Red Hat Enterprise Linux 3

System Administration Guide

Red Hat Enterprise Linux 3: System Administration Guide

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Introduction

Welcome to the *Red Hat Enterprise Linux System Administration Guide*.

The *Red Hat Enterprise Linux System Administration Guide* contains information on how to customize your Red Hat Enterprise Linux system to fit your needs. If you are looking for a step-by-step, task-oriented guide for configuring and customizing your system, this is the manual for you. This manual discusses many intermediate topics such as the following:

- Setting up a network interface card (NIC)
- Performing a Kickstart installation
- Configuring Samba shares
- Managing your software with RPM
- Determining information about your system
- Upgrading your kernel

This manual is divided into the following main categories:

- Installation-Related Reference
- Network-Related Reference
- System Configuration
- Package Management

This guide assumes you have a basic understanding of your Red Hat Enterprise Linux system. If you need help installing Red Hat Enterprise Linux, refer to the *Red Hat Enterprise Linux Installation Guide*. For more general information about system administration, refer to the *Red Hat Enterprise Linux Introduction to System Administration*. If you need more advanced documentation such as an overview of file systems, refer to the *Red Hat Enterprise Linux Reference Guide*. If you need security information, refer to the *Red Hat Enterprise Linux Security Guide*.

HTML, PDF, and RPM versions of the manuals are available on the Red Hat Enterprise Linux Documentation CD and online at http://www.redhat.com/docs/.

Note

Although this manual reflects the most current information possible, read the *Red Hat Enterprise Linux Release Notes* for information that may not have been available prior to our documentation being finalized. They can be found on the Red Hat Enterprise Linux CD #1 and online at http://www.redhat.com/docs/.

1. Changes to This Manual

The previous version of this manual was named the *Red Hat Linux Customization Guide*. It has been renamed the *Red Hat Enterprise Linux System Administration Guide* to better reflect the topics discussed as well as to more clearly define its role in the Red Hat documentation set.

It has been expanded to include new features in Red Hat Enterprise Linux 3 as well as topics requested by our readers. Significant changes to this manual include:

Chapter 7 *User-Defined Device Names*

This new chapter explains how to use devlabel.

Chapter 8 *Access Control Lists*

This new chapter explains the how to use access control lists for files and directories.

Chapter 9 *Kickstart Installations*

This chapter has been updated to include new kickstart directives.

Chapter 10 ***Kickstart Configurator***

This chapter has been updated to include the new options in **Kickstart Configurator**.

Chapter 14 *PXE Network Installations*

This new chapter explains how to perform a PXE installation.

Chapter 15 *Diskless Environments*

This new chapter explains how to create a diskless environment.

Chapter 24 *Samba*

This chapter has been updated for Samba 3.0 and now explains how to mount Samba shares.

Chapter 32 *Keyboard Configuration*

This new chapter explains the **Keyboard Configuration Tool**.

Chapter 33 *Mouse Configuration*

This new chapter explains the **Mouse Configuration Tool**.

Chapter 34 *X Window System Configuration*

This new chapter explains the **X Configuration Tool**.

Chapter 38 *Log Files*

This chapter has been updated to explain the new features of **Log Viewer**.

Chapter 39 *Upgrading the Kernel*

This chapter has been updated to explain the new kernel packages as well as how to upgrade the kernel on architectures other than x86.

Chapter 43 *OProfile*

This new chapter explains the how to use the OProfile system profiler.

2. Document Conventions

When you read this manual, certain words are represented in different fonts, typefaces, sizes, and weights. This highlighting is systematic; different words are represented in the same style to indicate their inclusion in a specific category. The types of words that are represented this way include the following:

`command`

Linux commands (and other operating system commands, when used) are represented this way. This style should indicate to you that you can type the word or phrase on the command line and press [Enter] to invoke a command. Sometimes a command contains words that would be displayed in a different style on their own (such as file names). In these cases, they are considered to be part of the command, so the entire phrase is displayed as a command. For example:

Use the `cat testfile` command to view the contents of a file, named `testfile`, in the current working directory.

`file name`

File names, directory names, paths, and RPM package names are represented this way. This style should indicate that a particular file or directory exists by that name on your system. Examples:

The `.bashrc` file in your home directory contains bash shell definitions and aliases for your own use.

The `/etc/fstab` file contains information about different system devices and file systems.

Install the `webalizer` RPM if you want to use a Web server log file analysis program.

application

This style indicates that the program is an end-user application (as opposed to system software). For example:

Use **Mozilla** to browse the Web.

[key]

A key on the keyboard is shown in this style. For example:

To use [Tab] completion, type in a character and then press the [Tab] key. Your terminal displays the list of files in the directory that start with that letter.

[key]-[combination]

A combination of keystrokes is represented in this way. For example:

The [Ctrl]-[Alt]-[Backspace] key combination exits your graphical session and return you to the graphical login screen or the console.

text found on a GUI interface

A title, word, or phrase found on a GUI interface screen or window is shown in this style. Text shown in this style is being used to identify a particular GUI screen or an element on a GUI screen (such as text associated with a checkbox or field). Example:

Select the **Require Password** checkbox if you would like your screensaver to require a password before stopping.

top level of a menu on a GUI screen or window

A word in this style indicates that the word is the top level of a pulldown menu. If you click on the word on the GUI screen, the rest of the menu should appear. For example:

Under **File** on a GNOME terminal, the **New Tab** option allows you to open multiple shell prompts in the same window.

If you need to type in a sequence of commands from a GUI menu, they are shown like the following example:

Go to **Main Menu Button** (on the Panel) => **Programming** => **Emacs** to start the **Emacs** text editor.

button on a GUI screen or window

This style indicates that the text can be found on a clickable button on a GUI screen. For example:

Click on the **Back** button to return to the webpage you last viewed.

`computer output`

Text in this style indicates text displayed to a shell prompt such as error messages and responses to commands. For example:

The `ls` command displays the contents of a directory. For example:

```
Desktop              about.html       logs          paulwesterberg.png
Mail                 backupfiles      mail          reports
```

The output returned in response to the command (in this case, the contents of the directory) is shown in this style.

`prompt`

A prompt, which is a computer's way of signifying that it is ready for you to input something, is shown in this style. Examples:

`$`

`#`

`[stephen@maturin stephen]$`

`leopard login:`

`user input`

Text that the user has to type, either on the command line, or into a text box on a GUI screen, is displayed in this style. In the following example, **`text`** is displayed in this style:

To boot your system into the text based installation program, you must type in the **`text`** command at the `boot:` prompt.

`replaceable`

Text used for examples which is meant to be replaced with data provided by the user is displayed in this style. In the following example, *<version-number>* is displayed in this style:

The directory for the kernel source is `/usr/src/`*<version-number>*`/`, where *<version-number>* is the version of the kernel installed on this system.

Additionally, we use several different strategies to draw your attention to certain pieces of information. In order of how critical the information is to your system, these items are marked as note, tip, important, caution, or a warning. For example:

Note

Remember that Linux is case sensitive. In other words, a rose is not a ROSE is not a rOsE.

Tip

The directory `/usr/share/doc/` contains additional documentation for packages installed on your system.

Important

If you modify the DHCP configuration file, the changes will not take effect until you restart the DHCP daemon.

Caution

Do not perform routine tasks as root — use a regular user account unless you need to use the root account for system administration tasks.

Warning

Be careful to remove only the necessary Red Hat Enterprise Linux partitions. Removing other partitions could result in data loss or a corrupted system environment.

3. More to Come

The *Red Hat Enterprise Linux System Administration Guide* is part of Red Hat's growing commitment to provide useful and timely support to Red Hat Enterprise Linux users. As new tools and applications are released, this guide will be expanded to include them.

3.1. Send in Your Feedback

If you spot a typo in the *Red Hat Enterprise Linux System Administration Guide*, or if you have thought of a way to make this manual better, we would love to hear from you! Please submit a report in Bugzilla (http://bugzilla.redhat.com/bugzilla/) against the component `rhel-sag`.

Be sure to mention the manual's identifier:

```
rhel-sag(EN)-3-Print-RHI (2003-07-25T17:10)
```

By mentioning this manual's identifier, we will know exactly which version of the guide you have.

If you have a suggestion for improving the documentation, try to be as specific as possible. If you have found an error, please include the section number and some of the surrounding text so we can find it easily.

4. Sign Up for Support

If you have a variant of Red Hat Enterprise Linux 3, please remember to sign up for the benefits you are entitled to as a Red Hat customer.

Registration enables access to the Red Hat Services you have purchased, such as technical support and Red Hat Network. To register your product, go to:

```
http://www.redhat.com/apps/activate/
```

Note

You must activate your product before attempting to connect to Red Hat Network. If your product has not been activated, Red Hat Network rejects registration to channels to which the system is not entitled.

Good luck, and thank you for choosing Red Hat Enterprise Linux!

The Red Hat Documentation Team

I. File Systems

File system refers to the files and directories stored on a computer. A file system can have different formats called *file system types*. These formats determine how the information is stored as files and directories. Some file system types store redundant copies of the data, while some file system types make hard drive access faster. This part discusses the ext3, swap, RAID, and LVM file system types. It also discusses the `parted` utility to manage partitions, the `devlabel` utility to create user-defined device names, and access control lists (ACLs) to customize file permissions.

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Chapter 1.
The ext3 File System

The default file system is the journaling *ext3* file system.

1.1. Features of ext3

The ext3 file system is essentially an enhanced version of the ext2 file system. These improvements provide the following advantages:

Availability

After an unexpected power failure or system crash (also called an *unclean system shutdown*), each mounted ext2 file system on the machine must be checked for consistency by the `e2fsck` program. This is a time-consuming process that can delay system boot time significantly, especially with large volumes containing a large number of files. During this time, any data on the volumes is unreachable.

The journaling provided by the ext3 file system means that this sort of file system check is no longer necessary after an unclean system shutdown. The only time a consistency check occurs using ext3 is in certain rare hardware failure cases, such as hard drive failures. The time to recover an ext3 file system after an unclean system shutdown does not depend on the size of the file system or the number of files; rather, it depends on the size of the *journal* used to maintain consistency. The default journal size takes about a second to recover, depending on the speed of the hardware.

Data Integrity

The ext3 file system provides stronger data integrity in the event that an unclean system shutdown occurs. The ext3 file system allows you to choose the type and level of protection that your data receives. By default, the ext3 volumes are configured to keep a high level of data consistency with regard to the state of the file system.

Speed

Despite writing some data more than once, ext3 has a higher throughput in most cases than ext2 because ext3's journaling optimizes hard drive head motion. You can choose from three journaling modes to optimize speed, but doing so means trade offs in regards to data integrity.

Easy Transition

It is easy to change from ext2 to ext3 and gain the benefits of a robust journaling file system without reformatting. Refer to Section 1.3 *Converting to an ext3 File System* for more on how to perform this task.

If you performed a fresh installation, the default file system assigned to the system's Linux partitions is ext3. If you upgrade from a version that uses ext2 partitions, the installation program allows you to convert these partitions to ext3 partitions without losing data. Refer to the appendix titled *Upgrading Your Current System* in the *Red Hat Enterprise Linux Installation Guide* for details.

The following sections walk you through the steps for creating and tuning ext3 partitions. For ext2 partitions, skip the partitioning and formating sections below and go directly to Section 1.3 *Converting to an ext3 File System*.

1.2. Creating an ext3 File System

After installation, it is sometimes necessary to create a new ext3 file system. For example, if you add a new disk drive to the system, you may want to partition the drive and use the ext3 file system.

The steps for creating an ext3 file system are as follows:

1. Create the partition using `parted` or `fdisk`.
2. Format the partition with the ext3 file system using `mkfs`.
3. Label the partition using `e2label`.
4. Create the mount point.
5. Add the partition to `/etc/fstab`.

Refer to Chapter 5 *Managing Disk Storage* for information on performing these steps.

1.3. Converting to an ext3 File System

The `tune2fs` program can add a journal to an existing ext2 file system without altering the data already on the partition. If the file system is already mounted while it is being transitioned, the journal will be visible as the file `.journal` in the root directory of the file system. If the file system is not mounted, the journal will be hidden and will not appear in the file system at all.

To convert an ext2 file system to ext3, log in as root and type:

```
/sbin/tune2fs -j /dev/hdbX
```

In the above command, replace /dev/*hdb* with the device name and *X* with the partition number.

After doing this, be certain to change the partition type from ext2 to ext3 in `/etc/fstab`.

If you are transitioning your root file system, you will have to use an `initrd` image (or RAM disk) to boot. To create this, run the `mkinitrd` program. For information on using the `mkinitrd` command, type `man mkinitrd`. Also make sure your GRUB or LILO configuration loads the `initrd`.

If you fail to make this change, the system will still boot, but the file system will be mounted as ext2 instead of ext3.

1.4. Reverting to an ext2 File System

Because ext3 is relatively new, some disk utilities do not yet support it. For example, you may need to shrink a partition with `resize2fs`, which does not yet support ext3. In this situation, it may be necessary to temporarily revert a file system to ext2.

To revert a partition, you must first unmount the partition by logging in as root and typing:

```
umount /dev/hdbX
```

In the above command, replace /dev/*hdb* with the device name and *X* with the partition number. For the remainder of this section, the sample commands will use *hdb1* for these values.

Next, change the file system type to ext2 by typing the following command as root:

```
/sbin/tune2fs -O ^has_journal /dev/hdb1
```

Check the partition for errors by typing the following command as root:

```
/sbin/e2fsck -y /dev/hdb1
```

Then mount the partition again as ext2 file system by typing:

```
mount -t ext2 /dev/hdb1 /mount/point
```

In the above command, replace */mount/point* with the mount point of the partition.

Next, remove the `.journal` file at the root level of the partition by changing to the directory where it is mounted and typing:

```
rm -f .journal
```

You now have an ext2 partition.

If you permanently change the partition to ext2, remember to update the `/etc/fstab` file.

Chapter 2. Swap Space

2.1. What is Swap Space?

Swap space in Linux is used when the amount of physical memory (RAM) is full. If the system needs more memory resources and the physical memory is full, inactive pages in memory are moved to the swap space. While swap space can help machines with a small amount of RAM, it should not be considered a replacement for more RAM. Swap space is located on hard drives, which have a slower access time than physical memory.

Swap space can be a dedicated swap partition (recommended), a swap file, or a combination of swap partitions and swap files.

The size of your swap space should be equal to twice your computer's RAM, or 32 MB, whichever amount is larger, but no more than 2048 MB (or 2 GB).

2.2. Adding Swap Space

Sometimes it is necessary to add more swap space after installation. For example, you may upgrade the amount of RAM in your system from 64 MB to 128 MB, but there is only 128 MB of swap space. It might be advantageous to increase the amount of swap space to 256 MB if you perform memory-intense operations or run applications that require a large amount of memory.

You have two options: add a swap partition or add a swap file. It is recommended that you add a swap partition, but that can be difficult if you do not have any free space available.

To add a swap partition (assuming `/dev/hdb2` is the swap partition you want to add):

1. The hard drive can not be in use (partitions can not be mounted, and swap space can not be enabled). The partition table should not be modified while in use because the kernel may not properly recognize the changes. Data could be overwritten by writing to the wrong partition because the partition table and partitions mounted do not match. The easiest way to achieve this is to boot your system in rescue mode. Refer to Chapter 11 *Basic System Recovery* for instructions on booting into rescue mode. When prompted to mount the file system, select **Skip**.

   Alternately, if the drive does not contain any partitions in use, you can unmount them and turn off all the swap space on the hard drive with the `swapoff` command.

2. Create the swap partition using `parted`:

   - At a shell prompt as root, type the command `parted /dev/hdb`, where /dev/*hdb* is the device name for the hard drive with free space.
   - At the `(parted)` prompt, type **`print`** to view the existing partitions and the amount of free space. The start and end values are in megabytes. Determine how much free space is on the hard drive and how much you want to allocate for a new swap partition.
   - At the `(parted)` prompt, type **`mkpartfs`** ***`part-type`*** **`linux-swap`** ***`start end`***, where *`part-type`* is one of primary, extended, or logical, *`start`* is the starting point of the partition, and *`end`* is the end point of the partition.

> **Warning**
>
> Changes take place immediately; be careful when you type.

- Exit `parted` by typing **`quit`**.

3. Now that you have created the swap partition, use the command `mkswap` to setup the swap partition. At a shell prompt as root, type the following:
   ```
   mkswap /dev/hdb2
   ```
4. To enable the swap partition immediately, type the following command:
   ```
   swapon /dev/hdb2
   ```
5. To enable it at boot time, edit `/etc/fstab` to include:
   ```
   /dev/hdb2               swap                    swap    defaults        0 0
   ```
   The next time the system boots, it enables the new swap partition.
6. After adding the new swap partition and enabling it, verify it is enabled by viewing the output of the command `cat /proc/swaps` or `free`.

To add a swap file:

1. Determine the size of the new swap file in megabytes and multiple by 1024 to determine the block size. For example, the block size of a 64 MB swap file is 65536.
2. At a shell prompt as root, type the following command with `count` being equal to the desired block size:
   ```
   dd if=/dev/zero of=/swapfile bs=1024 count=65536
   ```
3. Setup the swap file with the command:
   ```
   mkswap /swapfile
   ```
4. To enable the swap file immediately but not automatically at boot time:
   ```
   swapon /swapfile
   ```
5. To enable it at boot time, edit `/etc/fstab` to include:
   ```
   /swapfile               swap                    swap    defaults        0 0
   ```
   The next time the system boots, it enables the new swap file.
6. After adding the new swap file and enabling it, verify it is enabled by viewing the output of the command `cat /proc/swaps` or `free`.

2.3. Removing Swap Space

To remove a swap partition:

1. The hard drive can not be in use (partitions can not be mounted, and swap space can not be enabled). The easiest way to achieve this it to boot your system in rescue mode. Refer to Chapter 11 *Basic System Recovery* for instructions on booting into rescue mode. When prompted to mount the file system, select **Skip**.

   Alternately, if the drive does not contain any partitions in use, you can unmount them and turn off all the swap space on the hard drive with the `swapoff` command.
2. At a shell prompt as root, execute the following command to make sure the swap partition is disabled (where `/dev/hdb2` is the swap partition):
   ```
   swapoff /dev/hdb2
   ```
3. Remove its entry from `/etc/fstab`.
4. Remove the partition using `parted`:

- At a shell prompt as root, type the command `parted /dev/`*`hdb`*, where `/dev/`*`hdb`* is the device name for the hard drive with the swap space to be removed.
- At the `(parted)` prompt, type **`print`** to view the existing partitions and determine the minor number of the swap partition you wish to delete.
- At the `(parted)` prompt, type **`rm`** ***`MINOR`***, where *`MINOR`* is the minor number of the partition you want to remove.

  Warning

  Changes take effect immediately; you must type the correct minor number.

- Type **`quit`** to exit `parted`.

To remove a swap file:

1. At a shell prompt as root, execute the following command to disable the swap file (where `/swapfile` is the swap file):
   ```
   swapoff /swapfile
   ```
2. Remove its entry from `/etc/fstab`.
3. Remove the actual file:
   ```
   rm /swapfile
   ```

2.4. Moving Swap Space

To move swap space from one location to another, follow the steps for removing swap space, and then follow the steps for adding swap space.

Chapter 3.
Redundant Array of Independent Disks (RAID)

3.1. What is RAID?

The basic idea behind RAID is to combine multiple small, inexpensive disk drives into an array to accomplish performance or redundancy goals not attainable with one large and expensive drive. This array of drives appears to the computer as a single logical storage unit or drive.

RAID is a method in which information is spread across several disks, using techniques such as *disk striping* (RAID Level 0), *disk mirroring* (RAID level 1), and *disk striping with parity* (RAID Level 5) to achieve redundancy, lower latency and/or increase bandwidth for reading or writing to disks, and maximize the ability to recover from hard disk crashes.

The underlying concept of RAID is that data may be distributed across each drive in the array in a consistent manner. To do this, the data must first be broken into consistently-sized *chunks* (often 32K or 64K in size, although different sizes can be used). Each chunk is then written to a hard drive in RAID according to the RAID level used. When the data is to be read, the process is reversed, giving the illusion that multiple drives are actually one large drive.

3.2. Who Should Use RAID?

Anyone who needs to keep large quantities of data on hand (such as a system administrator) would benefit by using RAID technology. Primary reasons to use RAID include:

- Enhanced speed
- Increased storage capacity using a single virtual disk
- Lessened impact of a disk failure

3.3. Hardware RAID versus Software RAID

There are two possible RAID approaches: Hardware RAID and Software RAID.

3.3.1. Hardware RAID

The hardware-based system manages the RAID subsystem independently from the host and presents to the host only a single disk per RAID array.

An example of a Hardware RAID device would be one that connects to a SCSI controller and presents the RAID arrays as a single SCSI drive. An external RAID system moves all RAID handling "intelligence" into a controller located in the external disk subsystem. The whole subsystem is connected to the host via a normal SCSI controller and appears to the host as a single disk.

RAID controllers also come in the form of cards that *act* like a SCSI controller to the operating system but handle all of the actual drive communications themselves. In these cases, you plug the drives into the RAID controller just like you would a SCSI controller, but then you add them to the RAID controller's configuration, and the operating system never knows the difference.

3.3.2. Software RAID

Software RAID implements the various RAID levels in the kernel disk (block device) code. It offers the cheapest possible solution, as expensive disk controller cards or hot-swap chassis [1] are not required. Software RAID also works with cheaper IDE disks as well as SCSI disks. With today's fast CPUs, Software RAID performance can excel against Hardware RAID.

The MD driver in the Linux kernel is an example of a RAID solution that is completely hardware independent. The performance of a software-based array is dependent on the server CPU performance and load.

For information on configuring Software RAID during installation, refer to the Chapter 12 *Software RAID Configuration*.

For those interested in learning more about what Software RAID has to offer, here is a brief list of the most important features:

- Threaded rebuild process
- Kernel-based configuration
- Portability of arrays between Linux machines without reconstruction
- Backgrounded array reconstruction using idle system resources
- Hot-swappable drive support
- Automatic CPU detection to take advantage of certain CPU optimizations

3.4. RAID Levels and Linear Support

RAID supports various configurations, including levels 0, 1, 4, 5, and linear. These RAID types are defined as follows:

- *Level 0* — RAID level 0, often called "striping," is a performance-oriented striped data mapping technique. This means the data being written to the array is broken down into strips and written across the member disks of the array, allowing high I/O performance at low inherent cost but provides no redundancy. The storage capacity of a level 0 array is equal to the total capacity of the member disks in a Hardware RAID or the total capacity of member partitions in a Software RAID.
- *Level 1* — RAID level 1, or "mirroring," has been used longer than any other form of RAID. Level 1 provides redundancy by writing identical data to each member disk of the array, leaving a "mirrored" copy on each disk. Mirroring remains popular due to its simplicity and high level of data availability. Level 1 operates with two or more disks that may use parallel access for high data-transfer rates when reading but more commonly operate independently to provide high I/O transaction rates. Level 1 provides very good data reliability and improves performance for read-intensive applications but at a relatively high cost. [2] The storage capacity of the level 1 array is equal to the capacity of one of the mirrored hard disks in a Hardware RAID or one of the mirrored partitions in a Software RAID.

1. A hot-swap chassis allows you to remove a hard drive without having to power-down your system.
2. RAID level 1 comes at a high cost because you write the same information to all of the disks in the array, which wastes drive space. For example, if you have RAID level 1 set up so that your root (`/`) partition exists on two 40G drives, you have 80G total but are only able to access 40G of that 80G. The other 40G acts like a mirror of the first 40G.

- *Level 4* — Level 4 uses parity [3] concentrated on a single disk drive to protect data. It is better suited to transaction I/O rather than large file transfers. Because the dedicated parity disk represents an inherent bottleneck, level 4 is seldom used without accompanying technologies such as write-back caching. Although RAID level 4 is an option in some RAID partitioning schemes, it is not an option allowed in Red Hat Enterprise Linux RAID installations. [4] The storage capacity of Hardware RAID level 4 is equal to the capacity of member disks, minus the capacity of one member disk. The storage capacity of Software RAID level 4 is equal to the capacity of the member partitions, minus the size of one of the partitions if they are of equal size.
- *Level 5* — This is the most common type of RAID. By distributing parity across some or all of an array's member disk drives, RAID level 5 eliminates the write bottleneck inherent in level 4. The only performance bottleneck is the parity calculation process. With modern CPUs and Software RAID, that usually is not a very big problem. As with level 4, the result is asymmetrical performance, with reads substantially outperforming writes. Level 5 is often used with write-back caching to reduce the asymmetry. The storage capacity of Hardware RAID level 5 is equal to the capacity of member disks, minus the capacity of one member disk. The storage capacity of Software RAID level 5 is equal to the capacity of the member partitions, minus the size of one of the partitions if they are of equal size.
- *Linear RAID* — Linear RAID is a simple grouping of drives to create a larger virtual drive. In linear RAID, the chunks are allocated sequentially from one member drive, going to the next drive only when the first is completely filled. This grouping provides no performance benefit, as it is unlikely that any I/O operations will be split between member drives. Linear RAID also offers no redundancy and, in fact, decreases reliability — if any one member drive fails, the entire array cannot be used. The capacity is the total of all member disks.

3. Parity information is calculated based on the contents of the rest of the member disks in the array. This information can then be used to reconstruct data when one disk in the array fails. The reconstructed data can then be used to satisfy I/O requests to the failed disk before it is replaced and to repopulate the failed disk after it has been replaced.
4. RAID level 4 takes up the same amount of space as RAID level 5, but level 5 has more advantages. For this reason, level 4 is not supported.

Chapter 4. Logical Volume Manager (LVM)

4.1. What is LVM?

LVM is a method of allocating hard drive space into logical volumes that can be easily resized instead of partitions.

With LVM, the hard drive or set of hard drives is allocated to one or more *physical volumes*. A physical volume can not span over more than one drive.

The physical volumes are combined into *logical volume groups*, with the exception of the `/boot/` partition. The `/boot/` partition can not be on a logical volume group because the boot loader can not read it. If the root `/` partition is on a logical volume, create a separate `/boot/` partition which is not a part of a volume group.

Since a physical volume can not span over more than one drive, to span over more than one drive, create one or more physical volumes per drive.

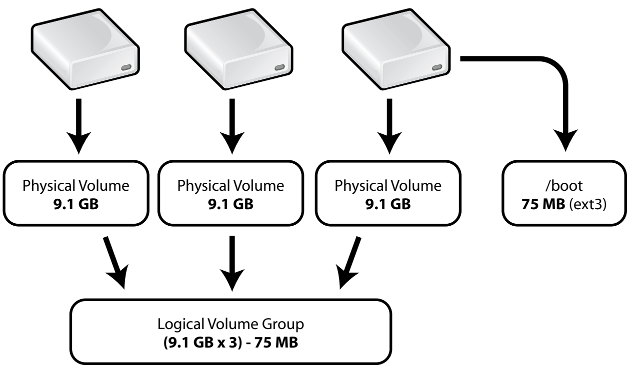

Figure 4-1. Logical Volume Group

The logical volume group is divided into *logical volumes*, which are assigned mount points such as `/home` and `/` and file system types such as ext3. When "partitions" reach their full capacity, free space from the logical volume group can be added to the logical volume to increase the size of the partition. When a new hard drive is added to the system, it can be added to the logical volume group, and the logical volumes that are the partitions can be expanded.

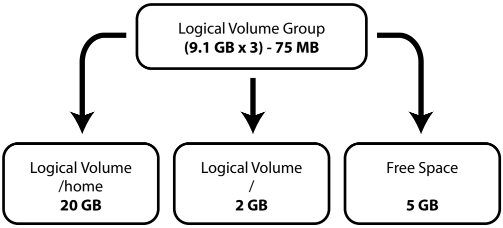

Figure 4-2. Logical Volumes

On the other hand, if a system is partitioned with the ext3 file system, the hard drive is divided into partitions of defined sizes. If a partition becomes full, it is not easy to expand the size of the partition. Even if the partition is moved to another hard drive, the original hard drive space has to be reallocated as a different partition or not used.

LVM support must be compiled into the kernel. The default Red Hat kernel is compiled with LVM support.

To learn how to configure LVM during the installation process, refer to Chapter 13 *LVM Configuration*.

4.2. Additional Resources

Use these sources to learn more about LVM.

4.2.1. Installed Documentation

- `rpm -qd lvm` — This command shows all the documentation available from the `lvm` package, including man pages.

4.2.2. Useful Websites

- http://www.sistina.com/products_lvm.htm — LVM webpage, which contains an overview, link to the mailing lists, and more.
- http://tldp.org/HOWTO/LVM-HOWTO/ — *LVM HOWTO* from the Linux Documentation Project.

Chapter 5.
Managing Disk Storage

Many users need to view the existing partition table, change the size of the partitions, remove partitions, or add partitions from free space or additional hard drives. The utility `parted` allows users to perform these tasks. This chapter discusses how to use `parted` to perform file system tasks.

If you want to view the system's disk space usage or monitor the disk space usage, refer to Section 42.3 *File Systems*.

You must have the `parted` package installed to use the `parted` utility. To start `parted`, at a shell prompt as root, type the command `parted /dev/hdb`, where `/dev/hdb` is the device name for the drive you want to configure. The `(parted)` prompt is displayed. Type `help` to view a list of available commands.

If you want to create, remove, or resize a partition, the device can not be in use (partitions can not be mounted, and swap space can not be enabled). The partition table should not be modified while in use because the kernel may not properly recognize the changes. Data could be overwritten by writing to the wrong partition because the partition table and partitions mounted do not match. The easiest way to achieve this it to boot your system in rescue mode. Refer to Chapter 11 *Basic System Recovery* for instructions on booting into rescue mode. When prompted to mount the file system, select **Skip**.

Alternately, if the drive does not contain any partitions in use, you can unmount them with the `umount` command and turn off all the swap space on the hard drive with the `swapoff` command.

Table 5-1 contains a list of commonly used `parted` commands. The sections that follow explain some of them in more detail.

Command	**Description**
`check` *`minor-num`*	Perform a simple check of the file system
`cp` *`from to`*	Copy file system from one partition to another; *`from`* and *`to`* are the minor numbers of the partitions
`help`	Display list of available commands
`mklabel` *`label`*	Create a disk label for the partition table
`mkfs` *`minor-num file-system-type`*	Create a file system of type *`file-system-type`*
`mkpart` *`part-type fs-type start-mb end-mb`*	Make a partition without creating a new file system
`mkpartfs` *`part-type fs-type start-mb end-mb`*	Make a partition and create the specified file system
`move` *`minor-num start-mb end-mb`*	Move the partition
`name` *`minor-num name`*	Name the partition for Mac and PC98 disklabels only
`print`	Display the partition table
`quit`	Quit `parted`
`rescue` *`start-mb end-mb`*	Rescue a lost partition from *`start-mb`* to *`end-mb`*

Command	Description
`resize` *minor-num start-mb end-mb*	Resize the partition from *start-mb* to *end-mb*
`rm` *minor-num*	Remove the partition
`select` *device*	Select a different device to configure
`set` *minor-num flag state*	Set the flag on a partition; *state* is either on or off

Table 5-1. `parted` commands

5.1. Viewing the Partition Table

After starting `parted`, type the following command to view the partition table:

```
print
```

A table similar to the following appears:

```
Disk geometry for /dev/hda: 0.000-9765.492 megabytes
Disk label type: msdos
Minor    Start       End     Type      Filesystem  Flags
1          0.031    101.975  primary   ext3        boot
2        101.975    611.850  primary   linux-swap
3        611.851    760.891  primary   ext3
4        760.891   9758.232  extended              lba
5        760.922   9758.232  logical   ext3
```

The first line displays the size of the disk, the second line displays the disk label type, and the remaining output shows the partition table. In the partition table, the **Minor** number is the partition number. For example, the partition with minor number 1 corresponds to `/dev/hda1`. The **Start** and **End** values are in megabytes. The **Type** is one of primary, extended, or logical. The **Filesystem** is the file system type, which can be one of ext2, ext3, FAT, hfs, jfs, linux-swap, ntfs, reiserfs, hp-ufs, sun-ufs, or xfs. The **Flags** column lists the flags set for the partition. Available flags are boot, root, swap, hidden, raid, lvm, or lba.

Tip

To select a different device without having to restart `parted`, use the `select` command followed by the device name such as `/dev/hdb`. Then, you can view its partition table or configure it.

5.2. Creating a Partition

Warning

Do not attempt to create a partition on a device that is in use.

Before creating a partition, boot into rescue mode (or unmount any partitions on the device and turn off any swap space on the device).

Start `parted`, where /dev/*hda* is the device on which to create the partition:

```
parted /dev/hda
```

View the current partition table to determine if there is enough free space:

```
print
```

If there is not enough free space, you can resize an existing partition. Refer to Section 5.4 *Resizing a Partition* for details.

5.2.1. Making the Partition

From the partition table, determine the start and end points of the new partition and what partition type it should be. You can only have four primary partitions (with no extended partition) on a device. If you need more than four partitions, you can have three primary partitions, one extended partition, and multiple logical partitions within the extended. For an overview of disk partitions, refer to the appendix *An Introduction to Disk Partitions* in the *Red Hat Enterprise Linux Installation Guide*.

For example, to create a primary partition with an ext3 file system from 1024 megabytes until 2048 megabytes on a hard drive type the following command:

```
mkpart primary ext3 1024 2048
```

Tip

> If you use the `mkpartfs` command instead, the file system is created after the partition is created. However, `parted` does not support creating an ext3 file system. Thus, if you wish to create an ext3 file system, use `mkpart` and create the file system with the `mkfs` command as described later. `mkpartfs` works for file system type linux-swap.

The changes start taking place as soon as you press [Enter], so review the command before executing to it.

After creating the partition, use the `print` command to confirm that it is in the partition table with the correct partition type, file system type, and size. Also remember the minor number of the new partition so that you can label it. You should also view the output of

```
cat /proc/partitions
```

to make sure the kernel recognizes the new partition.

5.2.2. Formating the Partition

The partition still does not have a file system. Create the file system:

```
/sbin/mkfs -t ext3 /dev/hdb3
```

Warning

Formatting the partition permanently destroys any data that currently exists on the partition.

5.2.3. Labeling the Partition

Next, give the partition a label. For example, if the new partition is `/dev/hda3` and you want to label it `/work`:

```
e2label /dev/hda3 /work
```

By default, the installation program uses the mount point of the partition as the label to make sure the label is unique. You can use any label you want.

5.2.4. Creating the Mount Point

As root, create the mount point:

```
mkdir /work
```

5.2.5. Add to `/etc/fstab`

As root, edit the `/etc/fstab` file to include the new partition. The new line should look similar to the following:

```
LABEL=/work           /work                 ext3    defaults        1 2
```

The first column should contain `LABEL=` followed by the label you gave the partition. The second column should contain the mount point for the new partition, and the next column should be the file system type (for example, ext3 or swap). If you need more information about the format, read the man page with the command `man fstab`.

If the fourth column is the word `defaults`, the partition is mounted at boot time. To mount the partition without rebooting, as root, type the command:

```
mount /work
```

5.3. Removing a Partition

Warning

Do not attempt to remove a partition on a device that is in use.

Before removing a partition, boot into rescue mode (or unmount any partitions on the device and turn off any swap space on the device).

Start `parted`, where /dev/*`hda`* is the device on which to remove the partition:

```
parted /dev/hda
```

View the current partition table to determine the minor number of the partition to remove:

```
print
```

Remove the partition with the command `rm`. For example, to remove the partition with minor number 3:

```
rm 3
```

The changes start taking place as soon as you press [Enter], so review the command before committing to it.

After removing the partition, use the `print` command to confirm that it is removed from the partition table. You should also view the output of

```
cat /proc/partitions
```

to make sure the kernel knows the partition is removed.

The last step is to remove it from the `/etc/fstab` file. Find the line that declares the removed partition, and remove it from the file.

5.4. Resizing a Partition

Warning

Do not attempt to resize a partition on a device that is in use.

Before resizing a partition, boot into rescue mode (or unmount any partitions on the device and turn off any swap space on the device).

Start `parted`, where /dev/*hda* is the device on which to resize the partition:

```
parted /dev/hda
```

View the current partition table to determine the minor number of the partition to resize as well as the start and end points for the partition:

```
print
```

Warning

The used space of the partition to resize must not be larger than the new size.

To resize the partition, use the `resize` command followed by the minor number for the partition, the starting place in megabytes, and the end place in megabytes. For example:

```
resize 3 1024 2048
```

After resizing the partition, use the `print` command to confirm that the partition has been resized correctly, is the correct partition type, and is the correct file system type.

After rebooting the system into normal mode, use the command `df` to make sure the partition was mounted and is recognized with the new size.

Chapter 6.
Implementing Disk Quotas

Disk space can be restricted by implementing disk quotas so that the system administrator is alerted before a user consumes too much disk space or a partition becomes full.

Disk quotas can be configured for individual users as well as user groups. This kind of flexibility makes it possible to give each user a small quota to handle "personal" file (such as email and reports), while allowing the projects they work on to have more sizable quotas (assuming the projects are given their own groups).

In addition, quotas can be set not just to control the number of disk blocks consumed but to control the number of inodes. Because inodes are used to contain file-related information, this allows control over the number of files that can be created.

The `quota` RPM must be installed to implement disk quotas. For more information on installing RPM packages, refer to Part III *Package Management*.

6.1. Configuring Disk Quotas

To implement disk quotas, use the following steps:

1. Enable quotas per file system by modifying `/etc/fstab`
2. Remount the file system(s)
3. Create the quota files and generate the disk usage table
4. Assign quotas

Each of these steps is discussed in detail in the following sections.

6.1.1. Enabling Quotas

As root, using a text editor, edit the `/etc/fstab` file and add the `usrquota` and/or `grpquota` options to the file systems that require quotas:

```
LABEL=/          /              ext3    defaults        1 1
LABEL=/boot      /boot          ext3    defaults        1 2
none             /dev/pts       devpts  gid=5,mode=620  0 0
LABEL=/home      /home          ext3    defaults,usrquota,grpquota  1 2
none             /proc          proc    defaults        0 0
none             /dev/shm       tmpfs   defaults        0 0
/dev/hda2        swap           swap    defaults        0 0
/dev/cdrom       /mnt/cdrom     udf,iso9660 noauto,owner,kudzu,ro  0 0
/dev/fd0         /mnt/floppy    auto    noauto,owner,kudzu  0 0
```

In this example, the `/home` file system has both user and group quotas enabled.

6.1.2. Remounting the File Systems

After adding the `userquota` and `grpquota` options, remount each file system whose `fstab` entry has been modified. If the file system is not in use by any process, use the `umount` command followed by the `mount` to remount the file system. If the file system is currently in use, the easiest method for remounting the file system is to reboot the system.

6.1.3. Creating Quota Files

After each quota-enabled file system is remounted, the system is capable of working with disk quotas. However, the file system itself is not yet ready to support quotas. The next step is to run the `quotacheck` command.

The `quotacheck` command examines quota-enabled file systems and builds a table of the current disk usage per file system. The table is then used to update the operating system's copy of disk usage. In addition, the file system's disk quota files are updated.

To create the quota files (`aquota.user` and `aquota.group`) on the file system, use the `-c` option of the `quotacheck` command. For example, if user and group quotas are enabled for the `/home` partition, create the files in the `/home` directory:

```
quotacheck -acug /home
```

The `-a` option means that all mounted non-NFS file systems in `/etc/mtab` are checked to see if quotas are enabled. The `-c` option specifies that the quota files should be created for each file system with quotas enabled, the `-u` specifies to check for user quotas, and the `-g` option specifies to check for group quotas.

If neither the `-u` or `-g` options are specified, only the user quota file is created. If only `-g` is specified, only the group quota file is created.

After the files are created, run the following command to generate the table of current disk usage per file system with quotas enabled:

```
quotacheck -avug
```

The options used are as follows:

- `a` — Check all quota-enabled, locally-mounted file systems
- `v` — Display verbose status information as the quota check proceeds
- `u` — Check user disk quota information
- `g` — Check group disk quota information

After `quotacheck` has finished running, the quota files corresponding to the enabled quotas (user and/or group) are populated with data for each quota-enabled file system such as `/home`.

6.1.4. Assigning Quotas per User

The last step is assigning the disk quotas with the `edquota` command.

To configure the quota for a user, as root in a shell prompt, execute the command:

```
edquota username
```

Perform this step for each user who needs a quota. For example, if a quota is enabled in `/etc/fstab` for the `/home` partition (`/dev/hda3`) and the command `edquota testuser` is executed, the following is shown in the editor configured as the default for the system:

```
Disk quotas for user testuser (uid 501):
  Filesystem           blocks       soft        hard      inodes       soft      hard
  /dev/hda3            440436          0           0       37418          0         0
```

Note

The text editor defined by the EDITOR environment variable is used by `edquota`. To change the editor, set the EDITOR environment variable to the full path of the editor of your choice.

The first column is the name of the file system that has a quota enabled for it. The second column shows how many blocks the user is currently using. The next two columns are used to set soft and hard block limits for the user on the file system. The `inodes` column shows how many inodes the user is currently using. The last two columns are used to set the soft and hard inode limits for the user on the file system.

A hard limit is the absolute maximum amount of disk space that a user or group can use. Once this limit is reached, no further disk space can be used.

The soft limit defines the maximum amount of disk space that can be used. However, unlike the hard limit, the soft limit can be exceeded for a certain amount of time. That time is known as the *grace period*. The grace period can be expressed in seconds, minutes, hours, days, weeks, or months.

If any of the values are set to 0, that limit is not set. In the text editor, change the desired limits. For example:

```
Disk quotas for user testuser (uid 501):
  Filesystem           blocks       soft        hard      inodes      soft      hard
  /dev/hda3            440436      500000      550000     37418         0         0
```

To verify that the quota for the user has been set, use the command:

```
quota testuser
```

6.1.5. Assigning Quotas per Group

Quotas can also be assigned on a per-group basis. For example, to set a group quota for the `devel` group, use the command (the group must exist prior to setting the group quota):

```
edquota -g devel
```

This command displays the existing quota for the group in the text editor:

```
Disk quotas for group devel (gid 505):
  Filesystem           blocks       soft        hard      inodes      soft      hard
  /dev/hda3            440400          0           0       37418         0         0
```

Modify the limits, save the file, and then configure the quota.

To verify that the group quota has been set, use the command:

```
quota -g devel
```

6.1.6. Assigning Quotas per File System

To assign quotas based on each file system enabled for quotas, use the command:

```
edquota -t
```

Like the other `edquota` commands, this one opens the current quotas for the file system in the text editor:

```
Grace period before enforcing soft limits for users:
Time units may be: days, hours, minutes, or seconds
  Filesystem             Block grace period     Inode grace period
  /dev/hda3                     7days                  7days
```

Change the block grace period or inode grace period, save the changes to the file, and exit the text editor.

6.2. Managing Disk Quotas

If quotas are implemented, they need some maintenance — mostly in the form of watching to see if the quotas are exceeded and making sure the quotas are accurate. Of course, if users repeatedly exceeds their quotas or consistently reaches their soft limits, a system administrator has a few choices to make depending on what type of users they are and how much disk space impacts their work. The administrator can either help the user determine how to use less disk space or increase the user's disk quota if needed.

6.2.1. Reporting on Disk Quotas

Creating a disk usage report entails running the `repquota` utility. For example, the command `repquota /home` produces this output:

```
*** Report for user quotas on device /dev/hda3
Block grace time: 7days; Inode grace time: 7days
                        Block limits                File limits
User            used    soft    hard  grace    used  soft  hard  grace
----------------------------------------------------------------------
root      --      36       0       0              4     0     0
tfox      --     540       0       0            125     0     0
testuser  --  440400  500000  550000          37418     0     0
```

To view the disk usage report for all quota-enabled file systems, use the command:

```
repquota -a
```

While the report is easy to read, a few points should be explained. The `--` displayed after each user is a quick way to determine whether the block or inode limits have been exceeded. If either soft limit is exceeded, a + appears in place of the corresponding `-`; the first `-` represents the block limit, and the second represents the inode limit.

The `grace` columns are normally blank. If a soft limit has been exceeded, the column contains a time specification equal to the amount of time remaining on the grace period. If the grace period has expired, `none` appears in its place.

6.2.2. Keeping Quotas Accurate

Whenever a file system is not unmounted cleanly (due to a system crash, for example), it is necessary to run `quotacheck`. However, `quotacheck` can be run on a regular basis, even if the system has not crashed. Running the following command periodically keeps the quotas more accurate (the options used have been described in Section 6.1.1 *Enabling Quotas*):

```
quotacheck -avug
```

The easiest way to run it periodically is to use `cron`. As root, either use the `crontab -e` command to schedule a periodic `quotacheck` or place a script that runs `quotacheck` in any one of the following directories (using whichever interval best matches your needs):

- `/etc/cron.hourly`
- `/etc/cron.daily`
- `/etc/cron.weekly`
- `/etc/cron.monthly`

The most accurate quota statistics can be obtained when the file system(s) analyzed are not in active use. Thus, the cron task should be schedule during a time where the file system(s) are used the least. If this time is various for different file systems with quotas, run `quotacheck` for each file system at different times with multiple cron tasks.

Refer to Chapter 37 *Automated Tasks* for more information about configuring `cron`.

6.2.3. Enabling and Disabling

It is possible to disable quotas without setting them to be 0. To turn all user and group quotas off, use the following command:

```
quotaoff -vaug
```

If neither the `-u` or `-g` options are specified, only the user quotas are disabled. If only `-g` is specified, only group quotas are disabled.

To enable quotas again, use the `quotaon` command with the same options.

For example, to enable user and group quotas for all file systems:

```
quotaon -vaug
```

To enable quotas for a specific file system, such as `/home`:

```
quotaon -vug /home
```

If neither the `-u` or `-g` options are specified, only the user quotas are enabled. If only `-g` is specified, only group quotas are enabled.

6.3. Additional Resources

For more information on disk quotas, refer to the following resources.

6.3.1. Installed Documentation

- The `quotacheck`, `edquota`, `repquota`, `quota`, `quotaon`, and `quotaoff` man pages

6.3.2. Related Books

- *Red Hat Enterprise Linux Introduction to System Administration*; Red Hat, Inc. — Available at http://www.redhat.com/docs/ and on the Documentation CD, this manual contains background information on storage management (including disk quotas) for new Red Hat Enterprise Linux system administrators.

Chapter 7. User-Defined Device Names

The `/dev/` directory contains virtual files that represent devices. Each virtual file represents a device for the system such as a storage device, USB device, or printer. These virtual files are called *device names*.

Device names for IDE devices begin with `hd`, and device names for SCSI devices begin with `sd`. The prefix is followed by a letter, starting with a, that represents the drive order. For example, `/dev/hda` is the first IDE hard drive, `/dev/hdb` is the second IDE hard drive, `/dev/hdc` is the third IDE drive, and so on.

If the device name is followed by a number, the number represents the partition number. For example, `/dev/hda1` represents the first partition on the first IDE drive.

If a hard drive is physically moved to a different location in the machine, is removed, or fails to initialize, some of the device names will change, potentially leaving device name references invalid. For example, as shown in Figure 7-1, if a system has three SCSI hard drives, and the second SCSI hard drive is removed, `/dev/sdc` becomes `/dev/sdb`, causing any references to `/dev/sdc` to become invalid and any references to `/dev/sdb` invalid as well since it is a different drive.

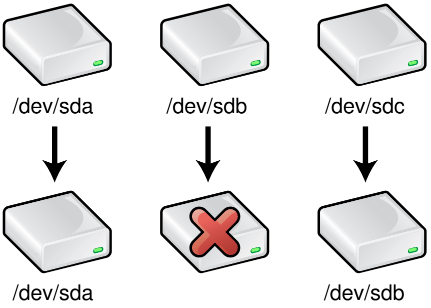

Figure 7-1. Removing a Hard Drive

Every hard drive has a unique identifier associated with it, called a *UUID*. To solve the problem of changing device names, `devlabel` allows for user-defined device names that are associated with these UUIDs. A symbolic link is created from the user-defined device name to the actual device name. If the actual device name changes, the symbolic link is updated to point to the same drive according to its UUID. Thus, both IDE and SCSI storage devices can be referenced by their user-defined names.

`Devlabel` also allows for automatically mounting hotplug devices such as removable hard drives and USB devices such as memory cards for digital cameras. If configured to mount automatically, after the device is plugged in, it is mounted with the user-defined device name.

7.1. Configuring `Devlabel`

User-defined device names can be added based on the device name, partition name, or the UUID of the drive.

Use the following syntax to add a user-defined device name for a storage device. The device specified can be the entire device or a single partition on a device.

```
devlabel add -d <device> -s <symlink>
```

For example, to add the symbolic link /dev/work to represent the /dev/hdb1 partition, use the following command:

```
devlabel add -d /dev/hdb1 -s /dev/work
```

If the command was successful, the following is displayed:

```
Created symlink /dev/work -> /dev/hdb1
Added /dev/work to /etc/sysconfig/devlabel
```

To add a device name for a device based on a UUID, use the following syntax:

```
devlabel add -u <uuid> -s <symlink>
```

To use devlabel to retrieve the UUID for a device (or to make sure it has one), use the following command:

```
devlabel printid -d <device>
```

The symbolic link names must be unique. If an existing link already exists when an attempt is made to add it, the configuration file is not modified, and the following is displayed:

```
The file /dev/work already exists.
Failure. Could not create a symlink.
```

To remove a symbolic link from the devlabel list, use the following command:

```
devlabel remove -s <symlink>
```

The entry is removed from the configuration file, and the symbolic link is deleted.

To determine the status of the devlabel symbolic links, use the following command:

```
devlabel status
```

It returns output similar to the following:

```
lrwxrwxrwx    1 root            9 Apr 29 13:20 /dev/work -> /dev/hdb1
lrwxrwxrwx    1 root            9 Apr 29 13:41 /dev/tcf -> /dev/hda1
```

7.1.1. Hotplug Devices

A program called *hotplug* performs actions when a system event, such as hardware being added or removed, takes place while the system is running. For example, if a USB hard drive or a USB media card reader is attached to the system, hotplug notifies users by logging a message in the system log file (/var/log/messages) and loads the proper kernel modules so the device works.

When a PCI, USB, or IEEE 1394 (also known as FireWire) device is plugged in, the hotplug scripts also restart devlabel so that the removable storage media receives a user-defined device name (such as /dev/usbcard), and optionally it can automatically mount the storage device.

After inserting the USB card reader into the USB port of the computer, issue the following command as root (where /dev/sda1 is the device name for the media card and /dev/usbcard is the user-defined device name to use):

```
devlabel add -d /dev/sda1 -s /dev/usbcard --automount
```

This commands adds an entry for the mount point to `/etc/sysconfig/devlabel` and creates a symbolic link from `/dev/usbcard` to `/dev/sda1`. The `--automount` option to `devlabel` specifies that the device should be automatically mounted when `devlabel` restarts if an entry for it is located in `/etc/fstab` and if the device exists (a device with the same UUID is found).

The `updfstab` is a program that scans the IDE and SCSI buses for new devices and adds entries to `/etc/fstab` for them if entries do not already exist. It also adds entries for USB devices since they appear as SCSI devices. Refer to the `updfstab` man page for more information.

When a USB device is inserted, `hotplug` runs the `updfstab` program, which adds an entry to `/etc/fstab` for the storage device (such as the media card) if it exists. (If a card reader without a card in it is inserted, an entry is not added.) The line added contains the actual device name (such as `/dev/sda1`) and the `kudzu` option. The `kudzu` option tells **Kudzu** [1] that it can remove the line if the device does not exist. Since the line is required by `devlabel`, the `kudzu` option must be removed so the line remains in the file. Also change the device name to the `devlabel` device name (such as `/dev/usbcard`) and create the mount point (such as `/mnt/usbcard`).

After modifying the line, it should look similar to the following:

```
/dev/usbcard    /mnt/usbcard    auto    noauto,owner 0 0
```

Because of `--automount`, when `devlabel` is restarted, the storage media in the USB card reader device is mounted in `/mnt/usbcard` when the USB device is plugged into the computer. The trick is that when the USB card reader is plugged into the computer, the card must already be in the reader. If not, `devlabel` can not find the storage device, and thus it can not automatically mount it.

If the USB card reader is already plugged in without a card, when the card is inserted, run the command `devlabel restart` as root to mount the media card.

7.2. How It Works

The command `devlabel restart` is called from the `/etc/rc.sysinit` script when the system is booted as well as by the appropriate scripts in the `/etc/hotplug/` directory.

The `restart` option to `devlabel` reads the list of devices in the configuration file (`/etc/sysconfig/devlabel`) and follows the symbolic links to determine if the device still exists in its former location, such as `/dev/hdb1`. If the symbolic link is invalid, an attempt is made to find the new location of the disk based on the disk's UUID. If a disk with the same UUID is found, the symbolic link is updated to point to the new location of the drive, the configuration file is updated with the new location, and a message similar to the following is displayed:

```
Device name incorrectly detected for symlink /dev/work!
The device /dev/hdb1 is now /dev/hdd1.
The symlink /dev/work will now point to the new device name.
```

If a disk with the UUID is not found (for example, the disk was removed), the following is displayed:

```
The device /dev/hdb1 no longer seems to exist. Because of this, the
symlink /dev/work -> /dev/hdb1 will not be available. The reference
to this symlink in /etc/sysconfig/devlabel will be ignored.
```

The entry for the device is not removed from the configuration file; it is just ignored for this instance.

1. **Kudzu** is a hardware probing tool run at system boot time to determine what hardware has been added or removed from the system.

7.3. Additional Resources

For more information concerning `devlabel`, refer to these resources.

7.3.1. Installed Documentation

- `man devlabel` — The man page for `devlabel` discusses all of the options and includes a brief description of how it works.
- `man updfstab` — The man page for the `updfstab` program, which is called by `hotplug` when a USB device is inserted.
- `man hotplug` — the man page for `hotplug`.

7.3.2. Useful Websites

- http://www.dell.com/us/en/esg/topics/power_ps1q03-lerhaupt.htm — In *Resolving Device Renaming Issues in Linux*, the developer who wrote the `devlabel` program explains how it works.
- http://www.lerhaupt.com/devlabel/devlabel.html — The developer's project page.

Chapter 8. Access Control Lists

Files and directories have permission sets for the owner of the file, the group associated with the file, and all other users for the system. However, these permission sets have limitations. For example, different permissions can not be configured for different users. Thus, *Access Control Lists* (ACLs) were implemented.

The Red Hat Enterprise Linux 3 kernel provides ACL support for the ext3 file system and NFS-exported file systems. ACLs are also recognized on ext3 file systems accessed via Samba.

Along with support in the kernel, the `acl` package is required to implement ACLs. It contains the utilities used to add, modify, remove, and retrieve ACL information.

The `cp` and `mv` commands copy or move any ACLs associated with files and directories.

8.1. Mounting File Systems

Before using ACLs for a file or directory, the partition for the file or directory must be mounted with ACL support. If it is a local ext3 file system, it can mounted with the following command:

```
mount -t ext3 -o acl <device-name> <partition>
```

For example:

```
mount -t ext3 -o acl /dev/hdb3 /work
```

Alternatively, if the partition is listed in the `/etc/fstab` file, the entry for the partition can include the `acl` option:

```
LABEL=/work      /work       ext3    acl        1 2
```

If an ext3 file system is accessed via Samba and ACLs have been enabled for it, the ACLs are recognized because Samba has been compiled with the `--with-acl-support` option. No special flags are required when accessing or mounting a Samba share.

8.1.1. NFS

By default, if the file system being exported by an NFS server supports ACLs and the NFS client can read ACLs, ACLs are utilized by the client system.

To disable ACLs on NFS shares when configuring the server, include the `no_acl` option in the `/etc/exports` file. To disable ACLs on an NFS share when mounting it on a client, mount it with the `no_acl` option via the command line or the `/etc/fstab` file.

8.2. Setting Access ACLs

There are two types of ACLs: *access ACLs* and *default ACLs*. An access ACL is the access control list for a specific file or directory. A default ACL can only be associated with a directory; if a file within the directory does not have an access ACL, it uses the rules of the default ACL for the directory. Default ACLs are optional.

ACLs can be configured:

1. Per user
2. Per group
3. Via the effective rights mask
4. For users not in the user group for the file

The `setfacl` utility sets ACLs for files and directories. Use the `-m` option to add or modify the ACL of a file or directory:

```
setfacl -m <rules> <files>
```

Rules (<*rules*>) must be specified in the following formats. Multiple rules can be specified in the same command if they are separated by commas.

`u:<uid>:<perms>`

Sets the access ACL for a user. The user name or UID may be specified. The user may be any valid user on the system.

`g:<gid>:<perms>`

Sets the access ACL for a group. The group name or GID may be specified. The group may be any valid group on the system.

`m:<perms>`

Sets the effective rights mask. The mask is the union of all permissions of the owning group and all of the user and group entries.

`o:<perms>`

Sets the access ACL for users other than the ones in the group for the file.

Whitespace is ignored. Permissions (<*perms*>) must be a combination of the characters `r`, `w`, and `x` for read, write, and execute.

If a file or directory already has an ACL, and the `setfacl` command is used, the additional rules are added to the existing ACL or the existing rule is modified.

For example, to give read and write permissions to user tfox:

```
setfacl -m u:tfox:rw /project/somefile
```

To remove all the permissions for a user, group, or others, use the `-x` option and do not specify any permissions:

```
setfacl -x <rules> <files>
```

For example, to remove all permissions from the user with UID 500:

```
setfacl -x u:500 /project/somefile
```

8.3. Setting Default ACLs

To set a default ACL, add `d:` before the rule and specify a directory instead of a file name.

For example, to set the default ACL for the `/share/` directory to read and execute for users not in the user group (an access ACL for an individual file can override it):

```
setfacl -m d:o:rx /share
```

8.4. Retrieving ACLs

To determine the existing ACLs for a file or directory, use the `getfacl` command:

```
getfacl <filename>
```

It returns output similar to the following:

```
# file: file
# owner: tfox
# group: tfox
user::rw-
user:smoore:r--
group::r--
mask::r--
other::r--
```

If a directory is specified, and it has a default ACL, the default ACL is also displayed such as:

```
# file: file
# owner: tfox
# group: tfox
user::rw-
user:smoore:r--
group::r--
mask::r--
other::r--
default:user::rwx
default:user:tfox:rwx
default:group::r-x
default:mask::rwx
default:other::r-x
```

8.5. Archiving File Systems With ACLs

Warning

The `tar` and `dump` commands do *not* backup ACLs.

The `star` utility is similar to the `tar` utility in that it can be used to generate archives of files; however, some of its options are different. Refer to Table 8-1 for a listing of more commonly used options. For all available options, refer to the `star` man page. The `star` package is required to use this utility.

Option	Description
`-c`	Creates an archive file.
`-n`	Do not extract the files; use in conjunction with `-x` to show what extracting the files does.
`-r`	Replaces files in the archive. The files are written to the end of the archive file, replacing any files with the same path and file name.
`-t`	Displays the contents of the archive file.

Option	Description
-u	Updates the archive file. The files are written to the end of the archive if they do not exist in the archive or if the files are newer than the files of the same name in the archive. This option only work if the archive is a file or an unblocked tape that may backspace.
-x	Extracts the files from the archive. If used with -U and a file in the archive is older than the corresponding file on the file system, the file is not extracted.
-help	Displays the most important options.
-xhelp	Displays the least important options.
-/	Do not strip leading slashes from file names when extracting the files from an archive. By default, they are striped when files are extracted.
-acl	When creating or extracting, archive or restore any ACLs associated with the files and directories.

Table 8-1. Command Line Options for `star`

8.6. Compatibility with Older Systems

If an ACL has been set on any file on a given file system, that file system has the `ext_attr` attribute. This attribute can be seen using the following command:

```
tune2fs -l <filesystem-device>
```

A file system that has acquired the `ext_attr` attribute can be mounted with older kernels, but those kernels do not enforce any ACLs which have been set.

Versions of the `e2fsck` utility included in version 1.22 and higher of the `e2fsprogs` package (including the versions in Red Hat Enterprise Linux 2.1 and 3) can check a file system with the `ext_attr` attribute. Older versions refuse to check it.

8.7. Additional Resources

Refer to the follow resources for more information.

8.7.1. Installed Documentation

- `acl` man page — Description of ACLs
- `getfacl` man page — Discusses how to get file access control lists
- `setfacl` man page — Explains how to set file access control lists
- `star` man page — Explains more about the `star` utility and its many options

8.7.2. Useful Websites

- http://acl.bestbits.at/ — Website for ACLs

- http://www.fokus.gmd.de/research/cc/glone/employees/joerg.schilling/private/star.html — Website for the `star` utility

II. Installation-Related Information

The *Red Hat Enterprise Linux Installation Guide* discusses the installation of Red Hat Enterprise Linux and some basic post-installation troubleshooting. However, advanced installation options are covered in this manual. This part provides instructions for *kickstart* (an automated installation technique), system recovery modes (how to boot your system if it does not boot in the normal runlevel), how to configure RAID during installation, and how to configure LVM during installation. Use this part in conjunction with the *Red Hat Enterprise Linux Installation Guide* to perform any of these advanced installation tasks.

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Chapter 9. Kickstart Installations

9.1. What are Kickstart Installations?

Many system administrators would prefer to use an automated installation method to install Red Hat Enterprise Linux on their machines. To answer this need, Red Hat created the kickstart installation method. Using kickstart, a system administrator can create a single file containing the answers to all the questions that would normally be asked during a typical installation.

Kickstart files can be kept on single server system and read by individual computers during the installation. This installation method can support the use of a single kickstart file to install Red Hat Enterprise Linux on multiple machines, making it ideal for network and system administrators.

Kickstart provides a way for users to automate a Red Hat Enterprise Linux installation.

9.2. How Do You Perform a Kickstart Installation?

Kickstart installations can be performed using a local CD-ROM, a local hard drive, or via NFS, FTP, or HTTP.

To use kickstart, you must:

1. Create a kickstart file.
2. Create a boot diskette with the kickstart file or make the kickstart file available on the network.
3. Make the installation tree available.
4. Start the kickstart installation.

This chapter explains these steps in detail.

9.3. Creating the Kickstart File

The kickstart file is a simple text file, containing a list of items, each identified by a keyword. You can create it by editing a copy of the `sample.ks` file found in the `RH-DOCS` directory of the Red Hat Enterprise Linux Documentation CD, using the **Kickstart Configurator** application, or writing it from scratch. The Red Hat Enterprise Linux installation program also creates a sample kickstart file based on the options that you selected during installation. It is written to the file `/root/anaconda-ks.cfg`. You should be able to edit it with any text editor or word processor that can save files as ASCII text.

First, be aware of the following issues when you are creating your kickstart file:

- Sections must be specified *in order*. Items within the sections do not have to be in a specific order unless otherwise specified. The section order is:
  - Command section — Refer to Section 9.4 *Kickstart Options* for a list of kickstart options. You must include the required options.
  - The `%packages` section — Refer to Section 9.5 *Package Selection* for details.
  - The `%pre` and `%post` sections — These two sections can be in any order and are not required. Refer to Section 9.6 *Pre-installation Script* and Section 9.7 *Post-installation Script* for details.

- Items that are not required can be omitted.
- Omitting any required item will result in the installation program prompting the user for an answer to the related item, just as the user would be prompted during a typical installation. Once the answer is given, the installation will continue unattended (unless it finds another missing item).
- Lines starting with a pound sign (#) are treated as comments and are ignored.
- For kickstart *upgrades*, the following items are required:
  - Language
  - Language support
  - Installation method
  - Device specification (if device is needed to perform installation)
  - Keyboard setup
  - The `upgrade` keyword
  - Boot loader configuration

  If any other items are specified for an upgrade, those items will be ignored (note that this includes package selection).

9.4. Kickstart Options

The following options can be placed in a kickstart file. If you prefer to use a graphical interface for creating your kickstart file, you can use the **Kickstart Configurator** application. Refer to Chapter 10 ***Kickstart Configurator*** for details.

Note

If the option is followed by an equals mark (=), a value must be specified after it. In the example commands, options in brackets ([]) are optional arguments for the command.

`autopart` (optional)

Automatically create partitions — 1 GB or more root (`/`) partition, a swap partition, and an appropriate boot partition for the architecture. One or more of the default partition sizes can be redefined with the `part` directive.

`autostep` (optional)

Similar to `interactive` except it goes to the next screen for you. It is used mostly for debugging.

`auth` or `authconfig` (required)

Sets up the authentication options for the system. It's similar to the `authconfig` command, which can be run after the install. By default, passwords are normally encrypted and are not shadowed.

`--enablemd5`

Use md5 encryption for user passwords.

`--enablenis`

Turns on NIS support. By default, `--enablenis` uses whatever domain it finds on the network. A domain should almost always be set by hand with the `--nisdomain=` option.

`--nisdomain=`

NIS domain name to use for NIS services.

`--nisserver=`

Server to use for NIS services (broadcasts by default).

`--useshadow` or `--enableshadow`

Use shadow passwords.

`--enableldap`

Turns on LDAP support in `/etc/nsswitch.conf`, allowing your system to retrieve information about users (UIDs, home directories, shells, etc.) from an LDAP directory. To use this option, you must install the `nss_ldap` package. You must also specify a server and a base DN with `--ldapserver=` and `--ldapbasedn=`.

`--enableldapauth`

Use LDAP as an authentication method. This enables the `pam_ldap` module for authentication and changing passwords, using an LDAP directory. To use this option, you must have the `nss_ldap` package installed. You must also specify a server and a base DN with `--ldapserver=` and `--ldapbasedn=`.

`--ldapserver=`

If you specified either `--enableldap` or `--enableldapauth`, use this option to specify the name of the LDAP server to use. This option is set in the `/etc/ldap.conf` file.

`--ldapbasedn=`

If you specified either `--enableldap` or `--enableldapauth`, use this option to specify the DN (distinguished name) in your LDAP directory tree under which user information is stored. This option is set in the `/etc/ldap.conf` file.

`--enableldaptls`

Use TLS (Transport Layer Security) lookups. This option allows LDAP to send encrypted usernames and passwords to an LDAP server before authentication.

`--enablekrb5`

Use Kerberos 5 for authenticating users. Kerberos itself does not know about home directories, UIDs, or shells. So if you enable Kerberos you will need to make users' accounts known to this workstation by enabling LDAP, NIS, or Hesiod or by using the `/usr/sbin/useradd` command to make their accounts known to this workstation. If you use this option, you must have the `pam_krb5` package installed.

`--krb5realm=`

The Kerberos 5 realm to which your workstation belongs.

`--krb5kdc=`

The KDC (or KDCs) that serve requests for the realm. If you have multiple KDCs in your realm, separate their names with commas (,).

`--krb5adminserver=`

The KDC in your realm that is also running kadmind. This server handles password changing and other administrative requests. This server must be run on the master KDC if you have more than one KDC.

`--enablehesiod`

Enable Hesiod support for looking up user home directories, UIDs, and shells. More information on setting up and using Hesiod on your network is in `/usr/share/doc/glibc-2.x.x/README.hesiod`, which is included in the `glibc` package. Hesiod is an extension of DNS that uses DNS records to store information about users, groups, and various other items.

`--hesiodlhs`

The Hesiod LHS ("left-hand side") option, set in `/etc/hesiod.conf`. This option is used by the Hesiod library to determine the name to search DNS for when looking up information, similar to LDAP's use of a base DN.

`--hesiodrhs`

The Hesiod RHS ("right-hand side") option, set in `/etc/hesiod.conf`. This option is used by the Hesiod library to determine the name to search DNS for when looking up information, similar to LDAP's use of a base DN.

