

Red Hat Enterprise Linux 6

Installation Guide

Installing Red Hat Enterprise Linux 6 for all architectures



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Edition 1.0

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This manual explains how to boot the Red Hat Enterprise Linux 6 installation program (**anaconda**) and to install Red Hat Enterprise Linux 6 on 32-bit and 64-bit x86 systems, 64-bit POWER systems, and IBM System z. It also covers advanced installation methods such as *kickstart* installations, PXE installations, and installations over VNC. Finally, it describes common post-installation tasks and explains how to troubleshoot installation problems.

| | |
|---|------------|
| Preface | xv |
| 1. Document Conventions | xv |
| 1.1. Typographic Conventions | xv |
| 1.2. Pull-quote Conventions | xvi |
| 1.3. Notes and Warnings | xvii |
| 2. Getting Help and Giving Feedback | xvii |
| 2.1. Do You Need Help? | xvii |
| 2.2. We Need Feedback! | xviii |
| 3. Acknowledgements | xviii |
| Introduction | xix |
| 1. What's New in this Edition? | xix |
| 2. Architecture-specific Information | xix |
| 3. Installation in Virtualized Environments | xix |
| 4. More to Come | xx |
| 5. Where to Find Other Manuals | xx |
| 1. Obtaining Red Hat Enterprise Linux | 1 |
| 2. Making Media | 5 |
| 2.1. Making an installation DVD | 5 |
| 2.2. Preparing a USB flash drive as an installation source | 6 |
| 2.3. Making Minimal Boot Media | 7 |
| 2.3.1. UEFI-based systems | 8 |
| I. x86, AMD64, and Intel 64 — Installation and Booting | 9 |
| 3. Planning for Installation on the x86 Architecture | 11 |
| 3.1. Upgrade or Install? | 11 |
| 3.2. Is Your Hardware Compatible? | 11 |
| 3.3. RAID and Other Disk Devices | 11 |
| 3.3.1. Hardware RAID | 11 |
| 3.3.2. Software RAID | 11 |
| 3.3.3. FireWire and USB Disks | 12 |
| 3.4. Do You Have Enough Disk Space? | 12 |
| 3.5. Selecting an Installation Method | 12 |
| 3.6. Choose a boot method | 13 |
| 4. Preparing for Installation | 15 |
| 4.1. Preparing for a Network Installation | 15 |
| 4.1.1. Preparing for FTP and HTTP installation | 16 |
| 4.1.2. Preparing for an NFS installation | 16 |
| 4.2. Preparing for a Hard Drive Installation | 17 |
| 5. System Specifications List | 21 |
| 6. Updating drivers during installation on Intel and AMD systems | 23 |
| 6.1. Limitations of driver updates during installation | 23 |
| 6.2. Preparing for a driver update during installation | 24 |
| 6.2.1. Preparing to use a driver update image file | 24 |
| 6.2.2. Preparing a driver disc | 25 |
| 6.2.3. Preparing an initial RAM disk update | 27 |
| 6.3. Performing a driver update during installation | 28 |
| 6.3.1. Let the installer automatically find a driver update disk | 29 |
| 6.3.2. Let the installer prompt you for a driver update | 29 |
| 6.3.3. Use a boot option to specify a driver update disk | 29 |
| 6.3.4. Select a PXE target that includes a driver update | 30 |

| | |
|--|-----------|
| 6.4. Specifying the location of a driver update image file or driver update disk | 30 |
| 7. Booting the Installer | 35 |
| 7.1. Starting the Installation Program | 36 |
| 7.1.1. Booting the Installation Program on x86, AMD64, and Intel 64 Systems | 36 |
| 7.1.2. Additional Boot Options | 38 |
| 7.2. The Boot Menu | 39 |
| 7.3. Installing from a Different Source | 41 |
| 7.4. Booting from the Network using PXE | 41 |
| 8. Configuring Language and Installation Source | 43 |
| 8.1. The Text Mode Installation Program User Interface | 43 |
| 8.1.1. Using the Keyboard to Navigate | 45 |
| 8.2. Language Selection | 45 |
| 8.3. Installation Method | 46 |
| 8.3.1. Installing from DVD | 46 |
| 8.3.2. Installing from a Hard Drive | 47 |
| 8.3.3. Performing a Network Installation | 48 |
| 8.3.4. Installing via NFS | 49 |
| 8.3.5. Installing via FTP or HTTP | 50 |
| 8.4. Verifying Media | 51 |
| 9. Installing using anaconda | 53 |
| 9.1. The Text Mode Installation Program User Interface | 53 |
| 9.2. The Graphical Installation Program User Interface | 53 |
| 9.2.1. Screenshots during installation | 54 |
| 9.2.2. A Note about Virtual Consoles | 54 |
| 9.3. Welcome to Red Hat Enterprise Linux | 55 |
| 9.4. Keyboard Configuration | 55 |
| 9.5. Storage Devices | 56 |
| 9.5.1. The Storage Devices Selection Screen | 57 |
| 9.6. Setting the Hostname | 63 |
| 9.6.1. Edit Network Connections | 64 |
| 9.7. Time Zone Configuration | 73 |
| 9.8. Set the Root Password | 75 |
| 9.9. Assign Storage Devices | 76 |
| 9.10. Initializing the Hard Disk | 78 |
| 9.11. Upgrading an Existing System | 79 |
| 9.11.1. The Upgrade Dialog | 79 |
| 9.11.2. Upgrading Using the Installer | 80 |
| 9.11.3. Upgrading Boot Loader Configuration | 81 |
| 9.12. Disk Partitioning Setup | 82 |
| 9.13. Encrypt Partitions | 84 |
| 9.14. Creating a Custom Layout or Modifying the Default Layout | 85 |
| 9.14.1. Create Storage | 87 |
| 9.14.2. Adding Partitions | 88 |
| 9.14.3. Create Software RAID | 91 |
| 9.14.4. Create LVM Logical Volume | 94 |
| 9.14.5. Recommended Partitioning Scheme | 97 |
| 9.15. Write changes to disk | 101 |
| 9.16. x86, AMD64, and Intel 64 Boot Loader Configuration | 101 |
| 9.16.1. Advanced Boot Loader Configuration | 104 |
| 9.16.2. Rescue Mode | 105 |
| 9.16.3. Alternative Boot Loaders | 106 |
| 9.17. Package Group Selection | 106 |

| | |
|--|------------|
| 9.17.1. Installing from Additional Repositories | 108 |
| 9.17.2. Customizing the Software Selection | 109 |
| 9.18. Installing Packages | 112 |
| 9.19. Installation Complete | 112 |
| 10. Troubleshooting Installation on an Intel or AMD System | 113 |
| 10.1. You are unable to boot Red Hat Enterprise Linux | 113 |
| 10.1.1. Are You Unable to Boot With Your RAID Card? | 113 |
| 10.1.2. Is Your System Displaying Signal 11 Errors? | 114 |
| 10.2. Trouble Beginning the Installation | 114 |
| 10.2.1. Problems with Booting into the Graphical Installation | 114 |
| 10.3. Trouble During the Installation | 115 |
| 10.3.1. No devices found to install Red Hat Enterprise Linux Error Message | 115 |
| 10.3.2. Saving traceback messages | 115 |
| 10.3.3. Trouble with Partition Tables | 119 |
| 10.3.4. Using Remaining Space | 119 |
| 10.3.5. Other Partitioning Problems | 119 |
| 10.3.6. Are You Seeing Python Errors? | 119 |
| 10.4. Problems After Installation | 120 |
| 10.4.1. Trouble With the Graphical GRUB Screen on an x86-based System? | 120 |
| 10.4.2. Booting into a Graphical Environment | 121 |
| 10.4.3. Problems with the X Window System (GUI) | 121 |
| 10.4.4. Problems with the X Server Crashing and Non-Root Users | 122 |
| 10.4.5. Problems When You Try to Log In | 122 |
| 10.4.6. Is Your RAM Not Being Recognized? | 123 |
| 10.4.7. Your Printer Does Not Work | 123 |
| 10.4.8. Apache-based httpd service/Sendmail Hangs During Startup | 124 |
| | |
| II. IBM POWER Architecture - Installation and Booting | 125 |
| 11. Planning for Installation on the POWER Architecture | 127 |
| 11.1. Upgrade or Install? | 127 |
| 11.2. Preparation for IBM eServer System p | 127 |
| 11.3. RAID and Other Disk Devices | 128 |
| 11.3.1. Hardware RAID | 128 |
| 11.3.2. Software RAID | 128 |
| 11.3.3. FireWire and USB Disks | 128 |
| 11.4. Do You Have Enough Disk Space? | 128 |
| 11.5. Choose a boot method | 129 |
| 12. Preparing for Installation | 131 |
| 12.1. Preparing for a Network Installation | 131 |
| 12.1.1. Preparing for FTP and HTTP installation | 132 |
| 12.1.2. Preparing for an NFS installation | 132 |
| 12.2. Preparing for a Hard Drive Installation | 134 |
| 13. Updating drivers during installation on IBM POWER systems | 137 |
| 13.1. Limitations of driver updates during installation | 137 |
| 13.2. Preparing for a driver update during installation | 138 |
| 13.2.1. Preparing to use a driver update image file | 138 |
| 13.2.2. Preparing a driver disc | 139 |
| 13.2.3. Preparing an initial RAM disk update | 142 |
| 13.3. Performing a driver update during installation | 143 |
| 13.3.1. Let the installer automatically find a driver update disk | 144 |

| | |
|---|------------|
| 13.3.2. Let the installer prompt you for a driver update | 144 |
| 13.3.3. Use a boot option to specify a driver update disk | 144 |
| 13.3.4. Select a PXE target that includes a driver update | 145 |
| 13.4. Specifying the location of a driver update image file or driver update disk | 145 |
| 14. Booting the Installer | 149 |
| 14.1. The Boot Menu | 150 |
| 14.2. Installing from a Different Source | 151 |
| 14.3. Booting from the Network using PXE | 151 |
| 15. Configuring Language and Installation Source | 153 |
| 15.1. The Text Mode Installation Program User Interface | 153 |
| 15.1.1. Using the Keyboard to Navigate | 155 |
| 15.2. Language Selection | 155 |
| 15.3. Installation Method | 156 |
| 15.3.1. Beginning Installation | 156 |
| 15.3.2. Installing from a Hard Drive | 156 |
| 15.3.3. Performing a Network Installation | 157 |
| 15.3.4. Installing via NFS | 158 |
| 15.3.5. Installing via FTP or HTTP | 159 |
| 15.4. Verifying Media | 160 |
| 16. Installing using anaconda | 161 |
| 16.1. The Text Mode Installation Program User Interface | 161 |
| 16.2. The Graphical Installation Program User Interface | 161 |
| 16.3. A Note about Linux Virtual Consoles | 162 |
| 16.4. Using the HMC vterm | 163 |
| 16.5. Welcome to Red Hat Enterprise Linux | 163 |
| 16.6. Storage Devices | 163 |
| 16.6.1. The Storage Devices Selection Screen | 164 |
| 16.7. Keyboard Configuration | 170 |
| 16.8. Setting the Hostname | 170 |
| 16.8.1. Edit Network Connections | 172 |
| 16.9. Time Zone Configuration | 181 |
| 16.10. Set the Root Password | 182 |
| 16.11. Assign Storage Devices | 184 |
| 16.12. Initializing the Hard Disk | 186 |
| 16.13. Upgrading an Existing System | 187 |
| 16.13.1. The Upgrade Dialog | 187 |
| 16.13.2. Upgrading Using the Installer | 188 |
| 16.14. Disk Partitioning Setup | 189 |
| 16.15. Encrypt Partitions | 191 |
| 16.16. Creating a Custom Layout or Modifying the Default Layout | 192 |
| 16.16.1. Create Storage | 194 |
| 16.16.2. Adding Partitions | 195 |
| 16.16.3. Create Software RAID | 198 |
| 16.16.4. Create LVM Logical Volume | 201 |
| 16.16.5. Recommended Partitioning Scheme | 204 |
| 16.17. Write changes to disk | 205 |
| 16.18. Package Group Selection | 206 |
| 16.18.1. Installing from Additional Repositories | 208 |
| 16.18.2. Customizing the Software Selection | 209 |
| 16.19. Installing Packages | 212 |
| 16.20. Installation Complete | 212 |
| 17. Troubleshooting Installation on an IBM POWER System | 213 |

| | |
|--|------------|
| 17.1. You are unable to boot Red Hat Enterprise Linux | 213 |
| 17.1.1. Is Your System Displaying Signal 11 Errors? | 213 |
| 17.2. Trouble Beginning the Installation | 214 |
| 17.2.1. Problems with Booting into the Graphical Installation | 214 |
| 17.3. Trouble During the Installation | 214 |
| 17.3.1. No devices found to install Red Hat Enterprise Linux Error Message | 214 |
| 17.3.2. Saving traceback messages | 214 |
| 17.3.3. Trouble with Partition Tables | 218 |
| 17.3.4. Other Partitioning Problems for IBM™ POWER System Users | 218 |
| 17.3.5. Are You Seeing Python Errors? | 218 |
| 17.4. Problems After Installation | 219 |
| 17.4.1. Unable to IPL from *NWSSTG | 219 |
| 17.4.2. Booting into a Graphical Environment | 219 |
| 17.4.3. Problems with the X Window System (GUI) | 220 |
| 17.4.4. Problems with the X Server Crashing and Non-Root Users | 220 |
| 17.4.5. Problems When You Try to Log In | 221 |
| 17.4.6. Your Printer Does Not Work | 221 |
| 17.4.7. Apache-based httpd service/Sendmail Hangs During Startup | 221 |
| | |
| III. IBM System z Architecture - Installation and Booting | 223 |
| 18. Planning for Installation on System z | 225 |
| 18.1. Pre-Installation | 225 |
| 18.2. Overview of the System z Installation Procedure | 225 |
| 18.2.1. Booting (IPL) the Installer | 226 |
| 18.2.2. Installation Phase 1 | 227 |
| 18.2.3. Installation Phase 2 | 227 |
| 18.2.4. Installation Phase 3 | 228 |
| 18.3. Graphical User Interface with X11 or VNC | 228 |
| 18.3.1. Installation using X11 forwarding | 229 |
| 18.3.2. Installation using X11 | 229 |
| 18.3.3. Installation using VNC | 229 |
| 18.3.4. Installation using a VNC listener | 230 |
| 18.3.5. Automating the Installation with Kickstart | 230 |
| 19. Preparing for Installation | 231 |
| 19.1. Preparing for a Network Installation | 231 |
| 19.1.1. Preparing for FTP and HTTP installation | 231 |
| 19.1.2. Preparing for an NFS installation | 232 |
| 19.2. Preparing for a Hard Drive Installation | 233 |
| 19.2.1. Accessing Installation Phase 3 and the Package Repository on a Hard Drive | 233 |
| 20. Booting (IPL) the Installer | 237 |
| 20.1. Installing under z/VM | 237 |
| 20.1.1. Using the z/VM Reader | 238 |
| 20.1.2. Using a prepared DASD | 239 |
| 20.1.3. Using a prepared FCP-attached SCSI Disk | 239 |
| 20.1.4. Using an FCP-attached SCSI DVD Drive | 240 |
| 20.2. Installing in an LPAR | 240 |
| 20.2.1. Using an FTP Server | 241 |
| 20.2.2. Using the HMC or SE DVD Drive | 241 |
| 20.2.3. Using a prepared DASD | 241 |
| 20.2.4. Using a prepared FCP-attached SCSI Disk | 241 |

| | |
|---|------------|
| 20.2.5. Using an FCP-attached SCSI DVD Drive | 242 |
| 21. Installation Phase 1: Configuring a Network Device | 243 |
| 21.1. A Note on Terminals | 246 |
| 22. Installation Phase 2: Configuring Language and Installation Source | 247 |
| 22.1. Non-interactive Line-Mode Installation | 247 |
| 22.2. The Text Mode Installation Program User Interface | 247 |
| 22.2.1. Using the Keyboard to Navigate | 249 |
| 22.3. Language Selection | 249 |
| 22.4. Installation Method | 250 |
| 22.4.1. Installing from DVD | 250 |
| 22.4.2. Installing from a Hard Drive | 251 |
| 22.4.3. Performing a Network Installation | 252 |
| 22.4.4. Installing via NFS | 252 |
| 22.4.5. Installing via FTP or HTTP | 253 |
| 22.5. Verifying Media | 254 |
| 22.6. Retrieving Phase 3 of the Installation Program | 254 |
| 23. Installation Phase 3: Installing using anaconda | 255 |
| 23.1. The Non-interactive Line-Mode Text Installation Program Output | 255 |
| 23.2. The Text Mode Installation Program User Interface | 255 |
| 23.3. The Graphical Installation Program User Interface | 255 |
| 23.4. Configure the Install Terminal | 255 |
| 23.5. Welcome to Red Hat Enterprise Linux | 256 |
| 23.6. Storage Devices | 257 |
| 23.6.1. The Storage Devices Selection Screen | 258 |
| 23.7. Setting the Hostname | 264 |
| 23.7.1. Edit Network Connections | 265 |
| 23.8. Time Zone Configuration | 274 |
| 23.9. Set the Root Password | 275 |
| 23.10. Assign Storage Devices | 277 |
| 23.11. Initializing the Hard Disk | 278 |
| 23.12. Upgrading an Existing System | 280 |
| 23.12.1. Upgrading Using the Installer | 281 |
| 23.13. Disk Partitioning Setup | 281 |
| 23.14. Encrypt Partitions | 283 |
| 23.15. Creating a Custom Layout or Modifying the Default Layout | 284 |
| 23.15.1. Create Storage | 286 |
| 23.15.2. Adding Partitions | 288 |
| 23.15.3. Create Software RAID | 290 |
| 23.15.4. Create LVM Logical Volume | 293 |
| 23.15.5. Recommended Partitioning Scheme | 296 |
| 23.16. Write changes to disk | 296 |
| 23.17. Package Group Selection | 297 |
| 23.17.1. Installing from Additional Repositories | 299 |
| 23.17.2. Customizing the Software Selection | 300 |
| 23.18. Installing Packages | 303 |
| 23.19. Installation Complete | 303 |
| 23.19.1. IPL under z/VM | 303 |
| 23.19.2. IPL on an LPAR | 304 |
| 23.19.3. Continuing after Reboot (re-IPL) | 304 |
| 24. Troubleshooting Installation on IBM System z | 305 |
| 24.1. You are unable to boot Red Hat Enterprise Linux | 305 |
| 24.1.1. Is Your System Displaying Signal 11 Errors? | 305 |

| | |
|--|------------|
| 24.2. Trouble During the Installation | 305 |
| 24.2.1. No devices found to install Red Hat Enterprise Linux Error Message | 305 |
| 24.2.2. Saving traceback messages | 306 |
| 24.2.3. Other Partitioning Problems | 309 |
| 24.2.4. Are You Seeing Python Errors? | 309 |
| 24.3. Problems After Installation | 310 |
| 24.3.1. Remote Graphical Desktops and XDMCP | 310 |
| 24.3.2. Problems When You Try to Log In | 310 |
| 24.3.3. Your Printer Does Not Work | 311 |
| 24.3.4. Apache-based httpd service/Sendmail Hangs During Startup | 311 |
| 25. Configuring an Installed Linux on System z Instance | 313 |
| 25.1. Adding DASDs | 313 |
| 25.1.1. Dynamically setting DASDs online | 313 |
| 25.1.2. Preparing a new DASD with low-level formatting | 314 |
| 25.1.3. Persistently setting DASDs online | 315 |
| 25.2. Adding FCP-Attached Logical Units (LUNs) | 318 |
| 25.2.1. Dynamically activating an FCP LUN | 318 |
| 25.2.2. Persistently activating FCP LUNs | 319 |
| 25.3. Adding a Network Device | 321 |
| 25.3.1. Adding a qeth Device | 322 |
| 25.3.2. Adding an LCS Device | 327 |
| 25.3.3. Mapping subchannels and network device names | 329 |
| 25.3.4. Configuring a System z Network Device for Network Root File System..... | 330 |
| 26. Parameter and Configuration Files | 331 |
| 26.1. Required parameters | 331 |
| 26.2. The z/VM configuration file | 332 |
| 26.3. Installation network parameters | 332 |
| 26.4. VNC and X11 parameters | 336 |
| 26.5. Loader parameters | 336 |
| 26.6. Parameters for kickstart installations | 336 |
| 26.7. Miscellaneous parameters | 337 |
| 26.8. Sample parameter file and CMS configuration file | 338 |
| 27. IBM System z References | 339 |
| 27.1. IBM System z Publications | 339 |
| 27.2. IBM Redbooks for System z | 339 |
| 27.3. Online resources | 340 |
| IV. Advanced installation options | 341 |
| 28. Boot Options | 343 |
| 28.1. Configuring the Installation System at the Boot Menu | 343 |
| 28.1.1. Specifying the Language | 343 |
| 28.1.2. Configuring the Interface | 344 |
| 28.1.3. Updating anaconda | 344 |
| 28.1.4. Specifying the Installation Method | 344 |
| 28.1.5. Manually Configuring the Network Settings | 345 |
| 28.2. Enabling Remote Access to the Installation System | 345 |
| 28.2.1. Enabling Remote Access with VNC | 345 |
| 28.2.2. Connecting the Installation System to a VNC Listener | 346 |
| 28.2.3. Enabling Remote Access with Telnet | 347 |
| 28.3. Logging to a Remote System During the Installation | 347 |

| | |
|--|------------|
| 28.3.1. Configuring a Log Server | 347 |
| 28.4. Automating the Installation with Kickstart | 348 |
| 28.5. Enhancing Hardware Support | 349 |
| 28.5.1. Overriding Automatic Hardware Detection | 349 |
| 28.6. Using the Maintenance Boot Modes | 350 |
| 28.6.1. Verifying boot media | 350 |
| 28.6.2. Booting Your Computer with the Rescue Mode | 351 |
| 28.6.3. Upgrading your computer | 351 |
| 29. Installing Without Media | 353 |
| 29.1. Retrieving Boot Files | 353 |
| 29.2. Editing the GRUB Configuration | 353 |
| 29.3. Booting to Installation | 354 |
| 30. Setting Up an Installation Server | 355 |
| 30.1. Setting up the Network Server | 355 |
| 30.2. PXE Boot Configuration | 355 |
| 30.3. Configuring the DHCP Server | 355 |
| 30.4. Starting the tftp Server | 355 |
| 30.5. Adding a Custom Boot Message | 356 |
| 30.6. Performing the PXE Installation | 356 |
| 31. Installing Through VNC | 357 |
| 31.1. VNC Viewer | 357 |
| 31.2. VNC Modes in Anaconda | 357 |
| 31.2.1. Direct Mode | 358 |
| 31.2.2. Connect Mode | 358 |
| 31.3. Installation Using VNC | 358 |
| 31.3.1. Installation Example | 359 |
| 31.3.2. Kickstart Considerations | 359 |
| 31.3.3. Firewall Considerations | 360 |
| 31.4. References | 360 |
| 32. Kickstart Installations | 361 |
| 32.1. What are Kickstart Installations? | 361 |
| 32.2. How Do You Perform a Kickstart Installation? | 361 |
| 32.3. Creating the Kickstart File | 361 |
| 32.4. Kickstart Options | 362 |
| 32.4.1. Advanced Partitioning Example | 382 |
| 32.5. Package Selection | 383 |
| 32.6. Pre-installation Script | 384 |
| 32.6.1. Example | 384 |
| 32.7. Post-installation Script | 385 |
| 32.7.1. Examples | 386 |
| 32.8. Making the Kickstart File Available | 386 |
| 32.8.1. Creating Kickstart Boot Media | 387 |
| 32.8.2. Making the Kickstart File Available on the Network | 387 |
| 32.9. Making the Installation Tree Available | 388 |
| 32.10. Starting a Kickstart Installation | 388 |
| 33. Kickstart Configurator | 395 |
| 33.1. Basic Configuration | 395 |
| 33.2. Installation Method | 396 |
| 33.3. Boot Loader Options | 397 |
| 33.4. Partition Information | 398 |
| 33.4.1. Creating Partitions | 399 |

| | |
|--|------------|
| 33.5. Network Configuration | 403 |
| 33.6. Authentication | 404 |
| 33.7. Firewall Configuration | 404 |
| 33.7.1. SELinux Configuration | 405 |
| 33.8. Display Configuration | 405 |
| 33.9. Package Selection | 406 |
| 33.10. Pre-Installation Script | 407 |
| 33.11. Post-Installation Script | 408 |
| 33.11.1. Chroot Environment | 409 |
| 33.11.2. Use an Interpreter | 409 |
| 33.12. Saving the File | 409 |
| V. After installation | 411 |
| 34. Firstboot | 413 |
| 34.1. License Agreement | 413 |
| 34.2. Set Up Software Updates | 414 |
| 34.2.1. Choose Server | 415 |
| 34.2.2. Red Hat Login | 416 |
| 34.2.3. Create Profile | 417 |
| 34.2.4. Review Subscription | 418 |
| 34.2.5. Finish Updates Setup | 419 |
| 34.3. Create User | 420 |
| 34.3.1. Authentication Configuration | 422 |
| 34.4. Date and Time | 423 |
| 34.5. Kdump | 424 |
| 35. Your Next Steps | 427 |
| 35.1. Updating Your System | 427 |
| 35.1.1. Driver update rpm packages | 427 |
| 35.2. Finishing an Upgrade | 429 |
| 35.3. Switching to a Graphical Login | 430 |
| 35.3.1. Enabling Access to Software Repositories from the Command Line | 431 |
| 36. Basic System Recovery | 435 |
| 36.1. Rescue Mode | 435 |
| 36.1.1. Common Problems | 435 |
| 36.1.2. Booting into Rescue Mode | 435 |
| 36.1.3. Booting into Single-User Mode | 438 |
| 36.1.4. Booting into Emergency Mode | 438 |
| 36.2. Rescue Mode on POWER Systems | 439 |
| 36.2.1. Special Considerations for Accessing the SCSI Utilities from Rescue Mode | 439 |
| 37. Upgrading Your Current System | 441 |
| 37.1. Determining Whether to Upgrade or Re-Install | 441 |
| 37.2. Upgrading Your System | 442 |
| 38. Removing Red Hat Enterprise Linux from x86-based systems | 445 |
| 38.1. Red Hat Enterprise Linux is the only operating system on the computer | 445 |
| 38.2. Your computer dual-boots Red Hat Enterprise Linux and another operating system | 446 |
| 38.2.1. Your computer dual-boots Red Hat Enterprise Linux and a Microsoft Windows operating system | 447 |
| 38.2.2. Your computer dual-boots Red Hat Enterprise Linux and a different Linux distribution | 451 |

| | |
|---|------------|
| 38.3. Replacing Red Hat Enterprise Linux with MS-DOS or legacy versions of Microsoft Windows | 454 |
| 39. Removing Red Hat Enterprise Linux from IBM System z | 457 |
| 39.1. Running a Different Operating System on your z/VM Guest or LPAR | 457 |
| VI. Technical appendixes | 459 |
| A. An Introduction to Disk Partitions | 461 |
| A.1. Hard Disk Basic Concepts | 461 |
| A.1.1. It is Not What You Write, it is How You Write It | 461 |
| A.1.2. Partitions: Turning One Drive Into Many | 462 |
| A.1.3. Partitions within Partitions — An Overview of Extended Partitions | 465 |
| A.1.4. Making Room For Red Hat Enterprise Linux | 465 |
| A.1.5. Partition Naming Scheme | 469 |
| A.1.6. Disk Partitions and Other Operating Systems | 470 |
| A.1.7. Disk Partitions and Mount Points | 470 |
| A.1.8. How Many Partitions? | 471 |
| B. iSCSI disks | 473 |
| B.1. iSCSI disks in anaconda | 473 |
| B.2. iSCSI disks during start up | 473 |
| C. Disk Encryption | 475 |
| C.1. What is block device encryption? | 475 |
| C.2. Encrypting block devices using dm-crypt/LUKS | 475 |
| C.2.1. Overview of LUKS | 475 |
| C.2.2. How will I access the encrypted devices after installation? (System Startup) | 476 |
| C.2.3. Choosing a Good Passphrase | 476 |
| C.3. Creating Encrypted Block Devices in Anaconda | 476 |
| C.3.1. What Kinds of Block Devices Can Be Encrypted? | 476 |
| C.3.2. Saving Passphrases | 477 |
| C.3.3. Creating and Saving Backup Passphrases | 477 |
| C.4. Creating Encrypted Block Devices on the Installed System After Installation | 477 |
| C.4.1. Create the block devices | 477 |
| C.4.2. Optional: Fill the device with random data | 477 |
| C.4.3. Format the device as a dm-crypt/LUKS encrypted device | 478 |
| C.4.4. Create a mapping to allow access to the device's decrypted contents | 478 |
| C.4.5. Create filesystems on the mapped device, or continue to build complex storage structures using the mapped device | 479 |
| C.4.6. Add the mapping information to /etc/crypttab | 479 |
| C.4.7. Add an entry to /etc/fstab | 479 |
| C.5. Common Post-Installation Tasks | 480 |
| C.5.1. Set a randomly generated key as an additional way to access an encrypted block device | 480 |
| C.5.2. Add a new passphrase to an existing device | 480 |
| C.5.3. Remove a passphrase or key from a device | 480 |
| D. Understanding LVM | 481 |
| E. The GRUB Boot Loader | 483 |
| E.1. Boot Loaders and System Architecture | 483 |
| E.2. GRUB | 483 |
| E.2.1. GRUB and the x86 Boot Process | 483 |
| E.2.2. Features of GRUB | 484 |

| | |
|---|------------|
| E.3. Installing GRUB | 485 |
| E.4. GRUB Terminology | 485 |
| E.4.1. Device Names | 485 |
| E.4.2. File Names and Blocklists | 486 |
| E.4.3. The Root File System and GRUB | 487 |
| E.5. GRUB Interfaces | 487 |
| E.5.1. Interfaces Load Order | 488 |
| E.6. GRUB Commands | 488 |
| E.7. GRUB Menu Configuration File | 490 |
| E.7.1. Configuration File Structure | 490 |
| E.7.2. Configuration File Directives | 491 |
| E.8. Changing Runlevels at Boot Time | 492 |
| E.9. Additional Resources | 493 |
| E.9.1. Installed Documentation | 493 |
| E.9.2. Useful Websites | 493 |
| E.9.3. Related Books | 493 |
| F. Boot Process, Init, and Shutdown | 495 |
| F.1. The Boot Process | 495 |
| F.2. A Detailed Look at the Boot Process | 495 |
| F.2.1. The BIOS | 495 |
| F.2.2. The Boot Loader | 496 |
| F.2.3. The Kernel | 497 |
| F.2.4. The <code>/sbin/init</code> Program | 497 |
| F.2.5. Job definitions | 500 |
| F.3. Running Additional Programs at Boot Time | 501 |
| F.4. SysV Init Runlevels | 501 |
| F.4.1. Runlevels | 501 |
| F.4.2. Runlevel Utilities | 502 |
| F.5. Shutting Down | 502 |
| G. Alternatives to busybox commands | 505 |
| H. Other Technical Documentation | 515 |
| I. Revision History | 517 |
| Index | 519 |

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](https://fedorahosted.org/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. Getting Help and Giving Feedback

2.1. Do You Need Help?

If you experience difficulty with a procedure described in this documentation, visit the Red Hat Customer Portal at <http://access.redhat.com>. Through the customer portal, you can:

- search or browse through a knowledgebase of technical support articles about Red Hat products.
- submit a support case to Red Hat Global Support Services (GSS).
- access other product documentation.

Red Hat also hosts a large number of electronic mailing lists for discussion of Red Hat software and technology. You can find a list of publicly available mailing lists at <https://www.redhat.com/mailman/listinfo>. Click on the name of any mailing list to subscribe to that list or to access the list archives. xvii

2.2. 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-Installation_Guide*

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.

3. Acknowledgements

Certain portions of this text first appeared in the *Fedora Installation Guide*, copyright © 2009 Red Hat, Inc. and others, published by the Fedora Project at <http://docs.fedoraproject.org/install-guide/>.

Introduction

Welcome to the *Red Hat Enterprise Linux Installation Guide*.

HTML and PDF versions of the guides are available 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 the documentation being finalized. You can find the Release Notes on the Red Hat Enterprise Linux DVD, online at <http://www.redhat.com/docs/>, or in the `/usr/share/doc/redhat-release-notes-6<variant>/` directory after installation, where `<variant>` is **Server**, **Client**, or **Desktop**.

1. What's New in this Edition?

Be sure to review the [Appendix I, Revision History](#) for features and bug fixes for this manual.

2. Architecture-specific Information

This manual is divided into different sections:

[Part I, “x86, AMD64, and Intel 64 — Installation and Booting”](#), [Part II, “IBM POWER Architecture - Installation and Booting”](#), and [Part III, “IBM System z Architecture - Installation and Booting”](#) are architecture specific, and give instructions on installing Red Hat Enterprise Linux 6 with specific reference to 32- and 64-bit Intel and AMD systems, IBM POWER-based systems, and IBM System z architecture systems, respectively.

[Part IV, “Advanced installation options”](#) covers more advanced methods of installing Red Hat Enterprise Linux, including: boot options, installing without medium, installing through VNC, and using **kickstart** to automate the installation process.

[Part V, “After installation”](#) deals with a number of common tasks, covers finalizing the installation and, as well as some installation-related tasks that you might perform at some time in the future. These include using a Red Hat Enterprise Linux installation disk to rescue a damaged system, upgrading to a new version of Red Hat Enterprise Linux, and removing Red Hat Enterprise Linux from your computer.

[Part VI, “Technical appendixes”](#) does not contain procedures, but provides technical background that you might find helpful to understand the options that Red Hat Enterprise Linux offers you at various points in the installation process.

3. Installation in Virtualized Environments

Virtualization is a broad computing term for running software, usually operating systems, concurrently and isolated from other programs on one system. Virtualization uses a hypervisor, a software layer that controls hardware and provides guest operating systems with access to underlying hardware. The hypervisor allows multiple operating systems to run on the same physical system by giving the guest operating system virtualized hardware.

You can install Red Hat Enterprise Linux 6 as a fully virtualized guest on a 64-bit x86 host system or in a *logical partition* (LPAR) on a POWER or IBM System z system.

For more information about installing Red Hat Enterprise Linux 6 in a virtualized environment on a 64-bit x86 host system, refer to "Part II. Installation" in the *Red Hat Enterprise Linux 6 Virtualization Guide*, available from <http://docs.redhat.com/>. For more information about installing Red Hat Enterprise Linux 6 in a virtualized environment under PowerVM on IBM System p, refer to *PowerVM Virtualization on IBM System p: Introduction and Configuration*, available from <http://publib-b.boulder.ibm.com/abstracts/sg247940.html>. For more information about installing Red Hat Enterprise Linux 6 in a virtualized environment under z/VM on System z, refer to *Part III, "IBM System z Architecture - Installation and Booting"* in this guide.

4. More to Come

The *Red Hat Enterprise Linux Installation Guide* is part of Red Hat's ongoing commitment to provide useful and timely support and information to Red Hat Enterprise Linux users.

5. Where to Find Other Manuals

Red Hat Enterprise Linux manuals are available online at <https://access.redhat.com/knowledge/docs/manuals/>.

In addition to this manual, which covers installation, the *Red Hat Enterprise Linux Deployment Guide* contains further information on system administration and security.

HTML and PDF versions of the guides are available 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 the documentation being finalized. You can find the Release Notes on the Red Hat Enterprise Linux DVD, online at <http://www.redhat.com/docs/>, or in the `/usr/share/doc/redhat-release-notes-6<variant>/` directory after installation, where `<variant>` is **Server**, **Client**, or **Desktop**.

Obtaining Red Hat Enterprise Linux

If you have a Red Hat subscription, you can download *ISO image files* of the Red Hat Enterprise Linux 6 installation DVD from the Software & Download Center that is part of the Red Hat customer portal. If you do not already have a subscription, either purchase one or obtain a free evaluation subscription from the Software & Download Center at <https://access.redhat.com/downloads>.

If you have a subscription or evaluation subscription, follow these steps to obtain the Red Hat Enterprise Linux 6 ISO image files:

1. Visit the customer portal at <https://access.redhat.com/login> and enter your Login and Password.
2. Click **Downloads** to visit the Software & Download Center.
3. Click the **Download your software** link to obtain a list of all currently supported Red Hat Enterprise Linux products.
4. Select a version of Red Hat Enterprise Linux and click on the link to that version. Note that you only need to select the most current version of the product; each release is a complete, functional version of the operating system and does not require previous releases. Ensure that you select a **server** release if you plan to deploy Red Hat Enterprise Linux to a server, or a **desktop** release if you plan to deploy to a client machine.

- Each version of Red Hat Enterprise Linux is available as an ISO image file for a single DVD, around 3 GB – 4 GB in size.

Red Hat Enterprise Linux Desktop (v. 5 for 32-bit x86)

Details Errata Packages Subscribed Systems **Downloads**

ISO Image Downloads

NOTE: By downloading this software, you agree to the terms and conditions of the applicable License Agreement (available at <http://www.redhat.com/licenses/>)

Not sure how to download and use these images? [Check out our ISO Download Help.](#)

Latest Release

Below please find the complete set of ISO images for the **latest release** of Red Hat Enterprise Linux Desktop (v. 5 for 32-bit x86). Depending on the variant of Red Hat Enterprise Linux Desktop (v. 5 for 32-bit x86) you'd like to install, you may only need a subset of these discs. ([more information](#))

Red Hat Enterprise Linux 5.4 Client (x86)

| ISO | Size | MD5 Checksum |
|--|----------|----------------------------------|
| Binary Disc 1 (Client Core) | 630 MB | d3824c3432e712e8f9f3e70b40a21adc |
| Binary Disc 2 (Client Core) | 626 MB | 8d1ae619d25070c145e7008dfdbf9b86 |
| Binary Disc 3 (Client Core) | 625 MB | 444d727baee4b5442d422441a0158c97 |
| Binary Disc 4 (Client Core) | 617 MB | d9ba596de7fe4cae67936c818acffe39 |
| Binary Disc 5 (Client Core/Workstation/Virtualization) | 630 MB | 3fc3491b99bb7eca326db05a155e0193 |
| Binary Disc 6 (Workstation) | 553 MB | e7d24d506f6c9787bdc07a365f7cfbe5 |
| Binary DVD (Client Core/Workstation/Virtualization) | 3,677 MB | 1cc4585c4f97f7d0225ac9888a2c799 |

[View Source ISO Images \(NOTE: these images are not necessary for installation.\)](#)

NOTE: You'll need an installation number to install Red Hat Enterprise Linux Desktop (v. 5 for 32-bit x86). [Not sure what an installation number is? Need to look up your installation numbers?](#)

Older Releases

Below please find complete sets of ISO images for the **older releases** of Red Hat Enterprise Linux Desktop (v. 5 for 32-bit x86). Note that only one set of ISO images is necessary to install any particular release of Red Hat Enterprise Linux Desktop (v. 5 for 32-bit x86).

[View ISO Images for Older Releases](#)

Figure 1.1. Selecting ISO Image Files

This same page contains links to ISO image files for the source code for Red Hat Enterprise Linux. You do not need to download the source code to install the operating system.

The page also contains links to ISO image files to make *minimal boot media*. These image files are always named **boot.iso** and are around 150 MB in size. You cannot install Red Hat Enterprise Linux from these files, but you can use these files to create bootable CDs, DVDs, or USB devices with which you can boot a system when you plan to complete the installation from an installation source available on a hard disk or over a network connection. Refer to [Section 2.3, “Making Minimal Boot Media”](#) for information on how to use the **boot.iso** file.

Note that the link to every image file is accompanied by a *checksum*. You can use this value to verify that a Red Hat Enterprise Linux image file is genuine and uncorrupted.

After you download an ISO image file of the installation DVD from the Red Hat Network, you can:

- burn it to a physical DVD (refer to [Section 2.1, “Making an installation DVD”](#)).
- transfer it to a USB device (refer to [Section 2.2, “Preparing a USB flash drive as an installation source”](#)).

-
- use it to prepare minimal boot media (refer to [Section 2.3, “Making Minimal Boot Media”](#)).
 - place it on a server to prepare for installations over a network (refer to [Section 4.1, “Preparing for a Network Installation”](#) for x86 architectures, [Section 12.1, “Preparing for a Network Installation”](#) for POWER or [Section 19.1, “Preparing for a Network Installation”](#) for IBM System z).
 - place it on a hard drive to prepare for installation to use the hard drive as an installation source (refer to [Section 4.2, “Preparing for a Hard Drive Installation”](#) for x86 architectures, [Section 12.2, “Preparing for a Hard Drive Installation”](#) for POWER or [Section 19.2, “Preparing for a Hard Drive Installation”](#) for IBM System z).
 - place it on a *pre-boot execution environment* (PXE) server to prepare for installations using PXE boot (refer to [Chapter 30, Setting Up an Installation Server](#)).

Making Media

Use the methods described in this section to create the following types of installation and boot media:

- an installation DVD
- a USB flash drive to use as an installation source
- a minimal boot CD or DVD that can boot the installer
- a USB flash drive to boot the installer

The following table indicates the types of boot and installation media available for different architectures and notes the image file that you need to produce the media.

Table 2.1. Boot and installation media

| Architecture | Installation DVD | Installation USB flash drive | Boot CD or boot DVD | Boot USB flash drive |
|-------------------------------|---|---|---------------------|---|
| BIOS-based 32-bit x86 | x86 DVD ISO image file | x86 DVD ISO image file | boot.iso | boot.iso |
| UEFI-based 32-bit x86 | Not available | | | |
| BIOS-based AMD64 and Intel 64 | x86_64 DVD ISO image file (to install 64-bit operating system) or x86 DVD ISO image file (to install 32-bit operating system) | x86_64 DVD ISO image file (to install 64-bit operating system) or x86 DVD ISO image file (to install 32-bit operating system) | boot.iso | boot.iso |
| UEFI-based AMD64 and Intel 64 | x86_64 DVD ISO image file | Not available | Not available | efiboot.img (from x86_64 DVD ISO image file) |
| POWER (64-bit only) | ppc DVD ISO image file | Not available | boot.iso | Not available |
| System z | s390 DVD ISO image file | Not available | Not available | Not available |

2.1. Making an installation DVD

You can make an installation DVD using the CD or DVD burning software on your computer.

The exact series of steps that produces a DVD from an ISO image file varies greatly from computer to computer, depending on the operating system and disc burning software installed. Use this procedure as a general guide. You might be able to omit certain steps on your computer, or might have to perform some of the steps in a different order from the order described here.

Make sure that your disc burning software is capable of burning discs from image files. Although this is true of most disc burning software, exceptions exist.

In particular, note that the disc burning feature built into Windows XP and Windows Vista cannot burn DVDs; and that earlier Windows operating systems did not have any disc burning capability installed

by default at all. Therefore, if your computer has a Windows operating system prior to Windows 7 installed on it, you need a separate piece of software for this task. Examples of popular disc burning software for Windows that you might already have on your computer include **Nero Burning ROM** and **Roxio Creator**.

Most widely used disc burning software for Linux, such as **Brasero** and **K3b** has the built-in ability to burn discs from ISO image files.

1. Download an ISO image file of the Red Hat Enterprise Linux 6 installation DVD as described in [Chapter 1, Obtaining Red Hat Enterprise Linux](#).
2. Insert a blank, writeable DVD into your computer's DVD burner. On some computers, a window opens and displays various options when you insert the disc. If you see a window like this, look for an option to launch your chosen disc burning program. If you do not see an option like this, close the window and launch the program manually.
3. Launch your disc burning program. On some computers, you can do this by right-clicking (or control-clicking) on the image file and selecting a menu option with a label like **Copy image to DVD**, or **Copy CD or DVD image**. Other computers might provide you with a menu option to launch your chosen disc burning program, either directly or with an option like **Open With**. If none of these options are available on your computer, launch the program from an icon on your desktop, in a menu of applications such as the **Start** menu on Windows operating systems.
4. In your disc burning program, select the option to burn a disc from an image file. For example, in **Brasero**, this option is called **Burn image**.

Note that you can skip this step when using certain disc burning software.

5. Browse to the ISO image file that you downloaded previously and select it for burning.
6. Click the button that starts the burning process.

On some computers, the option to burn a disc from an ISO file is integrated into a *context menu* in the file browser. For example, when you right-click an ISO file on a computer with a Linux or UNIX operating system that runs the GNOME desktop, the **Nautilus** file browser presents you with the option to **Write to disk**.

2.2. Preparing a USB flash drive as an installation source



Unusual USB Media

In a few cases with oddly formatted or partitioned USB media, image writing may fail.

You can install Red Hat Enterprise Linux on 32-bit x86 systems and BIOS-based AMD64 and Intel 64 systems using a USB flash drive, provided that your hardware supports booting from this type of device. Note that you cannot install Red Hat Enterprise Linux on POWER systems or UEFI-based AMD64 and Intel 64 systems from a USB flash drive, although you can use a USB flash drive to boot the Red Hat Enterprise Linux installer on UEFI-based AMD64 and Intel 64 systems — refer to [Section 2.3, “Making Minimal Boot Media”](#).

This procedure describes the steps to take on a system that runs Red Hat Enterprise Linux, but the commands are broadly similar for any Linux or UNIX operating system.



Warning — These instructions could destroy data

When you perform this procedure any data on the USB flash drive is destroyed with no warning. Make sure that you specify the correct USB flash drive, and make sure that this flash drive does not contain any data that you want to keep.

1. Plug in your USB flash drive.
2. Find the device name for your USB flash drive. If the flash drive has a volume name, look up the name in `/dev/disk/by-label`, or use `findfs`:

```
su -c 'findfs LABEL="MyLabel"'
```

If the media does not have a volume name, or you do not know it, run `dmesg` after you connect the USB flash drive. The device name, similar to `/dev/sdc`, appears in several lines towards the end of the output.

3. Use the `dd` command to transfer the ISO image to the USB device:

```
dd if=path/image_name.iso of=device
```

where `path/image_name.iso` is the ISO image file of the installation DVD that you downloaded from the Red Hat Customer Portal and `device` is the USB flash drive. For example:

```
dd if=~/.Download/RHEL6-Server-i386-DVD.iso of=/dev/sdc
```

2.3. Making Minimal Boot Media

A piece of *minimal boot media* is a CD, DVD, or USB flash drive that contains the software to boot the system and launch the installation program, but which does not contain the software that must be transferred to the system to create a Red Hat Enterprise Linux installation.

Use minimal boot media:

- to boot the system to install Red Hat Enterprise Linux over a network
- to boot the system to install Red Hat Enterprise Linux from a hard drive
- to use a kickstart file during installation (refer to [Section 32.8.1, “Creating Kickstart Boot Media”](#))
- to commence a network or hard-drive installation or to use an **anaconda** update or a kickstart file with a DVD installation.

You can use minimal boot media to start the installation process on 32-bit x86 systems, AMD64 or Intel 64 systems, and POWER systems. The process by which you create minimal boot media for systems of these various types is identical except in the case of AMD64 and Intel 64 systems with UEFI firmware interfaces — refer to [Section 2.3.1, “UEFI-based systems”](#).

To make minimal boot media for 32-bit x86 systems, BIOS-based AMD64 or Intel 64 systems, and POWER systems:

1. Download the ISO image file named **boot.iso** that is available at the same location as the images of the Red Hat Enterprise Linux 6 installation DVD — refer to [Chapter 1, Obtaining Red Hat Enterprise Linux](#).
2. Burn **boot.iso** to a blank CD or DVD using the same procedure detailed in [Section 2.1, “Making an installation DVD”](#) for the installation disc, or transfer the **boot.iso** file to a USB device with the **dd** command as detailed in [Section 2.2, “Preparing a USB flash drive as an installation source”](#). As the **boot.iso** file is only around 200 MB in size, you do not need an especially large USB flash drive.

2.3.1. UEFI-based systems

Red Hat does not provide an image to produce minimal boot CDs or DVDs for UEFI-based systems. Use a USB flash drive (as described in this section) to boot the Red Hat Enterprise Linux 6 installer, or use the installation DVD with the **linux askmethod** option to boot the installer from DVD and continue installation from a different installation source — refer to [Section 3.5, “Selecting an Installation Method”](#).

Use the **efidisk.img** file in the **images/** directory on the Red Hat Enterprise Linux 6 installation DVD to produce a bootable USB flash drive for UEFI-based systems.

1. Download an ISO image file of the Red Hat Enterprise Linux 6 installation DVD as described in [Chapter 1, Obtaining Red Hat Enterprise Linux](#).
2. Become root:

```
su -
```

3. Create a mount point for the ISO image file:

```
mkdir /mnt/dvdiso
```

4. Mount the image file:

```
mount DVD.iso /mnt/dvdiso -o loop
```

Where *DVD.iso* is the name of the ISO image file, for example **RHEL6-Server-x86_64-DVD.iso**.

5. Transfer **efidisk.img** from the ISO image file to your USB flash drive:

```
dd if=/mnt/dvdiso/images/efidisk.img of=/dev/device_name
```

For example:

```
dd if=/mnt/dvdiso/images/efidisk.img of=/dev/sdc
```

6. Unmount the ISO image file:

```
umount /mnt/dvdiso
```

Part I. x86, AMD64, and Intel 64 — Installation and Booting

The *Red Hat Enterprise Linux Installation Guide* for Intel and AMD 32-bit and 64-bit systems discusses the installation of Red Hat Enterprise Linux and some basic post-installation troubleshooting. For advanced installation options, refer to [Part IV, “Advanced installation options”](#).

Planning for Installation on the x86 Architecture

3.1. Upgrade or Install?

For information to help you determine whether to perform an upgrade or an installation refer to [Chapter 37, Upgrading Your Current System](#).

3.2. Is Your Hardware Compatible?

Hardware compatibility is particularly important if you have an older system or a system that you built yourself. Red Hat Enterprise Linux 6 should be compatible with most hardware in systems that were factory built within the last two years. However, hardware specifications change almost daily, so it is difficult to guarantee that your hardware is 100% compatible.

The most recent list of supported hardware can be found at:

<http://hardware.redhat.com/hcl/>

3.3. RAID and Other Disk Devices



Important — Systems with Intel BIOS RAID sets

Red Hat Enterprise Linux 6 uses **mdraid** instead of **dmraid** for installation onto Intel BIOS RAID sets. These sets are detected automatically, and devices with Intel ISW metadata are recognized as **mdraid** instead of **dmraid**. Note that the device node names of any such devices under **mdraid** are different from their device node names under **dmraid**. Therefore, special precautions are necessary when you migrate systems with Intel BIOS RAID sets.

Local modifications to **/etc/fstab**, **/etc/crypttab** or other configuration files which refer to devices by their device node names will not work in Red Hat Enterprise Linux 6. Before migrating these files, you must therefore edit them to replace device node paths with device UUIDs instead. You can find the UUIDs of devices with the **blkid** command.

3.3.1. Hardware RAID

RAID, or Redundant Array of Independent Disks, allows a group, or array, of drives to act as a single device. Configure any RAID functions provided by the mainboard of your computer, or attached controller cards, before you begin the installation process. Each active RAID array appears as one drive within Red Hat Enterprise Linux.

On systems with more than one hard drive you may configure Red Hat Enterprise Linux to operate several of the drives as a Linux RAID array without requiring any additional hardware.

3.3.2. Software RAID

You can use the Red Hat Enterprise Linux installation program to create Linux software RAID arrays, where RAID functions are controlled by the operating system rather than dedicated hardware. These

functions are explained in detail in [Section 9.14, “Creating a Custom Layout or Modifying the Default Layout”](#).

3.3.3. FireWire and USB Disks

Some FireWire and USB hard disks may not be recognized by the Red Hat Enterprise Linux installation system. If configuration of these disks at installation time is not vital, disconnect them to avoid any confusion.



Post-installation Usage

You can connect and configure external FireWire and USB hard disks after installation. Most such devices are recognized by the kernel and available for use at that time.

3.4. Do You Have Enough Disk Space?

Nearly every modern-day operating system (OS) uses *disk partitions*, and Red Hat Enterprise Linux is no exception. When you install Red Hat Enterprise Linux, you may have to work with disk partitions. If you have not worked with disk partitions before (or need a quick review of the basic concepts), refer to [Appendix A, An Introduction to Disk Partitions](#) before proceeding.

The disk space used by Red Hat Enterprise Linux must be separate from the disk space used by other OSes you may have installed on your system, such as Windows, OS/2, or even a different version of Linux. For x86, AMD64, and Intel 64 systems, at least two partitions (*/* and **swap**) must be dedicated to Red Hat Enterprise Linux.

Before you start the installation process, you must

- have enough *unpartitioned*¹ disk space for the installation of Red Hat Enterprise Linux, or
- have one or more partitions that may be deleted, thereby freeing up enough disk space to install Red Hat Enterprise Linux.

To gain a better sense of how much space you really need, refer to the recommended partitioning sizes discussed in [Section 9.14.5, “Recommended Partitioning Scheme”](#).

If you are not sure that you meet these conditions, or if you want to know how to create free disk space for your Red Hat Enterprise Linux installation, refer to [Appendix A, An Introduction to Disk Partitions](#).

3.5. Selecting an Installation Method

What type of installation method do you wish to use? The following installation methods are available:

DVD

If you have a DVD drive and the Red Hat Enterprise Linux DVD you can use this method. Refer to [Section 8.3.1, “Installing from DVD”](#), for DVD installation instructions.

If you booted the installation from a piece of media other than the installation DVD, you can specify the DVD as the installation source with the **linux askmethod** or **linux repo=cdrom:device:/device** boot option, or by selecting **Local CD/DVD** on the **Installation Method** menu (refer to [Section 8.3, “Installation Method”](#)).

Hard Drive

If you have copied the Red Hat Enterprise Linux ISO images to a local hard drive, you can use this method. You need a boot CD-ROM (use the **linux askmethod** or **linux repo=hd:device:/path** boot option), or by selecting **Hard drive** on the **Installation Method** menu (refer to [Section 8.3, “Installation Method”](#)). Refer to [Section 8.3.2, “Installing from a Hard Drive”](#), for hard drive installation instructions.

NFS

If you are installing from an NFS server using ISO images or a mirror image of Red Hat Enterprise Linux, you can use this method. You need a boot CD-ROM (use the **linux askmethod** or **linux repo=nfs:server :options:/path** boot option, or the **NFS directory** option on the **Installation Method** menu described in [Section 8.3, “Installation Method”](#)). Refer to [Section 8.3.4, “Installing via NFS”](#) for network installation instructions. Note that NFS installations may also be performed in GUI mode.

URL

If you are installing directly from an HTTP (Web) server or FTP server, use this method. You need a boot CD-ROM (use the **linux askmethod**, **linux repo=ftp://user:password@host/path**, or **linux repo=http://host/path** boot option, or the **URL** option on the **Installation Method** menu described in [Section 8.3, “Installation Method”](#)). Refer to [Section 8.3.5, “Installing via FTP or HTTP”](#), for FTP and HTTP installation instructions.

If you booted the distribution DVD and did not use the alternate installation source option **askmethod**, the next stage loads automatically from the DVD. Proceed to [Section 8.2, “Language Selection”](#).



DVD Activity

If you boot from a Red Hat Enterprise Linux installation DVD, the installation program loads its next stage from that disc. This happens regardless of which installation method you choose, unless you eject the disc before you proceed. The installation program still downloads *package data* from the source you choose.

3.6. Choose a boot method

You can use several methods to boot Red Hat Enterprise Linux.

Installing from a DVD requires that you have purchased a Red Hat Enterprise Linux product, you have a Red Hat Enterprise Linux 6 DVD, and you have a DVD drive on a system that supports booting from it. Refer to [Chapter 2, Making Media](#) for instructions to make an installation DVD.

Your BIOS may need to be changed to allow booting from your DVD/CD-ROM drive. For more information about changing your BIOS, refer to [Section 7.1.1, “Booting the Installation Program on x86, AMD64, and Intel 64 Systems”](#).

Other than booting from an installation DVD, you can also boot the Red Hat Enterprise Linux installation program from *minimal boot media* in the form of a bootable CD or USB flash drive. After you boot the system with a piece of minimal boot media, you complete the installation from a different installation source, such as a local hard drive or a location on a network. Refer to [Section 2.3, “Making Minimal Boot Media”](#) for instructions on making boot CDs and USB flash drives.

Finally, you can boot the installer over the network from a *preboot execution environment* (PXE) server. Refer to [Chapter 30, Setting Up an Installation Server](#). Again, after you boot the system, you

Chapter 3. Planning for Installation on the x86 Architecture

complete the installation from a different installation source, such as a local hard drive or a location on a network.

Preparing for Installation

4.1. Preparing for a Network Installation



Note

Make sure no installation DVD (or any other type of DVD or CD) is in your system's CD or DVD drive if you are performing a network-based installation. Having a DVD or CD in the drive might cause unexpected errors.

Ensure that you have boot media available on CD, DVD, or a USB storage device such as a flash drive.

The Red Hat Enterprise Linux installation medium must be available for either a network installation (via NFS, FTP, or HTTP) or installation via local storage. Use the following steps if you are performing an NFS, FTP, or HTTP installation.

The NFS, FTP, or HTTP server to be used for installation over the network must be a separate, network-accessible server. It must provide the complete contents of the installation DVD-ROM.



Note

The Red Hat Enterprise Linux installation program has the ability to test the integrity of the installation media. It works with the DVD, hard drive ISO, and NFS ISO installation methods. We recommend that you test all installation media before starting the installation process, and before reporting any installation-related bugs (many of the bugs reported are actually due to improperly-burned DVDs). To use this test, type the following command at the boot : prompt:

```
linux mediacheck
```



Note

The public directory used to access the installation files over FTP, NFS, or HTTP is mapped to local storage on the network server. For example, the local directory `/var/www/inst/rhel6` on the network server can be accessed as `http://network.server.com/inst/rhel6`.

In the following examples, the directory on the installation staging server that will contain the installation files will be specified as `/location/of/disk/space`. The directory that will be made publicly available via FTP, NFS, or HTTP will be specified as `/publicly/available/directory`. For example, `/location/of/disk/space` may be a directory you create called `/var/isos`. `/publicly/available/directory` might be `/var/www/html/rhel6`, for an HTTP install.

```
dd if=/dev/dvd of=/location/of/disk/space/RHEL6.iso
```

where *dvd* refers to your DVD drive device.

To copy the files from the installation DVD to a Linux instance, which acts as an installation staging server, continue with either [Section 4.1.1, “Preparing for FTP and HTTP installation”](#) or [Section 4.1.2, “Preparing for an NFS installation”](#).

4.1.1. Preparing for FTP and HTTP installation

Extract the files from the ISO image of the installation DVD and place them in a directory that is shared over FTP or HTTP.

Next, make sure that the directory is shared via FTP or HTTP, and verify client access. Test to see whether the directory is accessible from the server itself, and then from another machine on the same subnet to which you will be installing.

4.1.2. Preparing for an NFS installation

For NFS installation it is not necessary to extract all the files from the ISO image. It is sufficient to make the ISO image itself, the **install.img** file, and optionally the **product.img** file available on the network server via NFS.

1. Transfer the ISO image to the NFS exported directory. On a Linux system, run:

```
mv /location/of/disk/space/RHEL6.iso /publicly/available/directory/
```

2. Use a SHA256 checksum program to verify that the ISO image that you copied is intact. Many SHA256 checksum programs are available for various operating systems. On a Linux system, run:

```
$ sha256sum name_of_image.iso
```

where *name_of_image* is the name of the ISO image file. The SHA256 checksum program displays a string of 64 characters called a *hash*. Compare this hash to the hash displayed for this particular image on the **Download Software** page on the Red Hat Network (refer to [Chapter 1, Obtaining Red Hat Enterprise Linux](#)). The two hashes should be identical.

3. Copy the **images/** directory within the ISO file to a directory named **images/**. Enter the following commands:

```
mount -t iso9660 /path/to/RHEL6.iso /mnt/point -o loop,ro
cp -pr /mnt/point/images /path/images/
umount /mnt/point
```

4. Verify that the **images/** directory contains at least the **install.img** file, without which installation cannot proceed. Optionally, the **images/** directory should contain the **product.img** file, without which only the packages for a **Minimal** installation will be available during the package group selection stage (refer to [Section 9.17, “Package Group Selection”](#)).
5. Ensure that the **/publicly/available/directory** directory is exported via NFS via an entry in **/etc/exports** on the network server.

To export a directory read-only to a specific system, use:

```
/publicly/available/directory client.ip.address (ro)
```

To export a directory read-only to all systems, use:

```
/publicly/available/directory * (ro)
```

6. On the network server, start the NFS daemon (on a Red Hat Enterprise Linux system, use `/sbin/service nfs start`). If NFS is already running, reload the configuration file (on a Red Hat Enterprise Linux system use `/sbin/service nfs reload`).
7. Be sure to test the NFS share following the directions in the *Red Hat Enterprise Linux Deployment Guide*. Refer to your NFS documentation for details on starting and stopping the NFS server.



Note

The Red Hat Enterprise Linux installation program has the ability to test the integrity of the installation media. It works with the DVD, hard drive ISO, and NFS ISO installation methods. We recommend that you test all installation media before starting the installation process, and before reporting any installation-related bugs (many of the bugs reported are actually due to improperly-burned DVDs). To use this test, type the following command at the boot : prompt:

```
linux mediacheck
```

4.2. Preparing for a Hard Drive Installation



Note — Not all file systems supported

Hard drive installations only work from ext2, ext3, ext4, or FAT file systems. You cannot use a hard drives formatted for any other file system as an installation source for Red Hat Enterprise Linux.

To check the file system of a hard drive partition on a Windows operating system, use the **Disk Management** tool. To check the file system of a hard drive partition on a Linux operating system, use the **fdisk** tool.



Cannot Install from LVM Partitions

You cannot use ISO files on partitions controlled by LVM (Logical Volume Management).

Use this option to install Red Hat Enterprise Linux on systems without a DVD drive or network connection.

Hard drive installations use the following files:

- an *ISO image* of the installation DVD. An ISO image is a file that contains an exact copy of the content of a DVD.

Chapter 4. Preparing for Installation

- an **install.img** file extracted from the ISO image.
- optionally, a **product.img** file extracted from the ISO image.

With these files present on a hard drive, you can choose **Hard drive** as the installation source when you boot the installation program (refer to [Section 8.3, “Installation Method”](#)).

Ensure that you have boot media available on CD, DVD, or a USB storage device such as a flash drive.

To prepare a hard drive as an installation source, follow these steps:

1. Obtain an ISO image of the Red Hat Enterprise Linux installation DVD (refer to [Chapter 1, Obtaining Red Hat Enterprise Linux](#)). Alternatively, if you have the DVD on physical media, you can create an image of it with the following command on a Linux system:

```
dd if=/dev/dvd of=/location/of/disk/space/RHEL6.iso
```

where *dvd* refers to your DVD drive device.

2. Transfer the ISO image to the hard drive.

The ISO image must be located on a hard drive that is either internal to the computer on which you will install Red Hat Enterprise Linux, or on a hard drive that is attached to that computer by USB.

3. Use a SHA256 checksum program to verify that the ISO image that you copied is intact. Many SHA256 checksum programs are available for various operating systems. On a Linux system, run:

```
$ sha256sum name_of_image.iso
```

where *name_of_image* is the name of the ISO image file. The SHA256 checksum program displays a string of 64 characters called a *hash*. Compare this hash to the hash displayed for this particular image on the **Download Software** page on the Red Hat Network (refer to [Chapter 1, Obtaining Red Hat Enterprise Linux](#)). The two hashes should be identical.

4. Copy the **images/** directory within the ISO file to a directory named **images/**. Enter the following commands:

```
mount -t iso9660 /path/to/RHEL6.iso /mnt/point -o loop,ro
cp -pr /mnt/point/images /path/images/
umount /mnt/point
```

5. Verify that the **images/** directory contains at least the **install.img** file, without which installation cannot proceed. Optionally, the **images/** directory should contain the **product.img** file, without which only the packages for a **Minimal** installation will be available during the package group selection stage (refer to [Section 9.17, “Package Group Selection”](#)).

**Note**

The Red Hat Enterprise Linux installation program has the ability to test the integrity of the installation media. It works with the DVD, hard drive ISO, and NFS ISO installation methods. We recommend that you test all installation media before starting the installation process, and before reporting any installation-related bugs (many of the bugs reported are actually due to improperly-burned DVDs). To use this test, type the following command at the boot : prompt:

```
linux mediacheck
```


System Specifications List

The most recent list of supported hardware can be found at <http://hardware.redhat.com/hcl/>.

The installation program automatically detects and installs your computer's hardware. Although you should make sure that your hardware meets the minimum requirements to install Red Hat Enterprise Linux (refer to [Section 3.2, "Is Your Hardware Compatible?"](#)) you do not usually need to supply the installation program with any specific details about your system.

However, when performing certain types of installation, some specific details might be useful or even essential.

- If you plan to use a customized partition layout, record:
 - The model numbers, sizes, types, and interfaces of the hard drives attached to the system. For example, Seagate ST3320613AS 320 GB on SATA0, Western Digital WD7500AAKS 750 GB on SATA1. This will allow you to identify specific hard drives during the partitioning process.
- If you are installing Red Hat Enterprise Linux as an additional operating system on an existing system, record:
 - The mount points of the existing partitions on the system. For example, **/boot** on **sda1**, **/** on **sda2**, and **/home** on **sdb1**. This will allow you to identify specific partitions during the partitioning process.
- If you plan to install from an image on a local hard drive:
 - The hard drive and directory that holds the image.
- If you plan to install from a network location, or install on an iSCSI target:
 - The make and model numbers of the network adapters on your system. For example, Netgear GA311. This will allow you to identify adapters when manually configuring the network.
 - IP, DHCP, and BOOTP addresses
 - Netmask
 - Gateway IP address
 - One or more name server IP addresses (DNS)

If any of these networking requirements or terms are unfamiliar to you, contact your network administrator for assistance.

- If you plan to install from a network location:
 - The location of the image on an FTP server, HTTP (web) server, or NFS server – see [Section 8.3.5, "Installing via FTP or HTTP"](#) and [Section 8.3.4, "Installing via NFS"](#) for examples.
- If you plan to install on an iSCSI target:
 - The location of the iSCSI target. Depending on your network, you might also need a CHAP username and password, and perhaps a reverse CHAP username and password – see [Section 9.5.1.1, "Advanced Storage Options"](#).
- If your computer is part of a domain:

- You should verify that the domain name will be supplied by the DHCP server. If not, you will need to input the domain name manually during installation.

Updating drivers during installation on Intel and AMD systems

In most cases, Red Hat Enterprise Linux already includes drivers for the devices that make up your system. However, if your system contains hardware that has been released very recently, drivers for this hardware might not yet be included. Sometimes, a driver update that provides support for a new device might be available from Red Hat or your hardware vendor on a *driver disc* that contains *rpm packages*. Typically, the driver disc is available for download as an *ISO image file*.

Often, you do not need the new hardware during the installation process. For example, if you use a DVD to install to a local hard drive, the installation will succeed even if drivers for your network card are not available. In situations like this, complete the installation and add support for the piece of hardware afterward — refer to [Section 35.1.1, “Driver update rpm packages”](#) for details of adding this support.

In other situations, you might want to add drivers for a device during the installation process to support a particular configuration. For example, you might want to install drivers for a network device or a storage adapter card to give the installer access to the storage devices that your system uses. You can use a driver disc to add this support during installation in one of three ways:

1. place the ISO image file of the driver disc in a location accessible to the installer:
 - a. on a local hard drive
 - b. a USB flash drive
2. create a driver disc by extracting the image file onto:
 - a. a CD
 - b. a DVD

Refer to the instructions for making installation discs in [Section 2.1, “Making an installation DVD”](#) for more information on burning ISO image files to CD or DVD.

3. create an *initial ramdisk update* from the image file and store it on a PXE server. This is an advanced procedure that you should consider only if you cannot perform a driver update with any other method.

If Red Hat, your hardware vendor, or a trusted third party told you that you will require a driver update during the installation process, choose a method to supply the update from the methods described in this chapter and test it before beginning the installation. Conversely, do not perform a driver update during installation unless you are certain that your system requires it. Although installing an unnecessary driver update will not cause harm, the presence of a driver on a system for which it was not intended can complicate support.

6.1. Limitations of driver updates during installation

Unfortunately, some situations persist in which you cannot use a driver update to provide drivers during installation:

Devices already in use

You cannot use a driver update to replace drivers that the installation program has already loaded. Instead, you must complete the installation with the drivers that the installation program loaded and update to the new drivers after installation, or, if you need the new drivers for the installation process, consider performing an initial RAM disk driver update — refer to [Section 6.2.3, “Preparing an initial RAM disk update”](#).

Devices with an equivalent device available

Because all devices of the same type are initialized together, you cannot update drivers for a device if the installation program has loaded drivers for a similar device. For example, consider a system that has two different network adapters, one of which has a driver update available. The installation program will initialize both adapters at the same time, and therefore, you will not be able to use this driver update. Again, complete the installation with the drivers loaded by the installation program and update to the new drivers after installation, or use an initial RAM disk driver update.

6.2. Preparing for a driver update during installation

If a driver update is necessary and available for your hardware, Red Hat or a trusted third party such as the hardware vendor will typically provide it in the form of an image file in ISO format. Some methods of performing a driver update require you to make the image file available to the installation program, others require you to use the image file to make a driver update disk, and one requires you to prepare an initial RAM disk update:

Methods that use the image file itself

- local hard drive
- USB flash drive

Methods that use a driver update disk produced from an image file

- CD
- DVD

Methods that use an initial RAM disk update

- PXE

Choose a method to provide the driver update, and refer to [Section 6.2.1, “Preparing to use a driver update image file”](#), [Section 6.2.2, “Preparing a driver disc”](#) or [Section 6.2.3, “Preparing an initial RAM disk update”](#). Note that you can use a USB storage device either to provide an image file, or as a driver update disk.

6.2.1. Preparing to use a driver update image file

6.2.1.1. Preparing to use an image file on local storage

To make the ISO image file available on local storage, such as a hard drive or USB flash drive, simply copy the file onto the storage device. You can rename the file if you find it helpful to do so, but you must not change the filename extension, which must remain `.iso`. In the following example, the file is named `dd.iso`:

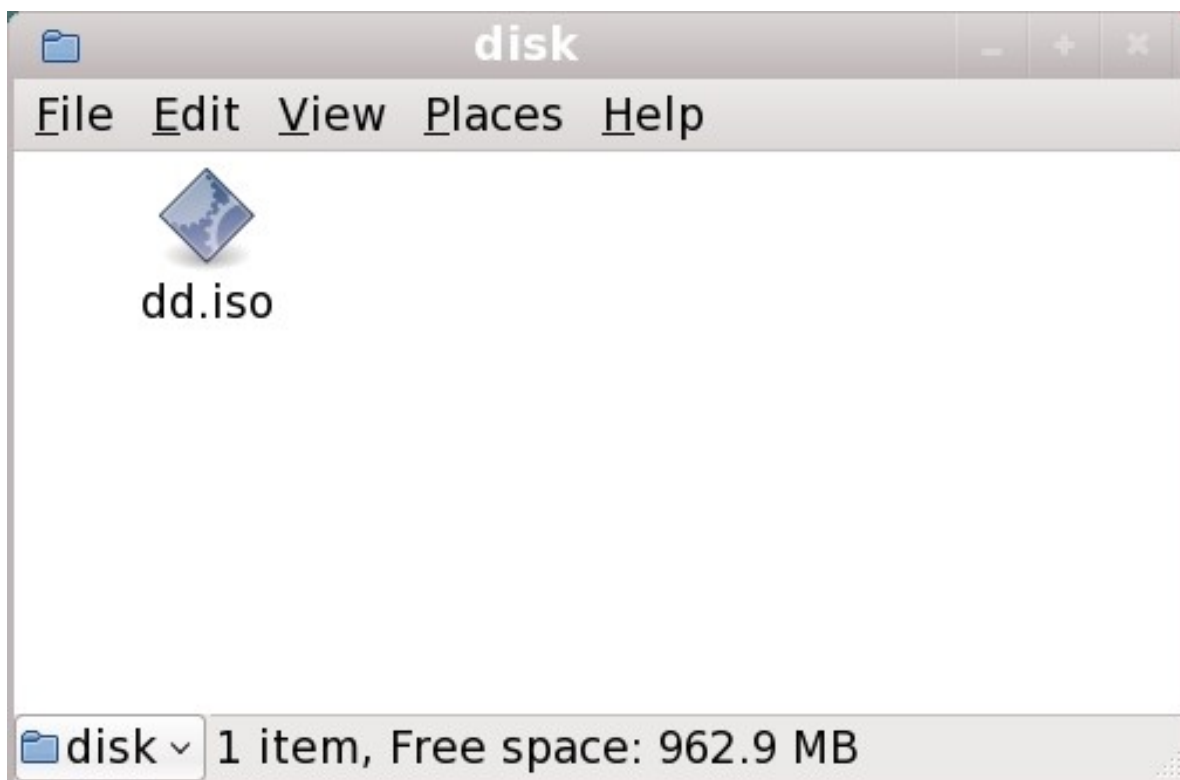


Figure 6.1. Content of a USB flash drive holding a driver update image file

Note that if you use this method, the storage device will contain only a single file. This differs from driver discs on formats such as CD and DVD, which contain many files. The ISO image file contains all of the files that would normally be on a driver disc.

Refer to [Section 6.3.2, “Let the installer prompt you for a driver update”](#) and [Section 6.3.3, “Use a boot option to specify a driver update disk”](#) to learn how to use the driver update disk during installation.

If you change the file system label of the device to **OEMDRV**, the installation program will automatically examine it for driver updates and load any that it detects. This behavior is controlled by the **dlabel=on** boot option, which is enabled by default. Refer to [Section 6.3.1, “Let the installer automatically find a driver update disk”](#).

6.2.2. Preparing a driver disc

You can create a driver update disc on CD or DVD.

6.2.2.1. Creating a driver update disk on CD or DVD



These instructions assume that you use the GNOME desktop

CD/DVD Creator is part of the GNOME desktop. If you use a different Linux desktop, or a different operating system altogether, you will need to use another piece of software to create the CD or DVD. The steps will be generally similar.

Make sure that the software that you choose can create CDs or DVDs from image files. While this is true of most CD and DVD burning software, exceptions exist. Look for a button or menu entry labeled **burn from image** or similar. If your software lacks this feature, or you do not select it, the resulting disk will hold only the image file itself, instead of the contents of the image file.

1. Use the desktop file manager to locate the ISO image file of the driver disc, supplied to you by Red Hat or your hardware vendor.

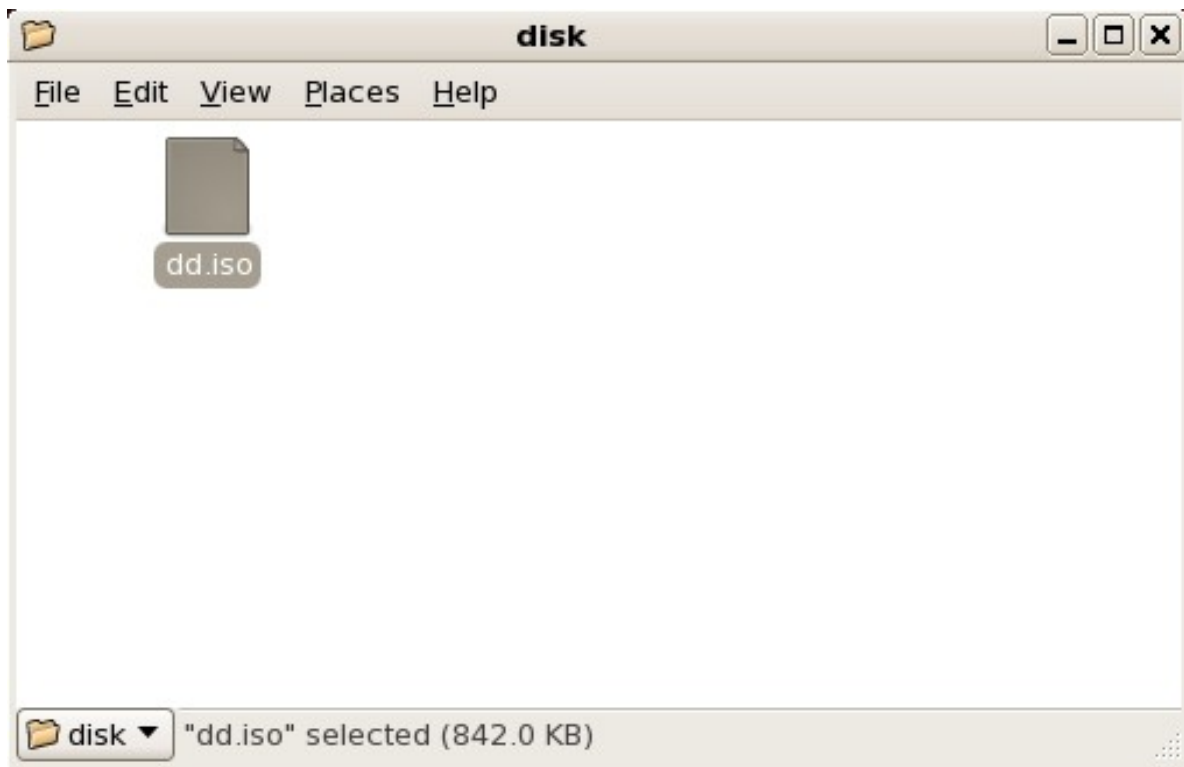


Figure 6.2. A typical .iso file displayed in a file manager window

2. Right-click on this file and choose **Write to disc**. You will see a window similar to the following:



Figure 6.3. CD/DVD Creator's Write to Disc dialog

3. Click the **Write** button. If a blank disc is not already in the drive, **CD/DVD Creator** will prompt you to insert one.

After you burn a driver update disk CD or DVD, verify that the disk was created successfully by inserting it into your system and browsing to it using the file manager. You should see a single file named **rhdd3** and a directory named **rpms**:

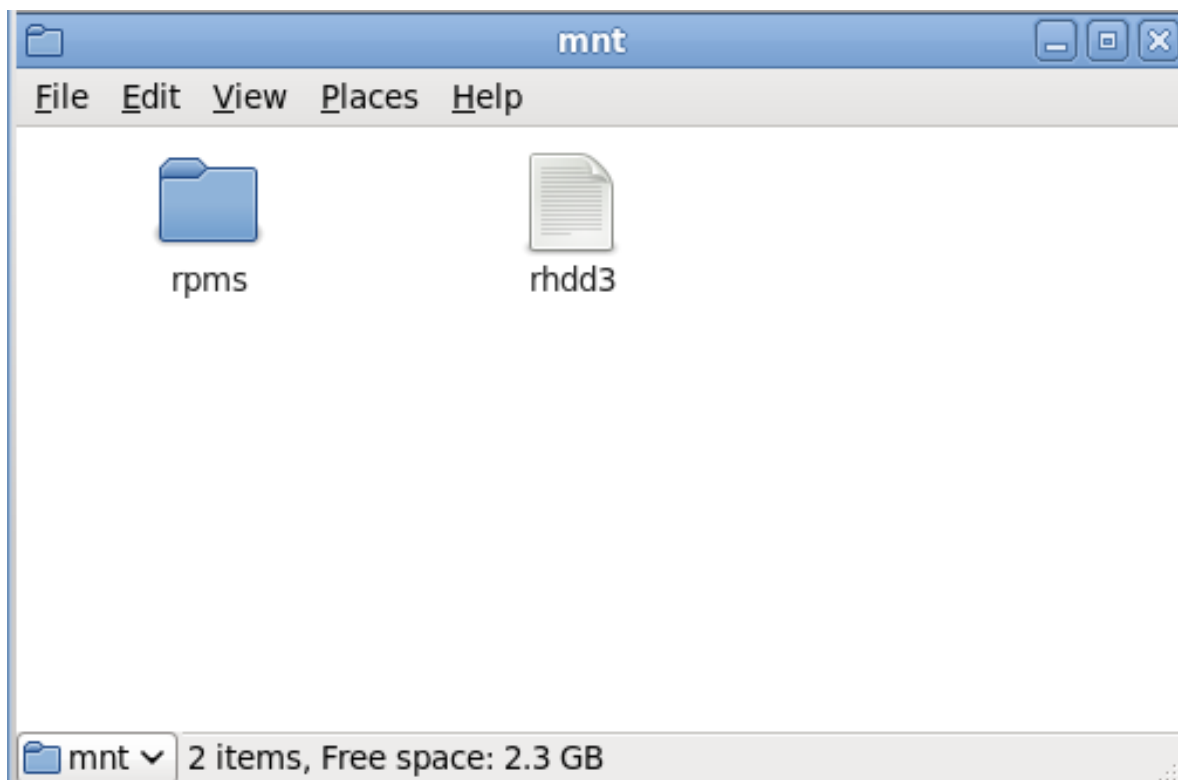


Figure 6.4. Contents of a typical driver update disc on CD or DVD

If you see only a single file ending in **.iso**, then you have not created the disk correctly and should try again. Ensure that you choose an option similar to **burn from image** if you use a Linux desktop other than GNOME or if you use a different operating system.

Refer to [Section 6.3.2, “Let the installer prompt you for a driver update”](#) and [Section 6.3.3, “Use a boot option to specify a driver update disk”](#) to learn how to use the driver update disk during installation.

6.2.3. Preparing an initial RAM disk update



Advanced procedure

This is an advanced procedure that you should consider only if you cannot perform a driver update with any other method.

The Red Hat Enterprise Linux installation program can load updates for itself early in the installation process from a *RAM disk* — an area of your computer's memory that temporarily behaves as if it were a disk. You can use this same capability to load driver updates. To perform a driver update during installation, your computer must be able to boot from a *preboot execution environment* (PXE) server, and you must have a PXE server available on your network. Refer to [Chapter 30, Setting Up an Installation Server](#) for instructions on using PXE during installation.

To make the driver update available on your PXE server:

Chapter 6. Updating drivers during installation on Intel and AMD systems

1. Place the driver update image file on your PXE server. Usually, you would do this by downloading it to the PXE server from a location on the Internet specified by Red Hat or your hardware vendor. Names of driver update image files end in **.iso**.
2. Copy the driver update image file into the **/tmp/initrd_update** directory.
3. Rename the driver update image file to **dd.img**.
4. At the command line, change into the **/tmp/initrd_update** directory, type the following command, and press **Enter**:

```
find . | cpio --quiet -c -o | gzip -9 >/tmp/initrd_update.img
```

5. Copy the file **/tmp/initrd_update.img** into the directory that holds the target that you want to use for installation. This directory is placed under the **/tftpboot/pxelinux/** directory. For example, **/tftpboot/pxelinux/r6c/** might hold the PXE target for Red Hat Enterprise Linux 6 Client.
6. Edit the **/tftpboot/pxelinux/pxelinux.cfg/default** file to include an entry that includes the initial RAM disk update that you just created, in the following format:

```
label target-dd
kernel target/vmlinuz
append initrd=target/initrd.img,target/dd.img
```

Where *target* is the target that you want to use for installation.

Refer to [Section 6.3.4, “Select a PXE target that includes a driver update”](#) to learn how to use an initial RAM disk update during installation.

Example 6.1. Preparing an initial RAM disk update from a driver update image file

In this example, **driver_update.iso** is a driver update image file that you downloaded from the Internet to a directory on your PXE server. The target that you want to PXE boot from is located in **/tftpboot/pxelinux/r6c/**

At the command line, change to the directory that holds the file and enter the following commands:

```
$ cp driver_update.iso /tmp/initrd_update/dd.img
$ cd /tmp/initrd_update
$ find . | cpio --quiet -c -o | gzip -9 >/tmp/initrd_update.img
$ cp /tmp/initrd_update.img /tftpboot/pxelinux/r6c/dd.img
```

Edit the **/tftpboot/pxelinux/pxelinux.cfg/default** file and include the following entry:

```
label r6c-dd
kernel r6c/vmlinuz
append initrd=r6c/initrd.img,r6c/dd.img
```

6.3. Performing a driver update during installation

You can perform a driver update during installation in the following ways:

- let the installer automatically find a driver update disk.
- let the installer prompt you for a driver update.

- use a boot option to specify a driver update disk.
- select a PXE target that includes a driver update.

6.3.1. Let the installer automatically find a driver update disk

Attach a block device with the filesystem label **OEMDRV** before starting the installation process. The installer will automatically examine the device and load any driver updates that it detects and will not prompt you during the process. Refer to [Section 6.2.1.1, “Preparing to use an image file on local storage”](#) to prepare a storage device for the installer to find.

6.3.2. Let the installer prompt you for a driver update

1. Begin the installation normally for whatever method you have chosen. If the installer cannot load drivers for a piece of hardware that is essential for the installation process (for example, if it cannot detect any network or storage controllers), it prompts you to insert a driver update disk:

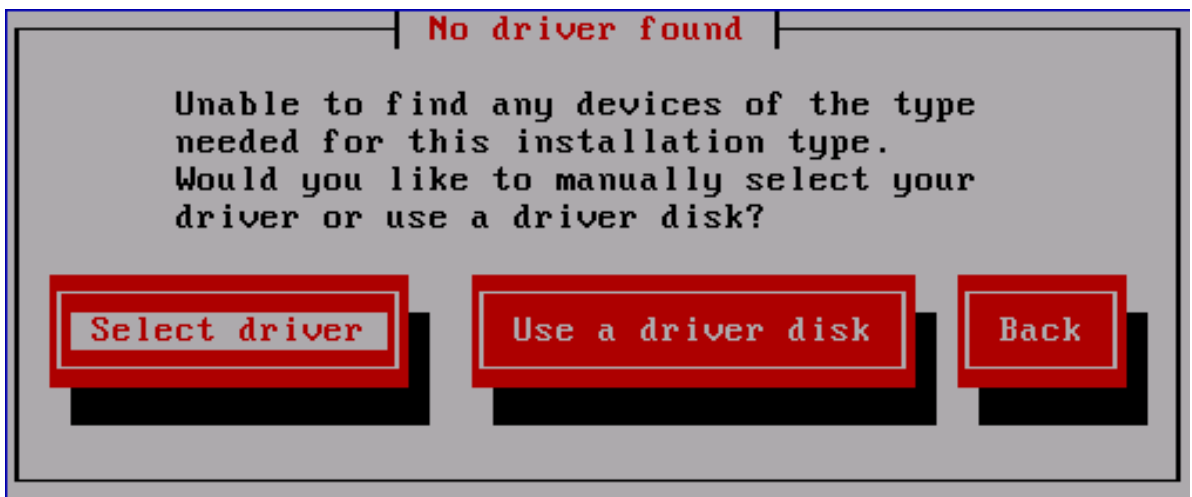


Figure 6.5. The no driver found dialog

2. Select **Use a driver disk** and refer to [Section 6.4, “Specifying the location of a driver update image file or driver update disk”](#).

6.3.3. Use a boot option to specify a driver update disk



Choose this method only for completely new drivers

This method only works to introduce completely new drivers, not to update existing drivers.

1. Type **linux dd** at the boot prompt at the start of the installation process and press **Enter**. The installer prompts you to confirm that you have a driver disk:



Figure 6.6. The driver disk prompt

2. Insert the driver update disk that you created on CD, DVD, or USB flash drive and select **Yes**. The installer examines the storage devices that it can detect. If there is only one possible location that could hold a driver disk (for example, the installer detects the presence of a DVD drive, but no other storage devices) it will automatically load any driver updates that it finds at this location.

If the installer finds more than one location that could hold a driver update, it prompts you to specify the location of the update. Refer to [Section 6.4, “Specifying the location of a driver update image file or driver update disk”](#).

6.3.4. Select a PXE target that includes a driver update

1. Select **network boot** in your computer's BIOS or boot menu. The procedure to specify this option varies widely among different computers. Consult your hardware documentation or the hardware vendor for specifics relevant to your computer.
2. In the preexecution boot environment (PXE), choose the boot target that you prepared on your PXE server. For example, if you labeled this environment **r6c-dd** in the `/tftpboot/pxelinux/pxelinux.cfg/default` file on your PXE server, type **r6c-dd** at the prompt and press **Enter**.

Refer to [Section 6.2.3, “Preparing an initial RAM disk update”](#) and [Chapter 30, Setting Up an Installation Server](#) for instructions on using PXE to perform an update during installation. Note that this is an advanced procedure — do not attempt it unless other methods of performing a driver update fail.

6.4. Specifying the location of a driver update image file or driver update disk

If the installer detects more than one possible device that could hold a driver update, it prompts you to select the correct device. If you are not sure which option represents the device on which the driver update is stored, try the various options in order until you find the correct one.

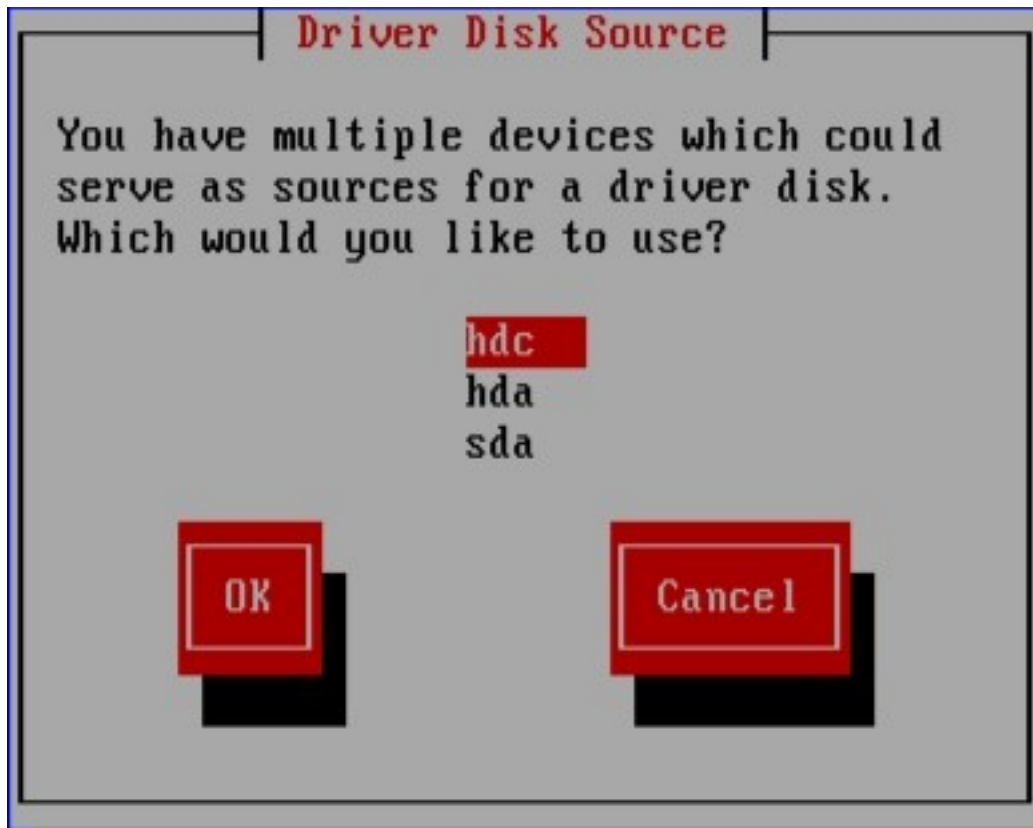


Figure 6.7. Selecting a driver disk source

If the device that you choose contains no suitable update media, the installer will prompt you to make another choice.

If you made a driver update disk on CD, DVD, or USB flash drive, the installer now loads the driver update. However, if the device that you selected is a type of device that could contain more than one partition (whether the device currently has more than one partition or not), the installer might prompt you to select the partition that holds the driver update.



Figure 6.8. Selecting a driver disk partition

The installer prompts you to specify which file contains the driver update:

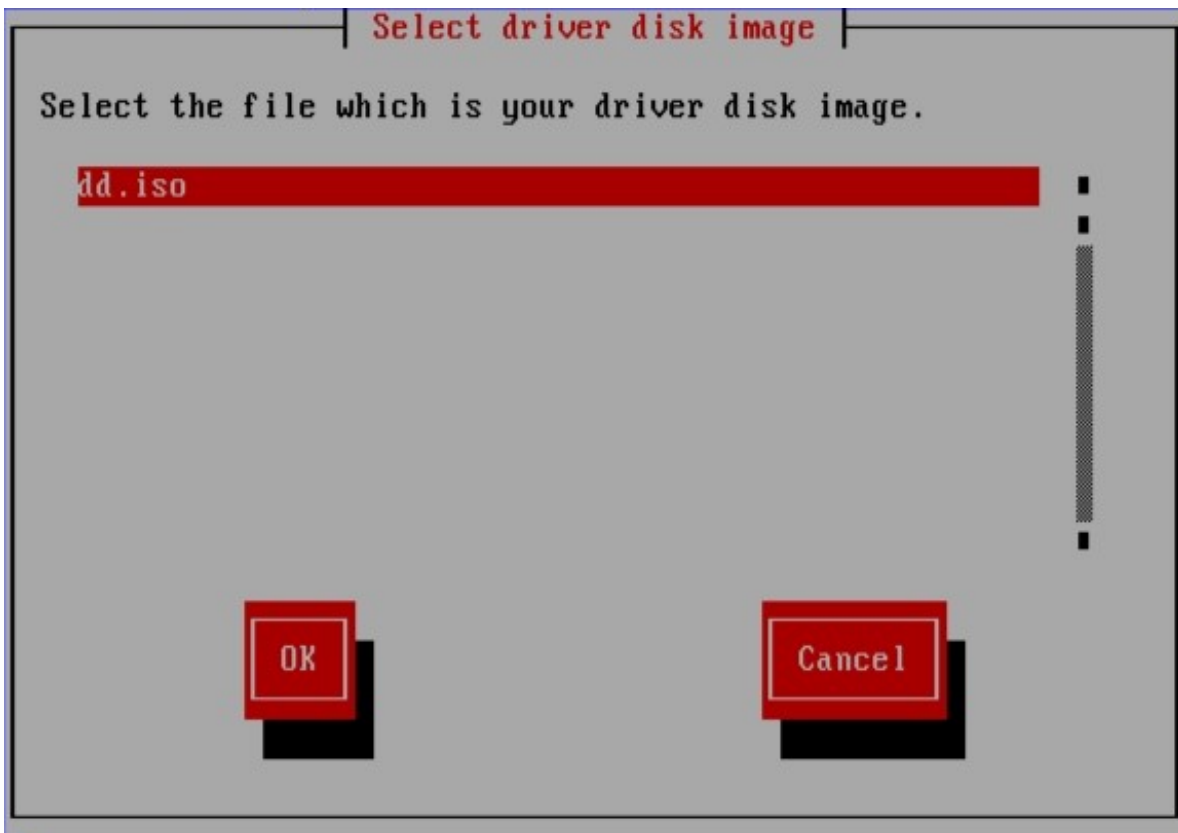


Figure 6.9. Selecting an ISO image

Expect to see these screens if you stored the driver update on an internal hard drive or on a USB storage device. You should not see them if the driver update is on a CD or DVD.

Regardless of whether you are providing a driver update in the form of an image file or with a driver update disk, the installer now copies the appropriate update files into a temporary storage area (located in system RAM and not on disk). The installer might ask whether you would like to use additional driver updates. If you select **Yes**, you can load additional updates in turn. When you have no further driver updates to load, select **No**. If you stored the driver update on removeable media, you can now safely eject or disconnect the disk or device. The installer no longer requires the driver update, and you can re-use the media for other purposes.

Booting the Installer



Important — UEFI for 32-bit x86 systems

Red Hat Enterprise Linux 6 does not support UEFI for 32-bit x86 systems.



Important — UEFI for AMD64 and Intel 64

Note that the boot configurations of UEFI and BIOS differ significantly from each other. Therefore, the installed system must boot using the same firmware that was used during installation. You cannot install the operating system on a system that uses BIOS and then boot this installation on a system that uses UEFI.

Red Hat Enterprise Linux 6 supports version 2.2 of the UEFI specification. Hardware that supports version 2.3 of the UEFI specification or later should boot and operate with Red Hat Enterprise Linux 6, but the additional functionality defined by these later specifications will not be available. The UEFI specifications are available from <http://www.uefi.org/specs/agreement/>

To start the installation program from a Red Hat Enterprise Linux DVD or from minimal boot media, follow this procedure:

1. Disconnect any external FireWire or USB disks that you do not need for installation. Refer to [Section 3.3.3, “FireWire and USB Disks”](#) for more information.
2. Power on your computer system.
3. Insert the media in your computer.
4. Power off your computer with the boot media still inside.
5. Power on your computer system.

You might need to press a specific key or combination of keys to boot from the media. On most computers, a message appears briefly on the screen very soon after you turn on the computer. Typically, it is worded something like **Press F10 to select boot device**, although the specific wording and the key that you must press varies widely from computer to computer. Consult the documentation for your computer or motherboard, or seek support from the hardware manufacturer or vendor.

If your computer does not allow you to select a boot device as it starts up, you might need to configure your system's *Basic Input/Output System* (BIOS) to boot from the media.

To change your BIOS settings on an x86, AMD64, or Intel 64 system, watch the instructions provided on your display when your computer first boots. A line of text appears, telling you which key to press to enter the BIOS settings.

Once you have entered your BIOS setup program, find the section where you can alter your boot sequence. The default is often C, A or A, C (depending on whether you boot from your hard drive [C] or a diskette drive [A]). Change this sequence so that the DVD is first in your boot order and that C or A (whichever is your typical boot default) is second. This instructs the computer to first look at the DVD drive for bootable media; if it does not find bootable media on the DVD drive, it then checks your hard drive or diskette drive.

Save your changes before exiting the BIOS. For more information, refer to the documentation that came with your system.



Note — Aborting the Installation

To abort the installation, either press **Ctrl +Alt+Del** or power off your computer with the power switch. You may abort the installation process without consequence at any time prior to selecting **Write changes to disk** on the **Write partitioning to disk** screen. Red Hat Enterprise Linux makes no permanent changes to your computer until that point. Please be aware that stopping the installation after partitioning has begun can leave your computer unusable.

7.1. Starting the Installation Program



Important — UEFI for 32-bit x86 systems

Red Hat Enterprise Linux 6 does not support UEFI for 32-bit x86 systems.



Important — UEFI for AMD64 and Intel 64

Note that the boot configurations of UEFI and BIOS differ significantly from each other. Therefore, the installed system must boot using the same firmware that was used during installation. You cannot install the operating system on a system that uses BIOS and then boot this installation on a system that uses UEFI.

Red Hat Enterprise Linux 6 supports version 2.2 of the UEFI specification. Hardware that supports version 2.3 of the UEFI specification or later should boot and operate with Red Hat Enterprise Linux 6, but the additional functionality defined by these later specifications will not be available. The UEFI specifications are available from <http://www.uefi.org/specs/agreement/>

To start, first make sure that you have all necessary resources for the installation. If you have already read through [Chapter 3, Planning for Installation on the x86 Architecture](#), and followed the instructions, you should be ready to start the installation process. When you have verified that you are ready to begin, boot the installation program using the Red Hat Enterprise Linux DVD or any boot media that you have created.



Note

Occasionally, some hardware components require a *driver update* during the installation. A driver update adds support for hardware that is not otherwise supported by the installation program. Refer to [Chapter 6, Updating drivers during installation on Intel and AMD systems](#) for more information.

7.1.1. Booting the Installation Program on x86, AMD64, and Intel 64 Systems

You can boot the installation program using any one of the following media (depending upon what your system can support):

- *Red Hat Enterprise Linux DVD* — Your machine supports a bootable DVD drive and you have the Red Hat Enterprise Linux installation DVD.
- *Boot CD-ROM* — Your machine supports a bootable CD-ROM drive and you want to perform network or hard drive installation.
- *USB flash drive* — Your machine supports booting from a USB device.
- *PXE boot via network* — Your machine supports booting from the network. This is an advanced installation path. Refer to [Chapter 30, Setting Up an Installation Server](#) for additional information on this method.

To create a boot CD-ROM or to prepare your USB flash drive for booting or installation, refer to [Section 2.3, “Making Minimal Boot Media”](#).

Insert the boot media and reboot the system.

You might need to press a specific key or combination of keys to boot from the media. On most computers, a message appears briefly on the screen very soon after you turn on the computer. Typically, it is worded something like **Press F10 to select boot device**, although the specific wording and the key that you must press varies widely from computer to computer. Consult the documentation for your computer or motherboard, or seek support from the hardware manufacturer or vendor.

If your computer does not allow you to select a boot device as it starts up, you might need to configure your system's *Basic Input/Output System* (BIOS) to boot from the media.

To change your BIOS settings on an x86, AMD64, or Intel 64 system, watch the instructions provided on your display when your computer first boots. A line of text appears, telling you which key to press to enter the BIOS settings.

Once you have entered your BIOS setup program, find the section where you can alter your boot sequence. The default is often C, A or A, C (depending on whether you boot from your hard drive [C] or a diskette drive [A]). Change this sequence so that the DVD is first in your boot order and that C or A (whichever is your typical boot default) is second. This instructs the computer to first look at the DVD drive for bootable media; if it does not find bootable media on the DVD drive, it then checks your hard drive or diskette drive.

Save your changes before exiting the BIOS. For more information, refer to the documentation that came with your system.

After a short delay, a screen containing the boot : prompt should appear. The screen contains information on a variety of boot options. Each boot option also has one or more help screens associated with it. To access a help screen, press the appropriate function key as listed in the line at the bottom of the screen.

As you boot the installation program, be aware of two issues:

- Once the boot : prompt appears, the installation program automatically begins if you take no action within the first minute. To disable this feature, press one of the help screen function keys.
- If you press a help screen function key, there is a slight delay while the help screen is read from the boot media.

Normally, you only need to press **Enter** to boot. Be sure to watch the boot messages to review if the Linux kernel detects your hardware. If your hardware is properly detected, continue to the next section. If it does not properly detect your hardware, you may need to restart the installation and use one of the boot options provided in [Chapter 28, Boot Options](#).

7.1.2. Additional Boot Options

While it is easiest to boot using a DVD and perform a graphical installation, sometimes there are installation scenarios where booting in a different manner may be needed. This section discusses additional boot options available for Red Hat Enterprise Linux.

To pass options to the boot loader on an x86, AMD64, or Intel 64 system, use the instructions as provided in the boot loader option samples below.



Note

Refer to [Chapter 28, Boot Options](#) for additional boot options not covered in this section.

- To perform a text mode installation, at the installation boot prompt, type:

```
linux text
```

- To specify an installation source, use the **linux repo=** option. For example:

```
linux repo=cdrom:device
```

```
linux repo=ftp://username:password@URL
```

```
linux repo=http://URL
```

```
linux repo=hd:device
```

```
linux repo=nfs:options:server:/path
```

```
linux repo=nfsiso:options:server:/path
```

In these examples, **cdrom** refers to a CD or DVD drive, **ftp** refers to a location accessible by FTP, **http** refers to a location accessible by HTTP, **hd** refers to an ISO image file accessible on a hard drive partition, **nfs** refers to an expanded tree of installation files accessible by NFS, and **nfsiso** refers to an ISO image file accessible by NFS.

- ISO images have an SHA256 checksum embedded in them. To test the checksum integrity of an ISO image, at the installation boot prompt, type:

```
linux mediacheck
```

The installation program prompts you to insert a DVD or select an ISO image to test, and select **OK** to perform the checksum operation. This checksum operation can be performed on any Red

Hat Enterprise Linux DVD. It is strongly recommended to perform this operation on any Red Hat Enterprise Linux DVD that was created from downloaded ISO images. This command works with the DVD, hard drive ISO, and NFS ISO installation methods.

- If you need to perform the installation in *serial mode*, type the following command:

```
linux console=<device>
```

For text mode installations, use:

```
linux text console=<device>
```

In the above command, *<device>* should be the device you are using (such as `ttyS0` or `ttyS1`). For example, **linux text console=ttyS0**.

Text mode installations using a serial terminal work best when the terminal supports UTF-8. Under UNIX and Linux, Kermit supports UTF-8. For Windows, Kermit '95 works well. Non-UTF-8 capable terminals works as long as only English is used during the installation process. An enhanced serial display can be used by passing the **utf8** command as a boot-time option to the installation program. For example:

```
linux console=ttyS0 utf8
```

7.1.2.1. Kernel Options

Options can also be passed to the kernel. For example, to apply updates for the anaconda installation program from a USB storage device enter:

```
linux updates
```

For text mode installations, use:

```
linux text updates
```

This command results in a prompt for the path to the device that contains updates for **anaconda**. It is not needed if you are performing a network installation and have already placed the updates image contents in **rhupdates/** on the server.

After entering any options, press **Enter** to boot using those options.

If you need to specify boot options to identify your hardware, please write them down. The boot options are needed during the boot loader configuration portion of the installation (refer to [Section 9.16, “x86, AMD64, and Intel 64 Boot Loader Configuration”](#) for more information).

For more information on kernel options refer to [Chapter 28, Boot Options](#).

7.2. The Boot Menu

The boot media displays a graphical boot menu with several options. If no key is hit within 60 seconds, the default boot option runs. To choose the default, either wait for the timer to run out or hit **Enter**

on the keyboard. To select a different option than the default, use the arrow keys on your keyboard, and hit **Enter** when the correct option is highlighted. If you want to customize the boot options for a particular option, press the **Tab** key.



Figure 7.1. The boot screen

For a listing and explanation of common boot options, refer to [Chapter 28, Boot Options](#).

The boot menu options are:

Install or upgrade an existing system

This option is the default. Choose this option to install Red Hat Enterprise Linux onto your computer system using the graphical installation program.

Install system with basic video driver

This option allows you to install Red Hat Enterprise Linux in graphical mode even if the installation program is unable to load the correct driver for your video card. If your screen appears distorted or goes blank when using the the **Install or upgrade an existing system** option, restart your computer and try this option instead.

Rescue installed system

Choose this option to repair a problem with your installed Red Hat Enterprise Linux system that prevents you from booting normally. Although Red Hat Enterprise Linux is an exceptionally stable computing platform, it is still possible for occasional problems to occur that prevent booting. The rescue environment contains utility programs that allow you fix a wide variety of these problems.

Boot from local drive

This option boots the system from the first installed disk. If you booted this disc accidentally, use this option to boot from the hard disk immediately without starting the installer.

7.3. Installing from a Different Source

You can install Red Hat Enterprise Linux from the ISO images stored on hard disk, or from a network using NFS, FTP, or HTTP methods. Experienced users frequently use one of these methods because it is often faster to read data from a hard disk or network server than from a DVD.

The following table summarizes the different boot methods and recommended installation methods to use with each:

Table 7.1. Boot methods and installation sources

| Boot method | Installation source |
|-----------------------------------|--|
| Installation DVD | DVD, network, or hard disk |
| Installation USB flash drive | USB flash drive, installation DVD, network, or hard disk |
| Minimal boot CD or USB, rescue CD | Network or hard disk |

Refer to [Section 3.5, “Selecting an Installation Method”](#) for information about installing from locations other than the media with which you booted the system.

7.4. Booting from the Network using PXE

To boot with

PXE, you need a properly configured server, and a network interface in your computer that supports PXE. For information on how to configure a PXE server, refer to [Chapter 30, Setting Up an Installation Server](#).

Configure the computer to boot from the network interface. This option is in the BIOS, and may be labeled **Network Boot** or **Boot Services**. Once you properly configure PXE booting, the computer can boot the Red Hat Enterprise Linux installation system without any other media.

To boot a computer from a PXE server:

1. Ensure that the network cable is attached. The link indicator light on the network socket should be lit, even if the computer is not switched on.
2. Switch on the computer.
3. A menu screen appears. Press the number key that corresponds to the desired option.

If your PC does not boot from the netboot server, ensure that the BIOS is configured to boot first from the correct network interface. Some BIOS systems specify the network interface as a possible boot device, but do not support the PXE standard. Refer to your hardware documentation for more information.



Note — Multiple NICs and PXE installation

Some servers with multiple network interfaces might not assign eth0 to the first network interface as the firmware interface knows it, which can cause the installer to try to use a different network interface from the one that was used by PXE. To change this behavior, use the following in **pxelinux.cfg/*** config files:

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

These configuration options above cause the installer to use the same network interface the firmware interface and PXE use. You can also use the following option:

```
ksdevice=link
```

This option causes the installer to use the first network device it finds that is linked to a network switch.

Configuring Language and Installation Source

Before the graphical installation program starts, you need to configure the language and installation source.

8.1. The Text Mode Installation Program User Interface



Important — Graphical installation recommended

We recommend that you install Red Hat Enterprise Linux using the graphical interface. If you are installing Red Hat Enterprise Linux on a system that lacks a graphical display, consider performing the installation over a VNC connection – see [Chapter 31, Installing Through VNC](#). If **anaconda** detects that you are installing in text mode on a system where installation over a VNC connection might be possible, **anaconda** asks you to verify your decision to install in text mode even though your options during installation are limited.

If your system has a graphical display, but graphical installation fails, try booting with the **xdriver=vesa** option – refer to [Chapter 28, Boot Options](#)

Both the loader and later **anaconda** use a screen-based interface that includes most of the on-screen *widgets* commonly found on graphical user interfaces. [Figure 8.1, “Installation Program Widgets as seen in URL Setup”](#), and [Figure 8.2, “Installation Program Widgets as seen in Choose a Language”](#), illustrate widgets that appear on screens during the installation process.



Note

Not every language supported in graphical installation mode is also supported in text mode. Specifically, languages written with a character set other than the Latin or Cyrillic alphabets are not available in text mode. If you choose a language written with a character set that is not supported in text mode, the installation program will present you with the English versions of the screens.

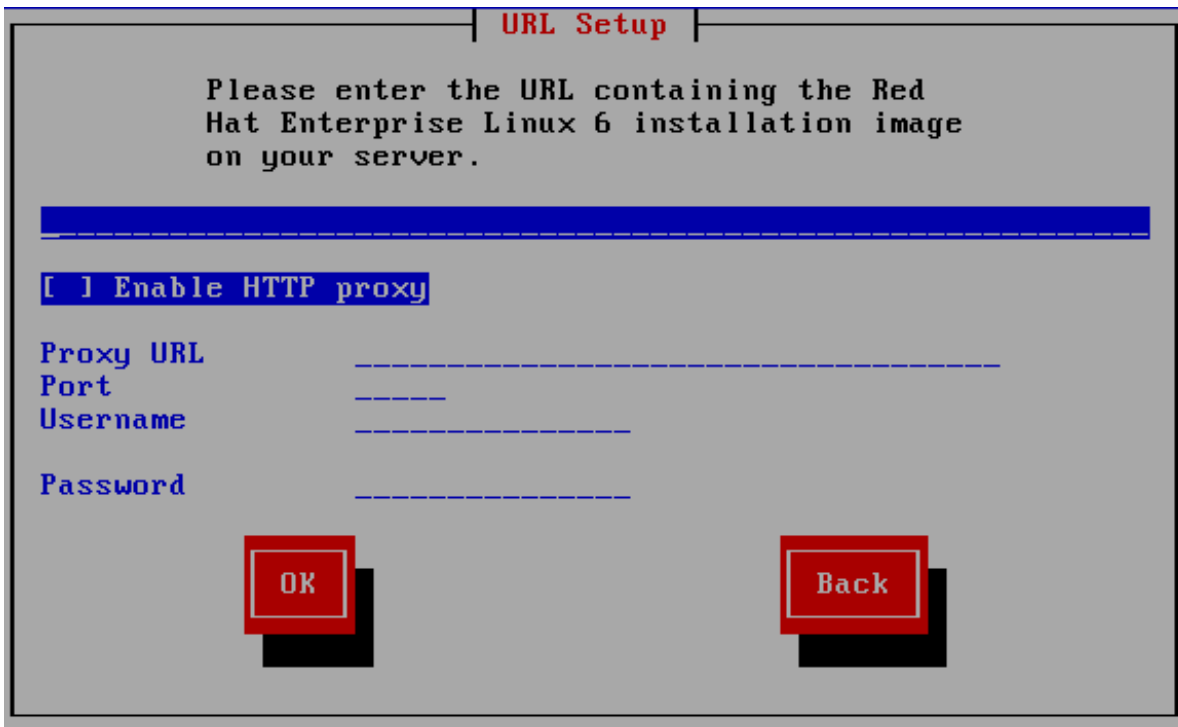


Figure 8.1. Installation Program Widgets as seen in **URL Setup**



Figure 8.2. Installation Program Widgets as seen in **Choose a Language**

The widgets include:

- Window — Windows (usually referred to as *dialogs* in this manual) appear on your screen throughout the installation process. At times, one window may overlay another; in these cases, you can only interact with the window on top. When you are finished in that window, it disappears, allowing you to continue working in the window underneath.
- Checkbox — Checkboxes allow you to select or deselect a feature. The box displays either an asterisk (selected) or a space (unselected). When the cursor is within a checkbox, press **Space** to select or deselect a feature.

- **Text Input** — Text input lines are regions where you can enter information required by the installation program. When the cursor rests on a text input line, you may enter and/or edit information on that line.
- **Text Widget** — Text widgets are regions of the screen for the display of text. At times, text widgets may also contain other widgets, such as checkboxes. If a text widget contains more information than can be displayed in the space reserved for it, a scroll bar appears; if you position the cursor within the text widget, you can then use the **Up** and **Down** arrow keys to scroll through all the information available. Your current position is shown on the scroll bar by a # character, which moves up and down the scroll bar as you scroll.
- **Scroll Bar** — Scroll bars appear on the side or bottom of a window to control which part of a list or document is currently in the window's frame. The scroll bar makes it easy to move to any part of a file.
- **Button Widget** — Button widgets are the primary method of interacting with the installation program. You progress through the windows of the installation program by navigating these buttons, using the **Tab** and **Enter** keys. Buttons can be selected when they are highlighted.
- **Cursor** — Although not a widget, the cursor is used to select (and interact with) a particular widget. As the cursor is moved from widget to widget, it may cause the widget to change color, or the cursor itself may only appear positioned in or next to the widget. In [Figure 8.1, "Installation Program Widgets as seen in URL Setup"](#), the cursor is positioned on the **OK** button. [Figure 8.2, "Installation Program Widgets as seen in Choose a Language"](#), shows the cursor on the **Edit** button.

8.1.1. Using the Keyboard to Navigate

Navigation through the installation dialogs is performed through a simple set of keystrokes. To move the cursor, use the **Left**, **Right**, **Up**, and **Down** arrow keys. Use **Tab**, and **Shift-Tab** to cycle forward or backward through each widget on the screen. Along the bottom, most screens display a summary of available cursor positioning keys.

To "press" a button, position the cursor over the button (using **Tab**, for example) and press **Space** or **Enter**. To select an item from a list of items, move the cursor to the item you wish to select and press **Enter**. To select an item with a checkbox, move the cursor to the checkbox and press **Space** to select an item. To deselect, press **Space** a second time.

Pressing **F12** accepts the current values and proceeds to the next dialog; it is equivalent to pressing the **OK** button.



Warning

Unless a dialog box is waiting for your input, do not press any keys during the installation process (doing so may result in unpredictable behavior).

8.2. Language Selection

Use the arrow keys on your keyboard to select a language to use during the installation process (refer to [Figure 8.3, "Language Selection"](#)). With your selected language highlighted, press the **Tab** key to move to the **OK** button and press the **Enter** key to confirm your choice.

The language you select here will become the default language for the operating system once it is installed. Selecting the appropriate language also helps target your time zone configuration later in the installation. The installation program tries to define the appropriate time zone based on what you specify on this screen.

To add support for additional languages, customize the installation at the package selection stage. For more information, refer to [Section 9.17.2, “Customizing the Software Selection”](#).

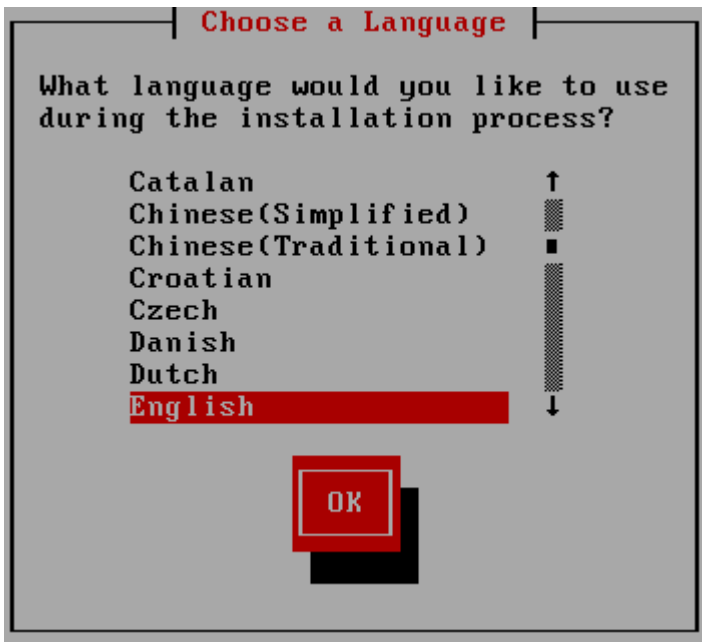


Figure 8.3. Language Selection

Once you select the appropriate language, click **Next** to continue.

8.3. Installation Method

If you booted the installation from minimal boot media or with the `askmethod` boot option, use the arrow keys on your keyboard to select an installation method (refer to [Figure 8.4, “Installation Method”](#)). With your selected method highlighted, press the **Tab** key to move to the **OK** button and press the **Enter** key to confirm your choice.

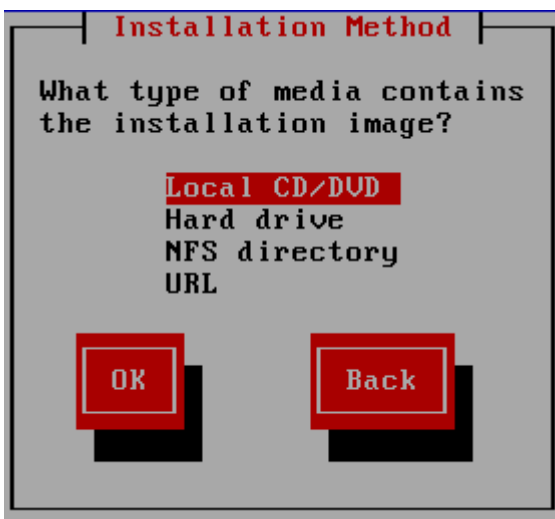


Figure 8.4. Installation Method

8.3.1. Installing from DVD

To install Red Hat Enterprise Linux from a DVD, place the DVD your DVD drive and boot your system from the DVD. Even if you booted from alternative media, you can still install Red Hat Enterprise Linux from DVD media.

The installation program then probes your system and attempts to identify your DVD drive. It starts by looking for an IDE (also known as an ATAPI) DVD drive.

Note

To abort the installation process at this time, reboot your machine and then eject the boot media. You can safely cancel the installation at any point before the **Write changes to disk** screen. Refer to [Section 9.15, “Write changes to disk”](#) for more information.

If your DVD drive is not detected, and it is a SCSI DVD, the installation program prompts you to choose a SCSI driver. Choose the driver that most closely resembles your adapter. You may specify options for the driver if necessary; however, most drivers detect your SCSI adapter automatically.

If the DVD drive is found and the driver loaded, the installer will present you with the option to perform a media check on the DVD. This will take some time, and you may opt to skip over this step. However, if you later encounter problems with the installer, you should reboot and perform the media check before calling for support. From the media check dialog, continue to the next stage of the installation process (refer to [Section 9.3, “Welcome to Red Hat Enterprise Linux”](#)).

8.3.2. Installing from a Hard Drive

The **Select Partition** screen applies only if you are installing from a disk partition (that is, you selected **Hard Drive** in the **Installation Method** dialog). This dialog allows you to name the disk partition and directory from which you are installing Red Hat Enterprise Linux. If you used the **repo=hd** boot option, you already specified a partition.

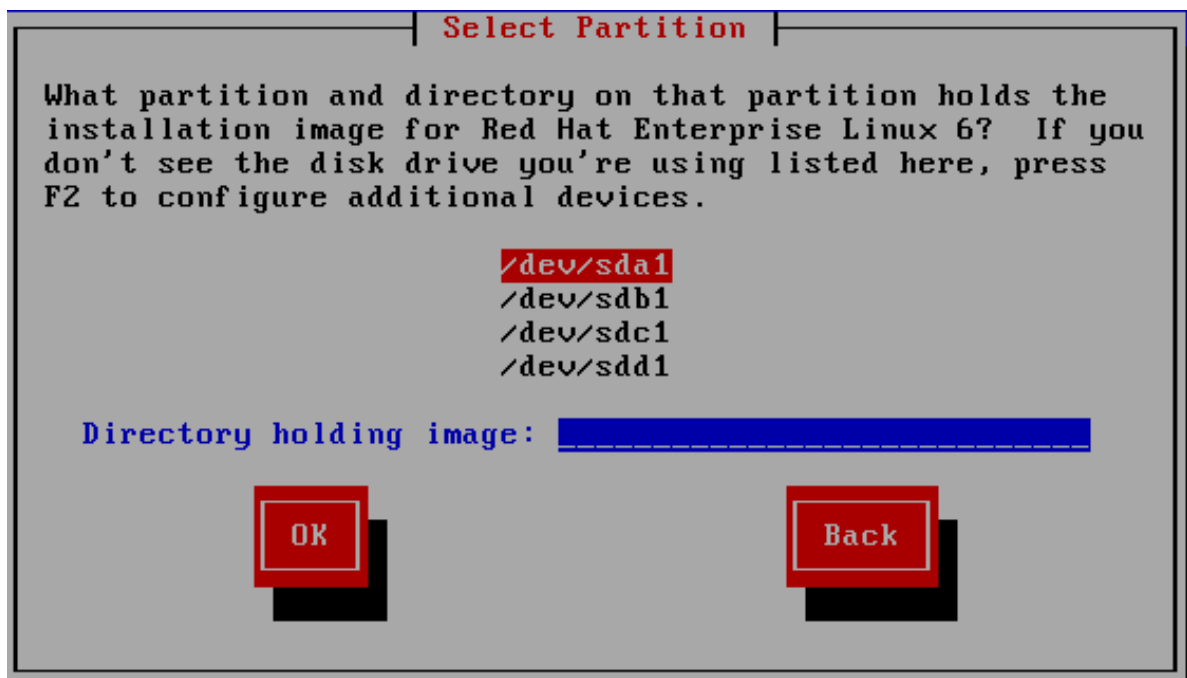


Figure 8.5. Selecting Partition Dialog for Hard Drive Installation

Select the partition containing the ISO files from the list of available partitions. Internal IDE, SATA, SCSI, and USB drive device names begin with **/dev/sd**. Each individual drive has its own letter, for example **/dev/sda**. Each partition on a drive is numbered, for example **/dev/sda1**.

Also specify the **Directory holding images**. Enter the full directory path from the drive that contains the ISO image files. The following table shows some examples of how to enter this information:

Table 8.1. Location of ISO images for different partition types

| Partition type | Volume | Original path to files | Directory to use |
|------------------|--------|------------------------|------------------|
| VFAT | D:\ | D:\Downloads\RHEL6 | /Downloads/RHEL6 |
| ext2, ext3, ext4 | /home | /home/user1/RHEL6 | /user1/RHEL6 |

If the ISO images are in the root (top-level) directory of a partition, enter a /. If the ISO images are located in a subdirectory of a mounted partition, enter the name of the directory holding the ISO images within that partition. For example, if the partition on which the ISO images is normally mounted as /home/, and the images are in /home/new/, you would enter /new/.



Use a leading slash

An entry without a leading slash may cause the installation to fail.

Select **OK** to continue. Proceed with [Chapter 9, Installing using anaconda](#).

8.3.3. Performing a Network Installation

The installation program is network-aware and can use network settings for a number of functions. For instance, if you boot the installer with the **askmethod** or **repo=** options, you can install Red Hat Enterprise Linux from a network server using FTP, HTTP, or NFS protocols. You can also instruct the installation program to consult additional software repositories later in the process.

If you are performing a network installation, the **Configure TCP/IP** dialog appears. This dialog asks for your IP and other network addresses. You can choose to configure the IP address and Netmask of the device via DHCP or manually.

By default, the installation program uses DHCP to automatically provide network settings. If you use a cable or DSL modem, router, firewall, or other network hardware to communicate with the Internet, DHCP is a suitable option. If your network has no DHCP server, clear the check box labeled **Use dynamic IP configuration (DHCP)**.

Enter the IP address you are using during installation and press **Enter**.

The installation program supports the IPv4 and IPv6 protocols.

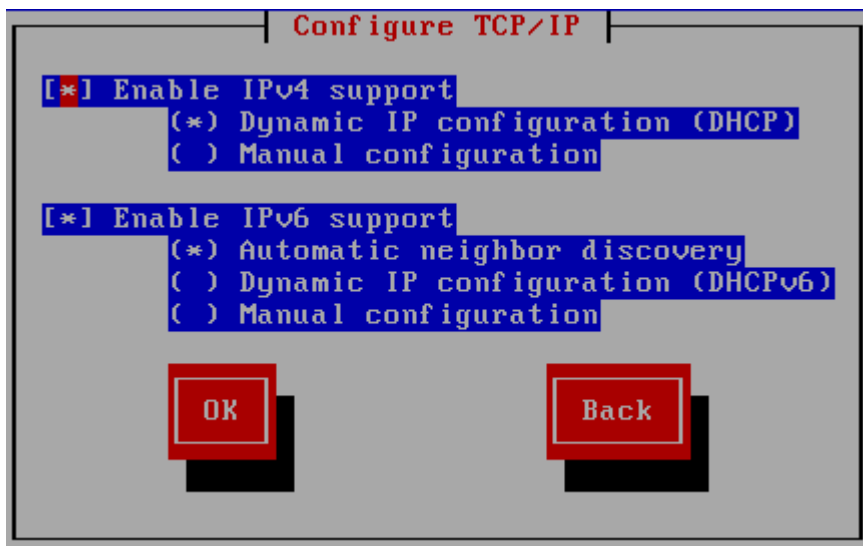


Figure 8.6. TCP/IP Configuration

When the installation process completes, it will transfer these settings to your system.

- If you are installing via NFS, proceed to [Section 8.3.4, “Installing via NFS”](#).
- If you are installing via Web or FTP, proceed to [Section 8.3.5, “Installing via FTP or HTTP”](#).

8.3.4. Installing via NFS

The NFS dialog applies only if you selected **NFS Image** in the **Installation Method** dialog. If you used the **repo=nfs** boot option, you already specified a server and path.

Enter the domain name or IP address of your NFS server. For example, if you are installing from a host named **eastcoast** in the domain **example.com**, enter **eastcoast.example.com** in the **NFS Server** field.

Next, enter the name of the exported directory. If you followed the setup described in [Section 4.1.2, “Preparing for an NFS installation”](#), you would enter the directory **/export/directory/**.

This dialog also allows you to specify NFS mount options. Refer to the *Red Hat Enterprise Linux Deployment Guide* for a list of common NFS mount options, or consult the man pages for **mount** and **nfs** for a comprehensive list of options.

If the NFS server is exporting a mirror of the Red Hat Enterprise Linux installation tree, enter the directory which contains the root of the installation tree. You will enter an Installation Key later on in the process which will determine which subdirectories are used to install from. If everything was specified properly, a message appears indicating that the installation program for Red Hat Enterprise Linux is running.

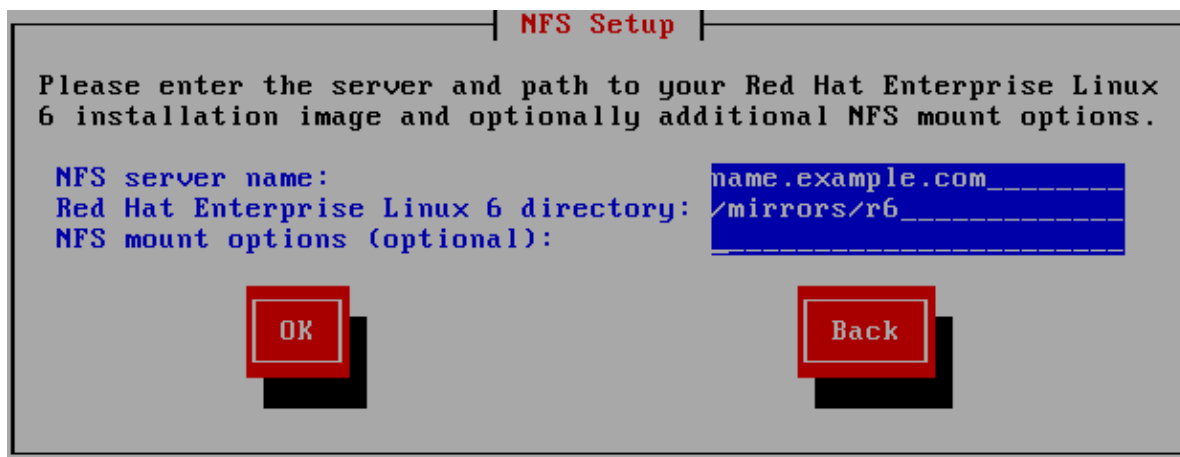


Figure 8.7. NFS Setup Dialog

If the NFS server is exporting the ISO image of the Red Hat Enterprise Linux DVD, enter the directory which contains the ISO image.

Proceed with [Chapter 9, Installing using anaconda](#).

8.3.5. Installing via FTP or HTTP



Important — you must specify the protocol

When you provide a URL to an installation source, you must explicitly specify **http://** or **ftp://** as the protocol.

The URL dialog applies only if you are installing from a FTP or HTTP server (if you selected **URL** in the **Installation Method** dialog). This dialog prompts you for information about the FTP or HTTP server from which you are installing Red Hat Enterprise Linux. If you used the **repo=ftp** or **repo=http** boot option, you already specified a server and path.

Enter the name or IP address of the FTP or HTTP site from which you are installing, and the name of the directory that contains the **/images** directory for your architecture. For example:

```
/mirrors/redhat/rhel-6/Server/i386/
```

Specify the address of a proxy server, and if necessary, provide a port number, username, and password. If everything was specified properly, a message box appears indicating that files are being retrieved from the server.

If your FTP or HTTP server requires user authentication, specify user and password as part of the URL as follows:

```
{ftp|http}://<user>:<password>@<hostname>[:<port>]/<directory>/
```

For example:

```
http://install:rhel6pw@name.example.com/mirrors/redhat/rhel-6/Server/i386/
```

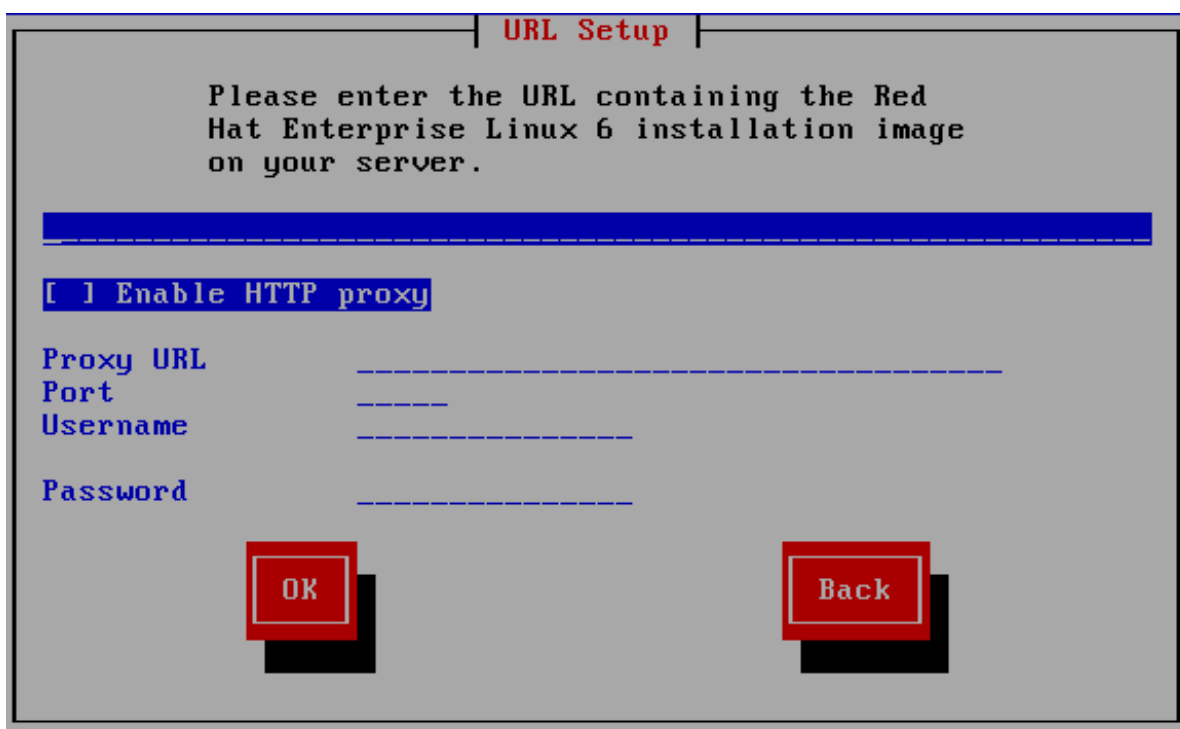


Figure 8.8. URL Setup Dialog

Proceed with [Chapter 9, Installing using anaconda](#).

8.4. Verifying Media

The DVD offers an option to verify the integrity of the media. Recording errors sometimes occur while producing DVD media. An error in the data for package chosen in the installation program can cause the installation to abort. To minimize the chances of data errors affecting the installation, verify the media before installing.

If the verification succeeds, the installation process proceeds normally. If the process fails, create a new DVD using the ISO image you downloaded earlier.

Installing using anaconda

This chapter describes an installation using the graphical user interface of **anaconda**.

9.1. The Text Mode Installation Program User Interface



Important — Graphical Interface on the Installed System

Installing in text mode does not prevent you from using a graphical interface on your system once it is installed.

Apart from the graphical installer, **anaconda** also includes a text-based installer.

If one of the following situations occurs, the installation program uses text mode:

- The installation system fails to identify the display hardware on your computer
- You choose the text mode installation from the boot menu

While text mode installations are not explicitly documented, those using the text mode installation program can easily follow the GUI installation instructions. However, because text mode presents you with a simpler, more streamlined insatallation process, certain options that are available in graphical mode are not also available in text mode. These differences are noted in the description of the installation process in this guide, and include:

- configuring advanced storage methods such as LVM, RAID, FCoE, zFCP, and iSCSI.
- customizing the partition layout
- customizing the bootloader layout
- selecting packages during installation
- configuring the installed system with **Firstboot**

If you choose to install Red Hat Enterprise Linux in text mode, you can still configure your system to use a graphical interface after installation. Refer to [Section 35.3, “Switching to a Graphical Login”](#) for instructions.

9.2. The Graphical Installation Program User Interface

If you have used a *graphical user interface (GUI)* before, you are already familiar with this process; use your mouse to navigate the screens, click buttons, or enter text fields.

You can also navigate through the installation using the keyboard. The **Tab** key allows you to move around the screen, the Up and Down arrow keys to scroll through lists, **+** and **-** keys expand and collapse lists, while **Space** and **Enter** selects or removes from selection a highlighted item. You can also use the **Alt+X** key command combination as a way of clicking on buttons or making other screen selections, where **X** is replaced with any underlined letter appearing within that screen.

**Note**

If you are using an x86, AMD64, or Intel 64 system, and you do not wish to use the GUI installation program, the text mode installation program is also available. To start the text mode installation program, use the following command at the boot : prompt:

```
linux text
```

Refer to [Section 7.2, “The Boot Menu”](#) for a description of the Red Hat Enterprise Linux boot menu and to [Section 8.1, “The Text Mode Installation Program User Interface”](#) for a brief overview of text mode installation instructions.

It is highly recommended that installs be performed using the GUI installation program. The GUI installation program offers the full functionality of the Red Hat Enterprise Linux installation program, including LVM configuration which is not available during a text mode installation.

Users who must use the text mode installation program can follow the GUI installation instructions and obtain all needed information.

9.2.1. Screenshots during installation

Anaconda allows you to take screenshots during the installation process. At any time during installation, press **Shift+Print Screen** and **anaconda** will save a screenshot to **/root/anaconda-screenshots**.

If you are performing a Kickstart installation, use the **autostep --autoscreenshot** option to generate a screenshot of each step of the installation automatically. Refer to [Section 32.3, “Creating the Kickstart File”](#) for details of configuring a Kickstart file.

9.2.2. A Note about Virtual Consoles

The Red Hat Enterprise Linux installation program offers more than the dialog boxes of the installation process. Several kinds of diagnostic messages are available to you, as well as a way to enter commands from a shell prompt. The installation program displays these messages on five *virtual consoles*, among which you can switch using a single keystroke combination.

A virtual console is a shell prompt in a non-graphical environment, accessed from the physical machine, not remotely. Multiple virtual consoles can be accessed simultaneously.

These virtual consoles can be helpful if you encounter a problem while installing Red Hat Enterprise Linux. Messages displayed on the installation or system consoles can help pinpoint a problem. Refer to [Table 9.1, “Console, Keystrokes, and Contents”](#) for a listing of the virtual consoles, keystrokes used to switch to them, and their contents.

Generally, there is no reason to leave the default console (virtual console #6) for graphical installations unless you are attempting to diagnose installation problems.

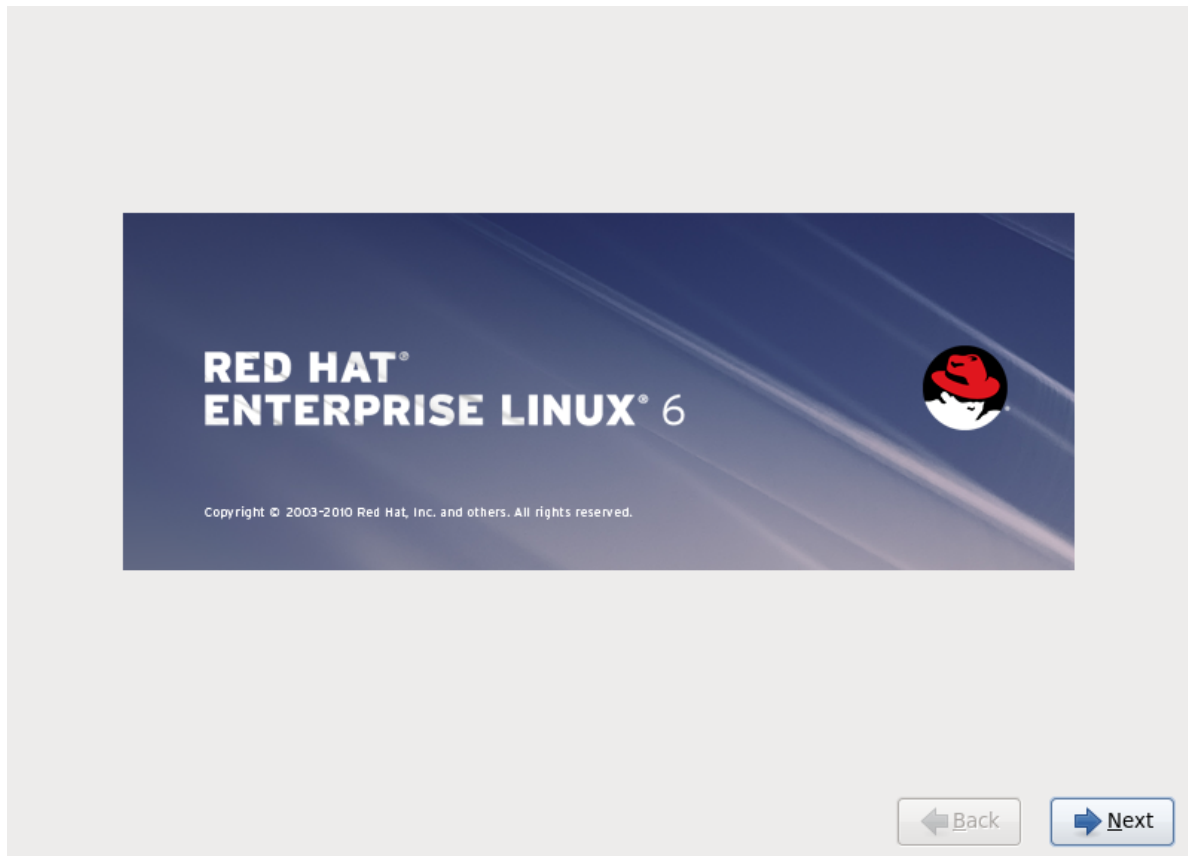
Table 9.1. Console, Keystrokes, and Contents

| console | keystrokes | contents |
|---------|--------------------|-------------------|
| 1 | ctrl+alt+f1 | graphical display |
| 2 | ctrl+alt+f2 | shell prompt |

| console | keystrokes | contents |
|---------|--------------------|--|
| 3 | ctrl+alt+f3 | install log (messages from installation program) |
| 4 | ctrl+alt+f4 | system-related messages |
| 5 | ctrl+alt+f5 | other messages |

9.3. Welcome to Red Hat Enterprise Linux

The **Welcome** screen does not prompt you for any input.



