Red Hat Enterprise Linux 6

Migration Planning Guide

Migrating to Red Hat Enterprise Linux 6

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Edition 6.1

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This guide documents migration of systems running Red Hat Enterprise Linux 5 to Red Hat Enterprise Linux 6.

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Preface

1. Document Conventions

This manual uses several conventions to highlight certain words and phrases and draw attention to specific pieces of information.

In PDF and paper editions, this manual uses typefaces drawn from the *Liberation Fonts*[1] set. The Liberation Fonts set is also used in HTML editions if the set is installed on your system. If not, alternative but equivalent typefaces are displayed. Note: Red Hat Enterprise Linux 5 and later includes the Liberation Fonts set by default.

1.1. Typographic Conventions

Four typographic conventions are used to call attention to specific words and phrases. These conventions, and the circumstances they apply to, are as follows.

`Mono-spaced Bold`

Used to highlight system input, including shell commands, file names and paths. Also used to highlight keycaps and key combinations. For example:

> To see the contents of the file **`my_next_bestselling_novel`** in your current working directory, enter the **`cat my_next_bestselling_novel`** command at the shell prompt and press **`Enter`** to execute the command.

The above includes a file name, a shell command and a keycap, all presented in mono-spaced bold and all distinguishable thanks to context.

Key combinations can be distinguished from keycaps by the hyphen connecting each part of a key combination. For example:

> Press **`Enter`** to execute the command.
>
> Press **`Ctrl`**+**`Alt`**+**`F2`** to switch to the first virtual terminal. Press **`Ctrl`**+**`Alt`**+**`F1`** to return to your X-Windows session.

The first paragraph highlights the particular keycap to press. The second highlights two key combinations (each a set of three keycaps with each set pressed simultaneously).

If source code is discussed, class names, methods, functions, variable names and returned values mentioned within a paragraph will be presented as above, in **`mono-spaced bold`**. For example:

> File-related classes include **`filesystem`** for file systems, **`file`** for files, and **`dir`** for directories. Each class has its own associated set of permissions.

Proportional Bold

This denotes words or phrases encountered on a system, including application names; dialog box text; labeled buttons; check-box and radio button labels; menu titles and sub-menu titles. For example:

> Choose **System** → **Preferences** → **Mouse** from the main menu bar to launch **Mouse Preferences**. In the **Buttons** tab, click the **Left-handed mouse** check box and click

[1] https://fedorahosted.org/liberation-fonts/

> **Close** to switch the primary mouse button from the left to the right (making the mouse suitable for use in the left hand).
>
> To insert a special character into a **gedit** file, choose **Applications** → **Accessories** → **Character Map** from the main menu bar. Next, choose **Search** → **Find…** from the **Character Map** menu bar, type the name of the character in the **Search** field and click **Next**. The character you sought will be highlighted in the **Character Table**. Double-click this highlighted character to place it in the **Text to copy** field and then click the **Copy** button. Now switch back to your document and choose **Edit** → **Paste** from the **gedit** menu bar.

The above text includes application names; system-wide menu names and items; application-specific menu names; and buttons and text found within a GUI interface, all presented in proportional bold and all distinguishable by context.

Mono-spaced Bold Italic or ***Proportional Bold Italic***

Whether mono-spaced bold or proportional bold, the addition of italics indicates replaceable or variable text. Italics denotes text you do not input literally or displayed text that changes depending on circumstance. For example:

> To connect to a remote machine using ssh, type **ssh *username*@*domain.name*** at a shell prompt. If the remote machine is **example.com** and your username on that machine is john, type **ssh john@example.com**.
>
> The **mount -o remount *file-system*** command remounts the named file system. For example, to remount the **/home** file system, the command is **mount -o remount /home**.
>
> To see the version of a currently installed package, use the **rpm -q *package*** command. It will return a result as follows: ***package-version-release***.

Note the words in bold italics above — username, domain.name, file-system, package, version and release. Each word is a placeholder, either for text you enter when issuing a command or for text displayed by the system.

Aside from standard usage for presenting the title of a work, italics denotes the first use of a new and important term. For example:

> Publican is a *DocBook* publishing system.

1.2. Pull-quote Conventions

Terminal output and source code listings are set off visually from the surrounding text.

Output sent to a terminal is set in **mono-spaced roman** and presented thus:

```
books        Desktop   documentation  drafts  mss    photos   stuff  svn
books_tests  Desktop1  downloads      images  notes  scripts  svgs
```

Source-code listings are also set in **mono-spaced roman** but add syntax highlighting as follows:

```
package org.jboss.book.jca.ex1;

import javax.naming.InitialContext;
```

```
public class ExClient
{
   public static void main(String args[])
       throws Exception
   {
      InitialContext iniCtx = new InitialContext();
      Object         ref    = iniCtx.lookup("EchoBean");
      EchoHome       home   = (EchoHome) ref;
      Echo           echo   = home.create();

      System.out.println("Created Echo");

      System.out.println("Echo.echo('Hello') = " + echo.echo("Hello"));
   }
}
```

1.3. Notes and Warnings

Finally, we use three visual styles to draw attention to information that might otherwise be overlooked.

Note

Notes are tips, shortcuts or alternative approaches to the task at hand. Ignoring a note should have no negative consequences, but you might miss out on a trick that makes your life easier.

Important

Important boxes detail things that are easily missed: configuration changes that only apply to the current session, or services that need restarting before an update will apply. Ignoring a box labeled 'Important' will not cause data loss but may cause irritation and frustration.

Warning

Warnings should not be ignored. Ignoring warnings will most likely cause data loss.

2. We Need Feedback!

If you find a typographical error in this manual, 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/* against the product **Red Hat Enterprise Linux.**

When submitting a bug report, be sure to mention the manual's identifier: doc-*Migration_Guide* and version number: **6**.

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

Introduction

The Migration Planning Guide documents the migration of any minor version of a Red Hat Enterprise Linux 5 installation to Red Hat Enterprise Linux 6 by highlighting key behavioral changes worthy of note when migrating.

This guide is intended to increase ease of use of Red Hat Enterprise Linux 6 by providing guidelines for changes in the product between Red Hat Enterprise Linux 5 and Red Hat Enterprise Linux 6. This guide is however *not* designed to explain all new features: it is focused on changes to the *behavior* of applications or components which were part of Red Hat Enterprise Linux 5 and have changed in Red Hat Enterprise Linux 6 or whose functionality has been superseded by another package.

1.1. Red Hat Enterprise Linux 6

Red Hat Enterprise Linux is the leading platform for open source computing. It is sold by subscription, delivers continuous value and is certified by top enterprise hardware and software vendors. From the desktop to the datacenter, Enterprise Linux couples the innovation of open source technology and the stability of a true enterprise-class platform.

Red Hat Enterprise Linux 6 is the next generation of Red Hat's comprehensive suite of operating systems, designed for mission-critical enterprise computing and certified by top enterprise software and hardware vendors. This release is available as a single kit on the following architectures:

- i386
- AMD64/Intel64
- System z
- IBM Power (64-bit)

In this release, Red Hat brings together improvements across the server, desktop and the overall Red Hat open source experience. The following are some of the many improvements and new features that are included in this release:

Power Management

Tickless kernel and improvements through the application stack to reduce wakeups, power consumption measurement by PowerTOP, Power Management (ASPM, ALPM), and adaptive system tuning by Tuned.

Next Generation Networking

Comprehensive IPv6 support (NFS 4, CIFS, mobile support [RFC 3775], ISATAP support), FCoE, iSCSI, and a new and improved mac80211 wireless stack.

Reliability, Availability, and Serviceability

System level enhancements from industry collaborations to make the most of hardware RAS capabilities and NUMA architectures.

Fine-grained Control and Management

Improved scheduler and better resource management in the kernel via Completely Fair Scheduler (CFS) and Control Groups (CG).

Scalable Filesystems

ext4 is the default filesystem, and xfs offers robustness, scalability, and high-performance.

Virtualization

KVM includes performance improvements and new features, sVirt protects the host, VMs, and data from a guest breach, SRIOV and NPIV deliver high performance virtual use of physical devices, and libvirt leverages kernel CG controller functionality.

