These features are not available in this release of LoadLeveler for Linux.

- Parallel environment (PE) and Parallel operating environment (POE)

The Parallel Environment for AIX product supports the execution and management of parallel applications. Its major components are:

1. The Parallel Operating Environment (POE) package for submitting and managing jobs
2. A message passing library (MPI) for communication among the tasks that make up a parallel program
3. Parallel Environment (PE) utilities

Support for PE and POE is not be available in this release of LoadLeveler for Linux.

- Network queuing system (NQS)

LoadLeveler for AIX is compatible with Cosmic Network Queuing System (NQS) version 2.0 and NQS systems that have similar interfaces. NQS scripts can be submitted to LoadLeveler for execution. Alternatively, LoadLeveler for can be used to route NQS jobs to an NQS cluster that is external to the LoadLeveler cluster. NQS is not supported by this release of LoadLeveler for Linux.

- **LoadL_GSmonitor** daemon

The **LoadL_GSmonitor** daemon in the LoadLeveler for AIX product uses the Group Services Application Programming Interface (GSAPI) to monitor machine availability and notify the LoadLeveler Central Manager when a machine is no longer reachable. This daemon is not available in the LoadLeveler for Linux product.

- Task guide tool

- Dynamic adapter setup

LoadLeveler for AIX can be configured to dynamically determine adapter characteristics, including those associated with the Switch Network Interface for the IBM @server pSeries High Performance Switch. This feature is not supported by LoadLeveler for Linux.

- System error log

Each LoadLeveler daemon has its own log file where information relevant to its operation is recorded. In addition to this feature which exists on all platforms,

Supported operating systems

LoadLeveler for AIX also uses the `errlog` function to record critical LoadLeveler events into the AIX system log. Support for an equivalent Linux function is not available in this release.

Restrictions for LoadLeveler AIX and Linux mixed clusters

When operating a LoadLeveler cluster that contains AIX 5L and Linux machines, the following restrictions apply:

- Nodes running LoadLeveler for AIX 3.3 must be at 3.3.0.1 or later.
- All nodes in a mixed LoadLeveler cluster must run LoadLeveler version 3.2 or later.
- The Central Manager node must run a version of LoadLeveler equal to or higher than any LoadLeveler version being run on a node in the cluster.
- DCE or CtSec security features cannot be used.
- NQS cannot be used.
- GANG scheduling cannot be used.
- AIX jobs that use checkpointing must be sent to AIX nodes for execution. This can be done by either defining and specifying job checkpointing for job classes that exist only on AIX nodes or by coding appropriate requirements expressions. Checkpointing jobs that are sent to a Linux node will be rejected by the **LoadL_startd** daemon running on the Linux node.
- POE jobs must be sent to AIX nodes only.
- WLM and Process tracking are supported in a mixed cluster. However, enforcement of the use of consumable resources will occur through WLM on AIX nodes only. Similarly, the functions associated with Process Tracking are effective only on AIX nodes.
- For the backfill scheduler, LoadLeveler for Linux does not support preempting jobs through the suspend method. In a mixed cluster, if you request preemption through the suspend method, the specified jobs running under AIX will be preempted, but those jobs running on Linux nodes will not be preempted.

Part 2. Configuring and managing the LoadLeveler environment

After installing LoadLeveler, you may customize it by modifying both the **configuration** file and the **administration** file. The configuration file contains many parameters that you can set or modify that will control how LoadLeveler operates. The administration file optionally lists and defines the machines in the LoadLeveler cluster and the characteristics of classes, users, and groups.

To easily manage LoadLeveler, you should have one global configuration file and only one administration file, both centrally located on a machine in the LoadLeveler cluster. Every other machine in the cluster must be able to read the configuration and administration file that are located on the central machine.

You may have multiple local configuration files that specify information specific to individual machines.

LoadLeveler does not prevent you from having multiple copies of administration files, but you need to be sure to update all the copies whenever you make a change to one. Having only one administration file prevents any confusion.

Table 6 identifies where you can find more information about using configuration and administration files to modify the LoadLeveler environment.

Table 6. Roadmap of tasks for LoadLeveler administrators

To learn about:	Read the following:
Controlling how LoadLeveler operates by customizing the global or local configuration file	Chapter 3, "Configuring the LoadLeveler environment," on page 31
Controlling LoadLeveler resources by customizing an administration file	Chapter 4, "Defining LoadLeveler resources to administer," on page 77
Additional ways to modify LoadLeveler that require customization of both the configuration and administration files	Chapter 5, "Performing additional administrator tasks," on page 93
Ways to control or monitor LoadLeveler operations by using the LoadLeveler commands, GUI, and APIs	<ul style="list-style-type: none">• Chapter 15, "Commands," on page 371• Chapter 6, "Using LoadLeveler's GUI to perform administrator tasks," on page 147• Chapter 16, "Application programming interfaces (APIs)," on page 481

Chapter 3. Configuring the LoadLeveler environment

One of your main tasks as system administrator is to configure LoadLeveler. To configure LoadLeveler, you need to know what the configuration information is and where it is located. Configuration information includes the following:

- The LoadLeveler user ID and group ID
- The configuration directory
- The global configuration file

Configuring LoadLeveler involves modifying the configuration files that specify the terms under which LoadLeveler can use machines. There are two types of configuration files:

- *Global Configuration File:* This file by default is called the **LoadL_config** file and it contains configuration information common to all nodes in the LoadLeveler cluster.
- *Local Configuration File:* This file is generally called **LoadL_config.local** (although it is possible for you to rename it). This file contains specific configuration information for an individual node. The **LoadL_config.local** file is in the same format as **LoadL_config** and the information in this file overrides any information specified in **LoadL_config**. It is an optional file that you use to modify information on a local machine. Its full pathname is specified in the **LoadL_config** file by using the **LOCAL_CONFIG** keyword. See “Specifying file and directory locations” on page 38 for more information.

You can run your installation with default values set by LoadLeveler, or you can change any or all of them. Table 7 lists topics that discuss how you may configure the LoadLeveler environment by modifying the configuration file.

Table 7. Roadmap of administrator tasks related to using or modifying the LoadLeveler configuration file

To learn about:	Read the following:
Using the default configuration files shipped with LoadLeveler	“Getting a quick start using the default configuration” on page 32
Modifying the global and local configuration files	“Modifying a configuration file” on page 33
Defining major elements of the LoadLeveler configuration	<ul style="list-style-type: none">• “Defining LoadLeveler administrators” on page 34• “Defining a LoadLeveler cluster” on page 35• “Defining LoadLeveler machine characteristics” on page 44• “Defining security mechanisms” on page 46• “Defining usage policies for consumable resources” on page 56• Defining a LoadLeveler multicluster

|

Table 7. Roadmap of administrator tasks related to using or modifying the LoadLeveler configuration file (continued)

To learn about:	Read the following:
Enabling optional LoadLeveler functions	<ul style="list-style-type: none">• “Enabling support for bulk data transfer and rCxt blocks” on page 56• “Gathering job accounting data” on page 57• “Managing job status through control expressions” on page 63• “Tracking job processes” on page 64• “Querying multiple LoadLeveler clusters” on page 65
Modifying LoadLeveler operations through installation exits	“Providing additional job-processing controls through installation exits” on page 66

Getting a quick start using the default configuration

If you are very familiar with UNIX system administration and job scheduling, follow the steps listed in this section to get LoadLeveler up and running on your network quickly in a default configuration. This default configuration will merely enable you to submit serial jobs; for a more complex setup, you will have to consult the rest of this manual. This section also does not address how to configure DCE or Cluster Security Services. For more information about configuring security services for LoadLeveler, see “Defining security mechanisms” on page 46. For this set up, it is recommended that you use **loadl** as the LoadLeveler user ID. Afterward, you can fine tune your configuration for greater efficiency when you become more familiar with the details of LoadLeveler.

LoadLeveler sets up the following default values for the configuration information:

- **loadl** is the LoadLeveler user ID and the LoadLeveler group ID. LoadLeveler daemons run under this user ID to perform file I/O, and many LoadLeveler files are owned by this user ID.
- The home directory of **loadl** is the configuration directory.
- **LoadL_config** is the name of the configuration file.

For information about configuration file keyword syntax and other details, see Chapter 11, “Configuration file reference,” on page 231.

Perform the following steps to use the default configuration files:

1. Ensure that the installation procedure has completed successfully and that the configuration file, **LoadL_config**, exists in LoadLeveler’s home directory or in the directory specified in **/etc/LoadL.cfg** (if this file exists).
2. Identify yourself as the LoadLeveler administrator in the **LoadL_config** file using the **LOADL_ADMIN** keyword. The syntax of this keyword is:

LOADL_ADMIN = list of user names (required)

Where *list of user names* is a blank-delimited list of those individuals who will have administrative authority.

Refer to “Defining LoadLeveler administrators” on page 34 for more information.

3. Define a machine to act as the LoadLeveler central manager by coding one machine stanza as follows in the administration file, which is called **LoadL_admin**. (Replace *machinename* with the actual name of the machine.)

```
machinename: type = machine
```

```
central_manager = true
```

Do not specify more than one machine as the central manager. Also, if during installation, you ran **llinit** with the **-cm** flag, the central manager is already defined in the **LoadL_admin** file because the **llinit** command takes parameters you entered and updates the administration and configuration files. See “Defining machines” on page 78 for more information.

4. Issue the following command for each machine to be included in the LoadLeveler cluster. (Replace *hostname* with the actual name of the machine.)

```
llctl -h hostname start
```

Issue this command for the central manager machine first. See “llctl - Control LoadLeveler daemons” on page 393 for more information.

You can also issue the following command to start LoadLeveler on all machines, except submit-only machines, listed in the administration file. The central manager machine is the first started, followed by other machines in the order listed in the administration file.

```
llctl -g start
```

llctl uses **rsh** or **remsh** to start LoadLeveler on the target machine. Therefore, the administrator using **llctl** must have rsh authority on the target machine. LoadLeveler will fail to start if any value has been set for the **MALLOCTYPE** environment variable.

Modifying a configuration file

By taking a look at the configuration files that come with LoadLeveler, you will find that there are many parameters that you can set. In most cases, you will only have to modify a few of these parameters. In some cases, though, depending upon the LoadLeveler nodes, network connection, and hardware availability, you may need to modify additional parameters.

All LoadLeveler commands, daemons, and processes read the administration and configuration files at start up time. If you change the administration or configuration files after LoadLeveler has already started, any LoadLeveler command or process, such as the **LoadL_starter** process, will read the newer version of the files while the running daemons will continue to use the data from the older version. To ensure that all LoadLeveler commands, daemons, and processes use the same configuration data, run the reconfiguration command on all machines in the cluster each time the administration or configuration files are changed.

To override the defaults, you must update the following keywords in the **/etc/LoadL.cfg** file:

LoadLUserid

Specifies the LoadLeveler user ID.

LoadLGroupid

Specifies the LoadLeveler group ID.

LoadLConfig

Specifies the full path name of the configuration file.

Note that if you change the LoadLeveler user ID to something other than **loadl**, you will have to make sure your configuration files are owned by this ID.

Customizing the configuration file

If Cluster Security (CtSec) services is enabled, make sure you update the **unix.map** file if the **LoadLUserid** is specified as something other than **loadl**. Refer to “Steps for enabling CtSec services” on page 53 for more details.

You can also override the **/etc/LoadL.cfg** file. For an example of when you might want to do this, see “Querying multiple LoadLeveler clusters” on page 65.

Before you modify a configuration file, you need to:

- Ensure that the installation procedure has completed successfully and that the configuration file, **LoadL_config**, exists in LoadLeveler’s home directory or in the directory specified in **/etc/LoadL.cfg**. For additional details about installation, see *LoadLeveler Installation Guide*.
- Know how to correctly specify keywords in the configuration file. For information about configuration file keyword syntax and other details, see Chapter 11, “Configuration file reference,” on page 231.
- Identify yourself as the LoadLeveler administrator using the **LOADL_ADMIN** keyword.

After you finish modifying the configuration file, notify LoadLeveler daemons by issuing the **llctl** command with either the **reconfig** or **recycle** keyword. Otherwise, LoadLeveler will not process the modifications you made to the configuration file.

Defining LoadLeveler administrators

Specify the **LOADL_ADMIN** keyword with a list of user names of those individuals who will have administrative authority. These users are able to invoke the administrator-only commands such as **llctl**, **llfavorjob**, and **llfavoruser**. These administrators can also invoke the administrator-only GUI functions. For more information, see Chapter 6, “Using LoadLeveler’s GUI to perform administrator tasks,” on page 147.

LoadLeveler administrators on this list also receive mail describing problems that are encountered by the master daemon. When DCE or CtSec are enabled, the **LOADL_ADMIN** list is used only as a mailing list. For more information, see “Defining security mechanisms” on page 46.

An administrator on a machine is granted administrative privileges on that machine. It does not grant him administrative privileges on other machines. To be an administrator on all machines in the LoadLeveler cluster, either specify your user ID in the global configuration file with no entries in the local configuration file, or specify your user ID in every local configuration file that exists in the LoadLeveler cluster.

For information about configuration file keyword syntax and other details, see Chapter 11, “Configuration file reference,” on page 231.

Defining a LoadLeveler cluster

Table 8 lists the topics that discuss how you may define the characteristics of the LoadLeveler cluster.

Table 8. Roadmap for defining LoadLeveler cluster characteristics

To learn about:	Read the following:
Defining characteristics of specific LoadLeveler daemons	<ul style="list-style-type: none"> • “Choosing a scheduler” • “Setting negotiator characteristics and policies” on page 36 • “Specifying alternate central managers” on page 37
Defining other cluster characteristics	<ul style="list-style-type: none"> • “Defining network characteristics” on page 38 • “Specifying file and directory locations” on page 38 • “Configuring recording activity and log files” on page 40 • “Setting up file system monitoring” on page 44
Correctly specifying configuration file keywords	Chapter 11, “Configuration file reference,” on page 231
Working with daemons and machines in a LoadLeveler cluster	<ul style="list-style-type: none"> • “llctl - Control LoadLeveler daemons” on page 393 • “llinit - Initialize machines in the LoadLeveler cluster” on page 414

Choosing a scheduler

This section discusses the types of schedulers available, which you may specify using the configuration file keyword **SCHEDULER_TYPE**. For information about configuration file keyword syntax and other details, see Chapter 11, “Configuration file reference,” on page 231.

LL_DEFAULT This scheduler runs both serial and parallel jobs, but is primarily meant for serial jobs. It efficiently uses CPU time by scheduling jobs on what otherwise would be idle nodes (and workstations). It does not require that users set a wall clock limit. Also, this scheduler starts, suspends, and resumes jobs based on workload. The default scheduler uses a reservation method to schedule parallel jobs. A possible drawback to the reservation method occurs when LoadLeveler tries to schedule a job requiring a large number of nodes. As LoadLeveler reserves nodes for the job, the reserved nodes will be idle for a period of time. Also, if the job cannot accumulate all the nodes it needs to run, the job may not get dispatched.

See “Scheduler support for parallel jobs” on page 168 for information on which keywords associated with parallel jobs are supported by the default scheduler.

BACKFILL This scheduler runs both serial and parallel jobs, but is primarily meant for parallel jobs. The objective of backfill scheduling is to maximize the use of resources to achieve the highest system efficiency, while preventing potentially excessive delays in starting jobs with large resource requirements. These large jobs can run because the backfill scheduler does not allow jobs with smaller resource requirements to continuously use up resource before the larger jobs can accumulate enough resource to run.

The backfill scheduler supports:

- The scheduling of multiple tasks per node.
- The scheduling of multiple user space tasks per adapter.
- The preemption of jobs.
- The use of reservations.

The above functions are not supported by the default LoadLeveler scheduler.

For more information about the backfill scheduler, see “Using the backfill scheduler” on page 98.

GANG

For more information on setting up Gang scheduling, see “Using the gang scheduler” on page 100.

API

This keyword option allows you to enable an external scheduler, such as the Extensible Argonne Scheduling sYstem (EASY). The API option is intended for installations that want to create a scheduling algorithm for parallel jobs based on site-specific requirements.

For more information about external schedulers, see “Using an external scheduler” on page 104.

Setting negotiator characteristics and policies

You may set the following negotiator characteristics and policies. For information about configuration file keyword syntax and other details, see Chapter 11, “Configuration file reference,” on page 231.

- Prioritize the queue maintained by the negotiator

Each job step submitted to LoadLeveler is assigned a system priority number, based on the evaluation of the **SYSPRIO** keyword expression in the configuration file of the central manager. The LoadLeveler system priority number is assigned when the central manager adds the new job step to the queue of job steps eligible for dispatch. Once assigned, the system priority number for a job step is not changed, except under the following circumstances:

- An administrator or user issues the **llprio** command to change the system priority of the job step.
- The value set for the **NEGOTIATOR_RECALCULATE_SYSPRIO_INTERVAL** keyword is not zero.
- An administrator uses the **llmodify** command with the **-s** option to alter the system priority of a job step.
- A program with administrator credentials uses the **ll_modify** subroutine to alter the system priority of a job step.

Job steps assigned higher **SYSPRIO** numbers are considered for dispatch before job steps with lower numbers.

For related information, see the following topics:

- “Controlling the central manager scheduling cycle” on page 66.
- “Setting and changing the priority of a job” on page 201.
- “llmodify - Change attributes of a submitted job step” on page 419.
- “ll_modify subroutine” on page 569.

- Prioritize the order of executing machines maintained by the negotiator

Each executing machine is assigned a machine priority number, based on the evaluation of the **MACHPRIO** keyword expression in the configuration file of the central manager. The LoadLeveler machine priority number is updated every

time the central manager updates its machine data. Machines assigned higher **MACHPRIO** numbers are considered to run jobs before machines with lower numbers. For example, a machine with a **MACHPRIO** of 10 is considered to run a job before a machine with a **MACHPRIO** of 5. Similarly, a machine with a **MACHPRIO** of -2 would be considered to run a job before a machine with a **MACHPRIO** of -3.

Note that the **MACHPRIO** keyword is valid only on the machine where the central manager is running. Using this keyword in a local configuration file has no effect.

When you use a **MACHPRIO** expression that is based on load average, the machine may be temporarily ordered later in the list immediately after a job is scheduled to that machine. This temporary drop in priority happens because the negotiator adds a compensating factor to the startd machine's load average every time the negotiator assigns a job. For more information, see "the **NEGOTIATOR_LOADAVG_INCREMENT** keyword" on page 258.

- Specify additional negotiator policies

This section lists keywords that were not mentioned in the previous configuration steps. Unless your installation has special requirements for any of these keywords, you can use them with their default settings.

- **NEGOTIATOR_INTERVAL**
- **NEGOTIATOR_CYCLE_DELAY**
- **NEGOTIATOR_CYCLE_TIME_LIMIT**
- **NEGOTIATOR_LOADAVG_INCREMENT**
- **NEGOTIATOR_PARALLEL_DEFER**
- **NEGOTIATOR_PARALLEL_HOLD**
- **NEGOTIATOR_RECALCULATE_SYSPRIO_INTERVAL**
- **NEGOTIATOR_REJECT_DEFER**
- **NEGOTIATOR_REMOVE_COMPLETED**
- **NEGOTIATOR_RESCAN_QUEUE**

Specifying alternate central managers

In one of your machine stanzas specified in the administration file, you specified that the machine would serve as the central manager. It is possible for some problem to cause this central manager to become unusable such as network communication or software or hardware failures. In such cases, the other machines in the LoadLeveler cluster believe that the central manager machine is no longer operating. To remedy this situation, you can assign one or more alternate central managers in the machine stanza to take control.

The following machine stanza example defines the machine `deep_blue` as an alternate central manager:

```
#
deep_blue:  type=machine
central_manager = alt
```

If the primary central manager fails, the alternate central manager then becomes the central manager. The alternate central manager is chosen based upon the order in which its respective machine stanza appears in the administration file.

When an alternate becomes the central manager, jobs will not be lost, but it may take a few minutes for all of the machines in the cluster to check in with the new central manager. As a result, job status queries may be incorrect for a short time.

When you define alternate central managers, you should set the following keywords in the configuration file:

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- **CENTRAL_MANAGER_HEARTBEAT_INTERVAL**
- **CENTRAL_MANAGER_TIMEOUT**

In the following example, the alternate central manager will wait for 30 intervals, where each interval is 45 seconds:

```
# Set a 45 second interval
CENTRAL_MANAGER_HEARTBEAT_INTERVAL = 45
# Set the number of intervals to wait
CENTRAL_MANAGER_TIMEOUT = 30
```

For more information on central manager backup, refer to “What happens if the central manager isn’t operating?” on page 591. For information about configuration file keyword syntax and other details, see Chapter 11, “Configuration file reference,” on page 231.

Defining network characteristics

A **port number** is an integer that specifies the port number to use to connect to the specified daemon. You can define these port numbers in the configuration file or the `/etc/services` file or you can accept the defaults. LoadLeveler first looks in the configuration file for these port numbers. If the port number is in the configuration file and is valid, this value is used. If it is an invalid value, the default value is used.

If LoadLeveler does not find the value in the configuration file, it looks in the `/etc/services` file. If the value is not found in this file, the default is used.

The configuration file keywords associated with port numbers are the following:

- **CLIENT_TIMEOUT**
- **CM_COLLECTOR_PORT**
- **MASTER_DGRAM_PORT**
- **MASTER_STREAM_PORT**
- **NEGOTIATOR_STREAM_PORT**
- **SCHEDD_STATUS_PORT**
- **SCHEDD_STREAM_PORT**
- **STARTD_STREAM_PORT**

The first field on each line in the example that follows represents the name of a “service”. In most cases, these services are also the names of daemons because few daemons need more than one udp and one tcp connection. There are two exceptions: LoadL_negotiator_collector is the service name for a second stream port that is used by the LoadL_negotiator daemon; LoadL_schedd_status is the service name for a second stream port used by the LoadL_schedd daemon.

LoadL_master	9616/tcp	# Master port number for stream port
LoadL_negotiator	9614/tcp	# Negotiator port number
LoadL_negotiator_collector	9612/tcp	# Second negotiator stream port
LoadL_schedd	9605/tcp	# Schedd port number for stream port
LoadL_schedd_status	9606/tcp	# Schedd stream port for job status data
LoadL_startd	9611/tcp	# Startd port number for stream port
LoadL_master	9617/udp	# Master port number for dgram port
LoadL_startd	9615/udp	# Startd port number for dgram port

For information about configuration file keyword syntax and other details, see Chapter 11, “Configuration file reference,” on page 231.

Specifying file and directory locations

The configuration file provided with LoadLeveler specifies default locations for all of the files and directories. You can modify their locations using the following

keywords. Keep in mind that the LoadLeveler installation process installs files in these directories and these files may be periodically cleaned up. Therefore, you should not keep any files that do not belong to LoadLeveler in these directories.

Managing distributed software systems is a primary concern for all system administrators. Allowing users to share file systems to obtain a single, network-wide image, is one way to make managing LoadLeveler easier.

To specify the location of the:	Specify this keyword:
Administration file	ADMIN_FILE
Local configuration file	LOCAL_CONFIG
Local directory	<p>The following subdirectories reside in the local directory. It is possible that the local directory and LoadLeveler's home directory are the same.</p> <ul style="list-style-type: none"> • COMM • EXECUTE • LOG • SPOOL and HISTORY <p>Tip: To maximize performance, you should keep the log, spool, and execute directories in a local file system. Also, to measure the performance of your network, consider using one of the available products, such as Toolbox/6000.</p>
Release directory	<p>RELEASEDIR</p> <p>The following subdirectories are created during installation and they reside in the release directory. You can change their locations.</p> <ul style="list-style-type: none"> • BIN • LIB
NQS directory	<p>NQS_DIR</p> <p>NQS is not supported by LoadLeveler for Linux.</p>

Customizing the configuration file

To specify the location of the:	Specify this keyword:
Core dump directory	<p>You may specify alternate directories to hold core dumps for the daemons and starter process:</p> <ul style="list-style-type: none">• MASTER_COREDUMP_DIR• NEGOTIATOR_COREDUMP_DIR• SCHEDD_COREDUMP_DIR• STARTD_COREDUMP_DIR• GSMONITOR_COREDUMP_DIR• KBDD_COREDUMP_DIR• STARTER_COREDUMP_DIR <p>When specifying core dump directories, be sure that the access permissions are set so the LoadLeveler daemon or process can write to the core dump directory. The permissions set for path names specified in the keywords mentioned above must allow writing by both root and the LoadLeveler ID. The permissions set for the path name specified for the STARTER_COREDUMP_DIR keyword must allow writing by root, the LoadLeveler ID, and any user who can submit LoadLeveler jobs.</p> <p>The simplest way to be sure the access permissions are set correctly is to set them the same as are set for the /tmp directory.</p> <p>If a problem with access permissions prevents a LoadLeveler daemon or process from writing to a core dump directory, then a message will be written to the log, and the daemon or process will continue using the default /tmp directory for core files.</p>

For information about configuration file keyword syntax and other details, see Chapter 11, “Configuration file reference,” on page 231.

Configuring recording activity and log files

The LoadLeveler daemons and processes keep log files according to the specifications in the configuration file. A number of keywords are used to describe where LoadLeveler maintains the logs and how much information is recorded in each log. These keywords, shown in Table 9, are repeated in similar form to specify the pathname of the log file, its maximum length, and the debug flags to be used.

“Controlling debugging output” on page 41 describes the events that can be reported through logging controls.

“Saving log files” on page 43 describes the configuration keyword to use to save logs for problem diagnosis.

For information about configuration file keyword syntax and other details, see Chapter 11, “Configuration file reference,” on page 231.

Table 9. Log control statements

Daemon/ Process	Log File <i>(required)</i> (See note 1)	Max Length <i>(required)</i> (See note 2)	Debug Control <i>(required)</i> (See note 4)
Master	MASTER_LOG = <i>path</i>	MAX_MASTER_LOG = <i>bytes</i>	MASTER_DEBUG = <i>flags</i>
Schedd	SCHEDD_LOG = <i>path</i>	MAX_SCHEDD_LOG = <i>bytes</i>	SCHEDD_DEBUG = <i>flags</i>
Startd	STARTD_LOG = <i>path</i>	MAX_STARTD_LOG = <i>bytes</i>	STARTD_DEBUG = <i>flags</i>

Table 9. Log control statements (continued)

Daemon/ Process	Log File <i>(required)</i> (See note 1)	Max Length <i>(required)</i> (See note 2)	Debug Control <i>(required)</i> (See note 4)
Starter	STARTER_LOG = <i>path</i>	MAX_STARTER_LOG = <i>bytes</i>	STARTER_DEBUG = <i>flags</i>
Negotiator	NEGOTIATOR_LOG = <i>path</i>	MAX_NEGOTIATOR_LOG = <i>bytes</i>	NEGOTIATOR_DEBUG = <i>flags</i>
Kbdd	KBDD_LOG = <i>path</i>	MAX_KBDD_LOG = <i>bytes</i>	KBDD_DEBUG = <i>flags</i>
GSmonitor	GSMONITOR_LOG = <i>path</i>	MAX_GSMONITOR_LOG = <i>bytes</i>	GSMONITOR_DEBUG = <i>flags</i>

Notes:

1. When coding the *path* for the log files, it is not necessary that all LoadLeveler daemons keep their log files in the same directory, however, you will probably find it a convenient arrangement.
2. There is a maximum length, in bytes, beyond which the various log files cannot grow. Each file is allowed to grow to the specified length and is then saved to an **.old** file. The **.old** files are overwritten each time the log is saved, thus the maximum space devoted to logging for any one program will be twice the maximum length of its log file. The default length is 64KB. To obtain records over a longer period of time, that don't get overwritten, you can use the SAVELOGS keyword in the local or global configuration files. See "Saving log files" on page 43 for more information on extended capturing of LoadLeveler logs.

You can also specify that the log file be started anew with every invocation of the daemon by setting the TRUNC statement to **true** as follows:

- TRUNC_MASTER_LOG_ON_OPEN = true | false
 - TRUNC_STARTD_LOG_ON_OPEN = true | false
 - TRUNC_SCHEDD_LOG_ON_OPEN = true | false
 - TRUNC_KBDD_LOG_ON_OPEN = true | false
 - TRUNC_STARTER_LOG_ON_OPEN = true | false
 - TRUNC_NEGOTIATOR_LOG_ON_OPEN = true | false
 - TRUNC_GSMONITOR_LOG_ON_OPEN = true | false
3. LoadLeveler creates temporary log files used by the **starter** daemon. These files are used for synchronization purposes. When a job starts, a **StarterLog.pid** file is created. When the job ends, this file is appended to the **StarterLog** file.
 4. Normally, only those who are installing or debugging LoadLeveler will need to use the debug flags, described in "Controlling debugging output" The default error logging, obtained by leaving the right side of the debug control statement null, will be sufficient for most installations.

Controlling debugging output

You can control the level of debugging output logged by LoadLeveler programs. The following flags are presented here for your information, though they are used primarily by IBM personnel for debugging purposes:

D_ACCOUNT

Logs accounting information about processes. If used, it may slow down the network.

D_ADAPTER

Logs messages related to adapters.

D_AFS

Logs information related to AFS credentials.

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D_CKPT

Logs information related to checkpoint and restart

D_DAEMON

Logs information regarding basic daemon set up and operation, including information on the communication between daemons.

D_DBX

Bypasses certain signal settings to permit debugging of the processes as they execute in certain critical regions.

D_DCE

Logs information related to DCE credentials and Cluster Security (CtSec) services identities. This flag is the same as the new **D_SECURITY** flag and is provided for compatibility.

D_EXPR

Logs steps in parsing and evaluating control expressions.

D_FULLDEBUG

Logs details about most actions performed by each daemon but doesn't log as much activity as setting all the flags.

D_HIERARCHICAL

Used to enable messages relating to problems related to the transmission of hierarchical messages. A hierarchical message is sent from an originating node to lower ranked receiving nodes.

D_JOB

Logs job requirements and preferences when making decisions regarding whether a particular job should run on a particular machine.

D_KERNEL

Activates diagnostics for errors involving the process tracking kernel extension.

D_LOAD

Displays the load average on the startd machine.

D_LOCKING

Logs requests to acquire and release locks.

D_MACHINE

Logs machine control functions and variables when making decisions regarding starting, suspending, resuming, and aborting remote jobs.

D_MUSTER

Logs information related to multicluster processing.

D_NEGOTIATE

Displays the process of looking for a job to run in the negotiator. It only pertains to this daemon.

D_NQS

Provides more information regarding the processing of NQS files.

D_PCRED

Directs that extra debug should be written to a file if the setpcred() function call fails.

D_PROC

Logs information about jobs being started remotely such as the number of bytes fetched and stored for each job.

D_QUEUE

Logs changes to the job queue.

D_REFCOUNT

Logs activity associated with reference counting of internal LoadLeveler objects.

D_RESERVATION

Logs reservation information in the negotiator and schedd daemon logs.

D_RESOURCE

Logs messages about the management and consumption of resources. These messages are recorded in the negotiator log.

D_SCHEDD

Displays how the schedd works internally.

D_SECURITY

Logs information related to DCE credentials and Cluster Security (CtSec) services identities. This flag replaces the **D_DCE** flag.

D_STANZAS

Displays internal information about the parsing of the administration file.

D_STARTD

Displays how the startd works internally.

D_STARTER

Displays how the starter works internally.

D_STREAM

Displays messages detailing socket I/O.

D_SWITCH

Logs entries related to switch activity and LoadLeveler Switch Table Object data.

D_THREAD

Displays the ID of the thread producing the log message. The thread ID is displayed immediately following the date and time. This flag is useful for debugging threaded daemons.

D_XDR

Logs information regarding External Data Representation (XDR) communication protocols.

For example:

```
SCHEDD_DEBUG = D_CKPT D_XDR
```

Causes the scheduler to log information about checkpointing user jobs and exchange xdr messages with other LoadLeveler daemons. These flags will primarily be of interest to LoadLeveler implementers and debuggers.

Saving log files

By default, LoadLeveler stores only the two most recent iterations of a daemon's log file (*<daemon name>Log*, and *<daemon name>Log.old*). Occasionally, for problem diagnosing, users will need to capture LoadLeveler logs over an extended period. Users can specify that all log files be saved to a particular directory by using the **SAVELOGS** keyword in a local or global configuration file. Be aware that LoadLeveler does not provide any way to manage and clean out all of those log files, so users must be sure to specify a directory in a file system with enough space to accommodate them. This file system should be separate from the one used for the LoadLeveler log, spool, and execute directories.

Each log file is represented by the name of the daemon that generated it, the exact time the file was generated, and the name of the machine on which the daemon is running. When you list the contents of the **SAVELOGS** directory, the list of log file names looks like this:

```
NegotiatorLogNov02.16:10:39.123456.c163n10.ppd.pok.ibm.com
NegotiatorLogNov02.16:10:42.987654.c163n10.ppd.pok.ibm.com
NegotiatorLogNov02.16:10:46.564123.c163n10.ppd.pok.ibm.com
NegotiatorLogNov02.16:10:48.234345.c163n10.ppd.pok.ibm.com
NegotiatorLogNov02.16:10:51.123456.c163n10.ppd.pok.ibm.com
NegotiatorLogNov02.16:10:53.566987.c163n10.ppd.pok.ibm.com
StarterLogNov02.16:09:19.622387.c163n10.ppd.pok.ibm.com
StarterLogNov02.16:09:51.499823.c163n10.ppd.pok.ibm.com
```

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```
StarterLogNov02.16:10:30.876546.c163n10.ppd.pok.ibm.com
SchedLogNov02.16:09:05.543677.c163n10.ppd.pok.ibm.com
SchedLogNov02.16:09:26.688901.c163n10.ppd.pok.ibm.com
SchedLogNov02.16:09:47.443556.c163n10.ppd.pok.ibm.com
SchedLogNov02.16:10:12.712680.c163n10.ppd.pok.ibm.com
SchedLogNov02.16:10:37.342156.c163n10.ppd.pok.ibm.com
StartLogNov02.16:09:05.697753.c163n10.ppd.pok.ibm.com
StartLogNov02.16:09:26.881234.c163n10.ppd.pok.ibm.com
StartLogNov02.16:09:47.231234.c163n10.ppd.pok.ibm.com
StartLogNov02.16:10:12.125556.c163n10.ppd.pok.ibm.com
StartLogNov02.16:10:37.961486.c163n10.ppd.pok.ibm.com
```

For information about configuration file keyword syntax and other details, see Chapter 11, “Configuration file reference,” on page 231.

Setting up file system monitoring

You can use the file system keywords to monitor the file system space or inodes used by LoadLeveler for:

- Logs
- Saving executables
- Spool information
- History files

You can also use the file system keywords to take preventive action and avoid problems caused by running out of file system space or inodes. This is done by setting the frequency that LoadLeveler checks the file system free space or inodes and by setting the upper and lower thresholds that initialize system responses to the free space or inodes available. By setting a realistic span between the lower and upper thresholds, you will avoid excessive system actions.

The file system monitoring keywords are:

- **FS_INTERVAL**
- **FS_NOTIFY**
- **FS_SUSPEND**
- **FS_TERMINATE**
- **INODE_NOTIFY**
- **INODE_SUSPEND**
- **INODE_TERMINATE**

For information about configuration file keyword syntax and other details, see Chapter 11, “Configuration file reference,” on page 231.

Defining LoadLeveler machine characteristics

You can use the following keywords to define the characteristics of machines in the LoadLeveler cluster. For information about configuration file keyword syntax and other details, see Chapter 11, “Configuration file reference,” on page 231.

- **ARCH**
- **CLASS**
- **CUSTOM_METRIC**
- **CUSTOM_METRIC_COMMAND**
- **FEATURE**
- **GSMONITOR_RUNS_HERE**
- **MAX_STARTERS**
- **SCHEDD_RUNS_HERE**
- **SCHEDD_SUBMIT_AFFINITY**
- **STARTD_RUNS_HERE**

- START_DAEMONS
- VM_IMAGE_ALGORITHM
- X_RUNS_HERE

Defining job classes that a LoadLeveler machine will accept

The following examples illustrate possible ways of defining job classes.

• Example 1

This example specifies multiple classes:

```
Class = No_Class(2)
```

or

```
Class = { "No_Class" "No_Class" }
```

The machine will only run jobs that have either defaulted to or explicitly requested class **No_Class**. A maximum of two LoadLeveler jobs are permitted to run simultaneously on the machine if the **MAX_STARTERS** keyword is not specified. See “Specifying how many jobs a machine can run” for more information on **MAX_STARTERS**.

• Example 2

This example specifies multiple classes:

```
Class = No_Class(1) Small(1) Medium(1) Large(1)
```

or

```
Class = { "No_Class" "Small" "Medium" "Large" }
```

The machine will only run a maximum of four LoadLeveler jobs that have either defaulted to, or explicitly requested **No_Class**, **Small**, **Medium**, or **Large** class. A LoadLeveler job with class **IO_bound**, for example, would not be eligible to run here.

• Example 3

This example specifies multiple classes:

```
Class = B(2) D(1)
```

or

```
Class = { "B" "B" "D" }
```

The machine will run only LoadLeveler jobs that have explicitly requested class **B** or **D**. Up to three LoadLeveler jobs may run simultaneously: two of class **B** and one of class **D**. A LoadLeveler job with class **No_Class**, for example, would not be eligible to run here.

Specifying how many jobs a machine can run

To specify how many jobs a machine can run, you need to take into consideration both the **MAX_STARTERS** keyword and the **Class** statement, which is described in more detail in “Defining LoadLeveler machine characteristics” on page 44.

For example, if the configuration file contains these statements:

```
Class = A(1) B(2) C(1)
MAX_STARTERS = 2
```

then the machine can run a maximum of two LoadLeveler jobs simultaneously. The possible combinations of LoadLeveler jobs are:

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- A and B
- A and C
- B and B
- B and C
- Only A, or only B, or only C

If this keyword is specified together with a **Class** statement, the maximum number of jobs that can be run is equal to the lower of the two numbers. For example, if:

```
MAX_STARTERS = 2
Class = class_a(1)
```

then the maximum number of job steps that can be run is one (the **Class** statement above defines one class).

If you specify **MAX_STARTERS** keyword without specifying a **Class** statement, by default one class still exists (called **No_Class**). Therefore, the maximum number of jobs that can be run when you do not specify a **Class** statement is one.

Note: If the **MAX_STARTERS** keyword is not defined in either the global configuration file or the local configuration file, the maximum number of jobs that the machine can run is equal to the number of classes in the **Class** statement.

Defining security mechanisms

LoadLeveler can be configured in one of two ways to control authentication and authorization of LoadLeveler functions:

- DCE security services, which uses DCE as the underlying security mechanism.
- Cluster Security (CtSec) services, a subcomponent of Reliable Scalable Cluster Technology (RSCT), which uses the host-based authentication (HBA) as an underlying security mechanism.

LoadLeveler permits only one security service to be configured at a time. CtSec services and DCE cannot both be configured as the security service for LoadLeveler. You can skip this section if you do not plan to use these security features or if you plan to use the DCE credential forwarding provided by the **llgetdce** and **llsetdce** program pair. Refer to “Using the alternative program pair: llgetdce and llsetdce” on page 68 for more information.

LoadLeveler for Linux does not support DCE or CtSec security.

LoadLeveler can be enabled to interact with OpenSSL for secure multicluster communications

Table 10 on page 47 lists the topics that explain LoadLeveler daemons and how you may define their characteristics and modify their behavior.

Table 10. Roadmap of configuration tasks for securing LoadLeveler operations

To learn about:	Read the following:
Securing LoadLeveler operations using DCE security services	<ul style="list-style-type: none"> • “Configuring LoadLeveler to use DCE security services” • “Steps for using SMIT and the lldcegrpmain command to configure DCE security” on page 48 • “Steps for manually configuring DCE security” on page 49 • “Usage notes” on page 52 • “Handling DCE security credentials” on page 68 • “lldcegrpmain - LoadLeveler DCE group maintenance utility” on page 398
Securing LoadLeveler operations using cluster security services	<ul style="list-style-type: none"> • “Configuring LoadLeveler to use cluster security services” on page 53 • “Steps for enabling CtSec services” on page 53 • “Limiting which security mechanisms LoadLeveler can use” on page 56
Enabling LoadLeveler to secure multicluster communication with OpenSSL	“Steps for securing communications within a LoadLeveler multicluster” on page 142
Correctly specifying configuration file keywords	Chapter 11, “Configuration file reference,” on page 231

Configuring LoadLeveler to use DCE security services

When LoadLeveler is configured to exploit DCE security, it uses PSSP and DCE security services to:

- Authenticate the identity of users and programs interacting with LoadLeveler.
- Authorize users and programs to use LoadLeveler services. It will prevent unauthorized users and programs from misusing resources or disrupting services.
- Delegate the DCE credentials of the user submitting a job to all processes making up that job.

When LoadLeveler is configured to exploit DCE security, most of its interactions with DCE are through the PSSP security services API. For this reason, it is important that you configure PSSP security services before you configure LoadLeveler for DCE. For more information on PSSP security services, please refer to: *RS/6000 SP Planning Volume 2, Control Workstation and Software Environment (GA22-7281)*, *Parallel System Support Programs for AIX Installation and Migration Guide Version 3 Release 2 (GA22-7347)*, and *Parallel System Support Programs for AIX Administration Guide Version 3 Release 2 (SA22-7348)*.

DCE maintains a registry of all DCE principals which have been authorized to login to the DCE cell. In order for LoadLeveler daemons to login to DCE, DCE accounts must be set up, and DCE key files must be created for these daemons. Each LoadLeveler daemon on each node is associated with a different DCE principal. The DCE principal of the Schedd daemon running on node A is distinct from the DCE principal of the Schedd daemon running on node B. Since it is possible for up to seven LoadLeveler daemons to run on any particular node (Master, Negotiator, Schedd, Startd, Kbdd, Starter, and GSmonitor), the number of DCE principal accounts and key files that must be created could reach as high as

7x(number of nodes). Since it is not always possible to know in advance on which node a particular daemon will run, a conservative approach would be to create accounts and key files for all seven daemons on all nodes in a given LoadLeveler cluster. However, it is only necessary to create accounts and key files for DCE principals which will actually be instantiated and run in the cluster.

These are the steps used for configuring LoadLeveler for DCE. IBM suggests that you use SMIT and the `lldcegrpmaint` command to perform this task. The manual steps are also described in “Steps for manually configuring DCE security” on page 49, and may be useful should you need to create a highly customized LoadLeveler environment. Some of the names used in this section are the default names as defined in the file `/usr/lpp/ssp/config/spsec_defaults` and can be overridden with appropriate specifications in the file `/spdata/sys1/spsec/spsec_overrides`. Also, the term “LoadLeveler node” is used to refer to a node on an SP system that will be part of a LoadLeveler cluster.

Steps for using SMIT and the `lldcegrpmaint` command to configure DCE security

Perform the following steps to use SMIT and the `lldcegrpmaint` command to configure DCE security:

1. Login to the SP control workstation as **root**, then login to DCE as **cell_admin**.
2. Start the SMIT program. From SMIT’s main menu, select the **RS/6000 SP System Management** option, then select the **RS/6000 SP Security** option in the next menu.
3. Perform the appropriate steps associated with this menu to configure the security features of this SP system. From LoadLeveler’s perspective, the important actions are:
 - **Create dcehostnames**
 - **Configure SP Trusted Services to use DCE Authentication**

Before continuing to step 4, ensure that:

- DCE hostnames for LoadLeveler nodes are defined.
 - A DCE group named **spsec-services** and a DCE organization named **spsec-services** are created.
 - The DCE principals of the LoadLeveler daemons on LoadLeveler nodes are created.
 - The DCE principals of the LoadLeveler daemons on LoadLeveler nodes are added to the **spsec-services** group and the **spsec-services** organization.
 - A DCE account is created for each DCE principal associated with the LoadLeveler daemons on the SP system.
 - A DCE key file is created for each LoadLeveler daemon on the LoadLeveler nodes.
4. If the LoadLeveler cluster consists of nodes spanning several SP systems, then you should repeat step 1 through step 3 for each SP system.
 5. PSSP security services use certain fields in the SDR (System Data Repository) to determine the current software configuration. Use the command `"splstdata -p"` to verify that the field **ts_auth_methods** is set to either **dce** or **dce:compat**. If **ts_auth_methods** is set to **dce:compat** then either DCE or non-DCE authentication is allowed. For some PSSP applications, this setting also implies that if DCE authentication is activated but, DCE authentication cannot be performed, then non-DCE authentication will be used. However, LoadLeveler can not change authentication methods dynamically, and the **dce:compat** setting

simply indicates that LoadLeveler can be brought up in either DCE or non-DCE authentication modes using the **DCE_ENABLEMENT** keyword.

6. Add these statements to the LoadLeveler global configuration file:

```
DCE_ENABLEMENT = TRUE
DCE_ADMIN_GROUP = LoadL-admin
DCE_SERVICES_GROUP = LoadL-services
```

DCE_ENABLEMENT must be set to **TRUE** to activate the DCE security features of LoadLeveler. The *LoadL-admin* group should be populated with DCE principals of users who are to be given LoadLeveler administrative privileges. For more information on populating the *LoadL-admin* group, see step 9. The *LoadL-services* group should be populated with the DCE principals of all the LoadLeveler daemons that will be running in the current cluster. You can use the **lldcegrpmain** command to automate this process. For more information on populating the *LoadL-services* group, see step 8. Note that these daemons are already members of the **spsec-services** group. If there is more than one DCE-enabled LoadLeveler cluster within the same DCE cell, then it is important that the name assigned to **DCE_SERVICES_GROUP** for each cluster be distinct; this will avoid any potential operational conflict.

7. Add DCE hostnames to the machine stanzas of the LoadLeveler administration file. The machine stanza of each node defined in the LoadLeveler administration file must contain a statement with this format:

```
dce_host_name = DCE hostname
```

Execute either "**SDRGetObjects Node dcehostname,**" or "**llexstSDR**" to obtain a listing of DCE hostnames of nodes on an SP system.

8. Execute the command:

```
lldcegrpmain config_pathname admin_pathname
```

Where *config_pathname* is the pathname of the LoadLeveler global configuration file and *admin_pathname* is the pathname of the LoadLeveler administration file. The **lldcegrpmain** command will:

- Create the *LoadL-services* and *LoadL-admin* DCE groups (if they do not already exist).
- Add the DCE principals of all the LoadLeveler daemons in the LoadLeveler cluster defined by the *admin_pathname* file to the *LoadL-services* group.

For more information about the **lldcegrpmain** command, see "lldcegrpmain - LoadLeveler DCE group maintenance utility" on page 398.

9. Add the DCE principals of users who will have LoadLeveler administrative authority for the cluster to the *LoadL-admin* group. For example, this command adds **loadl** to the **LoadL-admin** group:

```
dcecp -c group add LoadL-admin -member loadl
```

Steps for manually configuring DCE security

In this example, the LoadLeveler cluster consists of 3 nodes of an SP system which belong to the same DCE cell. Their hostnames and DCE hostnames are the same: c163n01.pok.ibm.com, c163n02.pok.ibm.com, and c163n03.pok.ibm.com. Assume that the basic PSSP security setup steps have been performed, and that the DCE group **spsec-services** and the DCE organization **spsec-services** have been created.

1. Login to any node in the DCE cell as **root** and login to DCE as **cell_admin**.
2. Create LoadLeveler's product directory if it does not already exist. First, see if the directory has already been created:

```
dcecp -c cdsli ././subsys
```

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This command lists the contents of the `./:/subsys` directory in DCE. LoadLeveler's product name within DCE is **LoadL**, so its product directory is `./:/subsys/LoadL`. If this directory already exists, then continue to the next step. If it does not exist, issue the following command to create it:

```
dcecp -c directory create ./:/subsys/LoadL
```

3. Create the DCE principal names for all of the LoadLeveler daemons in the LoadLeveler cluster. PSSP security services expect the DCE principal name of a LoadLeveler daemon to have the format:

product_name/dce_host_name/dce_daemon_name

Where:

product_name

Is the product name and should always be set to **LoadL**.

dce_host_name

Is the DCE hostname of the node on which the daemon will run.

dce_daemon_name

Is the DCE name of the daemon and is defined in the file `/usr/lpp/spp/config/spsec_defaults`. Go to the LoadLeveler section of this file. You will find a **SERVICE** record similar to this for all the seven daemons:

```
SERVICE:LoadL/Master:kw:root:system
```

The relevant portion of this record is **Master**; this is the DCE daemon name of **LoadL_master**. The DCE daemon names of other daemons can be identified in a similar manner.

For the `c163n01.pok.ibm.com` node, the following commands will create the desired principal names:

```
dcecp -c principal create LoadL/c163n01.pok.ibm.com/Master
dcecp -c principal create LoadL/c163n01.pok.ibm.com/Negotiator
dcecp -c principal create LoadL/c163n01.pok.ibm.com/Schedd
dcecp -c principal create LoadL/c163n01.pok.ibm.com/Kbdd
dcecp -c principal create LoadL/c163n01.pok.ibm.com/Startd
dcecp -c principal create LoadL/c163n01.pok.ibm.com/Starter
dcecp -c principal create LoadL/c163n01.pok.ibm.com/GSmonitor
```

These commands must then be repeated for each node in the LoadLeveler cluster, replacing the *dce_host_name* with the DCE hostname of each respective node.

4. Add the principals defined in step 3 to the PSSP security services' services group. This group is named **spsec-services**. PSSP security services require that any daemon using their APIs be members of this group. This command will add the DCE principal of the Master daemon on node `c163n01` to the **spsec-services** group.

```
dcecp -c group add spsec-services -member LoadL/c163n01.pok.ibm.com/Master
```

This operation must be repeated for all of the other LoadLeveler daemons on `c163n01`, and the complete set of operations must be repeated for all of the nodes in the LoadLeveler cluster.

5. Add the principals defined in step 3 to the **spsec-services** organization. The following command will add the DCE principal of the Master daemon on node `c163n01` to the **spsec-services** organization.
- ```
dcecp -c organization add spsec-services -member LoadL/c163n01.pok.ibm.com/Master
```

This operation must be repeated for all of the other LoadLeveler daemons on c163n01, and the complete set of operations must be repeated for all of the nodes in the LoadLeveler cluster.

6. Create a DCE account for each of the principals defined in step 3 on page 50. This series of commands will create a DCE account for the Master daemon on node c163n01:

```
dcecp <Enter>
dcecp> account create LoadL/c163n01.pok.ibm.com/Master \
 -group spsec-services -organization spsec-services \
 -password service-password -mypwd cell_admin's-password
dcecp> quit
```

The *service-password* passed to DCE in this command can be any valid DCE password. Please take note of it since you will need it when you create the key file for this daemon in step 8. The continuation character "\" is not supported by **dcecp**, but appears in the example merely for clarity. This operation must be repeated for the other LoadLeveler daemons on c163n01, and the complete set of operations must be repeated for all of the nodes in the LoadLeveler cluster.

7. Create directories to contain the key files for the principals defined in step 3 on page 50.

```
mkdir -p /spdata/sys1/keyfiles/LoadL/dce_host_name
```

You must login to the appropriate node to perform this operation. This operation must be repeated for every node in the LoadLeveler cluster.

NOTE: The directory **/spdata/sys1/keyfiles** should already exist on each node in the cluster which has been installed with a level of PSSP software that supports DCE Security exploitation. If this directory does not exist, then the node cannot support DCE Security and LoadLeveler in DCE mode will not run on it. If this configuration seems to be in error, contact your system administrator to determine which nodes in the cluster should support DCE Security.

8. Create a key file for each LoadLeveler daemon on the node on which it will run. The key file contains security-related information specific to each daemon. Use this series of commands:

```
dcecp <Enter>
dcecp> keytab create LoadL/c163n01.pok.ibm.com/Master \
 -storage /spdata/sys1/keyfiles/LoadL/c163n01.pok.ibm.com/Master \
 -data { LoadL/c163n01.pok.ibm.com/Master plain 1 service-password }
dcecp> quit
```

You must login to node c163n01 to perform this operation. DCE must be able to locate the key file locally, otherwise the daemon's login to DCE on startup will fail. The principal name passed to DCE in the preceding example is the same principal name defined in step 3 on page 50. The AIX path passed with the "-storage" flag should point to the same directory created in step 7. The principal name passed with the "-data" flag should match the principal name used at the beginning of the command. The password used in the *service-password* field must be the same as the service password defined when this principal's account was created in step 6.

This operation must be repeated for all of the other LoadLeveler daemons on node c163n01, and the complete set of operations must be repeated for all of the nodes in the LoadLeveler cluster.

9. Perform steps 5 on page 48, 6 on page 49, and 7 on page 49 of "Steps for using SMIT and the lldcegrpmaint command to configure DCE security" on page 48.

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10. Create the DCE groups *LoadL-admin*, and *LoadL-services*. This command creates the DCE group **LoadL-admin**:  

```
dcecp -c group create LoadL-admin
```
11. Add the DCE principals of users who will have LoadLeveler administrative authority for the cluster to the *LoadL-admin* group. This command adds **loadl** to the **LoadL-admin** group:  

```
dcecp -c group add LoadL-admin -member loadl
```
12. Add the principals defined in step 3 on page 50 to the *LoadL-services* group. This command will add the DCE principal of the Master daemon on node c163n01.pok.ibm.com to **LoadL-services**:  

```
dcecp -c group add LoadL-services -member LoadL/c163n01.pok.ibm.com/Master
```

This operation must be repeated for all of the other LoadLeveler daemons on node c163n01, and the complete set of operations must be repeated for all of the nodes in the LoadLeveler cluster.

### Usage notes

- If the **DCE\_ENABLEMENT** keyword is set to **TRUE**, LoadLeveler uses the PSSP security service API to perform mutual authentication of all appropriate transactions in addition to using the pair of programs specified by **DCE\_AUTHENTICATION\_PAIR** to obtain the opaque credentials object and to authenticate to DCE before starting a job. The default pair of programs used by LoadLeveler, **lldelegate** and **llimpersonate** support credentials forwarding. For more information about the **DCE\_AUTHENTICATION\_PAIR** keyword, see “Handling DCE security credentials” on page 68.

If the **DCE\_ENABLEMENT** keyword is not defined or set to **FALSE**, the limited form of DCE authentication introduced in LoadLeveler 2.1 can still be activated through the use of the **DCE\_AUTHENTICATION\_PAIR** keyword in conjunction with the **llgetdce** and **llsetdce** programs or an installation defined functionally equivalent pair of programs. If this level of DCE support meets your requirements, then you can ignore the setup steps in this section.

- When **DCE\_ENABLEMENT** is set to **TRUE**, LoadLeveler uses a different set of criteria to determine who owns job steps, and who has administrator privileges.
  - LoadLeveler considers you to be the owner of a job step if your DCE principal matches the DCE principal associated with that job step.
  - LoadLeveler administrators are usually defined to LoadLeveler through a list of names associated with the **LOADL\_ADMIN** keyword. However, when **DCE\_ENABLEMENT** is **TRUE**, this list is no longer used for this purpose. Instead, users and processes whose DCE principals are members of the *LoadL-admin* DCE group are given LoadLeveler administrative privileges.

Note: The **LOADL\_ADMIN** keyword is also used to provide LoadLeveler with a list of users who are to receive mail notification of problems encountered by the **LoadL\_master** daemon. This function is not affected by the **DCE\_ENABLEMENT** keyword.

- If **DCE\_ENABLEMENT** is set to **TRUE**, you must login to DCE with the **dce\_login** command before attempting to execute any LoadLeveler command. Also, if an AIX user's user name is different from the user's DCE principal name, then the AIX user must have a **.k5login** file in the home directory specifying which DCE principal may execute using the AIX account. For example, if your DCE principal in the cell **local\_dce\_cell** is **user1\_dce**, and your AIX user name is **user1**, then you will have to add an entry such as "user1\_dce@local\_dce\_cell" to the **.k5login** file in your home directory.

## Configuring LoadLeveler to use cluster security services

Cluster security (CtSec) services allows a software component to authenticate and authorize the identity of one of its peers or clients.

When configured to use CtSec services, LoadLeveler will:

- Authenticate the identity of users and programs interacting with LoadLeveler.
- Authorize users and programs to use LoadLeveler services. It prevents unauthorized users and programs from misusing resources or disrupting services.

To use CtSec services, all nodes running LoadLeveler must first be configured as part of a cluster running Reliable Scalable Cluster Technology (RSCT). For details on CtSec services administration, see *IBM Reliable Scalable Cluster Technology for AIX 5L and Linux Administration Guide*, SA22-7889.

CtSec services are designed to use multiple security mechanisms and each security mechanism must be configured for LoadLeveler. At the present time, directions are provided only for configuring the host-based authentication (HBA) security mechanism for LoadLeveler's use. If CtSec is configured to use additional security mechanisms that are not configured for LoadLeveler's use, then the LoadLeveler configuration file keyword **SEC\_IMPOSED\_MECHS** must be specified. This keyword is used to limit the security mechanisms that will be used by CtSec services to only those that are configured for use by LoadLeveler.

Authorization is based on user identity. When CtSec services are enabled for LoadLeveler, user identity will differ depending on the authentication mechanism in use. A user's identity in UNIX host-based authentication is the user's network identity which is comprised of the user name and host name, such as `user_name@host`.

LoadLeveler uses CtSec services to authorize owners of jobs, administrators and LoadLeveler daemons to perform certain actions. CtSec services uses its own identity mapping file to map the clients' network identity to a local identity when performing authorizations. A typical local identity is the user name without a hostname. The local identities of the LoadLeveler administrators must be added as members of the group specified by the keyword **SEC\_ADMIN\_GROUP**. The local identity of the LoadLeveler user name must be added as the sole member of the group specified by the keyword **SEC\_SERVICES\_GROUP**. The LoadLeveler Services and Administrative groups, those identified by the keywords **SEC\_SERVICES\_GROUP** and **SEC\_ADMIN\_GROUP**, must be the same across all nodes in the LoadLeveler cluster. To ensure consistency in performing tasks which require owner, administrative or daemon privileges across all nodes in the LoadLeveler cluster, user network identities must be mapped identically across all nodes in the LoadLeveler cluster. If this is not the case, LoadLeveler authorizations may fail.

### Steps for enabling CtSec services

To enable LoadLeveler to use CtSec services, perform the following steps:

1. Include, in the Trusted Host List, the host names of all hosts with which communications may take place. If LoadLeveler tries to communicate with a host not on the Trusted Host List the message: The host identified in the credentials is not a trusted host on this system will occur. Additionally, the system administrator should ensure that public keys are manually exchanged between all hosts in the LoadLeveler cluster. Refer to *IBM Reliable Scalable*

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*Cluster Technology for AIX 5L and Linux Administration Guide, SA22-7889* for information on setting up Trusted Host Lists and manually transferring public keys.

2. Create user IDs. Each LoadLeveler administrator and the LoadLeveler user ID need to be created, if they don't already exist. You can do this through SMIT or the **mkuser** command.
3. The **unix.map** file must contain the correct value for the service name **ctloadl** which specifies the LoadLeveler user name. If you have configured LoadLeveler to use **loadl** as the LoadLeveler user name, either by default or by specifying **loadl** in the **LoadLUserid** keyword of the **/etc/LoadL.cfg** file, nothing needs to be done. The default map file will contain the **ctloadl** service name already assigned to **loadl**. If you have configured a different user name in the **LoadLUserid** keyword of the **/etc/LoadL.cfg** file, you will need to make sure that the **/var/ct/cfg/unix.map** file exists and that it assigns the same user name to the **ctloadl** service name. If the **/var/ct/cfg/unix.map** file does not exist, create one by copying the default map file **/usr/sbin/rsct/cfg/unix.map**. Do not modify the default map file.

If the value of the **LoadLUserid** and the value associated with **ctloadl** are not the same a security services error which indicates a UNIX identity mismatch will occur.

4. To map network identities to local identities, add entries to the global mapping file of each machine in the LoadLeveler cluster. This file is located at: **/var/ct/cfg/ctsec\_map.global**. If this file doesn't yet exist, you should copy the default global mapping file to this location—don't modify the default mapping file. The default global mapping file, which is shared among all CtSec services exploiters, is located at **/usr/sbin/rsct/cfg/ctsec\_map.global**. See *IBM Reliable Scalable Cluster Technology for AIX 5L: Technical Reference, SA22-78900* for more information on the mapping file.

When adding names to the global mapping file, enter more specific entries ahead of the other, less specific entries. Remember that you must update the global mapping file on each machine in the LoadLeveler cluster, and each mapping file has to be updated with the security services identity of each member of the **administrator** group, the **services** group, and the users.

Therefore, you would have entries like this:

```
unix:brad@mach1.pok.ibm.com=bradleyf
unix:brad@mach2.pok.ibm.com=bradleyf
unix:brad@mach3.pok.ibm.com=bradleyf
unix:marsha@mach2.pok.ibm.com=marshab
unix:marsha@mach3.pok.ibm.com=marshab
unix:loadl@mach1.pok.ibm.com=loadl
unix:loadl@mach2.pok.ibm.com=loadl
unix:loadl@mach3.pok.ibm.com=loadl
```

However, if you're sure your LoadLeveler cluster is secure, you could specify mapping for all machines this way:

```
unix:brad@*=bradleyf
unix:marsha@*=marshab
unix:loadl@*=loadl
```

This indicates that the UNIX network identity of the users **brad**, **marsha** and **loadl** will map to their respective security services identities on every machine in the cluster. Refer to *IBM Reliable Scalable Cluster Technology for AIX 5L: RSCT Technical Reference, SA22-7800* for a description of the syntax used in the **ctsec\_map.global** file.

5. Create UNIX groups. The LoadLeveler **administrator** group and **services** group need to be created for every machine in the cluster and should contain the local identities of members. This can be done either by using SMIT or the **mkgroup** command.

For example, to create the group **lladmin** which lists the LoadLeveler administrators:

```
mkgroup "users=sam,betty,loadl" lladmin
```

These groups must be created on each machine in the LoadLeveler cluster and must contain the same entries.

To create the group **llsvcs** which lists the identity under which LoadLeveler daemons run using the default id of **loadl**:

```
mkgroup users=loadl llsvcs
```

These groups must be created on each machine in the LoadLeveler cluster and must contain the same entries.

6. Add or update these keywords in the LoadLeveler configuration file:

```
SEC_ENABLEMENT=CTSEC
```

```
SEC_ADMIN_GROUP=name of lladmin group
```

```
SEC_SERVICES_GROUP=group name that contains identities of LoadLeveler daemons
```

The **SEC\_ENABLEMENT=CTSEC** keyword indicates that CtSec services mechanism should be used. **SEC\_ADMIN\_GROUP** points to the name of the UNIX group which contains the local identities of the LoadLeveler administrators. The **SEC\_SERVICES\_GROUP** keyword points to the name of the UNIX group which contains the local identity of the LoadLeveler daemons. All LoadLeveler daemons run as the LoadLeveler user ID. Refer to step 5 for discussion of the **administrators** and **services** groups.

7. Update the **.rhosts** file in each user's home directory. This file is used to identify which UNIX identities can run LoadLeveler jobs on the local host machine. If the file does not exist in a user's home directory, you must create it. The **.rhosts** file must contain entries which specify all host and user combinations allowed to submit jobs which will run as the local user, either explicitly or through the use of wildcards.

Entries in the **.rhosts** file are specified this way:

```
HostNameField [UserNameField]
```

Refer to *IBM AIX Files Reference*, SC23-4168 for further details about the **.rhosts** file format.

**Tips for configuring LoadLeveler to use CtSec services:** When using CtSec services for LoadLeveler, each machine in the LoadLeveler cluster must be set up properly. CtSec authenticates network identities based on trust established between individual machines in a cluster, based on local host configurations. Because of this it is possible for most of the cluster to run correctly but to have transactions from certain machines experience authentication or authorization problems.

If unexpected authentication or authorization problems occur in a LoadLeveler cluster with CtSec enabled, check that the steps in "Steps for enabling CtSec services" on page 53 were correctly followed for each machine in the LoadLeveler cluster.

If any machine in a LoadLeveler cluster is improperly configured to run CtSec you may see that:

## Customizing the configuration file

- Users cannot perform user tasks (such as cancel) for jobs they submitted.  
Either the machine the job was submitted from or the machine the user operation was submitted from (or both) do not contain mapping files for the user that specify the same security services identity. The user should attempt the operation from the same machine the job was submitted from and record the results. If the user still cannot perform a user task on a job they submitted, then they should contact the LoadLeveler administrator who should review the steps in “Steps for enabling CtSec services” on page 53.
- LoadLeveler daemons fail to communicate.  
When LoadLeveler daemons communicate they must first authenticate each other. If the daemons cannot authenticate a message will be put in the daemon log indicating an authentication failure. Ensure the Trusted Hosts List on all LoadLeveler nodes contains the correct entries for all of the nodes in the LoadLeveler cluster. Also, make sure that the LoadLeveler Services group on all nodes of the LoadLeveler cluster contains the local identity for the LoadLeveler user name. The `ctsec_map.global` must contain mapping rules to map the LoadLeveler user name from every machine in the LoadLeveler cluster to the local identity for the LoadLeveler user name. An example of what may happen when daemons fail to communicate is that an Alternate Central Manager may take over while the Primary Central Manager is still active. This can occur when the Alternate Central Manager does not trust the Primary Central Manager.

### Limiting which security mechanisms LoadLeveler can use

As more security mechanisms become available, they must be configured for LoadLeveler’s use. If there are security mechanisms configured for CtSec that are not configured for LoadLeveler’s use, then the LoadLeveler configuration file keyword `SEC_IMPOSED_MECHS` must specify the mechanisms configured for LoadLeveler.

---

## Defining usage policies for consumable resources

The LoadLeveler scheduler can schedule jobs based on the availability of consumable resources. You can use the following keywords to configure consumable resources:

- `ENFORCE_RESOURCE_MEMORY`
- `ENFORCE_RESOURCE_POLICY`
- `ENFORCE_RESOURCE_SUBMISSION`
- `ENFORCE_RESOURCE_USAGE`
- `FLOATING_RESOURCES`
- `RESOURCES`
- `SCHEDULE_BY_RESOURCES`

For information about configuration file keyword syntax and other details, see Chapter 11, “Configuration file reference,” on page 231.

---

## Enabling support for bulk data transfer and rCxt blocks

On AIX systems with device drivers and network adapters that support remote direct-memory access (RDMA), LoadLeveler supports bulk data transfer for jobs that use either the Internet or User Space communication protocol mode. For jobs using the Internet protocol (IP jobs), LoadLeveler does not monitor or control the use of bulk transfer. For User Space jobs that request bulk transfer, however, LoadLeveler creates a consumable RDMA resource, and limits RDMA resources to only four for a single machine.

You do not need to perform specific configuration or job-definition tasks to enable bulk transfer for LoadLeveler jobs that use the IP network protocol. LoadLeveler cannot affect whether IP communication uses bulk transfer; the implementation of IP where the job runs determines whether bulk transfer is supported.

To enable User Space jobs to use bulk data transfer, however, you must update the LoadLeveler configuration file to include the value RDMA in the SCHEDULE\_BY\_RESOURCES list.

**Example:**

```
SCHEDULE_BY_RESOURCES = RDMA others
```

For additional information about using bulk data transfer and job-definition requirements, see “Using bulk data transfer” on page 163.

---

## Gathering job accounting data

Your organization may have a policy of charging users or groups of users for the amount of resources that their jobs consume. You can do this using LoadLeveler’s accounting feature. Using this feature, you can produce accounting reports that contain job resource information for completed serial and parallel jobs. You can also view job resource information on jobs that are continuing to run.

The following keywords allow you to control accounting functions:

- ACCT
- ACCT\_VALIDATION
- GLOBAL\_HISTORY
- HISTORY\_PERMISSION
- JOB\_ACCT\_Q\_POLICY
- JOB\_LIMIT\_POLICY

For example, the following section of the configuration file specifies that the accounting function is turned on. It also identifies the default module used to perform account validation and the directory containing the global history files:

```
ACCT = A_ON A_VALIDATE
ACCT_VALIDATION = $(BIN)/llacctval
GLOBAL_HISTORY = $(SPOOL)
```

Table 11 lists the topics related to configuring, gathering and using job accounting data.

*Table 11. Roadmap of tasks for gathering job accounting data*

| To learn about:                                       | Read the following:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Configuring LoadLeveler to gather job accounting data | <ul style="list-style-type: none"> <li>• “Collecting job resource data on serial and parallel jobs” on page 58</li> <li>• “Collecting job resource data based on machines” on page 58</li> <li>• “Collecting job resource data based on events” on page 59</li> <li>• “Collecting job resource information based on user accounts” on page 59</li> <li>• “Collecting accounting data for reservations” on page 125</li> <li>• “Collecting the accounting information and storing it into files” on page 60</li> <li>• “64-bit support for accounting functions” on page 61</li> <li>• “Example: Setting up job accounting files” on page 61</li> </ul> |

Table 11. Roadmap of tasks for gathering job accounting data (continued)

| To learn about:                                  | Read the following:                                                                                                                                                                                                                                                                                                        |
|--------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Managing accounting data                         | <ul style="list-style-type: none"><li>• “Producing accounting reports” on page 60</li><li>• “Correlating AIX and LoadLeveler accounting records” on page 60</li><li>• “llacctmrg - Collect machine history files” on page 373</li><li>• “llsummary - Return job resource information for accounting” on page 474</li></ul> |
| Correctly specifying configuration file keywords | Chapter 11, “Configuration file reference,” on page 231                                                                                                                                                                                                                                                                    |

## Collecting job resource data on serial and parallel jobs

Information on completed serial and parallel jobs is gathered using the UNIX *wait3* system call. Information on non-completed serial and parallel jobs is gathered in a platform-dependent manner by examining data from the UNIX process.

Accounting information on a completed serial job is determined by accumulating resources consumed by that job on the machines that ran the job. Similarly, accounting information on completed parallel jobs is gathered by accumulating resources used on all of the nodes that ran the job.

You can also view resource consumption information on serial and parallel jobs that are still running by specifying the **-x** option of the **llq** command. To enable **llq -x**, specify the following keywords in the configuration file:

- **ACCT = A\_ON A\_DETAIL**
- **JOB\_ACCT\_Q\_POLICY = number**

LoadLeveler for Linux cannot collect complete accounting information for MPICH and MPICH-GM jobs, so you should not rely on the accounting information for those types of jobs. For these parallel jobs, LoadLeveler uses an *mpirun* script to start MPICH tasks on various nodes, and to report completion of these tasks. LoadLeveler can collect accounting data for this job only from the node on which the *mpirun* script runs, not from the nodes on which *mpirun* executes MPICH tasks. Therefore, the accounting data for MPICH tasks is incomplete.

## Collecting job resource data based on machines

LoadLeveler can collect job resource usage information for every machine on which a job may run. A job may run on more than one machine because it is a parallel job or because the job is vacated from one machine and rescheduled to another machine.

To enable recording of resources by machine, you need to specify **ACCT = A\_ON A\_DETAIL** in the configuration file.

The machine's speed is part of the data collected. With this information, an installation can develop a charge back program which can charge more or less for resources consumed by a job on different machines. For more information on a machine's speed, refer to the machine stanza information. See “Defining machines” on page 78.

## Collecting job resource data based on events

In addition to collecting job resource information based upon machines used, you can gather this information based upon an event or time that you specify. For example, you may want to collect accounting information at the end of every work shift or at the end of every week or month. To collect accounting information on all machines in this manner, use the **llctl** command with the **capture** parameter:

```
llctl -g capture eventname
```

*eventname* is any string of continuous characters (no white space is allowed) that defines the event about which you are collecting accounting data. For example, if you were collecting accounting data on the *graveyard* work shift, your command could be:

```
llctl -g capture graveyard
```

This command allows you to obtain a snapshot of the resources consumed by active jobs up to and including the moment when you issued the command. If you want to capture this type of information on a regular basis, you can set up a crontab entry to invoke this command regularly. For example:

```
sample crontab for accounting
shift crontab 94/8/5
#
Set up three shifts, first, second, and graveyard shift.
Crontab entries indicate the end of shift.
#
#M H d m day command
#
00 08 * * * /u/load1/bin/llctl -g capture graveyard
00 16 * * * /u/load1/bin/llctl -g capture first
00 00 * * * /u/load1/bin/llctl -g capture second
```

For more information on the **llctl** command, refer to “**llctl** - Control LoadLeveler daemons” on page 393. For more information on the collection of accounting records, see “**llq** - Query job status” on page 431.

## Collecting job resource information based on user accounts

If your installation is interested in keeping track of resources used on an account basis, you can require all users to specify an account number in their job command files. They can specify this account number with the **account\_no** keyword which is explained in detail in “Job command file keyword descriptions” on page 324. Interactive POE jobs can specify an account number using the **LOADL\_ACCOUNT\_NO** environment variable.

LoadLeveler validates this account number by comparing it against a list of account numbers specified for the user in the user stanza in the administration file.

Account validation is under the control of the **ACCT** keyword in the configuration file. The routine that performs the validation is called **llacctval**. You can supply your own validation routine by specifying the **ACCT\_VALIDATION** keyword in the configuration file. The following are passed as character string arguments to the validation routine:

- User name
- User’s login group name
- Account number specified on the Job
- Blank separated list of account numbers obtained from the user’s stanza in the administration file.

## Customizing the configuration file

The account validation routine must exit with a return code of zero if the validation succeeds. If it fails, the return code is a nonzero number.

## Collecting the accounting information and storing it into files

LoadLeveler stores the accounting information that it collects in a file called *history* in the spool directory of the machine that initially scheduled this job, the schedd machine. Data on parallel jobs are also stored in the *history* files.

Resource information collected on the LoadLeveler job is constrained by the capabilities of the wait3 system call. Information for processes which fork child processes will include data for those child processes as long as the parent process waits for the child process to terminate. Complete data may not be collected for jobs which are not composed of simple parent/child processes. For example, if you have a LoadLeveler job which invokes an rsh command to execute a function on another machine, the resources consumed on the other machine will not be collected as part of the LoadLeveler accounting data.

LoadLeveler accounting uses the following types of files:

- The local history file which is local to each schedd machine is where job resource information is first recorded. These files are usually named *history* and are located in the spool directory of each schedd machine, but you may specify an alternate name with the **HISTORY** keyword in either the global or local configuration file.
- The global history file is a combination of the history files from some or all of the machines in the LoadLeveler cluster merged together. The command **llacctmrg** is used to collect files together into a global file. As the files are collected from each machine, the local history file for that machine is reset to contain no data. The file is named *globalhist.YYYYMMDDHHmm*. You may specify the directory in which to place the file when you invoke the **llacctmrg** command or you can specify the directory with the **GLOBAL\_HISTORY** keyword in the configuration file. The default value set up in the sample configuration file is the local spool directory.

## Producing accounting reports

You can produce three types of reports using either the local or global history file. These reports are called the *short*, *long*, and *extended* versions. As their names imply, the short version of the report is a brief listing of the resources used by LoadLeveler jobs. The long version provides more comprehensive detail with summarized resource usage, and the extended version of the report provides the comprehensive detail with detailed resource usage.

If you do not specify a report type, you will receive the default short version. The short report displays the number of jobs along with the total CPU usage according to user, class, group, and account number. The extended version of the report displays all of the data collected for every job.

- For examples of the short and extended versions of the report, see “llsummary - Return job resource information for accounting” on page 474.
- For information on the accounting APIs, refer to Chapter 16, “Application programming interfaces (APIs),” on page 481.

## Correlating AIX and LoadLeveler accounting records

For jobs running on AIX systems, you can use a job accounting key to correlate AIX accounting records with LoadLeveler accounting records. The job accounting key uniquely identifies each job step. LoadLeveler derives this key from the job

key and the date and time at which the job entered the queue (see the **QDate** variable description on page 283). The key is associated with the starter process for the job step and any of its child processes.

For checkpointed jobs, LoadLeveler does not change the job accounting key, regardless of how it restarts the job step. Jobs restarted from a checkpoint file or through a new job step retain the job accounting key for the original job step.

To access the job accounting key for a job step, you can use the following interfaces:

- The **llsummary** command, requesting the long version of the report. For details about using this command, see “llsummary - Return job resource information for accounting” on page 474.
- The **GetHistory** subroutine. For details about using this subroutine, see “Report generation subroutine” on page 485.
- The **ll\_get\_data** subroutine, through the **LL\_StepAcctKey** specification. For details about using this subroutine, see “ll\_get\_data subroutine” on page 503.

For information about AIX accounting records, see the system accounting topic in *AIX 5L System Management Guide: Operating System and Devices*.

## 64-bit support for accounting functions

LoadLeveler 64-bit support for accounting functions includes:

- Statistics of jobs such as usage, limits, consumable resources, and other 64-bit integer data are preserved in the history file as `rusage64`, `rlimit64` structures and as data items of type `int64_t`.
- The `LL_job_step` structure defined in `llapi.h` allows access to the 64-bit data items either as data of type `int64_t` or as data of type `int32_t`. In the latter case, the returned values may be truncated.
- The **llsummary** command displays 64-bit information where appropriate.
- The data access API supports both 64-bit and 32-bit access to accounting and usage information in a history file. Please refer to the code fragment on page 535 for an example of how to use the **ll\_get\_data** subroutine to access information stored in a LoadLeveler history file.

## Example: Setting up job accounting files

The following sample procedure walks you through the process of collecting account data. You can perform all of the steps or just the ones that apply to your situation.

1. Edit the configuration file according to the following table:

| Edit this keyword: | To:                                                                                |
|--------------------|------------------------------------------------------------------------------------|
| ACCT               | Turn accounting and account validation on and off and specify detailed accounting. |
| ACCT_VALIDATION    | Specify the account validation routine.                                            |
| GLOBAL_HISTORY     | Specify a directory in which to place the global history files.                    |

2. Specify account numbers and set up account validation by performing the following steps:
  - a. Specify a list of account numbers a user may use when submitting jobs, by using the **account** keyword in the user stanza in the administration file.

## Customizing the configuration file

- b. Instruct users to associate an account number with their job, by using the **account\_no** keyword in the job command file.

**Alternative:** You may use the LoadLeveler GUI to associate account numbers with jobs:

**Select** **File → Build a Job** from the main window.

▲ The Build a Job window appears.

**Type** The account number in the **account\_no** field on the Build a Job window.

**Press** **OK**

▲ The window closes and you return to the main window.

- c. Specify the **ACCT\_VALIDATION** keyword in the configuration file that identifies the module that will be called to perform account validation. The default module is called **llacctval**. You can replace this module with your installation's own accounting routine by specifying a new module with this keyword.

3. Specify machines and their weights by using the **speed** keyword in a machine's machine stanza in the administration file.

Also, if you have in your cluster machines of differing speeds and you want LoadLeveler accounting information to be normalized for these differences, specify **cpu\_speed\_scale=true** in each machine's respective machine stanza.

For example, suppose you have a cluster of two machines, called A and B, where Machine B is three times as fast as Machine A. Machine A has **speed=1.0**, and Machine B has **speed=3.0**. Suppose a job runs for 12 CPU seconds on Machine A. The same job runs for 4 CPU seconds on Machine B. When you specify **cpu\_speed\_scale=true**, the accounting information collected on Machine B for that job shows the normalized value of 12 CPU seconds rather than the actual 4 CPU seconds.

4. Merge multiple files collected from each machine into one file, using the **llacmtmrg** command.

**Alternative:** You may use the LoadLeveler GUI to merge the files:

**Select** A machine from the Machines window

**Select** **Admin → Collect Account Data...** from the Machines window.

▲ A window appears prompting you to enter a directory name where the file will be placed. If no directory is specified, the directory specified with the **GLOBAL\_HISTORY** keyword in the global configuration file is the default directory.

**Press** **OK**

▲ The window closes and you return to the main window.

5. Report job information on all the jobs in the history file, using the **llsummary** command.

**Alternative:** You may use the LoadLeveler GUI to report job information:

**Select** **Admin → Create Account Report...** from the Machines window.

**Note:** If you want to receive an extended accounting report, select the **extended** cascading button.

▲ A window appears prompting you to enter the following information:

- A short, long, or extended version of the output. The short version is the default version.

- Start and end date ranges for the report. If no date is specified, the default is to report all of the data in the report.
- The name of the input data file.
- The name of the output data file.

Press OK

▲ The window closes and you return to the main window. The report appears in the Messages window if no output data file was specified.

---

## Managing job status through control expressions

You can control running jobs by using five control functions as Boolean expressions in the configuration file. These functions are useful primarily for serial jobs. You define the expressions, using normal C conventions, with the following functions:

- START
- SUSPEND
- CONTINUE
- VACATE
- KILL

The expressions are evaluated for each job running on a machine using both the job and machine attributes. Some jobs running on a machine may be suspended while others are allowed to continue.

The START expression is evaluated twice; once to see if the machine can accept jobs to run and second to see if the specific job can be run on the machine. The other expressions are evaluated after the jobs have been dispatched and in some cases, already running.

When evaluating the START expression to determine if the machine can accept jobs, **Class != "Z"** evaluates to true only if Z is not in the class definition. This means that if two different classes are defined on a machine, **Class != "Z"** (where Z is one of the defined classes) always evaluates to false when specified in the START expression and, therefore, the machine will not be considered to start jobs.

Typically, machine load average, keyboard activity, time intervals, and job class are used within these various expressions to dynamically control job execution.

For additional information about:

- Time-related variables that you may use for this keyword, see “Variables to use for setting times” on page 285.
- Coding these control expressions in the configuration file, see Chapter 11, “Configuration file reference,” on page 231.

## How control expressions affect jobs

After LoadLeveler selects a job for execution, the job can be in any of several states. Figure 10 on page 64 shows how the control expressions can affect the state a job is in. The rectangles represent job or daemon states, and the diamonds represent the control expressions.

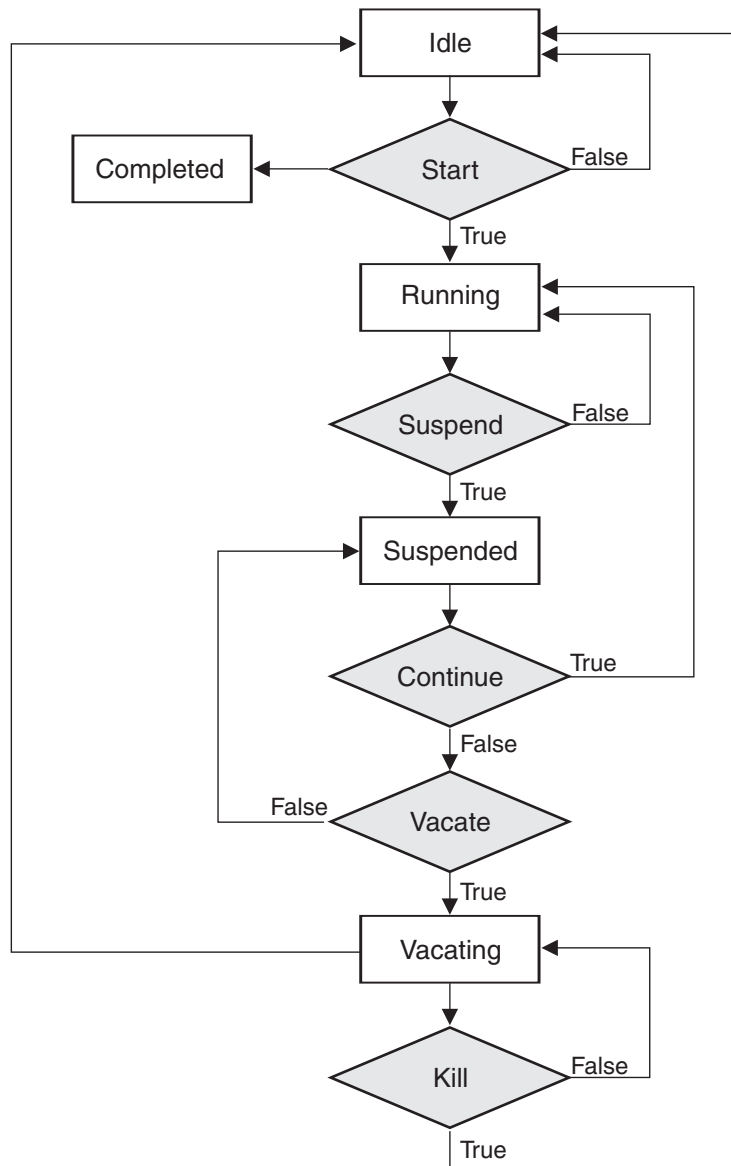


Figure 10. How control expressions affect jobs

Criteria used to determine when a LoadLeveler job will enter Start, Suspend, Continue, Vacate, and Kill states are defined in the LoadLeveler configuration files and may be different for each machine in the cluster. They may be modified to meet local requirements.

---

## Tracking job processes

When a job terminates, its orphaned processes may continue to consume or hold resources, thereby degrading system performance, or causing jobs to hang or fail. Process tracking allows LoadLeveler to cancel any processes (throughout the entire cluster), left behind when a job terminates. Process tracking is required by the gang scheduler. It is also required to do preemption by the suspend method when running either the backfill or API schedulers. Process tracking is optional in all other cases.

LoadLeveler for Linux does not support process tracking.

There are two keywords used in specifying process tracking:

#### PROCESS\_TRACKING

To activate process tracking, set **PROCESS\_TRACKING=TRUE** in the LoadLeveler global configuration file. By default, **PROCESS\_TRACKING** is set to **FALSE**.

#### PROCESS\_TRACKING\_EXTENSION

This keyword specifies the path to the kernel extension binary **LoadL\_pt\_ke** in the local or global configuration file. If the **PROCESS\_TRACKING\_EXTENSION** keyword is not supplied, then LoadLeveler will search the default directory **\$HOME/bin**.

The process tracking kernel extension is not unloaded when the **startd** daemon terminates. Therefore if a mismatch in the version of the loaded kernel extension and the installed kernel extension is found when the **startd** starts up the daemon will exit. In this case a reboot of the node is needed to unload the currently loaded kernel extension. If you install a new version of LoadLeveler which contains a new version of the kernel extension you may need to reboot the node.

For information about configuration file keyword syntax and other details, see Chapter 11, "Configuration file reference," on page 231.

---

## Querying multiple LoadLeveler clusters

This section applies only to those installations having more than one LoadLeveler cluster, where the separate clusters have not been organized into a multicluster environment. To organize separate LoadLeveler clusters into a multicluster environment, see "LoadLeveler multicluster support" on page 139.

You can query, submit, or cancel jobs in multiple LoadLeveler clusters by setting up a master configuration file for each cluster and using the **LOADL\_CONFIG** environment variable to specify the name of the master configuration file that the LoadLeveler commands must use. The master configuration file must be located in the **/etc** directory and the file name must have a format of *base\_name.cfg* where *base\_name* is a user defined identifier for the cluster.

The default name for the master configuration file is **/etc/LoadL.cfg**. The format for the **LOADL\_CONFIG** environment variable is

**LOADL\_CONFIG=/etc/base\_name.cfg** or **LOADL\_CONFIG=base\_name**. When you use the form **LOADL\_CONFIG=base\_name**, the prefix **/etc** and suffix **.cfg** are appended to the *base\_name*.

The following example explains how you can set up a machine to query multiple clusters:

You can configure **/etc/LoadL.cfg** to point to the configuration files for the "default" cluster, and you can configure **/etc/othercluster.cfg** to point to the configuration files of another cluster which the user can select.

For example, you can enter the following query command:

```
$ llq
```

The above command uses the configuration from **/etc/LoadL.cfg** and queries job information from the "default" cluster.

## Customizing the configuration file

To send a query to the cluster defined in the configuration file of `/etc/othercluster.cfg`, enter:

```
$ env LOADL_CONFIG=othercluster llq
```

Note that the machine from which you issue the `llq` command is considered as a submit-only machine by the other cluster.

---

## Handling switch-table errors

You may use the following configuration file keywords to control how LoadLeveler responds to switch-table errors:

- `ACTION_ON_SWITCH_TABLE_ERROR`
- `DRAIN_ON_SWITCH_TABLE_ERROR`
- `RESUME_ON_SWITCH_TABLE_ERROR_CLEAR`

For information about configuration file keyword syntax and other details, see Chapter 11, “Configuration file reference,” on page 231.

---

## Providing additional job-processing controls through installation exits

LoadLeveler allows administrators to further configure the environment through installation exits. Table 12 lists these additional job-processing controls.

*Table 12. Roadmap of administrator tasks accomplished through installation exits*

| To learn about:                                                                          | Read the following:                                                                                                              |
|------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| Writing a program to control when jobs are scheduled to run                              | “Controlling the central manager scheduling cycle”                                                                               |
| Writing a pair of programs to override the default LoadLeveler DCE authentication method | “Handling DCE security credentials” on page 68                                                                                   |
| Writing a program to refresh an AFS token when a job starts                              | “Handling an AFS token” on page 69                                                                                               |
| Writing a program to check or modify job requests when they are submitted                | “Filtering a job script” on page 70                                                                                              |
| Writing programs to run before and after job requests                                    | “Writing prolog and epilog programs” on page 70                                                                                  |
| Overriding the LoadLeveler default mail notification method                              | “Using your own mail program” on page 75                                                                                         |
| Defining a cluster metric to determine where a remote job is distributed                 | See the <b>CLUSTER_METRIC</b> configuration keyword description in Chapter 11, “Configuration file reference,” on page 231.      |
| Defining cluster user mapper for multicluster environment                                | See the <b>CLUSTER_USER_MAPPER</b> configuration keyword description in Chapter 11, “Configuration file reference,” on page 231. |
| Correctly specifying configuration file keywords                                         | Chapter 11, “Configuration file reference,” on page 231                                                                          |

## Controlling the central manager scheduling cycle

To determine when to run the LoadLeveler scheduling algorithm, the central manager uses the values set in the configuration file for the **NEGOTIATOR\_INTERVAL** and the **NEGOTIATOR\_CYCLE\_DELAY** keywords. When the **NEGOTIATOR\_INTERVAL** is set to zero, the central manager will not

run the scheduling algorithm until instructed to do so by an authorized process. This setting enables your program to control the central manager's scheduling activity through one of the following:

- The **llrunscheduler** command.
- The **ll\_run\_scheduler** subroutine.

Both the command and the subroutine instruct the central manager to run the scheduling algorithm.

You might choose to use this setting if, for example, you want to write a program that directly controls the assignment of the system priority for all LoadLeveler jobs. In this particular case, you would complete the following steps to control system priority assignment and the scheduling cycle:

1. Decide the following:
  - Which system priority value to assign to jobs from specific sources or with specific resource requirements.
  - How often the central manager should run the scheduling algorithm. Your program has to be designed to issue the **ll\_run\_scheduler** subroutine at regular intervals; otherwise, LoadLeveler will not attempt to schedule any job steps.

You also need to understand how changing the system priority affects the job queue. After you successfully use the **ll\_modify** subroutine or the **llmodify** command to change system priority values, LoadLeveler will not readjust the values for those job steps when the negotiator recalculates priorities at regular intervals set through the **NEGOTIATOR\_RECALCULATE\_SYSPRIO\_INTERVAL** keyword. Also, you can change the system priority for jobs only when those jobs are in the Idle state or a state similar to it. To determine which job states are similar to the Idle state or to the Running state, see Table 5 on page 18.
2. Code a program to use LoadLeveler APIs to perform the following functions:
  - a. Use the Data Access APIs to obtain data about all jobs.
  - b. Determine whether jobs have been added or removed.
  - c. Use the **ll\_modify** subroutine to set the system priority for the LoadLeveler jobs. The values you set through this subroutine will not be readjusted when the negotiator recalculates job step priorities.
  - d. Use the **ll\_run\_scheduler** subroutine to instruct the central manager to run the scheduling algorithm.
  - e. Set a timer for the scheduling interval, to repeat the scheduling instruction at regular intervals. This step is required to replace the effect of setting the configuration keyword **NEGOTIATOR\_CYCLE\_DELAY**, which LoadLeveler ignores when **NEGOTIATOR\_INTERVAL** is set to zero.
3. In the configuration file, set values for the following keywords:
  - Set the **NEGOTIATOR\_INTERVAL** keyword to zero to stop the central manager from automatically recalculating system priorities for jobs.
  - (Optional) Set the **SYSPRIO\_THRESHOLD\_TO\_IGNORE\_STEP** keyword to specify a threshold value. If the system priority assigned to a job step is less than this threshold value, the job will remain idle.
4. Issue the **llctl** command with either the **reconfig** or **recycle** keyword. Otherwise, LoadLeveler will not process the modifications you made to the configuration file.
5. (Optional) To make sure that the central manager's automatic scheduling activity has been disabled (by setting the **NEGOTIATOR\_INTERVAL** keyword to zero), use the **llstatus** command.
6. Run your program under a user ID with administrator authority.

## Customizing the configuration file

Once this procedure is complete, you might want to use one or more of the following commands to make sure that jobs are scheduled according to the correct system priority. The value of *q\_sysprio* in command output indicates the system priority for the job step.

- Use the command **llq -s** to detect whether a job step is idle because its system priority is below the value set for the **SYSPRIO\_THRESHOLD\_TO\_IGNORE\_STEP** keyword.
- Use the command **llq -l** to display the previous system priority for a job step.
- When unusual circumstances require you to change system priorities manually:
  1. Use the command **llmodify -s** to set the system priority for LoadLeveler jobs. The values you set through this command will not be readjusted when the negotiator recalculates job step priorities.
  2. Use the **llrunscheduler** command to instruct the central manager to run the scheduling algorithm.

## Handling DCE security credentials

You can write a pair of programs to override the default LoadLeveler DCE authentication method. To enable the programs, use the **DCE\_AUTHENTICATION\_PAIR** keyword in your configuration file. You may choose from one of the following pairs provided with LoadLeveler:

- If you specify **DCE\_ENABLEMENT=TRUE**, LoadLeveler uses the default program pair:  
`DCE_AUTHENTICATION_PAIR = $(BIN)/lldelegate, $(BIN)/llimpersonate`
- As an alternative, you can also specify the program pair:  
`DCE_AUTHENTICATION_PAIR = $(BIN)/llgetdce, $(BIN)/llsetdce`

If **DCE\_ENABLEMENT=FALSE** is specified, DCE credential forwarding will not take place by default in this case.

Specifying the **DCE\_AUTHENTICATION\_PAIR** keyword enables LoadLeveler support for forwarding DCE credentials to LoadLeveler jobs. You may override the default function provided by LoadLeveler to establish DCE credentials by substituting your own programs.

### Using the default program pair: lldelegate and llimpersonate

The program pair, **lldelegate** and **llimpersonate**, forwards DCE credentials using a technique referred to as credential forwarding. This technique is implemented using DCE API calls to forward the user's credentials from the **lldelegate** process. The **submit** process invokes the **lldelegate** process (through the **llsubmit** command or the **submit** API) to the **llimpersonate** process invoked by the LoadLeveler **starter** process running on the machines which will execute the user's program. This method of credential forwarding depends on the user obtaining a forwardable credential prior to invoking **llsubmit** or a program using the **submit** API (such as POE). The user can obtain forwardable credentials by specifying the **-f** flag when invoking either **dce\_login** or **kinit**.

Specification of the **lldelegate/llimpersonate** pair requires that LoadLeveler use SP Security Services, and the **ssp.clients** SP Authenticated Clients Commands filesset of the PSSP install image. You must also configure LoadLeveler to exploit DCE security.

### Using the alternative program pair: llgetdce and llsetdce

The program pair, **llgetdce** and **llsetdce**, forwards DCE credentials by copying credential cache files from the submitting machine to the executing machines.

While this technique may require less overhead, it has been known to produce credentials on the executing machines which are not fully capable of being forwarded by rsh commands. This is the only pair of programs offered in earlier releases of LoadLeveler.

### Forwarding DCE credentials

An example of a credentials object is a character string containing the DCE principle name and a password. *program1* writes the following to standard output:

- The length of the handle to follow
- The handle

If *program1* encounters errors, it writes error messages to standard error.

*program2* receives the following as standard input:

- The length of the handle to follow
- The same handle written by *program1*

*program2* writes the following to standard output:

- The length of the login context to follow
- An exportable DCE login context, which is the `idl_byte` array produced from the `sec_login_export_context` DCE API call. For more information, see the DCE Security Services API chapter in the Distributed Computing Environment for AIX Application Development Reference.
- A character string suitable for assigning to the `KRB5CCNAME` environment variable. This string represents the location of the credentials cache established in order for *program2* to export the DCE login context.

If *program2* encounters errors, it writes error messages to standard error. The parent process, the LoadLeveler starter process, writes those messages to the starter log.

For examples of programs that enable DCE security credentials, see the `samples/lldce` subdirectory in the release directory.

## Handling an AFS token

You can write a program, run by the scheduler, to refresh an AFS token when a job is started. To invoke the program, use the `AFS_GETNEWTOKEN` keyword in your configuration file.

Before running the program, LoadLeveler sets up standard input and standard output as pipes between the program and LoadLeveler. LoadLeveler also sets up the following environment variables:

### **LOADL\_STEP\_OWNER**

The owner (UNIX user name) of the job

### **LOADL\_STEP\_COMMAND**

The name of the command the user's job step invokes.

### **LOADL\_STEP\_CLASS**

The class this job step will run.

### **LOADL\_STEP\_ID**

The step identifier, generated by LoadLeveler.

### **LOADL\_JOB\_CPU\_LIMIT**

The number of CPU seconds the job is limited to.

### **LOADL\_WALL\_LIMIT**

The number of wall clock seconds the job is limited to.

## Customizing the configuration file

LoadLeveler writes the following current AFS credentials, in order, over the standard input pipe:

- The **ktc\_principal** structure indicating the service.
- The **ktc\_principal** structure indicating the client.
- The **ktc\_token** structure containing the credentials.

The **ktc\_principal** structure is defined in the AFS header file **afs\_rxkad.h**. The **ktc\_token** structure is defined in the AFS header file **afs\_auth.h**.

LoadLeveler expects to read these same structures in the same order from the standard output pipe, except these should be refreshed credentials produced by the installation exit.

The installation exit can modify the passed credentials (to extend their lifetime) and pass them back, or it can obtain new credentials. LoadLeveler takes whatever is returned and uses it to authenticate the user prior to starting the user's job.

## Filtering a job script

You can write a program to filter a job script when the job is submitted to the local cluster and when the job is submitted from a remote cluster. This program can, for example, modify defaults or perform site specific verification of parameters. To invoke the local job filter, specify the **SUBMIT\_FILTER** keyword in your configuration file. To invoke the remote job filter, specify the **CLUSTER\_REMOTE\_JOB\_FILTER** keyword in your configuration file. For more information on these keywords, see the **SUBMIT\_FILTER** or **CLUSTER\_REMOTE\_JOB\_FILTER** keyword in Chapter 11, "Configuration file reference," on page 231.

LoadLeveler sets the following environment variables when the program is invoked:

**LOADL\_ACTIVE**

LoadLeveler version

**LOADL\_STEP\_COMMAND**

Job command file name

**LOADL\_STEP\_ID**

The job identifier, generated by LoadLeveler

**LOADL\_STEP\_OWNER**

The owner (UNIX user name) of the job

For details about specific keyword syntax and use in the configuration file, see Chapter 11, "Configuration file reference," on page 231.

## Writing prolog and epilog programs

An administrator can write *prolog* and *epilog* installation exits that can run before and after a LoadLeveler job runs, respectively.

Prolog and epilog programs fall into two types:

- Those that run as the LoadLeveler user ID.
- Those that run in a user's environment.

Depending on the type of processing you want to perform before or after a job runs, specify one or more of the following configuration file keywords, in any combination:

- To run a prolog or epilog program under the LoadLeveler user ID, specify JOB\_PROLOG or JOB\_EPILOG, respectively.
- To run a prolog or epilog program under the user's environment, specify JOB\_USER\_PROLOG or JOB\_USER\_EPILOG, respectively.

You do not have to provide a prolog/epilog pair of programs. You may, for example, use only a prolog program that runs under the LoadLeveler user ID.

For details about specific keyword syntax and use in the configuration file, see Chapter 11, "Configuration file reference," on page 231.

A user environment prolog or epilog runs with AFS authentication, DCE authentication, or both (if either is installed and enabled). For security reasons, you must code these programs on the machines where the job runs *and* on the machine that schedules the job. If you do not define a value for these keywords, the user environment prolog and epilog settings on the executing machine are ignored.

The user environment prolog and epilog can set environment variables for the job by sending information to standard output in the following format:

```
env id = value
```

Where:

**id** Is the name of the environment variable

**value** Is the value (setting) of the environment variable

For example, the user environment prolog below sets the environment variable **STAGE\_HOST** for the job:

```
#!/bin/sh
echo env STAGE_HOST=shd22
```

### Coding conventions for prolog programs

The prolog program is invoked by the starter process. Once the starter process invokes the prolog program, the program obtains information about the job from environment variables.

**Syntax:**

*prolog\_program*

Where *prolog\_program* is the name of the prolog program as defined in the JOB\_PROLOG keyword.

No arguments are passed to the program, but several environment variables are set. For more information on these environment variables, see "Run-time environment variables" on page 361.

The real and effective user ID of the prolog process is the LoadLeveler user ID. If the prolog program requires root authority, the administrator must write a secure C or Perl program to perform the desired actions. You should *not* use shell scripts with set uid permissions, since these scripts may make your system susceptible to security problems.

**Return code values:**

0 The job will begin.

If the prolog program is ended with a signal, the job does not begin and a message is written to the starter log.

## Customizing the configuration file

### Sample prolog programs:

- **Sample of a prolog program for korn shell**

```
#!/bin/ksh
#
Set up environment
set -a
. /etc/environment
. /.profile
export PATH="$PATH:/loctools/lladmin/bin"
export LOG="/tmp/$LOADL_STEP_OWNER.$LOADL_STEP_ID.prolog"
#
Do set up based upon job step class
#
case $LOADL_STEP_CLASS in
 # A OSL job is about to run, make sure the osl filesystem is
 # mounted. If status is negative then filesystem cannot be
 # mounted and the job step should not run.
 "OSL")
 mount_osl_files >> $LOG
 if [status = 0]
 then EXIT_CODE=1
 else
 EXIT_CODE=0
 fi
 ;;
 # A simulation job is about to run, simulation data has to
 # be made available to the job. The status from copy script must
 # be zero or job step cannot run.
 "sim")
 copy_sim_data >> $LOG
 if [status = 0]
 then EXIT_CODE=0
 else
 EXIT_CODE=1
 fi
 ;;
 # All other job will require free space in /tmp, make sure
 # enough space is available.
 *)
 check_tmp >> $LOG
 EXIT_CODE=$?
 ;;
esac
The job step will run only if EXIT_CODE == 0
exit $EXIT_CODE
```

- **Sample of a prolog program for C shell**

```
#!/bin/csh
#
Set up environment
source /u/load1/.login
#
setenv PATH "${PATH}:/loctools/lladmin/bin"
setenv LOG "/tmp/${LOADL_STEP_OWNER}.${LOADL_STEP_ID}.prolog"
#
Do set up based upon job step class
#
switch ($LOADL_STEP_CLASS)
 # A OSL job is about to run, make sure the osl filesystem is
 # mounted. If status is negative then filesystem cannot be
 # mounted and the job step should not run.
 case "OSL":
 mount_osl_files >> $LOG
 if ($status < 0) then
 set EXIT_CODE = 1
 fi
 end
end
```

```

 else
 set EXIT_CODE = 0
 endif
 breaksw
A simulation job is about to run, simulation data has to
be made available to the job. The status from copy script must
be zero or job step cannot run.
case "sim":
 copy_sim_data >> $LOG
 if ($status == 0) then
 set EXIT_CODE = 0
 else
 set EXIT_CODE = 1
 endif
 breaksw
All other job will require free space in /tmp, make sure
enough space is available.
default:
 check_tmp >> $LOG
 set EXIT_CODE = $status
 breaksw
endsw

The job step will run only if EXIT_CODE == 0
exit $EXIT_CODE

```

### Coding conventions for epilog programs

The installation defined epilog program is invoked after a job step has completed. The purpose of the epilog program is to perform any required clean up such as unmounting file systems, removing files, and copying results. The exit status of both the prolog program and the job step is set in environment variables.

#### Syntax:

*epilog\_program*

Where *epilog\_program* is the name of the epilog program as defined in the JOB\_EPILOG keyword.

No arguments are passed to the program but several environment variables are set. These environment variables are described in “Run-time environment variables” on page 361. In addition, the following environment variables are set for the epilog programs:

#### LOADL\_PROLOG\_EXIT\_CODE

The exit code from the prolog program. This environment variable is set only if a prolog program is configured to run.

#### LOADL\_USER\_PROLOG\_EXIT\_CODE

The exit code from the user prolog program. This environment variable is set only if a user prolog program is configured to run.

#### LOADL\_JOB\_STEP\_EXIT\_CODE

The exit code from the job step.

**Note:** To interpret the exit status of the prolog program and the job step, convert the string to an integer and use the macros found in the `sys/wait.h` file. These macros include:

- WEXITSTATUS: gives you the exit code
- WTERMSIG: gives you the signal that terminated the program
- WIFEXITED: tells you if the program exited
- WIFSIGNALED: tells you if the program was terminated by a signal

## Customizing the configuration file

The exit codes returned by the WEXITSTATUS macro are the valid codes. However, if you look at the raw numbers in `sys/wait.h`, the exit code may appear to be 256 times the expected return code. The numbers in `sys/wait.h` are the wait3 system calls.

### Sample epilog programs:

- **Sample of an epilog program for korn shell**

```
#!/bin/ksh
#
Set up environment
set -a
. /etc/environment
. /.profile
export PATH="$PATH:/loctools/lladmin/bin"
export LOG="/tmp/$LOADL_STEP_OWNER.$LOADL_STEP_ID.epilog"
#
if [[-z $LOADL_PROLOG_EXIT_CODE]]
then
echo "Prolog did not run" >> $LOG
else
echo "Prolog exit code = $LOADL_PROLOG_EXIT_CODE" >> $LOG
fi
#
if [[-z $LOADL_USER_PROLOG_EXIT_CODE]]
then
echo "User environment prolog did not run" >> $LOG
else
echo "User environment exit code = $LOADL_USER_PROLOG_EXIT_CODE" >> $LOG
fi
#
if [[-z $LOADL_JOB_STEP_EXIT_CODE]]
then
echo "Job step did not run" >> $LOG
else
echo "Job step exit code = $LOADL_JOB_STEP_EXIT_CODE" >> $LOG
fi
#
#
Do clean up based upon job step class
#
case $LOADL_STEP_CLASS in
 # A OSL job just ran, unmount the filesystem.
 "OSL")
 umount_osl_files >> $LOG
 ;;
 # A simulation job just ran, remove input files.
 # Copy results if simulation was successful (second argument
 # contains exit status from job step).
 "sim")
 rm_sim_data >> $LOG
 if [$2 = 0]
 then copy_sim_results >> $LOG
 fi
 ;;
 # Clean up /tmp
 *)
 clean_tmp >> $LOG
 ;;
esac
```

- **Sample of an epilog program for C shell**

```
#!/bin/csh
#
Set up environment
source /u/loadl/.login
```

```

#
setenv PATH "${PATH}:/loctools/lladmin/bin"
setenv LOG "/tmp/${LOADL_STEP_OWNER}.${LOADL_STEP_ID}.prolog"
#
if (${LOADL_PROLOG_EXIT_CODE}) then
echo "Prolog exit code = $LOADL_PROLOG_EXIT_CODE" >> $LOG
else
echo "Prolog did not run" >> $LOG
endif
#
if (${LOADL_USER_PROLOG_EXIT_CODE}) then
echo "User environment exit code = $LOADL_USER_PROLOG_EXIT_CODE" >> $LOG
else
echo "User environment prolog did not run" >> $LOG
endif
#
if (${LOADL_JOB_STEP_EXIT_CODE}) then
echo "Job step exit code = $LOADL_JOB_STEP_EXIT_CODE" >> $LOG
else
echo "Job step did not run" >> $LOG
endif
#
Do clean up based upon job step class
#
switch ($LOADL_STEP_CLASS)
A OSL job just ran, unmount the filesystem.
case "OSL":
umount_osl_files >> $LOG
breaksw
A simulation job just ran, remove input files.
Copy results if simulation was successful (second argument
contains exit status from job step).
case "sim":
rm_sim_data >> $LOG
if ($argv{2} == 0) then
copy_sim_results >> $LOG
endif
breaksw
Clean up /tmp
default:
clean_tmp >> $LOG
breaksw
endsw

```

## Using your own mail program

You can write a program to override the LoadLeveler default mail notification method. You can use this program, for example, to display your own messages to users when a job completes, or to automate tasks such as sending error messages to a network manager.

The syntax for the program is the same as it is for standard UNIX mail programs; the command is called with the following arguments:

- **-s** to indicate a subject.
- A pointer to a string containing the subject.
- A pointer to a string containing a list of mail recipients.

The mail message is taken from standard input.

To enable this program to replace the default mail notification method, use the **MAIL** keyword in the configuration file. For details about specific keyword syntax and use in the configuration file, see Chapter 11, "Configuration file reference," on page 231.



---

# Chapter 4. Defining LoadLeveler resources to administer

After installing LoadLeveler, you may customize it by modifying the **administration** file. The administration file optionally lists and defines the machines in the LoadLeveler cluster and the characteristics of classes, users, and groups.

LoadLeveler does not prevent you from having multiple copies of administration files, but you need to be sure to update all the copies whenever you make a change to one. Having only one administration file prevents any confusion.

Table 13 lists the LoadLeveler resources you may define by modifying the administration file.

*Table 13. Roadmap of tasks for modifying the LoadLeveler administration file*

| To learn about:                                   | Read the following:                                                                                                                                                                                                                                                                     |
|---------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Modifying the administration file                 | "Steps for modifying an administration file"                                                                                                                                                                                                                                            |
| Defining LoadLeveler resources to administer      | <ul style="list-style-type: none"><li>• "Defining machines" on page 78</li><li>• "Defining adapters" on page 80</li><li>• "Defining classes" on page 83</li><li>• "Defining users" on page 87</li><li>• "Defining groups" on page 89</li><li>• "Defining clusters" on page 90</li></ul> |
| Correctly specifying administration file keywords | Chapter 12, "Administration file reference," on page 287                                                                                                                                                                                                                                |

---

## Steps for modifying an administration file

All LoadLeveler commands, daemons, and processes read the administration and configuration files at start up time. If you change the administration or configuration files after LoadLeveler has already started, any LoadLeveler command or process, such as the **LoadL\_starter** process, will read the newer version of the files while the running daemons will continue to use the data from the older version. To ensure that all LoadLeveler commands, daemons, and processes use the same configuration data, run the reconfiguration command on all machines in the cluster each time the administration or configuration files are changed.

**Before you begin:** You need to:

- Ensure that the installation procedure has completed successfully and that the administration file, **LoadL\_admin**, exists in LoadLeveler's home directory. For additional details about installation, see *LoadLeveler Installation Guide*.
- Know how to correctly specify keywords in the administration file. For information about administration file keyword syntax and other details, see Chapter 12, "Administration file reference," on page 287.
- (Optional) Know how to correctly issue the **llextrPD** or **llextrSDR** commands, if you choose to use them. For information about these commands, see "llextrPD - Extract data from an RSCT peer domain" on page 401 or "llextrSDR - Extract adapter information from the SDR" on page 404, respectively.

## Customizing the administration file

Perform the following steps to modify the administration file, **LoadL\_admin**:

1. Identify yourself as a LoadLeveler administrator using the **LOADL\_ADMIN** keyword.
2. In the administration file, provide the following stanza types:
  - One machine stanza to define the central manager for the LoadLeveler cluster. You also may create machine stanzas for other machines in the LoadLeveler cluster.  
You may use the **llexthSDR** or **llexthRPD** commands to automatically create machine stanzas.
  - (Optional) An adapter stanza for each type of network adapter that you want LoadLeveler jobs to be able to request.  
You may use the **llexthSDR** or **llexthRPD** commands to automatically create adapter stanzas.
3. (Optional) Specify one or more of the following stanza types:
  - A class stanza for each set of LoadLeveler jobs that have similar characteristics or resource requirements.
  - A user stanza for specific users, if their requirements do not match those characteristics defined in the default user stanza.
  - A group stanza for each set of LoadLeveler users that have similar characteristics or resource requirements.
4. (Optional) You may specify values for additional administration file keywords, which are listed and described in “Administration file keyword descriptions” on page 291.
5. Notify LoadLeveler daemons by issuing the **llctl** command with either the **reconfig** or **recycle** keyword. Otherwise, LoadLeveler will not process the modifications you made to the administration file.

---

## Defining machines

The information in a machine stanza defines the characteristics of that machine. You do not have to specify a machine stanza for every machine in the LoadLeveler cluster, but you must have one machine stanza for the machine that will serve as the central manager.

If you do not specify a machine stanza for a machine in the cluster, the machine and the central manager still communicate and jobs are scheduled on the machine but the machine is assigned the default values specified in the default machine stanza. If there is no default stanza, the machine is assigned default values set by LoadLeveler.

Any machine name used in the stanza must be a name which can be resolved to an IP address. This name is referred to as an interface name because the name can be used for a program to interface with the machine. Generally, interface names match the machine name, but they do not have to.

By default, LoadLeveler will append the DNS domain name to the end of any machine name without a domain name appended before resolving its address. If you specify a machine name without a domain name appended to it and you do not want LoadLeveler to append the DNS domain name to it, specify the name using a trailing period. You may have a need to specify machine names in this way if you are running a cluster with more than one nameserving technique. For example, if you are using a DNS nameserver and running NIS, you may have some machine names which are resolved by NIS which you do not want

LoadLeveler to append DNS names to. In situations such as this, you also want to specify **name\_server** keyword in your machine stanzas.

Under the following conditions, you must have a machine stanza for the machine in question:

- If you set the **MACHINE\_AUTHENTICATE** keyword to **true** in the configuration file, then you must create a machine stanza for each node that LoadLeveler includes in the cluster.
- If the machine's hostname (the name of the machine returned by the UNIX `hostname` command) does not match an interface name. In this case, you must specify the interface name as the machine stanza name and specify the machine's hostname using the **alias** keyword.
- If the machine's hostname does match an interface name but not the correct interface name.

For information on automatically creating machine stanzas, see "llexSDR - Extract adapter information from the SDR" on page 404 or "llexRPD - Extract data from an RSCT peer domain" on page 401.

## Planning considerations for defining machines

Before customizing the administration file, consider the following:

- **Node availability**

Some workstation owners might agree to accept LoadLeveler jobs only when they are not using the workstation themselves. Using LoadLeveler keywords, these workstations can be configured to be available at designated times only.

- **Common name space**

To run jobs on any machine in the LoadLeveler cluster, a user needs the same uid (the user ID number for a user) and gid (the group ID number for a group) on every machine in the cluster.

For example, if there are two machines in your LoadLeveler cluster, *machine\_1* and *machine\_2*, user john must have the same user ID and login group ID in the `/etc/passwd` file on both machines. If user john has user ID 1234 and login group ID 100 on *machine\_1*, then user john must have the same user ID and login group ID in `/etc/passwd` on *machine\_2*. (LoadLeveler requires a job to run with the same group ID and user ID of the person who submitted the job.)

If you do not have a user ID on one machine, your jobs will not run on that machine. Also, many commands, such as `llq`, will not work correctly if a user does not have a user ID on the central manager machine.

However, there are cases where you may choose to not give a user a login ID on a particular machine. For example, a user does not need an ID on every submit-only machine; the user only needs to be able to submit jobs from at least one such machine. Also, you may choose to restrict a user's access to a schedd machine that is not a public scheduler; again, the user only needs access to at least one schedd machine.

- **Resource handling**

Some nodes in the LoadLeveler cluster might have special software installed that users might need to run their jobs successfully. You should configure LoadLeveler to distinguish those nodes from other nodes using, for example, machine features.

### Machine stanza format and keyword summary

Machine stanzas take the following format. Default values for keywords appear in bold:

```
label: type = machine
adapter_stanzas = stanza_list
alias = machine_name
central_manager = true | false | alt
cpu_speed_scale = true | false
dce_host_name = dce_hostname
machine_mode = batch | interactive | general
master_node_exclusive = true | false
max_jobs_scheduled = number
name_server = list
pool_list = pool_numbers
reservation_permitted = true | false
resources = name(count) name(count) ... name(count)
schedd_fenced = true | false
schedd_host = true | false
spacct_exclude_enable = true | false
speed = number
submit_only = true | false
```

Figure 11. Format of a machine stanza

### Examples: Machine stanzas

- **Example 1**

In this example, the machine is being defined as the central manager.

```
#
machine_a: type = machine
central_manager = true # central manager runs here
```

- **Example 2**

This example sets up a submit-only node. Note that the **submit-only** keyword in the example is set to **true**, while the **schedd\_host** keyword is set to **false**. You must also ensure that you set the **schedd\_host** to **true** on at least one other node in the cluster.

```
#
machine_b: type = machine
central_manager = false # not the central manager
schedd_host = false # not a scheduling machine
submit_only = true # submit only machine
alias = machineb # interface name
```

- **Example 3**

In the following example, machine\_c is the central manager and has an alias associated with it:

```
#
machine_c: type = machine
central_manager = true # central manager runs here
schedd_host = true # defines a public scheduler
alias = brianne
```

---

## Defining adapters

An adapter stanza identifies network adapters that are available on the machines in the LoadLeveler cluster. If you want LoadLeveler jobs to be able to request specific adapters, you must either specify adapter stanzas or configure dynamic adapters in the administration file.

Note the following when using an adapter stanza:

- An adapter stanza is required for each adapter stanza name you specify on the **adapter\_stanzas** keyword of the machine stanza.
- The **adapter\_name**, **interface\_address**, and **interface\_name** keywords are required. For an SP switch adapter, the **switch\_node\_number** keyword is also required.
- For a High Performance Switch (HPS), the **logical\_id** and **network\_id** keywords are required.

For more information about dynamic adapters, see “Configuring dynamic adapters.”

For information on creating adapter stanzas, see “llexSDR - Extract adapter information from the SDR” on page 404 for PSSP domains or “llexRPD - Extract data from an RSCT peer domain” on page 401 for peer domains.

## Configuring dynamic adapters

LoadLeveler for Linux does not support dynamic adapter configurations.

LoadLeveler can dynamically determine the adapters in any OSI that has RSCT installed. This is true for an OSI that is in either a PEER domain or a PSSP domain. LoadLeveler must be told on an OSI basis if it is to handle dynamic adapter configuration changes for that OSI. The specification of whether to use dynamic or static adapter configuration for an OSI is done through the presence or absence of the machine stanza’s **adapter\_stanzas** keyword.

If a machine stanza in the administration file contains an **adapter\_stanzas** statement then this is taken as a directive by the LoadLeveler administrator to use only those specified adapters. For this OSI, LoadLeveler will not perform any dynamic adapter configuration or processing. If an adapter change occurs in this OSI then the administrator will have to make the corresponding change in the administration file and then stop and restart or reconfigure the LoadLeveler startd daemon to pick up the adapter changes. If an OSI (machine stanza) in the administration file does not contain the **adapter\_stanzas** keyword then this is taken as a directive by the LoadLeveler administrator for LoadLeveler to dynamically configure the adapters for that OSI. For that OSI, LoadLeveler will determine what adapters are present at startup via calls to the RMCAP. If an adapter change occurs during execution in the OSI then LoadLeveler will automatically detect and handle the change without requiring a restart or reconfiguration.

## Adapter stanza format and keyword summary

An adapter stanza has the following format:

## Customizing the administration file

```
label: type = adapter
adapter_name = name
adapter_type = type
css_type = type
device_driver_name = name
interface_address = IP_address
interface_name = name
logical_id = id
multilink_address = ip_address
multilink_list = adapter_name <, adapter_name>*
network_id = id
network_type = type
switch_node_number = integer
```

Figure 12. Format of an adapter stanza

## Examples: Adapter stanzas

- **Example 1: Specifying an adapter from the SP Switch2 family**

In the following example, the adapter stanza called “sp01sw.ibm.com” specifies an SP switch adapter. Note that sp01sw.ibm.com is also specified on the **adapter\_stanzas** keyword of the machine stanza for the “yugo” machine.

```
yugo: type=machine
 adapter_stanzas = sp01sw.ibm.com
...

sp01sw.ibm.com: type = adapter
 adapter_name = css0
 interface_address = 12.148.44.218
 interface_name = sp01sw.ibm.com
 network_type = switch
 switch_node_number = 7
 css_type = SP_Switch_MX2_Adapter
```

- **Example 2: Specifying an HPS adapter**

In the following example, the adapter stanza called “c121s0n10.ppd.pok.ibm.com” specifies an HPS adapter. Note that c121s0n10.ppd.pok.ibm.com is also specified on the **adapter\_stanzas** keyword of the machine stanza for the “yugo” machine.

```
yugo: type=machine
 adapter_stanzas = c121s0n10.ppd.pok.ibm.com
...

c121s0n10.ppd.pok.ibm.com: type = adapter
 adapter_name = sn0
 network_type = switch
 interface_address = 192.168.0.10
 interface_name = c121s0n10.ppd.pok.ibm.com
 multilink_address = 10.10.10.10
 logical_id = 2
 adapter_type = Switch_Network_Interface_For_HPS
 device_driver_name = sni0
 network_id = 1

c121f2rp02.ppd.pok.ibm.com: type = adapter
 adapter_name = en0
 network_type = ethernet
 interface_address = 9.114.66.74
 interface_name = c121f2rp02.ppd.pok.ibm.com
 device_driver_name = ent0
```

## Defining classes

The information in a class stanza defines characteristics for that class. These characteristics can include the quantities of consumable resources that may be used by a class per machine or cluster.

## Using limit keywords

A limit is the amount of a resource that a job step or a process is allowed to use. (A process is a dispatchable unit of work.) A job step may be made up of several processes.

Limits include both a **hard limit** and a **soft limit**. When a hard limit is exceeded, the job is usually terminated. When a soft limit is exceeded, the job is usually given a chance to perform some recovery actions. Limits are enforced either per process or per job step, depending on the type of limit. For parallel jobs steps, which consist of multiple tasks running on multiple machines, limits are enforced on a per task basis.

The class stanza includes the following **limit** keywords, which allow you to control the amount of resources used by a job step or a job process.

Table 14. Types of limit keywords

| Limit                   | How the limit is enforced |
|-------------------------|---------------------------|
| <b>ckpt_time_limit</b>  | Per job step              |
| <b>core_limit</b>       | Per process               |
| <b>cpu_limit</b>        | Per process               |
| <b>data_limit</b>       | Per process               |
| <b>file_limit</b>       | Per process               |
| <b>job_cpu_limit</b>    | Per job step              |
| <b>rss_limit</b>        | Per process               |
| <b>stack_limit</b>      | Per process               |
| <b>wall_clock_limit</b> | Per job step              |

For example, a common limit is the **cpu\_limit**, which limits the amount of CPU time a single process can use. If you set **cpu\_limit** to five hours and you have a job step that forks five processes, each process can use up to five hours of CPU time, for a total of 25 CPU hours. Another limit that controls the amount of CPU used is **job\_cpu\_limit**. For a serial job step, if you impose a **job\_cpu\_limit** of five hours, the entire job step (made up of all five processes) cannot consume more than five CPU hours. For information on using this keyword with parallel jobs, see 340.

You can specify limits in either the class stanza of the administration file or in the job command file. The lower of these two limits will be used to run the job even if the system limit for the user is lower. For more information, see:

- “Enforcing limits” on page 84
- “Administration file keyword descriptions” on page 291 or “Job command file keyword descriptions” on page 324

### Enforcing limits

LoadLeveler depends on the underlying operating system to enforce process limits. Users should verify that a process limit such as **rss\_limit** is enforced by the operating system, otherwise setting it in LoadLeveler will have no effect.

**Exceeding job step limits:** When a hard limit is exceeded LoadLeveler sends a *non-trappable* signal (except in the case of a parallel job) to the process group that LoadLeveler created for the job step. When a soft limit is exceeded, LoadLeveler sends a *trappable* signal to the process group. Any job application that intends to trap a signal sent by LoadLeveler must ensure that all processes in the process group set up the appropriate signal handler.

All processes in the job step normally receive the signal. The exception to this rule is when a child process creates its own process group. That action isolates the child's process, and its children, from any signals that LoadLeveler sends. Any child process creating its own process group is still known to process tracking. So, if process tracking is enabled, all the child processes are terminated when the main process terminates.

Table 15 summarizes the actions that the LoadL\_starter daemon takes when a job step limit is exceeded.

Table 15. Enforcing job step limits

| Type of Job | When a Soft Limit is Exceeded                                      | When a Hard Limit is Exceeded |
|-------------|--------------------------------------------------------------------|-------------------------------|
| Serial      | SIGXCPU or SIGKILL issued                                          | SIGKILL issued                |
| Parallel    | SIGXCPU issued to both the user program and to the parallel daemon | SIGTERM issued                |

On systems that do not support SIGXCPU, LoadLeveler does not distinguish between hard and soft limits. When a soft limit is reached on these platforms, LoadLeveler issues a SIGKILL.

**Enforcing per process limits:** For per process limits, what happens when your job reaches and exceeds either the soft limit or the hard limit depends on the operating system you are using.

When a job forks a process that exceeds a per process limit, such as the CPU limit, the operating system (not LoadLeveler) terminates the process by issuing a SIGXCPU. As a result, you will not see an entry in the LoadLeveler logs indicating that the process exceeded the limit. The job will complete with a 0 return code. LoadLeveler can only report the status of any processes it has started.

If you need more specific information, refer to your operating system documentation.

**How LoadLeveler uses hard limits:** See Table 16 on page 85 for more information on specifying limits.

Table 16. Setting limits

| If the hard limit is:                                                           | Then LoadLeveler does the following:                                                                                                                                                                                                                                                                                                                                                                                                         |
|---------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Set in both the class stanza and the job command file                           | Smaller of the two limits is taken into consideration. If the smaller limit is the job limit, the job limit is then compared with the user limit set on the machine that runs the job. The smaller of these two values is used. If the limit used is the class limit, the class limit is used without being compared to the machine limit.                                                                                                   |
| Not set in either the class stanza or the job command file                      | User per process limit set on the machine that runs the job is used.                                                                                                                                                                                                                                                                                                                                                                         |
| Set in the job command file and is less than its respective job soft limit      | The job is not submitted.                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Set in the class stanza and is less than its respective class stanza soft limit | Soft limit is adjusted downward to equal the hard limit.                                                                                                                                                                                                                                                                                                                                                                                     |
| Specified in the job command file                                               | <p>Hard limit must be greater than or equal to the specified soft limit and less than or equal to the limit set by the administrator in the class stanza of the administration file.</p> <p>Note: If the per process limit is not defined in the administration file and the hard limit defined by the user in the job command file is greater than the limit on the executing machine, then the hard limit is set to the machine limit.</p> |

## Allowing users to use a class

In a class stanza, you may define a list of users or a list of groups to identify those who may use the class. To do so, use the **include\_users** or **include\_groups** keyword, respectively, or you may use both keywords. If you specify both keywords, a particular user must satisfy both the **include\_users** and the **include\_groups** restrictions for the class. This requirement means that a particular user must be defined not only in a User stanza in the administration file, but also in one of the following ways:

- The user's name must appear in the **include\_users** keyword in a Group stanza whose name corresponds to a name in the **include\_groups** keyword of the Class stanza.
- The user's name must appear in the **include\_groups** keyword of the Class stanza. For information about specifying a user name in a group list, see the **include\_groups** keyword description in "Administration file keyword descriptions" on page 291.

## Class stanza format and keyword summary

Class stanzas are optional. Class stanzas take the following format. Default values for keywords appear in bold.

## Customizing the administration file

```
label: type = class
admin= list
ckpt_dir = directory
ckpt_time_limit = hardlimit,softlimit
class_comment = "string"
core_limit = hardlimit,softlimit
cpu_limit = hardlimit,softlimit
data_limit = hardlimit,softlimit
default_resources = name(count) name(count)...name(count)
env_copy = all | master
exclude_groups = list
exclude_users = list
file_limit = hardlimit,softlimit
include_groups = list
include_users = list
job_cpu_limit = hardlimit,softlimit
master_node_requirement = true | false
max_node = number
max_processors = number
max_protocol_instances = number
max_total_tasks = number
maxjobs = number
nice = value
NQS_class = true | false
NQS_submit = name
NQS_query = queue names
priority = number
rss_limit = hardlimit,softlimit
stack_limit = hardlimit,softlimit
total_tasks = number
wall_clock_limit = hardlimit,softlimit
```

Figure 13. Format of a class stanza

## Examples: Class stanzas

- **Example 1: Creating a class that excludes certain users**

```
class_a: type=class # class that excludes users
priority=10 # ClassSysprio
exclude_users=green judy # Excluded users
```

- **Example 2: Creating a class for small-size jobs**

```
small: type=class # class for small jobs
priority=80 # ClassSysprio (max=100)
cpu_limit=00:02:00 # 2 minute limit
data_limit=30mb # max 30 MB data segment
default_resources=ConsumableVirtualMemory(10mb) # resources consumed by each
ConsumableCpus(1) resA(3) floatinglicenseX(1) # task of a small job step if
 # resources are not explicitly
 # specified in the job command file
ckpt_time_limit=3:00,2:00 # 3 minute hardlimit,
 # 2 minute softlimit
core_limit=10mb # max 10 MB core file
file_limit=50mb # max file size 50 MB
stack_limit=10mb # max stack size 10 MB
rss_limit=35mb # max resident set size 35 MB
include_users = bob sally # authorized users
```

- **Example 3: Creating a class for medium-size jobs**

```
medium: type=class # class for medium jobs
priority=70 # ClassSysprio
cpu_limit=00:10:00 # 10 minute run time limit
data_limit=80mb,60mb # max 80 MB data segment
 # soft limit 60 MB data segment
ckpt_time_limit=5:00,4:30 # 5 minute hardlimit,
```

```

 # 4 minute 30 second softlimit to checkpoint
core_limit=30mb # max 30 MB core file
file_limit=80mb # max file size 80 MB
stack_limit=30mb # max stack size 30 MB
rss_limit=100mb # max resident set size 100 MB
job_cpu_limit=1800,1200 # hard limit is 30 minutes,
 # soft limit is 20 minutes

```

- **Example 4: Creating a class for large-size jobs**

```

large: type=class # class for large jobs
priority=60 # ClassSysprio
cpu_limit=00:10:00 # 10 minute run time limit
data_limit=120mb # max 120 MB data segment
default_resources=ConsumableVirtualMemory(40mb) # resources consumed
ConsumableCpus(2) resA(8) floatinglicenseX(1) resB(1) # by each task of
 # a large job step if resources are not
 # explicitly specified in the job command file
ckpt_time_limit=7:00,5:00 # 7 minute hardlimit,
 # 5 minute softlimit to checkpoint
core_limit=30mb # max 30 MB core file
file_limit=120mb # max file size 120 MB
stack_limit=unlimited # unlimited stack size
rss_limit=150mb # max resident set size 150 MB
job_cpu_limit = 3600,2700 # hard limit 60 minutes
 # soft limit 45 minutes
wall_clock_limit=12:00:00,11:59:55 # hard limit is 12 hours

```

- **Example 5: Creating a class to route jobs to NQS machines**

```

nqs: type=class # class for NQS jobs
NQS_class=true
NQS_submit=pipe_queue # NQS pipe queue name
NQS_query=one two three # list of queue names

```

You can use the class names in control expressions in both the global and local configuration file.

- **Example 6: Creating a class for master node machines**

```

sp-6hr-sp: type=class # class for master node machines
priority=50 # ClassSysprio (max=100)
ckpt_time_limit=25:00,20:00 # 25 minute hardlimit,
 # 20 minute softlimit to checkpoint
cpu_limit = 06:00:00 # 6 hour limit
job_cpu_limit = 06:00:00 # hard limit is 6 hours
core_limit = 1mb # max 1MB core file
master_node_requirement = true # master node definition

```

- **Example 7: Creating a class for MPICH-GM jobs**

```

MPICHGM: type=class # class for MPICH-GM jobs
default_resources = gports(1) # one gports resource is consumed by each
 # task, if resources are not explicitly
 # specified in the job command file

```

---

## Defining users

The information specified in a user stanza defines the characteristics of that user. You can have one user stanza for each user but this is not necessary. If an individual user does not have their own user stanza, that user uses the defaults defined in the default user stanza.

## User stanza format and keyword summary

User stanzas take the following format:

## Customizing the administration file

```
label: type = user
account = list
default_class = list
default_group = group name
default_interactive_class = class name
env_copy = all | master
max_node = number
max_processors = number
max_reservation_duration = number
max_reservations = number
max_total_tasks = number
maxidle = number
maxjobs = number
maxqueued = number
priority = number
total_tasks = number
```

Figure 14. Format of a user stanza

## Examples: User stanzas

- **Example 1**

In this example, user fred is being provided with a user stanza. His jobs will have a user priority of 100. If he does not specify a job class in his job command file, the default job class **class\_a** will be used. In addition, he can have a maximum of 15 jobs running at the same time.

```
Define user stanzas
fred: type = user
priority = 100
default_class = class_a
maxjobs = 15
```

- **Example 2**

This example explains how a default interactive class for a parallel job is set by presenting a series of user stanzas and class stanzas. This example assumes that users do not specify the `LOADL_INTERACTIVE_CLASS` environment variable.

```
default: type = user
 default_interactive_class = red
 default_class = blue

carol: type = user
 default_class = single double
 default_interactive_class = ijobs

steve: type = user
 default_class = single double

ijobs: type = class
 wall_clock_limit = 08:00:00

red: type = class
 wall_clock_limit = 30:00
```

If the user Carol submits an interactive job, the job is assigned to the default interactive class called **ijobs**. The job is assigned a wall clock limit of 8 hours. If the user Steve submits an interactive job, the job is assigned to the **red** class from the default user stanza. The job is assigned a wall clock limit of 30 minutes.

- **Example 3**

In this example, Jane's jobs have a user priority of 50, and if she does not specify a job class in her job command file the default job class **small\_jobs** is used. This

user stanza does not specify the maximum number of jobs that Jane can run at the same time so this value defaults to the value defined in the default stanza. Also, suppose Jane is a member of the primary UNIX group “staff.” Jobs submitted by Jane will use the default LoadLeveler group “staff.” Lastly, Jane can use three different account numbers.

```
Define user stanzas
jane: type = user
 priority = 50
 default_class = small_jobs
 default_group = Unix_Group
 account = dept10 user3 user4
```

---

## Defining groups

LoadLeveler groups are another way of granting control to the system administrator. Although a LoadLeveler group is independent from a UNIX group, you can configure a LoadLeveler group to have the same users as a UNIX group by using the **include\_users** keyword.

### Group stanza format and keyword summary

The information specified in a group stanza defines the characteristics of that group. Group stanzas are optional and take the following format:

```
label: type = group
admin = list
env_copy = all | master
exclude_users = list
include_users = list
max_node = number
max_processors = number
max_reservation_duration = number
max_reservations = number
max_total_tasks = number
maxidle = number
maxjobs = number
maxqueued = number
priority = number
total_tasks = number
```

Figure 15. Format of a group stanza

### Examples: Group stanzas

- **Example 1**

In this example, the group name is **department\_a**. The jobs issued by users belonging to this group will have a priority of 80. There are three members in this group.

```
Define group stanzas
department_a: type = group
priority = 80
include_users = susann holly fran
```

- **Example 2**

In this example, the group called **great\_lakes** has five members and these user's jobs have a priority of 100:

```
Define group stanzas
great_lakes: type = group
priority = 100
include_users = huron ontario michigan erie superior
```

## Defining clusters

The cluster stanza defines the LoadLeveler multicluster environment. Any cluster that wants to participate in the multicluster must have cluster stanzas defined for all clusters with which the local cluster interacts. If you have a cluster stanza defined, LoadLeveler is configured to be in the multicluster environment.

### Cluster stanza format and keyword summary

Cluster stanzas are optional. Cluster stanzas take the following format. Default values for keywords appear in bold.

The cluster stanza label must define a unique cluster name within the multicluster environment.

