— LPI Certification —
— General Linux 1 —

(Study Notes) [1] [2]

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Contents

Topic 101

Hardware & Architecture

Objective 101.1

Configure Fundamental BIOS Settings

1.1 Overview

1.1.1 Weight: []

1.1.2 Statement of Objective:

Candidates should be able to configure fundamental system hardware by making the correct settings in the system BIOS. This objective includes a proper understanding of BIOS configuration issues such as the use of LBA on IDE hard disks larger than 1024 cylinders, enabling or disabling integrated peripherals, as well as configuring systems with (or without) external peripherals such as keyboards. It also includes the correct setting for IRQ, DMA and I/O addresses for all BIOS administrated ports and settings for error handling.

1.1.3 Key files, terms, and utilities:

```
/proc/ioports
/proc/interrupts
/proc/dma
/proc/pci
```

1.1.4 Resources:

Large Disk HOWTO by Andries Brouwer

`http://www.linuxdoc.org/HOWTO/Large-Disk-HOWTO.html`

1.2 Notes

1.3 Lab

1.4 Questions

Objective 101.3

Configure Modem and Sound cards

3.1 Overview

3.1.1 Weight: []

3.1.2 Statement of Objective:

Ensure devices meet compatibility requirements (particularly that the modem is NOT a win-modem), verify that both the modem and sound card are using unique and correct IRQ's, I/O, and DMA addresses, if the sound card is PnP install and run sndconfig and isapnp, configure modem for outbound dial-up, configure modem for outbound PPP — SLIP — CSLIP connection, set serial port for 115.2 Kbps

3.1.3 Key files, terms, and utilities:

3.1.4 Resources:

3.2 Notes

3.3 LAB 1: Setting Up a Shell Dialup Service

When you have completed this exercise you will be able to dial into a shell account on a remote host.

3.3.1 Inbound Shell Login - Server

1. Edit `/etc/inittab` to automatically spawn `mgetty`.

   ```
   $ tail -1  /etc/inittab ↩
   T0:2345:respawn:/sbin/mgetty -x0 -s 57600 -D ttyS0
   ```

   (Change ttyS0 to whatever device your modem is connected to)

2. Connect the modem and phone line.

3. Run `# telinit q ↩` to reread `/etc/inittab`

4. Check that the modem's DTR indicator is on.

5. Check `mgetty` is there:

   ```
   $ ps aux |grep mgetty ↩
   root  ......   /sbin/mgetty -x0 -s 57600 ttyS0
   ```

3.3.2 Outbound Shell login - Client

This exercise uses the minicom terminal program. To get help at any time press Control-C Z.

1. Run `# minicom -s ↩` (as root) and setup the serial port to the desired `tty` and linespeed.

2. Give normal users access to the modem device.

3. Run minicom as a normal user. Once the modem has initialised typing `AT` at the minicom terminal will prompt the modem to return `OK`:

   ```
   AT ↩
   OK
   _
   ```

   and dial your server:

   ```
   OK
   ATDT12345678
   ```

4. When the modem answers and trains, you should be presented with a login prompt. Login as you normally would.

5. Logging out will disconnect the modem.

3.4 LAB 2: Setting Up a PPP Dialup Service

3.4.1 Inbound Dialup ppp - Server

1. Edit `/etc/inittab` to run `mgetty`.

   ```
   $ tail -1  /etc/inittab ↩
   T0:2345:respawn:/sbin/mgetty -x0 -s 57600 -D ttyS0
   ```

   Change `ttyS0` to whatever device your modem is connected to.

2. Add the following line (if not already there) to `/etc/modules.conf`

   ```
   alias ppp0 ppp_generic
   ```

3. Connect modem and phone line.

4. Run `# telinit q` ↩ to reread `/etc/inittab`

5. Edit `/etc/mgetty/login.config` and uncomment the line

   ```
   /AutoPPP/ - a_ppp /usr/sbin/pppd auth -chap +pap login debug
   ```

6. Edit the file `/etc/ppp/options` and uncomment or add the lines:

   ```
   asyncmap 0
   #auth
   crtscts
   lock
   modem
   -detach
   proxyarp
   ```

7. Edit the file `/etc/ppp/options.ttyS0` and uncomment or add the line:

   ```
   192.168.0.253:192.168.0.10
   ```

   The format of this line is `Server IP:Client IP`. Note that these addresses should be on the same network as your server unless you are prepared to setup routing for a new network. However, they should not clash with previously allocated IP addresses.

8. Edit `/etc/ppp/pap-secrets` and add:

   ```
   #user          interface    password      allowed-ip-addresses
   <username>     *            <password>    *
   ```

   This line says: Let user `<username>` with password `<password>` use any ppp interface with any IP address. The username and passwd can be anything you like and do not have to be in `/etc/passwd`. You will need the username and password pair when you come to set up the client.

3.4.2 Outbound Dialup ppp - Client

NOTE: If your client & server machines are already connected via a LAN you will probably need to bring down the LAN on your client machine. (Or at least remove any route associated with the LAN from the client). To do this: `ifconfig eth0 down` Type `$ /sbin/route -n` ↩ and make sure it looks like the line below before configuring ppp on the client:

```
Kernel IP routing table
Destination  Gateway  Genmask    Flags Metric Ref Use Iface
127.0.0.0    *        255.0.0.0  U     0      0     0 lo
```

Common to both methods: Edit /etc/modules.conf and add the following line:

```
alias ppp0 ppp_generic
```

From within X:

1. Run kppp and create an entry for your server, just as you would do for an ISP. The only items that need to be added are:
   - The telephone number of the server
   - The userid you selected in the server pap-secrets file
   - The password you selected in the server pap-secrets file
2. Click the Connect button and you should be away!.

From a terminal using wvdial:

1. Run `# wvdialconf /etc/wvdial.conf` ↩. You should end up with a file called `/etc/wvdial.conf` that looks something like:

   ```
   [Dialer Defaults]
   Modem = /dev/ttyS0
   Baud = 115200
   Init1 = ATZ
   Init2 = ATQ0 V1 E1 S0=0 &C1 &D2 S11=55 +FCLASS=0
   ; Phone = <Target Phone Number>
   ; Username = <Your Login Name>
   ; Password = <Your Password>
   ```

2. Now edit this file and add the following to the end of the file:

   ```
   [Dialer <server-name>]
   Username = username   #just as you entered into pap-secrets on the server
   Password = passwd     #just as you entered into pap-secrets on the server
   Phone = <telephone number>
   Inherits = Dialer Defaults
   Stupid mode = 1
   New PPPD = 1
   ```

Stupid mode tells wvdial to start pppd as soon as it sees the login prompt and not to log into the server as a normal user first.

3. Now you can dial your server by doing the following:

   ```
   $ wvdial <server-name>↩
   ```

   Where <server-name> is the name you gave to the second dialer stanza above.

   Note that wvdial will add an entry into /etc/ppp/pap-secrets containing the username and password pair automatically.

3.4.3 Adding Automatic DNS setup

You can have the server pass a pair of DNS IP addresses to the client which the client can use to resolve dns queries. If you do this, you should be able to use Windows as a client just like any other ISP.

Server Side:

Add the following line to /etc/ppp/options

```
ms-dns <DNS-IPADDR1>
ms-dns <DNS-IPADDR2>
```

The DNS ip addresses should be whatever your server is using (`$ cat /etc/resolv.conf ↩` to see). If your server is using the local interface (127.0.0.1) then you should set the address to that of eth0 and make sure that bind is configured to listen on that interface. The following line should be in /etc/named.conf

```
listen-on <ip-address>
```

Client Side:

Add the following line to /etc/ppp/options

```
usepeerdns
```

Now create a file called /etc/ppp/ip-up.local which contains:

```
cp /etc/resolv.conf /etc/ppp/resolv.conf.orig
echo "nameserver $DNS1" > /etc/resolv.conf
echo "nameserver $DNS2" >> /etc/resolv.conf
```

Create another file called /etc/ppp/ip-down.local which contains:

```
cp /etc/ppp/resolv.conf.orig /etc/resolv.conf
```

Congratulations. You now have a server which behaves just like an ISP!

3.5 Questions

Objective 101.4

Setup SCSI Devices

4.1 Overview

4.1.1 Weight: []

4.1.2 Statement of Objective:

Candidates should be able to configure SCSI devices using the SCSI BIOS as well as the necessary Linux tools. They also should be able to differentiate between the various types of SCSI. This objective includes manipulating the SCSI BIOS to detect used and available SCSI IDs and setting the correct ID number for different devices especially the boot device. It also includes managing the settings in the computer's BIOS to determine the desired boot sequence if both SCSI and IDE drives are used.

4.1.3 Key files, terms, and utilities:

```
SCSI ID
/proc/scsi/
scsi_info
```

4.1.4 Resources:

4.2 Notes

4.2.1 SCSI Devices

- SCSI - Small Computer Systems Interface
- SCSI can support a range of devices
  - Hard disks
  - Tape drives
  - Scanners
- There are many different types of SCSI based on:
  - Bus Width
  - Bus Speed
  - Max no of devices

4.2.2 SCSI TYPES

Name	Bus Width (bits)	Bus Speed (MB/s)	Max Devices
SCSI-1	8	5	8
Fast SCSI	8	10	8
Ultra SCSI	8	20	8
Ultra2 SCSI	8	40	8
Fast Wide SCSI	16	20	16
Wide Ultra SCSI	16	40	16
Wide Ultra2 SCSI	16	80	16
Ultra3 SCSI	16	160	16
Ultra320 SCSI	16	320	16

4.2.3 SCSI Key Points

- All devices on the SCSI bus are are numbered from 0 to N (7 or 15)
- The SCSI controller is usually numbered 7 or 15
- The higher the device number, the higher its priority
- To boot from a SCSI disk, it must be device 0
- The SCSI bus must be terminated at both ends
- SCSI controllers need a kernel module to make them work

4.2.4 SCSI Addressing

SCSI devices are addressed according to:

- SCSI adapter number (host)
- channel number (bus)
- id number (target)
- lun (lun)

4.2.5 SCSI Driver Layers

There are three layers to the SCSI subsystem:

- Low level driver - Controller specific
- Mid level driver - SCSI unifying layer
- Upper level driver - Device specific

4.2.6 SCSI Driver Layers - Example

Consider an SCSI hard disk as an example:

- Low level - `aha1542.o`
- Mid level - `scsi_mod.o`
- Upper level - `sd_mod`

4.2.7 SCSI Upper Level Drivers

These drivers bind themselves to `/dev` entries.
A non exhaustive, but pretty complete list:

- Disk driver (magnetic) - `sd.o`
- Disk driver (optical) - `sd_mod.o`
- CDROM driver - `sr.o`
- Tape drivers - `st.o`
- Generic drivers - `sg.o`

4.2.8 SCSI & the Kernel

To get SCSI working, you first need to load the appropriate module for your SCSI controller. For example:

- An Adaptec 1542 controller with an attached hard disk you would:

  ```
  # insmod aha1542 ↩
  ```

- Then load the mid level driver:

  ```
  # insmod scsi_mod ↩
  ```

- Finally, load the upper level driver:

  ```
  # insmod sd ↩
  ```

4.2.9 /proc/scsi

To see what devices have been found (at the mid level layer), have a look in the file `/proc/scsi`:

```
# cat /proc/scsi/scsi ↩
Attached devices:
Host: scsi0 Channel: 00 Id: 00 Lun: 00
  Vendor: CREATIVE Model: CD5233E        Rev: 1.00
  Type:   CD-ROM                         ANSI SCSI revision: 02
Host: scsi0 Channel: 00 Id: 01 Lun: 00
  Vendor: SONY     Model: CD-RW  CRX145E Rev: 1.0b
  Type:   CD-ROM                         ANSI SCSI revision: 02
```

4.3 Lab

4.4 Questions

Objective 101.5

Setup different PC expansion cards

5.1 Overview

5.1.1 Weight: []

5.1.2 Statement of Objective:

Candidates should be able to configure various cards for the various expansion slots. They should know the differences between ISA and PCI cards with respect to configuration issues. This objective includes the correct settings of IRQs, DMAs and I/O Ports of the cards, especially to avoid conflicts between devices. It also includes using isapnp if the card is an ISA PnP device.

5.1.3 Key files, terms, and utilities:

```
/proc/dma
/proc/interrupts
/proc/ioports
/proc/pci
pnpdump(8)
isapnp(8)
lspci(8)
```

5.1.4 Resources:

Linux Hardware Compatibility HOWTO - Steven Pritchard :

`http://www.linuxdoc.org/HOWTO/Hardware-HOWTO/index.html`

Linux PCI-HOWTO by Michael Will :

http://www.linuxdoc.org/HOWTO/PCI-HOWTO.html

Plug-and-Play-HOWTO David S.Lawyer :

http://www.linuxdoc.org/HOWTO/Plug-and-Play-HOWTO.html

5.2 Notes

5.3 Lab

5.4 Questions

Objective 101.6

Configure Communication Devices

6.1 Overview

6.1.1 Weight: []

6.1.2 Statement of Objective:

Candidates should be able to install and configure different internal and external communication devices like modems, ISDN adapters, and DSL switches. This objective includes verification of compatibility requirements (especially important if that modem is a winmodem), necessary hardware settings for internal devices (IRQs, DMAs, I/O ports), and loading and configuring suitable device drivers. It also includes communication device and interface configuration requirements, such as the right serial port for 115.2 Kbps, and the correct modem settings for outbound PPP connection(s).

6.1.3 Key files, terms, and utilities:

```
/proc/dma
/proc/interrupts
/proc/ioports
setserial(8)
```

6.1.4 Resources:

Linmodem-HOWTO by Sean Walbran and Marvin Stodolsky :

`http://www.linuxdoc.org/HOWTO/Linmodem-HOWTO.html`

Modem-HOWTO - David S.Lawyer :

http://www.linuxdoc.org/HOWTO/Modem-HOWTO.html

The Winmodems-and-Linux HOWTO by Alexandre J. :

http://www.linuxdoc.org/HOWTO/Winmodems-and-Linux-HOWTO.html

Serial HOWTO - David S.Lawyer original by Greg Hankins :

http://www.linuxdoc.org/HOWTO/Serial-HOWTO.html

The Linux Winmodem Support Website :

http://www.linmodems.org

6.2 Notes

6.3 Lab

6.4 Questions

Objective 101.7

Configure USB devices

7.1 Overview

7.1.1 Weight: []

7.1.2 Statement of Objective:

Candidates should be able to activate USB support, use and configure different USB devices. This objective includes the correct selection of the USB chipset and the corresponding module. It also includes the knowledge of the basic architecture of the layer model of USB as well as the different modules used in the different layers.

7.1.3 Key files, terms, and utilities:

```
lspci(8)
usb-uhci.o
usb-ohci.o
/etc/usbmgr/
usbmodules
/etc/hotplug
```

7.1.4 Resources:

The Linux-USB Project `http://www.linux-usb.org:`

The Linux USB Sub System by Brad Hards, Sigma Bravo Pty. Ltd.

Slides LCDP `gl1.101.7.slides.tex`

7.2 Notes

These notes were prepared by Andrew Eager.

7.2.1 The Universal Serial Bus

- A serial transmission scheme
- Two versions of USB Version 1 & Version 2
- Version
  - 1 released January 1996
  - supports speeds up to 12MBit/s (8.5Mbit/s in practice)
  - supports up to 127 devices connected to the bus

  Version 2:
  - announced 1999
  - supports speeds up to 480Mbit/s
- Devices can be self or bus powered

7.2.2 USB Topology

The system unit contains the host controller and one virtual root hub with at least one (and normally two) USB interfaces. These interfaces can then be connected directly to a USB device or to another HUB.

7.2.3 USB Device Driver Layers

The Device drivers used for the USB sub-system are split into two distinct layers:

Hardware Layer - usbcore & usb-uhci / usb-ohci

API Layer - Application / Product specific

7.2.4 USB Controllers

There are two categories of USB controller:

`usb-uhci` - For Intel, PIIX4, Via controllers

`usb-ohci` - For Compaq, iMacs, OPTi, SiS, ALi controllers

To determine your controller type, examine `/proc/pci` for a clue:

```
  [root@Node4] root]# cat /proc/pci
PCI devices found:
   .........
Bus  0, device   7, function  2:
    USB Controller: VIA Technologies, Inc. UHCI USB (rev 17).
      IRQ 10.
      Master Capable.  Latency=32.
      I/O at 0xe400 [0xe41f].
   .........
```

The UHCI controllers use a 16 bit IO address:

```
      I/O at 0xHHHH     eg:  I/O at 0xe400
```

The OHCI controllers use a 32 bit memory address:

```
     memory at 0xHH000000    eg memory at 0xee000000
```

7.2.5 USB Modules

Assuming you have a modular kernel, the following modules will be required:

1. `usbcore` - The base usb kernel module
2. plus one of the controller specific modules:
   - `usb-uhci` - For Intel, PIIX4, Via controllers
   - `usb-ohci` - For Compaq, iMacs, OPTi, SiS, ALi controllers

Configuration:

An entry in `/etc/modules.conf` aliases the specific controller to usb-controller as follows:

```
alias usb-controller usb-uhci
```

Starting up the USB sub-system

To have the usb sub-system startup automatically at boot time, all you need to do is ensure that the above alias line is present in `/etc/modules.conf`.

To startup manually, do the following steps:

1. `insmod usbcore`
2. `insmod usb-uhci` (or usb-ohci)
3. mount the `usbdevfs` filesystem (optional but highly recommended)

Example:

```
[root@Node4] root]# insmod usbcore
Using /lib/modules/2.4.18-4/kernel/drivers/usb/usbcore.o
[root@Node4] root]# insmod usb-uhci
Using /lib/modules/2.4.18-4/kernel/drivers/usb/usb-uhci.o
[root@Node4] root]# mount -t usbdevfs usbdevfs /proc/bus/usb
```

Once this is done, you should see the following entries in /proc/bus/usb:

```
[root@Node4] root]# ls /proc/bus/usb
001  devices  drivers
```

7.2.6 USB Interrogation Utilities

`lsusb` - A console view of USB devices

Lsusb is a text utility contained in the usbutils package. Use 'rpm -Uvh usbutils.xxx.rpm' to install.

```
[root@node4]# lsusb

Bus 001 Device 001: ID 0000:0000 Virtual Hub
Device Descriptor:
  bLength                18
  bDescriptorType         1
  bcdUSB               1.00
  bDeviceClass            9 Hub
  iProduct                2 USB UHCI Root Hub
 ..........

Bus 001 Device 002: ID 03f0:0601 Hewlett-Packard ScanJet 6300c
Device Descriptor:
  bLength                18
  bDescriptorType         1
  bcdUSB               1.00
  bDeviceClass            0 Interface
  bDeviceSubClass         0
  bDeviceProtocol         0
  bMaxPacketSize0         8
  idVendor           0x03f0 Hewlett-Packard
  idProduct          0x0601 ScanJet 6300c
  bcdDevice            1.00
  iManufacturer           1
  iProduct                2 HP ScanJet 6300C
  iSerial                 3 SG9941706SPE
........

Bus 001 Device 003: ID 1189:6000
Device Descriptor:
  bLength                18
  bDescriptorType         1
  bcdUSB               1.00
  bDeviceClass            0 Interface
  bDeviceSubClass         0
  bDeviceProtocol         0
  bMaxPacketSize0         8
  idVendor           0x1189
  idProduct          0x6000
```

```
  bcdDevice            a.03
  iManufacturer           0
  iProduct                1 USB Optical Storage Device
  iSerial                 0
```

usbview - An X view of USB devices

usbview is a GUI utility contained in the usbview package. Use `$ rpm -Uvh usbview.rpm ↩` to install.

usbview parses /proc/bus/usb/devices for connected USB devices. Any device that has a problem will be printed in red.