Enterprise Security Enhancement

SELinux includes improved ease of use, application sandboxing, and significantly increased coverage of system services, while SSSD provides unified access to identity and authentication services as well as caching for off-line use.

Development and Runtime Support

SystemTap (allows instrumentation of a running kernel without recompilation), ABRT (simple collection of bug information), and improvements to GCC (version 4.4.3), glibc (version 2.11.1), and GDB (version 7.0.1).

1.2. Application Compatibility

This release of Red Hat Enterprise Linux provides dependencies so applications designed to run on earlier versions of the operating system continue to run with minimum disruption. To that end, older versions of key libraries are included to preserve legacy interfaces that might have changed between this release and prior versions. These libraries serve as dependencies primarily for applications written in C/C++.

Please note that it is not necessary to re-test or re-certify applications between minor releases of Red Hat Enterprise Linux. Red Hat Enterprise Linux compatibility policies ensure that applications running on a version of the release will continue to run throughout the life of the release. For example, applications certified on Red Hat Enterprise Linux 6.0 will be fully compatible on Red Hat Enterprise Linux 6.1 and so on.

Refer to the following table for details on these compatibility packages:

Table 1.1. Compatibility Libraries

Package	Description
compat-db	The Berkeley DB database compatibility library. The Berkeley Database (Berkeley DB) is a programmatic toolkit that provides embedded database support for both traditional and client/server applications. This package contains various versions of Berkeley DB which were included in previous releases.
compat-expat1	Expat is a stream-oriented XML parser. This package provides library compatibility with previous versions.
compat-glibc	glibc is the C library used for system calls and other basic facilities. This package provides compatibility (and runtime libraries) for the compiling of binaries that require older glibc

Package	Description
	versions, and allows them to run on this release of Red Hat Enterprise Linux.
compat-libf2c-34	This package provides older versions of Fortran 77 shared libraries, which are needed to run dynamically-linked Fortran 77 programs.
compat-libgcc-296	Contains the 2.96 libgcc.a library and support object files to retain compatibility with older versions of GCC.
compat-libgfortran-41	This package includes a Fortran 95 runtime library for compatibility with GCC 4.1.x compiled Fortran applications.
compat-libstdc++-295	Provides compatibility with the GNU standard C++ library version 2.95.
compat-libstdc++-296	Provides compatibility with the GNU standard C++ library version 2.96.
compat-libstdc++-33	Provides compatibility with the GNU standard C++ library version 3.3.
compat-libtermcap	This package provides compatibility for older termcap-based programs.
compat-openldap	OpenLDAP is an open source suite of LDAP (Lightweight Directory Access Protocol) applications and development tools. The compat-openldap package includes older versions of the OpenLDAP shared libraries which may be required by some applications.
openssl098e	This package provides OpenSSL 0.98e, which may be required for some SSL applications.

Installation

This section outlines the differences between Red Hat Enterprise Linux 6 and Red Hat Enterprise Linux 5 installation procedures. Depending on which release of Red Hat Enterprise Linux 5 you are migrating from, not all of the options and techniques listed here may be relevant to your environment, as they may already be present in your Red Hat Enterprise Linux 5 environment.

2.1. Kernel and Boot Options

- You may perform memory testing before you install Red Hat Enterprise Linux by entering **`memtest86`** at the **`boot:`** prompt. This option runs the *Memtest86* stand alone memory testing software in place of the *Anaconda* system installer. Once started, *Memtest86* memory testing loops continually until the **`Esc`** key is pressed.

- The **`rdloaddriver`** kernel parameter is now needed to define the order of module loading, instead of the old **`scsi_hostadapter`** option.

2.2. Graphical Installer

This section describes what behaviors have changed in the graphical installer.

2.2.1. Devices and Disks

- Use of the /dev/hd*X* device name is deprecated on the i386 and x86_64 architecture for IDE drives, and has changed to /dev/sd*X*. This change does not apply to the PPC architecture.

- If you have difficulties with the installation not detecting a Smart Array card, enter **`linux isa`** at the installer prompt. This lets you manually select the required card.

- Whereas older IDE drivers supported up to 63 partitions per device, SCSI devices are limited to 15 partitions per device. Anaconda uses the new *libata* driver in the same fashion as the rest of Red Hat Enterprise Linux, so it is unable to detect more than 15 partitions on an IDE disk during the installation or upgrade process. If you are upgrading a system with more than 15 partitions, you may need to migrate the disk to Logical Volume Manager (LVM).

- A change in the way that the kernel handles storage devices means that device names like /dev/hd*X* or /dev/sd*X* may differ from the values used in earlier releases. Anaconda solves this problem by relying on partition labels. If these labels are not present, then Anaconda provides a warning that these partitions need to be labeled. Systems that use Logical Volume Management (LVM) and the device mapper usually do not require relabeling.

- Support is included for installation to encrypted block devices, including the root file system.

- Not all IDE RAID controllers are supported. If your RAID controller is not yet supported by **`dmraid`**, you may combine drives into RAID arrays by configuring Linux software RAID. For supported controllers, configure the RAID functions in the computer BIOS.

- The version of GRUB included in Red Hat Enterprise Linux 6 now supports ext4, so Anaconda now allows you to use the ext4 file system on any partition, including the **`/boot`** and root partitions.

2.2.2. Kickstart

This section describes what behaviors have changed in automated installations (Kickstart).

2.2.2.1. Behavioral Changes

- Previously, a Kickstart file that did not have a **network** line resulted in the assumption that DHCP should be used to configure the network. This was inconsistent with the rest of Kickstart in that all other missing lines mean installation should halt and prompt for input. Now, having no **network** line means that installation will halt and prompt for input. Also, the **--bootproto=query** option is deprecated. If you want to continue using DHCP without interruption, add **network --bootproto=dhcp** to your Kickstart file.

- Traditionally, disks have been referred to throughout Kickstart by a device node name (such as **sda**). The Linux kernel has moved to a more dynamic method where device names are not guaranteed to be consistent across reboots, so this can complicate usage in Kickstart scripts. To accommodate stable device naming, you can use any item from **/dev/disk** in place of a device node name. For example, instead of:

  ```
  part / --fstype=ext4 --onpart=sda1
  ```

  You could use an entry similar to one of the following:

  ```
  part / --fstype=ext4 --onpart=/dev/disk/by-path/pci-0000:00:05.0-scsi-0:0:0:0-part1
  part / --fstype=ext4 --onpart=/dev/disk/by-id/ata-ST3160815AS_6RA0C882-part1
  ```

  This provides a consistent way to refer to disks that is more meaningful than just **sda**. This is especially useful in large storage environments.

- You can also use shell-like entries to refer to disks. This is primarily intended to make it easier to use the **clearpart** and **ignoredisk** commands in large storage environments. For example, instead of:

  ```
  ignoredisk --drives=sdaa,sdab,sdac
  ```

  You could use an entry similar to the following:

  ```
  ignoredisk --drives=/dev/disk/by-path/pci-0000:00:05.0-scsi-*
  ```

- Kickstart will halt with an error in more cases than previous versions. For example, if you refer to a disk that does not exist, the installation will halt and inform you of the error. This is designed to help detect errors in Kickstart files before they lead to larger problems. As a side-effect, files that are designed to be generic across different machine configurations may fail more often. These should be dealt with on a case-by-case basis.

- The **/tmp/netinfo** file used for Kickstart network information has been removed. Anaconda now uses *NetworkManager* for interface configuration, and stores configuration in the ifcfg files in **/etc/sysconfig/network-scripts/**. It is possible to use this new location as a source of network settings for *%pre* and *%post* scripts.

2.2.2.2. Command Changes

This sections lists the most important changes to commands and their options:

- The **network --device** option can now refer to devices by MAC addresses instead of device name. Similar to disks, network device names can also change across reboots depending on the order in which devices are probed. In order to allow consistent naming in Kickstart, you could use an entry similar to the following:

```
network --device=00:11:22:33:44:55 --bootproto=dhcp
```

- The **langsupport**, **key** and **mouse** commands have been removed. Any use of these commands will result in a syntax error. The **monitor** command has also been deprecated.

  Instead of **langsupport**, add the appropriate group to the **%packages** section of your Kickstart file. For example, to include French support, add **@french-support**.

  There is no replacement for the **key** option, as an installation key is no longer requested during install. Simply remove this option from your file.