Click on the **Next** button to continue.

9.4. Keyboard Configuration

Using your mouse, select the correct layout type (for example, U.S. English) for the keyboard you would prefer to use for the installation and as the system default (refer to the figure below).

Once you have made your selection, click **Next** to continue.

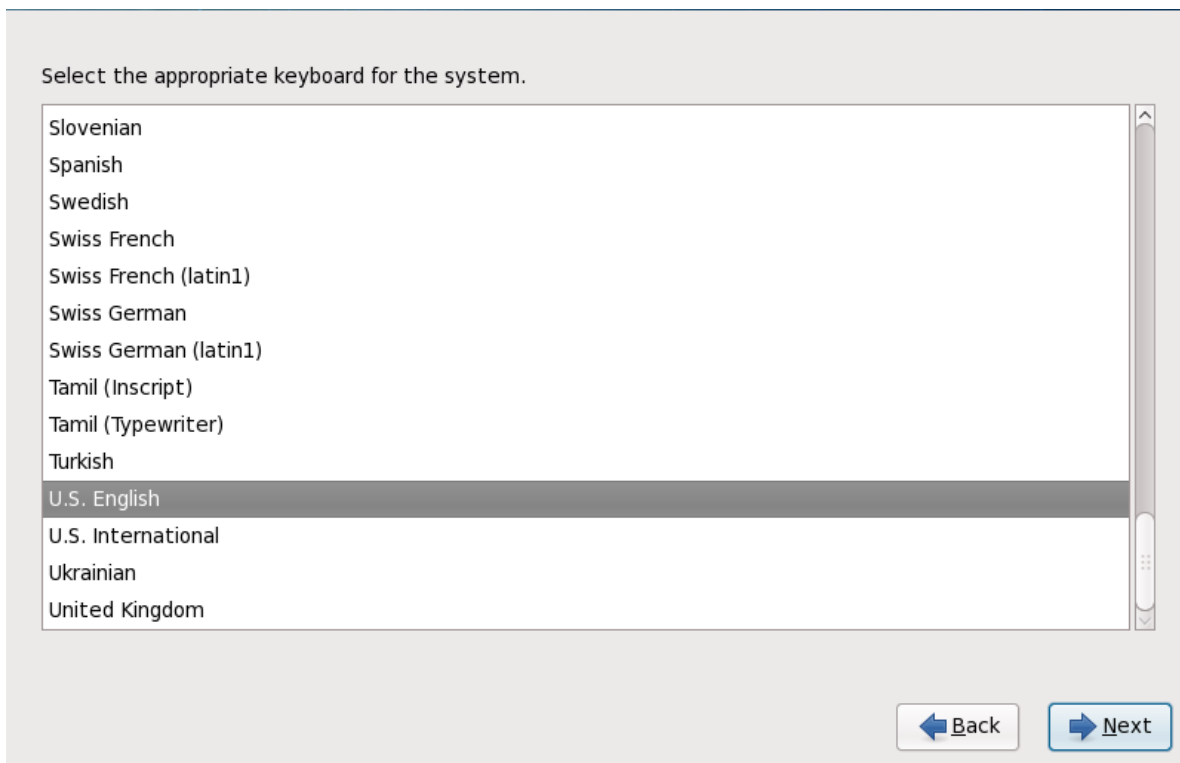


Figure 9.1. Keyboard Configuration

Red Hat Enterprise Linux includes support for more than one keyboard layout for many languages. In particular, most European languages include a **latin1** option, which uses *dead keys* to access certain characters, such as those with diacritical marks. When you press a dead key, nothing will appear on your screen until you press another key to "complete" the character. For example, to type **é** on a latin1 keyboard layout, you would press (and release) the **'** key, and then press the **E** key. By contrast, you access this character on some other keyboards by pressing and holding down a key (such as **Alt -Gr**) while you press the **E** key. Other keyboards might have a dedicated key for this character.



Note

To change your keyboard layout type after you have completed the installation, use the **Keyboard Configuration Tool**.

Type the **system-config-keyboard** command in a shell prompt to launch the **Keyboard Configuration Tool**. If you are not root, it prompts you for the root password to continue.

9.5. Storage Devices

You can install Red Hat Enterprise Linux on a large variety of storage devices. This screen allows you to select either basic or specialized storage devices.

What type of devices will your installation involve?

Basic Storage Devices

Installs or upgrades to typical types of storage devices. If you're not sure which option is right for you, this is probably it.

Specialized Storage Devices

Installs or upgrades to devices such as Storage Area Networks (SANs) or mainframe attached disks (DASD), usually in an enterprise environment

Figure 9.2. Storage devices

Basic Storage Devices

Select **Basic Storage Devices** to install Red Hat Enterprise Linux on the following storage devices:

- hard drives or solid-state drives connected directly to the local system.

Specialized Storage Devices

Select **Specialized Storage Devices** to install Red Hat Enterprise Linux on the following storage devices:

- *Storage area networks (SANs)*
- *Direct access storage devices (DASDs)*
- Firmware RAID devices
- Multipath devices

Use the **Specialized Storage Devices** option to configure *Internet Small Computer System Interface (iSCSI)* and *FCoE (Fiber Channel over Ethernet)* connections.

If you select **Basic Storage Devices**, **anaconda** automatically detects the local storage attached to the system and does not require further input from you. Proceed to [Section 9.6, “Setting the Hostname”](#).

9.5.1. The Storage Devices Selection Screen

The storage devices selection screen displays all storage devices to which **anaconda** has access.

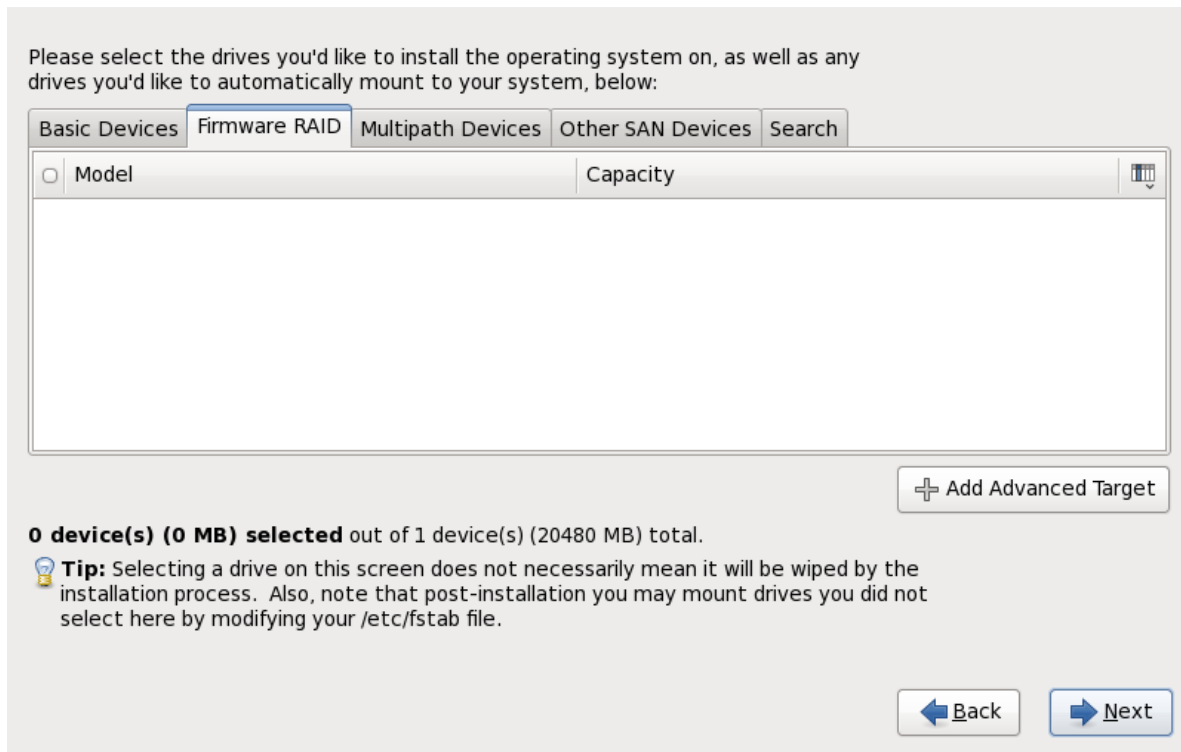


Figure 9.3. Select storage devices — Basic devices

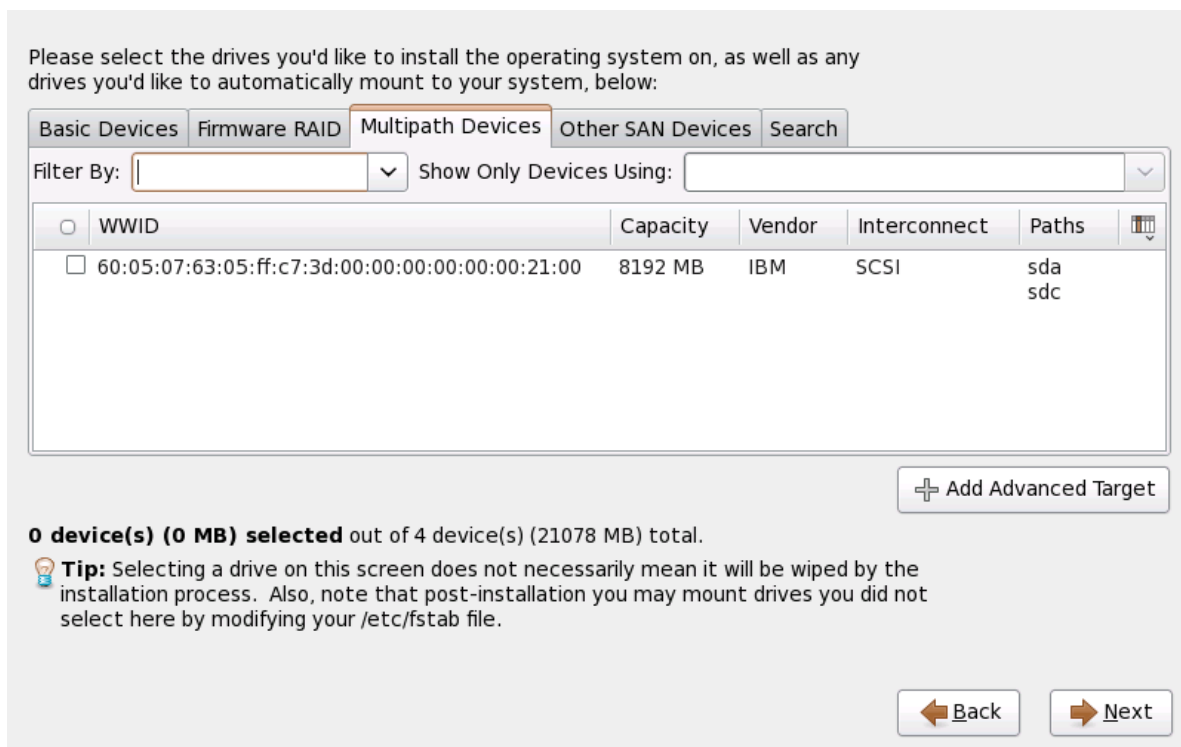


Figure 9.4. Select storage devices — Multipath Devices

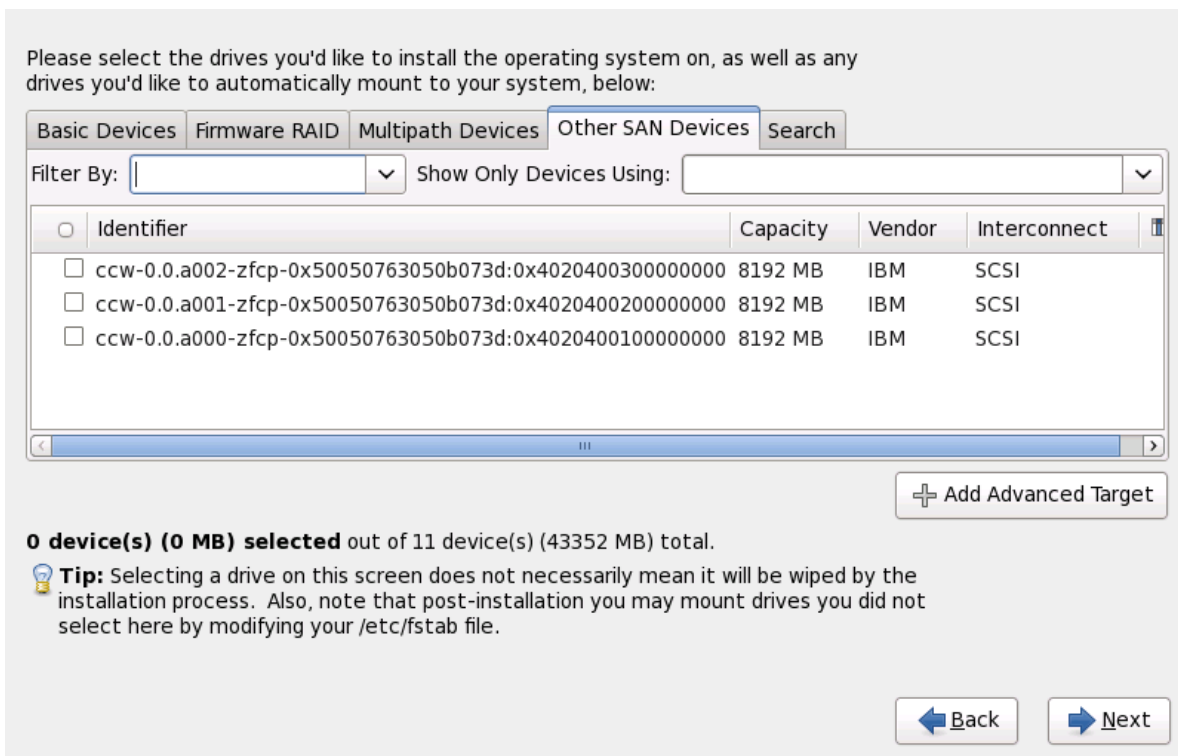


Figure 9.5. Select storage devices — Other SAN Devices

Devices are grouped under the following tabs:

Basic Devices

Basic storage devices directly connected to the local system, such as hard disk drives and solid-state drives.

Firmware RAID

Storage devices attached to a firmware RAID controller.

Multipath Devices

Storage devices accessible through more than one path, such as through multiple SCSI controllers or Fiber Channel ports on the same system.

Other SAN Devices

Any other devices available on a storage area network (SAN).

If you do need to configure iSCSI or FCoE storage, click **Add Advanced Target** and refer to [Section 9.5.1.1, “Advanced Storage Options”](#).

The storage devices selection screen also contains a **Search** tab that allows you to filter storage devices either by their *World Wide Identifier* (WWID) or by the port, target, or *logical unit number* (LUN) at which they are accessed.

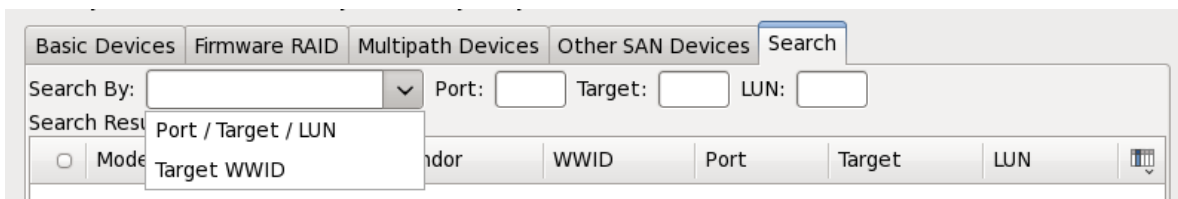


Figure 9.6. The Storage Devices Search Tab

The tab contains a drop-down menu to select searching by port, target, WWID, or LUN (with corresponding text boxes for these values). Searching by WWID or LUN requires additional values in the corresponding text box.

Each tab presents a list of devices detected by **anaconda**, with information about the device to help you to identify it. A small drop-down menu marked with an icon is located to the right of the column headings. This menu allows you to select the types of data presented on each device. For example, the menu on the **Multipath Devices** tab allows you to specify any of **WWID**, **Capacity**, **Vendor**, **Interconnect**, and **Paths** to include among the details presented for each device. Reducing or expanding the amount of information presented might help you to identify particular devices.

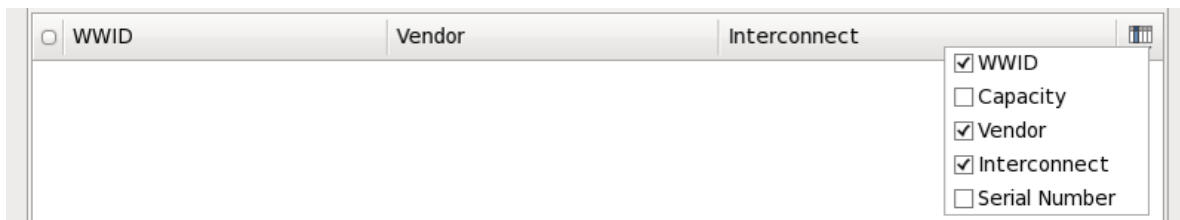


Figure 9.7. Selecting Columns

Each device is presented on a separate row, with a checkbox to its left. Click the checkbox to make a device available during the installation process, or click the *radio button* at the left of the column headings to select or deselect all the devices listed in a particular screen. Later in the installation process, you can choose to install Red Hat Enterprise Linux onto any of the devices selected here, and can choose to automatically mount any of the other devices selected here as part of the installed system.

Note that the devices that you select here are not automatically erased by the installation process. Selecting a device on this screen does not, in itself, place data stored on the device at risk. Note also that any devices that you do not select here to form part of the installed system can be added to the system after installation by modifying the `/etc/fstab` file.



Important — chain loading

Any storage devices that you do not select on this screen are hidden from **anaconda** entirely. To *chain load* the Red Hat Enterprise Linux boot loader from a different boot loader, select all the devices presented in this screen.

when you have selected the storage devices to make available during installation, click **Next** and proceed to [Section 9.10, “Initializing the Hard Disk”](#)

9.5.1.1. Advanced Storage Options

From this screen you can configure an *iSCSI* (SCSI over TCP/IP) target or *FCoE* (Fibre channel over ethernet) *SAN* (storage area network). Refer to [Appendix B, *iSCSI disks*](#) for an introduction to *iSCSI*.

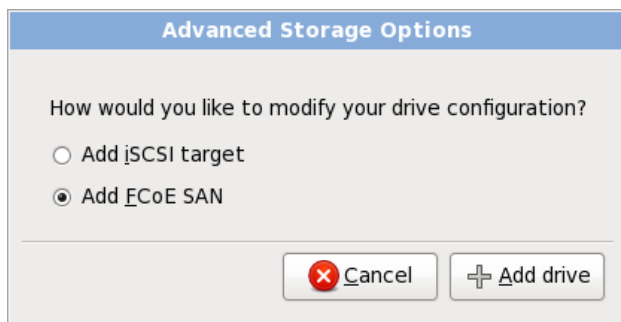


Figure 9.8. Advanced Storage Options

9.5.1.1.1. Enable Network Interfaces

Use this dialog to configure the network interfaces through which the system will connect to networked storage devices.

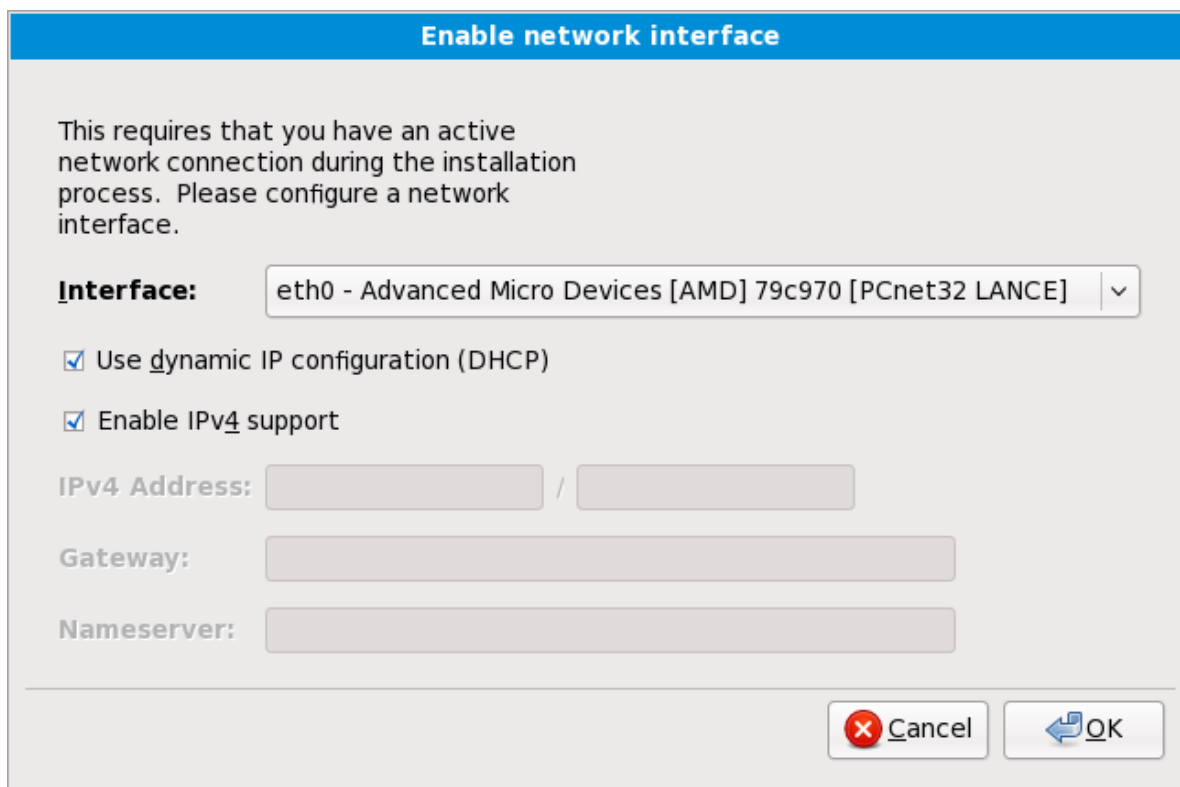


Figure 9.9. Enable Network Interface

If your network does not have DHCP enabled, or if you need to override the DHCP settings, select the network interface that you plan to use from the **Interfaces** menu. Clear the checkbox for **Use dynamic IP configuration (DHCP)**. You can now enter an IPv4 address and netmask for this system in the form *address / netmask*, along with the gateway address and nameserver address for your network.

Click **OK** to accept these settings and continue.

9.5.1.1.2. Configure iSCSI Parameters

To configure an iSCSI target invoke the 'Configure iSCSI Parameters' dialog by selecting 'Add iSCSI target' and clicking on the 'Add Drive' button. Fill in the details for the iSCSI target IP and provide a unique iSCSI initiator name to identify this system. If the iSCSI target uses CHAP (Challenge Handshake Authentication Protocol) for authentication, enter the CHAP username and password.

If your environment uses 2-way CHAP (also called "Mutual CHAP"), also enter the reverse CHAP username and password. Click the 'Add target' button to attempt connection to the iSCSI target using this information.

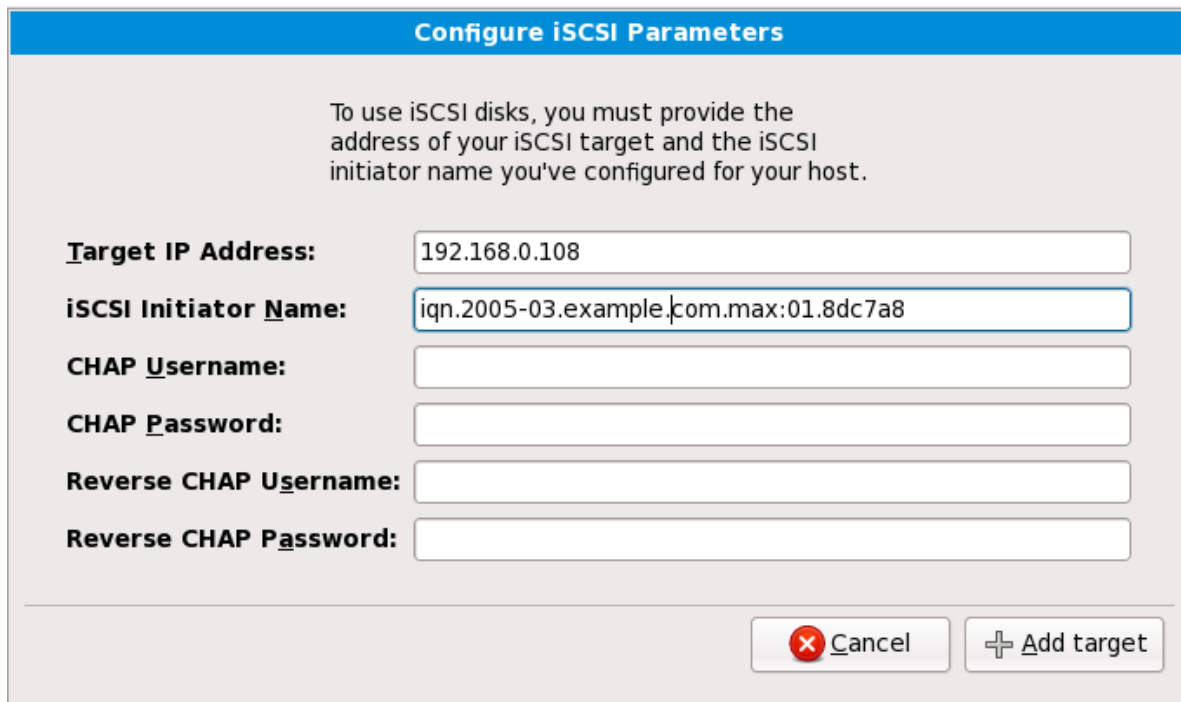


Figure 9.10. Configure iSCSI Parameters

Note that you will be able to reattempt with a different iSCSI target IP should you enter it incorrectly, but to change the iSCSI initiator name you will need to restart the installation.

9.5.1.1.3. Configure FCoE Parameters

To configure an FCoE SAN, select **Add FCoE SAN** and click **Add Drive**.

On the menu that appears in the next dialog box, select the network interface that is connected to your FCoE switch and click **Add FCoE Disk(s)**.

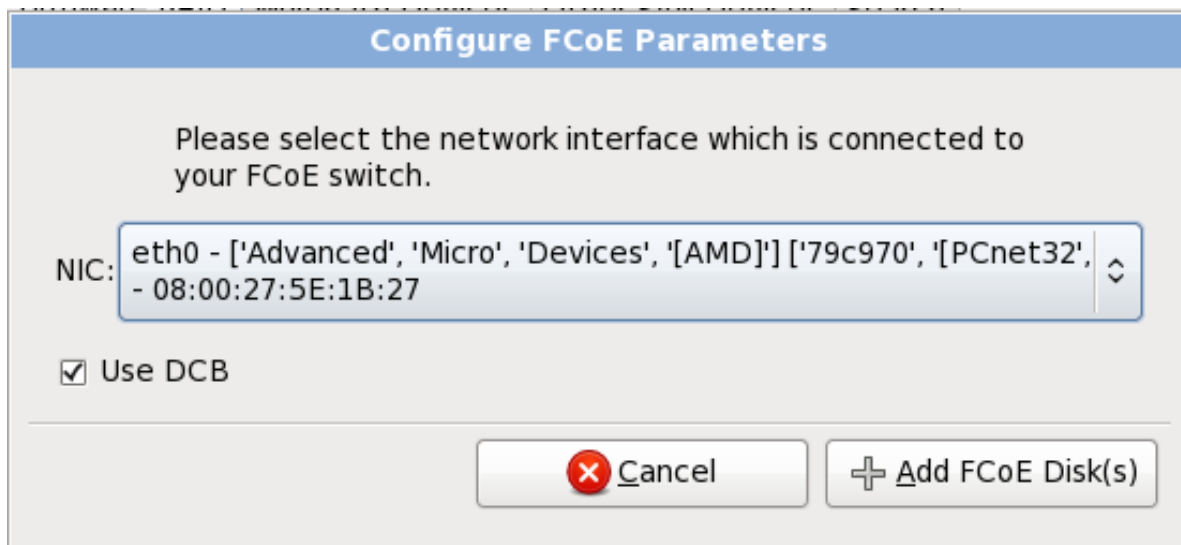


Figure 9.11. Configure FCoE Parameters

Data Center Bridging (DCB) is a set of enhancements to the Ethernet protocols designed to increase the efficiency of Ethernet connections in storage networks and clusters. Enable or disable the installer's awareness of DCB with the checkbox in this dialog.

9.6. Setting the Hostname

Setup prompts you to supply a host name for this computer, either as a *fully-qualified domain name* (FQDN) in the format *hostname.domainname* or as a *short host name* in the format *hostname*. Many networks have a *Dynamic Host Configuration Protocol* (DHCP) service that automatically supplies connected systems with a domain name. To allow the DHCP service to assign the domain name to this machine, specify the short host name only.



Valid Hostnames

You may give your system any name provided that the full hostname is unique. The hostname may include letters, numbers and hyphens.

Please name this computer. The hostname identifies the computer on a network.

Hostname:

Configure Network

Back Next

Figure 9.12. Setting the hostname

If your Red Hat Enterprise Linux system is connected *directly* to the Internet, you must pay attention to additional considerations to avoid service interruptions or risk action by your upstream service provider. A full discussion of these issues is beyond the scope of this document.



Modem Configuration

The installation program does not configure modems. Configure these devices after installation with the **Network** utility. The settings for your modem are specific to your particular Internet Service Provider (ISP).

9.6.1. Edit Network Connections



Important — Manual configuration is often needed

When a Red Hat Enterprise Linux 6 installation boots for the first time, it activates any network interfaces that you configured during the installation process. However, the installer does not prompt you to configure network interfaces on some common installation paths, for example, when you install Red Hat Enterprise Linux from a DVD to a local hard drive.

When you install Red Hat Enterprise Linux from a local installation source to a local storage device, be sure to configure at least one network interface manually if you require network access when the system boots for the first time.



Note

To change your network configuration after you have completed the installation, use the **Network Administration Tool**.

Type the **system-config-network** command in a shell prompt to launch the **Network Administration Tool**. If you are not root, it prompts you for the root password to continue.

The **Network Administration Tool** is now deprecated and will be replaced by **NetworkManager** during the lifetime of Red Hat Enterprise Linux 6.

To configure a network connection manually, click the button **Configure Network**. The **Network Connections** dialog appears that allows you to configure wired, wireless, mobile broadband, VPN, and DSL connections for the system using the **NetworkManager** tool. A full description of all configurations possible with **NetworkManager** is beyond the scope of this guide. This section only details the most typical scenario of how to configure wired connections during installation. Configuration of other types of network is broadly similar, although the specific parameters that you must configure are necessarily different.

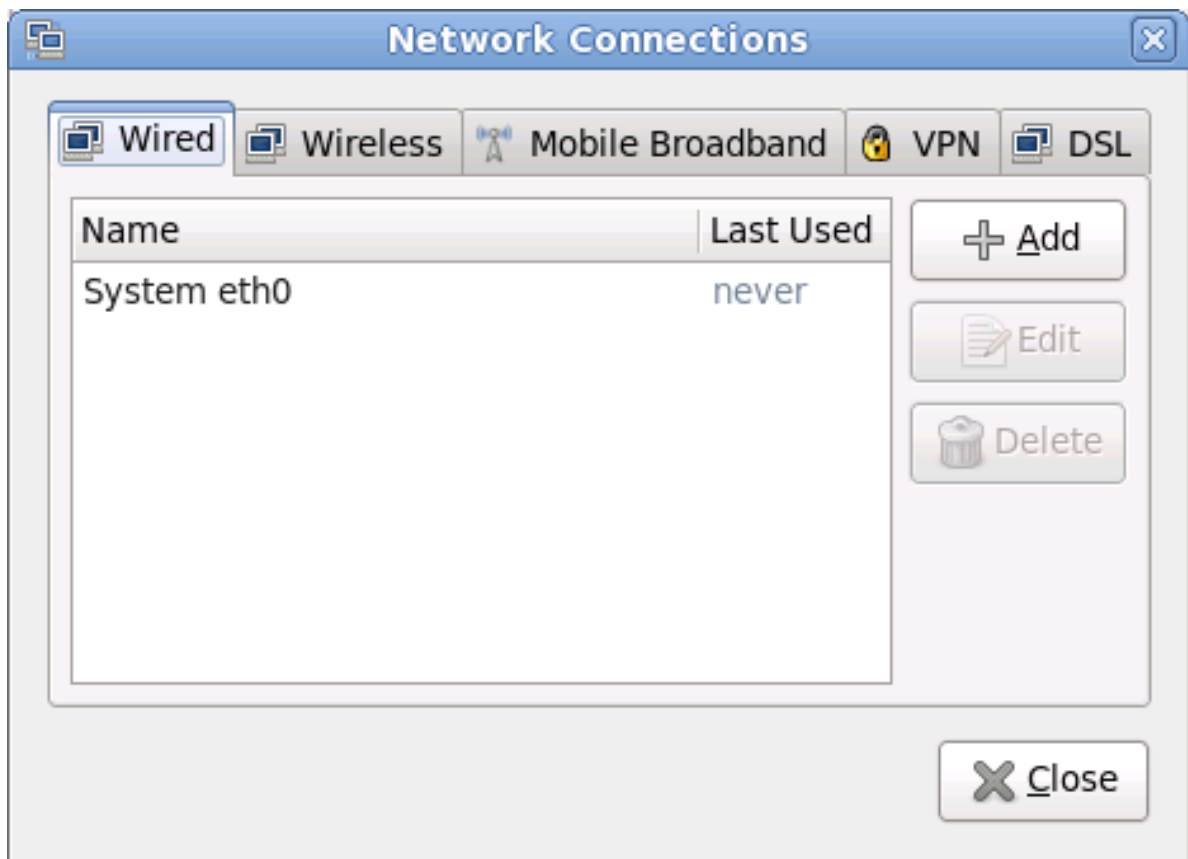


Figure 9.13. Network Connections

To add a new connection or to modify or remove a connection configured earlier in the installation process, click the tab that corresponds to the type of connection. To add a new connection of that type, click **Add**. To modify an existing connection, select it in the list and click **Edit**. In either case, a dialog box appears with a set of tabs that is appropriate to the particular connection type, as described below. To remove a connection, select it in the list and click **Delete**.

When you have finished editing network settings, click **Apply** to activate your changes. Note that re-configuring your network settings might require you to re-connect using the new settings.

9.6.1.1. Options common to all types of connection

Certain configuration options are common to all connection types.

Specify a name for the connection in the **Connection name** name field.

Select **Start automatically** to start the connection automatically when the system boots.

Select **Available to all users** to make the connection available to all users.

9.6.1.2. The Wired tab

Use the **Wired** tab to specify or change the *media access control* (MAC) address for the network adapter, and either set the *maximum transmission unit* (MTU, in bytes) that can pass through the interface.



Figure 9.14. The Wired tab

9.6.1.3. The 802.1x Security tab

Use the **802.1x Security** tab to configure 802.1X *port-based network access control* (PNAC). Select **Use 802.1X security for this connection** to enable access control, then specify details of your network. The configuration options include:

Authentication

Choose one of the following methods of authentication:

- **TLS** for *Transport Layer Security*
- **Tunneled TLS** for *Tunneled Transport Layer Security*, otherwise known as TTLS, or EAP-TTLS

- **Protected EAP (PEAP)** for *Protected Extensible Authentication Protocol*

Identity

Provide the identity of this server.

User certificate

Browse to a personal X.509 certificate file encoded with *Distinguished Encoding Rules* (DER) or *Privacy Enhanced Mail* (PEM).

CA certificate

Browse to a X.509 *certificate authority* certificate file encoded with *Distinguished Encoding Rules* (DER) or *Privacy Enhanced Mail* (PEM).

Private key

Browse to a *private key* file encoded with *Distinguished Encoding Rules* (DER), *Privacy Enhanced Mail* (PEM), or the *Personal Information Exchange Syntax Standard* (PKCS#12).

Private key password

The password for the private key specified in the **Private key** field. Select **Show password** to make the password visible as you type it.

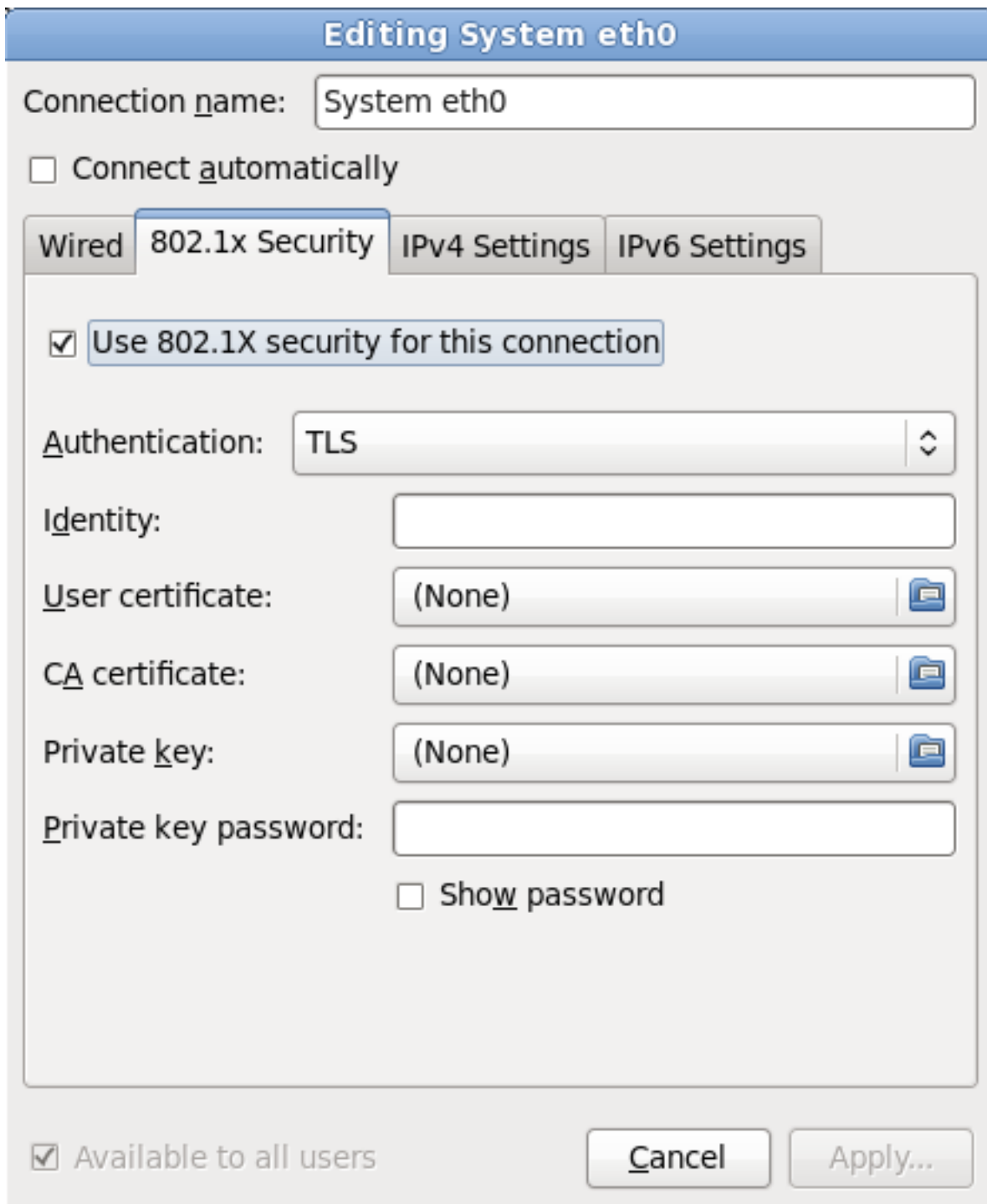


Figure 9.15. The 802.1x Security tab

9.6.1.4. The IPv4 Settings tab

Use the **IPv4 Settings tab** to configure the IPv4 parameters for the previously selected network connection.

Use the **Method** drop-down menu to specify which settings the system should attempt to obtain from a *Dynamic Host Configuration Protocol* (DHCP) service running on the network. Choose from the following options:

Automatic (DHCP)

IPv4 parameters are configured by the DHCP service on the network.

Automatic (DHCP) addresses only

The IPv4 address, netmask, and gateway address are configured by the DHCP service on the network, but DNS servers and search domains must be configured manually.

Manual

IPv4 parameters are configured manually for a static configuration.

Link-Local Only

A *link-local* address in the 169.254/16 range is assigned to the interface.

Shared to other computers

The system is configured to provide network access to other computers. The interface is assigned an address in the 10.42.x.1/24 range, a DHCP server and DNS server are started, and the interface is connected to the default network connection on the system with *network address translation* (NAT).

Disabled

IPv4 is disabled for this connection.

If you selected a method that requires you to supply manual parameters, enter details of the IP address for this interface, the netmask, and the gateway in the **Addresses** field. Use the **Add** and **Delete** buttons to add or remove addresses. Enter a comma-separated list of DNS servers in the **DNS servers** field, and a comma-separated list of domains in the **Search domains** field for any domains that you want to include in name server lookups.

Optionally, enter a name for this network connection in the **DHCP client ID** field. This name must be unique on the subnet. When you assign a meaningful DHCP client ID to a connection, it is easy to identify this connection when troubleshooting network problems.

Deselect the **Require IPv4 addressing for this connection to complete** check box to allow the system to make this connection on an IPv6-enabled network if IPv4 configuration fails but IPv6 configuration succeeds.



Figure 9.16. The IPv4 Settings tab

9.6.1.4.1. Editing IPv4 routes

Red Hat Enterprise Linux configures a number of routes automatically based on the IP addresses of a device. To edit additional routes, click the **Routes** button. The **Editing IPv4 routes** dialog appears.

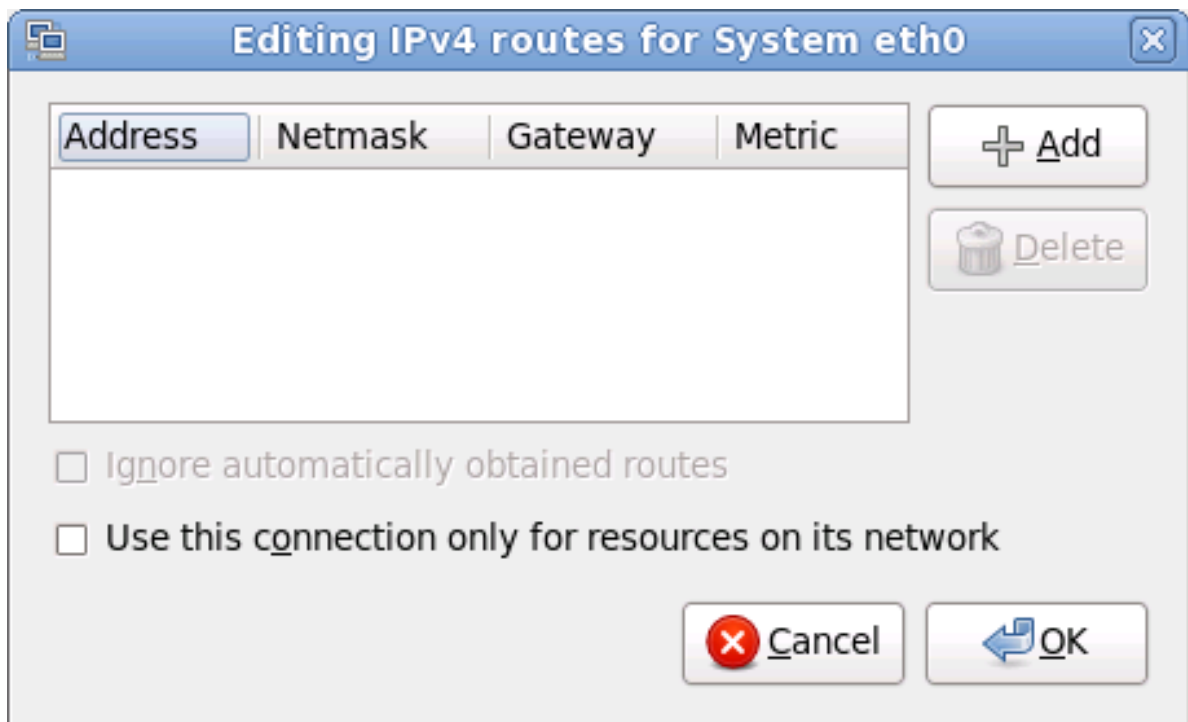


Figure 9.17. The Editing IPv4 Routes dialog

Click **Add** to add the IP address, netmask, gateway address, and metric for a new static route.

Select **Ignore automatically obtained routes** to make the interface use only the routes specified for it here.

Select **Use this connection only for resources on its network** to restrict connections only to the local network.

9.6.1.5. The IPv6 Settings tab

Use the **IPv6 Settings tab** to configure the IPv6 parameters for the previously selected network connection.

Use the **Method** drop-down menu to specify which settings the system should attempt to obtain from a *Dynamic Host Configuration Protocol* (DHCP) service running on the network. Choose from the following options:

Ignore

IPv6 is ignored for this connection.

Automatic

IPv6 parameters are configured by the DHCP service on the network.

Automatic, addresses only

The IPv6 address, prefix, and gateway address are configured by the DHCP service on the network, but DNS servers and search domains must be configured manually.

Manual

IPv6 parameters are configured manually for a static configuration.

Link-Local Only

A *link-local* address with the fe80::/10 prefix is assigned to the interface.

If you selected a method that requires you to supply manual parameters, enter details of the IP address for this interface, the netmask, and the gateway in the **Addresses** field. Use the **Add** and **Delete** buttons to add or remove addresses. Enter a comma-separated list of DNS servers in the **DNS servers** field, and a comma-separated list of domains in the **Search domains** field for any domains that you want to include in name server lookups.

Optionally, enter a name for this network connection in the **DHCP client ID** field. This name must be unique on the subnet. When you assign a meaningful DHCP client ID to a connection, it is easy to identify this connection when troubleshooting network problems.

Deselect the **Require IPv6 addressing for this connection to complete** check box to allow the system to make this connection on an IPv4-enabled network if IPv6 configuration fails but IPv4 configuration succeeds.

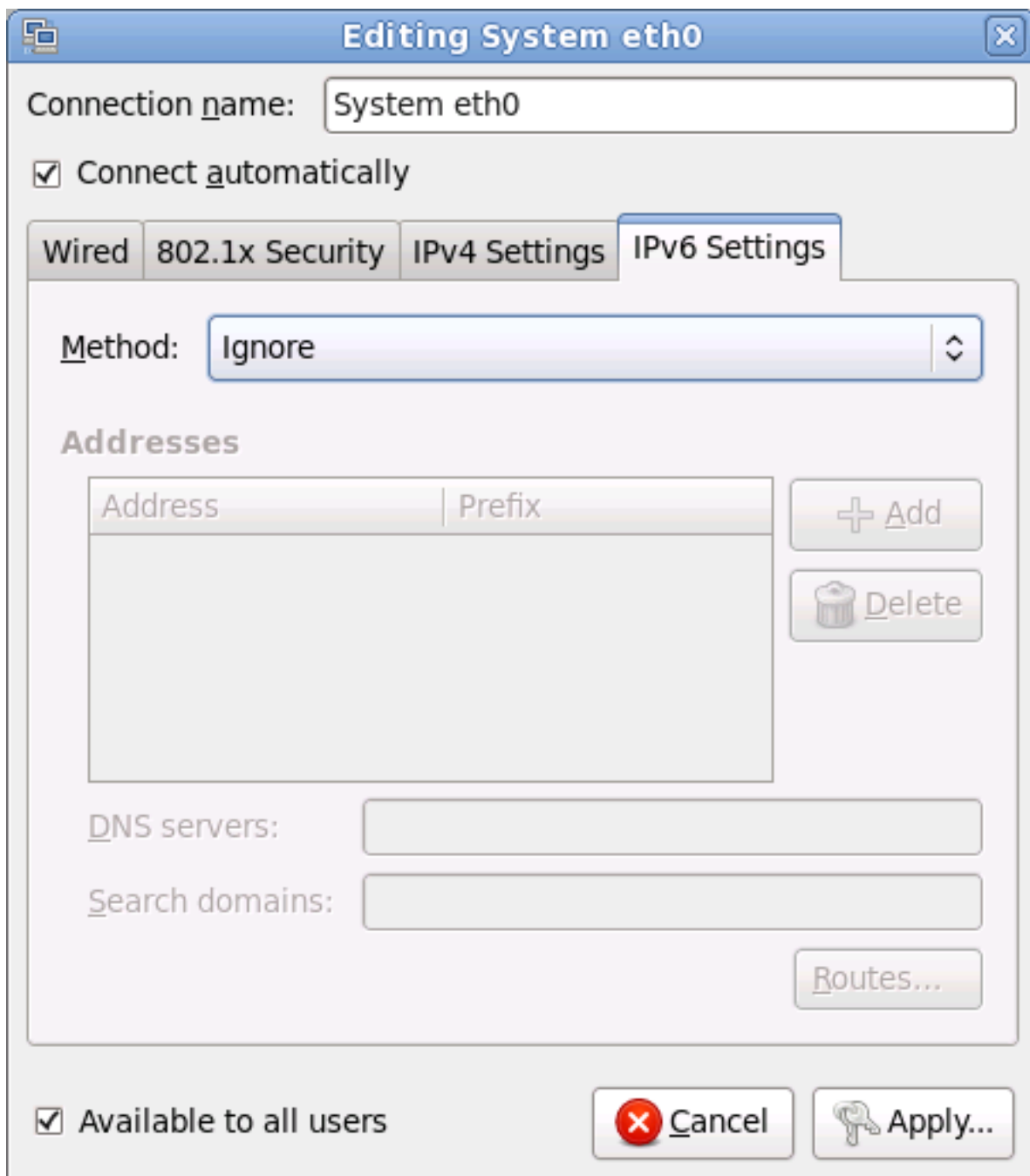


Figure 9.18. The IPv6 Settings tab

9.6.1.5.1. Editing IPv6 routes

Red Hat Enterprise Linux configures a number of routes automatically based on the IP addresses of a device. To edit additional routes, click the **Routes** button. The **Editing IPv6 routes** dialog appears.

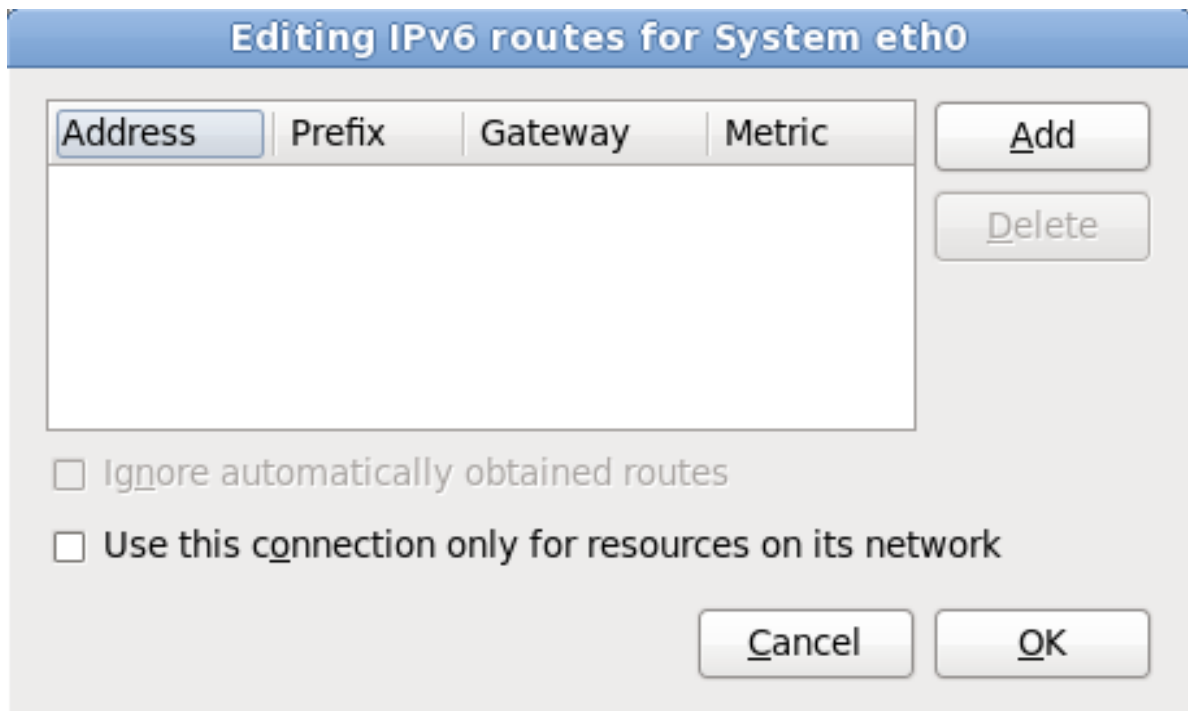


Figure 9.19. The Editing IPv6 Routes dialog

Click **Add** to add the IP address, netmask, gateway address, and metric for a new static route.

Select **Use this connection only for resources on its network** to restrict connections only to the local network.

9.7. Time Zone Configuration

Set your time zone by selecting the city closest to your computer's physical location. Click on the map to zoom in to a particular geographical region of the world.

Specify a time zone even if you plan to use NTP (Network Time Protocol) to maintain the accuracy of the system clock.

From here there are two ways for you to select your time zone:

- Using your mouse, click on the interactive map to select a specific city (represented by a yellow dot). A red **X** appears indicating your selection.
- You can also scroll through the list at the bottom of the screen to select your time zone. Using your mouse, click on a location to highlight your selection.

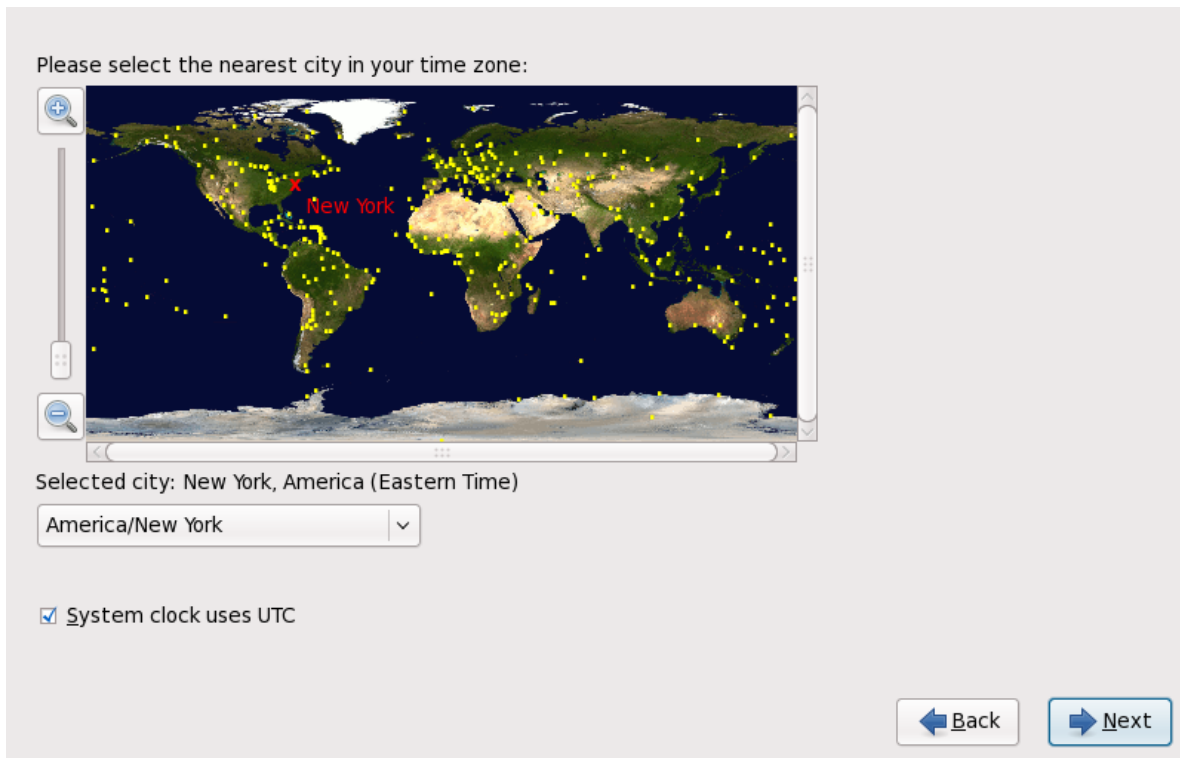


Figure 9.20. Configuring the Time Zone

If Red Hat Enterprise Linux is the only operating system on your computer, select **System clock uses UTC**. The system clock is a piece of hardware on your computer system. Red Hat Enterprise Linux uses the timezone setting to determine the offset between the local time and UTC on the system clock. This behavior is standard for systems that use UNIX, Linux, and similar operating systems.

Click **Next** to proceed.



Windows and the System Clock

Do not enable the **System clock uses UTC** option if your machine also runs Microsoft Windows. Microsoft operating systems change the BIOS clock to match local time rather than UTC. This may cause unexpected behavior under Red Hat Enterprise Linux.



Note

To change your time zone configuration after you have completed the installation, use the **Time and Date Properties Tool**.

Type the **system-config-date** command in a shell prompt to launch the **Time and Date Properties Tool**. If you are not root, it prompts you for the root password to continue.

To run the **Time and Date Properties Tool** as a text-based application, use the command **timeconfig**.

9.8. Set the Root Password

Setting up a root account and password is one of the most important steps during your installation. The root account is used to install packages, upgrade RPMs, and perform most system maintenance. Logging in as root gives you complete control over your system.



Note

The root user (also known as the superuser) has complete access to the entire system; for this reason, logging in as the root user is best done *only* to perform system maintenance or administration.

The root account is used for administering the system. Enter a password for the root user.

Root Password:

Confirm:

[← Back](#) [Next →](#)

Figure 9.21. Root Password

Use the root account only for system administration. Create a non-root account for your general use and use the **su** command to change to root only when you need to perform tasks that require superuser authorization. These basic rules minimize the chances of a typo or an incorrect command doing damage to your system.



Note

To become root, type **su -** at the shell prompt in a terminal window and then press **Enter**. Then, enter the root password and press **Enter**.

The installation program prompts you to set a root password¹ for your system. *You cannot proceed to the next stage of the installation process without entering a root password.*

The root password must be at least six characters long; the password you type is not echoed to the screen. You must enter the password twice; if the two passwords do not match, the installation program asks you to enter them again.

You should make the root password something you can remember, but not something that is easy for someone else to guess. Your name, your phone number, *qwerty*, *password*, *root*, *123456*, and *anteater* are all examples of bad passwords. Good passwords mix numerals with upper and lower case letters and do not contain dictionary words: *Aard387vark* or *420BMttNT*, for example. Remember that the password is case-sensitive. If you write down your password, keep it in a secure place. However, it is recommended that you do not write down this or any password you create.



Note

Do not use one of the example passwords offered in this manual. Using one of these passwords could be considered a security risk.

To change your root password after you have completed the installation, use the **Root Password Tool**.

Type the **system-config-users** command in a shell prompt to launch the **User Manager**, a powerful user management and configuration tool. If you are not root, it prompts you for the root password to continue.

Enter the root password into the **Root Password** field. Red Hat Enterprise Linux displays the characters as asterisks for security. Type the same password into the **Confirm** field to ensure it is set correctly. After you set the root password, select **Next** to proceed.

9.9. Assign Storage Devices

If you selected more than one storage device on the storage devices selection screen (refer to [Section 9.5, “Storage Devices”](#)), **anaconda** asks you to select which of these devices should be available for installation of the operating system, and which should only be attached to the file system for data storage. If you selected only one storage device, **anaconda** does not present you with this screen.

During installation, the devices that you identify here as being for data storage only are mounted as part of the file system, but are not partitioned or formatted.

¹ A root password is the administrative password for your Red Hat Enterprise Linux system. You should only log in as root when needed for system maintenance. The root account does not operate within the restrictions placed on normal user accounts, so changes made as root can have implications for your entire system.

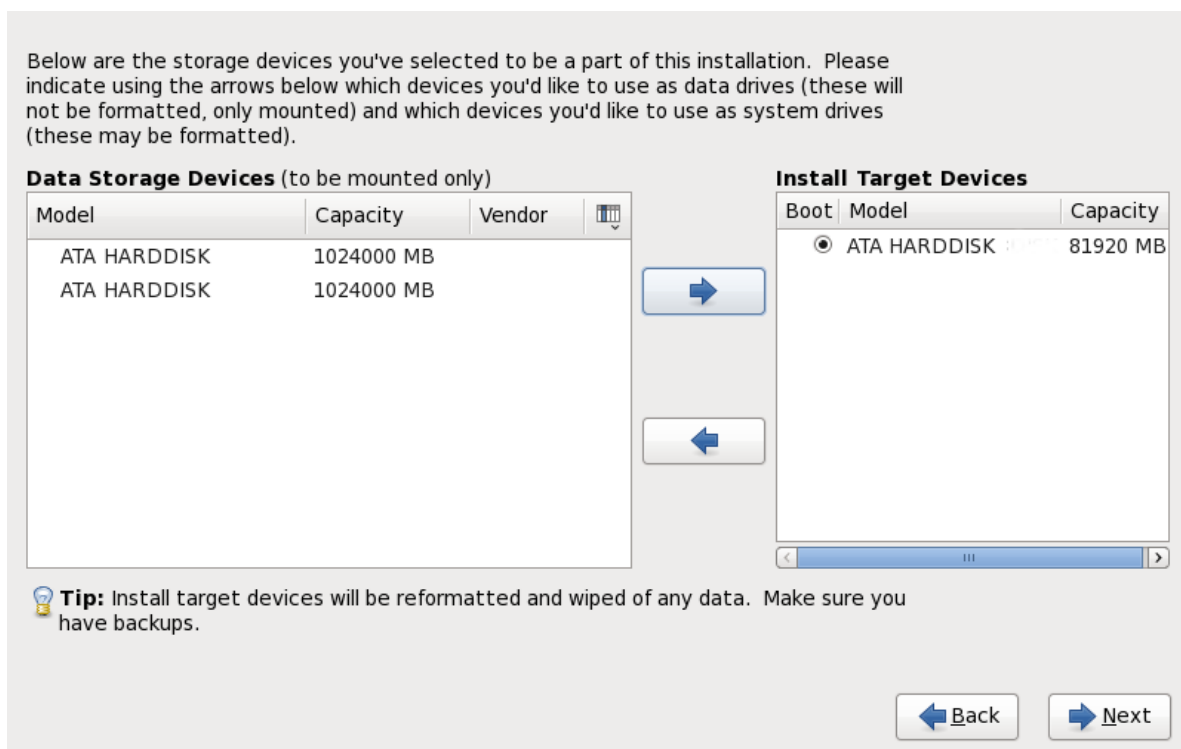


Figure 9.22. Assign storage devices

The screen is split into two panes. The left pane contains a list of devices to be used for data storage only. The right pane contains a list of devices that are to be available for installation of the operating system.

Each list contains information about the devices to help you to identify them. A small drop-down menu marked with an icon is located to the right of the column headings. This menu allows you to select the types of data presented on each device. Reducing or expanding the amount of information presented might help you to identify particular devices.

Move a device from one list to the other by clicking on the device, then clicking either the button labeled with a left-pointing arrow to move it to the list of data storage devices or the button labeled with a right-pointing arrow to move it to the list of devices available for installation of the operating system.

The list of devices available as installation targets also includes a radio button beside each device. Use this radio button to specify the device that you want to use as the boot device for the system.

Important — chain loading

If any storage device contains a boot loader that will chain load the Red Hat Enterprise Linux boot loader, include that storage device among the **Install Target Devices**. Storage devices that you identify as **Install Target Devices** remain visible to **anaconda** during boot loader configuration.

Storage devices that you identify as **Install Target Devices** on this screen are not automatically erased by the installation process unless you selected the **Use All Space** option on the partitioning screen (refer to [Section 9.12, “Disk Partitioning Setup”](#)).

When you have finished identifying devices to be used for installation, click **Next** to continue.

9.10. Initializing the Hard Disk

If no readable partition tables are found on existing hard disks, the installation program asks to initialize the hard disk. This operation makes any existing data on the hard disk unreadable. If your system has a brand new hard disk with no operating system installed, or you have removed all partitions on the hard disk, click **Re-initialize drive**.

The installation program presents you with a separate dialog for each disk on which it cannot read a valid partition table. Click the **Ignore all** button or **Re-initialize all** button to apply the same answer to all devices.

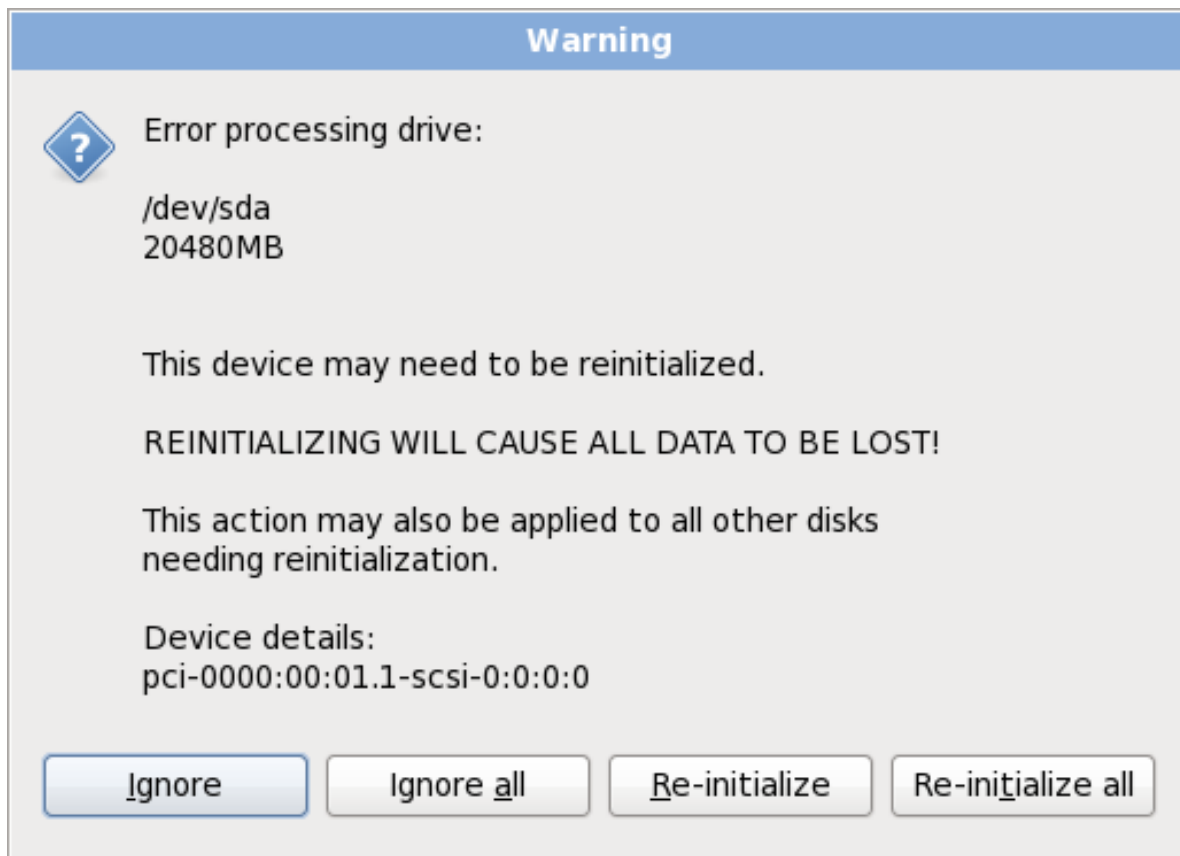



Figure 9.23. Warning screen – initializing hard drive

Certain RAID systems or other nonstandard configurations may be unreadable to the installation program and the prompt to initialize the hard disk may appear. The installation program responds to the physical disk structures it is able to detect.

To enable automatic initializing of hard disks for which it turns out to be necessary, use the kickstart command `clearpart --initlabel` (refer to [Chapter 32, Kickstart Installations](#))

 **Detach Unneeded Disks**

If you have a nonstandard disk configuration that can be detached during installation and detected and configured afterward, power off the system, detach it, and restart the installation.

9.11. Upgrading an Existing System



Red Hat does not support upgrades from earlier major versions

Although **anaconda** provides an option for upgrading from earlier major versions of Red Hat Enterprise Linux to Red Hat Enterprise Linux 6, Red Hat does not currently support this. More generally, Red Hat does not support in-place upgrades between any major versions of Red Hat Enterprise Linux. (A major version is denoted by a whole number version change. For example, Red Hat Enterprise Linux 4 and Red Hat Enterprise Linux 5 are both major versions of Red Hat Enterprise Linux.)

In-place upgrades across major releases do not preserve all system settings, services or custom configurations. Consequently, Red Hat strongly recommends fresh installations when upgrading from one major version to another.

The installation system automatically detects any existing installation of Red Hat Enterprise Linux. The upgrade process updates the existing system software with new versions, but does not remove any data from users' home directories. The existing partition structure on your hard drives does not change. Your system configuration changes only if a package upgrade demands it. Most package upgrades do not change system configuration, but rather install an additional configuration file for you to examine later.

Note that the installation medium that you are using might not contain all the software packages that you need to upgrade your computer.

9.11.1. The Upgrade Dialog

If your system contains a Red Hat Enterprise Linux installation, a dialog appears asking whether you want to upgrade that installation. To perform an upgrade of an existing system, choose the appropriate installation from the drop-down list and select **Next**.

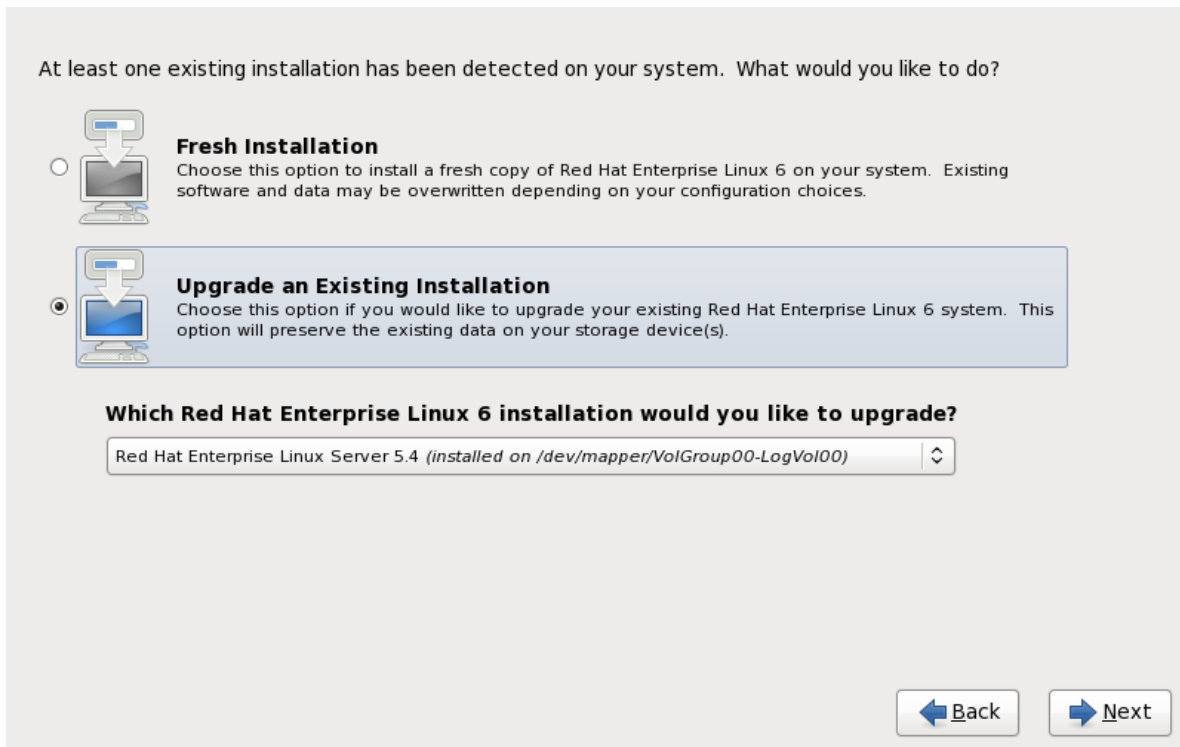


Figure 9.24. The Upgrade Dialog



Manually Installed Software

Software you have installed manually on your existing Red Hat Enterprise Linux system may behave differently after an upgrade. You may need to manually reinstall or recompile this software after an upgrade to ensure it performs correctly on the updated system.

9.11.2. Upgrading Using the Installer



Installations are Recommended

In general, Red Hat recommends that you keep user data on a separate **/home** partition and perform a fresh installation. For more information on partitions and how to set them up, refer to [Section 9.12, “Disk Partitioning Setup”](#).

If you choose to upgrade your system using the installation program, any software not provided by Red Hat Enterprise Linux that conflicts with Red Hat Enterprise Linux software is overwritten. Before you begin an upgrade this way, make a list of your system's current packages for later reference:

```
rpm -qa --qf '%{NAME} %{VERSION}-%{RELEASE} %{ARCH}\n' > ~/old-pkglist.txt
```

After installation, consult this list to discover which packages you may need to rebuild or retrieve from sources other than Red Hat.

Next, make a backup of any system configuration data:

```
su -c 'tar czf /tmp/etc-`date +%F`.tar.gz /etc'
```

```
su -c 'mv /tmp/etc-*.tar.gz /home'
```

Make a complete backup of any important data before performing an upgrade. Important data may include the contents of your entire **/home** directory as well as content from services such as an Apache, FTP, or SQL server, or a source code management system. Although upgrades are not destructive, if you perform one improperly there is a small possibility of data loss.



Storing Backups

Note that the above examples store backup materials in a **/home** directory. If your **/home** directory is not a separate partition, *you should not follow these examples verbatim!* Store your backups on another device such as CD or DVD discs or an external hard disk.

For more information on completing the upgrade process later, refer to [Section 35.2, “Finishing an Upgrade”](#).

9.11.3. Upgrading Boot Loader Configuration

Your completed Red Hat Enterprise Linux installation must be registered in the *boot loader* to boot properly. A boot loader is software on your machine that locates and starts the operating system. Refer to [Appendix E, The GRUB Boot Loader](#) for more information about boot loaders.

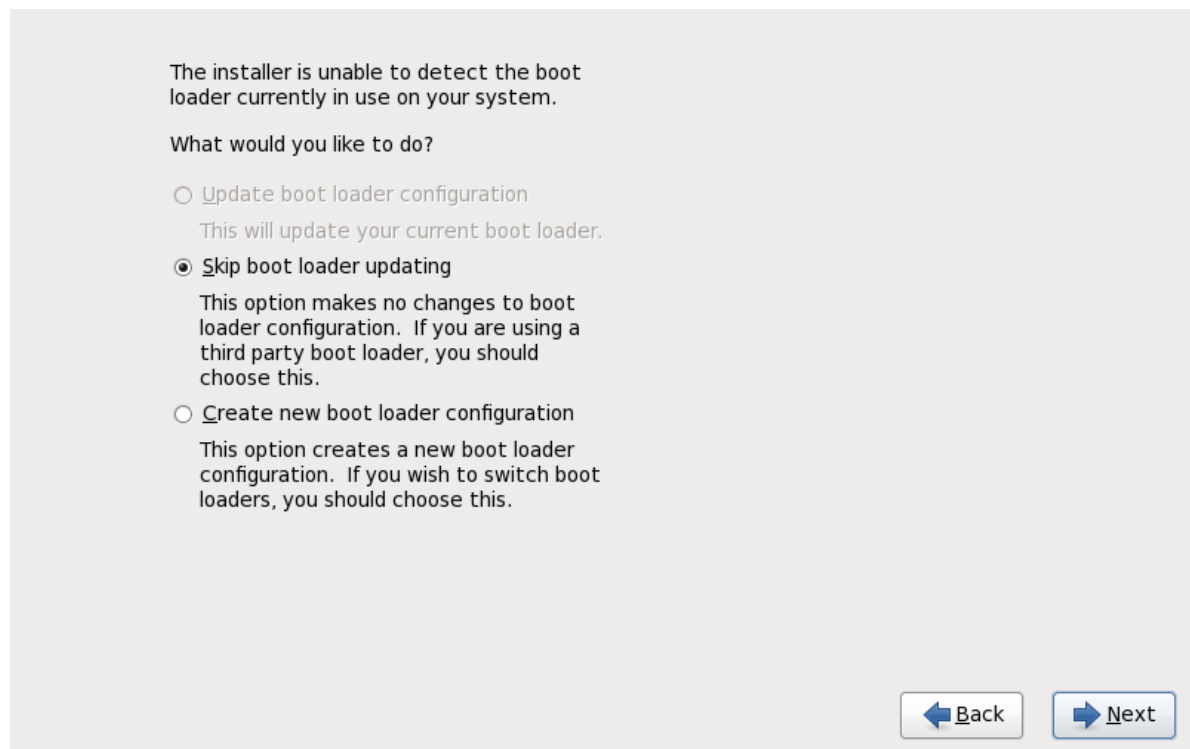


Figure 9.25. The Upgrade Boot Loader Dialog

If the existing boot loader was installed by a Linux distribution, the installation system can modify it to load the new Red Hat Enterprise Linux system. To update the existing Linux boot loader, select **Update boot loader configuration**. This is the default behavior when you upgrade an existing Red Hat Enterprise Linux installation.

GRUB is the standard boot loader for Red Hat Enterprise Linux on 32-bit and 64-bit x86 architectures. If your machine uses another boot loader, such as BootMagic, System Commander, or the loader

installed by Microsoft Windows, then the Red Hat Enterprise Linux installation system cannot update it. In this case, select **Skip boot loader updating**. When the installation process completes, refer to the documentation for your product for assistance.

Install a new boot loader as part of an upgrade process only if you are certain you want to replace the existing boot loader. If you install a new boot loader, you may not be able to boot other operating systems on the same machine until you have configured the new boot loader. Select **Create new boot loader configuration** to remove the existing boot loader and install GRUB.

After you make your selection, click **Next** to continue. If you selected the **Create new boot loader configuration** option, refer to [Section 9.16, “x86, AMD64, and Intel 64 Boot Loader Configuration”](#). If you chose to update or skip boot loader configuration, installation continues without further input from you.

9.12. Disk Partitioning Setup



Warning — Back up your data

It is always a good idea to back up any data that you have on your systems. For example, if you are upgrading or creating a dual-boot system, you should back up any data you wish to keep on your storage devices. Mistakes do happen and can result in the loss of all your data.



Important — Installing in text mode

If you install Red Hat Enterprise Linux in text mode, you can only use the default partitioning schemes described in this section. You cannot add or remove partitions or file systems beyond those that the installer automatically adds or removes. If you require a customized layout at installation time, you should perform a graphical installation over a VNC connection or a kickstart installation.

Furthermore, advanced options such as LVM, encrypted filesystems, and resizable filesystems are available only in graphical mode and kickstart.



Important — Booting from RAIDs

If you have a RAID card, be aware that some BIOSes do not support booting from the RAID card. In cases such as these, the **/boot/** partition must be created on a partition outside of the RAID array, such as on a separate hard drive. An internal hard drive is necessary to use for partition creation with problematic RAID cards.

A **/boot/** partition is also necessary for software RAID setups.

If you have chosen to automatically partition your system, you should select **Review** and manually edit your **/boot/** partition.

Partitioning allows you to divide your hard drive into isolated sections, where each section behaves as its own hard drive. Partitioning is particularly useful if you run multiple operating systems. If you are not

sure how you want your system to be partitioned, read [Appendix A, An Introduction to Disk Partitions](#) for more information.

Which type of installation would you like?

Use All Space
Removes all partitions on the selected device(s). This includes partitions created by other operating systems.
Tip: This option will remove data from the selected device(s). Make sure you have backups.

Replace Existing Linux System(s)
Removes only Linux partitions (created from a previous Linux installation). This does not remove other partitions you may have on your storage device(s) (such as VFAT or FAT32).
Tip: This option will remove data from the selected device(s). Make sure you have backups.

Shrink Current System
Shrinks existing partitions to create free space for the default layout.

Use Free Space
Retains your current data and partitions and uses only the unpartitioned space on the selected device(s), assuming you have enough free space available.

Create Custom Layout
Manually create your own custom layout on the selected device(s) using our partitioning tool.

Encrypt system

Review and modify partitioning layout

Figure 9.26. Disk Partitioning Setup

On this screen you can choose to create the default partition layout in one of four different ways, or choose to partition storage devices manually to create a custom layout.

The first four options allow you to perform an automated installation without having to partition your storage devices yourself. If you do not feel comfortable with partitioning your system, choose one of these options and let the installation program partition the storage devices for you. Depending on the option that you choose, you can still control what data (if any) is removed from the system.

Your options are:

Use All Space

Select this option to remove all partitions on your hard drives (this includes partitions created by other operating systems such as Windows VFAT or NTFS partitions).



Warning

If you select this option, all data on the selected hard drives is removed by the installation program. Do not select this option if you have information that you want to keep on the hard drives where you are installing Red Hat Enterprise Linux.

In particular, do not select this option when you configure a system to chain load the Red Hat Enterprise Linux boot loader from another boot loader.

Replace Existing Linux System(s)

Select this option to remove only partitions created by a previous Linux installation. This does not remove other partitions you may have on your hard drives (such as VFAT or FAT32 partitions).

Shrink Current System

Select this option to resize your current data and partitions manually and install a default Red Hat Enterprise Linux layout in the space that is freed.



Warning

If you shrink partitions on which other operating systems are installed, you might not be able to use those operating systems. Although this partitioning option does not destroy data, operating systems typically require some free space in their partitions. Before you resize a partition that holds an operating system that you might want to use again, find out how much space you need to leave free.

Use Free Space

Select this option to retain your current data and partitions and install Red Hat Enterprise Linux in the unused space available on the storage drives. Ensure that there is sufficient space available on the storage drives before you select this option — refer to [Section 3.4, “Do You Have Enough Disk Space?”](#).

Create Custom Layout

Select this option to partition storage devices manually and create customized layouts. Refer to [Section 9.14, “Creating a Custom Layout or Modifying the Default Layout ”](#)

Choose your preferred partitioning method by clicking the radio button to the left of its description in the dialog box.

Select **Encrypt system** to encrypt all partitions except the `/boot` partition. Refer to [Appendix C, Disk Encryption](#) for information on encryption.

To review and make any necessary changes to the partitions created by automatic partitioning, select the **Review** option. After selecting **Review** and clicking **Next** to move forward, the partitions created for you by **anaconda** appear. You can make modifications to these partitions if they do not meet your needs.



Important — chain loading

To configure the Red Hat Enterprise Linux boot loader to *chain load* from a different boot loader, you must specify the boot drive manually. If you chose any of the automatic partitioning options, you must now select the **Review and modify partitioning layout** option before you click **Next** or you cannot specify the correct boot drive.

Click **Next** once you have made your selections to proceed.

9.13. Encrypt Partitions

If you selected the **Encrypt System** option, the installer prompts you for a passphrase with which to encrypt the partitions on the system.

Partitions are encrypted using the *Linux Unified Key Setup* — refer to [Appendix C, Disk Encryption](#) for more information.

Enter passphrase for encrypted partition

Choose a passphrase for the encrypted devices. You will be prompted for this passphrase during system boot.

Enter passphrase:

Confirm passphrase:

Figure 9.27. Enter passphrase for encrypted partition

Choose a passphrase and type it into each of the two fields in the dialog box. You must provide this passphrase every time that the system boots.

Warning — Do not lose this passphrase

If you lose this passphrase, any encrypted partitions and the data on them will become completely inaccessible. There is no way to recover a lost passphrase.

Note that if you perform a kickstart installation of Red Hat Enterprise Linux, you can save encryption passphrases and create backup encryption passphrases during installation. Refer to [Section C.3.2, “Saving Passphrases”](#) and [Section C.3.3, “Creating and Saving Backup Passphrases”](#).

9.14. Creating a Custom Layout or Modifying the Default Layout

If you chose one of the four automatic partitioning options and did not select **Review**, skip ahead to [Section 9.17, “Package Group Selection”](#).

If you chose one of the automatic partitioning options and selected **Review**, you can either accept the current partition settings (click **Next**), or modify the setup manually in the partitioning screen.

If you chose to create a custom layout, you must tell the installation program where to install Red Hat Enterprise Linux. This is done by defining mount points for one or more disk partitions in which Red Hat Enterprise Linux is installed. You may also need to create and/or delete partitions at this time.

If you have not yet planned how to set up your partitions, refer to [Appendix A, An Introduction to Disk Partitions](#) and [Section 9.14.5, “Recommended Partitioning Scheme”](#). At a bare minimum, you need an appropriately-sized root partition, and usually a swap partition appropriate to the amount of RAM you have on the system.

Anaconda can handle the partitioning requirements for a typical installation.

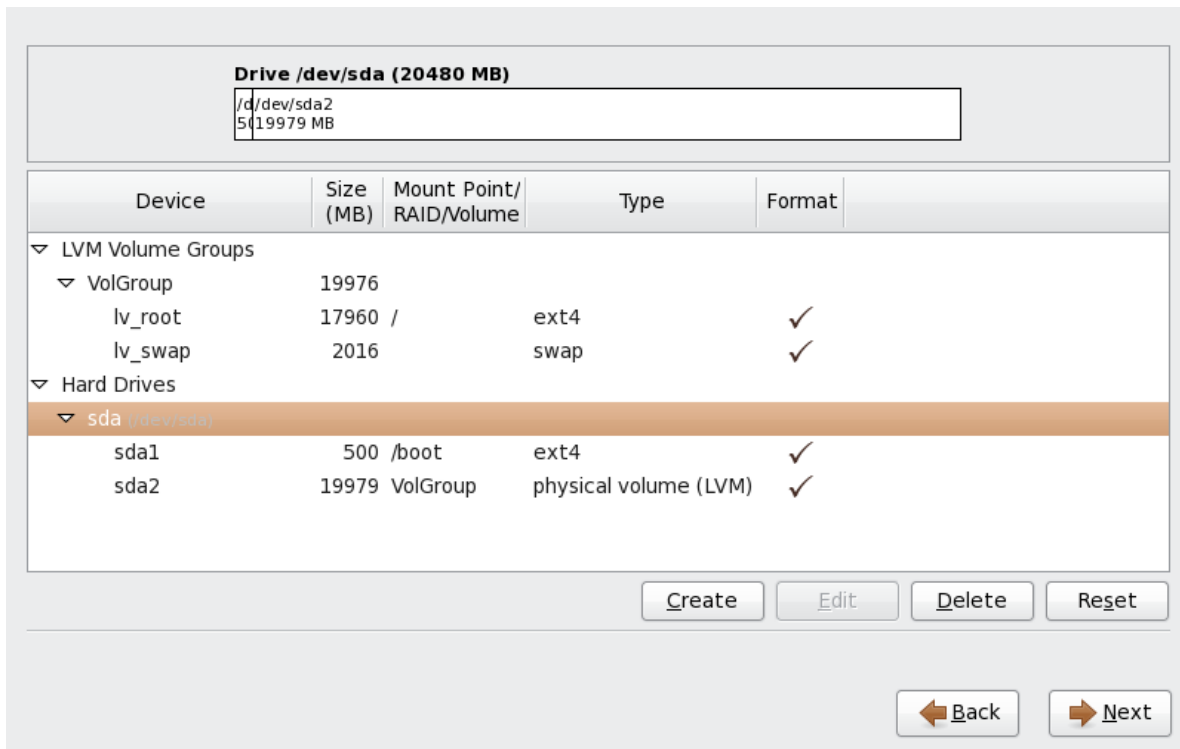


Figure 9.28. Partitioning on x86, AMD64, and Intel 64 Systems

The partitioning screen contains two panes. The top pane contains a graphical representation of the hard drive, logical volume, or RAID device selected in the lower pane.

Above the graphical representation of the device, you can review the name of the drive (such as / **dev/sda** or **LogVol100**), its size (in MB), and its model as detected by the installation program.

Using your mouse, click once to highlight a particular field in the graphical display. Double-click to edit an existing partition or to create a partition out of existing free space.

The lower pane contains a list of all drives, logical volumes, and RAID devices to be used during installation, as specified earlier in the installation process — refer to [Section 9.9, “Assign Storage Devices”](#)

Devices are grouped by type. Click on the small triangles to the left of each device type to view or hide devices of that type.

Anaconda displays several details for each device listed:

Device

the name of the device, logical volume, or partition

Size (MB)

the size of the device, logical volume, or partition (in MB)

Mount Point/RAID/Volume

the *mount point* (location within a file system) on which a partition is to be mounted, or the name of the RAID or logical volume group of which it is a part

Type

the type of partition. If the partition is a standard partition, this field displays the type of file system on the partition (for example, ext4). Otherwise, it indicates that the partition is a **physical volume (LVM)**, or part of a **software RAID**

Format

A check mark in this column indicates that the partition will be formatted during installation.

Beneath the lower pane are four buttons: **Create**, **Edit**, **Delete**, and **Reset**.

Select a device or partition by clicking on it in either the graphical representation in the upper pane or in the list in the lower pane, then click one of the four buttons to carry out the following actions:

Create

create a new partition, logical volume, or software RAID

Edit

change an existing new partition, logical volume, or software RAID

Delete

remove a partition, logical volume, or software RAID

Reset

undo all changes made in this screen

9.14.1. Create Storage

The **Create Storage** dialog allows you to create new storage partitions, logical volumes, and software RAID. **Anaconda** presents options as available or unavailable depending on the storage already present on the system or configured to transfer to the system.

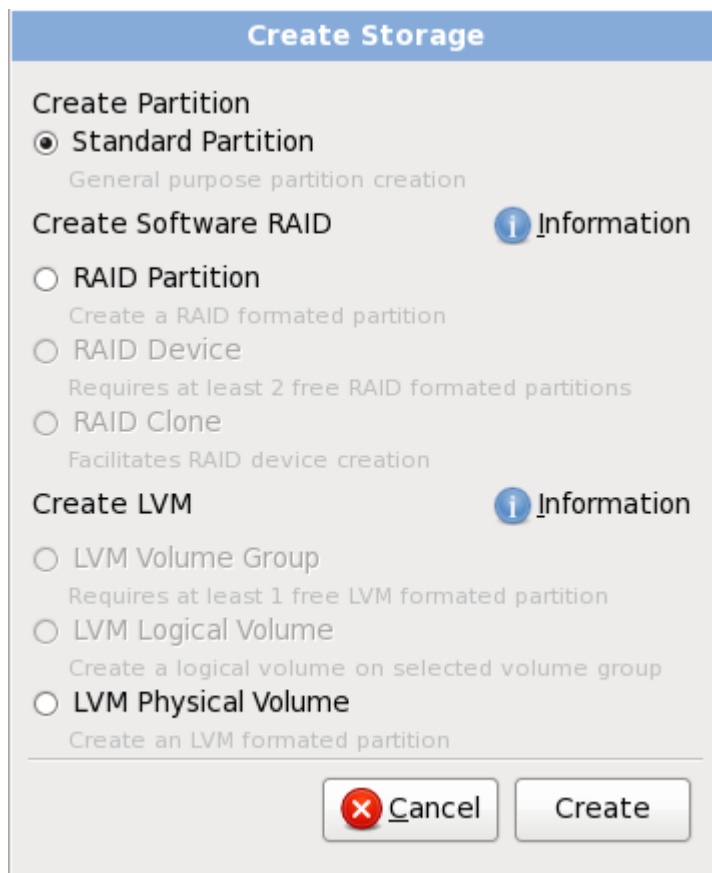


Figure 9.29. Creating Storage

Options are grouped under **Create Partition**, **Create Software RAID** and **Create LVM** as follows:

Create Partition

Refer to [Section 9.14.2, “Adding Partitions”](#) for details of the **Add Partition** dialog.

- **Standard Partition** — create a standard disk partition (as described in [Appendix A, An Introduction to Disk Partitions](#)) in unallocated space.

Create Software RAID

Refer to [Section 9.14.3, “Create Software RAID ”](#) for more detail.

- **RAID Partition** — create a partition in unallocated space to form part of a software RAID device. To form a software RAID device, two or more RAID partitions must be available on the system.
- **RAID Device** — combine two or more RAID partitions into a software RAID device. When you choose this option, you can specify the type of RAID device to create (the *RAID level*). This option is only available when two or more RAID partitions are available on the system.
- **RAID Clone** — create a mirror of a RAID partition on one storage device on another storage device. This option is only available when at least one RAID partition is available on the system.

Create LVM Logical Volume

Refer to [Section 9.14.4, “Create LVM Logical Volume ”](#) for more detail.

- **LVM Physical Volume** — create a *physical volume* in unallocated space.
- **LVM Volume Group** — create a *volume group* from one or more physical volumes. This option is only available when at least one physical volume is available on the system.
- **LVM Logical Volume** — create a *logical volume* on a volume group. This option is only available when at least one volume group is available on the system.

9.14.2. Adding Partitions

To add a new partition, select the **Create** button. A dialog box appears (refer to [Figure 9.30, “Creating a New Partition”](#)).



Note

You must dedicate at least one partition for this installation, and optionally more. For more information, refer to [Appendix A, An Introduction to Disk Partitions](#).

Add Partition

Mount Point: /

File System Type: ext4

Allowable Drives: sdb 20480 MB ATA HARDDISK

Size (MB): 20480

Additional Size Options

Fixed size

Fill all space up to (MB): 20480

Fill to maximum allowable size

Force to be a primary partition

Encrypt

Figure 9.30. Creating a New Partition

- **Mount Point:** Enter the partition's mount point. For example, if this partition should be the root partition, enter `/`; enter `/boot` for the `/boot` partition, and so on. You can also use the pull-down menu to choose the correct mount point for your partition. For a swap partition the mount point should not be set — setting the filesystem type to `swap` is sufficient.
- **File System Type:** Using the pull-down menu, select the appropriate file system type for this partition. For more information on file system types, refer to [Section 9.14.2.1, "File System Types"](#).
- **Allowable Drives:** This field contains a list of the hard disks installed on your system. If a hard disk's box is highlighted, then a desired partition can be created on that hard disk. If the box is *not* checked, then the partition will *never* be created on that hard disk. By using different checkbox settings, you can have **anaconda** place partitions where you need them, or let **anaconda** decide where partitions should go.
- **Size (MB):** Enter the size (in megabytes) of the partition. Note, this field starts with 200 MB; unless changed, only a 200 MB partition will be created.
- **Additional Size Options:** Choose whether to keep this partition at a fixed size, to allow it to "grow" (fill up the available hard drive space) to a certain point, or to allow it to grow to fill any remaining hard drive space available.

If you choose **Fill all space up to (MB)**, you must give size constraints in the field to the right of this option. This allows you to keep a certain amount of space free on your hard drive for future use.

- **Force to be a primary partition:** Select whether the partition you are creating should be one of the first four partitions on the hard drive. If unselected, the partition is created as a logical partition. Refer to [Section A.1.3, “Partitions within Partitions — An Overview of Extended Partitions”](#), for more information.
- **Encrypt:** Choose whether to encrypt the partition so that the data stored on it cannot be accessed without a passphrase, even if the storage device is connected to another system. Refer to [Appendix C, Disk Encryption](#) for information on encryption of storage devices. If you select this option, the installer prompts you to provide a passphrase before it writes the partition to the disk.
- **OK:** Select **OK** once you are satisfied with the settings and wish to create the partition.
- **Cancel:** Select **Cancel** if you do not want to create the partition.

9.14.2.1. File System Types

Red Hat Enterprise Linux allows you to create different partition types and file systems. The following is a brief description of the different partition types and file systems available, and how they can be used.

Partition types

- **standard partition** — A standard partition can contain a file system or swap space, or it can provide a container for software RAID or an LVM physical volume.
- **swap** — Swap partitions are used to support virtual memory. In other words, data is written to a swap partition when there is not enough RAM to store the data your system is processing. Refer to the *Red Hat Enterprise Linux Deployment Guide* for additional information.
- **software RAID** — Creating two or more software RAID partitions allows you to create a RAID device. For more information regarding RAID, refer to the chapter *RAID (Redundant Array of Independent Disks)* in the *Red Hat Enterprise Linux Deployment Guide*.
- **physical volume (LVM)** — Creating one or more physical volume (LVM) partitions allows you to create an LVM logical volume. LVM can improve performance when using physical disks. For more information regarding LVM, refer to the *Red Hat Enterprise Linux Deployment Guide*.

File systems

- **ext4** — The ext4 file system is based on the ext3 file system and features a number of improvements. These include support for larger file systems and larger files, faster and more efficient allocation of disk space, no limit on the number of subdirectories within a directory, faster file system checking, and more robust journalling. The ext4 file system is selected by default and is highly recommended.
- **ext3** — The ext3 file system is based on the ext2 file system and has one main advantage — journalling. Using a journalling file system reduces time spent recovering a file system after a crash as there is no need to **fsck** ² the file system.
- **ext2** — An ext2 file system supports standard Unix file types (regular files, directories, symbolic links, etc). It provides the ability to assign long file names, up to 255 characters.
- **xfs** — XFS is a highly scalable, high-performance file system that supports filesystems up to 16 exabytes (approximately 16 million terabytes), files up to 8 exabytes (approximately 8 million terabytes) and directory structures containing tens of millions of entries. XFS supports metadata journalling, which facilitates quicker crash recovery. The XFS file system can also be defragmented and resized while mounted and active.

- **vfat** — The VFAT file system is a Linux file system that is compatible with Microsoft Windows long filenames on the FAT file system.
- **Btrfs** — Btrfs is under development as a file system capable of addressing and managing more files, larger files, and larger volumes than the ext2, ext3, and ext4 file systems. Btrfs is designed to make the file system tolerant of errors, and to facilitate the detection and repair of errors when they occur. It uses checksums to ensure the validity of data and metadata, and maintains snapshots of the file system that can be used for backup or repair.

Because Btrfs is still experimental and under development, the installation program does not offer it by default. If you want to create a Btrfs partition on a drive, you must commence the installation process with the boot option **btrfs**. Refer to [Chapter 28, Boot Options](#) for instructions.



Btrfs is still experimental

Red Hat Enterprise Linux 6 includes Btrfs as a technology preview to allow you to experiment with this file system. You should not choose Btrfs for partitions that will contain valuable data or that are essential for the operation of important systems.

9.14.3. Create Software RAID

Redundant arrays of independent disks (RAIDs) are constructed from multiple storage devices that are arranged to provide increased performance and — in some configurations — greater fault tolerance. Refer to the *Red Hat Enterprise Linux Deployment Guide* for a description of different kinds of RAIDs.

To make a RAID device, you must first create software RAID partitions. Once you have created two or more software RAID partitions, select **RAID** to join the software RAID partitions into a RAID device.

RAID Partition

Choose this option to configure a partition for software RAID. This option is the only choice available if your disk contains no software RAID partitions. This is the same dialog that appears when you add a standard partition — refer to [Section 9.14.2, “Adding Partitions”](#) for a description of the available options. Note, however, that **File System Type** must be set to **software RAID**

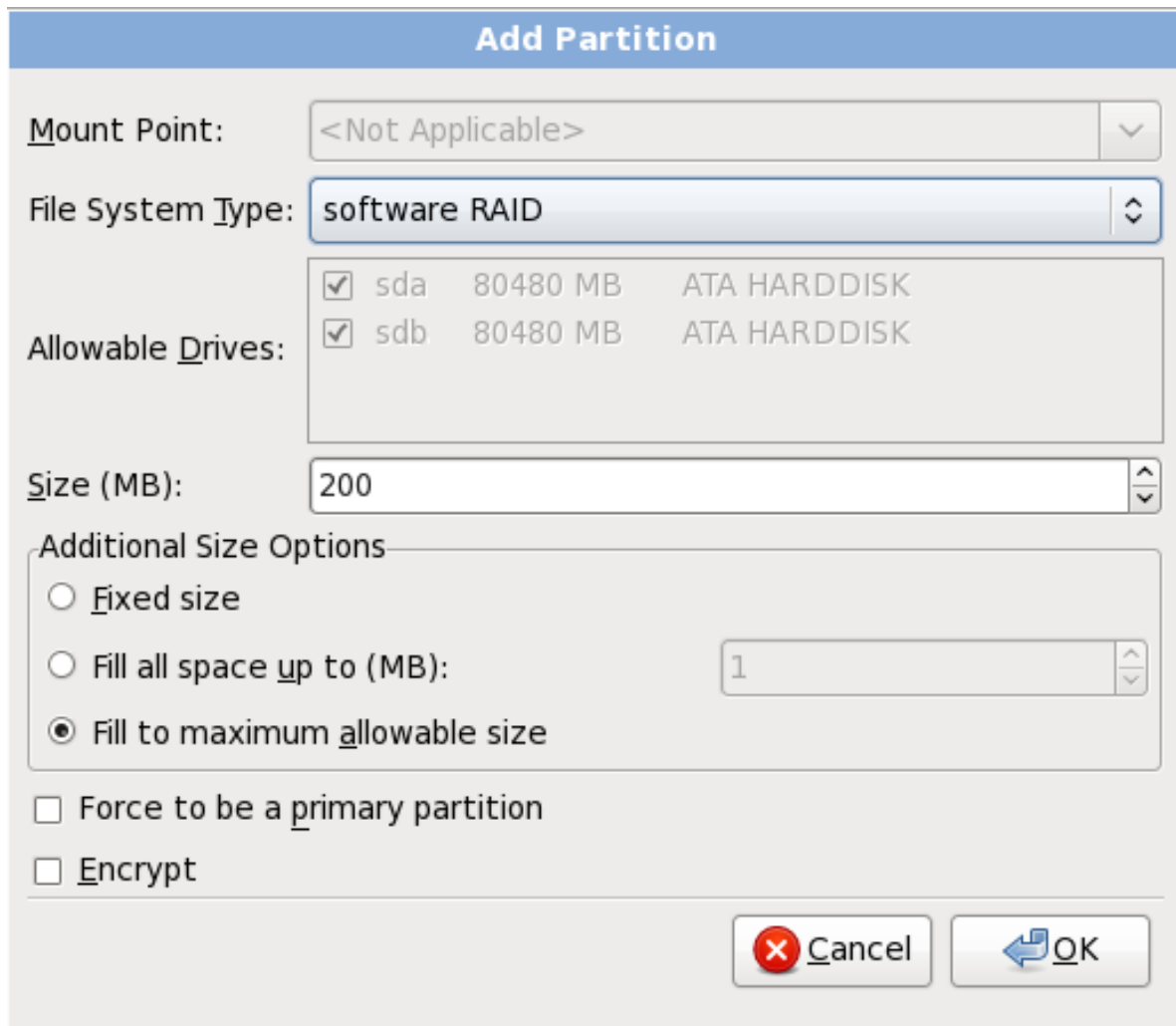


Figure 9.31. Create a software RAID partition

RAID Device

Choose this option to construct a RAID device from two or more existing software RAID partitions. This option is available if two or more software RAID partitions have been configured.

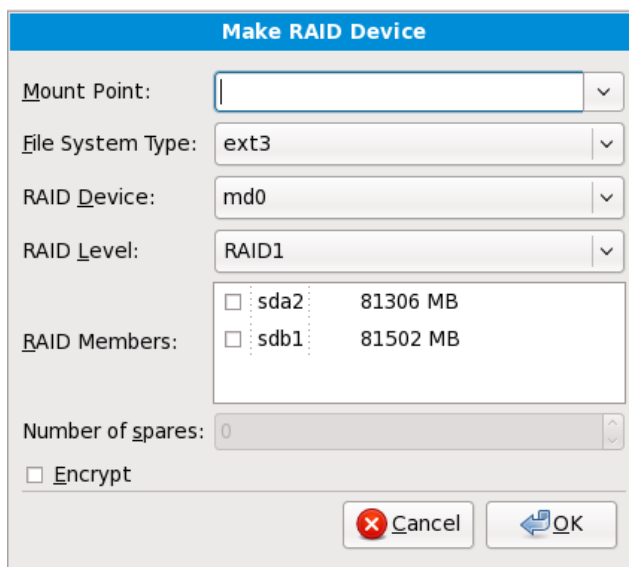


Figure 9.32. Create a RAID device

Select the file system type as for a standard partition.

Anaconda automatically suggests a name for the RAID device, but you can manually select names from **md0** to **md15**.

Click the checkboxes beside individual storage devices to include or remove them from this RAID.

The **RAID Level** corresponds to a particular type of RAID. Choose from the following options:

- **RAID 0** — distributes data across multiple storage devices. Level 0 RAID offers increased performance over standard partitions, and can be used to pool the storage of multiple devices into one large virtual device. Note that Level 0 RAID offers no redundancy and that the failure of one device in the array destroys the entire array. RAID 0 requires at least two RAID partitions.
- **RAID 1** — mirrors the data on one storage device onto one or more other storage devices. Additional devices in the array provide increasing levels of redundancy. RAID 1 requires at least two RAID partitions.
- **RAID 4** — distributes data across multiple storage devices, but uses one device in the array to store parity information that safeguards the array in case any device within the array fails. Because all parity information is stored on the one device, access to this device creates a bottleneck in the performance of the array. RAID 4 requires at least three RAID partitions.
- **RAID 5** — distributes data and parity information across multiple storage devices. Level 5 RAID therefore offers the performance advantages of distributing data across multiple devices, but does not share the performance bottleneck of level 4 RAID because the parity information is also distributed through the array. RAID 5 requires at least three RAID partitions.
- **RAID 6** — level 6 RAID is similar to level 5 RAID, but instead of storing only one set of parity data, they store two sets. RAID 6 requires at least four RAID partitions.
- **RAID 10** — level 10 RAID is a *nested RAID* or *hybrid RAID*. Level 10 RAID is constructed by distributing data over mirrored sets of storage devices. For example, a level 10 RAID constructed from four RAID partitions consists of two pairs of partitions in which one partition mirrors the other. Data is then distributed across both pairs of storage devices, as in a level 0 RAID. RAID 10 requires at least four RAID partitions.

RAID Clone

Choose this option to set up a RAID *mirror* of an existing disk. This option is available if two or more disks are attached to the system.

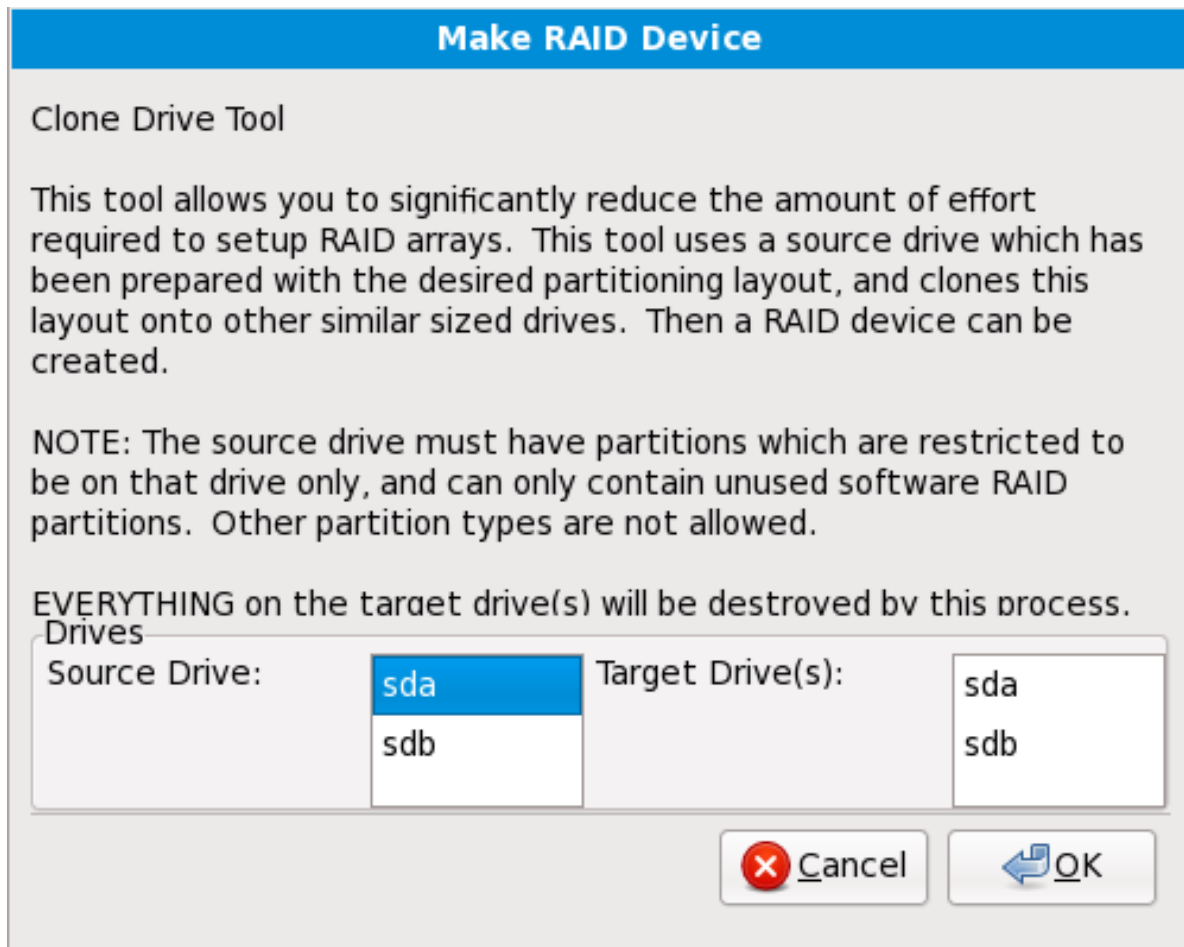


Figure 9.33. Clone a RAID device

9.14.4. Create LVM Logical Volume



Important — LVM Unavailable in Text-Mode Installations

LVM initial set up is not available during text-mode installation. If you need to create an LVM configuration from scratch, press **Alt+F2** to use a different virtual console, and run the **lvm** command. To return to the text-mode installation, press **Alt+F1**.

Logical Volume Management (LVM) presents a simple logical view of underlying physical storage space, such as a hard drives or LUNs. Partitions on physical storage are represented as *physical volumes* that can be grouped together into *volume groups*. Each volume group can be divided into multiple *logical volumes*, each of which is analogous to a standard disk partition. Therefore, LVM logical volumes function as partitions that can span multiple physical disks.

To read more about LVM, refer to the *Red Hat Enterprise Linux Deployment Guide*. Note, LVM is only available in the graphical installation program.

LVM Physical Volume

Choose this option to configure a partition or device as an LVM physical volume. This option is the only choice available if your storage does not already contain LVM Volume Groups. This is the same dialog that appears when you add a standard partition — refer to [Section 9.14.2, “Adding](#)

Partitions” for a description of the available options. Note, however, that **File System Type** must be set to **physical volume (LVM)**

Add Partition

Mount Point: <Not Applicable>

File System Type: physical volume (LVM)

Allowable Drives:

| | | | |
|-------------------------------------|-----|----------|--------------|
| <input checked="" type="checkbox"/> | sda | 20480 MB | ATA HARDDISK |
|-------------------------------------|-----|----------|--------------|

Size (MB): 200

Additional Size Options

Fixed size

Fill all space up to (MB): 1

Fill to maximum allowable size

Force to be a primary partition

Encrypt

Figure 9.34. Create an LVM Physical Volume

Make LVM Volume Group

Choose this option to create LVM volume groups from the available LVM physical volumes, or to add existing logical volumes to a volume group.

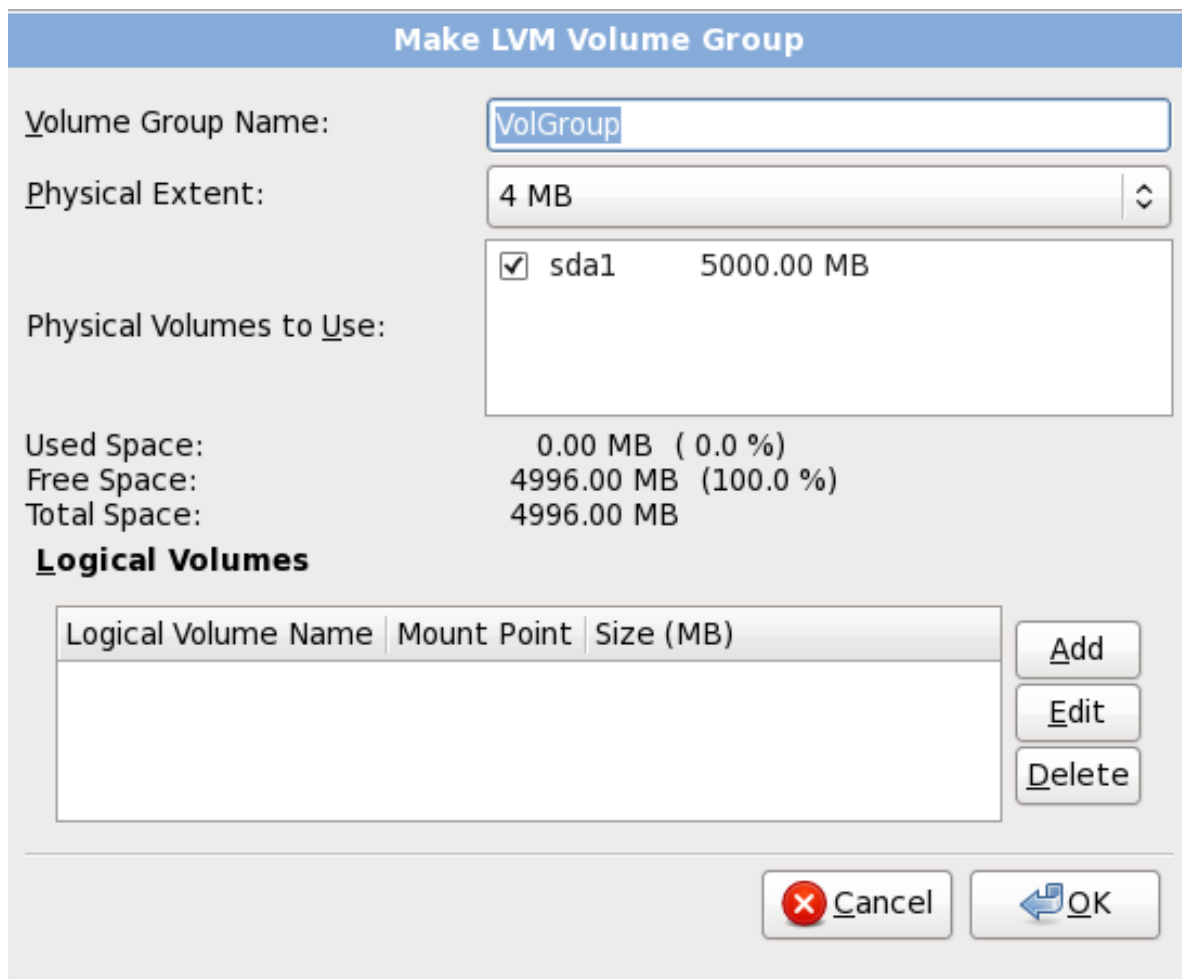


Figure 9.35. Make LVM Volume Group

To assign one or more physical volumes to a volume group, first name the volume group. Then select the physical volumes to be used in the volume group. Finally, configure logical volumes on any volume groups using the **Add**, **Edit** and **Delete** options.

You may not remove a physical volume from a volume group if doing so would leave insufficient space for that group's logical volumes. Take for example a volume group made up of two 5 GB LVM physical volume partitions, which contains an 8 GB logical volume. The installer would not allow you to remove either of the component physical volumes, since that would leave only 5 GB in the group for an 8 GB logical volume. If you reduce the total size of any logical volumes appropriately, you may then remove a physical volume from the volume group. In the example, reducing the size of the logical volume to 4 GB would allow you to remove one of the 5 GB physical volumes.

Make Logical Volume

Choose this option to create an LVM logical volume. Select a mount point, file system type, and size (in MB) just as if it were a standard disk partition. You can also choose a name for the logical volume and specify the volume group to which it will belong.

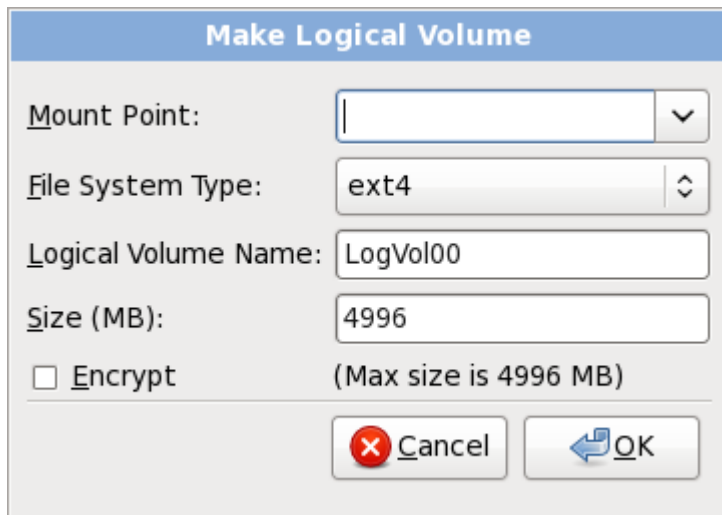


Figure 9.36. Make Logical Volume

9.14.5. Recommended Partitioning Scheme

9.14.5.1. x86, AMD64, and Intel 64 systems

Unless you have a reason for doing otherwise, we recommend that you create the following partitions for x86, AMD64, and Intel 64 systems:

- A swap partition
- A **/boot** partition
- A **/** partition
- A swap partition (at least 256 MB) — swap partitions are used to support virtual memory. In other words, data is written to a swap partition when there is not enough RAM to store the data your system is processing.

In years past, the recommended amount of swap space increased linearly with the amount of RAM in the system. But because the amount of memory in modern systems has increased into the hundreds of gigabytes, it is now recognized that the amount of swap space that a system needs is a function of the memory workload running on that system. However, given that swap space is usually designated at install time, and that it can be difficult to determine beforehand the memory workload of a system, we recommend determining system swap using the following table.

Table 9.2. Recommended System Swap Space

| Amount of RAM in the System | Recommended Amount of Swap Space |
|-----------------------------|----------------------------------|
| 4GB of RAM or less | a minimum of 2GB of swap space |
| 4GB to 16GB of RAM | a minimum of 4GB of swap space |
| 16GB to 64GB of RAM | a minimum of 8GB of swap space |
| 64GB to 256GB of RAM | a minimum of 16GB of swap space |
| 256GB to 512GB of RAM | a minimum of 32GB of swap space |

Note that you can obtain better performance by distributing swap space over multiple storage devices, particularly on systems with fast drives, controllers, and interfaces.

- **A /boot/ partition (250 MB)**

The partition mounted on **/boot/** contains the operating system kernel (which allows your system to boot Red Hat Enterprise Linux), along with files used during the bootstrap process. For most users, a 250 MB boot partition is sufficient.



Important — Supported file systems

The **GRUB** bootloader in Red Hat Enterprise Linux 6 supports only the ext2, ext3, and ext4 (recommended) file systems. You cannot use any other file system for **/boot**, such as Btrfs, XFS, or VFAT.



Note

If your hard drive is more than 1024 cylinders (and your system was manufactured more than two years ago), you may need to create a **/boot/** partition if you want the **/** (root) partition to use all of the remaining space on your hard drive.



Note

If you have a RAID card, be aware that some BIOSes do not support booting from the RAID card. In cases such as these, the **/boot/** partition must be created on a partition outside of the RAID array, such as on a separate hard drive.

- **A root partition (3.0 GB - 5.0 GB)**

This is where **/** (the root directory) is located. In this setup, all files (except those stored in **/boot**) are on the root partition.

A 3.0 GB partition allows you to install a minimal installation, while a 5.0 GB root partition lets you perform a full installation, choosing all package groups.



Root and /root

The **/** (or root) partition is the top of the directory structure. The **/root** directory/**root** (sometimes pronounced "slash-root") directory is the home directory of the user account for system administration.

Many systems have more partitions than the minimum listed above. Choose partitions based on your particular system needs. For example, consider creating a separate **/home** partition on systems that store user data. Refer to [Section 9.14.5.1.1, "Advice on Partitions"](#) for more information.

If you create many partitions instead of one large **/** partition, upgrades become easier. Refer to the description of the Edit option in [Section 9.14, "Creating a Custom Layout or Modifying the Default Layout"](#) for more information.

The following table summarizes minimum partition sizes for the partitions containing the listed directories. You *do not* have to make a separate partition for each of these directories. For instance, if the partition containing `/foo` must be at least 500 MB, and you do not make a separate `/foo` partition, then the `/` (root) partition must be at least 500 MB.

Table 9.3. Minimum partition sizes

| Directory | Minimum size |
|--------------------|--|
| <code>/</code> | 250 MB |
| <code>/usr</code> | 250 MB, but avoid placing this on a separate partition |
| <code>/tmp</code> | 50 MB |
| <code>/var</code> | 384 MB |
| <code>/home</code> | 100 MB |
| <code>/boot</code> | 250 MB |



Leave Excess Capacity Unallocated

Only assign storage capacity to those partitions you require immediately. You may allocate free space at any time, to meet needs as they occur. To learn about a more flexible method for storage management, refer to [Appendix D, Understanding LVM](#).

If you are not sure how best to configure the partitions for your computer, accept the default partition layout.

9.14.5.1.1. Advice on Partitions

Optimal partition setup depends on the usage for the Linux system in question. The following tips may help you decide how to allocate your disk space.

- If you expect that you or other users will store data on the system, create a separate partition for the `/home` directory within a volume group. With a separate `/home` partition, you may upgrade or reinstall Red Hat Enterprise Linux without erasing user data files.
- Consider encrypting any partitions that might contain sensitive data. Encryption prevents unauthorized people from accessing the data on the partitions, even if they have access to the physical storage device. In most cases, you should at least encrypt the `/home` partition.
- Each kernel installed on your system requires approximately 10 MB on the `/boot` partition. Unless you plan to install a great many kernels, the default partition size of 250 MB for `/boot` should suffice.



Important — Supported file systems

The **GRUB** bootloader in Red Hat Enterprise Linux 6 supports only the ext2, ext3, and ext4 (recommended) file systems. You cannot use any other file system for `/boot`, such as Btrfs, XFS, or VFAT.

- The `/var` directory holds content for a number of applications, including the **Apache** web server. It also is used to store downloaded update packages on a temporary basis. Ensure that the partition

containing the `/var` directory has enough space to download pending updates and hold your other content.



Warning

The **PackageKit** update software downloads updated packages to `/var/cache/yum/` by default. If you partition the system manually, and create a separate `/var/` partition, be sure to create the partition large enough (3.0 GB or more) to download package updates.

- The `/usr` directory holds the majority of software content on a Red Hat Enterprise Linux system. For an installation of the default set of software, allocate at least 4 GB of space. If you are a software developer or plan to use your Red Hat Enterprise Linux system to learn software development skills, you may want to at least double this allocation.



Do not place `/usr` on a separate partition

If `/usr` is on a separate partition from `/`, the boot process becomes much more complex, and in some situations (like installations on iSCSI drives), might not work at all.

- Consider leaving a portion of the space in an LVM volume group unallocated. This unallocated space gives you flexibility if your space requirements change but you do not wish to remove data from other partitions to reallocate storage.
- If you separate subdirectories into partitions, you can retain content in those subdirectories if you decide to install a new version of Red Hat Enterprise Linux over your current system. For instance, if you intend to run a **MySQL** database in `/var/lib/mysql`, make a separate partition for that directory in case you need to reinstall later.

The following table is a possible partition setup for a system with a single, new 80 GB hard disk and 1 GB of RAM. Note that approximately 10 GB of the volume group is unallocated to allow for future growth.



Example Usage

This setup is not optimal for all use cases.

Example 9.1. Example partition setup

Table 9.4. Example partition setup

| Partition | Size and type |
|---------------------|--|
| <code>/boot</code> | 250 MB ext3 partition |
| <code>swap</code> | 2 GB swap |
| LVM physical volume | Remaining space, as one LVM volume group |

The physical volume is assigned to the default volume group and divided into the following logical volumes:

Table 9.5. Example partition setup: LVM physical volume

| Partition | Size and type |
|-----------|---------------|
| / | 13 GB ext4 |
| /var | 4 GB ext4 |
| /home | 50 GB ext4 |

9.15. Write changes to disk

The installer prompts you to confirm the partitioning options that you selected. Click **Write changes to disk** to allow the installer to partition your hard drive and install Red Hat Enterprise Linux.

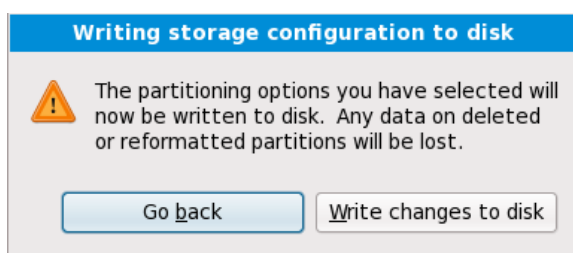


Figure 9.37. Writing storage configuration to disk

If you are certain that you want to proceed, click **Write changes to disk**.

Last chance to cancel safely

Up to this point in the installation process, the installer has made no lasting changes to your computer. When you click **Write changes to disk**, the installer will allocate space on your hard drive and start to transfer Red Hat Enterprise Linux into this space. Depending on the partitioning option that you chose, this process might include erasing data that already exists on your computer.

To revise any of the choices that you made up to this point, click **Go back**. To cancel installation completely, switch off your computer. To switch off most computers at this stage, press the power button and hold it down for a few seconds.

After you click **Write changes to disk**, allow the installation process to complete. If the process is interrupted (for example, by you switching off or resetting the computer, or by a power outage) you will probably not be able to use your computer until you restart and complete the Red Hat Enterprise Linux installation process, or install a different operating system.

9.16. x86, AMD64, and Intel 64 Boot Loader Configuration

To boot the system without boot media, you usually need to install a boot loader. A boot loader is the first software program that runs when a computer starts. It is responsible for loading and transferring control to the operating system kernel software. The kernel, in turn, initializes the rest of the operating system.

Installing in text mode

If you install Red Hat Enterprise Linux in text mode, the installer configures the bootloader automatically and you cannot customize bootloader settings during the installation process.

GRUB (GRand Unified Bootloader), which is installed by default, is a very powerful boot loader. GRUB can load a variety of free operating systems, as well as proprietary operating systems with chain-loading (the mechanism for loading unsupported operating systems, such as Windows, by loading another boot loader). Note that the version of GRUB in Red Hat Enterprise Linux 6 is an old and stable version now known as "GRUB Legacy" since upstream development moved to GRUB 2.³ Red Hat remains committed to maintaining the version of GRUB that we ship with Red Hat Enterprise Linux 6, just as we do with all packages that we ship.



The GRUB boot menu

The GRUB menu defaults to being hidden, except on dual-boot systems. To show the GRUB menu during system boot, press and hold the **Shift** key before the kernel is loaded. (Any other key works as well but the **Shift** key is the safest to use.)

Install boot loader on /dev/sda.

Use a boot loader password

Boot loader operating system list

| Default | Label | Device |
|----------------------------------|----------------------------|-----------|
| <input checked="" type="radio"/> | Red Hat Enterprise Linux 6 | /dev/sda2 |

Figure 9.38. Boot Loader Configuration

If there are no other operating systems on your computer, or you are completely removing any other operating systems the installation program will install **GRUB** as your boot loader without any intervention. In that case you may continue on to [Section 9.17, "Package Group Selection"](#).

You may have a boot loader installed on your system already. An operating system may install its own preferred boot loader, or you may have installed a third-party boot loader. If your boot loader does not recognize Linux partitions, you may not be able to boot Red Hat Enterprise Linux. Use **GRUB** as your boot loader to boot Linux and most other operating systems. Follow the directions in this chapter to install **GRUB**.

³ <http://www.gnu.org/software/grub/grub-legacy.en.html>



Installing GRUB

If you install GRUB, it may overwrite your existing boot loader.

By default, the installation program installs GRUB in the master boot record or MBR, of the device for the root file system. To decline installation of a new boot loader, unselect **Install boot loader on /dev/sda**.



Warning

If you choose not to install GRUB for any reason, you will not be able to boot the system directly, and you must use another boot method (such as a commercial boot loader application). Use this option only if you are sure you have another way of booting the system!

If you have other operating systems already installed, Red Hat Enterprise Linux attempts to automatically detect and configure **GRUB** to boot them. You may manually configure any additional operating systems if **GRUB** does not detect them.

To add, remove, or change the detected operating system settings, use the options provided.

Add

Select **Add** to include an additional operating system in GRUB.

Select the disk partition which contains the bootable operating system from the drop-down list and give the entry a label. **GRUB** displays this label in its boot menu.

Edit

To change an entry in the GRUB boot menu, select the entry and then select **Edit**.

Delete

To remove an entry from the GRUB boot menu, select the entry and then select **Delete**.

Select **Default** beside the preferred boot partition to choose your default bootable OS. You cannot move forward in the installation unless you choose a default boot image.



Note

The **Label** column lists what you must enter at the boot prompt, in non-graphical boot loaders, in order to boot the desired operating system.

Once you have loaded the GRUB boot screen, use the arrow keys to choose a boot label or type **e** for edit. You are presented with a list of items in the configuration file for the boot label you have selected.

Boot loader passwords provide a security mechanism in an environment where physical access to your server is available.

If you are installing a boot loader, you should create a password to protect your system. Without a boot loader password, users with access to your system can pass options to the kernel which can compromise your system security. With a boot loader password in place, the password must first be

entered before selecting any non-standard boot options. However, it is still possible for someone with physical access to the machine to boot from a diskette, CD-ROM, DVD, or USB media if the BIOS supports it. Security plans which include boot loader passwords should also address alternate boot methods.



GRUB Passwords Not Required

You may not require a **GRUB** password if your system only has trusted operators, or is physically secured with controlled console access. However, if an untrusted person can get physical access to your computer's keyboard and monitor, that person can reboot the system and access **GRUB**. A password is helpful in this case.

If you choose to use a boot loader password to enhance your system security, be sure to select the checkbox labeled **Use a boot loader password**.

Once selected, enter a password and confirm it.

GRUB stores the password in encrypted form, so it *cannot* be read or recovered. If you forget the boot password, boot the system normally and then change the password entry in the `/boot/grub/grub.conf` file. If you cannot boot, you may be able to use the "rescue" mode on the first Red Hat Enterprise Linux installation disc to reset the GRUB password.

If you do need to change the **GRUB** password, use the `grub-md5-crypt` utility. For information on using this utility, use the command `man grub-md5-crypt` in a terminal window to read the manual pages.



GRUB recognizes only the QWERTY keyboard layout

When selecting a GRUB password, be aware that GRUB recognizes only the QWERTY keyboard layout, regardless of the keyboard actually attached to the system. If you use a keyboard with a significantly different layout, it might be more effective to memorize a pattern of keystrokes rather than the word that the pattern produces.

To configure more advanced boot loader options, such as changing the drive order or passing options to the kernel, be sure **Configure advanced boot loader options** is selected before clicking **Next**.

9.16.1. Advanced Boot Loader Configuration

Now that you have chosen which boot loader to install, you can also determine where you want the boot loader to be installed. You may install the boot loader in one of two places:

- The master boot record (MBR) — This is the recommended place to install a boot loader, unless the MBR already starts another operating system loader, such as System Commander. The MBR is a special area on your hard drive that is automatically loaded by your computer's BIOS, and is the earliest point at which the boot loader can take control of the boot process. If you install it in the MBR, when your machine boots, GRUB presents a boot prompt. You can then boot Red Hat Enterprise Linux or any other operating system that you have configured the boot loader to boot.
- The first sector of your boot partition — This is recommended if you are already using another boot loader on your system. In this case, your other boot loader takes control first. You can then configure that boot loader to start GRUB, which then boots Red Hat Enterprise Linux.



GRUB as a Secondary Boot Loader

If you install GRUB as a secondary boot loader, you must reconfigure your primary boot loader whenever you install and boot from a new kernel. The kernel of an operating system such as Microsoft Windows does not boot in the same fashion. Most users therefore use GRUB as the primary boot loader on dual-boot systems.

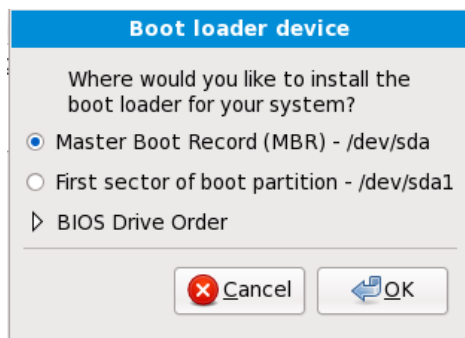


Figure 9.39. Boot Loader Installation



Note

If you have a RAID card, be aware that some BIOSes do not support booting from the RAID card. In cases such as these, the boot loader *should not* be installed on the MBR of the RAID array. Rather, the boot loader should be installed on the MBR of the same drive as the `/boot/` partition was created.

If your system only uses Red Hat Enterprise Linux, you should choose the MBR.

Click the **Change Drive Order** button if you would like to rearrange the drive order or if your BIOS does not return the correct drive order. Changing the drive order may be useful if you have multiple SCSI adapters, or both SCSI and IDE adapters, and you want to boot from the SCSI device.



Note

While partitioning your hard drive, keep in mind that the BIOS in some older systems cannot access more than the first 1024 cylinders on a hard drive. If this is the case, leave enough room for the `/boot` Linux partition on the first 1024 cylinders of your hard drive to boot Linux. The other Linux partitions can be after cylinder 1024.

In **parted**, 1024 cylinders equals 528MB. For more information, refer to:

<http://www.pcguides.com/ref/hdd/bios/sizeMB504-c.html>

9.16.2. Rescue Mode

Rescue mode provides the ability to boot a small Red Hat Enterprise Linux environment entirely from boot media or some other boot method instead of the system's hard drive. 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. If you need to use rescue mode, try the following method:

- Boot an x86, AMD64, or Intel 64 system from any installation medium, such as CD, DVD, USB, or PXE, and type **linux rescue** at the installation boot prompt. Refer to [Chapter 36, Basic System Recovery](#) for a more complete description of rescue mode.

For additional information, refer to the *Red Hat Enterprise Linux Deployment Guide*.

9.16.3. Alternative Boot Loaders

GRUB is the default bootloader for Red Hat Enterprise Linux, but is not the only choice. A variety of open-source and proprietary alternatives to **GRUB** are available to load Red Hat Enterprise Linux, including **LILO**, **SYSLINUX**, and **Acronis Disk Director Suite**.



Important

Red Hat does not support third-party boot loaders.

9.17. Package Group Selection

Now that you have made most of the choices for your installation, you are ready to confirm the default package selection or customize packages for your system.

The **Package Installation Defaults** screen appears and details the default package set for your Red Hat Enterprise Linux installation. This screen varies depending on the version of Red Hat Enterprise Linux you are installing.



Installing in text mode

If you install Red Hat Enterprise Linux in text mode, you cannot make package selections. The installer 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. To change the package selection, complete the installation, then use the **Add/Remove Software** application to make desired changes.

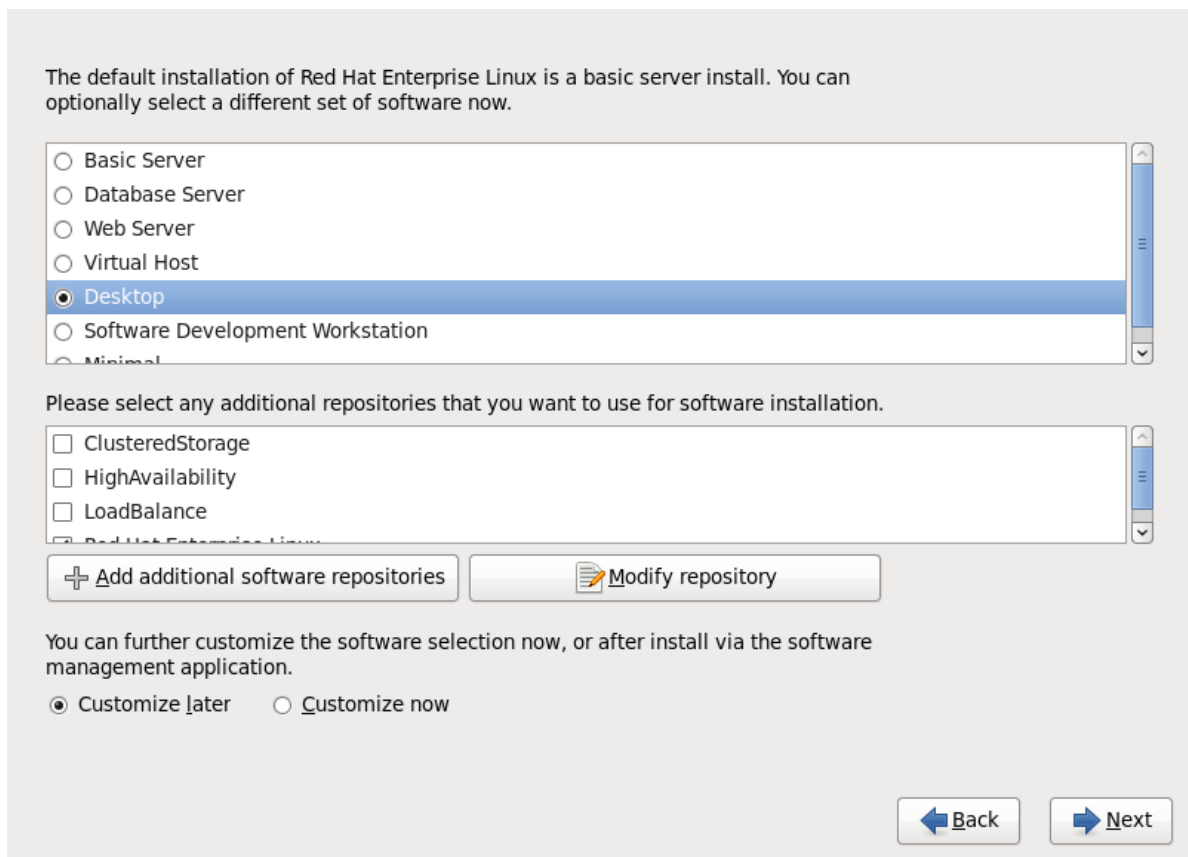


Figure 9.40. Package Group Selection

By default, the Red Hat Enterprise Linux installation process loads a selection of software that is suitable for a system deployed as a basic server. Note that this installation does not include a graphical environment. To include a selection of software suitable for other roles, click the radio button that corresponds to one of the following options:

Basic Server

This option provides a basic installation of Red Hat Enterprise Linux for use on a server.

Database Server

This option provides the **MySQL** and **PostgreSQL** databases.

Web server

This option provides the **Apache** web server.

Desktop

This option provides the **OpenOffice.org** productivity suite, graphical tools such as the **GIMP**, and multimedia applications.

Software Development Workstation

This option provides the necessary tools to compile software on your Red Hat Enterprise Linux system.

Minimal

This option provides only the packages essential to run Red Hat Enterprise Linux. A minimal installation provides the basis for a single-purpose server or desktop appliance and maximizes performance and security on such an installation.

If you choose to accept the current package list, skip ahead to [Section 9.18, “Installing Packages”](#).

To select a component, click on the checkbox beside it (refer to [Figure 9.40, “Package Group Selection”](#)).

To customize your package set further, select the **Customize now** option on the screen. Clicking **Next** takes you to the **Package Group Selection** screen.

9.17.1. Installing from Additional Repositories

You can define additional *repositories* to increase the software available to your system during installation. A repository is a network location that stores software packages along with *metadata* that describes them. Many of the software packages used in Red Hat Enterprise Linux require other software to be installed. The installer uses the metadata to ensure that these requirements are met for every piece of software you select for installation.

