HP Workstations for Linux
User Guide
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1 Overview of the HP Installer Kit for Linux

Introduction

This document provides an overview of the HP Installer Kit for Linux. For specific information on installing Linux operating systems, refer to Installing with the HP Installer Kit for Linux.

Use this document with the Hardware Support Matrix for HP Linux Workstations and the HP Installer CDs/HP Driver CDs, which can be found at http://www.hp.com/support/linux_hardware_matrix.

Supported operating systems

HP supports multiple versions of Red Hat® Linux on HP Intel® Pentium® 4 and Xeon® Workstations. The supported versions include Red Hat Linux 7.2, Red Hat Linux 7.3, Red Hat Linux 8.0, Red Hat Linux 9, Red Hat Enterprise Linux WS 3 (RHEL WS 3), RHEL WS 4, and RHEL Desktop 5.

To provide flexibility in installing the Red Hat operating system version of your choice, HP has created Installer CDs and Driver CDs. These CDs are included in the HP Installer Kit for Linux, and the CD images (ISOs) for these CDs can be downloaded from the HP support website at http://www.hp.com/go/workstationsupport.

The Installer Kit does not include the operating system, so you also need to download the operating system from the web or purchase a Red Hat box-set with the Red Hat version to be used with the Installer CD or the Driver CD. To view the existing Installation Support Matrix for HP Linux Workstations and the supported configurations and operating systems, go to http://www.hp.com/support/linux_hardware_matrix.

HP Installer CDs

The Installer Kit includes an Installer CD or a Driver CD, which are based on the needs of each supported Red Hat release. An Installer CD is provided for a Red Hat version when the amount of content to support HP workstations is substantial or critical to Linux boot or operation. Older versions of Red Hat Linux typically do not work without altering the most current version of HP Workstation hardware because new components, such as network cards, sound cards and core chipsets, require newer device drivers than what was released when the box-set was created. Often, the box-set kernel does not boot because of this issue. The Installer CD provides additional and updated critical drivers for the HP Workstation hardware used during installation and installed in the final image on the hard drive. Installer CD's were necessary for running the older Red Hat numbered releases (eg. 7.2, 7.3, 8.0, etc) on relatively new HP hardware. Since Red Hat discontinued support for those older releases and began offering it's Enterprise Linux products, HP has not found it necessary to create Installer CD's.

The Installer CD is used as the first CD for installing Red Hat Linux box-sets. To install the box-set, insert this CD and reboot the HP Workstation. This reboot starts Anaconda, the familiar Red Hat Installer. All the content added by HP is in the /NEW_DRIVERS directory on the CD and can be used by you to build your own image or to browse the content added by HP.
**HP Driver CDs**

HP provides a Driver CD for a Red Hat Enterprise Linux version when the amount of content added by HP for drivers and other software packages (called RPMS) is small and not as critical as when HP provides an Installer CD. Recent versions of Red Hat Linux include the most recent device drivers and typically only require up-to-date driver updates with minor fixes to support HP workstations. These recent releases can usually be supported using the Driver CD. This Driver CD can be used as a post-installation utility for the standard Red Hat Linux install. After the standard Red Hat install is complete and the system is rebooted, a Red Hat utility called “first-boot” is invoked which enables the user to set up the security level, time and date, root password, user accounts, and other settings. The last thing that first-boot enables you to do is to load additional CDs.

The Driver CD is designed for use during this additional CD phase. (Refer to *Installing with the HP Installer Kit for Linux*.) All the content added by HP is in the /HP directory on the CD, and you can use it to build your own image or to browse the HP content.
Obtaining the HP Installer Kit for Linux from the HP Support web site

Introduction

The HP Installer Kit for Linux enables you to install Red Hat Linux on HP workstations. The kit provides updated drivers, tools, and operating system to enable HP hardware with various Linux operating system versions.

This document discusses the CDs (ISOs) contained in the HP Installer Kit for Linux, the platforms, and how to download the CDs (ISOs) from the HP support website.

Table 2-1 Red Hat Linux supported hardware platforms

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<th>Red Hat Enterprise Linux 4 (x86)</th>
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<td><strong>Revision</strong></td>
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<td>Update 2</td>
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<td>Update 4 Rev. A</td>
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<td>HP Installer Kit for Linux—Installer CD for Red Hat 9</td>
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<td>HP Installer Kit for Linux—Installer CD for Red Hat 7.2</td>
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Obtaining the appropriate ISOs in the HP Installer Kit for Linux

1. Open a web browser and go to http://www.hp.com/go/workstationsupport.
2. Select your workstation model.
3. In the Tasks for… section, click Download drivers and software.
4. Select your operating system.
5. In the Quick jump to downloads by category section, click Software.
7. (Optional) Create Source DVD.

**NOTE:** The Source DVD provides source files for the drivers and internal Linux tools used on the Installation CDs.

8. Download Source DVD ISOs from any Linux operating system page:
   - HP Installer Kit for Linux-Source DVD; Part 1
   - HP Installer Kit for Linux-Source DVD; Part 2
   - HP Installer Kit for Linux-Source DVD; Part 3
   - HP Installer Kit for Linux-Source DVD; Part 4
   - HP Installer Kit for Linux-Source DVD; Part 5
9. Untar the ISOs (such as, tar -zxf <filename>).
10. To cat the output of tar, enter `cat srcDVD_3.2.part1.iso srcDVD_3.2.part2.iso srcDVD_3.2.part3.iso srcDVD_3.2.part4.iso srcDVD_3.2.part5.iso > srcDVD_3.2.iso`. 
3 Installing with the HP Installer Kit for Linux

Installing the operating system using the HP Installer CD

To install using the Installer CD:

1. Insert the HP Installer CD into the CD-ROM.
2. Reboot your workstation from the Installer CD.
3. Select one of the following options:
   - **gui** for a custom installation leveraging all software packages (called RPMS) needed to enable your HP hardware.
     - **WARNING!** This erases your hard disk and rewrites new disk partitions.
   - **install** for an HP identified installation leveraging all RPMS needed to enable your hardware as well as specific RPMS identified to optimize your HP Workstation experience.
     - **WARNING!** This erases your hard disk and rewrites new disk partitions.
   - **recover** for a fully automated, HP identified install that leverages the maximum amount of HP engineering.

4. Insert the Linux operating system CDs from the Red Hat Linux box-set as prompted.
5. Continue following the prompts until the operating system is successfully installed.

After the installation is complete, the installed system can be rebooted for the first time. The installed image contains the Red Hat Linux box-set image plus RPMS added by HP to ensure proper operation on HP workstations.

Installing the operating system using the HP Driver CD

To install using the HP Driver CD:

1. Install the operating system using the CDs included in your Red Hat Linux box-set.
2. If there is a Red Hat Driver Disk that corresponds to the Red Hat Linux operating system that is being installed, enter **linux dd** on the initial install splash screen and then press Enter.
   - **NOTE:** (Do not press Enter only, without first entering **linux dd**.)
3. When asked if you have a driver CD, select **Yes**. Place the Red Hat Driver Disk in the drive, and select the appropriate drive: **hd[abcd]**. Continue the normal installation.
4. After successfully installing the Red Hat Linux operating system, reboot your system.
5. The Red Hat Setup Agent (also known as "first-boot") will set up system parameters such as networking, time/date, adding new users, etc.

6. Complete this process. The Additional CDs screen displays, and you initialize the system with HP Driver CD components.

7. Insert the HP Driver CD.

8. When prompted, select Install for the Additional CD option.

9. When the driver installation task is completed, finish the first-boot setup.

10. Continue following the prompts until the operating system is successfully installed.

11. Reboot your system to enable the proper post-installation configuration of drivers.

Warranty

As part of your hardware warranty, HP provides software configuration and installation support for Red Hat Linux for up to 90 days from date of purchase of the Linux-enabled workstation configuration. To download the latest Linux drivers, visit [http://www.hp.com/go/workstationsupport](http://www.hp.com/go/workstationsupport).

For full warranty information, refer to the warranty that shipped with your HP Workstation or visit [http://www.hp.com/go/workstationsupport](http://www.hp.com/go/workstationsupport) and select the Warranty Information link.

Platform Support

For supported platforms see Table 2-1 Red Hat Linux supported hardware platforms on page 3.

Localization

Red Hat Linux delivers localization support throughout the installation process and with the base operating system on both Red Hat Linux 9 and RHEL WS 3. Some README files and menus in the HP Installer CD have only English support, but the Installer CD generally supports localization. The supported hardware localization kits are listed in the Installation Support Matrix.

Graphics

HP workstations may be ordered without a graphics card or with a selection of graphics cards that have gone through extensive verification by HP. See the Installation Support Matrix for a complete list of drivers and the platforms that support them. Because of certain power requirements of the high powered graphics cards, not all graphics cards are available on all boxes. Accelerated drivers that are supported by HP and the graphics vendors are available on the Installer CD and from the HP Support web site. These accelerated drivers are not found on the Red Hat Linux CD because they are not open source. Recent drivers that have not been qualified by HP are sometimes available from the graphics vendor web site. These drivers are not supported by HP, but the graphics vendor can provide some support with these versions of the drivers. When installing your Red Hat operating system with the HP Installer CD, the X configuration step is replaced with default values that typically work well for the accelerated graphics drivers. The default resolution is 1280 x 1024.

System RAM

HP supports different amounts of total RAM in the different boxes based on the number of hardware DIMM slots. The total memory supported for each hardware or operating system configuration is listed in the Hardware Support Matrix (http://www.hp.com/support/linux_hardware_matrix).

**Network cards**

The integrated network cards are all supported for different workstation platforms and are set up as the first network device (eth0) after the installation. In addition, network cards that can be ordered separately (called AMO kits) are supported. Intel® network cards and Broadcom network cards are both supported. Given that all HP workstations come with an integrated LAN, the additional cards can be used for a second LAN card or to replace the existing integrated LAN.
Introduction

Release Notes for Red Hat Enterprise Linux (RHEL) contain a list of known issues on HP Linux workstations when using RHEL 3, RHEL 4, and RHEL Client 5 as of January 2008.

For additional information or updates, visit http://www.hp.com/go/workstationsupport and complete the following steps:

1. Select your HP workstation.
2. From the "I would like to" section, select Troubleshoot a problem.
3. From the "useful documents" section, select Operating system.
4. Locate the Linux section.

If you are interested in other distributions that are certified on HP workstations, see http://www.hp.com/go/workstationsupport.
Customer advisories for Red Hat Enterprise Linux WS 3

Use the following table to determine which advisories are applicable to your workstation with RHEL 3.

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### Table 4-1 Customer advisories for Red Hat Enterprise Linux WS 3 (continued)

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Customer advisories for Red Hat Enterprise Linux WS 4

Use the following tables to determine which advisories are applicable to your system with RHEL 4.

Table 4-2 Customer advisories for Red Hat Enterprise Linux WS 4

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Customer advisories for Red Hat Enterprise Linux WS 3 (continued)

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Customer advisories for Red Hat Enterprise Linux Client 5

Use the following tables to determine which advisories are applicable to your system with RHEL Client 5.

Table 4-3  Customer advisories for Red Hat Enterprise Linux Client 5

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<td>/c00911010 Support for Fully Virtualized guest OS requires BIOS setting</td>
<td>4400, 6400, 8400, 9400</td>
<td>4400, 6400, 8400, 9400</td>
</tr>
<tr>
<td>/c00909919 (x86_64) FX4600 issues with vesa driver</td>
<td>4400, 6400, 8400, 9400</td>
<td></td>
</tr>
<tr>
<td>Advisory</td>
<td>Update 1</td>
<td>Base</td>
</tr>
<tr>
<td>------------------------------------------------------------------------------------------------------</td>
<td>-------------------</td>
<td>------------</td>
</tr>
<tr>
<td>/c01160514 X may fail to start with Specific NVIDIA Quadro Graphics Cards and certain Red Hat Linux 32 bit versions</td>
<td>4400, 6400, 8400</td>
<td>4400, 6400, 8400</td>
</tr>
<tr>
<td>/c01210315 Certain NVIDIA Quadro Graphics Cards may display a Black Screen during Red Hat Enterprise Linux 5 Desktop [x86_64] Install</td>
<td></td>
<td>4600, 9400</td>
</tr>
<tr>
<td>/c01210325 Updated NVIDIA Graphics Driver Required for Dual Graphics Cards and Certain Red Hat Linux Versions</td>
<td></td>
<td>4600</td>
</tr>
<tr>
<td>/c01210413 Black Screen with NVIDIA Quadro FX 4600 or FX 5600 Graphics Card and Red Hat Enterprise Linux 5 [x86_64]</td>
<td></td>
<td>4600, 9400</td>
</tr>
</tbody>
</table>
5 Setting up large memory configurations

Introduction

HP Linux workstations can support large memory configurations (greater than or equal to 4 GB). To use large memory configurations, an SMP (Symmetric Multiprocessing), hugemem, or bigmem kernel must be installed and configured. Even though a system may have more than 4 GB of memory, 3.5 GB is the maximum amount of memory that will be usable by a single process for running a uni-processor (UP) kernel.

Maximum memory allowed

The maximum amount of memory that can be supported on HP xw Series Workstations:

<table>
<thead>
<tr>
<th>Workstation</th>
<th>1 CPU*</th>
<th>2 CPU</th>
</tr>
</thead>
<tbody>
<tr>
<td>xw4100</td>
<td>4 GB</td>
<td>4 GB</td>
</tr>
<tr>
<td>xw4200</td>
<td>4 GB</td>
<td>4 GB</td>
</tr>
<tr>
<td>xw4300</td>
<td>4 GB</td>
<td>8 GB</td>
</tr>
<tr>
<td>xw4400</td>
<td>8 GB</td>
<td>8 GB</td>
</tr>
<tr>
<td>xw4550</td>
<td>4 GB</td>
<td>4 GB</td>
</tr>
<tr>
<td>xw4600</td>
<td>8 GB</td>
<td>8 GB</td>
</tr>
<tr>
<td>xw6000</td>
<td>4 GB</td>
<td>8 GB</td>
</tr>
<tr>
<td>xw6200</td>
<td>4 GB</td>
<td>8 GB</td>
</tr>
<tr>
<td>xw6400</td>
<td>16 GB</td>
<td>16 GB</td>
</tr>
<tr>
<td>xw6600</td>
<td>32 GB</td>
<td>32 GB</td>
</tr>
<tr>
<td>xw8000</td>
<td>4 GB</td>
<td>12 GB</td>
</tr>
<tr>
<td>xw8200</td>
<td>4 GB</td>
<td>16 GB</td>
</tr>
<tr>
<td>xw8400</td>
<td>32 GB</td>
<td>32 GB</td>
</tr>
<tr>
<td>xw8600</td>
<td>128 GB</td>
<td>128 GB</td>
</tr>
<tr>
<td>xw9300</td>
<td>16 GB</td>
<td>32 GB</td>
</tr>
<tr>
<td>xw9400</td>
<td>32 GB</td>
<td>64 GB</td>
</tr>
</tbody>
</table>

* If there is only one CPU but Hyper-Threading Technology is enabled, the maximum amount of memory supported equals the value in the "2 CPU" column. Although you can install 4 GB memory, only 3 to 3.5 GB will show up as addressable with a uni-processor kernel.

The maximum amount of memory for each workstation is limited by the number of memory slots on the system board and the maximum size of the supported memory sticks. The maximum amount of memory...
recommended for each Linux version varies depending on the kernel that it includes. See the most recent Linux Hardware Support Matrix (http://hp.com/support/linux_hardware_matrix) to find out the maximum memory currently verified for your configuration.

HP Installer Kit for Linux and factory preinstalled systems

If your Linux system has 4 GB or more of memory and the Red Hat Linux operating system was either preinstalled at the factory or installed using the HP Installer Kit for Linux, the correct kernel for supporting the large amount of memory should be automatically installed and configured.

x86 (32-bit) Red Hat Linux legacy information

Bigmem and hugemem kernels

The bigmem kernel is used on Red Hat Linux 7.2, 7.3, 8.0, and 9.

The hugemem kernel is used on Red Hat Enterprise Linux WS 3 (RHEL WS 3) and later.

Starting with RHEL WS 3, the i686 SMP kernel is sufficient for the maximum amount of memory, up to 16 GB, in HP workstations. With greater than 16 GB large memory configurations, use the hugemem kernel. With 4 GB and greater memory configurations, you will have access to all your memory (if the Enable Memory Remapping option is enabled in the BIOS).

In order for earlier Linux operating systems to use more than 3.5 GB of physical memory, a special kernel called the bigmem kernel must be used. For example, for kernel 2.4.18-26, the rpm package that provides that kernel for Red Hat 8.0 is kernel-bigmem-2.4.18-26.8.i686.rpm. If more than 3.5 GB of memory is installed, then enter `rpm -i kernel-bigmem-2.4.18-26.8.x.i686.rpm` when installing the bigmem kernel.

You need to reinstall accelerated HP graphics drivers from the HP Installer Kit for Linux CD or the latest driver from http://www.hp.com/go/workstationsupport. For the accelerated graphics driver to work correctly, you must install the source files for the particular version of the kernel that you installed. Before you attempt to reinstall the graphics driver, install the kernel source. The kernel source is available from the same location as the bigmem kernel rpm.

To reinstall the graphics driver:

1. Identify the accelerated driver that was installed on the UP kernel:
   a. Enter `rpm -qa | grep nv`
   b. Enter `rpm -qa | grep firegl`

2. To remove the driver that was identified, enter `rpm -e <name from output of previous step>`.

3. To Install the new driver, enter `rpm -i <driver name>.rpm`

4. Run the configure script:
   a. For Legacy Red Hat versions, enter `cd /usr/hp/graphics/<vendor name>`.
   b. For Red Hat Enterprise Linux, enter `cd /opt/hp/graphics/<vendor name>`.
   c. Enter `.configure`

You might also need to rebuild or reinstall any other loadable kernel modules on your system because a different module is needed for each Linux kernel.
Bigmem, hugemem, and UP systems

The bigmem and hugemem kernels as released by Red Hat are SMP (Symmetric Multi-Processing) kernels, which mean that they can support multiple CPUs. The bigmem and hugemem kernels have only been tested by HP on dual CPU systems and on single CPU systems with Hyper-Threading Technology enabled, plus 4 GB or more of memory. Thus, using the bigmem and hugemem kernels on systems with one virtual CPU or less than 4 GB of memory is not supported.

Performance implications

When using the bigmem and hugemem kernels, memory references inside the kernel require one more level of indirection, so general system performance might suffer compared to using the SMP or UP kernels. For user processes using large amounts of memory, the additional installed memory can prevent swapping to the hard drive, which should offset any memory reference penalty incurred by the bigmem and hugemem kernels.

On x86 (32-bit) systems, the Linux kernel makes available only 3 GB of address space available for each user process. Even though a single process can only use 3 GB of memory, installing 4 GB or more of memory and running the bigmem and hugemem kernels can still provide a performance advantage when running multiple processes requiring large amounts of memory.

The maximum amount of memory that you can malloc in one chunk is 2 GB, because of fragmentation of the malloc pool across a process address space.

Large memory and Memory Type Range Registers

In some situations, adding additional memory to a system can cause AGP graphics drivers to fail. In these cases, increasing the AGP aperture size might enable the configuration to operate.

On Intel Pentium family processors memory access is controlled using special dedicated registers in the processor called Memory Type Range Registers (MTRRs). For system RAM to be available for processor use, the system must be configured using these registers where the defined memory size must be a power of two. Maximizing configured memory results in some system memory sizes using almost all the MTRRs available in the processor. Some Linux graphics drivers require exclusive use of two MTRRs, which might not be available.

