

Altair®

PBS Professional™

10.4

Migration Guide

UNIX®, Linux® and Windows®

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1.1 Introduction

Congratulations on your decision to upgrade to PBS Professional, the trusted solution for workload management. This document will assist in migrating to PBS Professional from OpenPBS. The OpenPBS product was previously released under the following names:

NASA PBS

MRJ OpenPBS

Veridian OpenPBS

Altair OpenPBS

This document applies to upgrading from all previous versions of OpenPBS.

With over five years of enhancements and bug fixes since the last release of OpenPBS, the new PBS Professional workload management system is quite a bit different. While all these features generate the various reasons why you are upgrading today, they necessitate a more complicated migration process from the older versions. (For comparison, most PBS Professional upgrades involve three steps: shutdown PBS Professional; run new

INSTALL command; restart PBS Professional. Once you have migrated to PBS Professional, you will be able to use this simpler approach for future upgrades.)

1.2 Preparing to Upgrade to PBS Professional

There are two methods that you may choose between to upgrade to PBS Professional: a *clean install* or a *migration upgrade*. If you do not wish to save any jobs, queues, or configuration information, you can do a *clean install*. This involves completely removing the old version of PBS, and doing a clean installation of PBS Professional. This is the simplest approach, but may not be appropriate in your environment. Alternatively, you can preform a *migration upgrade*, which will allow you to preserve all queued jobs and current Server configuration.

1.3 Clean Installation of PBS Professional

Use the following procedures in order to do a clean installation of PBS Professional.

For each PBS Server you have running:

1. Shut down all PBS daemons on all nodes managed by this PBS Server.
2. Shut down all PBS daemons on the server node (head node) for this Server.
3. Uninstall PBS on all systems (including client hosts, if any)
4. Remove any left-over files and directories (such as `/usr/local/PBS`, `/usr/spool/PBS`, `/usr/pbs`, etc.)
5. Remove any `inittab` entries for PBS (and any PBS startup scripts in `/etc/init.d/` if used).

At this point, you should follow the normal installation procedures for PBS Professional. For details, see:

PBS Professional Quick Start Guide

PBS Professional Installation & Upgrade Guide

1.4 Migration Upgrade to PBS Professional

These procedures must be run as root. The `qmgr` and `qmove` commands which follow need to be run by a user who is a PBS Administrator—typically this is going to be "root" unless you have removed root's PBS Administrator privilege.

1. Save a copy of the Server and nodes configuration to files, as this information will be necessary later on in the migration process. You should, as a precaution, check that these saved files really exist and appear to be correct in so far as size is concerned.

```
# cd /tmp
# qmgr -c "print server" > server.out
# qmgr -c "print node @default" > nodes.out
```

2. Next, disable the queues by setting each queue's "enabled" attribute to false, and stop any further scheduling requests to the Scheduler by setting the Server's "scheduling" attribute to false. This will prevent any new jobs from being accepted or started by PBS.

```
# qmgr -c "set server scheduling = false"
# qmgr -c "set queue queuename enabled = false"
```

(repeat above command for each queue)

IMPORTANT:

All running jobs must be either complete or be terminated and requeued prior to continuing with the Migration Upgrade.

3. Shutdown PBS on all nodes and terminate the Scheduler. Then shut-down the Server using the `qterm` command.
4. Backup the Server's jobs directory, `PBS_HOME/server_priv/jobs`. Backup of the Server's jobs directory is only precautionary, but an extremely prudent step in the event of operator or other error.

```
# cd PBS_HOME/server_priv
# tar -cf /tmp/pbs_jobs_save.tar jobs
```

5. While OpenPBS does not include a system startup script (e.g. the equivalent of `/etc/init.d/pbs`), many sites create such a script. If such a start-up script exists, it should be moved aside (or removed completely) so as not to conflict with the PBS Professional version. For example:

```
# mv /etc/init.d/pbs /etc/init.d/openpbs
```

Likewise, PBS Professional uses a system-wide configuration file (`/etc/pbs.conf`). While this file is *not* included in OpenPBS, many sites have created such a file often under the same name. If this file exists under the name expected by PBS Professional, then move it aside, or remove it completely. For example:

```
# mv /etc/pbs.conf /etc/openpbs.conf
```

6. Install the new version of `pbs_mom` on each execution-only nodes (by selecting option #2 of the PBS Professional `INSTALL` program). At the end of each installation, do not opt for restarting the MOM at this time, wait until all jobs have been successfully moved over to the new Server.