□

7.2.7 Hotplugging Usb Devices

When a device is plugged into a USB port, it will automatically register itself with the USB subsystem. The upper API drivers will not however automatically 'insmod' themselves unless the hotplug package has been installed.

With the hotplug package installed, an entry in /proc/sys/kernel/hotplug will be created which will contain the name of an executable to be called whenever a new device is detected on the bus.

```
$ ls /proc/sys/kernel/hotplug ↩
/sbin/hotplug
```

For example, when a USB scanner is plugged in, hotplug will automatically load the module scanner.o. The xsane application can then be run directly without any user intervention.

- /sbin/hotplug is an executable which is called by the kernel (kernel space to user space interface)
- /etc/hotplug is a directory containing configuration information for hotplug (which drivers to load when a device is plugged in)

7.3 Lab

7.4 Questions

Topic 102

Linux Installation & Package Management

Objective 102.1

Design hard disk layout

1.1 Overview

1.1.1 Weight: []

1.1.2 Statement of Objective:

Candidates should be able to design a disk partitioning scheme for a Linux system. This objective includes allocating filesystems or swap space to separate partitions or disks, and tailoring the design to the intended use of the system. It also includes placing /boot on a partition that conforms with the BIOS' requirements for booting.

1.1.3 Key files, terms, and utilities:

```
/ (root) filesystem
/var filesystem
/home filesystem
swap space
mount points
partitions
cylinder 1024
```

1.1.4 Resources:

Mini-FAQ from Karsten M Self on Linux Partitioning :

`http://pw1.netcom.com/~kmself/Linux/FAQs/partition.html`

1.2 Notes

1.3 Lab

1.4 Questions

Objective 102.2

Install a boot manager

2.1 Overview

2.1.1 Weight: [1]

2.1.2 Statement of Objective:

Candidate should be able to select, install, and configure a boot manager. This objective includes providing alternative boot locations and backup boot options (for example, using a boot floppy).

2.1.3 Key files, terms, and utilities:

```
/etc/lilo.conf
/boot/grub/grub.conf
lilo
grub-install
MBR
superblock
first stage boot loader
```

2.1.4 Resources:

LinuxGazette GRUB Article :

`http://www.linuxgazette.com/issue64/kohli.html`

The Gnu Grub Site :

`http://www.gnu.org/software/grub/`

2.2 Notes

The notes for this section are based on slides prepared by Andrew Eager.

2.2.1 Disk Organization

Disk Organization

- A disk is organised into:
  - Cylinders
  - Heads
  - Sectors
- All sectors of Cyl 0, Head 0 are reserved:

Fdisk on a floppy confirms this:

```
Disk /dev/fd0: 2 heads, 18 sectors, 80 cylinders
Units = cylinders of 36 * 512 bytes

    Device   Start       End    Blocks
/dev/fd0p1       1         1         9
/dev/fd0p2       2         2        18
/dev/fd0p3       3         3        18
/dev/fd0p4      80        80        18
```

Note the first partition is smaller than the rest

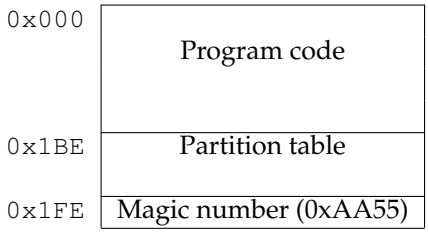
The DOS Boot Process

- A Power On Self Test is performed.
- Control is passed to the boot device
- The first sector on disk is loaded into memory
- The MBR code is executed:
  - It reads the partition table
  - Looks for an active partition
  - Loads the boot sector of active partition
  - Executes the code in that boot sector

The Master boot record

- The MBR is the first block (sector) on the disk
- It contains:
  - Boot Code: 446 bytes
  - Partition Table 64 bytes
  - MBR Signature 2 bytes (0x55AA)
  - TOTAL 512 bytes

The Master boot record



Boot Loaders

A boot loader is a program that is responsible for selecting the operating system to be booted. Once the desired OS is selected for boot, the boot loader must transfer control to it. Typical boot loaders are:

- The DOS boot loader. Not interactive
- LILO: An interactive boot loader
- GRUB: An interactive boot loader
- Boot Manager: An interactive boot loader

2.2.2 LILO - The Linux Loader

- LILO is a two stage loader:
- Stage 1 is 446 bytes long & is located in *either*
  - The MBR (Master boot record. Eg in /dev/hda) *OR*
  - The VBR (Volume boot record. Eg in /dev/hda1)
- Stage 2 is a file (/boot.b) located in /boot it contains the bulk of the lilo functionality

LILO Boot sequence—LILO in the VBR

When LILO is installed in the VBR, it is up to the MBR to transfer control to it. This is normally done by setting the partition where LILO is installed to 'active'. You would use fdisk (either dos or linux) to do this:

□

LILO and the BIOS

LILO uses the BIOS INT13 calls to read the following files:

- /boot/boot.b - The second stage loader
- /boot/map - The map file
- All kernels
- The Volume Boot sectors of all OS's it boots
- The boot message if one has been set

Configuring LILO

LILO is entirely configured within the file /etc/lilo.conf. This file contains three areas.

- Global Options (eg signon message, delay time etc)
- General 'per operating system' options
- Linux kernel options (Linux only - eg root device, ro etc)

Installing LILO

Once LILO has been configured, it can be installed by running **/sbin/lilo** as root from the command line. This will do the following:

- Make a backup copy of the boot sector (MBR or VBR)
- Create a /boot/map file with the locations of:
  - /boot/boot.b
  - The kernel
  - /boot/message
  - /boot/chain.b
- Make a boot sector containing the location of the map file
- Write the boot sector to either the MBR or VBR.

LILO diagnostics

When LILO runs, it prints the word 'L I L O' in the top left hand corner of the screen, one letter at a time:

- 'L' - Stage 1 loaded & running.
- 'LI' - Stage 2 was loaded but could not run
- 'LIL' - Stage 2 was loaded but could not locate the descriptor table
- 'LIL?' - Stage 2 was loaded at an incorrect address
- 'LIL-' - Stage 2 was loaded but descriptor table is corrupt
- 'LILO' - LILO has started up correctly.

2.2.3 grub—Grand Unified Bootloader

GRUB operates in a similar manner to LILO. It is a two stage loader that can load stage 1 into either the MBR or VBR.

The main differences between LILO and GRUB are:

- Stage 2 can be located beyond the 1024 cylinder limit.
- GRUB can boot from network devices using tftp

- GRUB has many more configuration options
- GRUB is effectively a mini shell and can be configured 'on-the-fly' by giving it commands directly at boot time.

Hard Disk Naming Conventions

GRUB uses a different naming convention to that of the rest of the Linux world. In general, the syntax used is: hdN,X where: N is the hard disk number (0 for the first, 1 for the second...) X is the partition number (0 for the first, 1 for the second...)

Examples: (hd0,1) refers to the 1st physical drive, 2nd primary partition (hd1,6) refers to the 2nd physical drive, 3rd logical partition (fd0) refers to the floppy drive

A file within a partition can be referred to by appending a path to it: EG: (hd0,0)/boot/vmlinuz, refers to the file /boot/vmlinuz on the 1st drive, 1st partition

Installing GRUB

Once the configuration file has been created, there are two ways to install GRUB:

Option 1: Run grub from the command line:

```
[root@cds grub]# /sbin/grub
grub> root (hd0,6)
grub> setup (hd0)
       or;
grub> setup (hd0,4)
```

Installing GRUB

Option 2: Use the grub-install command: To install into the MBR:

```
[root@cds grub]# grub-install /dev/hda
```

To install into the VBR:

```
[root@cds grub]# grub-install /dev/hda5
```

If you have a separate /boot partition, then you need to specify boot directory:

```
[root@cds grub]#
grub-install --root-directory=/boot /dev/hda5
```

2.2.4 Sample Installation

The diagram below shows the disk layout used for the sample configuration scripts.

□

LILO configuration

```
# Global configuration options
boot=/dev/hda
timeout=20
message=/boot/message
prompt
default=linux
vga=normal
map=/boot/map
install=/boot/boot.b

# Per image options
other=/dev/hda3
    label=WIN98

other=/dev/hda2
    label=QNX

other=/dev/hda1
    label=DOS

image=/boot/vmlinuz
    label=linux
    root=/dev/hda7
    read-only
```

GRUB configuration

```
default=0
timeout=10
fallback=1
splashimage=(hd0,0)/boot/grub/splash.xpm.gz

title RedHat 7.2
        root (hd0,4)
        kernel /vmlinuz ro root=/dev/hda7
        initrd /initrd.img

title Windows
        root (hd0,2)
        makeactive
        chainloader +1

title QNX
        root  (hd0,1)
        makeactive
```

```
        chainloader +1

title DOS
        root  (hd0,0)
        makeactive
        chainloader +1
```

2.3 Lab

2.3.1 grub entry for adding Debian

```
default=1
timeout=10
splashimage=(hd0,4)/grub/splash.xpm.gz
title Red Hat Linux (2.4.18-3debug)
        root (hd0,4)
        kernel /vmlinuz-2.4.18-3debug ro root=/dev/hda7
        initrd /initrd-2.4.18-3debug.img
title Win ME
        rootnoverify (hd0,0)
        chainloader +1
title Debian
     root (hd0,1)
     kernel /boot/vmlinuz-2.2.20-idepci ro root=/dev/hda2
```

2.4 Questions

Objective 102.3

Make and install programs from source

3.1 Overview

3.1.1 Weight: [5]

3.1.2 Statement of Objective:

Candidates should be able to build and install an executable program from source. This objective includes being able to unpack a file of sources. Candidates should be able to make simple customisations to the Makefile, for example changing paths or adding extra include directories.

3.1.3 Key files, terms, and utilities:

```
gunzip
gzip
bzip2
tar
configure
make
```

3.1.4 Resources:

TBA

3.2 Notes

3.2.1 Source Code Distribution

To distribute software in the form of source code a source tree is archived into one file using the tar command and then compressed. The resulting file is called a tarball.

Source code may also be distributed using the package management tools of a particular distribution.

Debian apt-get install kernel-source-2.2.27

Redhat rpm -Uhv at-3.1.8-23.src.rpm

Tarball tdb-1.0.6.tar.gz

subsectionSteps to Install a package from tarball

- Unpack the taball:

  ```
  $ tar zxvf my-prog.tar.gz ↩
  ```

- Change directory into the source tree:

  ```
  $ cd my-prog ↩
  ```

- Configure the `Makefile`:

  ```
  $ ./configure ↩
  ```

- Make:

  ```
  $ make ↩
  ```

- Install:

  ```
  $ su -c 'make install'↩
  ```

3.2.2 Installing the trivial database `tdb`

Download

Locate and download the `tarball`

- googling for it: `http://google.com`
- search on freshmeat: `http://freshmeat.net`
- see if it lives on sourceforge: `http://www.sf.net`

Download the tarball to a suitable directory such as `/tmp`.

Unpack

The tarball file is a compressed archived source tree.

Most commonly the file will be compressed using either `gzip` or `bzip2`

GNU `tar` can uncompress and unpack the archive:

```
$ tar zxvf tdb-1.0.6.tar.gz ↩
```

or

```
$ tar jxvf tdb-1.0.6.tar.bz2 ↩
```

cd into the tree

The unpacked tarball creates a source tree. The base of which is the name of the program

```
$ ls ↩
tdb-1.0.6  tdb-1.0.6.tar.gz

$ cd tdb-1.0.6 ↩

$ ls ↩
configure  tdb.c  tdb.h   README  INSTALL  COPYING
...
```

cd into the tree

```
$ ls -w 70 ↩
acconfig.h    install-sh     stamp-h.in       tdb.h
aclocal.m4    ltconfig       tdb.3            tdbiterate.c
AUTHORS       ltmain.sh      tdb.c            tdb_open.3
ChangeLog     Makefile.am    tdb_chainlock.3  tdb.spec
config.guess  Makefile.in    tdb_close.3      tdbspeed.c
config.h.in   missing        tdb_delete.3     tdb_store.3
config.sub    mkinstalldirs  tdbdump.c        tdbtest.c
configure     NEWS           tdb_error.3      tdbtool.c
configure.in  README         tdb_exists.3     tdbtorture.c
COPYING       spinlock.c     tdb_fetch.3      tdb_traverse.3
INSTALL       spinlock.h     tdb_firstkey.3   TODO
```

./configure

```
$ file configure ↩
configure: Bourne shell script text executable

$ head -5 configure ↩
#! /bin/sh

# Guess values for system-dependent variables
# Create Makefiles.
# Generated automatically using autoconf version 2.13
```

./configure

```
$ ./configure ↩
 creating cache ./config.cache
checking for a BSD compat install... /usr/bin/install -c
checking whether build environment is sane... yes
checking whether make sets $MAKE... yes
checking for working aclocal... found
...
creating ./config.status
creating Makefile
creating config.h
```

The Makefile

```
SHELL = /bin/sh
CC = gcc
CFLAGS = -g -O2
prefix = /usr/local
includedir = $prefix/include
...
tdbtool: $(tdbtool_OBJECTS) $(tdbtool_DEPENDENCIES)
        @rm -f tdbtool
        $(LINK) $(tdbtool_LDFLAGS) $(tdbtool_OBJECTS)
...
distclean: distclean-am
        -rm -f config.status
```

make

```
$ make ↩
/bin/sh ./libtool --mode=compile gcc -DHAVE_CONFIG_H -I.
-I. -I.     -g -O2  -c tdb.c
mkdir .libs
gcc -DHAVE_CONFIG_H -I. -I. -I. -g -O2 -c  -fPIC -DPIC
tdb.c -o .libs/tdb.lo
gcc -DHAVE_CONFIG_H -I. -I. -I. -g -O2 -c tdb.c -o tdb.o
>/dev/null 2>&1
mv -f .libs/tdb.lo tdb.lo
/bin/sh ./libtool --mode=compile gcc -DHAVE_CONFIG_H -I.
-I. -I.     -g -O2  -c spinlock.c
...
```

make install

```
su -c 'make install'
Password:
make[1]: Entering directory `/tmp/tdb-1.0.6'
/bin/sh ./mkinstalldirs /usr/local/lib
/bin/sh ./libtool  --mode=install /usr/bin/install -c
libtdb.la /usr/local/lib/libtdb.la
...
chmod 644 /usr/local/lib/libtdb.a
PATH="$PATH:/sbin" ldconfig -n /usr/local/lib
```

3.2.3 Play with the trivial database `tdb`

The utility `tdbtool` may be used to have a play with `tdb`.

- Start it and display the help by typing something random:

```
$ tdbtool ↩
tdb> ?

tdbtool:
  create    dbname     : create a database
  open      dbname     : open an existing database
  erase                : erase the database
  dump      dumpname   : dump the database as strings
  insert    key  data  : insert a record
  store     key  data  : store a record (replace)
  show      key        : show a record by key
  delete    key        : delete a record by key
  list                 : print the database hash table and freelist
  free                 : print the database freelist
  1 | first            : print the first record
  n | next             : print the next record
  q | quit             : terminate
  \n                   : repeat 'next' command
tdb>
```

- Create a database:

```
tdb> create test.tdb
```

- Add some data:

```
tdb> insert 1 thing
tdb> insert 2 foo
tdb> insert 3 bar
tdb> insert 55 whizz
```

- Have a look at an entry:

```
tdb> show 3

key 2 bytes
3
data 4 bytes
[000] 62 61 72 00      bar
```

- Experiment.

3.3 Lab

3.4 Questions

Objective 102.4

Manage shared libraries

4.1 Overview

4.1.1 Weight: []

4.1.2 Statement of Objective:

Candidates should be able to determine the shared libraries that executable programs depend on and install them when necessary. Candidates should be able to state where system libraries are kept.

4.1.3 Key files, terms, and utilities:

```
ldd
ldconfig

/etc/ld.so.conf
LD_LIBRARY_PATH
```

4.1.4 Resources:

Shared-Library HOWTO `http://linuxdocs.org/HOWTOs/Program-Library-HOWTO/`

4.2 Ken Foskey's Notes on Shared Libraries

4.2.1 What are they

Shared libraries are code bytes that perform useful tasks for programmers.

Consider the operating system itself. It provides services to access the hard disk, the hard disk can be ext2 or reiserfs. You do not change your scripting or programming in any way. The file system and hard disk interface has been isolated from the rest of the programs.

Libraries are a similar thing. There are a number of libraries, all performing some functions. For example putting text to the screen (`libncurses`), to doing complex graphics (`libpng`).

Finally shared libraries reduce memory usage, only one copy of the library is needed in memory no matter how many programs use it, therefore it is very efficient.

4.2.2 What we need to know about libraries.

From the point of view of users we need to be able to look at a program and determine whether the appropriate libraries are installed for it. Mostly package managers such as RPM and apt takes care of this but it is nice to know more detail. Especially when working with tarballs.

What programs are using:

Firstly when we are having problems we might want to check what the particular program is calling on, perhaps we might want to update a supporting library. Let us try on the zip command in `/usr/bin`

```
gandalf: /usr/bin
$ ldd zip ↩
libc.so.6 => /lib/libc.so.6 (0x40021000)
/lib/ld-linux.so.2 => /lib/ld-linux.so.2 (0x40000000)
```

The `ldd` command has told us that it uses `libc6` (the 'standard' c runtime libraries) and nothing else.

More complex, how about the IBM mainframe terminal emulator x3270:

```
gandalf: /usr/bin
$ ldd x3270 ↩
libnsl.so.1 => /lib/libnsl.so.1 (0x40021000)
libutil.so.1 => /lib/libutil.so.1 (0x40035000)
libXaw.so.7 => /usr/X11R6/lib/libXaw.so.7 (0x40038000)
libXmu.so.6 => /usr/X11R6/lib/libXmu.so.6 (0x4008a000)
libXt.so.6 => /usr/X11R6/lib/libXt.so.6 (0x4009e000)
libSM.so.6 => /usr/X11R6/lib/libSM.so.6 (0x400e9000)
libICE.so.6 => /usr/X11R6/lib/libICE.so.6 (0x400f1000)
libXext.so.6 => /usr/X11R6/lib/libXext.so.6 (0x40107000)
libX11.so.6 => /usr/X11R6/lib/libX11.so.6 (0x40114000)
libc.so.6 => /lib/libc.so.6 (0x401ee000)
libXpm.so.4 => /usr/X11R6/lib/libXpm.so.4 (0x4030a000)
/lib/ld-linux.so.2 => /lib/ld-linux.so.2 (0x40000000)
```

You can see that this uses a lot of X windowing libraries.

```
ldconfig & /etc/ld.so.conf
```

Or rather the other way around. `ldconfig` creates an optimised cache of the libraries in use in the system. It is used every time a new library is installed to update all the various links.