```
label: type = cluster
exclude_classes = class_name[(cluster_name)] ...
exclude_groups = group_name[(cluster_name)] ...
exclude_users = user_name[(cluster_name)] ...
inbound_hosts = hostname[(cluster_name)] ...
inbound_schedd_port = port_number
include_classes = class_name[(cluster_name)] ...
include_groups = group_name[(cluster_name)] ...
include_users = user_name[(clustername)] ...
local = true | false
multicluster_security = SSL
outbound_hosts = hostname[(cluster_name)] ...
secure_schedd_port = port_number
ssl_cipher_list = cipher_list
```

Figure 16. Format of a cluster stanza

### Examples: Cluster stanzas

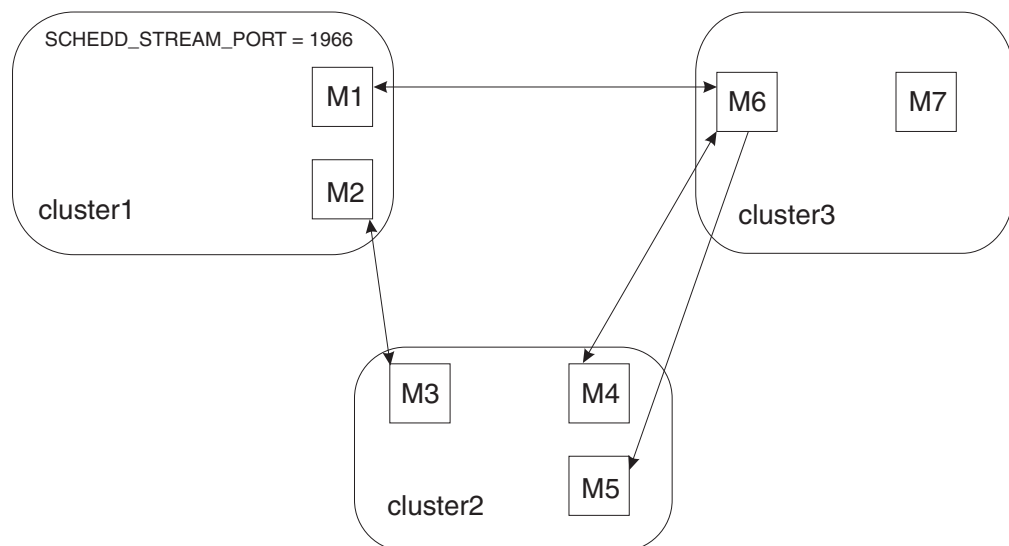


Figure 17. Multicluster Example

Figure 17 shows a simple multicluster with three clusters defined as members. Cluster1 has defined an alternate port number for the schedds running in its cluster by setting the **SCHEDD\_STREAM\_PORT = 1966**. All of the other clusters need to define what port to use when connecting to the inbound schedds of cluster1 by

specifying the **inbound\_schedd\_port = 1966** keyword in the cluster1 stanza. Cluster2 has a single machine connected to cluster1 and 2 machines connected to cluster3. Cluster3 has a single machine connected to both cluster2 and cluster1. Each cluster would set the **local** keyword to **true** for their cluster stanza in the cluster's administration file.

### **Multicluster with 3 clusters defined as members**

```
cluster1: type=cluster
 outbound_hosts = M2(cluster2) M1(cluster3)
 inbound_hosts = M2(cluster2) M1(cluster3)
 inbound_schedd_port = 1966

cluster2: type=cluster
 outbound_hosts = M3(cluster1) M4(cluster3)
 inbound_hosts = M3(cluster1) M4(cluster3) M5(cluster3)

cluster3: type=cluster
 outbound_hosts = M6
 inbound_hosts = M6
```



---

## Chapter 5. Performing additional administrator tasks

Table 17 lists additional ways to modify the LoadLeveler environment that either require an administrator to customize both the configuration and administration files, or require the use of the LoadLeveler commands or APIs.

*Table 17. Roadmap of additional administrator tasks*

| To learn about:                                                     | Read the following:                                                                                                                                                                                                                                                                                                            |
|---------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Setting up the environment for parallel jobs                        | "Setting up the environment for parallel jobs" on page 94                                                                                                                                                                                                                                                                      |
| Configuring and using alternative schedulers                        | <ul style="list-style-type: none"><li>• "Using the backfill scheduler" on page 98</li><li>• "Using the gang scheduler" on page 100</li><li>• "Using an external scheduler" on page 104</li><li>• "Example: Changing scheduler types" on page 115</li></ul>                                                                     |
| Using additional features available with an alternative scheduler   | <ul style="list-style-type: none"><li>• "Preempting and resuming jobs" on page 115</li><li>• "Configuring LoadLeveler to support reservations" on page 120</li></ul>                                                                                                                                                           |
| Working with AIX's workload balancing component                     | "Steps for integrating LoadLeveler with AIX Workload Manager" on page 126                                                                                                                                                                                                                                                      |
| Enabling LoadLeveler's checkpoint/restart function                  | "Checkpointing jobs" on page 128                                                                                                                                                                                                                                                                                               |
| Setting up the environment for NQS jobs                             | "Routing jobs to NQS machines" on page 135                                                                                                                                                                                                                                                                                     |
| Enabling LoadLeveler's scheduling affinity support                  | "LoadLeveler scheduling affinity support" on page 137                                                                                                                                                                                                                                                                          |
| Enabling LoadLeveler's multicluster support                         | <ul style="list-style-type: none"><li>• "LoadLeveler multicluster support" on page 139</li><li>• "Configuring a LoadLeveler multicluster" on page 140</li></ul>                                                                                                                                                                |
| Enabling LoadLeveler's Blue Gene support                            | <ul style="list-style-type: none"><li>• "LoadLeveler Blue Gene support" on page 143</li><li>• "Configuring LoadLeveler Blue Gene support" on page 145</li></ul>                                                                                                                                                                |
| Correctly specifying configuration and administration file keywords | <ul style="list-style-type: none"><li>• Chapter 11, "Configuration file reference," on page 231</li><li>• Chapter 12, "Administration file reference," on page 287</li></ul>                                                                                                                                                   |
| Managing LoadLeveler operations                                     | <ul style="list-style-type: none"><li>• Querying status<ul style="list-style-type: none"><li>• "llclass - Query class information" on page 387</li><li>• "llq - Query job status" on page 431</li><li>• "llqres - Query a reservation" on page 449</li><li>• "llstatus - Query machine status" on page 455</li></ul></li></ul> |

## Setting up the environment for parallel jobs

Table 17. Roadmap of additional administrator tasks (continued)

| To learn about:                                                                         | Read the following:                                                                                                                                                                                                                                                                                                                       |
|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>• Changing attributes of submitted jobs</li></ul> | <ul style="list-style-type: none"><li>• “llfavorjob - Reorder system queue by job” on page 408</li><li>• “llfavoruser - Reorder system queue by user” on page 410</li><li>• “llmodify - Change attributes of a submitted job step” on page 419</li><li>• “llprio - Change the user priority of submitted job steps” on page 429</li></ul> |
| <ul style="list-style-type: none"><li>• Changing the state of submitted jobs</li></ul>  | <ul style="list-style-type: none"><li>• “llcancel - Cancel a submitted job” on page 377</li><li>• “llhold - Hold or release a submitted job” on page 411</li></ul>                                                                                                                                                                        |

## Setting up the environment for parallel jobs

This chapter describes administration tasks that apply to parallel jobs. For information on submitting parallel jobs, see “Working with parallel jobs” on page 168.

### Scheduling considerations for parallel jobs

For parallel jobs, LoadLeveler supports gang scheduling and backfill scheduling for efficient use of system resources. These schedulers run both serial and parallel jobs, but they are meant primarily for installations running parallel jobs.

Gang and backfill scheduling also support:

- Multiple tasks per node
- Multiple user space tasks per adapter
- Preemption

Specify the LoadLeveler scheduler using the **SCHEDULER\_TYPE** keyword. For more information on this keyword and supported scheduler types, see “Choosing a scheduler” on page 35.

### Steps for reducing job launch overhead for parallel jobs

Administrators may define a number of LoadLeveler starter processes to be ready and waiting to handle job requests. Having this pool of ready processes reduces the amount of time LoadLeveler needs to prepare jobs to run. You also may control how environment variables are copied for a job. Reducing the number of environment variables that LoadLeveler has to copy reduces the amount of time LoadLeveler needs to prepare jobs to run.

**Before you begin:** You need to know:

- How many jobs might be starting at the same time. This estimate determines how many starter processes to have LoadLeveler start in advance, to be ready and waiting for job requests.
- The type of parallel jobs that typically are used. If IBM Parallel Environment (PE) is used for parallel jobs, PE copies the user’s environment to all executing nodes. In this case, you may configure LoadLeveler to avoid redundantly copying the same environment variables.

- How to correctly specify configuration keywords. For details about specific keyword syntax and use:
  - In the administration file, see Chapter 12, “Administration file reference,” on page 287.
  - In the configuration file, see Chapter 11, “Configuration file reference,” on page 231.

Perform the following steps to configure LoadLeveler to reduce job launch overhead for parallel jobs.

1. In the local or global configuration file, specify the number of starter processes for LoadLeveler to automatically start before job requests are submitted. Use the **PRESTARTED\_STARTERS** keyword to set this value.

**Tip:** The default value of 1 should be sufficient for most installations.

2. If typical parallel jobs use a facility such as Parallel Environment, which copies user environment variables to all executing nodes, set the **env\_copy** keyword in the class, user, or group stanzas to specify that LoadLeveler only copy user environment variables to the master node by default.

**Rules:**

- Users also may set this keyword in the job command file. If the **env\_copy** keyword is set in the job command file, that setting overrides any setting in the administration file. For more information, see “Step for controlling whether LoadLeveler copies environment variables to all executing nodes” on page 169.
  - If the **env\_copy** keyword is set in more than one stanza in the administration file, LoadLeveler determines the setting to use by examining all values set in the applicable stanzas. See Table 44 on page 298 to determine what value LoadLeveler will use.
3. Notify LoadLeveler daemons by issuing the **llctl** command with either the **reconfig** or **recycle** keyword. Otherwise, LoadLeveler will not process the modifications you made to the configuration and administration files.

When you are done with this procedure, you can use the POE stderr and LoadLeveler logs to trace actions during job launch.

## Steps for allowing users to submit interactive POE jobs

Perform the following steps to set up your system so that users can submit interactive POE jobs to LoadLeveler.

1. Make sure that you have installed LoadLeveler and defined LoadLeveler administrators. See “Defining LoadLeveler administrators” on page 34 for information on defining LoadLeveler administrators.
2. If running user space jobs, LoadLeveler must be configured to use switch adapters. A way to do this is to run the **llextrSDR** or **llextrRPD** command to extract node and adapter information from the SDR or from the RSCT peer domain. See “llextrSDR - Extract adapter information from the SDR” on page 404 and “llextrRPD - Extract data from an RSCT peer domain” on page 401 for additional information on the commands.
3. In the configuration file, define your scheduler to be the LoadLeveler backfill or gang scheduler by specifying **SCHEDULER\_TYPE = BACKFILL** or **SCHEDULER\_TYPE = GANG**. See “Choosing a scheduler” on page 35 for more information.
4. In the administration file, specify batch, interactive, or general use for nodes. You can use the **machine\_mode** keyword in the machine stanza to specify the

## Setting up the environment for parallel jobs

type of jobs that can run on a node; you must specify either **interactive** or **general** if you are going to run interactive jobs.

5. In the administration file, configure optional functions, including:
  - Setting up pools: you can organize nodes into pools by using the **pool\_list** keyword in the machine stanza. See “Defining machines” on page 78 for more information.
  - Enabling SP exclusive use accounting: you can specify that the accounting function on an SP system be informed that a job step has exclusive use of a machine by specifying **spacct\_exclusive\_enable = true** in the machine stanza (as shown in the previous example).  
See “Defining machines” on page 78 for more information on these keywords.
6. Consider setting up a class stanza for your interactive POE jobs. See “Setting up a class for parallel jobs” for more information. Define this class to be your default class for interactive jobs by specifying this class name on the **default\_interactive\_class** keyword. See “Defining users” on page 87 for more information.

### Setting up a class for parallel jobs

To define the characteristics of parallel jobs run by your installation you should set up a class stanza in the administration file and define a class (in the **Class** statement in the configuration file) for each task you want to run on a node.

Suppose your installation plans to submit long-running parallel jobs, and you want to define the following characteristics:

- Only certain users can submit these jobs
- Jobs have a 30 hour run time limit
- A job can request a maximum of 60 nodes and 120 total tasks
- Jobs will have a relatively low run priority

The following is a sample class stanza for long-running parallel jobs which takes into account the above characteristics:

```
long_parallel: type=class
wall_clock_limit = 1800
include_users = jack queen king ace
priority = 50
total_tasks = 120
max_node = 60
maxjobs = 2
```

Note the following about this class stanza:

- The **wall\_clock\_limit** keyword sets a wall clock limit of 1800 seconds (30 hours) for jobs in this class
- The **include\_users** keyword allows four users to submit jobs in this class
- The **priority** keyword sets a relative priority of 50 for jobs in this class
- The **total\_tasks** keyword specifies that a user can request up to 120 total tasks for a job in this class
- The **max\_node** keyword specifies that a user can request up to 60 nodes for a job in this class
- The **maxjobs** keyword specifies that a maximum of two jobs in this class can run simultaneously

Suppose users need to submit job command files containing the following statements:

```
node = 30
tasks_per_node = 4
```

In your LoadL\_config file, you must code the **Class** statement such that at least 30 nodes have four or more long\_parallel classes defined. That is, the configuration file for each of these nodes must include the following statement:

```
Class = { "long_parallel" "long_parallel" "long_parallel" "long_parallel" }
```

or

```
Class = long_parallel(4)
```

For more information, see “Defining LoadLeveler machine characteristics” on page 44.

### Setting up a parallel master node

LoadLeveler allows you to define a parallel master node that LoadLeveler will use as the first node for a job submitted to a particular class. To set up a parallel master node, code the following keywords in the node’s class and machine stanzas in the administration file:

```
MACHINE STANZA: (optional)
mach1: type = machine
master_node_exclusive = true
```

```
CLASS STANZA: (optional)
pmv3: type = class
master_node_requirement = true
```

Specifying **master\_node\_requirement = true** forces all parallel jobs in this class to use—as their first node—a machine with the **master\_node\_exclusive = true** setting. For more information on these keywords, see “Defining machines” on page 78 and “Defining classes” on page 83.

### Configuring LoadLeveler to support MPICH-GM jobs

LoadLeveler does not manage the GM ports on the Myrinet switch. For LoadLeveler to keep track of the GM ports they must be identified as LoadLeveler consumable resources.

Perform the following steps to use consumable resources to manage GM ports:

1. Pick a name for the GM port resource.

**Example:** As an example, this procedure assumes the name is **gmports**, but you may use another name.

**Tip:** Users who submit MPICH-GM jobs need to know the name that you define for the GM port resource.

2. In the LoadLeveler configuration file, specify the GM port resource name on the **SCHEDULE\_BY\_RESOURCES** keyword.

**Example:**

```
SCHEDULE_BY_RESOURCES = gmports
```

**Tip:** If the **SCHEDULE\_BY\_RESOURCES** keyword already is specified in the configuration file, you can just add the GM port resource name to other values already listed.

## Setting up the environment for parallel jobs

3. In the administration file, specify how many GM ports are available on each machine. Use the **resources** keyword to specify the GM port resource name and the number of GM ports.

### Example:

```
resources=gmpports(n)
```

### Tips:

- The **resources** keyword also must appear in the job command file for an MPICH-GM job.

### Example:

```
resources=gmpports(1)
```

- To determine the value of *n* use either the number specified in the GM documentation or the number of GM ports you have successfully used. Certain system configurations may not support all available GM ports, so you might need to specify a lower value for the **gmpports** resource than what is actually available.
4. Issue the **llctl** command with either the **reconfig** or **recycle** keyword. Otherwise, LoadLeveler will not process the modifications you made to the configuration and administration files.

For information about submitting MPICH-GM jobs, see “Running MPICH and MPICH-GM jobs” on page 178.

---

## Using the backfill scheduler

The backfill scheduling algorithm in LoadLeveler is designed to maximize the use of resources to achieve the highest system efficiency, while preventing potentially excessive delays in starting jobs with large resource requirements. These large jobs can run because the backfill scheduler does not allow jobs with smaller resource requirements to continuously use up resources before the larger jobs can accumulate enough resources to run. While backfill can be used for both serial and parallel jobs, the potential advantage is greater with parallel jobs.

Job steps are arranged in a queue based on their **SYSPRIO** order as they arrive from the Schedd nodes in the cluster. The queue may be periodically reordered depending on the value of the **RECALCULATE\_SYSPRIO\_INTERVAL** keyword. In each dispatching cycle, as determined by the **NEGOTIATOR\_INTERVAL** and **NEGOTIATOR\_CYCLE\_DELAY** configuration keywords, the backfill algorithm will examine these job steps sequentially in an attempt to find available resources to run each job step, then dispatch those steps to run. Once the backfill algorithm encounters a job step which it cannot immediately find resources for and dispatch, that job step becomes known as the “top dog”. The backfill algorithm will attempt to calculate the time at which enough resources will become free to run the “top dog”. This is based on the assumption that each currently running job step will run until its hard wall clock limit is reached and that when the job step terminates, the resources that step had been using will become available. The time at which enough currently running job steps will have terminated, meaning enough resources have become available to run the “top dog”, is called the “top dog’s” future start time. The future start time of the “top dog” is effectively guaranteed for the remainder of the execution of the backfill algorithm. The resources the top dog will use at that time are “reserved” (not to be confused with the reservation feature available in LoadLeveler).

In some cases, it may not be possible to calculate the future start time of a job step. Consider, for example, a case where there are 20 nodes in the cluster and a job step

requires 24 nodes to run. Even when all nodes in the cluster are idle, it will not be possible for this job step to run. Only the addition of nodes to the cluster would allow the job step to run, and there is no way the backfill algorithm can make any assumptions about when that could take place. In situations like this, the job step is not considered a "top dog", no resources are "reserved", and the backfill algorithm goes on to the next job step in the queue.

Once the "top dog's" future start time and resource usages have been computed, the remaining job steps in the queue are considered for "backfill". A backfill job step will only be dispatched if enough resources are currently available and one of the following conditions are met:

1. The backfill job step is expected to complete before the future start time of the "top dog", based on the hard wall clock limit of the backfill job step.
2. If the backfill job step is not expected to complete before the future start time of the "top dog", it cannot be using resources reserved by the "top dog" at the future start time.

Because of the conditions imposed on dispatching backfill job steps, it is possible for lower priority job steps to be scheduled ahead of and delay the dispatching of higher priority job steps. However, the highest priority job step in the queue, or the "top dog", is guaranteed not to be delayed any longer once it becomes the "top dog".

*Table 18. Roadmap of backfill scheduler tasks*

| Subtask                                                                      | Associated instructions (see . . . )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Configuring the backfill scheduler                                           | <ul style="list-style-type: none"> <li>• "Choosing a scheduler" on page 35</li> <li>• "Tips for using the backfill scheduler"</li> <li>• "Example: Backfill scheduling" on page 100</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                      |
| Using additional LoadLeveler features available under the backfill scheduler | <ul style="list-style-type: none"> <li>• "Preempting and resuming jobs" on page 115</li> <li>• "Configuring LoadLeveler to support reservations" on page 120</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Use the backfill scheduler to dispatch and manage jobs                       | <ul style="list-style-type: none"> <li>• "Scheduler support for parallel jobs" on page 168</li> <li>• "llclass - Query class information" on page 387</li> <li>• "llmodify - Change attributes of a submitted job step" on page 419</li> <li>• "llpreempt - Preempt a submitted job step" on page 426</li> <li>• "llq - Query job status" on page 431</li> <li>• "llsubmit - Submit a job" on page 471</li> <li>• "Data Access API" on page 492</li> <li>• "Error Handling API" on page 538</li> <li>• "ll_modify subroutine" on page 569</li> <li>• "ll_preempt subroutine" on page 573</li> </ul> |

## Tips for using the backfill scheduler

Note the following when using the backfill scheduler:

- To use this scheduler, either users must set a wall-clock limit in their job command file or the administrator must define a wall-clock limit value for the class to which a job is assigned. Jobs with the **wall\_clock\_limit** of **unlimited** cannot be used to backfill because they may not finish in time.
- Using wall clock limits that accurately reflect the actual running time of the job steps will result in a more efficient utilization of resources. When a job step's

## Using the backfill scheduler

wall clock limit is substantially longer than the amount of time the job step actually needs, it results in two inefficiencies in the backfill algorithm:

- The future start time of the "top dog" will be calculated to be much later due to the long wall clock limits of the running job steps, leaving a larger window for backfill job steps to run. This causes the "top dog" to start later than it would have if more accurate wall clock limits had been given.
  - A job step is less likely to be backfilled if its wall clock limit is longer because it is more likely to run past the future start time of the "top dog".
- You should use only the default settings for the **START** expression and the other job control functions described in "Managing job status through control expressions" on page 63. If you do not use these default settings, jobs will still run but the scheduler will not be as efficient. For example, the scheduler will not be able to guarantee a time at which the highest priority job will run.
  - You should configure any multiprocessor (SMP) nodes such that the number of jobs that can run on a node (determined by the **MAX\_STARTERS** keyword) is always less than or equal to the number of processors on the node.
  - Due to the characteristics of the backfill algorithm, in some cases this scheduler may not honor the **MACHPRIO** statement. For more information on **MACHPRIO**, see "Setting negotiator characteristics and policies" on page 36.
  - When using **PREEMPT\_CLASS** rules it is helpful to create a **SYSPRIO** expression which is consistent with the preemption rules. This can be done by using the **ClassSysprio** built-in variable with a multiplier, such as **SYSPRIO: (ClassSysprio \* 10000) - QDate**. If classes which appear on the left-hand side of **PREEMPT\_CLASS** rules are given a higher priority than those which appear on the right, preemption won't be required as often because the job steps which can preempt will be higher in the queue than the job steps which can be preempted.

### Example: Backfill scheduling

On a rack with 10 nodes, 8 of the nodes are being used by Job A. Job B has the highest priority in the queue, and requires 10 nodes. Job C has the next highest priority in the queue, and requires only two nodes. Job B has to wait for Job A to finish so that it can use the freed nodes. Because Job A is only using 8 of the 10 nodes, the backfill scheduler can schedule Job C (which only needs the two available nodes) to run as long as it finishes before Job A finishes (and Job B starts). To determine whether or not Job C has time to run, the backfill scheduler uses Job C's **wall\_clock\_limit** value to determine whether or not it will finish before Job A ends. If Job C has a **wall\_clock\_limit** of **unlimited**, it may not finish before Job B's start time, and it won't be dispatched.

---

## Using the gang scheduler

LoadLeveler for Linux does not support the use of the gang scheduler.

User applications do not have to be modified to take advantage of gang enhancements. However, user applications using the communications libraries need to be linked with the multi-threaded versions. Application environments such as POE function without modification.

To find out more about using the gang scheduler to provide preemption support, use the information in Table 19 on page 101.

Table 19. Roadmap of tasks for using the gang scheduler

| Subtask                                                                  | Associated instructions (see . . . )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|--------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Configuring the gang scheduler                                           | <ul style="list-style-type: none"> <li>• “Choosing a scheduler” on page 35</li> <li>• “Setting keywords for gang scheduling”</li> <li>• “Example: Configuration file for gang scheduling” on page 102</li> <li>• “Example: Administration file for gang scheduling” on page 103</li> </ul>                                                                                                                                                                                                                                                                                                          |
| Using additional LoadLeveler features available under the gang scheduler | “Preempting and resuming jobs” on page 115                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Use the gang scheduler to dispatch and manage jobs                       | <ul style="list-style-type: none"> <li>• “Scheduler support for parallel jobs” on page 168</li> <li>• “llclass - Query class information” on page 387</li> <li>• “llmodify - Change attributes of a submitted job step” on page 419</li> <li>• “llpreempt - Preempt a submitted job step” on page 426</li> <li>• “llq - Query job status” on page 431</li> <li>• “llsubmit - Submit a job” on page 471</li> <li>• “Data Access API” on page 492</li> <li>• “Error Handling API” on page 538</li> <li>• “ll_modify subroutine” on page 569</li> <li>• “ll_preempt subroutine” on page 573</li> </ul> |

## Setting keywords for gang scheduling

To use the gang scheduler, the LoadLeveler administrator sets values for specific configuration and administration file keywords. Depending on which keywords the administrator sets, general users also might have to set the `wall_clock_limit` in the job command file. Table 20 summarizes the job command, administration, and configuration file keywords related to gang scheduling. For additional information about using these settings, see “Planning to preempt jobs” on page 116.

Table 20. LoadLeveler keywords for gang scheduler preemption

| Keyword type / name                  | Notes                                                                                                                    |
|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| <b>Job command file keywords</b>     |                                                                                                                          |
| <code>preferences</code>             | Ignored under gang scheduling.                                                                                           |
| <code>wall_clock_limit</code>        | Either must be set in the administration file, for the class to which a job is assigned, or set in the job command file. |
| <b>Administration file keywords</b>  |                                                                                                                          |
| <code>master_node_exclusive</code>   | Ignored under gang scheduling.                                                                                           |
| <code>master_node_requirement</code> | Ignored under gang scheduling.                                                                                           |
| <code>max_total_tasks</code>         | Specific to gang scheduling.                                                                                             |
| <code>wall_clock_limit</code>        | Either must be set in the administration file, for the class to which a job is assigned, or set in the job command file. |
| <b>Configuration file keywords</b>   |                                                                                                                          |
| <code>MACHINE_AUTHENTICATE</code>    | Must be set to TRUE when you are using the gang scheduler.                                                               |

## Using the gang scheduler

Table 20. LoadLeveler keywords for gang scheduler preemption (continued)

| Keyword type / name      | Notes                                                                     |
|--------------------------|---------------------------------------------------------------------------|
| PREEMPTION_SUPPORT       | Specifies the level of preemption support for a cluster.                  |
| PROCESS_TRACKING         | Must be set to TRUE when you are using the gang scheduler.                |
| START_CLASS [class name] | Algorithm that determines whether or not the gang scheduler starts a job. |

### Example: Configuration file for gang scheduling

The following sample illustrates the configuration file (LoadL\_config) for using the preemption function with the gang scheduler:

```
ARCH = R6000
LOADL_ADMIN = loadl
MACHINE_AUTHENTICATE = True
SCHEDULER_TYPE = GANG
PROCESS_TRACKING = True

MAX_STARTERS = 20
Class = No_Class(1) small(3) medium(4) large(4) secure(6)

PREMPT_CLASS[secure] = ALL {allclasses}
PREMPT_CLASS[small] = ENOUGH {medium}
PREMPT_CLASS[medium] = ENOUGH {large}

START_CLASS[secure] = (secure < 2)
START_CLASS[No_Class] = (secure < 1) && (allclasses < 3)
START_CLASS[small] = (secure < 1) && (allclasses < 3)
START_CLASS[medium] = (secure < 1) && (allclasses < 4) && (small < 3)
START_CLASS[large] = (secure < 1) && (allclasses < 4) && (small < 3)
RELEASEDIR = /usr/lpp/LoadL/full
ADMIN_FILE = $(tilde)/LoadL_admin
LOG = /tmp/log
SPOOL = /tmp/spool
EXECUTE = /tmp/execute
HISTORY = /tmp/history
BIN = $(RELEASEDIR)/bin
LIB = $(RELEASEDIR)/lib
KBDD = $(BIN)/LoadL_kbdd
KBDD_LOG = $(LOG)/KbdLog
STARTD = $(BIN)/LoadL_startd
STARTD_LOG = $(LOG)/StartLog
SCHEDD = $(BIN)/LoadL_schedd
SCHEDD_LOG = $(LOG)/SchedLog
NEGOTIATOR = $(BIN)/LoadL_negotiator
NEGOTIATOR_LOG = $(LOG)/NegotiatorLog
GSMONITOR = $(BIN)/LoadL_GSmonitor
GSMONITOR_LOG = $(LOG)/GSmonitorLog
STARTER = $(BIN)/LoadL_starter
STARTER_LOG = $(LOG)/StarterLog
MASTER = $(BIN)/LoadL_master
MASTER_LOG = $(LOG)/MasterLog
PROCESS_TRACKING_EXTENSION = $(BIN)

START : T
SUSPEND : F
CONTINUE : T
VACATE : F
KILL : F
```

## Example: Administration file for gang scheduling

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The following sample illustrates the administration file (LoadL\_admin) for gang scheduling preemption:

```
default: type = machine
 pool_list = 1

default: type = class # default class stanza
 wall_clock_limit = 30:00 # default wall clock limit

default: type = user # default user stanza
 default_class = No_Class # default class = No_Class
 default_group = No_Group # default group = No_Group
 default_interactive_class = medium
 max_total_tasks = 50

default: type = group # default group stanza

secure: type = class # class for secure jobs
 wall_clock_limit = 120:30:00,120:00:00

small: type = class # class for small jobs
 wall_clock_limit = 35:00,30:00
 maxjobs = 2
 max_total_tasks = 20

medium: type = class # class for medium jobs
 wall_clock_limit = 04:30:00,04:00:00

large: type = class # class for large jobs
 wall_clock_limit = 120:30:00,120:00:00

c163n02.ppd.pok.ibm.com: type = machine
 adapter_stanzas = c163sn02.ppd.pok.ibm.com c163n02.ppd.pok.ibm.com
 alias = c163sn02.ppd.pok.ibm.com
 central_manager = true

c163n03.ppd.pok.ibm.com: type = machine
 adapter_stanzas = c163sn03.ppd.pok.ibm.com c163n03.ppd.pok.ibm.com
 alias = c163sn03.ppd.pok.ibm.com

c163sn03.ppd.pok.ibm.com: type = adapter
 adapter_name = css0
 network_type = switch
 interface_address = 9.114.52.131
 interface_name = c163sn03.ppd.pok.ibm.com
 multilink_address = 10.10.10.10
 logical_id = 2
 adapter_type=Switch_Network_Interface_For_HPS
 device_driver_name = sni0
 network_id = 1

c163n03.ppd.pok.ibm.com: type = adapter
 adapter_name = en0
 network_type = ethernet
 interface_address = 9.114.52.67
 interface_name = c163n03.ppd.pok.ibm.com

c163sn02.ppd.pok.ibm.com: type = adapter
 adapter_name = css0
 network_type = switch
 interface_address = 9.114.52.130
 interface_name = c163sn02.ppd.pok.ibm.com
 multilink_address = 10.10.10.10
```

## Using the gang scheduler

```
logical_id = 1
adapter_type=Switch_Network_Interface_For_HPS
device_driver_name = sni0
network_id = 1
device_driver_name = sni0
network_id = 1

c163n02.ppd.pok.ibm.com: type = adapter
adapter_name = en0
network_type = ethernet
interface_address = 9.114.52.66
interface_name = c163n02.ppd.pok.ibm.com
```

---

## Using an external scheduler

The LoadLeveler API provides interfaces that allow an external scheduler to manage the assignment of resources to jobs and dispatching those jobs. The primary interfaces for the tasks of an external scheduler are:

- **ll\_query** to obtain information about the LoadLeveler cluster, the machines of the cluster, jobs and AIX Workload Manager
- **ll\_get\_data** to obtain information about specific objects such as jobs, machines and adapters

There are two interfaces for starting a LoadLeveler job: **ll\_start\_job** and **ll\_start\_job\_ext**. Both support starting serial jobs. **ll\_start\_job\_ext** should be used to start parallel jobs because it allows control over which adapters are used by the communication protocols of each task. Without this control, it is impossible to assure that each task uses the same network for communication over a given protocol.

The steps for dispatching jobs with an external scheduler are:

1. Gather information about the LoadLeveler cluster ( **ll\_query(CLUSTER)** ).
2. Gather information about the machines in the LoadLeveler cluster ( **ll\_query(MACHINES)** ).
3. Gather information about the jobs in the cluster ( **ll\_query(JOBS)** ).
4. Determine the resources that are currently free. (See the note that follows.)
5. Determine which jobs to start. Assign resources to jobs to be started and dispatch ( **ll\_start\_job\_ext(LL\_start\_job\_info\_ext\*)** ).
6. Repeat steps 1 through 5.

### Note:

When an external scheduler is used, the LoadLeveler Negotiator does not keep track of the resources used by jobs started by the external scheduler. There are two ways that an external scheduler can keep track of the free resources available for starting new jobs. The method that should be used depends on whether the external scheduler runs continuously while all scheduling is occurring or is executed to start a finite number of jobs and then terminates.

If the external scheduler runs continuously, it should query the total resources available in the LoadLeveler system with **ll\_query** and **ll\_get\_data**. Then it can keep track of the resource assigned to jobs it starts while they are running and return the resources to the available pool when the jobs complete.

If the external scheduler is executed to start a finite number of jobs and then terminates, it must determine the pool of available resources when it first starts. It can do this by first querying the total resources in the LoadLeveler system using `ll_query` and `ll_get_data`. Then it would query the jobs in the system (again using `ll_query`), looking for jobs that are running. For each running job, it would remove the resources used by the job from the available pool. After all the running jobs are processed, the available pool would indicate the amount of free resource for starting new jobs.

To find out more about dispatching jobs with an external scheduler, use the information in Table 21.

Table 21. Roadmap of tasks for using an external scheduler

| Subtask                                                                                                    | Associated instructions (see . . . )                                                                                                                                                                                    |
|------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Learn about the LoadLeveler functions that are limited or not available when you use an external scheduler | “Replacing the default LoadLeveler scheduling algorithm with an external scheduler”                                                                                                                                     |
| Prepare the LoadLeveler environment for using an external scheduler                                        | “Customizing the configuration file to define an external scheduler” on page 106                                                                                                                                        |
| Use an external scheduler to dispatch jobs                                                                 | <ul style="list-style-type: none"> <li>• “Steps for getting information about the LoadLeveler cluster, its machines, and jobs” on page 107</li> <li>• “Assigning resources and dispatching jobs” on page 111</li> </ul> |

## Replacing the default LoadLeveler scheduling algorithm with an external scheduler

It is important to know how LoadLeveler keywords and commands behave when you replace the default LoadLeveler scheduling algorithm with an external scheduler. LoadLeveler scheduling keywords and commands fall into the following categories:

- Keywords not involved in scheduling decisions are unchanged.
- Keywords kept in the job object or in the machine which are used by the LoadLeveler default scheduler have their values maintained as before and passed to the query API.
- Keywords used only by the LoadLeveler default scheduler have no effect.

Table 22 discusses specific keywords and commands and how they behave when you disable the default LoadLeveler scheduling algorithm.

Table 22. Effect of LoadLeveler keywords under an external scheduler

| Keyword type / name              | Notes                                                                                                                                                                                                                                                                                                            |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Job command file keywords</b> |                                                                                                                                                                                                                                                                                                                  |
| class                            | This value is provided by the query APIs. Machines chosen by <code>ll_start_job</code> must have the class of the job available or the request will be rejected.                                                                                                                                                 |
| dependency                       | Supported as before. Job objects for which dependency cannot be evaluated (because a previous step has not run) are maintained in the NotQueued state, and attempts to start them via <code>ll_start_job</code> will result in an error. If the dependency is met, <code>ll_start_job</code> can start the proc. |

## Using an external scheduler

Table 22. Effect of LoadLeveler keywords under an external scheduler (continued)

| Keyword type / name                     | Notes                                                                                                                                                                                                                                                            |
|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| hold                                    | <b>ll_start_job</b> cannot start a job that is in Hold status.                                                                                                                                                                                                   |
| min_processors                          | <b>ll_start_job</b> must specify at least this number of processors.                                                                                                                                                                                             |
| max_processors                          | <b>ll_start_job</b> must specify no more than this number of processors.                                                                                                                                                                                         |
| preferences                             | Passed to the query API.                                                                                                                                                                                                                                         |
| requirements                            | <b>ll_start_job</b> returns an error if the machine(s) specified do not match the requirements of the job. This includes Disk and Virtual Memory requirements.                                                                                                   |
| startdate                               | The job remains in the Deferred state until the <b>startdate</b> specified in the job is reached. <b>ll_start_job</b> cannot start a job in the Deferred state.                                                                                                  |
| user_priority                           | Used in calculating the system priority (as described in “Setting and changing the priority of a job” on page 201). The system priority assigned to the job is available through the query API. No other control of the order in which jobs are run is enforced. |
| <b>Administration file keywords</b>     |                                                                                                                                                                                                                                                                  |
| master_node_exclusive                   | Ignored                                                                                                                                                                                                                                                          |
| master_node_requirement                 | Ignored                                                                                                                                                                                                                                                          |
| max_jobs_scheduled                      | Ignored                                                                                                                                                                                                                                                          |
| maxidle                                 | Supported                                                                                                                                                                                                                                                        |
| maxjobs                                 | Ignored                                                                                                                                                                                                                                                          |
| maxqueued                               | Supported                                                                                                                                                                                                                                                        |
| priority                                | Used to calculate the system priority (where appropriate).                                                                                                                                                                                                       |
| speed                                   | Available through the query API.                                                                                                                                                                                                                                 |
| <b>Configuration file keywords</b>      |                                                                                                                                                                                                                                                                  |
| MACHPRIO                                | Calculated but is not used.                                                                                                                                                                                                                                      |
| MAX_STARTERS                            | Calculated, and if starting the job causes this value to be exceeded, <b>ll_start_job</b> returns an error.                                                                                                                                                      |
| SYSPRIO                                 | Calculated and available to the query API.                                                                                                                                                                                                                       |
| NEGOTIATOR_PARALLEL_DEFER               | Ignored                                                                                                                                                                                                                                                          |
| NEGOTIATOR_PARALLEL_HOLD                | Ignored                                                                                                                                                                                                                                                          |
| NEGOTIATOR_RESCAN_QUEUE                 | Ignored                                                                                                                                                                                                                                                          |
| NEGOTIATOR_RECALCULATE_SYSPRIO_INTERVAL | Works as before. Set this value to 0 if you do not want the system priorities of job objects recalculated.                                                                                                                                                       |

## Customizing the configuration file to define an external scheduler

To use an external scheduler, one of the tasks you must perform is setting the configuration file keyword **SCHEDULER\_TYPE** to the value **API**. This keyword

option provides a time-based (rather than an event-based) interface. That is, your application must use the Query API to poll LoadLeveler at specific times for machine and job information.

When you enable a scheduler type of API, you must specify **AGGREGATE\_ADAPTERS=NO** to make the individual switch adapters available to the external scheduler. This means the external scheduler receives each individual adapter connected to the network, instead of collectively grouping them together. You'll see each adapter listed individually in the **llstatus -l** command output. When this keyword is set to **YES**, the **llstatus -l** command will show an aggregate adapter which contains information on all switch adapters on the same network. For detailed information about individual switch adapters, issue the **llstatus -a** command.

You also may use the **PREEMPTION\_SUPPORT** keyword, which specifies the level of preemption support for a cluster. Preemption allows for a running job step to be suspended so that another job step can run.

## Steps for getting information about the LoadLeveler cluster, its machines, and jobs

Perform the following steps to retrieve and use information about the LoadLeveler cluster, machines, jobs and AIX Workload Manager:

1. Create a query object for the kind of information you want.

**Example:** To query machine information, code the following instruction:

```
LL_element * query_element = ll_query(MACHINES);
```

2. Customize the query to filter the specific information you want. You can filter the list of objects for which you want information. For some queries, you can also filter how much information you want.

**Example:** The following lines customize the query for just hosts node01.ibm.com and node02.ibm.com and to return the information contained in the **llstatus -f** command:

```
char * hostlist[] = { "node01.ibm.com", "node02.ibm.com", NULL };
ll_set_request(query_element, QUERY_HOST, hostlist, STATUS_LINE);
```

3. Once the query has been customized:
  - a. Submit it using **ll\_get\_objs**, which returns the first object that matches the query.
  - b. Interrogate the returned object using the **ll\_get\_data** command to retrieve specific attributes. Depending on the information being queried for, the query may be directed to a specific node and a specific daemon on that node.

**Example:** A **JOBS** query for all data may be directed to the negotiator, schedd or the history file. If it is directed to the schedd, you must specify the host of the schedd you are interested in. The following demonstrates retrieving the name of the first machine returned by the query constructed previously:

```
int machine_count;
int rc;
LL_element * element = ll_get_objs(query_element, LL_CM, NULL, &machine_count, &rc)
char * mname;
ll_get_data(element, LL_MachineName, &mname);
```

Because there is only one negotiator in a LoadLeveler cluster, the host does not have to be specified. The third parameter is the address of an integer that will receive the count of objects returned and the fourth parameter is the address of

an integer that will receive the completion code of the call. If the call fails, NULL is returned and the location pointed to by the fourth parameter is set to a reason code. If the call succeeds, the value returned is used as the first parameter to a call to `ll_get_data`. The second parameter to `ll_get_data` is a specification that indicates what attribute of the object is being interrogated. The third parameter to `ll_get_data` is the address of the location into which to store the result. `ll_get_data` returns zero if it is successful and nonzero if an error occurs. It is important that the specification (the second parameter to `ll_get_data`) be valid for the object passed in (the first parameter) and that the address passed in as the third parameter point to the correct type for the specification. Undefined, potentially dangerous behavior will occur if either of these conditions is not met.

### Example: Retrieving specific information about machines

The following example demonstrates printing out the name and adapter list of all machines in the LoadLeveler cluster. The example could be extended to retrieve all of the information available about the machines in the cluster such as memory, disk space, pool list, features, supported classes, and architecture, among other things. A similar process would be used to retrieve information about the cluster overall.

```
int i, w, rc;
int machine_count;
LL_element * query_elem;
LL_element * machine;
LL_element * adapter;
char * machine_name;
char * adapter_name;
int * window_list;
int window_count;

/* First we need to obtain a query element which is used to pass
/* parameters in to the machine query
if ((query_elem = ll_query(MACHINES)) == NULL)
{
 fprintf(stderr, "Unable to obtain query element\n");
 /* without the query object we will not be able to do anything */
 exit(-1);
}

/* Get information relating to machines in the LoadLeveler cluster. */

/* QUERY_ALL: we are querying all machines
/* NULL: since we are querying all machines we do not need to
/* specify a filter to indicate which machines
/* ALL_DATA: we want all the information available about the machine */
rc=ll_set_request(query_elem, QUERY_ALL, NULL, ALL_DATA);
if(rc<0)
{
 /* A real application would map the return code to a message */
 printf("%d returned from ll_set_request\n", rc);
 /* Without customizing the query we cannot proceed */
 exit(rc);
}

/* If successful, ll_get_objs() returns the first object that
/* satisfies the criteria that are set in the query element and
/* the parameters. In this case those criteria are:
/* A machine (from the type of query object)
/* LL_CM: that the negotiator knows about
/* NULL: since there is only one negotiator we don't have to
/* specify which host it is on
/* The number of machines is returned in machine_count and the
/* return code is returned in rc
```

```

machine = ll_get_objs(query_elem, LL_CM, NULL, &machine_count, &rc);
if(rc < 0)
{
 /* A real application would map the return code to a message */
 printf("%d returned from ll_get_objs\n", rc);

 /* query was not successful -- we cannot proceed but we need to */
 /* release the query element */
 if(ll_deallocate(query_elem) == -1)
 {
 fprintf(stderr, "Attempt to deallocate invalid query element\n");
 }
 exit(rc);
}

printf("Number of Machines = %d\n", machine_count);
i = 0;
while(machine != NULL)
{
 printf("-----\n");
 printf("Machine %d:\n", i);

 int rc = ll_get_data(machine, LL_MachineName, &machine_name);
 if(0 == rc)
 {
 printf("Machine name = %s\n", machine_name);
 }
 else
 {
 printf("Error %d returned attempting to get machine name\n", rc);
 }

 printf("Adapters\n");
 ll_get_data(machine, LL_MachineGetFirstAdapter, &adapter);
 while(adapter != NULL)
 {
 rc = ll_get_data(adapter, LL_AdapterName, &adapter_name);
 if(0 != rc)
 {
 printf("Error %d returned attempting to get adapter name\n", rc);
 }
 }
 else
 {
 /* Because the list of windows on an adapter is returned */
 /* as an array of integers, we also need to know how big */
 /* the list is. First we query the window count, */
 /* storing the result in an integer, then we query for */
 /* the list itself, storing the result in a pointer to */
 /* an integer. The window list is allocated for us so */
 /* we need to free it when we are done */

 printf("%s : ", adapter_name);
 ll_get_data(adapter, LL_AdapterTotalWindowCount, &window_count);
 ll_get_data(adapter, LL_AdapterWindowList, &window_list);
 for (w = 0; w < iBuffer; w++)
 {
 printf("%d ", window_list[w]);
 }

 printf("\n");
 free(window_list);
 }
 /* After the first object has been gotten, GetNext returns */
 /* the next until the list is exhausted */
 ll_get_data(machine, LL_MachineGetNextAdapter, &adapter);
}

printf("\n");

```

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```
 i++;
 machine = ll_next_obj(query_elem);
 }

 /* First we need to release the individual objects that were */
 /* obtained by the query */
 if(ll_free_objs(query_elem) == -1)
 {
 fprintf(stderr,"Attempt to free invalid query element\n");
 }

 /* Then we need to release the query itself */
 if(ll_deallocate(query_elem) == -1)
 {
 fprintf(stderr,"Attempt to deallocate invalid query element\n");
 }
}
```

### Example: Retrieving information about jobs

The following example demonstrates retrieving information about jobs up to the point of starting a job:

```
int i, rc;
int job_count;
LL_element * query_elem;
LL_element * job;
LL_element * step;
int step_state;

/* First we need to obtain a query element which is used to pass */
/* parameters in to the jobs query */
if ((query_elem = ll_query(JOBS)) == NULL)
{
 fprintf(stderr,"Unable to obtain query element\n");
 /* without the query object we will not be able to do anything */
 exit(-1);
}

/* Get information relating to Jobs in the LoadLeveler cluster. */
printf("Jobs Information =====\n\n");
/* QUERY_ALL: we are querying all jobs */
/* NULL: since we are querying all jobs we do not need to */
/* specify a filter to indicate which jobs */
/* ALL_DATA: we want all the information available about the job */
rc=ll_set_request(query_elem,QUERY_ALL,NULL,ALL_DATA);
if(rc<0)
{
 /* A real application would map the return code to a message */
 printf("%d returned from ll_set_request\n"rc);
 /* Without customizing the query we cannot proceed */
 exit(rc);
}

/* If successful, ll_get_objs() returns the first object that */
/* satisfies the criteria that are set in the query element and */
/* the parameters. In this case those criteris are: */
/* A job (from the type of query object) */
/* LL_CM: that the negotiator knows about */
/* NULL: since there is only one negotiator we don't have to */
/* specify which host it is on */
/* The number of jobs is returned in job_count and the */
/* return code is returned in rc */
job = ll_get_objs(query_elem,LL_CM,NULL,&job_count,&rc);
if(rc<0)
{
 /* A real application would map the return code to a message */
 printf("%d returned from ll_get_objs\n"rc);
}
```

```

/* query was not successful -- we cannot proceed but we need to */
/* release the query element */
if(ll_deallocate(query_elem) == -1)
{
 fprintf(stderr,"Attempt to deallocate invalid query element\n");
}
exit(rc);
}

printf("Number of Jobs = %d\n", job_count);
step = NULL;
while(job!=NULL)
{
 /* Each job is composed of one or more steps which are started */
 /* individually. We need to check the state of the job's steps */
 ll_get_data(job,LL_JobGetFirstStep,&step);
 while(step!=NULL)
 {
 ll_get_data(step,LL_StepState,&step_state);
 /* We are looking for steps that are in idle state. The */
 /* state is returned as an int so we cast it to */
 /* enum StepState as declared in llapi.h */
 if((enum StepState)step_state == STATE_IDLE)
 break;
 }
 /* If we exit the loop with a valid step, it is the one to start */
 /* otherwise we need to keep looking */
 if(step != NULL)
 break;

 ll_next_obj(query_elem);
}

if(step==NULL)
{
 printf("No step to start\n");
 exit(0);
}

```

## Assigning resources and dispatching jobs

In “Example: Retrieving information about jobs” on page 110, we reached the point where a step to start was identified. In a real external scheduler, the decision would be reached after consideration of all the idle jobs and constructing a priority value based on attributes such as class and submit time, all of which are accessible through **ll\_get\_data**. Next, the list of available machines would be examined to determine whether a set exists with sufficient resources to run the job. This process also involves determining the size of that set of machines using attributes of the step such as number of nodes, instances of each node and tasks per node. The LoadLeveler data query API allows access to that information about each job but the interface for starting the job does not require that the machine and adapter resource match the specifications when the job was submitted. For example, a job could be submitted specifying **node=4** but could be started by an external scheduler on a single node only. Similarly, the job could specify the LAPI protocol with **network.lapi=...** but be started and told to use the MPI protocol. This is not considered an error since it is up to the scheduler to interpret (and enforce, if necessary), the specifications in the job command file.

In allocating adapter resources for a step, it is important that the order of the adapter usages be consistent with the structure of the step. In some environments a task can use multiple instances of adapter windows for a protocol. If the protocol requests striping (**sn\_all** or **csss**), an adapter window (or set of windows if instances are used) is allocated on each available network. If multiple protocols are

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used by the task (eg. MPI and LAPI), each protocol defines its own set of windows. The array of adapter usages passed in to **ll\_start\_job\_ext** must group the windows for all of the instances on one network for the same protocol together. If the protocol requests striping, that grouping must be immediately followed by the grouping for the next network. If the task uses multiple protocols, the set of adapter usages for the first protocol must be immediately followed by the set for the next protocol. Each task will have exactly the same pattern of adapter usage entries. Corresponding entries across all the tasks represent a communication path and must be able to communicate with each other. If the usages are for User Space communication, a network table will be loaded for each set of corresponding entries.

All of the job command file keywords for specifying job structure such as **total\_tasks**, **tasks\_per\_node**, **node=min,max** and **blocking** are supported by the **ll\_start\_job\_ext** interface but users should ensure that they understand the LoadLeveler model that is created for each combination when constructing the adapter usage list for **ll\_start\_job\_ext**. Jobs that are submitted with **node=number** and **tasks\_per\_node** result in more regular LoadLeveler models and are easier to create adapter usage lists for.

In the following example, it is assumed that the step found to be dispatched will run on one machine with two tasks, each task using one switch adapter window for MPI communication. The name of the machine to run on is contained in the variable **use\_machine (char\*)**, the names of the switch adapters are contained in **use\_adapter\_1 (char \*)** and **use\_adapter\_2 (char \*)** and the adapter windows on those adapters in **use\_window\_1 (int)** and **use\_window\_2 (int)**, respectively. Further more, each adapter will be allocated 1M of memory.

If the network adapters that the external scheduler assigns to the job allocate communication buffers in rCxt blocks instead of bytes (the Switch Network Interface for HPS is an example of such a network adapter), the **api\_rcxtblocks** field of **adapterUsage** should be used to specify the number of rCxt blocks to assign instead of the **mem** field.

```
LL_start_job_info_ext *start_info;
char * pChar;
LL_element * step;
LL_element * job;
int rc;
char * submit_host;
char * step_id;

start_info = (LL_start_job_info_ext *) (malloc(sizeof(LL_start_job_info_ext)));
if(start_info == NULL)
{
 fprintf(stderr, "Out of memory.\n");
 return;
}

/* Create a NULL terminated list of target machines. Each task
/* must have an entry in this list and the entries for tasks on the
/* same machine must be sequential. For example, if a job is to run
/* on two machines, A and B, and three tasks are to run on each
/* machine, the list would be: AAABBB
/* Any specifications on the job when it was submitted such as
/* nodes, total_tasks or tasks_per_node must be explicitly queried
/* and honored by the external scheduler in order to take effect.
/* They are not automatically enforced by LoadLeveler when an
/* external scheduler is used.
/*
/* In this example, the job will only be run on one machine
*/
```

```

/* with only one task so the machine list consists of only 1 machine */
/* (plus the terminating NULL entry) */
start_info->nodeList = (char **)malloc(2*sizeof(char *));
if (!start_info->nodeList)
{
 fprintf(stderr, "Out of memory.\n");
 return;
}

start_info->nodeList[0] = strdup(use_machine);
start_info->nodeList[1] = NULL;

/* Retrieve information from the job to populate the start_info */
/* structure */
/* In the interest of brevity, the success of the ll_get_data() */
/* is not tested. In a real application it should be */

/* The version number is set from the header that is included when */
/* the application using the API is compiled. This allows for */
/* checking that the application was compiled with a version of the */
/* API that is compatible with the version in the library when the */
/* application is run. */
start_info->version_num = LL_PROC_VERSION;

/* Get the first step of the job to start */
ll_get_data(job, LL_JobGetFirstStep, &step);
if (step == NULL)
{
 printf("No step to start\n");
 return;
}

/* In order to set the submitting host, cluster number and proc */
/* number in the start_info structure, we need to parse it out of */
/* the step id */

/* First get the submitting host and save it */
ll_get_data(job, LL_JobSubmitHost, &submit_host);
start_info->StepId.from_host = strdup(submit_host);
free(submit_host);

rc = ll_get_data(step, LL_StepID, &step_id);

/* The step id format is submit_host.jobno.stepno . Because the */
/* submit host is a dotted string of indeterminate length, the */
/* simplest way to detect where the job number starts is to retrieve */
/* the submit host from the job and skip forward its length in the */
/* step id. */

pChar = step_id + strlen(start_info->StepId.from_host) + 1;
/* The next segment is the cluster or job number */
pChar = strtok(pChar, ".");
start_info->StepId.cluster = atoi(pChar);
/* The last token is the proc or step number */
pChar = strtok(NULL, ".");
start_info->StepId.proc = atoi(pChar);
free(step_id);

/* For each protocol (eg. MPI or LAPI) on each task, we need to */
/* specify which adapter to use, whether a window is being used */
/* (subsystem = "US") or not (subsystem="IP"). If a window is used, */
/* the window ID and window buffer size must be specified. */
/* The adapter usage entries for the protocols of a task must be */
/* sequential and the set of entries for tasks on the same node must */
/* be sequential. For example the twelve entries for a job where */
/* each task uses one window for MPI and one for LAPI with three

```

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```
/* tasks per node and running on two nodes would be laid out as: */
/* 1: MPI window for 1st task running on 1st node */
/* 2: LAPI window for 1st task running on 1st node */
/* 3: MPI window for 2nd task running on 1st node */
/* 4: LAPI window for 2nd task running on 1st node */
/* 5: MPI window for 3rd task running on 1st node */
/* 6: LAPI window for 3rd task running on 1st node */
/* 7: MPI window for 1st task running on 2nd node */
/* 8: LAPI window for 1st task running on 2nd node */
/* 9: MPI window for 2nd task running on 2nd node */
/* 10: LAPI window for 2nd task running on 2nd node */
/* 11: MPI window for 3rd task running on 2nd node */
/* 12: LAPI window for 3rd task running on 2nd node */
/* An improperly ordered adapter usage list may cause the job not to */
/* be started or, if started, incorrect execution of the job */
/* */
/* This example starts the job with two tasks on one machine, using */
/* one switch adapter window on each task. The protocol is forced */
/* to MPI and a fixed window size of 1M is used. An actual external */
/* scheduler application would check the steps requirements and its */
/* adapter requirements of the step with ll_get_data */
/* */
start_info->adapterUsageCount = 2;
start_info->adapterUsage =
 (LL_ADAPTER_USAGE *)malloc((start_info->adapterUsageCount)
 * sizeof(LL_ADAPTER_USAGE));

start_info->adapterUsage[0].dev_name = use_adapter_1;
start_info->adapterUsage[0].protocol = "MPI";
start_info->adapterUsage[0].subsystem = "US";
start_info->adapterUsage[0].wid = use_window_1;
start_info->adapterUsage[0].mem = 1048577;

start_info->adapterUsage[1].dev_name = use_adapter_2;
start_info->adapterUsage[1].protocol = "MPI";
start_info->adapterUsage[1].subsystem = "US";
start_info->adapterUsage[1].wid = use_window_2;
start_info->adapterUsage[1].mem = 1048577;

if ((rc = ll_start_job_ext(start_info)) != API_OK)
{
 printf("Error %d returned attempting to start Job Step %s.%d.%d on %s\n",
 rc,
 start_info->StepId.from_host,
 start_info->StepId.cluster,
 start_info->StepId.proc,
 start_info->nodeList[0]
);
}
else
{
 printf("ll_start_job_ext() invoked to start job step: "
 "%s.%d.%d on machine: %s.\n\n",
 start_info->StepId.from_host, start_info->StepId.cluster,
 start_info->StepId.proc, start_info->nodeList[0]);
}
free(start_info->nodeList[0]);
free(start_info);
```

Finally, when the step and job element are no longer in use, `ll_free_objs()` and `ll_deallocate()` should be called on the query element.

## Example: Changing scheduler types

You can toggle between the default LoadLeveler scheduler and other types of schedulers by using the `SCHEDULER_TYPE` keyword. Changes to `SCHEDULER_TYPE` will not take effect at reconfiguration. The administrator must stop and restart or recycle LoadLeveler when changing `SCHEDULER_TYPE`. A combination of changes to `SCHEDULER_TYPE` and some other keywords may terminate LoadLeveler.

The following example illustrates how you can toggle between the default LoadLeveler scheduler and an external scheduler, such as the Extensible Argonne Scheduling sYstem (EASY), developed by Argonne National Laboratory and available as public domain code.

If you are running the default LoadLeveler scheduler, perform the following steps to switch to an external scheduler:

1. In the configuration file, set **`SCHEDULER_TYPE = API`**
2. On the central manager machine:
  - Issue **`llctl -g stop`** and **`llctl -g start`**, or
  - Issue **`llctl -g recycle`**

If you are running an external scheduler, this is how you can re-enable the LoadLeveler scheduling algorithm:

1. In the configuration file, set **`SCHEDULER_TYPE = LL_DEFAULT`**
2. On the central manager machine:
  - Issue **`llctl -g stop`** and **`llctl -g start`**, or
  - Issue **`llctl -g recycle`**

## Preempting and resuming jobs

Both the backfill and gang schedulers allow LoadLeveler jobs to be preempted so that a higher priority job step can run. Administrators may specify not only preemption rules for job classes, but also the method that LoadLeveler uses to preempt jobs. The backfill scheduler supports various methods of preemption; the gang scheduler supports preemption through only the suspend method.

LoadLeveler for Linux does not support the use of the gang scheduler, and does not support the use of the suspend method under the backfill scheduler.

Use Table 23 to find more information about preemption.

*Table 23. Roadmap of tasks for using preemption*

| Subtask                                                              | Associated instructions (see . . . )                            |
|----------------------------------------------------------------------|-----------------------------------------------------------------|
| Learn about types of preemption and what it means for preempted jobs | "Overview of preemption" on page 116                            |
| Prepare the LoadLeveler environment and jobs for preemption          | "Planning to preempt jobs" on page 116                          |
| Configure LoadLeveler to use preemption                              | "Steps for configuring a scheduler to preempt jobs" on page 119 |

### Overview of preemption

LoadLeveler supports two types of preemption:

- System-initiated preemption
  - Automatically enforced by LoadLeveler, except for job steps running under a reservation.
  - Governed by the PREEMPT\_CLASS rules defined in the global configuration file.
  - When resources required by an incoming job are in use by other job steps, all or some of those job steps in certain classes may be preempted according to the PREEMPT\_CLASS rules.
  - An automatically preempted job step will be resumed by LoadLeveler when resources become available and conditions such as START\_CLASS rules are satisfied.
  - An automatically preempted job step cannot be resumed using **llpreempt** command or **ll\_preempt** subroutine.
  - For the gang scheduler only, a special kind of system-initiated preemption is related to the **llmodify** command. When **llmodify -x 99** makes a job step non-preemptable, neither user-initiated preemption nor system-initiated preemption will be able to preempt the job step. All other job steps sharing the same node will be preempted and stay in preempted state until the non-preemptable job step finishes or becomes preemptable by **llmodify -x 1**.
- User-initiated preemption
  - Manually initiated by LoadLeveler administrators using **llpreempt** command or **ll\_preempt** subroutine.
  - A manually preempted job step cannot be resumed automatically by LoadLeveler.
  - A manually preempted job step can be resumed using **llpreempt** command or **ll\_preempt** subroutine. Issuing this command or subroutine, however, does not guarantee that the job step will successfully be resumed. A manually preempted job step that was resumed through these interfaces competes for resources with system-preempted job steps, and will be resumed only when resources become available.

For the backfill scheduler only, administrators may select which method LoadLeveler uses to preempt and resume jobs. The suspend method is the default behavior, and is the preemption method LoadLeveler uses for the gang scheduler and any external schedulers that support preemption. For more information about preemption methods, see “Planning to preempt jobs.”

For a preempted job to be resumed after system- or user-initiated preemption occurs through a method other than suspend, the **restart** keyword in the job command file must be set to **yes**. Otherwise, LoadLeveler vacates the job step and removes it from the cluster.

### Planning to preempt jobs

Consider the following points when planning to use preemption:

- **Avoiding circular preemption under the backfill and gang schedulers**

Both backfill and gang scheduling enable job preemption using rules specified with the PREEMPT\_CLASS keyword. When you are setting up the preemption rules, make sure that you do not create a circular preemption path. Circular preemption causes a job class to preempt itself after applying the preemption rules recursively. For example, the following keyword definitions set up circular preemption rules on Class\_A.:

```
PREEMPT_CLASS[Class_A] = ALL { Class_B }
PREEMPT_CLASS[Class_B] = ALL { Class_C }
PREEMPT_CLASS[Class_C] = ENOUGH { Class_A }
```

Another example of circular preemption involves **allclasses**:

```
PREEMPT_CLASS[Class_A] = ENOUGH {allclasses}
PREEMPT_CLASS[Class_B] = ALL {Class_A}
```

In this instance, **allclasses** means all classes except Class\_A, any additional preemption rule preempting Class\_A causes circular preemption.

- **Understanding implied START\_CLASS values**

Using the "ALL" value in the PREEMPT\_CLASS keyword places implied restrictions on when a job can start. For example,

```
PREEMPT_CLASS[Class_A] = ALL {Class_B Class_C}
```

tells LoadLeveler two things:

1. If a new Class\_A job is about to run on a node set, then preempt all Class\_B and Class\_C jobs on those nodes
2. If a Class\_A job is running on a node set, then do not start any Class\_B or Class\_C jobs on those nodes

This PREEMPT\_CLASS statement also implies the following START\_CLASS expressions:

1. START\_CLASS[Class\_B] = (Class\_A < 1)
2. START\_CLASS[Class\_C] = (Class\_A < 1)

LoadLeveler adds all implied START\_CLASS expressions to the START\_CLASS expressions specified in the configuration file. This overrides any existing values for START\_CLASS.

For example, if the configuration file contains the following statements:

```
PREEMPT_CLASS[Class_A] = ALL {Class_B Class_C}
START_CLASS[Class_B] = (Class_A < 5)
START_CLASS[Class_C] = (Class_C < 3)
```

When LoadLeveler runs through the configuration process, the PREEMPT\_CLASS statement on the first line generates the two implied START\_CLASS statements. When the implied START\_CLASS statements get added in, the user specified START\_CLASS statements are overridden and the resulting START\_CLASS statements are effectively equivalent to:

```
START_CLASS[Class_B] = (Class_A < 1)
START_CLASS[Class_C] = (Class_C < 3) && (Class_A < 1)
```

**Note:** LoadLeveler's central manager (CM) uses these effective expressions instead of the original statements specified in the configuration file. The output from **llclass -l** displays the original customer specified START\_CLASS expressions.

- **Selecting the preemption method under the backfill scheduler**

Use Table 24 on page 118 and Table 25 on page 118 to determine which preemption you want to use for jobs running under the backfill scheduler. You may define one or more of the following:

- A default preemption method to be used for all job classes, by setting the **DEFAULT\_PREEMPT\_METHOD** keyword in the configuration file.
- A specific preemption method for one or more classes or job steps, by using an option on:
  - The **PREEMPT\_CLASS** statement in the configuration file.
  - The **llpreempt** command, **ll\_preempt** subroutine or **ll\_preempt\_jobs** subroutine.

## Preempting and resuming jobs

### Notes:

1. LoadLeveler for Linux does not support the suspend method of preemption.
2. Process tracking must be enabled in order to use the suspend method to preempt a job. To configure LoadLeveler for process tracking, see “Tracking job processes” on page 64.
3. For a preempted job to be resumed after system- or user-initiated preemption occurs through a method other than suspend and remove, the **restart** keyword in the job command file must be **set** to yes. Otherwise, LoadLeveler vacates the job step and removes it from the cluster.

Table 24. Preemption methods for which LoadLeveler automatically resumes preempted jobs

| Preemption method (abbreviation) | LoadLeveler resumes preempted job: |                                      |                                                       |
|----------------------------------|------------------------------------|--------------------------------------|-------------------------------------------------------|
|                                  | At this time                       | At this location                     | At this processing point                              |
| Suspend (su)                     | When preempting job completes      | On the same nodes                    | At the point of suspension                            |
| Vacate (vc)                      | When nodes are available           | Any nodes that meet job requirements | At the beginning or at the last successful checkpoint |

Table 25. Preemption methods for which administrator or user intervention is required

| Preemption method (abbreviation) | Required intervention                                 | LoadLeveler resumes preempted job:                            |                                                       |
|----------------------------------|-------------------------------------------------------|---------------------------------------------------------------|-------------------------------------------------------|
|                                  |                                                       | At this location                                              | At this processing point                              |
| Remove (rm)                      | Administrator or user must resubmit the preempted job | Any nodes that meet job requirements, when they are available | At the beginning or at the last successful checkpoint |
| System Hold (sh)                 | Administrator must release the preempted job          |                                                               |                                                       |
| User Hold (uh)                   | User must release the preempted job                   |                                                               |                                                       |

- **Understanding how LoadLeveler treats resources held by jobs to be preempted**

When a job step is running, it may be holding the following resources:

- Processors
- Scheduling slots
- Real memory
- ConsumableCpus and ConsumableMemory
- Communication switches, if the **PREEMPTION\_TYPE** keyword is set to FULL in the configuration file.

When LoadLeveler suspends preemptable jobs running under the backfill or gang scheduler, certain resources held by those jobs do not become available for the preempting jobs. These resources include ConsumableVirtualMemory and floating resources. Under the backfill scheduler only, LoadLeveler releases these resources when you select a preemption method other than suspend. For all preemption methods other than suspend, LoadLeveler treats all job-step resources as available when it preempts the job step.

- **Learning about restrictions for gang scheduling preemption**

The following conditions are not supported with gang scheduling preemption:

- **MACHINE\_AUTHENTICATE** = false in the configuration file
- **PROCESS\_TRACKING** = false in the configuration file
- Circular preemption rules specified in the configuration file

If any of the conditions listed above exist, the following will occur:

- LoadLeveler will not start when SCHEDULER\_TYPE = GANG
- Reconfiguration will not take place when SCHEDULER\_TYPE = GANG
- **Understanding how LoadLeveler processes multiple entries for the same keywords**

If there are multiple entries for the same keyword in either a configuration file or an administration file, the last entry wins. For example, the following statements are all valid specifications for the same keyword START\_CLASS:

```
START_CLASS [Class_B] = (Class_A < 1)
START_CLASS [Class_B] = (Class_B < 1)
START_CLASS [Class_B] = (Class_C < 1)
```

However, all three statements identify Class\_B as the incoming class. LoadLeveler resolves these statements according to the "last one wins" rule. Because of that, the actual value used for the keyword is (Class\_C < 1).

## Steps for configuring a scheduler to preempt jobs

**Before you begin:**

- To define rules for starting and preempting jobs, you need to know certain details about the job characteristics and workload at your installation, including:
  - Which jobs require the same resources, or must be run on the same machines, and so on. This knowledge allows you to group specific jobs into a class.
  - Which jobs or classes have higher priority than others. This knowledge allows you to define which job classes can preempt other classes.
- To correctly configure LoadLeveler to preempt jobs, you might need to refer to the following information:
  - "Choosing a scheduler" on page 35.
  - "Planning to preempt jobs" on page 116.
  - Chapter 11, "Configuration file reference," on page 231.
  - Chapter 12, "Administration file reference," on page 287.
  - "llctl - Control LoadLeveler daemons" on page 393.

Perform the following steps to configure a scheduler to preempt jobs:

1. In the configuration file, use the **SCHEDULER\_TYPE** keyword to define the type of LoadLeveler or external scheduler you want to use. Of the LoadLeveler schedulers, only the backfill and gang schedulers support preemption.

**Rules:**

- a. If you select the gang scheduler, you must set both the following configuration keywords to **true**:
  - **PROCESS\_TRACKING**
  - **MACHINE\_AUTHENTICATION**
- b. If you select the backfill or API scheduler, you must set the **PREEMPTION\_SUPPORT** configuration keyword to either **full** or **no\_adapter**

2. (Optional) In the configuration file, use the **DEFAULT\_PREEMPT\_METHOD** to define the default method that the backfill scheduler should use for preempting jobs.

**Alternatives:** You also may set the preemption method through:

- The **PREEMPT\_CLASS** keyword or on the LoadLeveler preemption command or APIs, which override the setting for the **DEFAULT\_PREEMPT\_METHOD** keyword.
- The LoadLeveler GUI by selecting **Admin ► Preempt**.

## Preempting and resuming jobs

3. For either the backfill or API scheduler, to preempt by the suspend method requires that you set the **PROCESS\_TRACKING** configuration keyword to **true**.
4. In the configuration file, use the **PREEMPT\_CLASS** and **START\_CLASS** to define the preemption and start policies for job classes.
5. In the administration file, use the **max\_total\_tasks** keyword to define the maximum number of tasks that may be run per user, group, or class.
6. On the central manager machine:
  - Issue **llctl -g stop** and **llctl -g start**, or
  - Issue **llctl -g recycle**

When you are done with this procedure, you can use the **llq** command to determine whether jobs are being preempted and resumed correctly. If not, use the LoadLeveler logs to trace the actions of each daemon involved in preemption to determine the problem.

---

## Configuring LoadLeveler to support reservations

Under the backfill scheduler only, LoadLeveler allows authorized users to make reservations, which specify a time period during which specific node resources are reserved for use by particular users or groups. Normally, jobs wait to be dispatched until the resources they require become available. Through the use of reservations, wait time can be reduced because only jobs bound to the reservation may use the node resources as soon as the reservation period begins.

Use Table 26 to find additional information about reservations.

*Table 26. Roadmap of reservation tasks for administrators*

| Subtask                                                                                                                                                                          | Associated instructions (see . . . )                                                                                                                                                                                                                                              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Learn how reservations work in the LoadLeveler environment                                                                                                                       | <ul style="list-style-type: none"><li>• “Overview of reservations” on page 23</li><li>• “Understanding the reservation life cycle” on page 185</li></ul>                                                                                                                          |
| Configuring a LoadLeveler cluster to support reservations                                                                                                                        | <ul style="list-style-type: none"><li>• “Steps for configuring reservations in a LoadLeveler cluster”</li><li>• “Examples: Reservation keyword combinations in the administration file” on page 123</li><li>• “Collecting accounting data for reservations” on page 125</li></ul> |
| Working with reservations: <ul style="list-style-type: none"><li>• Creating reservations</li><li>• Submitting jobs under a reservation</li><li>• Managing reservations</li></ul> | “Working with reservations” on page 184                                                                                                                                                                                                                                           |
| Correctly coding and using administration and configuration keywords                                                                                                             | <ul style="list-style-type: none"><li>• Chapter 12, “Administration file reference,” on page 287</li><li>• Chapter 11, “Configuration file reference,” on page 231</li></ul>                                                                                                      |

## Steps for configuring reservations in a LoadLeveler cluster

Before you begin:

- You need to know that only the backfill scheduler supports the use of reservations. For information about configuring the backfill scheduler, see “Choosing a scheduler” on page 35.
- You need to decide:
  - Which users will be allowed to create reservations.
  - How many reservations users may own, and how long a duration for their reservations will be allowed.
  - Which nodes will be used for reservations.
  - How much setup time is required before the reservation period starts.
  - Whether accounting data for reservations is to be saved.
- For examples of possible reservation keyword combinations, see “Examples: Reservation keyword combinations in the administration file” on page 123.
- For details about specific keyword syntax and use:
  - In the administration file, see Chapter 12, “Administration file reference,” on page 287.
  - In the configuration file, see Chapter 11, “Configuration file reference,” on page 231.

Perform the following steps to configure reservations:

1. In the administration file, modify the user or group stanzas to authorize users to create reservations. You may grant the ability to create reservations to an individual user, a group of users, or a combination of users and groups. To do so, define the following keywords in the appropriate user or group stanzas:
  - **max\_reservations**, to set the maximum number of reservations that a user or group may have.
  - (Optional) **max\_reservation\_duration**, to set the maximum amount of time for the reservation period.

**Tip:** To quickly set up and use reservations, use one of the following examples:

- To allow every user to create a reservation, add **max\_reservations=1** to the default user stanza. Then every administrator or user may create a reservation, as long as the number of reservations has not reached the limit for a LoadLeveler cluster.
- To allow a specific group of users to make 10 reservations, add **max\_reservations=10** to the group stanza for that LoadLeveler group. Then every user in that group may create a reservation, as long as the number of reservations has not reached the limit for that group or for a LoadLeveler cluster.

See the **max\_reservations** description in Chapter 12, “Administration file reference,” on page 287 for more information about setting this keyword in the user or group stanza.

2. In the administration file, modify the machine stanza of each machine that may be reserved. To do so, set the **reservation\_permitted** keyword to **true**.

**Tip:** If you want to allow every machine to be reserved, you do not have to set this keyword; by default, any LoadLeveler machine may be reserved. If you want to prevent particular machines from being reserved, however, you must define a machine stanza for that machine and set the **reservation\_permitted** keyword to **false**.

3. In the global configuration file, set reservation policy by specifying values for the following keywords:

- **MAX\_RESERVATIONS** to specify the maximum number of reservations per cluster.

**Rule:** The total number of reservations supported in a LoadLeveler cluster is 10.

## Configuring LoadLeveler for reservations

- **RESERVATION\_CAN\_BE\_EXCEEDED** to specify whether LoadLeveler will be permitted to schedule job steps bound to a reservation when their expected end times exceed the reservation end time.

The default for this keyword is **TRUE**, which means that LoadLeveler will schedule these bound job steps even when they are expected to continue running beyond the time at which the reservation ends. Whether these job steps run and successfully complete depends on resource availability, which is not guaranteed after the reservation ends. In addition, these job steps become subject to preemption rules after the reservation ends.

**Tip:** You might want to set this keyword value to **FALSE** to prevent users from binding long-running jobs to run under reservations of short duration.

- **RESERVATION\_MIN\_ADVANCE\_TIME** to define the minimum time between the time at which a reservation is created and the time at which the reservation is to start.

**Tip:** To reduce the impact to the currently running workload, consider changing the default for this keyword, which allows reservations to begin as soon as they are created. You may, for example, require reservations to be made at least one day (1440 minutes) in advance, by specifying **RESERVATION\_MIN\_ADVANCE\_TIME=1440** in the global configuration file.

- **RESERVATION\_PRIORITY** to define whether LoadLeveler administrators may reserve nodes on which running jobs are expected to end after the start time for the reservation.

**Tip:** The default for this keyword is **NONE**, which means that LoadLeveler will not reserve a node on which running jobs are expected to end after the start time for the reservation. If you want to allow LoadLeveler administrators to reserve specific nodes regardless of the expected end times of job steps currently running on the node, set this keyword value to **HIGH**. Note, however, that setting this keyword value to **HIGH** might increase the number of job steps that must be preempted when LoadLeveler sets up the reservation, and many jobs might remain in Preempted state.

This keyword value applies only for LoadLeveler administrators; other reservation owners do not have this capability.

- **RESERVATION\_SETUP\_TIME** to define the amount of time LoadLeveler uses to prepare for a reservation before it is to start.
4. (Optional) In the global configuration file, set controls for the collection of accounting data for reservations:
    - To turn on accounting for reservations, add the **A\_RES** flag to the **ACCT** keyword.
    - To specify a file other than the default history file to contain the data, use the **RESERVATION\_HISTORY** keyword.

To learn how to collect accounting data for reservations, see “Collecting accounting data for reservations” on page 125.

5. If LoadLeveler is already started, to process the changes you made in the preceding steps, issue the command **llctl -g reconfig**

**Tip:** If you have changed the value of only the **RESERVATION\_PRIORITY** keyword, issue the command **llctl reconfig** only on the central manager node.

**Result:** The new keyword values take effect immediately, but they do not change the attributes of existing reservations.

When you are done with this procedure, you may perform additional tasks described in “Working with reservations” on page 184.

## Examples: Reservation keyword combinations in the administration file

The following examples demonstrate LoadLeveler behavior when the **max\_reservations** and **max\_reservation\_duration** keywords are set. The examples assume that only the user and group stanzas listed exist in the LoadLeveler administration file.

- **Example 1:** Assume the administration file contains the following stanzas:

```
default: type = user
 maxjobs = 10

group2: type = group
 include_users = rich dave steve

rich: type = user
 default_group = group2
```

This example shows that, by default, no one is allowed to make any reservations. No one, including LoadLeveler administrators, is permitted to make any reservations unless the **max\_reservations** keyword is used.

- **Example 2:** Assume the administration file contains the following stanzas:

```
default: type = user
 maxjobs = 10

group2: type = group
 include_users = rich dave steve

rich: type = user
 default_group = group2
 max_reservations = 5
```

This example shows how permission to make reservations can be granted to a specific user through the user stanza only. Because the **max\_reservations** keyword is not used in any group stanza, by default, the group stanzas neither grant permissions nor put any restrictions on reservation permissions. User Rich can make reservations in any group (group2, No\_Group, Group\_A, and so on), whether or not the group stanzas exist in the LoadLeveler administration file. The total number of reservations user Rich can own at any given time is limited to five.

- **Example 3:** Assume the administration file contains the following stanzas:

```
default: type = user
 maxjobs = 10

group2: type = group
 include_users = rich dave steve
 max_reservations = 5

rich: type = user
 default_group = group2
```

This example shows how permission to make reservations can be granted to a group of users through the group stanza only. Because the **max\_reservations** keyword is not used in any user stanza, by default, the user stanzas neither grant nor deny permission to make reservations. All users in group2 (Rich, Dave and Steve) can make reservations, but they must make reservations in group2 because other groups do not grant the permission to make reservations. The total number of reservations the users in group2 can own at any given time is limited to five.

- **Example 4:** Assume the administration file contains the following stanzas:

```
default: type = user
 maxjobs = 10
```

## Configuring LoadLeveler for reservations

```
group2: type = group
 include_users = rich dave steve
 max_reservations = 5
```

```
rich: type = user
 default_group = group2
 max_reservations = 0
```

This example shows how permission to make reservations can be granted to a group of users except one specific user. Because the **max\_reservations** keyword is set to zero in the user stanza for Rich, he does not have permission to make any reservation, even though all other users in group2 (Dave and Steve) can make reservations.

- **Example 5:** Assume the administration file contains the following stanzas:

```
default: type = group
 max_reservations = 0
```

```
default: type = user
 max_reservations = 0
```

```
group2: type = group
 include_users = rich dave steve
 max_reservations = 5
```

```
rich: type = user
 default_group = group2
 max_reservations = 5
```

```
dave: type = user
 max_reservations = 2
```

This example shows how permission to make reservations can be granted to specific user and group pairs. Because the **max\_reservations** keyword is set to zero in both the default user and group stanza, no one has permission to make any reservation unless they are specifically granted permission through both the user and group stanza. In this example:

- User Rich can own at any time up to five reservations in group2 only.
- User Dave can own at any time up to two reservations in group2 only.

The total number of reservations they can own at any given time is limited to five. No other combination of user or group pairs can make any reservations.

- **Example 6:** Assume the administration file contains the following stanzas:

```
default: type = user
 max_reservations = 1
```

This example permits any user to make one reservation in any group, until the number of reservations reaches the maximum number allowed in the LoadLeveler cluster.

- **Example 7:** Assume the administration file contains the following stanzas:

```
default: type = group
 max_reservations = 0
```

```
default: type = user
 max_reservations = 0
```

```
group1: type = group
 max_reservations = 6
 max_reservation_duration = 1440
```

```
carol: type = user
 default_group = group1
 max_reservations = 4
 max_reservation_duration = 720
```

```
dave: type = user
 default_group = group1
 max_reservations = 4
 max_reservation_duration = 2880
```

In this example, two users, Carol and Dave, are members of group1. Neither Carol nor Dave belong to any other group with a group stanza in the LoadLeveler administration file, although they may use any string as the name of a LoadLeveler group and belong to it by default.

Because the **max\_reservations** keyword is set to zero in the default group stanza, reservations can be made only in group1, which has an allotment of six reservations. Each reservation can have a maximum duration of 1440 minutes (24 hours).

Considering only the user-stanza attributes for reservations:

- User Carol can make up to four reservations with each having a maximum duration of 720 minutes (12 hours).
- User Dave can make up to four reservations with each having a maximum duration of 2880 minutes (48 hours).

If there are no reservations in the system and user Carol wants to make four reservations, she may do so. Each reservation can have a maximum duration of no more than 720 minutes. If Carol attempts to make a reservation with a duration greater than 720 minutes, LoadLeveler will not make the reservation because it exceeds the duration allowed for Carol.

Assume that Carol has created four reservations, and user Dave now wants to create four reservations:

- The number of reservations Dave may make is limited by the state of Carol's reservations and the maximum limit on reservations for group1. If the four reservations Carol made are still being set up, or are active, active shared or waiting, LoadLeveler will restrict Dave to making only two reservations at this time.
- Because the value of **max\_reservation\_duration** for the group is more restrictive than **max\_reservation\_duration** for user Dave, LoadLeveler enforces the group value, 1440 minutes.

If Dave belonged to another group that still had reservations available, then he could make reservations under that group, assuming the maximum number of reservations for the cluster had not been met. However, in this example, Dave cannot make any further reservations because they are allowed in group1 only.

## Collecting accounting data for reservations

LoadLeveler can collect accounting data for reservations, which are set periods of time during which node resources are reserved for the use of particular users or groups. To enable recording of reservation information, specify the following keywords in the configuration file:

- To turn on accounting for reservations, add the **A\_RES** flag to the **ACCT** keyword.
- To specify a file other than the default history file to contain the data, use the **RESERVATION\_HISTORY** keyword.

See Chapter 11, "Configuration file reference," on page 231 for details about the **ACCT** and **RESERVATION\_HISTORY** keywords.

When these keyword values are set and a reservation ends or is canceled, LoadLeveler records the following information:

- The reservation ID
- The time at which the reservation was created

## Configuring LoadLeveler for reservations

- The user ID of the reservation owner
- The name of the owning group
- Requested and actual start times
- Requested and actual duration
- Actual time at which the reservation ended or was canceled
- Whether the reservation was created with the SHARED or REMOVE\_ON\_IDLE options
- A list of users and a list of groups that were authorized to use the reservation
- The number of reserved nodes
- The names of reserved nodes

This reservation information is appended in a single line to the reservation history file for the reservation. The format of reservation history data is:

```
reservation id!reservation creation time!reservation owner!owning group!
requested start time!actual start time!
requested duration!actual duration!actual end time!
SHARED(yes if shared, no otherwise)!
REMOVE ON IDLE(yes if remove on idle, no otherwise)
!user list!group_list!number of nodes!hostlist
```

In reservation history data:

- The unit of measure for start times and end times is the number of seconds since January 1, 1970.
- The unit of time for durations is seconds.

The following is an example of a reservation history file entry:

```
c188f2n01.ppd.pok.ibm.com.4.r!1091038734!iris!No_Group!1091040300!1091040300!720
!720!1091041020!no!no!!!1!c188f2n01
```

To collect the reservation information stored in the history file, use one of the following:

- The **llacctmrg** command with the **-R** option. For **llacctmrg** command syntax, see “llacctmrg - Collect machine history files” on page 373.
- The LoadLeveler GUI. From the Machines window, use the LoadLeveler GUI by selecting one or more machines, then selecting **Admin ► Collect Reservation Data** and specifying the directory to contain the merged file. If you do not enter a directory, LoadLeveler uses the directory specified in the **GLOBAL\_HISTORY** keyword in the configuration file.

To format reservation history data contained in a file, use the sample script **llreshist.pl** in directory **/usr/lpp/LoadL/full/samples/llres/**.

---

## Steps for integrating LoadLeveler with AIX Workload Manager

Another administrative setup task you must consider is whether you want to enforce resource usage of **ConsumableCPUs** and **ConsumableMemory**. If you want to control these resources, AIX Workload Manager (WLM) can be integrated with LoadLeveler to balance workloads at the machine level.

WLM is not supported in LoadLeveler for Linux.

Workload balancing is done by assigning relative priorities to job processes. These job priorities prevent one job from monopolizing system resources when that resource is under contention.

To integrate LoadLeveler and WLM, perform the following steps:

1. Define **ConsumableCpus**, **ConsumableMemory**, or both as consumable resources in the **SCHEDULE\_BY\_RESOURCES** global configuration keyword. This enables the LoadLeveler scheduler to consider these consumable resources.
2. Define **ConsumableCpus**, **ConsumableMemory**, or both in the **ENFORCE\_RESOURCE\_USAGE** global configuration keyword. This enables enforcement of these consumable resources by AIX WLM.
3. Define **hard**, **soft** or **shares** in the **ENFORCE\_RESOURCE\_POLICY** configuration keyword. This defines what policy is used by LoadLeveler when setting WLM class resource entitlements.
4. (Optional) Set the **ENFORCE\_RESOURCE\_MEMORY** configuration keyword to **true**. This setting allows AIX WLM to limit the real memory usage of a WLM class as precisely as possible. When a class exceeds its limit, all processes in the class are killed.

**Rule:** **ConsumableMemory** must be defined in the **ENFORCE\_RESOURCE\_USAGE** keyword in the global configuration file, or LoadLeveler does not consider the **ENFORCE\_RESOURCE\_MEMORY** keyword to be valid.

**Tips:**

- When set to true, the **ENFORCE\_RESOURCE\_MEMORY** keyword overrides the policy set through the **ENFORCE\_RESOURCE\_POLICY** keyword for **ConsumableMemory** only. The **ENFORCE\_RESOURCE\_POLICY** keyword value still applies for **ConsumableCpus**.
  - **ENFORCE\_RESOURCE\_MEMORY** may be set in either the global or the local configuration file. In the global configuration file, this keyword sets the default value for all the machines in the LoadLeveler cluster. If the keyword also is defined in a local file, the local setting overrides the global setting.
5. Using the **resources** keyword in a machine stanza in the administration file, define the CPU and real memory machine resources available for user jobs.
    - The **ConsumableCpus** reserved word accepts a count value of "all." This indicates that the initial resource count will be obtained from the Startd machine update value for CPUs.
    - If no resources are defined for a machine, then no enforcement will be done on that machine.
    - If the count specified by the administrator is greater than what the Startd update indicates, the initial count value will be reduced to match what the Startd reports.
    - If the count specified by the administrator is less than what the Startd update indicates, the WLM resource shares assigned to a job will be adjusted to represent that difference and a WLM softlimit will be defined for each WLM class. For example, if the administrator defines 8 CPUs on a 16 CPU machine, then a job requesting 4 CPUs will get a share of 4 and a softlimit of 50%.
    - Use caution when determining the amount of real memory available for user jobs. A certain percentage of a machine's real memory will be dedicated to the Default and System WLM classes and will not be included in the calculation of real memory available for users jobs. Start LoadLeveler with the **ENFORCE\_RESOURCE\_USAGE** keyword enabled and issue **wlmstat -v -m**. Look at the npg column to determine how much memory is being used by these classes.
  6. Decide if all jobs should have their CPU or real memory resources enforced and then define the **ENFORCE\_RESOURCE\_SUBMISSION** global configuration keyword.

- If the value specified is true, LoadLeveler will check all jobs at submission time for the **resources** keyword. The job's **resources** keyword needs to have the same resources specified as the **ENFORCE\_RESOURCE\_USAGE** keyword in order to be submitted.
- If the value specified is false, no checking will be done and jobs submitted without the **resources** keyword will not have resources enforced and may interfere with other jobs whose resources are enforced.
- To support existing job command files without the **resources** keyword, the **default\_resources** keyword in the class stanza can be defined. The **default\_resources** keyword needs to be defined in the default interactive class to support interactive jobs.

For more information on the **ENFORCE\_RESOURCE\_USAGE** and the **ENFORCE\_RESOURCE\_SUBMISSION** keywords, see "Defining usage policies for consumable resources" on page 56.

---

## Checkpointing jobs

Checkpointing is a method of periodically saving the state of a job step so that if the step does not complete it can be restarted from the saved state. When checkpointing is enabled, checkpoints can be initiated from within the application at major milestones, or by the user, administrator or LoadLeveler external to the application. Both serial and parallel job steps can be checkpointed.

LoadLeveler for Linux does not support checkpointing of user jobs.

Once a job step has been successfully checkpointed, if that step terminates before completion, the checkpoint file can be used to resume the job step from its saved state rather than from the beginning. When a job step terminates and is removed from the LoadLeveler job queue, it can be restarted from the checkpoint file by submitting a new job and setting the **restart\_from\_ckpt = yes** job command file keyword. When a job is terminated and remains on the LoadLeveler job queue, such as when a job step is vacated, the job step will automatically be restarted from the latest valid checkpoint file. A job can be vacated as a result of flushing a node, issuing checkpoint and hold, stopping or recycling LoadLeveler or as the result of a node crash.

To find out more about checkpointing jobs, use the information in Table 27.

*Table 27. Roadmap of tasks for checkpointing jobs*

| Subtask                                                                     | Associated instructions (see . . . )                                                                                                                                                                                                                                                         |
|-----------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Preparing the LoadLeveler environment for checkpointing and restarting jobs | <ul style="list-style-type: none"><li>• "Checkpoint keyword summary" on page 129</li><li>• "Planning considerations for checkpointing jobs" on page 129</li><li>• "Checkpoint and restart limitations" on page 130</li><li>• "Naming checkpoint files and directories" on page 134</li></ul> |
| Checkpointing and restarting jobs                                           | <ul style="list-style-type: none"><li>• "Checkpointing a job" on page 202</li><li>• "Removing old checkpoint files" on page 135</li></ul>                                                                                                                                                    |
| Correctly specifying configuration and administration file keywords         | <ul style="list-style-type: none"><li>• Chapter 11, "Configuration file reference," on page 231</li><li>• Chapter 12, "Administration file reference," on page 287</li></ul>                                                                                                                 |

## Checkpoint keyword summary

The following is a summary of keywords associated with the checkpoint and restart function.

- **Configuration file keywords**
  - **CKPT\_CLEANUP\_INTERVAL**
  - **CKPT\_CLEANUP\_PROGRAM**
  - **CKPT\_EXECUTE\_DIR**
  - **MAX\_CKPT\_INTERVAL**
  - **MIN\_CKPT\_INTERVAL**

For more information about these keywords, see the following checkpoint topics and Chapter 11, “Configuration file reference,” on page 231.

- **Administration file keywords**
  - **ckpt\_dir**
  - **ckpt\_time\_limit**

For more information about these keywords, see the following checkpoint topics and Chapter 12, “Administration file reference,” on page 287.

- **Job command file keywords**
  - **checkpoint**
  - **ckpt\_dir**
  - **ckpt\_execute\_dir**
  - **ckpt\_file**
  - **ckpt\_time\_limit**
  - **restart\_from\_ckpt**

For more information about these keywords, see the following checkpoint topics and “Job command file keyword descriptions” on page 324.

## Planning considerations for checkpointing jobs

Review the following guidelines before you submit a checkpointing job:

- **Plan for jobs that you will restart on different nodes**

If you plan to migrate jobs (restart jobs on a different node or set of nodes), you should understand the difference between writing checkpoint files to a local file system versus a global file system (such as AFS or GPFS). The **ckpt\_file** and **ckpt\_dir** keywords in the job command and configuration files allows you to write to either type of file system. If you are using a local file system, before restarting the job from checkpoint, make certain that the checkpoint files are accessible from the machine on which the job will be restarted.

- **Reserve adequate disk space**

A checkpoint file requires a significant amount of disk space. The checkpoint will fail if the directory where the checkpoint file is written does not have adequate space. For serial jobs, one checkpoint file will be created. For parallel jobs, one checkpoint file will be created for each task. Since the old set of checkpoint files are not deleted until the new set of files are successfully created, the checkpoint directory should be large enough to contain two sets of checkpoint files. You can make an accurate size estimate only after you have run your job and noticed the size of the checkpoint file that is created.

- **Plan for staging executables**

If you want to stage the executable for a job step, use the **ckpt\_execute\_dir** keyword to define the directory where LoadLeveler will save the executable. This directory cannot be the same as the current location of the executable file, or LoadLeveler will not stage the executable.

## Checkpointing jobs

You may define the **ckpt\_execute\_dir** keyword in either the configuration file or the job command file. To decide where to define the keyword, use the information in Table 28.

Table 28. Deciding where to define the directory for staging executables

| If the <b>ckpt_execute_dir</b> keyword is defined in: | Then the following information applies:                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The configuration file only                           | <ul style="list-style-type: none"><li>• LoadLeveler stages the executable file in a new subdirectory of the specified directory. The name of the subdirectory is the job step ID.</li><li>• The user is the owner of the subdirectory and has permission 700.</li><li>• If the user issues the <b>llckpt</b> command with the <b>-k</b> option, LoadLeveler deletes the staged executable.</li><li>• LoadLeveler will delete the subdirectory and the staged executable when the job step ends.</li></ul> |
| The job command file only                             | <ul style="list-style-type: none"><li>• LoadLeveler stages the executable file in the directory specified in the job command file.</li><li>• The user is the owner of the file and has execute permission for it.</li><li>• The user is responsible for deleting the staged file after the job step ends.</li></ul>                                                                                                                                                                                       |
| Both the configuration and job command files          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Neither file (the keyword is not defined)             | LoadLeveler does not stage the executable file for the job step.                                                                                                                                                                                                                                                                                                                                                                                                                                          |

- **Set your checkpoint file size to the maximum**

To make sure that your job can write a large checkpoint file, assign your job to a job class that has its file size limit set to the maximum (unlimited). In the administration file, set up a class stanza for checkpointing jobs with the following entry:

```
file_limit = unlimited,unlimited
```

This statement specifies that there is no limit on the maximum size of a file that your program can create.

- **Choose a unique checkpoint file name**

To prevent another job step from writing over your checkpoint file with another checkpoint file, make certain that your checkpoint file name is unique. The **ckpt\_dir** and **ckpt\_file** keywords give you control over the location and name of these files.

For mode information, see “Naming checkpoint files and directories” on page 134.

## Checkpoint and restart limitations

- The following items cannot be checkpointed:
  - Programs that are being run under:
    - The dynamic probe class library (DPCL).
    - Any debugger.
  - MPI programs that are *not* compiled with **mpcc\_r**, **mpCC\_r**, **mpxlf\_r**, **mpxlf90\_r**, or **mpxlf95\_r**.
  - Processes that use:
    - Extended **shmat** support
    - Pinned shared memory segments.
  - Sets of processes in which any process is running a **setuid** program when a checkpoint occurs.

- Sets of processes if any process is running a **setgid** program when a checkpoint occurs.
- Interactive parallel jobs for which POE input or output is a pipe.
- Interactive parallel jobs for which POE input or output is redirected, unless the job is submitted from a shell that had the CHECKPOINT environment variable set to **yes** before the shell was started. If POE is run from inside a shell script and is run in the background, the script must be started from a shell started in the same manner for the job to be checkpointable.
- Interactive POE jobs for which the **su** command was used prior to checkpointing or restarting the job.

- The node on which a process is restarted must have:
  - The same operating system level (including PTFs). In addition, a restarted process may not load a module that requires a system call from a kernel extension that was not present at checkpoint time.
  - The same switch type as the node where the checkpoint occurred.

If any threads in a process were bound to a specific processor ID at checkpoint time, that processor ID must exist on the node where that process is restarted.

- If the LoadLeveler cluster contains nodes running a mix of 32-bit and 64-bit kernels then applications must be checkpointed and restarted on the same set of nodes. For more information, see “llckpt - Checkpoint a running job step” on page 384 and the **restart\_on\_same\_nodes** keyword description on page 355.
- For a parallel job, the number of tasks and the task geometry (the tasks that are common within a node) must be the same on a restart as it was when the job was checkpointed.
- Any regular file open in a process when it is checkpointed must be present on the node where that process is restarted, including the executable and any dynamically loaded libraries or objects.
- If any process uses sockets or pipes, user callbacks should be registered to save data that may be “in flight” when a checkpoint occurs, and to restore the data when the process is resumed after a checkpoint or restart. Similarly, any user shared memory in a parallel task should be saved and restored.
- A checkpoint operation will not begin on a process until each user thread in that process has released all pthread locks, if held. This can potentially cause a significant delay from the time a checkpoint is issued until the checkpoint actually occurs. Also, any thread of a process that is being checkpointed that does not hold any pthread locks and tries to acquire one will be stopped immediately. There are no similar actions performed for atomic locks (**\_check\_lock** and **\_clear\_lock**, for example).
- Atomic locks must be used in such a way that they do not prevent the releasing of pthread locks during a checkpoint. For example, if a checkpoint occurs and thread 1 holds a pthread lock and is waiting for an atomic lock, and thread 2 tries to acquire a different pthread lock (and does not hold any other pthread locks) before releasing the atomic lock that is being waited for in thread 1, the checkpoint will hang.
- A process must not hold a pthread lock when creating a new process (either implicitly using **popen**, for example, or explicitly using **fork**) if releasing the lock is contingent on some action of the new process. Otherwise, a checkpoint could occur which would cause the child process to be stopped before the parent could release the pthread lock causing the checkpoint operation to hang.
- The checkpoint operation will hang if any user pthread locks are held across:
  - Any collective communication calls in MPI or LAPI
  - Calls to **mpc\_init\_ckpt** or **mp\_init\_ckpt**
- Processes cannot be profiled at the time a checkpoint is taken.

## Checkpointing jobs

- There can be no devices other than TTYs or `/dev/null` open at the time a checkpoint is taken.
- Open files must either have an absolute pathname that is less than or equal to `PATHMAX` in length, or must have a relative pathname that is less than or equal to `PATHMAX` in length from the current directory at the time they were opened. The current directory must have an absolute pathname that is less than or equal to `PATHMAX` in length.
- Semaphores or message queues that are used within the set of processes being checkpointed must only be used by processes within the set of processes being checkpointed. This condition is not verified when a set of processes is checkpointed. The checkpoint and restart operations will succeed, but inconsistent results can occur after the restart.
- The processes that create shared memory must be checkpointed with the processes using the shared memory if the shared memory is ever detached from all processes being checkpointed. Otherwise, the shared memory may not be available after a restart operation.
- The ability to checkpoint and restart a process is not supported for B1 and C2 security configurations.
- A process can only checkpoint another process if it can send a signal to the process. In other words, the privilege checking for checkpointing processes is identical to the privilege checking for sending a signal to the process. A privileged process (the effective user ID is 0) can checkpoint any process. A set of processes can only be checkpointed if each process in the set can be checkpointed.
- A process can only restart another process if it can change its entire privilege state (real, saved, and effective versions of user ID, group ID, and group list) to match that of the restarted process. A set of processes can only be restarted if each process in the set can be restarted.
- The only DCE function supported is DCE credential forwarding by LoadLeveler using the `DCE_AUTHENTICATION_PAIR` configuration keyword. DCE credential forwarding is for the sole purpose of DFS<sup>TM</sup> access by the application.
- The following functions will return `ENOTSUP` if called in a job that has enabled checkpointing:
  - `clock_getcpuclockid()`
  - `clock_getres()`
  - `clock_gettime()`
  - `clock_nanosleep()`
  - `clock_settime()`
  - `mlock()`
  - `mlockall()`
  - `mq_close()`
  - `mq_getattr()`
  - `mq_notify()`
  - `mq_open()`
  - `mq_receive()`
  - `mq_send()`
  - `mq_setattr()`
  - `mq_timedreceive()`
  - `mq_timedsend()`
  - `mq_unlink()`

```

| - munlock()
| - munlockall()
| - nanosleep()
| - pthread_barrier_destroy()
| - pthread_barrier_init()
| - pthread_barrier_wait()
| - pthread_barrierattr_destroy()
| - pthread_barrierattr_getpshared()
| - pthread_barrierattr_init()
| - pthread_barrierattr_setpshared()
| - pthread_condattr_getclock()
| - pthread_condattr_setclock()
| - pthread_getcpuclockid()
| - pthread_mutex_getprioceiling()
| - pthread_mutex_setprioceiling()
| - pthread_mutex_timedlock()
| - pthread_mutexattr_getprioceiling()
| - pthread_mutexattr_getprotocol()
| - pthread_mutexattr_setprioceiling()
| - pthread_mutexattr_setprotocol()
| - pthread_rwlock_timedrdlock()
| - pthread_rwlock_timedwrlock()
| - pthread_setschedprio()
| - pthread_spin_destroy()
| - pthread_spin_init()
| - pthread_spin_lock()
| - pthread_spin_trylock()
| - pthread_spin_unlock()
| - sched_get_priority_max()
| - sched_get_priority_min()
| - sched_getparam()
| - sched_getscheduler()
| - sched_rr_get_interval()
| - sched_setparam()
| - sched_setscheduler()
| - sem_close()
| - sem_destroy()
| - sem_getvalue()
| - sem_init()
| - sem_open()
| - sem_post()
| - sem_timedwait()
| - sem_trywait()
| - sem_unlink()
| - sem_wait()

```

## Checkpointing jobs

```
| - shm_open()
| - shm_unlink()
| - timer_create()
| - timer_delete()
| - timer_getoverrun()
| - timer_gettime()
| - timer_settime()
```

## Naming checkpoint files and directories

At checkpoint time, a checkpoint file and potentially an error file will be created. For jobs which are enabled for checkpoint, a control file may be generated at the time of job submission. The directory which will contain these files must pre-exist and have sufficient space and permissions for these files to be written. The name and location of these files will be controlled through keywords in the job command file or the LoadLeveler configuration. The file name specified is used as a base name from which the actual checkpoint file name is constructed. To prevent another job step from writing over your checkpoint file, make certain that your checkpoint file name is unique. For serial jobs and the master task (POE) of parallel jobs, the checkpoint file name will be *<basename>.Tag*. For a parallel job, a checkpoint file is created for each task. The checkpoint file name will be *<basename>.Taskid.Tag*.

The tag is used to differentiate between a current and previous checkpoint file. A control file may be created in the checkpoint directory. This control file contains information LoadLeveler uses for restarting certain jobs. An error file may also be created in the checkpoint directory. The data in this file is in a machine readable format. The information contained in the error file is available in mail, LoadLeveler logs or is output of the checkpoint command. Both of these files are named with the same base name as the checkpoint file with the extensions *.cntl* and *.err*, respectively.

## Naming checkpoint files for serial and batch parallel jobs

The following describes the order in which keywords are checked to construct the full path name for a serial or batch checkpoint file:

- Base name for the checkpoint file name
  1. The **ckpt\_file** keyword in the job command file
  2. The default file name [*< jobname.>*]*<job\_step\_id>.ckpt*

Where:

*jobname*

The job\_name specified in the Job Command File. If job\_name is not specified, it is omitted from the default file name

*job\_step\_id*

Identifies the job step that is being checkpointed
- Checkpoint Directory Name
  1. The **ckpt\_dir** keyword in the job command file, if it contains a "/" as the first character
  2. The **ckpt\_dir** keyword in the job command file
  3. The **ckpt\_dir** keyword specified in the class stanza of the LoadLeveler admin file
  4. The default directory is the initial working directory

Note that two or more job steps running at the same time cannot both write to the same checkpoint file, since the file will be corrupted.

### Naming checkpointing files for interactive parallel jobs

The following describes the order in which keywords and variables are checked to construct the full path name for the checkpoint file for an interactive parallel job.

- Checkpoint File Name
  1. The value of the MP\_CKPTFILE environment variable within the POE process
  2. The default file name, poe.ckpt.<pid>
- Checkpoint Directory Name
  1. The value of the MP\_CKPTFILE environment variable within the POE process, if it contains a full path name.
  2. The value of the MP\_CKPTDIR environment variable within the POE process.
  3. The initial working directory.

**Note:** The keywords **ckpt\_dir** and **ckpt\_file** are not allowed in the command file for an interactive session. If they are present, they will be ignored and the job will be submitted.

### Removing old checkpoint files

To keep your system free of checkpoint files that are no longer necessary, LoadLeveler provides two keywords to help automate the process of removing these files:

- **CKPT\_CLEANUP\_PROGRAM**
- **CKPT\_CLEANUP\_INTERVAL**

Both keywords must contain valid values to automate this process. For information about configuration file keyword syntax and other details, see Chapter 11, “Configuration file reference,” on page 231.

---

## Routing jobs to NQS machines

Users can submit NQS scripts to LoadLeveler and have them routed to a machine outside of the LoadLeveler cluster that runs NQS. LoadLeveler supports COSMIC NQS version 2.0 and other versions of NQS that support the same commands and options and produce similar output for those commands.

LoadLeveler for Linux does not support NQS. If NQS is enabled, the LoadLeveler daemons on the Linux nodes will not start.

Figure 18 on page 136 illustrates a typical environment that allows users to have their jobs routed to machines outside of LoadLeveler for processing:

## Routing jobs to NQS machines

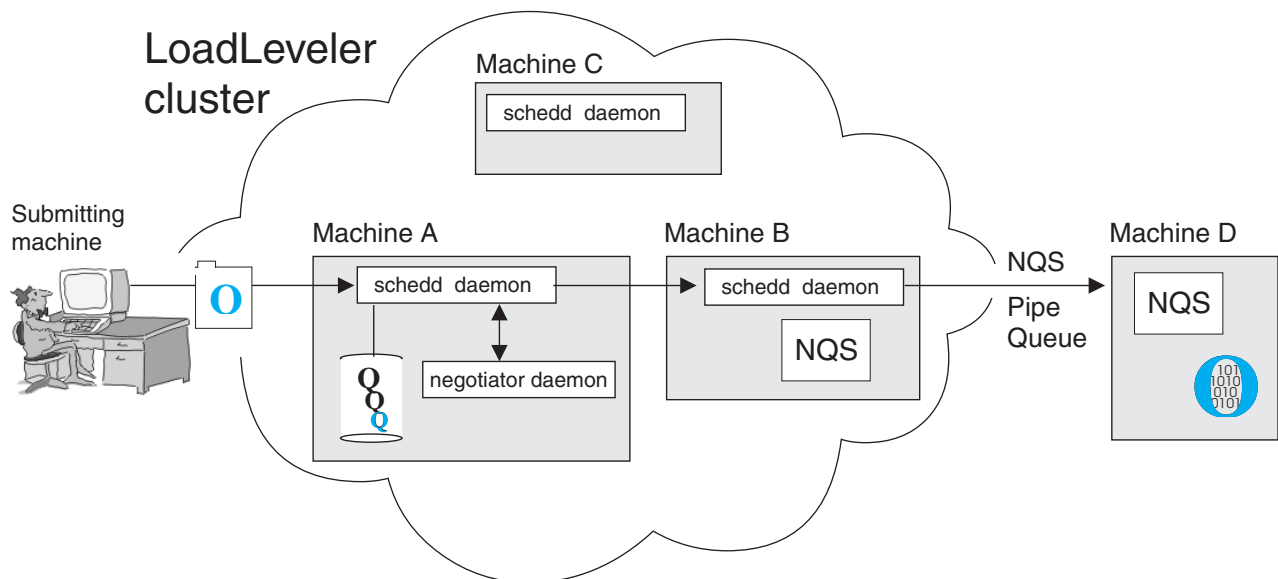


Figure 18. Environment illustrating jobs being routed to NQS machines.

As the diagram illustrates, machines A, B, and C, are members of the LoadLeveler cluster. Machine A has the central manager running on it and machine B has both LoadLeveler and NQS running on it. Machine C is a third member of the cluster. Machine D is outside of the cluster and is running NQS.

When a user submits a job to LoadLeveler, machine A, that runs the central manager, schedules the job to machine B. LoadLeveler running on machine B routes the job to machine D using NQS. Keep this diagram in mind as you continue to the NQS topics listed in Table 29.

Table 29. Roadmap of administrator tasks for NQS

| Subtask                                                 | Associated information (see . . . )                                                                                                                                                                                                   |
|---------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Setting up the NQS environment and LoadLeveler machines | <ul style="list-style-type: none"><li>• “Setting up the NQS environment”</li><li>• “Steps for designating machines to which jobs will be routed” on page 137</li><li>• “Steps for routing jobs to NQS machines” on page 137</li></ul> |
| Submitting and managing jobs running on NQS machines    | <ul style="list-style-type: none"><li>• “Steps for submitting a job to be routed to an NQS machine” on page 192</li><li>• “Querying the status of a job” on page 199</li><li>• “Canceling a job” on page 202</li></ul>                |

## Setting up the NQS environment

Setting up the NQS environment involves the following:

- Installing NQS on each node that an NQS class is defined. In Figure 18, this is machine B.
- Creating an NQS pipe queue on the LoadLeveler machine whose destination is the NQS batch queue on the machine designated to run the NQS jobs.  
In Figure 18, you would create the NQS pipe queue on machine B.
- Creating an NQS batch queue on the machine designated to run the NQS jobs.  
In Figure 18, this is machine D.

## Steps for designating machines to which jobs will be routed

To designate a machine to which your jobs will be routed, follow these steps:

1. Set up a special class in the administration (**LoadL\_admin**) file by adding the following class definitions:

```
NQS_class = true
NQS_submit = name
NQS_query = queue names
```

You can set up multiple classes to access different machines.

2. Modify the local configuration file on the machines that you want to accept this class of jobs.
3. Add the **NQS\_DIR** keyword to the configuration (**LoadL\_config**) file.
4. Notify LoadLeveler daemons by issuing the **llctl** command with either the **reconfig** or **recycle** keyword. Otherwise, LoadLeveler will not process the modifications you made to the administration and configuration files.

## Steps for routing jobs to NQS machines

The following procedure details how to set up your system for routing jobs to machines running NQS.

Assume Figure 18 on page 136 depicts your environment. You have three machines in the cluster named A, B, and C. Outside of the cluster, you have machine D running NQS.

Perform the following steps to have LoadLeveler route jobs to NQS machines:

1. Modify the administration file (**LoadL\_admin**) by defining the class **NQS** including the following stanzas:

```
NQS:
type = class
NQS_class = true
NQS_submit = pipe_a
NQS_query = queue@chevy.kgn.ibm.com
```

2. Modify the local configuration file (**LoadL\_config.local**) on the machines that you want to accept this class of jobs.

**Example:** In the configuration shown in Figure 18 on page 136, you would modify machine B's **LoadL\_config.local** file. To do this, add a class statement similar to:

```
CLASS = {"NQS" "a" "b"}
```

Where NQS is the name of the class of jobs that will be routed to the machines that run NQS, and a and b are names of additional classes.

---

## LoadLeveler scheduling affinity support

Enabling scheduling affinity allows LoadLeveler jobs to utilize the memory and adapter affinity features available in IBM @servers equipped with POWER5 or POWER4 CPU architecture. The Resource Set (RSet) functionality available in AIX 5L is made available for jobs to use in order to take advantage of these affinity features. Once the scheduling affinity feature has been configured, users can request scheduling affinity options for their jobs as a requirement or as a preference.

Memory affinity is a special purpose option for improving performance on IBM POWER5 or POWER4 machines. These machines contain Multiple Chip Modules

(MCMs), each containing multiple processors. System memory is attached to these MCMs. While any processor can access all of the memory in the system, a processor has faster access and higher bandwidth when addressing memory that is attached to its own MCM rather than memory attached to the other MCMs in the system. The concept of affinity also applies to the I/O subsystem. The processors running on CPUs from an MCM have faster access to the adapters attached to the I/O slots of that MCM. I/O affinity will be referred to as adapter affinity in this document. For more information on memory and adapter affinity, see *AIX Performance Management Guide*.

An RSet contains bit maps for CPU and memory pool resources. The RSet APIs available in AIX 5L can be used to attach RSets to processes. Attaching an RSet to a process limits the process to only using the resources contained in the RSet. One of the main uses of RSets is to limit the application processes to run only on the processors contained in a single MCM and hence to benefit from memory affinity. For more information on RSets, see *AIX System Management Guide: Operating System and Devices*.

### Configuring LoadLeveler to use scheduling affinity

Taking advantage of scheduling affinity requires certain changes to LoadLeveler configuration files for machines, and in some cases, LoadLeveler administration files. The steps for enabling LoadLeveler to use scheduling affinity are:

#### Configure one or more machines to enable scheduling affinity

This is accomplished through the use of the **RSET\_SUPPORT** configuration file keyword. Machines which are configured with this keyword indicate the ability to service jobs requesting or requiring scheduling affinity. Enable **RSET\_SUPPORT** with one of these values:

- Choose **RSET\_MCM\_AFFINITY** to allow jobs specifying `#@rset = RSET_MCM_AFFINITY` to run on this node. The **RSET\_MCM\_AFFINITY** option enables scheduling affinity. When this option is specified, LoadLeveler will create and attach RSets to task processes so that the RSet CPUs will be from same MCM..
- Choose **RSET\_CONSUMABLE\_CPUS** allow jobs specifying `#@rset = RSET_CONSUMABLE_CPUS` to run on this node. The **RSET\_CONSUMABLE\_CPUS** option is used to indicate that all of the tasks need to be attached to RSets with a number of CPUs equal to the number of **ConsumableCPUs** requested by the job. The CPUs will be selected such that the same CPU will not be shared among different tasks. Using this option requires LoadLeveler to be configured to use **ConsumableCPUs**. The difference between this option and the **RSET\_MCM\_AFFINITY** option is that when this option is specified, CPUs are selected regardless of their location with respect to an MCM.
- Choose **RSET\_USER\_DEFINED** to allow jobs specifying `#@rset = RSET_USER_DEFINED` to run on this node. The **RSET\_USER\_DEFINED** option enables scheduling affinity, allowing users more control over scheduling affinity parameters by allowing the use of user-defined RSets. Through the use of user-defined RSets, users can utilize new RSet features before a LoadLeveler implementation is released. This option also allows users to specify a different number of CPUs in their RSets depending on the needs of each task.

**Note:** If you do not plan to create your own RSets and only want to take advantage of memory or adapter affinity, we suggest using the **RSET\_MCM\_AFFINITY** option. This allows LoadLeveler to

dynamically allocate CPU and adapter resources to meet the scheduling affinity requirement of the job.  
See “Configuration file keyword descriptions” on page 232 for more information on the **RSET\_SUPPORT** keyword.

### Configure LoadLeveler to recognize ConsumableCPUs

ConsumableCPUs must be enabled on a machine if the **RSET\_SUPPORT** configuration file keyword is specified with a value of **RSET\_CONSUMABLE\_CPUS** in global configuration file or local configuration file for the same machine.

The **RSET\_MCM\_AFFINITY** option for keyword **RSET\_SUPPORT** can be used with or without **ConsumableCPUs** enabled. The CPU allocation to task RSets and task MCM selection will be slightly different in these two scenarios. If **ConsumableCPUs** is not specified, all CPUs from an MCM will be included in the task RSet and the MCM where the least number of tasks is running will be selected for the next task. If **ConsumableCPUs** is enabled, the task RSet will have the **ConsumableCPUs** number of CPUs in it and for the next task central manager will select an MCM based on number of unused CPUs available on MCMs.

**ConsumableCPUs** can be specified in several ways:

- If a list of CPUs is specified, only CPUs in the list are made available to LoadLeveler. CPUs specified in this manner must be on nodes that support RSets.
- If the number, *n*, of CPUs available for consumption is specified, the first *n* CPUs on nodes supporting RSets are marked available to LoadLeveler.
- If the reserved word **all** is specified, all CPUs on nodes supporting RSets are marked available to LoadLeveler.

For more information on specifying **ConsumableCPUs**, see the **resource** keyword description in “Administration file keyword descriptions” on page 291.

---

## LoadLeveler multicluster support

### Overview of LoadLeveler multicluster support

To provide a more scalable runtime environment and more efficient workload balancing, you may configure a LoadLeveler multicluster environment. A LoadLeveler multicluster environment consists of two or more LoadLeveler clusters, grouped together through network connections that allow the clusters to share resources. These clusters may be AIX, Linux, or mixed clusters.

Within a LoadLeveler multicluster environment:

- The **local cluster** is the cluster from which the user submits jobs or issues commands.
- A **remote cluster** is a cluster that accepts job submissions and commands from the local cluster.
- A **local gateway schedd** is a schedd within the local cluster serving as an inbound point from some remote cluster, an outbound point to some remote cluster, or both.
- A **remote gateway schedd** is a schedd within a remote cluster serving as an inbound point from the local cluster, an outbound point to the local cluster, or both.
- A **local central manager** is the central manager in the same cluster as the local gateway schedd.

## LoadLeveler multicluster support

- A **remote central manager** is the central manager in the same cluster as a remote gateway schedd.

A LoadLeveler multicluster environment addresses scalability and workload balancing issues by providing the ability to:

- Distribute workload among LoadLeveler clusters when jobs are submitted.
- Easily access multiple LoadLeveler cluster resources.
- Display information about the multicluster.
- Monitor and control operations in a multicluster.
- Transfer idle jobs from one cluster to another.
- Transfer user input and output files between clusters.
- Enable LoadLeveler to operate in a secure environment where clusters are separated by a firewall.

| Subtask                                               | Associated instructions (see . . . )                                                                        |
|-------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| Configure a LoadLeveler multicluster                  | "Configuring a LoadLeveler multicluster" on page 140                                                        |
| Submit and monitor jobs in a LoadLeveler multicluster | "Submitting and monitoring jobs in a LoadLeveler multicluster" on page 193                                  |
|                                                       |                                                                                                             |
| Related topics                                        | Additional information (see . . . )                                                                         |
| Administration file: Cluster stanzas                  | "Defining clusters" on page 90                                                                              |
| Administration file: Cluster keywords                 | "Administration file keyword descriptions" on page 291                                                      |
| Configuration file: Cluster keywords                  | "Configuration file keyword descriptions" on page 232                                                       |
| Job command file: Cluster keywords                    | "Job command file keyword descriptions" on page 324                                                         |
| Commands and APIs                                     | Chapter 15, "Commands," on page 371 or Chapter 16, "Application programming interfaces (APIs)," on page 481 |
| Diagnosis and messages                                | <i>LoadLeveler: Diagnosis and Messages Guide</i>                                                            |

## Configuring a LoadLeveler multicluster

| Subtask                                                            | Associated instructions (see . . . )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Configure the LoadLeveler multicluster environment                 | <ul style="list-style-type: none"><li>• "Steps for configuring a LoadLeveler multicluster" on page 141</li><li>• "Steps for securing communications within a LoadLeveler multicluster" on page 142</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                            |
| Display information about the LoadLeveler multicluster environment | <ul style="list-style-type: none"><li>• Use the <b>llstatus</b> command:<ul style="list-style-type: none"><li>– With the <b>-X</b> option to display information about machines in the multicluster.</li><li>– With the <b>-C</b> option to display information defined in cluster stanzas in the administration file.</li></ul></li><li>• Use the <b>llclass</b> command with the <b>-X</b> option to display information about classes on any cluster (local or remote).</li><li>• Use the <b>llq</b> command with the <b>-X</b> option to display information about jobs on any cluster (local or remote).</li></ul> |

| Subtask                                                                    | Associated instructions (see . . . )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|----------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Monitor and control operations in the LoadLeveler multicluster environment | <p>Existing LoadLeveler user commands accept the <b>-X</b> option for a multicluster environment.</p> <p><b>Rules:</b></p> <ul style="list-style-type: none"> <li>• Administrator only commands are not applicable in a multicluster environment.</li> <li>• The options <b>-x</b>, <b>-W</b>, <b>-s</b>, and <b>-p</b> cannot be specified together with the <b>-X</b> option on the <b>llmodify</b> command.</li> <li>• The options <b>-x</b> and <b>-w</b> cannot be specified together with the <b>-X</b> option on the <b>llq</b> command.</li> <li>• The <b>-X</b> option on the following commands is restricted to a single cluster: <ul style="list-style-type: none"> <li>– <b>llcancel</b></li> <li>– <b>llckpt</b></li> <li>– <b>llhold</b></li> <li>– <b>llmodify</b></li> <li>– <b>llprio</b></li> </ul> </li> <li>• The following commands are not applicable in a multicluster environment: <ul style="list-style-type: none"> <li>– <b>llacctmrg</b></li> <li>– <b>llchres</b></li> <li>– <b>lldbconvert</b></li> <li>– <b>lldcegrpmain</b></li> <li>– <b>llextrPD</b></li> <li>– <b>llextrSDR</b></li> <li>– <b>llinit</b></li> <li>– <b>llmkres</b></li> <li>– <b>llqres</b></li> <li>– <b>llrmres</b></li> <li>– <b>llrunscheduler</b></li> <li>– <b>llsummary</b></li> </ul> </li> </ul> |

## Steps for configuring a LoadLeveler multicluster

The primary task for configuring a LoadLeveler multicluster environment is to enable communication between gateway schedd daemons on all of the clusters in the multicluster. To do so requires defining each schedd daemon as either local or remote, and defining the inbound and outbound hosts with which the daemon will communicate.

**Before you begin:** You need to know that:

- A single machine may be defined as an inbound or outbound host, or as both.
- A single cluster must belong to only one multicluster.
- A single multicluster must consist of 10 or fewer clusters.
- Clusters must have unique host names within the multicluster network domain space.
- The inbound schedd becomes the **schedd\_host** of all remote jobs it receives.

Perform the following steps to configure a LoadLeveler multicluster:

1. In the administration file, define one cluster stanza for each cluster in the LoadLeveler multicluster environment.

**Rules:**

- You must define one cluster as the local cluster.
- You must code the following required cluster-stanza keywords and variable values:

## LoadLeveler multicluster support

```
cluster_name: type=cluster
outbound_hosts = hostname[(cluster_name)]
inbound_hosts = hostname[(cluster_name)]
```

- If you want to allow users to submit remote jobs to the local cluster, the list of inbound hosts must include the name of the inbound schedd and the cluster you are defining as remote or you must specify the name of an inbound schedd without any cluster specification so that it defaults to being an inbound schedd for all clusters.
  - If the configuration file keyword **SCHEDD\_STREAM\_PORT** for any cluster is set to use a port other than the default value of 9605, you must set the **inbound\_schedd\_port** keyword in the cluster stanza for that cluster.
2. (Optional) If the local cluster wants to provide job distribution where users allow LoadLeveler to select the appropriate cluster for job submission based on administration defined objectives, then define an installation exit to be executed at submit time using the **CLUSTER\_METRIC** configuration keyword. You can use the LoadLeveler data access APIs in this exit to query other clusters for information about possible metrics, such as the number of jobs in a specified job class, the number of jobs in the idle queue, or the number of free nodes in the cluster. For more detailed information, see “CLUSTER\_METRIC” on page 237.

**Tip:** LoadLeveler provides a set of sample exits for you to use as models. These samples are in the `${RELEASEDIR}/samples/llcluster` directory.
  3. (Optional) If the local cluster wants to perform user mapping on jobs arriving from remote clusters, define the **CLUSTER\_USER\_MAPPER** configuration keyword. For more information, see “CLUSTER\_USER\_MAPPER” on page 239.
  4. (Optional) If the local cluster wants to perform job filtering on jobs received from remote clusters, define the **CLUSTER\_REMOTE\_JOB\_FILTER** configuration keyword. For more information, see “CLUSTER\_REMOTE\_JOB\_FILTER” on page 238.
  5. Notify LoadLeveler daemons by issuing the **llctl** command with either the **reconfig** or **recycle** keyword. Otherwise, LoadLeveler will not process the modifications you made to the administration file.

### Additional considerations:

- Remote jobs are subjected to the same configuration checks as locally submitted jobs. Examples include account validation, class limits, include lists, and exclude lists.
- Remote jobs will be processed by the local **submit\_filter** prior to submission to a remote cluster.
- Any tracker program specified in the API parameters will be invoked upon the scheduling cluster nodes.
- If a step is enabled for checkpoint and the **ckpt\_execute\_dir** is not specified, LoadLeveler will not copy the executable to the remote cluster, the user must ensure that executable exists on the remote cluster. If the executable is not in a shared file system, the executable can be copied to the remote cluster using the **cluster\_input\_file** job command file keyword.

### Steps for securing communications within a LoadLeveler multicluster

Configuring LoadLeveler to use the OpenSSL library enables it to operate in a secure environment where clusters are separated by a firewall.

Perform the following steps to configure LoadLeveler to use OpenSSL in a multicluster environment:

1. Install SSL using the standard platform installation process.
2. Ensure a link exists from the installed SSL library to:
  - a. `/usr/lib/libssl.so` for 32-bit Linux platforms.
  - b. `/usr/lib64/libssl.so` for 64-bit Linux platforms.
  - c. `/usr/lib/libssl.a` for AIX platforms.
3. Create the SSL authorization keys by invoking the `llclusterauth` command with the `-k` option on all local gateway schedds.
 

**Result:** LoadLeveler creates a public key, a private key, and a security certificate for each gateway node.
4. Distribute the public keys to remote gateway schedds on other secure clusters. This is done by exchanging the public keys with the other clusters you wish to communicate with.
  - for AIX, public keys can be found in the `/var/LoadL/ssl/id_rsa.pub` file.
  - for Linux, public keys can be found in the `/var/opt/LoadL/ssl/id_rsa.pub` file.
5. Copy the public keys of the clusters you wish to communicate with into the `authorized_keys` directory on your inbound schedd nodes.
  - for AIX, `/var/loadl/ssl/authorized_keys`
  - for Linux, `/var/opt/LoadL/ssl/authorized_keys`
  - The authorization key files can be named anything within the `authorized_keys` directory.
6. Define the cluster stanzas within the LoadLeveler administration file, using the `multicluster_security = SSL` keyword. Define the keyword `ssl_cipher_list` if a specific OpenSSL cipher encryption method is desired. Use `secure_schedd_port` to define the port number to be used for secure inbound transactions to the cluster.
7. Notify LoadLeveler daemons by issuing the `llctl -g` command with the `recycle` keyword. Otherwise, LoadLeveler will not process the modifications you made to the administration file.
8. Configure firewalls to accept connections to the `secure_schedd_port` numbers you defined in the administration file.

---

## LoadLeveler Blue Gene support

### Overview of LoadLeveler Blue Gene support

Blue Gene is a massively parallel system based on a scalable cellular architecture which exploits a very large number of tightly interconnected compute nodes (c-nodes). Each c-node is based on system-on-a-chip technology, and is comprised of two PowerPC® 440 processors.

To take advantage of Blue Gene support, you must be using the backfill scheduler and the Blue Gene system must be at a release 2 or higher.

While LoadLeveler Blue Gene support is available on all platforms, Blue Gene software is only supported on IBM POWER servers running SLES 9. This limitation currently restricts LoadLeveler Blue Gene support to SLES 9 on IBM POWER servers.

#### Terms you should know:

- **Compute nodes**, also called c-nodes, are system-on-a-chip nodes that execute at most a single job at a time. All the c-nodes are interconnected in a

three-dimensional toroidal pattern. Each c-node has a unique address and location in the three-dimensional toroidal space. Compute nodes execute the jobs' tasks. Compute nodes run a minimal custom operating system called BLRTS.

- **Front End Nodes (FEN)** are machines from which users and administrators interact with Blue Gene. Applications are compiled on and submitted for execution in the Blue Gene core from FENs. User interactions with applications, including debugging, are also performed from the FENs.
- The **Service Node** is dedicated hardware that runs software to control and manage the Blue Gene system.
- **I/O nodes** are special nodes that connect the compute nodes to the outside world. I/O nodes allow processes that are executing in the compute nodes to perform I/O operations, such as accessing files, and to communicate with the job management system. Each I/O node serves anywhere from 8 to 64 c-nodes, depending on the physical configuration.
- **mpirun** is a program that is executed partly on the Front End Node, and partly on the Service Node. mpirun controls and monitors the parallel Blue Gene job. The mpirun program is executed by the user program that is run on the FEN by LoadLeveler.
- A **base partition (BP)** is a group of compute nodes connected in a 3D rectangular pattern and their controlled I/O nodes. A base partition is one of the basic allocation units for jobs. For example, an allocation for the job will require at least one base partition, unless an allocation requests a small partition, in which case sub base partition allocation is possible.
- A **small partition** is a group of c-nodes which are part of one base partition. Valid small partitions have size of 32 or 128 c-nodes.
- A **partition** is a group of base partitions, switches, and switch states allocated to a job. A partition is predefined or is created on demand to execute a job. Partitions are physically (electronically) isolated from each other (for example, messages cannot flow outside an allocated partition). A partition can have the topology of a mesh or a torus.
- The **Control System** is a component that serves as the interface to the Blue Gene system. It contains persistent storage with configuration and status information on the entire system. It also provides various services to perform actions on the Blue Gene system, such as launching a job.
- A **node card** is a group of 32 compute nodes within a base partition. This is the minimal allocation size for a partition.
- A **quarter** is a group of 4 node cards. This is a logical grouping of node cards within a base partition. A quarter, which is 128 compute nodes, is the next smallest allowed allocation size for a partition after a node card.
- A **switch state** is a set of internal switch connections which physically "wire" the partition. A switch has a number of incoming and outgoing wires. An internal switch connection physically connects one incoming wire with one outgoing wire, setting up a communication path between base partitions.

For more information on the Blue Gene system and Blue Gene terminology refer to the Blue Gene documentation listed in "Blue Gene documentation" on page xiii.

| Subtask                                 | Associated instructions (see . . . )                    |
|-----------------------------------------|---------------------------------------------------------|
| Configure LoadLeveler Blue Gene support | "Configuring LoadLeveler Blue Gene support" on page 145 |
| Submit and monitor Blue Gene jobs       | "Submitting and monitoring Blue Gene jobs" on page 195  |

| Related topic                          | Associated information (see . . . )                                                                         |
|----------------------------------------|-------------------------------------------------------------------------------------------------------------|
| Configuration file: Blue Gene keywords | "Configuration file keyword descriptions" on page 232                                                       |
| Job command file: Blue Gene keywords   | "Job command file keyword descriptions" on page 324                                                         |
| Commands and APIs                      | Chapter 15, "Commands," on page 371 or Chapter 16, "Application programming interfaces (APIs)," on page 481 |
| Diagnosis and messages                 | <i>LoadLeveler: Diagnosis and Messages Guide</i>                                                            |

## Configuring LoadLeveler Blue Gene support

| Subtask                                        | Associated instructions (see . . . )                                                                                                                                                                                                                                                                                                                                                                         |
|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Configuring LoadLeveler Blue Gene support      | "Steps for configuring LoadLeveler Blue Gene support"                                                                                                                                                                                                                                                                                                                                                        |
| Display information about the Blue Gene system | <ul style="list-style-type: none"> <li>Use the <b>llstatus</b> command with the <b>-b</b> option to display information about the Blue Gene system. The <b>llstatus</b> command can also be used with the <b>-B</b> option to display information about Blue Gene base partitions. Using <b>llstatus</b> with the <b>-P</b> option can be used to display information about Blue Gene partitions.</li> </ul> |
| Display information about Blue gene jobs       | <ul style="list-style-type: none"> <li>Use the <b>llsummary</b> command with the <b>-l</b> option to display job resource information.</li> <li>Use the <b>llq</b> command with the <b>-b</b> option to display information about all Blue Gene jobs.</li> </ul>                                                                                                                                             |

### Steps for configuring LoadLeveler Blue Gene support

The primary task for configuring LoadLeveler Blue Gene support consists of setting up the environment of the `LoadL_negotiator` daemon, the environment of any process that will run Blue Gene jobs, and the LoadLeveler configuration file.

Perform the following steps to configure LoadLeveler Blue Gene support:

1. Configure the **LoadL\_negotiator** daemon to run on a node which has access to the Blue Gene Control System.
2. Enable Blue Gene support by setting the **BG\_ENABLED** configuration file keyword to **true**.
3. (Optional) Set any of the following additional Blue Gene related configuration file keywords which your setup requires:
  - **BG\_ALLOW\_LL\_JOBS\_ONLY**
  - **BG\_CACHE\_PARTITIONS**
  - **BG\_MIN\_PARTITION\_SIZE**

See "Configuration file keyword descriptions" on page 232 for more information on these keywords.

4. Set the required environment variables for the **LoadL\_negotiator** daemon and any process that will run Blue Gene jobs. You can use global profiles to set the necessary environment variables for all users. Follow these steps to set environment variables for a LoadLeveler daemon:
  - a. Add required environment variable settings to global profile.

- b. Set the environment as the administrator before invoking **llctl start** on the central manager node.
- c. Build a shell script which sets the required environments and starts LoadLeveler, which can be invoked using **rsh** remotely.

**Note:** Using the **llctl -h** or **llctl -g** command to start the central manager remotely will not carry the environment variables from the login session to the LoadLeveler daemons on the remote nodes.

- Specify the full path name of the bridge configuration file by setting the **BRIDGE\_CONFIG\_FILE** environment variable. For details on the contents of the bridge configuration file, see the *Blue Gene/L: System Administration* book.

**Example:**

For ksh:

```
export BRIDGE_CONFIG_FILE=/var/bluegene/config/bridge.cfg
```

For csh:

```
setenv BRIDGE_CONFIG_FILE=/var/bluegene/config/bridge.cfg
```

- Specify the full path name of the file containing the data required to access the Blue Gene Control System database by setting the **DB\_PROPERTY** environment variable. For details on the contents of the database property file, see the *Blue Gene/L: System Administration* book.

**Example:**

For ksh:

```
export DB_PROPERTY=/var/bluegene/config/db.cfg
```

For csh:

```
setenv DB_PROPERTY=/var/bluegene/config/db.cfg
```

- Specify the hostname of the machine running the Blue Gene control system by setting the **MMCS\_SERVER\_IP** environment variable. For details on the use of this environment variable, see the *Blue Gene/L: System Administration* book.

**Example:**

For ksh:

```
export MMCS_SERVER_IP=bluegene.ibm.com
```

For csh:

```
setenv MMCS_SERVER_IP=bluegene.ibm.com
```

---

## Chapter 6. Using LoadLeveler's GUI to perform administrator tasks

The end user can perform many tasks more efficiently and faster using the graphical user interface (GUI) but there are certain tasks that end users cannot perform unless they have the proper authority. If you are defined as a LoadLeveler administrator in the LoadLeveler configuration file then you are immediately granted administrative authority and can perform the administrative tasks discussed in this section. To find out how to grant someone administrative authority, see "Defining LoadLeveler administrators" on page 34.

You can access LoadLeveler administrative commands using the **Admin** pull-down menu on both the Jobs window and the Machines window of the GUI. The **Admin** pull-down menu on the Jobs window corresponds to the command options available in the **llhold**, **llfavoruser**, and **llfavorjob** commands. The **Admin** pull-down menu on the Machines window corresponds to the command options available in the **llctl** command.

The main window of the GUI, as shown in Figure 36 on page 364, has three sub-windows: one for job status with pull-down menus for job-related commands, one for machine status with pull-down menus for machine-related commands, and one for messages and logs. There are a variety of facilities available that allow you to sort and select the items displayed.

---

### Job-related administrative actions

You access the administrative commands that act on jobs through the **Admin** pull-down menu in the Jobs window of the GUI.

You can perform the following tasks with this menu:

**Favor Users** Allows you to favor users. This means that you can select one or more users whose jobs you want to move up in the job queue. This corresponds to the **llfavoruser** command.

**Select** **Admin** from the Jobs window

**Select** **Favor User**

▲The **Order by User** window appears.

**Type in**

The name of the user whose jobs you want to favor.

**Press** **OK**

**Unfavor Users**

Allows you to unfavor users. This means that you want to unfavor the user's jobs which you previously favored. This corresponds to the **llfavoruser** command.

**Select** **Admin** from the Jobs window

**Select** **Unfavor User**

▲The **Order by User** window appears.

## Administrative uses of the GUI

- Type in**  
The name of the user for whom you want to unfavor their jobs.
- Press** OK
- Favor Jobs** Allows you to select a job that you want to favor. This corresponds to the **llfavorjob** command.
- Select** One or more jobs from the Jobs window
- Select** Admin from the Jobs window
- Select** Favor Job
- ▲The selected jobs are favored.
- Press** OK
- Unfavor Jobs** Allows you select a job that you want to unfavor. This corresponds to the **llfavorjob** command.
- Select** One or more jobs from the Jobs window
- Select** Admin from the Jobs window
- Select** Unfavor Job
- ▲Unfavors the jobs that you previously selected.
- Syshold** Allows you to place a system hold on a job. This corresponds to the **llhold** command.
- Select** A job from the Jobs window
- Select** Admin pull-down menu from the Jobs window
- Select** Syshold to place a system hold on the job.
- Release From Hold** Allows you to release the system hold on a job. This corresponds to the **llhold** command.
- Select** A job from the Jobs window
- Select** Admin pull-down menu from the Jobs window
- Select** Release From Hold to release the system hold on the job.
- Preempt** Available when using the Backfill, Gang or external schedulers. Preempt allows you to place the selected jobs in preempted state. This action corresponds to the **llpreempt** command.
- Select** One or more jobs from the Jobs window
- Select** Admin pull-down menu from the Jobs window
- Select** Preempt
- Resume Preempted Job** Available only when using the backfill, gang or external schedulers. Resume Preempted Job allows you to remove user-initiated preemption (initiated using the Preempt menu option or the **llpreempt** command) from the selected jobs. This action corresponds to the **llpreempt -r** command.
- Select** One or more jobs from the Jobs window
- Select** Admin pull-down menu from the Jobs window

**Select Resume Preempted Job****Prevent Preempt**

Available only when using the backfill, gang, or API scheduler. Prevent Preempt allows you to place the selected running job into a non-preemptable state. When the backfill or API scheduler is in use, this is equivalent to the **llmodify -p nopreempt** command. When the gang scheduler is in use, this is equivalent to the **llmodify -x 99** command.

**Select** One job from the Jobs window

**Select** Admin pull-down menu from the Jobs window

**Select Prevent Preempt**

**Allow Preempt**

Available only when using the backfill, gang, or API scheduler, Allow Preempt makes the unpreemptable job preemptable again. When the backfill or API scheduler is in use, this is equivalent to the **llmodify -p preempt** command. When the gang scheduler is in use, this is equivalent to the **llmodify -x 1** command.

**Select** One or more jobs from the Jobs window

**Select** Admin pull-down menu from the Jobs window

**Select**

**Allow Preempt**

**Extend Wallclock Limits**

Allows you to extend the wallclock limits by the number of minutes specified. This corresponds to the **llmodify -W** command.

**Select** Admin pull-down window from the Jobs window

**Select Extend Wallclock Limit**

▲The Extend Wallclock Limits window appears.

**Type in**

The number of minutes to extend the wallclock limit.

**Press** OK

**Modify Job Priority**

Allows you to modify the system priority of a job step. This corresponds to the **llmodify -s** command.

**Select** Admin pull-down window from the Jobs window

**Select Modify Job Priority**

▲The Modify Job Priority window appears.

**Type in**

An integer value for system priority.

**Press** OK

**Move to another cluster**

Allows you to move an idle job from the local cluster to another. This menu item appears only when a multicluster environment is configured. It corresponds to the **llmovejob** command.

**Select** Admin pull-down window from the Jobs window

## Administrative uses of the GUI

Select   Modify Job Priority

▲The Move Job to Another Cluster window appears.

**Select** The name of the target cluster.

Press OK

## Machine-related administrative actions

You access the administrative commands that act on machines using the **Admin** pull-down menu in the Machines window of the GUI.

Using the GUI pull-down menu, you can perform the tasks described in this section.

|                  |                                                                                                                                                                                                                                                                                                                                |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Start All</b> | Starts LoadLeveler on all machines listed in machine stanzas beginning with the central manager. Submit-only machines are skipped. Use this option when specifying alternate central managers in order to ensure the primary central manager starts before any alternate central manager attempts to serve as central manager. |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Select **Admin** from the Machines window.

Select Start All

## Start LoadLeveler

Allows you to start LoadLeveler on selected machines.

**Select** One or more machines on which you want to start LoadLeveler.

Select **Admin** from the Machines window.

Select Start LoadLeveler

**Start Drained** Allows you to start LoadLeveler with **startd** drained on selected machines.

**Select** One or more machines on which you want **startd** drained.

Select **Admin** from the Machines window.

Select Start Drained

## Stop LoadLeveler

Allows you to stop LoadLeveler on selected machines.

**Select** One or more machines on which you want to stop LoadLeveler.

Select **Admin** from the Machines window.

Select **Stop LoadLeveler**.

**Stop All** Stops LoadLeveler on all machines listed in machine stanzas. Submit-only machines are skipped.

Select **Admin** from the Machines window.

Select Stop All

|                 |                                                      |
|-----------------|------------------------------------------------------|
| <b>Reconfig</b> | Forces all daemons to reread the configuration files |
|-----------------|------------------------------------------------------|

|                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                            | <p><b>Select</b> The machine on which you want to operate. To reconfigure this <b>xloadl</b> session, choose <b>reconfig</b> but do not select a machine.</p> <p><b>Select</b> <b>Admin</b> from the Machines window.</p> <p><b>Select</b> <b>reconfig</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Recycle</b>             | <p>Stops all LoadLeveler daemons and restarts them.</p> <p><b>Select</b> The machine on which you want to operate.</p> <p><b>Select</b> <b>Admin</b> from the Machines window.</p> <p><b>Select</b> <b>recycle</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Configuration Tasks</b> | <p>Starts Configuration Tasks wizard</p> <p><b>Select</b> <b>Admin</b> from the Machines window.</p> <p><b>Select</b> <b>Config Tasks</b></p> <p>Note: Use the invoking script <b>lltg</b> to start the wizard outside of <b>xloadl</b>. This option will appear on the pull-down only if the LoadL.tguides filesset is installed.</p>                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Drain</b>               | <p>Allows no more LoadLeveler jobs to begin running on this machine but it does allow running jobs to complete.</p> <p><b>Select</b> The machine on which you want to operate.</p> <p><b>Select</b> <b>Admin</b> from the Machines window.</p> <p><b>Select</b> <b>drain</b>.</p> <p>A cascading menu allows you to select either <b>daemons</b>, <b>schedd</b>, <b>startd</b>, or <b>startd by class</b>. If you select <b>daemons</b>, both machines will be drained. If you select <b>schedd</b>, only the schedd on the selected machine will be drained. If you select <b>startd</b>, only the startd on the selected machine will be drained. If you select <b>startd by class</b>, a window appears which allows you to select classes to be drained.</p> |
| <b>Flush</b>               | <p>Terminates running jobs on this host and sends them back to the system queue to await redispach. No new jobs are redispached to this machine until <b>resume</b> is issued. Forces a checkpoint if jobs are enabled for checkpointing.</p> <p><b>Select</b> The machine on which you want to operate.</p> <p><b>Select</b> <b>Admin</b> from the Machines window.</p> <p><b>Select</b> <b>flush</b></p>                                                                                                                                                                                                                                                                                                                                                       |
| <b>Suspend</b>             | <p>Suspends all jobs on this host.</p> <p><b>Select</b> The machine on which you want to operate.</p> <p><b>Select</b> <b>Admin</b> from the Machines window.</p> <p><b>Select</b> <b>suspend</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Resume</b>              | <p>Resumes all jobs on this machine.</p> <p><b>Select</b> The machine on which you want to operate.</p> <p><b>Select</b> <b>Admin</b> from the Machines window</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

### Select **resume**

A cascading menu allows you to select either **daemons**, **schedd**, **startd**, or **startd by class**. If you select **daemons**, both machines will be resumed. If you select **schedd**, only the schedd on the selected machine will be resumed. If you select **startd**, only the startd on the selected machine will be resumed. If you select **startd by class**, a window appears which allows you to select classes to be resumed.

**Purge Schedd** Allows you to purge (remove) all of the jobs scheduled by the schedd on the selected machines. To use this option you must first specify `schedd_fenced=true` in the machine stanza for this machine and reconfigure the central manager. For more information on using this option, see “How do I recover resources allocated by a schedd machine?” on page 593.

**Select** One or more machines whose schedd is down and will be down long enough to necessitate that you recover the resources allocated to jobs scheduled by that schedd

**Select** **Admin** pull-down menu from the Machines window

**Select**  
**Purge Schedd**

**Press** **OK**

**Capture Data** Collects information on the machines selected.

**Select** The machine on which you want to operate.

**Select** **Admin** from the Machines window.

**Select** **Capture Data**.

### **Collect Account Data**

Collects accounting data on the machines selected.

**Select** The machine on which you want to operate.

**Select** **Admin** from the Machines window.

**Select** **Collect Account Data**.

A window appears prompting you to enter the name of the directory in which you want the collected data stored.

### **Collect Reservation Data**

Collects reservation data on the machines selected.

**Select** The machine on which you want to operate.

**Select** **Admin** from the Machines window.

**Select** **Collect Reservation Data**.

A window appears prompting you to enter the name of the directory in which you want the collected data stored.

### **Create Account Report**

Creates an accounting report for you.

**Select** **Admin → Create Account Report...**

**Note:** If you want to receive an extended accounting report, select the **extended** cascading button.

A window appears prompting you to enter the following information:

- A short, long, or extended version of the output. The short version is the default.
- The user ID
- The class name
- The LoadL (LoadLeveler) group name
- The UNIX group name
- The Allocated host
- The job ID
- The report Type
- The section
- A start and end date for the report. If no date is specified, the default is to report all of the data in the report.
- The name of the input data file.
- The name of the output data file. This is the same as stdout.

**Press** OK

The window closes and you return to the main window. The report appears in the Messages window if no output data file was specified.

### Version

Displays version and release data for LoadLeveler on the machines selected in an information window.

**Select** The machine on which you want to operate.

**Select** Admin from the Machines window.

**Select** version



---

## Part 3. Submitting and managing LoadLeveler jobs

After an administrator installs LoadLeveler and customizes the environment, general users may build and submit jobs to exploit the many features of the LoadLeveler runtime environment.

| To learn about:                                                                                    | Read the following:                                                                                                                                                                                                                                                                                                                                               |
|----------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Creating and submitting serial and parallel jobs                                                   | Chapter 7, "Building and submitting jobs," on page 157                                                                                                                                                                                                                                                                                                            |
| Controlling and monitoring LoadLeveler jobs                                                        | Chapter 8, "Managing submitted jobs," on page 199                                                                                                                                                                                                                                                                                                                 |
| Ways to control or monitor LoadLeveler operations by using the LoadLeveler commands, GUI, and APIs | <ul style="list-style-type: none"><li>• Chapter 15, "Commands," on page 371</li><li>• Chapter 9, "Example: Using commands to build, submit, and manage jobs," on page 205</li><li>• Chapter 10, "Using LoadLeveler's GUI to build, submit, and manage jobs," on page 207</li><li>• Chapter 16, "Application programming interfaces (APIs)," on page 481</li></ul> |



---

## Chapter 7. Building and submitting jobs

Table 30 lists the tasks that general users perform to run LoadLeveler jobs.

*Table 30. Roadmap of user tasks for building and submitting jobs*

| To learn about:                                                 | Read the following:                                                                                                                                                                                                                                                                                                                                                |
|-----------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Building jobs                                                   | <ul style="list-style-type: none"><li>• “Building a job command file”</li><li>• “Editing job command files” on page 163</li><li>• “Defining resources for a job step” on page 163</li><li>• “Using bulk data transfer” on page 163</li><li>• “Preparing a job for checkpoint/restart” on page 165</li><li>• “Preparing a job for preemption” on page 167</li></ul> |
| Submitting jobs                                                 | <ul style="list-style-type: none"><li>• “Submitting a job command file” on page 167</li><li>• “llsubmit - Submit a job” on page 471</li></ul>                                                                                                                                                                                                                      |
| Working with parallel jobs                                      | “Working with parallel jobs” on page 168                                                                                                                                                                                                                                                                                                                           |
| Working with reserved node resources and the jobs that use them | “Working with reservations” on page 184                                                                                                                                                                                                                                                                                                                            |
| Working with NQS jobs                                           | “Steps for submitting a job to be routed to an NQS machine” on page 192                                                                                                                                                                                                                                                                                            |
| Correctly specifying job command file keywords                  | Chapter 13, “Job command file reference,” on page 319                                                                                                                                                                                                                                                                                                              |

---

### Building a job command file

Before you can submit a job or perform any other job related tasks, you need to build a job command file. A job command file describes the job you want to submit, and can include LoadLeveler keyword statements. For example, to specify a binary to be executed, you can use the **executable** keyword, which is described later in this section. To specify a shell script to be executed, the **executable** keyword can be used; if it is not used, LoadLeveler assumes that the job command file itself is the executable.

The job command file can include the following:

- LoadLeveler keyword statements: A *keyword* is a word that can appear in job command files. A *keyword statement* is a statement that begins with a LoadLeveler keyword. These keywords are described in “Job command file keyword descriptions” on page 324.
- Comment statements: You can use comments to document your job command files. You can add comment lines to the file as you would in a shell script.
- Shell command statements: If you use a shell script as the executable, the job command file can include shell commands.
- LoadLeveler variables: See “Job command file variables” on page 360 for more information.

You can build a job command file either by using the Build a Job window on the GUI or by using a text editor.

### Using multiple steps in a job command file

To specify a stream of job steps, you need to list each job step in the job command file. You must specify one **queue** statement for each job step. Also, the executables for all job steps in the job command file must exist when you submit the job. For most keywords, if you specify the keyword in a job step of a multi-step job, its value is inherited by all proceeding job steps. Exceptions to this are noted in the keyword description.

LoadLeveler treats all job steps as independent job steps unless you use the **dependency** keyword. If you use the **dependency** keyword, LoadLeveler determines whether a job step should run based upon the exit status of the previously run job step.

For example, Figure 19 contains two separate job steps. Notice that step1 is the first job step to run and that step2 is a job step that runs only if step1 exits with the correct exit status.

```
This job command file lists two job steps called "step1"
and "step2". "step2" only runs if "step1" completes
with exit status = 0. Each job step requires a new
queue statement.
#
@ step_name = step1
@ executable = executable1
@ input = step1.in1
@ output = step1.out1
@ error = step2.err1
@ queue
@ dependency = (step1 == 0)
@ step_name = step2
@ executable = executable2
@ input = step2.in1
@ output = step2.out1
@ error = step2.err1
@ queue
```

Figure 19. Job command file with multiple steps

In Figure 19, step1 is called the *sustaining* job step. step2 is called the *dependent* job step because whether or not it begins to run is dependent upon the exit status of step1. A single sustaining job step can have more than one dependent job steps and a dependent job step can also have job steps dependent upon it.

In Figure 19, each job step has its own **executable**, **input**, **output**, and **error** statements. Your job steps can have their own separate statements, or they can use those statements defined in a previous job step. For example, in Figure 20 on page 159, step2 uses the **executable** statement defined in step1:

```
This job command file uses only one executable for
both job steps.
#
@ step_name = step1
@ executable = executable1
@ input = step1.in1
@ output = step1.out1
@ error = step1.err1
@ queue
@ dependency = (step1 == 0)
@ step_name = step2
@ input = step2.in1
@ output = step2.out1
@ error = step2.err1
@ queue
```

Figure 20. Job command file with multiple steps and one executable

## Examples: Job command files

- **Example 1: Generating multiple jobs with varying outputs**

To run a program several times, varying the initial conditions each time, you could can multiple LoadLeveler scripts, each specifying a different input and output file as described in Figure 22 on page 161. It would probably be more convenient to prepare different input files and submit the job only once, letting LoadLeveler generate the output files and do the multiple submissions for you.

Figure 21 illustrates the following:

- You can refer to the LoadLeveler name of your job symbolically, using **\$(jobid)** and **\$(stepid)** in the LoadLeveler script file.
- **\$(jobid)** refers to the job identifier.
- **\$(stepid)** refers to the job step identifier and increases after each **queue** command. Therefore, you only need to specify input, output, and error statements once to have LoadLeveler name these files correctly.

Assume that you created five input files and each input file has different initial conditions for the program. The names of the input files are in the form **longjob.in.x**, where *x* is 0–4.

Submitting the LoadLeveler script shown in Figure 21 results in your program running five times, each time with a different input file. LoadLeveler generates the output file from the LoadLeveler job step IDs. This ensures that the results from the different submissions are not merged.

```
@ executable = longjob
@ input = longjob.in.$(stepid)
@ output = longjob.out.$(jobid).$(stepid)
@ error = longjob.err.$(jobid).$(stepid)
@ queue
@ queue
@ queue
@ queue
@ queue
```

Figure 21. Job command file with varying input statements

To submit the job, type the command:

```
llsubmit longjob.cmd
```

LoadLeveler responds by issuing the following:

## Building a job command file

submit: The job "ll6.23" with 5 job steps has been submitted.

The following table shows you the standard input files, standard output files, and standard error files for the five job steps:

| Job Step | Standard Input | Standard Output  | Standard Error   |
|----------|----------------|------------------|------------------|
| ll6.23.0 | longjob.in.0   | longjob.out.23.0 | longjob.err.23.0 |
| ll6.23.1 | longjob.in.1   | longjob.out.23.1 | longjob.err.23.1 |
| ll6.23.2 | longjob.in.2   | longjob.out.23.2 | longjob.err.23.2 |
| ll6.23.3 | longjob.in.3   | longjob.out.23.3 | longjob.err.23.3 |
| ll6.23.4 | longjob.in.4   | longjob.out.23.4 | longjob.err.23.4 |

- **Example 2: Using LoadLeveler variables in a job command file**

Figure 22 on page 161 shows how you can use LoadLeveler variables in a job command file to assign different names to input and output files. This example assumes the following:

- The name of the machine from which the job is submitted is **lltest1**
- The user's home directory is **/u/rhclark** and the current working directory is **/u/rhclark/OSL**
- LoadLeveler assigns a value of 122 to **\$(jobid)**.

In Job Step 0:

- LoadLeveler creates the subdirectories **oslsslv\_out** and **oslsslv\_err** if they do not exist at the time the job step is started.

In Job Step 1:

- The character string **rhclark** denotes the home directory of user **rhclark** in **input**, **output**, **error**, and **executable** statements.
- The **\$(base\_executable)** variable is set to be the "base" portion of the **executable**, which is **oslsslv**.
- The **\$(host)** variable is equivalent to **\$(hostname)**. Similarly, **\$(jobid)** and **\$(stepid)** are equivalent to **\$(cluster)** and **\$(process)**, respectively.

In Job Step 2:

- This job step is executed only if the return codes from Step 0 and Step 1 are both equal to zero.
- The initial working directory for Step 2 is explicitly specified.

```

Job step 0 =====
The names of the output and error files created by this job step are:
#
output: /u/rhclark/OSL/oslsslv_out/lltest1.122.0.out
error : /u/rhclark/OSL/oslsslv_err/lltest1_122_0_err
#
@ job_name = OSL
@ step_name = step_0
@ executable = oslsslv
@ arguments = -maxmin=min -scale=yes -alg=dual
@ environment = OSL_ENV1=20000; OSL_ENV2=500000
@ requirements = (Arch == "R6000") && (OpSys == "AIX43")
@ input = test01.mps.$(stepid)
@ output = $(executable)_out/$(host).$(jobid).$(stepid).out
@ error = $(executable)_err/$(host).$(jobid).$(stepid)_err
@ queue
#
Job step 1 =====
The names of the output and error files created by this job step are:
#
output: /u/rhclark/OSL/oslsslv_out/lltest1.122.1.out
error : /u/rhclark/OSL/oslsslv_err/lltest1_122_1_err
#
@ step_name = step_1
@ executable = rhclark/$(job_name)/oslsslv
@ arguments = -maxmin=max -scale=no -alg=primal
@ environment = OSL_ENV1=60000; OSL_ENV2=500000; \
OSL_ENV3=70000; OSL_ENV4=800000;
@ input = rhclark/$(job_name)/test01.mps.$(stepid)
@ output = rhclark/$(job_name)/$(base_executable)_out/$(hostname).$(cluster).$(process).out
@ error = rhclark/$(job_name)/$(base_executable)_err/$(hostname).$(cluster).$(process)_err
@ queue
#
Job step 2 =====
The names of the output and error files created by this job step are:
#
output: /u/rhclark/OSL/oslsslv_out/lltest1.122.2.out
error : /u/rhclark/OSL/oslsslv_err/lltest1_122_2_err
#
@ step_name = OSL
@ dependency = (step_0 == 0) && (step_1 == 0)
@ comment = oslsslv
@ initialdir = /u/rhclark/$(step_name)
@ arguments = -maxmin=min -scale=yes -alg=dual
@ environment = OSL_ENV1=300000; OSL_ENV2=500000
@ input = test01.mps.$(stepid)
@ output = $(comment)_out/$(host).$(jobid).$(stepid).out
@ error = $(comment)_err/$(host).$(jobid).$(stepid)_err
@ queue

```

Figure 22. Using LoadLeveler variables in a job command file

### • Example 3: Using the job command file as the executable

The name of the sample script shown in Figure 23 on page 162 is **run\_spice\_job**. This script illustrates the following:

- The script does not contain the **executable** keyword. When you do not use this keyword, LoadLeveler assumes that the script is the executable. (Since the name of the script is **run\_spice\_job**, you can add the **executable = run\_spice\_job** statement to the script, but it is not necessary.)
- The job consists of four job steps (there are 4 **queue** statements). The **spice3f5** and **spice2g6** programs are invoked at each job step using different input data files:
  - **spice3f5**: Input for this program is from the file **spice3f5\_input\_x** where *x* has a value of 0, 1, and 2 for job steps 0, 1, and 2, respectively. The name of this file is passed as the first argument to the script. Standard output and standard error data generated by **spice3f5** are directed to the file **spice3f5\_output\_x**. The name of this file is passed as second argument to

## Building a job command file

the script. In job step 3, the names of the input and output files are **spice3f5\_input\_benchmark1** and **spice3f5\_output\_benchmark1**, respectively.

- **spice2g6**: Input for this program is from the file **spice2g6\_input\_x**. Standard output and standard error data generated by **spice2g6** together with all other standard output and standard error data generated by this script are directed to the files **spice\_test\_output\_x** and **spice\_test\_error\_x**, respectively. In job step 3, the name of the input file is **spice2g6\_input\_benchmark1**. The standard output and standard error files are **spice\_test\_output\_benchmark1** and **spice\_test\_error\_benchmark1**.

All file names that are not fully qualified are relative to the initial working directory **/home/loadl/spice**. LoadLeveler will send the job steps 0 and 1 of this job to a machine for that has a real memory of 64 MB or more for execution. Job step 2 most likely will be sent to a machine that has more than 128 MB of real memory and has the ESSL library installed since these preferences have been stated using the LoadLeveler **preferences** keyword. LoadLeveler will send job step 3 to the machine **l15.pok.ibm.com** for execution because of the explicit requirement for this machine in the **requirements** statement.

```
#!/bin/ksh
@ job_name = spice_test
@ account_no = 99999
@ class = small
@ arguments = spice3f5_input_${stepid} spice3f5_output_${stepid}
@ input = spice2g6_input_${stepid}
@ output = $(job_name)_output_${stepid}
@ error = $(job_name)_error_${stepid}
@ initialdir = /home/loadl/spice
@ requirements = ((Arch == "R6000") && \
(OpSys == "AIX43") && (Memory > 64))
@ queue
@ queue
@ preferences = ((Memory > 128) && (Feature == "ESSL"))
@ queue
@ class = large
@ arguments = spice3f5_input_benchmark1 spice3f5_output_benchmark1
@ requirements = (Machine == "l15.pok.ibm.com")
@ input = spice2g6_input_benchmark1
@ output = $(job_name)_output_benchmark1
@ error = $(job_name)_error_benchmark1
@ queue
OS_NAME=`uname`

case $OS_NAME in
 AIX)
 echo "Running $OS_NAME version of spice3f5" > $2
 AIX_bin/spice3f5 < $1 >> $2 2>&1
 echo "Running $OS_NAME version of spice2g6"
 AIX_bin/spice2g6
 ;;
 *)
 echo "spice3f5 for $OS_NAME is not available" > $2
 echo "spice2g6 for $OS_NAME is not available"
 ;;
esac
```

Figure 23. Job command file used as the executable

---

## Editing job command files

After you build a job command file, you can edit it using the editor of your choice. You may want to change the name of the executable or add or delete some statements.

When you create a job command file, it is considered the job executable unless you specify otherwise by using the **executable** keyword in the job command file. LoadLeveler copies the executable to the spool directory unless the **checkpoint** keyword was set to **yes** or **interval**. Jobs that are to be checkpointed cannot be moved to the spool directory. Do not make any changes to the executable while the job is still in the queue—it could affect the way that job runs.

---

## Defining resources for a job step

The LoadLeveler user may use the **resources** keyword in the job command file to specify the resources to be consumed by each task of a job step. If the **resources** keyword is specified in the job command file, it overrides any **default\_resources** specified by the administrator for the job step's class.

For example, the following job requests one CPU and one FRM license for each of its tasks:

```
resources = ConsumableCpus(1) FRMLicense(1)
```

If this were specified in a serial job step, one CPU and one FRM license would be consumed while the job step runs. If this were a parallel job step, then the number of CPUs and FRM licenses consumed while the job step runs would depend upon how many tasks were running on each machine. For more information on assigning tasks to nodes, see "Task-assignment considerations" on page 170.

---

## Using bulk data transfer

On AIX systems with device drivers and network adapters that support remote direct-memory access (RDMA), LoadLeveler supports bulk data transfer for jobs that use either the Internet or User Space communication protocol mode. For jobs using the Internet protocol (IP jobs), LoadLeveler does not monitor or control the use of bulk transfer. For User Space jobs that request bulk transfer, however, LoadLeveler creates a consumable RDMA resource requirement. Machines with network adapters that support RDMA are automatically given an RDMA consumable resource with an available amount of four. Each step that requests bulk transfer consumes one RDMA resource on each machine on which that step runs.

The RDMA resource is similar to user-defined consumable resources except in one important way: A user-specified resource requirement is consumed by every task of the job assigned to a machine, whereas the RDMA resource is consumed once on a machine no matter how many tasks of the job are running on the machine. Other than that exception, LoadLeveler handles the RDMA resource as it does all other consumable resources. LoadLeveler displays RDMA resources in the output of the following commands:

- `llq -l`
- `llstatus -l`
- `llstatus -R`
- `llsummary -l`

## Using bulk data transfer

Bulk transfer is supported only on systems where the device driver of the network adapters supports RDMA. To determine which systems will support bulk transfer, use the `llstatus` command with either the `-l` or `-R` flag to display machines with adapters that support RDMA (supporting machines will have an RDMA resource listed in the command output).

Under certain conditions, LoadLeveler displays a total count of RDMA resources as less than four:

- If jobs that LoadLeveler does not manage use RDMA, the amount of available RDMA resource reported to the Negotiator is reduced by the amount consumed by the unmanaged jobs.
- In rare situations, LoadLeveler jobs can fail to release their adapter resources before reporting to the Negotiator that they have completed. In these situations, the amount of available RDMA reported to the Negotiator is reduced by the amount consumed by the unreleased adapter resources. When the adapter resources are eventually released, the RDMA resource they consumed becomes available again.

These conditions do not require corrective action.

You do not need to perform specific job-definition tasks to enable bulk transfer for LoadLeveler jobs that use the IP network protocol. LoadLeveler cannot affect whether IP communication uses bulk transfer; the implementation of IP where the job runs determines whether bulk transfer is supported.

To enable User Space jobs to use bulk data transfer, however, **all** of the following tasks must be completed. If you omit one or more of these steps, the job will run but will not be able to use bulk transfer.

- • A LoadLeveler administrator must update the LoadLeveler configuration file to include the value `RDMA` in the `SCHEDULE_BY_RESOURCES` list.

**Example:**

```
SCHEDULE_BY_RESOURCES = RDMA others
```

- • Users must request bulk transfer for their LoadLeveler jobs, using one of the following methods:

- Specifying the `bulkxfer` keyword in the LoadLeveler job command file.

**Example:**

```
#@ bulkxfer=yes
```

If users specify this keyword for jobs that use the IP communication protocol, LoadLeveler ignores the `bulkxfer` keyword.

- Specifying a `POE` line command parameter on interactive jobs.

**Example:**

```
poe_job -use_bulk_xfer=yes
```

- Specifying an environment variable on interactive jobs.

**Example:**

```
export MP_USE_BULK_XFER=yes
poe_job
```

- • Because LoadLeveler honors the bulk transfer request only for LAPI or MPI jobs, users must ensure that the **network** keyword in the job command file specifies the MPI, LAPI, or MPI\_LAPI protocol for user space communication.

**Examples:**

```
network.MPI =sn_single,not_shared,US,HIGH
network.MPI_LAPI =sn_single,not_shared,US,HIGH
```

## Preparing a job for checkpoint/restart

Use the information in Table 31 to correctly configure your job for checkpointing.

Table 31. Checkpoint configurations

| To specify that:                                               | Do this:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|----------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Your job is checkpointable                                     | <ul style="list-style-type: none"> <li>• Add either one of the following two options to your job command file:               <ol style="list-style-type: none"> <li>1. <b>checkpoint = yes</b><br/>This enables your job to checkpoint in any of the following ways:                   <ul style="list-style-type: none"> <li>– The application can initiate the checkpoint.</li> <li>– Checkpoint from a program which invokes the <b>ll_ckpt</b> API.</li> <li>– Checkpoint using the <b>llckpt</b> command.</li> <li>– As the result of a flush command.</li> </ul> </li> <li>OR</li> <li>2. <b>checkpoint = interval</b><br/>This enables your job to checkpoint in any of the following ways:                   <ul style="list-style-type: none"> <li>– The application can initiate the checkpoint.</li> <li>– Checkpoint from a program which invokes the <b>ll_ckpt</b> API.</li> <li>– Checkpoint using the <b>llckpt</b> command.</li> <li>– Checkpoint automatically taken by LoadLeveler.</li> <li>– As the result of a flush command.</li> </ul> </li> </ol> </li> <li>• If you would like your job to checkpoint itself, use the API <b>ll_init_ckpt</b> in your serial application, or <b>mpc_init_ckpt</b> for parallel jobs to cause the checkpoint to occur.</li> </ul> |
| Your job step's executable is to be copied to the execute node | Add the <b>ckpt_execute_dir</b> keyword to the job command file.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

## Preparing a job for checkpoint/restart

Table 31. Checkpoint configurations (continued)

| To specify that:                                                   | Do this:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|--------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| LoadLeveler automatically checkpoints your job at preset intervals | <ol style="list-style-type: none"> <li>Add the following option to your job command file:<br/> <b>checkpoint = interval</b><br/> This enables your job to checkpoint in any of the following ways: <ul style="list-style-type: none"> <li>Checkpoint automatically at preset intervals</li> <li>Checkpoint initiated from user application</li> <li>Checkpoint from a program which invokes the <b>ll_ckpt</b> API</li> <li>Checkpoint using the <b>llckpt</b> command</li> <li>As the result of a flush command</li> </ul> </li> <li>The system administrators must set the following two keywords in the configuration file to specify how often LoadLeveler should take a checkpoint of the job. These two keywords are:<br/> <b>MIN_CKPT_INTERVAL = number</b><br/> Where <i>number</i> specifies the initial period, in seconds, between checkpoints taken for running jobs.<br/> <b>MAX_CKPT_INTERVAL = number</b><br/> Where <i>number</i> specifies the maximum period, in seconds, between checkpoints taken for running jobs.<br/> <p>The time between checkpoints will be increased after each checkpoint within these limits as follows:</p> <ul style="list-style-type: none"> <li>The first checkpoint is taken after a period of time equal to the <b>MIN_CKPT_INTERVAL</b> has passed.</li> <li>The second checkpoint is taken after LoadLeveler waits <i>twice as long</i> (<b>MIN_CKPT_INTERVAL</b> X 2)</li> <li>The third checkpoint is taken after LoadLeveler waits twice as long again (<b>MIN_CKPT_INTERVAL</b> X 4) before taking the third checkpoint.</li> </ul> <p>LoadLeveler continues to double this period until the value of <b>MAX_CKPT_INTERVAL</b> has been reached, where it stays for the remainder of the job.</p> <p>A minimum value of 900 (15 minutes) and a maximum value of 7200 (2 hours) are the defaults.</p> <p>You can set these keyword values globally in the global configuration file so that all machines in the cluster have the same value, or you can specify a different value for each machine by modifying the local configuration files.</p> </li> </ol> |
| Your job will not be checkpointed                                  | Add the following option to your job command file: <ul style="list-style-type: none"> <li><b>checkpoint = no</b></li> </ul> <p>This will disable checkpoint.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

Table 31. Checkpoint configurations (continued)

| To specify that:                                                                                                                                                                        | Do this:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Your job has successfully checkpointed and terminated. The job has left the LoadLeveler job queue and you want LoadLeveler to restart your executable from an existing checkpoint file. | <ol style="list-style-type: none"> <li>1. Add the following option to your job command file: <ul style="list-style-type: none"> <li>• <b>restart_from_ckpt = yes</b></li> </ul> </li> <li>2. Specify the name of the checkpoint file by setting the following job command file keywords to specify the directory and file name of the checkpoint file to be used: <ul style="list-style-type: none"> <li>• <b>ckpt_dir</b></li> <li>• <b>ckpt_file</b></li> </ul> </li> </ol> <p>When the job command file is submitted, a new job will be started which uses the specified checkpoint file to restart the previously checkpointed job.</p> <p>The job command file which was used to submit the original job should be used to restart from checkpoint. The only modifications to this file should be the addition of <b>restart_from_ckpt = yes</b> and ensuring <b>ckpt_dir</b> and <b>ckpt_file</b> point to the appropriate checkpoint file.</p> |
| Your job has successfully checkpointed. The job has been vacated and remains on the LoadLeveler job queue.                                                                              | <p>When the job restarts, if a checkpoint file is available, the job will be restarted from that file.</p> <p>If a checkpoint file is not available upon restart, the job will be started from the beginning.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

## Preparing a job for preemption

Depending on various configuration options, LoadLeveler may preempt your job so that a higher priority job step can run. Administrators may:

- Configure LoadLeveler or external schedulers to preempt jobs through various methods.
- Specify preemption rules for job classes.
- Manually preempt your job using LoadLeveler interfaces.

To ensure that your job can be resumed after preemption, set the **restart** keyword in the job command file to **yes**.

## Submitting a job command file

After building a job command file, you can submit it for processing either to a machine in the LoadLeveler cluster or one outside of the cluster. (See “Querying multiple LoadLeveler clusters” on page 65 for information on submitting a job to a machine outside the cluster.) You can submit a job command file either by using the GUI or the **llsubmit** command.

When you submit a job, LoadLeveler assigns a job identifier and one or more step identifiers.

The LoadLeveler job identifier consists of the following:

### **machine name**

The name of the machine which assigned the job identifier.

## Submitting a job command file

**jobid** A number given to a group of job steps that were initiated from the same job command file.

The LoadLeveler step identifier consists of the following:

**job identifier**

The job identifier described above.

**stepid** A number that is unique for every job step in the job you submit.

If a job command file contains multiple job steps, every job step will have the same jobid and a unique stepid.

For an example of submitting a job, see Chapter 9, “Example: Using commands to build, submit, and manage jobs,” on page 205.

In a multicluster environment, job and step identifiers are assigned by the local cluster and are retained by the job regardless of what cluster the job runs in.

## Submitting a job using a submit-only machine

You can submit jobs from submit-only machines. Submit-only machines allow machines that do not run LoadLeveler daemons to submit jobs to the cluster. You can submit a job using either the submit-only version of the GUI or the **llsubmit** command.

To install submit-only LoadLeveler, follow the procedure in the *LoadLeveler Installation Memo*.

In addition to allowing you to submit jobs, the submit-only feature allows you to cancel and query jobs from a submit-only machine.

---

## Working with parallel jobs

LoadLeveler allows you to schedule parallel batch jobs that have been written using the following:

- On AIX 5L, IBM Parallel Environment (PE)
  - On AIX 5L and Linux:
    - MPICH, which is an open-source, portable implementation of the Message-Passing Interface Standard developed by Argonne National Laboratory
    - MPICH-GM, which is a port of MPICH on top of Myrinet GM code
- Support for PE is not available in this release of LoadLeveler for Linux.

## Scheduler support for parallel jobs

Several LoadLeveler job command language keywords are associated with parallel jobs. Whether a keyword is appropriate is dependent upon the type of LoadLeveler scheduler you are running.

Table 32 on page 169 shows you the parallel keywords supported by LoadLeveler's default, Backfill, and Gang schedulers. If your administrator disabled the default LoadLeveler scheduler to run an external scheduler, see “Replacing the default LoadLeveler scheduling algorithm with an external scheduler” on page 105 for an explanation of which keywords are supported.

Table 32. Parallel keywords supported by the default, Backfill, and Gang schedulers

| Keywords supported by the default scheduler                                                                                 | Keywords supported by the Backfill and Gang schedulers                                                                                                                                          |
|-----------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• max_processors</li> <li>• min_processors</li> <li>• Adapter requirement</li> </ul> | <ul style="list-style-type: none"> <li>• network</li> <li>• node</li> <li>• node_usage</li> <li>• tasks_per_node</li> <li>• total_tasks</li> <li>• task_geometry</li> <li>• blocking</li> </ul> |

These keywords are used in the examples in this chapter, and are described in more detail in “Job command file keyword descriptions” on page 324.

## Step for controlling whether LoadLeveler copies environment variables to all executing nodes

You may specify that LoadLeveler is to copy, either to all executing nodes or to only the master executing node, the environment variables that are specified in the environment job command file statement for a parallel job.

**Before you begin:** You need to know:

- Whether Parallel Environment (PE) will be used to run the parallel job; if so, then LoadLeveler does not have to copy the application environment to the executing nodes.
  - How to correctly specify the **env\_copy** keyword. For information about keyword syntax and other details, see the **env\_copy** keyword description on page 336.
1. To specify whether LoadLeveler is to copy environment variables to only the master node, or to all executing nodes, use the **#@ env\_copy** keyword in the job command file.

**Alternative:** You can use the Job Builder window in the LoadLeveler GUI to specify a value for this keyword.

## Ensuring that parallel jobs in a cluster run on the correct levels of PE and LoadLeveler software

If support for parallel POE jobs is required, users must be aware that LoadLeveler uses Parallel Environment for parallel job submission, and that the PE software requires the same level of PE to be used throughout the parallel job. Different levels of PE cannot be mixed. PE 4.2 supports only LoadLeveler 3.3, and PE 4.1 supports only LoadLeveler 3.2. Therefore, a POE parallel job cannot run some of its tasks on LoadLeveler 3.3 machines and the remaining tasks on LoadLeveler 3.2 machines.

The **requirements** keyword of the job command file can be used to ensure that all the tasks of a POE job run on compatible levels of PE and LoadLeveler software in a cluster. Here are three examples showing different ways this can be done:

1. If the following requirements statement is included in the job command file, LoadLeveler’s central manager will select only 3.3 or higher machines with the appropriate OpSys level for this job step.