The basic options are:

- The **ClusteredStorage** repository includes packages for storage clustering using the Red Hat *global file system* (GFS).
- The **HighAvailability** repository includes packages for high-availability clustering (also known as *failover clustering*) using the Red Hat High-availability Service Management component.
- The **LoadBalance** repository includes packages for load-balancing clustering using *Linux Virtual Server* (LVS).
- The **Red Hat Enterprise Linux 6** repository is automatically selected for you. It contains the complete collection of software that was released as Red Hat Enterprise Linux 6, with the various pieces of software in their versions that were current at the time of release.

For more information about clustering with Red Hat Enterprise Linux 6, refer to the *Red Hat Enterprise Linux 6 Cluster Suite Overview*, available from <https://access.redhat.com/knowledge/docs/manuals/>.

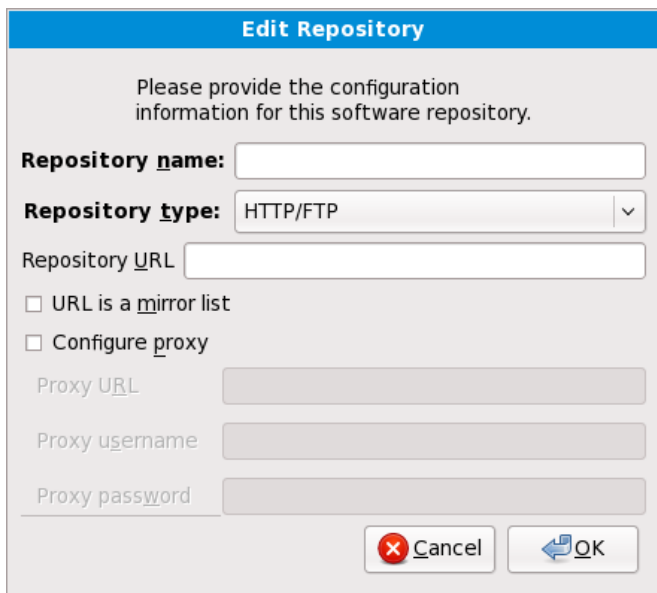


Figure 9.41. Adding a software repository

To include software from extra *repositories*, select **Add additional software repositories** and provide the location of the repository.

To edit an existing software repository location, select the repository in the list and then select **Modify repository**.



Network Access Required

If you change the repository information during a non-network installation, such as from a Red Hat Enterprise Linux DVD, the installer prompts you for network configuration information.

If you select **Add additional software repositories**, the **Edit repository** dialog appears. Provide a **Repository name** and the **Repository URL** for its location.

Once you have located a mirror, to determine the URL to use, find the directory on the mirror that *contains* a directory named **repodata**.

Once you provide information for an additional repository, the installer reads the package metadata over the network. Software that is specially marked is then included in the package group selection system.



Backtracking Removes Repository Metadata

If you choose **Back** from the package selection screen, any extra repository data you may have entered is lost. This allows you to effectively cancel extra repositories. Currently there is no way to cancel only a single repository once entered.

9.17.2. Customizing the Software Selection



Additional Language Support

Your Red Hat Enterprise Linux system automatically supports the language that you selected at the start of the installation process. To include support for additional languages, select the package group for those languages from the **Languages** category.

Select **Customize now** to specify the software packages for your final system in more detail. This option causes the installation process to display an additional customization screen when you select **Next**.

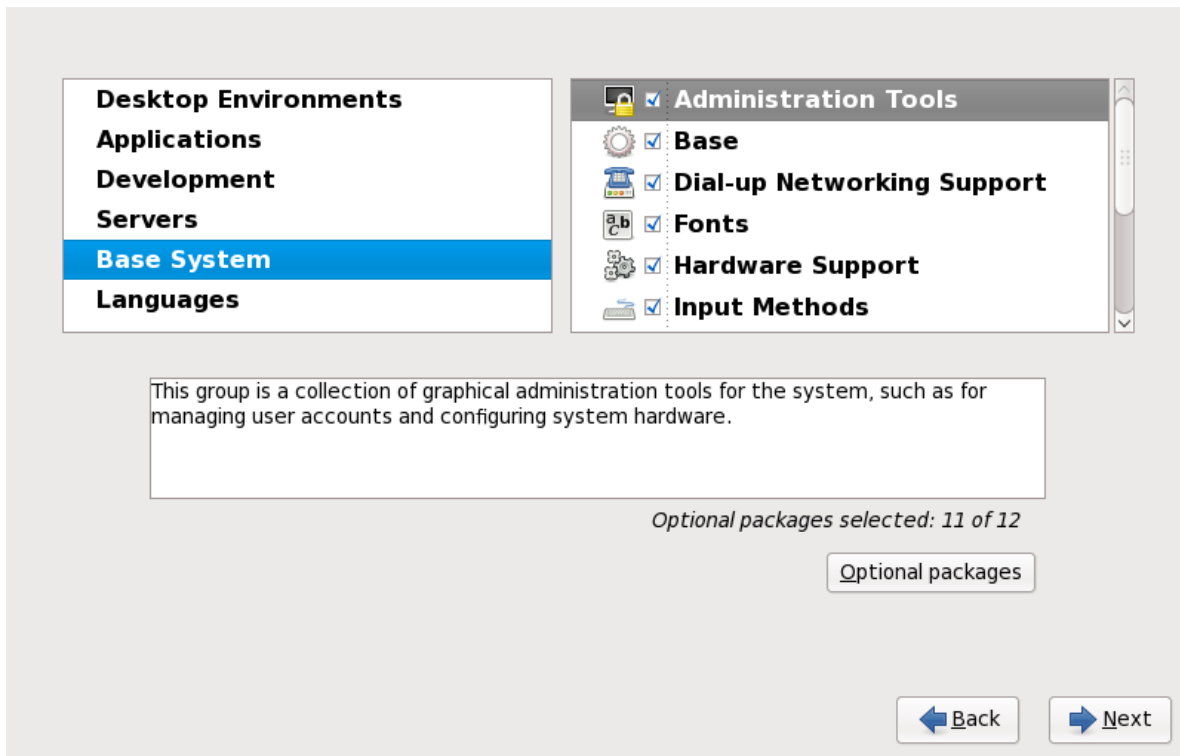


Figure 9.42. Package Group Details

Red Hat Enterprise Linux divides the included software into *package groups*. For ease of use, the package selection screen displays these groups as categories.

You can select package groups, which group components together according to function (for example, **X Window System** and **Editors**), individual packages, or a combination of the two.

To view the package groups for a category, select the category from the list on the left. The list on the right displays the package groups for the currently selected category.

To specify a package group for installation, select the check box next to the group. The box at the bottom of the screen displays the details of the package group that is currently highlighted. *None* of the packages from a group will be installed unless the check box for that group is selected.

If you select a package group, Red Hat Enterprise Linux automatically installs the base and mandatory packages for that group. To change which optional packages within a selected group will be installed, select the **Optional Packages** button under the description of the group. Then use the check box next to an individual package name to change its selection.

In the package selection list on the right, you can use the context menu as a shortcut to select or de-select base and mandatory packages or all optional packages.

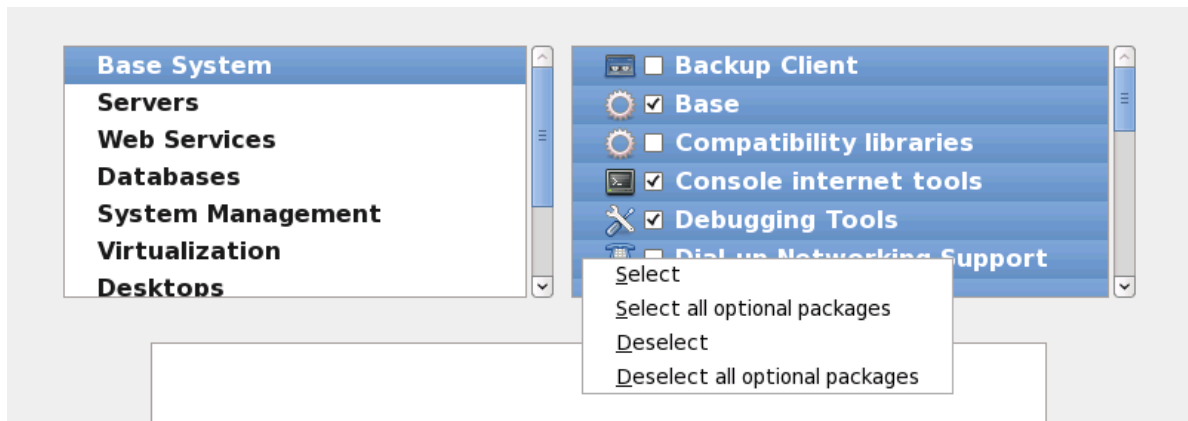


Figure 9.43. Package Selection List Context Menu

After you choose the desired packages, select **Next** to proceed. The installer checks your selection, and automatically adds any extra packages required to use the software you selected. When you have finished selecting packages, click **Close** to save your optional package selections and return to the main package selection screen.

The packages that you select are not permanent. After you boot your system, use the **Add/Remove Software** tool to either install new software or remove installed packages. To run this tool, from the main menu, select **System** → **Administration** → **Add/Remove Software**. The Red Hat Enterprise Linux software management system downloads the latest packages from network servers, rather than using those on the installation discs.

9.17.2.1. Core Network Services

All Red Hat Enterprise Linux installations include the following network services:

- centralized logging through syslog
- email through SMTP (Simple Mail Transfer Protocol)
- network file sharing through NFS (Network File System)
- remote access through SSH (Secure SHell)
- resource advertising through mDNS (multicast DNS)

The default installation also provides:

- network file transfer through HTTP (HyperText Transfer Protocol)
- printing through CUPS (Common UNIX Printing System)
- remote desktop access through VNC (Virtual Network Computing)

Some automated processes on your Red Hat Enterprise Linux system use the email service to send reports and messages to the system administrator. By default, the email, logging, and printing services do not accept connections from other systems. Red Hat Enterprise Linux installs the NFS sharing, HTTP, and VNC components without enabling those services.

You may configure your Red Hat Enterprise Linux system after installation to offer email, file sharing, logging, printing and remote desktop access services. The SSH service is enabled by default. You may use NFS to access files on other systems without enabling the NFS sharing service.

9.18. Installing Packages

At this point there is nothing left for you to do until all the packages have been installed. How quickly this happens depends on the number of packages you have selected and your computer's speed.

Depending on the available resources, you might see the following progress bar while the installer resolves dependencies of the packages you selected for installation:

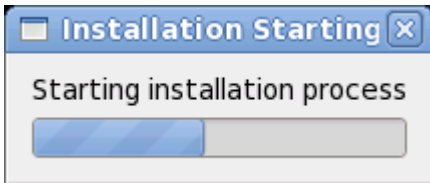


Figure 9.44. Starting installation

Red Hat Enterprise Linux reports the installation progress on the screen as it writes the selected packages to your system.

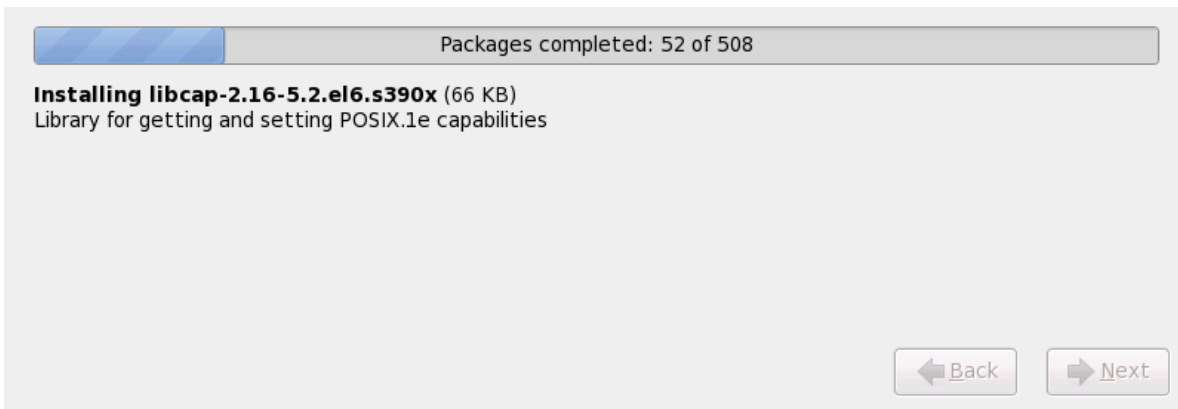


Figure 9.45. Packages completed

For your reference, a complete log of your installation can be found in `/root/install.log` once you reboot your system.

After installation completes, select **Reboot** to restart your computer. Red Hat Enterprise Linux ejects any loaded discs before the computer reboots.

9.19. Installation Complete

Congratulations! Your Red Hat Enterprise Linux installation is now complete!

The installation program prompts you to prepare your system for reboot. Remember to remove any installation media if it is not ejected automatically upon reboot.

After your computer's normal power-up sequence has completed, Red Hat Enterprise Linux loads and starts. By default, the start process is hidden behind a graphical screen that displays a progress bar. Eventually, a `login:` prompt or a GUI login screen (if you installed the X Window System and chose to start X automatically) appears.

The first time you start your Red Hat Enterprise Linux system in run level 5 (the graphical run level), the **FirstBoot** tool appears, which guides you through the Red Hat Enterprise Linux configuration. Using this tool, you can set your system time and date, install software, register your machine with Red Hat Network, and more. **FirstBoot** lets you configure your environment at the beginning, so that you can get started using your Red Hat Enterprise Linux system quickly.

Troubleshooting Installation on an Intel or AMD System

This section discusses some common installation problems and their solutions.

For debugging purposes, **anaconda** logs installation actions into files in the `/tmp` directory. These files include:

/tmp/anaconda.log

general **anaconda** messages

/tmp/program.log

all external programs run by **anaconda**

/tmp/storage.log

extensive storage module information

/tmp/yum.log

yum package installation messages

/tmp/syslog

hardware-related system messages

If the installation fails, the messages from these files are consolidated into `/tmp/anacdump.txt`.

All of the files above reside in the installer's ramdisk and are thus volatile. To make a permanent copy, copy those files to another system on the network using **scp** on the installation image (not the other way round).

10.1. You are unable to boot Red Hat Enterprise Linux

10.1.1. Are You Unable to Boot With Your RAID Card?

If you have performed an installation and cannot boot your system properly, you may need to reinstall and create your partitions differently.

Some BIOSes do not support booting from RAID cards. At the end of an installation, a text-based screen showing the boot loader prompt (for example, GRUB:) and a flashing cursor may be all that appears. If this is the case, you must repartition your system.

Whether you choose automatic or manual partitioning, you must install your `/boot` partition outside of the RAID array, such as on a separate hard drive. An internal hard drive is necessary to use for partition creation with problematic RAID cards.

You must also install your preferred boot loader (GRUB or LILO) on the MBR of a drive that is outside of the RAID array. This should be the same drive that hosts the `/boot/` partition.

Once these changes have been made, you should be able to finish your installation and boot the system properly.

10.1.2. Is Your System Displaying Signal 11 Errors?

A signal 11 error, commonly known as a *segmentation fault*, means that the program accessed a memory location that was not assigned to it. A signal 11 error may be due to a bug in one of the software programs that is installed, or faulty hardware.

If you receive a fatal signal 11 error during your installation, it is probably due to a hardware error in memory on your system's bus. Like other operating systems, Red Hat Enterprise Linux places its own demands on your system's hardware. Some of this hardware may not be able to meet those demands, even if they work properly under another OS.

Ensure that you have the latest installation updates and images. Review the online errata to see if newer versions are available. If the latest images still fail, it may be due to a problem with your hardware. Commonly, these errors are in your memory or CPU-cache. A possible solution for this error is turning off the CPU-cache in the BIOS, if your system supports this. You could also try to swap your memory around in the motherboard slots to check if the problem is either slot or memory related.

Another option is to perform a media check on your installation DVD. **Anaconda**, the installation program, has the ability to test the integrity of the installation media. It works with the DVD, hard drive ISO, and NFS ISO installation methods. Red Hat recommends that you test all installation media before starting the installation process, and before reporting any installation-related bugs (many of the bugs reported are actually due to improperly-burned DVDs). To use this test, type the following command at the boot : or yaboot : prompt:

```
linux mediacheck
```

For more information concerning signal 11 errors, refer to:

```
http://www.bitwizard.nl/sig11/
```

10.2. Trouble Beginning the Installation

10.2.1. Problems with Booting into the Graphical Installation

There are some video cards that have trouble booting into the graphical installation program. If the installation program does not run using its default settings, it tries to run in a lower resolution mode. If that still fails, the installation program attempts to run in text mode.

One possible solution is to use only a basic video driver during installation. You can do this either by selecting **Install system with basic video driver** on the boot menu, or using the **xdriver=vesa** boot option at the boot prompt. Alternatively, you can force the installer to use a specific screen resolution with the **resolution=** boot option. This option may be most helpful for laptop users. Another solution to try is the **driver=** option to specify the driver that should be loaded for your video card. If this works, you should report it as a bug, because the installer failed to detect your video card automatically. Refer to [Chapter 28, Boot Options](#) for more information on boot options.

**Note**

To disable frame buffer support and allow the installation program to run in text mode, try using the **nofb** boot option. This command may be necessary for accessibility with some screen reading hardware.

10.3. Trouble During the Installation

10.3.1. No devices found to install Red Hat Enterprise Linux Error Message

If you receive an error message stating **No devices found to install Red Hat Enterprise Linux**, there is probably a SCSI controller that is not being recognized by the installation program.

Check your hardware vendor's website to determine if a driver update is available that fixes your problem. For more general information on driver updates, refer to [Chapter 6, Updating drivers during installation on Intel and AMD systems](#).

You can also refer to the *Red Hat Hardware Compatibility List*, available online at:

<http://hardware.redhat.com/hcl/>

10.3.2. Saving traceback messages

If **anaconda** encounters an error during the graphical installation process, it presents you with a crash reporting dialog box:

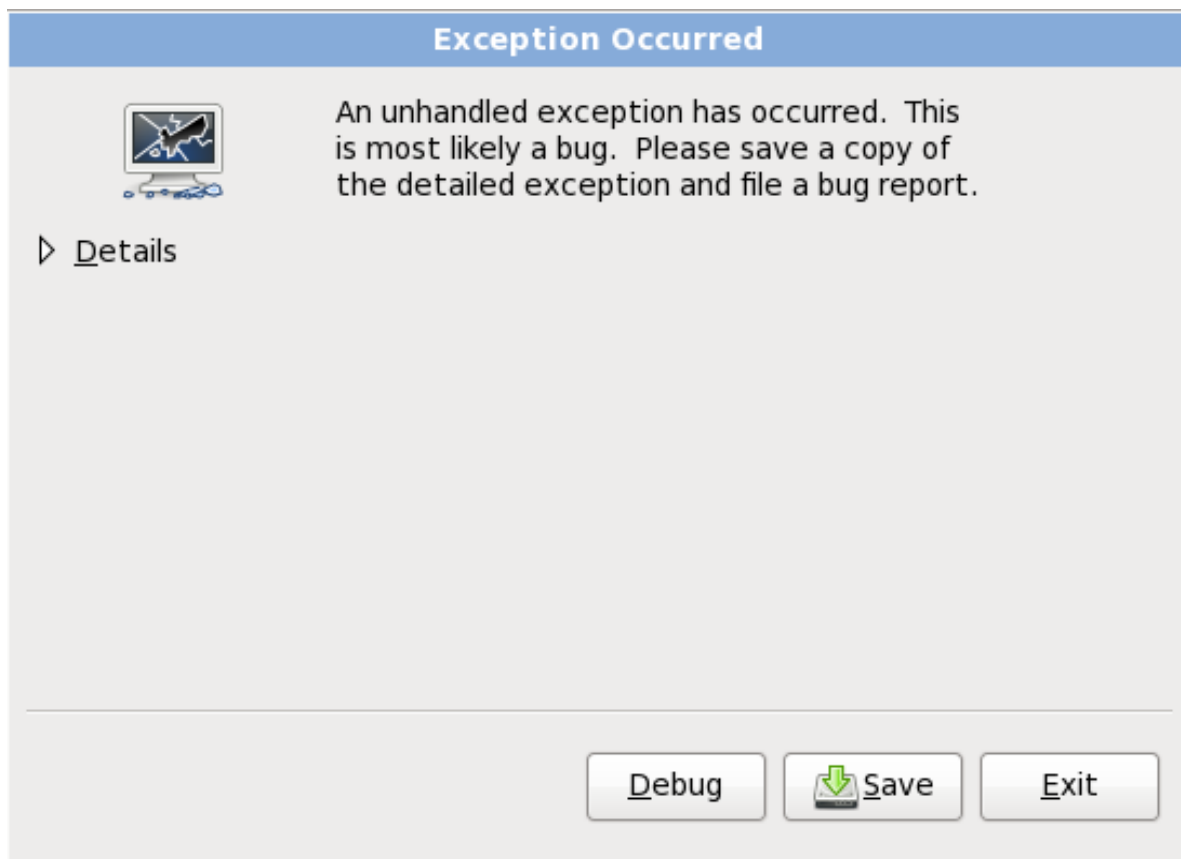


Figure 10.1. The Crash Reporting Dialog Box

Details

shows you the details of the error:

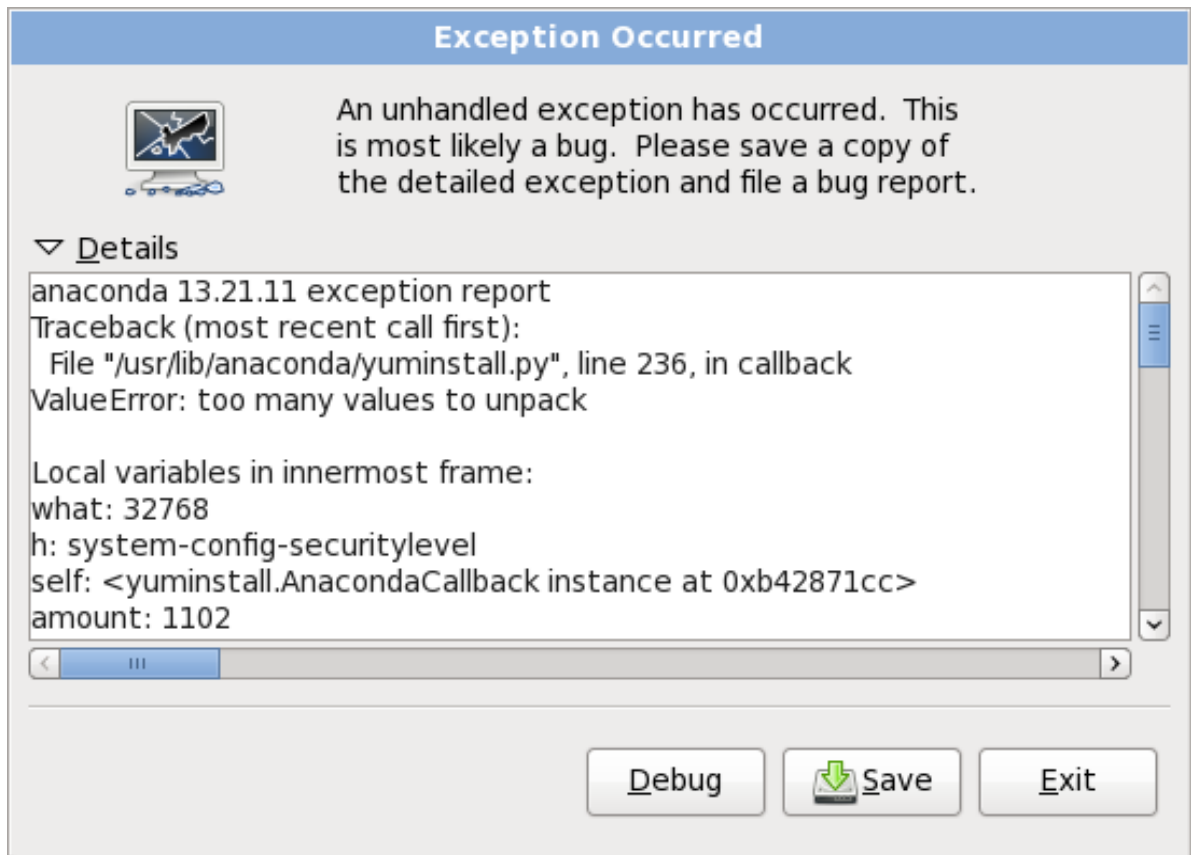


Figure 10.2. Details of the Crash

Save

saves details of the error locally or remotely:

Exit installer

exits the installation process.

If you select **Save** from the main dialog, you can choose from the following options:

Local disk

saves details of the error to the local hard drive, in a directory that you select with the file browser:

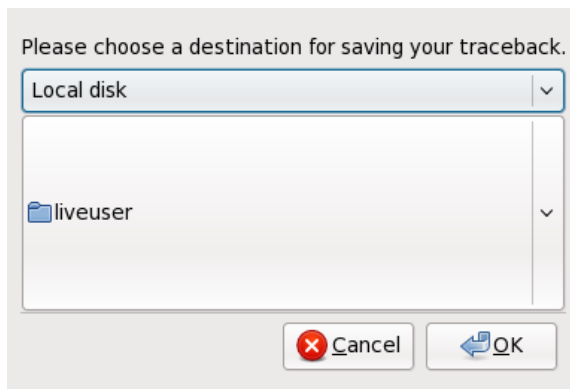


Figure 10.3. Save Crash Report to a Local disk

Bugzilla

submits details of the error to Red Hat's bug-tracking system, Bugzilla. You must supply an existing Bugzilla username and password, and a description of the bug.

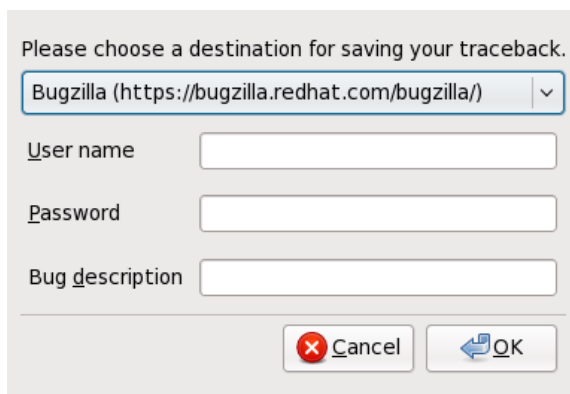


Figure 10.4. Save Crash Report to Bugzilla

Remote server

saves details of the error to a remote location using **SCP**. You must specify the username, password, host, and destination file.

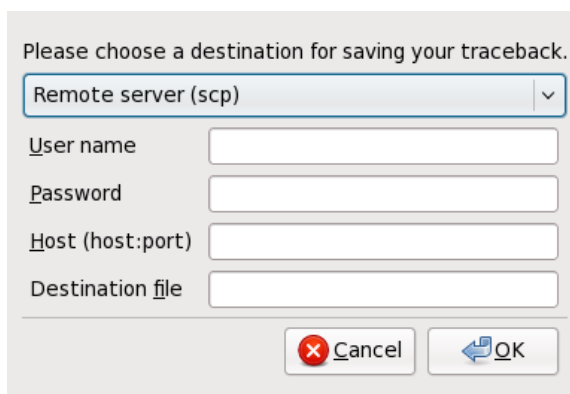


Figure 10.5. Save Crash Report to Remote Server

10.3.3. Trouble with Partition Tables

If you receive an error after the **Disk Partitioning Setup** ([Section 9.12, "Disk Partitioning Setup"](#)) phase of the installation saying something similar to

The partition table on device hda was unreadable. To create new partitions it must be initialized, causing the loss of ALL DATA on this drive.

you may not have a partition table on that drive or the partition table on the drive may not be recognizable by the partitioning software used in the installation program.

Users who have used programs such as **EZ-BIOS** have experienced similar problems, causing data to be lost (assuming the data was not backed up before the installation began) that could not be recovered.

No matter what type of installation you are performing, backups of the existing data on your systems should always be made.

10.3.4. Using Remaining Space

You have a **swap** and a **/** (root) partition created, and you have selected the root partition to use the remaining space, but it does not fill the hard drive.

If your hard drive is more than 1024 cylinders, you must create a **/boot** partition if you want the **/** (root) partition to use all of the remaining space on your hard drive.

10.3.5. Other Partitioning Problems

If you create partitions manually, but cannot move to the next screen, you probably have not created all the partitions necessary for installation to proceed.

You must have the following partitions as a bare minimum:

- A **/** (root) partition
- A **<swap>** partition of type swap



Note

When defining a partition's type as swap, do not assign it a mount point. **Anaconda** automatically assigns the mount point for you.

10.3.6. Are You Seeing Python Errors?

During some upgrades or installations of Red Hat Enterprise Linux, the installation program (also known as **anaconda**) may fail with a Python or traceback error. This error may occur after the selection of individual packages or while trying to save the upgrade log in the **/tmp/** directory. The error may look similar to:

```
Traceback (innermost last):
File "/var/tmp/anaconda-7.1//usr/lib/anaconda/iw/progress_gui.py", line 20, in run
rc = self.todo.doInstall ()
File "/var/tmp/anaconda-7.1//usr/lib/anaconda/todo.py", line 1468, in doInstall
self.fstab.savePartitions ()
File "fstab.py", line 221, in savePartitions
```

```
sys.exit(0)
SystemExit: 0
Local variables in innermost frame:
self: <fstab.GuiFstab instance at 8446fe0>
sys: <module 'sys' (built-in)>
ToDo object: (itodo ToDo p1 (dp2 S'method' p3 (iimage CdromInstallMethod
p4 (dp5 S'progressWindow' p6 <failed>
```

This error occurs in some systems where links to `/tmp/` are symbolic to other locations or have been changed since creation. These symbolic or changed links are invalid during the installation process, so the installation program cannot write information and fails.

If you experience such an error, first try to download any available updates for **anaconda**. Updates for **anaconda** and instructions for using them can be found at:

<http://fedoraproject.org/wiki/Anaconda/Updates>

You can also find and download errata for **anaconda** through your Red Hat Subscription. Log in to your account through the customer portal at <https://access.redhat.com/login>, click the **Errata** link at the top of the window, enter **anaconda** in the field marked **Filter by Synopsis**, and click **go**.

The **anaconda** website may also be a useful reference and can be found online at:

<http://fedoraproject.org/wiki/Anaconda>

You can also search for bug reports related to this problem. To search Red Hat's bug tracking system, go to:

<http://bugzilla.redhat.com/bugzilla/>

Finally, if you are still facing problems related to this error, register your product and contact our support team. To register your product, go to:

<http://www.redhat.com/apps/activate/>

10.4. Problems After Installation

10.4.1. Trouble With the Graphical GRUB Screen on an x86-based System?

If you are experiencing problems with GRUB, you may need to disable the graphical boot screen. To do this, become the root user and edit the `/boot/grub/grub.conf` file.

Within the `grub.conf` file, comment out the line which begins with `splashimage` by inserting the `#` character at the beginning of the line.

Press **Enter** to exit the editing mode.

Once the boot loader screen has returned, type **b** to boot the system.

Once you reboot, the `grub.conf` file is reread and any changes you have made take effect.

You may re-enable the graphical boot screen by uncommenting (or adding) the above line back into the **grub.conf** file.

10.4.2. Booting into a Graphical Environment

If you have installed the X Window System but are not seeing a graphical desktop environment once you log into your system, you can start the X Window System graphical interface using the command **startx**.

Once you enter this command and press **Enter**, the graphical desktop environment is displayed.

Note, however, that this is just a one-time fix and does not change the log in process for future log ins.

To set up your system so that you can log in at a graphical login screen, you must edit one file, **/etc/inittab**, by changing just one number in the runlevel section. When you are finished, reboot the computer. The next time you log in, you are presented with a graphical login prompt.

Open a shell prompt. If you are in your user account, become root by typing the **su** command.

Now, type **gedit /etc/inittab** to edit the file with **gedit**. The file **/etc/inittab** opens. Within the first screen, a section of the file which looks like the following appears:

```
# Default runlevel. The runlevels used are:
# 0 - halt (Do NOT set initdefault to this)
# 1 - Single user mode
# 2 - Multiuser, without NFS (The same as 3, if you do not have networking)
# 3 - Full multiuser mode
# 4 - unused
# 5 - X11
# 6 - reboot (Do NOT set initdefault to this)
# id:3:initdefault:
```

To change from a console to a graphical login, you should change the number in the line **id:3:initdefault:** from a **3** to a **5**.



Warning

Change *only* the number of the default runlevel from **3** to **5**.

Your changed line should look like the following:

```
id:5:initdefault:
```

When you are satisfied with your change, save and exit the file using the **Ctrl+Q** keys. A window appears and asks if you would like to save the changes. Click **Save**.

The next time you log in after rebooting your system, you are presented with a graphical login prompt.

10.4.3. Problems with the X Window System (GUI)

If you are having trouble getting X (the X Window System) to start, you may not have installed it during your installation.

If you want X, you can either install the packages from the Red Hat Enterprise Linux installation media or perform an upgrade.

If you elect to upgrade, select the X Window System packages, and choose GNOME, KDE, or both, during the upgrade package selection process.

Refer to [Section 35.3, “Switching to a Graphical Login”](#) for more detail on installing a desktop environment.

10.4.4. Problems with the X Server Crashing and Non-Root Users

If you are having trouble with the X server crashing when anyone logs in, you may have a full file system (or, a lack of available hard drive space).

To verify that this is the problem you are experiencing, run the following command:

```
df -h
```

The **df** command should help you diagnose which partition is full. For additional information about **df** and an explanation of the options available (such as the **-h** option used in this example), refer to the **df** man page by typing **man df** at a shell prompt.

A key indicator is 100% full or a percentage above 90% or 95% on a partition. The **/home/** and **/tmp/** partitions can sometimes fill up quickly with user files. You can make some room on that partition by removing old files. After you free up some disk space, try running X as the user that was unsuccessful before.

10.4.5. Problems When You Try to Log In

If you did not create a user account in the **firstboot** screens, switch to a console by pressing **Ctrl+Alt+F2**, log in as root and use the password you assigned to root.

If you cannot remember your root password, boot your system as **linux single**.

If you are using an x86-based system and GRUB is your installed boot loader, type **e** for edit when the GRUB boot screen has loaded. You are presented with a list of items in the configuration file for the boot label you have selected.

Choose the line that starts with **kernel** and type **e** to edit this boot entry.

At the end of the **kernel** line, add:

```
single
```

Press **Enter** to exit edit mode.

Once the boot loader screen has returned, type **b** to boot the system.

Once you have booted into single user mode and have access to the **#** prompt, you must type **passwd root**, which allows you to enter a new password for root. At this point you can type **shutdown -r now** to reboot the system with the new root password.

If you cannot remember your user account password, you must become root. To become root, type **su -** and enter your root password when prompted. Then, type **passwd <username>**. This allows you to enter a new password for the specified user account.

If the graphical login screen does not appear, check your hardware for compatibility issues. The *Hardware Compatibility List* can be found at:

<http://hardware.redhat.com/hcl/>

10.4.6. Is Your RAM Not Being Recognized?

Sometimes, the kernel does not recognize all of your memory (RAM). You can check this with the `cat /proc/meminfo` command.

Verify that the displayed quantity is the same as the known amount of RAM in your system. If they are not equal, add the following line to the `/boot/grub/grub.conf`:

```
mem=xxM
```

Replace `xx` with the amount of RAM you have in megabytes.

In `/boot/grub/grub.conf`, the above example would look similar to the following:

```
# NOTICE: You have a /boot partition. This means that
# all kernel paths are relative to /boot/
default=0
timeout=30
splashimage=(hd0,0)/grub/splash.xpm.gz
title Red Hat Enterprise Linux Client (2.6.27.19-170.2.35.el5.i686)
root (hd0,1)
kernel /vmlinuz-2.6.27.19-170.2.35.fc10.i686 ro root=UUID=04a07c13-e6bf-6d5a-
b207-002689545705 mem=1024M
initrd /initrd-2.6.27.19-170.2.35.fc10.i686.img
```

Once you reboot, the changes made to `grub.conf` are reflected on your system.

Once you have loaded the GRUB boot screen, type `e` for edit. You are presented with a list of items in the configuration file for the boot label you have selected.

Choose the line that starts with `kernel` and type `e` to edit this boot entry.

At the end of the `kernel` line, add

```
mem=xxM
```

where `xx` equals the amount of RAM in your system.

Press `Enter` to exit edit mode.

Once the boot loader screen has returned, type `b` to boot the system.

Remember to replace `xx` with the amount of RAM in your system. Press `Enter` to boot.

10.4.7. Your Printer Does Not Work

If you are not sure how to set up your printer or are having trouble getting it to work properly, try using the **Printer Configuration Tool**.

Type the `system-config-printer` command at a shell prompt to launch the **Printer Configuration Tool**. If you are not root, it prompts you for the root password to continue.

10.4.8. Apache-based httpd service/Sendmail Hangs During Startup

If you are having trouble with the Apache-based **httpd** service or Sendmail hanging at startup, make sure the following line is in the **/etc/hosts** file:

```
127.0.0.1 localhost.localdomain localhost
```

Part II. IBM POWER Architecture

- Installation and Booting

The *Red Hat Enterprise Linux Installation Guide* for IBM POWER systems discusses the installation of Red Hat Enterprise Linux and some basic post-installation troubleshooting. For advanced installation options, refer to [Part IV, “Advanced installation options”](#).



Important — only 64-bit POWER architecture is supported

Previous releases of Red Hat Enterprise Linux supported the 32-bit and 64-bit POWER architectures (**ppc** and **ppc64** respectively). Red Hat Enterprise Linux 6 supports only on the 64-bit POWER architecture (**ppc64**).

Planning for Installation on the POWER Architecture

11.1. Upgrade or Install?

For information to help you determine whether to perform an upgrade or an installation refer to [Chapter 37, Upgrading Your Current System](#).

11.2. Preparation for IBM eServer System p



Important — Check the real-base boot parameter

Ensure that the real-base boot parameter is set to **c00000**, otherwise you might see errors such as:

```
DEFAULT CATCH!, exception-handler=fff00300
```

The IBM eServer System p introduces many options for partitioning, virtual or native devices, and consoles. Both versions of the system use the same kernel and have many of the same options available, depending on the system configuration.

If you are using a non-partitioned system, you do not need any pre-installation setup. For systems using the HVSI serial console, hook up your console to the T2 serial port.

If using a partitioned system the steps to create the partition and start the installation are largely the same. You should create the partition at the HMC and assign some CPU and memory resources, as well as SCSI and Ethernet resources, which can be either virtual or native. The HMC create partition wizard steps you through the creation.

For more information on creating the partition, refer to IBM's Infocenter article on *Configuring Linux logical partitions* available online at: <http://publib.boulder.ibm.com/infocenter/eserver/v1r3s/index.jsp?topic=/iphbi/iphbikickoff.htm>

If you are using virtual SCSI resources, rather than native SCSI, you must configure a 'link' to the virtual SCSI serving partition, and then configure the virtual SCSI serving partition itself. You create a 'link' between the virtual SCSI client and server slots using the HMC. You can configure a virtual SCSI server on either AIX or i5/OS, depending on which model and options you have.

For more information on using virtual devices, including IBM Redbooks and other online resources see: <http://publib.boulder.ibm.com/infocenter/eserver/v1r3s/index.jsp?topic=/iphbi/iphbirelated.htm>

Once you have your system configured, you need to Activate from the HMC or power it on. Depending on what type of install you are doing, you may need to configure SMS to correctly boot the system into the installation program.

11.3. RAID and Other Disk Devices



Important — Systems with Intel BIOS RAID sets

Red Hat Enterprise Linux 6 uses **mdraid** instead of **dmraid** for installation onto Intel BIOS RAID sets. These sets are detected automatically, and devices with Intel ISW metadata are recognized as **mdraid** instead of **dmraid**. Note that the device node names of any such devices under **mdraid** are different from their device node names under **dmraid**. Therefore, special precautions are necessary when you migrate systems with Intel BIOS RAID sets.

Local modifications to `/etc/fstab`, `/etc/crypttab` or other configuration files which refer to devices by their device node names will not work in Red Hat Enterprise Linux 6. Before migrating these files, you must therefore edit them to replace device node paths with device UUIDs instead. You can find the UUIDs of devices with the **blkid** command.

11.3.1. Hardware RAID

RAID, or Redundant Array of Independent Disks, allows a group, or array, of drives to act as a single device. Configure any RAID functions provided by the mainboard of your computer, or attached controller cards, before you begin the installation process. Each active RAID array appears as one drive within Red Hat Enterprise Linux.

On systems with more than one hard drive you may configure Red Hat Enterprise Linux to operate several of the drives as a Linux RAID array without requiring any additional hardware.

11.3.2. Software RAID

You can use the Red Hat Enterprise Linux installation program to create Linux software RAID arrays, where RAID functions are controlled by the operating system rather than dedicated hardware. These functions are explained in detail in [Section 16.16, “Creating a Custom Layout or Modifying the Default Layout”](#).

11.3.3. FireWire and USB Disks

Some FireWire and USB hard disks may not be recognized by the Red Hat Enterprise Linux installation system. If configuration of these disks at installation time is not vital, disconnect them to avoid any confusion.



Post-installation Usage

You can connect and configure external FireWire and USB hard disks after installation. Most such devices are recognized by the kernel and available for use at that time.

11.4. Do You Have Enough Disk Space?

Nearly every modern-day operating system (OS) uses *disk partitions*, and Red Hat Enterprise Linux is no exception. When you install Red Hat Enterprise Linux, you may have to work with disk partitions. If you have not worked with disk partitions before (or need a quick review of the basic concepts), refer to [Appendix A, An Introduction to Disk Partitions](#) before proceeding.

The disk space used by Red Hat Enterprise Linux must be separate from the disk space used by other OSes you may have installed on your system.

Before you start the installation process, you must

- have enough *unpartitioned*¹ disk space for the installation of Red Hat Enterprise Linux, or
- have one or more partitions that may be deleted, thereby freeing up enough disk space to install Red Hat Enterprise Linux.

To gain a better sense of how much space you really need, refer to the recommended partitioning sizes discussed in [Section 16.16.5, “Recommended Partitioning Scheme”](#).

11.5. Choose a boot method

Installing from a DVD requires that you have purchased a Red Hat Enterprise Linux product, you have a Red Hat Enterprise Linux 6 DVD, and you have a DVD drive on a system that supports booting from it. Refer to [Chapter 2, Making Media](#) for instructions to make an installation DVD.

Other than booting from an installation DVD, you can also boot the Red Hat Enterprise Linux installation program from *minimal boot media* in the form of a bootable CD. After you boot the system with boot CD, you complete the installation from a different installation source, such as a local hard drive or a location on a network. Refer to [Section 2.3, “Making Minimal Boot Media”](#) for instructions on making boot CDs.

Preparing for Installation

12.1. Preparing for a Network Installation



Important — eHEA does not work with huge pages

The eHEA module fails to initialize if 16 GB *huge pages* are assigned to a system or partition and the kernel command line does not contain the huge page parameters. Therefore, when you perform a network installation through an IBM eHEA ethernet adapter, you cannot assign huge pages to the system or partition during the installation. Large pages should work.



Note

Make sure no installation DVD (or any other type of DVD or CD) is in your system's CD or DVD drive if you are performing a network-based installation. Having a DVD or CD in the drive might cause unexpected errors.

Ensure that you have boot media available on CD, DVD, or a USB storage device such as a flash drive.

The Red Hat Enterprise Linux installation medium must be available for either a network installation (via NFS, FTP, or HTTP) or installation via local storage. Use the following steps if you are performing an NFS, FTP, or HTTP installation.

The NFS, FTP, or HTTP server to be used for installation over the network must be a separate, network-accessible server. It must provide the complete contents of the installation DVD-ROM.



Note

The Red Hat Enterprise Linux installation program has the ability to test the integrity of the installation media. It works with the DVD, hard drive ISO, and NFS ISO installation methods. Red Hat recommends that you test all installation media before starting the installation process, and before reporting any installation-related bugs (many of the bugs reported are actually due to improperly-burned DVDs). To use this test, type the following command at the `yaboot :` prompt:

```
linux mediacheck
```



Note

The public directory used to access the installation files over FTP, NFS, or HTTP is mapped to local storage on the network server. For example, the local directory `/var/www/inst/rhel6` on the network server can be accessed as `http://network.server.com/inst/rhel6`.

In the following examples, the directory on the installation staging server that will contain the installation files will be specified as `/location/of/disk/space`. The directory that will be made publicly available via FTP, NFS, or HTTP will be specified as `/publicly/available/directory`. For example, `/location/of/disk/space` may be a directory you create called `/var/isos`. `/publicly/available/directory` might be `/var/www/html/rhel6`, for an HTTP install.

In the following, you will require an *ISO image*. An ISO image is a file containing an exact copy of the content of a DVD. To create an ISO image from a DVD use the following command:

```
dd if=/dev/dvd of=/location/of/disk/space/RHEL6.iso
```

where *dvd* refers to your DVD drive device.

To copy the files from the installation DVD to a Linux instance, which acts as an installation staging server, continue with either [Section 12.1.1, “Preparing for FTP and HTTP installation”](#) or [Section 12.1.2, “Preparing for an NFS installation”](#).

12.1.1. Preparing for FTP and HTTP installation

Extract the files from the ISO image of the installation DVD and place them in a directory that is shared over FTP or HTTP.

Next, make sure that the directory is shared via FTP or HTTP, and verify client access. Test to see whether the directory is accessible from the server itself, and then from another machine on the same subnet to which you will be installing.

12.1.2. Preparing for an NFS installation

For NFS installation it is not necessary to extract all the files from the ISO image. It is sufficient to make the ISO image itself, the `install.img` file, and optionally the `product.img` file available on the network server via NFS.

1. Transfer the ISO image to the NFS exported directory. On a Linux system, run:

```
mv /location/of/disk/space/RHEL6.iso /publicly/available/directory/
```

2. Use a SHA256 checksum program to verify that the ISO image that you copied is intact. Many SHA256 checksum programs are available for various operating systems. On a Linux system, run:

```
$ sha256sum name_of_image.iso
```

where *name_of_image* is the name of the ISO image file. The SHA256 checksum program displays a string of 64 characters called a *hash*. Compare this hash to the hash displayed for this

particular image on the **Download Software** page on the Red Hat Network (refer to [Chapter 1, Obtaining Red Hat Enterprise Linux](#)). The two hashes should be identical.

- Copy the **images/** directory within the ISO file to a directory named **images/**. Enter the following commands:

```
mount -t iso9660 /path/to/RHEL6.iso /mnt/point -o loop,ro
cp -pr /mnt/point/images /path/images/
umount /mnt/point
```

- Verify that the **images/** directory contains at least the **install.img** file, without which installation cannot proceed. Optionally, the **images/** directory should contain the **product.img** file, without which only the packages for a **Minimal** installation will be available during the package group selection stage (refer to [Section 16.18, "Package Group Selection"](#)).
- Ensure that the **/publicly/available/directory** directory is exported via NFS via an entry in **/etc/exports** on the network server.

To export a directory read-only to a specific system, use:

```
/publicly/available/directory client.ip.address (ro)
```

To export a directory read-only to all systems, use:

```
/publicly/available/directory * (ro)
```

- On the network server, start the NFS daemon (on a Red Hat Enterprise Linux system, use **/sbin/service nfs start**). If NFS is already running, reload the configuration file (on a Red Hat Enterprise Linux system use **/sbin/service nfs reload**).
- Be sure to test the NFS share following the directions in the *Red Hat Enterprise Linux Deployment Guide*. Refer to your NFS documentation for details on starting and stopping the NFS server.



Note

The Red Hat Enterprise Linux installation program has the ability to test the integrity of the installation media. It works with the DVD, hard drive ISO, and NFS ISO installation methods. We recommend that you test all installation media before starting the installation process, and before reporting any installation-related bugs (many of the bugs reported are actually due to improperly-burned DVDs). To use this test, type the following command at the boot : prompt:

```
linux mediacheck
```

12.2. Preparing for a Hard Drive Installation



Note — Not all file systems supported

Hard drive installations only work from ext2, ext3, ext4, or FAT file systems. You cannot use a hard drive formatted for any other file system as an installation source for Red Hat Enterprise Linux.

To check the file system of a hard drive partition on a Windows operating system, use the **Disk Management** tool. To check the file system of a hard drive partition on a Linux operating system, use the **fdisk** tool.



Cannot Install from LVM Partitions

You cannot use ISO files on partitions controlled by LVM (Logical Volume Management).

Use this option to install Red Hat Enterprise Linux on systems without a DVD drive or network connection.

Hard drive installations use the following files:

- an *ISO image* of the installation DVD. An ISO image is a file that contains an exact copy of the content of a DVD.
- an **install.img** file extracted from the ISO image.
- optionally, a **product.img** file extracted from the ISO image.

With these files present on a hard drive, you can choose **Hard drive** as the installation source when you boot the installation program (refer to [Section 15.3, “Installation Method”](#)).

Ensure that you have boot media available on CD, DVD, or a USB storage device such as a flash drive.

To prepare a hard drive as an installation source, follow these steps:

1. Obtain an ISO image of the Red Hat Enterprise Linux installation DVD (refer to [Chapter 1, Obtaining Red Hat Enterprise Linux](#)). Alternatively, if you have the DVD on physical media, you can create an image of it with the following command on a Linux system:

```
dd if=/dev/dvd of=/location/of/disk/space/RHEL6.iso
```

where *dvd* refers to your DVD drive device.

2. Transfer the ISO image to the hard drive.

The ISO image must be located on a hard drive that is either internal to the computer on which you will install Red Hat Enterprise Linux, or on a hard drive that is attached to that computer by USB.

3. Use a SHA256 checksum program to verify that the ISO image that you copied is intact. Many SHA256 checksum programs are available for various operating systems. On a Linux system, run:

```
$ sha256sum name_of_image.iso
```

where *name_of_image* is the name of the ISO image file. The SHA256 checksum program displays a string of 64 characters called a *hash*. Compare this hash to the hash displayed for this particular image on the **Download Software** page on the Red Hat Network (refer to [Chapter 1, Obtaining Red Hat Enterprise Linux](#)). The two hashes should be identical.

4. Copy the **images/** directory within the ISO file to a directory named **images/**. Enter the following commands:

```
mount -t iso9660 /path/to/RHEL6.iso /mnt/point -o loop,ro
cp -pr /mnt/point/images /path/images/
umount /mnt/point
```

5. Verify that the **images/** directory contains at least the **install.img** file, without which installation cannot proceed. Optionally, the **images/** directory should contain the **product.img** file, without which only the packages for a **Minimal** installation will be available during the package group selection stage (refer to [Section 9.17, "Package Group Selection"](#)).



Note

The Red Hat Enterprise Linux installation program has the ability to test the integrity of the installation media. It works with the DVD, hard drive ISO, and NFS ISO installation methods. We recommend that you test all installation media before starting the installation process, and before reporting any installation-related bugs (many of the bugs reported are actually due to improperly-burned DVDs). To use this test, type the following command at the boot : prompt:

```
linux mediacheck
```


Updating drivers during installation on IBM POWER systems

In most cases, Red Hat Enterprise Linux already includes drivers for the devices that make up your system. However, if your system contains hardware that has been released very recently, drivers for this hardware might not yet be included. Sometimes, a driver update that provides support for a new device might be available from Red Hat or your hardware vendor on a *driver disc* that contains *rpm packages*. Typically, the driver disc is available for download as an *ISO image file*.

Often, you do not need the new hardware during the installation process. For example, if you use a DVD to install to a local hard drive, the installation will succeed even if drivers for your network card are not available. In situations like this, complete the installation and add support for the piece of hardware afterward — refer to [Section 35.1.1, “Driver update rpm packages”](#) for details of adding this support.

In other situations, you might want to add drivers for a device during the installation process to support a particular configuration. For example, you might want to install drivers for a network device or a storage adapter card to give the installer access to the storage devices that your system uses. You can use a driver disc to add this support during installation in one of three ways:

1. place the ISO image file of the driver disc in a location accessible to the installer:
 - a. on a local hard drive
 - b. a USB flash drive
2. create a driver disc by extracting the image file onto:
 - a. a CD
 - b. a DVD

Refer to the instructions for making installation discs in [Section 2.1, “Making an installation DVD”](#) for more information on burning ISO image files to CD or DVD.

3. create an *initial ramdisk update* from the image file and store it on a PXE server. This is an advanced procedure that you should consider only if you cannot perform a driver update with any other method.

If Red Hat, your hardware vendor, or a trusted third party told you that you will require a driver update during the installation process, choose a method to supply the update from the methods described in this chapter and test it before beginning the installation. Conversely, do not perform a driver update during installation unless you are certain that your system requires it. Although installing an unnecessary driver update will not cause harm, the presence of a driver on a system for which it was not intended can complicate support.

13.1. Limitations of driver updates during installation

Unfortunately, some situations persist in which you cannot use a driver update to provide drivers during installation:

Devices already in use

You cannot use a driver update to replace drivers that the installation program has already loaded. Instead, you must complete the installation with the drivers that the installation program loaded and update to the new drivers after installation, or, if you need the new drivers for the installation process, consider performing an initial RAM disk driver update — refer to [Section 13.2.3, “Preparing an initial RAM disk update”](#).

Devices with an equivalent device available

Because all devices of the same type are initialized together, you cannot update drivers for a device if the installation program has loaded drivers for a similar device. For example, consider a system that has two different network adapters, one of which has a driver update available. The installation program will initialize both adapters at the same time, and therefore, you will not be able to use this driver update. Again, complete the installation with the drivers loaded by the installation program and update to the new drivers after installation, or use an initial RAM disk driver update.

13.2. Preparing for a driver update during installation

If a driver update is necessary and available for your hardware, Red Hat or a trusted third party such as the hardware vendor will typically provide it in the form of an image file in ISO format. Some methods of performing a driver update require you to make the image file available to the installation program, others require you to use the image file to make a driver update disk, and one requires you to prepare an initial RAM disk update:

Methods that use the image file itself

- local hard drive
- USB flash drive

Methods that use a driver update disk produced from an image file

- CD
- DVD

Methods that use an initial RAM disk update

- PXE

Choose a method to provide the driver update, and refer to [Section 13.2.1, “Preparing to use a driver update image file”](#), [Section 13.2.2, “Preparing a driver disc”](#) or [Section 13.2.3, “Preparing an initial RAM disk update”](#). Note that you can use a USB storage device either to provide an image file, or as a driver update disk.

13.2.1. Preparing to use a driver update image file

13.2.1.1. Preparing to use an image file on local storage

To make the ISO image file available on local storage, such as a hard drive or USB flash drive, simply copy the file onto the storage device. You can rename the file if you find it helpful to do so, but you must not change the filename extension, which must remain `.iso`. In the following example, the file is named `dd.iso`:

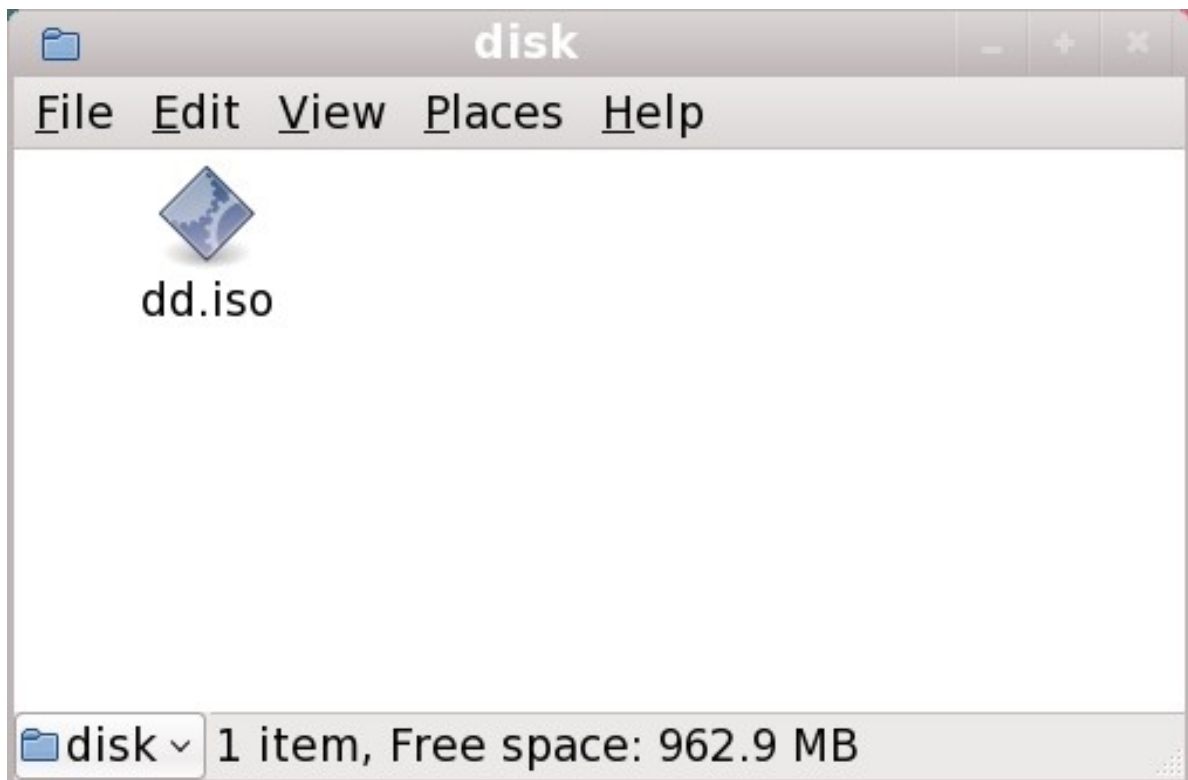


Figure 13.1. Content of a USB flash drive holding a driver update image file

Note that if you use this method, the storage device will contain only a single file. This differs from driver discs on formats such as CD and DVD, which contain many files. The ISO image file contains all of the files that would normally be on a driver disc.

Refer to [Section 13.3.2, “Let the installer prompt you for a driver update”](#) and [Section 13.3.3, “Use a boot option to specify a driver update disk”](#) to learn how to use the driver update disk during installation.

If you change the file system label of the device to **OEMDRV**, the installation program will automatically examine it for driver updates and load any that it detects. This behavior is controlled by the **dlabel=on** boot option, which is enabled by default. Refer to [Section 13.3.1, “Let the installer automatically find a driver update disk”](#).

13.2.2. Preparing a driver disc

You can create a driver update disc on CD or DVD.

13.2.2.1. Creating a driver update disk on CD or DVD



These instructions assume that you use the GNOME desktop

CD/DVD Creator is part of the GNOME desktop. If you use a different Linux desktop, or a different operating system altogether, you will need to use another piece of software to create the CD or DVD. The steps will be generally similar.

Make sure that the software that you choose can create CDs or DVDs from image files. While this is true of most CD and DVD burning software, exceptions exist. Look for a button or menu entry labeled **burn from image** or similar. If your software lacks this feature, or you do not select it, the resulting disk will hold only the image file itself, instead of the contents of the image file.

1. Use the desktop file manager to locate the ISO image file of the driver disc, supplied to you by Red Hat or your hardware vendor.

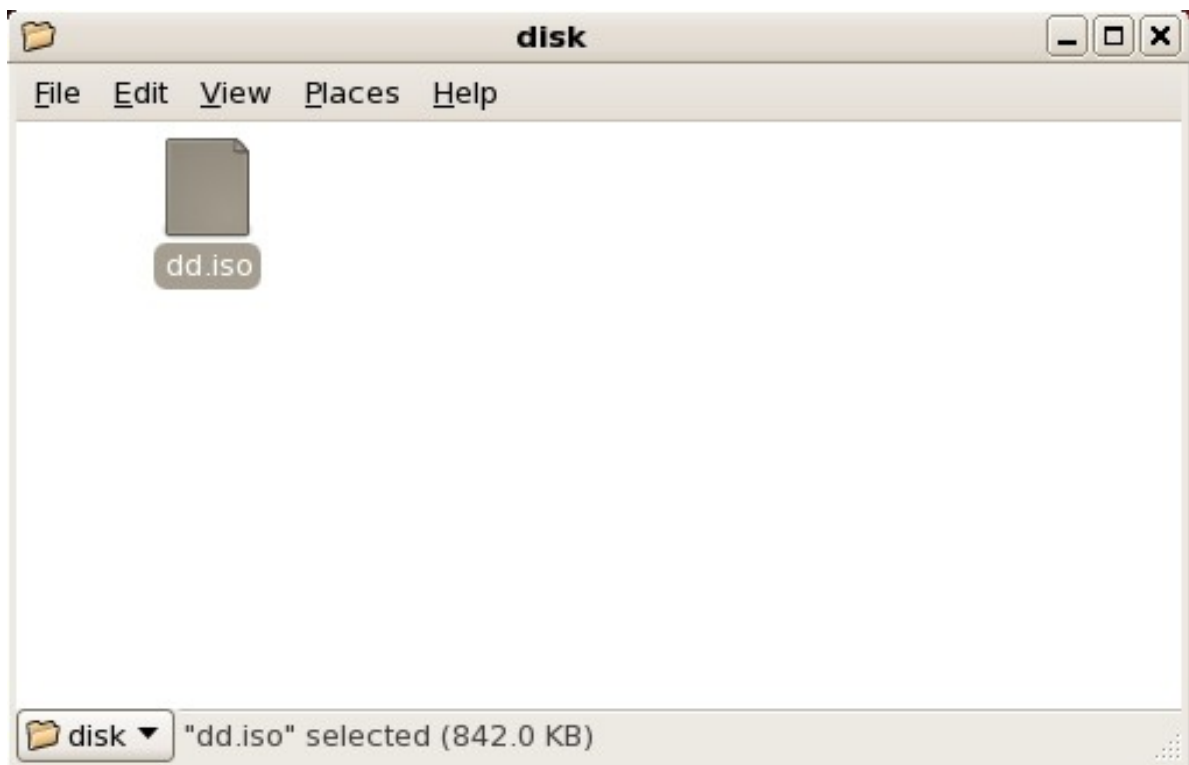


Figure 13.2. A typical .iso file displayed in a file manager window

2. Right-click on this file and choose **Write to disc**. You will see a window similar to the following:



Figure 13.3. CD/DVD Creator's Write to Disc dialog

3. Click the **Write** button. If a blank disc is not already in the drive, **CD/DVD Creator** will prompt you to insert one.

After you burn a driver update disk CD or DVD, verify that the disk was created successfully by inserting it into your system and browsing to it using the file manager. You should see a single file named **rhdd3** and a directory named **rpms**:

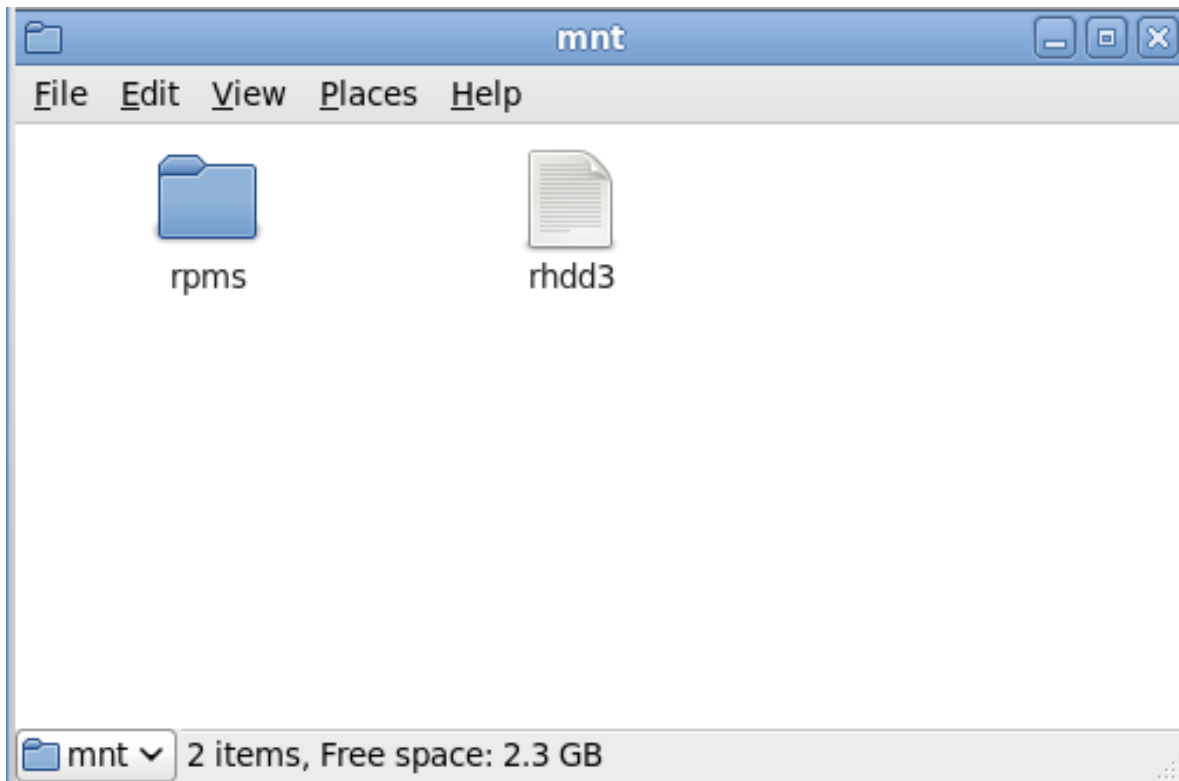


Figure 13.4. Contents of a typical driver update disc on CD or DVD

If you see only a single file ending in `.iso`, then you have not created the disk correctly and should try again. Ensure that you choose an option similar to **burn from image** if you use a Linux desktop other than GNOME or if you use a different operating system.

Refer to [Section 13.3.2, “Let the installer prompt you for a driver update”](#) and [Section 13.3.3, “Use a boot option to specify a driver update disk”](#) to learn how to use the driver update disk during installation.

13.2.3. Preparing an initial RAM disk update



Advanced procedure

This is an advanced procedure that you should consider only if you cannot perform a driver update with any other method.

The Red Hat Enterprise Linux installation program can load updates for itself early in the installation process from a *RAM disk* — an area of your computer's memory that temporarily behaves as if it were a disk. You can use this same capability to load driver updates. To perform a driver update during installation, your computer must be able to boot from a *preboot execution environment* (PXE) server, and you must have a PXE server available on your network. Refer to [Chapter 30, Setting Up an Installation Server](#) for instructions on using PXE during installation.

To make the driver update available on your PXE server:

1. Place the driver update image file on your PXE server. Usually, you would do this by downloading it to the PXE server from a location on the Internet specified by Red Hat or your hardware vendor. Names of driver update image files end in `.iso`.

2. Copy the driver update image file into the `/tmp/initrd_update` directory.
3. Rename the driver update image file to `dd.img`.
4. At the command line, change into the `/tmp/initrd_update` directory, type the following command, and press **Enter**:

```
find . | cpio --quiet -c -o | gzip -9 >/tmp/initrd_update.img
```

5. Copy the file `/tmp/initrd_update.img` into the directory that holds the target that you want to use for installation. This directory is placed under the `/tftpboot/pxelinux/` directory. For example, `/tftpboot/pxelinux/r6c/` might hold the PXE target for Red Hat Enterprise Linux 6 Client.
6. Edit the `/tftpboot/pxelinux/pxelinux.cfg/default` file to include an entry that includes the initial RAM disk update that you just created, in the following format:

```
label target-dd
kernel target/vmlinuz
append initrd=target/initrd.img,target/dd.img
```

Where *target* is the target that you want to use for installation.

Refer to [Section 13.3.4, “Select a PXE target that includes a driver update”](#) to learn how to use an initial RAM disk update during installation.

Example 13.1. Preparing an initial RAM disk update from a driver update image file

In this example, `driver_update.iso` is a driver update image file that you downloaded from the Internet to a directory on your PXE server. The target that you want to PXE boot from is located in `/tftpboot/pxelinux/r6c/`

At the command line, change to the directory that holds the file and enter the following commands:

```
$ cp driver_update.iso /tmp/initrd_update/dd.img
$ cd /tmp/initrd_update
$ find . | cpio --quiet -c -o | gzip -9 >/tmp/initrd_update.img
$ cp /tmp/initrd_update.img /tftpboot/pxelinux/r6c/dd.img
```

Edit the `/tftpboot/pxelinux/pxelinux.cfg/default` file and include the following entry:

```
label r6c-dd
kernel r6c/vmlinuz
append initrd=r6c/initrd.img,r6c/dd.img
```

13.3. Performing a driver update during installation

You can perform a driver update during installation in the following ways:

- let the installer automatically find a driver update disk.
- let the installer prompt you for a driver update.
- use a boot option to specify a driver update disk.
- select a PXE target that includes a driver update.

13.3.1. Let the installer automatically find a driver update disk

Attach a block device with the filesystem label **OEMDRV** before starting the installation process. The installer will automatically examine the device and load any driver updates that it detects and will not prompt you during the process. Refer to [Section 13.2.1.1, "Preparing to use an image file on local storage"](#) to prepare a storage device for the installer to find.

13.3.2. Let the installer prompt you for a driver update

1. Begin the installation normally for whatever method you have chosen. If the installer cannot load drivers for a piece of hardware that is essential for the installation process (for example, if it cannot detect any network or storage controllers), it prompts you to insert a driver update disk:

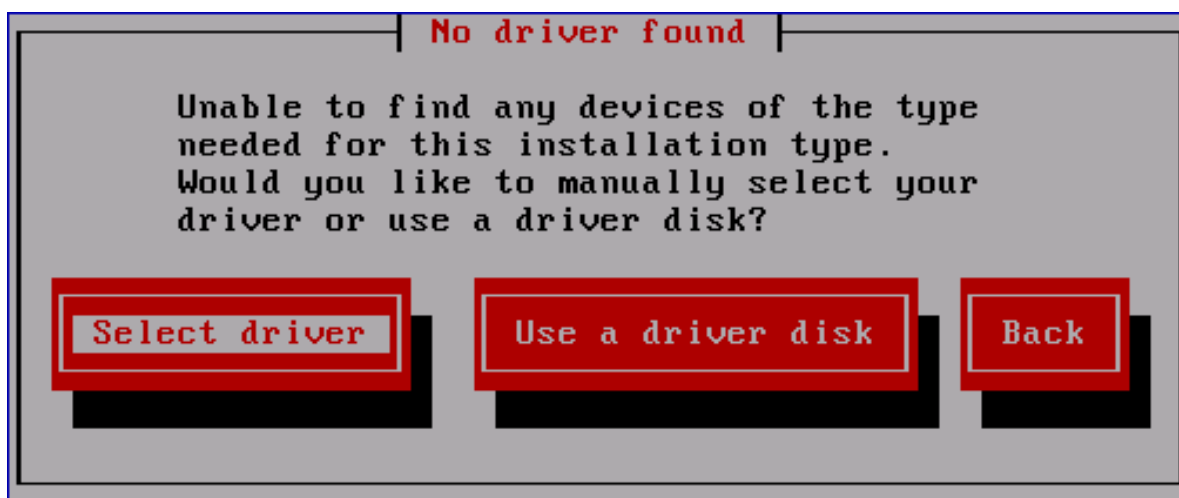


Figure 13.5. The no driver found dialog

2. Select **Use a driver disk** and refer to [Section 13.4, "Specifying the location of a driver update image file or driver update disk"](#).

13.3.3. Use a boot option to specify a driver update disk



Choose this method only for completely new drivers

This method only works to introduce completely new drivers, not to update existing drivers.

1. Type **linux dd** at the boot prompt at the start of the installation process and press **Enter**. The installer prompts you to confirm that you have a driver disk:



Figure 13.6. The driver disk prompt

2. Insert the driver update disk that you created on CD, DVD, or USB flash drive and select **Yes**. The installer examines the storage devices that it can detect. If there is only one possible location that could hold a driver disk (for example, the installer detects the presence of a DVD drive, but no other storage devices) it will automatically load any driver updates that it finds at this location.

If the installer finds more than one location that could hold a driver update, it prompts you to specify the location of the update. Refer to [Section 13.4, "Specifying the location of a driver update image file or driver update disk"](#).

13.3.4. Select a PXE target that includes a driver update

1. Select **network boot** in your computer's BIOS or boot menu. The procedure to specify this option varies widely among different computers. Consult your hardware documentation or the hardware vendor for specifics relevant to your computer.
2. In the preexecution boot environment (PXE), choose the boot target that you prepared on your PXE server. For example, if you labeled this environment **r6c-dd** in the `/tftpboot/pxelinux/pxelinux.cfg/default` file on your PXE server, type **r6c-dd** at the prompt and press **Enter**.

Refer to [Section 13.2.3, "Preparing an initial RAM disk update"](#) and [Chapter 30, Setting Up an Installation Server](#) for instructions on using PXE to perform an update during installation. Note that this is an advanced procedure — do not attempt it unless other methods of performing a driver update fail.

13.4. Specifying the location of a driver update image file or driver update disk

If the installer detects more than one possible device that could hold a driver update, it prompts you to select the correct device. If you are not sure which option represents the device on which the driver update is stored, try the various options in order until you find the correct one.

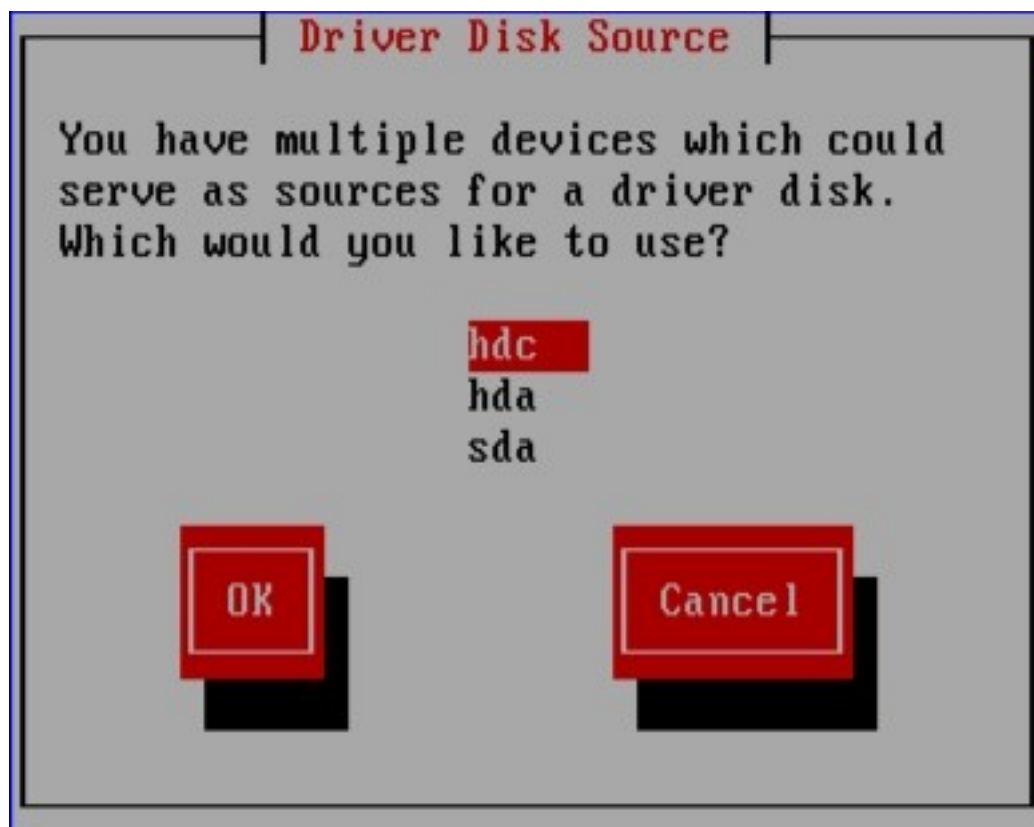


Figure 13.7. Selecting a driver disk source

If the device that you choose contains no suitable update media, the installer will prompt you to make another choice.

If you made a driver update disk on CD, DVD, or USB flash drive, the installer now loads the driver update. However, if the device that you selected is a type of device that could contain more than one partition (whether the device currently has more than one partition or not), the installer might prompt you to select the partition that holds the driver update.



Figure 13.8. Selecting a driver disk partition

The installer prompts you to specify which file contains the driver update:

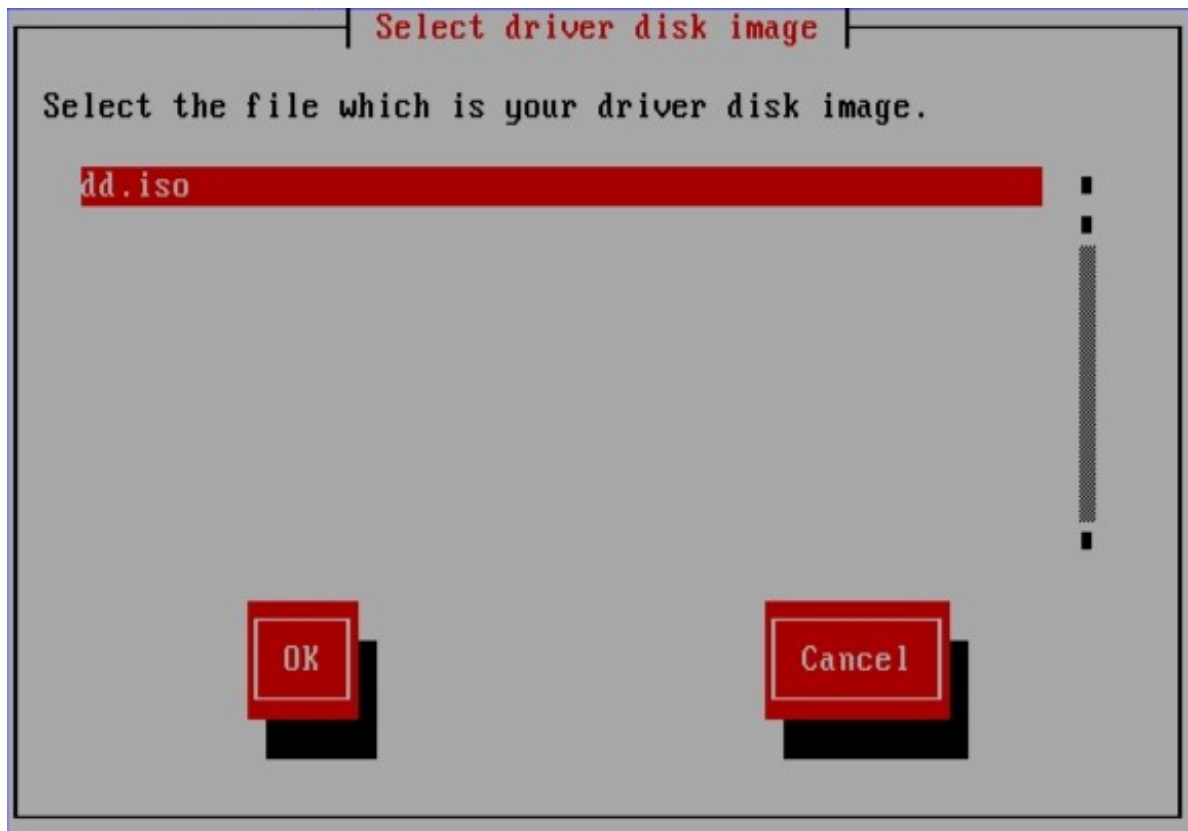


Figure 13.9. Selecting an ISO image

Expect to see these screens if you stored the driver update on an internal hard drive or on a USB storage device. You should not see them if the driver update is on a CD or DVD.

Regardless of whether you are providing a driver update in the form of an image file or with a driver update disk, the installer now copies the appropriate update files into a temporary storage area (located in system RAM and not on disk). The installer might ask whether you would like to use additional driver updates. If you select **Yes**, you can load additional updates in turn. When you have no further driver updates to load, select **No**. If you stored the driver update on removeable media, you can now safely eject or disconnect the disk or device. The installer no longer requires the driver update, and you can re-use the media for other purposes.

Booting the Installer



Important — ramdisk.image.gz sometimes fails to load

On some machines yaboot may not boot, returning the error message:

```
Cannot load ramdisk.image.gz: Claim failed for initrd memory at 02000000 rc=ffffffff
```

To work around this issue, change `real-base` to `c00000`. You can obtain the value of `real-base` from the OpenFirmware prompt with the `printenv` command and set the value with the `setenv` command.

To boot an IBM System p system from a DVD, you must specify the install boot device in the **System Management Services (SMS)** menu.

To enter the **System Management Services** GUI, press the **1** key during the boot process when you hear the chime sound. This brings up a graphical interface similar to the one described in this section.

On a text console, press **1** when the self test is displaying the banner along with the tested components:

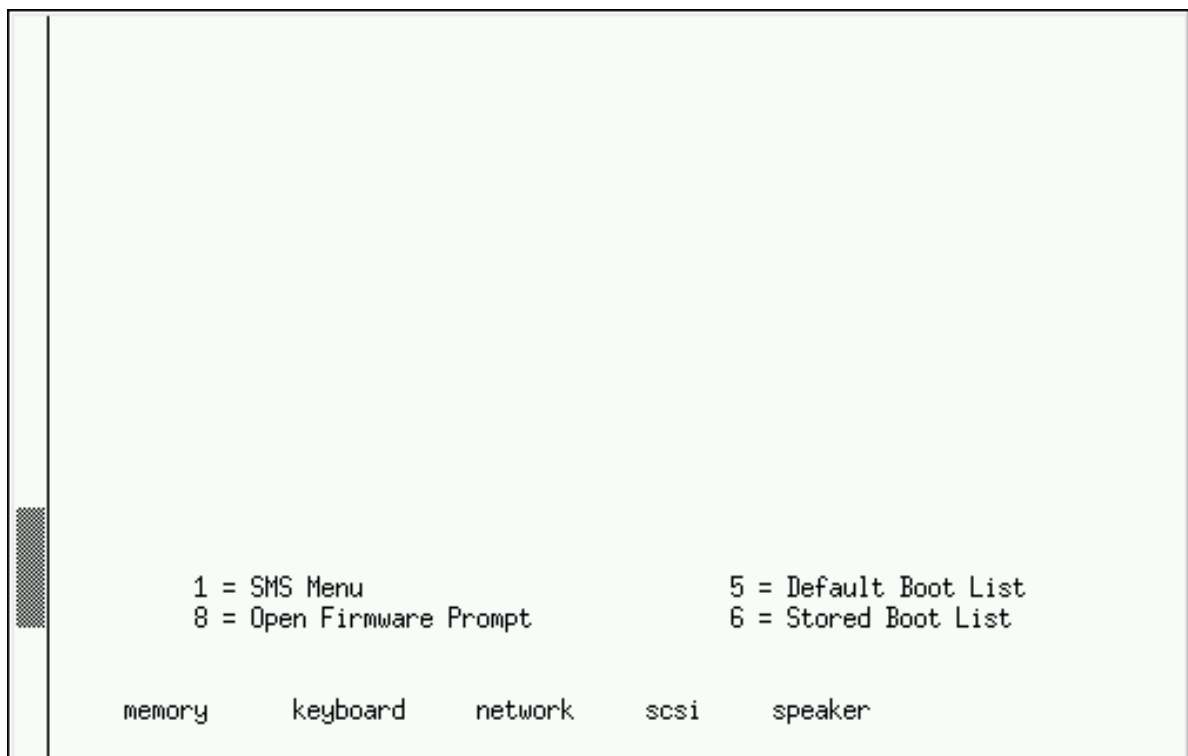


Figure 14.1. SMS console

Once in the SMS menu, select the option for **Select Boot Options**. In that menu, specify **Select Install or Boot a Device**. There, select **CD/DVD**, and then the bus type (in most cases SCSI). If you are uncertain, you can select to view all devices. This scans all available buses for boot devices, including network adapters and hard drives.

Finally, select the device containing the installation DVD. YABOOT is loaded from this device and you are presented with a `boot :` prompt. Press **Enter** or wait for the timeout to expire for the installation to begin.

If you are booting via the network, use the `images/netboot/ppc64.img` file on the DVD.

14.1. The Boot Menu

The boot media displays a graphical boot menu with several options. If no key is hit within 60 seconds, the default boot option runs. To choose the default, either wait for the timer to run out or hit **Enter** on the keyboard. To select a different option than the default, use the arrow keys on your keyboard, and hit **Enter** when the correct option is highlighted. If you want to customize the boot options for a particular option, press the **Tab** key.



Figure 14.2. The boot screen

For a listing and explanation of common boot options, refer to [Chapter 28, Boot Options](#).

The boot menu options are:

Install or upgrade an existing system

This option is the default. Choose this option to install Red Hat Enterprise Linux onto your computer system using the graphical installation program.

Install system with basic video driver

This option allows you to install Red Hat Enterprise Linux in graphical mode even if the installation program is unable to load the correct driver for your video card. If your screen appears distorted or goes blank when using the the **Install or upgrade an existing system** option, restart your computer and try this option instead.

Rescue installed system

Choose this option to repair a problem with your installed Red Hat Enterprise Linux system that prevents you from booting normally. Although Red Hat Enterprise Linux is an exceptionally stable

computing platform, it is still possible for occasional problems to occur that prevent booting. The rescue environment contains utility programs that allow you fix a wide variety of these problems.

Boot from local drive

This option boots the system from the first installed disk. If you booted this disc accidentally, use this option to boot from the hard disk immediately without starting the installer.

14.2. Installing from a Different Source

You can install Red Hat Enterprise Linux from the ISO images stored on hard disk, or from a network using NFS, FTP, or HTTP methods. Experienced users frequently use one of these methods because it is often faster to read data from a hard disk or network server than from a DVD.

The following table summarizes the different boot methods and recommended installation methods to use with each:

Table 14.1. Boot methods and installation sources

| Boot method | Installation source |
|-----------------------------------|--|
| Installation DVD | DVD, network, or hard disk |
| Installation USB flash drive | USB flash drive, installation DVD, network, or hard disk |
| Minimal boot CD or USB, rescue CD | Network or hard disk |

Refer to [Section 3.5, “Selecting an Installation Method”](#) for information about installing from locations other than the media with which you booted the system.

14.3. Booting from the Network using PXE

To boot with

PXE, you need a properly configured server, and a network interface in your computer that supports PXE. For information on how to configure a PXE server, refer to [Chapter 30, Setting Up an Installation Server](#).

Configure the computer to boot from the network interface. This option is in the BIOS, and may be labeled **Network Boot** or **Boot Services**. Once you properly configure PXE booting, the computer can boot the Red Hat Enterprise Linux installation system without any other media.

To boot a computer from a PXE server:

1. Ensure that the network cable is attached. The link indicator light on the network socket should be lit, even if the computer is not switched on.
2. Switch on the computer.
3. A menu screen appears. Press the number key that corresponds to the desired option.

If your PC does not boot from the netboot server, ensure that the BIOS is configured to boot first from the correct network interface. Some BIOS systems specify the network interface as a possible boot device, but do not support the PXE standard. Refer to your hardware documentation for more information.



Note — Multiple NICs and PXE installation

Some servers with multiple network interfaces might not assign eth0 to the first network interface as the firmware interface knows it, which can cause the installer to try to use a different network interface from the one that was used by PXE. To change this behavior, use the following in **pxelinux.cfg/*** config files:

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

These configuration options above cause the installer to use the same network interface the firmware interface and PXE use. You can also use the following option:

```
ksdevice=link
```

This option causes the installer to use the first network device it finds that is linked to a network switch.

Configuring Language and Installation Source

Before the graphical installation program starts, you need to configure the language and installation source.

15.1. The Text Mode Installation Program User Interface



Important — Graphical installation recommended

We recommend that you install Red Hat Enterprise Linux using the graphical interface. If you are installing Red Hat Enterprise Linux on a system that lacks a graphical display, consider performing the installation over a VNC connection – see [Chapter 31, Installing Through VNC](#). If **anaconda** detects that you are installing in text mode on a system where installation over a VNC connection might be possible, **anaconda** asks you to verify your decision to install in text mode even though your options during installation are limited.

If your system has a graphical display, but graphical installation fails, try booting with the **xdriver=vesa** option – refer to [Chapter 28, Boot Options](#)

Both the loader and later **anaconda** use a screen-based interface that includes most of the on-screen *widgets* commonly found on graphical user interfaces. [Figure 15.1, “Installation Program Widgets as seen in URL Setup”](#), and [Figure 15.2, “Installation Program Widgets as seen in Choose a Language”](#), illustrate widgets that appear on screens during the installation process.

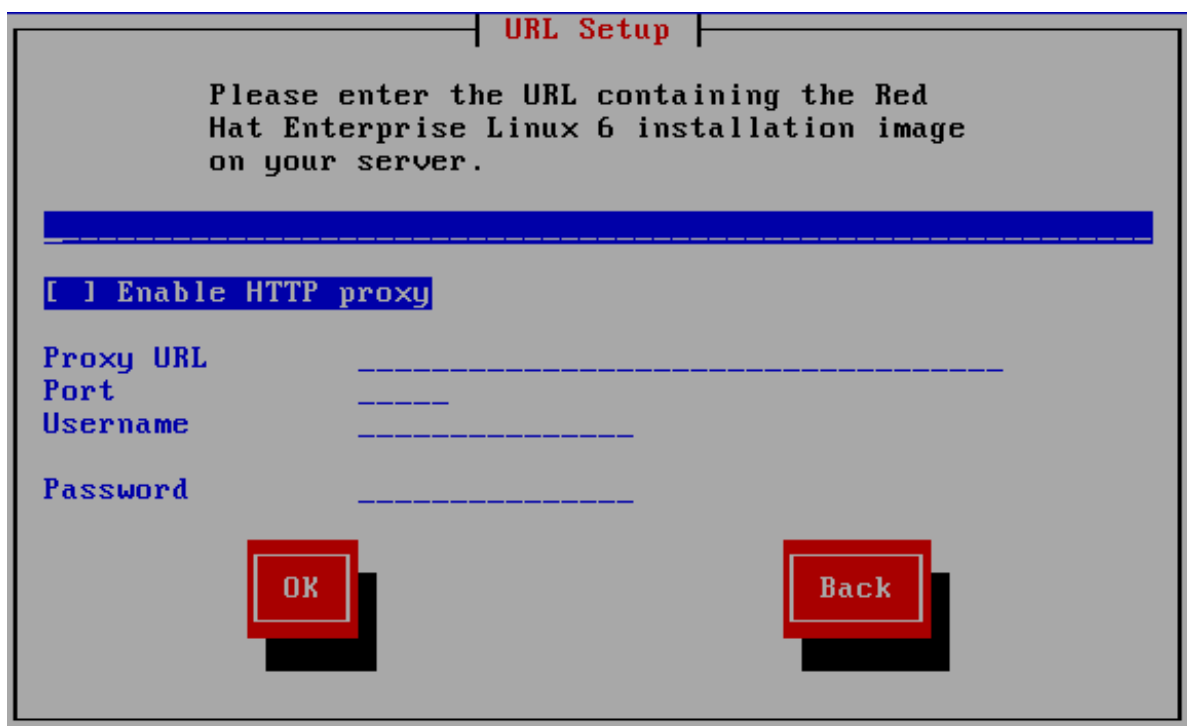


Figure 15.1. Installation Program Widgets as seen in **URL Setup**

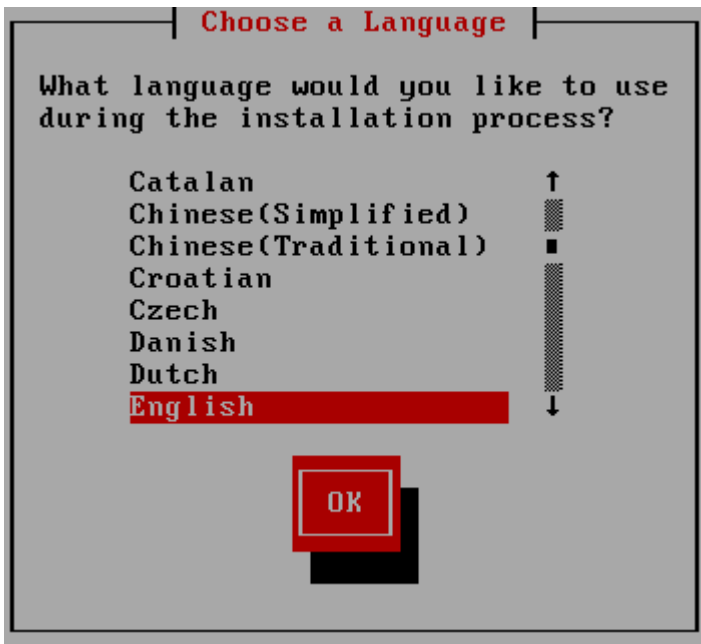


Figure 15.2. Installation Program Widgets as seen in **Choose a Language**

The widgets include:

- **Window** — Windows (usually referred to as *dialogs* in this manual) appear on your screen throughout the installation process. At times, one window may overlay another; in these cases, you can only interact with the window on top. When you are finished in that window, it disappears, allowing you to continue working in the window underneath.
- **Checkbox** — Checkboxes allow you to select or deselect a feature. The box displays either an asterisk (selected) or a space (unselected). When the cursor is within a checkbox, press **Space** to select or deselect a feature.
- **Text Input** — Text input lines are regions where you can enter information required by the installation program. When the cursor rests on a text input line, you may enter and/or edit information on that line.
- **Text Widget** — Text widgets are regions of the screen for the display of text. At times, text widgets may also contain other widgets, such as checkboxes. If a text widget contains more information than can be displayed in the space reserved for it, a scroll bar appears; if you position the cursor within the text widget, you can then use the **Up** and **Down** arrow keys to scroll through all the information available. Your current position is shown on the scroll bar by a # character, which moves up and down the scroll bar as you scroll.
- **Scroll Bar** — Scroll bars appear on the side or bottom of a window to control which part of a list or document is currently in the window's frame. The scroll bar makes it easy to move to any part of a file.
- **Button Widget** — Button widgets are the primary method of interacting with the installation program. You progress through the windows of the installation program by navigating these buttons, using the **Tab** and **Enter** keys. Buttons can be selected when they are highlighted.
- **Cursor** — Although not a widget, the cursor is used to select (and interact with) a particular widget. As the cursor is moved from widget to widget, it may cause the widget to change color, or the cursor itself may only appear positioned in or next to the widget. In [Figure 15.1, "Installation Program Widgets as seen in URL Setup"](#), the cursor is positioned on the **OK** button. [Figure 15.2, "Installation Program Widgets as seen in Choose a Language"](#), shows the cursor on the **Edit** button.

15.1.1. Using the Keyboard to Navigate

Navigation through the installation dialogs is performed through a simple set of keystrokes. To move the cursor, use the **Left**, **Right**, **Up**, and **Down** arrow keys. Use **Tab**, and **Shift-Tab** to cycle forward or backward through each widget on the screen. Along the bottom, most screens display a summary of available cursor positioning keys.

To "press" a button, position the cursor over the button (using **Tab**, for example) and press **Space** or **Enter**. To select an item from a list of items, move the cursor to the item you wish to select and press **Enter**. To select an item with a checkbox, move the cursor to the checkbox and press **Space** to select an item. To deselect, press **Space** a second time.

Pressing **F12** accepts the current values and proceeds to the next dialog; it is equivalent to pressing the **OK** button.



Warning

Unless a dialog box is waiting for your input, do not press any keys during the installation process (doing so may result in unpredictable behavior).

15.2. Language Selection

Use the arrow keys on your keyboard to select a language to use during the installation process (refer to [Figure 15.3, "Language Selection"](#)). With your selected language highlighted, press the **Tab** key to move to the **OK** button and press the **Enter** key to confirm your choice.

The language you select here will become the default language for the operating system once it is installed. Selecting the appropriate language also helps target your time zone configuration later in the installation. The installation program tries to define the appropriate time zone based on what you specify on this screen.

To add support for additional languages, customize the installation at the package selection stage. For more information, refer to [Section 16.18.2, "Customizing the Software Selection"](#).



Figure 15.3. Language Selection

Once you select the appropriate language, click **Next** to continue.

15.3. Installation Method

Use the arrow keys on your keyboard to select an installation method (refer to [Figure 15.4, “Installation Method”](#)). With your selected method highlighted, press the **Tab** key to move to the **OK** button and press the **Enter** key to confirm your choice.

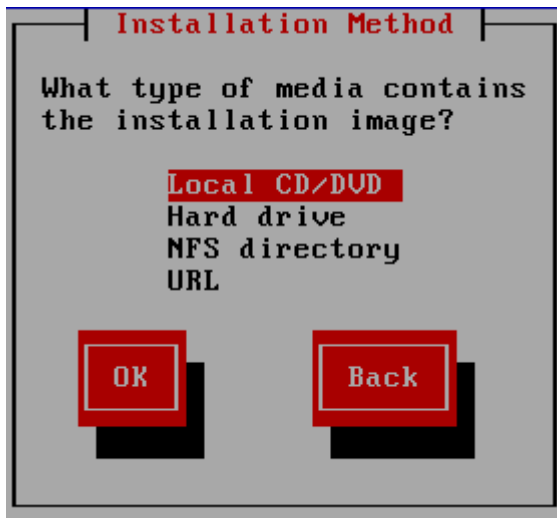


Figure 15.4. Installation Method

15.3.1. Beginning Installation

15.3.1.1. Installing from DVD

To install Red Hat Enterprise Linux from a DVD, place the DVD your DVD drive and boot your system from the DVD. Even if you booted from alternative media, you can still install Red Hat Enterprise Linux from DVD media.

The installation program then probes your system and attempts to identify your DVD drive. It starts by looking for an IDE (also known as an ATAPI) DVD drive.

If your DVD drive is not detected, and it is a SCSI DVD, the installation program prompts you to choose a SCSI driver. Choose the driver that most closely resembles your adapter. You may specify options for the driver if necessary; however, most drivers detect your SCSI adapter automatically.

If the DVD drive is found and the driver loaded, the installer will present you with the option to perform a media check on the DVD. This will take some time, and you may opt to skip over this step. However, if you later encounter problems with the installer, you should reboot and perform the media check before calling for support. From the media check dialog, continue to the next stage of the installation process (refer to [Section 16.5, “Welcome to Red Hat Enterprise Linux”](#)).

15.3.2. Installing from a Hard Drive

The **Select Partition** screen applies only if you are installing from a disk partition (that is, you selected **Hard Drive** in the **Installation Method** dialog). This dialog allows you to name the disk partition and directory from which you are installing Red Hat Enterprise Linux. If you used the **repo=hd** boot option, you already specified a partition.

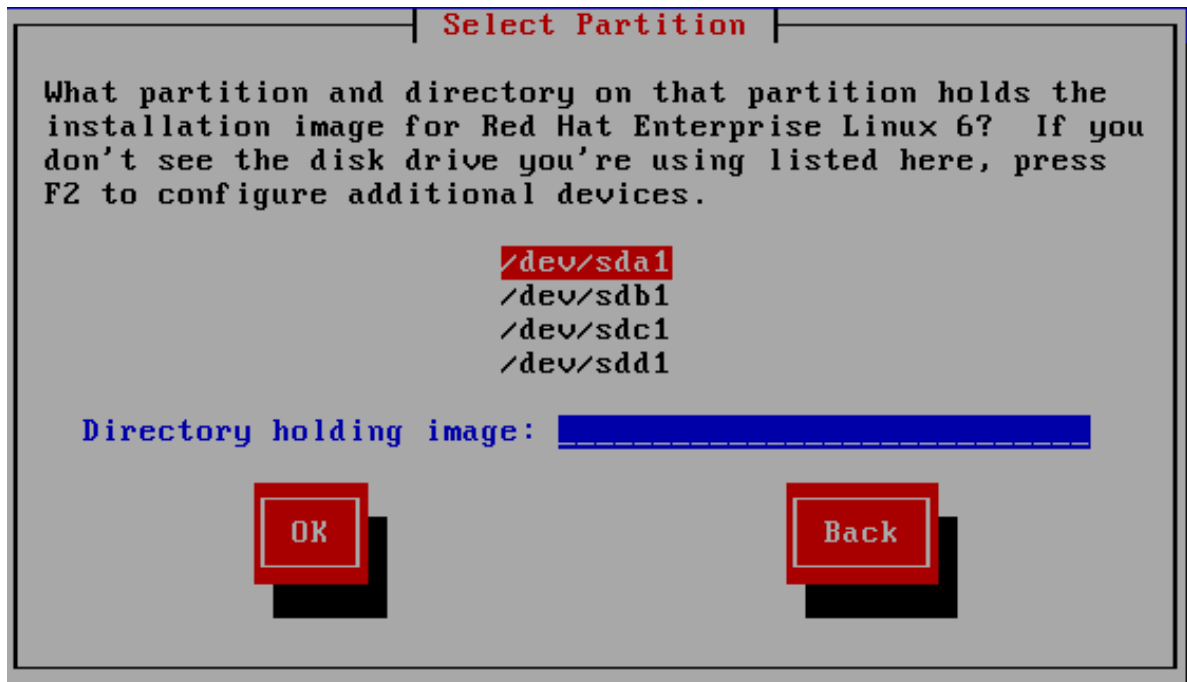


Figure 15.5. Selecting Partition Dialog for Hard Drive Installation

Select the partition containing the ISO files from the list of available partitions. Internal IDE, SATA, SCSI, and USB drive device names begin with `/dev/sd`. Each individual drive has its own letter, for example `/dev/sda`. Each partition on a drive is numbered, for example `/dev/sda1`.

Also specify the **Directory holding images**. Enter the full directory path from the drive that contains the ISO image files. The following table shows some examples of how to enter this information:

Table 15.1. Location of ISO images for different partition types

| Partition type | Volume | Original path to files | Directory to use |
|------------------|--------|------------------------|------------------|
| VFAT | D:\ | D:\Downloads\RHEL6 | /Downloads/RHEL6 |
| ext2, ext3, ext4 | /home | /home/user1/RHEL6 | /user1/RHEL6 |

If the ISO images are in the root (top-level) directory of a partition, enter a `/`. If the ISO images are located in a subdirectory of a mounted partition, enter the name of the directory holding the ISO images within that partition. For example, if the partition on which the ISO images is normally mounted as `/home/`, and the images are in `/home/new/`, you would enter `/new/`.



Use a leading slash

An entry without a leading slash may cause the installation to fail.

Select **OK** to continue. Proceed with [Chapter 16, Installing using anaconda](#).

15.3.3. Performing a Network Installation

If you are performing a network installation, the **Configure TCP/IP** dialog appears. This dialog asks for your IP and other network addresses. You can choose to configure the IP address and Netmask of the device via DHCP or manually.

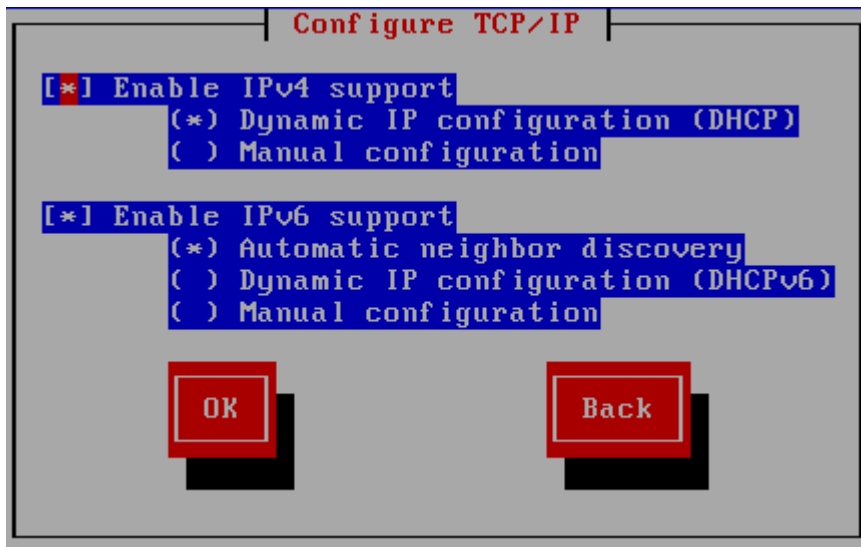


Figure 15.6. TCP/IP Configuration

- If you are installing via NFS, proceed to [Section 15.3.4, “Installing via NFS”](#).
- If you are installing via Web or FTP, proceed to [Section 15.3.5, “Installing via FTP or HTTP”](#).

15.3.4. Installing via NFS

The NFS dialog applies only if you selected **NFS Image** in the **Installation Method** dialog. If you used the **repo=nfs** boot option, you already specified a server and path.

Enter the domain name or IP address of your NFS server. For example, if you are installing from a host named **eastcoast** in the domain **example.com**, enter **eastcoast.example.com** in the **NFS Server** field.

Next, enter the name of the exported directory. If you followed the setup described in [Section 12.1.2, “Preparing for an NFS installation”](#), you would enter the directory **/export/directory/** which contains the **variant/** directory.

This dialog also allows you to specify NFS mount options. Refer to the *Red Hat Enterprise Linux Deployment Guide* for a list of common NFS mount options, or consult the man pages for **mount** and **nfs** for a comprehensive list of options.

If the NFS server is exporting a mirror of the Red Hat Enterprise Linux installation tree, enter the directory which contains the root of the installation tree. You will enter an Installation Key later on in the process which will determine which subdirectories are used to install from. If everything was specified properly, a message appears indicating that the installation program for Red Hat Enterprise Linux is running.

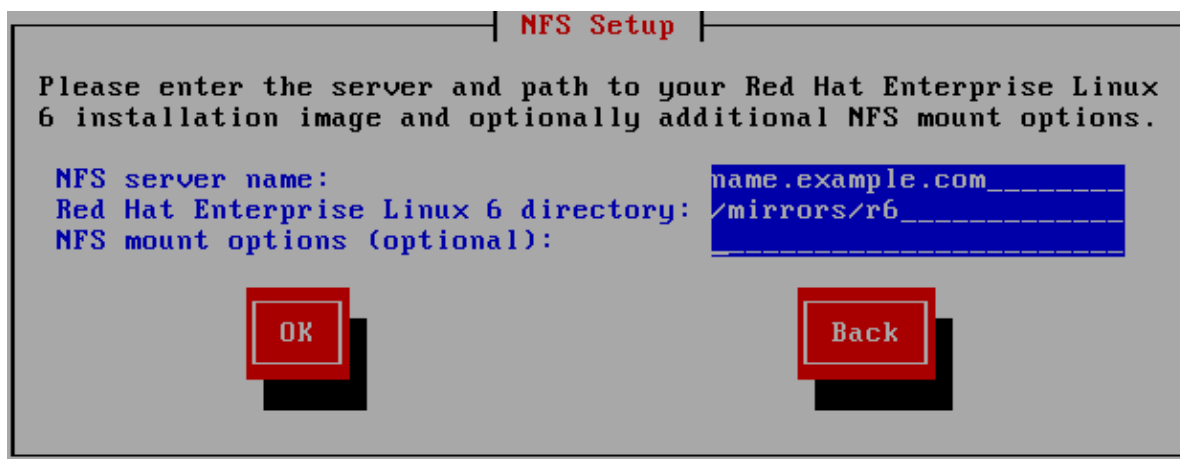


Figure 15.7. NFS Setup Dialog

If the NFS server is exporting the ISO image of the Red Hat Enterprise Linux DVD, enter the directory which contains the ISO image.

Proceed with [Chapter 16, Installing using anaconda](#).

15.3.5. Installing via FTP or HTTP



Important — you must specify the protocol

When you provide a URL to an installation source, you must explicitly specify **http://** or **ftp://** as the protocol.

The URL dialog applies only if you are installing from a FTP or HTTP server (if you selected **URL** in the **Installation Method** dialog). This dialog prompts you for information about the FTP or HTTP server from which you are installing Red Hat Enterprise Linux. If you used the **repo=ftp** or **repo=http** boot option, you already specified a server and path.

Enter the name or IP address of the FTP or HTTP site from which you are installing, and the name of the directory that contains the **/images** directory for your architecture. For example:

```
/mirrors/redhat/rhel-6/Server/ppc64/
```

Specify the address of a proxy server, and if necessary, provide a port number, username, and password. If everything was specified properly, a message box appears indicating that files are being retrieved from the server.

If your FTP or HTTP server requires user authentication, specify user and password as part of the URL as follows:

```
{ftp|http}://<user>:<password>@<hostname>[:<port>]/<directory>/
```

For example:

```
http://install:rhel6pw@name.example.com/mirrors/redhat/rhel-6/Server/ppc64/
```

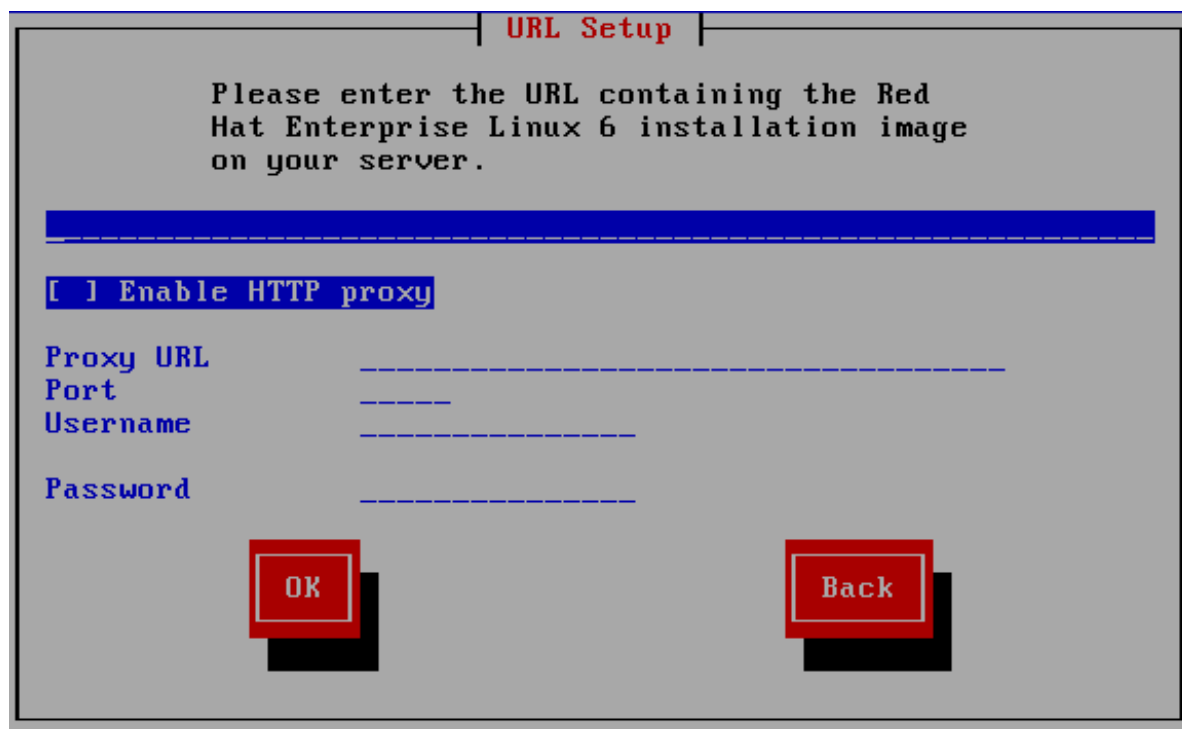


Figure 15.8. URL Setup Dialog

Proceed with [Chapter 16, Installing using anaconda](#).

15.4. Verifying Media

The DVD offers an option to verify the integrity of the media. Recording errors sometimes occur while producing DVD media. An error in the data for package chosen in the installation program can cause the installation to abort. To minimize the chances of data errors affecting the installation, verify the media before installing.

If the verification succeeds, the installation process proceeds normally. If the process fails, create a new DVD using the ISO image you downloaded earlier.

Installing using anaconda

This chapter describes an installation using the graphical user interface of **anaconda**.

16.1. The Text Mode Installation Program User Interface

While text mode installations are not explicitly documented, those using the text mode installation program can easily follow the GUI installation instructions. However, because text mode presents you with a simpler, more streamlined insatallation process, certain options that are available in graphical mode are not also available in text mode. These differences are noted in the description of the installation process in this guide, and include:

- configuring advanced storage methods such as LVM, RAID, FCoE, zFCP, and iSCSI.
- customizing the partition layout
- customizing the bootloader layout
- selecting packages during installation
- configuring the installed system with **Firstboot**

16.2. The Graphical Installation Program User Interface

If you have used a *graphical user interface (GUI)* before, you are already familiar with this process; use your mouse to navigate the screens, click buttons, or enter text fields.

You can also navigate through the installation using the keyboard. The **Tab** key allows you to move around the screen, the Up and Down arrow keys to scroll through lists, **+** and **-** keys expand and collapse lists, while **Space** and **Enter** selects or removes from selection a highlighted item. You can also use the **Alt+X** key command combination as a way of clicking on buttons or making other screen selections, where **X** is replaced with any underlined letter appearing within that screen.

If you would like to use a graphical installation with a system that does not have that capability, such as a partitioned system, you can use VNC or display forwarding. Both the VNC and display forwarding options require an active network during the installation and the use of boot time arguments. For more information on available boot time options, refer to [Chapter 28, Boot Options](#)

**Note**

If you do not wish to use the GUI installation program, the text mode installation program is also available. To start the text mode installation program, use the following command at the yaboot : prompt:

```
linux text
```

Refer to [Section 14.1, “The Boot Menu”](#) for a description of the Red Hat Enterprise Linux boot menu and to [Section 15.1, “The Text Mode Installation Program User Interface”](#) for a brief overview of text mode installation instructions.

It is highly recommended that installs be performed using the GUI installation program. The GUI installation program offers the full functionality of the Red Hat Enterprise Linux installation program, including LVM configuration which is not available during a text mode installation.

Users who must use the text mode installation program can follow the GUI installation instructions and obtain all needed information.

16.3. A Note about Linux Virtual Consoles

This information only applies to users of non-partitioned System p systems using a video card as their console. Users of partitioned System p systems should skip to [Section 16.4, “Using the HMC vterm”](#).

The Red Hat Enterprise Linux installation program offers more than the dialog boxes of the installation process. Several kinds of diagnostic messages are available to you, as well as a way to enter commands from a shell prompt. The installation program displays these messages on five *virtual consoles*, among which you can switch using a single keystroke combination.

A virtual console is a shell prompt in a non-graphical environment, accessed from the physical machine, not remotely. Multiple virtual consoles can be accessed simultaneously.

These virtual consoles can be helpful if you encounter a problem while installing Red Hat Enterprise Linux. Messages displayed on the installation or system consoles can help pinpoint a problem. Refer to [Table 16.1, “Console, Keystrokes, and Contents”](#) for a listing of the virtual consoles, keystrokes used to switch to them, and their contents.

Generally, there is no reason to leave the default console (virtual console #6) for graphical installations unless you are attempting to diagnose installation problems.

Table 16.1. Console, Keystrokes, and Contents

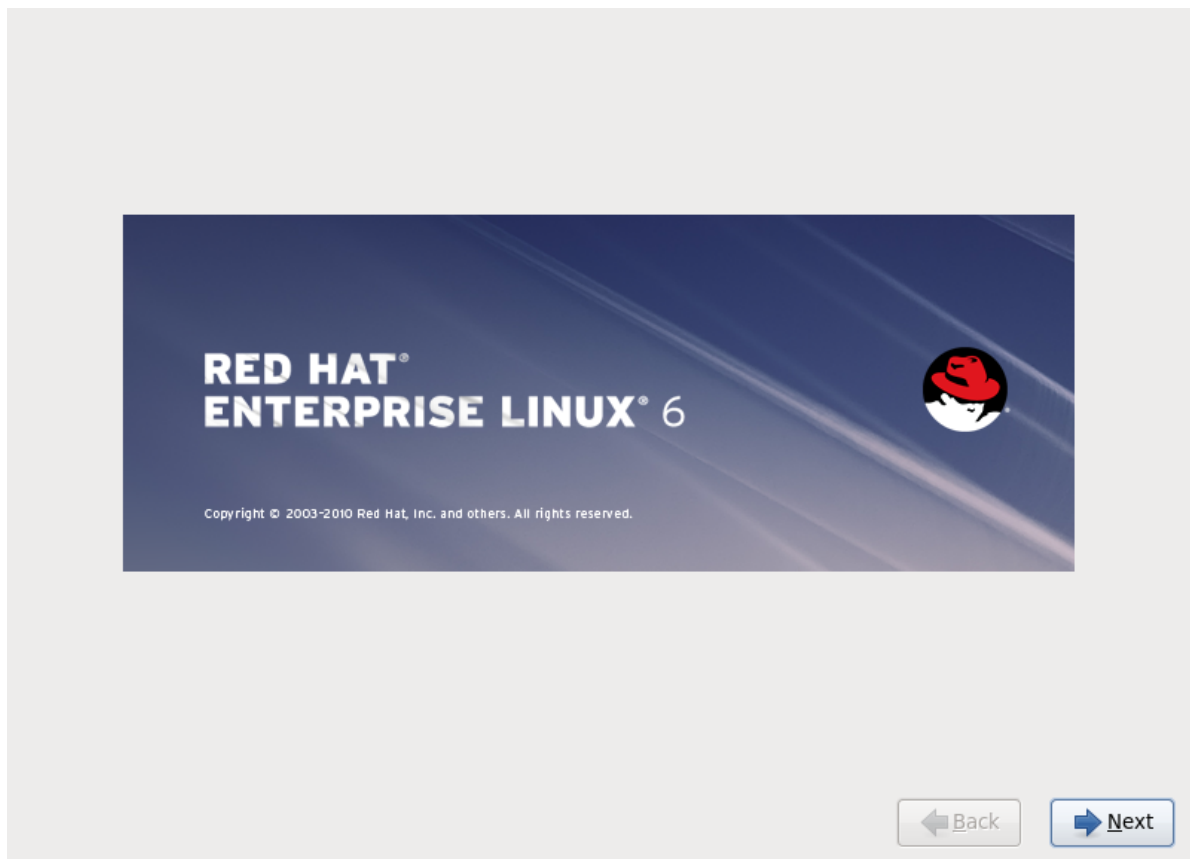
| console | keystrokes | contents |
|---------|--------------------|--|
| 1 | ctrl+alt+f1 | installation dialog |
| 2 | ctrl+alt+f2 | shell prompt |
| 3 | ctrl+alt+f3 | install log (messages from installation program) |
| 4 | ctrl+alt+f4 | system-related messages |
| 5 | ctrl+alt+f5 | other messages |
| 6 | ctrl+alt+f6 | x graphical display |

16.4. Using the HMC vterm

The HMC vterm is the console for any partitioned IBM System p. This is opened by right clicking on the partition on the HMC, and then selecting **Open Terminal Window**. Only a single vterm can be connected to the console at one time and there is no console access for partitioned system besides the vterm. This often is referred to as a 'virtual console', but is different from the virtual consoles in [Section 16.3, "A Note about Linux Virtual Consoles"](#).

16.5. Welcome to Red Hat Enterprise Linux

The **Welcome** screen does not prompt you for any input. From this screen you can access the Release Notes for Red Hat Enterprise Linux 6 by clicking on the Release Notes button.



Click on the **Next** button to continue.

16.6. Storage Devices

You can install Red Hat Enterprise Linux on a large variety of storage devices. This screen allows you to select either basic or specialized storage devices.

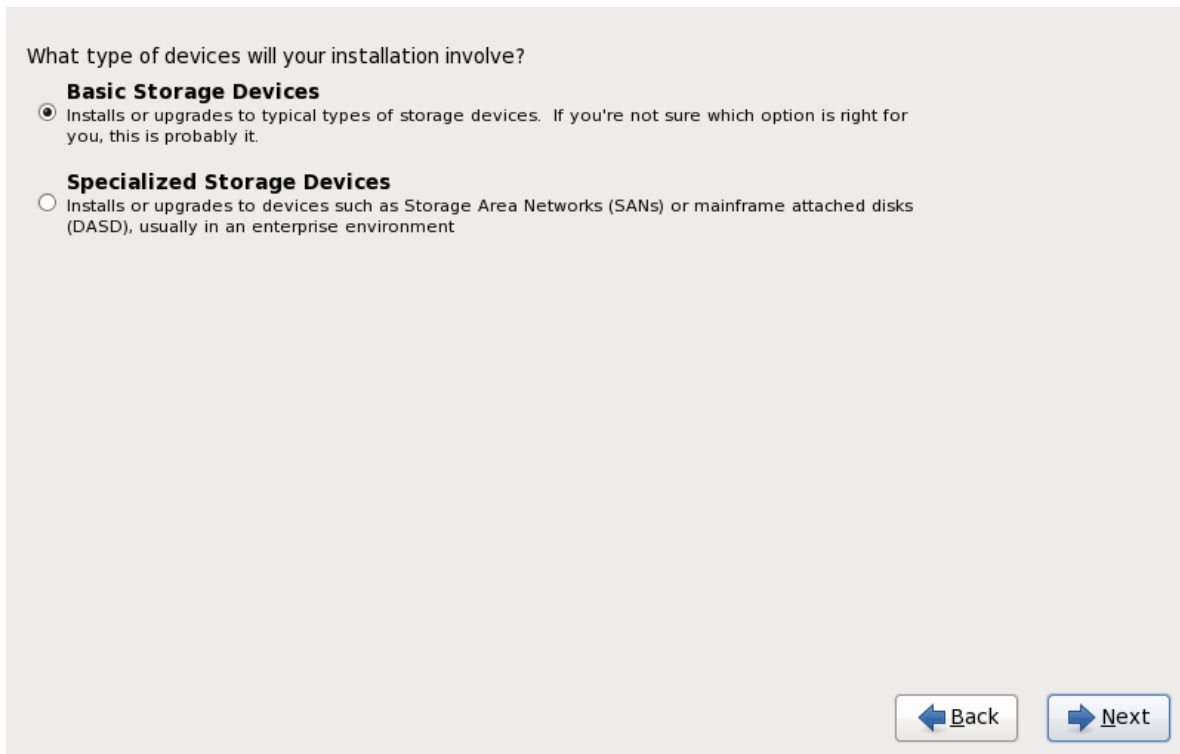


Figure 16.1. Storage devices

Basic Storage Devices

Select **Basic Storage Devices** to install Red Hat Enterprise Linux on the following storage devices:

- hard drives or solid-state drives connected directly to the local system.

Specialized Storage Devices

Select **Specialized Storage Devices** to install Red Hat Enterprise Linux on the following storage devices:

- *Storage area networks (SANs)*
- *Direct access storage devices (DASDs)*
- Firmware RAID devices
- Multipath devices

Use the **Specialized Storage Devices** option to configure *Internet Small Computer System Interface (iSCSI)* and *FCoE (Fiber Channel over Ethernet)* connections.

If you select **Basic Storage Devices**, **anaconda** automatically detects the local storage attached to the system and does not require further input from you. Proceed to [Section 16.8, “Setting the Hostname”](#).

16.6.1. The Storage Devices Selection Screen

The storage devices selection screen displays all storage devices to which **anaconda** has access.

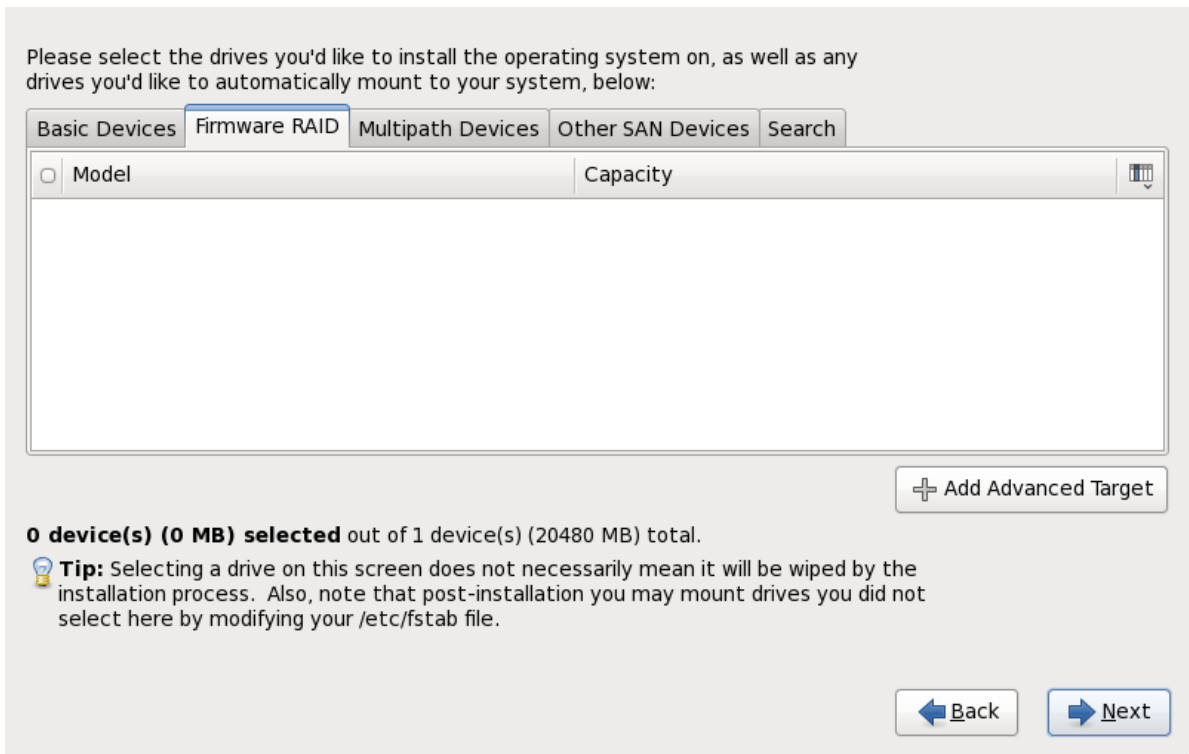


Figure 16.2. Select storage devices — Basic devices

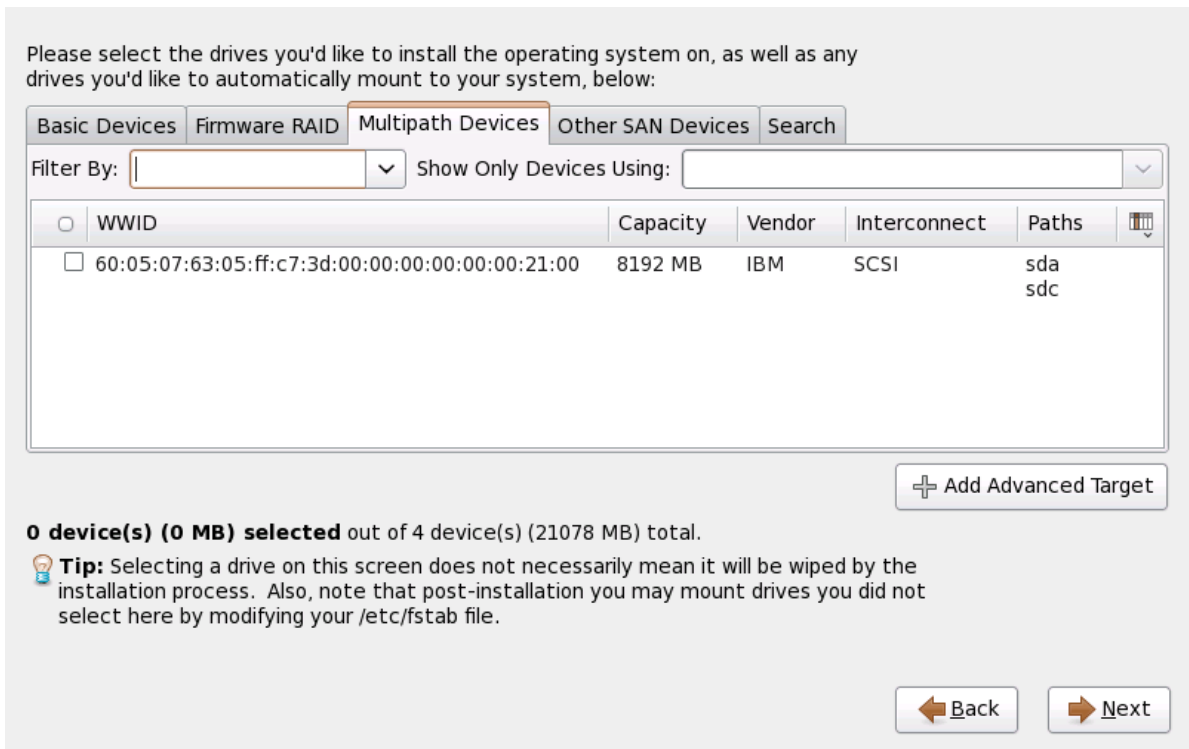


Figure 16.3. Select storage devices — Multipath Devices

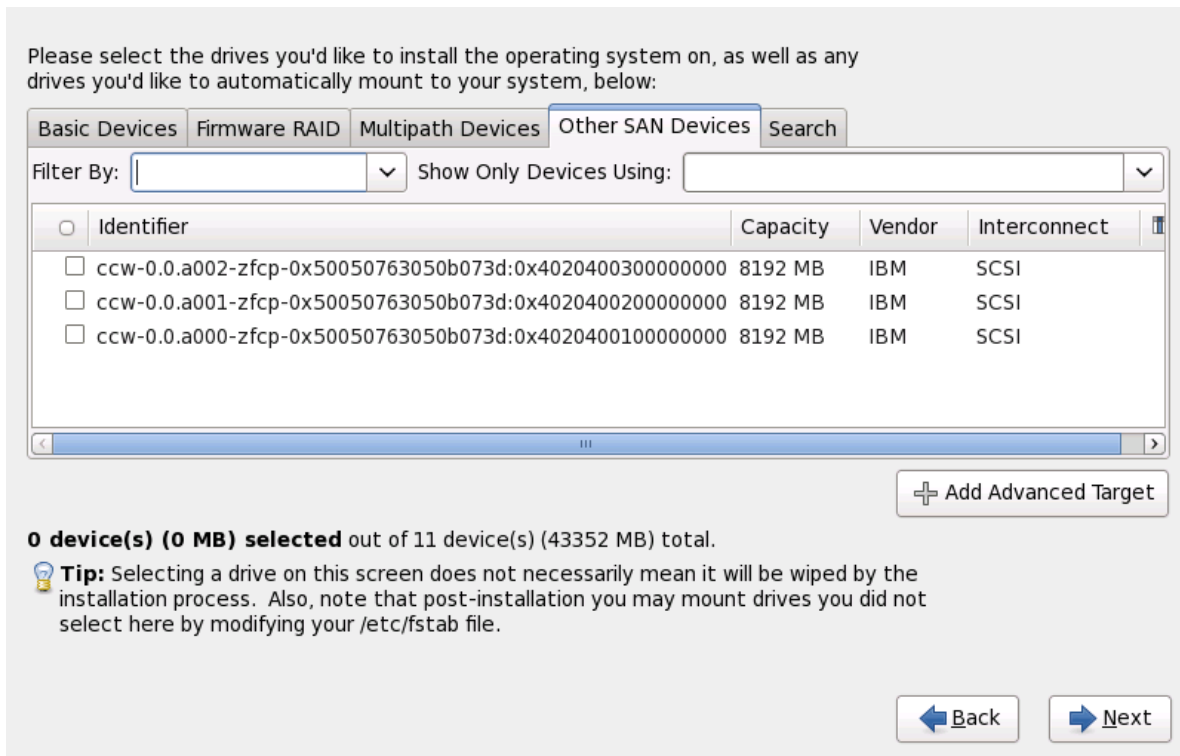


Figure 16.4. Select storage devices — Other SAN Devices

Devices are grouped under the following tabs:

Basic Devices

Basic storage devices directly connected to the local system, such as hard disk drives and solid-state drives.

Firmware RAID

Storage devices attached to a firmware RAID controller.

Multipath Devices

Storage devices accessible through more than one path, such as through multiple SCSI controllers or Fiber Channel ports on the same system.

Other SAN Devices

Any other devices available on a storage area network (SAN).

If you do need to configure iSCSI or FCoE storage, click **Add Advanced Target** and refer to [Section 16.6.1.1, “Advanced Storage Options”](#).

The storage devices selection screen also contains a **Search** tab that allows you to filter storage devices either by their *World Wide Identifier* (WWID) or by the port, target, or *logical unit number* (LUN) at which they are accessed.

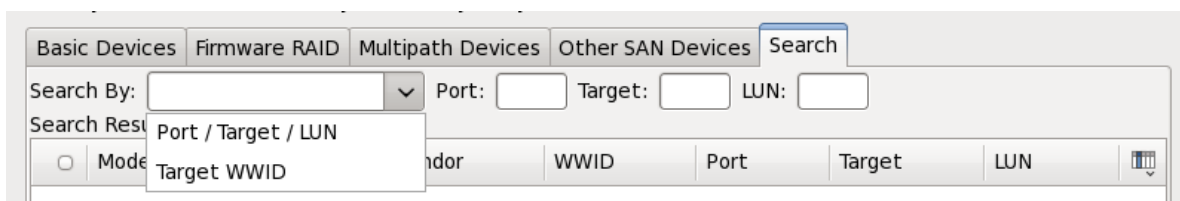


Figure 16.5. The Storage Devices Search Tab

The tab contains a drop-down menu to select searching by port, target, WWID, or LUN (with corresponding text boxes for these values). Searching by WWID or LUN requires additional values in the corresponding text box.

Each tab presents a list of devices detected by **anaconda**, with information about the device to help you to identify it. A small drop-down menu marked with an icon is located to the right of the column headings. This menu allows you to select the types of data presented on each device. For example, the menu on the **Multipath Devices** tab allows you to specify any of **WWID**, **Capacity**, **Vendor**, **Interconnect**, and **Paths** to include among the details presented for each device. Reducing or expanding the amount of information presented might help you to identify particular devices.

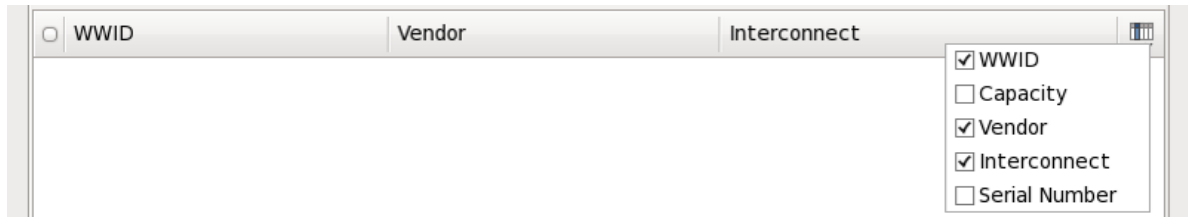


Figure 16.6. Selecting Columns

Each device is presented on a separate row, with a checkbox to its left. Click the checkbox to make a device available during the installation process, or click the *radio button* at the left of the column headings to select or deselect all the devices listed in a particular screen. Later in the installation process, you can choose to install Red Hat Enterprise Linux onto any of the devices selected here, and can choose to automatically mount any of the other devices selected here as part of the installed system.

Note that the devices that you select here are not automatically erased by the installation process. Selecting a device on this screen does not, in itself, place data stored on the device at risk. Note also that any devices that you do not select here to form part of the installed system can be added to the system after installation by modifying the `/etc/fstab` file.



Important — chain loading

Any storage devices that you do not select on this screen are hidden from **anaconda** entirely. To *chain load* the Red Hat Enterprise Linux boot loader from a different boot loader, select all the devices presented in this screen.

when you have selected the storage devices to make available during installation, click **Next** and proceed to [Section 16.12, “Initializing the Hard Disk”](#)

16.6.1.1. Advanced Storage Options

From this screen you can configure an *iSCSI* (SCSI over TCP/IP) target or *FCoE* (Fibre channel over ethernet) *SAN* (storage area network). Refer to [Appendix B, *iSCSI disks*](#) for an introduction to *iSCSI*.

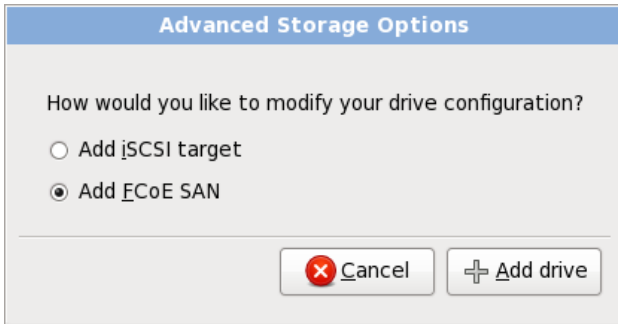


Figure 16.7. Advanced Storage Options

16.6.1.1.1. Enable Network Interfaces

Use this dialog to configure the network interfaces through which the system will connect to networked storage devices.

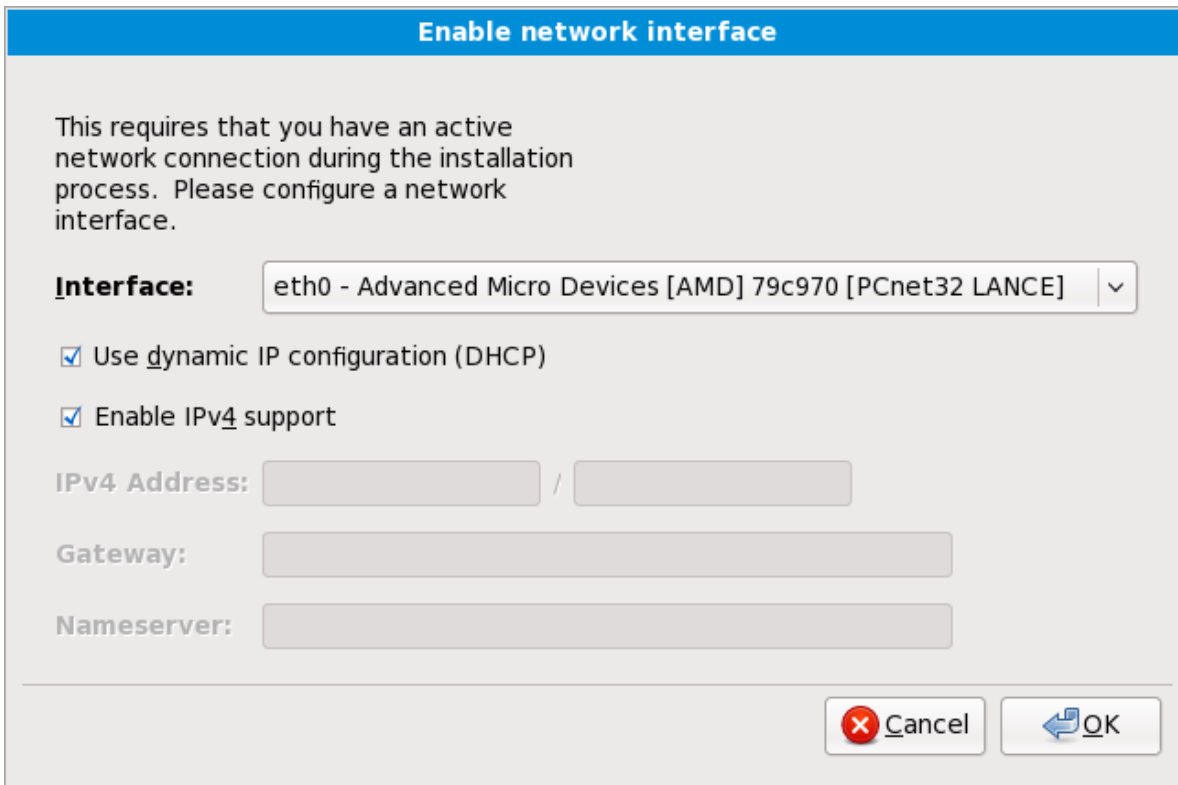


Figure 16.8. Enable Network Interface

If your network does not have DHCP enabled, or if you need to override the DHCP settings, select the network interface that you plan to use from the **Interfaces** menu. Clear the checkbox for **Use dynamic IP configuration (DHCP)**. You can now enter an IPv4 address and netmask for this system in the form *address / netmask*, along with the gateway address and nameserver address for your network.

Click **OK** to accept these settings and continue.

16.6.1.1.2. Configure iSCSI Parameters

To configure an iSCSI target invoke the 'Configure iSCSI Parameters' dialog by selecting 'Add iSCSI target' and clicking on the 'Add Drive' button. Fill in the details for the iSCSI target IP and provide a unique iSCSI initiator name to identify this system. If the iSCSI target uses CHAP (Challenge Handshake Authentication Protocol) for authentication, enter the CHAP username and password.

If your environment uses 2-way CHAP (also called "Mutual CHAP"), also enter the reverse CHAP username and password. Click the 'Add target' button to attempt connection to the iSCSI target using this information.

Configure iSCSI Parameters

To use iSCSI disks, you must provide the address of your iSCSI target and the iSCSI initiator name you've configured for your host.