  The **mouse** and **monitor** commands are not required as X can detect and configure settings automatically. For the same reason, the **xconfig --resolution=** command is no longer valid, and these can all be safely removed from the file.

- The **part --start** and **part --end** commands have been deprecated and have no effect. Anaconda no longer allows creating partitions at specific sector boundaries. If you require a more strict level of partitioning, use an external tool in **%pre** and then tell anaconda to use existing partitions with the **part --onpart** command. Otherwise, create partitions with a certain size or use **--grow**.

- Instead of creating groups manually in **%post**, you can now use the **group** command to create them for you. Please refer to the complete Kickstart documentation for more details.

- The default autopart algorithm has changed. For all machines, autopart will create a **/boot** (or other special bootloader partitions as required by the architecture) and swap. For machines with at least 50 GB of free disk space, autopart will create a reasonably sized root partition (**/**) and the rest will be assigned to **/home**. For those machines with less space, only root (**/**) will be created.

  If you do not want a **/home** volume created for you, do not use autopart. Instead, specify **/boot**, swap and **/**, making sure to allow the root volume to grow as necessary.

- Anaconda now includes a new storage filtering interface to control which devices are visible during installation. This interface corresponds to the existing **ignoredisk**, **clearpart** and **zerombr** commands. Because **ignoredisk** is optional, excluding it from the Kickstart file will not cause the filter UI to appear during installation. If you wish to use this interface, add:

```
ignoredisk --interactive
```

- The **--size=1 --grow** option from the **/tmp/partition-include** file can no longer be used. You must specify a reasonable default size and partitions will grow accordingly.

2.2.2.3. Packages Changes

These changes affect the **%packages** section:

- The **--ignoreDeps** and **--resolveDeps** arguments have been removed. Anaconda automatically resolves dependencies, but will skip installation of packages that have unmet dependencies.

- If you want to get the exact same set of packages via Kickstart that you would in a default GUI install accepting all of the defaults, add the following:

```
%packages --default
%end
```

- You can also optionally specify the architecture of packages that you want installed for multi-arch installs. For instance:

```
%packages
glibc.i686
%end
```

  This would add the x86 *glibc* package to the set, which can be useful on an x86-64 system that requires the x86 packages for compatibility reasons.

- It is not possible to audit and migrate all of the packages and groups in the **%packages** section. Some packages and groups have been removed, some added, and some have had their name changed. Please refer to the Release Notes for more details.

2.2.2.4. Script Changes

These changes affect the use of **%pre**, **%post** and **%traceback** scripts.

- Logging of errors while running scripts has been improved. Scripts are no longer removed after they are run, so they can be inspected. This is most useful on systems where the scripts are dynamically generated so you can see what was run. In addition, the stderr and stdout output is always logged for every script. This has one important side effect: if your scripts use an interactive program, you must pass **--logfile=/dev/tty3** to the header of your scripts. Otherwise, you will not be able to interact with the program.

2.2.2.5. Syntax Changes

Changes to the core Kickstart syntax are quite rare. However, there are two important syntax changes to be aware of:

- The **%include** option can now accept a URL as an argument, in addition to a file name.

- The **%packages**, **%post**, **%pre** and **%traceback** sections must have an **%end** option at the end. Previously, these sections had no explicit ending token, but ended where another began. Starting in Red Hat Enterprise Linux 6, using **%end** is required. Files without an **%end** token will fail.

2.2.2.6. Summary of Differences

This section lists the difference in commands and options in Red Hat Enterprise Linux 6:

Commands removed:

- **key**
- **langsupport**
- **mouse**

Commands deprecated:

- **monitor**
- **xconfig --resolution**

Commands added:

- **fcoe**
- **group**
- **rescue**
- **sshpw**
- **updates**

2.2.2.7. pykickstart

The *pykickstart* package contains utilities that can be used to make migration easier. Make sure you have the latest package installed. The **ksverdiff** command takes a starting and ending syntax version, and reports differences in commands and options for the two given versions. It states the new, deprecated and removed commands and options. For example:

```
$ ksverdiff --from RHEL5 --to RHEL6

The following commands were removed in RHEL6:
langsupport mouse key

The following commands were deprecated in RHEL6:
monitor

The following commands were added in RHEL6:
sshpw group rescue updates fcoe
 ...
```

You can also check the validity of your Kickstart file with the **ksvalidator** command. This command checks the validity of the file against any Kickstart syntax version that you specify. However, it can not inform you about problems that would only happen at install time, for example if you specify **part --ondisk=sdr** and no such device exists. Example usage:

```
$ ksvalidator --version RHEL6 my-rhel5-ks.cfg
```

2.2.3. Networking

This section describes what behaviors have changed in the graphical installer, relating to networking.

- Anaconda is now using *NetworkManager* for configuration of network interfaces during installation. The main network interface configuration screen in Anaconda has been removed. Users are only prompted for network configuration details if they are necessary during installation. The settings used during installation are then written to the system for later use.
- When using **boot.iso** to boot the installer, the source selection screen appears even if all of the default installation methods are chosen.
- When PXE booting and using a .iso file mounted via NFS for the installation media, add **repo=nfs:server:/path/** to the command line. The **install.img** and **product.img** files

also need to be extracted and/or placed into the **`nfs:server:/path/images/`** directory. The **`product.img`** file contains variant definitions and various install classes.

- Some systems with multiple network interfaces may not assign *eth0* to the first network interface as recognized by the system BIOS. This can cause the installer to attempt to use a different network interface than was initially used by PXE. To change this behavior, use the following in **`pxelinux.cfg/*`** configuration files:

```
IPAPPEND 2 APPEND
      ksdevice=bootif
```

- This configuration option causes the installer to use the same network interface as the system BIOS and PXE use. You can also use the following option, which will cause the installer to use the first network device it finds that is linked to a network switch:

```
ksdevice=link
```

2.2.4. Product Subscriptions and Content Updates

Red Hat Enterprise Linux 6 introduces an updated and more flexible service for content delivery and subscription management. This section describes the changes to the content service.

- The Red Hat Network hosted environment has been updated. Instead of channel-based subscriptions, it now uses product-and-quantity based subscriptions. The new Certificate-Based RHN includes redesigned client tools for managing subscriptions and systems, and works with the new Entitlements and Content Delivery Network (CDN).

  The traditional channel-based RHN is still available as *RHN Classic*.

  These two subscription services are available on the same platform, just with parallel technologies, so all subscriptions can be registered and managed either way.

- A new content server option, Red Hat Network Classic, has been added to the firstboot wizard. This uses the traditional channel-based RHN rather than the updated RHN and CDN. Certificate-Based RHN and RHN Classic are interoperable; if a system is registered using one service, the other service recognizes it and will not issue any warnings.

- A new set of client tools, the Red Hat Subscription Manager GUI and CLI, are provided with Red Hat Enterprise Linux 6.1 to manage subscriptions through Certificate-Based RHN. The existing **`rhn_*`** tools are still available to handle systems managed through RHN Classic.

2.3. Text-Based Installer

The text-mode installation option in Red Hat Enterprise Linux 6 is significantly more streamlined than it was in earlier versions. Text-mode installation now omits the more complicated steps that were previously part of the process, and provides you with an uncluttered and straightforward experience. This section describes the changes in behavior when using the text-based installer:

- Anaconda now automatically selects packages only from the base and core groups. These packages are sufficient to ensure that the system is operational at the end of the installation process, ready to install updates and new packages.

- Anaconda still presents you with the initial screen from previous versions that allows you to specify where anaconda should install Red Hat Enterprise Linux on your system. You can choose to use a whole drive, to remove existing Linux partitions, or to use the free space on the drive. However, anaconda now automatically sets the layout of the partitions and does not ask you to add or delete partitions or file systems from this basic layout. If you require a customized layout at installation time, you should perform a graphical installation over a VNC connection or a Kickstart installation. More advanced options, such as logical volume management (LVM), encrypted filesystems, and resizable filesystems are still only available in graphical mode and Kickstart.
- Anaconda now performs bootloader configuration automatically in the text-based installer.
- Text-mode installations using Kickstart are carried out in the same way that they were in previous versions. However, because package selection, advanced partitioning, and bootloader configuration are now automated in text mode, anaconda cannot prompt you for information that it requires during these steps. You must therefore ensure that the Kickstart file includes the packaging, partitioning, and bootloader configurations. If any of this information is missing, anaconda will exit with an error message.

