# Installing Debian GNU/Linux with HP Extensions on ProLiant Servers

**Edition 1**


**Manufacturing Part Number: 5990-8546**
**E0604**

U.S.A.

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# 1 Installing Debian GNU/Linux with HP Extensions on ProLiant Servers

## Announcement

This document provides instructions for installing Debian GNU/Linux with HP Foundation Extensions (FE) on supported ProLiant servers. The HP Foundation Extensions are modifications and additions to Debian 3.0 that both enable the Linux operating system on the supported ProLiant servers and provide customized features. To see the most current listing of supported servers, see http://www.hp.com/hps/linux/lx_debian .

Installation steps include:

1. Burning a Debian boot-floppies CD.
2. Configuring RAID Arrays before beginning operating system installation.
3. Configuring the BIOS.
4. Using the Debian boot-floppies CD to launch the Debian GNU/Linux Installer.
5. Performing the base Debian GNU/Linux operating system installation, including creating partitions and filesystems, then specifying their use.
6. Completing the Debian GNU/Linux with HP Extensions installation.

# Contents

# Pre-installation steps

Before installing your operating system complete the following tasks with the instructions outlined in this section:

1. Burn a Debian boot-floppies CD that you use to launch the Debian GNU/Linux installer.
2. Configure your RAID arrays.
3. Configure the BIOS.
4. Launch the Debian GNU/Linux Installer

## Burning a Debian boot-floppies CD

You must use Debian boot-floppies (boot-floppies) to launch the Debian GNU/Linux Installer on supported ProLiant servers. boot-floppies is an ISO image that loads the install kernel and the Debian GNU/Linux Installer.

1. Download the boot-floppies ISO image and its corresponding md5sum file from http://hpde.linux.hp.com.
2. Generate a message digest checksum (md5sum) of the boot-floppies ISO image on your system:
   a. If on a Linux system, use the `md5sum(1)` command to generate the file.
   b. Windows users can find the md5sum program on any Debian FTP mirror site in the “tools” directory. MD5summer (http://www.md5summer.org) is an alternative free software utility.
3. Confirm that the md5sum generated in Step 2 matches the md5sum file you downloaded in step 1.
4. Burn the ISO image to media:
   a. If on a Linux (or Linux-like) system, use `cdrecord` to burn the CD.
   b. If on a Windows system, you should be able to use any CD/DVD burning software; however, you must configure the software to write the ISO to disk exactly as it is, which can be called “raw mode” or something similar. Using raw mode is necessary because some Windows CD burning software modifies the image before burning it, and these modifications corrupt the media which can cause problems with booting or installation.

5. You'll be prompted to insert the boot-floppies CD in the instructions in "Configuring the BIOS" on page 6.

## Configuring RAID Arrays

These instructions assume you are configuring your drives for the first time. If you have an existing logical drive, delete it then follow the instructions below to reconfigure your RAID arrays.

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**IMPORTANT** Be sure you have access to the console prior to powering on your machine. To configure your RAID arrays, you must hit **F8** when prompted in Step 2 below, and this option times out quickly.

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1. Power on your machine.
2. After you see the message `HP Smart Array 5i Controller Initializing`, press **F8** when prompted.
3. From the `Main Menu` on the `Option Rom Configuration for Arrays` screen, make sure `Create Logical Drive` is highlighted, then press **Enter**.
4. On the following screen, default choices are marked with an `x` in the `Available Physical Drives`, `RAID Configurations`, `Space`, and `Maximum Boot Partition` boxes. You can press **Enter** to accept the default choices in every box on the screen without a problem. Use the **Tab** key to navigate among the boxes if you want to make changes.
5. On the next `Option Rom Configuration for Arrays` screen, press **F8** to save the configuration.
6. At the `Configuration Saved` message, press **Enter** to continue.
7. At the `Main Menu`, press **Esc** to exit.

## Configuring the BIOS

1. After configuring your RAID arrays, the system displays a set of prompts: **F1** to continue, **F9** for Rom-Based Setup Utility, **F10** for System Maintenance Menu, and **F12** for PXE boot.

   Press **F9** to configure the BIOS.
2. `System Options` is highlighted in the `ROM-Based Setup Utility`. Press **Enter**.