```
@ requirements = (LL_Version >= "3.3") && (OpSys == "AIX53")
```

## Working with parallel jobs

The requirements expression should contain the OpSys specification because the llsbmit command automatically adds the OpSys of the submitting machine to the other job requirements unless an OpSys requirement has already been explicitly specified.

2. If a requirements statement such as the following is specified, the tasks of a POE job will see a consistent environment when "hostname1" and "hostname2" run the same levels of PE and LoadLeveler software.

```
@ requirements = (Machine == { "hostname1" "hostname2" }) && (OpSys == "AIX53")
```

3. If the mixed cluster has been partitioned into 3.3 and 3.2 LoadLeveler pools, then you may use a requirements statement similar to one of the two following statements to select machines running the same levels of software.

```
• # @ requirements = (Pool == 33) && (OpSys == "AIX53")
```

```
• # @ requirements = (Pool == 32) && (OpSys == "AIX52")
```

Here, it is assumed that all the 3.3 machines in this mixed cluster are assigned to pool 33 and all 3.2 machines are assigned to pool 32. A LoadLeveler administrator can use the "pool\_list" keyword of the machine stanza of the LoadLeveler administration file to assign machines to pools.

If a statement such as # @ executable = /bin/poe is specified in a job command file, and if the job is intended to be run on 3.2 machines, then it is important that the job be submitted from a 3.2 machine. When the "executable" keyword is used, LoadLeveler will copy the associated binary on the submitting machine and send it to a running machine for execution. In this example, the POE program will fail if the submitting and the running machines are at different software levels. In a mixed cluster, this problem can be circumvented by not using the "executable" keyword in the job command file. By omitting this keyword, the job command file itself is the shell script that will be executed. If this script invokes a local version of the POE binary then there is no compatibility problem at run time.

## Task-assignment considerations

You can use the following keywords to specify how LoadLeveler assigns tasks to nodes. With the exception of unlimited blocking, each of these methods prioritizes machines in an order based on their **MACHPRIO** expressions. Various task assignment keywords can be used in combination, and others are mutually exclusive.

*Table 33. Valid combinations of task assignment keywords are listed in each column*

| Keyword           | Valid Combinations |   |   |   |   |   |   |   |
|-------------------|--------------------|---|---|---|---|---|---|---|
| total_tasks       | X                  | X |   |   |   |   |   |   |
| tasks_per_node    |                    |   | X | X |   |   |   |   |
| node = <min, max> |                    |   | X |   |   |   |   |   |
| node = <number>   | X                  |   |   | X |   |   |   |   |
| min_processors    |                    |   |   |   | X |   | X |   |
| max_processors    |                    |   |   |   |   | X | X |   |
| task_geometry     |                    |   |   |   |   |   |   | X |
| blocking          |                    | X |   |   |   |   |   |   |

The following examples show how each allocation method works. For each example, consider a 3-node SP with machines named "N1," "N2," and "N3". The

machines' order of priority, according to the values of their MACHPRIO expressions, is: N1, N2, N3. N1 has 4 initiators available, N2 has 6, and N3 has 8.

### node and total\_tasks

When you specify the node keyword with the total\_tasks keyword, the assignment function will allocate all of the tasks in the job step evenly among however many nodes you have specified. If the number of total\_tasks is not evenly divisible by the number of nodes, then the assignment function will assign any larger groups to the first nodes on the list that can accept them. In this example, 14 tasks must be allocated among 3 nodes:

```
@ node=3
@ total_tasks=14
```

Table 34. node and total\_tasks

| Machine | Available Initiators | Assigned Tasks |
|---------|----------------------|----------------|
| N1      | 4                    | 4              |
| N2      | 6                    | 5              |
| N3      | 8                    | 5              |

The assignment function divides the 14 tasks into groups of 5, 5, and 4, and begins at the top of the list, to assign the first group of 5. The assignment function starts at N1, but because there are only 4 available initiators, cannot assign a block of 5 tasks. Instead, the function moves down the list and assigns the two groups of 5 to N2 and N3, the assignment function then goes back and assigns the group of 4 tasks to N1.

### node and tasks\_per\_node

When you specify the node keyword with the tasks\_per\_node keyword, the assignment function will assign tasks in groups of the specified value among the specified number of nodes.

```
@ node = 3
@ tasks_per_node = 4
```

### blocking

When you specify blocking, tasks are allocated to machines in groups (blocks) of the specified number (blocking factor). The assignment function will assign one block at a time to the machine which is next in the order of priority until all of the tasks have been assigned. If the total number of tasks are not evenly divisible by the blocking factor, the remainder of tasks are allocated to a single node. The blocking keyword must be specified with the total\_tasks keyword. For example:

```
@ blocking = 4
@ total_tasks = 17
```

Where **blocking** specifies that a job's tasks will be assigned in blocks, and **4** designates the size of the blocks. Here is how a blocking factor of 4 would work with 17 tasks:

Table 35. Blocking

| Machine | Available Initiators | Assigned Tasks |
|---------|----------------------|----------------|
| N1      | 4                    | 4              |
| N2      | 6                    | 5              |

Table 35. Blocking (continued)

| Machine | Available Initiators | Assigned Tasks |
|---------|----------------------|----------------|
| N3      | 8                    | 8              |

The assignment function first determines that there will be 4 blocks of 4 tasks, with a remainder of one task. Therefore, the function will allocate the remainder with the first block that it can. N1 gets a block of four tasks, N2 gets a block, plus the remainder, then N3 gets a block. The assignment function begins again at the top of the priority list, and N3 is the only node with enough initiators available, so N3 ends up with the last block.

### unlimited blocking

When you specify unlimited blocking, the assignment function will allocate as many jobs as possible to each node; the function prioritizes nodes primarily by how many initiators each node has available, and secondarily on their MACHPRIO expressions. This method allows you to allocate tasks among as few nodes as possible. To specify unlimited blocking, specify "unlimited" as the value for the blocking keyword. The total\_tasks keyword must also be specified with unlimited blocking. For example:

```
@ blocking = unlimited
@ total_tasks = 17
```

Table 36. Unlimited blocking

| Machine | Available Initiators | Assigned Tasks |
|---------|----------------------|----------------|
| N3      | 8                    | 8              |
| N2      | 6                    | 6              |
| N1      | 4                    | 3              |

The assignment function begins with N3 (because N3 has the most initiators available), and assigns 8 tasks, N2 takes six, and N1 takes the remaining 3.

### task\_geometry

The task\_geometry keyword allows you to specify which tasks run together on the same machines, although you cannot specify which machines. In this example, the task\_geometry keyword groups 7 tasks to run on 3 nodes:

```
@ task_geometry = {(5,2)(1,3)(4,6,0)}
```

The entire task\_geometry expression must be enclosed within braces. The task IDs for each node must be enclosed within parenthesis, and must be separated by commas. The entire range of task IDs that you specify must begin with zero, and must end with the task ID which is one less than the total number of tasks. You can specify the task IDs in any order, but you cannot skip numbers (the range of task IDs must be complete). Commas may only appear between task IDs, and spaces may only appear between nodes and task IDs.

## Submitting jobs that use striping

When communication between parallel tasks occurs only over a single device such as css0 or en0, the application and the device are gated by each other. The device must wait for the application to fill a communication buffer before it transmits the buffer and the application must wait for the device to transmit and empty the buffer before it can refill the buffer. Thus the application and the device must wait for each other and this wastes time.

The technique of striping refers to using two or more communication paths to implement a single communication path as perceived by the application. As the application sends data, it fills up a buffer on one device. As that buffer is transmitted over the first device, the application's data begins filling up a second buffer and the application perceives no delay in being able to write. When the second buffer is full, it begins transmission over the second device and the application moves on to the next device. When all devices have been used, the application returns to the first device. Much, if not all of the buffer on the first device has been transmitted while the application wrote to the buffers on the other devices so the application waits for a minimal amount of time or possibly does not wait at all.

LoadLeveler supports striping in two ways. When multiple switch planes or networks are present, striping over them is indicated by requesting the device **csss** (multiple switch planes) or **sn\_all** (multiple networks).

If multiple adapters are present on the same network and the communication subsystem, such as LAPI, supports striping over multiple adapters on the same network, specifying the **instances** keyword on the network statement requests striping over adapters on the same network. The **instances** keyword specifies the number of adapters on a single network to stripe on. It is possible to stripe over multiple networks and over multiple adapters on each network by specifying both **sn\_all** and a value for **instances** greater than one. For HPS adapters, only machines that are connected to both networks are considered for **csss** or **sn\_all** jobs.

- **User space striping:** When **sn\_all** is specified on a network statement with **US** mode, LoadLeveler commits an equivalent set of adapter resources (adapter windows and memory) on each of the networks present in the system to the job on each node where the job runs. The communication subsystem is initialized to indicate that it should use the user space communication protocol on all the available switch adapters to service communication requests on behalf of the application.
- **IP striping:** When the **csss** device is specified on a network statement with the **IP** mode, LoadLeveler attempts to locate the striped IP address associated with the switch adapters, known as the multi-link address. If it is successful, it passes the multi-link address to POE for use. If multi-link addresses are not available, LoadLeveler instructs POE to use the IP address of one of the switch adapters. The IP address that is used is different each time a choice has to be made in an attempt to balance the adapter use. Multi-link addresses must be configured on the system prior to running LoadLeveler and they are specified with the **multilink\_address** keyword on the switch adapter stanza in the administration file. If a multi-link address is specified for a node, LoadLeveler assigns the multi-link address and multi-link IP name to the striping adapter on that node. If a multi-link address is not present on a node, the **csss** adapter associated with the node will not have an IP address or IP name. If not all of the nodes of a system have multi-link addresses but some do, LoadLeveler will only dispatch jobs that request IP striping to nodes that have multi-link addresses.

Jobs that request striping (both user space and IP) can be submitted to nodes with only one switch adapter. In that situation, the result is the same as if the job requested no striping.

**Note:** When configured, a multi-link address is associated with the virtual **ml0** device. The IP address of this device is the multi-link address. The **llexSDR** and **llexRPD** programs will create a stanza for the **ml0** device that will appear similar to Ethernet or token ring adapter stanzas except

that it will include the **multilink\_list** keyword that lists the adapters it performs striping over. As with any other device with an IP address, the **ml0** device can be requested in IP mode on the network statement. Doing so would yield a comparable effect to requesting **csss** IP except that no checking would be performed by LoadLeveler to ensure the associated adapters are actually working. Thus it would be possible to dispatch a job that requested communication over **ml0** only to have the job fail because the switch adapters that **ml0** stripes over were down.

- **Striping over one network:** If the **instances** keyword is specified on a network statement with a value greater than one, LoadLeveler allocates multiple sets of resources for the protocol using as many sets as the **instances** keyword specified. For User Space jobs, these sets are adapter windows and memory. For IP jobs, these sets are IP addresses. If multiple adapters exist on each node on the same network, then these sets of adapter resources will be distributed among all the available adapters on the same network. Even though LoadLeveler will allocate resources to support striping over a single network, the communication subsystem must be capable of exploiting these resources in order for them to be used.

### Understanding striping over multiple networks

Striping over multiple networks involves establishing a communication path using one or more of the available communication networks or switch fabrics. How those paths are established depends on the network adapter that is present. For the SP Switch2 family of adapters, it is not necessary to acquire communication paths among all tasks on all fabrics as long as there is at least one fabric over which all tasks can communicate. However, each adapter on a machine, if it is available, must use exactly the same adapter resources (window and memory amount) as the other adapters on that machine. Switch Network Interface for HPS adapters are not required to use exactly the same resources on each network, but in order for a machine to be selected, there must be an available communication path on all networks.

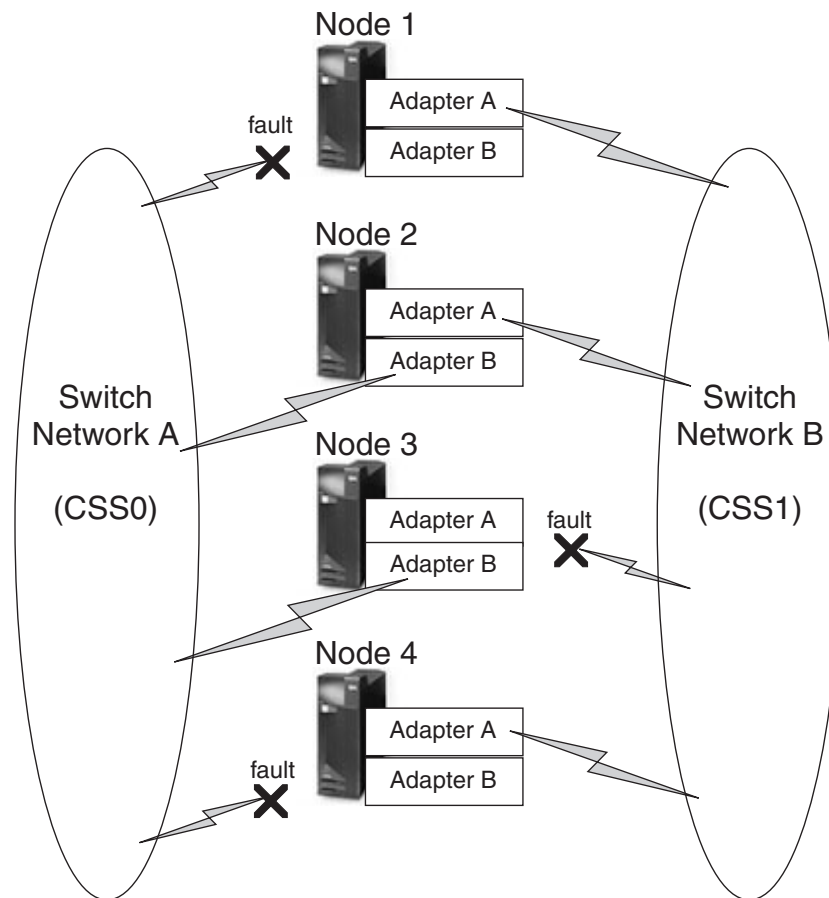


Figure 24. Striping over multiple networks

Consider these sample scenarios using the network configuration as shown in Figure 24 where the adapters are from the SP Switch2 family:

- If a three node job requests striping over networks, it will be dispatched to Node 1, Node 2 and Node 4 where it can communicate on Network B as long as the adapters on each machine have a common window free and sufficient memory available. It cannot run on Node 3 because that node only has a common communication path with Node 2, namely Network A.
- If a three node job does not request striping, it will not be run because there are not enough adapters connected to Network A to run the job. Notice both the adapter connected to Network A on Node 1 and the adapter connected to Network A on Node 4 are both at fault. SP Switch2 family adapters can only use the css0 adapter for non-striped communication.
- If a three node job requests striped IP and some but not all of the nodes have multi-linked addresses, the job will only be dispatched to the nodes that have the multi-link addresses.

Consider these sample scenarios using the network configuration as shown in Figure 24 where the adapters are Switch Network Interface for HPS adapters:

- If a three node job requests striping over networks, it will not be dispatched because there are not three nodes that have active connections to both networks.
- If a three node job does not request striping, it can be run on Node 1, Node 2, and Node 4 because they have an active connection to network B.

## Working with parallel jobs

- If a three node job requests striped IP and some but not all of the nodes have multi-linked addresses, the job will only be dispatched to the nodes that have the multi-link addresses.

Note that for all adapter types, adapters are allocated to a step that requests striping based on what the node knows is the available set of networks or fabrics. LoadLeveler expects each node to have the same knowledge about available networks. If this is not true, it is possible for tasks of a step to be assigned adapters which cannot communicate with tasks on other nodes.

Similarly, LoadLeveler expects all adapters that are identified as being on the same Network ID or fabric ID to be able to communicate with each other. If this is not true, such as when LoadLeveler operates with multiple, independent sets of networks, other attributes of the Step, such as the requirements expression, must be used to ensure that only nodes from a single network set are considered for the step.

As you can see from these scenarios, LoadLeveler will find enough nodes on the same communication path to run the job. If enough nodes connected to a common communication path cannot be found, no communication can take place and the job will not run.

### Understanding striping over a single network

Striping over a single network is only supported by Switch Network Interface for HPS adapters.

Figure 25 shows a network configuration where the adapters support striping over a single network.

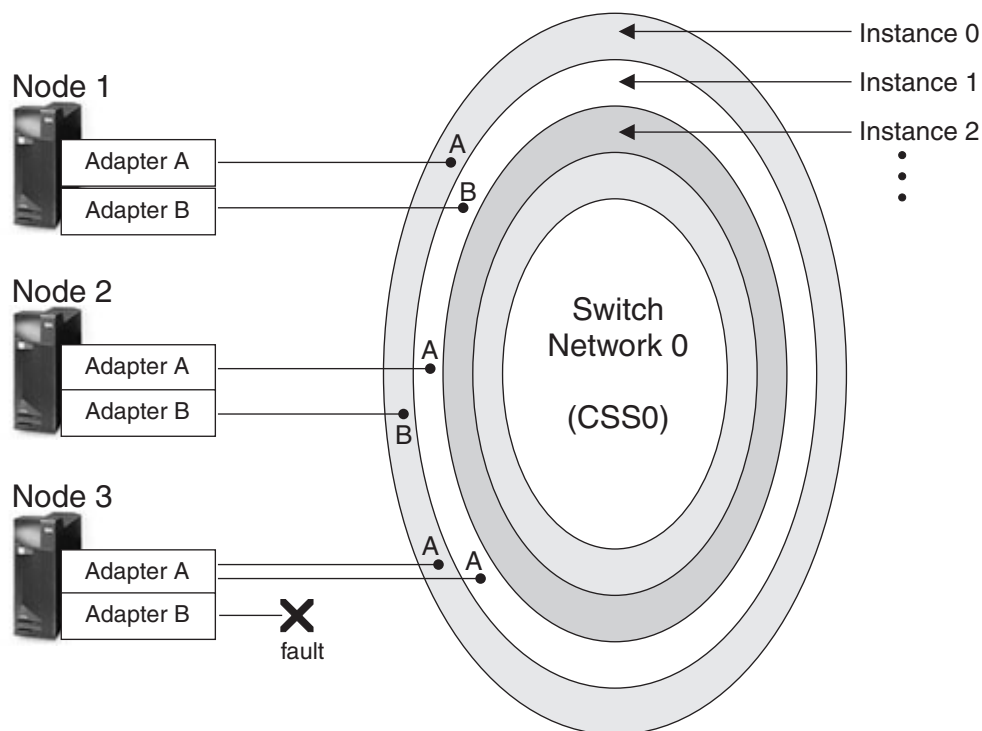


Figure 25. Striping over a single network

Both Adapter A and Adapter B on a node are connected to Network 0. The entire oval represents the physical network and the concentric ovals (shaded differently) represent the separate communication paths created for a job by the **instances** keyword on the network statement. In this case a three node job requests two instances for communication. On Node 1, adapter A is used for instance 0 and adapter B is used for instance 1. There is no requirement to use the same adapter for the same instance so on Node 2, adapter B was used for instance 0 and adapter A for instance 1.

On Node 3, where a fault is keeping adapter B from connecting to the network, adapter A is used for both instance 0 and instance 1 and Node 3 is available for the job to use.

The network itself does not impose any limitation on the total number of communication paths that can be active at a given time for either a single job or all the jobs using the network. As long as nodes with adapter resources are available, additional communication paths can be created.

### Examples: Requesting striping in network statements

You request that a job be run using striping with the **network** statement in your job command file. The default when instances is not specified for a job in the **network** statement is controlled by the class stanza keyword for **csss** and **sn\_all**. For more information on the **network** and **max\_protocol\_instances** statements, see the keyword descriptions in “Job command file keyword descriptions” on page 324.

Shown here are examples of IP and user space network modes:

- **Example 1: Requesting striping using IP mode**

To submit a job using IP striping, your network statement would look like this:

```
network.MPI = csss,,IP
```

- **Example 2: Requesting striping using user space mode**

To submit a job using user space striping, your network statement would look like this:

```
network.MPI = csss,,US
```

- **Example 3: Requesting striping over a single network**

To request IP striping over multiple adapter on a single network, the network statement would look like this:

```
network.MPI = sn_single,,IP,,instances=2
```

If the nodes on which the job runs have two or more adapters on the same network, two different IP addresses will be allocated to each task for MPI communication. If only one adapter exists per network, the same IP address will be used twice for each task for MPI communication.

- **Example 4: Requesting striping over multiple networks and multiple adapters on the same network**

To submit a user space job that will stripe MPI communication over multiple adapters on all networks present in the system the network statement would look like this:

```
network.MPI = sn_all,,US,,instances=2
```

If, on a node where the job runs, there are two adapters on each of the two networks, one adapter window would be allocated from each adapter for MPI communication by the job. If only one network were present with two adapters,

one adapter window from each of the two adapters would be used. If two networks were present but each only had one adapter on it, two adapter windows from each adapter would be used to satisfy the request for two instances.

### Running interactive POE jobs

POE will accept LoadLeveler job command files; however, you can still set the following environment variables to define specific LoadLeveler job attributes before running an interactive POE job:

#### **LOADL\_ACCOUNT\_NO**

The account number associated with the job.

#### **LOADL\_INTERACTIVE\_CLASS**

The class to which the job is assigned.

#### **MP\_TASK\_AFFINITY**

The affinity preferences requested for the job.

For information on other POE environment variables, see *IBM Parallel Environment for AIX; Operation and Use, Volume 1*.

For an interactive POE job, LoadLeveler does not start the POE process therefore LoadLeveler has no control over the process environment or resource limits.

You also may run interactive POE jobs under a reservation. For additional details about reservations and submitting jobs to run under them, see “Working with reservations” on page 184.

Interactive POE jobs cannot be submitted to a remote cluster.

### Running MPICH and MPICH-GM jobs

MPICH is an open-source, portable implementation of the Message-Passing Interface (MPI) Standard developed by Argonne National Laboratory. It contains a complete implementation of version 1.2 of the MPI Standard and also significant parts of MPI-2, particularly in the area of parallel I/O. MPICH and MPICH-GM are the two MPI implementations supported by LoadLeveler for AIX 5L and Linux:

- MPICH is currently used by a large number of providers of MPI implementations. Additional documentation for MPICH is available from the Argonne National Laboratory web site at <http://www-unix.mcs.anl.gov/mpi/mpich/docs.html>.
- MPICH-GM is a port of MPICH on top of GM (ch\_gm) and is supported by Myrinet. Additional documentation for MPICH-GM is available from the Myrinet web site at <http://www.myri.com/scs/>

For either MPICH or MPICH-GM, LoadLeveler allocates the machines to run the parallel job and starts the implementation specific script. LoadLeveler has no interaction with the parallel tasks started with the script.

- When using MPICH, the **mpirun** script is run on the first machine allocated to the job. The **mpirun** script manages the actual execution of the parallel tasks on the other nodes included in the LoadLeveler cluster. Cancelling the job with the **llcancel** command may not completely remove the MPICH application because the **llcancel** command terminates only the **mpirun** script, not the MPICH tasks.
- When using MPICH-GM, the **mpirun.ch\_gm** script is run on the first machine allocated to the job. The **mpirun.ch\_gm** script manages the actual execution of

the parallel tasks on the other nodes included in the LoadLeveler cluster. As with MPICH, **llcancel** terminates only the **mpirun.ch\_gm** script. To terminate the parallel tasks, start **mpirun.ch\_gm** with the **--gm-kill 0** option.

Sample programs are available:

- See “MPICH” on page 180 for a sample MPICH job command file.
- See “MPICH-GM” on page 182 for a sample MPICH-GM job command file.
- The LoadLeveler samples directory also contains sample files:
  - On AIX 5L, use directory `/usr/lpp/LoadL/full/samples/llmpich`
  - On Linux, use directory `/opt/ibmll/LoadL/full/samples/linux/llmpich`

These sample files include:

- `ivp.c`: A simple MPI application that you may run as an MPICH or MPICH-GM job.
- `ll_get_machine_list.c`: An application that queries the appropriate schedd daemon for information about the LoadLeveler machines assigned to run the various tasks of a job step.
- Shell scripts to create the `ll_get_machine_list` binary and to compile and link the `ivp.c` program:
  - For MPICH: `mpich_cmp.sh`
  - For MPICH-GM: `mpich_gm_cmp.sh`
- Job command files to run the `ivp.c` program as a batch job:
  - For MPICH: `mpich_ivp.cmd`
  - For MPICH-GM: `mpich_gm_ivp.cmd`

## Examples: Building parallel job command files

This section contains sample job command files for the following parallel environments:

- IBM AIX Parallel Operating Environment (POE)
- MPICH
- MPICH-GM

### POE

Figure 26 is a sample job command file for POE.

```
#
@ job_type = parallel
@ environment = COPY_ALL
@ output = poe.out
@ error = poe.error
@ node = 8,10
@ tasks_per_node = 2
@ network.LAPI = sn_all,US,,instances=1
@ network.MPI = sn_all,US,,instances=1
@ wall_clock_limit = 60
@ executable = /usr/bin/poe
@ arguments = /u/ric/c/My_POE_program -eulib "us"
@ class = POE
@ queue
```

Figure 26. POE job command file – multiple tasks per node

Figure 26 shows the following:

- The total number of nodes requested is a minimum of eight and a maximum of 10 (**node=8,10**). Two tasks run on each node (**tasks\_per\_node=2**). Thus the total number of tasks can range from 16 to 20.

## Working with parallel jobs

- Each task of the job will run using the LAPI protocol in US mode with a switch adapter (**network.LAPI=sn\_all,US,,instances=1**), and using the MPI protocol in US mode with a switch adapter (**network.MPI=sn\_all,US,,instances=1**).
- The maximum run time allowed for the job is 60 seconds (**wall\_clock\_limit=60**).

Figure 27 is a second sample job command file for POE

```
#
@ job_type = parallel
@ input = poe.in.1
@ output = poe.out.1
@ error = poe.err
@ node = 2,8
@ network.MPI = sn_single,shared,IP
@ wall_clock_limit = 60
@ class = POE
@ queue
/usr/bin/poe /u/richc/my_POE_setup_program -infolevel 2
/usr/bin/poe /u/richc/my_POE_main_program -infolevel 2
```

*Figure 27. POE sample job command file – invoking POE twice*

Figure 27 shows the following:

- POE is invoked twice, through **my\_POE\_setup\_program** and **my\_POE\_main\_program**.
- The job requests a minimum of two nodes and a maximum of eight nodes (**node=2,8**).
- The job by default runs one task per node.
- The job uses the MPI protocol with a switch adapter in IP mode (**network.MPI=sn\_single,shared,IP**).
- The maximum run time allowed for the job is 60 seconds (**wall\_clock\_limit=60**).

## MPICH

Figure 28 on page 181 is a sample job command file for MPICH.

```

! /bin/ksh
LoadLeveler JCF file for running an MPICH job
@ job_type = parallel
@ node = 4
@ tasks_per_node = 2
@ output = mpich_test.$(cluster).$(process).out
@ error = mpich_test.$(cluster).$(process).err
@ queue
echo "-----"
echo LOADL_STEP_ID=$LOADL_STEP_ID
echo "-----"
Make sure that the ll_get_machine_list binary is accessible on all machines
in the LoadLeveler cluster.

/common/NFS/ll_bin/ll_get_machine_list > /tmp/machinelist.$LOADL_STEP_ID
#
machine_count=`cat /tmp/machinelist.$LOADL_STEP_ID | wc -l`
echo $machine_count
echo MachineList:
cat /tmp/machinelist.$LOADL_STEP_ID
echo "-----"
/opt/mpich/bin/mpirun -np $machine_count -machinefile \
/tmp/machinelist.$LOADL_STEP_ID /common/NFS/ll_bin/mpich_test
#
rm /tmp/machinelist.$LOADL_STEP_ID

```

Figure 28. MPICH job command file

Figure 28 shows the following:

- The operation associated with the statement

```

/common/NFS/ll_bin/llmpich/ll_get_machine_list \
> /tmp/machinelist.$LOADL_STEP_ID

```

creates a temporary file that contains the list of machines that have been assigned by LoadLeveler to this parallel job step. `LOADL_STEP_ID` is an environment variable set by LoadLeveler. The source file `ll_get_machine_list.c` and the script `mpich_cmp.sh` that can be used to compile this file are located in the `/opt/ibmll/LoadL/full/samples/linux/llmpich` directory. `ll_get_machine_list` uses the LoadLeveler Data Access API to query the appropriate `LoadL_schedd` daemon for the machine list information.

- The statement `machine_count=`cat /tmp/machinelist.$LOADL_STEP_ID | wc -l`` counts the number of entries in the machine list. The number of entries in the machine list is equal to the number of parallel tasks.
- In the following job command file statement :

```

/opt/mpich/bin/mpirun -np $machine_count -machinefile \
/tmp/machinelist.$LOADL_STEP_ID /common/NFS/ll_bin/mpich_test

```

- `-np` specifies the number of parallel processes.
- `-machinefile` specifies the machine list file.

- `rm /tmp/machinelist.$LOADL_STEP_ID` removes the temporary machine list file once the application completes.

Canceling an MPICH job step with the `llcancel` command terminates only the `mpirun` script associated with the job step. It does not terminate all the tasks started by this `mpirun` script. This is also true for cancellation operations started by the `llctl flush` and `llctl stop` commands.

### MPICH-GM

Figure 29 is a sample job command file for MPICH-GM.

```
#!/bin/ksh
LoadLeveler JCF file for running an MPICH-GM job
@ job_type = parallel
@ resources = gmparts(1)
@ node = 4
@ tasks_per_node = 2
@ output = mpich_gm_test.${cluster}.${process}.out
@ error = mpich_gm_test.${cluster}.${process}.err
@ queue
echo "-----"
echo LOADL_STEP_ID=$LOADL_STEP_ID
echo "-----"
Make sure that the ll_get_machine_list binary is accessible on all machines
in the LoadLeveler cluster.
/common/NFS/ll_bin/ll_get_machine_list > /tmp/machinelist.$LOADL_STEP_ID
#
machine_count=`cat /tmp/machinelist.$LOADL_STEP_ID | wc -l`
echo $machine_count
echo MachineList:
cat /tmp/machinelist.$LOADL_STEP_ID
echo "-----"
/opt/mpich/bin/mpirun.ch_gm --gm-kill 0 -np $machine_count -machinefile \
/tmp/machinelist.$LOADL_STEP_ID /common/NFS/ll_bin/mpich_gm_test
#
rm /tmp/machinelist.$LOADL_STEP_ID
```

Figure 29. MPICH-GM job command file

Figure 29 shows the following:

- The statement **# @ resources = gmparts(1)** specifies that each task consumes one GM port. This is how LoadLeveler limits the number of GM ports simultaneously in use on any machine. This resource name is the name the LoadLeveler administrator specified in **schedule\_by\_resources** in the configuration file and each machine stanza in the administration file must define GM ports and specify the quantity of GM ports available on each machine. Use **llstatus -R** to confirm the names and values of the configured and available consumable resources.
- The operation associated with the statement

```
/common/NFS/ll_bin/llmpich/ll_get_machine_list \
> /tmp/machinelist.$LOADL_STEP_ID
```

creates a temporary file that contains the list of machines that have been assigned by LoadLeveler to this parallel job step. **LOADL\_STEP\_ID** is an environment variable set by LoadLeveler. The source file **ll\_get\_machine\_list.c** and the script **mpich\_gm\_cmp.sh** that can be used to compile this file are located in the **/opt/ibmll/LoadL/full/samples/linux/llmpich** directory. **ll\_get\_machine\_list** uses the LoadLeveler Data Access API to query the appropriate **LoadL\_schedd** daemon for the machine list information.

- The statement **machine\_count=`cat /tmp/machinelist.\$LOADL\_STEP\_ID | wc -l`** counts the number of entries in the machine list. The number of entries in the machine list is equal to the number of parallel tasks.
- In the following job command file statement:

```
/opt/mpich/bin/mpirun.ch_gm --gm-kill 0 -np $machine_count \
-machinefile /tmp/machinelist.$LOADL_STEP_ID \
/common/NFS/ll_bin/mpich_gm_test
```

- `/opt/mpich/bin/mpirun.ch_gm` specifies the location of the `mpirun.ch_gm` script shipped with the MPICH-GM implementation that runs the MPICH-GM application.
- `--gm-kill 0` indicates that all parallel tasks are stopped when any one task ends. This option is necessary for MPICH-GM jobs to respond properly to an `llcancel` command.
- `-np` specifies the number of parallel processes.
- `-machinefile` specifies the machine list file.
- `rm /tmp/machinelist.$LOADL_STEP_ID` removes the temporary machine list file once the application completes.

## Obtaining status of parallel jobs

Both end users and LoadLeveler administrators can obtain status of parallel jobs in the same way as they obtain status of serial jobs – either by using the `llq` command or by viewing the Jobs window on the graphical user interface (GUI). By issuing `llq -l`, or by using the Job Actions → Details selection in `xloadl`, users get a list of machines allocated to the parallel job. If you also need to see task instance information use the `-x` option in addition to the `-l` option (`llq -l -x`). See “`llq - Query job status`” on page 431 for samples of output using the `-x` and `-l` options with the `llq` command. As an alternative, you can also use the GUI and select: Job Actions → Extended Details.

## Obtaining allocated host names

`llq -l` output includes information on allocated host names. Another way to obtain the allocated host names is with the `LOADL_PROCESSOR_LIST` environment variable, which you can use from a shell script in your job command file as shown in Figure 30 on page 184.

This example uses `LOADL_PROCESSOR_LIST` to perform a remote copy of a local file to all of the nodes, and then invokes POE. Note that the processor list contains an entry for each task running on a node. If two tasks are running on a node, `LOADL_PROCESSOR_LIST` will contain two instances of the host name where the tasks are running. The example in Figure 30 on page 184 removes any duplicate entries.

Note that `LOADL_PROCESSOR_LIST` is set by LoadLeveler, not by the user. This environment variable is limited to 128 hostnames. If the value is greater than the 128 limit, the environment variable is not set.

## Working with reservations

```
#!/bin/ksh
@ output = my_POE_program.${cluster}.${process}.out
@ error = my_POE_program.${cluster}.${process}.err
@ class = POE
@ job_type = parallel
@ node = 8,12
@ network.MPI = css0,shared,US
@ queue

tmp_file="/tmp/node_list"
rm -f $tmp_file

Copy each entry in the list to a new line in a file so
that duplicate entries can be removed.
for node in $LOADL_PROCESSOR_LIST
do
 echo $node >> $tmp_file
done

Sort the file removing duplicate entries and save list in variable
nodelist= sort -u /tmp/node_list

for node in $nodelist
do
 rcp localfile $node:/home/userid
done

rm -f $tmp_file

/usr/bin/poe /home/userid/my_POE_program
```

Figure 30. Using `LOADL_PROCESSOR_LIST` in a shell script

---

## Working with reservations

Under the backfill scheduler only, LoadLeveler allows authorized users to make reservations, which specify a time period during which specific node resources are reserved for use by particular users or groups.

Use Table 37 to find information about working with reservations.

Table 37. Roadmap of tasks for reservation owners and users

| Subtask                                                    | Associated instructions (see . . . )                                                                                                                                                                           |
|------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Learn how reservations work in the LoadLeveler environment | <ul style="list-style-type: none"><li>• “Overview of reservations” on page 23</li><li>• “Understanding the reservation life cycle” on page 185</li></ul>                                                       |
| Creating new reservations                                  | “Creating new reservations” on page 187                                                                                                                                                                        |
| Managing jobs that run under a reservation                 | <ul style="list-style-type: none"><li>• “Submitting jobs to run under a reservation” on page 188</li><li>• “Removing bound jobs from the reservation” on page 190</li></ul>                                    |
| Managing existing reservations                             | <ul style="list-style-type: none"><li>• “Querying existing reservations” on page 190</li><li>• “Modifying existing reservations” on page 191</li><li>• “Canceling existing reservations” on page 191</li></ul> |
| Using the LoadLeveler interfaces for reservations          | <ul style="list-style-type: none"><li>• Chapter 15, “Commands,” on page 371</li><li>• “Reservation API” on page 547</li></ul>                                                                                  |

## Understanding the reservation life cycle

From the time at which LoadLeveler creates a reservation through the time the reservation ends or is canceled, a reservation goes through various states, which are indicated in command listings and other displays or output. Understanding these states is important because the current state of a reservation dictates what actions you can take; for example, if you want to modify the start time for a reservation, you may do so only while the reservation is in Waiting state. Table 38 lists the possible reservation states, their abbreviations, and usage notes.

*Table 38. Reservation states, abbreviations, and notes*

| Reservation state | Abbreviation in displays / output | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------------------|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Waiting           | W                                 | <p>When LoadLeveler first creates a reservation, the reservation is in Waiting state. While the reservation is in this state:</p> <ul style="list-style-type: none"> <li>• Only administrators and reservation owners may modify, cancel, and add users or groups to the reservation.</li> <li>• Administrators, reservation owners, and users or groups that are allowed to use the reservation may query it, and submit jobs to run during the reservation period.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Setup             | S                                 | <p>LoadLeveler changes the state of a reservation from Waiting to Setup just before the start time of the reservation. The actual time at which LoadLeveler places the reservation in Setup state depends on the value set for the <b>RESERVATION_SETUP_TIME</b> keyword in the configuration file.</p> <p>While the reservation is in Setup state:</p> <ul style="list-style-type: none"> <li>• Only administrators and reservation owners may modify, cancel, and add users or groups to the reservation.</li> <li>• Administrators, reservation owners, and users or groups that are allowed to use the reservation may query it, and submit jobs to run during the reservation period.</li> </ul> <p>During this setup period, LoadLeveler:</p> <ul style="list-style-type: none"> <li>• Stops scheduling unbound job steps to reserved nodes.</li> <li>• Preempts any jobs that are still running on the nodes that are reserved through this reservation. To preempt the running jobs, LoadLeveler uses the preemption method specified through the <b>DEFAULT_PREEMPT_METHOD</b> keyword in the configuration file.</li> </ul> |

Table 38. Reservation states, abbreviations, and notes (continued)

| Reservation state | Abbreviation in displays / output | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-------------------|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Active            | A                                 | <p>At the reservation start time, LoadLeveler changes the reservation state from Setup to Active. It also dispatches only job steps that are bound to the reservation, until the reservation completes or is canceled.</p> <p>LoadLeveler does not dispatch bound job steps that:</p> <ul style="list-style-type: none"> <li>• Require certain resources, such as floating consumable resources, that are not available during the reservation period.</li> <li>• Have expected end times that exceed the end time of the reservation. By default, LoadLeveler allows such jobs to run, but their completion is subject to resource availability. (An administrator may configure LoadLeveler to prevent such jobs from running.)</li> </ul> <p>These bound job steps remain idle unless the required resources become available.</p> <p>While the reservation is in Active state:</p> <ul style="list-style-type: none"> <li>• Only administrators and reservation owners may modify, cancel, and add users or groups to the reservation.</li> <li>• Administrators, reservation owners, and users or groups that are allowed to use the reservation may query it, and submit jobs to run during the reservation period.</li> </ul> |
| Active_Shared     | AS                                | <p>At the reservation start time, LoadLeveler changes the reservation state from Setup to Active. It also dispatches only job steps that are bound to the reservation, unless the reservation was created with the SHARED mode. In this case, if reserved resources are still available after LoadLeveler dispatches any bound job steps that are eligible to run, LoadLeveler changes the reservation state to Active_Shared, and begins dispatching job steps that are not bound to the reservation. Once the reservation state changes to Active_Shared, it remains in that state until the reservation completes or is canceled. During this time, LoadLeveler dispatches both bound and unbound job steps, pending resource availability; bound job steps are considered before unbound job steps.</p> <p>The conditions under which LoadLeveler will not dispatch bound job steps are the same as those listed in the notes for the Active state.</p> <p>The actions that administrators, reservation owners, and users may perform are the same as those listed in the notes for the Active state.</p>                                                                                                                        |
| Canceled          | CA                                | <p>When a reservation owner, administrator, or LoadLeveler issues a request to cancel the reservation, LoadLeveler changes the state of a reservation to Canceled and unbinds any job steps bound to this reservation. When the reservation is in this state, no one can modify or submit jobs to this reservation.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

Table 38. Reservation states, abbreviations, and notes (continued)

| Reservation state | Abbreviation in displays / output | Notes                                                                                                                                                                                            |
|-------------------|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Complete          | C                                 | When a reservation end time is reached, LoadLeveler changes the state of a reservation to Complete. When the reservation is in this state, no one can modify or submit jobs to this reservation. |

## Creating new reservations

You must be an authorized user or member of an authorized group to successfully create a reservation. LoadLeveler administrators define authorized users by adding the **max\_reservations** keyword to the user or group stanza in the administration file. The **max\_reservations** keyword setting also defines how many reservations you are allowed to own. Ask your administrator whether you are authorized to create reservations.

To be authorized to create reservations, LoadLeveler administrators also must have the **max\_reservations** keyword set in their user or group stanza.

To create a reservation, use the **llmkres** command. When you create a reservation, you must:

- Specify the start time and duration of the reservation. Use the **-t** and **-d** command options, respectively.
- Explicitly specify nodes through one of the following methods, which are mutually exclusive. You must use only one method when you request LoadLeveler to create a reservation.
  - The **-n** option on the **llmkres** command instructs LoadLeveler to reserve a number of nodes. LoadLeveler may select any unreserved node to satisfy a reservation. This command option is perhaps the easiest to use, because you need to know only how many nodes you want, not specific node characteristics.  
The minimum number of nodes a reservation must have is 1.
  - The **-h** option on the **llmkres** command instructs LoadLeveler to reserve specific nodes.
  - The **-f** option on the **llmkres** command instructs LoadLeveler to submit the specified job command file, and reserve appropriate nodes for the first job step in the job command file. Through this action, all job steps for the job are bound to the reservation. If the reservation request fails, LoadLeveler changes the state for all job steps for this job to NotQueued, and will not schedule any of those job steps to run.
  - The **-j** option on the **llmkres** command instructs LoadLeveler to reserve appropriate nodes for that job step. Through this action, the job step is bound to the reservation. If the reservation request fails, the job step remains in the same state as it was before.

You also may define other reservation attributes, including:

- Whether additional users or groups are allowed to use the reservation. Use the **-U** or **-G** command options, respectively.
- Whether the reservation will be in one or both of these optional modes:
  - SHARED mode: When you use the **-s** command option, LoadLeveler allows reserved resources to be shared by job steps that are not associated with a reservation. This mode enables the efficient use of reserved resources; if the

## Working with reservations

bound job steps do not use all of the reserved resources, LoadLeveler can schedule unbound job steps as well so the resources do not remain idle. Unless you specify this mode, however, only job steps bound to the reservation may use the reserved resources.

- REMOVE\_ON\_IDLE mode: When you use the **-i** command option, LoadLeveler automatically cancels the reservation when all bound job steps that can run finish running. Using this mode is efficient because it prevents LoadLeveler from wasting reserved resources when no jobs are available to use them. Selecting this mode is especially useful for workloads that will run unattended.

Additional rules apply to the use of these options; see “llmkres - Make a reservation” on page 416 for details.

### Alternatives:

- Use the **ll\_make\_reservation** and the **ll\_init\_reservation\_param** subroutines in a program.
- Use the LoadLeveler GUI by selecting **File ► Reservations ► Create a reservation**.

### Tips:

- If your user ID is not authorized to create reservations but you are member of a group with authority to create reservations, you must use the **-g** option to specify the name of the authorized group on the **llmkres** command.
- Only reservations in waiting and in use are counted toward the limit of allowed reservations set through the **max\_reservations** keyword. LoadLeveler does not count reservations that already have ended or are in the process of being canceled.
- Although you may create more than one reservation for a particular node or set of nodes, only one of those reservations may be active at a time. If LoadLeveler determines that the reservation you are requesting will overlap with another reservation, LoadLeveler fails the create request. No reservation periods for the same set of machines can overlap.

If the create request is successful, LoadLeveler assigns and returns to the owner a unique reservation identifier, in the form *host.rid.r*, where:

|             |                                                                                                 |
|-------------|-------------------------------------------------------------------------------------------------|
| <b>host</b> | The name of the machine which assigned the reservation identifier.                              |
| <b>rid</b>  | A number assigned to the reservation by LoadLeveler.                                            |
| <b>r</b>    | The letter <b>r</b> is used to distinguish a reservation identifier from a job step identifier. |

The following are examples of reservation identifiers:

c94n16.80.r  
c94n06.1.r

For details about the LoadLeveler interfaces for creating reservations, see:

- “llmkres - Make a reservation” on page 416.
- “ll\_make\_reservation subroutine” on page 547 and “ll\_init\_reservation\_param subroutine” on page 550.

## Submitting jobs to run under a reservation

LoadLeveler administrators, reservation owners, and authorized users may submit jobs to run under a reservation. You may bind both batch and interactive POE job steps to a reservation, both before a reservation starts or while it is active.

**Before you begin:**

- If you are a reservation owner and used the **-f** or **-j** options on the **llmkres** command when you created the reservation, you do not have to perform the steps listed in Table 39. Those command options automatically bind the job steps to the reservation. To find out whether a particular job step is bound to a reservation, use the command **llq -l** and check the listing for a reservation ID.
- To find out which reservation IDs you may use, check with your LoadLeveler administrator, or enter the command **llqres -l** and check the names in the Users or Groups fields (under the Modification time field) in the output listing. If your user name or a group name to which you belong appears in these output fields, you are authorized to use the reservation.
- LoadLeveler cannot guarantee that certain resources will be available during a reservation period. If you submit job steps that require these resources, LoadLeveler will bind the job steps to the reservation, but will not dispatch them unless the resources become available during the reservation. These resources include:
  - Specific nodes that were not reserved under this reservation.
  - Floating consumable resources for a cluster.
  - Resources that are not released through preemption, such as virtual memory and adapters.
  - Resources on a Blue Gene system can not be reserved. A reservation can include a node which launches a Blue Gene job, but would reserve resources only for the job launch program. Even though the job launch program for a Blue Gene job may be able to run, the job will not be dispatched until the requested resources are available on the Blue Gene system.

Also, your job step will be bound to the reservation but will remain idle when the job step requires more nodes than the number of reserved nodes.

- Whether bound job steps are successfully dispatched depends not only on resource availability, but also on administration file keywords that set maximum numbers, including:
  - **max\_jobs\_scheduled**
  - **maxidle**
  - **maxjobs**
  - **maxqueued**

If LoadLeveler determines that scheduling a bound job will exceed one or more of these configured limits, your job will remain idle unless conditions permit scheduling at a later time during the reservation period.

*Table 39. Instructions for submitting a job to run under a reservation*

| To bind this type of job: | Use these instructions:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Already submitted jobs    | <p>Use the <b>llbind</b> command</p> <p><b>Alternatives:</b></p> <ul style="list-style-type: none"> <li>• Use the <b>ll_bind_reservation</b> subroutine in a program.</li> <li>• From the Jobs window, use the LoadLeveler GUI by selecting one or more jobs, then selecting <b>Actions ► Bind to reservation</b>, and selecting the ID of the reservation to which you want to bind these jobs.</li> </ul> <p><b>Result:</b> LoadLeveler either sets the reservation ID for each job step that can be bound to the reservation, or sends a failure notification for the bind request.</p> |

Table 39. Instructions for submitting a job to run under a reservation (continued)

| To bind this type of job: | Use these instructions:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A new, unsubmitted job    | <ol style="list-style-type: none"> <li>Specify the reservation ID through the <b>LL_RES_ID</b> environment variable.<br/> <b>Tip:</b> You may examine but cannot modify this environment variable using a job command filter.</li> <li>Use the <b>llsubmit</b> command to submit the job.<br/> <b>Result:</b> If the job can be bound to the requested reservation, LoadLeveler sets the reservation ID for each job step that can be bound to the reservation. Otherwise, if the job step cannot be bound to the reservation, LoadLeveler changes the job state to NotQueued. To change the job step's state to Idle, issue the <b>llbind -r</b> command.</li> </ol> |

Use the **llqres** command or **llq** command with the **-l** option to check the success or failure of the binding request for each job step.

For details about the LoadLeveler interfaces for submitting jobs under reservations, see:

- “llbind - Bind job steps to a reservation” on page 375.
- “ll\_bind subroutine” on page 554.
- “llsubmit - Submit a job” on page 471.

## Removing bound jobs from the reservation

LoadLeveler administrators, reservation owners, and authorized users may use the **llbind** command to unbind one or more existing jobs from a reservation.

### Alternatives:

- Use the **ll\_bind\_reservation** subroutine in a program.
- From the Jobs window, use the LoadLeveler GUI by selecting one or more jobs, then selecting **Actions ► Unbind from reservation**, and selecting the ID of the reservation from which you want to unbind these jobs.

**Result:** LoadLeveler either unbinds the jobs from the reservation, or sends a failure notification for the unbind request. Use the **llqres** or **llq** command to check the success or failure of the remove request.

For details about the LoadLeveler interfaces for removing bound jobs from the reservation, see:

- “llbind - Bind job steps to a reservation” on page 375.
- “ll\_bind subroutine” on page 554.

## Querying existing reservations

Any LoadLeveler administrator or user may issue the **llqres** and **llq** commands to request specific information about reservations.

- To filter reservations displayed by owner, group, or nodes, use the **llqres** command with the **-u**, **-g**, or **-h** options.
- To show details of specific reservations, use the **llqres** command with the **-l** option.
- To show job steps that are bound to specific reservations, use the **llq** command with the **-R** option.

**Alternative:** Use the LoadLeveler GUI by selecting **File ► Reservations**.

For details about:

- Reservation attributes and **llqres** command syntax, see “llqres - Query a reservation” on page 449.
- **llq** command syntax, see “llq - Query job status” on page 431.

## Modifying existing reservations

Only administrators and reservation owners may use the **llchres** command to modify one or more attributes of a reservation. Certain attributes cannot be changed after a reservation has become active. Typical uses for the **llchres** command include the following:

- Using the command **llchres -U +newuser1 newuser2** to allow additional users to submit jobs to the reservation.
- If a reservation was made through the command **llmkres -h all** but LoadLeveler cannot include a particular node because it is down, you can use the command **llchres -h +node** to add the node to the reserved node list when that node becomes available again.
- If a reserved node is down after the reservation becomes active, a LoadLeveler administrator can use:
  - The command **llchres -h -node** to remove that node from the reservation.
  - The command **llchres -h +1** to add another node to the reservation.

### Alternatives:

- Use the **ll\_change\_reservation** subroutine in a program.
- Use the LoadLeveler GUI by selecting **File ► Reservations ► Modify a reservation**.

For details about the LoadLeveler interfaces for modifying reservations, see:

- “llchres - Change attributes of a reservation” on page 380.
- “ll\_change\_reservation subroutine” on page 551.

## Canceling existing reservations

Only administrators and reservation owners may use the **llrmres** command to cancel one or more reservations.

### Alternatives:

- Use the **ll\_remove\_reservation** subroutine in a program.
- Use the LoadLeveler GUI by selecting **File ► Reservations ► Cancel a reservation**.

**Result:** If the cancel request can be granted, LoadLeveler:

1. Unbinds all jobs associated with the reservation to be removed.
2. Removes the reservation.

Use the **llqres** command to check the success or failure of the remove request.

For details about the LoadLeveler interfaces for canceling reservations, see:

- “llrmres - Cancel a reservation” on page 452.
- “ll\_remove\_reservation subroutine” on page 557.

---

### Steps for submitting a job to be routed to an NQS machine

To submit an NQS job, tailor a job command file for NQS and use the **llsubmit** command to route the job to a machine running NQS. All options in the command file pertaining to scheduling are used by LoadLeveler to schedule the job. When the job is dispatched to the node running the specified NQS class, the LoadLeveler options pertaining to the runtime environment are converted to NQS options and the job is submitted to the specified NQS queue.

#### Before you begin:

- You need to know the differences between LoadLeveler and NQS options, and how they are processed. For details, see “Mapping NQS script options to LoadLeveler job command file options” on page 322.
- If you need details about issuing the **llsubmit** command, see “llsubmit - Submit a job” on page 471.

Perform the following steps to submit a job to be routed to an NQS machine:

1. In the job command file, specify a shell script to be submitted to the NQS node.

#### Rules:

- NQS accepts only shell scripts; binaries are not allowed.
  - You may specify a script originally written for NQS. In this case, any NQS options in the script are used to schedule the job, and once dispatched by LoadLeveler, the file is sent to NQS unmodified.
2. In the job command file, specify the **class** keyword value for NQS. For example:  
`class = NQS`
  3. Issue the **llsubmit** command.

#### Results:

- When a job is sent to an NQS class, **llsubmit** saves:
  - The name of the current directory (pwd) and the current value of the user file create mask (umask).
  - The following environment variables:
    - HOME
    - LOGNAME
    - MAIL
    - PATH
    - SHELL
    - TZ
    - USER
- When the job is dispatched, LoadLeveler:
  - Determines whether or not it is running in an NQS class.
  - Installs the environment variables that **llsubmit** saved, so that they are available to the NQS command **qsub**.
  - Issues the NQS command **qsub** to submit the job.

LoadLeveler monitors the job by periodically invoking a **qstat** command. A **qstat** command is first issued for the pipe queue on the local host. If the request id is not found, a **qstat** is issued for each queue listed in the NQS\_query class keyword. If the request id is still not found, starter marks the job as complete.

## Submitting jobs requesting scheduling affinity

A user can request that a job use scheduling affinity by setting the **RSET** job command file keyword. Specify **RSET** with a value of:

- **RSET\_MCM\_AFFINITY** to have LoadLeveler schedule the job to machines where **RSET\_SUPPORT** is enabled with a value of **RSET\_MCM\_AFFINITY**.
- **RSET\_CONSUMABLE\_CPUS** to have LoadLeveler schedule the job to machines where **RSET\_SUPPORT** is enabled with a value of **RSET\_CONSUMABLE\_CPUS**.
- *user\_defined\_rset* to have LoadLeveler schedule the job to machines where **RSET\_SUPPORT** is enabled with a value of **RSET\_USER\_DEFINED**; *user\_defined\_rset* is the name of a valid user-defined RSet.

Specifying the **RSET** job command file keyword defaults to requesting memory affinity as a requirement and adapter affinity as a preference. Scheduling affinity options can be customized by using the job command file keyword **MCM\_AFFINITY\_OPTIONS**. For more information on these keywords, see “Job command file keyword descriptions” on page 324.

**Note:** If a job specifies memory or adapter affinity scheduling as a requirement, LoadLeveler will only consider machines where **RSET\_SUPPORT** is set to **RSET\_MCM\_AFFINITY**. If there are not enough machines satisfying the memory affinity requirements, the job will stay in the idle state.

## Submitting and monitoring jobs in a LoadLeveler multicluster

| Subtask                                                                     | Associated instructions (see . . . )                                                                                                                                                                                                                                                                                                      |
|-----------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Prepare and submit a job in the LoadLeveler multicluster                    | “Steps for submitting jobs in a LoadLeveler multicluster environment”                                                                                                                                                                                                                                                                     |
| Display information about a job in the LoadLeveler multicluster environment | <ul style="list-style-type: none"> <li>• Use the <b>llq -X cluster_name</b> command to display information about jobs on remote clusters.</li> <li>• Use <b>llq -x -d</b> to display the user’s job command file keyword statements.</li> <li>• Use <b>llq -X cluster_name -l</b> to obtain multicluster specific information.</li> </ul> |
| Transfer an idle job from one cluster to another cluster                    | Use the <b>llmovejob</b> command, which is described in “llmovejob - Move a single idle job from the local cluster to another cluster” on page 424.                                                                                                                                                                                       |

## Steps for submitting jobs in a LoadLeveler multicluster environment

In a multicluster environment, you may specify either of the following:

- That a job is to run on a particular cluster.
- That LoadLeveler is to decide which cluster is best from the list of clusters, based on an administrator-defined metric. If **any** is specified, the job is submitted to the best cluster, based on an administrator-defined metric.

The following procedure explains how to prepare your job to be submitted in the multicluster environment.

**Before you begin:** You need to know that:

## Submitting jobs requesting scheduling affinity

- Only batch jobs are supported in the LoadLeveler multicluster environment. LoadLeveler will fail any interactive jobs that you attempt to submit in a multicluster environment.
- LoadLeveler assigns all steps of a multistep job to the same cluster.
- Job identifiers are assigned by the local cluster and are retained by the job regardless of what cluster the job executes in.
- Remote jobs are subjected to the same configuration checks as locally submitted jobs. Examples include account validation, class limits, include lists, and exclude lists.

Perform the following steps to submit jobs in a LoadLeveler multicluster environment.

1. If files used by your job need to be copied between clusters, you must specify the job files to be copied from the local to the remote cluster in the job command file. Use the **cluster\_input\_file** and **cluster\_output\_file** keywords to specify these files.

**Rules:**

- Any local file specified for copy must be accessible from the local gateway schedd machines. Input files must be readable. Directories and permissions must be in place to write output files.
- Any remote file specified for copy must be accessible from the remote gateway schedd machines. Directories and permissions must be in place to write input files. Output files must be readable when the job terminates.
- To copy more than one file, these keywords can be specified multiple times.

**Alternative:** Use the LoadLeveler GUI by selecting **File ► Build a Job** and editing the **Cluster Input File** and **Cluster Output File** fields.

**Tip:** Each instance of these keywords allows you to specify a single local file and a single remote file. If your job requires copying multiple files (for example, all files in a directory), you may want to use a procedure to consolidate the multiple files into a single file rather than specify multiple **cluster\_file** statements in the job command file. The following is an example of how you could consolidate input files:

- a. Use the **tar** command to produce a single tar file from multiple files.
- b. On the **cluster\_input\_file** keyword, specify the file that resulted from the **tar** command processing.
- c. Modify your job command file such that it uses the **tar** command to restore the multiple files from the tar file prior to invoking your application.

2. In the job command file, specify the clusters to which LoadLeveler may submit the job. The **cluster\_list** keyword is a blank-delimited list of cluster names or the reserved word **any** where:

- A single cluster name indicates that the job is to be submitted to that cluster.
- A list of multiple cluster names indicates that the job is to be submitted to one of the clusters as determined by the installation exit **CLUSTER\_METRIC**.
- The reserved word **any** indicates that the job is to be submitted to any cluster defined by the installation exit **CLUSTER\_METRIC**.

**Alternatives:**

- a. From the Jobs window, use the LoadLeveler GUI by selecting **Tools ► Set Cluster**.
- b. You can specify the clusters to which LoadLeveler can submit your job on the **llsubmit** command using the **-X** option. To do the same using the LoadLeveler GUI, select **File ► Submit a Job**, then select **Change Cluster** and **Submit**.

3. Use the **llsubmit** command or the LoadLeveler GUI to submit the job.

**Note:** Using Set Cluster when submitting from the Build a Job window, **cluster\_list** is set in the generated job command file, while when using the Submit a Job window, the **-X** option is set on the submit.

**Tip:** You may use the **-X** option on the **llsubmit** command to specify:

**-X {cluster\_list | any}**

Is a blank-delimited list of cluster names or the reserved word **any** where:

- A single cluster name indicates that the job is to be submitted to that cluster.
- A list of multiple cluster names indicates that the job is to be submitted to one of the clusters as determined by the installation exit **CLUSTER\_METRIC**.
- The reserved word **any** indicates that the job is to be submitted to any cluster defined by the installation exit **CLUSTER\_METRIC**.

The **llsubmit** command displays the assigned local outbound schedd, the assigned remote inbound schedd, the scheduling cluster and the job identifier when the remote job has been successfully submitted. Use the **-q** flag to stop these additional messages from being displayed.

**Note:** If a remote job is submitted with a list of clusters or the reserved word **any** and the installation exit **CLUSTER\_METRIC** is not specified, the remote job is not submitted.

When you are done, you can use commands to display information about the submitted job; for example:

- Use **llq -l -X cluster\_name -j job\_id** where *cluster\_name* and *job\_id* were displayed by the **llsubmit** command to display information about the remote job.
- Use **llq -l -X cluster\_list** to display the long listing about jobs, including scheduling cluster, submitting cluster, user-requested cluster, cluster input and output files.
- Use **llq -X all** to display information about all jobs in all configured clusters.

You can also use the LoadLeveler GUI to display information about your job. When you invoke **xloadl** in a multicluster environment, you will be prompted to open a window for other configured clusters. The title for remote clusters is in the form **local\_cluster>remote\_cluster**, where **local\_cluster** is the cluster of the machine where you started **xloadl**, and **remote\_cluster** is a remote cluster you selected. The jobs window contains the jobs running on that remote cluster.

---

## Submitting and monitoring Blue Gene jobs

### Steps for submitting Blue Gene jobs

The following procedure explains how to prepare your job to be submitted to the Blue Gene system. The submission of Blue Gene jobs is similar to the submission of other job types.

**Before you begin:** You need to know that:

- There is no preemption in Blue Gene.
- Checkpointing Blue Gene jobs is not currently supported.

## Submitting jobs requesting scheduling affinity

- While a reservation may be made on the front end nodes and Blue Gene jobs may be bound to this reservation, no Blue Gene resources will be associated with the reservation.

**Tip:** Use the **llstatus** command to check if Blue Gene support is enabled and whether Blue Gene is currently present. The **llstatus** command will display:

The BACKFILL scheduler with Blue Gene support is in use

Blue Gene is present

when Blue Gene is support is enabled and Blue Gene is currently present

Perform the following steps to submit Blue Gene jobs:

1. In the job command file, set the job type to Blue Gene by specifying:  

```
#@job_type = bluegene
```
2. Specify the size or shape of the Blue Gene job or the Blue Gene partition in which the job will run.
  - The size of the Blue Gene job can be specified by using the job command file keyword **bg\_size** to specify the size of the job. For more information, see the detailed description of the **bg\_size** keyword on page 327.
  - The shape of the Blue Gene job can be specified by using the job command file keyword **bg\_shape** to specify the shape of the job. If you require the specific shape you specified, you may wish to specify the **bg\_rotate** keyword to false. For more information on these keywords, see the detailed descriptions of the **bg\_shape** keyword326 and **bg\_rotate** keyword on page 326.
  - The partition in which the Blue Gene job is run can be specified using the **bg\_partition** job command file keyword. For more information, see the detailed description of the **bg\_partition** keyword on page 326
3. Specify any other job command file keywords you require, including the **bg\_connection** Blue Gene job command file keyword. See “Job command file keyword descriptions” on page 324 for more information on job command file keywords.
4. Upon completing your job command file, submit the job using the **llsubmit** command.

**Alternative:** Use the Build a Job window in the LoadLeveler GUI and select the radio button for Blue Gene under Job Type. Then the Blue Gene button can be clicked to request Blue Gene job request attributes. The generated job command file can be saved or submitted.

When you are done, you can use the **llq -b** command to display information about Blue Gene jobs in short form. For more information see “llq - Query job status” on page 431.

You can also use the LoadLeveler GUI to display the status of a Blue Gene job. From the Jobs window, after selecting one or more jobs, select **Actions ► Blue Gene Job Status**.

### Example:

The following is a sample job command file for a Blue Gene job:

```
@ job_name = bgsample
@ job_type = bluegene
@ comment = "BGL Job by Size"
@ error = $(job_name).err
```

## Submitting jobs requesting scheduling affinity

```
| # @ output = $(job_name).out
| # @ environment = COPY_ALL;
| # @ wall_clock_limit = 200:00,200:00
| # @ notification = always
| # @ notify_user = sam
| # @ bg_size = 1024
| # @ bg_connection = torus
| # @ class = 2bp
| # @ queue
| /usr/bin/mpirun -exe /bgscratch/sam/com -verbose 2 -args "-o 100 -b 64 -r"
```

## Submitting jobs requesting scheduling affinity

---

## Chapter 8. Managing submitted jobs

Table 40 lists the tasks and sources of additional information for managing LoadLeveler jobs.

*Table 40. Roadmap of user tasks for managing submitted jobs*

| To learn about:                                                 | Read the following:                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-----------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Displaying information about a submitted job or its environment | <ul style="list-style-type: none"><li>• “Querying the status of a job”</li><li>• “Working with machines” on page 200</li><li>• “Displaying currently available resources” on page 200</li><li>• “llclass - Query class information” on page 387</li><li>• “llq - Query job status” on page 431</li><li>• “llstatus - Query machine status” on page 455</li><li>• “llsummary - Return job resource information for accounting” on page 474</li></ul> |
| Changing the priority of a submitted job                        | <ul style="list-style-type: none"><li>• “Setting and changing the priority of a job” on page 201</li><li>• “llmodify - Change attributes of a submitted job step” on page 419</li></ul>                                                                                                                                                                                                                                                             |
| Changing the state of a submitted job                           | <ul style="list-style-type: none"><li>• “Placing and releasing a hold on a job” on page 202</li><li>• “Canceling a job” on page 202</li><li>• “llhold - Hold or release a submitted job” on page 411</li><li>• “llcancel - Cancel a submitted job” on page 377</li></ul>                                                                                                                                                                            |
| Checkpointing a submitted job                                   | <ul style="list-style-type: none"><li>• “Checkpointing a job” on page 202</li><li>• “llckpt - Checkpoint a running job step” on page 384</li></ul>                                                                                                                                                                                                                                                                                                  |

---

### Querying the status of a job

Once you submit a job, you can query the status of the job to determine, for example, if it is still in the queue or if it is running. You also receive other job status related information such as the job ID and the submitting user ID. You can query the status of a LoadLeveler job either by using the GUI or the **llq** command. For an example of querying the status of a job, see Chapter 9, “Example: Using commands to build, submit, and manage jobs,” on page 205.

- **Querying the status of a job running on an NQS machine:**

If your job command file was routed to an NQS machine for processing, you can obtain its status by using either the GUI or the **llq** command. Keep in mind that a machine in the LoadLeveler cluster monitors the NQS machine where your job is running. The status you see on the GUI (or from **llq**) is generated by the machine in the LoadLeveler cluster.

LoadLeveler monitors the job until **qstat** shows the job is no longer in any specified queue. Because LoadLeveler only checks the NQS machine for status periodically, the status of the job on the NQS machine may change before LoadLeveler has an opportunity to update the GUI. If this happens, NQS will notify you regarding the status of the job.

LoadLeveler will not send mail when the job completes. The LoadLeveler notification option is translated to the appropriate NQS flag (**me** or **mb**) and NQS will send the mail.

NQS does not provide job accounting. Therefore, the only accounting information LoadLeveler will have is the total time for the job.

- **Querying the status of a job using a submit-only machine:**

In addition to allowing you to submit and cancel jobs, a submit-only machine allows you to query the status of jobs. You can query a job using either the submit-only version of the GUI or by using the **llq** command. For information on **llq**, see “**llq** - Query job status” on page 431.

---

## Working with machines

You can perform the following types of tasks related to machines:

- **Display machine status**

When you submit a job to a machine, the status of the machine automatically appears in the Machines window on the GUI. This window displays machine related information such as the names of the machines running jobs, as well as the machine’s architecture and operating system. For detailed information on one or more machines in the cluster, you can use the Details option on the Actions pull-down menu. This will provide you with a detailed report that includes information such as the machine’s state and amount of installed memory.

For an example of displaying machine status, see Chapter 9, “Example: Using commands to build, submit, and manage jobs,” on page 205.

- **Display central manager**

The LoadLeveler administrator designates one of the machines in the LoadLeveler cluster as the central manager. When jobs are submitted to any machine, the central manager is notified and decides where to schedule the jobs. In addition, it keeps track of the status of machines in the cluster and jobs in the system by communicating with each machine. LoadLeveler uses this information to make the scheduling decisions and to respond to queries.

Usually, the system administrator is more concerned about the location of the central manager than the typical end user but you may also want to determine its location. One reason why you might want to locate the central manager is if you want to browse some configuration files that are stored on the same machine as the central manager.

- **Display public scheduling machines**

Public scheduling machines are machines that participate in the scheduling of LoadLeveler jobs on behalf of users at submit-only machines and users at other workstations that are not running the schedd daemon. You can find out the names of all these machines in the cluster.

Submit-only machines allow machines that are not part of the LoadLeveler cluster to submit jobs to the cluster for processing.

---

## Displaying currently available resources

The LoadLeveler user can get information about currently available resources by using the **llstatus** command with either the **-F**, or **-R** options. The **-F** option displays a list of all of the floating resources associated with the LoadLeveler cluster. The **-R** option lists all of the consumable resources associated with all of the machines in the LoadLeveler cluster. The user can specify a hostlist with the **llstatus** command to display only the consumable resources associated with specific hosts.

---

## Setting and changing the priority of a job

LoadLeveler uses the priority of a job to determine its position among a list of all jobs waiting to be dispatched. LoadLeveler schedules jobs based on the *adjusted system priority*, which takes in account both system priority and user priority:

### User priority

Every job has a user priority associated with it. A job with a higher priority runs before a job with a lower priority (when both jobs are owned by the same user). You can set this priority through the **user\_priority** keyword in the job command file, and modify it through the **llprio** command. See “llprio - Change the user priority of submitted job steps” on page 429 for more information.

### System priority

Every job has a system priority associated with it. Administrators can set this priority in the configuration file using the **SYSPRIO** keyword expression. The **SYSPRIO** expression can contain class, group, and user priorities, as shown in the following example:

```
SYSPRIO : (ClassSysprio * 100) + (UserSysprio * 10) + (GroupSysprio * 1) - (QDate)
```

The **SYSPRIO** expression is evaluated by LoadLeveler to determine the overall system priority of a job. To determine which jobs to run first, LoadLeveler does the following:

1. Assigns a system priority value when the negotiator adds the new job to the queue of jobs eligible for dispatch.
2. Orders jobs first by system priority.
3. Assigns jobs belonging to the same user and the same class an adjusted system priority, which takes all the system priorities and orders them by user priority. Jobs with a higher adjusted system priority are scheduled ahead of jobs with a lower adjusted system priority.

Only administrators may modify the system priority through the **llmodify** command with the **-s** option. See “llmodify - Change attributes of a submitted job step” on page 419 for more information.

## Example: How does a job’s priority affect dispatching order?

To understand how a job’s priority affects dispatching order, consider the sample jobs in Table 41, which lists the priorities assigned to jobs submitted by two users, Rich and Joe. Two of the jobs belong to Joe, and three belong to Rich. User Joe has two jobs (Joe1 and Joe2) in Class A with SYSPRIOs of 9 and 8 respectively. Since Joe2 has the higher user priority (20), and because both of Joe’s jobs are in the same class, Joe2’s priority is swapped with that of Joe1 when the adjusted system priority is calculated. This results in Joe2 getting an adjusted system priority of 9, and Joe1 getting an adjusted system priority of 8. Similarly, the Class A jobs belonging to Rich (Rich1 and Rich3) also have their priorities swapped. The priority of the job Rich2 does not change, since this job is in a different class (Class B).

Table 41. How LoadLeveler handles job priorities

| Job   | User Priority | System Priority (SYSPRIO) | Class | Adjusted System Priority |
|-------|---------------|---------------------------|-------|--------------------------|
| Rich1 | 50            | 10                        | A     | 6                        |
| Joe1  | 10            | 9                         | A     | 8                        |

Table 41. How LoadLeveler handles job priorities (continued)

| Job   | User Priority | System Priority (SYSPRIO) | Class | Adjusted System Priority |
|-------|---------------|---------------------------|-------|--------------------------|
| Joe2  | 20            | 8                         | A     | 9                        |
| Rich2 | 100           | 7                         | B     | 7                        |
| Rich3 | 90            | 6                         | A     | 10                       |

---

## Placing and releasing a hold on a job

You may place a hold on a job and thereby cause the job to remain in the queue until you release it.

There are two types of holds: a user hold and a system hold. Both you and your LoadLeveler administrator can place and release a user hold on a job. Only a LoadLeveler administrator, however, can place and release a system hold on a job.

You can place a hold on a job or release the hold either by using the GUI or the **llhold** command. For examples of holding and releasing jobs, see Chapter 9, “Example: Using commands to build, submit, and manage jobs,” on page 205.

As a user or an administrator, you can also use the **startdate** keyword described on page 356 to place a hold on a job. This keyword allows you to specify when you want to run a job.

---

## Canceling a job

You can cancel one of your jobs that is either running or waiting to run by using either the GUI or the **llcancel** command. You can use **llcancel** to cancel LoadLeveler jobs, including jobs from a submit-only machine and jobs routed to NQS.

To cancel NQS jobs using the LoadLeveler **llcancel** command, you need to know the LoadLeveler job ID for the NQS job. Once you submit the request to cancel the job, LoadLeveler forwards the request to the appropriate node and a **qdel** will be issued for the job for the queue listed in the **NQS\_submit** and **NQS\_query** keywords.

For more information about the **llcancel** command, see “llcancel - Cancel a submitted job” on page 377.

---

## Checkpointing a job

Checkpointing is a method of periodically saving the state of a job so that, if for some reason, the job does not complete, it can be restarted from the saved state. Checkpoints can be taken either under the control of the user application or external to the application.

The LoadLeveler API **ll\_init\_ckpt** is used to initiate a serial checkpoint from the user application. For initiating checkpoints from within a parallel application, the API **mpc\_init\_ckpt** should be used. These APIs allow the writer of the application to determine at what points in the application it would be appropriate save the state of the job. To enable parallel applications to initiate checkpointing, you must

use the APIs provided with the Parallel Environment (PE) program. For information on parallel checkpointing, see *IBM Parallel Environment for AIX: Operation and Use, Volume 1*.

It is also possible to checkpoint a program running under LoadLeveler outside the control of the application. There are several ways to do this:

- Use the **llckpt** command to initiate checkpoint for a specific job step.
- Checkpoint from a program which invokes the **ll\_ckpt** API to initiate checkpoint of a specific job step.
- Have LoadLeveler automatically checkpoint all running jobs that have been enabled for checkpoint. To enable this automatic checkpoint, specify **checkpoint = interval** in the job command file.
- As the result of an **llctl flush** command.

**Note:** For interactive parallel jobs, the environment variable **CHECKPOINT** must be set to **yes** in the environment prior to starting the parallel application or the job will not be enabled for checkpoint. For more information see *IBM Parallel Environment for AIX: MPI Programming Guide*.



---

## Chapter 9. Example: Using commands to build, submit, and manage jobs

The following procedure presents a series of simple tasks that a user might perform using commands. For additional information about individual commands noted in the procedure, see Chapter 15, “Commands,” on page 371.

1. Build your job command file by using a text editor to create a script file. Into the file enter the name of the executable, other keywords designating such things as output locations for messages, and the necessary LoadLeveler statements, as shown in Figure 31:

```
This job command file is called longjob.cmd. The
executable is called longjob, the input file is longjob.in,
the output file is longjob.out, and the error file is
longjob.err.
#
@ executable = longjob
@ input = longjob.in
@ output = longjob.out
@ error = longjob.err

@ queue
```

*Figure 31. Building a job command file*

2. You can optionally edit the job command file you created in step 1.
3. To submit the job command file that you created in step 1, use the **llsubmit** command:

```
llsubmit longjob.cmd
```

LoadLeveler responds by issuing a message similar to:

```
submit: The job "wizard.22" has been submitted.
```

Where wizard is the name of the machine to which the job was submitted and 22 is the job identifier (ID). You may want to record the identifier for future use (although you can obtain this information later if necessary).

4. To display the status of the job you just submitted, use the **llq** command. This command returns information about all jobs in the LoadLeveler queue:

```
llq wizard.22
```

Where wizard is the machine name to which you submitted the job, and 22 is the job ID. You can also query this job using the command **llq wizard.22.0**, where 0 is the step ID.

5. To change the priority of a job, use the **llprio** command. To increase the priority of the job you submitted by a value of 10, enter:

```
llprio +10 wizard.22.0
```

You can change the user priority of a job that is in the queue or one that is running. This only affects jobs belonging to the same user and the same class. If you change the priority of a job in the queue, the job's priority increases or decreases in relation to your other jobs in the queue. If you change the priority of a job that is running, it does not affect the job while it is running. It only affects the job if the job re-enters the queue to be dispatched again. For more information, see “Setting and changing the priority of a job” on page 201.

6. To place a temporary hold on a job in a queue, use the **llhold** command. This command only takes effect if jobs are in the Idle or NotQueued state. To place a hold on *wizard.22.0*, enter:  
**llhold wizard.22.0**
7. To release the hold you placed in step 6, use the **llhold** command:  
**llhold -r wizard.22.0**
8. To display the status of the machine to which you submitted a job, use the **llstatus** command:  
**llstatus -l wizard**
9. To cancel *wizard.22.0*, use the **llcancel** command:  
**llcancel wizard.22.0**

---

## Chapter 10. Using LoadLeveler's GUI to build, submit, and manage jobs

This section describes tasks a user may need to accomplish through the graphical user interface (GUI). You do not have to perform the tasks in the order listed. You may perform certain tasks before others without any difficulty; however, some tasks must be performed prior to others for succeeding tasks to work. For example, you cannot submit a job if you do not have a job command file that you built using either the GUI or an editor.

The tasks included in this section are listed in Table 42.

*Table 42. User tasks available through the GUI*

| Subtask                               | Associated information (see...)                                                                                                                                                                                                                                                                                                                                                             |
|---------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Building and submitting jobs          | <ul style="list-style-type: none"><li>• “Building jobs”</li><li>• “Editing the job command file” on page 218</li><li>• “Submitting a job command file” on page 220</li></ul>                                                                                                                                                                                                                |
| Obtaining job status                  | <ul style="list-style-type: none"><li>• “Displaying and refreshing job status” on page 220</li><li>• “Specifying which jobs appear in the Jobs window” on page 227</li><li>• “Sorting the Jobs window” on page 221</li></ul>                                                                                                                                                                |
| Managing a submitted job              | <ul style="list-style-type: none"><li>• “Changing the priority of your jobs” on page 222</li><li>• “Placing a job on hold” on page 222</li><li>• “Releasing the hold on a job” on page 222</li><li>• “Canceling a job” on page 222</li></ul>                                                                                                                                                |
| Working with machines                 | <ul style="list-style-type: none"><li>• “Displaying and refreshing machine status” on page 224</li><li>• “Specifying which machines appear in Machines window” on page 227</li><li>• “Sorting the Machines window” on page 225</li><li>• “Finding the location of the central manager” on page 226</li><li>• “Finding the location of the public scheduling machines” on page 226</li></ul> |
| Saving LoadLeveler messages in a file | “Saving LoadLeveler messages in a file” on page 228                                                                                                                                                                                                                                                                                                                                         |

---

### Building jobs

From the Jobs window:

**SELECT      File → Build a Job**

▲ The dialog box shown in Figure 32 on page 208 appears:

**Build a Job**

Tools Edit Help

Executable

Arguments

Stdin /dev/null

Stdout /dev/null

Stderr /dev/null

Cluster Input File More

Cluster Output File More

Initialdir /u/ptrimble

Notify User ptrimble@c94n13.ppd.pok.ibm.com

Start Date mm/dd/yyyy

Start Time hh:mm:ss

Priority

Image Size

Class Choices

Hold

Account Number

**Job Type**

- Serial
- Parallel
- Blue Gene

**Notification**

- Always
- Complete
- Error
- Never
- Start

**Restart**

- No
- Yes

**Same Nodes**

- No
- Yes

**Checkpoint**

- No
- Yes
- Interval

**Start From Ckpt**

- No
- Yes

Nodes

Network

Requirements

Resources

Preferences

Limits

Checkpoint Fields

Blue Gene

Submit Save Close

Figure 32. LoadLeveler build a job window

Complete those fields for which you want to override what is currently specified in your `skel.cmd` defaults file. Sample `skel.cmd` and `mcluster_skel.cmd` files are found in the samples subdirectory of the release directory. You can update this file to define defaults for your site, and then update the `*skelfile` resource in `Xloadl` to

point to your new **skel.cmd** file. If you want a personal defaults file, copy **skel.cmd** to one of your directories, edit the file, and update the **\*skelfile** resource in **.Xdefaults**.

| Field               | Input                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Executable          | Name of the program to run. It must be an executable file.<br><br>Optional. If omitted, the command file is executed as if it were a shell script.                                                                                                                                                                                                                                                                                                              |
| Arguments           | Parameters to pass to the program.<br><br>Required only if the executable requires them.                                                                                                                                                                                                                                                                                                                                                                        |
| Stdin               | Filename to use as standard input (stdin) by the program.<br><br>Optional. The default is <b>/dev/null</b> .                                                                                                                                                                                                                                                                                                                                                    |
| Stdout              | Filename to use as standard output (stdout) by the program.<br><br>Optional. The default is <b>/dev/null</b> .                                                                                                                                                                                                                                                                                                                                                  |
| Stderr              | Filename to use as standard error (stderr) by the program.<br><br>Optional. The default is <b>/dev/null</b> .                                                                                                                                                                                                                                                                                                                                                   |
| Cluster Input File  | A comma delimited local and remote pathname pair, representing the local file to copy to the remote location. If you have more than one pair to enter, the <b>More</b> button will display a <b>Cluster Input Files</b> input window.<br><br>Optional. The default is no files are copied.                                                                                                                                                                      |
| Cluster Output File | A comma delimited local and remote pathname pair, representing the local file destination to copy to the remote file into. If you have more than one pair to enter, the <b>More</b> button will display a <b>Cluster Output Files</b> input window.<br><br>Optional. The default is no files are copied.                                                                                                                                                        |
| Initialdir          | Initial directory. LoadLeveler changes to this directory before running the job.<br><br>Optional. The default is your current working directory.                                                                                                                                                                                                                                                                                                                |
| Notify User         | User id of person to notify regarding status of submitted job.<br><br>Optional. The default is your userid.                                                                                                                                                                                                                                                                                                                                                     |
| StartDate           | Month, day, and year in the format mm/dd/yyyy. The job will not start before this date.<br><br>Optional. The default is to run the job as soon as possible.                                                                                                                                                                                                                                                                                                     |
| StartTime           | Hour, minute, second in the format hh:mm:ss. The job will not start before this time.<br><br>Optional. The default is to run the job as soon as possible.<br><br>If you specify <i>StartTime</i> but not <i>StartDate</i> , the default <i>StartDate</i> is the current day. If you specify <i>StartDate</i> but not <i>StartTime</i> , the default <i>StartTime</i> is 00:00:00. This means that the job will start as soon as possible on the specified date. |

| Field                   | Input                                                                                                                                                                                                                                                                                                                                                                                                 |               |                                                                                  |                   |                                                         |                         |                                                                               |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|----------------------------------------------------------------------------------|-------------------|---------------------------------------------------------|-------------------------|-------------------------------------------------------------------------------|
| Priority                | <p>Number between 0 and 100, inclusive.</p> <p>Optional. The default is 50.</p> <p>This is the user priority. For more information on this priority, refer to “Setting and changing the priority of a job” on page 201.</p>                                                                                                                                                                           |               |                                                                                  |                   |                                                         |                         |                                                                               |
| Image size              | <p>Number in kilobytes that reflects the maximum size you expect your program to grow to as it runs.</p> <p>Optional.</p>                                                                                                                                                                                                                                                                             |               |                                                                                  |                   |                                                         |                         |                                                                               |
| Class                   | <p>Class name. The job will only run on machines that support the specified class name. Your system administrator defines the class names.</p> <p>Optional:</p> <ul style="list-style-type: none"> <li>Press the Choices button to get a list of available classes.</li> <li>Press the Details button under the class list to obtain long listing information about classes.</li> </ul>               |               |                                                                                  |                   |                                                         |                         |                                                                               |
| Hold                    | <p>Hold status of the submitted job. Permitted values are:</p> <table> <tr> <td><b>user</b></td><td>User hold</td></tr> <tr> <td><b>system</b></td><td>System hold (only valid for LoadLeveler administrators)</td></tr> <tr> <td><b>usersys</b></td><td>User and system hold (only valid for LoadLeveler administrators)</td></tr> </table> <p><b>Note:</b> The default is a no-hold state.</p>      | <b>user</b>   | User hold                                                                        | <b>system</b>     | System hold (only valid for LoadLeveler administrators) | <b>usersys</b>          | User and system hold (only valid for LoadLeveler administrators)              |
| <b>user</b>             | User hold                                                                                                                                                                                                                                                                                                                                                                                             |               |                                                                                  |                   |                                                         |                         |                                                                               |
| <b>system</b>           | System hold (only valid for LoadLeveler administrators)                                                                                                                                                                                                                                                                                                                                               |               |                                                                                  |                   |                                                         |                         |                                                                               |
| <b>usersys</b>          | User and system hold (only valid for LoadLeveler administrators)                                                                                                                                                                                                                                                                                                                                      |               |                                                                                  |                   |                                                         |                         |                                                                               |
| Account Number          | <p>Number associated with the job. For use with the llacctmrg and llsummary commands for acquiring job accounting data.</p> <p>Optional. Required only if the <b>ACCT</b> keyword is set to <b>A_VALIDATE</b> in the configuration file.</p>                                                                                                                                                          |               |                                                                                  |                   |                                                         |                         |                                                                               |
| Environment             | <p>Your initial environment variables when your job starts. Separate environment specifications with semicolons.</p> <p>Optional.</p>                                                                                                                                                                                                                                                                 |               |                                                                                  |                   |                                                         |                         |                                                                               |
| Copy Environment        | <p>All or Master, to indicate whether the environment variables specified in the keyword Environment are copied to all nodes or just to the master node of a parallel job.</p> <p>Optional.</p>                                                                                                                                                                                                       |               |                                                                                  |                   |                                                         |                         |                                                                               |
| Shell                   | <p>The name of the shell to use for the job.</p> <p>Optional. If not specified, the shell used in the owner’s password file entry is used. If none is specified, <b>/bin/sh</b> is used.</p>                                                                                                                                                                                                          |               |                                                                                  |                   |                                                         |                         |                                                                               |
| Group                   | <p>The LoadLeveler group name to which the job belongs.</p> <p>Optional.</p>                                                                                                                                                                                                                                                                                                                          |               |                                                                                  |                   |                                                         |                         |                                                                               |
| Step Name               | <p>The name of this job step.</p> <p>Optional.</p>                                                                                                                                                                                                                                                                                                                                                    |               |                                                                                  |                   |                                                         |                         |                                                                               |
| Node Usage              | <p>How the node is used. Permitted values are:</p> <table> <tr> <td><b>shared</b></td><td>The node can be shared with other tasks of other job steps. This is the default.</td></tr> <tr> <td><b>not shared</b></td><td>The node cannot be shared.</td></tr> <tr> <td><b>slice not shared</b></td><td>Has the same meaning as <b>not shared</b>. It is provided for compatibility.</td></tr> </table> | <b>shared</b> | The node can be shared with other tasks of other job steps. This is the default. | <b>not shared</b> | The node cannot be shared.                              | <b>slice not shared</b> | Has the same meaning as <b>not shared</b> . It is provided for compatibility. |
| <b>shared</b>           | The node can be shared with other tasks of other job steps. This is the default.                                                                                                                                                                                                                                                                                                                      |               |                                                                                  |                   |                                                         |                         |                                                                               |
| <b>not shared</b>       | The node cannot be shared.                                                                                                                                                                                                                                                                                                                                                                            |               |                                                                                  |                   |                                                         |                         |                                                                               |
| <b>slice not shared</b> | Has the same meaning as <b>not shared</b> . It is provided for compatibility.                                                                                                                                                                                                                                                                                                                         |               |                                                                                  |                   |                                                         |                         |                                                                               |

| Field         | Input                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Dependency    | A Boolean expression defining the relationship between the job steps.<br><br>Optional.                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Large Page    | Whether or not the job step requires Large Page memory.<br><b>yes</b> Use Large Page memory if available, otherwise use regular memory.<br><b>mandatory</b> Use of Large Page memory is mandatory.<br><b>no</b> Do not use Large Page memory.                                                                                                                                                                                                                                                                                                                  |
| Bulk Transfer | Indicates to the communication subsystem whether it should use the bulk transfer mechanism to communicate between tasks.<br><b>yes</b> Use bulk transfer.<br><b>no</b> Do not use bulk transfer.<br><br>Optional.                                                                                                                                                                                                                                                                                                                                              |
| Rset          | What type of RSet support is requested. Permitted values are:<br><b>rset_mcm_affinity</b><br>Requests scheduling affinity.<br><br>Use the <b>MCM options</b> button to specify task allocation method, memory affinity preference or requirement, and adapter affinity preference or requirement.<br><b>rset_consumable_cpus</b><br>Requests nodes where <b>rset_support</b> is set to <b>rset_consumable_cpus</b> .<br><i>rset_name</i><br>Requests a user defined RSet and nodes with <b>rset_support</b> set to <b>rset_user_defined</b> .<br><br>Optional. |
| Comments      | Comments associated with the job. These comments help to distinguish one job from another job.<br><br>Optional.                                                                                                                                                                                                                                                                                                                                                                                                                                                |

**Note:** The fields that appear in this table are what you see when viewing the Build a Job window. The text in these fields does not necessarily correspond with the keywords listed in “Job command file keyword descriptions” on page 324.

See “Job command file keyword descriptions” on page 324 for information on the defaults associated with these keywords.

**SELECT** A Job Type if you want to change the job type.

Your choices are:

**Serial**                Specifies a serial job.  
**Parallel**             Specifies a parallel job.  
**Blue Gene**          Specifies a bluegene job.

Note that the job type you select affects the choices that are active on the Build A Job window.

**SELECT** a Notification option.

Your choices are:

**Always**              Notify you when the job starts, completes, and if it incurs errors.

|               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                               |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|               | <b>Complete</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Notify you when the job completes. This is the default option as initially defined in the skel.cmd file.                                                                                                                                      |
|               | <b>Error</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Notify you if the job cannot run because of an error.                                                                                                                                                                                         |
|               | <b>Never</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Do not notify you.                                                                                                                                                                                                                            |
|               | <b>Start</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Notify you when the job starts.                                                                                                                                                                                                               |
| <b>SELECT</b> | a Restart option.<br>Your choices are:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                               |
|               | <b>No</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | This job is not restartable. This is the default.                                                                                                                                                                                             |
|               | <b>Yes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Restart the job.                                                                                                                                                                                                                              |
| <b>SELECT</b> | To restart the job on the same nodes from which it was vacated.<br>Your choices are:                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                               |
|               | <b>No</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Restart the job on any available nodes.                                                                                                                                                                                                       |
|               | <b>Yes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Restart the job on the same nodes it ran on previously. This option is valid after a job has been vacated.                                                                                                                                    |
|               | Note that there is no default for the selection.                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                               |
| <b>SELECT</b> | a Checkpoint option.<br>Your choices are:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                               |
|               | <b>No</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Do not checkpoint the job. This is the default.                                                                                                                                                                                               |
|               | <b>Yes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Yes, checkpoint the job at intervals you determine. See 328 for more information.                                                                                                                                                             |
|               | <b>Interval</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Yes, checkpoint the job at intervals determined by LoadLeveler. See 328 for more information.                                                                                                                                                 |
| <b>SELECT</b> | To start from a checkpoint file<br>Your choices are:                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                               |
|               | <b>No</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Do not start the job from a checkpoint file (start job from beginning).                                                                                                                                                                       |
|               | <b>Yes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Yes, restart the job from an existing checkpoint file when you submit the job. The file name must be specified by the job command file. The directory name may be specified by the job command file, configuration file, or default location. |
| <b>SELECT</b> | Nodes (available when the job type is parallel)<br>▲ The Nodes dialog box appears.<br><br>Complete the necessary fields to specify node information for a parallel job. Depending upon which model you choose, different fields will be available; any unavailable fields will be desensitized. LoadLeveler will assign defaults for any fields that you leave blank. For more information, see the appropriate job command file keyword (listed in parentheses) in "Job command file keyword descriptions" on page 324. |                                                                                                                                                                                                                                               |

| Field          | Available in:                                                | Input                                                                                                                                                                                              |
|----------------|--------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Min # of Nodes | Tasks Per Node Model and Tasks with Uniform Blocking Model   | Minimum number of nodes required for running the parallel job ( <b>node</b> keyword).<br><br>Optional. The default is one.                                                                         |
| Max # of Nodes | Tasks Per Node Model                                         | Maximum number of nodes required for running the parallel job ( <b>node</b> keyword).<br><br>Optional. The default is the minimum number of nodes.                                                 |
| Tasks per Node | Tasks Per Node Model                                         | The number of tasks of the parallel job you want to run per node ( <b>tasks_per_node</b> keyword).<br><br>Optional.                                                                                |
| Total Tasks    | Tasks with Uniform Blocking Model, and Custom Blocking Model | The total number of tasks of the parallel job you want to run on all available nodes ( <b>total_tasks</b> keyword).<br><br>Optional for Uniform, required for Custom Blocking. The default is one. |
| Blocking       | Custom Blocking Model                                        | The number of tasks assigned (as a block) to each consecutive node until all of a job's tasks have been assigned ( <b>blocking</b> keyword)                                                        |
| Task Geometry  | Custom Geometry Model                                        | The task ids of each task that you want to run on each node. You can use the "Set Geometry" button for step-by-step directions ( <b>task_geometry</b> keyword).                                    |

**SELECT**

Close to return to the Build a Job dialog box.

**SELECT**

Network (available when the job type is parallel)

▲ The Network dialog box appears.

The Network dialog box consists of two parts: The top half of the panel is for MPI, and the bottom half is for LAPI. Click on the check box to the left of **MPI** or **LAPI** to activate the part of the panel for which you want to specify network information. If you want to use MPI with LAPI, click on both:

- The MPI check box.
- The check box for **Share windows between MPI and LAPI**.

Complete those fields for which you want to specify network information. For more information, see the **network** keyword description in "Job command file keyword descriptions" on page 324.

| Field               | Input                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| MPI (MPI/LAPI)      | <p>Select:</p> <ul style="list-style-type: none"> <li>Only the <b>MPI</b> check box to use the Message Passing Interface (MPI) protocol only.</li> <li>Both the <b>MPI</b> check box and the <b>Share windows between MPI and LAPI</b> check box to use both MPI and the Low-level Application Programming Interface (LAPI) protocols. This selection corresponds to setting the <b>network</b> keyword in the job command file to <b>MPI_LAPI</b>.</li> </ul> <p>Optional.</p> |
| LAPI                | <p>Select the <b>LAPI</b> check box to use Low-level Application Programming Interface (LAPI) protocol only.</p> <p>Optional.</p>                                                                                                                                                                                                                                                                                                                                               |
| Adapter/Network     | <p>Select an adapter name or a network type from the list.</p> <p>Required for each protocol you select.</p>                                                                                                                                                                                                                                                                                                                                                                    |
| Adapter Usage       | <p>Specifies that the adapter is either shared or not shared.</p> <p>Optional. The default is shared.</p>                                                                                                                                                                                                                                                                                                                                                                       |
| Communication Mode  | <p>Specifies the communication subsystem mode used by the communication protocol that you specify and can be either IP (Internet Protocol) or US (User Space).</p> <p>Optional. The default is IP.</p>                                                                                                                                                                                                                                                                          |
| Communication Level | <p>Implies the amount of memory to be allocated to each window for User Space mode. Allocation can be Low, Average, or High. It is recognized only by SP_Switch2 adapters and will be ignored by Switch_Network_Interface_For_HPS adapters.</p>                                                                                                                                                                                                                                 |
| Instances           | <p>Specifies the number of windows or IP addresses the communication subsystem should allocate to this protocol.</p> <p>Optional. The default is 1 unless sn_all or csss is specified for network and then the default is max.</p>                                                                                                                                                                                                                                              |
| rCxt Blocks         | <p>The number of user rCxt blocks requested for each window used by the associated protocol. It is recognized only by Switch_Network_Interface_For_HPS adapters and will be ignored by SP_Switch2 adapters.</p> <p>Optional.</p>                                                                                                                                                                                                                                                |

**SELECT**

Close to return to the Build a Job dialog box.

**SELECT**

Requirements

▲ The Requirements dialog box appears.

Complete those fields for which you want to specify requirements. Defaults are used for those fields that you leave blank.

LoadLeveler dispatches your job only to one of those machines

with resources that matches the requirements you specify.

| Field                            | Input                                                                                                                                                                                                                                            |
|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Architecture<br>(see note 2)     | Machine type. The job will not run on any other machine type.<br><br>Optional. The default is the architecture of your current machine.                                                                                                          |
| Operating System<br>(see note 2) | Operating system. The job will not run on any other operating system.<br><br>Optional. The default is the operating system of your current machine.                                                                                              |
| Disk                             | Amount of disk space in the execute directory. The job will only run on a machine with at least this much disk space.<br><br>Optional. The default is defined in your local configuration file.                                                  |
| Memory                           | Amount of memory. The job will only run on a machine with at least this much memory.<br><br>Optional. The default is defined in your local configuration file.                                                                                   |
| Large Page Memory                | Amount of Large Page Memory, in megabytes. The job step requires at least this much Large Page Memory to run.<br><br>Optional.                                                                                                                   |
| Total Memory                     | Amount of total (regular and Large Page Memory) in megabytes needed to run the job step.<br><br>Optional.                                                                                                                                        |
| Machines                         | Machine names. The job will only run on the specified machines.<br><br>Optional.                                                                                                                                                                 |
| Features                         | Features. The job will only run on machines with specified features.<br><br>Optional.                                                                                                                                                            |
| Pool                             | Specifies the number associated with the pool you want to use. All available pools listed in the administration file appear as choices. The default is to select nodes from any pool.                                                            |
| LoadLeveler Version              | Specifies the version of LoadLeveler, in dotted decimal format, on the machine where you want the job to run. For example: 3.3.0.0 specifies that your job will run on a machine running LoadLeveler Version 3.3.0.0 or higher.<br><br>Optional. |
| Connectivity                     | A number from 0.0 through 1.0, representing the average connectedness of the node's managed adapters.                                                                                                                                            |
| Requirement                      | Requirements. The job will only run if these requirements are met.                                                                                                                                                                               |

| Field | Input |
|-------|-------|
|-------|-------|

### Notes:

1. If you enter a resource that is not available, you will NOT receive a message. LoadLeveler holds your job in the Idle state until the resource becomes available. Therefore, make certain that the spelling of your entry is correct. You can issue `llq -s jobID` to find out if you have a job for which requirements were not met.
2. If you do not specify an architecture or operating system, LoadLeveler assumes that your job can run only on your machine's architecture and operating system. If your job is not a shell script that can be run successfully on any platform, you should specify a required architecture and operating system.

|        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SELECT | Close to return to the Build a Job dialog box.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| SELECT | Resources <p>▲ The Resources dialog box appears.</p> <p>This dialog box allows you to set the amount of defined consumable resources required for a job step. Resources with an "*" appended to their names are not in the SCHEDULE_BY_RESOURCES list. For more information, see 353.</p>                                                                                                                                                                                                                                                                       |
| SELECT | Close to return to the Build a Job dialog box.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| SELECT | Preferences <p>▲ The Preferences dialog box appears.</p> <p>This dialog box is similar to the Requirements dialog box, with the exception of the Adapter choice, which is not supported as a Preference. Complete the fields for those parameters that you want to specify. These parameters are not binding. For any preferences that you specify, LoadLeveler attempts to find a machine that matches these preferences along with your requirements. If it cannot find the machine, LoadLeveler chooses the first machine that matches the requirements.</p> |
| SELECT | Close to return to the Build a Job dialog box.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| SELECT | Limits <p>▲ The Limits dialog box appears.</p> <p>Complete the fields for those limits that you want to impose upon your job. If you type <i>copy</i> in any field except <b>wall_clock_limit</b> or <b>job_cpu_limit</b>, the limits in effect on the submit machine are used. If you leave any field blank, the default limits in effect for your userid on the machine that runs the job are used. For more information, see "Using limit keywords" on page 83.</p>                                                                                          |

| Field            | Input                                                                                                                                                                                                                                 |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CPU Limit        | Maximum amount of CPU time that the submitted job can use. Express the amount as:<br>[[hours:]minutes:]seconds[ .fraction]<br><br>For example, 12:56:21 is 12 hours, 56 minutes, and 21 seconds.<br><br>Optional                      |
| Data Limit       | Maximum amount of the data segment that the submitted job can use. Express the amount as:<br>integer[.fraction][units]<br><br>Optional                                                                                                |
| Core Limit       | Maximum size of a core file.<br><br>Optional                                                                                                                                                                                          |
| RSS Limit        | Maximum size of the resident set size. It is the largest amount of physical memory a user's process can allocate.<br><br>Optional                                                                                                     |
| File Limit       | Maximum size of a file that is created.<br><br>Optional                                                                                                                                                                               |
| Stack Limit      | Maximum size of the stack.<br><br>Optional                                                                                                                                                                                            |
| Job CPU Limit    | Maximum total CPU time to be used by all processes of a serial job step or if a parallel job, then this is the total CPU time for each LoadL_starter process and its descendants for each job step of a parallel job.<br><br>Optional |
| Wall Clock Limit | Maximum amount of elapsed time for which a job can run.<br><br>Optional                                                                                                                                                               |

**SELECT**

Close to return to the Build a Job dialog box.

**SELECT**

Checkpointing to specify checkpoint options (available when the checkpoint option is set to Yes or Interval)

▲ The checkpointing dialog box appears.

Complete those fields for which you want to specify checkpoint information. For detailed information on specific keywords, see "Job command file keyword descriptions" on page 324.

| Field                  | Input                                                                                                              |
|------------------------|--------------------------------------------------------------------------------------------------------------------|
| Ckpt File              | Specifies a checkpoint file. The serial default is :<br>\$(job_name).\$(host).\$(domain).\$(jobid).\$(stepid).ckpt |
| Ckpt Directory         | Specifies a checkpoint directory name.                                                                             |
| Ckpt Execute Directory | Specifies a directory to use for staging the checkpoint executable file.                                           |

| Field            | Input                                                              |
|------------------|--------------------------------------------------------------------|
| Ckpt Time Limits | Sets the limits for the elapsed time a job can take checkpointing. |

**SELECT** Close to return to the Build a Job dialog box.

**SELECT** Blue Gene (available when the job type is bluegene)

▲ The Blue Gene window appears.

Complete the necessary fields to specify information for a Blue Gene job. Depending upon which request type you choose, different fields will be available; any unavailable fields will be desensitized. For more information, see the appropriate job command file keyword (listed in parentheses) in “Job command file keyword descriptions” on page 324.

| Field              | Available when requesting by: | Input                                                                                                                                                                                                                                                                            |
|--------------------|-------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| # of Compute Nodes | Size                          | The requested size in number of compute nodes that describes the size of the partition for this Blue Gene job. ( <b>bg_size</b> )                                                                                                                                                |
| Shape              | Shape                         | The requested shape of the requested Blue Gene job. The units of each dimension of the shape are in number of base partitions, $X \times Y \times Z$ , where X, Y, and Z are the number of base partitions in the X-direction, Y-direction, and Z-direction. ( <b>bg_shape</b> ) |
| Partition Name     | Partition                     | The name of an existing partition in the Blue Gene system where the requested job should run. ( <b>bg_partition</b> )                                                                                                                                                            |
| Connection Type    | Size and Shape                | The kinds of Blue Gene partitions that can be selected for this job. You can select Torus, Mesh, or Prefer Torus. ( <b>bg_connection</b> )<br><br>Optional. The default is Mesh.                                                                                                 |
| Rotate Dimensions  | Shape                         | Whether to consider all possible rotations of the specified shape (True) or only the specified shape (False) when assigning a partition for the Blue Gene job. ( <b>bg_rotate</b> )<br><br>Optional. The default is True.                                                        |

**SELECT** Close to return to the Build a Job dialog box.

## Editing the job command file

There are several ways that you can edit the job command file that you just built:

1. Using the Jobs window:

**SELECT** **File → Submit a Job**

▲ The Submit a Job dialog box appears.

**SELECT** The job file you want to edit from the file column.

**SELECT      Edit**

▲ Your job command file appears in a window. You can use any editor to edit the job command file. The default editor is specified in your `.Xdefaults` file.

If you have an icon manager, an icon may appear. An icon manager is a program that creates a graphic symbol, displayed on a screen, that you can point to with a device such as a mouse in order to select a particular function or application. Select this icon to view your job command file.

2. Using the **Tools Edit** pull-down menus on the Build a Job window:

Using the Edit pull-down menu, you can modify the job command file. Your choices appear in the following table:

| To                                         | Select                         |
|--------------------------------------------|--------------------------------|
| Add a step to the job command file         | Add a Step or Add a First Step |
| Delete a step from the job command file    | Delete a Step                  |
| Clear the fields in the Build a Job window | Clear Fields                   |
| Select defaults to use in the fields       | Set Field Defaults             |

**Note:** Other options include Go to Next Step, Go to Previous Step, and Go to Last Step that allow you to edit various steps in the job command file.

Using the **Tools** pull-down menu, you can modify the job command file. Your choices appear in the following table:

| To                                                                                            | Select            |
|-----------------------------------------------------------------------------------------------|-------------------|
| Name the job                                                                                  | Set Job Name      |
| Specify a cluster, cluster list, or any cluster, if a multicluster environment is configured. | Set Cluster       |
| Open a window where you can enter a script file                                               | Append Script     |
| Fill in the fields using another file                                                         | Restore from File |
| View the job command file in a window                                                         | View Entire Job   |
| Determine which step you are viewing                                                          | What is step #    |
| Start a new job command file                                                                  | Start a new job   |

| To                                                                      | Do This                                                                                                                                                                                                                                                                                 |
|-------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Save the information you entered into a file which you can submit later | <p><b>SELECT      Save</b></p> <p>▲ A window appears prompting you to enter a job filename.</p> <p><b>ENTER</b> a job filename in the text entry field.</p> <p><b>SELECT      OK</b></p> <p>▲ The window closes and the information you entered is saved in the file you specified.</p> |
| Submit the program immediately and discard the information you entered  | <p><b>SELECT      Submit</b></p>                                                                                                                                                                                                                                                        |

---

### Submitting a job command file

After building a job command file, you can submit it to one or more machines for processing. In addition to scripts with LoadLeveler keywords, you can also submit scripts that contain NQS options. You cannot, however, in this release of LoadLeveler, combine NQS and LoadLeveler options.

To submit a job, from the Jobs window:

**SELECT      File → Submit a Job**

▲ The Submit a Job dialog box appears.

**SELECT      The job file that you want to submit from the file column.**

You can also use the filter field and the directories column to select the file or you can type in the file name in the text entry field.

**SELECT      Submit**

▲ The job is submitted for processing.

You can now submit another job or you can press Close to exit the window.

---

### Displaying and refreshing job status

When you submit a job, the status of the job is automatically displayed in the Jobs window. You can update or refresh this status using the Jobs window and selecting one of the following:

- **Refresh → Refresh Jobs**
- **Refresh → Refresh All.**

To change how often the amount of time should pass before the jobs window is automatically refreshed, use the Jobs window.

**SELECT      Refresh → Set Auto Refresh**

▲ A window appears.

**TYPE IN      a value for the number of seconds to pass before the Jobs window is updated.**

Automatic refresh can be expensive in terms of network usage and CPU cycles. You should specify a refresh interval of 120 seconds or more for normal use.

**SELECT      OK**

▲ The window closes and the value you specified takes effect.

To receive detailed information on a job:

**SELECT      Actions → Extended Status** to receive additional information on the job. Selecting this option is the same as typing **llq -x** command.

You can also get information in the following way:

**SELECT      Actions → Extended Details**

Selecting this option is the same as typing **llq -x -l** command. You can also double click on the job in the Jobs window to get details on the job.

Note: Obtaining extended status or details on multiple jobs can be expensive in terms of network usage and CPU cycles.

**SELECT**

**Actions → Job Status**

You can also use the **llq -s** command to determine why a submitted job remains in the Idle or Deferred state.

**SELECT**

**Actions → Resource Use**

Allows you to display resource use for running jobs. Selecting this option is the same as entering the **llq -w** command.

**SELECT**

**Actions → Blue Gene Job Status**

Allows you to display Blue Gene job information for jobs. Selecting this option is the same as entering the **llq -b** command.

For more information on requests for job information, see “llq - Query job status” on page 431.

## Sorting the Jobs window

You can specify up to two sorting options for the Jobs window. The options you specify determine the order in which the jobs appear in the Jobs window.

From the Jobs window:

**Select Sort → Set Sort Parameters**

▲ A window appears

**Select** A primary and secondary sort

| To:                                                           | Select Sort                       |
|---------------------------------------------------------------|-----------------------------------|
| Sort jobs by the machine from which they were submitted       | <b>Sort by Submitting Machine</b> |
| Sort by owner                                                 | <b>Sort by Owner</b>              |
| Sort by the time the jobs were submitted                      | <b>Sort by Submission Time</b>    |
| Sort by the state of the job                                  | <b>Sort by State</b>              |
| Sort jobs by their user priority (last job listed runs first) | <b>Sort by Priority</b>           |
| Sort by the class of the job                                  | <b>Sort by Class</b>              |
| Sort by the group associated with the job                     | <b>Sort by Group</b>              |
| Sort by the machine running the job                           | <b>Sort by Running Machine</b>    |
| Sort by dispatch order                                        | <b>Sort by Dispatch Order</b>     |
| Not specify a sort                                            | <b>No Sort</b>                    |

You can select a sort type as either a Primary or Secondary sorting option. For example, suppose you select Sort by Owner as the primary sorting option and Sort by Class as the secondary sorting option. The Jobs window is sorted by owner and, within each owner, by class.

---

### Changing the priority of your jobs

If your job has not yet begun to run and is still in the queue, you can change the priority of the job in relation to your other jobs in the queue that belong to the same class. This only affects the user priority of the job. For more information on this priority, refer to “Setting and changing the priority of a job” on page 201. Only the owner of a job or the LoadLeveler administrator can change the priority of a job.

From the Jobs window:

- SELECT**            a job by clicking on it with the mouse
- SELECT**            **Actions → Priority**
  - ▲ A window appears.
- TYPE IN**          a number between 0 and 100, inclusive, to indicate a new priority.
- SELECT**            **OK**
  - ▲ The window closes and the priority of your job changes.

---

### Placing a job on hold

Only the owner of a job or the LoadLeveler administrator can place a hold on a job.

From the Jobs window:

- SELECT**            The job you want to hold by clicking on it with the mouse
- SELECT**            **Actions → Hold**
  - ▲ The job is put on hold and its status changes in the Jobs window.

---

### Releasing the hold on a job

Only the owner of a job or the LoadLeveler administrator can release a hold on a job.

From the Jobs window:

- SELECT**            The job you want to release by clicking on it with the mouse
- SELECT**            **Actions → Release from Hold**
  - ▲ The job is released from hold and its status is updated in the Jobs window.

---

### Canceling a job

Only the owner of a job or the LoadLeveler administrator can cancel a job.

From the Jobs window:

- SELECT**            The job you want to cancel by clicking on it with the mouse
- SELECT**            **Actions → Cancel**
  - ▲ LoadLeveler cancels the job and the job information disappears from the Jobs window.

---

## Modifying consumable resources and other job attributes

Modifies the consumable CPUs or memory requirements of a non-running job.

**SELECT**

**Modify → Consumable CPUs**

or

**Modify → Consumable Memory**

or

**Modify → Class**

or

**Modify → Account number**

or

**Modify → Blue Gene → Connection**

or

**Modify → Blue Gene → Partition**

or

**Modify → Blue Gene → Rotation**

or

**Modify → Blue Gene → Shape**

or

**Modify → Blue Gene → Size**

▲ A dialog box appears prompting you to enter a new value for the selected job attribute. Blue Gene attributes are available when Blue Gene is enabled.

**TYPE IN**

The new value

**SELECT**

**OK**

▲ The dialog box closes and the value you specified takes effect.

---

## Taking a checkpoint

Checkpoints the selected job.

**SELECT**

One of the following actions to take when checkpoint has completed:

- Continue the step
- Terminate the step
- Hold the step

▲ A checkpoint monitor for this step appears.

---

## Adding a job to a reservation

Binds selected job steps to a reservation so that they will only be scheduled to run on the nodes reserved for the reservation.

**SELECT**

The job you want to bind by clicking on it with the mouse.

**SELECT**

**Actions → Bind to Reservation**

▲ A window appears.

## Using the GUI

**SELECT**

A reservation from the list.

**SELECT**

**OK**

▲ The window closes and the job is bound to that reservation.

---

## Removing a job from a reservation

Unbinds selected job steps from reservations to which they currently belong.

**SELECT**

The job you want to unbind by clicking on it with the mouse.

**SELECT**

**Actions → Unbind from Reservation**

If the job is bound to a reservation, it is removed from the reservation.

---

## Displaying and refreshing machine status

The status of the machines is automatically displayed in the Machines window. You can update or refresh this status using the Machines window and selecting one of the following:

- **Refresh → Refresh Machines**
- **Refresh → Refresh All.**

To specify an amount of time to pass before the Machines window is automatically refreshed, from the Machines window:

**SELECT**

**Refresh → Set Auto Refresh**

▲ A window appears.

**TYPE IN**

a value for the number of seconds to pass before the Machines window is updated.

Automatic refresh can be expensive in terms of network usage and CPU cycles. You should specify a refresh interval of 120 seconds or more for normal use.

**SELECT**

**OK**

▲ The window closes and the value you specified takes effect.

To receive detailed information on a machine:

**SELECT**

**Actions → Details**

This displays status information about the selected machines. Selecting this option has the same effect as typing the **llstatus -l** command

**SELECT**

**Actions → Adapter Details**

This displays virtual and physical adapter information for each selected machine. Selecting this option has the same effect as typing the **llstatus -a** command

**SELECT**

**Actions → Floating Resources**

This displays consumable resources for the LoadLeveler cluster. Selecting this option has the same effect as typing the **llstatus -R** command

#### SELECT

##### Actions → Machine Resources

This displays consumable resources defined for the selected machines or all machines. Selecting this option has the same effect as typing the **llstatus -R** command

#### SELECT

##### Actions → Cluster Status

This displays status of machines in the defined cluster or clusters. It appears only when a multicluster environment is configured and is equivalent to the **llstatus -X all** command.

#### SELECT

##### Actions → Cluster Config

This displays cluster information from the LoadL\_admin file. Only fields with data specified or which have defaults when not specified are displayed. It appears only when a multicluster environment is configured and is equivalent to the **llstatus -C** command.

#### SELECT

##### Actions → Blue Gene ...

This displays information about the Blue Gene system. You can select the option for **Status** for a short listing, **Details** for a long listing, **Base Partitions** for Blue Gene base partition status, or **Partitions** for existing Blue Gene partition status. It is available only when Blue Gene support is enabled in LoadLeveler. This is equivalent to the **llstatus** command with the options **-b**, **-b -l**, **-B**, or **-P**.

## Sorting the Machines window

You can specify up to two sorting options for the Machines window. The options you specify determine the order in which machines appear in the window.

From the Machines window:

Select **Sort → Set Sort Parameters**

▲ A window appears

Select **A primary and secondary sort**

| To:                                                      | Select Sort →  |
|----------------------------------------------------------|----------------|
| Sort by machine name                                     | Sort by Name   |
| Sort by schedd state                                     | Sort by Schedd |
| Sort by total number of jobs scheduled                   | Sort by InQ    |
| Sort by number of running jobs scheduled by this machine | Sort by Act    |
| Sort by startd state                                     | Sort by Startd |
| Sort by the number of jobs running on this machine       | Sort by Run    |
| Sort by load average                                     | Sort by LdAvg  |
| Sort by keyboard idle time                               | Sort by Idle   |
| Sort by hardware architecture                            | Sort by Arch   |

|                               |               |
|-------------------------------|---------------|
| To:                           | Select Sort → |
| Sort by operating system type | Sort by OpSys |
| Not specify a sort            | No Sort       |

You can select a sort type as either a Primary or Secondary sorting option. For example, suppose you select Sort by Arch as the primary sorting option and Sort by Name as the secondary sorting option. The Machines window is sorted by hardware architecture, and within each architecture type, by machine name.

---

## Finding the location of the central manager

The LoadLeveler administrator designates one of the nodes in the LoadLeveler cluster as the central manager. When jobs are submitted at any node, the central manager is notified and decides where to schedule the jobs. In addition, it keeps track of the status of machines in the cluster and the jobs in the system by communicating with each node. LoadLeveler uses this information to make the scheduling decisions and to respond to queries.

To find the location of the central manager, from the Machines window:

**SELECT**      **Actions → Find Central Manager**

▲ A message appears in the message window declaring on which machine the central manager is located.

---

## Finding the location of the public scheduling machines

Public scheduling machines are those machines that participate in the scheduling of LoadLeveler jobs on behalf of the submit-only machines.

To get a list of these machines in your cluster, use the Machines window:

**SELECT**      **Actions → Find Public Scheduler**

▲ A message appears displaying the names of these machines.

---

## Finding the type of scheduler in use

The LoadLeveler administrator defines the scheduler used by the cluster. To determine which scheduler is currently in use:

**SELECT**      **Actions → Find Scheduler Type**

- ▲ A message appears displaying the type:
- ll\_default
  - Backfill
  - Gang
  - External (API)

## Specifying which jobs appear in the Jobs window

Normally, only your jobs appear in the Jobs window. You can, however, specify which jobs you want to appear by using the Select pull-down menu on the Jobs window.

| To Display                                             | Select Select →                                                                                                                                                                 |
|--------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| All jobs in the queue                                  | All                                                                                                                                                                             |
| All jobs belonging to a specific user (or users)       | <b>By User</b><br>▲ A window appears prompting you to enter the user IDs whose jobs you want to view.                                                                           |
| All jobs submitted to a specific machine (or machines) | <b>By Machine</b><br>▲ A window appears prompting you to enter the machine names on which the jobs you want to view are running.                                                |
| All jobs belonging to a specific group (or groups)     | <b>By Group</b><br>▲ A window appears prompting you to enter the LoadLeveler group names to which the jobs you want to view belong.                                             |
| All jobs having a particular ID                        | <b>By Job Id</b><br>A dialog box prompts you to enter the id of the job you want to appear. This ID appears in the left column of the Jobs window. Type in the ID and press OK. |

### Note:

When you choose By User, By Machines, or By Group, you can use a UNIX<sup>®</sup> regular expression enclosed in parenthesis. For example, you can enter (^k10) to display all machines beginning with the characters “k10”.

**SELECT**      **Select → Show Selection** to show the selection parameters.

## Specifying which machines appear in Machines window

You can specify which machines will appear in the Machines window. The default is to view all of the machines in the LoadLeveler pool.

From the Machines window:

| To                                     | Select Select →                                                                                                                  |
|----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| View all of the machines               | All                                                                                                                              |
| View machines by operating system      | <b>by OpSys</b><br>▲ A window appears prompting you to enter the operating system of those machines you want to view.            |
| View machines by hardware architecture | <b>by Arch</b><br>▲ A window appears prompting you to enter the hardware architecture of those machines you want to view.        |
| View machines by state                 | <b>by State</b><br>▲ A cascading pull-down menu appears prompting you to select the state of the machines that you want to view. |

**SELECT**      **Select → Show Selection** to show the selection parameters.

---

### Saving LoadLeveler messages in a file

Normally, all the messages that LoadLeveler generates appear in the Messages window. If you would also like to have these messages written to a file, use the Messages window.

**SELECT**      **Actions → Start logging to a file**

▲ A window appears prompting you to enter a filename in which to log the messages.

**TYPE IN**      The filename in the text entry field.

**SELECT**      **OK**

▲ The window closes.

---

## Part 4. LoadLeveler interfaces reference

The following topics provide the details you need to know to correctly use the LoadLeveler interfaces.

| To learn about:                                                | Read the following:                                                                                                                                                                                                                          |
|----------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Correctly specifying keywords in the LoadLeveler control files | <ul style="list-style-type: none"><li>• Chapter 11, “Configuration file reference,” on page 231</li><li>• Chapter 12, “Administration file reference,” on page 287</li><li>• Chapter 13, “Job command file reference,” on page 319</li></ul> |
| Starting and customizing the LoadLeveler GUI                   | Chapter 14, “Graphical user interface (GUI) reference,” on page 363                                                                                                                                                                          |
| Correctly coding the LoadLeveler commands and APIs             | <ul style="list-style-type: none"><li>• Chapter 15, “Commands,” on page 371</li><li>• Chapter 16, “Application programming interfaces (APIs),” on page 481</li></ul>                                                                         |



---

## Chapter 11. Configuration file reference

The configuration file contains many parameters that you can set or modify to control how LoadLeveler operates. You may control LoadLeveler's operation either:

- Across the cluster, by modifying the global configuration file, **LoadL\_config** , or
- Locally, by modifying the **LoadL\_config.local** file on individual machines.

| Subtask                                                                                 | Associated information (see . . . )                                                                                                                                                                                                       |
|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| To find out what administrator tasks you can accomplish by using the configuration file | Part 2, "Configuring and managing the LoadLeveler environment," on page 29                                                                                                                                                                |
| To learn how to correctly specify the contents of a configuration file                  | <ul style="list-style-type: none"><li>• "Configuration file syntax"</li><li>• "Configuration file keyword descriptions" on page 232</li><li>• "User-defined keywords" on page 279</li><li>• "LoadLeveler variables" on page 280</li></ul> |

---

### Configuration file syntax

The information in both the **LoadL\_config** and the **LoadL\_config.local** files is in the form of a statement. These statements are made up of *keywords* and *values*.

There are three types of configuration file keywords:

- Keywords, described in "Configuration file keyword descriptions" on page 232.
- User-defined variables, described in "User-defined keywords" on page 279.
- LoadLeveler variables, described in "LoadLeveler variables" on page 280.

Configuration file statements take one of the following formats:

*keyword=value*  
*keyword:value*

Statements in the form *keyword=value* are used primarily to customize an environment. Statements in the form *keyword:value* are used by LoadLeveler to characterize the machine and are known as part of the machine description. Every machine in LoadLeveler has its own machine description which is read by the central manager when LoadLeveler is started.

Keywords are *not* case sensitive. This means you can enter them in lower case, upper case, or mixed case.

To continue configuration file statements, use the back-slash character (\).

In the configuration file, comments must be on a separate line from keyword statements.

You can use the following types of constants and operators in the configuration file.

### Numerical and alphabetical constants

Constants may be represented as:

- Boolean expressions

## Configuration file reference

- Signed integers
- Floating point values
- Strings enclosed in double quotes (" ").

### Mathematical operators

You can use the following C operators. The operators are listed in order of precedence. All of these operators are evaluated from left to right:

- !
- \* /
- - +
- < <= > >=
- == !=
- &&
- ||

### 64-bit support for configuration file keywords and expressions

Administrators can assign 64-bit integer values to selected keywords in the configuration file.

#### floating\_resources

Consumable resources associated with the **floating\_resources** keyword may be assigned 64-bit integer values. Fractional and unit specifications are not allowed. The predefined ConsumableCpus, ConsumableMemory, and ConsumableVirtualMemory may not be specified as floating resources.

##### Example:

```
floating_resources = spice2g6(9876543210123) db2_license(1234567890)
```

#### MACHPRIO expression

The LoadLeveler variables Memory, VirtualMemory, FreeRealMemory, Disk, ConsumableMemory, ConsumableVirtualMemory, ConsumableCpus, PagesScanned, PagesFreed may be used in a MACHPRIO expression. They are 64-bit integers and 64-bit arithmetic is used to evaluate them.

##### Example:

```
MACHPRIO: (Memory + FreeRealMemory) - (LoadAvg*1000 + PagesScanned)
```

---

## Configuration file keyword descriptions

This section provides an alphabetical list of the keywords you can use in a LoadLeveler configuration file. It also provides examples of statements that use these keywords.

**ACCT** Turns the accounting function on or off.

##### Syntax:

```
ACCT = flag ...
```

The available flags are:

- |                 |                                                                                                                                                                                                                                                                                |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>A_DETAIL</b> | Enables extended accounting. Using this flag causes LoadLeveler to record detail resource consumption by machine and by events for each job step. This flag also enables the -x flag of the <b>llq</b> command, permitting users to view resource consumption for active jobs. |
| <b>A_RES</b>    | Turns reservation data recording on.                                                                                                                                                                                                                                           |
| <b>A_OFF</b>    | Turns accounting data recording off.                                                                                                                                                                                                                                           |

**A\_ON** Turns accounting data recording on. If specified without the **A\_DETAIL** flag, the following is recorded:

- The total amount of CPU time consumed by the entire job
- The maximum memory consumption of all tasks (or nodes).

**A\_VALIDATE** Turns account validation on.

**Default value:** A\_OFF

**Example:** This example specifies that accounting should be turned on and that extended accounting data should be collected and that the -x flag of the **llq** command be enabled.

ACCT = A\_ON A\_DETAIL

### ACCT\_VALIDATION

Identifies the executable called to perform account validation.

#### Syntax:

ACCT\_VALIDATION = *program*

Where *program* is a validation program.

**Default value:** \$(BIN)/llacctval (the accounting validation program shipped with LoadLeveler.

### ACTION\_ON\_MAX\_REJECT

Specifies the state in which jobs are placed when their rejection count has reached the value of the **MAX\_JOB\_REJECT** keyword. HOLD specifies that jobs are placed in User Hold status; SYSHOLD specifies that jobs are placed in System Hold status; CANCEL specifies that jobs are canceled. When a job is rejected, LoadLeveler sends a mail message stating why the job was rejected.

#### Syntax:

ACTION\_ON\_MAX\_REJECT = HOLD | SYSHOLD | CANCEL

**Default value:** HOLD

### ACTION\_ON\_SWITCH\_TABLE\_ERROR

Points to an administrator supplied program that will be run when **DRAIN\_ON\_SWITCH\_TABLE\_ERROR** is set to **true** and a switch table unload error occurs.

#### Syntax:

ACTION\_ON\_SWITCH\_TABLE\_ERROR = *program*

**Default value:** The default is to not run a program.

### ADMIN\_FILE

Points to the administration file containing user, class, group, machine, and adapter stanzas.

#### Syntax:

ADMIN\_FILE = *directory*

**Default value:** \$(tilde)/admin\_file

## Configuration file reference

### AFS\_GETNEWTOKEN

Specifies a filter that, for example, can be used to refresh an AFS token.

#### Syntax:

`AFS_GETNEWTOKEN = full_path_to_executable`

Where *full\_path\_to\_executable* is an administrator-supplied program that receives the AFS authentication information on standard input and writes the new information to standard output. The filter is run when the job is scheduled to run and can be used to refresh a token which expired when the job was queued.

**Default value:** The default is to not run a program.

### AGGREGATE\_ADAPTERS

Allows an external scheduler to specify per-window adapter usages.

#### Syntax:

`AGGREGATE_ADAPTERS = YES | NO`

When this keyword is set to **YES**, the resources from multiple switch adapters on the same switch network are treated as one aggregate pool available to each job. When this keyword is set to **NO**, the switch adapters are treated individually and a job cannot use resources from multiple adapters on the same network.

Set this keyword to **NO** when you are using an external scheduler; otherwise, set to **YES** (or accept the default).

**Default value:** YES

### ARCH

Indicates the standard architecture of the system. The architecture you specify here must be specified in the same format in the **requirements** and **preferences** statements in job command files. The administrator defines the character string for each architecture.

#### Syntax:

`ARCH = string`

**Default value:** Use the command `llstatus -l` to view the default.

**Example:** To define a machine as an RS/6000, the keyword would look like:

`ARCH = R6000`

### BG\_ALLOW\_LL\_JOBS\_ONLY

Specifies if only jobs submitted through LoadLeveler will be accepted by the Blue Gene job launcher program.

#### Syntax:

`BG_ALLOW_LL_JOBS_ONLY = true | false`

**Default value:** false

### BG\_CACHE\_PARTITIONS

Specifies whether allocated partitions are to be reused for Blue Gene jobs whenever possible.

#### Syntax:

BG\_CACHE\_PARTITIONS = true | false

**Default value:** true

#### BG\_ENABLED

Specifies whether Blue Gene support is enabled.

**Syntax:**

BG\_ENABLED = true | false

If the value of this keyword is **true**, the Central Manager will load the Blue Gene control system libraries and query the state of the Blue Gene system so that jobs of type **bluegene** can be scheduled.

**Default value:** false

#### BG\_MIN\_PARTITION\_SIZE

Specifies the smallest number of compute nodes in a partition.

**Syntax:**

BG\_MIN\_PARTITION\_SIZE = 32 | 128 | 512

The value for this keyword must not be smaller than the minimum partition size supported by the physical Blue Gene hardware. If the number of compute nodes requested in a job is less than the minimum partition size, then LoadLeveler will increase the requested size to the minimum partition size.

**Default value:** 32

**BIN** Defines the directory where LoadLeveler binaries are kept.

**Syntax:**

BIN = \$(RELEASEDIR)/bin

**Default value:** \$(tilde)/bin

#### CENTRAL\_MANAGER\_HEARTBEAT\_INTERVAL

Specifies the amount of time, in seconds, that defines how frequently primary and alternate central manager communicate with each other.

**Syntax:**

CENTRAL\_MANAGER\_HEARTBEAT\_INTERVAL = *number*

**Default value:** The default is 300 seconds or 5 minutes.

#### CENTRAL\_MANAGER\_TIMEOUT

Specifies the number of heartbeat intervals that an alternate central manager will wait before declaring that the primary central manager is not operating.

**Syntax:**

CENTRAL\_MANAGER\_TIMEOUT = *number*

**Default value:** The default is 6.

#### CKPT\_CLEANUP\_INTERVAL

Specifies the interval, in seconds, at which the **schedd** daemon will run the program specified by the **CKPT\_CLEANUP\_PROGRAM** keyword.

**Syntax:**

## Configuration file reference

`CKPT_CLEANUP_INTERVAL = number`

*number* must be a positive integer.

**Default value:** -1

### CKPT\_CLEANUP\_PROGRAM

Identifies an administrator-provided program which is to be run at the interval specified by the **ckpt\_cleanup\_interval** keyword. The intent of this program is to delete old checkpoint files created by jobs running under LoadLeveler during the checkpoint process.

**Syntax:**

`CKPT_CLEANUP_PROGRAM = program`

Where *program* is the fully qualified name of the program to be run. The program must be accessible and executable by LoadLeveler.

A sample program to remove checkpoint files is provided in the `/usr/lpp/LoadL/full/samples/llckpt/rmckptfiles.c` file.

**Default value:** No default value is set.

### CKPT\_EXECUTE\_DIR

Specifies the directory where the job step's executable will be saved for checkpointable jobs. You may specify this keyword in either the configuration file or the job command file; different file permissions are required depending on where this keyword is set. For additional information, see "Planning considerations for checkpointing jobs" on page 129.

**Syntax:**

`CKPT_EXECUTE_DIR = directory`

This directory cannot be the same as the current location of the executable file, or LoadLeveler will not stage the executable. In this case, the user must have execute permission for the current executable file.

**Default value:** By default, the executable of a checkpointable job step is not staged.

### CLASS

Determines whether a machine will accept jobs of a certain job class. For parallel jobs, you must define a class instance for each task you want to run on a node using one of two formats:

- The format, **CLASS = *class\_name* (*count*)**, defines the **CLASS** names using a statement that names the classes and sets the number of tasks for each class in parenthesis.

With this format, the following rules apply:

- Each class can have only one entry
- If a class has more than one entry or there is a syntax error, the entire **CLASS** statement will be ignored
- If the **CLASS** statement has a blank value or is not specified, it will be defaulted to **No\_Class (1)**
- The number of instances for a class specified inside the parenthesis ( ) must be an unsigned integer. If the number specified is 0, it is correct syntactically, but the class will not be defined in LoadLeveler

- If the number of instances for all classes in the **CLASS** statement are 0, the default **No\_Class(1)** will be used
- The format, **CLASS** = { "class1" "class2" "class2" "class2"}, defines the **CLASS** names using a statement that names each class and sets the number of tasks for each class based on the number of times that the class name is used inside the {} operands.

**Note:** With both formats, the class names list is blank delimited.

For a LoadLeveler job to run on a machine, the machine must have a vacancy for the class of that job. If the machine is configured for only one **No\_Class** job and a LoadLeveler job is already running there, then no further LoadLeveler jobs are started on that machine until the current job completes.

You can have a maximum of 1024 characters in the class statement. You cannot use **allclasses** as a class name, since this is a reserved LoadLeveler keyword.

You can assign multiple classes to the same machine by specifying the classes in the LoadLeveler configuration file (called **LoadL\_config**) or in the local configuration file (called **LoadL\_config.local**). The classes, themselves, should be defined in the administration file. See "Setting up a single machine to have multiple job classes" on page 601 and "Defining classes" on page 83 for more information on classes.

### Syntax:

```
CLASS = { "class_name" ... } | {"No_Class"} | class_name (count) ...
```

**Default value:** {"No\_Class"}

## CLIENT\_TIMEOUT

Specifies the maximum time, in seconds, that a daemon waits for a response over TCP/IP from a process. If the waiting time exceeds the specified amount, the daemon tries again to communicate with the process. In general, you should use the default setting unless you are experiencing delays due to an excessively loaded network. If so, you should try increasing this value.

### Syntax:

```
CLIENT_TIMEOUT = number
```

**Default value:** The default is 30 seconds.

## CLUSTER\_METRIC

Indicates the installation exit to be run by the schedd to determine where a remote job is distributed. If a remote job is submitted with a list of clusters or the reserved word **any** and the installation exit is not specified, the remote job is not submitted.

### Syntax:

```
CLUSTER_METRIC = full_pathname_to_executable
```

The installation exit is run with the following parameters passed as input. All parameters are character strings.

- The job ID of the job to be distributed
- The number of clusters in the list of clusters
- A blank-delimited list of clusters to be considered

If the user specifies the reserved word **any** as the **cluster\_list** during job submission, the job is sent to the first outbound schedd defined for the first configured remote cluster. The **CLUSTER\_METRIC** is executed on this machine to determine where the job will be distributed. If this machine is not the **outbound\_hosts** schedd for the assigned cluster, the job will be forwarded to the correct **outbound\_hosts** schedd. If the user specifies a list of clusters as the **cluster\_list** during job submission, the job is sent to the first outbound schedd defined for the first specified remote cluster. The **CLUSTER\_METRIC** is executed on this machine to determine where the job will be distributed. If this machine is not the **outbound\_hosts** schedd for the assigned cluster, the job will be forwarded to the correct **outbound\_hosts** schedd.

**Note:** The list of clusters may contain a single entry of the reserved word **any**, which indicates that the **CLUSTER\_METRIC** installation exit must determine its own list of clusters to select from. This can be all of the clusters available using the data access API or a predetermined list set by the administrator. If **any** is specified in place of a cluster list, the metric will receive a count of 1 followed by the keyword **any**.

The installation exit must write the remote cluster name to which the job is submitted as standard output and exit with a value of 0. An exit value of -1 indicates an error in determining the cluster for distribution and the job is not submitted. Returned cluster names that are not valid also cause the job to be not submitted. STDERR from the exit is written to the schedd log.

LoadLeveler provides a set of sample exits for use in distributing jobs by the following metrics:

- The number of jobs in the idle queue
- The number of jobs in the specified class
- The number of free nodes in the cluster

The installation exit samples are available in the **\${RELEASEDIR}/samples/llcluster** directory.

### **CLUSTER\_REMOTE\_JOB\_FILTER**

Indicates the installation exit to be run by the inbound schedd for each remote job request to filter the user's job command file statements during submission or move job. If the keyword is not specified, no job filtering is done.

#### **Syntax:**

**CLUSTER\_REMOTE\_JOB\_FILTER** = *full\_pathname\_to\_executable*

The installation exit is run with the submitting user's ID. All parameters are character strings.

This installation exit is executed on the **inbound\_hosts** of the local cluster when receiving a job submission or move job request.

The executable specified is called with the submitting user's unfiltered job command file statements as the standard input. The standard output is submitted to LoadLeveler. If the exit returns with a nonzero exit code, the remote job submission or job move will fail. A submit filter can only make changes to LoadLeveler job command file statements.

The data access API can be used by the remote job filter to query the Schedd for the job object received from the sending cluster.

If the local submission filter on the submitting cluster has added or deleted steps from the original user's job command file, the remote job filter must add or delete the same number of steps. The job command file statements returned by the remote job filter must contain the same number of steps as the job object received from the sending cluster.

Changes to the following job command file keyword statements are ignored:

- **executable**
- **environment**
- **image\_size**
- **cluster\_input\_file**
- **cluster\_output\_file**
- **cluster\_list**

The following job command file keyword will have different behavior:

- **initialdir** – If not set by the remote job filter or the submitting user's unfiltered job command file, the default value will remain the current working directory at the time the job was submitted. Access to the **initialdir** will be verified on the cluster selected to run the job. If access to **initialdir** fails, the submission or move job will fail.

To maintain compatibility between the **SUBMIT\_FILTER** and **CLUSTER\_REMOTE\_JOB\_FILTER** programs, the following environment variables are set when either exit is invoked:

- **LOADL\_ACTIVE** – the LoadLeveler version.
- **LOADL\_STEP\_COMMAND** – the location of the job command file passed as input to the program. This job command file only contains LoadLeveler keywords.
- **LOADL\_STEP\_ID** – The job identifier, generated by the submitting LoadLeveler cluster.

**Note:** The environment variable name is **LOADL\_STEP\_ID** although the value it contains is a "job" identifier. This name is used to be compatible with the local job filter interface.

- **LOADL\_STEP\_OWNER** – The owner (UNIX user name) of the job.

### **CLUSTER\_USER\_MAPPER**

Indicates the installation exit to be run by the inbound schedd for each remote job request to determine the user mapping of the cluster. This keyword implies that user mapping is performed. If the keyword is not specified, no user mapping is done.

#### **Syntax:**

**CLUSTER\_USER\_MAPPER** = *full\_pathname\_to\_executable*

The installation exit is run with the following parameters passed as input. All parameters are character strings.

- The user name to be mapped
- The cluster name where the user originated from

## Configuration file reference

This installation exit is executed on the **inbound\_hosts** of the local cluster when receiving a job submission, move job request or remote command.

The installation exit must write the new user name as standard output and exit with a value of 0. An exit value of -1 indicates an error and the job is not submitted. STDERR from the exit is written to the schedd log. An exit value of 1 indicates that the user name returned for this job was **not** mapped.

### COLLECTOR\_DGRAM\_PORT

Specifies the port number used when connecting to a daemon.

#### Syntax:

CM\_COLLECTOR\_PORT = *port number*

**Default value:** The default is 9612.

### COMM

Specifies a local directory where LoadLeveler keeps special files used for UNIX domain sockets for communicating among LoadLeveler daemons running on the same machine. This keyword allows the administrator to choose a different file system other than /tmp for these files. If you change the COMM option you must stop and then restart LoadLeveler using the **llctl** command.

#### Syntax:

COMM = *local directory*

**Default value:** The default location for the files is /tmp.

### CONTINUE

Determines whether suspended jobs should continue execution.

#### Syntax:

CONTINUE: *expression that evaluates to T or F (true or false)*

When **T**, suspended LoadLeveler jobs resume execution on the machine.

**Default value:** No default value is set.

For information about time-related variables that you may use for this keyword, see “Variables to use for setting times” on page 285.

### CUSTOM\_METRIC

Specifies a machine’s relative priority to run jobs.

#### Syntax:

CUSTOM\_METRIC = *number*

This is an arbitrary number which you can use in the MACHPRIO expression. Negative values are not allowed.

**Default value:** If you specify neither **CUSTOM\_METRIC** nor **CUSTOM\_METRIC\_COMMAND**, **CUSTOM\_METRIC = 1** is assumed. For more information, see “Setting negotiator characteristics and policies” on page 36.

For more information related to using this keyword, see “Defining a LoadLeveler cluster” on page 35.

**CUSTOM\_METRIC\_COMMAND**

Specifies an executable and any required arguments. The exit code of this command is assigned to **CUSTOM\_METRIC**. If this command does not exit normally, **CUSTOM\_METRIC** is assigned a value of 1. This command is forked every (**POLLING\_FREQUENCY** \* **POLLS\_PER\_UPDATE**) period.

**Syntax:**

**CUSTOM\_METRIC\_COMMAND** = *command*

**Default value:** No default is set; LoadLeveler does not run any command to determine **CUSTOM\_METRIC**.

**DCE\_ADMIN\_GROUP**

Specifies the DCE group containing the DCE IDs of those users who will have administrator authority for the current cluster.

**Restriction:** DCE security is not supported by LoadLeveler for Linux. This keyword is ignored.

**Syntax:**

**DCE\_ADMIN\_GROUP** = *group name*

**Default value:** No default value is set.

For more information related to using this keyword, see “Configuring LoadLeveler to use DCE security services” on page 47.

**DCE\_AUTHENTICATION\_PAIR**

Specifies a pair of installation supplied programs that are used to authenticate DCE security credentials.

**Restriction:** DCE security is not supported by LoadLeveler for Linux.

**Syntax:**

**DCE\_AUTHENTICATION\_PAIR** = *program1, program2*

Where *program1* and *program2* are LoadLeveler- or installation-supplied programs that are used to authenticate DCE security credentials. *program1* obtains a handle (an opaque credentials object), at the time the job is submitted, which is used to authenticate to DCE. *program2* uses the handle obtained by *program1* to authenticate to DCE before starting the job on the executing machines.

**Default value:** See “Handling DCE security credentials” on page 68 for information about defaults.

**DCE\_ENABLEMENT**

Activates the exploitation of DCE security.

**Notes:**

1. DCE security is not supported by LoadLeveler for Linux.
2. This keyword is mutually exclusive with the **SEC\_ENABLEMENT** keyword. Both keywords cannot be configured at the same time.

**Syntax:**

**DCE\_ENABLEMENT** = true | false

**Default value:** false

For more information related to using this keyword, see “Configuring LoadLeveler to use DCE security services” on page 47.

### DCE\_SERVICES\_GROUP

Specifies the DCE group containing all of the principal names of the LoadLeveler daemons that are authorized to run in the current cluster.

**Restriction:** DCE security is not supported by LoadLeveler for Linux. This keyword is ignored

**Syntax:**

DCE\_SERVICES\_GROUP = *group name*

**Default value:** No default value is set.

For more information related to using this keyword, see “Configuring LoadLeveler to use DCE security services” on page 47.

### DEFAULT\_PREEMPT\_METHOD

Specifies the default preemption method for LoadLeveler to use when a preempt method is not specified in a PREEMPT\_CLASS statement or in the **llpreempt** command. LoadLeveler also uses this default preemption method to preempt job steps that are running on reserved machines when a reservation period begins.

**Restrictions:**

- This keyword is valid only for the backfill scheduler.
- LoadLeveler for Linux does not support the suspend method of preemption, which is the default method. If you want to preempt jobs running on LoadLeveler for Linux, you must use this keyword to specify a method other than suspend.

**Syntax:**

DEFAULT\_PREEMPT\_METHOD = rm | sh | su | vc | uh

Valid values are:

- |           |                                                                                                                                                                                                                                                                                            |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>rm</b> | LoadLeveler preempts the jobs and removes them from the job queue. To rerun the job, the user must resubmit the job to LoadLeveler.                                                                                                                                                        |
| <b>sh</b> | LoadLeveler ends the jobs and puts them into System Hold state. They remain in that state on the job queue until an administrator releases them. After being released, the jobs go into Idle state and will be rescheduled to run as soon as resources for the job are available.          |
| <b>su</b> | LoadLeveler suspends the jobs and puts them in Preempted state. They remain in that state on the job queue until the preempting job has terminated, and resources are available to resume the preempted job on the same set of nodes. To use this value, process tracking must be enabled. |
| <b>vc</b> | LoadLeveler ends the jobs and puts them in Vacate state. They remain in that state on the job queue and will be rescheduled to run as soon as resources for the job are available.                                                                                                         |
| <b>uh</b> | LoadLeveler ends the jobs and puts them into User Hold state. They remain in that state on the job queue until an administrator releases them. After being released, the jobs go into Idle state and will be rescheduled to run as soon as resources for the job are available.            |

**Default value:** su (suspend method)

For more information related to using this keyword, see “Steps for configuring a scheduler to preempt jobs” on page 119.

#### **DRAIN\_ON\_SWITCH\_TABLE\_ERROR**

Specifies whether the **startd** should be drained when the switch table fails to unload. This will flag the administrator that intervention may be required to unload the switch table. When **DRAIN\_ON\_SWITCH\_TABLE\_ERROR** is set to true, the **startd** will be drained when the switch table fails to unload.

##### **Syntax:**

**DRAIN\_ON\_SWITCH\_TABLE\_ERROR** = true | false

**Default value:** false

#### **ENFORCE\_RESOURCE\_MEMORY**

Specifies whether the AIX Workload Manager is configured to limit, as precisely as possible, the real memory usage of a WLM class. For this keyword to be valid, ConsumableMemory must be set through the **ENFORCE\_RESOURCE\_USAGE** keyword.

##### **Syntax:**

**ENFORCE\_RESOURCE\_MEMORY** = true | false

**Default value:** false

#### **ENFORCE\_RESOURCE\_POLICY**

Specifies what type of resource entitlements will be assigned to the AIX Workload Manager classes. If the value specified is **shares**, it means a share value is assigned to the class based on the job step’s requested resources (one unit of resource equals one share). This is the default policy. If the value specified is **soft**, it means a percentage value is assigned to the class based on the job step’s requested resources and the total machine resources. This percentage can be exceeded if there is no contention for the resource. If the value specified is **hard**, it means a percentage value is assigned to the class based on the job step’s requested resources and the total machine resources. This percentage cannot be exceeded regardless of the contention for the resource. If desired, this keyword can be used in the LoadL\_config.local file to set up a different policy for each machine. The **ENFORCE\_RESOURCE\_USAGE** keyword must be set for this keyword to be valid.

##### **Syntax:**

**ENFORCE\_RESOURCE\_POLICY** = hard |soft | shares

**Default value:** shares

#### **ENFORCE\_RESOURCE\_SUBMISSION = true | false**

Indicates whether jobs submitted should be checked for the **resources** keyword. If the value specified is **true**, LoadLeveler will check all jobs at submission time for the **resources** keyword. The job command file **resources** keyword needs to have at least the resources specified as the **ENFORCE\_RESOURCE\_USAGE** keyword for the job to be submitted successfully.

## Configuration file reference

If the value specified is **false**, no checking will be done and jobs submitted without the **resources** keyword will not have resources enforced. In this instance, those jobs may interfere with other jobs whose resources are enforced.

### Syntax:

ENFORCE\_RESOURCE\_SUBMISSION = true | false

**Default value:** false

## ENFORCE\_RESOURCE\_USAGE

Specifies that the AIX Workload Manager should be used to enforce CPU or real memory resources. This keyword accepts the predefined resources **ConsumableCpus** and **ConsumableMemory**. Either memory or CPUs or both can be enforced but the resources must also be specified on the **SCHEDULE\_BY\_RESOURCES** keyword. If **deactivate** is specified, LoadLeveler will deactivate AIX Workload Manager on all the nodes in the LoadLeveler cluster.

**Restriction:** WLM enforcement is ignored by LoadLeveler for Linux.

### Syntax:

ENFORCE\_RESOURCE\_USAGE = **ConsumableCpus ConsumableMemory** | **deactivate**

## EXECUTE

Specifies the local directory to store the executables of jobs submitted by other machines.

### Syntax:

EXECUTE = *local directory*/**execute**

**Default value:** \$(tilde)/execute

## FEATURE

Specifies an optional characteristic to use to match jobs with machines. You can specify unique characteristics for any machine using this keyword. When evaluating job submissions, LoadLeveler compares any required features specified in the job command file to those specified using this keyword. You can have a maximum of 1024 characters in the feature statement.

### Syntax:

Feature = {"string" ...}

**Default value:** No default value is set.

**Example:** If a machine has licenses for installed products ABC and XYZ, in the local configuration file you can enter the following:

Feature = {"abc" "xyz"}

When submitting a job that requires both of these products, you should enter the following in your job command file:

requirements = (Feature == "abc") && (Feature == "xyz")

## FLOATING\_RESOURCES

Specifies which consumable resources are available collectively on all of the machines in the LoadLeveler cluster. The count for each resource must be an integer greater than or equal to zero, and each resource can only be specified once in the list. Any resource specified for this keyword that is

not already listed in the **SCHEDULE\_BY\_RESOURCES** keyword will not affect job scheduling. If any resource is specified incorrectly with the **FLOATING\_RESOURCES** keyword, then all floating resources will be ignored. **ConsumableCpus**, **ConsumableMemory**, and **ConsumableVirtualMemory** may not be specified as floating resources.

**Syntax:**

`FLOATING_RESOURCES = name(count) name(count) ... name(count)`

**Default value:** No default value is set.

## FS\_INTERVAL

Defines the number of minutes used as the interval for checking free file system space or inodes. If your file system receives many log messages or copies large executables to the LoadLeveler spool, the file system will fill up quicker and you should perform file size checking more frequently by setting the interval to a smaller value. LoadLeveler will not check the file system if the value of **FS\_INTERVAL** is:

- Set to zero
- Set to a negative integer

**Syntax:**

`FS_INTERVAL = minutes`

**Default value:** If **FS\_INTERVAL** is not specified but any of the other file-system keywords (**FS\_NOTIFY**, **FS\_SUSPEND**, **FS\_TERMINATE**, **INODE\_NOTIFY**, **INODE\_SUSPEND**, **INODE\_TERMINATE**) are specified, the **FS\_INTERVAL** value will default to 5 and the file system will be checked. If no file-system or inode keywords are set, LoadLeveler does not monitor file systems at all.

For more information related to using this keyword, see “Setting up file system monitoring” on page 44.

## FS\_NOTIFY

Defines the lower and upper amounts, in bytes, of free file-system space at which LoadLeveler is to notify the administrator:

- If the amount of free space becomes less than the lower threshold value, LoadLeveler sends a mail message to the administrator indicating that logging problems may occur.
- When the amount of free space becomes greater than the upper threshold value, LoadLeveler sends a mail message to the administrator indicating that problem has been resolved.

**Syntax:**

`FS_NOTIFY = lower threshold, upper threshold`

Specify space in bytes with the unit B. A metric prefix such as K, M or G may precede the B. The valid range for both the lower and upper thresholds are -1B and all positive integers. If the value is set to -1, the transition across the threshold is not checked.

**Default value:** In bytes: 1KB, -1B

For more information related to using this keyword, see “Setting up file system monitoring” on page 44.

### FS\_SUSPEND

Defines the lower and upper amounts, in bytes, of free file system space at which LoadLeveler drains and resumes the schedd and startd daemons running on a node.

- If the amount of free space becomes less than the lower threshold value, then LoadLeveler drains the schedd and the startd daemons if they are running on a node. When this happens, logging is turned off and mail notification is sent to the administrator.
- When the amount of free space becomes greater than the upper threshold value, LoadLeveler signals the schedd and the startd daemons to resume. When this happens, logging is turned on and mail notification is sent to the administrator.

#### Syntax:

`FS_SUSPEND = lower threshold, upper threshold`

Specify space in bytes with the unit B. A metric prefix such as K, M or G may precede the B. The valid range for both the lower and upper thresholds are -1B and all positive integers. If the value is set to -1, the transition across the threshold is not checked.

**Default value:** In bytes: -1B, -1B

For more information related to using this keyword, see “Setting up file system monitoring” on page 44.

### FS\_TERMINATE

Defines the lower and upper amounts, in bytes, of free file system space at which LoadLeveler is terminated. This keyword sends the SIGTERM signal to the Master daemon which then terminates all LoadLeveler daemons running on the node.

- If the amount of free space becomes less than the lower threshold value, all LoadLeveler daemons are terminated.
- An upper threshold value is required for this keyword. However, since LoadLeveler has been terminated at the lower threshold, no action occurs.

#### Syntax:

`FS_TERMINATE = lower threshold, upper threshold`

Specify space in bytes with the unit B. A metric prefix such as K, M or G may precede the B. The valid range for the lower threshold is -1B and all positive integers. If the value is set to -1, the transition across the threshold is not checked.

**Default value:** In bytes: -1B, -1B

For more information related to using this keyword, see “Setting up file system monitoring” on page 44.

### GLOBAL\_HISTORY

Identifies the directory that will contain the global history files produced by `llacctmrg` command when no directory is specified as a command argument.

#### Syntax:

`GLOBAL_HISTORY = directory`

**Default value:** The default value is \$(SPOOL) (the local spool directory).

For more information related to using this keyword, see “Collecting the accounting information and storing it into files” on page 60.

### GSMONITOR

Location of the gsmonitor executable (LoadL\_GSmonitor).

**Restriction:** This keyword is ignored by LoadLeveler for Linux.

**Syntax:**

GSMONITOR = *directory*

**Default value:** \$(BIN)/LoadL\_GSmonitor

### GSMONITOR\_COREDUMP\_DIR

Local directory for storing LoadL\_GSmonitor core dump files.

**Restriction:** This keyword is ignored by LoadLeveler for Linux.

**Syntax:**

GSMONITOR\_COREDUMP\_DIR = *directory*

**Default value:** The `/tmp` directory.

For more information related to using this keyword, see “Specifying file and directory locations” on page 38.

### GSMONITOR\_DOMAIN

Specifies the type of domain, PSSP or peer, on which the GSMONITOR daemon will execute.

**Restriction:** This keyword is ignored by LoadLeveler for Linux.

**Syntax:**

GSMONITOR\_DOMAIN = PEER | PSSP

**Default value:** No default value is set.

For more information related to using this keyword, see “The gsmonitor daemon” on page 13.

### GSMONITOR\_RUNS\_HERE

Specifies whether the gsmonitor daemon will run on the host.

**Restriction:** This keyword is ignored by LoadLeveler for Linux.

**Syntax:**

GSMONITOR\_RUNS\_HERE = TRUE | FALSE

**Default value:** FALSE

For more information related to using this keyword, see “The gsmonitor daemon” on page 13.

### HISTORY

Defines the path name where a file containing the history of local LoadLeveler jobs is kept.

**Syntax:**

HISTORY = *directory*

**Default value:** \$(SPOOL)/history

For more information related to using this keyword, see “Collecting the accounting information and storing it into files” on page 60.

### HISTORY\_PERMISSION

Specifies the owner, group, and world permissions of the history file associated with a LoadL\_schedd daemon.

**Syntax:**

HISTORY\_PERMISSION = *permissions* | rw-rw----

*permissions* must be a string with a length of nine characters and consisting of the characters, **r**, **w**, **x**, or **-**.

**Default value:** The default settings are 660 (**rw-rw----**). LoadL\_schedd will use the default setting if the specified permission are less than **rw-----**.

**Example:** A specification such as HISTORY\_PERMISSION = rw-rw-r-- will result in permission settings of 664.

### INODE\_NOTIFY

Defines the lower and upper amounts, in inodes, of free file-system inodes at which LoadLeveler is to notify the administrator:

- If the number of free inodes becomes less than the lower threshold value, LoadLeveler sends a mail message to the administrator indicating that logging problems may occur.
- When the number of free inodes becomes greater than the upper threshold value, LoadLeveler sends a mail message to the administrator indicating that problem has been resolved.

**Syntax:**

INODE\_NOTIFY = *lower threshold, upper threshold*

The valid range for both the lower and upper thresholds are -1 and all positive integers. If the value is set to -1, the transition across the threshold is not checked.

**Default value:** In inodes: 1000, -1

For more information related to using this keyword, see “Setting up file system monitoring” on page 44.

### INODE\_SUSPEND

Defines the lower and upper amounts, in inodes, of free file system inodes at which LoadLeveler drains and resumes the schedd and startd daemons running on a node.

- If the number of free inodes becomes less than the lower threshold value, then LoadLeveler drains the schedd and the startd daemons if they are running on a node. When this happens, logging is turned off and mail notification is sent to the administrator.
- When the number of free inodes becomes greater than the upper threshold value, LoadLeveler signals the schedd and the startd daemons to resume. When this happens, logging is turned on and mail notification is sent to the administrator.

**Syntax:**

INODE\_SUSPEND = *lower threshold, upper threshold*

The valid range for both the lower and upper thresholds are -1 and all positive integers. If the value is set to -1, the transition across the threshold is not checked.

**Default value:** In inodes: -1, -1

For more information related to using this keyword, see “Setting up file system monitoring” on page 44.

### INODE\_TERMINATE

Defines the lower and upper amounts, in inodes, of free file system inodes at which LoadLeveler is terminated. This keyword sends the SIGTERM signal to the Master daemon which then terminates all LoadLeveler daemons running on the node.

- If the number of free inodes becomes less than the lower threshold value, all LoadLeveler daemons are terminated.
- An upper threshold value is required for this keyword. However, since LoadLeveler has been terminated at the lower threshold, no action occurs.

#### Syntax:

INODE\_TERMINATE = *lower threshold, upper threshold*

The valid range for the lower threshold is -1 and all positive integers. If the value is set to -1, the transition across the threshold is not checked.

**Default value:** In inodes: -1, -1

For more information related to using this keyword, see “Setting up file system monitoring” on page 44.

### JOB\_ACCT\_Q\_POLICY

Specifies the amount of time, in seconds, that determines how often the startd daemon updates the schedd daemon with accounting data of running jobs. This controls the accuracy of the **llq -x** command.

#### Syntax:

JOB\_ACCT\_Q\_POLICY = *number*

**Default value:** 300 seconds

For more information related to using this keyword, see “Gathering job accounting data” on page 57.

### JOB\_EPILOG

Pathname of the epilog program.

#### Syntax:

JOB\_EPILOG = *program name*

**Default value:** No default value is set.

For more information related to using this keyword, see “Writing prolog and epilog programs” on page 70.

### JOB\_LIMIT\_POLICY

Specifies the amount of time, in seconds, that LoadLeveler checks to see if **job\_cpu\_limit** has been exceeded. The smaller of **JOB\_LIMIT\_POLICY**

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and **JOB\_ACCT\_Q\_POLICY** is used to control how often the **startd** daemon collects resource consumption data on running jobs, and how often the **job\_cpu\_limit** is checked.

**Syntax:**

**JOB\_LIMIT\_POLICY** = *number*

**Default value:** The default for **JOB\_LIMIT\_POLICY** is **POLLING\_FREQUENCY** multiplied by **POLLS\_PER\_UPDATE**.

### **JOB\_PROLOG**

Pathname of the prolog program.

**Syntax:**

**JOB\_PROLOG** = *program name*

**Default value:** No default value is set.

For more information related to using this keyword, see “Writing prolog and epilog programs” on page 70.

### **JOB\_USER\_EPILOG**

Pathname of the user epilog program.

**Syntax:**

**JOB\_USER\_EPILOG** = *program name*

**Default value:** No default value is set.

For more information related to using this keyword, see “Writing prolog and epilog programs” on page 70.

### **JOB\_USER\_PROLOG**

Pathname of the user prolog program.

**Syntax:**

**JOB\_USER\_PROLOG** = *program name*

**Default value:** No default value is set.

For more information related to using this keyword, see “Writing prolog and epilog programs” on page 70.

### **KBDD**

Location of kbdd executable (LoadL\_Kbdd).

**Syntax:**

**KBDD** = *directory*

**Default value:** \$(BIN)/LoadL\_kbdd

### **KBDD\_COREDUMP\_DIR**

Local directory for storing LoadL\_kbdd daemon core dump files.

**Syntax:**

**KBDD\_COREDUMP\_DIR** = *directory*

**Default value:** The **/tmp** directory.

For more information related to using this keyword, see “Specifying file and directory locations” on page 38.

**KILL** Determines whether or not vacated jobs should be sent the SIGKILL signal and replaced in the queue. It is used to remove a job that is taking too long to vacate.

**Syntax:**

*KILL: expression that evaluates to T or F (true or false)*

When **T**, vacated LoadLeveler jobs are removed from the machine with no attempt to take checkpoints.

For information about time-related variables that you may use for this keyword, see “Variables to use for setting times” on page 285.

**LIB** Defines the directory where LoadLeveler libraries are kept.

**Syntax:**

*LIB = directory*

**Default value:** \$(RELEASEDIR)/lib

**LOADL\_ADMIN**

List of LoadLeveler administrators.

**Syntax:**

*LOADL\_ADMIN = list of user names*

Where *list of user names* is a blank-delimited list of those individuals who will have administrative authority. These users are able to invoke the administrator-only commands such as **llctl**, **llfavorjob**, and **llfavoruser**. These administrators can also invoke the administrator-only GUI functions. For more information, see Chapter 6, “Using LoadLeveler’s GUI to perform administrator tasks,” on page 147.

**Default value:** No default value is set, which means no one has administrator authority until this keyword is defined with one or more user names.

**Example:** To grant administrative authority to users bob and mary, enter the following in the configuration file:

`LOADL_ADMIN = bob mary`

For more information related to using this keyword, see “Defining LoadLeveler administrators” on page 34.

**LOCAL\_CONFIG**

Specifies the path name of the optional local configuration file containing information specific to a node in the LoadLeveler network.

**Syntax:**

*LOCAL\_CONFIG = directory*

**Default value:** No default value is set.

**Examples:**

- If you are using a distributed file system like NFS, some examples are:

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```
LOCAL_CONFIG = $(tilde)/$(host).LoadL_config.local
LOCAL_CONFIG = $(tilde)/LoadL_config.$(host).$(domain)
LOCAL_CONFIG = $(tilde)/LoadL_config.local.$(hostname)
```

See “LoadLeveler variables” on page 280 for information about the **tilde**, **host**, and **domain** variables.