Tip

To look up user information for "jim", the Hesiod library looks up *jim.passwd<LHS><RHS>*, which should resolve to a TXT record that looks like what his passwd entry would look like (`jim:*:501:501:Jungle Jim:/home/jim:/bin/bash`). For groups, the situation is identical, except *jim.group<LHS><RHS>* would be used.

Looking up users and groups by number is handled by making "501.uid" a CNAME for "jim.passwd", and "501.gid" a CNAME for "jim.group". Note that the LHS and RHS do not have periods [.] put in front of them when the library determines the name for which to search, so the LHS and RHS usually begin with periods.

`--enablesmbauth`

Enables authentication of users against an SMB server (typically a Samba or Windows server). SMB authentication support does not know about home directories, UIDs, or shells. So if you enable it you will need to make users' accounts known to the workstation by enabling LDAP, NIS, or Hesiod or by using the `/usr/sbin/useradd` command to make their accounts known to the workstation. To use this option, you must have the `pam_smb` package installed.

`--smbservers=`

The name of the server(s) to use for SMB authentication. To specify more than one server, separate the names with commas (,).

`--smbworkgroup=`

The name of the workgroup for the SMB servers.

`--enablecache`

Enables the `nscd` service. The `nscd` service caches information about users, groups, and various other types of information. Caching is especially helpful if you choose to distribute information about users and groups over your network using NIS, LDAP, or hesiod.

`bootloader` (required)

Specifies how the boot loader should be installed and whether the boot loader should be LILO or GRUB. This option is required for both installations and upgrades. For upgrades, if `--useLilo` is not specified and LILO is the current bootloader, the bootloader will be changed to GRUB. To preserve LILO on upgrades, use `bootloader --upgrade`.

`--append=`

Specifies kernel parameters. To specify multiple parameters, separate them with spaces. For example:

```
bootloader --location=mbr --append="hdd=ide-scsi ide=nodma"
```

`--driveorder`

Specify which drive is first in the BIOS boot order. For example:

```
bootloader --driveorder=sda,hda
```

`--location=`

Specifies where the boot record is written. Valid values are the following: `mbr` (the default), `partition` (installs the boot loader on the first sector of the partition containing the kernel), or `none` (do not install the boot loader).

`--password=`

If using GRUB, sets the GRUB boot loader password the one specified with this option. This should be used to restrict access to the GRUB shell, where arbitrary kernel options can be passed.

`--md5pass=`

If using GRUB, similar to `--password=` except the password should already be encrypted.

`--useLilo`

Use LILO instead of GRUB as the boot loader.

`--linear`

If using LILO, use the `linear` LILO option; this is only for backward compatibility (and linear is now used by default).

`--nolinear`

If using LILO, use the `nolinear` LILO option; linear is the default.

`--lba32`

If using LILO, force use of lba32 mode instead of auto-detecting.

`--upgrade`

Upgrade the existing boot loader configuration, preserving the old entries. This option is only available for upgrades.

`clearpart` (optional)

Removes partitions from the system, prior to creation of new partitions. By default, no partitions are removed.

> **Note**
>
> If the `clearpart` command is used, then the `--onpart` command cannot be used on a logical partition.

`--all`

Erases all partitions from the system.

`--drives=`

Specifies which drives to clear partitions from. For example, the following clears the partitions on the first two drives on the primary IDE controller:

```
clearpart --drives hda,hdb
```

`--initlabel`

Initializes the disk label to the default for your architecture (for example `msdos` for x86 and `gpt` for Itanium). It is useful so that the installation program does not ask if it should initialize the disk label if installing to a brand new hard drive.

`--linux`

Erases all Linux partitions.

`--none` (default)

Do not remove any partitions.

`cmdline` (optional)

Perform the installation in a completely non-interactive command line mode. Any prompts for interaction will halt the install. This mode is useful on S/390 systems with the x3270 console.

`device` (optional)

On most PCI systems, the installation program will autoprobe for Ethernet and SCSI cards properly. On older systems and some PCI systems, however, kickstart needs a hint to find the proper devices. The `device` command, which tells the installation program to install extra modules, is in this format:

```
device <type> <moduleName> --opts=<options>
```

<type>

Replace with either `scsi` or `eth`

<moduleName>

Replace with the name of the kernel module which should be installed.

`--opts=`

Options to pass to the kernel module. Note that multiple options may be passed if they are put in quotes. For example:

```
--opts="aic152x=0x340 io=11"
```

`driverdisk` (optional)

Driver diskettes can be used during kickstart installations. You need to copy the driver diskettes's contents to the root directory of a partition on the system's hard drive. Then you need to use the `driverdisk` command to tell the installation program where to look for the driver disk.

```
driverdisk <partition> [--type=<fstype>]
```

Alternatively, a network location can be specified for the driver diskette:

```
driverdisk --source=ftp://path/to/dd.img
driverdisk --source=http://path/to/dd.img
driverdisk --source=nfs:host:/path/to/img
```

`<partition>`

Partition containing the driver disk.

`--type=`

File system type (for example, vfat or ext2).

`firewall` (optional)

This option corresponds to the **Firewall Configuration** screen in the installation program:

```
firewall --enabled|--disabled [--trust=] <device> [--port=]
```

`--enabled`

Reject incoming connections that are not in response to outbound requests, such as DNS replies or DHCP requests. If access to services running on this machine is needed, you can choose to allow specific services through the firewall.

`--disabled`

Do not configure any iptables rules.

`--trust=`

Listing a device here, such as eth0, allows all traffic coming from that device to go through the firewall. To list more than one device, use `--trust eth0 --trust eth1`. Do NOT use a comma-separated format such as `--trust eth0, eth1`.

`<incoming>`

Replace with one or more of the following to allow the specified services through the firewall.

- `--ssh`
- `--telnet`
- `--smtp`
- `--http`
- `--ftp`

`--port=`

You can specify that ports be allowed through the firewall using the port:protocol format. For example, to allow IMAP access through your firewall, specify `imap:tcp`. Numeric ports can also be specified explicitly; for example, to allow UDP packets on port 1234 through, specify `1234:udp`. To specify multiple ports, separate them by commas.

`firstboot` (optional)

Determine whether the **Setup Agent** starts the first time the system is booted. If enabled, the `firstboot` package must be installed. If not specified, this option is disabled by default.

`--enable`

The **Setup Agent** is started the first time the system boots.

`--disable`

The **Setup Agent** is not started the first time the system boots.

`--reconfig`

Enable the **Setup Agent** to start at boot time in reconfiguration mode. This mode enables the language, mouse, keyboard, root password, security level, time zone, and networking configuration options in addition to the default ones.

`install` (optional)

Tells the system to install a fresh system rather than upgrade an existing system. This is the default mode. For installation, you must specify the type of installation from one of `cdrom`, `harddrive`, `nfs`, or `url` (for ftp or http installations). The `install` command and the installation method command must be on separate lines.

`cdrom`

Install from the first CD-ROM drive on the system.

`harddrive`

Install from a Red Hat installation tree on a local drive, which must be either vfat or ext2.

- `--partition=`

  Partition to install from (such as, sdb2).

- `--dir=`

  Directory containing the `RedHat` directory of the installation tree.

For example:

```
harddrive --partition=hdb2 --dir=/tmp/install-tree
```

`nfs`

Install from the NFS server specified.

- `--server=`

  Server from which to install (hostname or IP).

- `--dir=`

  Directory containing the `RedHat` directory of the installation tree.

  For example:

  `nfs --server=nfsserver.example.com --dir=/tmp/install-tree`

`url`

  Install from an installation tree on a remote server via FTP or HTTP.

  For example:

  `url --url http://<server>/<dir>`

  or:

  `url --url ftp://<username>:<password>@<server>/<dir>`

`interactive` (optional)

Uses the information provided in the kickstart file during the installation, but allow for inspection and modification of the values given. You will be presented with each screen of the installation program with the values from the kickstart file. Either accept the values by clicking **Next** or change the values and click **Next** to continue. See also `autostep`.

`keyboard` (required)

Sets system keyboard type. Here is the list of available keyboards on i386, Itanium, and Alpha machines:

```
be-latin1, bg, br-abnt2, cf, cz-lat2, cz-us-qwertz, de,
de-latin1, de-latin1-nodeadkeys, dk, dk-latin1, dvorak, es, et,
fi, fi-latin1, fr, fr-latin0, fr-latin1, fr-pc, fr_CH, fr_CH-latin1,
gr, hu, hu101, is-latin1, it, it-ibm, it2, jp106, la-latin1, mk-utf,
no, no-latin1, pl, pt-latin1, ro_win, ru, ru-cp1251, ru-ms, ru1, ru2,
ru_win, se-latin1, sg, sg-latin1, sk-qwerty, slovene, speakup,
speakup-lt, sv-latin1, sg, sg-latin1, sk-querty, slovene, trq, ua,
uk, us, us-acentos
```

The file `/usr/lib/python2.2/site-packages/rhpl/keyboard_models.py` also contains this list and is part of the `rhpl` package.

`lang` (required)

Sets the language to use during installation. For example, to set the language to English, the kickstart file should contain the following line:

```
lang en_US
```

The file `/usr/share/redhat-config-language/locale-list` provides a list the valid language codes in the first column of each line and is part of the `redhat-config-languages` package.

`langsupport` (required)

Sets the language(s) to install on the system. The same language codes used with `lang` can be used with `langsupport`.

To install one language, specify it. For example, to install and use the French language `fr_FR`:

```
langsupport fr_FR
```

`--default=`

If language support for more than one language is specified, a default must be identified.

For example, to install English and French and use English as the default language:

```
langsupport --default=en_US fr_FR
```

If you use `--default` with only one language, all languages will be installed with the specified language set to the default.

`logvol` (optional)

Create a logical volume for Logical Volume Management (LVM) with the syntax:

```
logvol <mntpoint> --vgname=<name> --size=<size> --name=<name> <options>
```

The options are as follows:

--noformat

Use an existing logical volume and do not format it.

--useexisting

Use an existing logical volume and reformat it.

Create the partition first, create the logical volume group, and then create the logical volume. For example:

```
part pv.01 --size 3000
volgroup myvg pv.01
logvol / --vgname=myvg --size=2000 --name=rootvol
```

`mouse` (required)

Configures the mouse for the system, both in GUI and text modes. Options are:

`--device=`

Device the mouse is on (such as `--device=ttyS0`).

`--emulthree`

If present, simultaneous clicks on the left and right mouse buttons will be recognized as the middle mouse button by the X Window System. This option should be used if you have a two button mouse.

After options, the mouse type may be specified as one of the following:

```
alpsps/2, ascii, asciips/2, atibm, generic, generic3, genericps/2,
generic3ps/2, genericwheelps/2, genericusb, generic3usb, genericwheelusb,
geniusnm, geniusnmps/2, geniusprops/2, geniusscrollps/2, geniusscrollps/2+,
thinking, thinkingps/2, logitech, logitechcc, logibm, logimman,
logimmanps/2, logimman+, logimman+ps/2, logimmusb, microsoft, msnew,
msintelli, msintellips/2, msintelliusb, msbm, mousesystems, mmseries,
mmhittab, sun, none
```

This list can also be found in the `/usr/lib/python2.2/site-packages/rhpl/mouse.py` file, which is part of the `rhpl` package.

If the mouse command is given without any arguments, or it is omitted, the installation program will attempt to auto-detect the mouse. This procedure works for most modern mice.

`network` (optional)

Configures network information for the system. If the kickstart installation does not require networking (in other words, it is not installed over NFS, HTTP, or FTP), networking is not configured for the system. If the installation does require networking and network information is not provided in the kickstart file, the installation program assumes that the installation should be done over eth0 via a dynamic IP address (BOOTP/DHCP), and configures the final, installed system to determine its IP address dynamically. The `network` option configures networking information for kickstart installations via a network as well as for the installed system.

`--bootproto=`

One of `dhcp`, `bootp`, or `static`.

It default to `dhcp`. `bootp` and `dhcp` are treated the same.

The DHCP method uses a DHCP server system to obtain its networking configuration. As you might guess, the BOOTP method is similar, requiring a BOOTP server to supply the networking configuration. To direct a system to use DHCP:

```
network --bootproto=dhcp
```

To direct a machine to use BOOTP to obtain its networking configuration, use the following line in the kickstart file:

```
network --bootproto=bootp
```

The static method requires that you enter all the required networking information in the kickstart file. As the name implies, this information is static and will be used during and after the installation. The line for static networking is more complex, as you must include all network configuration information on one line. You must specify the IP address, netmask, gateway, and nameserver. For example: (the \ indicates that it is all one line):

```
network --bootproto=static --ip=10.0.2.15 --netmask=255.255.255.0 \
--gateway=10.0.2.254 --nameserver=10.0.2.1
```

If you use the static method, be aware of the following two restrictions:

- All static networking configuration information must be specified on *one* line; you cannot wrap lines using a backslash, for example.
- You can only specify one nameserver here. However, you can use the kickstart file's `%post` section (described in Section 9.7 *Post-installation Script*) to add more name servers, if needed.

`--device=`

Used to select a specific Ethernet device for installation. Note that using `--device=` will not be effective unless the kickstart file is a local file (such as `ks=floppy`), since the installation program will configure the network to find the kickstart file. For example:

```
network --bootproto=dhcp --device=eth0
```

`--ip=`

IP address for the machine to be installed.

`--gateway=`

Default gateway as an IP address.

`--nameserver=`

Primary nameserver, as an IP address.

`--nodns`

Do not configure any DNS server.

`--netmask=`

Netmask for the installed system.

`--hostname=`

Hostname for the installed system.

`part` or `partition` (required for installs, ignored for upgrades)

Creates a partition on the system.

If more than one Red Hat Enterprise Linux installation exists on the system on different partitions, the installation program prompts the user and asks which installation to upgrade.

Warning

All partitions created will be formatted as part of the installation process unless `--noformat` and `--onpart` are used.

<*mntpoint*>

The <*mntpoint*> is where the partition will be mounted and must be of one of the following forms:

- `/`<*path*>

  For example, `/`, `/usr`, `/home`

- `swap`

  The partition will be used as swap space.

  To determine the size of the swap partition automatically, use the `--recommended` option:

  ```
  swap --recommended
  ```

  The minimum size of the automatically-generated swap partition will be no smaller than the amount of RAM in the system and no bigger than twice the amount of RAM in the system.

- `raid.`<*id*>

  The partition will be used for software RAID (refer to `raid`).

- `pv.`<*id*>

  The partition will be used for LVM (refer to `logvol`).

`--size=`

The minimum partition size in megabytes. Specify an integer value here such as 500. Do not append the number with MB.

`--grow`

Tells the partition to grow to fill available space (if any), or up to the maximum size setting.

`--maxsize=`

The maximum partition size in megabytes when the partition is set to grow. Specify an integer value here, and do not append the number with MB.

`--noformat`

Tells the installation program not to format the partition, for use with the `--onpart` command.

`--onpart=` or `--usepart=`

Put the partition on the *already existing* device. For example:

```
partition /home --onpart=hda1
```

will put `/home` on `/dev/hda1`, which must already exist.

`--ondisk=` or `--ondrive=`

Forces the partition to be created on a particular disk. For example, `--ondisk=sdb` will put the partition on the second SCSI disk on the system.

`--asprimary`

Forces automatic allocation of the partition as a primary partition or the partitioning will fail.

`--type=` (replaced by `fstype`)

This option is no longer available. Use `fstype`.

`--fstype=`

Sets the file system type for the partition. Valid values are `ext2`, `ext3`, `swap`, and `vfat`.

`--start=`

Specifies the starting cylinder for the partition. It requires that a drive be specified with `--ondisk=` or `ondrive=`. It also requires that the ending cylinder be specified with `--end=` or the partition size be specified with `--size=`.

`--end=`

Specifies the ending cylinder for the partition. It requires that the starting cylinder be specified with `--start=`.

Note

If partitioning fails for any reason, diagnostic messages will appear on virtual console 3.

`raid` (optional)

Assembles a software RAID device. This command is of the form:

```
raid <mntpoint> --level=<level> --device=<mddevice> <partitions*>
```

<*mntpoint*>

Location where the RAID file system is mounted. If it is `/`, the RAID level must be 1 unless a boot partition (`/boot`) is present. If a boot partition is present, the `/boot` partition must be level 1 and the root (`/`) partition can be any of the available types. The <*partitions**> (which denotes that multiple partitions can be listed) lists the RAID identifiers to add to the RAID array.

`--level=`

RAID level to use (0, 1, or 5).

`--device=`

Name of the RAID device to use (such as md0 or md1). RAID devices range from md0 to md7, and each may only be used once.

`--spares=`

Specifies the number of spare drives allocated for the RAID array. Spare drives are used to rebuild the array in case of drive failure.

`--fstype=`

Sets the file system type for the RAID array. Valid values are ext2, ext3, swap, and vfat.

`--noformat`

Use an existing RAID device and do not format the RAID array.

`--useexisting`

Use an existing RAID device and reformat it.

The following example shows how to create a RAID level 1 partition for `/`, and a RAID level 5 for `/usr`, assuming there are three SCSI disks on the system. It also creates three swap partitions, one on each drive.

```
part raid.01 --size=60 --ondisk=sda
part raid.02 --size=60 --ondisk=sdb
part raid.03 --size=60 --ondisk=sdc
part swap --size=128 --ondisk=sda
part swap --size=128 --ondisk=sdb
part swap --size=128 --ondisk=sdc
part raid.11 --size=1 --grow --ondisk=sda
part raid.12 --size=1 --grow --ondisk=sdb
part raid.13 --size=1 --grow --ondisk=sdc
raid / --level=1 --device=md0 raid.01 raid.02 raid.03
raid /usr --level=5 --device=md1 raid.11 raid.12 raid.13
```

`reboot` (optional)

Reboot after the installation is complete (no arguments). Normally, kickstart displays a message and waits for the user to press a key before rebooting.

`rootpw` (required)

Sets the system's root password to the <*password*> argument.

```
rootpw [--iscrypted] <password>
```

`--iscrypted`

If this is present, the password argument is assumed to already be encrypted.

`skipx` (optional)

If present, X is not configured on the installed system.

`text` (optional)

Perform the kickstart installation in text mode. Kickstart installations are performed in graphical mode by default.

`timezone` (required)

Sets the system time zone to <*timezone*> which may be any of the time zones listed by `timeconfig`.

`timezone [--utc] <timezone>`

`--utc`

If present, the system assumes the hardware clock is set to UTC (Greenwich Mean) time.

`upgrade` (optional)

Tells the system to upgrade an existing system rather than install a fresh system. You must specify one of cdrom, harddrive, nfs, or url (for ftp and http) as the location of the installation tree. Refer to `install` for details.

`xconfig` (optional)

Configures the X Window System. If this option is not given, the user will need to configure X manually during the installation, if X was installed; this option should not be used if X is not installed on the final system.

`--noprobe`

Do not probe the monitor.

`--card=`

Use specified card; this card name should be from the list of cards in `/usr/share/hwdata/Cards` from the `hwdata` package. The list of cards can also be found on the **X Configuration** screen of the **Kickstart Configurator**. If this argument is not provided, the installation program will probe the PCI bus for the card. Since AGP is part of the PCI bus, AGP cards will be detected if supported. The probe order is determined by the PCI scan order of the motherboard.

`--videoram=`

Specify the amount of video RAM the video card has.

`--monitor=`

Use specified monitor; monitor name should be from the list of monitors in `/usr/share/hwdata/MonitorsDB` from the `hwdata` package. The list of monitors can also be found on the **X Configuration** screen of the **Kickstart Configurator**. This is ignored if `--hsync` or `--vsync` is provided. If no monitor information is provided, the installation program tries to probe for it automatically.

`--hsync=`

Specifies the horizontal sync frequency of the monitor.

`--vsync=`

Specifies the vertical sync frequency of the monitor.

`--defaultdesktop=`

Specify either GNOME or KDE to set the default desktop (assumes that GNOME Desktop Environment and/or KDE Desktop Environment has been installed through `%packages`).

`--startxonboot`

Use a graphical login on the installed system.

`--resolution=`

Specify the default resolution for the X Window System on the installed system. Valid values are 640x480, 800x600, 1024x768, 1152x864, 1280x1024, 1400x1050, 1600x1200. Be sure to specify a resolution that is compatible with the video card and monitor.

`--depth=`

Specify the default color depth for the X Window System on the installed system. Valid values are 8, 16, 24, and 32. Be sure to specify a color depth that is compatible with the video card and monitor.

`volgroup` (optional)

Use to create a Logical Volume Management (LVM) group with the syntax:

```
volgroup <name> <partition> <options>
```

The options are as follows:

--noformat

Use an existing volume group and do not format it.

--useexisting

Use an existing volume group and reformat it.

Create the partition first, create the logical volume group, and then create the logical volume. For example:

```
part pv.01 --size 3000
volgroup myvg pv.01
logvol / --vgname=myvg --size=2000 --name=rootvol
```

`zerombr` (optional)

If `zerombr` is specified, and `yes` is its sole argument, any invalid partition tables found on disks are initialized. This will destroy all of the contents of disks with invalid partition tables. This command should be in the following format:

```
zerombr yes
```

No other format is effective.

`%include`

Use the `%include /path/to/file` command to include the contents of another file in the kickstart file as though the contents were at the location of the `%include` command in the kickstart file.

9.5. Package Selection

Use the `%packages` command to begin a kickstart file section that lists the packages you would like to install (this is for installations only, as package selection during upgrades is not supported).

Packages can be specified by group or by individual package name. The installation program defines several groups that contain related packages. Refer to the `RedHat/base/comps.xml` file on the first Red Hat Enterprise Linux CD-ROM for a list of groups. Each group has an id, user visibility value, name, description, and package list. In the package list, the packages marked as mandatory are always installed if the group is selected, the packages marked default are selected by default if the group is selected, and the packages marked optional must be specifically selected even if the group is selected to be installed.

In most cases, it is only necessary to list the desired groups and not individual packages. Note that the `Core` and `Base` groups are always selected by default, so it is not necessary to specify them in the `%packages` section.

Here is an example `%packages` selection:

```
%packages
@ X Window System
@ GNOME Desktop Environment
@ Graphical Internet
@ Sound and Video
dhcp
```

As you can see, groups are specified, one to a line, starting with an `@` symbol, a space, and then the full group name as given in the `comps.xml` file. Groups can also be specified using the id for the group, such as `gnome-desktop`. Specify individual packages with no additional characters (the `dhcp` line in the example above is an individual package).

You can also specify which packages not to install from the default package list:

```
-autofs
```

The following options are available for the `%packages` option:

`--resolvedeps`

Install the listed packages and automatically resolve package dependencies. If this option is not specified and there are package dependencies, the automated installation will pause and prompt the user. For example:

`%packages --resolvedeps`

`--ignoredeps`

Ignore the unresolved dependencies and install the listed packages without the dependencies. For example:

`%packages --ignoredeps`

`--ignoremissing`

Ignore the missing packages and groups instead of halting the installation to ask if the installation should be aborted or continued. For example:

```
%packages --ignoremissing
```

9.6. Pre-installation Script

You can add commands to run on the system immediately after the `ks.cfg` has been parsed. This section must be at the end of the kickstart file (after the commands) and must start with the `%pre` command. You can access the network in the `%pre` section; however, *name service* has not been configured at this point, so only IP addresses will work.

Note

Note that the pre-install script is not run in the change root environment.

`--interpreter` */usr/bin/python*

Allows you to specify a different scripting language, such as Python. Replace */usr/bin/python* with the scripting language of your choice.

9.6.1. Example

Here is an example `%pre` section:

```
%pre

#!/bin/sh

hds=""
mymedia=""

for file in /proc/ide/h*
do
  mymedia=`cat $file/media`
  if [ $mymedia == "disk" ] ; then
      hds="$hds `basename $file`"
  fi
done

set $hds
numhd=`echo $#`

drive1=`echo $hds | cut -d' ' -f1`
drive2=`echo $hds | cut -d' ' -f2`

#Write out partition scheme based on whether there are 1 or 2 hard drives

if [ $numhd == "2" ] ; then
  #2 drives
  echo "#partitioning scheme generated in %pre for 2 drives" > /tmp/part-include
  echo "clearpart --all" >> /tmp/part-include
  echo "part /boot --fstype ext3 --size 75 --ondisk hda" >> /tmp/part-include
  echo "part / --fstype ext3 --size 1 --grow --ondisk hda" >> /tmp/part-include
```

```
  echo "part swap --recommended --ondisk $drive1" >> /tmp/part-include
  echo "part /home --fstype ext3 --size 1 --grow --ondisk hdb" >> /tmp/part-include
else
  #1 drive
  echo "#partitioning scheme generated in %pre for 1 drive" > /tmp/part-include
  echo "clearpart --all" >> /tmp/part-include
  echo "part /boot --fstype ext3 --size 75" >> /tmp/part-includ
  echo "part swap --recommended" >> /tmp/part-include
  echo "part / --fstype ext3 --size 2048" >> /tmp/part-include
  echo "part /home --fstype ext3 --size 2048 --grow" >> /tmp/part-include
fi
```

This script determines the number of hard drives in the system and writes a text file with a different partitioning scheme depending on whether it has one or two drives. Instead of having a set of partitioning commands in the kickstart file, include the line:

```
%include /tmp/part-include
```

The partitioning commands selected in the script will be used.

9.7. Post-installation Script

You have the option of adding commands to run on the system once the installation is complete. This section must be at the end of the kickstart file and must start with the `%post` command. This section is useful for functions such as installing additional software and configuring an additional nameserver.

Note

If you configured the network with static IP information, including a nameserver, you can access the network and resolve IP addresses in the `%post` section. If you configured the network for DHCP, the `/etc/resolv.conf` file has not been completed when the installation executes the `%post` section. You can access the network, but you can not resolve IP addresses. Thus, if you are using DHCP, you must specify IP addresses in the `%post` section.

Note

The post-install script is run in a chroot environment; therefore, performing tasks such as copying scripts or RPMs from the installation media will not work.

`--nochroot`

Allows you to specify commands that you would like to run outside of the chroot environment.

The following example copies the file `/etc/resolv.conf` to the file system that was just installed.

```
%post --nochroot
cp /etc/resolv.conf /mnt/sysimage/etc/resolv.conf
```

`--interpreter` */usr/bin/python*

Allows you to specify a different scripting language, such as Python. Replace */usr/bin/python* with the scripting language of your choice.

9.7.1. Examples

Turn services on and off:

```
/sbin/chkconfig --level 345 telnet off
/sbin/chkconfig --level 345 finger off
/sbin/chkconfig --level 345 lpd off
/sbin/chkconfig --level 345 httpd on
```

Run a script named `runme` from an NFS share:

```
mkdir /mnt/temp
mount 10.10.0.2:/usr/new-machines /mnt/temp
open -s -w -- /mnt/temp/runme
umount /mnt/temp
```

Add a user to the system:

```
/usr/sbin/useradd bob
/usr/bin/chfn -f "Bob Smith" bob
/usr/sbin/usermod -p 'kjdf$04930FTH/ ' bob
```

9.8. Making the Kickstart File Available

A kickstart file must be placed in one of the following locations:

- On a boot diskette
- On a boot CD-ROM
- On a network

Normally a kickstart file is copied to the boot diskette, or made available on the network. The network-based approach is most commonly used, as most kickstart installations tend to be performed on networked computers.

Let us take a more in-depth look at where the kickstart file may be placed.

9.8.1. Creating a Kickstart Boot Diskette

To perform a diskette-based kickstart installation, the kickstart file must be named `ks.cfg` and must be located in the boot diskette's top-level directory. Refer to the section *Making an Installation Boot Diskette* in the *Red Hat Enterprise Linux Installation Guide* for instruction on creating a boot diskette. Because the boot diskettes are in MS-DOS format, it is easy to copy the kickstart file under Linux using the `mcopy` command:

```
mcopy ks.cfg a:
```

Alternatively, you can use Windows to copy the file. You can also mount the MS-DOS boot diskette in Red Hat Enterprise Linux with the file system type vfat and use the `cp` command to copy the file on the diskette.

9.8.2. Creating a Kickstart Boot CD-ROM

To perform a CD-ROM-based kickstart installation, the kickstart file must be named `ks.cfg` and must be located in the boot CD-ROM's top-level directory. Since a CD-ROM is read-only, the file must be added to the directory used to create the image that is written to the CD-ROM. Refer to the *Making an Installation Boot CD-ROM* section in the *Red Hat Enterprise Linux Installation Guide* for instruction on creating a boot CD-ROM; however, before making the `file.iso` image file, copy the `ks.cfg` kickstart file to the `isolinux/` directory.

9.8.3. Making the Kickstart File Available on the Network

Network installations using kickstart are quite common, because system administrators can easily automate the installation on many networked computers quickly and painlessly. In general, the approach most commonly used is for the administrator to have both a BOOTP/DHCP server and an NFS server on the local network. The BOOTP/DHCP server is used to give the client system its networking information, while the actual files used during the installation are served by the NFS server. Often, these two servers run on the same physical machine, but they are not required to.

To perform a network-based kickstart installation, you must have a BOOTP/DHCP server on your network, and it must include configuration information for the machine on which you are attempting to install Red Hat Enterprise Linux. The BOOTP/DHCP server will provide the client with its networking information as well as the location of the kickstart file.

If a kickstart file is specified by the BOOTP/DHCP server, the client system will attempt an NFS mount of the file's path, and will copy the specified file to the client, using it as the kickstart file. The exact settings required vary depending on the BOOTP/DHCP server you use.

Here is an example of a line from the `dhcpd.conf` file for the DHCP server:

```
filename "/usr/new-machine/kickstart/";
next-server blarg.redhat.com;
```

Note that you should replace the value after `filename` with the name of the kickstart file (or the directory in which the kickstart file resides) and the value after `next-server` with the NFS server name.

If the filename returned by the BOOTP/DHCP server ends with a slash ("/"), then it is interpreted as a path only. In this case, the client system mounts that path using NFS, and searches for a particular file. The filename the client searches for is:

```
<ip-addr>-kickstart
```

The <*ip-addr*> section of the filename should be replaced with the client's IP address in dotted decimal notation. For example, the filename for a computer with an IP address of 10.10.0.1 would be `10.10.0.1-kickstart`.

Note that if you do not specify a server name, then the client system will attempt to use the server that answered the BOOTP/DHCP request as its NFS server. If you do not specify a path or filename, the client system will try to mount `/kickstart` from the BOOTP/DHCP server and will try to find the kickstart file using the same `<ip-addr>-kickstart` filename as described above.

9.9. Making the Installation Tree Available

The kickstart installation needs to access an *installation tree*. An installation tree is a copy of the binary Red Hat Enterprise Linux CD-ROMs with the same directory structure.

If you are performing a CD-based installation, insert the Red Hat Enterprise Linux CD-ROM #1 into the computer before starting the kickstart installation.

If you are performing a hard-drive installation, make sure the ISO images of the binary Red Hat Enterprise Linux CD-ROMs are on a hard drive in the computer.

If you are performing a network-based (NFS, FTP, or HTTP) installation, you must make the installation tree available over the network. Refer to the *Preparing for a Network Installation* section of the *Red Hat Enterprise Linux Installation Guide* for details.

9.10. Starting a Kickstart Installation

To begin a kickstart installation, you must boot the system from a Red Hat Enterprise Linux boot diskette, Red Hat Enterprise Linux boot CD-ROM, or the Red Hat Enterprise Linux CD-ROM #1 and enter a special boot command at the boot prompt. The installation program looks for a kickstart file if the `ks` command line argument is passed to the kernel.

Boot Diskette

If the kickstart file is located on a boot diskette as described in Section 9.8.1 *Creating a Kickstart Boot Diskette*, boot the system with the diskette in the drive, and enter the following command at the `boot:` prompt:

`linux ks=floppy`

CD-ROM #1 and Diskette

The **`linux ks=floppy`** command also works if the `ks.cfg` file is located on a vfat or ext2 file system on a diskette and you boot from the Red Hat Enterprise Linux CD-ROM #1.

An alternate boot command is to boot off the Red Hat Enterprise Linux CD-ROM #1 and have the kickstart file on a vfat or ext2 file system on a diskette. To do so, enter the following command at the `boot:` prompt:

`linux ks=hd:fd0:/ks.cfg`

With Driver Disk

If you need to use a driver disk with kickstart, specify the **`dd`** option as well. For example, to boot off a boot diskette and use a driver disk, enter the following command at the `boot:` prompt:

`linux ks=floppy dd`

Boot CD-ROM

If the kickstart file is on a boot CD-ROM as described in Section 9.8.2 *Creating a Kickstart Boot CD-ROM*, insert the CD-ROM into the system, boot the system, and enter the following command at the `boot:` prompt (where `ks.cfg` is the name of the kickstart file):

`linux ks=cdrom:/ks.cfg`

Other options to start a kickstart installation are as follows:

`ks=nfs:`<*`server`*>`:/`<*`path`*>

The installation program will look for the kickstart file on the NFS server <*`server`*>, as file <*`path`*>. The installation program will use DHCP to configure the Ethernet card. For example, if your NFS server is server.example.com and the kickstart file is in the NFS share `/mydir/ks.cfg`, the correct boot command would be `ks=nfs:server.example.com:/mydir/ks.cfg`.

`ks=http://<server>/<path>`

The installation program will look for the kickstart file on the HTTP server *<server>*, as file *<path>*. The installation program will use DHCP to configure the Ethernet card. For example, if your HTTP server is server.example.com and the kickstart file is in the HTTP directory `/mydir/ks.cfg`, the correct boot command would be `ks=http://server.example.com/mydir/ks.cfg`.

`ks=floppy`

The installation program looks for the file `ks.cfg` on a vfat or ext2 file system on the diskette in `/dev/fd0`.

`ks=floppy:/<path>`

The installation program will look for the kickstart file on the diskette in `/dev/fd0`, as file *<path>*.

`ks=hd:<device>:/<file>`

The installation program will mount the file system on *<device>* (which must be vfat or ext2), and look for the kickstart configuration file as *<file>* in that file system (for example, `ks=hd:sda3:/mydir/ks.cfg`).

`ks=file:/<file>`

The installation program will try to read the file *<file>* from the file system; no mounts will be done. This is normally used if the kickstart file is already on the `initrd` image.

`ks=cdrom:/<path>`

The installation program will look for the kickstart file on CD-ROM, as file *<path>*.

`ks`

If `ks` is used alone, the installation program will configure the Ethernet card to use DHCP. The kickstart file is read from the "bootServer" from the DHCP response as if it is an NFS server sharing the kickstart file. By default, the bootServer is the same as the DHCP server. The name of the kickstart file is one of the following:

- If DHCP is specified and the bootfile begins with a `/`, the bootfile provided by DHCP is looked for on the NFS server.
- If DHCP is specified and the bootfile begins with something other then a `/`, the bootfile provided by DHCP is looked for in the `/kickstart` directory on the NFS server.
- If DHCP did not specify a bootfile, then the installation program tries to read the file `/kickstart/1.2.3.4-kickstart`, where *1.2.3.4* is the numeric IP address of the machine being installed.

`ksdevice=<device>`

The installation program will use this network device to connect to the network. For example, to start a kickstart installation with the kickstart file on an NFS server that is connected to the system through the eth1 device, use the command `ks=nfs:<server>:/<path> ksdevice=eth1` at the `boot:` prompt.

Chapter 10.

Kickstart Configurator

Kickstart Configurator allows you to create or modify a kickstart file using a graphical user interface, so that you do not have to remember the correct syntax of the file.

To use **Kickstart Configurator**, you must be running the X Window System. To start **Kickstart Configurator**, select the **Main Menu Button** (on the Panel) => **System Tools** => **Kickstart**, or type the command `/usr/sbin/redhat-config-kickstart`.

As you are creating a kickstart file, you can select **File** => **Preview** at any time to review your current selections.

To start with an existing kickstart file, select **File** => **Open** and select the existing file.

10.1. Basic Configuration

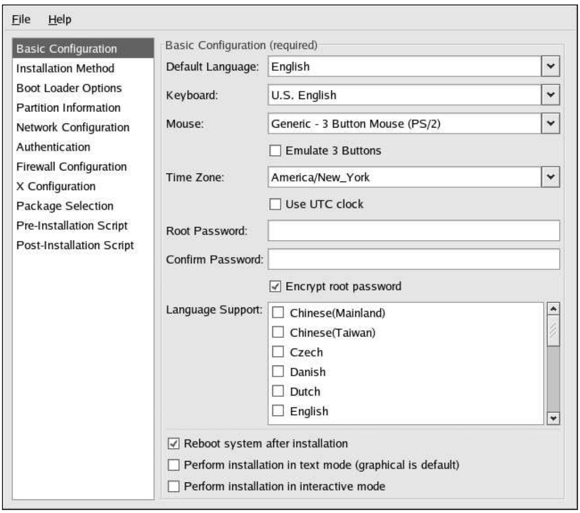

Figure 10-1. Basic Configuration

Choose the language to use during the installation and as the default language after installation from the **Default Language** menu.

Select the system keyboard type from the **Keyboard** menu.

Choose the mouse for the system from the **Mouse** menu. If **No Mouse** is selected, no mouse will be configured. If **Probe for Mouse** is selected, the installation program tries to auto-detect the mouse. Probing works for most modern mice.

If the system has a two-button mouse, a three-button mouse can be emulated by selecting **Emulate 3 Buttons**. If this option is selected, simultaneously clicking the left and right mouse buttons will be recognized as a middle mouse button click.

From the **Time Zone** menu, choose the time zone to use for the system. To configure the system to use UTC, select **Use UTC clock**.

Enter the desired root password for the system in the **Root Password** text entry box. Type the same password in the **Confirm Password** text box. The second field is to make sure you do not mistype the password and then realize you do not know what it is after you have completed the installation. To save the password as an encrypted password in the file, select **Encrypt root password**. If the encryption option is selected, when the file is saved, the plain text password that you typed will be encrypted and written to the kickstart file. Do not type an already encrypted password and select to encrypt it. Because a kickstart file is a plain text file that can be easily read, it is recommended that an encrypted password be used.

To install languages in addition to the one selected from the **Default Language** pulldown menu. check them in the **Language Support** list. The language selected from the **Default Language** pulldown menu is used by default after installation; however, the default can be changed with the **Language Configuration Tool** (`redhat-config-language`) after installation.

Choosing **Reboot system after installation** will reboot your system automatically after the installation is finished.

Kickstart installations are performed in graphical mode by default. To override this default and use text mode instead, select the **Perform installation in text mode** option.

You can perform a kickstart installation in interactive mode. This means that the installation program uses all the options pre-configured in the kickstart file, but it allows you to preview the options in each screen before continuing to the next screen. To continue to the next screen, click the **Next** button after you have approved the settings or change them before continuing the installation. To select this type of installation, select the **Perform installation in interactive mode** option.

10.2. Installation Method

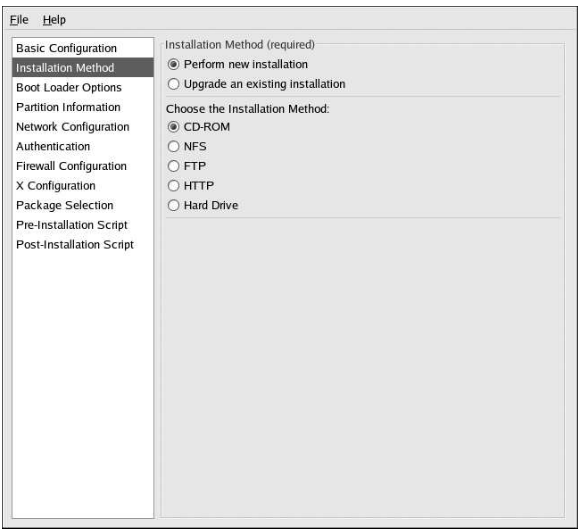

Figure 10-2. Installation Method

The **Installation Method** screen allows you to choose whether to perform a new installation or an upgrade. If you choose upgrade, the **Partition Information** and **Package Selection** options will be disabled. They are not supported for kickstart upgrades.

Also choose the type of kickstart installation or upgrade screen from the following options:

- **CD-ROM** — Choose this option to install or upgrade from the Red Hat Enterprise Linux CD-ROMs.
- **NFS** — Choose this option to install or upgrade from an NFS shared directory. In the text field for the the NFS server, enter a fully-qualified domain name or IP address. For the NFS directory, enter the name of the NFS directory that contains the `RedHat` directory of the installation tree. For example, if the NFS server contains the directory `/mirrors/redhat/i386/RedHat/`, enter `/mirrors/redhat/i386/` for the NFS directory.
- **FTP** — Choose this option to install or upgrade from an FTP server. In the FTP server text field, enter a fully-qualified domain name or IP address. For the FTP directory, enter the name of the FTP directory that contains the `RedHat` directory. For example, if the FTP server contains the directory `/mirrors/redhat/i386/RedHat/`, enter `/mirrors/redhat/i386/` for the FTP directory. If the FTP server requires a username and password, specify them as well.
- **HTTP** — Choose this option to install or upgrade from an HTTP server. In the text field for the HTTP server, enter the fully-qualified domain name or IP address. For the HTTP directory, enter the name of the HTTP directory that contains the `RedHat` directory. For example, if the HTTP server contains the directory `/mirrors/redhat/i386/RedHat/`, enter `/mirrors/redhat/i386/` for the HTTP directory.
- **Hard Drive** — Choose this option to install or upgrade from a hard drive. Hard drive installations require the use of ISO (or CD-ROM) images. Be sure to verify that the ISO images are intact before you start the installation. To verify them, use an `md5sum` program as well as the `linux mediacheck` boot option as discussed in the *Red Hat Enterprise Linux Installation Guide*. Enter the hard drive partition that contains the ISO images (for example, `/dev/hda1`) in the **Hard Drive Partition** text box. Enter the directory that contains the ISO images in the **Hard Drive Directory** text box.

10.3. Boot Loader Options

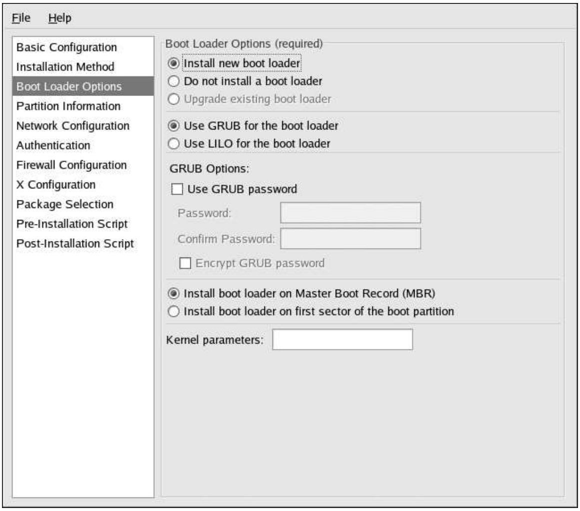

Figure 10-3. Boot Loader Options

You have the option of installing GRUB or LILO as the boot loader. If you do not want to install a boot loader, select **Do not install a boot loader**. If you choose not to install a boot loader, make sure you create a boot diskette or have another way to boot (such as a third-party boot loader) your system.

If you choose to install a boot loader, you must also choose which boot loader to install (GRUB or LILO) and where to to install the boot loader (the Master Boot Record or the first sector of the `/boot` partition). Install the boot loader on the MBR if you plan to use it as your boot loader. If you are using a different boot loader, install LILO or GRUB on the first sector of the `/boot` partition and configure the other boot loader to boot Red Hat Enterprise Linux.

To pass any special parameters to the kernel to be used when the system boots, enter them in the **Kernel parameters** text field. For example, if you have an IDE CD-ROM Writer, you can tell the kernel to use the SCSI emulation driver that must be loaded before using `cdrecord` by configuring **`hdd=ide-scsi`** as a kernel parameter (where **`hdd`** is the CD-ROM device).

If you choose GRUB as the boot loader, you can password protect it by configuring a GRUB password. Select **Use GRUB password**, and enter a password in the **Password** field. Type the same password in the **Confirm Password** text field. To save the password as an encrypted password in the file, select **Encrypt GRUB password**. If the encryption option is selected, when the file is saved, the plain text password that you typed will be encrypted and written to the kickstart file. Do not type an already encrypted password and select to encrypt it.

If you choose LILO as the boot loader, choose whether you want to use linear mode and whether you want to force the use of lba32 mode.

If **Upgrade an existing installation** is selected on the **Installation Method** page, select **Upgrade existing boot loader** to upgrade the existing boot loader configuration, while preserving the old entries.

10.4. Partition Information

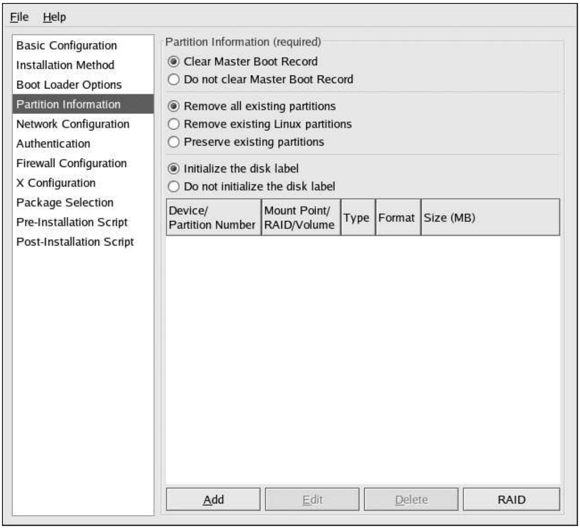

Figure 10-4. Partition Information

Select whether or not to clear the Master Boot Record (MBR). Choose to remove all existing partitions, remove all existing Linux partitions, or preserve existing partitions.

To initialize the disk label to the default for the architecture of the system (for example, `msdos` for x86 and `gpt` for Itanium), select **Initialize the disk label** if you are installing on a brand new hard drive.

10.4.1. Creating Partitions

To create a partition, click the **Add** button. The **Partition Options** window shown in Figure 10-5 appears. Choose the mount point, file system type, and partition size for the new partition. Optionally, you can also choose from the following:

- In the **Additional Size Options** section, choose to make the partition a fixed size, up to a chosen size, or fill the remaining space on the hard drive. If you selected swap as the file system type, you can select to have the installation program create the swap partition with the recommended size instead of specifying a size.
- Force the partition to be created as a primary partition.
- Create the partition on a specific hard drive. For example, to make the partition on the first IDE hard disk (`/dev/hda`), specify **`hda`** as the drive. Do not include `/dev` in the drive name.
- Use an existing partition. For example, to make the partition on the first partition on the first IDE hard disk (`/dev/hda1`), specify **`hda1`** as the partition. Do not include `/dev` in the partition name.
- Format the partition as the chosen file system type.

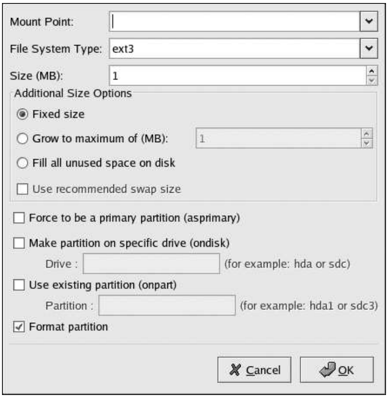

Figure 10-5. Creating Partitions

To edit an existing partition, select the partition from the list and click the **Edit** button. The same **Partition Options** window appears as when you chose to add a partition as shown in Figure 10-5, except it reflects the values for the selected partition. Modify the partition options and click **OK**.

To delete an existing partition, select the partition from the list and click the **Delete** button.

10.4.1.1. Creating Software RAID Partitions

Refer to Chapter 3 *Redundant Array of Independent Disks (RAID)* to learn more about RAID and the different RAID levels. RAID 0, 1, and 5 can be configured.

To create a software RAID partition, use the following steps:

1. Click the **RAID** button.
2. Select **Create a software RAID partition**.
3. Configure the partitions as previously described, except select **Software RAID** as the file system type. Also, you must specify a hard drive on which to make the partition or specify an existing partition to use.

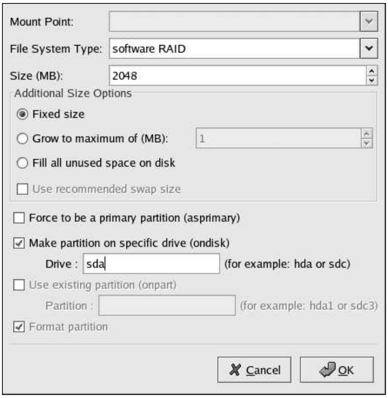

Figure 10-6. Creating a Software RAID Partition

Repeat these steps to create as many partitions as needed for your RAID setup. All of your partitions do not have to be RAID partitions.

After creating all the partitions needed to form a RAID device, follow these steps:

1. Click the **RAID** button.
2. Select **Create a RAID device**.
3. Select a mount point, file system type, RAID device name, RAID level, RAID members, number of spares for the software RAID device, and whether to format the RAID device.

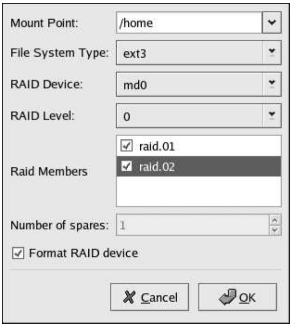

Figure 10-7. Creating a Software RAID Device

4. Click **OK** to add the device to the list.

10.5. Network Configuration

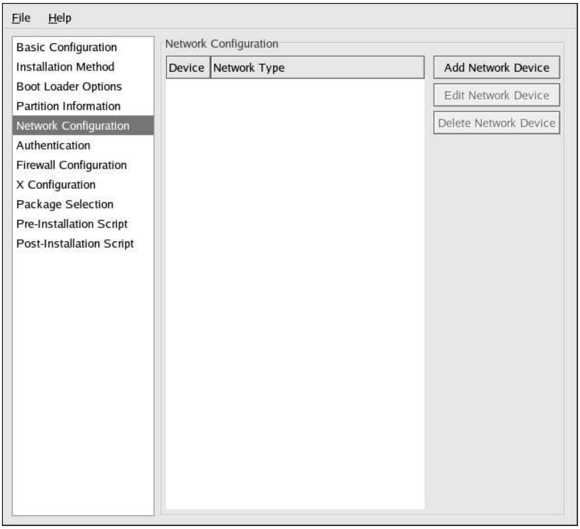

Figure 10-8. Network Configuration

If the system to be installed via kickstart does not have an Ethernet card, do not configure one on the **Network Configuration** page.

Networking is only required if you choose a networking-based installation method (NFS, FTP, or HTTP). Networking can always be configured after installation with the **Network Administration Tool** (`redhat-config-network`). Refer to Chapter 19 *Network Configuration* for details.

For each Ethernet card on the system, click **Add Network Device** and select the network device and network type for the device. Select **eth0** to configure the first Ethernet card, **eth1** for the second Ethernet card, and so on.

10.6. Authentication

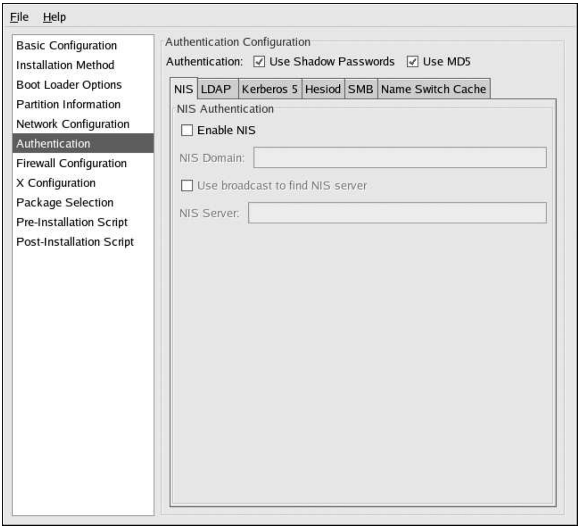

Figure 10-9. Authentication

In the **Authentication** section, select whether to use shadow passwords and MD5 encryption for user passwords. These options are highly recommended and chosen by default.

The **Authentication Configuration** options allow you to configure the following methods of authentication:

- NIS
- LDAP
- Kerberos 5
- Hesiod
- SMB
- Name Switch Cache

These methods are not enabled by default. To enable one or more of these methods, click the appropriate tab, click the checkbox next to **Enable**, and enter the appropriate information for the authentication method. Refer to Chapter 29 *Authentication Configuration* for more information about the options.

10.7. Firewall Configuration

The **Firewall Configuration** window is similar to the screen in the installation program and the **Security Level Configuration Tool**.

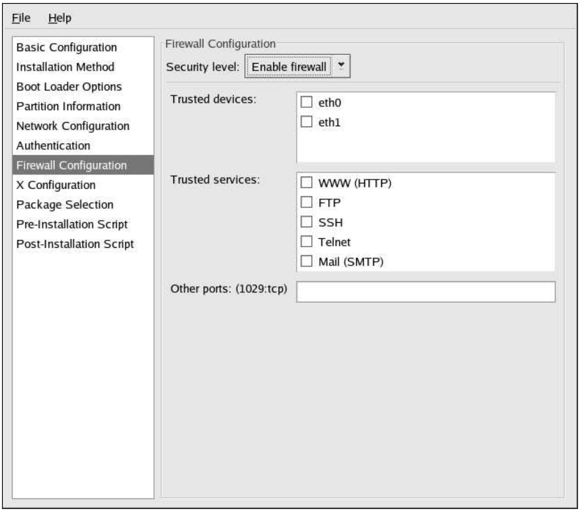

Figure 10-10. Firewall Configuration

If **Disable firewall** is selected, the system allows complete access to any active services and ports. No connections to the system are refused or denied.

Selecting **Enable firewall** configures the system to reject incoming connections that are not in response to outbound requests, such as DNS replies or DHCP requests. If access to services running on this machine is needed, you can choose to allow specific services through the firewall.

Only devices configured in the **Network Configuration** section are listed as available **Trusted devices**. Connections from any devices selected in the list are accepted by the system. For example, if **eth1** only receives connections from internal system, you might want to allow connections from it.

If a service is selected in the **Trusted services** list, connections for the service are accepted and processed by the system.

In the **Other ports** text field, list any additional ports that should be opened for remote access. Use the following format: **`port:protocol`**. For example, to allow IMAP access through the firewall, specify **`imap:tcp`**. Specify numeric ports can also be specified; to allow UDP packets on port 1234 through the firewall, enter **`1234:udp`**. To specify multiple ports, separate them with commas.

10.8. X Configuration

If you are installing the X Window System, you can configure it during the kickstart installation by checking the **Configure the X Window System** option on the **X Configuration** window as shown in Figure 10-11. If this option is not chosen, the X configuration options will be disabled and the `skipx` option will be written to the kickstart file.

10.8.1. General

The first step in configuring X is to choose the default color depth and resolution. Select them from their respective pulldown menus. Be sure to specify a color depth and resolution that is compatible with the video card and monitor for the system.

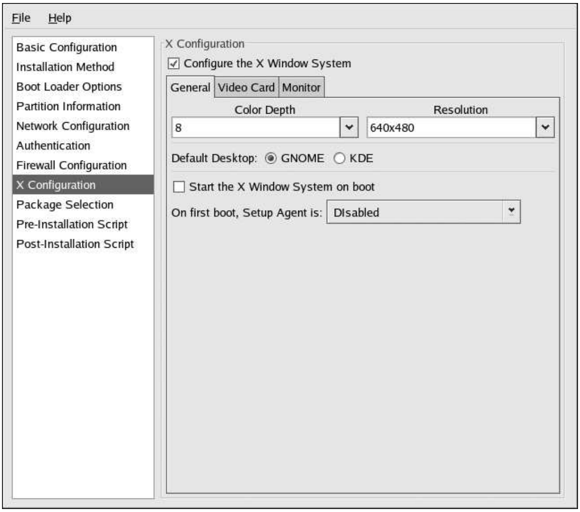

Figure 10-11. X Configuration - General

If you are installing both the GNOME and KDE desktops, you must choose which desktop should be the default. If only one desktop is to be installed, be sure to choose it. Once the system is installed, users can choose which desktop they want to be their default.

Next, choose whether to start the X Window System when the system is booted. This option will start the system in runlevel 5 with the graphical login screen. After the system is installed, this can be changed by modifying the `/etc/inittab` configuration file.

Also select whether to start the **Setup Agent** the first time the system is rebooted. It is disabled by default, but the setting can be changed to enabled or enabled in reconfiguration mode. Reconfiguration mode enables the language, mouse, keyboard, root password, security level, time zone, and networking configuration options in addition to the default ones.

10.8.2. Video Card

Probe for video card is selected by default. Accept this default to have the installation program probe for the video card during installation. Probing works for most modern video cards. If this option is selected and the installation program cannot successfully probe the video card, the installation program will stop at the video card configuration screen. To continue the installation process, select your video card from the list and click **Next**.

Alternatively, you can select the video card from the list on the **Video Card** tab as shown in Figure 10-12. Specify the amount of video RAM the selected video card has from the **Video Card RAM** pulldown menu. These values are used by the installation program to configure the X Window System.

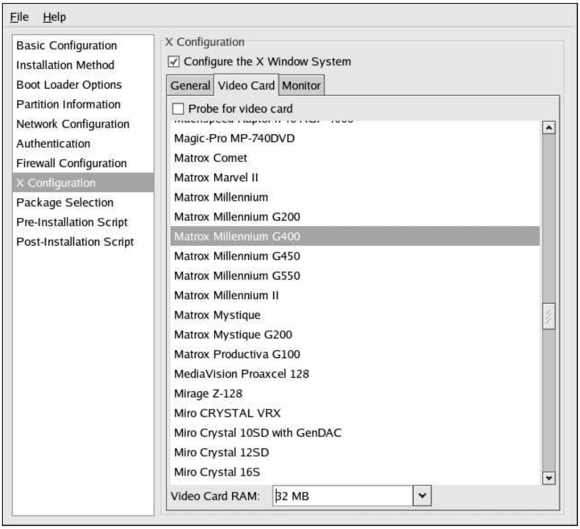

Figure 10-12. X Configuration - Video Card

10.8.3. Monitor

After configuring the video card, click on the **Monitor** tab as shown in Figure 10-13.

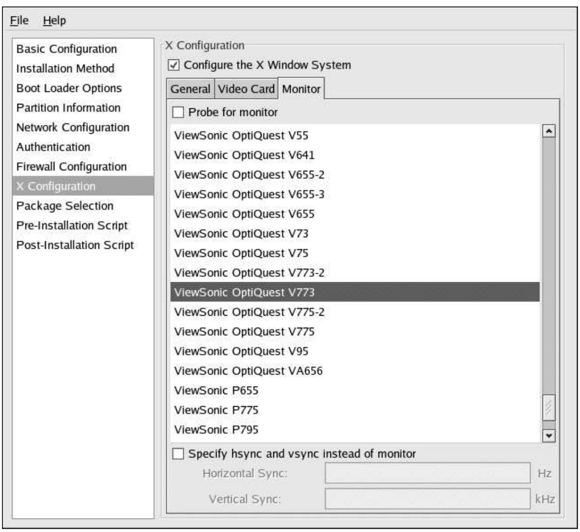

Figure 10-13. X Configuration - Monitor

Probe for monitor is selected by default. Accept this default to have the installation program probe for the monitor during installation. Probing works for most modern monitors. If this option is selected and the installation program cannot successfully probe the monitor, the installation program will stop at the monitor configuration screen. To continue the installation process, select your monitor from the list and click **Next**.

Alternatively, you can select your monitor from the list. You can also specify the horizontal and vertical sync rates instead of selecting a specific monitor by checking the **Specify hysnc and vsync instead of monitor** option. This option is useful if the monitor for the system is not listed. Notice that when this option is enabled, the monitor list is disabled.

10.9. Package Selection

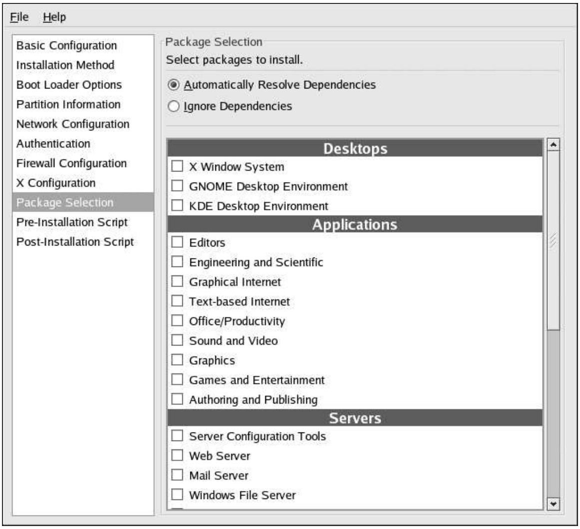

Figure 10-14. Package Selection

The **Package Selection** window allows you to choose which package groups to install.

There are also options available to resolve and ignore package dependencies automatically.

Currently, **Kickstart Configurator** does not allow you to select individual packages. To install individual packages, modify the `%packages` section of the kickstart file after you save it. Refer to Section 9.5 *Package Selection* for details.

10.10. Pre-Installation Script

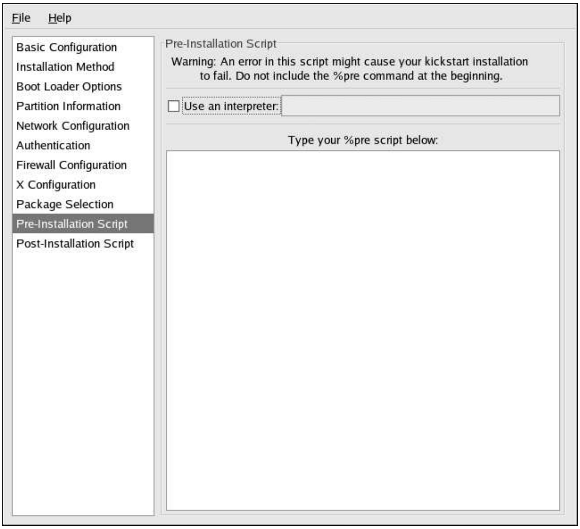

Figure 10-15. Pre-Installation Script

You can add commands to run on the system immediately after the kickstart file has been parsed and before the installation begins. If you have configured the network in the kickstart file, the network is enabled before this section is processed. To include a pre-installation script, type it in the text area.

To specify a scripting language to use to execute the script, select the **Use an interpreter** option and enter the interpreter in the text box beside it. For example, **`/usr/bin/python2.2`** can be specified for a Python script. This option corresponds to using `%pre --interpreter` *`/usr/bin/python2.2`* in your kickstart file.

Caution

Do not include the `%pre` command. It will be added for you.

10.11. Post-Installation Script

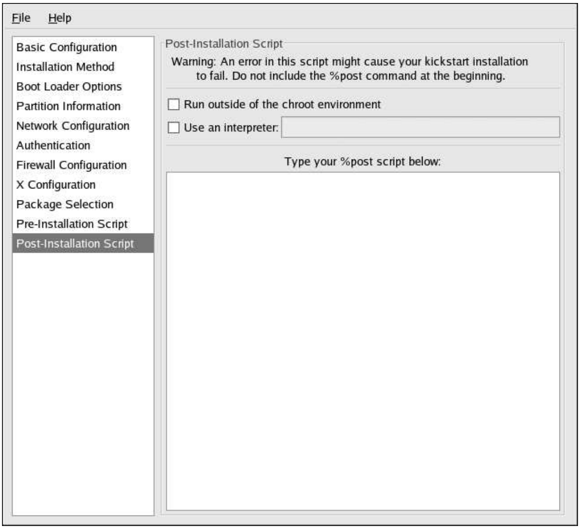

Figure 10-16. Post-Installation Script

You can also add commands to execute on the system after the installation is completed. If the network is properly configured in the kickstart file, the network is enabled, and the script can include commands to access resources on the network. To include a post-installation script, type it in the text area.

Caution

Do not include the `%post` command. It will be added for you.

For example, to change the message of the day for the newly installed system, add the following command to the `%post` section:

```
echo "Hackers will be punished!" > /etc/motd
```

Tip

More examples can be found in Section 9.7.1 *Examples*.

10.11.1. Chroot Environment

To run the post-installation script outside of the chroot environment, click the checkbox next to this option on the top of the **Post-Installation** window. This is equivalent to the using the `--nochroot` option in the `%post` section.

To make any changes to the newly installed file system in the post-installation section outside of the chroot environment, you must prepend the directory name with `/mnt/sysimage/`.

For example, if you select **Run outside of the chroot environment**, the previous example needs to be changed to the following:

```
echo "Hackers will be punished!" > /mnt/sysimage/etc/motd
```

10.11.2. Use an Interpreter

To specify a scripting language to use to execute the script, select the **Use an interpreter** option and enter the interpreter in the text box beside it. For example, **`/usr/bin/python2.2`** can be specified for a Python script. This option corresponds to using `%post --interpreter` *`/usr/bin/python2.2`* in your kickstart file.

10.12. Saving the File

To review the contents of the kickstart file after you have finished choosing your kickstart options, select **File** => **Preview** from the pull-down menu.

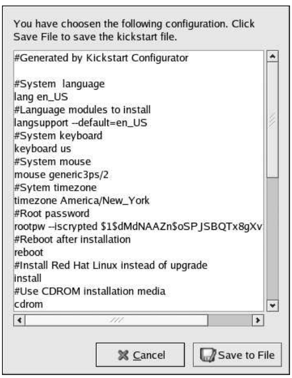

Figure 10-17. Preview

To save the kickstart file, click the **Save to File** button in the preview window. To save the file without previewing it, select **File** => **Save File** or press [Ctrl]-[S]. A dialog box appears. Select where to save the file.

After saving the file, refer to Section 9.10 *Starting a Kickstart Installation* for information on how to start the kickstart installation.

Chapter 11.
Basic System Recovery

When things go wrong, there are ways to fix problems. However, these methods require that you understand the system well. This chapter describes how to boot into rescue mode, single-user mode, and emergency mode, where you can use your own knowledge to repair the system.

11.1. Common Problems

You might need to boot into one of these recovery modes for any of the following reasons:

- You are unable to boot normally into Red Hat Enterprise Linux (runlevel 3 or 5).
- You are having hardware or software problems, and you want to get a few important files off of your system's hard drive.
- You forgot the root password.

11.1.1. Unable to Boot into Red Hat Enterprise Linux

This problem is often caused by the installation of another operating system after you have installed Red Hat Enterprise Linux. Some other operating systems assume that you have no other operating systems on your computer. They overwrite the Master Boot Record (MBR) that originally contained the GRUB or LILO boot loader. If the boot loader is overwritten in this manner, you will not be able to boot Red Hat Enterprise Linux unless you can get into rescue mode and reconfigure the boot loader.

Another common problem occurs when using a partitioning tool to resize a partition or create a new partition from free space after installation, and it changes the order of your partitions. If the partition number of your `/` partition changes, the boot loader might not be able to find it to mount the partition. To fix this problem, boot in rescue mode and modify `/boot/grub/grub.conf` if you are using GRUB or `/etc/lilo.conf` if you are using LILO. You *must* also run the `/sbin/lilo` command anytime you modify the LILO configuration file.

11.1.2. Hardware/Software Problems

This category includes a wide variety of different situations. Two examples include failing hard drives and specifying an invalid root device or kernel in the boot loader configuration file. If either of these occur, you might not be able to reboot into Red Hat Enterprise Linux. However, if you boot into one of the system recovery modes, you might be able to resolve the problem or at least get copies of your most important files.

11.1.3. Root Password

What can you do if you forget your root password? To reset it to a different password, boot into rescue mode or single-user mode and use the `passwd` command to reset the root password.