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| **NOTE** | If you'll use DHCP to automatically configure your network interface, record the network interface MAC addresses in the right hand box and give them to your DHCP server administrator. |

3. `OS Selection` is highlighted. Press **Enter**.
4. Use your arrow keys to highlight `Linux` and press **Enter**. Ignore the warning about installing Red Hat 8.0 and press the space bar to continue.
5. Press **Esc** to return to the main menu.
6. Arrow down to `Advanced Options` and press **Enter**.
7. Arrow down to `POST F1 Prompt` and press **Enter** to configure system boot prompt settings. Select `Disabled` or `Delayed` (either is fine) and press **Enter** to have the system boot automatically.
8. Press **Esc** to return to the main menu. Press **Esc** again. Before continuing, insert the boot-floppies CD in the drive, then press **F10** to confirm you want to exit the `Rom-Based Setup Utility`.
9. Proceed to "Launching the Debian GNU/Linux Installer" below to continue.

## Launching the Debian GNU/Linux Installer

1. The system reboots and you see a screen that says, `Welcome to Debian GNU/Linux 3.0!` Press **Enter**.
2. On the `Release Notes` page for Debian GNU/Linux 3.0:
   a. `Continue` is highlighted.
   b. Press **Enter** to access the `Debian GNU/Linux Installation Main Menu`.

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| **NOTE** | The Debian GNU/Linux Installation Main Menu displays installation and configuration options. `Next:` precedes the highlighted default option, (e.g., `Next: Configure the Keyboard`). `Alternate` precedes the subsequent configuration option in the list. As you complete each installation and configuration task, the interface highlights the next selection. |

c. Though you can accept the defaults for most of the Debian Installer menu options, disk partitioning requires explanation. Proceed through the installer until you reach the `Partition a Hard Disk` option. Follow the directions in "Creating Partitions and Filesystems for Debian GNU/Linux" on page 9 to continue the installation.

# Creating Partitions and Filesystems for Debian GNU/Linux

This section provides instructions to partition your disk. For most other Debian installation and configuration options, you can select the default and continue. However, when you select `Partition a Hard Disk` the installer runs the `cfdisk` command to create the partitions, specifying partition type, file system type, and size for each partition. You can specify up to three primary partitions and many logical partitions.

This guide outlines a simple partitioning scheme.

- Creating a /boot partition and tagging it as bootable.
- Creating a swap partition.
- (**Optional**) Creating a crash dump partition .
- Creating a root partition.

Follow the instructions below to put your entire Debian system into one root file system; however, it is more typical to have `/tmp`, `/usr`, `/var`, and `/home` in their own mounted partitions.

If you require a more complex partitioning setup, please see http://www.debian.org/releases/stable/i386/ch-partitioning.en.html.

**To begin partitioning**:

1. Highlight the `Partition a Hard Disk` option in the Debian GNU/Linux Installation Main Menu and press **Enter** to bring up the `Select Disk Drive` screen .
2. Select the disk you want to partition, (e.g., /dev/cciss/c0d0) and press **Enter**.
3. The `LILO Limitations` screen explains issues to consider when configuring your partitions. This information does not apply to ProLiant servers:
   a. `Continue` is highlighted.
   b. Press **Enter**.
4. Read the `Note on additional space for the ReiserFS Journal` and press **Enter** to continue.
5. At the `Do you wish to start with a zero table [y/N]?` prompt, type **y**.

| **NOTE** | If you are re-installing a system, you won't see this prompt because you have already set up partitions which you may need to change or delete. |
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**Creating a /boot partition and tagging it as bootable**:

1. On the `cfdisk 2.11n` screen, you create partitions. Right arrow to `[ New ]` and press **Enter** to create a partition that will be used for /boot.
2. `[Primary]` is highlighted at the bottom of the next screen. Press **Enter**.
3. At the `Size (in MB):` prompt, input **`128`** and press **Enter**.
4. `[Beginning]` is highlighted to add the partition at the beginning of free space. Press **Enter**. By default, new partitions are created as Linux partitions, so you do not need to adjust the type on this partition.
5. `[Bootable]` is highlighted. Press **Enter** to make the /boot partition bootable.
6. Write down the /boot partition name (e.g., c0d0p1) that appears in the left side of the `cfdisk 2.11n` screen under "Name" for use when following the directions in "Specifying Partition Use" on page 12.