`/etc/ld.so.conf` is a file that lists directories to be scanned. there is two directories implied `/usr/lib` and `/lib` that will always be scanned. On my system it contains:

```
/usr/X11R6/lib/Xaw3d
/usr/X11R6/lib
```

The tells `ldconfig` to also scan these directories. running `ldconfig` simply returns us to the command prompt, you will notice however that the `ld.so.cache` file has been updated.

If you have updated your `/etc/ld.so.conf` it is worth running `ldconfig -v`

```
gandalf:/etc # ldconfig -v ↩
ldconfig: Can't stat /usr/X11R6/lib/Xaw3d:
No such file or directory
/usr/X11R6/lib:
        libxrx.so.6 -> libxrx.so.6.3
        libXtst.so.6 -> libXtst.so.6.1
```

You will notice that the first directory listed in `ld.so.conf` was not valid and does not cause an error.

Note that the order of directories is very important, the first located shared library will be used.

4.2.3 LD_LIBRARY_PATH

Some time you need to install conflicting libraries onto your system. For example Open Office supplies all its own versions of the shared libraries so that it can perform quality control on the install. It must override the installed versions with its own. The answer is `LD_LIBRARY_PATH`, it makes Linux check the local path before going to the standard path.

A scenario that you may use you have discovered a bug in an application but you are using a back version of shared libraries. The support people have asked you to load the most current version of a shared library however this is a production server and you do not want to upgrade everything.

You grab the shared library please it in a non-standard area and then use the `LD_LIBRARY_PATH` to make the application find the new version first. If the bug persists then the shared libraries is not an issue, if it disappears then you can leave the `LD_LIBRARY_PATH` as a work around or install the library into your system properly.

4.2.4 Extra to POMS

From my setup for Open Office:

```
LD_PRELOAD=/usr/lib/libfreetype.so.6 \
/usr/local/OpenOffice.org1.0/program/swriter
```

The `LD_PRELOAD` will override the particular library with another regardless of the `LD_LIBRARY_PATH` or the `ld.so.cache file`. In this case it forces Open Office to use the debian version of libfreetype instead of Open Office version because it has better font drawing that the default.

Finally a bit about version numbers:

Libraries all have three numbers in the versions. These numbers are:

`current.revision.age`

If the age is reset to zero then you cannot use this library to replace with a previous version, if it is non-zero then it can replace a previous version. for more details see autobook section 10.4 library versioning.

4.3 Lab

4.4 Questions

1. (a)
   (b)
   (c)
   (d)
   (e)
2. (a)
   (b)
   (c)
   (d)
   (e)
3. Which tool is used to update the `ld.so.cache file`?
   (a) `ldconf`
   (b) `ldconfig`
   (c) `ldcache`
   (d) `ldd`
   (e) `ldupdate`
4. (a)
   (b)
   (c)
   (d)
   (e)

Objective 102.5

Use Debian package management

5.1 Overview

5.1.1 Weight: []

5.1.2 Statement of Objective:

Candidates should be able to perform Debian package management.This objective includes being able to use command-line and interactive tools to install, upgrade, or uninstall packages, as well as find packages containing specific files or software (such packages might or might not be installed). This objective also includes being able to obtain package information like version, content, dependencies, package integrity and installation status (whether or not the package is installed).

5.1.3 Key files, terms, and utilities:

```
/etc/dpkg/dpkg.cfg
/var/lib/dpkg/*
/etc/apt/apt.conf
/etc/apt/sources.list
dpkg
dselect
dpkg-reconfigure
apt-get
alien
```

5.1.4 Resources:

The Debian GNU/Linux FAQ :

`http://www.debian.org/doc/FAQ/index.html`

Quick Reference for Debian GNU/Linux :

`http://qref.sourceforge.net/`

lcdp slides :

`gl1.102.5.slides.tex`

5.2 Notes

These notes are based on a presentation given by Jeff Waugh.

5.2.1 Debian Package Management Overview

The main Debian Package Management tools are:

- Basic tool—`dpkg`

  `dpkg` is the back end for all Debian package management.

- Old Menu System—`dselect`

  `ncurses` menu system for `dselect`—bizarre interface.

- The Ultimate Package Tool—`apt-get`

  "Once you've been spoiled by the apt thing you just can't go back."

5.2.2 Debian Package Management Tool—`dpkg`

`dpkg` does basic package management: installation, removal, extraction and building.

Does not handle or fulfil dependencies, that's left for higher level software such as apt.

`dpkg` Tasks

- Install a package: `dpkg -i <package-file>`
- Remove a package: `dpkg -r <package-name>`
- Purge a package: `dpkg -P <package-name>`
- Find out which files a package owns: `dpkg -L <package-name>`
- Find out which package a file belongs to: `dpkg -S <file-name>`
- Extract information from package: `dpkg -e <package-file>`
- List contents of package file: `dpkg -c <package-file>`

/etc/dpkg/dpkg.cfg

- Configuration file for dpkg(1)
- Each line contains a single option which is exactly the same as a normal command line option for dpkg except for the leading dashes. Hashes for comments.
- See 'man dpkg' or 'dpkg –help' for commands.
- Example:

```
# dpkg configuration file
#
# This file can contain default options for dpkg.
# All command line options are allowed. Values can
# be specific by putting them after the option,
# separated by whitespace and/or an `=' sign.
#
no-debsig
abort-after 2
no-act
```

/var/lib/dpkg/*

- Package management status and system files, generally not directly manipulated.
- Most important files:

  alternatives: Contains files that define and store configuration for the command alternatives on the system. (Good examples: editor and x-window-manager.)

  available: Information about packages available to the system, retrieved from every specified sources. (See also: grep-available.)

  status: Information about packages installed on, or removed from your system.

5.2.3 Debian Package Mgt. Utility—apt-get

/etc/apt/apt.conf

- Configuration files for `apt(1)`.
- `apt.conf` used by administrator for unique system configurations.
- Example: Setting apt's HTTP proxy:

```
Acquire::http "http://192.168.10.1/";
```

- `apt.conf.d` managed by software that integrates with apt, such as our examples: `dpkg-reconfigure` and `apt-listchanges`.
- See '`man apt.conf`' for configuration directives and format.
- `apt-config(1)` is useful for troubleshooting `apt.conf` problems.

`/etc/apt/sources.list`

- Administrator-configured list of package repositories used by apt.
- Numerous retrieval methods: file, cdrom, http, ftp, copy, rsh and ssh.
- Many repositories exist for developers, specific software, other distributions, etc.
- Example:

```
deb http://mirror.aarnet.edu.au/debian woody main contrib non-free
deb file:/mnt/devserver/packages woody main contrib non-free
deb http://user:pass@example.com/path distro section section
deb ssh://user@example.com/path distro section section
```

5.2.4 Debian Package Mgt. Utility—`deselect`

- Hideous! Ugh! Run for your lives!
- Original frontend to apt/dpkg.
- Subject of many jokes:

> "All package managers feature creep until they're as complicated and horrible as dselect."
>
> "Debian's extensive features provide not only to ability shoot yourself in the foot, but to blow off each toe individually."

- Offers more help than apt-get, but is incredibly baroque and hard to use.

5.2.5 Debian Package Conversion Utility—`alien`

Theory :

> "alien is a program that converts between Redhat rpm, Debian deb, Stampede slp, Slackware tgz, and Solaris pkg file formats. If you want to use a package from another Linux distribution than the one you have installed on your system, you can use alien to convert it to your preferred package format and install it. It also supports LSB packages."

Reality :

- You are completely bat shit insane, and/or,
- You are using proprietary software.

Useful for quick stuff, or pulling apart RPMs and SRPMs without too much hassle.

5.3 Lab

5.3.1 Exploring dkpg

1. List `/var/lib/dpkg`:

   ```
   $ ls /var/lib/dpkg ↩
   ```

2. Have a look at the alternatives directory:

   ```
   $ ls /var/lib/dpkg/alternatives ↩
   ```

3. Have a look at an alternative file:

   ```
   $ cat /var/lib/dpkg/alternatives/vi ↩
   auto
   /usr/bin/vi
   vi.1.gz
   /usr/share/man/man1/vi.1.gz

   /usr/bin/nvi
   30
   /usr/share/man/man1/nvi.1.gz
   /usr/bin/vile
   20
   /usr/share/man/man1/vile.1.gz
   /usr/bin/vim
   120
   /usr/share/man/man1/vim.1.gz
   /bin/elvis-tiny
   10
   /usr/share/man/man1/elvis-tiny.1.gz
   ```

4. View the `dpkg` configuration file:

   ```
   $ cat /etc/dpkg/dpkg.cfg ↩
   ```

5. Inspect the list of packages available:

   ```
   $ less /var/lib/dpkg/available ↩
   ```

6. Look at the package status list:

   ```
   $ less /var/lib/dpkg/status ↩
   ```

5.3.2 Using dkpg

Download a few debs to your `/tmp`:

```
$ cd /tmp ↩
$ scp student@foozle:/mnt/floppy/*.deb . ↩
$ ls *.deb ↩
```

1. Obtain a debian package and install it:

   ```
   # dpkg -i junior-doc_1.15_all.deb ↩
   ```

   Note that this package has no dependencies.

2. Try to install a package with unmet dependencies:

   ```
    # dpkg -i junior-typing_1.1_all.deb ↩
   ```

   Note that this install was unsuccessful.

3. Check which files a debian package owns:

   ```
   $ dpkg -L junior-doc ↩
   ...
   ```

4. Find out which package a file belongs to:

   ```
   $ dpkg -S /usr/share/doc/junior-doc/quickguide ↩
   junior-doc: /usr/share/doc/junior-doc/quickguide
   ```

5. Extract information from the package:

   ```
   $ dpkg -e junior-doc_1.15_all.deb ↩
   ```

6. List the contents of a package:

   ```
   $ dpkg -c junior-doc_1.15_all.deb ↩
   ```

7. Remove the package: (Note that -P would purge any configuration files)

   ```
   # dpkg -r junior-doc ↩
   ```

5.3.3 Using the apt package management tool

1. Update your `/etc/apt/sources.list` with any CDROMs that you can mount locally. You can use `apt-cdrom` to do this for you.

   ```
   # apt-cdrom add -d /mnt/cdrom ↩
   ```

2. Edit your `sources.list`:

   ```
   # vi /etc/apt/sources.list ↩
   ```

   (a) Identify any lines you added using `apt-cdrom`.

   (b) "Hash out" any sources that don't currently exist on your system by adding a "#" at the beginning of the line.

   (c) Add any sources that you do have available:

      i. For locally mounted CDROMS images:

```
deb file:/nfs/woody/cd1 woody main
```

ii. For sources available over HTTP locally:

```
deb http://192.168.222.254/debian woody main contrib non-free
```

iii. For sources available over HTTP on the Internet:

```
deb http://http.us.debian.org/debian woody main contrib non-free
```

3. Do an update for apt:

```
# apt-get update ↩
```

4. Search for a package you might want to install:

```
$ apt-cache search junior ↩
```

5. View the information about your chosen packege:

```
$ apt-cache show junior-typing ↩
```

6. Download and install the package and it's dependencies:

```
# apt-get install junior-typing ↩
```

5.4 Questions

1. Which apt-get parameter updates the database of available packages?
   (a) renew
   (b) upgrade
   (c) update
   (d) reload
   (e) refresh
2. Which one of the following tools is used to convert packages from one system to another?
   (a) `alien`
   (b) `dpkg`
   (c) `apt`
   (d) `pkg_convert`
   (e) `rpm2deb`
3. Which tool provides a high-level user friendly interface to Debian package management?
   (a) `dselect`
   (b) `apt-get`
   (c) `dpkg`
   (d) `kdedpkg`
   (e) `gnodpkg`
4. Which of the following package formats is supported by the `alien` utility? Select all that apply.
   (a) `.deb`
   (b) `.bsd`
   (c) `.rpm`
   (d) `.tgz`
   (e) `.zip`
5. Which of the following sources may be not used by the apt-get utility?
   (a) NFS
   (b) IRC
   (c) FTP
   (d) HTTP
   (e) CD-ROM
6. Which one of these commands removes a Debian package, including its configuration files?

(a) `dpkg --remove <packagename>`

(b) `apt-get purge <packagename>`

(c) `dpkg -P <packagename>`

(d) `apt-remove config <packagename>`

(e) `dpkg -e <packagename>`

7. Which one of these commands will convert an RPM package to Debian format?

(a) alien -d package.rpm

(b) alien -c package

(c) alien -r package.rpm

(d) alien -t package.rpm

(e) alien -d package.deb

8. A Debian package may be installed with:

(a) `dpkg -i <packagename>`

(b) `rpm -i <packagename>`

(c) `apt --install <packagename>`

(d) `rpm --deb <packagename>`

(e) `apt-get -I <packagename>`

Objective 102.6

Use Red Hat Package Manager (RPM)

6.1 Overview

6.1.1 Weight: []

6.1.2 Statement of Objective:

Candidates should be able to perform package management under Linux distributions that use RPMs for package distribution. This objective includes being able to install, re-install, upgrade, and remove packages, as well as obtain status and version information on packages. This objective also includes obtaining package information such as version, status, dependencies, integrity, and signatures. Candidates should be able to determine what files a package provides, as well as find which package a specific file comes from.

6.1.3 Key files, terms, and utilities:

```
/etc/rpmrc
/usr/lib/rpm/*
```

6.1.4 Resources:

TBA

6.2 Notes

RPM - RedHat Package Manager

- RPM works with RedHat, Suse & Mandrake (among others) and can do the following:
  - Build an RPM package
  - Install an RPM package
  - Update an already installed RPM package
  - Query an RPM package
  - Erase an RPM package
  - Verify an RPM package.

RPM Packages

RPM package files consist of a single compressed file much like a tarball. Package files can be sourced from:

- Local media (hard disk, cdrom etc)
- An ftp site
- An http site

Packages sourced from local media are specified using just their filename. For example:

- `acroread-4.05-1.i686.rpm`

Packages sourced from ftp or http sites are specified using the following syntax:

- `ftp://USER:PASSWORD@HOST:PORT/path/to/package.rpm`

RPM Filenames

RPM Filenames use a standard naming scheme:
package-version-patch.arch.rpm
package - The name of the package version - The version number patch - patch number of this package arch - The architecture this package is for (i386, i586, i686, alpha, sparc)
Example:

`kernel-2.4.9-21.i686.rpm`

6.2.1 RPM Operating Modes

RPM operations are split up into 4 major modes:

- Querying & Verifying
- Installing, Upgrading or Removing
- Building Packages
- RPM database administration functions

Verifying package Integrity

Having downloaded an rpm from the Internet, the very first thing you want to do is verify its integrity. You do this with the -K or –checksig option to rpm:

```
# rpm -K kernel-2.4.9-31.i586.rpm ↩
kernel-2.4.9-31.i586.rpm: md5 gpg OK
```

NOTE: Some packages use PGP to check integrity while others use GnuPG.

6.2.2 Installing, Upgrading & Removing

Understanding the RPM terminology in relation to Installing, upgrading & removing rpm packages is essential:

- Install - Install a package. Good for Kernels
- Upgrade - Upgrade a package if it's installed, otherwise install the package
- Freshen - Upgrade a package only if it's already installed.
- Erase - Remove a package.

Installing, Upgrading & Removing - Options

The table below summarises the various options used for package installation, freshening and removal.

Mode	Short option	Long option
Install	-i	--install
Upgrade	-U	--upgrade
Freshen	-F	--freshen
Erase	-e	–erase

Using RPM on the command line

Generally you use rpm in one of the following modes:

- `rpm -i [install options] package_file ...`
- `rpm -U [install-options] package_file ...`
- `rpm -F [install-options] package_file ...`
- `rpm -e [erase-options] package_name ...`

Commonly used options are:

-v verbose

-h print progress hash marks

--force Force RPM to overwrite existing packages or files

--nodeps Bypass dependency checking

--replacefiles Overwrite files owned by other packages

Example - install option

Install kernel-2.4.18-4 without removing the existing kernel:

```
# rpm -q kernel
kernel-2.4.9-21
# rpm -ivh kernel-2.4.18-4*.rpm
Preparing...           ########################### [100%]
   1:kernel-2.4.18-4   ########################### [100%]
# rpm -q kernel
kernel-2.4.18-4
kernel-2.4.9-21
#
```

Example - Freshen option

Upgrade the existing kernel to kernel-2.4.18-4.

```
# rpm -q kernel
kernel-2.4.9-21
# rpm -Uvh kernel-2.4.18-4*.rpm
Preparing...           ########################### [100%]
   1:kernel-2.4.18-4   ########################### [100%]
# rpm -q kernel
kernel-2.4.18-4
#
```

Example - Upgrade option:

What the upgrade option does will depend on whether or not the package is currently installed. If installed, it will perform a freshen, otherwise it will perform an install:

```
# rpm -q gocr
package gocr is not installed
# rpm -Uvh gocr-0.3.4-1.i386.rpm
Preparing...           ########################### [100%]
   1:gocr-0.3.4-1.rpm  ########################### [100%]
# rpm -q gocr
gocr-0.3.4-1
# rpm -Uvh gocr-0.3.6-1.i386.rpm
Preparing...           ########################### [100%]
   1:gocr-0.3.6-1.rpm  ########################### [100%]
# rpm -q gocr
gocr-0.3.6-1
```

Example - Erase option

Remove the package gocr from the system

```
# rpm -q gocr
gocr-0.3.6-1
# rpm -e gocr
# rpm -q gocr
#
```

Querying Packages

RPM can be used to query a package (either installed or not).

```
rpm -q|--query [select-options] [query-options]
```

Select options : Choose what it is you want to query

- **-a** Query all installed packages.
- **-f** Query package owning FILE.
- **-p** Query an (uninstalled) package file

Query options : Choose what it is you want to see from the query:

- **-i** Show all information about the package
- **-l** Show what files are contained in the package
- **-R** List packages on which this package depends

Query - Example

Give a list of all packages with kern in their name:

```
$ rpm -qa | grep kern
kernelcfg-0.5-5
glibc-kernheaders-2.4-7.14
kernel-2.4.9-21
kernel-source-2.4.18-4
```

Show a list of all files in kernel-2.4.9-21

```
$ rpm -ql kernel-2.4.9-21
/boot/System.map-2.4.9-21
/boot/module-info-2.4.9-21
/boot/vmlinuz-2.4.9-21
....
```

Show package which owns /bin/ls:

```
$ rpm -qf /bin/ls
$ fileutils-4.1-10
```

Show complete information about the fileutils package:

```
$ rpm -qi fileutils

Name        : fileutils                    Relocations: (not relocateable)
Version     : 4.1                               Vendor: Red Hat, Inc.
Release     : 10                             Build Date: Mon 25 Mar 2002 12
Install date: Fri 24 May 2002 02:18:08 PM EST      Build Host: daffy.perf.
Group       : Applications/File             Source RPM: fileutils-4.1-10.s
Size        : 1679468                          License: GPL
Packager    : Red Hat, Inc. <http://bugzilla.redhat.com/bugzilla>
Summary     : The GNU versions of common file management utilities.
Description :
The fileutils package includes a number of GNU versions of common and
popular file management utilities. Fileutils includes the following
tools: chgrp (changes a file's group ownership), chown (changes a
file's ownership), chmod (changes a file's permissions), cp (copies
files), dd (copies and converts files), df (shows a filesystem's disk
usage), dir (gives a brief directory listing), dircolors (the setup
program for the color version of the ls command), du (shows disk
usage), install (copies files and sets permissions), ln (creates file
links), ls (lists directory contents), mkdir (creates directories),
mkfifo (creates FIFOs or named pipes), mknod (creates special files),
mv (renames files), rm (removes/deletes files), rmdir (removes empty
directories), sync (synchronizes memory and disk), touch (changes file
timestamps), and vdir (provides long directory listings).
```

Verifying package files

This option to rpm is used to verify the files installed on the system with those from the rpm package file. This is not to be confused with the *integrity* of the package file.