Target IP Address: 192.168.0.108

iSCSI Initiator Name: iqn.2005-03.example.com.max:01.8dc7a8

CHAP Username:

CHAP Password:

Reverse CHAP Username:

Reverse CHAP Password:

Figure 16.9. Configure iSCSI Parameters

Note that you will be able to reattempt with a different iSCSI target IP should you enter it incorrectly, but to change the iSCSI initiator name you will need to restart the installation.

16.6.1.1.3. Configure FCoE Parameters

To configure an FCoE SAN, select **Add FCoE SAN** and click **Add Drive**.

On the menu that appears in the next dialog box, select the network interface that is connected to your FCoE switch and click **Add FCoE Disk(s)**.

Configure FCoE Parameters

Please select the network interface which is connected to your FCoE switch.

NIC: eth0 - [Advanced, Micro, Devices, AMD] [79c970, PCnet32] - 08:00:27:5E:1B:27

Use DCB

Figure 16.10. Configure FCoE Parameters

Data Center Bridging (DCB) is a set of enhancements to the Ethernet protocols designed to increase the efficiency of Ethernet connections in storage networks and clusters. Enable or disable the installer's awareness of DCB with the checkbox in this dialog.

16.7. Keyboard Configuration

Using your mouse, select the correct layout type (for example, U.S. English) for the keyboard you would prefer to use for the installation and as the system default (refer to [Figure 16.11](#), “*Keyboard Configuration*”).

Once you have made your selection, click **Next** to continue.

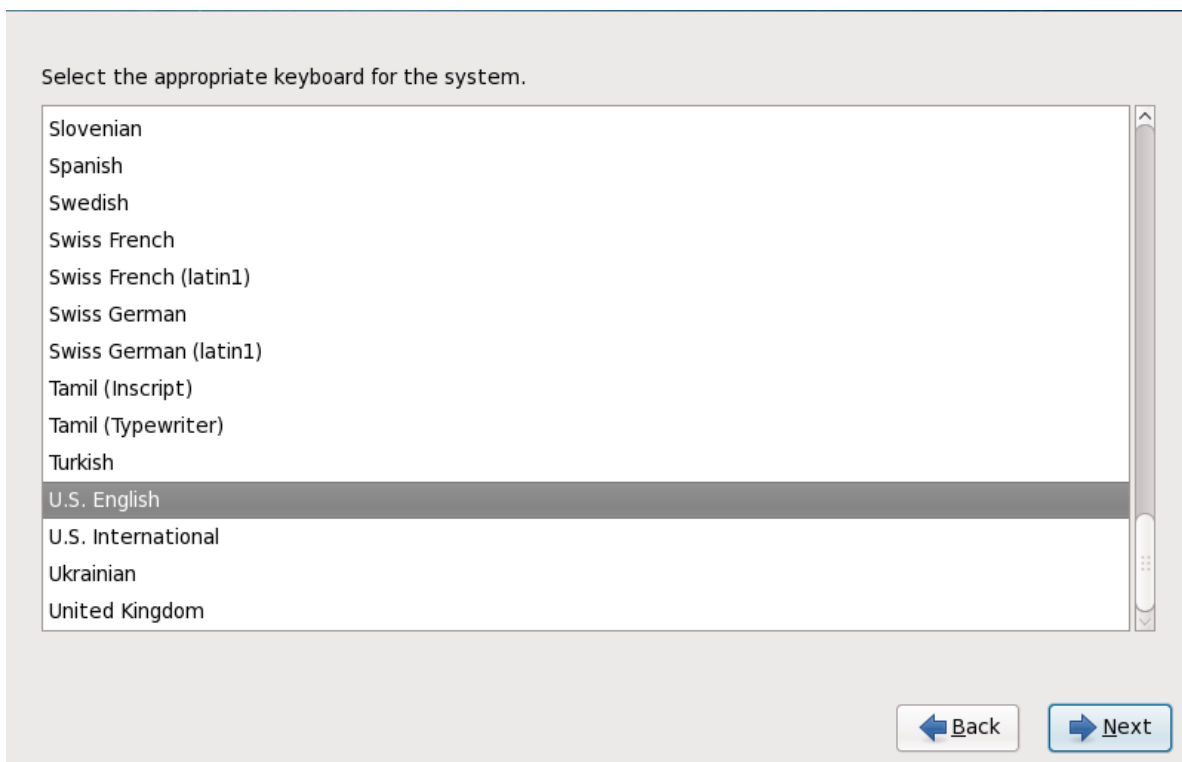


Figure 16.11. Keyboard Configuration



Note

To change your keyboard layout type after you have completed the installation, use the **Keyboard Configuration Tool**.

Type the **system-config-keyboard** command in a shell prompt to launch the **Keyboard Configuration Tool**. If you are not root, it prompts you for the root password to continue.

16.8. Setting the Hostname

Setup prompts you to supply a host name for this computer, either as a *fully-qualified domain name* (FQDN) in the format *hostname.domainname* or as a *short host name* in the format *hostname*. Many networks have a *Dynamic Host Configuration Protocol* (DHCP) service that automatically supplies connected systems with a domain name. To allow the DHCP service to assign the domain name to this machine, specify the short host name only.



Valid Hostnames

You may give your system any name provided that the full hostname is unique. The hostname may include letters, numbers and hyphens.

The screenshot shows a window titled "Please name this computer. The hostname identifies the computer on a network." It features a small icon of a computer and a network card. Below the text is a text input field labeled "Hostname:" containing the placeholder text "hostname". At the bottom left is a button labeled "Configure Network". At the bottom right are two buttons: "Back" with a left-pointing arrow and "Next" with a right-pointing arrow.

Figure 16.12. Setting the hostname

If your Red Hat Enterprise Linux system is connected *directly* to the Internet, you must pay attention to additional considerations to avoid service interruptions or risk action by your upstream service provider. A full discussion of these issues is beyond the scope of this document.



Modem Configuration

The installation program does not configure modems. Configure these devices after installation with the **Network** utility. The settings for your modem are specific to your particular Internet Service Provider (ISP).

16.8.1. Edit Network Connections



Important — Manual configuration is often needed

When a Red Hat Enterprise Linux 6 installation boots for the first time, it activates any network interfaces that you configured during the installation process. However, the installer does not prompt you to configure network interfaces on some common installation paths, for example, when you install Red Hat Enterprise Linux from a DVD to a local hard drive.

When you install Red Hat Enterprise Linux from a local installation source to a local storage device, be sure to configure at least one network interface manually if you require network access when the system boots for the first time.



Note

To change your network configuration after you have completed the installation, use the **Network Administration Tool**.

Type the **system-config-network** command in a shell prompt to launch the **Network Administration Tool**. If you are not root, it prompts you for the root password to continue.

The **Network Administration Tool** is now deprecated and will be replaced by **NetworkManager** during the lifetime of Red Hat Enterprise Linux 6.

To configure a network connection manually, click the button **Configure Network**. The **Network Connections** dialog appears that allows you to configure wired, wireless, mobile broadband, VPN, and DSL connections for the system using the **NetworkManager** tool. A full description of all configurations possible with **NetworkManager** is beyond the scope of this guide. This section only details the most typical scenario of how to configure wired connections during installation. Configuration of other types of network is broadly similar, although the specific parameters that you must configure are necessarily different.

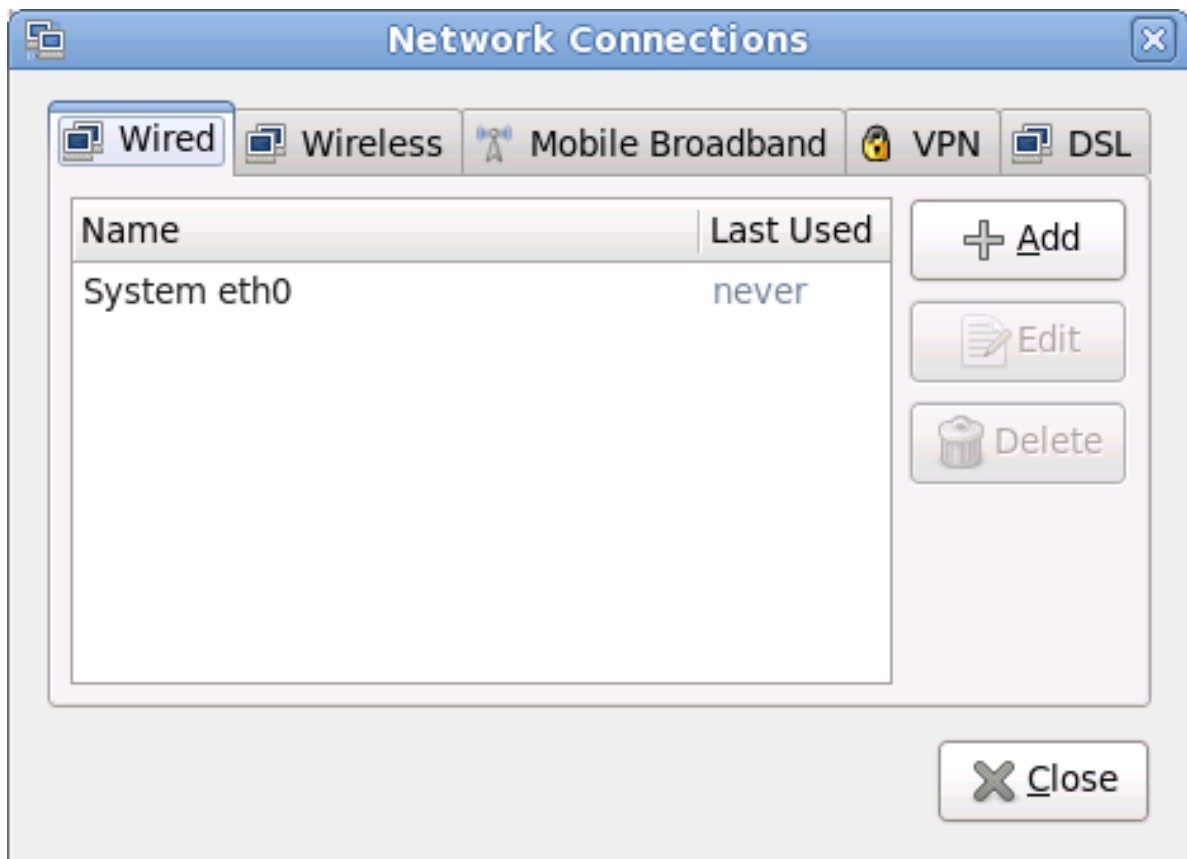


Figure 16.13. Network Connections

To add a new connection or to modify or remove a connection configured earlier in the installation process, click the tab that corresponds to the type of connection. To add a new connection of that type, click **Add**. To modify an existing connection, select it in the list and click **Edit**. In either case, a dialog box appears with a set of tabs that is appropriate to the particular connection type, as described below. To remove a connection, select it in the list and click **Delete**.

When you have finished editing network settings, click **Apply** to activate your changes. Note that re-configuring your network settings might require you to re-connect using the new settings.

16.8.1.1. Options common to all types of connection

Certain configuration options are common to all connection types.

Specify a name for the connection in the **Connection name** name field.

Select **Start automatically** to start the connection automatically when the system boots.

Select **Available to all users** to make the connection available to all users.

16.8.1.2. The Wired tab

Use the **Wired** tab to specify or change the *media access control* (MAC) address for the network adapter, and either set the *maximum transmission unit* (MTU, in bytes) that can pass through the interface.



Figure 16.14. The Wired tab

16.8.1.3. The 802.1x Security tab

Use the **802.1x Security** tab to configure 802.1X *port-based network access control* (PNAC). Select **Use 802.1X security for this connection** to enable access control, then specify details of your network. The configuration options include:

Authentication

Choose one of the following methods of authentication:

- **TLS** for *Transport Layer Security*
- **Tunneled TLS** for *Tunneled Transport Layer Security*, otherwise known as TTLS, or EAP-TTLS

- **Protected EAP (PEAP)** for *Protected Extensible Authentication Protocol*

Identity

Provide the identity of this server.

User certificate

Browse to a personal X.509 certificate file encoded with *Distinguished Encoding Rules* (DER) or *Privacy Enhanced Mail* (PEM).

CA certificate

Browse to a X.509 *certificate authority* certificate file encoded with *Distinguished Encoding Rules* (DER) or *Privacy Enhanced Mail* (PEM).

Private key

Browse to a *private key* file encoded with *Distinguished Encoding Rules* (DER), *Privacy Enhanced Mail* (PEM), or the *Personal Information Exchange Syntax Standard* (PKCS#12).

Private key password

The password for the private key specified in the **Private key** field. Select **Show password** to make the password visible as you type it.

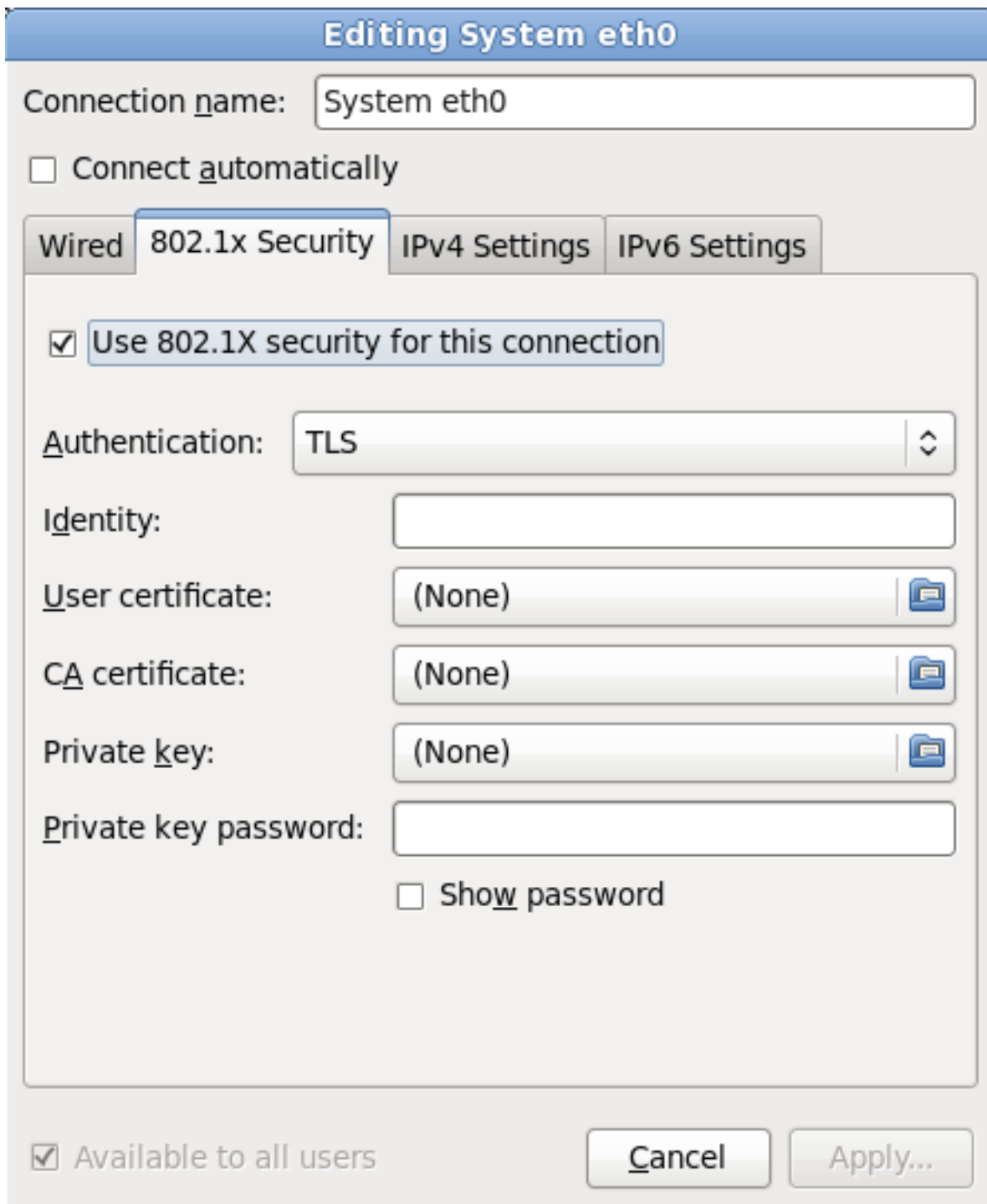


Figure 16.15. The 802.1x Security tab

16.8.1.4. The IPv4 Settings tab

Use the **IPv4 Settings tab** to configure the IPv4 parameters for the previously selected network connection.

Use the **Method** drop-down menu to specify which settings the system should attempt to obtain from a *Dynamic Host Configuration Protocol* (DHCP) service running on the network. Choose from the following options:

Automatic (DHCP)

IPv4 parameters are configured by the DHCP service on the network.

Automatic (DHCP) addresses only

The IPv4 address, netmask, and gateway address are configured by the DHCP service on the network, but DNS servers and search domains must be configured manually.

Manual

IPv4 parameters are configured manually for a static configuration.

Link-Local Only

A *link-local* address in the 169.254/16 range is assigned to the interface.

Shared to other computers

The system is configured to provide network access to other computers. The interface is assigned an address in the 10.42.x.1/24 range, a DHCP server and DNS server are started, and the interface is connected to the default network connection on the system with *network address translation* (NAT).

Disabled

IPv4 is disabled for this connection.

If you selected a method that requires you to supply manual parameters, enter details of the IP address for this interface, the netmask, and the gateway in the **Addresses** field. Use the **Add** and **Delete** buttons to add or remove addresses. Enter a comma-separated list of DNS servers in the **DNS servers** field, and a comma-separated list of domains in the **Search domains** field for any domains that you want to include in name server lookups.

Optionally, enter a name for this network connection in the **DHCP client ID** field. This name must be unique on the subnet. When you assign a meaningful DHCP client ID to a connection, it is easy to identify this connection when troubleshooting network problems.

Deselect the **Require IPv4 addressing for this connection to complete** check box to allow the system to make this connection on an IPv6-enabled network if IPv4 configuration fails but IPv6 configuration succeeds.



Figure 16.16. The IPv4 Settings tab

16.8.1.4.1. Editing IPv4 routes

Red Hat Enterprise Linux configures a number of routes automatically based on the IP addresses of a device. To edit additional routes, click the **Routes** button. The **Editing IPv4 routes** dialog appears.

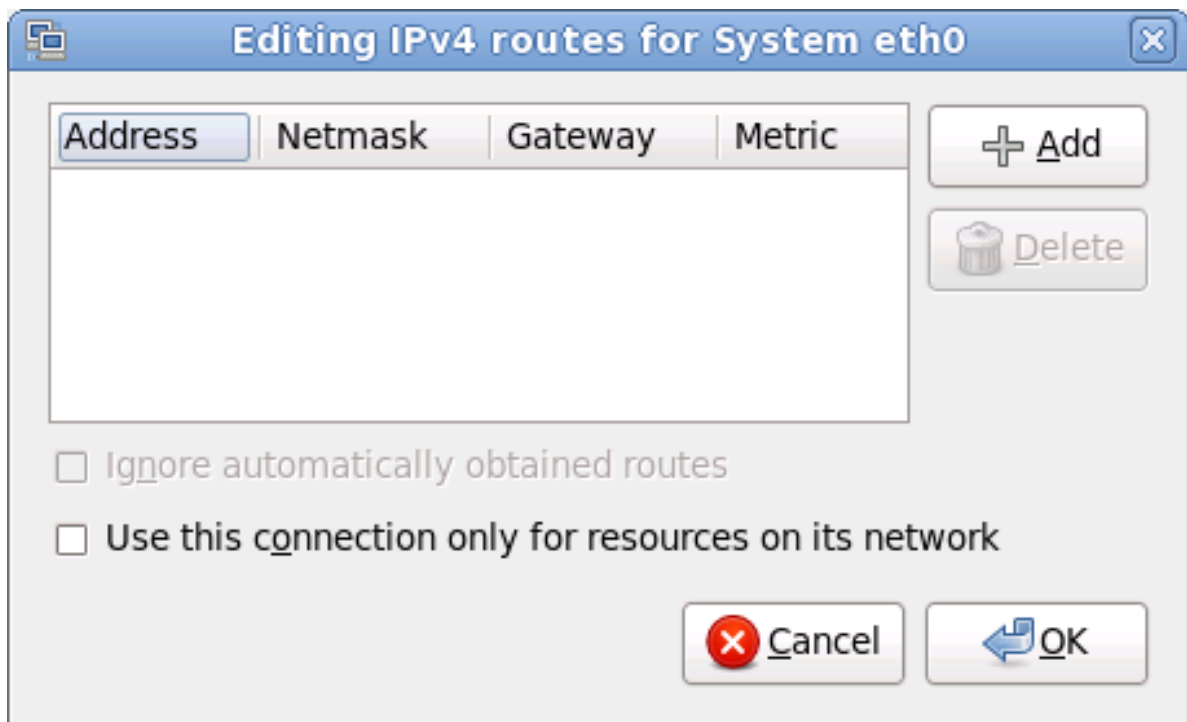


Figure 16.17. The Editing IPv4 Routes dialog

Click **Add** to add the IP address, netmask, gateway address, and metric for a new static route.

Select **Ignore automatically obtained routes** to make the interface use only the routes specified for it here.

Select **Use this connection only for resources on its network** to restrict connections only to the local network.

16.8.1.5. The IPv6 Settings tab

Use the **IPv6 Settings tab** to configure the IPv6 parameters for the previously selected network connection.

Use the **Method** drop-down menu to specify which settings the system should attempt to obtain from a *Dynamic Host Configuration Protocol* (DHCP) service running on the network. Choose from the following options:

Ignore

IPv6 is ignored for this connection.

Automatic

IPv6 parameters are configured by the DHCP service on the network.

Automatic, addresses only

The IPv6 address, prefix, and gateway address are configured by the DHCP service on the network, but DNS servers and search domains must be configured manually.

Manual

IPv6 parameters are configured manually for a static configuration.

Link-Local Only

A *link-local* address with the fe80::/10 prefix is assigned to the interface.

If you selected a method that requires you to supply manual parameters, enter details of the IP address for this interface, the netmask, and the gateway in the **Addresses** field. Use the **Add** and **Delete** buttons to add or remove addresses. Enter a comma-separated list of DNS servers in the **DNS servers** field, and a comma-separated list of domains in the **Search domains** field for any domains that you want to include in name server lookups.

Optionally, enter a name for this network connection in the **DHCP client ID** field. This name must be unique on the subnet. When you assign a meaningful DHCP client ID to a connection, it is easy to identify this connection when troubleshooting network problems.

Deselect the **Require IPv6 addressing for this connection to complete** check box to allow the system to make this connection on an IPv4-enabled network if IPv6 configuration fails but IPv4 configuration succeeds.

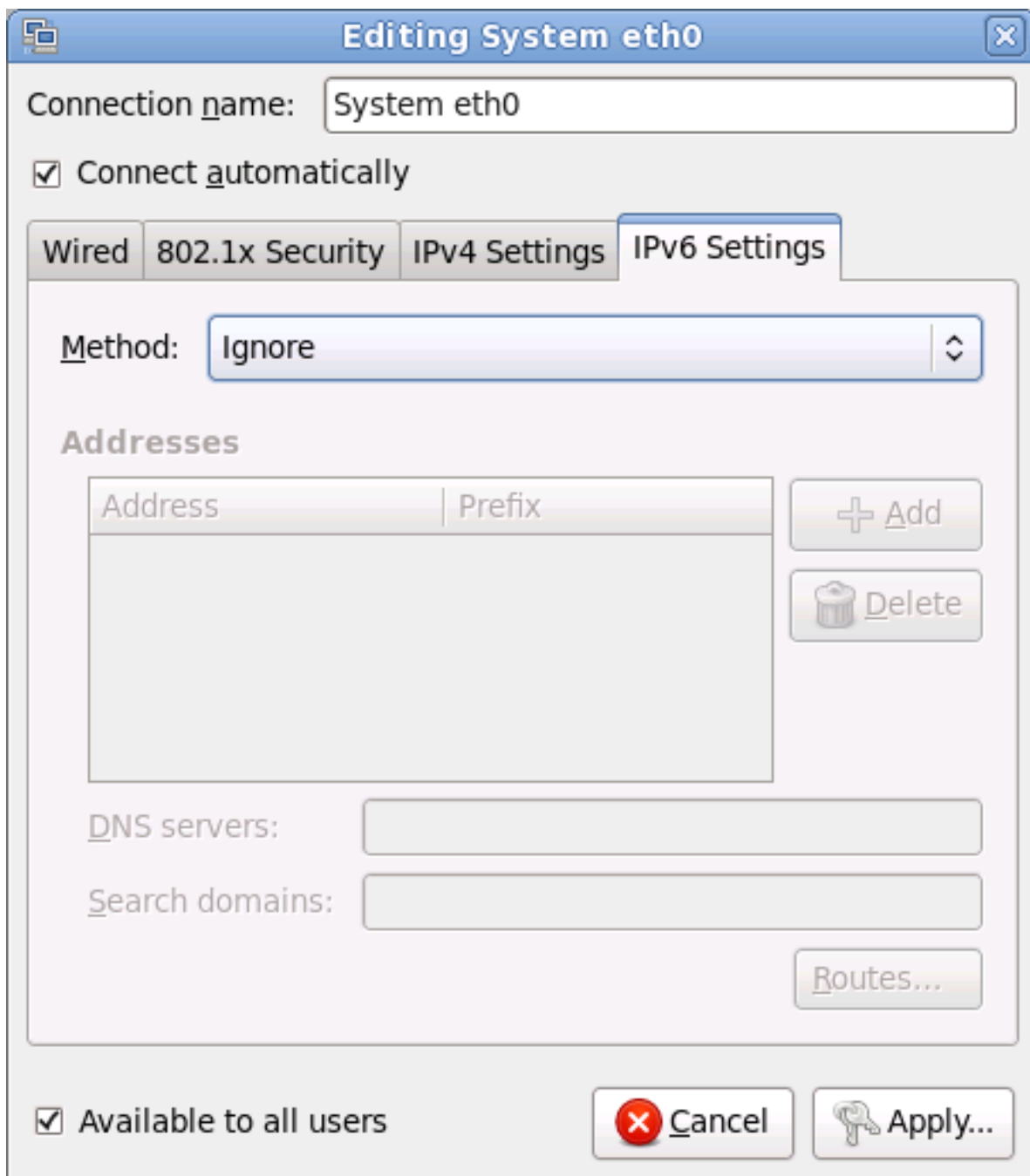


Figure 16.18. The IPv6 Settings tab

16.8.1.5.1. Editing IPv6 routes

Red Hat Enterprise Linux configures a number of routes automatically based on the IP addresses of a device. To edit additional routes, click the **Routes** button. The **Editing IPv6 routes** dialog appears.

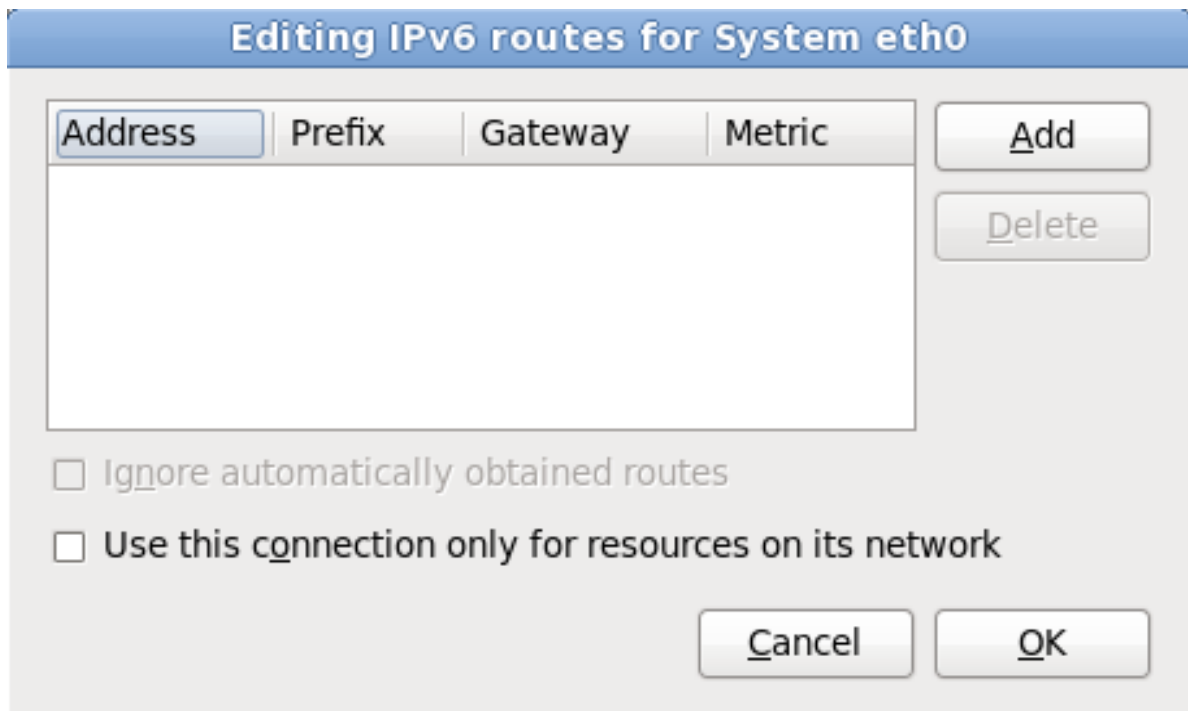


Figure 16.19. The Editing IPv6 Routes dialog

Click **Add** to add the IP address, netmask, gateway address, and metric for a new static route.

Select **Use this connection only for resources on its network** to restrict connections only to the local network.

16.9. Time Zone Configuration

Set your time zone by selecting the city closest to your computer's physical location. Click on the map to zoom in to a particular geographical region of the world.

From here there are two ways for you to select your time zone:

- Using your mouse, click on the interactive map to select a specific city (represented by a yellow dot). A red **X** appears indicating your selection.
- You can also scroll through the list at the bottom of the screen to select your time zone. Using your mouse, click on a location to highlight your selection.

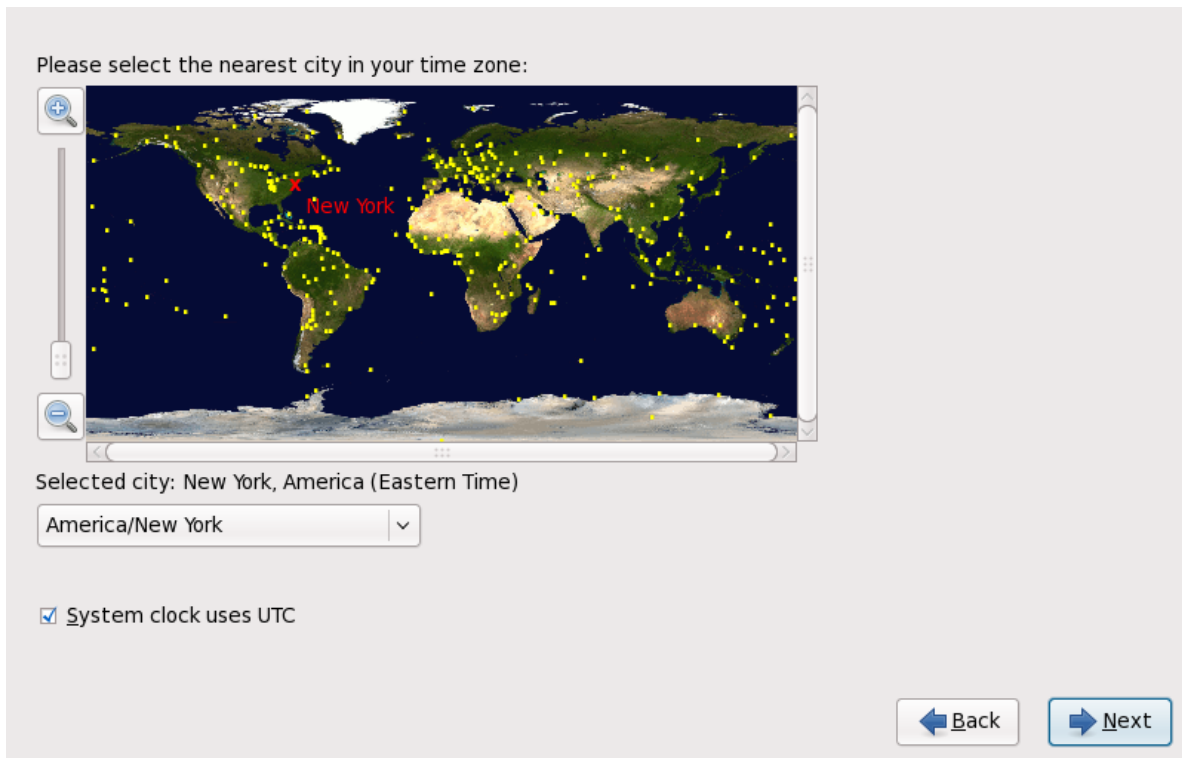


Figure 16.20. Configuring the Time Zone

If Red Hat Enterprise Linux is the only operating system on your computer, select **System clock uses UTC**. The system clock is a piece of hardware on your computer system. Red Hat Enterprise Linux uses the timezone setting to determine the offset between the local time and UTC on the system clock. This behavior is standard for systems that use UNIX, Linux, and similar operating systems.

Click **Next** to proceed.



Note

To change your time zone configuration after you have completed the installation, use the **Time and Date Properties Tool**.

Type the **system-config-date** command in a shell prompt to launch the **Time and Date Properties Tool**. If you are not root, it prompts you for the root password to continue.

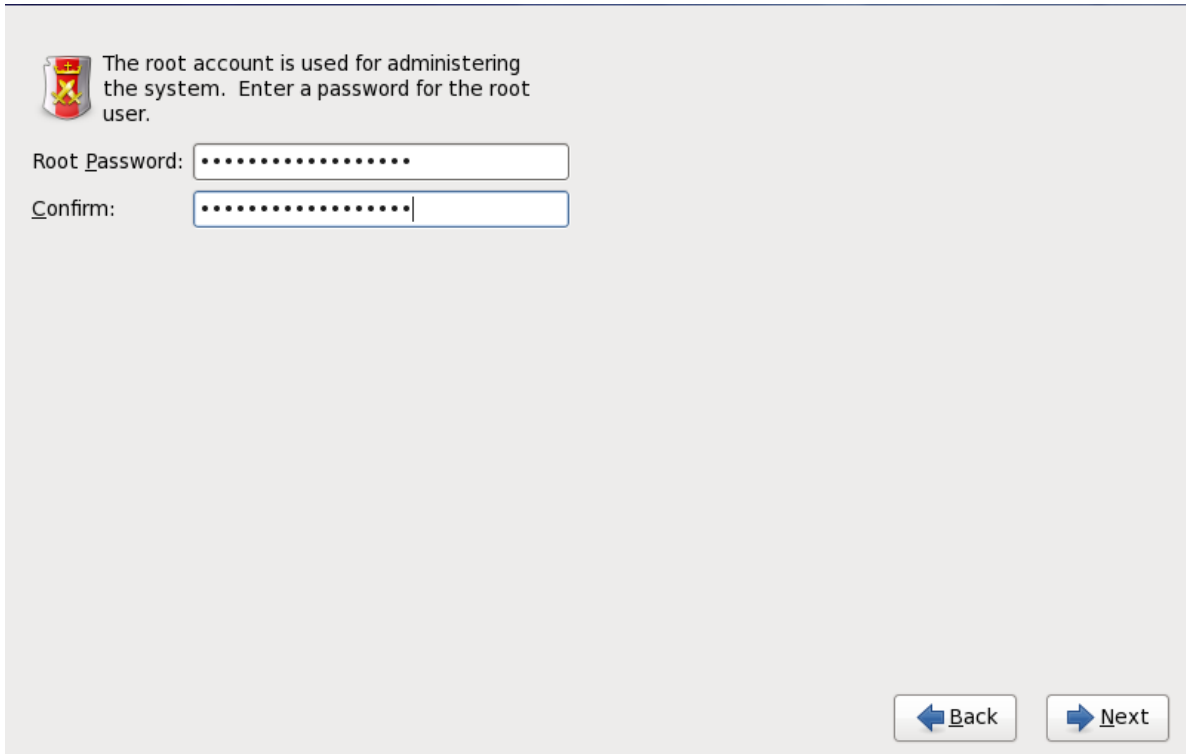
To run the **Time and Date Properties Tool** as a text-based application, use the command **timeconfig**.

16.10. Set the Root Password

Setting up a root account and password is one of the most important steps during your installation. The root account is used to install packages, upgrade RPMs, and perform most system maintenance. Logging in as root gives you complete control over your system.

 **Note**

The root user (also known as the superuser) has complete access to the entire system; for this reason, logging in as the root user is best done *only* to perform system maintenance or administration.



The root account is used for administering the system. Enter a password for the root user.

Root Password:

Confirm:

[Back](#) [Next](#)

Figure 16.21. Root Password

Use the root account only for system administration. Create a non-root account for your general use and use the **su** command to change to root only when you need to perform tasks that require superuser authorization. These basic rules minimize the chances of a typo or an incorrect command doing damage to your system.

 **Note**

To become root, type **su -** at the shell prompt in a terminal window and then press **Enter**. Then, enter the root password and press **Enter**.

The installation program prompts you to set a root password¹ for your system. *You cannot proceed to the next stage of the installation process without entering a root password.*

The root password must be at least six characters long; the password you type is not echoed to the screen. You must enter the password twice; if the two passwords do not match, the installation program asks you to enter them again.

¹ A root password is the administrative password for your Red Hat Enterprise Linux system. You should only log in as root when needed for system maintenance. The root account does not operate within the restrictions placed on normal user accounts, so changes made as root can have implications for your entire system.

You should make the root password something you can remember, but not something that is easy for someone else to guess. Your name, your phone number, *qwerty*, *password*, *root*, *123456*, and *anteater* are all examples of bad passwords. Good passwords mix numerals with upper and lower case letters and do not contain dictionary words: *Aard387vark* or *420BMttNT*, for example. Remember that the password is case-sensitive. If you write down your password, keep it in a secure place. However, it is recommended that you do not write down this or any password you create.



Note

Do not use one of the example passwords offered in this manual. Using one of these passwords could be considered a security risk.

To change your root password after you have completed the installation, use the **Root Password Tool**.

Type the **system-config-users** command in a shell prompt to launch the **User Manager**, a powerful user management and configuration tool. If you are not root, it prompts you for the root password to continue.

Enter the root password into the **Root Password** field. Red Hat Enterprise Linux displays the characters as asterisks for security. Type the same password into the **Confirm** field to ensure it is set correctly. After you set the root password, select **Next** to proceed.

16.11. Assign Storage Devices

If you selected more than one storage device on the storage devices selection screen (refer to [Section 16.6, “Storage Devices”](#)), **anaconda** asks you to select which of these devices should be available for installation of the operating system, and which should only be attached to the file system for data storage. If you selected only one storage device, **anaconda** does not present you with this screen.

During installation, the devices that you identify here as being for data storage only are mounted as part of the file system, but are not partitioned or formatted.

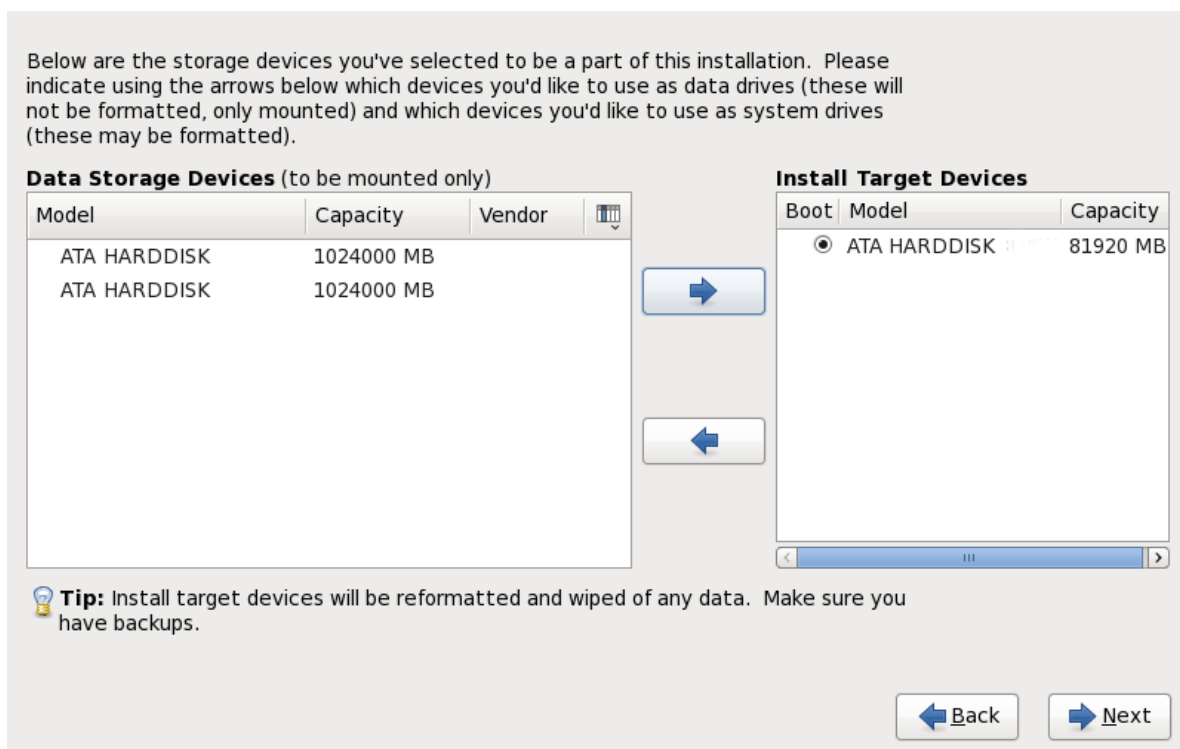


Figure 16.22. Assign storage devices

The screen is split into two panes. The left pane contains a list of devices to be used for data storage only. The right pane contains a list of devices that are to be available for installation of the operating system.

Each list contains information about the devices to help you to identify them. A small drop-down menu marked with an icon is located to the right of the column headings. This menu allows you to select the types of data presented on each device. Reducing or expanding the amount of information presented might help you to identify particular devices.

Move a device from one list to the other by clicking on the device, then clicking either the button labeled with a left-pointing arrow to move it to the list of data storage devices or the button labeled with a right-pointing arrow to move it to the list of devices available for installation of the operating system.

The list of devices available as installation targets also includes a radio button beside each device. Use this radio button to specify the device that you want to use as the boot device for the system.



Important — chain loading

If any storage device contains a boot loader that will chain load the Red Hat Enterprise Linux boot loader, include that storage device among the **Install Target Devices**. Storage devices that you identify as **Install Target Devices** remain visible to **anaconda** during boot loader configuration.

Storage devices that you identify as **Install Target Devices** on this screen are not automatically erased by the installation process unless you selected the **Use All Space** option on the partitioning screen (refer to [Section 16.14, “Disk Partitioning Setup”](#)).

When you have finished identifying devices to be used for installation, click **Next** to continue.

16.12. Initializing the Hard Disk

If no readable partition tables are found on existing hard disks, the installation program asks to initialize the hard disk. This operation makes any existing data on the hard disk unreadable. If your system has a brand new hard disk with no operating system installed, or you have removed all partitions on the hard disk, click **Re-initialize drive**.

The installation program presents you with a separate dialog for each disk on which it cannot read a valid partition table. Click the **Ignore all** button or **Re-initialize all** button to apply the same answer to all devices.

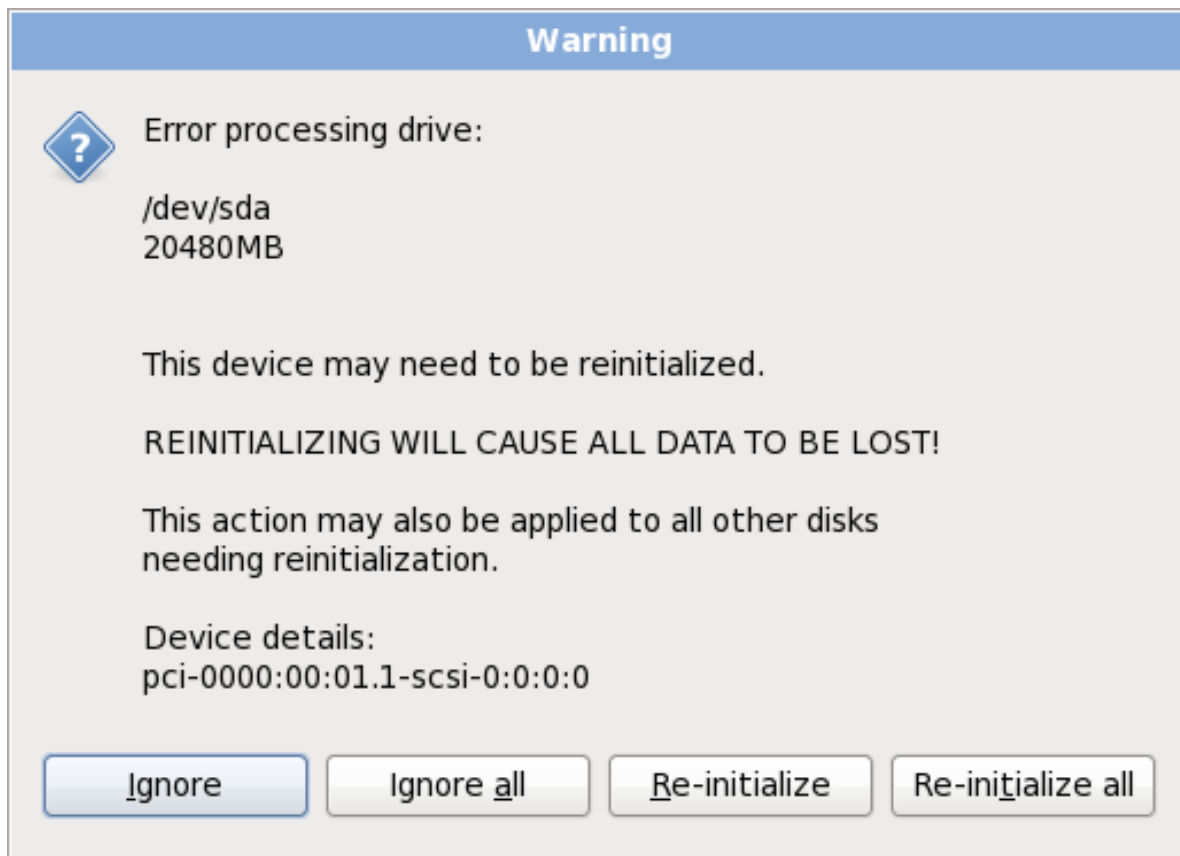



Figure 16.23. Warning screen – initializing hard drive

Certain RAID systems or other nonstandard configurations may be unreadable to the installation program and the prompt to initialize the hard disk may appear. The installation program responds to the physical disk structures it is able to detect.

To enable automatic initializing of hard disks for which it turns out to be necessary, use the kickstart command `clearpart --initlabel` (refer to [Chapter 32, Kickstart Installations](#))

 **Detach Unneeded Disks**

If you have a nonstandard disk configuration that can be detached during installation and detected and configured afterward, power off the system, detach it, and restart the installation.

16.13. Upgrading an Existing System



Red Hat does not support upgrades from earlier major versions

Although **anaconda** provides an option for upgrading from earlier major versions of Red Hat Enterprise Linux to Red Hat Enterprise Linux 6, Red Hat does not currently support this. More generally, Red Hat does not support in-place upgrades between any major versions of Red Hat Enterprise Linux. (A major version is denoted by a whole number version change. For example, Red Hat Enterprise Linux 4 and Red Hat Enterprise Linux 5 are both major versions of Red Hat Enterprise Linux.)

In-place upgrades across major releases do not preserve all system settings, services or custom configurations. Consequently, Red Hat strongly recommends fresh installations when upgrading from one major version to another.

The installation system automatically detects any existing installation of Red Hat Enterprise Linux. The upgrade process updates the existing system software with new versions, but does not remove any data from users' home directories. The existing partition structure on your hard drives does not change. Your system configuration changes only if a package upgrade demands it. Most package upgrades do not change system configuration, but rather install an additional configuration file for you to examine later.

Note that the installation medium that you are using might not contain all the software packages that you need to upgrade your computer.

16.13.1. The Upgrade Dialog

If your system contains a Red Hat Enterprise Linux installation, a dialog appears asking whether you want to upgrade that installation. To perform an upgrade of an existing system, choose the appropriate installation from the drop-down list and select **Next**.

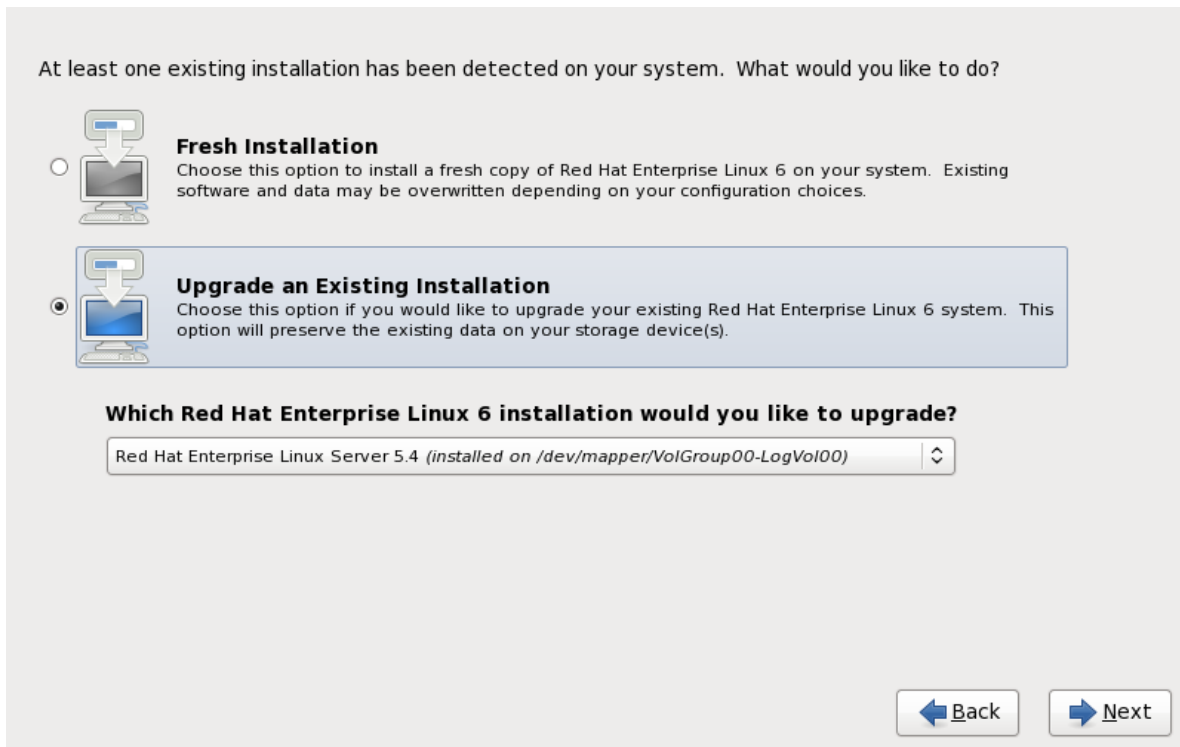


Figure 16.24. The Upgrade Dialog

Manually Installed Software

Software you have installed manually on your existing Red Hat Enterprise Linux system may behave differently after an upgrade. You may need to manually reinstall or recompile this software after an upgrade to ensure it performs correctly on the updated system.

16.13.2. Upgrading Using the Installer

Installations are Recommended

In general, Red Hat recommends that you keep user data on a separate **/home** partition and perform a fresh installation. For more information on partitions and how to set them up, refer to [Section 9.12, “Disk Partitioning Setup”](#).

If you choose to upgrade your system using the installation program, any software not provided by Red Hat Enterprise Linux that conflicts with Red Hat Enterprise Linux software is overwritten. Before you begin an upgrade this way, make a list of your system's current packages for later reference:

```
rpm -qa --qf '%{NAME} %{VERSION}-%{RELEASE} %{ARCH}\n' > ~/old-pkgList.txt
```

After installation, consult this list to discover which packages you may need to rebuild or retrieve from sources other than Red Hat.

Next, make a backup of any system configuration data:

```
su -c 'tar czf /tmp/etc-`date +%F`.tar.gz /etc'
```



```
su -c 'mv /tmp/etc-*.tar.gz /home'
```

Make a complete backup of any important data before performing an upgrade. Important data may include the contents of your entire **/home** directory as well as content from services such as an Apache, FTP, or SQL server, or a source code management system. Although upgrades are not destructive, if you perform one improperly there is a small possibility of data loss.



Storing Backups

Note that the above examples store backup materials in a **/home** directory. If your **/home** directory is not a separate partition, *you should not follow these examples verbatim!* Store your backups on another device such as CD or DVD discs or an external hard disk.

For more information on completing the upgrade process later, refer to [Section 35.2, “Finishing an Upgrade”](#).

16.14. Disk Partitioning Setup



Warning — Back up your data

It is always a good idea to back up any data that you have on your systems. For example, if you are upgrading or creating a dual-boot system, you should back up any data you wish to keep on your storage devices. Mistakes do happen and can result in the loss of all your data.



Important — Installing in text mode

If you install Red Hat Enterprise Linux in text mode, you can only use the default partitioning schemes described in this section. You cannot add or remove partitions or file systems beyond those that the installer automatically adds or removes. If you require a customized layout at installation time, you should perform a graphical installation over a VNC connection or a kickstart installation.

Furthermore, advanced options such as LVM, encrypted filesystems, and resizable filesystems are available only in graphical mode and kickstart.



Important — Booting from RAIDs

If you have a RAID card, be aware that some BIOSes do not support booting from the RAID card. In cases such as these, the **/boot/** partition must be created on a partition outside of the RAID array, such as on a separate hard drive. An internal hard drive is necessary to use for partition creation with problematic RAID cards.

A **/boot/** partition is also necessary for software RAID setups.

If you have chosen to automatically partition your system, you should select **Review** and manually edit your **/boot/** partition.

Partitioning allows you to divide your hard drive into isolated sections, where each section behaves as its own hard drive. Partitioning is particularly useful if you run multiple operating systems. If you are not sure how you want your system to be partitioned, read [Appendix A, An Introduction to Disk Partitions](#) for more information.

Which type of installation would you like?

Use All Space
Removes all partitions on the selected device(s). This includes partitions created by other operating systems.
Tip: This option will remove data from the selected device(s). Make sure you have backups.

Replace Existing Linux System(s)
Removes only Linux partitions (created from a previous Linux installation). This does not remove other partitions you may have on your storage device(s) (such as VFAT or FAT32).
Tip: This option will remove data from the selected device(s). Make sure you have backups.

Shrink Current System
Shrinks existing partitions to create free space for the default layout.

Use Free Space
Retains your current data and partitions and uses only the unpartitioned space on the selected device(s), assuming you have enough free space available.

Create Custom Layout
Manually create your own custom layout on the selected device(s) using our partitioning tool.

Encrypt system
 Review and modify partitioning layout

Figure 16.25. Disk Partitioning Setup

On this screen you can choose to create the default partition layout in one of four different ways, or choose to partition storage devices manually to create a custom layout.

The first four options allow you to perform an automated installation without having to partition your storage devices yourself. If you do not feel comfortable with partitioning your system, choose one of these options and let the installation program partition the storage devices for you. Depending on the option that you choose, you can still control what data (if any) is removed from the system.

Your options are:

Use All Space

Select this option to remove all partitions on your hard drives (this includes partitions created by other operating systems such as Windows VFAT or NTFS partitions).



Warning

If you select this option, all data on the selected hard drives is removed by the installation program. Do not select this option if you have information that you want to keep on the hard drives where you are installing Red Hat Enterprise Linux.

In particular, do not select this option when you configure a system to chain load the Red Hat Enterprise Linux boot loader from another boot loader.

Replace Existing Linux System(s)

Select this option to remove only partitions created by a previous Linux installation. This does not remove other partitions you may have on your hard drives (such as VFAT or FAT32 partitions).

Shrink Current System

Select this option to resize your current data and partitions manually and install a default Red Hat Enterprise Linux layout in the space that is freed.

**Warning**

If you shrink partitions on which other operating systems are installed, you might not be able to use those operating systems. Although this partitioning option does not destroy data, operating systems typically require some free space in their partitions. Before you resize a partition that holds an operating system that you might want to use again, find out how much space you need to leave free.

Use Free Space

Select this option to retain your current data and partitions and install Red Hat Enterprise Linux in the unused space available on the storage drives. Ensure that there is sufficient space available on the storage drives before you select this option — refer to [Section 11.4, “Do You Have Enough Disk Space?”](#).

Create Custom Layout

Select this option to partition storage devices manually and create customized layouts. Refer to [Section 16.16, “Creating a Custom Layout or Modifying the Default Layout”](#)

Choose your preferred partitioning method by clicking the radio button to the left of its description in the dialog box.

Select **Encrypt system** to encrypt all partitions except the `/boot` partition. Refer to [Appendix C, Disk Encryption](#) for information on encryption.

To review and make any necessary changes to the partitions created by automatic partitioning, select the **Review** option. After selecting **Review** and clicking **Next** to move forward, the partitions created for you by **anaconda** appear. You can make modifications to these partitions if they do not meet your needs.

**Important — chain loading**

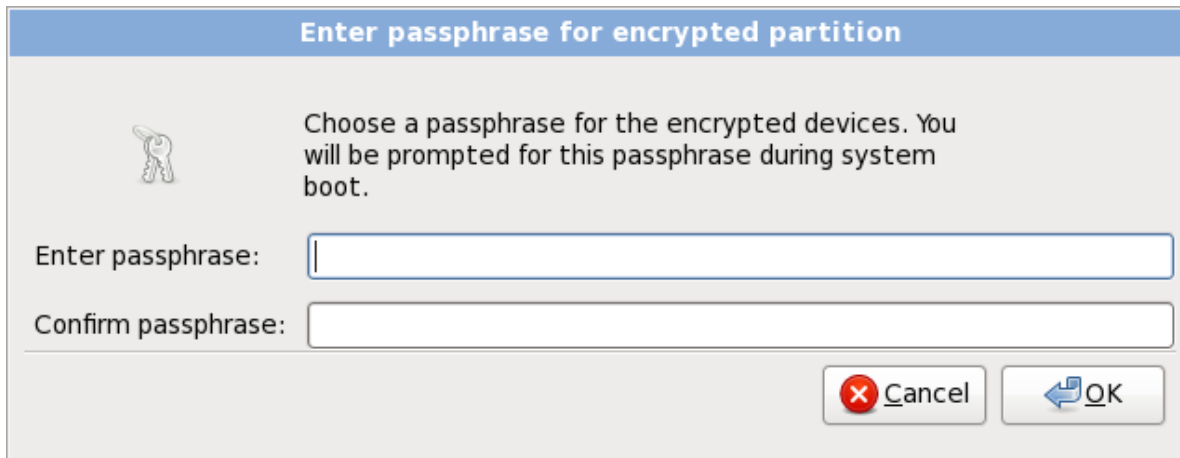
To configure the Red Hat Enterprise Linux boot loader to *chain load* from a different boot loader, you must specify the boot drive manually. If you chose any of the automatic partitioning options, you must now select the **Review and modify partitioning layout** option before you click **Next** or you cannot specify the correct boot drive.

Click **Next** once you have made your selections to proceed.

16.15. Encrypt Partitions

If you selected the **Encrypt System** option, the installer prompts you for a passphrase with which to encrypt the partitions on the system.

Partitions are encrypted using the *Linux Unified Key Setup* — refer to [Appendix C, Disk Encryption](#) for more information.



The screenshot shows a dialog box titled "Enter passphrase for encrypted partition". It contains a key icon and the text: "Choose a passphrase for the encrypted devices. You will be prompted for this passphrase during system boot." Below this text are two input fields: "Enter passphrase:" and "Confirm passphrase:". At the bottom right of the dialog are two buttons: "Cancel" and "OK".

Figure 16.26. Enter passphrase for encrypted partition

Choose a passphrase and type it into each of the two fields in the dialog box. You must provide this passphrase every time that the system boots.



Warning — Do not lose this passphrase

If you lose this passphrase, any encrypted partitions and the data on them will become completely inaccessible. There is no way to recover a lost passphrase.

Note that if you perform a kickstart installation of Red Hat Enterprise Linux, you can save encryption passphrases and create backup encryption passphrases during installation. Refer to [Section C.3.2, “Saving Passphrases”](#) and [Section C.3.3, “Creating and Saving Backup Passphrases”](#).

16.16. Creating a Custom Layout or Modifying the Default Layout

If you chose one of the four automatic partitioning options and did not select **Review**, skip ahead to [Section 16.17, “Write changes to disk”](#).

If you chose one of the automatic partitioning options and selected **Review**, you can either accept the current partition settings (click **Next**), or modify the setup manually in the partitioning screen.

If you chose to create a custom layout, you must tell the installation program where to install Red Hat Enterprise Linux. This is done by defining mount points for one or more disk partitions in which Red Hat Enterprise Linux is installed.

If you have not yet planned how to set up your partitions, refer to [Appendix A, An Introduction to Disk Partitions](#) and [Section 16.16.5, “Recommended Partitioning Scheme”](#). At a bare minimum, you need an appropriately-sized root (`/`) partition, a `/boot/` partition, PReP boot partition, and usually a swap partition appropriate to the amount of RAM you have on the system.

Anaconda can handle the partitioning requirements for a typical installation.

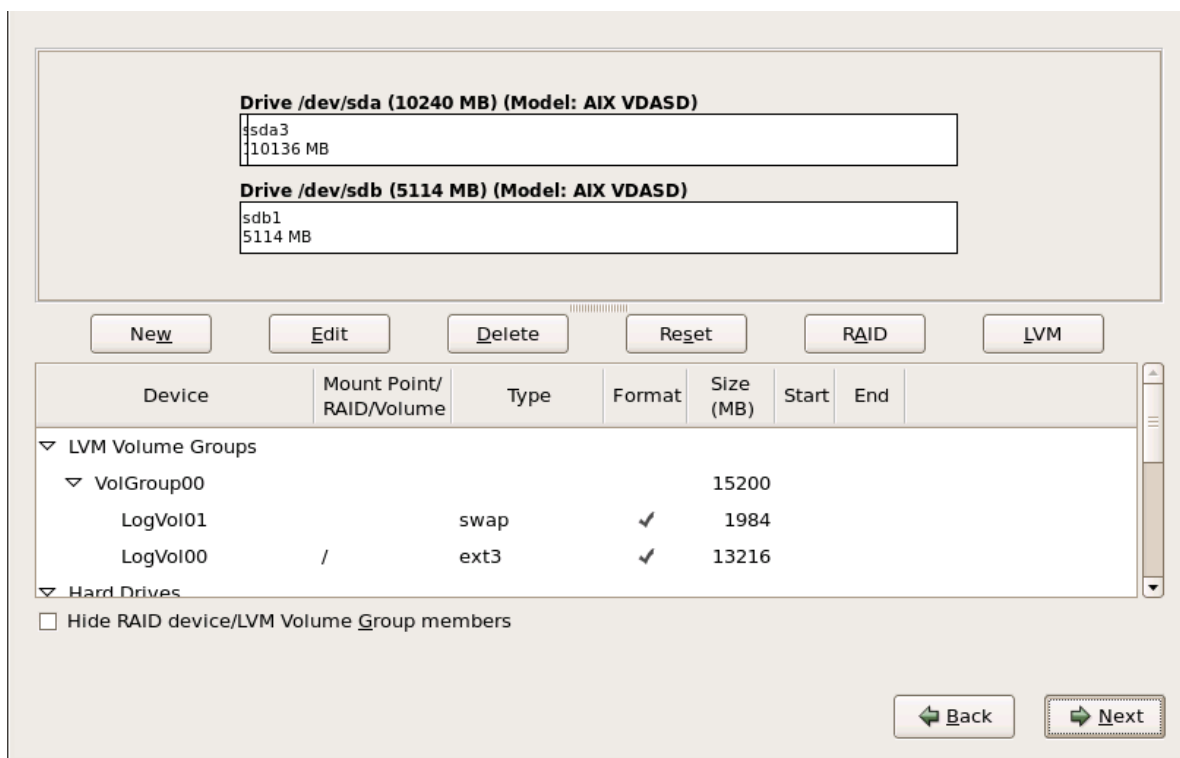


Figure 16.27. Partitioning on IBM System p

The partitioning screen contains two panes. The top pane contains a graphical representation of the hard drive, logical volume, or RAID device selected in the lower pane.

Above the graphical representation of the device, you can review the name of the drive (such as / **dev/sda** or **LogVol100**), its size (in MB), and its model as detected by the installation program.

Using your mouse, click once to highlight a particular field in the graphical display. Double-click to edit an existing partition or to create a partition out of existing free space.

The lower pane contains a list of all drives, logical volumes, and RAID devices to be used during installation, as specified earlier in the installation process — refer to [Section 16.11, “Assign Storage Devices”](#)

Devices are grouped by type. Click on the small triangles to the left of each device type to view or hide devices of that type.

Anaconda displays several details for each device listed:

Device

the name of the device, logical volume, or partition

Size (MB)

the size of the device, logical volume, or partition (in MB)

Mount Point/RAID/Volume

the *mount point* (location within a file system) on which a partition is to be mounted, or the name of the RAID or logical volume group of which it is a part

Type

the type of partition. If the partition is a standard partition, this field displays the type of file system on the partition (for example, ext4). Otherwise, it indicates that the partition is a **physical volume (LVM)**, or part of a **software RAID**

Format

A check mark in this column indicates that the partition will be formatted during installation.

Beneath the lower pane are four buttons: **Create**, **Edit**, **Delete**, and **Reset**.

Select a device or partition by clicking on it in either the graphical representation in the upper pane of in the list in the lower pane, then click one of the four buttons to carry out the following actions:

Create

create a new partition, logical volume, or software RAID

Edit

change an existing new partition, logical volume, or software RAID

Delete

remove a partition, logical volume, or software RAID

Reset

undo all changes made in this screen

16.16.1. Create Storage

The **Create Storage** dialog allows you to create new storage partitions, logical volumes, and software RAID. **Anaconda** presents options as available or unavailable depending on the storage already present on the system or configured to transfer to the system.

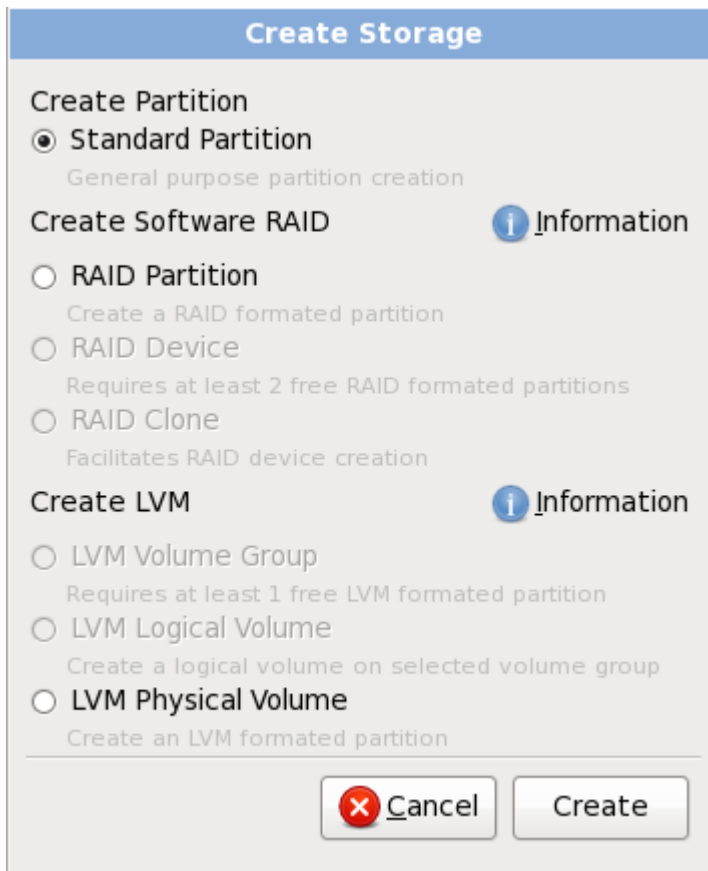


Figure 16.28. Creating Storage

Options are grouped under **Create Partition**, **Create Software RAID** and **Create LVM** as follows:

Create Partition

Refer to [Section 9.14.2, “Adding Partitions”](#) for details of the **Add Partition** dialog.

- **Standard Partition** — create a standard disk partition (as described in [Appendix A, An Introduction to Disk Partitions](#)) in unallocated space.

Create Software RAID

Refer to [Section 23.15.3, “Create Software RAID ”](#) for more detail.

- **RAID Partition** — create a partition in unallocated space to form part of a software RAID device. To form a software RAID device, two or more RAID partitions must be available on the system.
- **RAID Device** — combine two or more RAID partitions into a software RAID device. When you choose this option, you can specify the type of RAID device to create (the *RAID level*). This option is only available when two or more RAID partitions are available on the system.
- **RAID Clone** — create a mirror of a RAID partition on one storage device on another storage device. This option is only available when at least one RAID partition is available on the system.

Create LVM Logical Volume

Refer to [Section 16.16.4, “Create LVM Logical Volume ”](#) for more detail.

- **LVM Physical Volume** — create a *physical volume* in unallocated space.
- **LVM Volume Group** — create a *volume group* from one or more physical volumes. This option is only available when at least one physical volume is available on the system.
- **LVM Logical Volume** — create a *logical volume* on a volume group. This option is only available when at least one volume group is available on the system.

16.16.2. Adding Partitions

To add a new partition, select the **Create** button. A dialog box appears (refer to [Figure 16.29, “Creating a New Partition”](#)).



Note

You must dedicate at least one partition for this installation, and optionally more. For more information, refer to [Appendix A, An Introduction to Disk Partitions](#).

The screenshot shows the 'Add Partition' dialog box. It has a title bar 'Add Partition' in orange. Below it are several fields:

- Mount Point:** A text box containing '/boot' and a pull-down arrow on the right.
- File System Type:** A pull-down menu showing 'ext3'.
- Allowable Drives:** A list box containing one entry: a checked checkbox, 'hda', '5114 MB', and 'VMware Virtual IDE Hard Drive'.
- Size (MB):** A text box containing '100' and a vertical scroll bar on the right.
- Additional Size Options:** A group box containing three radio buttons:
 - Fixed size:** Selected with a radio button.
 - Fill all space up to (MB):** Unselected, with a text box containing '1' to its right.
 - Fill to maximum allowable size:** Unselected.
- Force to be a primary partition:** An unchecked checkbox.

 At the bottom right are two buttons: 'Cancel' with a blue 'X' icon and 'OK' with a green checkmark icon.

Figure 16.29. Creating a New Partition

- **Mount Point:** Enter the partition's mount point. For example, if this partition should be the root partition, enter /; enter **/boot** for the **/boot** partition, and so on. You can also use the pull-down menu to choose the correct mount point for your partition. For a swap partition the mount point should not be set — setting the filesystem type to **swap** is sufficient.
- **File System Type:** Using the pull-down menu, select the appropriate file system type for this partition. For more information on file system types, refer to [Section 16.16.2.1, “File System Types”](#).
- **Allowable Drives:** This field contains a list of the hard disks installed on your system. If a hard disk's box is highlighted, then a desired partition can be created on that hard disk. If the box is *not* checked, then the partition will *never* be created on that hard disk. By using different checkbox settings, you can have **anaconda** place partitions where you need them, or let **anaconda** decide where partitions should go.
- **Size (MB):** Enter the size (in megabytes) of the partition. Note, this field starts with 200 MB; unless changed, only a 200 MB partition will be created.
- **Additional Size Options:** Choose whether to keep this partition at a fixed size, to allow it to “grow” (fill up the available hard drive space) to a certain point, or to allow it to grow to fill any remaining hard drive space available.

If you choose **Fill all space up to (MB)**, you must give size constraints in the field to the right of this option. This allows you to keep a certain amount of space free on your hard drive for future use.

- **Force to be a primary partition:** Select whether the partition you are creating should be one of the first four partitions on the hard drive. If unselected, the partition is created as a logical partition. Refer to [Section A.1.3, “Partitions within Partitions — An Overview of Extended Partitions”](#), for more information.
- **Encrypt:** Choose whether to encrypt the partition so that the data stored on it cannot be accessed without a passphrase, even if the storage device is connected to another system. Refer to [Appendix C, Disk Encryption](#) for information on encryption of storage devices. If you select this option, the installer prompts you to provide a passphrase before it writes the partition to the disk.
- **OK:** Select **OK** once you are satisfied with the settings and wish to create the partition.
- **Cancel:** Select **Cancel** if you do not want to create the partition.

16.16.2.1. File System Types

Red Hat Enterprise Linux allows you to create different partition types and file systems. The following is a brief description of the different partition types and file systems available, and how they can be used.

Partition types

- **standard partition** — A standard partition can contain a file system or swap space, or it can provide a container for software RAID or an LVM physical volume.
- **swap** — Swap partitions are used to support virtual memory. In other words, data is written to a swap partition when there is not enough RAM to store the data your system is processing. Refer to the *Red Hat Enterprise Linux Deployment Guide* for additional information.
- **software RAID** — Creating two or more software RAID partitions allows you to create a RAID device. For more information regarding RAID, refer to the chapter *RAID (Redundant Array of Independent Disks)* in the *Red Hat Enterprise Linux Deployment Guide*.
- **physical volume (LVM)** — Creating one or more physical volume (LVM) partitions allows you to create an LVM logical volume. LVM can improve performance when using physical disks. For more information regarding LVM, refer to the *Red Hat Enterprise Linux Deployment Guide*.

File systems

- **ext4** — The ext4 file system is based on the ext3 file system and features a number of improvements. These include support for larger file systems and larger files, faster and more efficient allocation of disk space, no limit on the number of subdirectories within a directory, faster file system checking, and more robust journalling. The ext4 file system is selected by default and is highly recommended.
- **ext3** — The ext3 file system is based on the ext2 file system and has one main advantage — journalling. Using a journalling file system reduces time spent recovering a file system after a crash as there is no need to **fsck**² the file system.
- **ext2** — An ext2 file system supports standard Unix file types (regular files, directories, symbolic links, etc). It provides the ability to assign long file names, up to 255 characters.
- **xfs** — XFS is a highly scalable, high-performance file system that supports filesystems up to 16 exabytes (approximately 16 million terabytes), files up to 8 exabytes (approximately 8 million terabytes) and directory structures containing tens of millions of entries. XFS supports metadata journalling, which facilitates quicker crash recovery. The XFS file system can also be defragmented and resized while mounted and active.

- **vfat** — The VFAT file system is a Linux file system that is compatible with Microsoft Windows long filenames on the FAT file system.
- **Btrfs** — Btrfs is under development as a file system capable of addressing and managing more files, larger files, and larger volumes than the ext2, ext3, and ext4 file systems. Btrfs is designed to make the file system tolerant of errors, and to facilitate the detection and repair of errors when they occur. It uses checksums to ensure the validity of data and metadata, and maintains snapshots of the file system that can be used for backup or repair.

Because Btrfs is still experimental and under development, the installation program does not offer it by default. If you want to create a Btrfs partition on a drive, you must commence the installation process with the boot option **btrfs**. Refer to [Chapter 28, Boot Options](#) for instructions.



Btrfs is still experimental

Red Hat Enterprise Linux 6 includes Btrfs as a technology preview to allow you to experiment with this file system. You should not choose Btrfs for partitions that will contain valuable data or that are essential for the operation of important systems.

16.16.3. Create Software RAID

Redundant arrays of independent disks (RAIDs) are constructed from multiple storage devices that are arranged to provide increased performance and — in some configurations — greater fault tolerance. Refer to the *Red Hat Enterprise Linux Deployment Guide* for a description of different kinds of RAID.

To make a RAID device, you must first create software RAID partitions. Once you have created two or more software RAID partitions, select **RAID** to join the software RAID partitions into a RAID device.

RAID Partition

Choose this option to configure a partition for software RAID. This option is the only choice available if your disk contains no software RAID partitions. This is the same dialog that appears when you add a standard partition — refer to [Section 16.16.2, “Adding Partitions”](#) for a description of the available options. Note, however, that **File System Type** must be set to **software RAID**

Add Partition

Mount Point: <Not Applicable>

File System Type: software RAID

Allowable Drives:

| | | | |
|-------------------------------------|-----|----------|--------------|
| <input checked="" type="checkbox"/> | sda | 80480 MB | ATA HARDDISK |
| <input checked="" type="checkbox"/> | sdb | 80480 MB | ATA HARDDISK |

Size (MB): 200

Additional Size Options

Fixed size

Fill all space up to (MB): 1

Fill to maximum allowable size

Force to be a primary partition

Encrypt

Cancel OK

Figure 16.30. Create a software RAID partition

RAID Device

Choose this option to construct a RAID device from two or more existing software RAID partitions. This option is available if two or more software RAID partitions have been configured.

Make RAID Device

Mount Point:

File System Type: ext3

RAID Device: md0

RAID Level: RAID1

RAID Members:

| | | |
|--------------------------|------|----------|
| <input type="checkbox"/> | sda2 | 81306 MB |
| <input type="checkbox"/> | sdb1 | 81502 MB |

Number of spares: 0

Encrypt

Cancel OK

Figure 16.31. Create a RAID device

Select the file system type as for a standard partition.

Anaconda automatically suggests a name for the RAID device, but you can manually select names from **md0** to **md15**.

Click the checkboxes beside individual storage devices to include or remove them from this RAID.

The **RAID Level** corresponds to a particular type of RAID. Choose from the following options:

- **RAID 0** — distributes data across multiple storage devices. Level 0 RAID offers increased performance over standard partitions, and can be used to pool the storage of multiple devices into one large virtual device. Note that Level 0 RAID offers no redundancy and that the failure of one device in the array destroys the entire array. RAID 0 requires at least two RAID partitions.
- **RAID 1** — mirrors the data on one storage device onto one or more other storage devices. Additional devices in the array provide increasing levels of redundancy. RAID 1 requires at least two RAID partitions.
- **RAID 4** — distributes data across multiple storage devices, but uses one device in the array to store parity information that safeguards the array in case any device within the array fails. Because all parity information is stored on the one device, access to this device creates a bottleneck in the performance of the array. RAID 4 requires at least three RAID partitions.
- **RAID 5** — distributes data and parity information across multiple storage devices. Level 5 RAID therefore offers the performance advantages of distributing data across multiple devices, but does not share the performance bottleneck of level 4 RAID because the parity information is also distributed through the array. RAID 5 requires at least three RAID partitions.
- **RAID 6** — level 6 RAID is similar to level 5 RAID, but instead of storing only one set of parity data, they store two sets. RAID 6 requires at least four RAID partitions.
- **RAID 10** — level 10 RAID is a *nested RAID* or *hybrid RAID*. Level 10 RAID is constructed by distributing data over mirrored sets of storage devices. For example, a level 10 RAID constructed from four RAID partitions consists of two pairs of partitions in which one partition mirrors the other. Data is then distributed across both pairs of storage devices, as in a level 0 RAID. RAID 10 requires at least four RAID partitions.

RAID Clone

Choose this option to set up a RAID *mirror* of an existing disk. This option is available if two or more disks are attached to the system.

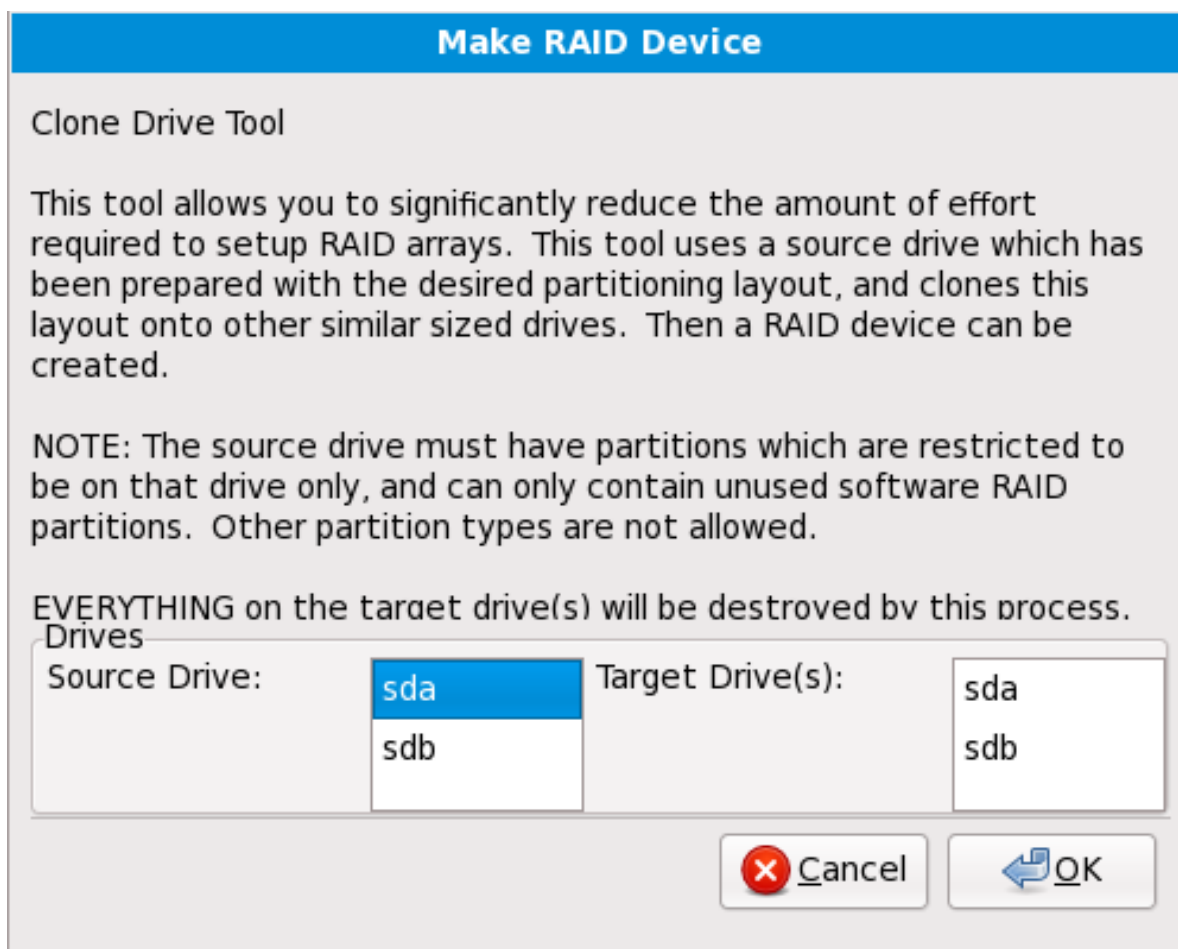


Figure 16.32. Clone a RAID device

16.16.4. Create LVM Logical Volume



Important — LVM Unavailable in Text-Mode Installations

LVM initial set up is not available during text-mode installation. If you need to create an LVM configuration from scratch, press **Alt+F2** to use a different virtual console, and run the **lvm** command. To return to the text-mode installation, press **Alt+F1**.

Logical Volume Management (LVM) presents a simple logical view of underlying physical storage space, such as a hard drives or LUNs. Partitions on physical storage are represented as *physical volumes* that can be grouped together into *volume groups*. Each volume group can be divided into multiple *logical volumes*, each of which is analogous to a standard disk partition. Therefore, LVM logical volumes function as partitions that can span multiple physical disks.

To read more about LVM, refer to the *Red Hat Enterprise Linux Deployment Guide*. Note, LVM is only available in the graphical installation program.

LVM Physical Volume

Choose this option to configure a partition or device as an LVM physical volume. This option is the only choice available if your storage does not already contain LVM Volume Groups. This is the same dialog that appears when you add a standard partition — refer to [Section 16.16.2, “Adding](#)

Partitions” for a description of the available options. Note, however, that **File System Type** must be set to **physical volume (LVM)**

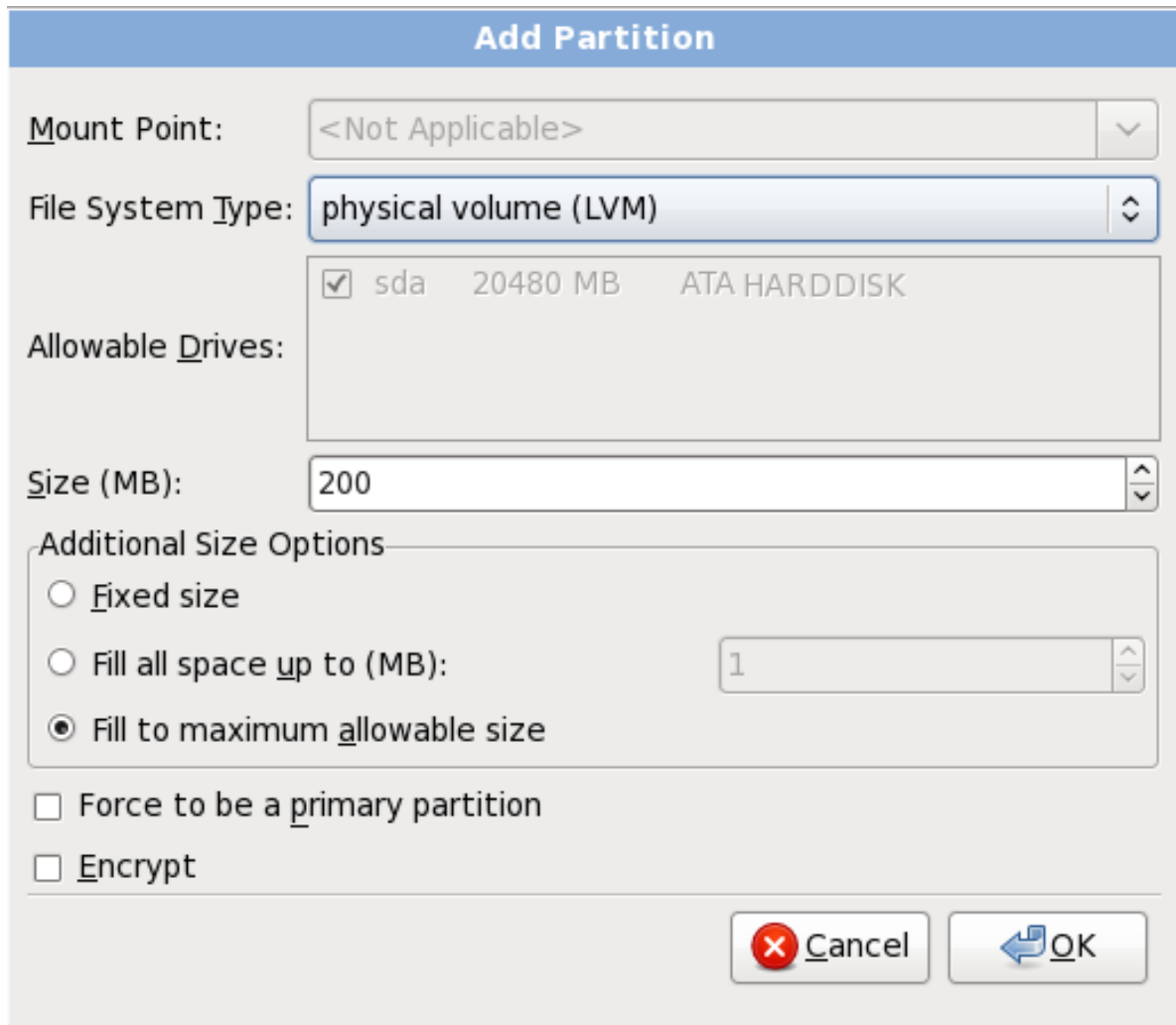


Figure 16.33. Create an LVM Physical Volume

Make LVM Volume Group

Choose this option to create LVM volume groups from the available LVM physical volumes, or to add existing logical volumes to a volume group.

Make LVM Volume Group

Volume Group Name:

Physical Extent:

Physical Volumes to Use:

| | | |
|-------------------------------------|------|------------|
| <input checked="" type="checkbox"/> | sda1 | 5000.00 MB |
|-------------------------------------|------|------------|

Used Space: 0.00 MB (0.0 %)
Free Space: 4996.00 MB (100.0 %)
Total Space: 4996.00 MB

Logical Volumes

| Logical Volume Name | Mount Point | Size (MB) |
|---------------------|-------------|-----------|
| | | |

Figure 16.34. Make LVM Volume Group

To assign one or more physical volumes to a volume group, first name the volume group. Then select the physical volumes to be used in the volume group. Finally, configure logical volumes on any volume groups using the **Add**, **Edit** and **Delete** options.

You may not remove a physical volume from a volume group if doing so would leave insufficient space for that group's logical volumes. Take for example a volume group made up of two 5 GB LVM physical volume partitions, which contains an 8 GB logical volume. The installer would not allow you to remove either of the component physical volumes, since that would leave only 5 GB in the group for an 8 GB logical volume. If you reduce the total size of any logical volumes appropriately, you may then remove a physical volume from the volume group. In the example, reducing the size of the logical volume to 4 GB would allow you to remove one of the 5 GB physical volumes.

Make Logical Volume

Choose this option to create an LVM logical volume. Select a mount point, file system type, and size (in MB) just as if it were a standard disk partition. You can also choose a name for the logical volume and specify the volume group to which it will belong.

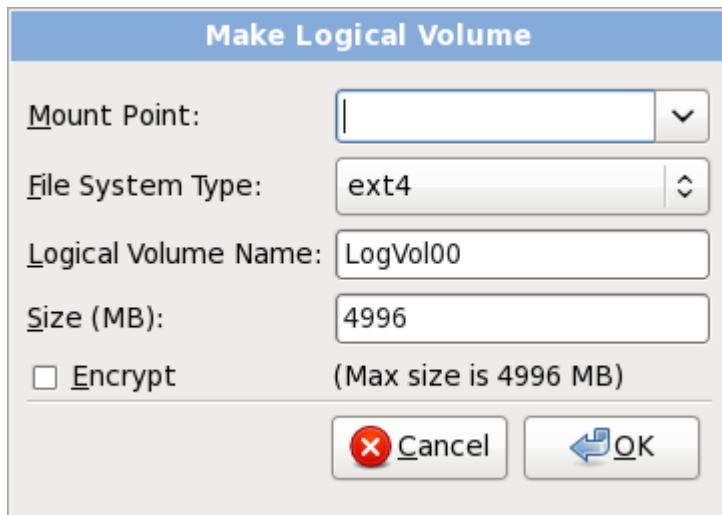


Figure 16.35. Make Logical Volume

16.16.5. Recommended Partitioning Scheme

Unless you have a reason for doing otherwise, we recommend that you create the following partitions:

- A swap partition (at least 256 MB) — swap partitions are used to support virtual memory. In other words, data is written to a swap partition when there is not enough RAM to store the data your system is processing.

In years past, the recommended amount of swap space increased linearly with the amount of RAM in the system. But because the amount of memory in modern systems has increased into the hundreds of gigabytes, it is now recognized that the amount of swap space that a system needs is a function of the memory workload running on that system. However, given that swap space is usually designated at install time, and that it can be difficult to determine beforehand the memory workload of a system, we recommend determining system swap using the following table.

Table 16.2. Recommended System Swap Space

| Amount of RAM in the System | Recommended Amount of Swap Space |
|-----------------------------|----------------------------------|
| 4GB of RAM or less | a minimum of 2GB of swap space |
| 4GB to 16GB of RAM | a minimum of 4GB of swap space |
| 16GB to 64GB of RAM | a minimum of 8GB of swap space |
| 64GB to 256GB of RAM | a minimum of 16GB of swap space |
| 256GB to 512GB of RAM | a minimum of 32GB of swap space |

Note that you can obtain better performance by distributing swap space over multiple storage devices, particularly on systems with fast drives, controllers, and interfaces.

- A PReP boot partition on the first partition of the hard drive — the PReP boot partition contains the YABOOT boot loader (which allows other POWER systems to boot Red Hat Enterprise Linux). Unless you plan to boot from a network source, you must have a PReP boot partition to boot Red Hat Enterprise Linux.

For IBM System p users: The PReP boot partition should be between 4-8 MB, not to exceed 10 MB.

- A **/boot/** partition (250 MB) — the partition mounted on **/boot/** contains the operating system kernel (which allows your system to boot Red Hat Enterprise Linux), along with files used during

the bootstrap process. Due to the limitations of most PC firmware, creating a small partition to hold these is a good idea. For most users, a 250 MB boot partition is sufficient.



Warning

If you have a RAID card, be aware that Red Hat Enterprise Linux 6 does not support setting up hardware RAID on an IPR card. If you already have the RAID array setup, Open Firmware does not support booting from the RAID card. In cases such as these, the `/boot/` partition must be created on a partition outside of the RAID array, such as on a separate hard drive.

- **A root partition (3.0 GB - 5.0 GB)**

This is where `/` (the root directory) is located. In this setup, all files (except those stored in `/boot`) are on the root partition.

A 3.0 GB partition allows you to install a minimal installation, while a 5.0 GB root partition lets you perform a full installation, choosing all package groups.



Root and `/root`

The `/` (or root) partition is the top of the directory structure. The `/root` directory/`root` (sometimes pronounced "slash-root") directory is the home directory of the user account for system administration.



Warning

The **PackageKit** update software downloads updated packages to `/var/cache/yum/` by default. If you partition the system manually, and create a separate `/var/` partition, be sure to create the partition large enough (3.0 GB or more) to download package updates.

16.17. Write changes to disk

The installer prompts you to confirm the partitioning options that you selected. Click **Write changes to disk** to allow the installer to partition your hard drive and install Red Hat Enterprise Linux.

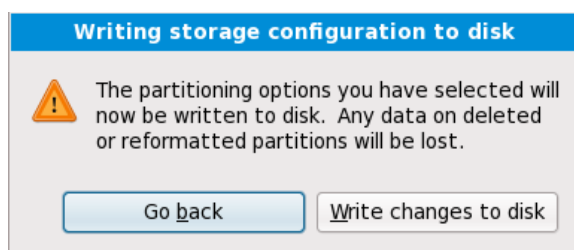


Figure 16.36. Writing storage configuration to disk

If you are certain that you want to proceed, click **Write changes to disk**.



Last chance to cancel safely

Up to this point in the installation process, the installer has made no lasting changes to your computer. When you click **Write changes to disk**, the installer will allocate space on your hard drive and start to transfer Red Hat Enterprise Linux into this space. Depending on the partitioning option that you chose, this process might include erasing data that already exists on your computer.

To revise any of the choices that you made up to this point, click **Go back**. To cancel installation completely, switch off your computer.

After you click **Write changes to disk**, allow the installation process to complete. If the process is interrupted (for example, by you switching off or resetting the computer, or by a power outage) you will probably not be able to use your computer until you restart and complete the Red Hat Enterprise Linux installation process, or install a different operating system.

16.18. Package Group Selection

Now that you have made most of the choices for your installation, you are ready to confirm the default package selection or customize packages for your system.

The **Package Installation Defaults** screen appears and details the default package set for your Red Hat Enterprise Linux installation. This screen varies depending on the version of Red Hat Enterprise Linux you are installing.



Installing in text mode

If you install Red Hat Enterprise Linux in text mode, you cannot make package selections. The installer 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. To change the package selection, complete the installation, then use the **Add/Remove Software** application to make desired changes.

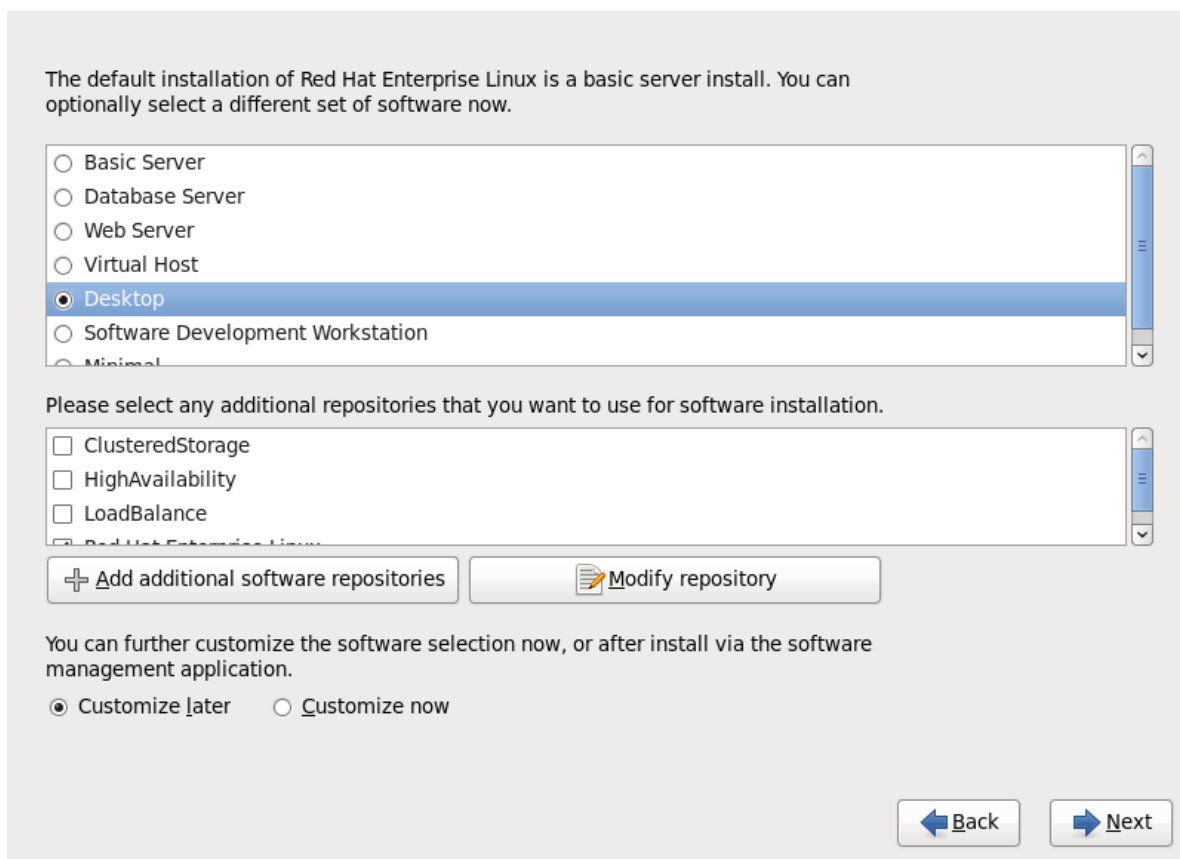


Figure 16.37. Package Group Selection

By default, the Red Hat Enterprise Linux installation process loads a selection of software that is suitable for a system deployed as a basic server. Note that this installation does not include a graphical environment. To include a selection of software suitable for other roles, click the radio button that corresponds to one of the following options:

Basic Server

This option provides a basic installation of Red Hat Enterprise Linux for use on a server.

Database Server

This option provides the **MySQL** and **PostgreSQL** databases.

Web server

This option provides the **Apache** web server.

Desktop

This option provides the **OpenOffice.org** productivity suite, graphical tools such as the **GIMP**, and multimedia applications.

Software Development Workstation

This option provides the necessary tools to compile software on your Red Hat Enterprise Linux system.

Minimal

This option provides only the packages essential to run Red Hat Enterprise Linux. A minimal installation provides the basis for a single-purpose server or desktop appliance and maximizes performance and security on such an installation.

If you choose to accept the current package list, skip ahead to [Section 16.19, “Installing Packages”](#).

To select a component, click on the checkbox beside it (refer to [Figure 16.37, “Package Group Selection”](#)).

To customize your package set further, select the **Customize now** option on the screen. Clicking **Next** takes you to the **Package Group Selection** screen.

16.18.1. Installing from Additional Repositories

You can define additional *repositories* to increase the software available to your system during installation. A repository is a network location that stores software packages along with *metadata* that describes them. Many of the software packages used in Red Hat Enterprise Linux require other software to be installed. The installer uses the metadata to ensure that these requirements are met for every piece of software you select for installation.

The basic options are:

- The **ClusteredStorage** repository includes packages for storage clustering using the Red Hat *global file system* (GFS).
- The **HighAvailability** repository includes packages for high-availability clustering (also known as *failover clustering*) using the Red Hat High-availability Service Management component.
- The **LoadBalance** repository includes packages for load-balancing clustering using *Linux Virtual Server* (LVS).
- The **Red Hat Enterprise Linux 6** repository is automatically selected for you. It contains the complete collection of software that was released as Red Hat Enterprise Linux 6, with the various pieces of software in their versions that were current at the time of release.

For more information about clustering with Red Hat Enterprise Linux 6, refer to the *Red Hat Enterprise Linux 6 Cluster Suite Overview*, available from <https://access.redhat.com/knowledge/docs/manuals/>.

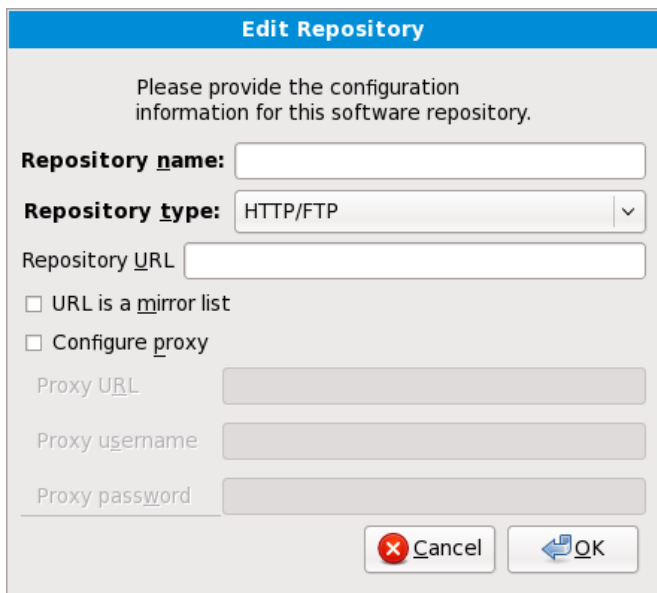


Figure 16.38. Adding a software repository

To include software from extra *repositories*, select **Add additional software repositories** and provide the location of the repository.

To edit an existing software repository location, select the repository in the list and then select **Modify repository**.



Network Access Required

If you change the repository information during a non-network installation, such as from a Red Hat Enterprise Linux DVD, the installer prompts you for network configuration information.

If you select **Add additional software repositories**, the **Edit repository** dialog appears. Provide a **Repository name** and the **Repository URL** for its location.

Once you have located a mirror, to determine the URL to use, find the directory on the mirror that *contains* a directory named **repodata**.

Once you provide information for an additional repository, the installer reads the package metadata over the network. Software that is specially marked is then included in the package group selection system.



Backtracking Removes Repository Metadata

If you choose **Back** from the package selection screen, any extra repository data you may have entered is lost. This allows you to effectively cancel extra repositories. Currently there is no way to cancel only a single repository once entered.

16.18.2. Customizing the Software Selection



Additional Language Support

Your Red Hat Enterprise Linux system automatically supports the language that you selected at the start of the installation process. To include support for additional languages, select the package group for those languages from the **Languages** category.



Note — 64-bit applications

Users who want support for developing or running 64-bit applications are encouraged to select the **Compatibility Arch Support** and **Compatibility Arch Development Support** packages to install architecture specific support for their systems.

Select **Customize now** to specify the software packages for your final system in more detail. This option causes the installation process to display an additional customization screen when you select **Next**.

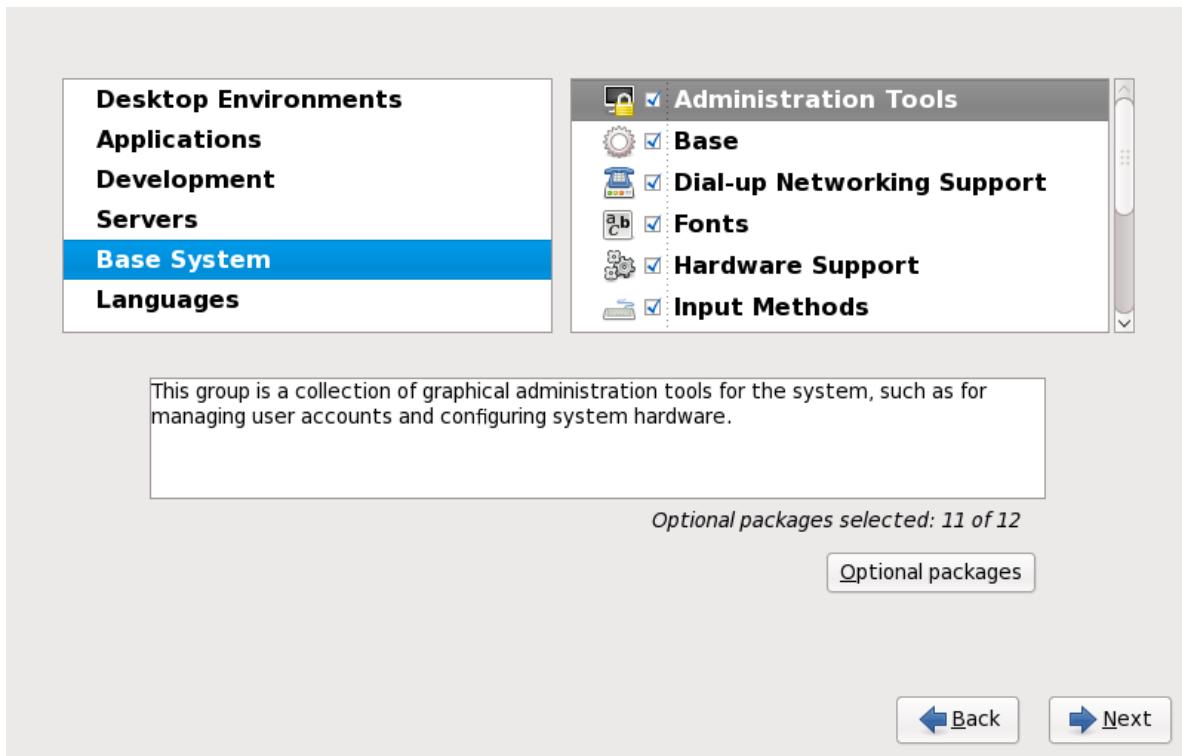


Figure 16.39. Package Group Details

Red Hat Enterprise Linux divides the included software into *package groups*. For ease of use, the package selection screen displays these groups as categories.

You can select package groups, which group components together according to function (for example, **X Window System** and **Editors**), individual packages, or a combination of the two.

To view the package groups for a category, select the category from the list on the left. The list on the right displays the package groups for the currently selected category.

To specify a package group for installation, select the check box next to the group. The box at the bottom of the screen displays the details of the package group that is currently highlighted. *None* of the packages from a group will be installed unless the check box for that group is selected.

If you select a package group, Red Hat Enterprise Linux automatically installs the base and mandatory packages for that group. To change which optional packages within a selected group will be installed, select the **Optional Packages** button under the description of the group. Then use the check box next to an individual package name to change its selection.

In the package selection list on the right, you can use the context menu as a shortcut to select or de-select base and mandatory packages or all optional packages.

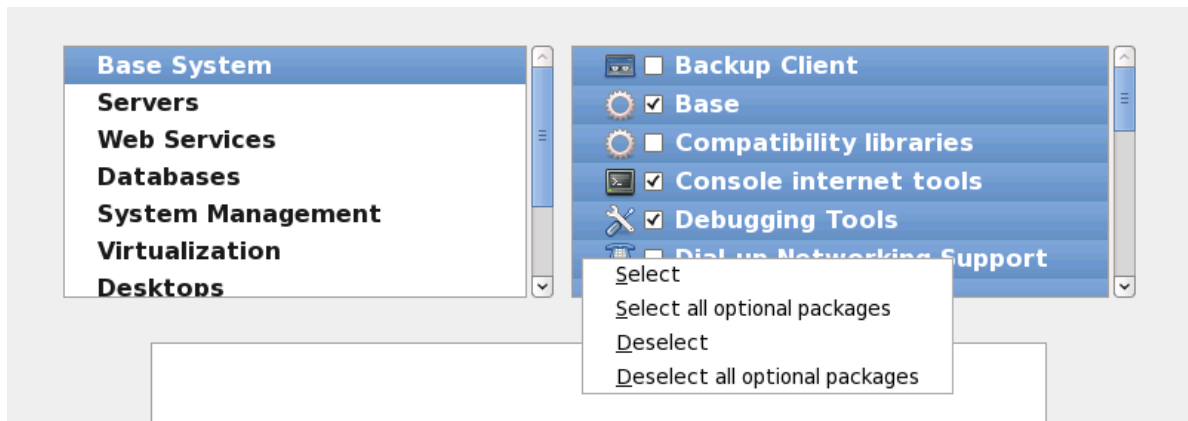


Figure 16.40. Package Selection List Context Menu

After you choose the desired packages, select **Next** to proceed. The installer checks your selection, and automatically adds any extra packages required to use the software you selected. When you have finished selecting packages, click **Close** to save your optional package selections and return to the main package selection screen.

The packages that you select are not permanent. After you boot your system, use the **Add/Remove Software** tool to either install new software or remove installed packages. To run this tool, from the main menu, select **System** → **Administration** → **Add/Remove Software**. The Red Hat Enterprise Linux software management system downloads the latest packages from network servers, rather than using those on the installation discs.

16.18.2.1. Core Network Services

All Red Hat Enterprise Linux installations include the following network services:

- centralized logging through syslog
- email through SMTP (Simple Mail Transfer Protocol)
- network file sharing through NFS (Network File System)
- remote access through SSH (Secure SHell)
- resource advertising through mDNS (multicast DNS)

The default installation also provides:

- network file transfer through HTTP (HyperText Transfer Protocol)
- printing through CUPS (Common UNIX Printing System)
- remote desktop access through VNC (Virtual Network Computing)

Some automated processes on your Red Hat Enterprise Linux system use the email service to send reports and messages to the system administrator. By default, the email, logging, and printing services do not accept connections from other systems. Red Hat Enterprise Linux installs the NFS sharing, HTTP, and VNC components without enabling those services.

You may configure your Red Hat Enterprise Linux system after installation to offer email, file sharing, logging, printing and remote desktop access services. The SSH service is enabled by default. You may use NFS to access files on other systems without enabling the NFS sharing service.

16.19. Installing Packages

At this point there is nothing left for you to do until all the packages have been installed. How quickly this happens depends on the number of packages you have selected and your computer's speed.

Depending on the available resources, you might see the following progress bar while the installer resolves dependencies of the packages you selected for installation:

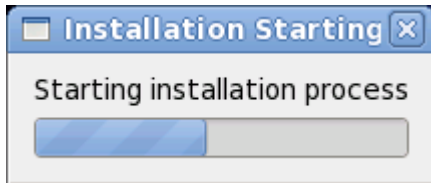


Figure 16.41. Starting installation

During installation of the selected packages and their dependencies, you see the following progress bar:

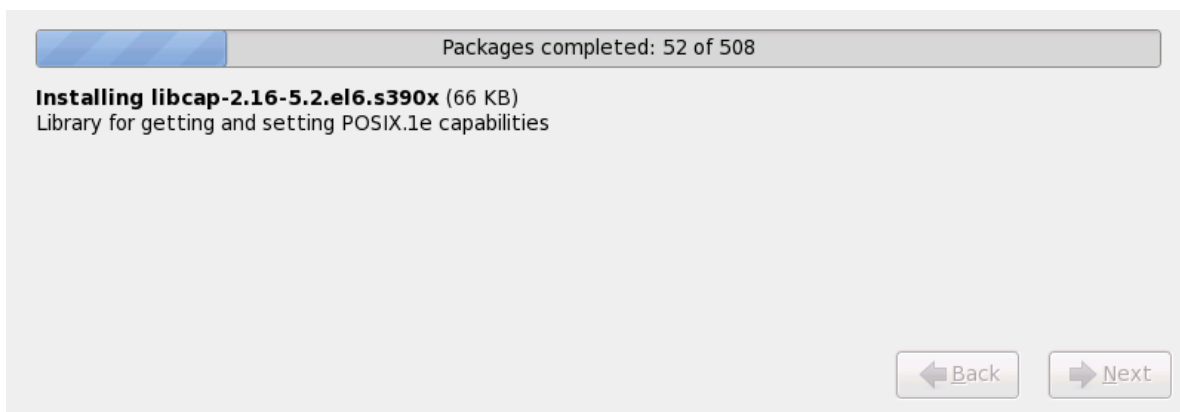


Figure 16.42. Packages completed

16.20. Installation Complete

Congratulations! Your Red Hat Enterprise Linux installation is now complete!

The installation program prompts you to prepare your system for reboot. Remember to remove any installation media if it is not ejected automatically upon reboot.

After your computer's normal power-up sequence has completed, Red Hat Enterprise Linux loads and starts. By default, the start process is hidden behind a graphical screen that displays a progress bar. Eventually, a `login:` prompt or a GUI login screen (if you installed the X Window System and chose to start X automatically) appears.

The first time you start your Red Hat Enterprise Linux system in run level 5 (the graphical run level), the **FirstBoot** tool appears, which guides you through the Red Hat Enterprise Linux configuration. Using this tool, you can set your system time and date, install software, register your machine with Red Hat Network, and more. **FirstBoot** lets you configure your environment at the beginning, so that you can get started using your Red Hat Enterprise Linux system quickly.

Troubleshooting Installation on an IBM POWER System

This section discusses some common installation problems and their solutions.

For debugging purposes, **anaconda** logs installation actions into files in the `/tmp` directory. These files include:

/tmp/anaconda.log

general **anaconda** messages

/tmp/program.log

all external programs run by **anaconda**

/tmp/storage.log

extensive storage module information

/tmp/yum.log

yum package installation messages

/tmp/syslog

hardware-related system messages

If the installation fails, the messages from these files are consolidated into `/tmp/anacdump.txt`.

You may also find the IBM Online Alert Section for System p useful. It is located at:

<http://www14.software.ibm.com/webapp/set2/sas/f/lopdiags/info/LinuxAlerts.html>

All of the files above reside in the installer's ramdisk and are thus volatile. To make a permanent copy, copy those files to another system on the network using **scp** on the installation image (not the other way round).

17.1. You are unable to boot Red Hat Enterprise Linux

17.1.1. Is Your System Displaying Signal 11 Errors?

A signal 11 error, commonly known as a *segmentation fault*, means that the program accessed a memory location that was not assigned to it. A signal 11 error may be due to a bug in one of the software programs that is installed, or faulty hardware.

If you receive a fatal signal 11 error during your installation, it is probably due to a hardware error in memory on your system's bus. Like other operating systems, Red Hat Enterprise Linux places its own demands on your system's hardware. Some of this hardware may not be able to meet those demands, even if they work properly under another OS.

Ensure that you have the latest installation updates and images. Review the online errata to see if newer versions are available. If the latest images still fail, it may be due to a problem with your hardware. Commonly, these errors are in your memory or CPU-cache. A possible solution for this error is turning off the CPU-cache in the BIOS, if your system supports this. You could also try to swap your memory around in the motherboard slots to check if the problem is either slot or memory related.

Another option is to perform a media check on your installation DVD. **Anaconda**, the installation program, has the ability to test the integrity of the installation media. It works with the DVD, hard drive

ISO, and NFS ISO installation methods. Red Hat recommends that you test all installation media before starting the installation process, and before reporting any installation-related bugs (many of the bugs reported are actually due to improperly-burned DVDs). To use this test, type the following command at the boot : or yaboot : prompt:

```
linux mediacheck
```

For more information concerning signal 11 errors, refer to:

```
http://www.bitwizard.nl/sig11/
```

17.2. Trouble Beginning the Installation

17.2.1. Problems with Booting into the Graphical Installation

There are some video cards that have trouble booting into the graphical installation program. If the installation program does not run using its default settings, it tries to run in a lower resolution mode. If that still fails, the installation program attempts to run in text mode.

One possible solution is to try using the **resolution=** boot option. Refer to [Chapter 28, Boot Options](#) for more information.



Note

To disable frame buffer support and allow the installation program to run in text mode, try using the **nofb** boot option. This command may be necessary for accessibility with some screen reading hardware.

17.3. Trouble During the Installation

17.3.1. No devices found to install Red Hat Enterprise Linux Error Message

If you receive an error message stating **No devices found to install Red Hat Enterprise Linux**, there is probably a SCSI controller that is not being recognized by the installation program.

Check your hardware vendor's website to determine if a driver diskette image is available that fixes your problem. For more general information on driver diskettes, refer to [Chapter 13, Updating drivers during installation on IBM POWER systems](#).

You can also refer to the *Red Hat Hardware Compatibility List*, available online at:

```
http://hardware.redhat.com/hcl/
```

17.3.2. Saving traceback messages

If **anaconda** encounters an error during the graphical installation process, it presents you with a crash reporting dialog box:

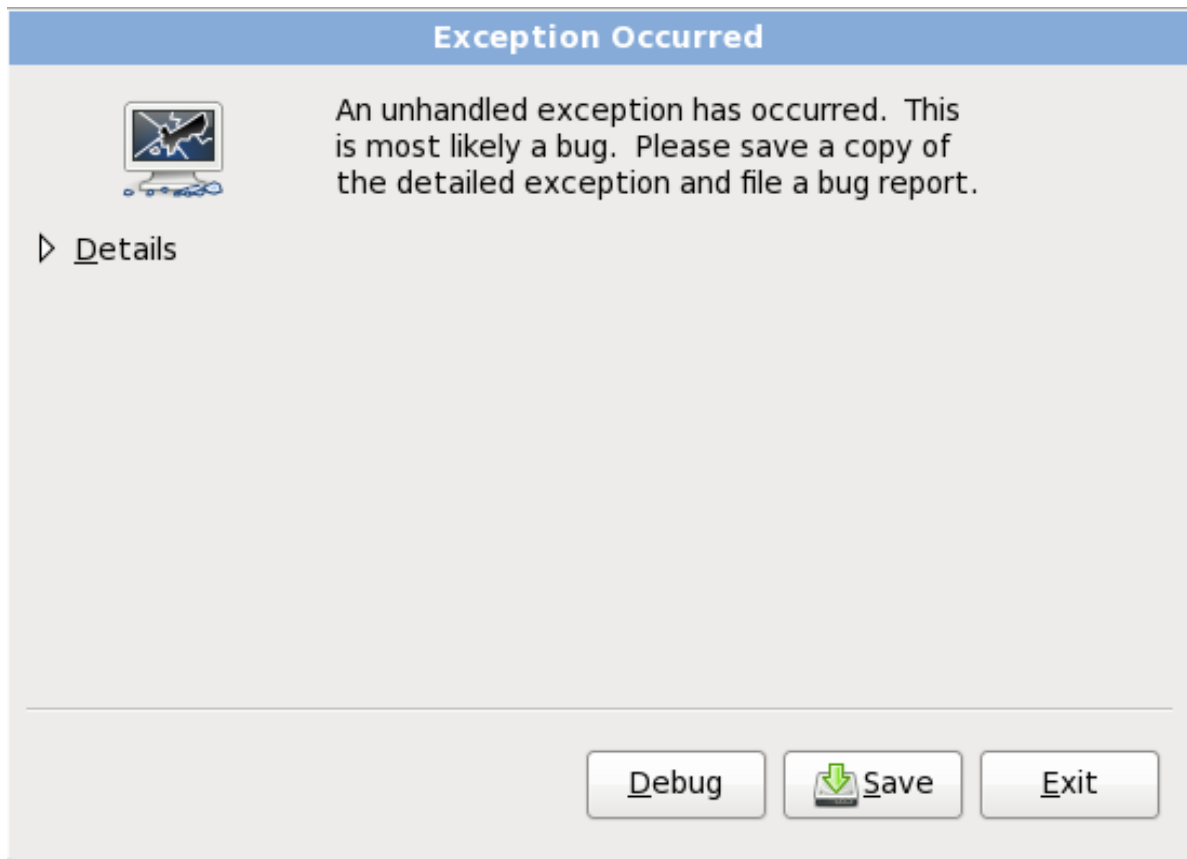


Figure 17.1. The Crash Reporting Dialog Box

Details

shows you the details of the error:

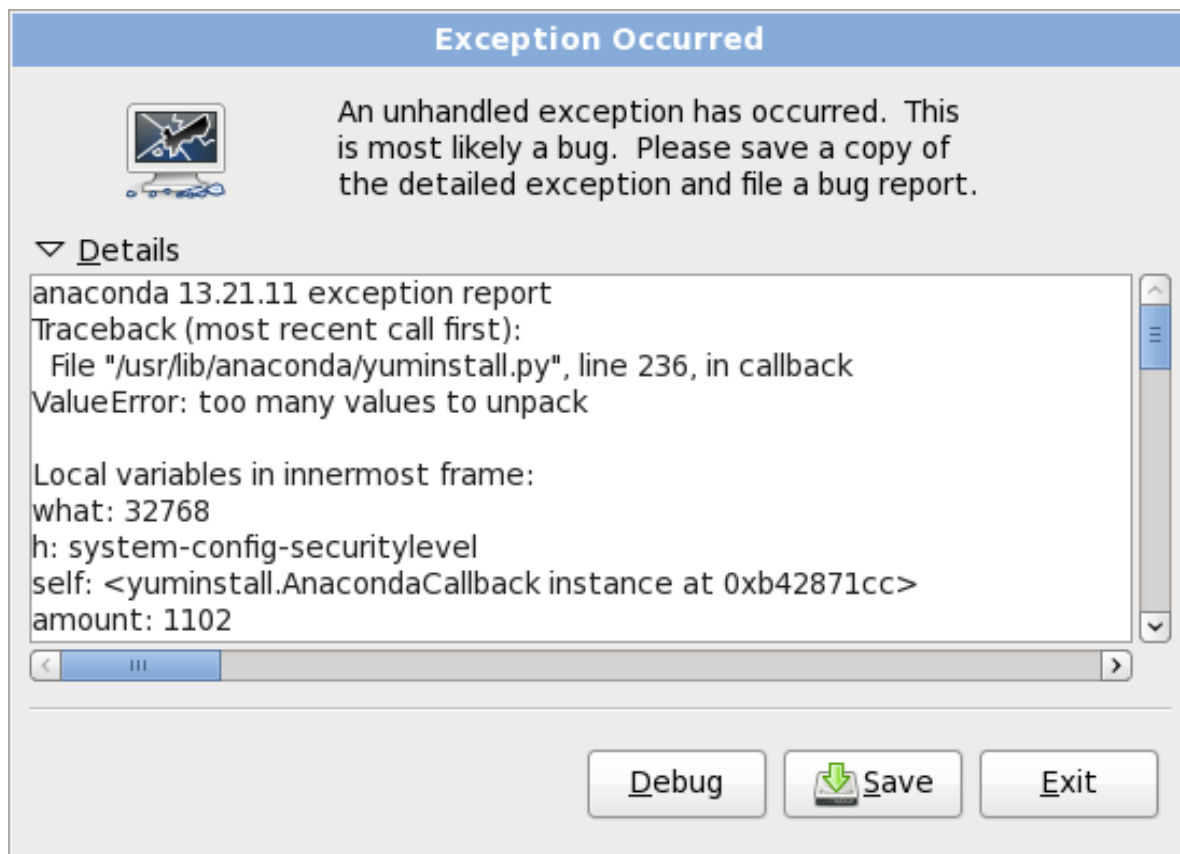


Figure 17.2. Details of the Crash

Save

saves details of the error locally or remotely:

Exit installer

exits the installation process.

If you select **Save** from the main dialog, you can choose from the following options:

Local disk

saves details of the error to the local hard drive, in a directory that you select with the file browser:

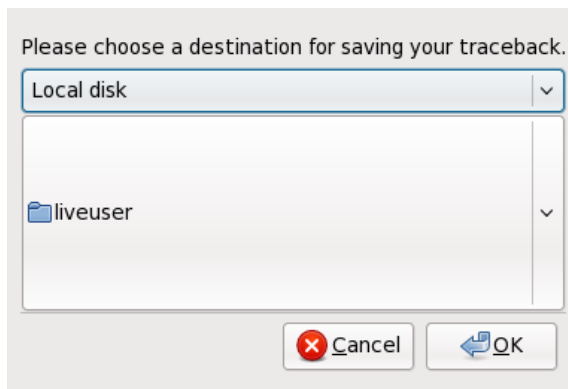


Figure 17.3. Save Crash Report to a Local disk

Bugzilla

submits details of the error to Red Hat's bug-tracking system, Bugzilla. You must supply an existing Bugzilla username and password, and a description of the bug.

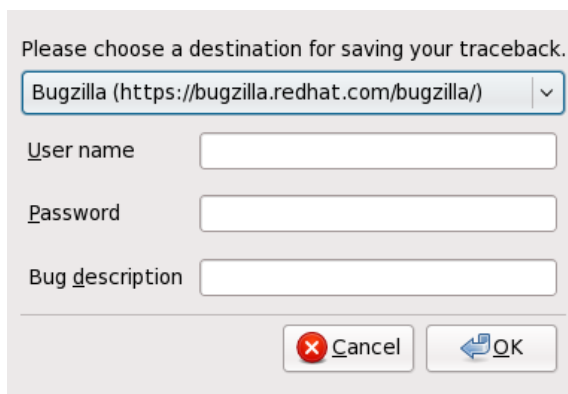


Figure 17.4. Save Crash Report to Bugzilla

Remote server

saves details of the error to a remote location using **SCP**. You must specify the username, password, host, and destination file.

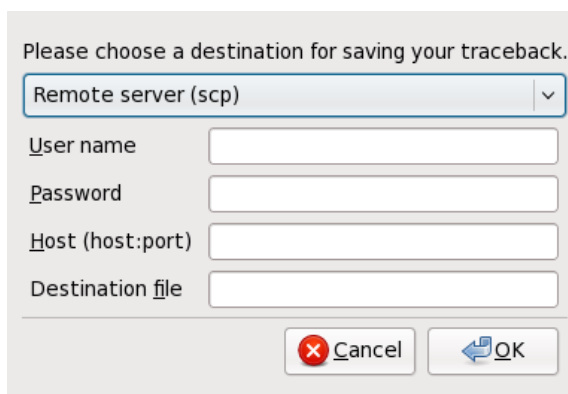


Figure 17.5. Save Crash Report to Remote Server



IBM System p systems

This information does not apply to users of headless IBM System p systems.

17.3.3. Trouble with Partition Tables

If you receive an error after the **Disk Partitioning Setup** ([Section 16.14, "Disk Partitioning Setup"](#)) phase of the installation saying something similar to

The partition table on device hda was unreadable. To create new partitions it must be initialized, causing the loss of ALL DATA on this drive.

you may not have a partition table on that drive or the partition table on the drive may not be recognizable by the partitioning software used in the installation program.

No matter what type of installation you are performing, backups of the existing data on your systems should always be made.

17.3.4. Other Partitioning Problems for IBM™ POWER System Users

If you create partitions manually, but cannot move to the next screen, you probably have not created all the partitions necessary for installation to proceed.

You must have the following partitions as a bare minimum:

- A / (root) partition
- A <swap> partition of type swap
- A PReP Boot partition.
- A /boot/ partition.



Note

When defining a partition's type as swap, do not assign it a mount point. **Anaconda** automatically assigns the mount point for you.

17.3.5. Are You Seeing Python Errors?

During some upgrades or installations of Red Hat Enterprise Linux, the installation program (also known as **anaconda**) may fail with a Python or traceback error. This error may occur after the selection of individual packages or while trying to save the upgrade log in the `/tmp/` directory. The error may look similar to:

```
Traceback (innermost last):
File "/var/tmp/anaconda-7.1//usr/lib/anaconda/iw/progress_gui.py", line 20, in run
rc = self.todo.doInstall ()
File "/var/tmp/anaconda-7.1//usr/lib/anaconda/todo.py", line 1468, in doInstall
self.fstab.savePartitions ()
File "fstab.py", line 221, in savePartitions
sys.exit(0)
```

```
SystemExit: 0
Local variables in innermost frame:
self: <fstab.GuiFstab instance at 8446fe0>
sys: <module 'sys' (built-in)>
ToDo object: (itodo ToDo p1 (dp2 S'method' p3 (iimage CdromInstallMethod
p4 (dp5 S'progressWindow' p6 <failed>
```

This error occurs in some systems where links to **/tmp/** are symbolic to other locations or have been changed since creation. These symbolic or changed links are invalid during the installation process, so the installation program cannot write information and fails.

If you experience such an error, first try to download any available updates for **anaconda**. Updates for **anaconda** and instructions for using them can be found at:

<http://fedoraproject.org/wiki/Anaconda/Updates>

You can also find and download errata for **anaconda** through your Red Hat Subscription. Log in to your account through the customer portal at <https://access.redhat.com/login>, click the **Errata** link at the top of the window, enter **anaconda** in the field marked **Filter by Synopsis**, and click **go**.

The **anaconda** website may also be a useful reference and can be found online at:

<http://fedoraproject.org/wiki/Anaconda>

You can also search for bug reports related to this problem. To search Red Hat's bug tracking system, go to:

<http://bugzilla.redhat.com/bugzilla/>

Finally, if you are still facing problems related to this error, register your product and contact our support team. To register your product, go to:

<http://www.redhat.com/apps/activate/>

17.4. Problems After Installation

17.4.1. Unable to IPL from *NWSSTG

If you are experiencing difficulties when trying to IPL from *NWSSTG, you may not have created a PReP Boot partition set as active.

17.4.2. Booting into a Graphical Environment

If you have installed the X Window System but are not seeing a graphical desktop environment once you log into your system, you can start the X Window System graphical interface using the command **startx**.

Once you enter this command and press **Enter**, the graphical desktop environment is displayed.

Note, however, that this is just a one-time fix and does not change the log in process for future log ins.

To set up your system so that you can log in at a graphical login screen, you must edit one file, `/etc/inittab`, by changing just one number in the runlevel section. When you are finished, reboot the computer. The next time you log in, you are presented with a graphical login prompt.

Open a shell prompt. If you are in your user account, become root by typing the `su` command.

Now, type `gedit /etc/inittab` to edit the file with `gedit`. The file `/etc/inittab` opens. Within the first screen, a section of the file which looks like the following appears:

```
# Default runlevel. The runlevels used are:
# 0 - halt (Do NOT set initdefault to this)
# 1 - Single user mode
# 2 - Multiuser, without NFS (The same as 3, if you do not have networking)
# 3 - Full multiuser mode
# 4 - unused
# 5 - X11
# 6 - reboot (Do NOT set initdefault to this)
# id:3:initdefault:
```

To change from a console to a graphical login, you should change the number in the line `id:3:initdefault:` from a **3** to a **5**.



Warning

Change *only* the number of the default runlevel from **3** to **5**.

Your changed line should look like the following:

```
id:5:initdefault:
```

When you are satisfied with your change, save and exit the file using the `Ctrl+Q` keys. A window appears and asks if you would like to save the changes. Click **Save**.

The next time you log in after rebooting your system, you are presented with a graphical login prompt.

17.4.3. Problems with the X Window System (GUI)

If you are having trouble getting X (the X Window System) to start, you may not have installed it during your installation.

If you want X, you can either install the packages from the Red Hat Enterprise Linux installation media or perform an upgrade.

If you elect to upgrade, select the X Window System packages, and choose GNOME, KDE, or both, during the upgrade package selection process.

Refer to [Section 35.3, “Switching to a Graphical Login”](#) for more detail on installing a desktop environment.

17.4.4. Problems with the X Server Crashing and Non-Root Users

If you are having trouble with the X server crashing when anyone logs in, you may have a full file system (or, a lack of available hard drive space).

To verify that this is the problem you are experiencing, run the following command:

```
df -h
```

The **df** command should help you diagnose which partition is full. For additional information about **df** and an explanation of the options available (such as the **-h** option used in this example), refer to the **df** man page by typing **man df** at a shell prompt.

A key indicator is 100% full or a percentage above 90% or 95% on a partition. The **/home/** and **/tmp/** partitions can sometimes fill up quickly with user files. You can make some room on that partition by removing old files. After you free up some disk space, try running X as the user that was unsuccessful before.

17.4.5. Problems When You Try to Log In

If you did not create a user account in the **firstboot** screens, switch to a console by pressing **Ctrl+Alt+F2**, log in as root and use the password you assigned to root.

If you cannot remember your root password, boot your system as **linux single**.

Once you have booted into single user mode and have access to the **#** prompt, you must type **passwd root**, which allows you to enter a new password for root. At this point you can type **shutdown -r now** to reboot the system with the new root password.

If you cannot remember your user account password, you must become root. To become root, type **su -** and enter your root password when prompted. Then, type **passwd <username>**. This allows you to enter a new password for the specified user account.

If the graphical login screen does not appear, check your hardware for compatibility issues. The *Hardware Compatibility List* can be found at:

```
http://hardware.redhat.com/hcl/
```

17.4.6. Your Printer Does Not Work

If you are not sure how to set up your printer or are having trouble getting it to work properly, try using the **Printer Configuration Tool**.

Type the **system-config-printer** command at a shell prompt to launch the **Printer Configuration Tool**. If you are not root, it prompts you for the root password to continue.

17.4.7. Apache-based httpd service/Sendmail Hangs During Startup

If you are having trouble with the Apache-based **httpd** service or Sendmail hanging at startup, make sure the following line is in the **/etc/hosts** file:

```
127.0.0.1 localhost.localdomain localhost
```

Part III. IBM System z Architecture - Installation and Booting

This part discusses installation and booting (or *initial program load*, IPL) of Red Hat Enterprise Linux on IBM System z.

Planning for Installation on System z

18.1. Pre-Installation

Red Hat Enterprise Linux 6 runs on System z9 or later IBM mainframe systems.

The installation process assumes that you are familiar with the IBM System z and can set up *logical partitions* (LPARs) and z/VM guest virtual machines. For additional information on System z, refer to <http://www.ibm.com/systems/z>.

Before you install Red Hat Enterprise Linux, you must decide on the following:

- Decide whether you want to run the operating system on an LPAR or as a z/VM guest operating system.
- Decide if you need swap space and if so how much. Although it is possible (and recommended) to assign enough memory to z/VM guest virtual machine and let z/VM do the necessary swapping, there are cases where the amount of required RAM is hard to predict. Such instances should be examined on a case-by-case basis. Refer to [Section 23.15.5, “Recommended Partitioning Scheme”](#).
- Decide on a network configuration. Red Hat Enterprise Linux 6 for IBM System z supports the following network devices:
 - Real and virtual *Open Systems Adapter* (OSA)
 - Real and virtual HiperSockets
 - *LAN channel station* (LCS) for real OSA

You require the following hardware:

- Disk space. Calculate how much disk space you need and allocate sufficient disk space on DASDs¹ or SCSI² disks. You require at least 2 GB for a server installation, and 5 GB if you want to install all packages. You also require disk space for any application data. After the installation, more DASD or SCSI disk partitions may be added or deleted as necessary.

The disk space used by the newly installed Red Hat Enterprise Linux system (the Linux instance) must be separate from the disk space used by other operating systems you may have installed on your system.

For more information about disks and partition configuration, refer to [Section 23.15.5, “Recommended Partitioning Scheme”](#).

- RAM. Acquire 1 GB (recommended) for the Linux instance. With some tuning, an instance might run with as little as 512 MB RAM.

18.2. Overview of the System z Installation Procedure

You can install Red Hat Enterprise Linux on System z interactively or in unattended mode. Installation on System z differs from installation on other architectures in that it is typically performed over a network and not from a local DVD. The installation can be summarized as follows:

1. Booting (IPL) the installer

Connect with the mainframe, then perform an *initial program load* (IPL), or boot, from the medium containing the installation program.

2. **Installation Phase 1**

Set up an initial network device. This network device is then used to connect to the installation system via SSH or VNC. This gets you a full-screen mode terminal or graphical display to continue installation as on other architectures.

3. **Installation Phase 2**

Specify which language to use, and how and where the installation program and the software packages to be installed from the repository on the Red Hat installation medium can be found.

4. **Installation Phase 3**

Use **anaconda** (the main part of the Red Hat installation program) to perform the rest of the installation.

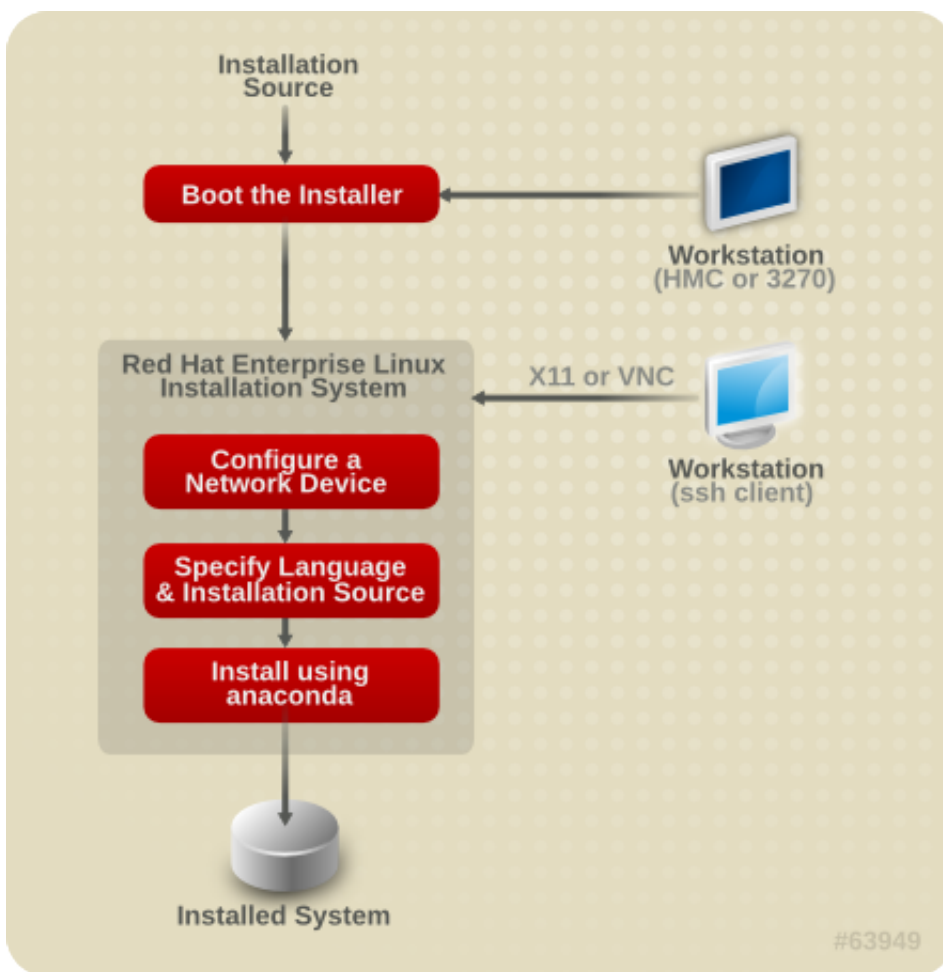


Figure 18.1. The Installation Process

18.2.1. Booting (IPL) the Installer

After establishing a connection with the mainframe, you need to perform an initial program load (IPL), or boot, from the medium containing the installation program. This document describes the most common methods of installing Red Hat Enterprise Linux 6 on System z. In general, you can use any method to boot the Linux installation system, which consists of a kernel (**kernel1.img**) and initial ramdisk (**initrd.img**) with at least the parameters in **generic.prm**. The Linux installation system is also called the *installer* in this book.

The control point from where you can start the IPL process depends on the environment where your Linux is to run. If your Linux is to run as a z/VM guest operating system, the control point is the

control program (CP) of the hosting z/VM. If your Linux is to run in LPAR mode, the control point is the mainframe's *Support Element* (SE) or an attached IBM System z *Hardware Management Console* (HMC).

You can use the following boot media only if Linux is to run as a guest operating system under z/VM:

- z/VM reader — refer to [Section 20.1.1, “Using the z/VM Reader”](#) for details.

You can use the following boot media only if Linux is to run in LPAR mode:

- SE or HMC through a remote FTP server — refer to [Section 20.2.1, “Using an FTP Server”](#) for details.
- SE or HMC DVD — refer to [Section 20.2.2, “Using the HMC or SE DVD Drive”](#) for details

You can use the following boot media for both z/VM and LPAR:

- DASD — refer to [Section 20.1.2, “Using a prepared DASD”](#) for z/VM or [Section 20.2.3, “Using a prepared DASD”](#) for LPAR
- SCSI device that is attached through an FCP channel — refer to [Section 20.1.3, “Using a prepared FCP-attached SCSI Disk”](#) for z/VM or [Section 20.2.4, “Using a prepared FCP-attached SCSI Disk”](#) for LPAR
- FCP-attached SCSI DVD — refer to [Section 20.1.4, “Using an FCP-attached SCSI DVD Drive”](#) for z/VM or [Section 20.2.5, “Using an FCP-attached SCSI DVD Drive”](#) for LPAR

If you use DASD and FCP-attached SCSI devices (except SCSI DVDs) as boot media, you must have a configured *zipl* boot loader. For more information, see the Chapter on *System z Device Drivers, Features, and Commands on Red Hat Enterprise Linux 6*.