**Creating a swap partition**:

1. Now create a swap partition. Press the down arrow key to highlight the remaining free space. Use the right arrow key to highlight `[ New ]` at the bottom of the screen and press **Enter**.
2. `[Primary]` is highlighted at the bottom of the resulting screen. Press **Enter** to create a primary partition.

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**NOTE** The minimum recommended size for swap space is 1024 MB (1 GB). You may want additional swap space depending on system use. You can add additional swap partitions if needed. The maximum size of a single swap partition on this system is 2048MB (26G).

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3. At the `Size (in MB):` prompt, input **`1024`** and press **Enter**.
4. Select `[Beginning]` to add the swap partition at the beginning of the free space and press **Enter**.
5. Change the file system type for the swap partition.
   a. Using your right arrow key, highlight `[Type]` and press **Enter**.
   b. A list of partition types is displayed on two pages. Press the space bar to go to the second page. The default selection is `82 (Linux swap)`. Press **Enter**.
6. Write down the swap partition name (e.g., c0d0p2) that appears in the left side of the `cfdisk 2.11n` screen under "Name" for use when following the directions in "Specifying Partition Use" on page 12.

**Creating a crash dump partition (Optional)**:

**NOTE** Kernel crash dump will be supported in a future release of Debian GNU/Linux with HP Extensions and will be an important system supportability component. If you do not want to create a crash dump partition now, skip to Step 2 in "Creating a root partition" below.

1. Press your down arrow key to highlight the remaining free space under the swap partition. Use your right arrow key to highlight `[ New ]` at the bottom of the screen and press **Enter**.
2. At the bottom of the resulting screen, use the right arrow key to select [ Logical ] and press **Enter**.
3. At the `Size (in MB):` prompt, input the size of RAM plus 20 percent and press **Enter**.
4. Select `[ Beginning ]` to add the crash partition at the beginning of the free space and press **Enter**.
5. Change the file system type for the crash partition to Linux swap:
   a. Using your right arrow key, highlight `[ Type ]` and press **Enter**.

      A list of partition types is displayed on two pages. Press any key to see the second page. The default selection is `82 (Linux swap)`. Press **Enter**.
6. Write down the crash dump partition name that appears in the left side of the `cfdisk 2.11n` screen for use when following the directions in "Specifying Partition Use" on page 12.

**Creating a root partition**:

1. Press the down arrow key to highlight the remaining free space. Use your right arrow key to highlight `[ New ]` at the bottom of the screen and press **Enter**.
2. At the bottom of the next screen, use the right arrow key to select `[ Logical ]` and press **Enter**.
3. The remaining disk space is highlighted for disk size selection. Either press **Enter** to make your root partition consume the rest of this disk, or leave space by entering a size of at least 4096 MB and press **Enter**.
4. If you did not consume the rest of the disk, select `[ Beginning ]` to add the "/ " partition at the beginning of the free space and press **Enter**. By default, new partitions are created as Linux partitions, so you do not need to adjust the type on this partition.

5. Write down the partition name (e.g., c0d0p6) that appears on the left side of the cfdisk 2.11 screen to use when following the directions in "Specifying Partition Use" below.

**Final Steps**:

1. If you like, create your other partitions now.
2. Once all partitions are created, use your right arrow key to highlight the `[ Write ]` option and press **Enter**.
3. At the prompt, `Are you sure you want to write the partition table to disk (yes or no)?`, type **`yes`** and press **Enter**.
4. If you did not already record this information, write down the partition names and file sizes that appear on the `cfdisk 2.11n` page to help you remember which partition you intend to use for swap, /boot, etc., when following the directions in "Specifying Partition Use" below.
5. Use your right arrow key to highlight `[ Quit ]` and press **Enter**.

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**NOTE** If you're on iLO console, you may see issues such as stale characters on the command line. They do not affect the functionality of your input. Ignore them and proceed.