The following table lists the characteristics verified:

5 - The MD5 checksum

S - The file size

L - Symbolic link

T - Modification time

D - Device major & minor number

U - User owner

G - Group owner

M - Permission and/or file type

Example - Verify package

```
$ rpm -V setup
S.5....T c /etc/bashrc
S.5....T c /etc/csh.cshrc
S.5....T c /etc/csh.login
S.5....T c /etc/host.conf
S.5....T c /etc/printcap
S.5....T c /etc/profile
..?..... c /etc/securetty
.M...... c /etc/shadow
```

6.3 Lab

Before you begin these exercises, you will need access to the RedHat installation disks or alternatively to an nfs exported copy of these. To mount an nfs copy of these disks, type the following as root:

```
# mount foozle:/export/rh73 /nfs/rh73 ↩
```

Before proceeding the GPG key will have to be imported:

```
# gpg --import /nfs/rh73/RPM-GPG-KEY ↩
```

Now you can access the RPM directory which contains the complete set of RPM's that came with the RedHat 7.3 distribution CD's:

```
# cd /nfs/rh73/RedHat/RPMS ↩
```

Exercises:

1. Have a look at all the packages starting with 'kernel'. Check the integrity of the following two kernel packages. Which one is NOT OK.

   `kernel-2.4.18-4.i386.rpm`
   `kernel-4.4.18-4.i386.rpm`

2. List all packages installed on the system that start with 'kernel'.
3. Install the package `kernel-2.4.18-4`. Once you have done this, repeat step 2 above to confirm that you now have two kernels on your system.
4. Now remove the package `kernel-2.4.18-4`. (Make doubly sure that you specify the kernel version/patch level when removing)
5. List the files contained in the kernel package.
6. Using the -i option, install the package `fetchmail-5.9.0-5.i386.rpm`.
7. Query which version of fetchmail is installed
8. Using the `-F` option, upgrade the fetchmail package to `fetchmail-5.9.0-11.i386.rpm`
9. Remove the fetchmail package.
10. Repeat exercises 6 to 8 above using the `-U` option to install and upgrade.
11. What does the procps package do? What files are contained in the procps package
12. What package contains the `/sbin/fdisk` binary?
13. Verify the following packages and explain what has changed in each case: - setup - procps

6.4 Questions

1. Which packaging system is used by Red Hat Mandrake and SuSE?
   (a) tgz
   (b) rhi
   (c) rpm
   (d) alien
   (e) deb
2. If you suspect that the rpm database is corrupted, which of the following might fix it?
   (a) rpm –rebuilddb
   (b) rpm –regendb
   (c) rpm –fixdb
   (d) rpm –unbugger
   (e) rpm –updated
3. Which methods does RPM support to check package integrity? (Select all that apply.)
   (a) MD5
   (b) 5DES
   (c) CRC
   (d) PGP
   (e) GnuPG
4. Which command(s) is/are used to remove an RPM package?
   (a) rpm –remove ¡packagename¿
   (b) rpm -e ¡packagename¿
   (c) rpm –uninstall ¡packagename¿
   (d) rpm -u ¡packagename¿
   (e) rpm -U ¡packagename¿
5. (a)
   (b)
   (c)
   (d)
   (e)
6. (a)
   (b)
   (c)
   (d)

(e)

7. (a)
   (b)
   (c)
   (d)
   (e)
8. (a)
   (b)
   (c)
   (d)
   (e)
9.

Topic 103

GNU & Unix Commands

Objective 103.1

Work on the command line

1.1 Overview

1.1.1 Weight: []

1.1.2 Statement of Objective:

Candidate should be able to Interact with shells and commands using the command line. This includes typing valid commands and command sequences, defining, referencing and exporting environment variables, using command history and editing facilities, invoking commands in the path and outside the path, using command substitution, applying commands recursively through a directory tree and using man to find out about commands.

1.1.3 Key files, terms, and utilities:

```
.
bash
echo
env
exec
export
man
pwd
set
unset
~/.bash_history
~/.profile
```

1.1.4 Resources:

1.2 Notes

1.3 Lab

1.4 Questions

Objective 103.2

Process text streams using filters

2.1 Overview

2.1.1 Weight: []

2.1.2 Statement of Objective:

Candidate should be able to apply filters to text streams. Tasks include sending text files and output streams through text utility filters to modify the output, and using standard UNIX commands found in the GNU textutils package.

2.1.3 Key files, terms, and utilities:

```
cat
cut
expand
fmt
head
join
nl
od
paste
pr
sed
sort
split
tac
tail
tr
unexpand
uniq
wc
```

2.1.4 Resources:

2.2 Notes

2.3 Lab

2.3.1 Text Filter Exercise

First catch some text

Locate a section of text to practice filtering through various filters. For example save the last 12 lines of the GPL license in a temporary file. Edit the file with `vi` and add some tabs and some extra blank lines. Also duplicate a few lines. Add some carriage returns to the ends of a few lines (in vi do this in edit mode with a Cntl-v Cntl-m. They should show up as ^Ms in vi).

```
$ locate gpl-lic
/usr/share/doc/HTML/en/common/gpl-license
...
$ tail -12 /usr/share/doc/HTML/en/common/gpl-license >  /tmp/some.txt
$ cd /tmp
```

The file `some.txt`

```
  Yoyodyne, Inc., hereby disclaims all copyright interest in the program
  'Gnomovision' (which makes passes at compilers) written by James Hacker.

  <signature of Ty Coon>, 1 April 1989^M
  Ty Coon,       President        of       Vice^M


This General Public License does not permit incorporating your program into
This General Public License does not permit incorporating your program into
This General Public License does not permit incorporating your program into
This General Public License does not permit incorporating your program into



proprietary programs.  If your program is a subroutine library, you may
consider it more useful to permit linking proprietary applications with the
library.  If this is what you want to do, use the GNU Library General
Public License instead of this License.
```

`cat` the file

Have a look at the man page for `cat`.

- Plain `cat` the file:

  ```
  $ cat some.txt
  ```

- `cat` the file with all lines numbered:

  ```
  $ cat -n some.txt
  ```

- `cat` the file with non-blank lines numbered:

  ```
  $ cat -b some.txt
  ```

- Check to see if there are any non printing characters:

```
$ cat -v some.txt
...
  <signature of Ty Coon>, 1 April 1989^M
...
```

- Display any tabs:

```
$ cat -T some.txt
...
  Ty Coon, ^IPresident ^Iof ^IVice
...
```

- Do a `-vET` all at once:

```
$ cat -A some.txt
...
  <signature of Ty Coon>, 1 April 1989^M$
  Ty Coon, ^IPresident ^Iof ^IVice^M$
...
```

- Strip out surplus blank lines:

```
$ cat -s some.txt
```

`tac` the file

Have a look at the man page for `tac`.
Try it out.

Remove duplicate lines with `uniq`

Have a look at the man page for `uniq`.

- Plain `uniq`

```
$ uniq some.txt
```

- Show the repetition count:

```
$ uniq -c some.txt
```

- Print only the repeated lines:

```
$ uniq -dc some.txt
```

Print lines from the beginning of a file with `head`

Have a look at the man page for `head`.
Try it out on `gpl-license`.

Print lines from the end of a file with `tail`

Have a look at the man page for `tail`.

- Try it out on `gpl-license`.
- Try the follow option:

  ```
  $ tail -f /var/log/messages
  ```

  Create a message in another console to see it work.

Isolate fields with `cut`

Have a look at the man page for `cut`.

- Use cut to display only the gecos field and the shell field of the `passwd` file:

  ```
  $ cut -d ":" -f5,7 /etc/passwd
  ```

Format the text with `fmt`

Have a look at the man page for `fmt`.

```
$ fmt -w 50 some.txt

$ fmt -t -w 60 some.txt
```

merge lines of files using `paste`

Have a look at the man page for `paste`.
Create two files and merge them.

```
$ cat > first
one
two
three
four
^D

$ cat > second
this
that
these and
those

$ paste first second
```

2.4 Questions

Objective 103.3

Perform basic file management

3.1 Overview

3.1.1 Weight: []

3.1.2 Statement of Objective:

Candidate should be able to use the basic UNIX commands to copy, move, and remove files and directories. Tasks include advanced file management operations such as copying multiple files recursively, removing directories recursively, and moving files that meet a wildcard pattern. This includes using simple and advanced wildcard specifications to refer to files, as well as using find to locate and act on files based on type, size, or time.

3.1.3 Key files, terms, and utilities:

```
cp
find
mkdir
mv
ls
rm
rmdir
touch
file globbing
```

3.1.4 Resources:

3.2 Notes

3.3 Lab

3.4 Questions

Objective 103.4

Use streams, pipes, and redirects

4.1 Overview

4.1.1 Weight: []

4.1.2 Statement of Objective:

Candidate should be able to redirect streams and connect them in order to efficiently process textual data. Tasks include redirecting standard input, standard output, and standard error, piping the output of one command to the input of another command, using the output of one command as arguments to another command and sending output to both stdout and a file.

4.1.3 Key files, terms, and utilities:

```
tee
xargs
<
<<
>
>>
|
``
```

4.1.4 Resources:

4.2 Notes

4.3 Lab

4.4 Questions

Objective 103.5

Create, monitor, and kill processes

5.1 Overview

5.1.1 Weight: []

5.1.2 Statement of Objective:

Candidate should be able to manage processes. This includes knowing how to run jobs in the foreground and background, bring a job from the background to the foreground and vice versa, start a process that will run without being connected to a terminal and signal a program to continue running after logout. Tasks also include monitoring active processes, selecting and sorting processes for display, sending signals to processes, killing processes and identifying and killing X applications that did not terminate after the X session closed.

5.1.3 Key files, terms, and utilities:

```
 &
bg
fg
jobs
kill
nohup
ps
top
```

5.1.4 Resources:

5.2 Notes

5.2.1 Processes

- A process is an executable loaded in memory.
- Linux is a multitasking operating system and so runs many processes concurrently.
- INIT (PID 1) is the mother of all processes.
- Programms, daemons, shells and commands are all processes.
- The kernel automatically manages processes.
- Normally processes live, execute and die without intervention from users.

5.2.2 Process Attributes and Concepts

The kernel starts the first process: `init` which has PID 1

Lifetime: Each process starts when it's command is executed, and lives till it dies or is killed.

Process ID (PID): Every process has a unique number assigned to it when it is started.

User ID and Group ID: Processes have the privileges associated with the user / group who started them.

Parent processes (PPID): Shell processes are descendants of init and commands run from them are child processes.

Environment: Each process inherits a set of *environmental variables* from it's parent process.

Current Working Directory: Each process starts with a default directory.

5.2.3 Process Monitoring

Processes have to be monitored so as to check their health and use of system resources.

- ps

```
$ ps aux |grep ssh
root  866  0.0  0.3  2676 1268 ?   S  07:56 0:00 /usr/sbin/sshd
```

- pstree

```
$ pstree
init-+-alarmd
     |-apmd
     |-kdeinit-+-autorun
     |         |-kdeinit---emacs
```

- top

```
$ top
 PID USER     PRI NI  SIZE  RSS SHARE STAT %CPU %MEM  TIME COMMAND
1792 geoffrey  11  0  8796 8796  7932 S     0.3  2.2  0:01 kdeinit
1590 root      14  0 57512  13M  2572 R     0.1  3.6  0:41 X
2857 geoffrey  14  0  1056 1056   836 R     0.1  0.2  0:01 top
```

5.2.4 Process Management

Normally the kernel automatically manages processes. However sometimes processes have to be started, stopped, restarted and killed.

- Starting a process:

```
#  /usr/sbin/httpd
ps aux |grep httpd
root      2987  0.0  0.4  4512 1584 ?   /usr/sbin/httpd
apache    3003  0.0  0.4  4656 1672 ?   /usr/sbin/httpd
```

- Occasionally processes die and have to be restarted.

- Processes may go berserk and have to be killed.

```
# kill -9 1234
```

- After configuration changes processes may have to be restarted so as to re-read their configuration files.

```
# service xinetd restart
Stopping xinetd:                [  OK  ]
Starting xinetd:                [  OK  ]
```

5.2.5 What is multitasking?

Multitasking is used to describe the situation where one processor (CPU) is used to perform multiple tasks concurrently.

- Only one task or program is executing instructions on the CPU.

- The CPU must be regularly switched between each program and others.

- This process is known as a *task switch*.

- At each *task switch* the Linux kernel must save the *context* of the CPU.

- The operating system uses the saved context when it switches back to the task the next time it gets some CPU time scheduled to it.

5.2.6 Task Scheduling

The total number of slices, when, how often and for how long the CPU is switched is determined by the multitasking algorithm and is handled by a software component within the kernel know as the *task scheduler*.

There are three basic types of task scheduling:

Nonpreemptive: A task must relinquish the CPU before a task switch occurs.

Preemptive: The kernel takes away the CPU from a task without notice.

Realtime: Tasks are prioritised. High priority tasks must complete before a task switch.

5.2.7 What is a Process?

The term process is a fundamental abstraction.

- Two of the more traditional definitions of a process are:

  "A program in execution."

  "A single program running in its own virtual address space"

- In practice, a process is simply an executable that has been loaded into memory and is either running or ready to run on the system.

5.2.8 Process types

Processes under Linux fall into three basic categories:

Interactive Process: An interactive process is a process initiated from (and controlled by) a shell. Interactive processes may be in foreground or background.
(Example: `ls, ls &`)

Batch Process: A batch process is a process that is not associated with a terminal but is submitted to a queue to be executed sequentially.
(Example `slocate` started by `cron`)

Daemon Process: A daemon process is a process that runs in the background until it's required. This kind of processes is usually initiated when Linux boots.
(Example: `inetd`, `lpd`)

5.2.9 Elements associated with a process

For each process running on the system, the kernel needs to keep a list of resources used by that process.

Some of these resources include:

- tty association (`tty_struct`)
- file system (eg current directory & open files) (`fs_struct`, `files_struct`)

- memory allocation (`mm_struct`)
- Signals received (`signal_struct`)

5.2.10 Process States

At any given point in time, a process is in one of 5 states:

TASK_RUNNING: The process is either executing on the CPU or waiting to be executed.

TASK_INTERRUPTIBLE: The process is sleeping until something becomes true. Raising a hardware interrupt, waiting for a system resource etc are examples of a condition that might wake the process up. If a signal is received by the process (eg KILL -HUP) the process will also be woken up.

TASK_UNINTERRUPTIBLE: Like the previous state except that delivering a signal will not wake the process up.

TASK_STOPPED: Process execution has stopped. A process enters this state after receiving a SIGSTOP signal. A debugger may use this to step through a program.

TASK_ZOMBIE: Process execution has stopped but the kernel has not yet ?cleaned up? the resources allocated to the process.

5.2.11 The Process Family Tree

Every process (with the sole exception of the kernel), must be created by another process. The terms *parent*, *child* and *sibling* (or sometimes *father*, *son* and *brother* in a patriarchal sense) are used to describe the relationships between processes.

As an example consider the following line executed from the bash prompt:

```
[andy@Node4] andy]$ ls & df -h &
```

The following relationships are true:

- The `ls` and `df` processes are both siblings to each other.
- The `bash` process (ie the shell) is the parent to both `ls` and `df`.
- The `ls` process has `bash` as its parent.
- The `df` process has `bash` as its parent.

5.2.12 The Kernel is at the Top of the Family Tree

- When Linux boots, the first thing it does is load the kernel into memory and start executing itself.
- One of the first things it does once execution starts, is to spawn a process called init, which in turn spawns other processes.

- In this sense, the kernel is at the top of the family tree, with only one child process called init.
- Init in turn has many children and probably many grandchildren.

```
Kernel -->
          Init -->
                  all other processes -->
                                          even more processes -->
```

5.2.13 Process IDs

In order for the kernel to keep track of all processes and their descendants, a process ID is assigned to every process running on the system. Process IDs are just numbers and run from 0 to 32767. The number 32767 is the largest signed integer available with a sixteen bit word size and is used to maintain backward compatibility with 16 bit architectures.

There are two PIDs (process IDs) that are always the same:

- kernel PID is always 0
- init PID is always 1

5.2.14 Process IDs

Each time a new process is created, a new PID is allocated and is equal to the last PID issued plus one. Once the last PID is reached, the PID wraps back around to zero and the next available PID is used (note that 0 and 1 will never be available). This scheme is a little like the assignment of telephone numbers: When a telephone service is disconnected, rather than just assigning the old telephone number to a new subscriber, the old number remains out of use until all other numbers have been used up. This saves "wrong numbers" to the new subscriber from callers who have not yet realised that the old number is no longer connected to the person they were trying to reach. In a similar vein, the kernel does this to minimise "wrong numbers" from other processes who have not yet worked out that their intended process no longer exists. This is especially true for Interprocess Communication (IPC) which uses the PID to identify a target process.

5.2.15 Displaying Process Information

There are three utilities used to display the state of running processes:

- `ps`
- `pstree`
- `top`
- The ps command is used to display a "snapshot" of all processes running on the system at the time the `ps` command was executed.
- `pstree` gives a tree view of the processes.

- The `top` command is used to display a real-time display of all processes running on the system. Top can also be used in interactive mode to `kill` or `renice` (change priority) of a process.