11.2. Booting into Rescue Mode

Rescue mode provides the ability to boot a small Red Hat Enterprise Linux environment entirely from a diskette, CD-ROM, or some other boot method instead of the system's hard drive.

As the name implies, rescue mode is provided to rescue you from something. During normal operation, your Red Hat Enterprise Linux system uses files located on your system's hard drive to do everything — run programs, store your files, and more.

However, there may be times when you are unable to get Red Hat Enterprise Linux running completely enough to access files on your system's hard drive. Using rescue mode, you can access the files stored on your system's hard drive, even if you cannot actually run Red Hat Enterprise Linux from that hard drive.

To boot into rescue mode, you must be able to boot the system using one of the following methods:

- By booting the system from an installation boot diskette.[1]
- By booting the system from an installation boot CD-ROM.[1]
- By booting the system from the Red Hat Enterprise Linux CD-ROM #1.

Once you have booted using one of the described methods, add the keyword **`rescue`** as a kernel parameter. For example, for an x86 system, type the following command at the installation boot prompt:

```
linux rescue
```

You are prompted to answer a few basic questions, including which language to use. It also prompts you to select where a valid rescue image is located. Select from **Local CD-ROM**, **Hard Drive**, **NFS image**, **FTP**, or **HTTP**. The location selected must contain a valid installation tree, and the installation tree must be for the same version of Red Hat Enterprise Linux as the Red Hat Enterprise Linux CD-ROM #1 from which you booted. If you used a boot CD-ROM or diskette to start rescue mode, the installation tree must be from the same tree from which the media was created. For more information about how to setup an installation tree on a hard drive, NFS server, FTP server, or HTTP server, refer to the *Red Hat Enterprise Linux Installation Guide*.

If you select a rescue image that does not require a network connect, you are asked whether or not you want to establish a network connection. A network connection is useful if you need to backup files to a different computer or install some RPM packages from a shared network location, for example.

You will also see the following message:

```
The rescue environment will now attempt to find your Red Hat
Linux installation and mount it under the directory
/mnt/sysimage.  You can then make any changes required to your
system.  If you want to proceed with this step choose
'Continue'. You can also choose to mount your file systems
read-only instead of read-write by choosing 'Read-only'.
If for some reason this process fails you can choose 'Skip'
and this step will be skipped and you will go directly to a
command shell.
```

If you select **Continue**, it attempts to mount your file system under the directory `/mnt/sysimage/`. If it fails to mount a partition, it notifies you. If you select **Read-Only**, it attempts to mount your file system under the directory `/mnt/sysimage/`, but in read-only mode. If you select **Skip**, your file system is not mounted. Choose **Skip** if you think your file system is corrupted.

Once you have your system in rescue mode, a prompt appears on VC (virtual console) 1 and VC 2 (use the [Ctrl]-[Alt]-[F1] key combination to access VC 1 and [Ctrl]-[Alt]-[F2] to access VC 2):

1. Refer to the *Red Hat Enterprise Linux Installation Guide* for more details.

1. Refer to the *Red Hat Enterprise Linux Installation Guide* for more details.

```
sh-2.05b#
```

If you selected **Continue** to mount your partitions automatically and they were mounted successfully, you are in single-user mode.

Even if your file system is mounted, the default root partition while in rescue mode is a temporary root partition, not the root partition of the file system used during normal user mode (runlevel 3 or 5). If you selected to mount your file system and it mounted successfully, you can change the root partition of the rescue mode environment to the root partition of your file system by executing the following command:

```
chroot /mnt/sysimage
```

This is useful if you need to run commands such as `rpm` that require your root partition to be mounted as `/`. To exit the chroot environment, type `exit`, and you will return to the prompt.

If you selected **Skip**, you can still try to mount a partition manually inside rescue mode by creating a directory such as */foo*, and typing the following command:

```
mount -t ext3 /dev/hda5 /foo
```

In the above command, */foo* is a directory that you have created and */dev/hda5* is the partition you want to mount. If the partition is of type `ext2`, replace `ext3` with `ext2`.

If you do not know the names of your partitions, use the following command to list them:

```
fdisk -l
```

From the prompt, you can run many useful commands such as

- `list-harddrives` to list the hard drives in the system
- `ssh`, `scp`, and `ping` if the network is started
- `dump` and `restore` for users with tape drives
- `parted` and `fdisk` for managing partitions
- `rpm` for installing or upgrading software
- `joe` for editing configuration files (If you try to start other popular editors such as `emacs`, `pico`, or `vi`, the `joe` editor will be started.)

11.3. Booting into Single-User Mode

One of the advantages of single-user mode is that you do not need a boot diskette or CD-ROM; however, it does not give you the option to mount the file systems as read-only or not mount them at all.

If your system boots, but does not allow you to log in when it has completed booting, try single-user mode.

In single-user mode, your computer boots to runlevel 1. Your local file systems are mounted, but your network is not activated. You have a usable system maintenance shell. Unlike rescue mode, single-user mode automatically tries to mount your file system; *do not* use single-user mode if your file system can not be mounted successfully. You can not use single-user mode if the runlevel 1 configuration on your system is corrupted.

On an x86 system using GRUB as the boot loader, use the following steps to boot into single-user mode:

1. If you have a GRUB password configured, type `p` and enter the password.
2. Select **Red Hat Enterprise Linux** with the version of the kernel that you wish to boot and type `a` to append the line.
3. Go to the end of the line and type **`single`** as a separate word (press the [Spacebar] and then type **`single`**). Press [Enter] to exit edit mode.
4. Back at the GRUB screen, type `b` to boot into single-user mode.

On an x86 system using LILO as the boot loader, at the LILO boot prompt (if you are using the graphical LILO, you must press [Ctrl]-[x] to exit the graphical screen and go to the `boot:` prompt) type:

```
linux single
```

For all other platforms, specify **`single`** as a kernel parameter at the boot prompt.

11.4. Booting into Emergency Mode

In emergency mode, you are booted into the most minimal environment possible. The root file system is be mounted read-only and almost nothing is set up. The main advantage of emergency mode over single-user mode is that the `init` files are not loaded. If `init` is corrupted or not working, you can still mount file systems to recover data that could be lost during a re-installation.

To boot into emergency mode, use the same method as described for single-user mode in Section 11.3 *Booting into Single-User Mode* with one exception, replace the keyword **`single`** with the keyword **`emergency`**.

Chapter 12.

Software RAID Configuration

Read Chapter 3 *Redundant Array of Independent Disks (RAID)* first to learn about RAID, the differences between Hardware and Software RAID, and the differences between RAID 0, 1, and 5.

Software RAID can be configured during the graphical installation of Red Hat Enterprise Linux or during a kickstart installation. This chapter discusses how to configure software RAID during installation, using the **Disk Druid** interface.

Before you can create a RAID device, you must first create RAID partitions, using the following step-by-step instructions:

1. On the **Disk Partitioning Setup** screen, select **Manually partition with Disk Druid**.
2. In **Disk Druid**, choose **New** to create a new partition.
3. Choose **software RAID** from the **File System Type** pulldown menu as shown in Figure 12-1.

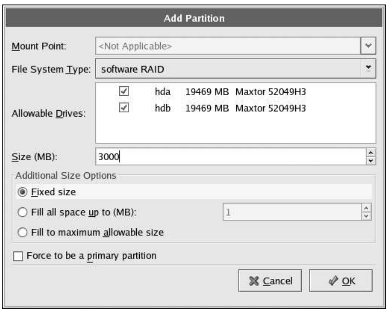

Figure 12-1. Creating a New RAID Partition

4. You will not be able to enter a mount point (you will be able to do that once you have created your RAID device).
5. A software RAID partition must be constrained to one drive. For **Allowable Drives**, select the drive on which RAID will be created. If you have multiple drives, all drives will be selected, and you must deselect all but one drive.
6. Enter the size that you want the partition to be.
7. Select **Fixed size** to make the partition the specified size, select **Fill all space up to (MB)** and enter a size in MBs to give range for the partition size, or select **Fill to maximum allowable size** to make it grow to fill all available space on the hard disk. If you make more than one partition growable, they will share the available free space on the disk.
8. Select **Force to be a primary partition** if you want the partition to be a primary partition.
9. Click **OK** to return to the main screen.

Repeat these steps to create as many partitions as needed for your RAID setup. Notice that all the partitions do not have to be RAID partitions. For example, you can configure only the `/home` partition as a software RAID device.

Once you have all of your partitions created as **software RAID** partitions, follow these steps:

1. Select the **RAID** button on the **Disk Druid** main partitioning screen (refer to Figure 12-4).
2. Figure 12-2 will appear. Select **Create a RAID device**.

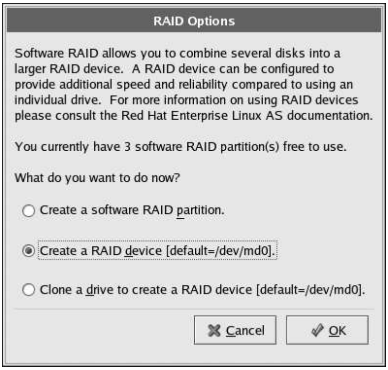

Figure 12-2. RAID Options

3. Next, Figure 12-3 will appear, where you can make a RAID device.

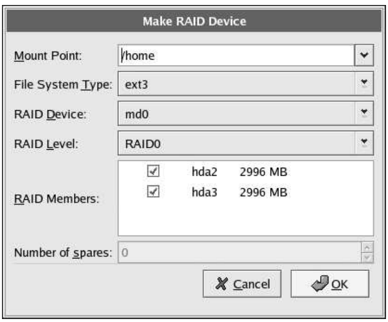

Figure 12-3. Making a RAID Device

4. Enter a mount point.
5. Choose the file system type for the partition.
6. Select a device name such as **md0** for the RAID device.
7. Choose your RAID level. You can choose from **RAID 0**, **RAID 1**, and **RAID 5**.

Note

If you are making a RAID partition of `/boot`, you must choose RAID level 1, and it must use one of the first two drives (IDE first, SCSI second). If you are not creating a RAID partition of `/boot`, and you are making a RAID partition of `/`, it must be RAID level 1 and it must use one of the first two drives (IDE first, SCSI second).

8. The RAID partitions you just created appear in the **RAID Members** list. Select which partitions of these partitions should be used to create the RAID device.
9. If configuring RAID 1 or RAID 5, specify the number of spare partitions. If a software RAID partition fails, the spare will automatically be used as a replacement. For each spare you want to specify, you must create an additional software RAID partition (in addition to the partitions for the RAID device). In the previous step, select the partitions for the RAID device and the partition(s) for the spare(s).
10. After clicking **OK**, the RAID device will appear in the **Drive Summary** list as shown in Figure 12-4. At this point, you can continue with your installation process. Refer to the *Red Hat Enterprise Linux Installation Guide* for further instructions.

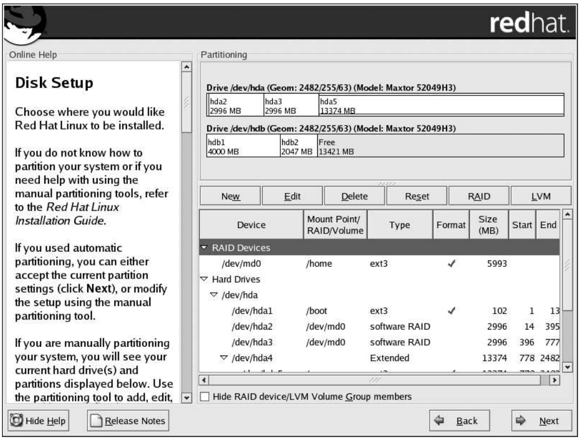

Figure 12-4. RAID Array Created

Chapter 13.

LVM Configuration

LVM can be configured during the graphical installation process or during a kickstart installation. You can use the utilities from the `lvm` package to create your LVM configuration, but these instructions focus on using **Disk Druid** during installation to complete this task.

Read Chapter 4 *Logical Volume Manager (LVM)* first to learn about LVM. An overview of the steps required to configure LVM:

- Create *physical volumes* from the hard drives.
- Create *volume groups* from the physical volumes.
- Create *logical volumes* from the volume groups and assign the logical volumes mount points.

Note

You can only edit LVM volume groups in GUI installation mode. In text installation mode, you can assign mount points to existing logical volumes.

To create a logical volume group with logical volumes during installation:

1. On the **Disk Partitioning Setup** screen, select **Manually partition with Disk Druid**.
2. Select **New**.
3. Select **physical volume (LVM)** from the **File System Type** pulldown menu as shown in Figure 13-1.

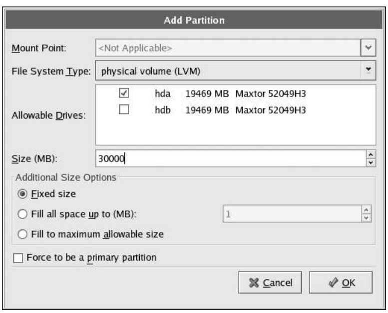

Figure 13-1. Creating a Physical Volume

4. You will not be able to enter a mount point (you will be able to do that once you have created your volume group).
5. A physical volume must be constrained to one drive. For **Allowable Drives**, select the drive on which the physical volume will be created. If you have multiple drives, all drives will be selected, and you must deselect all but one drive.

6. Enter the size that you want the physical volume to be.
7. Select **Fixed size** to make the physical volume the specified size, select **Fill all space up to (MB)** and enter a size in MBs to give range for the physical volume size, or select **Fill to maximum allowable size** to make it grow to fill all available space on the hard disk. If you make more than one growable, they will share the available free space on the disk.
8. Select **Force to be a primary partition** if you want the partition to be a primary partition.
9. Click **OK** to return to the main screen.

Repeat these step to create as many physical volumes as needed for your LVM setup. For example, if you want the volume group to span over more than one drive, create a physical volume on each of the drives.

Warning

The `/boot` partition can not be on a volume group because the boot loader can not read it. If you want to have your root partition on a logical volume, you will need to create a separate `/boot` partition which is not a part of a volume group.

Once all the physical volumes are created, follow these steps:

1. Click the **LVM** button to collect the physical volumes into volume groups. A volume group is basically a collection of physical volumes. You can have multiple logical volume groups, but a physical volume can only be in one volume group.

   Note

   There is overhead disk space reserved in the logical volume group. The summation of the physical volumes may not equal the size of the volume group; however, the size of the logical volumes shown is correct.

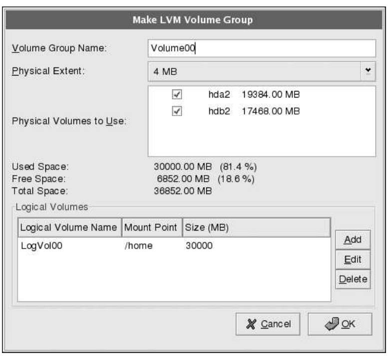

Figure 13-2. Creating an LVM Device

2. Change the **Volume Group Name** if desired.

3. All logical volumes inside the volume group must be allocated in *physical extent* units. By default, the physical extent is set to 4 MB; thus, logical volume sizes must be divisible by 4 MBs. If you enter a size that is not a unit of 4 MBs, the installation program automatically selects the closest size in units of 4 MBs. It is not recommended that you change this setting.
4. Select which physical volumes to use for the volume group.
5. Create logical volumes with mount points such as `/home`. Remember that `/boot` can not be a logical volume. To add a logical volume, click the **Add** button in the **Logical Volumes** section. A dialog window as shown in Figure 13-3 will appear.

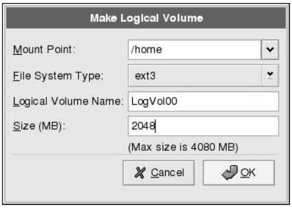

Figure 13-3. Creating a Logical Volume

Repeat these steps for each volume group you want to create.

Tip

You may want to leave some free space in the logical volume group so you can expand the logical volumes later.

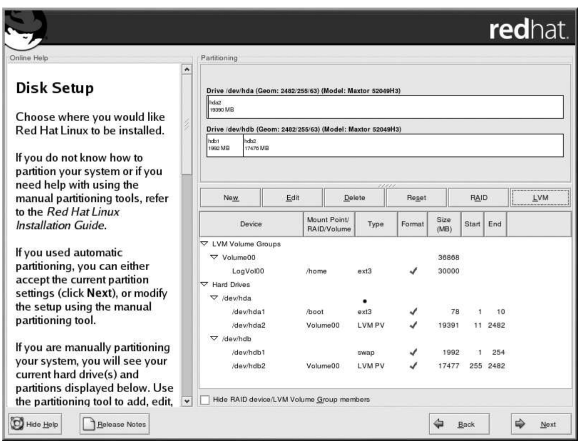

Figure 13-4. Logical Volumes Created

Chapter 14. PXE Network Installations

Red Hat Enterprise Linux allows for installation over a network using the NFS, FTP, or HTTP protocols. A network installation can be started from a network boot diskette, a boot CD-ROM, or by using the `askmethod` boot option with the Red Hat Enterprise Linux CD #1. Alternatively, if the system to be installed contains a network interface card (NIC) with Pre-Execution Environment (PXE) support, it can be configured to boot from files on another system on the network instead of a diskette or CD-ROM.

For a PXE network installation, the client's NIC with PXE support sends out a broadcast request for DHCP information. The DHCP server provides the client with an IP address, other network information such as name server, the IP address or hostname of the `tftp` server (which provides the files necessary to start the installation program), and the location of the files on the `tftp` server. This is possible because of PXELINUX, which is part of the `syslinux` package.

The following steps must be performed to prepare for a PXE installation:

1. Configure the network (NFS, FTP, HTTP) server to export the installation tree.
2. Configure the files on the `tftp` server necessary for PXE booting.
3. Configure which hosts are allowed to boot from the PXE configuration.
4. Start the `tftp` service.
5. Configure DHCP.
6. Boot the client, and start the installation.

14.1. Setting up the Network Server

First, configure an NFS, FTP, or HTTP server to export the entire installation tree for the version and variant of Red Hat Enterprise Linux to be installed. Refer to the section *Preparing for a Network Installation* in the *Red Hat Enterprise Linux Installation Guide* for detailed instructions.

14.2. PXE Boot Configuration

The next step is to copy the files necessary to start the installation to the `tftp` server so they can be found when the client requests them. The `tftp` server is usually the same server as the network server exporting the installation tree.

To copy these files, run the **Network Booting Tool** on the NFS, FTP, or HTTP server. A separate PXE server is not necessary.

For the command line version of these instructions, refer to Section 14.2.1 *Command Line Configuration*.

To use the graphical version of the **Network Booting Tool**, you must be running the X Window System, have root privileges, and have the `redhat-config-netboot` RPM package installed. To start the **Network Booting Tool** from the desktop, go to the **Main Menu Button** (on the Panel) => **System Settings** => **Server Settings** => **Network Booting Service**. Or, type the command `redhat-config-netboot` at a shell prompt (for example, in an **XTerm** or a **GNOME terminal**).

If starting the **Network Booting Tool** for the first time, select **Network Install** from the **First Time Druid**. Otherwise, select **Configure** => **Network Installation** from the pull-down menu, and then click **Add**. The dialog in Figure 14-1 is displayed.

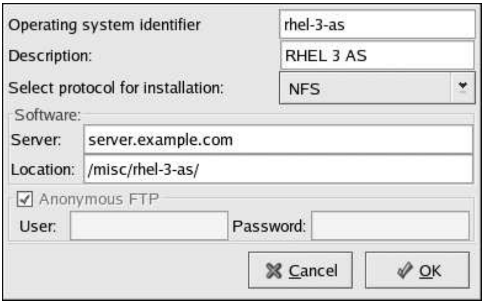

Figure 14-1. Network Installation Setup

Provide the following information:

- **Operating system identifier** — Provide a unique name using one word to identify the Red Hat Enterprise Linux version and variant. It is used as the directory name in the /tftpboot/linux-install/ directory.
- **Description** — Provide a brief description of the Red Hat Enterprise Linux version and variant.
- **Select protocol for installation** — Select NFS, FTP, or HTTP as the network installation type depending on which one was configured previously. If FTP is selected and anonymous FTP is not being used, uncheck **Anonymous FTP** and provide a valid username and password combination.
- **Server** — Provide the IP address or domain name of the NFS, FTP, or HTTP server.
- **Location** — Provide the directory shared by the network server. If FTP or HTTP was selected, the directory must be relative to the default directory for the FTP server or the document root for the HTTP server. For all network installations, the directory provided must contain the RedHat/ directory of the installation tree.

After clicking **OK**, the initrd.img and vmlinuz files necessary to boot the installation program are transfered from images/pxeboot/ in the provided installation tree to /tftpboot/linux-install/<*os-identifier*>/ on the tftp server (the one you are running the **Network Booting Tool** on).

14.2.1. Command Line Configuration

If the network server is not running X, the pxeos command line utility, which is part of the redhat-config-netboot package, can be used to configure the tftp server files as described in Section 14.4 *Starting the tftp Server*:

```
pxeos -a -i "<description>" -p <NFS|HTTP|FTP> -D 0 -s client.example.com \
-L <net-location> <os-identifer>
```

The following list explains the options:

- -a — Specifies that an OS instance is being added to the PXE configuration.
- -i "<*description*>" — Replace "<*description*>" with a description of the OS instance. This corresponds to the **Description** field in Figure 14-1.
- -p <NFS|HTTP|FTP> — Specify which of the NFS, FTP, or HTTP protocols to use for installation. Only one may be specified. This corresponds to the **Select protocol for installation** menu in Figure 14-1.

- `-D 0` — Indicates that it is not a diskless configuration since `pxeos` can be used to configure a diskless environment as well.
- `-s` *`client.example.com`* — Provide the name of the NFS, FTP, or HTTP server after the `-s` option. This corresponds to the **Server** field in Figure 14-1.
- `-L` *`<net-location>`* — Provide the location of the installation tree on that server after the `-L` option. This corresponds to the **Location** field in Figure 14-1.
- *`<os-identifer>`* — Specify the OS identifier, which is used as the directory name in the `/tftpboot/linux-install/` directory. This corresponds to the **Operating system identifier** field in Figure 14-1.

If FTP is selected as the installation protocol and anonymous login is not available, specify a username and password for login, with the following options before *`<os-identifer>`* in the previous command:

```
-A 0 -u <username> -p <password>
```

14.3. Adding PXE Hosts

After configuring the network server, the interface as shown in Figure 14-2 is displayed.

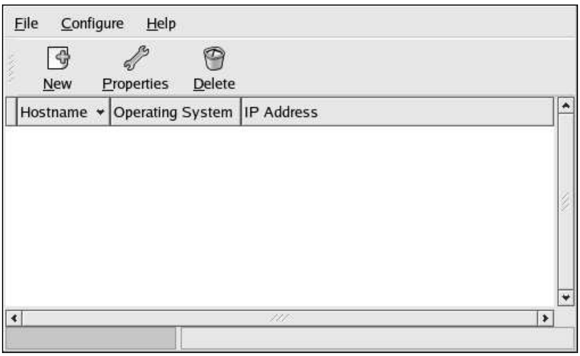

Figure 14-2. Add Hosts

The next step is to configure which hosts are allowed to connect to the PXE boot server. For the command line version of this step, refer to Section 14.3.1 *Command Line Configuration*.

To add hosts, click the **New** button.

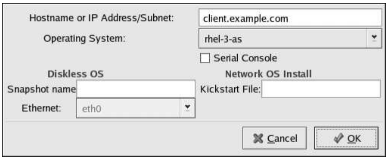

Figure 14-3. Add a Host

Enter the following information:

- **Hostname or IP Address/Subnet** — Enter the IP address, fully qualified hostname, or a subnet of systems that should be allowed to connect to the PXE server for installations.
- **Operating System** — Select the operating system identifier to install on this client. The list is populated from the network install instances created from the **Network Installation Dialog**.
- **Serial Console** — Select this option to use a serial console.
- **Kickstart File** — Specify the location of a kickstart file to use such as **`http://server.example.com/kickstart/ks.cfg`**. This file can be created with the **Kickstart Configurator**. Refer to Chapter 10 ***Kickstart Configurator*** for details.

Ignore the **Snapshot name** and **Ethernet** options. They are only used for diskless environments.

14.3.1. Command Line Configuration

If the network server is not running X, the `pxeboot` utility, a part of the `redhat-config-netboot` package, can be used to add hosts which are allowed to connect to the PXE server:

```
pxeboot -a -O <os-identifier> -r <value> <host>
```

The following list describes the options:

- `-a` — Specifies that a host is to be added.
- `-O` *<os-identifier>* — Replace *<os-identifier>* with the operating system identifier as defined in Section 14.2 *PXE Boot Configuration*.
- `-r` *<value>* — Replace *<value>* with the ram disk size
- *<host>* — Replace *<host>* with the IP address or hostname of the host to add.

14.4. Starting the `tftp` Server

On the DHCP server, verify that the `tftp-server` package is installed with the command `rpm -q tftp-server`. If it is not installed, install it via Red Hat Network or the Red Hat Enterprise Linux CD-ROMs. For more information on installing RPM packages, refer to Part III *Package Management*.

`tftp` is an xinetd-based service; start it with the following commands:

```
/sbin/chkconfig --level 345 xinetd on
/sbin/chkconfig --level 345 tftp on
```

This command configures the `tftp` and `xinetd` services to immediately turned on and also configures them to start at boot time in runlevels 3, 4, and 5.

14.5. Configuring the DHCP Server

If a DHCP server does not already exist on the network, configure one. Refer to Chapter 25 *Dynamic Host Configuration Protocol (DHCP)* for details. Make sure the configuration file contains the following so PXE booting is enabled for systems that support it:

```
allow booting;
allow bootp;
class "pxeclients" {
```

```
   match if substring(option vendor-class-identifier, 0, 9) = "PXEClient";
   next-server <server-ip>;
   filename "linux-install/pxelinux.0";
}
```

The IP address that follows the `next-server` option should be the IP address of the `tftp` server.

14.6. Adding a Custom Boot Message

Optionally, modify `/tftpboot/linux-install/msgs/boot.msg` to use a custom boot message.

14.7. Performing the PXE Installation

For instructions on how to configure the network interface card with PXE support to boot from the network, consult the documentation for the NIC. It varies slightly per card.

After the system boots the installation program, refer to the *Red Hat Enterprise Linux Installation Guide*.

Chapter 15. Diskless Environments

Some networks require multiple systems with the same configuration. They also require that these systems be easy to reboot, upgrade, and manage. One solution is to use a *diskless environment* in which most of the operating system, which can be read-only, is shared from a central server between the clients and the individual clients have their own directories on the central server for the rest of the operating system, which must be read/write. Each time the client boots, it mounts most of the OS from the NFS server as read-only and another directory as read-write. Each client has its own read-write directory so that one client can not affect the others.

The following steps are necessary to configure Red Hat Enterprise Linux to run on a diskless client:

1. Install Red Hat Enterprise Linux on a system so that the files can be copied to the NFS server. (Refer to the *Red Hat Enterprise Linux Installation Guide* for details.) Any software to be used on the clients must be installed on this system, and the `busybox-anaconda` package must be installed.
2. Create a directory on the NFS server to contain the diskless environment such as `/diskless/i386/RHEL3-AS/`. For example:
   ```
   mkdir -p /diskless/i386/RHEL3-AS/
   ```
   This directory is referred to as the `diskless directory`.
3. Create a subdirectory of this directory named `root/`:
   ```
   mkdir -p /diskless/i386/RHEL3-AS/root/
   ```
4. Copy Red Hat Enterprise Linux from the client system to the server using `rsync`. For example:
   ```
   rsync -a -e ssh installed-system.example.com:/ /diskless/i386/RHEL3-AS/root/
   ```
   The length of this operation depends on the network connection speed as well as the size of the file system on the installed system. It may take a while.
5. Start the `tftp` server as discussed in Section 15.1 *Start the `tftp` Server*.
6. Configure the DHCP server as discussed in Section 15.2 *Configuring the DHCP Server*.
7. Finish creating the diskless environment as discussed in Section 15.4 *Finish Configuring the Diskless Environment*.
8. Configure the diskless clients as discussed in Section 15.5 *Adding Hosts*.
9. Configure each diskless client to boot via PXE, and boot them.

15.1. Start the `tftp` Server

On the DHCP server, verify that the `tftp-server` package is installed with the command `rpm -q tftp-server`. If it is not installed, install it via Red Hat Network or the Red Hat Enterprise Linux CD-ROMs. For more information on installing RPM packages, refer to Part III *Package Management*.

`tftp` is an xinetd-based service; start it with the following commands:

```
/sbin/chkconfig --level 345 xinetd on
/sbin/chkconfig --level 345 tftp on
```

This command configures the `tftp` and `xinetd` services to immediately turned on and also configures them to start at boot time in runlevels 3, 4, and 5.

15.2. Configuring the DHCP Server

If a DHCP server does not already exist on the network, configure one. Refer to Chapter 25 *Dynamic Host Configuration Protocol (DHCP)* for details. Make sure the configuration file contains the following so PXE booting is enabled for systems that support it:

```
allow booting;
allow bootp;
class "pxeclients" {
   match if substring(option vendor-class-identifier, 0, 9) = "PXEClient";
   next-server <server-ip>;
   filename "linux-install/pxelinux.0";
}
```

The IP address that follows the `next-server` option should be the IP address of the `tftp` server.

15.3. Configuring the NFS Server

The shared read-only part of the operating system is shared via NFS.

Configure the NFS to export the `root/` and `snapshot/` directories by adding them to `/etc/exports`. For example:

```
/diskless/i386/RHEL3-AS/root/     *(ro,sync,no_root_squash)
/diskless/i386/RHEL3-AS/snapshot/ *(rw,sync,no_root_squash)
```

Replace `*` with one of the hostname formats discussed in Section 23.3.2 *Hostname Formats*. Make the hostname declaration as specific as possible so unwanted systems can not access the NFS mount.

If the NFS service is not running, start it:

```
service nfs start
```

If the NFS service is already running, reload the configuration file:

```
service nfs reload
```

15.4. Finish Configuring the Diskless Environment

To use the graphical version of the **Network Booting Tool**, you must be running the X Window System, have root privileges, and have the `redhat-config-netboot` RPM package installed. To start the **Network Booting Tool** from the desktop, go to the **Main Menu Button** (on the Panel) => **System Settings** => **Server Settings** => **Network Booting Service**. Or, type the command `redhat-config-netboot` at a shell prompt (for example, in an **XTerm** or a **GNOME terminal**).

If starting the **Network Booting Tool** for the first time, select **Diskless** from the **First Time Druid**. Otherwise, select **Configure** => **Diskless** from the pull-down menu, and then click **Add**.

A wizard appears to step you through the process:

1. Click **Forward** on the first page.
2. On the **Diskless Identifier** page, enter a **Name** and **Description** for the diskless environment. Click **Forward**.
3. Enter the IP address or domain name of the NFS server configured in Section 15.3 *Configuring the NFS Server* as well as the directory exported as the diskless environment. Click **Forward**.

4. The kernel versions installed in the diskless environment are listed. Select the kernel version to boot on the diskless system.
5. Click **Apply** to finish the configuration.

After clicking **Apply**, the diskless kernel and image file are created based on the kernel selected. They are copied to the PXE boot directory `/tftpboot/linux-install/<os-identifier>/`. The directory `snapshot/` is created in the same directory as the `root/` directory (for example, `/diskless/i386/RHEL3-AS/snapshot/`) with a file called `files` in it. This file contains a list of files and directories that must be read/write for each diskless system. Do not modify this file. If additional entries need to be added to the list, create a `files.custom` file in the same directory as the `files` file, and add each additional file or directory on a separate line.

15.5. Adding Hosts

Each diskless client must have its own *snapshot* directory on the NFS server that is used as its read/write file system. The **Network Booting Tool** can be used to create these snapshot directories.

After completing the steps in Section 15.4 *Finish Configuring the Diskless Environment*, a window appears to allow hosts to be added for the diskless environment. Click the **New** button. In the dialog shown in Figure 15-1, provide the following information:

- **Hostname or IP Address/Subnet** — Specify the hostname or IP address of a system to add it as a host for the diskless environment. Enter a subnet to specify a group of systems.
- **Operating System** — Select the diskless environment for the host or subnet of hosts.
- **Serial Console** — Select this checkbox to perform a serial installation.
- **Snapshot name** — Provide a subdirectory name to be used to store all of the read/write content for the host.
- **Ethernet** — Select the Ethernet device on the host to use to mount the diskless environment. If the host only has one Ethernet card, select **eth0**.

Ignore the **Kickstart File** option. It is only used for PXE installations.

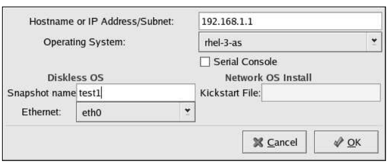

Figure 15-1. Add Diskless Host

In the existing `snapshot/` directory in the diskless directory, a subdirectory is created with the **Snapshot name** specified as the file name. Then, all of the files listed in `snapshot/files` and `snapshot/files.custom` are copied copy from the `root/` directory to this new directory.

15.6. Booting the Hosts

Consult the documentation for your PXE card to configure the host to boot via PXE.

When the diskless client boots, it mounts the remote `root/` directory in the diskless directory as read-only. It also mounts its individual snapshot directory as read/write. Then it mounts all the files and directories in the `files` and `files.custom` files using the `mount -o bind` over the read-only diskless directory to allow applications to write to the root directory of the diskless environment if they need to.

III. Package Management

All software on a Red Hat Enterprise Linux system is divided into RPM packages which can be installed, upgraded, or removed. This part describes how to manage the RPM packages on a Red Hat Enterprise Linux system using graphical and command line tools.

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Chapter 16.

Package Management with RPM

The RPM Package Manager (RPM) is an open packaging system, available for anyone to use, which runs on Red Hat Enterprise Linux as well as other Linux and UNIX systems. Red Hat, Inc. encourages other vendors to use RPM for their own products. RPM is distributable under the terms of the GPL.

For the end user, RPM makes system updates easy. Installing, uninstalling, and upgrading RPM packages can be accomplished with short commands. RPM maintains a database of installed packages and their files, so you can invoke powerful queries and verifications on your system. If you prefer a graphical interface, you can use **Package Management Tool** to perform many RPM commands. Refer to Chapter 17 ***Package Management Tool*** for details.

During upgrades, RPM handles configuration files carefully, so that you never lose your customizations — something that you can not accomplish with regular `.tar.gz` files.

For the developer, RPM allows you to take software source code and package it into source and binary packages for end users. This process is quite simple and is driven from a single file and optional patches that you create. This clear delineation between *pristine* sources and your patches along with build instructions eases the maintenance of the package as new versions of the software are released.

Note

Because RPM makes changes to your system, you must be root to install, remove, or upgrade an RPM package.

16.1. RPM Design Goals

To understand how to use RPM, it can be helpful to understand RPM's design goals:

Upgradability

Using RPM, you can upgrade individual components of your system without completely reinstalling. When you get a new release of an operating system based on RPM (such as Red Hat Enterprise Linux), you do not need to reinstall on your machine (as you do with operating systems based on other packaging systems). RPM allows intelligent, fully-automated, in-place upgrades of your system. Configuration files in packages are preserved across upgrades, so you won't lose your customizations. There are no special upgrade files needed to upgrade a package because the same RPM file is used to install and upgrade the package on your system.

Powerful Querying

RPM is designed to provide powerful querying options. You can do searches through your entire database for packages or just for certain files. You can also easily find out what package a file belongs to and from where the package came. The files an RPM package contains are in a compressed archive, with a custom binary header containing useful information about the package and its contents, allowing you to query individual packages quickly and easily.

System Verification

Another powerful feature is the ability to verify packages. If you are worried that you deleted an important file for some package, verify the package. You are notified of any anomalies. At that point, you can reinstall the package if necessary. Any configuration files that you modified are preserved during reinstallation.

Pristine Sources

A crucial design goal was to allow the use of "pristine" software sources, as distributed by the original authors of the software. With RPM, you have the pristine sources along with any patches that were used, plus complete build instructions. This is an important advantage for several reasons. For instance, if a new version of a program comes out, you do not necessarily have to start from scratch to get it to compile. You can look at the patch to see what you *might* need to do. All the compiled-in defaults, and all of the changes that were made to get the software to build properly are easily visible using this technique.

The goal of keeping sources pristine may only seem important for developers, but it results in higher quality software for end users, too. We would like to thank the folks from the BOGUS distribution for originating the pristine source concept.

16.2. Using RPM

RPM has five basic modes of operation (not counting package building): installing, uninstalling, upgrading, querying, and verifying. This section contains an overview of each mode. For complete details and options try `rpm --help`, or turn to Section 16.5 *Additional Resources* for more information on RPM.

16.2.1. Finding RPM Packages

Before using an RPM, you must know where to find them. An Internet search returns many RPM repositories, but if you are looking for RPM packages built by Red Hat, they can be found at the following locations:

- The Red Hat Enterprise Linux CD-ROMs
- The Red Hat Errata Page available at http://www.redhat.com/apps/support/errata/
- A Red Hat FTP Mirror Site available at http://www.redhat.com/download/mirror.html
- Red Hat Network — Refer to Chapter 18 *Red Hat Network* for more details on Red Hat Network

16.2.2. Installing

RPM packages typically have file names like `foo-1.0-1.i386.rpm`. The file name includes the package name (`foo`), version (`1.0`), release (`1`), and architecture (`i386`). Installing a package is as simple as logging in as root and typing the following command at a shell prompt:

```
rpm -Uvh foo-1.0-1.i386.rpm
```

If installation is successful, the following output is displayed:

```
Preparing...                ########################################### [100%]
   1:foo                    ########################################### [100%]
```

As you can see, RPM prints out the name of the package and then prints a succession of hash marks as the package is installed as a progress meter.

Starting with version 4.1 of RPM, the signature of a package is checked automatically when installing or upgrading a package. If verifying the signature fails, an error message such as the following is displayed:

```
error: V3 DSA signature: BAD, key ID 0352860f
```

If it is a new, header-only, signature, an error message such as the following is displayed:

```
error: Header V3 DSA signature: BAD, key ID 0352860f
```

If you do not have the appropriate key installed to verify the signature, the message contains the word `NOKEY` such as:

```
warning: V3 DSA signature: NOKEY, key ID 0352860f
```

Refer to Section 16.3 *Checking a Package's Signature* for more information on checking a package's signature.

Note

If you are installing a kernel package, you should use `rpm -ivh` instead. Refer to Chapter 39 *Upgrading the Kernel* for details.

Installing packages is designed to be simple, but you may sometimes see errors.

16.2.2.1. Package Already Installed

If the package of the same version is already installed, the following is displayed:

```
Preparing...                ########################################### [100%]
package foo-1.0-1 is already installed
```

To install the package anyway and the same version you are trying to install is already installed, you can use the `--replacepkgs` option, which tells RPM to ignore the error:

```
rpm -ivh --replacepkgs foo-1.0-1.i386.rpm
```

This option is helpful if files installed from the RPM were deleted or if you want the original configuration files from the RPM to be installed.

16.2.2.2. Conflicting Files

If you attempt to install a package that contains a file which has already been installed by another package or an earlier version of the same package, the following is displayed:

```
Preparing...                ########################################### [100%]
file /usr/bin/foo from install of foo-1.0-1 conflicts with file from package bar-2.0.20
```

To make RPM ignore this error, use the `--replacefiles` option:

```
rpm -ivh --replacefiles foo-1.0-1.i386.rpm
```

16.2.2.3. Unresolved Dependency

RPM packages can "depend" on other packages, which means that they require other packages to be installed to run properly. If you try to install a package which has an unresolved dependency, output similar to following is displayed:

```
Preparing...                ########################################### [100%]
error: Failed dependencies:
        bar.so.2 is needed by foo-1.0-1
    Suggested resolutions:
        bar-2.0.20-3.i386.rpm
```

If you are installing a package from the Red Hat Enterprise Linux CD-ROM set, it usually suggest the package(s) need to resolve the dependency. Find this package on the Red Hat Enterprise Linux CD-ROMs or from the Red Hat FTP site (or mirror), and add it to the command:

```
rpm -ivh foo-1.0-1.i386.rpm bar-2.0.20-3.i386.rpm
```

If installation of both packages is successful, output similar to the following is displayed:

```
Preparing...                ########################################### [100%]
   1:foo                    ########################################### [ 50%]
   2:bar                    ########################################### [100%]
```

If it does not suggest a package to resolve the dependency, you can try the `--redhatprovides` option to determine which package contains the required file. You need the `rpmdb-redhat` package installed to use this options.

```
rpm -q --redhatprovides bar.so.2
```

If the package that contains `bar.so.2` is in the installed database from the `rpmdb-redhat` package, the name of the package is displayed:

```
bar-2.0.20-3.i386.rpm
```

To force the installation anyway (a bad idea since the package probably will not run correctly), use the `--nodeps` option.

16.2.3. Uninstalling

Uninstalling a package is just as simple as installing one. Type the following command at a shell prompt:

```
rpm -e foo
```

Note

Notice that we used the package *name* `foo`, not the name of the original package *file* `foo-1.0-1.i386.rpm`. To uninstall a package, replace `foo` with the actual package name of the original package.

You can encounter a dependency error when uninstalling a package if another installed package depends on the one you are trying to remove. For example:

```
Preparing...                ########################################### [100%]
error: removing these packages would break dependencies:
        foo is needed by  bar-2.0.20-3.i386.rpm
```

To cause RPM to ignore this error and uninstall the package anyway (which is also a bad idea since the package that depends on it will probably fail to work properly), use the `--nodeps` option.

16.2.4. Upgrading

Upgrading a package is similar to installing one. Type the following command at a shell prompt:

```
rpm -Uvh foo-2.0-1.i386.rpm
```

What you do not see above is that RPM automatically uninstalled any old versions of the `foo` package. In fact, you may want to always use `-U` to install packages, since it works even when there are no previous versions of the package installed.

Since RPM performs intelligent upgrading of packages with configuration files, you may see a message like the following:

```
saving /etc/foo.conf as /etc/foo.conf.rpmsave
```

This message means that your changes to the configuration file may not be "forward compatible" with the new configuration file in the package, so RPM saved your original file, and installed a new one. You should investigate the differences between the two configuration files and resolve them as soon as possible, to ensure that your system continues to function properly.

Upgrading is really a combination of uninstalling and installing, so during an RPM upgrade you can encounter uninstalling and installing errors, plus one more. If RPM thinks you are trying to upgrade to a package with an *older* version number, the output is similar to the following:

```
package foo-2.0-1 (which is newer than foo-1.0-1) is already installed
```

To cause RPM to "upgrade" anyway, use the `--oldpackage` option:

```
rpm -Uvh --oldpackage foo-1.0-1.i386.rpm
```

16.2.5. Freshening

Freshening a package is similar to upgrading one. Type the following command at a shell prompt:

```
rpm -Fvh foo-1.2-1.i386.rpm
```

RPM's freshen option checks the versions of the packages specified on the command line against the versions of packages that have already been installed on your system. When a newer version of an already-installed package is processed by RPM's freshen option, it is upgraded to the newer version. However, RPM's freshen option does not install a package if no previously-installed package of the same name exists. This differs from RPM's upgrade option, as an upgrade *does* install packages, whether or not an older version of the package was already installed.

RPM's freshen option works for single packages or a group of packages. If you have just downloaded a large number of different packages, and you only want to upgrade those packages that are already installed on your system, freshening does the job. If you use freshening, you do not have to delete any unwanted packages from the group that you downloaded before using RPM.

In this case, issue the following command:

```
rpm -Fvh *.rpm
```

RPM automatically upgrades only those packages that are already installed.

16.2.6. Querying

Use the `rpm -q` command to query the database of installed packages. The `rpm -q foo` command displays the package name, version, and release number of the installed package foo:

```
foo-2.0-1
```

Note

Notice that we used the package *name* `foo`. To query a package, you need to replace `foo` with the actual package name.

Instead of specifying the package name, you can use the following options with `-q` to specify the package(s) you want to query. These are called *Package Specification Options*.

- `-a` queries all currently installed packages.
- `-f` <*file*> queries the package which owns <*file*>. When specifying a file, you must specify the full path of the file (for example, `/usr/bin/ls`).
- `-p` <*packagefile*> queries the package <*packagefile*>.

There are a number of ways to specify what information to display about queried packages. The following options are used to select the type of information for which you are searching. These are called *Information Selection Options*.

- `-i` displays package information including name, description, release, size, build date, install date, vendor, and other miscellaneous information.
- `-l` displays the list of files that the package contains.
- `-s` displays the state of all the files in the package.
- `-d` displays a list of files marked as documentation (man pages, info pages, READMEs, etc.).
- `-c` displays a list of files marked as configuration files. These are the files you change after installation to adapt the package to your system (for example, `sendmail.cf`, `passwd`, `inittab`, etc.).

For the options that display lists of files, you can add `-v` to the command to display the lists in a familiar `ls -l` format.

16.2.7. Verifying

Verifying a package compares information about files installed from a package with the same information from the original package. Among other things, verifying compares the size, MD5 sum, permissions, type, owner, and group of each file.

The command `rpm -V` verifies a package. You can use any of the *Package Selection Options* listed for querying to specify the packages you wish to verify. A simple use of verifying is `rpm -V foo`, which verifies that all the files in the foo package are as they were when they were originally installed. For example:

- To verify a package containing a particular file:
  `rpm -Vf /bin/vi`
- To verify ALL installed packages:
  `rpm -Va`
- To verify an installed package against an RPM package file:
  `rpm -Vp foo-1.0-1.i386.rpm`

  This command can be useful if you suspect that your RPM databases are corrupt.

If everything verified properly, there is no output. If there are any discrepancies they are displayed. The format of the output is a string of eight characters (a `c` denotes a configuration file) and then the file name. Each of the eight characters denotes the result of a comparison of one attribute of the file to the value of that attribute recorded in the RPM database. A single `.` (a period) means the test passed. The following characters denote failure of certain tests:

- `5` — MD5 checksum
- `S` — file size
- `L` — symbolic link
- `T` — file modification time
- `D` — device
- `U` — user
- `G` — group
- `M` — mode (includes permissions and file type)
- `?` — unreadable file

If you see any output, use your best judgment to determine if you should remove or reinstall the package, or fix the problem in another way.

16.3. Checking a Package's Signature

If you wish to verify that a package has not been corrupted or tampered with, examine only the md5sum by typing the following command at a shell prompt (<*rpm-file*> with filename of the RPM package):

```
rpm -K --nogpg <rpm-file>
```

The message <*rpm-file*>`: md5 OK` is displayed. This brief message means that the file was not corrupted by the download. To see a more verbose message, replace `-K` with `-Kvv` in the command.

On the other hand, how trustworthy is the developer who created the package? If the package is *signed* with the developer's GnuPG *key*, you know that the developer really is who they say they are.

An RPM package can be signed using Gnu Privacy Guard (or GnuPG), to help you make certain your downloaded package is trustworthy.

GnuPG is a tool for secure communication; it is a complete and free replacement for the encryption technology of PGP, an electronic privacy program. With GnuPG, you can authenticate the validity of documents and encrypt/decrypt data to and from other recipients. GnuPG is capable of decrypting and verifying PGP 5.*x* files, as well.

During installation, GnuPG is installed by default. That way you can immediately start using GnuPG to verify any packages that you receive from Red Hat. First, you need to import Red Hat's public key.

16.3.1. Importing Keys

To verify Red Hat packages, you must import the Red Hat GPG key. To do so, execute the following command at a shell prompt:

```
rpm --import /usr/share/rhn/RPM-GPG-KEY
```

To display a list of all keys installed for RPM verification, execute the command:

```
rpm -qa gpg-pubkey*
```

For the Red Hat key, the output includes:

```
gpg-pubkey-db42a60e-37ea5438
```

To display details about a specific key, use `rpm -qi` followed by the output from the previous command:

```
rpm -qi gpg-pubkey-db42a60e-37ea5438
```

16.3.2. Verifying Signature of Packages

To check the GnuPG signature of an RPM file after importing the builder's GnuPG key, use the following command (replace <*rpm-file*> with filename of the RPM package):

```
rpm -K <rpm-file>
```

If all goes well, the following message is displayed: `md5 gpg OK`. That means that the signature of the package has been verified and that it is not corrupt.

16.4. Impressing Your Friends with RPM

RPM is a useful tool for both managing your system and diagnosing and fixing problems. The best way to make sense of all of its options is to look at some examples.

- Perhaps you have deleted some files by accident, but you are not sure what you deleted. To verify your entire system and see what might be missing, you could try the following command:
  ```
  rpm -Va
  ```
  If some files are missing or appear to have been corrupted, you should probably either re-install the package or uninstall, then re-install the package.
- At some point, you might see a file that you do not recognize. To find out which package owns it, you would enter:
  ```
  rpm -qf /usr/X11R6/bin/ghostview
  ```
  The output would look like the following:
  ```
  gv-3.5.8-22
  ```
- We can combine the above two examples in the following scenario. Say you are having problems with `/usr/bin/paste`. You would like to verify the package that owns that program, but you do not know which package owns `paste`. Simply enter the following command:

```
rpm -Vf /usr/bin/paste
```

and the appropriate package is verified.

- Do you want to find out more information about a particular program? You can try the following command to locate the documentation which came with the package that owns that program:

```
rpm -qdf /usr/bin/free
```

The output would be like the following:

```
/usr/share/doc/procps-2.0.11/BUGS
/usr/share/doc/procps-2.0.11/NEWS
/usr/share/doc/procps-2.0.11/TODO
/usr/share/man/man1/free.1.gz
/usr/share/man/man1/oldps.1.gz
/usr/share/man/man1/pgrep.1.gz
/usr/share/man/man1/pkill.1.gz
/usr/share/man/man1/ps.1.gz
/usr/share/man/man1/skill.1.gz
/usr/share/man/man1/snice.1.gz
/usr/share/man/man1/tload.1.gz
/usr/share/man/man1/top.1.gz
/usr/share/man/man1/uptime.1.gz
/usr/share/man/man1/w.1.gz
/usr/share/man/man1/watch.1.gz
/usr/share/man/man5/sysctl.conf.5.gz
/usr/share/man/man8/sysctl.8.gz
/usr/share/man/man8/vmstat.8.gz
```

- You may find a new RPM, but you do not know what it does. To find information about it, use the following command:

```
rpm -qip crontabs-1.10-5.noarch.rpm
```

The output would look like the following:

```
Name        : crontabs                    Relocations: (not relocateable)
Version     : 1.10                             Vendor: Red Hat, Inc.
Release     : 5                            Build Date: Fri 07 Feb 2003 04:07:32 PM EST
Install date: (not installed)              Build Host: porky.devel.redhat.com
Group       : System Environment/Base      Source RPM: crontabs-1.10-5.src.rpm
Size        : 1004                            License: Public Domain
Signature   : DSA/SHA1, Tue 11 Feb 2003 01:46:46 PM EST, Key ID fd372689897da07a
Packager    : Red Hat, Inc. <http://bugzilla.redhat.com/bugzilla>
Summary     : Root crontab files used to schedule the execution of programs.
Description :
The crontabs package contains root crontab files. Crontab is the
program used to install, uninstall, or list the tables used to drive the
cron daemon. The cron daemon checks the crontab files to see when
particular commands are scheduled to be executed. If commands are
scheduled, then it executes them.
```

- Perhaps you now want to see what files the `crontabs` RPM installs. You would enter the following:

```
rpm -qlp crontabs-1.10-5.noarch.rpm
```

The output is similar to the following:

```
Name        : crontabs                    Relocations: (not relocateable)
Version     : 1.10                             Vendor: Red Hat, Inc.
Release     : 5                            Build Date: Fri 07 Feb 2003 04:07:32 PM EST
Install date: (not installed)              Build Host: porky.devel.redhat.com
Group       : System Environment/Base      Source RPM: crontabs-1.10-5.src.rpm
Size        : 1004                            License: Public Domain
Signature   : DSA/SHA1, Tue 11 Feb 2003 01:46:46 PM EST, Key ID fd372689897da07a
Packager    : Red Hat, Inc. <http://bugzilla.redhat.com/bugzilla>
Summary     : Root crontab files used to schedule the execution of programs.
Description :
The crontabs package contains root crontab files. Crontab is the
```

```
program used to install, uninstall, or list the tables used to drive the
cron daemon. The cron daemon checks the crontab files to see when
particular commands are scheduled to be executed. If commands are
scheduled, then it executes them.
```

These are just a few examples. As you use it, you will find many more uses for RPM.

16.5. Additional Resources

RPM is an extremely complex utility with many options and methods for querying, installing, upgrading, and removing packages. Refer to the following resources to learn more about RPM.

16.5.1. Installed Documentation

- `rpm --help` — This command displays a quick reference of RPM parameters.
- `man rpm` — The RPM man page gives more detail about RPM parameters than the `rpm --help` command.

16.5.2. Useful Websites

- http://www.rpm.org/ — The RPM website.
- http://www.redhat.com/mailman/listinfo/rpm-list/ — The RPM mailing list is archived here. To subscribe, send mail to <`rpm-list-request@redhat.com`> with the word `subscribe` in the subject line.

16.5.3. Related Books

- *Red Hat RPM Guide* by Eric Foster-Johnson; Wiley, John & Sons, Incorporated — This book is a comprehensive guide to RPM, from installing package to building RPMs.

Chapter 17. Package Management Tool

During installation, a default set of software packages are installed. Because people use their computers differently, users might want to install or remove packages after installation. The **Package Management Tool** allows users to perform these actions.

The X Window System is required to run the **Package Management Tool**. To start the application, go to the **Main Menu Button** (on the Panel) => **System Settings** => **Add/Remove Applications**, or type the command `redhat-config-packages` at shell prompt.

The same interface appears if you insert the Red Hat Enterprise Linux CD #1 into your computer.

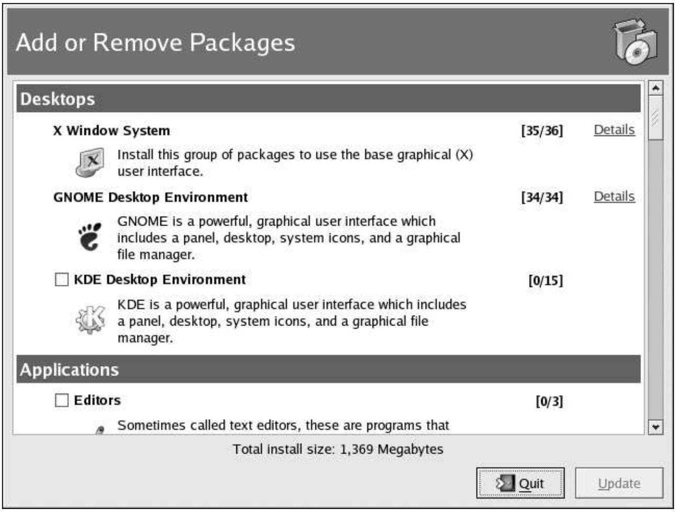

Figure 17-1. Package Management Tool

The interface for this application is similar to the one used for individual package selection during installation. Packages are divided into package groups, which contain a list of *standard packages* and *extra packages* that share common functionality. For example, the **Graphical Internet** group contains a Web browser, email client, and other graphical programs used to connected to the Internet. The standard packages can not be selected for removal unless the entire package group is removed. The extra packages are optional packages that can be selected for installation or removal, as long as the package group is selected.

The main window shows a list of package groups. If the package group has a checkmark in the checkbox beside it, packages from that group are currently installed. To view the individual packages list for a group, click the **Details** button beside it. The individual packages with a checkmark beside them are currently installed.

17.1. Installing Packages

To install the standard packages in a package group that is not currently installed, check the checkbox beside it. To customize the packages to be installed within the group, click the **Details** button beside it. The list of standard and extra packages is displayed, as shown in Figure 17-2. Clicking on the package name displays the disk space required to install the package at the bottom of the window. Checking the checkbox beside the package name marks it for installation.

You can also select individual packages from already installed package groups by click the **Details** button and checking any of the extra packages not already installed.

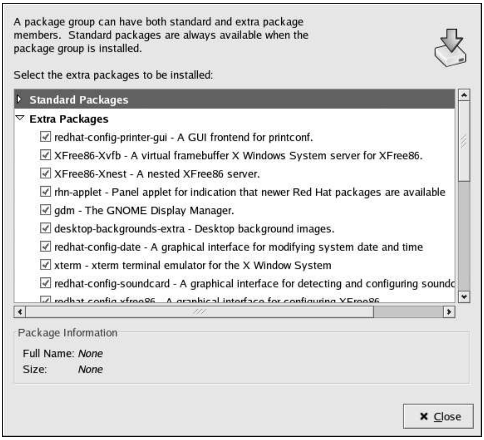

Figure 17-2. Individual Package Selection

After selecting package groups and individual packages to install, click the **Update** button on the main window. The number of packages to be installed and the amount of disk space required to install the packages as well as any package dependencies is displayed in a summary window. If there are package dependencies, they will be automatically added to the list of packages to install. Click the **Show Details** button to view the complete list of packages to be installed.

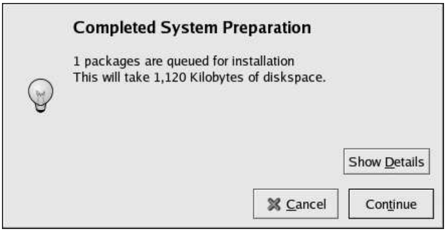

Figure 17-3. Package Installation Summary

Click **Continue** to start the installation process. When it is finished, an **Update Complete** message will appear.

Tip

If you use **Nautilus** to browse the files and directories on your computer, you can also use it to install packages. In **Nautilus**, go to the directory that contains an RPM package (they usually end in `.rpm`), and double-click on the RPM icon.

17.2. Removing Packages

To remove all the package installed within a package group, uncheck the checkbox beside it. To remove individual packages, click the **Details** button beside the package group and uncheck the individual packages.

When you are finished selecting packages to remove, click the **Update** button in the main window. The application computes the amount of disk space that will be freed as well as the software package dependencies. If other packages depend on the packages you selected to remove, they will be automatically added to the list of packages to be removed. Click the **Show Details** button to view the list of packages to be removed.

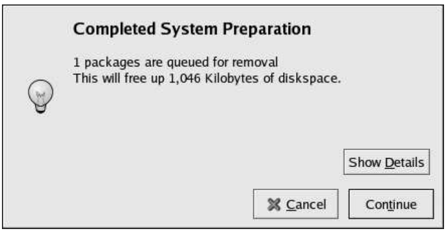

Figure 17-4. Package Removal Summary

Click **Continue** to start the removal process. When it is finished, an **Update Complete** message will appear.

Tip

You can combine the installation and removal of packages by selecting package groups/packages to be installed/removed and then clicking **Update**. The **Completed System Preparation** window will display the number of packages to be installed and removed.

Chapter 18.
Red Hat Network

Red Hat Network is an Internet solution for managing one or more Red Hat Enterprise Linux systems. All Security Alerts, Bug Fix Alerts, and Enhancement Alerts (collectively known as Errata Alerts) can be downloaded directly from Red Hat using the **Red Hat Update Agent** standalone application or through the RHN website available at https://rhn.redhat.com/.

Figure 18-1. Your RHN

Red Hat Network saves users time because they receive email when updated packages are released. Users do not have to search the Web for updated packages or security alerts. By default, Red Hat Network installs the packages as well. Users do not have to learn how to use RPM or worry about resolving software package dependencies; RHN does it all.

Red Hat Network features include:

- Errata Alerts — learn when Security Alerts, Bug Fix Alerts, and Enhancement Alerts are issued for all the systems in your network

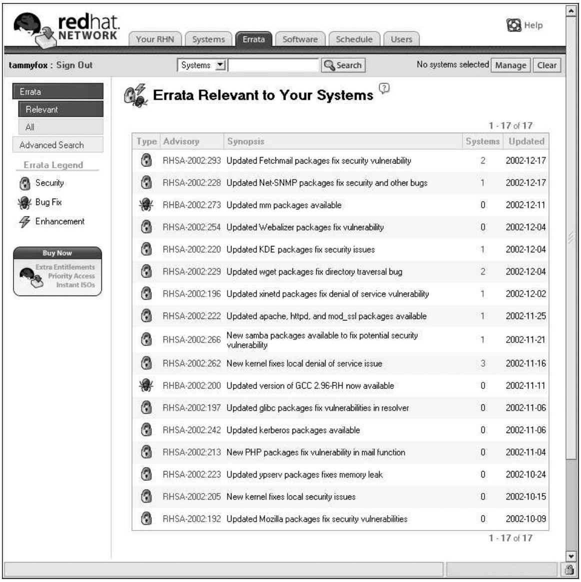

Figure 18-2. Relevant Errata

- Automatic email notifications — receive an email notification when an Errata Alert is issued for your system
- Scheduled Errata Updates — schedule delivery of Errata Updates
- Package installation — Schedule package installation on one or more systems with the click of a button
- **Red Hat Update Agent** — use the **Red Hat Update Agent** to download the latest software packages for your system (with optional package installation)
- Red Hat Network website — manage multiple systems, downloaded individual packages, and schedule actions such as Errata Updates through a secure Web browser connection from any computer

Caution

You must activate your Red Hat Enterprise Linux product before registered your system with Red Hat Network to make sure your system is entitled to the correct services. To activate your product, go to:

```
http://www.redhat.com/apps/activate/
```

After activating your product, registered it with Red Hat Network to receive Errata Updates. The registration process gathers information about the system that is required to notify you of updates. For example, a list of packages installed on the system is compiled so you are only notified about updates that are relevant to your system.

The first time the system is booted, the **Setup Agent** prompts you to register. If you did not register then, select **Main Menu Button** => **System Tools** => **Red Hat Network** on your desktop to start the registration process. Alternately, execute the command `up2date` from a shell prompt.

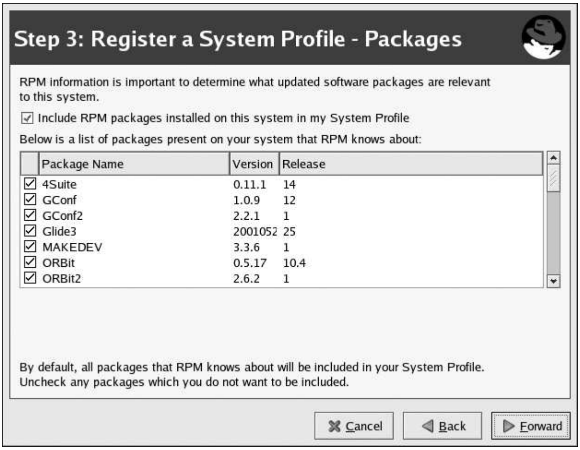

Figure 18-3. Registering with RHN

After registering, use one of the following methods to start receiving updates:

- Select **Main Menu Button** => **System Tools** => **Red Hat Network** on your desktop.
- Execute the command `up2date` from a shell prompt.
- Use the RHN website at https://rhn.redhat.com/.

For more detailed instructions, refer to the documentation available at:

`http://www.redhat.com/docs/manuals/RHNetwork/`

Tip

Red Hat Enterprise Linux includes the **Red Hat Network Alert Notification Tool**, a convenient panel icon that displays visible alerts when there is an update for your Red Hat Enterprise Linux system.

IV. Network-Related Configuration

After explaining how to configure the network, this part discusses topics related to networking such as how to allow remote logins, share files and directories over the network, and set up a Web server.

Table of Contents

Chapter 19.

Network Configuration

To communicate with other computers, computers need a network connection. This is accomplished by having the operating system recognize an interface card (such as Ethernet, ISDN modem, or token ring) and configuring the interface to connect to the network.

The **Network Administration Tool** can be used to configure the following types of network interfaces:

- Ethernet
- ISDN
- modem
- xDSL
- token ring
- CIPE
- wireless devices

It can also be used to configure IPsec connections, manage DNS settings, and manage the `/etc/hosts` file used to store additional hostnames and IP address combinations.

To use the **Network Administration Tool**, you must have root privileges. To start the application, go to the **Main Menu Button** (on the Panel) => **System Settings** => **Network**, or type the command `redhat-config-network` at a shell prompt (for example, in an **XTerm** or a **GNOME terminal**). If you type the command, the graphical version is displayed if X is running, otherwise, the text-based version is displayed. To force the text-based version to run, use the `redhat-config-network-tui` command.

To use the command line version, execute the command `redhat-config-network-cmd --help` as root to view all the options.

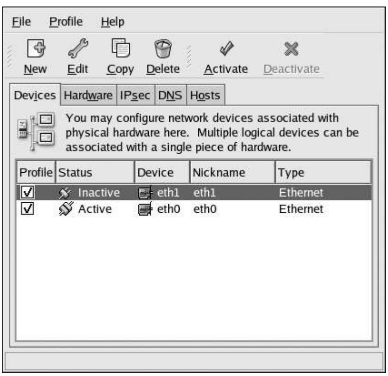

Figure 19-1. Network Administration Tool

If you prefer modifying the configuration files directly, refer to the *Red Hat Enterprise Linux Reference Guide* for information on their locations and contents.

Tip

Go to the Red Hat Hardware Compatibility List (http://hardware.redhat.com/hcl/) to determine if Red Hat Enterprise Linux supports your hardware device.

19.1. Overview

To configure a network connection with the **Network Administration Tool**, perform the following steps:

1. Add a network device associated with the physical hardware device.
2. Add the physical hardware device to the hardware list if it does not already exist.
3. Configure the hostname and DNS settings.
4. Configure any hosts that cannot be looked up through DNS.

This chapter discusses each of these steps for each type of network connection.

19.2. Establishing an Ethernet Connection

To establish an Ethernet connection, you need a network interface card (NIC), a network cable (usually a CAT5 cable), and a network to connect to. Different networks are configured to use different network speeds; make sure your NIC is compatible with the network to which you want to connect.

To add an Ethernet connection, follow these steps:

1. Click the **Devices** tab.
2. Click the **New** button on the toolbar.
3. Select **Ethernet connection** from the **Device Type** list, and click **Forward**.
4. If you have already added the network interface card to the hardware list, select it from the **Ethernet card** list. Otherwise, select **Other Ethernet Card** to add the hardware device.

   Note

   The installation program detects supported Ethernet devices and prompts you to configure them. If you configured any Ethernet devices during the installation, they are displayed in the hardware list on the **Hardware** tab.

5. If you selected **Other Ethernet Card**, the **Select Ethernet Adapter** window appears. Select the manufacturer and model of the Ethernet card. Select the device name. If this is the system's first Ethernet card, select **eth0** as the device name; if this is the second Ethernet card, select **eth1** (and so on). The **Network Administration Tool** also allows you to configure the resources for the NIC. Click **Forward** to continue.
6. In the **Configure Network Settings** window as shown in Figure 19-2, choose between DHCP and a static IP address. If the device receives a different IP address each time the network is started, do not specify a hostname. Click **Forward** to continue.
7. Click **Apply** on the **Create Ethernet Device** page.

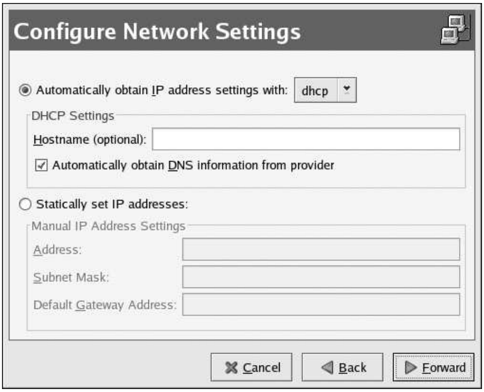

Figure 19-2. Ethernet Settings

After configuring the Ethernet device, it appears in the device list as shown in Figure 19-3.