If an error occurs when the graphics driver loads, the system memory configuration might not have enough free MTRRs. This can be verified from the console by viewing the /proc/mtrr file. Registers six and seven are normally unlisted or listed as OMB if X has not started since the last system boot. If viewing /proc/mtrr shows register six or seven is in use, changing the memory configuration might free an MTRR. You can do this by increasing the AGP graphics aperture by rebooting the system, selecting Setup at the initial screen, and selecting Advanced. However, a larger AGP aperture can reduce the amount of configured memory and can cause a decrease in performance for some graphics intensive applications.

Conclusion

Support for large memory configurations on HP Linux workstations requires you to use an SMP kernel if memory is 16 GB or less. The hugemem kernel is needed if the memory is greater than 16 GB on RHEL WS 3 and later. A bigmem kernel is needed on earlier Red Hat Linux versions.
6 Setting up multi-monitor configurations

Introduction

This chapter discusses a working overview of multiple-monitor solutions for HP workstations running the Linux operating system and the XFree86 X windowing system. It discusses system concepts, configuration examples, support information, and configuration trade offs for system designers. This chapter assumes familiarity with Linux configuration, basic X server usage, window managers, and essential video graphics card fundamentals.

Many advanced graphics cards have the speed and capacity to simultaneously drive multiple display monitors. While conventional systems provide single-monitor setups, multiple monitor setups support data-intensive visualization needs.

Basics

HP supports a wide spectrum of graphics device solutions from Professional 2D to Extreme 3D. Professional 2D devices offer affordable multiple screen solutions for business professionals. For users requiring 3D solutions, HP offers a range of devices from entry-level 3D with price-performance advantages to extreme 3D devices offering the latest features in programmability, stereo, antialiasing, and memory. Almost all HP workstation graphics cards provide two video output connectors and can drive dual video monitors.

In current HP workstations the primary graphics interface is now PCI Express (PCIe) 16x transfer rates of approximately 4-GB/s bandwidth. PCIe is seen as the new standard for a scalable interface as graphics and other devices become more powerful and require more bandwidth. A complete list of HP supported Linux graphics devices is located at [http://www.hp.com/support/linux_hardware_matrix](http://www.hp.com/support/linux_hardware_matrix).

Graphics drivers

Software drivers dictate the available functionality and performance of graphics cards under XFree86 on Linux. You should be aware of two distinctions:

- XFree86/X.org-native drivers—Graphics software provided by open-source developers included as part of the XFree86 and X.org distributions. Functionality and performance depend upon code maturity and low-level access. Often these drivers have basic functionality as device manufacturers choose to keep their acceleration techniques and full functionality limited to proprietary drivers.

- OEM proprietary drivers—Graphics software that is developed and maintained by respective manufacturers. This software provides the highest degree of card acceleration and functionality.

**NOTE:** Use OEM drivers when configuring multiple video ports on supplied HP graphics cards.

Both XFree86/X.org providers and OEM graphics partners provide robust graphics driver solutions on HP workstations. Version-matched drivers for ATI and NVIDIA graphics cards are provided with the HP Installer Kit for Linux CD and HP Driver CD for Red Hat Linux releases. The latest HP Driver CD and individual graphics driver updates are maintained and available on the HP Support web site: [http://www.hp.com/support](http://www.hp.com/support).
Multiple graphics cards

HP supports multiple, same-vendor graphics cards in a variety of combinations. The HP xw4600, xw6600, xw8600, xw9300, and xw9400 Workstations offer two full-speed x16 PCIe graphics slots which enable high end graphics configurations with two full performance graphics cards. The HP xw8200 Workstation offers one full-speed x16 PCIe graphics slot as well as a x4 PCIe slot for expansion options. Multiple graphics cards can also be supported by combining one PCIe-based graphics card with one or more PCI-based graphics cards. Same-vendor card requirements come from the tested reliability of a single universal graphics driver for all installed cards. Mixed-vendor combinations might require conflicting drivers that are not guaranteed to work together and thus cannot be fully supported by HP.

Many workstation customers typically reserve the high-performance PCIe channels for accelerated 3D graphics work. Additional PCI-based graphics cards provide complementary access to user interfaces (menus, navigation, help screens) or other workspaces.

Multiple monitors and displays

XFree86 and X.org manage display of each monitor as part of one or more screens that are used by the user’s window manager (such as; GNOME, KDE, and so on). Regardless of the number of graphics cards driving individual monitors, a primary goal is to expand an integrated viewable workspace across all monitors. Two and three monitor configurations typically define a horizontal setup (side-by-side). Four or more monitor configurations can define square or rectangular presentations (2-high x 2-wide, 2-high x 3-wide, and so on.). You can control how the mouse moves from monitor to monitor. You can also control how desktop workspaces appear in each display and how each display behaves relative to its neighbor. A detailed discussion of these configuration issues follows in the next section.

Figure 6-1  Office monitor configurations

Scalable Link Interface graphics acceleration

Dual PCIe graphics cards can be driven together to drive a single graphics display and achieve up to two times the performance of a single graphics card. This is performed through a new technology provided by NVIDIA called Scalable Link Interface (SLI). Not all graphics cards support the SLI technology, and SLI requires that the graphics cards being used are the same type (homogeneous configuration). For more information on these advanced settings, see the documentation provided with the drivers.

Independent and continuous displays

The X server tracks every graphics card video port as a unique entity, assuming one display monitor is connected to each port.
Independent display

This monitor configuration defines the conventional behavior of most computers. The edges define a specific boundary in which windows are viewable. All content remains fixed within the surrounding borders. Window managers provide a desktop only within the specified display.

Figure 6-2  Independent display

Continuous display

This monitor configuration shares viewable space with adjacent displays. One or more monitor borders can share content with other adjacent monitors. Windows are allowed to penetrate and span borders so that multiple monitor displays share content. Window managers provide a continuous desktop across all participating displays.

Figure 6-3  Continuous display

Xinerama

Xinerama, an XFree86 extension, supports continuous display technology on the X server. When enabled, it changes independent displays to continuous displays. Xinerama is configured with a ServerFlags option or enabled with a command-line option.

NOTE:  Xinerama supports only accelerated 3D between screens controlled by independent cards with recent NVIDIA drivers (not ATI drivers).

The vizconfig tool is a multi-card graphics configuration tool that provides a simple way to configure the multiple graphics cards described below. To run the vizconfig tool, enter run /opt/hp/viztools/bin/run_vizconfig

NVIDIA TwinView

NVIDIA TwinView driver extension supports Xinerama-like functionality across the two video ports of an NVIDIA graphics card. When configured, it enables the X server to manage the output of dual video ports as one continuous display or X screen. User windows can cross the entire graphics card framebuffer.

NOTE:  Xinerama can integrate each NVIDIA TwinView device as one logical display in a series of continuous displays.
ATI Big Desktop

ATI Big Desktop driver configuration mode supports Xinerama-like functionality across the two video ports of an ATI graphics card. When configured, ATI Big Desktop enables the X server to manage the output of dual video ports as one continuous display or X screen. User windows can cross the entire graphics card framebuffer.

**NOTE:** ATI Big Desktop mode can only be configured with the `–glrxconfig–rom ATI configuration tool`. When installed from the HP Installer Kit for Linux CD, this utility resides in the `/opt/hp/graphics/ati` directory.

This utility configures a new XF86Config or xorg.conf file with the necessary driver bit-flags properly set. See included documentation for more information.

**NOTE:** HP does not support any PCI-based ATI cards for personal workstations.

**Figure 6-4** ATI Big Desktop

---

Multi-monitor configuration strategies

Multi-monitor systems must balance a number of configuration details to deliver optimal functionality and performance. Users should consider the following when designing an ideal multi-monitor system:

- **Performance**—Continuous display configurations must consider:
  - Faster PCIe slots—Graphics cards driving 2D and 3D accelerated content for high performance.
  - Slower PCI slots—Graphics cards typically driving 2D content (user-interface, windows) for increased viewability.
  - Number of cards—More cards use more system bandwidth, reducing refresh performance and interactivity.
  - X server addressable screen units—32,000 units high and 32,000 units wide maximum for any continuous display.

- **Supportability**—Continuous display configurations must consider:
  - Matched monitor model type and functionality
  - Matched monitor resolution and refresh frequencies

- **Ergonomics**—Physical monitor placement should follow best practices for ergonomic design. Display configurations that are excessively wide can result in user fatigue and eye strain. Monitors extremely high can result in neck and back strain.
Configuring X with multiple graphics cards using the vizconfig tool

The vizconfig tool is designed to make it much easier to set up multi-head and multi-card graphics configurations.

On HP xw9300 Workstations, the tool has an icon preinstalled on the desktop. The installer can also be run from the command line by entering /opt/hp/viztools/bin/run_vizconfig.

(Today, the vizconfig tool works only on NVIDIA devices. ATI has a configuration tool called fglrxconfig with a GUI that configures a single graphics card.)

The vizconfig GUI is invoked, pointing and clicking is all you need to do for most configs. If you need to do anything that the vizconfig tool does not support, then you can edit the config file that vizconfig generates to add the missing functionality.

To use the vizconfig tool:

1. Log in as root.
2. Launch the vizconfig tool by clicking the desktop icon, or enter /opt/hp/viztools/bin/run_vizconfig.
3. Select the display arrangement from the Selected Display Arrangement list.
   - 1 Card, 1 Display
   - 1 Card, 2 Displays, (2x1)
   - 2 Cards, 2 Displays (2x1)
   - 2 Cards, 3 Displays (3x1)
   - 2 Cards, 4 Displays (4x1)
   - 2 Cards, 4 Displays (2x2)
   - 2 Cards, 4 Displays (1 over 3)
4. When a display arrangement is selected, you can set different options in the Options tab:
   - SLI Multiview (Xinerama)—Enables or disables 2D or 3D Xinerama
   - Use TwinView where possible—Enables or disables TwinView
   - HardwareOverlays—Enables or disables using hardware overlays
5. Set up the different monitors. The different monitors are shown in the picture of the current selected display arrangement. Also shown are the ways to connect the graphics cards to those monitors.
6. Select the display using the Selected Display list. The picture of the display arrangement will be updated to highlight the selected display
7. Set the resolution for this display with the Display Resolution slider.
8. If you want the display to be connected to the other connector on the graphics card, select Swap Left_Right Monitors. The picture of the display arrangement will be modified to reflect this change.
9. Repeat steps 6 through 8 as needed for each display.
10. Select SaveConfig to save the changes to the /etc/X11/<XF86Config or xorg.conf> file.
    If the tool was run as root, the system X configuration file (XF86Config or xorg.conf in /etc/X11) will be updated. The previous X configuration file is copied aside with a vizconfig.sav extension. If the tool was
not run as root, the generated file can be found in /usr/tmp/. To try the saved changes, restart the Xserver by pressing Ctrl-Alt-Backspace.

If the Xserver does not start, the old X configuration /etc/X11/<XF86Config or xorg.conf> file should be put back in place. Enter cp /etc/X11/XF86Config.vizconfig.sav /etc/X11/XF86Config. Diagnose the problem by looking at /var/log/Xfree86.0.log or /var/log/Xorg.0.log.

Once a vizconfig-generated config file is in place, vizconfig will use the settings from that config file as the starting point the next time vizconfig is run. This is based on several comment fields at the beginning of the X configuration file. That is, it will remember the display arrangement and the display resolutions, etc.

The vizconfig tool does not setup every possible multi-card configuration possible. Instead, it attempts to meet the most common needs of workstation customers. If a configuration is desired that is slightly different than the supported vizconfig configurations, you can use vizconfig to setup the closest configuration and then make minor edits to the X configuration file to get the desired result.

**NOTE:** When re-running vizconfig, manual edits of the config file will not be remembered and must be re-applied.

When using the highest resolution (2560x1600) on a high-resolution monitor such as the Apple 30 inch or HP 3065 Cinema display, more advanced graphics cards are needed. These include the NVIDIA Quadro FX 3500 or the FX 4600 which have 1-2 dual-link DVI connectors. Your display may also need to have a modified Modeline in the X configuration file if it is not a supported HP monitor. See the documentation in the /usr/share/doc/NVIDIA_GLX-1.0 directory for more configuration info.

**Figure 6-5 Monitor setup**

![Monitor setup](image)

---

**Configuring XFree86/X.org by editing configuration files**

On RHEL 4 and beyond, the X.org version of the X server replaces the older Xfree86 version. To ease the transition, the X.org X server will look for configuration files in all the old Xfree86 locations. The X.org versions of the files are referenced below for completeness.

Graphics vendors provide detailed information of how to edit and configure the Xserver when using their hardware. Examples include the documentation found in the /usr/share/doc/NVIDIA_GLX-1.0 directory for NVIDIA info.

On a Linux workstation, the default XFree86/X.org X server configuration file resides at /etc/X11/XF86Config or /etc/X11/xorg.conf.

To configure multiple files and start X with an alternative file, enter `/usr/X11R6/bin/XFree86 -xf86config /etc/X11/XF86Config.xinerama`.

Each file contains a complete description of the X server’s execution environment including monitor descriptions and timings, graphics drivers, and continuous display settings (for example, Xinerama). This section covers basic concepts for configuration.
The XF86Config file is a hierarchical definition file. In cascading order of significance, the sections are:

- **ServerLayout**—Highest level section that binds all input and output devices together for a given session including output device hints that describe screen position relationships (for example, RightOf, LeftOf, Above, Below, and so on).
- **Screen**—Definition that binds together a monitor and graphics card device description with color depth and display resolution preferences.
- **Monitor**—Monitor description and timing refresh information.
- **Device**—Graphics card description, device driver name and driver control options.

The following discussions build from lowest-level components to high-level server layout in the file.

- **Monitor section**—The configuration file must contain one or more monitor descriptions:

```plaintext
Section “Monitor”
  Identifier “name”
  entries
  HorizSync H-range   # example: 63.6
  VertRefresh V-range  # example: 60
EndSection
```

Each monitor is referred to in the Screen section by its unique Identifier. For multi-monitor configurations, one definition is sufficient if the monitors match in type and function. For simplicity, it is recommended that a single monitor configuration be attempted first to properly define compatible Horizontal and Vertical timings for the display. Digital Flat Panel (DFP) monitors, for example, have a narrow synchronization range to properly function. XFree86 will either fail to start or a monitor will remain blank if reasonable refresh timings cannot be synchronized with the graphics card. Attempts to run monitors at higher frequencies than their ratings can result in damage, so care should be taken to specify reasonable operational ranges. Reasonable starting defaults (one frequency, no ranges) for this section can be:

- CRT displays:
  HorizSync 80, VertRefresh 75 (75Hz refresh for 1280x1024)
- DFP displays:
  HorizSync 63.6, VertRefresh 60 (60Hz refresh for 1280x1024)

Red Hat distributions 9 and later include access to the XFree86 utility gtf for computing monitor modelines for this section if more specific timing ranges are required.

- **Device section**—The configuration file must contain one device description for each graphics card installed.

```plaintext
Section “Device”
  Identifier “name”
  entries
  Driver “drivername”   # example nvidia
  BusID “PCI:bus:device:function”   # example PCI:64:0:0
  Screen number   # optional, number = 0,1
EndSection
```

Each graphics card is referred to in the Screen section by its unique Identifier. Each device section must specify the loadable device driver provided to drive the graphics card. These drivers reside at `/usr/X11R6/lib/modules/drivers`.

Driver module names do not include the .o extension found on the files at this location, so nvidia_drv.o is simply nvidia in the configuration file.
Each graphics card resides at a specific PCI bus location in the workstation. Multi-monitor configurations require each card to be identified in the XF86Config file. The address locations are specified in decimal form. To identify each card, use the lspci utility (convert HEX to decimal here), or enter `more /proc/pci`.

Each device appears by its VGA controller address. Specify the XF86Config BusID address as `PCI:128:0:0` or `PCI:64:1:0` as shown next.

```plaintext
Bus 64, device 1, function 0:
    VGA compatible controller: nVidia Corporation NV34GL
    280/400 NVS] (rev a2).
Bus 128, device 0, function 0:
    VGA compatible controller: nVidia Corporation NV25GL
    980 XGL] (rev 163).
```

For graphics cards with multiple video output ports, each video output port usually defines a unique device. In order for the X server to properly address a single card with two video output ports, two device descriptions with the same BusID are defined but with different Device section Screen numbers. The use of the term Screen is private and unique to this section. It identifies the video output port within a range of zero to N-1 ports (usually 0 or 1 for a two-headed card). The first port always starts at zero. For example, an NVIDIA 980XGL or a PCIe Card might be described as shown.

```plaintext
Section "Device"
    Identifier "PCIe_card_port0"
    Driver "nvidia"
    BusID "PCI:64:0:0" # PCIe slot
    Screen 0 # port zero
EndSection

Section "Device"
    Identifier "PCIe_card_port1"
    Driver "nvidia"
    BusID "PCI:64:0:0" # PCIe slot
    Screen 1 # port one
EndSection
```

This effectively describes two available graphics devices to the X server located at the same bus address.

**NOTE:** When using the NVIDIA TwinView option to unite screens, the Device section Screen numbers are optional and might not always be necessary to uniquely identify the output port.

- **Screen section**—The configuration file contains one Screen section for each combination of Monitor and Device defined elsewhere in the file. Each Screen effectively defines one video display of your workstation.

**NOTE:** The use of Screen here differs from that used in the Device section as a port number ID.
Section “Screen”

Identifier “name”
Device “device_identifier”
Monitor “monitor_identifier”

entries

`DefaultDepth 24

SubSection “Display”
  Depth 24
  Modes “1280x1024” “1024x768” “800x600”
  entries

EndSubSection

EndSection

Three screen sections are required for the situation shown in the Figure 6-6 Three screen configuration on page 31 figure.

Figure 6-6  Three screen configuration

NVIDIA TwinView—The NVIDIA graphics driver specifies its TwinView configuration as Screen options within each Screen section that is used. After installing drivers from the HP Installer Kit for Linux CD, configured examples are installed at /opt/hp/graphics/nvidia/example_configs.

NVIDIA TwinView can privately specify the adjacency of two video outputs as a single Screen definition. Both monitors are treated as one unit by the X server.

- ServerLayout section—The configuration file must contain one or more ServerLayout descriptions.

Section “ServerLayout”
  Identifier “name”
  Screen screen-num “screen_identifier” position-info

  InputDevice “input_device_identifier”

  options

EndSection

Each Screen definition must be specified by its identifier for it to be activated in the final layout. The number screen-num is an integer from 0 to N-1 (sequentially) that specifies the associated X screen number for that display.

NOTE: This is not the same screen number as given internally within a Device description for multi-ported cards.
The position-information field describes the way multiple screens are positioned (RightOf, LeftOf, Above, Below are the most commonly used options).

For example, three displays are placed on a desktop side-by-side. They are defined as screenA, screenB, and screenC, respectively and have screen-num numbers 0, 1, and 2. The ServerLayout relationships are as follows:

Section “ServerLayout”
Identifier “three_wide”
  Screen 0 “screenA”  # display A
  Screen 1 “screenB” RightOf “screenA”  # display B
  Screen 2 “screenC” RightOf “screenB”  # display C
EndSection

Section “ServerFlags”
  Option “Xinerama” “true”  # option enables a continuous display
EndSection

Figure 6-7 ScreenLayout positions (Xinerama)

![Figure 6-7 ScreenLayout positions (Xinerama)](image)

Figure 6-8 ScreenLayout positions (non-Xinerama)

![Figure 6-8 ScreenLayout positions (non-Xinerama)](image)

When the Xinerama server option is specified (see Figure 6-7 ScreenLayout positions (Xinerama) on page 32), all Screens are joined into one continuous display. If Xinerama is not specified (or enabled on the command line), all screens behave as independent displays (see Figure 6-8 ScreenLayout positions (non-Xinerama) on page 32).