5.2.16 Process Monitoring—`ps`

usage: `ps [options]`

The `ps` command has a huge number of switches. The switches can be subdivided into two main groups:

- Process selection (which processes to display)
- Output control (how and what output should be displayed)

5.2.17 `ps` options

```
$ ps ?
ERROR: Garbage option.
********* simple selection *********  ********* selection by list *********
-A all processes                      -C by command name
-N negate selection                   -G by real group ID (supports names)
-a all w/ tty except session leaders  -U by real user ID (supports names)
-d all except session leaders         -g by session leader OR by group name
-e all processes                      -p by process ID
T  all processes on this terminal     -s processes in the sessions given
a  all w/ tty, including other users  -t by tty
g  all, even group leaders!           -u by effective user ID (supports names)
r  only running processes             U  processes for specified users
x  processes w/o controlling ttys     t  by tty
*********** output format **********  *********** long options ***********
-o,o user-defined  -f full            --Group --User --pid --cols
-j,j job control   s  signal          --group --user --sid --rows
-O,O preloaded -o  v  virtual memory  --cumulative --format --deselect
-l,l long          u  user-oriented   --sort --tty --forest --version
                   X  registers       --heading --no-heading
                    ********* misc options *********
-V,V show version       L  list format codes  f  ASCII art forest
-m,m show threads       S  children in sum    -y change -l format
-n,N set namelist file  c  true command name  n  numeric WCHAN,UID
-w,w wide output        e  show environment   -H process heirarchy
```

5.2.18 `ps` options

The switches that need to be known for the purposes of LPIC are as follows:

`a` Display processes for all users

`txx` Display processes within controlling terminal `txx`

`u` Display user information for the process

`l` Display in long format with detailed information

`s` Display signal information

`m` Display memory information

`x` Display processes without a controlling terminal

`S` Display CPU time and page faults of child processes

-C cmd Search for instances of command `cmd`.

-f Forest mode shows process family trees.

-w Wide format

5.2.19 ps field names & their meanings

USER The user who started the process

PID The process ID

%CPU Shows the cputime / realtime percentage.

%MEM The fraction of RSS divided by the total size of RAM

VSZ Size of virtual memory used by the process

RSS Resident set size (Data & Text segments only) in Kb

TTY The TTY associated with this process

STAT The current status (DRSTZW< NL) (details next slide)

TIME CPU time in MINS:SECS

COMMAND The full command line used to start the process

5.2.20 ps Status Field

```
$ ps aux
USER     PID %CPU %MEM    VSZ   RSS TTY      STAT START   TIME COMMAND
root       1  0.0  0.0   1304    72 ?        S    Mar21   0:19 init
```

D uninterruptible sleep (usually IO)

R runnable (on run queue)

S sleeping

T traced or stopped

Z a defunct (“zombie”) process

W has no resident pages

< high-priority process

N low-priority task

L has pages locked into memory (for real-time and custom IO)

5.2.21 `ps` Status Field

```
$ ps aux
USER       PID %CPU %MEM   VSZ  RSS TTY      STAT START   TIME COMMAND
root         1  0.0  0.2  1384  516 ?        S    11:43   0:04 init [5]
root         2  0.0  0.0     0    0 ?        SW   11:43   0:00 [keventd]
root         3  0.0  0.0     0    0 ?        SW   11:43   0:00 [kapm-idled]
root         5  0.0  0.0     0    0 ?        SW   11:43   0:00 [kswapd]
root         6  0.0  0.0     0    0 ?        SW   11:43   0:00 [kreclaimd]
root         7  0.0  0.0     0    0 ?        SW   11:43   0:00 [bdflush]
root         8  0.0  0.0     0    0 ?        SW   11:43   0:00 [kupdated]
root         9  0.0  0.0     0    0 ?        SW<  11:43   0:00 [mdrecoveryd]
root       103  0.0  0.0     0    0 ?        SW   11:44   0:00 [kjournald]
root       474  0.0  0.2  1444  620 ?        S    11:44   0:00 syslogd -m 0
root       479  0.0  0.4  2080 1152 ?        S    11:44   0:00 klogd -2
rpc        497  0.0  0.2  1632  708 ?        S    11:44   0:00 portmap
rpcuser    525  0.0  0.3  1624  796 ?        S    11:44   0:00 rpc.statd
ntp        735  0.0  0.8  2088 2080 ?        SL   11:44   0:00 ntpd -U ntp
root       759  0.0  0.3  5784  856 ?        S    11:44   0:00 ypbind
root       763  0.0  0.3  5784  856 ?        S    11:44   0:00 ypbind
.....
andy      1176  0.0  0.5  2620 1508 pts/0    S    11:46   0:00 bash
root      1343  0.0  0.7  3000 1816 tty1     S    15:21   0:00 ssh node10
andy      1664  0.0  0.3  2824  924 pts/1    R    21:52   0:00 ps -aux
```

5.2.22 Process Monitoring—`pstree`

```
$ pstree
init-+-anacron---run-parts---cfengine
     |-5*[apache-ssl]
     |-atd
     |-bash---startx---xinit-+-X
     |                       `-enlightenment-+-E-Clock.epplet
     |                                       |-E-Cpu.epplet
     |                                       |-Emix.epplet
     |                                       |-Eterm---bash-+-abiword---AbiWord
     |                                       |              `-mozilla-bin---moz
     |                                       |-Eterm---bash---bash
     |                                       |-Eterm---bash
     |                                       |-Eterm---bash---gv---gs
     |                                       |-Eterm---bash---mutt
     |                                       |-Eterm---bash---emacs-+-ispell
     |                                       |                      `-xdvi---gs
     |                                       |-Eterm---bash---pstree
     |                                       `-Eterm---bash---man---pager
     |-cron
     |-gcache
     |-6*[getty]
     |-inetd---nmbd
     |-junkbuster
```

5.2.23 `pstree` options

Three commonly used options for `pstree`:

`-a` Show command line arguments.

```
|-xfs -daemon
|-xfstt --port 7101 --daemon --user nobody
`-zope-z2 /usr/sbin/zope-z2
   `-python /usr/sbin/zope-z2
```

`-n` Sort processes with the same ancestor by PID

`-p` Show PIDs.

```
init(1)-+-anacron(27095)---run-parts(27755)---cfengine(27765)
        |-apache-ssl(27188)
        |-apache-ssl(27189)
```

5.2.24 Process Monitoring—`top`

The "top" command provides a continuously updated, real-time look at process activity, memory and swap file usage plus CPU activity.

It also shows what processes are running and by whom.

- Its primary use is as an administration and system information tool. It provides an extension to the functionality of the "ps" command.
- It makes it easy to find an errand process and "kill" that process. It also has an interactive interface whereby options can be passed while the command is actually running. All in all, a very useful tool.

5.2.25 `top`

```
 9:16am  up 13 days,  8:05,  8 users,  load average: 0.05, 0.05, 0.00
86 processes: 84 sleeping, 1 running, 1 zombie, 0 stopped
CPU states:  2.3% user,  0.7% system,  0.0% nice, 96.8% idle
Mem:  900236K av, 546472K used, 353764K free,  0K shrd,  37552K buff
Swap: 329324K av,  34784K used, 294540K free          190764K cached

  PID USER  PRI  NI  SIZE  RSS SHARE STAT LIB %CPU %MEM  TIME COMMAND
10281 root   16 -10 97952 6452  1584 S <    0  3.9  0.7 56:57 X
12547 geoff  16   0  1728 1728   764 R      0  0.9  0.1  0:01 top
10284 geoff  12   0  3012 2568  1352 S      0  0.7  0.2 50:49 enlight
12173 geoff  10   0  9340 9340  3768 S      0  0.3  1.0  0:11 emacs
12543 geoff   9   0  3328 3328  2072 S      0  0.1  0.3  0:00 Eterm
    1 root    9   0   116   72    52 S      0  0.0  0.0  0:19 init
    2 root    9   0     0    0     0 SW     0  0.0  0.0  0:01 keventd
```

5.2.26 top's basic command line options

Note: dashes not required.

-b Batch mode. Useful for sending output from top to other programs or to a file. Output is plain text.

-d Delay between screen updates. (default 5 seconds)

-i Start top ignoring any idle or zombie processes.

-p Monitor only processes with given process id. (x20)

-q This causes top to refresh without any delay.

5.2.27 `top`'s upper screen

```
 9:16am  up 13 days,  8:05,  8 users,  load average: 0.05, 0.05, 0.00
86 processes: 84 sleeping, 1 running, 1 zombie, 0 stopped
CPU states:  2.3% user,  0.7% system,  0.0% nice, 96.8% idle
Mem:  900236K av, 546472K used, 353764K free,  0K shrd,  37552K buff
Swap: 329324K av,  34784K used, 294540K free          190764K cached
```

- The current system time:
- The "up time" of the system:
- How many users are logged in.
- The "load average" : the average number of processes ready to run over the last 1,5 and 15 minutes
- "CPU States" shows the percentage of CPU time spent in usermode, system mode and at idle.
- "MEM" shows a complete set of statistics on current memory usage.
- "SWAP" gives us the same details as "MEM" but for the swap space.

5.2.28 top's lower screen

```
  PID USER  PRI  NI  SIZE  RSS SHARE STAT LIB %CPU %MEM  TIME COMMAND
10281 root   16 -10 97952 6452  1584 S <    0  3.9  0.7 56:57 X
12547 geoff  16   0  1728 1728   764 R      0  0.9  0.1  0:01 top
```

PID The process ID of each task.

USER The user name of the task's owner.

PRI The priority of the task.

NI The nice value of the task. Negative nice values are higher priority.

SIZE The size of the task's code plus data plus stack space, in kilobytes, is shown here.

RSS The total amount of physical memory used by the task,in kilobytes, is shown here. For ELF processes used library pages are counted here, for a.out processes not.

SHARE The amount of shared memory used by the task is shown in this column.

STAT The state of the task is shown here.

The state is either

S sleeping

D uninterruptible sleep

R running

Z zombies

T stopped or trace

These states are modified by trailing < for a process with negative nice value, N for a process with positive nice value, W for a swapped out process (this does not work correctly for kernel processes).

%CPU The task's share of the CPU time since the last screen update, expressed as a percentage of total CPU time per processor.

%MEM The task's share of the physical memory.

5.2.29 `top`: selected interactive commands

^L Redraw the screen
f|**F** Add and remove fields
h|**?** Displays a help screen
S Toggle cumulative mode
I Toggle between Irix and Solaris views (SMP-only)
k Kill a task (with any signal)
r Renice a task
T Sort by time / cumulative time
s Set the delay in seconds between updates
q Quit

5.2.30 `top`'s interactive commands

space Update display
^L Redraw the screen
f|**F** Add and remove fields
o|**O** Change order of displayed fields
h|**?** Displays a help screen
S Toggle cumulative mode
i Toggle display of idle proceses
I Toggle between Irix and Solaris views (SMP-only)
c Toggle display of command name/line
l Toggle display of load average
m Toggle display of memory information
t Toggle display of summary information
k Kill a task (with any signal)
r Renice a task
N Sort by pid (Numerically)
A Sort by age
P Sort by CPU usage
M Sort by resident memory usage
T Sort by time / cumulative time
u Show only a specific user
n|**#** Set the number of process to show
s Set the delay in seconds between updates
W Write configuration file /.toprc
q Quit

5.2.31 `~/.toprc`

```
$ cat toprc ↩
AbcDgHIjklMnoTP|qrsuzyV{EFWx
2
```

5.2.32 Killing Processes

5.2.33 Job Control

There are three comands and a pretzel used for job control.

- `jobs`
- `fg`
- `bg`
- `&`

They are bash built-ins:

```
$ type jobs fg bg  ↩
jobs is a shell builtin
fg is a shell builtin
bg is a shell builtin
```

For more information, see the Job Control section of man bash.

5.2.34 &— Direct the shell to execute a command in the background.

Example:

```
$ xeyes ↩
```

Notice the `xeyes` process is started in the foreground and you have no prompt. The user is locked out of further interaction with the shell until a process is stopped, terminated or completed.

Now start the xeyes process in the background.

```
$ xeyes & ↩
[1] 1650
$
```

Two numbers are listed and the prompt is now also displayed waiting for another command.

5.2.35 Job Control

```
$ xeyes & ↩
[1] 1650
$
```

- The [1] is the programs job id, a unique number for the shell starting from 1.
- The 1650 is the process id (pid), which identifies the process across the entiresystem.
- Either of these numbers can be used to interact with the program through bash.

5.2.36 Background Processing

The best candidates for background processing are programs that do not require user input, as these programs will keep on waiting until input is provided.

Programs that send their results to standard output (The screen), will do so even if running in the background. If the user is performing another operation, the results may be difficult to interpret. The output from these processes can be redirected to a file.

```
$ wc bigfile > bigfile.wc & ↩
[1] 1654
$
```

5.2.37 The `jobs` command

`$ jobs` ↩ :
Lists all commands stopped, or running in the background.

Options :
`-l` List pid

Example :
Start some processes in the background and suspend a foreground process.

```
$ jobs ↩
[1]+  Stopped                 less job_control.txt
[2]-  Running                 xeyes &
$
```

5.2.38 The `fg` command

`$ fg` ↩ :
Shell built-in used to force a suspended or background process to continue running in the foreground.

Example :

- Use the 'jobs' command to find job id.

```
$ jobs ↩
[1]+  Stopped                 less job_control.txt
[2]-  Running                 xeyes &
$
```

- Use `fg` to bring xeyes to foreground.

```
$ fg 2 ↩
xeyes
```

- A `%` used with the job id is equivalent to `fg 2`.

```
$ %2 ↩
xeyes
```

5.2.39 The `fg` command

A job can also be referred to by a string that uniquely identifies the beginningof the command line used to start a job. A '%' can also be used with a unique string.

```
$ fg x ↩
xeyes
```

or

```
$ %x ↩
xeyes
```

If `fg` is issued without any argument, the job with the '+' in the job list is brought to the foreground.

```
$ fg ↩
xeyes
```

5.2.40 The bg command

$ bg ↩ :
Used to force a suspended process to continue running in the background.

Example :
Use the 'jobs' command to find job id.

```
$ jobs ↩
[1]-  Stopped           find -name myfile >myfile.found  (wd: /)
[2]+  Stopped           less job_control.txt
[3]   Running           xeyes &
$
```

Job 1 shows the 'find' command was started in the foreground and then suspended.To start 'find' in the background, use the 'bg' command or '%'.

Example :

`$ bg 1 ↩` or `$ bg f ↩` or `$ %1 & ↩` or `$ %f & ↩`

5.3 Lab

5.4 Questions

Objective 103.6

Modify process execution priorities

6.1 Overview

6.1.1 Weight: []

6.1.2 Statement of Objective:

Candidate should be able to manage process execution priorities. Tasks include running a program with higher or lower priority, determining the priority of a process and changing the priority of a running process.

6.1.3 Key files, terms, and utilities:

```
nice
ps
renice
top
```

6.1.4 Resources:

6.2 Notes

6.3 Lab

1. This exercise requires a few example processes to play around with, so first we will create a few.
   - Using the `vi` editor (for practice) make a file called `a.c`.
     - Do not use the arrow keys—use h, j, k and l.
     - Do not use the Backspace or Delete keys—use `x`.
     - Be sure you are familiar with the use of `i`, `a`, `o` and `O` for entering new text.
     - For saving and quitting use each of `ZZ`, `:w`, `q:` and `!`.
     - Delete, Yank and Put with `dd`, `yy` and `p`.
     - Use `u` to undo, numerical modifiers (e.g. 5dd) and `.` to repeat.
   - The file should contain this text:

```
#include <stdio.h>

int main()
{
  int i = 0;

  while (1) {
    system("clear");
    printf("Process a: %d\n", i);
    ++i;
  }

  return 0;
}
```

   - Copy the file `a.c` to `b.c` and `c.c`.

```
$ cp a.c b,c.c ↩
```

   - Edit the `printf()` calls in files `b.c` and `c.c` to refer to `Process b:` and `Process c:` respectively.
   - Compile the programs:

```
$ gcc a.c -o a; gcc b.c -o b; gcc c.c -o c ↩
```

2. Test your three programs.
   - Start a program running in the background:

```
$ ./a ↩
 Process a: 400
```

   - Suspend the program:

```
^z
[1]+  Stopped                 ./a
```

   - Kill the job:

```
$ kill %1 ↩
```

3. Use `ps` to view the processes.

- Run the processes in the background with differing degrees of niceness:

```
$ ./a& nice ./b& nice -19 ./c& ↩
```

- Glance at and absorb the manpage for `ps`. Note well that some options are preceded by a minus(-) and others are not. For example `ps a` and `ps -a` do different things.
- Locate the processes using the `ps` command; try the `a`, `u`, `x`, and `f` options separately and in combinations. e.g.:

```
$ ps aux |grep "./a " ↩
```

- Kill and restart one of the processes (use the PID not "123456":

```
$ kill 123456  ↩
$ ps aux |grep "./a " ↩
$ ./a&
$ ps aux |grep "./a " ↩
```

4. Use `top` to view and modify the processes.
   - Run `top` in the foreground:

```
$ top ↩
```

   - Look at the `top` help: Press h
   - Sort by accumulated time: Press `T`
   - Re-nice a process (Note: Users may only monotonically increase the niceness processes, and (&&) they must own the process.):
     - Press r
     - PID to renice: 1234567890 ↩
     - Renice PID 1973 to value: 5 ↩
5. Reniceing from the command line:
   - After finding it's PID`renice` one of your processes:

```
$ ps aux |grep "./c " ↩
$ renice +15 1234567890
```

   - Re-nice negatively—notice that only the superuser may reduce the niceness of a process.

```
$ renice -10 1234567890 ↩
renice: 1234567890: setpriority: Permission denied
$ su -c 'renice -10 1234567890' ↩
```

6. Kill off `./a`, `./b` and `./c`.

6.4 Questions

Objective 103.7

Search text files using regular expressions

7.1 Overview

7.1.1 Weight: [3]

7.1.2 Statement of Objective:

The candidate should be able to manipulate files and text data using regular expressions. This objective includes creating simple regular expressions containing several notational elements. It also includes using regular expression tools to perform searches through a filesystem or file content.

7.1.3 Key files, terms, and utilities:

```
grep
regexp
sed
```

7.1.4 Resources:

Fun with Regular Expressions by Adrian J. Chung

`http://thelinuxgurus.org/regexp.html`

7.2 Notes

7.2.1 sed—stream editor

- Example (replace "teh" with "the"):

```
$ sed s/teh/the/g my_file.txt ↩
```

- Non-interactive.
- The original file is not touched by sed
- Save the results:

```
$ sed s/teh/the/g old.txt > new.txt↩
```

Calling sed

- sed one liners:

```
$ sed [opts] 'sed-cmds' input-file(s) ↩
```

- sed using a script file:

```
$ sed [opts] -f script-file input-file(s) ↩
```

- Script with a sed shebang:

```
$ cat script.sed  ↩
#!/bin/sed -f
...
```

headingThe `sed` options

-n No print. The default is to print all lines plus lines selected with the p command.

-e The next command is an edit command; used for multiple edits.

-f sed commands are in a file.

Finding text using sed

- Using line numbers: singly or in a range.
- Using Regular Expressions.