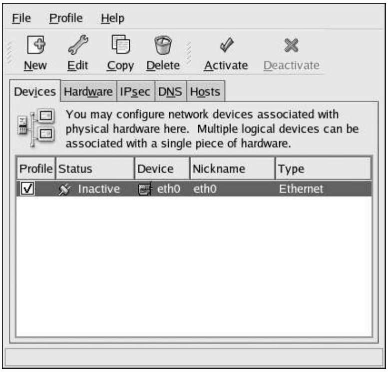

Figure 19-3. Ethernet Device

Be sure to select **File => Save** to save the changes.

After adding the Ethernet device, you can edit its configuration by selecting the device from the device list and clicking **Edit**. For example, when the device is added, it is configured to start at boot time by default. To change this setting, select to edit the device, modify the **Activate device when computer starts** value, and save the changes.

When the device is added, it is not activated immediately, as seen by its **Inactive** status. To activate the device, select it from the device list, and click the **Activate** button. If the system is configured to activate the device when the computer starts (the default), this step does not have to be performed again.

If you associate more than one device with an Ethernet card, the subsequent devices are *device aliases*. A device alias allows you to setup multiple virtual devices for one physical device, thus giving the one physical device more than one IP address. For example, you can configure an eth1 device and an eth1:1 device. For details, refer to Section 19.13 *Device Aliases*.

19.3. Establishing an ISDN Connection

An ISDN connection is an Internet connection established with a ISDN modem card through a special phone line installed by the phone company. ISDN connections are popular in Europe.

To add an ISDN connection, follow these steps:

1. Click the **Devices** tab.
2. Click the **New** button on the toolbar.
3. Select **ISDN connection** from the **Device Type** list, and click **Forward**.
4. Select the ISDN adapter from the pulldown menu. Then configure the resources and D channel protocol for the adapter. Click **Forward** to continue.

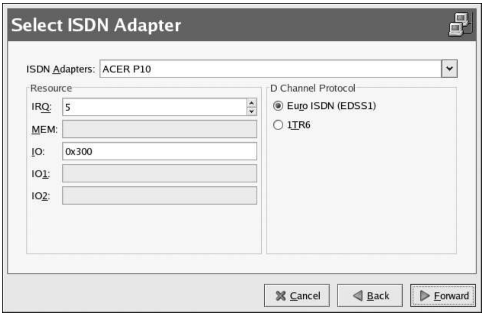

Figure 19-4. ISDN Settings

5. If your Internet Service Provider (ISP) is in the pre-configured list, select it. Otherwise, enter the required information about your ISP account. If you do not know the values, contact your ISP. Click **Forward**.
6. In the **IP Settings** window, select the **Encapsulation Mode** and whether to obtain an IP address automatically or whether to set one statically. Click **Forward** when finished.
7. On the **Create Dialup Connection** page, click **Apply**.

After configuring the ISDN device, it appears in the device list as a device with type **ISDN** as shown in Figure 19-5.

Be sure to select **File** => **Save** to save the changes.

After adding the ISDN device, you can edit its configuration by selecting the device from the device list and clicking **Edit**. For example, when the device is added, it is configured not to start at boot time by default. Edit its configuration to modify this setting. Compression, PPP options, login name, password, and more can be changed.

When the device is added, it is not activated immediately, as seen by its **Inactive** status. To activate the device, select it from the device list, and click the **Activate** button. If the system is configured to activate the device when the computer starts (the default), this step does not have to be performed again.

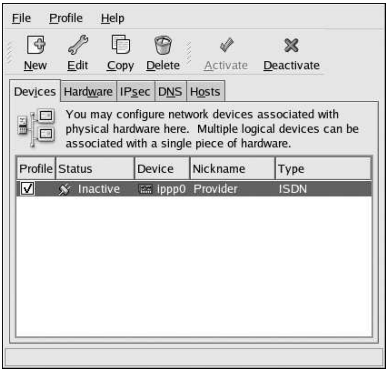

Figure 19-5. ISDN Device

19.4. Establishing a Modem Connection

A modem can be used to configure an Internet connection over an active phone line. An Internet Service Provider (ISP) account (also called a dial-up account) is required.

To add a modem connection, follow these steps:

1. Click the **Devices** tab.
2. Click the **New** button on the toolbar.
3. Select **Modem connection** from the **Device Type** list, and click **Forward**.
4. If there is a modem already configured in the hardware list (on the **Hardware** tab), the **Network Administration Tool** assumes you want to use it to establish a modem connection. If there are no modems already configured, it tries to detect any modems in the system. This probe might take a while. If a modem is not found, a message is displayed to warn you that the settings shown are not values found from the probe.
5. After probing, the window in Figure 19-6 appears.

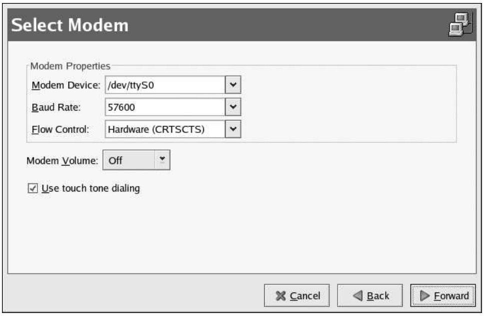

Figure 19-6. Modem Settings

6. Configure the modem device, baud rate, flow control, and modem volume. If you do not know these values, accept the defaults if the modem was probed successfully. If you do not have touch tone dialing, uncheck the corresponding checkbox. Click **Forward**.
7. If your ISP is in the pre-configured list, select it. Otherwise, enter the required information about your ISP account. If you do not know these values, contact your ISP. Click **Forward**.
8. On the **IP Settings** page, select whether to obtain an IP address automatically or whether to set on statically. Click **Forward** when finished.
9. On the **Create Dialup Connection** page, click **Apply**.

After configuring the modem device, it appears in the device list with the type `Modem` as shown in Figure 19-7.

Figure 19-7. Modem Device

Be sure to select **File** => **Save** to save the changes.

After adding the modem device, you can edit its configuration by selecting the device from the device list and clicking **Edit**. For example, when the device is added, it is configured not to start at boot time by default. Edit its configuration to modify this setting. Compression, PPP options, login name, password, and more can also be changed.

When the device is added, it is not activated immediately, as seen by its **Inactive** status. To activate the device, select it from the device list, and click the **Activate** button. If the system is configured to activate the device when the computer starts (the default), this step does not have to be performed again.

19.5. Establishing an xDSL Connection

DSL stands for Digital Subscriber Lines. There are different types of DSL such as ADSL, IDSL, and SDSL. The **Network Administration Tool** uses the term xDSL to mean all types of DSL connections.

Some DSL providers require that the system is configured to obtain an IP address through DHCP with an Ethernet card. Some DSL providers require you to configure a PPPoE (Point-to-Point Protocol over Ethernet) connection with an Ethernet card. Ask your DSL provider which method to use.

If you are required to use DHCP, refer to Section 19.2 *Establishing an Ethernet Connection* to configure your Ethernet card.

If you are required to use PPPoE, follow these steps:

1. Click the **Devices** tab.
2. Click the **New** button.
3. Select **xDSL connection** from the **Device Type** list, and click **Forward**.
4. If your Ethernet card is in the hardware list, select the **Ethernet Device** from the pulldown menu from the page shown in Figure 19-8. Otherwise, the **Select Ethernet Adapter** window appears.

> **Note**
>
> The installation program detects supported Ethernet devices and prompts you to configure them. If you configured any Ethernet devices during the installation, they are displayed in the hardware list on the **Hardware** tab.

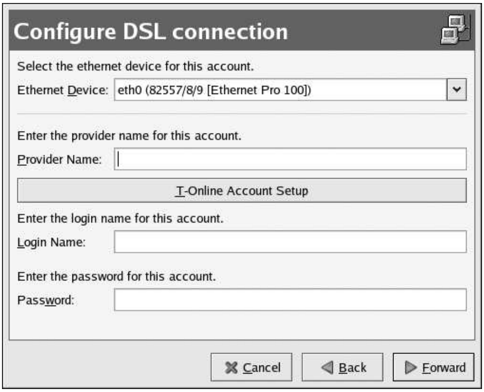

Figure 19-8. xDSL Settings

5. If the **Select Ethernet Adapter** window appears, select the manufacturer and model of the Ethernet card. Select the device name. If this is the system's first Ethernet card, select **eth0** as the device name; if this is the second Ethernet card, select **eth1** (and so on). The **Network Administration Tool** also allows you to configure the resources for the NIC. Click **Forward** to continue.
6. Enter the **Provider Name**, **Login Name**, and **Password**. If you have a T-Online account, instead of entering a **Login Name** and **Password** in the default window, click the **T-Online Account Setup** button and enter the required information. Click **Forward** to continue.
7. On the **Create DSL Connection** page, click **Apply**.

After configuring the DSL connection, it appears in the device list as shown in Figure 19-7.

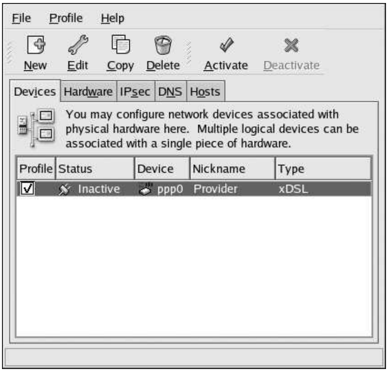

Figure 19-9. xDSL Device

Be sure to select **File** => **Save** to save the changes.

After adding the xDSL connection, you can edit its configuration by selecting the device from the device list and clicking **Edit**. For example, when the device is added, it is configured not to start at boot time by default. Edit its configuration to modify this setting.

When the device is added, it is not activated immediately, as seen by its **Inactive** status. To activate the device, select it from the device list, and click the **Activate** button. If the system is configured to activate the device when the computer starts (the default), this step does not have to be performed again.

19.6. Establishing a Token Ring Connection

A token ring network is a network in which all the computers are connected in a circular pattern. A *token*, or a special network packet, travels around the token ring and allows computers to send information to each other.

Tip

For more information on using token ring under Linux, refer to the *Linux Token Ring Project* website available at http://www.linuxtr.net/.

To add a token ring connection, follow these steps:

1. Click the **Devices** tab.
2. Click the **New** button on the toolbar.
3. Select **Token Ring connection** from the **Device Type** list and click **Forward**.
4. If you have already added the token ring card to the hardware list, select it from the **Tokenring card** list. Otherwise, select **Other Tokenring Card** to add the hardware device.
5. If you selected **Other Tokenring Card**, the **Select Token Ring Adapter** window as shown in Figure 19-10 appears. Select the manufacturer and model of the adapter. Select the device name. If this is the system's first token ring card, select **tr0**; if this is the second token ring card, select **tr1** (and so on). The **Network Administration Tool** also allows the user to configure the resources for the adapter. Click **Forward** to continue.

Figure 19-10. Token Ring Settings

6. On the **Configure Network Settings** page, choose between DHCP and static IP address. You may specify a hostname for the device. If the device receives a dynamic IP address each time the network is started, do not specify a hostname. Click **Forward** to continue.
7. Click **Apply** on the **Create Tokenring Device** page.

After configuring the token ring device, it appears in the device list as shown in Figure 19-11.

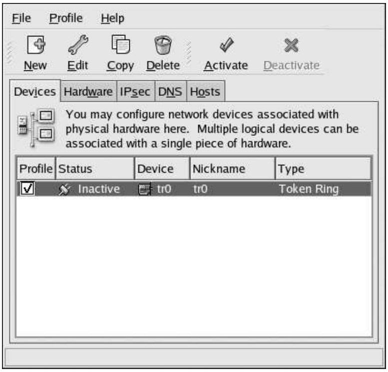

Figure 19-11. Token Ring Device

Be sure to select **File** => **Save** to save the changes.

After adding the device, you can edit its configuration by selecting the device from the device list and clicking **Edit**. For example, you can configure whether the device is started at boot time.

When the device is added, it is not activated immediately, as seen by its **Inactive** status. To activate the device, select it from the device list, and click the **Activate** button. If the system is configured to activate the device when the computer starts (the default), this step does not have to be performed again.

19.7. Establishing a CIPE Connection

CIPE stands for Crypto IP Encapsulation. It is used to configure an IP tunneling device. For example, CIPE can be used to grant access from the outside world into a Virtual Private Network (VPN). If you need to setup a CIPE device, contact your system administrator for the correct values.

To configure a CIPE connection, follow these steps:

1. Click the **Devices** tab.
2. Click the **New** button on the toolbar.
3. Select **CIPE (VPN) connection** from the **Device Type** list and click **Forward**.

   Contact your system administrator for the values to use.

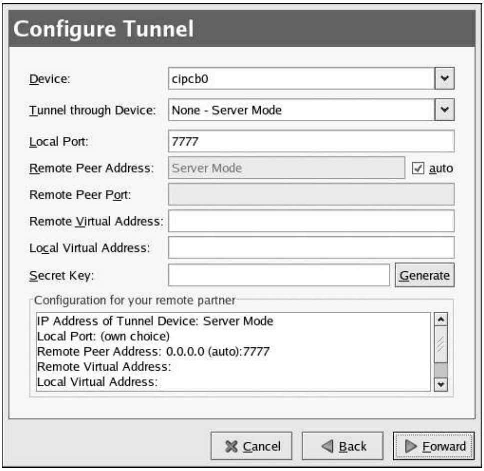

Figure 19-12. CIPE Settings

4. Click **Apply** on the **Create CIPE Connection** page.

After configuring the CIPE device, it appears in the device list as shown in Figure 19-13.

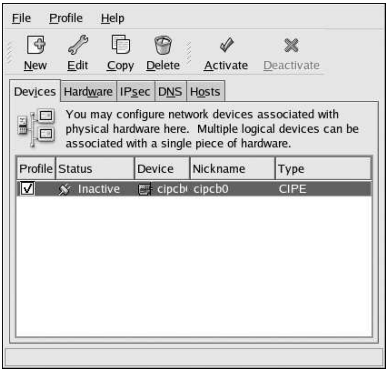

Figure 19-13. CIPE Device

Be sure to select **File** => **Save** to save the changes.

After adding the device, you can edit its configuration by selecting the device from the device list and clicking **Edit**. For example, you can configure whether the device is started at boot time and any routes to use while the device is activated.

When the device is added, it is not activated immediately, as seen by its **Inactive** status. To activate the device, select it from the device list, and click the **Activate** button. If the system is configured to activate the device when the computer starts (the default), this step does not have to be performed again.

Tip

For more information on CIPE and setting up CIPE, refer to the *Red Hat Enterprise Linux Security Guide*.

19.8. Establishing a Wireless Connection

Wireless Ethernet devices are becoming increasingly popular. The configuration is similar to the Ethernet configuration except that it allows you to configure settings such as the SSID and key for the wireless device.

To add a wireless Ethernet connection, follow these steps:

1. Click the **Devices** tab.
2. Click the **New** button on the toolbar.
3. Select **Wireless connection** from the **Device Type** list and click **Forward**.
4. If you have already added the wireless network interface card to the hardware list, select it from the **Wireless card** list. Otherwise, select **Other Wireless Card** to add the hardware device.

Note

The installation program usually detects supported wireless Ethernet devices and prompts you to configure them. If you configured them during the installation, they are displayed in the hardware list on the **Hardware** tab.

5. If you selected **Other Wireless Card**, the **Select Ethernet Adapter** window appears. Select the manufacturer and model of the Ethernet card and the device. If this is the first Ethernet card for the system, select **eth0**; if this is the second Ethernet card for the system, select **eth1** (and so on). The **Network Administration Tool** also allows the user to configure the resources for the wireless network interface card. Click **Forward** to continue.
6. On the **Configure Wireless Connection** page as shown in Figure 19-14, configure the settings for the wireless device.

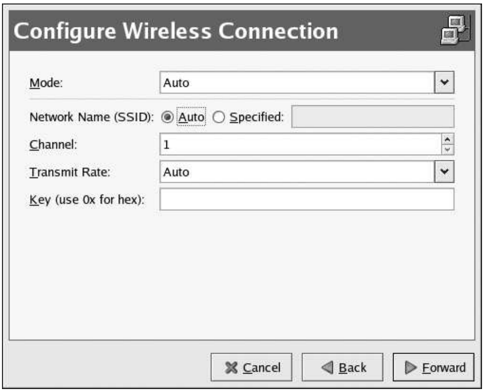

Figure 19-14. Wireless Settings

7. On the **Configure Network Settings** page, choose between DHCP and static IP address. You may specify a hostname for the device. If the device receives a dynamic IP address each time the network is started, do not specify a hostname. Click **Forward** to continue.
8. Click **Apply** on the **Create Wireless Device** page.

After configuring the wireless device, it appears in the device list as shown in Figure 19-15.

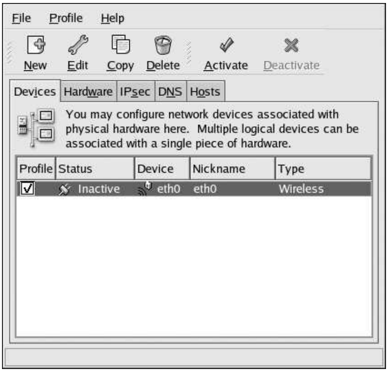

Figure 19-15. Wireless Device

Be sure to select **File** => **Save** to save the changes.

After adding the wireless device, you can edit its configuration by selecting the device from the device list and clicking **Edit**. For example, you can configure the device to activate at boot time.

When the device is added, it is not activated immediately, as seen by its **Inactive** status. To activate the device, select it from the device list, and click the **Activate** button. If the system is configured to activate the device when the computer starts (the default), this step does not have to be performed again.

19.9. Managing DNS Settings

The **DNS** tab allows you to configure the system's hostname, domain, name servers, and search domain. Name servers are used to look up other hosts on the network.

If the DNS server names are retrieved from DHCP or PPPoE (or retrieved from the ISP), do not add primary, secondary, or tertiary DNS servers.

If the hostname is retrieved dynamically from DHCP or PPPoE (or retrieved from the ISP), do not change it.

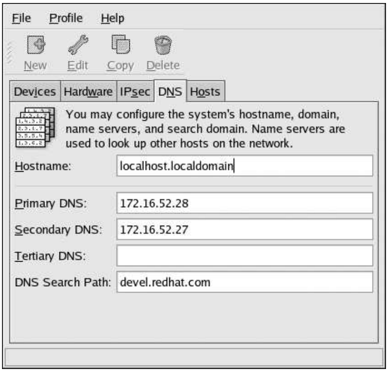

Figure 19-16. DNS Configuration

Note

The name servers section does not configure the system to be a name server. Instead, it configures the name servers to use when resolving IP address to hostnames and vice versa.

19.10. Managing Hosts

The **Hosts** tab allows you to add, edit, or remove hosts from the `/etc/hosts` file. This file contains IP addresses and their corresponding hostnames.

When your system tries to resolve a hostname to an IP address or determine the hostname for an IP address, it refers to the `/etc/hosts` file before using the name servers (if you are using the default Red Hat Enterprise Linux configuration). If the IP address is listed in the `/etc/hosts` file, the name servers are not used. If your network contains computers whose IP addresses are not listed in DNS, it is recommended that you add them to the `/etc/hosts` file.

To add an entry to the `/etc/hosts` file, go to the **Hosts** tab, click the **New** button on the toolbar, provide the requested information, and click **OK**. Select **File** => **Save** or press [Ctrl]-[S] to save the changes to the `/etc/hosts` file. The network or network services do not need to be restarted since the current version of the file is referred to each time an address is resolved.

Warning

Do not remove the `localhost` entry. Even if the system does not have a network connection or have a network connection running constantly, some programs need to connect to the system via the localhost loopback interface.

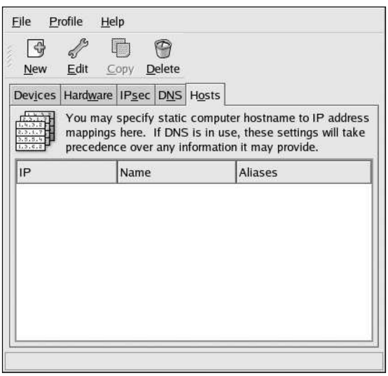

Figure 19-17. Hosts Configuration

Tip

To change lookup order, edit the `/etc/host.conf` file. The line `order hosts, bind` specifies that the `/etc/hosts` takes precedence over the name servers. Changing the line to `order bind, hosts` configures the system to resolve hostnames and IP addresses using the name servers first. If the IP address cannot be resolved through the name servers, the system then looks for the IP address in the `/etc/hosts` file.

19.11. Activating Devices

Network devices can be configured to be active or inactive at boot time. For example, a network device for a modem connection is usually not configured to start at boot time; whereas, an Ethernet connection is usually configured to activate at boot time. If your network device is configured not to start at boot time, you can use the **Red Hat Control Network** program to activate it after boot time. To start it, select **Main Menu Button** (on the Panel) => **System Tools** => **Network Device Control** or type the command `redhat-control-network`.

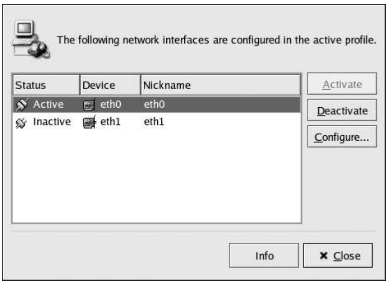

Figure 19-18. Activating Devices

To activate a device, select it from the list and click the **Activate** button. To stop the device, select it from the list and click **Deactivate**.

If more than one network profile is configured, they are listed in the interface and can be activated. Refer to Section 19.12 *Working with Profiles* for details.

19.12. Working with Profiles

Multiple logical network devices can be created for each physical hardware device. For example, if you have one Ethernet card in your system (eth0), you can create logical network devices with different nicknames and different configuration options, all to be specifically associated with eth0.

Logical network devices are different from device aliases. Logical network devices associated with the same physical device must exist in different profiles and cannot be activated simultaneously. Device aliases are also associated with the same physical hardware device, but device aliases associated with the same physical hardware can be activated at the same time. Refer to Section 19.13 *Device Aliases* for details about creating device aliases.

Profiles can be used to create multiple configuration sets for different networks. A configuration set can include logical devices as well as hosts and DNS settings. After configuring the profiles, you can use the **Network Administration Tool** to switch back and forth between them.

By default, there is one profile called **Common**. To create a new profile, select **Profile** => **New** from the pull-down menu, and enter a unique name for the profile.

You are now modifying the new profile as indicated by the status bar at the bottom of the main window.

Click on an existing device already in the list, and click the **Copy** button to copy the existing device to a logical network device. If you use the **New** button, a network alias will be created, which is incorrect. To change the properties of the logical device, select it from the list and click **Edit**. For example, the nickname can be changed to a more descriptive name, such as **`eth0_office`**, so that it can be recognized more easily.

In the list of devices, there is a column of checkboxes labeled **Profile**. For each profile, you can check or uncheck devices. Only the checked devices are included for the currently selected profile. For example, if you create a logical device named **`eth0_office`** in a profile called **`Office`** and want to activate the logical device if the profile is selected, uncheck the `eth0` device and check the `eth0_office` device.

For example, Figure 19-19 shows a profile called **Office** with the logical device **eth0_office**. It is configured to activate the first Ethernet card using DHCP.

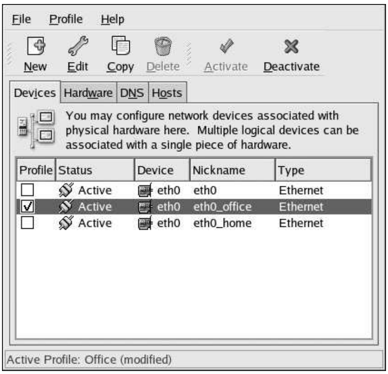

Figure 19-19. Office Profile

Notice that the **Home** profile as shown in Figure 19-20 activates the **eth0_home** logical device, which is associated with `eth0`.

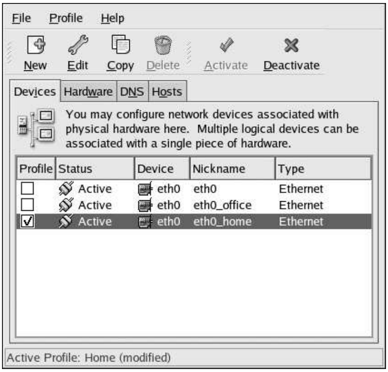

Figure 19-20. Home Profile

You can also configure `eth0` to activate in the **Office** profile only and to activate a ppp (modem) device in the **Home** profile only. Another example is to have the **Common** profile activate `eth0` and an **Away** profile activate a ppp device for use while traveling.

To activate a profile at boot time, modify the boot loader configuration file to include the `netprofile=<profilename>` option. For example, if the system uses GRUB as the boot loader and `/boot/grub/grub.conf` contains:

```
title Red Hat Enterprise Linux (2.4.21-1.1931.2.399.ent)
        root (hd0,0)
        kernel /vmlinuz-2.4.21-1.1931.2.399.ent ro root=LABEL=/
        initrd /initrd-2.4.21-1.1931.2.399.ent.img
```

modify it to the following (where *<profilename>* is the name of the profile to be activated at boot time):

```
title Red Hat Enterprise Linux (2.4.21-1.1931.2.399.ent)
        root (hd0,0)
        kernel /vmlinuz-2.4.21-1.1931.2.399.ent ro root=LABEL=/ netprofile=<profilename>
        initrd /initrd-2.4.21-1.1931.2.399.ent.img
```

To switch profiles after the system has booted, go to **Main Menu** (on the Panel) => **System Tools** => **Network Device Control** (or type the command `redhat-control-network`) to select a profile and activate it. The activate profile section only appears in the **Network Device Control** interface if more than the default **Common** interface exists.

Alternatively, execute the following command to enable a profile (replace *<profilename>* with the name of the profile):

```
redhat-config-network-cmd --profile <profilename> --activate
```

19.13. Device Aliases

Device aliases are virtual devices associated with the same physical hardware, but they can be activated at the same time to have different IP addresses. They are commonly represented as the device name followed by a colon and a number (for example, eth0:1). They are useful if you want to have multiple IP address for a system, but the system only has one network card.

After configuring the Ethernet device, such as `eth0`, to use a static IP address (DHCP does not work with aliases), go to the **Devices** tab and click **New**. Select the Ethernet card to configure with an alias, set the static IP address for the alias, and click **Apply** to create it. Since a device already exists for the Ethernet card, the one just created is the alias such as `eth0:1`.

Warning

> If you are configuring an Ethernet device to have an alias, neither the device nor the alias can be configured to use DHCP. You must configure the IP addresses manually.

Figure 19-21 shows an example of one alias for the `eth0` device. Notice the `eth0:1` device — the first alias for `eth0`. The second alias for `eth0` would have the device name `eth0:2`, and so on. To modify the settings for the device alias such as whether to activate it at boot time and the alias number, select it from the list and click the **Edit** button.

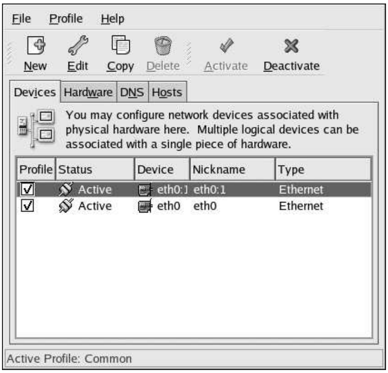

Figure 19-21. Network Device Alias Example

Select the alias and click the **Activate** button to activate the alias. If you have configured multiple profiles, select which profiles in which to include it.

To verify that the alias has been activated, use the command `/sbin/ifconfig`. The output should show the device and the device alias with different IP address:

```
eth0      Link encap:Ethernet  HWaddr 00:A0:CC:60:B7:G4
          inet addr:192.168.100.5  Bcast:192.168.100.255  Mask:255.255.255.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:161930 errors:1 dropped:0 overruns:0 frame:0
          TX packets:244570 errors:0 dropped:0 overruns:0 carrier:0
          collisions:475 txqueuelen:100
          RX bytes:55075551 (52.5 Mb)  TX bytes:178108895 (169.8 Mb)
          Interrupt:10 Base address:0x9000

eth0:1    Link encap:Ethernet  HWaddr 00:A0:CC:60:B7:G4
          inet addr:192.168.100.42  Bcast:192.168.100.255  Mask:255.255.255.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          Interrupt:10 Base address:0x9000

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
```

```
UP LOOPBACK RUNNING  MTU:16436  Metric:1
RX packets:5998 errors:0 dropped:0 overruns:0 frame:0
TX packets:5998 errors:0 dropped:0 overruns:0 carrier:0
collisions:0 txqueuelen:0
RX bytes:1627579 (1.5 Mb)  TX bytes:1627579 (1.5 Mb)
```

19.14. Establishing an IPsec Connection

IPsec stands for *Internet Protocol Security*. It is a Virtual Private Network solution in which an encrypted connection is established between two systems (*host-to-host*) or two networks (*network-to-network*).

Tip

Go to http://www.ipsec-howto.org/ for more information about IPsec.

19.14.1. Host-to-Host Connection

A host-to-host IPsec connection is an encrypted connection between two systems both running IPsec with the same authentication key. With the IPsec connection active, any network traffic between the two hosts is encrypted.

To configure a host-to-host IPsec connection, use the following steps for each host:

1. Start the **Network Administration Tool**.
2. From the **IPsec** tab, select **New**.
3. Click **Forward** to start configuring a host-to-host IPsec connection.
4. Provide a one word nickname such as **`ipsec0`** for the connection, and select whether the connection should be automatically activated when the computer starts. Click **Forward**.
5. Select **Host to Host encryption** as the connection type. Click **Forward**.
6. Select the type of encryption to use: manual or automatic.

   If manual is selected, an encryption key must be provided later in the process. If automatic is selected, the `racoon` daemon is used to manage the encryption key. If `racoon` is used, the `ipsec-tools` package must be installed.

   Click **Forward** to continue.
7. Specify the IP address of the other host.

   If you do not know the IP address of the other system, run the command `/sbin/ifconfig` <*`device`*> on the other system, where <*`device`*> is the Ethernet device used to connect to the other host. If only one Ethernet card exists in the system, the device name is eth0. The IP address is the number following the `inet addr:` label.

   Click **Forward** to continue.
8. If manual encryption was selected in step 6, specify the encryption key to use or click **Generate** to create one.

   Specify an authentication key or click **Generate** to generate one. It can be any combination of numbers and letters.

   Click **Forward** to continue.

9. Verify the information on the **IPsec — Summary** page, and click **Apply**.
10. Select **File => Save** to save the configuration.
11. Select the IPsec connection from the list, and click the **Activate** button.
12. Repeat for the other host. It is extremely important that the same keys from step 8 be used on the other hosts. Otherwise, IPsec will not work.

After configuring the IPsec connection, it appears in the IPsec list as shown in Figure 19-22.

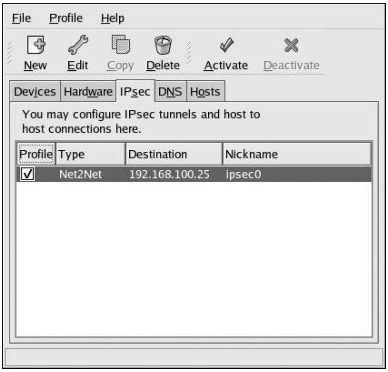

Figure 19-22. IPsec Connection

Two files are created in `/etc/sysconfig/network-scripts/` — `ifcfg-<nickname>` and `keys-<nickname>`. If automatic encryption is selected, `/etc/racoon/racoon.conf` is created as well.

When the interface is activated, `<remote-ip>.conf` and `psk.txt` are created in `/etc/racoon/`, and `racoon.conf` is modified to include `<remote-ip>.conf`.

Refer to Section 19.14.3 *Testing the IPsec Connection* to determine if the IPsec connection has been successfully established.

19.14.2. Network-to-Network (VPN) Connection

A network-to-network IPsec connection uses two IPsec routers, one for each network, through which the network traffic for the private subnets is routed.

For example, as shown in Figure 19-23, if the 192.168.0/24 private network wants to send network traffic to the 192.168.2.0/24 private network, the packets go through gateway0, to ipsec0, through the Internet, to ipsec1, to gateway1, and to the 192.168.2.0/24 subnet.

The IPsec routers must have publically addressable IP addresses as well as another Ethernet device connected to its private network. Traffic only travels through it if it is intended for the other IPsec router with which it has an encrypted connection.

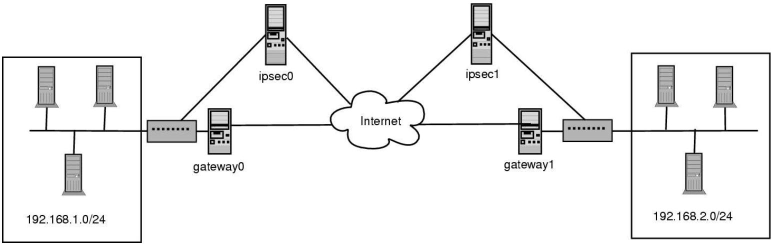

Figure 19-23. Network-to-Network IPsec

Alternate network configurations options include a firewall between each IP router and the Internet and an Intranet firewall between each IPsec router and subnet gateway. The IPsec router and the gateway for the subnet can be one system with two Ethernet devices, one with a public IP address that acts as the IPsec router and one with a private IP address that acts as the gateway for the private subnet. Each IPsec router can use the gateway for its private network or a public gateway to send the packets to the other IPsec router.

To configure a network-to-network IPsec connection, use the following steps:

1. Start the **Network Administration Tool**.
2. From the **IPsec** tab, select **New**.
3. Click **Forward** to start configuring a network-to-network IPsec connection.
4. Provide a one word nickname such as **`ipsec0`** for the connection, and select whether the connection should be automatically activated when the computer starts. Click **Forward**.
5. Select **Network to Network encryption (VPN)**, and click **Forward**.
6. Select the type of encryption to use: manual or automatic.

   If manual is selected, an encryption key must be provided later in the process. If automatic is selected, the `racoon` daemon is used to manage the encryption key. If `racoon` is used, the `ipsec-tools` package must be installed. Click **Forward** to continue.
7. On the **Local Network** page, enter the following information:
   - **Local Network Address** — The IP address of the device on the IPsec router connected to the private network.
   - **Local Subnet Mask** — The subnet mask of the local network IP address.
   - **Local Network Gateway** — The gateway for the private subnet.

   Click **Forward** to continue.

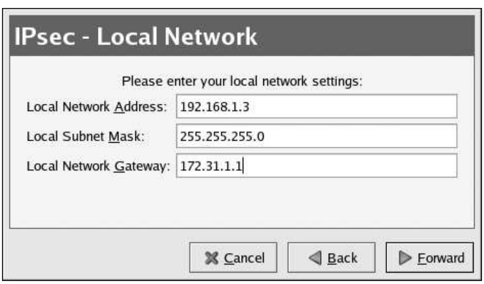

Figure 19-24. Local Network Information

8. On the **Remote Network** page, enter the following information:
   - **Remote IP Address** — The publically addressable IP address of the IPsec router for the *other* private network. In our example, for ipsec0, enter the publically addressable IP address of ipsec1, and vice versa.
   - **Remote Network Address** — The network address of the private subnet behind the *other* IPsec router. In our example, enter **`192.168.1.0`** if configuring ipsec1, and enter **`192.168.2.0`** if configuring ipsec0.
   - **Remote Subnet Mask** — The subnet mask of the remote IP address.
   - **Remote Network Gateway** — The IP address of the gateway for the remote network address.
   - If manual encryption was selected in step 6, specify the encryption key to use or click **Generate** to create one.

     Specify an authentication key or click **Generate** to generate one. It can be any combination of numbers and letters.

   Click **Forward** to continue.

   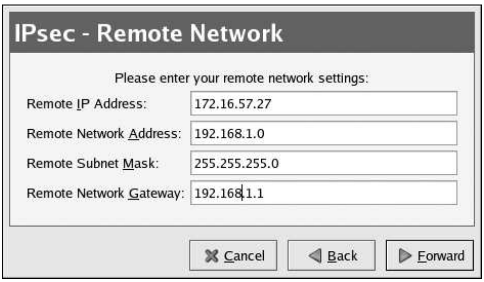

   Figure 19-25. Remote Network Information

9. Verify the information on the **IPsec — Summary** page, and click **Apply**.
10. Select **File** => **Save** to save the configuration.
11. Select the IPsec connection from the list, and click the **Activate** button.
12. As root at a shell prompt, enable IP forwarding:
    a. Edit `/etc/sysctl.conf` and set `net.ipv4.ip_forward` to **`1`**.
    b. Execute the following command to enable the change:
    ```
    sysctl -p /etc/sysctl.conf
    ```

The network script to activate the IPsec connection automatically creates network routes to send packets through the IPsec router if necessary.

Refer to Section 19.14.3 *Testing the IPsec Connection* to determine if the IPsec connection has been successfully established.

19.14.3. Testing the IPsec Connection

Use the `tcpdump` utility to view the network packets being transfered between the hosts (or networks) and verify that they are encrypted via IPsec. The packet should include an AH header and should be shown as ESP packets. ESP means it is encrypted. For example:

```
17:13:20.617872 pinky.example.com > ijin.example.com: \
     AH(spi=0x0aaa749f,seq=0x335): ESP(spi=0x0ec0441e,seq=0x335) (DF)
```

19.14.4. Starting and Stopping the Connection

If the IPsec connection was not configured to activate on boot, start and stop it as root via the command line.

To start the connection, execute the following command as root on each host for host-to-host IPsec or each IPsec router for network-to-network IPsec (replace *<ipsec-nick>* with the one word nickname configured earlier, such as `ipsec0`):

```
/sbin/ifup <ipsec-nick>
```

To stop the connection, execute the following command as root on each host for host-to-host IPsec or each IPsec router for network-to-network IPsec (replace *<ipsec-nick>* with the one word nickname configured earlier, such as `ipsec0`):

```
/sbin/ifdown <ipsec-nick>
```

19.15. Saving and Restoring the Network Configuration

The command line version of **Network Administration Tool** can be used to save the system's network configuration to a file. This file can then be used to restore the network setting to a Red Hat Enterprise Linux system.

This feature can be used as part of an automated backup script, to save the configuration before upgrading or reinstalling, or to copy the configuration to a different Red Hat Enterprise Linux system.

To save, or *export*, the system's network configuration to the file `/tmp/network-config`, execute the following command as root:

```
redhat-config-network-cmd -e > /tmp/network-config
```

To restore, or *import*, the network configuration from the file created from the previous command, execute the following command as root:

```
redhat-config-network-cmd -i -c -f /tmp/network-config
```

The `-i` option means to import the data, the `-c` option means to clear the existing configuration prior of importing, and the `-f` option specifies that the file to import is as follows.

Chapter 20. Basic Firewall Configuration

Just as a firewall in a building attempts to prevent a fire from spreading, a computer firewall attempts to prevent computer viruses from spreading to your computer and to prevent unauthorized users from accessing your computer. A firewall exists between your computer and the network. It determines which services on your computer remote users on the network can access. A properly configured firewall can greatly increase the security of your system. It is recommended that you configure a firewall for any Red Hat Enterprise Linux system with an Internet connection.

20.1. Security Level Configuration Tool

During the **Firewall Configuration** screen of the Red Hat Enterprise Linux installation, you were given the option to enable a basic firewall as well as allow specific devices, incoming services, and ports.

After installation, you can change this preference by using the **Security Level Configuration Tool**.

To start the application, select **Main Menu Button** (on the Panel) => **System Settings** => **Security Level** or type the command `redhat-config-securitylevel` from a shell prompt (for example, in an XTerm or a GNOME terminal).

Figure 20-1. Security Level Configuration Tool

Note

The **Security Level Configuration Tool** only configures a basic firewall. If the system needs to allow or deny access to specific ports or if the system needs more complex rules, refer to the *Red Hat Enterprise Linux Reference Guide* for details on configuring specific `iptables` rules.

Select one of the following options:

- **Disable firewall** — Disabling the firewall provides complete access to your system and does no security checking. Security checking is the disabling of access to certain services. This should only be selected if you are running on a trusted network (not the Internet) or plan to do more firewall configuration later.

  Warning

  If you have a firewall configured or any customized firewall rules in the `/etc/sysconfig/iptables` file, the file will be deleted if you select **Disable firewall** and click **OK** to save the changes.

- **Enable firewall** — This option configures the system to reject incoming connections that are not in response to outbound requests, such as DNS replies or DHCP requests. If access to services running on this machine is needed, you can choose to allow specific services through the firewall.

  If you are connecting your system to the Internet, but do not plan to run a server, this is the safest choice.

  Selecting any of the **Trusted devices** allows access to your system for all traffic from that device; it is excluded from the firewall rules. For example, if you are running a local network, but are connected to the Internet via a PPP dialup, you can check **eth0** and any traffic coming from your local network will be allowed. Selecting **eth0** as trusted means all traffic over the Ethernet is allowed, but the ppp0 interface is still firewalled. To restrict traffic on an interface, leave it unchecked.

  It is not recommended that you make any device that is connected to public networks, such as the Internet, a **Trusted device**.

  Enabling options in the **Trusted services** list allows the specified service to pass through the firewall.

  WWW (HTTP)

  The HTTP protocol is used by Apache (and by other Web servers) to serve webpages. If you plan on making your Web server publicly available, enable this option. This option is not required for viewing pages locally or for developing webpages. You must have the `httpd` package installed to serve webpages.

  Enabling **WWW (HTTP)** will not open a port for HTTPS, the SSL version of HTTP.

  FTP

  The FTP protocol is used to transfer files between machines on a network. If you plan on making your FTP server publicly available, enable this option. The `vsftpd` package must be installed for this option to be useful.

  SSH

  Secure Shell (SSH) is a suite of tools for logging into and executing commands on a remote machine. To allow remote access to the machine via ssh, enable this option. The `openssh-server` package must be installed to access your machine remotely using SSH tools.

  Telnet

  Telnet is a protocol for logging into remote machines. Telnet communications are unencrypted and provide no security from network snooping. Allowing incoming Telnet access is not recommended. To allow inbound Telnet access, you must have the `telnet-server` package installed.

  Mail (SMTP)

  To allow incoming mail delivery through your firewall so that remote hosts can connect directly to your machine to deliver mail, enable this option. You do not need to enable this if you collect your mail from your ISP's server using POP3 or IMAP, or if you use a tool such as `fetchmail`. Note that an improperly configured SMTP server can allow remote machines to use your server to send spam.

Click **OK** to save the changes and enable or disable the firewall. If **Enable firewall** was selected, the options selected are translated to `iptables` commands and written to the `/etc/sysconfig/iptables` file. The `iptables` service is also started so that the firewall is activated immediately after saving the selected options. If **Disable firewall** was selected, the `/etc/sysconfig/iptables` file is removed, and the `iptables` service is stopped immediately.

The options selected are also written to the `/etc/sysconfig/redhat-config-securitylevel` file so that the settings can be restored the next time the application is started. Do not edit this file by hand.

Even though the firewall is activated immediately, the `iptables` service is not configured to start automatically at boot time, refer to Section 20.2 *Activating the `iptables` Service* for details.

20.2. Activating the `iptables` Service

The firewall rules are only active if the `iptables` service is running. To manually start the service, use the command:

```
/sbin/service iptables restart
```

To ensure that it is started when the system is booted, issue the command:

```
/sbin/chkconfig --level 345 iptables on
```

The `ipchains` service is not included in Red Hat Enterprise Linux. However, if `ipchains` is installed (for example, an upgrade was performed, and the system had `ipchains` previously installed), the `ipchains` service should not be activated along with the `iptables` service. To make sure the `ipchains` service is disabled and configured not to start at boot time, execute the following two commands:

```
/sbin/service ipchains stop
/sbin/chkconfig --level 345 ipchains off
```

The **Services Configuration Tool** can be used to enable or disable the `iptables` and `ipchains` services.

Chapter 21.

Controlling Access to Services

Maintaining security on your system is extremely important. One way to manage security on your system is to manage access to system services carefully. Your system may need to provide open access to particular services (for example, `httpd` if you are running a Web server). However, if you do not need to provide a service, you should turn it off to minimize your exposure to possible bug exploits.

There are several different methods for managing access to system services. Decide which method of management to use based on the service, your system's configuration, and your level of Linux expertise.

The easiest way to deny access to a service is to turn it off. Both the services managed by `xinetd` (discussed later in this section) and the services in the `/etc/rc.d/init.d` hierarchy (also known as SysV services) can be configured to start or stop using three different applications:

- **Services Configuration Tool** — a graphical application that displays a description of each service, displays whether each service is started at boot time (for runlevels 3, 4, and 5), and allows services to be started, stopped, and restarted.
- **ntsysv** — a text-based application that allows you to configure which services are started at boot time for each runlevel. Changes do not take effect immediately for non-`xinetd` services. Non-`xinetd` services can not be started, stopped, or restarted using this program.
- `chkconfig` — a command line utility that allows you to turn services on and off for the different runlevels. Changes do not take effect immediately for non-`xinetd` services. Non-`xinetd` services can not be started, stopped, or restarted using this utility.

You may find that these tools are easier to use than the alternatives — editing the numerous symbolic links located in the directories below `/etc/rc.d` by hand or editing the `xinetd` configuration files in `/etc/xinetd.d`.

Another way to manage access to system services is by using `iptables` to configure an IP firewall. If you are a new Linux user, please realize that `iptables` may not be the best solution for you. Setting up `iptables` can be complicated and is best tackled by experienced Linux system administrators.

On the other hand, the benefit of using `iptables` is flexibility. For example, if you need a customized solution which provides certain hosts access to certain services, `iptables` can provide it for you. Refer to the *Red Hat Enterprise Linux Reference Guide* and the *Red Hat Enterprise Linux Security Guide* for more information about `iptables`.

Alternatively, if you are looking for a utility to set general access rules for your home machine, and/or if you are new to Linux, try the **Security Level Configuration Tool** (`redhat-config-securitylevel`), which allows you to select the security level for your system, similar to the **Firewall Configuration** screen in the installation program.

Refer to Chapter 20 *Basic Firewall Configuration* for more information. If you need more specific firewall rules, refer to the `iptables` chapter in the *Red Hat Enterprise Linux Reference Guide*.

21.1. Runlevels

Before you can configure access to services, you must understand Linux runlevels. A runlevel is a state, or *mode*, that is defined by the services listed in the directory `/etc/rc.d/rc<x>.d`, where <*x*> is the number of the runlevel.

The following runlevels exist:

- 0 — Halt
- 1 — Single-user mode
- 2 — Not used (user-definable)
- 3 — Full multi-user mode
- 4 — Not used (user-definable)
- 5 — Full multi-user mode (with an X-based login screen)
- 6 — Reboot

If you use a text login screen, you are operating in runlevel 3. If you use a graphical login screen, you are operating in runlevel 5.

The default runlevel can be changed by modifying the `/etc/inittab` file, which contains a line near the top of the file similar to the following:

```
id:5:initdefault:
```

Change the number in this line to the desired runlevel. The change do not take effect until you reboot the system.

To change the runlevel immediately, use the command `telinit` followed by the runlevel number. You must be root to use this command. The `telinit` command does not change the `/etc/inittab` file; it only changes the runlevel currently running. When the system is rebooted, it is booted in to the runlevel specified in `/etc/inittab`.

21.2. TCP Wrappers

Many UNIX system administrators are accustomed to using TCP wrappers to manage access to certain network services. Any network services managed by `xinetd` (as well as any program with built-in support for `libwrap`) can use TCP wrappers to manage access. `xinetd` can use the `/etc/hosts.allow` and `/etc/hosts.deny` files to configure access to system services. As the names imply, `hosts.allow` contains a list of rules that allow clients to access the network services controlled by `xinetd`, and `hosts.deny` contains rules to deny access. The `hosts.allow` file takes precedence over the `hosts.deny` file. Permissions to grant or deny access can be based on individual IP address (or hostnames) or on a pattern of clients. Refer to the *Red Hat Enterprise Linux Reference Guide* and `hosts_access` in section 5 of the man pages (`man 5 hosts_access`) for details.

21.2.1. `xinetd`

To control access to Internet services, use `xinetd`, which is a secure replacement for `inetd`. The `xinetd` daemon conserves system resources, provides access control and logging, and can be used to start special-purpose servers. `xinetd` can be used to provide access only to particular hosts, to deny access to particular hosts, to provide access to a service at certain times, to limit the rate of incoming connections and/or the load created by connections, and more

`xinetd` runs constantly and listens on all ports for the services it manages. When a connection request arrives for one of its managed services, `xinetd` starts up the appropriate server for that service.

The configuration file for `xinetd` is `/etc/xinetd.conf`, but the file only contains a few defaults and an instruction to include the `/etc/xinetd.d` directory. To enable or disable an `xinetd` service, edit its configuration file in the `/etc/xinetd.d` directory. If the `disable` attribute is set to **`yes`**, the service is disabled. If the `disable` attribute is set to **`no`**, the service is enabled. You can edit any of the `xinetd` configuration files or change its enabled status using the **Services Configuration Tool**, **ntsysv**, or `chkconfig`. For a list of network services controlled by `xinetd`, review the contents of the `/etc/xinetd.d` directory with the command `ls /etc/xinetd.d`.

21.3. Services Configuration Tool

The **Services Configuration Tool** is a graphical application developed by Red Hat to configure which SysV services in the `/etc/rc.d/init.d` directory are started at boot time (for runlevels 3, 4, and 5) and which `xinetd` services are enabled. It also allows you to start, stop, and restart SysV services as well as restart `xinetd`.

To start the **Services Configuration Tool** from the desktop, go to the **Main Menu Button** (on the Panel) => **System Settings** => **Server Settings** => **Services** or type the command `redhat-config-services` at a shell prompt (for example, in an **XTerm** or a **GNOME terminal**).

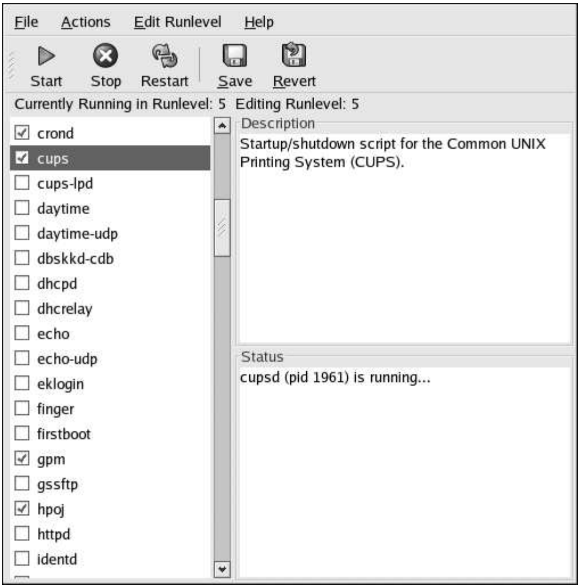

Figure 21-1. Services Configuration Tool

The **Services Configuration Tool** displays the current runlevel as well as the runlevel you are currently editing. To edit a different runlevel, select **Edit Runlevel** from the pulldown menu and select runlevel 3, 4, or 5. Refer to Section 21.1 *Runlevels* for a description of runlevels.

The **Services Configuration Tool** lists the services from the `/etc/rc.d/init.d` directory as well as the services controlled by `xinetd`. Click on the name of the service from the list on the left-hand side of the application to display a brief description of that service as well as the status of the service. If the service is not an `xinetd` service, the status window shows whether the service is currently running. If the service is controlled by `xinetd`, the status window displays the phrase **xinetd service**.

To start, stop, or restart a service immediately, select the service from the list and click the appropriate button on the toolbar (or choose the action from the **Actions** pulldown menu). If the service is an `xinetd` service, the action buttons are disabled because they can not be started or stopped individually.

If you enable/disable an `xinetd` service by checking or unchecking the checkbox next to the service name, you must select **File** => **Save Changes** from the pulldown menu to restart `xinetd` and immediately enable/disable the `xinetd` service that you changed. `xinetd` is also configured to remember the setting. You can enable/disable multiple `xinetd` services at a time and save the changes when you are finished.

For example, assume you check `rsync` to enable it in runlevel 3 and then save the changes. The `rsync` service is immediately enabled. The next time `xinetd` is started, `rsync` is still enabled.

Warning

> When you save changes to `xinetd` services, `xinetd` is restarted, and the changes take place immediately. When you save changes to other services, the runlevel is reconfigured, but the changes do not take effect immediately.

To enable a non-`xinetd` service to start at boot time for the currently selected runlevel, check the checkbox beside the name of the service in the list. After configuring the runlevel, apply the changes by selecting **File** => **Save Changes** from the pulldown menu. The runlevel configuration is changed, but the runlevel is not restarted; thus, the changes do not take place immediately.

For example, assume you are configuring runlevel 3. If you change the value for the `httpd` service from checked to unchecked and then select **Save Changes**, the runlevel 3 configuration changes so that `httpd` is not started at boot time. However, runlevel 3 is not reinitialized, so `httpd` is still running. Select one of following options at this point:

1. Stop the `httpd` service — Stop the service by selecting it from the list and clicking the **Stop** button. A message appears stating that the service was stopped successfully.
2. Reinitialize the runlevel — Reinitialize the runlevel by going to a shell prompt and typing the command `telinit 3` (where 3 is the runlevel number). This option is recommended if you change the **Start at Boot** value of multiple services and want to activate the changes immediately.
3. Do nothing else — You do not have to stop the `httpd` service. You can wait until the system is rebooted for the service to stop. The next time the system is booted, the runlevel is initialized without the `httpd` service running.

To add a service to a runlevel, select the runlevel from the **Edit Runlevel** pulldown menu, and then select **Actions** => **Add Service**. To delete a service from a runlevel, select the runlevel from the **Edit Runlevel** pulldown menu, select the service to be deleted from the list on the left, and select **Actions** => **Delete Service**.

21.4. ntsysv

The **ntsysv** utility provides a simple interface for activating or deactivating services. You can use **ntsysv** to turn an `xinetd`-managed service on or off. You can also use **ntsysv** to configure runlevels. By default, only the current runlevel is configured. To configure a different runlevel, specify one or more runlevels with the `--level` option. For example, the command `ntsysv --level 345` configures runlevels 3, 4, and 5.

The **ntsysv** interface works like the text mode installation program. Use the up and down arrows to navigate up and down the list. The space bar selects/unselects services and is also used to "press" the **Ok** and **Cancel** buttons. To move between the list of services and the **Ok** and **Cancel** buttons, use the [Tab] key. An * signifies that a service is set to on. Pressing the [F1] key displays a short description of the selected service.

Warning

> Services managed by `xinetd` are immediately affected by **ntsysv**. For all other services, changes do not take effect immediately. You must stop or start the individual service with the command `service`

daemon stop. In the previous example, replace *daemon* with the name of the service you want to stop; for example, httpd. Replace stop with start or restart to start or restart the service.

21.5. chkconfig

The chkconfig command can also be used to activate and deactivate services. The chkconfig --list command displays a list of system services and whether they are started (on) or stopped (off) in runlevels 0-6. At the end of the list is a section for the services managed by xinetd.

If the chkconfig --list command is used to query a service managed by xinetd, it displays whether the xinetd service is enabled (on) or disabled (off). For example, the command chkconfig --list finger returns the following output:

```
finger          on
```

As shown, finger is enabled as an xinetd service. If xinetd is running, finger is enabled.

If you use chkconfig --list to query a service in /etc/rc.d, service's settings for each runlevel are displayed. For example, the command chkconfig --list httpd returns the following output:

```
httpd          0:off    1:off    2:on     3:on     4:on     5:on     6:off
```

chkconfig can also be used to configure a service to be started (or not) in a specific runlevel. For example, to turn nscd off in runlevels 3, 4, and 5, use the following command:

```
chkconfig --level 345 nscd off
```

Warning

Services managed by xinetd are immediately affected by chkconfig. For example, if xinetd is running, finger is disabled, and the command chkconfig finger on is executed, finger is immediately enabled without having to restart xinetd manually. Changes for other services do not take effect immediately after using chkconfig. You must stop or start the individual service with the command service *daemon* stop. In the previous example, replace *daemon* with the name of the service you want to stop; for example, httpd. Replace stop with start or restart to start or restart the service.

21.6. Additional Resources

For more information, refer to the following resources.

21.6.1. Installed Documentation

- The man pages for ntsysv, chkconfig, xinetd, and xinetd.conf.
- man 5 hosts_access — The man page for the format of host access control files (in section 5 of the man pages).

21.6.2. Useful Websites

- http://www.xinetd.org — The `xinetd` webpage. It contains a more detailed list of features and sample configuration files.

21.6.3. Related Books

- *Red Hat Enterprise Linux Reference Guide*, Red Hat, Inc. — This companion manual contains detailed information about how TCP wrappers and `xinetd` allow or deny access as well as how to configure network access using them. It also provides instructions for creating `iptables` firewall rules.
- *Red Hat Enterprise Linux Security Guide* Red Hat, Inc. — This manual discusses securing services with TCP wrappers and `xinetd` such as logging denied connection attempts.

Chapter 22. OpenSSH

OpenSSH is a free, open source implementation of the SSH (*S*ecure *SH*ell) protocols. It replaces `telnet`, `ftp`, `rlogin`, `rsh`, and `rcp` with secure, encrypted network connectivity tools. OpenSSH supports versions 1.3, 1.5, and 2 of the SSH protocol. Since OpenSSH version 2.9, the default protocol is version 2, which uses RSA keys as the default.

22.1. Why Use OpenSSH?

If you use OpenSSH tools, you are enhancing the security of your machine. All communications using OpenSSH tools, including passwords, are encrypted. `Telnet` and `ftp` use plain text passwords and send all information unencrypted. The information can be intercepted, the passwords can be retrieved, and then your system can be compromised by an unauthorized person logging in to your system using one of the intercepted passwords. The OpenSSH set of utilities should be used whenever possible to avoid these security problems.

Another reason to use OpenSSH is that it automatically forwards the `DISPLAY` variable to the client machine. In other words, if you are running the X Window System on your local machine, and you log in to a remote machine using the `ssh` command, when you run a program on the remote machine that requires X, it will be displayed on your local machine. This feature is convenient if you prefer graphical system administration tools but do not always have physical access to your server.

22.2. Configuring an OpenSSH Server

To run an OpenSSH server, you must first make sure that you have the proper RPM packages installed. The `openssh-server` package is required and depends on the `openssh` package.

The OpenSSH daemon uses the configuration file `/etc/ssh/sshd_config`. The default configuration file should be sufficient for most purposes. If you want to configure the daemon in ways not provided by the default `sshd_config`, read the `sshd` man page for a list of the keywords that can be defined in the configuration file.

To start the OpenSSH service, use the command `/sbin/service sshd start`. To stop the OpenSSH server, use the command `/sbin/service sshd stop`. If you want the daemon to start automatically at boot time, refer to Chapter 21 *Controlling Access to Services* for information on how to manage services.

If you reinstall, and clients connected to the system before the reinstall with any of the OpenSSH tools, after the reinstall, the client users will see the following message:

```
@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
@    WARNING: REMOTE HOST IDENTIFICATION HAS CHANGED!     @
@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
IT IS POSSIBLE THAT SOMEONE IS DOING SOMETHING NASTY!
Someone could be eavesdropping on you right now (man-in-the-middle attack)!
It is also possible that the RSA host key has just been changed.
```

The reinstalled system creates a new set of identification keys for the system; hence, the warning about the RSA host key changing. If you want to keep the host keys generated for the system, backup the `/etc/ssh/ssh_host*key*` files and restore them after the reinstall. This process retains the system's identity, and when clients try to connect to the system after the reinstall, they will not receive the warning message.

22.3. Configuring an OpenSSH Client

To connect to an OpenSSH server from a client machine, you must have the `openssh-clients` and `openssh` packages installed on the client machine.

22.3.1. Using the `ssh` Command

The `ssh` command is a secure replacement for the `rlogin`, `rsh`, and `telnet` commands. It allows you to log in to a remote machine as well as execute commands on a remote machine.

Logging in to a remote machine with `ssh` is similar to using `telnet`. To log in to a remote machine named penguin.example.net, type the following command at a shell prompt:

```
ssh penguin.example.net
```

The first time you `ssh` to a remote machine, you will see a message similar to the following:

```
The authenticity of host 'penguin.example.net' can't be established.
DSA key fingerprint is 94:68:3a:3a:bc:f3:9a:9b:01:5d:b3:07:38:e2:11:0c.
Are you sure you want to continue connecting (yes/no)?
```

Type **`yes`** to continue. This will add the server to your list of known hosts as seen in the following message:

```
Warning: Permanently added 'penguin.example.net' (RSA) to the list of known hosts.
```

Next, you will see a prompt asking for your password for the remote machine. After entering your password, you will be at a shell prompt for the remote machine. If you do not specify a username the username that you are logged in as on the local client machine is passed to the remote machine. If you want to specify a different username, use the following command:

```
ssh username@penguin.example.net
```

You can also use the syntax `ssh -l` *`username`* `penguin.example.net`.

The `ssh` command can be used to execute a command on the remote machine without logging in to a shell prompt. The syntax is `ssh` *`hostname command`*. For example, if you want to execute the command `ls /usr/share/doc` on the remote machine penguin.example.net, type the following command at a shell prompt:

```
ssh penguin.example.net ls /usr/share/doc
```

After you enter the correct password, the contents of the remote directory `/usr/share/doc` will be displayed, and you will return to your local shell prompt.

22.3.2. Using the `scp` Command

The `scp` command can be used to transfer files between machines over a secure, encrypted connection. It is similar to `rcp`.

The general syntax to transfer a local file to a remote system is as follows:

```
scp localfile username@tohostname:/newfilename
```

The *`localfile`* specifies the source, and *`username@tohostname:/newfilename`* specifies the destination.

To transfer the local file `shadowman` to your account on penguin.example.net, type the following at a shell prompt (replace *username* with your username):

```
scp shadowman username@penguin.example.net:/home/username
```

This will transfer the local file `shadowman` to `/home/username/shadowman` on penguin.example.net.

The general syntax to transfer a remote file to the local system is as follows:

```
scp username@tohostname:/remotefile /newlocalfile
```

The *remotefile* specifies the source, and *newlocalfile* specifies the destination.

Multiple files can be specified as the source files. For example, to transfer the contents of the directory `/downloads` to an existing directory called `uploads` on the remote machine penguin.example.net, type the following at a shell prompt:

```
scp /downloads/* username@penguin.example.net:/uploads/
```

22.3.3. Using the `sftp` Command

The `sftp` utility can be used to open a secure, interactive FTP session. It is similar to `ftp` except that it uses a secure, encrypted connection. The general syntax is *sftp username@hostname.com*. Once authenticated, you can use a set of commands similar to those used by FTP. Refer to the `sftp` man page for a list of these commands. To read the man page, execute the command `man sftp` at a shell prompt. The `sftp` utility is only available in OpenSSH version 2.5.0p1 and higher.

22.3.4. Generating Key Pairs

If you do not want to enter your password every time you use `ssh`, `scp`, or `sftp` to connect to a remote machine, you can generate an authorization key pair.

Keys must be generated for each user. To generate keys for a user, use the following steps as the user who wants to connect to remote machines. If you complete the steps as root, only root will be able to use the keys.

Starting with OpenSSH version 3.0, `~/.ssh/authorized_keys2`, `~/.ssh/known_hosts2`, and `/etc/ssh_known_hosts2` are obsolete. SSH Protocol 1 and 2 share the `~/.ssh/authorized_keys`, `~/.ssh/known_hosts`, and `/etc/ssh/ssh_known_hosts` files.

Red Hat Enterprise Linux 3 uses SSH Protocol 2 and RSA keys by default.

Tip

If you reinstall and want to save your generated key pair, backup the `.ssh` directory in your home directory. After reinstalling, copy this directory back to your home directory. This process can be done for all users on your system, including root.

22.3.4.1. Generating an RSA Key Pair for Version 2

Use the following steps to generate an RSA key pair for version 2 of the SSH protocol. This is the default starting with OpenSSH 2.9.

1. To generate an RSA key pair to work with version 2 of the protocol, type the following command at a shell prompt:
   `ssh-keygen -t rsa`

   Accept the default file location of `~/.ssh/id_rsa`. Enter a passphrase different from your account password and confirm it by entering it again.

   The public key is written to `~/.ssh/id_rsa.pub`. The private key is written to `~/.ssh/id_rsa`. Never distribute your private key to anyone.
2. Change the permissions of the `.ssh` directory using the following command:
   `chmod 755 ~/.ssh`
3. Copy the contents of `~/.ssh/id_rsa.pub` to `~/.ssh/authorized_keys` on the machine to which you want to connect. If the file `~/.ssh/authorized_keys` exist, append the contents of the file `~/.ssh/id_rsa.pub` to the file `~/.ssh/authorized_keys` on the other machine.
4. Change the permissions of the `authorized_keys` file using the following command:
   `chmod 644 ~/.ssh/authorized_keys`
5. If you are running GNOME, skip to Section 22.3.4.4 *Configuring `ssh-agent` with GNOME*. If you are not running the X Window System, skip to Section 22.3.4.5 *Configuring `ssh-agent`*.

22.3.4.2. Generating a DSA Key Pair for Version 2

Use the following steps to generate a DSA key pair for version 2 of the SSH Protocol.

1. To generate a DSA key pair to work with version 2 of the protocol, type the following command at a shell prompt:
   `ssh-keygen -t dsa`

   Accept the default file location of `~/.ssh/id_dsa`. Enter a passphrase different from your account password and confirm it by entering it again.

   Tip

   A passphrase is a string of words and characters used to authenticate a user. Passphrases differ from passwords in that you can use spaces or tabs in the passphrase. Passphrases are generally longer than passwords because they are usually phrases instead of a single word.

   The public key is written to `~/.ssh/id_dsa.pub`. The private key is written to `~/.ssh/id_dsa`. It is important never to give anyone the private key.
2. Change the permissions of the `.ssh` directory with the following command:
   `chmod 755 ~/.ssh`
3. Copy the contents of `~/.ssh/id_dsa.pub` to `~/.ssh/authorized_keys` on the machine to which you want to connect. If the file `~/.ssh/authorized_keys` exist, append the contents of the file `~/.ssh/id_dsa.pub` to the file `~/.ssh/authorized_keys` on the other machine.
4. Change the permissions of the `authorized_keys` file using the following command:
   `chmod 644 ~/.ssh/authorized_keys`
5. If you are running GNOME, skip to Section 22.3.4.4 *Configuring `ssh-agent` with GNOME*. If you are not running the X Window System, skip to Section 22.3.4.5 *Configuring `ssh-agent`*.

22.3.4.3. Generating an RSA Key Pair for Version 1.3 and 1.5

Use the following steps to generate an RSA key pair, which is used by version 1 of the SSH Protocol. If you are only connecting between systems that use DSA, you do not need an RSA version 1.3 or RSA version 1.5 key pair.

1. To generate an RSA (for version 1.3 and 1.5 protocol) key pair, type the following command at a shell prompt:
   `ssh-keygen -t rsa1`

   Accept the default file location (`~/.ssh/identity`). Enter a passphrase different from your account password. Confirm the passphrase by entering it again.

   The public key is written to `~/.ssh/identity.pub`. The private key is written to `~/.ssh/identity`. Do not give anyone the private key.
2. Change the permissions of your `.ssh` directory and your key with the commands `chmod 755 ~/.ssh` and `chmod 644 ~/.ssh/identity.pub`.
3. Copy the contents of `~/.ssh/identity.pub` to the file `~/.ssh/authorized_keys` on the machine to which you wish to connect. If the file `~/.ssh/authorized_keys` does not exist, you can copy the file `~/.ssh/identity.pub` to the file `~/.ssh/authorized_keys` on the remote machine.
4. If you are running GNOME, skip to Section 22.3.4.4 *Configuring `ssh-agent` with GNOME*. If you are not running GNOME, skip to Section 22.3.4.5 *Configuring `ssh-agent`*.