Storage and File Systems

3.1. RAID

Upgrades

Performing an upgrade from a **dmraid** set to an **mdraid** set is not supported. A warning will be displayed when an upgrade of this type is attempted. Upgrades from existing **mdraid** sets and creation of new **mdraid** sets are possible.

The new default superblock can cause problems when upgrading sets. This new superblock format (used on all devices except when creating a RAID1 **/boot** partition) is now at the beginning of the array, and any file system or LVM data is offset from the beginning of the partition. When the array is not running, LVM and file system **mount** commands may not detect the device as having a valid volume or file system data. This is intentional, and means that if you want to mount a single disk in a RAID1 array, you need to start the array having only that single disk in it, then mount the array. You can not mount the bare disk directly. This change has been made as mounting a bare disk directly can silently corrupt the array if a resync is not forced.

On subsequent reboots, the RAID system may then consider the disk that was not included in the array as being incompatible, and will disconnect that device from the array. This is also normal. When you are ready to re-add the other disk back into the array, use the **mdadm** command to hot add the disk into the array, at which point a resync of the changed parts of the disk (if you have write intent bitmaps) or the whole disk (if you have no bitmap) will be performed, and the array will once again be synchronized. From this point, devices will not be disconnected from the array, as the array is considered to be properly assembled.

The new superblock supports the concept of named **mdraid** arrays. Dependency on the old method of array enumeration (for instance, **/dev/md0** then **/dev/md1**, etc.) for distinguishing between arrays has been dropped. You can now choose an arbitrary name for the array (such as **home**, **data**, or **opt**). Create the array with your chosen name using the **--name=opt** option. Whatever name is given to the array, that name will be created in **/dev/md/** (unless a full path is given as a name, in which case that path will be created; or unless you specify a single number, such as 0, and **mdadm** will start the array using the old **/dev/md***x* scheme). The Anaconda installer does not currently allow for the selection of array names, and instead uses the simple number scheme as a way to emulate how arrays were created in the past.

The new **mdraid** arrays support the use of write intent bitmaps. These help the system identify problematic parts of an array, so that in the event of an unclean shutdown, only the problematic parts need to be resynchronized, and not the entire disk. This drastically reduces the time required to resynchronize. Newly created arrays will automatically have a write intent bitmap added when suitable. For instance, arrays used for swap and very small arrays (such as **/boot** arrays) do not benefit from having write intent bitmaps. It is possible to add a write intent bitmap to your previously existing arrays after the upgrade is complete via the **mdadm --grow** command on the device, however write intent bitmaps do incur a modest performance hit (about 3-5% at a bitmap chunk size of 65536, but can increase to 10% or more at small bitmap chunk sizes such as 8192). This means that if a write intent bitmap is added to an array, it is best to keep the chunk size reasonably large. The recommended size is 65536.

3.2. ext4

Migration from ext3

It is recommended that those wishing to make use of ext4 start with a freshly formatted partition. However, you may install Red Hat Enterprise Linux 6 with the **ext4migrate** boot option if you wish to convert your legacy ext3 partitions to ext4. It is important to note that by doing this you will not receive all of the benefits ext4 offers, since the data currently residing on the partition will not make use of the extents features and other changes. New data will however make use of extents. Passing this boot option to migrate to ext4 is not recommended and it is strongly recommended that you back up file systems before attempting this migration.

Behavioral changes

Red Hat Enterprise Linux 6 provides full support for ext4 and it is the default file system for new installations. This section explains the major changes in behavior that this new file system introduces.

- The included version of the *GRUB* bootloader provides full support for ext4 partitions. The installer also allows you to place any **/boot** file system on an ext4 partition.
- The included version of the *e2fsprogs* package is fully compatible with ext4.
- In some cases, ext4 file systems created under Red Hat Enterprise Linux 5.3 with the *e4fsprogs* package created an **ext4dev** file system type. The **test_fs** feature flag identifying these file systems as a development version can be removed with the following command: **tune2fs -E ^test_fs**. This is done so that these file systems will be recognized as regular ext4 file systems.

3.3. fusecompress

fusecompress

Fusecompress is a compressing filesystem mountable by unprivileged users. Red Hat Enterprise Linux 6 includes an updated version that fixes several bugs but changes the on-disk format. Users with existing fusecompress filesystems will need to migrate their data to the new format. Unless decompression is performed before upgrading, the *fusecompress_offline1* package is required.

3.4. blockdev

blockdev

The **blockdev --rmpart** command option is no longer supported. The **partx(8)** and **delpart(8)** commands now provide this functionality.

Networking and Services

4.1. Interfaces and Configuration

NetworkManager

Red Hat Enterprise Linux 6 uses NetworkManager by default when configuring network interfaces.

Infiniband

Infiniband support (specifically the **openib** start script and the **openib.conf** file) was provided by the *openib* package in Red Hat Enterprise Linux 5. The package name has changed in Red Hat Enterprise Linux 6 to reflect its functionality more accurately. The Infiniband functionality is now distributed in the *rdma* package. The service is now called **rdma**, and the configuration file is located at **/etc/rdma/rdma.conf**.

4.2. Service Initialization

xinetd

Xinetd is a daemon used to start network services on demand. The changes in xinetd are related to the allowed limit of open file descriptors:

- The listening mechanism has changed from **select()** to **poll()**. With this change, the limit of open file descriptors used by xinetd can be changed.
- File descriptor limit can also now be changed on a per-service basis. This can be done in the configuration file for the service via the **rlimit_files** directive. The value can be a positive integer or UNLIMITED.

Runlevels

In Red Hat Enterprise Linux 6, the custom runlevels 7, 8 and 9 are no longer supported and can not be used.

Upstart

In Red Hat Enterprise Linux 6, *init* from the *sysvinit* package has been replaced with *Upstart*, an event-based init system. This system handles the starting of tasks and services during boot, stopping them during shutdown and supervising them while the system is running. For more information on Upstart itself, refer to the **init(8)** man page.

Processes are known to Upstart as jobs and are defined by files in the **/etc/init** directory. Upstart is very well documented via man pages. Command overview is in **init(8)** and job syntax is described in **init(5)**.

Upstart provides the following behavioral changes in Red Hat Enterprise Linux 6:

- The **/etc/inittab** file is deprecated, and is now used *only* for setting up the default runlevel via the *initdefault* line. Other configuration is done via **upstart** jobs in the **/etc/init** directory.
- The number of active tty consoles is now set by the *ACTIVE_CONSOLES* variable in **/etc/sysconfig/init**, which is read by the **/etc/init/start-ttys.conf** job. The default value is *ACTIVE_CONSOLES=/dev/tty[1-6]*, which starts a getty on tty1 through tty6.

- A serial getty is still automatically configured if the serial console is the primary system console. In prior releases, this was done by **kudzu**, which would edit **/etc/inittab**. In Red Hat Enterprise Linux 6, configuration of the primary serial console is handled by **/etc/init/serial.conf**.
- To configure a getty running on a non-default serial console, you must now write an Upstart job instead of editing **/etc/inittab**. For example, if a getty on ttyS1 is desired, the following job file (**/etc/init/serial-ttyS1.conf**) would work:

```
# This service maintains a getty on /dev/ttyS1.

start on stopped rc RUNLEVEL=[2345]
stop on starting runlevel [016]

respawn
exec /sbin/agetty /dev/ttyS1 115200 vt100-nav
```

As in prior releases, you should still make sure that ttyS1 is in **/etc/securetty** if you wish to allow root logins on this getty.

Because of the move to Upstart, using **/etc/shutdown.allow** for defining who can shut the machine down is no longer supported.