18.2.2. Installation Phase 1

After the kernel boot, you will configure one network device. This network device is needed to complete the installation.

The interface you will use in installation phase 1 is the **linuxrc** interface, which is line-mode and text-based. (Refer to [Chapter 21, Installation Phase 1: Configuring a Network Device](#).)

18.2.3. Installation Phase 2

In installation phase 2, you need to specify what language to use and where phase 3 of the installation program and the software packages to be installed from the repository on the Red Hat installation medium can be found. On System z, the installation sources are usually transferred from the DVD to a network server. Phase 3 of the installation program and the repository can be accessed in one of the following ways:

- Over the network using one of the FTP, HTTP, or NFS protocols. A separate network server (FTP, HTTP, or NFS), which holds all the required installation sources, must be set up in advance. For details on how to set up a network server, refer to [Section 19.1, “Preparing for a Network Installation”](#).
- Hard disk (DASD or a SCSI device attached through an FCP channel). You need to set up a disk that holds the required installation sources in advance. For details, Refer to [Section 19.2, “Preparing for a Hard Drive Installation”](#).
- Through an FCP-attached SCSI DVD. This is handled automatically if booted from FCP-attached SCSI DVD.

The interface you will use in installation phase 2 is the loader, which provides a full-screen text-based interface with a blue background by default. For unattended installations in cmdline mode, the loader offers line-mode, text-based output. (Refer to [Chapter 22, Installation Phase 2: Configuring Language and Installation Source](#).)

18.2.4. Installation Phase 3

In installation phase 3 you will use **anaconda** in graphical, text-based, or cmdline mode:

- **Graphical mode**
This can be used through a VNC client (recommended) or through an X11 server. You can use your mouse and keyboard to navigate through the screens, click buttons, and enter text in fields.
- **Text-based mode**
This interface does not offer all interface elements of the GUI and does not support all settings. Use this for interactive installations if you cannot use a VNC client or X11 server.
- **cmdline mode**
This is intended for automated installations on System z. (Refer to [Section 26.6, “Parameters for kickstart installations”](#))

If you have a slow network connection or prefer a text-based installation, do not use X11 forwarding when logging in over the network and do not set the `display=` variable in the parameter file (refer to [Section 26.4, “VNC and X11 parameters”](#) for details). In Red Hat Enterprise Linux 6 the text-based installation has been reduced to minimize user interaction. Features like installation on FCP-attached SCSI devices, changing partition layout, or package selection are only available with the graphical user interface installation. Use the graphical installation whenever possible. (Refer to [Chapter 23, Installation Phase 3: Installing using anaconda](#).)

18.3. Graphical User Interface with X11 or VNC

To run **anaconda** with the graphical user interface, use a workstation that has either an X Window System (X11) server or VNC client installed.

You can use X11 forwarding with an SSH client or X11 directly. If the installer on your workstation fails because the X11 server does not support required X11 extensions you might have to upgrade the X11 server or use VNC.

To use VNC, disable X11 forwarding in your SSH client prior to connecting to the Linux installation system on the mainframe or specify the `vnc` parameter in your parameter file. Using VNC is recommended for slow or long-distance network connections. Refer to [Section 28.2, “Enabling Remote Access to the Installation System”](#).

[Table 18.1, “Parameters and SSH login types”](#) shows how the parameters and SSH login type controls which **anaconda** user interface is used.

Table 18.1. Parameters and SSH login types

| Parameter | SSH login | User interface |
|---|------------------------------------|----------------|
| none | SSH without X11 forwarding | VNC or text |
| <code>vnc</code> | SSH with or without X11 forwarding | VNC |
| none | SSH with X11 forwarding | X11 |
| <code>display=IP/ hostname:display</code> | SSH without X11 forwarding | X11 |

18.3.1. Installation using X11 forwarding

You can connect a workstation to the Linux installation system on the mainframe and display the graphical installation program using SSH with X11 forwarding.

You require an SSH client that allows X11 forwarding. To open the connection, first start the X server on the workstation. Then connect to the Linux installation system. You can enable X11 forwarding in your SSH client when you connect.

For example, with OpenSSH enter the following in a terminal window on your workstation:

```
ssh -X install@linuxvm.example.com
```

Replace *linuxvm.example.com* with the hostname or IP address of the system you are installing. The **-X** option (the capital letter **X**) enables X11 forwarding.

18.3.2. Installation using X11

The direct connection from the X11 client to an X11 server on your local workstation requires an IP connection from your System z to your workstation. If the network and firewalls prevent such connections, use X11 forwarding or VNC instead.

The graphical installation program requires the DNS and hostname to be set correctly, and the Linux installation system must be allowed to open applications on your display. You can ensure this by setting the parameter *display=workstationname:0.0* in the parameter file, where *workstationname* is the hostname of the client workstation connecting to the Linux image. Alternatively, you can set the *display* environment variable and run loader manually after having logged in with SSH as user **root**. By default you log in as user **install**. This starts the loader automatically and does not allow overriding the *display* environment variable.

To permit X11 clients to open applications on the X11 server on your workstation, use the **xauth** command. To manage X11 authorization cookies with **xauth**, you must log in to the Linux installation system using SSH as user **root**. For details on **xauth** and how to manage authorization cookies, refer to the **xauth** manpage.

In contrast to setting up X11 authorizations with **xauth**, you can use **xhost** to permit the Linux installation system to connect to the X11 server:

```
xhost +linuxvm
```

Replace *linuxvm* with the hostname or IP address of the Linux installation system. This allows *linuxvm* to make connections to the X11 server.

If the graphical installation does not begin automatically, verify the *display=* variable settings in the parameter file. If performing an installation under z/VM, rerun the installation to load the new parameter file on the reader.

18.3.3. Installation using VNC

Using VNC is recommended for slow or long-distance network connections. To use VNC, disable X11 forwarding in your SSH client prior to connecting to the temporary Linux installation system. The loader will then provide a choice between text-mode and VNC; choose VNC here. Alternatively, provide the *vnc* variable and optionally the *vncpassword* variable in your parameter file (refer to [Section 26.4, “VNC and X11 parameters”](#) for details).

A message on the workstation SSH terminal prompts you to start the VNC client viewer and provides details about the VNC display specifications. Enter the specifications from the SSH terminal into the

VNC client viewer and connect to the temporary Linux installation system to begin the installation. Refer to [Chapter 31, Installing Through VNC](#) for details.

18.3.4. Installation using a VNC listener

To connect from your temporary Linux installation system to a VNC client running on your workstation in listening mode, use the `vncconnect` option in your parameter file, in addition to the options `vnc` and optionally `vncpassword`. The network and firewalls must allow an IP connection from your temporary Linux installation to your workstation.

To have the temporary Linux installation system automatically connect to a VNC client, first start the client in listening mode. On Red Hat Enterprise Linux systems, use the `-listen` option to run `vncviewer` as a listener. In a terminal window, enter the command:

```
vncviewer -listen
```

Refer to [Chapter 31, Installing Through VNC](#) for details.

18.3.5. Automating the Installation with Kickstart

You can allow an installation to run unattended by using Kickstart. A *Kickstart* file specifies settings for an installation. Once the installation system boots, it can read a Kickstart file and carry out the installation process without any further input from a user.

On System z, this also requires a parameter file (optionally an additional configuration file under `z/VM`). This parameter file must contain the required network options described in [Section 26.3, “Installation network parameters”](#) and specify a kickstart file using the `ks=` option. The kickstart file typically resides on the network. The parameter file often also contains the options `cmdline` and `RUNKS=1` to execute the loader without having to log in over the network with SSH (Refer to [Section 26.6, “Parameters for kickstart installations”](#)).

For further information and details on how to set up a kickstart file, refer to [Section 32.3, “Creating the Kickstart File”](#).

18.3.5.1. Every Installation Produces a Kickstart File

The Red Hat Enterprise Linux installation process automatically writes a Kickstart file that contains the settings for the installed system. This file is always saved as `/root/anaconda-ks.cfg`. You may use this file to repeat the installation with identical settings, or modify copies to specify settings for other systems.

Preparing for Installation

19.1. Preparing for a Network Installation



Note

Make sure no installation DVD (or any other type of DVD or CD) is in your hosting partition's drive if you are performing a network-based installation. Having a DVD or CD in the drive might cause unexpected errors.

Ensure that you have boot media available as described in [Chapter 20, Booting \(IPL\) the Installer](#).

The Red Hat Enterprise Linux installation medium must be available for either a network installation (via NFS, FTP, or HTTP) or installation via local storage. Use the following steps if you are performing an NFS, FTP, or HTTP installation.

The NFS, FTP, or HTTP server to be used for installation over the network must be a separate, network-accessible server. The separate server can be a virtual machine, LPAR, or any other system (such as a Linux on POWER or x86 system). It must provide the complete contents of the installation DVD-ROM.



Note

The public directory used to access the installation files over FTP, NFS, or HTTP is mapped to local storage on the network server. For example, the local directory `/var/www/inst/rhel6` on the network server can be accessed as `http://network.server.com/inst/rhel6`.

In the following examples, the directory on the installation staging server that will contain the installation files will be specified as `/location/of/disk/space`. The directory that will be made publicly available via FTP, NFS, or HTTP will be specified as `/publicly/available/directory`. For example, `/location/of/disk/space` may be a directory you create called `/var/isos`. `/publicly/available/directory` might be `/var/www/html/rhel6`, for an HTTP install.

In the following, you will require an *ISO image*. An ISO image is a file containing an exact copy of the content of a DVD. To create an ISO image from a DVD use the following command:

```
dd if=/dev/dvd of=/location/of/disk/space/RHEL6.iso
```

where `dvd` refers to your DVD drive device.

To copy the files from the installation DVD to a Linux instance, which acts as an installation staging server, continue with either [Section 19.1.1, "Preparing for FTP and HTTP installation"](#) or [Section 19.1.2, "Preparing for an NFS installation"](#).

19.1.1. Preparing for FTP and HTTP installation

Extract the files from the ISO image of the installation DVD and place them in a directory that is shared over FTP or HTTP.

Next, make sure that the directory is shared via FTP or HTTP, and verify client access. Test to see whether the directory is accessible from the server itself, and then from another machine on the same subnet to which you will be installing.

19.1.2. Preparing for an NFS installation

For NFS installation it is not necessary to extract all the files from the ISO image. It is sufficient to make the ISO image itself, the **install.img** file, and optionally the **product.img** file available on the network server via NFS.

1. Transfer the ISO image to the NFS exported directory. On a Linux system, run:

```
mv /location/of/disk/space/RHEL6.iso /publicly/available/directory/
```

2. Use a SHA256 checksum program to verify that the ISO image that you copied is intact. Many SHA256 checksum programs are available for various operating systems. On a Linux system, run:

```
$ sha256sum name_of_image.iso
```

where *name_of_image* is the name of the ISO image file. The SHA256 checksum program displays a string of 64 characters called a *hash*. Compare this hash to the hash displayed for this particular image on the **Download Software** page on the Red Hat Network (refer to [Chapter 1, Obtaining Red Hat Enterprise Linux](#)). The two hashes should be identical.

3. Copy the **images/** directory within the ISO file to a directory named **images/**. Enter the following commands:

```
mount -t iso9660 /path/to/RHEL6.iso /mnt/point -o loop,ro
cp -pr /mnt/point/images /path/images/
umount /mnt/point
```

4. Verify that the **images/** directory contains at least the **install.img** file, without which installation cannot proceed. Optionally, the **images/** directory should contain the **product.img** file, without which only the packages for a **Minimal** installation will be available during the package group selection stage (refer to [Section 23.17, "Package Group Selection"](#)).
5. Ensure that the **/publicly/available/directory** directory is exported via NFS via an entry in **/etc/exports** on the network server.

To export a directory read-only to a specific system, use:

```
/publicly/available/directory client.ip.address (ro)
```

To export a directory read-only to all systems, use:

```
/publicly/available/directory * (ro)
```

6. On the network server, start the NFS daemon (on a Red Hat Enterprise Linux system, use **/sbin/service nfs start**). If NFS is already running, reload the configuration file (on a Red Hat Enterprise Linux system use **/sbin/service nfs reload**).

7. Be sure to test the NFS share following the directions in the *Red Hat Enterprise Linux Deployment Guide*. Refer to your NFS documentation for details on starting and stopping the NFS server.



Note

The Red Hat Enterprise Linux installation program has the ability to test the integrity of the installation media. It works with the DVD, hard drive ISO, and NFS ISO installation methods. We recommend that you test all installation media before starting the installation process, and before reporting any installation-related bugs (many of the bugs reported are actually due to improperly-burned DVDs). To use this test, type the following command at the boot : prompt:

```
linux mediacheck
```

19.2. Preparing for a Hard Drive Installation

Use this option to install Red Hat Enterprise Linux on hardware systems without a DVD drive and if you do not want to access installation phase 3 and the package repository over a network.

19.2.1. Accessing Installation Phase 3 and the Package Repository on a Hard Drive



Note

Hard drive installations using DASD or FCP-attached SCSI storage only work from native ext2, ext3, or ext4 partitions. If you have a file system based on devices other than native ext2, ext3, or ext4 (particularly a file system based on RAID or LVM partitions) you will not be able to use it as a source to perform a hard drive installation.

Hard drive installations use an *ISO image* of the installation DVD (a file that contains an exact copy of the content of the DVD), and an **install.img** file extracted from the ISO image. With these files present on a hard drive, you can choose **Hard drive** as the installation source when you boot the installation program.

Hard drive installations use the following files:

- an *ISO image* of the installation DVD. An ISO image is a file that contains an exact copy of the content of a DVD.
- an **install.img** file extracted from the ISO image.
- optionally, a **product.img** file extracted from the ISO image.

With these files present on a hard drive, you can choose **Hard drive** as the installation source when you boot the installation program (refer to [Section 22.4, “Installation Method”](#)).

Ensure that you have boot media available as described in [Chapter 20, Booting \(IPL\) the Installer](#).

To prepare a DASD or FCP-attached device as an installation source, follow these steps:

Chapter 19. Preparing for Installation

1. Obtain an ISO image of the Red Hat Enterprise Linux installation DVD (refer to [Chapter 1, Obtaining Red Hat Enterprise Linux](#)). Alternatively, if you have the DVD on physical media, you can create an image of it with the following command on a Linux system:

```
dd if=/dev/dvd of=/location/of/disk/space/RHEL6.iso
```

where *dvd* refers to your DVD drive device.

2. Transfer the ISO images to the DASD or SCSI device.

The ISO files must be located on a hard drive that is activated in installation phase 1 (refer to [Chapter 21, Installation Phase 1: Configuring a Network Device](#)) or in installation phase 2 (refer to [Chapter 22, Installation Phase 2: Configuring Language and Installation Source](#)). This is automatically possible with DASDs.

For an FCP LUN, you must either boot (IPL) from the same FCP LUN or use the rescue shell provided by the installation phase 1 menus to manually activate the FCP LUN holding the ISOs as described in [Section 25.2.1, “Dynamically activating an FCP LUN”](#).

3. Use a SHA256 checksum program to verify that the ISO image that you copied is intact. Many SHA256 checksum programs are available for various operating systems. On a Linux system, run:

```
$ sha256sum name_of_image.iso
```

where *name_of_image* is the name of the ISO image file. The SHA256 checksum program displays a string of 64 characters called a *hash*. Compare this hash to the hash displayed for this particular image on the **Download Software** page on the Red Hat Network (refer to [Chapter 1, Obtaining Red Hat Enterprise Linux](#)). The two hashes should be identical.

4. Copy the **images/** directory within the ISO file to a directory named **images/**. Enter the following commands:

```
mount -t iso9660 /path/to/RHEL6.iso /mnt/point -o loop,ro
cp -pr /mnt/point/images /path/images/
umount /mnt/point
```

5. Verify that the **images/** directory contains at least the **install.img** file, without which installation cannot proceed. Optionally, the **images/** directory should contain the **product.img** file, without which only the packages for a **Minimal** installation will be available during the package group selection stage (refer to [Section 23.17, “Package Group Selection”](#)).
6. Make the DASD or SCSI LUN accessible to the new z/VM guest virtual machine or LPAR, and then proceed with installation. (Refer to [Chapter 20, Booting \(IPL\) the Installer](#)) or alternatively with [Section 19.2.1.1, “Preparing for Booting the Installer from a Hard Drive”](#).



Note — Verifying ISO images

The Red Hat Enterprise Linux installation program can test the integrity of the installation medium. It works with the DVD, hard drive ISO, and NFS ISO installation methods. We recommend that you test all installation media before starting the installation process, and before reporting any installation-related bugs. To use this test, add the *mediacheck* parameter to your parameter file (refer to [Section 26.7, “Miscellaneous parameters”](#)).

19.2.1.1. Preparing for Booting the Installer from a Hard Drive

If you would like to boot (IPL) the installer from a hard drive, in addition to accessing installation phase 3 and the package repository, you can optionally install the zipl boot loader on the same (or a different) disk. Be aware that zipl only supports one boot record per disk. If you have multiple partitions on a disk, they all “share” the disk's one boot record.

In the following, assume the hard drive is prepared as described in [Section 19.2.1, “Accessing Installation Phase 3 and the Package Repository on a Hard Drive”](#), mounted under `/mnt`, and you do not need to preserve an existing boot record.

To prepare a hard drive to boot the installer, install the zipl boot loader on the hard drive by entering the following command:

```
zipl -V -t /mnt/ -i /mnt/images/kernel.img -r /mnt/images/initrd.img -p /mnt/images/generic.prm
```

For more details on `zipl.conf`, refer to the chapter on zipl in *Linux on System z Device Drivers, Features, and Commands on Red Hat Enterprise Linux 6*.



Warning — Accessing a previously-installed operating system

If you have an operating system installed on the disk, and you still plan to access it later on, refer the chapter on zipl in *Linux on System z Device Drivers, Features, and Commands on Red Hat Enterprise Linux 6* for how to add a new entry in the zipl boot loader (that is, in `zipl.conf`).

Booting (IPL) the Installer

The steps to perform the initial boot (IPL) of the installer depend on the environment (either z/VM or LPAR) in which Red Hat Enterprise Linux will run. For more information on booting, see the *Booting Linux* chapter in *Linux on System z Device Drivers, Features, and Commands on Red Hat Enterprise Linux 6*.

20.1. Installing under z/VM

When installing under z/VM, you can boot from:

- the z/VM virtual reader
- a DASD or an FCP-attached SCSI device prepared with the `zipl` boot loader
- an FCP-attached SCSI DVD drive

Log on to the z/VM guest virtual machine chosen for the Linux installation. You can use **x3270** or **c3270** (from the `x3270-text` package in Red Hat Enterprise Linux) to log in to z/VM from other Linux systems. Alternatively, use the 3270 terminal emulator on the IBM System z Hardware Management Console (HMC). If you are working from a machine with a Windows operating system, Jolly Giant (<http://www.jollygiant.com/>) offers an SSL-enabled 3270 emulator. A free native Windows port of **c3270** called **wc3270** also exists.



Note — If your 3270 connection is interrupted

If your 3270 connection is interrupted and you cannot log in again because the previous session is still active, you can replace the old session with a new one by entering the following command on the z/VM logon screen:

```
logon user here
```

Replace *user* with the name of the z/VM guest virtual machine. Depending on whether an external security manager, for example RACF, is used, the logon command might vary.

If you are not already running **CMS** (single user operating system shipped with z/VM) in your guest, boot it now by entering the command:

```
#cp ipl cms
```

Be sure not to use CMS disks such as your A disk (often device number 0191) as installation targets. To find out which disks are in use by CMS use the following query:

```
query disk
```

You can use the following CP (z/VM Control Program, which is the z/VM hypervisor) query commands to find out about the device configuration of your z/VM guest virtual machine:

- Query the available main memory, which is called *storage* in System z terminology. Your guest should have at least 512 megabytes of main memory.

```
cp query virtual storage
```

- Query available network devices of type:

osa

OSA (CHPID type OSD, real or virtual (VSWITCH or GuestLAN type QDIO), both in QDIO mode)

hsi

HiperSockets (CHPID type IQD, real or virtual (GuestLAN type Hipers))

lcs

LCS (CHPID type OSE)

For example, to query all of the network device types mentioned above:

```
cp query virtual osa
```

- Query available DASDs. Only those that are flagged RW for read-write mode can be used as installation targets:

```
cp query virtual dasd
```

- Query available FCP channels:

```
cp query virtual fcp
```

20.1.1. Using the z/VM Reader

Perform the following steps to boot from the z/VM reader:

1. If necessary, add the device containing the z/VM TCP/IP tools to your CMS disk list. For example:

```
cp link tcpmaint 592 592
acc 592 fm
```

Replace *fm* with any FILEMODE letter.

2. Execute the command:

```
ftp host
```

Where *host* is the hostname or IP address of the FTP server that hosts the boot images (**kernel.img** and **initrd.img**).

3. Log in and execute the following commands. Use the (**repl** option if you are overwriting existing **kernel.img**, **initrd.img**, **generic.prm**, or **redhat.exec** files:

```
cd /location/of/install-tree/images/
ascii
get generic.prm (repl
get redhat.exec (repl
locsite fix 80
binary
get kernel.img (repl
get initrd.img (repl
```

```
quit
```

- Optionally check whether the files were transferred correctly by using the CMS command **filelist** to show the received files and their format. It is important that **kernel.img** and **initrd.img** have a fixed record length format denoted by **F** in the Format column and a record length of 80 in the **Lrecl** column. For example:

```
VMUSER FILELIST A0 V 169 Trunc=169 Size=6 Line=1 Col=1 Alt=0
Cmd Filename Filetype Fm Format Lrecl Records Blocks Date Time
REDHAT EXEC B1 V 22 1 1 4/15/10 9:30:40
GENERIC PRM B1 V 44 1 1 4/15/10 9:30:32
INITRD IMG B1 F 80 118545 2316 4/15/10 9:30:25
KERNEL IMG B1 F 80 74541 912 4/15/10 9:30:17
```

Press **PF3** to quit **filelist** and return to the CMS prompt.

- Finally execute the REXX script **redhat.exec** to boot (IPL) the installer:

```
redhat
```

20.1.2. Using a prepared DASD

Boot from the prepared DASD and select the zipl boot menu entry referring to the Red Hat Enterprise Linux installer. Use a command of the following form:

```
cp ipl DASD device number loadparm boot_entry_number
```

Replace *DASD device number* with the device number of the boot device, and *boot_entry_number* with the zipl configuration menu for this device. For example:

```
cp ipl eb1c loadparm 0
```

20.1.3. Using a prepared FCP-attached SCSI Disk

Perform the following steps to boot from a prepared FCP-attached SCSI disk:

- Configure the SCSI boot loader of z/VM to access the prepared SCSI disk in the FCP storage area network. Select the prepared zipl boot menu entry referring to the Red Hat Enterprise Linux installer. Use a command of the following form:

```
cp set loaddev portname WWPN lun LUN bootprog boot_entry_number
```

Replace *WWPN* with the WWPN of the storage system and *LUN* with the LUN of the disk. The 16-digit hexadecimal numbers must be split into two pairs of eight digits each. For example:

```
cp set loaddev portname 50050763 050b073d lun 40204011 00000000 bootprog 0
```

- Optionally, confirm your settings with the command:

```
query loaddev
```

- IPL the FCP device connected with the storage system containing the disk with the command:

```
cp ipl FCP_device
```

For example:

```
cp ipl fc00
```

20.1.4. Using an FCP-attached SCSI DVD Drive

This requires a SCSI DVD drive attached to an FCP-to-SCSI bridge which is in turn connected to an FCP adapter in your System z. The FCP adapter must be configured and available under z/VM.

1. Insert your Red Hat Enterprise Linux for System z DVD into the DVD drive.
2. Configure the SCSI boot loader of z/VM to access the DVD drive in the FCP storage area network and specify **1** for the boot entry on the Red Hat Enterprise Linux for System z DVD. Use a command of the following form:

```
cp set loaddev portname WWPN lun FCP_LUN bootprog 1
```

Replace *WWPN* with the WWPN of the FCP-to-SCSI bridge and *FCP_LUN* with the LUN of the DVD drive. The 16-digit hexadecimal numbers must be split into two pairs of eight characters each. For example:

```
cp set loaddev portname 20010060 eb1c0103 lun 00010000 00000000 bootprog 1
```

3. Optionally, confirm your settings with the command:

```
cp query loaddev
```

4. IPL on the FCP device connected with the FCP-to-SCSI bridge.

```
cp ipl FCP_device
```

For example:

```
cp ipl fc00
```

20.2. Installing in an LPAR

When installing in a *logical partition* (LPAR), you can boot from:

- an FTP server
- the DVD drive of the HMC or SE
- a DASD or an FCP-attached SCSI drive prepared with the zipl boot loader
- an FCP-attached SCSI DVD drive

Perform these common steps first:

1. Log in on the IBM System z *Hardware Management Console* (HMC) or the *Support Element* (SE) as a user with sufficient privileges to install a new operating system to an LPAR. The SYSPROG user is recommended.
2. Select **Images**, then select the LPAR to which you wish to install. Use the arrows in the frame on the right side to navigate to the **CPC Recovery** menu.
3. Double-click **Operating System Messages** to show the text console on which Linux boot messages will appear and potentially user input will be required. Refer to the chapter on booting Linux in *Linux on System z Device Drivers, Features, and Commands on Red Hat Enterprise Linux 6* and the *Hardware Management Console Operations Guide*, order number [SC28-6857], for details.

Continue with the procedure for your installation source.

20.2.1. Using an FTP Server

1. Double-click **Load from CD-ROM, DVD, or Server**.
2. In the dialog box that follows, select **FTP Source**, and enter the following information: Host Computer: Hostname or IP address of the FTP server you wish to install from (for example, ftp.redhat.com) User ID: Your user name on the FTP server (or anonymous) Password: Your password (use your email address if you are logging in as anonymous) Account (optional): Leave this field empty File location (optional): Directory on the FTP server holding Red Hat Enterprise Linux for System z (for example, /rhel/s390x/)
3. Click **Continue**.
4. In the dialog that follows, keep the default selection of **generic.ins** and click **Continue**.

20.2.2. Using the HMC or SE DVD Drive

1. Double-click **Load from CD-ROM, DVD, or Server**.
2. In the dialog box that follows, select **Local CD-ROM / DVD** then click **Continue**.
3. In the dialog that follows, keep the default selection of **generic.ins** then click **Continue**.

20.2.3. Using a prepared DASD

1. Double-click **Load**.
2. In the dialog box that follows, select **Normal** as the **Load type**.
3. As **Load address** fill in the device number of the DASD.
4. As **Load parameter** fill in the number corresponding the the zipl boot menu entry that you prepared for booting the Red Hat Enterprise Linux installer.
5. Click the **OK** button.

20.2.4. Using a prepared FCP-attached SCSI Disk

1. Double-click **Load**.

2. In the dialog box that follows, select **SCSI** as the **Load type**.
3. As **Load address** fill in the device number of the FCP channel connected with the SCSI disk.
4. As **World wide port name** fill in the WWPN of the storage system containing the disk as a 16-digit hexadecimal number.
5. As **Logical unit number** fill in the LUN of the disk as a 16-digit hexadecimal number.
6. As **Boot program selector** fill in the number corresponding the the zipl boot menu entry that you prepared for booting the Red Hat Enterprise Linux installer.
7. Leave the **Boot record logical block address** as **0** and the **Operating system specific load parameters** empty.
8. Click the **OK** button.

20.2.5. Using an FCP-attached SCSI DVD Drive

This requires to have a SCSI DVD drive attached to an FCP-to-SCSI bridge which is in turn connected to an FCP adapter in your System z machine. The FCP adapter has to be configured and available in your LPAR.

1. Insert your Red Hat Enterprise Linux for System z DVD into the DVD drive.
2. Double-click **Load**.
3. In the dialog box that follows, select **SCSI** as the **Load type**.
4. As **Load address** fill in the device number of the FCP channel connected with the FCP-to-SCSI bridge.
5. As **World wide port name** fill in the WWPN of the FCP-to-SCSI bridge as a 16-digit hexadecimal number.
6. As **Logical unit number** fill in the LUN of the DVD drive as a 16-digit hexadecimal number.
7. As **Boot program selector** fill in the number **1** to select the boot entry on the Red Hat Enterprise Linux for System z DVD.
8. Leave the **Boot record logical block address** as **0** and the **Operating system specific load parameters** empty.
9. Click the **OK** button.

Installation Phase 1: Configuring a Network Device

After the kernel boot, you will configure one network device using the `linuxrc` program. This network device is needed to complete the installation. If you are installing interactively (with the default parameter file `generic.prm`), you will be asked questions about your network. It is a good idea to have your data ready in the form of a datasheet or similar. If you want to automate this step, supply the information for each option in your parameter file or CMS configuration file.

As an example, let us look at how to configure an OSA network adapter under z/VM. When `linuxrc` starts, you see the following message:

```
Starting the zSeries initrd to configure networking. Version is 1.2
Starting udev...
```

Network devices are sensed and listed. The list of devices depends on the `cio_ignore` kernel parameter used. If no devices are found because of `cio_ignore`, as in the example below, you can clear the list of ignored devices. Note that this might take some time and result in a long list when there are many devices, such as on an LPAR.

```
Scanning for available network devices...
Autodetection found 0 devices.
Note: There is a device blacklist active! (Clearing might take long)
c) clear blacklist, m) manual config, r) rescan, s) shell:
c
Clearing device blacklist...
Scanning for available network devices...
Autodetection found 14 devices.

NUM CARD CU CHPID TYPE DRIVER IF DEVICES
 1 OSA (QDIO) 1731/01 00 OSD qeth eth 0.0.f500,0.0.f501,0.0.f502
 2 OSA (QDIO) 1731/01 01 OSD qeth eth 0.0.f503,0.0.f504,0.0.f505
 3 OSA (QDIO) 1731/01 02 OSD qeth eth 0.0.1010,0.0.1011,0.0.1012
 4 HiperSockets 1731/05 03 IQD qeth hsi 0.0.1013,0.0.1014,0.0.1015
 5 OSA (QDIO) 1731/01 04 OSD qeth eth 0.0.1017,0.0.1018,0.0.1019
 6 CTC adapter 3088/08 12 ? ctc ctc 0.0.1000,0.0.1001
 7 escon channel 3088/1f 12 ? ctc ctc 0.0.1002,0.0.1003
 8 ficon channel 3088/1e 12 ? ctc ctc 0.0.1004,0.0.1005
 9 OSA (QDIO) 1731/01 76 OSD qeth eth 0.0.f5f0,0.0.f5f1,0.0.f5f2
10 LCS OSA 3088/60 8a OSE lcs eth 0.0.1240,0.0.1241
11 HiperSockets 1731/05 fb IQD qeth hsi 0.0.8024,0.0.8025,0.0.8026
12 HiperSockets 1731/05 fc IQD qeth hsi 0.0.8124,0.0.8125,0.0.8126
13 HiperSockets 1731/05 fd IQD qeth hsi 0.0.8224,0.0.8225,0.0.8226
14 HiperSockets 1731/05 fe IQD qeth hsi 0.0.8324,0.0.8325,0.0.8326

<num>) use config, m) manual config, r) rescan, s) shell:
```

Enter the number of the configuration you want to use, for example **9**. Selecting from the table provides the installer with information for the type of network device and the device addresses for its subchannels. Alternatively, you can enter **m** and proceed to enter the network type (qeth), the read, write, data channels, and the OSA port. Accept defaults by pressing **Enter**; under z/VM you might need to press **Enter** twice.

```
m

* NOTE: To enter default or empty values press enter twice. *
```

```
Network type (qeth, lcs, ctc, ? for help). Default is qeth:
qeth

Read,write,data channel (e.g. 0.0.0300,0.0.0301,0.0.0302 or ? for help).
0.0.f5f0,0.0.f5f1,0.0.f5f2

Portname (1..8 characters, or ? for help). Default is no portname:

Relative port number for OSA (0, 1, or ? for help). Default is 0:

Layer mode (0 for layer3, 1 for layer2, or ? for help). Default is 1:

Activating network device...
Detected: OSA card in OSD mode, Gigabit Ethernet
Unique MAC address (e.g. 02:00:00:00:00:00, ? for help). Default is 02:00:00:AB:C9:81:
```

Then questions pertaining to your Linux instance are displayed:

```
Hostname of your new Linux guest (FQDN e.g. s390.redhat.com or ? for help):
host.subdomain.domain

IPv4 address / IPv6 addr. (e.g. 10.0.0.2 / 2001:0DB8:: or ? for help)
10.0.0.42

IPv4 netmask or CIDR prefix (e.g. 255.255.255.0 or 1..32 or ? for help). Default is
255.0.0.0:
24

IPv4 address of your default gateway or ? for help:
10.0.0.1
Trying to reach gateway 10.0.0.1...

IPv4 addresses of DNS servers (separated by colons ':' or ? for help):
10.1.2.3:10.3.2.1
Trying to reach DNS servers...

DNS search domains (separated by colons ':' or ? for help):
subdomain.domain:domain

DASD range (e.g. 200-203,205 or ? for help). Default is autoprobing:
eb1c
Activated DASDs:
0.0.eb1c(ECKD) dasda : active, blocksize: 4096, 1803060 blocks, 7043 MB
```



Important — you must define a DASD

The installer requires the definition of a DASD. For a SCSI-only installation, enter **none**. This satisfies the requirement for a defined DASD parameter, while resulting in a SCSI-only environment.

When you define the DASD as **none**, you receive an error message such as:

```
Incorrect format for lower bound of DASD range none: none
```

It is safe to disregard this error message; installation proceeds as normal.

If you make a mistake, the dialog either notices the error and asks you to re-enter the parameter, or you can go back later to restart the dialog:

```
Incorrect ... (<OPTION-NAME>):
0) redo this parameter, 1) continue, 2) restart dialog, 3) halt, 4) shell
```

When you restart the dialog, it remembers what you entered before:

```
Network type
0) default is previous "qeth", 1) new value, ?) help
```

At the end of the configuration, you see the message **Initial configuration completed**:

```
Initial configuration completed.
c) continue, p) parm file/configuration, n) network state, r) restart, s) shell
```

You can now check your network configuration by entering **n**:

```
n
eth0 Link encap:Ethernet HWaddr 02:00:00:AB:C9:81
inet addr:10.0.0.42 Bcast:10.0.0.255 Mask:255.255.255.0
UP BROADCAST RUNNING MULTICAST MTU:1492 Metric:1
RX packets:64 errors:0 dropped:0 overruns:0 frame:0
TX packets:4 errors:0 dropped:0 overruns:0 carrier:0
collisions:0 txqueuelen:1000
RX bytes:3334 (3.2 KiB) TX bytes:336 (336.0 b)

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:0 errors:0 dropped:0 overruns:0 frame:0
TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
collisions:0 txqueuelen:0
RX bytes:0 (0.0 b) TX bytes:0 (0.0 b)

Kernel IP routing table
Destination Gateway Genmask Flags Metric Ref Use Iface
127.0.0.1 0.0.0.0 255.255.255.255 UH 0 0 0 lo
10.0.0.0 0.0.0.0 255.255.255.0 U 0 0 0 eth0
0.0.0.0 10.0.0.1 0.0.0.0 UG 0 0 0 eth0

c) continue, p) parm file/configuration, n) network state, r) restart, s) shell
```

If you want to change something, enter **r** to restart the dialog. To show the parameters as specified in a parameter or configuration file or interactively enter **p**. You can then copy the output from your terminal and paste it into an editor to save it to disk on your local workstation. You can use the copy as a template for a parameter or configuration file for future installations:

```
p
NETTYPE=qeth
IPADDR=10.0.0.42
NETMASK=255.255.255.0
GATEWAY=10.0.0.1
HOSTNAME=host.subdomain.domain
SUBCHANNELS=0.0.f5f0,0.0.f5f1,0.0.f5f2
LAYER2=1
MACADDR=02:00:00:AB:C9:81
```

```
PORTNAME=OSAPORT
DNS=10.1.2.3:10.3.2.1
SEARCHDNS=subdomain.domain:domain
DASD=eb1c
```

```
c) continue, p) parm file/configuration, n) network state, r) restart, s) shell
```

Again, to change something, restart the dialog with **r**. Finally, if all is in order, enter **c** to continue:

```
c
```

```
Starting sshd to allow login over the network.
```

```
Connect now to 10.0.0.42 and log in as user install to start the installation.
```

```
E.g. using: ssh -x install@10.0.0.42
```

```
You may log in as the root user to start an interactive shell.
```

The preliminary network setup is now complete and the installer starts an SSH daemon. You can log into your Linux instance over SSH. If you are using **RUNKS=1** with kickstart and cmdline mode, **linuxrc** automatically starts the loader.

21.1. A Note on Terminals

During the installation, the installation program displays messages on a line-mode terminal. This is the HMC **Operating System Messages** applet if you install under LPAR, or a 3270 terminal if you install under z/VM.

Linuxrc provides a rescue shell on the line-mode terminal. Press the **Enter** key (twice under z/VM) to start the shell. You cannot use full-screen applications such as the **vi** editor on the line-mode terminal. Switch to line-mode based editors such as **ed**, **ex**, or **sed** to edit text files if necessary.

Be aware that long-running commands might not be interruptible with the escape sequence **Ctrl+C**. Call commands with options that make them return in time voluntarily. The shell on the 3270 terminal is available throughout the whole installation process until the point where the system needs to reboot.

Once the shell has been provided, you may exit with an error level of zero to get a new shell instance replacing the old one, or you may exit with an error level different from zero to force a shutdown of the installation system.

Connect to the installed system using user **root** to get a root shell without automatically starting the installer. For problem determination, you might connect with many ssh sessions.

Installation Phase 2: Configuring Language and Installation Source

Before the graphical installation program starts, you need to configure the language and installation source.

By default, if you are installing interactively (with the default parameter file **generic.prm**) the loader program to select language and installation source starts in text mode. In your new ssh session, the following message is displayed:

```
Welcome to the anaconda install environment 1.2 for zSeries
```

22.1. Non-interactive Line-Mode Installation

If the **cmdline** option was specified as boot option in your parameter file ([Section 26.6, “Parameters for kickstart installations”](#)) or in your kickstart file (refer to [Section 32.3, “Creating the Kickstart File”](#)), the loader starts up with line-mode oriented text output. In this mode, all necessary information must be provided in the kickstart file. The installer does not allow user interaction and stops if there is unspecified installation information.

22.2. The Text Mode Installation Program User Interface

Both the loader and later **anaconda** use a screen-based interface that includes most of the on-screen *widgets* commonly found on graphical user interfaces. [Figure 22.1, “Installation Program Widgets as seen in URL Setup”](#), and [Figure 22.2, “Installation Program Widgets as seen in Choose a Language”](#), illustrate widgets that appear on screens during the installation process.

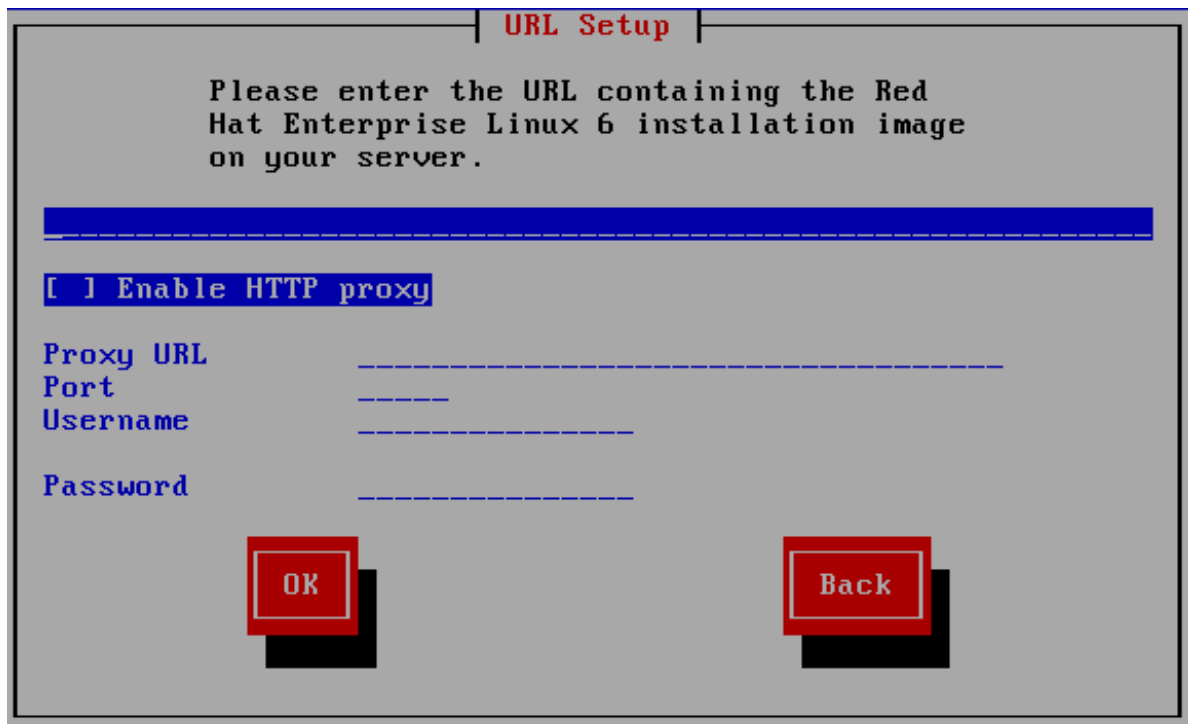


Figure 22.1. Installation Program Widgets as seen in **URL Setup**



Figure 22.2. Installation Program Widgets as seen in **Choose a Language**

Here is a list of the most important widgets shown in [Figure 22.1, “Installation Program Widgets as seen in URL Setup”](#) and [Figure 22.2, “Installation Program Widgets as seen in Choose a Language”](#):

- **Window** — Windows (usually referred to as *dialogs* in this manual) appear on your screen throughout the installation process. At times, one window may overlay another; in these cases, you can only interact with the window on top. When you are finished in that window, it disappears, allowing you to continue working in the window underneath.
- **Checkbox** — Checkboxes allow you to select or deselect a feature. The box displays either an asterisk (selected) or a space (unselected). When the cursor is within a checkbox, press **Space** to select or deselect a feature.
- **Text Input** — Text input lines are regions where you can enter information required by the installation program. When the cursor rests on a text input line, you may enter and/or edit information on that line.
- **Text Widget** — Text widgets are regions of the screen for the display of text. At times, text widgets may also contain other widgets, such as checkboxes. If a text widget contains more information than can be displayed in the space reserved for it, a scroll bar appears; if you position the cursor within the text widget, you can then use the **Up** and **Down** arrow keys to scroll through all the information available. Your current position is shown on the scroll bar by a # character, which moves up and down the scroll bar as you scroll.
- **Scroll Bar** — Scroll bars appear on the side or bottom of a window to control which part of a list or document is currently in the window's frame. The scroll bar makes it easy to move to any part of a file.
- **Button Widget** — Button widgets are the primary method of interacting with the installation program. You progress through the windows of the installation program by navigating these buttons, using the **Tab** and **Enter** keys. Buttons can be selected when they are highlighted.
- **Cursor** — Although not a widget, the cursor is used to select (and interact with) a particular widget. As the cursor is moved from widget to widget, it may cause the widget to change color, or the cursor itself may only appear positioned in or next to the widget. In [Figure 22.1, “Installation Program](#)

Widgets as seen in URL Setup", the cursor is positioned on the **OK** button. *Figure 22.2, "Installation Program Widgets as seen in Choose a Language"*, shows the cursor on the **Edit** button.

22.2.1. Using the Keyboard to Navigate

Navigation through the installation dialogs is performed through a simple set of keystrokes. To move the cursor, use the **Left**, **Right**, **Up**, and **Down** arrow keys. Use **Tab**, and **Shift-Tab** to cycle forward or backward through each widget on the screen. Along the bottom, most screens display a summary of available cursor positioning keys.

To "press" a button, position the cursor over the button (using **Tab**, for example) and press **Space** or **Enter**. To select an item from a list of items, move the cursor to the item you wish to select and press **Enter**. To select an item with a checkbox, move the cursor to the checkbox and press **Space** to select an item. To deselect, press **Space** a second time.

Pressing **F12** accepts the current values and proceeds to the next dialog; it is equivalent to pressing the **OK** button.



Warning

Unless a dialog box is waiting for your input, do not press any keys during the installation process (doing so may result in unpredictable behavior).

22.3. Language Selection

Use the arrow keys on your keyboard to select a language to use during the installation process (refer to *Figure 22.3, "Language Selection"*). With your selected language highlighted, press the **Tab** key to move to the **OK** button and press the **Enter** key to confirm your choice. You can automate this choice in the parameter file with the parameter `lang=` (refer to *Section 26.5, "Loader parameters"*) or with the kickstart command `lang` (refer to *Section 28.4, "Automating the Installation with Kickstart"*).

The language you select here will become the default language for the operating system once it is installed. Selecting the appropriate language also helps target your time zone configuration later in the installation. The installation program tries to define the appropriate time zone based on what you specify on this screen.

To add support for additional languages, customize the installation at the package selection stage. For more information, refer to *Section 23.17.2, "Customizing the Software Selection"*.

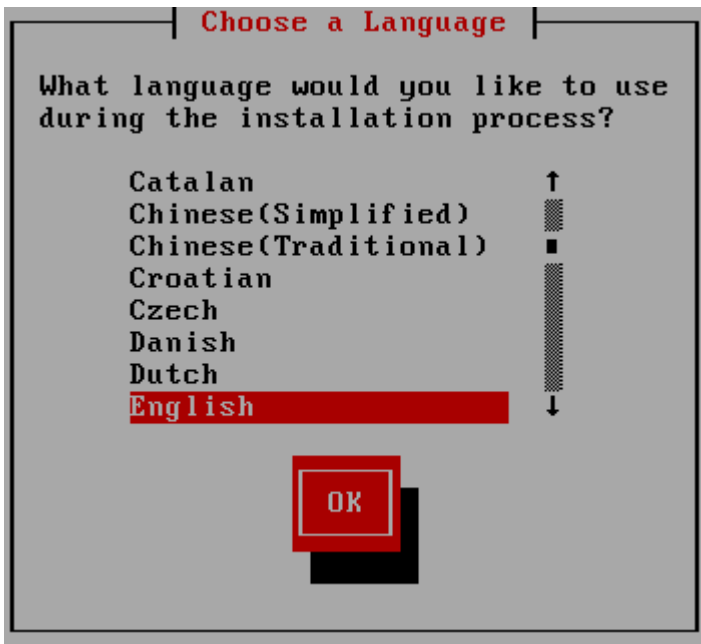


Figure 22.3. Language Selection

Once you select the appropriate language, click **Next** to continue.

22.4. Installation Method

Use the arrow keys on your keyboard to select an installation method (refer to [Figure 22.4, “Installation Method”](#)). With your selected method highlighted, press the **Tab** key to move to the **OK** button and press the **Enter** key to confirm your choice.



Figure 22.4. Installation Method

22.4.1. Installing from DVD

To install Red Hat Enterprise Linux from a DVD, place the DVD in your DVD drive and boot your system from the DVD as described in [Section 20.1.4, “Using an FCP-attached SCSI DVD Drive”](#) for z/VM or [Section 20.2.5, “Using an FCP-attached SCSI DVD Drive”](#) for LPAR.

The installation program then probes your system and attempts to identify your DVD-ROM drive. It starts by looking for a SCSI DVD-ROM drive.

Note

To abort the installation process at this time, reboot your machine and then eject the boot media. You can safely cancel the installation at any point before the **Write changes to disk** screen. Refer to [Section 23.16, “Write changes to disk”](#) for more information.

If the DVD drive is found and the driver loaded, the installer presents you with the option to perform a media check on the DVD. This takes some time, and you may opt to skip over this step. However, if you later encounter problems with the installer, you should reboot and perform the media check before calling for support. From the media check dialog, continue to the next stage of the installation process (refer to [Section 23.5, “Welcome to Red Hat Enterprise Linux”](#)).

22.4.2. Installing from a Hard Drive

The **Select Partition** screen applies only if you are installing from a disk partition (that is, you selected **Hard Drive** in the **Installation Method** dialog). This dialog allows you to name the disk partition and directory from which you are installing Red Hat Enterprise Linux. If you used the `repo=hd` boot option, you already specified a partition.

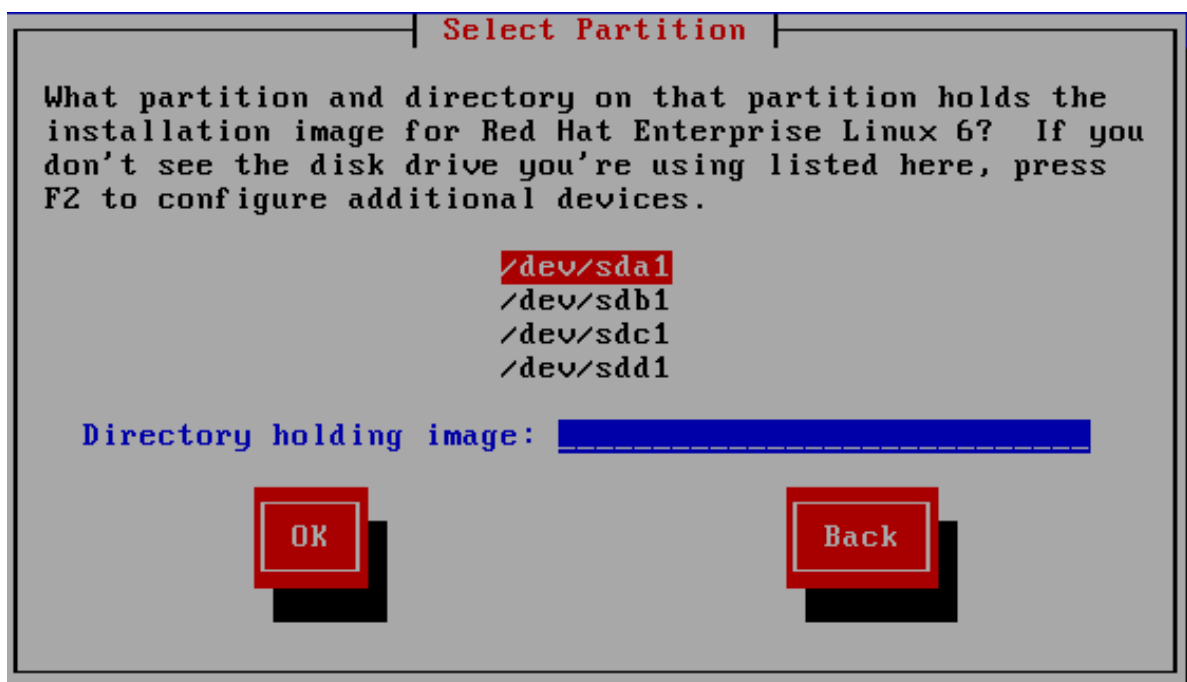


Figure 22.5. Selecting Partition Dialog for Hard Drive Installation

Select the partition containing the ISO files from the list of available partitions. DASD names begin with `/dev/dasd`. Each individual drive has its own letter, for example `/dev/dasda` or `/dev/sda`. Each partition on a drive is numbered, for example `/dev/dasda1` or `/dev/sda1`.

For an FCP LUN, you would have to either boot (IPL) from the same FCP LUN or use the rescue shell provided by the `linuxrc` menus to manually activate the FCP LUN holding the ISOs as described in [Section 25.2.1, “Dynamically activating an FCP LUN”](#).

Also specify the **Directory holding images**. Enter the full directory path from the drive that contains the ISO image files. The following table shows some examples of how to enter this information:

Table 22.1. Location of ISO images for different partition types

| File system | Mount point | Original path to files | Directory to use |
|------------------|-------------|------------------------|------------------|
| ext2, ext3, ext4 | /home | /home/user1/RHEL6 | /user1/RHEL6 |

If the ISO images are in the root (top-level) directory of a partition, enter a `/`. If the ISO images are located in a subdirectory of a mounted partition, enter the name of the directory holding the ISO images within that partition. For example, if the partition on which the ISO images is normally mounted as `/home/`, and the images are in `/home/new/`, you would enter `/new/`.



Use a leading slash

An entry without a leading slash may cause the installation to fail.

Select **OK** to continue. Proceed with [Chapter 23, Installation Phase 3: Installing using anaconda](#).

22.4.3. Performing a Network Installation

The installation program is network-aware and can use network settings for a number of functions. On System z, installation phases 2 and 3 take over the network configuration values specified previously either interactively or by means of a parameter or configuration file in installation phase 1. You can also instruct the installation program to consult additional software repositories later in the process.

- If you are installing via NFS, proceed to [Section 22.4.4, “Installing via NFS”](#).
- If you are installing via Web or FTP, proceed to [Section 22.4.5, “Installing via FTP or HTTP”](#).

22.4.4. Installing via NFS

The NFS dialog applies only if you selected **NFS Image** in the **Installation Method** dialog. If you used the `repo=nfs` boot option, you already specified a server and path.

Enter the domain name or IP address of your NFS server. For example, if you are installing from a host named `eastcoast` in the domain `example.com`, enter `eastcoast.example.com` in the **NFS Server** field.

Next, enter the name of the exported directory. If you followed the setup described in [Section 19.1.2, “Preparing for an NFS installation”](#), you would enter the directory `/export/directory/`.

This dialog also allows you to specify NFS mount options. Refer to the *Red Hat Enterprise Linux Deployment Guide* for a list of common NFS mount options, or consult the man pages for `mount` and `nfs` for a comprehensive list of options.

If the NFS server is exporting a mirror of the Red Hat Enterprise Linux installation tree, enter the directory which contains the root of the installation tree. You will enter an Installation Key later on in the process which will determine which subdirectories are used to install from. If everything was specified properly, a message appears indicating that the installation program for Red Hat Enterprise Linux is running.



Figure 22.6. NFS Setup Dialog

If the NFS server is exporting the ISO image of the Red Hat Enterprise Linux DVD, enter the directory which contains the ISO image.

Proceed with [Chapter 23, Installation Phase 3: Installing using anaconda](#).

22.4.5. Installing via FTP or HTTP



Important — you must specify the protocol

When you provide a URL to an installation source, you must explicitly specify **http://** or **ftp://** as the protocol.

The URL dialog applies only if you are installing from a FTP or HTTP server (if you selected **URL** in the **Installation Method** dialog). This dialog prompts you for information about the FTP or HTTP server from which you are installing Red Hat Enterprise Linux. If you used the **repo=ftp** or **repo=http** boot option, you already specified a server and path.

Enter the name or IP address of the FTP or HTTP site from which you are installing, and the name of the directory that contains the **/images** directory for your architecture. For example:

```
/mirrors/redhat/rhel-6/Server/s390x/
```

Specify the address of a proxy server, and if necessary, provide a port number, username, and password. If everything was specified properly, a message box appears indicating that files are being retrieved from the server.

If your FTP or HTTP server requires user authentication, specify user and password as part of the URL as follows:

```
{ftp|http}://<user>:<password>@<hostname>[:<port>]/<directory>/
```

For example:

```
http://install:rhel6pw@name.example.com/mirrors/redhat/rhel-6/Server/s390x/
```

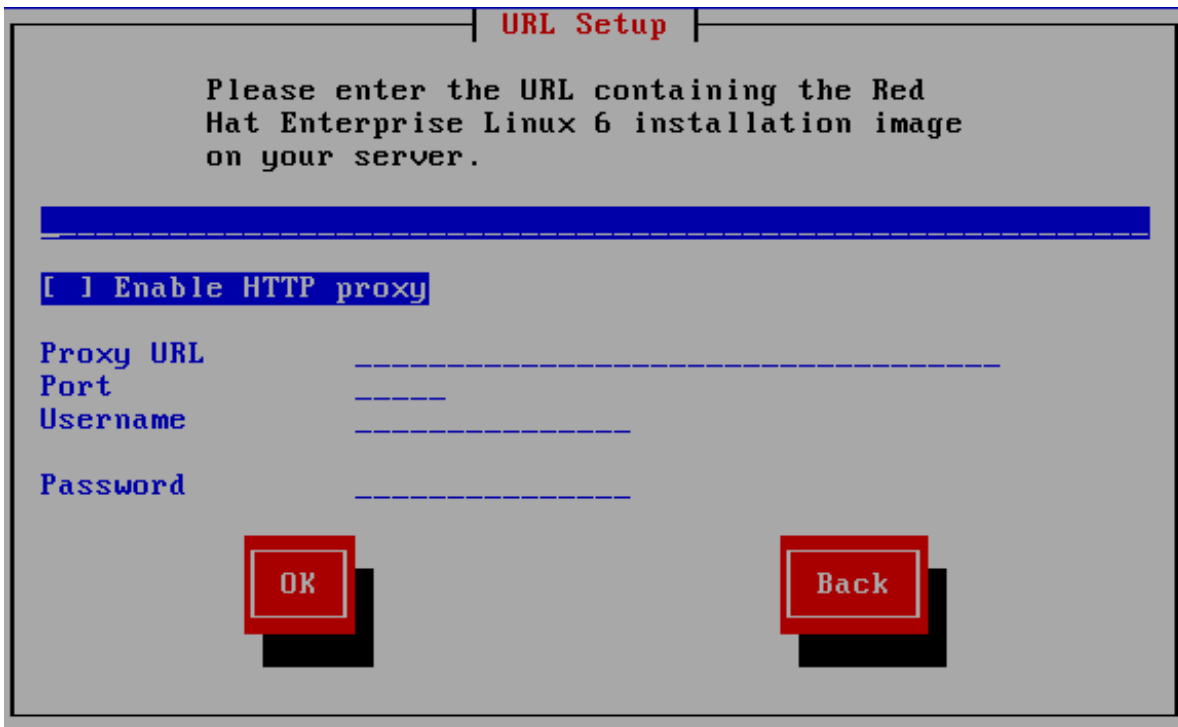


Figure 22.7. URL Setup Dialog

Proceed with [Chapter 23, Installation Phase 3: Installing using anaconda](#).

22.5. Verifying Media

The DVD offers an option to verify the integrity of the media. Recording errors sometimes occur while producing DVD media. An error in the data for package chosen in the installation program can cause the installation to abort. To minimize the chances of data errors affecting the installation, verify the media before installing.

If the verification succeeds, the installation process proceeds normally. If the process fails, create a new DVD using the ISO image you downloaded earlier.

22.6. Retrieving Phase 3 of the Installation Program

The loader then retrieves phase 3 of the installation program from the network into its RAM disk. This may take some time.

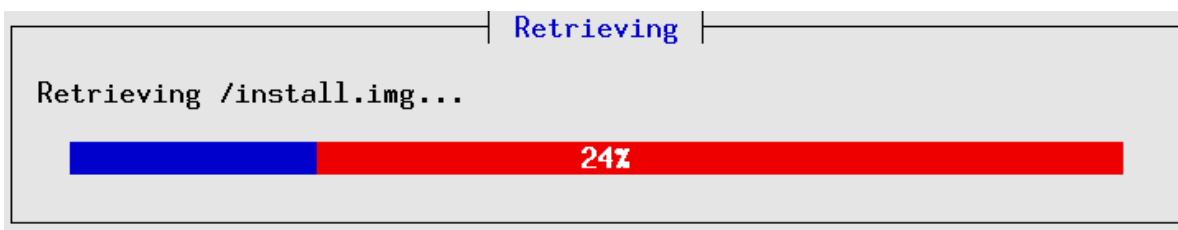


Figure 22.8. Retrieving phase 3 of the installation program

Installation Phase 3: Installing using anaconda

This chapter describes an installation using the graphical user interface of **anaconda**.

23.1. The Non-interactive Line-Mode Text Installation Program Output

If the **cmdline** option was specified as boot option in your parameter file (Refer to [Section 26.6, “Parameters for kickstart installations”](#)) or in your kickstart file (refer to [Chapter 32, Kickstart Installations](#)), **anaconda** starts with line-mode oriented text output. In this mode, all necessary information must be provided in the kickstart file. The installer will not allow user interaction and stops if there is unspecified installation information.

23.2. The Text Mode Installation Program User Interface

While text mode installations are not explicitly documented, those using the text mode installation program can easily follow the GUI installation instructions. However, because text mode presents you with a simpler, more streamlined installation process, certain options that are available in graphical mode are not also available in text mode. These differences are noted in the description of the installation process in this guide, and include:

- Interactively activating FCP LUNs
- configuring advanced storage methods such as LVM, RAID, FCoE, zFCP, and iSCSI.
- customizing the partition layout
- customizing the bootloader layout
- selecting packages during installation
- configuring the installed system with **Firstboot**

23.3. The Graphical Installation Program User Interface

If you have used a *graphical user interface (GUI)* before, you are already familiar with this process; use your mouse to navigate the screens, click buttons, or enter text fields.

You can also navigate through the installation using the keyboard. The **Tab** key allows you to move around the screen, the Up and Down arrow keys to scroll through lists, **+** and **-** keys expand and collapse lists, while **Space** and **Enter** selects or removes from selection a highlighted item. You can also use the **Alt+X** key command combination as a way of clicking on buttons or making other screen selections, where **X** is replaced with any underlined letter appearing within that screen.

23.4. Configure the Install Terminal

If you logged in with ssh and X11 forwarding, **anaconda** starts immediately with its graphical user interface.

If you did not set the *display=* variable and do not use X11 forwarding, **anaconda** gives you the choice of starting VNC or text mode.

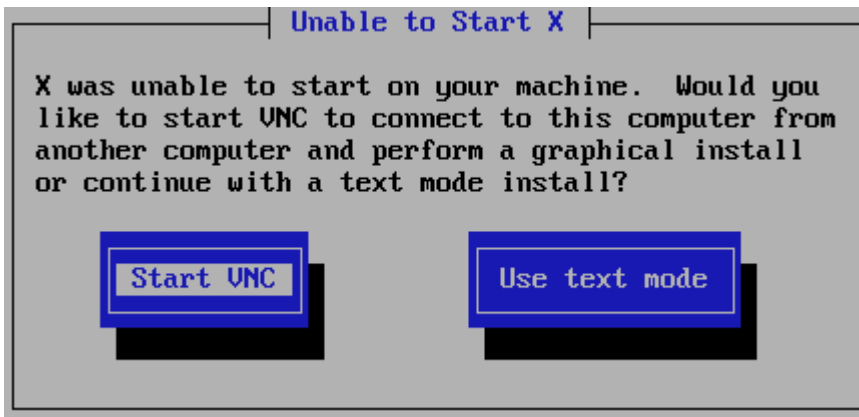


Figure 23.1. Choosing VNC or text mode

If you choose VNC, you will be asked for a password or you can choose to use VNC without a password. If you use a password, make a note of the password for future reference. The VNC server then starts.

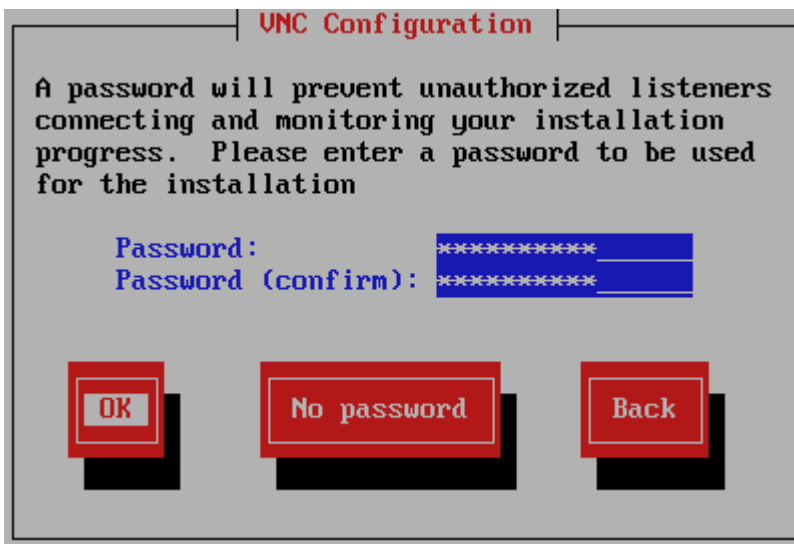
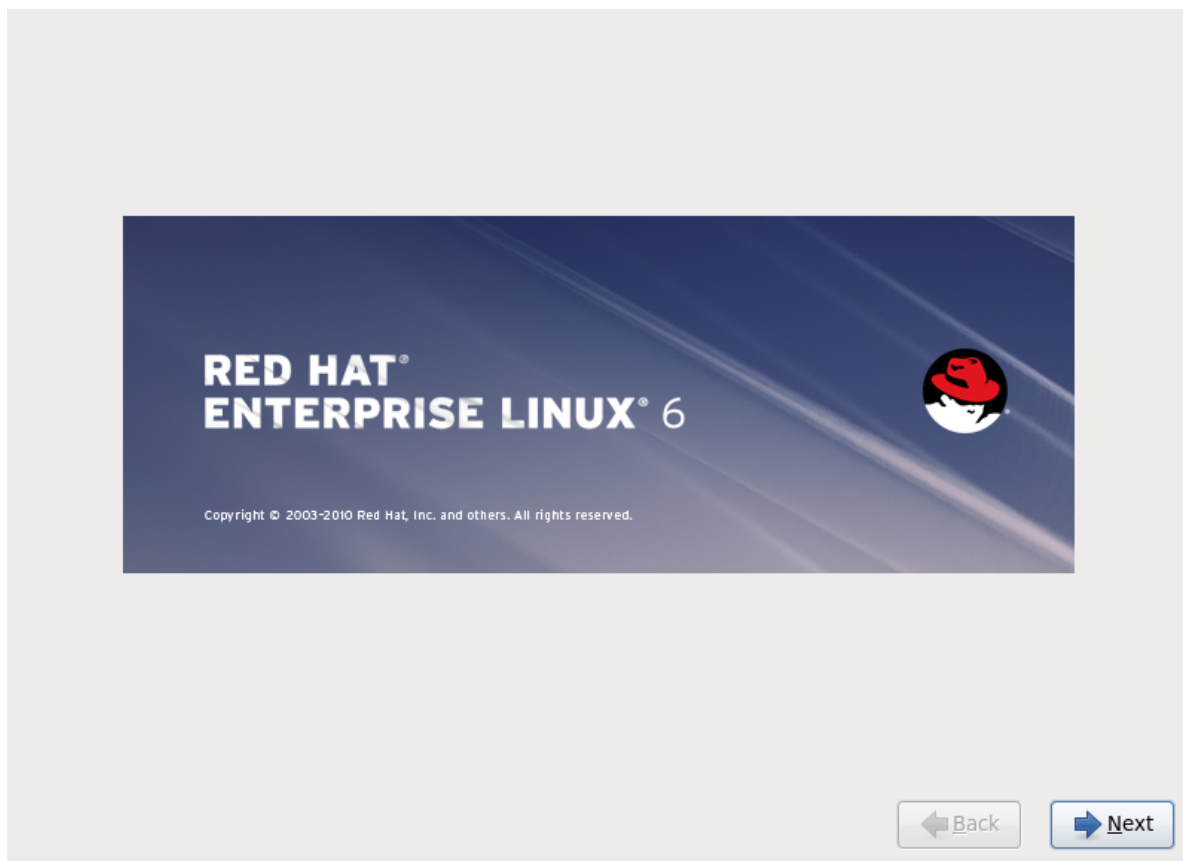


Figure 23.2. The VNC server starts

Now open a connection to the IP address of your z/VM guest virtual machine using a VNC client. Authenticate to the VNC server with the previously entered password.

23.5. Welcome to Red Hat Enterprise Linux

The **Welcome** screen does not prompt you for any input. From this screen you can access the Release Notes for Red Hat Enterprise Linux 6 by clicking on the Release Notes button.



Click on the **Next** button to continue.

23.6. Storage Devices

You can install Red Hat Enterprise Linux on a large variety of storage devices. For System z, select **Specialized Storage Devices**

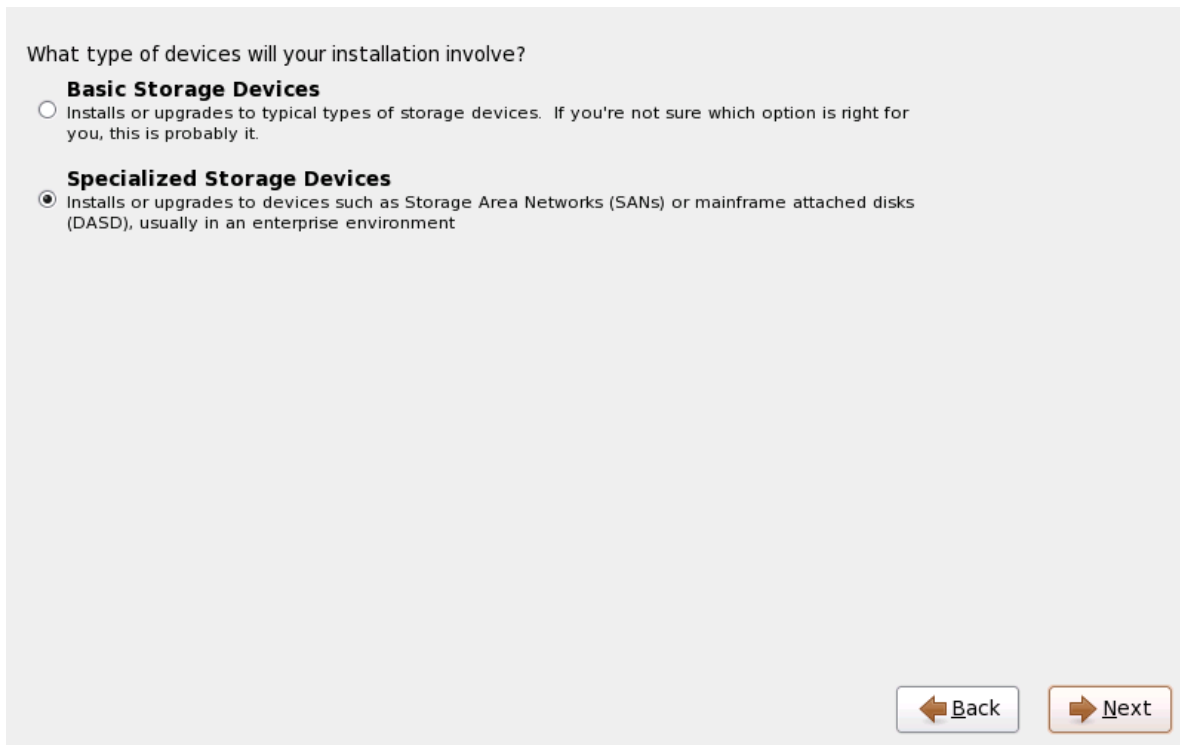


Figure 23.3. Storage devices

Basic Storage Devices

This option does not apply to System z.

Specialized Storage Devices

Select **Specialized Storage Devices** to install Red Hat Enterprise Linux on the following storage devices:

- *Direct access storage devices* (DASDs)
- Multipath devices such as FCP-attachable SCSI LUN with multiple paths
- *Storage area networks* (SANs) such as FCP-attachable SCSI LUNs with a single path

Use the **Specialized Storage Devices** option to configure *Internet Small Computer System Interface* (iSCSI) and *FCoE* (Fiber Channel over Ethernet) connections.

23.6.1. The Storage Devices Selection Screen

The storage devices selection screen displays all storage devices to which **anaconda** has access.

Devices are grouped under the following tabs:

Basic Devices

Basic storage devices directly connected to the local system, such as hard disk drives and solid-state drives. On System z, this contains activated DASDs.

Firmware RAID

Storage devices attached to a firmware RAID controller. This does not apply to System z.

Multipath Devices

Storage devices accessible through more than one path, such as through multiple SCSI controllers or Fiber Channel ports on the same system.

Other SAN Devices

Any other devices available on a storage area network (SAN) such as FCP LUNs attached over one single path.

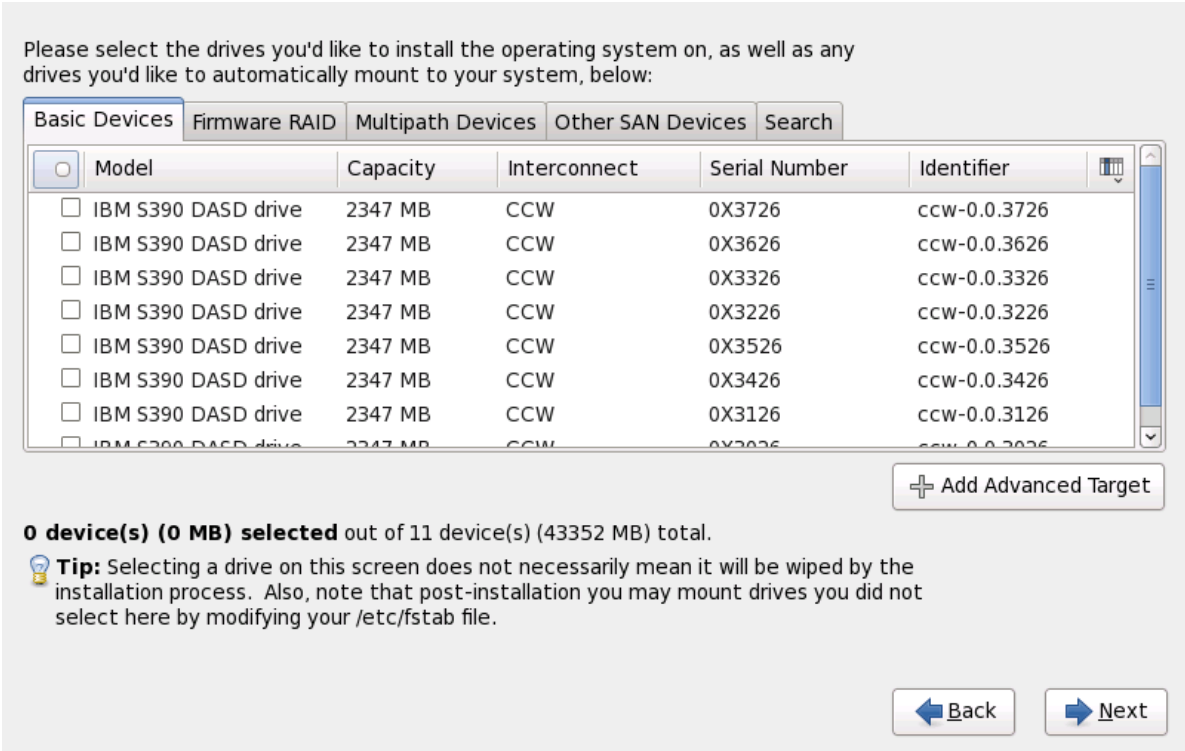


Figure 23.4. Select storage devices — Basic Devices

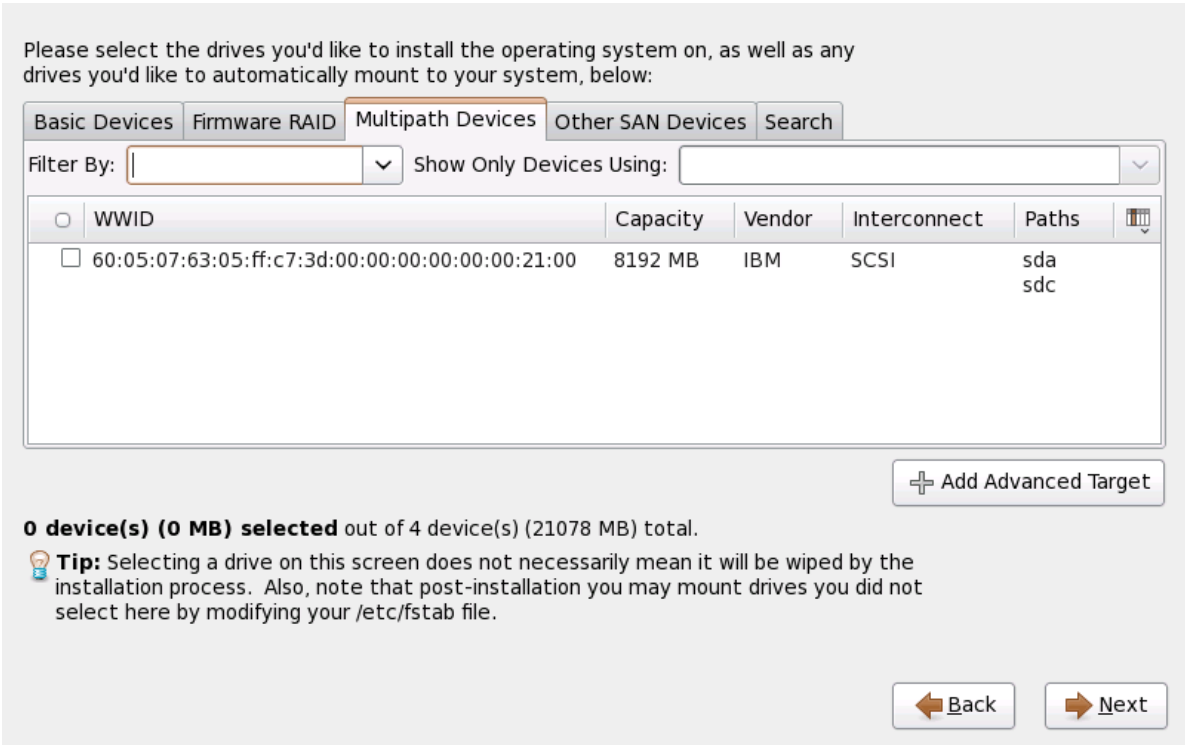


Figure 23.5. Select storage devices — Multipath Devices

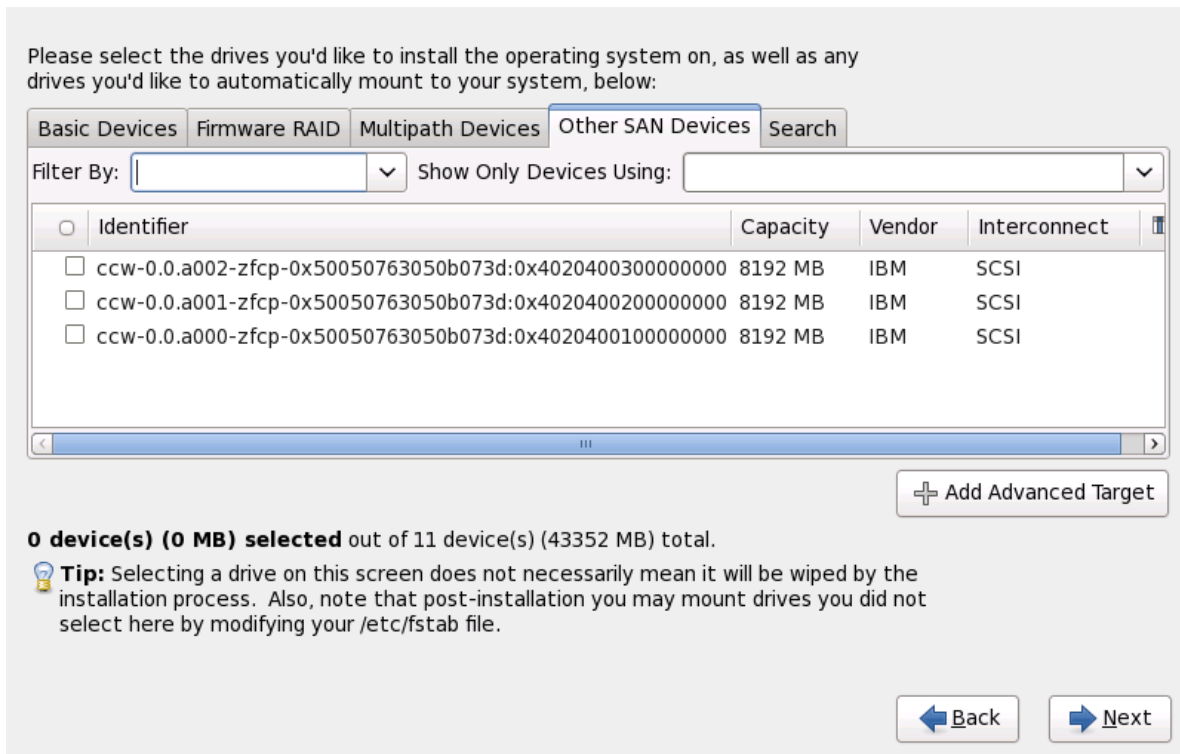


Figure 23.6. Select storage devices — Other SAN Devices

The storage devices selection screen also contains a **Search** tab that allows you to filter storage devices either by their *World Wide Identifier* (WWID) or by the port, target, or *logical unit number* (LUN) at which they are accessed.

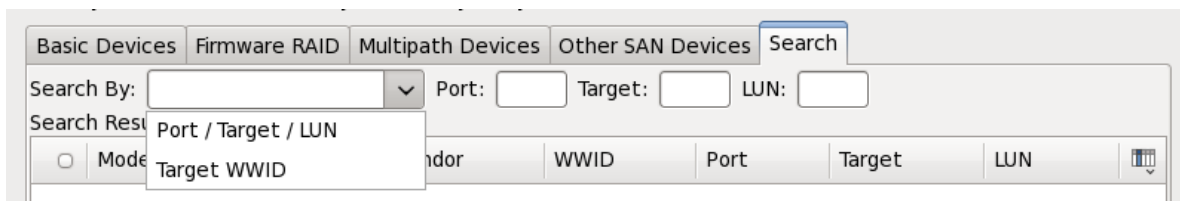


Figure 23.7. The Storage Devices Search Tab

The tab contains a drop-down menu to select searching by port, target, WWID, or LUN (with corresponding text boxes for these values). Searching by WWID or LUN requires additional values in the corresponding text box.

Each tab presents a list of devices detected by **anaconda**, with information about the device to help you to identify it. A small drop-down menu marked with an icon is located to the right of the column headings. This menu allows you to select the types of data presented on each device. For example, the menu on the **Multipath Devices** tab allows you to specify any of **WWID**, **Capacity**, **Vendor**, **Interconnect**, and **Paths** to include among the details presented for each device. Reducing or expanding the amount of information presented might help you to identify particular devices.



Figure 23.8. Selecting Columns

Each device is presented on a separate row, with a checkbox to its left. Click the checkbox to make a device available during the installation process, or click the *radio button* at the left of the column headings to select or deselect all the devices listed in a particular screen. Later in the installation process, you can choose to install Red Hat Enterprise Linux onto any of the devices selected here, and can choose to automatically mount any of the other devices selected here as part of the installed system.

Note that the devices that you select here are not automatically erased by the installation process. Selecting a device on this screen does not, in itself, place data stored on the device at risk. Note also that any devices that you do not select here to form part of the installed system can be added to the system after installation by modifying the `/etc/fstab` file.

when you have selected the storage devices to make available during installation, click **Next** and proceed to [Section 23.7, “Setting the Hostname”](#)

23.6.1.1. DASD low-level formatting

Any DASDs used must be low-level formatted. The installer detects this and lists the DASDs that need formatting.

If any of the DASDs specified interactively in `linuxrc` or in a parameter or configuration file are not yet low-level formatted, the following confirmation dialog appears:



Figure 23.9. Unformatted DASD Devices Found

To automatically allow low-level formatting of unformatted online DASDs specify the kickstart command `zerombr`. Refer to [Chapter 32, Kickstart Installations](#) for more details.

23.6.1.2. Advanced Storage Options

From this screen you can configure an *i*SCSI (SCSI over TCP/IP) target or FCP LUNs. Refer to [Appendix B, *i*SCSI disks](#) for an introduction to *i*SCSI.

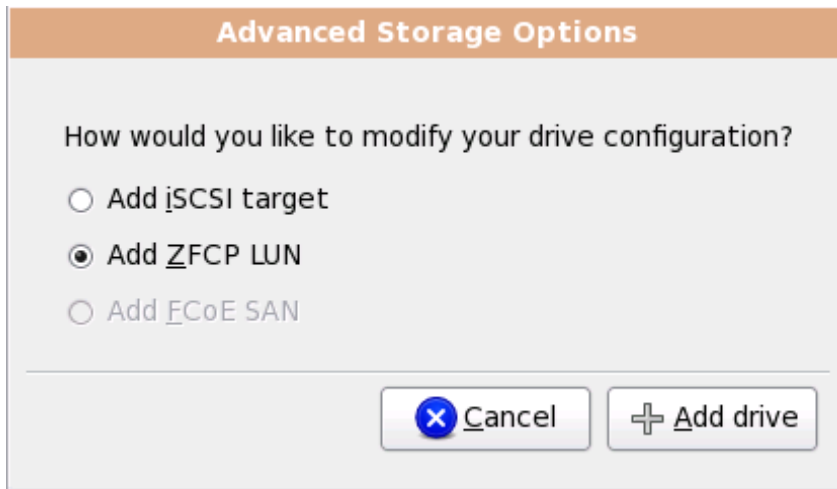


Figure 23.10. Advanced Storage Options

23.6.1.2.1. Configure *i*SCSI Parameters

To configure an *i*SCSI target invoke the 'Configure *i*SCSI Parameters' dialog by selecting 'Add *i*SCSI target' and clicking on the 'Add Drive' button. Fill in the details for the *i*SCSI target IP and provide a unique *i*SCSI initiator name to identify this system. If the *i*SCSI target uses CHAP (Challenge Handshake Authentication Protocol) for authentication, enter the CHAP username and password. If your environment uses 2-way CHAP (also called "Mutual CHAP"), also enter the reverse CHAP username and password. Click the 'Add target' button to attempt connection to the *i*SCSI target using this information.

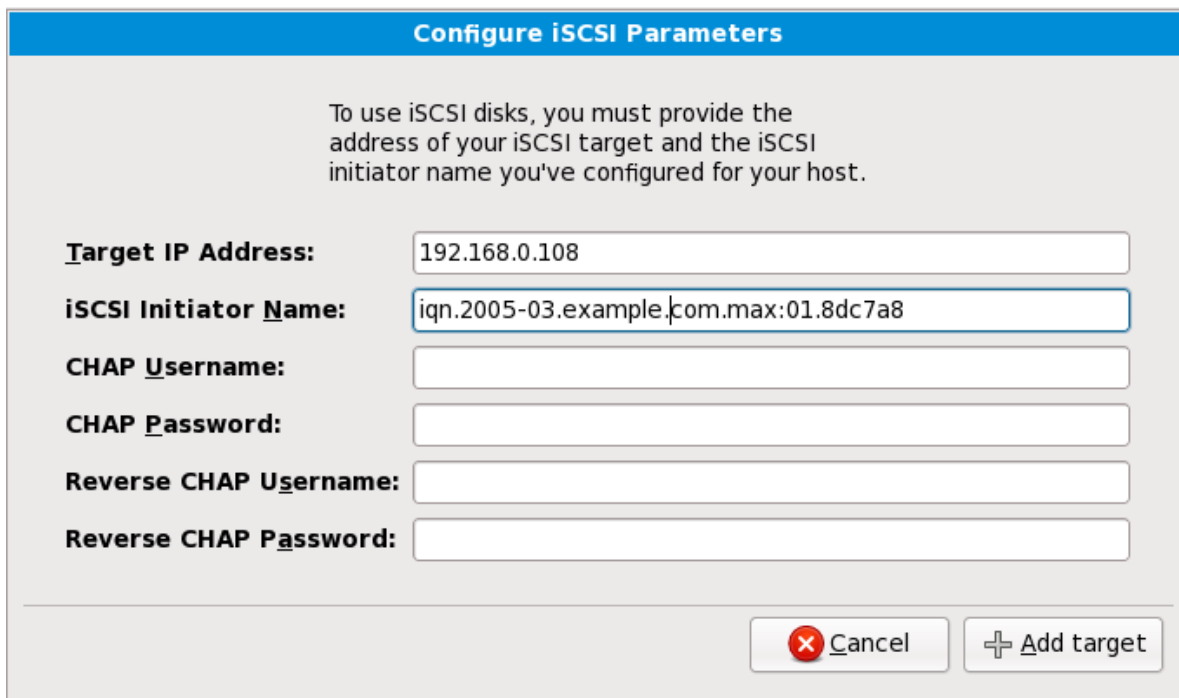


Figure 23.11. Configure *i*SCSI Parameters

Note that you will be able to reattempt with a different *i*SCSI target IP should you enter it incorrectly, but to change the *i*SCSI initiator name you will need to restart the installation.

23.6.1.2.2. FCP Devices

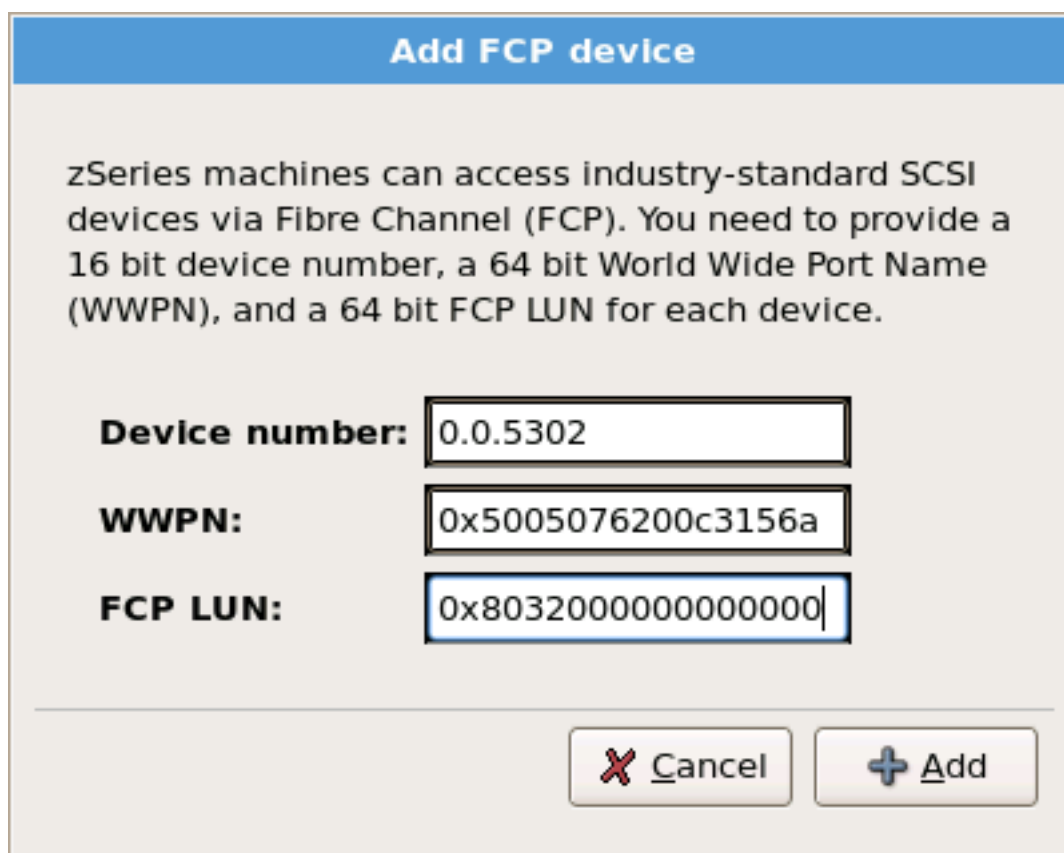
FCP devices enable IBM System z to use SCSI devices rather than, or in addition to, DASD devices. FCP devices provide a switched fabric topology that enables System z systems to use SCSI LUNs as disk devices in addition to traditional DASD devices.

IBM System z requires that any FCP device be entered manually (either in the installation program interactively, or specified as unique parameter entries in the parameter or CMS configuration file) for the installation program to activate FCP LUNs. The values entered here are unique to each site in which they are set up.

Notes

- Interactive creation of an FCP device is only possible in graphical mode. It is not possible to interactively configure an FCP device in a text-only install.
- Each value entered should be verified as correct, as any mistakes made may cause the system not to operate properly. Use only lower-case letters in hex values.
- For more information on these values, refer to the hardware documentation check with the system administrator who set up the network for this system.

To configure a Fiber Channel Protocol SCSI device, select **Add ZFCP LUN** and click **Add Drive**. In the **Add FCP device** dialog, fill in the details for the 16-bit device number, 64-bit World Wide Port Number (WWPN) and 64-bit FCP LUN. Click the **Add** button to connect to the FCP device using this information.



Add FCP device

zSeries machines can access industry-standard SCSI devices via Fibre Channel (FCP). You need to provide a 16 bit device number, a 64 bit World Wide Port Name (WWPN), and a 64 bit FCP LUN for each device.

Device number: 0.0.5302

WWPN: 0x5005076200c3156a

FCP LUN: 0x8032000000000000

Cancel **Add**

Figure 23.12. Add FCP Device

The newly added device should then be present and usable in the storage device selection screen on the **Multipath Devices** tab, if you have activated more than one path to the same LUN, or on **Other SAN Devices**, if you have activated only one path to the LUN.



Important — you must define a DASD

The installer requires the definition of a DASD. For a SCSI-only installation, enter **none** as the parameter interactively during phase 1 of an interactive installation, or add **DASD=none** in the parameter or CMS configuration file. This satisfies the requirement for a defined DASD parameter, while resulting in a SCSI-only environment.

When you define the DASD as **none**, you receive an error message such as:

```
Incorrect format for lower bound of DASD range none: none
```

It is safe to disregard this error message; installation proceeds as normal.

23.7. Setting the Hostname

Setup prompts you to supply a host name for this computer, either as a *fully-qualified domain name* (FQDN) in the format *hostname.domainname* or as a *short host name* in the format *hostname*. Many networks have a *Dynamic Host Configuration Protocol* (DHCP) service that automatically supplies connected systems with a domain name. To allow the DHCP service to assign the domain name to this machine, specify the short host name only.



Valid Hostnames

You may give your system any name provided that the full hostname is unique. The hostname may include letters, numbers and hyphens.

Change the default setting *localhost.localdomain* to a unique hostname for each of your Linux instances.

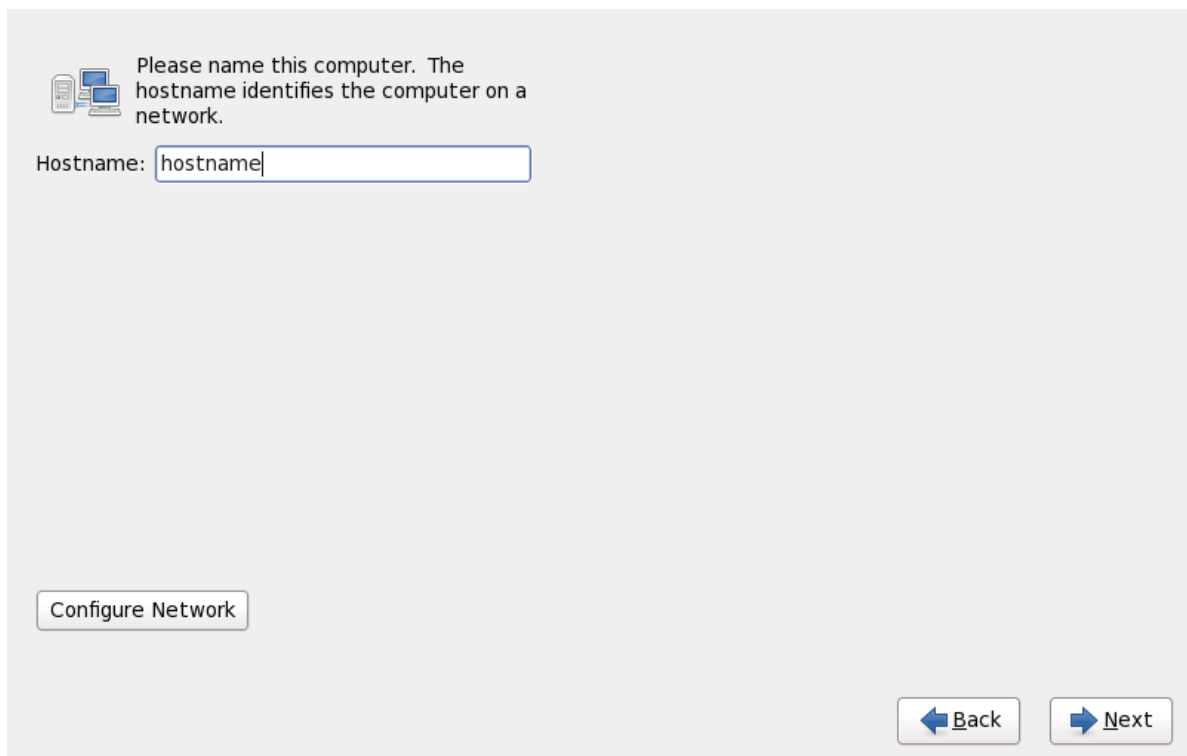


Figure 23.13. Setting the hostname

23.7.1. Edit Network Connections

Note

To change your network configuration after you have completed the installation, use the **Network Administration Tool**.

Type the **system-config-network** command in a shell prompt to launch the **Network Administration Tool**. If you are not root, it prompts you for the root password to continue.

The **Network Administration Tool** is now deprecated and will be replaced by **NetworkManager** during the lifetime of Red Hat Enterprise Linux 6.

Usually, the network connection configured earlier in installation phase 1 does not need to be modified during the rest of the installation. You cannot add a new connection on System z because the network subchannels need to be grouped and set online beforehand, and this is currently only done in installation phase 1. To change the existing network connection, click the button **Configure Network**. The **Network Connections** dialog appears that allows you to configure network connections for the system, not all of which are relevant to System z.

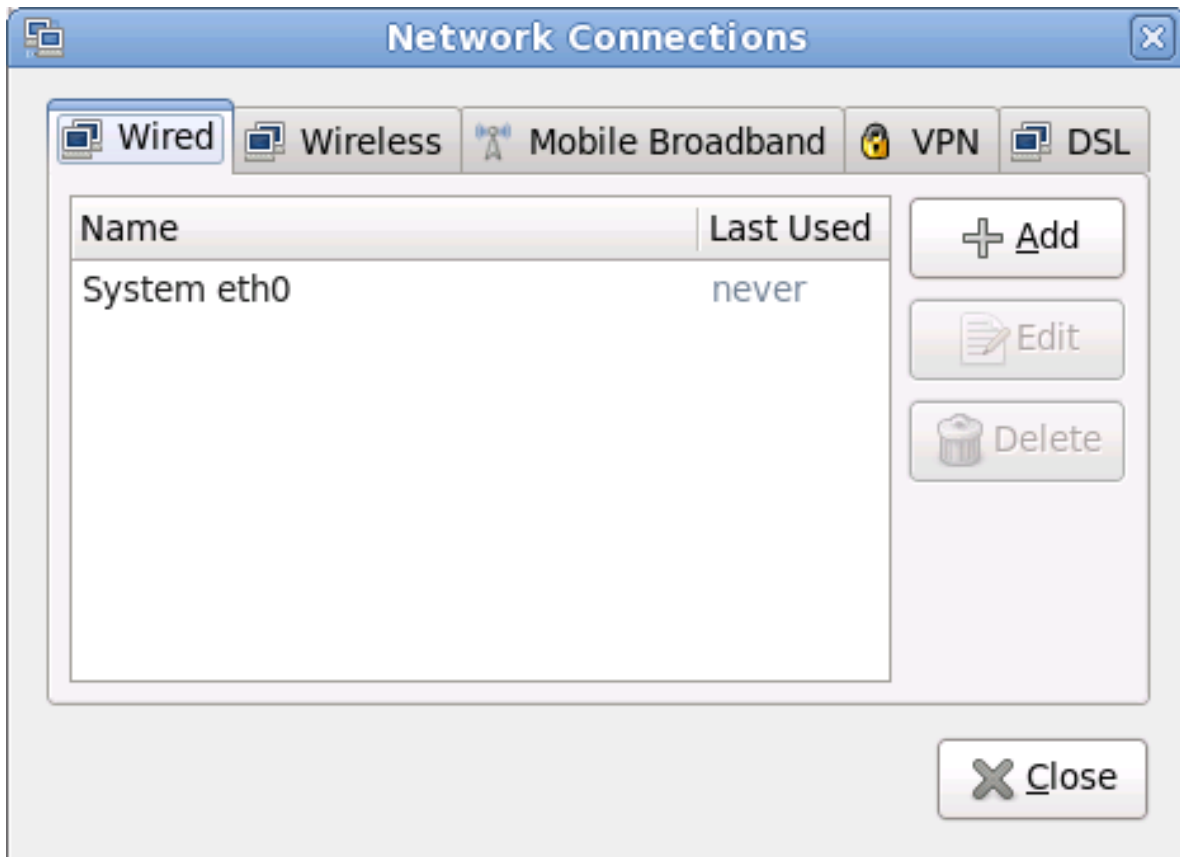


Figure 23.14. Network Connections

All network connections on System z are listed in the **Wired** tab. By default this contains the connection configured earlier in installation phase 1 and is either `eth0` (OSA, LCS), or `hsi0` (HiperSockets). Note that on System z you cannot add a new connection here. To modify an existing connection, select a row in the list and click the **Edit** button. A dialog box appears with a set of tabs appropriate to wired connections, as described below.

The most important tabs on System z are **Wired** and **IPv4 Settings**.

When you have finished editing network settings, click **Apply** to activate your changes. Note that re-configuring your network settings might require you to re-connect using the new settings.

23.7.1.1. Options common to all types of connection

Certain configuration options are common to all connection types.

Specify a name for the connection in the **Connection name** name field.

Select **Start automatically** to start the connection automatically when the system boots.

Select **Available to all users** to make the connection available to all users.

23.7.1.2. The Wired tab

Use the **Wired** tab to specify or change the *media access control* (MAC) address for the network adapter, and either set the *maximum transmission unit* (MTU, in bytes) that can pass through the interface.



Figure 23.15. The Wired tab

23.7.1.3. The 802.1x Security tab

Use the **802.1x Security** tab to configure 802.1X *port-based network access control* (PNAC). Select **Use 802.1X security for this connection** to enable access control, then specify details of your network. The configuration options include:

Authentication

Choose one of the following methods of authentication:

- **TLS** for *Transport Layer Security*
- **Tunneled TLS** for *Tunneled Transport Layer Security*, otherwise known as TTLS, or EAP-TTLS

- **Protected EAP (PEAP)** for *Protected Extensible Authentication Protocol*

Identity

Provide the identity of this server.

User certificate

Browse to a personal X.509 certificate file encoded with *Distinguished Encoding Rules* (DER) or *Privacy Enhanced Mail* (PEM).

CA certificate

Browse to a X.509 *certificate authority* certificate file encoded with *Distinguished Encoding Rules* (DER) or *Privacy Enhanced Mail* (PEM).

Private key

Browse to a *private key* file encoded with *Distinguished Encoding Rules* (DER), *Privacy Enhanced Mail* (PEM), or the *Personal Information Exchange Syntax Standard* (PKCS#12).

Private key password

The password for the private key specified in the **Private key** field. Select **Show password** to make the password visible as you type it.

Editing System eth0

Connection name: System eth0

Connect automatically

Wired | **802.1x Security** | IPv4 Settings | IPv6 Settings

Use 802.1X security for this connection

Authentication: TLS

Identity:

User certificate: (None)

CA certificate: (None)

Private key: (None)

Private key password:

Show password

Available to all users

Cancel Apply...

Figure 23.16. The 802.1x Security tab

23.7.1.4. The IPv4 Settings tab

Use the **IPv4 Settings tab** to configure the IPv4 parameters for the previously selected network connection.

The address, netmask, gateway, DNS servers and DNS search suffix for an IPv4 connection were configured during installation phase 1 or reflect the following parameters in the parameter file or configuration file: *IPADDR*, *NETMASK*, *GATEWAY*, *DNS*, *SEARCHDNS* (Refer to [Section 26.3, "Installation network parameters"](#)).

Use the **Method** drop-down menu to specify which settings the system should attempt to obtain from a *Dynamic Host Configuration Protocol* (DHCP) service running on the network. Choose from the following options:

Automatic (DHCP)

IPv4 parameters are configured by the DHCP service on the network.

Automatic (DHCP) addresses only

The IPv4 address, netmask, and gateway address are configured by the DHCP service on the network, but DNS servers and search domains must be configured manually.

Manual

IPv4 parameters are configured manually for a static configuration.

Link-Local Only

A *link-local* address in the 169.254/16 range is assigned to the interface.

Shared to other computers

The system is configured to provide network access to other computers. The interface is assigned an address in the 10.42.x.1/24 range, a DHCP server and DNS server are started, and the interface is connected to the default network connection on the system with *network address translation* (NAT).

Disabled

IPv4 is disabled for this connection.

If you selected a method that requires you to supply manual parameters, enter details of the IP address for this interface, the netmask, and the gateway in the **Addresses** field. Use the **Add** and **Delete** buttons to add or remove addresses. Enter a comma-separated list of DNS servers in the **DNS servers** field, and a comma-separated list of domains in the **Search domains** field for any domains that you want to include in name server lookups.

Optionally, enter a name for this network connection in the **DHCP client ID** field. This name must be unique on the subnet. When you assign a meaningful DHCP client ID to a connection, it is easy to identify this connection when troubleshooting network problems.

Deselect the **Require IPv4 addressing for this connection to complete** check box to allow the system to make this connection on an IPv6-enabled network if IPv4 configuration fails but IPv6 configuration succeeds.



Figure 23.17. The IPv4 Settings tab

23.7.1.4.1. Editing IPv4 routes

Red Hat Enterprise Linux configures a number of routes automatically based on the IP addresses of a device. To edit additional routes, click the **Routes** button. The **Editing IPv4 routes** dialog appears.

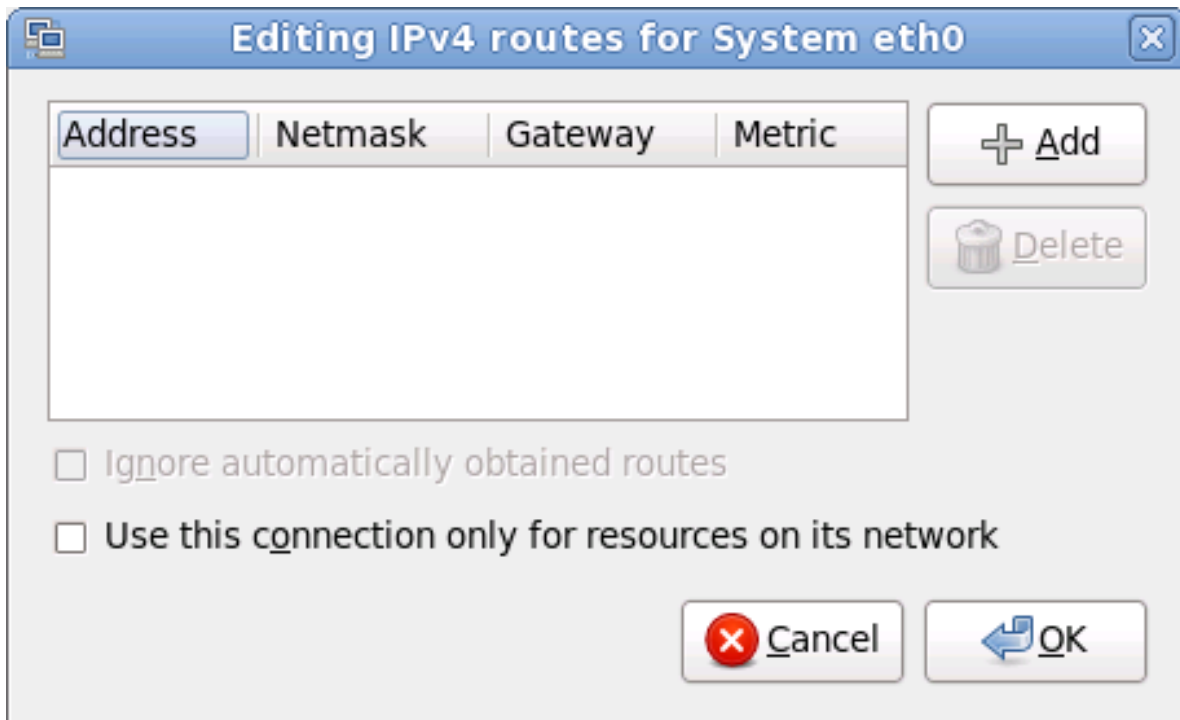


Figure 23.18. The Editing IPv4 Routes dialog

Click **Add** to add the IP address, netmask, gateway address, and metric for a new static route.

Select **Ignore automatically obtained routes** to make the interface use only the routes specified for it here.

Select **Use this connection only for resources on its network** to restrict connections only to the local network.

23.7.1.5. The IPv6 Settings tab

Use the **IPv6 Settings tab** to configure the IPv6 parameters for the previously selected network connection.

Use the **Method** drop-down menu to specify which settings the system should attempt to obtain from a *Dynamic Host Configuration Protocol* (DHCP) service running on the network. Choose from the following options:

Ignore

IPv6 is ignored for this connection.

Automatic

IPv6 parameters are configured by the DHCP service on the network.

Automatic, addresses only

The IPv6 address, prefix, and gateway address are configured by the DHCP service on the network, but DNS servers and search domains must be configured manually.

Manual

IPv6 parameters are configured manually for a static configuration.

Link-Local Only

A *link-local* address with the fe80::/10 prefix is assigned to the interface.

If you selected a method that requires you to supply manual parameters, enter details of the IP address for this interface, the netmask, and the gateway in the **Addresses** field. Use the **Add** and **Delete** buttons to add or remove addresses. Enter a comma-separated list of DNS servers in the **DNS servers** field, and a comma-separated list of domains in the **Search domains** field for any domains that you want to include in name server lookups.

Optionally, enter a name for this network connection in the **DHCP client ID** field. This name must be unique on the subnet. When you assign a meaningful DHCP client ID to a connection, it is easy to identify this connection when troubleshooting network problems.

Deselect the **Require IPv6 addressing for this connection to complete** check box to allow the system to make this connection on an IPv4-enabled network if IPv6 configuration fails but IPv4 configuration succeeds.

The screenshot shows a window titled "Editing System eth0" with a close button in the top right. The "Connection name" field contains "System eth0". The "Connect automatically" checkbox is checked. Below are four tabs: "Wired", "802.1x Security", "IPv4 Settings", and "IPv6 Settings", with the last one selected. The "Method" dropdown is set to "Ignore". The "Addresses" section contains a table with columns "Address" and "Prefix", and two buttons: "+ Add" and a trash icon "Delete". Below the table are fields for "DNS servers:" and "Search domains:", and a "Routes..." button. At the bottom, the "Available to all users" checkbox is checked, and there are "Cancel" and "Apply..." buttons.

| Address | Prefix |
|---------|--------|
|---------|--------|

Figure 23.19. The IPv6 Settings tab

23.7.1.5.1. Editing IPv6 routes

Red Hat Enterprise Linux configures a number of routes automatically based on the IP addresses of a device. To edit additional routes, click the **Routes** button. The **Editing IPv6 routes** dialog appears.

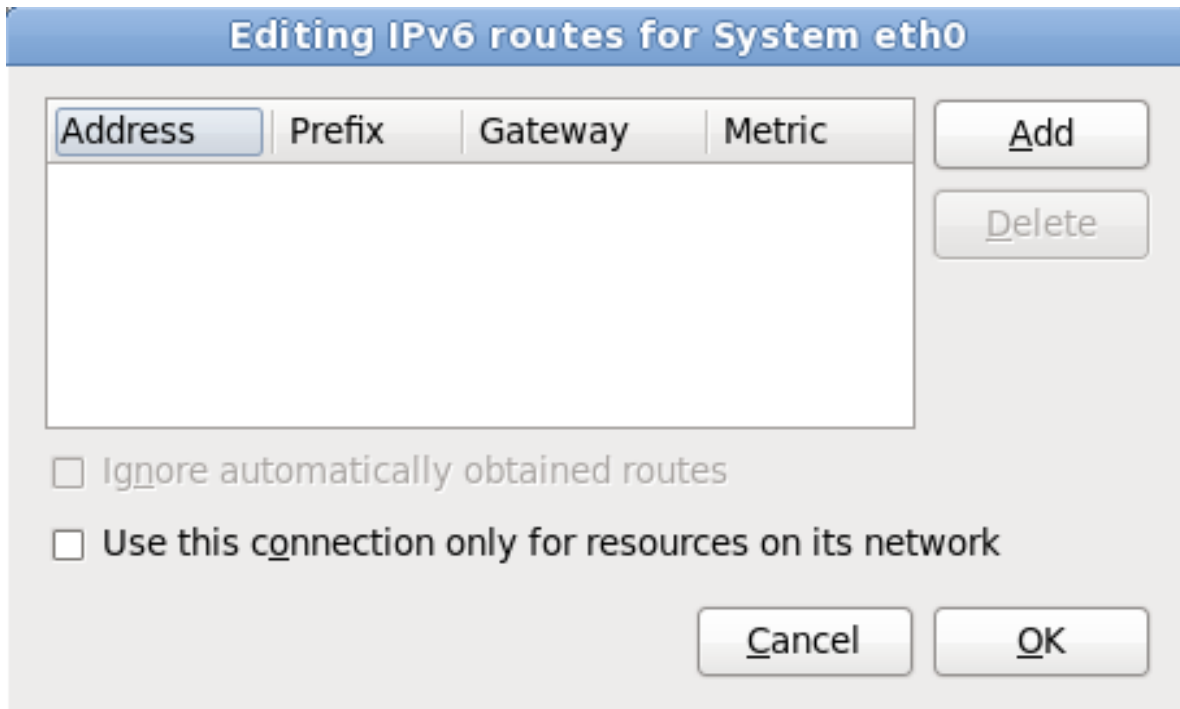


Figure 23.20. The Editing IPv6 Routes dialog

Click **Add** to add the IP address, netmask, gateway address, and metric for a new static route.

Select **Use this connection only for resources on its network** to restrict connections only to the local network.

23.8. Time Zone Configuration

Set your time zone by selecting the city closest to your computer's physical location. Click on the map to zoom in to a particular geographical region of the world.

Specify a time zone even if you plan to use NTP (Network Time Protocol) to maintain the accuracy of the system clock.

From here there are two ways for you to select your time zone:

- Using your mouse, click on the interactive map to select a specific city (represented by a yellow dot). A red **X** appears indicating your selection.
- You can also scroll through the list at the bottom of the screen to select your time zone. Using your mouse, click on a location to highlight your selection.

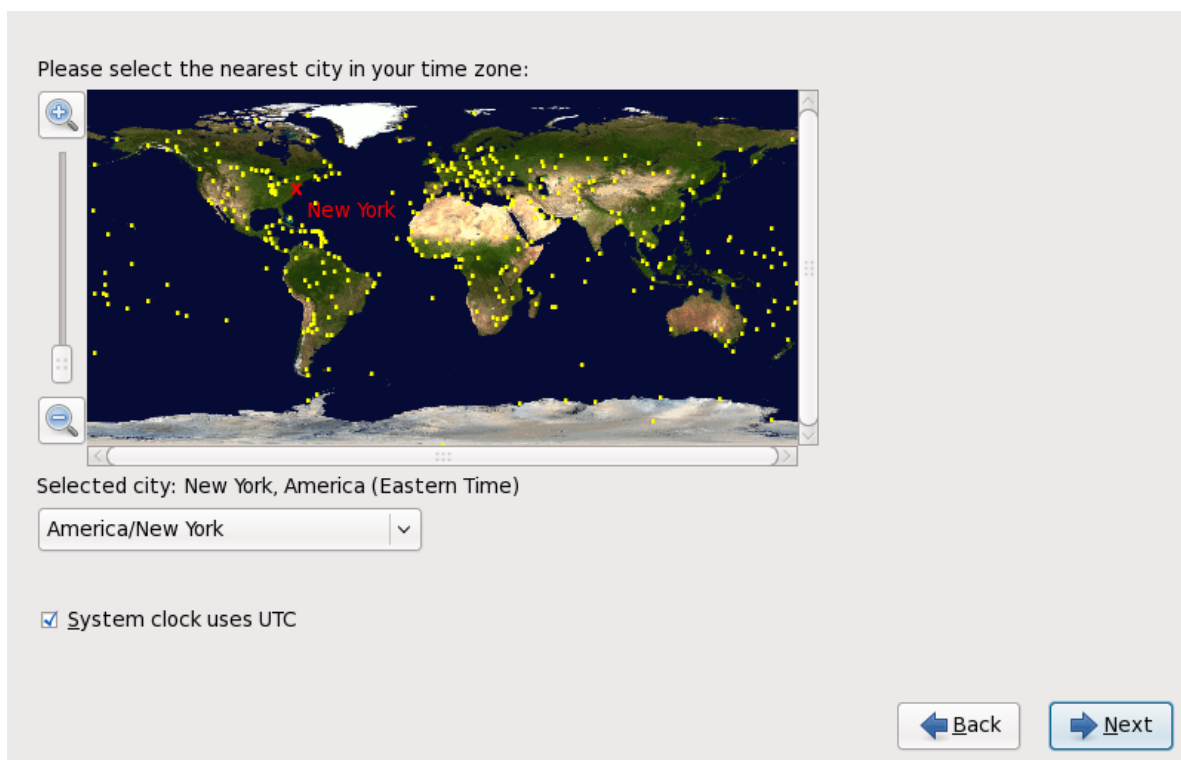


Figure 23.21. Configuring the Time Zone

Select **System clock uses UTC**. The system clock is a piece of hardware on your computer system. Red Hat Enterprise Linux uses the timezone setting to determine the offset between the local time and UTC on the system clock. This behavior is standard for systems that use UNIX, Linux, and similar operating systems.

Click **Next** to proceed.

Note

To change your time zone configuration after you have completed the installation, use the **Time and Date Properties Tool**.

Type the `system-config-date` command in a shell prompt to launch the **Time and Date Properties Tool**. If you are not root, it prompts you for the root password to continue.

To run the **Time and Date Properties Tool** as a text-based application, use the command `timeconfig`.

23.9. Set the Root Password

Setting up a root account and password is one of the most important steps during your installation. The root account is used to install packages, upgrade RPMs, and perform most system maintenance. Logging in as root gives you complete control over your system.



Note

The root user (also known as the superuser) has complete access to the entire system; for this reason, logging in as the root user is best done *only* to perform system maintenance or administration.

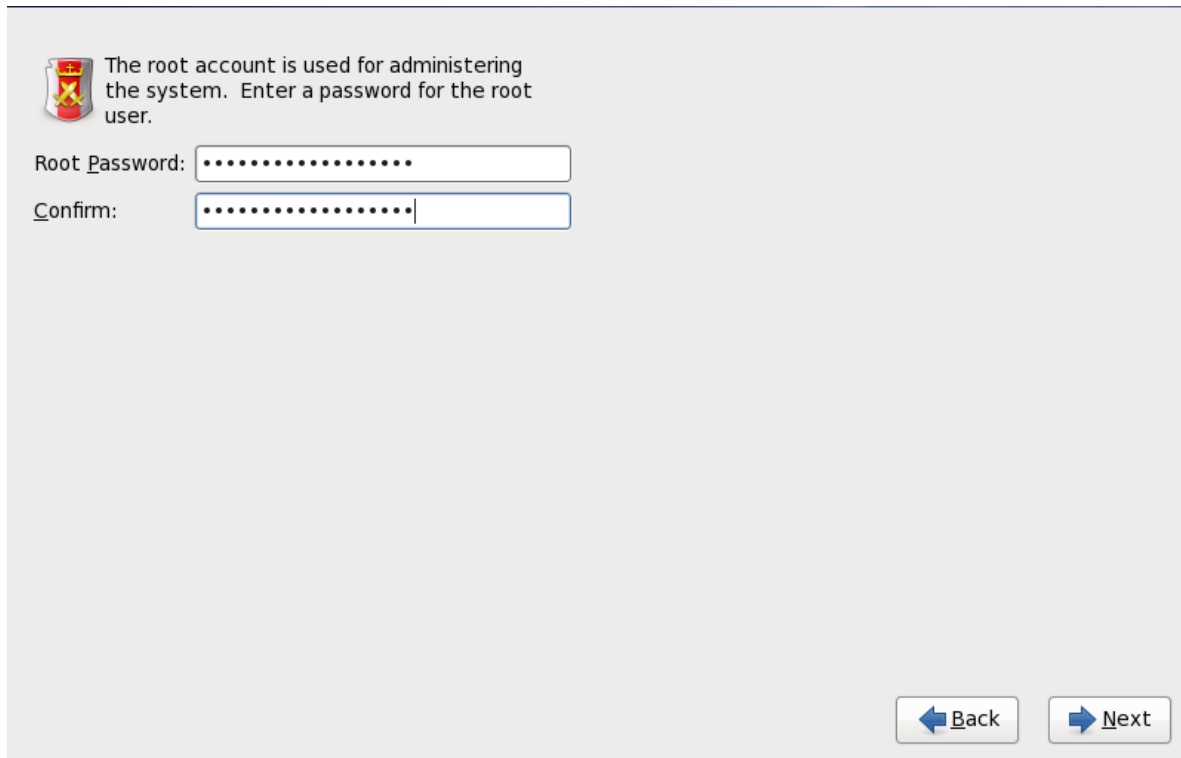


Figure 23.22. Root Password

Use the root account only for system administration. Create a non-root account for your general use and use the **su** command to change to root only when you need to perform tasks that require superuser authorization. These basic rules minimize the changes of a typo or an incorrect command doing damage to your system.



Note

To become root, type **su -** at the shell prompt in a terminal window and then press **Enter**. Then, enter the root password and press **Enter**.

The installation program prompts you to set a root password¹ for your system. *You cannot proceed to the next stage of the installation process without entering a root password.*

The root password must be at least six characters long; the password you type is not echoed to the screen. You must enter the password twice; if the two passwords do not match, the installation program asks you to enter them again.

¹ A root password is the administrative password for your Red Hat Enterprise Linux system. You should only log in as root when needed for system maintenance. The root account does not operate within the restrictions placed on normal user accounts, so changes made as root can have implications for your entire system.

You should make the root password something you can remember, but not something that is easy for someone else to guess. Your name, your phone number, *qwerty*, *password*, *root*, *123456*, and *anteater* are all examples of bad passwords. Good passwords mix numerals with upper and lower case letters and do not contain dictionary words: *Aard387vark* or *420BMttNT*, for example. Remember that the password is case-sensitive. If you write down your password, keep it in a secure place. However, it is recommended that you do not write down this or any password you create.



Note

Do not use one of the example passwords offered in this manual. Using one of these passwords could be considered a security risk.

To change your root password after you have completed the installation, use the **Root Password Tool**.

Type the **system-config-users** command in a shell prompt to launch the **User Manager**, a powerful user management and configuration tool. If you are not root, it prompts you for the root password to continue.

Enter the root password into the **Root Password** field. Red Hat Enterprise Linux displays the characters as asterisks for security. Type the same password into the **Confirm** field to ensure it is set correctly. After you set the root password, select **Next** to proceed.

23.10. Assign Storage Devices

If you selected more than one storage device on the storage devices selection screen (refer to [Section 23.6, “Storage Devices”](#)), **anaconda** asks you to select which of these devices should be available for installation of the operating system, and which should only be attached to the file system for data storage.

During installation, the devices that you identify here as being for data storage only are mounted as part of the file system, but are not partitioned or formatted.

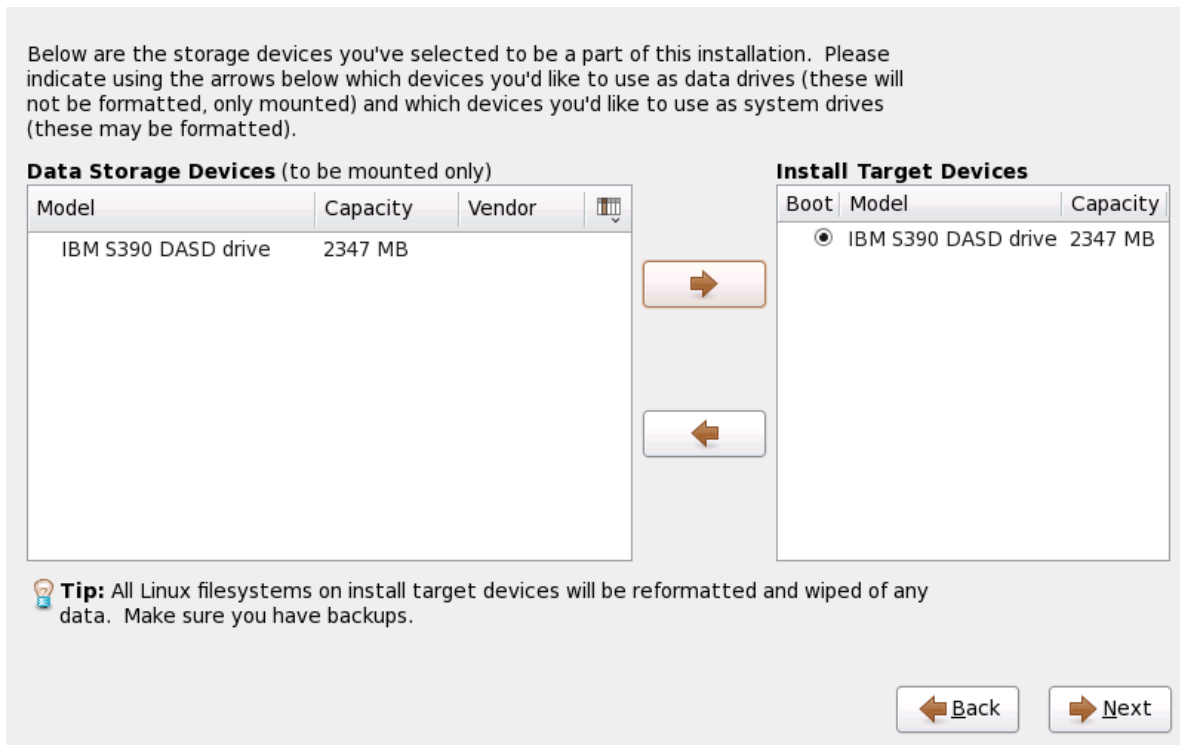


Figure 23.23. Assign storage devices

The screen is split into two panes. The left pane contains a list of devices to be used for data storage only. The right pane contains a list of devices that are to be available for installation of the operating system.

Each list contains information about the devices to help you to identify them. A small drop-down menu marked with an icon is located to the right of the column headings. This menu allows you to select the types of data presented on each device. Reducing or expanding the amount of information presented might help you to identify particular devices.

Move a device from one list to the other by clicking on the device, then clicking either the button labeled with a left-pointing arrow to move it to the list of data storage devices or the button labeled with a right-pointing arrow to move it to the list of devices available for installation of the operating system.

The list of devices available as installation targets also includes a radio button beside each device. On platforms other than System z, this radio button is used to specify the device to which you want to install the boot loader. On System z this choice does not have any effect. The **zipl** boot loader will be installed on the disk that contains the **/boot** directory, which is determined later on during partitioning.

When you have finished identifying devices to be used for installation, click **Next** to continue.

23.11. Initializing the Hard Disk

If no readable partition tables are found on existing hard disks, the installation program asks to initialize the hard disk. This operation makes any existing data on the hard disk unreadable. If your system has a brand new hard disk with no operating system installed, or you have removed all partitions on the hard disk, click **Re-initialize drive**.

The installation program presents you with a separate dialog for each disk on which it cannot read a valid partition table. Click the **Ignore all** button or **Re-initialize all** button to apply the same answer to all devices.

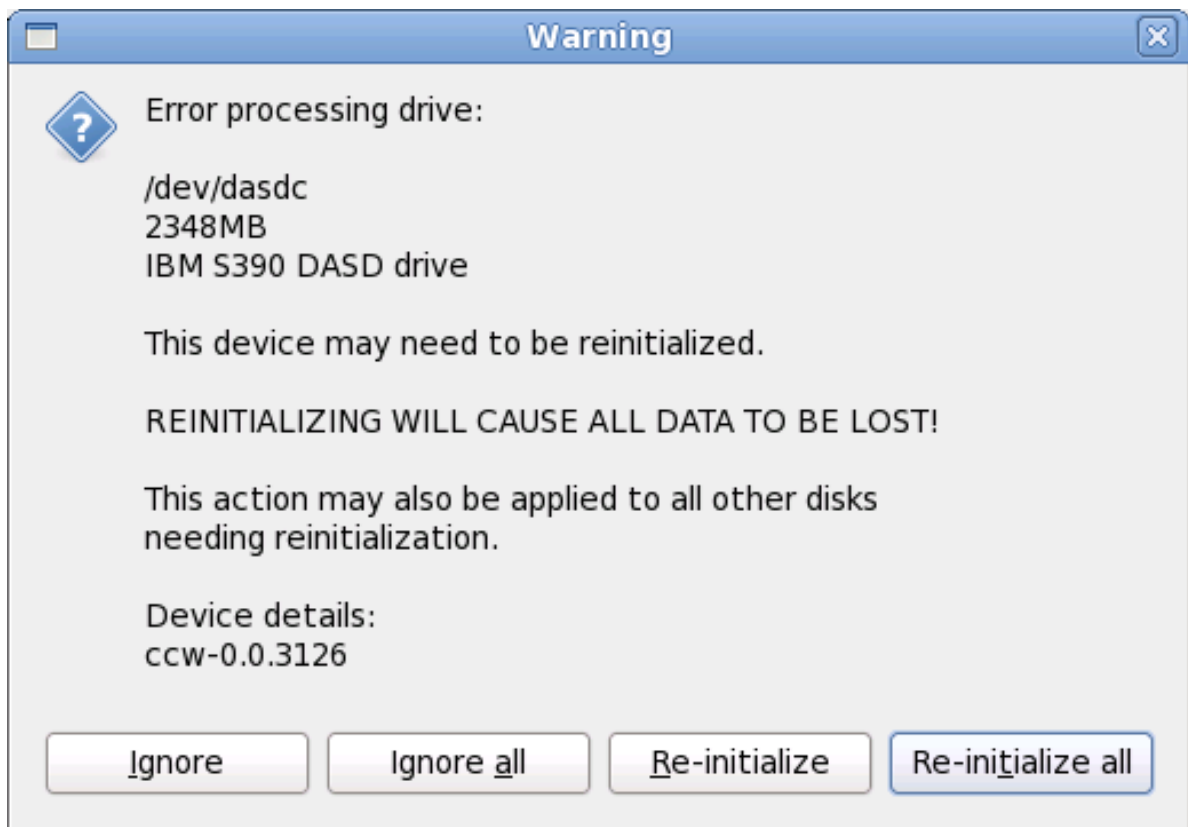


Figure 23.24. Warning screen – initializing DASD

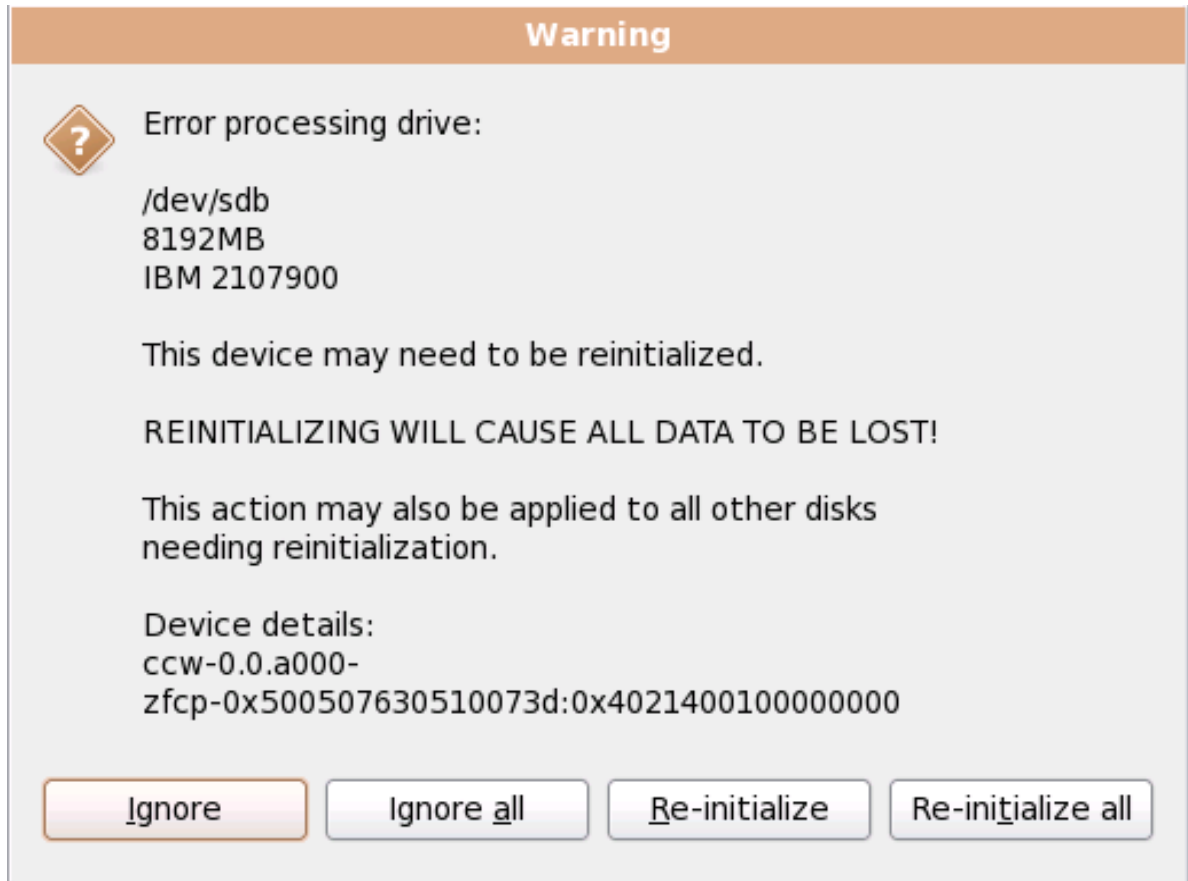


Figure 23.25. Warning screen – initializing FCP LUN

Certain RAID systems or other nonstandard configurations may be unreadable to the installation program and the prompt to initialize the hard disk may appear. The installation program responds to the physical disk structures it is able to detect.

To enable automatic initializing of hard disks for which it turns out to be necessary, use the kickstart command `clearpart --initlabel` (refer to [Chapter 32, Kickstart Installations](#))



Detach Unneeded Disks

If you have a nonstandard disk configuration that can be detached during installation and detected and configured afterward, power off the system, detach it, and restart the installation.

23.12. Upgrading an Existing System



Red Hat does not support upgrades from earlier major versions

Although **anaconda** provides an option for upgrading from earlier major versions of Red Hat Enterprise Linux to Red Hat Enterprise Linux 6, Red Hat does not currently support this. More generally, Red Hat does not support in-place upgrades between any major versions of Red Hat Enterprise Linux. (A major version is denoted by a whole number version change. For example, Red Hat Enterprise Linux 4 and Red Hat Enterprise Linux 5 are both major versions of Red Hat Enterprise Linux.)

In-place upgrades across major releases do not preserve all system settings, services or custom configurations. Consequently, Red Hat strongly recommends fresh installations when upgrading from one major version to another.

The installation system automatically detects any existing installation of Red Hat Enterprise Linux. The upgrade process updates the existing system software with new versions, but does not remove any data from users' home directories. The existing partition structure on your hard drives does not change. Your system configuration changes only if a package upgrade demands it. Most package upgrades do not change system configuration, but rather install an additional configuration file for you to examine later.

Note that the installation medium that you are using might not contain all the software packages that you need to upgrade your computer.



Manually Installed Software

Software you have installed manually on your existing Red Hat Enterprise Linux system may behave differently after an upgrade. You may need to manually reinstall or recompile this software after an upgrade to ensure it performs correctly on the updated system.

23.12.1. Upgrading Using the Installer



Installations are Recommended

In general, Red Hat recommends that you keep user data on a separate **/home** partition and perform a fresh installation. For more information on partitions and how to set them up, refer to [Section 9.12, “Disk Partitioning Setup”](#).

If you choose to upgrade your system using the installation program, any software not provided by Red Hat Enterprise Linux that conflicts with Red Hat Enterprise Linux software is overwritten. Before you begin an upgrade this way, make a list of your system's current packages for later reference:

```
rpm -qa --qf '%{NAME} %{VERSION}-%{RELEASE} %{ARCH}\n' > ~/old-pkglist.txt
```

After installation, consult this list to discover which packages you may need to rebuild or retrieve from sources other than Red Hat.

Next, make a backup of any system configuration data:

```
su -c 'tar czf /tmp/etc-`date +%F`.tar.gz /etc'
su -c 'mv /tmp/etc-*.tar.gz /home'
```

Make a complete backup of any important data before performing an upgrade. Important data may include the contents of your entire **/home** directory as well as content from services such as an Apache, FTP, or SQL server, or a source code management system. Although upgrades are not destructive, if you perform one improperly there is a small possibility of data loss.



Storing Backups

Note that the above examples store backup materials in a **/home** directory. If your **/home** directory is not a separate partition, *you should not follow these examples verbatim!* Store your backups on another device such as CD or DVD discs or an external hard disk.

For more information on completing the upgrade process later, refer to [Section 35.2, “Finishing an Upgrade”](#).

23.13. Disk Partitioning Setup



Warning — Back up your data

It is always a good idea to back up any data that you have on your systems. For example, if you are upgrading or creating a dual-boot system, you should back up any data you wish to keep on your storage devices. Mistakes do happen and can result in the loss of all your data.



Important — Installing in text mode

If you install Red Hat Enterprise Linux in text mode, you can only use the default partitioning schemes described in this section. You cannot add or remove partitions or file systems beyond those that the installer automatically adds or removes. If you require a customized layout at installation time, you should perform a graphical installation over a VNC connection or a kickstart installation.

Furthermore, advanced options such as LVM, encrypted filesystems, and resizable filesystems are available only in graphical mode and kickstart.

Partitioning allows you to divide your storage devices into isolated sections, where each section behaves as a separate Linux device. Partitioning is particularly useful if you run multiple operating systems, or wish to enforce a logical or functional distinction between your storage partitions (such as a `/home` partition that persistently contains user information).

Which type of installation would you like?

Use All Space
Removes all partitions on the selected device(s). This includes partitions created by other operating systems.
Tip: This option will remove data from the selected device(s). Make sure you have backups.

Replace Existing Linux System(s)
Removes only Linux partitions (created from a previous Linux installation). This does not remove other partitions you may have on your storage device(s) (such as VFAT or FAT32).
Tip: This option will remove data from the selected device(s). Make sure you have backups.

Shrink Current System
Shrinks existing partitions to create free space for the default layout.

Use Free Space
Retains your current data and partitions and uses only the unpartitioned space on the selected device(s), assuming you have enough free space available.

Create Custom Layout
Manually create your own custom layout on the selected device(s) using our partitioning tool.

Encrypt system

Review and modify partitioning layout

Figure 23.26. Disk Partitioning Setup

On this screen you can choose to create the default partition layout in one of four different ways, or choose to partition storage devices manually to create a custom layout.

The first four options allow you to perform an automated installation without having to partition your storage devices yourself. If you do not feel comfortable with partitioning your system, choose one of these options and let the installation program partition the storage devices for you. Depending on the option that you choose, you can still control what data (if any) is removed from the system.

Your options are:

Use All Space

Select this option to remove all partitions on your storage drives (this includes partitions created by other operating systems such as z/VM or z/OS).

**Warning**

If you select this option, all data on the selected DASD and SCSI storage devices is removed by the installation program.

Replace Existing Linux System(s)

Select this option to remove only Linux partitions (partitions created from a previous Linux installation). This does not remove other partitions you may have on your storage devices (such as z/VM or z/OS partitions).

Shrink Current System

Select this option to resize your current data and partitions manually and install a default Red Hat Enterprise Linux layout in the space that is freed.

**Warning**

If you shrink partitions on which other operating systems are installed, you might not be able to use those operating systems. Although this partitioning option does not destroy data, operating systems typically require some free space in their partitions. Before you resize a partition that holds an operating system that you might want to use again, find out how much space you need to leave free.

Use Free Space

Select this option to retain your current data and partitions and install Red Hat Enterprise Linux in the unused space available on the storage drives. Ensure that there is sufficient space available on the storage drives before you select this option — refer to [Section 18.1, “Pre-Installation”](#).

Create Custom Layout

Select this option to partition storage devices manually and create customized layouts. Refer to [Section 23.15, “Creating a Custom Layout or Modifying the Default Layout”](#)

Choose your preferred partitioning method by clicking the radio button to the left of its description in the dialog box.