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## Specifying Partition Use

Now that you have created your partitions, initialize and activate them as outlined in the following steps:

1. In the Debian GNU/Linux Installation main menu:
   a. Select `Initialize and Activate a Swap Partition`.
   b. Press **Enter**.
   c. If you created more than one swap partition, highlight the one you want to use for swap and press **Enter**. The `Scan for Bad Blocks?` screen appears. Scanning is very time consuming, unnecessary for new disk mechanisms, and is therefore not recommended. `No` is highlighted. Press **Enter**.
   d. `yes` is highlighted on the `Are you sure?` screen to verify your choice of disk as a swap device. Press **Enter**.
2. In the Debian GNU/Linux main menu:
   a. Select `Initialize a Linux Partition`.

b. Press **Enter**.

c. On the `Choose Filesystem Type` screen, make a selection depending on your preference and press **Enter**. HP recommends Ext3 for faster system recovery times.

d. If there is more than one partition listed at the `Please select the partition to initialize as a Linux filesystem` prompt, select the one you want to use for your "/boot" partition and press **Enter**. Otherwise, see Step 2e.

e. Respond to the `Scan for Bad Blocks?` screen that appears again. As stated in 1c above, scanning is very time consuming, unnecessary for new disk mechanisms, and not recommended. `no` is highlighted. Press **Enter**.

f. `Yes` is highlighted on the `Are You Sure?` screen. Press **Enter** to verify your choice of disk as a Linux partition.

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**NOTE** If you set up only one Linux partitions on the disk, the installer asks if you're sure you want to initialize it as a Linux file system. `Yes` is highlighted. Press **Enter**.

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g. On the `Mount as the Root Filesystem?` screen:

1. `Yes` is highlighted
2. Press **Enter** to mount the root file system and return to the Debian GNU/Linux Installation main menu.

3. In the Debian GNU/Linux main menu:

a. Arrow to `Select Alternate: Initialize a Linux Partition`.

b. Press **Enter**.

c. On the `Choose Filesystem Type` screen, make a selection depending on your preference and press **Enter**. HP recommends Ext3 for faster system recovery times.

d. If there is more than one partition listed at the `Please select the partition to initialize as a Linux filesystem` prompt, select the one you want to use for your "/" (root) partition and press **Enter**. Otherwise, see Step 2e.

e. Respond to the `Scan for Bad Blocks?` screen that appears again. As stated in 1c above, scanning is very time consuming, unnecessary for new disk mechanisms, and not recommended. `no` is highlighted. Press **Enter**.

f. `Yes` is highlighted on the `Are You Sure?` screen. Press **Enter** to verify your choice of disk as a Linux partition.

g. On `Select Mount Boot Point`:

1. `/boot` is highlighted.
2. Press **Enter**.

4. If you created more than two filesystem partitions, select `Initialize a Linux partition` for each partition you created and complete the steps to intialize it.

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**NOTE** You do not need to initalize the crash dump partition. When the crash dump functionality becomes available, you can use it without first manually initializing the partition.

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Now that you have set up your partitions, continue through the Debian GNU/Linux Installation Main Menu using the instructions in “Completing the Base Debian Installation” on page 15.

## Completing the Base Debian Installation

Now that you have set up your partitions as outlined in the previous section, follow the directions below to complete the base Debian GNU/Linux installation.

From the Debian GNU/Linux installer main menu:

1. `Install Kernel and Driver Modules` is the highlighted option. Press **Enter**.
   a. On the `Found a Debian CD-ROM` screen, `Yes` is highlighted.
   b. Press **Enter** and the Debian installation from the boot-floppies CD proceeds.
2. `Configure Device Driver Modules` is the next option highlighted in the installer:
   a. Press **Enter**.
   b. On the `Note about loaded drivers` screen, `Continue` is highlighted. Press **Enter**.
   c. On the `Select Category` screen, arrow down to `kernel/drivers/ide/pci` and press **Enter**.
   d. On the `Select kernel/drivers/ide/pci modules` screen, arrow down to `serverworks` and press **Enter**.
   e. At the `Install this module in the kernel?` prompt, `<YES>` is highlighed. Press **Enter**.
   f. On the `Enter Command Line Arguments` screen, do not input anything. Press **Enter** to continue.
   g. At the message that installation succeeded, press **Enter**.
   h. On the `Select kernel/drivers/ide/pci modules` screen, `Exit` is highlighted. Press **Enter**.
3. On the `Select Category` screen, arrow down to `kernel/drivers/net` and press **Enter**.
   a. On the `Select kernel/drivers/net modules` screen, arrow down to `tg3` and press **Enter**. `<Yes>` is highlighted on the following screen. Press **Enter**.
   b. On the `Enter Command-Line Arguments` screen, do not input anything. Press **Enter** to continue.
   c. You should see a message that installation succeeded. Press **Enter**.
   d. On the `Select kernel/drivers/net modules` screen, `Exit` is highlighted. Press **Enter**.

e. `Exit` is highlighted on the `Select Category` screen. Press **Enter**.