4.3. IPTables/Firewalls

IPTables includes a **SECMARK** target module. This is used to set the security mark value associated with the packet for use by security subsystems such as SELinux. It is only valid in the mangle table. Refer to the following for example usage:

```
iptables -t mangle -A INPUT -p tcp --dport 80 -j SECMARK --selctx \
 system_u:object_r:httpd_packet_t:s0
```

4.4. Apache HTTP Server

Below is a list of changes for the Apache HTTP Server that are noteworthy when migrating to Red Hat Enterprise Linux 6:

- The **mod_file_cache**, **mod_mem_cache**, and **mod_imagemap** modules are no longer supported.
- The **Charset=UTF-8** option has been added to the default **IndexOptions** directive. If directory listings with a non UTF-8 character set are required (such as those produced by **mod_autoindex**), this option should be changed.
- The **distcache** distributed session cache is no longer supported in **mod_ssl**.
- The default location of the process ID (pid) file has moved from **/var/run** to **/var/run/httpd**.
- The *mod_python* package is no longer included as upstream development has ceased. Red Hat Enterprise Linux 6 provides *mod_wsgi* as an alternative, with support for Python scripting via the WSGI interface.

4.5. PHP

PHP changes are listed below:

- PHP has been upgraded to version 5.3. Compatibility issues may require scripts to be updated. For further details, refer to the following URLs:
  - *http://php.net/manual/migration52.php*
  - *http://php.net/manual/migration53.php*
- The following changes have been made to the default configuration (**/etc/php.ini**):
  - **error_reporting** is now set to **E_ALL & ~E_DEPRECATED** (previously **E_ALL**)
  - **short_open_tag** is now set to **Off** (previously **On**)
  - **variables_order** is now set to **GPCS** (previously **EGPCS**)
  - **enable_dl** is now to set to **Off** (previously **On**)
- The **mime_magic**, **dbase**, and **ncurses** extensions are no longer distributed.

4.6. BIND

There are several major changes in BIND configuration:

- Default ACL configuration - in Red Hat Enterprise Linux 5, the default ACL configuration allowed queries and offered recursion for all hosts. By default in Red Hat Enterprise Linux 6, all hosts can make queries for authoritative data but only hosts from the local network can make recursive queries.
- New **allow-query-cache** option - the **allow-recursion** option has been deprecated in favor of this option. It is used to control access to server caches, which include all non-authoritative data (like recursive lookups and root nameserver hints).
- Chroot environment management - the **bind-chroot-admin** script, which was used to create symlinks from a non-chroot environment to a chroot environment, is deprecated and no longer exists. Instead, configuration can be managed directly in a non-chroot environment and init scripts automatically mount needed files to the chroot environment during `named` startup in the case that files are not already present in the chroot.
- **/var/named** directory permissions - The **/var/named** directory is no longer writable. All zone files that need to be writable (such as dynamic DNS zones, DDNS) should be placed in the new writable directory: **/var/named/dynamic**.
- The **dnssec [yes|no]** option no longer exists - The global **dnssec [yes|no]** options have been split into two new options: **dnssec-enable** and **dnssec-validation**. The **dnssec-enable** option enables DNSSEC support. The **dnssec-validation** option enables DNSSEC validation. Note that setting **dnssec-enable** to "no" on recursive server means that it cannot be used as a forwarder by another server that performs DNSSEC validation. Both options are set to yes by default.
- You no longer need to specify the **controls** statement in **/etc/named.conf** if you use the **rndc** management utility. The `named` service automatically allows control connections via the loopback device and both `named` and **rndc** use the same secret key generated during installation (located in **/etc/rndc.key**).

In a default installation, BIND is installed with DNSSEC validation enabled, and uses the ISC DLV register. This means all signed domains (such as gov., se., cz.), that have their key in the ISC DLV register, are cryptographically validated on the recursive server. If validation fails due to attempts at

cache poisoning, then the end user will not be given this forged/spoofed data. DNSSEC deployment is now a widely-implemented feature, is an important step in making the Internet more secure for end users, and is fully supported in Red Hat Enterprise Linux 6. As previously mentioned, DNSSEC validation is controlled with the **dnssec-validation** option in **/etc/named.conf**.

4.7. NTP

NTP (Network Time Protocol) is used to synchronize the clocks of computer systems over the network. In Red Hat Enterprise Linux 6, the default configuration file, **/etc/ntp.conf**, now has the following lines commented:

```
#server 127.127.1.0 # local clock
#fudge 127.127.1.0 stratum 10
```

This configuration means that ntpd will only distribute time information to network clients if it is specifically synchronized to an NTP server or a reference clock. To get ntpd to offer this information even when not synchronized, the two lines should be uncommented.

Also, when ntpd is started with the **-x** option (in OPTIONS in the **/etc/sysconfig/ntpd** file), or if there are servers specified in **/etc/ntp/step-tickers**, the service no longer runs the **ntpdate** command before starting. There is now a separate ntpdate service which can be enabled independently from the ntpd service. This ntpdate service is disabled by default, and should be used only when other services require the correct time before starting, or do not function properly when time modifications occur later by ntpd.

You may encounter problems running this service with the default NetworkManager configuration. It may be necessary to add **NETWORKWAIT=1** to **/etc/sysconfig/network**, as described in the Red Hat Enterprise Linux Deployment Guide.

4.8. Kerberos

In Red Hat Enterprise Linux 6, Kerberos clients and servers (including KDCs) will default to not using keys for the ciphers **des-cbc-crc**, **des-cbc-md4**, **des-cbc-md5**, **des-cbc-raw**, **des3-cbc-raw**, **des-hmac-sha1**, and **arcfour-hmac-exp**. By default, clients will not be able to authenticate to services which have keys of these types.

Most services can have a new set of keys (including keys for use with stronger ciphers) added to their keytabs and experience no downtime, and the ticket granting service's keys can likewise be updated to a set which includes keys for use with stronger ciphers, using the kadmin **cpw -keepold** command.

As a temporary workaround, systems that need to continue to use the weaker ciphers require the **allow_weak_crypto** option in the *libdefaults* section of the **/etc/krb5.conf** file. This variable is set to *false* by default, and authentication will fail without having this option enabled:

```
[libdefaults]
allow_weak_crypto = yes
```

Additionally, support for Kerberos IV, both as an available shared library and as a supported authentication mechanism in applications, has been removed. Newly-added support for lockout policies requires a change to the database dump format. Master KDCs which need to dump databases in a format which older KDCs can consume should run kdb5_util's **dump** command with the **-r13** option.

4.9. Mail

4.9.1. Sendmail

In some releases of Red Hat Enterprise Linux 5, the *sendmail* Mail Transport Agent (MTA) accepted network connections from external hosts by default. In Red Hat Enterprise Linux 6, *sendmail* by default only accepts connections from the local system (localhost). To grant *sendmail* the ability to act as a server for remote hosts, perform one of the following steps:

- Edit **/etc/mail/sendmail.mc** and change the **DAEMON_OPTIONS** line to also listen on network devices
- Comment out the **DAEMON_OPTIONS** line in **/etc/mail/sendmail.mc**.

To put either of these changes into effect, install the *sendmail-cf* package, then regenerate **/etc/mail/sendmail.cf**. This is done by running the following commands:

```
su -c 'yum install sendmail-cf'
su -c 'make -C /etc/mail'
```

4.9.2. Exim

Exim has been removed from Red Hat Enterprise Linux 6. Postfix is the default and recommended MTA.

4.9.3. Dovecot

Dovecot configuration

The configuration for Dovecot 2.x has changed. The master configuration file **/etc/dovecot.conf** has moved to **/etc/dovecot/dovecot.conf** and other parts of Dovecot configuration have moved to **/etc/dovecot/conf.d/*.conf**. The majority of the configuration is the same and is compatible with this new version; however, you can test your configuration and list which options have been renamed, removed, or otherwise changed in this new version with the following command:

```
doveconf [-n] -c /old/dovecot.conf
```

4.10. MySQL®

DBD Driver

The MySQL DBD driver has been dual-licensed and the related licensing issues have been resolved. The resulting *apr-util-mysql* package is now included in the Red Hat Enterprise Linux 6 software repositories.

4.11. PostgreSQL

Upgrading Databases

If you are upgrading from an existing Red Hat Enterprise Linux 5 installation in which PostgreSQL 8.4 (*postgresql84-** packages) was in use, the Red Hat Enterprise 6 PostgreSQL packages will operate as a drop-in replacement.

However, if you are upgrading from a Red Hat Enterprise Linux 5 installation in which PostgreSQL 8.1 (*postgresql-** packages) or earlier was in use, and you have existing database content that needs to be preserved, you will need to follow the dump and reload procedure here due to changes in the data format: *http://www.postgresql.org/docs/8.4/interactive/install-upgrading.html*. Ensure that you perform the dump step **before** upgrading to Red Hat Enterprise Linux 6.