Vendor-specific Documentation—When OEM proprietary accelerated drivers are loaded from the HP Installer Kit for Linux CD, documentation and configuration examples are installed at:

/opt/hp_graphics/vendor-name/
/opt/hp_graphics/ati/
/opt/hp_graphics/nvidia/

Please consult these directories for valuable graphics card customization information, including specifics about the NVIDIA TwinView and the ATI Big Desktop functionality.
Example configurations

Example A—Three-monitor configuration

This section describes a three-monitor workstation configuration with 2 x 3D graphics and 1 x 2D graphics.

Figure 6-9 Three-monitor NVIDIA TwinView setup

On an HP workstation running Linux, two graphics cards are installed:

- PCIe x16 slot = NVIDIA FX1400 with two DVI connectors (A,B)
- PCI slot = NVIDIA 2850NVS with two VGA connectors (C)

To configure two independent desktops:

- 3D desktop across two continuous displays (A,B) using two matched monitors on one graphics card
- 2D desktop across one independent display (C) for menus on second graphics card

**NOTE:** Xinerama is not used in this solution. If Xinerama is enabled, then one continuous display for (A,B,C) will be formed.

**NOTE:** This solution demonstrates NVIDIA TwinView to create the continuous displays (A,B).

Assuming three matched monitors of the exact same type, the following configuration highlights apply.

Example A code:
... Section “Monitor”
  Identifier “HP Monitor”
  HorizSync H-range  # example: 63.6
  VertRefresh V-range  # example: 60
EndSection

... Section “Device”
  Identifier “FX1400”
  Driver “nvidia”

  BusID “PCI:64:0:0”  # PCIe x16 slot
EndSection

... Section “Device”
  Identifier “NV285_NVSC”
  Driver “nvidia”

  BusID “PCI:6:4:0”  # PCI slot
EndSection

... Section “Screen”
  Identifier “PCIe Screen”
  Device “FX1400”
  Monitor “HP Monitor”
  DefaultColorDepth 24

  Option “TwinView”
  Option “MetaModes” “1280x1024, 1280x1024”

  Option “TwinViewOrientation” “LeftOf”

  SubSection “Display”
    Depth 24
    Modes “1280x1024”
EndSubSection
EndSection
Section "Monitor"
  Identifier "HP Monitor"
  HorizSync H-range # example: 63.6
  VertRefresh V-range # example: 60
EndSection

Section "Device"
  Identifier "card_0" # 280NVS - PCIe
  Driver "nvidia"
    BusID "PCI:64:0:0" # PCIe slot
    Screen 0 # note - connector 1
EndSection

Section "Device"
  Identifier "card_1" # 280NVS - PCIe
  Driver "nvidia"
    BusID "PCI:64:0:0" # PCIe slot
    Screen 1 # note - connector 2
EndSection

Section "Device"
  Identifier "card_2" # 280NVS - PCI
  Driver "nvidia"
    BusID "PCI:6:4:0" # PCI slot
    Screen 0 # note - connector 1
EndSection

Section "Device"
  Identifier "card_3" # 280NVS - PCI
  Driver "nvidia"
    BusID "PCI:6:4:0" # PCI slot
    Screen 1 # note - connector 2
EndSection

Section "Screen"
  Identifier "screen_A" # display A
  Device "card_0"
  Monitor "HP Monitor"
EndSection

Section "Screen"
  Identifier "screen_B" # display B
  Device "card_1"
  Monitor "HP Monitor"
EndSection

Section "Screen"
  Identifier "screen_C" # display C
  Device "card_2"
  Monitor "HP Monitor"
EndSection
Example B—Four-monitor configuration

This section describes a four monitor configuration with 4 x 2D graphics.

On an HP workstation running Linux, two graphics cards are installed:

- PCIe slot = NVIDIA 280NVS with two VGA connectors (A,B)
- PCI slot = NVIDIA 280NVS with two VGA connectors (C,D)

To configure one continuous desktop, all screens merge to form a single continuous display.

**NOTE:** Two NVIDIA TwinView Screens can be used as in example A. This example demonstrates the generalized Xinerama configuration solution.

Assuming four matched monitors of the exact same type, the following configuration highlights apply.

Example B code:
Section “Monitor”
   Identifier “HP Monitor”
   HorizSync H-range # example: 63.6
   VertRefresh V-range # example: 60
EndSection

Section “Device”
   Identifier “card_0” # 280NVS - PCIe
   Driver “nvidia”
   BusID “PCI:64:0:0” # PCIe slot
   Screen 0 # note - connector 1
EndSection

Section “Device”
   Identifier “card_1” # 280NVS - PCIe
   Driver “nvidia”
   BusID “PCI:64:0:0” # PCIe slot
   Screen 1 # note - connector 2
EndSection

Section “Device”
   Identifier “card_2” # 280NVS - PCI
   Driver “nvidia”
   BusID “PCI:6:4:0” # PCI slot
   Screen 0 # note - connector 1
EndSection

Section “Device”
   Identifier “card_3” # 280NVS - PCI
   Driver “nvidia”
   BusID “PCI:6:4:0” # PCI slot
   Screen 1 # note - connector 2
EndSection

Section “Screen”
   Identifier “screen_A” # display A
   Device “card_0”
   Monitor “HP Monitor”
EndSection

Section “Screen”
   Identifier “screen_B” # display B
   Device “card_1”
   Monitor “HP Monitor”
EndSection

Section “Screen”
   Identifier “screen_C” # display C
   Device “card_2”
   Monitor “HP Monitor”
EndSection
Example C—Four-monitor configuration for current shipping HP Workstations

This section describes a four-monitor configuration with 4 x 3D graphics for the HP Workstation with dual PCI-E x16 slots.

On an HP Workstation with dual PCI-E x16 slots running Linux, two graphics cards are installed:

- PCIe slot 0 = NVIDIA 3D-capable graphics card with two DVI-I connectors [A,B]
- PCIe slot 1 = NVIDIA 3D-capable graphics card with two DVI-I connectors [C,D]

To configure one continuous desktop, all screens merge to form a single continuous display.

**NOTE:** Two NVIDIA TwinView Screens with two 3D-capable graphics cards can be used on the current shipping HP Workstations because these are the only models that offers dual PCIe x16-capable slots.

Assuming four matched monitors of the exact same type, the following configuration highlights apply.

Example C code:
Section "Device"
  Identifier "NV PCIe-1"
  VendorName "nvidia"
  Driver "nvidia"
  BusID "PCI:10:0:0"
  Option "IgnoreEDID"
  Option "UseInt10Module"
  # sample TwinView setup
  Option "TwinView"
  Option "TwinViewOrientation" "RightOf"
  Option "MetaModes" "1280x1024,1280x1024"
EndSection

Section "Device"
  Identifier "NV PCIe-2"
  VendorName "nvidia"
  Driver "nvidia"
  BusID "PCI:129:0:0"
  Option "IgnoreEDID"
  # Option "UseInt10Module"
  # sample TwinView setup
  Option "TwinView"
  Option "TwinViewOrientation" "RightOf"
  Option "MetaModes" "1280x1024,1280x1024"
EndSection

Section "Screen"
  Identifier "Screen TwinView-1"
  Device "NV PCIe-1"
  Monitor "MyMonitor"
  DefaultColorDepth 24
  Subsection "Display"
    Depth 24
    Modes "1280x1024"
  EndSubsection
EndSection
Troubleshooting

When editing an X configuration file, each time the X server is started, it writes out the log file /var/log/XFree86.0.log or /var/log/Xorg.0.log. If the results are not as expected, or the X server fails to start, go to the log file.

Both the X server and OEM accelerated drivers will write configuration confirmations, warnings, and errors to this file. Usually, you can resolve configuration issues based on output in this log file.

Known limitations

There are a few notable limitations in Linux when configuring multiple monitors, especially with multiple graphics cards. On earlier consumer Red Hat releases (before Red Hat Enterprise Linux), the GNOME window manager did not handle independent displays correctly. In such cases the KDE window manager must be used as it handles independent displays quite well. But, even with KDE, a few anomalies may be noticed. The toolbars might differ in style on the primary display from the other independent displays. With the release of RHEL, the GNOME window manager supports independent displays. Further, the GNOME window manager enables you to customize toolbars per display.
7 Using the HP 16x DVD burner

Introduction

The HP 16x DVD±R/RW Dual Layer Drive for HP Linux workstations is available as an integrated or after market option for HP workstations.

Recording modes, media type, and recording software

The HP 16x DVD±R/RW Dual Layer Drive supports the following recording modes:

- **Disk-at-once**—records one or more tracks to a blank disk, leaving no gaps between the tracks and allowing for no sessions
- **Session-at-once**—records similar to Disk-at-once except that new sessions can be written later.
- **Track-at-once**—records one or more tracks, separating each track with a gap and allowing for further sessions.
- **Packet writing**—records data in small increments, eliminating the need to open or close a session each time data is written.

The HP 16x DVD±R/RW Dual Layer Drive supports the following media types:


Note: Some media are more reliable than others, so verify that the data transfers to the media as expected.

The following DVD recording software is included with your Linux operating system:

- Red Hat Linux 7.3, 8.0, and 9 support cdrecord for burning CDs.
- Red Hat Enterprise Linux WS 3 and WS 4 support growisofs for burning DVDs and cdrecord for burning CDs.

Growisofs is part of the dvd_rw-tools rpm tool provided with RHEL WS 3 and WS 4.

Note: Red Hat Enterprise Linux does not support Lightscribe labeling technology. For more information, please visit [http://www.lightscribe.com](http://www.lightscribe.com).

- Red Hat Enterprise Linux 5 Desktop support growisofs for burning DVDs and cdrecord for burning CDs.
CD and DVD burning software

Cdrecord

1. To determine if cdrecord is installed (as part of the cdrecord package), enter `rpm –qa | grep cdrecord`. If it is not installed, enter `rpm –i cdrecord<revision>.rpm`.

2. After cdrecord.rpm is installed, you can access the basic man page by entering `man cdrecord`. You can also read the documentation provided in `/usr/share/doc/cdrecord <revision>/`.

To format or clear the content of a CD-RW:

a. Enter `cdrecord –scanbus`.

b. Enter `cdrecord dev=N,N,N blank=fast`.

To burn an existing file.iso to a CD-R/RW:

- For RHEL 4, enter `cdrecord dev=/dev/cdwriter driveropts=burnfree –dao –data file.iso`.

Growisofs

1. Determine if growisofs is installed (part of the dvd+rw-tools package). Enter `rpm –qa | grep dvd+rw-tools`. If it is not installed, enter `rpm –i dvd+rw-tools<revision>.rpm`. Check that the cdrecord and dvdrecord packages are installed.

2. (Optional) After the dvd+rw-tools rpm is installed, you can access a tutorial in `/usr/share/doc/dvd+rw-tools<revision>/index.html`.

**NOTE:** There is no man page for growisofs because all arguments are passed to mkisofs(8). The few exceptions are covered in the tutorial.

To format new DVD media (assuming your DVD device is `/dev/scd0`), enter `dvd+rw-format -blank=full /dev/scd0`.

To burn a DVD±RW, DVD±R, or DL DVD+R:

**NOTE:** Assume the files are in `/tmp` on the initial session, and that you will add the files in `/bin` in a later session.

1. Enter `growisofs -Z -R /dev/scd0 /tmp`.

2. Enter `growisofs -M -R /dev/scd0 /bin`.

To burn an existing iso file (file.iso), enter `growisofs -Z /dev/scd0=file.iso`. 
HP and Creative Labs have partnered to create a Linux audio driver for the X-Fi audio card. The X-Fi audio cards, also known as *Extreme Music* and *Extreme Gamer*, are supported on the HP xw4400, xw4600, xw6400, xw6600, xw8400, xw8600, and xw9400 Workstations with the Creative x86_64 Linux driver on RHEL 4 U4 and later RHEL 4 updates (RHEL 5 support expected Spring 2008) under the following requirements:

- Intel® Pentium® III 1 GHz or AMD Athlon® 1 GHz processor
- Intel, AMD or 100% compatible motherboard
- RHEL4 U4 (or later) Linux® x86_64 (AMD64/EM64T) or derivative, like FC5
- 256 MB RAM
- 200 MB of free hard disk space
- Available PCI 2.1 slot
- Internet connection for software download and installation
- Headphones or amplified speakers (available separately)

### Installing Drivers

Before proceeding, ensure that your audio card is installed and that you are in init runlevel 3. To learn how to install your audio card, consult your installation card shipped with your hardware.

**NOTE:** Installing the X-Fi card in a HP Workstation that is listed above will automatically disable, via BIOS, the onboard audio chipset. To re-enable the onboard audio chipset, remove the X-Fi card from the workstation chassis.

After you have installed your audio card, turn on your computer. With Internet access, obtain the driver rpm at [http://www.hp.com/support/](http://www.hp.com/support/) and look up the appropriate Workstation model.

As an example, if you have a xw6600, go to [http://www.hp.com/support/xw6600](http://www.hp.com/support/xw6600).

1. Go to **Download drivers and software**.
2. Choose **Red Hat Enterprise Linux 4 (AMD64/EM64T)** and select **Software**.
3. Click to download the latest version of the X-Fi driver `XFiDrv_Linux_US-version-release.x86_64.rpm`
4. Accept the EULA to start the download.

**Install RPM package**

- Run `rpm -ivh XFiDrv_Linux_US-version-release.x86_64.rpm`

**Update RPM package**

- Run `rpm -Uvh XFiDrv_Linux_US-version-release.x86_64.rpm`
NOTE: This command will automatically uninstall the current device driver and install this device driver.

Remove RPM package

- Run `rpm -e XFiDrv_Linux_US-version-release`

NOTE: All these commands must be run from a command line while in init level 3.

Verify Driver Installed Correctly

From a command line, start up ‘alsamixer’ and unmute channels as appropriate. Make sure the ‘master’ and ‘PCM’ volume controls are turned up at least to 50. From a command line, test PCM audio functions with ‘aplay /usr/share/sounds/shutdown.wav’, or use any .wav file you have available.

Connecting 2.1 channel analog speakers to your audio card

Figure 8-1 SB046X, SB055X, SB073X series
Table 8-1  Jack, Connector or Cable

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Line Out 1 jack</td>
</tr>
<tr>
<td>2</td>
<td>2 channel audio cable (available separately)</td>
</tr>
<tr>
<td>3</td>
<td>Audio Input jack</td>
</tr>
</tbody>
</table>
Connecting your 2.1 channel digital speakers to your audio card

Figure 8-3  SB046X, SB055X, SB073X series

Table 8-2  SB046X, SB055X, SB073X series

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FlexiJack</td>
</tr>
<tr>
<td>2</td>
<td>RCA-to-miniplug cable (available separately)</td>
</tr>
<tr>
<td>3</td>
<td>RCA-to-RCA cable (available separately)</td>
</tr>
<tr>
<td>4</td>
<td>Digital In jack</td>
</tr>
</tbody>
</table>
Figure 8-4  SB077X series

Table 8-3  Device/Cable

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Optical S/PDIF Out jack</td>
</tr>
<tr>
<td>2</td>
<td>Optical cable (available separately)</td>
</tr>
</tbody>
</table>

NOTE:  Actual products may differ slightly from those pictured.
Connecting Headphones

You can connect stereo headphones to the Line Out 1 jack on your Sound Blaster X-Fi audio card.

Figure 8-5  SB046X, SB055X, SB073X series
Table 8-4  Jack, Connector or Cable

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Connects to stereo headphones with a 3.50 mm (1/8-inch) plug. Use a convertor if your headphones come with a larger plug.</td>
</tr>
</tbody>
</table>

**Problems with Sound**

No audio output when playing digital files such as .WAV, MIDI files or AVI clips.

Check the following:

- There are no error messages during installation of the driver.
- All the driver modules (for example, ctalsa.ko) are loaded.
- The relevant mixer slider strips in alsamixer are not muted or set to "0".
- There is no hardware conflict between the card and a peripheral device.

**No sound from the speakers.**

Check the following:

- The powered speakers or external amplifier are connected to the card's Line Out jacks.
- The speakers' volume control knob, if any, is set at mid-range.

**No sound from the headphones.**
Check the following:

- The headphones are connected to the Headphone jack.

**Additional information**

See the documentation files in /opt/Creative for more details, once you have successfully installed the RPM driver.
Introducing HP 64-bit Linux workstations

This chapter presents an overview of the HP 64-bit Linux workstations.

**HP 64-bit Linux workstation family**

AMD64-based workstations from HP complement three existing HP 64-bit capable workstations based on Intel EM64T technology.

64-bit RHEL is available on all Intel and AMD workstations from HP, including both 32- and 64-bit configurations.

**AMD-64 technology**

AMD created 64-bit extensions—called x86–64—in the x86 architecture. AMD supports it across the AMD Opteron processor family. AMD defined these extensions as a logical superset of the x86 architecture so that 32-bit applications run on a 64-bit operating system. This provides compatibility that other 64-bit architectures have not enjoyed.

**Intel's Extended Memory 64 Technology**

Intel Extended Memory 64 Technology (EM64T) is an enhancement to Intel IA32 architecture. This technology enables the processor to run newly compiled 64-bit code and access larger amounts of memory. EM64T is derived from and compatible with the AMD64 extensions that AMD has already made to the x86 architecture (x86–64). This enables all user-level 64-bit programs compiled for AMD64 to run on EM64T. It also enables programs compiled on EM64T to run on AMD64 if the code was not compiled with special Intel or AMD options. EM64T is supported across all HP Intel workstations, including the HP xw4300, xw6400, and xw8400 Workstations.

**x86–64 technology**

These x86–64 extensions include:

- Extended memory addressability using 64-bit pointers
- 64-bit general purpose registers
- 128-bit XMM registers
- Eight general purpose registers
- Double precision integer support

A new extended IA-32 mode enables 32-bit and 64-bit applications to run simultaneously on the same 64-bit operating system.
64-bit processing support

Red Hat Enterprise Linux (RHEL) has added operating system support for 64-bit processors from Intel and AMD in RHEL WS 3, Update 2, and in subsequent RHEL WS 3 updates. RHEL WS 4 (all updates) and RHEL 5 Desktop (all updates) also supports 64-bit processing.

There are both 64-bit and 32-bit versions of the operating system, but only the 64-bit version is capable of running 64-bit code.

The 64-bit RHEL WS 3 box set can be purchased from HP. The HP Installer Kit for Linux must be ordered or downloaded from the HP Support web site (http://www.hp.com/go/workstationsupport) to complement the RHEL 64-bit box set. The Installer Kit provides necessary graphics drivers and other HP content. Red Hat Enterprise The 64-bit version of RHEL WS 4 is the only preinstalled Linux operating system available for all HP workstations.

Other Linux distributions also support 64-bit versions. Other 64-bit certifications are posted on the HP Linux website. To see the certifications for Red Hat and other Linux distributions, go to http://www.hp.com/linux and select Support matrices.

Running 32-bit applications on a 64-bit Linux operating system

To run 32-bit applications on a 64-bit Linux operating system, the 32-bit runtime environment is needed in addition to the application. Many applications use a variety of shared libraries including core Linux support libraries such as glib and math libraries, X window libraries such as Xlib and Xext, and toolkits such as Qt. RHEL provides libraries and runtime support for some of the 32-bit packages that are available in their 32-bit version of the operating system. This is typically not all 32-bit software and some applications may not have all 32-bit shared libraries and runtime support needed for the application.

Because some files in the 32-bit runtime support conflict with 64-bit runtime files, the 32-bit packages cannot be installed over the 64-bit operating system. To run 32-bit applications that require more runtime support than provided by RHEL, the required files must be in place on the system running the application. The ldd command enumerates all static library references in the application.