Examples:

x Where x is a line number

x,y In a range of lines, from x to y

/pattern/ Where pattern is a regex

/patern/patern/ Choice of patterns

/pattern/,x Look for the pattern on this line

x,/pattern/ Look only at line x for the pattern

x,y! Not lines x to y

Basic sed editing commands

p Print the matched lines

= Display the line number of the file

a \ Append the text after the addressed line

i \ Insert new text after the addressed line

d Delete addressed lines

c Replace addressed text with new text

s Substitute pattern with replacement pattern

r Read text from another file

w Write text to file

q Quit after first pattern has been matched, or just quit

l Show control characters in their octal ASCII equivalent

() Group a series of commands to be performed only on addressed lines

n Read the next line of text from another file and append it

g Paste the contents of pattern2 into pattern1

y Translate characters

n Append next input line; this allows pattern matching across two lines

sed examples

- Print line 3 only:

```
$ sed -n '3p' foo.txt ↩
```

- Print lines 5 through 8:

```
$ sed -n '5,8p' foo.txt ↩
```

- Print lines with *Fred* in them:

```
$ sed -n '/fred/p' foo.txt  ↩
```

- Search for *Fred* only on line 4:

```
$ sed -n '4,/Fred/p' foo.txt ↩
```

- Print lines containing $100:

```
$ sed -n '/\$100/p' foo.txt
```

- Print file 10th line to the last:

```
$ sed -n '1,$p' ↩
```

- Print lines with ing's in them

```
$ sed -n '/.*ing/p' ↩
```

sed examples

- Print just the line number of a match:

```
$ sed -n '/funny/=' foo.txt ↩
3
```

- Print the line and its number:

```
$ sed -n -e '/fun/p' -e '/fun/=' foo.txt ↩
That was funny
3
```

- Appending text:

```
$ cat my.script
/funny/p
/funny/a ha ha ha
$ sed -n -f my.script foo.txt ↩
That was funny
ha ha ha
```

- Substitution:

```
$ sed -n 's/this/that/' foo.file
```

Using a sed script

- Create a script find_the.sh that will print (append) "Got One!" every time it sees the word "the" in a file.

```
#!/bin/sed -f
/the/ a\
Got one!
```

- Run the script:

```
$ chmod u+x find_the.sh ↩

$ ./find_the.sh  owl.pussy.cat.poem ↩

"Dear Pig, are you willing to sell
                          for one shilling
Your ring?" Said the Piggy, "I will."
Got one!
So they took it away, and were married
                                    next day
Got one!
By the Turkey who lives on the hill.
Got one!
```

The Owl and the Pussy-Cat

The Owl and the Pussy-Cat went to sea
In a beautiful pea-green boat:
They took some honey, and plenty of money
Wrapped up in a five-pound note.
The Owl looked up to the stars above,
And sang to a small guitar,
"O lovely Pussy, O Pussy, my love,
What a beautiful Pussy you are,
You are,
You are!
What a beautiful Pussy you are!"

Pussy said to the Owl, "You elegant fowl,
How charmingly sweet you sing!
Oh! let us be married; too long we have tarried:
But what shall we do for a ring?"
They sailed away, for a year and a day,
To the land where the bong-tree grows;
And there in a wood a Piggy-wig stood,
With a ring at the end of his nose,
His nose,
His nose,
With a ring at the end of his nose.

"Dear Pig, are you willing to sell for one shilling
Your ring?" Said the Piggy, "I will."
So they took it away, and were married next day
By the Turkey who lives on the hill.
They dined on mince and slices of quince,
Which they ate with a runcible spoon;
And hand in hand on the edge of the sand
They danced by the light of the moon,
The moon,
The moon,
They danced by the light of the moon.

Edward Lear

Inserting test with `sed`

- Create a script find_the.sh that will print (append) "Got One!" every time it sees the word "the" in a file.

```
#!/bin/sed -f
/Owl/ i\
Owl coming up!
```

- Run the script:

```
$ chmod u+x owl.sh ↩
```

```
$ ./owl.sh  owl.pussy.cat.poem ↩
Wrapped up in a five-pound note.
Owl coming up!
The Owl looked up to the stars above,
```

7.3 Lab

Using the poem "The Owl and the Pussy-cat" by Edward Lear as a sample text answer the following the steps below. Write down the commands that you use and answer any questions.

The text for the poem may be snarfed from the internet by googleing. It's copyright has expired.

1. What version of `sed` are you using?
2. Print all the lines containing the word Pussy.
3. Print all the lines containing the word the or The.
4. Print all the lines starting with a capital p.
5. Print lines that don't have the word "the".
6. Print lines that end in double ticks (") with or without following punctuation.
7. Print lines with four letter words starting with a capital letter.
8. Print lines that are preceeded by lines with a capital p in them.
9. Save lines with hyphenated words to a file called h_words.txt

7.4 Questions

Objective 103.8

Perform basic file editing operations using vi

8.1 Overview

8.1.1 Weight: [1]

8.1.2 Statement of Objective:

Candidate must be able to edit text files using vi. This objective includes vi navigation, basic vi modes, inserting, editing, deleting, copying, and finding text.

8.1.3 Key files, terms, and utilities:

```
vi
 /, ?
 h,j,k,l
 G, H, L
 i, c, d, dd, p, o, a
 ZZ, :w!, :q!, :e!
 :!
```

8.1.4 Resources:

- `$ info text ↩`
- VI Lovers Home Page: Resource listing for using the vi text editor

  `http://www.thomer.com/vi/vi.html`

8.2 Notes

8.3 Lab

8.3.1 Vi tour

Note

Should you need a good sized text file to practice editing on, you will almost certainly find a copy of the GPL Liscence on your system. Be sure to deconsecrate the file by renaming before mungeing it. You may locate one thus:

```
$ locate GPL ↩
...
/usr/share/doc/netpbm-9.14/GPL_LICENSE.txt
/usr/share/doc/cdda2wav-1.10/GPL
/usr/share/doc/cdparanoia-alpha9.8/GPL
/usr/share/doc/stunnel-3.19/COPYRIGHT.GPL
/usr/share/doc/libesmtp-0.8.4/COPYING.GPL
...
```

Make a scratch copy at a suitable location and open it for editing:

```
$ cp /usr/share/doc/stunnel-3.19/COPYRIGHT.GPL  ↩
/tmp/munged_gpl.txt ↩
$ vi /tmp/munged_gpl.txt ↩
```

vi

Vi is the unix editor, simply it is available on just about every Unix installation by default. This is the reason that you have to have a minimum of basic vi skills to allow you to change files when you favourite editor is not available, boot disks have vi due to lack of space.

Please note that there are many implementations of vi, the baseline is a very crude editor. This extends to a very extended and powerful VIM editor available on most platforms. I use vim because I am restricted to vi on many of the unix systems I support, rather than trying to 'switch editors' mentally I have vi on every platform I use, including Windows.

vi is a mode editor

Vi is an editor and it is definitely not a friendly editing environment. In fact a random typing of keys of the keyboard can render your text totally unreadable. Vi has been around a long time it was created in an era where editors were modal. The editor can be in three different unrelated states described below.

Input mode This is the mode where you simply type. You characters appear in the text file as you type.

Command mode This is where character take on special significance, for example 'i' for insert 'D' to delete to the end of the line.

Line mode This is the mode when you press a : in command mode, this is where you can type some powerful (and sed like) commands to alter the document.

Rather than bore you with yet another description I will give you a series of exercises to work through showing each command. In the examples ¡esc¿ means to press the escape key. This will return you to command mode or cancel an action in other modes.

Inserting text

There are at least three ways to insert text into a document in vi, the following exercises will take you through the basic commands.

Exercise 1 - insert Create a text document, just to get you used to switching in and out of the insert and command mode.

```
$ vi test.txt ↩
ithis is the Linux course<return>
We want a few lines of txt to work with. <esc>
```

The i inserts text before the cursor.

Exercise 2 - open We want to add some extra text to the document, we want to enter it on the line after the current line, we use the open command by pressing o.

```
oI am adding an line after the current line.<esc>
```

Exercise 3 - append Now I want ot continue adding another sentence on the current line. If I press 'i' I will insert before the full stop, in this case I want to append it after the full stop.

```
a I want to add another sentence.<esc>
```

You line should now look like:

```
I am adding an line after the current line. I want to
add another sentence.
```

Movement keys & multiplication

There are a huge number of ways to move around in vi, the arrow keys will not always work . You should be aware of the single character work arounds for these in case your terminal is not set up properly on the box you are 'telnet'ing or 'ssh'ing from or to.

h Left one character *

j Down one line *

k Up one line *

l Left one character *

w Forward one word

b Back one word

e End of current word

G End of file *

nG Goto a particular line *

{ Back one paragraph

} Forward one paragraph

$ End of current line

^ non blank character in line

0 Beginning of line (also `|`)

Ones marked with an asterisk are requierd by POMS, Personally I find word movement is my main tool here. I also use the control keys to scroll screens a far bit. These are listed on the printed cheat sheet.

ALL these movement commands can be prefixed by a number to muliply the effect of the movement. To move up 99 lines enter 99k.

Note that some vi editor have a status on the bottom line, sometime it will show that you have entered a multiplier, sometimes it is quiet but the results are _unexpected_.

Exercise 4 - back In the previous exercise I have forgotten a word after the an I wanted the word 'extra'. I have to go back that position in the line.

`12b` will get me back to the beginning of the word I want to insert before, this is an example of a count followed by a command.

Warning on the counts it can repeat most commands whether it makes sense or not at the time. For example enter the following:

```
4iextra <esc>
```

What happened? Why?

This is handy with asterisks `70i*<esc>`, try it.

`12b` moves the cursor back 12 words. A word is a sequence of chanracters separated by a space character like a ¡space¿ or a ¡tab¿ Also the punctuation characters or '.', '?', ';' and so on.

Exercise 5 - general movement Edit a large text file on your system. You should be able to do the following with two keystrokes.

- Jump to line 6
- Move 8 character to the right.
- Go to the end of the line

- Go to the beginning of the line.
- Jump to the top of the paragraph in the document (a paragraph is delimitted by blank lines.)

You should be able to do this with one keystroke

- Move to the left margin To the end of the line
- Move to the end of the file.

The undo command

The real vi command undo is very very limitted. It does not allow for a lot of recovery. There are two undo commands 'U' and 'u'.

The lower case u will undo the last action that you have done. This includes itself so it will cycle through doing and undoing.

The upper case U will undo the any change to the current line and restore it back to its original state.

Extended vi editors such as vim will allow multiple lower case u undo commands but do not rely on it on an unknow box. To get out of a problem you simply have to quit without with ':q!'.

No exercise here, I figure you will find this out without any help. Try both commands. Check the difference.

Deleting changing and copying text

d Delete *

c Change *

x Delete one character

y Yank (copy text)

Ones marked with an asterisk are required by POMS, Personally I use single character deletion all the time. I use line deletion all the time.

There delete command and yank command can be used with a movement to delete all text within this movement. For example d$ will delete to the end of the current line, y$ will yank it into a buffer. Delete will also store the deletion in a buffer to get it back quickly just use paste describe later.

To delete or yank a line simply repeat the d or y. To delete a single line use dd, to delete the current line and the next two use 3dd. To yank the next 10 lines use 10yy.

Exercise 6

Please your cursor in the middle of a line. Delete from the current position to the beginning of the line with two keystrokes.

Delete from the current position to the end of the line.

Note that there is a shorthand for d$ (delete, move to end of line) by using a capital D. Move to the center of a line of text and try it.

8.4 Questions

Topic 104

Devices, Linux Filesystems, Filesystem Hierarchy Standard

Objective 104.1

Create partitions and filesystems

1.1 Overview

1.1.1 Weight: [3]

1.1.2 Statement of Objective:

Candidates should be able to configure disk partitions and then create filesystems on media such as hard disks. This objective includes using various mkfs commands to set up partitions to various filesystems, including ext2, ext3, reiserfs, vfat, and xfs.

1.1.3 Key files, terms, and utilities:

`fdisk`
`mkfs`

1.1.4 Resources:

1.2 Notes

1.2.1 Using `fdisk`

Care must be taken using `fdisk` as any changes to your disk's partition table will make existing data on the disk unaccessible. There is debate about what the "`f`" in `fdisk` stands for.

Using `fdisk` non-destructively on a hard disk

- View the partition table for the hard disk:

```
# fdisk -l /dev/hda ↩

Disk /dev/hda: 255 heads, 63 sectors, 3648 cylinders
Units = cylinders of 16065 * 512 bytes

   Device Boot Start   End    Blocks   Id  System
/dev/hda1   *      1   768   6168928+   c  Win95 FAT32 (LBA)
/dev/hda2        769  3648  23133600    5  Extended
/dev/hda5        769   780     96358+  83  Linux
```

- Print the size of a partition in blocks (30G disk):

```
# fdisk -s /dev/hda ↩
29302560
# fdisk -s /dev/hda5 ↩
96358
```

Using `fdisk` on a diskette

Warning: it makes no sense to use `fdisk` on a floppy—this is just an exercise.

- Format the floppy disk:

```
# fdformat /dev/fd0 ↩
```

- Start fdisk using the floppy diskette:

```
# fdisk /dev/hda ↩
```

- Look at the menu:

```
Command (m for help): m ↩
```

- Print the partition table:

```
Command (m for help): p ↩

Disk /dev/fd0: 2 heads, 18 sectors, 80 cylinders
Units = cylinders of 36 * 512 bytes

    Device Boot    Start       End    Blocks   Id  System
```

- Use n for new and construct this partition table:

```
    Device Boot    Start       End    Blocks   Id  System
/dev/fd0p1 *           1        20       351    1  FAT12
/dev/fd0p2            21        25        90   83  Linux
/dev/fd0p3            26        80       990    5  Extended
/dev/fd0p5            26        30        81   83  Linux
/dev/fd0p6            31        70       711   83  Linux
/dev/fd0p7            71        80       171   83  Linux
```

- List the partition types:

```
Command (m for help): l ↩
```

- Change the first partition to type 1:

```
Command (m for help): t ↩
```

- Toggle the bootable flag on the first partition:

```
Command (m for help): a ↩
```

Using `cfdisk`

`cfdisk` is reputably more user friendly than `fdisk`. There are some partition adjustments that may require `cfdisk`.

Have a look at your floppy diskette partitions:

```
# cfdisk /dev/fd0 ↩
```

Using `sfdisk`

`sfdisk` is interactive partition editor.

Have a look at your floppy diskette partitions:

```
# sfdisk /dev/fd0 ↩
```

You may wish to Cntl-C out of this program if you wish not to edit the partition table.

Using `GNU parted`

`parted` is a partition editor that can resize partitions.

- Have a look at your floppy diskette partitions:

```
# parted /dev/fd0 ↩
```

- Check the menu:

```
(parted) p ↩
```

- Experiment on you partitioned floppy.

1.3 Lab

1.4 Questions

Objective 104.2

Maintain the integrity of filesystems

2.1 Overview

2.1.1 Weight: [3]

2.1.2 Statement of Objective:

Candidates should be able to verify the integrity of filesystems, monitor free space and inodes, and repair simple filesystem problems. This objective includes the commands required to maintain a standard filesystem, as well as the extra data associated with a journaling filesystem.

2.1.3 Key files, terms, and utilities:

```
du
df
fsck
e2fsck
mke2fs
debugfs
dumpe2fs
tune2fs
```

2.1.4 Resources:

2.2 Notes

2.2.1 Summary of Commands

Command	*Function*
du	Display disk usage
df	Display disk space free
fsck	Check Filesystem
e2fsck	Check an ext2 Filesystem
mke2fs	Create an ext2 Filesystem
debugfs	Debug an ext2 Filesystem
dumpe2fs	Dump Filesystem information
tune2fs	Adjust parameters on ext2 Filesystem

2.2.2 `du` - Disk Usage

- du shows *disk usage*
- du can work with subdirectories or an entire disk
- Usage is:

```
du [options] [directory]
```

2.2.3 Options to du

Option	*Function*
-a	Show counts for all files & directories
-b	Display size in bytes
-c	Print total for all arguments after processing
-h	Print in *human readable* form
-k	Show size in Kilobytes
-m	Display size in Megabytes
-s	Display a summary for each argument
-x	Skip directories containing other filesystems

2.2.4 `df` - Disk Free

- df shows disk space used & available
- Default is to display all filesystems
- Usage is:

```
df [options] [directory]
```

2.2.5 Options to df

Option	*Function*
-a	Show counts for all filesystems
-t *fs type*	Limit listing to *fs type*
-h	Print in *human readable* form
-k	Show size in Kilobytes
-m	Display size in Megabytes
-i	Display inode information
-l	Limit listing to local filesystems
-x *fs type*	Exclude *fs type* from listing

2.2.6 `fsck` - Check and repair a Linux file system

- fsck is used to check and optionally repair a one or more Linux file systems.
- filesys can be a device name (e.g. /dev/hdc1, /dev/sdb2), a mount point (e.g. /, /usr, /home), or an ext2 label.
- fsck will try to run filesystems on different physical drives in parallel to reduce total amount time to check all of the filesystems.
- fsck makes 5 passes on the filesystem:
  - Pass 1: Check inodes, blocks & sizes
  - Pass 2: Check directory structure
  - Pass 3: Check directory connectivity
  - Pass 4: Check reference counts
  - Pass 5: Check group summary information

2.2.7 fsck Options

Option	*Function*
-p	Automatically repair without prompting
-n	Don't make changes to filesystem
-y	Assume yes to all questions
-f	Force check even if fs is clean
-r	Interactively prompt for changes
-v	Be verbose
-A	Check all filesystems in `/etc/fstab`
-C	Display a progress bar
-N	Don't execute, show what would be done

2.2.8 fsck error codes

When fsck completes, it will return a value (`$?`) as follows:

Code	*Meaning*
0	No errors
1	Errors found & corrected
2	System should be rebooted
4	Filesystem error left uncorrected
8	Operational error
16	Usage or syntax error
128	Shared library error

2.2.9 `e2fsck` - Check a Linux ext2 FS

- e2fsck is used to check a Linux second extended file system (e2fs)
- e2fsck also supports ext2 filesystems countaining a journal, which are also sometimes known as ext3 filesystems.
- e2fsck operates in a similar manner to fsck (see man page)

2.2.10 `mke2fs` - Create a Linux ext2 filesystem

- mke2fs is used to create an ext2 filesystem
- mke2fs takes a device special file as its argument
- mkfs.ext2 is the same as mke2fs
- To make an ext3 filesystem, you first make an ext2 filesystem and then add a journal to it using tune2fs or use the `-j` option to mke2fs
- Usage is:

```
mke2fs [options] device
```

2.2.11 mke2fs Options

Option	*Use*
-V	Be verbose
-b *blocksize*	Make blocks *blocksize* bytes
-c	Check for bad blocks on device
-i *bytes per inode*	Create an inode for each *bytes per inode*
-j	Create a journal (ext3)
-L *label*	Set the volume label
-N *inodes*	Create the fs with specified number of inodes
-n	Show what would be done (don't actually create fs)

2.2.12 `debugfs` - Ext2 filesystem debugger

- debugfs is a file system debugger
- It can be used to examine and change the state of an ext2 file system.
- debugfs is an interactive debugger. It understands a number of commands:

cat filespec Dump the contents of the inode filespec to stdout.

cd filespec Change the current working directory to filespec.

chroot filespec Change the root directory to be the directory file spec.

close Close the currently open file system.

quit Exit debugfs.