IMPORTANT:

If you only wish to preserve existing configuration information, and do not have any jobs that must be migrated to PBS Professional, you can safely skip Steps 7 through 10, and Step 15.

7. On the Server node, move the existing `PBS_HOME` and execution hierarchies (`PBS_EXEC`) to a temporary location. For example, if

PBS_HOME is */var/spool/PBS* and *PBS_EXEC* is */usr/pbs*, then type the following:

```
# mv /var/spool/PBS /var/spool/PBS.old
# mv /usr/pbs /usr/pbs.old
```

8. There is a bug in OpenPBS that causes the directory tree security check to override the “-d alternate_directory” option. Therefore we need to make a temporary symbolic link from the old *PBS_HOME* to the new, just until the Server performs its security check. Continuing the example given in Step 7 above, you would type:

```
# ln -s /var/spool/PBS.old /var/spool/PBS
```

9. Next start the OpenPBS Server on different ports and direct it to take for the location of its database the location that you specified in Step 7.

```
# /usr/pbs.old/sbin/pbs_server -p 13001 -M 13002 \ -R
13003 -S 13004 -d /var/spool/PBS.old
```

10. Once the OpenPBS Server has started, delete the link created in Step 8 above:

```
# rm /var/spool/PBS
```

11. Install PBS Professional on the Server host using the `INSTALL` program; *do not* start PBS on that host. (Be sure to select directory locations different from the relocated OpenPBS directories.)

12. Start the PBS Professional Server in a way that it receives an empty configuration. Do this as follows, substituting the correct values for *PBS_HOME* and *PBS_EXEC* (corresponding to what you specified to the `INSTALL` program):

```
# rm PBS_HOME/server_priv/nodes
# PBS_EXEC/sbin/pbs_server -t create
```

This command will prompt with a question "Create mode and Server database?" which should be answered with a "yes".

13. Now give to the PBS Professional Server instance a duplicate of the queues and Server parameters that got saved in Step 1 (this assumes

you want the PBS Professional Server instance to have the same configuration as the old OpenPBS instance).

```
# qmgr < /tmp/server.out
```

14. The saved nodes list (from Step 1 above) must be edited in order for it to be read by PBS Professional. Edit the file, and remove the leading comment symbol (“#”) from the `#create node . . .` lines. Then read the file into `qmgr` as shown.

```
# qmgr < /tmp/nodes.out
```

15. Now list the jobs at the OpenPBS Server and move the jobs one at a time from the OpenPBS Server to the PBS Professional Server. Note that the standard port number of the PBS Professional Server (15001) needs to be part of the destination queue specification. The commands need to be run out of the OpenPBS directory, which will be in `/usr/pbs.old/bin` (unless you specified otherwise in step 7). Call this location `/oldpath/`. This first step in the sequence is here to catch the special case where your Server's host happens to be also running a `pbs_mom`. The command will present a message about "no such node" if the host is not in the Server's nodes set. This is not a problem.

```
# /oldpath/qmgr -c "d n serverhost" serverhost:13001
```

If the message "Cannot delete busy object" occurs, rerun the command again, after you use `qrerun` or `qdel` to remove job(s) currently using the node.

```
# qenable workq queue1 queue2 . . .
```

```
# /oldpath/qstat @host:13001
```

```
# /oldpath/qmove queue@host:15001 job_id1@host:13001
```

```
# /oldpath/qmove queue@host:15001 job_id2@host:13001
```

```
# /oldpath/qmove queue@host:15001 job_idN@host:13001
```

```
# qstat
```

16. All of the jobs should now be under control of the PBS Professional Server and located in the new Server's home. The old OpenPBS Server can now be shut down and the PBS Professional MOMs (`pbs_mom`) started.

At this point, you should proceed with further configuration as described in the **PBS Professional Administrator's Guide**.

1.5 Deprecated Scheduler Configuration Parameters

The table below shows which Scheduling parameters have been deprecated, and the new method of achieving the former functionality.