Once the missing libraries are discovered, follow these steps to add the 32-bit rpm programs that contain the missing libraries:

1. Enter `rpm2cpio <32-bit rpm> > <32-bit path>`.
2. Enter `rpm -i --force <64-bit rpm>`.
3. Enter `export LD_LIBRARY_PATH=$LD_LIBRARY_PATH:<32-bit path>`, where 32-bit path resembles /32bitlibs, and 32-bit rpm is the name of the 32-bit rpm.

PCI Express graphics on 64-bit workstations

The new 64-bit workstations support PCI Express x16 graphics cards instead of AGP-8x graphics cards. The HP xw6400, xw6600, xw8600, xw9300, and xw9400 Workstations support two of these PCI Express x16 graphics cards. The previous generation of workstations (xw4400, xw6400, and xw8400) provide a single PCI-E x16 slot for graphics.

On RHEL releases prior to RHEL WS 3 Update 5 and RHEL WS 4 Update 1, the 64-bit NVIDIA driver requires a configuration change to the kernel to expand the size of the software TLB buffer space. The /boot/grub/grub.conf file must be changed to add `swiotlb=16384` to the end of the lines that begin with `kernel`. This addition is done automatically by the HP graphics driver rpms, but it must be done manually if the NVIDIA run scripts were used to install NVIDIA drivers.

Building and using graphics intensive 64-bit applications are similar to other 64-bit applications except for the dependency on graphics middleware and libraries. Make sure that all libraries used to build the application are available in 64-bit versions. Although HP delivers the 32-bit OpenGL libraries (from the
graphics vendors) needed to run 32-bit graphics applications on the 64-bit version of the operating system, 32-bit runtime issues can cause problems in the graphics area. 64-bit graphics libraries have approximately the same performance as 32-bit libraries.
# Frequently Asked Questions for HP 64-bit Linux Workstations

## Questions and answers

The following is a list of frequently asked questions and the answers concerning 64-bit support on HP Linux workstations.

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>When will a 64-bit Red Hat Linux operating system be supported on HP workstations with EM64T technology from Intel and AMD64 technology from AMD?</td>
<td>Today! HP Intel-based and AMD-based workstations support 64-bit Red Hat Linux when preinstalled and when using Red Hat box set and the HP Installer Kit for Linux.</td>
</tr>
<tr>
<td>What version of Red Hat Linux supports 64-bit processing?</td>
<td>Red Hat Enterprise Linux (RHEL) WS 3 has a 32-bit version and a 64-bit version. HP pre-installs the 64-bit version on all workstations and supports both 32-bit and 64-bit processing with the Driver CD in the HP Installer Kit for Linux. No 64-bit versions of earlier Red Hat releases (such as Red Hat Linux 7.3) are supported on HP workstations.</td>
</tr>
<tr>
<td>Do I need two versions of my 64-bit application—one for Intel workstations and one for AMD workstations?</td>
<td>No. Intel defined the EM64T extensions to the x86 architecture to be compatible with the AMD64 instructions. As long as you do not use any special Intel or AMD options to the compiler when you build your application (such as 3dnow), your application runs on either an Intel system or an AMD system.</td>
</tr>
<tr>
<td>Are there other 64-bit distributions of Linux that will work on the HP workstations?</td>
<td>Yes, HP has tried other distributions on the HP workstations but RHEL is the only Linux distribution supported by HP.</td>
</tr>
<tr>
<td>Can I run 32-bit applications on a 64-bit Linux operating system?</td>
<td>Yes, as long as the runtime support (mainly shared libraries) for the application exists on the system. Some versions of Linux are much better than others at providing a complete set of 32-bit libraries. When 32-bit libraries and 64-bit libraries are on the same operating system, companion library directories are required. The 32-bit libraries are in the conventional</td>
</tr>
<tr>
<td>Question</td>
<td>Answer</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>What do I do if 32-bit applications do not run because of missing shared libraries?</td>
<td>Retrieve the library from Red Hat 32-bit RHEL 3 distribution, put it on your system in the appropriate directory, and report the missing library to Red Hat through your Red Hat Network subscription. This will help Red Hat to get the right set of 32-bit libraries needed for most applications in future releases. Alternately, you can complete the following steps to access the shared libraries: 1. Enter <code>rpm2cpio &lt;32-bit rpm&gt; &gt; &lt;32-bitpath&gt;</code>. 2. Enter <code>rpm -i --force &lt;64-bit rpm&gt;</code>. 3. Enter <code>export LD_LIBRARY_PATH=$LD_LIBRARY_PATH:&lt;32-bitpath&gt;</code>.</td>
</tr>
<tr>
<td>Can I run the 32-bit versions of Red Hat Linux on a 64-bit operating system such as the HP xw9300, xw4300, xw8200, xw6200, and xw4200 Workstation?</td>
<td>Yes, you can. If you are performing the installation yourself, the installation process informs you that you are installing a 32-bit operating system on a 64-bit machine and asks you if that is what you really want to do. Select Yes and continue.</td>
</tr>
<tr>
<td>How do I install the 64-bit version of Linux?</td>
<td>Purchase RHEL WS 3 software and perform the Red Hat Anaconda installation. When you complete the installation and are rebooting for the first time, the FirstBoot utility runs and asks if you have additional CDs to install. Insert the HP Driver CD for RHEL 3 and select Yes. This process installs RHEL 3, any HP additions, and the accelerated graphics driver. The HP xw9300, xw4300, xw8200, and xw6200 Workstations can be ordered with the 64-bit operating system preinstalled.</td>
</tr>
<tr>
<td>After I have installed the 64-bit version of Linux, what do I have to do to build 64-bit applications?</td>
<td>When you rebuild the applications, the compiler builds 64-bit by default. Although this is true for most applications, some applications must be made 64-bit clean. This means that you must review the code to eliminate any assumptions about 32-bit characteristics, such as pointer arithmetic issues. Some makefiles that explicitly declare paths such as /lib, /usr/lib, and /usr/X11R6/lib might need to be changed to append 64, such as /lib64, /usr/lib64 and /usr/X11R6/lib64.</td>
</tr>
</tbody>
</table>
11 Software RAID in Linux workstations

Introduction

This chapter provides an overview of software RAID solutions for HP workstations running the Linux operating system. It discusses the various RAID levels, the differences between hardware and software RAID, configuring software RAID on Linux workstations, disk failure, recovery, and other information pertaining to running software RAID on a Linux system.

NOTE: While BIOS messages might refer to hardware RAID, hardware RAID is not supported by HP Linux workstations.

RAID basics

Software RAID considerations

The Linux kernel offers integrated software RAID without the need for additional hardware disk controllers or kernel patches. All that is required are multiple hard disks and a small amount of setup. Unlike most hardware RAID solutions, software RAID can be used with Integrated Drive Electronics (IDE) disks as well as SATA, SAS, and SCSI.

Software RAID has disadvantages in managing the disks, breaking up data as necessary, and managing parity data. The CPU must assume some extra loading. It has been found that heavily disk-intensive workloads result in roughly double the CPU overhead (for example, from 15% to 30%) when software RAID is in use. For most applications, this overhead is easily handled by excess headroom in the processors. But for some applications where disk and CPU performance are very well balanced and already near-bottleneck, this additional CPU overhead can become troublesome. Hardware RAID offers advantages because of its large hardware cache and the capability for better scheduling of operations in parallel. However, software RAID offers more flexibility for disk and disk controller setup. Additionally, hardware RAID requires that a failed RAID controller must be replaced with an identical model to avoid data loss, whereas software RAID imposes no such requirements.

Some software RAID schemes offer data protection through mirroring (copying the data to multiple disks in case one fails) or parity data (checksums that allow error detection and limited rebuilding of data in case of a failure), but all software RAID solutions on HP workstations require the shutdown of the system so that the failed drive can be replaced before redundancy can be restored. The replacement of failed drives in software RAID requires only a minimum amount of work.

Performance and bottlenecks

Disk I/O bandwidth is typically limited by the system bus speeds, the disk controller, and the disks themselves. The balance of these hardware limitations, as affected by the software configuration, determines where the real bottleneck is in the system.

Several RAID levels offer improved performance relative to a stand alone disk. If your disk throughput is throttled by a single disk controller, there is probably little you can do with RAID to improve the performance without adding another controller. On the other hand, if the raw disk performance is the bottleneck, a tuned software RAID solution can dramatically improve the throughput. The slower the
disk is relative to the rest of the system, the better RAID performance will scale, because the slowest piece of the performance pipeline is being directly addressed by moving to RAID.

**RAID levels**

**RAID-linear: Concatenating disks**

RAID-linear is not a true RAID configuration. It is a method of making two smaller disks look like a larger one by appending one to the other. For instance, two 40-GB disks configured with RAID-linear look like one 80-GB disk. RAID-linear offers no practical performance or reliability over standard separate disks. Spare disks are not supported in RAID-linear. If one disk fails, the RAID array fails as well. RAID-linear is not supported by HP Linux workstations.

**RAID-0: Striping**

RAID-0, or striping, spreads data out in small chunks over multiple disks so that a read or write operation can fully utilize all the disk and disk controller bandwidth available by having each disk or disk controller share the load of any particular operation. The drives in the array are treated as one large address space and successive data blocks are typically written to different drives in the array. RAID-0 arrays are comprised of a minimum of two disk drives. To optimize read and write speeds, partitions in RAID-0 arrays should be located on different physical hard disks.

<table>
<thead>
<tr>
<th>Table 11-1  Software RAID-0 efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read performance</td>
</tr>
<tr>
<td>Excellent</td>
</tr>
</tbody>
</table>

Read performance is excellent, scaling toward controller maximum speed as more disks are added. The use of multiple controllers aid in scaling. Write performance is excellent as well, typically scaling even better than read performance. Space efficiency is quite good. There is very little overhead. RAID-0 offers no protection against disk crashes. It is somewhat worse than non-RAID configurations because a single disk crash is guaranteed to affect the data across the array.

**RAID-1: Mirroring**

RAID-1, or mirroring, means that the data is copied or mirrored across multiple physical disks. The data from a single physical disk or partition, when put into a RAID-1 array, are copied transparently to the other disks in the array. This provides increased reliability for data integrity. If one disk fails, the data remains on the other disks.

**Tip:** Although RAID-1, as well as other RAID levels such as RAID-5, provides some data protection, this is only protection against common hardware problems such as failure of a single disk. RAID should not be viewed as a substitute for regular data back ups.

Because it is possible to read from two (or more) disks at once, there is a possible performance increase using RAID-1. Typically performance is sacrificed for recovery of data. Because data is mirrored, only half of the physical space is utilized, and data must be replicated to multiple disks, marginally increasing write times.

<table>
<thead>
<tr>
<th>Table 11-2  Software RAID-1 efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read performance</td>
</tr>
</tbody>
</table>

RAID-0 offers no protection against disk crashes. It is somewhat worse than non-RAID configurations because a single disk crash is guaranteed to affect the data across the array.
There have not been significant gains using software RAID-1. Writes will be fractionally slower than non-RAID configurations because data must be replicated to several disks. Only 50% space efficiency for two-disk RAID-1, because the data is fully replicated on each disk. Reliability is very good; if one disk crashes, the other disks still have a full copy of the data.

RAID-2: Error checking and correction

RAID-2 adds error checking and correcting (ECC) checksums to RAID-1. ECC stands for either Error Correcting Code or Error Checking and Correcting. It is a code in which each data signal conforms to specific rules of construction so that departures from this construction in the received signal can generally be automatically detected and corrected. RAID-2 is rarely seen these days because most hard-disk controllers already do ECC, and this scheme offers few advantages over other RAID configurations. Software RAID-2 is not supported by HP Linux workstations.

RAID 3: Byte-level striping with parity disk

RAID-3 does striping at a very small granularity. It also adds a parity disk which helps in error detection and recovery. Parity for hard disks refers to use of a parity bit, which counts whether the number of 1 bits in some preceding data was even or odd. If a single bit is changed in transmission, the parity bit changes, providing a redundancy check for data transmission. Parity bits are a very simple example of ECCs, or Error Correcting Codes. The small granularity of RAID-3 leads to gains only when record sizes are very small and drive spindles are carefully synchronized. RAID-5 is generally preferred and RAID-3 is very seldom used. Software RAID-3 is not supported by HP Linux workstations.

RAID 4: Block-level striping with parity disk

RAID-4 adds error checking and recovery to RAID-3 by performing block-level striping with the addition of a single parity disk. At least three disks are required for a RAID-4 array. Since all operations access the parity disk, that disk can become a bottleneck. RAID-4 can work in some operations, but RAID-5 is generally preferred where a compromise between speed and reliability is sought. Software RAID-4 is not supported by HP Linux workstations.

RAID 5: Block-level striping with distributed parity

To add error checking and recovery to RAID-0 and to eliminate the parity disk bottleneck of RAID-4, RAID-5 is a combination of data striping and parity. Data and parity blocks are successively written across the drives of the array. RAID-5 ensures data integrity. If a single disk fails, you can recover the data on the lost disk from the parity data on the others. RAID-5 requires a minimum of three disks. The effective disk space availability of n disks in a RAID-5 array is n-1 disks.

Table 11-3  Software RAID-5 efficiency

<table>
<thead>
<tr>
<th>Read performance</th>
<th>Write performance</th>
<th>Space efficiency</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor to moderate</td>
<td>Moderate</td>
<td>66-75% (3 and 4-disk)</td>
<td>Good</td>
</tr>
</tbody>
</table>

For both small and large blocks, RAID-5 performs poorly because parity data is interspersed with real data. The performance of RAID-5 can be dramatically improved by file system tuning. While RAID-5 eliminates the parity-disk bottleneck of RAID-4, block-write performance is still slower than raw disks. RAID-5 efficiency is about the same as RAID-4, where one disk is used to hold parity data, except the parity data is spread across drives rather than concentrated on one drive. Parity data is retained for all data. RAID-5 arrays can tolerate the failure of one disk.
Additional RAID levels

More RAID levels can be created from the basic RAID levels by means of nesting. This is accomplished by creating a second RAID array of other RAID disks instead of creating a RAID of physical disks. Nested RAID levels include:

- RAID-0+1: A mirrored array of striped disks
- RAID-10 (RAID-1+0): A striped array of mirrored disks
- RAID-100 (RAID-10+0): A striped array of RAID-10 arrays
- RAID-5+0
- RAID-0+5

In nested RAID solutions, it is preferable to have a RAID-0 level on top to provide better performance and to reduce the number of disks that need to be regenerated when a disk fails. For example, RAID-10 is usually preferred over RAID-0+1. Nested RAID levels are not supported by the RHEL installer. They must be configured manually.

While the Linux kernel allows for RAID-linear, RAID-0, RAID-1, RAID-4, RAID-5, and nested RAID levels, HP only supports RAID-0, RAID-1, RAID-5, and RAID-10.

RAID configuration strategies

When configuring RAID workstations, you must take several factors into account to deliver optimal performance, capacity, and redundancy. Consider the following items when designing a RAID workstation.

Capacity versus fault-tolerance

With most implementations of RAID, capacity and fault-tolerance are mutually exclusive. Capacity refers to the amount of usable disk space provided by the hard drives used. When a RAID configuration that provides fault tolerance is used, such as RAID-1 or RAID-5, the amount of usable disk space decreases relative to the total capacity of the disks. For example, in RAID-1, the data is mirrored across multiple disks, so only some of the disks are available for use, while the other disks provide redundancy and fault-tolerance and are not available for primary storage use. In general, the more fault-tolerance that is provided with a RAID solution, the smaller the available capacity of the disks will be.

Cost

As the number of physical disks required for an installation increases, the cost also increases. For example, a different RAID controller may be needed if a certain number of disks is being used; many RAID controllers only support up to four disks, so if more than four disks is needed, a higher-capacity RAID controller will be required. Each physical disk has a cost associated with it, so RAID solutions with more disks will tend to have a higher cost. Additionally, in order to deal with the issue of capacity versus fault-tolerance as outlined above, a RAID solution with redundancy may require higher capacity disks to offset this, which might also increase costs.

RAID performance considerations

With many different RAID levels available, it can be difficult to decide which RAID configuration meets your needs. Because high speed and data protection are almost always mutually exclusive in RAID
implementations, there is a trade off between them. The following are examples of different RAID configurations.

- If a file system has an external backup method, such as automated nightly tape backups, but needs to have quick read and write times, a RAID-0 is the best choice. This configuration makes optimal use of the disk and disk controller bandwidth, although it does not provide data protection. RAID-0 is most useful when performance is a key issue, but data protection is not.

- If you need to have backup drives available at all times so that there is no loss of data, even in case of a disk failure, RAID-1 is the best choice. A RAID-1 setup using several physical hard disks provides a good degree of redundancy so that no critical data is lost. This redundancy is most valuable in a system that depends upon data reliability but not higher disk speeds.

- If a compromise between speed and redundancy is required, RAID-5 provides a good balance between disk speeds and parity data availability to rebuild the RAID array in case of failure. RAID-5 is moderately efficient in both areas and is simpler to set up than a nested RAID configuration.

The optimal RAID configuration for a particular system depends on the specific needs of the system. For example, how often will reads or writes need to be performed? How important is the ability to survive in case of multiple disk failures? You might want to experiment with different configurations to determine the RAID setup that works best for your system.

**Configuring Red Hat Enterprise Linux with software RAID**

To configure software RAID on a workstation running Linux, you must use Linux revision 2.4 or later.

**Tip:** You can configure software RAID with late 2.2.x or 2.0.x Linux kernels if you have a matching RAID patch and version .90 of the raidtools installed. The patch and the raidtools can be downloaded from [http://people.redhat.com/mingo](http://people.redhat.com/mingo).

While you can manually configure software RAID after a Linux system has been installed and configured, HP recommends that you configure software RAID at installation. The RHEL installation utility includes a configuration tool to set up software RAID partitions.

**NOTE:** While the Linux kernel allows for RAID-linear, RAID-0, RAID-1, RAID-4, RAID-5, and nested RAID levels, the Anaconda installer only allows for RAID-0, RAID-1, and RAID-5.

To configure software RAID using RHEL media:

1. Power up your HP workstation and boot to your RHEL installation media.
2. Continue the installation until you reach the Disk Partitioning Setup screen.
3. Select **Manually partition with Disk Druid**.

4. Select **New** to create a new partition.

5. From the File System Type list, choose **Software RAID**.

6. Select one physical disk on which to create the partition.

7. Choose the size of the partition.

8. Click **OK**.

9. Repeat steps 4–8 until all necessary software RAID partitions are created.

10. From the Main Partitioning menu, select **RAID**.
11. From the RAID Options screen, select **Create a RAID Device** and click **OK**.

12. Choose a Mount Point, File System Type, Device, and RAID Level for this partition.

13. Click **OK**.

14. Continue the setup.

The RHEL Anaconda installer supports only RAID-0, RAID-1, and RAID-5. Other levels or nested RAID must be configured manually after installation. If you are creating a nested RAID array, you can configure the “bottom” RAID level (for example, the RAID-1 array in the case of nested RAID-10) in Anaconda and the “top” RAID level manually later. You can also configure both parts of the nested RAID level manually after installation.
Tip: The GRUB and LILO boot loaders support booting to RAID-1, or booting to no RAID at all. If you want to use a RAID level other than RAID-1, you must put the /boot partition on a non-RAID part of the file system.

Manual setup of software RAID data partitions

To manually set up a software RAID partition on multiple disks after installation:

1. Create partitions for the RAID array on two or more disks. These partitions will correspond to Linux block file devices. For example, the second partition on the third SCSI disk will be /dev/sdc2, the first partition on the second IDE disk will be /dev/hdb1, etc.

   NOTE: You can use Disk Druid, fdisk, sfdisk, or any other partitioning tools to do this. It is better if the partitions are of the same size and on the same type of disk. The type of the partitions will be “Linux raid auto,” or 0xfd. A reboot might be required after writing the new partition table.