22.3.4.4. Configuring `ssh-agent` with GNOME

The `ssh-agent` utility can be used to save your passphrase so that you do not have to enter it each time you initiate an `ssh` or `scp` connection. If you are using GNOME, the `openssh-askpass-gnome` utility can be used to prompt you for your passphrase when you log in to GNOME and save it until you log out of GNOME. You will not have to enter your password or passphrase for any `ssh` or `scp` connection made during that GNOME session. If you are not using GNOME, refer to Section 22.3.4.5 *Configuring `ssh-agent`*.

To save your passphrase during your GNOME session, follow the following steps:

1. You will need to have the package `openssh-askpass-gnome` installed; you can use the command `rpm -q openssh-askpass-gnome` to determine if it is installed or not. If it is not installed, install it from your Red Hat Enterprise Linux CD-ROM set, from a Red Hat FTP mirror site, or using Red Hat Network.
2. Select **Main Menu Button** (on the Panel) => **Preferences** => **More Preferences** => **Sessions**, and click on the **Startup Programs** tab. Click **Add** and enter **`/usr/bin/ssh-add`** in the **Startup Command** text area. Set it a priority to a number higher than any existing commands to ensure that it is executed last. A good priority number for `ssh-add` is 70 or higher. The higher the priority number, the lower the priority. If you have other programs listed, this one should have the lowest priority. Click **Close** to exit the program.
3. Log out and then log back into GNOME; in other words, restart X. After GNOME is started, a dialog box will appear prompting you for your passphrase(s). Enter the passphrase requested. If you have both DSA and RSA key pairs configured, you will be prompted for both. From this point on, you should not be prompted for a password by `ssh`, `scp`, or `sftp`.

22.3.4.5. Configuring `ssh-agent`

The `ssh-agent` can be used to store your passphrase so that you do not have to enter it each time you make a `ssh` or `scp` connection. If you are not running the X Window System, follow these steps from a shell prompt. If you are running GNOME but you do not want to configure it to prompt you for your passphrase when you log in (see Section 22.3.4.4 *Configuring `ssh-agent` with GNOME*), this procedure will work in a terminal window, such as an XTerm. If you are running X but not GNOME, this procedure will work in a terminal window. However, your passphrase will only be remembered for that terminal window; it is not a global setting.

1. At a shell prompt, type the following command:
   ```
   exec /usr/bin/ssh-agent $SHELL
   ```
2. Then type the command:
   ```
   ssh-add
   ```
   and enter your passphrase(s). If you have more than one key pair configured, you will be prompted for each one.
3. When you log out, your passphrase(s) will be forgotten. You must execute these two commands each time you log in to a virtual console or open a terminal window.

22.4. Additional Resources

The OpenSSH and OpenSSL projects are in constant development, and the most up-to-date information for them is available from their websites. The man pages for OpenSSH and OpenSSL tools are also good sources of detailed information.

22.4.1. Installed Documentation

- The `ssh`, `scp`, `sftp`, `sshd`, and `ssh-keygen` man pages — These man pages include information on how to use these commands as well as all the parameters that can be used with them.

22.4.2. Useful Websites

- http://www.openssh.com/ — The OpenSSH FAQ page, bug reports, mailing lists, project goals, and a more technical explanation of the security features.
- http://www.openssl.org/ — The OpenSSL FAQ page, mailing lists, and a description of the project goal.
- http://www.freessh.org/ — SSH client software for other platforms.

22.4.3. Related Books

- *Red Hat Enterprise Linux Reference Guide* — Learn the event sequence of an SSH connection, review a list of configuration files, and discover how SSH can be used for X forwarding.

Chapter 23.
Network File System (NFS)

Network File System (NFS) is a way to share files between machines on a network as if the files were located on the client's local hard drive. Red Hat Enterprise Linux can be both an NFS server and an NFS client, which means that it can export file systems to other systems and mount file systems exported from other machines.

23.1. Why Use NFS?

NFS is useful for sharing directories of files between multiple users on the same network. For example, a group of users working on the same project can have access to the files for that project using a shared directory of the NFS file system (commonly known as an NFS share) mounted in the directory `/myproject`. To access the shared files, the user goes into the `/myproject` directory on his machine. There are no passwords to enter or special commands to remember. Users work as if the directory is on their local machines.

23.2. Mounting NFS File Systems

Use the `mount` command to mount a shared NFS directory from another machine:

```
mount shadowman.example.com:/misc/export /misc/local
```

Warning

The mount point directory on local machine (`/misc/local` in the above example) must exist.

In this command, `shadowman.example.com` is the hostname of the NFS file server, `/misc/export` is the directory that `shadowman` is exporting, and `/misc/local` is the location to mount the file system on the local machine. After the `mount` command runs (and if the client has proper permissions from the `shadowman.example.com` NFS server) the client user can execute the command `ls /misc/local` to display a listing of the files in `/misc/export` on `shadowman.example.com`.

23.2.1. Mounting NFS File Systems using `/etc/fstab`

An alternate way to mount an NFS share from another machine is to add a line to the `/etc/fstab` file. The line must state the hostname of the NFS server, the directory on the server being exported, and the directory on the local machine where the NFS share is to be mounted. You must be root to modify the `/etc/fstab` file.

The general syntax for the line in `/etc/fstab` is as follows:

```
server:/usr/local/pub    /pub   nfs    rsize=8192,wsize=8192,timeo=14,intr
```

The mount point `/pub` must exist on the client machine. After adding this line to `/etc/fstab` on the client system, type the command `mount /pub` at a shell prompt, and the mount point `/pub` will be mounted from the server.

23.2.2. Mounting NFS File Systems using autofs

A third option for mounting an NFS share is the use of autofs. Autofs uses the automount daemon to manage your mount points by only mounting them dynamically when they are accessed.

Autofs consults the master map configuration file `/etc/auto.master` to determine which mount points are defined. It then starts an automount process with the appropriate parameters for each mount point. Each line in the master map defines a mount point and a separate map file that defines the file systems to be mounted under this mount point. For example, the `/etc/auto.misc` file might define mount points in the `/misc` directory; this relationship would be defined in the `/etc/auto.master` file.

Each entry in `auto.master` has three fields. The first field is the mount point. The second field is the location of the map file, and the third field is optional. The third field can contain information such as a timeout value.

For example, to mount the directory `/proj52` on the remote machine penguin.example.net at the mount point `/misc/myproject` on your machine, add the following line to `auto.master`:

```
/misc   /etc/auto.misc --timeout 60
```

Add the following line to `/etc/auto.misc`:

```
myproject  -rw,soft,intr,rsize=8192,wsize=8192 penguin.example.net:/proj52
```

The first field in `/etc/auto.misc` is the name of the `/misc` subdirectory. This directory is created dynamically by automount. It should not actually exist on the client machine. The second field contains mount options such as `rw` for read and write access. The third field is the location of the NFS export including the hostname and directory.

Note

The directory `/misc` must exist on the local file system. There should be no subdirectories in `/misc` on the local file system.

Autofs is a service. To start the service, at a shell prompt, type the following commands:

```
/sbin/service autofs restart
```

To view the active mount points, type the following command at a shell prompt:

```
/sbin/service autofs status
```

If you modify the `/etc/auto.master` configuration file while autofs is running, you must tell the automount daemon(s) to reload by typing the following command at a shell prompt:

```
/sbin/service autofs reload
```

To learn how to configure autofs to start at boot time, refer to Chapter 21 *Controlling Access to Services* for information on managing services.

23.2.3. Using TCP

The default transport protocol for NFS is UDP; however, the Red Hat Enterprise Linux 3 kernel includes support for NFS over TCP. To use NFS over TCP, include the `-o tcp` option to `mount` when mounting the NFS-exported file system on the client system. For example:

```
mount -o tcp shadowman.example.com:/misc/export /misc/local
```

If the NFS mount is specified in `/etc/fstab`:

```
server:/usr/local/pub    /pub   nfs    rsize=8192,wsize=8192,timeo=14,intr,tcp
```

If it is specified in an autofs configuration file:

```
myproject  -rw,soft,intr,rsize=8192,wsize=8192,tcp penguin.example.net:/proj52
```

Since the default is UDP, if the `-o tcp` option is not specified, the NFS-exported file system is accessed via UDP.

The advantages of using TCP include the following:

- Improved connection durability, thus less `NFS stale file handles` messages.
- Performance gain on heavily loaded networks because TCP acknowledges every packet, unlike UDP which only acknowledges completion.
- TCP has better congestion control than UDP (which has none). On a very congested network, UDP packets are the first types of packet that are dropped. Which means if NFS is writing data (in 8K chunks) all of that 8K has to retransmitted. With TCP because of its reliability, one parts of that 8K data is transmitted at a time.
- Error detection. When a tcp connection breaks (due to the server going down) the client stops sending data and starts the reconnection process. With UDP, since its connection-less, the client continue to pound the network with data until server comes up.

The main disadvantage is that there is a very small performance hit due to the overhead associated with the TCP protocol.

23.2.4. Preserving ACLs

The Red Hat Enterprise Linux 3 kernel provides ACL support for the ext3 file system and ext3 file systems mounted with the NFS or Samba protocols. Thus, if an ext3 file system has ACLs enabled for it and is NFS exported, if the NFS client can read ACLs, they are used by the NFS client as well.

For more information about mounting NFS file systems with ACLs, refer to Chapter 8 *Access Control Lists*.

23.3. Exporting NFS File Systems

Sharing files from an NFS server is known as exporting the directories. The **NFS Server Configuration Tool** can be used to configure a system as an NFS server.

To use the **NFS Server Configuration Tool**, you must be running the X Window System, have root privileges, and have the `redhat-config-nfs` RPM package installed. To start the application, select **Main Menu Button** (on the Panel) => **System Settings** => **Server Settings** => **NFS**, or type the command `redhat-config-nfs`.

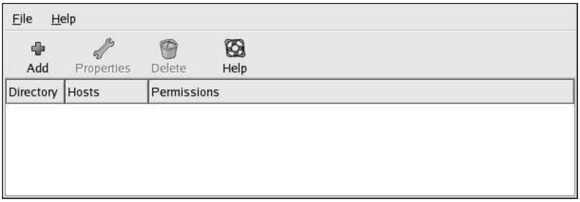

Figure 23-1. NFS Server Configuration Tool

To add an NFS share, click the **Add** button. The dialog box shown in Figure 23-2 will appear.

The **Basic** tab requires the following information:

- **Directory** — Specify the directory to share, such as `/tmp`.
- **Host(s)** — Specify the host(s) to which to share the directory. Refer to Section 23.3.2 *Hostname Formats* for an explanation of possible formats.
- **Basic permissions** — Specify whether the directory should have read-only or read/write permissions.

Figure 23-2. Add Share

The **General Options** tab allows the following options to be configured:

- **Allow connections from port 1024 and higher** — Services started on port numbers less than 1024 must be started as root. Select this option to allow the NFS service to be started by a user other than root. This option corresponds to `insecure`.
- **Allow insecure file locking** — Do not require a lock request. This option corresponds to `insecure_locks`.
- **Disable subtree checking** — If a subdirectory of a file system is exported, but the entire file system is not exported, the server checks to see if the requested file is in the subdirectory exported. This check is called *subtree checking*. Select this option to disable subtree checking. If the entire file system is exported, selecting to disable subtree checking can increase the transfer rate. This option corresponds to `no_subtree_check`.
- **Sync write operations on request** — Enabled by default, this option does not allow the server to reply to requests before the changes made by the request are written to the disk. This option corresponds to `sync`. If this is not selected, the `async` option is used.
  - **Force sync of write operations immediately** — Do not delay writing to disk. This option corresponds to `no_wdelay`.

The **User Access** tab allows the following options to be configured:

- **Treat remote root user as local root** — By default, the user and group IDs of the root user are both 0. Root squashing maps the user ID 0 and the group ID 0 to the user and group IDs of anonymous so that root on the client does not have root privileges on the NFS server. If this option is selected, root is not mapped to anonymous, and root on a client has root privileges to exported directories. Selecting this option can greatly decrease the security of the system. Do not select it unless it is absolutely necessary. This option corresponds to `no_root_squash`.
- **Treat all client users as anonymous users** — If this option is selected, all user and group IDs are mapped to the anonymous user. This option corresponds to `all_squash`.
  - **Specify local user ID for anonymous users** — If **Treat all client users as anonymous users** is selected, this option lets you specify a user ID for the anonymous user. This option corresponds to `anonuid`.
  - **Specify local group ID for anonymous users** — If **Treat all client users as anonymous users** is selected, this option lets you specify a group ID for the anonymous user. This option corresponds to `anongid`.

To edit an existing NFS share, select the share from the list, and click the **Properties** button. To delete an existing NFS share, select the share from the list, and click the **Delete** button.

After clicking **OK** to add, edit, or delete an NFS share from the list, the changes take place immediately — the server daemon is restarted, and the old configuration file is saved as `/etc/exports.bak`. The new configuration is written to `/etc/exports`.

The **NFS Server Configuration Tool** reads and writes directly to the `/etc/exports` configuration file. Thus, the file can be modified manually after using the tool, and the tool can be used after modifying the file manually (provided the file was modified with correct syntax).

23.3.1. Command Line Configuration

If you prefer editing configuration files using a text editor or if you do not have the X Window System installed, you can modify the configuration file directly.

The `/etc/exports` file controls what directories the NFS server exports. Its format is as follows:

```
directory hostname(options)
```

The only option that needs to be specified is one of `sync` or `async` (`sync` is recommended). If `sync` is specified, the server does not reply to requests before the changes made by the request are written to the disk.

For example:

```
/misc/export      speedy.example.com(sync)
```

would allow users from `speedy.example.com` to mount `/misc/export` with the default read-only permissions, but:

```
/misc/export      speedy.example.com(rw,sync)
```

would allow users from `speedy.example.com` to mount `/misc/export` with read/write privileges.

Refer to Section 23.3.2 *Hostname Formats* for an explanation of possible hostname formats.

Refer to the *Red Hat Enterprise Linux Reference Guide* for a list of options that can be specified.

Caution

Be careful with spaces in the `/etc/exports` file. If there are no spaces between the hostname and the options in parentheses, the options apply only to the hostname. If there is a space between the hostname and the options, the options apply to the rest of the world. For example, examine the following lines:

```
/misc/export speedy.example.com(rw,sync)
/misc/export speedy.example.com (rw,sync)
```

The first line grants users from `speedy.example.com` read-write access and denies all other users. The second line grants users from `speedy.example.com` read-only access (the default) and allows the rest of the world read-write access.

Each time you change `/etc/exports`, you must inform the NFS daemon of the change, or reload the configuration file with the following command:

```
/sbin/service nfs reload
```

23.3.2. Hostname Formats

The host(s) can be in the following forms:

- Single machine — A fully qualified domain name (that can be resolved by the server), hostname (that can be resolved by the server), or an IP address
- Series of machines specified with wildcards — Use the * or ? character to specify a string match. Wildcards are not to be used with IP addresses; however, they may accidentally work if reverse DNS lookups fail. When specifying wildcards in fully qualified domain names, dots (.) are not included in the wildcard. For example, `*.example.com` includes one.example.com but does not include one.two.example.com.
- IP networks — Use *`a.b.c.d/z`*, where *`a.b.c.d`* is the network and *`z`* is the number of bits in the netmask (for example 192.168.0.0/24). Another acceptable format is *`a.b.c.d/netmask`*, where *`a.b.c.d`* is the network and *`netmask`* is the netmask (for example, 192.168.100.8/255.255.255.0).
- Netgroups — In the format *`@group-name`*, where *`group-name`* is the NIS netgroup name.

23.3.3. Starting and Stopping the Server

On the server that is exporting NFS file systems, the `nfs` service must be running.

View the status of the NFS daemon with the following command:

```
/sbin/service nfs status
```

Start the NFS daemon with the following command:

```
/sbin/service nfs start
```

Stop the NFS daemon with the following command:

```
/sbin/service nfs stop
```

To start the `nfs` service at boot time, use the command:

```
/sbin/chkconfig --level 345 nfs on
```

You can also use `chkconfig`, **ntsysv** or the **Services Configuration Tool** to configure which services start at boot time. Refer to Chapter 21 *Controlling Access to Services* for details.

23.4. Additional Resources

This chapter discusses the basics of using NFS. For more detailed information, refer to the following resources.

23.4.1. Installed Documentation

- The man pages for `nfsd`, `mountd`, `exports`, `auto.master`, and `autofs` (in manual sections 5 and 8) — These man pages show the correct syntax for the NFS and autofs configuration files.

23.4.2. Useful Websites

- http://nfs.sourceforge.net/ — the NFS webpage, includes links to the mailing lists and FAQs.
- http://www.tldp.org/HOWTO/NFS-HOWTO/index.html — The *Linux NFS-HOWTO* from the Linux Documentation Project.

23.4.3. Related Books

- *Managing NFS and NIS Services* by Hal Stern; O'Reilly & Associates, Inc.

redhat

Chapter 24.

Samba

Samba uses the SMB protocol to share files and printers across a network connection. Operating systems that support this protocol include Microsoft Windows, OS/2, and Linux.

The Red Hat Enterprise Linux 3 kernel contains *Access Control List* (ACL) support for ext3 file systems. If the Samba server shares an ext3 file system with ACLs enabled for it, and the kernel on the client system contains support for reading ACLs from ext3 file systems, the client automatically recognizes and uses the ACLs. Refer to Chapter 8 *Access Control Lists* for more information on ACLs.

24.1. Why Use Samba?

Samba is useful if you have a network of both Windows and Linux machines. Samba allows files and printers to be shared by all the systems in a network. To share files between Linux machines only, use NFS as discussed in Chapter 23 *Network File System (NFS)*. To share printers between Linux machines only, you do not need to use Samba; refer to Chapter 36 *Printer Configuration*.

24.2. Configuring a Samba Server

The default configuration file (`/etc/samba/smb.conf`) allows users to view their home directories as a Samba share. It also shares all printers configured for the system as Samba shared printers. In other words, you can attach a printer to the system and print to it from the Windows machines on your network.

24.2.1. Graphical Configuration

To configure Samba using a graphical interface, use the **Samba Server Configuration Tool**. For command line configuration, skip to Section 24.2.2 *Command Line Configuration*.

The **Samba Server Configuration Tool** is a graphical interface for managing Samba shares, users, and basic server settings. It modifies the configuration files in the `/etc/samba/` directory. Any changes to these files not made using the application are preserved.

To use this application, you must be running the X Window System, have root privileges, and have the `redhat-config-samba` RPM package installed. To start the **Samba Server Configuration Tool** from the desktop, go to the **Main Menu Button** (on the Panel) => **System Settings** => **Server Settings** => **Samba** or type the command `redhat-config-samba` at a shell prompt (for example, in an XTerm or a GNOME terminal).

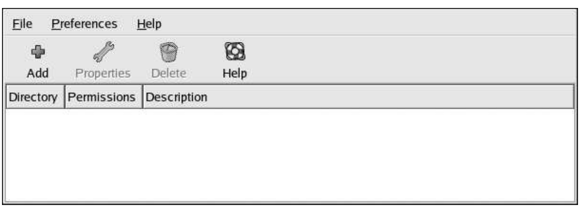

Figure 24-1. Samba Server Configuration Tool

Note

The **Samba Server Configuration Tool** does not display shared printers or the default stanza that allows users to view their own home directories on the Samba server.

24.2.1.1. Configuring Server Settings

The first step in configuring a Samba server is to configure the basic settings for the server and a few security options. After starting the application, select **Preferences** => **Server Settings** from the pulldown menu. The **Basic** tab is displayed as shown in Figure 24-2.

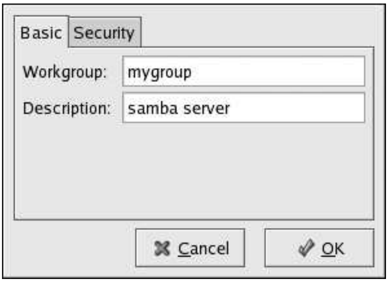

Figure 24-2. Configuring Basic Server Settings

On the **Basic** tab, specify which workgroup the computer should be in as well as a brief description of the computer. They correspond to the `workgroup` and `server string` options in `smb.conf`.

Figure 24-3. Configuring Security Server Settings

The **Security** tab contains the following options:

- **Authentication Mode** — This corresponds to the `security` option. Select one of the following types of authentication.
  - **ADS** — The Samba server acts as a domain member in an Active Directory Domain (ADS) realm. For this option, Kerberos must be installed and configured on the server, and Samba must become a member of the ADS realm using the `net` utility, which is part of the `samba-client` package. Refer to the `net` man page for details. This option does not configure Samba to be an ADS Controller.

  - **Domain** — The Samba server relies on a Windows NT Primary or Backup Domain Controller to verify the user. The server passes the username and password to the Controller and waits for it to return. Specify the NetBIOS name of the Primary or Backup Domain Controller in the **Authentication Server** field.

    The **Encrypted Passwords** option must be set to **Yes** if this is selected.
  - **Server** — The Samba server tries to verify the username and password combination by passing them to another Samba server. If it can not, the server tries to verify using the user authentication mode. Specify the NetBIOS name of the other Samba server in the **Authentication Server** field.
  - **Share** — Samba users do not have to enter a username and password combination on a per Samba server basis. They are not prompted for a username and password until they try to connect to a specific shared directory from a Samba server.
  - **User** — (Default) Samba users must provide a valid username and password on a per Samba server basis. Select this option if you want the **Windows Username** option to work. Refer to Section 24.2.1.2 *Managing Samba Users* for details.

- **Encrypt Passwords** — This option must be enabled if the clients are connecting from a Windows 98, Windows NT 4.0 with Service Pack 3, or other more recent versions of Microsoft Windows. The passwords are transfered between the server and the client in an encrypted format instead of in as a plain-text word that can be intercepted. This corresponds to the `encrypted passwords` option. Refer to Section 24.2.3 *Encrypted Passwords* for more information about encrypted Samba passwords.
- **Guest Account** — When users or guest users log into a Samba server, they must be mapped to a valid user on the server. Select one of the existing usernames on the system to be the guest Samba account. When guests logs in to the Samba server, they have the same privileges as this user. This corresponds to the `guest account` option.

After clicking **OK**, the changes are written to the configuration file and the daemon is restart; thus, the changes take effect immediately.

24.2.1.2. Managing Samba Users

The **Samba Server Configuration Tool** requires that an existing user account be active on the system acting as the Samba server before a Samba user can be added. The Samba user is associated with the existing user account.

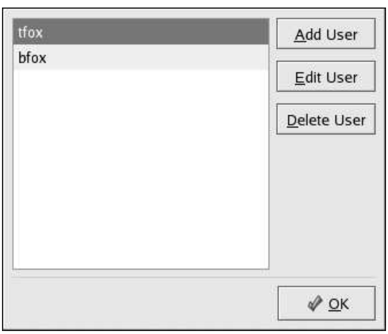

Figure 24-4. Managing Samba Users

To add a Samba user, select **Preferences** => **Samba Users** from the pulldown menu, and click the **Add User** button. On the **Create New Samba User** window select a **Unix Username** from the list of existing users on the local system.

If the user has a different username on a Windows machine and will be logging into the Samba server from the Windows machine, specify that Windows username in the **Windows Username** field. The **Authentication Mode** on the **Security** tab of the **Server Settings** preferences must be set to **User** for this option to work.

Also configure a **Samba Password** for the Samba User and confirm the Samba Password by typing it again. Even if you select to use encrypted passwords for Samba, it is recommended that the Samba passwords for all users are different from their system passwords.

To edit an existing user, select the user from the list, and click **Edit User**. To delete an existing Samba user, select the user, and click the **Delete User** button. Deleting a Samba user does not delete the associated system user account.

The users are modified immediately after clicking the **OK** button.

24.2.1.3. Adding a Share

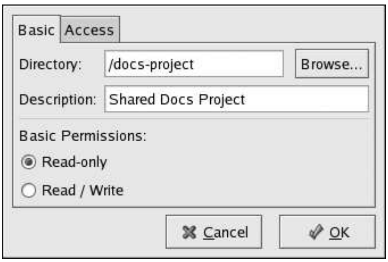

Figure 24-5. Adding a Share

To add a share, click the **Add** button. The **Basic** tab configures the following options:

- **Directory** — The directory to share via Samba. The directory must exist.
- **Descriptions** — A brief description of the share.
- **Basic Permissions** — Whether users should only be able to read the files in the shared directory or whether they should be able to read and write to the shared directory.

On the **Access** tab, select whether to allow only specified users to access the share or whether to allow all Samba users to access the share. If you select to allow access to specific users, select the users from the list of available Samba users.

The share is added immediately after clicking **OK**.

24.2.2. Command Line Configuration

Samba uses `/etc/samba/smb.conf` as its configuration file. If you change this configuration file, the changes do not take effect until you restart the Samba daemon with the command `service smb restart`.

To specify the Windows workgroup and a brief description of the Samba server, edit the following lines in your `smb.conf` file:

```
workgroup = WORKGROUPNAME
server string = BRIEF COMMENT ABOUT SERVER
```

Replace *`WORKGROUPNAME`* with the name of the Windows workgroup to which this machine should belong. The *`BRIEF COMMENT ABOUT SERVER`* is optional and is used as the Windows comment about the Samba system.

To create a Samba share directory on your Linux system, add the following section to your `smb.conf` file (after modifying it to reflect your needs and your system):

```
[sharename]
comment = Insert a comment here
path = /home/share/
valid users = tfox carole
public = no
writable = yes
printable = no
create mask = 0765
```

The above example allows the users tfox and carole to read and write to the directory `/home/share`, on the Samba server, from a Samba client.

24.2.3. Encrypted Passwords

Encrypted passwords are enabled by default because it is more secure. If encrypted passwords are not used, plain text passwords are used, which can be intercepted by someone using a network packet sniffer. It is recommended that encrypted passwords be used.

The Microsoft SMB Protocol originally used plaintext passwords. However, Windows NT 4.0 with Service Pack 3 or higher, Windows 98, Windows 2000, Windows ME, and Windows XP require encrypted Samba passwords. To use Samba between a Linux system and a system running one of these Windows operating systems, you can either edit your Windows registry to use plaintext passwords or configure Samba on your Linux system to use encrypted passwords. If you choose to modify your registry, you must do so for all your Windows machines — this is risky and may cause further conflicts. It is recommended that you use encrypted passwords for better security.

To configure Samba to use encrypted passwords, follow these steps:

1. Create a separate password file for Samba. To create one based on your existing `/etc/passwd` file, at a shell prompt, type the following command:
   ```
   cat /etc/passwd | mksmbpasswd.sh > /etc/samba/smbpasswd
   ```
   If the system uses NIS, type the following command:
   ```
   ypcat passwd | mksmbpasswd.sh > /etc/samba/smbpasswd
   ```
   The `mksmbpasswd.sh` script is installed in your `/usr/bin` directory with the `samba` package.
2. Change the permissions of the Samba password file so that only root has read and write permissions:
   ```
   chmod 600 /etc/samba/smbpasswd
   ```
3. The script does not copy user passwords to the new file, and a Samba user account is not active until a password is set for it. For higher security, it is recommended that the user's Samba password be different from the user's system password. To set each Samba user's password, use the following command (replace *`username`* with each user's username):
   ```
   smbpasswd username
   ```

4. Encrypted passwords must be enabled. Since they are enabled by default, they do not have to be specifically enabled in the configuration file. However, they can not be disabled in the configuration file either. In the file `/etc/samba/smb.conf`, verify that the following line does not exist:

   ```
   encrypt passwords = no
   ```

   If it does exist but is commented out with a semi-colon (`;`) at the beginning of the line, then the line is ignored, and encrypted passwords are enabled. If this line exist but is not commented out, either remove it or comment it out.

   To specifically enable encrypted passwords in the configuration file, add the following lines to `etc/samba/smb.conf`:

   ```
   encrypt passwords = yes
   smb passwd file = /etc/samba/smbpasswd
   ```

5. Make sure the `smb` service is started by typing the command `service smb restart` at a shell prompt.
6. If you want the `smb` service to start automatically, use **ntsysv**, `chkconfig`, or the **Services Configuration Tool** to enable it at runtime. Refer to Chapter 21 *Controlling Access to Services* for details.

The `pam_smbpass` PAM module can be used to sync users' Samba passwords with their system passwords when the `passwd` command is used. If a user invokes the `passwd` command, the password he uses to log in to the Red Hat Enterprise Linux system as well as the password he must provide to connect to a Samba share are changed.

To enable this feature, add the following line to `/etc/pam.d/system-auth` below the `pam_cracklib.so` invocation:

```
password required /lib/security/pam_smbpass.so nullok use_authtok try_first_pass
```

24.2.4. Starting and Stopping the Server

On the server that is sharing directories via Samba, the `smb` service must be running.

View the status of the Samba daemon with the following command:

```
/sbin/service smb status
```

Start the daemon with the following command:

```
/sbin/service smb start
```

Stop the daemon with the following command:

```
/sbin/service smb stop
```

To start the `smb` service at boot time, use the command:

```
/sbin/chkconfig --level 345 smb on
```

You can also use `chkconfig`, **ntsysv** or the **Services Configuration Tool** to configure which services start at boot time. Refer to Chapter 21 *Controlling Access to Services* for details.

Tip

To view active connections to the system, execute the command `smbstatus`.

24.3. Connecting to a Samba Share

You can use **Nautilus** to view available Samba shares on your network. Select **Main Menu Button** (on the Panel) => **Network Servers** to view a list of Samba workgroups on your network. You can also type **`smb:`** in the **Location:** bar of Nautilus to view the workgroups.

As shown in Figure 24-6, an icon appears for each available SMB workgroup on the network.

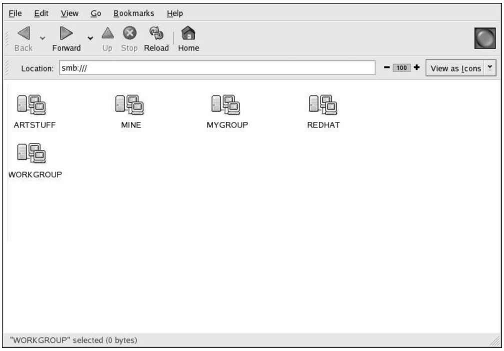

Figure 24-6. SMB Workgroups in Nautilus

Double-click one of the workgroup icons to view a list of computers within the workgroup.

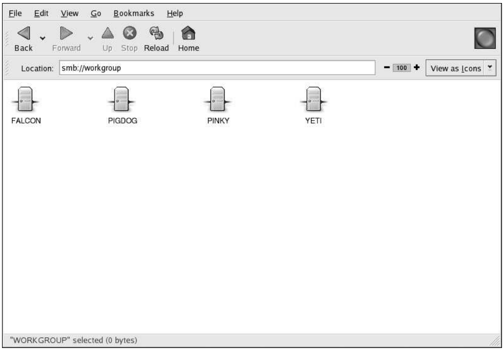

Figure 24-7. SMB Machines in Nautilus

As you can see from Figure 24-7, there is an icon for each machine within the workgroup. Double-click on an icon to view the Samba shares on the machine. If a username and password combination is required, you are prompted for them.

Alternately, you can also specify the Samba server and sharename in the **Location:** bar for **Nautilus** using the following syntax (replace <*servername*> and <*sharename*> with the appropriate values):

```
smb://<servername>/<sharename>/
```

24.3.1. Command Line

To query the network for Samba servers, use the `findsmb` command. For each server found, it displays its IP address, NetBIOS name, workgroup name, operating system, and SMB server version.

To connect to a Samba share from a shell prompt, type the following command:

```
smbclient //<hostname>/<sharename> -U <username>
```

Replace <*hostname*> with the hostname or IP address of the Samba server you want to connect to, <*sharename*> with the name of the shared directory you want to browse, and <*username*> with the Samba username for the system. Enter the correct password or press [Enter] if no password is required for the user.

If you see the `smb:\>` prompt, you have successfully logged in. Once you are logged in, type **`help`** for a list of commands. If you wish to browse the contents of your home directory, replace *sharename* with your username. If the `-U` switch is not used, the username of the current user is passed to the Samba server.

To exit `smbclient`, type **`exit`** at the `smb:\>` prompt.

24.3.2. Mounting the Share

Sometimes it is useful to mount a Samba share to a directory so the files in the directory can be treated as if they are part of the local file system.

To mount a Samba share to a directory, create the directory if it does not exist, and execute the following command as root:

```
mount -t  smbfs -o username=<username> //<servername>/<sharename> /mnt/point/
```

This command mounts <*sharename*> from <*servername*> in the local directory */mnt/point/*.

24.4. Additional Resources

For configuration options not covered here, please refer to the following resources.

24.4.1. Installed Documentation

- `smb.conf` man page — explains how to configure the Samba configuration file
- `smbd` man page — describes how the Samba daemon works
- `smbclient` and `findsmb` man pages — learn more about these client tools

- `/usr/share/doc/samba-<version-number>/docs/` — help files included with the `samba` package

24.4.2. Useful Websites

- http://www.samba.org/ — The Samba webpage contains useful documentation, information about mailing lists, and a list of GUI interfaces.
- http://www.samba.org/samba/docs/using_samba/toc.html — an online version of *Using Samba, 2nd Edition* by Jay Ts, Robert Eckstein, and David Collier-Brown; O'Reilly & Associates

redhat

Chapter 25. Dynamic Host Configuration Protocol (DHCP)

Dynamic Host Configuration Protocol (DHCP) is a network protocol for automatically assigning TCP/IP information to client machines. Each DHCP client connects to the centrally-located DHCP server which returns that client's network configuration including IP address, gateway, and DNS servers.

25.1. Why Use DHCP?

DHCP is useful for fast delivery of client network configuration. When configuring the client system, the administrator can choose DHCP and not have to enter an IP address, netmask, gateway, or DNS servers. The client retrieves this information from the DHCP server. DHCP is also useful if an administrator wants to change the IP addresses of a large number of systems. Instead of reconfiguring all the systems, he can just edit one DHCP configuration file on the server for the new set of IP addresses. If the DNS servers for an organization changes, the changes are made on the DHCP server, not on the DHCP clients. Once the network is restarted on the clients (or the clients are rebooted), the changes take effect.

Furthermore, if a laptop or any type of mobile computer is configured for DHCP, it can be moved from office to office without being reconfigured as long as each office has a DHCP server that allows it to connect to the network.

25.2. Configuring a DHCP Server

To configure a DHCP server, modify the configuration file `/etc/dhcpd.conf`.

DHCP also uses the file `/var/lib/dhcp/dhcpd.leases` to store the client lease database. Refer to Section 25.2.2 *Lease Database* for more information.

25.2.1. Configuration File

The first step in configuring a DHCP server is to create the configuration file that stores the network information for the clients. Global options can be declared for all clients, and options can be declared for each client system.

The configuration file can contain any extra tabs or blank lines for easier formatting. The keywords are case-insensitive, and lines beginning with a hash mark (#) are considered comments.

Two DNS update schemes are currently implemented — the ad-hoc DNS update mode and the interim DHCP-DNS interaction draft update mode. If and when these two are accepted as part of the IETF standards process, there will be a third mode — the standard DNS update method. The DHCP server must be configured to use one of the two current schemes. Version 3.0b2pl11 and previous version used the ad-hoc mode; however, it has been deprecated. To keep the same behavior, add the following line to the top of the configuration file:

```
ddns-update-style ad-hoc;
```

To use the recommended mode, add the following line to the top of the configuration file:

```
ddns-update-style interim;
```

Refer to the `dhcpd.conf` man page for details about the different modes.

There are two types of statements in the configuration file:

- Parameters — state how to perform a task, whether to perform a task, or what network configuration options to send to the client.
- Declarations — describe the topology of the network, describe the clients, provide addresses for the clients, or apply a group of parameters to a group of declarations.

Some parameters must start with the `option` keyword and are referred to as options. Options configure DHCP options; whereas, parameters configure values that are not optional or control how the DHCP server behaves.

Parameters (including options) declared before a section enclosed in curly brackets ({ }) are considered global parameters. Global parameters apply to all the sections below it.

Important

If the configuration file is changed, the changes do not take effect until the DHCP daemon is restarted with the command `service dhcpd restart`.

In Example 25-1, the `routers`, `subnet-mask`, `domain-name`, `domain-name-servers`, and `time-offset` options are used for any `host` statements declared below it.

As shown in Example 25-1, a `subnet` can be declared. A `subnet` declaration must be included for every subnet in the network. If it is not, the DHCP server fails to start.

In this example, there are global options for every DHCP client in the subnet and a `range` declared. Clients are assigned an IP address within the `range`.

```
subnet 192.168.1.0 netmask 255.255.255.0 {
        option routers                  192.168.1.254;
        option subnet-mask              255.255.255.0;

        option domain-name              "example.com";
        option domain-name-servers       192.168.1.1;

        option time-offset              -18000;     # Eastern Standard Time

 range 192.168.1.10 192.168.1.100;
}
```

Example 25-1. Subnet Declaration

All subnets that share the same physical network should be declared within a `shared-network` declaration as shown in Example 25-2. Parameters within the `shared-network` but outside the enclosed `subnet` declarations are considered global parameters. The name of the `shared-network` should be a descriptive title for the network such as test-lab to describe all the subnets in a test lab environment.

```
shared-network name {
    option domain-name              "test.redhat.com";
    option domain-name-servers      ns1.redhat.com, ns2.redhat.com;
    option routers                  192.168.1.254;
    more parameters for EXAMPLE shared-network
    subnet 192.168.1.0 netmask 255.255.255.0 {
        parameters for subnet
        range 192.168.1.1 192.168.1.31;
```

```
    }
    subnet 192.168.1.32 netmask 255.255.255.0 {
        parameters for subnet
        range 192.168.1.33 192.168.1.63;
    }
}
```

Example 25-2. Shared-network Declaration

As demonstrated in Example 25-3, the `group` declaration can be used to apply global parameters to a group of declarations. For example, shared networks, subnets, hosts, or other groups can be grouped.

```
group {
   option routers                  192.168.1.254;
   option subnet-mask              255.255.255.0;

   option domain-name              "example.com";
   option domain-name-servers       192.168.1.1;

   option time-offset              -18000;     # Eastern Standard Time

   host apex {
      option host-name "apex.example.com";
      hardware ethernet 00:A0:78:8E:9E:AA;
      fixed-address 192.168.1.4;
   }

   host raleigh {
      option host-name "raleigh.example.com";
      hardware ethernet 00:A1:DD:74:C3:F2;
      fixed-address 192.168.1.6;
   }
}
```

Example 25-3. Group Declaration

To configure a DHCP server that leases a dynamic IP address to a system within a subnet, modify Example 25-4 with your values. It declares a default lease time, maximum lease time, and network configuration values for the clients. This example assigns IP addresses in the `range` 192.168.1.10 and 192.168.1.100 to client systems.

```
default-lease-time 600;
max-lease-time 7200;
option subnet-mask 255.255.255.0;
option broadcast-address 192.168.1.255;
option routers 192.168.1.254;
option domain-name-servers 192.168.1.1, 192.168.1.2;
option domain-name "example.com";

subnet 192.168.1.0 netmask 255.255.255.0 {
   range 192.168.1.10 192.168.1.100;
}
```

Example 25-4. Range Parameter

To assign an IP address to a client based on the MAC address of the network interface card, use the `hardware ethernet` parameter within a `host` declaration. As demonstrated in Example

25-5, the `host apex` declaration specifies that the network interface card with the MAC address 00:A0:78:8E:9E:AA always receives the IP address 192.168.1.4.

Notice that the optional parameter `host-name` can be used to assign a host name to the client.

```
host apex {
   option host-name "apex.example.com";
   hardware ethernet 00:A0:78:8E:9E:AA;
   fixed-address 192.168.1.4;
}
```

Example 25-5. Static IP Address using DHCP

Tip

The sample configuration file provided can be used as a starting point. Custom configuration options can be added to it. To copy it to the proper location, use the following command:

```
cp /usr/share/doc/dhcp-<version-number>/dhcpd.conf.sample /etc/dhcpd.conf
```

(where <*version-number*> is the DHCP version number).

For a complete list of option statements and what they do, refer to the `dhcp-options` man page.

25.2.2. Lease Database

On the DHCP server, the file `/var/lib/dhcp/dhcpd.leases` stores the DHCP client lease database. This file should not be modified by hand. DHCP lease information for each recently assigned IP address is automatically stored in the lease database. The information includes the length of the lease, to whom the IP address has been assigned, the start and end dates for the lease, and the MAC address of the network interface card that was used to retrieve the lease.

All times in the lease database are in Greenwich Mean Time (GMT), not local time.

The lease database is recreated from time to time so that it is not too large. First, all known leases are saved in a temporary lease database. The `dhcpd.leases` file is renamed `dhcpd.leases~`, and the temporary lease database is written to `dhcpd.leases`.

The DHCP daemon could be killed or the system could crash after the lease database has been renamed to the backup file but before the new file has been written. If this happens, the `dhcpd.leases` file does not exist, but it is required to start the service. Do not create a new lease file. If you do, all the old leases will be lost and cause many problems. The correct solution is to rename the `dhcpd.leases~` backup file to `dhcpd.leases` and then start the daemon.

25.2.3. Starting and Stopping the Server

Important

When the DHCP server is started for the first time, it will fail unless the `dhcpd.leases` file exists. Use the command `touch /var/lib/dhcp/dhcpd.leases` to create the file if it does not exist.

To start the DHCP service, use the command `/sbin/service dhcpd start`. To stop the DHCP server, use the command `/sbin/service dhcpd stop`. To configure the daemon to start automatically at boot time, refer to Chapter 21 *Controlling Access to Services* for information on how to manage services.

If more than one network interface is attached to the system, but the DHCP server should only be started on one of the interface, configure the DHCP server to start only on that device. In `/etc/sysconfig/dhcpd`, add the name of the interface to the list of `DHCPDARGS`:

```
# Command line options here
DHCPDARGS=eth0
```

This is useful for a firewall machine with two network cards. One network card can be configured as a DHCP client to retrieve an IP address to the Internet. The other network card can be used as a DHCP server for the internal network behind the firewall. Specifying only the network card connected to the internal network makes the system more secure because users can not connect to the daemon via the Internet.

Other command line options that can be specified in `/etc/sysconfig/dhcpd` include:

- `-p` <*portnum*> — Specify the udp port number on which `dhcpd` should listen. The default is port 67. The DHCP server transmits responses to the DHCP clients at a port number one greater than the udp port specified. For example, if the default port 67 is used, the server listens on port 67 for requests and responses to the client on port 68. If a port is specified here and the DHCP relay agent is used, the same port on which the DHCP relay agent should listen must be specified. Refer to Section 25.2.4 *DHCP Relay Agent* for details.
- `-f` — Run the daemon as a foreground process. This is mostly used for debugging.
- `-d` — Log the DHCP server daemon to the standard error descriptor. This is mostly used for debugging. If this is not specified, the log is written to `/var/log/messages`.
- `-cf` <*filename*> — Specify the location of the configuration file. The default location is `/etc/dhcpd.conf`.
- `-lf` <*filename*> — Specify the location of the lease database file. If a lease database file already exists, it is very important that the same file be used every time the DHCP server is started. It is strongly recommended that this option only be used for debugging purposes on non-production machines. The default location is `/var/lib/dhcp/dhcpd.leases`.
- `-q` — Do not print the entire copyright message when starting the daemon.

25.2.4. DHCP Relay Agent

The DHCP Relay Agent (`dhcrelay`) allows for the relay of DHCP and BOOTP requests from a subnet with no DHCP server on it to one or more DHCP servers on other subnets.

When a DHCP client requests information, the DHCP Relay Agent forwards the request to the list of DHCP servers specified when the DHCP Relay Agent is started. When a DHCP server returns a reply, the reply is broadcast or unicast on the network that sent the original request.

The DHCP Relay Agent listens for DHCP requests on all interfaces unless the interfaces are specified in `/etc/sysconfig/dhcrelay` with the `INTERFACES` directive.

To start the DHCP Relay Agent, use the command `service dhcrelay start`.

25.3. Configuring a DHCP Client

The first step for configuring a DHCP client is to make sure the kernel recognizes the network interface card. Most cards are recognized during the installation process, and the system is configured to use the correct kernel module for the card. If a card is added after installation, **Kudzu**[1] should recognize it and prompt for the configuration of the corresponding kernel module for it. Be sure to check the Hardware Compatibility List available at http://hardware.redhat.com/hcl/. If the network card is not configured by the installation program or **Kudzu** and you know which kernel module to load for it, refer to Chapter 40 *Kernel Modules* for details on loading kernel modules.

To configure a DHCP client manually, modify the `/etc/sysconfig/network` file to enable networking and the configuration file for each network device in the `/etc/sysconfig/network-scripts` directory. In this directory, each device should have a configuration file named `ifcfg-eth0`, where `eth0` is the network device name.

The `/etc/sysconfig/network` file should contain the following line:

```
NETWORKING=yes
```

The `NETWORKING` variable must be set to `yes` if you want networking to start at boot time.

The `/etc/sysconfig/network-scripts/ifcfg-eth0` file should contain the following lines:

```
DEVICE=eth0
BOOTPROTO=dhcp
ONBOOT=yes
```

A configuration file is needed for each device to be configured to use DHCP.

Other options for the network script include:

- `DHCP_HOSTNAME` — Only use this option if the DHCP server requires the client to specify a hostname before receiving an IP address. (The DHCP server daemon in Red Hat Enterprise Linux does not support this feature.)
- `PEERDNS=`<*answer*>, where <*answer*> is one of the following:
  - `yes` — Modify `/etc/resolv.conf` with information from the server. If using DHCP, then `yes` is the default.
  - `no` — Do not modify `/etc/resolv.conf`.
- `SRCADDR=`<*address*>, where <*address*> is the specified source IP address for outgoing packets.
- `USERCTL=`<*answer*>, where <*answer*> is one of the following:
  - `yes` — Non-root users are allowed to control this device.
  - `no` — Non-root users are not allowed to control this device.

For a graphical interface for configuring a DHCP client, refer to Chapter 19 *Network Configuration* for details on using **Network Administration Tool** to configure a network interface to use DHCP.

1. **Kudzu** is a hardware probing tool run at system boot time to determine what hardware has been added or removed from the system.

25.4. Additional Resources

For configuration options not covered here, refer to the following resources.

25.4.1. Installed Documentation

- `dhcpd` man page — describes how the DHCP daemon works
- `dhcpd.conf` man page — explains how to configure the DHCP configuration file; includes some examples
- `dhcpd.leases` man page — explains how to configure the DHCP leases file; includes some examples
- `dhcp-options` man page — explains the syntax for declaring DHCP options in `dhcpd.conf`; includes some examples
- `dhcrelay` man page — explains the DHCP Relay Agent and its configuration options.

Chapter 26. Apache HTTP Server Configuration

Red Hat Enterprise Linux provides version 2.0 of the Apache HTTP Server. If you want to migrate an existing configuration file by hand, refer to the migration guide at `/usr/share/doc/httpd-<ver>/migration.html` or the *Red Hat Enterprise Linux Reference Guide* for details.

If you configured the Apache HTTP Server with the **HTTP Configuration Tool** in previous versions of Red Hat Enterprise Linux and then performed an upgrade, you can use the **HTTP Configuration Tool** to migrate the configuration file to the new format for version 2.0. Start the **HTTP Configuration Tool**, make any changes to the configuration, and save it. The configuration file saved will be compatible with version 2.0.

The **HTTP Configuration Tool** allows you to configure the `/etc/httpd/conf/httpd.conf` configuration file for the Apache HTTP Server. It does not use the old `srm.conf` or `access.conf` configuration files; leave them empty. Through the graphical interface, you can configure directives such as virtual hosts, logging attributes, and maximum number of connections.

Only modules provided with Red Hat Enterprise Linux can be configured with **HTTP Configuration Tool**. If additional modules are installed, they can not be configured using this tool.

The `httpd` and `redhat-config-httpd` RPM packages need to be installed to use the **HTTP Configuration Tool**. It also requires the X Window System and root access. To start the application, go to the **Main Menu Button** => **System Settings** => **Server Settings** => **HTTP** or type the command `redhat-config-httpd` at a shell prompt (for example, in an XTerm or GNOME Terminal).

Caution

> Do not edit the `/etc/httpd/conf/httpd.conf` configuration file by hand if you wish to use this tool. The **HTTP Configuration Tool** generates this file after you save your changes and exit the program. If you want to add additional modules or configuration options that are not available in **HTTP Configuration Tool**, you cannot use this tool.

The general steps for configuring the Apache HTTP Server using the **HTTP Configuration Tool** are as following:

1. Configure the basic settings under the **Main** tab.
2. Click on the **Virtual Hosts** tab and configure the default settings.
3. Under the **Virtual Hosts** tab, configure the Default Virtual Host.
4. If you want to serve more than one URL or virtual host, add the additional virtual hosts.
5. Configure the server settings under the **Server** tab.
6. Configure the connections settings under the **Performance Tuning** tab.
7. Copy all necessary files to the `DocumentRoot` and `cgi-bin` directories.
8. Exit the application and select to save your settings.

26.1. Basic Settings

Use the **Main** tab to configure the basic server settings.

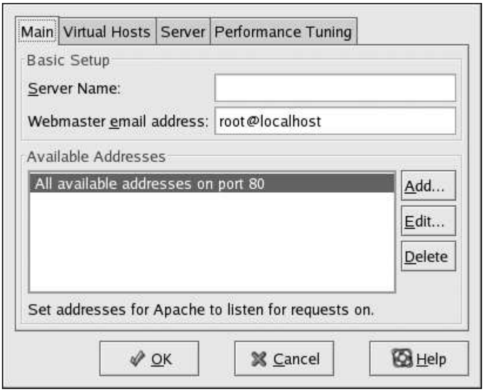

Figure 26-1. Basic Settings

Enter a fully qualified domain name that you have the right to use in the **Server Name** text area. This option corresponds to the `ServerName` directive in `httpd.conf`. The `ServerName` directive sets the hostname of the Web server. It is used when creating redirection URLs. If you do not define a server name, the Web server attempts to resolve it from the IP address of the system. The server name does not have to be the domain name resolved from the IP address of the server. For example, you might want to set the server name to www.example.com when your server's real DNS name is actually foo.example.com.

Enter the email address of the person who maintains the Web server in the **Webmaster email address** text area. This option corresponds to the `ServerAdmin` directive in `httpd.conf`. If you configure the server's error pages to contain an email address, this email address will be used so that users can report a problem by sending email to the server's administrator. The default value is root@localhost.

Use the **Available Addresses** area to define the ports on which the server will accept incoming requests. This option corresponds to the `Listen` directive in `httpd.conf`. By default, Red Hat configures the Apache HTTP Server to listen to port 80 for non-secure Web communications.

Click the **Add** button to define additional ports on which to accept requests. A window as shown in Figure 26-2 will appear. Either choose the **Listen to all addresses** option to listen to all IP addresses on the defined port or specify a particular IP address over which the server will accept connections in the **Address** field. Only specify one IP address per port number. If you want to specify more than one IP address with the same port number, create an entry for each IP address. If at all possible, use an IP address instead of a domain name to prevent a DNS lookup failure. Refer to http://httpd.apache.org/docs-2.0/dns-caveats.html for more information about *Issues Regarding DNS and Apache*.

Entering an asterisk (*) in the **Address** field is the same as choosing **Listen to all addresses**. Clicking the **Edit** button in the **Available Addresses** frame shows the same window as the **Add** button except with the fields populated for the selected entry. To delete an entry, select it and click the **Delete** button.

Tip

> If you set the server to listen to a port under 1024, you must be root to start it. For port 1024 and above, `httpd` can be started as a regular user.

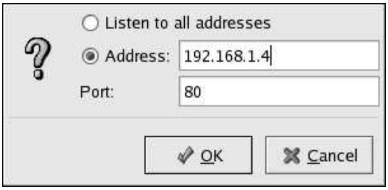

Figure 26-2. Available Addresses

26.2. Default Settings

After defining the **Server Name**, **Webmaster email address**, and **Available Addresses**, click the **Virtual Hosts** tab and click the **Edit Default Settings** button. The window shown in Figure 26-3 will appear. Configure the default settings for your Web server in this window. If you add a virtual host, the settings you configure for the virtual host take precedence for that virtual host. For a directive not defined within the virtual host settings, the default value is used.

26.2.1. Site Configuration

The default values for the **Directory Page Search List** and **Error Pages** will work for most servers. If you are unsure of these settings, do not modify them.

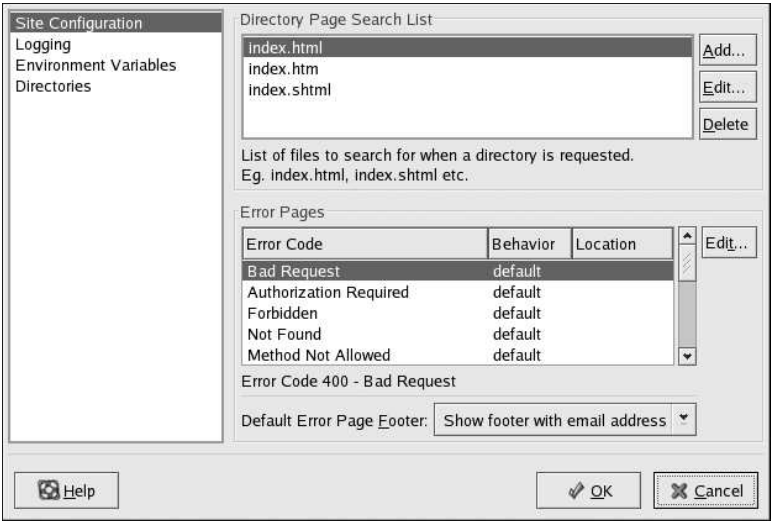

Figure 26-3. Site Configuration

The entries listed in the **Directory Page Search List** define the `DirectoryIndex` directive. The `DirectoryIndex` is the default page served by the server when a user requests an index of a directory by specifying a forward slash (/) at the end of the directory name.

For example, when a user requests the page http://*www.example.com*/*this_directory*/, they are going to get either the `DirectoryIndex` page if it exists, or a server-generated directory list. The server will try to find one of the files listed in the `DirectoryIndex` directive and will return the first one it finds. If it does not find any of these files and if `Options Indexes` is set for that directory, the server will generate and return a list, in HTML format, of the subdirectories and files in the directory.

Use the **Error Code** section to configure Apache HTTP Server to redirect the client to a local or external URL in the event of a problem or error. This option corresponds to the `ErrorDocument` directive. If a problem or error occurs when a client tries to connect to the Apache HTTP Server, the default action is to display the short error message shown in the **Error Code** column. To override this default configuration, select the error code and click the **Edit** button. Choose **Default** to display the default short error message. Choose **URL** to redirect the client to an external URL and enter a complete URL including the http:// in the **Location** field. Choose **File** to redirect the client to an internal URL and enter a file location under the document root for the Web server. The location must begin the a slash (/) and be relative to the Document Root.

For example, to redirect a 404 Not Found error code to a webpage that you created in a file called `404.html`, copy `404.html` to *`DocumentRoot`*`/../error/404.html`. In this case, *`DocumentRoot`* is the Document Root directory that you have defined (the default is `/var/www/html/`). If the Document Root is left as the default location, the file should be copied to `/var/www/error/404.html`. Then, choose **File** as the Behavior for **404 - Not Found** error code and enter `/error/404.html` as the **Location**.

From the **Default Error Page Footer** menu, you can choose one of the following options:

- **Show footer with email address** — Display the default footer at the bottom of all error pages along with the email address of the website maintainer specified by the `ServerAdmin` directive. Refer to Section 26.3.1.1 *General Options* for information about configuring the `ServerAdmin` directive.
- **Show footer** — Display just the default footer at the bottom of error pages.
- **No footer** — Do not display a footer at the bottom of error pages.

26.2.2. Logging

By default, the server writes the transfer log to the file `/var/log/httpd/access_log` and the error log to the `/var/log/httpd/error_log` file.

The transfer log contains a list of all attempts to access the Web server. It records the IP address of the client that is attempting to connect, the date and time of the attempt, and the file on the Web server that it is trying to retrieve. Enter the name of the path and file in which to store this information. If the path and filename does not start with a slash (/), the path is relative to the server root directory as configured. This option corresponds to the `TransferLog` directive.

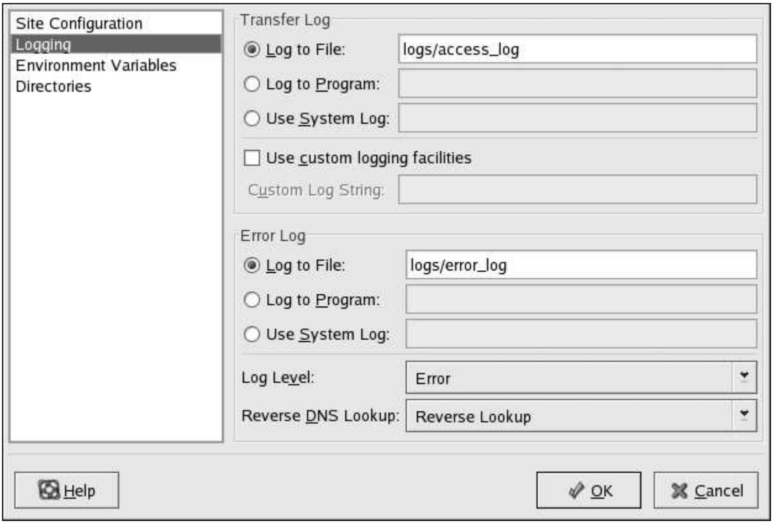

Figure 26-4. Logging

You can configure a custom log format by checking **Use custom logging facilities** and entering a custom log string in the **Custom Log String** field. This configures the `LogFormat` directive. Refer to http://httpd.apache.org/docs-2.0/mod/mod_log_config.html#formats for details on the format of this directive.

The error log contains a list of any server errors that occur. Enter the name of the path and file in which to store this information. If the path and filename does not start with a slash (/), the path is relative to the server root directory as configured. This option corresponds to the `ErrorLog` directive.

Use the **Log Level** menu to set how verbose the error messages in the error logs will be. It can be set (from least verbose to most verbose) to emerg, alert, crit, error, warn, notice, info or debug. This option corresponds to the `LogLevel` directive.

The value chosen with the **Reverse DNS Lookup** menu defines the `HostnameLookups` directive. Choosing **No Reverse Lookup** sets the value to off. Choosing **Reverse Lookup** sets the value to on. Choosing **Double Reverse Lookup** sets the value to double.

If you choose **Reverse Lookup**, your server will automatically resolve the IP address for each connection which requests a document from your Web server. Resolving the IP address means that your server will make one or more connections to the DNS in order to find out the hostname that corresponds to a particular IP address.

If you choose **Double Reverse Lookup**, your server will perform a double-reverse DNS. In other words, after a reverse lookup is performed, a forward lookup is performed on the result. At least one of the IP addresses in the forward lookup must match the address from the first reverse lookup.

Generally, you should leave this option set to **No Reverse Lookup**, because the DNS requests add a load to your server and may slow it down. If your server is busy, the effects of trying to perform these reverse lookups or double reverse lookups may be quite noticeable.

Reverse lookups and double reverse lookups are also an issue for the Internet as a whole. All of the individual connections made to look up each hostname add up. Therefore, for your own Web server's benefit, as well as for the Internet's benefit, you should leave this option set to **No Reverse Lookup**.

26.2.3. Environment Variables

Sometimes it is necessary to modify environment variables for CGI scripts or server-side include (SSI) pages. The Apache HTTP Server can use the `mod_env` module to configure the environment variables which are passed to CGI scripts and SSI pages. Use the **Environment Variables** page to configure the directives for this module.

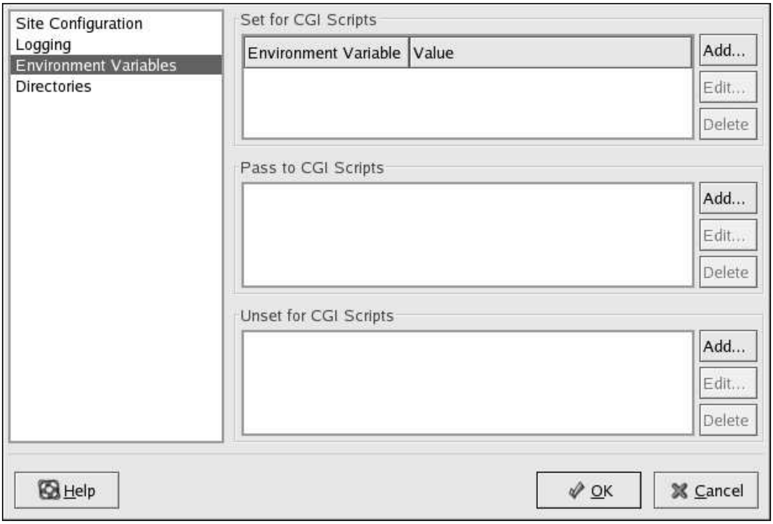

Figure 26-5. Environment Variables

Use the **Set for CGI Scripts** section to set an environment variable that is passed to CGI scripts and SSI pages. For example, to set the environment variable `MAXNUM` to `50`, click the **Add** button inside the **Set for CGI Script** section as shown in Figure 26-5 and type **`MAXNUM`** in the **Environment Variable** text field and **`50`** in the **Value to set** text field. Click **OK** to add it to the list. The **Set for CGI Scripts** section configures the `SetEnv` directive.

Use the **Pass to CGI Scripts** section to pass the value of an environment variable when the server was first started to CGI scripts. To see this environment variable, type the command `env` at a shell prompt. Click the **Add** button inside the **Pass to CGI Scripts** section and enter the name of the environment variable in the resulting dialog box. Click **OK** to add it to the list. The **Pass to CGI Scripts** section configures the `PassEnv` directive.

If you want to remove an environment variable so that the value is not passed to CGI scripts and SSI pages, use the **Unset for CGI Scripts** section. Click **Add** in the **Unset for CGI Scripts** section, and enter the name of the environment variable to unset. Click **OK** to add it to the list. This corresponds to the `UnsetEnv` directive.

To edit any of these environment values, select it from the list and click the corresponding **Edit** button. To delete any entry from the list, select it and click the cooresponding **Delete** button.

To learn more about environment variables in Apache HTTP Server, refer to the following:

`http://httpd.apache.org/docs-2.0/env.html`

26.2.4. Directories

Use the **Directories** page to configure options for specific directories. This corresponds to the `<Directory>` directive.

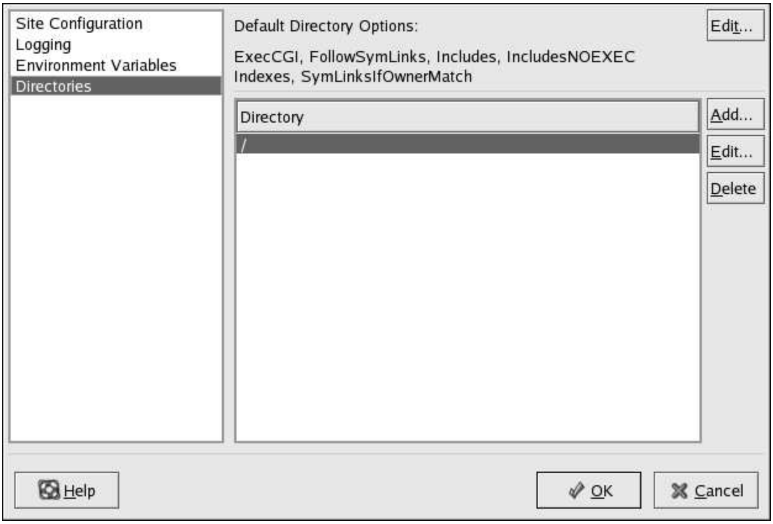

Figure 26-6. Directories

Click the **Edit** button in the top right-hand corner to configure the **Default Directory Options** for all directories that are not specified in the **Directory** list below it. The options that you choose are listed as the Options directive within the `<Directory>` directive. You can configure the following options:

- **ExecCGI** — Allow execution of CGI scripts. CGI scripts are not executed if this option is not chosen.
- **FollowSymLinks** — Allow symbolic links to be followed.
- **Includes** — Allow server-side includes.
- **IncludesNOEXEC** — Allow server-side includes, but disable the `#exec` and `#include` commands in CGI scripts.
- **Indexes** — Display a formatted list of the directory's contents, if no `DirectoryIndex` (such as `index.html`) exists in the requested directory.
- **Multiview** — Support content-negotiated multiviews; this option is disabled by default.
- **SymLinksIfOwnerMatch** — Only follow symbolic links if the target file or directory has the same owner as the link.

To specify options for specific directories, click the **Add** button beside the **Directory** list box. The window shown in Figure 26-7 appears. Enter the directory to configure in the **Directory** text field at the bottom of the window. Select the options in the right-hand list, and configure the `Order` directive with the left-hand side options. The `Order` directive controls the order in which allow and deny directives are evaluated. In the **Allow hosts from** and **Deny hosts from** text field, you can specify one of the following:

- Allow all hosts — Type **`all`** to allow access to all hosts.
- Partial domain name — Allow all hosts whose names match or end with the specified string.
- Full IP address — Allow access to a specific IP address.
- A subnet — Such as **`192.168.1.0/255.255.255.0`**
- A network CIDR specification — such as **`10.3.0.0/16`**

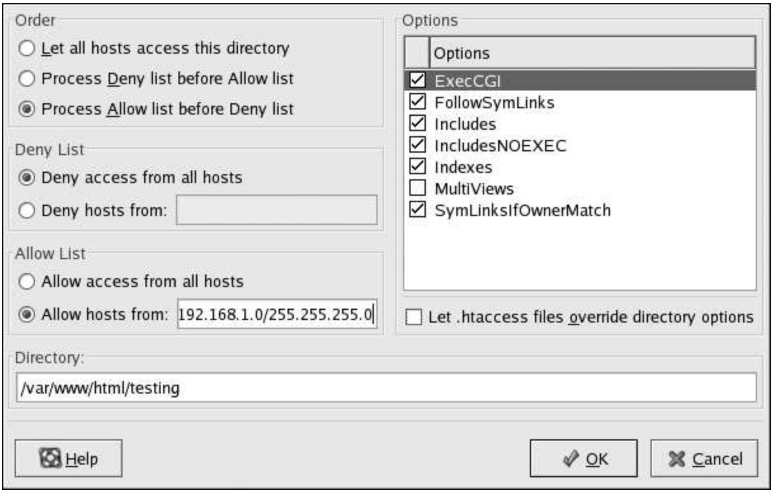

Figure 26-7. Directory Settings

If you check the **Let .htaccess files override directory options**, the configuration directives in the `.htaccess` file take precedence.

26.3. Virtual Hosts Settings

You can use the **HTTP Configuration Tool** to configure virtual hosts. Virtual hosts allow you to run different servers for different IP addresses, different host names, or different ports on the same machine. For example, you can run the website for http://www.example.com and http://www.anotherexample.com on the same Web server using virtual hosts. This option corresponds to the <VirtualHost> directive for the default virtual host and IP based virtual hosts. It corresponds to the <`NameVirtualHost`> directive for a name based virtual host.

The directives set for a virtual host only apply to that particular virtual host. If a directive is set server-wide using the **Edit Default Settings** button and not defined within the virtual host settings, the default setting is used. For example, you can define a **Webmaster email address** in the **Main** tab and not define individual email addresses for each virtual host.

The **HTTP Configuration Tool** includes a default virtual host as shown in Figure 26-8.