2.2.13 `dumpe2fs` - Dump filesystem information

- dumpe2fs prints the super block and blocks group information for the filesystem present on device
- Usage is:

```
dumpe2fs [options] device
```

- Common options are:

Option	*Use*
-b	Display badblocks on device
-h	Display superblock information

2.2.14 `tune2fs` - Adjust filesystem parameters on ext2 fs

- tune2fs adjusts tunable filesystem parameters on a Linux ext2 filesystem.
- tune2fs can be used to add a journal to an ext2 filesystem.
- Usage is:

```
tune2fs [options] device
```

2.2.15 tune2fs - Common options

Option	*Use*
-c *max-mounts*	Set no of mounts before fsck is forced
-g *group*	Set the group who can use reserved blocks
-j	Add a journal to the filesystem
-L *label*	Set the volume label
-r *blocks*	Set the number of reserved blocks

2.3 Lab

2.4 Questions

Objective 104.3

Control mounting and unmounting filesystem

3.1 Overview

3.1.1 Weight: [3]

3.1.2 Statement of Objective:

Candidates should be able to configure the mounting of a filesystem. This objective includes the ability to manually mount and unmount filesystems, configure filesystem mounting on bootup, and configure user mountable removeable filesystems such as tape drives, floppies, and CDs.

3.1.3 Key files, terms, and utilities:

```
/etc/fstab
mount
umount
```

3.1.4 Resources:

3.2 Notes

3.3 Lab

3.4 Questions

Objective 104.4

Managing Disk Quota

4.1 Overview

4.1.1 Weight: [3]

4.1.2 Statement of Objective:

Candidates should be able to manage disk quotas for users. This objective includes setting up a disk quota for a filesystem, editing, checking, and generating user quota reports.

4.1.3 Key files, terms, and utilities:

```
quota
edquota
repquota
quotao
```

4.1.4 Resources:

TBA

4.2 Notes

Section prepared by Pia Smith

To acheive a general understanding of quotas. In particular the functions of each command, keeping in mind quotas are set on a per-filesystem basis.

4.2.1 Enabling Quotas

In order to use quotas they must first be enabled. To do this there are a few steps:

1. Firstly add the userquota and grpquota options to the relevant filesystems in `/etc/fstab`, as shown:

   ```
   /dev/hda2  /home  ext3  defaults,usrquota,grpquota  1 2
   ```

2. Then create the quota.user and quota.group files at the top of the filesystem, in this case, /home. Ensure that only root can read these files, like so:

   ```
   fehung:~# touch /home/quota.user /home/quota.group
   fehung:~# chmod 600 /home/quota.user /home/quota.group
   ```

3. We then initialise the `quota.*` files as databases by running `quotacheck`.

   ```
   fehung:/home# quotacheck -augv
   Cannot get exact used space... Results might be inaccurate.
   quotacheck: Scanning /dev/hda2 [/home] done
   quotacheck: Checked 143 directories and 689 files
   ```

4. Confirm that the databases have actually been initialised by making sure that the quota.* files are larger than 0.

5. Run quotaon to enable the quota system:

   ```
   fehung:/home# quotaon -a
   ```

6. There are two further things to ensure quota is turned on when boots, and that the database is checked regularly:

   (a) To ensure quota is turned on upon system boot, add the following to the system's initialisation script (/etc/rc.d/rc.sysinit or similar):

   ```
   if [ -x /sbin/quotacheck ]
   then
      echo "Checking quotas."
      /sbin/quotacheck -auvg
      echo "Done."
   fi
   if [ -x /sbin/quotaon ]
   then
      echo "Enabling quotas."
      /sbin/quotaon -avug
   fi
   ```

   (b) To ensure that the databases are checked regularly, add a script to one of the crontab system directories, (such as /etc/cron.weekly/) to run quotacheck:

   ```
   #!/bin/bash
   /sbin/quotacheck -auvg
   ```

   or a job in crontab to acheive the same thing.

The filesystem (in this case /home) is now ready to accept quotas on a per user or group basis.

4.2.2 Quota Limits

There are five types of quota limits that can be enforced:

Per-user hard limit this is the absolute maximum of a users allocated space, once reached the user cannot write anything else to the filesystem, and the currently worked upon file if saved is truncated and useless. The user doesn't lose what is in the current shell, so they can free up some space and then save the file.

Per-group hard limit this is the absolute maximum of a groups allocated space, once reached the group cannot write anything else to the filesystem, and the currently worked upon file if saved is truncated and useless. Users in the group don't lose what is in the current shell, so they can free up some space and then save the file.

Per-user soft limit an abstract limit enforced on users that is less than the hard limit, and once reached, the user enters the grace period. After the soft limit has been reached the user starts getting warnings printed on the terminal that the quota has been exceeded.

Per-group soft limit an abstract limit enforced on groups that is less than the hard limit, and once reached, the group enters the grace period. After the soft limit has been reached the group starts getting warnings printed on the terminal that the quota has been exceeded.

Grace Period Once a soft limit has been reached the user/group enters the grace period which is an abstract time before the hard limit is enforced, regardless of whether the hard limit is reached (assuming the user doesn't get their quota down below the soft limit in that time).

4.2.3 Setting up and configuring quotas.

The next move is to edit the quota reference for each user. We can get around this with scripts, but essentially this is not nice :)

We can actually edit the quota of a typical user on our system and then copy the attributes of that users quota to other users, as follows:

```
fehung:/home/greebo# edquota greebo
```

This edits the quota for user greebo, in this file we change the soft and hard limits to whatever we choose, example:

```
Disk quotas for user greebo (uid 1000):
Filesystem  blocks   soft   hard  inodes   soft   hard
/dev/hda2      538  29000  30000     689      0      0
```

The first first soft and hard values are relevant to blocks and the second to inodes, here the user has a block soft and hard limit but no limit on inodes used.

We can then attribqute these settings to the rest of the users on our system like so:

```
fehung:/home/greebo# edquota -p greebo $(awk -F: '$3 > \
999 { print $1 }' /etc/passwd)
```

and can confirm this worked by running `edquota <randomuser>` to see whether the new settings copied across.

We can only modify the grace limit system wide. We do this by running `edquota -tu`, and changing the value.

4.2.4 Quota commands

`quota(1)`

`quota(1)` is used to display quotas on users and groups, using the -u switch for users and -g switch for groups:

```
fehung:/home# quota -uv greebo ↩
Disk quotas for user greebo (uid 1000):
Filesystem  blocks  quota  limit  grace  files  quota  limit  grace
 /dev/hda2     538  29000  30000           689      0      0
```

`quotaon(1)`

`quotaon(1)` turns on the quota system, quotaoff turns it off. Easy!

`repquota(1)`

`repquota(1)` reports on the status on quotas. Common options are as follows:

```
-a      reports on all quotas
-g      reports on group quotas
-u      reports on user quotas
-v      verbose mode
```

Examples:

```
# repquota -v /home ↩
```

or

```
# repquota -a ↩
```

4.3 Lab

4.4 Questions

Objective 104.5

Use file permissions to control access to files

5.1 Overview

5.1.1 Weight: [5]

5.1.2 Statement of Objective:

Candidates should be able to control file access through permissions. This objective includes access permissions on regular and special files as well as directories. Also included are access modes such as suid, sgid, and the sticky bit, the use of the group field to grant file access to workgroups, the immutable flag, and the default file creation mode.

5.1.3 Key files, terms, and utilities:

```
chmod
umask
chattr
```

5.1.4 Resources:

5.2 Notes

Notes for slide presentation: `gl1.104.5.slides.tex`
Prepared by Andrew Eager

5.2.1 File Permissions

- An access control mechanism
- Based on relation between file & user
- Analogy:
  - Documents receive classification
  - Employees receive clearance
  - Access to a particular document is determined by the documents classification and the employees clearance
- A file has 3 modes of access:
  - Read (r) - Can view the file
  - Write (w) - Can change the file
  - Execute (x) - Can run the file (program)
- A file can be accessed by 3 different types of people:
  - The file owner or user (u)
  - A member of the files group (g)
  - Anyone else or others (o)

5.2.2 Directory Permissions

- Directories are treated in the same way as files
- They have an associated owner
- They have an associated group
- The permissions do slightly different things
  - Read (r) - Can view the contents of directory (ls)
  - Write (w) - Can add, delete, rename files
  - Execute (x) - Can 'cd' into the directory and open files in it or its subdirectories

5.2.3 USERS & GROUPS

- A user is any one person (one & only one)
- A group consists of one or more users
- A user may be a member of more than one group

□

5.2.4 `ls -l` is your friend

All of the file's attributes can be examined using the `ls -l` command:

```
$ ls -l rubbles* ↩
-rwxrw---x  1 barney  flinstones  16345  Nov15  08:45  rubbles.txt
```

□

5.2.5 Numeric Equivalents

- Each of the permission bits are bitmapped as follows:

□

5.2.6 Change Permissions with `chmod`

- chmod is used to change file permissions
- Permissions can be specified:
  - In absolute form - Use octal specification
  - Surgically - Use who/how/what specification

`chmod` - Octal specification

When using an octal specification, you must set the permissions for each of the user, group and other in one go:

```
$ chmod 0543 test.txt
$ ls -l test.txt
-r-xr---wx    1 andy     andy   ...  test.txt
```

`chmod` - who/how/what specification

Who may be one of:

u - The file's owner (user)

g - The file's group

o - Other users (world)

a - All three of them

`chmod` - who/how/what specification

How may be one of:

+ - Add permission, existing unaffected

− - Remove permission, existing unaffected

= - Set permission, existing replaced

chmod - who/how/what specification

What may be one of:

r - Read permission

w - Write permission

x - Execute permission

5.2.7 chmod - what specification

5.2.8 Some examples:

Add execute permission for the file's owner (and leave everything else)

```
# chmod u+x file.txt ↩
```

Remove write permission from group and others (and leave everything else)

```
# chmod go-w file.txt ↩
```

Set the file to read only for everyone (kills existing permissions)

```
# chmod a=r file.txt ↩
```

5.2.9 Permission Defaults: umask

- When a file is created, the system needs to know what permissions to assign to the newly created file. This is done using `umask`.
- You set the bits in umask that you *don't* want set on any newly created file.
- A newly created file will *never* have the execute bit set, regardless of the value of `umask`.
- For example, a `umask` of 0022 will ensure that write access is not granted to group and others.

```
$ umask 0022
$ touch test.txt
$ ls -l test.txt
-rw-r--r--    1 andy     andy    ... test.txt
```

5.2.10 SUID Setuid bit (4000)

The setuid bit is represented by a 'S' in the user/executable field in the file permissions if the file is not executable or by an 's' in that field if the file is executable:

```
-rwSrw-rw-    --> Setuid bit set, not executable
-rwsrw-rw-    --> Setuid bit set, executable
```

The setuid bit is only used for files:

Files:

The user executing the file gains the privileges of the file's owner for the duration of that process' run life. For example, a program owned by root with the setuid bit set `(setuid root)` when run by a normal user will gain root privileges for the purposes of that process. It changes the effective user. One exception: Setuid is ignored if the executable file is a script (security)

Directories:

The setuid bit is ignored completely on directories and does SFA

Setuid bit - Example

```
$ ls -l hexdump
-rwxr-xr-x    1 root     root ...  hexdump
$ ls -l /dev/hda1
brw-rw----    1 root     disk ...  /dev/hda1
$ hexdump -n 10 /dev/hda1
 hexdump: /dev/hda1: Permission denied

# chmod 4755 hexdump
# ls -l hexdump
-rwsr-xr-x    1 root     root ...  hexdump

$ hexdump -n 10 /dev/hda1
0000000 ace9 4100 4a50 5726 1a4e
```

5.2.11 SGID Setgid bit (2000)

The setgid bit is represented by a 'S' in the group/executable field in the file permissions if the file is not executable or by a 's' in that field if the file is executable:

```
-rw-rwSrw-    --> Setgid bit set, not executable
-rw-rwsrw-    --> Setgid bit set, executable
```

Setgid bit - Example

```
$ ls -l hexdump
-rwxr-xr-x    1 root     root ...  hexdump
$ ls -l /dev/hda1
brw-rw----    1 root     disk ...  /dev/hda1
$ hexdump -n 10 /dev/hda1
hexdump: /dev/hda1: Permission denied

# chmod 2755 hexdump
# ls -l hexdump
-rwxr-sr-x    1 root     root ... hexdump

$ hexdump -n 10 /dev/hda1
```

```
hexdump: /dev/hda1: Permission denied
```

Setgid bit - Example

```
# chgrp disk hexdump
# ls -l hexdump
-rwxr-sr-x    1 root     disk .... hexdump

$ hexdump -n 10 /dev/hda1
0000000 ace9 4100 4a50 5726 1a4e
```

5.2.12 Sticky bit (1000)

The sticky bit is represented by a 'T' in the others/executable field in the file permissions if the file is not executable or by a 't' in that fied if the file is executable:

```
-rw-rw-rwT    --> Sticky bit set, not executable
-rw-rw-rwt    --> Sticky bit set, executable
```

Sticky bit (1000)

The sticky bit takes on a different meaning for files & directories:

Files Keep programs in swap even after execution. (Historical, not really useful but maintained for backward comparability)

Directories Files in a directory with the sticky bit set can not be deleted by anyone other than:

- The owner of the file
- The owner of the directory
- The root user

Sticky bit Example

```
[andy@Node4] tmp]$ ls -ld /tmp
drwxrwxrwt   27 root     root    ... /tmp
[andy@Node4] tmp]$ ls -l andy-temp
-rw-rw-rw-    1 andy     andy    ...  andy-temp

[patsy@Node4] tmp]$ cat andy-temp
This is Andy's file
[patsy@Node4] tmp]$ rm andy-temp
rm: cannot unlink 'andy-temp': Operation not permitted

[andy@Node4] tmp]$ rm andy-temp
[andy@Node4] tmp]$
```

5.2.13 Ken Caldwell's Summary: Use file permissions to control access to files

Linux is a multi user operating system and therefore needs to provide a system whereby the users can control access to their files.

All users are given a unique User IDentification number (UID) and are assigned to at least one group(of users). Each group is identified by a Group IDentification number (GID). Frequently users are assigned to a group containing only one member (themselves) as their primary group. The system administrator can add a user to other groups such as may be convenient for example "sales", "engineering", "finance" or "management"

Not all "users" of the system are natural people others such as bin, daemon, lp, fetchmail and nobody also exist.

About file access permissions

Any file created by a user will be owned by that user and belong to the current group of that user. That is to say the file will be tagged with its creator's UID and GID. The file will also be tagged with its (default) permissions according to the umask of its creator.

The permissions pertaining to an ordinary file are the permission to Read the file, the permission to edit or delete the file (Write) and the permission to eXecute the file. These permissions are specified for: 1 The file's owner (ie the User who created the file) 2 Members of the Group associated with the file. (as determined by the GID) 3 all Others

Permissions are shown in the long format output of the ls command as a nine character string such as, for example, rwxr-x–x. The first three characters represent the permissions of the User who created the file. In this case permission to Read, Write and eXecute the file. Members of the Group have Read and eXecute permission while Others have only eXecute permission. Permissions can also be expressed as an octal number with one digit for the user, one for the group and one for the others. Read permission is given a value of 4, write permission a value of 2 and execute permission a value of 1. In our previous example the file could be described as having the permissions 751.

Permissions are interpreted slightly differently when applied to directories. The read permission is interpreted to mean the ability to list the directory. The write permission is interpreted to mean the ability to write files to, or delete files from, the directory. The execute permission allows a user to cd to that directory or to include it in a path to a directory to which you wish to change.

The initial permissions of a file upon creation are determined by subtracting the user's umask from 777. The default umask is usually 002 on systems where users have their own exclusive group or 022 otherwise. In the former case files will be created with rwxrwxr-x permissions and in the latter case rwxr-xr-x.

The permissions of a file may be altered by the file's owner by means of the chmod command. The chmod command is invoked as:

$ chmod (required change) filename

The bit in brackets can be either the octal value of the new permissions e.g. 644 or a string made up of three elements. The first element is one or more of u, g, o or a standing for User, Group, Others or All. The second element is +, - or = meaning add the designated access, remove the designated access or set exact access specified. The third element is the access type ie one or more of r,w or x.

There are three further access modes which we haven't discussed so far. They are SUID, SGID and the sticky bit. These are also expressed as an octal digit, 4 for SUID, 2 for SGID and 1 for the "sticky bit". Thus an executable file which we have previously described as having permissions 775 could more exactly be described as having permissions 0755. If the file was SUID the description would be 4755. Again the meanings are different for ordinary files and directories.

An executable file with the SUID bit set runs with the UID of the file owner instead of inheriting the UID of the parent process. Similarly for the SGID bit. The "sticky bit" has no meaning on Linux systems when applied to ordinary files. If the "sticky bit" is set on a directory then only the owner of a file may delete it from that directory even if the directory is world writeable. This is most often seen on the /tmp directory. If the SGID bit is set on a directory then all files created in that directory will be assigned the GID of the directory rather than the GID of the user. Another way of creating files with a desired GID is to change the user's GID with the newgrp command.

5.3 Lab

5.3.1 File Permissions Exercises

File permissions & the root user

1. Log into the system as root and make sure you are in root's home directory:

   ```
   # cd /root ↩
   ```

2. Create a new file called test.txt using touch:

   ```
   # touch test.txt ↩
   ```

3. Remove all permissions of test.txt using chmod:

   ```
   # chmod 0000 test.txt ↩
   ```

4. Now write something to test.txt:

   ```
   # cat > test.txt ↩
   ```

5. This is root writing to a file without any permissions! Can you read this?

   ```
   <ctrl-d>
   #
   ```

6. Now try to read the file:

   ```
   # cat test.txt ↩
   ```

7. Have a look at the owner, group and permissions of test.txt using ls -l:

   ```
   # ls -l test.txt ↩
   ```

File permissions & a normal user

1. Log out from root and log back in as a normal user.
2. Try repeating the exercise above as a normal user.
3. Change the permissions of test.txt to write only:

   ```
   $ chmod 0200 test.txt (or chmod u=w test.txt) ↩
   ```

4. Now try writing something to the file:

   ```
   $ cat > test.txt ↩
   ```

5. This is a user writing to a file with only write permissions! Can you read this?

```
<ctrl-d>
$
```

6. What do you see when you try to read the file ?

   $ **cat test.txt** ↩

7. Have a look at what permissions are set for the file:

   $ **ls -l test.txt** ↩

8. Now add read permissions to the file:

   $ **chmod u+r test.txt** ↩

9. Look again at what permissions are set for the file:

   $ **ls -l test.txt** ↩

10. Can you read the file now?

Umask exercises

1. Log in as a normal user.
2. Have a look to see what your umask is set to:

   $ **umask** ↩

   Umask =

3. Touch a file and have a look at the resulting permissions:

   $ **touch test.txt** ↩
   $ **ls -l test.txt** ↩
   $ **rm test.txt** ↩

   Record the permissions:

4. Now set your umask to 0000 and try the same again:

   $ **umask 0000** ↩
   $ **touch test.txt** ↩
   $ **ls -l test.txt** ↩
   $ **rm test.txt** ↩

   Record the permissions:

5. Now set your umask to 0777 and try the same again: $ **umask 0777** ↩ $ **touch test.txt** ↩ $ **ls -l test.txt** ↩ $ **rm test.txt** ↩

   Record the permissions:

6. What do you notice about umask and the execute permission bit?

5.3.2 SUID & GUID Exercises

NOTE:

These exercises involve jumping in and out of super user mode. You may want to do these exercises under X with two shells open on the same desktop. Open one shell as a normal user and the other as a superuser.

