Redbooks Paper

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Installing Linux on the IBM @server xSeries 450

Introduction

This Redpaper describes the installation of SuSE Linux Enterprise Server (SLES) V8.0 on the x450. The document starts with an overview of Linux on the Itanium 2 platform. It then describes the available distributions and the subset of those supported on the x450. The document then describes the procedure to install SLES and ways to modify the boot process.

Background

The goal of the project to port the Linux kernel to the Itanium platform was to have a single optimized port of the Linux kernel for every Itanium-based machine. The kernel has been available at http://www.kernel.org since early 2000.

The development model used to create this new porting of the kernel was the same as used for other Linux development work: open source developers working together around the world on a cooperative effort to make it available before any other operating system and even before the official release of the processor itself. This is one of the key points of Linux's success, and also of this Itanium 2 kernel port.

This effort was also possible thanks to many companies and institutions that contributed to this development effort, such as Intel, IBM, Caldera (now the SCO Group), the European Organization for Nuclear Research (CERN), Red Hat, SGI, SuSE, Turbolinux, and VA Linux Systems (now VA Software).

Each company distributed the work among their developers to achieve the best results. The main tasks were as follows.

- Port of the kernel itself
- Initial port of GNU Compiler Collection (GCC) to IA-64 architecture
- Port of GAS, emacs, ld, GNUPro toolkit
- Port of performance, measurement, and analysis tools

Intel provided the IA-32 and IA-64 platform specifications and the EFI, and helped on the Apache port. The rest of the work was distributed among the companies involved, and also among private individuals around the world.

Linux for IA-64 provides a new pure 64-bit kernel but maintains compatibility at the API level with Linux for x86 wherever this is possible. The error messages, the system signal, and the ioctl codes will remain as compatible as possible between the two platforms. Also in this version, as started in the Linux kernel from version 2.1.126 onwards, developers tried to minimize changes to make the code as platform-independent as possible, while optimizing the platform-specific features to improve performance on Itanium processors.

The IA-64 Linux kernel follows the standards defined by Intel and other companies. These include:

- EFI (Extensible Firmware Interface), as detailed in

  http://developer.intel.com/technology/efi/
- DIG64 (Developers Interface Guide for 64-bit Intel Architecture Servers), as detailed in

  http://www.dig64.org
- System V UNIX ABI (Application Binary Interface), as detailed in

  http://www.linuxbase.org/spec/refspecs/elf/gabi4+/contents.html.

Linux IA-64 kernel overview

The following information is helpful if you plan to recompile or port software to the IA-64 kernel. The main objective of this section is to introduce some basic concepts about the Linux kernel and the most important differences between the IA-32 version and the new 64-bit IPF (Itanium Processor Family, or IA-64) architecture. Your preferred Linux distribution may have performed this recompilation for you, but it is very common to recompile software under Linux, for instance if you get only the source code and not an installable package.

Data types

In 1996, The Open Group decided to extend the *Single UNIX Specification for 64-bit Systems* to create a new standard on 64-bit for any UNIX operating system. Linux kernel developers attempt to follow The Open Group standards as much as possible, so the Linux IA-64 kernel uses the LP64 Data Model, as defined by The Open Group. This data model is LP64 because it allows long and integer types of up to 64 bits. 32-bit Intel processors use the LP32 Data Model. This model is an industry standard and is used in all other 64-bit Linux and UNIX implementations.

Some of the usual data types on C change between the LP64 and the LP32 Data Models, as shown in Table 1.

Table 1 Comparison of C types between LP32 and LP64

Data type in C	LP32	LP64
char	8	8
short	16	16
int	32	32
long	32	64
long long	64	64

Data type in C	LP32	LP64
pointer	32	64
enum	32	32
float	32	32
double	64	64
long double	128	128

Keep these comparisons in mind while programming or porting applications to any 64-bit operating system, not only Linux. It is easy to assume that every data type is the same size, and that is why the LP Data Model standard was created.

Note: The LP64 Data Model example discussed in this Redpaper is not the only 64-bit Data Model defined by The Open Group. There are other models, such as LP64, ILP64, or LLP64 for 64-bit and ILP32 or LP32 for 32-bit. For more information about the Data Models defined by The Open Group and also about their standardization activities, go to:

http://www.opengroup.org

Byte order

The IA-64 kernel of Linux also uses standard byte order at a byte level. The native byte order is little-endian, although big-endian processes are still possible.