4. `Configure the Network` is the next option highlighted in the installer. Press **Enter**.

   a. On the `Choose the Hostname` screen, enter a hostname of your choosing. Use your down arrow to select `OK` and press **Enter**.

   b. On the `Choose Network Interface` screen, use your arrow keys to highlight your primary network interface and press **Enter**.

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**NOTE** eth0 corresponds to NIC 1 and eth1 corresponds to NIC 2 as labeled on the back of your server.

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   c. On the `Automatic Network Configuration` screen, choose one of the following:

      1. To automatically configure the interface, highlight `yes` to use DHCP or BootP and press **Enter**. `Continue` is highlighted. Press **Enter** to proceed.

      2. To manually configure your ethernet interface, highlight `no`, press **Enter**, and supply the requested information on the additional configuration screens.

5. Next select `Install the Base System` from the installer and press **Enter** to install the base packages that enable the server to boot on its own.

6. `Make System Bootable` is the next highlighted option in the installer menu. Press **Enter** to install the boot loader.

   a. Use your arrow keys to select `Install LILO in the MBR (use this if unsure)` and press **Enter**.

   b. On the `Securing LILO` screen, `Continue` is highlighted. Press **Enter**.

7. Skip `Make a boot-floppy` in the main menu and select `Reboot the system` on the main menu. Press **Enter**.

8. At the `Reboot the System?` screen, remove the boot-floppies CD from the drive.

9. Press **Enter** and confirm you want to reboot the system when prompted.

10. The system reboots and after some time, the `Debian System Configuration` screen says that your installation was successful. `OK` is highlighted. Press **Enter**.

Now follow the directions under “Completing the Debian with HP Extensions Installation” on page 17.

# Completing the Debian with HP Extensions Installation

Complete your Debian with HP Extensions installation using the instructions below. After initial steps such as time zone configuration and password setup, you complete installation over the network.

## Installation Steps

The Debian installer prompts you to finish the installation by completing the tasks listed below. This document provides additional instructions for steps that are not evident through the user interface.

1. Time zone configuration
2. Password setup
3. Debian System Configuration
4. `Apt Configuration`

   Several `Apt Configuration` screens prompt for a variety of information for which details are provided below.

## Completing Installation Over The Network

1. The next `Apt Configuration` step prompts, `Choose the method apt should use to access the Debian archive.` Arrow down to highlight `http` and press **Enter**.
2. You are next asked if you want to use non-US software. Make your selection and press **Enter**.
3. You are asked if you want to use non-free software. Make your selection and press **Enter**.
4. Next select a country the Debian mirror should be in and press **Enter**.
5. The following `Apt Configuration` screen prompts you to select the Debian mirror `apt` should use. You can safely use the default or highlight another selection from the list with your arrow keys and press **Enter**.
6. On the next screen you can input http proxy information if you need to use a proxy server to access sites outside your organization's firewall. Press **Enter**. If you don't wish to use a proxy server, leave this field blank and press **Enter**.

7. The following Apt Configuration screen states, `Apt is now configured, and should be able to install Debian packages. However, you may want to add another source to apt, so it can download packages from more than one location. Add another apt source?` Highlight `Yes` and press **Enter**.

---

**NOTE** **The Apt Configuration instructions that follow enable installation of HP Extensions to Debian.**

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8. You now select a method to access the Debian archive from which you will add the HP Extension packages.

   a. Using your arrow keys, highlight `edit sources list by hand` and press **Enter**. You drop to an editor called Nano that displays the `/etc/apt/sources.list` file. Arrow to the end of the file and type these lines after the last entry to access the Debian archive with the HP Extensions packages:

   ```
   deb http://hpde.linux.hp.com/hpde/1.2/ hpde main
   deb http://hpde.linux.hp.com/hpde/1.2/ hpde/updates main
   ```

   b. When done, press **Ctrl + o** to save.
   At `File name to write: /etc/apt/sources.list`, press **Enter**.
   Press **Ctrl + x** to exit the editor.