   Tip: If you are setting up a RAID-1 array, use the same partition number on each disk for elements in the array. When one disk fails, if it is not the last disk in the array, the other disk will be renamed on restart. For example, if sdb fails but sdc is still functional, when your system is restarted, the old sdc is renamed sdb. If you use a consistent partition number, your configuration files will remain valid (such as sdb1 and sdc1 being RAID partitions), no matter how the devices are renamed.

2. Create the /etc/raidtab file. Sample configuration files can usually be found in /usr/share/doc/raidtools-*.

   Tip: You can view the file named /proc/mdstat by running the command cat /proc/mdstat. This file tells you that you have the right RAID mode registered, as well as which RAID devices are active.

3. Use the mkraid command to create the initial RAID configuration on the partitions you previously specified in /etc/raidtab. Enter mkraid /dev/md0.

   If you are using mdadm, enter mdadm --create --verbose /dev/md0 --level=raidlevel --raid-devices=n /dev/sda1 /dev/sdb2, and press Enter.

   NOTE: /dev/md0 is the name of the RAID device, raidlevel is the RAID level specified as a number (such as 0, 1), n is the number of disks in the RAID array, and /dev/sda1, /dev/sdb2 are the names of the drives in the RAID array.

4. Create a file system on your RAID device. Enter mkfs -t ext3 /dev/md0.

5. Mount the file system like a normal block file device:

   a. Enter mkdir /raid.

   b. Enter mount /dev/md0 /raid.

      where /raid is where the file system you created resides.

6. Edit your /etc/fstab file. You will need to comment out the lines containing the partitions that are now in the RAID array, such as /dev/sda1 and /dev/sdb2, by adding a # at the beginning of the line. Add a line for the RAID array file system: /dev/md0 /raid ext3 defaults 0 1

Manual configuration examples

Most of the work in manual configuration of a software RAID array comes from the creation of the appropriate /etc/raidtab file. The following are examples of /etc/raidtab files and the corresponding mdadm commands needed to set up each of the basic RAID configurations supported by HP.
RAID-0

/etc/raidtab file:
raiddev /dev/md0
  raid-level 0
  nr-raid-disks 2
  nr-spare-disks 0
  persistent-superblock 1
  chunk-size 4
  device /dev/hda1
  raid-disk 0
  device /dev/hdb1
  raid-disk 1

Command: mdadm -Cv /dev/md0 --level=0 --raid-devices=2 /dev/hda1 /dev/hdb1

RAID-1

/etc/raidtab file:
raiddev /dev/md0
  raid-level 1
  nr-raid-disks 2
  nr-spare-disks 0
  persistent-superblock 1
  chunk-size 4
  device /dev/sda1
  raid-disk 0
  device /dev/sdb1
  raid-disk 1

Command: mdadm -Cv /dev/md0 --level=1 --raid-devices=2 /dev/sda1 /dev/sdb1

RAID-5

/etc/raidtab file:
raiddev /dev/md0
  raid-level 5
  nr-raid-disks 4
  nr-spare-disks 0
  persistent-superblock 1
  chunk-size 4
  device /dev/hda1
  raid-disk 0
  device /dev/hdb1
  raid-disk 1
  device /dev/hdc1
  raid-disk 2
  device /dev/hdd1
  raid-disk 3

Command: mdadm -Cv /dev/md0 --level=5 --raid-devices=4 /dev/hda1 /dev/hdb1 /dev/hdc1 /dev/hdd1
RAID-10

/etc/raidtab file:
raiddev /dev/md0
  raid-level 0
  nr-raid-disks 2
  nr-spare-disks 0
  chunk-size 4
  device /dev/sda1
  raid-disk 0
  device /dev/sdb1
  raid-disk 1
raiddev /dev/md1
  raid-level 0
  nr-raid-disks 2
  nr-spare-disks 0
  chunk-size 4
  device /dev/sdc1
  raid-disk 0
  device /dev/sdd1
  raid-disk 1
raiddev /dev/md2
  raid-level 1
  nr-raid-disks 2
  nr-spare-disks 0
  chunk-size 4
  device /dev/md0
  raid-disk 0
  device /dev/md1
  raid-disk 1

Commands:
- mdadm -Cv /dev/md0 --level=0 --raid-devices=2 /dev/sda1 /dev/sdb1
- mdadm -Cv /dev/md1 --level=0 --raid-devices=2 /dev/sdc1 /dev/sdd1
- mdadm -Cv /dev/md2 --level=1 --raid-devices=2 /dev/md0 /dev/md1

NOTE: In a RAID-10 configuration, you need to add three lines to the /etc/fstab file, one for each RAID array. You do not need to specify a mount point for /dev/md0 or /dev/md1. If no mount point is specified, you see error messages during startup, but the RAID-10 array still initializes and mounts correctly.

NOTE: These configuration files are meant as examples. Your /etc/raidtab file will differ based on your specific hard drive configuration.

Disk failure and recovery

Spare disks and disk failure

Spare disks do not take part in the RAID configuration until one of the active disks fails. The failed device is marked as bad and reconstruction of the RAID array begins immediately on the first available spare disk.

CAUTION: If multiple bad blocks have built up on the active disks over time, the reconstruction process can sometimes trigger the failure of one of the good disks, leading to failure of the entire array. However, performing regular file system checks (fsck) of the entire RAID file system should almost completely eliminate this risk.

Spare disks are not required for a RAID configuration. While most RAID levels can handle the failure of one physical disk, the failure of another disk causes the entire array to fail. Start rebuilding the array as
quickly as possible after a disk failure. When a disk fails, the crashed disk is marked as faulty. Faulty
disks still look and behave as members of the RAID array; they are simply treated as inactive parts of
the file system.

When a disk fails, information regarding the failure appears in the standard log and stat files. /proc/
mdstat displays information regarding the drives in the RAID array. RAID role numbers show the role
that the disks play in the RAID configuration. For an array with n disks, disks with RAID role numbers
greater than or equal to n are designated spare disks. A failed disk is marked with an “F” and is replaced
with the device with the lowest role number greater than n that has not failed.

To remove and replace a failed disk:

1. To remove the failed disk from the RAID array, enter `raidhotremove /dev/md0 /dev/sdc2` (where /
dev/sdc2 is the name of the failed drive).

   If you want to use mdadm instead of raidtools, enter `mdadm /dev/md0 -r /dev/sdc2`.

   **NOTE:** raidhotremove can not be used to pull a disk out of a running array. It should only be used
for removing failed disks. After recovery ends, a new disk should be designated as /dev/sdc2 (or
as whichever disk failed).

2. To add this new disk to the array, enter `raidhotadd /dev/md1 /dev/sdc2`.

   To optionally use mdadm, enter `mdadm /dev/md1 -a /dev/sdc2` instead.

   **Tip:** You can use mdadm as a daemon to monitor a RAID array. To do this, enter `mdadm --monitor --
mail=root@localhost --delay=1800 /dev/md0`.

   This polls the array in intervals of 1800 seconds. Critical events and failures are emailed to the system
administrator. There are many other monitoring systems available for Linux software RAID as well.

**Multiple disk failure**

In the case of a temporary failure of multiple disks. The RAID superblocks are out of sync and the RAID
array can no longer be initialized. You can use mdadm to try and recreate the array. Enter `mdadm --
assemble --force`.

If this fails, you can use mkraid to rewrite the RAID superblocks by entering `mkraid --force`.

**CAUTION:** Ensure that you always have a complete and up-to-date /etc/raidtab file. Otherwise, data
on all disks might be lost.

**Additional configuration information**

**Persistent superblock**

Previously, the raidtools, which are included with most major Linux distributions, read your /etc/raidtab
file and initialized the file system. This required that the file system on which /etc/raidtab resided was
mounted. Consequently, you could not boot to a RAID.

The persistent superblock solves problems. When an array is initialized with the persistent-superblock
option in the /etc/raidtab file, a special superblock is written to the beginning of all disks participating in
the array. This superblock enables the kernel to read the configuration of RAID devices directly from
the disks involved, instead of reading from the /etc/raidtab configuration file that might not be available
at all times. You must maintain a consistent /etc/raidtab file, because you might need this file for later
reconstruction of the array.

The persistent superblock is mandatory if you want auto-detection of your RAID devices upon system
boot.
**Chunk sizes**

The chunk size is defined as the smallest amount of data that can be written to a device. You can never write completely in parallel to a set of disks. If you have two disks and want to write a byte, you must write four bits on each disk, with every second bit going to disk 0 and the others to disk 1. Hardware does not support that, so chunk size is used instead. A write of 16 KB with a chunk size of 4 KB will cause the first and the third 4 KB chunks to be written to the first disk, and the second and fourth chunks to be written to the second disk. For large writes, you can see lower overhead by having fairly large chunks, whereas arrays that are primarily holding small files can benefit more from a smaller chunk size.

Chunk sizes must be specified for all RAID levels, including linear mode. The argument to the chunk-size option in the `/etc/raidtab` file specifies the chunk size in KB, so “4” means 4 KB.

For optimal performance, experiment with the value, as well as with the block size of the file system you put in the array.

**Swap space in RAID configuration**

You do not need to use RAID for swap performance. The kernel can stripe the swap space over multiple physical disks, provided each stripe is given the same priority in the `/etc/fstab` file. For example, the `/etc/fstab` file for striping the swap space over three drives might look like the following:

```
/dev/sda2 swap swap defaults,pri=1 0 0
/dev/sdb2 swap swap defaults,pri=1 0 0
/dev/sdc2 swap swap defaults,pri=1 0 0
```

This striping enables the machine to swap in parallel over multiple physical devices. The Linux kernel has this capability. There is no need for RAID implementation of swap space.

**Boot partitions in a mirrored RAID configuration**

The mirroring for Linux in software RAID configuration is the mirroring of partitions, not of physical drives. For this reason, the Master Boot Record (MBR) is not mirrored in a RAID-1 configuration, and therefore, the mirrored drive or drives are not inherently bootable. You cannot mirror the boot partition of a hard drive using utilities such as Disk Druid, so the mirrored drives must be configured manually to make them bootable by Linux in case the first drive fails.

One possible configuration for a software RAID-1 array in Linux is to install the `/boot` partition on a separate physical hard disk from the rest of the file system. For example, `/dev/sda1` would be a hard disk containing the `/boot` partition, and `/dev/sdb1` and `/dev/sdc1` would be separate physical disks making up the `/` partition, configured in a RAID-1 array that is independent of the `/boot` partition. In this case, failure of one of the hard disks in the RAID array does not affect the disk with the `/boot` partition.

If placing the `/` and `/boot` partitions on separate physical drives as described above is not possible or desirable, manual configuration is required to ensure that all hard drives in a RAID-1 array are bootable in case of failure. In this case, you will need to create a bootable partition on each physical hard disk that will be part of the RAID-1 array.

To manually mirror your boot partition:

1. Power up your HP workstation and boot to your RHEL installation media.
2. Continue the installation until you reach the Disk Partitioning Setup screen.
3. Select Manually partition with Disk Druid.

Figure 11-1  Disk partitioning setup

4. On each disk that will be in the RAID-1 array, create a partition that will be bootable. One drive must have the /boot partition; all other drives must have a partition of the same size of format ext3.

Tip: Use the same partition number for each bootable partition. For example, if your primary /boot partition resides on /dev/sda1, you should create a partition called /boot1, located on /dev/sdb1, and so on for each hard disk.

5. Create a bootable partition on each disk that will be in the RAID-1 array.

6. Create a RAID device by selecting the RAID option in the main partitioning menu, then selecting Create a RAID Device from the RAID Options screen. Configure as desired.
7. Continue the setup.

At this point, finish with the initial installation and configuration of your workstation. Now you have a partition that will be made bootable on each hard disk in the RAID array. You can verify your current disk setup by running the df command in a terminal window.

Now you can mirror the original /boot partition to the partitions you created on the other drives.

8. For each other bootable partition, copy the contents of the /boot partition to the new partition. Enter `cp -a /boot/* /boot1/` (if your other bootable partition is named /boot1).

9. Repeat step 8 for each bootable partition until each hard drive in the RAID array has been configured.

10. Edit the /etc/fstab file to allow the system to boot without the original /boot partition. Comment out the line with the /boot partition by inserting a # at the beginning of that line in the file. The workstation can now boot to any other drive in the RAID array if the first disk fails.

Tip: While you do not need to have /boot mounted for the system to boot normally, you need to mount it if you are running a kernel update. After the update is complete, repeat these steps to mirror the new /boot partition to the bootable partitions on the other drives. After this is done, the /boot partition can safely be removed from the /etc/fstab file again.

Software RAID and LVM

Software RAID can be used with the Linux or Logical Volume Manager (LVM) to provide a greater degree of flexibility with regard to the setup of the file system. The LVM provides a level of abstraction of the physical disks in a file system, making it easy to manage. It works by grouping physical disks into a volume group, which can then be partitioned into logical volumes. These logical volumes behave much like ordinary disk block devices, except that logical volumes can be dynamically grown, shrunk, or moved without rebooting the system or entering into maintenance/standalone mode. In general, it adds a layer of abstraction between file system mount points (such as / or /usr) and hard disk devices such as /dev/hda1 or /dev/sdb2.

The benefit of using LVM is the flexibility of being able to add or remove physical hard drives or move data between existing drives without disrupting the file system or users. LVM cannot be used to dynamically resize RAID devices, nor can physical drives be simply added and removed from a RAID array as they can while using LVM without RAID. To implement software RAID with LVM:

1. Set up RAID partitions using Disk Druid, fdisk, or a partition manager.

2. Create the RAID array during installation using the Anaconda installer, or manually after installation.

   Tip: Any supported RAID level can be used with LVM because neither software RAID nor LVM knows about the other.

3. Use LVM to create a physical volume on the RAID device. For example, if the RAID array is /dev/md0, enter `pvcreate /dev/md0`.

4. Create a volume group from the physical volume. For example, enter `vgcreate lvm-raid /dev/md0`. In this case, a volume group called lvm-raid is created from the device /dev/md0.

5. Logical volumes can now be created. Enter `lvcreate -l 57235 lvm-raid -n lvm0`.

   This creates a logical volume called lvm0 of size 57235 from the lvm-raid volume group. As many partitions as necessary can be created in this way. The lvdisplay command can be used to verify the status of logical volumes; the vgdisplay command provides status about the volume group as a whole. The available space can be seen using the vgdisplay command.

Continue the setup of the file system.
Additional information

Visit the following web sites for more information:

12 Installing and Configuring SAS Hardware RAID on HP Linux Workstations

Introduction

This chapter provides an overview of hardware RAID solutions for HP workstations running the Linux operating system. It assumes a basic understanding of computer hardware, filesystems, and the Linux operating system. It covers an overview of hardware RAID solutions, the differences between software and hardware RAID offerings, and information regarding the configuration of hardware RAID on HP Linux workstations.

There are different levels of hardware RAID available; not all of them are supported options for HP Linux workstations.

- Hardware-assisted RAID is a step up from software RAID, but is not considered true hardware RAID. Hardware-assisted SAS RAID uses the LSI megaraid driver already present in the Linux kernel. It is provided by the LSI 3041E plug-in card on the HP xw4000 and xw6000 Workstation series and by the LSI 1064 and 1068 controllers on the motherboard on the HP xw8000 and xw9000 Workstation series.

- True hardware RAID, also known as raid-on-chip, or ROC, makes use of a dedicated RAID processor. It is provided by the LSI 8344ELP and 8888ELP plug-in cards on the HP xw8000 and xw9000 family platforms. SAS drives are the only drives supported for use with RAID on HP Linux workstations.

- Hardware-assisted SATA RAID requires use of the dmraid interface, and is not supported on HP Linux workstations.

Supported Configurations

Hardware RAID for HP Linux workstations is currently supported for user-configured RAID solutions for the HP workstations below. Not all configurations that are made available by the RAID chipsets or plug-in cards are supported by HP; only the configurations listed below are supported on HP Linux workstations.

<table>
<thead>
<tr>
<th>RAID Type</th>
<th>xw4000</th>
<th>xw6400</th>
<th>xw8400</th>
<th>xw9400</th>
<th>xw4600</th>
<th>xw6600</th>
<th>xw8600</th>
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<td>LSI 3041E</td>
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<tr>
<td>RAID 1</td>
<td>2 drives</td>
<td>2 drives</td>
<td>2 drives</td>
<td>2 drives</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LSI 8344ELP</td>
<td></td>
<td></td>
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<td>2-4 drives</td>
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<tr>
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<td></td>
<td></td>
<td></td>
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<td>2 drives</td>
<td></td>
</tr>
<tr>
<td>RAID Level</td>
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<td>LSI 1068</td>
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<td></td>
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</tr>
<tr>
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<td>3-6 drives*</td>
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<td>2-6 drives*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* HP xw8600 Workstation can accommodate 6 internal 2.5" drives

Not all possible hardware RAID configurations are supported on HP Linux workstations.

- Only SAS drives are supported with hardware-assisted and full hardware RAID.
- SATA and PATA drives are not supported with hardware RAID, but can be used with software RAID solutions.
- Supported operating systems are:
  - Red Hat Enterprise Linux 4.5 and later
  - Red Hat Enterprise Linux 5.0 and later
  - SUSE Linux Enterprise Server 9 SP4 and later
  - SUSE Linux Enterprise Server 10 SP1 and later
  - SUSE Linux Enterprise Desktop 10 SP1 and later
- Support for Red Hat Enterprise Linux (RHEL) operating systems will be provided by HP. Support for SLE operating systems will be provided by Novell.
- The Linux Hardware Matrix contains information on all current platforms and is a good place to learn which RAID controllers are supported on a given platform.

### LSI 3041E and Integrated LSI 1064/1068 Setup

The LSI 3041E is a 4-port SATA/SAS RAID controller providing SAS support for the HP xw4000 and xw6000 Workstation series. Note that while the controller provides functionality for SATA RAID, SATA RAID is not supported on HP Linux workstations. The HP xw8000 and xw9000 Workstation series use an onboard LSI 1064 or 1068 SAS controller, which uses the same BIOS configuration utility as the LSI 3041E plug-in card. The following steps can be used as a guide for setting up the LSI 3041E or the onboard LSI controllers for SAS RAID; details will vary based on the specific configuration (RAID level, number of disks) used.

**Step 1:** Boot the workstation, and when prompted, press any key to view option ROM messages. A message indicating the presence of the LSI onboard controller or plug-in card and the LSI Logic MPT SAS BIOS will appear.
Step 2: Press CTRL-C when indicated to begin RAID configuration and enter the LSI Logic MPT Setup Utility. The first screen will display a list of available adapters. The LSI 3041E plug-in card appears on this list as the SAS1064E, the LSI onboard controllers are listed as the LSI1064 or LSI1068. This screen can be used to change the boot order of the adapters.

Figure 12-2  LSI Logic MPT Setup Utility – Adapter selection

Step 3: Press enter to select and configure the highlighted adapter from the list. The next screen will display properties of the selected adapter. Information on the attached drives, any RAID arrays present, and more advanced adapter properties is available.
Step 4: To create, manage or delete a SAS RAID array, highlight RAID Properties and press enter. If an array is presently configured on the controller, the “View Existing Array” will be present.

Step 5: To create a new array, select one of the options to create either an IM, IME, or IS volume and press enter. IM, or Integrated Mirroring, is also known as RAID-1. IME, or Integrated Mirroring Enhanced, is RAID-10. IS, or Integrated Striping, is RAID-0. The next screen will list the disks. For each disk to be part of the array, move to the column labeled “RAID Disk” and press the space bar to add the disk to the array. The next column, “Hot Spr,” can be used to mark disks to be hot spares in case of disk failure. When the disks have been marked as desired, press C to create the array.
Step 6: After an array has been created, the utility gives options for managing it through the “View Existing Array” menu. Viewing the array will display various properties of the RAID array, including the disks present and their status.