All Intel processors are little-endian based. This means that the bytes at lower addresses have a lower significance given a 16-bit or 32-bit word (the word is stored “little-end-first”). In big-endian architectures, the bytes’ addresses have a higher significance (the word is stored “big-end-first”). The IA-64 Linux kernel uses little-endian by default, but allows for the possibility of using big-endian byte order.

Choosing a Linux distribution

When we talk about Linux, we are not talking about one company, one version or one distributor, as we may with other operating systems. Linux is the kernel, the base of the system, and there are many companies that develop Linux distributions built around the kernel.

In this section, we discuss the major Linux distributors that work with IBM and their different products available for the Itanium 2 platform: Red Hat and UnitedLinux.

Note: The IBM Linux support page is found at:

http://www.pc.ibm.com/qtechinfo/MIGR-48NT8D.html

Here you can find information about the Linux distributions supported by IBM, as well as documents, information, and drivers for IBM products.

Note: Debian Linux is also available for Itanium 2 platforms, but we will not discuss this Linux distribution because it is not supported by IBM.

Red Hat Linux 7.2 for Itanium

Red Hat is a major Linux distributor, but at the time of writing this Redpaper, Red Hat did not have any product available for the Itanium 2 platform. The latest released version of Red Hat Linux for Itanium processors is V7.2, but that has now been discontinued.

Red Hat is working on a new release of their Advanced Server which will be available on Itanium 2 platforms (which currently run on IA-32 architectures only). For the latest information on Red Hat's plans and IBM's support plans, go to:

```
http://www.redhat.com/software/itanium
http://www.pc.ibm.com/us/compat/nos/redchat.html
```

The UnitedLinux initiative

In 2002, four of the companies that were developing different Linux distributions (Conectiva, The SCO Group, SuSE and Turbolinux) announced that they would work together to build a unique base for a Linux distribution. The primary idea was to create a base system from which each company would develop its products, solutions, and services.

The official definition of UnitedLinux, as found on their Web site, is:

"*UnitedLinux is a standards-based, worldwide Linux solution targeted at the business user and developed by Conectiva, The SCO Group, SuSE, and Turbolinux. Designed to be an enterprise-class, industry-standard Linux operating system, UL provides a single stable, uniform platform for application development, certification, and deployment and allows Linux vendors, Independent Software Vendors (ISVs), and Independent Hardware Vendors (IHVs) to support a single high-value Linux offering rather than many different versions".*

UnitedLinux attempts to offer enterprise-level solutions based on Linux, starting from a standard base that each distributor can freely adapt to the needs of its customers. UnitedLinux will also be based on all the Linux standards defined as of this date, such as the Linux Standard Base standard. The main advantage for customers is that they can work with any of UnitedLinux companies and with any of their products; the base system, the configuration files, and the file locations will remain the same, in the same place and with the same properties. This is a main advantage for customers that use Linux, but do not have a unified distribution across their systems.

IBM will continue to support Red Hat as it has been doing, but will be focused more on the services that the distributor provides than the Linux distribution.

For more information about the UnitedLinux initiative, go to:

```
http://www.unitedlinux.com/en/info/faqs.html
```

The IPF (IA-64) Linux plans for each of the four UnitedLinux partners are as follows:

- Conectiva Linux

  Conectiva has not officially released any version of their Conectiva Linux product for any Itanium processor. To find out about Conectiva's products and services, go to:

  ```
  http://www.conectiva.com
  ```

- Caldera SCO Linux 64

  The SCO Group, previously called Caldera, has announced a version of its SCO Linux product for the Itanium family. This product is called Caldera SCO Linux 64.

To find out about SCO's products on Linux for 64-bit platforms or IBM support for SCO products, go to:

http://www.sco.com/products/openlinux64
http://www.pc.ibm.com/us/compat/nos/thecscocgroup.html

- Turbolinux 7.0 for Itanium

  Turbolinux also has a product for Itanium processors, Turbolinux 7.0 for Itanium, but it is not their latest version, which is V8.0.