Table 1-1: Deprecated Scheduler Configuration Parameters

Deprecated Parameter	PBS Professional Alternative
cpus_per_ssinode	See “Scheduler Support for SGI IRIX cpuset” in the PBS Professional Administrator’s Guide
load_balancing_rr	To duplicate this setting, enable <code>load_balancing</code> and set <code>smp_cluster_dist</code> to <code>round_robin</code>
mem_per_ssinode	See “Scheduler Support for SGI IRIX cpuset” in the PBS Professional Administrator’s Guide
key	Use <code>job_sort_key</code>
preempt_checkpoint	Use <code>preempt_order</code>
preempt_fairshare	Use <code>preempt_prio</code>
preempt_requeue	Add an “R” to <code>preempt_order</code> parameter
preempt_starving	Add "starving_jobs" <code>preempt_prio</code> parameter
preempt_suspend	Add an “S” to <code>preempt_order</code> parameter
sort_by	Use <code>job_sort_key</code>
assign_ssinodes	Such configuration now occurs automatically

1.6 Internal Changes That May Affect Users

The following differences between OpenPBS and PBS Professional may cause difficulties for users and administrators: The reader is advised to review these to determine if they apply to the local site. Most sites tend not to be affected by these changes. Those that are can easily adapt to the new method/feature available under PBS Professional.

- One noticeable difference between OpenPBS and PBS Professional is that the PBS Professional accounting records enclose the Account string (specified by the user) in double-quotes. This allows the Account string to consist of more than a single word. This change may affect locally developed accounting tools.
- When a job is deleted in OpenPBS, there is an entry in the Server's accounting logfile ("D") that specifies the job was deleted. In PBS Professional, this record is written to the Server's logfile in every case, but to the Accounting logfile only when the delete request is for a non-running job.
- In PBS Professional, the `exec_host` string (visible via `qstat`) appends to the execution hostname a "/" followed by the logical CPU number. OpenPBS has only the execution hostname.

1.7 New Features of PBS Professional

This section is provided to quickly give you an overview of some of the important new features in PBS Professional, compared to OpenPBS. Descriptions and usage instructions for the following features are provided in either the **PBS Professional Administrator's Guide** or the **PBS Professional User's Guide**.

1.8 Fault Tolerance in PBS Professional

1.8.1 Server Redundancy and Failover

The PBS Professional Server can be deployed in an active/passive manner. The passive (back-up) Server monitors the health of the active PBS Professional Server and can automatically assume its role in the event of a failure of the active Server or associated hardware host. Such switching from passive to active occurs without interruption to users or jobs (running or queued). See also "Configuring PBS Redundancy" in the **PBS Professional Administrator's Guide**.

1.8.2 Automatic Job Recovery

"Automatic Job Recovery" provides the ability for any job which has been interrupted due to a failure in the infrastructure (hardware, software, or network failure) to automatically be requeued and re-scheduled without manual intervention. For details see the Server parameter "node_fail_requeue".

1.8.3 Requeue or Delete Jobs Running on Dead Nodes

Jobs which are running on a node that has crashed or is unreachable may be deleted or requeued via the `qdel` and `qrerun` commands. To be sure the user means that this action should take place, the `-w force` option must be specified on the command.

1.8.4 Restarting MOM

On starting up, `pbs_mom` will send a Restart notice to the Server declared by `$clienthost` directives in the config file. Thus the Server will not have to wait for the next ping cycle, 5 minutes, to detect that a MOM is up.

1.9 Usability Features of PBS Professional

1.9.1 Desktop Cycle Harvesting

An advanced feature in PBS Professional is "cycle harvesting" from user desktop workstations. If a system is configured for cycle harvesting, it becomes available for batch usage by PBS if its keyboard and mouse remain unused or idle for a certain period of time. The workstation will be shown in state "free" when the status of the node is queried. If the keyboard or mouse is used, the workstation becomes unavailable for batch work and PBS will suspend any running jobs on that workstation and not attempt to schedule any additional work on that workstation. The workstation will be shown in state "busy", and any suspended jobs will be shown in state "U", a new state. Cycle-harvesting support includes multi-node and MPI jobs, as well as systems running the X11 Windowing System.

1.9.2 Floating Licenses

PBS can be enabled with floating licenses with which you may have more CPUs configured online than the number of CPUs licensed. Nodes become licensed as needed to run jobs up to the number of floating licenses. The licenses are released from a node when no jobs remain running on the node.

1.10 Configuration and Administration Features

1.10.1 Site-Specific Job Termination Action

"Site-Specific Job Termination Action" allows a site to specify a script (or program) to be run by `pbs_mom` in place of the normal `SIGTERM/SIGKILL` action when MOM is terminating a job (due to the job exceeding a limit or when the job is deleted by the Server on shutdown or because of a `qdel` command). See also the MOM "`$action terminate`" parameter.