Step 7: Select the “Manage Array” option and press enter to use the utility’s management features. From here, the disks that are configured to be hot spares can be managed, the array can be activated, deactivated, or deleted, and if the array is not at an “Optimal” status due to a disk failure or other problem, it can be synchronized from this menu.
LSI 8344ELP and LSI 8888ELP Setup

The LSI 8344ELP and LSI 8888ELP are 8-port SATA/SAS RAID controllers providing additional SAS support for the HP xw8000 and xw9000 family platforms. Note that while the controller provides functionality for SATA RAID, SATA RAID is not supported on HP Linux workstations. The HP xw8000 and xw9000 family platforms also have onboard SAS RAID capabilities that can be described best as hardware-assisted RAID; the 8344ELP and 8888ELP plug-in cards are considered to be full hardware RAID. The following steps can be used as a guide for setting up the LSI 8344ELP or the LSI 8888ELP for SAS RAID; details will vary based on the specific configuration used.
Step 1: Boot the workstation, and when prompted, press CTRL-H to enter LSI’s WebBIOS utility. WebBIOS will be run after POST completes. Select your adapter from the Adapter Selection screen and press start to enter the utility.

Figure 12-8  LSI WebBIOS – Adapter selection

Step 2: The main WebBIOS screen can be used to configure the adapter, the physical disks, and the virtual disks or RAID arrays. The first view shows the physical disks connected to the adapter, any RAID arrays presently configured, as well as the status of both physical and virtual disks.

Figure 12-9  LSI WebBIOS – Main screen
Step 3: The Configuration Wizard can be used to create a new RAID array on the device. From the MegaRAID Configuration Wizard screen, there are options available to clear any existing device configuration, add new drives to an existing configuration, or create a new configuration from scratch. Clicking on either “New Configuration” or “Add Configuration” proceeds to the next step of the wizard, where there are options for either custom or automatic configurations.

Figure 12-10  LSI WebBIOS – Configuration wizard

Step 4: Automatic configurations will automatically add all available disks to a RAID array, with the RAID level determined by whether or not redundancy is selected. Custom configuration allows the user to select disks, array size, and RAID level. The next screen allows for the selection of the disks which will be part of the RAID array. Select from the available disks those disks that will be part of the RAID array and click “Accept DG” to proceed.
Step 5: The next screen allows for more advanced configuration of the RAID array. Many details about the disk policies can be selected here. The most important options on this screen are the RAID level and size. First select the RAID level from the drop-down menu - the RAID levels available will vary depending on the number of physical disks in the disk group. The configuration window to the right of the screen will display information on the maximum size of the RAID array for the different available RAID levels. In the text box labeled “Select Size,” enter a size in MB up to this available maximum size. When these options have been selected, further customization can be done, or click “Accept” or “Next” to move to the next step of configuration.

Figure 12-12 LSI WebBIOS – Virtual disk configuration
Step 6: The next screen will display the physical disks on the left and the proposed virtual disk (RAID array) on the right as a preview of the proposed disk configuration. If changes are needed, press “Back” to go back and change details of the configuration, or press “Accept” to accept the configuration. On the next screen, press “Yes” to save the configuration, then press “Yes” to initialize the new RAID array. If a disk in the RAID array fails or needs to be replaced for any reason, the WebBIOS utility can be used to easily rebuild the RAID array. If a disk failure occurs, the change to the RAID array will be indicated by a message on the screen before entering the utility.

Figure 12-13 Foreign configuration on LSI adapter

Step 7: Press C or CTRL-H when indicated to enter the utility. When the home screen appears, the new disk will be marked as “Unconfigured bad” and the missing disk will be labeled in red. Click on the new unconfigured disk in order to configure it and add it to the RAID array.
Step 8: From the next screen, select the option to make the disk “Unconfigured good” so it can be made to be part of a disk group and click “Go.” The next screen will display the configured disk groups. The group from which the original disk was missing will be indicated. Select the location of the disk from the row labeled “DG Missing Row,” where the listed options will be the locations where a disk was missing from the RAID array. The radio button marked “Replace Missing PD” will be checked. Click “Go” to complete the operation.

Figure 12-15 LSI WebBIOS – Replacing a physical disk

Step 9: After the disk has been replaced, it will start with an offline status. Select the option marked “Make Online” to bring the physical disk online and finish rebuilding the RAID array.
At any point during RAID configuration or management, the home button will return to the main screen of the configuration utility, and the exit button will cancel any unsaved changes and exit the application.

Additional RAID Information

OS Installation

The above steps document the process for setting up a hardware RAID array using the tools provided by the hardware RAID adapter. After this setup process is complete, an operating system can be installed. If the user does not wish to have the RAID array be bootable, a separate SATA or SAS boot disk can be used, and the RAID array can be a separate disk group for data storage only. During operating system installation, the configured RAID array will be recognized as a logical disk group, and can be set up and partitioned as desired.

Other Workstation Platforms

The above information applies only to the desktop workstation platforms discussed herein. Hardware RAID support is not available on the HP xw4550, since only SAS RAID is supported on HP Linux workstations. The xw4550 only supports SATA drives, and SATA RAID support is not available. The HP xw460c blade workstation supports hardware RAID levels 0 or 1 using the SAS drives that are available for use on that platform.
13 Advanced graphics: Multi-user support for the HP Workstations

Introduction

Adding multiple users on a single workstation with attached keyboards is made possible on Linux by changes to the X11R6.9 changes (also on the X11R7 version). This version of X windows comes with Red Hat Enterprise Linux 5 (RHEL 5) and Fedora Core 5 (FC5) and SUSE Linux Enterprise Desktop 10 (SLED 10). A driver called “evdev” enables input from all USB devices on the system without collision of the different X servers that are running on a system. X 6.9 also prevents graphics cards from interfering with each other.

The HP xw4600, xw6600, xw8600, and xw9400 Workstations have dual PCI Express x16 graphics slots. This capability, couple with one or two multi-core Intel or AMD Opteron processors, provides an unprecedented amount of graphics processing power for a Linux workstation. Support of multiple users with this workstation is viable given this much speed.

This chapter discusses how to set up such a system.

Setup

Workstation hardware should be ordered as a unit to contain the desired processors, graphics cards, displays, and memory. Extra keyboards and mice must be ordered separately. To set up the workstation:

1. Plug in the keyboards and mice as desired.
2. Reboot the workstation so the kernel will recognize the input devices.
3. Choose an initial configuration that requires few changes.
   
   **NOTE:** Future changes to the USB ports used for different keyboards and mice will require changes to the xorg.conf configuration file.

4. Determine what the real input devices are. Look in /proc/bus/input/devices file to see all the active hardware.
   
   **NOTE:** The filename for the device files in /dev/input/ for the corresponding device (eventX for keyboards and mouseX for mice) are located by the Handlers line for each device.

5. Ensure you have the correct device file for each device. Wiggle each mouse and type on each keyboard until the od command returns data. This data will indicate what device actually responds.

6. Exit the command and repeat this process for the next device file:

   - `od < /dev/input/event0` (should give you data when you type on the PS2 keyboard)
   - `od < /dev/input/event1` (should give you input when you wiggle the PS2 mouse)
   - `od < /dev/input/event2.....`
**Xorg.conf config file details**

When you have all the devices and their device files identified, edit the /etc/X11/xorg.conf file. Start with a multi-display configuration using both graphics cards and edit the xorg.conf file for that config. Multi-display configurations can be set up easily and interactively using the HP graphics configuration tool, vizconfig. Use vizconfig to configure the number of monitors that you plan to use.

To use vizconfig:

1. Log in as root.
2. Launch vizconfig using desktop icon or by executing /opt/hp/viztools/bin/run_vizconfig.
3. Select display arrangement (such as 3x1 or 2x2) from the Selected Display Arrangement list.
4. When a display arrangement is selected, you can select different options under the Options tab:
   - SLI Multiview (Xinerama) — enables/disables 2d/3d Xinerama
   - Use twinview where possible — enables/disables twinview
5. Set up the different monitors. The different monitors are shown in the picture of the currently selected display arrangement along with how the graphics cards are connected to those displays.
6. Select the display using the Selected Display list. The picture of the display arrangement updates to highlight the selected display.
7. Set the resolution for this display with the Display Resolution slider.
8. (Optional) If you want the display to be connected to the other connector on the graphics card, select **Swap Left_Right Monitors**. The picture of the display arrangement is modified to reflect this change.
9. Repeat steps 6 – 8 as needed for each display.
10. Select **SaveConfig** to save the changes to the /etc/X11/xorg.conf file.

**NOTE:** Any edits made to the Xconfig file after running vizconfig will not be used by vizconfig the next time it is run. You must apply these edits each time vizconfig is run.

When you have a working multi-display /etc/X11/xorg.conf file, you must edit it to activate multi-seat. First add device sections for the keyboards and mice. To configure these input devices on release 6.9 or later versions of the Xorg X server for each keyboard, construct an InputDevice section for your /etc/X11/xorg.conf:

```plaintext
Section "InputDevice"
  Identifier "KeyboardN"
  Driver "evdev"
  Option "Device" "/dev/input/eventX"
EndSection
```

N is the sequential keyboard number, and X is the event handler identified during setup.

Here is the xorg.conf section that describes the PS2 Console Keyboard:
Section "InputDevice"
  Identifier "Keyboard0"
  Driver "evdev"
  Option "Device" "/dev/input/event0"
  Option "AutoRepeat" "250 30"
  Option "XkbRules" "xfree86"
  Option "XkbModel" "pc105"
  Option "XkbLayout" "us"
EndSection

Here is the first USB keyboard found through the discovery process identified in setup:

Section "InputDevice"
  Identifier "Keyboard1"
  Driver "evdev"
  Option "Device" "/dev/input/event4"
EndSection

For each USB mouse, construct an InputDevice section for the xorg.conf file:

Section "InputDevice"
  Identifier "MouseN"
  Driver "evdev"
  Option "Device" "/dev/input/eventX"
EndSection

N is the sequential mouse number, and X is the event handler identified during setup.

Use Mouse0 for the PS2 mouse.

Here is the PS2 mouse section:

Section "InputDevice"
  Identifier "Mouse0"
  Driver "mouse"
  Option "Protocol" "IMPS/2"
  Option "Device" "/dev/input/mouse0"
  Option "Emulate3Buttons" "off"
  Option "ZAxisMapping" "4 5"
EndSection

Here is the first USB mouse section found through the discovery process:

Section "InputDevice"
  Identifier "Mouse2"
  Driver "evdev"
  Option "ZAxisMapping" "4 5"
  Option "Device" "/dev/input/event3"
EndSection

Next, create a ServerLayout section for your xorg.conf file for each seat. The following server layouts were derived from the server layout created by vizconfig:
Section "ServerLayout"
  Identifier "Seat0"
  Screen 0 "Screen Primary"
  Option "IsolateDevice" "True"
  InputDevice "Mouse0" "CorePointer"
  InputDevice "Keyboard0" "CoreKeyboard"
EndSection

Section "ServerLayout"
  Identifier "Seat1"
  Screen 0 "Screen Secondary"
  Option "IsolateDevice" "True"
  InputDevice "Mouse1" "CorePointer"
  InputDevice "Keyboard1" "CoreKeyboard"
EndSection

In future releases of the HP Installer Kit for Linux, example xorg.conf files will be /opt/hp/viztools/configfiles.

Starting two X servers

Once you have an xorg.conf file that contains all the components, start two X servers at the same time using that config file:

1. Start two X servers at the same time using that config file.

2. Start a single X server on the first layout. Enter `startx -- :0 -novtswitch -layout Seat0`.
   
   **NOTE:** The first layout is the default and so is :0.

3. Once the first X server is working well, start the second X server. Enter `startx -- :1 -novtswitch -sharevts -layout Seat1`.

Now, two X servers are running without signal collision. The options passed into the X server and the IsolatedDevice option in the config file prevent the X servers from interfering each other's screens.

**NOTE:** All startx parameters after the double-dash (--) go directly to the X server.

You can access this system remotely using ssh and performing "killall X" to kill an X server.

Create a separate login screen on each X server/seat using the /etc/X11/gdm/gdm.conf file. Add the following lines to the X server part of the gdm.conf file, one for each seat:

```
0=Standard
1=Standard1
```

Add these sections in the gdm.conf file:

```
[server-Standard]
name=Standard server
command=/usr/X11R6/bin/X -novtswitch
flexible=false

[server-Standard1]
name=Standard server
command=/usr/X11R6/bin/X1 -novtswitch -sharevts -layout Layout1
flexible=false
```
Rerestart the gdm and have login screens at each seat.

Additional information

See the documentation files in /opt/hp/graphics/nvidia or the example config files in /opt/hp/viztools/configfiles for details. If you want to set up a config that is different than the example config files demonstrate, use vizconfig to create a config file and modify it to get the additional features that you need.
14 Advanced graphics: Immersive visualization for the HP Workstations

Introduction

The HP xw9300 and xw9400 Workstations coupled with two NVIDIA high-end graphics cards are great solutions for a reasonably priced, fully-capable Linux visualization center or advanced visualization Linux workstation. This chapter discusses how to set up a visualization center driving projection systems, power walls, or stations with large-screen display monitors. A smaller-scale Visualization Station setup can be used to drive stereo monitors or large pixel-format digital flat panels for smaller, less expensive environments. This chapter also discusses some key applications and benefits of these immersive visualization environments. The HP xw9300/xw9400 Workstation visualization centers and stations are a low-cost alternative to high-end SGI visualization centers.

Overview

The HP xw9300 and xw9400 Workstations have dual PCI Express x16 graphics slots. This capability, coupled with the two Dual-Core AMD Opteron processors, provides an unprecedented amount of graphics processing power for a Linux workstation. Two NVIDIA high-end graphics cards such as the FX4500 optionally enhanced with NVIDIA Gsync cards for stereo synchronization enable you to share your immersive graphics experience with a group of people.

This chapter discusses the mechanics of how to set up such a system. This chapter focuses on how to integrate the HP xw9300 and xw9400 Workstations into the visualization solution alternatives. Some alternatives are used as examples.

New projector technologies such as the Sony SXRD 4000 system simplify the maintenance and the vizcenter setup because they do not require projector overlap, and calibration is simpler. X window setup becomes much more like a Visualization workstations.

Visualization Station setup

A Visualization Station with three to four high-end HP 30-inch monitors can provide an immersive experience for power-user or group review settings. Smaller monitors such as the HP 24-inch flat panel
display can also be used to drive down cost and provide a visually compelling immersive environment. The following figure illustrates a setup with a single 30-inch and two 23-inch displays.

**Figure 14-1** Virtualization station

---

**Suggested hardware requirements**

The following are suggested hardware requirements.

- HP Workstation with dual PCI-E x16 slots.
- One of the following graphics card options:
  - Dual NVIDIA FX45xx or FX55xx graphics cards (other graphics cards can be used if 30-inch displays are not used)
  - Dual NVIDIA Quadroplex processors to support more displays or a single card per display
- If stereo is required:
  - StereoGraphics CrystalEyes stereo glasses
  - StereoGraphics stereo emitters
  - NVIDIA Gsync card for graphics card synchronization
  - High-refresh monitors
- If stereo is not required:
  - Three or four HP LP2465 DFP Displays (24-inch, 1920x1200)
  - Three or four HP LP3065 DFP Displays (30-inch, 2560x1600)

**Setting up the hardware**

The workstation hardware must be ordered as a unit to include the desired processors, graphics cards, monitors, and memory. Monitors can be arranged as three or four in a row (horizontally), or in a 2x2 matrix.

If using large-screen LCD displays instead of monitors, you cannot use active stereo. There is no need for overlap for the visualization station as with the vizcenter projectors, although you might want to have gaps behind the monitor bezels instead of projector overlap. Unless you have some different requirements, use the vizconfig setup tool to set up the X window system of the visualization workstation. (See [Setting up the X window system on page 93](#).)
**NVIDIA Gsync card**

If stereo is required, add the Gsync card:

1. Open the chassis of the workstation.
2. Insert the Gsync card in the PCI-X slot next to the bottom graphics card.

*NOTE:* The spacing on the Gsync card is slightly different for PCI-X slots, so apply light pressure to the back of the workstation near the card slot as you push the card into the slot.

As of NVIDIA release 8756 or later, a single Gsync card synchronizes both graphics cards. The two ribbon cables included with the Gsync card should be connected to the two graphics cards as indicated in the figure below. The connectors for the primary graphics card and the secondary graphics cards are labeled on the Gsync card. External connectors are not needed for this configuration. The external connectors are used when connecting to other graphics cards and to an external sync signal. The StereoGraphics glasses can be plugged into the three-pin DIN connector on the top (primary) graphics card.

![Figure 14-2 NVIDIA Gsync card](image)

**Setting up the X window system**

Simple visualization station configurations can be set up easily and interactively using the HP graphics configuration tool, vizconfig. Vizconfig sets up the xorg.conf file or XF86Config file for you. You might need to adjust the video cables to get the cables ordered correctly or make minor edits to the xorg.conf file for a specific feature. Vizconfig sets up several common multi-display configurations, including 3-in-a-row, 4-in-a-row, 2x2, and 3-in-a-row with one display above the center display. In a horizontal arrangement, the two displays on the left must be attached to the top graphics card. In a 2x2 arrangement, the two displays on the left (one above the other) must be attached to the top graphics card.

To use vizconfig:

1. Login as root.
2. Launch vizconfig using the desktop icon or by executing `/opt/hp/viztools/bin/run_vizconfig`.
3. Select a display arrangement from the Selected Display Arrangement list (such as 3x1 or 2x2).

4. When a display arrangement is selected, you can also set different options in the Options tab. Your options are as follows:
   - SLI Multiview (Xinerama) – this enables/disables 2d/3d Xinerama
   - Use TwinView where possible – enables/disables twinview
   - HardwareOverlays – enables/disables using the hardware overlays

5. Set up the different monitors. The different monitors are shown in the picture of the selected display arrangement along with how the graphics cards are connected to those displays.

6. Select the display using the Selected Display list. The picture of the display arrangement is updated to highlight the selected display.

7. Set the resolution for this display with the Display Resolution slider.

8. (Optional) If you want the display to be connected to the other connector on the graphics card, select Swap Left_Right Monitors. The picture of the display arrangement is modified to reflect this change.

9. Repeat steps 6 – 8 as needed for each display.

10. Select SaveConfig to save the changes to the /etc/X11/xorg.conf file.

   **NOTE:** Any edits made directly to X config file after running vizconfig, are not used by vizconfig next time it is run. You must apply these edits each time vizconfig is run.

   If you need to use Stereo, once vizconfig generates an /etc/X11/xorg.conf file or an /etc/X11/XF86Config file, you must add Option "Stereo" "3" to the Screen entries to enable active stereo. If you are not planning on using stereo, you should not use this option as it uses graphics card resources.

   To cause the two graphics cards to appear as one large screen to the X11 window system, set Option "Xinerama" "true" in the xorg.conf/XF86Config file. Vizconfig turns Xinerama on by default.

   You might need to add a Modeline specific for your displays. The vizconfig tool includes modelines for HP 20-, 23-, and 30-inch monitors. If you want to be explicit about the resolution and the refresh frequency for monitors, then insert the Modeline generated by the gtf command directly into the xorg.conf file in the appropriate Monitor section as shown below. (See Modelines in the sample file and add your new Modeline there).