  To find out about Turbolinux products on Linux for 64-bit platforms or IBM support for SCO products, go to:

  http://www.turbolinux.com/products/tls7i
  http://www.pc.ibm.com/us/compat/nos/turbolinux.html

- SuSE SLES 8 for IA-64

  SuSE Linux Enterprise Server 8 was the only commercial Linux distribution supporting Itanium 2 processors available at the time of writing of this Redpaper. We had access to a pre-release beta version of this distribution that provided a 2.4.19 kernel optimized for Itanium 2.

  For information on IBM Support of SuSE products, go to:

  http://www.pc.ibm.com/us/compat/nos/suse.html

Installing SuSE Linux Enterprise Server

In this section, we focus on the installation procedure of SuSE SLES 8 and all the issues you may encounter. We used SuSE SLES 8 Release Candidate 2 to write this Redpaper.

Requirements and hardware used

According to the *Installation and Administration Addendum* found in the doc directory on the first CD of SuSE SLES 8, the requirements to use this Linux distribution are as follows:

- An Itanium or Itanium 2 processor
- At least 256 MB of main memory
- A hard disk larger than 10 GB
- Firmware version EFI 1.0.2 or 1.1.0 (preferred)

Our testing system was one pre-production x450 unit with:

- One Itanium 2 processor running at 900 MHz
- Two GB of DDR RAM
- EFI Version 1.10
- Firmware Version 0.9.19

We also connected an RXE-100 expansion enclosure after the installation.

Before starting the installation

Before starting the installation, we recommend you perform the following tasks.

- Disconnect the RXE-100 expansion enclosure if it is connected to the system.

  Our testing showed that the RXE-100 may not be recognized by the kernel during installation and that the installation process may hang. Once the system is installed, you can reconnect it and all your PCI devices will be recognized automatically.

- Disconnect the LS-120 if you have one installed.

  Do not start the installation procedure with an LS-120 drive unit in the spare media bay in the front of the x450. We encountered problems trying to install the preview release of SuSE SLES 8 which disappeared when we removed the unit from the bay (in our machine, the LS-120 drive was on the secondary bus of the primary IDE interface).

SuSE SLES 8 supports LVM volumes during the installation, so you can install it on LVM partitions. We used only internal disks for our tests. Notice that the default file system used on SuSE is the journaling file system ReiserFS. For more information about the ReiserFS file system, go to:

http://www.namesys.com/

Installation procedure

The installation procedure for SuSE Linux Enterprise Server V8 is like any other SuSE Linux installation, except that you work on a different architecture, so the bootable CD-ROM will not boot directly, as it would on any IA-32 architecture. Following are the steps to follow for a SuSE SLES 8 installation.

1. Power on the server and immediately insert the first SuSE CD-ROM in the drive.

   Although it is not necessary to insert the CD at this point, it makes the installation process easier because the CD-ROM file system is automatically detected and mapped.

2. Wait for the EFI Boot Manager menu to appear (Figure 1).

3. Select the entry for the CD-ROM drive. In the x450, this is the ACPI entry with the strings `PCI` and `ATA(Primary/Master)`. Press **Enter**.