Other Changes

Refer to the following URL for possible application compatibility issues associated with the transition from PostgreSQL 8.1 to 8.4: *http://wiki.postgresql.org/wiki/WhatsNew84*

4.12. Squid

Squid has been updated to 3.1, and now provides native IPv6 support. The configuration file **`/etc/squid/squid.conf`** has been significantly shortened; the configuration options for Squid 3.1 have changed and are not entirely backwards compatible with some older versions. For complete details on configuration and other changes, please refer to the Squid 3.1 release notes: *http://www.squid-cache.org/Versions/v3/3.1/RELEASENOTES.html*.

Squid provides the ability to authenticate users via *ncsa_auth* and *pam_auth* helpers. The permissions of these helpers has changed in Red Hat Enterprise Linux 6. Previous releases enabled the setuid flag for the *ncsa_auth* and *pam_auth*, as elevated privileges were needed to access system files needed for authentication. Now, in Red Hat Enterprise Linux 6, Squid does not require the setting of the setuid flag for these helpers. This change has been made because of the security risks present when running setuid flags. Normal functionality has been maintained without setting these flags.

4.13. Bluetooth

Bluetooth Service On Demand

In order to support Bluetooth devices, the Bluetooth background service was started by default in previous versions of Red Hat Enterprise Linux. In this release, the Bluetooth service is started on demand when needed and automatically stops 30 seconds after the use of the device has stopped. This reduces overall initial startup time and resource consumption.

4.14. Cron

Vixie cron and Cronie

Red Hat Enterprise Linux 6 includes the *cronie* package as a replacement for *vixie-cron*. The main difference between these packages is how the regular jobs (daily, weekly, monthly) are done. Cronie uses the **`/etc/anacrontab`** file, which by default looks like the following:

```
# the maximal random delay added to the base delay of the jobs
RANDOM_DELAY=45

# the jobs will be started during the following hours only
START_HOURS_RANGE=3-22

# period in days   delay in minutes   job-identifier      command

1   5  cron.daily nice run-parts /etc/cron.daily
7   25  cron.weekly nice run-parts /etc/cron.weekly
@monthly  45  cron.monthly nice run-parts /etc/cron.monthly
```

These regular jobs will be executed once a day in the 03:00-22:00 time interval, including a random delay. For example, *cron.daily* will have a 5 minute forced delay plus a random delay of 0-45 minutes. You could also run jobs with no delays, between 4 and 5:

```
RANDOM_DELAY=0 # or don't use this option at all

START_HOURS_RANGE=4-5

# period in days   delay in minutes   job-identifier      command
1   0  cron.daily nice run-parts /etc/cron.daily
7   0  cron.weekly nice run-parts /etc/cron.weekly
@monthly  0  cron.monthly nice run-parts /etc/cron.monthly
```

Features of *cronie* include:

- Random delay for starting the job in **`/etc/anacrontab`**.
- Time range of regular jobs can be defined in **`/etc/anacrontab`**.
- Each cron table can have its own defined time zone with the CRON_TZ variable.
- By default, the cron daemon checks for changes in tables with inotify.

For further details about *cronie* and *cronie-anacron*, please refer to the Red Hat Enterprise Linux Deployment Guide.

4.15. Logging

The **`dateext`** option is now enabled by default in **`/etc/logrotate.conf`**. This option archives old versions of log files by adding a extension representing the date (in YYYYMMDD format). Previously, a number was appended to files.

Command Line Tools

This section describes the behavioral changes of command-line tools in Red Hat Enterprise Linux 6.

5.1. Grep

The behavior of the **grep** command has changed with regards to searching for upper and lower case strings. Using interval searching in the [a-z] format is dependent on the *LC_COLLATE* variable.

You can set **LC_COLLATE=C** to preserve old behavior and to achieve proper results when performing interval searching with this method; however, in Red Hat Enterprise Linux 6, the recommended way of interval searching is to use the [[:lower:]],[[:upper:]] format.

This change can significantly affect output, so scripts and processes should be reviewed to continue to achieve the correct results.

5.2. Sed

The *sed* command with the **-i** option lets you delete the contents of a read-only file and lets you delete other protected files. The permissions on a file define what actions can take place to that file, while the permissions on a directory define what actions can be taken to the list of files in that directory. For this reason, **sed** does not let you use **-i** on a write-enabled file in a read-only directory, and will break symbolic or hard links when the **-i** option is used on such a file.

5.3. Pcre

The *pcre* package has been updated to 7.8. It includes the following behavioral changes:

- UTF-8 checking now references RFC 3629 instead of RFC 2279. This makes it more restrictive in the strings that it accepts. For example, the UTF-8 character ordinal value is now limited to 0x0010FFFF:

  ```
  $ echo -ne "\x00\x11\xff\xff" | recode UCS-4-BE..UTF8 | pcregrep --utf-8 '.'
  pcregrep: pcre_exec() error -10 while matching this line:
  ```

  Please refer to the RFC for more details: *http://tools.ietf.org/html/rfc3629#section-12*.

- Saved patterns that were compiled by earlier versions of PCRE must be recompiled. This affects applications that serialize pre-compiled PCRE expressions to external memory (for example, a file) and load them later. This is usually done for performance reasons, for example in large spam filters.

5.4. Shells

The location of the shell binary files has changed. For example, the **bash** and **ksh** binaries are no longer in **/usr/bin**. Both binaries are now found in **/bin**. Scripts will require updating to point to the new location of the binary.

5.5. Nautilus

The **nautilus-open-terminal** package provides a right-click **Open Terminal** option to open a new terminal window in the current directory. Previously, when this option was chosen from the **Desktop**, the new terminal window location defaulted to the user's home directory. However, in Red Hat Enterprise Linux 6, the default behavior opens the Desktop directory (i.e **~/Desktop/**). To enable

the previous behavior, use the following command to set the **desktop_opens_home_dir** GConf boolean to true:

```
gconftool-2 -s /aps/nautilus-open-terminal/desktop_opens_dir --type=bool
true
```

Desktop

- In Red Hat Enterprise Linux 6, the GUI console has moved from tty7 to tty1.

GDM Configuration

A number of GDM settings are now managed within GConf.

The GDM default greeter is called the simple Greeter and is configured via GConf. Default values are stored in GConf in the *gdm-simple-greeter.schemas* file. Use **gconftool2** or **gconf-editor** to edit these values. The following options exist for the Greeter:

- /apps/gdm/simple-greeter/banner_message_enable

  ```
  false (boolean)
  ```

  Controls whether the banner message text is displayed.

- /apps/gdm/simple-greeter/banner_message_text

  ```
  NULL (string)
  ```

  Specifies the text banner message to show on the greeter window.

- /apps/gdm/simple-greeter/logo_icon_name

  ```
  computer (string)
  ```

  Set to the themed icon name to use for the greeter logo.

- /apps/gdm/simple-greeter/disable_restart_buttons

  ```
  false (boolean)
  ```

  Controls whether to show the restart buttons in the login window.

- /apps/gdm/simple-greeter/wm_use_compiz

  ```
  false (booleans)
  ```

  Controls whether compiz is used as the window manager instead of metacity.

Plugins can also be disabled using GConf. For example, if you want to disable the sound plugin then unset the following key: **/apps/gdm/simple-greeter/settings-manager-plugins/sound/active**.

Security and Authentication

This chapter covers behavioral changes for security and authentication, including SELinux, SSSD, LDAP, Checksums, and PAM.

7.1. SELinux

The `sshd` daemon is now a confined service.

7.2. SSSD

SSSD (System Security Services Daemon) offers access to remote identity and authentication mechanisms, referred to as *providers*. It allows those providers to be plugged in as SSSD back-ends, abstracting the local and network identity and authentication sources and allowing any kind of identity data provider to be plugged in. A *domain* is a database containing user information, which may serve as the source of a provider's identity information. Multiple identity providers are supported, allowing two or more identity servers to act as separate user namespaces. Collected information is available to applications on the front-end through standard PAM and NSS interfaces.