   ```
   gtf 1280 1024 96 # (or whatever your desired settings are)
   ```

   Sample:

   ```
   Modeline for 1280x1024 projector or monitor with Stereo
   # 1280x1024 @ 96.00 Hz (GTF) hsync: 103.87 kHz; pclk: 182.81 MHz Modeline
   "1280x1024_96" 182.81 1280 1376 1520 1760 1024 1025
   1028 1082 -HSync +Vsync
   ```

   **NOTE:** The stereo across two graphics cards does not work properly with the Gsync card until you obtain NVIDIA rel87xx+ drivers.

   When you have a fully stereo-capable driver from NVIDIA, you will can turn on the stereo emitter whenever the X server initiates (not just when there is a stereo window on the screen). Insert Option "ForceStereoFlipping" "1" in the ServerLayout section.
Visualization Center setup

After setting up the station, set up the Visualization Center.

Suggested hardware requirements

The following are suggested hardware requirements to set up the Visualization Center.

- HP Workstation with dual PCI-E x16 slots.
- One of the following graphics card options:
  - Dual NVIDIA FX45xx or FX55xx graphics cards
  - Dual NVIDIA Quadroplex units (to support more projectors or single card per projector port)
- NVIDIA Gsync card for graphics card synchronization
- Appropriate large displays or projection system (overlap and edge-blend support if needed)
- If stereo is required:
  - High refresh Projectors
  - NVIDIA Gsync card for graphics card synchronization
  - StereoGraphics CrystalEyes stereo glasses
  - StereoGraphics stereo emitters
- Sufficient system memory for application data

Setting up the hardware

The workstation hardware must be ordered as a unit and arrive with desired processors, graphics cards, and memory.

NVIDIA Gsync card

If stereo is required, the Gsync card must be added, unless you are using an NVIDIA quadroplex unit that already contains a Gsync card. To add the Gsync card:

1. Open the chassis of the HP xw9300 or xw9400 Workstation.
2. Place the Gsync card in the PCI-X slot next to the bottom graphics card.

NOTE: The spacing on the Gsync card is slightly different for PCI-X slots, so apply light pressure to the back of the workstation near the card slot as you push the card into the slot.

As of NVIDIA release 8756 or later, a single Gsync card will synchronize both graphics cards. The two ribbon cables included with the Gsync card must be connected to the two graphics cards as indicated in previous section. The connectors for the primary graphics card and the secondary graphics cards are labeled on the Gsync card. External connectors are not needed for this configuration; the external connectors are used when connecting to other graphics cards and to an external sync signal. The StereoGraphics glasses can be plugged into the three-pin DIN connector on the top (primary) graphics card.

The stereo emitter is connected to the primary graphics card using the three-pin DIN cable. Extender cables are useful for these cables because the emitters must be placed near the screen facing toward the audience. Many vizcenter rooms are set up with BNC-style emitters. NVIDIA has only the three-pin DIN connector on the graphics cards, but adapter cables are available from StereoGraphics that go from the three-pin DIN to BNC. You need at least two emitters for a typical visualization room. You can use
the three-pin DIN on both graphics cards to drive two emitters (one emitter per card). The Gsync card synchronizes the two stereo emitter signals.

Connect the graphics cards to the projection system.

**Setup considerations**

A Panoram Integrator projection system can be used to perform the edge-blending. The Panoram Integrator is connected to three 1280x1024 Christie monitors. Panoram Technologies has some newer products, such as the Integrator 3000 and PixelBlaster, that work well with the HP xw9300 and xw9400 Workstations. Visit [http://panoramtech.com](http://panoramtech.com) for more information.

Barco has some projectors that will do the edge-blending directly without the need for a front-end system such as the Panoram Integrator product. The BarcoReality SIM 4, 5, and 6 products are examples of this. Visit [http://barco.com/simulation](http://barco.com/simulation) for more information.

There are other projectors on the market that perform edge blending directly. These projection systems must be set up and calibrated to get a high-quality image. The complexity of this setup and ongoing maintenance should be a major factor in selecting this projection equipment.

The Sony SXRD 4000 projector is a single projector that calibrates all four channels within the projector, making it much easier to set up and calibrate. It also offers very bright projection.

**Setting up the X Windows system**

To set up the X11 manually:

1. Set up your `/etc/X11/xorg.conf` file (or `XF86Config`) by using the sample config file, `xorg.conf.vizcenter1`.
2. If you are using Xfree86, change the keyboard driver to `kbd` and `/dev/input/mice` to `/dev/mouse`.
3. Select your resolution.

   The config file is set up to run the projectors at 1280x1024 at 96 Hz. If this is not the desired resolution and frequency, you must add a Modeline (unless you can use a standard mode such as 1280x1024).

   If you want to be explicit about the resolution and the refresh frequency, add the Modeline generated by the `gtf` command:

   ```
   gtf 1280 1024 96 # or whatever your desired settings are
   ```

   The output of `gtf` can be inserted directly into the `xorg.conf` file in the appropriate Monitor section as shown below. (See Modelines in the sample file and add your new Modeline there.)

   ```
   # Modeline for 1280x1024 projector or monitor with Stereo
   # 1280x1024 @ 96.00 Hz (GTF) hsync: 103.87 kHz; pclk: 182.81 MHz Modeline
   "1280x1024_96" 182.81 1280 1376 1520 1760 1024 1025 1028 1082 -HSync +Vsync
   ```

   **NOTE:** Often the output of the `gtf` command is not optimal for the projectors or monitors that you are using. You may need to find better timings from the display provider as shown:

   ```
   # Modeline for 1280x1024 projector or monitor with Stereo
   # 1280x1024 @ 96.00 Hz (GTF) hsync: 103.87 kHz; pclk: 182.81 MHz Modeline
   "1280x1024_96" 182.81 1280 1376 1520 1760 1024 1025 1028 1082 -HSync +Vsync
   ```

   You must reference this Modeline in the appropriate places of your config file. The easy way to find this is just search on `1280x1024_96` and replace with the name you gave to your Modeline. Ensure that you
do not replace the actual Modeline definition of the existing 1280x1024_96. Rather, replace the references.

Be careful to set the horizontal sync and vertical refresh based on the specs of the projector. Search on HorizSync, SecondMonitorHorizSync, VertRefresh and SecondMonitorVertRefresh and change accordingly. The projector provides these settings through a mechanism called EDID, so you might eliminate any explicit settings for horizontal sync and vertical refresh as your first step, and add them only if necessary.

# In Monitor Section
HorizSync 30-120
VertRefresh 56-96

# In Twinview Section
Option "SecondMonitorHorizSync" "30-120"
Option "SecondMonitorVertRefresh" "56-96"

Setup the overlap regions.

This assumes that you have projectors that can blend in an overlap region to provide a smooth transition from one projector image to the next. The NVIDIA cards generate the same image on the edges of both projectors in the overlap region that you specify in xorg.conf. The projectors then blend the overlap region by having each projector intensity decrease linearly from full image intensity to 0 in the overlap region (edge). In the sample config file, 15% of the image for overlap (15% of 1280 = 192 pixels) is used. In order to specify a 192 pixel overlap region in between the left and center projector, the Twinview option "MetaModes" takes an offset for each left edge. Twinview drives the first two projectors. The first offset is +0+0 for the first projector because there is no blending on the left edge of the left projector. The next offset in the "MetaModes" option is +1088+0. It is not an offset from one projector to the other. Rather, 8 is an offset in the overall virtual screen space (1088+892+1088 by 1024), so it is (1280-192), or the width of the first projector minus the desired overlap.

Here is an example:

# Overlap region is 1280-192=1088
Option "MetaModes" "1280x1024_96 +0+0, 1280x1024_96 +1088+0"

This specifies an overlap within a Twinview screen. The third projector is on a different graphics card and must be specified in the Screen line in the layout section of the config file. Go to the first ServerLayout section named "MyLayout" and look at the offsets at the end of the Screen 0 and Screen 1 lines. The first screen is the Twinview screen and has an offset of "0 0" because there is no blending on the left side of the left projector. The offset of the third projector is just the width of the first two projectors minus the two blend regions (1280+1280-192-192 = 2176). To enable windows spanning two graphics cards, turn on Xinerama.

Section "ServerLayout"
Identifier "MyLayout"
Option "Xinerama" "on"
Screen 0 "Screen TwinView-1" 0 0
# Overlap for 3rd projector 1280+1280-192-192=2176
Screen 1 "Screen Display-2a" 2176 0
EndSection

The sample config file is set up to enable Stereo. If this is not desired, comment out all instances of the stereo option: # Option "Stereo" "3".

The stereo emitter signal will not turn on until a stereo window is created. Stereo on the second graphics card (third display) does not work properly until you get the NVIDIA rel80 drivers (>8000). When you have a rel80 driver from NVIDIA, you will also be able to turn on the stereo emitter whenever the X
server starts up (not just when there is a stereo window on the screen). Example: Option "ForceStereoFlipping" "1".

After all the xorg.conf file changes have been made, the X server must be restarted to take effect.

Then to synchronize the two graphics cards for stereo, you must then run the NVIDIA tool, nvidia-settings and enable the frame lock with the primary display being the framelock server and the other two displays should be set up as framelock clients. This setup is specified in the nvidia-settings menu:

Configuring applications for visualization centers

Many high-end applications can transparently take advantage of these new visualization center setups. The applications are already built using standard OpenGL graphics, and the NVIDIA driver properly splits the OpenGL graphics commands across the graphics cards to affect a single large screen space for the application to run in.

Some applications, such as the Halliburton Landmark GeoProbe, were written to accommodate SGI Onyx Multipipe capabilities for graphics. In GeoProbe's case, the GeoProbe developers have enabled the multipipe graphics capability on the xw9300 and xw9400 Linux workstations, thus enabling GeoProbe to realize all pixels provided on all displays at maximal performance when rendering very graphics intensive datasets. For GeoProbe to run in this mode, the X configuration must not use the Xinerama option, (vizconfig sets this by default) but instead should have one screen assigned per graphics port. This setup enables full performance on the multipipe applications. Most applications that are not multipipe aware require that X windows be set up in Xinerama mode to display large windows that span more than two displays.

Additional information

See the documentation files in /opt/hp/graphics/nvidia or the example config files in /opt/hp/graphics/ nvidia/example_configs for more details. If you are setting up a config that is different from the example config files, use vizconfig to create a config file and modify it to get the additional features that you need. Remember that any edits made to config file will have to be made again once vizconfig is re-run.
15 Linux virtualization with Xen

Introduction

This chapter provides an overview of the Linux virtualization technologies available with Xen. It begins with an overview of virtualization concepts and the different types of virtualization, with emphasis on Xen paravirtualization. It also discusses the installation, setup, and configuration of the Xen host and guest operating systems. This chapter assumes a basic understanding of computer hardware and the Linux operating system.

Virtualization basics

Virtualization overview

Virtualization is most often used in areas such as:

- Operating system research: The virtualized environment enables operating system development and testing place to take place in a secure virtual environment, where crashes or bugs do not affect the host machine.
- Server consolidation: Hosting multiple servers on a single physical machine, reducing hardware costs and increasing ease of management and maintenance, enables companies to keep servers available 24/7.
- Hardware independence: Virtualization enables legacy systems to run on new hardware.
- Multiple operating systems: Enabling multiple operating systems to run simultaneously on the same machine with near-native performance.
- Live migration: Virtualization enables for live migration of running virtual machines between different physical machines.

Virtualization technologies

There are several different types of virtualization technology in use today, each with different levels of abstraction. This section gives a brief overview on each of the three most common virtualization methods, with special emphasis on paravirtualization, the technique that Xen uses.

Xen and paravirtualization

Paravirtualization is a popular technique used by open-source projects such as Xen or User-mode Linux (UML). In Xen architecture, the hypervisor, also known as domain 0, is the privileged domain that the
physical hardware boots to. It is from here that the less-privileged guest domains are created and managed.

**Figure 15-1** Paravirtualization approach

Paravirtualization is unique in that it enables guest operating systems to run natively on the underlying hardware by taking advantage of the virtualization technology of Intel VT and AMD AMD-V. Alternative virtualization approaches usually require the hypervisor to patch the guest operating system to keep it from interacting directly with the hardware, which results in a much higher performance loss, as well as stability and security issues. Because Xen paravirtualization has a small code base and makes use of native Linux device drivers, it has performance that is up to 10 times greater than that of other virtualization techniques. The drivers of the guest operating systems are run in a lower-privileged ring than the hypervisor, protecting the hypervisor from driver failures in the guests.

The Xen hypervisor is designed for secure and efficient virtualization of CPU, memory, and I/O. Guest operating systems make system calls to an API provided by the hypervisor, enabling the hypervisor to monitor changes made by the guest operating system and thus to manage the state of hardware data structures more efficiently. The hypervisor can also make guests aware of the fact that they are virtualized, which enables smarter scheduling and rescheduling decisions by the hypervisor by keeping track of how much time has passed between operations. I/O is virtualized on Xen by using a single set of drivers for all guest systems and the hypervisor, where paravirtualizing drivers that are hardware independent are used in place of hardware-specific drivers. Aside from adding greater security for the hypervisor, this approach can make use of any Linux device drivers available, as well as provide very high I/O performance.

**Installation**

**Installing Xen from source**

The requirements for installing Xen from source are as follows:

- A functional Linux distribution, preferably with a 2.6 kernel, must have the GRUB bootloader.
- The xend control tools require the following: The iproute2 package, Linux bridge-utils, and Linux hotplug system.
- If building Xen from source, the following are also needed: build tools, development installations of zlib and Python 2.2 (or later), and LaTeX.
Installation can be performed in one of three ways: from a binary tarball, from RPMs, or from source.

- To install from a binary tarball, download the appropriate tarball from http://www.xensource.com/download. Once downloaded, the installation can be completed with the following commands:
  1. Enter `tar zxvf xen-3.0-install.tgz`.
  2. Enter `cd xen-3.0-install`.
  3. Enter `sh ./install.sh`.

- To install from RPMs, first download the appropriate RPMs from http://www.xensource.com/download. Enter `rpm –ivh rpmname` to install RPMs.

  **NOTE:** RPMs are not available for all distributions and are currently available for 32-bit SMP only.

- To install from source, first obtain the Xen source tarball from http://www.xensource.com/download. To install the files, enter `make install` and press Enter.

  **NOTE:** This tarball includes a makefile that will build Xen and the xend control tools. If necessary, download and unpack the Linux 2.6 source and patch it for use with Xen, then build two kernels, one as the privileged domain 0 kernel and a smaller unprivileged kernel for use in virtual machines. Files produced by the build process are stored in the dist/install directory.

Xen configuration

After installing Xen from source, the system must be configured in order to boot and run Xen.

- An entry must be added to grub.conf to allow Xen to boot. An example entry for Xen in this file is as follows:

  - `title Xen 3.0 / XenLinux 2.6`
  - `root (hd0,0)`
  - `kernel /xen-3.0.gz ro root=LABEL=/12 rhgb quiet`
  - `module /vmlinuz-2.6.16-xen ro root=LABEL=/12 rhgb quiet`
  - `module /initrd-2.6.16-xen.img`

  **NOTE:** If an initrd is needed, it is added as a module line, not as an initrd line. Different distributions require different parameters to be passed in.

- The Thread Local Storage (TLS) libraries should be disabled before booting Xen, as failure to do so can significantly reduce performance. To disable TLS, enter `mv /lib/tls /lib/tls.disabled`.

  This can be undone at any time by restoring the TLS libraries to their original location.

- You can also configure serial console access. To do this, the system BIOS, GRUB, Xen, Linux, and login must each be configured for serial access. For details on this configuration, refer to the Xen Users’ Manual.

Installing Xen with Red Hat Enterprise Linux 5

Installing Xen with RHEL 5 is simple because RHEL 5 integrates Xen into its source code so that the operating system and Xen can be installed at the same time. To install Xen with RHEL 5, boot to the RHEL installation media. Continue through the installation to the software selection screen.
software selection screen, select **Virtualization** to configure the machine for use with virtualization, then select the **Customize now** option to customize the list of installed packages now.

**Figure 15-2** Software selection

![Software selection screen](image1)

On the next screen, select **virtualization**, and ensure that all available packages are selected to be installed.

**Figure 15-3** Virtualization packages

![Virtualization packages](image2)

Continue with the rest of the installation process. After RHEL is installed on your system, the Xen tools will be available using the Applications>System Tools>Virtual Machine Manager menu. This application provides a convenient GUI interface for setting up and managing virtual machines.

**Guest configuration**

All Xen guests require some storage space, such as a separate hard disk, a hard disk partition, a logical volume, or file-based storage. Use the method that works best for your system requirements when the instructions refer to storage methods. Additionally, all guests require an appropriate configuration file. These files are usually located in the `/etc/xen` directory.
**Guest configuration with Red Hat Enterprise Linux**

The RHEL Virtual Machine Manager (VMM) provides a GUI interface for setting up and managing virtual machines with Xen. When started, the VMM will prompt the user to connect to a hypervisor, in this case the local Xen host. After the hypervisor is started, the VMM will display a status screen displaying the currently running domains, which at first will be only the hypervisor, Domain-0:

**Figure 15-4  Virtual machine manager**

1. From the File/New machine… menu or the New button, a new guest domain can be created. From this menu, information about the name of the guest, the type of virtualization (paravirtualization or full virtualization if the CPU supports it), the location of the operating system install media, storage options, and CPU/memory options must be entered. After entering the necessary information, the guest domain will be created.

2. Access the RHEL Xen VMM by using the virt-manager command. A command-line tool for creating guest domains is available by using the virt-install command.

3. After setting up guest domains, you can manage the guests with the VMM. Right-click a domain, and select Details for information about the domain, such as memory, CPU, and other hardware usage, as well as other options such as pausing or stopping the domain. Right-click, and select Open to open a console for the guest.

**Configuration from the host operating system**

One method of installing a guest operating system involves creating an image tarball from the pre-existing Linux installation.