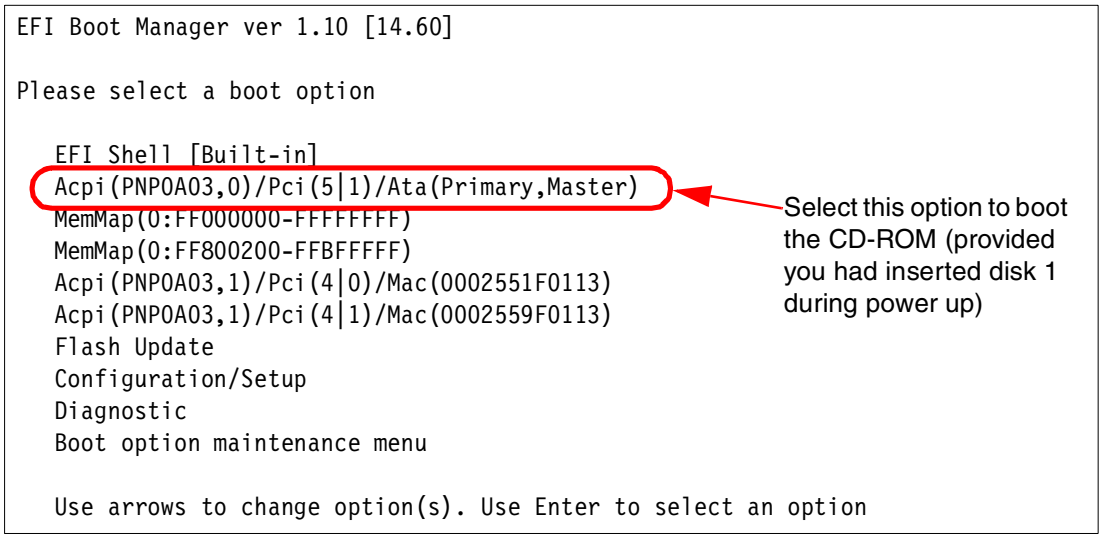

Figure 1 EFI Boot Manager: select this option to boot from the CD-ROM

Manually starting the CD-ROM: If you did not have the CD-ROM inserted before the EFI Boot Manager menu loaded, perform the following steps.

1. Insert SuSE Disk 1 into the drive.
2. Select **EFI Shell** and press **Enter**.
3. Enter the command **`map -r`** to remap all file systems.
4. Enter `exit` to go back to the Boot Manager menu.
5. Select **Boot option maintenance menu** and press **Enter**.
6. Select **Boot from a file** and press **Enter**.
7. Select the CD-ROM entry **Ata(Primary,Master)/CD**.
8. Browse to the efi/boot folder.
9. Select the file **bootia64.efi** and press **Enter**.

4. The SuSE welcome screen appears (Figure 2).

   The installation procedure is the same as for any other version of SuSE Linux. This will let you select your installation method or boot a rescue environment.

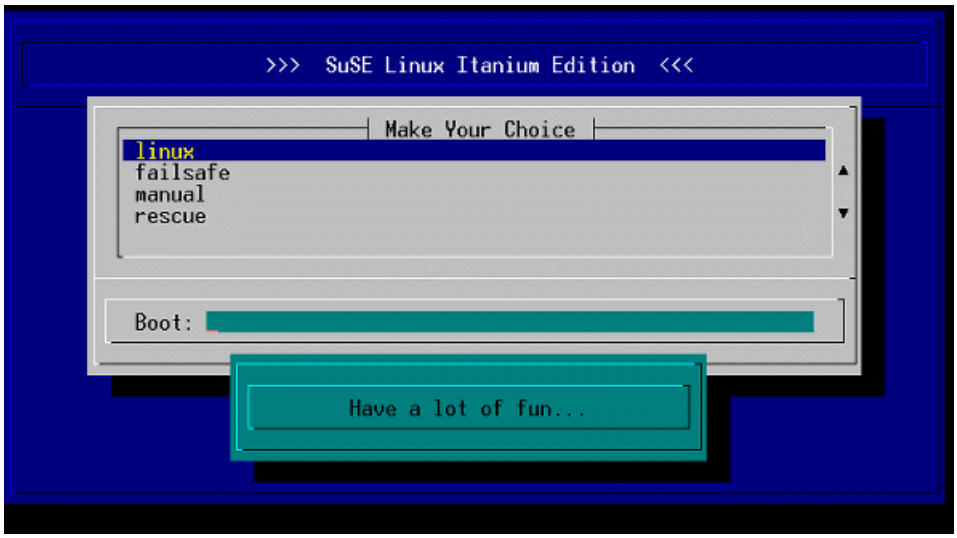

Figure 2 SuSE SLES 8 welcome screen

5. Select **linux** and press **Enter**. This will boot the YaST2 software that will help you to select the packages you may want to install. It will also help you with the hardware configuration and will then install all the packages.

Installation

To configure your system and select your packages, here are the elements you will encounter while installing SuSE SLES 8.

1. License Agreement.
2. Language Selection. English is the default.
3. Installation Mode Selection, where you can choose between different installation methods. The default installation should be sufficient. If you need to add or remove packages, you can always do it later.
4. Installation Settings, where you can select what you want to install and where.
5. Package Installation, which is the part of the installation that copies the files from the installation CDs and installs the packages.