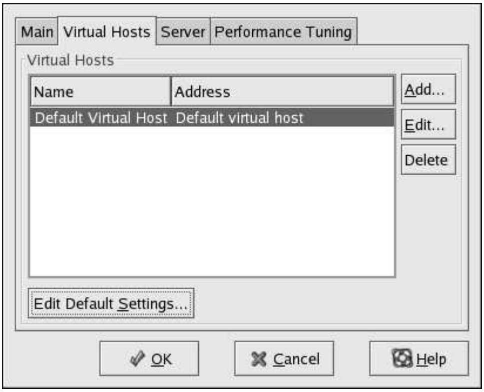

Figure 26-8. Virtual Hosts

http://httpd.apache.org/docs-2.0/vhosts/ and the Apache HTTP Server documentation on your machine provides more information about virtual hosts.

26.3.1. Adding and Editing a Virtual Host

To add a virtual host, click the **Virtual Hosts** tab and then click the **Add** button. You can also edit a virtual host by selecting it in the list and clicking the **Edit** button.

26.3.1.1. General Options

The **General Options** settings only apply to the virtual host that you are configuring. Set the name of the virtual host in the **Virtual Host Name** text area. This name is used by **HTTP Configuration Tool** to distinguish between virtual hosts.

Set the **Document Root Directory** value to the directory that contains the root document (such as index.html) for the virtual host. This option corresponds to the `DocumentRoot` directive within the `<VirtualHost>` directive. The default `DocumentRoot` is `/var/www/html`.

The **Webmaster email address** corresponds to the `ServerAdmin` directive within the `VirtualHost` directive. This email address is used in the footer of error pages if you choose to show a footer with an email address on the error pages.

In the **Host Information** section, choose **Default Virtual Host**, **IP based Virtual Host**, or **Name based Virtual Host**.

Default Virtual Host

You should only configure one default virtual host (remember that there is one setup by default). The default virtual host settings are used when the requested IP address is not explicitly listed in another virtual host. If there is no default virtual host defined, the main server settings are used.

IP based Virtual Host

If you choose **IP based Virtual Host**, a window appears to configure the <VirtualHost> directive based on the IP address of the server. Specify this IP address in the **IP address** field. To specify more than one IP address, separate each IP address with spaces. To specify a port, use the syntax *`IP Address:Port`*. Use :* to configure all ports for the IP address. Specify the host name for the virtual host in the **Server Host Name** field.

Name based Virtual Host

If you choose **Name based Virtual Host**, a window appears to configure the `NameVirtualHost` directive based on the host name of the server. Specify the IP address in the **IP address** field. To specify more than one IP address, separate each IP address with spaces. To specify a port, use the syntax *`IP Address:Port`*. Use :* to configure all ports for the IP address. Specify the host name for the virtual host in the **Server Host Name** field. In the **Aliases** section, click **Add** to add a host name alias. Adding an alias here adds a `ServerAlias` directive within the `NameVirtualHost` directive.

26.3.1.2. SSL

Note

You can not use name based virtual hosts with SSL, because the SSL handshake (when the browser accepts the secure Web server's certificate) occurs before the HTTP request which identifies the appropriate name based virtual host. If you want to use name-based virtual hosts, they will only work with your non-secure Web server.

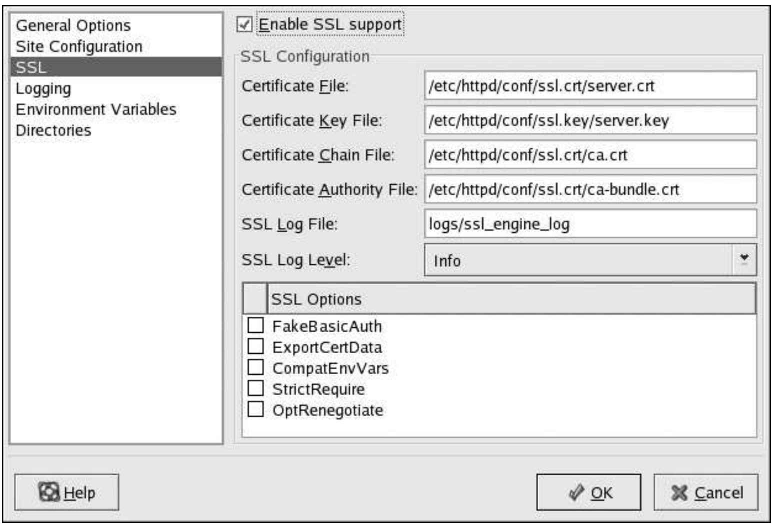

Figure 26-9. SSL Support

If an Apache HTTP Server is not configured with SSL support, communications between an Apache HTTP Server and its clients are not encrypted. This is appropriate for websites without personal or confidential information. For example, an open source website that distributes open source software and documentation has no need for secure communications. However, an ecommerce website that requires credit card information should use the Apache SSL support to encrypt its communications. Enabling Apache SSL support enables the use of the `mod_ssl` security module. To enable it through **HTTP Configuration Tool** you must allow access through port 443 under the **Main** tab => **Available**

Addresses. Refer to Section 26.1 *Basic Settings* for details. Then, select the virtual host name in the **Virtual Hosts** tab, click the **Edit** button, choose **SSL** from the left-hand menu, and check the **Enable SSL Support** option as shown in Figure 26-9. The **SSL Configuration** section is pre-configured with the dummy digital certificate. The digital certificate provides authentication for your secure Web server and identifies the secure server to client Web browsers. You must purchase your own digital certificate. Do not use the dummy one provided for your website. For details on purchasing a CA-approved digital certificate, refer to the Chapter 27 *Apache HTTP Secure Server Configuration*.

26.3.1.3. Additional Virtual Host Options

The **Site Configuration**, **Environment Variables**, and **Directories** options for the virtual hosts are the same directives that you set when you clicked the **Edit Default Settings** button, except the options set here are for the individual virtual hosts that you are configuring. Refer to Section 26.2 *Default Settings* for details on these options.

26.4. Server Settings

The **Server** tab allows you to configure basic server settings. The default settings for these options are appropriate for most situations.

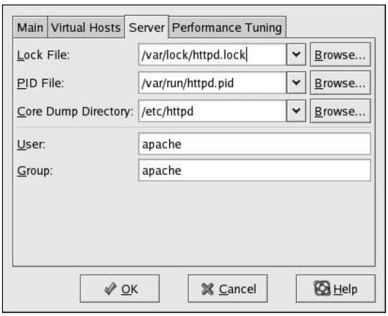

Figure 26-10. Server Configuration

The **Lock File** value corresponds to the `LockFile` directive. This directive sets the path to the lockfile used when the server is compiled with either USE_FCNTL_SERIALIZED_ACCEPT or USE_FLOCK_SERIALIZED_ACCEPT. It must be stored on the local disk. It should be left to the default value unless the `logs` directory is located on an NFS share. If this is the case, the default value should be changed to a location on the local disk and to a directory that is readable only by root.

The **PID File** value corresponds to the `PidFile` directive. This directive sets the file in which the server records its process ID (pid). This file should only be readable by root. In most cases, it should be left to the default value.

The **Core Dump Directory** value corresponds to the `CoreDumpDirectory` directive. The Apache HTTP Server tries to switch to this directory before dumping core. The default value is the `ServerRoot`. However, if the user that the server runs as can not write to this directory, the core dump can not be written. Change this value to a directory writable by the user the server runs as, if you want to write the core dumps to disk for debugging purposes.

The **User** value corresponds to the `User` directive. It sets the userid used by the server to answer requests. This user's settings determine the server's access. Any files inaccessible to this user will also be inaccessible to your website's visitors. The default for `User` is apache.

The user should only have privileges so that it can access files which are supposed to be visible to the outside world. The user is also the owner of any CGI processes spawned by the server. The user should not be allowed to execute any code which is not intended to be in response to HTTP requests.

Warning

Unless you know exactly what you are doing, do not set the `User` directive to root. Using root as the `User` will create large security holes for your Web server.

The parent `httpd` process first runs as root during normal operations, but is then immediately handed off to the apache user. The server must start as root because it needs to bind to a port below 1024. Ports below 1024 are reserved for system use, so they can not be used by anyone but root. Once the server has attached itself to its port, however, it hands the process off to the apache user before it accepts any connection requests.

The **Group** value corresponds to the `Group` directive. The `Group` directive is similar to the `User` directive. `Group` sets the group under which the server will answer requests. The default group is also apache.

26.5. Performance Tuning

Click on the **Performance Tuning** tab to configure the maximum number of child server processes you want and to configure the Apache HTTP Server options for client connections. The default settings for these options are appropriate for most situations. Altering these settings may affect the overall performance of your Web server.

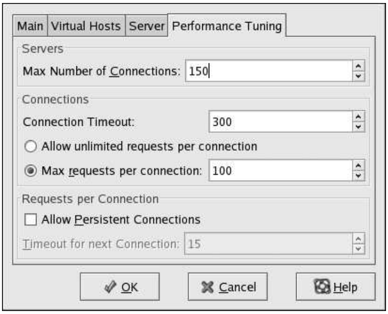

Figure 26-11. Performance Tuning

Set **Max Number of Connections** to the maximum number of simultaneous client requests that the server will handle. For each connection, a child `httpd` process is created. After this maximum number of processes is reached, no one else will be able to connect to the Web server until a child server process is freed. You can not set this value to higher than 256 without recompiling. This option corresponds to the `MaxClients` directive.

Connection Timeout defines, in seconds, the amount of time that your server will wait for receipts and transmissions during communications. Specifically, **Connection Timeout** defines how long your server will wait to receive a GET request, how long it will wait to receive TCP packets on a POST or PUT request and how long it will wait between ACKs responding to TCP packets. By default, **Connection Timeout** is set to 300 seconds, which is appropriate for most situations. This option corresponds to the `TimeOut` directive.

Set the **Max requests per connection** to the maximum number of requests allowed per persistent connection. The default value is 100, which should be appropriate for most situations. This option corresponds to the `MaxRequestsPerChild` directive.

If you check the **Allow unlimited requests per connection** option, the `MaxKeepAliveRequests` directive to 0, and unlimited requests are allowed.

If you uncheck the **Allow Persistent Connections** option, the `KeepAlive` directive is set to false. If you check it, the `KeepAlive` directive is set to true, and the `KeepAliveTimeout` directive is set to the number that is selected as the **Timeout for next Connection** value. This directive sets the number of seconds your server will wait for a subsequent request, after a request has been served, before it closes the connection. Once a request has been received, the **Connection Timeout** value applies instead.

Setting the **Persistent Connections** to a high value may cause a server to slow down, depending on how many users are trying to connect to it. The higher the number, the more server processes waiting for another connection from the last client that connected to it.

26.6. Saving Your Settings

If you do not want to save your Apache HTTP Server configuration settings, click the **Cancel** button in the bottom right corner of the **HTTP Configuration Tool** window. You will be prompted to confirm this decision. If you click **Yes** to confirm this choice, your settings will not be saved.

If you want to save your Apache HTTP Server configuration settings, click the **OK** button in the bottom right corner of the **HTTP Configuration Tool** window. A dialog window will appear. If you answer **Yes**, your settings will be saved in `/etc/httpd/conf/httpd.conf`. Remember that your original configuration file will be overwritten.

If this is the first time that you have used the **HTTP Configuration Tool**, you will see a dialog window warning you that the configuration file has been manually modified. If the **HTTP Configuration Tool** detects that the `httpd.conf` configuration file has been manually modified, it will save the manually modified file as `/etc/httpd/conf/httpd.conf.bak`.

Important

> After saving your settings, you must restart the `httpd` daemon with the command `service httpd restart`. You must be logged in as root to execute this command.

26.7. Additional Resources

To learn more about the Apache HTTP Server, refer to the following resources.

26.7.1. Installed Documentation

- /usr/share/docs/httpd-<*version*>/migration.html — The *Apache Migration HOWTO* document contains a list of changes from version 1.3 to version 2.0 as well as information about how to migration the configuration file manually.

26.7.2. Useful Websites

- http://www.apache.org/ — *The Apache Software Foundation*.
- http://httpd.apache.org/docs-2.0/ — The Apache Software Foundation's documentation on Apache HTTP Server version 2.0, including the *Apache HTTP Server Version 2.0 User's Guide*.
- http://www.redhat.com/support/resources/web_ftp/apache.html — Red Hat Support maintains a list of useful Apache HTTP Server links.
- http://www.redhat.com/support/docs/faqs/RH-apache-FAQ/book1.html — The Apache Centralized Knowledgebase compiled by Red Hat.

26.7.3. Related Books

- *Apache: The Definitive Guide* by Ben Laurie and Peter Laurie; O'Reilly & Associates, Inc.
- *Red Hat Enterprise Linux Reference Guide*; Red Hat, Inc. — This companion manual includes instructions for migrating from Apache HTTP Server version 1.3 to Apache HTTP Server version 2.0 manually, more details about the Apache HTTP Server directives, and instructions for adding modules to the Apache HTTP Server.

Chapter 27. Apache HTTP Secure Server Configuration

27.1. Introduction

This chapter provides basic information on the Apache HTTP Server with the `mod_ssl` security module enabled to use the OpenSSL library and toolkit. The combination of these three components are referred to in this chapter as the secure Web server or just as the secure server.

The `mod_ssl` module is a security module for the Apache HTTP Server. The `mod_ssl` module uses the tools provided by the OpenSSL Project to add a very important feature to the Apache HTTP Server — the ability to encrypt communications. In contrast, using regular HTTP, communications between a browser and a Web server are sent in plain text, which could be intercepted and read by someone along the route between the browser and the server.

This chapter is not meant to be complete and exclusive documentation for any of these programs. When possible, this guide points to appropriate places where you can find more in-depth documentation on particular subjects.

This chapter shows you how to install these programs. You can also learn the steps necessary to generate a private key and a certificate request, how to generate your own self-signed certificate, and how to install a certificate to use with your secure server.

The `mod_ssl` configuration file is located at `/etc/httpd/conf.d/ssl.conf`. For this file to be loaded, and hence for `mod_ssl` to work, you must have the statement `Include conf.d/*.conf` in `/etc/httpd/conf/httpd.conf`. This statement is included by default in the default Apache HTTP Server configuration file.

27.2. An Overview of Security-Related Packages

To enable the secure server, you need to have the following packages installed at a minimum:

`httpd`

: The `httpd` package contains the `httpd` daemon and related utilities, configuration files, icons, Apache HTTP Server modules, man pages and other files used by the Apache HTTP Server.

`mod_ssl`

: The `mod_ssl` package includes the `mod_ssl` module, which provides strong cryptography for the Apache HTTP Server via the Secure Sockets Layer (SSL) and Transport Layer Security (TLS) protocols.

`openssl`

: The `openssl` package contains the OpenSSL toolkit. The OpenSSL toolkit implements the SSL and TLS protocols and also includes a general purpose cryptography library.

Additionally, other software packages provide certain security functionalities (but are not required by the secure server to function):

`httpd-devel`

The `httpd-devel` package contains the Apache HTTP Server include files, header files and the APXS utility. You need all of these if you intend to load any extra modules, other than the modules provided with this product. See the *Red Hat Enterprise Linux Reference Guide* for more information on loading modules onto your secure server using Apache's DSO functionality.

If you do not intend to load other modules onto your Apache HTTP Server, you do not need to install this package.

OpenSSH packages

The OpenSSH packages provide the OpenSSH set of network connectivity tools for logging into and executing commands on a remote machine. OpenSSH tools encrypt all traffic (including passwords), so you can avoid eavesdropping, connection hijacking, and other attacks on the communications between your machine and the remote machine.

The `openssh` package includes core files needed by both the OpenSSH client programs and the OpenSSH server. The `openssh` package also contains `scp`, a secure replacement for `rcp` (for copying files between machines).

The `openssh-askpass` package supports the display of a dialog window which prompts for a password during use of the OpenSSH agent.

The `openssh-askpass-gnome` package can be used in conjunction with the GNOME desktop environment to display a graphical dialog window when OpenSSH programs prompt for a password. If you are running GNOME and using OpenSSH utilities, you should install this package.

The `openssh-server` package contains the `sshd` secure shell daemon and related files. The secure shell daemon is the server side of the OpenSSH suite and must be installed on your host to allow SSH clients to connect to your host.

The `openssh-clients` package contains the client programs needed to make encrypted connections to SSH servers, including the following: `ssh`, a secure replacement for `rsh`; `sftp`, a secure replacement for `ftp` (for transferring files between machines); and `slogin`, a secure replacement for `rlogin` (for remote login) and `telnet` (for communicating with another host via the Telnet protocol).

For more information about OpenSSH, see Chapter 22 *OpenSSH*, the *Red Hat Enterprise Linux Reference Guide*, and the OpenSSH website at http://www.openssh.com.

`openssl-devel`

The `openssl-devel` package contains the static libraries and the include file needed to compile applications with support for various cryptographic algorithms and protocols. You need to install this package only if you are developing applications which include SSL support — you do not need this package to use SSL.

`stunnel`

The `stunnel` package provides the Stunnel SSL wrapper. Stunnel supports the SSL encryption of TCP connections, so it can provide encryption for non-SSL aware daemons and protocols (such as POP, IMAP and LDAP) without requiring any changes to the daemon's code.

Table 27-1 displays a summary of the secure server packages and whether or not each package is optional for the installation of a secure server.

Package Name	Optional?
`httpd`	no
`mod_ssl`	no

Package Name	Optional?
`openssl`	no
`httpd-devel`	yes
`openssh`	yes
`openssh-askpass`	yes
`openssh-askpass-gnome`	yes
`openssh-clients`	yes
`openssh-server`	yes
`openssl-devel`	yes
`stunnel`	yes

Table 27-1. Security Packages

27.3. An Overview of Certificates and Security

Your secure server provides security using a combination of the Secure Sockets Layer (SSL) protocol and (in most cases) a digital certificate from a Certificate Authority (CA). SSL handles the encrypted communications and the mutual authentication between browsers and your secure server. The CA-approved digital certificate provides authentication for your secure server (the CA puts its reputation behind its certification of your organization's identity). When your browser is communicating using SSL encryption, the `https://` prefix is used at the beginning of the Uniform Resource Locator (URL) in the navigation bar.

Encryption depends upon the use of keys (think of them as secret encoder/decoder rings in data format). In conventional or symmetric cryptography, both ends of the transaction have the same key, which they use to decode each other's transmissions. In public or asymmetric cryptography, two keys co-exist: a public key and a private key. A person or an organization keeps their private key a secret and publishes their public key. Data encoded with the public key can only be decoded with the private key; data encoded with the private key can only be decoded with the public key.

To set up your secure server, use public cryptography to create a public and private key pair. In most cases, you send your certificate request (including your public key), proof of your company's identity, and payment to a CA. The CA verifies the certificate request and your identity, and then sends back a certificate for your secure server.

A secure server uses a certificate to identify itself to Web browsers. You can generate your own certificate (called a "self-signed" certificate), or you can get a certificate from a CA. A certificate from a reputable CA guarantees that a website is associated with a particular company or organization.

Alternatively, you can create your own self-signed certificate. Note, however, that self-signed certificates should not be used in most production environments. Self-signed certificates are not automatically accepted by a user's browser — users are prompted by the browser to accept the certificate and create the secure connection. See Section 27.5 *Types of Certificates* for more information on the differences between self-signed and CA-signed certificates.

Once you have a self-signed certificate or a signed certificate from the CA of your choice, you need to install it on your secure server.

27.4. Using Pre-Existing Keys and Certificates

If you already have an existing key and certificate (for example, if you are installing the secure server to replace another company's secure server product), you can probably be able to use your existing key and certificate with the secure server. In the following two situations, you are not able to use your existing key and certificate:

- *If you are changing your IP address or domain name* — Certificates are issued for a particular IP address and domain name pair. You must get a new certificate if you are changing your IP address or domain name.
- *If you have a certificate from VeriSign and you are changing your server software* — VeriSign is a widely used CA. If you already have a VeriSign certificate for another purpose, you may have been considering using your existing VeriSign certificate with your new secure server. However, you are not be allowed to because VeriSign issues certificates for one specific server software and IP address/domain name combination.

  If you change either of those parameters (for example, if you previously used a different secure server product), the VeriSign certificate you obtained to use with the previous configuration will not work with the new configuration. You must obtain a new certificate.

If you have an existing key and certificate that you can use, you do not have to generate a new key and obtain a new certificate. However, you may need to move and rename the files which contain your key and certificate.

Move your existing key file to:

```
/etc/httpd/conf/ssl.key/server.key
```

Move your existing certificate file to:

```
/etc/httpd/conf/ssl.crt/server.crt
```

After you have moved your key and certificate, skip to Section 27.9 *Testing The Certificate*.

If you are upgrading from the Red Hat Secure Web Server, your old key (`httpsd.key`) and certificate (`httpsd.crt`) are located in `/etc/httpd/conf/`. Move and rename your key and certificate so that the secure server can use them. Use the following two commands to move and rename your key and certificate files:

```
mv /etc/httpd/conf/httpsd.key /etc/httpd/conf/ssl.key/server.key
mv /etc/httpd/conf/httpsd.crt /etc/httpd/conf/ssl.crt/server.crt
```

Then start your secure server with the command:

```
/sbin/service httpd start
```

For a secure server, you are prompted to enter your passphrase. After you type it in and press [Enter], the server starts.

27.5. Types of Certificates

If you installed your secure server from the RPM package provided by Red Hat, a random key and a test certificate are generated and put into the appropriate directories. Before you begin using your secure server, however, you must generate your own key and obtain a certificate which correctly identifies your server.

You need a key and a certificate to operate your secure server — which means that you can either generate a self-signed certificate or purchase a CA-signed certificate from a CA. What are the differences between the two?

A CA-signed certificate provides two important capabilities for your server:

- Browsers (usually) automatically recognize the certificate and allow a secure connection to be made, without prompting the user.
- When a CA issues a signed certificate, they are guaranteeing the identity of the organization that is providing the webpages to the browser.

If your secure server is being accessed by the public at large, your secure server needs a certificate signed by a CA so that people who visit your website know that the website is owned by the organization who claims to own it. Before signing a certificate, a CA verifies that the organization requesting the certificate was actually who they claimed to be.

Most Web browsers that support SSL have a list of CAs whose certificates they automatically accept. If a browser encounters a certificate whose authorizing CA is not in the list, the browser asks the user to either accept or decline the connection.

You can generate a self-signed certificate for your secure server, but be aware that a self-signed certificate does not provide the same functionality as a CA-signed certificate. A self-signed certificate is not automatically recognized by most Web browsers, and a self-signed certificate does not provide any guarantee concerning the identity of the organization that is providing the website. A CA-signed certificate provides both of these important capabilities for a secure server. If your secure server is to be used in a production environment, you probably need a CA-signed certificate.

The process of getting a certificate from a CA is fairly easy. A quick overview is as follows:

1. Create an encryption private and public key pair.
2. Create a certificate request based on the public key. The certificate request contains information about your server and the company hosting it.
3. Send the certificate request, along with documents proving your identity, to a CA. We cannot tell you which certificate authority to choose. Your decision may be based on your past experiences, or on the experiences of your friends or colleagues, or purely on monetary factors.

   Once you have decided upon a CA, you need to follow the instructions they provide on how to obtain a certificate from them.
4. When the CA is satisfied that you are indeed who you claim to be, they send you a digital certificate.
5. Install this certificate on your secure server, and begin handling secure transactions.

Whether you are getting a certificate from a CA or generating your own self-signed certificate, the first step is to generate a key. See Section 27.6 *Generating a Key* for instructions on how to generate a key.

27.6. Generating a Key

You must be root to generate a key.

First, `cd` to the `/etc/httpd/conf/` directory. Remove the fake key and certificate that were generated during the installation with the following commands:

```
rm ssl.key/server.key
rm ssl.crt/server.crt
```

Next, you need to create your own random key. Change to the `/usr/share/ssl/certs/` directory, and type in the following command:

```
make genkey
```

Your system displays a message similar to the following:

```
umask 77 ; \
/usr/bin/openssl genrsa -des3 1024 > /etc/httpd/conf/ssl.key/server.key
Generating RSA private key, 1024 bit long modulus
.......++++++
................................................................++++++
e is 65537 (0x10001)
Enter pass phrase:
```

You now need to type in a passphrase. For best security, it should contain at least eight characters, include numbers and/or punctuation, and not be a word in a dictionary. Also, remember that your passphrase is case sensitive.

Note

You need to remember and enter this passphrase every time you start your secure server, so do not forget it.

Re-type the passphrase to verify that it is correct. Once you have typed it in correctly, `/etc/httpd/conf/ssl.key/server.key`, containing your key, is created.

Note that if you do not want to type in a passphrase every time you start your secure server, you need to use the following two commands instead of `make genkey` to create the key.

Use the following command to create your key:

```
/usr/bin/openssl genrsa 1024 > /etc/httpd/conf/ssl.key/server.key
```

Then use the following command to make sure the permissions are set correctly for the file:

```
chmod go-rwx /etc/httpd/conf/ssl.key/server.key
```

After you use the above commands to create your key, you do not need to use a passphrase to start your secure server.

Caution

Disabling the passphrase feature for your secure server is a security risk. It is NOT recommend that you disable the passphrase feature for secure server.

The problems associated with not using a passphrase are directly related to the security maintained on the host machine. For example, if an unscrupulous individual compromises the regular UNIX security on the host machine, that person could obtain your private key (the contents of your `server.key` file). The key could be used to serve Web pages that appear to be from your secure server.

If UNIX security practices are rigorously maintained on the host computer (all operating system patches and updates are installed as soon as they are available, no unnecessary or risky services are operating, and so on), secure server's passphrase may seem unnecessary. However, since your secure server should not need to be re-booted very often, the extra security provided by entering a passphrase is a worthwhile effort in most cases.

The `server.key` file should be owned by the root user on your system and should not be accessible to any other user. Make a backup copy of this file. and keep the backup copy in a safe, secure place. You need the backup copy because if you ever lose the `server.key` file after using it to create your certificate request, your certificate no longer works and the CA is not able to help you. Your only option is to request (and pay for) a new certificate.

If you are going to purchase a certificate from a CA, continue to Section 27.7 *Generating a Certificate Request to Send to a CA*. If you are generating your own self-signed certificate, continue to Section 27.8 *Creating a Self-Signed Certificate*.

27.7. Generating a Certificate Request to Send to a CA

Once you have created a key, the next step is to generate a certificate request which you need to send to the CA of your choice. Make sure you are in the `/usr/share/ssl/certs` directory, and type in the following command:

```
make certreq
```

Your system displays the following output and asks you for your passphrase (unless you disabled the passphrase option):

```
umask 77 ; \
/usr/bin/openssl req -new -key /etc/httpd/conf/ssl.key/server.key
-out /etc/httpd/conf/ssl.csr/server.csr
Using configuration from /usr/share/ssl/openssl.cnf
Enter pass phrase:
```

Type in the passphrase that you chose when you were generating your key. Your system displays some instructions and then ask for a series of responses from you. Your inputs are incorporated into the certificate request. The display, with example responses, looks similar to the following:

```
You are about to be asked to enter information that will be incorporated
into your certificate request.
What you are about to enter is what is called a Distinguished Name or a
DN.
There are quite a few fields but you can leave some blank
For some fields there will be a default value,
If you enter '.', the field will be left blank.
-----
Country Name (2 letter code) [GB]:US
State or Province Name (full name) [Berkshire]:North Carolina
Locality Name (eg, city) [Newbury]:Raleigh
Organization Name (eg, company) [My Company Ltd]:Test Company
Organizational Unit Name (eg, section) []:Testing
Common Name (your name or server's hostname) []:test.example.com
Email Address []:admin@example.com
Please enter the following 'extra' attributes
to be sent with your certificate request
A challenge password []:
An optional company name []:
```

The default answers appear in brackets `[]` immediately after each request for input. For example, the first information required is the name of the country where the certificate will be used, shown like the following:

```
Country Name (2 letter code) [GB]:
```

The default input, in brackets, is `GB`. To accept the default, press [Enter], or fill in your country's two letter code.

You have to type in the rest of the values. All of these should be self-explanatory, but you need to follow these guidelines:

- Do not abbreviate the locality or state. Write them out (for example, St. Louis should be written out as Saint Louis).
- If you are sending this CSR to a CA, be very careful to provide correct information for all of the fields, but especially for the `Organization Name` and the `Common Name`. CAs check the information provided in the CSR to determine whether your organization is responsible for what you provided as the `Common Name`. CAs rejects CSRs which include information they perceive as invalid.
- For `Common Name`, make sure you type in the *real* name of your secure server (a valid DNS name) and not any aliases which the server may have.
- The `Email Address` should be the email address for the webmaster or system administrator.
- Avoid any special characters like @, #, &, !, etc. Some CAs reject a certificate request which contains a special character. So, if your company name includes an ampersand (&), spell it out as "and" instead of "&."
- Do not use either of the extra attributes (`A challenge password` and `An optional company name`). To continue without entering these fields, just press [Enter] to accept the blank default for both inputs.

The file `/etc/httpd/conf/ssl.csr/server.csr` is created when you have finished entering your information. This file is your certificate request, ready to send to your CA.

After you have decided on a CA, follow the instructions they provide on their website. Their instructions tell you how to send your certificate request, any other documentation that they require, and your payment to them.

After you have fulfilled the CA's requirements, they send a certificate to you (usually by email). Save (or cut and paste) the certificate that they send you as `/etc/httpd/conf/ssl.crt/server.crt`. Be sure to keep a backup of this file.

27.8. Creating a Self-Signed Certificate

You can create your own self-signed certificate. Note that a self-signed certificate does not provide the security guarantees of a CA-signed certificate. See Section 27.5 *Types of Certificates* for more details about certificates.

To make your own self-signed certificate, first create a random key using the instructions provided in Section 27.6 *Generating a Key*. Once you have a key, make sure you are in the `/usr/share/ssl/certs` directory, and type the following command:

```
make testcert
```

The following output is shown, and you are prompted for your passphrase (unless you generated a key without a passphrase):

```
umask 77 ; \
/usr/bin/openssl req -new -key /etc/httpd/conf/ssl.key/server.key
-x509 -days 365 -out /etc/httpd/conf/ssl.crt/server.crt
Using configuration from /usr/share/ssl/openssl.cnf
Enter pass phrase:
```

After you enter your passphrase (or without a prompt if you created a key without a passphrase), you are asked for more information. The computer's output and a set of inputs looks like the following (provide the correct information for your organization and host):

```
You are about to be asked to enter information that will be incorporated
into your certificate request.
What you are about to enter is what is called a Distinguished Name or a
DN.
There are quite a few fields but you can leave some blank
For some fields there will be a default value,
If you enter '.', the field will be left blank.
-----
Country Name (2 letter code) [GB]:US
State or Province Name (full name) [Berkshire]:North Carolina
Locality Name (eg, city) [Newbury]:Raleigh
Organization Name (eg, company) [My Company Ltd]:My Company, Inc.
Organizational Unit Name (eg, section) []:Documentation
Common Name (your name or server's hostname) []:myhost.example.com
Email Address []:myemail@example.com
```

After you provide the correct information, a self-signed certificate is created in `/etc/httpd/conf/ssl.crt/server.crt`. Restart the secure server after generating the certificate with following the command:

```
/sbin/service httpd restart
```

27.9. Testing The Certificate

To test the test certificate installed by default, a CA-signed certificate, and a self-signed certificate, point your Web browser to the following home page (replacing *`server.example.com`* with your domain name):

`https://`*`server.example.com`*

Note

Note the `s` after `http`. The `https:` prefix is used for secure HTTP transactions.

If you are using a CA-signed certificate from a well-known CA, your browser probably automatically accepts the certificate (without prompting you for input) and creates the secure connection. Your browser does not automatically recognize a test or a self-signed certificate, because the certificate is not signed by a CA. If you are not using a certificate from a CA, follow the instructions provided by your browser to accept the certificate.

Once your browser accepts the certificate, your secure server displays a default home page.

27.10. Accessing The Server

To access your secure server, use a URL similar to the following:

`https://`*`server.example.com`*

Your non-secure server can be accessed using an URL similar to the following:

`http://`*`server.example.com`*

The standard port for secure Web communications is port 443. The standard port for non-secure Web communications is port 80. The secure server default configuration listens on both of the two standard ports. Therefore, do not need to specify the port number in a URL (the port number is assumed).

However, if you configure your server to listen on a non-standard port (for example, anything other than 80 or 443), you must specify the port number in every URL which is intended to connect to the server on the non-standard port.

For example, you may have configured your server so that you have a virtual host running non-secured on port 12331. Any URLs intended to connect to that virtual host must specify the port number in the URL. The following URL example attempts to connect to a non-secure server listening on port 12331:

`http://server.example.com:12331`

27.11. Additional Resources

Refer to Section 26.7 *Additional Resources* for additional references about the Apache HTTP Server.

27.11.1. Useful Websites

- http://www.redhat.com/mailman/listinfo/redhat-secure-server — The `redhat-secure-server` mailing list.

  You can also subscribe to the `redhat-secure-server` mailing list by emailing <`redhat-secure-server-request@redhat.com`> and include the word *subscribe* in the subject line.

- http://www.modssl.org/ — The `mod_ssl` website is the definitive source for information about `mod_ssl`. The website includes a wealth of documentation, including a *User Manual* at http://www.modssl.org/docs/.

27.11.2. Related Books

- *Apache: The Definitive Guide*, 2nd edition, by Ben Laurie and Peter Laurie, O'Reilly & Associates, Inc.

Chapter 28. BIND Configuration

This chapter assumes that the reader has a basic understanding of BIND and DNS; it does not attempt to explain the concepts of BIND and DNS. This chapter does explain how to use the **Domain Name Service Configuration Tool** (`redhat-config-bind`) to configure basic BIND server zones. The **Domain Name Service Configuration Tool** creates the `/etc/named.conf` configuration file and the zone configuration files in the `/var/named/` directory each time changes are applied.

Important

> Do not edit the `/etc/named.conf` configuration file. **Domain Name Service Configuration Tool** generates this file after changes are applied. To configure settings that are not configurable using **Domain Name Service Configuration Tool**, add them to the `/etc/named.custom` file.

The **Domain Name Service Configuration Tool** requires the X Window System and root access. To start the **Domain Name Service Configuration Tool**, go to the **Main Menu Button** (on the Panel) => **System Settings** => **Server Settings** => **Domain Name Service** or type the command `redhat-config-bind` at a shell prompt (for example, in an XTerm or GNOME Terminal).

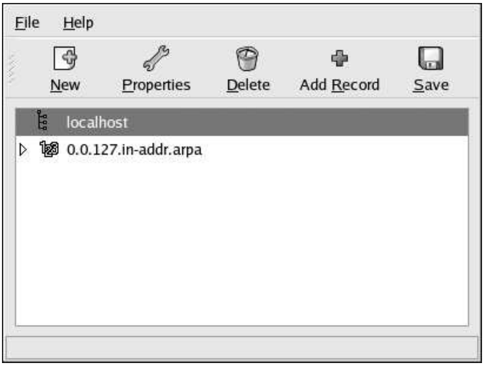

Figure 28-1. Domain Name Service Configuration Tool

The **Domain Name Service Configuration Tool** configures the default zone directory to be `/var/named/`. All zone files specified are relative to this directory. The **Domain Name Service Configuration Tool** also includes basic syntax checking when values are entered. For example, if a valid entry is an IP address, only numbers and periods (.) are allowed in the text area.

The **Domain Name Service Configuration Tool** allows for the addition of a forward master zone, a reverse master zone, and a slave zone. After adding the zones, they can be edited or deleted from the main window as shown in Figure 28-1.

After adding, editing, or deleting a zone, click the **Save** button or select **File** => **Save** to write the `/etc/named.conf` configuration file and all the individual zone files in the `/var/named/` directory. Saving changes also causes the `named` service to reload the configuration files. Selecting **File** => **Quit** saves the changes before quitting the application.

28.1. Adding a Forward Master Zone

To add a forward master zone (also known as a primary master), click the **New** button, select **Forward Master Zone**, and enter the domain name for the master zone in the **Domain name** text area.

A new window as shown in Figure 28-2 appears with the following options:

- **Name** — Domain name that was just entered in the previous window.
- **File Name** — File name of the DNS database file, relative to `/var/named`. It is preset to the domain name with `.zone` appended to it.
- **Contact** — Email address of the main contact for the master zone.
- **Primary Nameserver (SOA)** — State of authority (SOA) record. This specifies the nameserver that is the best resource of information for this domain.
- **Serial Number** — The serial number of the DNS database file. This number must be incremented each time the file is changed, so that the slave nameservers for the zone retrieve the latest data. The **Domain Name Service Configuration Tool** increments this number each time the configuration changes. It can also be incremented manually by clicking the **Set** button next to the **Serial Number** value.
- **Time Settings** — The **Refresh**, **Retry**, **Expire**, and **Minimum** TTL (Time to Live) values that are stored in the DNS database file. All values are in seconds.
- **Records** — Add, edit, and delete record resources of type **Host**, **Alias**, and **Name server**.

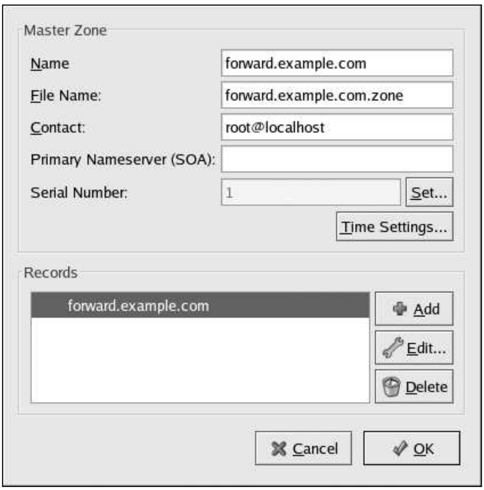

Figure 28-2. Adding a Forward Master Zone

A **Primary Nameserver (SOA)** must be specified, and at least one nameserver record must be specified by clicking the **Add** button in the **Records** section.

After configuring the Forward Master Zone, click **OK** to return to the main window as shown in Figure 28-1. From the pulldown menu, click **Save** to write the `/etc/named.conf` configuration file, write all the individual zone files in the `/var/named` directory, and have the daemon reload the configuration files.

The configuration creates an entry similar to the following in `/etc/named.conf`:

```
zone  "forward.example.com" {
 type master;
 file  "forward.example.com.zone";
};
```

It also creates the file `/var/named/forward.example.com.zone` with the following information:

```
$TTL 86400
@       IN      SOA     ns.example.com.  root.localhost (
                        2 ; serial
                        28800 ; refresh
                        7200 ; retry
                        604800 ; expire
                        86400 ; ttl
                        )


        IN      NS      192.168.1.1.
```

28.2. Adding a Reverse Master Zone

To add a reverse master zone, click the **New** button and select **Reverse Master Zone**. Enter the first three octets of the IP address range to be configure. For example, to configure the IP address range 192.168.10.0/255.255.255.0, enter 192.168.10 in the **IP Address (first 3 Octets)** text area.

A new window appears, as shown in Figure 28-3, with the following options:

1. **IP Address** — The first three octets entered in the previous window.
2. **Reverse IP Address** — Non-editable. Pre-populated based on the IP Address entered.
3. **Contact** —Email address of the main contact for the master zone.
4. **File Name** — File name of DNS database file in the `/var/named` directory.
5. **Primary Nameserver (SOA)** — State of authority (SOA) record. This specifies the nameserver that is the best resource of information for this domain.
6. **Serial Number** — The serial number of the DNS database file. This number must be incremented each time the file is changed, so that the slave nameservers for the zone retrieve the latest data. The **Domain Name Service Configuration Tool** increments this number each time the configuration changes. It can also be incremented manually by clicking the **Set** button next to the **Serial Number** value.
7. **Time Settings** — The **Refresh**, **Retry**, **Expire**, and **Minimum** TTL (Time to Live) values that are stored in the DNS database file.
8. **Nameservers** — Add, edit, and delete name servers for the reverse master zone. At least one nameserver is required.
9. **Reverse Address Table** — List of IP addresses within the reverse master zone and their hostnames. For example, for the reverse master zone 192.168.10, 192.168.10.1 can be added in the **Reverse Address Table** with the hostname one.example.com. The hostname must end with a period (.) to specify that it is a full hostname.

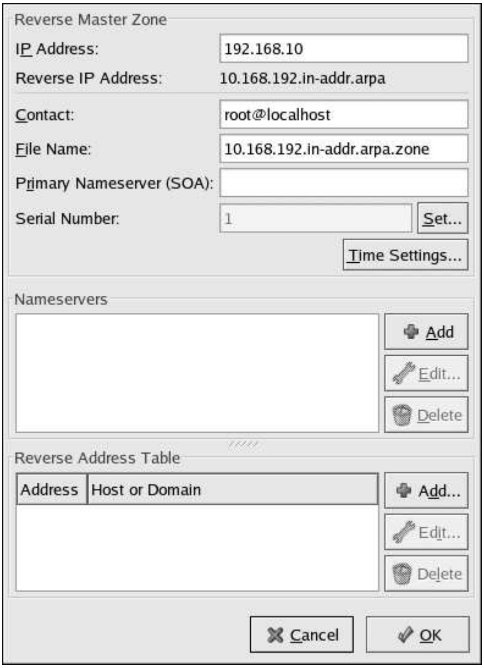

Figure 28-3. Adding a Reverse Master Zone

A **Primary Nameserver (SOA)** must be specified, and at least one nameserver record must be specified by clicking the **Add** button in the **Nameservers** section.

After configuring the Reverse Master Zone, click **OK** to return to the main window as shown in Figure 28-1. From the pulldown menu, click **Save** to write the `/etc/named.conf` configuration file, write all the individual zone files in the `/var/named` directory, and have the daemon reload the configuration files.

The configuration creates an entry similar to the following in `/etc/named.conf`:

```
zone  "10.168.192.in-addr.arpa" {
        type master;
        file  "10.168.192.in-addr.arpa.zone";
};
```

It also creates the file `/var/named/10.168.192.in-addr.arpa.zone` with the following information:

```
$TTL 86400
@       IN      SOA     ns.example.com. root.localhost (
                        2 ; serial
                        28800 ; refresh
                        7200 ; retry
                        604800 ; expire
                        86400 ; ttk
                        )
```

```
@       IN      NS      ns2.example.com.

1       IN      PTR     one.example.com.
2       IN      PTR     two.example.com.
```

28.3. Adding a Slave Zone

To add a slave zone (also known as a secondary master), click the **New** button and select **Slave Zone**. Enter the domain name for the slave zone in the **Domain name** text area.

A new window appears, as shown in Figure 28-4, with the following options:

- **Name** — The domain name that was entered in the previous window.
- **Masters List** — The nameservers from which the slave zone retrieves its data. Each value must be a valid IP address. Only numbers and periods (.) can be entered in the text area.
- **File Name** — File name of the DNS database file in `/var/named`.

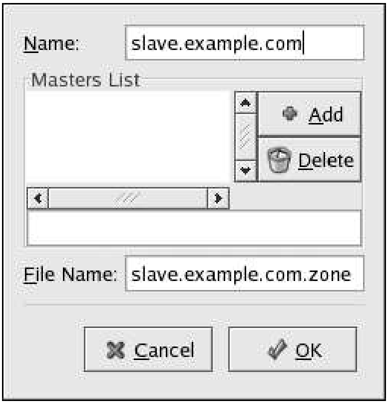

Figure 28-4. Adding a Slave Zone

After configuring the slave zone, click **OK** to return to the main window as shown in Figure 28-1. Click **Save** to write the `/etc/named.conf` configuration file and have the daemon reload the configuration files.

The configuration creates an entry similar to the following in `/etc/named.conf`:

```
zone "slave.example.com" {
        type slave;
        file "slave.example.com.zone";
        masters {
                 1.2.3.4;
                };
};
```

The configuration file `/var/named/slave.example.com.zone` is created by the `named` service when it downloads the zone data from the master server(s).

Chapter 29. Authentication Configuration

When a user logs in to a Red Hat Enterprise Linux system, the username and password combination must be verified, or *authenticated*, as a valid and active user. Sometimes the information to verify the user is located on the local system, and other times the system defers the authentication to a user database on a remote system.

The **Authentication Configuration Tool** provides a graphical interface for configuring NIS, LDAP, and Hesiod to retrieve user information as well as for configuring LDAP, Kerberos, and SMB as authentication protocols.

Note

If you configured a medium or high security level during installation or with the **Security Level Configuration Tool**, network authentication methods, including NIS and LDAP, are not allowed through the firewall.

This chapter does not explain each of the different authentication types in detail. Instead, it explains how to use the **Authentication Configuration Tool** to configure them.

To start the graphical version of the **Authentication Configuration Tool** from the desktop, select **Main Menu Button** (on the Panel) => **System Settings** => **Authentication** or type the command `authconfig-gtk` at a shell prompt (for example, in an **XTerm** or a **GNOME terminal**). To start the text-based version, type the command `authconfig` at a shell prompt.

Important

After exiting the authentication program, the changes made take effect immediately.

29.1. User Information

The **User Information** tab has several options. To enable an option, click the empty checkbox beside it. To disable an option, click the checkbox beside it to clear the checkbox. Click **OK** to exit the program and apply the changes.

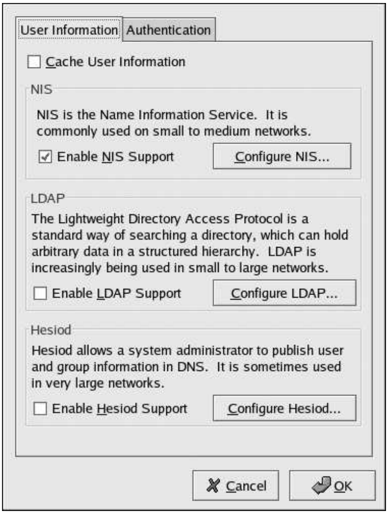

Figure 29-1. User Information

The following list explains what each option configures:

- **Cache User Information** — Select this option to enable the name service cache daemon (`nscd`) and configure it to start at boot time.

  The `nscd` package must be installed for this option to work.

- **Enable NIS Support** — Select this option to configure the system as an NIS client which connects to an NIS server for user and password authentication. Click the **Configure NIS** button to specify the NIS domain and NIS server. If the NIS server is not specified, the daemon attempts to find it via broadcast.

  The `ypbind` package must be installed for this option to work. If NIS support is enabled, the `portmap` and `ypbind` services are started and are also enabled to start at boot time.

- **Enable LDAP Support** — Select this option to configure the system to retrieve user information via LDAP. Click the **Configure LDAP** button to specify the **LDAP Search Base DN** and **LDAP Server**. If **Use TLS to encrypt connections** is selected, Transport Layer Security is used to encrypt passwords sent to the LDAP server.

  The `openldap-clients` package must be installed for this option to work.

  For more information about LDAP, refer to the *Red Hat Enterprise Linux Reference Guide*.

- **Enable Hesiod Support** — Select this option to configure the system to retrieve information from a remote Hesiod database, including user information.

  The `hesiod` package must be installed.

29.2. Authentication

The **Authentication** tab allows for the configuration of network authentication methods. To enable an option, click the empty checkbox beside it. To disable an option, click the checkbox beside it to clear the checkbox.

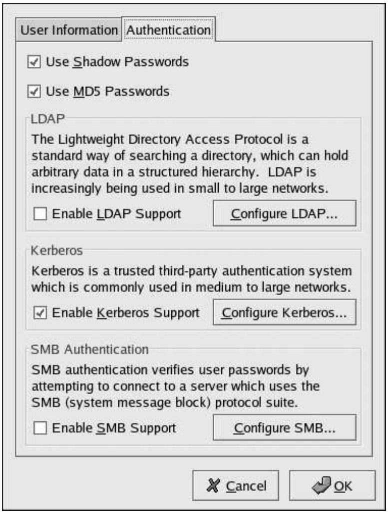

Figure 29-2. Authentication

The following explains what each option configures:

- **Use Shadow Passwords** — Select this option to store passwords in shadow password format in the `/etc/shadow` file instead of `/etc/passwd`. Shadow passwords are enabled by default during installation and are highly recommended to increase the security of the system.

  The `shadow-utils` package must be installed for this option to work. For more information about shadow passwords, refer to the *Users and Groups* chapter in the *Red Hat Enterprise Linux Reference Guide*.

- **Use MD5 Passwords** — Select this option to enable MD5 passwords, which allows passwords to be up to 256 characters instead of eight characters or less. It is selected by default during installation and is highly recommended for increased security.

- **Enable LDAP Support** — Select this option to have standard PAM-enabled applications use LDAP for authentication. Click the **Configure LDAP** button to specify the following:

  - **Use TLS to encrypt connections** — Use Transport Layer Security to encrypt passwords sent to the LDAP server.
  - **LDAP Search Base DN** — Retrieve user information by its Distinguished Name (DN).
  - **LDAP Server** — Specify the IP address of the LDAP server.

  The `openldap-clients` package must be installed for this option to work. Refer to the *Red Hat Enterprise Linux Reference Guide* for more information about LDAP.

- **Enable Kerberos Support** — Select this option to enable Kerberos authentication. Click the **Configure Kerberos** button to configure:

  - **Realm** — Configure the realm for the Kerberos server. The realm is the network that uses Kerberos, composed of one or more KDCs and a potentially large number of clients.
  - **KDC** — Define the Key Distribution Center (KDC), which is the server that issues Kerberos tickets.
  - **Admin Servers** — Specify the administration server(s) running `kadmind`.

The `krb5-libs` and `krb5-workstation` packages must be installed for this option to work. Refer to the *Red Hat Enterprise Linux Reference Guide* for more information on Kerberos.

- **Enable SMB Support** — This option configures PAM to use an SMB server to authenticate users. Click the **Configure SMB** button to specify:
  - **Workgroup** — Specify the SMB workgroup to use.
  - **Domain Controllers** — Specify the SMB domain controllers to use.

29.3. Command Line Version

The **Authentication Configuration Tool** can also be run as a command line tool with no interface. The command line version can be used in a configuration script or a kickstart script. The authentication options are summarized in Table 29-1.

Option	Description
`--enableshadow`	Enable shadow passwords
`--disableshadow`	Disable shadow passwords
`--enablemd5`	Enable MD5 passwords
`--disablemd5`	Disable MD5 passwords
`--enablenis`	Enable NIS
`--disablenis`	Disable NIS
--nisdomain=<*domain*>	Specify NIS domain
--nisserver=<*server*>	Specify NIS server
`--enableldap`	Enable LDAP for user information
`--disableldap`	Disable LDAP for user information
`--enableldaptls`	Enable use of TLS with LDAP
`--disableldaptls`	Disable use of TLS with LDAP
`--enableldapauth`	Enable LDAP for authentication
`--disableldapauth`	Disable LDAP for authentication
--ldapserver=<*server*>	Specify LDAP server
--ldapbasedn=<*dn*>	Specify LDAP base DN
`--enablekrb5`	Enable Kerberos
`--disablekrb5`	Disable Kerberos
--krb5kdc=<*kdc*>	Specify Kerberos KDC
--krb5adminserver=<*server*>	Specify Kerberos administration server
--krb5realm=<*realm*>	Specify Kerberos realm
`--enablesmbauth`	Enable SMB
`--disablesmbauth`	Disable SMB

Option	Description
`--smbworkgroup=`<*workgroup*>	Specify SMB workgroup
`--smbservers=`<*server*>	Specify SMB servers
`--enablehesiod`	Enable Hesiod
`--disablehesiod`	Disable Hesiod
`--hesiodlhs=`<*lhs*>	Specify Hesiod LHS
`--hesiodrhs=`<*rhs*>	Specify Hesiod RHS
`--enablecache`	Enable `nscd`
`--disablecache`	Disable `nscd`
`--nostart`	Do not start or stop the `portmap`, `ypbind`, or `nscd` services even if they are configured
`--kickstart`	Do not display the user interface
`--probe`	Probe and display network defaults

Table 29-1. Command Line Options

Tip

These options can also be found in the `authconfig` man page or by typing `authconfig --help` at a shell prompt.

V. System Configuration

Part of a system administrator's job is configuring the system for various tasks, types of users, and hardware configurations. This section explains how to configure a Red Hat Enterprise Linux system.

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Chapter 30. Console Access

When normal (non-root) users log into a computer locally, they are given two types of special permissions:

1. They can run certain programs that they would not otherwise be able to run
2. They can access certain files (normally special device files used to access diskettes, CD-ROMs, and so on) that they would not otherwise be able to access

Since there are multiple consoles on a single computer and multiple users can be logged into the computer locally at the same time, one of the users has to "win" the race to access the files. The first user to log in at the console owns those files. Once the first user logs out, the next user who logs in owns the files.

In contrast, *every* user who logs in at the console is allowed to run programs that accomplish tasks normally restricted to the root user. If X is running, these actions can be included as menu items in a graphical user interface. As shipped, the console-accessible programs include `halt`, `poweroff`, and `reboot`.

30.1. Disabling Shutdown Via [Ctrl]-[Alt]-[Del]

By default, `/etc/inittab` specifies that your system is set to shutdown and reboot the system in response to a [Ctrl]-[Alt]-[Del] key combination used at the console. To completely disable this ability, comment out the following line in `/etc/inittab` by putting a hash mark (`#`) in front of it:

```
ca::ctrlaltdel:/sbin/shutdown -t3 -r now
```

Alternatively, you may just want to allow certain non-root users the right to shutdown the system from the console using [Ctrl]-[Alt]-[Del]. You can restrict this privilege to certain users, by taking the following steps:

1. Add the `-a` option to the `/etc/inittab` line shown above, so that it reads:
   ```
   ca::ctrlaltdel:/sbin/shutdown -a -t3 -r now
   ```
   The `-a` flag tells `shutdown` to look for the `/etc/shutdown.allow` file.
2. Create a file named `shutdown.allow` in `/etc`. The `shutdown.allow` file should list the usernames of any users who are allowed to shutdown the system using [Ctrl]-[Alt]-[Del]. The format of the `/etc/shutdown.allow` file is a list of usernames, one per line, like the following:
   ```
   stephen
   jack
   sophie
   ```

According to this example `shutdown.allow` file, stephen, jack, and sophie are allowed to shutdown the system from the console using [Ctrl]-[Alt]-[Del]. When that key combination is used, the `shutdown -a` in `/etc/inittab` checks to see if any of the users in `/etc/shutdown.allow` (or root) are logged in on a virtual console. If one of them is, the shutdown of the system continues; if not, an error message is written to the system console instead.

For more information on `shutdown.allow` see the `shutdown` man page.

30.2. Disabling Console Program Access

To disable access by users to console programs, run the following command as root:

```
rm -f /etc/security/console.apps/*
```

In environments where the console is otherwise secured (BIOS and boot loader passwords are set, [Ctrl]-[Alt]-[Delete] is disabled, the power and reset switches are disabled, and so forth), you may not want to allow any user at the console to run `poweroff`, `halt`, and `reboot`, which are accessible from the console by default.

To remove these abilities, run the following commands as root:

```
rm -f /etc/security/console.apps/poweroff
rm -f /etc/security/console.apps/halt
rm -f /etc/security/console.apps/reboot
```

30.3. Disabling All Console Access

The PAM `pam_console.so` module manages console file permissions and authentication. (Refer to the *Red Hat Enterprise Linux Reference Guide* for more information on configuring PAM.) To disable all console access, including program and file access, comment out all lines that refer to `pam_console.so` in the `/etc/pam.d/` directory. As root, the following script does the trick:

```
cd /etc/pam.d
for i in * ; do
sed '/[^#].*pam_console.so/s/^/#/' < $i > foo && mv foo $i
done
```

30.4. Defining the Console

The `pam_console.so` module uses the `/etc/security/console.perms` file to determine the permissions for users at the system console. The syntax of the file is very flexible; you can edit the file so that these instructions no longer apply. However, the default file has a line that looks like this:

```
<console>=tty[0-9][0-9]* :[0-9]\.[0-9] :[0-9]
```

When users log in, they are attached to some sort of named terminal, either an X server with a name like `:0` or `mymachine.example.com:1.0` or a device like `/dev/ttyS0` or `/dev/pts/2`. The default is to define that local virtual consoles and local X servers are considered local, but if you want to consider the serial terminal next to you on port `/dev/ttyS1` to also be local, you can change that line to read:

```
<console>=tty[0-9][0-9]* :[0-9]\.[0-9] :[0-9] /dev/ttyS1
```

30.5. Making Files Accessible From the Console

In `/etc/security/console.perms`, there is a section with lines like:

```
<floppy>=/dev/fd[0-1]* \
         /dev/floppy/* /mnt/floppy*
<sound>=/dev/dsp* /dev/audio* /dev/midi* \
        /dev/mixer* /dev/sequencer \
```

```
        /dev/sound/* /dev/beep
<cdrom>=/dev/cdrom* /dev/cdroms/* /dev/cdwriter* /mnt/cdrom*
```

You can add your own lines to this section, if necessary. Make sure that any lines you add refer to the appropriate device. For example, you could add the following line:

```
<scanner>=/dev/scanner /dev/usb/scanner*
```

(Of course, make sure that `/dev/scanner` is really your scanner and not, say, your hard drive.)

That is the first step. The second step is to define what is done with those files. Look in the last section of `/etc/security/console.perms` for lines similar to:

```
<console> 0660 <floppy> 0660 root.floppy
<console> 0600 <sound>  0640 root
<console> 0600 <cdrom>  0600 root.disk
```

and add a line like:

```
<console> 0600 <scanner> 0600 root
```

Then, when you log in at the console, you are given ownership of the `/dev/scanner` device with the permissions of 0600 (readable and writable by you only). When you log out, the device is owned by root and still has the permissions 0600 (now readable and writable by root only).

30.6. Enabling Console Access for Other Applications

To make other applications accessible to console users, a bit more work is required.

First of all, console access *only* works for applications which reside in `/sbin/` or `/usr/sbin/`, so the application that you wish to run must be there. After verifying that, do the following steps:

1. Create a link from the name of your application, such as our sample *`foo`* program, to the `/usr/bin/consolehelper` application:
   ```
   cd /usr/bin
   ln -s consolehelper foo
   ```
2. Create the file `/etc/security/console.apps/`*`foo`*:
   ```
   touch /etc/security/console.apps/foo
   ```
3. Create a PAM configuration file for the *`foo`* service in `/etc/pam.d/`. An easy way to do this is to start with a copy of the halt service's PAM configuration file, and then modify the file if you want to change the behavior:
   ```
   cp /etc/pam.d/halt /etc/pam.d/foo
   ```

Now, when `/usr/bin/`*`foo`* is executed, `consolehelper` is called, which authenticates the user with the help of `/usr/sbin/userhelper`. To authenticate the user, `consolehelper` asks for the user's password if `/etc/pam.d/`*`foo`* is a copy of `/etc/pam.d/halt` (otherwise, it does precisely what is specified in `/etc/pam.d/`*`foo`*) and then runs `/usr/sbin/`*`foo`* with root permissions.

In the PAM configuration file, an application can be configured to use the *pam_timestamp* module to remember (cache) a successful authentication attempt. When an application is started and proper authentication is provided (the root password), a timestamp file is created. By default, a successful authentication is cached for five minutes. During this time, any other application that is configured to use `pam_timestamp` and run from the same session is automatically authenticated for the user — the user does not have to enter the root password again.

This module is included in the `pam` package. To enable this feature, the PAM configuration file in `etc/pam.d/` must include the following lines:

```
auth sufficient /lib/security/pam_timestamp.so
session optional /lib/security/pam_timestamp.so
```

The first line that begins with `auth` should be after any other `auth sufficient` lines, and the line that begins with `session` should be after any other `session optional` lines.

If an application configured to use `pam_timestamp` is successfully authenticated from the **Main Menu Button** (on the Panel), the  icon is displayed in the notification area of the panel if you are running the GNOME or KDE desktop environment. After the authentication expires (the default is five minutes), the icon disappears.

The user can select to forget the cached authentication by clicking on the icon and selecting the option to forget authentication.

30.7. The `floppy` Group

If, for whatever reason, console access is not appropriate for you and you need to give non-root users access to your system's diskette drive, this can be done using the `floppy` group. Add the user(s) to the `floppy` group using the tool of your choice. For example, the `gpasswd` command can be used to add user fred to the `floppy` group:

```
gpasswd -a fred floppy
```

Now, user fred is able to access the system's diskette drive from the console.

Chapter 31.

Date and Time Configuration

The **Time and Date Properties Tool** allows the user to change the system date and time, to configure the time zone used by the system, and to setup the Network Time Protocol (NTP) daemon to synchronize the system clock with a time server.

You must be running the X Window System and have root privileges to use the tool. To start the application from the desktop go to the **Main Menu Button** => **System Settings** => **Date & Time** or type the command `redhat-config-date` at a shell prompt (for example, in an XTerm or a GNOME terminal).

31.1. Time and Date Properties

As shown in Figure 31-1, the first tabbed window that appears is for configuring the system date and time and the NTP daemon (`ntpd`).

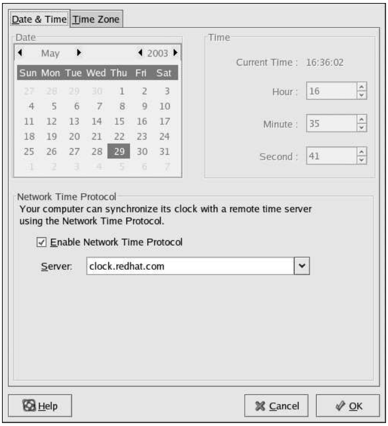


Figure 31-1. Time and Date Properties

To change the date, use the arrows to the left and right of the month to change the month, use the arrows to the left and right of the year to change the year, and click on the day of the week to change the day of the week. Changes take place after the **OK** button is clicked.

To change the time, use the up and down arrow buttons beside the **Hour**, **Minute**, and **Second** in the **Time** section. Changes take place until after the **OK** button is clicked.

The Network Time Protocol (NTP) daemon synchronizes the system clock with a remote time server or time source (such as a satellite). The application allows you to configure an NTP daemon to synchronize your system clock with a remote server. To enable this feature, select **Enable Network Time Protocol**. This enables the **Server** pulldown menu. You can choose one of the predefined servers or type a server name in the pulldown menu. Your system does not start synchronizing with the NTP server until you click **OK**. After you click **OK**, the configuration is be saved and the NTP daemon is started (or restarted if it is already running).

Clicking the **OK** button applies any changes made to the date and time, the NTP daemon settings, and the time zone settings. It also exits the program.

31.2. Time Zone Configuration

To configure the system time zone, click the **Time Zone** tab. The time zone can be changed by either using the interactive map or by choosing the desired time zone from the list below the map. To use the map, click on the city that represents the desired time zone. A red **X** appears and the time zone selection changes in the list below the map. Click **OK** to apply the changes and exit the program.

Figure 31-2. Timezone Properties

If your system clock is set to use UTC, select the **System clock uses UTC** option. UTC stands for the *Universal Time, Coordinated*, also known as Greenwich mean time (GMT). Other time zones are determined by adding or subtracting from the UTC time.

Chapter 32. Keyboard Configuration

The installation program allows users to configure a keyboard layout for their systems. To configure a different keyboard layout after installation, use the **Keyboard Configuration Tool**.

To start the **Keyboard Configuration Tool**, select the **Main Menu** button (on the panel) => **System Settings** => **Keyboard**, or type the command `redhat-config-keyboard` at a shell prompt.

Figure 32-1. Keyboard Configuration Tool

Select a keyboard layout from the list (for example, **U.S. English**) and click **OK**. For changes to take effect, you should log out of your graphical desktop session and log back in.

Chapter 33. Mouse Configuration

The installation program allows users to select the type of mouse connected to the system. To configure a different mouse type for the system, use the **Mouse Configuration Tool**.

To start the **Mouse Configuration Tool**, select **Main Menu Button** (on the Panel) => **System Settings** => **Mouse**, or type the command `redhat-config-mouse` at a shell prompt (for example, in an XTerm or GNOME terminal). If the X Window System is not running, the text-based version of the tool is started.

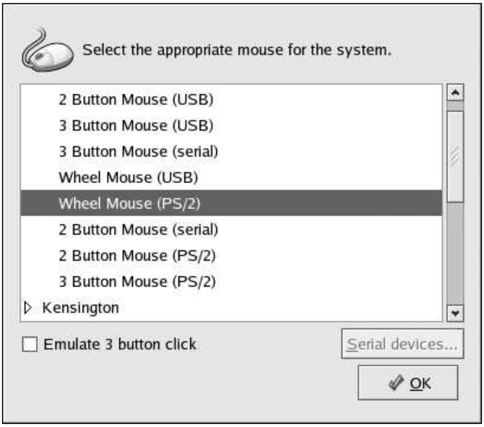


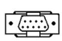
Figure 33-1. Select Mouse

Select the new mouse type for the system. If there is not an exact match, select one that is most compatible with the system and the mouse.

The built-in pointing device such as a touch pad on a laptop computer is usually PS/2 compatible.

All the mouse types are appended with **PS/2**, **serial**, or **USB** in parentheses. This specifies the mouse port.

A PS/2 mouse port looks similar to .

A serial mouse port looks similar to .

A USB mouse port looks similar to .

If the specific mouse model is not listed, select one of the **Generic** entries, based on the mouse's number of buttons and its interface.

Tip

Select the **Generic - Wheel Mouse** entry, with the proper mouse port, to enable the scroll button on the mouse.

The scroll button on a wheel mouse can be used as the middle mouse button for cutting text, pasting text, and other middle mouse button functions. If the mouse only has two buttons, select **Emulate 3 buttons** to use a two-button mouse as a three-button mouse. When this option enabled, clicking the two mouse buttons simultaneously emulates a middle mouse button click.

If a serial port mouse is selected, click the **Serial devices** button to configure the correct serial device number, such as `/dev/ttyS0` for the mouse.

Click **OK** to save the new mouse type. The selection is written to the file `/etc/sysconfig/mouse`, and the console mouse service, `gpm` is restarted. The changes are also written to the X Window System configuration file `/etc/X11/XF86Config`; however, the mouse type change is not automatically applied to the current X session. To enable the new mouse type, log out of the graphical desktop and log back in.

Tip

To reset the order of the mouse buttons for a left-handed user, go to the **Main Menu** Button (on the Panel) => **Preferences** => **Mouse**, and select **Left-handed mouse** for the mouse orientation.

Chapter 34.
X Window System Configuration

During installation, the system's monitor, video card, and display settings are configured. To change any of these settings for the system, use the **X Configuration Tool**.

To start the **X Configuration Tool**, select **Main Menu Button** (on the Panel) => **System Settings** => **Display**, or type the command `redhat-config-xfree86` at a shell prompt (for example, in an XTerm or GNOME terminal). If the X Window System is not running, a small version of X is started to run the program.

After changing any of the settings, log out of the graphical desktop and log back in to enable the changes.

34.1. Display Settings

The **Display** tab allows users to change the *resolution* and *color depth*. The display of a monitor consists of tiny dots called *pixels*. The number of pixels displayed at one time is called the resolution. For example, the resolution 1024x768 means that 1024 horizontal pixels are used, and 768 vertical pixels are used. The higher the resolution numbers, the more images the monitor can display at one time. For example, the higher the resolution, the smaller the desktop icons appear, and the more icons it takes to fill the entire desktop.

The color depth of the display determines how many possible colors are displayed. The higher the color depth, the more contrast between colors.