- If you are using a local file system, an example is:

```
LOCAL_CONFIG = /var/LoadL/LoadL_config.local
```

**LOG** Defines the local directory to store log files. It is not necessary to keep all the log files created by the various LoadLeveler daemons and programs in one directory, but you will probably find it convenient to do so.

**Syntax:**

```
LOG = local directory/log
```

**Default value:** \$(tilde)/log

**MACHINE\_AUTHENTICATE**

Specifies whether machine validation is performed. When set to **true**, LoadLeveler only accepts connections from machines specified in the administration file. When set to **false**, LoadLeveler accepts connections from any machine.

When set to **true**, every communication between LoadLeveler processes will verify that the sending process is running on a machine which is identified via a machine stanza in the administration file. The validation is done by capturing the address of the sending machine when the **accept** function call is issued to accept a connection. The **gethostbyaddr** function is called to translate the address to a name, and the name is matched with the list derived from the administration file.

**Note:** **MACHINE\_AUTHENTICATE** must be set as “true” for Gang scheduling to work. For more information see “Planning to preempt jobs” on page 116.

**Syntax:**

```
MACHINE_AUTHENTICATE = true | false
```

**Default value:** false

For more information related to using this keyword, see “Defining a LoadLeveler cluster” on page 35.

**MACHINE\_UPDATE\_INTERVAL**

Specifies the time, in seconds, during which machines must report to the central manager.

**Syntax:**

```
MACHINE_UPDATE_INTERVAL = number
```

Where *number* specifies the time period, in seconds, during which machines must report to the central manager. Machines that do not report in this number of seconds are considered *down*. *number* must be a numerical value and cannot be an arithmetic expression.

**Default value:** The default is 300 seconds.

For more information related to using this keyword, see “Setting negotiator characteristics and policies” on page 36.

### MACHPRIO

Machine priority expression.

#### Syntax:

`MACHPRIO = expression`

You can use the following LoadLeveler variables in the **MACHPRIO** expression:

- **LoadAvg**
- **Connectivity**
- **Cpus**
- **Speed**
- **Memory**
- **VirtualMemory**
- **Disk**
- **CustomMetric**
- **MasterMachPriority**
- **ConsumableCpus**
- **ConsumableMemory**
- **ConsumableVirtualMemory**
- **PagesFreed**
- **PagesScanned**
- **FreeRealMemory**

For detailed descriptions of these variables, see “LoadLeveler variables” on page 280.

**Default value:** (0 - LoadAvg)

#### Examples:

- Example 1

This example orders machines by the Berkeley one-minute load average.

`MACHPRIO : 0 - (LoadAvg)`

Therefore, if **LoadAvg** equals .7, this example would read:

`MACHPRIO : 0 - (.7)`

The **MACHPRIO** would evaluate to -.7.

- Example 2

This example orders machines by the Berkeley one-minute load average normalized for machine speed:

`MACHPRIO : 0 - (1000 * (LoadAvg / (Cpus * Speed)))`

Therefore, if **LoadAvg** equals .7, **Cpus** equals 1, and **Speed** equals 2, this example would read:

`MACHPRIO : 0 - (1000 * (.7 / (1 * 2)))`

This example further evaluates to:

`MACHPRIO : 0 - (350)`

The **MACHPRIO** would evaluate to -350.

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Notice that if the speed of the machine were increased to 3, the equation would read:

**MACHPRIO** : 0 - (1000 \* (.7 / (1 \* 3)))

The **MACHPRIO** would evaluate to approximately -233. Therefore, as the speed of the machine increases, the **MACHPRIO** also increases.

- **Example 3**

This example orders machines accounting for real memory and available swap space (remembering that Memory is in Mbytes and VirtualMemory is in Kbytes):

**MACHPRIO** : 0 - (10000 \* (LoadAvg / (Cpus \* Speed))) +  
(10 \* Memory) + (VirtualMemory / 1000)

- **Example 4**

This example sets a relative machine priority based on the value of the **CUSTOM\_METRIC** keyword.

**MACHPRIO** : CustomMetric

To do this, you must specify a value for the **CUSTOM\_METRIC** keyword or the **CUSTOM\_METRIC\_COMMAND** keyword in either the **LoadL\_config.local** file of a machine or in the global **LoadL\_config** file. To assign the same relative priority to all machines, specify the **CUSTOM\_METRIC** keyword in the global configuration file. For example:

**CUSTOM\_METRIC** = 5

You can override this value for an individual machine by specifying a different value in that machine's **LoadL\_config.local** file.

- **Example 5**

This example gives master nodes the highest priority:

**MACHPRIO** : (MasterMachPriority \* 10000)

- **Example 6**

This example gives nodes the with highest percentage of switch adapters with connectivity the highest priority:

**MACHPRIO** : Connectivity

For more information related to using this keyword, see "Setting negotiator characteristics and policies" on page 36.

**MAIL** Name of a local mail program used to override default mail notification.

**Syntax:**

**MAIL** = *program name*

**Default value:** No default value is set.

For more information related to using this keyword, see "Using your own mail program" on page 75.

**MASTER**

Location of the master executable (LoadL\_master).

**Syntax:**

**MASTER** = *directory*

**Default value:** \$(BIN)/LoadL\_master

For more information related to using this keyword, see “How LoadLeveler daemons process jobs” on page 7.

### MASTER\_COREDUMP\_DIR

Local directory for storing LoadL\_master core dump files.

#### Syntax:

MASTER\_COREDUMP\_DIR = *directory*

**Default value:** The `/tmp` directory.

For more information related to using this keyword, see “Specifying file and directory locations” on page 38.

### MASTER\_DGRAM\_PORT

The port number used when connecting to the daemon.

#### Syntax:

MASTER\_DGRAM\_PORT = *port number*

**Default value:** The default is 9617.

For more information related to using this keyword, see “Defining network characteristics” on page 38.

### MASTER\_STREAM\_PORT

Specifies the port number to be used when connecting to the daemon.

#### Syntax:

MASTER\_STREAM\_PORT = *port number*

**Default value:** The default is 9616.

For more information related to using this keyword, see “Defining network characteristics” on page 38.

### MAX\_CKPT\_INTERVAL

The maximum number of seconds between checkpoints for running jobs.

#### Syntax:

MAX\_CKPT\_INTERVAL = *number*

**Default value:** 7200 (2 hours)

For more information related to using this keyword, see “Checkpointing jobs” on page 128.

### MAX\_JOB\_REJECT

Determines the number of times a job is rejected before it is canceled or put in User Hold or System Hold status.

#### Syntax:

MAX\_JOB\_REJECT = *number*

*number* must be a numerical value and cannot be an arithmetic expression. **MAX\_JOB\_REJECT** may be set to unlimited rejects by specifying a value of -1.

**Default value:** The default value is 0, which indicates a rejected job will immediately be canceled or placed on hold.

For related information, see the **NEGOTIATOR\_REJECT\_DEFER** keyword.

### **MAX\_RESERVATIONS**

Specifies the maximum number of reservations that this LoadLeveler cluster may have. Only reservations in waiting and in use are counted toward this limit; LoadLeveler does not count reservations that already have ended or are in the process of being canceled.

#### **Syntax:**

**MAX\_RESERVATIONS** = *number*

The maximum value for *number* is 10; if you specify a greater value, LoadLeveler will use 10.

**Default value:** 10

### **MAX\_STARTERS**

Specifies the maximum number of tasks that can run simultaneously on a machine. In this case, a task can be a serial job step or a parallel task.

**MAX\_STARTERS** defines the number of initiators on the machine (the number of tasks that can be initiated from a **startd**).

#### **Syntax:**

**MAX\_STARTERS** = *number*

**Default value:** If this keyword is not specified, the default is the number of elements in the **Class** statement.

For more information related to using this keyword, see “Specifying how many jobs a machine can run” on page 45.

### **MIN\_CKPT\_INTERVAL**

The minimum number of seconds between checkpoints for running jobs.

#### **Syntax:**

**MIN\_CKPT\_INTERVAL** = *number*

**Default value:** 900 (15 minutes)

For more information related to using this keyword, see “Checkpointing jobs” on page 128.

### **NEGOTIATOR**

Location of the negotiator executable (LoadL\_negotiator).

#### **Syntax:**

**NEGOTIATOR** = *directory*

**Default value:** \$(BIN)/LoadL\_negotiator

For more information related to using this keyword, see “How LoadLeveler daemons process jobs” on page 7.

### **NEGOTIATOR\_COREDUMP\_DIR**

Local directory for storing LoadL\_negotiator core dump files.

#### **Syntax:**

**NEGOTIATOR\_COREDUMP\_DIR** = *directory*

**Default value:** The /tmp directory.

For more information related to using this keyword, see “Specifying file and directory locations” on page 38.

### NEGOTIATOR\_CYCLE\_DELAY

Specifies the minimum time, in seconds, the negotiator delays between periods when it attempts to schedule jobs. This time is used by the negotiator daemon to respond to queries, reorder job queues, collect information about changes in the states of jobs, and so on. Delaying the scheduling of jobs might improve the overall performance of the negotiator by preventing it from spending excessive time attempting to schedule jobs.

#### Syntax:

NEGOTIATOR\_CYCLE\_DELAY = *number*

*number* must be a numerical value and cannot be an arithmetic expression.

**Default value:** The default is 0 seconds

### NEGOTIATOR\_CYCLE\_TIME\_LIMIT

Specifies the maximum amount of time, in seconds, that LoadLeveler will allow the negotiator to spend in one cycle trying to schedule jobs. The negotiator cycle will end, after the specified number of seconds, even if there are additional jobs waiting for dispatch. Jobs waiting for dispatch will be considered at the next negotiator cycle. The **NEGOTIATOR\_CYCLE\_TIME\_LIMIT** keyword applies only to the backfill and gang schedulers.

#### Syntax:

NEGOTIATOR\_CYCLE\_TIME\_LIMIT = *number*

Where *number* must be a positive integer or zero and cannot be an arithmetic expression.

**Default value:** If the keyword value is not specified or a value of zero is used, the negotiator cycle will be unlimited.

### NEGOTIATOR\_INTERVAL

The time interval, in seconds, at which the negotiator daemon updates the status of jobs in the LoadLeveler cluster and negotiates with machines that are available to run jobs.

#### Syntax:

NEGOTIATOR\_INTERVAL = *number*

Where *number* specifies the interval, in seconds, at which the negotiator daemon performs a “negotiation loop” during which it attempts to assign available machines to waiting jobs. A negotiation loop also occurs whenever job states or machine states change. *number* must be a numerical value and cannot be an arithmetic expression.

When this keyword is set to zero, the central manager’s automatic scheduling activity is been disabled, and LoadLeveler will not attempt to schedule any jobs unless instructed to do so through the **llrunscheduler** command or **ll\_run\_scheduler** subroutine.

**Default value:** The default is 30 seconds.

For more information related to using this keyword, see “Controlling the central manager scheduling cycle” on page 66.

### NEGOTIATOR\_LOADAVG\_INCREMENT

Specifies the value the negotiator adds to the startd machine’s load average whenever a job in the Pending state is queued on that machine. This value is used to compensate for the increased load caused by starting another job.

#### Syntax:

```
NEGOTIATOR_LOADAVG_INCREMENT = number
```

*number* must be a numerical value and cannot be an arithmetic expression.

**Default value:** The default value is .5

### NEGOTIATOR\_PARALLEL\_DEFER

Specifies the amount of time, in seconds, that defines how long a job stays out of the queue after it fails to get the correct number of processors. This keyword applies only to the default LoadLeveler scheduler. This keyword must be greater than the **NEGOTIATOR\_INTERVAL** value; if it is not, the default is used.

#### Syntax:

```
NEGOTIATOR_PARALLEL_DEFER = number
```

*number* must be a numerical value and cannot be an arithmetic expression.

**Default value:** The default is **NEGOTIATOR\_INTERVAL** multiplied by 5.

### NEGOTIATOR\_PARALLEL\_HOLD

Specifies the amount of time, in seconds, that defines how long a job is given to accumulate processors. This keyword applies only to the default LoadLeveler scheduler. This keyword must be greater than the **NEGOTIATOR\_INTERVAL** value; if it is not, the default is used.

#### Syntax:

```
NEGOTIATOR_PARALLEL_HOLD = number
```

*number* must be a numerical value and cannot be an arithmetic expression.

**Default value:** The default is **NEGOTIATOR\_INTERVAL** multiplied by 5.

### NEGOTIATOR\_RECALCULATE\_SYSPRIO\_INTERVAL

Specifies the amount of time, in seconds, between calculation of the **SYSPRIO** values for waiting jobs. Recalculating the priority can be CPU-intensive; specifying low values for the **NEGOTIATOR\_RECALCULATE\_SYSPRIO\_INTERVAL** keyword may lead to a heavy CPU load on the **negotiator** if a large number of jobs are running or waiting for resources. A value of 0 means the **SYSPRIO** values are not recalculated.

You can use this keyword to base the order in which jobs are run on the current number of running, queued, or total jobs for a user or a group.

#### Syntax:

```
NEGOTIATOR_RECALCULATE_SYSPRIO_INTERVAL = number
```

*number* must be a numerical value and cannot be an arithmetic expression.

**Default value:** The default is 120 seconds.

#### NEGOTIATOR\_REJECT\_DEFER

Specifies the amount of time in seconds the negotiator waits before it considers scheduling a job to a machine that recently rejected the job.

**Syntax:**

NEGOTIATOR\_REJECT\_DEFER = *number*

*number* must be a numerical value and cannot be an arithmetic expression.

**Default value:** The default is 120 seconds.

For related information, see the **MAX\_JOB\_REJECT** keyword.

#### NEGOTIATOR\_REMOVE\_COMPLETED

Specifies the amount of time, in seconds, that you want the negotiator to keep information regarding completed and removed jobs so that you can query this information using the **llq** command.

**Syntax:**

NEGOTIATOR\_REMOVE\_COMPLETED = *number*

*number* must be a numerical value and cannot be an arithmetic expression.

**Default value:** The default is 0 seconds.

#### NEGOTIATOR\_RESCAN\_QUEUE

specifies the amount of time in seconds that defines how long the negotiator waits to rescan the job queue for machines which have bypassed jobs which could not run due to conditions which may change over time. This keyword must be greater than the **NEGOTIATOR\_INTERVAL** value; if it is not, the default is used.

**Syntax:**

NEGOTIATOR\_RESCAN\_QUEUE = *number*

*number* must be a numerical value and cannot be an arithmetic expression.

**Default value:** The default is 900 seconds.

#### NEGOTIATOR\_STREAM\_PORT

Specifies the port number used when connecting to the daemon.

**Syntax:**

NEGOTIATOR\_STREAM\_PORT = *port number*

**Default value:** The default is 9614.

For more information related to using this keyword, see “Defining network characteristics” on page 38.

#### NQS\_DIR

Defines the directory where NQS commands **qsub**, **qstat**, and **qdel** reside.

**Restriction:** NQS is not supported by LoadLeveler for Linux.

**Syntax:**

NQS\_DIR = *NQS directory*

**Default value:** The default is **/usr/bin**

### OBITUARY\_LOG\_LENGTH

Specifies the number of lines from the end of the file that are appended to the mail message. The master daemon mails this log to the LoadLeveler administrators when one of the daemons dies.

**Syntax:**

OBITUARY\_LOG\_LENGTH = *number*

*number* must be a numerical value and cannot be an arithmetic expression.

**Default value:** The default is 25.

### POLLING\_FREQUENCY

Specifies the interval, in seconds, with which the startd daemon evaluates the load on the local machine and decides whether to suspend, resume, or abort jobs. This time is also the minimum interval at which the kbdd daemon reports keyboard or mouse activity to the startd daemon.

**Syntax:**

POLLING\_FREQUENCY = *number*

*number* must be a numerical value and cannot be an arithmetic expression.

**Default value:** The default is 5.

### POLLS\_PER\_UPDATE

Specifies how often, in **POLLING\_FREQUENCY** intervals, startd daemon updates the central manager. Due to the communication overhead, it is impractical to do this with the frequency defined by the **POLLING\_FREQUENCY** keyword. Therefore, the startd daemon only updates the central manager every *n*th (where *n* is the number specified for **POLLS\_PER\_UPDATE**) local update. Change **POLLS\_PER\_UPDATE** when changing the **POLLING\_FREQUENCY**.

**Syntax:**

POLLS\_PER\_UPDATE = *number*

*number* must be a numerical value and cannot be an arithmetic expression.

**Default value:** The default is 24.

### PRESTARTED\_STARTERS

Specifies how many prestarted starter processes LoadLeveler will maintain on an execution node to manage jobs when they arrive. The startd daemon starts the number of starter processes specified by this keyword. You may specify this keyword in either the global or local configuration file.

**Syntax:**

PRESTARTED\_STARTERS = *number*

*number* must be less than or equal to the value specified through the **MAX\_STARTERS** keyword. If the value of **PRESTARTED\_STARTERS** specified is greater than **MAX\_STARTERS**, LoadLeveler records a warning message in the startd log and assigns **PRESTARTED\_STARTERS** the same value as **MAX\_STARTERS**.

If the value **PRESTARTED\_STARTERS** is zero, no starter processes will be started before jobs arrive on the execution node.

**Default value:** The default is 1.

## PREEMPT\_CLASS

Defines the preemption rule for a job class.

**Syntax:** The following forms illustrate correct syntax.

```
PREEMPT_CLASS[incoming_class] = ALL[:preempt_method] {
outgoing_class1 [outgoing_class2 ...] }
```

Using this form, ALL indicates that job steps of *incoming\_class* have priority and will not share nodes with job steps of *outgoing\_class1*, *outgoing\_class2*, or other outgoing classes. If a job step of the *incoming\_class* is to be started on a set of nodes, all job steps of *outgoing\_class1*, *outgoing\_class2*, or other outgoing classes running on those nodes will be preempted.

```
PREEMPT_CLASS[incoming_class] = ENOUGH[:preempt_method] {
outgoing_class1 [outgoing_class2 ...] }
```

Using this form, ENOUGH indicates that job steps of *incoming\_class* will share nodes with job steps of *outgoing\_class1*, *outgoing\_class2*, or other outgoing classes if there are sufficient resources. If a job step of the *incoming\_class* is to be started on a set of nodes, one or more job steps of *outgoing\_class1*, *outgoing\_class2*, or other outgoing classes running on those nodes may be preempted to get needed resources.

Combinations of these forms are also allowed.

### Notes:

1. The optional specification *preempt\_method* indicates which method LoadLeveler is to use to preempt the jobs; this specification is valid only for the backfill scheduler. Valid values for this specification in keyword syntax are the highlighted abbreviations in parentheses:
  - Remove (**rm**)
  - System hold (**sh**)
  - Suspend (**su**)
  - Vacate (**vc**)
  - User hold (**uh**)

LoadLeveler for Linux does not support the suspend method of preemption. For more information about preemption methods, see “Steps for configuring a scheduler to preempt jobs” on page 119.
2. Using the “ALL” value in the PREEMPT\_CLASS keyword places implied restrictions on when a job can start. See “Planning to preempt jobs” on page 116 for more information.
3. The incoming class is designated inside [ ] brackets.
4. Outgoing classes are designated inside { } curly braces.
5. The job classes on the right hand (outgoing) side of the statement must be different from incoming class, or it may be **allclasses**. If the outgoing side is defined as **allclasses** then all job classes are preemptable with the exception of the incoming class specified within brackets.
6. A class name or **allclasses** should not be in both the ALL list and the ENOUGH list. If you do so, the entire statement will be ignored. An example of this is:

```
PREEMPT_CLASS[Class_A]=ALL{allclasses} ENOUGH {allclasses}
```

7. If you use **allclasses** as an outgoing (preemptable) class, then no other class names should be listed at the right hand side as the entire statement will be ignored. An example of this is:  
**PREEMPT\_CLASS[Class\_A]=ALL{Class\_B} ENOUGH {allclasses}**
8. More than one ALL statement and more than one ENOUGH statement may appear at the right hand side. Multiple statements have a cumulative effect.
9. Each ALL or ENOUGH statement can have multiple class names inside the curly braces. However, a blank space delimiter is required between each class name.
10. Both the ALL and ENOUGH statements can include an optional specification indicating the method LoadLeveler will use to preempt the jobs. Valid values for this specification are listed in the description of the DEFAULT\_PREEMPT\_METHOD keyword on page 242. If a value is specified on the PREEMPT\_CLASS ALL or ENOUGH statement, that value overrides the value set on the DEFAULT\_PREEMPT\_METHOD keyword, if any.
11. ALL and ENOUGH may be in mixed cases.
12. Spaces are allowed around the brackets and curly braces.
13. PREEMPT\_CLASS [allclasses] will be ignored.

**Default value:** No default value is set.

### Examples:

**PREEMPT\_CLASS[Class\_B]=ALL{Class\_E Class\_D} ENOUGH {Class\_C}**

This indicates that all Class\_E jobs and all Class\_D jobs and enough Class\_C jobs will be preempted to enable an incoming Class\_B job to run.

**PREEMPT\_CLASS[Class\_D]=ENOUGH:VC {Class\_E}**

This indicates that zero, one, or more Class\_E jobs will be preempted using the vacate method to enable an incoming Class\_D job to run.

## PREEMPTION\_SUPPORT

For the gang, backfill, or API schedulers only, specifies the level of preemption support for a cluster.

### Syntax:

**PREEMPTION\_SUPPORT= full | no\_adapter | none**

- When set to **full**, preemption is fully supported.
- When set to **no\_adapter**, preemption is supported but the adapter resources are not released by preemption.
- When set to **none**, preemption is not supported, and preemption requests will be rejected.

### Notes:

1. If the value of this keyword is set to any value other than **none** for the default scheduler, LoadLeveler will not start.
2. For the gang scheduler only, when this keyword is set to **full** or **no\_adapter**, LoadLeveler checks to ensure that:
  - **MACHINE\_AUTHENTICATE = TRUE** and **PROCESS\_TRACKING = TRUE** are specified in the configuration file, and
  - Only supported adapters are defined in the administration file.

3. For the backfill or API scheduler, when this keyword is set to **full** or **no\_adapter** and preemption by the suspend method is required, the configuration keyword **PROCESS\_TRACKING** must be set to **true**.

**Default value:** The default value for the gang scheduler is **full**. The default value for all other schedulers is **none**; if you want to enable preemption under these schedulers, you must set a value for this keyword.

## PROCESS\_TRACKING

Specifies whether or not LoadLeveler will cancel any processes (throughout the entire cluster), left behind when a job terminates.

**Restriction:** Process tracking is ignored by LoadLeveler for Linux.

**Syntax:**

PROCESS\_TRACKING = TRUE | FALSE

When **TRUE** ensures that when a job is terminated, no processes created by the job will continue running.

**Note:** It is necessary to set this keyword to **true** in order to use the gang scheduler or to do preemption by the suspend method with the backfill or API scheduler.

**Default value:** FALSE

## PROCESS\_TRACKING\_EXTENSION

Specifies the directory containing the kernel extension binary **LoadL\_pt\_ke**.

**Restriction:** Process tracking is ignored by LoadLeveler for Linux.

**Syntax:**

PROCESS\_TRACKING\_EXTENSION = *directory*

**Default value:** The directory **\$HOME/bin**

For more information related to using this keyword, see “Tracking job processes” on page 64.

## PUBLISH\_OBITUARIES

Specifies whether or not the master daemon sends mail to the administrator when any daemon it manages ends abnormally. When set to **true**, this keyword specifies that the master daemon sends mail to the administrators identified by **LOADL\_ADMIN** keyword.

**Syntax:**

PUBLISH\_OBITUARIES = true | false

**Default value:** **true**

## REJECT\_ON\_RESTRICTED\_LOGIN

Specifies whether the user’s account status will be checked on every node where the job will be run by calling the AIX **loginrestrictions** function with the **S\_DIST\_CLNT** flag.

**Restriction:** Login restriction checking is ignored by LoadLeveler for Linux.

Login restriction checking includes:

- Does the account still exist?
- Is the account locked?
- Has the account expired?

## Configuration file reference

- Do failed login attempts exceed the limit for this account?
- Is login disabled via `/etc/nologin`?

If the AIX **loginrestrictions** function indicates a failure then the user's job will be rejected and will be processed according to the LoadLeveler configuration parameters **MAX\_JOB\_REJECT** and **ACTION\_ON\_MAX\_REJECT**.

**Syntax:**

`REJECT_ON_RESTRICTED_LOGIN = true | false`

**Default value:** `false`

### **RELEASEDIR**

Defines the directory where all the LoadLeveler software resides.

**Syntax:**

`RELEASEDIR = release directory`

**Default value:** `$(RELEASEDIR)`

### **RESERVATION\_CAN\_BE\_EXCEEDED**

Specifies whether LoadLeveler will schedule job steps that are bound to a reservation when their end times (based on hard wall-clock limits) exceed the reservation end time.

**Syntax:**

`RESERVATION_CAN_BE_EXCEEDED = true | false`

When this keyword is set to false, LoadLeveler schedules only those job steps that will complete before the reservation ends. When set to true, LoadLeveler schedules job steps to run under a reservation even if their end times are expected to exceed the reservation end time. When the reservation ends, however, the reserved nodes no longer belong to the reservation, and so these nodes might not be available for the jobs to continue running. In this case, LoadLeveler might preempt the running jobs.

Note that this keyword setting does not change the actual end time of the reservation. It only affects how LoadLeveler manages job steps whose end times exceed the end time of the reservation.

**Default value:** `true`

### **RESERVATION\_HISTORY**

Defines the name of a file that is to contain the local history of reservations.

**Syntax:**

`RESERVATION_HISTORY = file name`

LoadLeveler appends a single line to the reservation history file for each reservation. For an example, see "Collecting accounting data for reservations" on page 125.

**Default value:** `$(SPOOL)/reservation_history`

**RESERVATION\_MIN\_ADVANCE\_TIME**

Specifies the minimum time, in minutes, between the time at which a reservation is created and the time at which the reservation is to start.

**Syntax:**

`RESERVATION_MIN_ADVANCE_TIME = number of minutes`

By default, the earliest time at which a reservation may start is the current time plus the value set for the **RESERVATION\_SETUP\_TIME** keyword.

**Default value:** 0 (zero)

**RESERVATION\_PRIORITY**

Specifies whether LoadLeveler administrators may reserve nodes on which running jobs are expected to end after the reservation start time. This keyword value applies only for LoadLeveler administrators; other reservation owners do not have this capability.

**Syntax:**

`RESERVATION_PRIORITY = NONE | HIGH`

When you set this keyword to HIGH, before activating the reservation, LoadLeveler preempts the job steps running on the reserved nodes. The only exceptions are non-preemptable jobs; LoadLeveler will not preempt those jobs because of any reservations.

**Default value:** NONE

**RESERVATION\_SETUP\_TIME**

Specifies how much time, in seconds, that LoadLeveler may use to prepare for a reservation before it is to start. The tasks that LoadLeveler performs during this time include checking and reporting node conditions, and preempting job steps still running on the reserved nodes.

For a given reservation, LoadLeveler uses the **RESERVATION\_SETUP\_TIME** keyword value that is set at the time that the reservation is created, not whatever value might be set when the reservation starts. If the start time of the reservation is modified, however, LoadLeveler uses the **RESERVATION\_SETUP\_TIME** keyword value that is set at the time of the modification.

**Syntax:**

`RESERVATION_SETUP_TIME = number of seconds`

**Default value:** 60

**RESTARTS\_PER\_HOUR**

Specifies how many times the master daemon attempts to restart a daemon that dies abnormally. Because one or more of the daemons may be unable to run due to a permanent error, the master only attempts **\$(RESTARTS\_PER\_HOUR)** restarts within a 60 minute period. Failing that, it sends mail to the administrators identified by the **LOADL\_ADMIN** keyword and exits.

**Syntax:**

`RESTARTS_PER_HOUR = number`

*number* must be a numerical value and cannot be an arithmetic expression.

**Default value:** The default is 12.

### RESUME\_ON\_SWITCH\_TABLE\_ERROR\_CLEAR

Specifies whether or not the **startd** that was drained when the switch table failed to unload will automatically resume once the unload errors are cleared. The unload error is considered cleared after LoadLeveler can successfully unload the switch table. For this keyword to work, the **DRAIN\_ON\_SWITCH\_TABLE\_ERROR** option in the configuration file must be turned on and not disabled. Flushing, suspending, or draining of a **startd** manually or automatically will disable this option until the **startd** is manually resumed.

**Syntax:**

RESUME\_ON\_SWITCH\_TABLE\_ERROR\_CLEAR = true | **false**

**Default value:** false

### RSET\_SUPPORT

Indicates the level of RSet support present on a machine.

**Restriction:** RSET support is not available on Linux platforms.

**Syntax:**

RSET\_SUPPORT = *option*

The available options are:

#### RSET\_CONSUMABLE\_CPUS

Indicates that the jobs scheduled to the machine will be attached to RSets with the number of CPUs specified by the consumableCPUs variable.

#### RSET\_MCM\_AFFINITY

Indicates the machine can run jobs requesting memory and adapter affinity.

**RSET\_NONE** Indicates LoadLeveler RSet support is not available on the machine.

#### RSET\_USER\_DEFINED

Indicates the machine can be used for jobs with a user-created RSet in their job command file.

**Default value:** RSET\_NONE

### SAVELOGS

Specifies the directory in which log files are archived.

**Syntax:**

SAVELOGS = *directory*

Where *directory* is the directory in which log files will be archived.

**Default value:** No default value is set.

For more information related to using this keyword, see “Configuring recording activity and log files” on page 40.

### SCHEDD

Location of the schedd executable (LoadL\_schedd).

**Syntax:**

`SCHEDD = directory`

**Default value:** `$(BIN)/LoadL_schedd`

For more information related to using this keyword, see “How LoadLeveler daemons process jobs” on page 7.

### **SCHEDD\_COREDUMP\_DIR**

Specifies the local directory for storing LoadL\_schedd core dump files.

#### **Syntax:**

`SCHEDD_COREDUMP_DIR = directory`

**Default value:** The `/tmp` directory.

For more information related to using this keyword, see “Specifying file and directory locations” on page 38.

### **SCHEDD\_INTERVAL**

Specifies the interval, in seconds, at which the schedd daemon checks the local job queue and updates the negotiator daemon.

#### **Syntax:**

`SCHEDD_INTERVAL = number`

*number* must be a numerical value and cannot be an arithmetic expression.

**Default value:** The default is 60 seconds.

### **SCHEDD\_RUNS\_HERE**

Specifies whether the schedd daemon runs on the host. If you do not want to run the schedd daemon, specify **false**.

This keyword does not designate a machine as a public scheduling machine. Unless configured as a public scheduling machine, a machine configured to run the schedd daemon will only accept job submissions from the same machine running the schedd daemon. A public scheduling machine accepts job submissions from other machines in the LoadLeveler cluster. To configure a machine as a public scheduling machine, see the **schedd\_host** keyword description in “Administration file keyword descriptions” on page 291.

#### **Syntax:**

`SCHEDD_RUNS_HERE = true | false`

**Default value:** **true**

### **SCHEDD\_SUBMIT\_AFFINITY**

Specifies whether job submissions are directed to a locally running schedd daemon. When the keyword is set to **true**, job submissions are directed to a schedd daemon running on the same machine where the submission takes place, provided there is a schedd daemon running on that machine. In this case the submission is said to have “affinity” for the local schedd daemon. If there is no schedd daemon running on the machine where the submission takes place, or if this keyword is set to **false**, the job submission will only be directed to a schedd daemon serving as a public scheduling machine. In this case, if there are no public scheduling machines configured the job cannot be submitted. A public scheduling machine accepts job submissions from other machines in the LoadLeveler

cluster. To configure a machine as a public scheduling machine, see the **schedd\_host** keyword description in “Administration file keyword descriptions” on page 291.

Installations with a large number of nodes should consider setting this keyword to **false** to more evenly distribute dispatching of jobs among the schedd daemons. For more information, see “Scaling considerations” on page 597.

**Syntax:**

SCHEDD\_SUBMIT\_AFFINITY = true | false

**Default value:** true

### SCHEDD\_STATUS\_PORT

Specifies the port number used when connecting to the daemon.

**Syntax:**

SCHEDD\_STATUS\_PORT = *port number*

**Default value:** The default is 9606.

For more information related to using this keyword, see “Defining network characteristics” on page 38.

### SCHEDD\_STREAM\_PORT

Specifies the port number used when connecting to the daemon.

**Syntax:**

SCHEDD\_STREAM\_PORT = *port number*

**Default value:** The default is 9605.

For more information related to using this keyword, see “Defining network characteristics” on page 38.

### SCHEDULE\_BY\_RESOURCES

Specifies which consumable resources are considered by the LoadLeveler schedulers. Each consumable resource name may be an administrator-defined alphanumeric string, or may be one of the following predefined resources:

- ConsumableCpus
- ConsumableMemory
- ConsumableVirtualMemory
- RDMA

Each string may only appear in the list once. These resources are either floating resources, or machine resources. If any resource is specified incorrectly with the **SCHEDULE\_BY\_RESOURCES** keyword, then all scheduling resources will be ignored.

**Syntax:**

SCHEDULE\_BY\_RESOURCES = *name name ... name*

**Default value:** No default value is set.

### SCHEDULER\_TYPE

Specifies the LoadLeveler scheduling algorithm:

### LL\_DEFAULT

Specifies the default LoadLeveler scheduling algorithm. If `SCHEDULER_TYPE` has not been defined, LoadLeveler will use the default scheduler (`LL_DEFAULT`).

### BACKFILL

Specifies the LoadLeveler backfill scheduler. When you specify this keyword, you should use only the default settings for the **START** expression and the other job control expressions described in “Managing job status through control expressions” on page 63.

**API** Specifies that you will use an external scheduler. External schedulers communicate to LoadLeveler through the job control API. For more information on setting an external scheduler, see “Using an external scheduler” on page 104.

### GANG

Specifies that you will use the LoadLeveler gang scheduling algorithm. For more information, see “Using the gang scheduler” on page 100.

**Restriction:** Gang scheduling is not supported by LoadLeveler for Linux.

#### Syntax:

`SCHEDULER_TYPE = LL_DEFAULT | BACKFILL | API | GANG`

**Default value:** `LL_DEFAULT`

#### Notes:

1. If a scheduler type is not set, LoadLeveler will start, but it will use the default scheduler.
2. If you have set `SCHEDULER_TYPE` with an option that is not valid, LoadLeveler will not start.
3. If you change the scheduler option specified by `SCHEDULER_TYPE`, you must stop and restart LoadLeveler using `llctl` or recycle using `llctl`.

For more information related to using this keyword, see “Defining a LoadLeveler cluster” on page 35.

### SEC\_ADMIN\_GROUP

When security services are enabled, this keyword points to the name of the UNIX group that contains the local identities of the LoadLeveler administrators.

**Restriction:** Neither DCE nor CtSec security are supported on LoadLeveler for Linux.

#### Syntax:

`SEC_ADMIN_GROUP = name of lladmin group`

**Default value:** No default value is set.

For more information related to using this keyword, see “Configuring LoadLeveler to use cluster security services” on page 53.

### SEC\_ENABLEMENT

Specifies the security mechanism to be used.

## Configuration file reference

**Restriction:** Do not set this keyword to DCE or CtSec in the configuration file for a Linux machine. Neither DCE nor CtSec security are supported on LoadLeveler for Linux.

**Syntax:**

SEC\_ENABLEMENT = COMPAT | DCE | CTSEC

**Default value:** If the keyword **DCE\_ENABLEMENT** is set to true, the default value for **SEC\_ENABLEMENT** is **DCE**; otherwise, no default value is set.

### SEC\_SERVICES\_GROUP

When security services are enabled, this keyword specifies the name of the LoadLeveler services group.

**Restriction:** Neither DCE nor CtSec security are supported on LoadLeveler for Linux.

**Syntax:**

SEC\_SERVICES\_GROUP=*group name*

Where *group name* defines the identities of the LoadLeveler daemons.

**Default value:** No default value is set.

### SEC\_IMPOSED\_MECHS

Specifies a blank-delimited list of LoadLeveler's permitted security mechanisms when Cluster Security (CtSec) services are enabled.

**Restriction:** CtSec security is not supported on LoadLeveler for Linux.

**Syntax:** Specify a blank delimited list containing combinations of the following values:

- none** If this is the only value specified, then users *will* run unauthenticated and, if authorization is necessary, the job will fail. If this is not the only value specified, then users *may* run unauthenticated and, if authorization is necessary, the job will fail.
- unix** If this is the only value specified, then UNIX host-based authentication will be used; otherwise, other mechanisms may be used.

**Default value:** No default value is set.

**Example:**

SEC\_IMPOSED\_MECHS = none unix

### SPOOL

Defines the local directory where LoadLeveler keeps the local job queue and checkpoint files

**Syntax:**

SPOOL = *local directory/spool*

**Default value:** \$(tilde)/spool

### START

Determines whether a machine can run a LoadLeveler job.

**Syntax:**

START: *expression that evaluates to T or F (true or false)*

When the expression evaluates to **T**, LoadLeveler considers dispatching a job to the machine. When you use a **START** expression that is based on the CPU load average, the negotiator may evaluate the expression as **F** even though the load average indicates the machine is Idle. This is because the negotiator adds a compensating factor to the startd machine's load average every time the negotiator assigns a job. For more information, see "the **NEGOTIATOR\_INTERVAL** keyword" on page 257.

**Default value:** No default value is set, which means that no jobs will be started.

For information about time-related variables that you may use for this keyword, see "Variables to use for setting times" on page 285.

### **START\_CLASS**

Specifies the rule for starting a job of the *incoming\_class*. The **START\_CLASS** rule is applied whenever the backfill or gang scheduler decides whether a job step of the *incoming\_class* should start or not.

#### **Syntax:**

```
START_CLASS[incoming_class] = (start_class_expression) [&& (start_class_expression) ...]
```

Where *start\_class\_expression* takes the form:

#### **run\_class < number\_of\_tasks**

Which indicates that a job step of the *incoming\_class* is only allowed to run on a node when the number of tasks of *run\_class* running on that node is less than *number\_of\_tasks*.

#### **Notes:**

1. **START\_CLASS** [**allclasses**] will be ignored.
2. The job class specified by *run\_class* may be the same as or different from the class specified by *incoming\_class*.
3. You can also define *run\_class* as **allclasses**. If you do, the total number of all job tasks running on that node cannot exceed the value specified by *number\_of\_tasks*.
4. A class name or **allclasses** should not appear twice on the right-hand side of the keyword statement. However, you can use other class names with **allclasses** on the right hand side of the statement.
5. If there is more than one *start\_class\_expression*, you must use **&&** between adjacent *start\_class\_expressions*.
6. Both the **START** keyword and the **START\_CLASS** keyword have to be true before a new job can start.
7. Parenthesis ( ) are optional around *start\_class\_expression*.

For information related to using this keyword, see "Planning to preempt jobs" on page 116.

**Default value:** No default value is set.

#### **Examples:**

```
START_CLASS[Class_A] = (Class_A < 1)
```

This statement indicates that a **Class\_A** job can only start on nodes that do not have any **Class\_A** jobs running.

## Configuration file reference

**START\_CLASS[Class\_B] = allclasses < 5**

This statement indicates that a Class\_B job can only start on nodes with maximum 4 tasks running.

### **START\_DAEMONS**

Specifies whether to start the LoadLeveler daemons on the node.

#### **Syntax:**

START\_DAEMONS = **true** | false

#### **Default value: true**

When **true**, the daemons are started. In most cases, you will probably want to set this keyword to **true**. An example of why this keyword would be set to **false** is if you want to run the daemons on most of the machines in the cluster but some individual users with their own local configuration files do not want their machines to run the daemons. The individual users would modify their local configuration files and set this keyword to **false**. Because the global configuration file has the keyword set to **true**, their individual machines would still be able to participate in the LoadLeveler cluster.

Also, to define the machine as strictly a submit-only machine, set this keyword to **false**.

### **STARTD**

Location of the startd executable (LoadL\_startd).

#### **Syntax:**

STARTD = *directory*

#### **Default value: \$(BIN)/LoadL\_startd**

For more information related to using this keyword, see “How LoadLeveler daemons process jobs” on page 7.

### **STARTD\_COREDUMP\_DIR**

Local directory for storing LoadL\_startd core dump files.

#### **Syntax:**

STARTD\_COREDUMP\_DIR = *directory*

#### **Default value: The /tmp directory.**

For more information related to using this keyword, see “Specifying file and directory locations” on page 38.

### **STARTD\_DGRAM\_PORT**

Specifies the port number used when connecting to the daemon.

#### **Syntax:**

STARTD\_DGRAM\_PORT = *port number*

#### **Default value: The default is 9615.**

For more information related to using this keyword, see “Defining network characteristics” on page 38.

## STARTD\_RUNS\_HERE = true | false

Specifies whether the startd daemon runs on the host. If you do not want to run the startd daemon, specify **false**.

### Syntax:

STARTD\_RUNS\_HERE = true | false

**Default value:** true

## STARTD\_STREAM\_PORT

Specifies the port number used when connecting to the daemon.

### Syntax:

STARTD\_STREAM\_PORT = *port number*

**Default value:** The default is 9611.

For more information related to using this keyword, see “Defining network characteristics” on page 38.

## STARTER

Location of the starter executable (LoadL\_starter).

### Syntax:

STARTER = *directory*

**Default value:** \$(BIN)/LoadL\_starter

For more information related to using this keyword, see “How LoadLeveler daemons process jobs” on page 7.

## STARTER\_COREDUMP\_DIR

Local directory for storing LoadL\_starter coredump files.

### Syntax:

STARTER\_COREDUMP\_DIR = *directory*

**Default value:** The /tmp directory.

For more information related to using this keyword, see “Specifying file and directory locations” on page 38.

## SUBMIT\_FILTER

Specifies the program you want to run to filter a job script when the job is submitted.

### Syntax:

SUBMIT\_FILTER = *full\_path\_to\_executable*

Where *full\_path\_to\_executable* is called with the job command file as the standard input. The standard output is submitted to LoadLeveler. If the program returns with a nonzero exit code, the job submission is canceled. A submit filter can only make changes to LoadLeveler job command file keyword statements.

**Default value:** No default value is set.

**Multicluster use:** In a multicluster environment, if you specified a valid cluster list with either the **llsubmit -X** option or the **ll\_cluster** API, then the **SUBMIT\_FILTER** will instead be invoked with a modified job

## Configuration file reference

command file that contains a **cluster\_list** keyword generated from either the **llsubmit -X** option or the **ll\_cluster** API.

The modified job command file will contain an inserted `# @ cluster_list = cluster` statement just prior to the first `# @ queue` statement. This **cluster\_list** statement takes precedence and overrides all previous specifications of any **cluster\_list** statements from the original job command file.

### Example: SUBMIT\_FILTER in a multicluster environment

The following job command file, `job.cmd`, requests to be run remotely on `cluster1`:

```
#!/bin/sh
@ cluster_list = cluster1
@ error = job1.$(Host).$(Cluster).$(Process).err
@ output = job1.$(Host).$(Cluster).$(Process).out
@ queue
```

After issuing `llsubmit -X cluster2 job.cmd`, the modified job command file statements will be run on `cluster2`:

```
#!/bin/sh
@ cluster_list = cluster1
@ error = job1.$(Host).$(Cluster).$(Process).err
@ output = job1.$(Host).$(Cluster).$(Process).out
@ cluster_list = cluster2
@ queue
```

For more information related to using this keyword, see “Filtering a job script” on page 70.

## SUSPEND

Determines whether running jobs should be suspended.

### Syntax:

**SUSPEND:** *expression that evaluates to T or F (true or false)*

When **T**, LoadLeveler temporarily suspends jobs currently running on the machine. Suspended LoadLeveler jobs will either be continued or vacated. This keyword is not supported for parallel jobs.

**Default value:** No default value is set.

For information about time-related variables that you may use for this keyword, see “Variables to use for setting times” on page 285.

## SYSPRIO

System priority expression.

### Syntax:

**SYSPRIO** = *expression*

You can use the following LoadLeveler variables to define the **SYSPRIO** expression:

- **ClassSysprio**
- **GroupQueuedJobs**
- **GroupRunningJobs**
- **GroupSysprio**
- **GroupTotalJobs**

- QDate
- UserPrio
- UserQueuedJobs
- UserRunningJobs
- UserSysprio
- UserTotalJobs

For detailed descriptions of these variables, see “LoadLeveler variables” on page 280.

**Default value:** 0 (zero)

**Notes:**

1. The **SYSPRIO** keyword is valid only on the machine where the central manager is running. Using this keyword in a local configuration file has no effect.
2. It is recommended that you do not use **UserPrio** in the **SYSPRIO** expression, since user jobs are already ordered by **UserPrio**.
3. You can use the **UserRunningJobs**, **GroupRunningJobs**, **UserQueuedJobs**, **GroupQueuedJobs**, **UserQueuedJobs**, **GroupQueuedJobs** **UserTotalJobs**, and **GroupTotalJobs** parameters to prioritize the queue based on current usage. You should also set **NEGOTIATOR\_RECALCULATE\_SYSPRIO\_INTERVAL** so that the priorities are adjusted according to current usage rather than usage only at submission time.

**Examples:**

- Example 1

This example creates a FIFO job queue based on submission time:

**SYSPRIO** : 0 - (QDate)

- Example 2

This example accounts for Class, User, and Group system priorities:

**SYSPRIO** : (ClassSysprio \* 100) + (UserSysprio \* 10) + (GroupSysprio \* 1) - (QDate)

- Example 3

This example orders the queue based on the number of jobs a user is currently running. The user who has the fewest jobs running is first in the queue. You should set

**NEGOTIATOR\_RECALCULATE\_SYSPRIO\_INTERVAL** in conjunction with this **SYSPRIO** expression.

**SYSPRIO** : 0 - UserRunningJobs

For more information related to using this keyword, see “Setting negotiator characteristics and policies” on page 36.

**SYSPRIO\_THRESHOLD\_TO\_IGNORE\_STEP**

Specifies a threshold value for system priority. When the system priority assigned to a job step is less than the value set for this keyword, the scheduler ignores the job, which will remain in Idle state.

**Syntax:**

**SYSPRIO\_THRESHOLD\_TO\_IGNORE\_STEP** = *integer*

Any integer is a valid value.

**Default value:** INT\_MIN

## Configuration file reference

For more information related to using this keyword, see “Controlling the central manager scheduling cycle” on page 66.

### TRUNC\_GSMONITOR\_LOG\_ON\_OPEN

When **true**, specifies that the log file is restarted with every invocation of the daemon.

#### Syntax:

TRUNC\_GSMONITOR\_LOG\_ON\_OPEN = true | false

**Default value:** false

For more information related to using this keyword, see “Configuring recording activity and log files” on page 40.

### TRUNC\_KBDD\_LOG\_ON\_OPEN

When **true**, specifies the log file is restarted with every invocation of the daemon.

#### Syntax:

TRUNC\_KBDD\_LOG\_ON\_OPEN = true | false

**Default value:** false

For more information related to using this keyword, see “Configuring recording activity and log files” on page 40.

### TRUNC\_MASTER\_LOG\_ON\_OPEN

When **true**, specifies the log file is re started with every invocation of the daemon.

#### Syntax:

TRUNC\_MASTER\_LOG\_ON\_OPEN = true | false

**Default value:** false

For more information related to using this keyword, see “Configuring recording activity and log files” on page 40.

### TRUNC\_NEGOTIATOR\_LOG\_ON\_OPEN

When **true**, specifies the log file is restarted with every invocation of the daemon.

#### Syntax:

TRUNC\_NEGOTIATOR\_LOG\_ON\_OPEN = true | false

**Default value:** false

For more information related to using this keyword, see “Configuring recording activity and log files” on page 40.

### TRUNC\_SCHEDD\_LOG\_ON\_OPEN

When **true**, specifies the log file is restarted with every invocation of the daemon.

#### Syntax:

TRUNC\_SCHEDD\_LOG\_ON\_OPEN = true | false

**Default value:** false

For more information related to using this keyword, see “Configuring recording activity and log files” on page 40.

### TRUNC\_STARTD\_LOG\_ON\_OPEN

When **true**, specifies the log file is restarted with every invocation of the daemon.

#### Syntax:

TRUNC\_STARTD\_LOG\_ON\_OPEN = true | false

**Default value:** false

For more information related to using this keyword, see “Configuring recording activity and log files” on page 40.

### TRUNC\_STARTER\_LOG\_ON\_OPEN

When **true**, specifies the log file is restarted with every invocation of the daemon.

#### Syntax:

TRUNC\_STARTER\_LOG\_ON\_OPEN = true | false

**Default value:** false

For more information related to using this keyword, see “Configuring recording activity and log files” on page 40.

### UPDATE\_ON\_POLL\_INTERVAL\_ONLY

Specifies whether or not the LoadLeveler **startd** daemons will send machine update transactions to the Central Manager. Normally the LoadLeveler startd daemons running on executing nodes will send transactions to the Central Manager to provide updates of machine information at various times. An update is sent every polling interval. The polling interval is calculated by multiplying the values for the two keywords, **POLLING\_FREQUENCY** and **POLLS\_PER\_UPDATE**, specified in the LoadLeveler configuration file.

In addition, updates are sent at other times such as when new jobs are started and when jobs terminate on the executing node. If you have a large and highly active cluster (the workload consists of a large number of short running jobs), the normal method for updating the central manager can add excessive network traffic. **UPDATE\_ON\_POLL\_INTERVAL\_ONLY** can help reduce this source of network traffic.

When **true** is specified, the LoadLeveler startd daemon will only send machine updates to the Central Manager at every polling interval and not at other times.

#### Syntax:

UPDATE\_ON\_POLL\_INTERVAL\_ONLY = false | true

**Default value:** false

### VACATE

Determines whether suspended jobs should be vacated.

#### Syntax:

VACATE: *expression that evaluates to T or F (true or false)*

When **T**, suspended LoadLeveler jobs are removed from the machine and placed back into the queue (provided you specify **restart=yes** in the job command file). If a checkpoint was taken, the job restarts from the checkpoint. Otherwise, the job restarts from the beginning.

**Default value:** No default value is set.

For information about time-related variables that you may use for this keyword, see “Variables to use for setting times” on page 285.

### VM\_IMAGE\_ALGORITHM

Specifies the virtual memory algorithm, which is used for checking the **image\_size** requirement. This keyword is used together with the **large\_page** job command file keyword to specify which algorithm the Central Manager uses to decide whether a machine has enough virtual memory to run a job step.

This keyword is critical for job steps that must use Large Page memory (specified by the job command file keyword **large\_page=M**). If the **VM\_IMAGE\_ALGORITHM** keyword is set to **FREE\_PAGING\_SPACE**, the Large Page job step will never be scheduled to run. This keyword must be set to **FREE\_PAGING\_SPACE\_PLUS\_FREE\_REAL\_MEMORY** to run Large Page jobs.

When **FREE\_PAGING\_SPACE** is specified, LoadLeveler considers only free paging space when determining if a machine has enough virtual memory to run a job step.

When **FREE\_PAGING\_SPACE\_PLUS\_FREE\_REAL\_MEMORY** is specified and the job step specifies:

- **large\_page=N** (does not use Large Page memory), LoadLeveler considers free paging space and free regular memory when determining if a machine has enough virtual memory to run a job step.
- **large\_page=Y** (uses Large Page memory, if available), LoadLeveler considers free paging space, free regular memory, and free Large Page memory when determining if a machine has enough virtual memory to run a job step, although Large Page memory is only considered for machines configured to exploit the Large Page feature.
- **large\_page=M** (must use Large Page memory), LoadLeveler considers only Large Page memory when determining if a machine has enough virtual memory to run a job step. Only machines configured to exploit the Large Page feature are considered.

IBM suggests that you set this keyword to the value **FREE\_PAGING\_SPACE\_PLUS\_FREE\_REAL\_MEMORY** since more types of virtual memory are considered, increasing the chances of finding a machine with enough virtual memory to run the job step.

#### Syntax:

**VM\_IMAGE\_ALGORITHM** = **FREE\_PAGING\_SPACE** | **FREE\_PAGING\_SPACE\_PLUS\_FREE\_REAL\_MEMORY**

**Default value:** **FREE\_PAGING\_SPACE**

### WALLCLOCK\_ENFORCE

Specifies whether the job command file keyword **wall\_clock\_limit** will be enforced for this job. The **WALLCLOCK\_ENFORCE** keyword is valid only when an external scheduler is enabled.

**Syntax:**

```
WALLCLOCK_ENFORCE = true | false
```

**Default value:** true

**X\_RUNS\_HERE**

Specifies whether the `kbdd` (keyboard) daemon runs on the host. If you do not want to run the `kbdd` daemon, specify **false**.

**Syntax:**

```
X_RUNS_HERE = true | false
```

**Default value:** true

---

## User-defined keywords

This type of variable, which is generally created and defined by the user, can be named using any combination of letters and numbers. A user-defined variable is set equal to values, where the *value* defines conditions, names files, or sets numeric values. For example, you can create a variable named **MY\_MACHINE** and set it equal to the name of your machine named *iron* as follows:

```
MY_MACHINE = iron.ore.met.com
```

You can then identify the keyword using a dollar sign (\$) and parenthesis. For example, the literal **\$(MY\_MACHINE)** following the definition in the previous example results in the automatic substitution of **iron.ore.met.com** in place of **\$(MY\_MACHINE)**.

User-defined definitions may contain references, enclosed in parenthesis, to previously defined keywords. Therefore:

```
A = xxx
C = $(A)
```

is a valid expression and the resulting value of **C** is *xxx*. Note that **C** is actually bound to **A**, not to its value, so that

```
A = xxx
C = $(A)
A = yyy
```

is also legal and the resulting value of **C** is *yyy*.

The sample configuration file shipped with the product defines and uses the following “user-defined” variables.

**BackgroundLoad**

Defines the variable **BackgroundLoad** and assigns to it a floating point constant. This might be used as a noise factor indicating no activity.

**CPU\_Busy**

Defines the variable **CPU\_Busy** and reassigns to it at each evaluation the Boolean value True or False, depending on whether the Berkeley one-minute load average is equal to or greater than the saturation level of 1.5.

**CPU\_Idle**

Defines the variable **CPU\_Idle** and reassigns to it at each evaluation the Boolean value True or False, depending on whether the Berkeley one-minute load average is equal or less than 0.7.

## Configuration file reference

### HighLoad

Is a keyword that the user can define to use as a saturation level at which no further jobs should be started.

### HOURL

Defines the variable **HOURL** and assigns to it a constant integer value.

### JobLoad

Defines the variable **JobLoad** which defines the load on the machine caused by running the job.

### KeyboardBusy

Defines the variable **KeyboardBusy** and reassigns to it at each evaluation the Boolean value True or False, depending on whether the keyboard and mouse have been idle for fifteen minutes.

### LowLoad

Defines the variable **LowLoad** and assigns to it the value of **BackgroundLoad**. This might be used as a restart level at which jobs can be started again and assumes only running 1 job on the machine.

### mail

Specifies a local program you want to use in place of the LoadLeveler default mail notification method.

### MINUTE

Defines the variable **MINUTE** and assigns to it a constant integer value.

### StateTimer

Defines the variable **StateTimer** and reassigns to it at each evaluation the number of seconds since the current state was entered.

---

## LoadLeveler variables

LoadLeveler provides the following variables that you can use in your configuration file statements. LoadLeveler variables are evaluated by the LoadLeveler daemons at various stages. They do not require you to use any special characters (such as a parenthesis or a dollar sign) to identify them.

### Arch

Indicates the system architecture. Note that **Arch** is a special case of a LoadLeveler variable called a machine variable. You specify a machine variable using the following format:

*variable : \$(value)*

### ClassSysprio

The priority for the class of the job step, defined in the class stanza in the administration file.

**Default:** 0

For additional information about using this variable, see the **SYSPRIO** keyword description.

### Connectivity

The ratio of the number of active switch adapters on a node to the total number of switch adapters on the node. The value ranges from 0.0 (all switch adapters are down) to 1.0 (all switch adapters are active). A node with no switch adapters has a connectivity of 0.0. Connectivity can be used in a **MACHPRIO** expression to favor nodes that do not have any down switch adapters or in a job's **REQUIREMENTS** to require only nodes with a certain connectivity.

For additional information about using this variable, see the **MACHPRIO** keyword description.

### **ConsumableCpus**

The number of **ConsumableCpus** currently available on the machine, if **ConsumableCpus** is defined in the configuration file keyword, **SCHEDULE\_BY\_RESOURCES**. If it is not defined in **SCHEDULE\_BY\_RESOURCES**, then it is equivalent to **Cpus**.

For additional information about using this variable, see the **MACHPRIO** keyword description.

### **ConsumableMemory**

The amount of **ConsumableMemory**, in megabytes, currently available on the machine, if **ConsumableMemory** is defined in the configuration file keyword, **SCHEDULE\_BY\_RESOURCES**. If it is not defined in **SCHEDULE\_BY\_RESOURCES**, then it is equivalent to **Memory**.

For additional information about using this variable, see the **MACHPRIO** keyword description.

### **ConsumableVirtualMemory**

The amount of **ConsumableVirtualMemory**, in megabytes, currently available on the machine, if **ConsumableVirtualMemory** is defined in the configuration file keyword, **SCHEDULE\_BY\_RESOURCES**. If it is not defined in **SCHEDULE\_BY\_RESOURCES**, then it is equivalent to **VirtualMemory**.

For additional information about using this variable, see the **MACHPRIO** keyword description.

### **Cpus**

The number of processors of the machine, reported by the **startd** daemon.

For additional information about using this variable, see the **MACHPRIO** keyword description.

### **CurrentTime**

The **UNIX date**; the current system time, in seconds, since January 1, 1970, as returned by the **time()** function.

### **CustomMetric**

Sets a relative priority number for one or more machines, based on the value of the **CUSTOM\_METRIC** keyword.

For additional information about using this variable, see the **MACHPRIO** keyword description.

### **Disk**

The free disk space in kilobytes on the file system where the executables for the **LoadLeveler** jobs assigned to this machine are stored. This refers to the file system that is defined by the **execute** keyword.

For additional information about using this variable, see the **MACHPRIO** keyword description.

### **domain or domainname**

Dynamically indicates the official name of the domain of the current host machine where the program is running. Whenever a machine name can be specified or one is assumed, a domain name is assigned if none is present.

### **EnteredCurrentState**

The value of **CurrentTime** when the current state (**START**, **SUSPEND**, etc) was entered.

### FreeRealMemory

The amount of free real memory, in megabytes, on the machine. This value should track very closely with the "fre" value of the **vmstat** command and the "free" value of the **svmon -G** command (units are 4K blocks).

For additional information about using this variable, see the **MACHPRIO** keyword description.

### GroupQueuedJobs

The number of job steps associated with a LoadLeveler group which are either running or queued. (That is, job steps which are in one of these states: Checkpointing, Preempted, Preempt Pending, Resume Pending, Running, Starting, Pending, or Idle.)

For additional information about using this variable, see the **SYSPRIO** keyword description.

### GroupRunningJobs

The number of job steps for the LoadLeveler group which are in one of these states: Checkpointing, Preempted, Preempt Pending, Resume Pending, Running, Starting, or Pending.

For additional information about using this variable, see the **SYSPRIO** keyword description.

### GroupSysprio

The priority for the group of the job step, defined in the group stanza in the administration file.

**Default:** 0

For additional information about using this variable, see the **SYSPRIO** keyword description.

### GroupTotalJobs

The total number of job steps associated with this LoadLeveler group. Total job steps are all job steps reported by the **llq** command.

For additional information about using this variable, see the **SYSPRIO** keyword description.

### host or hostname

Dynamically indicates the standard host name as returned by `gethostname()` for the machine where the program is running. **host** and **hostname** are equivalent, and contain the name of the machine without the domain name appended to it. If administrators need to specify the domain name in the configuration file, they may use **domain** or **domainname** along with **host** or **hostname**. For example:

```
$(host).$(domain)
```

### KeyboardIdle

The number of seconds since the keyboard or mouse was last used. It also includes any telnet or interactive activity from any remote machine.

### LoadAvg

The Berkely one-minute load average, a measure of the CPU load on the system. The load average is the average of the number of processes ready to run or waiting for disk I/O to complete. The load average does not map to CPU time.

For additional information about using this variable, see the **MACHPRIO** keyword description.

### Machine

Indicates the name of the current machine. Note that **Machine** is a special case of a LoadLeveler variable called a machine variable. See the description of the **Arch** variable for more information.

### MasterMachPriority

A value that is equal to 1 for nodes which are master nodes (those with **master\_node\_exclusive = true**); this value is equal to 0 for nodes which are not master nodes. Assigning a high priority to master nodes may help job scheduling performance for parallel jobs which require master node features.

For additional information about using this variable, see the **MACHPRIO** keyword description.

### Memory

The size of real memory, in megabytes, of the machine, reported by the startd daemon.

For additional information about using this variable, see the **MACHPRIO** keyword description.

### OpSys

Indicates the operating system on the host where the program is running. This value is automatically determined and need not be defined in the configuration file. Note that **OpSys** is a special case of a LoadLeveler variable called a machine variable. See the description of the **Arch** variable for more information.

### PagesFreed

The number of pages freed per second by the page replacement algorithm of the virtual memory manager.

For additional information about using this variable, see the **MACHPRIO** keyword description.

### PagesScanned

The number of pages scanned per second by the page replacement algorithm of the virtual memory manager.

For additional information about using this variable, see the **MACHPRIO** keyword description.

### QDate

The difference in seconds between the UNIX date when the job step enters the queue and the UNIX date when the negotiator daemon starts up.

For additional information about using this variable, see the **SYSPRIO** keyword description.

### Speed

The relative speed of the machine, defined in a machine stanza in the administration file.

**Default:** 1

For additional information about using this variable, see the **MACHPRIO** keyword description.

### State

The state of the startd daemon.

### tilde

The home directory for the LoadLeveler user ID.

## Configuration file reference

### UserPrio

The user defined priority of the job step, specified in the job command file with the **user\_priority** keyword. The priority ranges from 0 to 100, with higher numbers corresponding to greater priority.

**Default:** 50

For additional information about using this variable, see the **SYSPRIO** keyword description.

### UserQueuedJobs

The number of job steps either running or queued for the user. (That is, job steps that are in one of these states: Checkpointing, Preempted, Preempt Pending, Resume Pending, Running, Starting, Pending, or Idle.)

For additional information about using this variable, see the **SYSPRIO** keyword description.

### UserRunningJobs

The number of job step steps for the user which are in one of these states: Checkpointing, Preempted, Preempt Pending, Resume Pending, Running, Starting, or Pending.

For additional information about using this variable, see the **SYSPRIO** keyword description.

### UserSysprio

The priority of the user who submitted the job step, defined in the user stanza in the administration file.

**Default:** 0

For additional information about using this variable, see the **SYSPRIO** keyword description.

### UserTotalJobs

The total number of job steps associated with this user. Total job steps are all job steps reported by the **llq** command.

For additional information about using this variable, see the **SYSPRIO** keyword description.

### VirtualMemory

The size of available swap space (free paging space) on the machine, in kilobytes, reported by the **startd** daemon.

For additional information about using this variable, see the **MACHPRIO** keyword description.

## Variables to use for setting dates

You can use the following date variables:

### tm\_mday

The number of the day of the month (1-31).

### tm\_mon

Number of months since January (0-11).

### tm\_wday

Number of days since Sunday (0-6).

### tm\_yday

Number of days since January 1 (0-365).

**tm\_year**

The number of years since 1900 (0-9999). For example:

```
tm_year == 100
```

Denotes the year 2000.

**tm4\_year**

The integer representation of the current year. For example:

```
tm4_year == 2010
```

Denotes the year 2010.

## Variables to use for setting times

You can use the following time variables in the START, SUSPEND, CONTINUE, VACATE, and KILL expressions. If you use these variables in the START expression and you are operating across multiple time zones, unexpected results may occur. This is because the negotiator daemon evaluates the START expressions and this evaluation is done in the time zone in which the negotiator resides. Your executing machine also evaluates the START expression and if your executing machine is in a different time zone, the results you may receive may be inconsistent. To prevent this inconsistency from occurring, ensure that both your negotiator daemon and your executing machine are in the same time zone.

**tm\_hour**

The number of hours since midnight (0-23).

**tm\_isdst**

Daylight Savings Time flag: positive when in effect, zero when not in effect, negative when information is unavailable. For example, to start jobs between 5 PM and 8 AM during the month of October, factoring in an adjustment for Daylight Savings Time, you can issue:

```
START: (tm_mon == 9) && (tm_hour < 8) && (tm_hour > 17) && (tm_isdst = 1)
```

**tm\_min**

Number of minutes after the hour (0-59).

**tm\_sec**

Number of seconds after the minute (0-59).



---

## Chapter 12. Administration file reference

The administration file lists and defines the machines in the LoadLeveler cluster, as well as the characteristics of classes, users, groups, and clusters. LoadLeveler does not prevent you from having multiple copies of administration files, but having only one administration file prevents confusion and avoids potential problems that might arise from having multiple files to update. To use only one administration file that is available to all machines in a cluster, you must place the file in a shared file system.

| Subtask                                                                                  | Associated information (see . . . )                                                                                                                           |
|------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| To find out what administrator tasks you can accomplish by using the administration file | Part 2, “Configuring and managing the LoadLeveler environment,” on page 29                                                                                    |
| To learn how to correctly specify the contents of an administration file                 | <ul style="list-style-type: none"><li>• “Administration file structure and syntax”</li><li>• “Administration file keyword descriptions” on page 291</li></ul> |

---

### Administration file structure and syntax

The administration file is called **LoadL\_admin** and it lists and defines the *machine*, *user*, *class*, *group*, and *adapter* stanzas.

#### Machine stanza

Defines the roles that the machines in the LoadLeveler cluster play. See “Defining machines” on page 78 for more information.

#### User stanza

Defines LoadLeveler users and their characteristics. See “Defining users” on page 87 for more information.

#### Class stanza

Defines the characteristics of the job classes. See “Defining classes” on page 83 for more information.

#### Group stanza

Defines the characteristics of a collection of users that form a LoadLeveler group. See “Defining groups” on page 89 for more information.

#### Adapter stanza

Defines the network adapters available on the machines in the LoadLeveler cluster. See “Defining adapters” on page 80 for more information.

#### Cluster stanza

Defines the characteristics of a LoadLeveler cluster for use in a Multicluster environment. See “Defining clusters” on page 90 for more information.

Stanzas have the following general format:

## Administration file reference

```
label: type = type_of_stanza
keyword1 = value1
keyword2 = value2
...
```

Figure 33. Format of administration file stanzas

Keywords are *not* case sensitive. This means you can enter them in lower case, upper case, or mixed case.

The following is a simple example of an administration file illustrating several stanzas:

```
machine_a: type = machine
 central_manager = true # defines this machine as the central manager
 adapter_stanzas = adapter_a # identifies an adapter stanza

class_a: type = class
 priority = 50 # priority of this class

user_a: type = user
 priority = 50 # priority of this user

group_a: type = group
 priority = 50 # priority of this group

adapter_a: type = adapter
 adapter_name = en0 #defines an adapter
```

Figure 34. Sample administration file stanzas

## Stanza characteristics

The characteristics of a stanza are:

- Every stanza has a label associated with it. The label specifies the name you give to the stanza.
- Every stanza has a **type** field that specifies it as a user, class, machine, group, or adapter stanza.
- New line characters are ignored. This means that separate parts of a stanza can be included on the same line. However, it is not recommended to have parts of a stanza cross line boundaries.
- White space is ignored, other than to delimit keyword identifiers. This eliminates confusion between tabs and spaces at the beginning of lines.
- A crosshatch sign (#) identifies a comment and can appear anywhere on the line. All characters following this sign on that line are ignored.
- Multiple stanzas of the same label are allowed, but only the first label is used.
- Default stanzas specify the default values for any keywords which are not otherwise specified. Each stanza type can have an associated default stanza. A default stanza must appear in the administration file ahead of any specific stanza entries of the same type. For example, a default class stanza must appear ahead of any specific class stanzas you enter.

## Syntax for limit keywords

The syntax for setting a limit is:

```
limit_type = hardlimit,softlimit
```

For example:

```
core_limit = 120kb,100kb
```

To specify only a hard limit, you can enter, for example:

```
core_limit = 120kb
```

To specify only a soft limit, you can enter, for example:

```
core_limit = ,100kb
```

In a keyword statement, you cannot have any blanks between the numerical value (100 in the above example) and the units (kb). Also, you cannot have any blanks to the left or right of the comma when you define a limit in a job command file.

For limit keywords that refer to a data limit — such as **data\_limit**, **core\_limit**, **file\_limit**, **stack\_limit**, and **rss\_limit** — the hard limit and the soft limit are expressed as:

```
integer[.fraction][units]
```

The allowable units for these limits are:

```
b bytes
w words
kb kilobytes (2**10 bytes)
kw kilowords (2**12 bytes)
mb megabytes (2**20 bytes)
mw megawords (2**22 bytes)
gb gigabytes (2**30 bytes)
gw gigawords (2**32 bytes)
tb terabytes (2**40 bytes)
tw terawords (2**42 bytes)
pb petabytes (2**50 bytes)
pw petawords (2**52 bytes)
eb exabytes (2**60 bytes)
ew exawords (2**62 bytes)
```

If no units are specified for data limits, then bytes are assumed.

For limit keywords that refer to a time limit — such as **ckpt\_time\_limit**, **cpu\_limit**, **job\_cpu\_limit**, and **wall\_clock\_limit** — the hard limit and the soft limit are expressed as:

```
[[hours:]minutes:]seconds[.fraction]
```

Fractions are rounded to seconds.

You can use the following character strings with all limit keywords except the **copy** keyword for **wall\_clock\_limit**, **job\_cpu\_limit** and **ckpt\_time\_limit**:

|                      |                                                            |
|----------------------|------------------------------------------------------------|
| <b>rlim_infinity</b> | Represents the largest positive number.                    |
| <b>unlimited</b>     | Has same effect as <b>rlim_infinity</b> .                  |
| <b>copy</b>          | Uses the limit currently active when the job is submitted. |

## 64-bit support for administration file keywords

Administrators can assign 64-bit integer values to selected keywords in the administration file. System resource limits, with the exception of CPU limits, are treated by LoadLeveler daemons and commands as 64-bit limits.

Table 43 on page 290 describes 64-bit support for specific administration file keywords.

Table 43. Notes on 64-bit support for administration file keywords

| Keyword                  | Stanza  | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------------------------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>core_limit</b>        | Class   | 64-bit integer values can be assigned to these limits. Fractional specifications are allowed and will be converted to 64-bit integer values. Unit specifications are accepted and can be one of the following: b, w, kb, kw, mb, mw, gb, gw, tb, tw, pb, pw, eb, ew.<br><br><b>Example:</b><br>core_limit = 8gb,4.25gb                                                                                                                                   |
| <b>data_limit</b>        |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>default_resources</b> | Class   | Consumable resources associated with the <b>default_resources</b> keyword can be assigned 64-bit integer values. Fractional specifications are not allowed. Unit specifications are valid only when specifying the values of the predefined ConsumableMemory and ConsumableVirtualMemory resources.<br><br><b>Example:</b><br>default_resources = ConsumableVirtualMemory(12 gb) db2_license(112)                                                        |
| <b>file_limit</b>        | Class   | See the notes for <b>core_limit</b> and <b>data_limit</b> , above.                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>resources</b>         | Machine | Consumable resources associated with the <b>resources</b> keyword can be assigned 64-bit integer values. Fractional specifications are not allowed. Unit specifications are valid only when specifying the values of the predefined ConsumableMemory and ConsumableVirtualMemory resources.<br><br><b>Examples:</b><br>resources = spice2g6(9123456789012) ConsumableMemory(10 gw)<br>resources = ConsumableVirtualMemory(15 pb) db2_license(1234567890) |
| <b>rss_limit</b>         | Class   | See the notes for <b>core_limit</b> and <b>data_limit</b> , above.<br><br><b>Example:</b><br>rss_limit = 1.25eb,3.33pw                                                                                                                                                                                                                                                                                                                                   |
| <b>stack_limit</b>       |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

## 64-bit limits on Linux systems

Applications managed by LoadLeveler for AIX can be 64-bit applications if the hardware architecture on which AIX is running is capable of supporting 64-bit processes. Resource limits, such as data limits and stack limits, can be 64-bit limits. When a value of *unlimited* is specified for a process limit (**cpu\_limit** excepted) in the LoadLeveler administration file or job command file, the AIX version of LoadLeveler stores this value internally as INT64\_MAX. Before starting the user job, LoadL\_starter sets the appropriate limit to this value. This behavior is correct because, on AIX, RLIM64\_INFINITY is the same as INT64\_MAX (= 0x7FFFFFFFFFFFFFFFLL).

On Linux systems, RLIM64\_INFINITY is equal to UINT64\_MAX (= 0xFFFFFFFFFFFFFFFFULL). To maintain compatibility with AIX, LoadLeveler for Linux also stores *unlimited* internally as INT64\_MAX. However, LoadL\_starter on Linux sets all process limits (**cpu\_limit** excepted) that are in the range (INT64\_MAX, UINT64\_MAX) to UINT64\_MAX before starting the jobs managed by LoadLeveler.

For historical reasons, LoadLeveler for AIX treats the hard and soft time limits, such as **cpu\_limit**, **job\_cpu\_limit**, and **wall\_clock\_limit**, as 32-bit limits and *unlimited* means INT32\_MAX. For consistency reasons, LoadLeveler for Linux assumes the same behavior.

## Administration file keyword descriptions

### **account**

Specifies a list of account numbers available to a user submitting jobs.

#### **Syntax:**

`account = list`

Where *list* is a blank-delimited list of account numbers that identifies the account numbers a user can use when submitting jobs.

**Default:** A null list.

### **adapter\_name**

Specifies the name the operating system uses to refer to an interface card installed on a node.

#### **Syntax:**

`adapter_name = string`

Where *string* is the name of a particular interface card installed on the node. Some examples are **en0**, **tk1**, and **css0**. Whenever a machine has one or more adapters with a name that starts with **css** (for example, **css0** or **css1**), a virtual adapter named **csss** is created for that machine. This adapter is used on the network statement when a job requires striped communication. This keyword defines the adapters a user can specify in a job command file using the **network** keyword.

### **adapter\_stanzas**

Specifies a list of adapter stanza names that define the adapters on a machine that can be requested.

#### **Syntax:**

`adapter_stanzas = stanza_list`

Where *stanza\_list* is a blank-delimited list of one or more adapter stanza names which specify adapters available on this machine. To take advantage of dynamic adapter configuration you must *exclude* this keyword from the machine stanza. LoadLeveler will then dynamically obtain the adapter configuration for this machine from the RSCT.

**Note:** The dynamic adapter configuration feature cannot be used to determine adapter characteristics for the following switch adapters:

- SP\_Switch\_MX2\_Adapter
- SP\_Switch2\_Adapter
- SP\_Switch2\_PCI\_Attachment\_Adapter
- SP\_Switch2\_MX2\_Adapter
- SP\_Switch2\_PCI-X\_Attachment\_Adapter

All adapter stanzas you define must be specified on this keyword. If the keyword is specified without defining any adapter stanza names no adapter will be configured for the machine.

### **adapter\_type**

Specifies the type of switch adapter to be used. This keyword is used for the High Performance Switch in a peer domain. The **llextrPD** command will not generate an **adapter\_type** statement if no AdapterType is found in the cluster.

**Syntax:**

`adapter_type = type`

Where *type* is the designation for the type of switch adapter.

**admin** Specifies a list of administrators for a group or class.

**Syntax:**

`admin = list`

Where *list* is a blank-delimited list of administrators for either this class or this group, depending on whether this keyword appears in a class or group stanza, respectively. These administrators can hold, release, and cancel jobs in this class or this group.

**alias** Lists one or more alias names to associate with the machine name.

**Syntax:**

`alias = machine_name`

Where *machine\_name* is a blank-delimited list of one or more machine names. Depending upon your network configurations, you can need to add **alias** keywords for machines that have multiple interfaces.

In general, if your cluster is configured with machine host names which match the host names corresponding to the IP address configured for the LAN adapters which LoadLeveler is expected to use, you will not have to specify the **alias** keyword. For example, if all of the machines in your cluster are configured like this sample machine, you should not have to specify the **alias** keyword.

Machine `porsche.kgn.ibm.com`

- The hostname command returns `porsche.kgn.ibm.com`.
- The Ethernet adapter address 129.40.8.20 resolves to hostname `porsche.kgn.ibm.com`.

However, if any machine in your cluster is configured like either of the following two sample machines, then you will have to specify the **alias** keyword for those machines:

1. Machine `yugo.kgn.ibm.com`

- The hostname command returns `yugo.kgn.ibm.com`.
- The Ethernet adapter address 129.40.8.21 resolves to hostname `chevy.kgn.ibm.com`.
- No adapter address resolves to `yugo`.

You need to code the machine stanza as:

```
chevy: type = machine
alias = yugo
```

2. Machine `rover.kgn.ibm.com`

- The hostname command returns `rover.kgn.ibm.com`.
- The FDDI adapter address 129.40.9.22 resolves to hostname `rover.kgn.ibm.com`.
- The Ethernet adapter address 129.40.8.22 resolves to hostname `bmw.kgn.ibm.com`.
- No route exists via the FDDI adapter to the clusters central manager machine.

- A route exists from this machine to the central manager via the Ethernet adapter.

You need to code the machine stanza as:

```
bmw: type = machine
alias = rover
```

### **central\_manager**

Determines whether the machine is the LoadLeveler central manager.

#### **Syntax:**

```
central_manager = true| false | alt
```

Where:

- **true** designates this machine as the LoadLeveler central manager host, where the negotiator daemon runs. You must specify one and only one machine stanza identifying the central manager. For example:

```
machine_a: type = machine
central_manager = true
```

- **false** specifies that this machine is not the central manager.
- **alt** specifies that this machine can serve as an alternate central manager in the event that the primary central manager is not functioning. For more information on recovering if the primary central manager is not operating, refer to “What happens if the central manager isn’t operating?” on page 591. Submit-only machines cannot have their machine stanzas set to this value.

If you are going to select machines to serve as alternate central managers, you should look at the following keywords in the configuration file:

- **CENTRAL\_MANAGER\_HEARTBEAT\_INTERVAL**
- **CENTRAL\_MANAGER\_TIMEOUT**

For information on setting these keywords, see “Specifying alternate central managers” on page 37.

**Default:** false

### **ckpt\_dir**

Specifies the directory to be used for checkpoint files for jobs that did not specify this directory in the job command file.

#### **Syntax:**

```
ckpt_dir = directory
```

Where *directory* is the directory location to be used for checkpoint files that did not have a directory name specified in the job command file. If the value specified does not have a fully qualified directory path (including the beginning forward slash), the initial working directory will be inserted before the specified value.

The value specified by the **ckpt\_dir** keyword is only used when the **ckpt\_file** keyword in the job command file does not contain a full path name and the **ckpt\_dir** keyword in the job command file is not specified. For more information on determining the checkpoint directory, see “Naming checkpoint files and directories” on page 134.

**Default:** Initial working directory

### ckpt\_time\_limit

Specifies the hard limit, soft limit, or both limits for the elapsed time that checkpointing a job can take.

#### Syntax:

```
ckpt_time_limit = hardlimit,softlimit
```

Where *hardlimit,softlimit* defines the maximum time that checkpointing a job can take. When LoadLeveler detects that the softlimit has been exceeded, it attempts to end the checkpoint and allow the job to continue. If this is not possible, and the hard limit is exceeded, LoadLeveler will terminate the job. The start time of the checkpoint is defined as the time when the Startd daemon receives status from the starter that a checkpoint has started.

**Default:** Unlimited

#### Examples:

```
ckpt_time_limit = 30:45 #hardlimit - 30 minutes 45 seconds
ckpt_time_limit = 30:45,25:00 #hardlimit - 30 minutes 44 seconds
 #softlimit - 25 minutes
```

For additional information about limit keywords, see the following topics:

- “Syntax for limit keywords” on page 288
- “Using limit keywords” on page 83

### class\_comment

Text characterizing the class.

#### Syntax:

```
class_comment = "string"
```

Where *string* is text characterizing the class. This information appears when the user is building a job command file using the GUI and requests Choice information on the classes to which he or she is authorized to submit jobs. The comment string associated with this keyword cannot contain an equal sign (=) or a colon (;) character. The length of the string cannot exceed 1024 characters.

**Default:** No default value is set.

### core\_limit

Specifies the hard limit, soft limit, or both limits for the size of a core file a job can create.

#### Syntax:

```
ore_limit = hardlimit,softlimit
```

#### Examples:

```
core_limit = unlimited
core_limit = 30mb
```

For additional information about limit keywords, see the following topics:

- “Syntax for limit keywords” on page 288
- “Using limit keywords” on page 83

### cpu\_limit

Specifies hard limit, soft limit, or both limits for the CPU time to be used by each individual process of a job step.

**Syntax:**

```
cpu_limit = hardlimit,softlimit
```

For example, if you impose a **cpu\_limit** of five hours and you have a job step composed of five processes, each process can consume five CPU hours; the entire job step can therefore consume 25 total hours of CPU.

**Examples:**

```
cpu_limit = 12:56:21 # hardlimit = 12 hours 56 minutes 21 seconds
cpu_limit = 56:00,50:00 # hardlimit = 56 minutes 0 seconds
 # softlimit = 50 minutes 0 seconds
cpu_limit = 1:03 # hardlimit = 1 minute 3 seconds
cpu_limit = unlimited # hardlimit = 2,147,483,647 seconds
 # (X'7FFFFFFF')
cpu_limit = rlim_infinity # hardlimit = 2,147,483,647 seconds
 # (X'7FFFFFFF')
cpu_limit = copy # current CPU hardlimit value on the
 # submitting machine.
```

For additional information about limit keywords, see the following topics:

- “Syntax for limit keywords” on page 288
- “Using limit keywords” on page 83

**cpu\_speed\_scale**

Determines whether CPU time is normalized according to machine speed.

**Syntax:**

```
cpu_speed_scale = true | false
```

Where **true** specifies that CPU time (which is used, for example, in setting limits, in accounting information, and reported by the **llq -x** command), is in normalized units for each machine. **false** specifies that CPU time is in native units for each machine. For an example of using this keyword to normalize accounting information, see “Example: Setting up job accounting files” on page 61.

**Default:** **false**

**css\_type**

Designates the type of switch adapter to be used.

**Syntax:**

```
css_type = type
```

Where *type* is one of the following choices:

- SP\_Switch\_MX2\_Adapter
- SP\_Switch2\_Adapter

This keyword must be specified in combination with a switch adapter (“css . . .”), otherwise it will be ignored. The *css\_type* attribute for the available adapters are defined in the SDR. Use the command **SDRGetObjects Adapter css\_type** to obtain a list of *css\_types*, or use **llexstSDR** to obtain all of the adapter information from the SDR.

**data\_limit**

Specifies hard limit, soft limit, or both for the data segment to be used by each process of the submitted job.

**Syntax:**

```
data_limit = hardlimit,softlimit
```

### Examples:

```
data_limit = 125621 # hardlimit = 125621 bytes
data_limit = 5621kb # hardlimit = 5621 kilobytes
data_limit = 2mb # hardlimit = 2 megabytes
data_limit = 2.5mw # hardlimit = 2.5 megawords
data_limit = unlimited # hardlimit = 9,223,372,036,854,775,807 bytes
 # (X'7FFFFFFFFFFFFFFF')
data_limit = rlim_infinity # hardlimit = 9,223,372,036,854,775,807 bytes
 # (X'7FFFFFFFFFFFFFFF')
data_limit = copy # copy data hardlimit value from
 # submitting machine.
```

For additional information about limit keywords, see the following topics:

- “Syntax for limit keywords” on page 288
- “Using limit keywords” on page 83

### dce\_host\_name

Specifies the DCE host name of this machine.

#### Syntax:

```
dce_host_name = dce_hostname
```

Where *dce hostname* is the DCE hostname of this machine. Use either the “**SDRGetObjects Node dcehostname**” or **llexSDR** command to obtain a listing of DCE host names of nodes on an SP system.

### default\_class

Specifies a class name that is the default value assigned to jobs submitted by users for which no class statement appears.

#### Syntax:

```
default_class = list
```

Where *list* is a blank-delimited list of class names used for jobs which do not include a **class** statement in the job command file. If you specify only one default class name, this class is assigned to the job. If you specify a list of default class names, LoadLeveler searches the list to find a class which satisfies the resource limit requirements. If no class satisfies these requirements, LoadLeveler rejects the job.

Suppose a job requests a CPU limit of 10 minutes. Also, suppose the default class list is `default_class = short long`, where `short` is a class for jobs up to five minutes in length and `long` is a class for jobs up to one hour in length. LoadLeveler will select the `long` class for this job because the `short` class does not have sufficient resources.

**Default:** If no **default\_class** is specified in the user stanza, or if there is no user stanza at all, then jobs submitted without a **class** statement are assigned to the **default\_class** that appears in the default user stanza. If you do not define a **default\_class**, jobs are assigned to the class called **No\_Class**.

### default\_group

Specifies the default group name to which the user belongs.

#### Syntax:

```
default_group = group_name
```

Where *group\_name* is the default group assigned to jobs submitted by the user.

If you specify **default\_group = Unix\_Group**, LoadLeveler sets the user's LoadLeveler group to his or her current UNIX group.

**Default:** If a **default\_group** statement does not appear in the user stanza, or if there is no user stanza at all, then jobs submitted by the user without a **group** statement are assigned to the **default\_group** that appears in the default user stanza. If you do not define a **default\_group**, jobs are assigned to the group called **No\_Group**.

#### **default\_interactive\_class**

Specifies a class to which interactive jobs are assigned for jobs submitted by users who do not specify a class using the `LOADL_INTERACTIVE_CLASS` variable. You can specify only one default interactive class name.

##### **Syntax:**

```
default_interactive_class = class_name
```

Where *class\_name* is the class to which an interactive job submitted by this user is assigned if the user does not specify a class using the `LOADL_INTERACTIVE_CLASS` environment variable.

**Default:** If you do not set a **default\_interactive\_class** value in the user stanza, or if there is no user stanza at all, then interactive jobs submitted without a **class** statement are assigned to the **default\_interactive\_class** that appears in the default user stanza. If you do not define a **default\_interactive\_class**, interactive jobs are assigned to the class called **No\_Class**.

See "Examples: User stanzas" on page 88 for more information on how LoadLeveler assigns a default interactive class to jobs.

#### **default\_resources**

Specifies the default amount of resources consumed by a task of a job step, provided that no **resources** keyword is coded for the step in the job command file. If a resources keyword is coded for a job step, then it overrides any **default resources** associated with the associated job class.

##### **Syntax:**

```
default_resources = name(count) name(count)...name(count)
```

The administrator defines the name and count values for **default\_resources**. In addition, *name(count)* could be **ConsumableCpus(count)**, **ConsumableMemory(count units)**, or **ConsumableVirtualMemory(count units)**.

**ConsumableMemory** and **ConsumableVirtualMemory** are the only two consumable resources that can be specified with both a count and units. The count for each specified resource must be an integer greater than or equal to zero. The allowable units are those normally used with LoadLeveler data limits:

```
b bytes
w words
kb kilobytes (2**10 bytes)
kw kilowords (2**12 bytes)
mb megabytes (2**20 bytes)
mw megawords (2**22 bytes)
gb gigabytes (2**30 bytes)
gw gigawords (2**32 bytes)
tb terabytes (2**40 bytes)
```

tw terawords (2\*\*42 bytes)  
 pb petabytes (2\*\*50 bytes)  
 pw petawords (2\*\*52 bytes)  
 eb exabytes (2\*\*60 bytes)  
 ew exawords (2\*\*62 bytes)

The **ConsumableMemory** and **ConsumableVirtualMemory** values are stored in MB (megabytes) and rounded up. Therefore, the smallest amount of **ConsumableMemory** or **ConsumableVirtualMemory** which you can request is one megabyte. If no units are specified, then megabytes are assumed. Resources defined here that are not in the **SCHEDULE\_BY\_RESOURCES** list in the global configuration file will not effect the scheduling of the job.

### device\_driver\_name

Specifies the device driver interface needed for user space function.

#### Syntax:

device\_driver\_name = *name*

Where *name* specifies the device driver interface. A **device\_driver\_name** will be present for all adapter stanzas whose name begins with **sn** This keyword is for peer domain switch adapters.

### env\_copy

Specifies a default value for the job command file **env\_copy** keyword for the class, group or user stanza containing the keyword.

#### Syntax:

env\_copy = **all** | master

Table 44 states the value that LoadLeveler uses depending on the combination of values set in the user, group, or class stanzas.

Table 44. Summary of possible values set for the **env\_copy** keyword in the administration file

| env_copy keyword setting in applicable stanzas in the administration file         | Resulting LoadLeveler default behavior for copying the job environment             |
|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| All stanzas that set the <b>env_copy</b> keyword specify <b>env_copy</b> = master | master becomes the default value for the job command file <b>env_copy</b> keyword. |
| One or more stanzas explicitly set <b>env_copy</b> = all                          | all becomes the default value for the job command file <b>env_copy</b> keyword.    |
| The <b>env_copy</b> keyword is not specified in any stanza                        |                                                                                    |

**Default value:** No default value is set.

For more information, see:

- The job command file env\_copy keyword description on page 336.
- “Steps for reducing job launch overhead for parallel jobs” on page 94.

### exclude\_classes

**exclude\_classes** can be specified within a cluster stanza.

Specifies a blank-delimited list of one or more job classes that will not accept remote jobs within the cluster.

#### Syntax:

```
exclude_classes = class_name[(cluster_name)] ...
```

Where *class\_name* specifies a class to be excluded and *cluster\_name* can be used to specify that remote jobs from *cluster\_name* submitted under *class\_name* will be excluded but any other jobs submitted under *class\_name* from other clusters will be allowed.

Do not specify a list of **exclude\_classes** and **include\_classes**. Only one of these keywords can be used within any cluster stanza. **exclude\_classes** takes precedence over **include\_classes** if both are specified.

**Default:** The default is that no classes are excluded.

## **exclude\_groups**

**exclude\_groups** can be specified within a class stanza and a cluster stanza.

### Class stanza:

When used within a class stanza, **exclude\_groups** specifies a list of group names identifying those who cannot submit jobs of a particular class.

### **Syntax:**

```
exclude_groups = list
```

Where *list* is a blank-delimited list of groups who are *not* allowed to submit jobs of *class name*.

This list can contain individual user names. To allow a list of users to be included with the list of group names, add a plus sign (+) to each user name that you add to the list. LoadLeveler treats these names as implicit groups.

For example, to add user **mike** to a list of group names, specify:

```
exclude_groups = prod +mike
```

If the string **+mike** is also the actual name of a group stanza, LoadLeveler treats this name as a group, not an implicit group. In this case, LoadLeveler will not prevent user **mike** from submitting jobs to this class unless the user is a member of the **prod** or **+mike** group.

If this keyword is specified, this list limits groups and users of that class to those on the list.

Do not specify both a list of included groups and a list of excluded groups. Only one of these may be used for any class stanza. **exclude\_groups** takes precedence over **include\_groups** if both are specified.

**Default:** The default is that no groups are excluded.

### Cluster stanza:

When used within a cluster stanza, **exclude\_groups** specifies a blank-delimited list of one or more groups that will not accept remote jobs within the cluster.

### **Syntax:**

```
exclude_groups = group_name[(cluster_name)] ...
```

Where *group\_name* specifies a group that is not allowed to submit remote jobs and *cluster\_name* can be used to specify that remote jobs from *cluster\_name* submitted under *group\_name* will be excluded but any other jobs submitted under *group\_name* from other clusters will be allowed.

Do not specify a list of **exclude\_groups** and **include\_groups**. Only one of these may be used within any cluster stanza. **exclude\_groups** takes precedence over **include\_groups** if both are specified.

**Default:** The default is that no groups are excluded.

### **exclude\_users**

**exclude\_users** may be specified within a class, group, and cluster stanza.

#### **Class or group stanza:**

When used within a class or group stanza **exclude\_users** specifies a list of user names identifying those who cannot submit jobs of a particular class or who are not members of the group.

#### **Syntax:**

`exclude_users = list`

The definition of this keyword varies slightly, depending on the type of administration file stanza in which the keyword appears:

- In a class stanza: *list* is a blank-delimited list of users who are *not* permitted to submit jobs of *class\_name*.
- In a group stanza: *list* is a blank-delimited list of users who do not belong to the group.

Do not specify both a list of included users and a list of excluded users. Only one of these may be used for any class or group. **exclude\_users** takes precedence over **include\_users** if both are specified.

**Default:** The default is that no users are excluded.

#### **Cluster stanza:**

When used within a cluster stanza, **exclude\_users** specifies a blank-delimited list of one or more users who cannot submit jobs to the cluster.

#### **Syntax:**

`exclude_users = user_name[(cluster_name)] ...`

Where *user\_name* specifies a user that is not allowed to submit remote jobs and *cluster\_name* can be used to specify that remote jobs from *cluster\_name* submitted under the *user\_name* will be excluded but any other jobs submitted under that *user\_name* from other clusters will be allowed.

Do not specify a list of **exclude\_users** and **include\_users**. Only one of these may be used within any cluster stanza. **exclude\_users** takes precedence over **include\_users** if both are specified.

**Default:** The default is that no users are excluded.

**file\_limit**

Specifies the hard limit, soft limit, or both limits for the size of a file that a job can create.

**Syntax:**

`file_limit = hardlimit,softlimit`

For additional information about limit keywords, see the following topics:

- “Syntax for limit keywords” on page 288
- “Using limit keywords” on page 83

**inbound\_hosts**

Specifies a blank-delimited list of hostnames that define the machines configured for inbound connections from other clusters.

**Syntax:**

`inbound_hosts = hostname[(cluster_name)] ...`

Where *hostname* specifies a machine configured for inbound connections from other clusters and *cluster\_name* can be used to specify a specific cluster if the host is not connected to all clusters in the multicluster. These hostnames must be fully qualified with domain names if the machines exist in a different domain. This keyword is required in a multicluster environment.

**Note:** The same machine can be defined as both an **inbound\_host** and an **outbound\_host**.

**inbound\_schedd\_port**

Specifies the port number to use to connect to the Schedd for inbound transactions to this cluster.

**Syntax:**

`inbound_schedd_port = port_number`

Where *port\_number* is a positive integer which specifies the port number used to connect to the Schedd for inbound transactions to this cluster.

**Default:** The default port is 9605.

**include\_classes**

**include\_classes** can be specified within a cluster stanza.

Specifies a blank-delimited list of one or more job classes that will accept remote jobs within the cluster.

**Syntax:**

`include_classes = class_name[(cluster_name)] ...`

Where *class\_name* specifies a class to be included and *cluster\_name* can be used to specify that remote jobs from *cluster\_name* will be included but any other jobs submitted under *class\_name* from other clusters will not be allowed.

Do not specify a list of **exclude\_classes** and **include\_classes**. Only one of these can be used within any cluster stanza. **exclude\_classes** takes precedence over **include\_classes** if both are specified.

**Default:** The default is that all classes are included.

### **include\_groups**

**include\_groups** can be specified within a class stanza and a cluster stanza.

#### **Class stanza:**

When used within a class stanza, **include\_groups** specifies a list of group names identifying those who can submit jobs of a particular class.

#### **Syntax:**

```
include_groups = list
```

Where *list* is a blank-delimited list of groups who are allowed to submit jobs of *class name*.

This list can contain individual user names. To allow a list of users to be included with the list of group names, add a plus sign (+) to each user name that you add to the list. LoadLeveler treats these names as implicit groups.

For example, to add user **mike** to a list of group names, specify:

```
exclude_groups = prod +mike
```

If the string **+mike** is also the actual name of a group stanza, LoadLeveler treats this name as a group, not an implicit group. In this case, LoadLeveler will not allow user **mike** to submit jobs to this class unless the user is a member of the **prod** or **+mike** group.

If this keyword is specified, this list limits groups and users of that class to those on the list.

Do not specify both a list of included groups and a list of excluded groups. Only one of these may be used for any class stanza. **exclude\_groups** takes precedence over **include\_groups** if both are specified.

**Default:** The default is that all groups are included.

#### **Cluster stanza:**

When used within a cluster stanza, **include\_groups** specifies a blank-delimited list of one or more groups that will accept remote jobs within the cluster.

#### **Syntax:**

```
include_groups = group_name[(cluster_name)] ...
```

Where *group\_name* specifies a group that is allowed to submit remote jobs and *cluster\_name* can be used to specify that remote jobs from *cluster\_name* submitted under *group\_name* will be included but any other jobs submitted under *group\_name* from other clusters will not be allowed.

Do not specify a list of **exclude\_groups** and **include\_groups**. Only one of these may be used within any cluster stanza. **exclude\_groups** takes precedence over **include\_groups** if both are specified.

**Default:** The default is that all groups are included.

### **include\_users**

**include\_users** may be specified within a class, group, and cluster stanza.

#### **Class or group stanza:**

When used within a class or group stanza **include\_users** specifies a list of user names identifying those who can submit jobs of a particular class or who are members of the group.

#### **Syntax:**

```
include_users = list
```

The definition of this keyword varies slightly, depending on the type of administration file stanza in which the keyword appears:

- In a class stanza: *list* is a blank-delimited list of users who are permitted to submit jobs of *class\_name*.
- In a group stanza: *list* is a blank-delimited list of users who belong to the group.

Do not specify both a list of included users and a list of excluded users. Only one of these may be used for any class or group. **exclude\_users** takes precedence over **include\_users** if both are specified.

**Default:** The default is that all users are included.

#### **Cluster stanza:**

When used within a cluster stanza, **include\_users** specifies a blank-delimited list of one or more users who can submit jobs to the cluster.

#### **Syntax:**

```
include_users = user_name[(cluster_name)] ...
```

Where *user\_name* specifies a user that is allowed to submit remote jobs and *cluster\_name* can be used to specify that remote jobs from *cluster\_name* submitted under the *user\_name* will be included but any other jobs submitted under that *user\_name* from other clusters will not be allowed.

Do not specify a list of **exclude\_users** and **include\_users**. Only one of these may be used within any cluster stanza. **exclude\_users** takes precedence over **include\_users** if both are specified.

**Default:** The default is that all users are included.

### **interface\_address**

Specifies the IP address by which the adapter is known to other nodes in the network.

#### **Syntax:**

```
interface_address = string
```

Where *string* is the IP address by which the adapter is known to other nodes in the network. For example: 7.14.21.28. This keyword is required.

### **interface\_name**

Specifies the name by which the adapter is known to other nodes in the network.

**Syntax:**

```
interface_name = string
```

Where *string* is the name by which the adapter is known by other nodes in the network.

**job\_cpu\_limit**

Specifies the hard limit, soft limit, or both limits for the total amount of CPU time that all tasks of an individual job step can use per machine.

**Syntax:**

```
job_cpu_limit = hardlimit,softlimit
```

**Example:**

```
job_cpu_limit = 10000
```

For more information on this keyword, see:

- **JOB\_LIMIT\_POLICY** on page “Collecting job resource data on serial and parallel jobs” on page 58
- For additional information about limit keywords, see the following topics:
  - Syntax for limit keywords
  - Using limit keywords

**local** Specifies the scope of the cluster definition.

**Syntax:**

```
local = true | false
```

This keyword is required in the local cluster’s administration file in a multicluster environment.

**Default: false**

**logical\_id**

Specifies the logical ID that uniquely identifies the adapter on its network.

**Syntax:**

```
logical_id = id
```

This keyword is for peer domain switch adapters.

**machine\_mode**

Specifies the type of jobs this machine can run.

**Syntax:**

```
machine_mode = batch | interactive | general
```

Where:

- |                    |                                                                                                           |
|--------------------|-----------------------------------------------------------------------------------------------------------|
| <b>batch</b>       | Specifies this machine can run only batch jobs.                                                           |
| <b>interactive</b> | Specifies this machine can run only interactive jobs. Only POE is currently enabled to run interactively. |
| <b>general</b>     | Specifies this machine can run both batch jobs and interactive jobs.                                      |

**Default: general**

**master\_node\_exclusive**

Specifies whether or not this machine is used only as a master node.

**Syntax:**

```
master_node_exclusive = true| false
```

Where **true** specifies that the machine accepts only jobs (serial or parallel) submitted to classes that have **master\_node\_requirement** set to **true**. If the job type is parallel, only the master task is run on a machine with **master\_node\_exclusive** set to **true**.

**Note:** **master\_node\_exclusive** is ignored by the Gang scheduler.

**Default:** false

**master\_node\_requirement**

Specifies whether or not parallel jobs in this class require the master node feature.

**Syntax:**

```
master_node_requirement = true| false
```

Where **true** specifies that parallel jobs do require the master node feature. For these jobs, LoadLeveler allocates the first node (called the “master”) on a machine having the **master\_node\_exclusive = true** setting in its machine stanza. If most or all of your parallel jobs require this feature, you should consider placing the statement **master\_node\_requirement = true** in your default class stanza. Then, for classes that do not require this feature, you can use the statement **master\_node\_requirement = false** in their class stanzas to override the default setting. One machine per class should have the **true** setting; if more than one machine has this setting, normal scheduling selection is performed.

**Note:** **master\_node\_requirement** is ignored by Gang scheduler.

**Default:** false

**max\_jobs\_scheduled**

Specifies the maximum number of job steps that this machine can run.

**Syntax:**

```
max_jobs_scheduled = number
```

Where *number* is the maximum number of jobs submitted from this scheduling (schedd) machine that can run (or start running) in the LoadLeveler cluster at one time. If *number* of jobs are already running, no other jobs submitted from this machine will run, even if resources are available in the LoadLeveler cluster. When one of the running jobs completes, any waiting jobs then become eligible to be run.

**Default:** The default is -1, which means there is no maximum.

**max\_node**

Specifies the maximum number of nodes that can be requested for a particular class or by a particular user or group for a parallel job.

**Syntax:**

```
max_node = number
```

Where *number* specifies the maximum number of nodes for a parallel job in a job command file using the **node** keyword. The **max\_node** keyword will not affect the use of the **min\_processors** and **max\_processors** keywords in the job command file.

**Default:** The default is -1, which means there is no limit.

### **max\_processors**

Specifies the maximum number of processors that can be requested for a particular class or by a particular user or group for a parallel job.

#### **Syntax:**

`max_processors = number`

Where *number* specifies the maximum number of processors for a parallel job in a job command file using the **min\_processors** and **max\_processors** keywords.

**Default:** The default is -1 which means that there is no limit.

### **max\_protocol\_instances**

Specifies the maximum number of instances on the network statement.

#### **Syntax:**

`max_protocol_instances = number`

Where *number* specifies the maximum value allowed on the instances keyword on the network statement for jobs submitted on this class.

**Default:** The default is 2.

### **max\_reservation\_duration**

Specifies the maximum time, in minutes, that advance reservations made for this user or group can last.

#### **Syntax:**

`max_reservation_duration = number of minutes`

When the duration is defined in both the user and group stanza for a specific user, LoadLeveler uses the more restrictive of the two values to determine the maximum duration.

**Default:** The default is -1, which means that no limit is placed on the duration of the reservation.

For more information, see “Steps for configuring reservations in a LoadLeveler cluster” on page 120.

### **max\_reservations**

Specifies the maximum number of advance reservations that this user or group can make.

#### **Syntax:**

`max_reservations = number of reservations`

This number includes all reservations except those in COMPLETE or CANCEL state.

Table 45 summarizes the resulting behavior for various sample combinations of **max\_reservations** settings in user and group stanzas.

Table 45. Sample user and group settings for the *max\_reservations* keyword

| When the user stanza value is: | And the group stanza value is: | Then the user can create this number of reservations in this group: |
|--------------------------------|--------------------------------|---------------------------------------------------------------------|
| Not defined                    | Not defined                    | 0 (zero)                                                            |
| 2                              | Not defined                    | 2 (with any group as the owning group)                              |
| Not defined                    | 1                              | 1                                                                   |
| 3                              | 1                              | 1 (the user can create more reservations in other groups)           |
| 1                              | 2                              | 1                                                                   |
| 0                              | 2                              | 0                                                                   |
| 1                              | 0                              | 0 (the user can create one reservation in another group)            |

**Default:** Undefined, which means that no reservations will be authorized or disallowed. LoadLeveler considers this keyword undefined if negative values are set for it.

#### **max\_total\_tasks**

Specifies the maximum number of tasks that the Backfill or Gang scheduler allows a user, group, or class to run at any given time.

##### **Syntax:**

`max_total_tasks = number`

where *number* is -1, 0, or any positive integer.

**Default:** The default value for this keyword is -1, which allows an unlimited number of tasks.

#### **maxidle**

Specifies the maximum number of idle job steps this user or group can have simultaneously.

##### **Syntax:**

`maxidle = number`

Where *number* is the maximum number of idle jobs either this user or this group can have in queue, depending on whether this keyword appears in a user or group stanza. That is, *number* is the maximum number of jobs which the negotiator will consider for dispatch for the user or group. Jobs above this maximum are placed in the NotQueued state. This action prevents one of the following situations:

- Individual users from dominating the number of jobs that are either running or are being considered to run.
- Groups from flooding the job queue.

**Default:** If the user or group stanza does not specify **maxidle** or if there is no user or group stanza at all, the maximum number of jobs that can be simultaneously in queue for the user or group is defined in the default stanza. If no value is found, or the limit found is -1, then no limit is placed on the number of jobs that can be simultaneously idle for the user or group.

For more information, see “Controlling the mix of idle and running jobs” on page 599.

### **maxjobs**

Specifies the maximum number of job steps this user, class, or group can have running simultaneously.

#### **Syntax:**

`maxjobs = number`

The definition of this keyword varies slightly, depending on the type of administration file stanza in which the keyword appears:

- In a class stanza: *number* is the maximum number of jobs that can run in this class.
- In a user stanza: *number* is the maximum number of jobs this user can run at any time.
- In a group stanza: *number* is a maximum number of jobs this group can run at any time.

**Default:** If the stanza does not specify **maxjobs**, or if there is no class, user, or group stanza at all, the maximum jobs is defined in the default stanza. The default is -1, which means:

- In a class stanza: No limit is placed on the number of jobs a user can submit.
- In a user stanza: No limit is placed on the number of jobs that can simultaneously run for the user. Regardless of this limit, there is no limit to the number of jobs a user can submit.
- In a group stanza: No limit is placed on the number of jobs that can be simultaneously run for the group. Regardless of the limit set to running jobs, there is no limit to the number of jobs that a group can submit.

For more information, see “Controlling the mix of idle and running jobs” on page 599.

### **maxqueued**

Specifies the maximum number of job steps a single group or user can have queued at the same time.

#### **Syntax:**

`maxqueued = number`

Where *number* is the maximum number of jobs allowed in the queue for this user or group, depending on whether this keyword appears in a user or group stanza. This is the maximum number of jobs which can be either running or being considered to be dispatched by the negotiator for that user or group. Jobs above this maximum are placed in the NotQueued state. This action prevents one of the following situations:

- Individual users from dominating the number of jobs that are either running or are being considered to run.
- Groups from flooding the job queue.

**Default:** If the user or group stanza does not specify **maxqueued** or if there is no user or group stanza at all, the maximum number of jobs that can be simultaneously in queue for the user or group is defined in the default stanza. If no value is found, or the limit found is -1, then no limit is

placed on the number of jobs that can be simultaneously idle for the user or group. Regardless of this limit, there is no limit to the number of jobs a user or group can submit.

For more information, see “Controlling the mix of idle and running jobs” on page 599.

#### **multiclust<sub>er</sub>\_security**

Specifies a security mechanism to use for authentication and authorization of intercluster communications.

##### **Syntax:**

`multicluster_security = SSL`

The only valid specification for this keyword is **SSL**. When **SSL** is specified, LoadLeveler uses the OpenSSL library to provide secure intercluster transactions. If this keyword is omitted or left blank and the **MACHINE\_AUTHENTICATE** in the configuration file is set to **true**, then LoadLeveler will accept intercluster transactions only from machines listed as **inbound\_hosts** or **outbound\_hosts** in the administration file. Otherwise, intercluster transactions are accepted from any machine.

For more information, see “Steps for securing communications within a LoadLeveler multiclust<sub>er</sub>” on page 142.

#### **multilink\_<sub>address</sub>**

Specifies the multilink address used for IP striping on the associated adapter.

##### **Syntax:**

`multilink_address = ip_address`

Where *ip\_<sub>address</sub>* indicates the IP address that includes the adapters that can be striped across.

#### **multilink\_<sub>list</sub>**

Specifies the IP addresses of the adapters that this multilink device stripes across.

##### **Syntax:**

`multilink_list = adapter_name <, adapter_name>*`

Where *adapter\_<sub>name</sub>* indicates multilinked devices which stripes IP addresses across the adapters given in the list.

#### **name\_<sub>server</sub>**

Specifies a list of name servers used for a machine.

##### **Syntax:**

`name_server = list`

Where *list* is a blank-delimited list of character strings that is used to specify which nameservers are used for the machine. Valid strings are DNS, NIS, and LOCAL. LoadLeveler uses the list to determine when to append a DNS domain name for machine names specified in LoadLeveler commands issued from the machine described in this stanza.

If DNS is specified alone, LoadLeveler will always append the DNS domain name to machine names specified in LoadLeveler commands. If

## Administration file reference

NIS or LOCAL is specified, LoadLeveler will never append a DNS domain name to machine names specified in LoadLeveler commands. If DNS is specified with either NIS or LOCAL, LoadLeveler will always look up the name in the administration file to determine whether to append a DNS domain name. If the name is specified with a trailing period, it doesn't append the domain name.

### **network\_id**

Specifies a unique numerical network identifier. This value is set by the **llextrPD** command and should not be changed.

#### **Syntax:**

`network_id = number`

**Default:** No default value is set.

### **network\_type**

#### **Syntax:**

`network_type = string`

Where *string* specifies the type of network that the adapter supports (for example, Ethernet). This should be unique for each communication path (for example, **css0** and **css1** define two different communication paths). This is an administrator defined name. This keyword defines the types of networks a user can specify in a job command file using the **network** keyword.

**Default:** No default value is set.

**nice** Increments the *nice* value of a job.

#### **Syntax:**

`nice = value`

Where *value* is the amount by which the current UNIX *nice* value is incremented. The *nice* value is one factor in a job's run priority. The lower the number, the higher the run priority. If two jobs are running on a machine, the *nice* value determines the percentage of the CPU allocated to each job.

This value ranges from -20 to 20. Values out of this range are placed at the top (or bottom) of the range. For example, if your current *nice* value is 15, and you specify `nice = 10`, the resulting value is 20 (the upper limit) rather than 25. The default is 0.

If the administrator has decided to enforce consumable resources, the *nice* value will only adjust priorities of processes within the same WLM class. Because LoadLeveler defines a single class for every job step, the *nice* value has no effect.

For more information, consult the appropriate UNIX documentation.

### **NQS\_class**

Specifies whether any job submitted to this class is routed to an NQS machine.

**Restriction:** LoadLeveler for Linux does not support NQS jobs.

#### **Syntax:**

`NQS_class = true|false`

When **true**, any job submitted to this class will be routed to an NQS machine.

**Default:** false

### NQS\_query

Specifies a list of queue names to use to monitor and cancel jobs.

**Restriction:** LoadLeveler for Linux does not support NQS jobs.

**Syntax:**

`NQS_query = queue names`

Where *queue names* is a blank-delimited list of queue names (including host names if necessary) to be used with the **qstat** command to monitor the job and with the **qdel** command to cancel the job.

**Default:** No default value is set.

### NQS\_submit

Specifies a name that identifies the name of the NQS pipe queue to which the job will be routed.

**Restriction:** LoadLeveler for Linux does not support NQS jobs.

**Syntax:**

`NQS_submit = name`

Where *name* is the name of the NQS pipe queue to which the job will be routed. When the job is dispatched to LoadLeveler, LoadLeveler will invoke the **qsub** command using the name of this queue.

**Default:** No default value is set.

### outbound\_hosts

Blank-delimited list of hostnames that define the machines configured for outbound connections to other clusters.

**Syntax:**

`outbound_hosts = hostname[(cluster_name)] ...`

Where *hostname* specifies a machine configured for outbound connections to other clusters and *cluster\_name* can be used to specify a specific cluster if the host is not connected to all clusters in the multicluster. These hostnames must be fully qualified with domain names if the machines exist in a different domain. This keyword is required in a multicluster environment.

**Note:** The same machine can be defined as both an **outbound\_host** and an **inbound\_host**.

### pool\_list

Specifies a list of pool numbers to which the machine belongs. Do not use negative numbers in a machine pool\_list.

**Syntax:**

`pool_list = pool_numbers`

Where *pool\_numbers* is a blank-delimited list of non-negative numbers identifying pools to which the machine belongs. These numbers can be any positive integers including zero.

### priority

Identifies the priority of the appropriate user, class, or group.

#### Syntax:

`priority = number`

Where *number* is a integer that specifies the priority for jobs either in this class, or submitted by this user or group, depending on whether this keyword appears in a class, user, or group stanza, respectively.

The number specified for priority is referenced as either **ClassSysprio**, **UserSysprio**, or **GroupSysprio** in the configuration file. You can use **ClassSysprio**, **UserSysprio**, or **GroupSysprio** when assigning job priorities. If the variable **ClassSysprio**, **UserSysprio**, or **GroupSysprio** does not appear in the **SYSPRIO** expression in the configuration file, then the priority specified in the administration file is ignored. See “LoadLeveler variables” on page 280 for more information about the **ClassSysprio**, **UserSysprio**, or **GroupSysprio** keywords.

**Default:** The default is 0.

### reservation\_permitted

Specifies whether the machine can be reserved through new reservation requests.

#### Syntax:

`reservation_permitted = true | false`

If the value of this keyword is changed to false for this machine when it already is reserved through existing reservations, LoadLeveler will reserve this machine until those existing reservations complete or are canceled.

**Default:** true, which means that this machine can be reserved through new reservation requests.

### resources

Specifies quantities of the consumable resources initially available on the machine.

#### Syntax:

`resources = name(count) name(count) ... name(count)`

Where *name(count)* is an administrator-defined name and count, or could also be **ConsumableCpus(count)**, **ConsumableMemory(count units)**, or **ConsumableVirtualMemory(count units)**. **ConsumableMemory** and **ConsumableVirtualMemory** are the only two consumable resources that can be specified with both a count and units. The count for each specified resource must be an integer greater than or equal to zero. The allowable units are those normally used with LoadLeveler data limits:

b bytes  
w words  
kb kilobytes (2\*\*10 bytes)  
kw kilowords (2\*\*12 bytes)  
mb megabytes (2\*\*20 bytes)  
mw megawords (2\*\*22 bytes)

```

gb gigabytes (2**30 bytes)
gw gigawords (2**32 bytes)
tb terabytes (2**40 bytes)
tw terawords (2**42 bytes)
pb petabytes (2**50 bytes)
pw petawords (2**52 bytes)
eb exabytes (2**60 bytes)
ew exawords (2**62 bytes)

```

The **ConsumableMemory** and **ConsumableVirtualMemory** resource values are stored in mb (megabytes) and rounded up. Therefore, the smallest amount of **ConsumableMemory** or **ConsumableVirtualMemory** which you can request is one megabyte. If no units are specified, then megabytes are assumed. Resources defined here that are not in the **SCHEDULE\_BY\_RESOURCES** list in the global configuration file will not effect the scheduling of the job.

For the **ConsumableCPUs** resource, a value of **all** can be specified instead of count. This indicates that the CPU resource value will be obtained from the Startd daemons. However, these resources will not be available for scheduling until the first **Startd** update.

Also for the **ConsumableCPUs**, when the **RSET\_SUPPORT** keyword is set to one of the options enabling affinity, a list of CPU IDs can be specified. A list within < > angle brackets indicates a list of CPU IDs. Only CPUs with logical IDs specified in the list will be considered available for LoadLeveler jobs. The following example specifies a list of CPUs:

```
resources = consumableCPUs< 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 >
```

CPU IDs can also be specified using a list of ranges:

```
resources = consumableCPUs< 0-6 10-16 >
```

If Rset support is enabled with either the **RSET\_MCM\_AFFINITY** or **RSET\_CONSUMABLE\_CPUS** option, this keyword must be used to specify the exact CPU logical IDs of consumable CPUs in the administration file. If the **all** reserved word is used, all CPUs will be considered by LoadLeveler.

The logical IDs of the CPUs available on a machine can be found issuing the `bindprocessor -q` command.

**Default:** No default value is set.

#### **rss\_limit**

Specifies the hard limit, soft limit, or both limits for the resident set size for a job.

##### **Syntax:**

```
rss_limit = hardlimit,softlimit
```

For additional information about limit keywords, see the following topics:

- “Syntax for limit keywords” on page 288
- “Using limit keywords” on page 83

#### **schedd\_fenced**

Specifies whether or not the central manager is to ignore connections from the schedd daemon running on this machine.

##### **Syntax:**

`schedd_fenced = true | false`

Where **true** specifies that the central manager ignores connections from the schedd daemon running on this machine. Use the **true** setting together with the `llctl -h host purgeschedd` command when you want to attempt to recover resources lost when a node running the schedd daemon fails. A **true** setting prevents conflicts from arising when a schedd machine is restarted while a purge is taking place. For more information, see “How do I recover resources allocated by a schedd machine?” on page 593.

**Default:** false

### **schedd\_host**

Specifies whether or not this machine is used to help submit-only machines access LoadLeveler hosts that run LoadLeveler jobs.

#### **Syntax:**

`schedd_host = true | false`

When **true** this keyword specifies that if a schedd is running on a machine that it will serve as a public scheduling machine. A public scheduling machine accepts job submissions from other machines in the LoadLeveler cluster. Jobs are submitted to a public scheduling machine if:

- The submission occurs on a machine which does not run the schedd daemon. These include submit-only machines and machines which are configured to run other LoadLeveler daemons but not the schedd daemon.
- The submission occurs on a machine which runs the schedd daemon but is configured to submit jobs to a public scheduling machine by having the **SCHEDD\_SUBMIT\_AFFINITY** keyword set to **false** in the global or local configuration file.

This keyword does not configure LoadLeveler to run the schedd daemon on a node. Use the configuration keyword **SCHEDD\_RUNS\_HERE** to run the schedd daemon on a node. Refer to 267 for more information.

**Default:** false

### **secure\_schedd\_port**

Specifies the port number to use to connect to the Schedd for secure inbound transactions to this cluster.

#### **Syntax:**

`secure_schedd_port = port_number`

Where *port\_number* is a positive integer that specifies the port number used to connect to the Schedd for secure inbound transactions to this cluster. This port is only used if the **multicluster\_security** keyword is set to **SSL**. The secure schedd port should be different from the normal schedd port.

**Default:** 9607

### **spacct\_exclude\_enable**

Specifies whether the SP accounting function is informed whenever this machine is being used exclusively by a particular job.

#### **Syntax:**

`spacct_exclude_enable = true | false`

Where **true** specifies that the accounting function on an SP system is informed that a job step has exclusive use of this machine. Note that your SP system must have exclusive user accounting enabled in order for this keyword to have an effect. For more information on SP accounting, see *Parallel System Support Programs for AIX: Administration Guide*, GC23-3899.

**Default:** **false**

**speed** Specifies the weight associated with the machine for scheduling purposes.

**Syntax:**

`speed = number`

Where *number* is a floating point number that is used for machine scheduling purposes in the **MACHPRIO** expression. For more information on machine scheduling and the MACHPRIO expression, see “Setting negotiator characteristics and policies” on page 36. In addition, the **speed** keyword is also used to define the weight associated with the machine. This weight is used when gathering accounting data on a machine basis.

To distinguish speed among different machines, you must include this value in the local configuration file. For information on how the **speed** keyword can be used to schedule machines, refer to “Setting negotiator characteristics and policies” on page 36.

**Default:** The default is 1.0.

**ssl\_cipher\_list**

Specifies a cipher list defining what encryption methods are available to OpenSSL when securing multicluster connections.

**Syntax:**

`ssl_cipher_list = cipher_list`

Where *cipher\_list* is a valid cipher list as documented by the OpenSSL **ciphers** command.

**Default:** This keyword will default to the “ALL:eNULL:!aNULL” string.

**stack\_limit**

Specifies the hard limit, soft limit, or both limits for the size of a stack.

**Syntax:**

`stack_limit = hardlimit,softlimit`

For additional information about limit keywords, see the following topics:

- Syntax for limit keywords
- Using limit keywords

**submit\_only**

Specifies whether or not this machine is a submit-only machine.

**Syntax:**

`submit_only = true| false`

Where **true** designates this as a submit-only machine. If you set this keyword to **true**, in the administration file set **central\_manager** and **schedd\_host** to **false**.

**Default:** false

### **switch\_node\_number**

Identifies the node on which the SP switch adapter is installed.

**Restriction:** This keyword is valid for pre-HPS network adapters.

#### **Syntax:**

`switch_node_number = integer`

Where *integer* specifies the node on which the SP switch adapter is installed. This keyword is required for SP switch adapters. Its value is defined in the `switch_node_number` field in the Node class in the SDR. This value must match the value in the `/spdata/sys1/st/switch_node_number` file of the Parallel System Support Programs (PSSP).

### **total\_tasks**

Specifies the maximum number of tasks that can be requested for a particular class or by a particular user or group for a parallel job.

#### **Syntax:**

`total_tasks = number`

Where *number* specifies the maximum number of tasks for a parallel job in a job command file using the **total\_tasks** keyword.

**Default:** The default is -1, which means there is no limit.

### **type** Identifies the type of stanza in the administration file.

#### **Syntax:**

`type = stanza_type`

Where *stanza\_type* is one of the following:

- Adapter
- Class
- Group
- Machine
- User

**Default:** No default value is set.

### **wall\_clock\_limit**

Specifies the hard limit, soft limit, or both limits for the amount of elapsed time for which a job can run.

#### **Syntax:**

`wall_clock_limit = hardlimit,softlimit`

Note that LoadLeveler uses the time the negotiator daemon dispatches the job as the start time of the job. When a job is checkpointed, vacated, and then restarted, the **wall\_clock\_limit** is not adjusted to account for the amount of time that elapsed before the checkpoint occurred. This keyword is not supported for NQS jobs.

If you are running the Backfill or Gang scheduler, you must set a wall clock limit either in the job command file or in a class stanza (for the class associated with the job you submit). LoadLeveler administrators should consider setting a default wall clock limit in a default class stanza. For

more information on setting a wall clock limit when using the Backfill or Gang scheduler, see “Choosing a scheduler” on page 35.

For additional information about limit keywords, see the following topics:

- “Syntax for limit keywords” on page 288
- “Using limit keywords” on page 83



---

## Chapter 13. Job command file reference

A LoadLeveler job consists of one or more job steps, each of which is defined in a single job command file. A job command file specifies the name of the job, as well as the job steps that you want to submit, and can contain other LoadLeveler statements.

| Subtask                                                              | Associated information (see . . . )                                                                                                       |
|----------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| To find out how to work with a job command file                      | Chapter 7, “Building and submitting jobs,” on page 157                                                                                    |
| To learn how to correctly specify the contents of a job command file | <ul style="list-style-type: none"><li>• “Job command file syntax”</li><li>• “Job command file keyword descriptions” on page 324</li></ul> |

---

### Job command file syntax

The following general rules apply to job command files.

- Keyword statements begin with # @. There can be any number of blanks between the # and the @.
- Comments begin with #. Any line whose first non-blank character is a pound sign (#) and is not a LoadLeveler keyword statement is regarded as a comment.
- Statement components are separated by blanks. You can use blanks before or after other delimiters to improve readability but they are not required if another delimiter is used.
- The back-slash (\) is the line continuation character. Note that the continued line must not begin with # @. If your job command file is the script to be executed, you must start the continued line with a #. See Figure 22 on page 161 and Figure 23 on page 162 for examples using the back-slash for line continuation.
- Keywords are *not* case sensitive. This means you can enter them in lower case, upper case, or mixed case.

### Serial job command file

Figure 35 is an example of a simple serial job command file which is run from the current working directory. The job command file reads the input file, **longjob.in1**, from the current working directory and writes standard output and standard error files, **longjob.out1** and **longjob.err1**, respectively, to the current working directory.

```
The name of this job command file is file.cmd.
The input file is longjob.in1 and the error file is
longjob.err1. The queue statement marks the end of
the job step.
#
@ executable = longjob
@ input = longjob.in1
@ output = longjob.out1
@ error = longjob.err1
@ queue
```

*Figure 35. Serial job command file*

### Parallel job command file

In addition to building job command files to submit serial jobs, you can also build job command files to submit parallel jobs. Before constructing parallel job command files, consult your LoadLeveler system administrator to see if your installation is configured for parallel batch job submission.

For more information on submitting parallel jobs, see “Working with parallel jobs” on page 168.

### Syntax for limit keywords

The syntax for setting a limit is:

```
limit_type = hardlimit,softlimit
```

For example:

```
core_limit = 120kb,100kb
```

To specify only a hard limit, you can enter, for example:

```
core_limit = 120kb
```

To specify only a soft limit, you can enter, for example:

```
core_limit = ,100kb
```

In a keyword statement, you cannot have any blanks between the numerical value (100 in the above example) and the units (kb). Also, you cannot have any blanks to the left or right of the comma when you define a limit in a job command file.

For limit keywords that refer to a data limit — such as **data\_limit**, **core\_limit**, **file\_limit**, **stack\_limit**, and **rss\_limit** — the hard limit and the soft limit are expressed as:

```
integer[.fraction][units]
```

The allowable units for these limits are:

```
b bytes
w words
kb kilobytes (2**10 bytes)
kw kilowords (2**12 bytes)
mb megabytes (2**20 bytes)
mw megawords (2**22 bytes)
gb gigabytes (2**30 bytes)
gw gigawords (2**32 bytes)
tb terabytes (2**40 bytes)
tw terawords (2**42 bytes)
pb petabytes (2**50 bytes)
pw petawords (2**52 bytes)
eb exabytes (2**60 bytes)
ew exawords (2**62 bytes)
```

If no units are specified for data limits, then bytes are assumed.

For limit keywords that refer to a time limit — such as **ckpt\_time\_limit**, **cpu\_limit**, **job\_cpu\_limit**, and **wall\_clock\_limit** — the hard limit and the soft limit are expressed as:

```
[[hours:]minutes:]seconds[.fraction]
```

Fractions are rounded to seconds.

You can use the following character strings with all limit keywords except the **copy** keyword for **wall\_clock\_limit**, **job\_cpu\_limit** and **ckpt\_time\_limit**:

|                      |                                                            |
|----------------------|------------------------------------------------------------|
| <b>rlim_infinity</b> | Represents the largest positive number.                    |
| <b>unlimited</b>     | Has same effect as <b>rlim_infinity</b> .                  |
| <b>copy</b>          | Uses the limit currently active when the job is submitted. |

## 64-bit support for job command file keywords

Users can assign 64-bit integer values to selected keywords in the job command file. System resource limits, with the exception of CPU limits, are treated by LoadLeveler daemons and commands as 64-bit limits.

Table 46 describes 64-bit support for specific job command file keywords.

Table 46. Notes on 64-bit support for job command file keywords

| Keyword name           | Notes                                                                                                                                                                                                                                              |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>ckpt_time_limit</b> | Not supported. The hard and soft time limits associated with this keyword are 32-bit integers. If a value that cannot be contained in a 32-bit integer is assigned to this limit, the value will be truncated to either 2147483647 or -2147483648. |
| <b>core_limit</b>      | 64-bit integer values may be assigned to this limit. Fractional specifications are allowed and will be converted to 64-bit integer values. Refer to the allowable units for these limits listed under "Syntax for limit keywords" on page 320.     |
| <b>cpu_limit</b>       | Not supported. The hard and soft time limits associated with this keyword are 32-bit integers. If a value that cannot be contained in a 32-bit integer is assigned to this limit, the value will be truncated to either 2147483647 or -2147483648. |
| <b>data_limit</b>      | 64-bit integer values may be assigned to these limits. Fractional specifications are allowed and will be converted to 64-bit integer values. Refer to the allowable units for these limits listed under "Syntax for limit keywords" on page 320.   |
| <b>file_limit</b>      |                                                                                                                                                                                                                                                    |
| <b>image_size</b>      | 64-bit integer values may be assigned to this keyword. Fractional and unit specifications are not allowed. The default unit of <b>image_size</b> is kb.<br><br><b>Example:</b><br>image_size = 12345678901                                         |
| <b>job_cpu_limit</b>   | Not supported. The hard and soft time limits associated with this keyword are 32-bit integers. If a value that cannot be contained in a 32-bit integer is assigned to this limit, the value will be truncated to either 2147483647 or -2147483648. |
| <b>preferences</b>     | 64-bit integer values may be associated with the LoadLeveler variables "Memory" and "Disk" in the expressions assigned to these keywords. Fractional and unit specifications are not allowed.                                                      |
| <b>requirements</b>    | <b>Examples:</b><br>requirements = (Arch == "R6000") && (Disk > 5000000000) && (Memory > 6000000000)<br>preferences = (Disk > 6000000000) && (Memory > 9000000000)                                                                                 |

Table 46. Notes on 64-bit support for job command file keywords (continued)

| Keyword name            | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>resources</b>        | Consumable resources associated with the <b>resources</b> keyword may be assigned 64-bit integer values. Fractional specifications are not allowed. Unit specifications are valid only when specifying the values of the predefined ConsumableMemory and ConsumableVirtualMemory resources.<br><br><b>Examples:</b><br>resources = spice2g6(123456789012) ConsumableMemory(10 gb)<br>resources = ConsumableVirtualMemory(15 pb) db2_license(1) |
| <b>rss_limit</b>        | 64-bit integer values may be assigned to these limits. Fractional specifications are allowed and will be converted to 64-bit integer values. Refer to the allowable units for these limits listed under “Syntax for limit keywords” on page 320.                                                                                                                                                                                               |
| <b>stack_limit</b>      |                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>wall_clock_limit</b> | Not supported. The hard and soft time limits associated with this keyword are 32-bit integers. If a value that cannot be contained in a 32-bit integer is assigned to this limit, the value will be truncated to either 2147483647 or -2147483648.                                                                                                                                                                                             |

## Mapping NQS script options to LoadLeveler job command file options

When you prepare a job to be routed to an NQS machine, you must specify a shell script in the LoadLeveler job command file. You may specify scripts that were originally written for NQS and therefore contain NQS options. LoadLeveler maps the NQS options as closely as possible to LoadLeveler features, but exact functions are not always available. Table 47 summarizes the NQS options and their LoadLeveler equivalents.

**Note:** 64-bit integer values in a LoadLeveler job command file will be mapped to 64-bit integer values in an NQS script. 64-bit integer values in an NQS script may be truncated when mapped to a LoadLeveler job command file. Truncation occurs when the corresponding LoadLeveler keywords support only 32-bit integers.

Table 47. Mapping of NQS options to LoadLeveler equivalents

| NQS option | Equivalent LoadLeveler option | Notes                                |
|------------|-------------------------------|--------------------------------------|
| <b>a</b>   | <b>startdate</b>              | Used only for LoadLeveler scheduling |
| <b>e</b>   | <b>error</b>                  | —                                    |
| <b>ke</b>  | No equivalent                 | Ignored                              |
| <b>ko</b>  | No equivalent                 | Ignored                              |
| <b>lc</b>  | <b>core_limit</b>             | —                                    |
| <b>ld</b>  | <b>data_limit</b>             | —                                    |
| <b>lf</b>  | <b>file_limit</b>             | —                                    |
| <b>lm</b>  | <b>rss_limit</b>              | —                                    |
| <b>lM</b>  | No equivalent                 | Ignored                              |
| <b>ln</b>  | No equivalent                 | Ignored                              |
| <b>ls</b>  | <b>stack_limit</b>            | —                                    |
| <b>lt</b>  | <b>cpu_limit</b>              | —                                    |

Table 47. Mapping of NQS options to LoadLeveler equivalents (continued)

| NQS option | Equivalent LoadLeveler option | Notes                                                                                            |
|------------|-------------------------------|--------------------------------------------------------------------------------------------------|
| <b>IT</b>  | No equivalent                 | Ignored                                                                                          |
| <b>lv</b>  | No equivalent                 | Ignored                                                                                          |
| <b>lw</b>  | No equivalent                 | Ignored                                                                                          |
| <b>mb</b>  | <b>notification</b>           | The conversion varies depending on the value specified for <b>notification</b> :                 |
|            |                               | <b>always</b> Converted to <b>-mb</b> and <b>-me</b> options                                     |
|            |                               | <b>complete</b> Converted to <b>-me</b> option                                                   |
|            |                               | <b>error</b> Converted to <b>-me</b> option                                                      |
|            |                               | <b>never</b> Ignored                                                                             |
|            |                               | <b>start</b> Converted to <b>-mb</b> option                                                      |
| <b>me</b>  | <b>notification</b>           |                                                                                                  |
| <b>mu</b>  | <b>notify_user</b>            | —                                                                                                |
| <b>nr</b>  | <b>restart</b>                | The conversion varies depending on the value specified for <b>restart</b> :                      |
|            |                               | <b>yes</b> Ignored                                                                               |
|            |                               | <b>no</b> Converted to <b>-nr</b> option                                                         |
| <b>o</b>   | <b>output</b>                 | —                                                                                                |
| <b>p</b>   | <b>user_priority</b>          | Used only for LoadLeveler scheduling                                                             |
| <b>q</b>   | <b>class</b>                  | Used only for LoadLeveler scheduling                                                             |
| <b>r</b>   | No equivalent                 | Ignored                                                                                          |
| <b>re</b>  | No equivalent                 | Ignored                                                                                          |
| <b>ro</b>  | No equivalent                 | Ignored                                                                                          |
| <b>s</b>   | <b>shell</b>                  | —                                                                                                |
| <b>x</b>   | <b>environment = COPY_ALL</b> | If <b>COPY_ALL</b> is not specified, an error message is generated and the job is not submitted. |
| <b>z</b>   | No equivalent                 | Suppresses messages but not mail                                                                 |

A similar conversion of options occurs when the job is dispatched to the node running the specified NQS class; in this case, LoadLeveler options pertaining to the runtime environment are converted to NQS options. Table 48 summarizes the LoadLeveler options and their NQS equivalents.