6. Prepare for the initial boot, which is the part of the installation that runs the configuration scripts and installs the boot manager.

   Once all your packages are copied to the hard disk, reboot the server.

   Once the system rebooted, on the EFI menu select **SuSE SLES** to start the Linux boot process. This entry will also be configured to be the default entry to boot, so if you do not press any key, the system will automatically boot SuSE SLES.

   You can modify your boot settings EFI boot maintenance menu and the elilo.conf file as we discuss later.

   The remainder of the installation is completed. The first time SuSE SLES 8 boots, it will finish configuring your system. This will boot the graphical interface and then YaST will be launched. If you encounter problems during this first boot, refer to “Linux boot process” on page 8.
7. Root password: the installation program will ask you to enter a password for the root user.
8. Add user: the installation program will ask you to create a user. You need to create this user to continue the installation. This is done for security reasons. You should log on as a normal user, and use the root account as little as possible.
9. Desktop settings: you will be prompted to configure your desktop settings and choose which mode, text or graphical, you want to use the next time the machine is booted.
10. Hardware configuration: if you have some additional hardware, such as network interfaces, you can configure them here.

Installation notes: If you install on a mirrored disk configuration while the mirror is being created, the SCSI driver detection on the installation program may take some time. The driver works perfectly well, but it takes longer to load than in a non-mirrored configuration. You may also notice that the I/O throughput slows down.

Linux boot process

The Linux boot process on IA-64 systems uses elilo instead of the classic lilo or grub boot loaders. elilo.conf is a file stored in the root director of the EFI System Partition.

There is no longer a need for boot loaders because the EFI system can manage the boot procedure for the different operating systems. The boot loader is helpful, however, if we need to provide boot parameters to the kernel, for example if we want to recover from some special situations by putting parameters to the boot command line, if we want to boot on initlevel 3 only once and our system is configured to boot on initlevel 5 by default, etc.

If you do not press any key before the delay estimated on the elilo.conf file, Linux will start loading automatically. To reduce the delay or remove it completely, change or remove the corresponding line in elilo.conf.

Example 1 shows a typical elilo.conf configuration file. As you can see, the elilo configuration is very similar to the old lilo configuration. One of the main advantages of elilo is that you do not need to execute any command to make your changes active: elilo will automatically take any changes you may make on the elilo.conf file.

Example 1 An example of elilo.conf, found in the EFI System Partition root directory

```
timeout=10
read-only

image=vmlinuz
label=linux
root=/dev/sda3
initrd=initdisk
append="console=ttyS0,115200"
```

Once elilo is loaded, select which Linux kernel image you want to load; the boot procedure is the same as for other Linux startup processes.

1. The Linux kernel image loads on memory.
2. The setup function is called, enabling basic devices, buses and video.
3. The startup function is called, enabling stacks, decompressing the kernel, and identifying the processor type.
4. The start_kernel function is called, starting all memory procedures, kernel cache and executes /sbin/init.
5. The boot procedure continues.

IA-32 applications

The IA-32 runtime environment is installed by default. This environment contains glibc, ncurses, C++ and X11 libraries to guarantee compatibility with IA-32 applications.

If you want to compile any application from code source to the IA-32 platform, this is still possible, and you may also compile it to IA-64. This will offer you the possibility to still use older IA-32 applications, if you do not have the source code or you do not want to recompile it to IA-64.

Information about the installed system

Our recently installed Linux system can offer us some information about the x450, such as CPU details, memory, etc. The following sections outline what the Linux kernel found about the CPU used during our tests. We used the /proc file system to obtain this information.

CPU information

Linux recognizes the x450's processor(s) as Itanium 2 from the IA-64 architecture. During our tests, we only had one single CPU, and it was identified by the system as the CPU number 0. On multiprocessor systems, we will find all the information regarding every CPU.

Example 2 /proc/cpuinfo output

```
linux:~ # cat /proc/cpuinfo
processor  : 0
vendor     : GenuineIntel
arch       : IA-64
family     : Itanium 2
model      : 0
revision   : 6
archrev    : 0
features   : branchlong
```

```
cpu number : 0
cpu regs   : 4
cpu MHz    : 900.000000
itc MHz    : 900.000000
BogoMIPS   : 1132.46
```

Memory information

We used 3 GB of DDR memory, and it was fully recognized by Linux. We also set up some swap memory, but it was never used during our tests. Example 3 shows the output of the meminfo file on the /proc file system and more details about the memory.