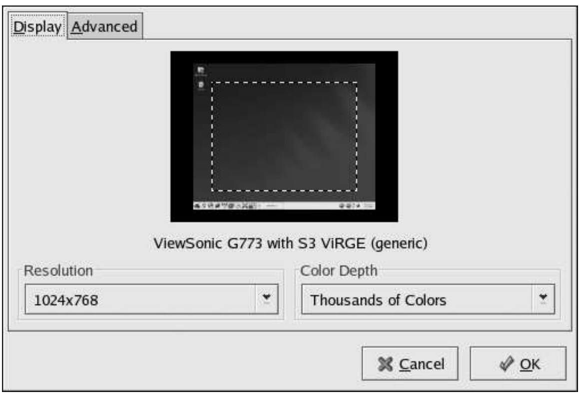


Figure 34-1. Display Settings

34.2. Advanced Settings

When the application is started, it probes the monitor and video card. If the hardware is probed properly, the information for it is shown on the **Advanced** tab as shown in Figure 34-2.

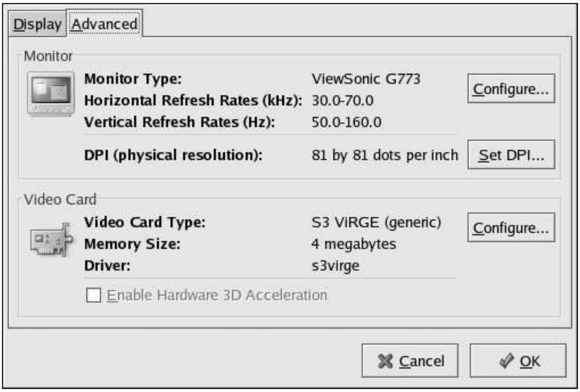


Figure 34-2. Advanced Settings

To change the monitor type or any of its settings, click the corresponding **Configure** button. To change the video card type or any of its settings, click the **Configure** button beside its settings.

Chapter 35. User and Group Configuration

The **User Manager** allows you to view, modify, add, and delete local users and groups.

To use the **User Manager**, you must be running the X Window System, have root privileges, and have the `redhat-config-users` RPM package installed. To start the **User Manager** from the desktop, go to the **Main Menu Button** (on the Panel) => **System Settings** => **Users & Groups**. Or, type the command `redhat-config-users` at a shell prompt (for example, in an XTerm or a GNOME terminal).

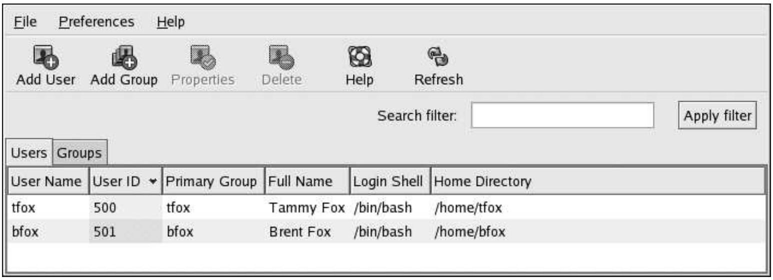


Figure 35-1. User Manager

To view a list of local users on the system, click the **Users** tab. To view a list of local groups on the system, click the **Groups** tab.

To find a specific user or group, type the first few letters of the name in the **Search filter** field. Press [Enter] or click the **Apply filter** button. The filtered list is displayed.

To sort the users or groups, click on the column name. The users or groups are sorted by the value of that column.

Red Hat Enterprise Linux reserves user IDs below 500 for system users. By default, **User Manager** does not display system users. To view all users, including the system users, uncheck **Preferences => Filter system users and groups** from the pulldown menu.

35.1. Adding a New User

To add a new user, click the **Add User** button. A window as shown in Figure 35-2 appears. Type the username and full name for the new user in the appropriate fields. Type the user's password in the **Password** and **Confirm Password** fields. The password must be at least six characters.

Tip

The longer the user's password, the more difficult it is for someone else to guess it and log in to the user's account without permission. It is also recommended that the password not be based on a dictionary term and that the password be a combination of letters, numbers, and special characters.

Select a login shell. If you are not sure which shell to select, accept the default value of `/bin/bash`. The default home directory is `/home/`*`username`*`/`. You can change the home directory that is created for the user, or you can choose not to create the home directory by unselecting **Create home directory**.

If you select to create the home directory, default configuration files are copied from the `/etc/skel/` directory into the new home directory.

Red Hat Enterprise Linux uses a *user private group* (UPG) scheme. The UPG scheme does not add or change anything in the standard UNIX way of handling groups; it offers a new convention. Whenever you create a new user, by default, a unique group with the same name as the user is created. If you do not want to create this group, unselect **Create a private group for the user**.

To specify a user ID for the user, select **Specify user ID manually**. If the option is not selected, the next available user ID starting with number 500 is assigned to the new user. Red Hat Enterprise Linux reserves user IDs below 500 for system users.

Click **OK** to create the user.

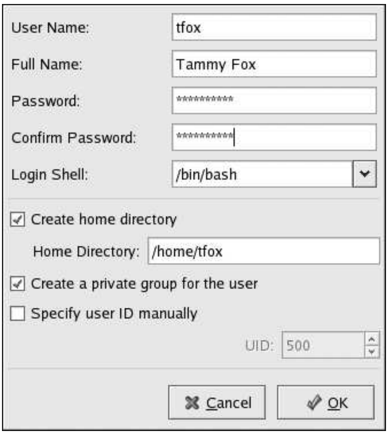


Figure 35-2. New User

To configure more advanced user properties such as password expiration, modify the user's properties after adding the user. Refer to Section 35.2 *Modifying User Properties* for more information.

To add the user to more user groups, click on the **User** tab, select the user, and click **Properties**. In the **User Properties** window, select the **Groups** tab. Select the groups that you want the user to be a member of, select the primary group for the user, and click **OK**.

35.2. Modifying User Properties

To view the properties of an existing user, click on the **Users** tab, select the user from the user list, and click **Properties** from the button menu (or choose **File => Properties** from the pulldown menu). A window similar to Figure 35-3 appears.

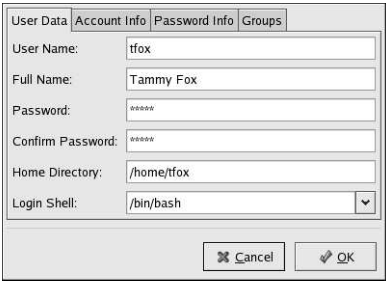


Figure 35-3. User Properties

The **User Properties** window is divided into multiple tabbed pages:

- **User Data** — Shows the basic user information configured when you added the user. Use this tab to change the user's full name, password, home directory, or login shell.
- **Account Info** — Select **Enable account expiration** if you want the account to expire on a certain date. Enter the date in the provided fields. Select **User account is locked** to lock the user account so that the user cannot log in to the system.
- **Password Info** — This tab shows the date that the user's password last changed. To force the user to change passwords after a certain number of days, select **Enable password expiration**. The number of days before the user's password expires, the number of days before the user is warned to change passwords, and days before the account becomes inactive can also be changed.
- **Groups** — Select the groups that you want the user to be a member of and the user's primary group.

35.3. Adding a New Group

To add a new user group, click the **Add Group** button. A window similar to Figure 35-4 appears. Type the name of the new group to create. To specify a group ID for the new group, select **Specify group ID manually** and select the GID. Red Hat Enterprise Linux reserves group IDs lower than 500 for system groups.

Click **OK** to create the group. The new group appears in the group list.

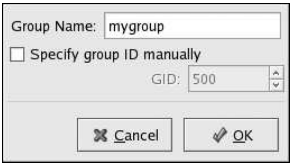


Figure 35-4. New Group

To add users to the group, refer to Section 35.4 *Modifying Group Properties*.

35.4. Modifying Group Properties

To view the properties of an existing group, select the group from the group list and click **Properties** from the button menu (or choose **File** => **Properties** from the pulldown menu). A window similar to Figure 35-5 appears.

Figure 35-5. Group Properties

The **Group Users** tab displays which users are members of the group. Select additional users to be added to the group, or unselect users to be removed from the group. Click **OK** to modify the users in the group.

35.5. Command Line Configuration

If you prefer command line tools or do not have the X Window System installed, use this section to configure users and groups.

35.5.1. Adding a User

To add a user to the system:

1. Issue the `useradd` command to create a locked user account:
   `useradd <username>`
2. Unlock the account by issuing the `passwd` command to assign a password and set password aging guidelines:
   `passwd <username>`

Command line options for `useradd` are detailed in Table 35-1.

Option	Description
`-c` *comment*	Comment for the user
`-d` *home-dir*	Home directory to be used instead of default `/home/`*username*`/`
`-e` *date*	Date for the account to be disabled in the format YYYY-MM-DD

Option	Description
`-f` *days*	Number of days after the password expires until the account is disabled. (If **0** is specified, the account is disabled immediately after the password expires. If **-1** is specified, the account is not be disabled after the password expires.)
`-g` *group-name*	Group name or group number for the user's default group (The group must exist prior to being specified here.)
`-G` *group-list*	List of additional (other than default) group names or group numbers, separated by commas, of which the user is a member. (The groups must exist prior to being specified here.)
`-m`	Create the home directory if it does not exist
`-M`	Do not create the home directory
`-n`	Do not create a user private group for the user
`-r`	Create a system account with a UID less than 500 and without a home directory
`-p` *password*	The password encrypted with `crypt`
`-s`	User's login shell, which defaults to `/bin/bash`
`-u` *uid*	User ID for the user, which must be unique and greater than 499

Table 35-1. `useradd` Command Line Options

35.5.2. Adding a Group

To add a group to the system, use the command `groupadd`:

`groupadd` <*group-name*>

Command line options for `groupadd` are detailed in Table 35-2.

Option	Description
`-g` *gid*	Group ID for the group, which must be unique and greater than 499
`-r`	Create a system group with a GID less than 500
`-f`	Exit with an error if the group already exists (The group is not altered.) If `-g` and `-f` are specified, but the group already exists, the `-g` option is ignored

Table 35-2. `groupadd` Command Line Options

35.5.3. Password Aging

For security reasons, it is a good practice to require users to change their passwords periodically. This can be done when adding or editing a user on the **Password Info** tab of the **User Manager**.

To configure password expiration for a user from a shell prompt, use the `chage` command, followed by an option from Table 35-3, followed by the username of the user.

Important

Shadow passwords must be enabled to use the `chage` command.

Option	Description
`-m` *days*	Specify the minimum number of days between which the user must change passwords. If the value is 0, the password does not expire.
`-M` *days*	Specify the maximum number of days for which the password is valid. When the number of days specified by this option plus the number of days specified with the `-d` option is less than the current day, the user must change passwords before using the account.
`-d` *days*	Specify the number of days since January 1, 1970 the password was changed.
`-I` *days*	Specify the number of inactive days after the password expiration before locking the account. If the value is 0, the account is not locked after the password expires.
`-E` *date*	Specify the date on which the account is locked, in the format YYYY-MM-DD. Instead of the date, the number of days since January 1, 1970 can also be used.
`-W` *days*	Specify the number of days before the password expiration date to warn the user.

Table 35-3. `chage` Command Line Options

Tip

If the `chage` command is followed directly by a username (with no options), it displays the current password aging values and allows them to be changed.

If a system administrator wants a user to set a password the first time the user log in, the user's initial or null password can be set to expire immediately, forcing the user to change it immediately after logging in for the first time.

To force a user to configure a password the first time the user logs in at the console, follow these steps. Note, this process does not work if the user logs in using the SSH protocol.

1. *Lock the user's password* — If the user does not exist, use the `useradd` command to create the user account, but do not give it a password so that it remains locked.

   If the password is already enabled, lock it with the command:

   ```
   usermod -L username
   ```

2. *Force immediate password expiration* — Type the following command:

   ```
   chage -d 0 username
   ```

   This command sets the value for the date the password was last changed to the epoch (January 1, 1970). This value forces immediate password expiration no matter what password aging policy, if any, is in place.

3. *Unlock the account* — There are two common approaches to this step. The administrator can assign an initial password or assign a null password.

   Warning

   Do not use the `passwd` command to set the password as it disables the immediate password expiration just configured.

   To assign an initial password, use the following steps:

   - Start the command line Python interpreter with the `python` command. It displays the following:

     ```
     Python 2.2.2 (#1, Dec 10 2002, 09:57:09)
     [GCC 3.2.1 20021207 (Red Hat Enterprise Linux 3 3.2.1-2)] on linux2
     Type "help", "copyright", "credits" or "license" for more information.
     >>>
     ```

   - At the prompt, type the following (replacing *`password`* with the password to encrypt and *`salt`* with a combination of exactly 2 upper or lower case alphabetic characters, digits, the dot (.) character, or the slash (/) character such as `ab` or `12`:

     ```
     import crypt; print crypt.crypt("password","salt")
     ```

     The output is the encrypted password similar to `12CsGd8FRcMSM`.

   - Type [Ctrl]-[D] to exit the Python interpreter.
   - Cut and paste the exact encrypted password output, without a leading or trailing blank spaces, into the following command:

     ```
     usermod -p "encrypted-password" username
     ```

   Instead of assigning an initial password, a null password can be assigned using the command:

   ```
   usermod -p "" username
   ```

   Caution

   While using a null password is convenient for both the user and the administrator, there is a slight risk that a third party can log in first and access the system. To minimize this threat, it is recommended that the administrator verifies that the user is ready to log in when the account is unlocked.

   In either case, upon initial log in, the user is prompted for a new password.

35.6. Explaining the Process

The following steps illustrate what happens if the command `useradd juan` is issued on a system that has shadow passwords enabled:

1. A new line for `juan` is created in `/etc/passwd`. The line has the following characteristics:
   - It begins with the username `juan`.
   - There is an `x` for the password field indicating that the system is using shadow passwords.
   - A UID at or above 500 is created. (Under Red Hat Enterprise Linux, UIDs and GIDs below 500 are reserved for system use.)
   - A GID at or above 500 is created.
   - The optional GECOS information is left blank.
   - The home directory for `juan` is set to `/home/juan/`.
   - The default shell is set to `/bin/bash`.

2. A new line for `juan` is created in `/etc/shadow`. The line has the following characteristics:
   - It begins with the username `juan`.
   - Two exclamation points (`!!`) appear in the password field of the `/etc/shadow` file, which locks the account.

     Note

     If an encrypted password is passed using the `-p` flag, it is placed in the `/etc/shadow` file on the new line for the user.

   - The password is set to never expire.

3. A new line for a group named `juan` is created in `/etc/group`. A group with the same name as a user is called a *user private group*. For more information on user private groups, refer to Section 35.1 *Adding a New User*.

   The line created in `/etc/group` has the following characteristics:
   - It begins with the group name `juan`.
   - An `x` appears in the password field indicating that the system is using shadow group passwords.
   - The GID matches the one listed for user `juan` in `/etc/passwd`.

4. A new line for a group named `juan` is created in `/etc/gshadow`. The line has the following characteristics:
   - It begins with the group name `juan`.
   - An exclamation point (`!`) appears in the password field of the `/etc/gshadow` file, which locks the group.
   - All other fields are blank.

5. A directory for user `juan` is created in the `/home/` directory. This directory is owned by user `juan` and group `juan`. However, it has read, write, and execute privileges *only* for the user `juan`. All other permissions are denied.
6. The files within the `/etc/skel/` directory (which contain default user settings) are copied into the new `/home/juan/` directory.

At this point, a locked account called `juan` exists on the system. To activate it, the administrator must next assign a password to the account using the `passwd` command and, optionally, set password aging guidelines.

35.7. Additional Information

Refer to these resources for more information on user and group management.

35.7.1. Installed Documentation

- The man pages for `useradd`, `passwd`, `groupadd`, and `chage`.

35.7.2. Related Books

- *Red Hat Enterprise Linux Reference Guide* — This manual gives a list of standard users and groups, discusses user private groups, and provides an overview of shadow passwords.
- *Red Hat Enterprise Linux Introduction to System Administration* — This companion manual contains more information on managing users and groups as well as managing user resources.

Chapter 36. Printer Configuration

The **Printer Configuration Tool** allows users to configure a printer. This tool helps maintain the printer configuration file, print spool directories, and print filters.

Red Hat Enterprise Linux 3 uses the CUPS printing system. If a system was upgraded from a previous Red Hat Enterprise Linux version that used CUPS, the upgrade process preserved the configured queues.

Using the **Printer Configuration Tool** requires root privileges. To start the application, select **Main Menu Button** (on the Panel) => **System Settings** => **Printing**, or type the command `redhat-config-printer`. This command automatically determines whether to run the graphical or text-based version depending on whether the command is executed in the graphical desktop environment or from a text-based console.

To force the **Printer Configuration Tool** to run as a text-based application, execute the command `redhat-config-printer-tui` from a shell prompt.

Important

> Do not edit the `/etc/printcap` file or the files in the `/etc/cups/` directory. Each time the printer daemon (`cups`) is started or restarted, new configuration files are dynamically created. The files are dynamically created when changes are applied with the **Printer Configuration Tool** as well.

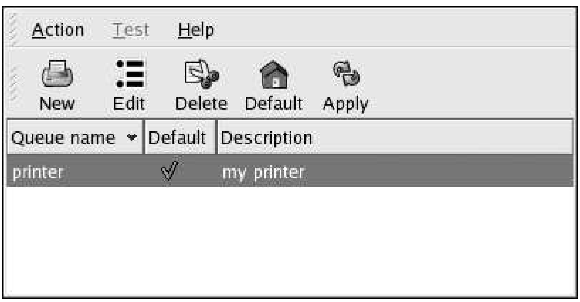


Figure 36-1. Printer Configuration Tool

The following types of print queues can be configured:

- **Locally-connected** — a printer attached directly to the computer through a parallel or USB port.
- **Networked CUPS (IPP)** — a printer that can be accessed over a TCP/IP network via the Internet Printing Protocol, also known as IPP (for example, a printer attached to another Red Hat Enterprise Linux system running CUPS on the network).
- **Networked UNIX (LPD)** — a printer attached to a different UNIX system that can be accessed over a TCP/IP network (for example, a printer attached to another Red Hat Enterprise Linux system running LPD on the network).

- **Networked Windows (SMB)** — a printer attached to a different system which is sharing a printer over a SMB network (for example, a printer attached to a Microsoft Windows™ machine).
- **Networked Novell (NCP)** — a printer attached to a different system which uses Novell's NetWare network technology.
- **Networked JetDirect** — a printer connected directly to the network through HP JetDirect instead of to a computer.

Important

If you add a new print queue or modify an existing one, you must apply the changes to them to take effect.

Clicking the **Apply** button saves any changes that you have made and restarts the printer daemon. The changes are not written to the configuration file until the printer daemon is restarted. Alternatively, you can choose **Action** => **Apply**.

36.1. Adding a Local Printer

To add a local printer, such as one attached through a parallel port or USB port on your computer, click the **New** button in the main **Printer Configuration Tool** window to display the window in Figure 36-2. Click **Forward** to proceed.

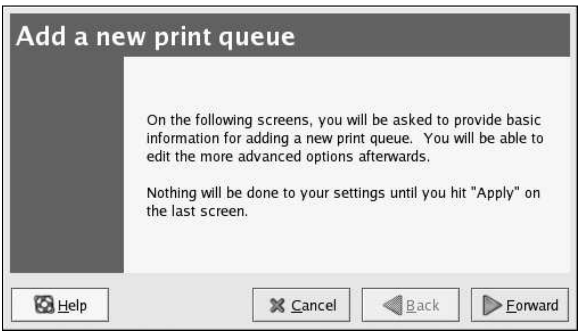


Figure 36-2. Adding a Printer

In the window shown in Figure 36-3, enter a unique name for the printer in the **Name** text field. The printer name cannot contain spaces and must begin with a letter. The printer name may contain letters, numbers, dashes (-), and underscores (_). Optionally, enter a short description for the printer, which can contain spaces.

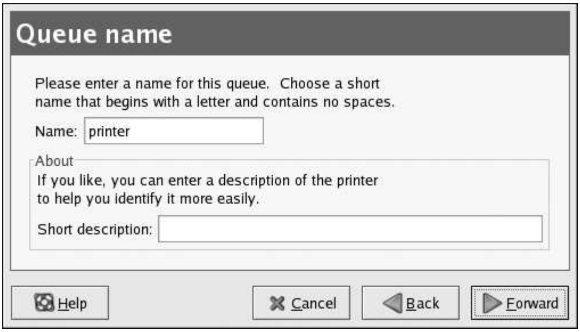


Figure 36-3. Selecting a Queue Name

After clicking **Forward**, Figure 36-4 appears. Select **Locally-connected** from the **Select a queue type** menu, and select the device. The device is usually `/dev/lp0` for a parallel printer or `/dev/usb/lp0` for a USB printer. If no devices appear in the list, click **Rescan devices** to rescan the computer or click **Custom device** to specify it manually. Click **Forward** to continue.

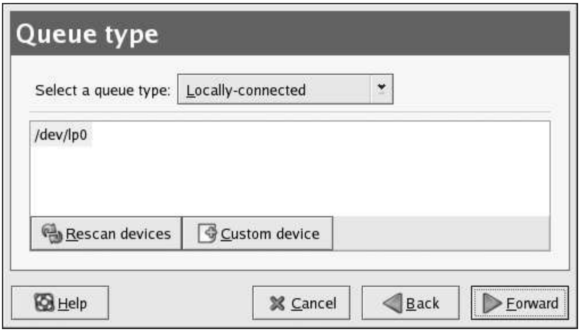


Figure 36-4. Adding a Local Printer

Next, select the printer type. Refer to Section 36.7 *Selecting the Printer Model and Finishing* for details.

36.2. Adding an IPP Printer

An IPP printer is a printer attached to a different Linux system on the same network running CUPS or a printer configured on another operating system to use IPP. By default, the **Printer Configuration Tool** browses the network for any shared IPP printers. (This option can be changed by selecting **Action** => **Sharing** from the pulldown menu.) Any networked IPP printer found via CUPS browsing appears in the main window under the **Browsed queues** category.

If you have a firewall configured on the print server, it must be able to send and receive connections on the incoming UDP port, 631. If you have a firewall configured on the client (the computer sending the print request), it must be allowed to send and accept connections on port 631.

If you disable the automatic browsing feature, you can still add a networked IPP printer by clicking the **New** button in the main **Printer Configuration Tool** window to display the window in Figure 36-2. Click **Forward** to proceed.

In the window shown in Figure 36-3, enter a unique name for the printer in the **Name** text field. The printer name cannot contain spaces and must begin with a letter. The printer name may contain letters, numbers, dashes (-), and underscores (_). Optionally, enter a short description for the printer, which can contain spaces.

After clicking **Forward**, Figure 36-5 appears. Select **Networked CUPS (IPP)** from the **Select a queue type** menu.

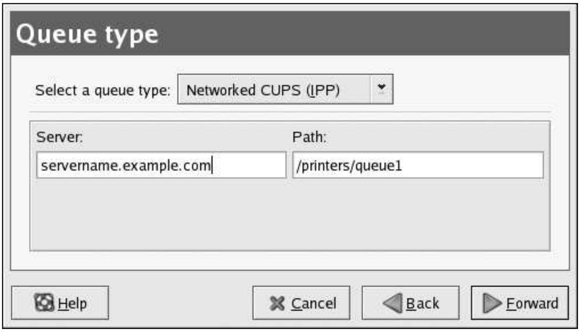


Figure 36-5. Adding an IPP Printer

Text fields for the following options appear:

- **Server** — The hostname or IP address of the remote machine to which the printer is attached.
- **Path** — The path to the print queue on the remote machine.

Click **Forward** to continue.

Next, select the printer type. Refer to Section 36.7 *Selecting the Printer Model and Finishing* for details.

Important

The networked IPP print server must allow connections from the local system. Refer to Section 36.13 *Sharing a Printer* for more information.

36.3. Adding a Remote UNIX (LPD) Printer

To add a remote UNIX printer, such as one attached to a different Linux system on the same network, click the **New** button in the main **Printer Configuration Tool** window. The window shown in Figure 36-2 will appear. Click **Forward** to proceed.

In the window shown in Figure 36-3, enter a unique name for the printer in the **Name** text field. The printer name cannot contain spaces and must begin with a letter. The printer name may contain letters, numbers, dashes (-), and underscores (_). Optionally, enter a short description for the printer, which can contain spaces.

Select **Networked UNIX (LPD)** from the **Select a queue type** menu, and click **Forward**.

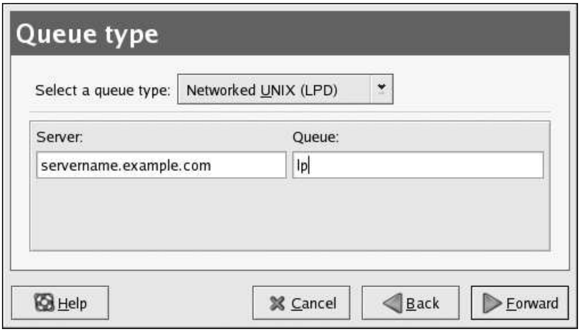


Figure 36-6. Adding a Remote LPD Printer

Text fields for the following options appear:

- **Server** — The hostname or IP address of the remote machine to which the printer is attached.
- **Queue** — The remote printer queue. The default printer queue is usually `lp`.

Click **Forward** to continue.

Next, select the printer type. Refer to Section 36.7 *Selecting the Printer Model and Finishing* for details.

Important

The remote print server must accept print jobs from the local system.

36.4. Adding a Samba (SMB) Printer

To add a printer which is accessed using the SMB protocol (such as a printer attached to a Microsoft Windows system), click the **New** button in the main **Printer Configuration Tool** window. The window shown in Figure 36-2 will appear. Click **Forward** to proceed.

In the window shown in Figure 36-3, enter a unique name for the printer in the **Name** text field. The printer name cannot contain spaces and must begin with a letter. The printer name may contain letters, numbers, dashes (-), and underscores (_). Optionally, enter a short description for the printer, which can contain spaces.

Select **Networked Windows (SMB)** from the **Select a queue type** menu, and click **Forward**. If the printer is attached to a Microsoft Windows system, choose this queue type.

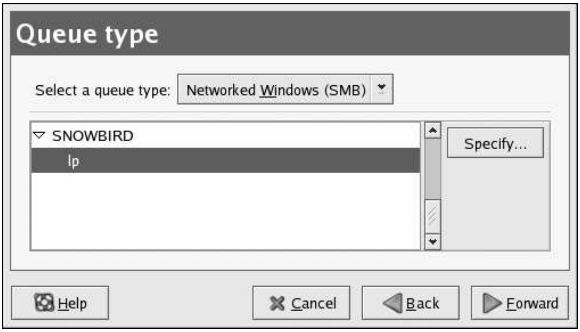


Figure 36-7. Adding a SMB Printer

As shown in Figure 36-7, SMB shares are automatically detected and listed. Click the arrow beside each share name to expand the list. From the expanded list, select a printer.

If the printer you are looking for does not appear in the list, click the **Specify** button on the right. Text fields for the following options appear:

- **Workgroup** — The name of the Samba workgroup for the shared printer.
- **Server** — The name of the server sharing the printer.
- **Share** — The name of the shared printer on which you want to print. This name must be the same name defined as the Samba printer on the remote Windows machine.
- **User name** — The name of the user you must log in as to access the printer. This user must exist on the Windows system, and the user must have permission to access the printer. The default user name is typically `guest` for Windows servers, or `nobody` for Samba servers.
- **Password** — The password (if required) for the user specified in the **User name** field.

Click **Forward** to continue. The **Printer Configuration Tool** then attempts to connect to the shared printer. If the shared printer requires a username and password, a dialog window appears prompting you to provide a valid username and password for the shared printer. If an incorrect share name is specified, you can change it here as well. If a workgroup name is required to connect to the share, it can be specified in this dialog box. This dialog window is the same as the one shown when the **Specify** button is clicked.

Next, select the printer type. Refer to Section 36.7 *Selecting the Printer Model and Finishing* for details.

Warning

If you require a username and password, they are stored unencrypted in files only readable by root and lpd. Thus, it is possible for others to learn the username and password if they have root access. To avoid this, the username and password to access the printer should be different from the username and password used for the user's account on the local Red Hat Enterprise Linux system. If they are different, then the only possible security compromise would be unauthorized use of the printer. If there are file shares from the server, it is recommended that they also use a different password than the one for the print queue.

36.5. Adding a Novell NetWare (NCP) Printer

To add a Novell NetWare (NCP) printer, click the **New** button in the main **Printer Configuration Tool** window. The window shown in Figure 36-1 will appear. Click **Forward** to proceed.

In the window shown in Figure 36-3, enter a unique name for the printer in the **Name** text field. The printer name cannot contain spaces and must begin with a letter. The printer name may contain letters, numbers, dashes (-), and underscores (_). Optionally, enter a short description for the printer, which can contain spaces.

Select **Networked Novell (NCP)** from the **Select a queue type** menu.

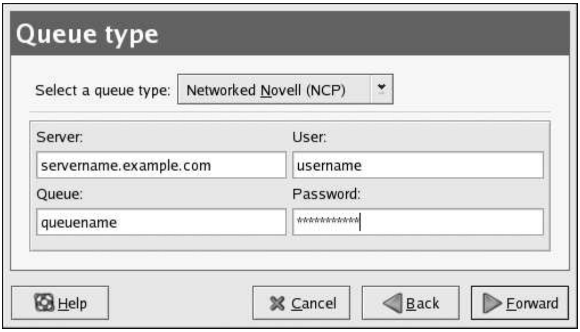


Figure 36-8. Adding an NCP Printer

Text fields for the following options appear:

- **Server** — The hostname or IP address of the NCP system to which the printer is attached.
- **Queue** — The remote queue for the printer on the NCP system.
- **User** — The name of the user you must log in as to access the printer.
- **Password** — The password for the user specified in the **User** field above.

Next, select the printer type. Refer to Section 36.7 *Selecting the Printer Model and Finishing* for details.

Warning

If you require a username and password, they are stored unencrypted in files only readable by root and lpd. Thus, it is possible for others to learn the username and password if they have root access. To avoid this, the username and password to access the printer should be different from the username and password used for the user's account on the local Red Hat Enterprise Linux system. If they are different, then the only possible security compromise would be unauthorized use of the printer. If there are file shares from the server, it is recommended that they also use a different password than the one for the print queue.

36.6. Adding a JetDirect Printer

To add a JetDirect printer, click the **New** button in the main **Printer Configuration Tool** window. The window shown in Figure 36-1 will appear. Click **Forward** to proceed.

In the window shown in Figure 36-3, enter a unique name for the printer in the **Name** text field. The printer name cannot contain spaces and must begin with a letter. The printer name may contain letters, numbers, dashes (-), and underscores (_). Optionally, enter a short description for the printer, which can contain spaces.

Select **Networked JetDirect** from the **Select a queue type** menu, and click **Forward**.

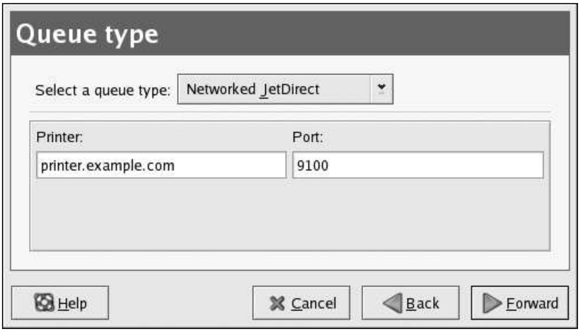


Figure 36-9. Adding a JetDirect Printer

Text fields for the following options appear:

- **Printer** — The hostname or IP address of the JetDirect printer.
- **Port** — The port on the JetDirect printer that is listening for print jobs. The default port is 9100.

Next, select the printer type. Refer to Section 36.7 *Selecting the Printer Model and Finishing* for details.

36.7. Selecting the Printer Model and Finishing

After selecting the queue type of the printer, the next step is to select the printer model.

You will see a window similar to Figure 36-10. If it was not auto-detected, select the model from the list. The printers are divided by manufacturers. Select the name of the printer manufacturer from the pulldown menu. The printer models are updated each time a different manufacturer is selected. Select the printer model from the list.

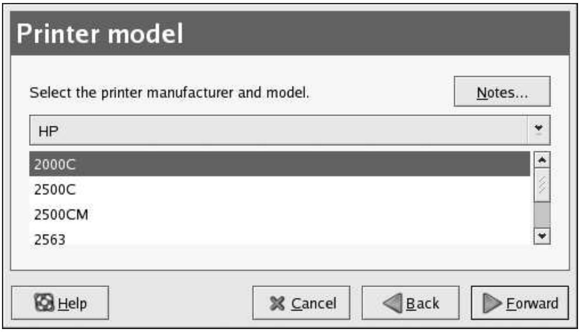


Figure 36-10. Selecting a Printer Model

The recommended print driver is selected based on the printer model selected. The print driver processes the data that you want to print into a format the printer can understand. Since a local printer is attached directly to your computer, you need a print driver to process the data that is sent to the printer.

If you are configuring a remote printer (IPP, LPD, SMB, or NCP), the remote print server usually has its own print driver. If you select an additional print driver on your local computer, the data is filtered multiple times and is converted to a format that the printer can not understand.

To make sure the data is not filtered more than once, first try selecting **Generic** as the manufacturer and **Raw Print Queue** or **Postscript Printer** as the printer model. After applying the changes, print a test page to try out this new configuration. If the test fails, the remote print server might not have a print driver configured. Try selecting a print driver according to the manufacturer and model of the remote printer, applying the changes, and printing a test page.

Tip

> You can select a different print driver after adding a printer by starting the **Printer Configuration Tool**, selecting the printer from the list, clicking **Edit**, clicking the **Driver** tab, selecting a different print driver, and then applying the changes.

36.7.1. Confirming Printer Configuration

The last step is to confirm your printer configuration. Click **Apply** to add the print queue if the settings are correct. Click **Back** to modify the printer configuration.

Click the **Apply** button in the main window to save your changes and restart the printer daemon. After applying the changes, print a test page to ensure the configuration is correct. Refer to Section 36.8 *Printing a Test Page* for details.

If you need to print characters beyond the basic ASCII set (including those used for languages such as Japanese), you must review your driver options and select **Prerender Postscript**. Refer to Section 36.9 *Modifying Existing Printers* for details. You can also configure options such as paper size if you edit the print queue after adding it.

36.8. Printing a Test Page

After you have configured your printer, you should print a test page to make sure the printer is functioning properly. To print a test page, select the printer that you want to try out from the printer list, then select the appropriate test page from the **Test** pulldown menu.

If you change the print driver or modify the driver options, you should print a test page to test the different configuration.

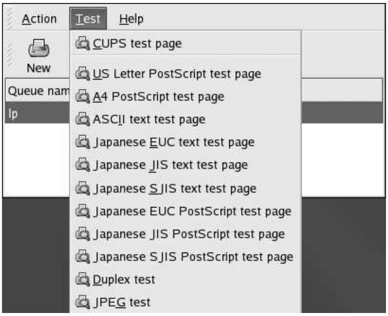


Figure 36-11. Test Page Options

36.9. Modifying Existing Printers

To delete an existing printer, select the printer and click the **Delete** button on the toolbar. The printer is removed from the printer list. Click **Apply** to save the changes and restart the printer daemon.

To set the default printer, select the printer from the printer list and click the **Default** button on the toolbar. The default printer icon appears in the **Default** column of the default printer in the list. A IPP browsed queue printer can not be set as the default printer in the **Printer Configuration Tool**. To make an IPP printer the default, either add it as described in Section 36.2 *Adding an IPP Printer* and make it the default or use the **GNOME Print Manager** to set it as the default. To start the **GNOME Printer Manager**, select **Main Menu** => **System Tools** => **Print Manager**. Right-click on the queue name, and select **Set as Default**. Setting the default printer in the **GNOME Print Manager** only changes the default printer for the user who configures it; it is not a system-wide setting.

After adding the printer(s), the settings can be edited by selecting the printer from the printer list and clicking the **Edit** button. The tabbed window shown in Figure 36-12 is displayed. The window contains the current values for the selected printer. Make any necessary changes, and click **OK**. Click **Apply** in the main **Printer Configuration Tool** window to save the changes and restart the printer daemon.

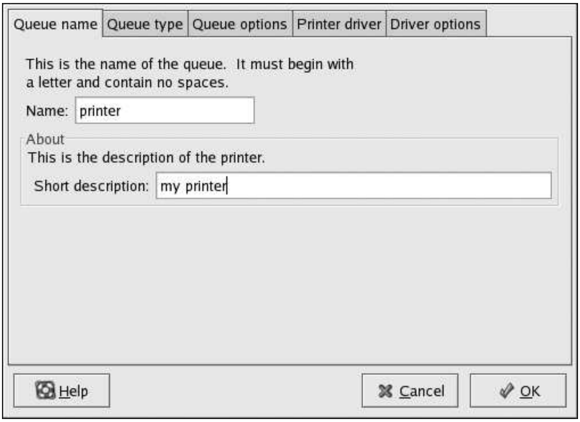


Figure 36-12. Editing a Printer

36.9.1. Queue Name

To rename a printer or change its short description, change the value in the **Queue name** tab. Click **OK** to return to the main window. The name of the printer should change in the printer list. Click **Apply** to save the change and restart the printer daemon.

36.9.2. Queue Type

The **Queue type** tab shows the queue type that was selected when adding the printer and its settings. The queue type of the printer can be changed or just the settings. After making modifications, click **OK** to return to the main window. Click **Apply** to save the changes and restart the printer daemon.

Depending on which queue type is chosen, different options are displayed. Refer to the appropriate section on adding a printer for a description of the options.

36.9.3. Printer Driver

The **Printer driver** tab shows which print driver is currently being used. If it is changed, click **OK** to return to the main window. Click **Apply** to save the change and restart the printer daemon.

36.9.4. Driver Options

The **Driver Options** tab displays advanced printer options. Options vary for each print driver. Common options include:

- **Prerender Postscript** should be selected if characters beyond the basic ASCII set are being sent to the printer but they are not printing correctly (such as Japanese characters). This option prerenders non-standard PostScript fonts so that they are printed correctly.

  If the printer does not support the fonts you are trying to print, try selecting this option. For example, select this option to print Japanese fonts to a non-Japanese printer.

  Extra time is required to perform this action. Do not choose it unless problems printing the correct fonts exist.

Also select this option if the printer can not handle PostScript level 3. This option converts it to PostScript level 1.

- **GhostScript pre-filtering** — allows you to select **No pre-filtering**, **Convert to PS level 1**, or **Convert to PS level 2** in case the printer can not handle certain PostScript levels. This option is only available if the PostScript driver is used.
- **Page Size** allows the paper size to be selected. The options include US Letter, US Legal, A3, and A4.
- **Effective Filter Locale** defaults to **C**. If Japanese characters are being printed, select **ja_JP**. Otherwise, accept the default of **C**.
- **Media Source** defaults to **Printer default**. Change this option to use paper from a different tray.

To modify the driver options, click **OK** to return to the main window. Click **Apply** to save the change and restart the printer daemon.

36.10. Saving the Configuration File

When the printer configuration is saved using the **Printer Configuration Tool**, the application creates its own configuration file that is used to create the files in the `/etc/cups` directory. You can use the command line options to save or restore the **Printer Configuration Tool** file. If the `/etc/cups/` directory is saved and restored to the same locations, the printer configuration is not restored because each time the printer daemon is restarted, it creates a new `/etc/printcap` file from the **Printer Configuration Tool** configuration file. When creating a backup of the system's configuration files, use the following method to save the printer configuration files.

To save your printer configuration, type this command as root:

```
/usr/sbin/redhat-config-printer-tui --Xexport > settings.xml
```

Your configuration is saved to the file `settings.xml`.

If this file is saved, it can be used to restore the printer settings. This is useful if the printer configuration is deleted, if Red Hat Enterprise Linux is reinstalled, or if the same printer configuration is needed on multiple systems. The file should be saved on a different system before reinstalling. To restore the configuration, type this command as root:

```
/usr/sbin/redhat-config-printer-tui --Ximport < settings.xml
```

If you already have a configuration file (you have configured one or more printers on the system already) and you try to import another configuration file, the existing configuration file will be overwritten. If you want to keep your existing configuration and add the configuration in the saved file, you can merge the files with the following command (as root):

```
/usr/sbin/redhat-config-printer-tui --Ximport --merge < settings.xml
```

Your printer list will then consist of the printers you configured on the system as well as the printers you imported from the saved configuration file. If the imported configuration file has a print queue with the same name as an existing print queue on the system, the print queue from the imported file will override the existing printer.

After importing the configuration file (with or without the `merge` command), you must restart the printer daemon. Issue the command:

```
/sbin/service cups restart
```

36.11. Command Line Configuration

If you do not have X installed and you do not want to use the text-based version, you can add a printer via the command line. This method is useful if you want to add a printer from a script or in the %post section of a kickstart installation.

36.11.1. Adding a Local Printer

To add a printer:

```
redhat-config-printer-tui --Xadd-local options
```

Options:

--device=*node*
: (Required) The device node to use. For example, `/dev/lp0`.

--make=*make*
: (Required) The IEEE 1284 MANUFACTURER string or the printer manufacturer's name as in the foomatic database if the manufacturer string is not available.

--model=*model*
: (Required) The IEEE 1284 MODEL string or the printer model listed in the foomatic database if the model string is not available.

--name=*name*
: (Optional) The name to be given to the new queue. If one is not given, a name based on the device node (such as "lp0") will be used.

--as-default
: (Optional) Set this as the default queue.

After adding the printer, use the following command to start/restart the printer daemon:

```
service cups restart
```

36.11.2. Removing a Local Printer

A printer queue can also be removed via the command line.

As root, to remove a printer queue:

```
redhat-config-printer-tui --Xremove-local options
```

Options:

--device=*node*
: (Required) The device node used such as `/dev/lp0`.

--make=*make*
: (Required) The IEEE 1284 MANUFACTURER string, or (if none is available) the printer manufacturer's name as in the foomatic database.

--model=*model*

(Required) The IEEE 1284 MODEL string, or (if none is available) the printer model as listed in the foomatic database.

After removing the printer from the **Printer Configuration Tool** configuration, restart the printer daemon for the changes to take effect:

```
service cups restart
```

If all printers have been removed, and you do not want to run the printer daemon anymore, execute the following command:

```
service cups stop
```

36.11.3. Setting the Default Printer

To set the default printer, use the following command, and specify the *queuename*:

```
redhat-config-printer-tui --Xdefault --queue=queuename
```

36.12. Managing Print Jobs

When you send a print job to the printer daemon, such as printing text file from **Emacs** or printing an image from **The GIMP**, the print job is added to the print spool queue. The print spool queue is a list of print jobs that have been sent to the printer and information about each print request, such as the status of the request, the username of the person who sent the request, the hostname of the system that sent the request, the job number, and more.

If you are running a graphical desktop environment, click the **Printer Manager** icon on the panel to start the **GNOME Print Manager** as shown in Figure 36-13.

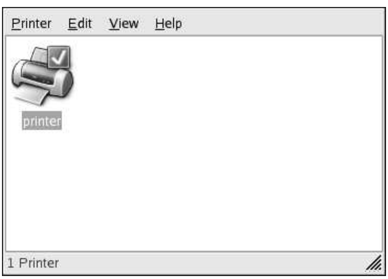


Figure 36-13. GNOME Print Manager

It can also be started by selecting **Main Menu Button** (on the Panel) => **System Tools** => **Print Manager**.

To change the printer settings, right-click on the icon for the printer and select **Properties**. The **Printer Configuration Tool** is then started.

Double-click on a configured printer to view the print spool queue as shown in Figure 36-14.

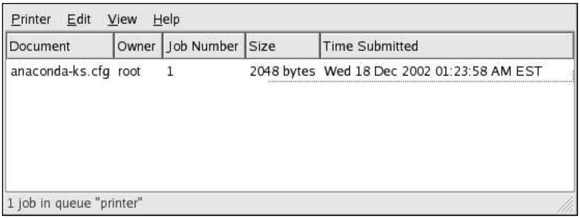


Figure 36-14. List of Print Jobs

To cancel a specific print job listed in the **GNOME Print Manager**, select it from the list and select **Edit => Cancel Documents** from the pulldown menu.

If there are active print jobs in the print spool, a printer notification icon might appears in the **Panel Notification Area** of the desktop panel as shown in Figure 36-15. Because it probes for active print jobs every five seconds, the icon might not be displayed for short print jobs.

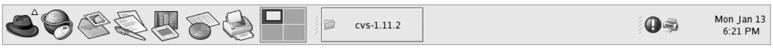


Figure 36-15. Printer Notification Icon

Clicking on the printer notification icon starts the **GNOME Print Manager** to display a list of current print jobs.

Also located on the Panel is a **Print Manager** icon. To print a file from **Nautilus**, browse to the location of the file and drag and drop it on to the **Print Manager** icon on the Panel. The window shown in Figure 36-16 is displayed. Click **OK** to start printing the file.

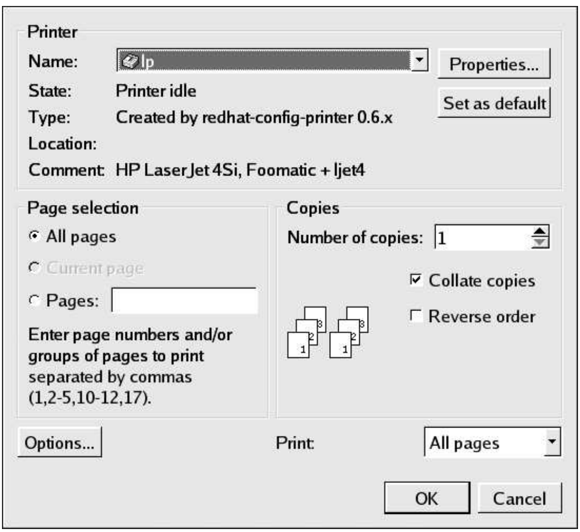


Figure 36-16. Print Verification Window

To view the list of print jobs in the print spool from a shell prompt, type the command `lpq`. The last few lines will look similar to the following:

```
Rank   Owner/ID              Class  Job Files        Size Time
active user@localhost+902     A     902 sample.txt   2050 01:20:46
```

Example 36-1. Example of `lpq` output

If you want to cancel a print job, find the job number of the request with the command `lpq` and then use the command `lprm` *`job number`*. For example, `lprm 902` would cancel the print job in Example 36-1. You must have proper permissions to cancel a print job. You can not cancel print jobs that were started by other users unless you are logged in as root on the machine to which the printer is attached.

You can also print a file directly from a shell prompt. For example, the command `lpr sample.txt` will print the text file `sample.txt`. The print filter determines what type of file it is and converts it into a format the printer can understand.

36.13. Sharing a Printer

The **Printer Configuration Tool**'s ability to share configuration options can only be used if you are using the CUPS printing system.

Allowing users on a different computer on the network to print to a printer configured for your system is called *sharing* the printer. By default, printers configured with the **Printer Configuration Tool** are not shared.

To share a configured printer, start the **Printer Configuration Tool** and select a printer from the list. Then select **Action** => **Sharing** from the pulldown menu.

Note

If a printer is not selected, **Action** => **Sharing** only shows the system-wide sharing options normally shown under the **General** tab.

On the **Queue** tab, select the option to make the queue available to other users.

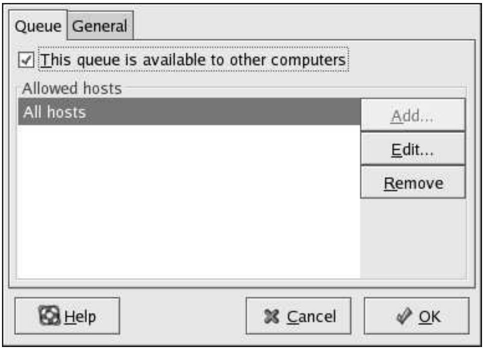


Figure 36-17. Queue Options

After selecting to share the queue, by default, *all* hosts are allowed to print to the shared printer. Allowing all systems on the network to print to the queue can be dangerous, especially if the system is directly connected to the Internet. It is recommended that this option be changed by selecting the **All hosts** entry and clicking the **Edit** button to display the window shown in Figure 36-18.

If you have a firewall configured on the print server, it must be able to send and receive connections on the incoming UDP port, 631. If you have a firewall configured on the client (the computer sending the print request), it must be allowed to send and accept connections on port 631.

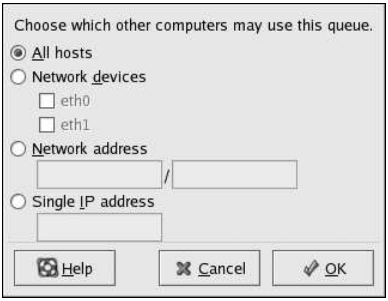


Figure 36-18. Allowed Hosts

The **General** tab configures settings for all printers, including those not viewable with the **Printer Configuration Tool**. There are two options:

- **Automatically find remote shared queues** — Selected by default, this option enables IPP browsing, which means that when other machines on the network broadcast the queues that they have, the queues are automatically added to the list of printers available to the system; no additional configuration is required for a printer found from IPP browsing. This option does not automatically share the printers configured on the local system.
- **Enable LPD protocol** — This option allows the printer to receive print jobs from clients configured to use the LPD protocol using the `cups-lpd` service, which is an `xinetd` service.

Warning

If this option is enabled, all print jobs are accepted from all hosts if they are received from an LPD client.

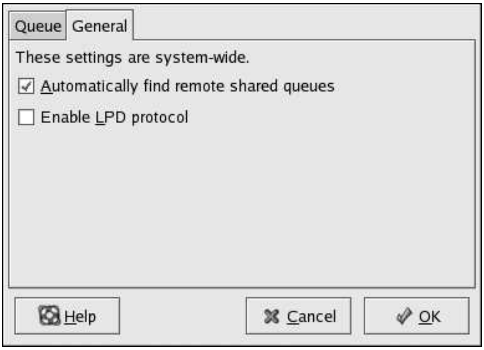


Figure 36-19. System-wide Sharing Options

36.14. Additional Resources

To learn more about printing on Red Hat Enterprise Linux, refer to the following resources.

36.14.1. Installed Documentation

- `map lpr` — The manual page for the `lpr` command that allows you to print files from the command line.
- `man lprm` — The manual page for the command line utility to remove print jobs from the print queue.
- `man mpage` — The manual page for the command line utility to print multiple pages on one sheet of paper.
- `man cupsd` — The manual page for the CUPS printer daemon.
- `man cupsd.conf` — The manual page for the CUPS printer daemon configuration file.
- `man classes.conf` — The manual page for the class configuration file for CUPS.

36.14.2. Useful Websites

- http://www.linuxprinting.org — *GNU/Linux Printing* contains a large amount of information about printing in Linux.
- http://www.cups.org/ — Documentation, FAQs, and newsgroups about CUPS.

Chapter 37.
Automated Tasks

In Linux, tasks can be configured to run automatically within a specified period of time, on a specified date, or when the system load average is below a specified number. Red Hat Enterprise Linux comes pre-configured to run important system tasks to keep the system updated. For example, the slocate database used by the `locate` command is updated daily. A system administrator can use automated tasks to perform periodic backups, monitor the system, run custom scripts, and more.

Red Hat Enterprise Linux comes with several automated tasks utilities: `cron`, `at`, and `batch`.

37.1. Cron

Cron is a daemon that can be used to schedule the execution of recurring tasks according to a combination of the time, day of the month, month, day of the week, and week.

Cron assumes that the system is on continuously. If the system is not on when a task is scheduled, it is not executed. To schedule one-time tasks, refer to Section 37.2 *At and Batch*.

To use the cron service, the `vixie-cron` RPM package must be installed, and the `crond` service must be running. To determine if the package is installed, use the `rpm -q vixie-cron` command. To determine if the service is running, use the command `/sbin/service crond status`.

37.1.1. Configuring Cron Tasks

The main configuration file for cron, `/etc/crontab`, contains the following lines:

```
SHELL=/bin/bash
PATH=/sbin:/bin:/usr/sbin:/usr/bin
MAILTO=root
HOME=/

# run-parts
01 * * * * root run-parts /etc/cron.hourly
02 4 * * * root run-parts /etc/cron.daily
22 4 * * 0 root run-parts /etc/cron.weekly
42 4 1 * * root run-parts /etc/cron.monthly
```

The first four lines are variables used to configure the environment in which the cron tasks are run. The value of the `SHELL` variable tells the system which shell environment to use (in this example the bash shell), and the `PATH` variable defines the path used to execute commands. The output of the cron tasks are emailed to the username defined with the `MAILTO` variable. If the `MAILTO` variable is defined as an empty string (`MAILTO=""`), email is not sent. The `HOME` variable can be used to set the home directory to use when executing commands or scripts.

Each line in the `/etc/crontab` file represents a task and has the format:

```
minute   hour   day   month   dayofweek   command
```

- `minute` — any integer from 0 to 59
- `hour` — any integer from 0 to 23
- `day` — any integer from 1 to 31 (must be a valid day if a month is specified)

- `month` — any integer from 1 to 12 (or the short name of the month such as jan or feb)
- `dayofweek` — any integer from 0 to 7, where 0 or 7 represents Sunday (or the short name of the week such as sun or mon)
- `command` — the command to execute (the command can either be a command such as `ls /proc >> /tmp/proc` or the command to execute a custom script)

For any of the above values, an asterisk (*) can be used to specify all valid values. For example, an asterisk for the month value means execute the command every month within the constraints of the other values.

A hyphen (-) between integers specifies a range of integers. For example, **`1-4`** means the integers 1, 2, 3, and 4.

A list of values separated by commas (,) specifies a list. For example, **`3, 4, 6, 8`** indicates those four specific integers.

The forward slash (/) can be used to specify step values. The value of an integer can be skipped within a range by following the range with **`/<integer>`**. For example, **`0-59/2`** can be used to define every other minute in the minute field. Step values can also be used with an asterisk. For instance, the value **`*/3`** can be used in the month field to run the task every third month.

Any lines that begin with a hash mark (#) are comments and are not processed.

As shown in the `/etc/crontab` file, it uses the `run-parts` script to execute the scripts in the `/etc/cron.hourly`, `/etc/cron.daily`, `/etc/cron.weekly`, and `/etc/cron.monthly` directories on an hourly, daily, weekly, or monthly basis respectively. The files in these directories should be shell scripts.

If a cron task needs to be executed on a schedule other than hourly, daily, weekly, or monthly, it can be added to the `/etc/cron.d` directory. All files in this directory use the same syntax as `/etc/crontab`. Refer to Example 37-1 for examples.

```
# record the memory usage of the system every monday
# at 3:30AM in the file /tmp/meminfo
30 3 * * mon cat /proc/meminfo >> /tmp/meminfo
# run custom script the first day of every month at 4:10AM
10 4 1 * * /root/scripts/backup.sh
```

Example 37-1. Crontab Examples

Users other than root can configure cron tasks by using the `crontab` utility. All user-defined crontabs are stored in the `/var/spool/cron` directory and are executed using the usernames of the users that created them. To create a crontab as a user, login as that user and type the command `crontab -e` to edit the user's crontab using the editor specified by the `VISUAL` or `EDITOR` environment variable. The file uses the same format as `/etc/crontab`. When the changes to the crontab are saved, the crontab is stored according to username and written to the file `/var/spool/cron/`*`username`*.

The cron daemon checks the `/etc/crontab` file, the `/etc/cron.d/` directory, and the `/var/spool/cron` directory every minute for any changes. If any changes are found, they are loaded into memory. Thus, the daemon does not need to be restarted if a crontab file is changed.

37.1.2. Controlling Access to Cron

The `/etc/cron.allow` and `/etc/cron.deny` files are used to restrict access to cron. The format of both access control files is one username on each line. Whitespace is not permitted in either file. The cron daemon (`crond`) does not have to be restarted if the access control files are modified. The access control files are read each time a user tries to add or delete a cron task.

The root user can always use cron, regardless of the usernames listed in the access control files.

If the file `cron.allow` exists, only users listed in it are allowed to use cron, and the `cron.deny` file is ignored.

If `cron.allow` does not exist, users listed in `cron.deny` are not allowed to use cron.

37.1.3. Starting and Stopping the Service

To start the cron service, use the command `/sbin/service crond start`. To stop the service, use the command `/sbin/service crond stop`. It is recommended that you start the service at boot time. Refer to Chapter 21 *Controlling Access to Services* for details on starting the cron service automatically at boot time.

37.2. At and Batch

While cron is used to schedule recurring tasks, the `at` command is used to schedule a one-time task at a specific time. The `batch` command is used to schedule a one-time task to be executed when the systems load average drops below 0.8.

To use `at` or `batch` the `at` RPM package must be installed, and the `atd` service must be running. To determine if the package is installed, use the `rpm -q at` command. To determine if the service is running, use the command `/sbin/service atd status`.

37.2.1. Configuring At Jobs

To schedule a one-time job at a specific time, type the command `at` *`time`*, where *`time`* is the time to execute the command.

The argument *`time`* can be one of the following:

- HH:MM format — For example, 04:00 specifies 4:00AM. If the time is already past, it is executed at the specified time the next day.
- midnight — Specifies 12:00AM.
- noon — Specifies 12:00PM.
- teatime — Specifies 4:00PM.
- month-name day year format — For example, January 15 2002 specifies the 15th day of January in the year 2002. The year is optional.
- MMDDYY, MM/DD/YY, or MM.DD.YY formats — For example, 011502 for the 15th day of January in the year 2002.
- now + time — time is in minutes, hours, days, or weeks. For example, now + 5 days specifies that the command should be executed at the same time five days from now.

The time must be specified first, followed by the optional date. For more information about the time format, read the `/usr/share/doc/at-<version>/timespec` text file.

After typing the `at` command with the time argument, the `at>` prompt is displayed. Type the command to execute, press [Enter], and type Ctrl-D. More than one command can be specified by typing each command followed by the [Enter] key. After typing all the commands, press [Enter] to go to a blank line and type Ctrl-D. Alternatively, a shell script can be entered at the prompt, pressing [Enter] after each line in the script, and typing Ctrl-D on a blank line to exit. If a script is entered, the shell used is the shell set in the user's SHELL environment, the user's login shell, or `/bin/sh` (whichever is found first).

If the set of commands or script tries to display information to standard out, the output is emailed to the user.

Use the command `atq` to view pending jobs. Refer to Section 37.2.3 *Viewing Pending Jobs* for more information.

Usage of the `at` command can be restricted. Refer to Section 37.2.5 *Controlling Access to At and Batch* for details.

37.2.2. Configuring Batch Jobs

To execute a one-time task when the load average is below 0.8, use the `batch` command.

After typing the `batch` command, the `at>` prompt is displayed. Type the command to execute, press [Enter], and type Ctrl-D. More than one command can be specified by typing each command followed by the [Enter] key. After typing all the commands, press [Enter] to go to a blank line and type Ctrl-D. Alternatively, a shell script can be entered at the prompt, pressing [Enter] after each line in the script, and typing Ctrl-D on a blank line to exit. If a script is entered, the shell used is the shell set in the user's SHELL environment, the user's login shell, or `/bin/sh` (whichever is found first). As soon as the load average is below 0.8, the set of commands or script is executed.

If the set of commands or script tries to display information to standard out, the output is emailed to the user.

Use the command `atq` to view pending jobs. Refer to Section 37.2.3 *Viewing Pending Jobs* for more information.

Usage of the `batch` command can be restricted. Refer to Section 37.2.5 *Controlling Access to At and Batch* for details.

37.2.3. Viewing Pending Jobs

To view pending `at` and `batch` jobs, use the `atq` command. It displays a list of pending jobs, with each job on a line. Each line follows the job number, date, hour, job class, and username format. Users can only view their own jobs. If the root user executes the `atq` command, all jobs for all users are displayed.

37.2.4. Additional Command Line Options

Additional command line options for `at` and `batch` include:

Option	Description
`-f`	Read the commands or shell script from a file instead of specifying them at the prompt.
`-m`	Send email to the user when the job has been completed.
`-v`	Display the time that the job will be executed.

Table 37-1. `at` and `batch` Command Line Options

37.2.5. Controlling Access to At and Batch

The `/etc/at.allow` and `/etc/at.deny` files can be used to restrict access to the `at` and `batch` commands. The format of both access control files is one username on each line. Whitespace is not permitted in either file. The `at` daemon (`atd`) does not have to be restarted if the access control files are modified. The access control files are read each time a user tries to execute the `at` or `batch` commands.

The root user can always execute `at` and `batch` commands, regardless of the access control files.

If the file `at.allow` exists, only users listed in it are allowed to use `at` or `batch`, and the `at.deny` file is ignored.

If `at.allow` does not exist, users listed in `at.deny` are not allowed to use `at` or `batch`.

37.2.6. Starting and Stopping the Service

To start the `at` service, use the command `/sbin/service atd start`. To stop the service, use the command `/sbin/service atd stop`. It is recommended that you start the service at boot time. Refer to Chapter 21 *Controlling Access to Services* for details on starting the cron service automatically at boot time.

37.3. Additional Resources

To learn more about configuring automated tasks, refer to the following resources.

37.3.1. Installed Documentation

- `cron` man page — overview of cron.
- `crontab` man pages in sections 1 and 5 — The man page in section 1 contains an overview of the `crontab` file. The man page in section 5 contains the format for the file and some example entries.
- `/usr/share/doc/at-`<*version*>`/timespec` contains more detailed information about the times that can be specified for cron jobs.
- `at` man page — description of `at` and `batch` and their command line options.

Chapter 38. Log Files

Log files are files that contain messages about the system, including the kernel, services, and applications running on it. There are different log files for different information. For example, there is a default system log file, a log file just for security messages, and a log file for cron tasks.

Log files can be very useful when trying to troubleshoot a problem with the system such as trying to load a kernel driver or when looking for unauthorized log in attempts to the system. This chapter discusses where to find log files, how to view log files, and what to look for in log files.

Some log files are controlled by a daemon called `syslogd`. A list of log messages maintained by `syslogd` can be found in the `/etc/syslog.conf` configuration file.

38.1. Locating Log Files

Most log files are located in the `/var/log/` directory. Some applications such as `httpd` and `samba` have a directory within `/var/log/` for their log files.

Notice the multiple files in the log file directory with numbers after them. These are created when the log files are rotated. Log files are rotated so their file sizes do not become too large. The `logrotate` package contains a cron task that automatically rotates log files according to the `/etc/logrotate.conf` configuration file and the configuration files in the `/etc/logrotate.d/` directory. By default, it is configured to rotate every week and keep four weeks worth of previous log files.

38.2. Viewing Log Files

Most log files are in plain text format. You can view them with any text editor such as `Vi` or **Emacs**. Some log files are readable by all users on the system; however, root privileges are required to read most log files.

To view system log files in an interactive, real-time application, use the **Log Viewer**. To start the application, go to the **Main Menu Button** (on the Panel) => **System Tools** => **System Logs**, or type the command `redhat-logviewer` at a shell prompt.

The application only displays log files that exist; thus, the list might differ from the one shown in Figure 38-1.

To filter the contents of the log file for keywords, type the keyword or keywords in the **Filter for** text field, and click **Filter**. Click **Reset** to reset the contents.

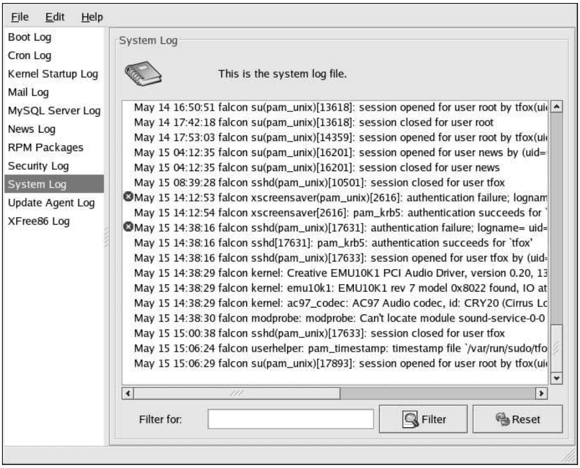


Figure 38-1. Log Viewer

By default, the currently viewable log file is refreshed every 30 seconds. To change the refresh rate, select **Edit** => **Preferences** from the pulldown menu. The window shown in Figure 38-2 will appear. In the **Log Files** tab, click the up and down arrows beside the refresh rate to change it. Click **Close** to return to the main window. The refresh rate is changed immediately. To refresh the currently viewable file manually, select **File** => **Refresh Now** or press [Ctrl]-[R].

On the **Log Files** tab in the Preferences, the log file locations can be modified. Select the log file from the list, and click the **Edit** button. Type the new location of the log file or click the **Browse** button to locate the file location using a file selection dialog. Click **OK** to return to the preferences, and click **Close** to return to the main window.

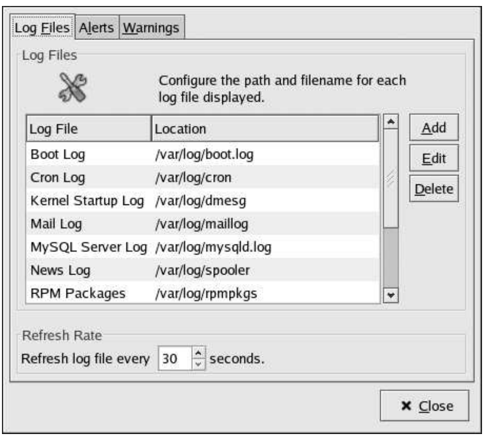


Figure 38-2. Log File Locations

38.3. Adding a Log File

To add a log file to the list, select **Edit** => **Preferences**, and click the **Add** button in the **Log Files** tab.

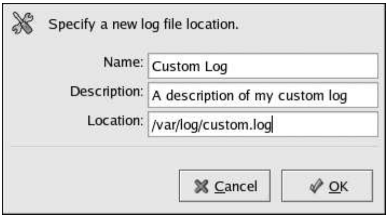


Figure 38-3. Adding a Log File

Provide a name, description, and the location of the log file to add. After clicking **OK**, the file is immediately added to the viewing area if the file exists.

38.4. Examining Log Files

Log Viewer can be configured to display an alert icon beside lines that contain key alert words and a warning icon beside lines that contain key warning words.

To add alerts words, select **Edit** => **Preferences** from the pulldown menu, and click on the **Alerts** tab. Click the **Add** button to add an alert word. To delete an alert word, select the word from the list, and click **Delete**.

The alert icon  is displayed to the left of the lines that contains any of the alert words.

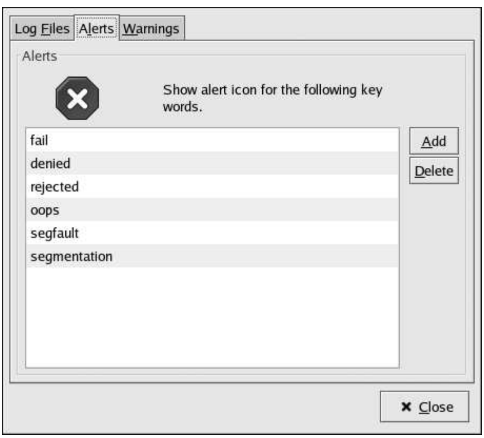


Figure 38-4. Alerts

To add warning words, select **Edit** => **Preferences** from the pull-down menu, and click on the **Warnings** tab. Click the **Add** button to add a warning word. To delete a warning word, select the word from the list, and click **Delete**.

The warning icon  is displayed to the left of the lines that contains any of the warning words.

Figure 38-5. Warning

Chapter 39. Upgrading the Kernel

The Red Hat Enterprise Linux kernel is custom built by the Red Hat kernel team to ensure its integrity and compatibility with supported hardware. Before Red Hat releases a kernel, it must first pass a rigorous set of quality assurance tests.