Table 48. Mapping of LoadLeveler options to NQS equivalents

| LoadLeveler option            | Equivalent NQS option | Notes                                                                                            |
|-------------------------------|-----------------------|--------------------------------------------------------------------------------------------------|
| <b>arguments</b>              | No equivalent         | An error message is generated and the job is not submitted.                                      |
| <b>checkpoint</b>             | No equivalent         | An error message is generated and the job is not submitted.                                      |
| <b>class</b>                  | <b>-q</b>             | Used only for LoadLeveler scheduling.                                                            |
| <b>core_limit</b>             | <b>-lc</b>            | —                                                                                                |
| <b>cpu_limit</b>              | <b>-lt</b>            | —                                                                                                |
| <b>data_limit</b>             | <b>-ld</b>            | —                                                                                                |
| <b>environment = COPY_ALL</b> | <b>-x</b>             | If <b>COPY_ALL</b> is not specified, an error message is generated and the job is not submitted. |
| <b>error</b>                  | <b>-e</b>             | —                                                                                                |

Table 48. Mapping of LoadLeveler options to NQS equivalents (continued)

| LoadLeveler option   | Equivalent NQS option                                                                                                                                                                                                                                                                                                    | Notes                                                       |
|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|
| <b>executable</b>    | No equivalent                                                                                                                                                                                                                                                                                                            | An error message is generated and the job is not submitted. |
| <b>file_limit</b>    | <b>-lf</b>                                                                                                                                                                                                                                                                                                               | —                                                           |
| <b>hold</b>          | No equivalent                                                                                                                                                                                                                                                                                                            | Used only for LoadLeveler scheduling.                       |
| <b>image_size</b>    | No equivalent                                                                                                                                                                                                                                                                                                            | An error message is generated and the job is not submitted. |
| <b>initialdir</b>    | No equivalent                                                                                                                                                                                                                                                                                                            | An error message is generated and the job is not submitted. |
| <b>input</b>         | No equivalent                                                                                                                                                                                                                                                                                                            | An error message is generated and the job is not submitted. |
| <b>notification</b>  | The conversion varies depending on the value specified for <b>notification</b> :<br><b>always</b> Converted to <b>-mb</b> and <b>-me</b> options<br><b>complete</b> Converted to <b>-me</b> option<br><b>error</b> Converted to <b>-me</b> option<br><b>never</b> Ignored<br><b>start</b> Converted to <b>-mb</b> option |                                                             |
| <b>notify_user</b>   | <b>-mu</b>                                                                                                                                                                                                                                                                                                               | —                                                           |
| <b>output</b>        | <b>-o</b>                                                                                                                                                                                                                                                                                                                | —                                                           |
| <b>preferences</b>   | No equivalent                                                                                                                                                                                                                                                                                                            | Used only for LoadLeveler scheduling.                       |
| <b>queue</b>         | No equivalent                                                                                                                                                                                                                                                                                                            | Places one copy of the job in the LoadLeveler queue.        |
| <b>requirements</b>  | No equivalent                                                                                                                                                                                                                                                                                                            | Used only for LoadLeveler scheduling.                       |
| <b>restart</b>       | The conversion varies depending on the value specified for <b>restart</b> :<br><b>yes</b> Ignored<br><b>no</b> Converted to <b>-nr</b> option                                                                                                                                                                            |                                                             |
| <b>rss_limit</b>     | <b>-lw</b>                                                                                                                                                                                                                                                                                                               | —                                                           |
| <b>shell</b>         | <b>-s</b>                                                                                                                                                                                                                                                                                                                | —                                                           |
| <b>stack_limit</b>   | <b>-ls</b>                                                                                                                                                                                                                                                                                                               | —                                                           |
| <b>startdate</b>     | No equivalent                                                                                                                                                                                                                                                                                                            | Used only for LoadLeveler scheduling.                       |
| <b>user_priority</b> | No equivalent                                                                                                                                                                                                                                                                                                            | Used only for LoadLeveler scheduling.                       |

For more information on submitting jobs to NQS machines, see “Steps for submitting a job to be routed to an NQS machine” on page 192.

## Job command file keyword descriptions

This section provides an alphabetical list of the keywords you can use in a LoadLeveler script. It also provides examples of statements that use these keywords. For most keywords, if you specify the keyword in a job step of a multi-step job, its value is inherited by all proceeding job steps. Exceptions to this are noted in the keyword description.

If a blank value is used after the equal sign, it is as if no keyword was specified.

**account\_no**

Supports centralized accounting. Allows you to specify an account number to associate with a job. This account number is stored with job resource information in local and global history files. It may also be validated before LoadLeveler allows a job to be submitted. For more information, see “Gathering job accounting data” on page 57.

**Syntax:**

**account\_no** = *string*

where *string* is a text string that can consist of a combination of numbers and letters.

**Default value:** No default value is set.

**Example:** If the job accounting group charges for job time based upon the department to which you belong, your account number would be similar to:

`account_no = dept34ca`

**arguments**

Specifies the list of arguments to pass to your program when your job runs.

**Syntax:**

**arguments** = *arg1 arg2 ...*

**Default value:** No default arguments are set.

**Example:** If your job requires the numbers 5, 8, 9 as input, your arguments keyword would be similar to:

`arguments = 5 8 9`

**bg\_connection**

Specifies the type of wiring requested for the Blue Gene partition in which the job step will run.

**Syntax:**

**bg\_connection** = **TORUS** | MESH | **PREFER\_TORUS**

where:

**TORUS**

Specifies that the admissible partitions must be wireable as a torus.

**MESH**

Specifies that the admissible partitions must be wireable as a mesh.

**PREFER\_TORUS**

Specifies that the admissible partitions should be wireable as a torus, but if there are no such partitions then the selected partition must be wireable as a mesh.

This keyword is only valid for job type **bluegene**. This keyword cannot be used if the **bg\_partition** keyword is specified. This keyword is not inherited by other job steps.

|                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                     | <p><b>Default value:</b> MESH is the default value.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>bg_partition</b> | <p>Specifies the ID of the Blue Gene partition that the job will run in.</p> <p><b>Syntax:</b></p> <p><b>bg_partition</b> = <i>partition_id</i></p> <p>where <i>partition_id</i> is a string identifying a partition in the Blue Gene system.</p> <p>This keyword is only valid for job type <b>bluegene</b>. This keyword can not be used if any of the following keywords are specified: <b>bg_connection</b>, <b>bg_rotate</b>, <b>bg_shape</b>, <b>bg_size</b>. This keyword is not inherited by other job steps.</p> <p><b>Default value:</b> No default is set.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>bg_rotate</b>    | <p>Specifies whether the scheduler should consider all possible rotations of the given shape of the job when searching for a partition for the job.</p> <p><b>Syntax:</b></p> <p><b>bg_rotate</b> = <u>true</u>   false</p> <p>where <b>true</b> implies that the shape can be rotated to fit some free resource and <b>false</b> implies that the shape will not be rotated.</p> <p>Assigning a value of <b>true</b> to this keyword will increase the likelihood of the scheduler finding a partition to run the job and optimizes overall scheduling of Blue Gene resources. <b>bg_rotate</b> must be set to <b>false</b> when using the <b>mapfile</b> argument of <b>mpirun</b> to specify how the job's tasks are to be assigned to the allocated compute nodes.</p> <p>This keyword is only valid for job type <b>bluegene</b>. This keyword is not inherited by other job steps.</p> <p><b>Note:</b> This keyword can only be used in conjunction with the <b>bg_shape</b> job command file keyword. If <b>bg_shape</b> is not present, this keyword is ignored.</p> <p><b>Default value:</b> The default value is true.</p> |
| <b>bg_shape</b>     | <p>Specifies the requested shape of the Blue Gene job to be started in the system.</p> <p><b>Syntax:</b></p> <p><b>bg_shape</b> = <i>XXYxZ</i></p> <p>where <i>X</i>, <i>Y</i>, and <i>Z</i> are positive integers indicating the number of base partitions in the X-direction, Y-direction, and Z-direction, respectively, of the requested job shape. The values of <i>X</i>, <i>Y</i>, and <i>Z</i></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

or their rotations, if **bg\_rotate** is **true**, must not be greater than the corresponding X, Y, and Z sizes of the Blue Gene system, otherwise the job will never be able to start.

This keyword is only valid for job type **bluegene**. This keyword can not be used if the **bg\_partition** or **bg\_size** keyword is specified. This keyword is not inherited by other job steps.

**Note:** The X, Y, and Z dimensions of the allocated partition will be exactly as defined by the **bg\_shape** job command file keyword *unless* the job command file keyword **bg\_rotate** is specified as **true**, in which case all possible rotations of the dimensions are possible.

**Default value:** No default is set.

## **bg\_size**

Specifies the requested size of the Blue Gene job to be started in the system.

### **Syntax:**

**bg\_size** = *bg\_size*

where *bg\_size* is an integer indicating the size of the job in units of compute nodes. No guarantees are made as to the shape of the allocated partition for a given size. The only guarantee is that the size of the allocated shape will be no smaller than the requested size and as close to the request size as possible.

This keyword is only valid for job type **bluegene**. This keyword can not be used if the **bg\_partition** or **bg\_shape** keyword is specified. This keyword is not inherited by other job steps.

**Note:** Not all values given for **bg\_size** are representable. For example, consider an 8x4x4 Blue Gene system in units of base partitions and a requested **bg\_size** of 5632 (equivalent to 11 base partitions). Since 11 is a prime number, it cannot be decomposed. Furthermore, it is greater than any one dimension of the system. In this case, a 3x4x1 partition is allocated, since it is the smallest number of base partitions larger than the requested size.

**Default value:** If **bg\_size**, **bg\_shape**, or **bg\_partition** are not specified then **bg\_size** defaults to the configured minimum partition size. This is the value of the **BG\_MIN\_PARTITION\_SIZE** keyword in the configuration file.

## **blocking**

Blocking specifies that tasks be assigned to machines in multiples of a certain integer. Unlimited blocking specifies that tasks be assigned to each machine until it runs out of initiators, at which time tasks will be assigned to the machine which is next in the order of priority. If the total number of tasks are not evenly divisible by the blocking factor, the remainder of tasks are allocated to a single node.

### **Syntax:**

**blocking** = *integer* | **unlimited**

where:

### **integer**

Specifies the blocking factor to be used. The blocking factor must be a positive integer. With a blocking factor of 4, LoadLeveler will allocate 4 tasks at a time to each machine with at least 4 initiators available. This keyword must be specified with the `total_tasks` keyword. **Example:**

```
blocking = 4
total_tasks = 17
```

LoadLeveler will allocate tasks to machines in an order based on the values of their MACHPRIO expressions (beginning with the highest MACHPRIO value). In cases where `total_tasks` is not a multiple of the blocking factor, LoadLeveler assigns the remaining number of tasks as soon as possible (even if that means assigning the remainder to a machine at the same time as it assigns another block).

### **unlimited**

Specifies that LoadLeveler allocate as many tasks as possible to each machine, until all of the tasks have been allocated. LoadLeveler will prioritize machines based on the number of initiators each machine currently has available. Unlimited blocking is the only means of allocating tasks to nodes that does not prioritize machines primarily by MACHPRIO expression.

**Default value:** No default is set, which means that no blocking is requested.

### **bulkxfer**

Indicates whether the communication subsystem will use bulk data transfer for user space communication.

#### **Syntax:**

```
bulkxfer = yes | no
```

#### **Default:** no

For additional information about bulk data transfer, see “Using bulk data transfer” on page 163.

### **checkpoint**

Indicates if a job is able to be checkpointed. Checkpointing a job is a way of saving the state of the job so that if the job does not complete it can be restarted from the saved state rather than starting the job from the beginning.

If you specify a value that is not valid for the **checkpoint** keyword, an error message is generated and the job is not submitted.

#### **Syntax:**

```
checkpoint = interval | yes | no
```

Where:

### **interval**

Specifies that LoadLeveler will automatically checkpoint your program at preset intervals. The time interval is

specified by the settings in the **MIN\_CKPT\_INTERVAL** and **MAX\_CKPT\_INTERVAL** keywords in the configuration file. Since a job with a setting of **interval** is considered checkpointable, you can initiate a checkpoint using any method in addition to the automatic checkpoint. The difference between **interval** and **yes** is that **interval** enables LoadLeveler to automatically take checkpoints on the specified intervals while the value **yes** does not enable that ability.

**yes** Enables a job step to be checkpointed. With this setting, a checkpoint can be initiated either under the control of an application or by a method external to the application. With a setting of **yes**, LoadLeveler will not checkpoint on the intervals specified by the **MIN\_CKPT\_INTERVAL** and **MAX\_CKPT\_INTERVAL** keywords in the configuration file. The difference between **yes** and **interval** is that **interval** enables LoadLeveler to automatically take checkpoints on the specified intervals while the value **yes** does not enable that ability.

**no** The step cannot be checkpointed.

**Default value:** no

**Restriction:** On Linux machines only: If a job with **checkpoint = interval** or **checkpoint = yes** is dispatched, it is rejected.

**Example:** If a checkpoint is initiated from within the application but checkpoints are not to be taken automatically by LoadLeveler you can use:

```
checkpoint = yes
```

For detailed information on checkpointing, see “Checkpointing jobs” on page 128.

## **ckpt\_dir**

Specifies the directory which contains the checkpoint file.

Checkpoint files can become quite large. When specifying **ckpt\_dir**, make sure that there is sufficient disk space to contain the files. Guidelines can be found in “Checkpointing jobs” on page 128.

### **Syntax:**

```
ckpt_dir = pathname
```

The values for **ckpt\_dir** are case sensitive.

**Default value:** The value of the **ckpt\_dir** keyword in the class stanza of the administration file

**Restriction:** The keyword **ckpt\_dir** is not allowed in the command file for interactive POE sessions.

**Example:** If checkpoint files were to be stored in the /tmp directory the job command file would include:

```
ckpt_dir = /tmp
```

For more information on naming directories for checkpointing, see “Naming checkpoint files and directories” on page 134.

### **ckpt\_execute\_dir**

Specifies the directory where the job step’s executable will be saved for checkpointable jobs. You may specify this keyword in either the configuration file or the job command file; different file permissions are required depending on where this keyword is set. For additional information, see “Planning considerations for checkpointing jobs” on page 129.

#### **Syntax:**

`ckpt_execute_dir = directory`

This directory cannot be the same as the current location of the executable file, or LoadLeveler will not stage the executable. In this case, the user must have execute permission for the current executable file.

**Default value:** No default value is set.

### **ckpt\_file**

Used to specify the base name of the checkpoint file. The checkpoint file is created by the AIX checkpoint functions and is derived from the filename specified in the **ckpt\_file** keyword in the job command file or the default file name.

#### **Syntax:**

`ckpt_file = filename`

The value for the **ckpt\_file** keyword is case sensitive.

**Default value:** [jobname.]job\_step\_id.ckpt

**Restriction:** The keyword **ckpt\_file** is not allowed in the command file for interactive POE sessions.

**Example:** If you are storing checkpoint files in a file with the base name “myckptfiles” which is placed in the directory named by the **ckpt\_dir** keyword, the job command file would contain:

```
ckpt_file = myckptfiles
```

Alternatively, if you are naming the checkpoint files “myckptfiles” and storing them in the directory /tmp, the keyword in the job command file can contain:

```
ckpt_file = /tmp/myckptfiles
```

Or the combination of **ckpt\_dir** and **ckpt\_file** keywords can be used, producing the same result.

```
ckpt_dir = /tmp
ckpt_file = myckptfiles
```

For more information on naming files for checkpointing, see “Naming checkpoint files and directories” on page 134.

### **ckpt\_time\_limit**

Specifies the hard or soft limit, or both limits for the elapsed time checkpointing a job can take. When the soft limit is exceeded, LoadLeveler will attempt to stop the checkpoint and allow the job to continue. If the checkpoint is not able to be stopped and the hard limit is exceeded, LoadLeveler will terminate the job.

**Syntax:**

**ckpt\_time\_limit** = *hardlimit,softlimit*

**Default value:** The value of the **ckpt\_time\_limit** keyword in the class stanza of the administration file

**Examples:**

```
ckpt_time_limit = 00:10:00,00:05:00
ckpt_time_limit = 12:30,7:10
ckpt_time_limit = rlim_infinity
ckpt_time_limit = unlimited
```

For more information about the values and units you can use with this keyword, and how limits are enforced, see “Using limit keywords” on page 83.

## class

Specifies the name of a job class defined locally in your cluster. You can use the **llclass** command to find out information on job classes.

**Syntax:**

**class** = *name*

**Default value:** If you do not specify a value for this keyword, the default job class, **No\_Class**, is assigned.

**Example:** If you are allowed to submit jobs belonging to a class called “largejobs”, your class keyword would look like the following:

```
class = largejobs
```

## cluster\_input\_file

Specifies an individual file to be copied from the local pathname to the remote pathname when the job is run.

**Syntax:**

**cluster\_input\_file** = *local\_pathname, remote\_pathname*

where:

*local\_pathname*

Specifies the full pathname of the file to be copied from the local cluster. This file must be accessible by the submitting user on the node where the local gateway schedd runs. *local\_pathname* must be specified.

*remote\_pathname*

Specifies the full pathname the file will be copied to on the assigned cluster. This file must be accessible by the mapped user on the schedd node of the selected cluster.

*remote\_pathname* must be specified. Normally the file specified

by *remote\_pathname* will be deleted following the job termination. It will not be deleted if the cluster selected to run the job is the same cluster where the job was submitted and *remote\_pathname* resolves to the same pathname specified as *local\_pathname*.

If LoadLeveler fails to copy an input file to the selected cluster, the assignment of the job to the selected cluster will fail. If the cluster was assigned by the administrator using the **llmovejob** command, an error message will be displayed in the command response describing the reason for failure and the job will remain in the cluster it was in and be placed in system hold. If the cluster was assigned during job submission, the job submission fails and an error message will be displayed in the command response describing the reason for failure.

**Default value:** No default value is set.

### **cluster\_list**

Allows you to specify that a job is to run on a particular cluster or that LoadLeveler is to decide which cluster is best from the list of clusters specified. If this keyword is specified, it must be in the first job step of a multistep job. Any definitions in other steps are ignored.

#### **Syntax:**

**cluster\_list** = *cluster\_list*

Where *cluster\_list* is a blank-delimited list of cluster names or the reserved word **any**. Depending on the specified value, **cluster\_list** can have one of three effects:

- Specifying a single cluster name indicates that a job is to be submitted to that cluster.
- Specifying a list of multiple cluster names indicates that the job is to be submitted to one of the clusters specified with the installation exit **CLUSTER\_METRIC** choosing from the list.
- Specifying the reserved word **any** indicates the job is to be submitted to any cluster defined by the installation exit **CLUSTER\_METRIC**.

**Note:** If a cluster list is specified using either the **llsubmit -X** command or the **ll\_cluster** API, then that cluster list takes precedence over a **cluster\_list** specified in the job command file.

### **cluster\_output\_file**

Specifies an individual output file to be copied to the submitting cluster from the cluster selected to run the job after the job completes.

#### **Syntax:**

**cluster\_output\_file** = *local\_pathname*, *remote\_pathname*

where:

*local\_pathname*

Specifies the full pathname the file will be copied to on the local cluster. This file must be accessible by the submitting user on the node where the local gateway schedd runs. *local\_pathname* must be specified.

*remote\_pathname*

Specifies the full pathname of the file that will be copied from the assigned cluster. This file must be accessible by the mapped user on the schedd node of the selected cluster. *remote\_pathname* must be specified. Normally the file specified by *remote\_pathname* will be deleted following the job termination. It will not be deleted if the cluster selected to run the job is the same cluster where the job was submitted and *remote\_pathname* resolves to the same pathname specified as *local\_pathname*.

If LoadLeveler fails to copy an output file from a selected cluster to the local cluster during job termination, the job termination will proceed and the remote file will not be deleted. Mail will be sent to the user describing the reason for the failed copy.

**Default value:** No default value is set.

**comment**

Specifies text describing characteristics or distinguishing features of the job.

**core\_limit**

Specifies the hard limit, soft limit, or both limits for the size of a core file. This limit is a per process limit.

**Syntax:**

**core\_limit** = *hardlimit,softlimit*

This keyword accepts both 32-bit and 64-bit integer values.

**Default value:** No default value is set.

**Examples:**

```
core_limit = 125621,10kb
core_limit = 5621kb,5000kb
core_limit = 2mb,1.5mb
core_limit = 2.5mw
core_limit = unlimited
core_limit = rlim_infinity
core_limit = copy
```

For more information about the values and units you can use with this keyword, and how limits are enforced, see “Using limit keywords” on page 83.

**cpu\_limit**

Specifies the hard limit, soft limit, or both limits for the amount of CPU time that a submitted job step can use. This limit is a per process limit.

**Syntax:**

**cpu\_limit** = *hardlimit,softlimit*

**Default value:** No default value is set.

**Examples:**

```
cpu_limit = 12:56:21,12:50:00
cpu_limit = 56:21.5
cpu_limit = 1:03,21
cpu_limit = unlimited
cpu_limit = rlim_infinity
cpu_limit = copy
```

For more information about the values and units you can use with this keyword, and how limits are enforced, see “Using limit keywords” on page 83.

### **data\_limit**

Specifies the hard limit, soft limit, or both limits for the size of the data segment to be used by the job step. This limit is a per process limit.

**Syntax:**

**data\_limit** = *hardlimit,softlimit*

This keyword accepts both 32-bit and 64-bit integer values.

**Default value:** No default value is set.

**Examples:**

```
data_limit = ,125621
data_limit = 5621kb
data_limit = 2mb
data_limit = 2.5mw,2mb
```

For more information about the values and units you can use with this keyword, and how limits are enforced, see “Using limit keywords” on page 83.

### **dependency**

Specifies the dependencies between job steps. A job dependency, if used in a given job step, must be explicitly specified for that step.

**Syntax:**

**dependency** = *step\_name operator value*

where:

*step\_name*

Is the name of a previously defined job step (as described in 357).

*operator*

Is one of the following:

|              |                          |
|--------------|--------------------------|
| <b>==</b>    | Equal to                 |
| <b>!=</b>    | Not equal to             |
| <b>&lt;=</b> | Less than or equal to    |
| <b>&gt;=</b> | Greater than or equal to |
| <b>&lt;</b>  | Less than                |
| <b>&gt;</b>  | Greater than             |

&& And  
|| Or

*value*

Is usually a number that specifies the job return code to which the *step\_name* is set. It can also be one of the following

LoadLeveler defined job step return codes:

**CC\_NOTRUN**

The return code set by LoadLeveler for a job step which is not run because the dependency is not met. The value of CC\_NOTRUN is 1002.

**CC\_REMOVED**

The return code set by LoadLeveler for a job step which is removed from the system (because, for example, **llcancel** was issued against the job step). The value of CC\_REMOVED is 1001.

**Default value:** No default value is set.

**Examples:** The following are examples of dependency statements:

- **Example 1:** In the following example, the step that contains this dependency statement will run if the return code from step 1 is zero:

```
dependency = (step1 == 0)
```

- **Example 2:** In the following example, step1 will run with the executable called **myprogram1**. Step2 will run only if LoadLeveler removes step1 from the system. If step2 does run, the executable called **myprogram2** gets run.

```
Beginning of step1
@ step_name = step1
@ executable = myprogram1
@ ...
@ queue
Beginning of step2
@ step_name = step2
@ dependency = step1 == CC_REMOVED
@ executable = myprogram2
@ ...
@ queue
```

- **Example 3:** In the following example, step1 will run with the executable called **myprogram1**. Step2 will run if the return code of step1 equals zero. If the return code of step1 does not equal zero, step2 does not get executed. If step2 is not run, the dependency statement in step3 gets evaluated and it is determined that step2 did not run. Therefore, **myprogram3** gets executed.

```
Beginning of step1
@ step_name = step1
@ executable = myprogram1
@ ...
@ queue
Beginning of step2
@ step_name = step2
@ dependency = step1 == 0
@ executable = myprogram2
@ ...
@ queue
Beginning of step3
@ step_name = step3
```

```
@ dependency = step2 == CC_NOTRUN
@ executable = myprogram3
@ ...
@ queue
```

- **Example 4:** In the following example, the step that contains step2 returns a non-negative value if successful. This step should take into account the fact that LoadLeveler uses a value of 1001 for CC\_REMOVED and 1002 for CC\_NOTRUN. This is done with the following dependency statement:

```
dependency = (step2 >= 0) && (step2 < CC_REMOVED)
```

### env\_copy

Specifies whether environment variables for a batch or interactive parallel job are copied to all executing nodes, or to only the master node. When **all** is specified either explicitly or by default, any environment variables (specified by the **environment** keyword in the job command file) will be copied to all nodes where the job step runs. When **master** is specified, the environment variables will be copied only to the node selected to run the master task of the parallel job.

Although a LoadLeveler administrator may set this keyword in one or more class, group, or user stanzas in the administration file, an explicit setting in the job command file overrides any settings in the administration file that are relevant for the parallel job.

LoadLeveler ignores this keyword if it is set for a serial job.

#### Syntax:

```
env_copy = all | master
```

**Default value:** LoadLeveler uses the default value all only when both of the following conditions are true:

- The **env\_copy** keyword is not specified in the job command file.
- The **env\_copy** keyword is not specified in any class, group, or user stanza that is relevant to the parallel job.

### environment

Specifies login initial environment variables set by LoadLeveler when your job step starts. If the same environment variables are set in the user's initialization files (such as the .profile), those set by the login initialization files will supersede those set by LoadLeveler.

You may use the **env\_copy** keyword to instruct LoadLeveler to copy these environment variables to all executing nodes, or to only the master executing node.

#### Syntax:

```
environment = env1 ; env2 ; ...
```

Separate environment specifications (*env1*, *env2*, and so on) with semicolons. An environment specification may be one of the following:

#### **COPY\_ALL**

Specifies that all the environment variables from your shell be copied.

- \$var** Specifies that the environment variable *var* be copied into the environment of your job when LoadLeveler starts it.
- !var** Specifies that the environment variable *var* not be copied into the environment of your job when LoadLeveler starts it. This specification is most useful together with COPY\_ALL.
- var=value** Specifies that the environment variable *var* be set to the value "value" and copied into the environment of your job when LoadLeveler starts it.
- When processing the string you specify for *var*, LoadLeveler first removes any leading or trailing blanks, and copies the remaining string, as is, into the environment.

**Default value:** No default value is set.

#### Additional considerations:

If you specify the **environment** job command file keyword with **COPY\_ALL**, the **\$USER** and **\$HOME** environment variables from your shell are not copied and set when your job step starts. The **\$USER** and **\$HOME** environment variables of the user ID on the executing node will be set. If you explicitly specify **\$USER** or **\$HOME** it will be copied and set when your job step starts.

If more than one environment specification is defined for the environment keyword, the specifications precedence from right to left. For example if you specify:

```
environment = COPY_ALL; USER=jsmith
```

The **\$USER** environment variable will be set to jsmith.

However, if you specify:

```
environment = USER=jsmith; COPY_ALL
```

The **\$USER** environment variable is not set to jsmith. Instead, the **\$USER** environment variable of the user ID on the executing node is set.

#### Examples:

- This example illustrates how to specify that LoadLeveler is to copy all the environment variables from your shell except for env2:  
environment = COPY\_ALL; !env2;
- This example illustrates how LoadLeveler processes the string you specify with *var*: If you specify the following:  
environment = env3 = "quoted string"; env4 = imbedded blanks;

LoadLeveler uses these values:

- For env3: **"quoted string"**
- For env4: **imbedded blanks**

error

Specifies the name of the file to use as standard error (stderr) when your job step runs.

**Syntax:**

**error** = *filename*

**Default value:** If you do not specify a value for this keyword, the file `/dev/null` is used.

**Example:**

```
error = $(jobid).$(stepid).err
```

### **executable**

Identifies the name of the program to run, which can be a shell script or a binary. For parallel jobs, **executable** must be the parallel job launcher (POE for AIX, or mpirun for Linux), or the name of a program that invokes the parallel job launcher.

Note that the **executable** statement automatically sets the **\$(base\_executable)** variable, which is the file name of the executable without the directory component. See Figure 22 on page 161 for an example of using the **\$(base\_executable)** variable.

**Syntax:**

**executable** = *name*

**Default value:** If you do not include this keyword, then it will default to the job command file that is being submitted, and LoadLeveler will assume that the file is a valid shell script.

**Examples:**

- # @ executable = a.out
- # @ executable = /usr/bin/poe (for POE jobs)

### **file\_limit**

Specifies the hard limit, soft limit, or both limits for the size of a file. This limit is a per process limit.

**Syntax:**

**file\_limit** = *hardlimit,softlimit*

This keyword accepts both 32-bit and 64-bit integer values.

**Default value:** No default value is set.

**Example:**

```
file_limit = 100pb,50tb
```

For more information about the values and units you can use with this keyword, and how limits are enforced, see “Using limit keywords” on page 83.

### **group**

Specifies the LoadLeveler group.

**Syntax:**

**group** = *group\_name*

**Default value:** If you do not specify a value for this keyword, LoadLeveler uses the default group, **No\_Group**.

**Example:**

```
group = my_group_name
```

## hold

Specifies whether you want to place a hold on your job step when you submit it. There are three types of holds:

**user** Specifies user hold

**system** Specifies system hold

**usersys** Specifies user and system hold

To remove the hold on the job, you can use either the GUI or the **llhold -r** command.

**Syntax:**

```
hold = user | system | usersys
```

**Default value:** No default is set, which means that no hold is requested.

**Example:** To put a user hold on a job, the keyword statement would be:

```
hold = user
```

## image\_size

Specifies the maximum virtual image size to which your program will grow during execution. LoadLeveler tries to execute your job steps on a machine that has enough resources to support executing and checkpointing your job step. If your job command file has multiple job steps, the job steps will not necessarily run on the same machine, unless you explicitly request that they do.

If you underestimate the image size of your job step, your job step may crash due to the inability to acquire more address space. If you overestimate the image size, LoadLeveler may have difficulty finding machines that have the required resources.

**Syntax:**

```
image_size = number
```

where *number* must be a positive integer. This keyword accepts both 32-bit and 64-bit integer values. If you do not specify the units associated with this keyword, LoadLeveler uses the default unit, which is kilobytes. For a list of allowable units, see the **resources** keyword description on page 353.

**Default value:** If you do not specify the image size of your job command file, the image size is that of the executable.

**Example:** To set an image size of 11 KB, the keyword statement would be:

```
image_size = 11
```

### **initialdir**

Specifies the path name of the directory to use as the initial working directory during execution of the job step. File names mentioned in the command file which do not begin with a slash ( / ) are relative to the initial directory. The initial directory must exist on the submitting machine as well as on the machine where the job runs.

#### **Syntax:**

**initialdir** = *pathname*

**Note:** When operating in a multicluster environment, access to **initialdir** will be verified on the cluster selected to run the job. If access to **initialdir** fails, the submission or move job will fail.

**Default value:** If you do not specify a value for this keyword, the initial directory is the current working directory at the time you submitted the job.

#### **Example:**

```
initialdir = /var/home/mike/ll_work
```

### **input**

Specifies the name of the file to use as standard input (stdin) when your job step runs.

#### **Syntax:**

**input** = *filename*

**Default value:** If you do not specify an input file, LoadLeveler uses the file **/dev/null**

#### **Example:**

```
input = input.$(process)
```

### **job\_cpu\_limit**

Specifies the hard limit, soft limit, or both limits for the CPU time used by all processes of a serial job step. For example, if a job step runs as multiple processes, the total CPU time consumed by all processes is added and controlled by this limit.

For parallel job steps, LoadLeveler enforces these limits differently. Parallel job steps usually have tasks running on several different nodes and each task can have several processes associated with it. In addition, the parallel tasks running on a node are descendants of a LoadL\_starter process. Therefore, if you specify a hard or soft CPU time limit of S seconds and if a LoadL\_starter has N tasks running under it, then all tasks associated with that LoadL\_starter will be terminated if the total CPU time of the LoadL\_starter process and its children is greater than S\*N seconds.

If several LoadL\_starter processes are involved in running a parallel job step, then LoadLeveler enforces the limits associated with the job\_cpu\_limit keyword independently for each LoadL\_starter. LoadLeveler determines how often to check the job\_cpu\_limit by looking at the values for JOB\_LIMIT\_POLICY and

JOB\_ACCT\_Q\_POLICY. The smaller value associated with these two configuration keywords sets the interval for checking the `job_cpu_limit`. For more information on JOB\_LIMIT\_POLICY and JOB\_ACCT\_Q\_POLICY see “Collecting job resource data on serial and parallel jobs” on page 58.

**Syntax:**

`job_cpu_limit = hardlimit,softlimit`

**Default value:** No default is set.

**Example:**

`job_cpu_limit = 12:56,12:50`

For more information about the values and units you can use with this keyword, and how limits are enforced, see “Using limit keywords” on page 83.

**job\_name**

Specifies the name of the job. This keyword must be specified in the first job step. If it is specified in other job steps in the job command file, it is ignored.

The `job_name` only appears in the long reports of the `llq`, `llstatus`, and `llsummary` commands, and in mail related to the job.

**Syntax:**

`job_name = job_name`

You can name the job using any combination of letters, numbers, or both.

**Default value:** No default value is set.

**Example:**

`job_name = my_first_job`

**job\_type**

Specifies the type of job step to process.

**Syntax:**

`job_type = serial | parallel | bluegene`

**Default value:** serial

**large\_page**

Specifies whether or not a job step requires Large Page support from AIX.

**Restriction:** Large Page memory is not supported in LoadLeveler for Linux. In this case, specifying **M** would cause the job to never be sent.

**Syntax:**

`large_page = value`

where *value* can be **Y**, **M**, or **N**. **Y** informs LoadLeveler to use Large Page memory, if available, but to otherwise use regular memory. **M** means use of Large Page memory is mandatory.

**Default value:** **N**, which means to not use Large Page memory.

**Example:** To ask LoadLeveler to use Large Page memory for the job step, if available, specify:

```
large_page = Y
```

### **max\_processors**

Specifies the maximum number of nodes requested for a parallel job, regardless of the number of processors contained in the node. This keyword is equivalent to the maximum value you specify on the **node** keyword. In any new job command files you create for parallel jobs, you should use the **node** keyword to request nodes/processors. Note that if you specify in a job command file both the **max\_processors** keyword and the **node** keyword, the job is not submitted.

#### **Syntax:**

```
max_processors = number
```

**Default value:** No default is set.

#### **Example:**

```
max_processors = 6
```

### **mcm\_affinity\_options**

Specifies the affinity options for a job.

#### **Syntax:**

```
mcm_affinity_options = affinity_option
```

Where *affinity\_option* is a blank-delimited list of one, two, or three keywords chosen from the three groupings of keywords in the list that follows. Only one option from each group may be specified.

#### *task affinity options*

The following options are task affinity options. These options are mutually exclusive.

##### **mcm\_accumulate**

Specifying this option tells the Central Manager to accumulate tasks on the same MCM whenever possible.

##### **mcm\_distribute**

Specifying this option tells the Central Manager to distribute tasks across all available MCMs on a machine.

#### *memory affinity options*

The following options are memory affinity options. These options are mutually exclusive.

##### **mcm\_mem\_none**

Specifying this option indicates the job has no memory affinity requirement.

**mcm\_mem\_pref**

Specifying this option indicates the job requests memory affinity.

**mcm\_mem\_req**

Specifying this option indicates the job requires memory affinity.

*adapter affinity options*

The following options are adapter affinity options. These options are mutually exclusive.

**mcm\_sni\_none**

Specifying this option indicates the job has no adapter affinity requirement.

**mcm\_sni\_pref**

Specifying this option indicates the job request adapter affinity.

**mcm\_sni\_req**

Specifying this option indicates the job requires adapter affinity.

Your job containing the keyword **mcm\_affinity\_options** will not be submitted to LoadLeveler unless the **rset** keyword is set to **RSET\_MCM\_AFFINITY**.

**Default value:** **mcm\_accumulate mcm\_mem\_req mcm\_sni\_pre**

**Example:**

```
mcm_affinity_options = mcm_mem_req mcm_sni_pref mcm_distribute
```

This example shows how to have a job set memory affinity as a requirement, adapter affinity as a preference, and mcm task allocation method as distribute.

**min\_processors**

Specifies the minimum number of nodes requested for a parallel job, regardless of the number of processors contained in the node. This keyword is equivalent to the minimum value you specify on the **node** keyword. In any new job command files you create for parallel jobs, you should use the **node** keyword to request nodes/processors. Note that if you specify in a job command file both the **min\_processors** keyword and the **node** keyword, the job is not submitted.

**Syntax:**

```
min_processors = number
```

**Default value:** No default is set.

**Example:**

```
min_processors = 4
```

**network**

Specifies communication protocols, adapters, and their characteristics. You need to specify this keyword when you want a task of a parallel job step to request a specific adapter that is defined in the LoadLeveler administration file. You do not need to specify this keyword when you want a task to access a shared,

default adapter through TCP/IP. (A default adapter is an adapter whose name matches a machine stanza name.)

Note that you cannot specify both the **network** statement and the **Adapter** requirement in a job command file. Also, the value of the **network** keyword applies only to the job step in which you specify the keyword. (That is, this keyword is not inherited by other job steps.)

### Syntax:

```
network.protocol = type[, usage[, mode[,comm_level[, instances=<number|max> \
[, rcxtblocks=number]]]]]
```

where:

*protocol*

Specifies the communication protocols that are used with an adapter, and can be the following:

**MPI** Specifies the message passing interface (MPI). You can specify in a job step both **network.MPI** and **network.LAPI**.

**LAPI** Specifies the low-level application programming interface (LAPI). You can specify in a job step both **network.MPI** and **network.LAPI**.

LAPI is not supported on LoadLeveler for Linux.

**MPI\_LAPI**

Specifies sharing adapter windows between MPI and LAPI. When you specify **network.MPI\_LAPI** in a job step, you cannot specify any other network statements in that job step.

LAPI is not supported on LoadLeveler for Linux.

*type*

This field is required and specifies one of the following:

*adapter\_name*

The possible values are the names associated with the interface cards installed on a node (for example, en0, tk1 and css0 ). Note, when css0 is specified for the HPS switch, it takes on a different meaning described below.

*network\_type*

Specifies a **network\_type** as specified in the LoadLeveler administration file. The LoadLeveler administrator must specify values used as **network\_type** in the adapter stanza of the LoadLeveler administration file using the **network\_type** keyword. For example, an installation can define a network type of "switch" to identify **css0** adapters. For more information on specifying **network\_type**, see "Defining adapters" on page 80.

**sn\_single**

When used for the HPS switch it specifies that LoadLeveler use a common, single switch network. When used for a switch other than the HPS switch it is comparable to specifying an **adapter\_name** of **css0**.

**sn\_all** Specifies that striped communication should be

used over all available switch networks. The networks specified must be accessible by all machines selected to run the job. For more information on striping, see “Submitting jobs that use striping” on page 172.

**csss** **csss** may be used interchangeably with **sn\_all**. This option is provided for compatibility with job command files created with older versions of LoadLeveler.

**css0** **css0** may be used interchangeably with **sn\_single**. This option is provided for compatibility with job command files created with older versions of LoadLeveler.

The following are optional and if omitted their position must be specified with a comma:

*usage* Specifies whether the adapter can be shared with tasks of other job steps. Possible values are **shared**, which is the default, or **not\_shared**. If **not\_shared** is specified, LoadLeveler can only guarantee that the adapter will not be shared by other jobs running on the same OSI. If the adapter is shared by more than one OSI, LoadLeveler can not guarantee that the adapter is not shared with jobs running on a different OSI.

*mode* Specifies the communication subsystem mode used by the communication protocol that you specify, and can be either **IP** (Internet Protocol), which is the default, or **US** (User Space). Note that each instance of the US mode requested by a task running on the SP switch requires an adapter window. For example, if a task requests both the MPI and LAPI protocols such that both protocol instances require US mode, two adapter windows will be used. For more information on adapter windows, see *Parallel System Support Programs for AIX Administration Guide*.

*comm\_level*

The **comm\_level** keyword should be used to suggest the amount of inter-task communication that users *expect* to occur in their parallel jobs. This suggestion is used to allocate adapter device resources. For more information on device resources, consult the *PSSP: Administration Guide*, SA22-7348 and *RSCT Administration Guide*, SA22-7889. Specifying a level that is higher than what the job actually needs will not speed up communication, but may make it harder to schedule a job (because it requires more resources). The **comm\_level** keyword can only be specified with **US** mode. The three communication levels are:

**LOW** Implies that minimal inter-task communication will occur.

**AVERAGE**

This is the default value. Unless you know the specific communication characteristics of your job, the best way to determine the **comm\_level** is through trial-and-error.

**HIGH** Implies that a great deal of inter-task communication will occur.

**Note:** This keyword is recognized only by SP\_Switch2 adapters and will be ignored by Switch\_Network\_Interface\_For\_HPS adapters.

**instances**=<number|max>

If **instances** is specified as a number, it indicates the number of parallel communication paths made available to the protocol on each network. The number actually used will depend on the implementation of the protocol subsystem. If **instances** is specified by **max**, the actual value used is determined by the **MAX\_PROTOCOL\_INSTANCES** for the class to which the job is submitted. The default value for **instances** is 1.

For the best performance set **MAX\_PROTOCOL\_INSTANCES** so that the communication subsystem uses every available adapter before it reuses any of the adapters.

**rcxtblocks**=number

Integer value specifying the number of user rCxt blocks requested for each window used by the associated protocol. The values of this keyword are not inherited between steps in a multistep job.

**Note:** Use of this keyword will prevent adapters from the SP Switch2 family from being used by the job.

**Default value:** If you do not specify the **network** keyword, LoadLeveler allows the task to access a shared, default adapter through TCP/IP. The default adapter is the adapter associated with the machine name.

### Examples:

- **Example 1:** To use the MPI protocol with an SP switch adapter in User Space mode without sharing the adapter, enter the following:

```
network.MPI = sn_single,not_shared,US,HIGH
```

- **Example 2:** To use the MPI protocol with a shared SP switch adapter in IP mode, enter the following:

```
network.MPI = sn_single,,IP
```

Because a shared adapter is the default, you do not need to specify **shared**.

- **Example 3:** A communication level can only be specified if User Space mode is also specified:

```
network.MPI = sn_single,,US,AVERAGE
```

Note that LoadLeveler can ensure that an adapter is dedicated (not shared) if you request the adapter in US mode, since any user who requests a user space adapter must do so using the **network** statement. However, if you request a dedicated adapter in IP mode, the adapter will only be dedicated if all other LoadLeveler users who request this adapter do so using the **network** statement.

- **Example 4:** **css0** can be used in place of **sn\_single**:

```
network.MPI = css0, not_shared,US,HIGH
```

**node**

Specifies the minimum and maximum number of nodes requested by a job step. You must specify at least one of these values. The value of the **node** keyword applies only to the job step in which you specify the keyword. (That is, this keyword is not inherited by other job steps.)

When you use the **node** keyword together with the **total\_tasks** keyword, the *min* and *max* values you specify on the **node** keyword must be equal, or you must specify only one value. For example:

```
node = 6
total_tasks = 12
```

**Syntax:**

**node** = [*min*][, *max*]

where:

- min* Specifies the minimum number of nodes requested by the job step.
- max* Specifies the maximum number of nodes requested by the job step. The maximum number of nodes a job step can request is limited by the **max\_node** keyword in the administration file (provided this keyword is specified). That is, the maximum must be less than or equal to any **max\_node** value specified in a user, group, or class stanza.

**Default value:** The default value for *min* is 1; the default value for *max* is the *min* value for this keyword.

**Example:** To specify a range of six to twelve nodes, enter the following:

```
node = 6,12
```

To specify a maximum of seventeen nodes, enter the following:

```
node = ,17
```

For information on specifying the number of tasks you want to run on a node, see “Task-assignment considerations” on page 170, 358, and 358.

**node\_usage**

Specifies whether this job step shares nodes with other job steps.

**Syntax:**

**node\_usage** = shared | **not\_shared**

where:

**shared**

Specifies that nodes can be shared with other tasks of other job steps.

**not\_shared**

Specifies that nodes are not shared. No other job steps are scheduled on this node.

**Default value:** **shared**

### notification

Specifies when the user specified in the **notify\_user** keyword is sent mail.

#### Syntax:

**notification** = **always**|**error**|**start**|**never**|**complete**

where:

#### **always**

Notify the user when the job begins, ends, or if it incurs error conditions.

**error** Notify the user only if the job fails.

**start** Notify the user only when the job begins.

**never** Never notify the user.

#### **complete**

Notify the user only when the job ends.

**Default value:** **complete**

#### Examples:

- If you want to be notified with mail only when your job step completes, your notification keyword would be:  
`notification = complete`
- When a LoadLeveler job ends, you may receive mail notification indicating the job exit status. For example, you could get the following mail message:  
Your LoadLeveler job  
myjob1  
exited with status 4.  
The return code 4 is from the user's job. LoadLeveler retrieves the return code and returns it in the mail message, but it is not a LoadLeveler return code.

### notify\_user

Specifies the user to whom mail is sent based on the **notification** keyword.

#### Syntax:

**notify\_user** = *userID*

**Default value:** The default is the submitting user at the submitting machine.

**Example:** If you are the job step owner but you want a coworker whose name and user ID is **bob**, to receive mail regarding the job step, your notify keyword would be:

`notify_user = bob@mailserv.pok.ibm.com`

### output

Specifies the name of the file to use as standard output (stdout) when your job step runs.

#### Syntax:

**output** = *filename*

**Default value:** If you do not specify this keyword, LoadLeveler uses the file `/dev/null`

**Example:**

```
output = out.${jobid}
```

## preferences

Specifies the characteristics that you prefer be available on the machine that executes the job steps. LoadLeveler attempts to run the job steps on machines that meet your preferences. If such a machine is not available, LoadLeveler will then assign machines that meet only your requirements.

The values you can specify in a **preferences** statement are the same values you can specify in a **requirements** statement, with the exception of the **Adapter** requirement. See 349 for more information.

**Restriction:** Preferences are ignored when using Gang scheduling.

**Syntax:**

```
preferences = Boolean_expression
```

**Default value:** No default preferences are set.

**Examples:**

```
preferences = (Memory <=16) && (Arch == "R6000")
preferences = Memory >= 64
```

## queue

Places one copy of the job step in the queue. This statement is required. The **queue** statement essentially marks the end of the job step. Note that you can specify statements between **queue** statements.

**Syntax:**

```
queue
```

## requirements

Specifies the requirements which a machine in the LoadLeveler cluster must meet to execute any job steps. You can specify multiple requirements on a single requirements statement.

**Syntax:**

```
requirements = Boolean_expression
```

When strings are used as part of a Boolean expression that must be enclosed in double quotes. Sample requirement statements are included following the descriptions of the supported requirements, which are:

**Adapter**

Specifies the predefined type of network you want to use to run a parallel job step. In any new job command files you create, you should use the **network** keyword to request adapters and types of networks.

The **Adapter** requirement is provided for compatibility with Version 1.3 job command files when run under the

LoadLeveler Backfill scheduler. It is also the way to specify when running with the default LoadLeveler scheduler. When using the default scheduler, the **Adapter** requirement is specified as the physical name of the device, such as *en0* or *css0*.

Note that you cannot specify both the **Adapter** requirement and the **network** statement in a job command file.

For the Backfill scheduler you can use the predefined network types. The predefined network types are:

**hps\_ip**

Refers to an SP switch in IP mode.

**hps\_user**

Refers to an SP switch in user space mode. If the switch in user mode is requested by the job, no other jobs using the switch in user mode will be allowed on nodes running that job.

**ethernet**

Refers to Ethernet.

**fdi** Refers to Fiber Distributed Data Interface (FDDI).

**tokenring**

Refers to Token Ring.

**fcs** Refers to Fiber Channel Standards.

Note that LoadLeveler converts the above network types to the **network** statement.

### Arch

Specifies the machine architecture on which you want your job step to run. It describes the particular kind of platform for which your executable has been compiled. The default is the architecture of the submitting machine.

### Connectivity

Connectivity is the ratio of the number of active switch adapters on a node to the total number of switch adapters on the node. The value ranges from 0.0 (all switch adapters are down) to 1.0 (all switch adapters are active). A node with no switch adapters has a connectivity of 0.0 . Connectivity can be used in a **MACHPRIO** expression to favor nodes that do not have any down switch adapters or in a job **REQUIREMENTS** statement to require only nodes with a certain connectivity.

### Disk

Specifies the amount of disk space in kilobytes you believe is required in the LoadLeveler **execute** directory to run the job step.

**Note:** The Disk variable in an expression associated with the **requirements** and **preferences** keywords are 64-bit integers.

### Feature

Specifies the name of a feature defined on a machine where you want your job step to run. Be sure to specify a feature in the same way in which the feature is specified in the configuration file. To find out what features are available, use the **llstatus** command.

**LargePageMemory**

Specifies the amount, in megabytes, of Large Page Memory required to run the job.

**Note:** The Memory variable in an expression associated with the **requirements** and **preferences** keywords are 64-bit integers.

**LL\_Version**

Specifies the LoadLeveler version, in dotted decimal format, on which you want your job step to run. For example, LoadLeveler Version 2 Release 1 (with no modification levels) is written as 2.1.0.0.

**Machine**

Specifies the names of machines on which you want the job step to run. Be sure to specify a machine in the same way in which it is specified in the machine configuration file.

If you have a mixed LoadLeveler cluster where the OpSys values of the machines may be either AIX53 or AIX52, using the **requirements** keyword to specify a Machine requirement may result in an expression that always evaluates to false. If the OpSys value of the submitting machine is AIX53, the **llsubmit** command automatically adds (OpSys == "AIX53") to the other job requirements unless an OpSys requirement has already been explicitly specified. This behavior means that the specification:

```
requirements = (Machine == "jupiter")
```

automatically becomes:

```
requirements = (Machine == "jupiter") && (OpSys == "AIX53")
```

This requirement cannot be satisfied unless the OpSys value of "jupiter" is also AIX53. In this case, a better strategy would be to use an expression such as:

```
requirements =
 (Machine == "jupiter") && ((OpSys == "AIX52") || (OpSys == "AIX53"))
```

**Memory**

Specifies the amount, in megabytes, of regular physical memory required in the machine where you want your job step to run.

**Note:** The Memory variable in an expression associated with the **requirements** and **preferences** keywords are 64-bit integers.

**OpSys**

Specifies the operating system on the machine where you want your job step to run. It describes the particular kind of platform for which your executable has been compiled. The default is the operating system of the submitting machine. The executable must be compiled on a machine that matches these requirements.

**Pool**

Specifies the number of a pool where you want your job step to run.

### TotalMemory

Specifies the amount, in megabytes, of regular physical memory and Large Page memory required in the machine where you want your job step to run.

**Note:** The Memory variable in an expression associated with the **requirements** and **preferences** keywords are 64-bit integers.

**Default value:** No default requirements are set.

### Examples:

- **Example 1:** To specify a memory requirement and a machine architecture requirement, enter:  
`requirements = (Memory >=16) && (Arch == "R6000")`
- **Example 2:** To specify that your job requires multiple machines for a parallel job, enter:  
`requirements = (Machine == { "116" "115" "110" })`
- **Example 3:** You can set a machine equal to a job step name. This setting means that you want the job step to run on the same machine on which the previous job step ran. For example:  
`requirements = (Machine == machine.step_name)`

Where *step\_name* is a step name previously defined in the job command file. The use of **Machine == machine.step\_name** is limited to serial jobs.

### Example:

```
@ step_name = step1
@ executable = c1
@ output = $(executable).$(jobid).$(step_name).out
@ queue
@ step_name = step2
@ dependency = (step1 == 0)
@ requirements = (Machine == machine.step1)
@ executable = c2
@ output = $(executable).$(jobid).$(step_name).out
@ queue
```

- **Example 4:** To specify a requirement for a specific pool number, enter:  
`requirements = (Pool == 7)`
- **Example 5:** To specify a requirement that the job runs on LoadLeveler Version 2 Release 1 or any follow-on release, enter:  
`requirements = (LL_Version >= "2.1")`

Note that the statement **requirements = (LL\_Version == "2.1")** matches only the value 2.1.0.0.

- **Example 6:** To specify the job runs if all switch connections are up, enter:  
`# @ requirements = (Connectivity == 1.0)`

To specify the job runs if at least half of the switch connections are up, enter:

```
@ requirements = (Connectivity >= .5)
```

To specify the job runs if there is at least some connectivity, enter:

```
@ requirements = (Connectivity > 0)
```

## resources

Specifies quantities of the consumable resources consumed by each task of a job step. The resources may be machine resources or floating resources.

### Syntax:

```
resources=name(count) name(count) ... name(count)
```

where *name(count)* is one of the following:

- An administrator defined name and count
- **ConsumableCpus**(*count*)
- **ConsumableMemory**(*count units*)
- **ConsumableVirtualMemory**(*count units*)

**ConsumableMemory** and **ConsumableVirtualMemory** are the only two consumable resources that can be specified with both a count and units.

The count for each specified resource must be an integer greater than or equal to zero, except for the following instances in which the integer must be greater than zero:

- **ConsumableMemory**
- **ConsumableVirtualMemory**
- **ConsumableCpus** when the enforcement policy is *hard* or *soft*

**ConsumableCpus** can have a value of zero when the administrator has not requested that consumable resources be enforced, or when the enforcement policy is *shares*.

When you set **ConsumableCpus** to zero, the meaning varies depending on whether use is being enforced. With no enforcement, zero means the job is requesting a negligible amount of CPU. With an enforcement policy of *shares*, it means the job is requesting a tiny percentage of available shares.

If the count is not valid then LoadLeveler will issue a message and the job will not be submitted. The allowable units are those normally used with LoadLeveler data limits:

```
b bytes
w words (4 bytes)
kb kilobytes (2**10 bytes)
kw kilowords (2**12 bytes)
mb megabytes (2**20 bytes)
mw megawords (2**22 bytes)
gb gigabytes (2**30 bytes)
gw gigawords (2**32 bytes)
tb terabytes (2**40 bytes)
tw terawords (2**42 bytes)
pb petabytes (2**50 bytes)
pw petawords (2**52 bytes)
eb exabytes (2**60 bytes)
ew exawords (2**62 bytes)
```

The **resources** keyword accepts both 32-bit and 64-bit integer values. These values, however, are assigned to the consumable resources defined in the **resources** keyword and not to the keyword itself.

**ConsumableMemory** and **ConsumableVirtualMemory** values are stored in mb (megabytes) and rounded up. Therefore, the smallest amount of **ConsumableMemory** or **ConsumableVirtualMemory** which you can request is one megabyte. If no units are specified, then megabytes are assumed. However, **image\_size** units are in kilobytes. Resources defined here that are not in the **SCHEDULE\_BY\_RESOURCES** list in the global configuration file will not affect the scheduling of the job.

When resource usage and resource submission is enforced, the **resources** keyword must specify requirements for the resources defined in the **ENFORCE\_RESOURCE\_USAGE** keyword.

**Default value:** If the **resources** keyword is not specified in the job step, then the **default\_resources** (if any) defined in the administration file for the class will be used for each task of the job step.

### **restart**

Specifies whether LoadLeveler considers a job to be “restartable.”

**Syntax:**

**restart** = yes|no

If **restart=yes**, and the job is vacated from its executing machine before completing, the central manager requeues the job. It can start running again when a machine on which it can run becomes available. If **restart=no**, a vacated job is canceled rather than requeued.

Note that jobs which are checkpointable (**checkpoint = yes | interval**) are always considered “restartable”.

**Default value:** yes

### **restart\_from\_ckpt**

Indicates whether a job step is to be restarted from a checkpoint file.

**Restriction:** This keyword is ignored by LoadLeveler for Linux.

**Syntax:**

**restart\_from\_ckpt** = yes | no

where:

**yes** Indicates LoadLeveler will restart the job step from the checkpoint file specified by the job command file keyword **ckpt\_file**. The location of the **ckpt\_file** will be determined by the values of the job command file keyword **ckpt\_file** or **ckpt\_dir**, the administrator defined location or the default location. See “Naming checkpoint files and directories” on page 134 for a description of how the

checkpoint directory location is determined. This value is valid only when a job is being restarted from a previous checkpoint.

**no** The job step will be started from the beginning, not from the checkpoint file.

**Default value:** no

If you specify an invalid value for this keyword, the system generates an error message and the job is not submitted.

#### **restart\_on\_same\_nodes**

Indicates that a job step is to be restarted on the same set of nodes that it was run on previously. This keyword applies only to restarting a job step after a vacate (this condition is when the job step is terminated and then returned to the LoadLeveler job queue).

**Syntax:**

**restart\_on\_same\_nodes** = **yes** | **no**

where:

**yes** Indicates that the job step is to be restarted on the same set of nodes on which it had run.

**no** Indicates that it is not required to restart a vacated job on the same nodes.

**Default value:** no

#### **rset**

This keyword indicates that the job tasks need to be attached to RSets with CPUs selected by different LoadLeveler scheduling algorithms or RSets created by users.

**Syntax:**

**rset** = *value*

Value can be one of the following keywords or a user defined RSet name.

##### **RSET\_CONSUMABLE\_CPUS**

Specifying this option indicates that the job needs to be scheduled to machines where **RSET\_SUPPORT** is set to **RSET\_CONSUMABLE\_CPUS** and the tasks need to be attached to RSets with a number of CPUs equal to the number of **ConsumableCPUs** requested by the job without two tasks sharing a CPU.

##### **RSET\_MCM\_AFFINITY**

Specifying this value requests affinity scheduling with memory affinity as a requirement, adapter affinity as a preference, and the task MCM allocation method set to accumulate. The affinity options may be changed from these defaults by using the **mcm\_affinity\_options** keyword.

When anything other than the above values is specified, LoadLeveler considers the value to be a user defined RSet name and schedules the job to nodes with **RSET\_SUPPORT** set to **RSET\_USER\_DEFINED**.

**Default value:** No default is set.

**Example:**

`rset=RSET_MCM_AFFINITY`

This example shows how to request affinity scheduling for a job.

### **shell**

Specifies the name of the shell to use for the job step.

**Syntax:**

**shell** = *name*

**Default value:** If you do not specify a value for this keyword, LoadLeveler uses the shell used in the owner's password file entry. If none is specified, LoadLeveler uses `/bin/sh`

**Example:** If you want to use the Korn shell, the shell keyword would be:

`shell = /bin/ksh`

### **stack\_limit**

Specifies the hard limit, soft limit, or both limits for the size of the stack that is created.

**Syntax:**

**stack\_limit** = *hardlimit,softlimit*

This keyword accepts both 32-bit and 64-bit integer values.

**Default value:** No default is set.

**Example:**

`stack_limit = 120000,100000`

Because no units have been specified in the above example, LoadLeveler assumes that the figure represents a number of bytes.

For more information about the values and units you can use with this keyword, and how limits are enforced, see "Using limit keywords" on page 83.

### **startdate**

Specifies when you want to run the job step.

**Syntax:**

**startdate** = *date time*

*date* is expressed as *MM/DD/YYYY*, and *time* is expressed as *HH:mm(:ss)*.

**Default value:** If you do not specify a start date, LoadLeveler uses the current date and time.

**Example:** If you want the job to run on August 28th, 2010 at 1:30 PM, issue:

```
startdate = 08/28/2010 13:30
```

If you specify a start date that is in the future, your job is kept in the Deferred state until that start date.

### step\_name

Specifies the name of the job step. You can name the job step using any combination of letters, numbers, underscores (\_) and periods (.). You cannot, however, name it T or F, or use a number in the first position of the step name. The step name you use must be unique and can be used only once.

#### Syntax:

```
step_name = step_name
```

**Default value:** If you don't specify a step name, by default the first job step is named the character string "0", the second is named the character string "1", and so on.

#### Example:

```
step_name = step_3
```

### task\_geometry

The **task\_geometry** keyword allows you to group tasks of a parallel job step to run together on the same node. Although **task\_geometry** allows for a great deal of flexibility in how tasks are grouped, you cannot specify the particular nodes that these groups run on; the scheduler will decide which nodes will run the specified groupings.

#### Syntax:

```
task_geometry={{(task id,task id,...)(task id,task id, ...) ... }
```

**Default value:** No default value is set.

**Example:** A job with 6 tasks will run on 4 different nodes:

```
task_geometry={{(0,1) (3) (5,4) (2)}}
```

Each number in the example above represents a task ID in a job, each set of parenthesis contains the task IDs assigned to one node. The entire range of tasks specified must begin with 0, and must be complete; no number can be skipped (the largest task id number should end up being the value that is one less than the total number of tasks). The entire statement following the keyword must be enclosed in braces, and each grouping of nodes must be enclosed in parenthesis. Commas can only appear between task IDs, and spaces can only appear between nodes and task IDs.

The **task\_geometry** keyword cannot be specified under **any** of the following conditions:

- The step is serial.
- **job\_type** is anything other than **parallel**
- Any of the following keywords are specified:
  - **tasks\_per\_node**
  - **total\_tasks**
  - **node**
  - **min\_processors**
  - **max\_processors**
  - **blocking**

For more information, see “Task-assignment considerations” on page 170.

### **tasks\_per\_node**

Specifies the number of tasks of a parallel job you want to run per node. Use this keyword together with the **node** keyword. The value you specify on the **node** keyword can be a range or a single value. If the **node** keyword is not specified, then the default value is one node.

The maximum number of tasks a job step can request is limited by the **total\_tasks** keyword in the administration file (provided this keyword is specified). That is, the maximum must be less than any **total\_tasks** value specified in a user, group, or class stanza.

The value of the **tasks\_per\_node** keyword applies only to the job step in which you specify the keyword. (That is, this keyword is not inherited by other job steps.)

Also, you cannot specify both the **tasks\_per\_node** keyword and the **total\_tasks** keyword within a job step.

#### **Syntax:**

**tasks\_per\_node** = *number*

where *number* is the number of tasks you want to run per node.

**Default value:** The default is one task per node.

**Example:** To specify a range of seven to 14 nodes, with four tasks running on each node, enter the following:

```
node = 7,14
tasks_per_node = 4
```

The above job step runs 28 to 56 tasks, depending on the number of nodes allocated to the job step.

### **total\_tasks**

Specifies the total number of tasks of a parallel job you want to run on all available nodes. Use this keyword together with the **node** keyword. The value you specify on the **node** keyword must be a single value rather than a range of values. If the **node** keyword is not specified, then the default value is one node.

The maximum number of tasks a job step can request is limited by the **total\_tasks** keyword in the administration file (provided this keyword is specified). That is, the maximum must be less than any **total\_tasks** value specified in a user, group, or class stanza. The

value of the **total\_tasks** keyword applies only to the job step in which you specify the keyword. (That is, this keyword is not inherited by other job steps.) Also, you cannot specify both the **total\_tasks** keyword and the **tasks\_per\_node** keyword within a job step.

If you specify an unequal distribution of tasks per node, LoadLeveler allocates the tasks on the nodes in a round-robin fashion. For example, if you have three nodes and five tasks, two tasks run on the first two nodes and one task runs on the third node.

**Syntax:**

**total\_tasks** = *number*

Where *number* is the total number of tasks you want to run.

**Default value:** No default is set.

**Example:** To run two tasks on each of 12 available nodes for a total of 24 tasks, enter the following:

```
node = 12
total_tasks = 24
```

### **user\_priority**

Sets the initial priority of your job step. Priority only affects your job steps. It orders job steps you submitted with respect to other job steps submitted by you, not with respect to job steps submitted by other users.

**Syntax:**

**user\_priority** = *number*

Where *number* is a number between 0 and 100, inclusive. A higher number indicates the job step will be selected before a job step with a lower number. Note that this keyword is not the UNIX *nice* priority.

This priority guarantees the order the jobs are considered for dispatch. It does not guarantee the order in which they will run.

**Default value:** The default priority is 50.

### **wall\_clock\_limit**

Sets the hard limit, soft limit, or both limits for the elapsed time for which a job can run. In computing the elapsed time for a job, LoadLeveler considers the start time to be the time the job is dispatched.

If you are running either the Backfill or Gang scheduler, you must either set a wall clock limit in the job command file or the administrator must define a wall clock limit value for the class to which a job is assigned. In most cases, this wall clock limit value should not be **unlimited**. For more information, see “Choosing a scheduler” on page 35.

**Syntax:**

**wall\_clock\_limit** = *hardlimit,softlimit*

An example is:

```
wall_clock_limit = 5:00,4:30
```

For more information about the values and units you can use with this keyword, and how limits are enforced, see “Using limit keywords” on page 83.

## Job command file variables

LoadLeveler has several variables you can use in a job command file. These variables are useful for distinguishing between output and error files.

You can refer to variables in mixed case, but you must specify them using the following syntax:

**`$(variable_name)`**

The following variables are available to you:

### **`$(domain)`**

The domain of the host from which the job was submitted.

### **`$(home)`**

The home directory for the user on the cluster selected to run the job. Since the user may differ from the submitting user when a remote cluster is selected to run the job and user mapping is used, so may the home directory differ.

### **`$(host)`**

The hostname of the machine from which the job was submitted. In a job command file, the **`$(host)`** variable and the **`$(hostname)`** variable are equivalent.

### **`$(jobid)`**

The sequential number assigned to this job by the schedd daemon. The **`$(jobid)`** variable and the **`$(cluster)`** variable are equivalent.

### **`$(schedd_host)`**

The hostname of the scheduling machine.

### **`$(schedd_hostname)`**

The hostname and domain name of the scheduling machine.

### **`$(stepid)`**

The sequential number assigned to this job step when multiple queue statements are used with the job command file. The **`$(stepid)`** variable and the **`$(process)`** variable are equivalent.

### **`$(user)`**

The user name on the cluster selected to run the job. This might be a different user name than the user name who submitted the job. It is possible for the value of this variable to differ from the submitting user name when a remote cluster is selected to run the job and user name mapping is being used.

In addition, the following keywords are also available as variables. However, you must define them in the job command file. These keywords are described in detail in “Job command file keyword descriptions” on page 324.

- **`$(executable)`**
- **`$(class)`**
- **`$(comment)`**
- **`$(job_name)`**
- **`$(step_name)`**

Note that for the **\$(comment)** variable, the keyword definition must be a single string with no blanks. Also, the **executable** statement automatically sets the **\$(base\_executable)** variable, which is the file name of the executable without the directory component. See Figure 22 on page 161 for an example of using the **\$(base\_executable)** variable.

## Run-time environment variables

The following environment variables are set by LoadLeveler for all jobs. These environment variables are also set before running prolog and epilog programs. For more information on prolog and epilog programs, see “Writing prolog and epilog programs” on page 70.

### **LOADLBATCH**

Set to **yes** to indicate the job is running under LoadLeveler.

### **LOADLBATCH**

Set to **yes** to indicate the job is running under LoadLeveler.

### **LOADL\_ACTIVE**

The LoadLeveler version.

### **LOADL\_CKPT\_FILE**

Identifies the directory and file name for checkpointing files. LoadLeveler will only set this environmental variable if checkpointing is enabled.

### **LOADL\_JOB\_NAME**

The three part job identifier.

### **LOADL\_PID**

The process ID of the starter process.

### **LOADL\_PROCESSOR\_LIST**

A Blank-delimited list of hostnames allocated for the step. This environment variable is limited to 128 hostnames. If the value is greater than the 128 limit, the environment variable is not set.

### **LOADL\_STARTD\_PORT**

The port number where the startd daemon runs.

### **LOADL\_STEP\_ACCT**

The account number of the job step owner.

### **LOADL\_STEP\_ARGS**

Any arguments passed by the job step.

### **LOADL\_STEP\_CLASS**

The job class for serial jobs.

### **LOADL\_STEP\_COMMAND**

The name of the executable (or the name of the job command file if the job command file is the executable).

### **LOADL\_STEP\_ERR**

The file used for standard error messages (stderr).

### **LOADL\_STEP\_GROUP**

The UNIX group name of the job step owner.

### **LOADL\_STEP\_ID**

The job step ID.

### **LOADL\_STEP\_IN**

The file used for standard input (stdin).

## Job command file variables

### LOADL\_STEP\_INITDIR

The initial working directory.

### LOADL\_STEP\_NAME

The name of the job step.

### LOADL\_STEP\_NICE

The UNIX *nice* value of the job step. This value is determined by the **nice** keyword in the class stanza. For more information, see “Defining classes” on page 83.

### LOADL\_STEP\_OUT

The file used for standard output (stdout).

### LOADL\_STEP\_OWNER

The job step owner.

### LOADL\_STEP\_TYPE

The job type (SERIAL, PARALLEL, or NQS)

## Example 1

The following job command file creates an output file called **stance.78.out**, where **stance** is the host and **78** is the job ID.

```
@ executable = my_job
@ arguments = 5
@ output = $(host).$(jobid).out
@ queue
```

## Example 2

The following job command file creates an **output** file called **computel.step1.March05**.

```
@ comment = March05
@ job_name = computel
@ step_name = step1
@ executable = my_job
@ output = $(job_name).$(step_name).$(comment)
@ queue
```

For additional information, see “Examples: Job command files” on page 159.

---

## Chapter 14. Graphical user interface (GUI) reference

The LoadLeveler GUI provides an interface for users and administrators similar in function to the LoadLeveler command line. For more information Chapter 6, “Using LoadLeveler’s GUI to perform administrator tasks,” on page 147 or Chapter 10, “Using LoadLeveler’s GUI to build, submit, and manage jobs,” on page 207.

If this is the first time you are using a Motif-based GUI, you should refer to the appropriate Motif documentation for general GUI information.

In “Customizing the GUI” on page 366 you will also find information on customizing the GUI by:

- Modifying windows and buttons
- Creating pull-down menus
- Customizing window fields
- Modifying help panels
- Setting up administrative tasks

**Note:** LoadLeveler provides two types of graphical user interfaces. One interface is for users whose machines interact fully with LoadLeveler. The second interface is available to users of submit-only machines that participate on a limited basis with LoadLeveler.

---

### Starting the GUI

To start the GUI, check your PATH variable to ensure that it is pointing to the LoadLeveler binaries. Also, check to see that your DISPLAY variable is set to your display. Then, type one of the following to start the GUI in the background:

- **xloadl\_so &** (if you are running a submit-only machine)
- **xloadl &** (for all other users)

**Note:** When you invoke the GUI in a multicluster environment, an additional window appears. This window allows you to start additional local instances of **xloadl** or **xloadl\_so** for each remote cluster present in your multicluster environment. These instances of **xloadl** are distinguished through the instance window titles:

- The **xloadl** instances for remote clusters have titles of the form *local\_cluster\_name→remote\_cluster\_name*, for instance, **MY\_C2→MY\_C3**, where MY\_C2 and MY\_C3 are cluster names (local and remote, respectively).
- The **xloadl** instance for the local cluster has a title of the form *local\_cluster\_name*, for instance, **MY\_C2**, where MY\_C2 is the name of the local cluster.

### Specifying GUI options

In general, you can specify GUI options in any of the following ways:

- Within the GUI using menu selections
- On the **xloadl** (or **xloadl\_so**) command line. Enter **xloadl -h** or **xloadl\_so -h** to see a list of the available options.
- In the **Xloadl** file. See “Customizing the GUI” on page 366 for more information.

## The LoadLeveler main window

LoadLeveler's main window has three sub-windows, titled Jobs, Machines, and Messages, as shown in Figure 36. Each of these sub-windows has its own menu bar.

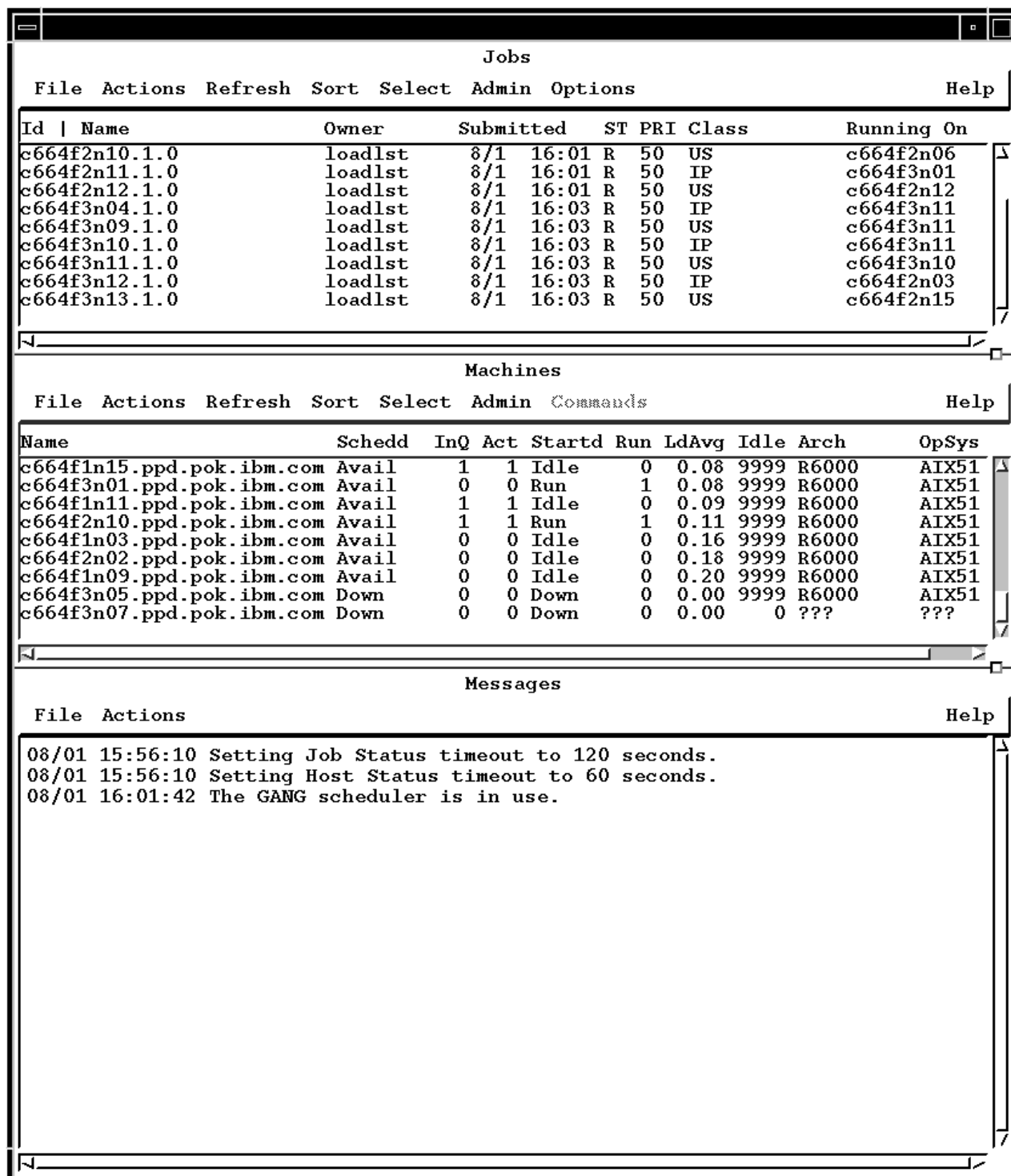


Figure 36. Main window of the LoadLeveler GUI

The menu bar on the Jobs window relates to actions you can perform on jobs. The menu bar on the Machines window relates to actions you can perform on machines. Similarly, the menu bar on the Messages window displays actions you can perform related to LoadLeveler generated messages.

When you select an item from a menu bar, a pull-down menu appears. You can select an item from the pull-down menu to carry out an action or to bring up another pull-down menu originating from the first one.

## Getting help using the GUI

You can get help when using the GUI by pressing the Help key. This key is function key 1 (F1) on most keyboards. To receive help on specific parts of the LoadLeveler GUI, click the mouse on the area or field for which you want help and press F1. A help screen appears describing that area. You can also get help by using the Help pull-down menu and the Help push buttons available in pop-up windows.

Before you invoke the GUI, make sure your PATH statement includes the directory containing the LoadLeveler executables. Otherwise, some GUI functions may not work correctly.

## Differences between LoadLeveler's GUI and other graphical user interfaces

LoadLeveler's GUI contains many items common to other GUIs. There are, however, some differences that you should be aware of. These differences are:

- Accelerators or mnemonics do not appear on the menu bars.
- Submerged windows do not necessarily rise to the top when refreshed.

## GUI typographic conventions

This book uses the following typographic conventions when describing the way tasks are accomplished using the GUI.

### Task step conventions

Each task step includes a user action and a system response. User actions appear in **UPPERCASE BOLDFACE** type and the system response to an action follows a ▲. For example:

**SELECT**

**Refresh → Set Auto Refresh**

▲ A window appears.

An action is sometimes represented by itself, for example:

**SELECT            OK**

### Selection table and decision table conventions

Some actions require a selection or decision. Selection and decision actions are presented in tables.

Selection tables list all possible selections in the left column of the table. The following is an example of a selection table:

| To           | Do This                                               |
|--------------|-------------------------------------------------------|
| Submit a job | Refer to "Submitting a job command file" on page 220. |
| Cancel a job | Refer to "Canceling a job" on page 222.               |

Decision tables present a question or series of questions before indicating the action. The following is an example of a decision table:

| Did the job you submitted complete processing? |                              |
|------------------------------------------------|------------------------------|
| Yes                                            | Submit another job.          |
| No                                             | Check the status of the job. |

### Menu selection conventions

Selections from a menu bar are indicated with an  $\rightarrow$ . For example, if a menu bar included an option called **Actions** and **Actions** included an option called **Cancel**, the instructions would read:

**SELECT        Actions  $\rightarrow$  Cancel**

## 64-bit support for the GUI

The LoadLeveler Graphical User Interface (xloadl or xloadl\_so) accepts and displays 64-bit information where appropriate.

## Customizing the GUI

You can customize the GUI to suit your needs by overriding the default settings of the LoadLeveler resource variables. For example, you can set the color, initial size, and location of the main window.

This section tells you how to customize the GUI by modifying either (or both) of the following files:

**Xloadl**            For fully participating machines  
**Xloadl\_so**        For submit-only machines

If the LoadLeveler administrator has set up these resource files, the files are located in the **/usr/lib/X11/app-defaults** directory. Otherwise, the files are located in the **lib** directory of the LoadLeveler release directory:

- For AIX, in **/usr/lpp/LoadL/full/lib** and **/usr/lpp/LoadL/so/lib**, respectively.
- For Linux, in **/opt/ibmll/LoadL/full/lib** and **/opt/ibmll/LoadL/so/lib**, respectively.

These files contain the default values for the graphical user interface. This section discusses the syntax of these files, and gives you an overview of some of the resources you can modify.

An administrator with root authority can make changes to the resources for the entire installation by editing the **Xloadl** file. Any user can make local changes by placing the resource names with their new values in the user's **.Xdefaults** file.

### Syntax of an Xloadl file

- Comments begin with **!**
- Resource variables may begin with **\***
- Colons follow resource variables
- Resource variable values follow colons.

### Modifying windows and buttons

All of the windows and buttons that are part of the GUI have certain characteristics in common. For example, they all have a foreground and

background color, as well as a size and a location. Each one of these characteristics is represented by a resource variable. For example, the foreground characteristic is represented by the resource variable **foreground**. In addition, every resource variable has a value associated with it. The values of the resource variable **foreground** are a range of colors.

Before customizing a window, you need to locate the resource variables associated with the desired window. To do this, search for the window identifier in your Xloadl file. The following table lists the windows and their respective identifiers:

*Table 49. Window identifiers in the Xloadl file*

| Window              | Identifier     |
|---------------------|----------------|
| Account Report Data | reporter       |
| Build a Job         | builder        |
| Checkpoint Fields   | ckpt           |
| Jobs                | job_status     |
| Limits              | limits         |
| Machines            | machine_status |
| Messages            | message_area   |
| Network             | network        |
| Nodes               | nodes          |
| Preferences         | preferences    |
| Requirements        | requirements   |
| Script              | script         |
| Submit a Job        | submit         |
| Task Geometry       | tgeometry      |

The following table lists the resource variables for all the windows and the buttons along with a description of each resource variable. Use the information in this table to modify your graphical user interface by changing the values of desired resource variables. The values of these resource variables depend upon Motif requirements.

| Resource Variable | Description                         |
|-------------------|-------------------------------------|
| background        | The background color of the object  |
| foreground        | The foreground color of the object  |
| geometry          | The location of the object          |
| height            | The height of the object            |
| labelString       | The text associated with the object |
| width             | The width of the object             |

## Creating your own pull-down menus

You can add a pull-down menu to both the Jobs window and the Machines window.

To add a pull-down menu to the Jobs window, in the **Xloadl** file:

1. Set **userJobPulldown** to **True**
2. Set **userJob.labelString** to the name of your menu.

## Customizing the GUI

3. Fill in the appropriate information for your first menu item, **userJob\_Option1**
4. To define more menu items, fill in the appropriate information for **userJob\_Option2**, **userJob\_Option3**, and so on. You can define up to ten menu items.

For more information, refer to the comments in the **Xloadl** file.

To add a pull-down menu to the Machines window, in the **Xloadl** file:

1. Set **userMachinePulldown** to **True**
2. Set **userMachine.labelString** to the name of your menu.
3. Fill in the appropriate information for your first menu item, **userMachine\_Option1**
4. To define more menu items, fill in the appropriate information for **userMachine\_Option2**, **userMachine\_Option3**, and so on. You can define up to ten menu items.

### Example – creating a new pull-down

Suppose you want to create a new menu bar item containing a selection which executes the **ping** command against a machine you select on the Machines window.

```
*userMachinePulldown: True
*userMachine.labelString: Commands
*userMachine_Option1: True
*userMachine_Option1_command: ping -c1
*userMachine_Option1.labelString: ping
*userMachine_Option1_parameter: True
*userMachine_Option1_output: Window
```

*Figure 37. Creating a new pull-down menu*

The **Xloadl** definitions shown in the Figure 37 create a menu bar item called “Commands”. The first item in the Commands pull-down menu is called “ping”. When you select this item, the command **ping -c1** is executed, with the machine you selected on the Machines window passed to this command. Your output is displayed in an informational window.

For more information, refer to the comments in the **Xloadl** file.

## Customizing fields on the Jobs window and the Machines window

You can control which fields are displayed and which fields are not displayed on the Jobs window and the Machine window by changing the **Xloadl** file. Look in the **Xloadl** file for “Resources for specifying lengths of fields displayed in the Jobs and Machines windows”.

In most cases, you can remove a field from a window by setting its associated resource value to 0. To remove the Arch field from the Machines window, enter the following:

```
*mach_arch_len : 0
```

Note that the Job ID and Machine Name fields must always be displayed and therefore cannot be set to 0.

All fields have a minimum length value. If you specify a smaller value, the minimum is used.

## Modifying help panels

Help panels have the same characteristics as all of the windows plus a few unique ones:

| Resource Variable     | Values                                  | Description                          |
|-----------------------|-----------------------------------------|--------------------------------------|
| help*work_area.width  | Any integer*                            | The width of the help panel.         |
| help*work_area.height | Any integer*                            | The height of the help panel.        |
| help*scrollHorizontal | [true   false]<br>The default is False. | Sets the scrolling option on or off. |
| help*wordWrap         | [true   false]<br>The default is True.  | Sets word wrapping on or off.        |

**Note:**

\* The work area and height depend upon your screen limitations.



## Chapter 15. Commands

LoadLeveler provides two types of commands: those that are available to all users of LoadLeveler, and those that are reserved for LoadLeveler administrators. If security services are not configured, then administrators are identified by the LOADL\_ADMIN keyword in the configuration file. If security services are configured, the configuration file must identify the administrator's group. Refer to "Defining security mechanisms" on page 46 for more information.

The administrator commands can operate on the entire LoadLeveler job queue and all machines configured. The user commands mainly affect those jobs submitted by that user. Some commands, such as **llhold**, include options that can only be performed by an administrator.

Table 50 lists:

- All of the LoadLeveler commands
- The intended users
- The supported operating systems
- Whether the command can be issued across clusters to all clusters, a single cluster, or only within the local cluster
- A reference to the full description of each command

Table 50. LoadLeveler command summary

| Command name         | Intended users                        | Supported operating systems | Multicluster support | For more information, see...                                           |
|----------------------|---------------------------------------|-----------------------------|----------------------|------------------------------------------------------------------------|
| <b>llacctmrg</b>     | Administrators only                   | AIX and Linux               | No                   | "llacctmrg - Collect machine history files" on page 373                |
| <b>llbind</b>        | Both administrators and general users | AIX and Linux               | No                   | "llbind - Bind job steps to a reservation" on page 375                 |
| <b>llcancel</b>      | Both administrators and general users | AIX and Linux               | Single cluster       | "llcancel - Cancel a submitted job" on page 377                        |
| <b>llchres</b>       | Both administrators and general users | AIX and Linux               | No                   | "llchres - Change attributes of a reservation" on page 380             |
| <b>llckpt</b>        | Both administrators and general users | AIX only                    | Single cluster       | "llckpt - Checkpoint a running job step" on page 384                   |
| <b>llclass</b>       | Both administrators and general users | AIX and Linux               | Yes                  | "llclass - Query class information" on page 387                        |
| <b>llclusterauth</b> | Administrators only                   | AIX and Linux               | No                   | "llclusterauth - Generates public and private keys" on page 392        |
| <b>llctl</b>         | Administrators only                   | AIX and Linux               | No                   | "llctl - Control LoadLeveler daemons" on page 393                      |
| <b>lldbconvert</b>   | Administrators only                   | AIX and Linux               | No                   | "lldbconvert - Job migration utility" on page 397                      |
| <b>lldcegrpmain</b>  | DCE administrators only               | AIX only                    | No                   | "lldcegrpmain - LoadLeveler DCE group maintenance utility" on page 398 |
| <b>llxtRPD</b>       | Both administrators and general users | AIX and Linux               | No                   | "llxtRPD - Extract data from an RSCT peer domain" on page 401          |

## LoadLeveler commands

Table 50. LoadLeveler command summary (continued)

| Command name          | Intended users                        | Supported operating systems | Multicluster support                                                                  | For more information, see...                                                               |
|-----------------------|---------------------------------------|-----------------------------|---------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| <b>llexSDR</b>        | Both administrators and general users | AIX only                    | No                                                                                    | "llexSDR - Extract adapter information from the SDR" on page 404                           |
| <b>llfavorjob</b>     | Administrators only                   | AIX and Linux               | No                                                                                    | "llfavorjob - Reorder system queue by job" on page 408                                     |
| <b>llfavoruser</b>    | Administrators only                   | AIX and Linux               | No                                                                                    | "llfavoruser - Reorder system queue by user" on page 410                                   |
| <b>llhold</b>         | Both administrators and general users | AIX and Linux               | Single cluster                                                                        | "llhold - Hold or release a submitted job" on page 411                                     |
| <b>llinit</b>         | Administrators only                   | AIX and Linux               | No                                                                                    | "llinit - Initialize machines in the LoadLeveler cluster" on page 414                      |
| <b>llmkres</b>        | Both administrators and general users | AIX and Linux               | No                                                                                    | "llmkres - Make a reservation" on page 416                                                 |
| <b>llmodify</b>       | Both administrators and general users | AIX and Linux               | Single cluster (not supported with <b>-p</b> , <b>-s</b> , <b>-x</b> , or <b>-W</b> ) | "llmodify - Change attributes of a submitted job step" on page 419                         |
| <b>llmovejob</b>      | Administrators only                   | AIX and Linux               | No                                                                                    | "llmovejob - Move a single idle job from the local cluster to another cluster" on page 424 |
| <b>llpreempt</b>      | Administrators only                   | AIX and Linux*              | No                                                                                    | "llpreempt - Preempt a submitted job step" on page 426                                     |
| <b>llprio</b>         | Both administrators and general users | AIX and Linux               | Single cluster                                                                        | "llprio - Change the user priority of submitted job steps" on page 429                     |
| <b>llq</b>            | Both administrators and general users | AIX and Linux               | Yes (not supported with <b>-d</b> , <b>-w</b> or <b>-x</b> )                          | "llq - Query job status" on page 431                                                       |
| <b>llqres</b>         | Both administrators and general users | AIX and Linux               | No                                                                                    | "llqres - Query a reservation" on page 449                                                 |
| <b>llrmres</b>        | Both administrators and general users | AIX and Linux               | No                                                                                    | "llrmres - Cancel a reservation" on page 452                                               |
| <b>llrunscheduler</b> | Administrators only                   | AIX and Linux               | No                                                                                    | "llrunscheduler - Run the central manager's scheduling algorithm" on page 454              |
| <b>llstatus</b>       | Both administrators and general users | AIX and Linux               | Yes                                                                                   | "llstatus - Query machine status" on page 455                                              |
| <b>llsubmit</b>       | Both administrators and general users | AIX and Linux               | Yes                                                                                   | "llsubmit - Submit a job" on page 471                                                      |
| <b>llsummary</b>      | Both administrators and general users | AIX and Linux               | No                                                                                    | "llsummary - Return job resource information for accounting" on page 474                   |

\* - On LoadLeveler for Linux platforms, the suspend preempt method is not supported.

## llacctmrg - Collect machine history files

### Purpose

Collects individual machine history files together into a single file.

### Syntax

```
llacctmrg [-?] [-H] [-v] [-R] [-h hostlist] [-d directory]
```

### Flags

- ? Provides a short usage message.
- H Provides extended help information.
- v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.
- R Merges individual machine reservation history files into a single history file.
- h *hostlist*  
Specifies a blank-delimited list of machines from which to collect data. The default is all machines in the LoadLeveler cluster.
- d *directory*  
Specifies the directory to hold the new global history file. If not specified, the directory specified in the **GLOBAL\_HISTORY** keyword in the configuration file is used.

### Description

This command by default collects data from all the machines identified in the administration file. To override the default, specify a machine or a list of machines using the **-h** flag.

When the **llacctmrg** command ends, accounting information is stored in a file called **globalhist.YYYYMMDDHHmm**.

where:

**YYYY** Indicates the year  
**MM** Indicates the month  
**DD** Indicates the day  
**HH** Indicates the hour  
**mm** Indicates the minute.

Information such as the amount of resources consumed by the job and other job-related data is stored in this file.

Note that when the collection of accounting information to the global history file is complete, the accounting information is cleared in the history file.

For job data, you can use this file as input to the **llsummary** command. For example, if you created the file **globalhist.199808301050**, you can issue **llsummary globalhist.199808301050** to process the accounting information stored in this file.

When the **-R** flag is used to merge reservation history files instead of job history files, a file named **reservation\_globalhist.YYYYMMDDHHmm** is created in the specified directory. You can view reservation data with any text editor. For more

information on the format of the reservation history file, see the accounting information in Chapter 3, “Configuring the LoadLeveler environment,” on page 31.

Data on processes which fork child processes will be included in the file only if the parent process waits for the child process to end. Therefore, complete data may not be collected for jobs which are not composed of simple parent/child processes. For example, if a LoadLeveler job invokes an **rsh** command to execute some function on another machine, the resources consumed on the other machine will not be collected as part of the accounting data.

## Examples

1. The following example collects data from machines named **mars** and **pluto**:  
`llacctmrg -h mars pluto`
2. The following example collects data from the machine named **mars** and places the data in an existing directory called **merge**:  
`llacctmrg -h mars -d merge`
3. The following example collects reservation history data from all machines in the LoadLeveler cluster:  
`llacctmrg -R`

You should receive a response similar to the following:

```
llacctmrg: History transferred successfully from
c94n04.ppd.pok.ibm.com (98 bytes).
```

A file named **reservation\_globlhist.200502100915** is generated in the global history file location, assuming **llacctmrg** is issued at the time of 09:15 02/10/2005.

## Results

The following shows a sample system response from the **llacctmrg -h mars -d merge** command.

```
llacctmrg: History transferred successfully from mars (10080 bytes)
```

## Security

LoadLeveler administrators can issue this command.

## llbind - Bind job steps to a reservation

### Purpose

**llbind** – Binds job steps to a reservation in LoadLeveler, or unbinds job steps from the reservations to which they currently belong. The bound job steps will only be scheduled to run on the nodes reserved by the reservation.

### Syntax

```
llbind { -? | -H | -v | [-q] { -r | -R reservation_ID } job_step_list }
```

### Flags

|                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| -?                | Provides a short usage message.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| -H                | Provides extended help information.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| -v                | Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| -q                | Specifies quiet mode: print no messages other than error messages.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| -r                | Specifies an unbind operation. LoadLeveler eliminates any association between the job steps and a reservation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| -R reservation_ID | Specifies a reservation identifier to which the job steps will be bound. The format of a full LoadLeveler reservation identifier is [host.]rid[.r].<br>where:<br><ul style="list-style-type: none"> <li>• <i>host</i> is the name of the machine that assigned the reservation identifier.</li> <li>• <i>rid</i> is the number assigned to the reservation when it was created. An <i>rid</i> is required.</li> <li>• <i>r</i> indicates that this is a reservation ID (<i>r</i> is optional).</li> </ul> The reservation identifier may be specified in an abbreviated form, <i>rid[.r]</i> , when the command is invoked on the same machine that assigned the reservation identifier. In this case, LoadLeveler will use the local machine's hostname to construct the full reservation identifier. |
| job_step_list     | Is a blank-delimited list of job steps to be bound to the reservation or unbound from their respective reservations. The name of each job step should be in the form [host].jobid[.stepid].<br>where:<br><ul style="list-style-type: none"> <li>• <i>host</i> is the name of the machine that assigned the job and step identifiers.</li> <li>• <i>jobid</i> is the job number assigned to the job when it was submitted.</li> <li>• <i>stepid</i> is the job step number assigned to the job step when it was submitted.</li> </ul> The job or step identifier may be specified in an abbreviated form, <i>jobid</i> or <i>jobid.stepid</i> , when the command is invoked on the same                                                                                                                 |

machine that assigned the job and step identifiers. In this case, LoadLeveler will use the local machine's hostname to construct the full job or step identifier.

### Description

The **llbind** command is for LoadLeveler administrators and owner or users of a reservation. Regular users can only bind their own job steps to a reservation that they are allowed to use, while a LoadLeveler administrator can bind any job steps to any reservation.

Bound job steps will be scheduled to run on the reserved nodes only.

Only job steps in an idle-like state can be bound to a reservation. A job step that is in an idle-like state that is already bound to a reservation can be bound to a new reservation using the **llbind** command. The command will first unbind the job step from the reservation it is currently bound to and then bind it to the requested reservation.

Only existing job steps queued in LoadLeveler can be bound to a reservation through this command. The `LL_RES_ID` environment variable can be used to bind an interactive POE job to a reservation or cause **llsubmit** to both submit and bind a batch job to a reservation. For additional information about setting the `LL_RES_ID` environment variable to bind an interactive POE job to a reservation, see Chapter 7, "Building and submitting jobs," on page 157. The **llqres** command can be used to view the list of job steps bound to the reservation.

This command is for the BACKFILL scheduler only.

### Examples

1. To request to bind the job step `c188f2n01.6.0` to reservation `c188f1n03.2.r`, issue:  
`llbind -R c188f1n03.2.r c188f2n01.6.0`

You should receive a response similar to the following:

Request to bind job steps to reservation `c188f1n03.2.r` has been sent to LoadLeveler

2. To request to unbind the job step `c188f2n01.6.0` from the reservation to which it is currently bound, issue:  
`llbind -r c188f2n01.6.0`

You should receive a response similar to the following:

Request to unbind job steps from their respective reservations has been sent to LoadLeveler.

### Security

LoadLeveler administrators and users can issue this command.

## llcancel - Cancel a submitted job

### Purpose

Cancels one or more jobs from the LoadLeveler queue.

### Syntax

```
llcancel { -? | -H | -v | -f hostlist | [-q] [-X cluster_name]
 [-u userlist] [-h hostlist] [joblist] }
```

### Flags

**-?** Provides a short usage message.

**-H** Provides extended help information.

**-v** Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.

**-f** *hostlist*

Forces all jobs that are running on the machines in the *hostlist* to be vacated. Those machines in the *hostlist* are then marked as "Down" in the LoadLeveler cluster. The *hostlist* for the **-f** option should only specify machines that have gone down and should only be used for those machines that still have jobs displayed in the LoadLeveler queue.

The **-f** option is intended to be used by administrators for cleanup and recovery after a machine has permanently crashed or was inadvertently removed from the cluster before all activity has quiesced. If you need to return the machine to the cluster later, you must clear all files from the spool and execute directory of the machines in the *hostlist*.

**-q** Specifies quiet mode: print no messages other than error messages.

**-X** *cluster\_name*

Specifies the name of a single cluster where the command is to run.

**-u** *userlist*

Is a blank-delimited list of users. When used with the **-h** option, only the user's jobs monitored on the machines in the *hostlist* are canceled. When used alone, only the user's jobs monitored by the machine issuing the command are canceled.

**-h** *hostlist*

Is a blank-delimited list of machine names. All jobs monitored on machines in this list are canceled. When issued with the **-u** option, the *userlist* is used to further select jobs for cancellation.

*joblist*

Is a blank-delimited list of job and step identifiers. When a job identifier is specified, the command action is taken for all steps of the job. At least one job or step identifier must be specified.

The format of a job identifier is *host.jobid*. The format of a step identifier is *host.jobid.stepid*.

where:

- *host* is the name of the machine that assigned the job and step identifiers.
- *jobid* is the job number assigned to the job when it was submitted.
- *stepid* is the job step number assigned to the job step when it was submitted.

## llcancel

The job or step identifier may be specified in an abbreviated form, *jobid* or *jobid.stepid*, when the command is invoked on the same machine that assigned the job and step identifiers. In this case, LoadLeveler will use the local machine's hostname to construct the full job or step identifier.

The **-u** or **-h** flags override the *joblist* parameter.

When the **-h** flag is specified by a non-administrator, all jobs submitted from the machines in *hostlist* by the user issuing the command are canceled.

When the **-h** flag is specified by an administrator, all jobs submitted by the administrator are canceled, unless the **-u** is also specified, in which case all jobs both submitted by users in *userlist* and monitored on machines in *hostlist* are canceled.

Group administrators and class administrators are considered normal users unless they are also LoadLeveler administrators.

## Description

When you issue **llcancel**, the command is sent to the negotiator. You should then use the **llq** command to verify your job was canceled. A job state of CA (Canceled) indicates the job was canceled. A job state of RP (Remove Pending) indicates the job is in the process of being canceled.

When cancelling a job from a submit-only machine, you must specify the machine name that scheduled the job. For example, if you submitted the job from machine A, a submit-only machine, and machine B, a scheduling machine, scheduled the job to run, you must specify machine B's name in the cancel command. If machine A and B are in different sub-domains, you must specify the fully qualified name of the job in the cancel command. You can use the **llq -l** command to determine the fully qualified name of the job.

## Examples

1. This example cancels the job step 3 that is part of the job 18 that is scheduled by the machine named bronze:  
`llcancel bronze.18.3`
2. This example cancels all the job steps that are a part of job 8 that are scheduled by the machine named gold:  
`llcancel gold.8`
3. This example cancels the job steps that are a part of job 5 that is scheduled to run in cluster1:  
`llcancel -X cluster1 silver.5`

## Results

1. The following shows a sample system response for the **llcancel gold.8** command:  
`llcancel: Cancel command has been sent to the central manager.`
2. The following shows a sample system response for the **llcancel -X cluster1 silver.5** command. The remote command has been sent to the central manager in cluster1:  
`llcancel: Cancel command has been sent to the central manager.`

## **Security**

LoadLeveler administrators and users can issue this command.

## llchres - Change attributes of a reservation

### Purpose

llchres – Changes one or more of the attributes of a LoadLeveler reservation.

### Syntax

```
llchres { -? | -H | -v | [-q] [-t start_time | -t {+|-} minutes]
 [-d [+|-] duration] [-n [+|-] number_of_nodes |
 -h all | -h [+|-] host_list | -j job_step | -f job_command_file]
 [-U [+|-] user_list] [-G [+|-] group_list] [-s {yes|no}]
 [-i {yes|no}] [-u user] [-g group] -R reservation }
```

### Flags

|                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| -?                              | Provides a short usage message.                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| -H                              | Provides extended help information.                                                                                                                                                                                                                                                                                                                                                                                                                              |
| -q                              | Specifies quiet mode: print no messages other than error messages.                                                                                                                                                                                                                                                                                                                                                                                               |
| -v                              | Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.                                                                                                                                                                                                                                                                                                               |
| -t <i>start_time</i>            | Modifies the <i>start_time</i> for a reservation using a 24-hour clock. The format [mm/dd[/[cc]yy]] HH:MM must be used.                                                                                                                                                                                                                                                                                                                                          |
| -t {+ -} <i>minutes</i>         | Modifies the start time for a reservation using <i>minutes</i> . When <i>minutes</i> is preceded by a plus (+) sign or minus (-) sign, the current start time is postponed or moved closer, respectively, by the number of minutes specified.                                                                                                                                                                                                                    |
| -d [+ -] <i>duration</i>        | Specifies a new duration for the reservation in minutes. If <i>duration</i> is preceded by a plus (+) sign or minus (-) sign, the current duration of the reservation is increased or decreased, respectively, by the value specified.                                                                                                                                                                                                                           |
| -n [+ -] <i>number_of_nodes</i> | Specifies a new request for the number of nodes to reserve. If <i>number_of_nodes</i> is preceded by a plus (+) sign or minus (-) sign, the current number of nodes in the reservation is increased or decreased, respectively, by the value specified.                                                                                                                                                                                                          |
| -h all                          | Reserves all machines currently in the LoadLeveler cluster that can be used for a reservation.                                                                                                                                                                                                                                                                                                                                                                   |
| -h [+ -] <i>host_list</i>       | Specifies a change to the list of machines to be reserved. When a blank-delimited host list is specified, it indicates that a new list of hosts are to be reserved. Specifying a plus (+) sign before host list adds the listed machines to the reservation. Specifying a minus (-) sign removes the listed machines from the reservation. Note that when a host list is specified, the first character of any host name cannot be a plus (+) or minus (-) sign. |
| -j <i>job_step</i>              | Specifies a new request that a set of nodes that the job step can run on be reserved. The job step must be in an idle-like state and takes the form [ <i>host</i> ]. <i>jobid.stepid</i> .                                                                                                                                                                                                                                                                       |

where:

- *host* is the name of the machine that assigned the step identifier.
- *jobid* is the job number assigned to the job when it was submitted.
- *stepid* is the job step number assigned to the job step when it was submitted.

The step identifier may be specified in an abbreviated form, *jobid.stepid*, when the command is invoked on the same machine that assigned the step identifier. In this case, LoadLeveler will use the local machine's hostname to construct the full step identifier.

You must be an administrator or the owner of both the reservation and job step to make this request. If the request to modify the reservation is successful, the job step will be bound to the reservation.

**-f** *job\_command\_file*

Specifies the full path to a new *job\_command\_file* that will be submitted and the first job step used to determine what nodes to reserve. The job ID of the newly created job will be displayed. All job steps will be bound to the reservation, or if the modification request fails, will be placed in the **NotQueued** state. The job ID of the newly created job will be displayed.

**-U** [**+** | **-**] *user\_list*

Specifies a new blank-delimited list of users who can use the reservation. If the list of users is preceded by a plus (+) sign or minus (-) sign, add those users to or remove those users from the existing list of users that can use the reservation, respectively.

**-G** [**+** | **-**] *group\_list*

Specifies a new blank-delimited list of LoadLeveler groups that can use the reservation. If the list of groups is preceded by a plus (+) sign or minus (-) sign, those groups will be added to or removed from the existing list of groups, respectively. The first character of any group name cannot be plus (+) sign or minus (-) sign.

**-s** {**yes** | **no**}

SHARED mode is enabled when the reserved word **yes** is specified. When the reserved word **no** is specified, SHARED mode is disabled.

**-i** {**yes** | **no**}

REMOVE\_ON\_IDLE mode is enabled when the reserved word **yes** is specified. When the reserved word **no** is specified, REMOVE\_ON\_IDLE mode is disabled.

**-u** *user*

Specifies a new user ID that will own the reservation.

**-g** *group*

Specifies a new LoadLeveler group that will own the reservation.

**-R** *reservation*

Specifies the reservation identifier to be modified. The format of a full LoadLeveler reservation identifier is [*host*].[*rid*][.*r*].

where:

- *host* is the name of the machine that assigned the reservation identifier.
- *rid* is the number assigned to the reservation when it was created. An *rid* is required.
- *r* indicates that this is a reservation ID (*r* is optional).

The reservation identifier may be specified in an abbreviated form, *rid[.r]*, when the command is invoked on the same machine that assigned the reservation identifier. In this case, LoadLeveler will use the local machine's host name to construct the full reservation identifier.

**Note:** When a plus (+) sign or minus (–) sign is used to increase or decrease a value, there cannot be spaces between the plus (+) sign or minus (–) sign and the value.

## Description

The **llchres** command is for LoadLeveler administrators and the owner of a reservation. Either all requested changes will be made and a message indicating the reservation request has been sent will be displayed, or none of the changes will be made and a message describing the reason for the failure will be displayed along with the message that the request was sent. If a connection error occurs and the request cannot be sent, a message will be displayed.

Note that it is possible for a time out to occur while this command is waiting for a response from the LoadLeveler central manager. Even if a time out occurs or the command process is killed, the command may still succeed. To determine if the request has been granted, issue the **llqres** command.

Modification requests are subject to resource availability checks and reservation policies.

Notes on changing a reservation:

- Administrators can change the attributes of any reservation, including the user ID that owns the reservation, while non-administrators can change attributes of only the reservations they own and cannot change the reservation owner.
- A reservation owner who is not a LoadLeveler administrator cannot change the start time, duration or reserved nodes if the start time is not at least later than the current time by the number of minutes specified by the `RESERVATION_MIN_ADVANCE_TIME` keyword.
- The new reservation start time must be later than the current time by at least the amount of time specified by the `RESERVATION_SETUP_TIME` keyword.
- A reservation in the CANCEL or COMPLETE state cannot be changed.
- When a reservation is not in the WAITING state, the start time cannot be changed.
- When a reservation is not in the WAITING state, the only ways to change reserved nodes are to add a number of nodes, or to add or delete a list of nodes.
- A reserved node with a bound step running cannot be removed from the reservation.
- When changing the reservation duration, the end time of the reservation must be later than the current time.
- You cannot delete all reserved nodes from a reservation; a reservation must have at least one reserved node.
- You cannot add a node that is already reserved to a reservation when using **llchres -h +host\_list**.
- You cannot delete a node that is not reserved from a reservation when using **llchres -h -host\_list**.

- If you want to change the owner of a reservation, the new owner must be able to own an additional reservation (**max\_reservations** for the user is not specified or if specified, the quota is not used up yet). If you want to change the group that owns the reservation, the new group must be able to own an additional reservation (**max\_reservations** for the group is not specified or if specified, the quota is not used up yet). If the change request is granted, the new owner and group must have the permission to own a new reservation (they cannot both have **max\_reservations** unspecified).

This command is for the BACKFILL scheduler only.

## Examples

1. To have reservation c94n16.20.r start an hour later than currently scheduled with four fewer nodes, issue:  
`llchres -t +60 -n -4 -R c94n16.20.r`

You should receive a response similar to the following:

Request to change reservation c94n16.20.r has been sent to LoadLeveler

2. To change the duration from 20 to 50 minutes and enable only users chris, jay, and dave to use the reservation c94n16.31.r, issue:  
`llchres -U chris jay dave -d 50 -R c94n16.31.r`

You should receive a response similar to the following:

Request to change reservation c94n16.31.r has been sent to LoadLeveler

## Security

LoadLeveler administrators and users can issue this command.

## llckpt - Checkpoint a running job step

### Purpose

Checkpoints a single job step.

The **llckpt** command is not supported in LoadLeveler for Linux.

### Syntax

```
llckpt { -? | -H | -v | [-k | -u] [-r] [-q] [-X cluster_name] jobstep }
```

### Flags

- ? Provides a short usage message.
- H Provides extended help information.
- v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.
- k Specifies that the job step is to be terminated after a successful checkpoint. The default is for the job to continue. Note that you cannot use the **-k** and **-u** flags together. If you need to restart the job on the same node, do not use the **-k** flag.
- u Specifies that the job step is to be put on user hold after a successful checkpoint. The default is for the job to continue. Note that you cannot use the **-k** and **-u** flags together.
- r When this flag is issued, it specifies that the command is to return without waiting for the checkpoint to complete. When using this flag you should be aware that information relating to the success or failure of the checkpoint will not be available to the command. The default is for the checkpoint to complete before returning.
- q Specifies quiet mode: print no messages other than error messages.
- X *cluster\_name*  
Specifies the name of a single cluster where the command is to run.
- jobstep*  
Is the name of a job step to be checkpointed.  
  
The format of a full LoadLeveler step identifier is *host.jobid.stepid*.  
  
where:
  - *host* is the name of the machine that assigned the step identifier.
  - *jobid* is the job number assigned to the job when it was submitted.
  - *stepid* is the job step number assigned to the job step when it was submitted.
 The step identifier may be specified in an abbreviated form, *jobid.stepid*, when the command is invoked on the same machine that assigned the step identifier. In this case, LoadLeveler will use the local machine's hostname to construct the full step identifier.

### Description

The **llckpt** command should be used to save the state of the job in the event it does not complete. Use the command only with jobs that are marked as checkpointable. You can mark a job step for checkpoint by specifying

**checkpoint=yes** or **checkpoint=interval** in the job command file. Use **checkpoint=yes** to set checkpointing for an interactive job. For more information, see “Checkpointing jobs” on page 128.

When a job is checkpointed it can later be restarted from the checkpoint file rather than the beginning of the job. To restart a job from a checkpoint file, the original job command file should be used with the value of the **restart\_from\_ckpt** keyword set to **yes**. The name and location of the checkpoint file should be specified by the **ckpt\_dir** and **ckpt\_file** keywords.

If you need to restart the job on the same nodes, do not use the **-k** flag. Instead, use the **-u** flag to place the job in a hold state. You can later release the job from the hold state by issuing the **llhold -r** command.

## Examples

1. This example checkpoints the job step 1 that is part of job 12 which was scheduled by the machine named **iron**. Upon successful completion of checkpoint, the job step will return to the RUNNING state.  
llckpt iron.12.1
2. This example checkpoints the job step 3 that is part of job 14 which was scheduled by the machine named **bronze**. Upon successful completion of checkpoint the job step will be put on user hold:  
llckpt -u bronze.14.3

## Results

When the **-r** option is not used, the **llckpt** command will wait for the checkpoint to complete. Immediately upon executing the command **llckpt iron.12.1** the following message is displayed:

```
llckpt: The llckpt command will wait for the results of the checkpoint on
job step iron.12.1 before returning
```

Once the checkpoint has successfully completed, the following message is displayed:

```
llckpt: Checkpoint of job step iron.12.1 completed successfully
```

If there was a problem taking the checkpoint, the second message would have this form:

```
llckpt: Checkpoint FAILED for job step iron.12.1 with the following error:
primary error code = <numeric error number>,
secondary error code = <secondary numeric error/extended numeric error>,
error msg len = <length of message>, error msg = <text describing the error>
```

Where: primary error code is defined by **/usr/include/sys/errno.h** and secondary error code is defined by **/usr/include/sys/chkerror.h**.

The **-r** option is used to return without waiting for the result of a checkpoint. The following output is displayed for the command **llckpt -r bronze.14.3**:

```
llckpt: The llckpt command will not wait for the checkpoint of
job step bronze.14.3 to complete before returning.
```

Due to delays in communication between LoadLeveler daemons, status information may not be returned at the same time that checkpoint termination is

## llckpt

received. This indicates that the checkpoint has completed but the success or failure status is not known. When this happens, the following message is displayed:

```
llckpt: Checkpoint of job step iron.12.1 completed. No status information is available.
```

## Security

LoadLeveler administrators and users can issue this command.

# llclass - Query class information

## Purpose

Returns information about classes.

## Syntax

```
llclass [-?] [-H] [-v] [-l] [-X {cluster_list | all}] [-c classlist | classlist]
```

## Flags

- ? Provides a short usage message.
- H Provides extended help information.
- v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.
- l Specifies that a long listing be generated for each class for which status is requested. If -l is *not* specified, then the standard listing is generated.
- X {cluster\_list | all}  
Indicates that you can specify the -X flag with either:
  - cluster\_list Is a blank-delimited list of clusters where the command is to run.
  - all Is the reserved word indicating that the command is to run in all accessible clusters.
- c classlist | classlist  
Is a blank-delimited list of classes for which you are requesting status. The -c classlist flag is used to distinguish a classlist when specified in combination with the -X flag. If a classlist is not specified, all classes are queried.

If you have more than a few classes configured for LoadLeveler, consider redirecting the output to a file when you use the -l flag.

## Description

The llclass command queries information about job classes. The output of this command displays the number of defined classes and usage information.

## Examples

- To generate a standard listing for class Parallel, issue:

```
llclass Parallel
```

This example generates the standard listing where there are 24 initiators of class Parallel configured in the cluster, with one job step of class Parallel using 6 initiators currently running. You should receive output similar to the following:

| Name     | MaxJobCPU<br>d+hh:mm:ss | MaxProcCPU<br>d+hh:mm:ss | Free<br>Slots | Max<br>Slots | Description        |
|----------|-------------------------|--------------------------|---------------|--------------|--------------------|
| Parallel | 2+02:45:00              | 05:30:00                 | 18            | 24           | Parallel job class |

The **standard listing** includes the following fields:

## llclass

### Description

Lists the information provided in the `class_comment` keyword for the specified class. The `class_comment` keyword is defined in the class stanza of the LoadLeveler administration file.

### Free Slots

The number of initiators (slots) available for the specified class in the LoadLeveler cluster. A serial job step uses one initiator at run time. A parallel job step with N tasks uses N initiators at run time.

### MaxJobCPU

The hard job CPU limit of job steps for the specified class. For a description of the job CPU limit for serial and parallel job steps, see 340.

### MaxProcCPU

The hard CPU limit for the processes of the job steps of the specified class.

### Max Slots

The number of configured initiators (slots) for the specified class in the LoadLeveler cluster.

**Name** The name of the class.

2. To generate a long listing for classes named *silver* and *gold*, issue:

```
llclass -l silver gold
```

The **long listing** includes the following fields:

### Admin

The list of administrators for the specified class.

### Ckpt\_limit

Hard and soft checkpoint limits of a job step of the specified class.

### Class\_ckpt\_dir

The name of the directory containing the checkpointing files of job steps of the specified class.

### Class\_comment

Lists the information provided in the `class_comment` keyword for the specified class. The `class_comment` keyword is defined in the class stanza of the LoadLeveler administration file.

### Core\_limit

The hard and soft core size limits of processes of job steps of the specified class.

### Cpu\_limit

The hard and soft CPU limits of processes of job steps of the specified class.

### Data\_limit

The hard and soft data area limits of processes of job steps of the specified class.

### Exclude\_Groups

Groups who are not allowed to submit jobs of the specified class.

### Exclude\_Users

Users who are not permitted to submit jobs of the specified class.

**Execution\_factor**

Obsolete keyword.

**Free\_slots**

The number of available initiators (slots) for the specified class in the LoadLeveler cluster. A serial job step uses one initiator of the appropriate class at run time. A parallel job step with N tasks uses N initiators at run time.

**File\_limit**

The hard and soft file size limits of processes of job steps of the specified class.

**Include\_Groups**

Groups having permission to submit jobs of the specified class.

**Include\_Users**

Users who are permitted to submit jobs of the specified class.

**Job\_cpu\_limit**

The hard and soft job CPU limits of job steps of the specified class. For a description of the job CPU limit for serial and parallel job steps, see 340.

**Maximum\_slots**

The total number of configured initiators (slots) for the specified class in the LoadLeveler cluster.

**Maxjobs**

The maximum number of job steps of the specified class that can run at any time in the LoadLeveler cluster.

**Max\_processors**

The maximum number of processors than can be used for a parallel job step of the specified class.

**Max\_total\_tasks**

Used for Gang and Backfill scheduling only. Max\_total\_tasks sets the maximum number of tasks allowed to run at any given time for job steps of the specified class in the LoadLeveler cluster.

**Max\_proto\_instances**

The maximum number of protocol instances allowed for a job step of the specified class.

**Name** The name of the class

**Nice** The *nice* value of jobs of the specified class.

**NQS\_class**

Indicates whether this class is a gateway for an NQS system.

**NQS\_query**

The NQS queues to query where the job has been dispatched.

**NQS\_submit**

The NQS queue where the job will be submitted.

**Preempt\_class**

Used for Gang and Backfill scheduling only, Preempt\_class sets the preemption rule for job steps of the specified class.

**Priority**

The system priority of the specified class relative to other classes.

## llclass

### Resource\_requirement

The default consumable resource requirements for job steps of the specified class.

### Rss\_limit

The hard and soft rss size limits of processes of job steps of the specified class.

### Stack\_limit

The hard and soft stack size limits of processes of job steps of the specified class.

### Start\_class

Used for Gang and Backfill scheduling only, Start\_class sets the starting rule for job steps of the specified class.

### Wall\_clock\_limit

The hard and soft wall clock (elapsed time) limits of job steps of the specified class.

See Appendix B, "Sample command output," on page 603 for sample output of long listings.

- This example generates the standard listing for all accessible clusters including the local cluster in a multicluster environment:

```
llclass -X all
```

The output representing a cluster is delineated with a cluster header similar to the following:

```
===== Cluster c556_Cluster1 =====
```

| Name     | MaxJobCPU<br>d+hh:mm:ss | MaxProcCPU<br>d+hh:mm:ss | Free<br>Slots | Max<br>Slots | Description        |
|----------|-------------------------|--------------------------|---------------|--------------|--------------------|
| -----    | -----                   | -----                    | -----         | -----        | -----              |
| mpich    | 3+08:00:00              | 12:30:00                 | 100           | 132          | MPICH Jobs         |
| parallel | 23:59:00                | 01:00:00                 | 32            | 256          | POE Parallel Jobs  |
| No_Class | 01:00:00                | 00:30:00                 | 120           | 512          | Default Class      |
| large    | 2+08:00:00              | 18:30:00                 | 50            | 128          | Large Serial Jobs  |
| medium   | 12:00:00                | 02:30:00                 | 60            | 128          | Medium Serial Jobs |
| small    | 01:00:00                | 00:30:00                 | 12            | 128          | Small Serial Jobs  |

```
===== Cluster c556_Cluster2 =====
```

| Name     | MaxJobCPU<br>d+hh:mm:ss | MaxProcCPU<br>d+hh:mm:ss | Free<br>Slots | Max<br>Slots | Description       |
|----------|-------------------------|--------------------------|---------------|--------------|-------------------|
| -----    | -----                   | -----                    | -----         | -----        | -----             |
| mpich    | 3+08:00:00              | 12:30:00                 | 110           | 132          | MPICH Jobs        |
| parallel | 23:59:00                | 01:00:00                 | 48            | 256          | POE Parallel Jobs |
| No_Class | 01:00:00                | 00:30:00                 | 128           | 512          | Default Class     |
| large    | 2+08:00:00              | 18:30:00                 | 74            | 128          | Large Serial Jobs |
| ESSL     | 23:00:00                | 12:30:00                 | 55            | 128          | ESSL Jobs         |
| OSL      | 12:00:00                | 06:00:00                 | 33            | 128          | OSL Jobs          |

## Related Information

Each machine periodically updates the central manager with a snapshot of its environment. Since the information returned by **llclass** is a collection of these snapshots, all taken at varying times, the total picture may not be completely consistent.

## Security

LoadLeveler administrators and users can issue this command.

## llclusterauth - Generates public and private keys

### Purpose

**llclusterauth** – Generates public and private keys that are used to provide secure intercluster communications.

### Syntax

**llclusterauth** [-?] | [-H] | [-v] | [-k]

### Flags

- ?** Provides a short usage message.
- H** Provides extended help information.
- v** Outputs the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.
- k** Creates a public key, a private key, a security certificate, and a directory for authorized keys. The keys and certificate are created in the **/var/LoadL/ssl** directory for AIX and in the **/var/opt/LoadL/ssl** directory for Linux.
  - The private key is stored in **id\_rsa**
  - The public key is stored in **id\_rsa.pub**
  - The security certificate is stored in **id\_rsa.cert**
  - The authorized keys are stored in **authorized\_keys**

This command must run with **root** authority when using the **-k** flag to create key files.

If any directory in the path for the security files does not exist, the command will create the directory and set the owner to **root** and set the permissions to '0700'. The key and certificate files will be owned by **root** with permissions of '0600'.

### Description

The **llclusterauth** command generates public and private keys that are used to provide secure intercluster communications. When multicluster security is configured to use Secure Sockets Layer (SSL), a connection on a secure port will be accepted only if the public key for the node requesting the connection is stored in a file in the authorized keys directory on the node being connected to.

### Standard Error

- An error message is issued and the command exits for the following error cases:
- The command process does not have **root** authority
  - A required directory for the security files cannot be created
  - A security file cannot be created

### Security

LoadLeveler administrators can issue this command.

## llctl - Control LoadLeveler daemons

### Purpose

Controls LoadLeveler daemons on all members of the LoadLeveler cluster.

### Syntax

`llctl [-?] [-H] [-v] [-q] [-g | -h hostname] keyword`

### Flags

- ? Provides a short usage message.
- H Provides extended help information.
- v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.
- q Specifies quiet mode: print no messages other than error messages.
- g Indicates that the command applies globally to all machines, except submit-only machines, that are listed in the administration file.
- h *host*  
Indicates that the command applies to only the *host* machine in the LoadLeveler cluster. If neither -h nor -g is specified, the default is the machine on which the llctl command is issued.

*keyword*

Must be specified after all flags and can be the following:

#### **capture** *eventname*

Captures accounting data for all jobs running on the designated machines. *eventname* is the name you associate with the data, and must be a character string containing no blanks. For more information, see “Collecting job resource data based on events” on page 59.

#### **drain** [**schedd** | **startd**] [*classlist* | **allclasses**]

When you issue **drain** with no options, the following happens: (1) no more LoadLeveler jobs can begin running on this machine, and (2) no more LoadLeveler jobs can be submitted through this machine. When you issue **drain schedd**, the following happens: (1) the schedd machine accepts no more LoadLeveler jobs for submission, (2) job steps in the Starting or Running state in the schedd queue are allowed to continue running, and (3) job steps in the Idle state in the schedd queue are drained, meaning they will not get dispatched. When you issue **drain startd**, the following happens: (1) the startd machine accepts no more LoadLeveler jobs to be run, and (2) job steps already running on the startd machine are allowed to complete. When you issue **drain startd classlist**, the classes you specify which are available on the startd machine are drained (made unavailable). When you issue **drain startd allclasses**, all available classes on the startd machine are drained.

#### **flush**

Terminates running jobs on this machine and sends them back, in the Idle state, to the negotiator to await redispach (provided **restart=yes** in the job command file). No new jobs are sent to this machine until **resume** is issued. Forces a checkpoint if jobs are enabled for checkpointing. However, the checkpoint gets canceled if it does not complete within the time period specified in the **ckpt\_time\_limit** keyword in the job command file.

**purgeschedd**

Requests that all jobs scheduled by the specified *host* machine be purged (removed). To use this keyword, you must first specify **schedd\_fenced=true** in the machine stanza for this *host*. The **-g** option cannot be specified with this keyword. For more information, see “How do I recover resources allocated by a schedd machine?” on page 593.

**reconfig**

Forces all daemons to reread the administration and configuration files.

**recycle**

Stops all LoadLeveler daemons and restarts them.

**resume [schedd | startd [*classlist* | **allclasses**]]**

When you issue **resume** with no options, job submission and job execution on this machine is resumed. When you issue **resume schedd**, the schedd machine resumes the submission of jobs. When you issue **resume startd**, the startd machine resumes the execution of jobs. When you issue **resume startd *classlist***, the startd machine resumes the execution of those job classes you specify which are also configured (defined on the machine). When you issue **resume startd allclasses**, the startd machine resumes the execution of all configured classes.

**start [*drained*]**

When you issue **start** with no options it starts the LoadLeveler daemons on the machine or machines designated, either explicitly or implicitly. When you issue **start** without the **-g** or **-h** flag the LoadLeveler daemons are started on the same machine that issued the command. When you issue **start** with either the **-g** or **-h** flag, **rshell** (**rsh**) is used to start the LoadLeveler daemons on all machines specified in the administration file, or on the machine specified by the **-h** flag. You must have **rsh** privileges in order to use either the **-g** or **-h** flag.

When you issue **start** with the **drained** option the LoadLeveler daemons are started, but the startd daemon is started in the drained state.

LoadLeveler commands that run **rshell** include **llctl version** and **llctl start**.

**stop**

Stops the LoadLeveler daemons on the specified machine.

**suspend**

Suspends all jobs on this machine. This is not supported for parallel jobs.

**version**

Displays release number, service level, service level date, and operating system information for every LoadLeveler executable.

When you issue **llctl version** with either the **-g** or **-h** flag, **rshell** (**rsh**) is used to run the command on all machines specified in the administration file, or on the machine specified by the **-h** flag. You must have **rsh** privileges in order to use **llctl version** with either the **-g** or **-h** flag.

LoadLeveler commands that run **rshell** include **llctl version** and **llctl start**.

## Description

This command sends a message to the master daemon on the target machine requesting that action be taken on the members of the LoadLeveler cluster. Note the following when using this command:

- To perform the control operations of the **llctl** command, you must be a LoadLeveler administrator. The only exception to this rule is the "start" operation.
- LoadLeveler will fail to start if any value has been set for the **MALLOCTYPE** environment variable.
- After you make changes to the administration and configuration files for a running cluster, be sure to issue **llctl reconfig**. This command causes the LoadLeveler daemons to reread these files, and prevents problems that can occur when the LoadLeveler commands are using a new configuration while the daemons are using an old configuration.

**Note:** Changes to **SCHEDULER\_TYPE** will not take effect at reconfiguration. The administrator must stop and restart or recycle LoadLeveler when changing **SCHEDULER\_TYPE**.

- The **llctl drain startd classlist** command drains classes on the startd machine, and the startd daemon remains operational. If you reconfigure the daemon, the draining of classes remains in effect. However, if the startd goes down and is brought up again (either by the master daemon or by a LoadLeveler administrator), the startd daemon is configured according to the global or local configuration file in effect, and therefore the draining of classes is lost.

Draining all the classes on a startd machine is *not* equivalent to draining the startd machine. When you drain all the classes, the startd enters the Idle state. When you drain the startd, the startd enters the Drained state. Similarly, resuming all the classes on a startd machine is *not* equivalent to resuming the startd machine.

- If a job step is running on a machine that receives the **llctl recycle** command, or the **llctl stop** and **llctl start** commands, the running job step is terminated. If the restart option in the job command file was set to yes, then the job step will be restarted when LoadLeveler is restarted. If the job step is checkpointable, it will be restarted from the last valid checkpoint file when LoadLeveler is restarted.
- If you find that the **llctl -g** command (even if it is specified with additional options) is taking a long time to complete, you should consider using the AIX command **dsh** to send **llctl** commands (omitting the **-g** flag) to multiple nodes in a parallel fashion.
- When a node running a schedd daemon fails, resources that have been allocated to any of the jobs scheduled by that schedd are unavailable until the schedd is restarted. Administrators can, however, recover these resources by using the **llctl** command's **purgeschedd** keyword to purge (remove) all of the jobs scheduled by the schedd on the down node. The **purgeschedd** keyword can only work in conjunction with the **schedd\_fenced** keyword, in the administration file, which causes the central manager to ignore (fence) the schedd daemon running on the target node. You must reconfigure the central manager so it can recognize this fence. To use the **purgeschedd** keyword:
  1. Recognize that a node running a schedd daemon is down, and that the node will be down long enough to necessitate that you recover the resources allocated to jobs scheduled by that schedd.
  2. Add the statement "**schedd\_fenced = true**" to the failed node's administration file machine stanza.
  3. Reconfigure the central manager node so that the central manager recognizes the fenced schedd daemon.
  4. Invoke "**llctl -h host purgeschedd**" to purge all of the jobs scheduled by the schedd on the failed node.

5. Once the failed node is working again, remove all of the files in the LoadLeveler spool directory. Remove the "schedd\_fenced = true" statement from the administration file, then reconfigure the central manager node before starting schedd on the machine.

## Examples

1. This example stops LoadLeveler on the machine named *iron*:

```
llctl -h iron stop
```

2. This example starts the LoadLeveler daemons on all members of the LoadLeveler cluster (with the exception of the submit-only machines), starting with the central manager, as defined in the machine stanzas of the administration file:

```
llctl -g start
```

3. This example causes the LoadLeveler daemons on machine *iron* to re-read the administration and configuration files, which may contain new configuration information for the *iron* machine:

```
llctl -h iron reconfig
```

4. This example drains the classes *medium* and *large* on the machine named *iron*.

```
llctl -h iron drain startd medium large
```

5. This example drains the classes *medium* and *large* on all machines.

```
llctl -g drain startd medium large
```

6. This example stops all the jobs on the system, then allows only jobs of a certain class (*medium*) to run.

```
llctl -g drain startd allclasses
llctl -g flush
llctl -g resume
llctl -g resume startd medium
```

7. This example resumes the classes *medium* and *large* on the machine named *iron*.

```
llctl -h iron resume startd medium large
```

8. This example illustrates how to capture accounting information on a work shift called *day* on the machine *iron*:

```
llctl -h iron capture day
```

You can capture accounting information on all the machines in the LoadLeveler cluster by using the **-g** option, or you can collect accounting information on the local machine by simply issuing the following:

```
llctl capture day
```

Capturing information on the local machine is the default. For more information, see "Collecting job resource data based on events" on page 59.

## Security

LoadLeveler administrators can issue this command.

## lldbconvert - Job migration utility

### Purpose

**lldbconvert** – Administrators can use the **lldbconvert** utility to convert jobs from LoadLeveler 3.2 format to LoadLeveler 3.3 format.

### Syntax

```
lldbconvert [-d] [-D] [-H] [-?] [-v] [-o OpSys]
```

### Flags

|                 |                                                                                                                                                                         |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>-d</b>       | Displays contents of input spool (no conversion).                                                                                                                       |
| <b>-D</b>       | Converts LoadLeveler 3.2 spool to LoadLeveler 3.3 spool and displays contents of output <b>spool</b> after conversion.                                                  |
| <b>-H</b>       | Provides extended help information.                                                                                                                                     |
| <b>-?</b>       | Provides a short usage message.                                                                                                                                         |
| <b>-v</b>       | Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.                      |
| <b>-o OpSys</b> | Converts LoadLeveler 3.2 spool to LoadLeveler 3.3 spool, forcing <b>OpSys</b> test to: ' <b>OpSys</b> == " <i>OpSys</i> "' if it occurs in Requirements or Preferences. |

### Description

On machines where jobs need to be migrated, log in as **loadl** (or the primary LoadLeveler user ID defined in **/etc/LoadL.cfg**) and run **lldbconvert** from the local LoadLeveler **spool** directory.

The **-o** flag is needed when the operating system specified in the requirement statement no longer matches the operating system after the migration, for example, if it changes from AIX52 to AIX53. This flag converts requirements statements in the form **OpSys=="*your\_os*"**. Statements in other formats (such as those with *your\_os* not enclosed in double quotes) are not converted.

When you create the **LoadL\_admin** file for the version to which you are migrating, you should preserve all of the job class definitions used in the version from which you are migrating. For example, if a converted job needs to run as a large class job, and class large is not defined in the LoadLeveler 3.3 **LoadL\_admin** file, the job will never be run.

**lldbconvert** only converts job steps that are in one of the following states: **Idle**, **Hold**, **Deferred**, or **NotQueued**. If the conversion is successful, you will receive further instructions from **lldbconvert** on what to do before starting LoadLeveler on the given machine.

Once you run **lldbconvert**, do not move the converted job queues to another **schedd** machine.

### Security

LoadLeveler administrators can issue this command.

## lldcegrpmaint - LoadLeveler DCE group maintenance utility

### Purpose

This command extracts the names of the DCE groups associated with the DCE\_ADMIN\_GROUP and DCE\_SERVICES\_GROUP keywords from the LoadLeveler configuration file. It will create these groups if they do not already exist. This command also adds the DCE principal names of the LoadLeveler daemons to the group specified by the DCE\_SERVICES\_GROUP keyword.

The **lldcegrpmaint** command is not supported in LoadLeveler for Linux.

### Syntax

```
lldcegrpmaint [-?] [-H] [-v] config_pathname admin_pathname
```

### Flags

- ? Provides a short usage message.
- H Provides extended help information.
- v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.

*config\_pathname*

Pathname of the LoadLeveler configuration file.

*admin\_pathname*

Pathname of the LoadLeveler administration file.

### Description

The **lldcegrpmaint** command is available to DCE administrators who have logged in to DCE as **cell\_admin**. The command performs the following functions:

1. Extracts the names of the DCE groups associated with the DCE\_ADMIN\_GROUP and DCE\_SERVICES\_GROUP keywords from the LoadLeveler global configuration file. These groups are known generically as the LoadL-admin group and the LoadL-services group. The LoadL-admin group contains the DCE principal names of users who have administrative authority for LoadLeveler. The LoadL-services group contains the DCE principal names of all the LoadLeveler daemons which run in the current LoadLeveler cluster. The **lldcegrpmaint** command will create these groups if they do not already exist.
2. Populates the LoadL-services group with the DCE principal names of the LoadLeveler daemons. These names are derived from the DCE hostnames associated with the *dce\_host\_name* keyword in the LoadLeveler administration file, and LoadLeveler related information defined in the */usr/lpp/ssp/config/spsec\_defaults* file. In order for this step to work, the machine stanzas in the administration file must contain the DCE hostnames of all the machines in the LoadLeveler cluster. The **llexSDR** command can be used to retrieve the DCE hostnames.

Before running the **lldcegrpmaint** command, a DCE administrator should make sure that basic DCE Security setup steps have been performed. If SMIT panels are used, the steps under the "RS/6000 SP Security" panel should be performed in sequence (from top to bottom) to properly update the DCE Registry. This measure is important for LoadLeveler, and for any other function that exploits DCE

Security. For the purposes of the lldcegrpmaint command, the important actions are: (1) "Create dcehostnames" and (2) "Configure SP Trusted Services to use DCE Authentication."

Note: lldcegrpmaint does not add the names associated with the LOADL\_ADMIN keyword in the configuration file to the LoadL-admin group. It is the administrator's responsibility to add appropriate DCE principals to this group.

## Examples

In this example, it is assumed that the DCE cell name is /.../c163.ppd.pok.ibm.com and that LoadLeveler configuration and administration files are named /u/loadl/LoadL\_config and /u/loadl/LoadL\_admin, respectively, and contain the statements:

```
DCE_ENABLEMENT=TRUE
DCE_ADMIN_GROUP=LoadL-admin4
DCE_SERVICES_GROUP=LoadL-services4
```

and

```
c163n02.ppd.pok.ibm.com: type = machine central_manager = true
machine_mode = general
schedd_host = true
dce_host_name = c163n02.ppd.pok.ibm.com

c163n03.ppd.pok.ibm.com: type = machine central_manager = false
machine_mode = general
schedd_host = true
dce_host_name = c163n03.ppd.pok.ibm.com
```

It is also assumed that there is no override specification in the file /spdata/sys1/spsec/spsec\_overrides and that the file /usr/lpp/ssp/config/spsec\_defaults contains the following:

```
SERVICE:LoadL/Master:kw:root:system
SERVICE:LoadL/Negotiator:kw:root:system
SERVICE:LoadL/Schedd:kw:root:system
SERVICE:LoadL/Startd:kw:root:system
SERVICE:LoadL/Starter:kw:root:system
SERVICE:LoadL/Kbdd:kw:root:system
SERVICE:LoadL/GSmonitor:kw:root:system
```

Executing the command:

```
lldcegrpmaint /u/loadl/LoadL_config /u/loadl/LoadL_admin
```

results in:

1. The creation of the DCE groups:  

```
/.../c163.ppd.pok.ibm.com/LoadL-admin4
/.../c163.ppd.pok.ibm.com/LoadL-services4
```
2. The population of the DCE group LoadL-services4 with the DCE principals:  

```
/.../c163.ppd.pok.ibm.com/LoadL/c163n02.ppd.pok.ibm.com/Master
/.../c163.ppd.pok.ibm.com/LoadL/c163n02.ppd.pok.ibm.com/Negotiator
/.../c163.ppd.pok.ibm.com/LoadL/c163n02.ppd.pok.ibm.com/Schedd
/.../c163.ppd.pok.ibm.com/LoadL/c163n02.ppd.pok.ibm.com/Startd
/.../c163.ppd.pok.ibm.com/LoadL/c163n02.ppd.pok.ibm.com/Starter
/.../c163.ppd.pok.ibm.com/LoadL/c163n02.ppd.pok.ibm.com/Kbdd
/.../c163.ppd.pok.ibm.com/LoadL/c163n02.ppd.pok.ibm.com/GSmonitor
/.../c163.ppd.pok.ibm.com/LoadL/c163n02.ppd.pok.ibm.com/Master
/.../c163.ppd.pok.ibm.com/LoadL/c163n03.ppd.pok.ibm.com/Negotiator
/.../c163.ppd.pok.ibm.com/LoadL/c163n03.ppd.pok.ibm.com/Schedd
/.../c163.ppd.pok.ibm.com/LoadL/c163n03.ppd.pok.ibm.com/Startd
```

## Ildcegrpmain

```
../c163.ppd.pok.ibm.com/LoadL/c163n03.ppd.pok.ibm.com/Starter
../c163.ppd.pok.ibm.com/LoadL/c163n03.ppd.pok.ibm.com/Kbdd
../c163.ppd.pok.ibm.com/LoadL/c163n03.ppd.pok.ibm.com/GSmonitor
```

## Security

DCE Administrators can issue this command.

## llextrPD - Extract data from an RSCT peer domain

### Purpose

Extracts the necessary data from an RSCT peer domain (or local node if there is no active domain) to set up the administration file.

For Linux, the **llextrPD** command is supported on the following platforms:

- RHEL 3 and RHEL 4 on IBM IA-32 xSeries servers
- SLES 9 on IBM IA-32 xSeries servers

### Syntax

```
llextrPD [-H | -? | -v | [-m] [-a adapter_name]]
```

### Flags

- ? Provides a short usage message.
- H Provides extended help information.
- v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.
- m Specifies that only machine stanzas are to be generated. The adapter stanzas (and the corresponding **adapter\_stanzas** statement of the machine stanza) will be suppressed in the final output. This option is for Dynamic Adapter Configuration support for peer domains with AIX RSCT.

LoadLeveler will dynamically detect and handle adapters and adapter changes for any machine in these domains which do not specify an adapter stanza in the administration file.

**-a *adapter\_name***

Specifies that the interface name of the given *adapter\_name* on each node is used as the label (machine stanza name) of the generated machine stanza.

If you do not specify an adapter (or if an adapter is specified but does not exist on a particular node) then the label used for that machine is the Name field from the RSCT IBM.PeerNode class for the machine in the cluster. This default naming behaves the same as the **llextrSDR** command does when extracting data from the SDR for a PSSP domain.

**Note:** If an administrator wants to configure LoadLeveler to communicate using the Switch Network Interface for High Performance Switch (HPS) adapters in a peer domain they should use the **-a** flag with **ml0** specified as the *adapter\_name*. **ml0** is guaranteed to be present on every node that contains an HPS adapter.

It is recommended that you do not specify **sn** as the adapter name. If you do, the machine will be named with the IP name of the **sn** adapter. If that IP name becomes unavailable because the adapter changes, LoadLeveler will not be able to contact any daemons on that machine.

### Description

The command extracts the data for LoadLeveler to setup the administration file. If you plan to use the **llextrPD** command to construct machine and adapter stanzas for the LoadLeveler administration file, RSCT is required.

The **llextrPD** command must be run on one of the nodes in an active RSCT peer domain to obtain the RSCT peer nodes and network interface data from that cluster. If you are not running the command in an active RSCT peer domain you will just get information from the local machine. Adapter stanza names for HPS adapters are not included in the machine stanza alias. If you run an application which requires LoadLeveler to recognize a node by the interface name of a HPS adapter you must manually add the adapter stanza name for the HPS adapter as an alias in the machine stanza.

Since it is possible to have nodes defined to both the RSCT peer and the PSSP domains at the same time the system administrator must be very cautious when extracting and merging data from different domains to ensure duplicate or conflicting information does not end up in the LoadLeveler administration file. Use the **llextrPD** command to extract data from peer domains and the **llextrSDR** command to extract data from PSSP domains.

## Examples

1. The following example extracts the data from an RSCT peer domain:

```
llextrPD -a ml0
```

### Results:

```
#llextrPD: Cluster = "llcluster" ID = "0Jt9zGF7nbDWwWjjTDrxjG" on
Thu Mar 17 15:24:13 2005
```

```
c121san10.ppd.pok.ibm.com: type = machine adapter_stanzas =
c121s0n10.ppd.pok.ibm.com c121s1n10.ppd.pok.ibm.com
c121san10.ppd.pok.ibm.com c121f2rp02.ppd.pok.ibm.com
alias = c121f2rp02.ppd.pok.ibm.com
```

```
c121s0n10.ppd.pok.ibm.com: type = adapter
adapter_name = sn0
network_type = switch
interface_address = 192.168.0.10
interface_name = c121s0n10.ppd.pok.ibm.com
multilink_address = 10.10.10.10
logical_id = 2
adapter_type = Switch_Network_Interface_For_HPS
device_driver_name = sni0
network_id = 1
```

```
c121s1n10.ppd.pok.ibm.com: type = adapter
adapter_name = sn1
network_type = switch
interface_address = 192.168.1.10
interface_name = c121s1n10.ppd.pok.ibm.com
multilink_address = 10.10.10.10
logical_id = 0
adapter_type = Switch_Network_Interface_For_HPS
device_driver_name = sni1
network_id = 1
```

```
c121san10.ppd.pok.ibm.com: type = adapter
adapter_name = ml0
network_type = multilink
interface_address = 10.10.10.10
interface_name = c121san10.ppd.pok.ibm.com
multilink_list = sn0,sn1
```

```
c121f2rp02.ppd.pok.ibm.com: type = adapter
adapter_name = en0
network_type = ethernet
interface_address = 9.114.66.74
interface_name = c121f2rp02.ppd.pok.ibm.com
```

```

device_driver_name = ent0

c121san04.ppd.pok.ibm.com: type = machine adapter_stanzas =
 c121s0n04.ppd.pok.ibm.com c121s1n04.ppd.pok.ibm.com
 c121san04.ppd.pok.ibm.com c121f1rp04.ppd.pok.ibm.com
 alias = c121f1rp04.ppd.pok.ibm.com

c121s0n04.ppd.pok.ibm.com: type = adapter
 adapter_name = sn0
 network_type = switch
 interface_address = 192.168.0.4
 interface_name = c121s0n04.ppd.pok.ibm.com
 multilink_address = 10.10.10.4
 logical_id = 11
 adapter_type = Switch_Network_Interface_For_HPS
 device_driver_name = sni0
 network_id = 1

c121s1n04.ppd.pok.ibm.com: type = adapter
 adapter_name = sn1
 network_type = switch
 interface_address = 192.168.1.4
 interface_name = c121s1n04.ppd.pok.ibm.com
 multilink_address = 10.10.10.4
 logical_id = 9
 adapter_type = Switch_Network_Interface_For_HPS
 device_driver_name = sni1
 network_id = 1

c121san04.ppd.pok.ibm.com: type = adapter
 adapter_name = m10
 network_type = multilink
 interface_address = 10.10.10.4
 interface_name = c121san04.ppd.pok.ibm.com
 multilink_list = sn0,sn1

c121f1rp04.ppd.pok.ibm.com: type = adapter
 adapter_name = en0
 network_type = ethernet
 interface_address = 9.114.66.68
 interface_name = c121f1rp04.ppd.pok.ibm.com
 device_driver_name = ent0

```

2. The following example extracts the data from an RSCT peer domain for a dynamic adapter configuration:

```
llextrPD -m -a m10
```

#### Results:

```
#llextrPD: Cluster = "acc97" ID = "28jek7RdrHdGwr5C6zQwWm" on
Thu Mar 17 14:37:33 2005
```

```
c97m10n13.ppd.pok.ibm.com: type = machine
 alias = c97n13.ppd.pok.ibm.com
```

```
c97m10n09.ppd.pok.ibm.com: type = machine
 alias = c97n09.ppd.pok.ibm.com
```

```
c97m10n01.ppd.pok.ibm.com: type = machine
 alias = c97n01.ppd.pok.ibm.com
```

```
c97m10n05.ppd.pok.ibm.com: type = machine
 alias = c97n05.ppd.pok.ibm.com
```

## Security

LoadLeveler administrators and users can issue this command.

## llexSDR - Extract adapter information from the SDR

### Purpose

Extracts adapter information from the system data repository (SDR) and creates adapter and machine stanzas for each node in an RS/6000 SP partition. You can use the information in these stanzas in the LoadLeveler administration file. This command writes the stanzas to standard output.

The **llexSDR** command is not supported in LoadLeveler for Linux.

### Syntax

```
llexSDR [-?] [-H] [-v] [-a adapter_name]
```

### Flags

- ? Provides a short usage message.
- H Provides extended help information.
- v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.
- a *adapter\_name*  
Specifies that the interface name of the given *adapter* on each node is used as the label (machine stanza name) of the generated machine stanza. If you do not specify an *adapter*, the label used is the **initial\_hostname** field of the Node class in the SDR.

### Description

In the SDR, the Node class contains an entry for each node in the partition. The Adapter class contains an entry for each adapter configured on a node. This command extracts the information in the Adapter class and creates an adapter stanza. This command also creates a machine stanza which identifies the node and the adapters attached to the node. The generated machine stanza also includes the **spacct\_exclude\_enable** keyword, whose value is obtained from the `spacct_exclude_enable` attribute in the class of the SDR. For more information, see “Defining adapters” on page 80 or “Defining machines” on page 78.

The partition for which information is extracted is either the default partition or that specified with the `SP_NAME` environment variable. For the control workstation, the default partition is the default system partition. For an SP node, the default partition is the partition to which the node belongs.

You must issue this command on a machine with the `ssp.clients` file set installed. If you issue this command from a non-SP workstation, you must set `SP_NAME` to the IP address of the appropriate SDR instance for the partition.

Since it is possible to have nodes defined to both the PSSP and the RSCT peer domains at the same time the system administrator must be very cautious when extracting and merging data from different domains to ensure duplicate or conflicting information does not end up in the LoadLeveler administration file. Use the **llexSDR** command to extract data from PSSP domains and the **llexRPD** command to extract data from peer domains.

## Examples

1. The following example creates adapter and machine stanzas for all nodes in a partition:  
llexSDR
2. The following example creates machine stanzas with each node's css0 interface name as the label:  
llexSDR -a css0

## Results

You may need to alter or add information to the stanzas produced by this command when you incorporate the stanzas into the administration file. For example, administrators may want to have each **network\_type** field use a value that reflects the type of nodes installed on the network. Users will need to know the values used for **network\_type** so that they can specify an appropriate value in their job command files.

Also, the output of this command includes fully-qualified machine names. If your existing administration file uses short names, you may need to change either the command output or your existing administration file so that you use either all fully qualified names or all short names.

This is sample output for the llexSDR command:

```
#llexSDR: System Partition = "c97s" on Thu Mar 17 16:43:13 2005
```

```
c98n05.ppd.pok.ibm.com: type = machine adapter_stanzas =
 c97san04.ppd.pok.ibm.com c97s2n04.ppd.pok.ibm.com
 c97sn04.ppd.pok.ibm.com c98n05.ppd.pok.ibm.com
 spacct_exclude_enable = false
 dce_host_name = c98n05.ppd.pok.ibm.com
 alias = c97san04.ppd.pok.ibm.com c97s2n04.ppd.pok.ibm.com
 c97sn04.ppd.pok.ibm.com
```

```
c97san04.ppd.pok.ibm.com: type = adapter
 adapter_name = ml0
 network_type = multilink
 interface_address = 9.114.59.196
 interface_name = c97san04.ppd.pok.ibm.com
 multilink_list = css0,css1
```

```
c97s2n04.ppd.pok.ibm.com: type = adapter
 adapter_name = css1
 network_type = switch
 interface_address = 9.114.59.4
 interface_name = c97s2n04.ppd.pok.ibm.com
 multilink_address = 9.114.59.196
 switch_node_number = 3
 css_type = SP_Switch2_Adapter
```

```
c97sn04.ppd.pok.ibm.com: type = adapter
 adapter_name = css0
 network_type = switch
 interface_address = 9.114.59.132
 interface_name = c97sn04.ppd.pok.ibm.com
 multilink_address = 9.114.59.196
 switch_node_number = 3
 css_type = SP_Switch2_Adapter
```

```
c98n05.ppd.pok.ibm.com: type = adapter
 adapter_name = en0
 network_type = ethernet
```

```

interface_address = 9.114.59.70
interface_name = c98n05.ppd.pok.ibm.com

.
.
.

c97n05.ppd.pok.ibm.com: type = machine adapter_stanzas =
 c97san02.ppd.pok.ibm.com c97s2n02.ppd.pok.ibm.com
 c97sn02.ppd.pok.ibm.com c97n05.ppd.pok.ibm.com
 spacct_exclude_enable = false
 dce_host_name = c97n05.ppd.pok.ibm.com
 alias = c97san02.ppd.pok.ibm.com c97s2n02.ppd.pok.ibm.com
 c97sn02.ppd.pok.ibm.com

c97san02.ppd.pok.ibm.com: type = adapter
 adapter_name = m10
 network_type = multilink
 interface_address = 9.114.59.194
 interface_name = c97san02.ppd.pok.ibm.com
 multilink_list = css0,css1

c97s2n02.ppd.pok.ibm.com: type = adapter
 adapter_name = css1
 network_type = switch
 interface_address = 9.114.59.2
 interface_name = c97s2n02.ppd.pok.ibm.com
 multilink_address = 9.114.59.194
 switch_node_number = 1
 css_type = SP_Switch2_Adapter

c97sn02.ppd.pok.ibm.com: type = adapter
 adapter_name = css0
 network_type = switch
 interface_address = 9.114.59.130
 interface_name = c97sn02.ppd.pok.ibm.com
 multilink_address = 9.114.59.194
 switch_node_number = 1
 css_type = SP_Switch2_Adapter

c97n05.ppd.pok.ibm.com: type = adapter
 adapter_name = en0
 network_type = ethernet
 interface_address = 9.114.59.66
 interface_name = c97n05.ppd.pok.ibm.com

```

This is sample output for the **llexSDR -a css0** command:

```
#llexSDR: System Partition = "c97s" on Thu Mar 17 17:24:07 2005
```

```

c97sn04.ppd.pok.ibm.com: type = machine adapter_stanzas =
 c97san04.ppd.pok.ibm.com c97s2n04.ppd.pok.ibm.com
 c97sn04.ppd.pok.ibm.com c98n05.ppd.pok.ibm.com
 spacct_exclude_enable = false
 alias = c97san04.ppd.pok.ibm.com c97s2n04.ppd.pok.ibm.com
 c98n05.ppd.pok.ibm.com

c97san04.ppd.pok.ibm.com: type = adapter
 adapter_name = m10
 network_type = multilink
 interface_address = 9.114.59.196
 interface_name = c97san04.ppd.pok.ibm.com
 multilink_list = css0,css1

c97s2n04.ppd.pok.ibm.com: type = adapter
 adapter_name = css1
 network_type = switch

```

```

interface_address = 9.114.59.4
interface_name = c97s2n04.ppd.pok.ibm.com
multilink_address = 9.114.59.196
switch_node_number = 3
css_type = SP_Switch2_Adapter

c97sn04.ppd.pok.ibm.com: type = adapter
adapter_name = css0
network_type = switch
interface_address = 9.114.59.132
interface_name = c97sn04.ppd.pok.ibm.com
multilink_address = 9.114.59.196
switch_node_number = 3
css_type = SP_Switch2_Adapter

c98n05.ppd.pok.ibm.com: type = adapter
adapter_name = en0
network_type = ethernet
interface_address = 9.114.59.70
interface_name = c98n05.ppd.pok.ibm.com

```

## Security

LoadLeveler administrators and users can issue this command.

## llfavorjob - Reorder system queue by job

### Purpose

Sets specified jobs to a higher system priority than all jobs that are not favored. This command also *unfavors* previously favored jobs, restoring the original priority, when you specify the **-u** flag.

### Syntax

**llfavorjob** [-?] [-H] [-v] [-q] [-u] *joblist*

### Flags

- ?** Provides a short usage message.
- H** Provides extended help information.
- v** Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.
- q** Specifies quiet mode: print no messages other than error messages.
- u** Unfavors previously favored jobs, requeuing them according to their original priority levels.

*joblist*

Is a blank-delimited list of job and step identifiers. When a job identifier is specified, the command action is taken for all steps of the job. At least one job or step identifier must be specified.

The format of a job identifier is *host.jobid*. The format of a step identifier is *host.jobid.stepid*.

where:

- *host* is the name of the machine that assigned the job and step identifiers.
- *jobid* is the job number assigned to the job when it was submitted.
- *stepid* is the job step number assigned to the job step when it was submitted.

The job or step identifier may be specified in an abbreviated form, *jobid* or *jobid.stepid*, when the command is invoked on the same machine that assigned the job and step identifiers. In this case, LoadLeveler will use the local machine's hostname to construct the full job or step identifier.