Example 3 /proc/meminfo output

```
linux:~ # cat /proc/meminfo
        total:    used:    free:  shared: buffers:  cached:
Mem:  3112976384 1308147712 1804828672        0 76251136 518733824
Swap: 1044496384        0 1044496384
Total # of HugePages:       32          Available:       32
HugePageSize: 16777216(0x4000KB)
HugePageRegionNumber: 4
MemTotal:      3040016 kB
MemFree:       1762528 kB
MemShared:           0 kB
Buffers:         74464 kB
Cached:         506576 kB
SwapCached:          0 kB
Active:         356800 kB
Inactive:       263072 kB
HighTotal:           0 kB
HighFree:            0 kB
LowTotal:      3040016 kB
LowFree:       1762528 kB
SwapTotal:     1020016 kB
SwapFree:      1020016 kB
```

Modules used by the default kernel

SuSE SLES 8 provides a default kernel that loads almost all the drivers we will need for our x450, and also some drivers we will never use.

As we can see in Example 4, it also loads some modules that are not used, identified with `unused`, including:

- parport_pc (the x450 does not provide a parallel port)
- isa_pnp (the x450 does not have any ISA buses)
- keybdev (the x450 does not support a standard keyboard device)
- joydev (for joystick support).

You can unload any unused module with the **rmmod** command. Enter **man rmmod** for more information about rmmod options and parameters.

Example 4 /proc/modules output

```
linux:~ # cat /proc/modules
lp                     17112   0 (autoclean)
parport_pc             39960   0 (unused)
parport                67480   0 [lp parport_pc]
```

```
videodev               16024   0 (autoclean)
iptable_mangle          4064   0 (autoclean) (unused)
iptable_nat            36320   0 (autoclean) (unused)
ip_conntrack           38816   1 (autoclean) [iptable_nat]
iptable_filter          3272   0 (autoclean) (unused)
ip_tables              29800   5 [iptable_mangle iptable_nat iptable_filter]
af_packet              34952   1 (autoclean)
bcm5700               175160   1
isa-pnp                83896   0 (unused)
ipv6                  375120  -1 (autoclean)
keybdev                 4416   0 (unused)
hid                    44024   0 (unused)
mousedev               12152   2
st                     63720   0 (autoclean) (unused)
sr_mod                 33232   0 (autoclean)
cdrom                  61504   0 (autoclean) [sr_mod]
sg                     67616   0 (autoclean)
joydev                 13808   0 (unused)
evdev                  10440   0 (unused)
input                   9784   0 [keybdev hid mousedev joydev evdev]
usb-uhci               60088   0 (unused)
usbcore               145016   1 [hid usb-uhci]
nls_iso8859-1           4432   1 (autoclean)
nls_cp437               5936   1 (autoclean)
lvm-mod               123432   0 (autoclean)
ide-scsi               21728   0
reiserfs              495352   1
mptscsih               75456   4
mptbase                80128   3 [mptscsih]
```

Notice that the Broadcom driver, bcm5700, is used by only one Ethernet card. This is because we were using only one port during our tests and also because SuSE SLES 8 provides LVM support by default.

Partitions on IA-64 Linux

The EFI system implements a new way to work with partitions. This means that the IA-32 tools to manage partitions on Linux may not work properly.

For example, if you run **fdisk** to see the content of a partition or disk, you do not see the true content of the disks. Modifying this partition can destroy the Linux installation.

Example 5 shows the **fdisk** output for one of our test partitions. We had two disks configured on the system: one to run SuSE SLES 8, and the other to run Windows 2003 Server.

Example 5 fdisk output of two EFI partitions

```
Disk /dev/sda: 255 heads, 63 sectors, 1106 cylinders
Units = cylinders of 16065 * 512 bytes

   Device Boot    Start       End    Blocks   Id  System
/dev/sda1             1      1107   8887079+  ee  EFI GPT

Disk /dev/sdb: 255 heads, 63 sectors, 1106 cylinders
Units = cylinders of 16065 * 512 bytes
```

```
   Device Boot    Start       End    Blocks   Id  System
/dev/sdb1             1      1107   8887079+  ee  EFI GPT
```

The two disks included more than one partition. In fact, there were at least three partitions on each disk: one for EFI, one for the operating system boot images, and another for the data. As you can see in the example, fdisk does not see any of these partitions, but only a big partition of type EFI GP.