Select **Encrypt system** to encrypt all partitions except the `/boot` partition. Refer to [Appendix C, Disk Encryption](#) for information on encryption.

To review and make any necessary changes to the partitions created by automatic partitioning, select the **Review** option. After selecting **Review** and clicking **Next** to move forward, the partitions created for you by **anaconda** appear. You can make modifications to these partitions if they do not meet your needs.

Click **Next** once you have made your selections to proceed.

23.14. Encrypt Partitions

If you selected the **Encrypt System** option, the installer prompts you for a passphrase with which to encrypt the partitions on the system.

Partitions are encrypted using the *Linux Unified Key Setup* — refer to [Appendix C, Disk Encryption](#) for more information.

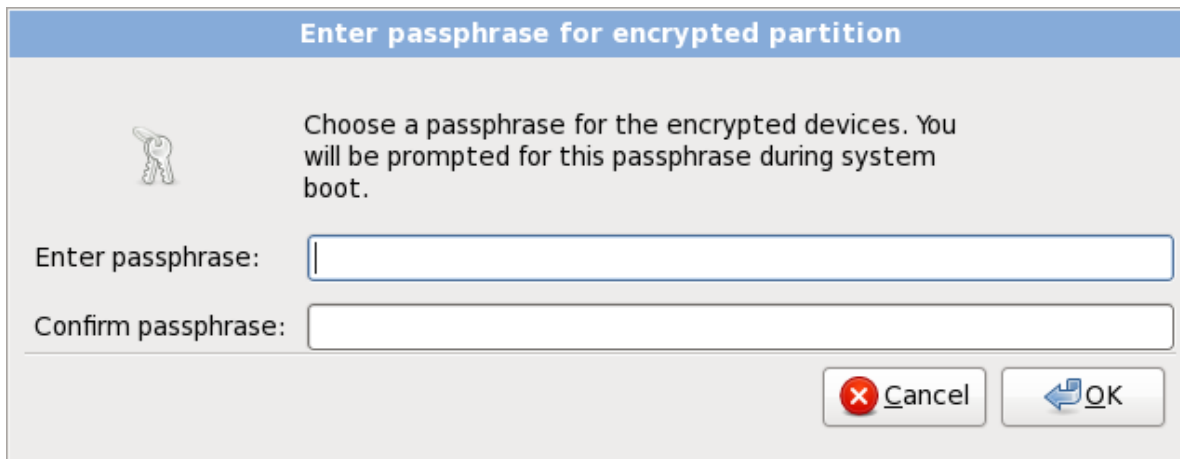


Figure 23.27. Enter passphrase for encrypted partition

Choose a passphrase and type it into each of the two fields in the dialog box. You must provide this passphrase every time that the system boots.



Warning — Do not lose this passphrase

If you lose this passphrase, any encrypted partitions and the data on them will become completely inaccessible. There is no way to recover a lost passphrase.

Note that if you perform a kickstart installation of Red Hat Enterprise Linux, you can save encryption passphrases and create backup encryption passphrases during installation. Refer to [Section C.3.2, “Saving Passphrases”](#) and [Section C.3.3, “Creating and Saving Backup Passphrases”](#).

23.15. Creating a Custom Layout or Modifying the Default Layout

If you chose one of the four automatic partitioning options and did not select **Review**, skip ahead to [Section 23.16, “Write changes to disk”](#).

If you chose to create a custom layout, you must tell the installation program where to install Red Hat Enterprise Linux. This is done by defining mount points for one or more disk partitions in which Red Hat Enterprise Linux is installed.

If you have not yet planned how to set up your partitions, refer to [Appendix A, An Introduction to Disk Partitions](#) and [Section 23.15.5, “Recommended Partitioning Scheme”](#). At a bare minimum, you need an appropriately-sized root partition, and usually a swap partition appropriate to the amount of RAM you have on the system.

Anaconda can handle the partitioning requirements for a typical installation.

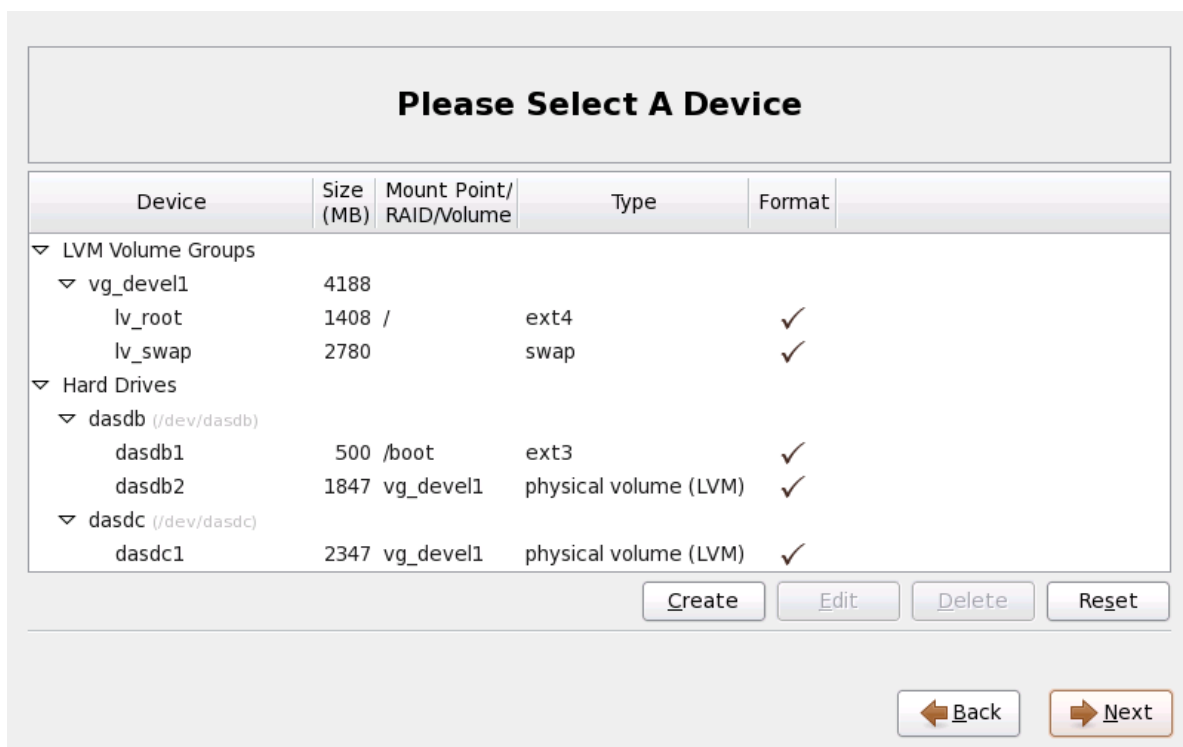


Figure 23.28. Partitioning on System z

The partitioning screen contains two panes. The top pane contains a graphical representation of the DASD, FCP LUN, or logical volume selected in the lower pane.

Above the display, you can review the **Drive** name (such as /dev/dasda), the **Geom** (which shows the hard disk's geometry and consists of three numbers representing the number of cylinders, heads, and sectors as reported by the hard disk), and the **Model** of the hard drive as detected by the installation program.

Using your mouse, click once to highlight a particular field in the graphical display. Double-click to edit an existing partition or to create a partition out of existing free space.

The lower pane contains a list of all DASDs, FCP LUNs, and logical volumes to be used during installation, as specified earlier in the installation process — refer to [Section 23.10, “Assign Storage Devices”](#). Note that if you specified a CMSDASD in your parameter file, DASD names begin at **dasdb**; **dasda** was assigned to the CMSDASD and this name is no longer available at this point in the installation process.

Devices are grouped by type. Click on the small triangles to the left of each device type to view or hide devices of that type.

Anaconda displays several details for each device listed:

Device

the name of the device, logical volume, or partition

Size (MB)

the size of the device, logical volume, or partition (in MB)

Mount Point/RAID/Volume

the *mount point* (location within a file system) on which a partition is to be mounted, or the name of the RAID or logical volume group of which it is a part

Type

the type of partition. If the partition is a standard partition, this field displays the type of file system on the partition (for example, ext4). Otherwise, it indicates that the partition is a **physical volume (LVM)**, or part of a **software RAID**

Format

A check mark in this column indicates that the partition will be formatted during installation.

Beneath the lower pane are four buttons: **Create**, **Edit**, **Delete**, and **Reset**.

Select a device or partition by clicking on it in either the graphical representation in the upper pane of in the list in the lower pane, then click one of the four buttons to carry out the following actions:

Create

create a new partition, logical volume, or software RAID

Edit

change an existing new partition, logical volume, or software RAID

Delete

remove a partition, logical volume, or software RAID

Reset

undo all changes made in this screen

Finally, note which device is associated with **/boot**. The kernel files and bootloader sector will be associated with this device. The first DASD or SCSI LUN will be used, and the device number will be used when re-IPLing the post-installed system.



Note — device names and types are illustrative only

The screenshots in the following subsections of this manual sometimes show hard disk types and device names that do not appear as such on System z. These screenshots are only intended to illustrate the installation interface itself and apply equally to DASDs and FCP-attached SCSI disks.

23.15.1. Create Storage

The **Create Storage** dialog allows you to create new storage partitions, logical volumes, and software RAIDs. **Anaconda** presents options as available or unavailable depending on the storage already present on the system or configured to transfer to the system.

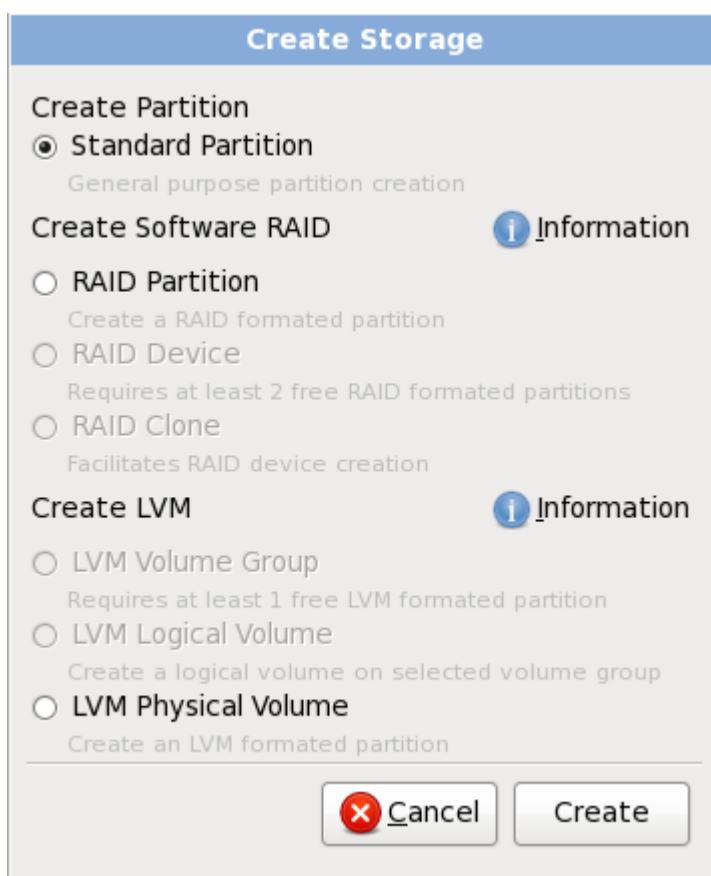


Figure 23.29. Creating Storage

Options are grouped under **Create Partition**, **Create Software RAID** and **Create LVM** as follows:

Create Partition

Refer to [Section 23.15.2, “Adding Partitions”](#) for details of the **Add Partition** dialog.

- **Standard Partition** — create a standard disk partition (as described in [Appendix A, An Introduction to Disk Partitions](#)) in unallocated space.

Create Software RAID

On System z, the storage subsystem uses RAID transparently, and you do not need to set it up.

Refer to [Section 23.15.3, “Create Software RAID ”](#) for more detail.

- **RAID Partition** — create a partition in unallocated space to form part of a software RAID device. To form a software RAID device, two or more RAID partitions must be available on the system.
- **RAID Device** — combine two or more RAID partitions into a software RAID device. When you choose this option, you can specify the type of RAID device to create (the *RAID level*). This option is only available when two or more RAID partitions are available on the system.
- **RAID Clone** — create a mirror of a RAID partition on one storage device on another storage device. This option is only available when at least one RAID partition is available on the system.

Create LVM Logical Volume

Refer to [Section 23.15.4, “Create LVM Logical Volume ”](#) for more detail.

- **LVM Physical Volume** — create a *physical volume* in unallocated space.

- **LVM Volume Group** — create a *volume group* from one or more physical volumes. This option is only available when at least one physical volume is available on the system.
- **LVM Logical Volume** — create a *logical volume* on a volume group. This option is only available when at least one volume group is available on the system.

23.15.2. Adding Partitions

To add a new partition, select the **Create** button. A dialog box appears (refer to [Figure 23.30, “Creating a New Partition”](#)).



Note

You must dedicate at least one partition for this installation, and optionally more. For more information, refer to [Appendix A, An Introduction to Disk Partitions](#).

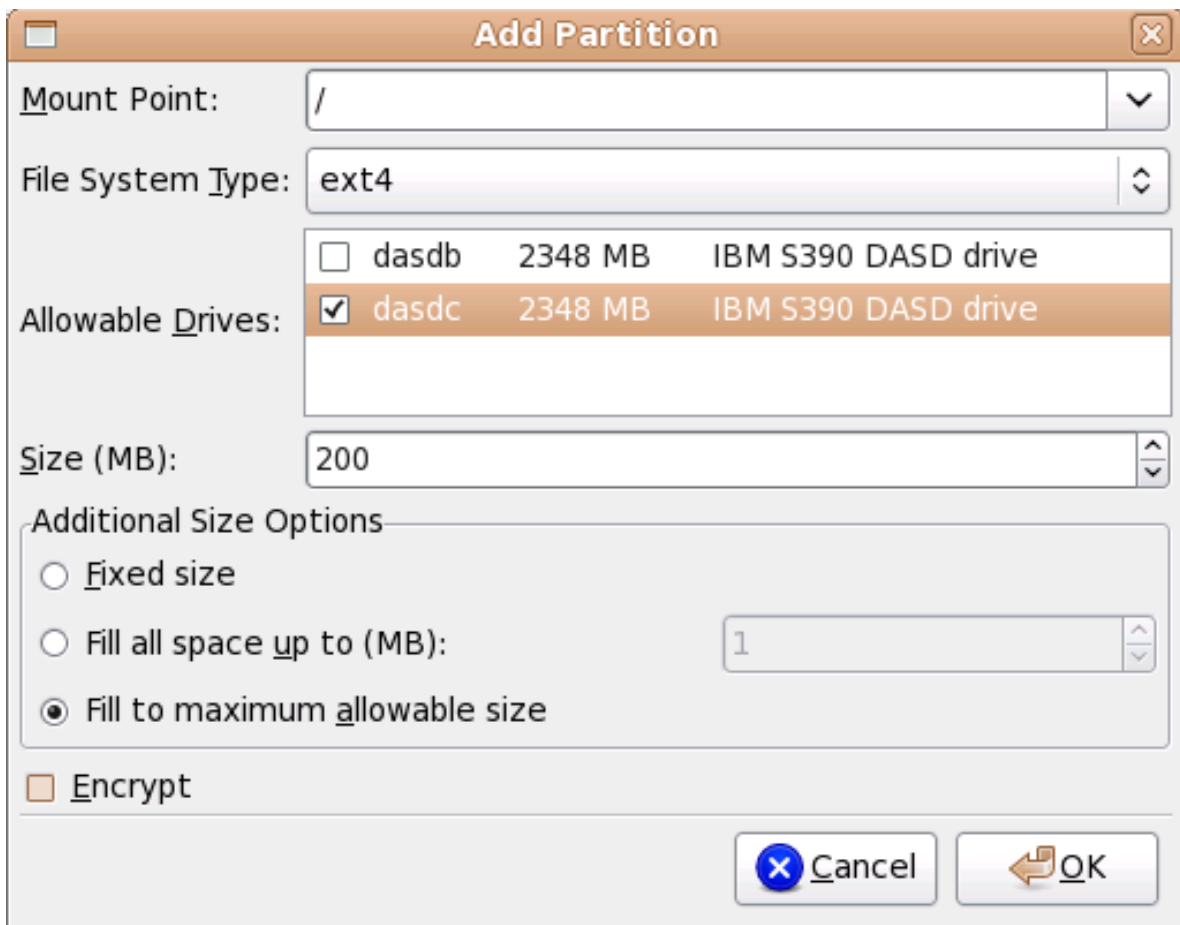


Figure 23.30. Creating a New Partition

- **Mount Point:** Enter the partition's mount point. For example, if this partition should be the root partition, enter `/`; enter `/boot` for the `/boot` partition, and so on. You can also use the pull-down menu to choose the correct mount point for your partition. For a swap partition the mount point should not be set — setting the filesystem type to **swap** is sufficient.
- **File System Type:** Using the pull-down menu, select the appropriate file system type for this partition. For more information on file system types, refer to [Section 9.14.2.1, “File System Types”](#).

- **Allowable Drives:** This field contains a list of the hard disks installed on your system. If a hard disk's box is highlighted, then a desired partition can be created on that hard disk. If the box is *not* checked, then the partition will *never* be created on that hard disk. By using different checkbox settings, you can have **anaconda** place partitions where you need them, or let **anaconda** decide where partitions should go.
- **Size (MB):** Enter the size (in megabytes) of the partition. Note, this field starts with 200 MB; unless changed, only a 200 MB partition will be created.
- **Additional Size Options:** Choose whether to keep this partition at a fixed size, to allow it to "grow" (fill up the available hard drive space) to a certain point, or to allow it to grow to fill any remaining hard drive space available.

If you choose **Fill all space up to (MB)**, you must give size constraints in the field to the right of this option. This allows you to keep a certain amount of space free on your hard drive for future use.

- **Force to be a primary partition:** Select whether the partition you are creating should be one of the first four partitions on the hard drive. If unselected, the partition is created as a logical partition. Refer to [Section A.1.3, "Partitions within Partitions — An Overview of Extended Partitions"](#), for more information.
- **Encrypt:** Choose whether to encrypt the partition so that the data stored on it cannot be accessed without a passphrase, even if the storage device is connected to another system. Refer to [Appendix C, Disk Encryption](#) for information on encryption of storage devices. If you select this option, the installer prompts you to provide a passphrase before it writes the partition to the disk.
- **OK:** Select **OK** once you are satisfied with the settings and wish to create the partition.
- **Cancel:** Select **Cancel** if you do not want to create the partition.

23.15.2.1. File System Types

Red Hat Enterprise Linux allows you to create different partition types and file systems. The following is a brief description of the different partition types and file systems available, and how they can be used.

Partition types

- **standard partition** — A standard partition can contain a file system or swap space, or it can provide a container for software RAID or an LVM physical volume.
- **swap** — Swap partitions are used to support virtual memory. In other words, data is written to a swap partition when there is not enough RAM to store the data your system is processing. Refer to the *Red Hat Enterprise Linux Deployment Guide* for additional information.
- **software RAID** — Creating two or more software RAID partitions allows you to create a RAID device. For more information regarding RAID, refer to the chapter *RAID (Redundant Array of Independent Disks)* in the *Red Hat Enterprise Linux Deployment Guide*.
- **physical volume (LVM)** — Creating one or more physical volume (LVM) partitions allows you to create an LVM logical volume. LVM can improve performance when using physical disks. For more information regarding LVM, refer to the *Red Hat Enterprise Linux Deployment Guide*.

File systems

- **ext4** — The ext4 file system is based on the ext3 file system and features a number of improvements. These include support for larger file systems and larger files, faster and more efficient allocation of disk space, no limit on the number of subdirectories within a directory, faster

file system checking, and more robust journalling. The ext4 file system is selected by default and is highly recommended.

- **ext3** — The ext3 file system is based on the ext2 file system and has one main advantage — journalling. Using a journalling file system reduces time spent recovering a file system after a crash as there is no need to **fsck** ² the file system.
- **ext2** — An ext2 file system supports standard Unix file types (regular files, directories, symbolic links, etc). It provides the ability to assign long file names, up to 255 characters.
- **xfs** — XFS is a highly scalable, high-performance file system that supports filesystems up to 16 exabytes (approximately 16 million terabytes), files up to 8 exabytes (approximately 8 million terabytes) and directory structures containing tens of millions of entries. XFS supports metadata journalling, which facilitates quicker crash recovery. The XFS file system can also be defragmented and resized while mounted and active.



Important — XFS not supported on System z

Red Hat Enterprise Linux 6 does not support XFS on System z.

- **vfat** — The VFAT file system is a Linux file system that is compatible with Microsoft Windows long filenames on the FAT file system.
- **Btrfs** — Btrfs is under development as a file system capable of addressing and managing more files, larger files, and larger volumes than the ext2, ext3, and ext4 file systems. Btrfs is designed to make the file system tolerant of errors, and to facilitate the detection and repair of errors when they occur. It uses checksums to ensure the validity of data and metadata, and maintains snapshots of the file system that can be used for backup or repair.

Because Btrfs is still experimental and under development, the installation program does not offer it by default. If you want to create a Btrfs partition on a drive, you must commence the installation process with the boot option **btrfs**. Refer to [Chapter 28, Boot Options](#) for instructions.



Btrfs is still experimental

Red Hat Enterprise Linux 6 includes Btrfs as a technology preview to allow you to experiment with this file system. You should not choose Btrfs for partitions that will contain valuable data or that are essential for the operation of important systems.

23.15.3. Create Software RAID



Note — Software RAIDs are unnecessary on System z

On System z, the storage subsystem uses RAID transparently. There is no need to set up a software RAID.

Redundant arrays of independent disks (RAIDs) are constructed from multiple storage devices that are arranged to provide increased performance and — in some configurations — greater fault tolerance. Refer to the *Red Hat Enterprise Linux Deployment Guide* for a description of different kinds of RAIDs.

To make a RAID device, you must first create software RAID partitions. Once you have created two or more software RAID partitions, select **RAID** to join the software RAID partitions into a RAID device.

RAID Partition

Choose this option to configure a partition for software RAID. This option is the only choice available if your disk contains no software RAID partitions. This is the same dialog that appears when you add a standard partition — refer to [Section 23.15.2, “Adding Partitions”](#) for a description of the available options. Note, however, that **File System Type** must be set to **software RAID**

The screenshot shows the 'Add Partition' dialog box with the following configuration:

- Mount Point:** <Not Applicable>
- File System Type:** software RAID
- Allowable Drives:**

| | | | |
|-------------------------------------|-----|----------|--------------|
| <input checked="" type="checkbox"/> | sda | 80480 MB | ATA HARDDISK |
| <input checked="" type="checkbox"/> | sdb | 80480 MB | ATA HARDDISK |
- Size (MB):** 200
- Additional Size Options:**
 - Fixed size
 - Fill all space up to (MB): 1
 - Fill to maximum allowable size
- Force to be a primary partition
- Encrypt

Buttons: Cancel, OK

Figure 23.31. Create a software RAID partition

RAID Device

Choose this option to construct a RAID device from two or more existing software RAID partitions. This option is available if two or more software RAID partitions have been configured.

Make RAID Device

Mount Point:

File System Type: ext3

RAID Device: md0

RAID Level: RAID1

| RAID Members: | Size |
|-------------------------------|----------|
| <input type="checkbox"/> sda2 | 81306 MB |
| <input type="checkbox"/> sdb1 | 81502 MB |

Number of spares: 0

Encrypt

Figure 23.32. Create a RAID device

Select the file system type as for a standard partition.

Anaconda automatically suggests a name for the RAID device, but you can manually select names from **md0** to **md15**.

Click the checkboxes beside individual storage devices to include or remove them from this RAID.

The **RAID Level** corresponds to a particular type of RAID. Choose from the following options:

- **RAID 0** — distributes data across multiple storage devices. Level 0 RAID offers increased performance over standard partitions, and can be used to pool the storage of multiple devices into one large virtual device. Note that Level 0 RAID offers no redundancy and that the failure of one device in the array destroys the entire array. RAID 0 requires at least two RAID partitions.
- **RAID 1** — mirrors the data on one storage device onto one or more other storage devices. Additional devices in the array provide increasing levels of redundancy. RAID 1 requires at least two RAID partitions.
- **RAID 4** — distributes data across multiple storage devices, but uses one device in the array to store parity information that safeguards the array in case any device within the array fails. Because all parity information is stored on the one device, access to this device creates a bottleneck in the performance of the array. RAID 4 requires at least three RAID partitions.
- **RAID 5** — distributes data and parity information across multiple storage devices. Level 5 RAID offers the performance advantages of distributing data across multiple devices, but does not share the performance bottleneck of level 4 RAID because the parity information is also distributed through the array. RAID 5 requires at least three RAID partitions.
- **RAID 6** — level 6 RAID is similar to level 5 RAID, but instead of storing only one set of parity data, they store two sets. RAID 6 requires at least four RAID partitions.
- **RAID 10** — level 10 RAID is a *nested RAID* or *hybrid RAID*. Level 10 RAID is constructed by distributing data over mirrored sets of storage devices. For example, a level 10 RAID constructed from four RAID partitions consists of two pairs of partitions in which one partition mirrors the other. Data is then distributed across both pairs of storage devices, as in a level 0 RAID. RAID 10 requires at least four RAID partitions.

RAID Clone

Choose this option to set up a RAID *mirror* of an existing disk. This option is available if two or more disks are attached to the system.

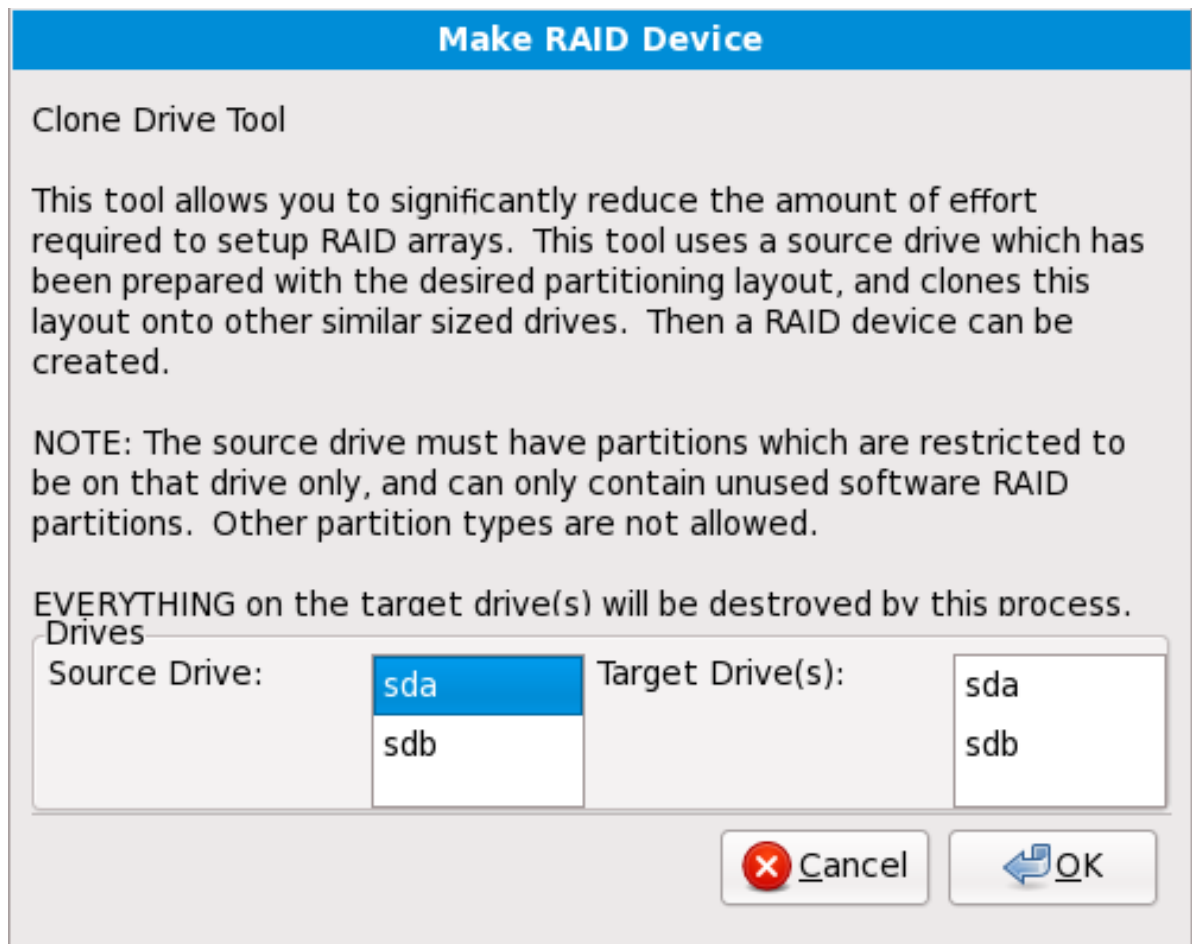


Figure 23.33. Clone a RAID device

23.15.4. Create LVM Logical Volume



Important — LVM Unavailable in Text-Mode Installations

LVM initial set up is not available during text-mode installation. If you need to create an LVM configuration from scratch, establish another SSH connection to the installation image with the root user and run the `lvm` command.

Logical Volume Management (LVM) presents a simple logical view of underlying physical storage space, such as a hard drives or LUNs. Partitions on physical storage are represented as *physical volumes* that can be grouped together into *volume groups*. Each volume group can be divided into multiple *logical volumes*, each of which is analogous to a standard disk partition. Therefore, LVM logical volumes function as partitions that can span multiple physical disks.

To read more about LVM, refer to the *Red Hat Enterprise Linux Deployment Guide*. Note, LVM is only available in the graphical installation program.

LVM Physical Volume

Choose this option to configure a partition or device as an LVM physical volume. This option is the only choice available if your storage does not already contain LVM Volume Groups. This is the same dialog that appears when you add a standard partition — refer to [Section 23.15.2, “Adding Partitions”](#) for a description of the available options. Note, however, that **File System Type** must be set to **physical volume (LVM)**

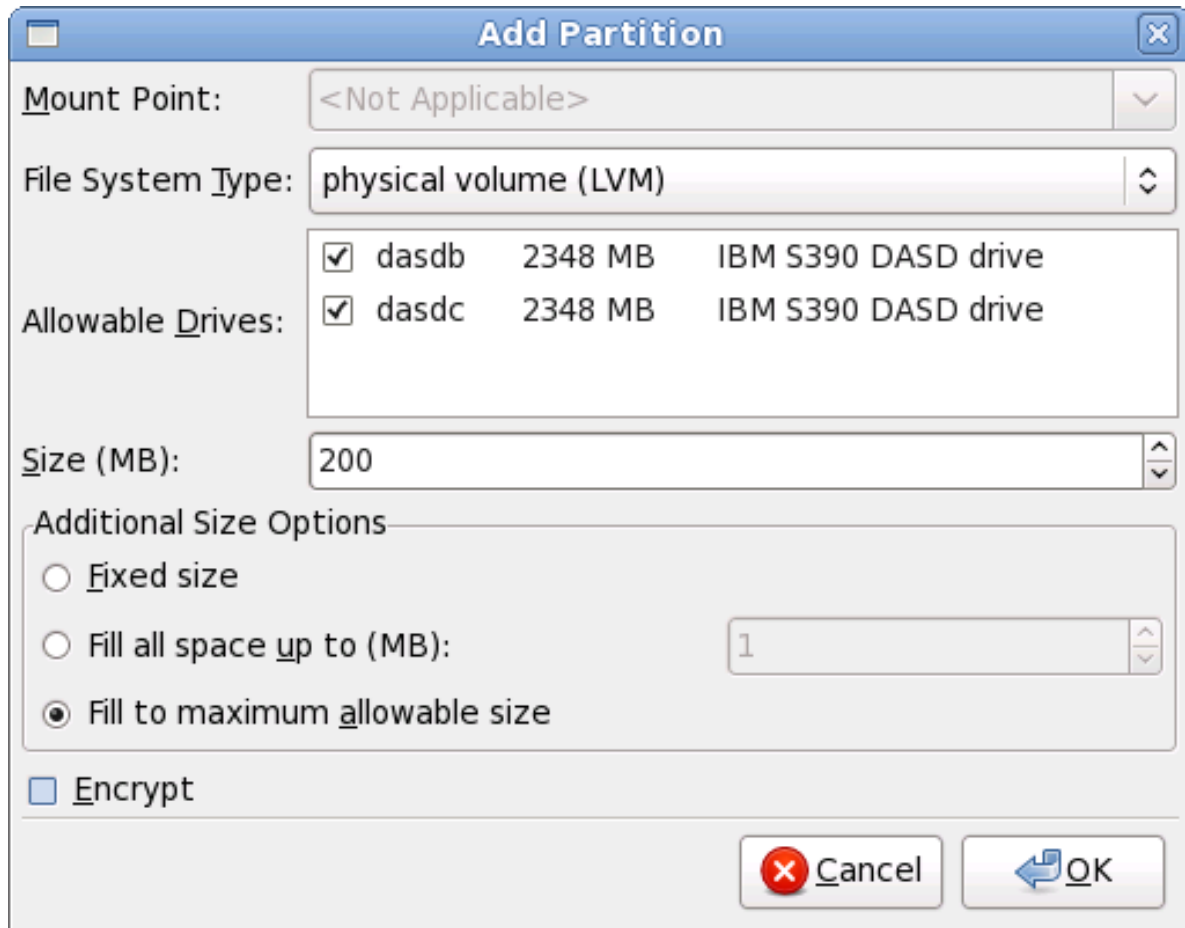


Figure 23.34. Create an LVM Physical Volume

Make LVM Volume Group

Choose this option to create LVM volume groups from the available LVM physical volumes, or to add existing logical volumes to a volume group.

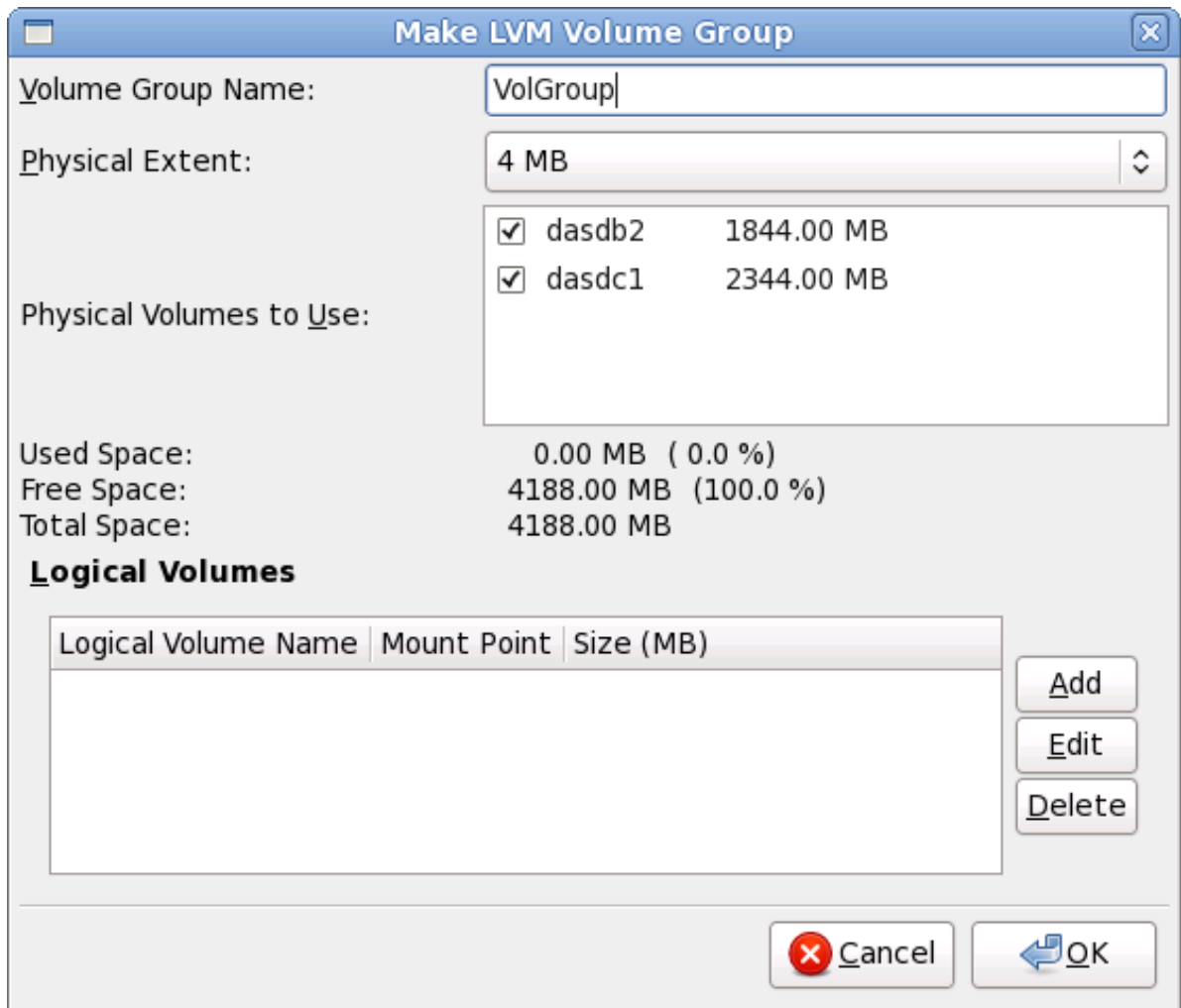


Figure 23.35. Make LVM Volume Group

To assign one or more physical volumes to a volume group, first name the volume group. Then select the physical volumes to be used in the volume group. Finally, configure logical volumes on any volume groups using the **Add**, **Edit** and **Delete** options.

You may not remove a physical volume from a volume group if doing so would leave insufficient space for that group's logical volumes. Take for example a volume group made up of two 5 GB LVM physical volume partitions, which contains an 8 GB logical volume. The installer would not allow you to remove either of the component physical volumes, since that would leave only 5 GB in the group for an 8 GB logical volume. If you reduce the total size of any logical volumes appropriately, you may then remove a physical volume from the volume group. In the example, reducing the size of the logical volume to 4 GB would allow you to remove one of the 5 GB physical volumes.

Make Logical Volume

Choose this option to create an LVM logical volume. Select a mount point, file system type, and size (in MB) just as if it were a standard disk partition. You can also choose a name for the logical volume and specify the volume group to which it will belong.

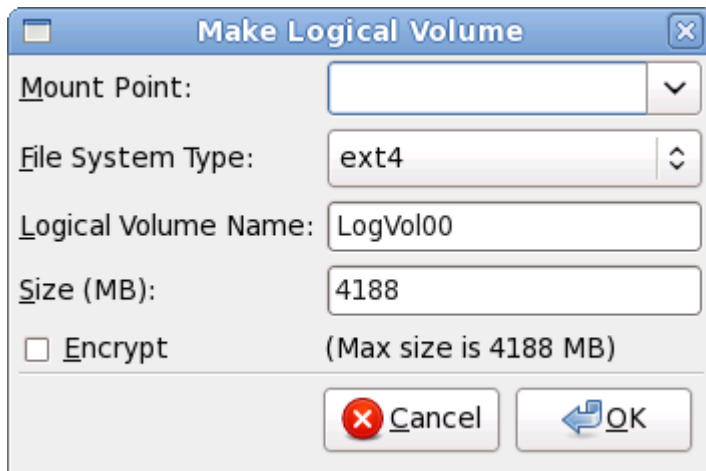


Figure 23.36. Make Logical Volume

23.15.5. Recommended Partitioning Scheme

Configuring efficient swap space for Linux on System z is a complex task. It very much depends on the specific environment and should be tuned to the actual system load.

Refer to the following resources for more information and to guide your decision:

- 'Chapter 7. Linux Swapping' in the IBM Redbook *Linux on IBM System z: Performance Measurement and Tuning* [IBM Form Number SG24-6926-01], [ISBN 0738485586], available from <http://www.redbooks.ibm.com/abstracts/sg246926.html>
- *Linux on System z performance* in the IBM Systems Information Center at http://publib.boulder.ibm.com/infocenter/systems/index.jsp?topic=/liaag/icon_Linux_on_System_z_performance.htm
- *Linux Performance when running under VM*, available from <http://www.vm.ibm.com/perf/tips/linuxper.html>

23.16. Write changes to disk

The installer prompts you to confirm the partitioning options that you selected. Click **Write changes to disk** to allow the installer to partition your hard drive and install Red Hat Enterprise Linux.

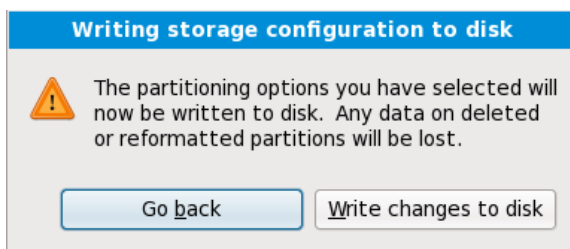


Figure 23.37. Writing storage configuration to disk

If you are certain that you want to proceed, click **Write changes to disk**.



Last chance to cancel safely

Up to this point in the installation process, the installer has made no lasting changes to your computer. When you click **Write changes to disk**, the installer will allocate space on your hard drive and start to transfer Red Hat Enterprise Linux into this space. Depending on the partitioning option that you chose, this process might include erasing data that already exists on your computer.

To revise any of the choices that you made up to this point, click **Go back**. To cancel installation completely, switch off your computer.

After you click **Write changes to disk**, allow the installation process to complete. If the process is interrupted (for example, by you switching off or resetting the computer, or by a power outage) you will probably not be able to use your computer until you restart and complete the Red Hat Enterprise Linux installation process, or install a different operating system.

23.17. Package Group Selection

Now that you have made most of the choices for your installation, you are ready to confirm the default package selection or customize packages for your system.

The **Package Installation Defaults** screen appears and details the default package set for your Red Hat Enterprise Linux installation. This screen varies depending on the version of Red Hat Enterprise Linux you are installing.



Installing in text mode

If you install Red Hat Enterprise Linux in text mode, you cannot make package selections. The installer 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. To change the package selection, complete the installation, then use the **Add/Remove Software** application to make desired changes.

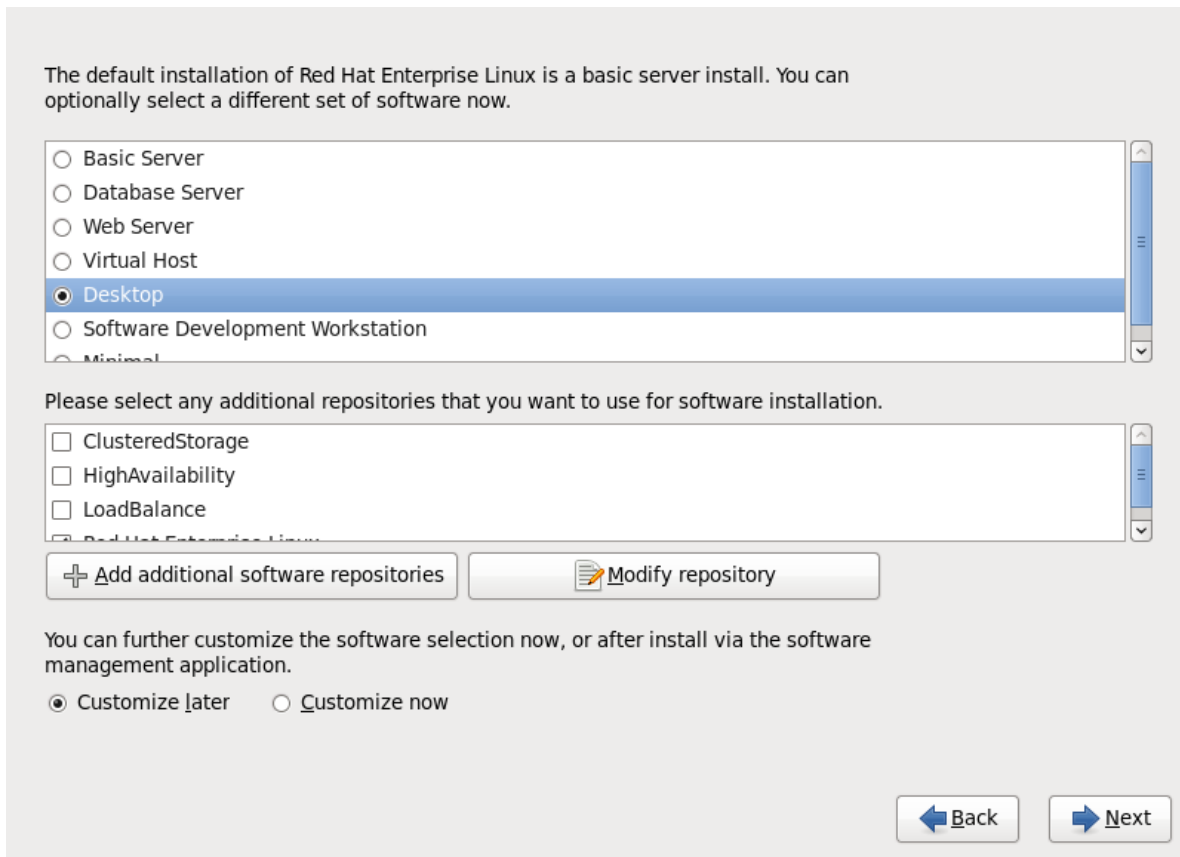


Figure 23.38. Package Group Selection

By default, the Red Hat Enterprise Linux installation process loads a selection of software that is suitable for a system deployed as a basic server. Note that this installation does not include a graphical environment. To include a selection of software suitable for other roles, click the radio button that corresponds to one of the following options:

Basic Server

This option provides a basic installation of Red Hat Enterprise Linux for use on a server.

Database Server

This option provides the **MySQL** and **PostgreSQL** databases.

Web server

This option provides the **Apache** web server.

Desktop

This option provides the **OpenOffice.org** productivity suite, graphical tools such as the **GIMP**, and multimedia applications.

Software Development Workstation

This option provides the necessary tools to compile software on your Red Hat Enterprise Linux system.

Minimal

This option provides only the packages essential to run Red Hat Enterprise Linux. A minimal installation provides the basis for a single-purpose server or desktop appliance and maximizes performance and security on such an installation.

If you choose to accept the current package list, skip ahead to [Section 23.18, “Installing Packages”](#).

To select a component, click on the checkbox beside it (refer to [Figure 23.38, “Package Group Selection”](#)).

To customize your package set further, select the **Customize now** option on the screen. Clicking **Next** takes you to the **Package Group Selection** screen.

23.17.1. Installing from Additional Repositories

You can define additional *repositories* to increase the software available to your system during installation. A repository is a network location that stores software packages along with *metadata* that describes them. Many of the software packages used in Red Hat Enterprise Linux require other software to be installed. The installer uses the metadata to ensure that these requirements are met for every piece of software you select for installation.

The basic options are:

- The **ClusteredStorage** repository includes packages for storage clustering using the Red Hat *global file system* (GFS).
- The **HighAvailability** repository includes packages for high-availability clustering (also known as *failover clustering*) using the Red Hat High-availability Service Management component.
- The **LoadBalance** repository includes packages for load-balancing clustering using *Linux Virtual Server* (LVS).
- The **Red Hat Enterprise Linux 6** repository is automatically selected for you. It contains the complete collection of software that was released as Red Hat Enterprise Linux 6, with the various pieces of software in their versions that were current at the time of release.

For more information about clustering with Red Hat Enterprise Linux 6, refer to the *Red Hat Enterprise Linux 6 Cluster Suite Overview*, available from <https://access.redhat.com/knowledge/docs/manuals/>.

Figure 23.39. Adding a software repository

To include software from extra *repositories*, select **Add additional software repositories** and provide the location of the repository.

To edit an existing software repository location, select the repository in the list and then select **Modify repository**.



Network Access Required

If you change the repository information during a non-network installation, such as from a Red Hat Enterprise Linux DVD, the installer prompts you for network configuration information.

If you select **Add additional software repositories**, the **Edit repository** dialog appears. Provide a **Repository name** and the **Repository URL** for its location.

Once you have located a mirror, to determine the URL to use, find the directory on the mirror that *contains* a directory named **repodata**.

Once you provide information for an additional repository, the installer reads the package metadata over the network. Software that is specially marked is then included in the package group selection system.



Backtracking Removes Repository Metadata

If you choose **Back** from the package selection screen, any extra repository data you may have entered is lost. This allows you to effectively cancel extra repositories. Currently there is no way to cancel only a single repository once entered.

23.17.2. Customizing the Software Selection



Additional Language Support

Your Red Hat Enterprise Linux system automatically supports the language that you selected at the start of the installation process. To include support for additional languages, select the package group for those languages from the **Languages** category.



Note — 31-bit applications

Users of IBM System z who want support for developing or running legacy 31-bit applications are encouraged to select the **Compatibility Arch Support** and **Compatibility Arch Development Support** packages to install architecture specific support for their systems.

Select **Customize now** to specify the software packages for your final system in more detail. This option causes the installation process to display an additional customization screen when you select **Next**.

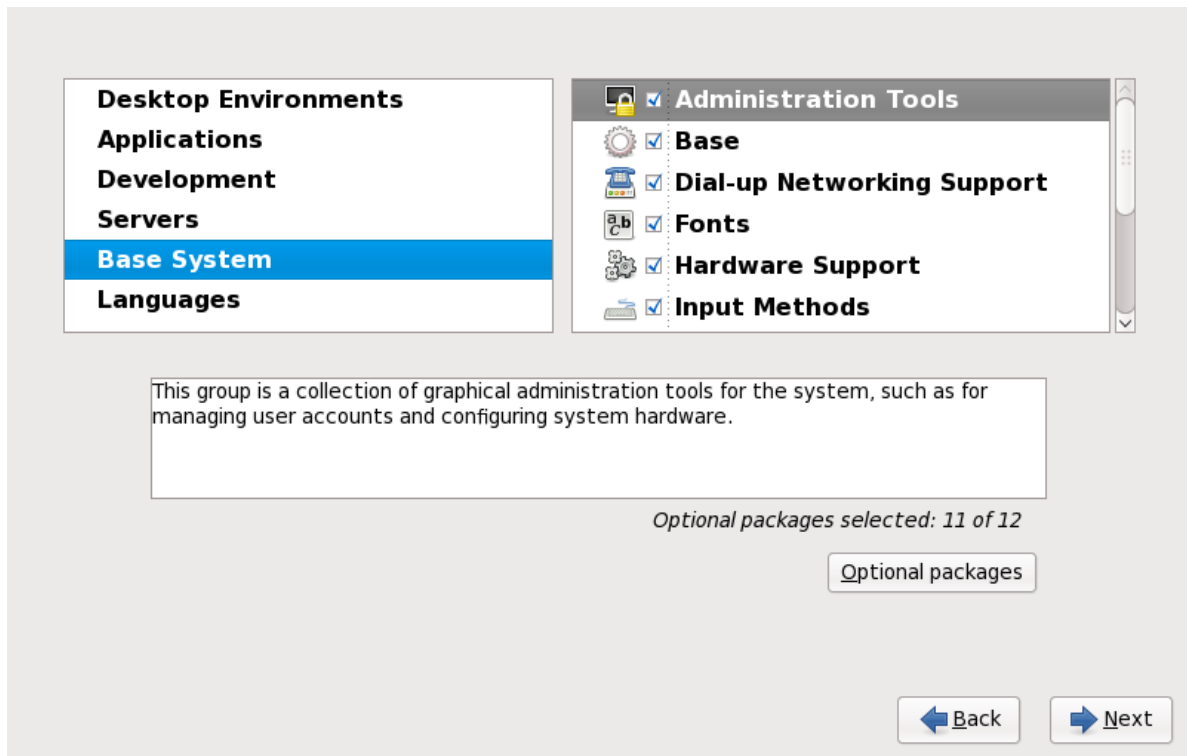


Figure 23.40. Package Group Details

Red Hat Enterprise Linux divides the included software into *package groups*. For ease of use, the package selection screen displays these groups as categories.

You can select package groups, which group components together according to function (for example, **X Window System** and **Editors**), individual packages, or a combination of the two.

To view the package groups for a category, select the category from the list on the left. The list on the right displays the package groups for the currently selected category.

To specify a package group for installation, select the check box next to the group. The box at the bottom of the screen displays the details of the package group that is currently highlighted. *None* of the packages from a group will be installed unless the check box for that group is selected.

If you select a package group, Red Hat Enterprise Linux automatically installs the base and mandatory packages for that group. To change which optional packages within a selected group will be installed, select the **Optional Packages** button under the description of the group. Then use the check box next to an individual package name to change its selection.

In the package selection list on the right, you can use the context menu as a shortcut to select or de-select base and mandatory packages or all optional packages.

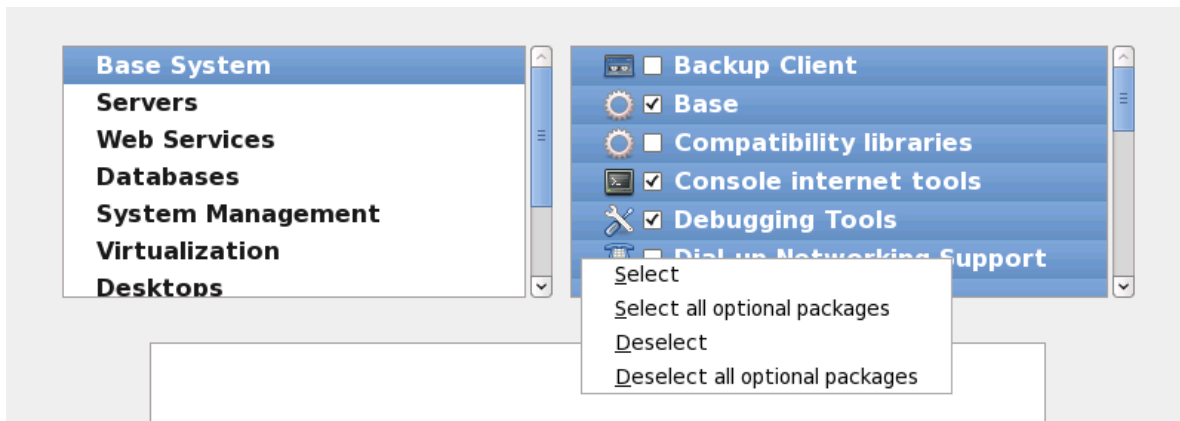


Figure 23.41. Package Selection List Context Menu

After you choose the desired packages, select **Next** to proceed. The installer checks your selection, and automatically adds any extra packages required to use the software you selected. When you have finished selecting packages, click **Close** to save your optional package selections and return to the main package selection screen.

The packages that you select are not permanent. After you boot your system, use the **Add/Remove Software** tool to either install new software or remove installed packages. To run this tool, from the main menu, select **System** → **Administration** → **Add/Remove Software**. The Red Hat Enterprise Linux software management system downloads the latest packages from network servers, rather than using those on the installation discs.

23.17.2.1. Core Network Services

All Red Hat Enterprise Linux installations include the following network services:

- centralized logging through syslog
- email through SMTP (Simple Mail Transfer Protocol)
- network file sharing through NFS (Network File System)
- remote access through SSH (Secure SHell)
- resource advertising through mDNS (multicast DNS)

The default installation also provides:

- network file transfer through HTTP (HyperText Transfer Protocol)
- printing through CUPS (Common UNIX Printing System)
- remote desktop access through VNC (Virtual Network Computing)

Some automated processes on your Red Hat Enterprise Linux system use the email service to send reports and messages to the system administrator. By default, the email, logging, and printing services do not accept connections from other systems. Red Hat Enterprise Linux installs the NFS sharing, HTTP, and VNC components without enabling those services.

You may configure your Red Hat Enterprise Linux system after installation to offer email, file sharing, logging, printing and remote desktop access services. The SSH service is enabled by default. You may use NFS to access files on other systems without enabling the NFS sharing service.

23.18. Installing Packages

At this point there is nothing left for you to do until all the packages have been installed. How quickly this happens depends on the number of packages you have selected and your computer's speed.

Depending on the available resources, you might see the following progress bar while the installer resolves dependencies of the packages you selected for installation:

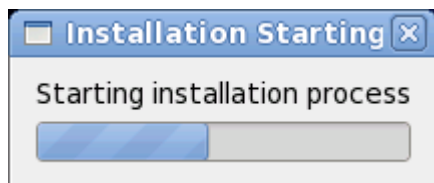


Figure 23.42. Starting installation

During installation of the selected packages and their dependencies, you see the following progress bar:

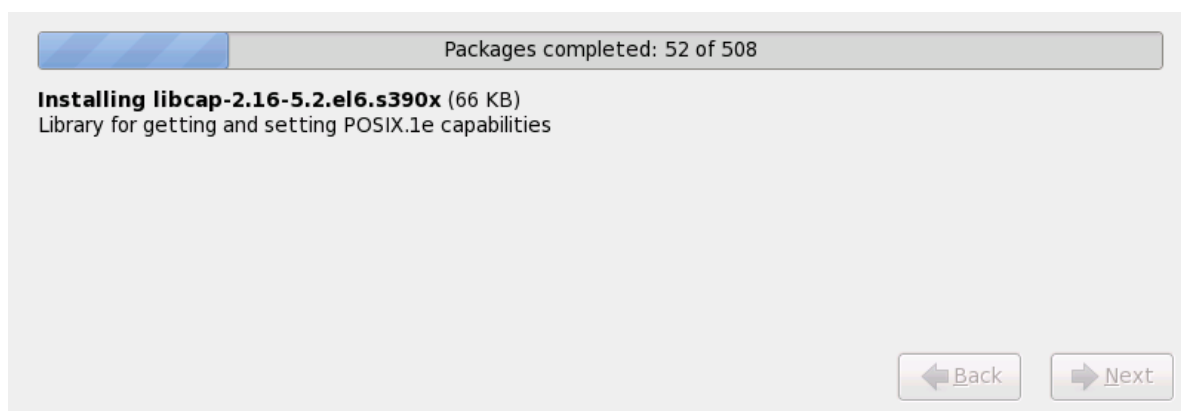


Figure 23.43. Packages completed

23.19. Installation Complete

Congratulations! Your Red Hat Enterprise Linux installation is now complete!

The installation program prompts you to prepare your system for reboot.

The installation program automatically reboots into the installed system.

Should the installation program not reboot, the installation program shows information from which device to do an IPL (boot). Accept the shutdown option and after shutdown, IPL from the DASD or SCSI LUN where the `/boot` partition for Red Hat Enterprise Linux has been installed.

23.19.1. IPL under z/VM

To IPL from a DASD, for example using the DASD device 200 on the 3270 console, issue the command:

```
#cp i 200
```

In DASD only environments where automatic partitioning (clearing data from all partitions) was used, the first activated DASD is where the `/boot` partition is typically located.

Using `/boot` on an FCP LUN, you must provide the WWPN and LUN for the FCP-attached device from which to IPL.

To IPL from an FCP-attached device:

1. Provide FCP routing information to an FCP-attached device, for example, where **0x50050763050B073D** is the WWPN, and **0x4020400100000000** is the FCP LUN:

```
#cp set loaddev portname50050763 050B073D lun 40204001 00000000
```

2. IPL the FCP adapter, for example **FC00**:

```
#cp ip1 FC00
```



Note

To disconnect from the 3270 terminal without stopping the Linux running in your virtual machine, use **#cp disconnect** instead of **#cp logoff**. When your virtual machine is re-connected using the usual logon procedure, it might be placed in CP console function mode (**CP READ**). If so, to resume execution on your virtual machine, enter the **BEGIN** command.

23.19.2. IPL on an LPAR

For LPAR-based installations, on the HMC, issue a load command to the LPAR, specifying the particular DASD, or the FCP adapter, WWPN, and FCP LUN where the **/boot** partition is located.

23.19.3. Continuing after Reboot (re-IPL)

Following the automatic reboot or the manual IPL of the installed Red Hat Enterprise Linux operating system, you can log on to the system via **ssh**. Note that the only place from which you can log in as root is from the 3270 terminal or from other terminal devices listed in **/etc/securetty**.

The first time you start your Red Hat Enterprise Linux system in a graphical environment, you can use **FirstBoot** to guide you through Red Hat Enterprise Linux configuration. Using this tool, you can set your system time and date, install software, register your machine with Red Hat Network, and more. **FirstBoot** lets you configure your environment at the beginning, so that you can get started using your Red Hat Enterprise Linux system quickly.

Troubleshooting Installation on IBM System z

This section discusses some common installation problems and their solutions.

For debugging purposes, **anaconda** logs installation actions into files in the `/tmp` directory. These files include:

/tmp/anaconda.log

general **anaconda** messages

/tmp/program.log

all external programs run by **anaconda**

/tmp/storage.log

extensive storage module information

/tmp/yum.log

yum package installation messages

If the installation fails, the messages from these files are consolidated into `/tmp/anacdump.txt`.

All of the files above reside in the installer's ramdisk and are thus volatile. To make a permanent copy, copy those files to another system on the network using **scp** on the installation image (not the other way round).

24.1. You are unable to boot Red Hat Enterprise Linux

24.1.1. Is Your System Displaying Signal 11 Errors?

A signal 11 error, commonly known as a *segmentation fault*, means that the program accessed a memory location that was not assigned to it. A signal 11 error may be due to a bug in one of the software programs that is installed, or faulty hardware.

Ensure that you have the latest installation updates and images from Red Hat. Review the online errata to see if newer versions are available.

24.2. Trouble During the Installation

24.2.1. No devices found to install Red Hat Enterprise Linux Error Message

If you receive an error message stating **No devices found to install Red Hat Enterprise Linux**, then there may be an issue with your DASD devices. If you encounter this error, add the **DASD=<disks>** parameter to your parameter file or CMS configuration file (where *disks* is the DASD range reserved for installation) and start the install again.

Additionally, make sure you format the DASDs using the **dasdfmt** command within a Linux root shell, instead of formatting the DASDs using CMS. **Anaconda** automatically detects any DASD devices that are not yet formatted and asks you whether to format the devices.

24.2.2. Saving traceback messages

If **anaconda** encounters an error during the graphical installation process, it presents you with a crash reporting dialog box:

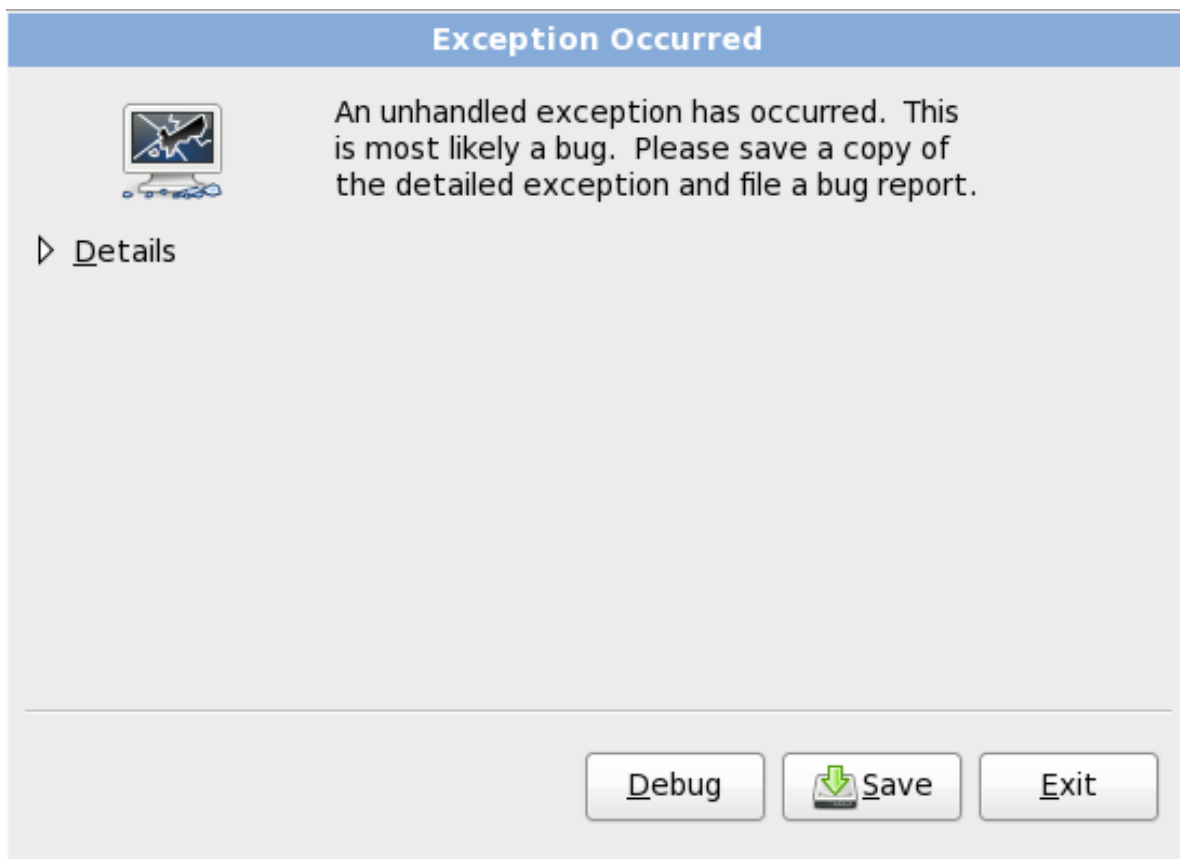


Figure 24.1. The Crash Reporting Dialog Box

Details

shows you the details of the error:

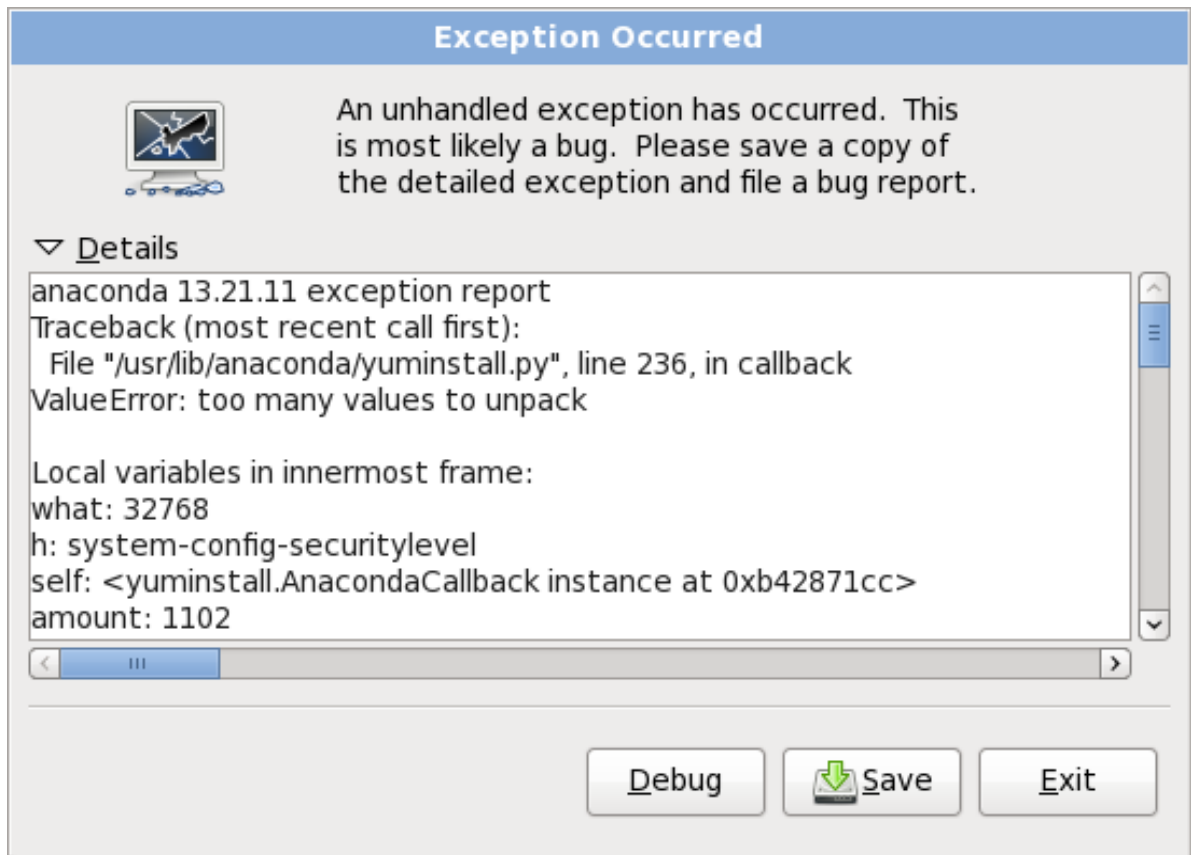


Figure 24.2. Details of the Crash

Save

saves details of the error locally or remotely:

Exit installer

exits the installation process.

If you select **Save** from the main dialog, you can choose from the following options:

Local disk

saves details of the error to the local hard drive, in a directory that you select with the file browser:

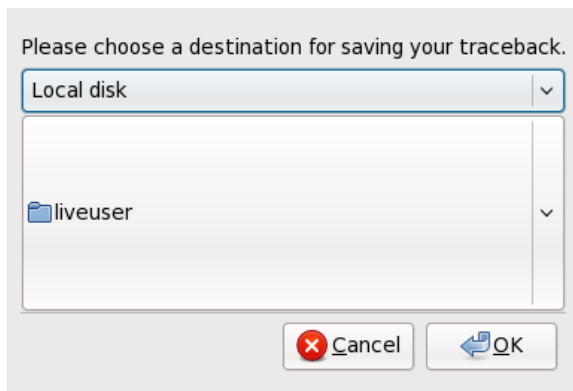


Figure 24.3. Save Crash Report to a Local disk

Bugzilla

submits details of the error to Red Hat's bug-tracking system, Bugzilla. You must supply an existing Bugzilla username and password, and a description of the bug.

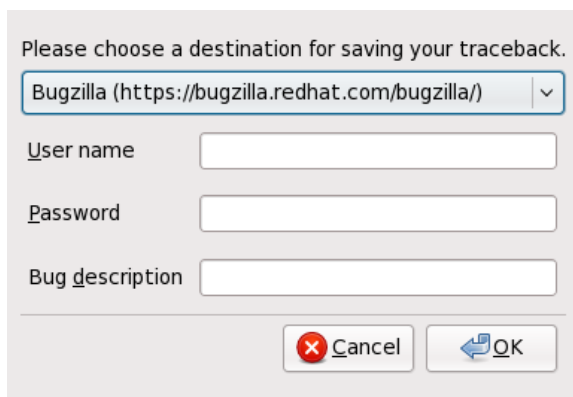


Figure 24.4. Save Crash Report to Bugzilla

Remote server

saves details of the error to a remote location using **SCP**. You must specify the username, password, host, and destination file.

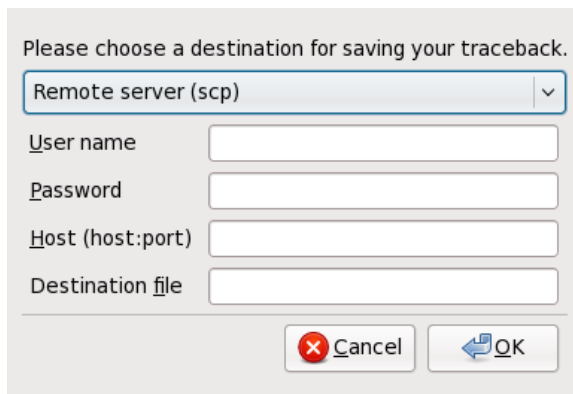


Figure 24.5. Save Crash Report to Remote Server

24.2.3. Other Partitioning Problems

If you create partitions manually, but cannot move to the next screen, you probably have not created all the partitions necessary for installation to proceed.

You must have the following partitions as a bare minimum:

- A / (root) partition
- A <swap> partition of type swap



Note

When defining a partition's type as swap, do not assign it a mount point. **Anaconda** automatically assigns the mount point for you.

24.2.4. Are You Seeing Python Errors?

During some upgrades or installations of Red Hat Enterprise Linux, the installation program (also known as **anaconda**) may fail with a Python or traceback error. This error may occur after the selection of individual packages or while trying to save the upgrade log in the `/tmp/` directory. The error may look similar to:

```
Traceback (innermost last):
File "/var/tmp/anaconda-7.1//usr/lib/anaconda/iw/progress_gui.py", line 20, in run
rc = self.todo.doInstall ()
File "/var/tmp/anaconda-7.1//usr/lib/anaconda/todo.py", line 1468, in doInstall
self.fstab.savePartitions ()
File "fstab.py", line 221, in savePartitions
sys.exit(0)
SystemExit: 0
Local variables in innermost frame:
self: <fstab.GuiFstab instance at 8446fe0>
sys: <module 'sys' (built-in)>
ToDo object: (itodo ToDo p1 (dp2 S'method' p3 (iimage CdromInstallMethod
p4 (dp5 S'progressWindow' p6 <failed>
```

This error occurs in some systems where links to `/tmp/` are symbolic to other locations or have been changed since creation. These symbolic or changed links are invalid during the installation process, so the installation program cannot write information and fails.

If you experience such an error, first try to download any available updates for **anaconda**. Updates for **anaconda** and instructions for using them can be found at:

<http://fedoraproject.org/wiki/Anaconda/Updates>

You can also find and download errata for **anaconda** through your Red Hat Subscription. Log in to your account through the customer portal at <https://access.redhat.com/login>, click the **Errata** link at the top of the window, enter **anaconda** in the field marked **Filter by Synopsis**, and click **go**.

The **anaconda** website may also be a useful reference and can be found online at:

<http://fedoraproject.org/wiki/Anaconda>

You can also search for bug reports related to this problem. To search Red Hat's bug tracking system, go to:

```
http://bugzilla.redhat.com/bugzilla/
```

Finally, if you are still facing problems related to this error, register your product and contact our support team. To register your product, go to:

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

24.3. Problems After Installation

24.3.1. Remote Graphical Desktops and XDMCP

If you have installed the X Window System and would like to log in to your Red Hat Enterprise Linux system using a graphical login manager, enable the *X Display Manager Control Protocol* (XDMCP). This protocol allows users to remotely log in to a desktop environment from any X Window System compatible client (such as a network-connected workstation or X11 terminal). To enable remote login using XDMCP, edit the following line in the `/etc/gdm/custom.conf` file on the Red Hat Enterprise Linux system with a text editor such as `vi` or `nano`:

Add the line **Enable=true**, save the file, and exit the text editor. Switch to runlevel 5 to start the X11 server:

```
/sbin/init 5
```

From the client machine, start a remote X11 session using `X`. For example:

```
X :1 -query s390vm.example.com
```

The command connects to the remote X11 server via XDMCP (replace `s390vm.example.com` with the hostname of the remote X11 server) and displays the remote graphical login screen on display `:1` of the X11 server system (usually accessible by using the **Ctrl-Alt-F8** key combination).

You can also access remote desktop sessions using a *nested* X11 server, which opens the remote desktop as a window in your current X11 session. `Xnest` allows users to open a remote desktop nested within their local X11 session. For example, run `Xnest` using the following command, replacing `s390vm.example.com` with the hostname of the remote X11 server:

```
Xnest :1 -query s390vm.example.com
```

24.3.2. Problems When You Try to Log In

If you did not create a user account in the `firstboot` screens, switch to a console by pressing **Ctrl+Alt+F2**, log in as root and use the password you assigned to root.

If you cannot remember your root password, boot your system into single user mode by appending the boot option `single` to the `zipl` boot menu or by any other means to append kernel command line options at IPL.

Once you have booted into single user mode and have access to the # prompt, you must type **passwd root**, which allows you to enter a new password for root. At this point you can type **shutdown -r now** to reboot the system with the new root password.

If you cannot remember your user account password, you must become root. To become root, type **su -** and enter your root password when prompted. Then, type **passwd <username>**. This allows you to enter a new password for the specified user account.

If the graphical login screen does not appear, check your hardware for compatibility issues. The *Hardware Compatibility List* can be found at:

```
http://hardware.redhat.com/hcl/
```

24.3.3. Your Printer Does Not Work

If you are not sure how to set up your printer or are having trouble getting it to work properly, try using the **Printer Configuration Tool**.

Type the **system-config-printer** command at a shell prompt to launch the **Printer Configuration Tool**. If you are not root, it prompts you for the root password to continue.

24.3.4. Apache-based httpd service/Sendmail Hangs During Startup

If you are having trouble with the Apache-based **httpd** service or Sendmail hanging at startup, make sure the following line is in the **/etc/hosts** file:

```
127.0.0.1 localhost.localdomain localhost
```


Configuring an Installed Linux on System z Instance

For more information about Linux on System z, see the publications listed in [Chapter 27, IBM System z References](#). Some of the most common tasks are described here.

25.1. Adding DASDs

The following is an example of how to set a DASD online, format it, and make the change persistent.



Note

Make sure the device is attached or linked to the Linux system if running under z/VM.

```
CP ATTACH EB1C TO *
```

To link a mini disk to which you have access, issue, for example:

```
CP LINK RHEL6X 4B2E 4B2E MR
DASD 4B2E LINKED R/W
```

See the z/VM: CP Commands and Utilities Reference, SC24-6175 for details about the commands.

25.1.1. Dynamically setting DASDs online

To set a DASD online, follow these steps:

1. Use the `cio_ignore` command to remove the DASD from the list of ignored devices and make it visible to Linux:

```
# cio_ignore -r device_number
```

Replace *device_number* with the device number of the DASD. For example:

```
# cio_ignore -r 4b2e
```

2. Set the device online. Use a command of the following form:

```
# chccwdev -e device_number
```

Replace *device_number* with the device number of the DASD. For example:

```
# chccwdev -e 4b2e
```

As an alternative, you can set the device online using sysfs attributes:

1. Use the `cd` command to change to the `/sys/` directory that represents that volume:

```
# cd /sys/bus/ccw/drivers/dasd-eckd/0.0.4b2e/
```

```
# ls -l
total 0
-r--r--r-- 1 root root 4096 Aug 25 17:04 availability
-rw-r--r-- 1 root root 4096 Aug 25 17:04 cmb_enable
-r--r--r-- 1 root root 4096 Aug 25 17:04 cutype
-rw-r--r-- 1 root root 4096 Aug 25 17:04 detach_state
-r--r--r-- 1 root root 4096 Aug 25 17:04 devtype
-r--r--r-- 1 root root 4096 Aug 25 17:04 discipline
-rw-r--r-- 1 root root 4096 Aug 25 17:04 online
-rw-r--r-- 1 root root 4096 Aug 25 17:04 readonly
-rw-r--r-- 1 root root 4096 Aug 25 17:04 use_diag
```

2. Check to see if the device is already online:

```
# cat online
0
```

3. If it is not online, run the following command to bring it online:

```
# echo 1 > online
# cat online
1
```

3. Verify which block devnode it is being accessed as:

```
# ls -l
total 0
-r--r--r-- 1 root root 4096 Aug 25 17:04 availability
lrwxrwxrwx 1 root root    0 Aug 25 17:07 block -> ../../../../block/dasdb
-rw-r--r-- 1 root root 4096 Aug 25 17:04 cmb_enable
-r--r--r-- 1 root root 4096 Aug 25 17:04 cutype
-rw-r--r-- 1 root root 4096 Aug 25 17:04 detach_state
-r--r--r-- 1 root root 4096 Aug 25 17:04 devtype
-r--r--r-- 1 root root 4096 Aug 25 17:04 discipline
-rw-r--r-- 1 root root    0 Aug 25 17:04 online
-rw-r--r-- 1 root root 4096 Aug 25 17:04 readonly
-rw-r--r-- 1 root root 4096 Aug 25 17:04 use_diag
```

As shown in this example, device 4B2E is being accessed as `/dev/dasdb`.

These instructions set a DASD online for the current session, but this is not persistent across reboots. For instructions on how to set a DASD online persistently, refer to [Section 25.1.3, “Persistently setting DASDs online”](#). When you work with DASDs, use the persistent device symbolic links under `/dev/disk/by-path/`.

You can find more information in the DASD Chapter in *Linux on System z Device Drivers, Features, and Commands on Red Hat Enterprise Linux 6*.

25.1.2. Preparing a new DASD with low-level formatting

Once the disk is online, change back to the `/root` directory and low-level format the device. This is only required once for a DASD during its entire lifetime:

```
# cd
# dasdfmt -b 4096 -d cdl -p /dev/disk/by-path/ccw-0.0.4b2e
Drive Geometry: 10017 Cylinders * 15 Heads = 150255 Tracks

I am going to format the device /dev/disk/by-path/ccw-0.0.4b2e in the following way:
Device number of device : 0x4b2e
```

```

Labelling device      : yes
Disk label           : VOL1
Disk identifier      : 0X4B2E
Extent start (trk no) : 0
Extent end (trk no)  : 150254
Compatible Disk Layout : yes
Blocksize           : 4096

---> ATTENTION! <---
All data of that device will be lost.
Type "yes" to continue, no will leave the disk untouched: yes
cyl   97 of 3338 |#-----|      2%

```

When the progress bar reaches the end and the format is complete, **dasdfmt** prints the following output:

```

Rereading the partition table...
Exiting...

```

Now, use **fdasd** to partition the DASD. You can create up to three partitions on a DASD. In our example here, we create one partition spanning the whole disk:

```

# fdasd -a /dev/disk/by-path/ccw-0.0.4b2e
auto-creating one partition for the whole disk...
writing volume label...
writing VTOC...
checking !
wrote NATIVE!
rereading partition table...

```

For more information, see the chapter on DASD in *Linux on System z Device Drivers, Features, and Commands on Red Hat Enterprise Linux 6*.

After a (low-level formatted) DASD is online, it can be used like any other disk under Linux. For instance, you can create file systems, LVM physical volumes, or swap space on its partitions, for example **/dev/disk/by-path/ccw-0.0.4b2e-part1**. Never use the full DASD device (**dev/dasdb**) for anything but the commands **dasdfmt** and **fdasd**. If you want to use the entire DASD, create one partition spanning the entire drive as in the **fdasd** example above.

To add additional disks later without breaking existing disk entries in, for example, **/etc/fstab**, use the persistent device symbolic links under **/dev/disk/by-path/**.

25.1.3. Persistently setting DASDs online

The above instructions described how to activate DASDs dynamically in a running system. However, such changes are not persistent and do not survive a reboot. Making changes to the DASD configuration persistent in your Linux system depends on whether the DASDs belong to the root file system. Those DASDs required for the root file system need to be activated very early during the boot process by the **initramfs** to be able to mount the root file system.

Cio_ignore is handled transparently for persistent device configurations and you do not need to free devices from the ignore list manually.

25.1.3.1. DASDs that are part of the root file system

The only file you have to modify to add DASDs that are part of the root file system is **/etc/zipl.conf**. Then run the **zipl** boot loader tool. There is no need to recreate the **initramfs**.

Chapter 25. Configuring an Installed Linux on System z Instance

There are two boot parameters to activate DASDs early in the boot process:

- `rd_DASD=`
- `rd_DASD_MOD=` — only provided for compatibility with old system configurations. Refer to the `dasd=` parameter description in the DASD device driver chapter in *Linux on System z Device Drivers, Features, and Commands on Red Hat Enterprise Linux 6* for details.

The `rd_DASD` option takes a comma-separated list as input. The list contains a device bus ID and optional additional parameters consisting of key-value-pairs that correspond to DASD `sysfs` attributes.

Below is an example `zipl.conf` for a system that uses physical volumes on partitions of two DASDs for an LVM volume group `vg_devel1` that contains a logical volume `lv_root` for the root file system.

```
[defaultboot]
default=linux
target=/boot/
[linux]
    image=/boot/vmlinuz-2.6.32-19.el6.s390x
    ramdisk=/boot/initramfs-2.6.32-19.el6.s390x.img
    parameters="root=/dev/mapper/vg_devel1-lv_root
rd_DASD=0.0.0200,use_diag=0,readonly=0,erplog=0,failfast=0
rd_DASD=0.0.0207,use_diag=0,readonly=0,erplog=0,failfast=0 rd_LVM_LV=vg_devel1/lv_root
rd_NO_LUKS rd_NO_MD rd_NO_DM LANG=en_US.UTF-8 SYSFONT=latarcyrheb-sun16 KEYTABLE=us
cio_ignore=all,!0.0.0009"
```

Suppose that you would like to add another physical volume on a partition of a third DASD with device bus ID `0.0.202b`. To do this, simply add `rd_DASD=0.0.202b` to the parameters line of your boot kernel in `zipl.conf`:

```
[defaultboot]
default=linux
target=/boot/
[linux]
    image=/boot/vmlinuz-2.6.32-19.el6.s390x
    ramdisk=/boot/initramfs-2.6.32-19.el6.s390x.img
    parameters="root=/dev/mapper/vg_devel1-lv_root
rd_DASD=0.0.0200,use_diag=0,readonly=0,erplog=0,failfast=0
rd_DASD=0.0.0207,use_diag=0,readonly=0,erplog=0,failfast=0 rd_DASD=0.0.202b
rd_LVM_LV=vg_devel1/lv_root rd_NO_LUKS rd_NO_MD rd_NO_DM LANG=en_US.UTF-8
SYSFONT=latarcyrheb-sun16 KEYTABLE=us cio_ignore=all,!0.0.0009"
```

Run `zipl` to apply the changes of `/etc/zipl.conf` for the next IPL:

```
# zipl -V
Using config file '/etc/zipl.conf'
Target device information
Device.....: 5e:00
Partition.....: 5e:01
Device name.....: dasda
DASD device number.....: 0201
Type.....: disk partition
Disk layout.....: ECKD/compatible disk layout
Geometry - heads.....: 15
Geometry - sectors.....: 12
Geometry - cylinders.....: 3308
Geometry - start.....: 24
File system block size.....: 4096
Physical block size.....: 4096
Device size in physical blocks..: 595416
Building bootmap in '/boot/'
Building menu 'rh-automatic-menu'
```



```

Adding #1: IPL section 'linux' (default)
 kernel image.....: /boot/vmlinuz-2.6.32-19.el6.s390x
 kernel parmline...: 'root=/dev/mapper/vg_devel1-lv_root
 rd_DASD=0.0.0200,use_diag=0,readonly=0,erplog=0,failfast=0
 rd_DASD=0.0.0207,use_diag=0,readonly=0,erplog=0,failfast=0 rd_DASD=0.0.020b
 rd_LVM_LV=vg_devel1/lv_root rd_NO_LUKS rd_NO_MD rd_NO_DM LANG=en_US.UTF-8
 SYSFONT=latarcyrheb-sun16 KEYTABLE=us cio_ignore=all,!0.0.0009'
 initial ramdisk...: /boot/initramfs-2.6.32-19.el6.s390x.img
 component address:
   kernel image....: 0x00010000-0x00a70fff
   parmline.....: 0x00001000-0x00001fff
   initial ramdisk.: 0x02000000-0x022d2fff
   internal loader.: 0x0000a000-0x0000afff
Preparing boot device: dasda (0201).
Preparing boot menu
Interactive prompt.....: enabled
Menu timeout.....: 15 seconds
Default configuration...: 'linux'
Syncing disks...
Done.

```

25.1.3.2. DASDs that are not part of the root file system

DASDs that are not part of the root file system, that is, *data disks*, are persistently configured in the file `/etc/dasd.conf`. It contains one DASD per line. Each line begins with the device bus ID of a DASD. Optionally, each line can continue with options separated by space or tab characters. Options consist of key-value-pairs, where the key and value are separated by an equals sign.

The key corresponds to any valid `sysfs` attribute a DASD may have. The value will be written to the key's `sysfs` attribute. Entries in `/etc/dasd.conf` are activated and configured by `udev` when a DASD is added to the system. At boot time, all DASDs visible to the system get added and trigger `udev`.

Example content of `/etc/dasd.conf`:

```

0.0.0207
0.0.0200 use_diag=1 readonly=1

```

Modifications of `/etc/dasd.conf` only become effective after a reboot of the system or after the dynamic addition of a new DASD by changing the system's I/O configuration (that is, the DASD is attached under z/VM). Alternatively, you can trigger the activation of a new entry in `/etc/dasd.conf` for a DASD which was previously not active, by executing the following commands:

1. Use the `cio_ignore` command to remove the DASD from the list of ignored devices and make it visible to Linux:

```
# cio_ignore -r device_number
```

For example:

```
# cio_ignore -r 021a
```

2. Trigger the activation by writing to the `uevent` attribute of the device:

```
echo add > /sys/bus/ccw/devices/device-bus-ID/uevent
```

For example:

```
echo add > /sys/bus/ccw/devices/0.0.021a/uevent
```

25.2. Adding FCP-Attached Logical Units (LUNs)

The following is an example of how to add an FCP LUN.



Note

If running under z/VM, make sure the FCP adapter is attached to the z/VM guest virtual machine. For multipathing in production environments there would be at least two FCP devices on two different physical adapters (CHPIDs). For example:

```
CP ATTACH FC00 TO *
CP ATTACH FCD0 TO *
```

25.2.1. Dynamically activating an FCP LUN

Follow these steps to activate a LUN:

1. Use the `cio_ignore` command to remove the FCP adapter from the list of ignored devices and make it visible to Linux:

```
# cio_ignore -r device_number
```

Replace `device_number` with the device number of the FCP adapter. For example:

2. To bring the FCP adapter device online, use the following command:

```
# chccwdev -e fc00
```

3. Verify that the required WWPN was found by the automatic port scanning of the `zfcplib` driver:

```
# ls -l /sys/bus/ccw/drivers/zfcplib/0.0.fc00/
drwxr-xr-x. 3 root root  0 Apr 28 18:19 0x500507630040710b
drwxr-xr-x. 3 root root  0 Apr 28 18:19 0x50050763050b073d
drwxr-xr-x. 3 root root  0 Apr 28 18:19 0x500507630e060521
drwxr-xr-x. 3 root root  0 Apr 28 18:19 0x500507630e860521
-r--r--r--. 1 root root 4096 Apr 28 18:17 availability
-r--r--r--. 1 root root 4096 Apr 28 18:19 card_version
-rw-r--r--. 1 root root 4096 Apr 28 18:17 cmb_enable
-r--r--r--. 1 root root 4096 Apr 28 18:17 cutype
-r--r--r--. 1 root root 4096 Apr 28 18:17 devtype
lrwxrwxrwx. 1 root root  0 Apr 28 18:17 driver -> ../../../../bus/ccw/drivers/zfcplib
-rw-r--r--. 1 root root 4096 Apr 28 18:17 failed
-r--r--r--. 1 root root 4096 Apr 28 18:19 hardware_version
drwxr-xr-x. 35 root root  0 Apr 28 18:17 host0
-r--r--r--. 1 root root 4096 Apr 28 18:17 in_recovery
-r--r--r--. 1 root root 4096 Apr 28 18:19 lic_version
-r--r--r--. 1 root root 4096 Apr 28 18:17 modalias
-rw-r--r--. 1 root root 4096 Apr 28 18:17 online
-r--r--r--. 1 root root 4096 Apr 28 18:19 peer_d_id
-r--r--r--. 1 root root 4096 Apr 28 18:19 peer_wwnn
-r--r--r--. 1 root root 4096 Apr 28 18:19 peer_wwpn
```

```
--w-----. 1 root root 4096 Apr 28 18:19 port_remove
--w-----. 1 root root 4096 Apr 28 18:19 port_rescan
drwxr-xr-x. 2 root root    0 Apr 28 18:19 power
-r--r--r--. 1 root root 4096 Apr 28 18:19 status
lrwxrwxrwx. 1 root root    0 Apr 28 18:17 subsystem -> ../../../../bus/ccw
-rw-r--r--. 1 root root 4096 Apr 28 18:17 uevent
```

4. Activate the FCP LUN by adding it to the port (WWPN) through which you would like to access the LUN:

```
# echo 0x4020400100000000 > /sys/bus/ccw/drivers/zfcp/0.0.fc00/0x50050763050b073d/unit_add
```

5. Find out the assigned SCSI device name:

```
# lszfcp -DV
/sys/devices/css0/0.0.0015/0.0.fc00/0x50050763050b073d/0x4020400100000000
/sys/bus/ccw/drivers/zfcp/0.0.fc00/host0/rport-0:0-21/target0:0:21/0:0:21:1089355792
```

For more information, refer to the chapter on SCSI-over-Fibre Channel in *Linux on System z Device Drivers, Features, and Commands on Red Hat Enterprise Linux 6*.

25.2.2. Persistently activating FCP LUNs

The above instructions described how to activate FCP LUNs dynamically in a running system. However, such changes are not persistent and do not survive a reboot. How you make the changes to the FCP configuration persistent in your Linux system depends on whether the FCP LUNs belong to the root file system. Those required for the root file system need to be activated very early during the boot process by the `initramfs` to be able to mount the root file system. `Cio_ignore` is handled transparently for persistent device configurations and you do not need to free devices from the ignore list manually.

25.2.2.1. FCP LUNs that are part of the root file system

The only file you have to modify for adding FCP LUNs that are part of the root file system is `/etc/zipl.conf` followed by a run of the `zipl` boot loader tool. There is no more need to recreate the `initramfs`.

Red Hat Enterprise Linux provides a parameter to activate FCP LUNs early in the boot process: `rd_ZFCP=`. The value is a comma-separated list containing the device bus ID, the WWPN as 16 digit hexadecimal number prefixed with `0x`, and the FCP LUN prefixed with `0x` and padded with zeroes to the right to have 16 hexadecimal digits.

The following example `zipl.conf` is for a system that uses physical volumes on partitions of two FCP LUNs for an LVM volume group `vg_devel1` that contains a logical volume `lv_root` for the root file system. For simplicity, the example shows a configuration without multipathing.

```
[defaultboot]
default=linux
target=/boot/
[linux]
image=/boot/vmlinuz-2.6.32-19.el6.s390x
ramdisk=/boot/initramfs-2.6.32-19.el6.s390x.img
parameters="root=/dev/mapper/vg_devel1-lv_root
rd_ZFCP=0.0.fc00,0x5105074308c212e9,0x401040a000000000
rd_ZFCP=0.0.fc00,0x5105074308c212e9,0x401040a100000000"
```

Chapter 25. Configuring an Installed Linux on System z Instance

```
rd_LVM_LV=vg_devel1/lv_root rd_NO_LUKS rd_NO_MD rd_NO_DM LANG=en_US.UTF-8
SYSFONT=latarcyrheb-sun16 KEYTABLE=us cio_ignore=all,!0.0.0009"
```

To add another physical volume on a partition of a third FCP LUN with device bus ID 0.0.fc00, WWPN 0x5105074308c212e9 and FCP LUN 0x401040a300000000, simply add **rd_ZFCP=0.0.fc00,0x5105074308c212e9,0x401040a300000000** to the parameters line of your boot kernel in **zipl.conf**, for example:

```
[defaultboot]
default=linux
target=/boot/
[linux]
image=/boot/vmlinuz-2.6.32-19.el6.s390x
ramdisk=/boot/initramfs-2.6.32-19.el6.s390x.img
parameters="root=/dev/mapper/vg_devel1-lv_root
rd_ZFCP=0.0.fc00,0x5105074308c212e9,0x401040a000000000
rd_ZFCP=0.0.fc00,0x5105074308c212e9,0x401040a100000000
rd_ZFCP=0.0.fc00,0x5105074308c212e9,0x401040a300000000
rd_LVM_LV=vg_devel1/lv_root rd_NO_LUKS rd_NO_MD rd_NO_DM LANG=en_US.UTF-8
SYSFONT=latarcyrheb-sun16 KEYTABLE=us cio_ignore=all,!0.0.0009"
```

Run **zipl** to apply the changes of **/etc/zipl.conf** for the next IPL:

```
# zipl -V
Using config file '/etc/zipl.conf'
Target device information
Device.....: 08:00
Partition.....: 08:01
Device name.....: sda
Device driver name.....: sd
Type.....: disk partition
Disk layout.....: SCSI disk layout
Geometry - start.....: 2048
File system block size.....: 4096
Physical block size.....: 512
Device size in physical blocks..: 10074112
Building bootmap in '/boot/'
Building menu 'rh-automatic-menu'
Adding #1: IPL section 'linux' (default)
kernel image.....: /boot/vmlinuz-2.6.32-19.el6.s390x
kernel parmline...: 'root=/dev/mapper/vg_devel1-lv_root
rd_ZFCP=0.0.fc00,0x5105074308c212e9,0x401040a000000000
rd_ZFCP=0.0.fc00,0x5105074308c212e9,0x401040a100000000
rd_ZFCP=0.0.fc00,0x5105074308c212e9,0x401040a300000000 rd_LVM_LV=vg_devel1/lv_root
rd_NO_LUKS rd_NO_MD rd_NO_DM LANG=en_US.UTF-8 SYSFONT=latarcyrheb-sun16 KEYTABLE=us
cio_ignore=all,!0.0.0009'
initial ramdisk...: /boot/initramfs-2.6.32-19.el6.s390x.img
component address:
kernel image....: 0x00010000-0x007a21ff
parmline.....: 0x00001000-0x000011ff
initial ramdisk.: 0x02000000-0x028f63ff
internal loader.: 0x0000a000-0x0000a3ff
Preparing boot device: sda.
Detected SCSI PCBIOS disk layout.
Writing SCSI master boot record.
Syncing disks...
Done.
```

25.2.2.2. FCP LUNs that are not part of the root file system

FCP LUNs that are not part of the root file system, such as data disks, are persistently configured in the file **/etc/zfcp.conf**. It contains one FCP LUN per line. Each line contains the device bus

ID of the FCP adapter, the WWPN as 16 digit hexadecimal number prefixed with **0x**, and the FCP LUN prefixed with **0x** and padded with zeroes to the right to have 16 hexadecimal digits, separated by a space or tab. Entries in **/etc/zfcp.conf** are activated and configured by **udev** when an FCP adapter is added to the system. At boot time, all FCP adapters visible to the system are added and trigger **udev**.

Example content of **/etc/zfcp.conf**:

```
0.0.fc00 0x5105074308c212e9 0x401040a000000000
0.0.fc00 0x5105074308c212e9 0x401040a100000000
0.0.fc00 0x5105074308c212e9 0x401040a300000000
0.0.fcd0 0x5105074308c2aee9 0x401040a000000000
0.0.fcd0 0x5105074308c2aee9 0x401040a100000000
0.0.fcd0 0x5105074308c2aee9 0x401040a300000000
```

Modifications of **/etc/zfcp.conf** only become effective after a reboot of the system or after the dynamic addition of a new FCP channels by changing the system's I/O configuration (for example, a channel is attached under z/VM). Alternatively, you can trigger the activation of a new entry in **/etc/zfcp.conf** for an FCP adapter which was previously not active, by executing the following commands:

1. Use the `cio_ignore` command to remove the FCP adapter from the list of ignored devices and make it visible to Linux:

```
# cio_ignore -r device_number
```

Replace *device_number* with the device number of the FCP adapter. For example:

```
# cio_ignore -r fcfc
```

2. To trigger the uevent that activates the change, issue:

```
echo add > /sys/bus/ccw/devices/device-bus-ID/uevent
```

For example:

```
echo add > /sys/bus/ccw/devices/0.0.fcfc/uevent
```

25.3. Adding a Network Device

Network device driver modules are loaded automatically by **udev**.

You can add a network interface on IBM System z dynamically or persistently.

- Dynamically
 1. Load the device driver
 2. Remove the network devices from the list of ignored devices.
 3. Create the group device.
 4. Configure the device.
 5. Set the device online.

- Persistently
 1. Create a configuration script.
 2. Activate the interface.

The following sections provide basic information for each task of each IBM System z network device driver. [Section 25.3.1, “Adding a qeth Device”](#) describes how to add a qeth device to an existing instance of Red Hat Enterprise Linux. [Section 25.3.2, “Adding an LCS Device”](#) describes how to add an lcs device to an existing instance of Red Hat Enterprise Linux. [Section 25.3.3, “Mapping subchannels and network device names”](#) describes how persistent network device names work. [Section 25.3.4, “Configuring a System z Network Device for Network Root File System”](#) describes how to configure a network device to use with a root file system that is only accessible through the network.

25.3.1. Adding a qeth Device

The qeth network device driver supports System z OSA-Express features in QDIO mode, HiperSockets, z/VM guest LAN, and z/VM VSWITCH.

Based on the type of interface being added, the qeth device driver assigns one of the base interface names:

- `hsin` for HiperSockets devices
- `ethn` for Ethernet features

The value *n* is an integer that uniquely identifies the device. *n* is **0** for the first device of that type, **1** for the second, and so on.

25.3.1.1. Dynamically adding a qeth device

To add a qeth device dynamically, follow these steps:

1. Determine whether the qeth device driver modules are loaded. The following example shows loaded qeth modules:

```
# lsmod | grep qeth
qeth_l3          127056  9
qeth_l2          73008  3
ipv6            492872  155ip6t_REJECT,nf_conntrack_ipv6,qeth_l3
qeth            115808  2 qeth_l3,qeth_l2
qdio            68240  1 qeth
ccwgroup       12112  2 qeth
```

If the output of the `lsmod` command shows that the qeth modules are not loaded, run the `modprobe` command to load them:

```
# modprobe qeth
```

2. Use the `cio_ignore` command to remove the network channels from the list of ignored devices and make them visible to Linux:

```
# cio_ignore -r read_device_bus_id,write_device_bus_id,data_device_bus_id
```

Replace `read_device_bus_id,write_device_bus_id,data_device_bus_id` with the three device bus IDs representing a network device. For example, if the `read_device_bus_id`

is **0.0.f500**, the *write_device_bus_id* is **0.0.f501**, and the *data_device_bus_id* is **0.0.f502**:

```
# cio_ignore -r 0.0.f500,0.0.f501,0.0.f502
```

3. Use the `znetconf` command to sense and list candidate configurations for network devices:

```
# znetconf -u
Scanning for network devices...
Device IDs                Type      Card Type      CHPID Drv.
-----
0.0.f500,0.0.f501,0.0.f502 1731/01  OSA (QDIO)      00 qeth
0.0.f503,0.0.f504,0.0.f505 1731/01  OSA (QDIO)      01 qeth
0.0.0400,0.0.0401,0.0.0402 1731/05  HiperSockets    02 qeth
```

4. Select the configuration you want to work with and use `znetconf` to apply the configuration and to bring the configured group device online as network device.

```
# znetconf -a f500
Scanning for network devices...
Successfully configured device 0.0.f500 (eth1)
```

5. Optionally, you can also pass arguments that are configured on the group device before it is set online:

```
# znetconf -a f500 -o portname=myname
Scanning for network devices...
Successfully configured device 0.0.f500 (eth1)
```

Now you can continue to configure the network `eth1` interface.

Alternatively, you can use `sysfs` attributes to set the device online as follows:

1. Create a qeth group device:

```
# echo read_device_bus_id,write_device_bus_id,data_device_bus_id > /sys/bus/ccwgroup/
drivers/qeth/group
```

For example:

```
# echo 0.0.f500,0.0.f501,0.0.f502 > /sys/bus/ccwgroup/drivers/qeth/group
```

2. Next, verify that the qeth group device was created properly by looking for the read channel:

```
# ls /sys/bus/ccwgroup/drivers/qeth/0.0.f500
```

You may optionally set additional parameters and features, depending on the way you are setting up your system and the features you require, such as:

- *portno*
- *layer2*
- *portname*

For information on additional parameters, refer to the chapter on the qeth device driver in *Linux on System z Device Drivers, Features, and Commands on Red Hat Enterprise Linux 6*.

3. Bring the device online by writing 1 to the online sysfs attribute:

```
# echo 1 > /sys/bus/ccwgroup/drivers/qeth/0.0.f500/online
```

4. Then verify the state of the device:

```
# cat /sys/bus/ccwgroup/drivers/qeth/0.0.f500/online
1
```

A return value of **1** indicates that the device is online, while a return value **0** indicates that the device is offline.

5. Find the interface name that was assigned to the device:

```
# cat /sys/bus/ccwgroup/drivers/qeth/0.0.f500/if_name
eth1
```

Now you can continue to configure the network eth1 interface.

The following command from the *s390utils* package shows the most important settings of your qeth device:

```
# lsqeth eth1
Device name           : eth1
-----
card_type             : OSD_1000
cdev0                 : 0.0.f500
cdev1                 : 0.0.f501
cdev2                 : 0.0.f502
chpid                 : 76
online                : 1
portname              : OSAPORT
portno                : 0
state                 : UP (LAN ONLINE)
priority_queueing     : always queue 0
buffer_count          : 16
layer2                : 1
isolation             : none
```

25.3.1.2. Dynamically removing a qeth device

To remove a qeth device, use the `znetconf` tool. For example:

1. Use the **znetconf** command to show you all configured network devices:

```
znetconf -c
Device IDs           Type   Card Type   CHPID Drv. Name   State
-----
0.0.8036,0.0.8037,0.0.8038 1731/05 HiperSockets   FB qeth hsi1    online
0.0.f5f0,0.0.f5f1,0.0.f5f2 1731/01 OSD_1000       76 qeth eth0     online
0.0.f500,0.0.f501,0.0.f502 1731/01 GuestLAN QDIO  00 qeth eth1     online
```


2. Select the network device to be removed and trigger **znetconf** to set the device offline and ungroup the ccw group device.

```
# znetconf -r f500
Remove network device 0.0.f500 (0.0.f500,0.0.f501,0.0.f502)?
Warning: this may affect network connectivity!
Do you want to continue (y/n)?y
Successfully removed device 0.0.f500 (eth1)
```

3. Verify the success of the removal:

```
znetconf -c
Device IDs                Type      Card Type      CHPID Drv. Name      State
-----
0.0.8036,0.0.8037,0.0.8038 1731/05  HiperSockets   FB qeth hsi1         online
0.0.f5f0,0.0.f5f1,0.0.f5f2 1731/01  OSD_1000       76 qeth eth0         online
```

25.3.1.3. Persistently adding a qeth device

To make your new qeth device persistent you need to create the configuration file for your new interface. The network interface configuration files are placed in `/etc/sysconfig/network-scripts/`.

The network configuration files use the naming convention **ifcfg-*device***, where *device* is the value found in the **if_name** file in the qeth group device that was created earlier. In this example it is **eth1**. **Cio_ignore** is handled transparently for persistent device configurations and you do not need to free devices from the ignore list manually.

If a configuration file for another device of the same type already exists, the simplest solution is to copy it to the new name.

```
# cd /etc/sysconfig/network-scripts
# cp ifcfg-eth0 ifcfg-eth1
```

If you do not have a similar device defined you must create one. Use this example of **ifcfg-eth0** as a template:

`/etc/sysconfig/network-scripts/ifcfg-eth0`

```
# IBM QETH
DEVICE=eth0
BOOTPROTO=static
IPADDR=10.12.20.136
NETMASK=255.255.255.0
ONBOOT=yes
NETTYPE=qeth
SUBCHANNELS=0.0.09a0,0.0.09a1,0.0.09a2
PORTNAME=OSAPORT
OPTIONS='layer2=1 portno=0'
MACADDR=02:00:00:23:65:1a
TYPE=Ethernet
```

Edit the new `ifcfg-eth1` file as follows:

1. Modify the `DEVICE` statement to reflect the contents of the **if_name** file from your ccwgroup.
2. Modify the `IPADDR` statement to reflect the IP address of your new interface.

3. Modify the *NETMASK* statement as needed.
4. If the new interface is to be activated at boot time, then make sure *ONBOOT* is set to **yes**.
5. Make sure the *SUBCHANNELS* statement matches the hardware addresses for your qeth device.
6. Modify the *PORTNAME* statement or leave it out if it is not necessary in your environment.
7. You may add any valid sysfs attribute and its value to the *OPTIONS* parameter. The Red Hat Enterprise Linux installer currently uses this to configure the layer mode (*Layer2*) and the relative port number (*portno*) of qeth devices.

The qeth device driver default for OSA devices is now layer 2 mode. To continue using old ifcfg definitions that rely on the previous default of layer 3 mode, add **layer2=0** to the *OPTIONS* parameter.

/etc/sysconfig/network-scripts/ifcfg-eth1

```
# IBM QETH
DEVICE=eth1
BOOTPROTO=static
IPADDR=192.168.70.87
NETMASK=255.255.255.0
ONBOOT=yes
NETTYPE=qeth
SUBCHANNELS=0.0.0600,0.0.0601,0.0.0602
PORTNAME=OSAPORT
OPTIONS='layer2=1 portno=0'
MACADDR=02:00:00:b3:84:ef
TYPE=Ethernet
```

Changes to an **ifcfg** file only become effective after rebooting the system or after the dynamic addition of new network device channels by changing the system's I/O configuration (for example, attaching under z/VM). Alternatively, you can trigger the activation of a **ifcfg** file for network channels which were previously not active yet, by executing the following commands:

1. Use the `cio_ignore` command to remove the network channels from the list of ignored devices and make them visible to Linux:

```
# cio_ignore -r read_device_bus_id,write_device_bus_id,data_device_bus_id
```

Replace *read_device_bus_id*, *write_device_bus_id*, *data_device_bus_id* with the three device bus IDs representing a network device. For example, if the *read_device_bus_id* is **0.0.0600**, the *write_device_bus_id* is **0.0.0601**, and the *data_device_bus_id* is **0.0.0602**:

```
# cio_ignore -r 0.0.0600,0.0.0601,0.0.0602
```

2. To trigger the uevent that activates the change, issue:

```
echo add > /sys/bus/ccw/devices/read-channel/uevent
```

For example:

```
echo add > /sys/bus/ccw/devices/0.0.0600/uevent
```

3. Check the status of the network device:

```
# lsqeth
```

4. Now start the new interface:

```
# ifup eth1
```

5. Check the status of the interface:

```
# ifconfig eth1
eth1      Link encap:Ethernet  HWaddr 02:00:00:00:00:01
          inet addr:192.168.70.87  Bcast:192.168.70.255  Mask:255.255.255.0
          inet6 addr: fe80::ff:fe00:1/64  Scope:Link
          UP BROADCAST RUNNING NOARP MULTICAST  MTU:1492  Metric:1
          RX packets:23 errors:0 dropped:0 overruns:0 frame:0
          TX packets:3 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:644 (644.0 b)  TX bytes:264 (264.0 b)
```

6. Check the routing for the new interface:

```
# route
Kernel IP routing table
Destination    Gateway         Genmask         Flags Metric Ref    Use Iface
192.168.70.0  *                255.255.255.0  U      0      0      0 eth1
10.1.20.0     *                255.255.255.0  U      0      0      0 eth0
default       10.1.20.1       0.0.0.0        UG     0      0      0 eth0
```

7. Verify your changes by using the ping command to ping the gateway or another host on the subnet of the new device:

```
# ping -c 1 192.168.70.8
PING 192.168.70.8 (192.168.70.8) 56(84) bytes of data.
64 bytes from 192.168.70.8: icmp_seq=0 ttl=63 time=8.07 ms
```

8. If the default route information has changed, you must also update `/etc/sysconfig/network` accordingly.

25.3.2. Adding an LCS Device

The *LAN channel station* (LCS) device driver supports 1000Base-T Ethernet on the OSA-Express2 and OSA-Express 3 features.

Based on the type of interface being added, the LCS driver assigns one base interface name:

- `ethn` for OSA-Express Fast Ethernet and Gigabit Ethernet

`n` is `0` for the first device of that type, `1` for the second, and so on.

25.3.2.1. Dynamically adding an LCS device

1. Load the device driver:

```
# modprobe lcs
```

2. Use the `cio_ignore` command to remove the network channels from the list of ignored devices and make them visible to Linux:

```
# cio_ignore -r read_device_bus_id,write_device_bus_id
```

Replace `read_device_bus_id` and `write_device_bus_id` with the two device bus IDs representing a network device. For example:

```
# cio_ignore -r 0.0.09a0,0.0.09a1
```

3. Create the group device:

```
# echo read_device_bus_id,write_device_bus_id > /sys/bus/ccwgroup/drivers/lcs/group
```

4. Configure the device. OSA cards can provide up to 16 ports for a single CHPID. By default, the LCS group device uses port `0`. To use a different port, issue a command similar to the following:

```
# echo portno > /sys/bus/ccwgroup/drivers/lcs/device_bus_id/portno
```

Replace `portno` with the port number you want to use. For more information about configuration of the LCS driver, refer to the chapter on LCS in *Linux on System z Device Drivers, Features, and Commands on Red Hat Enterprise Linux 6*.

5. Set the device online:

```
# echo 1 > /sys/bus/ccwgroup/drivers/lcs/read_device_bus_id/online
```

6. To find out what network device name has been assigned, enter the command:

```
# ls -l /sys/bus/ccwgroup/drivers/lcs/read_device_bus_ID/net/  
drwxr-xr-x 4 root root 0 2010-04-22 16:54 eth1
```

25.3.2.2. Persistently adding an LCS device

`cio_ignore` is handled transparently for persistent device configurations and you do not need to free devices from the ignore list manually.

To add an LCS device persistently, follow these steps:

1. Create a configuration script as file in `/etc/sysconfig/network-scripts/` with a name like `ifcfg-ethn` where `n` is an integer starting with `0`. The file should look similar to the following:

```
/etc/sysconfig/network-scripts/ifcfg-eth0  
# IBM LCS  
DEVICE=eth0  
BOOTPROTO=static  
IPADDR=10.12.20.136  
NETMASK=255.255.255.0  
ONBOOT=yes  
NETTYPE=lcs  
SUBCHANNELS=0.0.09a0,0.0.09a1  
PORTNAME=0  
OPTIONS=' '  
TYPE=Ethernet
```

2. Modify the value of *PORTNAME* to reflect the LCS port number (*portno*) you would like to use. You can add any valid lcs sysfs attribute and its value to the optional *OPTIONS* parameter. Refer to [Section 25.3.1.3, “Persistently adding a qeth device”](#) for the syntax.
3. Set the *DEVICE* parameter as follows:

```
DEVICE=ethn
```

4. Issue an **ifup** command to activate the device:

```
# ifup ethn
```

Changes to an **ifcfg** file only become effective after rebooting the system. You can trigger the activation of a **ifcfg** file for network channels by executing the following commands:

1. Use the **cio_ignore** command to remove the LCS device adapter from the list of ignored devices and make it visible to Linux:

```
# cio_ignore -r read_device_bus_id,write_device_bus_id
```

Replace *read_device_bus_id* and *write_device_bus_id* with the device bus IDs of the LCS device. For example:

```
# cio_ignore -r 0.0.09a0,0.0.09a1
```

2. To trigger the uevent that activates the change, issue:

```
echo add > /sys/bus/ccw/devices/read-channel/uevent
```

For example:

```
echo add > /sys/bus/ccw/devices/0.0.09a0/uevent
```

25.3.3. Mapping subchannels and network device names

The *DEVICE=* option in the **ifcfg** file does not determine the mapping of subchannels to network device names. Instead, the udev rules file **/etc/udev/rules.d/70-persistent-net.rules** determines which network device channel gets which network device name.

When configuring a new network device on System z, the system automatically adds a new rule to that file and assigns the next unused device name. You can then edit the values assigned to the *NAME=* variable for each device.

Example content of **/etc/udev/rules.d/70-persistent-net.rules**:

```
# This file was automatically generated by the /lib/udev/write_net_rules
# program run by the persistent-net-generator.rules rules file.
#
# You can modify it, as long as you keep each rule on a single line.
# S/390 qeth device at 0.0.f5f0
SUBSYSTEM=="net", ACTION=="add", DRIVERS=="qeth", KERNELS=="0.0.f5f0", ATTR{type}=="1",
KERNEL=="eth*", NAME="eth0"
# S/390 ctcn device at 0.0.1000
```

```

SUBSYSTEM=="net", ACTION=="add", DRIVERS=="ctcm", KERNELS=="0.0.1000", ATTR{type}=="256",
KERNEL=="ctc*", NAME="ctc0"
# S/390 qeth device at 0.0.8024
SUBSYSTEM=="net", ACTION=="add", DRIVERS=="qeth", KERNELS=="0.0.8024", ATTR{type}=="1",
KERNEL=="hsi*", NAME="hsi0"
# S/390 qeth device at 0.0.8124
SUBSYSTEM=="net", ACTION=="add", DRIVERS=="qeth", KERNELS=="0.0.8124", ATTR{type}=="1",
KERNEL=="hsi*", NAME="hsi1"
# S/390 qeth device at 0.0.1017
SUBSYSTEM=="net", ACTION=="add", DRIVERS=="qeth", KERNELS=="0.0.1017", ATTR{type}=="1",
KERNEL=="eth*", NAME="eth3"
# S/390 qeth device at 0.0.8324
SUBSYSTEM=="net", ACTION=="add", DRIVERS=="qeth", KERNELS=="0.0.8324", ATTR{type}=="1",
KERNEL=="hsi*", NAME="hsi3"
# S/390 qeth device at 0.0.8224
SUBSYSTEM=="net", ACTION=="add", DRIVERS=="qeth", KERNELS=="0.0.8224", ATTR{type}=="1",
KERNEL=="hsi*", NAME="hsi2"
# S/390 qeth device at 0.0.1010
SUBSYSTEM=="net", ACTION=="add", DRIVERS=="qeth", KERNELS=="0.0.1010", ATTR{type}=="1",
KERNEL=="eth*", NAME="eth2"
# S/390 lcs device at 0.0.1240
SUBSYSTEM=="net", ACTION=="add", DRIVERS=="lcs", KERNELS=="0.0.1240", ATTR{type}=="1",
KERNEL=="eth*", NAME="eth1"
# S/390 qeth device at 0.0.1013
SUBSYSTEM=="net", ACTION=="add", DRIVERS=="qeth", KERNELS=="0.0.1013", ATTR{type}=="1",
KERNEL=="hsi*", NAME="hsi4"

```

25.3.4. Configuring a System z Network Device for Network Root File System

To add a network device that is required to access the root file system, you only have to change the boot options. The boot options can be in a parameter file (refer to [Chapter 26, Parameter and Configuration Files](#)) or part of a `zipl.conf` on a DASD or FCP-attached SCSI LUN prepared with the `zipl` boot loader. There is no need to recreate the `initramfs`.

Dracut (the `mkinitrd` successor that provides the functionality in the `initramfs` that in turn replaces `initrd`) provides a boot parameter to activate network devices on System z early in the boot process: `rd_ZNET=`.

As input, this parameter takes a comma-separated list of the *NETTYPE* (`qeth`, `lcs`, `ctc`), two (`lcs`, `ctc`) or three (`qeth`) device bus IDs, and optional additional parameters consisting of key-value pairs corresponding to network device `sysfs` attributes. This parameter configures and activates the System z network hardware. The configuration of IP addresses and other network specifics works the same as for other platforms. Refer to the **dracut** documentation for more details.

`Cio_ignore` for the network channels is handled transparently on boot.

Example boot options for a root file system accessed over the network through NFS:

```

root=10.16.105.196:/nfs/nfs_root cio_ignore=all,!0.0.0009
rd_ZNET=qeth,0.0.0a00,0.0.0a01,0.0.0a02,layer2=1,portno=0,portname=OSAPORT
ip=10.16.105.197:10.16.105.196:10.16.111.254:255.255.248.0:nfs=server.subdomain.domain:eth0:none
rd_NO_LUKS rd_NO_LVM rd_NO_MD rd_NO_DM LANG=en_US.UTF-8 SYSFONT=latarcyrheb-sun16
KEYTABLE=us

```

Parameter and Configuration Files

The IBM System z architecture can use a customized parameter file to pass boot parameters to the kernel and the installer. This section describes the contents of this parameter file.

You need only read this section if you intend to change the shipped parameter file. You need to change the parameter file if you want to:

- automate the user input for **linuxrc** or the loader (refer to [Chapter 21, Installation Phase 1: Configuring a Network Device](#) and [Chapter 22, Installation Phase 2: Configuring Language and Installation Source](#)).
- install unattended with kickstart.
- choose non-default installation settings that are not accessible through the installer's interactive user interface, such as rescue mode.

The parameter file can be used to set up networking non-interactively before the installation program (loader and **anaconda**) starts.

The kernel parameter file is limited to 895 characters plus an end-of-line character. The parameter file can be variable or fixed record format. Fixed record format increases the file size by padding each line up to the record length. Should you encounter problems with the installer not recognizing all specified parameters in LPAR environments, you can try to put all parameters in one single line or start and end each line with a space character.

For more details on kernel parameters and different possibilities of specifying them, see the chapter on booting Linux and the chapter on kernel parameters in *Linux on System z Device Drivers, Features, and Commands on Red Hat Enterprise Linux 6*.

The parameter file contains kernel parameters, such as **root=/dev/ram0** or **ro**, and parameters for the installation process, such as **vncpassword=test** or **vnc**.

26.1. Required parameters

The following parameters are required and must be included in the parameter file. They are also provided in the file **generic.prm** in directory **images/** of the installation DVD:

root=file_system

where *file_system* represents the device on which the root file system can be found. For installation purposes, it must be set to **/dev/ram0**, which is the ramdisk containing the Red Hat Enterprise Linux installation program.

ro

mounts the root file system, which is a ramdisk, read-only.

ip=off

disables automatic network configuration.

ramdisk_size=size

modifies the memory size reserved for the ramdisk to ensure that the Red Hat Enterprise Linux installation program fits within it. For example: **ramdisk_size=40000**.

The file **generic.prm** also contains the additional parameter **cio_ignore=all,!0.0.0009**. This setting speeds up boot and device detection on systems with many devices. The installer transparently handles the activation of ignored devices.



Important — adapt the *cio_ignore* parameter to your system

To avoid installation problems arising from **cio_ignore** support not being implemented throughout the entire stack, adapt the *cio_ignore*= parameter value to your system or remove the parameter entirely from your parameter file used for booting (IPL) the installer.

When installing from an FCP-attached DVD drive, and you encounter a problem with ignored devices, select the menu option **clear blacklist** in **linuxrc** (refer to [Chapter 21, Installation Phase 1: Configuring a Network Device](#)) to remove the list of ignored devices.

26.2. The z/VM configuration file

This applies only if installing under z/VM. Under z/VM, you can use a configuration file on a CMS-formatted disk. The purpose of the CMS configuration file is to save space in the parameter file by moving the parameters that configure the initial network setup, the DASD, and the FCP specification out of the parameter file (refer to [Section 26.3, “Installation network parameters”](#)).

Each line of the CMS configuration file contains a single variable and its associated value, in the following shell-style syntax: **variable=value** .

You must also add the *CMSDASD* and *CMSCONFFILE* parameters to the parameter file. These parameters point the installation program to the configuration file:

CMSDASD=*cmsdasd_address*

Where *cmsdasd_address* is the device number of a CMS-formatted disk that contains the configuration file. This is usually the CMS user's A disk.

For example: *CMSDASD*=191

CMSCONFFILE=*configuration_file*

Where *configuration_file* is the name of the configuration file. This value must be specified in lower case. It is specified in a Linux file name format: **CMS_file_name.CMS_file_type**.

The CMS file **REDHAT CONF** is specified as **redhat.conf**. The CMS file name and the file type can each be from one to eight characters that follow the CMS conventions.

For example: *CMSCONFFILE*=*redhat.conf*

26.3. Installation network parameters

The following parameters can be used to set up the preliminary network automatically and can be defined in either the parameter file or the CMS configuration file. The parameters in this section are the only parameters that can also be used in a CMS configuration file. All other parameters in other sections must be specified in the parameter file.

NETTYPE=*type*

Where *type* must be one of the following: **qeth**, **lcs**, or **ctc**. The default is **qeth**.

Choose **lcs** for:

- OSA-2 Ethernet/Token Ring
- OSA-Express Fast Ethernet in non-QDIO mode
- OSA-Express High Speed Token Ring in non-QDIO mode

- Gigabit Ethernet in non-QDIO mode

Choose **qeth** for:

- OSA-Express Fast Ethernet
- Gigabit Ethernet (including 1000Base-T)
- High Speed Token Ring
- HiperSockets
- ATM (running Ethernet LAN emulation)

SUBCHANNELS=device_bus_IDs

Where *bus_IDs* is a comma-separated list of two or three device bus IDs.

Provides required device bus IDs for the various network interfaces:

```
qeth: SUBCHANNELS="read_device_bus_id,write_device_bus_id,data_device_bus_id"
lcs or ctc: SUBCHANNELS="read_device_bus_id,write_device_bus_id"
```

For example (a sample qeth SUBCHANNEL statement):

```
SUBCHANNELS=0.0.f5f0,0.0.f5f1,0.0.f5f2
```

PORTNAME=osa_portname , *PORTNAME=lcs_portnumber*

This variable supports OSA devices operating in qdio mode or in non-qdio mode.

When using qdio mode (**NETTYPE=qeth**), *osa_portname* is the portname specified on the OSA device when operating in qeth mode.

When using non-qdio mode (**NETTYPE=lcs**), *lcs_portnumber* is used to pass the relative port number as a decimal integer in the range of 0 through 15.

PORTNO=portnumber

You can add either **PORTNO=0** (to use port 0) or **PORTNO=1** (to use port 1 of OSA features with two ports per CHPID) to the CMS configuration file to avoid being prompted for the mode.

LAYER2=value

Where *value* can be **0** or **1**.

Use **LAYER2=0** to operate an OSA or HiperSockets device in layer 3 mode (**NETTYPE=qeth**). Use **LAYER2=1** for layer 2 mode. For virtual network devices under z/VM this setting must match the definition of the GuestLAN or VSWITCH to which the device is coupled.

To use network services that operate on layer 2 (the Data Link Layer or its MAC sublayer) such as DHCP, layer 2 mode is a good choice.

The qeth device driver default for OSA devices is now layer 2 mode. To continue using the previous default of layer 3 mode, set **LAYER2=0** explicitly.

VSWITCH=value

Where *value* can be **0** or **1**.

Specify **VSWITCH=1** when connecting to a z/VM VSWITCH or GuestLAN, or **VSWITCH=0** (or nothing at all) when using directly attached real OSA or directly attached real HiperSockets.

MACADDR=MAC_address

When you specify **LAYER2=1** and **VSWITCH=0**, optionally use this parameter to specify the MAC address. Linux needs six colon-separated octets and lower case hex digits. Note that this is different from the z/VM notation, so be careful if you copy and paste information from z/VM.

If you specify **LAYER2=1** and **VSWITCH=1**, you must not specify the *MACADDR*, because z/VM assigns a unique MAC address to virtual network devices in layer 2 mode.

CTCPROT=value

Where *value* can be **0**, **1**, or **3**.

Specifies the CTC protocol for **NETTYPE=ctc**. The default is **0**.

HOSTNAME=string

Where *string* is the hostname of the newly-installed Linux instance.

IPADDR=IP

Where *IP* is the IP address of the new Linux instance.

NETMASK=netmask

Where *netmask* is the netmask.

The netmask supports the syntax of a prefix integer (from 1 to 32) as specified in IPv4 *classless interdomain routing* (CIDR). For example, you can specify **24** instead of **255.255.255.0**, or **20** instead of **255.255.240.0**.

GATEWAY=gw

Where *gw* is the gateway IP address for this network device.

MTU=mtu

Where *mtu* is the *Maximum Transmission Unit* (MTU) for this network device.

DNS=server1:server2:additional_server_terms:serverN

Where *server1:server2:additional_server_terms:serverN* is a list of DNS servers, separated by colons. For example:

```
DNS=10.1.2.3:10.3.2.1
```

SEARCHDNS=domain1:domain2:additional_dns_terms:domainN

Where *domain1:domain2:additional_dns_terms:domainN* is a list of the search domains, separated by colons. For example:

```
SEARCHDNS=subdomain.domain:domain
```

You only need to specify *SEARCHDNS=* if you specify the *DNS=* parameter.

DASD=

Defines the DASD or range of DASDs to configure for the installation. For a detailed description of the syntax, refer to the **dasd_mod** device driver module option described in the chapter on the DASD device driver in *Linux on System z Device Drivers, Features, and Commands on Red Hat Enterprise Linux 6*.

Linuxrc supports a comma-separated list of device bus IDs or of ranges of device bus IDs with the optional attributes **ro**, **diag**, **erplog**, and **failfast**. Optionally, you can abbreviate device bus IDs to device numbers with leading zeros stripped. Any optional attributes should be

separated by colons and enclosed in parentheses. Optional attributes follow a device bus ID or a range of device bus IDs.

The only supported global option is **autodetect**. This does not support the specification of non-existent DASDs to reserve kernel device names for later addition of DASDs. Use persistent DASD device names (for example **/dev/disk/by-path/. . .**) to enable transparent addition of disks later. Other global options such as **probeonly**, **nopav**, or **nofcx** are not supported by linuxrc.

Only specify those DASDs that you really need to install your system. All unformatted DASDs specified here must be formatted after a confirmation later on in the installer (refer to [Section 23.6.1.1, "DASD low-level formatting"](#)). Add any data DASDs that are not needed for the root file system or the **/boot** partition after installation as described in [Section 25.1.3.2, "DASDs that are not part of the root file system"](#).

For FCP-only environments, specify **DASD=none**. Should **linuxrc** show an error message and ask to correct the parameter, select **continue**. It is safe to disregard this error message. When installing with kickstart and **RUNKS=1**, **linuxrc** will simply continue without asking to correct the parameter.

For example:

```
DASD=eb1c,0.0.a000-0.0.a003,eb10-eb14(diag),0.0.ab1c(ro:diag)
```

```
FCP_n="device_bus_ID WWPN FCP_LUN"
```

Where:

- *n* is typically an integer value (for example **FCP_1** or **FCP_2**) but could be any string with alphabetic or numeric characters or underscores.
- *device_bus_ID* specifies the device bus ID of the FCP device representing the *host bus adapter* (HBA) (for example **0.0.fc00** for device fc00).
- *WWPN* is the world wide port name used for routing (often in conjunction with multipathing) and is as a 16-digit hex value (for example **0x50050763050b073d**).
- *FCP_LUN* refers to the storage logical unit identifier and is specified as a 16-digit hexadecimal value padded with zeroes to the right (for example **0x4020400100000000**).

These variables can be used on systems with FCP devices to activate FCP LUNs such as SCSI disks. Additional FCP LUNs can be activated during the installation interactively or by means of a kickstart file. There is no interactive question for FCP in linuxrc. An example value may look similar to the following:

```
FCP_1="0.0.fc00 0x50050763050b073d 0x4020400100000000"
```



Important — values are site-specific

Each of the values used in the FCP parameters (for example **FCP_1** or **FCP_2**) are site-specific and are normally supplied by the FCP storage administrator.

The installation program prompts you for any required parameters not specified in the parameter or configuration file except for FCP_n.

26.4. VNC and X11 parameters

The following parameters can be defined in a parameter file but do not work in a CMS configuration file. With these parameters you control what interface will be used for **anaconda**.

To use an X11 user interface without X11 forwarding, specify the following X11 parameter:

display=IP/hostname:display

Sets the hostname or IP address and the X11 display where the installer should connect to and display its graphical user interface.

To use a VNC server instead of an X11 user interface, specify the following VNC parameters:

vnc

Specify *vnc* to use the VNC graphical user interface later in the installation process.

vncpassword=

This parameter sets the password used to connect to the VNC server. The password parameter is optional. If not used, the VNC server does not use a password and anybody can connect to the VNC server.

vncconnect=IP/hostname[:port]

When used in addition to *vnc* and *vncpassword=*, this optional parameter specifies the hostname or IP address (and optionally, a TCP port) where a VNC client is running in listening mode. The installer connects to and displays its graphical user interface on this VNC client.

26.5. Loader parameters

The following parameters can be defined in a parameter file but do not work in a CMS configuration file.

To automate the loader screens, specify the following parameters:

lang=language

Sets the language of the installer user interface, for example, **en** for English or **de** for German. This automates the response to **Choose a Language** (refer to [Section 22.3, “Language Selection”](#)).

repo=installation_source

Sets the installation source to access stage 2 as well as the repository with the packages to be installed. This automates the response to **Installation Method** (refer to [Section 22.4, “Installation Method”](#)).

26.6. Parameters for kickstart installations

The following parameters can be defined in a parameter file but do not work in a CMS configuration file.

ks=URL

References a kickstart file, which usually resides on the network for Linux installations on System z. Replace *URL* with the full path including the file name of the kickstart file. This parameter activates automatic installation with kickstart. Refer to [Section 28.4, “Automating the Installation with Kickstart”](#) and [Section 32.10, “Starting a Kickstart Installation”](#) for more details.]

RUNKS=value

Where *value* is defined as *1* if you want to run the loader automatically on the Linux console without having to log in over the network with SSH. To use **RUNKS=1**, the console must either support full-screen or the *cmdline* option below should be used. The latter applies for the 3270 terminal under z/VM or the operating system messages console for LPAR. We recommend **RUNKS=1** for fully automatic installations with kickstart. When **RUNKS=1** is set, **linuxrc** automatically continues in case of parameter errors and does not interrupt unattended installations by prompting for user interaction.

Leave out the parameter or specify **RUNKS=0** otherwise.

cmdline

When *cmdline* is specified, output on line-mode terminals (such as 3270 under z/VM or operating system messages for LPAR) becomes readable, as the installer disables escape terminal sequences that are only applicable to UNIX-like consoles. This requires installation with a kickstart file that answers all questions, since the installer does not support interactive user input in *cmdline* mode.

Ensure that your kickstart file contains all required parameters before you use either the *RUNKS* or *cmdline* options. Refer to [Chapter 32, Kickstart Installations](#) for details.

26.7. Miscellaneous parameters

The following parameters can be defined in a parameter file but do not work in a CMS configuration file.

askmethod

Do not use an automatically detected DVD as installation source but ask for the installation method to manually specify the installation source. This parameter is useful if you booted from an FCP-attached DVD but want to continue with another installation source, for example on the network or on a local hard disk.

mediacheck

Turns on testing of an ISO-based installation source; for example, when booted from an FCP-attached DVD or using *repo=* with an ISO on local hard disk or mounted with NFS.

nopath

Disables support for multi-pathing devices.

proxy=[protocol://][username[:password]@]host[:port]

Specify a proxy to use with installation over HTTP, HTTPS, or FTP.

rescue

Boot into a rescue system running from a ramdisk that can be used to fix and restore an installed system.

stage2=URL

Specifies a path to an **install.img** file instead of to an installation source. Otherwise, follows the same syntax as *repo=*. If *stage2* is specified, it takes precedence over all other methods of finding the **install.img**. Otherwise, **anaconda** attempts to find the **install.img** first on any existing DVD, and then from the location given by *repo=* or *method=*.

If only *stage2=* is given without *repo=* or *method=*, **anaconda** uses whatever repos the installed system would have enabled by default for installation.

`syslog=IP/hostname[:port]`

Makes the installer send log messages to a remote syslog server.

The boot parameters described here are the most useful for installations and trouble shooting on System z, but only a subset of those that influence the installer. Refer to [Chapter 28, Boot Options](#) for a more complete list of installer boot parameters.

26.8. Sample parameter file and CMS configuration file

To change the parameter file, begin by extending the shipped `generic.prm` file.

Example of `generic.prm` file:

```
root=/dev/ram0 ro ip=off ramdisk_size=40000 cio_ignore=all,!0.0.0009
CMSDASD=191 CMSCONFFILE=redhat.conf
vnc
```

Example of `redhat.conf` file configuring a QETH network device (pointed to by `CMSCONFFILE` in `generic.prm`):

```
NETTYPE="qeth"
SUBCHANNELS="0.0.0600,0.0.0601,0.0.0602"
PORTNAME="FOOBAR"
PORTNO="0"
LAYER2="1"
MACADDR="02:00:be:3a:01:f3"
HOSTNAME="foobar.systemz.example.com"
IPADDR="192.168.17.115"
NETMASK="255.255.255.0"
GATEWAY="192.168.17.254"
DNS="192.168.17.1"
SEARCHDNS="systemz.example.com:example.com"
DASD="200-203"
```

IBM System z References

27.1. IBM System z Publications

Current versions of the Linux on System z publications can be found at http://www.ibm.com/developerworks/linux/linux390/documentation_red_hat.html. They include:

IBM . 2010. *Linux on System z Device Drivers, Features, and Commands on Red Hat Enterprise Linux 6*. SC34-2597.

IBM . 2010. *Linux on System z Using the Dump Tools on Red Hat Enterprise Linux* . SC34-2607.

IBM . 2009. *Linux on System z How to use FC-attached SCSI devices with Linux on System z*. SC33-8413.

IBM . 2010. *How to use Execute-in-Place Technology with Linux on z/VM*. SC34-2594.

IBM . 2009. *Linux on System z How to Set up a Terminal Server Environment on z/VM*. SC34-2596.

IBM . 2009. *Linux on System z libica Programmer's Reference Version 2*. SC34-2602.

IBM . 2008. *Linux on System z How to Improve Performance with PAV*. SC33-8414.

IBM . 2008. *z/VM Getting Started with Linux on System z*. SC24-6194.

27.2. IBM Redbooks for System z

Current versions of the Redbooks can be found at <http://www.ibm.com/redbooks>. They include:

Introductory publications

IBM Redbooks . 2007. *Introduction to the New Mainframe: z/VM Basics*. SG24-7316.

IBM Redbooks . 2008. *z/VM and Linux on IBM System z The Virtualization Cookbook for Red Hat Enterprise Linux 5.2*. SG24-7492.

IBM Redbooks . 2009. *Practical Migration to Linux on System z*. SG24-7727.

Performance and high availability

IBM Redbooks . 2008. *Linux on IBM System z: Performance Measurement and Tuning*. SG24-6926.

IBM Redbooks . 2009. *Achieving High Availability on Linux for System z with Linux-HA Release 2*. SG24-7711.

Security

IBM Redbooks . 2010. *Security for Linux on System z*. SG24-7728.

IBM Redbooks . 2006. *Using Cryptographic Adapters for Web Servers with Linux on IBM System z9 and zSeries*. REDP-4131.

Networking

IBM Redbooks . 2009. *IBM System z Connectivity Handbook*. SG24-5444.

IBM Redbooks . 2009. *OSA Express Implementation Guide*. SG24-5948.

IBM Redbooks . 2007. *HiperSockets Implementation Guide*. SG24-6816.

IBM Redbooks . 2007. *Fibre Channel Protocol for Linux and z/VM on IBM System z*. SG24-7266.

27.3. Online resources

For z/VM publications, refer to <http://www.ibm.com/vm/library/> .

For System z I/O connectivity information, refer to <http://www.ibm.com/systems/z/connectivity/> .

For System z cryptographic coprocessor information, refer to <http://www.ibm.com/security/cryptocards/> .

Brad Hinson and Mike MacIsaac. *Sharing and maintaining RHEL 5.3 Linux under z/VM*. <http://www.linuxvm.org/Present/misc/ro-root-RH5.pdf>.

Part IV. Advanced installation options

This part of the *Red Hat Enterprise Linux Installation Guide* covers more advanced or uncommon methods of installing Red Hat Enterprise Linux, including:

- boot options.
 - installing without media.
 - installing through VNC.
 - using **kickstart** to automate the installation process.
-

Boot Options

The Red Hat Enterprise Linux installation system includes a range of functions and options for administrators. To use boot options, enter **linux *option*** at the boot : prompt.

If you specify more than one option, separate each of the options by a single space. For example:

```
linux option1 option2 option3
```



Anaconda Boot Options

The anaconda installer has many boot options, most are listed on the wiki <http://fedoraproject.org/wiki/Anaconda/Options>.



Kernel Boot Options

The <http://fedoraproject.org/wiki/KernelCommonProblems> page lists many common kernel boot options. The full list of kernel options is in the file `/usr/share/doc/kernel-doc-version/Documentation/kernel-parameters.txt`, which is installed with the kernel-doc package.



Rescue Mode

The Red Hat Enterprise Linux installation and *rescue discs* may either boot with *rescue mode*, or load the installation system. For more information on rescue discs and rescue mode, refer to [Section 28.6.2, “Booting Your Computer with the Rescue Mode”](#).

28.1. Configuring the Installation System at the Boot Menu

You can use the boot menu to specify a number of settings for the installation system, including:

- language
- display resolution
- interface type
- Installation method
- network settings

28.1.1. Specifying the Language

To set the language for both the installation process and the final system, specify the ISO code for that language with the **lang** option. Use the **keymap** option to configure the correct keyboard layout.

For example, the ISO codes **e1_GR** and **gr** identify the Greek language and the Greek keyboard layout:

```
linux lang=e1_GR keymap=gr
```

28.1.2. Configuring the Interface

To use a specific display resolution, enter **resolution=setting** as a boot option. For example, to set the display resolution to 1024×768, enter:

```
linux resolution=1024x768
```

To run the installation process in **text** mode, enter:

```
linux text
```

To enable support for a serial console, enter **serial** as an additional option.

Use **display=ip:0** to allow remote display forwarding. In this command, *ip* should be replaced with the IP address of the system on which you want the display to appear.