1. Use a command similar to the following to create the tarball:

```bash
ENWW Guest configuration  103```
After creating the tarball, mount the desired guest storage location on the hypervisor and unpack the tarball in that location. To copy the modules for the Xen kernel into the /lib/modules directory of the guest, enter `cp -r /lib/modules/`uname –r`/ /guest-storage/lib/modules`.

Here, `/guest-storage/` is the guest storage location. In the guest file system, move the /lib/tls directory to /lib/tls/disabled in order to avoid problems with the TLS libraries as described in the Xen configuration section.

**Configuration from an installation CD/DVD**

To create a guest operating system from the operating system installation disks, boot the machine to the first installation disk. The exact installation steps will vary depending on the Linux distribution being used. Continue through the installation until disk partitioning options are reached. Choose to set up disk
partitioning yourself; this may be under advanced, custom, or manual option depending on your distribution.

**Figure 15-5** Disk partitioning setup

1. Install the new operating system / directory into the storage location that has been created for this guest. For example, if installing the new operating system to the /dev/sdb5 partition, set up partitioning as shown next.

**Figure 15-6** Disk setup
2. Continue with the installation until boot loader options are reached. Because the GRUB boot loader has already been configured to allow Xen to boot, a new boot loader should not be installed. Select the option to not install a boot loader.

Figure 15-7 Boot loader installation

3. Continue with the installation. After installation and system reboot, the new system cannot be booted into because a boot loader was not installed. To fix this, boot into Xen and edit the grub.conf file to include an entry for the new operating system, if desired. The /etc/fstab file on the guest operating system needs to be edited to prevent file system problems when booting the guest.

Configuration from pre-built Xen images

Pre-built Xen image files can be downloaded from a variety of sources. A notable site is http://www.jailtime.org. Complete the following steps:

1. Download the desired distribution file onto the Xen machine.
2. Enter `tar -xvjf xenimagefile.img.tar.bz2` to copy the file to the guest storage location and unpack it. This will unpack the distribution image file and configuration files into the guest storage.
3. Copy the configuration files into the appropriate directory on the hypervisor, usually /etc/xen.

Guest configuration files

Every guest on a Xen system requires its own configuration file. There are two default configuration files in the /etc/xen directory that can be customized as needed. The file xmexample2 has many parameters in it, most of which are explained in the file’s comments, but only a few of those parameters are required for a virtual machine to run. The most important parameters include:

- **Kernel**: The kernel which will be booted—this is usually the Xen Linux kernel.
- **Root**: The root file system.
- **Disk**: The disk partition on which the system is installed.
- **Memory**: The amount of memory the virtual machine uses.

A minimal example of a Xen configuration file might be:
Table 15-1  Xen configuration example

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>kernel</td>
<td>'/boot/vmlinuz-2.6.16.29-xen'</td>
</tr>
<tr>
<td>disk</td>
<td>['phy:sdb1,sdb1,w']</td>
</tr>
<tr>
<td>root</td>
<td>'/dev/sdb1 ro'</td>
</tr>
<tr>
<td>memory</td>
<td>256</td>
</tr>
</tbody>
</table>

There are many other parameters that can be configured as needed; these are merely the minimum parameters needed to get a virtual machine running. Other parameters that might be useful include:

- name = vmname where vmname is a unique name for the virtual machine.
- vcpus = n where n is the number of CPUs the virtual machine has.
- cpus = 0–2 specifies which CPUs the virtual machine will run on. In this example it will run on CPUs 0, 1, and 2.
- ramdisk /boot/vmlinuz-2.6.16.29-xen.img specifies the image of the initial ramdisk.
- vif [''] creates a default network device.

More parameters and information about them can be found in the file /etc/xen/xmexample2.

Managing guests

Management of Xen guests is done through the Xen daemon xend, which must be running before you can start, stop, and manage virtual machines. Because it requires access to privileged system functions, xend must be run as root, either using the command line or controlled by an HTTP-based protocol. The four basic xend commands that can be run are as follows:

- xend start — starts xend if it is not already running.
- xend stop — stops xend if it is running.
- xend restart— restarts xend if it is already running, and starts it otherwise.
- xend status — indicates xend current status using its return code.

After xend is running, management of virtual machines is done using the xm tool. There are many commands that can be used with the xm tool; the most commonly used commands include:

- xm create -c configfile creates a new virtual machine whose parameters are specified in the file named configfile located in /etc/xen and turns the command line into the console for that machine.
- xm list lists the currently running virtual machines.
- xm pause and xm unpause are used to pause and unpause a specific domain.
- xm destroy destroys the specified domain
- xm reboot and xm shutdown

More information on the commands available can be found by running the xm help command.

If Xen is installed alongside RHEL 5, then guests can also be managed through the GUI tool provided by the operating system.
**Additional information**

For more information on Xen, visit the following web sites:

- [http://www.hp.com/go/linux](http://www.hp.com/go/linux)
- [http://www.hp.com/go/workstations](http://www.hp.com/go/workstations)
- [http://www.xensource.com](http://www.xensource.com)
- [http://www.redhat.com](http://www.redhat.com)
16 Links

This chapter provides links to Linux resources.

Linux resources

Check the following resources for additional information on topics presented in this user manual.

- Hardware support matrix for HP xw Linux Workstations: [http://www.hp.com/support/linux_hardware_matrix](http://www.hp.com/support/linux_hardware_matrix)
- General web information on DVDs: [http://www.dvdhelp.us/](http://www.dvdhelp.us/)
- For additional information on HP products and services, visit: [http://www.hp.com/](http://www.hp.com/)
- For the location of the nearest sales office, call:
  - United States: +1 800 637 7740
  - Japan: +81 3 3331 6111
  - Canada: +1 905 206 4725
  - Latin America: +1 305 267 4220
  - Australia/New Zealand: +61 3 9272 2895
  - Asia Pacific: +8522 599 7777
  - Europe/Africa/Middle East: +41 22 780 81 11

For more information, contact any of our worldwide sales offices or HP Channel Partners (in the U.S. call 1 800 637 7740).
Enabling Hyper-Threading Technology

HP workstations support Hyper-Threading (HT) Technology on systems installed with Red Hat Linux versions 8.0, 9, or Red Hat Enterprise Linux WS 3 (RHEL WS 3) or later. HT Technology is disabled in the BIOS by default. It must be enabled and run with a symmetric multiprocessing (SMP) kernel. HT Technology is not supported on AMD processors.

What is Hyper-Threading Technology?

HT Technology is a high-performance technology, developed by Intel, that enables a single processor to execute multiple threads of instructions simultaneously. HT Technology enables the processor to utilize its execution resources more efficiently, delivering increased performance and improving user productivity. Not all systems or applications benefit from HT Technology. For more information about HT Technology, visit the Intel website at http://www.intel.com/.

Notes, limitations, and requirements

Hardware

- HT Technology is not supported on earlier HP Workstation platforms such as the HP xw4000 and xw5000 Workstations.
- HT Technology is not supported on Dual-Core or AMD platforms such as the HP xw4300 and xw9300 Workstations.
- A system must be use one or two Intel Pentium 4 or Xeon processors.
- Red Hat Linux process schedulers support four logical CPUs (or two CPU pairs with HT Technology) on the HP xw8000 or xw8200 Workstations and the HP xw6000 or xw6200 Workstations, and two logical CPUs on the HP xw4100 or xw4200 Workstations.
- Systems with above normal disk I/O activity might experience better performance using SCSI drives instead of IDE or SATA drives. SCSI drives take better advantage of increased simultaneous reads and writes provided with HT Technology.

Software

- An SMP kernel is required.
- Some kernels before 2.4.20 produce boot or system hangs while running hyper-threaded applications. If this occurs, download the latest SMP kernel from http://www.redhat.com/.
- The HP Installer Kit for Linux CD and preinstalled versions of Red Hat + HP additions have been tested using HT Technology. Some versions contain kernels that work and others do not.

The following table identifies the tested Red Hat version and kernel version combinations that support HT Technology.
Table 17-1  HT Technology support

<table>
<thead>
<tr>
<th>Red Hat Version</th>
<th>Kernel Version (box set/HP media)</th>
<th>HT Technology works?</th>
</tr>
</thead>
<tbody>
<tr>
<td>RHEL WS 4 Update 4</td>
<td>2.6.9-42</td>
<td>Yes</td>
</tr>
<tr>
<td>RHEL WS 4 Update 3</td>
<td>2.6.9-34</td>
<td>Yes</td>
</tr>
<tr>
<td>RHEL WS 4 Update 2</td>
<td>2.6.9-22</td>
<td>Yes</td>
</tr>
<tr>
<td>RHEL WS 4 Update 1</td>
<td>2.6.9-11</td>
<td>Yes</td>
</tr>
<tr>
<td>RHEL WS 3 Update 8</td>
<td>2.4.21-47</td>
<td>Yes</td>
</tr>
<tr>
<td>RHEL WS 3 Update 7</td>
<td>2.4.21-40</td>
<td>Yes</td>
</tr>
<tr>
<td>RHEL WS 3 Update 6</td>
<td>2.4.21-37</td>
<td>Yes</td>
</tr>
<tr>
<td>RHEL WS 3 Update 5</td>
<td>2.4.21-32</td>
<td>Yes</td>
</tr>
<tr>
<td>RHEL WS 3 Update 4 (32-bit and EM64T)</td>
<td>2.4.21-27</td>
<td>Yes</td>
</tr>
<tr>
<td>RHEL WS 3 Update 2 (32-bit and EM64T)</td>
<td>2.4.21-15</td>
<td>Yes</td>
</tr>
<tr>
<td>RHEL WS 3 (32-bit and EM64T)</td>
<td>2.4.21-4</td>
<td>Yes</td>
</tr>
<tr>
<td>Red Hat 9</td>
<td>2.4.20-8</td>
<td>Yes</td>
</tr>
<tr>
<td>Red Hat 8.0</td>
<td>2.4.18-14</td>
<td>Yes (some applications may hang)</td>
</tr>
<tr>
<td>Red Hat 7.3</td>
<td>2.4.18-26</td>
<td>No (intermittent boot hangs)</td>
</tr>
<tr>
<td>Red Hat 7.2</td>
<td>2.4.18-3</td>
<td>No</td>
</tr>
</tbody>
</table>

Enabling HT Technology

To enable HT Technology:

1. Download and install the latest BIOS version from [www.hp.com/go/workstationsupport](http://www.hp.com/go/workstationsupport)

   **NOTE:** A BIOS update is critical for the following platforms. Some earlier BIOS versions do not fully support HT Technology.
   
   - xw8000 requires 1.10 or later
   - xw6000 requires 1.16 or later
   - xw4100 requires 1.14 or later

2. Reboot, and go into the BIOS setup menu.
3. Select the Advanced menu.
4. From the Processors or Devices menu, change the Hyperthreading option to enabled.
5. Save the changes, and Exit.
6. Verify that the SMP kernel is installed and that the boot loader is configured to load it.

   **NOTE:** For information about the boot loader configuration, visit [http://www.redhat.com/](http://www.redhat.com/).
Adding an x86 SMP kernel

For systems that were installed with a single processor, the SMP kernel and source .rpm files must be installed from either CD 1 of your Red Hat boxset (look in the RedHat/RPMS directory for kernel-smp*.rpm, kernel-hugemem*.rpm, or kernel-source*.rpm), or downloaded from http://www.redhat.com.

In the Red Hat boxset, look in the RedHat/RPMS directory for kernel-smp*.rpm, kernel-hugemem*.rpm, or kernel-source*.rpm.

To add an x86 SMP kernel:

1. To find out if you need to install a new SMP kernel, enter `uname -r`.
2. Verify that the output has smp, bigmem, or hugemem in the name. You only need to install a new kernel if:
   - Only a UP (non-SMP) kernel is installed
   - The SMP kernel is likely to be too old to support the Hyper-Threading Technology (see Table 17-1 HT Technology support on page 112)
3. Reinstall an accelerated HP graphics driver from the HP Installer Kit for Linux CD, or install the latest driver from www.hp.com/go/workstationsupport. (This step is required so that an accelerated kernel module for the new SMP kernel is built.)

   **NOTE:** The matching kernel source (kernel-source*.rpm) must be installed for this step to be successful. On RHEL 4 and later, matching kernel source is not required.

4. Identify the accelerated driver that was installed on the UP kernel:
   - Enter `rpm -qa | grep nv`
   - Enter `rpm -qa | grep firegl`
5. Remove the driver that was identified by entering `rpm -e <name from output of previous step>`.
6. Install the new driver by entering `rpm -i <driver name> .rpm`.
7. Run one of the following configure scripts:
   - `cd /opt/hp/graphics/<vendor name>` (either ATI or NVIDIA)
   - `/configure`

Verifying HT Technology

To verify that HT Technology is active and working correctly:

1. Check `/proc/cpuinfo` to verify how many CPUs are identified.
2. Enter `top` to verify that processes are active on all virtual processors.
3. Measure application performance with HT Technology disabled and enabled.

Conclusion

This newly integrated functionality requires relatively new BIOS and kernel versions. Not all applications run faster with HT Technology enabled.
Enabling FireWire on HP Linux workstations

The supported HP Linux workstation operating systems do not support IEEE-1394 (FireWire®). This chapter offers tips for manually enabling FireWire devices on systems installed with the 32-bit version of Red Hat Enterprise Linux WS 3 (RHEL WS 3) or later.

**NOTE:** These drivers are unsupported. Use at your own risk.

Tested operating systems and devices

Although FireWire is not officially supported, some hardware devices have been detected and mounted successfully.

**Disclaimer:** Because of lack of drivers and software, you might encounter problems with:

- File transfer performance
- Device connections
- Simultaneous FireWire and USB drive key device mounting
- Advanced device connections

A 20 GB HP ipod and a Western Digital WD800B02-RNN external hard drive were tested both with the front ports and a 1394 PCI card ports with HP xw8200, xw6200, and xw4200 Linux Workstations.

<table>
<thead>
<tr>
<th>Operating System</th>
<th>Pass</th>
<th>Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>32-bit RHEL WS 3 Update 2</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>64-bit RHEL WS 3 Update 2</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>32-bit RHEL WS 3 Update 4</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>64-bit RHEL WS 3 Update 4</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Red Hat 7.x</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

Manually installing modules

Installing unsupported kernel modules

**Prerequisites**

- HP xw8200, xw6200, xw4200 Workstations or later
- Workstation already installed with a supported 32-bit version of RHEL. Visit [http://hp.com/support/linux_hardware_matrix](http://hp.com/support/linux_hardware_matrix) to verify.
- Red Hat Installation CD
Installation

1. Mount RHEL WS 3 (Update 5) operating system Installation CD 4. This package might be on a different CD depending on the operating system version.

2. Install kernel-smp-unsupported-2.4.21-32.EL.i686.rpm (or its equivalent for your configuration).

   **NOTE:** For x86-64 architecture, always use the smp-unsupported package. Although your kernel will be labeled .EL like x86 UP kernels are, it is actually an SMP kernel.

3. Change to the directory where they were installed (/lib/modules/2.4.21…/unsupported/drivers/ieee1394/).

4. Using /sbin/insmod, load the following modules:
   - ieee1394
   - ohci1394
   - sbp2

5. Install the FireWire hardware (that is; external hard drive). Follow manufacturer's instructions for set up.

Mounting the device

1. Look for the new device in the output from fdisk -l (that is, /dev/sdb1).

2. If a new device is not automatically detected, download a script that will complete a scan of the SCSI bus. Download the script directly or cut and paste text below. (Visit [http://www.garloff.de/kurt/linux/rescan-scsi-bus.sh](http://www.garloff.de/kurt/linux/rescan-scsi-bus.sh).)

3. Make a temporary directory by entering `mkdir /mnt/fw`.

4. Mount the device to a local directory. Enter `mount /dev/sdb1 /mnt/fw`.
   
   If you are prompted to specify a file system type, enter `/dev/sda1` or `/dev/sdb2`. 
Script
rescan-scsi-bus.sh

unsetcolor ()
{
    red=""; green=""
    yellow=""; norm=""
}
# Return hosts. sysfs must be mounted
findhosts_26 ()
{
    hosts=
    if ! ls /sys/class/scsi_host/host* \>/dev/null 2>&1; then
        echo "No SCSI host adapters found in sysfs"
        exit 1;
        #hosts=" 0"
    #return
    fi
    for hostdir in /sys/class/scsi_host/host*; do
        hostno=${hostdir#*/sys/class/scsi_host/host}
        hostname=`cat $hostdir/proc_name`
        hosts="$hosts $hostno"
        echo "Host adapter $hostno ($hostname) found."
    done
}
# Return hosts. /proc/scsi/HOSTADAPTER/* must exist
findhosts ()
{
    hosts=
    for driverdir in /proc/scsi/*; do
        driver=${driverdir#*/proc/scsi/}
        if test $driver = scsi -o $driver = sg -o $driver = dummy -o $driver =
        device_info; then continue; fi
        for hostdir in $driverdir/*; do
            name=${hostdir#*/proc/scsi/*/}
            if test $name = add_map -o $name = map -o $name = mod_parm; then continue; fi
            num=$name
            driverinfo=$driver
            if test -r $hostdir/status; then
                num=$(printf '%d' `grep -m 'SCSI host number://' $hostdir/status`)
            driverinfo="$driver:$name"
            fi
            hosts="$hosts $num"
            echo "Host adapter $num ($driverinfo) found."
        done
    done
    # Test if SCSI device $host $channen $id $lun exists
    # Outputs description from /proc/scsi/scsi, returns new
testexist ()
{
grepstr="s$host Channel: 0*$channel Id: 0*$id Lun: 0*$lun"
new="cat /proc/scsi/scsi | grep -e"$grepstr"
if test ! -z "$new"; then
cat /proc/scsi/scsi | grep -e"$grepstr"
cat /proc/scsi/scsi | grep -A2 -e"$grepstr" | tail -n2 | pr -c -l1
fi
# Perform search (scan $host)
dosearch ()
{
for channel in $channelsearch; do
for id in $idsearch; do
for lun in $lunsearch; do
new="$host $channel $id $lun"

echo "Scanning for device $new ..."
printf "%s\n"$yellowOLD: $norm"

testexist

echo "scsi remove-single-device $new" >/proc/scsi/scsi
printf "\n"$redDEL: $norm\n"

echo "$new"

for rmdev in /dev/sr* /dev/dvd* /dev/cdrom* /dev/ram*; do
if test -d "$rmdev"; then

echo "$rmdev"
echo "scsi remove-single-device $new" >/proc/scsi/scsi
printf "\n"$redDEL: $norm\n"

echo "$new"

fi
done

echo "Remove all devices"
done
docheck

echo "Done!
"fi

# main
if test "$1" = -h --help -o "$1" = -h -o "$1" = -? ; then

echo "Usage: rescanscsi-bus.sh [options] [host [host ...]]"
echo "Options:"
echo "-l activates scanning for LUNs 0-7 [default: 0]"
echo "-w scan for target device IDs 0 .. 15 [default: 0-7]"
echo "-c enables scanning of channels 0 1 [default: 0]"
echo "-r enables removing of devices [default: disabled]"
echo "--remove: same as \-r"
echo "--nooptscan: don't stop looking for LUNs is 0 is not found"
echo "--color: use coloured prefixes OLD/NEW/DEL"
echo "--hosts=LIST: Scan only host(s) in LIST"
echo "--channels=LIST: Scan only channel(s) in LIST"
echo "--ids=LIST: Scan only target ID(s) in LIST"
echo "--luns=LIST: Scan only lun(s) in LIST"
echo "Host numbers may thus be specified either directly on cmd line (deprecated) or"
echo "or with the --hosts=LIST parameter (recommended)."
echo "LIST: A[-B],[C[-D]][... is a comma separated list of single values and ranges"
echo "(No spaces allowed.)"
exit 0
fi
expandlist ()
{
list=$1
result=""
first=${list%%,*}
rest=${list##*,}
while test ! -z "$first"; do
beg=${first%%-*}
if test "$beg" = "$first"; then
result="$result $beg"
else
end=${first##-*}
result="$result `seq $beg $end`"
fi
test "$rest" = ""$first" & & rest=""
first=${rest%%,*}
rest=${rest##*,}
done
echo $result
}
if test ! -d /proc/scsi/; then
echo "Error: SCSI subsystem not active"
exit 1
fi
# defaults
unsetcolor
lunsearch="0"
idssearch=`seq 0 7`
channelsearch="0"
remove=""
optscan=1
if test -d /sys/class/scsi_host; then
findhosts 26
else
findhosts
fi
# Scan options
opt="$1"
while test ! -z "$opt" -a -z "$opt##-*"; do
opt=${opt#-}
case "$opt" in
l) lunsearch=`seq 0 7` ;;
w) idssearch=`seq 0 15` ;;
c) channelsearch="0 1"
) remove=1 ;;
r)  remove=1 ;;
-h) arg=${opt#-hosts=}; hosts=`expandlist $arg` ;;
-c) arg=${opt#-channels=}; channelsearch=`expandlist $arg` ;;
-i) arg=${opt#-ids=}; idssearch=`expandlist $arg` ;;
-l) arg=${opt#-luns=}; lunsearch=`expandlist $arg` ;;
-o) arg=${opt#-color=}; unsetcolor ;;
-n) arg=${opt#-nocolor=}; color=0 ;;
*) echo "Unknown option -$opt !" ;;
esac
shift
opt="$1"
done
# Hosts given?
if test "@$1" != "@"; then
hosts=$*;
fi
echo "Scanning hosts $hosts channels $channelsearch for "
echo "SCSI target IDs "$idsearch", LUNs "$lunsearch"
test -z "$remove" || echo "and remove devices that have disappeared"
declare -i found=0

declare -i rmvd=0
for host in $hosts; do
dosearch;
done
echo "$found new device(s) found."
echo "$rmvd device(s) removed."