9. The next `Apt Configuration` screen states that apt is configured and asks if you want to add another apt source. Highlight `no` and press **Enter**.
10. When asked if you want to use security updates from security.debian.org, `Yes` is highlighted. Press **Enter**.
11. The `Debian System Configuration` screen asks if you want to run `tasksel` to select additional software. `Yes` is highlighted. Press **Enter** to run `tasksel`.
12. In the `Debian Task Installer`, place your cursor between the brackets preceeding the choice(s) you want to make and press the space bar to select. An asterisk (*) marks your selections. To remove a selection, place your cursor between the brackets of the marked listing and press the space bar again.

    If installing on a supported ProLiant server, select the HP Foundation Extensions listing appropriate for your memory size and any other desired tasks.

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**NOTE** HP supports a subset of the tasks listed, including the ones it provides. While HP does not support all Debian packages, it does support the system on which they are used.

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13. After making your selections from the `Debian Task Installer`, tab to highlight `Finish` and press **Enter**.
14. The `Debian System Configuration` screen asks if you want to run `dselect`. If you are unfamiliar with `dselect`, do not use it. Highlight `no` and press **Enter**. Package installation begins. Otherwise, highlight `yes`, and may the Force be with you.
15. On the screen that displays packages, press **Enter** at the `Do you want to continue? [Y/n]` prompt to install them.

---

**NOTE** In some cases, such as the one above, the interface capitalizes the default choice (`Y`) rather than highlighting it. You can simply press **Enter** to accept the default or enter **`y`** and press **Enter**.

---

The installer downloads packages from the network and installs them after download is complete.

16. Several screens (e.g. `Configuring Debconf` and `Configuring ssh`, among others) now prompt you to configure the packages you just installed. Always accept the default by pressing **Enter** if unsure how to answer.

    Depending on individual choices you made during the installation process, other screens may prompt for more detailed information and the interface gives you clear explanations about what to provide in most cases. However, you may find the information provided below helpful when prompted to configure your boot loader:

---

**NOTE** On the `Configuring Locales` screen, select the locales you require and **Tab** to highlight `OK`. Press **Enter** to avoid scrolling down the long list. If you don't know which locales to select, it is safe to just **Tab** to highlight `OK` and press **Enter** to continue.

---

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**IMPORTANT** When installing a new kernel image, you are asked, `Install a boot block using the existing /etc/lilo.conf? [Yes]`. Press **Enter** to accept the `Yes` default and make the new kernel bootable.

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17. At the prompt, `Do you want to upgrade to glibc [Y/n]?`, type **`y`** and press **Enter**.
18. At the prompt, `Do you wish to Restart Services [Y/n]?`, type **`y`** and press **Enter**.
19. At the prompt, `Select the number of the default dictionary [1]`, press **Enter** to select American. Or if you feel compelled to spell color and favorite with a "u," select 2. God save the queen.

20. At the prompt, `Would you like to create a boot floppy now? [No]`, press **Enter** to say no.
21. At the prompt, `Do you want to erase any previously downloaded .deb files? [Y/n]`, press **Enter**.
22. When done, the `Debian System Configuration` screen says, `Have fun! You may now login at the login: prompt. Thank you for choosing Debian!`

    `OK` is highlighted. Press **Enter**.
23. Configure your xim mail transport as prompted.
24. On the resulting screen, you can login to your Debian GNU/Linux with HP Extensions operating system.

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**NOTE** After you have installed your system and received a boot prompt you can login and use `apt-get(8)` to install extra packages.

You can use the `tasksel(1)` option to install many commonly used packages at once rather than installing them individually with `apt-get`.

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# Upgrading Debian GNU/Linux with HP Extensions

1. Ensure the following lines are at the end of the `/etc/apt/sources.list` file:
   a. deb http://hpde.linux.hp.com/hpde/1.2 hpde/updates main
   b. deb http://security.debian.org/ woody/updates main
2. Type `apt-get update` and press **Enter**.
3. Type `apt-get -u dist-upgrade` and press **Enter**.
4. If executing a kernel upgrade, type `reboot` and press **Enter**.

# Upgrading ProLiant Firmware

In addition to the system firmware (BIOS), ProLiant systems contain several devices with upgradable firmware chips. Firmware upgrade documentation for Debian on ProLiant systems is available at (**find out from Jeanne where we are hosting docs and bits for ProLiant**). HP recommends you run the latest release of each firmware image to ensure optimal system operation.