Instead of using **fdisk**, you can use **parted**. The **parted** utility is included on the SuSE SLES base system. As shown in Example 6, the **parted** output does not show the same information in the partition table, but recognizes the real partitions on the system. The **parted** utility can identify every partition on the partition table.

Example 6 GNU parted output (some lines removed)

```
linux:~ # parted
GNU Parted 1.6.3
...
Using /dev/sda
(parted) print
Disk geometry for /dev/sda: 0.000-8568.000 megabytes
Disk label type: gpt
Minor    Start       End     file system  Name                  Flags
1          0.017     54.906  fat32                              boot
2         54.906   1051.062  linux-swap
3       1051.062   8565.375  reiserfs
(parted)
```

The FAT32 partition is the EFI System Partition where the kernel images and other files needed to boot Linux are stored. The EFI System Partition is also available as the /boot partition once you log into Linux.

For more information about the parted utility, use **man parted** or go to:

http://www.gnu.org/software/parted

Using the serial port for the Linux console

You can redirect all kernel console messages to the serial port. This can be done by entering the following command at the elilo prompt or adding it to the elilo.conf file.

```
append="console=ttyS0,115200"
```

You can also redirect not only kernel messages, but any other system message from the default messages console (which is virtual terminal number 10 on SuSE Linux, and /var/log/messages on other Linux distributions) to the serial port. To do so, you must use the syslog daemon. This daemon controls the flow of system messages and redirects them to whichever location we want. To redirect all syslog messages to the serial port, edit the /etc/syslog.conf file and add the following string to the line that you want to be redirected to the serial port:

```
/dev/ttyS0
```

Example 7 shows an example of this.

Example 7 Redirection of kernel messages to the serial port with the syslogd daemon

```
# This is only a part of the /etc/syslog.conf file
# Your file may be different. Here we will send all the kernel
# warning messages to the serial port

kern.warn; /dev/ttyS0
```

To activate the changes you made in the syslog daemon, enter the command:

```
/etc/init.d/syslog restart
```

Refer to the syslog daemon man page for more information about the configuration.

RXE-100 Expansion Enclosure

The RXE-100 Expansion Enclosure is now fully supported under Linux. The x450 will recognize any device attached to any of the 12 RXE-100 slots.

When installing SuSE SLES 8, it is recommended that you disconnect the RXE-100 before the operating system installation, and then reconnect it again once the system is installed. The installation program uses a limited version of the kernel that may not recognize your devices on the RXE enclosure or may crash the installation.

Active PCI support (Hot Plug) is not supported on Linux.

Tip: To easily view all your recognized PCI devices, you can use the YaST tool. To invoke YaST, simply enter `yast` at the command prompt, then go to the Hardware and PCI information section.

As you can see in Figure 3, all the PCI slots are recognized, including the 12 external PCI slots.