1.10.2 Site-Specific Job Checkpoint-Restart

"Site-Specific Job Checkpoint-Restart" allows an Administrator to replace the built-in checkpoint facilities of PBS Professional with a site-defined external command. This is most useful on computer systems that do not have OS-level checkpointing. This feature is implemented by setting five MOM configuration parameters. See also "Site-specific Job Checkpoint / Restart" in the **PBS Professional Administrator's Guide**.

1.10.3 `/etc/pbs.conf` file for Runtime Configuration

Placement of PBS-related files is specified in the `/etc/pbs.conf` file. This allows the installation of the binary files and PBS directories wherever the site wishes. This file can be relocated, if needed. PBS will check for the environment variable `PBS_CONF_FILE` for the location of the PBS configuration file. For the GUIs, this can be set via the X resource, `*defConfFile`.

1.10.4 Sites can add resources without recompiling PBS

It is possible for the Administrator to define, at run-time, new resources within PBS. Once created, jobs may request these new resources and the Standard Scheduler can be directed to consider the new resources in the scheduling policy.

1.10.5 Nodes Associated with Queue

Nodes may be associated with a queue. A queue can have one node or multiple nodes associated with it. Jobs residing in the queue execute only on the node or nodes associated with the queue. Jobs that are not in the queue cannot execute on these nodes. Each node can only be associated with a single queue, or not associated with any queue.

1.10.6 Node Attributes and Resources

Many new attributes have been added to nodes.

1.10.7 New Qterm Options to Shut Down Mom and Scheduler

The `qterm` command has been enhanced with two new options. In addition to shutting down the Server process (`pbs_server`), the Scheduler and all the MOMs can also be shutdown using options to the `qterm` command.

1.10.8 Advance Reservation for Resources

The advance resources reservation capability (`pbs_rsub`, `pbs_rdel`, `pbs_rstat`) provides capabilities for accounting, access control, advance resource reservation for an individual job, and the optional return of identification and status (`resevation_ID`, `confirmed/denied`) upon submission of the `pbs_rsub` command.

1.10.9 Suspend/Resume on Multi-node Jobs

The PBS suspend/resume and checkpoint/restart capabilities support both single- and multi-node jobs. With checkpoint of multi-node jobs, the system must be able to save the complete session state in a file. This means any open socket will cause the operation to fail. PBS normally sets up a socket connection to a process (`pbs_demux`) which collects stdio streams from all tasks. If this is not turned off, the checkpoint cannot work. Therefore, a new job attribute has been added: `no_stdio_sockets`. See the `pbs_job_attributes` man page for more details.

1.10.10 New run limit

There are now "per user" resource run limits. Before an Administrator could limit the number of jobs a user can run. Now they can limit the amount of resources users can use. The new queue and Server attribute is called `max_user_res`. You assign it in `qmgr`. This limit can be both hard and soft.

1.10.11 New Per-resource Group Limit

A new per-resource group limit (hard and soft) for jobs has been added. For details see the new Server parameter "`max_group_res`".

1.10.12 Enhanced Job Accounting and Reporting Package

The job accounting capabilities of PBS Professional have been enhanced through the addition of a new job statistics reporting tool, `pbs-report`.

1.10.13 Server - User Password Checking

Earlier versions of PBS required that the Owner of a job submitted to a PBS Server have a valid password file entry on the host running the Server. This requirement can be eliminated under certain conditions. See the **Administrator's Guide** for details.

1.10.14 Simplified User Authorization for Sites with Common User Name Space

For sites where all users' login names and UIDs are the same on all hosts within the PBS cluster and on all hosts from which the users may submit jobs to the PBS cluster, a new `pbs_server` attribute provides for skipping part of the user authorization. If the attribute `"flatuid"` is set true, the Server will accept for execution any job that will run on behalf of the name / UID under which it was submitted.

1.10.15 Job "mem" limit enforcement

Enforcement of the "mem" (physical memory) resource usage is now available on all platforms. Enforcement is configurable by a entry in MOM's config file.

1.10.16 Enforcement of ncpus

Enforcement of the "ncpus" (number of CPUs used) is now available on all platforms. Enforcement is configurable by a set of entries in MOM's config file.

1.10.17 Logging via Syslog

Historically each PBS daemon logged various levels of information about events in its own log file. While having the advantage of a concise location, the disadvantage is that in a cluster the logged information is scattered across many execution hosts. If your site uses the "syslog" subsystem, PBS may now be configured to make full use of it.

1.10.18 Job Exit Status Passed to Prologue

Job exit status is now passed to the epilogue. See also "Prologue and Epilogue Arguments" in the **Administrator's Guide**.