On the system you want the display to appear on, you must execute the command **xhost +remotehostname**, where *remotehostname* is the name of the host from which you are running the original display. Using the command **xhost +remotehostname** limits access to the remote display terminal and does not allow access from anyone or any system not specifically authorized for remote access.

28.1.3. Updating anaconda

You can install Red Hat Enterprise Linux with a newer version of the **anaconda** installation program than the one supplied on your installation media.

The boot option

```
linux updates
```

presents you with a prompt that asks you for a disk image containing **anaconda** updates. You do not need to specify this option if you are performing a network installation and have already placed the updates image contents in **rhupdates/** on the server.

To load the **anaconda** updates from a network location instead, use:

```
linux updates=
```

followed by the URL for the location where the updates are stored.

28.1.4. Specifying the Installation Method

Use the **askmethod** option to display additional menus that enable you to specify the installation method and network settings. You may also configure the installation method and network settings at the boot : prompt itself.

To specify the installation method from the boot : prompt, use the **repo** option. Refer to [Table 28.1, “Installation methods”](#) for the supported installation methods.

Table 28.1. Installation methods

| Installation method | Option format |
|-----------------------------|---|
| DVD drive | repo=cdrom:device |
| Hard Drive | repo=hd:device/path |
| HTTP Server | repo=http://host/path |
| FTP Server | repo=ftp://username:password@host/path |
| NFS Server | repo=nfs:server:/path |
| ISO images on an NFS Server | repo=nfsiso:server:/path |

28.1.5. Manually Configuring the Network Settings

By default, the installation system uses DHCP to automatically obtain the correct network settings. To manually configure the network settings yourself, either enter them in the **Configure TCP/IP** screen, or at the boot : prompt. You may specify the **ip** address, **netmask**, **gateway**, and **dns** server settings for the installation system at the prompt. If you specify the network configuration at the boot : prompt, these settings are used for the installation process, and the **Configure TCP/IP** screen does not appear.

This example configures the network settings for an installation system that uses the IP address 192.168.1.10:

```
linux ip=192.168.1.10 netmask=255.255.255.0 gateway=192.168.1.1 dns=192.168.1.2,192.168.1.3
```

28.2. Enabling Remote Access to the Installation System

You may access either graphical or text interfaces for the installation system from any other system. Access to a text mode display requires **telnet**, which is installed by default on Red Hat Enterprise Linux systems. To remotely access the graphical display of an installation system, use client software that supports the VNC (Virtual Network Computing) display protocol.



Installing a VNC Client on Red Hat Enterprise Linux

Red Hat Enterprise Linux includes the VNC client **vncviewer**. To obtain **vncviewer**, install the *tigervnc* package.

The installation system supports two methods of establishing a VNC connection. You may start the installation, and manually login to the graphical display with a VNC client on another system. Alternatively, you may configure the installation system to automatically connect to a VNC client on the network that is running in *listening mode*.

28.2.1. Enabling Remote Access with VNC

To enable remote graphical access to the installation system, enter two options at the prompt:

```
linux vnc vncpassword=qwerty
```

The **vnc** option enables the VNC service. The **vncpassword** option sets a password for remote access. The example shown above sets the password as **qwerty**.



VNC Passwords

The VNC password must be at least six characters long.

Specify the language, keyboard layout and network settings for the installation system with the screens that follow. You may then access the graphical interface through a VNC client. The installation system displays the correct connection setting for the VNC client:

```
Starting VNC...
The VNC server is now running.
Please connect to computer.mydomain.com:1 to begin the install...
Starting graphical installation...
Press <enter> for a shell
```

You may then login to the installation system with a VNC client. To run the **vncviewer** client on Red Hat Enterprise Linux, choose **Applications** → **Accessories** → **VNC Viewer**, or type the command **vncviewer** in a terminal window. Enter the server and display number in the **VNC Server** dialog. For the example above, the **VNC Server** is **computer.mydomain.com:1**.

28.2.2. Connecting the Installation System to a VNC Listener

To have the installation system automatically connect to a VNC client, first start the client in listening mode. On Red Hat Enterprise Linux systems, use the **-listen** option to run **vncviewer** as a listener. In a terminal window, enter the command:

```
vncviewer -listen
```



Firewall Reconfiguration Required

By default, **vncviewer** uses TCP port 5500 when in listening mode. To permit connections to this port from other systems, choose **System** → **Administration** → **Firewall**. Select **Other ports**, and **Add**. Enter **5500** in the **Port(s)** field, and specify **tcp** as the **Protocol**.

Once the listening client is active, start the installation system and set the VNC options at the boot : prompt. In addition to **vnc** and **vncpassword** options, use the **vncconnect** option to specify the name or IP address of the system that has the listening client. To specify the TCP port for the listener, add a colon and the port number to the name of the system.

For example, to connect to a VNC client on the system `desktop.mydomain.com` on the port 5500, enter the following at the boot : prompt:

```
linux vnc vncpassword=qwerty vncconnect=desktop.mydomain.com:5500
```

28.2.3. Enabling Remote Access with Telnet

To enable remote access to a text mode installation, use the **telnet** option at the boot : prompt:

```
linux text telnet
```

You may then connect to the installation system with the **telnet** utility. The **telnet** command requires the name or IP address of the installation system:

```
telnet computer.mydomain.com
```



Telnet Access Requires No Password

To ensure the security of the installation process, only use the **telnet** option to install systems on networks with restricted access.

28.3. Logging to a Remote System During the Installation

By default, the installation process sends log messages to the console as they are generated. You may specify that these messages go to a remote system that runs a *syslog* service.

To configure remote logging, add the **syslog** option. Specify the IP address of the logging system, and the UDP port number of the log service on that system. By default, syslog services that accept remote messages listen on UDP port 514.

For example, to connect to a syslog service on the system 192.168.1.20, enter the following at the boot : prompt:

```
linux syslog=192.168.1.20:514
```

28.3.1. Configuring a Log Server

Red Hat Enterprise Linux uses **rsyslog** to provide a syslog service. The default configuration of **rsyslog** rejects messages from remote systems.



Only Enable Remote Syslog Access on Secured Networks

The **rsyslog** configuration detailed below does not make use of any of the security measures available in **rsyslog**. Crackers may slow or crash systems that permit access to the logging service, by sending large quantities of false log messages. In addition, hostile users may intercept or falsify messages sent to the logging service over the network.

To configure a Red Hat Enterprise Linux system to accept log messages from other systems on the network, edit the file **/etc/rsyslog.conf**. You must use root privileges to edit the file **/etc/rsyslog.conf**. Uncomment the following lines by removing the hash preceding them:

```
$ModLoad imudp.so
$UDPServerRun 514
```

Restart the **rsyslog** service to apply the change:

```
su -c '/sbin/service rsyslog restart'
```

Enter the root password when prompted.



Firewall Reconfiguration Required

By default, the **syslog** service listens on UDP port 514. To permit connections to this port from other systems, choose **System** → **Administration** → **Firewall**. Select **Other ports**, and **Add**. Enter **514** in the **Port(s)** field, and specify **udp** as the **Protocol**.

28.4. Automating the Installation with Kickstart

You can allow an installation to run unattended by using Kickstart. A *Kickstart* file specifies settings for an installation. Once the installation system boots, it can read a Kickstart file and carry out the installation process without any further input from a user.



Every Installation Produces a Kickstart File

The Red Hat Enterprise Linux installation process automatically writes a Kickstart file that contains the settings for the installed system. This file is always saved as **/root/anaconda-ks.cfg**. You may use this file to repeat the installation with identical settings, or modify copies to specify settings for other systems.



Important — Kickstart installations and Firstboot

Firstboot does not run after a system is installed from a Kickstart file unless a desktop and the X Window System were included in the installation and graphical login was enabled. Either specify a user with the **user** option in the Kickstart file before installing additional systems from it (refer to [Section 32.4, “Kickstart Options”](#) for details) or log into the installed system with a virtual console as root and add users with the **adduser** command.

Red Hat Enterprise Linux includes a graphical application to create and modify Kickstart files by selecting the options that you require. Use the package **system-config-kickstart** to install this utility. To load the Red Hat Enterprise Linux Kickstart editor, choose **Applications** → **System Tools** → **Kickstart**.

Kickstart files list installation settings in plain text, with one option per line. This format lets you modify your Kickstart files with any text editor, and write scripts or applications that generate custom Kickstart files for your systems.

To automate the installation process with a Kickstart file, use the **ks** option to specify the name and location of the file:


```
linux ks=location/kickstart-file.cfg
```

You may use Kickstart files that are held on either removable storage, a hard drive, or a network server. Refer to [Table 28.2, “Kickstart sources”](#) for the supported Kickstart sources.

Table 28.2. Kickstart sources

| Kickstart source | Option format |
|------------------|---|
| DVD drive | ks=cdrom:/directory/ks.cfg |
| Hard Drive | ks=hd:/device/directory/ks.cfg |
| Other Device | ks=file:/device/directory/ks.cfg |
| HTTP Server | ks=http://server.mydomain.com/directory/ks.cfg |
| FTP Server | ks=ftp://server.mydomain.com/directory/ks.cfg |
| NFS Server | ks=nfs:server.mydomain.com:/directory/ks.cfg |

To obtain a Kickstart file from a script or application on a Web server, specify the URL of the application with the **ks=** option. If you add the option **kssendmac**, the request also sends HTTP headers to the Web application. Your application can use these headers to identify the computer. This line sends a request with headers to the application `http://server.mydomain.com/kickstart.cgi`:

```
linux ks=http://server.mydomain.com/kickstart.cgi kssendmac
```

28.5. Enhancing Hardware Support

By default, Red Hat Enterprise Linux attempts to automatically detect and configure support for all of the components of your computer. Red Hat Enterprise Linux supports the majority of hardware in common use with the software *drivers* that are included with the operating system. To support other devices you may supply additional drivers during the installation process, or at a later time.

28.5.1. Overriding Automatic Hardware Detection

For some models of device automatic hardware configuration may fail, or cause instability. In these cases, you may need to disable automatic configuration for that type of device, and take additional steps to manually configure the device after the installation process is complete.



Check the Release Notes

Refer to the Release Notes for information on known issues with specific devices.

To override the automatic hardware detection, use one or more of the following options:

Table 28.3. Hardware Options

| Compatibility | Option |
|---|-----------------|
| Disable all hardware detection | noprobe |
| Disable graphics, keyboard, and mouse detection | headless |
| Disable passing keyboard and mouse information to stage 2 of the installation program | nopass |

| Compatibility | Option |
|---|---------------------------|
| Use basic VESA driver for video | <code>xdriver=vesa</code> |
| Disable shell access on virtual console 2 during installation | <code>noshell</code> |
| Disable advanced configuration and power interface (ACPI) | <code>acpi=off</code> |
| Disable machine check exception (MCE) CPU self-diagnosis. | <code>nomce</code> |
| Disable non-uniform memory access on the AMD64 architecture | <code>numa-off</code> |
| Force kernel to detect a specific amount of memory, where xxx is a value in megabytes | <code>mem=xxxm</code> |
| Enable DMA only for IDE and SATA drives | <code>libata.dma=1</code> |
| Disable BIOS-assisted RAID | <code>nodmraid</code> |
| Disable Firewire device detection | <code>nofirewire</code> |
| Disable parallel port detection | <code>noparport</code> |
| Disable PC Card (PCMCIA) device detection | <code>nopcmcia</code> |
| Disable USB storage device detection | <code>nousbstorage</code> |
| Disable all USB device detection | <code>nousb</code> |
| Disable all probing of network hardware | <code>nonet</code> |



Additional Screen

The `isa` option causes the system to display an additional text screen at the beginning of the installation process. Use this screen to configure the ISA devices on your computer.



Important

Other kernel boot options have no particular meaning for **anaconda** and do not affect the installation process. However, if you use these options to boot the installation system, **anaconda** will preserve them in the bootloader configuration.

28.6. Using the Maintenance Boot Modes

28.6.1. Verifying boot media

You can test the integrity of an ISO-based installation source before using it to install Red Hat Enterprise Linux. These sources include DVD, and ISO images stored on a hard drive or NFS server. Verifying that the ISO images are intact before you attempt an installation helps to avoid problems that are often encountered during installation.

Red Hat Enterprise Linux offers you two ways to test installation ISOs:

- select **OK** at the prompt to test the media before installation when booting from the Red Hat Enterprise Linux DVD
- boot Red Hat Enterprise Linux with the option `mediacheck` option.

28.6.2. Booting Your Computer with the Rescue Mode

You may boot a command-line Linux system from either a rescue disc or an installation disc, without installing Red Hat Enterprise Linux on the computer. This enables you to use the utilities and functions of a running Linux system to modify or repair systems that are already installed on your computer.

The rescue disc starts the rescue mode system by default. To load the rescue system with the installation disc, choose **Rescue installed system** from the boot menu.

Specify the language, keyboard layout and network settings for the rescue system with the screens that follow. The final setup screen configures access to the existing system on your computer.

By default, rescue mode attaches an existing operating system to the rescue system under the directory `/mnt/sysimage/`.

28.6.3. Upgrading your computer

A previous boot option, **upgrade**, has been superseded by a stage in the installation process where the installation program prompts you to upgrade or reinstall earlier versions of Red Hat Enterprise Linux that it detects on your system.

However, the installation program may not correctly detect a previous version of Red Hat Enterprise Linux if the contents of the `/etc/redhat-release` file have changed. The boot option **upgradeany** relaxes the test that the installation program performs and allows you to upgrade a Red Hat Enterprise Linux installation that the installation program has not correctly identified.

Installing Without Media



Linux Required

This procedure assumes you are already using Red Hat Enterprise Linux or another relatively modern Linux distribution, and the **GRUB** boot loader. It also assumes you are a somewhat experienced Linux user.

This section discusses how to install Red Hat Enterprise Linux on your system without making any additional physical media. Instead, you can use your existing **GRUB** boot loader to start the installation program.

29.1. Retrieving Boot Files

To perform an installation without media or a PXE server, your system must have two files stored locally, a kernel and an initial RAM disk.

Copy the **vmlinuz** and **initrd.img** files from a Red Hat Enterprise Linux DVD (or DVD image) to the **/boot/** directory, renaming them to **vmlinuz-install** and **initrd.img-install**. You must have root privileges to write files into the **/boot/** directory.

29.2. Editing the GRUB Configuration

The **GRUB** boot loader uses the configuration file **/boot/grub/grub.conf**. To configure **GRUB** to boot from the new files, add a boot stanza to **/boot/grub/grub.conf** that refers to them.

A minimal boot stanza looks like the following listing:

```
title Installation
  root (hd0,0)
  kernel /vmlinuz-install
  initrd /initrd.img-install
```

You may wish to add options to the end of the **kernel** line of the boot stanza. These options set preliminary options in **Anaconda** which the user normally sets interactively. For a list of available installer boot options, refer to [Chapter 28, Boot Options](#).

The following options are generally useful for medialess installations:

- **ip=**
- **repo=**
- **lang=**
- **keymap=**
- **ksdevice=** (if installation requires an interface other than eth0)
- **vnc** and **vncpassword=** for a remote installation

When you are finished, change the **default** option in **/boot/grub/grub.conf** to point to the new first stanza you added:

```
default 0
```

29.3. Booting to Installation

Reboot the system. **GRUB** boots the installation kernel and RAM disk, including any options you set. You may now refer to the appropriate chapter in this guide for the next step. If you chose to install remotely using VNC, refer to [Section 28.2, “Enabling Remote Access to the Installation System”](#) for assistance in connecting to the remote system.

Setting Up an Installation Server

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.

30.1. 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 [Section 4.1, “Preparing for a Network Installation”](#) for detailed instructions.

30.2. 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.

30.3. Configuring the DHCP Server

If a DHCP server does not already exist on the network, configure one. Refer to the Red Hat Enterprise Linux Deployment Guide for details. Make sure the configuration file contains the following so that PXE booting is enabled for systems which 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"; }
```

where the `next-server <server-ip>` should be replaced with the IP address of the **tftp** server.

30.4. Starting the tftp Server

On the DHCP server, verify that the **tftp-server** package is installed with the command `rpm -q tftp-server`.

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

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

These commands configure the **tftp** and **xinetd** services to immediately turn on and also configure them to start at boot time in runlevels 3, 4, and 5.

30.5. Adding a Custom Boot Message

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

30.6. 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 [Chapter 9, Installing using anaconda](#).

Installing Through VNC

The Red Hat Enterprise Linux installer (**anaconda**) offers you two interactive modes of operation. The original mode is a text-based interface. The newer mode uses GTK+ and runs in the X Window environment. This chapter explains how you can use the graphical installation mode in environments where the system lacks a proper display and input devices typically associated with a workstation. This scenario is typical of systems in datacenters, which are often installed in a rack environment and do not have a display, keyboard, or mouse. Additionally, a lot of these systems even lack the ability to connect a graphical display. Given that enterprise hardware rarely needs that ability at the physical system, this hardware configuration is acceptable.

Even in these environments, however, the graphical installer remains the recommended method of installation. The text mode environment lacks a lot of capabilities found in the graphical mode. Many users still feel that the text mode interface provides them with additional power or configuration ability not found in the graphical version. The opposite is true. Much less development effort is put in to the text-mode environment and specific things (for example, LVM configuration, partition layout, package selection, and bootloader configuration) are deliberately left out of the text mode environment. The reasons for this are:

- Less screen real estate for creating user interfaces similar to those found in the graphical mode.
- Difficult internationalization support.
- Desire to maintain a single interactive installation code path.

Anaconda therefore includes a **Virtual Network Computing** (VNC) mode that allows the graphical mode of the installer to run locally, but display on a system connected to the network. Installing in VNC mode provides you with the full range of installation options, even in situations where the system lacks a display or input devices.

31.1. VNC Viewer

Performing a VNC installation requires a VNC viewer running on your workstation or other terminal computer. Locations where you might want a VNC viewer installed:

- Your workstation
- Laptop on a datacenter crash cart

VNC is open source software licensed under the GNU General Public License.

VNC clients are available in the repositories of most Linux distributions. Use your package manager to search for a client for your chosen distribution. For example, on Red Hat Enterprise Linux, install the *tigervnc* package:

```
# yum install tigervnc
```

Once you have verified you have a VNC viewer available, it's time to start the installation.

31.2. VNC Modes in Anaconda

Anaconda offers two modes for VNC installation. The mode you select will depend on the network configuration in your environment.

31.2.1. Direct Mode

Direct mode VNC in anaconda is when the client initiates a connection to the VNC server running in anaconda. Anaconda will tell you when to initiate this connection in the VNC viewer. Direct mode can be activated by either of the following commands:

- Specify **vnc** as a boot argument.
- Specify the **vnc** command in the kickstart file used for installation.

When you activate VNC mode, anaconda will complete the first stage of the installer and then start VNC to run the graphical installer. The installer will display a message on the console in the following format:

```
Running anaconda VERSION, the PRODUCT system installer - please wait...
```

Anaconda will also tell you the IP address and display number to use in your VNC viewer. At this point, you need to start the VNC viewer and connect to the target system to continue the installation. The VNC viewer will present anaconda to you in graphical mode.

There are some disadvantages to direct mode, including:

- Requires visual access to the system console to see the IP address and port to connect the VNC viewer to.
- Requires interactive access to the system console to complete the first stage of the installer.

If either of these disadvantages would prevent you from using direct mode VNC in anaconda, then connect mode is probably more suited to your environment.

31.2.2. Connect Mode

Certain firewall configurations or instances where the target system is configured to obtain a dynamic IP address may cause trouble with the direct VNC mode in anaconda. In addition, if you lack a console on the target system to see the message that tells you the IP address to connect to, then you will not be able to continue the installation.

The VNC connect mode changes how VNC is started. Rather than anaconda starting up and waiting for you to connect, the VNC connect mode allows anaconda to automatically connect to your view. You won't need to know the IP address of the target system in this case.

To activate the VNC connect mode, pass the **vnconnect** boot parameter:

```
boot: linux vnconnect=HOST
```

Replace HOST with your VNC viewer's IP address or DNS host name. Before starting the installation process on the target system, start up your VNC viewer and have it wait for an incoming connection.

Start the installation and when your VNC viewer displays the graphical installer, you are ready to go.

31.3. Installation Using VNC

Now that you have installed a VNC viewer application and selected a VNC mode for use in anaconda, you are ready to begin the installation.

31.3.1. Installation Example

The easiest way to perform an installation using VNC is to connect another computer directly to the network port on the target system. The laptop on a datacenter crash cart usually fills this role. If you are performing your installation this way, make sure you follow these steps:

1. Connect the laptop or other workstation to the target system using a crossover cable. If you are using regular patch cables, make sure you connect the two systems using a small hub or switch. Most recent Ethernet interfaces will automatically detect if they need to be crossover or not, so it may be possible to connect the two systems directly using a regular patch cable.
2. Configure the VNC viewer system to use a RFC 1918 address with no gateway. This private network connection will only be used for the purpose of installation. Configure the VNC viewer system to be 192.168.100.1/24. If that address is in use, just pick something else in the RFC 1918 address space that is available to you.
3. Start the installation on the target system.
 - a. Booting the installation DVD.

If booting the installation DVD, make sure **vnc** is passed as a boot parameter. To add the **vnc** parameter, you will need a console attached to the target system that allows you to interact with the boot process. Enter the following at the prompt:

```
boot: linux vnc
```

- b. Boot over the network.

If the target system is configured with a static IP address, add the **vnc** command to the kickstart file. If the target system is using DHCP, add **vncconnect=HOST** to the boot arguments for the target system. HOST is the IP address or DNS host name of the VNC viewer system. Enter the following at the prompt:

```
boot: linux vncconnect=HOST
```

4. When prompted for the network configuration on the target system, assign it an available RFC 1918 address in the same network you used for the VNC viewer system. For example, 192.168.100.2/24.



Note

This IP address is only used during installation. You will have an opportunity to configure the final network settings, if any, later in the installer.

5. Once the installer indicates it is starting anaconda, you will be instructed to connect to the system using the VNC viewer. Connect to the viewer and follow the graphical installation mode instructions found in the product documentation.

31.3.2. Kickstart Considerations

If your target system will be booting over the network, VNC is still available. Just add the **vnc** command to the kickstart file for the system. You will be able to connect to the target system using

your VNC viewer and monitor the installation progress. The address to use is the one the system is configured with via the kickstart file.

If you are using DHCP for the target system, the reverse **vncconnect** method may work better for you. Rather than adding the **vnc** boot parameter to the kickstart file, add the **vncconnect=HOST** parameter to the list of boot arguments for the target system. For HOST, put the IP address or DNS host name of the VNC viewer system. See the next section for more details on using the vncconnect mode.

31.3.3. Firewall Considerations

If you are performing the installation where the VNC viewer system is a workstation on a different subnet from the target system, you may run in to network routing problems. VNC works fine so long as your viewer system has a route to the target system and ports 5900 and 5901 are open. If your environment has a firewall, make sure ports 5900 and 5901 are open between your workstation and the target system.

In addition to passing the **vnc** boot parameter, you may also want to pass the **vncpassword** parameter in these scenarios. While the password is sent in plain text over the network, it does provide an extra step before a viewer can connect to a system. Once the viewer connects to the target system over VNC, no other connections are permitted. These limitations are usually sufficient for installation purposes.



Important

Be sure to use a temporary password for the **vncpassword** option. It should not be a password you use on any systems, especially a real root password.

If you continue to have trouble, consider using the **vncconnect** parameter. In this mode of operation, you start the viewer on your system first telling it to listen for an incoming connection. Pass **vncconnect=HOST** at the boot prompt and the installer will attempt to connect to the specified HOST (either a hostname or IP address).

31.4. References

- VNC description at Wikipedia: <http://en.wikipedia.org/wiki/Vnc>
- TigerVNC: <http://tigervnc.sourceforge.net/>
- RFC 1918 - Address Allocation for Private Networks: <http://www.ietf.org/rfc/rfc1918.txt>
- Anaconda boot options: <http://fedoraproject.org/wiki/Anaconda/Options>
- Kickstart documentation: <http://fedoraproject.org/wiki/Anaconda/Kickstart>

Kickstart Installations

32.1. 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 a 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.

All kickstart scriptlets and the log files of their execution are stored in the `/tmp` directory to assist with debugging installation failures.



Note — `/tmp/netinfo` no longer used

Anaconda now configures network interfaces with **NetworkManager**. Consequently, kickstart users that referenced the network settings located in `/tmp/netinfo` in previous versions of Red Hat Enterprise Linux must now source the `ifcfg` files in `/etc/sysconfig/network-scripts`.

32.2. How Do You Perform a Kickstart Installation?

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

To use kickstart, you must:

1. Create a kickstart file.
2. Create a boot media 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.

32.3. 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 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 32.4, “Kickstart Options”](#) for a list of kickstart options. You must include the required options.
- The **%packages** section — Refer to [Section 32.5, “Package Selection”](#) for details.
- The **%pre** and **%post** sections — These two sections can be in any order and are not required. Refer to [Section 32.6, “Pre-installation Script”](#) and [Section 32.7, “Post-installation Script”](#) for details.
- Items that are not required can be omitted.
- Omitting any required item results 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 continues unattended (unless it finds another missing item).
- Lines starting with a pound (also known as hash) sign (#) are treated as comments and are ignored.
- For kickstart *upgrades*, the following items are required:
 - Language
 - Installation method
 - Device specification (if device is needed to perform the installation)
 - Keyboard setup
 - The **upgrade** keyword
 - Boot loader configuration

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

32.4. 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, use the **Kickstart Configurator** application. Refer to [Chapter 33, 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.

- **--encrypted** — Should all devices with support be encrypted by default? This is equivalent to checking the **Encrypt** checkbox on the initial partitioning screen.
- **--passphrase=** — Provide a default system-wide passphrase for all encrypted devices.

- **--escrowcert=URL_of_X.509_certificate** — Store data encryption keys of all encrypted volumes as files in / (root), encrypted using the X.509 certificate from the URL specified with *URL_of_X.509_certificate*. The keys are stored as a separate file for each encrypted volume. This option is only meaningful if **--encrypted** is specified.
- **--backupperphrase=** — Add a randomly-generated passphrase to each encrypted volume. Store these passphrases in separate files in / (root), encrypted using the X.509 certificate specified with **--escrowcert**. This option is only meaningful if **--escrowcert** is specified.

ignoredisk (optional)

Causes the installer to ignore the specified disks. This is useful if you use autopartition and want to be sure that some disks are ignored. For example, without **ignoredisk**, attempting to deploy on a SAN-cluster the kickstart would fail, as the installer detects passive paths to the SAN that return no partition table.

The **ignoredisk** option is also useful if you have multiple paths to your disks.

The syntax is:

```
ignoredisk --drives=drive1,drive2,...
```

where *driveN* is one of **sda**, **sdb**,..., **hda**,... etc.

- **--only-use** — specifies a list of disks for the installer to use. All other disks are ignored. For example, to use disk sda during installation and ignore all other disks:

```
ignoredisk --only-use=sda
```

autostep (optional)

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

- **--autoscreenshot** — Take a screenshot at every step during installation and copy the images over to **/root/anaconda-screenshots** after installation is complete. This is most useful for documentation.

auth or **authconfig** (required)

Sets up the authentication options for the system. It is 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 (distinguished name) 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 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. If you enable Kerberos, you must make users' accounts known to this workstation by enabling LDAP, NIS, or Hesiod or by using the **/usr/sbin/useradd** command. 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.

**Note**

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 library does not place a period . in front of the LHS and RHS values when performing a search. Therefore the LHS and RHS values need to have a period placed in front of them in order if they require this.

- **--enablembauth** — 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. If you enable SMB, you must 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.
- **--smbserver=** — 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. This option is required for both installations and upgrades.

**Important**

If you select text mode for a kickstart installation, make sure that you specify choices for the partitioning, bootloader, and package selection options. These steps are automated in text mode, and **anaconda** cannot prompt you for missing information. If you do not provide choices for these options, **anaconda** will stop the installation process.

- **--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 to 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.
- **--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 all the partitions on the first two drives on the primary IDE controller:

```
clearpart --drives=hda,hdb --all
```

- **--initlabel** — Initializes the disk label to the default for your architecture (for example **msdos** for x86). 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 halts the install. This mode is useful on IBM System z systems with the 3270 terminal under z/VM and operating system messages applet on LPAR. The recommended use is in conjunction with **RUNKS=1** and **ks=**. Refer to [Section 26.6, “Parameters for kickstart installations”](#).

device (optional)

On most PCI systems, the installation program autoprobes 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 <moduleName> --opts=<options>
```

- **<moduleName>** — Replace with the name of the kernel module which should be installed.

- **--opts=** — Mount options to use for mounting the NFS export. Any options that can be specified in `/etc/fstab` for an NFS mount are allowed. The options are listed in the **nfs(5)** man page. Multiple options are separated with a comma.

driverdisk (optional)

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

```
driverdisk <partition> --source=<url> --biospart=<biospart> [--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.
- *<url>* — URL for the driver disk. NFS locations can be given in the form **nfs:host:/path/to/img**.
- *<biospart>* — BIOS partition containing the driver disk (for example, **82p2**).
- **--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** or **--enable** — 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** or **--disable** — 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 **Firstboot** 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** or **--enabled** — The **Setup Agent** is started the first time the system boots.
- **--disable** or **--disabled** — 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.

graphical (optional)

Perform the kickstart installation in graphical mode. This is the default.

halt (optional)

Halt the system after the installation has successfully completed. This is similar to a manual installation, where *anaconda* displays a message and waits for the user to press a key before rebooting. During a kickstart installation, if no completion method is specified, this option is used as the default.

The **halt** option is roughly equivalent to the **shutdown -h** command.

For other completion methods, refer to the **poweroff**, **reboot**, and **shutdown** kickstart options.

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 **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 optical drive on the system.
- **harddrive** — Install from a Red Hat installation tree on a local drive, which must be either *vfat* or *ext2*.
 - **--biospart=**
BIOS partition to install from (such as 82).
 - **--partition=**
Partition to install from (such as *sdb2*).
 - **--dir=**
Directory containing the *variant* 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 *variant* directory of the installation tree.

- **--opts=**

Mount options to use for mounting the NFS export. (optional)

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 are 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. Refer to the **autostep** command.

iscsi (optional)

`iscsi --ipaddr= [options]`.

Specifies additional iSCSI storage to be attached during installation. If you use the *iscsi* parameter, you must also assign a name to the iSCSI node, using the *iscsiname* parameter. The *iscsiname* parameter must appear before the *iscsi* parameter in the kickstart file.

We recommend that wherever possible you configure iSCSI storage in the system BIOS or firmware (iBFT for Intel systems) rather than use the *iscsi* parameter. **Anaconda** automatically detects and uses disks configured in BIOS or firmware and no special configuration is necessary in the kickstart file.

If you must use the *iscsi* parameter, ensure that networking is activated at the beginning of the installation, and that the *iscsi* parameter appears in the kickstart file before you refer to iSCSI disks with parameters such as *clearpart* or *ignoredisk*.

- **--port=** (mandatory) — the port number (typically, **--port=3260**)
- **--user=** — the username required to authenticate with the target
- **--password=** — the password that corresponds with the username specified for the target

- **--reverse-user=** — the username required to authenticate with the initiator from a target that uses reverse CHAP authentication
- **--reverse-password=** — the password that corresponds with the username specified for the initiator

iscsiname (optional)

Assigns a name to an iSCSI node specified by the `iscsi` parameter. If you use the `iscsi` parameter in your kickstart file, this parameter is mandatory, and you must specify `iscsiname` in the kickstart file before you specify `iscsi`.

key (optional)

Specify an installation key, which is needed to aid in package selection and identify your system for support purposes. This command is specific to Red Hat Enterprise Linux.

- **--skip** — Skip entering a key. Usually if the key command is not given, `anaconda` will pause at this step to prompt for a key. This option allows automated installation to continue if you do not have a key or do not want to provide one.

keyboard (required)

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

```
be-latin1, bg, br-abnt2, cf, cz-lat2, cz-us-qwertz, de, de-latin1,
de-latin1-noddeadkeys, 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-qwerty, 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 and the default language to use on the installed system. For example, to set the language to English, the kickstart file should contain the following line:

```
lang en_US
```

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

Certain languages (mainly Chinese, Japanese, Korean, and Indic languages) are not supported during text mode installation. If one of these languages is specified using the `lang` command, installation will continue in English though the running system will have the specified language by default.

langsupport (deprecated)

The `langsupport` keyword is deprecated and its use will cause an error message to be printed to the screen and installation to halt. Instead of using the `langsupport` keyword, you should now list the support package groups for all languages you want supported in the `%packages` section of

your kickstart file. For instance, adding support for French means you should add the following to `%packages`:

```
@french-support
```

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.
- **--fstype=** — Sets the file system type for the logical volume. Valid values are **xfs**, **ext2**, **ext3**, **ext4**, **swap**, **vfat**, and **hfs**.
- **--fsoptions=** — Specifies a free form string of options to be used when mounting the filesystem. This string will be copied into the `/etc/fstab` file of the installed system and should be enclosed in quotes.
- **--bytes-per-inode=** — Specifies the size of inodes on the filesystem to be made on the logical volume. Not all filesystems support this option, so it is silently ignored for those cases.
- **--grow=** — Tells the logical volume to grow to fill available space (if any), or up to the maximum size setting.
- **--maxsize=** — The maximum size in megabytes when the logical volume is set to grow. Specify an integer value here, and do not append the number with MB.
- **--recommended=** — Determine the size of the logical volume automatically.
- **--percent=** — Specify the size of the logical volume as a percentage of available space in the volume group.
- **--encrypted** — Specifies that this logical volume should be encrypted.
- **--passphrase=** — Specifies the passphrase to use when encrypting this logical volume. Without the above **--encrypted** option, this option does nothing. If no passphrase is specified, the default system-wide one is used, or the installer will stop and prompt if there is no default.
- **--escrowcert=URL_of_X.509_certificate** — Store data encryption keys of all encrypted volumes as files in `/` (root), encrypted using the X.509 certificate from the URL specified with `URL_of_X.509_certificate`. The keys are stored as a separate file for each encrypted volume. This option is only meaningful if **--encrypted** is specified.
- **--backuppassphrase=** — Add a randomly-generated passphrase to each encrypted volume. Store these passphrases in separate files in `/` (root), encrypted using the X.509 certificate specified with **--escrowcert**. This option is only meaningful if **--escrowcert** is specified.

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
```

logging (optional)

This command controls the error logging of anaconda during installation. It has no effect on the installed system.

- **--host=** — Send logging information to the given remote host, which must be running a syslogd process configured to accept remote logging.
- **--port=** — If the remote syslogd process uses a port other than the default, it may be specified with this option.
- **--level=** — One of debug, info, warning, error, or critical.

Specify the minimum level of messages that appear on tty3. All messages will still be sent to the log file regardless of this level, however.

mediacheck (optional)

If given, this will force anaconda to run mediacheck on the installation media. This command requires that installs be attended, so it is disabled by default.

monitor (optional)

If the monitor command is not given, anaconda will use X to automatically detect your monitor settings. Please try this before manually configuring your monitor.

- **--hsync=** — Specifies the horizontal sync frequency of the monitor.
- **--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.
- **--noprobe=** — Do not try to probe the monitor.
- **--vsync=** — Specifies the vertical sync frequency of the monitor.

mouse (deprecated)

The mouse keyword is deprecated.

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 defaults 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 is 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.

Note that although the presentation of this example on this page has broken the line, in a real kickstart file, you must include all this information on a single line with no break.

```
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 also configure multiple nameservers here. To do so, specify them as a comma-delimited list in the command line.

Note that although the presentation of this example on this page has broken the line, in a real kickstart file, you must include all this information on a single line with no break.

```
network --bootproto=static --ip=10.0.2.15 --netmask=255.255.255.0
--gateway=10.0.2.254 --nameserver 192.168.2.1,192.168.3.1
```

- **--device=** — Used to select a specific Ethernet device for installation. Note that using **--device=** is not effective unless the kickstart file is a local file (such as **ks=hd**), since the installation program configures 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.
- **--ethtool=** — Specifies additional low-level settings for the network device which will be passed to the ethtool program.
- **--essid=** — The network ID for wireless networks.
- **--wepkey=** — The encryption key for wireless networks.
- **--onboot=** — Whether or not to enable the device at boot time.
- **--dhcpclass=** — The DHCP class.
- **--mtu=** — The MTU of the device.
- **--noipv4** — Disable IPv4 on this device.
- **--noipv6** — Disable IPv6 on this device.

multipath (optional)

`multipath --name= --device= --rule=`

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 are formatted as part of the installation process unless **--noformat** and **--onpart** are used.



Important

If you select text mode for a kickstart installation, make sure that you specify choices for the partitioning, bootloader, and package selection options. These steps are automated in text mode, and **anaconda** cannot prompt you for missing information. If you do not provide choices for these options, **anaconda** will stop the installation process.

For a detailed example of **part** in action, refer to [Section 32.4.1, “Advanced Partitioning Example”](#).

- `<mntpoint>` — The `<mntpoint>` is where the partition is mounted and must be of one of the following forms:

- `/<path>`

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

- `swap`

The partition is used as swap space.

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

```
swap --recommended
```

The recommended maximum swap size for machines with less than 2GB of RAM is twice the amount of RAM. For machines with 2GB or more, this recommendation changes to 2GB plus the amount of RAM.

- **raid.<id>**

The partition is used for software RAID (refer to **raid**).

- **pv.<id>**

The partition is 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.



Note

If you use **--grow=** without setting **--maxsize=** on a swap partition, **Anaconda** will limit the maximum size of the swap partition. For systems that have less than 2GB of physical memory, the imposed limit is twice the amount of physical memory. For systems with more than 2GB, the imposed limit is the size of physical memory plus 2GB.

- **--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
```

puts **/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** puts the partition on the second SCSI disk on the system.
- **--asprimary** — Forces automatic allocation of the partition as a primary partition, or the partitioning fails.
- **--type=** (replaced by **fstype**) — This option is no longer available. Use **fstype**.
- **--fstype=** — Sets the file system type for the partition. Valid values are **xfs**, **ext2**, **ext3**, **ext4**, **swap**, **vfat**, and **hfs**.

- **--bytes-per-inode=** — Specifies the size of inodes on the filesystem to be made on the partition. Not all filesystems support this option, so it is silently ignored for those cases.
- **--recommended** — Determine the size of the partition automatically.
- **--onbiosdisk** — Forces the partition to be created on a particular disk as discovered by the BIOS.
- **--fsoptions** — Specifies a free form string of options to be used when mounting the filesystem. This string will be copied into the `/etc/fstab` file of the installed system and should be enclosed in quotes.
- **--encrypted** — Specifies that this partition should be encrypted.
- **--passphrase=** — Specifies the passphrase to use when encrypting this partition. Without the above **--encrypted** option, this option does nothing. If no passphrase is specified, the default system-wide one is used, or the installer will stop and prompt if there is no default.
- **--escrowcert=URL_of_X.509_certificate** — Store data encryption keys of all encrypted partitions as files in `/` (root), encrypted using the X.509 certificate from the URL specified with `URL_of_X.509_certificate`. The keys are stored as a separate file for each encrypted partition. This option is only meaningful if **--encrypted** is specified.
- **--backupperphrase=** — Add a randomly-generated passphrase to each encrypted partition. Store these passphrases in separate files in `/` (root), encrypted using the X.509 certificate specified with **--escrowcert**. This option is only meaningful if **--escrowcert** is specified.



Note

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

poweroff (optional)

Shut down and power off the system after the installation has successfully completed. Normally during a manual installation, anaconda displays a message and waits for the user to press a key before rebooting. During a kickstart installation, if no completion method is specified, the **halt** option is used as default.

The **poweroff** option is roughly equivalent to the **shutdown -p** command.



Note

The **poweroff** option is highly dependent on the system hardware in use. Specifically, certain hardware components such as the BIOS, APM (advanced power management), and ACPI (advanced configuration and power interface) must be able to interact with the system kernel. Contact your manufacturer for more information on you system's APM/ACPI abilities.

For other completion methods, refer to the **halt**, **reboot**, and **shutdown** kickstart options.

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 `md15`, and each may only be used once.
- **--bytes-per-inode=** — Specifies the size of inodes on the filesystem to be made on the RAID device. Not all filesystems support this option, so it is silently ignored for those cases.
- **--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 **xfs**, **ext2**, **ext3**, **ext4**, **swap**, **vfat**, and **hfs**.
- **--fsoptions=** — Specifies a free form string of options to be used when mounting the filesystem. This string will be copied into the `/etc/fstab` file of the installed system and should be enclosed in quotes.
- **--noformat** — Use an existing RAID device and do not format the RAID array.
- **--useexisting** — Use an existing RAID device and reformat it.
- **--encrypted** — Specifies that this RAID device should be encrypted.
- **--passphrase=** — Specifies the passphrase to use when encrypting this RAID device. Without the above **--encrypted** option, this option does nothing. If no passphrase is specified, the default system-wide one is used, or the installer will stop and prompt if there is no default.
- **--escrowcert=URL_of_X.509_certificate** — Store the data encryption key for this device in a file in `/` (root), encrypted using the X.509 certificate from the URL specified with `URL_of_X.509_certificate`. This option is only meaningful if **--encrypted** is specified.
- **--backuppassphrase=** — Add a randomly-generated passphrase to this device. Store the passphrase in a file in `/` (root), encrypted using the X.509 certificate specified with **--escrowcert**. This option is only meaningful if **--escrowcert** is specified.

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=sd
```

```
part swap --size=128 --ondisk=sda
part swap --size=128 --ondisk=sdb
part swap --size=128 --ondisk=sd
```

```
part raid.11 --size=1 --grow --ondisk=sda
part raid.12 --size=1 --grow --ondisk=sdb
part raid.13 --size=1 --grow --ondisk=sd
```

```
raid / --level=1 --device=md0 raid.01 raid.02 raid.03
raid /usr --level=5 --device=md1 raid.11 raid.12 raid.13
```

For a detailed example of **raid** in action, refer to [Section 32.4.1, “Advanced Partitioning Example”](#).

reboot (optional)

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

The **reboot** option is roughly equivalent to the **shutdown -r** command.

Specify **reboot** to automate installation fully when installing in cmdline mode on System z.

For other completion methods, refer to the **halt**, **poweroff**, and **shutdown** kickstart options.

The **halt** option is the default completion method if no other methods are explicitly specified in the kickstart file.



Note

Use of the **reboot** option *may* result in an endless installation loop, depending on the installation media and method.

repo (optional)

Configures additional yum repositories that may be used as sources for package installation. Multiple repo lines may be specified.

```
repo --name=<repid> [--baseurl=<url>| --mirrorlist=<url>]
```

- **--name=** — The repo id. This option is required.
- **--baseurl=** — The URL for the repository. The variables that may be used in yum repo config files are not supported here. You may use one of either this option or **--mirrorlist**, not both.
- **--mirrorlist=** — The URL pointing at a list of mirrors for the repository. The variables that may be used in yum repo config files are not supported here. You may use one of either this option or **--baseurl**, not both.

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.

selinux (optional)

Sets the state of SELinux on the installed system. SELinux defaults to enforcing in anaconda.

```
selinux [--disabled|--enforcing|--permissive]
```

- **--enforcing** — Enables SELinux with the default targeted policy being enforced.



Note

If the **selinux** option is not present in the kickstart file, SELinux is enabled and set to **--enforcing** by default.

- **--permissive** — Outputs warnings based on the SELinux policy, but does not actually enforce the policy.
- **--disabled** — Disables SELinux completely on the system.

For more information regarding SELinux for Red Hat Enterprise Linux, refer to the *Red Hat Enterprise Linux 6 Deployment Guide*.

services (optional)

Modifies the default set of services that will run under the default runlevel. The services listed in the disabled list will be disabled before the services listed in the enabled list are enabled.

- **--disabled** — Disable the services given in the comma separated list.
- **--enabled** — Enable the services given in the comma separated list.



Do not include spaces in the list of services

If you include spaces in the comma-separated list, kickstart will enable or disable only the services up to the first space. For example:

```
services --disabled auditd, cups, smartd, nfslock
```

will disable only the **auditd** service. To disable all four services, this entry should include no spaces between services:

```
services --disabled auditd,cups,smartd,nfslock
```

shutdown (optional)

Shut down the system after the installation has successfully completed. During a kickstart installation, if no completion method is specified, the **halt** option is used as default.

The **shutdown** option is roughly equivalent to the **shutdown** command.

For other completion methods, refer to the **halt**, **poweroff**, and **reboot** kickstart options.

skipx (optional)

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

sshpw (optional)

The installer can start **ssh** to provide interactivity and inspection, just like it can with **telnet**. This command controls the accounts created in the installation environment that may be remotely

logged into. Each instance of this command creates a user. These users will not be created on the final system — they only exist for use while the installer is running.

```
sshpw --username=<name> <password> [--iscrypted|--plaintext] [--lock]
```

- **--username** — Provides the name of the user. This option is required.
- **--iscrypted** — If this is present, the password argument is assumed to already be encrypted. **--plaintext** has the opposite effect — the password argument is assumed to not be encrypted.
- **--lock** — If this is present, the new user account is locked by default. That is, the user will not be able to login from the console.

text (optional)

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



Important

If you select text mode for a kickstart installation, make sure that you specify choices for the partitioning, bootloader, and package selection options. These steps are automated in text mode, and **anaconda** cannot prompt you for missing information. If you do not provide choices for these options, **anaconda** will stop the installation process.

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.

user (optional)

Creates a new user on the system.

```
user --name=<username> [--groups=<list>] [--homedir=<homedir>] [--password=<password>] [--iscrypted] [--shell=<shell>] [--uid=<uid>]
```

- **--name=** — Provides the name of the user. This option is required.
- **--groups=** — In addition to the default group, a comma separated list of group names the user should belong to. The groups must exist before the user account is created.
- **--homedir=** — The home directory for the user. If not provided, this defaults to `/home/<username>`.

- **--password=** — The new user's password. If not provided, the account will be locked by default.
- **--iscrypted=** — Is the password provided by **--password** already encrypted or not?
- **--shell=** — The user's login shell. If not provided, this defaults to the system default.
- **--uid=** — The user's UID. If not provided, this defaults to the next available non-system UID.

vnc (optional)

Allows the graphical installation to be viewed remotely via VNC. This method is usually preferred over text mode, as there are some size and language limitations in text installs. With no options, this command will start a VNC server on the machine with no password and will print out the command that needs to be run to connect a remote machine.

```
vnc [--host=<hostname>] [--port=<port>] [--password=<password>]
```

- **--host=** — Instead of starting a VNC server on the install machine, connect to the VNC viewer process listening on the given hostname.
- **--port=** — Provide a port that the remote VNC viewer process is listening on. If not provided, anaconda will use the VNC default.
- **--password=** — Set a password which must be provided to connect to the VNC session. This is optional, but recommended.

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.
- **--pesize=** — Set the size of the physical extents.

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
```

For a detailed example of **volgroup** in action, refer to [Section 32.4.1, “Advanced Partitioning Example”](#).

xconfig (optional)

Configures the X Window System. If this option is not given, the user must 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.

- **--driver** — Specify the X driver to use for the video hardware.
- **--videoram=** — Specifies the amount of video RAM the video card has.

- **--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.
- **--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.

zerombr (optional)

If **zerombr** is specified any invalid partition tables found on disks are initialized. This destroys all of the contents of disks with invalid partition tables.

Specific to System z: If **zerombr** is specified, any DASD visible to the installer which is not already low-level formatted gets automatically low-level formatted with **dasdfmt**. The command also prevents user choice during interactive installations. If **zerombr** is not specified and there is at least one unformatted DASD visible to the installer, a non-interactive kickstart installation will exit unsuccessfully. If **zerombr** is not specified and there is at least one unformatted DASD visible to the installer, an interactive installation exits if the user does not agree to format all visible and unformatted DASDs. To circumvent this, only activate those DASDs that you will use during installation. You can always add more DASDs after installation is complete.

Note that this command was previously specified as **zerombr yes**. This form is now deprecated; you should now simply specify **zerombr** in your kickstart file instead.

zfcp (optional)

Define a Fiber channel device (IBM System z).

```
zfcp [--devnum=<devnum>] [--wwpn=<wwpn>] [--fcplun=<fcplun>]
```

%include (optional)

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.

32.4.1. Advanced Partitioning Example

The following is a single, integrated example showing the **clearpart**, **raid**, **part**, **volgroup**, and **logvol** kickstart options in action:

```
clearpart --drives=hda,hdc --initlabel
# Raid 1 IDE config
part raid.11 --size 1000 --asprimary --ondrive=hda
part raid.12 --size 1000 --asprimary --ondrive=hda
part raid.13 --size 2000 --asprimary --ondrive=hda
part raid.14 --size 8000 --ondrive=hda
part raid.15 --size 1 --grow --ondrive=hda
part raid.21 --size 1000 --asprimary --ondrive=hdc
part raid.22 --size 1000 --asprimary --ondrive=hdc
part raid.23 --size 2000 --asprimary --ondrive=hdc
part raid.24 --size 8000 --ondrive=hdc
part raid.25 --size 1 --grow --ondrive=hdc

# You can add --spares=x
raid / --fstype ext3 --device md0 --level=RAID1 raid.11 raid.21
raid /safe --fstype ext3 --device md1 --level=RAID1 raid.12 raid.22
raid swap --fstype swap --device md2 --level=RAID1 raid.13 raid.23
raid /usr --fstype ext3 --device md3 --level=RAID1 raid.14 raid.24
```

```
raid pv.01      --fstype ext3 --device md4 --level=RAID1 raid.15 raid.25

# LVM configuration so that we can resize /var and /usr/local later
volgroup sysvg pv.01
logvol /var      --vgname=sysvg  --size=8000      --name=var
logvol /var/freespace --vgname=sysvg  --size=8000      --name=freespacetouse
logvol /usr/local --vgname=sysvg  --size=1 --grow --name=usrlocal
```

This advanced example implements LVM over RAID, as well as the ability to resize various directories for future growth.

32.5. Package Selection



Warning — @Everything is not supported

You can use a kickstart file to install every available package by specifying **@Everything** or simply ***** in the **%packages** section. Red Hat does not support this type of installation.

Moreover, using a kickstart file in this way will introduce package and file conflicts onto the installed system. Packages known to cause such problems are assigned to the **@Conflicts (variant)** group, where *variant* is **Server** or **Client**. If you specify **@Everything** in a kickstart file, be sure to exclude **@Conflicts (variant)** or the installation will fail:

```
@Everything (Server)
-@Conflicts
```

Note that Red Hat does not support the use of **@Everything** in a kickstart file, even if you exclude **@Conflicts (variant)**.

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, including with globs using the asterisk. The installation program defines several groups that contain related packages. Refer to the **variant/repo/comp-*.xml** file on the Red Hat Enterprise Linux DVD 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 **comp.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:

--nobase

Do not install the @Base group. Use this option to perform a minimal installation, for example, for a single-purpose server or desktop appliance.

--resolvedeps

The **--resolvedeps** option has been deprecated. Dependencies are resolved automatically every time now.

--ignoredeps

The **--ignoredeps** option has been deprecated. Dependencies are resolved automatically every time now.

--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
```

32.6. 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 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.

32.6.1. 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-include
  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 are used.



Note

The pre-installation script section of kickstart *cannot* manage multiple install trees or source media. This information must be included for each created ks.cfg file, as the pre-installation script occurs during the second stage of the installation process.

32.7. 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 do 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.

--log /path/to/logfile

Logs the output of the post-install script. Note that the path of the log file must take into account whether or not you use the **--nochroot** option. For example, without **--nochroot**:

```
%post --log=/root/ks-post.log
```

with **--nochroot**:

```
%post --nochroot --log=/mnt/sysimage/root/ks-post.log
```

32.7.1. Examples

Register the system to a Red Hat Network Satellite and log the output:

```
%post --log=/root/ks-post.log
wget -O- http://proxy-or-sat.example.com/pub/bootstrap_script | /bin/bash
/usr/sbin/rhnreg_ks --activationkey=<activationkey>
```

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

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



Note

NFS file locking is *not* supported while in kickstart mode, therefore **-o nolock** is required when mounting an NFS mount.

32.8. 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.

32.8.1. Creating Kickstart Boot Media

Diskette-based booting is no longer supported in Red Hat Enterprise Linux. Installations must use CD-ROM or flash memory products for booting. However, the kickstart file may still reside on a diskette's top-level directory, and must be named **ks.cfg**.

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 [Section 2.3, "Making Minimal Boot Media"](#) for instructions on creating boot media; however, before making the **file.iso** image file, copy the **ks.cfg** kickstart file to the **isolinux/** directory.

To perform a pen-based flash memory kickstart installation, the kickstart file must be named **ks.cfg** and must be located in the flash memory's top-level directory. Create the boot image first, and then copy the **ks.cfg** file.

Refer to [Section 2.3, "Making Minimal Boot Media"](#) for instructions on creating live USB media using the **boot.iso** image file that you can download from the Software & Download Center of the Red Hat customer portal.



Note

Creation of USB flashdrives for booting is possible, but is heavily dependent on system hardware BIOS settings. Refer to your hardware manufacturer to see if your system supports booting to alternate devices.

32.8.2. 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 provides 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 attempts an NFS mount of the file's path, and copies 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 file name 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 file name the client searches for is:

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

The `<ip-addr>` section of the file name should be replaced with the client's IP address in dotted decimal notation. For example, the file name 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 attempts to use the server that answered the BOOTP/DHCP request as its NFS server. If you do not specify a path or file name, the client system tries to mount `/kickstart` from the BOOTP/DHCP server and tries to find the kickstart file using the same `<ip-addr>-kickstart` file name as described above.

32.9. Making the Installation Tree Available

The kickstart installation must access an *installation tree*. An installation tree is a copy of the binary Red Hat Enterprise Linux DVD with the same directory structure.

If you are performing a DVD-based installation, insert the Red Hat Enterprise Linux installation DVD 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 DVD 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 or ISO image available over the network. Refer to [Section 4.1, "Preparing for a Network Installation"](#) for details.

32.10. Starting a Kickstart Installation



Important — Kickstart installations and Firstboot

Firstboot does not run after a system is installed from a Kickstart file unless a desktop and the X Window System were included in the installation and graphical login was enabled. Either specify a user with the **user** option in the Kickstart file before installing additional systems from it (refer to [Section 32.4, "Kickstart Options"](#) for details) or log into the installed system with a virtual console as root and add users with the **adduser** command.

To begin a kickstart installation, you must boot the system from boot media you have made or the Red Hat Enterprise Linux DVD, 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.

DVD and local storage

The **linux ks=** command also works if the **ks.cfg** file is located on a vfat or ext2 file system on local storage and you boot from the Red Hat Enterprise Linux DVD.

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=hd:partition:/path/ks.cfg dd
```

Boot CD-ROM

If the kickstart file is on a boot CD-ROM as described in [Section 32.8.1, "Creating Kickstart Boot Media"](#), 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:

askmethod

Do not automatically use the DVD as the install source if we detect a Red Hat Enterprise Linux DVD in your DVD drive.

autostep

Make kickstart non-interactive.

debug

Start up pdb immediately.

dd

Use a driver disk.

dhcpclass=<class>

Sends a custom DHCP vendor class identifier. ISC's dhcpd can inspect this value using "option vendor-class-identifier".

dns=<dns>

Comma separated list of nameservers to use for a network installation.

driverdisk

Same as 'dd'.

expert

Turns on special features:

- allows partitioning of removable media
- prompts for a driver disk

gateway=<gw>

Gateway to use for a network installation.

graphical

Force graphical install. Required to have ftp/http use GUI.

isa

Prompt user for ISA devices configuration.

ip=<ip>

IP to use for a network installation, use 'dhcp' for DHCP.

keymap=<keymap>

Keyboard layout to use. Valid values are those which can be used for the 'keyboard' kickstart command.

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

The installation program looks for the kickstart file on the NFS server <server>, as file <path>. The installation program uses 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 looks for the kickstart file on the HTTP server <server>, as file <path>. The installation program uses 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=hd:<device>:/<file>

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

ks=bd:<biosdev>:/<path>

The installation program mounts the file system on the specified partition on the specified BIOS device <biosdev>, and looks for the kickstart configuration file specified in <path> (for example, **ks=bd:80p3:/mydir/ks.cfg**). Note this does not work for BIOS RAID sets.

ks=file:/<file>

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

ks=cdrom:/<path>

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

ks

If **ks** is used alone, the installation program configures 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 boot file begins with a /, the boot file provided by DHCP is looked for on the NFS server.
- If DHCP is specified and the boot file begins with something other than a /, the boot file provided by DHCP is looked for in the /**kickstart** directory on the NFS server.
- If DHCP did not specify a boot file, 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 uses this network device to connect to the network. For example, consider a system connected to an NFS server through the eth1 device. To perform a kickstart installation on this system using a kickstart file from the NFS server, you would use the command **ks=nfs:<server>:/<path> ksdevice=eth1** at the boot : prompt.

kssendmac

Adds HTTP headers to ks=http:// request that can be helpful for provisioning systems. Includes MAC address of all nics in CGI environment variables of the form: "X-RHN-Provisioning-MAC-0: eth0 01:23:45:67:89:ab".

lang=<lang>

Language to use for the installation. This should be a language which is valid to be used with the 'lang' kickstart command.

loglevel=<level>

Set the minimum level required for messages to be logged. Values for <level> are debug, info, warning, error, and critical. The default value is info.

mediacheck

Activates loader code to give user option of testing integrity of install source (if an ISO-based method).

netmask=<nm>

Netmask to use for a network installation.

nofallback

If GUI fails exit.

nofb

Do not load the VGA16 framebuffer required for doing text-mode installation in some languages.

nofirewire

Do not load support for firewire devices.

noipv6

Disable IPv6 networking during installation.

**This option is not available during PXE installations**

During installations from a PXE server, IPv6 networking might become active before **anaconda** processes the Kickstart file. If so, this option will have no effect during installation.

nomount

Don't automatically mount any installed Linux partitions in rescue mode.

nonet

Do not auto-probe network devices.

noparport

Do not attempt to load support for parallel ports.

nopass

Don't pass keyboard/mouse info to stage 2 installer, good for testing keyboard and mouse config screens in stage2 installer during network installs.

nopcmcia

Ignore PCMCIA controller in system.

noprobe

Do not attempt to detect hw, prompts user instead.

noshell

Do not put a shell on tty2 during install.

nousb

Do not load USB support (helps if install hangs early sometimes).

nousbstorage

Do not load usbstorage module in loader. May help with device ordering on SCSI systems.

repo=cdrom

Do a DVD based installation.

repo=ftp://<path>

Use <path> for an FTP installation.

repo=hd:<dev>:<path>

Use <path> on <dev> for a hard drive installation.

repo=http://<path>

Use <path> for an HTTP installation.

repo=nfs:<path>

Use <path> for an NFS installation.

rescue

Run rescue environment.

resolution=<mode>

Run installer in mode specified, '1024x768' for example.

serial

Turns on serial console support.

skipddc

Skips DDC probe of monitor, may help if it's hanging system.

syslog=<host>[:<port>]

Once installation is up and running, send log messages to the syslog process on <host>, and optionally, on port <port>. Requires the remote syslog process to accept connections (the -r option).

text

Force text mode install.

**Important**

If you select text mode for a kickstart installation, make sure that you specify choices for the partitioning, bootloader, and package selection options. These steps are automated in text mode, and **anaconda** cannot prompt you for missing information. If you do not provide choices for these options, **anaconda** will stop the installation process.

updates

Prompt for storage device containing updates (bug fixes).

updates=ftp://<path>

Image containing updates over FTP.

updates=http://<path>

Image containing updates over HTTP.

upgradeany

Don't require an /etc/redhat-release that matches the expected syntax to upgrade.

vnc

Enable vnc-based installation. You will need to connect to the machine using a vnc client application.

vncconnect=<host>[:<port>]

Once installation is up and running, connect to the vnc client named <host>, and optionally use port <port>.

Requires 'vnc' option to be specified as well.

vncpassword=<password>

Enable a password for the vnc connection. This will prevent someone from inadvertently connecting to the vnc-based installation.

Requires 'vnc' option to be specified as well.

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 and **Kickstart Configurator** must be installed on your system. To start **Kickstart Configurator**, select **Applications** (the main menu on the panel) => **System Tools** => **Kickstart**, or type the command `/usr/sbin/system-config-kickstart`. If **Kickstart Configurator** does not appear on the menu or you cannot start it from the command line, run `su - yum install system-config-kickstart` to make sure that the package is installed, or search for the package in your graphical package manager.

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.

33.1. Basic Configuration

Figure 33.1. Basic Configuration

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

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

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 is 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.

Click **Specify installation key** to provide the key for this installation of Red Hat Enterprise Linux.

Choosing **Target Architecture** specifies which specific hardware architecture distribution is used during installation.

Choosing **Target Architecture** specifies which specific hardware architecture distribution is used during installation.

Choosing **Reboot system after installation** reboots 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.

33.2. Installation Method

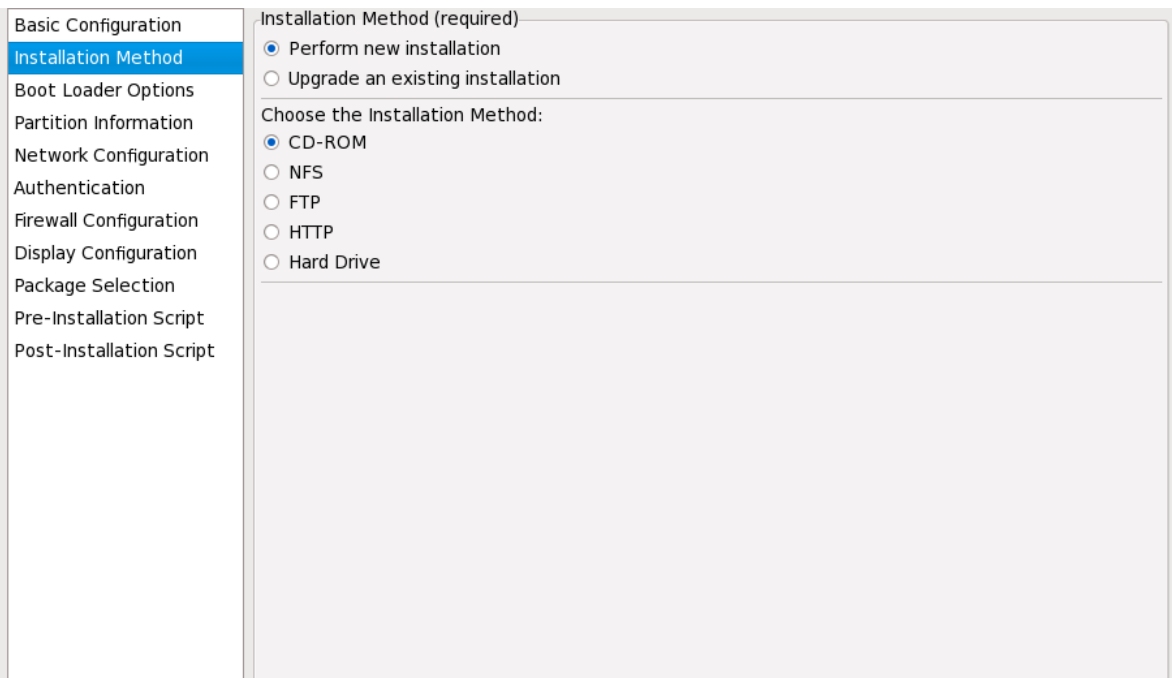


Figure 33.2. Installation Method

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 are disabled. They are not supported for kickstart upgrades.

Choose the type of kickstart installation or upgrade from the following options:

- **DVD** — Choose this option to install or upgrade from the Red Hat Enterprise Linux DVD.
- **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 **variant** directory of the installation tree. For example, if the NFS server contains the directory `/mirrors/redhat/i386/Server/`, 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 **variant** directory. For example, if the FTP server contains the directory `/mirrors/redhat/i386/Server/`, enter `/mirrors/redhat/i386/Server/` 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 **variant** directory. For example, if the HTTP server contains the directory `/mirrors/redhat/i386/Server/`, enter `/mirrors/redhat/i386/Server/` 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 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 [Section 28.6.1, “Verifying boot media”](#). 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.

33.3. Boot Loader Options

The screenshot shows the 'Boot Loader Options' configuration window. On the left, a sidebar lists various configuration steps, with 'Boot Loader Options' highlighted. The main window is titled 'Boot Loader Options (required)' and contains the following elements:

- Install new boot loader** (selected with a radio button)
- Do not install a boot loader** (radio button)
- Upgrade existing boot loader** (radio button)
- GRUB Options:**
 - Use GRUB password
 - Password:
 - Confirm Password:
 - Encrypt GRUB password
- Install boot loader on Master Boot Record (MBR)** (selected with a radio button)
- Install boot loader on first sector of the boot partition** (radio button)
- Kernel parameters:

Figure 33.3. Boot Loader Options

Please note that this screen will be disabled if you have specified a target architecture other than `x86 / x86_64`.

GRUB is the default boot loader for Red Hat Enterprise Linux on x86 / x86_64 architectures. 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 your system, such as a third-party boot loader.

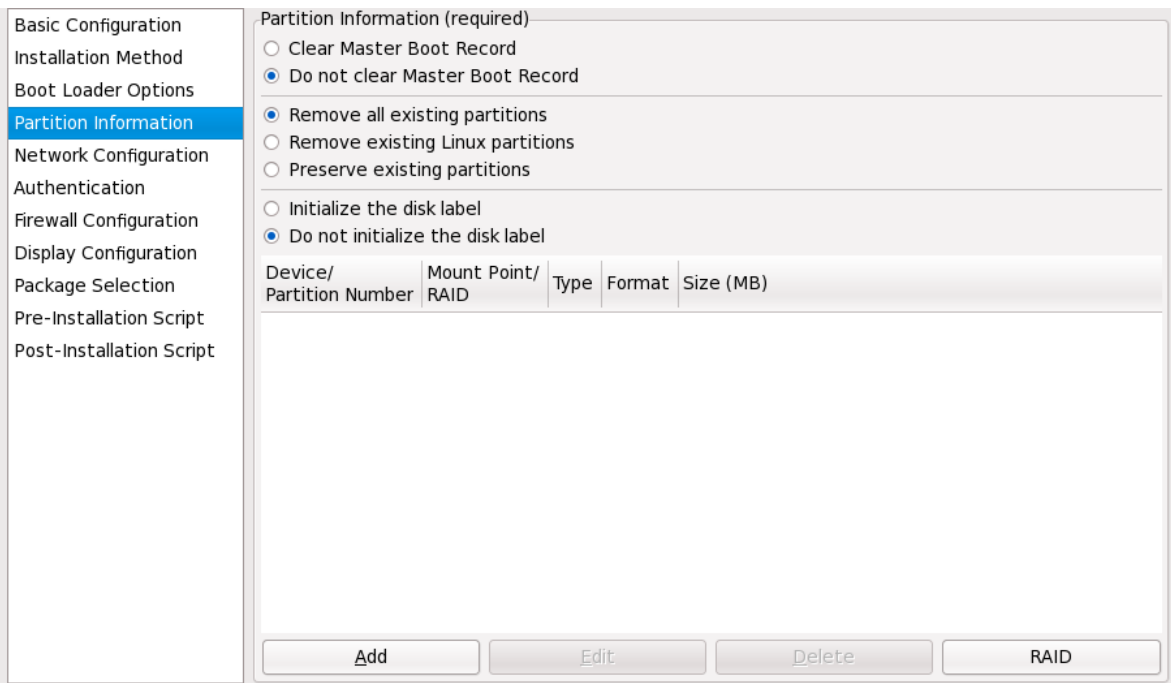
You must choose where to install the boot loader (the Master Boot Record or the first sector of the / **boot** partition). Install the boot loader on the MBR if you plan to use it as your boot loader.

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).

You can password protect the GRUB boot loader 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 is encrypted and written to the kickstart file. If the password you typed was already encrypted, unselect the encryption option.

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.

33.4. Partition Information



Basic Configuration
Installation Method
Boot Loader Options
Partition Information
Network Configuration
Authentication
Firewall Configuration
Display Configuration
Package Selection
Pre-Installation Script
Post-Installation Script

Partition Information (required)

Clear Master Boot Record
 Do not clear Master Boot Record

Remove all existing partitions
 Remove existing Linux partitions
 Preserve existing partitions

Initialize the disk label
 Do not initialize the disk label

| Device/ Partition Number | Mount Point/ RAID | Type | Format | Size (MB) |
|-----------------------------|----------------------|------|--------|-----------|
|-----------------------------|----------------------|------|--------|-----------|

Add Edit Delete RAID

Figure 33.4. 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), select **Initialize the disk label** if you are installing on a brand new hard drive.

**Note**

Although **anaconda** and **kickstart** support Logical Volume Management (LVM), at present there is no mechanism for configuring this using the **Kickstart Configurator**.

33.4.1. Creating Partitions

To create a partition, click the **Add** button. The **Partition Options** window shown in [Figure 33.5, "Creating Partitions"](#) 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.

Mount Point:

File System Type:

Size (MB):

Additional Size Options

Fixed size

Grow to maximum of (MB):

Fill all unused space on disk

Use recommended swap size

Force to be a primary partition (asprimary)

Format partition

Make partition on specific drive (ondisk)

Drive : (for example: hda or sdc)

Use existing partition (onpart)

Partition : (for example: hda1 or sdc3)

Figure 33.5. 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 33.5, “Creating Partitions”](#), 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.

33.4.1.1. Creating Software RAID Partitions

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.

Mount Point:

File System Type: software RAID

Size (MB): 2048

Additional Size Options

Fixed size

Grow to maximum of (MB): 1

Fill all unused space on disk

Use recommended swap size

Force to be a primary partition (asprimary)

Format partition

Make partition on specific drive (ondisk)

Drive : hda| (for example: hda or sdc)

Use existing partition (onpart)

Partition : (for example: hda1 or sdc3)

Figure 33.6. 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.

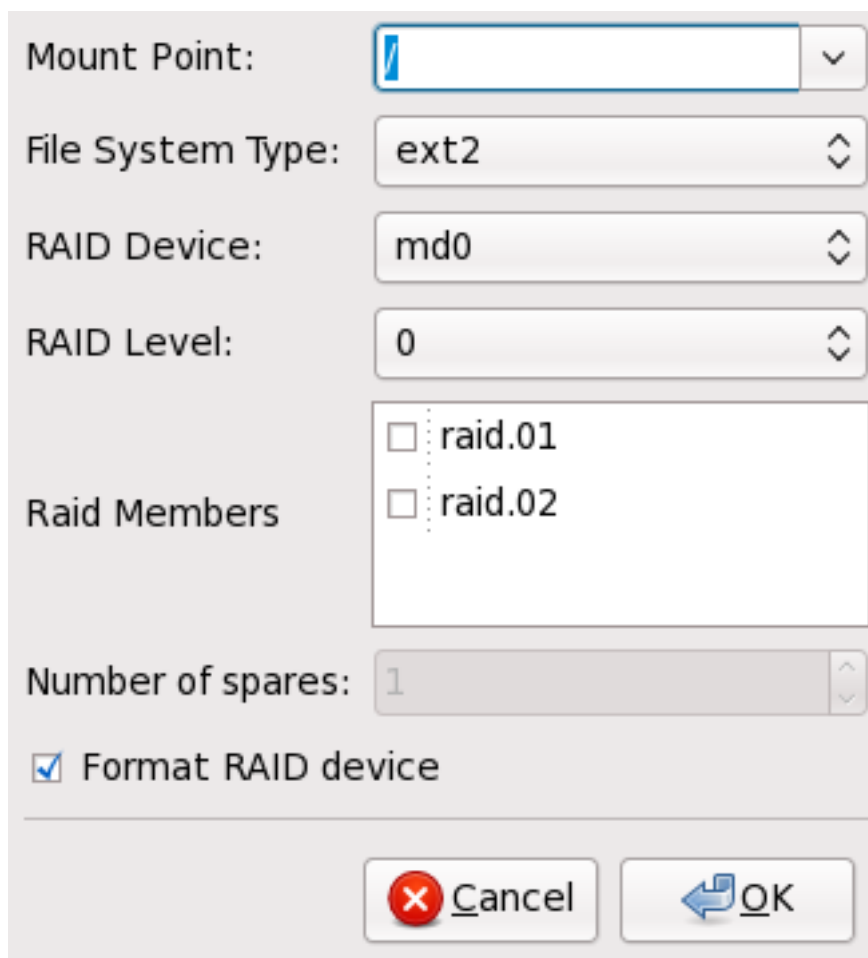


Figure 33.7. Creating a Software RAID Device

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

33.5. Network Configuration



Figure 33.8. 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 (system-config-network)**. Refer to the Red Hat Enterprise Linux Deployment Guide 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.

33.6. Authentication

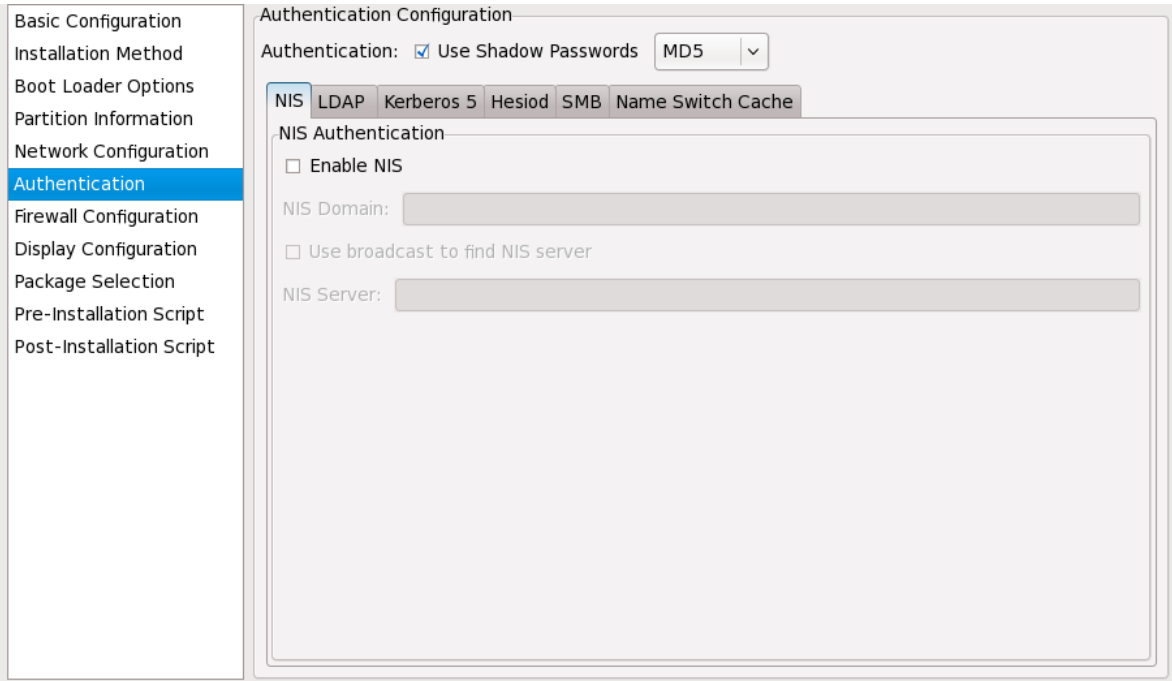


Figure 33.9. Authentication

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 the Red Hat Enterprise Linux Deployment Guide for more information about the options.

33.7. Firewall Configuration

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

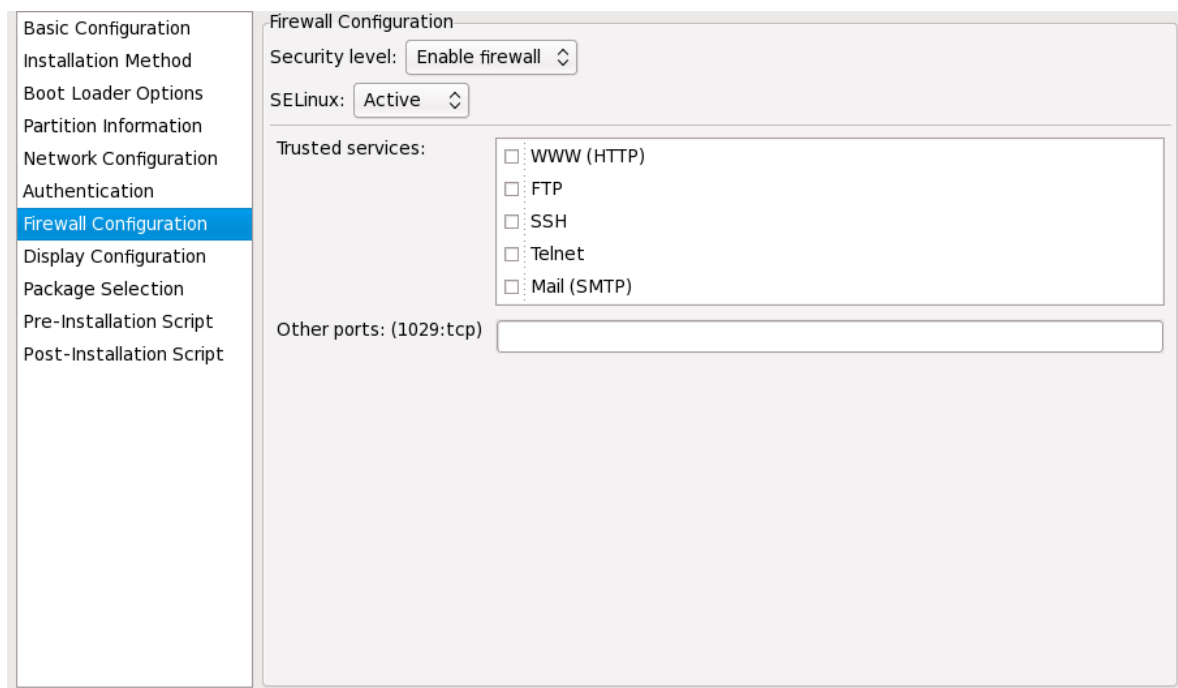


Figure 33.10. Firewall Configuration

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 required, 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**. Numeric ports can also be specified explicitly; to allow UDP packets on port 1234 through the firewall, enter **1234:udp**. To specify multiple ports, separate them with commas.

33.7.1. SELinux Configuration

Kickstart can set SELinux to **enforcing**, **permissive** or **disabled** mode. Finer grained configuration is not possible at this time.

33.8. Display 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 **Display Configuration** window as shown in [Figure 33.11, “X Configuration”](#). If this option is not chosen, the X configuration options are disabled and the **skipx** option is written to the kickstart file.



Figure 33.11. X Configuration

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.

33.9. Package Selection

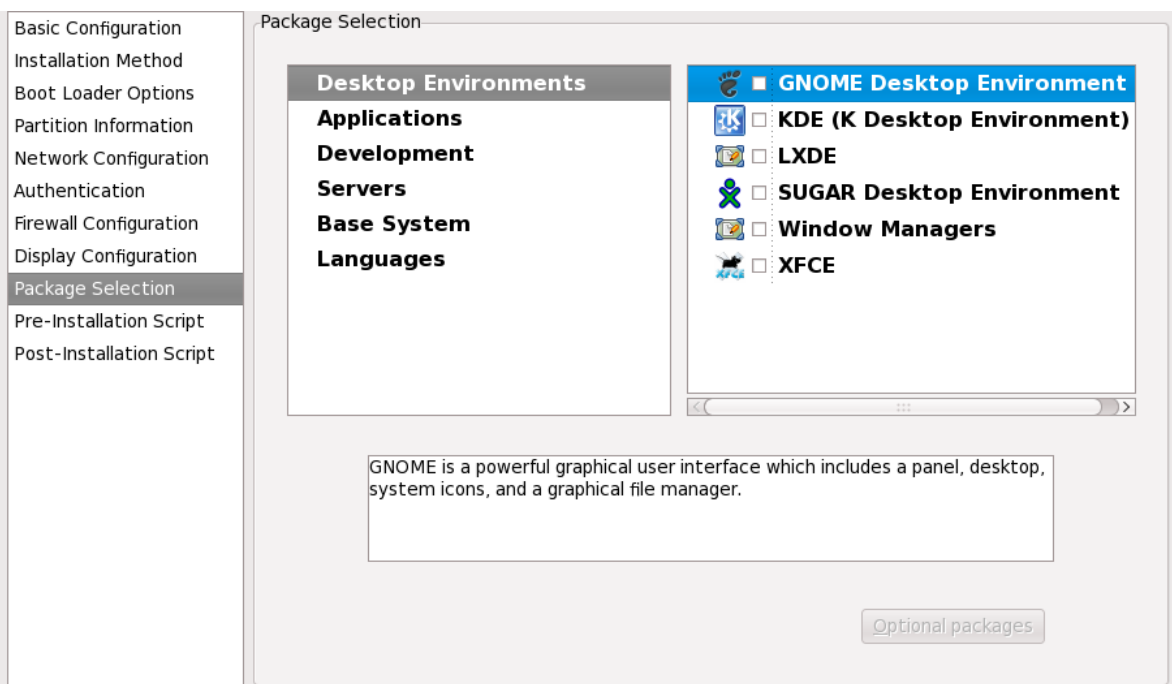


Figure 33.12. Package Selection

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

Package resolution is carried out 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 32.5, “Package Selection”](#) for details.

33.10. Pre-Installation Script

Figure 33.13. 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.



Important — anaconda no longer uses busybox

The version of **anaconda** in previous releases of Red Hat Enterprise Linux included a version of **busybox** that provided shell commands in the pre-installation and post-installation environments. The version of **anaconda** in Red Hat Enterprise Linux 6 no longer includes **busybox**, and uses GNU **bash** commands instead.

Refer to [Appendix G, Alternatives to busybox commands](#) for more information.

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/python2.6` can be specified for a Python script. This option corresponds to using `%pre --interpreter /usr/bin/python2.6` in your kickstart file.

Only the most commonly used commands are available in the pre-installation environment:

arping, **awk**, **basename**, **bash**, **bunzip2**, **bzcat**, **cat**, **chattr**, **chgrp**, **chmod**, **chown**, **chroot**, **chvt**, **clear**, **cp**, **cpio**, **cut**, **date**, **dd**, **df**, **dirname**, **dmesg**, **du**, **e2fsck**, **e2label**, **echo**,

egrep, eject, env, expr, false, fdisk, fgrep, find, fsck, fsck.ext2, fsck.ext3, ftp, grep, gunzip, gzip, hdparm, head, hostname, hwclock, ifconfig, insmod, ip, ipcalc, kill, killall, less, ln, load_policy, login, losetup, ls, lsattr, lsmod, md5sum, mkdir, mke2fs, mkfs.ext2, mkfs.ext3, mknod, mkswap, mktemp, modprobe, more, mount, mt, mv, nslookup, openvt, pidof, ping, ps, pwd, readlink, rm, rmdir, rmmmod, route, rpm, sed, sh, sha1sum, sleep, sort, swapoff, swapon, sync, tail, tar, tee, telnet, top, touch, true, tune2fs, umount, uniq, vconfig, vi, wc, wget, xargs, zcat.



Important

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



Note

The pre-installation script is run after the source media is mounted and stage 2 of the bootloader has been loaded. For this reason it is not possible to change the source media in the pre-installation script.

33.11. Post-Installation Script

Basic Configuration
Installation Method
Boot Loader Options
Partition Information
Network Configuration
Authentication
Firewall Configuration
Display Configuration
Package Selection
Pre-Installation Script
Post-Installation Script

Post-Installation Script
Warning: An error in this script might cause your kickstart installation to fail. Do not include the `%post` command at the beginning.

Run outside of the chroot environment
 Use an interpreter:

Type your `%post` script below:

Figure 33.14. 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.



Important — anaconda no longer uses busybox

The version of **anaconda** in previous releases of Red Hat Enterprise Linux included a version of **busybox** that provided shell commands in the pre-installation and post-installation environments. The version of **anaconda** in Red Hat Enterprise Linux 6 no longer includes **busybox**, and uses GNU **bash** commands instead.

Refer to [Appendix G, Alternatives to busybox commands](#) for more information.



Important

Do not include the **%post** command. It is 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
```



Note

More examples can be found in [Section 32.7.1, "Examples"](#).

33.11.1. 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 using the **--nochroot** option in the **%post** section.

To make changes to the newly installed file system, within the post-installation section, but 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 must be changed to the following:

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

33.11.2. 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.

33.12. 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.

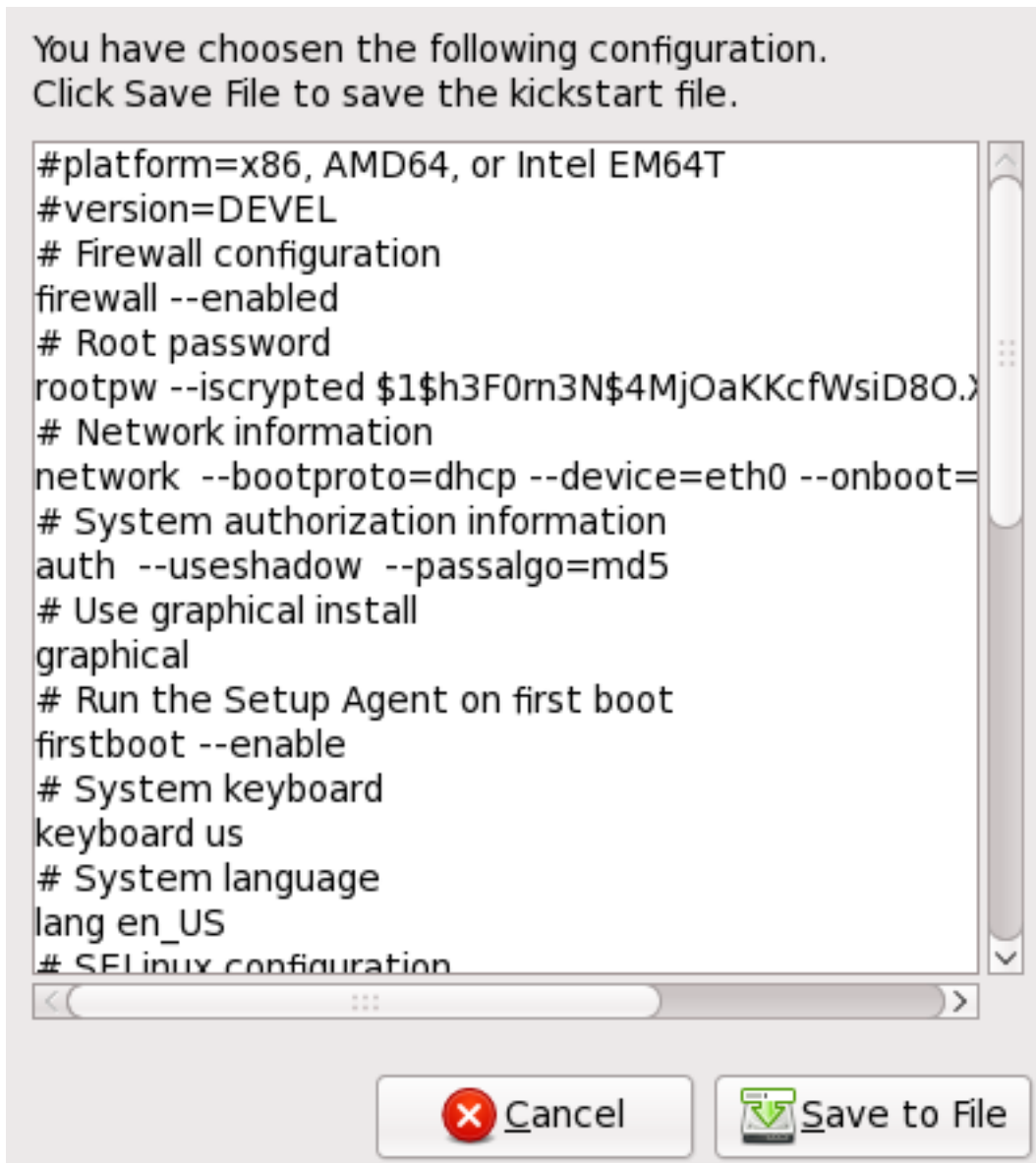


Figure 33.15. Preview

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 32.10, “Starting a Kickstart Installation”](#) for information on how to start the kickstart installation.

Part V. After installation

This part of the *Red Hat Enterprise Linux Installation Guide* covers finalizing the installation, as well as some installation-related tasks that you might perform at some time in the future. These include:

- using a Red Hat Enterprise Linux installation disk to rescue a damaged system.
 - upgrading to a new version of Red Hat Enterprise Linux.
 - removing Red Hat Enterprise Linux from your computer.
-

Firstboot



Important — Firstboot not available after text-mode installation

Firstboot is only available on systems after a graphical installation or after a kickstart installation where a desktop and the X window system were installed and graphical login was enabled. If you performed a text-mode installation or a kickstart installation that did not include a desktop and the X window system, the **Firstboot** configuration tool does not appear.

Firstboot launches the first time that you start a new Red Hat Enterprise Linux system. Use **Firstboot** to configure the system for use before you log in.

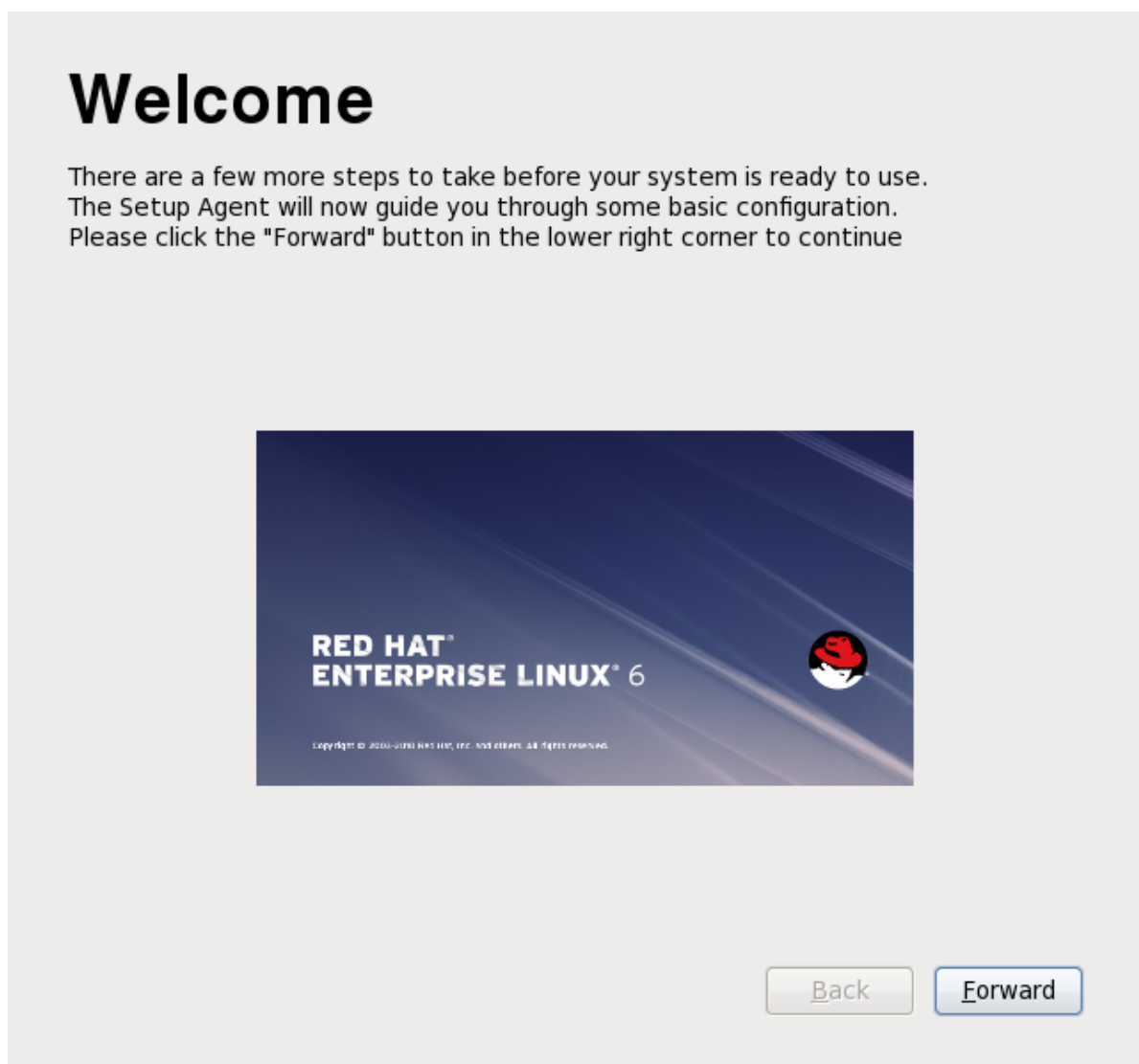


Figure 34.1. Firstboot welcome screen

Select **Forward** to start **Firstboot**.

34.1. License Agreement

This screen displays the overall licensing terms for Red Hat Enterprise Linux.

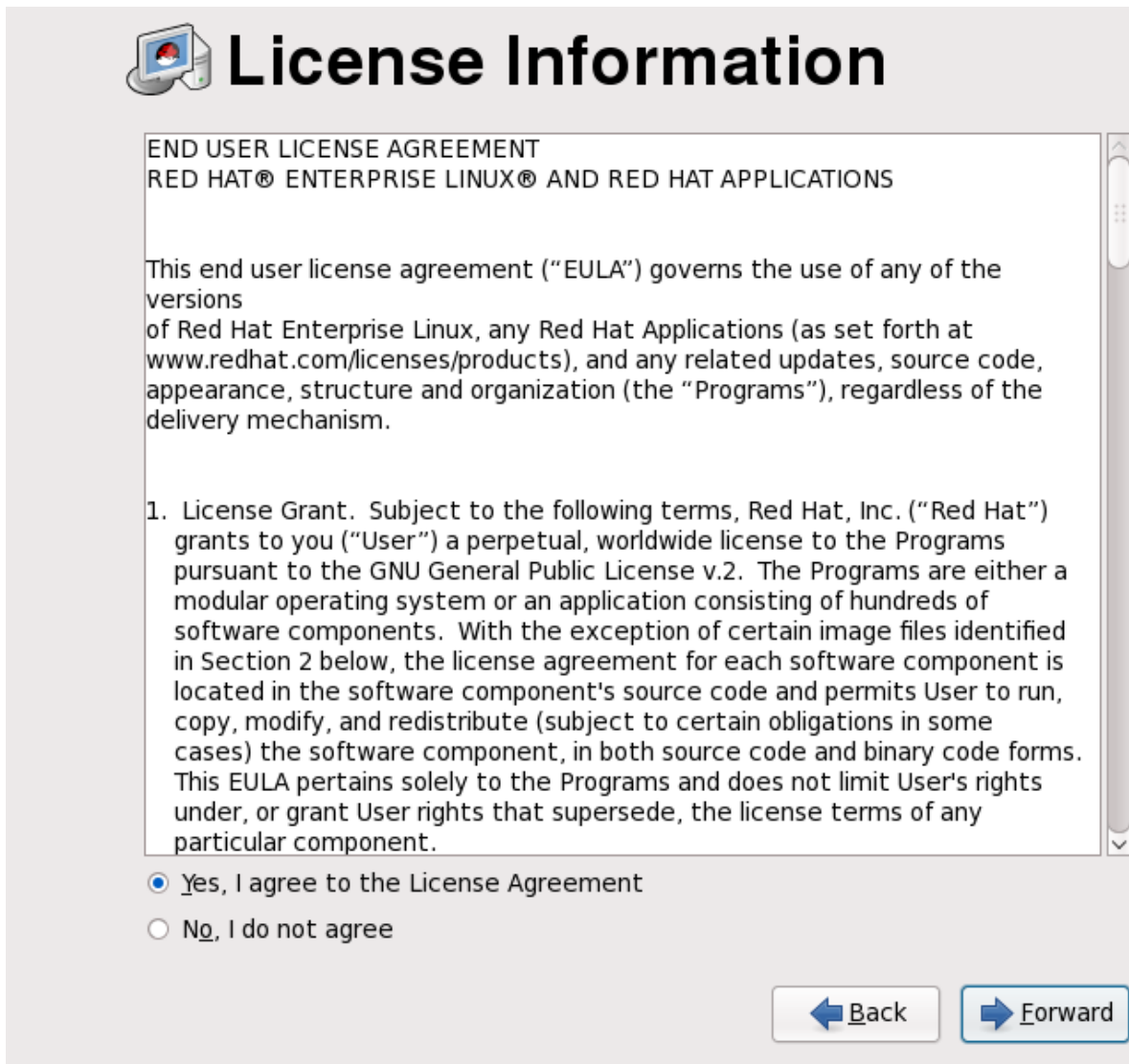


Figure 34.2. Firstboot license screen

If you agree to the terms of the licence, select **Yes, I agree to the License Agreement** and click **Forward**.

34.2. Set Up Software Updates

Use the **Set Up Software Updates** screen to register your system with the Red Hat Network (RHN) and configure the system to receive updates from RHN itself, or from a Satellite server. To register your system, select **Yes, I'd like to register now** and click **Forward**.

Set Up Software Updates

This assistant will guide you through connecting your system to Red Hat Network (RHN) for software updates, such as:

- Your Red Hat Network or Red Hat Network Satellite login
- A name for your system's Red Hat Network profile
- The address to your Red Hat Network Satellite (optional)

[Why Should I Connect to RHN? ...](#)

Would you like to register your system at this time? **(Strongly recommended.)**

- Yes, I'd like to register now.
- No, I prefer to register at a later time.

[Back](#)

[Forward](#)

Figure 34.3. Set Up Software Updates

If you choose not to register your system now, run **rhncp_register** from a terminal on the installed system.

34.2.1. Choose Server

Use the **Choose Server** screen to choose whether to receive updates directly from RHN or from a Red Hat Network Satellite or Red Hat Network Proxy. Click **Advanced Network Configuration** to configure a proxy server if necessary.

Choose Server

You may connect your system to **Red Hat Network** (<https://rhn.redhat.com/>) or to a **Red Hat Network Satellite** or **Red Hat Network Proxy** in order to receive software updates.

- I'd like to receive updates from **Red Hat Network**. (I don't have access to a Red Hat Network Satellite or Proxy.)

- I have access to a **Red Hat Network Satellite** or **Red Hat Network Proxy**. I'd like to receive software updates from the Satellite or Proxy below:

Red Hat Network Location:

 **Example:** <https://satellite.example.com>

Advanced Network Configuration ...

Back

Forward

Figure 34.4. Choose Server

34.2.2. Red Hat Login


Provide your login and password for the Red Hat Network in the **Red Hat Login** screen. If you have lost your login or password, visit <http://www.redhat.com/wapps/sso/rhn/lostPassword.html> or, if you use a Red Hat Satellite, consult the *organization administrator* for your Red Hat Satellite.

Red Hat Login

Please enter your account information for
Red Hat Network (<http://rhn.redhat.com/>)

Login:

Password:

 Tip: Forgot your login or password? Look it up at
<http://www.redhat.com/wapps/sso/rhn/lostPassword.html>


 Tip: Forgot your login or password? Contact
your Satellite's *Organization Administrator*.

Figure 34.5. Red Hat Login

34.2.3. Create Profile

Give this system a name in the **Create Profile** so that you can readily identify when you use the management features of the Red Hat Network. This stage of the registration process also submits a profile of the system hardware and a list of the packages installed on the system to the Red Hat Network. Click the **View Hardware Profile** or **View Package Profile** buttons to see the information that will be sent. Deselect the hardware profile or package profile check boxes if you do not want to send these profiles to the Red Hat Network.

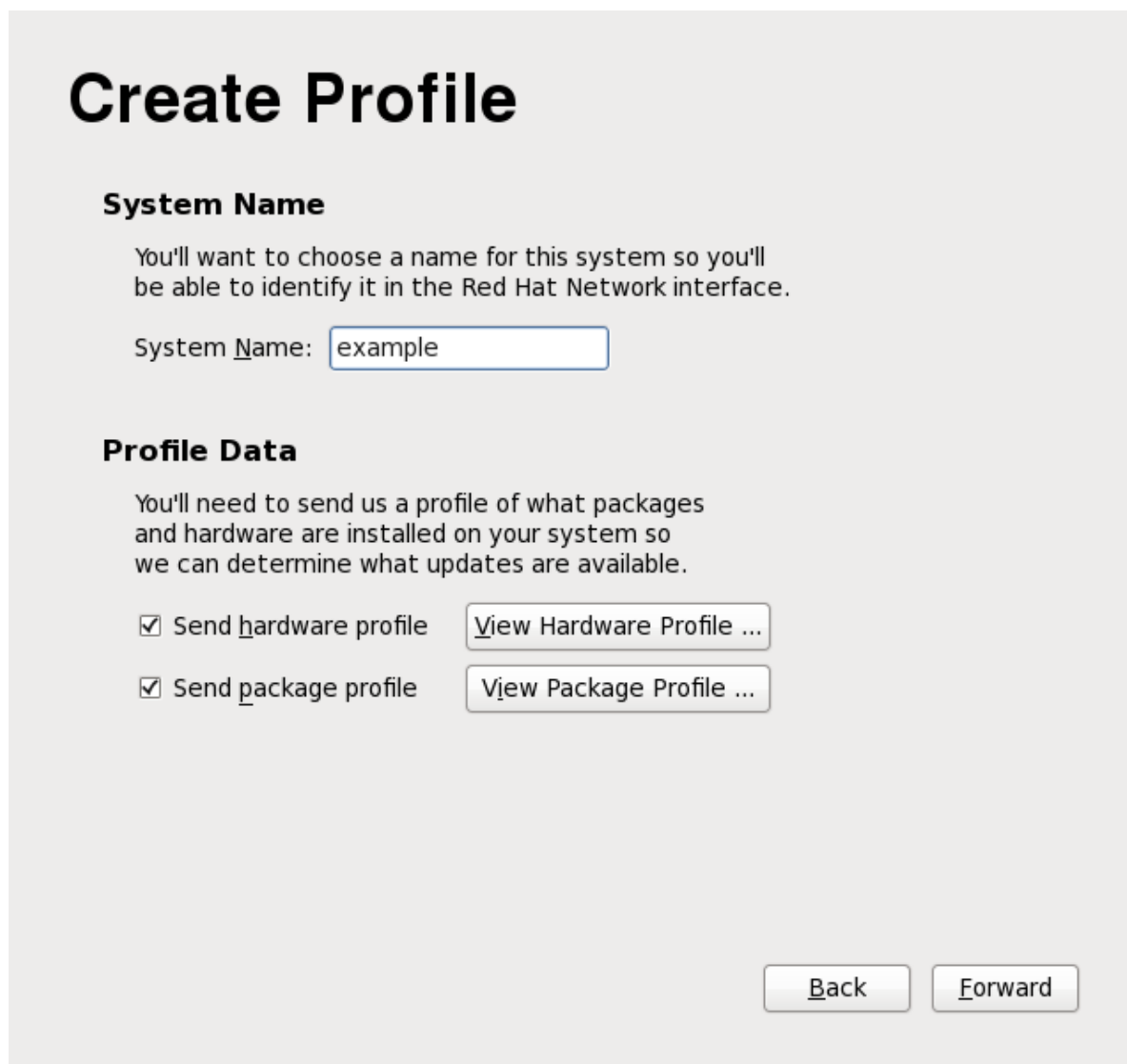


Figure 34.6. Create Profile

34.2.4. Review Subscription

The **Review Subscription** screen contains information about the software channels from which this system will receive updates and about Red Hat Network service levels. Review this information, then click **Forward**.

Review Subscription

Please review the subscription details below:

Software channel subscriptions:

This system will receive updates from the following Red Hat Network software channels:

- rhel-i386-server-6-beta

Warning: If an installed product on this system is not listed above, you will not receive updates or support for that product. If you would like to receive updates for that product, please visit <http://rhn.redhat.com/> and subscribe this system to the appropriate software channels to get updates for that product. See Kbase article 6227 for more details. (http://kbase.redhat.com/faq/FAQ_58_6227.shtm)

RHN service level:

Depending on what RHN modules are associated with a system, you'll enjoy different benefits of Red Hat Network. The following are the RHN modules associated with this system:

- Management module: automatic updates, systems grouping, systems permissions, system package profiling

Back

Forward

Figure 34.7. Review Subscription

34.2.5. Finish Updates Setup

The **Finish Updates Setup** screen confirms that you have configured updates for this system. Click **Forward** to create a user account as described in [Section 34.3, "Create User"](#).

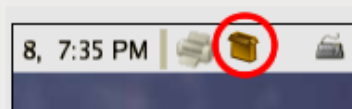
Finish Updates Setup



Software update setup has been completed for this system.

Your system is now ready to receive the software updates that will keep it secure and supported.

You'll know when software updates are available when a package icon appears in the notification area of your desktop (usually in the upper-right corner, circled below.) Clicking on this icon, when available, will guide you through applying any updates that are available:



Back

Forward

Figure 34.8. Finish Updates Setup

34.3. Create User

Create a user account for yourself with this screen. Always use this account to log in to your Red Hat Enterprise Linux system, rather than using the root account.

Create User

It is recommended that you create a 'username' for regular (non-administrative) use of your system. To create a system 'username,' please provide the information requested below.

Username:

Full Name:

Password:

Confirm Password:

If you need to use network authentication, such as Kerberos or NIS, please click the Use Network Login button.

Figure 34.9. Firstboot create user screen

Enter a user name and your full name, and then enter your chosen password. Type your password once more in the **Confirm Password** box to ensure that it is correct.

To configure Red Hat Enterprise Linux to use network services for authentication of user information, click **Use Network Login**. Refer to [Section 34.3.1, “Authentication Configuration”](#) for further details.



Important — Create at least one user account

If you do not create at least one user account in this step, you will not be able to log in to the Red Hat Enterprise Linux graphical environment. If you skipped this step during installation, refer to [Section 10.4.2, “Booting into a Graphical Environment”](#).



Note — Creating Extra User Accounts

To add additional user accounts to your system after the installation is complete, choose **System** → **Administration** → **Users & Groups**.

34.3.1. Authentication Configuration

If you clicked **Use Network Login** on the **Create User** screen, you must now specify how users are to be authenticated on the system. Use the drop-down menu to select from the following types of user database:

- **Local accounts only** (for use when the user database on the network is not accessible)
- **LDAP** (Lightweight Directory Access Protocol)
- **NIS** (Network Information Service)
- **Winbind** (for use with Microsoft Active Directory)

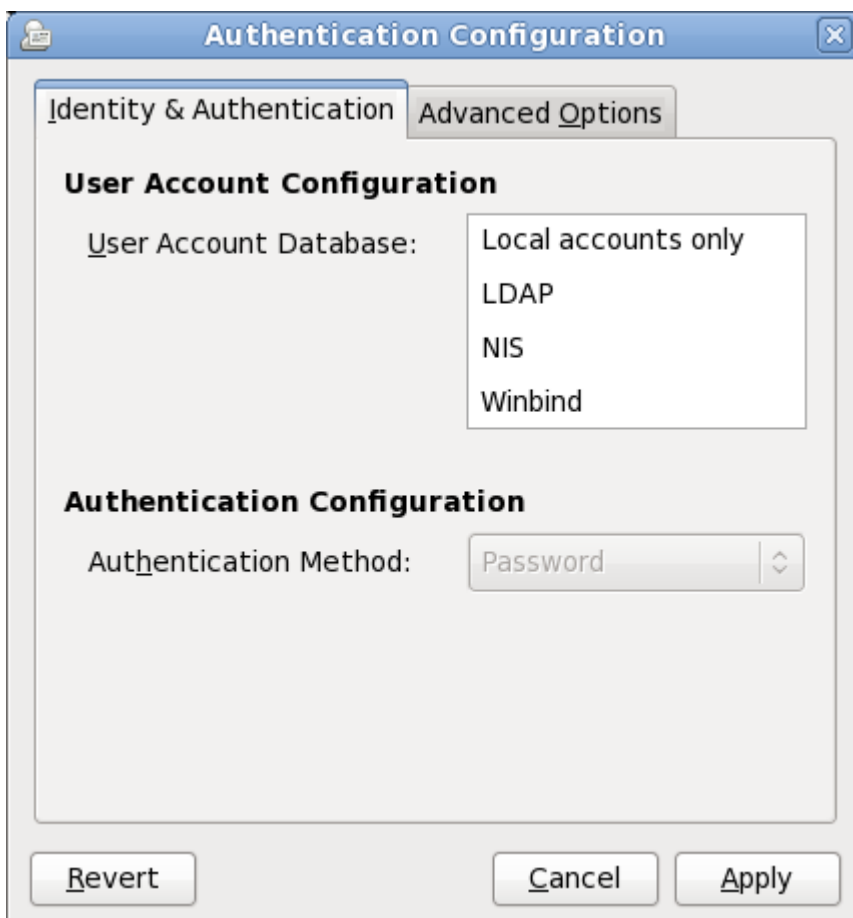


Figure 34.10. Firstboot Authentication Configuration screen

When you select the type of user database appropriate for your network, you must provide additional details relevant to that database type. For example, if you select **LDAP**, you must specify the *base distinguished name* for LDAP searches, and the address of the LDAP server. You must also select an **Authentication Method** relevant to the type of user database that you chose, for example, a Kerberos password, LDAP password, or NIS password.

The **Advanced Options** tab lets you enable other authentication mechanisms, including fingerprint readers, smart cards, and local access control in `/etc/security/access.conf`.

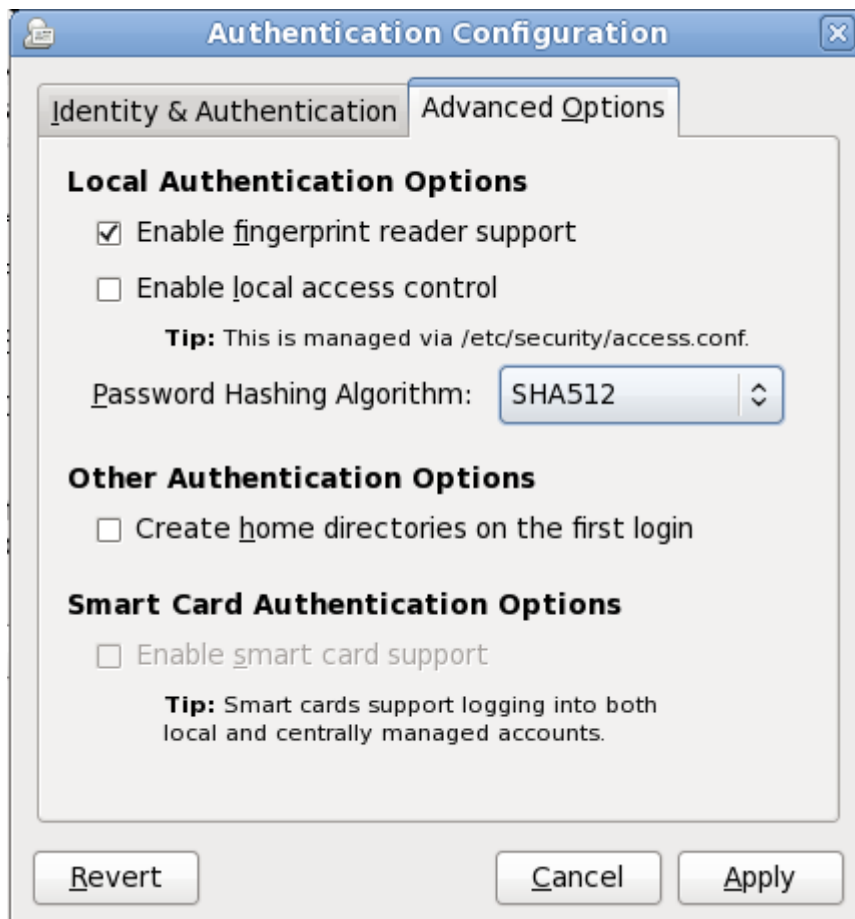


Figure 34.11. Firstboot authentication Advanced Options screen

34.4. Date and Time

Use this screen to adjust the date and time of the system clock. To change these settings after installation, click **System** → **Administration** → **Date & Time**.

Date and Time

Please set the date and time for the system.

Date and Time

Current date and time: Thu 18 Feb 2010 11:18:30 AM EST

Synchronize date and time over the network

Manually set the date and time of your system:

Date

| < February > | | | | | | | < 2010 > |
|--------------|-----|-----|-----|-----|-----|-----|----------|
| Sun | Mon | Tue | Wed | Thu | Fri | Sat | |
| 31 | 1 | 2 | 3 | 4 | 5 | 6 | |
| 7 | 8 | 9 | 10 | 11 | 12 | 13 | |
| 14 | 15 | 16 | 17 | 18 | 19 | 20 | |
| 21 | 22 | 23 | 24 | 25 | 26 | 27 | |
| 28 | 1 | 2 | 3 | 4 | 5 | 6 | |
| 7 | 8 | 9 | 10 | 11 | 12 | 13 | |

Time

Hour : ^ v

Minute : ^ v

Second : ^ v

Figure 34.12. Firstboot date and time screen

Click the **Synchronize date and time over the network** checkbox to configure your system to use *Network Time Protocol* (NTP) servers to maintain the accuracy of the clock. NTP provides time synchronization service to computers on the same network. Many public NTP servers are available on the Internet.

34.5. Kdump

Use this screen to select whether or not to use the **Kdump** kernel crash dumping mechanism on this system. Note that if you select this option, you will need to reserve memory for **Kdump** and that this memory will not be available for any other purpose.

Kdump

Kdump is a kernel crash dumping mechanism. In the event of a system crash, kdump will capture information from your system that can be invaluable in determining the cause of the crash. Note that kdump does require reserving a portion of system memory that will be unavailable for other uses.

Enable kdump?

Total System Memory (MB): 1003

Kdump Memory (MB): 128

Usable System Memory (MB): 875

← Back

Finish

Figure 34.13. Kdump screen

If you do not want to use **Kdump** on this system, click **Next**. If you want to use **Kdump**, select the **Enable kdump** option, then select an amount of memory to reserve for **Kdump** and click **Next**.

Kdump

Kdump is a kernel crash dumping mechanism. In the event of a system crash, kdump will capture information from your system that can be invaluable in determining the cause of the crash. Note that kdump does require reserving a portion of system memory that will be unavailable for other uses.

Enable kdump?

Total System Memory (MB): 1003

Kdump Memory (MB):

Usable System Memory (MB): 875

Figure 34.14. Kdump enabled

Your Next Steps

35.1. Updating Your System

Red Hat releases updated software packages for Red Hat Enterprise Linux throughout the support period of each version. Updated packages add new features, improve reliability, resolve bugs, or remove security vulnerabilities. To ensure the security of your system, update regularly, and as soon as possible after Red Hat issues a security announcement.

35.1.1. Driver update rpm packages

Occasionally, when a new piece of hardware is not yet supported in the kernel that you have installed, Red Hat or a hardware vendor might make a driver update available. Although you can install driver updates during the installation process (refer to [Chapter 6, Updating drivers during installation on Intel and AMD systems](#) for Intel and AMD systems and [Chapter 13, Updating drivers during installation on IBM POWER systems](#) for IBM POWER systems) we recommend that you do this only for devices that are essential to carry out the installation. In all other cases, complete the installation first, and then add support for the device with a driver update rpm package as described in this section.

Do not install a driver update rpm unless you are certain that your system requires it. Installing a driver update on a system for which it was not intended can cause system difficulties.

To see a list of driver updates already installed on your system, click **System** → **Administration** → **Add/Remove Software** on your desktop, and enter the root password if prompted for it. Click the **Search** tab, enter the word **kmod-** (notice the final -) and click **Search**.

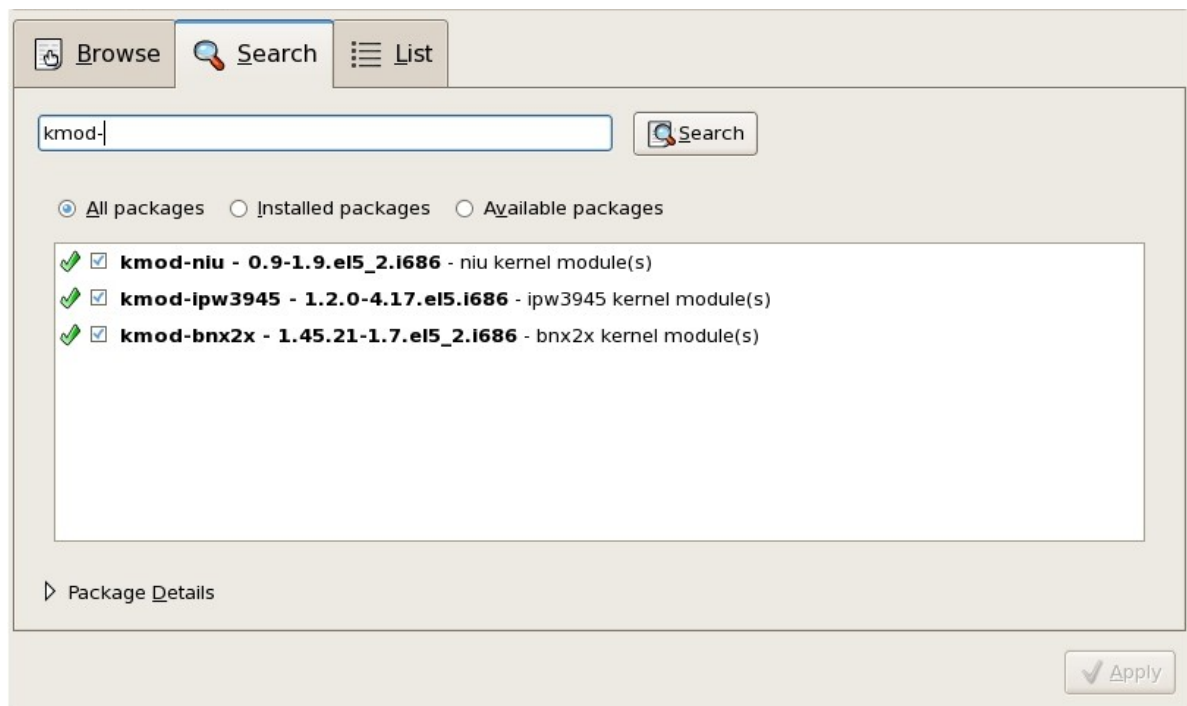


Figure 35.1. Listing installed Driver Update RPM packages

Alternatively, you can use the command line, as follows:

```
$ rpm -qa | egrep ^kmod-
```

Note the - on the end of **kmod**. This will list all installed packages that begin with **kmod-**, which should include all driver updates that are currently installed on your system. Additional drivers provided by third-party update software are not listed in this output. Contact the third-party vendor for details.

To install a new driver update rpm package:

1. Download the driver update rpm package from the location specified by Red Hat or your hardware vendor. The package file name will begin with **kmod** (short for *kernel module*) and have a form similar to this example:

kmod-ipw3945-1.2.04.17.e16.i686.rpm

In the example, the driver update rpm package supplies an Intel IPW3945 WiFi driver update with version number 1.2.0-4.17 for Red Hat Enterprise Linux 6, on i686 systems. A version of this driver package for systems running a Xen kernel will be similar, but include **xen** in the package name:

kmod-ipw3945-xen-1.2.04.17.e16.i686.rpm

Driver update rpm packages are signed packages, and like all other software packages, they are automatically validated at install time. To perform this step manually, type the following at a command line:

```
$ rpm --checksig -v filename.rpm
```

where *filename.rpm* is the driver update rpm package file name. This verifies the package against using the standard Red Hat GPG package signing key that is already installed on any Red Hat Enterprise Linux 6 system. If you need this key for verification purposes on another system, you can obtain it from: <https://www.redhat.com/security/team/key/>

2. Locate and double-click the file that you downloaded. The system might prompt you for the root password, after which it will present the following **Installing Packages** box:



Figure 35.2. The installing packages box

Click **Apply** to complete the package installation.

Alternatively, you can install a driver update manually on the command line:

```
$ rpm -ivh kmod-ipw3945-1.2.04.17.el6.i686
```

- Whether you used a graphical install, or a command line install, reboot your system to ensure your system is using the new driver.

If Red Hat ships a kernel errata update before the next release of Red Hat Enterprise Linux, your system will continue to use the driver updates that you have installed. There is no need to re-install driver updates following an errata update. Generally, when Red Hat releases a new version of Red Hat Enterprise Linux, all driver updates for the previous version are incorporated in the new version. However, if it was not possible to include a particular driver, you will need to perform another driver update when you install the new version of Red Hat Enterprise Linux. In this case, Red Hat or your hardware party vendor will inform you of the location of the update.

35.2. Finishing an Upgrade



System Updates Recommended

Once you have rebooted your system after performing an upgrade, you should also perform a manual system update. Consult [Section 35.1, “Updating Your System”](#) for more information.

If you chose to upgrade your system from a previous release rather than perform a fresh installation, you may want to examine the differences in the package set. [Section 9.11.2, “Upgrading Using the Installer”](#), [Section 16.13.2, “Upgrading Using the Installer”](#), or [Section 23.12.1, “Upgrading Using the Installer”](#) (depending on your system architecture) advised you to create a package listing for your original system. You can now use that listing to determine how to bring your new system close to the original system state.

Most software repository configurations are stored in packages that end with the term **release**. Check the old package list for the repositories that were installed:

```
awk '{print $1}' ~/old-pkglist.txt | grep 'release$'
```

If necessary, retrieve and install these packages from their original sources on the Internet. Follow the instructions at the originating site to install the repository configuration packages for use by **yum** and other software management tools on your Red Hat Enterprise Linux system.

Then run the following commands to make a list of other missing software packages:

```
awk '{print $1}' ~/old-pkglist.txt | sort | uniq > ~/old-pkgnames.txt
rpm -qa --qf '%{NAME}\n' | sort | uniq > ~/new-pkgnames.txt
diff -u ~/old-pkgnames.txt ~/new-pkgnames.txt | grep '^-' | sed 's/^-//' > /tmp/pkgs-to-install.txt
```

Now use the file `/tmp/pkgs-to-install.txt` with the **yum** command to restore most or all of your old software:

```
su -c 'yum install `cat /tmp/pkgs-to-install.txt`'
```



Missing Software

Due to changes in package complements between Red Hat Enterprise Linux releases, it is possible this method may not restore all the software on your system. You can use the routines above to again compare the software on your system, and remedy any problems you find.

35.3. Switching to a Graphical Login



Important — Access to Software Repositories Might Be Required

To switch to a graphical environment, you might need to install extra software from a *repository*. You can access Red Hat Enterprise Linux repositories with your Red Hat Network subscription through the Internet or use a Red Hat Enterprise Linux installation DVD as a repository. Refer to [Section 35.3.1, “Enabling Access to Software Repositories from the Command Line”](#).



Important — This section does not apply to System z

To use a graphical user interface on System z, use `vnserver` instead.

If you installed using a text login and wish to switch to a graphical login, follow this procedure.

1. If you are not already root, switch users to the root account:

```
su -
```

Provide the administrator password when prompted.

2. If you have not already done so, install the **X Window System** and a graphical desktop environment. For example, to install the GNOME desktop environment, use this command:

```
yum groupinstall "X Window System" "GNOME Desktop Environment"
```

To install the KDE desktop environment, use:

```
yum groupinstall "X Window System" KDE
```

To install the XFCE desktop environment, use:

```
yum groupinstall "X Window System" XFCE
```

This step may take some time as your Red Hat Enterprise Linux system downloads and installs additional software. You may be asked to provide the installation media depending on your original installation source.

3. Run the following command to edit the `/etc/inittab` file:

```
vi /etc/inittab
```

4. Press the **I** key to enter **insert** mode.
5. Find the line that includes the text **initdefault**. Change the numeral **3** to **5**.
6. Type **:wq** and press the **Enter** key to save the file and exit the **vi** text editor.

Reboot the system using the **reboot** command. Your system will restart and present a graphical login.

If you encounter any problems with the graphical login, refer to [Chapter 10, Troubleshooting Installation on an Intel or AMD System](#).

35.3.1. Enabling Access to Software Repositories from the Command Line

The usual way to install new software on a Red Hat Enterprise Linux system is through a software repository. You can access Red Hat Enterprise Linux repositories through the Internet with your Red Hat Network subscription, or use a Red Hat Enterprise Linux installation DVD as a repository. The software that you access through online repositories is more up-to-date than what is available on an installation DVD. Furthermore, configuring a Red Hat Enterprise Linux system to access online repositories is generally easier than configuring the system to use an installation DVD as a repository, as long as you have an existing, wired network connection available.

35.3.1.1. Enabling Access to Software Repositories Through the Internet

If you supplied your Red Hat Network subscription number during the installation process, your system is already configured to access Red Hat Enterprise Linux repositories through the Internet. Therefore, all you must do is ensure that the system can access the Internet. If you have an existing, wired network connection available, this process is straightforward:

1. If you are not already root, switch users to the root account:

```
su -
```

2. Ensure that the system is plugged into your network. Note that your network might be as small as two devices — a computer and an external modem/router.
3. Run **system-config-network**. The network configuration tool starts and displays the **Select Action** screen.
4. Select **Device configuration** and press **Enter**. The network configuration tool displays the **Select A Device** screen with a list of network interfaces present on your system. The first interface is named `eth0` by default.
5. Select a network interface to configure and press **Enter**. The network configuration tool takes you to the **Network Configuration** screen.
6. You can manually configure a static IP, gateway, and DNS servers on this screen or leave these fields blank to accept the default values. When you have chosen a configuration, select **OK**, and press **Enter**. The network configuration tool takes you back to the **Select A Device** screen.
7. Select **Save** and press **Enter**. The network configuration tool takes you back to the **Select Action** screen.
8. Select **Save&Quit** and press **Enter**. The network configuration tool saves your settings and exits.

9. Run `ifup interface`, where *interface* is the network interface that you configured with the network configuration tool. For example, run `ifup eth0` to start `eth0`.

Configuration of dial-up or wireless Internet connections is more complicated and beyond the scope of this guide.

35.3.1.2. Using a Red Hat Enterprise Linux Installation DVD as a Software Repository

To use a Red Hat Enterprise Linux installation DVD as a software repository, either in the form of a physical disc, or in the form of an ISO image file.

1. If you are using a physical DVD, insert the disc into your computer.
2. If you are not already root, switch users to the root account:

```
su -
```

3. Create a *mount point* for the repository:

```
mkdir -p /path/to/repo
```

where */path/to/repo* is a location for the repository, for example, `/mnt/repo`

4. *Mount* the DVD on the mount point that you just created. If you are using a physical disc, you need to know the *device name* of your DVD drive. You can find the names of any CD or DVD drives on your system with the command `cat /proc/sys/dev/cdrom/info`. The first CD or DVD drive on the system is typically named `sr0`. When you know the device name, mount the DVD:

```
mount -r -t iso9660 /dev/device_name /path/to/repo
```

For example: `mount -r -t iso9660 /dev/sr0 /mnt/repo`

If you are using an ISO image file of a disc, mount the image file like this:

```
mount -r -t iso9660 -o loop /path/to/image/file.iso /path/to/repo
```

For example: `mount -r -o loop /home/root/Downloads/RHEL6-Server-i386-DVD.iso /mnt/repo`

Note that you can only mount an image file if the storage device that holds the image file is itself mounted. For example, if the image file is stored on a hard drive that it not mounted automatically when the system boots, you must mount the hard drive before you mount an image file stored on that hard drive. Consider a hard drive named `/dev/sdb` that is not automatically mounted at boot time and which has an image file stored in a directory named **Downloads** on its first partition:

```
mkdir /mnt/temp
mount /dev/sdb1 /mnt/temp
mkdir /mnt/repo
mount -r -t iso9660 -o loop mount -r -o loop /mnt/temp/Downloads/RHEL6-Server-i386-DVD.iso /mnt/repo
```

If you are not sure whether a storage device is mounted, run the **mount** command to obtain a list of current mounts. If you are not sure of the device name or partition number of a storage device, run **fdisk -l** and try to identify it in the output.

5. Create a new *repo file* in the `/etc/yum.repos.d/` directory. The name of the file is not important, as long as it ends in `.repo`. For example, **dvd.repo** is an obvious choice.

1. Choose a name for the repo file and open it as a new file with the **vi** text editor. For example:

```
vi /etc/yum.repos.d/dvd.repo
```

2. Press the **I** key to enter **insert** mode.
3. Supply the details of the repository. For example:

```
[dvd]
baseurl=file:///mnt/repo/Server
enabled=1
gpgcheck=1
gpgkey=file:///etc/pki/rpm-gpg/RPM-GPG-KEY-redhat-release
```

The name of the repository is specified in square brackets — in this example, **[dvd]**. The name is not important, but you should choose something that is meaningful and recognizable.

The line that specifies the **baseurl** should contain the path to the mount point that you created previously, suffixed with **/Server** for a Red Hat Enterprise Linux server installation DVD, or with **/Client** for a Red Hat Enterprise Linux client installation DVD.

4. Press the **Esc** key to exit **insert** mode.
5. Type **:wq** and press the **Enter** key to save the file and exit the **vi** text editor.
6. After installing or upgrading software from the DVD, delete the repo file that you created.

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.

36.1. Rescue Mode

36.1.1. 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.

36.1.1.1. 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 system(s) on your computer. They overwrite the Master Boot Record (MBR) that originally contained the GRUB boot loader. If the boot loader is overwritten in this manner, you cannot 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 the `/boot/grub/grub.conf` file.

For instructions on how to reinstall the GRUB boot loader from a rescue environment, refer to [Section 36.1.2.1, "Reinstalling the Boot Loader"](#).

36.1.1.2. 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.

36.1.1.3. 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.

36.1.2. Booting into Rescue Mode

Rescue mode provides the ability to boot a small Red Hat Enterprise Linux environment entirely from 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 methods¹:

- By booting the system from a boot CD-ROM or DVD.
- By booting the system from other installation boot media, such as USB flash devices.
- By booting the system from the Red Hat Enterprise Linux installation DVD.

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 disk from which you booted. If you used a boot CD-ROM or other media 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 earlier section of this guide.

If you select a rescue image that does not require a network connection, 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.

The following message is displayed:

```
The rescue environment will now attempt to find your 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 earlier sections of this guide for more details.