SSSD runs as a suite of services, independent of the applications that use it. Those applications therefore no longer need to make their own connections to remote domains, or even be aware of which is being used. Robust local caching of identity and group membership information allows operations regardless of where identity comes from (e.g., LDAP, NIS, IPA, DB, Samba, etc.), offers improved performance, and allows authentication to be performed even when operating offline and online authentication is unavailable. SSSD also allows the use of multiple providers of the same type (e.g., multiple LDAP providers) and allows domain-qualified identity requests to be resolved by those different providers. Further details can found in the Red Hat Enterprise Linux 6 Deployment Guide.

7.3. LDAP

OpenLDAP

The configuration required for the OpenLDAP service has changed in Red Hat Enterprise Linux 6. In previous versions, `slapd` was configured via the **`/etc/openldap/slapd.conf`** file. The `slapd` configuration in Red Hat Enterprise Linux 6 is now stored in a special LDAP directory (**`/etc/openldap/slapd.d/`**) with a pre-defined schema and Directory Information Tree (DIT). Further details of this configuration schema can be found at *openldap.org*[1]. The following section details an example on how to convert the old configuration file to work with the new directory:

7.3.1. Converting slapd configuration

This example assumes that the file to convert from the old `slapd` configuration is located at **`/etc/openldap/slapd.conf`** and the new directory for OpenLDAP configuration is located at **`/etc/openldap/slapd.d/`**.

- Remove the contents of the new **`/etc/openldap/slapd.d/`** directory:

```
# rm -rf /etc/openldap/slapd.d/*
```

[1] http://www.openldap.org/doc/admin24/slapdconf2.html#Configuration%20Layout

- Run **slaptest** to check the validity of the configuration file and specify the new configuration directory:

```
slaptest -f /etc/openldap/slapd.conf -F /etc/openldap/slapd.d
```

- Configure permissions on the new directory:

```
chown -R ldap:ldap /etc/openldap/slapd.d
```

```
chmod -R 000 /etc/openldap/slapd.d
```

```
chmod -R u+rwX /etc/openldap/slapd.d
```

- Once the service is confirmed to be working in the new configuration directory, remove the old configuration file:

```
rm -rf /etc/openldap/slapd.conf
```

7.4. Checksums

Red Hat Enterprise Linux now uses the SHA-256 digest algorithm for data verification and authentication in more places than before, upgrading from the cryptographically weaker SHA-1 and MD5 algorithms.

7.5. Pluggable Authentication Modules (PAM)

Common configuration for PAM services is located in the **/etc/pam.d/system-auth-ac** file.

Authentication modules are now also written into additional PAM configuration files: **/etc/pam.d/password-auth-ac**, **etc/pam.d/smartcard-auth-ac** and **/etc/pam.d/fingerprint-auth-ac**.

The PAM module for `sshd` and other remote services such as `ftpd` now include the **/etc/pam.d/password-auth** file in Red Hat Enterprise Linux 6 instead of **/etc/pam.d/system-auth**.

7.6. System Users

The threshold for statically assigned UID/GID numbers (defined by the *setup* package in the **/usr/share/doc/setup-*/uidgid** file) has increased from 100 (in Red Hat Enterprise Linux 3, 4, and 5) to 200 in Red Hat Enterprise Linux 6. This change can affect systems that have 100-200 dynamically or statically assigned UID/GIDs, and cause failure in the installation and running of some applications.

Dynamic UID/GID allocation now ranges from 499 downward in Red Hat Enterprise Linux 6. For static system user creation without reservations enforced by the *setup* package, it is recommended to use the UID/GID area of 300 and above.

Kernel

8.1. Kernel

The *dracut* tool has replaced the use of *mkinitrd*. Also, the **/etc/modprobe.conf** file is no longer used by default in the management of kernel modules, however it can still be used if manually created. Refer to the following for an example usage of the *dracut* tool.:

```
# mv /boot/initramfs-$(uname -r).img /boot/initramfs-$(uname -r)-old.img
# dracut --force /boot/initramfs-$(uname -r).img $(uname -r)
```

Package And Driver Changes

The list of included packages and system drivers undergoes regular changes in Red Hat Enterprise Linux releases. This is done for a number of reasons: packages and drivers are added or updated in the operating system to provide new functionality, or the packages and drivers may represent out-of-date hardware and are removed; the upstream project for the packages and drivers might no longer be maintained, or hardware-specific packages and drivers are no longer supported by a hardware vendor and are removed.

This chapter lists the new and updated packages and drivers in Red Hat Enterprise Linux 6, as well as those that have been deprecated and discontinued (removed).

9.1. System Configuration Tools Changes

system-config-bind

The *system-config-bind* tool has been deprecated and removed without replacement. Editing the name server configuration manually via the **`named.conf`** file is recommended in Red Hat Enterprise Linux 6. Comprehensive BIND documentation is installed as part of the *bind* package in **`/usr/share/doc/bind-x.y.z`**. Also, sample configurations can be found in the **`/usr/share/doc/bind-x.y.z/sample`** directory. The *system-config-bind* tool from previous versions does, however, generate standard BIND configuration, so depending on your environment it is possible to migrate to the version of BIND found in Red Hat Enterprise Linux 6 by moving old configuration files to the correct location and performing sufficient testing.

system-config-boot

The *system-config-boot* tool allowed graphical configuration of the GRUB bootloader. In Red Hat Enterprise Linux 6 it has been deprecated and removed without replacement. The default GRUB configuration is sufficient for many users, however if manual changes are required, the boot configuration can be accessed and changed in the **`grub.conf`** file, located in the **`/boot/grub`** directory. Full documentation for configuring GRUB can be found at the GRUB homepage: *http://www.gnu.org/software/grub/*.

system-config-cluster

The *system-config-cluster* tool has been deprecated and removed without replacement. Using *ricci* and *luci* (from the *Conga* project) is recommended.

system-config-display

The *system-config-display* tool has been replaced by *XRandr* configuration tools as found in both supported desktops: GNOME and KDE. There is no explicit configuration file (**`xorg.conf`**) in the default X server installation as display management is now done dynamically via one of the following menu options:

GNOME: **System** → **Preferences** → **Display**

KDE: **System Settings** → **Computer Administration** → **Display**

Note: The command line utility (**`xrandr`**) can be also used for display configuration. See the **`xrandr --help`** command or the manual page via the **`man xrandr`** command for further details.

system-config-httpd

The *system-config-httpd* tool has been deprecated and removed without replacement. Users should configure web servers manually. Configuration can be done in the **/etc/httpd** directory. The main configuration file is located at **/etc/httpd/conf/httpd.conf**. This file is well documented with detailed comments in the file for most server configurations; however if required, the complete Apache web server documentation is shipped in the *httpd-manual* package.

system-config-lvm

The *system-config-lvm* tool has been deprecated. Users should perform management of logical volumes via the *gnome-disk-util* or the *lvm* tools.

system-config-netboot

The *system-config-netboot* tool has been deprecated and removed without replacement. Using Red Hat Satellite is recommended.

system-config-network

The *system-config-network* tool has been replaced by *NetworkManager* - a modern and powerful network configuration tool. *NetworkManager-applet* (nm-applet) is installed by default in both supported desktop environments and can be found in the system tray panel area. See the NetworkManager home page for further information: *http://projects.gnome.org/NetworkManager/*.

system-config-nfs

The *system-config-nfs* tool has been deprecated and removed without replacement. Users should set up NFS server configuration manually.

system-config-rootpassword

The *system-config-rootpassword* tool has been replaced by the *system-config-users* tool - a powerful user management and configuration tool. The root password can be set in the *system-config-users* tool by unchecking the **"Hide system users and groups"** option in the Preferences dialog. The root user will now be shown in the main listing, and the password can be modified like any other user.

system-config-samba

The *system-config-samba* tool has been deprecated and removed without replacement. Users should set up SMB server configuration manually.

system-config-securitylevel

The *system-config-securitylevel* tool has been removed. Users should instead use the *system-config-firewall* tool.

system-config-soundcard

The *system-config-soundcard* tool has been removed. Sound card detection and configuration is done automatically.

system-config-switchmail

The *system-config-switchmail* tool has been deprecated and removed without replacement. Postfix is the preferred and default MTA (Mail Transfer Agent) in Red Hat Enterprise Linux 6. If you are

using another MTA, it should be configured manually according to its specific configuration files and techniques.