1.10.19 pbsnodes Command Changes

Changes have been made to the `pbsnodes(1)` command to make it safer for the Administrator and more friendly for the user. The `-d` option is now required to make the listed nodes `down` and clear "down" from the unlisted nodes. This will require a change to any scripts that use this feature of the command.

1.10.20 New "pbs_probe" Command

A new administrator command "pbs_probe" has been added to print post-installation diagnostic information. For details of use, see "pbs_probe" manual page or the **Administrator's Guide**.

1.11 Scheduler Features In PBS Professional

1.11.1 Network Topography Scheduling

"Network Topography Scheduling" facilitates the ability to group computation nodes to match the network topology. This information can then be utilized to make scheduling decisions, such as ensuring that large MPI jobs are scheduled to run on nodes within the same network switch. All the nodes selected for a job should be on one high speed switches, but which switch doesn't matter. For details, see the new Server parameter "node_group_key".

1.11.2 Preemptive Job Scheduling

There is now the ability to preempt currently running jobs in order to run higher priority work. If a high priority job can not run right away, the Scheduler looks for jobs to preempt, in order to run the higher priority job. A job can be preempted in several ways. The scheduler can suspend the job, checkpoint the job (if supported by the underlying operating system), or requeue the job. Jobs which are preempting are not preemptable, nor are jobs utilizing advance reservations. This feature includes multiple preemption levels, as well as the ability to set the order in which the Scheduler will attempt to preempt a job.

1.11.3 Fairshare Job Scheduling

PBS Professional provides full, hierarchal fairshare scheduling. In addition, the Administrator can set which PBS resource is collected for fairshare usage (see the Scheduler parameter: `fairshare_usage_res`), as well as what the fairshare "entity" is, which can be any PBS job attribute (i.e. `euser`, `egroup`, `account` etc). For details see the Scheduler parameter: `fairshare_entity`.

1.12 Computational Grid Features

1.12.1 New Peer Scheduling Capability

PBS Professional provides the ability to dynamically distribute workload across geographically separated areas, and have the jobs run according to local policy. Customers define the "peer" systems or clusters with which they wish to share jobs, and the PBS Scheduler will pull work from those peer systems and run the jobs locally, according to local policy.

1.12.2 Bi-directional Support for Globus V.2

The PBS Professional provides bi-directional support for the Globus Grid Toolkit.

1.12.3 Support for GridFTP via X.509

PBS Professional supports the GridFTP file transfer program using X.509 certificates.

1.13 SGI-Specific Features of PBS Professional

1.13.1 Support for SGI Altix "cpusets"

SGI Altix "cpusets" are supported. See the **Administrator's Guide** for caveats and details.

1.14 User-Specific Features of PBS Professional

1.14.1 Support for OpenMP Jobs

To provide support for OpenMP jobs, the environment variable `OMP_NUM_THREADS` is created for the job, with a value of the number of CPUs allocated to the job. The environment variable `NCPUS` is also set to this value.

1.14.2 New Node Specifications

There are a number of new features and capabilities associated with requesting nodes and controlling where jobs are run. See the **PBS Professional User's Guide** for details.

1.14.3 TMPDIR

Each job will have a scratch directory created when it is run. The environment variable `TMPDIR` will contain the name of the directory. It will be removed when the job terminates.

1.14.4 New resource specification language

PBS now supports the ability to request resources and select characteristics of a node on which to run jobs. It is called a `resc_spec`, and uses a C-like expression language.

1.14.5 Blocking Qsub

New "Blocking qsub" functionality, causes `qsub` to wait for job completion before returning. This is useful for batch processing of large software compilations, etc. For details, see the `qsub` section of the **PBS Professional User's Guide**.



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the aggrieved party shall be entitled to seek specific performance and/or injunctive relief (without posting a bond or other security) in order to enforce or prevent any violation of this Agreement.

11. [RESERVED]

12. Notice. All notices given by one party to the other under the Agreement or these Additional Terms shall be sent by certified mail, return receipt requested, or by overnight courier, to the respective addresses set forth in this Agreement or to such other address either party has specified in writing to the other. All notices shall be deemed given upon actual receipt.

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Altair Engineering, Inc. _____

1820 E. Big Beaver Rd _____

Troy, MI 48083 _____

Attn: Tom M. Perring Attn: _____

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one or more counterparts, all of which together shall constitute one and the same instrument. **Execution.** Copies of this Agreement executed via original signatures, facsimile or email shall be deemed binding on the parties.

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