Red Hat Enterprise Linux kernels are packaged in RPM format so that they are easy to upgrade and verify. For example, when the `kernel` RPM package distributed by Red Hat, Inc. is installed, an `initrd` image is created; thus, it is not necessary to use the `mkinitrd` command after installing a different kernel. It also modifies the boot loader configuration file to include the new kernel.

Warning

> Building a custom kernel is not supported by the Red Hat Installation Support Team. For more information on building a custom kernel from the source code, refer to Appendix A *Building a Custom Kernel*.

39.1. Overview of Kernel Packages

Red Hat Enterprise Linux contains the following kernel packages (some may not apply to your architecture):

- `kernel` — contains the kernel and the following key features:
  - Uniprocessor support for x86 and Athlon systems (can be run on a multi-processor system, but only one processor is utilized)
  - Multi-processor support for all other architectures
  - For x86 systems, only the first 4 GB of RAM is used; use the `kernel-hugemem` package for x86 system with over 4 GB of RAM
- `kernel-hugemem` — (only for i686 systems) In addition to the options enabled for the `kernel` package. The key configuration options are as follows:
  - Support for more than 4 GB of RAM (up to 16 GB for x86)
  - PAE (Physical Address Extension), or 3 level paging on x86 processors that support PAE
  - Support for multiple processors
  - 4GB/4GB split — 4GB of virtual address space for kernel and almost 4GB for each user process on x86 systems
- `kernel-BOOT` — used during installation only.
- `kernel-pcmcia-cs` — contains support for PCMCIA cards.
- `kernel-smp` — contains the kernel for multi-processor systems. The following are the key features:
  - Multi-processor support
  - Support for more than 4 GB of RAM (up to 64 GB for x86)

  - PAE (Physical Address Extension), or 3 level paging on x86 processors that support PAE

- `kernel-source` — Contains the source code files for the Linux kernel
- `kernel-utils` — Contains utilities that can be used to control the kernel or system hardware.
- `kernel-unsupported` — exists for some architectures

  Because it is not possible for Red Hat Enterprise Linux to contain support for every piece of hardware available, this package contains modules that are not supported by Red Hat, Inc. during installation or after installation. The package is not installed during the installation process; it must be installed after installation. Drivers in the unsupported package are provided on a best-effort basis — updates and fixes may or may not be incorporated over time.

39.2. Preparing to Upgrade

Before upgrading the kernel, take a few precautionary steps. If the system has a diskette drive, the first step is to make sure a working boot diskette exists for the system in case a problem occurs. If the boot loader is not configured properly to boot the new kernel, the system cannot be booted into Red Hat Enterprise Linux without a working boot diskette.

To create the boot diskette, login as root, and type the following command at a shell prompt:

```
/sbin/mkbootdisk 'uname -r'
```

Tip

Refer to the man page for `mkbootdisk` for more options.

Reboot the machine with the boot diskette and verify that it works before continuing.

Hopefully, the diskette will not be needed, but store it in a safe place just in case.

To determine which kernel packages are installed, execute the following command at a shell prompt:

```
rpm -qa | grep kernel
```

The output contains some or all of the following packages, depending on the system's architecture (the version numbers and packages may differ):

```
kernel-2.4.21-1.1931.2.399.ent
kernel-source-2.4.21-1.1931.2.399.ent
kernel-utils-2.4.21-1.1931.2.399.ent
kernel-pcmcia-cs-3.1.31-13
kernel-smp-2.4.21-1.1931.2.399.ent
```

From the output, determine which packages need to be download for the kernel upgrade. For a single processor system, the only required package is the `kernel` package. Refer to Section 39.1 *Overview of Kernel Packages* for descriptions of the different packages.

In the filename, each kernel package contains the architecture for which the package was built. The format is kernel-<*variant*>-<*version*>.<*arch*>.rpm, where <*variant*> is `smp`, `utils`, etc. The <*arch*> is one of the following:

1. `x86_64` for AMD64 and Intel® Extended Memory 64 Technology (Intel® EM64T).

2. `ia64` for the Intel® Itanium™ architecture.
3. `ppc64pseries` for the IBM® eServer™ pSeries™ architecture.
4. `ppc64iseries` for the IBM® eServer™ iSeries™ architecture.
5. `s390` for the IBM® S/390® architecture.
6. `s390x` for the IBM® eServer™ zSeries® architecture.
7. x86 variant: The x86 kernels are optimized for different x86 versions. The options are as follows:
   - `athlon` for AMD Athlon® and AMD Duron® systems
   - `i686` for Intel® Pentium® II, Intel® Pentium® III, and Intel® Pentium® 4 systems

39.3. Downloading the Upgraded Kernel

There are several ways to determine if there is an updated kernel available for the system.

- Security Errata; go to the following location for information on security errata, including kernel upgrades that fix security issues:
  `http://www.redhat.com/apps/support/errata/`
- Via Quarterly Updates; refer to the following location for details:
  `http://www.redhat.com/apps/support/errata/rhlas_errata_policy.html`
- Use Red Hat Network to download the kernel RPM packages and install the packages. Red Hat Network can download the latest kernel, upgrade the kernel on the system, create an initial RAM disk image if needed, and configure the boot loader to boot the new kernel. For more information, refer to http://www.redhat.com/docs/manuals/RHNetwork/.

If Red Hat Network was used to download and install the updated kernel, following the instructions in Section 39.5 *Verifying the Initial RAM Disk Image* and Section 39.6 *Verifying the Boot Loader*, except do not change the kernel to boot by default because Red Hat Network automatically changes the default kernel to the latest version. To install the kernel manually, continue to Section 39.4 *Performing the Upgrade*.

39.4. Performing the Upgrade

After retrieving all the necessary packages, it is time to upgrade the existing kernel. At a shell prompt as root, change to the directory that contains the kernel RPM packages and follow these steps.

Important

It is strongly recommended that the old kernel is kept in case there are problems with the new kernel.

Use the `-i` argument with the `rpm` command to keep the old kernel. If the `-U` option is used to upgrade the `kernel` package, it will overwrite the currently installed kernel. (the kernel version may vary):

```
rpm -ivh kernel-2.4.21-1.1931.2.399.ent.<arch>.rpm
```

If the system is a multi-processor system, install the `kernel-smp` packages as well (the kernel version may vary):

```
rpm -ivh kernel-smp-2.4.21-1.1931.2.399.ent.<arch>.rpm
```

If the system is `i686`-based and contains more than 4 gigabytes of RAM, install the `kernel-hugemem` package built for the `i686` architecture as well (the kernel version might vary):

```
rpm -ivh kernel-hugemem-2.4.21-1.1931.2.399.ent.i686.rpm
```

If the `kernel-source` or `kernel-utils` packages are to be upgraded, the older versions are probably not needed. Use the following commands to upgrade these packages (the versions might vary):

```
rpm -Uvh kernel-source-2.4.21-1.1931.2.399.ent.<arch>.rpm
rpm -Uvh kernel-utils-2.4.21-1.1931.2.399.ent.<arch>.rpm
```

The next step is to verify that the initial RAM disk image has been created. Refer to Section 39.5 *Verifying the Initial RAM Disk Image* for details.

39.5. Verifying the Initial RAM Disk Image

If the system uses the ext3 file system, a SCSI controller, or uses labels to reference partitions in `/etc/fstab`, an initial RAM disk is needed. The initial RAM disk allows a modular kernel to have access to modules that it might need to boot from before the kernel has access to the device where the modules normally reside.

On the Red Hat Enterprise Linux architectures other than IBM eServer iSeries, the initial RAM disk can be created with the `mkinitrd` command. However, this step is performed automatically if the kernel and its associated packages are installed or upgraded from the RPM packages distributed by Red Hat, Inc.; thus, it does not need to be executed manually. To verify that it was created, use the command `ls -l /boot` to make sure the `initrd-<version>.img` file was created (the version should match the version of the kernel just installed).

On iSeries systems, the initial RAM disk file and vmlinux file are combined into one file, which is created with the `addRamDisk` command. This step is performed automatically if the kernel and its associated packages are installed or upgraded from the RPM packages distributed by Red Hat, Inc.; thus, it does not need to be executed manually. To verify that it was created, use the command `ls -l /boot` to make sure the `/boot/vmlinitrd-<kernel-version>` file was created (the version should match the version of the kernel just installed).

The next step is to verify that the boot loader has been configured to boot the new kernel. Refer to Section 39.6 *Verifying the Boot Loader* for details.

39.6. Verifying the Boot Loader

The `kernel` RPM package configures the boot loader to boot the newly installed kernel (except for IBM eServer iSeries systems). However, it does not configure the boot loader to boot the new kernel by default.

It is always a good idea to confirm that the boot loader has been configured correctly. This is a crucial step. If the boot loader is configured incorrectly, the system will not boot into Red Hat Enterprise Linux properly. If this happens, boot the system with the boot diskette created earlier and try configuring the boot loader again.

39.6.1. x86 Systems

x86 systems have the option of using GRUB or LILO as the boot loader with one exception — AMD64 and Intel® EM64T systems do not have the option of using LILO. For all x86 systems, GRUB is the default.

39.6.1.1. GRUB

If GRUB is used as the boot loader, confirm that the file `/boot/grub/grub.conf` contains a `title` section with the same version as the `kernel` package just installed (if the `kernel-smp` or `kernel-hugemem` package was installed as well, a section will exist for it as well):

```
# Note that you do not have to rerun grub after making changes to this file
# NOTICE:  You have a /boot partition.  This means that
#          all kernel and initrd paths are relative to /boot/, eg.
#          root (hd0,0)
#          kernel /vmlinuz-version ro root=/dev/hda2
#          initrd /initrd-version.img
#boot=/dev/hda
default=1
timeout=10
splashimage=(hd0,0)/grub/splash.xpm.gz
title Red Hat Enterprise Linux (2.4.21-1.1931.2.399.ent)
        root (hd0,0)
        kernel /vmlinuz-2.4.21-1.1931.2.399.ent ro root=LABEL=/
        initrd /initrd-2.4.21-1.1931.2.399.ent.img
title Red Hat Enterprise Linux (2.4.20-2.30.ent)
        root (hd0,0)
        kernel /vmlinuz-2.4.20-2.30.ent ro root=LABEL=/
        initrd /initrd-2.4.20-2.30.ent.img
```

If a separate `/boot/` partition was created, the paths to the kernel and initrd image are relative to `/boot/`.

Notice that the default is not set to the new kernel. To configure GRUB to boot the new kernel by default, change the value of the `default` variable to the title section number for the title section that contains the new kernel. The count starts with 0. For example, if the new kernel is the first title section, set `default` to **0**.

Begin testing the new kernel by rebooting the computer and watching the messages to ensure that the hardware is detected properly.

39.6.1.2. LILO

If LILO is used as the boot loader, confirm that the file `/etc/lilo.conf` contains an `image` section with the same version as the `kernel` package just installed (if the `kernel-smp` or `kernel-hugemem` package was installed, a section will exist for it as well):

Notice that the default is not set to the new kernel. To configure LILO to boot the new kernel by default, set the `default` variable to the value of the `label` in the `image` section for the new kernel. Run the `/sbin/lilo` command as root to enable the changes. After running it, the output will be similar to the following:

```
Added 2.4.21-1.1931.2.399.ent *
Added linux
```

The `*` after `2.4.21-1.1931.2.399.ent` means the kernel in that section is the default kernel that LILO will boot.

Begin testing the new kernel by rebooting the computer and watching the messages to ensure the hardware is detected properly.

39.6.2. Itanium Systems

Itanium systems use ELILO as the boot loader, which uses `/boot/efi/EFI/redhat/elilo.conf` as the configuration file. Confirm that this file contains an `image` section with the same version as the `kernel` package just installed:

```
prompt
timeout=50
default=old

image=vmlinuz-2.4.21-1.1931.2.399.ent
        label=linux
        initrd=initrd-2.4.21-1.1931.2.399.ent.img
        read-only
        append="root=LABEL=/"
image=vmlinuz-2.4.20-2.30.ent
        label=old
        initrd=initrd-2.4.20-2.30.ent.img
        read-only
        append="root=LABEL=/"
```

Notice that the default is not set to the new kernel. To configure ELILO to boot the new kernel, change the value of the `default` variable to the value of the `label` for the `image` section that contains the new kernel.

Begin testing the new kernel by rebooting the computer and watching the messages to ensure that the hardware is detected properly.

39.6.3. IBM S/390 and IBM eServer zSeries Systems

The IBM S/390 and IBM eServer zSeries systems use z/IPL as the boot loader, which uses `/etc/zipl.conf` as the configuration file. Confirm that the file contains a section with the same version as the kernel package just installed:

```
[defaultboot]
default=old
target=/boot/
[linux]
        image=/boot/vmlinuz-2.4.21-1.1931.2.399.ent
        ramdisk=/boot/initrd-2.4.21-1.1931.2.399.ent.img
        parameters="root=LABEL=/"
[old]
        image=/boot/vmlinuz-2.4.20-2.30.ent
        ramdisk=/boot/initrd-2.4.20-2.30.ent.img
        parameters="root=LABEL=/"
```

Notice that the default is not set to the new kernel. To configure z/IPL to boot the new kernel by default change the value of the `default` variable to the name of the section that contains the new kernel. The first line of each section contains the name in brackets.

After modifying the configuration file, run the following command as root to enable the changes:

```
/sbin/zipl
```

Begin testing the new kernel by rebooting the computer and watching the messages to ensure that the hardware is detected properly.

39.6.4. IBM eServer iSeries Systems

The `/boot/vmlinitrd-<kernel-version>` file is installed when you upgrade the kernel. However, you must use the `dd` command to configure the system to boot the new kernel:

1. As root, issue the command `cat /proc/iSeries/mf/side` to determine the default side (either A, B, or C).
2. As root, issue the following command, where `<kernel-version>` is the version of the new kernel and `<side>` is the side from the previous command:
   `dd if=/boot/vmlinitrd-<kernel-version> of=/proc/iSeries/mf/<side>/vmlinux bs=8k`

Begin testing the new kernel by rebooting the computer and watching the messages to ensure that the hardware is detected properly.

39.6.5. IBM eServer pSeries Systems

IBM eServer pSeries systems use YABOOT as the boot loader, which uses `/etc/aboot.conf` as the configuration file. Confirm that the file contains an `image` section with the same version as the `kernel` package just installed:

```
boot=/dev/sda1
init-message=Welcome to Red Hat Enterprise Linux!
Hit <TAB> for boot options

partition=2
timeout=30
install=/usr/lib/yaboot/yaboot
delay=10
nonvram

image=/vmlinux--2.4.20-2.30.ent
        label=old
        read-only
        initrd=/initrd--2.4.20-2.30.ent.img
        append="root=LABEL=/"

image=/vmlinux-2.4.21-1.1931.2.399.ent
        label=linux
        read-only
        initrd=/initrd-2.4.21-1.1931.2.399.ent.img
        append="root=LABEL=/"
```

Notice that the default is not set to the new kernel. The kernel in the first image is booted by default. To change the default kernel to boot either move its image stanza so that it is the first one listed or add the directive `default` and set it to the `label` of the image stanza that contains the new kernel.

Begin testing the new kernel by rebooting the computer and watching the messages to ensure that the hardware is detected properly.

Chapter 40. Kernel Modules

The Linux kernel has a modular design. At boot time, only a minimal resident kernel is loaded into memory. Thereafter, whenever a user requests a feature that is not present in the resident kernel, a *kernel module*, sometimes referred to as a *driver*, is dynamically loaded into memory.

During installation, the hardware on the system is probed. Based on this probing and the information provided by the user, the installation program decides which modules need to be loaded at boot time. The installation program sets up the dynamic loading mechanism to work transparently.

If new hardware is added after installation and the hardware requires a kernel module, the system must be configured to load the proper kernel module for the new hardware. When the system is booted with the new hardware, the **Kudzu** program runs, detects the new hardware if it is supported, and configures the module for it. The module can also be specified manually by editing the module configuration file, `/etc/modules.conf`.

Note

Video card modules used to display the X Window System interface are part of the `XFree86` package, not the kernel; thus, this chapter does not apply to them.

For example, if a system included an SMC EtherPower 10 PCI network adapter, the module configuration file contains the following line:

```
alias eth0 tulip
```

If a second network card is added to the system and is identical to the first card, add the following line to `/etc/modules.conf`:

```
alias eth1 tulip
```

See the *Red Hat Enterprise Linux Reference Guide* for an alphabetical list of kernel modules and the hardware supported by the modules.

40.1. Kernel Module Utilities

A group of commands for managing kernel modules is available if the `modutils` package is installed. Use these commands to determine if a module has been loaded successfully or when trying different modules for a piece of new hardware.

The command `/sbin/lsmod` displays a list of currently loaded modules. For example:

```
Module                  Size  Used by    Not tainted
iptable_filter          2412   0 (autoclean) (unused)
ip_tables              15864   1 [iptable_filter]
nfs                    84632   1 (autoclean)
lockd                  59536   1 (autoclean) [nfs]
sunrpc                 87452   1 (autoclean) [nfs lockd]
soundcore               7044   0 (autoclean)
ide-cd                 35836   0 (autoclean)
cdrom                  34144   0 (autoclean) [ide-cd]
parport_pc             19204   1 (autoclean)
```

```
lp                      9188   0 (autoclean)
parport                39072   1 (autoclean) [parport_pc lp]
autofs                 13692   0 (autoclean) (unused)
e100                   62148   1
microcode               5184   0 (autoclean)
keybdev                 2976   0 (unused)
mousedev                5656   1
hid                    22308   0 (unused)
input                   6208   0 [keybdev mousedev hid]
usb-uhci               27468   0 (unused)
usbcore                82752   1 [hid usb-uhci]
ext3                   91464   2
jbd                    56336   2 [ext3]
```

For each line, the first column is the name of the module, the second column is the size of the module, and the third column is the use count.

The information after the use count varies slightly per module. If `(unused)` is listed on the line for the module, the module is currently not being used. If `(autoclean)` is on the line for the module, the module can be autocleaned by the `rmmod -a` command. When this command is executed, any modules that are tagged with autoclean, that have not been used since the previous autoclean action, are unloaded. Red Hat Enterprise Linux does not perform this autoclean action by default.

If a module name is listed at the end of the line in brackets, the module in the brackets is dependent on the module listed in the first column of the line. For example, in the line

```
usbcore                82752   1 [hid usb-uhci]
```

the `hid` and `usb-uhci` kernel modules depend on the usbcore module.

The `/sbin/lsmod` output is the same as the output from viewing `/proc/modules`.

To load a kernel module, use the `/sbin/modprobe` command followed by the kernel module name. By default, `modprobe` attempts to load the module from the `/lib/modules/<kernel-version>/kernel/drivers/` subdirectories. There is a subdirectory for each type of module, such as the `net/` subdirectory for network interface drivers. Some kernel modules have module dependencies, meaning that other modules must be loaded first for it to load. The `/sbin/modprobe` command checks for these dependencies and loads the module dependencies before loading the specified module.

For example, the command

```
/sbin/modprobe hid
```

loads any module dependencies and then the `hid` module.

To print to the screen all commands as `/sbin/modprobe` executes them, use the `-v` option. For example:

```
/sbin/modprobe -v hid
```

Output similar to the following is displayed:

```
/sbin/insmod /lib/modules/2.4.21-1.1931.2.399.ent/kernel/drivers/usb/hid.o
Using /lib/modules/2.4.21-1.1931.2.399.ent/kernel/drivers/usb/hid.o
Symbol version prefix 'smp_'
```

The `/sbin/insmod` command also exists to load kernel modules; however, it does not resolve dependencies. Thus, it is recommended that the `/sbin/modprobe` command be used.

To unload kernel modules, use the `/sbin/rmmod` command followed by the module name. The `rmmod` utility only unloads modules that are not in use and that are not a dependency of other modules in use.

For example, the command

```
/sbin/rmmod hid
```

unloads the `hid` kernel module.

Another useful kernel module utility is `modinfo`. Use the command `/sbin/modinfo` to display information about a kernel module. The general syntax is:

```
/sbin/modinfo [options] <module>
```

Options include `-d` which displays a brief description of the module and `-p` which lists the parameters the module supports. For a complete list of options, refer to the `modinfo` man page (`man modinfo`).

40.2. Additional Resources

For more information on kernel modules and their utilities, refer to the following resources.

40.2.1. Installed Documentation

- `lsmod` man page — description and explanation of its output.
- `insmod` man page — description and list of command line options.
- `modprobe` man page — description and list of command line options.
- `rmmod` man page — description and list of command line options.
- `modinfo` man page — description and list of command line options.
- `/usr/src/linux-2.4/Documentation/modules.txt` — how to compile and use kernel modules. This file is part of the `kernel-source` package.

40.2.2. Useful Websites

- http://www.redhat.com/mirrors/LDP/HOWTO/Module-HOWTO/index.html — *Linux Loadable Kernel Module HOWTO* from the Linux Documentation Project.

Chapter 41. Mail Transport Agent (MTA) Configuration

A *Mail Transport Agent* (MTA) is essential for sending email. A *Mail User Agent* (MUA) such as **Evolution**, **Mozilla Mail**, and **Mutt**, is used to read and compose email. When a user sends an email from an MUA, the messages are handed off to the MTA, which sends the message to a series of MTAs until it reaches its destination.

Even if a user does not plan to send email from the system, some automated tasks or system programs might use the `/bin/mail` command to send email containing log messages to the root user of the local system.

Red Hat Enterprise Linux 3 provides two MTAs: Sendmail and Postfix. If both are installed, `sendmail` is the default MTA. The **Mail Transport Agent Switcher** allows for the selection of either `sendmail` or `postfix` as the default MTA for the system.

The `redhat-switch-mail` RPM package must be installed to use the text-based version of the **Mail Transport Agent Switcher** program. If you want to use the graphical version, the `redhat-switch-mail-gnome` package must also be installed. For more information on installing RPM packages, refer to Part III *Package Management*.

To start the **Mail Transport Agent Switcher**, select **Main Menu Button** (on the Panel) => **System Tools** => **More System Tools** => **Mail Transport Agent Switcher**, or type the command `redhat-switch-mail` at a shell prompt (for example, in an XTerm or GNOME terminal).

The program automatically detect if the X Window System is running. If it is running, the program starts in graphical mode as shown in Figure 41-1. If X is not detected, it starts in text-mode. To force **Mail Transport Agent Switcher** to run in text-mode, use the command `redhat-switch-mail-nox`.

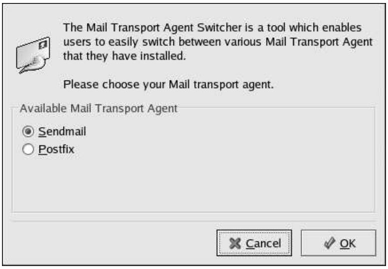


Figure 41-1. Mail Transport Agent Switcher

If you select **OK** to change the MTA, the selected mail daemon is enabled to start at boot time, and the unselected mail daemon is disabled so that is does not start at boot time. The selected mail daemon is started, and the other mail daemon is stopped; thus making the changes take place immediately.

For more information about email protocols and MTAs, refer to the *Red Hat Enterprise Linux Reference Guide*.

VI. System Monitoring

System administrators also monitor system performance. Red Hat Enterprise Linux contains tools to assist administrators with these tasks.

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Chapter 42.

Gathering System Information

Before you learn how to configure your system, you should learn how to gather essential system information. For example, you should know how to find the amount of free memory, the amount of available hard drive space, how your hard drive is partitioned, and what processes are running. This chapter discusses how to retrieve this type of information from your Red Hat Enterprise Linux system using simple commands and a few simple programs.

42.1. System Processes

The `ps ax` command displays a list of current system processes, including processes owned by other users. To display the owner of the processes along with the processes use the command `ps aux`. This list is a static list; in other words, it is a snapshot of what is running when you invoked the command. If you want a constantly updated list of running processes, use `top` as described below.

The `ps` output can be long. To prevent it from scrolling off the screen, you can pipe it through less:

```
ps aux | less
```

You can use the `ps` command in combination with the `grep` command to see if a process is running. For example, to determine if **Emacs** is running, use the following command:

```
ps ax | grep emacs
```

The `top` command displays currently running processes and important information about them including their memory and CPU usage. The list is both real-time and interactive. An example of `top`'s output is provided as follows:

```
 19:11:04  up  7:25,  9 users,  load average: 0.00, 0.05, 0.12
89 processes: 88 sleeping, 1 running, 0 zombie, 0 stopped
CPU states:  cpu    user    nice  system    irq  softirq  iowait    idle
           total    6.6%    0.0%    0.0%   0.0%     0.0%    0.0%  192.8%
           cpu00    6.7%    0.0%    0.1%   0.1%     0.0%    0.0%   92.8%
           cpu01    0.0%    0.0%    0.0%   0.0%     0.0%    0.0%  100.0%
Mem:  1028556k av,  241972k used,  786584k free,       0k shrd,   37712k buff
       162316k active,             18076k inactive
Swap: 1020116k av,       0k used, 1020116k free                   99340k cached

  PID USER     PRI  NI  SIZE  RSS SHARE STAT %CPU %MEM   TIME CPU COMMAND
 1899 root      15   0 17728  12M  4172 S     6.5  1.2 111:20   0 X
 6380 root      15   0  1144 1144   884 R     0.3  0.1   0:00   0 top
    1 root      15   0   488  488   432 S     0.0  0.0   0:05   1 init
    2 root      RT   0     0    0     0 SW    0.0  0.0   0:00   0 migration/0
    3 root      RT   0     0    0     0 SW    0.0  0.0   0:00   1 migration/1
    4 root      15   0     0    0     0 SW    0.0  0.0   0:00   0 keventd
    5 root      34  19     0    0     0 SWN   0.0  0.0   0:00   0 ksoftirqd/0
    6 root      34  19     0    0     0 SWN   0.0  0.0   0:00   1 ksoftirqd/1
    9 root      25   0     0    0     0 SW    0.0  0.0   0:00   0 bdflush
    7 root      15   0     0    0     0 SW    0.0  0.0   0:00   1 kswapd
    8 root      15   0     0    0     0 SW    0.0  0.0   0:00   1 kscand
   10 root      15   0     0    0     0 SW    0.0  0.0   0:01   1 kupdated
   11 root      25   0     0    0     0 SW    0.0  0.0   0:00   0 mdrecoveryd
```

To exit `top`, press the [q] key.

Useful interactive commands that you can use with `top` include the following:

Command	Description
[Space]	Immediately refresh the display
[h]	Display a help screen
[k]	Kill a process. You will be prompted for the process ID and the signal to send to it.
[n]	Change the number of processes displayed. You will be prompted to enter the number.
[u]	Sort by user.
[M]	Sort by memory usage.
[P]	Sort by CPU usage.

Table 42-1. Interactive `top` commands

Tip

Application such as **Mozilla** and **Nautilus** are *thread-aware* — multiple threads are created to handle multiple users or multiple requests, and each thread is given a process ID. By default, `ps` and `top` only display the main (initial) thread. To view all threads, use the command `ps -m` or type [Shift]-[H] in `top`.

If you prefer a graphical interface for `top`, you can use the **GNOME System Monitor**. To start it from the desktop, select **Main Menu Button** (on the Panel) => **System Tools** => **System Monitor** or type `gnome-system-monitor` at a shell prompt from within the X Window System. Then select the **Process Listing** tab.

The **GNOME System Monitor** allows you to search for process in the list of running process as well as view all processes, your processes, or active processes.

To learn more about a process, select it and click the **More Info** button. Details about the process will be displayed at the bottom of the window.

To stop a process, select it and click **End Process**. This function is useful for processes that have stopped responding to user input.

To sort by the information in a specific column, click on the name of the column. The column that the information is sorted by appears in a darker gray color.

By default, the **GNOME System Monitor** does not display threads. To change this preferences, select **Edit** => **Preferences**, click the **Process Listing** tab, and select **Show Threads**. The preferences also allows you to configure the update interval, what type of information to display about each process by default, and the colors of the system monitor graphs.

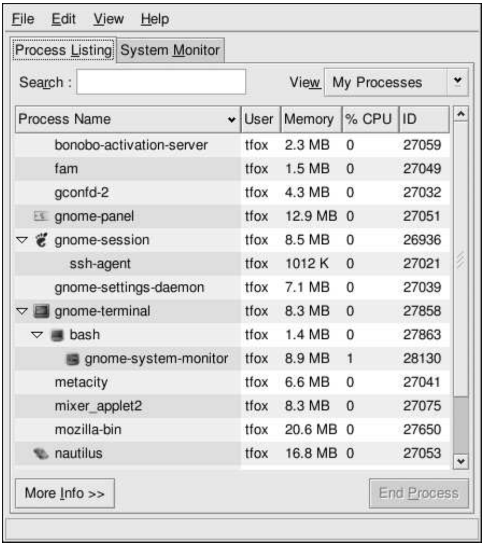

Figure 42-1. GNOME System Monitor

42.2. Memory Usage

The `free` command displays the total amount of physical memory and swap space for the system as well as the amount of memory that is used, free, shared, in kernel buffers, and cached.

```
             total       used       free     shared    buffers     cached
Mem:        256812     240668      16144     105176      50520      81848
-/+ buffers/cache:     108300     148512
Swap:       265032        780     264252
```

The command `free -m` shows the same information in megabytes, which are easier to read.

```
             total       used       free     shared    buffers     cached
Mem:           250        235         15        102         49         79
-/+ buffers/cache:        105        145
Swap:          258          0        258
```

If prefer a graphical interface for `free`, you can use the **GNOME System Monitor**. To start it from the desktop, go to the **Main Menu Button** (on the Panel) => **System Tools** => **System Monitor** or type `gnome-system-monitor` at a shell prompt from within X Window System. Then choose the **System Monitor** tab.

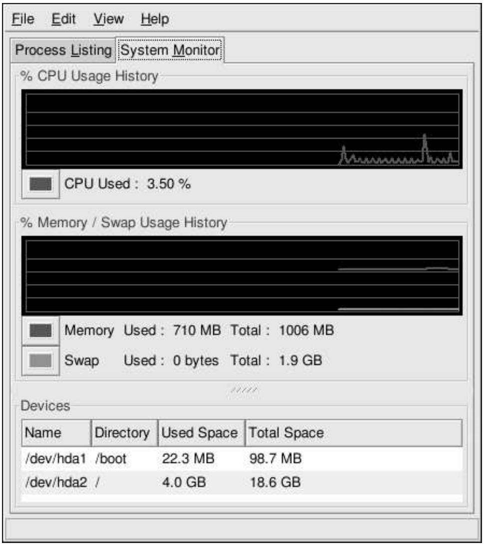

Figure 42-2. GNOME System Monitor

42.3. File Systems

The `df` command reports the system's disk space usage. If you type the command `df` at a shell prompt, the output looks similar to the following:

```
Filesystem           1k-blocks      Used Available Use% Mounted on
/dev/hda2             10325716   2902060   6899140  30% /
/dev/hda1                15554      8656      6095  59% /boot
/dev/hda3             20722644   2664256  17005732  14% /home
none                    256796         0    256796   0% /dev/shm
```

By default, this utility shows the partition size in 1 kilobyte blocks and the amount of used and available disk space in kilobytes. To view the information in megabytes and gigabytes, use the command `df -h`. The `-h` argument stands for human-readable format. The output looks similar to the following:

```
Filesystem            Size  Used Avail Use% Mounted on
/dev/hda2             9.8G  2.8G  6.5G  30% /
/dev/hda1              15M  8.5M  5.9M  59% /boot
/dev/hda3              20G  2.6G   16G  14% /home
none                  251M     0  250M   0% /dev/shm
```

In the list of partitions, there is an entry for `/dev/shm`. This entry represents the system's virtual memory file system.

The `du` command displays the estimated amount of space being used by files in a directory. If you type `du` at a shell prompt, the disk usage for each of the subdirectories will be displayed in a list. The grand total for the current directory and subdirectories will also be shown as the last line in the list. If you do not want to see the totals for all the subdirectories, use the command `du -hs` to see only the grand total for the directory in human-readable format. Use the `du --help` command to see more options.

To view the system's partitions and disk space usage in a graphical format, use the **System Monitor** tab as shown at the bottom of Figure 42-2.

42.4. Hardware

If you are having trouble configuring your hardware or just want to know what hardware is in your system, you can use the **Hardware Browser** application to display the hardware that can be probed. To start the program from the desktop, select **Main Menu Button** => **System Tools** => **Hardware Browser** or type `hwbrowser` at a shell prompt. As shown in Figure 42-3, it displays your CD-ROM devices, floppy disks, hard drives and their partitions, network devices, pointing devices, system devices, and video cards. Click on the category name in the left menu, and the information will be displayed.

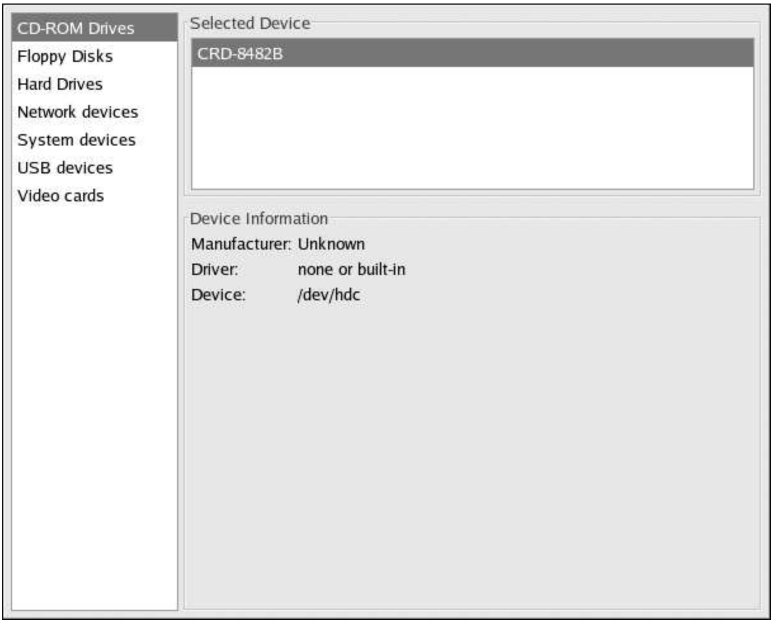

Figure 42-3. Hardware Browser

You can also use the `lspci` command to list all PCI devices. Use the command `lspci -v` for more verbose information or `lspci -vv` for very verbose output.

For example, `lspci` can be used to determine the manufacturer, model, and memory size of a system's video card:

```
01:00.0 VGA compatible controller: Matrox Graphics, Inc. MGA G400 AGP (rev 04) \
(prog-if 00 [VGA])
Subsystem: Matrox Graphics, Inc. Millennium G400 Dual Head Max
Flags: medium devsel, IRQ 16
Memory at f4000000 (32-bit, prefetchable) [size=32M]
Memory at fcffc000 (32-bit, non-prefetchable) [size=16K]
Memory at fc000000 (32-bit, non-prefetchable) [size=8M]
```

```
Expansion ROM at 80000000 [disabled] [size=64K]
Capabilities: [dc] Power Management version 2
Capabilities: [f0] AGP version 2.0
```

The `lspci` is also useful to determine the network card in your system if you do not know the manufacturer or model number.

42.5. Additional Resources

To learn more about gathering system information, refer to the following resources.

42.5.1. Installed Documentation

- `ps --help` — Displays a list of options that can be used with `ps`.
- `top` manual page — Type `man top` to learn more about `top` and its many options.
- `free` manual page — type `man free` to learn more about `free` and its many options.
- `df` manual page — Type `man df` to learn more about the `df` command and its many options.
- `du` manual page — Type `man du` to learn more about the `du` command and its many options.
- `lspci` manual page — Type `man lspci` to learn more about the `lspci` command and its many options.
- `/proc/` directory — The contents of the `/proc/` directory can also be used to gather more detailed system information. Refer to the *Red Hat Enterprise Linux Reference Guide* for additional information about the `/proc/` directory.

42.5.2. Related Books

- *Red Hat Enterprise Linux Introduction to System Administration*; Red Hat, Inc. — Includes a chapter on monitoring resources.

Chapter 43. OProfile

OProfile is a low overhead, system-wide performance monitoring tool. It uses the performance monitoring hardware on the processor to retrieve information about the kernel and executables on the system such as when memory is referenced, the number of L2 cache requests, and the number of hardware interrupts received. On a Red Hat Enterprise Linux system, the `oprofile` RPM package must be installed to use this tool.

Many processors include dedicated performance monitoring hardware. This hardware makes it possible to detect when certain events happen (such as the requested data not being in cache). The hardware normally takes the form of one or more *counters* that are incremented each time an event takes place. When the counter value "rolls over," an interrupt is generated, making it possible to control the amount of detail (and therefore, overhead) produced by performance monitoring.

OProfile uses this hardware (or a timer-based substitute in cases where performance monitoring hardware is not present) to collect *samples* of performance-related data each time a counter generates an interrupt. These samples are periodically written out to disk; later, the data contained in these samples can then be used to generate reports on system-level and application-level performance.

Important

The kernel support for OProfile in Red Hat Enterprise Linux 3 is based on the back-ported code from the 2.5 development kernel. When referring to OProfile documentation, 2.5-specific features apply to OProfile in Red Hat Enterprise Linux 3, even though the kernel version is 2.4. Likewise, OProfile features specific to the 2.4 kernel do *not* apply to Red Hat Enterprise Linux 3.

OProfile is a useful tool, but be aware of some limitations when using it:

- *Use of shared libraries* — Samples for code in shared libraries are not attributed to the particular application unless the `--separate=library` option is used.
- *Performance monitoring samples are inexact* — When a performance monitoring register triggers a sample, the interrupt handling is not precise like a divide by zero exception. Due to the out-of-order execution of instructions by the processor, the sample may be recorded on a nearby instruction.
- *`oprofpp` does not associate samples for inline functions' properly* — `oprofpp` uses a simple address range mechanism to determine which function an address is in. Inline function samples are not attributed to the inline function but rather to the function the inline function was inserted into.
- *OProfile accumulates data from multiple runs* — OProfile is a system-wide profiler and expects processes to start up and shut down multiple times. Thus, samples from multiple runs accumulate. Use the command `opcontrol --reset` to clear out the samples from previous runs.
- *Non-CPU-limited performance problems* — OProfile is oriented to finding problems with CPU-limited processes. OProfile does not identify processes that are asleep because they are waiting on locks or for some other event to occur (for example an I/O device to finish an operation).

In Red Hat Enterprise Linux, only the multi-processor (SMP) kernels have OProfile support enabled. To determine which kernel is running, issue the following command:

```
uname -r
```

If the kernel version returned ends in .entsmp, the multi-processor kernel is running. If it is not, install it via Red Hat Network or from the distribution CDs, even if the system is not a multi-processor system. The multi-processor kernel can run an a single-processor system.

43.1. Overview of Tools

Table 43-1 provides a brief overview of the tools provided with the oprofile package.

Command	Description
opcontrol	Configures what data is collected. Refer to Section 43.2 *Configuring OProfile* for details.
op_help	Displays available events for the system's processor along with a brief description of each.
op_merge	Merges multiple samples from the same executable. Refer to Section 43.5.4 *Using op_merge* for details.
op_time	Gives an overview of all profiled executables. Refer to Section 43.5.1 *Using op_time* for details.
op_to_source	Creates annotated source for an executable if the application was compiled with debugging symbols. Refer to Section 43.5.3 *Using op_to_source* for details.
oprofiled	Runs as a daemon to periodically write sample data to disk.
oprofpp	Retrieves profile data. Refer to Section 43.5.2 *Using oprofpp* for details.
op_import	Converts sample database files from a foreign binary format to the native format for the system. Only use this option when analyzing a sample database from a different architecture.

Table 43-1. OProfile Commands

43.2. Configuring OProfile

Before OProfile can be run, it must be configured. At a minimum, selecting to monitor the kernel (or selecting not to monitor the kernel) is required. The following sections describe how to use the opcontrol utility to configure OProfile. As the opcontrol commands are executed, the setup options are saved to the /root/.oprofile/daemonrc file.

43.2.1. Specifying the Kernel

First, configure whether OProfile should monitor the kernel. This is the only configuration option that is required before starting OProfile. All others are optional.

To monitor the kernel, execute the following command as root:

```
opcontrol --vmlinux=/boot/vmlinux-`uname -r`
```

To configure OProfile not to monitor the kernel, execute the following command as root:

```
opcontrol --no-vmlinux
```

This command also loads the `oprofile` kernel module (if it is not already loaded) and creates the `/dev/oprofile/` directory if it does not already exist. Refer to Section 43.6 *Understanding /dev/profile/* for details about this directory.

Note

Even if OProfile is configured not to profile the kernel, the SMP kernel still must be running so that the `oprofile` module can be loaded from it.

Setting whether samples should be collected within the kernel only changes what data is collected, not how or where the collected data is stored. To generate different sample files for the kernel and application libraries, refer to Section 43.2.3 *Separating Kernel and User-space Profiles*.

43.2.2. Setting Events to Monitor

Most processors contain *counters*, which are used by OProfile to monitor specific events. As shown in Table 43-2, the number of counters available depends on the processor.

Processor	`cpu_type`	Number of Counters
Pentium Pro	i386/ppro	2
Pentium II	i386/pii	2
Pentium III	i386/piii	2
Pentium 4 (non-hyper-threaded)	i386/p4	8
Pentium 4 (hyper-threaded)	i386/p4-ht	4
Athlon	i386/athlon	4
AMD64	x86-64/hammer	4
Itanium	ia64/itanium	4
Itanium 2	ia64/itanium2	4
TIMER_INT	timer	1
IBM eServer iSeries	timer	1
IBM eServer pSeries	timer	1
IBM eServer S/390	timer	1
IBM eServer zSeries	timer	1

Table 43-2. OProfile Processors and Counters

Use Table 43-2 to verify that the correct processor type was detected and to determine the number of events that can be monitored simultaneously. `timer` is used as the processor type if the processor does not have supported performance monitoring hardware.

If `timer` is used, events can not be set for any processor because the hardware does not have support for hardware performance counters. Instead, the timer interrupt is used for profiling.

If `timer` is not used as the processor type, the events monitored can be changed, and counter 0 for the processor is set to a time-based event by default. If more than one counter exists on the processor, the counters other than counter 0 are not set to an event by default. The default events monitored are shown in Table 43-3.

Processor	Default Event for Counter 0	Description
Pentium Pro, Pentium II, Pentium III, Athlon, AMD64	CPU_CLK_UNHALTED	The processor's clock is not halted
Pentium 4 (HT and non-HT), Intel® EM64T	GLOBAL_POWER_EVENTS	The time during which the processor is not stopped
Itanium 2	CPU_CYCLES	CPU Cycles
TIMER_INT	(none)	Sample for each timer interrupt

Table 43-3. Default Events

The number of events that can be monitored at one time is determined by the number of counters for the processor. However, it is not a one-to-one correlation; on some processors, certain events must be mapped to specific counters. To determine the number of counters available, execute the following command:

```
cat /dev/oprofile/cpu_type
```

The events available vary depending on the processor type. To determine the events available for profiling, execute the following command as root (the list is specific to the system's processor type):

```
op_help
```

The events for each counter can be configured via the command line or with a graphical interface. If the counter can not be set to a specific event, an error message is displayed.

To set the event for each configurable counter via the command line, use `opcontrol`:

```
opcontrol --ctrlN-event=<event-name>
```

Replace *N* with the counter number (starting with 0), and replace *<event-name>* with the exact name of the event from `op_help`.

43.2.2.1. Sampling Rate

By default, a time-based event set is selected. It creates approximately 2000 samples per second per processor. If the timer interrupt is used, the timer is set to whatever the jiffy rate is and is not user-settable. If the `cpu_type` is not `timer`, each event can have a *sampling rate* set for it. The sampling rate is the number of events between each sample snapshot.

When setting the event for the counter, a sample rate can also be specified:

```
opcontrol --ctrN-event=<event-name> --ctrN-count=<sample-rate>
```

Replace *<sample-rate>* with the number of events to wait before sampling again. The smaller the count, the more frequent the samples. For events that do not happen frequently, a lower count may be needed to capture the event instances.

Caution

Be extremely careful when setting sampling rates. Sampling too frequently can overload the system, causing the system to appear as if it is frozen or causing the system to actually freeze.

43.2.2.2. Unit Masks

If the `cpu_type` is not `timer`, *unit masks* may also be required to further define the event.

Unit masks for each event are listed with the `op_help` command. The values for each unit mask are listed in hexadecimal format. To specify more than one unit mask, the hexadecimal values must be combined using a bitwise *or* operation.

```
opcontrol --ctrN-event=<event-name> --ctrN-count=<sample-rate> --ctrN-unit-mask=<value>
```

43.2.3. Separating Kernel and User-space Profiles

By default, kernel mode and user mode information is gathered for each event. To configure OProfile not to count events in kernel mode for a specific counter, execute the following command (where *N* is the counter number):

```
opcontrol --ctrN-kernel=0
```

Execute the following command to start profiling kernel mode for the counter again:

```
opcontrol --ctrN-kernel=1
```

To configure OProfile not to count events in user mode for a specific counter, execute the following command (where *N* is the counter number):

```
opcontrol --ctrN-user=0
```

Execute the following command to start profiling user mode for the counter again:

```
opcontrol --ctrN-user=1
```

When the OProfile daemon writes the profile data to sample files, it can separate the kernel and library profile data into separate sample files. To configure how the daemon writes to sample files, execute the following command as root:

```
opcontrol --separate=<choice>
```

<*choice*> can be one of the following:

- `none` — do not separate the profiles (default)
- `library` — generate per-application profiles for libraries
- `kernel` — generate per-application profiles for the kernel and kernel modules
- `all` — generate per-application profiles for libraries and per-application profiles for the kernel and kernel modules

If `--separate=library` is used, the sample file name includes the name of the executable as well as the name of the library.

43.3. Starting and Stopping OProfile

To start monitoring the system with OProfile, execute the following command as root:

```
opcontrol --start
```

Output similar to the following is displayed:

```
Using log file /var/lib/oprofile/oprofiled.log
Daemon started.
Profiler running.
```

The settings in `/root/.oprofile/daemonrc` are used.

The OProfile daemon, `oprofiled`, is started; it periodically writes the sample data to the `/var/lib/oprofile/samples/` directory. The log file for the daemon is located at `/var/lib/oprofile/oprofiled.log`.

If OProfile is restarted with different configuration options, the sample files for the previous session are automatically backed up in the directory `/var/lib/oprofile/samples/session-N`, where *N* is the number of the previously backed-up session plus 1.

```
Backing up samples file to directory /var/lib/oprofile/samples//session-1
Using log file /var/lib/oprofile/oprofiled.log
Daemon started.
Profiler running.
```

To stop the profiler, executing the following command as root:

```
opcontrol --shutdown
```

43.4. Saving Data

Sometimes it is useful to save samples at a specific time. For example, when profiling an executable, it may be useful to gather different samples based on different input data sets. If the number of events to be monitored exceeds the number of counters available for the processor, multiple runs of OProfile can be used to collect data, saving the sample data to different files each time.

To save the current set of sample files, execute the following command, replacing <*name*> with a unique descriptive name for the current session.

```
opcontrol --save=<name>
```

The directory `/var/lib/oprofile/samples/name/` is created and the current sample files are copied to it.

43.5. Analyzing the Data

Periodically, the OProfile daemon, `oprofiled` collects the samples and writes them to the `/var/lib/oprofile/samples/` directory. Before reading the data, make sure all data has been written to this directory by executing the following command as root:

```
opcontrol --dump
```

Each sample file name is based on the name of the executable, with a closing curly bracket (`}`) replacing each forward slash (`/`). The file name ends with a hash mark (`#`), followed by the counter number used for that sample file. For example, the following file includes the sample data for the `/sbin/syslogd` executable collected with counter 0:

```
}sbin}syslogd#0
```

The following tools are available to profile the sample data once it has been collected:

- `op_time`
- `oprofpp`
- `op_to_source`
- `op_merge`

Use these tools, along with the binaries profiled, to generate reports that can be further analyzed.

Warning

> The executable being profiled must be used with these tools to analyze the data. If it must change after the data is collected, backup the executable used to create the samples as well as the sample files.

Samples for each executable are written to a single sample file. Samples from each dynamically linked library are also written to a single sample file. While OProfile is running, if the executable being monitored changes and a sample file for the executable exists, the existing sample file is automatically deleted. Thus, if the existing sample file is needed, it must be backed up, along with the executable used to create it before replacing the executable with a new version. Refer to Section 43.4 *Saving Data* for details on how to backup the sample file.

43.5.1. Using `op_time`

The `op_time` tool provides an overview of all the executables being profiled.

The following is part of an example output:

```
581         0.2949  0.0000 /usr/bin/oprofiled
966         0.4904  0.0000 /usr/sbin/cupsd
1028        0.5218  0.0000 /usr/sbin/irqbalance
1187        0.6026  0.0000 /bin/bash
1480        0.7513  0.0000 /usr/bin/slocate
2039        1.0351  0.0000 /usr/lib/rpm/rpmq
6249        3.1722  0.0000 /usr/X11R6/bin/XFree86
8842        4.4885  0.0000 /bin/sed
31342      15.9103  0.0000 /usr/bin/gdmgreeter
58283      29.5865  0.0000 /no-vmlinux
82853      42.0591  0.0000 /usr/bin/perl
```

Each executable is listed on its own line. The first column is the number of samples recorded for the executable. The second column is the percentage of samples relative to the total number of samples. The third column is unused, and the fourth is the name of the executable.

Refer to the `op_time` man page for a list of available command line options such as the `-r` option used to sort the output from the executable with the largest number of samples to the one with the smallest number of samples. The `-c` option is also useful for specifying a counter number.

43.5.2. Using `oprofpp`

To retrieve more detailed information about a specific executable, use `oprofpp`:

```
oprofpp <mode> <executable>
```

<executable> must be the full path to the executable to be analyzed. *<mode>* must be one of the following:

`-l`

List sample data by symbols. For example, the following is part of the output from running the command `oprofpp -l /usr/X11R6/bin/XFree86`:

```
vma      samples  %          symbol name
...
08195d10 4        3.0303     miComputeCompositeClip
080b9180 5        3.78788    Dispatch
080cdce0 5        3.78788    FreeResource
080ce4a0 5        3.78788    LegalNewID
080ce640 5        3.78788    SecurityLookupIDByClass
080dd470 9        6.81818    WaitForSomething
080e1360 12       9.09091    StandardReadRequestFromClient
...
```

The first column is the starting virtual memory address (vma). The second column is the number of samples for the symbol. The third column is the percentage of samples for this symbol relative to the overall samples for the executable, and the fourth column is the symbol name.

To sort the output from the largest number of samples to the smallest (reverse order), use `-r` in conjunction with the `-l` option.

`-s` *<symbol-name>*

List sample data specific to a symbol name. For example, the following output is from the command `oprofpp -s StandardReadRequestFromClient /usr/X11R6/bin/XFree86`:

```
vma      samples  %          symbol name
080e1360 12       100        StandardReadRequestFromClient
080e1360 1        8.33333
080e137f 1        8.33333
080e13bb 1        8.33333
080e13f4 1        8.33333
080e13fb 1        8.33333
080e144a 1        8.33333
080e15aa 1        8.33333
080e1668 1        8.33333
080e1803 1        8.33333
080e1873 1        8.33333
080e190a 2        16.6667
```

The first line is a summary for the symbol/executable combination.

The first column consists of the virtual memory addresses sampled. The second column is the number of samples for the memory address. The third column is the percentage of samples for the memory address relative to the total number of samples for the symbol.

`-L`

List sample data by symbols with more details than `-l`. For example:

```
vma      samples  %          symbol name
08083630 2        1.51515    xf86Wakeup
 08083641 1        50
 080836a1 1        50
080b8150 1        0.757576   Ones
```

```
 080b8179 1         100
080b8fb0 2         1.51515     FlushClientCaches
 080b8fb9 1         50
 080b8fba 1         50
...
```

The data is the same as the `-l` option except that for each symbol, each virtual memory address used is shown. For each virtual memory address, the number of samples and percentage of samples relative to the number of samples for the symbol is displayed.

`-g` <*file-name*>

Generate output to a file in `gprof` format. If the generated file is named `gmon.out`, `gprof` can be used to further analyze the data. Refer to the `gprof` man page for details.

Other options to further restrict the data are as follows:

`-f` <*file-name*>

Use the specified sample file <*file-name*>. By default, the sample file in `/var/lib/oprofile/samples/` is used. Use this option to specify a sample file from a previous session.

`-i` <*file-name*>

Use <*file-name*> as the name of the executable for which to retrieve data.

`-d`

Demangle C++ symbol names.

`-D`

Demangle C++ symbol names, and simplify STL library demangled names.

`--counter` <*number*>

Gather information from a specific counter. The default counter is 0 if not specified.

`-o`

Display the line number in the source code for each sample. When the executable was compiled, GCC's `-g` option should have been used. Otherwise, this option can not display the line numbers. None of the Red Hat Enterprise Linux executables are compiled with this option by default.

```
vma       samples   %      symbol name        linear info
0806cbb0 0         0      _start             ../sysdeps/i386/elf/start.S:47
```

`-e` <*symbol-name*>

Exclude the comma-separated list of symbols from the output.

`-k`

Display an additional column containing the shared library. This option only produces results if the `--separate=library` option to `opcontrol` is specified when configuring OProfile and if the `--dump-gprof-file` option is not used in conjunction with this option.

`-t` <*format*>

Display the output in a specific column order. This option can not be used with `-g`.

Use the following letters to represent the columns:

Letter	Description
`v`	Virtual memory address
`s`	Number of samples
`S`	Cumulative number of samples
`p`	Percentage of samples relative to total number of samples for the executable
`P`	Cumulative percentage of samples relative to total number of samples for the executable
`q`	Percentage of samples relative to all executables sampled
`Q`	Cumulative percentage of samples relative to all executables sampled
`n`	Symbol name
`l`	File name of source file and line number, including full path
`L`	Base name of the source code file name and line number
`i`	Name of the executable, including full path
`I`	Base name of the executable
`d`	Details of the sample
`h`	Display column headers

Table 43-4. Letters for Column Order

`--session` <*name*>

Specify the full path to the session or a directory relative to the `/var/lib/oprofile/samples/` directory.

`-p` <*path-list*>

Specify a comma-separated list of paths in which the executables to be analyzed are located.

43.5.3. Using `op_to_source`

The `op_to_source` tool tries to match the samples for particular instructions to the corresponding lines in the source code. The resulting files generated should have the samples for the lines at the left. It also puts in a comment at the beginning of each function listing the total samples for the function.

For this utility to work, the executable must be compiled with GCC's `-g` option. By default, Red Hat Enterprise Linux packages are not compiled with this option.

The general syntax for `op_to_source` is as follows:

```
op_to_source --source-dir <src-dir> <executable>
```

The directory containing the source code and the executable to be analyzed must be specified. Refer to the `op_to_source` man page for a list of additional command line options.

43.5.4. Using `op_merge`

If multiple sample files exist for the exact same executable or library, the sample files can be merged for easier analysis.

For example, to merge files for the library `/usr/lib/library-1.2.3.so`, execute the following command as root:

```
op_merge /usr/lib/library-1.2.3.so
```

The resulting file is `/var/lib/oprofile/samples/}usr}lib}library-1.2.3.so`.

To limit the samples merged to a specific counter, use the `-c` option followed by the counter number.

43.6. Understanding `/dev/profile/`

The `/dev/oprofile/` directory contains the file system for OProfile. Use the `cat` command to display the values of the virtual files in this file system. For example, the following command displays the type of processor OProfile detected:

```
cat /dev/oprofile/cpu_type
```

A directory exists in `/dev/oprofile/` for each counter. For example, if there are 2 counters, the directories `/dev/oprofile/0/` and `dev/oprofile/1/` exist.

Each directory for a counter contains the following files:

- `count` — Interval between samples
- `enabled` — If 0, the counter is off and no samples are collected for it; If 1, the counter is on and samples are being collected for it
- `event` — Event to monitor
- `kernel` — If 0, samples are not collected for this counter event when the processor is in kernel-space; if 1, samples are collected even if the processor is in kernel-space
- `unit_mask` — Which unit masks are enabled for the counter
- `user` — If 0, samples are not collected for the counter event when the processor is in user-space; if 1, samples are collected even if the processor is in user-space

The values of these files can be retrieved with the `cat` command. For example:

```
cat /dev/oprofile/0/count
```

43.7. Example Usage

While OProfile can be used by developers to analyze application performance, it can also be used by system administrators to perform system analysis. For example:

- *Determine which applications and services are used the most on a system* — `op_time` can be used to determine how much processor time an application or service uses. If the system is used for multiple services but is under performing, the services consuming the most processor time can be moved to dedicated systems.

- *Determine processor usage* — The `CPU_CLK_UNHALTED` event can be monitored to determine the processor load over a given period of time. This data can then be used to determine if additional processors or a faster processor might improve system performance.

43.8. Graphical Interface

Some OProfile preferences can be set with a graphical interface. To start it, execute the `oprof_start` command as root at a shell prompt.

After changing any of the options, they can be saved by clicking the **Save and quit** button. The preferences are written to `/root/.oprofile/daemonrc`, and the application exits. Exiting the application does not stop OProfile from sampling.

On the **Setup** tab, to set events for the processor counters as discussed in Section 43.2.2 *Setting Events to Monitor*, select the counter from the pulldown menu and select the event from the list. A brief description of the event appears in the text box below the list. Only events available for the specific counter and the specific architecture are displayed. The interface also displays whether or not the profiler is running and some brief statistics about it.

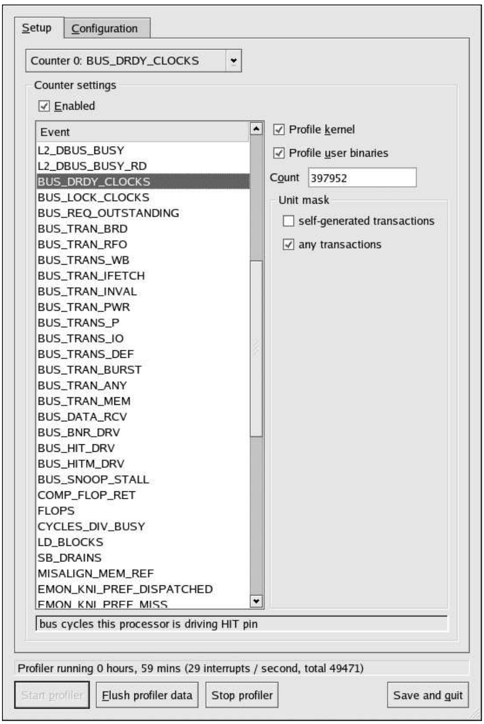

Figure 43-1. OProfile Setup

On the right side of the tab, select the **Profile kernel** option to count events in kernel mode for the currently selected event, as discussed in Section 43.2.3 *Separating Kernel and User-space Profiles*.

This is equivalent to the `opcontrol --ctrN-kernel=1` command, where *N* is the counter number. If this option is unselected, it is equivalent to the `opcontrol --ctrN-kernel=0` command.

Select the **Profile user binaries** option to count events in user mode for the currently selected event, as discussed in Section 43.2.3 *Separating Kernel and User-space Profiles*. This is equivalent to the `opcontrol --ctrN-user=1` command, where *N* is the counter number. If this option is unselected, it is equivalent to the `opcontrol --ctrN-user=0` command.

Use the **Count** text field to set the sampling rate for the currently selected event as discussed in Section 43.2.2.1 *Sampling Rate*.

If any unit masks are available for the currently selected event, as discussed in Section 43.2.2.2 *Unit Masks*, they are displayed in the **Unit Masks** area on the right side of the **Setup** tab. Select the checkbox beside the unit mask to enable it for the event.

On the **Configuration** tab, to profile the kernel, enter the name and location of the `vmlinux` file for the kernel to monitor in the **Kernel image file** text field. To configure OProfile not to monitor the kernel, select **No kernel image**.

Figure 43-2. OProfile Configuration

If the **Verbose** option is selected, the `oprofiled` daemon log includes more information.

If **Per-application kernel samples files** is selected, OProfile generates per-application profiles for the kernel and kernel modules as discussed in Section 43.2.3 *Separating Kernel and User-space Profiles*. This is equivalent to the `opcontrol --separate=kernel` command. If **Per-application shared libs samples files** is selected, OProfile generates per-application profiles for libraries. This is equivalent to the `opcontrol --separate=library` command.

To force data to be written to samples files as discussed in Section 43.5 *Analyzing the Data*, click the **Flush profiler data** button. This is equivalent to the `opcontrol --dump` command.

To start OProfile from the graphical interface, click **Start profiler**. To stop the profiler, click **Stop profiler**. Exiting the application does not stop OProfile from sampling.

43.9. Additional Resources

This chapter only highlights OProfile and how to configure and use it. To learn more, refer to the following resources.

43.9.1. Installed Docs

- `/usr/share/doc/oprofile-0.5.4/oprofile.html` — *OProfile Manual*
- `oprofile` man page — Discusses `opcontrol`, `oprofpp`, `op_to_source`, `op_time`, `op_merge`, and `op_help`

43.9.2. Useful Websites

- http://oprofile.sourceforge.net/ — contains the latest documentation, mailing lists, IRC channels, and more

VII. Appendixes

This part contains instructions for building a custom kernel from the source files provided by Red Hat, Inc..

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Appendix A. Building a Custom Kernel

Many people new to Linux often ask, "Why should I build my own kernel?" Given the advances that have been made in the use of kernel modules, the most accurate response to that question is, "Unless you already know why you need to build your own kernel, you probably do not need to."

The kernel provided with Red Hat Enterprise Linux and via the Red Hat Enterprise Linux Errata system provides support for most modern hardware and kernel features. For most users, it does not need to be recompiled. This appendix is provided as a guide for users who want to recompile their kernel to learn more about it, for users who want to compile an experimental feature into the kernel, and so on.

To upgrade the kernel using the kernel packages distributed by Red Hat, Inc., refer to Chapter 39 *Upgrading the Kernel*.

Warning

Building a custom kernel is not supported by the Installation Support Team. For more information on upgrading the kernel using the RPM packages distributed by Red Hat, Inc., refer to Chapter 39 *Upgrading the Kernel*.

A.1. Preparing to Build

Before building a custom kernel, it is extremely important to make sure that a working emergency boot diskette exists in case a mistake is made. To make a boot diskette that will boot using the currently running kernel, execute the following command:

```
/sbin/mkbootdisk `uname -r`
```

After making the diskette, test it to make sure that it boots the system.

To recompile the kernel, the `kernel-source` package must be installed. Issue the command

```
rpm -q kernel-source
```

to determine if it is installed. If it is not installed, install it from the Red Hat Enterprise Linux CD-ROMs or Red Hat Network. For more information on installing RPM packages, refer to Part III *Package Management*.

A.2. Building the Kernel

To build a custom kernel (perform all these steps as root):

Note

This example uses 2.4.21-1.1931.2.399.ent as the kernel version (the kernel version might differ). To determine the kernel version, type the command `uname -r` and replace 2.4.21-1.1931.2.399.ent with the kernel version that is returned.

1. Open a shell prompt and change to the directory `/usr/src/linux-2.4/`. All commands from this point forward must be executed from this directory.
2. It is important that kernel build starts with the source tree in a known condition. Therefore, it is recommended that the command `make mrproper` is issued first to remove any configuration files along with the remains of any previous builds that may be scattered around the source tree. If an existing configuration file already exists as the file `/usr/src/linux-2.4/.config`, back it up to a different directory before running this command and copy it back afterward.
3. It is recommended that the configuration of the default Red Hat Enterprise Linux kernel be used as a starting point. To do this, copy the configuration file for the system's architecture from the `/usr/src/linux-2.4/configs/` directory to `/usr/src/linux-2.4/.config`. If the system has more than one processor, copy the file that contains the keyword `smp`. However, if the system has more than four gigabytes of memory, copy the file that contains the keyword `hugemem`.
4. Next, customize the settings. The recommended method is to use the command `make menuconfig` to run the **Linux Kernel Configuration** program. The X Window System is not required.

   After finishing the configuration, select **Exit** and select **Yes** to save the new kernel configuration file (`/usr/src/linux-2.4/.config`).

   Even if no changes were made to any of the settings, running the `make menuconfig` command (or one of the other methods for kernel configuration) is required before continuing.

   Other available methods for kernel configuration include:

   - `make config` — An interactive text program. Components are presented in a linear format and answered one at a time. This method does not require the X Window System and does not allow answers to be changed for previous questions.
   - `make xconfig` — The method requires the X Window System and the `tk` package. This method is not recommended because it does not parse the configuration files reliably.
   - `make oldconfig` — This is a non-interactive script that reads the existing configuration file (`.config`) and only prompts for answers to any new questions that did not previously exist.

Note

To use `kmod` and kernel modules answer **`Yes`** to `kmod support` and `module version (CONFIG_MODVERSIONS) support` during the configuration.

5. After creating a `/usr/src/linux-2.4/.config` file, use the command `make dep` to set up the dependencies correctly.
6. Use the command `make clean` to prepare the source tree for the build.
7. It is recommended that the custom kernel have a modified version number so that the existing kernel is not overwritten. The method described here is the easiest to recover from in the event of a mishap. For other possibilities, details can be found at http://www.redhat.com/mirrors/LDP/HOWTO/Kernel-HOWTO.html or in the `Makefile` in `/usr/src/linux-2.4/`.

   By default, `/usr/src/linux-2.4/Makefile` includes the word `custom` at the end of the line beginning with `EXTRAVERSION`. Appending the string allows the system to have the old working kernel and the new kernel (version 2.4.21-1.1931.2.399.entcustom) on the system at the same time.

   If the system contains more than one custom kernel, a good method is to append the date at the end (or another identifier).

8. For x86, AMD64, and Intel® EM64T, build the kernel with `make bzImage`. For the Itanium architecture, build the kernel with `make compressed`. For the S/390 and zSeries architectures, build the kernel with `make image`. For the iSeries and pSeries architectures, build the kernel with `make boot`.
9. Build any modules configured with `make modules`.
10. Use the command `make modules_install` to install the kernel modules (even if nothing was actually built). Notice the underscore (_) in the command. This installs the kernel modules into the directory path `/lib/modules/`<*KERNELVERSION*>`/kernel/drivers` (where *KERNELVERSION* is the version specified in the `Makefile`). In this example it would be `/lib/modules/2.4.21-1.1931.2.399.entcustom/kernel/drivers/`.
11. Use `make install` to copy the new kernel and its associated files to the proper directories.

    In addition to installing the kernel files in the `/boot` directory, this command also executes the `/sbin/new-kernel-pkg` script that builds a new `initrd` image and adds new entries to the boot loader configuration file.

    If the system has a SCSI adapter and the SCSI driver was compiled as a module or if the kernel was built with ext3 support as a module (the default in Red Hat Enterprise Linux), the `initrd` image is required.
12. Even though the `initrd` image and boot loader modifications are made, verify that they were done correctly and be sure to use the custom kernel version instead of 2.4.21-1.1931.2.399.ent. Refer to Section 39.5 *Verifying the Initial RAM Disk Image* and Section 39.6 *Verifying the Boot Loader* for instructions on verifying these modifications.

A.3. Additional Resources

For more information on the Linux kernel, refer to the following resources.

A.3.1. Installed Documentation

- `/usr/src/linux-2.4/Documentation/` — This directory contains advanced documentation on the Linux kernel and its modules. These documents are written for people interested in contributing to the kernel source code and understanding how the kernel works.

A.3.2. Useful Websites

- http://www.redhat.com/mirrors/LDP/HOWTO/Kernel-HOWTO.html — *The Linux Kernel HOWTO* from the Linux Documentation Project.
- http://www.kernel.org/pub/linux/docs/lkml/ — The linux-kernel mailing list.

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