9.2. Bash (Bourne-Again Shell)

Red Hat Enterprise Linux 6 includes version 4.1 of Bash as its default shell. This section describes the compatibility issues that this version introduces over previous versions.

- Bash-4.0 and later now allows process substitution constructs to pass unchanged through brace expansion, so any expansion of the contents will have to be separately specified, and each process substitution will have to be separately entered.
- Bash-4.0 and later now allows SIGCHLD to interrupt the wait builtin, as Posix specifies, so the SIGCHLD trap is no longer always invoked once per exiting child if you are using `wait' to wait for all children.
- Since Bash-4.0 and later now follows Posix rules for finding the closing delimiter of a $() command substitution, it will not behave as previous versions did, but will catch more syntax and parsing errors before spawning a subshell to evaluate the command substitution.
- The programmable completion code uses the same set of delimiting characters as readline when breaking the command line into words, rather than the set of shell metacharacters, so programmable completion and readline should be more consistent.
- When the read builtin times out, it attempts to assign any input read to specified variables, which also causes variables to be set to the empty string if there is not enough input. Previous versions discarded the characters read.
- In Bash-4.0 and later, when one of the commands in a pipeline is killed by a SIGINT while executing a command list, the shell acts as if it received the interrupt.
- Bash-4.0 and later versions change the handling of the **`set -e`** option so that the shell exits if a pipeline fails (and not just if the last command in the failing pipeline is a simple command). This is not as Posix specifies. There is work underway to update this portion of the standard; the Bash-4.0 behavior attempts to capture the consensus at the time of release.
- Bash-4.0 and later fixes a Posix mode bug that caused the **`. (source)`** builtin to search the current directory for its filename argument, even if **`"."`** is not in the system PATH. Posix says that the shell shouldn't look in the PWD variable in this case.
- Bash-4.1 uses the current locale when comparing strings using operators to the **`[[`** command. This can be reverted to the previous behavior by setting one of the **`compatNN`** *shopt* options.

Regular Expressions

Further to the points already listed, quoting the pattern argument to the regular expression matching conditional operator =~ may cause regexp matching to stop working. This occurs on all architectures. In versions of *bash* prior to 3.2, the effect of quoting the regular expression argument to the **[[** command's =~ operator was not specified. The practical effect was that double-quoting the pattern argument required backslashes to quote special pattern characters, which interfered with the backslash processing performed by double-quoted word expansion and was inconsistent with how the == shell pattern matching operator treated quoted characters.

In *bash* version 3.2, the shell was changed to internally quote characters in single- and double-quoted string arguments to the =~ operator, which suppresses the special meaning of the characters that are important to regular expression processing *(`.', `[', `\', `(', `), `*', `+', `?', `{', `|', `^', and `$')* and

forces them to be matched literally. This is consistent with how the == pattern matching operator treats quoted portions of its pattern argument.

Since the treatment of quoted string arguments was changed, several issues have arisen, chief among them the problem of white space in pattern arguments and the differing treatment of quoted strings between *bash* 3.1 and *bash* 3.2. Both problems may be solved by using a shell variable to hold the pattern. Since word splitting is not performed when expanding shell variables in all operands of the **[[** command, this provides the ability to quote patterns as you wish when assigning the variable, then expand the values to a single string that may contain whitespace. The first problem may be solved by using backslashes or any other quoting mechanism to escape the white space in the patterns.

Bash 4.0 introduces the concept of a *compatibility level*, controlled by several options to the *shopt* builtin. If the *compat31* option is enabled, bash will revert to the 3.1 behavior with respect to quoting the right-hand side of the =~ operator.

9.3. Other Package Changes

Updated Packages

The following table lists updated packages in Red Hat Enterprise Linux 6 and a description of noteworthy changes.

Table 9.1. Updated Packages

Updated Package	Description
OProfile	OProfile has been updated to 0.9.5. This newer version includes support for Intel Atom and i7 processors, AMD Family 11h processors, and the Instruction Based Sampling (IBS) feature in AMD Family 10h.
quota, edquota, setquota	Now accepts a user name or user ID as an argument. If the argument appears to be a number it will be considered a user ID, otherwise it will be translated into an ID automatically. Be aware that this can cause a problem if the user name consists solely of digits. The **quota** package has been updated. The **-x** argument, which forced user name to ID translation in utilities such as **quota**, **edquota** and **setquota** has been removed. This functionality is now provided by the **--always-resolve** option.
module-init-tools	**/etc/modprobe.conf** does not exist by default. Can still be used if manually created.

Discontinued Packages

The following table lists discontinued (removed) packages in Red Hat Enterprise Linux 6 and their replacements or alternatives.

Table 9.2. Discontinued Packages

Discontinued Package	Replaced By
aspell	hunspell. aspell is only provided as a build dependency. Applications that want to use spell-checking must use hunspell.
beecrypt	NSS/OpenSSL
crash-spu-commands	None. Cell-specific packages no longer included.
dhcpv6/dhcpv6-client	dhcp/dhclient binaries now have IPv6 capability built in.
elfspe2	None. Cell-specific packages no longer included.
exim	Postfix
gnbd	iSCSI recommended for use instead.
gnome-vfs	gvfs
ipsec-tools	Openswan
kmod-gnbd	iSCSI recommended for use instead.
lam	openmpi
libspe2	None. Cell-specific packages no longer included.
libspe2-devel	None. Cell-specific packages no longer included.
linuxwacom	xorg-x11-drv-wacom
mod_python	mod_wsgi, which uses the WSGI interface, can be used as an alternative for Python scripting.
mkinitrd	dracut
nss_ldap	nss-pam-ldapd, pam_ldap
openmotif-2.2	openmotif-2.3
spu-tools	None. Cell-specific packages no longer included.
switchdesk	The session management performed by both supported session managers: GDM and KDM.
syslog	rsyslog
SysVinit	upstart
vixie-cron	cronie

Deprecated Packages

- qt3
- GFS1
- gcj - Included in Red Hat Enterprise Linux 6 for performance reasons, however gcj is not likely to be included in future releases.

9.4. Driver Changes

This section describes the driver changes in Red Hat Enterprise Linux 6. Please note that all drivers are now loaded to initramfs by default.

Discontinued Drivers

- aic7xxx_old
- atp870u
- cpqarray
- DAC960
- dc395x
- gdth
- hfs
- hfsplus
- megaraid
- net/tokenring/
- paride
- qla1280
- sound/core/oss
- sound/drivers/opl3/*
- sound/pci/nm256

Deprecated Drivers

- aacraid
- aic7xxx
- i2o
- ips
- megaraid_mbox
- mptlan
- mptfc
- sym53c8xx

Discontinued Kernel Components

- NBD - Network Block Device supplanted by iSCSI in Red Hat Enterprise Linux 6.
- HFS - Apple filesystem support discontinued in Red Hat Enterprise Linux 6.
- Tux - Web Server accelerator discontinued in Red Hat Enterprise Linux 6.
- Non-PAE x86 kernel - Previous versions of Red Hat Enterprise Linux contained multiple kernels for the i686 architecture: a kernel with, and a kernel without PAE. It has been many years since

non-PAE hardware was sold in volume. Hence in Red Hat Enterprise Linux 6, there is only a single kernel, one that includes PAE.

- The Anticipatory I/O scheduler is deprecated and is not present in Red Hat Enterprise Linux 6. It is replaced by the CFQ (Completely Fair Queueing) I/O scheduler, which has been the default I/O scheduler in the Linux kernel since 2006. Customers using the Anticipatory I/O scheduler are encouraged to test their workload using CFQ and file bugs for any performance issues observed. While the goal is to make CFQ perform on par with the Anticipatory I/O scheduler in all tested workloads, Red Hat cannot guarantee that there will be no outliers.

9.5. Library Changes

32-bit libraries are not installed by default on Red Hat Enterprise Linux 6. You can change this behavior by setting **`multilib_policy=all`** in **`/etc/yum.conf`**, which will enable multilib policy as a system-wide policy.

Appendix A. Revision History

Revision 6.1-39 **Wed May 18 2011** **Scott Radvan** *sradvan@redhat.com*

Review for 6.1 release.