### Description

If this command is issued against jobs that are already running, it has no effect. If the job vacates, however, and returns to the queue, the job gets re-ordered with the new priority.

If more than one job is affected by this command, then the jobs are ordered by the **sysprio** expression and are scanned before the not favored jobs. However, favored jobs which do not match the job requirements with available machines may run after not favored jobs. This command remains in effect until reversed with the **-u** option.

### Examples

1. This example assigns job steps 12.4 on the machine *iron* and 8.2 on *zinc* the highest priorities in the system, with the job steps ordered by the **sysprio** expression:

```
llfavorjob iron.12.4 zinc.8.2
```

2. This example unfavors job steps 12.4 on the machine *iron* and 8.2 on the machine *zinc*:

```
llfavorjob -u iron.12.4 zinc.8.2
```

## Security

LoadLeveler administrators can issue this command.

## llfavoruser - Reorder system queue by user

### Purpose

Sets a user's job(s) to the highest priority in the system, regardless of the current setting of the job priority. Jobs already running are not affected. This command also *unfavors* the user's jobs, restoring the original priority, when you specify the **-u** flag.

### Syntax

```
llfavoruser [-?] [-H] [-v] [-q] [-u] userlist
```

### Flags

- ?** Provides a short usage message.
- H** Provides extended help information.
- v** Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.
- q** Specifies quiet mode: print no messages other than error messages.
- u** Unfavors previously favored users, reordering their jobs according to their original priority levels. If **-u** is **not** specified, the user's jobs are favored.

*userlist*

Is a blank-delimited list of users whose jobs are given the highest priority. If **-u** is specified, *userlist* jobs are *unfavored*.

### Description

This command affects your current and future jobs until you remove the favor.

When the central manager daemon is restarted, any favor applied to users is revoked.

The user's jobs still remain ordered by user priority (which may cause jobs for the user to swap **sysprio**). If more than one user is affected by this command, the jobs of favored users are ordered by **sysprio** and are scanned before the jobs of not favored users. However, jobs of favored users which do not match job requirements with available machines may run after jobs of not favored users.

### Examples

1. This example grants highest priority to all queued jobs submitted by users ellen and fred according to the **sysprio** expression:  

```
llfavoruser ellen fred
```
2. This example unfavors all queued jobs submitted by users ellen and fred:  

```
llfavoruser -u ellen fred
```

### Security

LoadLeveler administrators can issue this command.

## llhold - Hold or release a submitted job

### Purpose

Places jobs in user hold or system hold and releases jobs from both types of hold. Users can only move their own jobs into and out of user hold. Only LoadLeveler administrators can move jobs into and release them from system hold.

### Syntax

```
llhold [-?] [-H] [-v] [-q] [-s] [-r] [-X cluster_name]
 [-u userlist] [-h hostlist] [joblist]
```

### Flags

- ? Provides a short usage message.
- H Provides extended help information.
- v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.
- q Specifies quiet mode: print no messages other than error messages.
- s Puts jobs in system hold. Only a LoadLeveler administrator can use this option.

If neither **-s** nor **-r** is specified, LoadLeveler puts the jobs in user hold.

- r Releases a job from hold. A job step in user hold can be released by the owner or a LoadLeveler administrator. A job step in system hold can only be released by a LoadLeveler administrator. If a job step that is in both system hold and user hold is released by a LoadLeveler administrator, the job step will be released from system hold but remains in user hold. If the owner releases a job step that is in both system hold and user hold, the job step is released from user hold but remains in system hold.

Only a LoadLeveler administrator can release jobs from system hold. Only an administrator or the owner of a job can release it from user hold.

If neither **-s** nor **-r** is specified, LoadLeveler puts the jobs in user hold.

- X *cluster\_name*  
Specifies the name of a single cluster where the command is to run.

- u *userlist*  
Is a blank-delimited list of users. When used with the **-h** option, only the user's jobs monitored on the machines in the *hostlist* are held or released. When used alone, only the user's jobs monitored on the schedd machine are held or released.

- h *hostlist*  
Is a blank-delimited list of machine names. All jobs monitored on machines in this list are held or released. When issued with the **-u** option, the *userlist* is used to further select jobs for holding or releasing.

When issued by a non-administrator, this option only acts upon jobs that user has submitted to the machines in *hostlist*.

When issued by an administrator, all jobs monitored on the machines are acted upon unless the **-u** option is also used. In that case, the *userlist* is also part of the selection process, and only jobs both submitted by users in *userlist* and monitored on the machines in the *hostlist* are acted upon.

## llhold

*joblist*

Is a blank-delimited list of job and step identifiers. When a job identifier is specified, the command action is taken for all steps of the job. At least one job or step identifier must be specified.

The format of a job identifier is *host.jobid*. The format of a step identifier is *host.jobid.stepid*.

where:

- *host* is the name of the machine that assigned the job and step identifiers.
- *jobid* is the job number assigned to the job when it was submitted.
- *stepid* is the job step number assigned to the job step when it was submitted.

The job or step identifier may be specified in an abbreviated form, *jobid* or *jobid.stepid*, when the command is invoked on the same machine that assigned the job and step identifiers. In this case, LoadLeveler will use the local machine's hostname to construct the full job or step identifier.

## Description

This command does not affect a job step that is running unless the job step attempts to enter the Idle state. At this point, the job step is placed in the Hold state.

To ensure a job is released from both system hold and user hold, the administrator must issue the command with **-r** specified to release it from system hold. The administrator or the submitting user can reissue the command to release the job from user hold.

This command will fail if:

- A nonadministrator attempts to move a job into or out of system hold.
- A nonadministrator attempts to move a job submitted by someone else into or out of user hold.

## Examples

1. This example places job 23, job step 0 and job 19, job step 1 on hold:  
`llhold 23.0 19.1`
2. This example releases job 23, job step 0, job 19, job step 1, and job 20, job step 3 from a hold state:  
`llhold -r 23.0 19.1 20.3`
3. This example places all jobs from users abe, barbara, and carol2 in system hold:  
`llhold -s -u abe barbara carol2`
4. This example releases from a hold state all jobs on machines bronze, iron, and steel:  
`llhold -r -h bronze iron steel`
5. This example releases from a hold state all jobs on machines bronze, iron, and steel that smith submitted:  
`llhold -r -u smith -h bronze iron steel`

## Results

The following shows a sample system response for the **llhold -r -h bronze** command:

```
llhold: Hold command has been sent to the central manager.
```

## **Security**

LoadLeveler administrators and users can issue this command.

## llinit - Initialize machines in the LoadLeveler cluster

### Purpose

Initializes a new machine as a member of the LoadLeveler cluster

### Syntax

```
llinit [-?] [-H] [-q] [-prompt] [-local pathname] [-release pathname]
 [-cm machine] [-debug]
```

### Flags

- ? Provides a short usage message.
- H Provides extended help information.
- q Specifies quiet mode: print no messages other than error messages.
- prompt  
Prompts or leads you through a set of questions that help you to complete the **llinit** command.
- local *pathname*  
*pathname* is the local directory in which the spool, execute, and log subdirectories will be created. The default, if this flag is not used, is the home directory.  
  
There must be a unique local directory for each LoadLeveler cluster member.
- release *pathname*  
*pathname* is the release directory, where the LoadLeveler bin, lib, man, include, and samples subdirectories are located. The default, if this flag is not used, is the **/usr/lpp/LoadL/full** directory on AIX or the **/opt/ibmll/LoadL/full** directory on Linux.
- cm *machine*  
*machine* is the central manager machine, where the negotiator daemon runs.
- debug  
Displays debug messages during the execution of **llinit**.

### Description

This command runs once on each machine during the installation process. It must be run by the user ID you have defined as the LoadLeveler user ID. The log, spool, and execute directories are created with the correct modes and ownerships. The LoadLeveler configuration and administration files, **LoadL\_config** and **LoadL\_admin**, respectively, are copied from LoadLeveler's release directory to LoadLeveler's home directory. The local configuration file, **LoadL\_config.local**, is copied from LoadLeveler's release directory to LoadLeveler's local directory.

**llinit** initializes a new machine as a member of the LoadLeveler cluster by doing the following:

- Creates the following LoadLeveler subdirectories with the given permissions:
  - **spool** subdirectory, with permissions set to 700.
  - **execute** subdirectory, with permissions set to 1777.
  - **log** subdirectory, with permissions set to 775.
- Copies the **LoadL\_config** and **LoadL\_admin** files from the release directory samples subdirectory into the home directory of the LoadLeveler user ID.

- Copies the **LoadL\_config.local** file from the release directory samples subdirectory into the local directory.
- Creates symbolic links from the loadl home directory to the spool, execute, and log subdirectories and the **LoadL\_config.local** file in the local directory (if home and local directories are not identical).
- Creates symbolic links from the home directory to the bin, lib, man, samples, and include subdirectories in the release directory.
- Updates the **LoadL\_config** with the release directory name.
- Updates the **LoadL\_admin** with the central manager machine name.

Before running **llinit** ensure that your HOME environment variable is set to LoadLeveler's home directory. To run **llinit**, you must have:

- Write privileges in the LoadLeveler home directory
- Write privileges in the LoadLeveler release directory
- Write privileges in the LoadLeveler local directory.

## Examples

The following example initializes a machine, assigning **/var/loadl** as the local directory, **/usr/lpp/LoadL/full** as the release directory, and the machine named **bronze** as the central manager.

```
llinit -local /var/loadl -release /usr/lpp/LoadL/full -cm bronze
```

Ensure that the local directory exists before running the preceding command.

## Results

The command:

```
llinit -local /home/ll_admin -release /usr/lpp/LoadL/full -cm mars
```

will yield the following output:

```
llinit: creating directory "/home/ll_admin/spool"
llinit: creating directory "/home/ll_admin/log"
llinit: creating directory "/home/ll_admin/execute"
llinit: set permission "700" on "/home/ll_admin/spool"
llinit: set permission "775" on "/home/ll_admin/log"
llinit: set permission "1777" on "/home/ll_admin/execute"
llinit: creating file "/home/ll_admin/LoadL_admin"
llinit: creating file "/home/ll_admin/LoadL_config"
llinit: creating file "/home/ll_admin/LoadL_config.local"
llinit: editing file /home/ll_admin/LoadL_config
llinit: editing file /home/ll_admin/LoadL_admin
llinit: creating symbolic link "/home/ll_admin/bin -> \
/usr/lpp/LoadL/full/bin"
llinit: creating symbolic link "/home/ll_admin/lib -> \
/usr/lpp/LoadL/full/lib"
llinit: creating symbolic link "/home/ll_admin/man -> \
/usr/lpp/LoadL/full/man"
llinit: creating symbolic link "/home/ll_admin/samples -> \
/usr/lpp/LoadL/full/samples"
llinit: creating symbolic link "/home/ll_admin/include -> \
/usr/lpp/LoadL/full/include"
llinit: program complete.
```

## Security

LoadLeveler administrators can issue this command.

## llmkres - Make a reservation

### Purpose

**llmkres** – Creates a LoadLeveler reservation. A set of nodes can be reserved in advance for a period of time to run both interactive and batch jobs. For additional information on running interactive jobs with reservations, see Chapter 7, “Building and submitting jobs,” on page 157.

### Syntax

```
llmkres { -? | -H | -v | [-q] -t start_time -d duration { -n number_of_nodes |
-h host_list | -h all | -j job_step | -f job_command_file }
[-U user_list] [-G group_list] [-s {yes | no}] [-i {yes | no}] [-g group] }
```

### Flags

|                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>-?</b>                        | Provides a short usage message.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>-H</b>                        | Provides extended help information.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>-v</b>                        | Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>-q</b>                        | Specifies quiet mode: print no messages other than error messages.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>-t</b> <i>start_time</i>      | Specifies the start time of the reservation using the format [mm/dd[/[cc]yy] ] HH:MM. Hours must be specified using a 24-hour clock.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>-d</b> <i>duration</i>        | Specifies the duration of the reservation in minutes.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>-n</b> <i>number_of_nodes</i> | Specifies the number of nodes to reserve.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>-h</b> <i>host_list</i>       | Specifies a blank-delimited list of machines to reserve.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>-h</b> <b>all</b>             | Reserves all machines currently in the LoadLeveler cluster that can be used for a reservation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>-j</b> <i>job_step</i>        | Specifies a job step whose requirements will be used to determine what nodes to reserve. The job step must be in an idle-like state and takes the form [ <i>host.</i> ] <i>jobid.stepid</i> .<br><br>where:<br><ul style="list-style-type: none"> <li>• <i>host</i> is the name of the machine that assigned the job and step identifiers.</li> <li>• <i>jobid</i> is the job number assigned to the job when it was submitted.</li> <li>• <i>stepid</i> is the job step number assigned to the job step when it was submitted.</li> </ul> <p>The step identifier may be specified in an abbreviated form, <i>jobid.stepid</i>, when the command is invoked on the same machine that assigned the step identifier. In this case, LoadLeveler will use the local machine’s hostname to construct the full step identifier.</p> <p>You must be an administrator or the job step owner to make this request. If the request to make the reservation is successful, the job step will be bound to the reservation. If the request is not successful, there is no change to the status of the job step.</p> |

- f** *job\_command\_file* Specifies the path to a *job\_command\_file* that will be submitted and the first job step used to determine what nodes to reserve. All job steps will be bound to the reservation, or if the reservation request fails, be placed in the **NotQueued** state. The job ID of the newly created job will be displayed.
- U** *user\_list* Specifies a blank-delimited list of users who can use the reservation.
- G** *group\_list* Specifies a blank-delimited list of LoadLeveler groups whose users can use the reservation.
- s** {yes|no} Specifies if the SHARED option is selected for the reservation. For a SHARED reservation, after all bound job steps that can run on the reserved nodes are scheduled to run, the remaining resources can be used to run job steps not bound to the reservation. Only bound job steps can be scheduled to run on a reservation that is not shared. The default is not to share the reservation.
- i** {yes|no} Specifies if the REMOVE\_ON\_IDLE option is selected for the reservation. For a REMOVE\_ON\_IDLE reservation, if all bound job steps are finished or if all bound job steps are Idle and none can run on the reserved nodes, the reservation will be removed (canceled) automatically by LoadLeveler. If this option is not set, the reservation will remain, regardless of being used or not. The default is not to remove the reservation automatically.
- g** *group* Specifies a LoadLeveler group that will own the reservation. The default is what is specified as the *default\_group* in the user stanza or No\_Group. Ownership of a reservation by a group does not imply that all of the members of the group can use the reservation, but rather is used as a count toward the maximum number of reservations that a group can own.

## Description

The **llmkres** command is for users authorized by LoadLeveler administrators. The user ID requesting the creation of a reservation becomes the owner of the reservation and can use the reservation. A unique reservation ID will be displayed upon successful creation of the reservation, otherwise a message will be printed out to indicate a failure.

Note that it is possible for a time out to occur while this command is waiting for a response from the LoadLeveler central manager. Even if a time out occurs or the command process is killed, the command may still succeed. To determine if the request has been granted, issue the **llqres** command.

The owner of a reservation maintains certain privileges beyond those allowed for users of the reservation. The owner of a reservation and LoadLeveler administrators can always use the reservation. The owner of a reservation (and the LoadLeveler administrator) can cancel or change a reservation. Users of a reservation are allowed to bind their jobs to a reservation. When a reservation is created, the **-U** and **-G** flag can be used to specify who can use the reservation.

This command is for the BACKFILL scheduler only.

## Examples

1. To reserve 3 nodes for 2 hours starting at 2pm of the current year allowing members of the LoadLeveler group **loadlusr** to use the reservation, issue:

```
llmkres -t 01/16 14:00 -d 120 -n 3 -G loadlusr
```

Note that if you specify a date that has already passed in the current year, you must include the year or an error will occur.

You should receive a response similar to the following:

The reservation c94n16.pok.ibm.com.20.r has been successfully made.

2. To reserve nodes based on the requirements of one user job, issue:

```
llmkres -t 01/17/2005 02:00 -d 420 -f weather.cmd -i yes
```

You should receive a response similar to the following:

The job "c94n16.pok.ibm.com.25" has been submitted.

The reservation c94n16.pok.ibm.com.31.r has been successfully made.

3. To reserve two nodes for use by the reservation owner and two additional users issue:

```
llmkres -t 01/17 13:30 -d 240 -h c94n01 c94n16 -U jay chris
```

You should receive a response similar to the following:

The reservation c94n16.pok.ibm.com.55.r has been successfully made.

## Security

LoadLeveler administrators and users can issue this command.

## llmodify - Change attributes of a submitted job step

### Purpose

Changes the attributes or characteristics of a submitted job.

### Syntax

```
llmodify { -? | -H | -v | [-q] [-X cluster_name]
 { -x execution_factor | -c consumable_cpus |
 -m consumable_real_memory | -W wclimit_add_min | -C job_class |
 -a account_no | -s q_sysprio | -p {preempt|nopreempt} |
 -k keyword=value } jobstep }
```

### Flags

**-?** Provides a short usage message.

**-H** Provides extended help information.

**-v** Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.

**-q** Specifies quiet mode: print no messages other than error messages.

**-X** *cluster\_name*

Specifies the name of a single cluster where the command is to run. This flag cannot be specified with the **-p**, **-s**, **-W**, or **-x** flags.

**-x** *execution\_factor*

For Gang scheduling only, specifies the execution factor value. Valid values are 1 and 99. This is a LoadLeveler administrator only option.

**99** Makes a job step in RUNNING or STARTING state non-preemptable. All other job steps running on the same nodes are preempted until the non-preemptable job step finishes running or its execution factor is lowered.

**1** Returns a job step to the normal preemptable state. This value is the default.

**-c** *consumable\_cpus*

Specifies the consumable CPU value for an idle-like job step.

Allows the ConsumableCpus resource requirement to be reset to the specified value. This value can be any integer equal to or greater than zero (0) and should follow the rules for the **resources** keyword in the job command file.

**-m** *consumable\_real\_memory*

Specifies the consumable real memory value for an idle-like job step.

Allows the ConsumableMemory resource requirement to be reset to the specified value. No units should be specified, as megabytes (MB) is assumed. This value can be any integer greater than zero (0) and should follow the rules for the **resources** keyword in the job command file.

**-W** *wclimit\_add\_min*

Specifies additional time in minutes to add to the wall clock limits of a running-like job step. This option is for preventing a job step from being killed due to the wall clock limits. This is a LoadLeveler administrator only option.

Both the hard limit and soft limit are increased by the specified value. This value can be any integer greater than 0.

## llmodify

The increase will only be effective if a limit was originally set and not already exceeded. If you attempt to modify the wall clock limit for a job step that is approaching its current wall clock limit, it is possible for the current wall clock limit to expire before it can be changed.

Specifying **llmodify -W** will fail if the job step is extended into a reservation. The reservations in conflict must be canceled before the request to increase the job step's wall clock limit can be granted.

### **-C** *job\_class*

Specifies the job class name.

Allows the job class name to be reset to the specified value for an idle-like job step. This value can be any string without white spaces.

### **-a** *account\_no*

Specifies the account number.

Allows the account number to be reset to the specified value for an idle-like job step.

### **-s** *q\_sysprio*

Specifies the job step priority.

This option allows the *q\_sysprio* for a job step to be reset to the specified integer value. The new job step priority will be fixed. Once the priority has been modified, it will no longer be changed if the central manager recalculates priorities. This is a LoadLeveler administrator only option.

### **-p {preempt|nopreempt}**

Specifies whether a job is preemptable or nonpreemptable.

### **-k** *keyword=value*

Modifies *keyword* to the new *value* provided.

where *keyword* is one of the following:

#### **account\_no**

Changes the account number to the specified value for an idle-like job step.

#### **bg\_connection**

Changes the connection option of an idle-like Blue Gene job. The subsequent *value* argument must be a string that is either **TORUS**, **MESH**, or **PREFER\_TORUS**.

#### **bg\_partition**

Changes the requested partition ID of an idle-like Blue Gene job. If this value is specified, any value specified for **bg\_connection**, **bg\_shape**, **bg\_size**, or **bg\_rotate** will be ignored.

#### **bg\_rotate**

Changes the rotate option of an idle-like Blue Gene job. The subsequent *value* argument must be a string that is either **True** or **False**.

#### **bg\_shape**

Changes the shape of an idle-like Blue Gene job. The subsequent *value* argument must be of the form "*XxYxZ*", where *X*, *Y*, and *Z* are integers in units of the number of base partitions. If this value is specified, any value previously specified for **bg\_size** or **bg\_partition** will be ignored.

#### **bg\_size**

Changes the size of an idle-like Blue Gene job. The subsequent *value*

argument must be an integer in units of compute nodes. If this value is specified, any value previously specified for **bg\_shape** or **bg\_partition** will be ignored.

**class** Changes the job class name to the specified value for an idle-like job step. The value can be any string without white spaces.

**consumableCpus**

Changes the ConsumableCpus resource requirement to the specified value. The value can be any integer equal to or greater than zero (0).

**consumableMemory**

Changes the ConsumableMemory resource requirement to the specified value. No units should be specified, as megabytes (MB) is assumed. This value can be any integer greater than zero (0).

**execution\_factor**

For Gang scheduling only, changes the execution factor value. Valid values are 1 and 99. This is a LoadLeveler administrator only option.

**preemptable**

Specifies whether a job is preemptable or nonpreemptable. The value must be either **yes** or **no**.

**priority**

Changes the *q\_sysprio* for a job step to the specified integer value. The new job step priority will be fixed. This is a LoadLeveler administrator only option.

**wclimit\_add**

Increases the wall clock limit of a running-like job step by the number of specified minutes. This is a LoadLeveler administrator only option.

*jobstep*

Is the name of a job step to be modified.

The format of a full LoadLeveler step identifier is *host.jobid.stepid*.

where:

- *host* is the name of the machine that assigned the job and step identifiers.
- *jobid* is the job number assigned to the job when it was submitted.
- *stepid* is the job step number assigned to the job step when it was submitted.

The step identifier may be specified in an abbreviated form, *jobid.stepid*, when the command is invoked on the same machine that assigned the step identifier. In this case, LoadLeveler will use the local machine's hostname to construct the full step identifier.

## Description

All options are for the job step owner or a LoadLeveler administrator on an idle-like job step with the following exceptions:

- **-p**, **-s**, **-x**, and **-W** are LoadLeveler administrator only options
- **-x 1** is valid for a job step in any state
- **-x 99** is valid only for a job step in RUNNING or STARTING state
- **-W** is valid only for a job step in a running-like state

A request to mark a job step nonpreemptable will fail if the job step's expected end time extends into an existing reservation.

## llmodify

At the time a job step is modified, LoadLeveler does not check to make certain that the job step with the modified values can be scheduled to run.

To determine if a modification request is successful, issue the **llq -x -l** command and check the following field in the output.

| Options and keywords                           | Field to check                          |
|------------------------------------------------|-----------------------------------------|
| <b>-a</b> or <b>-k</b> <i>account_no</i>       | Account                                 |
| <b>-C</b> or <b>-k</b> <i>class</i>            | Class                                   |
| <b>-c</b> or <b>-k</b> <i>consumableCpus</i>   | Resources                               |
| <b>-m</b> or <b>-k</b> <i>consumableMemory</i> | Resources                               |
| <b>-p</b> or <b>-k</b> <i>preemptable</i>      | Preemptable                             |
| <b>-k</b> <i>bg_connection</i>                 | Wiring Requested                        |
| <b>-k</b> <i>bg_partition</i>                  | Partition Requested                     |
| <b>-k</b> <i>bg_rotate</i>                     | Rotate                                  |
| <b>-k</b> <i>bg_shape</i>                      | Shape Requested                         |
| <b>-k</b> <i>bg_size</i>                       | Size Requested                          |
| <b>-s</b> or <b>-k</b> <i>priority</i>         | q_sysprio                               |
| <b>-W</b> or <b>-k</b> <i>wclimit_add</i>      | Wall Clk Hard Limit/Wall Clk Soft Limit |
| <b>-x</b> or <b>-k</b> <i>execution_factor</i> | Execution Factor                        |

An idle-like state is one of the following job states:

- Idle
- Deferred
- User Hold
- System Hold
- User & System Hold
- Not Queued
- Vacated
- Vacate Pending
- Rejected
- Reject Pending

A running-like state is one of the following job states:

- Checkpointing
- Pending
- Preempted
- Preempt Pending
- Resume Pending
- Running
- Starting

## Examples

1. This example puts the job step c163n07.12.0 in a non-preemptable state:  
`llmodify -p nopreempt c163n07.12.0`
2. To extend the wall clock limits of job step c163n07.12.0 by 30 minutes:  
`llmodify -W 30 c163n07.12.0`
3. To change the shape of job step c193n04.11.0 to **4x5x4** base partitions:  
`llmodify -k bg_shape=4x5x4 c193n04.11.0`

4. To change the connection type of job step c193n04.11.0 to **MESH**:  
`llmodify -k bg_connection=MESH c193n04.11.0`
5. This example changes the ConsumableCpus resource requirement of job step c188f2n08.15.0 in cluster1 to the value 3:  
`llmodify -X cluster1 -c 3 c188f2n08.15.0`

## Results

The following shows a sample system response for **llmodify -s 109 c163n07.12.0**:

```
llmodify: request has been sent to LoadLeveler.
```

**llmodify** returns the following exit values:

- 0**       The command ran successfully.
- 1**      An error occurred.

## Security

LoadLeveler administrators and users can issue this command.

## llmovejob - Move a single idle job from the local cluster to another cluster

### Purpose

**llmovejob** – Moves a single idle-like job from the local cluster to a remote cluster.

### Syntax

```
llmovejob { -? | -H | -v | -C cluster_name -j job_ID }
```

### Flags

|                               |                                                                                                                                                                              |
|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>-?</b>                     | Provides a short usage message.                                                                                                                                              |
| <b>-H</b>                     | Provides extended help information.                                                                                                                                          |
| <b>-v</b>                     | Outputs the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.                            |
| <b>-C <i>cluster_name</i></b> | Indicates the remote cluster the job specified by <i>job_ID</i> should be transferred to. The <b>-C</b> flag must be specified in combination with the <b>-j</b> flag.       |
| <b>-j <i>job_ID</i></b>       | Indicates the <i>job_ID</i> to be transferred to the cluster specified by <i>cluster_name</i> . The <b>-j</b> flag must be specified in combination with the <b>-C</b> flag. |

### Description

The **llmovejob** command moves a single idle-like job from one cluster to another. Upon successful transfer, the job's submitting owner is notified of the move by mail. If any steps within the job are not idle, the transfer request is rejected and the command exits with an error message. The remote job retains the original *job\_ID* from the local cluster. Upon transfer, the remote cluster performs any user mapping and remote job filtering necessary for the job.

Any changes made to the idle job in the local cluster by the **llmodify** command will not be carried forward to the remote cluster. Any jobs submitted when the local cluster was not configured as a part of a multicluster cannot be moved once the cluster converts to a multicluster environment.

Prior to moving the job, the administrator can examine the LoadLeveler statements in the job command file using the **llq -x -d** command. This will show what values the moved job will use during submission to the remote cluster.

Only administrators can issue the **llmovejob** command. In a mixed operating system multicluster environment, administrators must ensure the binary compatibility of the job being transferred.

### Standard Error

An error message is issued and the command exits for the following error cases:

- The cluster name is unknown
- The requested cluster cannot be accessed
- The job is not in the Idle state
- The job is unknown

- The **-C** and **-j** flags were not specified together

## Examples

This example moves the idle job **silver.11** from the local cluster to the remote cluster **cluster1**:

```
llmovejob -C cluster1 -j silver.11
```

You should receive output similar to the following:

```
Job silver.11 has been submitted to cluster cluster1
```

## Security

LoadLeveler administrators can issue this command.

## llpreempt - Preempt a submitted job step

### Purpose

Preempts the job steps specified in the *joblist* argument using the preempt method specified in the *preempt\_method* argument or resumes the jobs steps specified in the *joblist* argument. Only jobs that have been preempted with the preempt method of suspend through the **llpreempt** command or the **ll\_preempt** subroutine can be resumed with this command. The **llpreempt** command cannot resume a job step that was preempted through the PREEMPT\_CLASS rules or a job step that was preempted with a preempt method other than suspend.

### Syntax

```
llpreempt -? | -H | -v | [-q] [-r | -m method] { [-u userlist]
 [-h hostlist] | [joblist] }
```

### Flags

- ? Provides a short usage message.
- H Provides extended help information.
- v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.
- q Specifies quiet mode: print no messages other than error messages.
- r Resumes the specified jobs. This option is valid only for jobs that were preempted by the suspend method.
- m *preempt\_method*
  - su Indicates preempted jobs that are to be suspended. Suspended jobs will stay in the preempted state until the action is undone with the **-r** flag. The suspend method is the only valid preempt method for the GANG scheduler. This is the default.  
  
Preemption using the suspend method is not supported by the LoadLeveler for Linux platforms. On these platforms, the **llpreempt** command will have no effect if the suspend method is specified either explicitly as a command line option (**-m su**), or implicitly through the **default\_preempt\_method = su** configuration keyword. Note that **su** is the default value of the **default\_preempt\_method** keyword.
  - vc** Indicates that preempted jobs are to be vacated. The preempted jobs will be terminated and remain in the job queue. The job will be rescheduled to run as soon as resources for the job are available.
  - rm** Indicates that preempted jobs are to be removed. The preempted jobs will be terminated and removed from the job queue. In order to rerun the job, you must resubmit the job to LoadLeveler.
  - sh** Indicates that preempted jobs are to be put into system hold. The preempted jobs will be terminated and remain in the job queue in system hold state. The jobs will remain in system hold until released by a LoadLeveler administrator using the **llhold** command. After being released, the job will go into the idle state where it will be rescheduled to run as soon as resources for the job are available.
  - uh** Indicates that preempted jobs are to be put into user hold. The preempted jobs will be terminated and remain in the job queue in user

hold state. The jobs will remain in the user hold until released by the owner of the job step or by a LoadLeveler administrator using the **llhold** command. After being released, the job will go into the idle state where it will be rescheduled to run as soon as resources for the job are available.

**-u** *userlist*

Specifies a blank-delimited list of user names. When used with the **-h** option, only the user's job steps monitored on the machines in the *hostlist* are preempted. When used alone, only the user's jobs monitored by the machine issuing the command are preempted.

**-h** *hostlist*

Specifies a blank-delimited list of host names. All job steps monitored by these hosts are preempted. When used with the **-u** option, only the specified user's job steps monitored by these hosts are preempted.

*joblist*

Is a blank-delimited list of job and step identifiers to be preempted. When a job identifier is specified, the command action is taken for all steps of the job. At least one job or step identifier must be specified.

The format of a job identifier is *host.jobid*. The format of a step identifier is *host.jobid.stepid*.

where:

- *host* is the name of the machine that assigned the job and step identifiers.
- *jobid* is the job number assigned to the job when it was submitted.
- *stepid* is the job step number assigned to the job step when it was submitted.

The job or step identifier may be specified in an abbreviated form, *jobid* or *jobid.stepid*, when the command is invoked on the same machine that assigned the job and step identifiers. In this case, LoadLeveler will use the local machine's hostname to construct the full job or step identifier.

If the **-u** or **-h** option is specified, the *joblist* is ignored.

## Description

This is a LoadLeveler administrator command used for Gang, Backfill, and external schedulers only. Regular users do not have the authority to run this command. This command can only be used when the preemption function is enabled (Gang, Backfill, or external schedulers with preemption enabled). The only preempt method allowed when running the GANG scheduler is suspend (**su**).

LoadLeveler for Linux platforms support all preempt methods except suspend (**su**).

Job steps with a **job\_type** of **bluegene** cannot be made preemptable.

## Examples

1. This example requests that job step c163n07.12.0 be preempted by the default preempt method:  
llpreempt c163n07.12.0
2. This example requests that job step c163n07.12.0 be resumed:  
llpreempt -r c163n07.12.0
3. This example requests that all job steps owned by user frank and monitored by host c52n01 be preempted by the system hold method:  
llpreempt -m sh -u frank -h c52n01

## **llpreempt**

### **Results**

The following shows a sample system response for the **llpreempt** command:

```
llpreempt: request has been sent to LoadLeveler.
```

### **Security**

LoadLeveler administrators can issue this command.

## llprio - Change the user priority of submitted job steps

### Purpose

Changes the user priority of one or more job steps in the LoadLeveler queues. You can adjust the priority by supplying a + (plus) or – (minus) immediately followed by an *integer* value. **llprio** does not affect a job step that is running, even if its priority is lower than other jobs steps, unless the job step goes into the Idle state.

### Syntax

```
llprio [-?] [-H] [-v] [-q] [-X cluster_name]
 [+integer | -integer | -p priority] joblist
```

### Flags

- ? Provides a short usage message.
- H Provides extended help information.
- v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.
- q Specifies quiet mode: print no messages other than error messages.
- X *cluster\_name*  
Specifies the name of a single cluster where the command is to run.
- + | - *integer*  
Operates on the current priority of the job step, making it higher (closer to execution) or lower (further from execution) by adding or subtracting the value of *integer*.
- p *priority*  
Is the new absolute value for priority. The valid range is 0–100 (inclusive) where 0 is the lowest possible priority and 100 is highest.
- joblist*  
Is a blank-delimited list of jobs. When a job identifier is specified, the command action is taken for all steps of the job. At least one job or step identifier must be specified.  
  
The format of a job identifier is *host.jobid*. The format of a step identifier is *host.jobid.stepid*.  
  
where:
  - *host* is the name of the machine that assigned the job and step identifiers.
  - *jobid* is the job number assigned to the job when it was submitted.
  - *stepid* is the job step number assigned to the job step when it was submitted.
 The job or step identifier may be specified in an abbreviated form, *jobid* or *jobid.stepid*, when the command is invoked on the same machine that assigned the job and step identifiers. In this case, LoadLeveler will use the local machine's hostname to construct the full job or step identifier.

### Description

The user priority of a job step ranges from 0 to 100 inclusively, with higher numbers corresponding to greater priority. The default priority is 50. Only the owner of a job step or the LoadLeveler administrator can change the priority of that job step. Note that the priority is not the UNIX *nice* priority.

## llprio

Priority changes resulting in a value less than 0 become 0.

Priority changes resulting in a value greater than 100 become 100.

Any change to a job step's priority applied by a user is relative only to *that user's other job steps* in the same class. If you have three job steps enqueued, you can reorder those three job steps with **llprio** but the result does not affect job steps submitted by other users, regardless of their priority and position in the queue.

For more information, see “Setting and changing the priority of a job” on page 201.

## Examples

1. This example raises the priority of job 4, job step 1 submitted to machine bronze by a value of 25:  
`llprio +25 bronze.4.1`
2. This example sets the priority of job 18, job step 4 submitted to machine silver to 100, the highest possible value:  
`llprio -p 100 silver.18.4`

## Results

The following shows a sample system response for the **llprio -p 100 silver.18.4** command:

```
llprio: Priority command has been sent to the central manager.
```

## Security

LoadLeveler administrators and users can issue this command.

## llq - Query job status

### Purpose

Queries information about jobs in the LoadLeveler queues.

### Syntax

```
llq [-?] [-H] [-v] [-x [-d]] [-s] [-l] [-b] [-w] [-X {cluster_list | all}]
 [-j joblist | joblist] [-u userlist] [-h hostlist] [-c classlist]
 [-R reservation_list] [-f category_list] [-r category_list]
```

### Flags

**-?** Provides a short usage message.

**-H** Provides extended help information.

**-v** Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.

**-x** Provides extended information about the selected job. If the **-x** flag is used with the **-r**, **-s**, or **-f** flag, an error message is generated.

CPU usage and other resource consumption information on active jobs can only be reported using the **-x** flag if the LoadLeveler administrator has enabled it by specifying **A\_ON** and **A\_DETAIL** for the **ACCT** keyword in the LoadLeveler configuration file.

Normally, **llq** connects with the central manager to obtain job information. When you specify **-x**, **llq** connects to the schedd machine that received the specified job to get extended job information. However, some statistics, including those corresponding to System Priority and **q\_sysprio**, are available only from the central manager. Do not use the **-x** option if you need these statistics.

When specified without **-l**, CPU usage for active jobs is reported in the short format.

**Note:** Using both the **-l** and **-x** options without a *joblist* specification can produce a very long report and excessive network traffic.

**-d** Displays the user-specified unfiltered job command file keyword statements. Information is available only on jobs submitted in a multicluster environment. You must specify the **-d** flag in combination with the **-x** flag.

**-s** Provides information on why a selected list of jobs remain in the NotQueued, Idle, or Deferred state. Along with this flag, users must specify a list of jobs. The user can also optionally supply a list of machines to be considered when determining why the jobs cannot run. If a list of machines is not provided, the default is the list of machines in the LoadLeveler cluster. For each job, **llq** determines why the job remains in one of the given states instead of Running.

**-l** Specifies that a long listing be generated for each job for which status is requested.

**-b** Shows Blue Gene jobs in short form. This is the Blue Gene equivalent of the **llq** standard listing. Using this flag will display the following fields:

**BG** The state of the job on the Blue Gene system.

**Id** The LoadLeveler job step ID.

**LL** The LoadLeveler state of the job step.

**Owner**

The user ID of the job's owner.

**Partition**

The name of the Blue Gene partition assigned to the job.

**PT** The state of the Blue Gene partition assigned to the job.

**Size** The number of Blue Gene compute nodes allocated for the job.

**Submitted**

The time the job step was submitted to LoadLeveler.

**-w** Provides AIX Workload Manager (WLM) CPU and real memory statistics for jobs in the running state. This flag can be used with a joblist, steplist, or a single stepid. All other flags except **-h** will result in an error message.

When the **-w** flag is augmented with a single stepid, the **-h** flag can be used in conjunction with **-w** to specify a single hostname.

This flag can only be used when ENFORCE\_RESOURCE\_USAGE is enabled in the configuration file. Otherwise, an error message is produced.

The following statistics are displayed for every node the job is running on:

- Current<sup>®</sup> CPU resource consumption as a percentage of the total resources available
- Total CPU time consumed in milliseconds
- Current real memory consumption as a percentage of the total resources available
- The highest number of resident memory pages used

**-X** {*cluster\_list* | **all**}

Indicates that you can specify the **-X** flag with either:

*cluster\_list* Is a blank-delimited list of clusters where the command is to run.

**all** Is the reserved word indicating that the command is to run in all accessible clusters.

**-j** *joblist* | *joblist*

Is a blank-delimited list of job and step identifiers. When a job identifier is specified, the command action is taken for all steps of the job. At least one job or step identifier must be specified.

The format of a job identifier is *host.jobid*. The format of a step identifier is *host.jobid.stepid*.

where:

- *host* is the name of the machine that assigned the job and step identifiers.
- *jobid* is the job number assigned to the job when it was submitted.
- *stepid* is the job step number assigned to the job step when it was submitted.

The job or step identifier may be specified in an abbreviated form, *jobid* or *jobid.stepid*, when the command is invoked on the same machine that assigned the job and step identifiers. In this case, LoadLeveler will use the local machine's hostname to construct the full job or step identifier.

The **-j** *joblist* flag is used to distinguish a *joblist* when specified in combination with the any flag that supports a list.

If the **-X** flag is specified in combination with a *joblist*, the **-j** flag must be specified. For example:

```
llq -X my_cluster1 my_cluster2 -j c94n13.2.1 c94n13.25.0
```

**-u** *userlist*

Is a blank-delimited list of users. Only job steps belonging to users in this list are queried.

**-h** *hostlist*

Is a blank-delimited list of machines. If the **-s** flag is not specified, only job steps managed by the schedd on machines in this list are queried. If the **-s** flag is specified, the list of machines is considered when determining why a job remains in the Idle state.

When the **-h** flag is used with the **-w** flag, only a single machine name can be specified to obtain the WLM statistics for that machine.

**-c** *classlist*

Is a blank-delimited list of classes. Only job steps belonging to classes in this list are queried.

**-f** *category\_list*

Is a blank-delimited list of categories you want to query. Each category you specify must be preceded by a percent sign. The *category\_list* cannot contain duplicate entries. This flag allows you to create a customized version of the standard **llq** listing. You cannot use this flag with the **-l** flag. The output fields produced by this flag all have a fixed length. The output is displayed in the order in which you specify the categories. *category\_list* can be one or more of the following:

|            |                                                                                 |
|------------|---------------------------------------------------------------------------------|
| <b>%a</b>  | Account number                                                                  |
| <b>%c</b>  | Class                                                                           |
| <b>%cc</b> | Completion code                                                                 |
| <b>%dc</b> | Completion date                                                                 |
| <b>%dd</b> | Dispatch Date                                                                   |
| <b>%dh</b> | Hold date                                                                       |
| <b>%dq</b> | Queue date ("Submitted" date of "standard" <b>llq</b> output)                   |
| <b>%gl</b> | LoadLeveler group                                                               |
| <b>%gu</b> | UNIX group                                                                      |
| <b>%h</b>  | Hostname (first hostname if more than one machine is allocated to the job step) |
| <b>%id</b> | Step ID                                                                         |
| <b>%is</b> | Virtual image size                                                              |
| <b>%jn</b> | Job name                                                                        |
| <b>%jt</b> | Job type                                                                        |
| <b>%nh</b> | Number of hosts allocated to the job step                                       |
| <b>%o</b>  | Job owner                                                                       |
| <b>%p</b>  | User priority                                                                   |
| <b>%R</b>  | Reservation ID                                                                  |
| <b>%sn</b> | Step name                                                                       |
| <b>%st</b> | Status                                                                          |
| <b>%X</b>  | Cluster name where the job is to be scheduled                                   |
| <b>%Xf</b> | Cluster name from where the job was sent                                        |
| <b>%Xk</b> | Cluster name the user requested                                                 |
| <b>%Xs</b> | Cluster name from where the job was submitted                                   |
| <b>%Xu</b> | User name of the original submission                                            |

**-r** *category\_list*

Is a blank-delimited list of formats (categories) you want to query. Each category you specify must be preceded by a percent sign. The *category\_list*

cannot contain duplicate entries. This flag allows you to create a customized version of the standard **llq** listing. You cannot use this flag with the **-l** flag. The output produced by this flag is considered raw, in that the fields can be variable in length. Output fields are separated by an exclamation point (!). The output is displayed in the order in which you specify the formats. *category\_list* can be one or more of the formats listed under the **-f** flag.

#### **-R** *reservation\_list*

Is a blank-delimited list of reservation identifiers. Only job steps bound to reservations in this list are queried. The format of a full LoadLeveler reservation identifier is [*host*].[*rid*][*r*].

where:

- *host* is the name of the machine that assigned the reservation identifier.
- *rid* is the number assigned to the reservation when it was created. An *rid* is required.
- *r* indicates that this is a reservation ID (*r* is optional).

The reservation identifier may be specified in an abbreviated form, *rid*[*r*], when the command is invoked on the same machine that assigned the reservation identifier. In this case, LoadLeveler will use the local machine's host name to construct the full reservation identifier.

If a job step is not specified and if **-u**, **-h**, **-c**, or **-R** is not specified, all jobs are queried.

If a job step is specified, you cannot specify **-u**, **-h**, **-c**, or **-R**, except in the cases of **-w** and **-s**, for which the **-h** flag has special meaning.

When **-u**, **-h**, **-c**, or **-R** are used in combination, the result is the intersection of the job steps selected by each flag.

The **-b** flag can be used alone or with the **-u** flag and the *joblist* argument. If used in conjunction with any other flag, an error will occur.

You cannot specify **-d**, **-x**, or **-w** in combination with the **-X** flag.

## Description

The **llq** command queries information about jobs in the LoadLeveler queues.

## Examples

1. This example generates the standard listing where the machine mars has two jobs running and one job waiting:

| Id         | Owner   | Submitted  | ST | PRI | Class    | Running On |
|------------|---------|------------|----|-----|----------|------------|
| mars.498.0 | brownap | 5/20 11:31 | R  | 100 | silver   | mars       |
| mars.499.0 | brownap | 5/20 11:31 | R  | 50  | No_Class | mars       |
| mars.501.0 | brownap | 5/20 11:31 | I  | 50  | silver   |            |

3 job step(s) in query, 1 waiting, 0 pending, 2 running, 0 held,  
0 preempted

The **standard listing** includes the following fields:

**Class** Job class.

**Id** The format of a full LoadLeveler step identifier is *host.jobid.stepid*. If the **llq** command returns information about a job owned by a schedd in the same domain, then the domain of the hostname will not appear in the output. However, when the **llq** command reports information about a job owned by a schedd in a different domain, the fully qualified hostname is always included. Due to space limitations, the domain of the host may be truncated to fit in the space allocated to the Id field. If the domain is truncated, a dash (-) will appear at the end to indicate that characters have been left out. To see the full job ID, run **llq** with the **-l** flag.

**Owner** User ID that the job will be run under.

**PRI** User priority of the job step, where the values are defined with the **user\_priority** keyword in the job command file or changed by the **llprio** command, which is described in “llprio - Change the user priority of submitted job steps” on page 429

#### Running On

If running, the name of the machine the job step is running on. This is blank when the job is not running. For a parallel job step, only the first machine is shown.

**ST** For more information, see “LoadLeveler job states” on page 18.

#### Submitted

Date and time of job submission.

2. This example generates the long listing. The long listing is generated when you specify the **-x -l** flags with the **llq** command:

```
llq -l -x c271f2rp01.ppd.pok.ibm.com.16.0
```

The **long listing** includes the following fields. See Appendix B, “Sample command output,” on page 603 for sample output of long listings.

#### Account

The account number specified in the job command file.

#### Adapter Requirement

Reflects the settings of the network keyword in the job command file.

For more information on the network keyword, see “Job command file keyword descriptions” on page 324.

#### Allocated Hosts

The machines that have been allocated for this job step.

**Args** Arguments that were passed to the executable.

#### Blocking

Reflects the settings for the blocking keyword in the job command file.

#### Blue Gene Job ID

The ID of the Blue Gene job in the Blue Gene DB2<sup>®</sup> database. This field is displayed for Blue Gene jobs only.

#### Blue Gene Status

The state of the Blue Gene job in the Blue Gene DB2 database. This field is displayed for Blue Gene jobs only.

**Bulk Transfer**

Indicates that the value will be Yes or No depending on whether the application requested that the communication subsystem use bulk transfer by specifying `bulkxfer=yes` in the job command file.

**Checkpoint File**

Location of the directory and file name to be used for checkpoint data.

**Checkpointable**

Indicates if LoadLeveler considers the job step checkpointable (yes, no, or interval).

**Ckpt Accum Time**

Accumulated time, in seconds, the job step has spent checkpointing.

**Ckpt Elapse Time**

Amount of time taken to perform the last successful checkpoint.

**Ckpt Execute Dir**

The directory where the job step's executable will be saved for checkpointable jobs.

**Ckpt Hard Limit**

Checkpoint hard limit as specified at job step submission.

**Ckpt Soft Limit**

Checkpoint soft limit as specified at job step submission.

**Ckpt Start Time**

The start time of the current checkpoint in progress. Blank if no checkpoint running.

**Class** The class of the job step as specified at job submission.

**class\_sysprio**

The class priority of the job step, where the value is defined in the administration file.

**Cluster input file**

The information format is *local\_pathname, remote\_pathname*.

where:

*local\_pathname*

Is the full pathname of the file to be copied from the local cluster.

*remote\_pathname*

Is the full pathname of the file that will be copied into the remote cluster.

**Cluster output file**

The information format is *local\_pathname, remote\_pathname*.

where:

*local\_pathname*

Is the full pathname of the file that will be copied into the local cluster.

*remote\_pathname*

Is the full pathname of the file to be copied from the remote cluster.

**Cmd** The name of the executable associated with the executable keyword (if specified) or the name of the job command file.

**Comment**

The comment specified by the comment keyword in the job command file.

**Completion Code**

The status returned by the wait3 UNIX system call.

**Completion Date**

Date and time job completed or exited.

**Core Hard Limit**

Core hard limit as specified at job submission.

**Core Soft Limit**

Core soft limit as specified at job submission.

**Cpu Hard Limit**

CPU hard limit as specified at job submission.

**Cpu Soft Limit**

CPU soft limit as specified at job submission.

**Data Hard Limit**

Data hard limit as specified at job submission.

**Data Soft Limit**

Data soft limit as specified at job submission.

**DCE Principal**

The DCE principal name associated with the process that submitted the job to LoadLeveler.

**Dependency**

Job step dependencies as specified at job submission.

**Dispatch Time**

The time that the job was dispatched.

**Env** Environment variables to be set before executable runs. Appears only when the -x option is specified.

**Err** The file to be used for stderr.

**Error Text**

The error text in the Blue Gene job record from the Blue Gene DB2 database. This field is displayed for Blue Gene jobs only.

**Execution Factor**

Used only for Gang scheduling, Execution factor is used to prevent preemption of a job step.

**Fail Ckpt Time/Date**

Time and date stamp of the last failed checkpoint.

**File Hard Limit**

File hard limits as specified at job submission.

**File Soft Limit**

File soft limit as specified at job submission.

**Favored Job**

Indicates whether the job has been specified to have a higher system priority than all jobs that are not favored (**yes** or **no**).

**Good Ckpt Time/Date**

Time and date stamp of the last successful checkpoint.

**group\_sysprio**

The group priority of the job step, where the value is defined in the administration file.

**high water**

The highest number of resident memory pages used. Real Memory resource only.

**Hold Job Until**

Job step is deferred until this date and time.

**In**

The file to be used for stdin.

**Initial Working Dir**

The directory from which the job step is run. The relative directory from which the stdio files are accessed, if appropriate.

**Job Accounting Key**

The Job Accounting Key is a unique identifier for a LoadLeveler job step. The accounting key is stored in the AIX accounting record for each process associated with a LoadLeveler job step. This field can be used to correlate AIX accounting records with LoadLeveler accounting records. The Job Accounting Key is stored in the history file and can be displayed using the **llsummary -l** command.

This keyword is not applicable on LoadLeveler for Linux platforms.

For more information on the Job Accounting Key, see "Correlating AIX and LoadLeveler accounting records" on page 60.

**Job Name**

The name of the job.

**Job Step ID**

The job step identifier.

**Large Page**

Indicates whether Large Page memory should be used to run this job step. Can be Y (use Large Page memory if available), N (No), or M (Mandatory).

**LoadLeveler Group**

The LoadLeveler group associated with the job step.

**Machine Speed**

For a serial job step, the value associated with the "speed" keyword of the machine that is running this job step. For a parallel job step, the value associated with the "speed" keyword of the first machine that has been allocated for this job step.

**Max Processors**

The maximum number of processors that can be used for this job step.

**McmAffinityOptions**

The MCM affinity options for the job.

**Min Processors**

The minimum number of processors needed for this job step.

**Negotiator Messages**

Informational messages for the job step if it is in the Idle or NotQueued state.

**(Node) Allocated Hosts**

- The machines of this Node type that have been allocated for this job step. The format is:

```
hostname:task status:adapter usage, ... ,adapter usage, \
 cpu usage, ... ,cpu usage + ... +
hostname:task status:adapter usage, ... ,adapter usage, \
 cpu usage, ... ,cpu usage
```

- The adapter usage information has the format:

```
adapter name(adapter window ID, network protocol, mode, \
 adapter window memory)
```

For information on the units used to report window memory, see the description of the “Adapter” field in “llstatus - Query machine status” on page 455.

- The CPU usage information has one of the following formats:

```
CPU <cpulist>
MCMnumber:CPU <cpulist>
```

The *cpulist* is a blank-delimited list of individual CPU IDs or CPU ranges, or a combination of both CPU IDs and CPU ranges. The CPU range is specified as the starting CPU ID and the ending CPU ID separated by a hyphen (-).

**(Node) Name**

Blank value. Reserved for future use.

**(Node) Node actual**

Actual number of machines of this Node type that are used in the running of this job step.

**(Node) Node maximum**

Maximum number of machines of this Node type that can be used to run this job step.

**(Node) Node minimum**

Minimum number of machines of this Node type required to run this job step.

**(Node) Preferences**

Job step preferences as specified at job submission.

**(Node) Requirements**

Job step requirements as specified at job submission.

**(Node/Master Task) Exec Args**

The arguments passed to the master task executable.

**(Node/Master Task) Executable**

The executable associated with the master task.

**(Node/Master Task) Num Task Inst**

The number of task instances of the master task.

**(Node/Master Task) Task Instance**

- Task instance information has the format:

```
hostname:task ID:adapter usage, ... ,adapter usage
```

- Adapter usage information has the format:

```
adapter name(adapter window ID, network protocol, mode, \
 adapter window memory)
```

For information on the units used to report window memory, see the description of the “Adapter” field in “llstatus - Query machine status” on page 455.

**(Node/Task) Num Task Inst**

The number of task instances.

**(Node/Task) Task Instance**

- Task instance information has the format:  
hostname:task ID:adapter usage, ... ,adapter usage, cpu usage
- Adapter usage information has the format:  
adapter name(adapter window ID, network protocol, mode, \ adapter window memory)  
For information on the units used to report window memory, see the description of the “Adapter” field in “llstatus - Query machine status” on page 455.
- The CPU usage information has one of the following formats:  
  
CPU <cpulist>  
MCMnumber:CPU <cpulist>  
The *cpulist* is a blank-delimited list of individual CPU IDs or CPU ranges, or a combination of both CPU IDs and CPU ranges. The CPU range is specified as the starting CPU ID and the ending CPU ID separated by a hyphen (-).

**Node Usage**

A request that a node be shared or not shared or that a time-slice is not shared. The user specifies this request while submitting the job.

**Notifications**

The notification status for the job step, where:

**always**

Indicates notification is sent through the mail for all four notification categories below.

**complete**

Indicates notification is sent through the mail only when the job step completes.

**error**

Indicates notification is sent through the mail only when the job step terminates abnormally.

**never**

Indicates notification is never sent.

**start**

Indicates notification is sent through the mail only when starting or restarting the job step.

**Notify User**

The user to be notified by mail of a job’s status.

**NQS Query Queues**

The NQS queue names you can use to monitor the job.

**NQS Submit Queue**

The name of the NQS pipe queue to which the NQS job will be routed.

**Out** The file to be used for stdout.

**Outbound Schedds**

The list of schedds that have acted as the outbound schedd for the

job. The last schedd in the list is the current outbound schedd. This field only displays multicluster-specific information that was submitted or moved to a remote cluster.

**Owner**

The user ID that the job will be run under.

**Partition ID**

The ID of the Blue Gene partition allocated for the job. This field is displayed for Blue Gene jobs only.

**Partition State**

The state of the Blue Gene partition allocated for the job. This field is displayed for Blue Gene jobs only.

**Preempt Wait Count**

Specifies the number of job steps that an idle job step must preempt before it can be started.

**Preemptable**

Indicates whether a job step is preemptable (yes or no).

**Preferences**

Job step preferences as specified at job submission.

**previous q\_sysprio**

The previous adjusted system priority of the job step. For more information, see “Example: How does a job’s priority affect dispatching order?” on page 201.

**q\_sysprio**

The adjusted system priority of the job step. For more information, see “Example: How does a job’s priority affect dispatching order?” on page 201.

**Queue Date**

The date and time that LoadLeveler received the job.

**Requested Cluster**

The cluster the user specified at job submission.

**Requested Res. ID**

The reservation identifier that a job step is requested to be bound to, but has not yet been bound to. This field will be set when a job submitted with a request to bind has been successfully submitted, but the bind has not yet occurred. The bind may never occur if either the owner of the job step is not allowed to use the reservation, or if the reservation does not exist.

If a job command file is used to select nodes to reserve in a make or change reservation request and the request fails, all steps of the job, if submitted successfully, will have MAKERES as their Requested Res. ID and the steps will be in the **NQ** state.

**Requirements**

Job step requirements as specified at job submission.

**Reservation ID**

The reservation identifier that a job step is bound to. If a job step is not bound to any reservation, this field will be blank.

**Resource**

The resource being enforced by WLM. This is either **CPU** or **Real Memory**.

**Resources**

Reflects the settings for the resources keyword in the job command file.

**Restart**

Restart status (**yes** or **no**).

**Restart From Ckpt**

Indicates if a job has been restarted from an existing checkpoint (**yes** or **no**).

**Restart Same Nodes**

Indicates if a job step should be restarted on the same nodes after vacate (**yes** or **no**).

**Rotate** Indicates whether the scheduler is free to rotate the requested Blue Gene partition shape in order to match an available partition (**TRUE** or **FALSE**). This field is displayed for Blue Gene jobs only.

**RSet** The RSet requirement of the job.

**Rss Hard Limit**

RSS hard limit as specified at job step submission.

**Rss Soft Limit**

RSS soft limit as specified at job step submission.

**Running Host**

For a serial job step, the machine that is running this job step. For a parallel job step, the first machine that has been allocated for this job step.

**Schedd History**

The list of schedds that have acted as the schedd host for the job. The last one in the list is the current schedd host. This field only displays multicluster-specific information.

**Scheduling Cluster**

The cluster name where the job is to be scheduled. This field only displays multicluster-specific information.

**Sending Cluster**

The cluster name that the job was sent from when moved. This field only displays multicluster-specific information.

**Shape Allocated**

The allocated shape of the Blue Gene partition for the job. This field is defined only for running-like jobs. This field is displayed for Blue Gene jobs only.

**Shape Requested**

The requested shape of the Blue Gene partition for the job, if defined, in units of base partitions. This field is displayed for Blue Gene jobs only.

**Shell** The shell to be used when the job step runs.

**Size Allocated**

The size of the Blue Gene partition for the job in units of compute

nodes. The size allocated is not always identical to the requested size. This field is displayed for Blue Gene jobs only.

**Size Requested**

The requested size of the Blue Gene partition for the job in units of compute nodes. The size must be equivalent to the size of the shape, if such is defined. This field is displayed for Blue Gene jobs only.

**snapshot**

Current CPU or Real Memory consumption as a percentage of the total resources available.

**Stack Hard Limit**

Stack hard limit as specified at job submission.

**Stack Soft Limit**

Stack soft limit as specified at job submission.

**Starter idrss/Step Starter idrss**

An integral value of the amount of unshared memory in the data segment of a process (expressed in units of kilobytes \* seconds-of-execution).

**Starter inblock/Step inblock**

Number of times file system performed input. Cumulative total.

**Starter isrss/Step isrss**

Depending on the Operating System, this field may contain the integral value of unshared stack size.

**Starter ixrss/Step ixrss**

An integral value indicating the amount of memory used by the text segment that was also shared among other processes (expressed in units of kilobytes \* seconds-of-execution).

**Starter majflt/Step majflt**

Number of page faults (I/O required). Cumulative total.

**Starter maxrss/Step maxrss**

Maximum resident set size utilized. Maximum value.

**Starter minflt/Step minflt**

Number of page faults (reclaimed). Cumulative total.

**Starter msgrcv/Step msgrcv**

Number of IPC messages received. Cumulative total.

**Starter msgsnd/Step msgsnd**

Number of IPC messages sent. Cumulative total.

**Starter nivcsw/Step nivcsw**

Number of involuntary context switches. Cumulative total.

**Starter nsignals/Step nsignals**

Number of signals delivered. Cumulative total.

**Starter nswap/Step nswap**

Number of times swapped out. Cumulative total.

**Starter nvcswh/Step nvcswh**

Number of context switches due to voluntarily giving up processor. Cumulative total.

**Starter outhblock/Step outhblock**

Number of times file system performed output. Cumulative total.

**Starter System Time/Step System Time**

CPU system time of Starter/Step processes. Cumulative total.

**Starter Total Time/Step Total Time**

CPU total time of Starter/Step processes. Cumulative total.

**Starter User Time/Step User Time**

CPU user time of Starter/Step processes. Cumulative total.

**Status** The status (state) of the job. For more information, see “LoadLeveler job states” on page 18.

**Step Adapter Memory**

The total adapter pinned memory for the job step.

**Step Cpu Hard Limit**

Job step CPU hard limit as specified at job submission.

**Step Cpu Soft Limit**

Job step CPU soft limit as specified at job submission.

**Step Cpus**

The total ConsumableCpus for the job step.

**Step Name**

The name of the job step

**Step rCxt Blocks**

The number of rCxt blocks for High Performance Switch adapters.

**Step Real Memory**

The total ConsumableMemory for the job step.

**Step Type**

Type of job step:

- Serial
- General parallel
- Blue Gene

**Step Virtual Memory**

The total ConsumableVirtualMemory for the job step.

**Structure Version**

An internal version identifier.

**Submitting Cluster**

The cluster name where the job was submitted from. This field only displays multicluster-specific information.

**Submitting Host**

The name of the machine to which the job is submitted.

**Submitting User**

The user name that the job was submitted under. This field only displays multicluster-specific information.

**System Priority**

The overall system priority of the job step, where the value is defined by the SYSPRIO expression in the configuration file.

**Task\_geometry**

Reflects the settings for the task\_geometry keyword in the job command file.

**total** Total CPU time consumed in milliseconds. CPU resource only.

**Unix Group**

The effective UNIX group name.

**User Priority**

The priority of the job step, as specified by the user in the job command, or changed by the **llprio** command.

**User Space Windows®**

The number of switch adapter windows assigned to the job step.

**user\_sysprio**

The user system priority of the job step, where the value is defined in the administration file.

**Virtual Image Size**

The value of the `image_size` keyword (if specified) or the size of the executable associated with the `executable` keyword (if specified) or the size of the job command file.

**Wall Clk Hard Limit**

Wall clock hard limit as specified at job submission.

**Wall Clk Soft Limit**

Wall clock soft limit as specified at job submission.

**Wiring Allocated**

Allocated type of wiring for the Blue Gene partition. It is either TORUS or MESH. This field is displayed for Blue Gene jobs only.

**Wiring Requested**

Requested type of wiring for the Blue Gene partition. It is TORUS, MESH, or PREFER\_TORUS. This field is displayed for Blue Gene jobs only.

3. Using the abbreviated form of *jobid*, this example generates a standard listing for all job steps with *jobid* 12 assigned by the local machine:

```
llq 12
```

4. This example generates a standard listing for all job steps owned by either rich or nathan and bound to reservation 6:

```
llq -u rich nathan -R 6
```

5. This example generates an extended listing for all job steps of class batch or class highprio, managed by the schedd daemon on either c94n07 or c94n09:

```
llq -x -c batch highprio -h c94n07 c94n09
```

6. The following example generates a standard listing for all job steps bound to reservation c94n04.2.r:

```
llq -R c94n04.2.r
```

You should receive a response similar to the following:

| Id         | Owner | Submitted | ST | PRI | Class  | Running On |
|------------|-------|-----------|----|-----|--------|------------|
| c94n04.5.0 | zhong | 2/8 08:17 | I  | 50  | classA |            |

```
1 job step(s) in query, 1 waiting, 0 pending, 0 running, 0 held,
0 preempted
```

7. The following example generates a customized listing for all job steps:

```
llq -f %id %o %R
```

You should receive a response similar to the following:

```

Step Id Owner Reservation ID

c94n04.5.0 zhong c94n04.2.r
c94n04.4.0 zhong

2 job step(s) in queue, 1 waiting, 0 pending, 0 running, 1 held,
0 preempted

```

8. The following is sample output for **llq -X cluster2**. The output representing a cluster is delineated with a cluster header, in this example it is cluster2.

```

===== Cluster cluster2 =====

Id Owner Submitted ST PRI Class Running On

c188f2n02.9.0 brownap 10/29 13:54 R 50 april c188f2n08

1 job step(s) in query, 0 waiting, 0 pending, 1 running, 0 held, 0 preempted

```

9. The following is sample output for **llq -X all** command where there are two clusters:

```

===== Cluster cluster1 =====

Id Owner Submitted ST PRI Class Running On

c193n13.283.0 rolf 8/4 10:58 R 50 No_Class c193n13
c193n13.283.0 rolf 8/4 10:58 R 50 No_Class c193n13
c193n13.289.0 rolf 8/4 10:58 R 50 No_Class c193n13
c193n13.291.0 rolf 8/4 10:59 R 50 No_Class c193n13
c193n13.293.0 rolf 8/4 10:59 R 50 No_Class c193n13
c193n13.295.0 rolf 8/4 10:59 R 50 No_Class c193n13
c193n13.297.0 rolf 8/4 11:01 R 50 No_Class c193n13
c193n13.299.0 brownap 8/4 11:02 R 50 No_Class c193n13

7 job step(s) in queue, 0 waiting, 0 pending, 7 running, 0 held, 0 preempted

===== Cluster cluster2 =====

Id Owner Submitted ST PRI Class Running On

c193n13.265.0 llbld 8/2 13:42 R 50 No_Class c197blade3b14
c193n13.267.0 llbld 8/2 13:43 R 50 No_Class c197blade3b14
c193n13.271.0 llbld 8/2 13:55 I 50 No_Class
c193n13.273.0 llbld 8/4 10:53 I 50 No_Class
c193n13.275.0 llbld 8/4 10:53 I 50 No_Class
c193n13.277.0 llbld 8/4 10:53 I 50 No_Class
c193n13.279.0 llbld 8/4 10:58 I 50 No_Class

7 job step(s) in queue, 5 waiting, 0 pending, 2 running, 0 held, 0 preempted

```

10. The following is sample output for **llq -b** for a standard Blue Gene listing:

```

Id Owner Submitted LL BG PT Partition Size

fen01.193.0 jdoe 2/21 22:52 R C part031 65536
fen02.1305.0 jfoe 2/20 02:36 R R B part031 1024
fen01.194.0 jane 2/21 14:12 I

```

11. This example generates a customized and formatted standard listing:

```
llq -f %id %c %dq %dd %gl %h
```

You should receive output similar to the following:

| Step Id | Class    | Queue Date  | Disp. Date  | LL Group | Running On      |
|---------|----------|-------------|-------------|----------|-----------------|
| 116.2.0 | No_Class | 04/08 09:19 | 04/08 09:21 | No_Group | 116.pok.ibm.com |
| 116.1.0 | No_Class | 04/08 09:19 | 04/08 09:21 | No_Group | 116.pok.ibm.com |
| 116.3.0 | No_Class | 04/08 09:19 | 04/08 09:21 | No_Group | 115.pok.ibm.com |

```
3 job step(s) in queue, 0 waiting, 0 pending, 3 running, 0 held, 0 preempted
```

12. This example generates a customized, unformatted (raw) standard listing. Output fields are separated by an exclamation point (!).

```
llq -r %id %c %dq %dd %gl %h
```

You should receive output similar to the following:

```
116.pok.ibm.com.2.0!No_Class!04/08/2005 09:19!04/08/2005 09:21! \
 No_Group!116.pok.ibm.com
116.pok.ibm.com.1.0!No_Class!04/08/2005 09:19!04/08/2005 09:21! \
 No_Group!116.pok.ibm.com
116.pok.ibm.com.3.0!No_Class!04/08/2005 09:19!04/08/2005 09:21! \
 No_Group!115.pok.ibm.com
```

13. This example generates a WLM CPU and real memory statistics listing where c209f1n05.13.0 is a CPU intensive parallel job step currently running on the 2 nodes c209f1n05 and c209f1n01: If the LoadLeveler interface to AIX Workload Manager (WLM) is enabled, the **-w** option can be used to obtain CPU and real memory statistics of job steps in running state. Note that Large Page memory information is not included in the statistics since WLM does not manage Large Page memory.

```
llq -w c209f1n05.13.0
```

You should receive output similar to the following:

```
===== Job Step c209f1n05.ppd.pok.ibm.com.13.0 =====
c209f1n05.ppd.pok.ibm.com:
 Resource: CPU
 snapshot: 99
 total: 80172
 Resource: Real Memory
 snapshot: 1
 high water: 2561

c209f1n01.ppd.pok.ibm.com:
 Resource: CPU
 snapshot: 100
 total: 79303
 Resource: Real Memory
 snapshot: 1
 high water: 1919
```

14. The following is sample llq -l output for task instances and allocated hosts if the job requested MCM affinity:

```

Allocated Hosts: e189f4rp04.ppd.pok.ibm.com:: \
 sn1(MPI,IP,-1,Shared,0 rCxt Blks), \
 sn1(MPI,IP,-1,Shared,0 rCxt Blks), \
 MCM0:CPU< 0-5 >,MCM0:CPU< 0-5 > \
+ e189f4rp03.ppd.pok.ibm.com:: \
 sn1(MPI,IP,-1,Shared,0 rCxt Blks), \
 sn1(MPI,IP,-1,Shared,0 rCxt Blks), \
 MCM1:CPU< 4-5 >,MCM1:CPU< 4-5 >

Num Task Inst: 4
Task Instance: e189f4rp04:0:sn1(MPI,IP,-1,Shared,0 rCxt Blks), \
 MCM0:CPU< 0-5 >
Task Instance: e189f4rp04:1:sn1(MPI,IP,-1,Shared,0 rCxt Blks), \
 MCM0:CPU< 0-5 >
Task Instance: e189f4rp03:2:sn1(MPI,IP,-1,Shared,0 rCxt Blks), \
 MCM1:CPU< 4-5 >
Task Instance: e189f4rp03:3:sn1(MPI,IP,-1,Shared,0 rCxt Blks), \
 MCM1:CPU< 4-5 >

```

Note that the < > notation will be used to list individual CPU IDs instead of the CPU count ( ) notation when the **RSET\_SUPPORT** configuration file keyword is set to **RSET\_CONSUMABLE\_CPUS** or **RSET\_MCM\_AFFINITY**.

15. The following example shows the Resource Set information in the llq -l listing when the consumable CPUs Resource Set requirement is requested:

```

Allocated Hosts : e189f4rp01.ppd.pok.ibm.com:: \
 sn0(MPI,IP,-1,Shared,0 rCxt Blks), \
 sn0(MPI,IP,-1,Shared,0 rCxt Blks), \
 CPU< 0-5 >,CPU< 0-5>
+ e189f4rp02.ppd.pok.ibm.com:: \
 sn0(MPI,IP,-1,Shared,0 rCxt Blks), \
 sn0(MPI,IP,-1,Shared,0 rCxt Blks), \
 CPU< 0-5 >,CPU< 0-5 >

Num Task Inst: 4
Task Instance: e189f4rp01:0:sn0(MPI,IP,-1,Shared,0 rCxt Blks), \
 CPU< 0-5 >
Task Instance: e189f4rp01:1:sn0(MPI,IP,-1,Shared,0 rCxt Blks), \
 CPU< 0-5 >
Task Instance: e189f4rp02:2:sn0(MPI,IP,-1,Shared,0 rCxt Blks), \
 CPU< 0-5 >
Task Instance: e189f4rp02:3:sn0(MPI,IP,-1,Shared,0 rCxt Blks), \
 CPU< 0-5 >

```

16. The following example shows output for the llq -l command when rCxt blocks are present:

```

.
.
.
Adapter Requirement: (sn_single,MPI,US,shared,AVERAGE,instances=1, \
 rcxtblks=5)
.
.
.

Num Task Inst: 4
Task Instance: c60f1rp02:0:sn1(MPI,US,10,Shared,5 rCxt Blks),
Task Instance: c60f1rp02:1:sn0(MPI,US,10,Shared,5 rCxt Blks),
Task Instance: c60f1rp02:2:sn1(MPI,US,11,Shared,5 rCxt Blks),
Task Instance: c60f1rp02:3:sn0(MPI,US,11,Shared,5 rCxt Blks),

```

## Security

LoadLeveler administrators and users can issue this command.

## llqres - Query a reservation

### Purpose

llqres – Returns information about reservations in LoadLeveler.

### Syntax

```
llqres { -? | -H | -v | [-l|-r] [-s] [[-u user_list] [-g group_list]
[-h host_list] [-b begin_time] [-e end_time] | -R reservation_list }
```

### Flags

|                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>-?</b>                         | Provides a short usage message.                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>-H</b>                         | Provides extended help information.                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>-v</b>                         | Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.                                                                                                                                                                                                                                                                                           |
| <b>-l</b>                         | Specifies that a long listing be generated for each reservation to be queried.                                                                                                                                                                                                                                                                                                                                                               |
| <b>-r</b>                         | Specifies raw mode for output. Each reservation will occupy one line with the output fields separated by an exclamation point (!).                                                                                                                                                                                                                                                                                                           |
| <b>-s</b>                         | Specifies that short host names will be used in the output of machine names.                                                                                                                                                                                                                                                                                                                                                                 |
| <b>-u <i>user_list</i></b>        | Specifies a blank-delimited list of users. Reservations to be queried are owned by one of these users.                                                                                                                                                                                                                                                                                                                                       |
| <b>-g <i>group_list</i></b>       | Specifies a blank-delimited list of LoadLeveler groups. Reservations to be queried are owned by one of these groups.                                                                                                                                                                                                                                                                                                                         |
| <b>-h <i>host_list</i></b>        | Specifies a blank-delimited list of machines. Reservations to be queried use one or more of these machines.                                                                                                                                                                                                                                                                                                                                  |
| <b>-b <i>begin_time</i></b>       | Reservations to be queried are active at or after the specified begin time. The <b>-b</b> flag can be used together with the <b>-e</b> flag to query reservations expected to be active between the begin and end times. The <i>begin_time</i> must be specified using the format [mm/dd[/[cc]yy]] HH:MM. Hours must be specified using a 24-hour clock.                                                                                     |
| <b>-e <i>end_time</i></b>         | Reservations to be queried are active at or before the specified end time. The <b>-e</b> flag can be used together with the <b>-b</b> flag to query reservations expected to be active between the begin and end times. The <i>end_time</i> must be specified using the format [mm/dd[/[cc]yy]] HH:MM. Hours must be specified using a 24-hour clock.                                                                                        |
| <b>-R <i>reservation_list</i></b> | Is a blank-delimited list of reservation identifiers to be queried. The format of a full LoadLeveler reservation identifier is [ <i>host</i> ]. <i>rid</i> [. <i>r</i> ].<br><br>where: <ul style="list-style-type: none"> <li>• <i>host</i> is the name of the machine that assigned the reservation identifier.</li> <li>• <i>rid</i> is the number assigned to the reservation when it was created. An <i>rid</i> is required.</li> </ul> |

- **r** indicates that this is a reservation ID (**r** is optional).

The reservation identifier may be specified in an abbreviated form, *rid[.r]*, when the command is invoked on the same machine that assigned the reservation identifier. In this case, LoadLeveler will use the local machine's host name to construct the full reservation identifier.

When **-R** is specified, **-u**, **-g**, and **-h** are ignored.

## Description

All users can issue this command. Reservations satisfying all criteria specified by **-u**, **-g**, **-h**, **-b**, and **-e** will be queried if more than one of these options are present. By default, the **llqres** command queries all existing reservations.

This command is for the BACKFILL scheduler only.

## Examples

1. When issuing the **llqres** command, you should receive output similar to the following:

| Id          | Owner | ST | Start Time | Duration | #Nodes |
|-------------|-------|----|------------|----------|--------|
| -----       | ----- | -- | -----      | -----    | -----  |
| c94n16.30.r | loadl | A  | 3/16 14:00 | 120      | 3      |
| c94n16.31.r | dave  | W  | 3/17 02:00 | 420      | 4      |
| c94n16.35.r | carol | W  | 3/17 13:30 | 240      | 2      |

When issuing the **llqres -l** command, you should receive output similar to the following:

```
===== Reservation c94n16.ppd.pok.ibm.com.30.r =====
 ID: c94n16.ppd.pok.ibm.com.30.r
 Creation Time: Wed Mar 16 08:12:23 EDT 2005
 Owner: loadl
 Group: No_Group
 Start Time: Wed Mar 16 14:00:00 EDT 2005
 Duration: 120 minutes
Expected End Time: Wed Mar 16 16:00:00 EDT 2005
 SHARED: no
 REMOVE_ON_IDLE: no
 Status: ACTIVE
 Modified By: loadl
Modification Time: Wed Mar 16 10:21:14 EDT 2005
 Users: 0
 Groups: 1
 loadlusr
 Nodes: 3
 c94n01.ppd.pok.ibm.com
 c94n11.ppd.pok.ibm.com
 c94n12.ppd.pok.ibm.com
 Job Steps: 0

===== Reservation c94n16.ppd.pok.ibm.com.31.r =====
 ID: c94n16.ppd.pok.ibm.com.31.r
 Creation Time: Wed Mar 16 10:55:18 EDT 2005
 Owner: dave
 Group: No_Group
 Start Time: Thu Mar 17 02:00:00 EDT 2005
 Duration: 420 minutes
Expected End Time: Thu Mar 17 09:00:00 EDT 2005
 SHARED: no
 REMOVE_ON_IDLE: yes
 Status: WAITING
 Modified By: dave
```

```

Modification Time: Wed Mar 16 10:55:18 EDT 2005
 Users: 0
 Groups: 0
 Nodes: 4
 c94n01.ppd.pok.ibm.com
 c94n02.ppd.pok.ibm.com
 c94n12.ppd.pok.ibm.com
 c94n16.ppd.pok.ibm.com
 Job Steps: 1
 c94n16.ppd.pok.ibm.com.25.0

```

```

===== Reservation c94n16.ppd.pok.ibm.com.35.r =====
 ID: c94n16.ppd.pok.ibm.com.35.r
 Creation Time: Wed Mar 16 10:58:19 EDT 2005
 Owner: carol
 Group: No_Group
 Start Time: Thu Mar 17 13:30:00 EDT 2005
 Duration: 240 minutes
 Expected End Time: Thu Mar 17 17:30:00 EDT 2005
 SHARED: no
 REMOVE_ON_IDLE: no
 Status: WAITING
 Modified By: carol
 Modification Time: Wed Mar 16 10:58:19 EDT 2005
 Users: 2
 jay
 iris
 Groups: 0
 Nodes: 2
 c94n01.ppd.pok.ibm.com
 c94n02.ppd.pok.ibm.com
 Job Steps: 0

```

2. To determine if any reservations will be active on the machine c94n01 before performing an hours worth of maintenance beginning at 8:00 on 3/18/2005, issue the following command:

```
llqres -b 03/18/2005 8:00 -e 3/18/2005 9:00 -h c94n01
```

You should receive output similar to the following:

| Id          | Owner | ST | Start Time | Duration | #Nodes |
|-------------|-------|----|------------|----------|--------|
| -----       | ----  | -- | -----      | -----    | -----  |
| c94n16.31.r | dave  | W  | 3/18 02:00 | 420      | 4      |

3. There are no job steps associated with a reservation in the following example. The short form is used for host names:

```
llqres -r -s -R c94n16.30.r
```

You should receive output similar to the following:

```

c94n16.30.r!Wed Mar 16 08:12:23 EDT 2005!load!No_Group!Wed Mar 16 14:00:00 EDT
2005!120!Wed Mar 16 16:00:00 EDT 2005!no!no!ACTIVE!load!Wed Mar 16 10:21:14 EDT
2005!0!!1!load!usr!3!c94n01,c94n11,c94n12!0!

```

4. There are job steps associated with a reservation in the following example. The short form is used for host names:

```
llqres -r -s -R c94n16.31.r
```

You should receive output similar to the following:

```

c94n16.31.r!Wed Mar 16 10:35:18 EDT 2005!dave!No_Group!Thu Mar 17 02:00:00 EDT
2005!420!Thu Mar 17 09:00:00 EDT 2005!no!yes!WAITING!dave!Wed Mar 16 10:55:18
EDT 2005!0!!0!!4!c94n01,c94n02,c94n12,c94n16!1!c94n16.25.0

```

## llrmres - Cancel a reservation

### Purpose

llrmres – Cancels a reservation in LoadLeveler.

### Syntax

```
llrmres { -? | -H | -v | [-q] { [-u user_list] [-g group_list] [-h host_list] |
-R {all | reservation_list} } }
```

### Flags

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| -?                                  | Provides a short usage message.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| -H                                  | Provides extended help information.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| -v                                  | Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| -q                                  | Specifies quiet mode: print no messages other than error messages.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| -u <i>user_list</i>                 | Specifies a blank-delimited list of user IDs. Reservations to be canceled are owned by one of these users.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| -g <i>group_list</i>                | Specifies a blank-delimited list of LoadLeveler groups. Reservations to be canceled are owned by one of these groups.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| -h <i>host_list</i>                 | Specifies a blank-delimited list of machines. Reservations to be canceled use one or more of these machines.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| -R {all   <i>reservation_list</i> } | <p>Is a blank-delimited list of reservation identifiers to be canceled. A LoadLeveler administrator can specify the reserved word <b>all</b> to cancel all reservations in the system. Nonadministrators can specify the reserved word <b>all</b> to cancel all of the reservations that they own. The format of a full LoadLeveler reservation identifier is [<i>host.</i>]<i>rid</i>[.<i>r</i>].</p> <p>where:</p> <ul style="list-style-type: none"> <li>• <i>host</i> is the name of the machine that assigned the reservation identifier.</li> <li>• <i>rid</i> is the number assigned to the reservation when it was created. An <i>rid</i> is required.</li> <li>• <i>r</i> indicates that this is a reservation ID (<i>r</i> is optional).</li> </ul> <p>The reservation identifier may be specified in an abbreviated form, <i>rid</i>[.<i>r</i>], when the command is invoked on the same machine that assigned the reservation identifier. In this case, LoadLeveler will use the local machine's host name to construct the full reservation identifier.</p> |

### Description

The **llrmres** command is for LoadLeveler administrators and owners of a reservation. Owners of a reservation can cancel their own reservation. A LoadLeveler administrator can cancel any reservation. The state of a job step will not be changed directly by the cancellation of a reservation. Reservations satisfying

all criteria specified by the **-u**, **-g**, and **-h** flags will be canceled if more than one of these options are present. The **llqres** command can be used to see the status of the reservation.

This command is for the BACKFILL scheduler only.

## Examples

1. To request to cancel all reservations owned by user ID iris that use machine c188f2n01, issue the following command. Note that this request can be made either by an administrator or the user iris.

```
llrmres -u iris -h c188f2n01
```

You should receive a response similar to the following:

The request to remove reservations has been sent to the central manager.

2. To request that the LoadLeveler administrator cancel all reservations, issue:

```
llrmres -R all
```

You should receive a response similar to the following:

The request to remove reservations has been sent to the central manager.

## Security

LoadLeveler administrators and users can issue this command.

---

## llrnscheduler - Run the central manager's scheduling algorithm

### Purpose

**llrnscheduler** – Runs the central manager's scheduling algorithm when the internal scheduling interval is disabled.

### Syntax

**llrnscheduler** [-?] | [-H] | [-v] | [-q]

### Flags

- ? Provides a short usage message.
- H Provides extended help information.
- v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.
- q Specifies quiet mode: print no messages other than error messages.

### Description

The **llrnscheduler** command is used to run the central manager's scheduling algorithm when the internal scheduling interval has been disabled so that an external program can control when the central manager attempts to schedule job steps. The **llrnscheduler** command sends a request to the central manager to run the scheduling algorithm. The central manager's scheduling algorithm will run only once each time the **llrnscheduler** command is invoked. Each time the scheduling algorithm runs, the central manager will schedule as many job steps as the current available resources allow.

The request to run the scheduling algorithm is ignored if the internal scheduling interval has not been disabled by setting the **NEGOTIATOR\_INTERVAL** configuration keyword to 0. If **NEGOTIATOR\_INTERVAL** is set to 0, the **llstatus** command will report that the scheduler interval is disabled.

### Security

LoadLeveler administrators can issue this command.

## llstatus - Query machine status

### Purpose

Returns status information about machines in the LoadLeveler cluster. It does not provide status on any NQS machine.

### Syntax

```
llstatus [-?] [-H] [-v] [-R] [-F] [-M] [-l] [-a] [-C] [-b]
 [-B {base_partition_list | all}] [-P {partition_list | all}]
 [-X {cluster_list | all}] [-f category_list] [-r category_list]
 [-h hostlist | hostlist]
```

### Flags

- ? Provides a short usage message.
- H Provides extended help information.
- v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.
- R Lists the machine consumable resources associated with each machine for which status is requested. This option should not be used with any other option.
- F Lists all of the floating consumable resources associated with the LoadLeveler cluster. This option should not be used with any other option.
- M Lists the Multiple Chip Modules (MCMs) available on a machine, where:
  - Available CPUs**  
Are the CPU IDs of the CPUs available for LoadLeveler on this MCM.
  - Used CPUs**  
Are the CPU IDs of the CPUs used by LoadLeveler jobs on this MCM.
  - Adapters**  
Are the switch adapters connected to this MCM of the form:  
[used windows/available windows, used memory/available memory]

where:

  - used windows**  
Is the total number of windows used.
  - available windows**  
Is the total number of available windows.
  - used adapter window memory**  
For High Performance Switch adapters, it is the number of rCxt blocks used.  
  
For information on the units used to report window memory, see the description of the “Adapter” field in the long listing.
  - available adapter window memory**  
For High Performance Switch adapters, it is the number of rCxt blocks used.  
  
For information on the units used to report window memory, see the description of the “Adapter” field in the long listing.
- Total Tasks**  
Is the total number of tasks that are running using CPUs of this MCM.

## llstatus

Note that the < > notation will be used to list individual CPU IDs instead of the CPU count ( ) notation when the **RSET\_SUPPORT** configuration file keyword is set to **RSET\_CONSUMABLE\_CPUS** or **RSET\_MCM\_AFFINITY**.

- l Specifies that a long listing be generated for each machine for which status is requested. If -l is *not* specified, the standard list is generated.
- a Displays information for each virtual adapter followed by information for each physical adapter it manages.
- C Displays cluster stanza information defined in the administration file. Only fields that contain data are displayed. If -C is specified without the -X flag, cluster stanza information will be reported from one outbound local schedd. If the -X and -C flags are specified, cluster stanza information will be reported from an inbound schedd in each available remote cluster specified with the -X flag. If the -h flag is specified, cluster stanza information will only be reported from the specified hosts.
- b Displays Blue Gene system information. It is valid only when specified as a single option or in combination with the -l flag. When used as single option, **llstatus** displays a short listing of information on the Blue Gene system. When used the -l flag, **llstatus** displays a detailed listing of the components of the Blue Gene system.
- P {*partition\_list* | **all**}  
Displays Blue Gene partition information. It is valid only when specified as a single option. When this flag is specified, **llstatus** displays information on all Blue Gene partitions in the *partition\_list*.  
  
*partition\_list*      Is a blank-delimited list of Blue Gene partitions.  
**all**                      Is the reserved word indicating that the command is to return information for all partitions.
- B {*base\_partition\_list* | **all**}  
Displays Blue Gene base partition information. It is valid only when specified as a single option. When this flag is specified, **llstatus** displays information on all Blue Gene base partitions in the *base\_partition\_list*.  
  
*base\_partition\_list*  
                            Is a blank-delimited list of Blue Gene base partitions.  
**all**                      Is the reserved word indicating that the command is to return information for all base partitions.
- X {*cluster\_list* | **all**}  
Indicates that you can specify the -X flag with either:  
  
*cluster\_list*            Specifies a blank-delimited list of clusters for which status is requested.  
**all**                      Is a reserved word which specifies that status is requested for all accessible clusters.
- f *category\_list*  
Is a blank-delimited list of categories you want to query. Each category you specify must be preceded by a percent sign. The *category\_list* cannot contain duplicate entries. This flag allows you to create a customized version of the standard **llstatus** listing. The output fields produced by this flag all have a fixed length. The output is displayed in the order in which you specify the categories. *category\_list* can be one or more of the following:  
  
%a      Hardware architecture

|             |                                                                              |
|-------------|------------------------------------------------------------------------------|
| <b>%act</b> | Number of job steps dispatched by the schedd daemon on this machine          |
| <b>%cm</b>  | Custom Metric value                                                          |
| <b>%cpu</b> | Number of CPUs on this machine                                               |
| <b>%d</b>   | Available disk space in the LoadLeveler execute directory                    |
| <b>%i</b>   | Number of seconds since last keyboard or mouse activity                      |
| <b>%inq</b> | Number of job steps in the job queue of this schedd machine                  |
| <b>%l</b>   | Berkeley one-minute load average                                             |
| <b>%m</b>   | Physical memory on this machine                                              |
| <b>%mt</b>  | Maximum number of initiators that can be used simultaneously on this machine |
| <b>%n</b>   | Machine name                                                                 |
| <b>%o</b>   | Operating system on this machine                                             |
| <b>%r</b>   | Number of initiators used by the startd daemon on this machine               |
| <b>%sca</b> | Availability of the schedd daemon                                            |
| <b>%scs</b> | State of the schedd daemon                                                   |
| <b>%sta</b> | Availability of the startd daemon                                            |
| <b>%sts</b> | State of the startd daemon                                                   |
| <b>%v</b>   | Available swap space (free paging space) of this machine                     |
| <b>%X</b>   | Local cluster name                                                           |

#### **-r** *category\_list*

Is a blank-delimited list of categories you want to query. Each category you specify must be preceded by a percent sign. The *category\_list* cannot contain duplicate entries. This flag allows you to create a customized version of the standard **llstatus** listing. The output produced by this flag is considered raw, in that the fields can be variable in length. The output is displayed in the order in which you specify the formats. Output fields are separated by an exclamation point (!). *category\_list* can be one or more of the categories listed under the **-f** flag.

#### **-h** *hostlist*

Is a blank-delimited list of machines for which status is requested.

If the **-X** flag is specified in combination with a *hostlist*, the **-h** flag must be specified. For example:

```
llstatus -X my_cluster1 my_cluster2 -h c94n13 c94n14
```

## Description

If you have more than a few machines configured for LoadLeveler, consider redirecting the output to a file when using the **-l** flag.

Each machine periodically updates the central manager with a snapshot of its situation. Since the information returned by using **llstatus** is a collection of such snapshots, all taken at varying times, the total picture may not be completely consistent.

## llstatus

| In most cases, if a *hostlist* is not specified, all machines are queried. However, if the  
| -X and -C flags are specified without a *hostlist*, the command will run on one  
| inbound schedd in the remote cluster.

Certain resources such as remote direct-memory access (RDMA) have their available value always calculated by **startd**. Available ConsumableCpus resources are calculated by **startd** if the value is specified as **all** in the administration file. When the value of a resource is calculated by **startd**, the **llstatus** command appends a plus (+) sign to the resource name in the output reports. Resources that are automatically created, such as RDMA, have a less than (<) sign appended to them.

## Examples

1. This example generates the standard listing where there are two nodes in the cluster. The standard listing is generated when you do *not* specify the **-l** option with the **llstatus** command.

```
llstatus
```

You should receive output similar to the following:

| Name                   | Schedd | InQ        | Act    | Startd    | Run | LdAvg | Idle | Arch  | OpSys |
|------------------------|--------|------------|--------|-----------|-----|-------|------|-------|-------|
| k10n09.ppd.pok.ibm.com | Avail  | 3          | 1      | Run       | 1   | 2.72  | 0    | R6000 | AIX53 |
| k10n12.ppd.pok.ibm.com | Avail  | 0          | 0      | Idle      | 0   | 0.00  | 365  | R6000 | AIX53 |
| R6000/AIX53            |        | 2 machines | 3 jobs | 1 running |     |       |      |       |       |
| Total Machines         |        | 2 machines | 3 jobs | 1 running |     |       |      |       |       |

The Central Manager is defined on k10n09.ppd.pok.ibm.com

The BACKFILL scheduler is in use

Cluster name is cluster2

All machines on the machine\_list are present.

The **standard listing** includes the following fields:

**Act** Number of job steps dispatched by the schedd daemon on this machine.

**Arch** The hardware architecture of the machine as listed in the configuration file.

**Idle** The number of seconds since keyboard or mouse activity in a login session was detected. Highest number displayed is 9999.

**InQ** Number of job steps in the job queue of this schedd machine.

**LdAvg** Berkeley one-minute load average on this machine.

**Name** Hostname of the machine.

**OpSys** The operating system on this machine.

**Run** The number of initiators used by the startd daemon to run LoadLeveler jobs on this machine. One initiator is used for each serial job step and one initiator is used for each task of a parallel job step.

**Schedd** State of the schedd daemon, which can be one of the following:

- Down
- Drned (Drained)
- Drning (Draining)
- Avail (Available)

For more information, see “The schedd daemon” on page 9.

**Startd** State of the startd daemon, which can be:

- Busy
- Down
- Drned (Drained)
- Drning (Draining)
- Flush
- Idle
- None
- Run (Running)
- Suspnd (Suspend)

For more information, see “The startd daemon” on page 10.

### Total Machines

The standard listing includes the following summary fields:

**jobs** The number of job steps in LoadLeveler job queues.

#### **machines**

The number of machines in the cluster that have made a status report to the Central Manager.

#### **running**

The number of initiators used by all the startd daemons in the LoadLeveler cluster. One initiator is used for each serial job step. One initiator is used for each task of a parallel job step.

The standard listing also contains summary information for the cluster such as the type of scheduler and the cluster name.

2. This example generates the long listing. The long listing is generated when you specify the **-l** flag with the **llstatus** command. See Appendix B, “Sample command output,” on page 603 for sample output of long listings.

```
llstatus -l c271f2rp02
```

The **long listing** includes the following fields:

### **Adapter**

Network adapter information associated with this machine.

- For a switch adapter, the information format is:

```
adapter_name(network_type, interface_name,
interface_address, multilink_address, switch_node_number or
adapter_logical_id,
available_adapter_windows/total_adapter_windows,
available_device_memory/total_device_memory,
adapter_fabric_connectivity, adapter_state)
```

For example:

```
Adapter = networks(striped,c60f1rp01m10.ppd.pok.ibm.com, \
10.10.10.1,-1,32/32,1596/1596 rCxt Blks,1,READY) \
en0(ethernet,c60f1rp01.ppd.pok.ibm.com,9.114.88.65,) \
network1(aggregate,,10.10.10.1,-1,32/32,1596/1596 rCxt Blks,1, \
READY)m10(multilink,c60f1rp01m10.ppd.pok.ibm.com,10.10.10.1,)
```

**Note:** The `available_device_memory` and `total_device_memory` fields (also referred to as available window memory and total window memory) may be reported in megabytes (as indicated by M in the previous example) or rCxt blocks, depending on the type of switch adapter that is present.

The following adapters report adapter window memory in MBs:

- SP Switch2 Adapter
- SP Switch2 PCI Attachment Adapter
- SP Switch2 MX2 Adapter
- SP Switch2 PCI-X Attachment Adapter

The following adapter reports adapter window memory in rCxt Blocks:

- Switch Network Interface for the High Performance Switch

Possible values for `adapter_state` are:

### **READY**

The adapter can be used for communication.

### **NOT\_READY**

The adapter is not ready to be used for communication.

**-1** The state of the adapter cannot be determined because the machine that it is on cannot be contacted.

- For non-switch adapters, the format is:  
`adapter_name(network_type, interface_name, interface_address, multilink_address)`

**Arch** Hardware architecture of this machine.

### **AvailableClasses**

List of available classes and the associated number of available initiators on this machine.

### **Completed**

The number of job steps in this state on this schedd machine.

### **Config Time Stamp**

Date and time of last configuration or reconfiguration.

### **ConfiguredClasses**

List of configured classes and the associated number of configured initiators on this machine.

### **ConsumableResources**

List of consumable resources associated with this machine. Each element of this list has the format: `resource_name(available, total)`.

**Note:** The individual CPU ID `< >` notation will be used to list individual CPU IDs instead of the CPU count `( )` notation for machines where the **RSET\_SUPPORT** configuration file keyword is set to **RSET\_MCM\_AFFINITY** or **RSET\_CONSUMABLE\_CPUS**. The CPU count `( )` notation will be used when the **RSET\_SUPPORT** configuration file keyword is set to **RSET\_USER\_DEFINED** or **RSET\_NONE**, or if this keyword is not specified in the configuration file.

**CONTINUE**

The expression, defined following C conventions in the configuration file, that evaluates to true or false (T or F). This determines whether suspended jobs are continued on this machine.

**Cpus** Number of CPUs on this machine.

**CustomMetric**

This value can be the number assigned to the CUSTOM\_METRIC keyword or the exit code of the executable associated with the CUSTOM\_METRIC\_COMMAND keyword or the default value of 1.

**Disk** Available space, in kilobytes (less 512KB) in LoadLeveler's execute directory on this machine.

**DrainedClasses**

List of classes which have been drained. If a job step is in a class named on this list, that job step will not start on this machine.

**DrainingClasses**

List of classes which are currently being drained on this machine. If a job step is in a class named on this list, that job step will not start on this machine.

**Entered Current State**

Date and time when machine state was set.

**FabricConnectivity**

Represents the current state of connectivity between the machine and the switch through the switch adapters. The format of the field is: network\_id: connectivity, network\_id: connectivity... where connectivity is either 1 or 0. A value of 1 indicates an active connection from the machine to a given network\_id through one of the switch adapters.

If a machine does not have switch adapters, the **FabricConnectivity** field has no meaning and should be ignored by the user.

**Feature**

Set of all features on this machine.

**FreeLargePageMemory**

Free Large Page memory.

In LoadLeveler for Linux, the **FreeLargePageMemory** field has no meaning and should be ignored by the user.

**FreeRealMemory**

Free real memory, in megabytes, on this machine. This value should track closely with the "fre" value of the **vmstat** command and the "free" value of the **svmon -G** command whose units are 4KB blocks.

**Held** The number of job steps in this state on this schedd machine.

**Idle** The number of job steps in this state on this schedd machine.

**Keyboard Idle**

Number of seconds since last keyboard or mouse activity.

**KILL** The expression, defined following C conventions in the configuration file, that evaluates to true or false (T or F). This determines whether jobs running on this machine should be sent the SIGKILL signal.

**LargePageMemory**

Configured Large Page physical memory.

In LoadLeveler for Linux, the **LargePageMemory** field has no meaning and should be ignored by the user.

**LargePageSize**

The size of a Large Page memory block.

In LoadLeveler for Linux, the **LargePageSize** field has no meaning and should be ignored by the user.

**LoadAvg**

Berkely one-minute load average on machine.

**Machine**

Fully qualified name of the machine.

**Machine Mode**

The type of job this machine can run. This can be: **batch**, **interactive**, or **general**.

**MACHPRIO**

Actual expression that determines machine priority, defined in the configuration file.

**MasterMachPriority**

The machine priority for the parallel master node.

**Max\_Starters**

Maximum number of initiators that can be used simultaneously on this machine.

**Mcms** The MCMs information associated with this machine has the format:

*mcm\_info ... mcm\_info*

The format of *mcm\_info* is:

MCMnumber Available Cpus: < cpulist > (Total Cpus)

Used Cpus: < cpulist > (Total Cpus)

Adapters: adapter\_info .... adapter\_info

Total Tasks: (Tasks)

where:

**Available Cpus**

Are the CPUs available for LoadLeveler on this MCM.

**Used Cpus**

Are the CPUs used by LoadLeveler jobs from this MCM.

**Adapters**

Are the switch adapters connected to this MCM.

**Total tasks**

Is the total number of tasks that are running using CPUs of this MCM.

where *number* is the MCM sequence number:

*cpulist* Is a blank-delimited list of individual CPU IDs or CPU ranges, or a combination of both CPU IDs and CPU ranges associated with the MCM.

*adapter\_info*

Has the format:

[used windows/available windows, used memory/available memory]

where:

**used windows**

Is the total number of windows used.

**available windows**

Is the total number of available windows.

**used memory**

Is the total memory used. It is the number of rCxt blocks for the High Performance Switch adapter.

**available memory**

Is the total available memory. It is the number of rCxt blocks for the High Performance Switch adapter.

**Tasks** Is the total number of tasks that are running using the CPUs of this MCM.

**Memory**

Regular physical memory, in megabytes, on this machine.

**Name** Hostname of the machine.

**OpSys**

Operating system on this machine.

**PagesFreed**

Pages freed per second. This value corresponds to the "fr" value of the **vmstat** command output.

In LoadLeveler for Linux, the **PagesFreed** field has no meaning and should be ignored by the user.

**PagesPaged In**

Pages paged in from paging space per second. This value corresponds to the "pi" value of the **vmstat** command output.

In LoadLeveler for Linux, the **PagesPagedIn** field has no meaning and should be ignored by the user.

**PagesPagedOut**

Pages paged out to paging space per second. This value corresponds to the "po" value of the **vmstat** command output.

In LoadLeveler for Linux, the **PagesPagedOut** field has no meaning and should be ignored by the user.

**PagesScanned**

Pages scanned by the page-replacement algorithm per second. This value corresponds to the "sr" value of the **vmstat** command output.

In LoadLeveler for Linux, the **PagesScanned** field has no meaning and should be ignored by the user.

**Pending**

The number of job steps in this state on this schedd machine.

**Pool** The identifier of the pool where this startd machine is located.

## Prestarted\_Starters

The maximum number of Prestarted Starters that can be started on this machine at any time.

## Remove Pending

The number of job steps in this state on this schedd machine.

## ReservationPermitted

Indicates whether or not the node can be reserved. It is displayed as T or F (true or false).

## Reservations

The IDs of reservations that will use the node now or in the future.

## RSetSupportType

Indicates the type of RSet support set up on a machine. Possible values are:

### RSET\_CONSUMABLE\_CPUS

Creates and attaches RSets for tasks with the number of CPUs derived from **ConsumableCPUs**.

### RSET\_MCM\_AFFINITY

Creates and attaches RSets for tasks to satisfy memory and affinity requests.

### RSET\_NONE

Indicates that LoadLeveler RSet support is not available.

### RSET\_USER\_DEFINED

Attaches user-created RSets to Tasks.

## Running

The number of initiators used by the startd daemon to run LoadLeveler jobs. One initiator is used for each serial job step. One initiator is used for each task of a parallel job step.

## Running steps

The list of job steps currently running on this machine.

## ScheddAvail

Flag indicating if machine is running a schedd daemon (0=no, 1=yes).

## ScheddRunning

The number of job steps submitted to this machine that are running somewhere in the LoadLeveler cluster.

## ScheddState

The state of the schedd daemon on this machine, which can be one of the following:

- Down
- Drned (Drained)
- Drning (Draining)
- Avail (Available)

## Speed

Speed associated with the machine.

## START

The expression, defined following C conventions in the configuration file, that evaluates to true or false (T or F). This determines whether jobs can be started on this machine.

## StartdAvail

Flag indicating if machine is running a startd daemon (0=no, 1=yes).

**Starting**

The number of job steps in this state on this schedd machine.

**State** State of the startd daemon, which can be:

- Busy
- Down
- Drained
- Draining
- Flush
- Idle
- None
- Running
- Suspend

For more information, see “The startd daemon” on page 10.

**Subnet**

The TCP/IP subnet that this machine resides on.

**SUSPEND**

The expression, defined following C conventions in the configuration file, that evaluates to true or false (T or F). This determines whether running jobs should be suspended on this machine.

**SYSPRIO**

Actual expression that determines overall system priority of a job step. Defined in the configuration file.

**TimeStamp**

The date and time the central manager last received a status update from this schedd machine.

**Tmp** Available space, in kilobytes (less than 512 KB) in the /tmp directory on this machine.

**Total Jobs**

The number of total job steps submitted to this schedd machine.

**TotalMemory**

The sum of configured regular and Large Page memory.

**Unexpanded**

The number of job steps in this state on this schedd machine.

**VACATE**

The expression, defined following C conventions in the configuration file, that evaluates to true or false (T or F). This determines whether suspended jobs are vacated on this machine.

**Virtual Memory**

Available swap space (free paging space) in kilobytes, on this machine.

3. This example generates a listing of cluster information defined in the administration file for **cluster2**. Only fields with data are displayed.

```
llstatus -X cluster2 -C
```

The output representing a cluster is delineated with a cluster header similar to the following:

```
===== Cluster cluster2 =====
```

```
llstatus: Sending request to Schedd "c188f2n08.ppd.pok.ibm.com" in
```

```

cluster "cluster2"

cluster2: type = cluster
 Local = True
 inbound_schedd_port = 9605
 secure_schedd_port = 9607
 multicluster_security = NOT_SET
 ssl_cipher_list = ALL:eNULL:!aNULL
 inbound_hosts = c188f2n08.ppd.pok.ibm.com
 outbound_hosts = c188f2n08.ppd.pok.ibm.com
 exclude_classes = badtesters(cluster3) OKtesters(cluster1)

cluster1: type = cluster
 Local = False
 inbound_schedd_port = 9605
 secure_schedd_port = 9607
 multicluster_security = NOT_SET
 ssl_cipher_list = ALL:eNULL:!aNULL
 inbound_hosts = c188f2n02.ppd.pok.ibm.com
 outbound_hosts = c188f2n02.ppd.pok.ibm.com
 exclude_users = load1(cluster2)
 exclude_groups = april(cluster3)
 include_classes = No_Class

cluster3: type = cluster
 Local = False
 inbound_schedd_port = 1966
 secure_schedd_port = 9607
 multicluster_security = NOT_SET
 ssl_cipher_list = ALL:eNULL:!aNULL
 inbound_hosts = c94n02.ppd.pok.ibm.com
 outbound_hosts = c94n02.ppd.pok.ibm.com(cluster1)
 c94n06.ppd.pok.ibm.com(cluster2)

```

4. This example generates a listing of all of the consumable resources associated with all of the machines in the LoadLeveler cluster.

llstatus -R

You should receive output similar to the following:

| Machine                   | Consumable Resource(Available, Total)     |
|---------------------------|-------------------------------------------|
| c209f1n01.ppd.pok.ibm.com | ConsumableCpus(4,4)+ ConsumableMemory \   |
|                           | (1.000 gb,1.000 gb) n01_res(123,500)      |
| c209f1n02.ppd.pok.ibm.com | ConsumableCpus< 0 1 2 3 4>< 0 1 2 3 4 > \ |
|                           | n02_res(123,500) Frame5(10,10)            |
| c209f1n05.ppd.pok.ibm.com | ConsumableCpus(4,4)+ ConsumableMemory \   |
|                           | (1.000 gb,1.000 gb) spice2g6(250,360)     |

Resources with "+" appended to their names have the Total value reported from Startd.

**Note:** The individual CPU ID < > notation will be used to list individual CPU IDs instead of the CPU count ( ) notation for machines where the **RSET\_SUPPORT** configuration file keyword is set to **RSET\_MCM\_AFFINITY** or **RSET\_CONSUMABLE\_CPUS**. The CPU count ( ) notation will be used when the **RSET\_SUPPORT** configuration file keyword is set to **RSET\_USER\_DEFINED** or **RSET\_NONE**, or if this keyword is not specified in the configuration file.

5. This example generates a listing of information related to MCMs of machines in the LoadLeveler cluster.

llstatus -M

You should receive output similar to the following:

```

Machine MCM details

c61f2sq01.ppd.pok.ibm.com
 MCM0
 Available Cpus :< 0-15 >(16)
 Used Cpus :< >(0)
 Adapters :
 Total Tasks : (0)
 MCM1
 Available Cpus :< 16-29 >(14)
 Used Cpus :< 16-27 >(12)
 Adapters :sn1[16/16,798/798 rCxt Blks]
 sn0[12/16,790/798 rCxt Blks]
 Total Tasks : (4)

c61f2sq02.ppd.pok.ibm.com
 MCM0
 Available Cpus :< 0-1 >(2)
 Used Cpus :< >(0)
 Adapters :
 Total Tasks : (0)
 MCM1
 Available Cpus :< 2-3 >(2)
 Used Cpus :< >(0)
 Adapters :
 Total Tasks : (0)

```

**Note:** The **-M** option will list the MCM information only when the **RSET\_SUPPORT** configuration file keyword is set to **RSET\_MCM\_AFFINITY**.

- This example generates a listing of all of the floating consumable resources associated with all of the machines in the LoadLeveler cluster. This option should not be specified with any other option.

```
llstatus -F
```

You should receive output similar to the following:

| Floating Resource | Available | Total |
|-------------------|-----------|-------|
| EDA_licenses      | 20        | 29    |
| Frame5            | 15        | 20    |
| WorkBench6        | 5         | 7     |
| XYZ_software      | 6         | 6     |

- This example generates a customized and formatted standard listing.

```
llstatus -f %n %scs %inq %m %v %sts %l %o
```

You should receive output similar to the following:

| Name            | Schedd | InQ | Memory     | FreeVMemory | Startd | LdAvg   | OpSys |
|-----------------|--------|-----|------------|-------------|--------|---------|-------|
| l15.pok.ibm.com | Avail  | 0   | 128        | 22708       | Run    | 0.23    | AIX53 |
| l16.pok.ibm.com | Avail  | 3   | 224        | 16732       | Run    | 0.51    | AIX53 |
| R6000/AIX53     |        |     | 2 machines | 3 jobs      | 3      | running |       |
| Total Machines  |        |     | 2 machines | 3 jobs      | 3      | running |       |

The Central Manager is defined on ll5.pok.ibm.com

The BACKFILL scheduler is in use

All machines on the machine\_list are present.

- This example generates a customized and unformatted (raw) standard listing.

**Customized, Unformatted Standard Listing:** A customized Output fields are separated by an exclamation point (!).

```
llstatus -r %n %scs %inq %m %v %sts %l %o
```

You should receive output similar to the following:

```
ll5.pok.ibm.com!Avail!0!128!22688!Running!0.14!AIX53
ll6.pok.ibm.com!Avail!3!224!16668!Running!0.37!AIX53
```

- This example generates a listing containing information about the status of adapters associated with all of the machines in the LoadLeveler cluster:

```
llstatus -a
```

You should receive output similar to the following:

```
c271f2rp02.ppd.pok.ibm.com
ml0(multilink,c271f2san02.ppd.pok.ibm.com,10.10.10.6,)
networks(striped,c271f2san02.ppd.pok.ibm.com,10.10.10.6,,-1,500/512, \
500M/512M,1,READY)
network1(aggregate,,,10.10.10.6,-1,500/512,500M/512M,1,READY)
sn0(switch,c271f2s0n02.ppd.pok.ibm.com,192.168.0.6,10.10.10.6,2,250 \
/256,250M/256M,1,READY,MCM0)
sn1(switch,c271f2s1n02.ppd.pok.ibm.com,192.168.1.6,10.10.10.6,0,250 \
/256,250M/256M,1,READY,MCM0)
en0(ethernet,c271f2rp02.ppd.pok.ibm.com,9.114.175.82,)
```

- For a switch adapter, the information format is:

```
adapter_name(network_type, interface_name, interface_address,
multilink_address, switch_node_number or adapter_logical_id,
available_adapter_windows/total_adapter_windows,
available_device_memory/total_device_memory,
adapter_fabric_connectivity, adapter_state[,adapter mcm id])
```

- For non-switch adapters, the format is:

```
adapter_name(network_type, interface_name, interface_address,
multilink_address)
```

**Note:** The adapter MCM ID will be printed only for High Performance Switch adapters and only when the **RSET\_SUPPORT** configuration file keyword is set to **RSET\_MCM\_AFFINITY**. A value of MCM-1 for this field means that none of the CPUs from the physical MCM, where that adapter is connected to, is part of the machine's partition.

- This example generates a listing containing information about the status of the Blue Gene system in the LoadLeveler cluster.

```
llstatus -b
```

You should receive output similar to the following:

| Name | Base Partitions | c-nodes | InQ | Run |
|------|-----------------|---------|-----|-----|
| BGL  | 1x2x4           | 8x16x32 | 4   | 1   |

- This example generates information for base partitions R000 and R020:

```
llstatus -B R000 R020
```

You should receive output similar to the following:

```

Base Partition Id: R000
 Base Partition State: UP
 Location: (0,0,0)
 Sub Divided Busy: False
 PartitionState=READY Partition=DD1_R000

Base Partition Id: R020
 Base Partition State: UP
 Location: (0,1,0)
 Sub Divided Busy: True
 Node Card List:
 NodeCardId=J102 NodeCardState=UP Quarter=Q1 PartitionSate=NONE \
 Partition=R020_J102_128
 NodeCardId=J104 NodeCardState=UP Quarter=Q1 PartitionSate=NONE \
 Partition=R020_J102_128
 NodeCardId=J106 NodeCardState=UP Quarter=Q1 PartitionSate=NONE \
 Partition=R020_J102_128
 NodeCardId=J108 NodeCardState=UP Quarter=Q1 PartitionSate=NONE \
 Partition=R020_J102_128
 NodeCardId=J111 NodeCardState=UP Quarter=Q2 PartitionSate=NONE \
 Partition=R020_J111_128
 NodeCardId=J113 NodeCardState=UP Quarter=Q2 PartitionSate=NONE \
 Partition=R020_J111_128
 NodeCardId=J115 NodeCardState=UP Quarter=Q2 PartitionSate=NONE \
 Partition=R020_J111_128
 NodeCardId=J117 NodeCardState=UP Quarter=Q2 PartitionSate=NONE \
 Partition=R020_J111_128
 NodeCardId=J203 NodeCardState=UP Quarter=Q3 PartitionSate=NONE \
 Partition=R020_J203_128
 NodeCardId=J205 NodeCardState=UP Quarter=Q3 PartitionSate=NONE \
 Partition=R020_J203_128
 NodeCardId=J207 NodeCardState=UP Quarter=Q3 PartitionSate=NONE \
 Partition=R020_J203_128
 NodeCardId=J209 NodeCardState=UP Quarter=Q3 PartitionSate=NONE \
 Partition=R020_J203_128
 NodeCardId=J210 NodeCardState=UP Quarter=Q4 PartitionSate=NONE \
 Partition=R020_J210_128
 NodeCardId=J212 NodeCardState=UP Quarter=Q4 PartitionSate=NONE \
 Partition=R020_J210_128
 NodeCardId=J214 NodeCardState=UP Quarter=Q4 PartitionSate=NONE \
 Partition=R020_J210_128
 NodeCardId=J216 NodeCardState=UP Quarter=Q4 PartitionSate=NONE \
 Partition=R020_J210_128

```

12. This example generates information for partitions DD1\_R000 and R020\_J214\_32:

```
llstatus -P DD1_R000 R020_J214_32
```

You should receive output similar to the following:

```

Partition Id: DD1_R000
 Partition State: READY
 Description: Generated via genBlock
 Owner: archerc
 Connection: TORUS
 Mode: COPROCESSOR
 MloaderImage: /bgl/BlueLight/ddldriver/bglsys/bin/mmcs-mloader.rts
 BlrtsImage: /bgl/BlueLight/ddldriver/bglsys/bin/rts_hw.rts
 LinuxImage: /bgl/BlueLight/ddldriver/bglsys/bin/zImage.elf
 RamDiskImage: /bgl/BlueLight/ddldriver/bglsys/bin/ramdisk.elf
 Small Partitions: False
 Base Partition List: R000
 Switch ID: X_R000
 Switch State: UP
 Base Partition: R000

```

## llstatus

```
| Switch Dimension: X
| Switch Connections:
| FromPort=PORT_S0 ToPort=PORT_S1 PartionState=READY \
| Partition=DD1_R000
| Switch ID: Y_R000
| Switch State: UP
| Base Partition: R000
| Switch Dimension: Y
| Switch Connections:
| FromPort=PORT_S0 ToPort=PORT_S1 PartionState=READY \
| Partition=DD1_R000
| Switch ID: Z_R000
| Switch State: UP
| Base Partition: R000
| Switch Dimension: Z
| Switch Connections:
| FromPort=PORT_S0 ToPort=PORT_S1 PartionState=READY \
| Partition=DD1_R000
|
| Partition Id: R020_J214_32
| Partition State: READY
| Description: Generated via genSmallBlock
| Owner: liuycdl
| Connection: MESH
| Mode: COPROCESSOR
| MloaderImage: /bgl/BlueLight/ddldriver/bglsys/bin/mmcs-mloader.rts
| BlrtsImage: /bgl/BlueLight/ddldriver/bglsys/bin/rts_hw.rts
| LinuxImage: /bgl/BlueLight/ddldriver/bglsys/bin/zImage.elf
| RamDiskImage: /bgl/BlueLight/ddldriver/bglsys/bin/ramdisk.elf
| Small Partitions: True
| Base Partition List: R020
| Node Card List: J214
```

## Security

LoadLeveler administrators and users can issue this command.

## lsubmit - Submit a job

### Purpose

Submits a job to LoadLeveler to be dispatched based upon job requirements in the job command file.

You can submit both LoadLeveler jobs and NQS jobs. To submit NQS jobs, the job command file must contain the shell script to be submitted to the NQS node.

### Syntax

```
lsubmit [-H] [-?] [-v] [-q] [-X {cluster_list | any}] [cmdfile | -]
```

### Flags

- ? Provides a short usage message.
- H Provides extended help information.
- v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.
- q Specifies quiet mode: print no messages other than error messages.

-X {*cluster\_list* | **any**}

Is a blank-delimited list of cluster names or the reserved word **any** where:

- A single cluster name indicates that the job is to be submitted to that cluster.
- A list of multiple cluster names indicates that the job is to be submitted to one of the clusters as determined by the installation exit **CLUSTER\_METRIC**.
- The reserved word **any** indicates the job is to be submitted to any cluster defined by the installation exit **CLUSTER\_METRIC**.

If a *cluster\_list* is specified with the -X option on the **lsubmit** command, the specified *cluster\_list* takes precedence over any *cluster\_list* statements already specified in the job command file.

*cmdfile*

Is the name of the job command file containing LoadLeveler commands.

- Specifies that LoadLeveler commands that would normally be in the job command file are read from stdin. When entry is complete, press Ctrl-D to end the input.

### Description

- Users with **uid** or **gid** equal to 0 are not allowed to issue the **lsubmit** command.
- When a LoadLeveler job ends, you may receive UNIX mail notification indicating the job exit status. For example, you could get the following mail message:  

```
Your LoadLeveler job
myjob1
exited with status 139.
```

The return code 139 is from the user's job, and is not a LoadLeveler return code.
- For more information on writing a program to filter job scripts, see "Filtering a job script" on page 70.
- The **lsubmit** command will display an error and fail to submit the job if the **resources** keyword in the job command file does not match the resources to be

enforced and LoadLeveler is set to check for the **resources** specification. For more information, see “Defining usage policies for consumable resources” on page 56.

- If the LL\_RES\_ID environment variable is set, the **llsubmit** command will set the requested reservation ID of the submitted job steps using the value of the LL\_RES\_ID environment variable. When the central manager receives the job steps from the schedd, it will bind the job steps to a reservation, if specified. If the job steps cannot be bound to the reservation, they will be placed in the **NotQueued** state and the requested reservation ID will keep the same value. If the value of LL\_RES\_ID is set to blank, it will be treated as if it were unset.
- If unspecified, default requirements are added to jobs requiring that the architecture and operating systems of machines selected to run the job be the same as those on the submitting machine. If you want to submit a job from one type of machine (for example, one with **Arch = R6000** and **OpSys = AIX52**) to run on another type of machine (for example, one with **Arch = i386** and **OpSys = Linux2**), you must specify a requirements statement that includes the **Arch** and **OpSys** requirements. The explicitly coded **Arch** and **OpSys** requirements override the default values.
- In a multicluster environment, job identifiers are assigned by the local cluster and are retained by the job regardless of what cluster the job runs in.  
  
If the job was submitted as a remote job in a multicluster environment, the host represented in *host.jobid.stepid*, is the name of the local schedd machine that assigned the *jobid*. To determine the managing schedd machine, issue the **llq -l** command to obtain the Schedd Host field.  
  
If the administrator has not defined a **CLUSTER\_METRIC** for the local cluster, the **llsubmit** command will display an error and fail to submit the job if the user specifies the **-X** flag with a *cluster\_list* or the reserved word **any**. The **llsubmit** command will also display an error and fail to submit the job if the user specifies the **-X cluster\_name** in the following instances:
  - The local cluster is not in the multicluster environment
  - The specified cluster name is not configured
  - The specified cluster name does not have *inbound\_hosts* specified

For LoadLeveler for Linux, the **llsubmit** command will display an error and fail to submit the job if it is an NQS job.

## Examples

1. This example shows a job command file named **qtrlyrun.cmd** is submitted:  
`llsubmit qtrlyrun.cmd`
2. This example shows a job being submitted to a remote cluster:  
`llsubmit -X cluster1 jcf.cmd`

## Results

1. The following shows the results of the **llsubmit qtrlyrun.cmd** command issued from the machine **earth**:  
`llsubmit: The job "earth.505" has been submitted.`  
Note that 505 is the job ID generated by LoadLeveler.
2. The following shows the results from a remote submit:  
`Job c188f2n08.ppd.pok.ibm.com.21 assigned to local outbound \`  
`Schedd c188f2n08.ppd.pok.ibm.com.`  
`Job c188f2n08.ppd.pok.ibm.com.21 assigned to remote inbound \`

```
| Schedd c188f2n02.ppd.pok.ibm.com.
| Job c188f2n08.ppd.pok.ibm.com.21 has been submitted to cluster "cluster1"
| llsubmit: The job "c188f2n08.ppd.pok.ibm.com.21" has been submitted.
```

## **Related Information**

Subroutines: **llsubmit**

## **Security**

LoadLeveler administrators and users can issue this command.

## llsummary - Return job resource information for accounting

### Purpose

Returns job resource information on completed jobs for accounting purposes.

You must enable the recording of accounting data in order to generate any of the four throughput reports. To do this, specify **ACCT=A\_ON** in your **LoadL\_config** file. For detailed usage of the ACCT keyword, see “Gathering job accounting data” on page 57.

### Syntax

```
llsummary [-?] [-H] [-v] [-x] [-l] [-s MM/DD/YYYY to MM/DD/YYYY]
 [-e MM/DD/YYYY to MM/DD/YYYY] [-g group]
 [-G unixgroup] [-a allocated] [-r report] [-j jobname]
 [-d section] [-c class] [-u user] [filelist]
```

### Flags

- ? Provides a short usage message.
- H Provides extended help information.
- v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.
- x Provides extended information. Using -x can produce a very long report. This option is meaningful only when used with the -l option. You must enable the recording of accounting data in order to collect information with the -x flag. To do this, specify **ACCT=A\_ON A\_DETAIL** in your **LoadL\_config** file.
- l Specifies that the long form of output is displayed.
- s Specifies a range for the start date (queue date) for accounting data to be included in this report. The format for entering the date is either *MM/DD/YYYY* (where *MM* is month, *DD* is day, and *YYYY* is year), *MM/DD/YY* (where *YY* is a two-digit year value), or a string of digits representing the number of seconds since 1970. If a two-digit year value is used, then 69-99 maps to 1969-1999, and 00-68 maps to 2000-2068. The default is to include all the data in the report.
- e Specifies a range for the end date (completion date) for accounting data to be included in this report. The format for entering the date is either *MM/DD/YYYY* (where *MM* is month, *DD* is day, and *YYYY* is year), *MM/DD/YY* (where *YY* is a two-digit year value), or a string of digits representing the number of seconds since 1970. The default is to include all the data in the report.
- u *user*  
Specifies the user ID for whom accounting data is reported.
- c *class*  
Specifies the class for which accounting data is reported. For reports of all formats (short, long and extended), **llsummary** will report information about every job which contains at least one step of the specified class. For the short format, **llsummary** also reports a job count and step count for each class; for these counts, a job's class is determined by the class of its first step.
- g *group*  
Specifies the LoadLeveler group for which accounting data is reported. For

reports of all formats (short, long and extended), **lsummary** reports information about every job which contains at least one step of the specified group. For the short format, **lsummary** also reports a job count and step count for each group; for these counts, a job's group is determined by the group of its first step.

**-G** *unixgroup*

Specifies the UNIX group for which accounting data is reported.

**-a** *allocated*

Specifies the hostname that was allocated to run the job. You can specify the allocated host in short or long form.

**-r** *report*

Specifies the report type. You must enable the recording of accounting data in order to collect information with the **-r** flag. To do this, specify **ACCT=A\_ON A\_DETAIL** in your **LoadL\_config** file. You can choose one or more of the following reports:

**avgthroughput**

Provides average queue time, run time, and CPU time for jobs that ran for at least some period of time.

**maxthroughput**

Provides maximum queue time, run time, and CPU time for jobs that ran for at least some period of time.

**minthroughput**

Provides minimum queue time, run time, and CPU time for jobs that ran for at least some period of time.

**numeric**

Reports CPU times in seconds rather than hours, minutes, and seconds.

**resource**

Provides CPU usage for all submitted jobs, including those that did not run. This is the default.

**throughput**

Selects all throughput reports.

**-d** *section*

Specifies the category (data section) for which you want to generate a report. You can specify one or more of the following: **user**, **group**, **unixgroup**, **class**, **account**, **day**, **week**, **month**, **jobid**, **jobname**, **allocated**.

**-j** *host.jobid*

Specifies the job for which accounting data is reported.

The format of a full LoadLeveler job identifier is *host.jobid*.

where:

- *host* is the name of the machine that assigned the job identifiers.
- *jobid* is the job number assigned to the job when it was submitted.

The entire *host.jobid* string is required.

*filelist*

Is a blank-delimited list of files containing the accounting data. If not specified, the default is the local history file on the machine from which the command was issued. You can use the **llacctmrg** command to combine history files on different **schedd** machines into a single history file.

## Description

In order to create an accounting report with the **llsummary** command, you must have read access to a history file. If a history file name is not specified as an argument, **llsummary** uses the history file in the LoadLeveler spool directory of the local machine as input. By default, the permissions of the spool directory are set by the **llinit** command to 700 at install time. However, these permissions may be changed by a system administrators with root privileges.

The file permissions of the history file created by a LoadL\_schedd daemon are controlled by the **HISTORY\_PERMISSION** configuration keyword. A specification such as **HISTORY\_PERMISSION = rw-rw-r--** will result in permission settings of 664. The default settings are 660.

## Examples

1. The following example requests summary reports (standard listing) of all the jobs submitted on your machine between the days of January 12, 2005 and March 12, 2005:

```
llsummary -s 01/12/2005 to 03/12/2005
```

2. This example generates the standard listing when you do not specify **-l**, **-r**, or **-d** with **llsummary**.

This sample report includes summaries of the following data:

- Number of jobs, Total CPU usage, per user.
- Number of jobs, Total CPU usage, per class.
- Number of jobs, Total CPU usage, per group.
- Number of jobs, Total CPU usage, per account number.

```
llsummary
```

You should receive output similar to the following:

| Name    | Jobs | Steps | Job Cpu    | Starter Cpu | Leverage |
|---------|------|-------|------------|-------------|----------|
| krystal | 15   | 36    | 0+00:09:50 | 0+00:00:10  | 59.0     |
| lixin3  | 18   | 54    | 0+00:08:28 | 0+00:00:16  | 31.8     |
| TOTAL   | 33   | 90    | 0+00:18:18 | 0+00:00:27  | 40.7     |

| Class    | Jobs | Steps | Job Cpu    | Starter Cpu | Leverage |
|----------|------|-------|------------|-------------|----------|
| small    | 9    | 21    | 0+00:01:03 | 0+00:00:06  | 10.5     |
| large    | 12   | 36    | 0+00:13:45 | 0+00:00:11  | 75.0     |
| osl2     | 3    | 9     | 0+00:00:27 | 0+00:00:02  | 13.5     |
| No_Class | 9    | 24    | 0+00:03:01 | 0+00:00:06  | 30.2     |
| TOTAL    | 33   | 90    | 0+00:18:18 | 0+00:00:27  | 40.7     |

| Group       | Jobs | Steps | Job Cpu    | Starter Cpu | Leverage |
|-------------|------|-------|------------|-------------|----------|
| No_Group    | 12   | 30    | 0+00:09:32 | 0+00:00:09  | 63.6     |
| chemistry   | 7    | 18    | 0+00:04:50 | 0+00:00:05  | 58.0     |
| engineering | 14   | 42    | 0+00:03:56 | 0+00:00:12  | 19.7     |
| TOTAL       | 33   | 90    | 0+00:18:18 | 0+00:00:27  | 40.7     |

| Account | Jobs | Steps | Job Cpu    | Starter Cpu | Leverage |
|---------|------|-------|------------|-------------|----------|
| 33333   | 16   | 39    | 0+00:05:54 | 0+00:00:11  | 32.2     |
| 22222   | 15   | 45    | 0+00:12:05 | 0+00:00:13  | 55.8     |
| 99999   | 2    | 6     | 0+00:00:18 | 0+00:00:01  | 18.0     |
| TOTAL   | 33   | 90    | 0+00:18:18 | 0+00:00:27  | 40.7     |

The **standard listing** includes the following fields:

**Account**

Account number specified for the jobs.

**Class** Class specified or defaulted for the jobs.

**Group** User's login group.

**Job CPU**

Total CPU time consumed by user's jobs.

**Jobs** Count of the total number of jobs submitted by this user, class, group, or account.

**Leverage**

Ratio of job CPU to starter CPU.

**Name** User ID submitting jobs.

**Starter CPU**

Total CPU time consumed by LoadLeveler starter processes on behalf of the user jobs.

**Steps** Count of the total number of job steps submitted by this user, class, group, or account.

3. To generate a throughput report, issue:

```
llsummary -r throughput
```

You should receive output similar to the following. Note that only the user output is shown, the class, group, and account lines are not shown.

| Name  | Jobs | Steps | AvgQueueTime | AvgRealTime | AvgCPUTime |
|-------|------|-------|--------------|-------------|------------|
| load1 | 1    | 4     | 0+00:00:03   | 0+00:05:27  | 0+00:05:17 |
| user1 | 2    | 6     | 0+00:03:05   | 0+00:03:45  | 0+00:03:04 |
| ALL   | 3    | 10    | 0+00:01:52   | 0+00:04:26  | 0+00:03:58 |

| Name  | Jobs | Steps | MinQueueTime | MinRealTime | MinCPUTime |
|-------|------|-------|--------------|-------------|------------|
| load1 | 1    | 4     | 0+00:00:01   | 0+00:02:49  | 0+00:02:44 |
| user1 | 2    | 6     | 0+00:02:02   | 0+00:03:43  | 0+00:03:02 |
| ALL   | 3    | 10    | 0+00:00:01   | 0+00:02:49  | 0+00:02:44 |

| Name  | Jobs | Steps | MaxQueueTime | MaxRealTime | MaxCPUTime |
|-------|------|-------|--------------|-------------|------------|
| load1 | 1    | 4     | 0+00:00:06   | 0+00:12:58  | 0+00:12:37 |
| user1 | 2    | 6     | 0+00:06:21   | 0+00:03:48  | 0+00:03:07 |
| ALL   | 3    | 10    | 0+00:06:21   | 0+00:12:58  | 0+00:12:37 |

The **-r** listing includes the following fields:

**AvgCPUTime**

Average amount of accumulated CPU time for jobs associated with this user, class, group, or account.

**AvgQueueTime**

Average amount of time the job spent queued before running for this user, class, group, or account.

**AvgRealTime**

Average amount of accumulated wall clock time for jobs associated with this user, class, group, or account.

**MaxCPUTime**

Time of the job with the greatest amount of CPU time for this user, class, group, or account.

## llsummary

### MaxQueueTime

Time of the job that spent the greatest amount of time in queue before running for this user, class, group, or account.

### MaxRealTime

Time of the job with the greatest amount of wall clock time for this user, class, group, or account.

### MinCPUTime

Time of the job with the least amount of CPU time for this user, class, group, or account.

### MinQueueTime

Time of the job that spent the least amount of time in queue before running for this user, class, group, or account.

### MinRealTime

Time of the job with the least amount of wall clock time for this user, class, group, or account.

The ALL line for the Average listing displays the average time for all users, classes, groups, and accounts. The ALL line for the Minimum listing displays the time of the job with the least amount of time for all users, classes, groups, and accounts. The ALL line for the Maximum listing displays the time of the job with the greatest amount of time for all users, classes, groups, and accounts.

4. The following example generates the long listing that contains Blue Gene-specific information:

```
llsummary -l -j job_name
```

You should receive output similar to the following:

```
.
.
.
 Step Type: bluegene
 Min Processors: 1
 Max Processors: 1
 Size Requested: 2048
 Size Allocated: 2048
 Shape Requested:
 Shape Allocated: 32x8x8
 Wiring Requested: PREFER_TORUS
 Wiring Allocated: TORUS
 Rotate: TRUE
 Partition Requested:
 Partition Allocated: part130
 Error Text:
 Alloc. Host Count: 1
.
.
.
```

5. The following example generates the long listing that contains multicluster-specific information submitted or moved to a remote cluster:

```
llsummary -l
```

You should receive output similar to the following:

```
.
.
.
 Scheduling Cluster: cluster1
 Submitting Cluster: cluster2
```

```

Sending Cluster: cluster2
Submitting User: brownap
Schedd History: c188f2n08.ppd.pok.ibm.com
Outbound Schedds: c188f2n08.ppd.pok.ibm.com
.
.
.
Cluster input file: /u/brownap/copyfile_input, /tmp/copyfile_input1
Cluster input file: /u/brownap/copyfile_input, /tmp/copyfile_input2
Cluster input file: /u/brownap/copyfile_input, /tmp/copyfile_input3
Cluster output file: /tmp/copyfile_output, /u/brownap/copyfile_output
.
.
.

```

For an explanation of the fields in the long listing, see “llq - Query job status” on page 431. See Appendix B, “Sample command output,” on page 603 for sample output of long listings.

## Security

LoadLeveler administrators and users can issue this command.



---

## Chapter 16. Application programming interfaces (APIs)

LoadLeveler provides several application programming interfaces (APIs). These APIs allow application programs written by customers to interact with the LoadLeveler environment using specific data and functions that are a part of LoadLeveler. These interfaces can be subroutines within a library or installation exits.

The header file **llapi.h** defines all of the API data structures and subroutines. This file is located in the **include** subdirectory of the LoadLeveler release directory. You must include this file when you call any API subroutine.

The library **libllapi.a** (AIX) or **libllapi.so** (Linux) is a shared library containing all of the LoadLeveler API subroutines. This library is located in the **lib** subdirectory of the LoadLeveler release directory.

**Attention:** These APIs are not *thread safe*; they should not be linked to by a threaded application.

Table 51 lists all of the LoadLeveler APIs, along with the intended users and supported operating systems for each, and a reference to the full descriptions of each interface.

*Table 51. LoadLeveler API summary*

| Task / API category             | Interface name                            | Intended users                                                                                | Supported operating systems |
|---------------------------------|-------------------------------------------|-----------------------------------------------------------------------------------------------|-----------------------------|
| Generate accounting reports     | <b>llacctval</b> user exit                | Administrators only                                                                           | AIX and Linux               |
| "Accounting API" on page 484    | <b>GetHistory</b> subroutine              | Both administrators and general users                                                         | AIX and Linux               |
| Checkpoint LoadLeveler jobs     | <b>ckpt</b> subroutine                    | Provided for backward compatibility only. Use <b>ll_init_ckpt</b> and <b>ll_ckpt</b> instead. | AIX only                    |
| "Checkpointing API" on page 486 | <b>ll_init_ckpt</b> subroutine            | Both administrators and general users                                                         | AIX only                    |
|                                 | <b>ll_ckpt</b> subroutine                 | Both administrators and general users                                                         | AIX only                    |
|                                 | <b>ll_set_ckpt_callbacks</b> subroutine   | Both administrators and general users                                                         | AIX only                    |
|                                 | <b>ll_unset_ckpt_callbacks</b> subroutine | Both administrators and general users                                                         | AIX only                    |

## Summary of LoadLeveler APIs

Table 51. LoadLeveler API summary (continued)

| Task / API category                                                                            | Interface name                              | Intended users                        | Supported operating systems |
|------------------------------------------------------------------------------------------------|---------------------------------------------|---------------------------------------|-----------------------------|
| Access LoadLeveler objects and retrieve data from objects<br><br>“Data Access API” on page 492 | <b>ll_query</b> subroutine                  | Both administrators and general users | AIX and Linux               |
|                                                                                                | <b>ll_set_request</b> subroutine            | Both administrators and general users | AIX and Linux               |
|                                                                                                | <b>ll_reset_request</b> subroutine          | Both administrators and general users | AIX and Linux               |
|                                                                                                | <b>ll_get_objs</b> subroutine               | Both administrators and general users | AIX and Linux               |
|                                                                                                | <b>ll_get_data</b> subroutine               | Both administrators and general users | AIX and Linux               |
|                                                                                                | <b>ll_next_obj</b> subroutine               | Both administrators and general users | AIX and Linux               |
|                                                                                                | <b>ll_free_objs</b> subroutine              | Both administrators and general users | AIX and Linux               |
|                                                                                                | <b>ll_deallocate</b> subroutine             | Both administrators and general users | AIX and Linux               |
| Convert an error object into an error message<br><br>“Error Handling API” on page 538          | <b>ll_error</b> subroutine                  | Both administrators and general users | AIX and Linux               |
| Submit parallel jobs<br><br>“Parallel Job API” on page 539                                     | <b>ll_get_hostlist</b> subroutine           | Both administrators and general users | AIX only                    |
|                                                                                                | <b>ll_start_host</b> subroutine             | Both administrators and general users | AIX only                    |
| Query APIs<br><br>“Query API” on page 544                                                      | <b>ll_get_jobs</b> subroutine               | Both administrators and general users | AIX only                    |
|                                                                                                | <b>ll_free_jobs</b> subroutine              | Both administrators and general users | AIX only                    |
|                                                                                                | <b>ll_get_nodes</b> subroutine              | Both administrators and general users | AIX only                    |
|                                                                                                | <b>ll_free_nodes</b> subroutine             | Both administrators and general users | AIX only                    |
| Reservation APIs<br><br>“Reservation API” on page 547                                          | <b>ll_make_reservation</b> subroutine       | Both administrators and general users | AIX and Linux               |
|                                                                                                | <b>ll_init_reservation_param</b> subroutine | Both administrators and general users | AIX and Linux               |
|                                                                                                | <b>ll_change_reservation</b> subroutine     | Both administrators and general users | AIX and Linux               |
|                                                                                                | <b>ll_bind</b> subroutine                   | Both administrators and general users | AIX and Linux               |
|                                                                                                | <b>ll_remove_reservation</b> subroutine     | Both administrators and general users | AIX and Linux               |
| Submit jobs to LoadLeveler<br><br>“Submit API” on page 558                                     | <b>llsubmit</b> subroutine                  | Both administrators and general users | AIX and Linux               |
|                                                                                                | <b>llfree_job_info</b> subroutine           | Both administrators and general users | AIX and Linux               |
|                                                                                                | <b>monitor_program</b> user exit            | Both administrators and general users | AIX and Linux               |

Table 51. LoadLeveler API summary (continued)

| Task / API category                                                                                                     | Interface name                     | Intended users                                                                                                                                                                                                                                                                                                                                                                                                          | Supported operating systems |
|-------------------------------------------------------------------------------------------------------------------------|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
| Perform LoadLeveler control operations and work with an external scheduler<br><br>“Workload Management API” on page 561 | <b>ll_cluster</b> subroutine       | Both administrators and general users                                                                                                                                                                                                                                                                                                                                                                                   | AIX and Linux               |
|                                                                                                                         | <b>ll_cluster_auth</b> subroutine  | Administrators only                                                                                                                                                                                                                                                                                                                                                                                                     | AIX and Linux               |
|                                                                                                                         | <b>ll_control</b> subroutine       | Both administrators and general users may specify the following control operations:<br><ul style="list-style-type: none"> <li>• LL_CONTROL_HOLD_USER</li> <li>• LL_CONTROL_PRIO_ABS</li> <li>• LL_CONTROL_PRIO_ADJ</li> <li>• LL_CONTROL_START</li> <li>• LL_CONTROL_START_DRAINED</li> </ul> All other control operations defined in the <code>llapi.h</code> header file are intended for use by administrators only. | AIX and Linux               |
|                                                                                                                         | <b>ll_modify</b> subroutine        | Both administrators and general users                                                                                                                                                                                                                                                                                                                                                                                   | AIX and Linux               |
|                                                                                                                         | <b>ll_move_job</b> subroutine      | Administrators only                                                                                                                                                                                                                                                                                                                                                                                                     | AIX and Linux               |
|                                                                                                                         | <b>ll_preempt</b> subroutine       | Administrators only                                                                                                                                                                                                                                                                                                                                                                                                     | AIX only                    |
|                                                                                                                         | <b>ll_preempt_jobs</b> subroutine  | Administrators only                                                                                                                                                                                                                                                                                                                                                                                                     | AIX and Linux               |
|                                                                                                                         | <b>ll_run_scheduler</b> subroutine | Administrators only                                                                                                                                                                                                                                                                                                                                                                                                     | AIX and Linux               |
|                                                                                                                         | <b>ll_start_job</b> subroutine     | Administrators only                                                                                                                                                                                                                                                                                                                                                                                                     | AIX and Linux               |
|                                                                                                                         | <b>ll_start_job_ext</b> subroutine | Administrators only                                                                                                                                                                                                                                                                                                                                                                                                     | AIX and Linux               |
|                                                                                                                         | <b>ll_terminate_job</b> subroutine | Administrators only                                                                                                                                                                                                                                                                                                                                                                                                     | AIX and Linux               |

## 64-bit support for the LoadLeveler APIs

LoadLeveler for AIX APIs support both 32-bit and 64-bit applications. LoadLeveler for Linux APIs support 32-bit applications on 32-bit platforms and 64-bit applications on 64-bit platforms.

### AIX

In LoadLeveler 3.2 or later releases, the LoadLeveler API library (**libllapi.a**) consists of two sets of objects: 32-bit and 64-bit. Both sets of objects and interfaces are provided since the AIX linker cannot create an executable from a mixture of 32-bit and 64-bit objects. They must be all of the same type. Developers attempting to exploit the 64-bit capabilities of the LoadLeveler API library should take into consideration the following issues:

- If DCE is not enabled, all interfaces of the LoadLeveler API library are available in both 32-bit and 64-bit formats. Interfaces with the same names are functionally equivalent.
- If DCE is enabled (`DCE_ENABLEMENT = TRUE` or `SEC_ENABLEMENT=DCE`), only the 32-bit interfaces of the LoadLeveler API library are available. Subroutine calls using the 64-bit interfaces of the **libllapi.a** library that require DCE authentication will fail with appropriate error codes and messages.

### Linux

On Linux, the LoadLeveler 3.3 API library (**libllapi.so**) is a 32-bit library on 32-bit platforms and a 64-bit library on 64-bit platforms. The library **libllapi.so** is a 32-bit library on the following platforms:

- RHEL 3 and RHEL 4 on IBM IA-32 xSeries servers
- SLES 9 on IBM IA-32 xSeries servers

**libllapi.so** is a 64-bit library on the following platforms:

- RHEL 3 and RHEL 4 on IBM @servers with AMD Opteron or Intel EM64T processors
- RHEL 4 on IBM POWER servers
- SLES 9 on IBM @servers with AMD Opteron or Intel EM64T processors
- SLES 9 on IBM POWER servers

---

## Accounting API

The LoadLeveler Accounting API provides a user exit for account validation and a subroutine for extracting accounting data. Job accounting information saved in a history file can also be queried by using the Data Access API.

### Account validation user exit

LoadLeveler provides the **llacctval** executable to perform account validation.

#### Purpose

**llacctval** compares the account number a user specifies in a job command file with the account numbers defined for that user in the LoadLeveler administration file. If the account numbers match, **llacctval** returns a value of zero. Otherwise, it returns a non-zero value.

#### Syntax

```
program user_name user_group user_acct# acct1 acct2 ...
```

#### Parameters

*program*

Is the name of the program that performs the account validation. The default is **llacctval**. The name you specify here must match the value specified on the **ACCT\_VALIDATION** keyword in the configuration file.

*user\_name*

Is the name of the user whose account number you want to validate.

*user\_group*

Is the login group name of the user.

*user\_acct#*

Is the account number specified by the user in the job command file.

*acct1 acct2 ...*

Are the account numbers obtained from the user stanza in the LoadLeveler administration file.

#### Description

**llacctval** is invoked from within the **llsubmit** command. If the return code is non-zero, **llsubmit** does not submit the job.

You can replace **llacctval** with your own accounting user exit (see below).

To enable account validation, you must specify the following keyword in the configuration file:

```
ACCT = A_VALIDATE
```

To use your own accounting exit, specify the following keyword in the configuration file:

```
ACCT_VALIDATION = pathname
```

where *pathname* is the name of your accounting exit.

## Return values

If the validation succeeds, the exit status must be zero. If it does not succeed, the exit status must be a non-zero number.

## Report generation subroutine

LoadLeveler provides the **GetHistory** subroutine to generate accounting reports.

### Purpose

**GetHistory** processes local or global LoadLeveler history files.

### Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

### Syntax

```
#include "llapi.h"
```

```
int GetHistory(char *filename, int (*func) (LL_job *), int version);
```

### Parameters

*filename*

Specifies the name of the history file.

*(\*func) (LL\_job \*)*

Specifies the user-supplied function you want to call to process each history record. The function must return an integer and must accept as input a pointer to the LL\_job structure. The LL\_job structure is defined in the **llapi.h** file.

*version*

Specifies the version of the history record you want to create.

LL\_JOB\_VERSION in the **llapi.h** file creates an LL\_job history record.

### Description

**GetHistory** opens the history file you specify, reads one LL\_job accounting record, and calls a user-supplied routine, passing to the routine the address of an LL\_job structure. **GetHistory** processes all history records one at a time and then closes the file. Any user can call this subroutine.

The user-supplied function must include the following files:

```
#include <sys/resource.h>
#include <sys/types.h>
#include <sys/time.h>
```

The ll\_event\_usage structure is part of the LL\_job structure and contains the following LoadLeveler defined data:

**int** *event*

Specifies the event identifier. This is an integer whose value is one of the following:

- 1 Represents a LoadLeveler-generated event.
- 2 Represents an installation-generated event.

**char** \**name*

Specifies a character string identifying the event. This can be one of the following:

- An installation generated string that uses the command **llctl capture eventname**.
- LoadLeveler-generated strings, which can be the following:
  - started
  - checkpoint
  - vacated
  - completed
  - rejected
  - removed

### Return values

**GetHistory** returns a zero when successful.

### Error values

**GetHistory** returns -1 to indicate that the version is not supported or that an error occurred opening the history file.

### Examples

Makefiles and examples which use this API are located in the **samples/llphist** subdirectory of the release directory. The examples include the executable **llpjob**, which invokes **GetHistory** to print every record in the history file. In order to compile **llpjob**, the sample Makefile must update the **RELEASE\_DIR** field to represent the current LoadLeveler release directory. The syntax for **llpjob** is:

```
llpjob history_file
```

Where *history\_file* is a local or global history file.

---

## Checkpointing API

LoadLeveler for Linux does not support the checkpointing API.

This section describes routines used for checkpointing jobs running under LoadLeveler. For more information, see “Checkpointing jobs” on page 128. For information on checkpointing parallel jobs, see *IBM Parallel Environment for AIX: Operation and Use, Volume 1*.

### ckpt subroutine

#### Purpose

Specify the **ckpt** subroutine in a FORTRAN, C, or C++ program to activate checkpointing from within the application. Whenever this subroutine is invoked, a checkpoint of the program is taken.

**Note:** This API is obsolete and is supported for backward compatibility only. It calls **ll\_init\_ckpt**.

**C++ syntax**

```
extern "C">{void ckpt();}
```

**C syntax**

```
void ckpt();
```

**FORTRAN syntax**

```
call ckpt()
```

**ll\_init\_ckpt****Purpose**

Initiates a checkpoint from within a serial application.

**Library**

LoadLeveler API library **libllapi.a**.

**Syntax**

```
#include "llapi.h"
```

```
int ll_init_ckpt (LL_ckpt_info *ckpt_info);
```

**Parameters**

*ckpt\_info*

A pointer to a LL\_ckpt\_info structure, which has the following fields:

**int** *version*

The version of the API that the program was compiled with (from llapi.h).

**char\*** *step\_id*

NULL, not used.

**enum ckpt\_type** *ckptType*

NULL, not used.

**enum wait\_option** *waitType*

NULL, not used.

**int** *abort\_sig*

NULL, not used.

**cr\_error\_t** \**cp\_error\_data*

AIX structure containing error info from **ll\_init\_ckpt**. When the return code indicates the checkpoint was attempted but failed (-7), detailed information is returned in this structure.

**int** *ckpt\_rc*

Return code from checkpoint.

**int** *soft\_limit*

This field is ignored.

**int** *hard\_limit*

This field is ignored.

**Description**

This subroutine is only available if you have enabled checkpointing. **ll\_init\_ckpt** initiates a checkpoint from within a serial application. The checkpoint file name will consist of a base name with a suffix of a numeric checkpoint tag to

## ll\_init\_ckpt

differentiate from an earlier checkpoint file. LoadLeveler sets the environment variable **LOADL\_CKPT\_FILE** which identifies the directory and file name for checkpoint files.

### Return values

- 0 The checkpoint completed successfully.
- 1 Indicates **ll\_init\_ckpt()** returned as a result of a restart operation.

### Error values

- 1 Cannot retrieve the job step ID from the environment variable **LOADL\_STEP\_ID**.
- 2 Cannot retrieve the checkpoint file name from the environment variable **LOADL\_CKPT\_FILE**, checkpoint has not been enabled for the job step (checkpoint not set to yes or interval).
- 3 Cannot allocate memory.
- 4 Checkpoint/restart ID is not valid, checkpointing is not enabled for the job step.
- 5 Request to take checkpoint denied by starter.
- 6 Request to take checkpoint failed, no response from starter, possible communication problem.
- 7 Checkpoint attempted but failed. Details of error can be found in the **LL\_ckpt\_info** structure.
- 8 Cannot install SIGINT signal handler.

## ll\_ckpt

### Purpose

Initiates a checkpoint on a specific job step.

### Library

LoadLeveler API library **libllapi.a**

### Syntax

```
#include "llapi.h"
```

```
int ll_ckpt (LL_ckpt_info *ckpt_info);
```

### Parameters

*ckpt\_info*

A pointer to a **LL\_ckpt\_info** structure, which has the following fields:

**int** *version*

The version of the API that the program was compiled with (from **llapi.h**).

**char\*** *step\_id*

A job or step identifier. When a job identifier is specified, the action of the API is taken for all steps of the job. At least one job or step identifier must be specified.

The format of a job identifier is *host.jobid*. The format of a step identifier is *host.jobid.stepid*.

where:

- *host* is the name of the machine that assigned the job and step identifiers.
- *jobid* is the job number assigned to the job when it was submitted.
- *stepid* is the job step number assigned to the job step when it was submitted.

The job or step identifier may be specified in an abbreviated form, *jobid* or *jobid.stepid*, when the API is invoked on the same machine that assigned the job and step identifiers. In this case, LoadLeveler will use the local machine's host name to construct the full job or step identifier.

#### **enum ckpt\_type** *ckptType*

The action to be taken after the checkpoint successfully completes. The values for **enum ckpt\_type** are:

##### **CKPT\_AND\_CONTINUE**

Allow the job to continue after the checkpoint.

##### **CKPT\_AND\_TERMINATE**

Terminate the job after the checkpoint.

##### **CKPT\_AND\_HOLD**

Puts the job on user hold after the checkpoint.

**Note:** If checkpoint is not successful, the job continues on return regardless of these settings.

#### **enum wait\_option** *waitType*

Flag used to identify blocking action during checkpoint. By default **ll\_ckpt()** will block until the checkpoint completes. The values for the **enum wait\_option** are:

##### **CKPT\_NO\_WAIT**

Disables blocking while the job is being checkpointed.

##### **CKPT\_WAIT**

Job is blocked while being checkpointed. This is the default.

#### **int abort\_sig**

Identifies the signal to be used to interrupt a checkpoint initiated by the API. Upon receipt of this signal the checkpoint will be aborted. Default is SIGINT.

#### **cr\_error\_t \*cp\_error\_data**

AIX structure containing error info from **ckpt**.

#### **int ckpt\_rc**

Return code from checkpoint

#### **int soft\_limit**

Time, in seconds, indicating the maximum time allocated for a checkpoint operation to complete before the checkpoint operation is aborted. The job is allowed to continue. The value for *soft\_limit* specified here will override any soft limit value specified in the job command file. If the value for soft limit specified by the administration file is less than the value specified here, the administration file value takes precedence.

Values are:

- 1** Indicates there is no limit.
- 0** Indicates the existing soft limit for the job step should be enforced.

### Positive integer

Indicates the number of seconds allocated for the limit.

### int *hard\_limit*

Time, in seconds, indicating the maximum time allocated for a checkpoint operation to complete before the job is terminated. The value for hard-limit specified here will override any hard limit value specified in the job command file. If the value for hard limit specified by the administration file is less than the value specified here, the administration file value will take precedence.