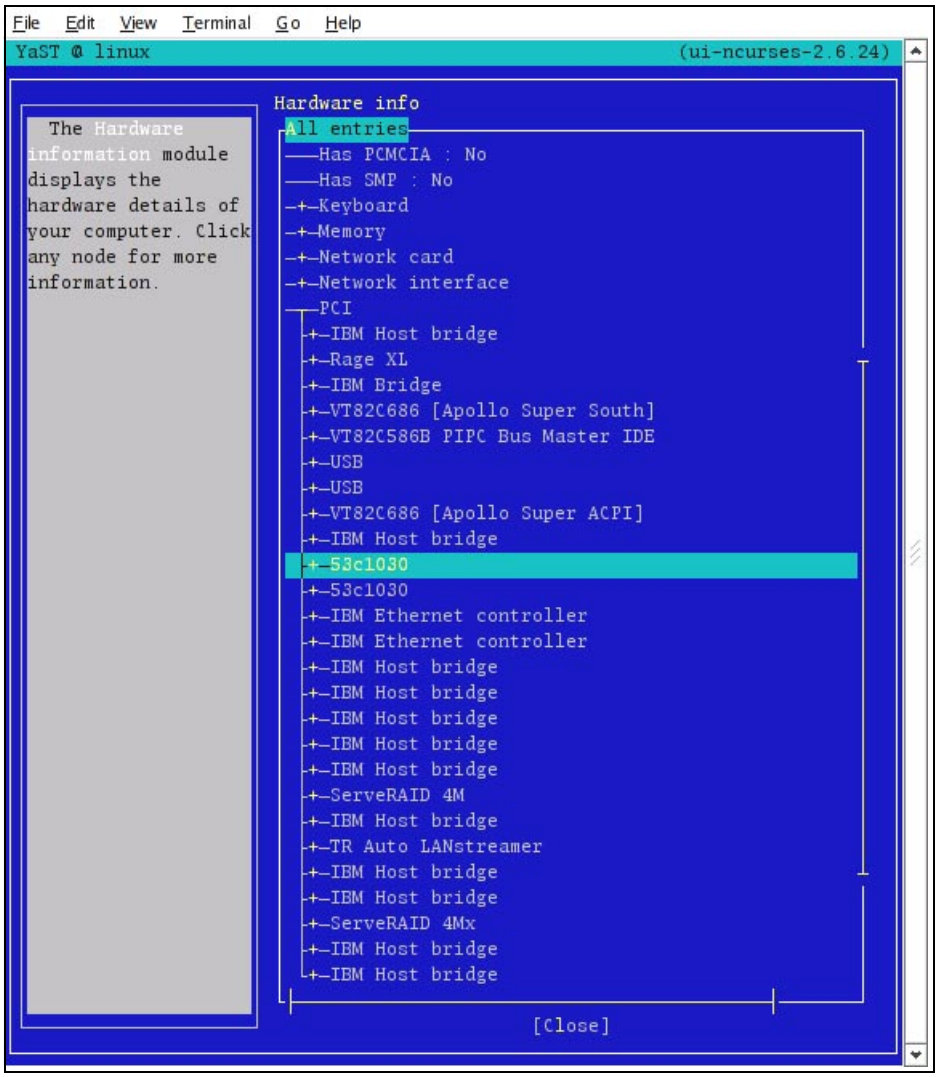

Figure 3 PCI information on YaST

Upgrading drivers

Any update to the Linux installation should be done through the official support service provided from IBM and SuSE. To visit the xSeries support page, go to:

`http://www.pc.ibm.com/support`

The most significant drivers and modules that you should maintain on the x450 are:

- Broadcom Gigabit Ethernet

  The Broadcom Gigabit Ethernet adapter is supported on Linux with the bcm5700 module. This module supports all the 5700 series of Gigabit adapters from Broadcom. This module comes with SuSE SLES 8 and both Broadcom ports are detected during the installation.

- LSI SCSI chipset

  The default kernel that comes with SuSE SLES 8 has the LSI chipset support precompiled. This will automatically support any SCSI devices connected to your LSI chipset.

- ATI Rage XL video controller

  The video controller used in the x450 is an ATI Rage XL device. This device is supported by XFree86, with the ATI driver. This driver supports almost all the ATI graphics controllers. ATI controllers are supported on both major versions of XFree86, V3.3.6 and V4.2.1. To review the status of any supported ATI graphics device supported by the XFree86 project, see:

  http://www.xfree86.org/current/Status6.html#6

  For generic information about the status of any driver, see:

  http://www.xfree86.org/current/Status.html

  ATI also has a support page for Linux, where you can access all the information you may need to find any new drivers or simply know more about ATI's support of Linux:

  http://mirror.ati.com/support/faq/linux.html

- XA-64 chipset

  At the time of writing, there was no official kernel update to support the new 64-bit chipset. The x450 will work in 64-bit native mode without any kernel patches. If IBM or SuSE release any specific patch for the XA-64 chipset, you will find more information about how to upgrade your current kernel on the xSeries support page:

  http://www.pc.ibm.com/support

The team that wrote this Redpaper

This Redpaper was produced by a team of specialists from around the world working at the International Technical Support Organization, Raleigh Center.

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