```
sh-3.00b#
```

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** to return to the prompt.

If you selected **Skip**, you can still try to mount a partition or LVM2 logical volume manually inside rescue mode by creating a directory such as **/foo**, and typing the following command:

```
mount -t ext4 /dev/mapper/Vo1Group00-LogVo102 /foo
```

In the above command, **/foo** is a directory that you have created and **/dev/mapper/Vo1Group00-LogVo102** is the LVM2 logical volume you want to mount. If the partition is of type **ext2** or **ext3** replace **ext4** with **ext2** or **ext3** respectively.

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

```
fdisk -l
```

If you do not know the names of all LVM2 physical volumes, volume groups, or logical volumes, use the following commands to list them:

```
pvdisplay
```

```
vgdisplay
```

```
lvdisplay
```

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

- **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



Note

If you try to start other popular editors such as **emacs**, **pico**, or **vi**, the **joe** editor is started.

36.1.2.1. Reinstalling the Boot Loader

In many cases, the GRUB boot loader can mistakenly be deleted, corrupted, or replaced by other operating systems.

The following steps detail the process on how GRUB is reinstalled on the master boot record:

- Boot the system from an installation boot medium.
- Type **linux rescue** at the installation boot prompt to enter the rescue environment.
- Type **chroot /mnt/sysimage** to mount the root partition.
- Type **/sbin/grub-install bootpart** to reinstall the GRUB boot loader, where *bootpart* is the boot partition (typically, */dev/sda*).
- Review the **/boot/grub/grub.conf** file, as additional entries may be needed for GRUB to control additional operating systems.
- Reboot the system.

36.1.3. Booting into Single-User Mode

One of the advantages of single-user mode is that you do not need a boot 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 cannot be mounted successfully.* You cannot use single-user mode if the runlevel 1 configuration on your system is corrupted.

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

1. At the GRUB splash screen at boot time, press any key to enter the GRUB interactive menu.
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.

36.1.4. Booting into Emergency Mode

In emergency mode, you are booted into the most minimal environment possible. The root file system is 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 36.1.3, “Booting into Single-User Mode”](#) with one exception, replace the keyword **single** with the keyword **emergency**.

36.2. Rescue Mode on POWER Systems

You can use the installation disks in rescue mode, in case your system does not boot. Rescue mode gives you access to the disk partitions on your system so you can make any changes necessary to rescue your installation.

After the Language Selection screen ([Section 15.2, “Language Selection”](#)), the installation program attempts to mount the disk partitions on your system. It then presents you with a shell prompt where you can make the changes you need. These changes may include storing the kernel and command line into the IPL source, as described in the Installation Complete section ([Section 16.20, “Installation Complete”](#)).

When your changes are complete, you can exit the shell using **exit 0**. This causes a reboot from the C side. To reboot from the A or B side or from *NWSSTG, you should vary off the system instead of exiting the shell.

36.2.1. Special Considerations for Accessing the SCSI Utilities from Rescue Mode

If your system uses Native DASD disks, you may need access to the SCSI utilities from rescue mode. These utilities are located on the driver disc CD. The driver disc CD cannot be mounted from rescue mode unless special steps are taken. These steps are described below.

If you have a second CD-ROM drive assigned to your Linux system, you can mount the driver disc CD in the second drive.

If you have only one CD-ROM drive, you must set up an NFS boot, using the following steps:

1. Boot from the CD-ROM with the **linux rescue askmethod** command. This allows you to manually select NFS as the source of your rescue media instead of defaulting to the CD-ROM drive.
2. Copy the first installation disc onto a file system of another Linux system.
3. Make this copy of the installation disc available through NFS or FTP.
4. Vary off or power down the system you need to rescue. Set its IPL parameters as instructed for booting the Installation discs in rescue mode, except that the IPL source should point to the copy of **boot.img** on your IFS (from step 1, above).
5. *Make sure the installation disc is not in your DVD drive.*
6. IPL the Linux system.
7. Follow the prompts as described in [Section 36.2, “Rescue Mode on POWER Systems”](#). An additional prompt for the installation source appears. Select NFS or FTP (as appropriate) and complete the following network configuration screen.
8. When the Linux system has booted into rescue mode, the CD-ROM drive is available for use and you can mount the driver media to access the SCSI utilities.

Upgrading Your Current System

This chapter explains the various methods available for upgrading your Red Hat Enterprise Linux system.

37.1. Determining Whether to Upgrade or Re-Install



Red Hat does not support upgrades from earlier major versions

Although **anaconda** provides an option for upgrading from earlier major versions of Red Hat Enterprise Linux to Red Hat Enterprise Linux 6, Red Hat does not currently support this. More generally, Red Hat does not support in-place upgrades between any major versions of Red Hat Enterprise Linux. (A major version is denoted by a whole number version change. For example, Red Hat Enterprise Linux 4 and Red Hat Enterprise Linux 5 are both major versions of Red Hat Enterprise Linux.)

In-place upgrades across major releases do not preserve all system settings, services or custom configurations. Consequently, Red Hat strongly recommends fresh installations when upgrading from one major version to another.

While upgrading from Red Hat Enterprise Linux version 4 Update 4 is technically possible, you are more likely to have a consistent experience by backing up your data and then installing this release of Red Hat Enterprise Linux 6 over your previous Red Hat Enterprise Linux installation.

To upgrade from Red Hat Enterprise Linux 4 you should bring your system up to date using RHN before performing the upgrade.

This recommended reinstallation method helps to ensure the best system stability possible.

For more information about re-installing your Red Hat Enterprise Linux system, refer to the Whitepapers available online at http://www.redhat.com/rhel/resource_center/.

If you currently use Red Hat Enterprise Linux 4 Update 4, you can perform a traditional, installation program-based upgrade.

However, before you chose to upgrade your system, there are a few things you should keep in mind:

- Individual package configuration files may or may not work after performing an upgrade due to changes in various configuration file formats or layouts.
- If you have one of Red Hat's layered products (such as the Cluster Suite) installed, it may need to be manually upgraded after the Red Hat Enterprise Linux upgrade has been completed.
- Third party or ISV applications may not work correctly following the upgrade.

Upgrading your system installs updated versions of the packages which are currently installed on your system.

The upgrade process preserves existing configuration files by renaming them with an **.rpm`save`** extension (for example, **sendmail.cf.rpm`save`**). The upgrade process also creates a log of its actions in **/root/upgrade.log**.



Warning

As software evolves, configuration file formats can change. It is very important to carefully compare your original configuration files to the new files before integrating your changes.



Note

It is always a good idea to back up any data that you have on your systems. For example, if you are upgrading or creating a dual-boot system, you should back up any data you wish to keep on your hard drives. Mistakes do happen and can result in the loss of all of your data.

Some upgraded packages may require the installation of other packages for proper operation. If you choose to customize your packages to upgrade, you may be required to resolve dependency problems. Otherwise, the upgrade procedure takes care of these dependencies, but it may need to install additional packages which are not on your system.

Depending on how you have partitioned your system, the upgrade program may prompt you to add an additional swap file. If the upgrade program does not detect a swap file that equals twice your RAM, it asks you if you would like to add a new swap file. If your system does not have a lot of RAM (less than 256 MB), it is recommended that you add this swap file.

37.2. Upgrading Your System

The **Upgrade Examine** screen appears if you have instructed the installation program to perform an upgrade.



Note

If the contents of your `/etc/redhat-release` file have been changed from the default, your Red Hat Enterprise Linux installation may not be found when attempting an upgrade to Red Hat Enterprise Linux 6.

You can relax some of the checks against this file by booting with the following boot command:

```
linux upgradeany
```

Use the **linux upgradeany** command if your Red Hat Enterprise Linux installation was not given as an option to upgrade.

To perform an upgrade, select **Perform an upgrade of an existing installation**. Click **Next** when you are ready to begin your upgrade.

To re-install your system, select **Perform a new Red Hat Enterprise Linux installation** and refer to <http://www.redhat.com/docs/wp/> as well as [Chapter 9, Installing using anaconda](#), [Chapter 16, Installing using anaconda](#), or [Chapter 23, Installation Phase 3: Installing using anaconda](#) for further instructions.

To perform a new installation of Red Hat Enterprise Linux on your system, select **Perform a new Red Hat Enterprise Linux installation** and refer to [Chapter 9, Installing using anaconda](#), [Chapter 16,](#)

Installing using anaconda, or *Chapter 23, Installation Phase 3: Installing using anaconda* for further instructions.

Removing Red Hat Enterprise Linux from x86-based systems



These instructions may destroy data!

If you have data from Red Hat Enterprise Linux that you want to keep, back it up before you proceed. Write your data to CD, DVD, external hard disk, or other storage device.

As a precaution, also back up data from any other operating systems that are installed on the same computer. Mistakes do happen and can result in the loss of all your data.

If you back up data from Red Hat Enterprise Linux to be used later in another operating system, make sure that the storage medium or device is readable by that other operating system. For example, without extra third-party software, Microsoft Windows cannot read an external hard drive that you have formatted with Red Hat Enterprise Linux to use the ext2, ext3, or ext4 file system.

To uninstall Red Hat Enterprise Linux from your x86-based system, you must remove the Red Hat Enterprise Linux boot loader information from your master boot record (MBR) and remove any partitions that contain the operating system. The method for removing Red Hat Enterprise Linux from your computer varies, depending on whether Red Hat Enterprise Linux is the only operating system installed on the computer, or whether the computer is configured to dual-boot Red Hat Enterprise Linux and another operating system.

These instructions cannot cover every possible computer configuration. If your computer is configured to boot three or more operating systems, or has a highly-customized partition scheme, use the following sections as a general guide to partition removal with the various tools described. In these situations, you will also need to learn to configure your chosen bootloader. See [Appendix E, The GRUB Boot Loader](#) for a general introduction to the subject, but detailed instructions are beyond the scope of this document.



Legacy versions of Microsoft operating systems

Fdisk, the disk partitioning tool provided with MS-DOS and Microsoft Windows, is unable to remove the file systems used by Red Hat Enterprise Linux. MS-DOS and versions of Windows prior to Windows XP (except for Windows 2000) have no other means of removing or modifying partitions. Refer to [Section 38.3, “Replacing Red Hat Enterprise Linux with MS-DOS or legacy versions of Microsoft Windows”](#) for alternative removal methods for use with MS-DOS and these versions of Windows.

38.1. Red Hat Enterprise Linux is the only operating system on the computer

If Red Hat Enterprise Linux is the only operating system on your computer, use the installation media for the replacement operating system to remove Red Hat Enterprise Linux. Examples of installation media include the Windows XP installation CD, Windows Vista installation DVD, or the installation CD, CDs, or DVD of another Linux distribution.

Note that some manufacturers of factory-built computers pre-installed with Microsoft Windows do not supply the Windows installation CD or DVD with the computer. The manufacturer may instead have supplied their own "system restore disk", or have included software with the computer that allowed you to create your own "system restore disk" when you first started the computer. In some cases, the system restore software is stored on a separate partition on the system's hard drive. If you cannot identify the installation media for an operating system that was pre-installed on your computer, consult the documentation supplied with the machine, or contact the manufacturer.

When you have located the installation media for your chosen operating system:

1. Back up any data that you want to keep.
2. Shut down the computer.
3. Boot your computer with the installation disk for the replacement operating system.
4. Follow the prompts presented during the installation process. Windows, OS X, and most Linux installation disks allow you to manually partition your hard drive during the installation process, or will offer you the option to remove all partitions and start with a fresh partition scheme. At this point, remove any existing partitions that the installation software detects or allow the installer to remove the partitions automatically. "System restore" media for computers pre-installed with Microsoft Windows might create a default partition layout automatically without input from you.



Warning

If your computer has system restore software stored on a partition on a hard drive, take care when removing partitions while installing an operating system from other media. Under these circumstances, you could destroy the partition holding the system restore software.

38.2. Your computer dual-boots Red Hat Enterprise Linux and another operating system

If your computer is configured to dual-boot Red Hat Enterprise Linux and another operating system, removing Red Hat Enterprise Linux without removing the partitions containing the other operating system and its data is more complicated. Specific instructions for a number of operating systems are set out below. To keep neither Red Hat Enterprise Linux nor the other operating system, follow the steps described for a computer with only Red Hat Enterprise Linux installed: [Section 38.1, "Red Hat Enterprise Linux is the only operating system on the computer"](#)

38.2.1. Your computer dual-boots Red Hat Enterprise Linux and a Microsoft Windows operating system

38.2.1.1. Windows 2000, Windows Server 2000, Windows XP, and Windows Server 2003



Warning

Once you commence this process, your computer may be left in an unbootable state until you complete the entire set of instructions. Carefully read the steps below before beginning the removal process. Consider opening these instructions on another computer or printing them so that you have access to them at all times during the process.

This procedure relies on the **Windows Recovery Console** that loads from the Windows installation disk, so you will not be able to complete the procedure without access to this disk. If you start this procedure and do not complete it, you could leave your computer in a condition where you cannot boot it. The "system restore disk" supplied with some factory-built computers that are sold with Windows pre-installed on them might not include the **Windows Recovery Console**.

During the process outlined in these instructions, the **Windows Recovery Console** will prompt you for the Administrator password for your Windows system. Do not follow these instructions unless you know the Administrator password for your system or are certain that an Administrator password has never been created, even by the computer manufacturer.

1. Remove the Red Hat Enterprise Linux partitions
 - a. Boot your computer into your Microsoft Windows environment.
 - b. Click **Start>Run...**, type **diskmgmt.msc** and press **Enter**. The **Disk Management** tool opens.

The tool displays a graphical representation of your disk, with bars representing each partition. The first partition is usually labeled **NTFS** and corresponds to your **C:** drive. At least two Red Hat Enterprise Linux partitions will be visible. Windows will not display a file system type for these partitions, but may allocate drive letters to some of them.

- c. Right-click on one of the Red Hat Enterprise Linux partitions, then click **Delete Partition** and click **Yes** to confirm the deletion. Repeat this process for the other Red Hat Enterprise Linux partitions on your system. As you delete partitions, Windows labels the space on the hard drive previously occupied by those partitions as **unallocated**.
2. Enable Windows to use the space on your hard drive vacated by Red Hat Enterprise Linux (optional)



Note

This step is not required to remove Red Hat Enterprise Linux from your computer. However, if you skip this step, you will leave part of your hard drive's storage capacity unusable by Windows. Depending on your configuration, this might be a significant portion of the storage capacity of the drive.

Decide whether to extend an existing Windows partition to use the extra space, or create a new Windows partition in that space. If you create new a Windows partition, Windows will allocate a new drive letter to it and will interact with it as if it is a separate hard drive.

Extending an existing Windows partition



Note

The **diskpart** tool used in this step is installed as part of the Windows XP and Windows 2003 operating systems. If you are performing this step on a computer running Windows 2000 or Windows Server 2000, you can download a version of **diskpart** for your operating system from the Microsoft website.

- a. Click **Start>Run...**, type **diskpart** and press **Enter**. A command window appears.
- b. Type **list volume** and press **Enter**. **Diskpart** displays a list of the partitions on your system with a volume number, its drive letter, volume label, filesystem type, and size. Identify the Windows partition that you would like to use to occupy the space vacated on your hard drive by Red Hat Enterprise Linux and take note of its volume number (for example, your Windows **C:** drive might be "Volume 0").
- c. Type **select volume N** (where *N* is the volume number for the Windows partition that you want to extend) and press **Enter**. Now type **extend** and press **Enter**. **Diskpart** now extends your chosen partition to fill the remaining space on your hard drive. It will notify you when the operation is complete.

Adding a new Windows partition

- a. In the the **Disk Management** window, right-click on disk space that Windows labels as **unallocated** and select **New Partition** from the menu. The **New Partition Wizard** starts.
 - b. Follow the prompts presented by the **New Partition Wizard**. If you accept the default options, the tool will create a new partition that fills all available space on the hard drive, assigns it the next available drive letter, and formats it with the NTFS file system.
3. Restore the Windows bootloader
- a. Insert the Windows installation disk and restart your computer. As your computer starts, the following message will appear on the screen for a few seconds:

Press any key to boot from CD

Press any key while the message is still showing and the Windows installation software will load.

- b. When the **Welcome to Setup** screen appears, you can start the **Windows Recovery Console**. The procedure is slightly different on different versions of Windows:
 - On Windows 2000 and Windows Server 2000, press the **R** key, then the **C** key.
 - On Windows XP and Windows Server 2003, press the **R** key.
- c. The **Windows Recovery Console** scans your hard drives for Windows installations, and assigns a number to each one. It displays a list of Windows installations and prompts you to select one. Type the number corresponding to the Windows installation that you want to restore.
- d. The **Windows Recovery Console** prompts you for the Administrator password for your Windows installation. Type the Administrator password and press the **Enter** key. If there is no administrator password for this system, press only the **Enter** key.
- e. At the prompt, type the command **fixmbr** and press the **Enter**. The **fixmbr** tool now restores the Master Boot Record for the system.
- f. When the prompt reappears, type **exit** and press the **Enter** key.
- g. Your computer will restart and boot your Windows operating system.

38.2.1.2. Windows Vista and Windows Server 2008



Warning

Once you commence this process, your computer may be left in an unbootable state until you complete the entire set of instructions. Carefully read the steps below before beginning the removal process. Consider opening these instructions on another computer or printing them so that you have access to them at all times during the process.

This procedure relies on the **Windows Recovery Environment** that loads from the Windows installation disk and you will not be able to complete the procedure without access to this disk. If you start this procedure and do not complete it, you could leave your computer in a condition where you cannot boot it. The "system restore disk" supplied with some factory-built computers that are sold with Windows pre-installed on them might not include the **Windows Recovery Environment**.

1. Remove the Red Hat Enterprise Linux partitions
 - a. Boot your computer into your Microsoft Windows environment.
 - b. Click **Start** then type **diskmgmt.msc** into the **Start Search** box and press **Enter**. The **Disk Management** tool opens.

The tool displays a graphical representation of your disk, with bars representing each partition. The first partition is usually labeled **NTFS** and corresponds to your **C:** drive. At least two Red Hat Enterprise Linux partitions will be visible. Windows will not display a file system type for these partitions, but may allocate drive letters to some of them.
 - c. Right-click on one of the Red Hat Enterprise Linux partitions, then click **Delete Partition** and click **Yes** to confirm the deletion. Repeat this process for the other Red Hat Enterprise Linux

partitions on your system. As you delete partitions, Windows labels the space on the hard drive previously occupied by those partitions as **unallocated**.

2. Enable Windows to use the space on your hard drive vacated by Red Hat Enterprise Linux (optional)



Note

This step is not required to remove Red Hat Enterprise Linux from your computer. However, if you skip this step, you will leave part of your hard drive's storage capacity unusable by Windows. Depending on your configuration, this might be a significant portion of the storage capacity of the drive.

Decide whether to extend an existing Windows partition to use the extra space, or create a new Windows partition in that space. If you create new a Windows partition, Windows will allocate a new drive letter to it and will interact with it as if it is a separate hard drive.

Extending an existing Windows partition

- a. In the **Disk Management** window, right-click on the Windows partition that you want to extend and select **Extend Volume** from the menu. The **Extend Volume Wizard** opens.
- b. Follow the prompts presented by the **Extend Volume Wizard**. If you accept the defaults that it offers you, the tool will extend the selected volume to fill all available space on the hard drive.

Adding a new Windows partition

- a. In the **Disk Management** window, right-click on disk space that Windows labels as **unallocated** and select **New Simple Volume** from the menu. The **New Simple Volume Wizard** starts.
- b. Follow the prompts presented by the **New Simple Volume Wizard**. If you accept the default options, the tool will create a new partition that fills all available space on the hard drive, assigns it the next available drive letter, and formats it with the NTFS file system.

3. Restore the Windows bootloader

- a. Insert the Windows installation disk and restart your computer. As your computer starts, the following message will appear on the screen for a few seconds:

Press any key to boot from CD or DVD

Press any key while the message is still showing and the Windows installation software will load.

- b. In the **Install Windows** dialog, select a language, time and currency format, and keyboard type. Click **Next**
- c. Click **Repair your computer**.
- d. The **Windows Recovery Environment (WRE)** shows you the Windows installations that it can detect on your system. Select the installation that you want to restore, then click **Next**.
- e. Click **Command prompt**. A command window will open.
- f. Type `bootrec /fixmbr` and press **Enter**.

- g. When the prompt reappears, close the command window, then click **Restart**.
- h. Your computer will restart and boot your Windows operating system.

38.2.2. Your computer dual-boots Red Hat Enterprise Linux and a different Linux distribution



Note

Because of the differences between the many different Linux distributions, these instructions are a general guide only. Specific details will vary according to your chosen distribution and the configuration of your particular computer. This example uses **GParted** as a partition editor and **gedit** as a text editor, but many other tools are available to perform these tasks. To follow these instructions exactly as written, install **GParted** and **gedit**.

1. **Remove Red Hat Enterprise Linux partitions**
 - a. Boot the Linux version that you want to keep on your computer.
 - b. Open **GParted**, either from a desktop menu or by typing **gparted** at the command line and pressing **Enter**.
 - c. **GParted** displays the partitions that it detects on your computer, both as a graph and as a table.

Right-click the Red Hat Enterprise Linux partitions, then select **Delete**.

2. **Remove Red Hat Enterprise Linux entries from your bootloader**



Example only

These instructions assume that your system uses the **GRUB** bootloader. If you use a different bootloader (such as **LILO**) consult the documentation for that software to identify and remove Red Hat Enterprise Linux entries from its list of boot targets and to ensure that your default operating system is correctly specified.

- a. At the command line, type **su -** and press **Enter**. When the system prompts you for the root password, type the password and press **Enter**.
- b. Type **gedit /boot/grub/grub.conf** and press **Enter**. This opens the **grub.conf** file in the **gedit** text editor.
- c. A typical Red Hat Enterprise Linux entry in the **grub.conf** file consists of four lines:

Example 38.1. Example Red Hat Enterprise Linux entry in **grub.conf**

```
title Red Hat Enterprise Linux (2.6.27.19-170.2.35.el5.i686)
```

```
root (hd0,1)
```

```
kernel /vmlinuz-2.6.27.19-170.2.35.el5.i686 ro root=UUID=04a07c13-e6bf-6d5a-
b207-002689545705 rhgb quiet
```

```
initrd /initrd-2.6.27.19-170.2.35.el5.i686.img
```

Depending on the configuration of your system, there may be multiple Red Hat Enterprise Linux entries in **grub.conf**, each corresponding to a different version of the Linux kernel. Delete each of the Red Hat Enterprise Linux entries from the file.

- d. **Grub.conf** contains a line that specifies the default operating system to boot, in the format **default=N** where *N* is a number equal to or greater than 0. If *N* is set to 0, **GRUB** will boot the first operating system in the list. If *N* is set to 1, it will boot the second operating system, and so forth.

Identify the entry for the operating system that you want **GRUB** to boot by default and note its place in the order within the list.

Make sure that the **default=** line contains the number *one below* the number of your chosen default operating system in the list.

Save the updated **grub.conf** file and close **gedit**

3. Make space available to your operating system



Note

This step is not required to remove Red Hat Enterprise Linux from your computer. However, if you skip this step, you will leave part of your hard drive's storage capacity unusable by your other Linux operating system. Depending on your configuration, this might be a significant portion of the storage capacity of the drive.



Note

To carry out this step, you require live media for a Linux distribution, for example, the Fedora Live CD or the Knoppix DVD.

The method to make the space freed by removing the Red Hat Enterprise Linux partitions available to your other Linux operating system differs, depending on whether your chosen operating system is installed on disk partitions configured to use Logical Volume Management (LVM) or not.

- **If you do not use LVM**
 - a. Boot your computer from Linux live media, and install **gparted** if it is not already present.
 - b. Open **GParted**, either from a desktop menu or by typing **gparted** at the command line and pressing **Enter**.
 - c. **GParted** displays the partitions on your system both as a graph and as a table. Click on the partition that you want to extend to use the space freed by removing Red Hat Enterprise Linux, and click the **Resize/Move** button.
 - d. A new dialog opens, allowing you to specify a new size for the partition by entering it as numbers, or by dragging the sides of the graphical representation of the partition so that it fills the available space. Click the **Resize/Move** button in this dialog to confirm your choice.

- e. Back in the main **GParted** window, click **Apply**. Take note of the name of the partition that you just resized, for example, `/dev/sda3`.
 - f. When **GParted** finishes resizing the partition, type `e2fsck partition` at a command line and press **Enter**, where *partition* is the partition that you just resized. For example, if you just resized `/dev/sda3`, you would type `e2fsck /dev/sda3`.

Linux now checks the file system of the newly-resized partition.
 - g. When the file system check finishes, type `resize2fs partition` at a command line and press **Enter**, where *partition* is the partition that you just resized. For example, if you just resized `/dev/sda3`, you would type `resize2fs /dev/sda3`.

Linux now resizes your file system to fill the newly-resized partition.
 - h. Restart your computer. The extra space is now available to your Linux installation.
- **If you use LVM**
 - a. Boot your computer from Linux live media and install **gparted** and **lvml2** if they are not already present.
 - b. **Create a new partition in the free space on the disk**
 - i. Open **GParted**, either from a desktop menu or by typing **gparted** at the command line and pressing **Enter**.
 - ii. **GParted** displays the partitions on your system both as a graph and as a table. The space freed by removing Red Hat Enterprise Linux is labeled **unallocated**. Right-click on the unallocated space and select **New**. Accept the defaults and **GParted** will create a new partition that fills the space available on the drive.
 - iii. Click **Apply**. **GParted** writes the changes to your hard drive. Take note of the name of the partition that you just created, and the name of the device that holds the partition. For example, you may have created `/dev/sda3` on device `/dev/sda`.
 - c. **Change the partition type identifier**
 - i. **Fdisk** is a partitioning tool capable of preparing partitions for LVM. At a command line, type `fdisk device` and press **Enter**, where *device* is the name of the device on which you just created a partition. For example, `fdisk /dev/sda`.
 - ii. At the prompt `Command (m for help):`, press **T** and **Enter** to use **fdisk** to change a partition type.
 - iii. At the prompt `Partition number (1-4):`, type the number of the partition that you just created. For example, if you just created partition `/dev/sda3`, type the number **3** and press **Enter**. This identifies the partition whose type **fdisk** will change.
 - iv. At the prompt `Hex code (type L to list codes):`, type the code **8e** and press **Enter**. This is the code for a Linux LVM partition.
 - v. At the prompt `Command (m for help):`, press **W** and **Enter**. **Fdisk** writes the new type code to the partition and exits.
 - d. **Expand the volume group**
 - i. At the command prompt, type **lvml** and press **Enter** to start the **lvml2** tool.

- ii. At the `lvm>` prompt, type **`pvcreate partition`** and press **Enter**, where *partition* is the partition that you recently created. For example, **`pvcreate /dev/sda3`**. This creates `/dev/sda3` as a physical volume in LVM.
 - iii. At the `lvm>` prompt, type **`vgextend VolumeGroup partition`** and press **Enter**, where *VolumeGroup* is the LVM volume group on which Linux is installed and *partition* is the partition that you recently created. For example, if Linux is installed on `/dev/VolumeGroup00`, you would type **`vgextend /dev/VolumeGroup00 /dev/sda3`** to extend that volume group to include the physical volume at `/dev/sda3`.
 - iv. At the `lvm>` prompt, type **`lvextend -l +100%FREE LogVol`** and press **Enter**, where *LogVol* is the logical volume that contains your Linux filesystem. For example, to extend `LogVol100` to fill the newly-available space in its volume group, `VolGroup00`, type **`lvextend -l +100%FREE /dev/VolGroup00/LogVol100`**.
 - v. At the `lvm>` prompt, type **`exit`** and press **Enter** to exit `lvm2`
- e. Type **`e2fsck LogVol`** at the command line and press **Enter**, where *LogVol* is the logical volume that you just resized. For example, if you just resized `/dev/VolumeGroup00/LogVol100`, you would type **`e2fsck /dev/VolumeGroup00/LogVol100`**.
- Linux now checks the file system of the newly-resized logical volume.
- f. When the file system check finishes, type **`resize2fs LogVol`** at a command line and press **Enter**, where *LogVol* is the partition that you just resized. For example, if you just resized `/dev/VolumeGroup00/LogVol100`, you would type **`resize2fs /dev/VolumeGroup00/LogVol100`**.
- Linux now resizes your file system to fill the newly-resized logical volume.
- g. Restart your computer. The extra space is now available to your Linux installation.

38.3. Replacing Red Hat Enterprise Linux with MS-DOS or legacy versions of Microsoft Windows

In DOS and Windows, use the Windows **`fdisk`** utility to create a new MBR with the *undocumented* flag `/mbr`. This *ONLY* rewrites the MBR to boot the primary DOS partition. The command should look like the following:

```
fdisk /mbr
```

If you need to remove Linux from a hard drive and have attempted to do this with the default DOS (Windows) **`fdisk`**, you will experience the *Partitions exist but they do not exist* problem. The best way to remove non-DOS partitions is with a tool that understands partitions other than DOS.

To begin, insert the Red Hat Enterprise Linux DVD and boot your system. When the boot prompt appears, type: **`linux rescue`**. This starts the rescue mode program.

You are prompted for your keyboard and language requirements. Enter these values as you would during the installation of Red Hat Enterprise Linux.

Next, a screen appears telling you that the program attempts to find a Red Hat Enterprise Linux install to rescue. Select **`Skip`** on this screen.

After selecting **Skip**, you are given a command prompt where you can access the partitions you would like to remove.

First, type the command **list-harddrives**. This command lists all hard drives on your system that are recognizable by the installation program, as well as their sizes in megabytes.



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.

To remove partitions, use the partitioning utility **parted**. Start **parted**, where `/dev/hda` is the device on which to remove the partition:

```
parted /dev/hda
```

Using the **print** command, view the current partition table to determine the minor number of the partition to remove:

```
print
```

The **print** command also displays the partition's type (such as linux-swaps, ext2, ext3, ext4 and so on). Knowing the type of the partition helps you in determining whether to remove the partition.

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

```
rm 3
```



Important

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.

Once you have removed the Linux partitions and made all of the changes you need to make, type **quit** to quit **parted**.

After quitting **parted**, type **exit** at the boot prompt to exit rescue mode and reboot your system, instead of continuing with the installation. The system should reboot automatically. If it does not, you can reboot your computer using **Control+Alt+Delete**.

Removing Red Hat Enterprise Linux from IBM System z

If you want to delete the existing operating system data, first, if any Linux disks contain sensitive data, ensure that you destroy the data according to your security policy. To proceed you can consider these options:

- Overwrite the disks with a new installation.
- Start a new installation and use the partitioning dialog (refer to [Section 23.13, “Disk Partitioning Setup”](#)) to format the partitions where Linux was installed. After the **Write changes to disk** dialog described in [Section 23.16, “Write changes to disk”](#), exit the installer.
- Make the DASD or SCSI disk where Linux was installed visible from another system, then delete the data. However, this might require special privileges. Ask your system administrator for advice. You can use Linux commands such as **dasdfmt** (DASD only), **parted**, **mke2fs** or **dd**. For more details about the commands, refer to the respective man pages.

39.1. Running a Different Operating System on your z/VM Guest or LPAR

If you want to boot from a DASD or SCSI disk different from where the currently installed system resides under a z/VM guest virtual machine or an LPAR, shut down the Red Hat Enterprise Linux installed and use the desired disk, where another Linux instance is installed, to boot from. This leaves the contents of the installed system unchanged.

Part VI. Technical appendixes

The appendixes in this section do not contain instructions that tell you how to install Red Hat Enterprise Linux. Instead, they provide technical background that you might find helpful to understand the options that Red Hat Enterprise Linux offers you at various points in the installation process.

Appendix A. An Introduction to Disk Partitions



Note

This appendix is not necessarily applicable to non-x86-based architectures. However, the general concepts mentioned here may apply.

This appendix is not necessarily applicable to non-x86-based architectures. However, the general concepts mentioned here may apply.

If you are reasonably comfortable with disk partitions, you could skip ahead to [Section A.1.4, “Making Room For Red Hat Enterprise Linux”](#), for more information on the process of freeing up disk space to prepare for a Red Hat Enterprise Linux installation. This section also discusses the partition naming scheme used by Linux systems, sharing disk space with other operating systems, and related topics.

A.1. Hard Disk Basic Concepts

Hard disks perform a very simple function — they store data and reliably retrieve it on command.

When discussing issues such as disk partitioning, it is important to know a bit about the underlying hardware. Unfortunately, it is easy to become bogged down in details. Therefore, this appendix uses a simplified diagram of a disk drive to help explain what is really happening when a disk drive is partitioned. [Figure A.1, “An Unused Disk Drive”](#), shows a brand-new, unused disk drive.

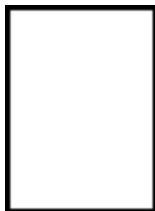


Figure A.1. An Unused Disk Drive

Not much to look at, is it? But if we are talking about disk drives on a basic level, it is adequate. Say that we would like to store some data on this drive. As things stand now, it will not work. There is something we need to do first.

A.1.1. It is Not What You Write, it is How You Write It

Experienced computer users probably got this one on the first try. We need to *format* the drive. Formatting (usually known as “making a *file system*”) writes information to the drive, creating order out of the empty space in an unformatted drive.

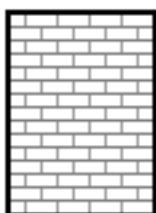


Figure A.2. Disk Drive with a File System

As [Figure A.2, “Disk Drive with a File System”](#), implies, the order imposed by a file system involves some trade-offs:

- A small percentage of the drive's available space is used to store file system-related data and can be considered as overhead.
- A file system splits the remaining space into small, consistently-sized segments. For Linux, these segments are known as *blocks*.¹

Given that file systems make things like directories and files possible, these trade-offs are usually seen as a small price to pay.

It is also worth noting that there is no single, universal file system. As [Figure A.3, “Disk Drive with a Different File System”](#), shows, a disk drive may have one of many different file systems written on it. As you might guess, different file systems tend to be incompatible; that is, an operating system that supports one file system (or a handful of related file system types) may not support another. This last statement is not a hard-and-fast rule, however. For example, Red Hat Enterprise Linux supports a wide variety of file systems (including many commonly used by other operating systems), making data interchange between different file systems easy.

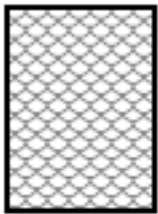


Figure A.3. Disk Drive with a Different File System

Of course, writing a file system to disk is only the beginning. The goal of this process is to actually *store* and *retrieve* data. Let us take a look at our drive after some files have been written to it.

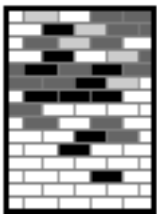


Figure A.4. Disk Drive with Data Written to It

As [Figure A.4, “Disk Drive with Data Written to It”](#), shows, some of the previously-empty blocks are now holding data. However, by just looking at this picture, we cannot determine exactly how many files reside on this drive. There may only be one file or many, as all files use at least one block and some files use multiple blocks. Another important point to note is that the used blocks do not have to form a contiguous region; used and unused blocks may be interspersed. This is known as *fragmentation*. Fragmentation can play a part when attempting to resize an existing partition.

As with most computer-related technologies, disk drives changed over time after their introduction. In particular, they got bigger. Not larger in physical size, but bigger in their capacity to store information. And, this additional capacity drove a fundamental change in the way disk drives were used.

A.1.2. Partitions: Turning One Drive Into Many

As disk drive capacities soared, some people began to wonder if having all of that formatted space in one big chunk was such a great idea. This line of thinking was driven by several issues, some

philosophical, some technical. On the philosophical side, above a certain size, it seemed that the additional space provided by a larger drive created more clutter. On the technical side, some file systems were never designed to support anything above a certain capacity. Or the file systems *could* support larger drives with a greater capacity, but the overhead imposed by the file system to track files became excessive.

The solution to this problem was to divide disks into *partitions*. Each partition can be accessed as if it was a separate disk. This is done through the addition of a *partition table*.



Note

While the diagrams in this chapter show the partition table as being separate from the actual disk drive, this is not entirely accurate. In reality, the partition table is stored at the very start of the disk, before any file system or user data. But for clarity, they are separate in our diagrams.

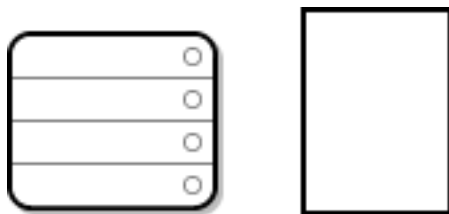


Figure A.5. Disk Drive with Partition Table

As [Figure A.5, “Disk Drive with Partition Table”](#) shows, the partition table is divided into four sections or four *primary* partitions. A primary partition is a partition on a hard drive that can contain only one logical drive (or section). Each section can hold the information necessary to define a single partition, meaning that the partition table can define no more than four partitions.

Each partition table entry contains several important characteristics of the partition:

- The points on the disk where the partition starts and ends
- Whether the partition is "active"
- The partition's type

Let us take a closer look at each of these characteristics. The starting and ending points actually define the partition's size and location on the disk. The "active" flag is used by some operating systems' boot loaders. In other words, the operating system in the partition that is marked "active" is booted.

The partition's type can be a bit confusing. The type is a number that identifies the partition's anticipated usage. If that statement sounds a bit vague, that is because the meaning of the partition type is a bit vague. Some operating systems use the partition type to denote a specific file system type, to flag the partition as being associated with a particular operating system, to indicate that the partition contains a bootable operating system, or some combination of the three.

By this point, you might be wondering how all this additional complexity is normally used. Refer to [Figure A.6, “Disk Drive With Single Partition”](#), for an example.

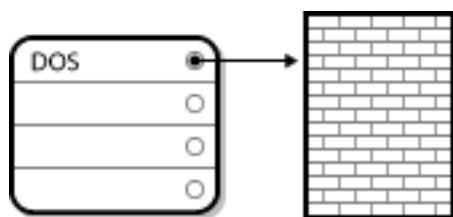


Figure A.6. Disk Drive With Single Partition

In many cases, there is only a single partition spanning the entire disk, essentially duplicating the method used before partitions. The partition table has only one entry used, and it points to the start of the partition.

We have labeled this partition as being of the "DOS" type. Although it is only one of several possible partition types listed in [Table A.1, "Partition Types"](#), it is adequate for the purposes of this discussion.

[Table A.1, "Partition Types"](#), contains a listing of some popular (and obscure) partition types, along with their hexadecimal numeric values.

Table A.1. Partition Types

| Partition Type | Value | Partition Type | Value |
|----------------------|-------|--------------------|-------|
| Empty | 00 | Novell Netware 386 | 65 |
| DOS 12-bit FAT | 01 | PIC/IX | 75 |
| XENIX root | 02 | Old MINIX | 80 |
| XENIX usr | 03 | Linux/MINUX | 81 |
| DOS 16-bit <=32M | 04 | Linux swap | 82 |
| Extended | 05 | Linux native | 83 |
| DOS 16-bit >=32 | 06 | Linux extended | 85 |
| OS/2 HPFS | 07 | Amoeba | 93 |
| AIX | 08 | Amoeba BBT | 94 |
| AIX bootable | 09 | BSD/386 | a5 |
| OS/2 Boot Manager | 0a | OpenBSD | a6 |
| Win95 FAT32 | 0b | NEXTSTEP | a7 |
| Win95 FAT32 (LBA) | 0c | BSDI fs | b7 |
| Win95 FAT16 (LBA) | 0e | BSDI swap | b8 |
| Win95 Extended (LBA) | 0f | Syrinx | c7 |
| Venix 80286 | 40 | CP/M | db |
| Novell | 51 | DOS access | e1 |
| PReP Boot | 41 | DOS R/O | e3 |
| GNU HURD | 63 | DOS secondary | f2 |
| Novell Netware 286 | 64 | BBT | ff |

A.1.3. Partitions within Partitions — An Overview of Extended Partitions

Of course, over time it became obvious that four partitions would not be enough. As disk drives continued to grow, it became more and more likely that a person could configure four reasonably-sized partitions and still have disk space left over. There needed to be some way of creating more partitions.

Enter the extended partition. As you may have noticed in [Table A.1, "Partition Types"](#), there is an "Extended" partition type. It is this partition type that is at the heart of extended partitions.

When a partition is created and its type is set to "Extended," an extended partition table is created. In essence, the extended partition is like a disk drive in its own right — it has a partition table that points to one or more partitions (now called *logical partitions*, as opposed to the four *primary partitions*) contained entirely within the extended partition itself. [Figure A.7, "Disk Drive With Extended Partition"](#), shows a disk drive with one primary partition and one extended partition containing two logical partitions (along with some unpartitioned free space).

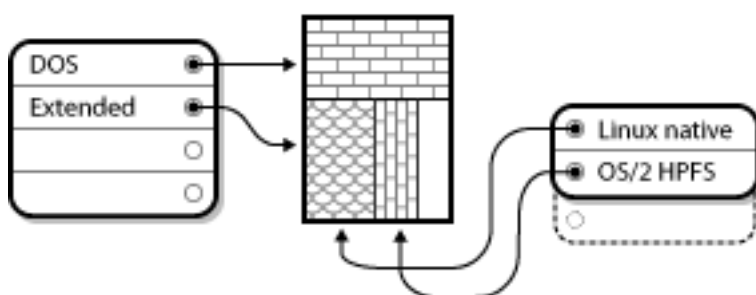


Figure A.7. Disk Drive With Extended Partition

As this figure implies, there is a difference between primary and logical partitions — there can only be four primary partitions, but there is no fixed limit to the number of logical partitions that can exist. However, due to the way in which partitions are accessed in Linux, you should avoid defining more than 12 logical partitions on a single disk drive.

Now that we have discussed partitions in general, let us review how to use this knowledge to install Red Hat Enterprise Linux.

A.1.4. Making Room For Red Hat Enterprise Linux

The following list presents some possible scenarios you may face when attempting to repartition your hard disk:

- Unpartitioned free space is available
- An unused partition is available
- Free space in an actively used partition is available

Let us look at each scenario in order.

Note

Keep in mind that the following illustrations are simplified in the interest of clarity and do not reflect the exact partition layout that you encounter when actually installing Red Hat Enterprise Linux.

A.1.4.1. Using Unpartitioned Free Space

In this situation, the partitions already defined do not span the entire hard disk, leaving unallocated space that is not part of any defined partition. *Figure A.8, "Disk Drive with Unpartitioned Free Space"*, shows what this might look like.

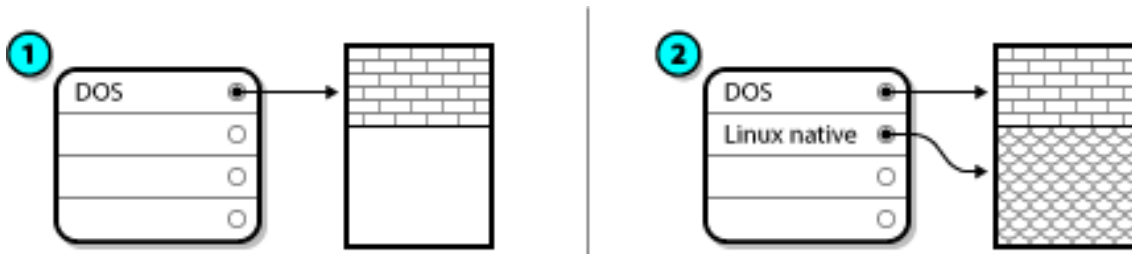


Figure A.8. Disk Drive with Unpartitioned Free Space

In *Figure A.8, "Disk Drive with Unpartitioned Free Space"*, 1 represents an undefined partition with unallocated space and 2 represents a defined partition with allocated space.

If you think about it, an unused hard disk also falls into this category. The only difference is that *all* the space is not part of any defined partition.

In any case, you can create the necessary partitions from the unused space. Unfortunately, this scenario, although very simple, is not very likely (unless you have just purchased a new disk just for Red Hat Enterprise Linux). Most pre-installed operating systems are configured to take up all available space on a disk drive (refer to *Section A.1.4.3, "Using Free Space from an Active Partition"*).

Next, we will discuss a slightly more common situation.

A.1.4.2. Using Space from an Unused Partition

In this case, maybe you have one or more partitions that you do not use any longer. Perhaps you have dabbled with another operating system in the past, and the partition(s) you dedicated to it never seem to be used anymore. *Figure A.9, "Disk Drive With an Unused Partition"*, illustrates such a situation.

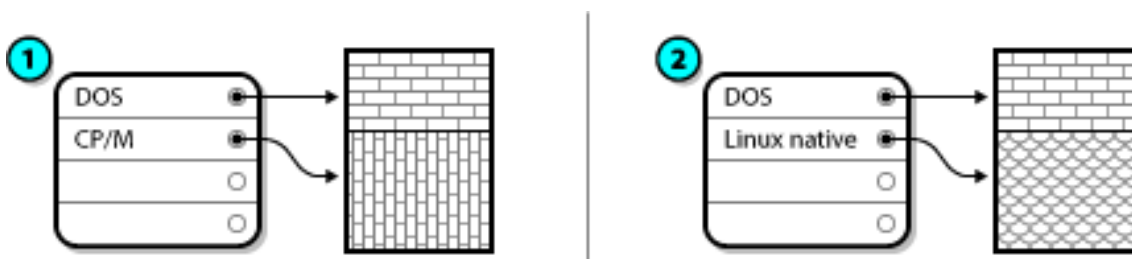


Figure A.9. Disk Drive With an Unused Partition

In *Figure A.9, "Disk Drive With an Unused Partition"*, 1 represents an unused partition and 2 represents reallocating an unused partition for Linux.

If you find yourself in this situation, you can use the space allocated to the unused partition. You first must delete the partition and then create the appropriate Linux partition(s) in its place. You can delete the unused partition and manually create new partitions during the installation process.

A.1.4.3. Using Free Space from an Active Partition

This is the most common situation. It is also, unfortunately, the hardest to handle. The main problem is that, even if you have enough free space, it is presently allocated to a partition that is already in use.

If you purchased a computer with pre-installed software, the hard disk most likely has one massive partition holding the operating system and data.

Aside from adding a new hard drive to your system, you have two choices:

Destructive Repartitioning

Basically, you delete the single large partition and create several smaller ones. As you might imagine, any data you had in the original partition is destroyed. This means that making a complete backup is necessary. For your own sake, make two backups, use verification (if available in your backup software), and try to read data from your backup *before* you delete the partition.



Warning

If there was an operating system of some type installed on that partition, it needs to be reinstalled as well. Be aware that some computers sold with pre-installed operating systems may not include the CD-ROM media to reinstall the original operating system. The best time to notice if this applies to your system is *before* you destroy your original partition and its operating system installation.

After creating a smaller partition for your existing operating system, you can reinstall any software, restore your data, and start your Red Hat Enterprise Linux installation. [Figure A.10, “Disk Drive Being Destructively Repartitioned”](#) shows this being done.

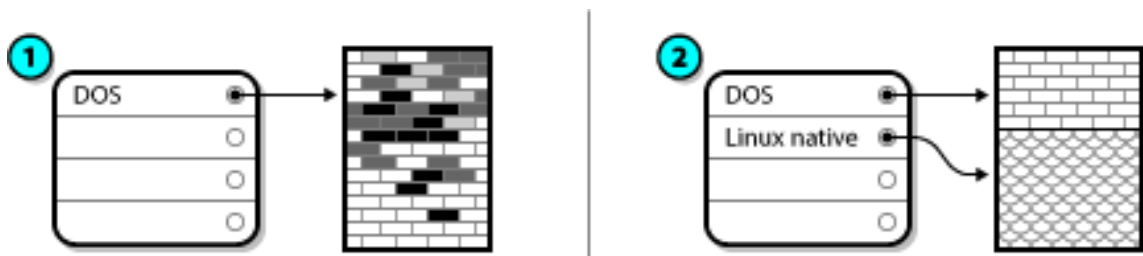


Figure A.10. Disk Drive Being Destructively Repartitioned

In [Figure A.10, “Disk Drive Being Destructively Repartitioned”](#), 1 represents before and 2 represents after.



Warning

As [Figure A.10, “Disk Drive Being Destructively Repartitioned”](#), shows, any data present in the original partition is lost without proper backup!

Non-Destructive Repartitioning

Here, you run a program that does the seemingly impossible: it makes a big partition smaller without losing any of the files stored in that partition. Many people have found this method to be reliable and trouble-free. What software should you use to perform this feat? There are several disk management software products on the market. Do some research to find the one that is best for your situation.

While the process of non-destructive repartitioning is rather straightforward, there are a number of steps involved:

- Compress and backup existing data
- Resize the existing partition
- Create new partition(s)

Next we will look at each step in a bit more detail.

A.1.4.3.1. Compress existing data

As *Figure A.11, "Disk Drive Being Compressed"*, shows, the first step is to compress the data in your existing partition. The reason for doing this is to rearrange the data such that it maximizes the available free space at the "end" of the partition.

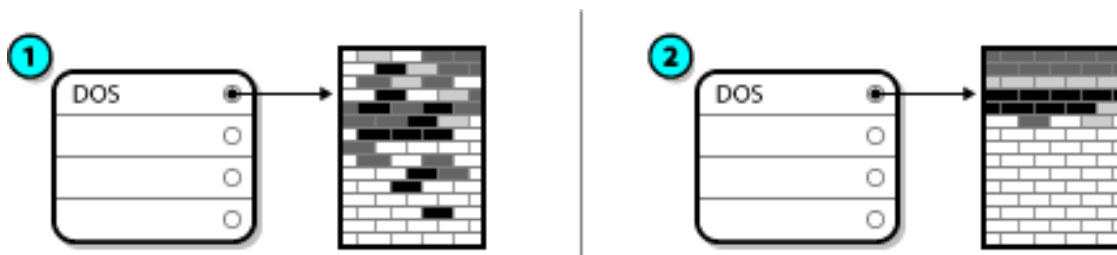


Figure A.11. Disk Drive Being Compressed

In *Figure A.11, "Disk Drive Being Compressed"*, 1 represents before and 2 represents after.

This step is crucial. Without it, the location of your data could prevent the partition from being resized to the extent desired. Note also that, for one reason or another, some data cannot be moved. If this is the case (and it severely restricts the size of your new partition(s)), you may be forced to destructively repartition your disk.

A.1.4.3.2. Resize the existing partition

Figure A.12, "Disk Drive with Partition Resized", shows the actual resizing process. While the actual result of the resizing operation varies depending on the software used, in most cases the newly freed space is used to create an unformatted partition of the same type as the original partition.

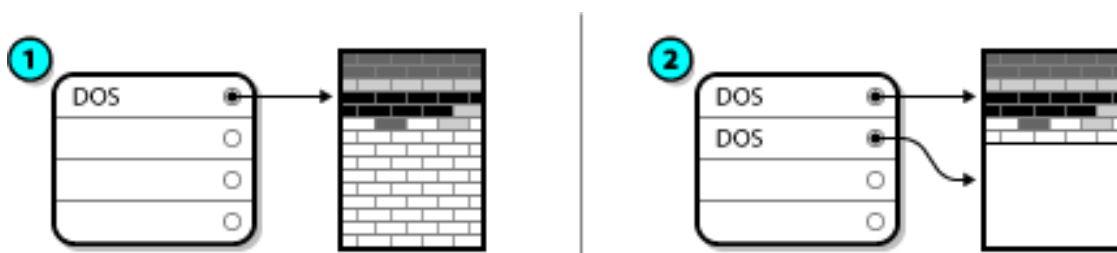


Figure A.12. Disk Drive with Partition Resized

In *Figure A.12, "Disk Drive with Partition Resized"*, 1 represents before and 2 represents after.

It is important to understand what the resizing software you use does with the newly freed space, so that you can take the appropriate steps. In the case we have illustrated, it would be best to delete the new DOS partition and create the appropriate Linux partition(s).

A.1.4.3.3. Create new partition(s)

As the previous step implied, it may or may not be necessary to create new partitions. However, unless your resizing software is Linux-aware, it is likely that you must delete the partition that was

created during the resizing process. *Figure A.13, "Disk Drive with Final Partition Configuration"*, shows this being done.



Figure A.13. Disk Drive with Final Partition Configuration

In *Figure A.13, "Disk Drive with Final Partition Configuration"*, 1 represents before and 2 represents after.

Note

The following information is specific to x86-based computers only.

As a convenience to our customers, we provide the **parted** utility. This is a freely available program that can resize partitions.

If you decide to repartition your hard drive with **parted**, it is important that you be familiar with disk storage and that you perform a backup of your computer data. You should make two copies of all the important data on your computer. These copies should be to removable media (such as tape, CD-ROM, or diskettes), and you should make sure they are readable before proceeding.

Should you decide to use **parted**, be aware that after **parted** runs you are left with *two* partitions: the one you resized, and the one **parted** created out of the newly freed space. If your goal is to use that space to install Red Hat Enterprise Linux, you should delete the newly created partition, either by using the partitioning utility under your current operating system or while setting up partitions during installation.

A.1.5. Partition Naming Scheme

Linux refers to disk partitions using a combination of letters and numbers which may be confusing, particularly if you are used to the "C drive" way of referring to hard disks and their partitions. In the DOS/Windows world, partitions are named using the following method:

- Each partition's type is checked to determine if it can be read by DOS/Windows.
- If the partition's type is compatible, it is assigned a "drive letter." The drive letters start with a "C" and move on to the following letters, depending on the number of partitions to be labeled.
- The drive letter can then be used to refer to that partition as well as the file system contained on that partition.

Red Hat Enterprise Linux uses a naming scheme that is more flexible and conveys more information than the approach used by other operating systems. The naming scheme is file-based, with file names in the form of **/dev/xxyN**.

Here is how to decipher the partition naming scheme:

/dev/

This is the name of the directory in which all device files reside. Since partitions reside on hard disks, and hard disks are devices, the files representing all possible partitions reside in **/dev/**.

xx

The first two letters of the partition name indicate the type of device on which the partition resides, usually either **hd** (for IDE disks) or **sd** (for SCSI disks).

y

This letter indicates which device the partition is on. For example, **/dev/hda** (the first IDE hard disk) or **/dev/sdb** (the second SCSI disk).

N

The final number denotes the partition. The first four (primary or extended) partitions are numbered **1** through **4**. Logical partitions start at **5**. So, for example, **/dev/hda3** is the third primary or extended partition on the first IDE hard disk, and **/dev/sdb6** is the second logical partition on the second SCSI hard disk.



Note

There is no part of this naming convention that is based on partition type; unlike DOS/Windows, *all* partitions can be identified under Red Hat Enterprise Linux. Of course, this does not mean that Red Hat Enterprise Linux can access data on every type of partition, but in many cases it is possible to access data on a partition dedicated to another operating system.

Keep this information in mind; it makes things easier to understand when you are setting up the partitions Red Hat Enterprise Linux requires.

A.1.6. Disk Partitions and Other Operating Systems

If your Red Hat Enterprise Linux partitions are sharing a hard disk with partitions used by other operating systems, most of the time you will have no problems. However, there are certain combinations of Linux and other operating systems that require extra care.

A.1.7. Disk Partitions and Mount Points

One area that many people new to Linux find confusing is the matter of how partitions are used and accessed by the Linux operating system. In DOS/Windows, it is relatively simple: Each partition gets a "drive letter." You then use the correct drive letter to refer to files and directories on its corresponding partition.

This is entirely different from how Linux deals with partitions and, for that matter, with disk storage in general. The main difference is that each partition is used to form part of the storage necessary to support a single set of files and directories. This is done by associating a partition with a directory through a process known as *mounting*. Mounting a partition makes its storage available starting at the specified directory (known as a *mount point*).

For example, if partition **/dev/hda5** is mounted on **/usr/**, that would mean that all files and directories under **/usr/** physically reside on **/dev/hda5**. So the file **/usr/share/doc/FAQ/txt/Linux-FAQ** would be stored on **/dev/hda5**, while the file **/etc/gdm/custom.conf** would not.

Continuing our example, it is also possible that one or more directories below **/usr/** would be mount points for other partitions. For instance, a partition (say, **/dev/hda7**) could be mounted on **/usr/**

local/, meaning that **/usr/local/man/what is** would then reside on **/dev/hda7** rather than **/dev/hda5**.

A.1.8. How Many Partitions?

At this point in the process of preparing to install Red Hat Enterprise Linux, you must give some consideration to the number and size of the partitions to be used by your new operating system. The question of "how many partitions" continues to spark debate within the Linux community and, without any end to the debate in sight, it is safe to say that there are probably as many partition layouts as there are people debating the issue.

Keeping this in mind, we recommend that, unless you have a reason for doing otherwise, you should at least create the following partitions: **swap**, **/boot/**, and **/** (root).

For more information, refer to [Section 9.14.5, "Recommended Partitioning Scheme"](#).

Appendix B. iSCSI disks

Internet Small Computer System Interface (iSCSI) is a protocol that allows computers to communicate with storage devices by SCSI requests and responses carried over TCP/IP. Because iSCSI is based on the standard SCSI protocols, it uses some terminology from SCSI. The device on the SCSI bus to which requests get sent (and which answers these requests) is known as the *target* and the device issuing requests is known as the *initiator*. In other words, an iSCSI disk is a target and the iSCSI software equivalent of a SCSI controller or SCSI Host Bus Adapter (HBA) is called an initiator. This appendix only covers Linux as an iSCSI initiator: how Linux uses iSCSI disks, but not how Linux hosts iSCSI disks.

Linux has a software iSCSI initiator in the kernel that takes the place and form of a SCSI HBA driver and therefore allows Linux to use iSCSI disks. However, as iSCSI is a fully network-based protocol, iSCSI initiator support needs more than just the ability to send SCSI packets over the network. Before Linux can use an iSCSI target, Linux must find the target on the network and make a connection to it. In some cases, Linux must send authentication information to gain access to the target. Linux must also detect any failure of the network connection and must establish a new connection, including logging in again if necessary.

The discovery, connection, and logging in is handled in userspace by the **iscsiadm** utility, and the error handling is also handled in userspace by **iscsid**.

Both **iscsiadm** and **iscsid** are part of the **iscsi-initiator-utils** package under Red Hat Enterprise Linux.

B.1. iSCSI disks in anaconda

Anaconda can discover (and then log in to) iSCSI disks in two ways:

1. When **anaconda** starts, it checks if the BIOS or add-on boot ROMs of the system support *iSCSI Boot Firmware Table* (iBFT), a BIOS extension for systems which can boot from iSCSI. If the BIOS supports iBFT, **anaconda** will read the iSCSI target information for the configured boot disk from the BIOS and log in to this target, making it available as an installation target.
2. If you select the **Specialized Storage Devices** option during installation, the storage device selection screen presents you with an **Add Advanced Target** button. If you click this button, you can add iSCSI target information like the discovery IP address. **Anaconda** probes the given IP address and logs in to any targets that it finds. See [Section 9.5.1.1, “Advanced Storage Options”](#) for the details that you can specify for iSCSI targets.

While **anaconda** uses **iscsiadm** to find and log into iSCSI targets, **iscsiadm** automatically stores any information about these targets in the **iscsiadm** iSCSI database. **Anaconda** then copies this database to the installed system and marks any iSCSI targets not used for `/` so that the system will automatically log in to them when it starts. If `/` is placed on an iSCSI target, **initrd** will log into this target and **anaconda** does not include this target in start up scripts to avoid multiple attempts to log into the same target.

If `/` is placed on an iSCSI target, **anaconda** sets **NetworkManager** to ignore any network interfaces that were active during the installation process. These interfaces will also be configured by **initrd** when the system starts. If **NetworkManager** were to reconfigure these interfaces, the system would lose its connection to `/`.

B.2. iSCSI disks during start up

iSCSI-related events might occur at a number of points while the system starts:

Appendix B. iSCSI disks

1. The init script in the **initrd** will log in to iSCSI targets used for / (if any). This is done using the **iscsistart** utility (which can do this without requiring **iscsid** to run).
2. When the root filesystem has been mounted and the various service initscripts get run, the **iscsid** initscript will get called. This script will then start **iscsid** if any iSCSI targets are used for /, or if any targets in the iSCSI database are marked to be logged in to automatically.
3. After the classic network service script has been run (or would have been run if enabled) the **iscsi** initscript will run. If the network is accessible, this will log in to any targets in the iSCSI database which are marked to be logged in to automatically. If the network is not accessible, this script will exit quietly.
4. When using **NetworkManager** to access the network (instead of the classic network service script), **NetworkManager** will call the **iscsi** initscript. See: `/etc/NetworkManager/dispatcher.d/04-iscsi`



Important

Because **NetworkManager** is installed in **/usr**, you cannot use it to configure network access if **/usr** is on network-attached storage such as an iSCSI target.

If **iscsid** is not needed as the system starts, it will not start automatically. If you start **iscsiadm**, **iscsiadm** will start **iscsid** in turn.

Appendix C. Disk Encryption

C.1. What is block device encryption?

Block device encryption protects the data on a block device by encrypting it. To access the device's decrypted contents, a user must provide a passphrase or key as authentication. This provides additional security beyond existing OS security mechanisms in that it protects the device's contents even if it has been physically removed from the system.

C.2. Encrypting block devices using dm-crypt/LUKS

Linux Unified Key Setup (LUKS) is a specification for block device encryption. It establishes an on-disk format for the data, as well as a passphrase/key management policy.

LUKS uses the kernel device mapper subsystem via the **dm-crypt** module. This arrangement provides a low-level mapping that handles encryption and decryption of the device's data. User-level operations, such as creating and accessing encrypted devices, are accomplished through the use of the **cryptsetup** utility.

C.2.1. Overview of LUKS

- What LUKS does:
 - LUKS encrypts entire block devices
 - LUKS is thereby well-suited for protecting the contents of mobile devices such as:
 - Removable storage media
 - Laptop disk drives
 - The underlying contents of the encrypted block device are arbitrary.
 - This makes it useful for encrypting **swap** devices.
 - This can also be useful with certain databases that use specially formatted block devices for data storage.
 - LUKS uses the existing device mapper kernel subsystem.
 - This is the same subsystem used by LVM, so it is well tested.
 - LUKS provides passphrase strengthening.
 - This protects against dictionary attacks.
 - LUKS devices contain multiple key slots.
 - This allows users to add backup keys/passphrases.
- What LUKS does *not* do:
 - LUKS is not well-suited for applications requiring many (more than eight) users to have distinct access keys to the same device.
 - LUKS is not well-suited for applications requiring file-level encryption.

More detailed information about LUKS is available from the project website at <http://code.google.com/p/cryptsetup/>.

C.2.2. How will I access the encrypted devices after installation? (System Startup)

During system startup you will be presented with a passphrase prompt. After the correct passphrase has been provided the system will continue to boot normally. If you used different passphrases for multiple encrypted devices you may need to enter more than one passphrase during the startup.



Tip

Consider using the same passphrase for all encrypted block devices in a given system. This will simplify system startup and you will have fewer passphrases to remember. Just make sure you choose a good passphrase!

C.2.3. Choosing a Good Passphrase

While dm-crypt/LUKS supports both keys and passphrases, the anaconda installer only supports the use of passphrases for creating and accessing encrypted block devices during installation.

LUKS does provide passphrase strengthening but it is still a good idea to choose a good (meaning "difficult to guess") passphrase. Note the use of the term "passphrase", as opposed to the term "password". This is intentional. Providing a phrase containing multiple words to increase the security of your data is important.

C.3. Creating Encrypted Block Devices in Anaconda

You can create encrypted devices during system installation. This allows you to easily configure a system with encrypted partitions.

To enable block device encryption, check the "Encrypt System" checkbox when selecting automatic partitioning or the "Encrypt" checkbox when creating an individual partition, software RAID array, or logical volume. After you finish partitioning, you will be prompted for an encryption passphrase. This passphrase will be required to access the encrypted devices. If you have pre-existing LUKS devices and provided correct passphrases for them earlier in the install process the passphrase entry dialog will also contain a checkbox. Checking this checkbox indicates that you would like the new passphrase to be added to an available slot in each of the pre-existing encrypted block devices.



Tip

Checking the "Encrypt System" checkbox on the "Automatic Partitioning" screen and then choosing "Create custom layout" does not cause any block devices to be encrypted automatically.



Tip

You can use **kickstart** to set a separate passphrase for each new encrypted block device.

C.3.1. What Kinds of Block Devices Can Be Encrypted?

Most types of block devices can be encrypted using LUKS. From anaconda you can encrypt partitions, ~~476~~ physical volumes, LVM logical volumes, and software RAID arrays.

C.3.2. Saving Passphrases

If you use a kickstart file during installation, you can automatically save the passphrases used during installation to an encrypted file on the local file system. To use this feature, you must have an X.509 certificate available at a location that **anaconda** can access. To specify the URL of this certificate, add the `--escrowcert` parameter to any of the **autopart**, **logvol**, **part** or **raid** commands. During installation, the encryption keys for the specified devices are saved in files in `/` (root), encrypted with the certificate.

Note that this feature is available only while performing a kickstart installation. Refer to [Chapter 32, Kickstart Installations](#) for more detail.

C.3.3. Creating and Saving Backup Passphrases

If you use a kickstart file during installation, **anaconda** can add a randomly generated backup passphrase to each block device on the system and save each passphrase to an encrypted file on the local file system. Specify the URL of this certificate with the `--escrowcert` parameter as described in [Section C.3.2, "Saving Passphrases"](#), followed by the `--backuppassphrase` parameter for each of the kickstart commands that relate to the devices for which you want to create backup passphrases.

Note that this feature is available only while performing a kickstart installation. Refer to [Chapter 32, Kickstart Installations](#) for more detail.

C.4. Creating Encrypted Block Devices on the Installed System After Installation

Encrypted block devices can be created and configured after installation.

C.4.1. Create the block devices

Create the block devices you want to encrypt by using **parted**, **pvccreate**, **lvcreate** and **mdadm**.

C.4.2. Optional: Fill the device with random data

Filling `<device>` (eg: `/dev/sda3`) with random data before encrypting it greatly increases the strength of the encryption. The downside is that it can take a very long time.



Warning

The commands below will destroy any existing data on the device.

- The best way, which provides high quality random data but takes a long time (several minutes per gigabyte on most systems):

```
dd if=/dev/urandom of=<device>
```

- Fastest way, which provides lower quality random data:

```
badblocks -c 10240 -s -w -t random -v <device>
```

C.4.3. Format the device as a dm-crypt/LUKS encrypted device



Warning

The command below will destroy any existing data on the device.

```
cryptsetup luksFormat <device>
```



Tip

For more information, read the **cryptsetup(8)** man page.

After supplying the passphrase twice the device will be formatted for use. To verify, use the following command:

```
cryptsetup isLuks <device> && echo Success
```

To see a summary of the encryption information for the device, use the following command:

```
cryptsetup luksDump <device>
```

C.4.4. Create a mapping to allow access to the device's decrypted contents

To access the device's decrypted contents, a mapping must be established using the kernel **device-mapper**.

It is useful to choose a meaningful name for this mapping. LUKS provides a UUID (Universally Unique Identifier) for each device. This, unlike the device name (eg: **/dev/sda3**), is guaranteed to remain constant as long as the LUKS header remains intact. To find a LUKS device's UUID, run the following command:

```
cryptsetup luksUUID <device>
```

An example of a reliable, informative and unique mapping name would be **luks-uuid**, where **<uuid>** is replaced with the device's LUKS UUID (eg: **luks-50ec957a-5b5a-47ee-85e6-f8085bbc97a8**). This naming convention might seem unwieldy but is it not necessary to type it often.

```
cryptsetup luksOpen <device> <name>
```

There should now be a device node, **/dev/mapper/<name>**, which represents the decrypted device. This block device can be read from and written to like any other unencrypted block device.

To see some information about the mapped device, use the following command:

```
dmsetup info <name>
```

Create filesystems on the mapped device, or continue to build complex storage structures using the mapped device



Tip

For more information, read the **dmsetup(8)** man page.

C.4.5. Create filesystems on the mapped device, or continue to build complex storage structures using the mapped device

Use the mapped device node (**/dev/mapper/<name>**) as any other block device. To create an **ext2** filesystem on the mapped device, use the following command:

```
mke2fs /dev/mapper/<name>
```

To mount this filesystem on **/mnt/test**, use the following command:



Important

The directory **/mnt/test** must exist before executing this command.

```
mount /dev/mapper/<name> /mnt/test
```

C.4.6. Add the mapping information to **/etc/crypttab**

In order for the system to set up a mapping for the device, an entry must be present in the **/etc/crypttab** file. If the file doesn't exist, create it and change the owner and group to **root:root** and change the mode to **0744**. Add a line to the file with the following format:

```
<name> <device> none
```

The **<device>** field should be given in the form "UUID=<luks_uuid>", where **<luks_uuid>** is the LUKS uuid as given by the command **cryptsetup luksUUID <device>**. This ensures the correct device will be identified and used even if the device node (eg: **/dev/sda5**) changes.



Tip

For details on the format of the **/etc/crypttab** file, read the **crypttab(5)** man page.

C.4.7. Add an entry to **/etc/fstab**

Add an entry to **/etc/fstab**. This is only necessary if you want to establish a persistent association between the device and a mountpoint. Use the decrypted device, **/dev/mapper/<name>** in the **/etc/fstab** file.

In many cases it is desirable to list devices in **/etc/fstab** by UUID or by a filesystem label. The main purpose of this is to provide a constant identifier in the event that the device name (eg: **/dev/sda4**) changes. LUKS device names in the form of **/dev/mapper/luks-<luks_uuid>** are based only on the device's LUKS UUID, and are therefore guaranteed to remain constant. This fact makes them suitable for use in **/etc/fstab**.



Title

For details on the format of the `/etc/fstab` file, read the `fstab(5)` man page.

C.5. Common Post-Installation Tasks

The following sections are about common post-installation tasks.

C.5.1. Set a randomly generated key as an additional way to access an encrypted block device

These sections are about generating keys and adding keys.

C.5.1.1. Generate a key

This will generate a 256-bit key in the file `$HOME/keyfile`.

```
dd if=/dev/urandom of=$HOME/keyfile bs=32 count=1
chmod 600 $HOME/keyfile
```

C.5.1.2. Add the key to an available keyslot on the encrypted device

```
cryptsetup luksAddKey <device> ~/keyfile
```

C.5.2. Add a new passphrase to an existing device

```
cryptsetup luksAddKey <device>
```

After being prompted for any one of the existing passphrases for authentication, you will be prompted to enter the new passphrase.

C.5.3. Remove a passphrase or key from a device

```
cryptsetup luksRemoveKey <device>
```

You will be prompted for the passphrase you wish to remove and then for any one of the remaining passphrases for authentication.

Appendix D. Understanding LVM

LVM (Logical Volume Management) partitions provide a number of advantages over standard partitions. LVM partitions are formatted as *physical volumes*. One or more physical volumes are combined to form a *volume group*. Each volume group's total storage is then divided into one or more *logical volumes*. The logical volumes function much like standard partitions. They have a file system type, such as ext4, and a mount point.



The /boot Partition and LVM

On most architectures, the boot loader cannot read LVM volumes. You must make a standard, non-LVM disk partition for your **/boot** partition.

However, on System z, the **zipl** boot loader supports **/boot** on LVM logical volumes with linear mapping.

To understand LVM better, imagine the physical volume as a pile of *blocks*. A block is simply a storage unit used to store data. Several piles of blocks can be combined to make a much larger pile, just as physical volumes are combined to make a volume group. The resulting pile can be subdivided into several smaller piles of arbitrary size, just as a volume group is allocated to several logical volumes.

An administrator may grow or shrink logical volumes without destroying data, unlike standard disk partitions. If the physical volumes in a volume group are on separate drives or RAID arrays then administrators may also spread a logical volume across the storage devices.

You may lose data if you shrink a logical volume to a smaller capacity than the data on the volume requires. To ensure maximum flexibility, create logical volumes to meet your current needs, and leave excess storage capacity unallocated. You may safely grow logical volumes to use unallocated space, as your needs dictate.



LVM and the Default Partition Layout

By default, the installation process creates **/** and swap partitions within LVM volumes, with a separate **/boot** partition.

Appendix E. The GRUB Boot Loader

When a computer running Linux is turned on, the operating system is loaded into memory by a special program called a *boot loader*. A boot loader usually exists on the system's primary hard drive (or other media device) and has the sole responsibility of loading the Linux kernel with its required files or (in some cases) other operating systems into memory.

E.1. Boot Loaders and System Architecture

Each architecture capable of running Red Hat Enterprise Linux uses a different boot loader. The following table lists the boot loaders available for each architecture:

Table E.1. Boot Loaders by Architecture

| Architecture | Boot Loaders |
|-------------------------|--------------|
| AMD® AMD64 | GRUB |
| IBM® eServer™ System i™ | OS/400® |
| IBM® eServer™ System p™ | YABOOT |
| IBM® System z® | z/IPL |
| IBM® System z® | z/IPL |
| x86 | GRUB |

This appendix discusses commands and configuration options for the GRUB boot loader included with Red Hat Enterprise Linux for the x86 architecture.



Important — Supported file systems

The **GRUB** bootloader in Red Hat Enterprise Linux 6 supports only the ext2, ext3, and ext4 (recommended) file systems. You cannot use any other file system for **/boot**, such as Btrfs, XFS, or VFAT.

E.2. GRUB

The *GNU GRand Unified Boot loader* (GRUB) is a program which enables the selection of the installed operating system or kernel to be loaded at system boot time. It also allows the user to pass arguments to the kernel.

E.2.1. GRUB and the x86 Boot Process

This section discusses the specific role GRUB plays when booting an x86 system. For a look at the overall boot process, refer to [Section F.2, “A Detailed Look at the Boot Process”](#).

GRUB loads itself into memory in the following stages:

1. *The Stage 1 or primary boot loader is read into memory by the BIOS from the MBR*¹. The primary boot loader exists on less than 512 bytes of disk space within the MBR and is capable of loading either the Stage 1.5 or Stage 2 boot loader.
2. *The Stage 1.5 boot loader is read into memory by the Stage 1 boot loader, if necessary.* Some hardware requires an intermediate step to get to the Stage 2 boot loader. This is sometimes true when the **/boot/** partition is above the 1024 cylinder head of the hard drive or when using LBA

mode. The Stage 1.5 boot loader is found either on the `/boot/` partition or on a small part of the MBR and the `/boot/` partition.

3. *The Stage 2 or secondary boot loader is read into memory.* The secondary boot loader displays the GRUB menu and command environment. This interface allows the user to select which kernel or operating system to boot, pass arguments to the kernel, or look at system parameters.
4. *The secondary boot loader reads the operating system or kernel as well as the contents of `/boot/sysroot/` into memory.* Once GRUB determines which operating system or kernel to start, it loads it into memory and transfers control of the machine to that operating system.

The method used to boot Linux is called *direct loading* because the boot loader loads the operating system directly. There is no intermediary between the boot loader and the kernel.

The boot process used by other operating systems may differ. For example, the Microsoft® Windows® operating system, as well as other operating systems, are loaded using *chain loading*. Under this method, the MBR points to the first sector of the partition holding the operating system, where it finds the files necessary to actually boot that operating system.

GRUB supports both direct and chain loading boot methods, allowing it to boot almost any operating system.



Warning

During installation, Microsoft's DOS and Windows installation programs completely overwrite the MBR, destroying any existing boot loaders. If creating a dual-boot system, it is best to install the Microsoft operating system first.

E.2.2. Features of GRUB

GRUB contains several features that make it preferable to other boot loaders available for the x86 architecture. Below is a partial list of some of the more important features:

- *GRUB provides a true command-based, pre-OS environment on x86 machines.* This feature affords the user maximum flexibility in loading operating systems with specified options or gathering information about the system. For years, many non-x86 architectures have employed pre-OS environments that allow system booting from a command line.
- *GRUB supports Logical Block Addressing (LBA) mode.* LBA places the addressing conversion used to find files in the hard drive's firmware, and is used on many IDE and all SCSI hard devices. Before LBA, boot loaders could encounter the 1024-cylinder BIOS limitation, where the BIOS could not find a file after the 1024 cylinder head of the disk. LBA support allows GRUB to boot operating systems from partitions beyond the 1024-cylinder limit, so long as the system BIOS supports LBA mode. Most modern BIOS revisions support LBA mode.
- *GRUB can read ext2 partitions.* This functionality allows GRUB to access its configuration file, `/boot/grub/grub.conf`, every time the system boots, eliminating the need for the user to write a new version of the first stage boot loader to the MBR when configuration changes are made. The only time a user needs to reinstall GRUB on the MBR is if the physical location of the `/boot/` partition is moved on the disk. For details on installing GRUB to the MBR, refer to [Section E.3, "Installing GRUB"](#).

E.3. Installing GRUB

If GRUB was not installed during the installation process, it can be installed afterward. Once installed, it automatically becomes the default boot loader.

Before installing GRUB, make sure to use the latest GRUB package available or use the GRUB package from the installation DVD. For instructions on installing packages, refer to the chapter titled *Package Management with RPM* in the *Red Hat Enterprise Linux Deployment Guide*.

Once the GRUB package is installed, open a root shell prompt and run the command `/sbin/grub-install <location>`, where `<location>` is the location that the GRUB Stage 1 boot loader should be installed. For example, the following command installs GRUB to the MBR of the master IDE device on the primary IDE bus:

```
/sbin/grub-install /dev/hda
```

The next time the system boots, the GRUB graphical boot loader menu appears before the kernel loads into memory.



Important — GRUB and RAID

GRUB cannot construct a software RAID. Therefore, the `/boot` directory must reside on a single, specific disk partition. The `/boot` directory cannot be striped across multiple disks, as in a level 0 RAID. To use a level 0 RAID on your system, place `/boot` on a separate partition outside the RAID.

Similarly, because the `/boot` directory must reside on a single, specific disk partition, **GRUB** cannot boot the system if the disk holding that partition fails or is removed from the system. This is true even if the disk is mirrored in a level 1 RAID. The following Red Hat Knowledgebase article describes how to make the system bootable from another disk in the mirrored set: <http://kbase.redhat.com/faq/docs/DOC-7095>

Note that these issues apply only to RAID that is implemented in software, where the individual disks that make up the array are still visible as individual disks on the system. These issues do not apply to hardware RAID where multiple disks are represented as a single device.

E.4. GRUB Terminology

One of the most important things to understand before using GRUB is how the program refers to devices, such as hard drives and partitions. This information is particularly important when configuring GRUB to boot multiple operating systems.

E.4.1. Device Names

When referring to a specific device with GRUB, do so using the following format (note that the parentheses and comma are very important syntactically):

```
(<type-of-device><bios-device-number>,<partition-number>)
```

The `<type-of-device>` specifies the type of device from which GRUB boots. The two most common options are `hd` for a hard disk or `fd` for a 3.5 diskette. A lesser used device type is also available called `nd` for a network disk. Instructions on configuring GRUB to boot over the network are available online at <http://www.gnu.org/software/grub/manual/>.

The *<bios-device-number>* is the BIOS device number. The primary IDE hard drive is numbered **0** and a secondary IDE hard drive is numbered **1**. This syntax is roughly equivalent to that used for devices by the kernel. For example, the **a** in **hda** for the kernel is analogous to the **0** in **hd0** for GRUB, the **b** in **hdb** is analogous to the **1** in **hd1**, and so on.

The *<partition-number>* specifies the number of a partition on a device. Like the *<bios-device-number>*, most types of partitions are numbered starting at **0**. However, BSD partitions are specified using letters, with **a** corresponding to **0**, **b** corresponding to **1**, and so on.



Note

The numbering system for devices under GRUB always begins with **0**, not **1**. Failing to make this distinction is one of the most common mistakes made by new users.

To give an example, if a system has more than one hard drive, GRUB refers to the first hard drive as **(hd0)** and the second as **(hd1)**. Likewise, GRUB refers to the first partition on the first drive as **(hd0, 0)** and the third partition on the second hard drive as **(hd1, 2)**.

In general the following rules apply when naming devices and partitions under GRUB:

- It does not matter if system hard drives are IDE or SCSI, all hard drives begin with the letters **hd**. The letters **fd** are used to specify 3.5 diskettes.
- To specify an entire device without respect to partitions, leave off the comma and the partition number. This is important when telling GRUB to configure the MBR for a particular disk. For example, **(hd0)** specifies the MBR on the first device and **(hd3)** specifies the MBR on the fourth device.
- If a system has multiple drive devices, it is very important to know how the drive boot order is set in the BIOS. This is a simple task if a system has only IDE or SCSI drives, but if there is a mix of devices, it becomes critical that the type of drive with the boot partition be accessed first.

E.4.2. File Names and Blocklists

When typing commands to GRUB that reference a file, such as a menu list, it is necessary to specify an absolute file path immediately after the device and partition numbers.

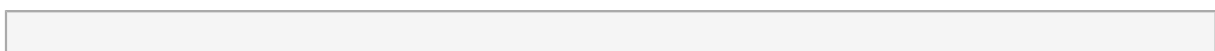
The following illustrates the structure of such a command:

```
(<device-type><device-number>, <partition-number>)</path/to/file>
```

In this example, replace *<device-type>* with **hd**, **fd**, or **nd**. Replace *<device-number>* with the integer for the device. Replace *</path/to/file>* with an absolute path relative to the top-level of the device.

It is also possible to specify files to GRUB that do not actually appear in the file system, such as a chain loader that appears in the first few blocks of a partition. To load such files, provide a *blocklist* that specifies block by block where the file is located in the partition. Since a file is often comprised of several different sets of blocks, blocklists use a special syntax. Each block containing the file is specified by an offset number of blocks, followed by the number of blocks from that offset point. Block offsets are listed sequentially in a comma-delimited list.

The following is a sample blocklist:



```
0+50,100+25,200+1
```

This sample blocklist specifies a file that starts at the first block on the partition and uses blocks 0 through 49, 100 through 124, and 200.

Knowing how to write blocklists is useful when using GRUB to load operating systems which require chain loading. It is possible to leave off the offset number of blocks if starting at block 0. As an example, the chain loading file in the first partition of the first hard drive would have the following name:

```
(hd0,0)+1
```

The following shows the **chainloader** command with a similar blocklist designation at the GRUB command line after setting the correct device and partition as root:

```
chainloader +1
```

E.4.3. The Root File System and GRUB

The use of the term *root file system* has a different meaning in regard to GRUB. It is important to remember that GRUB's root file system has nothing to do with the Linux root file system.

The GRUB root file system is the top level of the specified device. For example, the image file **(hd0,0)/grub/splash.xpm.gz** is located within the **/grub/** directory at the top-level (or root) of the **(hd0,0)** partition (which is actually the **/boot/** partition for the system).

Next, the **kernel** command is executed with the location of the kernel file as an option. Once the Linux kernel boots, it sets up the root file system that Linux users are familiar with. The original GRUB root file system and its mounts are forgotten; they only existed to boot the kernel file.

Refer to the **root** and **kernel** commands in [Section E.6, "GRUB Commands"](#) for more information.

E.5. GRUB Interfaces

GRUB features three interfaces which provide different levels of functionality. Each of these interfaces allows users to boot the Linux kernel or another operating system.

The interfaces are as follows:



Note

The following GRUB interfaces can only be accessed by pressing any key within the three seconds of the GRUB menu bypass screen.

Menu Interface

This is the default interface shown when GRUB is configured by the installation program. A menu of operating systems or preconfigured kernels are displayed as a list, ordered by name. Use the arrow keys to select an operating system or kernel version and press the **Enter** key to boot it. If you do nothing on this screen, then after the time out period expires GRUB will load the default option.

Press the **e** key to enter the entry editor interface or the **c** key to load a command line interface.

Refer to [Section E.7, “GRUB Menu Configuration File”](#) for more information on configuring this interface.

Menu Entry Editor Interface

To access the menu entry editor, press the **e** key from the boot loader menu. The GRUB commands for that entry are displayed here, and users may alter these command lines before booting the operating system by adding a command line (**o** inserts a new line after the current line and **O** inserts a new line before it), editing one (**e**), or deleting one (**d**).

After all changes are made, the **b** key executes the commands and boots the operating system. The **Esc** key discards any changes and reloads the standard menu interface. The **c** key loads the command line interface.



Note

For information about changing runlevels using the GRUB menu entry editor, refer to [Section E.8, “Changing Runlevels at Boot Time”](#).

Command Line Interface

The command line interface is the most basic GRUB interface, but it is also the one that grants the most control. The command line makes it possible to type any relevant GRUB commands followed by the **Enter** key to execute them. This interface features some advanced shell-like features, including **Tab** key completion based on context, and **Ctrl** key combinations when typing commands, such as **Ctrl+a** to move to the beginning of a line and **Ctrl+e** to move to the end of a line. In addition, the arrow, **Home**, **End**, and **Delete** keys work as they do in the **bash** shell.

Refer to [Section E.6, “GRUB Commands”](#) for a list of common commands.

E.5.1. Interfaces Load Order

When GRUB loads its second stage boot loader, it first searches for its configuration file. Once found, the menu interface bypass screen is displayed. If a key is pressed within three seconds, GRUB builds a menu list and displays the menu interface. If no key is pressed, the default kernel entry in the GRUB menu is used.

If the configuration file cannot be found, or if the configuration file is unreadable, GRUB loads the command line interface, allowing the user to type commands to complete the boot process.

If the configuration file is not valid, GRUB prints out the error and asks for input. This helps the user see precisely where the problem occurred. Pressing any key reloads the menu interface, where it is then possible to edit the menu option and correct the problem based on the error reported by GRUB. If the correction fails, GRUB reports an error and reloads the menu interface.

E.6. GRUB Commands

GRUB allows a number of useful commands in its command line interface. Some of the commands accept options after their name; these options should be separated from the command and other options on that line by space characters.

The following is a list of useful commands:

- **boot** — Boots the operating system or chain loader that was last loaded.

- **chainloader** *</path/to/file>* — Loads the specified file as a chain loader. If the file is located on the first sector of the specified partition, use the blocklist notation, **+1**, instead of the file name.

The following is an example **chainloader** command:

```
chainloader +1
```

- **displaymem** — Displays the current use of memory, based on information from the BIOS. This is useful to determine how much RAM a system has prior to booting it.
- **initrd** *</path/to/initrd>* — Enables users to specify an initial RAM disk to use when booting. An **initrd** is necessary when the kernel needs certain modules in order to boot properly, such as when the root partition is formatted with the ext3 or ext4 file system.

The following is an example **initrd** command:

```
initrd /initrd-2.6.8-1.523.img
```

- **install** *<stage-1>* *<install-disk>* *<stage-2>* **p** *config-file* — Installs GRUB to the system MBR.
 - *<stage-1>* — Signifies a device, partition, and file where the first boot loader image can be found, such as **(hd0,0)/grub/stage1**.
 - *<install-disk>* — Specifies the disk where the stage 1 boot loader should be installed, such as **(hd0)**.
 - *<stage-2>* — Passes the stage 2 boot loader location to the stage 1 boot loader, such as **(hd0,0)/grub/stage2**.
 - **p** *<config-file>* — This option tells the **install** command to look for the menu configuration file specified by *<config-file>*, such as **(hd0,0)/grub/grub.conf**.



Warning

The **install** command overwrites any information already located on the MBR.

- **kernel** *</path/to/kernel>* *<option-1>* *<option-N>* ... — Specifies the kernel file to load when booting the operating system. Replace *</path/to/kernel>* with an absolute path from the partition specified by the root command. Replace *<option-1>* with options for the Linux kernel, such as **root=/dev/VolGroup00/LogVol00** to specify the device on which the root partition for the system is located. Multiple options can be passed to the kernel in a space separated list.

The following is an example **kernel** command:

```
kernel /vmlinuz-2.6.8-1.523 ro root=/dev/VolGroup00/LogVol00
```

The option in the previous example specifies that the root file system for Linux is located on the **hda5** partition.

- **root** (*<device-type><device-number>, <partition>*) — Configures the root partition for GRUB, such as (**hd0,0**), and mounts the partition.

The following is an example **root** command:

```
root (hd0,0)
```

- **rootnoverify** (*<device-type><device-number>, <partition>*) — Configures the root partition for GRUB, just like the **root** command, but does not mount the partition.

Other commands are also available; type **help --all** for a full list of commands. For a description of all GRUB commands, refer to the documentation available online at <http://www.gnu.org/software/grub/manual/>.

E.7. GRUB Menu Configuration File

The configuration file (**/boot/grub/grub.conf**), which is used to create the list of operating systems to boot in GRUB's menu interface, essentially allows the user to select a pre-set group of commands to execute. The commands given in [Section E.6, “GRUB Commands”](#) can be used, as well as some special commands that are only available in the configuration file.

E.7.1. Configuration File Structure

The GRUB menu interface configuration file is **/boot/grub/grub.conf**. The commands to set the global preferences for the menu interface are placed at the top of the file, followed by stanzas for each operating kernel or operating system listed in the menu.

The following is a very basic GRUB menu configuration file designed to boot either Red Hat Enterprise Linux or Microsoft Windows Vista:

```
default=0
timeout=10
splashimage=(hd0,0)/grub/splash.xpm.gz
hiddenmenu
title Red Hat Enterprise Linux Server (2.6.18-2.el5PAE)
root (hd0,0)
kernel /boot/vmlinuz-2.6.18-2.el5PAE ro root=LABEL=/1 rhgb quiet
initrd /boot/initrd-2.6.18-2.el5PAE.img

# section to load Windows
title Windows
rootnoverify (hd0,0)
chainloader +1
```

This file configures GRUB to build a menu with Red Hat Enterprise Linux as the default operating system and sets it to autoboot after 10 seconds. Two sections are given, one for each operating system entry, with commands specific to the system disk partition table.

**Note**

Note that the default is specified as an integer. This refers to the first **title** line in the GRUB configuration file. For the **Windows** section to be set as the default in the previous example, change the **default=0** to **default=1**.

Configuring a GRUB menu configuration file to boot multiple operating systems is beyond the scope of this chapter. Consult [Section E.9, “Additional Resources”](#) for a list of additional resources.

E.7.2. Configuration File Directives

The following are directives commonly used in the GRUB menu configuration file:

- **chainloader** *</path/to/file>* — Loads the specified file as a chain loader. Replace *</path/to/file>* with the absolute path to the chain loader. If the file is located on the first sector of the specified partition, use the blocklist notation, **+1**.
- **color** *<normal-color>* *<selected-color>* — Allows specific colors to be used in the menu, where two colors are configured as the foreground and background. Use simple color names such as **red/black**. For example:

```
color red/black green/blue
```

- **default=<integer>** — Replace *<integer>* with the default entry title number to be loaded if the menu interface times out.
- **fallback=<integer>** — Replace *<integer>* with the entry title number to try if the first attempt fails.
- **hiddenmenu** — Prevents the GRUB menu interface from being displayed, loading the **default** entry when the **timeout** period expires. The user can see the standard GRUB menu by pressing the **Esc** key.
- **initrd** *</path/to/initrd>* — Enables users to specify an initial RAM disk to use when booting. Replace *</path/to/initrd>* with the absolute path to the initial RAM disk.
- **kernel** *</path/to/kernel>* *<option-1>* *<option-N>* — Specifies the kernel file to load when booting the operating system. Replace *</path/to/kernel>* with an absolute path from the partition specified by the root directive. Multiple options can be passed to the kernel when it is loaded.

These options include:

- **rhgb** (*Red Hat graphical boot*) — displays an animation during the boot process, rather than lines of text.
- **quiet** — suppresses all but the most important messages in the part of the boot sequence before the Red Hat graphical boot animation begins.
- **password=<password>** — Prevents a user who does not know the password from editing the entries for this menu option.

Optionally, it is possible to specify an alternate menu configuration file after the **password=<password>** directive. In this case, GRUB restarts the second stage boot loader and

uses the specified alternate configuration file to build the menu. If an alternate menu configuration file is left out of the command, a user who knows the password is allowed to edit the current configuration file.

For more information about securing GRUB, refer to the chapter titled *Workstation Security* in the *Red Hat Enterprise Linux Deployment Guide*.

- **map** — Swaps the numbers assigned to two hard drives. For example:

```
map (hd0) (hd3)
map (hd3) (hd0)
```

assigns the number **0** to the fourth hard drive, and the number **3** to the first hard drive. This option is especially useful if you configure your system with an option to boot a Windows operating system, because the Windows boot loader must find the Windows installation on the first hard drive.

For example, if your Windows installation is on the fourth hard drive, the following entry in **grub.conf** will allow the Windows boot loader to load Windows correctly:

```
title Windows
map (hd0) (hd3)
map (hd3) (hd0)
rootnoverify (hd3,0)
chainloader +1
```

- **root (<device-type><device-number>, <partition>)** — Configures the root partition for GRUB, such as **(hd0, 0)**, and mounts the partition.
- **rootnoverify (<device-type><device-number>, <partition>)** — Configures the root partition for GRUB, just like the **root** command, but does not mount the partition.
- **timeout=<integer>** — Specifies the interval, in seconds, that GRUB waits before loading the entry designated in the **default** command.
- **splashimage=<path-to-image>** — Specifies the location of the splash screen image to be used when GRUB boots.
- **title group-title** — Specifies a title to be used with a particular group of commands used to load a kernel or operating system.

To add human-readable comments to the menu configuration file, begin the line with the hash mark character (**#**).

E.8. Changing Runlevels at Boot Time

Under Red Hat Enterprise Linux, it is possible to change the default runlevel at boot time.

To change the runlevel of a single boot session, use the following instructions:

- When the GRUB menu bypass screen appears at boot time, press any key to enter the GRUB menu (within the first three seconds).
- Press the **a** key to append to the **kernel** command.
- Add **<space><runlevel>** at the end of the boot options line to boot to the desired runlevel. For example, the following entry would initiate a boot process into runlevel 3:


```
grub append> ro root=/dev/VolGroup00/LogVol100 rhgb quiet 3
```

E.9. Additional Resources

This chapter is only intended as an introduction to GRUB. Consult the following resources to discover more about how GRUB works.

E.9.1. Installed Documentation

- `/usr/share/doc/grub-<version-number>/` — This directory contains good information about using and configuring GRUB, where `<version-number>` corresponds to the version of the GRUB package installed.
- **info grub** — The GRUB info page contains a tutorial, a user reference manual, a programmer reference manual, and a FAQ document about GRUB and its usage.

E.9.2. Useful Websites

- <http://www.gnu.org/software/grub/>² — The home page of the GNU GRUB project. This site contains information concerning the state of GRUB development and an FAQ.
- <http://kbase.redhat.com/faq/docs/DOC-6864> — Details booting operating systems other than Linux.

E.9.3. Related Books

- *Red Hat Enterprise Linux Deployment Guide*; Red Hat, Inc. — The *Workstation Security* chapter explains, in a concise manner, how to secure the GRUB boot loader.

You can find the current version of the *Red Hat Enterprise Linux Deployment Guide* at <http://www.redhat.com/docs/manuals/enterprise/>. In the version of the book for Red Hat Enterprise Linux 5, the relevant section is 43.1.2. *BIOS and Boot Loader Security*: http://www.redhat.com/docs/en-US/Red_Hat_Enterprise_Linux/5/html/Deployment_Guide/ch-sec-network.html#s1-wstation-boot-sec.

Appendix F. Boot Process, Init, and Shutdown

An important and powerful aspect of Red Hat Enterprise Linux is the open, user-configurable method it uses for starting the operating system. Users are free to configure many aspects of the boot process, including specifying the programs launched at boot-time. Similarly, system shutdown gracefully terminates processes in an organized and configurable way, although customization of this process is rarely required.

Understanding how the boot and shutdown processes work not only allows customization, but also makes it easier to troubleshoot problems related to starting or shutting down the system.

F.1. The Boot Process

Below are the basic stages of the boot process for an x86 system:

1. The system BIOS checks the system and launches the first stage boot loader on the MBR of the primary hard disk.
2. The first stage boot loader loads itself into memory and launches the second stage boot loader from the `/boot/` partition.
3. The second stage boot loader loads the kernel into memory, which in turn loads any necessary modules and mounts the root partition read-only.
4. The kernel transfers control of the boot process to the `/sbin/init` program.
5. The `/sbin/init` program loads all services and user-space tools, and mounts all partitions listed in `/etc/fstab`.
6. The user is presented with a login screen for the freshly booted Linux system.

Because configuration of the boot process is more common than the customization of the shutdown process, the remainder of this chapter discusses in detail how the boot process works and how it can be customized to suite specific needs.

F.2. A Detailed Look at the Boot Process

The beginning of the boot process varies depending on the hardware platform being used. However, once the kernel is found and loaded by the boot loader, the default boot process is identical across all architectures. This chapter focuses primarily on the x86 architecture.

F.2.1. The BIOS

When an x86 computer is booted, the processor looks at the end of system memory for the *Basic Input/Output System* or *BIOS* program and runs it. The BIOS controls not only the first step of the boot process, but also provides the lowest level interface to peripheral devices. For this reason it is written into read-only, permanent memory and is always available for use.

Other platforms use different programs to perform low-level tasks roughly equivalent to those of the BIOS on an x86 system.

Once loaded, the BIOS tests the system, looks for and checks peripherals, and then locates a valid device with which to boot the system. Usually, it checks any diskette drives and optical drives present

for bootable media, then, failing that, looks to the system's hard drives. In most cases, the order of the drives searched while booting is controlled with a setting in the BIOS, and it looks on the master IDE device on the primary IDE bus. The BIOS then loads into memory whatever program is residing in the first sector of this device, called the *Master Boot Record* or *MBR*. The MBR is only 512 bytes in size and contains machine code instructions for booting the machine, called a boot loader, along with the partition table. Once the BIOS finds and loads the boot loader program into memory, it yields control of the boot process to it.

F.2.2. The Boot Loader

This section looks at the default boot loader for the x86 platform, GRUB. Depending on the system's architecture, the boot process may differ slightly. Refer to [Section F.2.2.1, “Boot Loaders for Other Architectures”](#) for a brief overview of non-x86 boot loaders. For more information about configuring and using GRUB, see [Appendix E, The GRUB Boot Loader](#).

A boot loader for the x86 platform is broken into at least two stages. The first stage is a small machine code binary on the MBR. Its sole job is to locate the second stage boot loader and load the first part of it into memory.

GRUB has the advantage of being able to read ext2, ext3, and ext4¹ partitions and load its configuration file — `/boot/grub/grub.conf` — at boot time. Refer to [Section E.7, “GRUB Menu Configuration File”](#) for information on how to edit this file.



Important — Supported file systems

The **GRUB** bootloader in Red Hat Enterprise Linux 6 supports ext2, ext3, and ext4 file systems. It does not support other file systems such as VFAT, Btrfs or XFS. Furthermore, **GRUB** does not support LVM.



Note

If upgrading the kernel using the **Red Hat Update Agent**, the boot loader configuration file is updated automatically. More information on Red Hat Network can be found online at the following URL: <https://rhn.redhat.com/>.

Once the second stage boot loader is in memory, it presents the user with a graphical screen showing the different operating systems or kernels it has been configured to boot. On this screen a user can use the arrow keys to choose which operating system or kernel they wish to boot and press **Enter**. If no key is pressed, the boot loader loads the default selection after a configurable period of time has passed.

Once the second stage boot loader has determined which kernel to boot, it locates the corresponding kernel binary in the `/boot/` directory. The kernel binary is named using the following format — `/boot/vmlinuz-<kernel-version>` file (where `<kernel-version>` corresponds to the kernel version specified in the boot loader's settings).

For instructions on using the boot loader to supply command line arguments to the kernel, refer to [Appendix E, The GRUB Boot Loader](#). For information on changing the runlevel at the boot loader prompt, refer [Section E.8, “Changing Runlevels at Boot Time”](#).

¹ GRUB reads ext3 and ext4 file systems as ext2, disregarding the journal file.

The boot loader then places one or more appropriate *initramfs* images into memory. Next, the kernel decompresses these images from memory to `/sysroot/`, a RAM-based virtual file system, via `cpio`. The `initramfs` is used by the kernel to load drivers and modules necessary to boot the system. This is particularly important if SCSI hard drives are present or if the systems use the ext3 or ext4 file system.

Once the kernel and the `initramfs` image(s) are loaded into memory, the boot loader hands control of the boot process to the kernel.

For a more detailed overview of the GRUB boot loader, refer to [Appendix E, The GRUB Boot Loader](#).

F.2.2.1. Boot Loaders for Other Architectures

Once the kernel loads and hands off the boot process to the `init` command, the same sequence of events occurs on every architecture. So the main difference between each architecture's boot process is in the application used to find and load the kernel.

For example, the IBM eServer pSeries architecture uses `yaboot`, and the IBM System z systems use the `z/IPL` boot loader.

Consult the sections of this guide specific to these platforms for information on configuring their boot loaders.

F.2.3. The Kernel

When the kernel is loaded, it immediately initializes and configures the computer's memory and configures the various hardware attached to the system, including all processors, I/O subsystems, and storage devices. It then looks for the compressed `initramfs` image(s) in a predetermined location in memory, decompresses it directly to `/sysroot/`, and loads all necessary drivers. Next, it initializes virtual devices related to the file system, such as LVM or software RAID, before completing the `initramfs` processes and freeing up all the memory the disk image once occupied.

The kernel then creates a root device, mounts the root partition read-only, and frees any unused memory.

At this point, the kernel is loaded into memory and operational. However, since there are no user applications that allow meaningful input to the system, not much can be done with the system.

To set up the user environment, the kernel executes the `/sbin/init` program.

F.2.4. The `/sbin/init` Program

The `/sbin/init` program (also called `init`) coordinates the rest of the boot process and configures the environment for the user.

When the `init` command starts, it becomes the parent or grandparent of all of the processes that start up automatically on the system. First, it runs the `/etc/rc.d/rc.sysinit` script, which sets the environment path, starts swap, checks the file systems, and executes all other steps required for system initialization. For example, most systems use a clock, so `rc.sysinit` reads the `/etc/sysconfig/clock` configuration file to initialize the hardware clock. Another example is if there are special serial port processes which must be initialized, `rc.sysinit` executes the `/etc/rc.serial` file.

The `init` command then processes the jobs in the `/etc/event.d` directory, which describe how the system should be set up in each *SysV init runlevel*. Runlevels are a state, or *mode*, defined by the services listed in the `SysV /etc/rc.d/rc<x>.d/` directory, where `<x>` is the number of the runlevel. For more information on SysV init runlevels, refer to [Section F.4, "SysV Init Runlevels"](#).

Appendix F. Boot Process, Init, and Shutdown

Next, the **init** command sets the source function library, **/etc/rc.d/init.d/functions**, for the system, which configures how to start, kill, and determine the PID of a program.

The **init** program starts all of the background processes by looking in the appropriate **rc** directory for the runlevel specified as the default in **/etc/inittab**. The **rc** directories are numbered to correspond to the runlevel they represent. For instance, **/etc/rc.d/rc5.d/** is the directory for runlevel 5.

When booting to runlevel 5, the **init** program looks in the **/etc/rc.d/rc5.d/** directory to determine which processes to start and stop.

Below is an example listing of the **/etc/rc.d/rc5.d/** directory:

```
K05innd -> ../init.d/innd
K05saslauthd -> ../init.d/saslauthd
K10dc_server -> ../init.d/dc_server
K10psacct -> ../init.d/psacct
K10radiusd -> ../init.d/radiusd
K12dc_client -> ../init.d/dc_client
K12FreeWnn -> ../init.d/FreeWnn
K12mailman -> ../init.d/mailman
K12mysqld -> ../init.d/mysqld
K15httpd -> ../init.d/httpd
K20netdump-server -> ../init.d/netdump-server
K20rstatd -> ../init.d/rstatd
K20rusersd -> ../init.d/rusersd
K20rwhod -> ../init.d/rwhod
K24irda -> ../init.d/irda
K25squid -> ../init.d/squid
K28amd -> ../init.d/amd
K30spamassassin -> ../init.d/spamassassin
K34dhcrelay -> ../init.d/dhcrelay
K34yppasswdd -> ../init.d/yppasswdd
K35dhcpcd -> ../init.d/dhcpcd
K35smb -> ../init.d/smb
K35vncserver -> ../init.d/vncserver
K36lisa -> ../init.d/lisa
K45arpwatch -> ../init.d/arpwatch
K45named -> ../init.d/named
K46radvd -> ../init.d/radvd
K50netdump -> ../init.d/netdump
K50snmpd -> ../init.d/snmpd
K50snmptrapd -> ../init.d/snmptrapd
K50tux -> ../init.d/tux
K50vsftpd -> ../init.d/vsftpd
K54dovecot -> ../init.d/dovecot
K61ldap -> ../init.d/ldap
K65kadmin -> ../init.d/kadmin
K65kprop -> ../init.d/kprop
K65krb524 -> ../init.d/krb524
K65krb5kdc -> ../init.d/krb5kdc
K70aep1000 -> ../init.d/aep1000
K70bcm5820 -> ../init.d/bcm5820
K74ypserv -> ../init.d/ypserv
K74ypxfrd -> ../init.d/ypxfrd
K85mdmpd -> ../init.d/mdmpd
K89netplugd -> ../init.d/netplugd
K99microcode_ctl -> ../init.d/microcode_ctl
S04readahead_early -> ../init.d/readahead_early
S05kudzu -> ../init.d/kudzu
S06cpuspeed -> ../init.d/cpuspeed
S08ip6tables -> ../init.d/ip6tables
S08iptables -> ../init.d/iptables
S09isdn -> ../init.d/isdn
```

```

S10network -> ../init.d/network
S12syslog -> ../init.d/syslog
S13irqbalance -> ../init.d/irqbalance
S13portmap -> ../init.d/portmap
S15mdmonitor -> ../init.d/mdmonitor
S15zebra -> ../init.d/zebra
S16bgpd -> ../init.d/bgpd
S16ospf6d -> ../init.d/ospf6d
S16ospfd -> ../init.d/ospfd
S16ripd -> ../init.d/ripd
S16ripngd -> ../init.d/ripngd
S20random -> ../init.d/random
S24pcmcia -> ../init.d/pcmcia
S25netfs -> ../init.d/netfs
S26apmd -> ../init.d/apmd
S27ypbind -> ../init.d/ypbind
S28autofs -> ../init.d/autofs
S40smartd -> ../init.d/smartd
S44acpid -> ../init.d/acpid
S54hpoj -> ../init.d/hpoj
S55cups -> ../init.d/cups
S55sshd -> ../init.d/sshd
S56rawdevices -> ../init.d/rawdevices
S56xinetd -> ../init.d/xinetd
S58ntpd -> ../init.d/ntpd
S75postgresql -> ../init.d/postgresql
S80sendmail -> ../init.d/sendmail
S85gpm -> ../init.d/gpm
S87iim -> ../init.d/iim
S90canna -> ../init.d/canna
S90crond -> ../init.d/crond
S90xfs -> ../init.d/xfs
S95atd -> ../init.d/atd
S96readahead -> ../init.d/readahead
S97messagebus -> ../init.d/messagebus
S97rhnsd -> ../init.d/rhnsd
S99local -> ../rc.local

```

As illustrated in this listing, none of the scripts that actually start and stop the services are located in the `/etc/rc.d/rc5.d/` directory. Rather, all of the files in `/etc/rc.d/rc5.d/` are *symbolic links* pointing to scripts located in the `/etc/rc.d/init.d/` directory. Symbolic links are used in each of the `rc` directories so that the runlevels can be reconfigured by creating, modifying, and deleting the symbolic links without affecting the actual scripts they reference.

The name of each symbolic link begins with either a **K** or an **S**. The **K** links are processes that are killed on that runlevel, while those beginning with an **S** are started.

The `init` command first stops all of the **K** symbolic links in the directory by issuing the `/etc/rc.d/init.d/<command> stop` command, where `<command>` is the process to be killed. It then starts all of the **S** symbolic links by issuing `/etc/rc.d/init.d/<command> start`.



Note

After the system is finished booting, it is possible to log in as root and execute these same scripts to start and stop services. For instance, the command `/etc/rc.d/init.d/httpd stop` stops the Apache HTTP Server.

Each of the symbolic links are numbered to dictate start order. The order in which the services are started or stopped can be altered by changing this number. The lower the number, the earlier it is started. Symbolic links with the same number are started alphabetically.



Note

One of the last things the **init** program executes is the `/etc/rc.d/rc.local` file. This file is useful for system customization. Refer to [Section F.3, “Running Additional Programs at Boot Time”](#) for more information about using the `rc.local` file.

After the **init** command has progressed through the appropriate `rc` directory for the runlevel, **Upstart** forks an `/sbin/mingetty` process for each virtual console (login prompt) allocated to the runlevel by the job definition in the `/etc/event.d` directory. Runlevels 2 through 5 have all six virtual consoles, while runlevel 1 (single user mode) has one, and runlevels 0 and 6 have none. The `/sbin/mingetty` process opens communication pathways to `tty` devices², sets their modes, prints the login prompt, accepts the user's username and password, and initiates the login process.

In runlevel 5, **Upstart** runs a script called `/etc/X11/prefdm`. The `prefdm` script executes the preferred X display manager³ — `gdm`, `kdm`, or `xdm`, depending on the contents of the `/etc/sysconfig/desktop` file.

Once finished, the system operates on runlevel 5 and displays a login screen.

F.2.5. Job definitions

Previously, the `sysvinit` package provided the **init** daemon for the default configuration. When the system started, this **init** daemon ran the `/etc/inittab` script to start system processes defined for each runlevel. The default configuration now uses an event-driven **init** daemon provided by the `Upstart` package. Whenever particular *events* occur, the **init** daemon processes *jobs* stored in the `/etc/event.d` directory. The **init** daemon recognises the start of the system as such an event.

Each job typically specifies a program, and the events that trigger **init** to run or to stop the program. Some jobs are constructed as *tasks*, which perform actions and then terminate until another event triggers the job again. Other jobs are constructed as *services*, which **init** keeps running until another event (or the user) stops it.

For example, the `/etc/events.d/tty2` job is a service to maintain a virtual terminal on `tty2` from the time that the system starts until the system shuts down, or another event (such as a change in runlevel) stops the job. The job is constructed so that **init** will restart the virtual terminal if it stops unexpectedly during that time:

```
# tty2 - getty
#
# This service maintains a getty on tty2 from the point the system is
# started until it is shut down again.

start on stopped rc2
start on stopped rc3
start on stopped rc4
start on started prefdm

stop on runlevel 0
stop on runlevel 1
stop on runlevel 6
```

² Refer to the Red Hat Enterprise Linux Deployment Guide for more information about `tty` devices.

³ Refer to the Red Hat Enterprise Linux Deployment Guide for more information about display managers.


```
respawn
exec /sbin/mingetty tty2
```

F.3. Running Additional Programs at Boot Time

The `/etc/rc.d/rc.local` script is executed by the `init` command at boot time or when changing runlevels. Adding commands to the bottom of this script is an easy way to perform necessary tasks like starting special services or initialize devices without writing complex initialization scripts in the `/etc/rc.d/init.d/` directory and creating symbolic links.

The `/etc/rc.serial` script is used if serial ports must be setup at boot time. This script runs `setserial` commands to configure the system's serial ports. Refer to the `setserial` man page for more information.

F.4. SysV Init Runlevels

The SysV init runlevel system provides a standard process for controlling which programs `init` launches or halts when initializing a runlevel. SysV init was chosen because it is easier to use and more flexible than the traditional BSD-style init process.

The configuration files for SysV init are located in the `/etc/rc.d/` directory. Within this directory, are the `rc`, `rc.local`, `rc.sysinit`, and, optionally, the `rc.serial` scripts as well as the following directories:

```
init.d/ rc0.d/ rc1.d/ rc2.d/ rc3.d/ rc4.d/ rc5.d/ rc6.d/
```

The `init.d/` directory contains the scripts used by the `/sbin/init` command when controlling services. Each of the numbered directories represent the six runlevels configured by default under Red Hat Enterprise Linux.

F.4.1. Runlevels

The idea behind SysV init runlevels revolves around the idea that different systems can be used in different ways. For example, a server runs more efficiently without the drag on system resources created by the X Window System. Or there may be times when a system administrator may need to operate the system at a lower runlevel to perform diagnostic tasks, like fixing disk corruption in runlevel 1.

The characteristics of a given runlevel determine which services are halted and started by `init`. For instance, runlevel 1 (single user mode) halts any network services, while runlevel 3 starts these services. By assigning specific services to be halted or started on a given runlevel, `init` can quickly change the mode of the machine without the user manually stopping and starting services.

The following runlevels are defined by default under Red Hat Enterprise Linux:

- **0** — Halt
- **1** — Single-user text mode
- **2** — Not used (user-definable)
- **3** — Full multi-user text mode
- **4** — Not used (user-definable)

- **5** — Full multi-user graphical mode (with an X-based login screen)
- **6** — Reboot

In general, users operate Red Hat Enterprise Linux at runlevel 3 or runlevel 5 — both full multi-user modes. Users sometimes customize runlevels 2 and 4 to meet specific needs, since they are not used.

The default runlevel for the system is listed in `/etc/inittab`. To find out the default runlevel for a system, look for the line similar to the following near the bottom of `/etc/inittab`:

```
id:5:initdefault:
```

The default runlevel listed in this example is five, as the number after the first colon indicates. To change it, edit `/etc/inittab` as root.



Warning

Be very careful when editing `/etc/inittab`. Simple typos can cause the system to become unbootable. If this happens, either use a boot diskette, enter single-user mode, or enter rescue mode to boot the computer and repair the file.

For more information on single-user and rescue mode, refer to the chapter titled *Basic System Recovery* in the *Red Hat Enterprise Linux Deployment Guide*.

It is possible to change the default runlevel at boot time by modifying the arguments passed by the boot loader to the kernel. For information on changing the runlevel at boot time, refer to [Section E.8, “Changing Runlevels at Boot Time”](#).

F.4.2. Runlevel Utilities

One of the best ways to configure runlevels is to use an *initscript utility*. These tools are designed to simplify the task of maintaining files in the SysV init directory hierarchy and relieves system administrators from having to directly manipulate the numerous symbolic links in the subdirectories of `/etc/rc.d/`.

Red Hat Enterprise Linux provides three such utilities:

- `/sbin/chkconfig` — The `/sbin/chkconfig` utility is a simple command line tool for maintaining the `/etc/rc.d/init.d/` directory hierarchy.
- `/usr/sbin/ntsysv` — The ncurses-based `/sbin/ntsysv` utility provides an interactive text-based interface, which some find easier to use than `chkconfig`.
- **Services Configuration Tool** — The graphical **Services Configuration Tool** (`system-config-services`) program is a flexible utility for configuring runlevels.

Refer to the chapter titled *Controlling Access to Services* in the *Red Hat Enterprise Linux Deployment Guide* for more information regarding these tools.

F.5. Shutting Down

To shut down Red Hat Enterprise Linux, the root user may issue the `/sbin/shutdown` command. The `shutdown` man page has a complete list of options, but the two most common uses are:

```
/sbin/shutdown -h now
```

and

```
/sbin/shutdown -r now
```

After shutting everything down, the **-h** option halts the machine, and the **-r** option reboots.

PAM console users can use the **reboot** and **halt** commands to shut down the system while in runlevels 1 through 5. For more information about PAM console users, refer to the Red Hat Enterprise Linux Deployment Guide.

If the computer does not power itself down, be careful not to turn off the computer until a message appears indicating that the system is halted.

Failure to wait for this message can mean that not all the hard drive partitions are unmounted, which can lead to file system corruption.

Appendix G. Alternatives to busybox commands

Unlike previous releases of Red Hat Enterprise Linux, Red Hat Enterprise Linux 6 does not include a version of **busybox** to provide shell commands in the pre-installation and post-installation environments. [Table G.1, “Alternatives to busybox commands”](#) contains a list of **busybox** commands, equivalent ways to implement the same functionality in **bash**, and the availability of these alternatives in the %pre and %post environments. The table also indicates the exact path to the command, although you do not generally need to specify the path because the PATH environment variable is set in the installation environment.

If a command is only available in %post, the command is running on the target system and its availability therefore depends on whether the package that provides the command is installed. Every command that appears in the "New command or alternative" column of [Table G.1, “Alternatives to busybox commands”](#) is available for Red Hat Enterprise Linux 6, although not every command is available on every installed system.

Where a command is listed as unavailable, you might be able to create equivalent functionality with a Python script. The Python language is available to %pre and %post script authors, complete with a set of Python modules ready for use. Therefore, if a particular command is not available to you in the installation environment, we recommend that you use Python as the script language.

Table G.1. Alternatives to busybox commands

| Busybox command | %pre | %post | New command or alternative |
|-----------------|------|-------|---|
| addgroup | no | yes | /usr/sbin/groupadd |
| adduser | no | yes | /usr/sbin/useradd |
| adjtimex | no | no | none |
| ar | no | yes | /usr/bin/ar |
| arping | yes | yes | /sbin/arping or /usr/sbin/arping |
| ash | yes | yes | /bin/bash |
| awk | yes | yes | /sbin/awk , /sbin/gawk , or /usr/bin/gawk ¹ |
| basename | yes | yes | /bin/bash ² , /usr/bin/basename |
| bbconfig | no | no | none — this command is a specific to Busybox |
| bunzip2 | yes | yes | /usr/bin/bunzip2 , /usr/bin/bzip2 -d |
| busybox | no | no | none |
| bzcat | yes | yes | /usr/bin/bzcat , /usr/bin/bzip2 -dc |
| cal | no | yes | /usr/bin/cal |
| cat | yes | yes | /usr/bin/cat |

Appendix G. Alternatives to busybox commands

| Busybox command | <i>%pre</i> | <i>%post</i> | New command or alternative |
|------------------|-------------|--------------|--|
| catv | no | no | cat -vET or cat -A |
| chattr | yes | yes | /usr/bin/chattr |
| chgrp | yes | yes | /usr/bin/chgrp |
| chmod | yes | yes | /usr/bin/chmod |
| chown | yes | yes | /usr/bin/chown |
| chroot | yes | yes | /usr/sbin/chroot |
| chvt | yes | yes | /usr/bin/chvt |
| cksum | no | yes | /usr/bin/cksum |
| clear | yes | yes | /usr/bin/clear |
| cmp | no | yes | /usr/bin/cmp |
| comm | no | yes | /usr/bin/comm |
| cp | yes | yes | /usr/bin/cp |
| cpio | yes | yes | /usr/bin/cpio |
| crond | no | no | none — no daemons available to scriptlets |
| crontab | no | yes | /usr/bin/crontab |
| cut | yes | yes | /usr/bin/cut |
| date | yes | yes | /usr/bin/date |
| dc | no | yes | /usr/bin/dc |
| dd | yes | yes | /usr/bin/dd |
| deallocvt | no | yes | /usr/bin/deallocvt |
| delgroup | no | yes | /usr/sbin/groupdel |
| deluser | no | yes | /usr/sbin/userdel |
| devfsd | no | no | none — Red Hat Enterprise Linux does not use devfs |
| df | yes | yes | /usr/bin/df |
| diff | no | yes | /usr/bin/diff |
| dirname | yes | yes | /bin/bash³ , /usr/bin/directoryname |
| dmesg | yes | yes | /usr/bin/dmesg |
| dnsd | no | no | none — no daemons available to scriptlets |
| dos2unix | no | no | sed 's/.\$//' |
| dpkg | no | no | none — no support for Debian packages |
| dpkg-deb | no | no | none — no support for Debian packages |

| Busybox command | %pre | %post | New command or alternative |
|------------------------|-------------|--------------|--|
| du | yes | yes | /usr/bin/du |
| dumpkmap | no | no | none |
| dumpleases | no | no | none |
| e2fsck | yes | yes | /usr/sbin/e2fsck |
| e2label | yes | yes | /usr/sbin/e2label |
| echo | yes | yes | /usr/bin/echo |
| ed | no | no | /sbin/sed, /usr/bin/sed |
| egrep | yes | yes | /sbin/egrep, /usr/bin/egrep |
| eject | yes | yes | /usr/bin/eject |
| env | yes | yes | /usr/bin/env |
| ether-wake | no | no | none |
| expr | yes | yes | /usr/bin/expr |
| fakeidentd | no | no | none — no daemons available to scriptlets |
| false | yes | yes | /usr/bin/false |
| fbset | no | yes | /usr/sbin/fbset |
| fdflush | no | no | none |
| fdformat | no | yes | /usr/bin/fdformat |
| fdisk | yes | yes | /usr/sbin/fdisk |
| fgrep | yes | yes | /sbin/fgrep, /usr/bin/fgrep |
| find | yes | yes | /usr/bin/find |
| findfs | no | no | none |
| fold | no | yes | /usr/bin/fold |
| free | no | yes | /usr/bin/free |
| freeramdisk | no | no | none |
| fsck | yes | yes | /usr/sbin/fsck |
| fsck.ext2 | yes | yes | /usr/sbin/fsck.ext2, /usr/sbin/e2fsck |
| fsck.ext3 | yes | yes | /usr/sbin/fsck.ext3, /usr/sbin/e2fsck |
| fsck.minix | no | no | none — no support for the Minix file system |
| ftpget | yes | yes | /usr/bin/ftp or Python ftplib module |
| ftpput | yes | yes | /usr/bin/ftp or Python ftplib module |

Appendix G. Alternatives to busybox commands

| Busybox command | <i>%pre</i> | <i>%post</i> | New command or alternative |
|-----------------|-------------|--------------|---|
| fuser | no | yes | /sbin/fuser |
| getopt | no | yes | /usr/bin/getopt |
| getty | no | no | none |
| grep | yes | yes | /sbin/grep, /usr/bin/grep |
| gunzip | yes | yes | /usr/bin/gunzip, /usr/bin/gzip -d |
| gzip | yes | yes | /usr/bin/gzip |
| hdparm | yes | yes | /usr/sbin/hdparm |
| head | yes | yes | /usr/bin/head |
| hexdump | no | yes | /usr/bin/hexdump |
| hostid | no | yes | /usr/bin/hostid or Python |
| hostname | yes | yes | /sbin/hostname, /usr/bin/hostname |
| httpd | no | no | none — no daemons available to scriptlets |
| hush | no | no | none |
| hwclock | yes | yes | /usr/sbin/hwclock |
| id | no | yes | /usr/bin/id or Python |
| ifconfig | yes | yes | /sbin/ifconfig, /usr/sbin/ifconfig |
| ifdown | no | no | ifconfig device down |
| ifup | no | no | ifconfig device up |
| inetd | no | no | none — no daemons available to scriptlets |
| insmod | yes | yes | /sbin/insmod, /usr/sbin/insmod |
| install | no | yes | /usr/bin/install or mkdir/cp/chmod/chown/chgrp |
| ip | yes | yes | /sbin/ip, /usr/sbin/ip |
| ipaddr | no | no | ifconfig or ip |
| ipcalc | yes | yes | /sbin/ipcalc, /usr/bin/ipcalc |
| ipcrm | no | yes | /usr/bin/ipcrm |
| ipcs | no | yes | /usr/bin/ipcs |
| iplink | no | no | ip |

| Busybox command | %pre | %post | New command or alternative |
|------------------------|-------------|--------------|---|
| iproute | no | no | ip |
| iptunnel | no | yes | /sbin/iptunnel |
| kill | yes | yes | /sbin/kill, /usr/bin/kill |
| killall | yes | yes | /usr/bin/killall |
| lash | no | no | none |
| last | no | yes | /usr/bin/last |
| length | no | no | Python or bash |
| less | yes | yes | /usr/bin/less |
| linux32 | no | no | none |
| linux64 | no | no | none |
| ln | yes | yes | /sbin/ln, /usr/bin/ln |
| load_policy | yes | yes | /sbin/load_policy, /usr/sbin/load_policy |
| loadfont | no | no | none |
| loadkmap | no | no | none |
| login | yes | yes | /usr/bin/login |
| logname | no | yes | /usr/bin/logname |
| losetup | yes | yes | /usr/bin/losetup |
| ls | yes | yes | /usr/bin/ls |
| lsattr | yes | yes | /usr/bin/lsattr |
| lsmod | yes | yes | /usr/bin/lsmod |
| lzmacat | no | yes | /usr/bin/lzmadec |
| makedevs | no | no | /usr/bin/mknod |
| md5sum | yes | yes | /usr/bin/md5sum |
| mdev | no | no | none |
| mesg | no | yes | /usr/bin/mesg |
| mkdir | yes | yes | /sbin/mkdir, /usr/bin/mkdir |
| mke2fs | yes | yes | /usr/sbin/mke2fs |
| mkfifo | no | yes | /usr/bin/mkfifo |
| mkfs.ext2 | yes | yes | /usr/sbin/mkfs.ext2 |
| mkfs.ext3 | yes | yes | /usr/sbin/mkfs.ext3 |
| mkfs.minix | no | no | none — no support for Minix filesystem |
| mknod | yes | yes | /usr/bin/mknod |

Appendix G. Alternatives to busybox commands

| Busybox command | %pre | %post | New command or alternative |
|------------------------|-------------|--------------|---|
| mkswap | yes | yes | /usr/sbin/mkswap |
| mktemp | yes | yes | /usr/bin/mktemp |
| modprobe | yes | yes | /sbin/modprobe, /usr/sbin/modprobe |
| more | yes | yes | /usr/bin/more |
| mount | yes | yes | /sbin/mount, /usr/bin/mount |
| mountpoint | no | no | Look at the output of the mount command |
| msh | no | no | none |
| mt | yes | yes | /usr/bin/mt |
| mv | yes | yes | /usr/bin/mv |
| nameif | no | no | none |
| nc | no | yes | /usr/bin/nc |
| netstat | no | yes | /bin/netstat |
| nice | no | yes | /bin/nice |
| nohup | no | yes | /usr/bin/nohup |
| nslookup | yes | yes | /usr/bin/nslookup |
| od | no | yes | /usr/bin/od |
| openvt | yes | yes | /usr/bin/openvt |
| passwd | no | yes | /usr/bin/passwd |
| patch | no | yes | /usr/bin/patch |
| pidof | yes | yes | /usr/sbin/pidof |
| ping | yes | yes | /usr/bin/ping |
| ping6 | no | yes | /bin/ping6 |
| pipe_progress | no | no | none |
| pivot_root | no | yes | /sbin/pivot_root |
| printenv | no | yes | /usr/bin/printenv |
| printf | no | yes | /usr/bin/printf |
| ps | yes | yes | /usr/bin/ps |
| pwd | yes | yes | /usr/bin/pwd |
| rdate | no | yes | /usr/bin/rdate |
| readlink | yes | yes | /sbin/readlink, /usr/bin/readlink |
| readprofile | no | yes | /usr/sbin/readprofile |
| realpath | no | no | Python os.path.realpath() |
| renice | no | yes | /usr/bin/renice |

| Busybox command | %pre | %post | New command or alternative |
|--------------------------|-------------|--------------|---|
| reset | no | yes | /usr/bin/reset |
| rm | yes | yes | /sbin/rm, /usr/bin/rm |
| rmdir | yes | yes | /sbin/rmdir, /usr/bin/rmdir |
| rmmmod | yes | yes | /sbin/rmmmod, /usr/bin/rmmmod |
| route | yes | yes | /sbin/route, /usr/sbin/route |
| rpm | yes | yes | /usr/bin/rpm |
| rpm2cpio | no | yes | /usr/bin/rpm2cpio |
| run-parts | no | no | none |
| runlevel | no | no | none |
| rx | no | no | none |
| sed | yes | yes | /sbin/sed, /usr/bin/sed |
| seq | no | yes | /usr/bin/seq |
| setarch | no | yes | /usr/bin/setarch |
| setconsole | no | no | none |
| setkeycodes | no | yes | /usr/bin/setkeycodes |
| setlogcons | no | no | none |
| setsid | no | yes | /usr/bin/setsid |
| sh | yes | yes | /sbin/sh, /usr/bin/sh |
| sha1sum | yes | yes | /usr/bin/sha1sum |
| sleep | yes | yes | /sbin/sleep, /usr/bin/sleep |
| sort | yes | yes | /usr/bin/sort |
| start-stop-daemon | no | no | none |
| stat | no | yes | /usr/bin/stat or Python os.stat() |
| strings | no | yes | /usr/bin/strings |
| stty | no | yes | /bin/stty |
| su | no | yes | /bin/su |
| sulogin | no | yes | /sbin/sulogin |
| sum | no | yes | /usr/bin/sum |
| swapoff | yes | yes | /usr/sbin/swapoff |
| swapon | yes | yes | /usr/sbin/swapon |
| switch_root | no | yes | /sbin/switch_root |

Appendix G. Alternatives to busybox commands

| Busybox command | <i>%pre</i> | <i>%post</i> | New command or alternative |
|-------------------|-------------|--------------|--|
| sync | yes | yes | /usr/bin/sync |
| sysctl | no | yes | /sbin/sysctl |
| tail | yes | yes | /usr/bin/tail |
| tar | yes | yes | /usr/bin/tar |
| tee | yes | yes | /usr/bin/tee |
| telnet | yes | yes | /usr/bin/telnet |
| telnetd | no | no | none — no daemons available to scriptlets |
| test | no | yes | /usr/bin/test or [in bash |
| tftp | no | yes | /usr/bin/tftp |
| time | no | yes | /usr/bin/time or Python |
| top | yes | yes | /usr/bin/top |
| touch | yes | yes | /sbin/touch, /usr/bin/touch |
| tr | no | yes | /usr/bin/tr or Python |
| traceroute | no | yes | /bin/traceroute |
| true | yes | yes | /usr/bin>true |
| tty | no | yes | /usr/bin/tty |
| tune2fs | yes | yes | /usr/sbin/tune2fs |
| udhcpc | no | no | /sbin/dhclient |
| udhcpd | no | no | none — no daemons available to scriptlets |
| umount | yes | yes | /sbin/umount, /usr/bin/umount |
| uname | no | yes | /bin/uname or Python os.uname() |
| uncompress | no | no | none |
| uniq | yes | yes | /usr/bin/uniq |
| unix2dos | no | no | sed 's/\$//' |
| unlzma | no | yes | /usr/bin/unlzma |
| unzip | no | yes | /usr/bin/unzip |
| uptime | no | yes | /usr/bin/uptime or Python reading /proc/uptime |
| usleep | no | yes | /bin/usleep or Python |
| uudecode | no | yes | /usr/bin/uudecode or Python |

| Busybox command | <i>%pre</i> | <i>%post</i> | New command or alternative |
|-----------------|-------------|--------------|---|
| uuencode | no | yes | /usr/bin/uuencode or Python |
| vconfig | yes | yes | /usr/sbin/vconfig |
| vi | yes | yes | /usr/bin/vi |
| vlock | no | no | none |
| watch | no | yes | /usr/bin/watch |
| watchdog | no | no | none |
| wc | yes | yes | /usr/bin/wc |
| wget | yes | yes | /sbin/wget, /usr/bin/wget |
| which | no | yes | /usr/bin/which |
| who | no | yes | /usr/bin/who |
| whoami | no | yes | /usr/bin/whoami |
| xargs | yes | yes | /usr/bin/xargs |
| yes | no | yes | /usr/bin/yes |
| zcat | yes | yes | /usr/bin/zcat |
| zcip | no | no | NetworkManager should take care of this |

¹ Red Hat Enterprise Linux 6 ships with GNU **awk** rather than the busybox **awk** in the installation environment.

² GNU bash can provide basename functionality using string manipulation. If `var="/usr/bin/command"`, then `echo ${var##*/}` gives **command**.

³ GNU bash can provide dirname functionality using string manipulation. If `var="/usr/bin/command"`, then `echo ${var%/*}` gives **/usr/bin**.

Appendix H. Other Technical Documentation

To learn more about

anaconda, the Red Hat Enterprise Linux installation program, visit the project Web page: <http://www.fedoraproject.org/wiki/Anaconda>.

Both **anaconda** and Red Hat Enterprise Linux systems use a common set of software components. For detailed information on key technologies, refer to the Web sites listed below:

Boot Loader

Red Hat Enterprise Linux uses the **GRUB** boot loader. Refer to <http://www.gnu.org/software/grub/> for more information.

Disk Partitioning

Red Hat Enterprise Linux uses **parted** to partition disks. Refer to <http://www.gnu.org/software/parted/> for more information.

Storage Management

Logical Volume Management (LVM) provides administrators with a range of facilities to manage storage. By default, the Red Hat Enterprise Linux installation process formats drives as LVM volumes. Refer to <http://www.tldp.org/HOWTO/LVM-HOWTO/> for more information.

Audio Support

The Linux kernel used by Red Hat Enterprise Linux incorporates PulseAudio audio server. For more information about PulseAudio, refer to the project documentation: <http://www.pulseaudio.org/wiki/Documentation>.

Graphics System

Both the installation system and Red Hat Enterprise Linux use the **Xorg** suite to provide graphical capabilities. Components of **Xorg** manage the display, keyboard and mouse for the desktop environments that users interact with. Refer to <http://www.x.org/> for more information.

Remote Displays

Red Hat Enterprise Linux and **anaconda** include VNC (Virtual Network Computing) software to enable remote access to graphical displays. For more information about VNC, refer to the documentation on the RealVNC Web site: <http://www.realvnc.com/documentation.html>.

Command-line Interface

By default, Red Hat Enterprise Linux uses the GNU **bash** shell to provide a command-line interface. The GNU Core Utilities complete the command-line environment. Refer to <http://www.gnu.org/software/bash/bash.html> for more information on **bash**. To learn more about the GNU Core Utilities, refer to <http://www.gnu.org/software/coreutils/>.

Remote System Access

Red Hat Enterprise Linux incorporates the OpenSSH suite to provide remote access to the system. The SSH service enables a number of functions, which include access to the command-line from other systems, remote command execution, and network file transfers. During the installation process **anaconda** may use the **scp**

Appendix H. Other Technical Documentation

feature of OpenSSH to transfer crash reports to remote systems. Refer to the OpenSSH Web site for more information: <http://www.openssh.com/>.

Access Control

SELinux provides Mandatory Access Control (MAC) capabilities that supplement the standard Linux security features. Refer to the SELinux Project Pages for more information: <http://docs.fedoraproject.org/selinux-guide>.

Firewall

The Linux kernel used by Red Hat Enterprise Linux incorporates the **netfilter** framework to provide firewall features. The Netfilter project website provides documentation for both **netfilter**, and the **iptables** administration facilities: <http://netfilter.org/documentation/index.html>.

Software Installation

Red Hat Enterprise Linux uses **yum** to manage the RPM packages that make up the system. Refer to <http://docs.fedoraproject.org/yum/> for more information.

Virtualization

Virtualization provides the capability to simultaneously run multiple operating systems on the same computer. Red Hat Enterprise Linux also includes tools to install and manage the secondary systems on a Red Hat Enterprise Linux host. You may select virtualization support during the installation process, or at any time thereafter. Refer to the *Red Hat Enterprise Linux Virtualization Guide* available from <http://www.redhat.com/docs/> for more information.

Appendix I. Revision History

Note that revision numbers relate to the edition of this manual, not to version numbers of Red Hat Enterprise Linux.

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remove inaccurate information about PXE installations — BZ#643669

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Rüdiger Landmann

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Rüdiger Landmann

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Version for GA release

Index

Symbols

- /boot/ partition
 - recommended partitioning, 97, 204
- /root/install.log
 - install log file location, 112
- /var/ partition
 - recommended partitioning, 97, 204

A

- about , 497
- adding partitions, 88, 195, 288
 - file system type, 90, 197, 289
- anacdump.txt, 113, 213, 305
- Anaconda, 515
- anaconda.log, 113, 213, 305
- array (see RAID)
- automatic partitioning, 82, 82, 189, 189, 281, 281

B

- Basic Input/Output System (see BIOS)
- BIOS
 - definition of, 495
 - (see also boot process)
- BIOS (Basic Input/Output System), 35
- boot loader, 81, 101
 - (see also GRUB)
 - configuration, 101
 - GRUB, 101
 - installing on boot partition, 104
 - MBR, 104
 - password, 104
 - upgrading, 81
- boot loader password, 104
- boot loaders, 483
 - (see also GRUB)
 - definition of, 483
 - types of
 - ELILO, 483
 - GRUB, 483
 - OS/400, 483
 - YABOOT, 483
 - z/IPL, 483
- boot options, 38
 - from network, 38
 - mediacheck, 38
 - serial mode, 39
 - UTF-8, 39
 - text mode, 38
- boot process, 495, 495
 - (see also boot loaders)
 - chain loading, 483

- direct loading, 483
 - for x86, 495
 - stages of, 495, 495
 - /sbin/init command, 497
 - BIOS, 495
 - boot loader, 496
 - EFI shell, 495
 - kernel, 497

- booting
 - emergency mode, 438
 - installation program
 - x86, AMD64 and Intel 64, 36
 - rescue mode, 436
 - single-user mode, 438
- booting the installation program
 - IBM System p , 149

C

- canceling the installation, 47, 251
- CD/DVD media
 - booting, 35, 149
 - making, 5
 - (see also ISO images)
- Chain loading, 60, 77, 84, 104, 167, 185, 191
- chkconfig , 502
 - (see also services)
- clock, 73, 181, 274
- CMS configuration files, 331
 - sample CMS configuration file, 338
- configuration
 - clock, 73, 73, 181, 181, 274, 274
 - GRUB, 101
 - hardware, 21
 - time, 73, 181, 274
 - time zone, 73, 181, 274
- configuration files
 - CMS configuration files, 331
 - the z/VM configuration file, 332
- consoles, virtual, 54, 162

D

- DASD installation, 251
- DHCP
 - diskless environment, 355
 - PXE installations, 355
- DHCP (Dynamic Host Configuration Protocol), 63, 170, 264
- Disk Partitioner
 - adding partitions, 88, 195, 288
- disk partitioning, 82, 189, 281
- disk space, 12, 128
- diskless environment
 - DHCP configuration, 355

documentation

other manuals, xx

driver diskette, 36

DVD

ATAPI, 46, 156

IDE, 46, 156

installation from, 46, 156

SCSI, 47, 156, 251

DVD media

downloading, 1

(see also ISO images)

E

EFI shell

definition of, 495

(see also boot process)

emergency mode, 438

Encryption

Backup passphrases

Creating backup passphrases, 477

Saving backup passphrases, 477

Passphrases

Saving passphrases, 477

ext2 (see file systems)

ext3 (see file systems)

ext4 (see file systems)

extended partitions, 465

Extensible Firmware Interface shell (see EFI shell)

F

FCoE

installation, 60, 167, 262

FCP devices, 263

feedback

contact information for this manual, xviii

file system

formats, overview of, 461

file system types, 90, 197, 289

file systems

ext2, 47, 156, 251

ext3, 47, 156, 251

ext4, 47, 156, 251

vfat, 47, 156, 251

firewall

documentation, 516

Firstboot , 413

via Kickstart, 368

FTP

installation, 15, 50, 131, 159, 231, 253

G

GRUB, 101, 483, 496

(see also boot loaders)

additional resources, 493

installed documentation, 493

related books, 493

useful websites, 493

alternatives to, 106

boot process, 483

Changing Runlevels at Boot Time, 492

changing runlevels with, 487

commands, 488

configuration, 101

configuration file

/boot/grub/grub.conf , 490

structure, 490

definition of, 483

documentation, 515

features, 484

installing, 485

interfaces, 487

command line, 487

menu, 487

menu entry editor, 487

order of, 488

menu configuration file, 490

directives, 491

role in boot process, 496

terminology, 485

devices, 485

files, 486

root file system, 487

grub.conf , 490

(see also GRUB)

H

halt, 502

(see also shutdown)

Hard disk

initializing, 78, 186, 278

hard disk

basic concepts, 461

extended partitions, 465

file system formats, 461

partition introduction, 462

partition types, 464

partitioning of, 461

hard drive installation, 47, 156, 251

preparing for, 17, 134, 233

hardware

compatibility, 11

configuration, 21

hardware preparation, eServer System p, 127

help

getting help, xvii

HMC vterm, 163

hostname, 63, 63, 170, 170, 264, 264
HTTP
 installation, 15, 50, 131, 159, 231, 253

I

init command, 497
 (see also boot process)
 configuration files
 /etc/inittab , 501
 role in boot process, 497
 (see also boot process)
 runlevels
 directories for, 501
 runlevels accessed by, 501
 SysV init
 definition of, 501

install log file
 /root/install.log , 112

installation
 aborting, 47, 251
 disk space, 12, 128
 DVD, 46, 156
 from network, 38
 FTP, 15, 50, 131, 159, 231, 253
 GUI, 53, 161, 255
 hard drive, 17, 47, 134, 156, 233, 251
 HTTP, 15, 50, 131, 159, 231, 253
 keyboard navigation, 45, 155, 249
 kickstart (see kickstart installations)
 mediacheck, 38
 method
 DVD, 12
 hard drive, 13
 NFS image, 13
 selecting, 12
 URL, 13
 network, 15, 131, 231
 NFS, 15, 49, 131, 158, 231, 252
 server information, 49, 159, 253
 partitioning, 85, 192, 284
 program
 graphical user interface, 53, 161, 255
 starting, 36
 text mode user interface, 43, 153, 247
 virtual consoles, 54, 162
 serial mode, 39
 UTF-8, 39
 starting, 46, 156
 text mode, 38

installation method
 selecting, 46, 156, 250

installation program
 x86, AMD64 and Intel 64
 booting, 36

installing packages, 106, 206, 297
introduction, xix
IPL NWSSTG, 219
IPv4, 63, 170, 264
iscsi
 installation, 60, 167, 262
ISO images
 downloading, 1

K

kdump, 424
kernel
 role in boot process, 497
kernel options, 39
keyboard
 configuration, 55, 170
 navigating the installation program using, 45, 155, 249
keymap
 selecting type of keyboard, 55, 170
Kickstart, 230, 348
kickstart
 how the file is found, 388
 parameters for System z parameter files, 336
Kickstart Configurator , 395
 %post script, 408
 %pre script, 407
 authentication options, 404
 basic options, 395
 boot loader, 397
 boot loader options, 397
 Display configuration, 405
 firewall configuration, 404
 installation method selection, 396
 interactive, 396
 keyboard, 395
 language, 395
 network configuration, 403
 package selection, 406
 partitioning, 398
 software RAID, 400
 preview, 395
 reboot, 396
 root password, 395
 encrypt, 395
 saving, 409
 SELinux configuration, 405
 text mode installation, 396
 time zone, 395
kickstart file
 %include , 382
 %post, 385
 %pre, 384
 auth , 363

- authconfig , 363
- autopart , 362
- autostep , 363
- bootloader , 365
- CD-ROM-based, 387
- clearpart , 366
- cmdline , 366
- creating, 362
- device , 366
- diskette-based, 387
- driverdisk , 367
- firewall , 367
- firstboot , 368
- flash-based, 387
- format of, 361
- graphical , 368
- halt , 368
- ignoredisk , 363
- include contents of another file, 382
- install , 368
- installation methods, 368
- interactive , 369
- iscsi , 369
- iscsiname , 370
- key , 370
- keyboard , 370
- lang , 370
- langsupport , 370
- logging , 372
- logvol , 371
- mediacheck , 372, 372, 378
- mouse , 372
- multipath , 374
- network , 372
- network-based, 387, 388
- options, 362
 - partitioning examples, 382
- package selection specification, 383
- part , 374
- partition , 374
- post-installation configuration, 385
- poweroff , 376
- pre-installation configuration, 384
- raid , 376
- reboot , 378
- rootpw , 378
- selinux , 378
- services , 379
- shutdown , 379
- skipx , 379
- sshpw , 379
- text , 380
- timezone , 380
- upgrade , 380

- user , 380
- vnc , 381
- volgroup , 381
- what it looks like, 361
- xconfig , 381
- zerombr , 382
- zfcpl , 382

kickstart installations, 361

- CD-ROM-based, 387
- diskette-based, 387
- file format, 361
- file locations, 386
- flash-based, 387
- installation tree, 388
- LVM, 371
- network-based, 387, 388
- starting, 388
 - from a boot CD-ROM, 389
 - from DVD with a diskette, 389

L

- language
 - selecting, 45, 155, 249
- LILO, 496
 - (see also boot loaders)
 - role in boot process, 496
- log files, 113, 213, 305
 - kickstart installations, 361
- LVM
 - documentation, 515
 - logical volume, 481
 - physical volume, 481
 - understanding, 481
 - volume group, 481
 - with kickstart, 371

M

- manuals, xx
- master boot record, 101
- Master Boot Record, 435 (see MBR)
 - reinstalling, 438
- MBR
 - definition of, 495, 495
 - (see also boot loaders)
 - (see also boot process)
 - installing boot loader on, 104
- modem, 63, 170, 264
- mount points
 - partitions and, 470

N

- network
 - installations

- FTP, 50, 159, 253
- HTTP, 50, 159, 253
- NFS, 49, 158, 252
- network installation
 - performing, 48, 157, 252
 - preparing for, 15, 131, 231
- NFS
 - installation, 15, 49, 131, 158, 231, 252
- NFS (Network File System)
 - install from, 48, 252
- NTP (Network Time Protocol), 73, 274, 423
- ntsysv , 502
 - (see also services)

O

- OpenSSH, 515
 - (see also SSH)
- OS/2 boot manager, 104
- OS/400, 483
 - (see also boot loaders)

P

- package groups, 110, 210, 301
- packages
 - groups, 106, 206, 297
 - selecting, 106, 206, 297
 - installing, 106, 206, 297
 - selecting, 106, 206, 297
- parameter files, 331
 - installation network parameters, 332
 - kickstart parameters, 336
 - loader parameters, 336
 - required parameters, 331
 - sample parameter file, 338
 - VNC parameters, 336
 - X11 parameters, 336
- parm files (see parameter files)
- parted partitioning utility, 469
- partition
 - extended, 465
- partitioning, 85, 192, 284
 - automatic, 82, 189, 281
 - basic concepts, 461
 - creating new, 88, 195, 288
 - file system type, 90, 197, 289
 - destructive, 467
 - extended partitions, 465
 - how many partitions, 463, 471
 - introduction to, 462
 - making room for partitions, 465
 - mount points and, 470
 - naming partitions, 469
 - non-destructive, 467

- numbering partitions, 469
- other operating systems, 470
- primary partitions, 463
- recommended, 97, 204
- types of partitions, 464
- using free space, 466
- using in-use partition, 466
- using unused partition, 466
- Partitioning , 85, 192, 284
 - adding partitions
 - file system type, 90, 197, 289
- Passphrases
 - Block device encryption passphrases
 - Creating backup block device encryption passphrases, 477
 - Saving backup block device encryption passphrases, 477
 - Saving block device encryption passphrases, 477
- password
 - boot loader, 104
 - setting root, 75, 182, 275
- Planning for Installation
 - System z, 225
- POWER systems rescue mode, 439
 - accessing SCSI utilities, 439
- program.log, 113, 213, 305
- programs
 - running at boot time, 501
- PulseAudio, 515
- PXE (Pre-boot eXecution Environment), 41, 151
- PXE installations
 - boot message, custom, 356
 - configuration, 355
 - DHCP configuration, 355
 - overview, 355
 - performing, 356
 - setting up the network server, 355

R

- RAID
 - hardware, 11, 128
 - kickstart installations, 376
 - Kickstart Configurator, 400
 - software, 11, 128
 - system unbootable after disk failure, 485
 - trouble booting from drive attached to RAID card, 113
- rc.local
 - modifying, 501
- rc.serial , 501
 - (see also setserial command)
- re-installation, 441
- removing

- Red Hat Enterprise Linux
 - from IBM System z, 457
 - from x86-based systems, 445
- rescue discs, 351
- rescue mode, 105, 351
 - definition of, 435
 - utilities available, 437
- rescue mode, POWER systems, 439
 - accessing SCSI utilities, 439
- root / partition
 - recommended partitioning, 97, 204
- root password, 75, 182, 275
- runlevel 1, 438
- runlevels (see `init` command)
 - changing with GRUB, 487
 - configuration of, 502
 - (see also `services`)

S

- `scp`, 516
 - (see also `SSH`)
- screenshots
 - during installation, 54
- selecting
 - packages, 106, 206, 297
- SELinux
 - documentation, 516
- serial console, 344
- serial ports (see `setserial` command)
- services
 - configuring with `chkconfig` , 502
 - configuring with `ntsysv` , 502
 - configuring with `Services Configuration Tool` , 502
- `Services Configuration Tool` , 502
 - (see also `services`)
- `setserial` command
 - configuring, 501
- shutdown, 502
 - (see also `halt`)
- single-user mode, 438
- `SSH` (Secure SHell)
 - documentation, 515
- starting
 - installation, 36, 46, 156
- steps
 - booting with CD-ROM or DVD, 13
 - disk space, 12, 128
 - eServer System p hardware preparation, 127
 - hardware compatibility, 11
 - installing from DVD, 129
- storage devices
 - basic storage devices, 56, 163, 257
 - specialized storage devices, 56, 163, 257

- `storage.log`, 113, 213, 305
- swap file
 - upgrade, 442
- swap partition
 - recommended partitioning, 97, 204
- `syslog`, 113, 213, 305, 347
- system recovery, 435
 - common problems, 435
 - forgetting the root password, 435
 - hardware/software problems, 435
 - reinstalling the boot loader, 438
 - unable to boot into Red Hat Enterprise Linux, 435
- `system-config-kickstart` (see `Kickstart Configurator`)
- `SysV init` (see `init` command)

T

- TCP/IP configuration, 48, 157, 252
- Telnet, 347
- text interface, 344
- `tftp` , 355
- time zone
 - configuration, 73, 181, 274
- traceback messages
 - saving traceback messages without removeable media, 115, 115, 214, 214, 306, 306
- troubleshooting, 113, 213, 305
 - after the installation, 120, 219, 310
 - Apache-based `httpd` service hangs during startup, 124, 221, 311
 - booting into a graphical environment, 121, 219
 - booting into GNOME or KDE, 121, 219
 - booting into the X Window System, 121, 219
 - graphical GRUB screen, 120
 - graphical login, 310
 - logging in, 122, 221, 310
 - printers, 123, 221, 311
 - RAM not recognized, 123
 - Sendmail hangs during startup, 124, 221, 311
 - X (X Window System), 121, 220
 - X server crashes, 122, 220
 - beginning the installation, 114, 214
 - frame buffer, disabling, 114, 214
 - GUI installation method unavailable, 114, 214
 - booting, 113, 213, 305
 - RAID cards, 113
 - signal 11 error, 114, 213, 305
 - during the installation, 115, 214, 305
 - completing partitions, 119, 218, 309

No devices found to install Red Hat Enterprise Linux error message, 115, 214, 305
partition tables, 119, 119, 218, 218
Python errors, 119, 218, 309
saving traceback messages without removeable media, 115, 214, 306
using remaining hard drive space, 119
DVD failure
 DVD verification, 38

U

UEFI (Unified Extensible Firmware Interface), 35
uninstalling
 from IBM System z, 457
 from x86-based systems, 445
upgrade, 441
 adding a swap file, 442
USB flash media
 downloading, 1
 making, 5
USB media
 booting, 35, 149
user interface, graphical
 installation program, 53, 161, 255
user interface, text mode
 installation program, 43, 153, 247

V

vfat (see file systems)
virtual consoles, 54, 162
virtualization, xix
Virtualization
 documentation, 516
VNC (Virtual Network Computing), 345
 documentation, 515
 enabling, 345
 installing client, 345
 listening mode, 346

X

XDMCP, 310
Xorg, 515

Y

YABOOT, 483
 (see also boot loaders)
yum
 documentation, 516
yum.log, 113, 213, 305

Z

z/IPL, 483