Values are:

- 1 Indicates there is no limit.
- 0 Indicates the existing hard limit for the job step should be enforced.

### Positive integer

Indicates the number of seconds allocated for the limit.

## Description

This function initiates a checkpoint for the specified job step. **ll\_ckpt()** will, by default, block until the checkpoint operation completes. To disable blocking, the flag *waitType* must be set to **NO\_WAIT**. This function is allowed to be executed by the owner of the job step or a LoadLeveler administrator.

## Return Values

- 0 Checkpoint completed successfully.
- 1 Checkpoint event did not receive status and the success or failure of the checkpoint is unclear.

## Error Values

- 1 Error occurred attempting to checkpoint.
- 2 Format not valid for job step, not in the form *host.jobid.stepid*.
- 3 Cannot allocate memory.
- 4 API cannot create listen socket.
- 5 64-bit API not supported when DCE is enabled.
- 6 Configuration file errors.
- 7 DCE identity cannot be established.
- 8 No DCE credentials.
- 9 DCE credentials life time less than 300 seconds.

## ll\_set\_ckpt\_callbacks

### Purpose

Used by an application to register callbacks which will be invoked when a job step is checkpointed, resumed, and restarted.

### Library

LoadLeveler API library **libllapi.a**

**Syntax**

```
#include "llapi.h"
```

```
int ll_set_ckpt_callbacks (callbacks_t *cbs);
```

**Parameters**

*cbs*

A pointer to a **callbacks\_t** structure, which is defined as:

```
typedef struct {
 void (*checkpoint_callback) (void) ;
 void (*restart_callback) (void) ;
 void (*resume_callback) (void) ;
} callbacks_t;
```

Where:

**checkpoint\_callback**

Pointer to the function to be invoked at checkpoint time.

**restart\_callback**

Pointer to the function to be invoked at restart time.

**resume\_callback**

Pointer to the function to be called when an application is resumed after taking a checkpoint.

**Description**

This function is called to register functions to be invoked when a job step is checkpointed, resumed and restarted.

**Return values**

If successful, a non-negative integer is returned which is a handle used to identify the particular set of callback functions. The handle can be used as input to the **ll\_unset\_ckpt\_callbacks** function. If an error occurs, a negative number is returned.

**Error values**

- 1 Process is not enabled for checkpointing.
- 2 Unable to allocate storage to store callback structure.
- 3 Cannot allocate memory.

**ll\_unset\_ckpt\_callbacks****Purpose**

Unregisters previously registered checkpoint, resume, and restart callbacks.

**Library**

LoadLeveler API library **libllapi.a**

**Syntax**

```
#include "llapi.h"
```

```
int ll_unset_ckpt_callbacks(int handle);
```

### Parameters

*handle*

An integer indicating the set of callback functions to be unregistered. This integer is the value returned by the **ll\_set\_ckpt\_callbacks** function which was used to register the callbacks.

### Description

This API is called to unregister checkpoint, resume and restart application callback functions which were previously registered with the **ll\_set\_ckpt\_callbacks** function.

### Return values

0 Success.

### Error values

-1 Unable to unregister callback. Argument not valid, specified handle does not reference a valid callback structure.

---

## Data Access API

This API gives you access to LoadLeveler objects and allows you to retrieve specific data from those objects. You can use this API to query the negotiator daemon for information about its current set of jobs, classes, and machines. This API can also be used to:

- Query a LoadLeveler history file for job accounting information
- Query the startd and schedd daemons for selected Workload Manager and job information

The Data Access API consists of the following subroutines:

- **ll\_query**
- **ll\_set\_request**
- **ll\_reset\_request**
- **ll\_get\_objs**
- **ll\_get\_data**
- **ll\_next\_obj**
- **ll\_free\_objs**
- **ll\_deallocate**

## Using the data access API

To access data from a remote cluster, you need to call the **ll\_cluster** API to define the cluster prior to any Data Access API calls.

To use this API, you need to call the data access subroutines in the following order:

- Call **ll\_query** to initialize the query object. See “ll\_query subroutine” on page 495 for more information.
- Call **ll\_set\_request** to filter the objects you want to query. See “ll\_set\_request subroutine” on page 495 for more information.
- Call **ll\_get\_objs** to retrieve a list of objects from a LoadLeveler daemon or history file. See “ll\_get\_objs subroutine” on page 500 for more information.
- Call **ll\_get\_data** to retrieve specific data from an object. See “ll\_get\_data subroutine” on page 503 for more information.

- Call **ll\_next\_obj** to retrieve the next object in the list. See “ll\_next\_obj subroutine” on page 530 for more information.
- Call **ll\_free\_objs** to free the list of objects you received. See “ll\_free\_objs subroutine” on page 530 for more information.
- Call **ll\_deallocate** to end the query. See “ll\_deallocate subroutine” on page 531 for more information.

To see code that uses these subroutines, refer to “Examples of using the Data Access API” on page 531. For more information on LoadLeveler objects, see “Understanding the LoadLeveler job object model.”

## Understanding the LoadLeveler job object model

The **ll\_get\_data** subroutine of the data access API allows you to access the LoadLeveler job model. The LoadLeveler job model consists of objects that have attributes and connections to other objects. An attribute is a characteristic of the object and generally has a primitive data type (such as integer, float, or character). The job name, submission time and job priority are examples of attributes.

Objects are connected to one or more other objects through relationships. An object can be connected to other objects through more than one relationship, or through the same relationship. For example, A Job object is connected to a Credential object and to Step objects through two different relationships. A Job object can be connected to more than one Step object through the same relationship of “having a Step.” When an object is connected through different relationships, different specifications are used to retrieve the appropriate object.

When an object is connected to more than one object through the same relationship, there are Count, GetFirst and GetNext specifications associated with the relationship. The Count operation returns the number of connections. You must use the GetFirst operation to initialize access to the first such connected object. You must use the GetNext operation to get the remaining objects in succession. You can not use GetNext after the last object has been retrieved.

You can use the **ll\_get\_data** subroutine to access both attributes and connected objects. See the “ll\_get\_data subroutine” on page 503 for more information.

The root of the job model is the Job object, as shown in Figure 38 on page 494. The job is queried for information about the number of steps it contains and the time it was submitted. The job is connected to a single Credential object and one or more Step objects. Elements for these objects can be obtained from the job.

You can query the Credential object to obtain the ID and group of the submitter of the job.

The Step object represents one executable unit of the job (all the tasks that are executed together). It contains information about the execution state of the step, messages generated during execution of the step, the number of nodes in the step, the number of unique machines the step is running on, the time the step was dispatched, the execution priority of the step, the unique identifier given to the step by LoadLeveler, the class of the step and the number of processes running for the step (task instances). The Step is connected to one or more Switch Table objects, one or more Machine objects and one or more Node objects. The list of Machines represents all of the hosts where one or more nodes of the step are running. If two or more nodes are running on the same host, the Machine object for the host

occurs only once in the step's Machine list. The Step object is connected to one Switch Table object for each of the protocols (MPI and LAPI) used by the Step.

Each Node object manages a set of executables that share common requirements and preferences. The Node can be queried for the number of tasks it manages, and is connected to one or more Task objects.

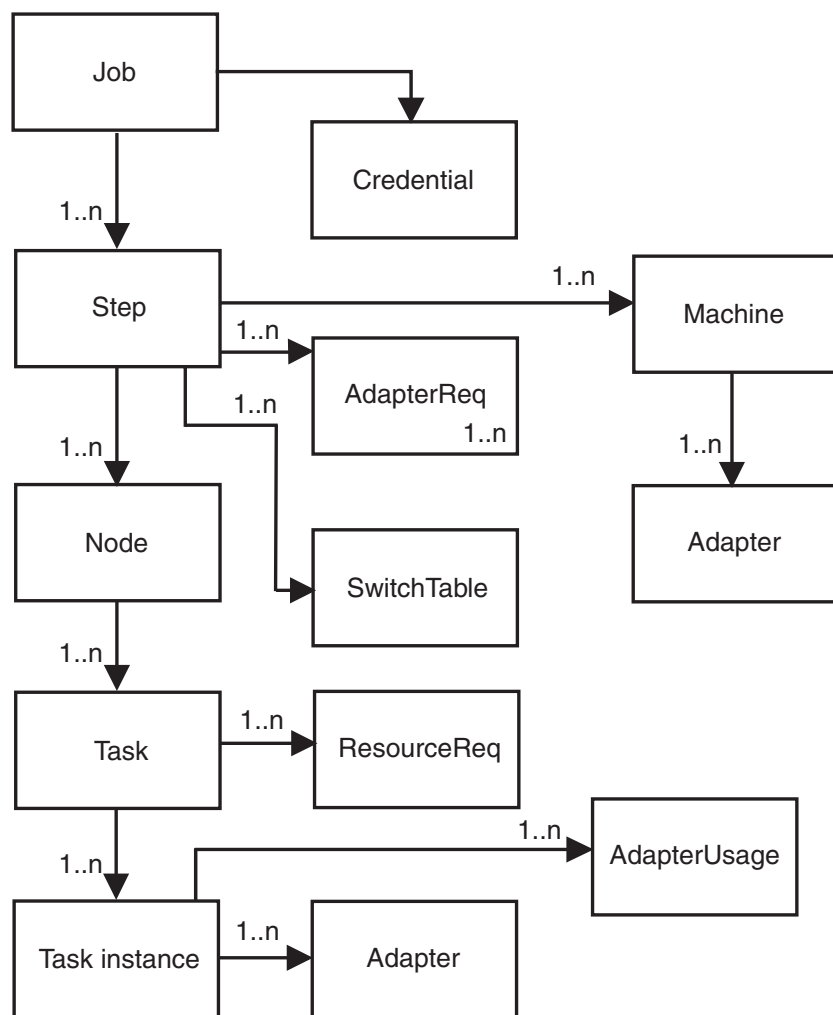


Figure 38. LoadLeveler job object model

The Task object represents one or more copies of the same executable. The Task object can be queried for the executable, the executable arguments, and the number of instances of the executable.

Table 52 on page 504 describes the specifications and elements available when you use the `ll_get_data` subroutine. Each specification name describes the object you need to specify and the attribute returned. For example, the specification `LL_JobGetFirstStep` includes the object you need to specify (`LL_Job`) and the value returned (`GetFirstStep`).

This table is sorted alphabetically by object; within each object the specifications are also sorted alphabetically.

## ll\_query subroutine

### Purpose

The **ll\_query** subroutine initializes the query object and defines the type of query you want to perform. The **LL\_element** created and the corresponding data returned by this function is determined by the *query\_type* you select.

### Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

### Syntax

```
#include "llapi.h"
```

```
LL_element * ll_query (enum QueryType query_type);
```

### Parameters

*query\_type*

Can be:

- **JOBS** (to query job information)
- **MACHINES** (to query machine information)
- **CLASSES** (to query information about job classes)
- **CLUSTER** (to query cluster information)
- **WLMSTAT** (to query AIX Workload Manager)
- **RESERVATIONS** (to query reservation information)
- **MCLUSTERS** (to query multicluster objects)

Multicluster objects only exist when LoadLeveler has a multicluster configuration.

- **BLUE\_GENE** (to query information about the Blue Gene system)

### Description

*query\_type* is the input field for this subroutine.

This subroutine is used in conjunction with other data access subroutines to query information about job and machine objects. You must call **ll\_query** prior to using the other data access subroutines.

### Return values

This subroutine returns a pointer to an **LL\_element** object. The pointer is used by subsequent data access subroutine calls.

### Error values

**NULL** The subroutine was unable to create the appropriate pointer.

### Related information

Subroutines: **ll\_get\_data**, **ll\_set\_request**, **ll\_reset\_request**, **ll\_get\_objs**, **ll\_free\_objs**, **ll\_next\_obj**, **ll\_deallocate**, **ll\_cluster**

## ll\_set\_request subroutine

### Purpose

The **ll\_set\_request** subroutine determines the data requested during a subsequent **ll\_get\_objs** call to query specific objects. You can filter your queries based on the *query\_type*, *object\_filter*, and *data\_filter* you select.

### Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

## Syntax

```
#include "llapi.h"
```

```
int ll_set_request (LL_element *query_element, QueryFlags query_flags,
 char **object_filter, DataFilter data_filter);
```

## Parameters

*query\_element*

Is a pointer to the **LL\_element** returned by the **ll\_query** subroutine.

*query\_flags*

When *query\_type* (in **ll\_query**) is **JOBS**, *query\_flags* can be the following:

**QUERY\_ALL**

Query all jobs.

**QUERY\_BG\_JOB**

Query by **bluegene** type jobs only.

**QUERY\_CLASS**

Query by LoadLeveler class.

**QUERY\_ENDDATE**

Query by job end dates. History file query only.

**QUERY\_GROUP**

Query by LoadLeveler group.

**QUERY\_HOST**

Query by machine name.

**QUERY\_JOBID**

Query by job ID.

**QUERY\_PROCID**

Query by process ID of a task of a job step.

**QUERY\_RESERVATION\_ID**

Query job steps bound to a particular reservation.

**QUERY\_STARTDATE**

Query by job start dates. History file query only.

**QUERY\_STEPID**

Query by step ID.

**QUERY\_USER**

Query by user ID.

When *query\_type* (in **ll\_query**) is **MACHINES**, *query\_flags* can be the following:

**QUERY\_ALL**

Query all machines.

**QUERY\_HOST**

Query by machine names.

When *query\_type* (in **ll\_query**) is **CLASSES**, *query\_flags* can be the following:

**QUERY\_ALL**

Query all classes.

**QUERY\_CLASS**

Query by LoadLeveler class.

When *query\_type* (in **ll\_query**) is **CLUSTER**, *query\_flags* can be the following:

**QUERY\_ALL**

Query cluster information from central manager.

When *query\_type* (in **ll\_query**) is **WLMSTAT**, *query\_flags* can be the following:

**QUERY\_STEPID**

Query by step ID.

When *query\_type* (in **ll\_query**) is **RESERVATIONS**, *query\_flags* can be the following:

**QUERY\_ALL**

Query all reservations.

**QUERY\_GROUP**

Query by LoadLeveler group that owns the reservations.

**QUERY\_HOST**

Query by machine name.

**QUERY\_RESERVATION\_ID**

Query by reservation ID.

**QUERY\_USER**

Query by user ID that owns the reservations.

When *query\_type* (in **ll\_query**) is **MCLUSTERS**, *query\_flags* can be the following:

**QUERY\_ALL**

Query all multiclusters.

When *query\_type* (in **ll\_query**) is **BLUE\_GENE**, *query\_flags* can be the following:

**QUERY\_ALL**

Query Blue Gene base partitions, switches, and wires.

**QUERY\_BG\_BASE\_PARTITION**

Query Blue Gene base partitions, including any small partitions allocated on the base partition.

**QUERY\_BG\_PARTITION**

Query partitions defined on the Blue Gene system.

*object\_filter*

Specifies search criteria. The value you specify for *object\_filter* is related to the value you specify for *query\_flags*:

| If you specify:                | Note                                                                                                                                                    |
|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>QUERY_ALL</b>               | You do not need an <i>object_filter</i> .                                                                                                               |
| <b>QUERY_BG_BASE_PARTITION</b> | The <i>object_filter</i> must contain a list of base partition IDs. For all base partitions, the first entry in the list must contain the string "all". |
| <b>QUERY_BG_PARTITION</b>      | The <i>object_filter</i> must contain a list of partition IDs. For all partitions, the first entry in the list must contain the string "all".           |
| <b>QUERY_CLASS</b>             | The <i>object_filter</i> must contain a list of LoadLeveler class names.                                                                                |
| <b>QUERY_GROUP</b>             | The <i>object_filter</i> must contain a list of LoadLeveler group names.                                                                                |

|                                     |                                                                                                                                                                                                  |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| QUERY_HOST                          | The <i>object_filter</i> must contain a list of LoadLeveler machine names. When the query type is <b>JOBS</b> , the machine names must be the names of machines to which the jobs are submitted. |
| QUERY_JOBID                         | The <i>object_filter</i> must contain a list of job IDs (in the form <i>host.jobid</i> ).                                                                                                        |
| QUERY_PROCID                        | The <i>object_filter</i> must contain a list with a single process ID of a task of a job step.                                                                                                   |
| QUERY_RESERVATION_ID                | The <i>object_filter</i> must contain a list of reservation IDs.                                                                                                                                 |
| QUERY_STARTDATE or<br>QUERY_ENDDATE | The <i>object_filter</i> must contain a list of two start dates or two end dates having the format <i>MM/DD/YYYY</i> .                                                                           |
| QUERY_STEPID                        | The <i>object_filter</i> must contain a list of step IDs (in the form <i>host.jobid.stepid</i> ).                                                                                                |
| QUERY_USER                          | The <i>object_filter</i> must contain a list of user IDs.                                                                                                                                        |

The last entry in the *object\_filter* array must be NULL.

#### *data\_filter*

Filters the data returned from the object you query. The value you specify for *data\_filter* is related to the value you specify for *query\_type*. The *data\_filter* must be **ALL\_DATA** (the default) when:

- You query a history file for job information
- You specify **JOBS** and *query\_flags* **QUERY\_PROCID**
- You specify **BLUE\_GENE**, **CLASSES**, **CLUSTER**, **MACHINES**, **MCLUSTERS**, **RESERVATIONS**, or **WLMSTAT**

### Description

*query\_element*, *query\_flags*, *object\_filter*, and *data\_filter* are the input fields for this subroutine.

The **QUERY\_PROCID** flag should not be used in combination with any other *query\_flags*.

You can request certain combinations of object filters by calling **ll\_set\_request** more than once. When you do this, the query flags you specify are or-ed together. The following are valid combinations of object filters:

- **QUERY\_JOBID** and **QUERY\_STEPID**: the result is the union of both queries and any other query flags (such as, **QUERY\_HOST**) will be ignored
- **QUERY\_STARTDATE** and **QUERY\_ENDDATE**: the result is the intersection of both queries
- **QUERY\_HOST**, **QUERY\_USER**, **QUERY\_GROUP**, **QUERY\_CLASS**, and **QUERY\_RESERVATION\_ID**: the result is the intersections of all of the queries
- When the *query\_type* is **QUERY\_RESERVATIONS**, **QUERY\_RESERVATION\_ID** takes precedence and any other query flags are ignored (with the exception of **QUERY\_ALL**, which always replaces any other query flags)

That is, to query jobs owned by certain users and on a specific machines, issue **ll\_set\_request** first with **QUERY\_USER** and the appropriate user IDs, and then issue it again with **QUERY\_HOST** and the appropriate host names.

For example, suppose you issue **ll\_set\_request** with a user ID list of anton and meg, and then issue it again with a host list of k10n10 and k10n11. The objects returned are all of the jobs on k10n10 and k10n11 which belong to anton or meg.

Note that if you use two consecutive calls with the same flag, the second call will replace the previous call.

Also, you should not use the **QUERY\_ALL** flag in combination with any other flag, since **QUERY\_ALL** will replace any existing requests.

For history file queries, *query\_flags* is restricted to the following: **QUERY\_ALL**, **QUERY\_STARTDATE**, **QUERY\_ENDDATE**.

### Return values

This subroutine returns a zero to indicate success.

### Error values

- 1 You specified a *query\_element* that is not valid.
- 2 You specified a *query\_flag* that is not valid.
- 3 You specified an *object\_filter* that is not valid.
- 4 You specified a *data\_filter* that is not valid.
- 5 A system error occurred.

### Related information

Subroutines: **ll\_get\_data**, **ll\_query**, **ll\_reset\_request**, **ll\_get\_objs**, **ll\_free\_objs**, **ll\_next\_obj**, **ll\_deallocate**, **ll\_cluster**

## ll\_reset\_request subroutine

### Purpose

The **ll\_reset\_request** subroutine resets the request data to NULL for the *query\_element* you specify.

### Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

### Syntax

```
#include "llapi.h"
```

```
int ll_reset_request (LL_element *query_element);
```

### Parameters

*query\_element*

Is a pointer to the **LL\_element** returned by the **ll\_query** function.

### Description

*query\_element* is the input field for this subroutine.

This subroutine is used in conjunction with **ll\_set\_request** to change the data requested with the **ll\_get\_objs** subroutine.

### Return values

This subroutine returns a zero to indicate success.

### Error values

- 1 The subroutine was unable to reset the appropriate data.

**Related information**

Subroutines: `ll_get_data`, `ll_set_request`, `ll_query`, `ll_get_objs`, `ll_free_objs`, `ll_next_obj`, `ll_deallocate`

**ll\_get\_objs subroutine****Purpose**

The `ll_get_objs` subroutine sends a query request to the daemon you specify along with the request data you specified in the `ll_set_request` subroutine. `ll_get_objs` receives a list of objects matching the request.

**Library**

LoadLeveler API library `libllapi.a` (AIX) or `libllapi.so` (Linux)

**Syntax**

```
#include "llapi.h"
```

```
LL_element * ll_get_objs (LL_element *query_element ,LL_Daemon query_daemon,
 char *hostname,int * number_of_objs,
 int * error_code);
```

**Parameters**

*query\_element*

Is a pointer to the `LL_element` returned by the `ll_query` function.

*query\_daemon*

Specifies the LoadLeveler daemon you want to query or whether you want to query job information stored in a history file. The enum `LL_Daemon` is defined in `llapi.h` as:

```
enum LL_Daemon {LL_STARTD, LL_SCHEDD, LL_CM, LL_MASTER, LL_STARTER,
 LL_HISTORY_FILE};
```

The following indicates which daemons respond to which query flags. When *query\_type* (in `ll_query`) is `JOBS`, the *query\_flags* (in `ll_set_request`) listed in the left-hand column are responded to by the daemons listed in the right-hand column:

|                        |                                                                           |
|------------------------|---------------------------------------------------------------------------|
| <b>QUERY_ALL</b>       | negotiator (LL_CM), schedd (LL_SCHEDD), or history file (LL_HISTORY_FILE) |
| <b>QUERY_JOBID</b>     | negotiator (LL_CM) or schedd (LL_SCHEDD)                                  |
| <b>QUERY_STEPID</b>    | negotiator (LL_CM) or schedd (LL_SCHEDD)                                  |
| <b>QUERY_PROCID</b>    | startd (LL_STARTD)                                                        |
| <b>QUERY_USER</b>      | negotiator (LL_CM) or schedd (LL_SCHEDD)                                  |
| <b>QUERY_CLASS</b>     | negotiator (LL_CM) or schedd (LL_SCHEDD)                                  |
| <b>QUERY_HOST</b>      | negotiator (LL_CM)                                                        |
| <b>QUERY_STARTDATE</b> | history file (LL_HISTORY_FILE)                                            |
| <b>QUERY_ENDDATE</b>   | history file (LL_HISTORY_FILE)                                            |

|                      |                                          |
|----------------------|------------------------------------------|
| QUERY_RESERVATION_ID | negotiator (LL_CM) or schedd (LL_SCHEDD) |
|----------------------|------------------------------------------|

When *query\_type* (in **ll\_query**) is **MACHINES**, the *query\_flags* (in **ll\_set\_request**) listed in the left-hand column are responded to by the daemons listed in the right-hand column:

|            |                    |
|------------|--------------------|
| QUERY_ALL  | negotiator (LL_CM) |
| QUERY_HOST | negotiator (LL_CM) |

When *query\_type* (in **ll\_query**) is **CLASSES**, the *query\_flags* (in **ll\_set\_request**) listed in the left-hand column are responded to by the daemons listed in the right-hand column:

|             |                    |
|-------------|--------------------|
| QUERY_ALL   | negotiator (LL_CM) |
| QUERY_CLASS | negotiator (LL_CM) |

When *query\_type* (in **ll\_query**) is **CLUSTER**, the *query\_flags* (in **ll\_set\_request**) listed in the left-hand column are responded to by the daemons listed in the right-hand column:

|           |                    |
|-----------|--------------------|
| QUERY_ALL | negotiator (LL_CM) |
|-----------|--------------------|

When *query\_type* (in **ll\_query**) is **WLMSTAT**, the *query\_flags* (in **ll\_set\_request**) listed in the left-hand column are responded to by the daemons listed in the right-hand column:

|              |                    |
|--------------|--------------------|
| QUERY_STEPID | startd (LL_STARTD) |
|--------------|--------------------|

When *query\_type* (in **ll\_query**) is **RESERVATIONS**, the *query\_flags* (in **ll\_set\_request**) listed in the left-hand column are responded to by the daemons listed in the right-hand column:

|                      |                    |
|----------------------|--------------------|
| QUERY_ALL            | negotiator (LL_CM) |
| QUERY_USER           | negotiator (LL_CM) |
| QUERY_GROUP          | negotiator (LL_CM) |
| QUERY_HOST           | negotiator (LL_CM) |
| QUERY_RESERVATION_ID | negotiator (LL_CM) |

When *query\_type* (in **ll\_query**) is **MCLUSTERS**, the *query\_flags* (in **ll\_set\_request**) listed in the left-hand column are responded to by the daemons listed in the right-hand column:

|           |                    |
|-----------|--------------------|
| QUERY_ALL | schedd (LL_SCHEDD) |
|-----------|--------------------|

*hostname*

Specifies the *hostname* of the daemon or the history file name to be queried.

When *query\_type* is **JOBS**, if *query\_daemon* is:

**LL\_SCHEDD or LL\_STARTD**

The local machine is queried if the *hostname* is NULL.

### LL\_CM

The *hostname* is ignored.

### LL\_HISTORY\_FILE

The *hostname* represents the history file to obtain data from. If the *hostname* is NULL, an error is returned.

When *query\_type* is **MCLUSTER**, the *query\_daemon* must be **LL\_SCHEDD**. If you specify NULL for the *hostname*:

- The cluster specified by the **ll\_cluster** API is the local cluster, a configured outbound **schedd** daemon for the local cluster is queried.
- The cluster specified by the **ll\_cluster** API is a remote cluster, a configured inbound **schedd** daemon for the remote cluster is queried.

*number\_of\_objs*

Is a pointer to an integer representing the number of objects received from the daemon.

*error\_code*

Is a pointer to an integer representing the error code issued when the function returns a NULL value. For more information, see “Error values.”

## Description

*query\_element*, *query\_daemon*, and *hostname* are the input fields for this subroutine. *number\_of\_objs* and *error\_code* are output fields.

Each LoadLeveler daemon returns only the objects that it knows about.

## Return values

This subroutine returns a pointer to the first object in the list. You must use the **ll\_next\_obj** subroutine to access the next object in the list.

## Error values

This subroutine returns a NULL to indicate failure. The *error\_code* parameter is set to one of the following:

- 1 *query\_element* not valid.
- 2 *query\_daemon* not valid.
- 3 Cannot resolve *hostname*.
- 4 Request type for specified daemon not valid.
- 5 System error.
- 6 No valid objects meet the request.
- 7 Configuration error.
- 9 Connection to daemon failed.
- 10 Error processing history file (LL\_HISTORY\_FILE query only).
- 11 History file must be specified in the *hostname* argument (LL\_HISTORY\_FILE query only).
- 12 Unable to access the history file (LL\_HISTORY\_FILE query only).
- 13 DCE identity of calling program cannot be established.
- 14 No DCE credentials.
- 15 DCE credentials within 300 secs of expiration.
- 16 64-bit API is not supported when DCE is enabled.

## Related information

Subroutines: **ll\_cluster**, **ll\_deallocate**, **ll\_free\_objs**, **ll\_get\_data**, **ll\_get\_objs**, **ll\_next\_obj**, **ll\_query**, **ll\_set\_request**

## ll\_get\_data subroutine

Before you use this subroutine, make sure you are familiar with the concepts discussed in “Understanding the LoadLeveler job object model” on page 493.

### Purpose

The **ll\_get\_data** subroutine returns data from a valid **LL\_element**.

### Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

### Syntax

```
#include "llapi.h"
```

```
int ll_get_data (LL_element *element, enum LLAPI_Specification specification,
 void* resulting_data_type);
```

### Parameters

*element*

Is a pointer to the **LL\_element** returned by the **ll\_get\_objs** subroutine.

*specification*

Specifies the data field within the data object you want to read.

*resulting\_data\_type*

Is a pointer to the location where you want the data stored. If the call returns a nonzero value, an error has occurred and the contents of the location are undefined.

### Description

*object* and *specification* are input fields, while *resulting\_data\_type* is an output field.

The **ll\_get\_data** subroutine of the data access API allows you to access LoadLeveler objects. The parameters of **ll\_get\_data** are a LoadLeveler object (**LL\_element**), a specification that indicates what information about the object is being requested, and a pointer to the area where the information being requested should be stored.

If the specification indicates an attribute of the element that is passed in, the result pointer must be the address of a variable of the appropriate type, and must be initialized to NULL. The type returned by each specification is found in Table 52 on page 504. If the specification queries the connection to another object, the returned value is of type **LL\_element**. You can use a subsequent **ll\_get\_data** call to query information about the new object.

The data type **char\*** and any arrays of type **int** or **char** must be freed by the caller.

**LL\_element** pointers cannot be freed by the caller.

For the specifications, **LL\_MachineOperatingSystem** and **LL\_MachineArchitecture**, *resulting\_data\_type* returns the string "???" if a query is made before the associated records are updated with their actual values by the appropriate startd daemons.

### Return values

This subroutine returns a zero to indicate success.

### Error values

-1      You specified an *object* that is not valid.

-2 You specified an LLAPI\_Specification that is not valid.

### Related information

Subroutines: `ll_query`, `ll_set_request`, `ll_reset_request`, `ll_get_objs`, `ll_next_obj`, `ll_free_objs`, `ll_deallocate`

Table 52. Specifications for `ll_get_data` subroutine

| Object     | Specification                           | Resulting Data Type | Description                                                                                                                                                                                                                                                              |
|------------|-----------------------------------------|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Adapter    | <code>LL_AdapterAvailWindowCount</code> | <code>int*</code>   | A pointer to an integer indicating the number of adapter windows not in use.                                                                                                                                                                                             |
| Adapter    | <code>LL_AdapterCommInterface</code>    | <code>int*</code>   | Contains the adapter's communication interface.                                                                                                                                                                                                                          |
| Adapter    | <code>LL_AdapterInterfaceAddress</code> | <code>char**</code> | A pointer to a string containing the adapter's interface IP address.                                                                                                                                                                                                     |
| Adapter    | <code>LL_AdapterMaxWindowSize</code>    | <code>int*</code>   | A pointer to the integer indicating the maximum allocatable adapter window memory.                                                                                                                                                                                       |
| Adapter    | <code>LL_AdapterMCMId</code>            | <code>char**</code> | A pointer to a string containing the MCM ID for the adapter.                                                                                                                                                                                                             |
| Adapter    | <code>LL_AdapterMemory</code>           | <code>int*</code>   | A pointer to the integer indicating the amount of total adapter memory.                                                                                                                                                                                                  |
| Adapter    | <code>LL_AdapterMinWindowSize</code>    | <code>int*</code>   | A pointer to the integer indicating the minimum allocatable adapter window memory.                                                                                                                                                                                       |
| Adapter    | <code>LL_AdapterName</code>             | <code>char**</code> | A pointer to a string containing the adapter name.                                                                                                                                                                                                                       |
| Adapter    | <code>LL_AdapterRcxtBlocks</code>       | <code>int*</code>   | A pointer to the integer indicating the number of rCxt blocks available on an adapter.                                                                                                                                                                                   |
| Adapter    | <code>LL_AdapterTotalWindowCount</code> | <code>int*</code>   | A pointer to the integer indicating the number of windows on the adapter.                                                                                                                                                                                                |
| Adapter    | <code>LL_AdapterWindowList</code>       | <code>int**</code>  | A pointer to an array indicating window numbers for the adapter. <code>LL_AdapterTotalWindowCount</code> indicates the size of this array. If the adapter has no windows, <code>LL_AdapterTotalWindowCount</code> is zero and <code>LL_AdapterWindowList</code> is null. |
| AdapterReq | <code>LL_AdapterReqCommLevel</code>     | <code>int*</code>   | A pointer to the integer indicating the adapter's communication level.                                                                                                                                                                                                   |
| AdapterReq | <code>LL_AdapterReqInstances</code>     | <code>int*</code>   | A pointer to an integer containing the requested adapter instances.                                                                                                                                                                                                      |
| AdapterReq | <code>LL_AdapterReqMode</code>          | <code>char**</code> | A pointer to a string containing the requested adapter mode (IP or US).                                                                                                                                                                                                  |
| AdapterReq | <code>LL_AdapterReqProtocol</code>      | <code>char**</code> | A pointer to a string containing the requested adapter protocol.                                                                                                                                                                                                         |
| AdapterReq | <code>LL_AdapterReqRcxtBlocks</code>    | <code>int*</code>   | A pointer to the integer indicating the number of rCxt blocks requested for the adapter usage.                                                                                                                                                                           |
| AdapterReq | <code>LL_AdapterReqTypeName</code>      | <code>char**</code> | A pointer to a string containing the requested adapter type.                                                                                                                                                                                                             |

Table 52. Specifications for *ll\_get\_data* subroutine (continued)

| Object       | Specification                 | Resulting Data Type | Description                                                                                                                                               |
|--------------|-------------------------------|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| AdapterReq   | LL_AdapterReqUsage            | int*                | A pointer to the integer indicating the requested adapter usage. This integer will be one of the values defined in the Usage enum.                        |
| AdapterUsage | LL_AdapterUsageDevice         | char**              | A pointer to a string containing the name of the adapter device being used.                                                                               |
| AdapterUsage | LL_AdapterUsageMode           | char**              | A pointer to a string containing the mode used for css IP or US.                                                                                          |
| AdapterUsage | LL_AdapterUsageProtocol       | char**              | A pointer to a string containing the task's protocol.                                                                                                     |
| AdapterUsage | LL_AdapterUsageRxtBlocks      | int*                | A pointer to the integer indicating the number of rCxt blocks associated with the adapter usage.                                                          |
| AdapterUsage | LL_AdapterUsageTag            | char**              | A pointer to a character string that indicates which switch table the adapter usage is in. Adapter usages with the same tag are in the same switch table. |
| AdapterUsage | LL_AdapterUsageWindow         | int*                | Contains the adapter window assigned to the task.                                                                                                         |
| AdapterUsage | LL_AdapterUsageWindowMemory64 | uint64_t*           | A pointer to an unsigned 64-bit integer indicating the number of bytes used by the adapter window.                                                        |
| BgBP         | LL_BgBPCurrentPartition       | char**              | A pointer to a string containing the ID of the partition to which the base partition is part of.                                                          |
| BgBP         | LL_BgBPCurrentPartitionState  | int*                | A pointer to an integer indicating the state of the current partition (BgPartitionState_t).                                                               |
| BgBP         | LL_BgBPGetFirstNodeCard       | LL_element*         | A pointer to the element associated with the first node card in the Blue Gene base partition.                                                             |
| BgBP         | LL_BgBPGetNextNodeCard        | LL_element*         | A pointer to the element associated with the next node card in the Blue Gene base partition.                                                              |
| BgBP         | LL_BgBPId                     | char**              | A pointer to a string containing the ID of the base partition in the Blue Gene system.                                                                    |
| BgBP         | LL_BgBPLocation               | int**               | A pointer to an array indicating the location of the base partition in the Blue Gene system in each dimension.                                            |
| BgBP         | LL_BgBPNodeCardCount          | int*                | A pointer to an integer indicating the number of node cards in the base partition.                                                                        |
| BgBP         | LL_BgBPState                  | int*                | A pointer to an integer indicating the state of the base partition (BgBPState_t).                                                                         |
| BgBP         | LL_BgBPSubDividedBusy         | int*                | A pointer to an integer indicating that small partitions are active in the base partition.                                                                |

## Data Access API

Table 52. Specifications for *ll\_get\_data* subroutine (continued)

| Object      | Specification                      | Resulting Data Type | Description                                                                                                       |
|-------------|------------------------------------|---------------------|-------------------------------------------------------------------------------------------------------------------|
| BgMachine   | LL_BgMachineBPSize                 | int**               | A pointer to an array indicating the size of a base partition in compute nodes in each dimension.                 |
| BgMachine   | LL_BgMachineGetFirstBP             | LL_element*         | The element associated with the first base partition in the Blue Gene base partition list.                        |
| BgMachine   | LL_BgMachineGetFirstPartition      | LL_element*         | The element associated with the first partition in the Blue Gene partition list.                                  |
| BgMachine   | LL_BgMachineGetFirstSwitch         | LL_element*         | The element associated with the first switch in the Blue Gene switch list.                                        |
| BgMachine   | LL_BgMachineGetFirstWire           | LL_element*         | The element associated with the first wire in the Blue Gene wire list.                                            |
| BgMachine   | LL_BgMachineGetNextBP              | LL_element*         | The element associated with the next base partition in the Blue Gene base partition list.                         |
| BgMachine   | LL_BgMachineGetNextPartition       | LL_element*         | The element associated with the next partition in the Blue Gene partition list.                                   |
| BgMachine   | LL_BgMachineGetNextSwitch          | LL_element*         | The element associated with the next switch in the Blue Gene switch list.                                         |
| BgMachine   | LL_BgMachineGetNextWire            | LL_element*         | The element associated with the next wire in the Blue Gene wire list.                                             |
| BgMachine   | LL_BgMachinePartitionCount         | int*                | A pointer to an integer indicating the number of defined partitions in the Blue Gene system.                      |
| BgMachine   | LL_BgMachineSize                   | int**               | A pointer to an array indicating the size of the Blue Gene system in number of base partitions in each dimension. |
| BgMachine   | LL_BgMachineSwitchCount            | int*                | A pointer to an integer indicating the number of switches in the Blue Gene system.                                |
| BgMachine   | LL_BgMachineWireCount              | int*                | A pointer to an integer indicating the number of wires in the Blue Gene system.                                   |
| BgNodeCard  | LL_BgNodeCardCurrentPartition      | char**              | A pointer to a string containing the ID of the partition that the node card is assigned to.                       |
| BgNodeCard  | LL_BgNodeCardCurrentPartitionState | int*                | The state of the current partition (BgPartitionState_t).                                                          |
| BgNodeCard  | LL_BgNodeCardId                    | char**              | A pointer to a string containing the ID of the node card.                                                         |
| BgNodeCard  | LL_BgNodeCardQuarter               | int*                | The quarter of the base partition the node card is in (BgQuarter_t).                                              |
| BgNodeCard  | LL_BgNodeCardState                 | int*                | The state of the node card (BgNodeCardState_t).                                                                   |
| BgPartition | LL_BgPartitionBLRTSImage           | char**              | A pointer to a string containing the file name of compute node's kernel image.                                    |

Table 52. Specifications for *ll\_get\_data* subroutine (continued)

| Object      | Specification                      | Resulting Data Type | Description                                                                                   |
|-------------|------------------------------------|---------------------|-----------------------------------------------------------------------------------------------|
| BgPartition | LL_BgPartitionBPCount              | int*                | A pointer to an integer indicating the number of base partitions in the partition.            |
| BgPartition | LL_BgPartitionBPList               | char***             | A pointer to an array containing the list of base partition IDs assigned to the partition.    |
| BgPartition | LL_BgPartitionConnection           | int*                | The connection type of the partition (BgConnection_t).                                        |
| BgPartition | LL_BgPartitionDescription          | char**              | A pointer to a string containing the partition description.                                   |
| BgPartition | LL_BgPartitionGetFirstSwitch       | LL_element*         | The element associated with the first switch in the partition.                                |
| BgPartition | LL_BgPartitionGetNextSwitch        | LL_element*         | The element associated with the next switch in the partition.                                 |
| BgPartition | LL_BgPartitionId                   | char**              | A pointer to a string containing the ID of the Blue Gene partition.                           |
| BgPartition | LL_BgPartitionLinuxImage           | char**              | A pointer to a string containing the file name of the I/O nodes' Linux image.                 |
| BgPartition | LL_BgPartitionMLoaderImage         | char**              | A pointer to a string containing the file name of the machine loader image.                   |
| BgPartition | LL_BgPartitionMode                 | int*                | The node mode of the partition (BgNodeMode_t).                                                |
| BgPartition | LL_BgPartitionNodeCardList         | char***             | A pointer to an array containing the list of node card IDs assigned to the partition.         |
| BgPartition | LL_BgPartitionOwner                | char**              | A pointer to a string containing the user name of the owner of the partition.                 |
| BgPartition | LL_BgPartitionRamDiskImage         | char**              | A pointer to a string containing the file name of the ram disk image.                         |
| BgPartition | LL_BgPartitionSmall                | int*                | A pointer to an integer indicating if the partition is smaller than a base partition.         |
| BgPartition | LL_BgPartitionState                | int*                | A pointer to an integer indicating the state of the Blue Gene partition (BgPartitionState_t). |
| BgPartition | LL_BgPartitionSwitchCount          | int*                | A pointer to an integer indicating the number of switches in the partition.                   |
| BgPortConn  | LL_BgPortConnCurrentPartition      | char**              | A pointer to a string containing the ID of the partition to which the connection is assigned. |
| BgPortConn  | LL_BgPortConnCurrentPartitionState | int*                | A pointer to an integer indicating the state of the current partition (BgPartitionState_t).   |
| BgPortConn  | LL_BgPortConnFromSwitchPort        | int*                | A pointer to an integer indicating the from switch port ID (BgPort_t).                        |
| BgPortConn  | LL_BgPortConnToSwitchPort          | int*                | A pointer to an integer indicating the to switch port ID (BgPort_t).                          |

## Data Access API

Table 52. Specifications for *ll\_get\_data* subroutine (continued)

| Object   | Specification                  | Resulting Data Type | Description                                                                                                  |
|----------|--------------------------------|---------------------|--------------------------------------------------------------------------------------------------------------|
| BgSwitch | LL_BgSwitchBasePartitionId     | char**              | A pointer to a string containing the ID of the base partition connected to the switch.                       |
| BgSwitch | LL_BgSwitchConnCount           | int*                | A pointer to an integer indicating the number of connections in the switch.                                  |
| BgSwitch | LL_BgSwitchDimension           | int*                | A pointer to an integer indicating the dimension the switch is associated with (BgSwitchDimension_t).        |
| BgSwitch | LL_BgSwitchGetFirstConn        | LL_element*         | A pointer to the element associated with the first connection in the switch connection list.                 |
| BgSwitch | LL_BgSwitchGetNextConn         | LL_element*         | A pointer to the element associated with the next connection in the switch connection list.                  |
| BgSwitch | LL_BgSwitchId                  | char**              | A pointer to a string containing the ID of the Blue Gene switch.                                             |
| BgSwitch | LL_BgSwitchState               | int*                | A pointer to an integer indicating the state of the switch (BgSwitchState_t).                                |
| BgWire   | LL_BgWireCurrentPartition      | char**              | A pointer to a string containing the ID of the partition which the wire is assigned.                         |
| BgWire   | LL_BgWireCurrentPartitionState | int*                | A pointer to an integer indicating the state of the current partition (BgPartitionState_t).                  |
| BgWire   | LL_BgWireFromPortCompId        | char**              | A pointer to a string containing the base partition or the switch the wire source port is part of.           |
| BgWire   | LL_BgWireFromPortId            | int*                | A pointer to an integer indicating the ID of the wire source port (BgPort_t).                                |
| BgWire   | LL_BgWireId                    | char**              | A pointer to a string containing the ID of the Blue Gene wire.                                               |
| BgWire   | LL_BgWireToPortCompId          | char**              | A pointer to a string containing the base partition or the switch the wire destination port is part of.      |
| BgWire   | LL_BgWireToPortId              | int*                | A pointer to an integer indicating the ID of the wire destination port (BgPort_t).                           |
| BgWire   | LL_BgWireState                 | int*                | A pointer to an integer indicating the state of the wire (BgWireState_t).                                    |
| Class    | LL_ClassAdmin                  | char***             | A pointer to an array of strings containing administrators for the class. The array ends with a NULL string. |
| Class    | LL_ClassCkptDir                | char**              | A pointer to a string containing the directory for checkpoint files.                                         |
| Class    | LL_ClassCkptTimeHardLimit      | int64_t*            | Specifies the checkpoint time hard limit.                                                                    |
| Class    | LL_ClassCkptTimeSoftLimit      | int64_t*            | Specifies the checkpoint time soft limit.                                                                    |
| Class    | LL_ClassComment                | char**              | A pointer to a string containing the class comment.                                                          |

Table 52. Specifications for *ll\_get\_data* subroutine (continued)

| Object | Specification                       | Resulting Data Type | Description                                                                                                           |
|--------|-------------------------------------|---------------------|-----------------------------------------------------------------------------------------------------------------------|
| Class  | LL_ClassConstraints                 | int*                | Specifies whether values of Maximum and Free Slots are constrained by MAX_STARTERS and MAXJOBS                        |
| Class  | LL_ClassCoreLimitHard               | int64_t*            | Specifies the core file hard limit.                                                                                   |
| Class  | LL_ClassCoreLimitSoft               | int64_t*            | Specifies the core file soft limit.                                                                                   |
| Class  | LL_ClassCpuLimitHard                | int64_t*            | Specifies the cpu hard limit.                                                                                         |
| Class  | LL_ClassCpuLimitSoft                | int64_t*            | Specifies the cpu soft limit.                                                                                         |
| Class  | LL_ClassCpuStepLimitHard            | int64_t*            | Specifies the Hard Job_cpu_limit.                                                                                     |
| Class  | LL_ClassCpuStepLimitSoft            | int64_t*            | Specifies the Soft Job_cpu_limit.                                                                                     |
| Class  | LL_ClassDataLimitHard               | int64_t*            | Specifies the data hard limit.                                                                                        |
| Class  | LL_ClassDataLimitSoft               | int64_t*            | Specifies the data soft limit.                                                                                        |
| Class  | LL_ClassExcludeGroups               | char***             | A pointer to an array of strings containing groups not permitted to use the class. The array ends with a NULL string. |
| Class  | LL_ClassExcludeUsers                | char***             | A pointer to an array of strings containing users not permitted to use the class. The array ends with a NULL string.  |
| Class  | LL_ClassExecutionFactor             | int*                | Specifies the execution factor.                                                                                       |
| Class  | LL_ClassFileLimitHard               | int64_t*            | Specifies the file size hard limit.                                                                                   |
| Class  | LL_ClassFileLimitSoft               | int64_t*            | Specifies the file size soft limit.                                                                                   |
| Class  | LL_ClassFreeSlots                   | int*                | Specifies the number of available initiators.                                                                         |
| Class  | LL_ClassGetFirstResourceRequirement | LL_element*         | A pointer to the element associated with the first resource requirement.                                              |
| Class  | LL_ClassGetNextResourceRequirement  | LL_element*         | A pointer to the element associated with the next resource requirement.                                               |
| Class  | LL_ClassIncludeGroups               | char***             | A pointer to an array of strings containing groups permitted to use the class. The array ends with a NULL string.     |
| Class  | LL_ClassIncludeUsers                | char***             | A pointer to an array of strings containing users permitted to use the class. The array ends with a NULL string.      |
| Class  | LL_ClassMaximumSlots                | int*                | Specifies the total number of configured initiators                                                                   |
| Class  | LL_ClassMaxJobs                     | int*                | Lists the maximum number of job steps that can run at any time.                                                       |
| Class  | LL_ClassMaxProcessors               | int*                | Lists the maximum number of processors for a parallel job step.                                                       |
| Class  | LL_ClassMaxProtocolInstances        | int*                | Specifies the maximum number of adapter windows per protocol per task.                                                |
| Class  | LL_ClassMaxTotalTasks               | int*                | Specifies the value for Max_total_tasks.                                                                              |

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Table 52. Specifications for *ll\_get\_data* subroutine (continued)

| Object  | Specification                    | Resulting Data Type | Description                                                                                                                   |
|---------|----------------------------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------|
| Class   | LL_ClassName                     | char**              | A pointer to a string containing the name of the class.                                                                       |
| Class   | LL_ClassNice                     | int*                | Specifies the nice value.                                                                                                     |
| Class   | LL_ClassNqsClass                 | int*                | Tells whether the class is an NQS gateway                                                                                     |
| Class   | LL_ClassNqsQuery                 | char***             | A pointer to an array of strings containing NQS queues to query about job dispatch. The array ends with a NULL string.        |
| Class   | LL_ClassNqsSubmit                | char**              | A pointer to a string containing the NQS queue to submit jobs.                                                                |
| Class   | LL_ClassPreemptClass             | char**              | A pointer to a string containing the PREEMPT_CLASS rule.                                                                      |
| Class   | LL_ClassPriority                 | int*                | The class system priority                                                                                                     |
| Class   | LL_ClassRssLimitHard             | int64_t*            | Specifies the resident set size hard limit.                                                                                   |
| Class   | LL_ClassRssLimitSoft             | int64_t*            | Specifies the resident set size soft limit.                                                                                   |
| Class   | LL_ClassStackLimitHard           | int64_t*            | Specifies the stack size hard limit.                                                                                          |
| Class   | LL_ClassStackLimitSoft           | int64_t*            | Specifies the stack size soft limit.                                                                                          |
| Class   | LL_ClassStartClass               | char**              | A pointer to a string containing the START_CLASS rule.                                                                        |
| Class   | LL_ClassWallClockLimitHard       | int64_t*            | Specifies the wall clock hard limit.                                                                                          |
| Class   | LL_ClassWallClockLimitSoft       | int64_t*            | Specifies the wall clock soft limit.                                                                                          |
| Cluster | LL_ClusterClusterMetric          | char**              | A pointer to a string containing the CLUSTER_METRIC string.                                                                   |
| Cluster | LL_ClusterClusterRemoteJobFilter | char**              | A pointer to a string containing the CLUSTER_REMOTE_JOB_FILTER string.                                                        |
| Cluster | LL_ClusterClusterUserMapper      | char**              | A pointer to a string containing the CLUSTER_USER_MAPPER string.                                                              |
| Cluster | LL_ClusterDefinedResourceCount   | int*                | A pointer to an integer indicating the number of consumable resources defined in the cluster.                                 |
| Cluster | LL_ClusterDefinedResources       | char***             | A pointer to an array containing the names of consumable resources defined in the cluster. The array ends with a NULL string. |
| Cluster | LL_ClusterEnforcedResourceCount  | int*                | A pointer to an integer indicating the number of enforced resources                                                           |
| Cluster | LL_ClusterEnforcedResources      | char***             | A pointer to an array of characters indicating the number of enforced resources                                               |
| Cluster | LL_ClusterEnforceMemory          | int*                | A pointer to a boolean integer indicating absolute memory limit.                                                              |
| Cluster | LL_ClusterEnforceSubmission      | int*                | A pointer to a boolean integer indicating resources required at time of submission.                                           |
| Cluster | LL_ClusterGetFirstResource       | LL_element*         | A pointer to the element associated with the first resource.                                                                  |

Table 52. Specifications for *ll\_get\_data* subroutine (continued)

| Object      | Specification                      | Resulting Data Type | Description                                                                                                                                        |
|-------------|------------------------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| Cluster     | LL_ClusterGetNextResource          | LL_element*         | A pointer to the element associated with the next resource.                                                                                        |
| Cluster     | LL_ClusterMusterEnvironment        | int*                | A pointer to an integer indicating that the multicluster environment is enabled.                                                                   |
| Cluster     | LL_ClusterSchedulerType            | char**              | A pointer to a string containing the scheduler type.                                                                                               |
| Cluster     | LL_ClusterSchedulingResourceCount  | int*                | A pointer to an integer indicating the number of consumable resources considered by the scheduler for the cluster.                                 |
| Cluster     | LL_ClusterSchedulingResources      | char***             | A pointer to an array containing the names of consumable resources considered by the scheduler for the cluster. The array ends with a NULL string. |
| ClusterFile | LL_ClusterFileLocalPath            | char**              | A pointer to a string containing the expanded local file pathname.                                                                                 |
| ClusterFile | LL_ClusterFileRemotePath           | char**              | A pointer to a string containing the expanded remote file pathname.                                                                                |
| Credential  | LL_CredentialGid                   | int*                | A pointer to an integer containing the UNIX gid of the user submitting the job.                                                                    |
| Credential  | LL_CredentialGroupName             | char**              | A pointer to a string containing the UNIX group name of the user submitting the job.                                                               |
| Credential  | LL_CredentialUid                   | int*                | A pointer to an integer containing the UNIX uid of the person submitting the job.                                                                  |
| Credential  | LL_CredentialUserName              | char**              | A pointer to a string containing the user ID of the user submitting the job.                                                                       |
| DispUsage   | LL_DispatchUsageEventUsageCount    | int*                | Count of Event Usages                                                                                                                              |
| DispUsage   | LL_DispatchUsageGetFirstEventUsage | LL_element*         | First Event Usage                                                                                                                                  |
| DispUsage   | LL_DispatchUsageGetNextEventUsage  | LL_element*         | Next Event Usage                                                                                                                                   |
| DispUsage   | LL_DispatchUsageStarterIdrss64     | int64_t*            | Starter idrss value of dispatch                                                                                                                    |
| DispUsage   | LL_DispatchUsageStarterInblock64   | int64_t*            | Starter inblock value of dispatch                                                                                                                  |
| DispUsage   | LL_DispatchUsageStarterIsrss64     | int64_t*            | Starter isrss value of dispatch                                                                                                                    |
| DispUsage   | LL_DispatchUsageStarterIxrss64     | int64_t*            | Starter ixrss value of dispatch                                                                                                                    |
| DispUsage   | LL_DispatchUsageStarterMajflt64    | int64_t*            | Starter majflt value of dispatch                                                                                                                   |
| DispUsage   | LL_DispatchUsageStarterMaxrss64    | int64_t*            | Starter maxrss value of dispatch                                                                                                                   |
| DispUsage   | LL_DispatchUsageStarterMinflt64    | int64_t*            | Starter minflt value of dispatch                                                                                                                   |
| DispUsage   | LL_DispatchUsageStarterMsgrcv64    | int64_t*            | Starter msgrcv value of dispatch                                                                                                                   |
| DispUsage   | LL_DispatchUsageStarterMsgsnd64    | int64_t*            | Starter msgsnd value of dispatch                                                                                                                   |
| DispUsage   | LL_DispatchUsageStarterNivcs64     | int64_t*            | Starter nivcs64 value of dispatch                                                                                                                  |
| DispUsage   | LL_DispatchUsageStarterNsignals64  | int64_t*            | Starter nsignals value of dispatch                                                                                                                 |
| DispUsage   | LL_DispatchUsageStarterNswap64     | int64_t*            | Starter nswap value of dispatch                                                                                                                    |
| DispUsage   | LL_DispatchUsageStarterNvcs64      | int64_t*            | Starter nvcs64 value of dispatch                                                                                                                   |

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Table 52. Specifications for *ll\_get\_data* subroutine (continued)

| Object     | Specification                    | Resulting Data Type | Description                       |
|------------|----------------------------------|---------------------|-----------------------------------|
| DispUsage  | LL_DisUsageStarterOublock64      | int64_t*            | Starter oublock value of dispatch |
| DispUsage  | LL_DisUsageStarterSystemTime64   | int64_t*            | Starter system time of dispatch   |
| DispUsage  | LL_DisUsageStarterUserTime64     | int64_t*            | Starter user time of dispatch     |
| DispUsage  | LL_DisUsageStepIdrssi64          | int64_t*            | Step idrssi value of dispatch     |
| DispUsage  | LL_DisUsageStepInblock64         | int64_t*            | Step inblock value of dispatch    |
| DispUsage  | LL_DisUsageStepIsrssi64          | int64_t*            | Step isrssi value of dispatch     |
| DispUsage  | LL_DisUsageStepIxrssi64          | int64_t*            | Step ixrssi value of dispatch     |
| DispUsage  | LL_DisUsageStepMajflt64          | int64_t*            | Step majflt value of dispatch     |
| DispUsage  | LL_DisUsageStepMaxrss64          | int64_t*            | Step maxrss value of dispatch     |
| DispUsage  | LL_DisUsageStepMinflt64          | int64_t*            | Step minflt value of dispatch     |
| DispUsage  | LL_DisUsageStepMsgrcv64          | int64_t*            | Step msgrcv value of dispatch     |
| DispUsage  | LL_DisUsageStepMsgsnd64          | int64_t*            | Step msgsnd value of dispatch     |
| DispUsage  | LL_DisUsageStepNivcsw64          | int64_t*            | Step nivcsw value of dispatch     |
| DispUsage  | LL_DisUsageStepNsignals64        | int64_t*            | Step nsignals value of dispatch   |
| DispUsage  | LL_DisUsageStepNswap64           | int64_t*            | Step nswap value of dispatch      |
| DispUsage  | LL_DisUsageStepNvcsw64           | int64_t*            | Step nvcsw value of dispatch      |
| DispUsage  | LL_DisUsageStepOublock64         | int64_t*            | Step oublock value of dispatch    |
| DispUsage  | LL_DisUsageStepSystemTime64      | int64_t*            | Step system time of dispatch.     |
| DispUsage  | LL_DisUsageStepUserTime64        | int64_t*            | Step user time of dispatch        |
| EventUsage | LL_EventUsageEventId             | int*                | Event id                          |
| EventUsage | LL_EventUsageEventName           | char**              | Event name                        |
| EventUsage | LL_EventUsageEventTimestamp      | int*                | Event timestamp                   |
| EventUsage | LL_EventUsageStarterIdrssi64     | int64_t*            | Starter idrssi value of event     |
| EventUsage | LL_EventUsageStarterInblock64    | int64_t*            | Starter inblock value of event    |
| EventUsage | LL_EventUsageStarterIsrssi64     | int64_t*            | Starter isrssi value of event     |
| EventUsage | LL_EventUsageStarterIxrssi64     | int64_t*            | Starter ixrssi value of event     |
| EventUsage | LL_EventUsageStarterMajflt64     | int64_t*            | Starter majflt value of event     |
| EventUsage | LL_EventUsageStarterMaxrss64     | int64_t*            | Starter maxrss value of event     |
| EventUsage | LL_EventUsageStarterMinflt64     | int64_t*            | Starter minflt value of event     |
| EventUsage | LL_EventUsageStarterMsgrcv64     | int64_t*            | Starter msgrcv value of event     |
| EventUsage | LL_EventUsageStarterMsgsnd64     | int64_t*            | Starter msgsnd value of event     |
| EventUsage | LL_EventUsageStarterNivcsw64     | int64_t*            | Starter nivcsw value of event     |
| EventUsage | LL_EventUsageStarterNsignals64   | int64_t*            | Starter nsignals value of event   |
| EventUsage | LL_EventUsageStarterNswap64      | int64_t*            | Starter nswap value of event      |
| EventUsage | LL_EventUsageStarterNvcsw64      | int64_t*            | Starter nvcsw value of event      |
| EventUsage | LL_EventUsageStarterOublock64    | int64_t*            | Starter oublock value of event    |
| EventUsage | LL_EventUsageStarterSystemTime64 | int64_t*            | Starter system time of event      |
| EventUsage | LL_EventUsageStarterUserTime64   | int64_t*            | Starter user time of event        |
| EventUsage | LL_EventUsageStepIdrssi64        | int64_t*            | Step idrssi value of event        |

Table 52. Specifications for *ll\_get\_data* subroutine (continued)

| Object     | Specification                   | Resulting Data Type | Description                                                                                                                    |
|------------|---------------------------------|---------------------|--------------------------------------------------------------------------------------------------------------------------------|
| EventUsage | LL_EventUsageStepInblock64      | int64_t*            | Step inblock value of event                                                                                                    |
| EventUsage | LL_EventUsageStepIsrssi64       | int64_t*            | Step isrssi value of event                                                                                                     |
| EventUsage | LL_EventUsageStepIxrsi64        | int64_t*            | Step ixrsi value of event                                                                                                      |
| EventUsage | LL_EventUsageStepMajflt64       | int64_t*            | Step majflt value of event                                                                                                     |
| EventUsage | LL_EventUsageStepMaxrsi64       | int64_t*            | Step maxrsi value of event                                                                                                     |
| EventUsage | LL_EventUsageStepMinflt64       | int64_t*            | Step minflt value of event                                                                                                     |
| EventUsage | LL_EventUsageStepMsgrcv64       | int64_t*            | Step msgrcv value of event                                                                                                     |
| EventUsage | LL_EventUsageStepMsgsnd64       | int64_t*            | Step msgsnd value of event                                                                                                     |
| EventUsage | LL_EventUsageStepNivcsi64       | int64_t*            | Step nivcsi value of event                                                                                                     |
| EventUsage | LL_EventUsageStepNsignals64     | int64_t*            | Step nsignals value of event                                                                                                   |
| EventUsage | LL_EventUsageStepNswap64        | int64_t*            | Step nswap value of event                                                                                                      |
| EventUsage | LL_EventUsageStepNvcsi64        | int64_t*            | Step nvcsi value of event                                                                                                      |
| EventUsage | LL_EventUsageStepOublock64      | int64_t*            | Step oublock value of event                                                                                                    |
| EventUsage | LL_EventUsageStepSystemTime64   | int64_t*            | Step system time of event                                                                                                      |
| EventUsage | LL_EventUsageStepUserTime64     | int64_t*            | Step user time of event                                                                                                        |
| Job        | LL_JobCredential                | LL_element*         | A pointer to the element associated with the job credential.                                                                   |
| Job        | LL_JobGetFirstClusterInputFile  | LL_element*         | A pointer to the element associated with the first input ClusterFile.                                                          |
| Job        | LL_JobGetFirstStep              | LL_element*         | A pointer to the element associated with the first step of the job, to be used in subsequent <b>ll_get_data</b> calls.         |
| Job        | LL_JobGetNextClusterInputFile   | LL_element*         | A pointer to the element associated with the next input ClusterFile.                                                           |
| Job        | LL_JobGetFirstClusterOutputFile | LL_element*         | A pointer to the element associated with the first output ClusterFile.                                                         |
| Job        | LL_JobGetNextClusterOutputFile  | LL_element*         | A pointer to the element associated with the next output ClusterFile.                                                          |
| Job        | LL_JobGetNextStep               | LL_element*         | A pointer to the element associated with the next step.                                                                        |
| Job        | LL_JobIsRemote                  | int*                | A pointer to an integer. If the integer contains the value 1, the job is remote.                                               |
| Job        | LL_JobJobQueueKey               | int*                | A pointer to an integer indicating the key used to write the job to the spool.                                                 |
| Job        | LL_JobLocalOutboundSchedds      | char***             | A pointer to an array containing a list of local outbound schedds. The last schedd in the list is the current outbound schedd. |
| Job        | LL_JobName                      | char**              | A pointer to a character string containing the job name.                                                                       |
| Job        | LL_JobRequestedCluster          | char***             | A pointer to an array containing the list of user-requested clusters.                                                          |

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Table 52. Specifications for *ll\_get\_data* subroutine (continued)

| Object  | Specification                 | Resulting Data Type | Description                                                                                                                     |
|---------|-------------------------------|---------------------|---------------------------------------------------------------------------------------------------------------------------------|
| Job     | LL_JobRsetName                | char**              | A pointer to a character string containing the RSet name used by the job. If no RSet name was used, the value is NULL.          |
| Job     | LL_JobSchedd                  | char**              | A pointer to a string containing the schedd managing the job.                                                                   |
| Job     | LL_JobScheddHistory           | char***             | A pointer to an array containing a list of managing schedds. The last schedd in the list is the current managing schedd.        |
| Job     | LL_JobSchedulingCluster       | char**              | A pointer to a string containing the name of the cluster where the job is scheduled.                                            |
| Job     | LL_JobSendingCluster          | char**              | A pointer to a string containing the name of the sending cluster.                                                               |
| Job     | LL_JobStepCount               | int*                | A pointer to an integer indicating the number of steps connected to the job.                                                    |
| Job     | LL_JobStepType                | int*                | A pointer to an integer indicating the type of job, which can be INTERACTIVE_JOB or BATCH_JOB.                                  |
| Job     | LL_JobSubmitHost              | char**              | A pointer to a character string containing the name of the host machine from which the job was submitted.                       |
| Job     | LL_JobSubmitTime              | time_t*             | A pointer to the time_t structure indicating when the job was submitted.                                                        |
| Job     | LL_JobSubmittingCluster       | char**              | A pointer to a string containing the name of the submitting cluster.                                                            |
| Job     | LL_JobSubmittingUser          | char**              | A pointer to a string containing the name of the submitting user.                                                               |
| Job     | LL_JobUsersJCF                | char**              | A pointer to a string containing the user's JCF keyword statements.                                                             |
| Job     | LL_JobVersionNum              | int*                | A pointer to an integer indicating the job's version number                                                                     |
| Machine | LL_MachineAdapterList         | char***             | A pointer to an array containing the list of adapters associated with the machine. The array ends with a NULL string.           |
| Machine | LL_MachineArchitecture        | char**              | A pointer to a string containing the machine architecture.                                                                      |
| Machine | LL_MachineAvailableClassList  | char***             | A pointer to an array containing the currently available job classes defined on the machine. The array ends with a NULL string. |
| Machine | LL_MachineConfigTimeStamp     | int*                | A pointer to an integer containing the date and time value of the last configuration or reconfiguration.                        |
| Machine | LL_MachineConfiguredClassList | char***             | A pointer to an array containing the initiators on the machine. The array ends with a NULL string.                              |
| Machine | LL_MachineContinueExpr        | char**              | A pointer to a string containing the machine's continue control expression.                                                     |

Table 52. Specifications for *ll\_get\_data* subroutine (continued)

| Object  | Specification               | Resulting Data Type | Description                                                                                                       |
|---------|-----------------------------|---------------------|-------------------------------------------------------------------------------------------------------------------|
| Machine | LL_MachineCpuList           | int*                | A pointer to an integer containing the list of CPUs on the machine.                                               |
| Machine | LL_MachineCPUs              | int*                | A pointer to an integer containing the number of CPUs on the machine.                                             |
| Machine | LL_MachineDisk              | int*                | A pointer to an integer indicating the disk space in KBs in the machine's execute directory.                      |
| Machine | LL_MachineDisk64            | int64_t*            | A pointer to a 64-bit integer indicating the disk space in KBs in the machine's execute directory.                |
| Machine | LL_MachineDrainClassList    | char***             | A pointer to an array containing the drain class list on the machine. The array ends with a NULL string.          |
| Machine | LL_MachineDrainingClassList | char***             | A pointer to an array containing the draining class list on the machine. The array ends with a NULL string.       |
| Machine | LL_MachineFeatureList       | char***             | A pointer to an array containing the features defined on the machine. The array ends with a NULL string.          |
| Machine | LL_MachineFreeRealMemory    | int*                | A pointer to an integer indicating the amount of free real memory in MBs on the machine.                          |
| Machine | LL_MachineFreeRealMemory64  | int64_t*            | A pointer to a 64-bit integer indicating the amount of free real memory in MBs on the machine.                    |
| Machine | LL_MachineGetFirstAdapter   | LL_element*         | A pointer to the element associated with the machine's first adapter.                                             |
| Machine | LL_MachineGetFirstMCM       | LL_element*         | A pointer to the element associated with the machine's first MCM.                                                 |
| Machine | LL_MachineGetFirstResource  | LL_element*         | A pointer to the element associated with the machine's first resource.                                            |
| Machine | LL_MachineGetNextAdapter    | LL_element*         | A pointer to the element associated with the machine's next adapter.                                              |
| Machine | LL_MachineGetNextMCM        | LL_element*         | A pointer to the element associated with the machine's next MCM.                                                  |
| Machine | LL_MachineGetNextResource   | LL_element*         | A pointer to the element associated with the machine's next resource.                                             |
| Machine | LL_MachineKbdddIdle         | int*                | A pointer to an integer indicating the number of seconds since the kbddd daemon detected keyboard mouse activity. |
| Machine | LL_MachineKillExpr          | char**              | A pointer to a string containing the machine's kill control expression.                                           |
| Machine | LL_MachineLargePageCount64  | int64_t*            | A pointer to a 64-bit integer indicating the number of Large Pages defined on the machine.                        |
| Machine | LL_MachineLargePageFree64   | int64_t*            | A pointer to a 64-bit integer indicating the number of Large Pages free.                                          |

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Table 52. Specifications for *ll\_get\_data* subroutine (continued)

| Object  | Specification                | Resulting Data Type | Description                                                                                                                                               |
|---------|------------------------------|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Machine | LL_MachineLargePageSize64    | int64_t*            | A pointer to a 64-bit integer indicating the size of the machine's Large Page.                                                                            |
| Machine | LL_MachineLoadAverage        | double*             | A pointer to a double containing the load average on the machine.                                                                                         |
| Machine | LL_MachineMachineMode        | char**              | A pointer to a string containing the configured machine mode.                                                                                             |
| Machine | LL_MachineMaxTasks           | int*                | A pointer to an integer indicating the maximum number of tasks this machine can run at one time.                                                          |
| Machine | LL_MachineName               | char**              | A pointer to a string containing the machine name.                                                                                                        |
| Machine | LL_MachineOperatingSystem    | char**              | A pointer to a string containing the operating system on the machine.                                                                                     |
| Machine | LL_MachinePagesFreed         | int*                | A pointer to an integer indicating the number of pages freed per second by the page replacement algorithm.                                                |
| Machine | LL_MachinePagesFreed64       | int64_t*            | A pointer to a 64-bit integer indicating the number of pages freed per second by the page replacement algorithm.                                          |
| Machine | LL_MachinePagesPagedIn       | int*                | A pointer to an integer indicating the number of pages paged in per second from paging space.                                                             |
| Machine | LL_MachinePagesPagedIn64     | int64_t*            | A pointer to a 64-bit integer indicating the number of pages paged in per second from paging space.                                                       |
| Machine | LL_MachinePagesPagedOut      | int*                | A pointer to an integer indicating the number of pages paged out per second to paging space.                                                              |
| Machine | LL_MachinePagesPagedOut64    | int64_t*            | A pointer to a 64-bit integer indicating the number of pages paged out per second to paging space.                                                        |
| Machine | LL_MachinePagesScanned       | int*                | A pointer to an integer indicating the number of pages scanned per second by the page replacement algorithm.                                              |
| Machine | LL_MachinePagesScanned64     | int64_t*            | A pointer to a 64-bit integer indicating the number of pages scanned per second by the page replacement algorithm.                                        |
| Machine | LL_MachinePoolList           | int**               | A pointer to an array indicating the pool numbers to which this machine belongs. The size of the array can be determined by using LL_MachinePoolListSize. |
| Machine | LL_MachinePoolListSize       | int*                | A pointer to an integer indicating the number of pools configured for the machine.                                                                        |
| Machine | LL_MachinePrestartedStarters | int*                | A pointer to an integer indicating the number of prestarted Starters on a machine.                                                                        |

Table 52. Specifications for *ll\_get\_data* subroutine (continued)

| Object    | Specification                  | Resulting Data Type | Description                                                                                                         |
|-----------|--------------------------------|---------------------|---------------------------------------------------------------------------------------------------------------------|
| Machine   | LL_MachineRealMemory           | int*                | A pointer to an integer indicating the physical memory in MBs on the machine.                                       |
| Machine   | LL_MachineRealMemory64         | int64_t*            | A pointer to a 64-bit integer indicating the physical memory in MBs on the machine.                                 |
| Machine   | LL_MachineReservationList      | char***             | A pointer to an array containing the list of reservation IDs using this machine. The array ends with a NULL string. |
| Machine   | LL_MachineReservationPermitted | int*                | A pointer to an integer to determine if this machine can be reserved.                                               |
| Machine   | LL_MachineScheddRunningJobs    | int*                | A pointer to an integer indicating a list of the running jobs assigned to schedd.                                   |
| Machine   | LL_MachineScheddState          | int*                | A pointer to an integer indicating the machine's schedd state.                                                      |
| Machine   | LL_MachineScheddTotalJobs      | int*                | A pointer to an integer indicating the total number of jobs assigned to the schedd.                                 |
| Machine   | LL_MachineSpeed                | double*             | A pointer to a double containing the configured speed of the machine.                                               |
| Machine   | LL_MachineStartdRunningJobs    | int*                | A pointer to an integer containing the number of running jobs known by the startd daemon.                           |
| Machine   | LL_MachineStartdState          | char**              | A pointer to a string containing the state of the startd daemon.                                                    |
| Machine   | LL_MachineStartExpr            | char**              | A pointer to a string containing the machine's start control expression.                                            |
| Machine   | LL_MachineStepList             | char***             | A pointer to an array containing the steps running on the machine. The array ends with a NULL string.               |
| Machine   | LL_MachineSuspendExpr          | char**              | A pointer to a string containing the machine's suspend control expression.                                          |
| Machine   | LL_MachineTimeStamp            | time_t*             | A pointer to a time_t structure indicating the time the machine last reported to the negotiator.                    |
| Machine   | LL_MachineUsedCpuList          | int*                | A pointer to an integer containing the list of CPUs being used on the machine.                                      |
| Machine   | LL_MachineVacateExpr           | char**              | A pointer to a string containing the machine's vacate control expression.                                           |
| Machine   | LL_MachineVirtualMemory        | int*                | A pointer to an integer indicating the free swap space in KBs on the machine.                                       |
| Machine   | LL_MachineVirtualMemory64      | int64_t*            | A pointer to a 64-bit integer indicating the free swap space in KBs on the machine.                                 |
| MachUsage | LL_MachUsageDispUsageCount     | int*                | Count of Dispatch Usages                                                                                            |
| MachUsage | LL_MachUsageGetFirstDispUsage  | LL_element*         | First Dispatch Usage                                                                                                |
| MachUsage | LL_MachUsageGetNextDispUsage   | LL_element*         | Next Dispatch Usage                                                                                                 |

## Data Access API

Table 52. Specifications for *ll\_get\_data* subroutine (continued)

| Object    | Specification                   | Resulting Data Type | Description                                                                                                                                     |
|-----------|---------------------------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| MachUsage | LL_MachUsageMachineName         | char**              | Machine name                                                                                                                                    |
| MachUsage | LL_MachUsageMachineSpeed        | double*             | Machine speed                                                                                                                                   |
| MCluster  | LL_MClusterExcludeClasses       | char***             | A pointer to an array containing a list of exclude classes.                                                                                     |
| MCluster  | LL_MClusterExcludeGroups        | char***             | A pointer to an array containing a list of exclude groups.                                                                                      |
| MCluster  | LL_MClusterExcludeUsers         | char***             | A pointer to an array containing a list of exclude users.                                                                                       |
| MCluster  | LL_MClusterInboundHosts         | char***             | A pointer to an array containing a list of inbound machines.                                                                                    |
| MCluster  | LL_MClusterInboundScheddPort    | int*                | A pointer to an integer containing the cluster schedd port number.                                                                              |
| MCluster  | LL_MClusterIncludeClasses       | char***             | A pointer to an array containing a list of include classes.                                                                                     |
| MCluster  | LL_MClusterIncludeGroups        | char***             | A pointer to an array containing a list of include groups.                                                                                      |
| MCluster  | LL_MClusterIncludeUsers         | char***             | A pointer to an array containing a list of include users.                                                                                       |
| MCluster  | LL_MClusterLocal                | int*                | A pointer to an integer. If the integer contains the value 1, the cluster is local. If the integer contains the value 0, the cluster is remote. |
| MCluster  | LL_MClusterMulticlusterSecurity | char**              | A pointer to a string containing the security method for the multicluster.                                                                      |
| MCluster  | LL_MClusterName                 | char*               | A pointer to a string containing the cluster name.                                                                                              |
| MCluster  | LL_MClusterOutboundHosts        | char***             | A pointer to an array containing a list of outbound machines.                                                                                   |
| MCluster  | LL_MClusterSecureScheddPort     | int*                | A pointer to an integer containing the secure schedd port for the cluster.                                                                      |
| MCluster  | LL_MClusterSslCipherList        | char**              | A pointer to a string containing the list of cipher for SSL.                                                                                    |
| MCM       | LL_MCMCPUList                   | int**               | A pointer to an array indicating the list of CPUs on the MCM.                                                                                   |
| MCM       | LL_MCMCPUs                      | int*                | A pointer to an integer containing the number of CPUs within the MCM.                                                                           |
| MCM       | LL_MCMID                        | int*                | A pointer to an integer containing the ID of the MCM.                                                                                           |
| Node      | LL_NodeGetFirstTask             | LL_element*         | A pointer to the element associated with the first task for this node.                                                                          |
| Node      | LL_NodeGetNextTask              | LL_element*         | A pointer to the element associated with the next task for this node.                                                                           |
| Node      | LL_NodeInitiatorCount           | int*                | A pointer to an integer indicating the number of tasks running on the node.                                                                     |
| Node      | LL_NodeMaxInstances             | int*                | A pointer to an integer indicating the maximum number of machines requested.                                                                    |

Table 52. Specifications for *ll\_get\_data* subroutine (continued)

| Object      | Specification                  | Resulting Data Type | Description                                                                                                                             |
|-------------|--------------------------------|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| Node        | LL_NodeMinInstances            | int*                | A pointer to an integer indicating the minimum number of machines requested.                                                            |
| Node        | LL_NodeRequirements            | char**              | A pointer to a string containing the node requirements.                                                                                 |
| Node        | LL_NodeTaskCount               | int*                | A pointer to an integer indicating the different types of tasks running on the node.                                                    |
| Reservation | LL_ReservationCreateTime       | time_t*             | A pointer to the time_t structure indicating the creation time of the reservation.                                                      |
| Reservation | LL_ReservationDuration         | int*                | A pointer to an integer containing the reservation duration in the unit of minutes.                                                     |
| Reservation | LL_ReservationGroup            | char**              | A pointer to a string containing the LoadLeveler group that owns the reservation.                                                       |
| Reservation | LL_ReservationGroups           | char***             | A pointer to an array containing the LoadLeveler groups whose users may run jobs in the reservation. The array ends with a NULL string. |
| Reservation | LL_ReservationID               | char**              | A pointer to a string containing the ID of the reservation.                                                                             |
| Reservation | LL_ReservationJobs             | char***             | A pointer to an array containing the job steps bound to the reservation. The array ends with a NULL string.                             |
| Reservation | LL_ReservationMachines         | char***             | A pointer to an array containing the machines reserved by the reservation. The array ends with a NULL string.                           |
| Reservation | LL_ReservationModeRemoveOnIdle | int*                | A pointer to an integer indicating that RESERVATION_REMOVE_ON_IDLE mode is on if 1; off if 0.                                           |
| Reservation | LL_ReservationModeShared       | int*                | A pointer to an integer indicating that RESERVATION_SHARED mode is on if 1; off if 0.                                                   |
| Reservation | LL_ReservationModifiedBy       | char**              | A pointer to a string containing the user ID who last modified the reservation.                                                         |
| Reservation | LL_ReservationModifyTime       | time_t*             | A pointer to the time_t structure indicating the last modification time.                                                                |
| Reservation | LL_ReservationOwner            | char**              | A pointer to a string containing the owner of the reservation.                                                                          |
| Reservation | LL_ReservationStartTime        | time_t*             | A pointer to the time_t structure indicating the beginning time of the reservation.                                                     |
| Reservation | LL_ReservationStatus           | int*                | A pointer to an integer containing the state of the reservation that takes one of the Reservation_State_t values in llapi.h.            |

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Table 52. Specifications for *ll\_get\_data* subroutine (continued)

| Object      | Specification                 | Resulting Data Type | Description                                                                                                                                                        |
|-------------|-------------------------------|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Reservation | LL_ReservationUsers           | char***             | A pointer to an array containing the users who may run jobs in the reservation. The array ends with a NULL string.                                                 |
| Resource    | LL_ResourceAvailableValue     | int*                | A pointer to an integer indicating the value of available resources.                                                                                               |
| Resource    | LL_ResourceAvailableValue64   | int64_t*            | A pointer to a 64-bit integer indicating the value of available resources.                                                                                         |
| Resource    | LL_ResourceInitialValue       | int*                | A pointer to an integer indicating the initial resource value.                                                                                                     |
| Resource    | LL_ResourceInitialValue64     | int64_t*            | A pointer to a 64-bit integer indicating the initial resource value.                                                                                               |
| Resource    | LL_ResourceName               | char**              | A pointer to a string containing the resource name.                                                                                                                |
| ResourceReq | LL_ResourceRequirementName    | char**              | A pointer to a string containing the resource requirement name.                                                                                                    |
| ResourceReq | LL_ResourceRequirementValue   | int*                | A pointer to an integer indicating the value of the resource requirement.                                                                                          |
| ResourceReq | LL_ResourceRequirementValue64 | int64_t*            | A pointer to a 64-bit integer indicating the value of the resource requirement.                                                                                    |
| Step        | LL_StepAccountNumber          | char**              | A pointer to a string containing the account number specified by the user submitting the job.                                                                      |
| Step        | LL_StepAcctKey                | int64_t*            | A pointer to a 64-bit integer that can be used to identify all of the AIX accounting records for the job step. This value is only available from the history file. |
| Step        | LL_StepBgErrorText            | char**              | A pointer to a string containing the error text for the Blue Gene job record in the Blue Gene database.                                                            |
| Step        | LL_StepBgJobId                | char**              | A pointer to a string containing the ID of the Blue Gene job in the Blue Gene database.                                                                            |
| Step        | LL_StepBgJobState             | int*                | A pointer to an integer indicating the state of the Blue Gene job in the Blue Gene database (BgJobState_t).                                                        |
| Step        | LL_StepBgNodeMode             | int*                | A pointer to an integer indicating the mode of the compute nodes (BgNodeMode_t).                                                                                   |
| Step        | LL_StepBgPartitionAllocated   | char**              | A pointer to a string containing the ID of the Blue Gene partition allocated for the job.                                                                          |
| Step        | LL_StepBgPartitionRequested   | char**              | A pointer to a string containing the ID of the Blue Gene partition requested for the job step.                                                                     |
| Step        | LL_StepBgPartitionState       | int*                | A pointer to an integer indicating the state of the Blue Gene partition allocated for the job step (BgPartitionState_t).                                           |

Table 52. Specifications for *ll\_get\_data* subroutine (continued)

| Object | Specification               | Resulting Data Type | Description                                                                                                                                                                                                                              |
|--------|-----------------------------|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Step   | LL_StepBgShapeAllocated     | int**               | A pointer to an array indicating the shape of the Blue Gene compute nodes allocated for the job step.                                                                                                                                    |
| Step   | LL_StepBgShapeRequested     | int**               | A pointer to an array indicating the shape of Blue Gene compute nodes requested for the job step.                                                                                                                                        |
| Step   | LL_StepBgSizeAllocated      | int*                | A pointer to an integer indicating the number of Blue Gene compute nodes allocated for the job step.                                                                                                                                     |
| Step   | LL_StepBgSizeRequested      | int*                | A pointer to an integer indicating the number of Blue Gene compute nodes requested for the job step.                                                                                                                                     |
| Step   | LL_StepBgWiringAllocated    | int*                | A pointer to an integer indicating the allocated type of wiring for the Blue Gene job (BgConnection_t).                                                                                                                                  |
| Step   | LL_StepBgWiringRequested    | int*                | A pointer to an integer indicating the requested type of wiring for the Blue Gene job (BgConnection_t).                                                                                                                                  |
| Step   | LL_StepBlocking             | int*                | A pointer to an integer representing blocking as specified by the user in the job command file. <ul style="list-style-type: none"> <li>• Returns -1 if unlimited is specified</li> <li>• Returns 0 if blocking is unspecified</li> </ul> |
| Step   | LL_StepBulkXfer             | int*                | A pointer to an integer that is set to 1 if the step requested bulk transfer and 0 if it did not.                                                                                                                                        |
| Step   | LL_StepCheckpointable       | int*                | A pointer to an integer indicating if checkpointing was enabled via the <b>checkpoint</b> keyword (0=disabled, 1=enabled).                                                                                                               |
| Step   | LL_StepCheckpointing        | Boolean             | If <b>True</b> , indicates that a checkpoint is currently being taken for the step.                                                                                                                                                      |
| Step   | LL_StepCkptAccumTime        | int*                | A pointer to an integer indicating the amount of accumulated time, in seconds, that the job step has spent checkpointing.                                                                                                                |
| Step   | LL_StepCkptExecuteDirectory | char**              | A pointer to a string containing the directory where the job step's executable will be saved.                                                                                                                                            |
| Step   | LL_StepCkptFailStartTime    | time_t*             | A pointer to a time_t structure indicating the start time of the last unsuccessful checkpoint.                                                                                                                                           |
| Step   | LL_StepCkptFile             | char**              | A pointer to a string containing the directory and file name which contain checkpoint information for the last successful checkpoint.                                                                                                    |
| Step   | LL_StepCkptGoodElapseTime   | int*                | A pointer to an integer indicating the amount of time, in seconds, it took for the last successful checkpoint to complete.                                                                                                               |

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Table 52. Specifications for *ll\_get\_data* subroutine (continued)

| Object | Specification               | Resulting Data Type | Description                                                                                                                    |
|--------|-----------------------------|---------------------|--------------------------------------------------------------------------------------------------------------------------------|
| Step   | LL_StepCkptGoodStartTime    | time_t*             | A pointer to a time_t structure indicating the start time of the last successful checkpoint.                                   |
| Step   | LL_StepCkptRestart          | int*                | A pointer to an integer indicating the value specified by the user for the <b>restart_from_ckpt</b> keyword (0= no, 1= yes).   |
| Step   | LL_StepCkptRestartSameNodes | int*                | A pointer to a string indicating the value specified by the user for the <b>restart_on_same_nodes</b> keyword (0= no, 1= yes). |
| Step   | LL_StepCkptTimeHardLimit    | int*                | A pointer to an integer indicating the hard limit set by the user in the <b>ckpt_time_limit</b> keyword.                       |
| Step   | LL_StepCkptTimeHardLimit64  | int64_t*            | A pointer to a 64-bit integer indicating the hard limit set by the user in the <b>ckpt_time_limit</b> keyword.                 |
| Step   | LL_StepCkptTimeSoftLimit    | int*                | A pointer to an integer indicating the soft limit set by the user in <b>ckpt_time_limit</b> keyword.                           |
| Step   | LL_StepCkptTimeSoftLimit64  | int64_t*            | A pointer to a 64-bit integer indicating the soft limit set by the user in <b>ckpt_time_limit</b> keyword.                     |
| Step   | LL_StepClassSystemPriority  | int*                | A pointer to an integer indicating the class priority of the job step.                                                         |
| Step   | LL_StepComment              | char**              | A pointer to a string indicating the comment specified by the user submitting the job.                                         |
| Step   | LL_StepCompletionCode       | int*                | A pointer to an integer indicating the completion code of the step.                                                            |
| Step   | LL_StepCompletionDate       | time_t*             | A pointer to a time_t structure indicating the completion date of the step.                                                    |
| Step   | LL_StepCoreLimitHard        | int*                | A pointer to an integer indicating the core hard limit set by the user in the <b>core_limit</b> keyword.                       |
| Step   | LL_StepCoreLimitHard64      | int64_t*            | A pointer to a 64-bit integer indicating the core hard limit set by the user in the <b>core_limit</b> keyword.                 |
| Step   | LL_StepCoreLimitSoft        | int*                | A pointer to an integer indicating the core soft limit set by the user in the <b>core_limit</b> keyword.                       |
| Step   | LL_StepCoreLimitSoft64      | int64_t*            | A pointer to a 64-bit integer indicating the core soft limit set by the user in the <b>core_limit</b> keyword.                 |
| Step   | LL_StepCpuLimitHard         | int*                | A pointer to an integer indicating the CPU hard limit set by the user in the <b>cpu_limit</b> keyword.                         |

Table 52. Specifications for `ll_get_data` subroutine (continued)

| Object | Specification             | Resulting Data Type | Description                                                                                                           |
|--------|---------------------------|---------------------|-----------------------------------------------------------------------------------------------------------------------|
| Step   | LL_StepCpuLimitHard64     | int64_t*            | A pointer to a 64-bit integer indicating the CPU hard limit set by the user in the <b>cpu_limit</b> keyword.          |
| Step   | LL_StepCpuLimitSoft       | int*                | A pointer to an integer indicating the CPU soft limit set by the user in the <b>cpu_limit</b> keyword.                |
| Step   | LL_StepCpuLimitSoft64     | int64_t*            | A pointer to a 64-bit integer indicating the CPU soft limit set by the user in the <b>cpu_limit</b> keyword.          |
| Step   | LL_StepCpuStepLimitHard   | int*                | A pointer to an integer indicating the CPU step hard limit set by the user in the <b>job_cpu_limit</b> keyword.       |
| Step   | LL_StepCpuStepLimitHard64 | int64_t*            | A pointer to a 64-bit integer indicating the CPU step hard limit set by the user in the <b>job_cpu_limit</b> keyword. |
| Step   | LL_StepCpuStepLimitSoft   | int*                | A pointer to an integer indicating the CPU step soft limit set by the user in the <b>job_cpu_limit</b> keyword.       |
| Step   | LL_StepCpuStepLimitSoft64 | int64_t*            | A pointer to a 64-bit integer indicating the CPU step soft limit set by the user in the <b>job_cpu_limit</b> keyword. |
| Step   | LL_StepDataLimitHard      | int*                | A pointer to an integer indicating the data hard limit set by the user in the <b>data_limit</b> keyword.              |
| Step   | LL_StepDataLimitHard64    | int64_t*            | A pointer to a 64-bit integer indicating the data hard limit set by the user in the <b>data_limit</b> keyword.        |
| Step   | LL_StepDataLimitSoft      | int*                | A pointer to an integer indicating the data soft limit set by the user in the <b>data_limit</b> keyword.              |
| Step   | LL_StepDataLimitSoft64    | int64_t*            | A pointer to a 64-bit integer indicating the data soft limit set by the user in the <b>data_limit</b> keyword.        |
| Step   | LL_StepDependency         | char**              | A pointer to a string containing the step dependency value.                                                           |
| Step   | LL_StepDispatchTime       | time_t*             | A pointer to a time_t structure indicating the time the negotiator dispatched the job.                                |
| Step   | LL_StepEnvironment        | char**              | A pointer to a string containing the environment variables set by the user in the executable.                         |
| Step   | LL_StepErrorFile          | char**              | A pointer to a string containing the standard error file name used by the executable.                                 |
| Step   | LL_StepExecSize           | int*                | A pointer to an integer indicating the executable size.                                                               |
| Step   | LL_StepExecutionFactor    | int*                | A pointer to an integer indicating the execution_factor of the job step.                                              |

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Table 52. Specifications for *ll\_get\_data* subroutine (continued)

| Object | Specification              | Resulting Data Type | Description                                                                                                                                  |
|--------|----------------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| Step   | LL_StepFavoredJob          | int*                | A pointer to an integer that specifies whether the step is favored using the <b>llfavorjob</b> command.                                      |
| Step   | LL_StepFileLimitHard       | int*                | A pointer to an integer indicating the file hard limit set by the user in the <b>file_limit</b> keyword.                                     |
| Step   | LL_StepFileLimitHard64     | int64_t*            | A pointer to a 64-bit integer indicating the file hard limit set by the user in the <b>file_limit</b> keyword.                               |
| Step   | LL_StepFileLimitSoft       | int*                | A pointer to an integer indicating the file soft limit set by the user in the <b>file_limit</b> keyword.                                     |
| Step   | LL_StepFileLimitSoft64     | int64_t*            | A pointer to a 64-bit integer indicating the file soft limit set by the user in the <b>file_limit</b> keyword.                               |
| Step   | LL_StepGetFirstAdapterReq  | LL_element*         | A pointer to the element associated with the first adapter requirement.                                                                      |
| Step   | LL_StepGetFirstMachine     | LL_element*         | A pointer to the element associated with the first machine in the step.                                                                      |
| Step   | LL_StepGetFirstMachUsage   | LL_element*         | First Mach Usage                                                                                                                             |
| Step   | LL_StepGetFirstNode        | LL_element*         | A pointer to the element associated with the first node of the step.                                                                         |
| Step   | LL_StepGetFirstSwitchTable | LL_element*         | A pointer to the element associated with the first switch table for this step.                                                               |
| Step   | LL_StepGetMasterTask       | LL_element*         | A pointer to the element associated with the master task of the step.                                                                        |
| Step   | LL_StepGetNextAdapterReq   | LL_element*         | A pointer to the element associated with the next adapter requirement.                                                                       |
| Step   | LL_StepGetNextMachine      | LL_element*         | A pointer to the element associated with the next machine of the step.                                                                       |
| Step   | LL_StepGetNextMachUsage    | LL_element*         | Next Mach Usage of step                                                                                                                      |
| Step   | LL_StepGetNextNode         | LL_element*         | A pointer to the element associated with the next node of the step.                                                                          |
| Step   | LL_StepGetNextSwitchTable  | LL_element*         | A pointer to the element associated with the next switch table for this step.                                                                |
| Step   | LL_StepGroupSystemPriority | int*                | A pointer to an integer indicating the group priority of a job step.                                                                         |
| Step   | LL_StepHoldType            | int*                | A pointer to an integer indicating the hold state of the step (user, system, and so on). The value returned is in the HoldType enum.         |
| Step   | LL_StepHostList            | char***             | A pointer to an array containing the list of hosts in the <b>host.list</b> file associated with the step. The array ends with a null string. |
| Step   | LL_StepID                  | char**              | A pointer to a string containing the ID of the step.                                                                                         |

Table 52. Specifications for *ll\_get\_data* subroutine (continued)

| Object | Specification           | Resulting Data Type | Description                                                                                                                                                                        |
|--------|-------------------------|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Step   | LL_StepImageSize        | int*                | A pointer to an integer indicating the image size of the executable.                                                                                                               |
| Step   | LL_StepImageSize64      | int64_t*            | A pointer to a 64-bit integer indicating the image size of the executable.                                                                                                         |
| Step   | LL_StepInputFile        | char**              | A pointer to a string containing the standard input file name used by the executable.                                                                                              |
| Step   | LL_StepIwd              | char**              | A pointer to a string containing the initial working directory name used by the executable.                                                                                        |
| Step   | LL_StepJobClass         | char**              | A pointer to a string containing the class of the step.                                                                                                                            |
| Step   | LL_StepLargePage        | char**              | A pointer to a string containing the Large Page level of support associated with the job step.                                                                                     |
| Step   | LL_StepLoadLevelerGroup | char**              | A pointer to a string containing the name of the LoadLeveler group specified by the step.                                                                                          |
| Step   | LL_StepMachineCount     | int*                | A pointer to an integer indicating the number of machines assigned to the step.                                                                                                    |
| Step   | LL_StepMachUsageCount   | int*                | Count of Machine Usages                                                                                                                                                            |
| Step   | LL_StepMessages         | char**              | A pointer to a string containing a list of messages from LoadLeveler                                                                                                               |
| Step   | LL_StepName             | char**              | A pointer to a string containing the name of the step.                                                                                                                             |
| Step   | LL_StepNodeCount        | int*                | A pointer to an integer indicating the number of node objects associated with the step.                                                                                            |
| Step   | LL_StepNodeUsage        | int*                | A pointer to an integer indicating the node usage specified by the user (SHARED or NOT_SHARED). The value returned is in the enum Usage.                                           |
| Step   | LL_StepOutputFile       | char**              | A pointer to a character string containing the standard output file name used by the executable.                                                                                   |
| Step   | LL_StepParallelMode     | int*                | A pointer to an integer indicating the mode of the step.                                                                                                                           |
| Step   | LL_StepPreemptable      | int*                | A pointer to an integer indicating whether the job step is preemptable. The integer is set to 0 if the job step is not preemptable and is set to 1 if the job step is preemptable. |
| Step   | LL_StepPreemptWaitList  | char***             | A pointer to an array containing the job steps that an idle job must preempt. The array ends with a NULL string.                                                                   |
| Step   | LL_StepPriority         | int*                | A pointer to an integer indicating the priority of the step.                                                                                                                       |

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Table 52. Specifications for *ll\_get\_data* subroutine (continued)

| Object | Specification                 | Resulting Data Type | Description                                                                                                                                                                                                                       |
|--------|-------------------------------|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Step   | LL_StepQueueSystemPriority    | int*                | A pointer to an integer indicating the adjusted system priority of the job step. Only the CM has the current value for LL_StepQueueSystemPriority.                                                                                |
| Step   | LL_StepRequestedReservationID | char**              | A pointer to a string containing the step's requested reservation ID.                                                                                                                                                             |
| Step   | LL_StepReservationID          | char**              | A pointer to a string containing the step's reservation ID.                                                                                                                                                                       |
| Step   | LL_StepRestart                | int*                | A pointer to an integer representing whether restart is specified as yes (default value) or no by the user in the job command file. <ul style="list-style-type: none"> <li>• 1 indicates yes</li> <li>• 0 indicates no</li> </ul> |
| Step   | LL_StepRssLimitHard           | int*                | A pointer to an integer indicating the RSS hard limit set by the user in the <b>rss_limit</b> keyword.                                                                                                                            |
| Step   | LL_StepRssLimitHard64         | int64_t*            | A pointer to a 64-bit integer indicating the RSS hard limit set by the user in the <b>rss_limit</b> keyword.                                                                                                                      |
| Step   | LL_StepRssLimitSoft           | int*                | A pointer to an integer indicating the RSS soft limit set by the user in the <b>rss_limit</b> keyword.                                                                                                                            |
| Step   | LL_StepRssLimitSoft64         | int64_t*            | A pointer to a 64-bit integer indicating the RSS soft limit set by the user in the <b>rss_limit</b> keyword.                                                                                                                      |
| Step   | LL_StepShell                  | char**              | A pointer to a character string containing the shell name used by the executable.                                                                                                                                                 |
| Step   | LL_StepStackLimitHard         | int*                | A pointer to an integer indicating the stack hard limit set by the user in the <b>stack_limit</b> keyword.                                                                                                                        |
| Step   | LL_StepStackLimitHard64       | int64_t*            | A pointer to a 64-bit integer indicating the stack hard limit set by the user in the <b>stack_limit</b> keyword.                                                                                                                  |
| Step   | LL_StepStackLimitSoft         | int*                | A pointer to an integer indicating the stack soft limit set by the user in the <b>stack_limit</b> keyword.                                                                                                                        |
| Step   | LL_StepStackLimitSoft64       | int64_t*            | A pointer to a 64-bit integer indicating the stack soft limit set by the user in the <b>stack_limit</b> keyword.                                                                                                                  |
| Step   | LL_StepStartCount             | int*                | A pointer to an integer indicating the number of times the step has been started.                                                                                                                                                 |
| Step   | LL_StepStartDate              | time_t*             | A pointer to a time_t structure indicating the value the user specified in the <b>startdate</b> keyword.                                                                                                                          |
| Step   | LL_StepStarterIdrss64         | int64_t*            | Starter idrss value                                                                                                                                                                                                               |
| Step   | LL_StepStarterInblock64       | int64_t*            | Starter inblock value                                                                                                                                                                                                             |
| Step   | LL_StepStarterIsrss64         | int64_t*            | Starter isrss value                                                                                                                                                                                                               |

Table 52. Specifications for `ll_get_data` subroutine (continued)

| Object | Specification              | Resulting Data Type | Description                                                                                                                                                                |
|--------|----------------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Step   | LL_StepStarterIxrss64      | int64_t*            | Starter ixrss value                                                                                                                                                        |
| Step   | LL_StepStarterMajflt64     | int64_t*            | Starter majflt value                                                                                                                                                       |
| Step   | LL_StepStarterMaxrss64     | int64_t*            | Starter maxrss value                                                                                                                                                       |
| Step   | LL_StepStarterMinflt64     | int64_t*            | Starter minflt value                                                                                                                                                       |
| Step   | LL_StepStarterMsgrcv64     | int64_t*            | Starter msgrcv value                                                                                                                                                       |
| Step   | LL_StepStarterMsgsnd64     | int64_t*            | Starter msgsnd value                                                                                                                                                       |
| Step   | LL_StepStarterNivcsw64     | int64_t*            | Starter nivcsw value                                                                                                                                                       |
| Step   | LL_StepStarterNsignals64   | int64_t*            | Starter nsignals value                                                                                                                                                     |
| Step   | LL_StepStarterNswap64      | int64_t*            | Starter nswap value                                                                                                                                                        |
| Step   | LL_StepStarterNvcsw64      | int64_t*            | Starter nvcsw value                                                                                                                                                        |
| Step   | LL_StepStarterOublock64    | int64_t*            | Starter oublock value                                                                                                                                                      |
| Step   | LL_StepStarterSystemTime64 | int64_t*            | Starter system time                                                                                                                                                        |
| Step   | LL_StepStarterUserTime64   | int64_t*            | Starter user time                                                                                                                                                          |
| Step   | LL_StepStartTime           | time_t*             | A pointer to a time_t structure indicating the time at which the starter process for the job started. This value is retrieved from the schedd daemon and the history file. |
| Step   | LL_StepState               | int*                | A pointer to an integer indicating the state of the Step (Idle, Pending, Starting, etc.). The value returned is in the StepState enum.                                     |
| Step   | LL_StepStepIdrss64         | int64_t*            | Step idrss value                                                                                                                                                           |
| Step   | LL_StepStepInblock64       | int64_t*            | Step inblock value                                                                                                                                                         |
| Step   | LL_StepStepIsrss64         | int64_t*            | Step isrss value                                                                                                                                                           |
| Step   | LL_StepStepIxrss64         | int64_t*            | Step ixrss value                                                                                                                                                           |
| Step   | LL_StepStepMajflt64        | int64_t*            | Step majflt value                                                                                                                                                          |
| Step   | LL_StepStepMaxrss64        | int64_t*            | Step maxrss value                                                                                                                                                          |
| Step   | LL_StepStepMinflt64        | int64_t*            | Step minflt value                                                                                                                                                          |
| Step   | LL_StepStepMsgrcv64        | int64_t*            | Step msgrcv value                                                                                                                                                          |
| Step   | LL_StepStepMsgsnd64        | int64_t*            | Step msgsnd value                                                                                                                                                          |
| Step   | LL_StepStepNivcsw64        | int64_t*            | Step nivcsw value                                                                                                                                                          |
| Step   | LL_StepStepNsignals64      | int64_t*            | Step nsignals value                                                                                                                                                        |
| Step   | LL_StepStepNswap64         | int64_t*            | Step nswap value                                                                                                                                                           |
| Step   | LL_StepStepNvcsw64         | int64_t*            | Step nvcsw value                                                                                                                                                           |
| Step   | LL_StepStepOublock64       | int64_t*            | Step oublock value                                                                                                                                                         |
| Step   | LL_StepStepSystemTime64    | int64_t*            | Step system time                                                                                                                                                           |
| Step   | LL_StepStepUserTime64      | int64_t*            | Step user time                                                                                                                                                             |
| Step   | LL_StepSystemPriority      | int*                | A pointer to an integer indicating the overall system priority of the job step. Only the CM has the current value for LL_StepSystemPriority.                               |

## Data Access API

Table 52. Specifications for `ll_get_data` subroutine (continued)

| Object | Specification                 | Resulting Data Type | Description                                                                                                                                                                                                                                                                                                                                                                               |
|--------|-------------------------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Step   | LL_StepTaskGeometry           | char**              | A pointer to a string containing the values specified in the <code>task_geometry</code> statement by the user in the job command file. The syntax is the same as specified in the statement , {(task id, task id, ...) (task id, task id, ...) ...}. If unspecified, a null string is returned.                                                                                           |
| Step   | LL_StepTaskInstanceCount      | int*                | A pointer to an integer indicating the number of task instances in the step. This is only available from the <code>schedd</code> daemon.                                                                                                                                                                                                                                                  |
| Step   | LL_StepTasksPerNode Requested | int*                | A pointer to an integer representing the tasks per node specified by the user in the job command file. If unspecified, the integer will contain a 0.                                                                                                                                                                                                                                      |
| Step   | LL_StepTotalNodesRequested    | char**              | A pointer to a string containing the values specified by the user in the job command file node statement. The syntax is the same as specified in the statement, [min],[max], where min contains the minimum number of nodes requested and max contains the maximum nodes requested. If unspecified, a null string is returned.                                                            |
| Step   | LL_StepTotalTasksRequested    | int*                | A pointer to an integer representing the total tasks specified by the user in the job command file. If unspecified, the integer will contain a 0.                                                                                                                                                                                                                                         |
| Step   | LL_StepUserSystemPriority     | int*                | A pointer to an integer indicating the user system priority of the job step.                                                                                                                                                                                                                                                                                                              |
| Step   | LL_StepWallClockLimitHard     | int*                | A pointer to an integer indicating the wall clock hard limit set by the user in the <b>wall_clock_limit</b> keyword.                                                                                                                                                                                                                                                                      |
| Step   | LL_StepWallClockLimitHard64   | int64_t*            | A pointer to a 64-bit integer indicating the wall clock hard limit set by the user in the <b>wall_clock_limit</b> keyword.                                                                                                                                                                                                                                                                |
| Step   | LL_StepWallClockLimitSoft     | int*                | A pointer to an integer indicating the wall clock soft limit set by the user in the <b>wall_clock_limit</b> keyword.                                                                                                                                                                                                                                                                      |
| Step   | LL_StepWallClockLimitSoft64   | int64_t*            | A pointer to a 64-bit integer indicating the wall clock soft limit set by the user in the <b>wall_clock_limit</b> keyword.                                                                                                                                                                                                                                                                |
| Step   | LL_StepWallClockUsed          | int*                | A pointer to an integer that is the number of seconds of elapsed time for this step. This specification is valid only for step objects obtained from the <b>startd</b> daemon, and only when using the API or Gang scheduler, otherwise a value of zero is returned. The value does not include any time that a job step has spent in a preempted by suspend state or doing a checkpoint. |

Table 52. Specifications for *ll\_get\_data* subroutine (continued)

| Object        | Specification                       | Resulting Data Type | Description                                                                                  |
|---------------|-------------------------------------|---------------------|----------------------------------------------------------------------------------------------|
| Task          | LL_TaskExecutable                   | char**              | A pointer to a string containing the name of the executable.                                 |
| Task          | LL_TaskExecutableArguments          | char**              | A pointer to a string containing the arguments passed by the user in the executable.         |
| Task          | LL_TaskGetFirstResourceRequirement  | LL_element          | A pointer to the element associated with the first resource requirement.                     |
| Task          | LL_TaskGetFirstTaskInstance         | LL_element*         | A pointer to the element associated with the first task instance.                            |
| Task          | LL_TaskGetNextResourceRequirement   | LL_element*         | A pointer to the element associated with the next resource requirement.                      |
| Task          | LL_TaskGetNextTaskInstance          | LL_element*         | A pointer to the element associated with the next task instance.                             |
| Task          | LL_TaskIsMaster                     | int*                | A pointer to an integer, where I indicates master task.                                      |
| Task          | LL_TaskTaskInstanceCount            | int*                | A pointer to an integer indicating the number of task instances.                             |
| Task Instance | LL_TaskInstanceAdapterCount         | int*                | A pointer to the integer indicating the number of adapters.                                  |
| Task Instance | LL_TaskInstanceCpuList              | int*                | A pointer to the integer indicating the number of CPUs used by a given task instance object. |
| Task Instance | LL_TaskInstanceGetFirstAdapter      | LL_element*         | A pointer to the element associated with the first adapter.                                  |
| Task Instance | LL_TaskInstanceGetFirstAdapterUsage | LL_element*         | A pointer to the element associated with the first adapter usage.                            |
| Task Instance | LL_TaskInstanceGetNextAdapter       | LL_element*         | A pointer to the element associated with the next adapter.                                   |
| Task Instance | LL_TaskInstanceGetNextAdapterUsage  | LL_element*         | A pointer to the element associated with the next adapter usage.                             |
| Task Instance | LL_TaskInstanceMachineName          | char**              | A pointer to the string indicating the machine assigned to a task.                           |
| Task Instance | LL_TaskInstanceTaskID               | int*                | A pointer to the integer indicating the task ID.                                             |
| WlmStat       | LL_WlmStatCpuSnapshotUsage          | int*                | A pointer to CPU usage obtained from the AIX Workload Manager.                               |
| WlmStat       | LL_WlmStatCpuTotalUsage             | int64_t*            | A pointer to total CPU usage obtained from the AIX Workload Manager.                         |
| WlmStat       | LL_WlmStatMemoryHighWater           | int64_t*            | A pointer to real memory high water mark obtained from the AIX Workload Manager.             |
| WlmStat       | LL_WlmStatMemorySnapshotUsage       | int*                | A pointer to real memory usage obtained from the Workload Manager.                           |

## ll\_next\_obj subroutine

### Purpose

The **ll\_next\_obj** subroutine returns the next object in the *query\_element* list you specify.

### Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

### Syntax

```
#include "llapi.h"
```

```
LL_element * ll_next_obj (LL_element *query_element);
```

### Parameters

*query\_element*

Is a pointer to the **LL\_element** returned by the **ll\_query** function.

### Description

*query\_element* is the input field for this subroutine.

Use this subroutine in conjunction with the **ll\_get\_objs** subroutine to “loop” through the list of objects queried.

### Return values

This subroutine returns a pointer to the next object in the list.

### Error values

**NULL** Indicates an error or the end of the list of objects.

### Related information

Subroutines: **ll\_get\_data**, **ll\_set\_request**, **ll\_query**, **ll\_get\_objs**, **ll\_free\_objs**, **ll\_deallocate**, **ll\_cluster**

## ll\_free\_objs subroutine

### Purpose

The **ll\_free\_objs** subroutine frees all of the **LL\_element** objects in the *query\_element* list that were obtained by the **ll\_get\_objs** subroutine. You must free the *query\_element* by using the **ll\_deallocate** subroutine.

### Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

### Syntax

```
#include "llapi.h"
```

```
int ll_free_objs (LL_element *query_element);
```

### Parameters

*query\_element*

Is a pointer to the **LL\_element** returned by the **ll\_query** function.

### Description

*query\_element* is the input field for this subroutine.

**Return values**

This subroutine returns a zero to indicate success.

**Error values**

-1        You specified a *query\_element* that is not valid.

**Related information**

Subroutines: `ll_get_data`, `ll_set_request`, `ll_query`, `ll_get_objs`, `ll_reset_request`, `ll_free_objs`

**ll\_deallocate subroutine****Purpose**

The `ll_deallocate` subroutine deallocates the *query\_element* allocated by the `ll_query` subroutine.

**Library**

LoadLeveler API library `libllapi.a` (AIX) or `libllapi.so` (Linux)

**Syntax**

```
#include "llapi.h"
```

```
int ll_deallocate (LL_element *query_element);
```

**Parameters**

*query\_element*

Is a pointer to the `LL_element` returned by the `ll_query` function.

**Description**

*query\_element* is the input field for this subroutine.

**Return values**

This subroutine returns a zero to indicate success.

**Error values**

-1        You specified a *query\_element* that is not valid.

**Related information**

Subroutines: `ll_get_data`, `ll_set_request`, `ll_query`, `ll_get_objs`, `ll_reset_request`, `ll_next_obj`, `ll_free_objs`

**Examples of using the Data Access API**

These examples are provided in the `samples/lldata_access` subdirectory of the release directory (usually `/usr/lpp/LoadL/full`).

**Example 1:** The following example shows how LoadLeveler's Data Access API can be used to obtain machine, job, and cluster information. The program consists of three steps:

1. Getting information about selected hosts in the LoadLeveler cluster
2. Getting information about jobs of selected classes
3. Getting floating consumable resource information in the LoadLeveler cluster

## Data Access API

```
#include <stdio.h>
#include "llapi.h"

main(int argc, char *argv[])
{
 LL_element *queryObject, *machine, *resource, *cluster;
 LL_element *job, *step, *node, *task, *credential, *resource_req;
 int rc, obj_count, err_code, value;
 double load_avg;
 enum StepState step_state;
 char **host_list, **class_list;
 char *name, *res_name, *step_id, *job_class, *node_req;
 char *task_exec, *ex_args, *startd_state;

 /* Step 1: Display information of selected machines in the LL cluster */

 /* Initialize the query: Machine query */
 queryObject = ll_query(MACHINES);
 if (!queryObject) {
 printf("Query MACHINES: ll_query() returns NULL.\n"); exit(1);
 }

 /* Set query parameters: query specific machines by name */
 host_list = (char **)malloc(3*sizeof(char *));
 host_list[0] = "c163n12.ppd.pok.ibm.com";
 host_list[1] = "c163n11.ppd.pok.ibm.com";
 host_list[2] = NULL;
 rc = ll_set_request(queryObject, QUERY_HOST, host_list, ALL_DATA);
 if (rc) {
 printf("Query MACHINES: ll_set_request() return code is non-zero.\n"); exit(1);
 }

 /* Get the machine objects from the LoadL_negotiator (central manager) daemon */
 machine = ll_get_objs(queryObject, LL_CM, NULL, &obj_count, &err_code);
 if (machine == NULL) {
 printf("Query MACHINES: ll_get_objs() returns NULL. Error code = %d\n", err_code);
 }
 printf("Number of machines objects returned = %d\n", obj_count);

 /* Process the machine objects */
 while(machine) {
 rc = ll_get_data(machine, LL_MachineName, &name);
 if (!rc) {
 printf("Machine name: %s -----\n", name); free(name);
 }
 rc = ll_get_data(machine, LL_MachineStartdState, &startd_state);
 if (rc) {
 printf("Query MACHINES: ll_get_data() return code is non-zero.\n"); exit(1);
 }
 }
}
```

Figure 39. Obtaining machine, job, and cluster information with the Data Access API (Part 1 of 4)

```

printf("Startd State: %s\n", startd_state);
if (strcmp(startd_state, "Down") != 0) {
 rc = ll_get_data(machine, LL_MachineRealMemory, &value);
 if (!rc) printf("Total Real Memory: %d\n", value);
 rc = ll_get_data(machine, LL_MachineVirtualMemory, &value);
 if (!rc) printf("Free Swap Space: %d\n", value);
 rc = ll_get_data(machine, LL_MachineLoadAverage, &load_avg);
 if (!rc) printf("Load Average: %f\n", load_avg);
}
free(startd_state);
/* Consumable Resources associated with this machine */
resource = NULL;
ll_get_data(machine, LL_MachineGetFirstResource, &resource);
while(resource) {
 rc = ll_get_data(resource, LL_ResourceName, &res_name);
 if (!rc) {printf("Resource Name = %s\n", res_name); free (res_name);}
 rc = ll_get_data(resource, LL_ResourceInitialValue, &value);
 if (!rc) printf(" Total: %d\n", value);
 rc = ll_get_data(resource, LL_ResourceAvailableValue, &value);
 if (!rc) printf(" Available: %d\n", value);
 resource = NULL;
 ll_get_data(machine, LL_MachineGetNextResource, &resource);
}
machine = ll_next_obj(queryObject);
}

/* Free objects obtained from Negotiator */
ll_free_objs(queryObject);
/* Free query element */
ll_deallocate(queryObject);

/* Step 2: Display information of selected jobs */

/* Initialize the query: Job query */
queryObject = ll_query(JOBS);
if (!queryObject) {
 printf("Query JOBS: ll_query() returns NULL.\n");
 exit(1);
}

/* Query all class "Parallel" and "No_Class" jobs submitted to c163n11, c163n12 */
class_list = (char **)malloc(3*sizeof(char *));
class_list[0] = "Parallel";
class_list[1] = "No_Class";
class_list[2] = NULL;
rc = ll_set_request(queryObject, QUERY_HOST, host_list, ALL_DATA);
if (rc) {printf("Query JOBS: ll_set_request() return code is non-zero.\n"); exit(1);}
rc = ll_set_request(queryObject, QUERY_CLASS, class_list, ALL_DATA);
if (rc) {printf("Query JOBS: ll_set_request() return code is non-zero.\n"); exit(1);}

/* Get the requested job objects from the Central Manager */
job = ll_get_objs(queryObject, LL_CM, NULL, &obj_count, &err_code);
if (job == NULL) {
 printf("Query JOBS: ll_get_objs() returns NULL. Error code = %d\n", err_code);
}
printf("Number of job objects returned = %d\n", obj_count);

/* Process the job objects and display selected information of each job step.

```

Figure 39. Obtaining machine, job, and cluster information with the Data Access API (Part 2 of 4)

## Data Access API

```
*
* Notes:
* 1. Since LL_element is defined as "void" in llapi.h, when using
* ll_get_data it is important that a valid "specification"
* parameter be used for a given "element" argument.
* 2. Checking of return code is not always made in the following
* loop to minimize the length of the listing.
*/

while(job) {
 rc = ll_get_data(job, LL_JobName, &name);
 if (!rc) {printf("Job name: %s\n", name); free(name);}

 rc = ll_get_data(job, LL_JobCredential, &credential);
 if (!rc) {
 rc = ll_get_data(credential, LL_CredentialUserName, &name);
 if (!rc) {printf("Job owner: %s\n", name); free(name);}
 rc = ll_get_data(credential, LL_CredentialGroupName, &name);
 if (!rc) {printf("Unix Group: %s\n", name); free(name);}
 }
 step = NULL;
 ll_get_data(job, LL_JobGetFirstStep, &step);
 while(step) {
 rc = ll_get_data(step, LL_StepID, &step_id);
 if (!rc) {printf(" Step ID: %s\n", step_id); free(step_id);}
 rc = ll_get_data(step, LL_StepJobClass, &job_class);
 if (!rc) {printf(" Step Job Class: %s\n", job_class); free(job_class);}
 rc = ll_get_data(step, LL_StepState, &step_state);
 if (!rc) {
 if (step_state == STATE_RUNNING) {
 printf(" Step Status: Running\n");
 printf(" Allocated Hosts:\n");
 machine = NULL;
 ll_get_data(step, LL_StepGetFirstMachine, &machine);
 while(machine) {
 rc = ll_get_data(machine, LL_MachineName, &name);
 if (!rc) {printf(" %s\n", name); free(name);}
 machine = NULL;
 ll_get_data(step, LL_StepGetNextMachine, &machine);
 }
 }
 else {
 printf(" Step Status: Not Running\n");
 }
 }
 node = NULL;
 ll_get_data(step, LL_StepGetFirstNode, &node);
 while(node) {
 rc = ll_get_data(node, LL_NodeRequirements, &node_req);
 if (!rc) {printf(" Node Requirements: %s\n", node_req); free(node_req);}
 task = NULL;
 ll_get_data(node, LL_NodeGetFirstTask, &task);
 while(task) {
```

Figure 39. Obtaining machine, job, and cluster information with the Data Access API (Part 3 of 4)

```

 rc = ll_get_data(task, LL_TaskExecutable, &task_exec);
 if (!rc) {printf(" Task Executable: %s\n", task_exec); free(task_exec);}
 rc = ll_get_data(task, LL_TaskExecutableArguments, &ex_args);
 if (!rc) {printf(" Task Executable Arguments: %s\n", ex_args);
 free(ex_args);}
 resource_req = NULL;
 ll_get_data(task, LL_TaskGetFirstResourceRequirement, &resource_req);
 while(resource_req) {
 rc = ll_get_data(resource_req, LL_ResourceRequirementName, &name);
 if (!rc) {printf(" Resource Req Name: %s\n", name); free(name);}
 rc = ll_get_data(resource_req, LL_ResourceRequirementValue, &value);
 if (!rc) {printf(" Resource Req Value: %d\n", value);}
 resource_req = NULL;
 ll_get_data(task, LL_TaskGetNextResourceRequirement, &resource_req);
 }
 task = NULL;
 ll_get_data(node, LL_NodeGetNextTask, &task);
}
node = NULL;
ll_get_data(step, LL_StepGetNextNode, &node);
}
step = NULL;
ll_get_data(job, LL_JobGetNextStep, &step);
}
job = ll_next_obj(queryObject);
}
ll_free_objs(queryObject);
ll_deallocate(queryObject);

/* Step 3: Display Floating Consumable Resources information of LL cluster. */

/* Initialize the query: Cluster query */
queryObject = ll_query(CLUSTERS);
if (!queryObject) {
 printf("Query CLUSTERS: ll_query() returns NULL.\n");
 exit(1);
}
ll_set_request(queryObject, QUERY_ALL, NULL, ALL_DATA);
cluster = ll_get_objs(queryObject, LL_CM, NULL, &obj_count, &err_code);
if (!cluster) {
 printf("Query CLUSTERS: ll_get_objs() returns NULL. Error code = %d\n", err_code);
}
printf("Number of Cluster objects = %d\n", obj_count);
while(cluster) {
 resource = NULL;
 ll_get_data(cluster, LL_ClusterGetFirstResource, &resource);
 while(resource) {
 rc = ll_get_data(resource, LL_ResourceName, &res_name);
 if (!rc) {printf("Resource Name = %s\n", res_name); free(res_name);}
 rc = ll_get_data(resource, LL_ResourceInitialValue, &value);
 if (!rc) {printf("Resource Initial Value = %d\n", value);}
 rc = ll_get_data(resource, LL_ResourceAvailableValue, &value);
 if (!rc) {printf("Resource Available Value = %d\n", value);}
 resource = NULL;
 ll_get_data(cluster, LL_ClusterGetNextResource, &resource);
 }
 cluster = ll_next_obj(queryObject);
}
ll_free_objs(queryObject);
ll_deallocate(queryObject);
}

```

Figure 39. Obtaining machine, job, and cluster information with the Data Access API (Part 4 of 4)

**Example 2:** The following example shows how LoadLeveler's Data Access API can be used to extract job accounting information saved in a history file.

## Data Access API

```
#include <stdio.h>
#include "llapi.h"
#define STR_NULL(ptr) (ptr ? ptr : "")

main(int argc, char *argv[])
{
 LL_element *queryObject, *job = NULL, *step = NULL;
 LL_element *mach_usage = NULL, *disp_usage = NULL, *event_usage = NULL;
 int64_t int64_data;
 int rc, obj_count, err_code, job_count, step_count, int_data;
 char *str_data;
 char *start_dates[] = { "01/23/2005", "01/25/2005", NULL };
 char *end_dates[] = { "01/23/2005", "02/01/2005", NULL };
 int mach_usage_count, disp_usage_count, event_usage_count;

 /* Initialize the query: Job query */
 queryObject = ll_query(JOBS);
 if (!queryObject) { printf("Query JOBS: ll_query() returns NULL.\n"); exit(1); }

 /* Request information of job steps started/ended between certain dates. */
 rc = ll_set_request(queryObject, QUERY_STARTDATE, start_dates, ALL_DATA);
 if (rc) { printf("ll_set_request() - QUERY_STARTDATE - RC = %d\n", rc); exit(1); }
 rc = ll_set_request(queryObject, QUERY_ENDDATE, end_dates, ALL_DATA);
 if (rc) { printf("ll_set_request() - QUERY_ENDDATE - RC = %d\n", rc); exit(1); }

 /* Get the requested job objects from the specified history file. */
 job = ll_get_objs(queryObject, LL_HISTORY_FILE,
 "/tmp/spool/c209f1n05/history", &obj_count, &err_code);
 if (!job) { printf("ll_get_objs() returns NULL. Error code = %d\n", err_code); exit(1); }

 printf("*****\n");
 printf("Number of job objects returned = %d\n", obj_count);
 printf("*****\n");

 /* Loop through the job objects. */
 job_count = 0;
 while (job) {
 job_count++;
 printf("=====\n");
 printf("Job number = %d\n", job_count);

 /* Loop through the job step objects. */
 }
}
```

Figure 40. Extracting job accounting information from a history file (Part 1 of 3)

```

ll_get_data(job, LL_JobGetFirstStep, &step);
step_count = 0;
while (step) {
 step_count++;
 printf("=====\n");
 printf(" Step number = %d\n", step_count);
 ll_get_data(step, LL_StepID, &str_data);
 printf(" LL_StepID = %s\n", STR_NULL(str_data));
 ll_get_data(step, LL_StepImageSize, &int_data);
 printf(" LL_StepImageSize = %d\n", int_data);
 ll_get_data(step, LL_StepImageSize64, &int64_data);
 printf(" LL_StepImageSize64 = %lld\n", int64_data);

 /* Process CPU limit */
 ll_get_data(step, LL_StepCpuLimitHard, &int_data);
 printf(" LL_StepCpuLimitHard = %d\n", int_data);
 ll_get_data(step, LL_StepCpuLimitHard64, &int64_data);
 printf(" LL_StepCpuLimitHard64 = %lld\n", int64_data);
 ll_get_data(step, LL_StepCpuLimitSoft, &int_data);
 printf(" LL_StepCpuLimitSoft = %d\n", int_data);
 ll_get_data(step, LL_StepCpuLimitSoft64, &int64_data);
 printf(" LL_StepCpuLimitSoft64 = %lld\n", int64_data);

 /* Job Step CPU limit */
 ll_get_data(step, LL_StepCpuStepLimitHard64, &int64_data);
 printf(" LL_StepCpuStepLimitHard64 = %lld\n", int64_data);
 ll_get_data(step, LL_StepCpuStepLimitSoft64, &int64_data);
 printf(" LL_StepCpuStepLimitSoft64 = %lld\n", int64_data);

 /* Process Data Limit */
 ll_get_data(step, LL_StepDataLimitHard64, &int64_data);
 printf(" LL_StepDataLimitHard64 = %lld\n", int64_data);
 ll_get_data(step, LL_StepDataLimitSoft64, &int64_data);
 printf(" LL_StepDataLimitSoft64 = %lld\n", int64_data);

 /* CPU time used by the job step. */
 ll_get_data(step, LL_StepStepUserTime64, &int64_data);
 printf(" LL_StepStepUserTime64 = %lld (microsecs)\n", int64_data);
 ll_get_data(step, LL_StepStepSystemTime64, &int64_data);
 printf(" LL_StepStepSystemTime64 = %lld (microsecs)\n", int64_data);

 /* Loop through the machine usage objects. */
 /* A parallel job step run on 3 machines typically has 3 machine usage objects. */
 mach_usage_count = 0;
 rc = ll_get_data(step, LL_StepGetFirstMachUsage, &mach_usage);
 while (mach_usage) {
 mach_usage_count++;

```

Figure 40. Extracting job accounting information from a history file (Part 2 of 3)

## Data Access API

```
printf(" -----\\n");
printf(" Machine Usage number = %d\\n", mach_usage_count);
ll_get_data(mach_usage, LL_MachUsageMachineName, &str_data);
printf(" Machine name = %s\\n", STR_NULL(str_data));

/* Loop through the dispatch usage objects. */
disp_usage_count = 0;
ll_get_data(mach_usage, LL_MachUsageGetFirstDispUsage, &disp_usage);
while (disp_usage) {
 disp_usage_count++;
 printf(" -----\\n");
 printf(" Dispatch Usage number = %d\\n", disp_usage_count);

 ll_get_data(disp_usage, LL_DispatchUsageStepUserTime64, &int64_data);
 printf(" LL_DispatchUsageStepUserTime64 = %lld (microsecs)\\n", int64_data);
 ll_get_data(disp_usage, LL_DispatchUsageStepSystemTime64, &int64_data);
 printf(" LL_DispatchUsageStepSystemTime64 = %lld (microsecs)\\n", int64_data);

 /* Loop through the event usage objects. */
 /* Each dispatch typically has 2 events: "started" and "completed". */
 /* There may be other events if the LL administrator executes the command */
 /* "llctl -g capture <user event name>" while the job is running. */
 event_usage_count = 0;
 ll_get_data(disp_usage, LL_DispatchUsageGetFirstEventUsage, &event_usage);
 while (event_usage) {
 event_usage_count++;
 printf(" -----\\n");
 printf(" Event Usage number = %d\\n", event_usage_count);
 ll_get_data(event_usage, LL_EventUsageEventName, &str_data);
 printf(" LL_EventUsageEventName = %s\\n", STR_NULL(str_data));
 ll_get_data(event_usage, LL_EventUsageStepUserTime64, &int64_data);
 printf(" LL_EventUsageStepUserTime64 = %lld (microsecs)\\n", int64_data);
 ll_get_data(event_usage, LL_EventUsageStepSystemTime64, &int64_data);
 printf(" LL_EventUsageStepSystemTime64 = %lld (microsecs)\\n", int64_data);
 ll_get_data(disp_usage, LL_DispatchUsageGetNextEventUsage, &event_usage);
 }
 ll_get_data(mach_usage, LL_MachUsageGetNextDispUsage, &disp_usage);
}
rc = ll_get_data(step, LL_StepGetNextMachUsage, &mach_usage);
}
ll_get_data(job, LL_JobGetNextStep, &step);
}
job = ll_next_obj(queryObject);
}
exit(0);
}
```

Figure 40. Extracting job accounting information from a history file (Part 3 of 3)

---

## Error Handling API

This API allows you to gather the information contained in the LoadLeveler error object and output that information as an error message.

### ll\_error subroutine

#### Purpose

This routine converts a LoadLeveler error object to an error message string. As an option, you can print the error message string to stdout or stderr.

#### Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

## Syntax

```
#include "llapi.h"
```

```
char *ll_error (LL_element **errObj, int print_to);
```

## Parameters

*errObj*

This is the address of a pointer to a LoadLeveler error object. A NULL *errObj* pointer indicates that any internal error objects will be printed.

*print\_to*

1 - print error message to stdout

2 - print error message to stderr

Any other value - no error message printed

## Description

This subroutine also prints any error messages generated by APIs that do not support an error object as a parameter. When called with a NULL *errObj*, any error messages previously stored by such APIs, will be printed as directed by the *print\_to* parameter and then deleted.

It is the caller's responsibility to free the storage associated with the error message string.

The LoadLeveler error object pointed to by *\*errObj* is deleted upon exit and NULL is assigned to *\*errObj*.

## Return values

The **ll\_error** API returns a NULL return code if there is no error object to print.

---

## Parallel Job API

**Note:** This is the last release that LoadLeveler will support the Parallel Job API.

If you are using any of the parallel operating environments already supported by LoadLeveler, you do not have to use the parallel API. However, if you have another application environment that you want to use, you need to use the subroutines described here to interface with LoadLeveler.

LoadLeveler for Linux does not support the parallel job API.

The parallel job API consists of two subroutines:

- **ll\_get\_hostlist** acquires the list of LoadLeveler selected parallel nodes.
- **ll\_start\_host** starts the parallel task under the LoadLeveler starter.

The following section describes how parallel job submission works. Understanding this will help you to better understand the parallel API.

## Interaction between LoadLeveler and the parallel API

This API does not give you access to any new LoadLeveler functions from Version 2 Release 1.0, or later releases.

## Parallel Job API

Program applications which use the parallel APIs to interface with LoadLeveler are supported under a job type called **parallel**. When a user submits a job specifying the keyword **job\_type** equal to **parallel**, the LoadLeveler API job control flow is as follows:

The negotiator selects nodes based on the resources you request. Once the nodes have been obtained, the negotiator contacts the schedd to start the job. The schedd marks the job pending and contacts the affected startds to start their starter processes.

One machine becomes the **Master Starter**. The Master Starter is one of the selected parallel nodes. After all starters are started and have completed initialization, the Master Starter starts the executable specified in the job command file. The executable referred to as the **Parallel Master** uses this API to start tasks on remote nodes. A **LOADLBATCH** environment variable is set to **YES** so that the Parallel Master can distinguish between callers.

The Parallel Master must:

- Obtain the machine list through the **ll\_get\_hostlist** API.
- Start a task on all allocated machines through the **ll\_start\_host** API. It is mandatory that one and only one task be started on each machine. Each task is considered a Parallel Slave. Acquiring the task name, path and arguments is the responsibility of the Parallel Master. The user may pass this information through the **arguments** or **environment** keywords in the job command file.

When the Parallel Master starts, the job is marked Running. Once the Parallel Master and all tasks exit, the job is marked Complete.

### Termination paths

The Parallel Master is expected to cleanup and exit when:

- All of the Parallel Slaves have exited.
- A negative value is returned by either the **ll\_get\_hostlist** or **ll\_start\_host** subroutine.
- A **SIGCONT**, followed by a **SIGTERM**, is received. A possible reason for this is that LoadLeveler receives a job cancel request.  
The **SIGTERM** is also sent to all parallel tasks.
- A **SIGCONT**, followed by a **SIGUSR1**, is received. Reasons for this include:
  - The Parallel Master receives a **VACATE** or **FLUSH** request.
  - LoadLeveler receives a stop LoadLeveler daemons command.The **SIGUSR1** is also sent to all parallel tasks.

A **SIGKILL** is issued to any process which does not exit within two minutes of receiving a termination signal.

Note that a **SIGUSR1** indicates the job must terminate but will be restarted, while a **SIGTERM** indicates the job must terminate but will not be restarted.

## ll\_get\_hostlist subroutine

### Purpose

This subroutine obtains a list of machines from the Master Starter machine so that the Parallel Master can start the Parallel Slaves. The Parallel Master is the

LoadLeveler executable specified in the job command file and the Parallel Slaves are the processes started by the Parallel Master through the `ll_start_host` API.

**Note:** This API is obsolete and is supported for backward compatibility only.

## Library

LoadLeveler API library `libllapi.a`

## Syntax

```
int ll_get_hostlist (struct JM_JOB_INFO* jobinfo);
```

## Parameters

*jobinfo* is a pointer to the `JM_JOB_INFO` structure defined in `llapi.h`. No fields are required to be filled in. `ll_get_hostlist` allocates storage for an array of `JM_NODE_INFO` structures and returns the pointer in the *jm\_min\_node\_info* pointer. It is the caller's responsibility to free this storage.

```
struct JM_JOB_INFO {
 int jm_request_type;
 char jm_job_description[50];
 enum JM_ADAPTER_TYPE jm_adapter_type;
 int jm_css_authentication;
 int jm_min_num_nodes;
 struct JM_NODE_INFO *jm_min_node_info;
};

struct JM_NODE_INFO {
 char jm_node_name [MAXHOSTNAMELEN];
 char jm_node_address [50];
 int jm_switch_node_number;
 int jm_pool_id;
 int jm_cpu_usage;
 int jm_adapter_usage;
 int jm_num_virtual_tasks;
 int *jm_virtual_task_ids;
 enum JM_RETURN_CODE jm_return_code;
};
```

The following data is filled in for the `JM_JOB_INFO` structure:

*jm\_min\_num\_nodes*

Is the number of elements in the array of `JM_NODE_INFO` structures. It is the number of hosts allocated to a job.

*jm\_min\_node\_info*

Is the pointer to the array of `JM_NODE_INFO` structures. The first entry in this array describes the node which is mapped to task 0. The second entry is mapped to task 1, and so on.

The following data is filled in for each `JM_NODE_INFO` structure:

*jm\_node\_name*

Is the name of the node.

*jm\_node\_address*

Is the address corresponding to the adapter requested.

*jm\_switch\_node\_number*

Is the relative node number set only for jobs running on the SP switch adapter. For all other jobs it is set to -1.

### Description

The Parallel Master must:

- Issue error messages as appropriate.
- Exit when **ll\_get\_hostlist** returns with a negative return value. The Parallel Master exit status is included in the job mail returned to the user.

### Return values

This subroutine returns a zero to indicate success.

### Error values

- 2 Cannot get LoadLeveler step ID from environment.
- 5 Cannot make socket. This means that the UNIX stream socket could not be created. This socket is needed to establish communications with the starter for both of the API's functions.
- 6 Cannot connect to host.
- 8 Cannot get hostlist.
- 10 DCE identity cannot be determined.
- 11 No DCE credentials.
- 12 DCE credentials within 300 secs of expiration.
- 13 64-bit API not supported when DCE is enabled.

## ll\_start\_host subroutine

### Purpose

This subroutine starts a task on a selected machine.

### Library

LoadLeveler API library **libllapi.a**

### Syntax

```
int ll_start_host (char *host, char *start_cmd);
```

### Parameters

*host*

Is the name of the node on which you want to start the task.

*start\_cmd*

Is the actual command to execute on the node, including flags and arguments.

### Description

This function must be invoked for all the machines returned from the **ll\_get\_hostlist** subroutine once and only once by the Parallel Master. Acquiring the **start\_cmd** is the responsibility of the Parallel Master. The user may pass this information through the **arguments** or **environment** keywords in the job command file.

The Parallel Master must:

- Issue error messages as appropriate.
- Exit when **ll\_start\_host** returns a negative value. The Parallel Master exit status is included in the job mail returned to the user.

### Return values

This subroutine returns an integer greater than one to indicate the socket connected to the Parallel Slave's standard I/O (stdio).

**Error values**

- 2 Cannot get LoadLeveler step ID from environment.
- 4 Nameserver cannot resolve host.
- 6 Cannot connect to host.
- 7 Cannot send PASS\_OPEN\_SOCKET command to remote startd.
- 9 The command you specified failed.

**Examples**

A sample program called **para\_api.c** is provided in the **samples/lppara** subdirectory of the release directory, usually **/usr/lpp/LoadL/full**.

In order to run this example, you need to do the following:

1. Copy the sample Makefile and the sample program called **para\_api.c** to your home directory.
2. Update the **startCmd** variable in **para\_api.c** to reflect your home directory versus **/usr/lpp/LoadL/full/samples/lppara**. For example:

```
char *startCmd = "/home/user/para_api -s";
```

3. Issue **make** to create the executable **para\_api**.
4. Update your job command file as follows:

```
#!/bin/ksh
@ initialdir = /home/user
@ executable = para_api
@ output = para_api.${cluster}.${process}.out
@ error = para_api.${cluster}.${process}.err
@ job_type = parallel
@ min_processors = 2
@ max_processors = 2
@ queue
```

5. Submit the job command file to LoadLeveler.

The syntax to invoke the Parallel Master is:

```
para_api
```

The syntax to invoke the Parallel Slave is:

```
para_api -s
```

The Parallel Master does the following:

- Acquires the hostlist through the **ll\_get\_hostlist** API and prints out the returned fields.
- Starts a Parallel Slave task by executing the command specified in the **StartCmd** variable on all hosts returned in the hostlist.
- Acquires the socket connected to the Parallel Slave's standard I/O (stdio).
- Writes a command over the socket to verify stdin.
- Reads acknowledgments over the socket to verify stderr and stdout.
- Prints out host names and acknowledgments.

Example output follows:

```
num_nodes=2
```

```
name=host1.kgn.ibm.com address=9.115.8.162 switch_number=-1
```

```
name=host2.kgn.ibm.com address=9.115.8.164 switch_number=-1
```

```
Connected to host1.kgn.ibm.com at sock 3
```

```
Received acko "8000" and acke "10000" from host 0
```

## Parallel Job API

```
Connected to host2.kgn.ibm.com at sock 4
Received acko "8001" and acke "10001" from host 1
```

```
<Master Exiting>
```

The Parallel Slave does the following:

- Reads command from stdin.
- Writes acknowledgment to stdout and stderr.

---

## Query API

This API provides information about the jobs and machines in the LoadLeveler cluster. You can use this together with the workload management API, since the workload management API requires you to know which machines are available and which jobs need to be scheduled. See “Workload Management API” on page 561 for more information. These APIs exist for backward compatibility. It is recommended that you use the Data Access API when possible.

LoadLeveler for Linux does not support the query API.

The query API consists of the following subroutines: **ll\_get\_jobs**, **ll\_free\_jobs**, **ll\_get\_nodes**, and **ll\_free\_nodes**.

### ll\_get\_jobs subroutine

#### Purpose

This subroutine, available to any user, returns information about all jobs in the LoadLeveler job queue.

**Note:** This is an obsolete API and is supported for backward compatibility only.

#### Library

LoadLeveler API library **libllapi.a**

#### Syntax

```
#include "llapi.h"
```

```
int ll_get_jobs (LL_get_jobs_info *);
```

#### Parameters

*ptr* Specifies the pointer to the **LL\_get\_jobs\_info** structure that was allocated by the caller. The **LL\_get\_jobs\_info** members are:

**int** *version\_num*

Represents the version number of the **LL\_start\_job\_info** structure. This should be set to **LL\_PROC\_VERSION**.

**int** *numJobs*

Represents the number of entries in the array.

**LL\_job** *\*\*JobList*

Represents the pointer to an array of **LL\_job** structures. The **LL\_job** structure is defined in **llapi.h**.

#### Description

The **LL\_get\_jobs\_info** structure contains an array of **LL\_job** structures indicating each job in the LoadLeveler system.

Some job information, such as the start time of the job, is not available to this API. (It is recommended that you use the dispatch time, which is available, in place of the start time.) Also, some accounting information is not available to this API.

### Return values

This subroutine returns a value of zero when successful. Otherwise, it returns an integer value defined in the **llapi.h** file.

### Error values

- 1      There is an error in the input parameter.
- 2      The API cannot connect to the central manager.
- 3      The API cannot allocate memory.
- 4      A configuration error occurred.
- 16     DCE identity cannot be determined.
- 17     No DCE credentials.
- 18     DCE credentials within 300 secs of expiration.
- 19     64-bit API not supported when DCE is enabled.

### Examples

Makefiles and examples which use this subroutine are located in the **samples/llsch** subdirectory of the release directory.

### Related information

Subroutines: **ll\_free\_jobs**, **ll\_free\_nodes**, **ll\_get\_nodes**.

## ll\_free\_jobs subroutine

### Purpose

This subroutine, available to any user, frees storage that was allocated by **ll\_get\_jobs**.

### Library

LoadLeveler API library **libllapi.a**

### Syntax

```
#include "llapi.h"

int ll_free_jobs (LL_get_jobs_info *ptr);
```

### Parameters

*ptr* Specifies the address of the **LL\_get\_jobs\_info** structure to be freed.

### Description

This subroutine frees the storage pointed to by the **LL\_get\_jobs\_info** pointer.

### Return values

This subroutine returns a value of zero when successful. Otherwise, it returns an integer value defined in the **llapi.h** file.

### Error values

- 8      The *version\_num* member of the **LL\_get\_jobs\_info** structure did not match the current version.

### Examples

Makefiles and examples which use this subroutine are located in the **samples/llsch** subdirectory of the release directory.

### Related information

Subroutines: `ll_get_jobs`, `ll_free_nodes`, `ll_get_nodes`

## ll\_get\_nodes subroutine

### Purpose

This subroutine, available to any user, returns information about all of nodes known by the negotiator daemon.

**Note:** This is an obsolete API and is supported for backward compatibility only.

### Library

LoadLeveler API library `libllapi.a`

### Syntax

```
#include "llapi.h"
```

```
int ll_get_nodes(LL_get_nodes_info *ptr);
```

### Parameters

*ptr* Specifies the pointer to the `LL_get_nodes_info` structure that was allocated by the caller. The `LL_get_nodes_info` members are:

`int version_num`

Represents the version number of the `LL_start_job_info` structure.

`int numNodes`

Represents the number of entries in the *NodeList* array.

`LL_node **NodeList`

Represents the pointer to an array of `LL_node` structures. The `LL_node` structure is defined in `llapi.h`.

### Description

The `LL_get_node_info` structure contains an array of `LL_job` structures indicating each node in the LoadLeveler system.

### Return values

This subroutine returns a value of zero when successful.

### Error values

- 1 There is an error in the input parameter.
- 2 The API cannot connect to the central manager.
- 3 The API cannot allocate memory.
- 4 A configuration error occurred.
- 16 DCE identity cannot be determined.
- 17 No DCE credentials.
- 18 DCE credentials within 300 secs of expiration.
- 19 64-bit API not supported when DCE is enabled.

### Examples

Makefiles and examples which use this subroutine are located in the `samples/llsch` subdirectory of the release directory.

### Related information

Subroutines: `ll_free_jobs`, `ll_free_nodes`, `ll_get_jobs`

## ll\_free\_nodes subroutine

### Purpose

This subroutine, available to any user, frees storage that was allocated by `ll_get_nodes`.

### Library

LoadLeveler API library `libllapi.a`

### Syntax

```
#include "llapi.h"
```

```
int ll_nodes_jobs (LL_get_nodes_info *ptr);
```

### Parameters

*ptr* Specifies the address of the `LL_get_nodes_info` structure to be freed.

### Description

This subroutine frees the storage pointed to by the `LL_get_nodes_info` pointer.

### Return values

This subroutine returns a value of zero when successful.

### Error values

-8 The *version\_num* member of the `LL_get_jobs_info` structure did not match the current version.

### Examples

Makefiles and examples which use this subroutine are located in the `samples/llsch` subdirectory of the release directory.

### Related information

Subroutines: `ll_get_jobs`, `ll_free_nodes`, `ll_get_nodes`

---

## Reservation API

This API allows you to make, change, and remove reservations. In addition, it provides the ability to bind job steps to a reservation and unbind job steps from a reservation. General users should refer to “Working with reservations” on page 184 for additional information. Additional information for LoadLeveler administrators is in “Configuring LoadLeveler to support reservations” on page 120.

This API consists of the following subroutines:

- `ll_make_reservation`
- `ll_init_reservation_param`
- `ll_change_reservation`
- `ll_bind`
- `ll_remove_reservation`

## ll\_make\_reservation subroutine

### Purpose

The `ll_make_reservation` subroutine enables you to create a LoadLeveler reservation.

### Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

### Syntax

```
#include "llapi.h"
```

```
int ll_make_reservation (int version, LL_element **errObj,
 LL_reservation_param **param);
```

### Parameters

*version*

Is an input parameter that indicates the LoadLeveler API version (this should be **LL\_API\_VERSION**).

*errObj*

Provides the address of a pointer to an **LL\_element** that points to an error object if this function fails.

The caller must free the error object storage before reusing the pointer. You can also use the **ll\_error** subroutine to display error messages stored in the error object. If you are going to use the **ll\_error** subroutine, the pointer must be initialized to NULL to ensure that a valid pointer is passed to the **ll\_error** subroutine.

If a job command file is used to create a reservation and the job is successfully submitted, an informational message will be returned.

*param*

Provides the address of a pointer to a **LL\_reservation\_param** structure defined in **llapi.h**. The caller must allocate and free storage for this structure. It is suggested that the caller use the **ll\_init\_reservation\_param** call to initialize the structure.

In the **LL\_reservation\_param** structure, the fields are defined as follows:

**char \*\*ID**

Contains the address where the reservation ID is to be returned.

**char \*start\_time**

Contains a string specifying the start time of a reservation in the format of "[mm/dd[/[cc]yy] ]HH:MM".

**int duration**

Specifies how long the reservation lasts in the unit of minutes.

**enum LL\_reservation\_data data\_type**

Indicates how the nodes should be reserved. The valid values are:

RESERVATION_BY_NODE	by number of nodes
RESERVATION_BY_HOSTLIST	by specifying a hostlist
RESERVATION_BY_JOBSTEP	by specifying a jobstep
RESERVATION_BY_JCF	by job command file

**void \*data**

Contains the pointer to the actual data specifying what nodes to reserve:

data_type	data is a pointer of the type
RESERVATION_BY_NODE	int *
RESERVATION_BY_HOSTLIST	char **, a NULL terminated array of machine names
RESERVATION_BY_JOBSTEP	char *, a jobstep name in the format

RESERVATION\_BY\_JCF                      of host.jobid.stepid  
                                               char \*, the full pathname  
                                               to a LoadLeveler Job Command File

**int options**

Specifies options that control characteristics of the reservation. The follow values can be OR'ed together to set this parameter:

#### **RESERVATION\_SHARED**

Selects the SHARED option for the reservation. For a SHARED reservation, after all bound job steps which can run on the reserved nodes are scheduled to run, the remaining resources can be used to run job steps not bound to the reservation. Only bound job steps can be scheduled to run on a reservation that is not shared.

#### **RESERVATION\_REMOVE\_ON\_IDLE**

Selects the REMOVE\_ON\_IDLE option for the reservation. For a REMOVE\_ON\_IDLE reservation, if all bound job steps are finished or if all bound job steps are Idle and none can run on the reserved nodes, the reservation will be removed (canceled) automatically by LoadLeveler. If this option is not set, the reservation will remain, regardless of being used or not.

**char \*\*users**

Contains the list of users who can use the reservation. This pointer should be set to NULL so only the reservation owner and the LoadLeveler administrator can use the reservation.

**char \*\*groups**

Contains the list of LoadLeveler groups whose users can use the reservation. This pointer should be set to NULL so only the list of LoadLeveler groups and the LoadLeveler administrator can use the reservation.

**char \*group**

Contains a string of a LoadLeveler group that will own the reservation.

## **Description**

The **ll\_make\_reservation( )** subroutine is the API for the **llmkres** command used to create a new reservation.

The **ll\_init\_reservation\_param** subroutine can be used to initialize the **LL\_reservation\_param** structure.

This function is for the BACKFILL scheduler only.

Only users authorized by LoadLeveler administrators to make reservations can use this function.

## **Return values**

### **RESERVATION\_OK**

Request successfully sent to LoadLeveler.

### **RESERVATION\_LIMIT\_EXCEEDED**

Exceeds the maximum number of reservations allowed for the cluster.

### **RESERVATION\_TOO\_CLOSE**

Reservation is being made within the minimum advance time.

### **RESERVATION\_NO\_STORAGE**

The system cannot allocate memory.

### **RESERVATION\_CONFIG\_ERR**

Errors were encountered while processing configuration files.

### **RESERVATION\_USER\_LIMIT\_EXCEEDED**

Exceeds the maximum number of reservations for the user.

### **RESERVATION\_GROUP\_LIMIT\_EXCEEDED**

Exceeds the maximum number of reservations for the group.

### **RESERVATION\_NO\_PERMISSION**

Permission cannot be granted.

### **RESERVATION\_SCHEDD\_CANT\_CONNECT**

The schedd cannot connect to the central manager.

### **RESERVATION\_API\_CANT\_CONNECT**

The subroutine cannot connect to the schedd or central manager.

### **RESERVATION\_JOB\_SUBMIT\_FAILED**

Submit of the job command file failed.

### **RESERVATION\_NO\_MACHINE**

One or more machines in the host list are not in the LoadLeveler cluster.

### **RESERVATION\_WRONG\_MACHINE**

Reservations are not permitted on one or more machines in the host list.

### **RESERVATION\_NO\_RESOURCE**

Insufficient resources in the LoadLeveler cluster.

### **RESERVATION\_NO\_JOBSTEP**

The job step used for node selection does not exist.

### **RESERVATION\_WRONG\_JOBSTEP**

The job step used for node selection is not in the right state.

### **RESERVATION\_NOT\_SUPPORTED**

The scheduler in use does not support reservations.

### **RESERVATION\_REQUEST\_DATA\_NOT\_VALID**

Input is not valid.

### **RESERVATION\_CANT\_TRANSMIT**

A data transmission failure occurred.

### **RESERVATION\_TOO\_LONG**

The duration exceeds the maximum reservation duration.

### **RESERVATION\_NO\_DCE\_CRED**

DCE is enabled, the user has no credentials.

### **RESERVATION\_INSUFFICIENT\_DCE\_CRED**

DCE is enabled, credential lifetime is less than 5 minutes.

## **Related information**

Commands: **llmkres**

Subroutines: **ll\_error**

A sample program called **res.c** is provided in the **samples/llres** subdirectory of the release directory.

## **ll\_init\_reservation\_param subroutine**

### **Purpose**

The **ll\_init\_reservation\_param** subroutine is used to initialize the optional fields in the **LL\_reservation\_param** structure to default values prior to passing that structure to the **ll\_make\_reservation** subroutine.

### **Library**

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

## Syntax

```
#include "llapi.h"
```

```
int ll_init_reservation_param (int version, LL_element **errObj,
 LL_reservation_param **param);
```

## Parameters

*version*

Is an input parameter that indicates the LoadLeveler API version (this should be the same value as **LL\_API\_VERSION** in **llapi.h**).

*errObj*

Provides the address of a pointer to an **LL\_element** that points to an error object if this function fails.

The caller must free the error object storage before reusing the pointer. You can also use the **ll\_error** subroutine to display error messages stored in the error object. If you are going to use the **ll\_error** subroutine, the pointer must be initialized to NULL to ensure that a valid pointer is passed to the **ll\_error** subroutine.

*param*

Provides the address of a pointer to a **LL\_reservation\_param** structure. The **LL\_reservation\_param** structure will be initialized.

## Description

The **ll\_init\_reservation\_param( )** subroutine is used in conjunction with the **ll\_make\_reservation** subroutine. A program using this function would only have to set the required fields and any optional fields where the default value is not applicable.

## Return values

This subroutine returns a zero to indicate success.

## Related information

Subroutines: **ll\_make\_reservation**

## ll\_change\_reservation subroutine

### Purpose

The **ll\_change\_reservation** subroutine enables you to change the attributes of a reservation.

### Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

## Syntax

```
#include "llapi.h"
```

```
int ll_change_reservation (int version, LL_element **errObj, char **ID,
 LL_reservation_change_param **param);
```

## Parameters

*version*

Is an input parameter that indicates the LoadLeveler API version (this should be the same value as **LL\_API\_VERSION** in **llapi.h**).

*errObj*

Provides the address of a pointer to an **LL\_element** that points to an error object if this function fails.

The caller must free the error object storage before reusing the pointer. You can also use the **ll\_error** subroutine to display error messages stored in the error object. If you are going to use the **ll\_error** subroutine, the pointer must be initialized to NULL to ensure that a valid pointer is passed to the **ll\_error** subroutine.

When using a job command file to change a reservation once the job is successfully submitted, an informational message will be returned in *errObj* that contains the name of the job.

**ID** Provides the reservation identifier. The format of a full LoadLeveler reservation identifier is *[host.]rid[.r]*.

where:

- *host* is the name of the machine that assigned the reservation identifier.
- *rid* is the number assigned to the reservation when it was created. An *rid* is required.
- *r* indicates that this is a reservation ID (*r* is optional).

The reservation identifier may be specified in an abbreviated form, *rid[.r]*, when the API is invoked on the same machine that assigned the reservation identifier. In this case, LoadLeveler will use the local machine's host name to construct the full reservation identifier.

*param*

Provides the address of a pointer to a NULL-terminated array of **LL\_reservation\_change\_param** structures as defined in **llapi.h**. The caller must allocate and free storage for the **LL\_reservation\_change** structures.

In the **LL\_reservation\_change\_param** structure, the fields are defined as follows:

**enum LL\_reservation\_data type**

Contains the type of the data to modify.

To modify	Specify	Type of New Data
start_time	RESERVATION_START_TIME	char *
start_time	RESERVATION_ADD_START_TIME	int *
duration	RESERVATION_DURATION	int *
duration	RESERVATION_ADD_DURATION	int *
number_of_nodes	RESERVATION_BY_NODE	int *
number_of_nodes	RESERVATION_ADD_NUM_NODE	int *
hostlist	RESERVATION_BY_HOSTLIST	char **, NULL terminated
hostlist	RESERVATION_ADD_HOSTS	char **, NULL terminated
hostlist	RESERVATION_DEL_HOSTS	char **, NULL terminated
jobstep	RESERVATION_BY_JOBSTEP	char *
job_command_file	RESERVATION_BY_JCF	char *
userlist	RESERVATION_USERLIST	char **, NULL terminated
userlist	RESERVATION_ADD_USERS	char **, NULL terminated
userlist	RESERVATION_DEL_USERS	char **, NULL terminated
grouplist	RESERVATION_GROUPLIST	char **, NULL terminated
grouplist	RESERVATION_ADD_GROUPS	char **, NULL terminated

group	RESERVATION_DEL_GROUPS	NULL terminated char **
shared mode	RESERVATION_MODE_SHARED	NULL terminated int *; *data = 0: Not Shared *data = 1: Share
remove on idle mode	RESERVATION_MODE_REMOVE_ON_IDLE	int *; *data = 0: Do not remove on Idle *data = 1: Remove on Idle
owner	RESERVATION_OWNER	char *
group	RESERVATION_GROUP	char *

If several options are available to modify the same type of data, only one is allowed. For example, `RESERVATION_DURATION` and `RESERVATION_ADD_DURATION` are mutually exclusive. *number\_of\_nodes*, *hostlist*, *jobstep*, and *job\_command\_file* are all used to modify the reserved nodes and, therefore, the associated enums are all mutually exclusive.

The duration of a reservation can be decreased (corresponding to the `-d -nn` option on `llchres`) by specifying the data type `RESERVATION_ADD_DURATION` and providing a negative value. The same is true for `RESERVATION_ADD_NUM_NODE` and `RESERVATION_ADD_START_TIME`.

**void \*data**

Specifies the new data for the modification corresponding to *type*.

## Description

The `ll_change_reservation( )` subroutine is the API for the `llchres` command. The "Notes on changing a reservation" listed in the `llchres` command also apply to the `ll_change_reservation` subroutine.

More than one attribute of a reservation can be changed with a single call. Either all of the changes can and will be made, or none of the changes will be made. If the changes cannot be made, *errObj* will contain a message indicating a reason for the failure. The message may not contain all of the reasons the request cannot be satisfied.

This function is for the BACKFILL scheduler only.

Only LoadLeveler administrators and the owner of the reservation can use this function.

## Return values

### RESERVATION\_OK

Request successfully sent to LoadLeveler.

### RESERVATION\_TOO\_CLOSE

Reservation is being made within the minimum advance time.

### RESERVATION\_NO\_STORAGE

The system cannot allocate memory.

### **RESERVATION\_CONFIG\_ERR**

Errors were encountered while processing configuration files.

### **RESERVATION\_USER\_LIMIT\_EXCEEDED**

Exceeds the maximum number of reservations for the user.

### **RESERVATION\_GROUP\_LIMIT\_EXCEEDED**

Exceeds the maximum number of reservations for the group.

### **RESERVATION\_NO\_PERMISSION**

Permission cannot be granted.

### **RESERVATION\_WRONG\_STATE**

The reservation is not in the correct state.

### **RESERVATION\_API\_CANT\_CONNECT**

The subroutine cannot connect to the schedd or central manager.

### **RESERVATION\_JOB\_SUBMIT\_FAILED**

Submit of the job command file failed.

### **RESERVATION\_NO\_MACHINE**

One or more machines in the host list are not in the LoadLeveler cluster.

### **RESERVATION\_WRONG\_MACHINE**

Reservations are not permitted on one or more machines in the host list.

### **RESERVATION\_NO\_RESOURCE**

Insufficient resources in the LoadLeveler cluster.

### **RESERVATION\_NO\_JOBSTEP**

The job step used for node selection does not exist.

### **RESERVATION\_WRONG\_JOBSTEP**

The job step used for node selection is not in the right state.

### **RESERVATION\_NOT\_SUPPORTED**

The scheduler in use does not support reservations.

### **RESERVATION\_NOT\_EXIST**

The reservation does not exist.

### **RESERVATION\_REQUEST\_DATA\_NOT\_VALID**

Input is not valid.

### **RESERVATION\_CANT\_TRANSMIT**

A data transmission failure occurred.

### **RESERVATION\_TOO\_LONG**

The duration exceeds the maximum reservation duration.

### **RESERVATION\_NO\_DCE\_CRED**

DCE is enabled, the user has no credentials.

### **RESERVATION\_INSUFFICIENT\_DCE\_CRED**

DCE is enabled, credential lifetime is less than 5 minutes.

## **Related information**

Commands: **llchres**

Subroutines: **ll\_error**, **ll\_make\_reservation**

## **ll\_bind subroutine**

### **Purpose**

The **ll\_bind** subroutine enables you to bind job steps to a reservation. The **ll\_bind** subroutine can also be used to unbind a list of job steps from the reservations to which they are currently bound to, or whichever reservation they have requested to bind to in the event that the bind has not yet occurred.

### **Library**

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

## Syntax

```
#include "llapi.h"
```

```
int ll_bind (int version, LL_element **errObj, LL_bind_param **param);
```

## Parameters

*version*

Is an input parameter that indicates the LoadLeveler API version (this should be the same value as **LL\_API\_VERSION** in **llapi.h**).

*errObj*

Provides the address of a pointer to an **LL\_element** that points to an error object if this function fails.

The caller must free the error object storage before reusing the pointer. You can also use the **ll\_error** subroutine to display error messages stored in the error object. If you are going to use the **ll\_error** subroutine, the pointer must be initialized to NULL to ensure that a valid pointer is passed to the **ll\_error** subroutine.

*param*

Provides the address of a pointer to a **LL\_bind\_param** structure as defined in **llapi.h**.

In the **LL\_bind\_param** structure, the fields are defined as follows:

**char \*\*jobsteplist**

A NULL-terminated array of job or step identifiers. When a job identifier is specified, the action of the API is taken for all steps of the job. At least one job or step identifier must be specified.

The format of a job identifier is *host.jobid*. The format of a step identifier is *host.jobid.stepid*.

where:

- *host* is the name of the machine that assigned the job and step identifiers.
- *jobid* is the job number assigned to the job when it was submitted.
- *stepid* is the job step number assigned to the job step when it was submitted.

The job or step identifier may be specified in an abbreviated form, *jobid* or *jobid.stepid*, when the API is invoked on the same machine that assigned the job and step identifiers. In this case, LoadLeveler will use the local machine's *hostname* to construct the full job or step identifier.

**char \*ID**

The reservation identifier. The format of a full LoadLeveler reservation identifier is [*host.*]*rid*[.*r*].

where:

- *host* is the name of the machine that assigned the reservation identifier.
- *rid* is the number assigned to the reservation when it was created. An *rid* is required.
- *r* indicates that this is a reservation ID (*r* is optional).

The reservation identifier may be specified in an abbreviated form, *rid*[.*r*], when the API is invoked on the same machine that assigned the

## Reservation API

reservation identifier. In this case, LoadLeveler will use the local machine's host name to construct the full reservation identifier.

### **int unbind**

Indicates that a value of 1 means that the job steps in *jobsteplist* are to be unbound from the reservations to which they are currently bound. A value of 0 indicates that the job steps in the job step list are to be bound to the reservation specified by the ID.

## **Description**

The **ll\_bind( )** subroutine is the API for the **llbind** command.

This function is for the BACKFILL scheduler only and only jobs in an idle-like state can be bound to a reservation.

LoadLeveler administrators can bind any job step to a reservation. If a job step is already bound to a reservation, it will first be unbound from the current reservation before being bound to the requested reservation. Nonadministrators must be the owner of the job steps to be bound or unbound, and either be the owner of the reservation or one of the users specified by the owner as having permission to use the reservation.

## **Return values**

### **RESERVATION\_OK**

Request successfully sent to LoadLeveler.

### **RESERVATION\_REQUEST\_DATA\_NOT\_VALID**

Input is not valid.

### **RESERVATION\_CONFIG\_ERR**

Errors were encountered while processing configuration files.

### **RESERVATION\_NO\_DCE\_CRED**

DCE is enabled, the user has no credentials.

### **RESERVATION\_INSUFFICIENT\_DCE\_CRED**

DCE is enabled, credential lifetime is less than 5 minutes.

### **RESERVATION\_NO\_STORAGE**

The system cannot allocate memory.

### **RESERVATION\_CANT\_TRANSMIT**

A data transmission failure occurred.

### **RESERVATION\_API\_CANT\_CONNECT**

The subroutine cannot connect to the schedd or central manager.

### **RESERVATION\_NOT\_SUPPORTED**

The scheduler in use does not support reservations.

### **RESERVATION\_NOT\_EXIST**

The reservation does not exist.

### **RESERVATION\_NO\_PERMISSION**

Permission cannot be granted.

### **RESERVATION\_WRONG\_STATE**

The reservation is not in the correct state.

## **Related information**

Commands: **llbind**

Subroutines: **ll\_error**, **ll\_make\_reservation**

## ll\_remove\_reservation subroutine

### Purpose

The **ll\_remove\_reservation** subroutine enables you to cancel one or more reservations.

### Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

### Syntax

```
#include "llapi.h"
```

```
int ll_remove_reservation (int version, LL_element **errObj, char **IDs,
 char **user_list, char **host_list, char **group_list);
```

### Parameters

*version*

Is an input parameter that indicates the LoadLeveler API version (this should be the same value as **LL\_API\_VERSION** in **llapi.h**).

*errObj*

Provides the address of a pointer to an **LL\_element** that points to an error object if this function fails.

The caller must free the error object storage before reusing the pointer. You can also use the **ll\_error** subroutine to display error messages stored in the error object. If you are going to use the **ll\_error** subroutine, the pointer must be initialized to NULL to ensure that a valid pointer is passed to the **ll\_error** subroutine.

*IDs*

Specifies a NULL-terminated array of reservation identifiers. The format of a full LoadLeveler reservation identifier is *[host.]rid[.r]*.

where:

- *host* is the name of the machine that assigned the reservation identifier.
- *rid* is the number assigned to the reservation when it was created. An *rid* is required.
- *r* indicates that this is a reservation ID (*r* is optional).

The reservation identifier may be specified in an abbreviated form, *rid[.r]*, when the API is invoked on the same machine that assigned the reservation identifier. In this case, LoadLeveler will use the local machine's host name to construct the full reservation identifier.

*user\_list*

Specifies a NULL-terminated array of user IDs that own reservations.

*host\_list*

Specifies a NULL-terminated array of machine names.

*group\_list*

Specifies a NULL-terminated array of LoadLeveler groups.

### Description

The **ll\_remove\_reservation()** subroutine is the API for the **llrmres** command.

A list of reservation IDs cannot be specified when *user\_list*, *host\_list*, or *group\_list* is specified. If reservation IDs is non-NULL when *user\_list*, *host\_list*, or *group\_list* is

## Reservation API

also non-NULL, the return value will be **RESERVATION\_REQUEST\_DATA\_NOT\_VALID**. Input for *user\_list*, *host\_list*, or *group\_list* can be provided in any combination.

This function is for the BACKFILL scheduler only.

Only LoadLeveler administrators and the owner of the reservation can use this function.

### Return values

#### **RESERVATION\_OK**

Request successfully sent to LoadLeveler.

#### **RESERVATION\_REQUEST\_DATA\_NOT\_VALID**

Input is not valid.

#### **RESERVATION\_CONFIG\_ERR**

Errors were encountered while processing configuration files.

#### **RESERVATION\_NO\_DCE\_CRED**

DCE is enabled, the user has no credentials.

#### **RESERVATION\_INSUFFICIENT\_DCE\_CRED**

DCE is enabled, credential lifetime is less than 5 minutes.

#### **RESERVATION\_NO\_STORAGE**

The system cannot allocate memory.

#### **RESERVATION\_CANT\_TRANSMIT**

A data transmission failure occurred.

#### **RESERVATION\_API\_CANT\_CONNECT**

The subroutine cannot connect to the schedd or central manager.

#### **RESERVATION\_NOT\_SUPPORTED**

The scheduler in use does not support reservations.

### Related information

Commands: **llrmres**

Subroutines: **ll\_error**, **ll\_make\_reservation**

---

## Submit API

This API allows you to submit jobs to LoadLeveler. The submit API consists of the **llsubmit** subroutine, the **llfree\_job\_info** subroutine, and a user exit for monitoring programs.

In LoadLeveler for Linux only:

- **llsubmit** returns an error value of -1 and writes the error messages to stderr when:
  - **DCE\_ENABLEMENT** is **TRUE**
  - **SEC\_ENABLEMENT** is **DCE** or **CTSEC**
  - **SCHEDULER\_TYPE** is **GANG**
  - **pvm\_root** or **NQS\_DIR** is specified
- If the **job\_cmd\_file** argument is associated with a **PVM** job or an **NQS** job, **llsubmit** returns a value of -1 and writes the error messages to stderr.

### llsubmit subroutine

**llsubmit** is both the name of a LoadLeveler command used to submit jobs as well as the subroutine described here.

## Purpose

The **llsubmit** subroutine submits jobs to LoadLeveler for scheduling.

## Syntax

```
int llsubmit (char *job_cmd_file, char *monitor_program, char *monitor_arg,
 LL_job *job_info, int job_version);
```

## Parameters

*job\_cmd\_file*

Is a pointer to a string containing the name of the job command file.

*monitor\_program*

Is a pointer to a string containing the name of the monitor program to be invoked when the state of the job is changed. Set to NULL if a monitoring program is not provided.

*monitor\_arg*

Is a pointer to a string which is stored in the job object and is passed to the monitor program. The maximum length of the string is 1023 bytes. If the length exceeds this value, it is truncated to 1023 bytes. Set to NULL if an argument is not provided.

*job\_info*

Is a pointer to a structure defined in the **llapi.h** header file. No fields are required to be filled in. Upon return, the structure will contain the number of job steps in the job command file and a pointer to an array of pointers to information about each job step. Space for the array and the job step information is allocated by **llsubmit**. The caller should free this space using the **llfree\_job\_info** subroutine.

*job\_version*

Is an integer indicating the version of **llsubmit** being used. This argument should be set to **LL\_JOB\_VERSION** which is defined in the **llapi.h** include file.

## Description

LoadLeveler must be installed and configured correctly on the machine on which the submit application is run.

The uid and gid in effect when **llsubmit** is invoked are the uid and gid used when the job is run.

To submit a job to a remote cluster, call the **ll\_cluster** API to define the cluster prior to calling the **llsubmit** API. If the job being submitted has the **cluster\_list** keyword defined in the job command file, the cluster specified by the **ll\_cluster** API takes precedence over the **cluster\_list** keyword.

## Return values

0        The job was submitted successfully.

## Error values

-1        Error, error messages written to stderr.

## Related information

Subroutines: **ll\_cluster**

## llfree\_job\_info subroutine

### Purpose

**llfree\_job\_info** frees space for the array and the job step information used by **llsubmit**.

### Syntax

```
void llfree_job_info (LL_job *job_info, int job_version);
```

### Parameters

*job\_info*

Is a pointer to a **LL\_job** structure. Upon return, the space pointed to by the **step\_list** variable and the space associated with the **LL\_job** step structures pointed to by the **step\_list** array are freed. All fields in the **LL\_job** structure are set to zero.

*job\_version*

Is an integer indicating the version of **llfree\_job\_info** being used. This argument should be set to **LL\_JOB\_VERSION** which is defined in the **llapi.h** header file.

## Monitoring programs

### Purpose

Using the **monitor\_program** user exit, you can create a program that monitors jobs submitted using the **llsubmit** subroutine. The **schedd** daemon invokes this monitor program if the **monitor\_program** argument to **llsubmit** is not null. The monitor program is invoked each time a job step changes state. This means that the monitor program will be informed when the job step is started, completed, vacated, removed, or rejected. If you suspect the monitor program encountered problems or didn't run, you should check the listing in the **schedd** log. In the event of a monitor program failure, the job is still run.

### Syntax

```
monitor_program job_id user_arg state exit_status
```

### Parameters

*monitor\_program*

Is the name of the program supplied in the **monitor\_program** argument passed to the **llsubmit** function.

*job\_id*

Is the full ID for the job step.

*user\_arg*

The string supplied to the **monitor\_arg** argument that is passed to the **llsubmit** function.

*state*

Is the current state of the job step. Possible values for the state are:

**JOB\_STARTED**

The job step has started.

**JOB\_COMPLETED**

The job step has completed.

**JOB\_VACATED**

The job step has been vacated. The job step will be rescheduled if the job step is restartable or if it is checkpointable.

**JOB\_REJECTED**

A **startd** daemon has rejected the job. The job will be rescheduled to another machine if possible.

**JOB\_REMOVED**

The job step was canceled or could not be started.

**JOB\_NOTRUN**

The job step cannot be run because a dependency cannot be met.

*exit\_status*

Is the exit status from the job step. The argument is meaningful only if the state is **JOB\_COMPLETED**.

---

## Workload Management API

The Workload Management API consists of the following subroutines:

- **ll\_cluster** subroutine
- **ll\_cluster\_auth** subroutine
- **ll\_control** subroutine
- **ll\_move\_job** subroutine
- **ll\_modify** subroutine
- **ll\_preempt** subroutine
- **ll\_preempt\_jobs** subroutine
- **ll\_run\_scheduler** subroutine
- **ll\_start\_job** subroutine
- **ll\_terminate\_job** subroutine
- **ll\_start\_job\_ext** subroutine

The **ll\_control** subroutine can be used to perform most of the LoadLeveler control operations and is designed for general use.

The **ll\_preempt** subroutine is not available in LoadLeveler for Linux. For LoadLeveler 3.3, the **ll\_preempt** subroutine was replaced with the **ll\_preempt\_jobs** subroutine.

The **ll\_start\_job** and **ll\_terminate\_job** subroutines are intended to be used together with an external scheduler.

Note that the **ll\_start\_job** and **ll\_terminate\_job** subroutines automatically connect to an alternate central manager if they cannot contact the primary central manager. You should use **ll\_start\_job** and **ll\_terminate\_job** in conjunction with the query API. The query API collects information regarding which machines are available and which jobs need to be scheduled. See “Query API” on page 544 for more information.

**Note:** The AIX Workload Manager (WLM) and the LoadLeveler Workload Management API are two distinct and unrelated components.

### **ll\_cluster** subroutine

#### **Purpose**

The **ll\_cluster** subroutine enables other APIs to operate on a remote cluster.

### Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

### Syntax

```
#include "llapi.h"
```

```
int ll_cluster (int version, LL_element **errObj, LL_cluster_param *param);
```

### Parameters

*version*

Input parameter that indicates the LoadLeveler API version (should have the same value as **LL\_API\_VERSION** in *llapi.h*).

*errObj*

Provides the address of a pointer to **LL\_element** that points to an error object if this function fails.

*param*

Provides a pointer to an **LL\_cluster\_param** structure.

```
typedef enum LL_cluster_op {
 CLUSTER_SET,
 CLUSTER_UNSET
} ClusterOp_t;

typedef struct {
 ClusterOp_t action;
 char **cluster_list;
}
LL_cluster_param;
```

In the **enum LL\_Cluster\_op** structure, valid values are:

#### **CLUSTER\_SET**

Sets the multicluster environment to *cluster\_list*.

#### **CLUSTER\_UNSET**

Unsets the multicluster environment.

In the **LL\_cluster\_param** structure, the fields are defined as follows:

*action*

Determines whether the cluster environment should be set or unset. The set action must have a corresponding *cluster\_list*. The unset action ignores the *cluster\_list* data.

*cluster\_list*

Is a NULL-terminated array of cluster stanza names. Only one cluster name is allowed. The reserved words **any** and **all** are not allowed.

### Description

This API is called to enable other APIs to run on remote clusters in a multicluster environment and can be invoked by all users. To issue an API multiple times for different clusters, the **ll\_cluster** and corresponding APIs must be issued for each cluster.

### Return values

#### **CLUSTER\_SUCCESS**

Cluster name successfully set.

**CLUSTER\_SYSTEM\_ERROR**

LoadLeveler internal system error.

**CLUSTER\_INVALID\_CLUSTER\_PARAM**

An input parameter that is not valid was specified. Possible causes are that the *cluster\_list* parameter is NULL or that the reserved words **any** or **all** were specified.

**CLUSTER\_INVALID\_ACTION\_PARAM**

An *action* parameter that is not valid was specified. Valid values are **CLUSTER\_UNSET** and **CLUSTER\_SET**.

**Related information**

Subroutines: **ll\_ckpt**, **ll\_deallocate**, **ll\_free\_objs**, **ll\_get\_data**, **ll\_get\_objs**, **ll\_modify**, **ll\_next\_obj**, **ll\_query**, **ll\_reset\_request**, **ll\_set\_request**, **llsubmit**

**ll\_cluster\_auth subroutine****Purpose**

The **ll\_cluster\_auth** subroutine creates a public key, a private key, and a security certificate.

**Library**

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

**Syntax**

```
#include "llapi.h"
```

```
int ll_cluster_auth (int version, LL_cluster_auth_param **param);
```

**Parameters**

*version*

Input parameter that indicates the LoadLeveler API version (should have the same value as **LL\_API\_VERSION** in **llapi.h**).

*param*

Provides the address of a pointer to an array of pointers to **LL\_cluster\_auth\_param** structures. The last element of the array must be NULL.

```
typedef enum LL_cluster_auth_op {
 CLUSTER_AUTH_GENKEY
} ClusterAuthOp_t;
```

```
typedef struct {
 ClusterAuthOp_t type;
}
LL_cluster_auth_param;
```

In the **enum LL\_cluster\_auth\_op** structure, valid values are:

**CLUSTER\_AUTH\_GENKEY**

Generates required keys.

In the **enum LL\_cluster\_auth\_op** structure, the fields are defined as follows:

*type*

Indicates the requested operation.

### Description

The `ll_cluster_auth( )` subroutine is the API for the `llclusterauth` command. Refer to the `llclusterauth` command for information about other available command options.

This function must be run from a process with **root** authority.

The `ll_cluster_auth( )` subroutine creates a public key, a private key, a security certificate, and a directory for authorized keys. The keys and certificate are created in the `/var/LoadL/ssl` directory for AIX and in the `/var/opt/LoadL/ssl` directory for Linux.

- The private key is stored in `id_rsa`
- The public key is stored in `id_rsa.pub`
- The security certificate is stored in `id_rsa.cert`
- The authorized keys are stored in `authorized_keys`

In order for a connection to be accepted, the public key for the node requesting the connection must be stored in the authorized keys file on the node being connected to. Only a process with **root** authority can run this subroutine.

### Return values

The following return values are defined in `llapi.h`:

#### `API_OK`

Request successfully sent to LoadLeveler.

#### `API_INVALID_INPUT`

An input parameter that is not valid was specified.

#### `API_CONFIG_ERR`

Errors encountered while processing configuration files.

#### `API_64BIT_DCE_ERR`

64-bit API not supported when DCE is enabled.

#### `API_CANT_AUTH`

Caller not authorized.

#### `API_CANT_LISTEN`

API cannot create listen socket.

#### `API_CANT_CONNECT`

Failed to connect to LoadLeveler.

#### `API_TIMEOUT`

Timed out waiting for a response.

#### `API_SSL_ERR`

Timed out waiting for a response.

#### `API_STEP_NOT_IDLE`

Request failed, the job step is not in the IDLE state.

### Related information

Commands: `llclusterauth`

## ll\_control subroutine

### Purpose

This subroutine allows an application program to perform most of the functions that are currently available through the standalone commands: **llctl**, **llfavorjob**, **llfavoruser**, **llhold**, and **llprio**.

In LoadLeveler for Linux only, **ll\_control** returns an error condition when:

- **DCE\_ENABLEMENT** is **TRUE**
- **SEC\_ENABLEMENT** is **DCE** or **CTSEC**
- **SCHEDULER\_TYPE** is **GANG**
- **NQS\_DIR** is specified

### Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

### Syntax

```
#include "llapi.h"
```

```
int ll_control (int control_version, enum LL_control_op control_op,
 char **host_list, char ** user_list, char **job_list,
 char **class_list, int priority);
```

### Parameters

**int control\_version**

An integer indicating the version of **ll\_control** being used. This argument should be set to **LL\_CONTROL\_VERSION**.

**enum LL\_control\_op**

The control operation to be performed. The enum **LL\_control\_op** is defined in **llapi.h** as:

```
enum LL_control_op {
 LL_CONTROL_RECYCLE, LL_CONTROL_RECONFIG, LL_CONTROL_START, LL_CONTROL_STOP,
 LL_CONTROL_DRAIN, LL_CONTROL_DRAIN_STARTD, LL_CONTROL_DRAIN_SCHEDD,
 LL_CONTROL_PURGE_SCHEDD, LL_CONTROL_FLUSH, LL_CONTROL_SUSPEND,
 LL_CONTROL_RESUME, LL_CONTROL_RESUME_STARTD, LL_CONTROL_RESUME_SCHEDD,
 LL_CONTROL_FAVOR_JOB, LL_CONTROL_UNFAVOR_JOB, LL_CONTROL_FAVOR_USER,
 LL_CONTROL_UNFAVOR_USER, LL_CONTROL_HOLD_USER, LL_CONTROL_HOLD_SYSTEM,
 LL_CONTROL_HOLD_RELEASE, LL_CONTROL_Prio_ABS, LL_CONTROL_Prio_ADJ,
 LL_CONTROL_START_DRAINED,};
```

**char \*\*host\_list**

A NULL-terminated array of host names.

**char \*\*user\_list**

A NULL-terminated array of user names.

**char \*\*job\_list**

A NULL-terminated array of job or step identifiers. When a job identifier is specified, the action of the API is taken for all steps of the job. At least one job or step identifier must be specified.

The format of a job identifier is *host.jobid*. The format of a step identifier is *host.jobid.stepid*.

where:

- *host* is the name of the machine that assigned the job and step identifiers.
- *jobid* is the job number assigned to the job when it was submitted.
- *stepid* is the job step number assigned to the job step when it was submitted.

The job or step identifier may be specified in an abbreviated form, *jobid* or *jobid.stepid*, when the API is invoked on the same machine that assigned the job and step identifiers. In this case, LoadLeveler will use the local machine's host name to construct the full job or step identifier.

**char \*\*class\_list**

A NULL-terminated array of class names.

**int priority**

An integer representing the new absolute value of user priority or adjustment to the current user priority of job steps.

### Description

The **ll\_control** subroutine performs operations that are essentially equivalent to those performed by the standalone commands: **llctl**, **llfavorjob**, **llfavoruser**, **llhold**, and **llprio**. Because of this similarity, descriptions of the **ll\_control** operations are grouped according to the standalone command they resemble.

**llctl type of operations:** These are the **ll\_control** operations which mirror operations performed by the **llctl** command. This summary includes a brief description of each of the allowed **llctl** types of operations. For more information about the **llctl** command, see “**llctl** - Control LoadLeveler daemons” on page 393.

#### **LL\_CONTROL\_START:**

Starts the LoadLeveler daemons on the specified machines. The calling program must have rsh privileges to start LoadLeveler daemons on remote machines.

**Note:** LoadLeveler will fail to start if any value has been set for the **MALLOCTYPE** environment variable.

#### **LL\_CONTROL\_START\_DRAINED:**

Starts the LoadLeveler in the drained state.

#### **LL\_CONTROL\_STOP:**

Stops the LoadLeveler daemons on the specified machines.

#### **LL\_CONTROL\_RECYCLE:**

Stops, and then restarts, all of the LoadLeveler daemons on the specified machines.

#### **LL\_CONTROL\_RECONFIG:**

Forces all of the LoadLeveler daemons on the specified machines to reread the configuration files.

#### **LL\_CONTROL\_DRAIN:**

When this operation is selected, the following happens: (1) No LoadLeveler jobs can start running on the specified machines, and (2) No LoadLeveler jobs can be submitted to the specified machines.

#### **LL\_CONTROL\_DRAIN\_SCHEDD:**

No LoadLeveler jobs can be submitted to the specified machines.

#### **LL\_CONTROL\_DRAIN\_STARTD:**

Keeps LoadLeveler jobs from starting on the specified machines. If a *class\_list* is specified, then the classes specified will be drained (made unavailable). The literal string “**allclasses**” can be used as an abbreviation for all of the classes.

#### **LL\_CONTROL\_FLUSH:**

Terminates running jobs on the specified machines and send them back to the negotiator to await redispatch (if *restart=yes*).

**LL\_CONTROL\_PURGE\_SCHEDD:**

Purges the specified schedd host's job queue; a *host\_list* consisting of one host name must be specified.

**LL\_CONTROL\_SUSPEND:**

Suspends all jobs on the specified machines. This operation is not supported for parallel jobs.

**LL\_CONTROL\_RESUME:**

Resumes job submission to, and job execution on, the specified machines.

**LL\_CONTROL\_RESUME\_STARTD:**

Resumes job execution on the specified machines; if a *class\_list* is specified, then execution of jobs associated with these classes is resumed.

**LL\_CONTROL\_RESUME\_SCHEDD:**

Resumes job submission to the specified machines.

For these **llctl** type of operations, the *user\_list*, *job\_list*, and *priority* arguments are not used and should be set to **NULL** or zero. The *class\_list* argument is meaningful only if the operation is **LL\_CONTROL\_DRAIN\_STARTD**, or **LL\_CONTROL\_RESUME\_STARTD**. If *class\_list* is not being used, then it should be set to **NULL**. If *host\_list* is **NULL**, then the scope of the operation is all machines in the LoadLeveler cluster. Unlike the standalone **llctl** command, where the scope of the operation is either global or one host, **ll\_control** operations allow the user to specify a list of hosts (through the *host\_list* argument). To perform these operations, the calling program must have LoadLeveler administrator authority. The only exception to this rule is the **LL\_CONTROL\_START** operation.

**llfavorjob type of operations:** The **llfavorjob** type of control operations are: **LL\_CONTROL\_FAVOR\_JOB**, and **LL\_CONTROL\_UNFAVOR\_JOB**. For these operations, the *user\_list*, *host\_list*, *class\_list*, and *priority* arguments are not used and should be set to **NULL** or zero. **LL\_CONTROL\_FAVOR\_JOB** is used to set specified job steps to a higher system priority than all job steps that are not favored. **LL\_CONTROL\_UNFAVOR\_JOB** is used to unfavor previously favored job steps, restoring the original priorities. The calling program must have LoadLeveler administrator authority to perform these operations.

**llfavoruser type of operations:** The **llfavoruser** type of control operations are: **LL\_CONTROL\_FAVOR\_USER**, and **LL\_CONTROL\_UNFAVOR\_USER**. For these operations, the *host\_list*, *job\_list*, *class\_list*, and *priority* arguments are not used and should be set to **NULL** or zero. **LL\_CONTROL\_FAVOR\_USER** sets jobs of one or more users to the highest priority in the system, regardless of the current setting. Jobs already running are not affected. **LL\_CONTROL\_UNFAVOR\_USER** is used to unfavor previously favored user's jobs, restoring the original priorities. The calling program must have LoadLeveler administrator authority to perform these operations.

**llhold type of operations:** The **llhold** type of control operations are: **LL\_CONTROL\_HOLD\_USER**, **LL\_CONTROL\_HOLD\_SYSTEM**, and **LL\_CONTROL\_HOLD\_RELEASE**. For these operations, the *class\_list* and *priority* arguments are not used, and should be set to **NULL** or zero. **LL\_CONTROL\_HOLD\_USER** and **LL\_CONTROL\_HOLD\_SYSTEM** place jobs in user hold and system hold, respectively. **LL\_CONTROL\_HOLD\_RELEASE** is used to release jobs from both types of hold. The calling program must have LoadLeveler administrator authority to put jobs into system hold, and to release jobs from system hold. If a job is in both user and system holds then the **LL\_CONTROL\_HOLD\_RELEASE** operation must be performed twice to release the

job from both types of hold. If the user is not a LoadLeveler administrator then the **llhold** types of operations have no effect on jobs that do not belong to that user.

**llprio type of operations:** The **llprio** type of control operations are: **LL\_CONTROL\_PRIO\_ABS**, and **LL\_CONTROL\_PRIO\_ADJ**. For these operations, the *user\_list*, *host\_list*, and *class\_list* arguments are not used, and should be set to **NULL**. **llprio** type of operations change the user priority of one or more job steps in the LoadLeveler queue. **LL\_CONTROL\_PRIO\_ABS** specifies a new absolute value of the user priority, and **LL\_CONTROL\_PRIO\_ADJ** specifies an adjustment to the current user priority. The valid range of LoadLeveler user priorities is 0–100 (inclusive); 0 is the lowest possible priority, and 100 is the highest. The **llprio** type of operations have no effect on a running job step unless this job step returns to **Idle** state. If the user is not a LoadLeveler administrator, then an **llprio** type of operation has no effect on jobs that do not belong to that user.

### Return values

- 0 The specified command has been sent to the appropriate LoadLeveler daemon.
- 2 The specified command cannot be sent to the central manager.
- 3 The specified command cannot be sent to one of the **LoadL\_master** daemons.
- 4 ll\_control encountered an error while processing the administration or configuration file.
- 6 A data transmission failure has occurred.
- 7 The calling program does not have LoadLeveler administrator authority.
- 19 An incorrect **ll\_control** version has been specified.
- 20 A system error has occurred.
- 21 The system cannot allocate memory.
- 22 A **control\_op** operation that is not valid has been specified.
- 23 The **job\_list** argument contains one or more errors.
- 24 The **host\_list** argument contains one or more errors.
- 25 The **user\_list** argument contains one or more errors.
- 26 Incompatible arguments have been specified for **HOLD** operation.
- 27 Incompatible arguments have been specified for **PRIORITY** operation.
- 28 Incompatible arguments have been specified for **FAVORJOB** operation.
- 29 Incompatible arguments have been specified for **FAVORUSER** operation.
- 30 An error occurred while ll\_control tried to start a child process.
- 31 An error occurred while ll\_control tried to start the **LoadL\_master** daemon.
- 32 An error occurred while ll\_control tried to execute the **llpurgeschedd** command.
- 33 The **class\_list** argument contains incompatible information.
- 34 ll\_control cannot create a file in the **/tmp** directory.
- 35 LoadLeveler has encountered miscellaneous incompatible input specifications.
- 36 DCE identity cannot be determined.
- 37 No DCE credentials.
- 38 DCE credentials within 300 secs of expiration.
- 39 64-bit API not supported when DCE is enabled.
- 40 This release of LoadLeveler for Linux does not support DCE.
- 41 This release of LoadLeveler for Linux does not support CTSEC.
- 42 This release of LoadLeveler for Linux does not support GANG.
- 43 This release of LoadLeveler for Linux does not support PVM.
- 44 This release of LoadLeveler for Linux does not support NQS.

### Related information

Commands: **llprio**, **llhold**, **llfavoruser**, **llfavorjob**, **llctl**

## ll\_modify subroutine

### Purpose

The **ll\_modify** subroutine modifies the attributes of a submitted job step.

In LoadLeveler for Linux only, **ll\_modify** returns an error condition when:

- **DCE\_ENABLEMENT** is **TRUE**
- **SEC\_ENABLEMENT** is **DCE** or **CTSEC**
- **SCHEDULER\_TYPE** is **GANG**
- **NQS\_DIR** is specified

### Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

### Syntax

```
#include "llapi.h"
```

```
int ll_modify (int version, void *errObj, LL_modify_param **param,
 char **steplist);
```

### Parameters

*version*

Input parameter that indicates the LoadLeveler API version (should have the same value as **LL\_API\_VERSION** in **llapi.h**).

*errObj*

Provides the address of a pointer to **LL\_element** that points to an error object if this function fails.

The caller must free the error object storage before reusing the pointer. You can also use the **ll\_error** subroutine to display error messages stored in the error object. If you are going to do so, the pointer should be initialized to **NULL** to avoid a segmentation fault when the pointer is passed to the **ll\_error** subroutine.

*param*

Provides the address of an array of 2 pointers to the **LL\_modify\_param** structure defined in **llapi.h**. The first pointer should point to an **LL\_modify\_param** structure already filled out by the caller. The second pointer should be assigned **NULL**.

In the **LL\_modify\_param** structure:

*type* Describes the attribute to be modified.

On LoadLeveler for Linux *type* cannot be set to **EXECUTION\_FACTOR**.

*data* Is a pointer to the new attribute value.

All job step attributes types that can be modified through **ll\_modify( )** are listed in **enum LL\_modify\_op** in **llapi.h**.

The **LL\_modify\_op** structure stores user inputs to the function, where:

*type* Is the type of the command option.

*data* Is a pointer to the data value associated with the command option.

*name* Is a **NULL** terminated array of job step names. Only a single job step is allowed in the current implementation.

### *steplist*

A NULL terminated array of job or step identifiers. When a job identifier is specified, the action of the API is taken for all steps of the job. At least one job or step identifier must be specified.

The format of a job identifier is *host.jobid*. The format of a step identifier is *host.jobid.stepid*.

where:

- *host* is the name of the machine that assigned the job and step identifiers.
- *jobid* is the job number assigned to the job when it was submitted.
- *stepid* is the job step number assigned to the job step when it was submitted.

The job or step identifier may be specified in an abbreviated form, *jobid* or *jobid.stepid*, when the API is invoked on the same machine that assigned the job and step identifiers. In this case, LoadLeveler will use the local machine's host name to construct the full job or step identifier.

### Description

**ll\_modify( )** is the API for the **llmodify** command. Refer to the **llmodify** command for information about other available command options.

In **enum LL\_modify\_op**:

- The **EXECUTION\_FACTOR** option can be used only with the Gang scheduler. Only LoadLeveler administrators have authority to modify this attribute of a job step.
- The system priority option will be ignored for any job step not in an idle state. The data field for the **SYSPRIO** option is an integer. The system priority for a job step set with the **SYSPRIO** option will not be changed when LoadLeveler recalculates system priorities.
- The **keyword** value is to be used to specify a string in the form, **keyword=value**, where keyword is the attribute of the job step to modify and *value* is the new value for the attribute. For a list of supported keywords and their descriptions, see "llmodify - Change attributes of a submitted job step" on page 419.
- The attributes that can be modified by the **enums** are described in "llmodify - Change attributes of a submitted job step" on page 419.

### Return values

The following return values are defined in **llapi.h**:

#### **MODIFY\_SUCCESS**

Request successfully sent to LoadLeveler.

#### **MODIFY\_INVALID\_PARAM**

An input parameter that is not valid was specified.

#### **MODIFY\_CONFIG\_ERROR**

Errors encountered while processing config files.

#### **MODIFY\_NOT\_IDLE**

Request failed, job step not in IDLE state.

#### **MODIFY\_WRONG\_STATE**

Request failed, job step in wrong state.

#### **MODIFY\_NOT\_AUTH**

Caller not authorized.

**MODIFY\_SYSTEM\_ERROR**

LoadLeveler internal system error.

**MODIFY\_CANT\_TRANSMIT**

Communication error while sending request.

**MODIFY\_CANT\_CONNECT**

Failed to connect to LoadLeveler.

**MODIFY\_INVALID\_PARAM**

The specified keyword is not supported.

**MODIFY\_NO\_DCE\_SUPPORT\_ERR**

DCE\_ENABLEMENT was set to TRUE or SEC\_ENABLEMENT was set to DCE. LoadLeveler for Linux does not support DCE.

**MODIFY\_NO\_CTSEC\_SUPPORT\_ERR**

SEC\_ENABLEMENT was set to CTSEC. LoadLeveler for Linux does not support CTSEC.

**MODIFY\_NO\_GANG\_SUPPORT\_ERR**

SCHEDULER\_TYPE was set to GANG. LoadLeveler for Linux does not support GANG scheduling.

**MODIFY\_NO\_PVM\_SUPPORT\_ERR**

pvm\_root was specified. LoadLeveler for Linux does not support PVM.

**MODIFY\_NO\_NQS\_SUPPORT\_ERR**

NQS\_DIR was specified. LoadLeveler for Linux does not support NQS.

**MODIFY\_OVERLAP\_RESERVATION**

Request failed. The requested change would cause the job step to overlap with a reservation.

**Related information**

Commands: **llmodify**

Subroutines: **ll\_cluster**, **ll\_error**

**Example**

```
/* mymodify.c - make a job step non-preemptable */
#include <stdio.h>
#include <string.h>
#include "llapi.h"

int main(int argc, char *argv[])
{
 int rc, exec_factor = 99;
 LL_modify_param mycmd, *cmdp[2];
 char *step_list[2];
 LL_element *errObj = NULL;
 char *errmsg;

 if (argc < 2) {
 printf("Usage: %s job_step_name \n", argv[0]); exit(1);
 }

 step_list[0] = argv[1];
 step_list[1] = NULL;
 printf("\n*** Make Job Step %s non-preemptable ***\n\n",
 step_list[0]);

 /* Initialize the LL_modify_param structure */
 mycmd.type = EXECUTION_FACTOR;
 mycmd.data = &exec_factor
```

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```
cmdp[0] = &mycmd
cmdp[1] = NULL;

/* change execution factor to 99 for the job step */
printf("Change execution factor to %d\n", exec_factor);
rc = ll_modify(LL_API_VERSION, &errObj, cmdp, step_list);
if (rc) {
 errmsg = ll_error(&errObj, 0);
 printf("ll_modify() return code: %d\n%s\n", rc, errmsg);
 free(errmsg);
 exit(1);
}
return 0;
}
```

### ll\_move\_job subroutine

#### Purpose

The **ll\_move\_job** subroutine moves an idle job from one cluster to another.

#### Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

#### Syntax

```
#include "llapi.h"
```

```
int ll_move_job (int version, LL_element **errObj, LL_move_job_param *param);
```

#### Parameters

*version*

Input parameter that indicates the LoadLeveler API version (should have the same value as **LL\_API\_VERSION** in **llapi.h**).

*errObj*

Provides the address of a pointer to **LL\_element** that points to an error object if this function fails.

*param*

Provides the address of a pointer to an **LL\_move\_job\_param** structure.

```
typedef struct {
 char *cluster_name;
 char *job_id;
}
LL_move_job_param;
```

In the **LL\_move\_job\_param** structure, the fields are defined as follows:

*cluster\_name*

The name of the cluster to which the job will be moved.

*job\_id*

The job ID of the job to be moved.

#### Description

The **ll\_move\_job( )** subroutine is the API for the **llmovejob** command. Refer to the **llmovejob** command for information about other available command options.

The **ll\_move\_job** API moves a single idle job from one cluster to another. If any steps within the job are not idle, the transfer request is rejected and the API returns

API\_STEP\_NOT\_IDLE. The remote job retains the original *job\_ID* from the local cluster. Upon transfer, the remote cluster performs any user mapping and remote job filtering necessary for the job.

Any changes made to the idle job in the local cluster by the **llmodify** command will not be carried forward to the remote cluster. Any jobs submitted when the local cluster was not configured as a part of a multicluster cannot be moved if the cluster's configuration is changed to a multicluster environment. .

Only administrators can issue the **ll\_move\_job( )** subroutine. In a mixed operating multicluster environment, administrators must ensure the binary compatibility of the job being transferred.

### Return values

The following return values are defined in `llapi.h`:

#### API\_OK

Request successfully sent to LoadLeveler.

#### API\_INVALID\_INPUT

An input parameter that is not valid was specified.

#### API\_CONFIG\_ERR

Errors encountered while processing configuration files.

#### API\_64BIT\_DCE\_ERR

64-bit API not supported when DCE is enabled.

#### API\_CANT\_AUTH

Caller not authorized.

#### API\_CANT\_LISTEN

API cannot create listen socket.

#### API\_CANT\_CONNECT

Failed to connect to LoadLeveler.

#### API\_TIMEOUT

Timed out waiting for a response.

#### API\_STEP\_NOT\_IDLE

Request failed, the job step is not in the IDLE state.

### Related information

Commands: **llmovejob**

## ll\_preempt subroutine

### Purpose

The **ll\_preempt** subroutine enables you to preempt a running job step or to resume a job step that has already been preempted through the **llpreempt** command or the **ll\_preempt** subroutine (user-initiated). The **ll\_preempt** subroutine cannot resume a job step preempted through PREEMPT\_CLASS rules (system-initiated).

The **ll\_preempt** subroutine is not available in LoadLeveler for Linux.

For LoadLeveler 3.3, the **ll\_preempt** subroutine was replaced with the **ll\_preempt\_jobs** subroutine.

### Library

LoadLeveler API library, **libllapi.a**

### Syntax

```
#include "llapi.h"
```

```
int ll_preempt (int version, LL_element **errObj, char *job_step,
 enum LL_preempt_op type);
```

### Parameters

*version*

Input parameter that indicates the LoadLeveler API version (should have the same value as **LL\_API\_VERSION** in llapi.h).

*errObj*

Provides the address of a pointer to LL\_element that points to an error object if this function fails.

The caller must free the error object storage before reusing the pointer. You can also use the ll\_error subroutine to display error messages stored in the error object. If you are going to do so, the pointer should be initialized to NULL to avoid a segmentation fault when the pointer is passed to the ll\_error subroutine.

*jobstep*

A string used to specify the name of a job step.

*type*

- Preempts job step if *type* equals PREEMPT\_STEP
- Resumes job step if *type* equals RESUME\_STEP

### Description

**ll\_preempt()** is the API for the **llpreempt** command.

- This function is for Gang scheduling and external schedulers
- Only LoadLeveler administrators have authority to use this function

### Return values

**API\_OK**

Request successfully sent to LoadLeveler.

**API\_INVALID\_INPUT**

An input parameter that is not valid was specified.

**API\_CONFIG\_ERR**

Errors encountered while processing config files.

**API\_CANT\_AUTH**

Caller not authorized.

**API\_CANT\_CONNECT**

Failed to connect to LoadLeveler.

**API\_64BIT\_DCE\_ERR**

64-bit API not supported when DCE is enabled.

## ll\_preempt\_jobs subroutine

### Purpose

The **ll\_preempt\_jobs** subroutine is used to preempt a set of running job steps using the specified preempt method, or to resume job steps that have already been

preempted with the preempt method of suspend through the **llpreempt** command or the **ll\_preempt\_jobs** subroutine. The **ll\_preempt\_jobs** subroutine cannot resume a job step that was preempted through the PREEMPT\_CLASS rules, or a job step that was preempted with a preempt method other than suspend.

## Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

## Syntax

```
#include "llapi.h"
```

```
int ll_preempt_jobs (int version, void *errObj, LL_preempt_param **param);
```

## Parameters

*version*

Is an input parameter that indicates the LoadLeveler API version (this should be the same value as **LL\_API\_VERSION** in **llapi.h**).

*errObj*

Provides the address of a pointer to an **LL\_element** that points to an error object if this function fails.

*param*

Is a pointer to an array of structures. The structure specifies the parameters for a preempt operation.

```
typedef struct LL_preempt_param {
 enum LL_preempt_op type;
 enum LL_preempt_method method;
 char ** user_list;
 char ** host_list;
 char ** jobstep_list;
} LL_preempt_param;

enum LL_preempt_op {PREEMPT_STEP, RESUME_STEP};

enum LL_preempt_method {LL_PREEMPT_SUSPEND, LL_PREEMPT_VACATE,
 LL_PREEMPT_REMOVE, LL_PREEMPT_SYS_HOLD, LL_PREEMPT_USER_HOLD}
```

In the **LL\_preempt\_param** structure, the fields are defined as follows:

*type* Is the type of operation on the job steps, **preempt** or **resume**.

*method* Is the method to be used to preempt the specified job steps. This argument is ignored if the type argument is not set to **PREEMPT\_STEP**. Valid values for this argument are:

- LL\_PREEMPT\_SUSPEND
- LL\_PREEMPT\_VACATE
- LL\_PREEMPT\_REMOVE
- LL\_PREEMPT\_SYS\_HOLD
- LL\_PREEMPT\_USER\_HOLD

LoadLeveler for Linux does not support preemption by the suspend method. Job steps running on Linux nodes will not be suspended when *method* in the **LL\_preempt\_param** structure has the value **LL\_PREEMPT\_SUSPEND**. The call to the **ll\_preempt\_jobs** subroutine is equivalent to a no-op in this case.

In the **enum LL\_preempt\_op** structure, valid values are:

- PREEMPT\_STEP
- RESUME\_STEP

In the **enum LL\_preempt\_method** structure, valid values are:

- LL\_PREEMPT\_SUSPEND
- LL\_PREEMPT\_VACATE
- LL\_PREEMPT\_REMOVE
- LL\_PREEMPT\_SYS\_HOLD
- LL\_PREEMPT\_USER\_HOLD

*user\_list*

Is a pointer to a NULL-terminated array of pointers to strings containing user names. All running job steps belonging to all users in the list and monitored by the machine the subroutine is running on will be preempted or resumed. If a *host\_list* is also specified, only the user's job steps monitored on the specified hosts will be preempted or resumed.

*host\_list*

Is a pointer to a NULL-terminated array of pointers to strings containing host names. All job steps monitored by the hosts will be preempted or resumed. If a *user\_list* is also provided, only the running job steps monitored by the hosts and owned by the specified users will be preempted or resumed.

*jobstep\_list*

Is a pointer to a NULL-terminated array of job or step identifiers. When a job identifier is specified, the action of the API is taken for all steps of the job. At least one job or step identifier must be specified.

The format of a job identifier is *host.jobid*. The format of a step identifier is *host.jobid.stepid*.

where:

- *host* is the name of the machine that assigned the job and step identifiers.
- *jobid* is the job number assigned to the job when it was submitted.
- *stepid* is the job step number assigned to the job step when it was submitted.

The job or step identifier may be specified in an abbreviated form, *jobid* or *jobid.stepid*, when the API is invoked on the same machine that assigned the job and step identifiers. In this case, LoadLeveler will use the local machine's host name to construct the full job or step identifier.

### Description

The **ll\_preempt\_jobs( )** subroutine is the API for the **llpreempt** command. See the **llpreempt** command for information about the available command options. In order to provide source code compatibility for applications using the current version of the **preempt** function, the **ll\_preempt()** subroutine will not be modified to support the new preemption options. The **ll\_preempt()** subroutine will continue to be supported as is.

### Return values

- 0 Request successfully sent to the central manager.
- 1 An *LL\_preempt\_op* that is not valid was specified.
- 2 Cannot send request to central manager.
- 3 An incorrect version was specified.
- 4 Errors encountered while processing the LoadLeveler administration or configuration files.
- 5 A system error occurred.

- 6 A data transmission failure occurred.
- 7 The calling program does not have LoadLeveler administrator authority.

## ll\_run\_scheduler subroutine

### Purpose

The **ll\_run\_scheduler** subroutine is used when the internal scheduling interval has been disabled so that an external program can control when the central manager attempts to schedule job steps. The **ll\_run\_scheduler** subroutine sends a request to the central manager to run the scheduling algorithm.

### Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

### Syntax

```
#include "llapi.h"
```

```
int ll_run_scheduler (int version);
```

### Parameters

*version*

Is an input parameter that indicates the LoadLeveler API version (this should be the same value as **LL\_API\_VERSION** in **llapi.h**).

### Description

The **ll\_run\_scheduler( )** subroutine sends a request to the central manager to run the LoadLeveler scheduling algorithm. The central manager's scheduling algorithm will run only once each time the **llrunscheduler** command is invoked. Each time the scheduling algorithm runs, the central manager will schedule as many job steps as the current available resources allow. The LoadLeveler scheduling interval must be disabled, that is the configuration keyword **NEGOTIATOR\_INTERVAL** must be set to zero in order to use this algorithm. Only LoadLeveler administrators have authority to use this algorithm.

### Return values

**RUN\_SCHED\_SUCCESS**

Request successfully sent to the central manager.

**RUN\_SCHED\_CONFIG\_ERROR**

Errors were encountered while processing configuration files.

**RUN\_SCHED\_NOT\_AUTH**

Calling program does not have LoadLeveler administrator authority.

**RUN\_SCHED\_NOT\_AUTH**

An internal system error occurred.

**RUN\_SCHED\_CANT\_TRANSMIT**

A data transmission failure occurred.

**RUN\_SCHED\_CANT\_CONNECT**

The schedd cannot connect to the central manager.

## ll\_start\_job subroutine

### Purpose

This subroutine tells the LoadLeveler negotiator to start a job on the specified nodes.

## Workload Management API

In LoadLeveler for Linux only, **ll\_start\_job** returns an error condition when:

- **DCE\_ENABLEMENT** is **TRUE**
- **SEC\_ENABLEMENT** is **DCE** or **CTSEC**
- **SCHEDULER\_TYPE** is **GANG**
- **NQS\_DIR** is specified

### Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

### Syntax

```
#include "llapi.h"
```

```
int ll_start_job (LL_start_job_info *ptr);
```

### Parameters

*ptr* Specifies the pointer to the **LL\_start\_job\_info** structure that was allocated by the caller. The **LL\_start\_job\_info** members are:

**int** *version\_num*

Represents the version number of the **LL\_start\_job\_info** structure. Should be set to **LL\_PROC\_VERSION**.

**LL\_STEP\_ID** *StepId*

Represents the step ID of the job step to be started.

**char** \*\**nodeList*

Is a pointer to an array of node names where the job will be started. The first member of the array is the parallel master node. The array must be ended with a **NULL**.

### Description

This subroutine does not allow you to specify adapter usage information. Use the **ll\_start\_job\_ext** subroutine instead.

You must set **SCHEDULER\_TYPE = API** in the global configuration file to use this subroutine.

Only jobs steps currently in the Idle state are started.

Only processes having the LoadLeveler administrator user ID can invoke this subroutine.

An external scheduler uses this subroutine to start jobs that are in idle state. The list of jobs that are currently in the system is retrieved with the **ll\_get\_objs** API function, passing in a query element with type **JOBS**. The list of machines available to run jobs on is obtained with the **ll\_get\_objs** and a query element with type **MACHINES**. Additional data about both jobs and machines is obtained with the **ll\_get\_data** function call.

When this function is used to start a step, adapter resources are assigned to the step according to JCF network statements, if they are present. Adapter resources are assigned in the same manner as the backfill scheduler assigns adapter resources, except that the **Communication Level** on the network statement is ignored and a value of **AVERAGE** is used. It is the responsibility of the external scheduler to ensure the machines to which the step is dispatched have sufficient adapter resources to run the step. Otherwise the step will not be started.

## Return values

This subroutine returns a value of zero to indicate the start job request was accepted by the negotiator. However, a return code of zero does not necessarily imply the job started. You can use the **llq** command to verify the job started. Otherwise, this subroutine returns an integer value defined in the **llapi.h** file.

## Error values

- 1      There is an error in the input parameter.
- 2      The subroutine cannot connect to the central manager.
- 4      An error occurred reading parameters from the administration or the configuration file.
- 5      The negotiator cannot find the specified *StepId* in the negotiator job queue.
- 6      A data transmission failure occurred.
- 7      The subroutine cannot authorize the action because you are not a LoadLeveler administrator.
- 8      The job object version number is incorrect.
- 9      The *StepId* is not in the Idle state.
- 10     One of the nodes specified is not available to run the job.
- 11     One of the nodes specified does not have an available initiator for the class of the job.
- 12     For one of the nodes specified, the requirements statement does not satisfy the job requirements.
- 13     The number of nodes specified was less than the minimum or more than the maximum requested by the job.
- 14     The LoadLeveler default scheduler is enabled.
- 15     The same node was specified twice in **ll\_start\_job** *nodeList*.
- 16     DCE identity cannot be determined.
- 17     No DCE credentials.
- 18     DCE credentials within 300 secs of expiration.
- 19     64-bit not supported when DCE enabled.

## Examples

Makefiles and examples which use this subroutine are located in the **samples/llsch** subdirectory of the release directory. The examples include the executable **sch\_api**, which invokes the query API and the job control API to start the second job in the list received from **ll\_get\_jobs** on two nodes. You should submit at least two jobs prior to running the sample. To compile **sch\_api**, copy the sample to a writeable directory and update the **RELEASE\_DIR** field to represent the current LoadLeveler release directory.

## Related information

Subroutines: **ll\_get\_jobs**, **ll\_terminate\_job**, **ll\_get\_nodes**, **ll\_start\_jobs\_ext**

## ll\_start\_job\_ext subroutine

### Purpose

This subroutine tells the LoadLeveler negotiator to start a job on the specified nodes, indicating which adapter and adapter resources to use.

In LoadLeveler for Linux only, **ll\_start\_job\_ext** returns an error condition when:

- **DCE\_ENABLEMENT** is **TRUE**
- **SEC\_ENABLEMENT** is **DCE** or **CTSEC**
- **SCHEDULER\_TYPE** is **GANG**
- **NQS\_DIR** is specified

An external scheduler uses this subroutine to start jobs that are in idle state. The list of jobs that are currently in the system is retrieved with the `ll_get_objs` API function, passing in a query element with type **JOBS**. The list of machines available to run jobs on is obtained with the `ll_get_objs` and a query element with type **MACHINES**. Additional data about both jobs and machines is obtained with the `ll_get_data` function call.

When this function is used to start a step, the external scheduler specifies the adapter resources that are assigned to the step and network statements in the JCF, if they are present, are ignored. It is the responsibility of the external scheduler to manage the availability of adapter resources and LoadLeveler does not prevent or detect the over commitment of adapter resources.

### Library

LoadLeveler API library `libllapi.a` (AIX) or `libllapi.so` (Linux)

### Syntax

```
#include "llapi.h"
```

```
int ll_start_job_ext (LL_start_job_info_ext *ptr);
```

### Parameters

*ptr* Specifies the pointer to the `LL_start_job_info_ext` structure that was allocated and populated by the caller. The `LL_start_job_info_ext` members are:

**int** *version\_num*

Represents the version number of the `LL_start_job_info_ext` structure. Should be set to `LL_PROC_VERSION`.

**LL\_STEP\_ID** *StepId*

Represents the step ID of the job step to be started.

**char \*\*** *odelist*

A pointer to an array of node names where the job will be started. The first member of the array is the parallel master node. The array must be ended with a `NULL`.

**int** *adapterUsageCount*

This is the size of the adapterUsage list. To determine what this number should be, add all the adapter usages for all protocols needed by one task and multiply the result by the number of tasks in the job.

**LL\_ADAPTER\_USAGE** \* *adapterUsage*

This is a list of adapter information. The size of this list is given by `adapterUsageCount`. The members of this structure are:

**char** \* *dev\_name*

The device name of the adapter to be used.

**char** \* *protocol*

A character string representing the communication protocol this usage supports. Valid values are **MPI**, **LAPI**, and **MPI\_LAPI**.

**char** \* *subsystem*

The communication subsystem this usage supports. Valid values are **IP** or **US**.

**int** *wid*

For **US** subsystem usages, this indicates which adapter window ID to use. For **IP** subsystem usages, this field is ignored.

**uint64\_t mem**

For **US** subsystem usages, this is the amount of adapter memory to dedicate to the adapter usage. For **IP** subsystem usages, this field is ignored.

**uint64\_t api\_rcxtblocks**

For **US** subsystem usages, this is the number of user rCxt blocks to allocate for each adapter window. For **IP** subsystem usages, this field is ignored.

**Notes:**

- 1. This field should only be used on systems which contain Switch\_Network\_Interface\_For\_HPS adapters. When using this field, the *mem* field should not be used.
- 2. Previously existing applications which use **ll\_start\_job\_ext** can be used unchanged to start jobs on systems with Switch\_Network\_Interface\_For\_HPS adapters, the value previously specified for the memory request will be ignored.

Each element in the adapterUsage list represents one communication channel for a task. If the subsystem is US (User Space), a communication channel will require a switch adapter window. Adapter windows, and User Space usages, must be specified on actual switch adapters that are only accessible if AGGREGATE\_ADAPTERS=False is specified in the configuration file.

**Description**

You must set **SCHEDULER\_TYPE = API** in the global configuration file to use this subroutine. In order to have access to the physical switch adapters in the LoadLeveler cluster (as opposed to virtual adapters representing all of the adapters on a network or adapters striping across multiple networks) you must specify **AGGREGATE\_ADAPTERS = False** in the global configuration file.

Only jobs steps currently in the Idle state are started.

Only processes having the LoadLeveler administrator user ID can invoke this subroutine.

An external scheduler uses this subroutine in conjunction with the **ll\_query** and **ll\_get\_data** subroutines of the query API. The query API returns information about which machines are available for scheduling and which jobs are currently in the job queue waiting to be scheduled.

The node list that is passed to the external scheduler API specifies the node on which each task of the job being started is to run. The distribution of tasks to nodes in the node list must be consistent with the node allocation specified by the job command file of the job being started. If it is not, the results are undefined and the job may fail to start or may start with incorrect node assignments. Except when **BLOCKING** is specified, the entries for tasks that are running on the same node must all be specified sequentially in the node list. The table below describes how nodes should be arranged in the node list for the possible combinations of node and task specification in the job command file. In the table, '/' denotes integer division and (N mod M) is the remainder of the integer division of N by M.

Job command file specification	Required nodelist structure
node=N tasks_per_node=T	There must be N different machine names specified, each specified T times.

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node=N,M tasks_per_node=T	There must be between N and M different machine names specified, each specified T times.
node=N total_tasks=TT TT evenly divisible by N	There must be N different machine names specified, each specified TT/N times.
node=N total_tasks=TT TT not evenly divisible by N	There must be N different machine names specified. The first (TT mod N) unique machine names must each be specified (TT/N +1) times and the remaining machine names are each specified TT/N times.
total_tasks=TT BLOCKING=B  TT evenly divisible by B	There must be TT/B sets of machine names specified, each set specifies a machine name B times. It is permissible for a machine name to be specified in more than one set.
total_tasks=TT BLOCKING=B TT not evenly divisible by B	There must be TT/B+1 sets of machine names specified. The first TT/B sets specify a machine name B times. The last set specifies a machine name (TT mod B) times. It is permissible for a machine name to be specified in more than one set.
total_tasks=TT BLOCKING=UNLIMITED	There must be TT entries in the node list. It is permissible for a machine name to be specified in the list more than once and it is not required that the specifications be contiguous.
task_geometry	There is a 1:1 correspondence between entries in the nodelist and task ids specified in the task geometry statement. Entries in the node list that correspond to task IDs in the same set must specify the same machine. Entries in the node list that correspond to task IDs in different sets must specify different machines.

### Return values

This routine returns a non-zero value to indicate the start request was not delivered to the negotiator. These values are defined in the **llapi.h** file and explained in "Error values." A return code of zero indicates the request was successfully delivered to the negotiator, but constraints on the negotiator may stop the job from starting. You can use the **llq** command to verify the job started.

### Error values

- 1 There is an error in the input parameter.
- 2 The subroutine cannot connect to the central manager.
- 4 An error occurred reading parameters from the administration or the configuration file.
- 5 The negotiator cannot find the specified StepId in the negotiator job queue.
- 6 A data transmission failure occurred.
- 7 The subroutine cannot authorize the action because you are not a LoadLeveler administrator.
- 8 The job object version number is incorrect.
- 9 The StepId is not in the Idle state.
- 10 One of the nodes specified is not available to run the job.
- 11 One of the nodes specified does not have an available initiator for the class of the job.
- 12 For one of the nodes specified, the requirements statement does not satisfy the job requirements.

- 13 The number of nodes specified was less than the minimum or more than the maximum requested by the job.
- 14 The LoadLeveler default scheduler is enabled.
- 15 The same node was specified twice in the ll\_start\_job nodeList.
- 16 DCE identity cannot be determined.
- 17 No DCE credentials
- 18 DCE credentials within 300 secs of expiration
- 19 64-bit API not supported when DCE is enabled
- 20 Adapter usage information does not match job structure.
- 21 Adapter usage requested an adapter not on the machine.
- 22 Wrong number of entries on adapter usage list.
- 23 The adapter usage information did not specify the same protocol usage on each task.
- 24 An invalid protocol string was specified on an adapter usage.
- 25 The adapter usages specified incompatible protocols
- 26 An adapter usage specified a communication subsystem that was not IP or US

### Examples

Makefiles and examples which use this subroutine are located in the **samples/llsch** subdirectory of the release directory. The examples include the executable **sch\_api\_ext**, which invokes the query API and the job control API to start the first job in the list received from **ll\_query** on one node and to cancel the second job in the list. To compile **sch\_api\_ext**, copy the sample to a writeable directory and update the **RELEASE\_DIR** field to represent the current LoadLeveler release directory.

### Related information

Subroutines: **ll\_start\_job**, **ll\_query**, **ll\_get\_data**, **ll\_terminate\_job**, **ll\_start\_job**

## ll\_terminate\_job subroutine

### Purpose

This subroutine tells the negotiator to cancel the specified job step.

In LoadLeveler for Linux only, **ll\_terminate\_job** returns an error condition when:

- **DCE\_ENABLEMENT** is **TRUE**
- **SEC\_ENABLEMENT** is **DCE** or **CTSEC**
- **SCHEDULER\_TYPE** is **GANG**
- **NQS\_DIR** is specified

### Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

### Syntax

```
#include "llapi.h"
```

```
int ll_terminate_job (LL_terminate_job_info *ptr);
```

### Parameters

*ptr* Specifies the pointer to the **LL\_terminate\_info** structure that was allocated by the caller. The **LL\_terminate\_job\_info** members are:

**int** *version\_num*

Represents the version number of the **LL\_terminate\_job\_info** structure. Should be set to **LL\_PROC\_VERSION**.

### **LL\_STEP\_ID** *StepId*

Represents the step ID of the job step to be terminated.

### **char \*msg**

A pointer to a null terminated array of characters. If this pointer is null or points to a null string, a default message is used. This message will be available through **ll\_get\_data** to tell the process why a program was terminated.

## Description

You do not need to disable the default LoadLeveler scheduler in order to use this subroutine.

Only processes having the LoadLeveler administrator user ID can invoke this subroutine.

An external scheduler uses this subroutine in conjunction with the **ll\_get\_job** subroutine (of the job control API) and **ll\_start\_jobs** subroutine (of the query API). The external scheduler must use this subroutine to return errors from **ll\_start\_job** to interactive parallel jobs.

## Return values

This subroutine returns a value of zero when successful, to indicate the terminate job request was accepted by the negotiator. However, a return code of zero does not necessarily imply the negotiator canceled the job. Use the **llq** command to verify the job was canceled. Otherwise, this subroutine returns an integer value defined in the **llapi.h** file.

## Error values

- 1     There is an error in the input parameter.
- 4     An error occurred reading parameters from the administration or the configuration file.
- 6     A data transmission failure occurred.
- 7     The subroutine cannot authorize the action because you are not a LoadLeveler administrator or you are not the user who submitted the job.
- 8     The job object version number is incorrect.
- 17    No DCE credentials.
- 18    DCE credentials within 300 secs of expiration.
- 19    64-bit API not supported when DCE is enabled.

## Examples

Makefiles and examples which use this subroutine are located in the **samples/llsch** subdirectory of the release directory. The examples include the executable **sch\_api**, which invokes the query API and the job control API to terminate the first job reported by the **ll\_get\_jobs** subroutine. You should submit at least two jobs prior to running the sample. To compile **sch\_api**, copy the sample to a writeable directory and update the **RELEASE\_DIR** field to represent the current LoadLeveler release directory.

## Related information

Subroutines: **ll\_get\_jobs**, **ll\_start\_job**, **ll\_get\_nodes**

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## Appendix A. Troubleshooting

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### Troubleshooting LoadLeveler

This chapter is divided into the following sections:

- “Frequently asked questions,” which contains answers to questions frequently asked by LoadLeveler customers. This section focuses on answers that may help you get out of problem situations. The questions and answers are organized into the following categories:
  - **Jobs submitted to LoadLeveler do not run.** See “Why won’t my job run?” for more information.
  - **One or more of your machines goes down.** See “What happens to running jobs when a machine goes down?” on page 590 for more information.
  - **The central manager is not operating.** See “What happens if the central manager isn’t operating?” on page 591 for more information.
  - **Miscellaneous questions.** See “Other questions” on page 594 for more information.
- “Troubleshooting in a multicluster environment” on page 595, which contains common questions and answers pertaining to operations within a multicluster environment.
- “Helpful hints” on page 597, which contains tips on running LoadLeveler, including some productivity aids.
- “Getting help from IBM” on page 602, which tells you how to contact IBM for assistance.

It is helpful to create error logs when you are diagnosing a problem. See to “Configuring recording activity and log files” on page 40 for information on setting up error logs.

### Frequently asked questions

This section contains answers to questions frequently asked by LoadLeveler customers.

#### Why won’t my job run?

If you submitted your job but it has not run, issue **llq -s** first to help diagnose the problem. If you need more help diagnosing the problem, refer to the following table:

Why your job might not be running:	Possible solution
Job requires specific machine, operating system, or other resource.	Does the resource exist in the LoadLeveler cluster? If yes, wait until it becomes available.  Check the GUI to compare the job requirements to the machine details, especially <b>Arch</b> , <b>OpSys</b> , and <b>Class</b> . Ensure that the spelling and capitalization matches.

Why your job might not be running:	Possible solution
Job requires specific job class	<ul style="list-style-type: none"> <li>Is the class defined in the administration file? Use <b>llclass</b> to determine this. If yes,</li> <li>Is there a machine in the cluster that supports that class? If yes, you need to wait until the machine becomes available to run your job.</li> </ul>
The maximum number of jobs are already running on all the eligible machines	Wait until one of the machines finishes a job before scheduling your job.
The start expression evaluates to false.	<p>Examine the configuration files (both <b>LoadL_config</b> and <b>LoadL_config.local</b>) to determine the <b>START</b> control function expression used by LoadLeveler to start a job. As a problem determination measure, set the <b>START</b> and <b>SUSPEND</b> values, as shown in this example:</p> <pre>START: T SUSPEND: F</pre>
A job step is running on the node that your job requires, and that job step's preemption rules list your job's class as one that cannot share the node	The running job step is in a job class for which an administrator has defined preemption rules through the <b>PREEMPT_CLASS</b> keyword. When your job step's class is listed in the <b>ALL</b> clause of that keyword, your job step must wait until the running job step finishes.
The priority of your job is lower than the priority of other jobs.	You cannot affect the system priority given to this job by the negotiator daemon but you can try to change your user priority to move this job ahead of other jobs you previously submitted using the <b>llprio</b> command or the GUI.
The information the central manager has about machines and jobs may not be current.	Wait a few minutes for the central manager to be updated and then the job may be dispatched. This time limit (a few minutes) depends upon the polling frequency and polls per update set in the <b>LoadL_config</b> file. The default polling frequency is five seconds.
You do not have the same user ID on all the machines in the cluster.	To run jobs on any machine in the cluster, you have to have the same user ID and the same uid number on every machine in the pool. If you do not have a userid on one machine, your jobs will not be scheduled to that machine.
CtSec is enabled and the <b>.rhosts</b> file was not updated.	The <b>.rhosts</b> file should contain entries which specify all the host and user combinations allowed to submit jobs which will run as the local user. See step 7 on page 55 for more details.

Why your job might not be running:	Possible solution
Your job is not bound to a reservation under which nodes that your job requires to run are reserved	<p>When an unbound job requires nodes that are reserved under a reservation, LoadLeveler will not start the job unless one of the following conditions is true:</p> <ul style="list-style-type: none"> <li>• The reservation was created with SHARED mode specified. If the reservation is using SHARED mode, your job will remain idle until the reservation state becomes Active_Shared.</li> <li>• The job's expected end time (current time plus the hard wall clock limit) indicates that the job will complete before the reservation starts.</li> </ul> <p>If neither condition is true, but you have the authority to use the reservation, you may use the <b>llbind</b> command to bind your job to the reservation. Otherwise, your unbound job will remain idle until the reservation completes or is canceled.</p> <p>To check the reservation's status and attributes, use the <b>llqres</b> command. To find out which reservations you may use, check with your LoadLeveler administrator, or enter the command <b>llqres -l</b> and check the names in the Users or Groups fields (under the Modification time field) in the output listing. If your user name or a group name to which you belong appears in these output fields, you are authorized to use the reservation.</p>
Your job is bound to a reservation but the reservation is not active yet	<p>LoadLeveler schedules bound job steps to run only when a reservation becomes active. Use the command <b>llq -l</b> to find the ID of the reservation to which the job is bound. Use the command <b>llqres -l</b> to find the start time of the reservation, and wait until that time to check the job status again.</p>
Your job is bound to a reservation that does not reserve all of the resources that your job requires to run	<p>If a bound job requires specific resources that are not available during the reservation period, LoadLeveler will not dispatch the job to run under the reservation. This situation can occur if the job requires one or more of the following:</p> <ul style="list-style-type: none"> <li>• Specific nodes that were not selected for the reservation.</li> <li>• More than the total number of reserved nodes.</li> <li>• Floating consumable resources, which cannot be reserved under a reservation.</li> </ul> <p>If the LoadLeveler cluster has the resources that the job requires, use the command <b>llbind -r</b>, which unbinds the job from the reservation.</p>
Your job is bound to a reservation but the maximum number of jobs you may run has been reached already	<p>If LoadLeveler detects that you currently are running the maximum number of jobs that you are allowed to run, it will not start your bound job even if the reservation is active.</p>

Why your job might not be running:	Possible solution
Your job is bound to a reservation but the job's expected end time exceeds the reservation's end time	<p>LoadLeveler will dispatch your job only if its expected end time (current time plus the hard wall clock limit) does not exceed the end time of the reservation, or if both of the following conditions are true:</p> <ul style="list-style-type: none"> <li>• This reservation is configured to allow jobs to continue running even when their expected end time exceeds the end of the reservation, and</li> <li>• The resources required to run your job are available.</li> </ul> <p>Otherwise, this bound job will remain idle until either:</p> <ul style="list-style-type: none"> <li>• The reservation completes or is canceled, or</li> <li>• You use the command <b>llbind -r</b>, which unbinds the job from the reservation.</li> </ul>
Your job is bound to a reservation that does not exist	<p>LoadLeveler puts your job in NotQueued state until the reservation is created. In that case, LoadLeveler will bind your job to the reservation. Otherwise, use the command <b>llbind -r</b> to unbind the job from the reservation.</p>

You can use the **llq** command to query the status of your job or the **llstatus** command to query the status of machines in the cluster. Refer to Chapter 15, "Commands," on page 371 for information on these commands.

### Why won't my parallel job run?

If you submitted your parallel job but it has not run, issue **llq -s** first to help diagnose the problem. If issuing this command does not help, refer to the previous table and to the following table for more information:

Why your job might not be running:	Possible solution
The minimum number of processors requested by your job is not available.	Sufficient resources must be available. Specifying a smaller number of processors may help if your job can run with fewer resources.
The pool in your <b>requirements</b> statement specifies a pool which is invalid or not available.	The specified pool must be valid and available.
The adapter specified in the <b>requirements</b> statement or the <b>network</b> statement identifies an adapter which is invalid or not available.	<p>The specified adapter must be valid and available.</p> <p>Use <b>llstatus -a</b> to check the status of the adapters in the system. Switch adapters that show a state of 'NOT READY' or '-1' should be reported to the LoadLeveler administrator. Switch adapters with a state of '-1' indicate that the machine those adapters are on could not be queried for status.</p> <p>If the network statement specifies <b>rcxtblocks</b>, only Switch Network Interface for HPS adapters can be used for the step.</p>

**Gang scheduler checklist:** Before running the Gang Scheduler, verify that:

- **MACHINE\_AUTHENTICATE** is set to TRUE
- **PROCESS\_TRACKING** is set to TRUE
- Applications are compiled with the multi-threaded library

**Common set-up problems with parallel jobs:** This section presents a list of common problems found in setting up parallel jobs:

- If jobs appear to remain in a Pending or Starting state: check that the nameserver is consistent. Compare results of **host machine\_name** and **host IP\_address**
- For POE:
  - Specify the POE partition manager as the executable. Do *not* specify the parallel job as the executable.
  - Pass the parallel job as an argument to POE.
  - The parallel job must exist and must be specified as a full path name.
  - If the job runs in user space, specify the flag **-eulib us**.
  - Specify the correct adapter (when needed).
  - Specify a POE job only once in the job command file.
  - Compile only with the supported level of POE.
  - Specify only **parallel** as the *job\_type*.

## Why won't my checkpointed job restart?

If the job you submitted has the keyword **restart\_from\_ckpt = yes** and if the checkpoint file specified does not exist, the job will move to the Starting state and will then be removed from the queue. A mail message will be generated indicating the checkpoint file does not exist and a message will also appear in the StarterLog. Verify the values of the **ckpt\_file** keyword in the Job Command File and the value of the **ckpt\_dir** keyword in the Job Command or Administration File to ensure they resolve to the directory and file name of the desired checkpoint file.

**Note:** When a job is enabled for checkpoint, it is important to ensure the name of the checkpoint file is unique.

## Why won't my submit-only job run?

If a job you submitted from a *submit-only* machine does not run, verify that you have defined the following statements in the machine stanza of the administration file of the submit-only machine:

```
submit_only = true
schedd_host = false
central_manager = false
```

Verify that another machine has set **schedd\_host = true** and **schedd\_runs\_here = true**.

## Why won't my job run on a cluster with both AIX and Linux machines?

The default shell on Linux (in both Red Hat Enterprise Linux and SUSE Linux Enterprise Server) is **bash** and **bash** may not be available on AIX. If a job step contains a **bash** script it will be rejected if it is run on an AIX node. The **ksh** is available on both AIX and Linux. You can specify which shell to use in the keyword **shell** in your job command file:

```
@shell = /bin/ksh
```

Also, AIX and Linux are not binary compatible so jobs written in compiled languages such as C or Fortran must be compiled for the environment they will run on.

### Why does a job stay in the Pending (or Starting) state?

If a job appears to stay in the Pending or Starting state, it is possible the job is continually being dispatched and rejected. Check the setting of the **MAX\_JOB\_REJECT** keyword. If it is set to -1 the job will be rejected an unlimited number of times. Try resetting this keyword to a small number, such as 10. Also, check the setting of the **ACTION\_ON\_MAX\_REJECT** keyword. These keywords are described in Chapter 11, "Configuration file reference," on page 231.

### What happens to running jobs when a machine goes down?

Both the startd daemon and the schedd daemon maintain persistent states of all jobs. Both daemons use a specific protocol to ensure that the state of all jobs is consistent across LoadLeveler. In the event of a failure, the state can be recovered. Neither the schedd nor the startd daemon discard the job state information until it is passed onto and accepted by another daemon in the process.

If	Then
The network goes down but the machines are still running	If the network goes down but the machines are still running, when LoadLeveler is restarted, it looks for all jobs that were marked running when it went down. On the machine where the job is running, the startd daemon searches for the job and if it can verify that the job is still running, it continues to manage the job through completion. On the machine where schedd is running, schedd queues a transaction to the startd to reestablish the state of the job. This transaction stays queued until the state is established. Until that time, LoadLeveler assumes the state is the same as when the system went down.
The network partitions or goes down.	All transactions are left queued until the recipient has acknowledged them. Critical transactions such as those between the schedd and startd are recorded on disk. This ensures complete delivery of messages and prevents incorrect decisions based on incomplete state information.
The machine with startd goes down.	Because job state is maintained on disk in startd, when LoadLeveler is restarted it can forward correct status to the rest of LoadLeveler. In the case of total machine failure, this is usually "JOB VACATED", which causes the job to be restarted elsewhere. In the case that only LoadLeveler failed, it is often possible to "find" the job if it is still running and resume management of it. In this case LoadLeveler sends JOB RUNNING to the schedd and central manager, thereby permitting the job to run to completion.
The central manager machine goes down.	<p>All machines in the cluster send current status to the central manager on a regular basis. When the central manager restarts, it queries each machine that checks in, requesting the entire queue from each machine. Over the period of a few minutes the central manager restores itself to the state it was in before the failure. Each schedd is responsible for maintaining the correct state of each job as it progressed while the central manager is down. Therefore, it is guaranteed that the central manager will correctly rebuild itself.</p> <p>All jobs started when the central manager was down will continue to run and complete normally with no loss of information. Users may continue to submit jobs. These new jobs will be forwarded correctly when the central manager is restarted.</p>

If	Then
The schedd machine goes down	<p>When schedd starts up again, it reads the queue of jobs and for every job which was in some sort of active state (i.e. PENDING, STARTING, RUNNING), it queries the machine where it is marked active.</p> <p>The running machine is required to return current status of the job. If the job completed while schedd was down, JOB COMPLETE is returned with exit status and accounting information. If the job is running, JOB RUNNING is returned. If the job was vacated, JOB VACATED is returned. Because these messages are left queued until delivery is confirmed, no job will be lost or incorrectly dispatched due to schedd failure.</p> <p>During the time the schedd is down, the central manager will not be able to start new jobs that were submitted to that schedd.</p> <p>To recover the resources allocated to jobs scheduled by a schedd machine, see "How do I recover resources allocated by a schedd machine?" on page 593.</p>
The llsubmit machine goes down	schedd gets its own copy of the executable so it does not matter if the llsubmit machine goes down.

**Why does llstatus indicate that a machine is down when llq indicates a job is running on the machine?:** If a machine fails while a job is running on the machine, the central manager does not change the status of any job on the machine. When the machine comes back up the central manager will be updated.

### What happens if the central manager isn't operating?

In one of your machine stanzas specified in the administration file, you specified a machine to serve as the central manager. It is possible for some problem to cause this central manager to become unusable such as network communication or software or hardware failures. In such cases, the other machines in the LoadLeveler cluster believe that the central manager machine is no longer operating. If you assigned one or more alternate central managers in the machine stanza, a new central manager will take control. The alternate central manager is chosen based upon the order in which its respective machine stanza appears in the administration file.

Once an alternate central manager takes control, it starts up its negotiator daemon and notifies all of the other machines in the LoadLeveler cluster that a new central manager has been selected. Figure 41 on page 592 illustrates how a machine can become the alternate central manager.

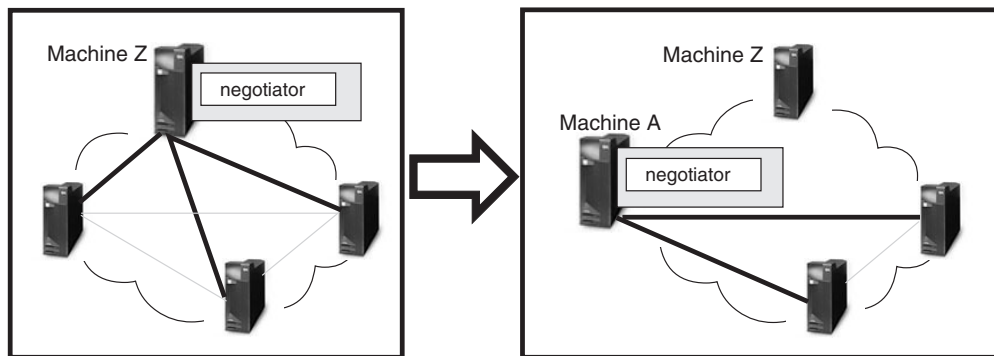


Figure 41. When the primary central manager is unavailable

The diagram illustrates that Machine Z is the primary central manager but Machine A took control of the LoadLeveler cluster by becoming the alternate central manager. Machine A remains in control as the alternate central manager until either:

- The primary central manager, Machine Z, resumes operation. In this case, Machine Z notifies Machine A that it is operating again and, therefore, Machine A terminates its negotiator daemon.
- Machine A also loses contact with the remaining machines in the pool. In this case, another machine authorized to serve as an alternate central manager takes control. Note that Machine A may remain as its own central manager.

Figure 42 illustrates how multiple central managers can function within the same LoadLeveler pool.

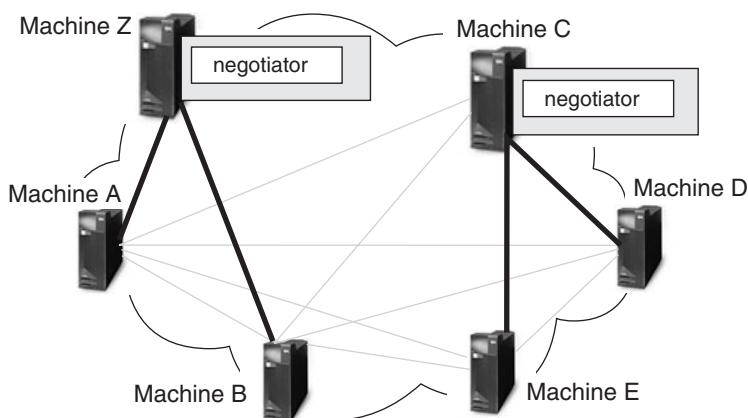


Figure 42. Multiple central managers

In this diagram, the primary central manager is serving Machines A and B. Due to some network failure, Machines C, D, and E have lost contact with the primary central manager machine and, therefore, Machine C which is authorized to serve as an alternate central manager, assumes that role. Machine C remains as the alternate central manager until either:

- The primary central manager is able to contact Machines C, D, and E. In this case, the primary central manager notifies the alternate central managers that it is operating again and, therefore, Machine C terminates its negotiator daemon. The negotiator daemon running on the primary central manager machine is refreshed to discard any old job status information and to pick up the new job status information from the newly rejoined machines.

- Machine C loses contact with Machines D and E. In this case, if machine D or E is authorized to act as an alternate central manager, it assumes that role. Otherwise, there will be no central manager serving these machines. Note that Machine C remains as its own central manager.

While LoadLeveler can handle this situation of two concurrent central managers without any loss of integrity, some installations may find administering it somewhat confusing. To avoid any confusion, you should specify all primary and alternate central managers on the same LAN segment.

For information on selecting alternate central managers, refer to “Defining machines” on page 78.

## How do I recover resources allocated by a schedd machine?

If a node running the schedd daemon fails, resources allocated to jobs scheduled by this schedd cannot be freed up until you restart the schedd. Administrators must do the following to enable the recovery of schedd resources:

1. Recognize that a node running the schedd daemon is down and will be down long enough such that it is necessary for you to recover the schedd resources.
2. Add the statement **schedd\_fenced=true** to the machine stanza of the failed node. This statement specifies that the central manager ignores connections from the schedd daemon running on this machine, and prevents conflicts from arising when a schedd machine is restarted while a purge (see below) is taking place.
3. Reconfigure the central manager node so that it recognizes the “fenced” schedd daemon. From the central manager machine issue **llctl reconfig**.
4. Issue **llctl -h host purgeschedd** to purge all jobs scheduled by the schedd on the failed node.
5. Remove all files in the LoadLeveler spool directory of the failed node. Once the failed node is working again, you can remove the **schedd\_fenced=true** statement.

## Why can't I find a core file on Linux?

On Linux, when a LoadLeveler daemon terminates abnormally a core file is not generated. Why? Although a LoadLeveler daemon begins its existence as a root process, it uses the system functions **seteuid()** and **setegid()** to switch to effective user ID of **loadl** and effective group ID of **loadl** immediately after startup if the file **/etc/LoadL.cfg** is not defined. If this file is defined, the user ID associated with the **LoadLUserid** keyword and the group ID associated with the **LoadLGroupid** keyword are used instead of the default **loadl** user and group IDs.

On Linux systems, unless the default kernel runtime behavior is modified, the standard kernel action for a process that has successfully invoked **seteuid()** and **setegid()** to have a different effective user ID and effective group ID is not to dump a core file. So, if you want Linux to create a core file when a LoadLeveler daemon terminates abnormally you must use the file **/etc/LoadL.cfg** to set both **LoadLUserid** and **LoadLGroupid** to **root**.

On Red Hat Enterprise Linux 3.3 systems, the command **sysctl -w kernel.core\_setuid\_ok=1** can be used to change the default kernel core file creation behavior of **setuid** programs. If the **core\_setuid\_ok** option is enabled, the values of **LoadLUserid** and **LoadLGroupid** in the **/etc/LoadL.cfg** file do not have to be **root** for the successful creation of LoadLeveler core files.

### Other questions

**Why do I have to setuid = 0?:** The master daemon starts the startd daemon and the startd daemon starts the starter process. The starter process runs the job. The job needs to be run by the userid of the submitter. You either have to have a separate master daemon running for every ID on the system or the master daemon has to be able to **su** to every userid and the only user ID that can **su** any other userid is **root**.

**Why doesn't LoadLeveler execute my .profile or .login script?:** When you submit a batch job to LoadLeveler, the operating system will execute your **.profile** script before executing the batch job if your login shell is the Korn shell. On the other hand, if your login shell is the Bourne shell, on most operating systems (including AIX), the **.profile** script is not executed. Similarly, if your login shell is the C shell then AIX will execute your **.login** script before executing your LoadLeveler batch job but some other variants of UNIX may not invoke this script.

The reason for this discrepancy is due to the interactions of the shells and the operating system. To understand the nature of the problem, examine the following C program that attempts to open a login Korn shell and execute the "ls" command:

```
#include <stdio.h>
main()
{
 execl("/bin/ksh", "-", "-c", "ls", NULL);
}
```

UNIX documentations in general (SunOS, HP-UX, AIX, IRIX) give the impression that if the second argument is "-" then you get a login shell regardless of whether the first argument is /bin/ksh or /bin/csh or /bin/sh. In practice, this is not the case. Whether you get a login shell or not is implementation dependent and varies depending upon the UNIX version you are using. On AIX you get a login shell for /bin/ksh and /bin/csh but not the Bourne shell.

If your login shell is the Bourne shell and you would like the operating system to execute your **.profile** script before starting your batch job, add the following statement to your job command file:

```
@ shell = /bin/ksh
```

LoadLeveler will open a login Korn shell to start your batch job which may be a shell script of any type (Bourne shell, C shell, or Korn shell) or just a simple executable.

**What happens when a mksysb is created when LoadLeveler is running jobs?:**

When you create a mksysb (an image of the currently installed operating system) at a time when LoadLeveler is running jobs, the state of the jobs is saved as part of the mksysb. When the mksysb is restored on a node, those jobs will appear to be on the node, in the same state as when they were saved, even though the jobs are not actually there. To delete these phantom jobs, you must remove all files from the LoadLeveler **spool** and **execute** directories and then restart LoadLeveler.

**What can I do when a reserved node is down?:** If the reservation has not started yet, the node might become available before the reservation start time. If the node is still not available when the reservation starts, a LoadLeveler administrator may use the **llchres** command to remove the node and replace it with another.

## Troubleshooting in a multicluster environment

### How do I determine if I am in a multicluster environment?

- Issue the `llstatus` command.
  - Output of command will display "Cluster name is *cluster\_name*".

### How do I determine how my multicluster environment is defined and what are the inbound and outbound hosts defined for each cluster?

- Issue `llstatus -C` command.
  - Output of command will display the local cluster's administration file cluster stanza information.
- Issue `llstatus -X all -C` command.
  - Output of command will display the administration file cluster stanza information for all clusters defined in the local cluster's configuration.

### Why is my multicluster environment not enabled?

- Issue `llstatus -X all -C`.
  - The cluster stanzas defined for each cluster participating in the multicluster environment must have the same **outbound\_hosts** and **inbound\_hosts** defined.
  - Determine if any of the clusters are being started with **SCHEDD\_STREAM\_PORT** defined. The **inbound\_schedd\_port** keyword must be set for that cluster.
- Set the **D\_MUSTER** debug flag for the **SCHEDD\_DEBUG** configuration keyword on the machines defined as **inbound\_hosts** and **outbound\_hosts**, reconfigure LoadLeveler and examine the SchedLog on those machines for information about configuration errors.
- If the clusters are trying to enable OpenSSL, examine the SchedLog on the **inbound\_hosts** and **outbound\_hosts** for messages about SSL initialization errors and that multicluster is being disabled.

### How do I find log messages from my multicluster defined installation exits?

- Determine which machine is executing the installation exit.
  - For **CLUSTER\_METRIC**:
    - If the user specifies the reserved word **any** as the **cluster\_list** during job submission, the job is sent to the first outbound schedd defined for the first configured remote cluster. The **CLUSTER\_METRIC** is executed on this schedd to determine where the job will be distributed. If this schedd is not the **outbound\_hosts schedd** for the assigned cluster, the job will be forwarded to the correct **outbound\_hosts schedd**. If the user specifies a list of clusters as the **cluster\_list** during job submission, the job is sent to the first outbound schedd defined for the first specified remote cluster. The **CLUSTER\_METRIC** is executed on this schedd to determine where the job will be distributed. If this schedd is not the **outbound\_hosts schedd** for the assigned cluster, the job will be forwarded to the correct **outbound\_hosts schedd**.
  - For **CLUSTER\_USER\_MAPPER**:
    - This installation exit is executed on the **inbound\_hosts** of the local cluster when receiving a job submission, move job request or remote command.
  - For **CLUSTER\_REMOTE\_JOB\_FILTER**:

- This installation exit is executed on the **inbound\_hosts** of the local cluster when receiving a job submission or move job request.
- Set the **D\_MUSTER** debug flag for the **SCHEDD\_DEBUG** configuration keyword on the machines defined as **inbound\_hosts** and **outbound\_hosts**, reconfigure LoadLeveler and examine the SchedLog on those machines for information about configuration errors.

### Why won't my remote job be submitted or moved?

- Determine if the remote job filter has changed the number of steps within the job.
  - If the local submission filter on the submitting cluster has added or deleted steps from the original user's job command file, the remote job filter must add or delete the same number of steps. The job command file statements returned by the remote job filter must contain the same number of steps as the job object received from the sending cluster.
- Determine if the job failed the assigned cluster's include and exclude rules for the cluster and/or class stanzas.
  - If the assigned cluster has **CLUSTER\_USER\_MAPPING** enabled, the mapped user ID is applied to the rules.
- Issue **llq** to determine if the job being moved has all of its steps in an idle-like state.
  - The **llmovejob** command should fail and report this situation.
- Issue **llq -x -d job\_id** to determine if the job being moved has a job command file associated with it.
  - A job cannot be moved that was not submitted while in the multicluster environment.
- See "How do I find log messages from my multicluster defined installation exits?" on page 595 to determine if an installation exit has returned an error.
- Determine that the file system in the assigned cluster has the desired availability and permissions.
  - User may be mapped to another user ID thus another **\$HOME**.
  - User needs to have **initialdir** available.
  - **cluster\_input\_file** and **cluster\_output\_file** need requested file locations to be available.
  - If clusters share a common file system, users requesting **cluster\_input\_file** and **cluster\_output\_file** may have their remote location files removed if a local job is moved to another cluster. During a **llmovejob** operation, the files are copied from the remote location to the remote location instead of from the local location to the remote location. LoadLeveler only knows that the job being moved has access to the remote location because they were copied during the local submission. After the **llmovejob** is complete, LoadLeveler removes the files from the local cluster in the remote location, thus removing the files just copied.
- Determine if the job is an interactive jobs.
  - Interactive jobs may not be submitted to remote clusters.
- If the **llsubmit** or **llmovejob** command times out while waiting for a response from the remote cluster, LoadLeveler is not able to determine if the command was successful and it is recommended that the user issue **llq** to the remote cluster to determine if the job was submitted or moved.

## Why did the **CLUSTER\_REMOTE\_JOB\_FILTER** not update the job with all of the statements I defined?

- See the **CLUSTER\_REMOTE\_JOB\_FILTER** configuration file keyword description for a list of keywords that are not changed by the filter.

## How do I find my remote job?

- Capture the **stdout** of the **llsubmit** and **llmovejob** commands to see the **outbound\_hosts** machine assigned to the job, the **inbound\_hosts** machine assigned to the job, the cluster assigned to the job, and the job identifier assigned to the job.
  - The schedd host represented in the job identifier for remote jobs does not represent the managing schedd of the job. It represents the schedd that assigned the job number.
- Issue the **llq -X all** command and search for the desired job identifier.
- Check for pertinent mail messages.
  - If a job has been moved by an administrator, the submitting user will receive mail notification.
  - The job may have completed already. If the user has **notify\_user** and **notification** set, mail will indicate job status.

## Why won't my remote job run?

If the remote job has been received by the central manager of the remote cluster, follow the troubleshooting tips for local jobs in "why won't my job run" or "why won't my parallel job run". - Use the information from the **llsubmit** and **llq** commands to determine the machines that have processed the job. Examine the schedd logs on those machines for information relating to the specific job. - Capture the **stdout** of the **llsubmit** and **llmovejob** commands to see the **outbound\_hosts** machine assigned to the job, the **inbound\_hosts** machine assigned to the job, the cluster assigned to the job and the job identifier assigned to the job. \* The schedd host represented in the job identifier for remote jobs does not represent the managing schedd of the job. It represents the schedd that assigned the job number. - Issue **llq -X remote\_cluster -l job\_ID** \* Check for the multicluster environment related keywords: See **llq** command for detailed data descriptions. Scheduling Cluster - what cluster is the job running in. Submitting Cluster - what cluster was the job submitted from Sending Cluster - during move job what cluster did the job come from. Requested Cluster - cluster\_list specified by user. Schedd History - History of managing schedds. Outbound Schedds - History of outbound schedds. Submitting User - user name of submitting - Check for pertinent mail messages.

## Why does **llq -X all** show no jobs running when there are jobs running?

- When not using **CLUSTER\_USER\_MAPPER**, check that the user's uid are the same between the local cluster and remote cluster.

## Helpful hints

This section contains tips on running LoadLeveler, including some productivity aids.

### Scaling considerations

If you are running LoadLeveler on a large number of nodes (128 or more), network traffic between LoadLeveler daemons can become excessive to the point of

overwhelming a receiving daemon. To reduce network traffic, consider the following daemon, keyword, and command recommendations for large installations.

- Set the **POLLS\_PER\_UPDATE\*POLLING\_FREQUENCY** interval to five minutes or more. This limits the volume of machine updates the startd daemons send to the negotiator. For example, set **POLLS\_PER\_UPDATE** to 10 and set **POLLING\_FREQUENCY** to 30 seconds.
- If your installation's mix of jobs includes a high percentage of parallel jobs requiring many nodes, specify **schedd\_host=yes** in the machine stanza of each schedd machine. The schedd daemons must communicate with hundreds of startd daemons every time a job runs. You can distribute this communication by activating many schedd daemons. You should activate as many schedd daemons as there are jobs likely to be running at any one time. When you do this, each schedd handles the dispatching of one parallel job.
- If your installation allows jobs to be submitted from machines running the schedd daemon, you should consider avoiding "schedd affinity" by specifying **SCHEDD\_SUBMIT\_AFFINITY=FALSE** in the LoadLeveler configuration file. By default, the **llsubmit** command submits a job to the machine where the command was invoked provided the schedd daemon is running on the machine. (This is called schedd affinity.)
- You can decrease the amount of time the negotiator daemon spends running negotiation loops by increasing the **NEGOTIATOR\_INTERVAL** and the **NEGOTIATOR\_CYCLE\_DELAY**. For example, set **NEGOTIATOR\_INTERVAL** to 600, and set **NEGOTIATOR\_CYCLE\_DELAY** to 30.
- Make sure the machine update interval is not too short by setting the **MACHINE\_UPDATE\_INTERVAL** to a value larger than three times the polling interval (**POLLS\_PER\_UPDATE\*POLLING\_FREQUENCY**). This prevents the negotiator from prematurely marking a machine as "down" or prematurely cancelling jobs.
- In a large LoadLeveler cluster, issuing the **llctl** command with the **-g** can take minutes to complete. To speed this up, set up a working collective containing the machines in the cluster and use the **dsh** command; for example, **dsh llctl reconfig**. This command also allows you to limit your operation to a subset of machines by defining other working collectives.

### Hints for running jobs

**Determining when your job started and stopped:** By reading the notification mail you receive after submitting a job, you can determine the time the job was submitted, started, and stopped. Suppose you submit a job and receive the following mail when the job finishes:

```
Submitted at: Sun Apr 30 11:40:41 1996
Started at: Sun Apr 30 11:45:00 1996
Exited at: Sun Apr 30 12:49:10 1996

Real Time: 0 01:08:29
Job Step User Time: 0 00:30:15
Job Step System Time: 0 00:12:55
Total Job Step Time: 0 00:43:10

Starter User Time: 0 00:00:00
Starter System Time: 0 00:00:00
Total Starter Time: 0 00:00:00
```

This mail tells you the following:

**Submitted at** The time you issued the **llsubmit** command or the time you submitted the job with the graphical user interface.

**Started at** The time the starter process executed the job.

**Exited at** The actual time your job completed.

**Real Time** The wall clock time from submit to completion.

## **Job Step User Time**

The CPU time the job consumed executing in user space.

## **Job Step System Time**

The CPU time the system (AIX) consumed on behalf of the job.

## **Total Job Step Time**

The sum of the two fields above.

## **Starter User Time**

The CPU time consumed by the LoadLeveler starter process for this job, executing in user space. Time consumed by the starter process is the only LoadLeveler overhead which can be directly attributed to a user's job.

## **Starter System Time**

The CPU time the system (AIX) consumed on behalf of the LoadLeveler starter process running for this job.

## **Total Starter Time**

The sum of the two fields above.

You can also get the starting time by issuing **llsummary -l -x** and then issuing **awk /Date|Event/** against the resulting file. For this to work, you must have **ACCT = A\_ON A\_DETAIL** set in the **LoadL\_config** file.

**Running jobs at a specific time of day:** Using a machine's local configuration file, you can set up the machine to run jobs at a certain time of day (sometimes called an *execution window*). The following coding in the local configuration file runs jobs between 5:00 PM and 8:00 AM daily, and suspends jobs the rest of the day:

```
START: (tm_hour >= 1700) || (tm_hour <= 0800)
SUSPEND: (tm_hour > 0800) && (tm_hour < 1700)
CONTINUE: (tm_hour >= 1700) || (tm_hour <= 0800)
```

**Controlling the mix of idle and running jobs:** Three keywords determine the mix of idle and running jobs for a user. By a running job, we mean a job that is in one of the following states: Checkpointing, Preempted, Preempt Pending, Resume Pending, Running, Pending, or Starting. These keywords, which are described in detail in "Defining users" on page 87, are:

## **maxqueued**

Controls the number of jobs in any of these states: Idle, Running, Pending, or Starting.

## **maxjobs**

Controls the number of jobs in any of these states: Running, Pending, or Starting; thus it controls a subset of what **maxqueued** controls. **maxjobs** effectively controls the number of jobs in the Running state, since Pending and Starting are usually temporary states.

## **maxidle**

Controls the number of jobs in any of these states: Idle, Pending, or Starting;

thus it controls a subset of what **maxqueued** controls. **maxidle** effectively controls the number of jobs in the Idle state, since Pending and Starting are usually temporary states.

*What happens when you submit a job:* For a user's job to be allowed into the job queue, the total of other jobs (in the Idle, Pending, Starting and Running states) for that user must be less than the **maxqueued** value for that user. Also, the total idle jobs (those in the Idle, Pending, and Starting states) must be less than the **maxidle** value for the user. If either of these constraints are at the maximum, the job is placed in the Not Queued state until one of the other jobs changes state. If the user is at the **maxqueued** limit, a job must complete, be canceled, or be held before the new job can enter the queue. If the user is at the **maxidle** limit, a job must start running, be canceled, or be held before the new job can enter the queue.

Once a job is in the queue, the job is not taken out of queue unless the user places a hold on the job, the job completes, or the job is canceled. (An exception to this, when you are running the default LoadLeveler scheduler, is parallel jobs which do not accumulate sufficient machines in a given time period. These jobs are moved to the Deferred state, meaning they must vie for the queue when their Deferred period expires.)

Once a job is in the queue, the job will run unless the **maxjobs** limit for the user is at a maximum.

Note the following restrictions for using these keywords:

- If **maxqueued** is greater than (**maxjobs** + **maxidle**), the **maxqueued** value will never be reached.
- If either **maxjobs** or **maxidle** is greater than **maxqueued**, then **maxqueued** will be the only restriction in effect, since **maxjobs** and **maxidle** will never be reached.

**Sending output from several job steps to one output file:** You can use dependencies in your job command file to send the output from many job steps to the same output file. For example:

```
@ step_name = step1
@ executable = ssba.job
@ output = ssba.tmp
@ ...
@ queue
#
@ step_name = append1
@ dependency = (step1 != CC_REMOVED)
@ executable = append.ksh
@ output = /dev/null
@ queue
@
@ step_name = step2
@ dependency = (append1 == 0)
@ executable = ssba.job
@ output = ssba.tmp
@ ...
@ queue
@
@ step_name = append2
@ dependency = (step2 != CC_REMOVED)
@ executable = append.ksh
@ output = /dev/null
@ queue
#
...
```

Then, the file **append.ksh** could contain the line **cat ssba.tmp >> ssba.log**. All your output will reside in **ssba.log**. (Your dependencies can look for different return values, depending on what you need to accomplish.)

You can achieve the same result from within **ssba.job** by appending your output to an output file rather than writing it to **stdout**. Then your output statement for each step would be **/dev/null** and you wouldn't need the append steps.

## Hints for using machines

**Setting up a single machine to have multiple job classes:** You can define a machine to have multiple job classes which are active at different times. For example, suppose you want a machine to run jobs of Class A any time, and you want the same machine to run Class B jobs between 6 p.m. and 8 a.m.

You can combine the **Class** keyword with a user-defined macro (called **Off\_shift** in this example).

For example:

```
Off_Shift = ((tm_hour >= 18) || (tm_hour < 8))
```

Then define your **START** statement:

```
START : (Class == "A") || ((Class == "B") && $(Off_Shift))
```

Make sure you have the parenthesis around the **Off\_Shift** macro, since the logical OR has a lower precedence than the logical AND in the **START** statement.

Also, to take weekends into account, code the following statements. Remember that Saturday is day 6 and Sunday is day 0.

```
Off_Shift = ((tm_wday == 6) || (tm_wday == 0) || (tm_hour >= 18) \
|| (tm_hour < 8))
```

```
Prime_Shift = ((tm_wday != 6) && (tm_wday != 0) && (tm_hour >= 8) \
&& (tm_hour < 18))
```

**Reporting the load average on machines:** You can use the **/usr/bin/rup** command to report the load average on a machine. The **rup machine\_name** command gives you a report that looks similar to the following:

```
localhost up 23 days, 10:25, load average: 1.72, 1.05, 1.17
```

You can use this command to report the load average of your local machine or of remote machines. Another command, **/usr/bin/uptime**, returns the load average information for only your local host.

## History files and schedd

The **schedd** daemon writes to the spool/history file only when a job is completed or removed. Therefore, you can delete the history file and restart **schedd** even when some jobs are scheduled to run on other hosts.

However, you should clean up the **spool/job\_queue.dir** and **spool/job\_queue.pag** files only when no jobs are being scheduled on the machine.

You should not delete these files if there are any jobs in the job queue that are being scheduled from this machine (for example, jobs with names such as *thismachine.clusterno.jobno*).

### Getting help from IBM

Should you require help from IBM in resolving a LoadLeveler problem, you can get assistance by calling IBM Support. Before you call, be sure you have the following information:

1. Your access code (customer number).
2. The LoadLeveler product number.
3. The name and version of the operating system you are using.
4. A telephone number where you can be reached.

In addition, issue the following command:

```
llctl version
```

This command will provide you with code level information. Provide this information to the IBM representative.

The number for IBM support in the United States is 1-800-IBM-4YOU (426-4968).

The Facsimile number is 800-2IBM-FAX (2426-329).

---

## Appendix B. Sample command output

---

### llq command

#### llq -l command output listing

##### llq -l command output listing for a POE Parallel non-checkpointing job step

The following listing shows the llq -l output for a POE Parallel non-checkpointing job step:

```
===== Job Step c197blade6b09.ppd.pok.ibm.com.17.0 =====
 Job Step Id: c197blade6b09.ppd.pok.ibm.com.17.0
 Job Name: Parallel_POE_Test_1
 Step Name: Step_1
 Structure Version: 10
 Owner: llbld
 Queue Date: Mon Oct 17 12:06:54 2005
 Status: Running
 Reservation ID: e189f5rp01.ppd.pok.ibm.com.2.r
 Requested Res. ID:
 Scheduling Cluster: CLUSTER1
 Submitting Cluster: CLUSTER2
 Sending Cluster: CLUSTER2
 Requested Cluster: CLUSTER1
 Schedd History: e189f5rp02.ppd.pok.ibm.com
 Outbound Schedds: c197blade6b10.ppd.pok.ibm.com
 Submitting User: llbld
 Execution Factor: 1
 Dispatch Time: Mon Oct 17 11:59:17 2005
 Completion Date:
 Completion Code:
 Favored Job: No
 User Priority: 50
 user_sysprio: 0
 class_sysprio: 30
 group_sysprio: 70
 System Priority: -2880
 q_sysprio: -2880
 Previous q_sysprio: 0
 Notifications: Complete
 Virtual Image Size: 460 kb
 Large Page: N
 Checkpointable: no
 Ckpt Start Time:
 Good Ckpt Time/Date:
 Ckpt Elapse Time: 0 seconds
 Fail Ckpt Time/Date:
 Ckpt Accum Time: 0 seconds
 Checkpoint File:
 Ckpt Execute Dir:
 Restart From Ckpt: no
 Restart Same Nodes: no
 Restart: no
 Preemptable: yes
 Preempt Wait Count: 0
 Hold Job Until:
 RSet:
 McmAffinityOptions:
 Env:
 In: /dev/null
 Out: poe5_1.e189f5rp02.17.0.out
 Err: poe5_1.e189f5rp02.17.0.err
 Initial Working Dir: /c197b4_b04/ll_exp/LL_TEST_llbld/PARA_50
 Dependency:
 Resources: spice2g6(2) ConsumableCpus(1)
 Step Type: General Parallel
 Node Usage: shared
 Submitting Host: c197blade6b09.ppd.pok.ibm.com
 Schedd Host: e189f5rp02.ppd.pok.ibm.com
 Job Queue Key:
 Notify User: llbld@e189f5rp02.ppd.pok.ibm.com
 Shell: /bin/ksh
```

## Sample command output

```
LoadLeveler Group: chemistry
Class: classM
Ckpt Hard Limit: undefined
Ckpt Soft Limit: undefined
Cpu Hard Limit: 00:30:00 (1800 seconds)
Cpu Soft Limit: 00:25:00 (1500 seconds)
Data Hard Limit: 8.200 gb (8804682956 bytes)
Data Soft Limit: 7.100 gb (7623566950 bytes)
Core Hard Limit: 11.200 gb (12025908428 bytes)
Core Soft Limit: 11.100 gb (11918534246 bytes)
File Hard Limit: unlimited
File Soft Limit: unlimited
Stack Hard Limit: 400.000 mb (419430400 bytes)
Stack Soft Limit: 300.000 mb (314572800 bytes)
Rss Hard Limit: 15.200 gb (16320875724 bytes)
Rss Soft Limit: 15.100 gb (16213501542 bytes)
Step Cpu Hard Limit: 3+08:00:00 (288000 seconds)
Step Cpu Soft Limit: 23:59:59 (86399 seconds)
Wall Clk Hard Limit: 00:06:00 (360 seconds)
Wall Clk Soft Limit: 00:06:00 (360 seconds)
Comment: "Parallel_POE_Test: Test Suite 251"
Account:
Unix Group: users
NQS Submit Queue:
NQS Query Queues:
Negotiator Messages:
Bulk Transfer: No
Step rCxt Blocks: 0
Adapter Requirement: (sn_single,LAPI,US,shared,LOW,instances=1,),(sn_single,MPI,US,shared, \
LOW,instances=1,)
Step Cpus: 4
Step Virtual Memory: 0.000 mb
Step Real Memory: 0.000 mb

Node

Name :
Requirements : (Arch == "R6000") && ((OpSys == "AIX53") || (OpSys == "AIX52"))
Preferences :
Node minimum : 2
Node maximum : 2
Node actual : 2
Allocated Hosts : e189f5rp01.ppd.pok.ibm.com::sn0(LAPI,US,16,Shared,0 rCxt Blks), \
 sn0(MPI,US,17,Shared,0 rCxt Blks),sn0(LAPI,US,18,Shared,0 rCxt Blks), \
 sn0(MPI,US,19, Shared,0 rCxt Blks)
 + e189f5rp02.ppd.pok.ibm.com::sn0(LAPI,US,16,Shared,0 rCxt Blks), \
 sn0(MPI,US,17,Shared,0 rCxt Blks),sn0(LAPI,US,18,Shared,0 rCxt Blks), \
 sn0(MPI,US,19, Shared,0 rCxt Blks)

Master Task

Executable : /c197b4_b04/11_exp/LL_TEST_11b1d/PARA_50/AIX_test_poe
Exec Args : /c197b4_b04/11_exp/LL_TEST_11b1d/PARA_50/ivp_cpu_15_20_sleep_60000 -euilib \
 us -ilevel 6 -labelio yes -corefile_format STDERR
Num Task Inst: 1
Task Instance: e189f5rp01:-1,

Task

Num Task Inst: 4
Task Instance: e189f5rp01:0:sn0(LAPI,US,16,Shared,0 rCxt Blks),sn0(MPI,US,17,Shared,0 rCxt Blks),
Task Instance: e189f5rp01:1:sn0(LAPI,US,18,Shared,0 rCxt Blks),sn0(MPI,US,19,Shared,0 rCxt Blks),
Task Instance: e189f5rp02:2:sn0(LAPI,US,16,Shared,0 rCxt Blks),sn0(MPI,US,17,Shared,0 rCxt Blks),
Task Instance: e189f5rp02:3:sn0(LAPI,US,18,Shared,0 rCxt Blks),sn0(MPI,US,19,Shared,0 rCxt Blks),

1 job step(s) in queue, 0 waiting, 0 pending, 1 running, 0 held, 0 preempted
```

## llq -l command output listing for a Blue Gene enabled system

The following listing is a fragment of the llq -l output for a system where Blue Gene support is enabled and Blue Gene is present:

```
===== Job Step bgldd1.rchland.ibm.com.37.0 =====
Job Step Id: bgldd1.rchland.ibm.com.37.0
Job Name: bgldd1.rchland.ibm.com.37
Step Name: 0
....
Cmd: /usr/bin/mpirun
Args: -exe /test/com -cwd /test -args "-o 100 -b 64 -e 8388608 -n -i -r" -verbose 2
```

```

Env:
 In: /dev/null
 Out: /bglscratch/varella/out.bgldd1/bgldd1.R010_J111_128.37.0.out
 Err: /bglscratch/varella/out.bgldd1/bgldd1.mpirun.R010_J111_128.37.0.out
Initial Working Dir: /test/jcf
Dependency:
Resources:
Requirements: (Arch == "PPC64") && (OpSys == "Linux2")
Preferences:
 Step Type: Blue Gene
Size Requested:
Size Allocated:
Shape Requested:
Shape Allocated:
Wiring Requested: MESH
Wiring Allocated:
 Rotate: True
Blue Gene Status:
Blue Gene Job Id:
Partition Requested: R010_J111_128
Partition Allocated:
Error Text:
....

```

## llq -l -x command output listing

The following listing shows the `llq -l -x` output for a POE Parallel non-checkpointing job step when the LoadLeveler cluster runs with Job Accounting enabled:

```

===== Job Step c197blade6b09.ppd.pok.ibm.com.17.0 =====
Job Step Id: c197blade6b09.ppd.pok.ibm.com.17.0
Job Name: Parallel_POE_Test_1
Step Name: Step_1
Structure Version: 10
Owner: llbld
Queue Date: Mon Oct 17 12:06:54 2005
Status: Running
Reservation ID: e189f5rp01.ppd.pok.ibm.com.2.r
Requested Res. ID:
Scheduling Cluster: CLUSTER1
Submitting Cluster: CLUSTER2
Sending Cluster: CLUSTER2
Requested Cluster: CLUSTER1
Schedd History: e189f5rp02.ppd.pok.ibm.com
Outbound Schedds: c197blade6b10.ppd.pok.ibm.com
Submitting User: llbld
Execution Factor: 1
Dispatch Time: Mon Oct 17 11:59:17 2005
Completion Date:
Completion Code:
 Favored Job: No
 User Priority: 50
 user_sysprio: 0
 class_sysprio: 30
 group_sysprio: 70
System Priority:
 q_sysprio:
Previous q_sysprio:
Notifications: Complete
Virtual Image Size: 460 kb
Large Page: N
Checkpointable: no
Ckpt Start Time:
Good Ckpt Time/Date:
Ckpt Elapse Time: 0 seconds
Fail Ckpt Time/Date:
Ckpt Accum Time: 0 seconds
Checkpoint File:
Ckpt Execute Dir:
Restart From Ckpt: no
Restart Same Nodes: no
Restart: no
Preemptable: yes
Preempt Wait Count: 0
Hold Job Until:
RSet:
McmAffinityOptions:
 Env: LESSKEY=/etc/lesskey.bin NNTPSERVER=news INFODIR= ...
 In: /dev/null
 Out: poe5_1.e189f5rp02.17.0.out
 Err: poe5_1.e189f5rp02.17.0.err

```

## Sample command output

```
Initial Working Dir: /c197b4_b04/l1_exp/LL_TEST_l1b1d/PARA_50
Dependency:
 Resources: spice2g6(2) ConsumableCpus(1)
 Step Type: General Parallel
 Node Usage: shared
Submitting Host: c197blade6b09.ppd.pok.ibm.com
Schedd Host: e189f5rp02.ppd.pok.ibm.com
Job Queue Key: 000006
Notify User: l1b1d@e189f5rp02.ppd.pok.ibm.com
Shell: /bin/ksh
LoadLeveler Group: chemistry
Class: classM
Ckpt Hard Limit: undefined
Ckpt Soft Limit: undefined
Cpu Hard Limit: 00:30:00 (1800 seconds)
Cpu Soft Limit: 00:25:00 (1500 seconds)
Data Hard Limit: 8.200 gb (8804682956 bytes)
Data Soft Limit: 7.100 gb (7623566950 bytes)
Core Hard Limit: 11.200 gb (12025908428 bytes)
Core Soft Limit: 11.100 gb (11918534246 bytes)
File Hard Limit: unlimited
File Soft Limit: unlimited
Stack Hard Limit: 400.000 mb (419430400 bytes)
Stack Soft Limit: 300.000 mb (314572800 bytes)
Rss Hard Limit: 15.200 gb (16320875724 bytes)
Rss Soft Limit: 15.100 gb (16213501542 bytes)
Step Cpu Hard Limit: 3+08:00:00 (288000 seconds)
Step Cpu Soft Limit: 23:59:59 (86399 seconds)
Wall Clk Hard Limit: 00:06:00 (360 seconds)
Wall Clk Soft Limit: 00:06:00 (360 seconds)
Comment: "Parallel_POE_Test: Test Suite 251"
Account:
Unix Group: users
User Space Windows: 8
NQS Submit Queue:
NQS Query Queues:
Negotiator Messages:
 Bulk Transfer: No
 Step rCxt Blocks: 0
Adapter Requirement: (sn_single,LAPI,US,shared,LOW,instances=1,),(sn_single,MPI,US,shared,LOW,instances=1,)
 Step Cpus: 4
Step Virtual Memory: 0.000 mb
Step Real Memory: 0.000 mb
----- Detail for c197blade6b09.ppd.pok.ibm.com.17.0 -----
Running Host: e189f5rp01.ppd.pok.ibm.com
Machine Speed: 1.000000
Starter User Time: 00:00:00.070000
Starter System Time: 00:00:00.180000
Starter Total Time: 00:00:00.250000
 Starter maxrss: 2796
 Starter ixrss: 4288
 Starter idrss: 14444
 Starter isrss: 0
 Starter minflt: 0
 Starter majflt: 0
 Starter nswap: 0
 Starter inblock: 0
 Starter oublock: 0
 Starter msgsnd: 0
 Starter msgrcv: 0
 Starter nsignals: 1
 Starter nvcsw: 831
 Starter nivcsw: 8
 Step User Time: 00:01:16.820000
 Step System Time: 00:00:00.610000
 Step Total Time: 00:01:17.430000

 Step maxrss: 5824
 Step ixrss: 159816
 Step idrss: 44481652
 Step isrss: 0
 Step minflt: 9922
 Step majflt: 1
 Step nswap: 0
 Step inblock: 0
 Step oublock: 0
 Step msgsnd: 0
 Step msgrcv: 0
 Step nsignals: 0
 Step nvcsw: 4217
 Step nivcsw: 99

Node

Name :
```

```

Requirements : (Arch == "R6000") && ((OpSys == "AIX53") || (OpSys == "AIX52"))
Preferences :
Node minimum : 2
Node maximum : 2
Node actual : 2
Allocated Hosts : e189f5rp01.ppd.pok.ibm.com:RUNNING:sn0(LAPI,US,16,Shared,0 rCxt Blks), \
 sn0(MPI,US,17,Shared,0 rCxt Blks),sn0(LAPI,US,18,Shared,0 rCxt Blks), \
 sn0(MPI,US,19,Shared,0 rCxt Blks)
 + e189f5rp02.ppd.pok.ibm.com:RUNNING:sn0(LAPI,US,16,Shared,0 rCxt Blks), \
 sn0(MPI,US,17,Shared,0 rCxt Blks),sn0(LAPI,US,18,Shared,0 rCxt Blks), \
 sn0(MPI,US,19,Shared,0 rCxt Blks)

Master Task

Executable : /c197b4_b04/l1_exp/LL_TEST_l1b1d/PARA_50/AIX_test_poe
Exec Args : /c197b4_b04/l1_exp/LL_TEST_l1b1d/PARA_50/ivp_cpu_15_20_sleep_60000 -euilib \
 us -ilevel 6 -labelio yes -corefile_format STDERR
Num Task Inst: 1
Task Instance: e189f5rp01:-1,

Task

Num Task Inst: 4
Task Instance: e189f5rp01:0:sn0(LAPI,US,16,Shared,0 rCxt Blks),sn0(MPI,US,17,Shared,0 rCxt Blks),
Task Instance: e189f5rp01:1:sn0(LAPI,US,18,Shared,0 rCxt Blks),sn0(MPI,US,19,Shared,0 rCxt Blks),
Task Instance: e189f5rp02:2:sn0(LAPI,US,16,Shared,0 rCxt Blks),sn0(MPI,US,17,Shared,0 rCxt Blks),
Task Instance: e189f5rp02:3:sn0(LAPI,US,18,Shared,0 rCxt Blks),sn0(MPI,US,19,Shared,0 rCxt Blks),

1 job step(s) in queue, 0 waiting, 0 pending, 1 running, 0 held, 0 preempted

```

## llstatus command

### llstatus -l command output listing

The following listing shows the output from **llstatus -l** on a machine connected to a switch network:

```

=====
Name = e289f5rp01.ppd.pok.ibm.com
Machine = e289f5rp01.ppd.pok.ibm.com
Arch = R6000
OpSys = AIX52
SYSPRIO = (0 - QDate)
MACHPRIO = (0 - LoadAvg)
VirtualMemory = 517104 kb
Disk = 498456 kb
KeyboardIdle = 1
Tmp = 498456 kb
LoadAvg = 0.250412
ConfiguredClasses = mpi(20) Parallel(18) 85ba(10) misc(4) tiny(1) S(1) M(1) No_Class(8) osl(10) small(12) no_limit(1)
AvailableClasses = mpi(20) Parallel(14) misc(4) tiny(1) S(1) M(1) No_Class(8) small(12) no_limit(1)
DrainingClasses =
DrainedClasses = 85ba osl
Pool = 1 7
FabricConnectivity = 1:1,2:1
Adapter = networks(striped,e289f5rp01m10.ppd.pok.ibm.com,10.10.10.15,-1,12/16,794/798 \
rCxt Blks,11,READY) network1(aggregate,,10.10.10.15,-1,12/16,794/798 rCxt Blks,1,READY) \
network2(aggregate,,10.10.10.15,-1,12/16,794/798 \
rCxt Blks,1,READY) en0(ethernet,e289f5rp01.ppd.pok.ibm.com,9.114.170.97,) \
m10(multilink,e289f5rp01m10.ppd.pok.ibm.com,10.10.10.15,)
Feature = OSL ESSL
Max_Starters = 100
Prestarted_Starters = 1
Total Memory = 30720 mb
Memory = 26624 mb
FreeRealMemory = 24338 mb
LargePageSize = 16.000 mb
LargePageMemory = 4.000 gb
FreeLargePageMemory = 3.109 gb
PagesFreed = 0
PagesScanned = 0
PagesPagedIn = 0
PagesPagedOut = 0
ConsumableResources = spice2g6(126,130) ConsumableCpus(6,6) ConsumableMemory(25.219 gb,26.000 gb) RDMA*(4,4)+<
ConfigTimeStamp = Sun Oct 16 19:07:56 2005
Cpus = 6
RSetSupportType = RSET_NONE
Speed = 1.000000
Subnet = 9.114.170
MasterMachPriority = 0.000000
CustomMetric = 1
StartdAvail = 1
State = Running
EnteredCurrentState = Sun Oct 16 19:06:42 2005
START = T
SUSPEND = F

```

## Sample command output

```
CONTINUE = T
VACATE = F
KILL = F
Machine Mode = general
Running = 4
ScheddAvail = 1
ScheddState = Avail
ScheddRunning = 2
Pending = 0
Starting = 0
Idle = 0
Unexpanded = 0
Held = 0
Removed = 1
RemovedPending = 0
Completed = 0
TotalJobs = 2
Running Steps = e289f5rp01.ppd.pok.ibm.com.4.0 e289f5rp01.ppd.pok.ibm.com.5.0
ReservationPermitted = T
Reservations = e289f5rp01.ppd.pok.ibm.com.1.r e289f5rp01.ppd.pok.ibm.com.2.r
TimeStamp = Sun Oct 16 19:07:56 2005
```

## llstatus -l -b command output listing

The following listing shows the output from **llstatus -l -b** command:

```
Total Blue Gene Base Partitions 8
Total Blue Gene Compute Nodes 4096
Machine Size in Base Partitons X=1 Y=2 Z=4
Machine Size in Compute Nodes X=8 Y=16 Z=32
```

-- list of base partitions --

Z = 3

=====

```
+-----+
| |
| 1 R021 |
| <none> |
| <none> |
|-----+-----|
| R001 |
| 0 <none> |
| <none> |
|-----+-----|
+-----+
```

Z = 2

=====

```
+-----+
| |
| 1 R031 |
| <sdb> |
| * |
|-----+-----|
| R011 |
| 0 <none> |
| <none> |
|-----+-----|
+-----+
```

Z = 1

=====

```
+-----+
| |
| 1 R030 |
| <none> |
| <none> |
|-----+-----|
| R010 |
| 0 <sdb> |
| * |
|-----+-----|
+-----+
```

Z = 0



## Sample command output

```
Wire State: UP
FromComponent=R001 FromPort=MINUS_Z
ToComponent=Z_R001 ToPort=PORT_S0
PartitionState=FREE Partition=DD1FULL
```

## llsummary command

### llsummary -l -x command output listing

The following listing is a fragment of the **llsummary -l -x** output for a POE Parallel job step submitted from LoadLeveler CLUSTER2 to LoadLeveler CLUSTER1:

```
===== Job c197blade6b10.ppd.pok.ibm.com 18 =====
 Job Id: c197blade6b10.ppd.pok.ibm.com 18
 Job Name: Parallel_POE_Test_2
 Structure Version: 210
 Owner: llbld
 Unix Group: users
 Submitting Host: c197blade6b09.ppd.pok.ibm.com
 Submitting Userid: 2938172
 Submitting Groupid: 100
 Scheduling Cluster: CLUSTER1
 Submitting Cluster: CLUSTER2
 Sending Cluster: CLUSTER2
 Submitting User: llbld
 Schedd History: e189f5rp02.ppd.pok.ibm.com
 Outbound Schedds: c197blade6b10.ppd.pok.ibm.com
 Number of Steps: 1
----- Step c197blade6b10.ppd.pok.ibm.com.18.0 -----
 Job Step Id: c197blade6b10.ppd.pok.ibm.com.18.0
 Step Name: Step_1
 Queue Date: Mon Oct 17 13:37:21 2005
 Job Accounting Key: 4851468961616806319
 Dependency:
 Status: Removed
 Dispatch Time: Mon Oct 17 13:29:38 2005
 Start Time: Mon Oct 17 13:29:38 2005
 Completion Date: Mon Oct 17 13:32:13 2005
 Completion Code: 0
 Start Count: 1
 User Priority: 50
 user_sysprio: 0
 class_sysprio: 30
 group_sysprio: 70
 Notifications: Complete
 Virtual Image Size: 460 kb
 Checkpointable: no
 Good Ckpt Time/Date:
 Ckpt Accum Time: 0
 Checkpoint File:
 Restart From Ckpt: no
 Restart Same Nodes: no
 Restart: no
 Hold Job Until:
 Cmd: /c197b4_b04/ll_exp/LL_TEST_llbld/PARA_50/AIX_test_poe
 Args: /c197b4_b04/ll_exp/LL_TEST_llbld/PARA_50/ivp_cpu_150_200_sleep_300 -ilevel 6 \
 -labelio yes -corefile_format STDERR
 Env: LESSKEY=/etc/lesskey.bin; NNTPSERVER=news; INFODIR=
 In: /dev/null
 Out: poe5_1.e189f5rp02.18.0.out
 Err: poe5_1.e189f5rp02.18.0.err
 Initial Working Dir: /c197b4_b04/ll_exp/LL_TEST_llbld/PARA_50
 Requirements: (Arch == "R6000") && ((OpSys == "AIX53") || (OpSys == "AIX52"))
 Preferences:
 Step Type: General Parallel
 Min Processors: 2
 Max Processors: 2
 Alloc. Host Count: 2
 Allocated Host: e189f5rp02.ppd.pok.ibm.com
 e189f5rp01.ppd.pok.ibm.com
 Node Usage: shared
 Reservation ID: e189f5rp01.ppd.pok.ibm.com.2.r
 Notify User: llbld@e189f5rp02.ppd.pok.ibm.com
 Shell: /bin/ksh
 LoadLeveler Group: chemistry
 Class: classM
 Ckpt Hard Limit: undefined
 Ckpt Soft Limit: undefined
 Cpu Hard Limit: 00:30:00 (1800 seconds)
 Cpu Soft Limit: 00:25:00 (1500 seconds)
 Data Hard Limit: 8.200 gb (8804682956 bytes)
 Data Soft Limit: 7.100 gb (7623566950 bytes)
 Core Hard Limit: 11.200 gb (12025908428 bytes)
 Core Soft Limit: 11.100 gb (11918534246 bytes)
```

```

File Hard Limit: unlimited
File Soft Limit: unlimited
Stack Hard Limit: 400.000 mb (419430400 bytes)
Stack Soft Limit: 300.000 mb (314572800 bytes)
Rss Hard Limit: 15.200 gb (16320875724 bytes)
Rss Soft Limit: 15.100 gb (16213501542 bytes)
Step Cpu Hard Limit: 3+08:00:00 (288000 seconds)
Step Cpu Soft Limit: 23:59:59 (86399 seconds)
Wall Clk Hard Limit: 00:15:00 (900 seconds)
Wall Clk Soft Limit: 00:15:00 (900 seconds)
Comment: "Parallel_POE_Test: Test Suite 252"
Account:
NQS Submit Queue:
NQS Query Queues:
Job Tracking Exit:
Job Tracking Args:
Task geometry:
Resources: spice2g6(2) ConsumableCpus(1)
Blocking: UNSPECIFIED
Adapter Requirement: ,
Step Cpus: 4
Step Virtual Memory: 0.000 mb
Step Real Memory: 0.000 mb
Large Page: N
Bulk Transfer: No
Step rCxt Blocks: 0
----- Detail for c197blade6b10.ppd.pok.ibm.com.18.0 -----
Running Host: e189f5rp02.ppd.pok.ibm.com
Machine Speed: 1.000000
Event: System
Event Name: started
Time of Event: Mon Oct 17 13:29:38 2005
Starter User Time: 00:00:00.000000
Starter System Time: 00:00:00.000000
Starter Total Time: 00:00:00.000000
Starter maxrss: 0
Starter ixrss: 0
Starter idrss: 0
Starter isrss: 0
Starter minflt: 0
Starter majflt: 0
Starter nswap: 0
Starter inblock: 0
Starter oublock: 0
Starter msgsnd: 0
Starter msgrcv: 0
Starter nsignals: 0
Starter nvcsw: 0
Starter nivcsw: 0
Step User Time: 00:00:00.000000
Step System Time: 00:00:00.000000
Step Total Time: 00:00:00.000000
Step maxrss: 0
Step ixrss: 0
Step idrss: 0
Step isrss: 0
Step minflt: 0
Step majflt: 0
Step nswap: 0
Step inblock: 0
Step oublock: 0
Step msgsnd: 0
Step msgrcv: 0
Step nsignals: 0
Step nvcsw: 0
Step nivcsw: 0
Event: Installation Defined
Event Name: user_event_1
Time of Event: Mon Oct 17 13:30:26 2005
Starter User Time: 00:00:00.040000
Starter System Time: 00:00:00.070000
Starter Total Time: 00:00:00.110000
Starter maxrss: 2920
Starter ixrss: 2688
Starter idrss: 10080
Starter isrss: 0
Starter minflt: 0
Starter majflt: 0
Starter nswap: 0
Starter inblock: 0
Starter oublock: 0
Starter msgsnd: 0
Starter msgrcv: 0
Starter nsignals: 1
Starter nvcsw: 125
Starter nivcsw: 6
Step User Time: 00:00:56.650000
Step System Time: 00:00:00.570000
Step Total Time: 00:00:57.220000
Step maxrss: 5820

```

## Sample command output

```
Step ixrss: 96212
Step idrss: 32909784
Step isrss: 0
Step minflt: 5610
Step majflt: 8
Step nswap: 0
Step inblock: 0
Step oublock: 0
Step msgsnd: 0
Step msgrcv: 0
Step nsignals: 0
Step nvcs: 1225
Step nivcs: 74
Event: Installation Defined
Event Name: user_event_2
Time of Event: Mon Oct 17 13:31:26 2005
Starter User Time: 00:00:00.040000
Starter System Time: 00:00:00.070000
Starter Total Time: 00:00:00.110000
Starter maxrss: 2920
Starter ixrss: 2688
Starter idrss: 10080
Starter isrss: 0
Starter minflt: 0
Starter majflt: 0
Starter nswap: 0
Starter inblock: 0
Starter oublock: 0
Starter msgsnd: 0
Starter msgrcv: 0
Starter nsignals: 1
Starter nvcs: 126
Starter nivcs: 6
Step User Time: 00:01:57.330000
Step System Time: 00:00:00.680000
Step Total Time: 00:01:58.010000
Step maxrss: 5820
Step ixrss: 193460
Step idrss: 68162184
Step isrss: 0
Step minflt: 5610
Step majflt: 8
Step nswap: 0
Step inblock: 0
Step oublock: 0
Step msgsnd: 0
Step msgrcv: 0
Step nsignals: 0
Step nvcs: 2681
Step nivcs: 135
Event: System
Event Name: removed
Time of Event: Mon Oct 17 13:32:12 2005
Starter User Time: 00:00:00.040000
Starter System Time: 00:00:00.070000
Starter Total Time: 00:00:00.110000
Starter maxrss: 2920
Starter ixrss: 2688
Starter idrss: 10080
Starter isrss: 0
Starter minflt: 0
Starter majflt: 0
Starter nswap: 0
Starter inblock: 0
Starter oublock: 0
Starter msgsnd: 0
Starter msgrcv: 0
Starter nsignals: 1
Starter nvcs: 127
Starter nivcs: 6
Step User Time: 00:02:38.300000
Step System Time: 00:00:00.690000
Step Total Time: 00:02:38.990000
Step maxrss: 5820
Step ixrss: 259012
Step idrss: 91924788
Step isrss: 0
Step minflt: 5610
Step majflt: 8
Step nswap: 0
Step inblock: 0
Step oublock: 0
Step msgsnd: 0
Step msgrcv: 0
Step nsignals: 0
Step nvcs: 3665
Step nivcs: 182
Running Host: e189f5rp01.ppd.pok.ibm.com
Machine Speed: 1.000000
Event: System
```

```

 Event Name: started
 Time of Event: Mon Oct 17 13:29:38 2005
 Starter User Time: 00:00:00.000000
 Starter System Time: 00:00:00.000000
 Starter Total Time: 00:00:00.000000
 Starter maxrss: 0
 Starter ixrss: 0
 Starter idrss: 0
 Starter isrss: 0
 Starter minflt: 0
 Starter majflt: 0
 Starter nswap: 0
 Starter inblock: 0
 Starter oublock: 0
 Starter msgsnd: 0
 Starter msgrcv: 0
 Starter nsignals: 0
 Starter nvcsw: 0
 Starter nivcsw: 0
 Step User Time: 00:00:00.000000
 Step System Time: 00:00:00.000000
 Step Total Time: 00:00:00.000000
 Step maxrss: 0
 Step ixrss: 0
 Step idrss: 0
 Step isrss: 0
 Step minflt: 0
 Step majflt: 0
 Step nswap: 0
 Step inblock: 0
 Step oublock: 0
 Step msgsnd: 0
 Step msgrcv: 0
 Step nsignals: 0
 Step nvcsw: 0
 Step nivcsw: 0
 Event: Installation Defined
 Event Name: user_event_1
 Time of Event: Mon Oct 17 13:30:26 2005
 Starter User Time: 00:00:00.050000
 Starter System Time: 00:00:00.050000
 Starter Total Time: 00:00:00.100000
 Starter maxrss: 2736
 Starter ixrss: 2900
 Starter idrss: 8096
 Starter isrss: 0
 Starter minflt: 0
 Starter majflt: 0
 Starter nswap: 0
 Starter inblock: 0
 Starter oublock: 0
 Starter msgsnd: 0
 Starter msgrcv: 0
 Starter nsignals: 0
 Starter nvcsw: 82
 Starter nivcsw: 2
 Step User Time: 00:01:23.510000
 Step System Time: 00:00:00.170000
 Step Total Time: 00:01:23.680000
 Step maxrss: 5824
 Step ixrss: 201432
 Step idrss: 48432264
 Step isrss: 0
 Step minflt: 4347
 Step majflt: 0
 Step nswap: 0
 Step inblock: 0
 Step oublock: 0
 Step msgsnd: 0
 Step msgrcv: 0
 Step nsignals: 0
 Step nvcsw: 1128
 Step nivcsw: 95
 Event: Installation Defined
 Event Name: user_event_2
 Time of Event: Mon Oct 17 13:31:26 2005
 Starter User Time: 00:00:00.050000
 Starter System Time: 00:00:00.050000
 Starter Total Time: 00:00:00.100000
 Starter maxrss: 2736
 Starter ixrss: 2900
 Starter idrss: 8096
 Starter isrss: 0
 Starter minflt: 0
 Starter majflt: 0
 Starter nswap: 0
 Starter inblock: 0
 Starter oublock: 0
 Starter msgsnd: 0
 Starter msgrcv: 0

```

## Sample command output

```
Starter nsignals: 0
Starter nvcsw: 83
Starter nivcsw: 2
Step User Time: 00:03:25.070000
Step System Time: 00:00:00.210000
Step Total Time: 00:03:25.280000
Step maxrss: 5824
Step ixrss: 493176
Step idrss: 118937064
Step isrss: 0
Step minflt: 4347
Step majflt: 0
Step nswap: 0
Step inblock: 0
Step oublock: 0
Step msgsnd: 0
Step msgrcv: 0
Step nsignals: 0
Step nvcsw: 2586
Step nivcsw: 239
Event: System
Event Name: removed
Time of Event: Mon Oct 17 13:32:13 2005
Starter User Time: 00:00:00.050000
Starter System Time: 00:00:00.050000
Starter Total Time: 00:00:00.100000
Starter maxrss: 2828
Starter ixrss: 29
Starter idrss: 80
Starter isrss: 0
Starter minflt: 1212
Starter majflt: 3
Starter nswap: 0
Starter inblock: 0
Starter oublock: 0
Starter msgsnd: 0
Starter msgrcv: 0
Starter nsignals: 2
Starter nvcsw: 96
Starter nivcsw: 2
Step User Time: 00:04:47.170000
Step System Time: 00:00:00.260000
Step Total Time: 00:04:47.430000
Step maxrss: 5844
Step ixrss: 690216
Step idrss: 166555080
Step isrss: 0
Step minflt: 5061
Step majflt: 0
Step nswap: 0
Step inblock: 0
Step oublock: 0
Step msgsnd: 0
Step msgrcv: 0
Step nsignals: 5
Step nvcsw: 3586
Step nivcsw: 324

Node

Name :
Requirements : (Arch == "R6000") && ((OpSys == "AIX53") || (OpSys == "AIX52"))
Preferences :
Node minimum : 2
Node maximum : 2
Node actual : 2
Allocated Hosts : e189f5rp02.ppd.pok.ibm.com:PENDING:sn1(LAPI,US,8,Shared,0 rCxt Blks)sn1(MPI,US,9,Shared,0 \
rCxt Blks)sn1(LAPI,US,10,Shared,0 rCxt Blks)sn1(MPI,US,11,Shared,0 rCxt Blks)
+ e189f5rp01.ppd.pok.ibm.com:PENDING:sn1(LAPI,US,8,Shared,0 rCxt Blks)sn1(MPI,US,9,Shared,0 \
rCxt Blks)sn1(LAPI,US,10,Shared,0 rCxt Blks)sn1(MPI,US,11,Shared,0 rCxt Blks)

Master Task

Executable : /c197b4_b04/11_exp/LL_TEST_11bld/PARA_50/AIX_test_poe
Exec Args : /c197b4_b04/11_exp/LL_TEST_11bld/PARA_50/ivp_cpu_150_200_sleep_300 -ilevel 6 -labelio yes \
-corefile_format STDERR
Num Task Inst: 1
Task Instance: e189f5rp02:-1

Task

Num Task Inst: 4
Task Instance: e189f5rp02:0:sn1(LAPI,US,8,Shared,0 rCxt Blks),sn1(MPI,US,9,Shared,0 rCxt Blks)
Task Instance: e189f5rp02:1:sn1(LAPI,US,10,Shared,0 rCxt Blks),sn1(MPI,US,11,Shared,0 rCxt Blks)
Task Instance: e189f5rp01:2:sn1(LAPI,US,8,Shared,0 rCxt Blks),sn1(MPI,US,9,Shared,0 rCxt Blks)
Task Instance: e189f5rp01:3:sn1(LAPI,US,10,Shared,0 rCxt Blks),sn1(MPI,US,11,Shared,0 rCxt Blks)
```

---

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## Glossary

### A

**AFS.** A distributed file system that provides authentication services.

**AIX.** Abbreviation for Advanced Interactive Executive, IBM's licensed version of the UNIX operating system. AIX is particularly suited to support technical computing applications, including high function graphics and floating point computations.

**Authentication.** The process of validating the identity of a user or server.

**Authorization.** The process of obtaining permission to perform specific actions.

### B

**Berkeley Load Average.** The average number of processes on the operating system's ready to run queue.

### C

**C.** A general purpose programming language. It was formalized by ANSI standards committee for the C language (X3J11) in 1984 and by Uniforum in 1983.

**client.** (1) A function that requests services from a server, and makes them available to the user. (2) An address space in MVS™ that is using TCP/IP services. (3) A term used in an environment to identify a machine that uses the resources of the network.

**cluster.** (1) A group of processors interconnected through a high speed network that can be used for high performance computing. (2) A group of jobs submitted from the same job command file. (3) A set of machines with something in common between them. This commonality could be that they are all backed up by one machine or they are all in the LoadLeveler administration file.

**Cluster 1600.** See IBM @server Cluster 1600.

**cluster security services.** A component of RSCT that is used by RSCT applications and other RSCT components to perform authentication within peer domains.

**CtSec.** Cluster security services.

### D

**daemon.** A process, not associated with a particular user, that performs system-wide functions such as administration and control of networks, execution of time-dependent activities, line printer spooling, and so on.

**datagram.** A protocol known as the User Datagram Protocol (UDP). It is an internet standard protocol that allows an application program on one machine to send a datagram to an application program on another machine. UDP uses the Internet Protocol to deliver datagrams. Conceptually, the important difference between UDP and IP is that UDP messages include a protocol port number, allowing the sender to distinguish among multiple destinations (application programs) on the remote machines. In practice, UDP also includes a checksum over the data being sent.

**DCE.** Distributed Computing Environment.

**default.** An alternative value, attribute, or option that is assumed when none has been specified.

**DFS.** Distributed File System. A subset of the IBM Distributed Computing Environment.

### H

**host.** A computer connected to a network, and providing an access method to that network. A host provides end-user services.

### I

**IBM @server Cluster 1600.** An IBM @server Cluster 1600 is any PSSP or CSM-managed cluster comprised of POWER microprocessor based systems (including RS/6000 SMPs, RS/6000 SP nodes, and pSeries SMPs).

**IBM @server 325 and 326 servers.** LoadLeveler for Linux supports the IBM @server 325 and 326 servers with 64-bit AMD Opteron processors. The supported Linux distributions are RHEL 3, RHEL 4, or SLES 9.

### L

| **LAPI.** Abbreviation for Low-level Application  
| Programming Interface. LAPI is an IBM message  
| passing interface that implements a one sided  
| communication model.

| **local central manager.** The central manager in the  
| same cluster as the local gateway schedd.

| **local cluster.** The cluster from which the user submits jobs or issues commands.

| **local gateway schedd.** A schedd within the local cluster serving as an inbound point from some remote cluster, an outbound point to some remote cluster, or both.

## M

| **MCM.** Abbreviation for Multiple Chip Module. The fundamental processor building blocks of POWER5 and POWER4 servers.

| **memory affinity.** An option available in AIX 5L to allocate memory attached to the same MCM where the process runs, to improve the performance of applications on POWER5 and POWER4 servers.

**menu.** A display of a list of available functions for selection by the user.

**Motif.** The UNIX industry's standard user interface, originally developed by the Open Systems Foundation. Motif is based on the X-Window system and is a Presentation Manager look-alike. Motif is available for all IBM AIX workstations.

| **MPI.** Abbreviation for Message Passing Interface. MPI is a message passing library specification. MPI is used in this document to refer to the IBM communication subsystem that implements the MPI Library Specification.

**MPICH.** A portable implementation of the full Message-Passing Interface (MPI) standard. MPICH was developed by Argonne National Laboratory to be highly portable and is used by a large number of providers of MPI implementations.

**MPICH-GM.** A port of MPICH on top of Myrinet GM code. Myrinet-GM is a low level message-passing system for Myrinet networks.

## N

**network.** An interconnected group of nodes, lines, and terminals. A network provides the ability to transmit data to and receive data from other systems and users.

**NFS.** Network File System.

**node.** In a network, the point where one or more functional units interconnect transmission lines. A computer location defined in a network.

**NQS.** Network Queueing System.

| **NUMA.** NonUniform Memory Architecture. Computer architecture in which certain CPUs have a faster access to certain memory.

## O

**OSI.** Operating System Instance. In the LoadLeveler documentation, OSI and node are used interchangeably.

## P

**parameter.** (1) A variable that is given a constant value for a specified application and that may denote the application. (2) An item in a menu for which the operator specifies a value or for which the system provides a value when the menu is interpreted. (3) A name in a procedure that is used to refer to an argument that is passed to the procedure. (4) A particular piece of information that a system or application program needs to process a request.

**process.** (1) A unique, finite course of events defined by its purpose or by its effect, achieved under defined conditions. (2) Any operation or combination of operations on data. (3) A function being performed or waiting to be performed. (4) A program in operation. For example, a daemon is a system process that is always running on the system.

**peer domain.** A set of nodes configured for high availability by the configuration resource manager. Such a domain has no distinguished or master node. All nodes are aware of all other nodes, and administrative commands can be issued from any node in the domain. All nodes also have a consistent view of the domain membership.

## R

| **rCxt Blocks.** Remote context blocks. Interprocess communication buffers used by LAPI for RDMA.

| **RDMA.** See Remote Direct Memory Access.

**Reliable Scalable Cluster Technology.** A set of software components that together provide a comprehensive clustering environment for AIX. RSCT is the infrastructure used by a variety of IBM products to provide clusters with improved system availability, scalability, and ease of use.

| **remote central manager.** The central manager in the same cluster as a remote gateway schedd.

| **remote cluster.** A cluster that accepts job submissions and commands from the local cluster.

| **Remote Direct Memory Access.** A technique employed by some communication subsystems for economical communication between tasks.

| **remote gateway schedd.** A schedd within a remote cluster serving as an inbound point from the local cluster, an outbound point to the local cluster, or both.

**RSCT.** See Reliable Scalable Cluster Technology.

**RSCT peer domain.** See peer domain.

| **RSet.** Resource Set. A data structure used to represent  
| physical resources such as CPU and memory in AIX 5L.

## S

**SDR.** Abbreviation for System Data Repository. A repository of system information describing SP hardware and operating characteristics.

**server.** (1) A function that provides services for users. A machine may run client and server processes at the same time. (2) A machine that provides resources to the network. It provides a network service, such as disk storage and file transfer, or a program that uses such a service.

**shell.** The shell is the primary user interface for the UNIX operating system. It serves as command language interpreter, programming language, and allows foreground and background processing. Some widely used implementations of the shell concept include Bourne, Bourne Again, C, and Korn.

| **SMT.** Symmetric MultiThreading. A processor design  
| that combines hardware multithreading with  
| superscalar processor technology allowing multiple  
| threads in a CPU to issue instructions simultaneously  
| during each cycle, thus emulating multiple CPUs from  
| a single physical processor.

**stream.** An internet standard transport level protocol that provides the reliable, full duplex, stream service on which many application protocols depend. TCP allows a process on one machine to send a stream of data to a process on another. It is connection-oriented in the sense that before transmitting data, participants must establish a connection. Software implementing TCP usually resides in the operating system and uses the IP protocol to transmit information across the Internet. It is possible to terminate (shut down) one direction of flow across a TCP connection, leaving a one-way (simplex) connection. The Internet protocol suite is often referred to as TCP/IP because TCP is one of the two most fundamental protocols.

**System Administrator.** The user who is responsible for setting up, modifying, and maintaining LoadLeveler.

## U

**user.** Anyone who is using LoadLeveler.

## W

**working directory.** All files without a fully qualified path name are relative to this directory.

**workstation.** (1) A configuration of input/output equipment at which an operator works. (2) A terminal or microcomputer, usually one that is connected to a mainframe or to a network, at which a user can perform applications.



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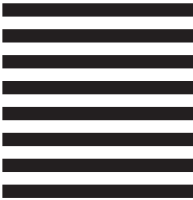
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