1. Copy the file `/usr/bin/hexdump` to `/bin/mydump`:

   ```
   $ cp -a /usr/bin/hexdump ~/bin/mydump ↩
   ```

2. As root, change directory to your normal user home directory and change owner and group to root:

   ```
   # chown root:root mydump ↩
   ```

3. Now try to dump the first 10 bytes on `/dev/hda`. What part of the disk are you looking at?

   ```
   $ mydump -n 10 /dev/hda ↩
   ```

4. As root, set the UID bit on the file and have a look at the new permissions:

   ```
   # chmod u+s mydump ↩
   # ls -l mydump ↩
   ```

5. Try dumping the first 10 bytes on `/dev/hda`

6. As root remove the SUID from the file and set the SGID bit: (could do this as two commands if you feel better).

   ```
   # chmod u-s,g+s mydump ↩
   # ls -l mydump ↩
   ```

7. Try dumping the first 10 bytes on `/dev/hda`

8. Have a look at the group owner for `/dev/hda` and change the group owner of myfile to the same group:

   ```
   # ls -l /dev/hda ↩
   brw-rw----    1 root     disk       3,   0 Apr 12 00:25 /dev/hda
   # chgrp disk mydump ↩
   ```

9. Try dumping the first 10 bytes on /dev/hda

10. Clean up after yourself! Remove the file mydump.

5.3.3 Stickey Bit Exercises

Note: For this exercise, you will need two normal user logins. Create any additional logins as follows:

```
# ls -l ↩
# adduser user-name ↩
# mkdir /home/user-name ↩
# passwd user-name ↩
```

1. As root, Make a world read/writable /mytmp directory.

   ```
   # ls -l ↩
   # umask 0000 ↩
   # mkdir /mytmp ↩
   # ls -ld /mytmp ↩
   drwxrwxrwx    2 root     root         4096 Sep  4 12:01 mytmp/
   ```

2. As User A, touch a file in /mytmp:

   ```
   [user-A]$ touch /mytmp/user-a-file.txt ↩
   ```

3. Have a look at the permissions for the file:

   ```
   [user-A]$ ls -l /mytmp ↩
   ```

4. Log in as user B and try to remove the file in /mytmp:

   ```
   [user-B]$ rm /mytmp/user-a-file.txt ↩
   ```

5. What happened when user-B tried to delete the file. Were you ultimately able to delete the file even after the warning ?

6. As root, set the sticky bit on the directory `/mytmp`:

   ```
   # chmod u+t /mytmp ↩
   ```

7. Repeat the above from step 2 onwards.

8. Remove the `/mytmp` directory and its contents:

   ```
   # rm -r /mytmp ↩
   ```

5.4 Questions

Objective 104.6

Manage file ownership

6.1 Overview

6.1.1 Weight: [1]

6.1.2 Statement of Objective:

Candidates should be able to control user and group ownership of files. This objective includes the ability to change the user and group owner of a file as well as the default group owner for new files.

6.1.3 Key files, terms, and utilities:

`chmod`
`chown`
`chgrp`

6.1.4 Resources:

6.2 Notes

6.2.1 Change File Ownership with `chown`

by Andrew Eager

- A file's owner can be changed using chown:

```
# ls -l rubble.txt
-rw-rw-r--    1 barney   flinstones ...  rubble.txt

# chown fred rubble.txt
# ls -l rubble.txt
-rw-rw-r--    1 fred     flinstones ...  rubble.txt
```

- A file's owner & group can also be changed using chown:

```
# ls -l rubble.txt
-rw-rw-r--    1 barney   flinstones ...  rubble.txt

# chown fred:flinfolks rubble.txt
# ls -l rubble.txt
-rw-rw-r--    1 fred     flinfolks  ...  rubble.txt
```

6.2.2 Change File Group Ownership with `chgrp`

- To change only the group use chgrp:

```
# ls -l rubble.txt
-rw-rw-r--    1 barney   flinstones ...  rubble.txt

# chgrp flinfolks rubble.txt
# ls -l rubble.txt
-rw-rw-r--    1 barney   flinfolks  ...  rubble.txt
```

6.2.3 Summary: Managing File Ownership

by Ken Caldwell

The UID and/or the GID of a file may be changed by the file's owner by means of the chown command. man chown for all the options but typically invoked as:

```
$ chown newowner:newgroup filename ↩
```

or:

```
$ chown 314:42 filename ↩
```

`chgrp` is similar but may only be used to change the group.

6.3 Lab

6.4 Questions

Objective 104.7

Create and change hard and symbolic links

7.1 Overview

7.1.1 Weight: []

7.1.2 Statement of Objective:

Candidates should be able to create and manage hard and symbolic links to a file. This objective includes the ability to create and identify links, copy files through links, and use linked files to support system administration tasks.

7.1.3 Key files, terms, and utilities:

`ln`

7.1.4 Resources:

7.2 Notes

7.2.1 `ln` — link

A *link* is a pseudofile that creates a shortcut to the original file located elsewere on the filesystem.

Symbolic links

Hard links

7.2.2 Linux files and *inodes*

In creating a file with a command such as:

```
$ cat -n "Hello" > foo
```

1. An *inode* number in the superblock is allocated to the file
2. The files inode is populated with information
3. A directory entry (Hard link) is made in a directory file
4. The file's data is written to a place on the disk pointed to by the *inode*

7.2.3 Linux files and *inodes*

□

7.2.4 The *inode* information

- Some of the information contained in a file's inode can be displayed with the `ls` command:

```
$ ls -il foo ↩
2723514 -rw-r--r--   2 geoff geoff   16 Mar 22 09:38 /tmp/foo
```

- A more complete view of inode information may be had with `stat`:

```
$ stat foo ↩
   File: "/tmp/foo"
   Size: 5               Blocks: 2       IO Block: 4096   Regular File
 Device: 802h/2050d      Inode: 2723514  Links: 1
 Access: (0644/-rw-r--r--) Uid: ( 1000/geoffrey) Gid: ( 1000/geoffrey)
 Access: Fri Mar 22 08:25:00 2002
 Modify: Fri Mar 22 09:38:19 2002
 Change: Fri Mar 22 09:52:26 2002
```

7.2.5 *Hard links* are directory entries

- A file may have one or more *hard links* to it. Additional *hard links* are made with the `ln` command:

```
$ ln foo bar ↩
$ ls -il foo bar ↩
2723514 -rw-r--r--    2 geoff geoff    5 Mar 22 09:38 bar
2723514 -rw-r--r--    2 geoff geoff    5 Mar 22 09:38 foo
```

- there is only one file on the disk
- it has one inode
- it has two names (hard links)

7.2.6 Hard links are directory entries

□

7.2.7 `foo` a.k.a. `bar`

- One inode one set of permissions:

```
$ chmod 640 foo ↩
$ ls -l foo bar ↩
-rw-r-----    2 geoff geoff    5 Mar 22 09:38 bar
-rw-r-----    2 geoff geoff    5 Mar 22 09:38 foo
```

- Same contents:

```
$ echo "Hello there!" > bar ↩
$ head foo bar ↩
==> foo <==
Hello there!
==> bar <==
Hello there!
```

- Same contents:

```
$ diff foo bar ↩
$
```

- Same inode:

```
$ ls -il foo bar ↩
2723514 -rw-r-----    12 geoff geoff    5 Mar 22 09:38 bar
2723514 -rw-r-----    12 geoff geoff    5 Mar 22 09:38 foo
```

7.2.8 Hard link constraints

- Hard links are confined within the volume:

```
$ ln foo ~/fred ↩
ln: creating hard link '/home/geoffrey/fred' to 'foo':
Invalid cross-device link
```

- Directories may not have multiple hard links:

```
$ ln /tmp doh ↩
ln: '/tmp': hard link not allowed for directory
```

- `ln` declines to clobber unless forced:

```
$ ln foo bar ↩
ln: 'bar': File exists
$ ln -f foo bar ↩
```

7.2.9 Symbolic links

7.2.10 A *symbolic link* is a file that points to another

□

7.3 Lab

7.3.1 Make some files and directories

These directories and files are just examples to experiment with. Follow the steps.

1. change to you home directory – `$ cd`
2. check where you are – `$ pwd`
3. make a new directory – `$ mkdir test.dir`
4. change to the new directory – `$ cd test.dir`
5. check where you are – `$ pwd`
6. check what's there – `$ ls`
7. make an empty file – `$ touch a.file`
8. make a hard link to the a.file – `$ ln a.file b.file`
9. make a soft link to the a.file – `$ ln -s a.file c.file`
10. check what's there (the a includes hidden files) – `$ ls -al`
11. make a subdirectory – `$ mkdir sub.dir`
12. make a soft link to the subdirectory – `$ ln -s sub.dir ln.dir`

13. take a look (the i shows the inode numbers) – `$ ls -li`
    Your list should look something like this:

```
[geoffrey@freckle text.dir]$ ls -li ↩
total 1
 454378 -rw-rw-r--   2 geoffrey geoffrey     0 Sep  1 14:35 a.file
 454378 -rw-rw-r--   2 geoffrey geoffrey     0 Sep  1 14:35 b.file
 454379 lrwxrwxrwx   1 geoffrey geoffrey     6 Sep  1 14:37 c.file -> a.file
 454380 -rw-rw-r--   1 geoffrey geoffrey     0 Sep  1 14:44 d.file
 454381 lrwxrwxrwx   1 geoffrey geoffrey     7 Sep  1 15:04 ln.dir -> sub.dir
 456433 drwxrwxr-x   2 geoffrey geoffrey  1024 Sep  1 14:35 sub.dir
```

7.3.2 Hard and soft links

Note that `a.file` and `b.file` have the same inode number, this indicates that the two names represent the same file. But `c.file` is an alias to that file with two names

```
 454378 -rw-rw-r--   2 geoffrey geoffrey        0 Sep  1 14:35 a.file
 454378 -rw-rw-r--   2 geoffrey geoffrey        0 Sep  1 14:35 b.file
 454379 lrwxrwxrwx   1 geoffrey geoffrey        6 Sep  1 14:37 c.file -> a.file
```

The following should show you that they they are the same file.

1. add some text into `a.file`
   `$ echo "this is going into the in a.file" >> a.file`
2. look in a.file `$ cat a.file` ... the text went in?
3. look at the `c.file` – `$ cat c.file` – it's a soft link to `a.file`
4. nuke the `a.file` – `$ rm a.file`
5. take another look at the `c.file` – `$ cat c.file` nothing to link to now
6. but what about the `b.file` – `$ cat b.file`

7.4 Questions

Objective 104.8

Find system files and place files in the correct location

8.1 Overview

8.1.1 Weight: []

8.1.2 Statement of Objective:

Candidates should be thouroughly familiar with the Filesystem Hierarchy Standard, including typical file locations and directory classifications. This objective includes the ability to find files and commands on a Linux system.

8.1.3 Key files, terms, and utilities:

```
find
locate
slocate
updatedb
whereis
which
/etc/updatedb.conf
```

8.1.4 Resources:

8.2 Notes

8.2.1 Ken Foskey's Summary: Using `find`

:vi tw=72

...heading ... The find command.

The find command is one of the fundamental tools of Unix. It is a tool that is constantly rediscovered as you perform more and more complex operations with it. The man page of this simple tool is 555 lines long.

The most basic use of find is:

find ¡directory¿ -name "<mask>"

To find a missing file somewhere in you home directory

find -name missing.file

where is shorthand for your home directory. You can also use masks like "*.txt.gz" but you must put it in quotes.

Why do you have to put it in quotes?

...pause for discussion from floor...

When you use an * in a bash command line it is interpreted as a file expansion and it is looked for in the current directory and if it does exist it is substituted before the command is sent to find. If it is not found then your shell may generate an error message (for example csh, I think).

... page ...

According to the man page 'find - search for files in a directory hierachy' This is true but you can also find directories as well, like the filesystems .

First we will start with some basic options:

Doing options: -print list the filename (default, never really use it). -exec run a command -ok run a command after prompting for confirmation. -ls list file like 'ls -dils', is a lot of file information.

Advanced doing options, I am sure you will use these one day:

-prune don't descend past this directory. -printf Print a filename based on format like C printf. -print0 print but end with a null character. -fprintf ¡fn¿ print a format string to a filename, (scripting??) -fprint ¡fn¿ print filenames to a file. -fls ¡fn¿ ls to a file

Options on what entries we select:

Most of these options take a number, +number, -number. A little explanation is required first.

picking one option, -atime:

-atime 2 Will pick any file accessed two days ago. -atime -2 Will pick any file access more than two days ago -atime +2 Will pick any file accessed in the last day.

** file date and time

Some basic stuff based on the file details itself.

-atime n files on access date -ctime n files on creation date (note chmod mucks this up) -mtime n files on modification date

-anewer n files on access date based on another file. -cnewer n files on creation date based on another file. -newer n files on modification date based on another file.

example: delete all files older than 7 days in the /data directory who have a .A extension.

Write the solution here.

A script may run a command and then 'touch' a tag file to give a timestamp when it was run. assume that the last thing a script does is touch modification.tag in the /parms directory. Write a command line that lists all details of files modified in the /apps/source/ directory based on this tag file.

.... pause to get suggestions from floor... .... lecturers note solution is find /data -mnewer /parms/modification.tag -ls....

Write solution here.

There is also a amin, cmin and mmin version of the above.

** Owner and group.

One problem with the Unix authenticification system, when you delete a userid you end up with magic numbers on a directory listing. It is handy to be able to change the ownership on all files from the exiting staff member to the new person working on those projects.

-nouser users numeric id does not have and entry in /etc/passwd -nogroup group numeric id does not have an entry in /etc/group -uid n User by number -user name User by name -gid n Group by number -group name Group by name

I recently converted from Redhat to Debian. I installed a new harddisk and mounted the old one as /mnt/old1. I notice that when I do ls -al I get a username of 500 in the directory listing. Change all the occurences of 500 to the username of ken.

.... lecturers note solution is AS ROOT

```
find /mnt/old1 –uid 500 –exec chown ken {} \;....
```

Write solution here

** Inode number and links

You have a directory listing, the hard link count is greater than 1. ... lecturers note wait and ask class how we know this ....

You have no idea where the other hard link is and you want to locate the other version to see what impact a change may have.

-inode n

... lecturers note, I have no idea how to do this ....

Write solution here

Advanced options on what entries we select:

-iregex Use regex rather than standard file masks.

Options on how we go through the directories: -xdev don't go into other file systems.

8.2.2 Andrew Eager's Summary: Using `locate`, `updatedb` and `slocate`

SLOCATE - Secure Locate

LOCATE - Normal Locate (Normally symlinked to slocate)

Slocate is used to find files on the system without actually having to search the entire directory tree. A database of all files on the system is created and is then used by slocate to reveal the files actual location. It is important to note that slocate may return a result which is no longer valid since the directory structure may have been modified since the slocate database was last created. For example, you create a file called poobar.txt, create the slocate database and then remove poobar.txt. Slocate will still return poobar.txt?s original location until the slocate database is recreated.

Slocate can be used in two modes:

- Search mode:- To locate an actual file within the database
- Database creation mode:- To build the database

Search usage:

```
slocate [-qi] [-d <path>] [-r <regexp>] <search string>...
```

`-q` Quiet mode. Suppress error messages.

`-i` Does a case insensitive search.

`-d` Specify a database to use.

`-r` Pass a regular expression instead of a search string.

Examples:

```
locate ls $ locate ls ↩
    ...
     /etc/X11/xkb/symbols/xfree68/ataritt
    /etc/X11/xkb/symbols/xfree68/amiga
    /etc/alternatives/tclsh
    ...

locate -r "/ls$" $ locate -r "/ls$" ↩
    /home/geoffrey/tafe/mos/compress/ls
    /usr/lib/bitchx/help/8_Scripts/ls
    /bin/ls
```

The above example illustrates the need for a regex option to `locate`. In the first example there will be lots of hits. In the second there is only one (the actual `ls` command).

As well as searching for a file in the database, `locate` can also build the search database.

Database Creation Usage:

As well as searching for a file in the database, slocate can also build the search database.

-u Create slocate database starting at path /.

-U <**dir**> Create slocate database starting at path < *dir* >.

-c Parse original GNU Locate's `/etc/updatedb.conf`

-e <**dir1...**> Exclude directories from the slocate database when using the -u or -U options.

-f <**fs...**> Exclude file system types from the slocate database

-l Security level. 0–> security off, 1–> security on

-q Quiet mode. Error messages are suppressed.

-o <**file**> Specify the name of the database file to create

-v Be verbose

Examples

- Create a database for all directories under `/usr` and place the resulting database file into `slocate.db` in andy's home directory.

```
# slocate -U /usr -o /home/andy/slocate.db ↩
```

- Create a database for all directories under /usr, excluding directories under /usr/man and place the resulting database file into slocate.db in andy?s home directory.

```
# slocate  -U /usr   -e /usr/man  -o /home/andy/slocate.db ↩
```

Update `slocate` database—`update`

`updatedb` is simply a link to slocate that implies the -u option. (Excerpt from the man page:- man updatedb)

```
$ ls -l `which updatedb` ↩
lrwxrwxrwx  1 root  root 7 Mar 27 10:44 /usr/bin/updatedb -> slocate*
```

`updatedb` is typically executed periodically via cron.

`/etc/updatedb.conf`

- The `updatedb` (or `slocate`) tool can use a configuration file to decide which directories and file systems are included when the database is created. This file is normally located in `/etc/updatedb.conf`
- The following is a list of keywords that are recognised by updatedb (slocate) and their equivalent command line options

PRUNEFS <fs_type1 fs_type2...> - Option -f

PRUNEPATHS <dir1 dir2 dir3...> - Opion -e

- Example `updatedb.conf`

```
PRUNEFS="devpts NFS nfs afs proc smbfs autofs auto iso9660"
PRUNEPATHS="/tmp /usr/tmp /var/tmp /afs /net?
export PRUNEFS
export PRUNEPATHS
```

`slocate` Exercises

1. Create an `slocate` database in your home directory including all directories from `/` down.
2. Using the database created in step 1, locate all files with `rm` in the filename
3. Using the database created in step 1, locate the executable file `rm` using a regex. (ie `/some/path/rm`)
4. Create an slocate database in your home directory include all directories from `/` down but excluding the `/bin` directory.
5. Repeat (2) and (3) above. Do you notice anything different ?
6. After backing up your existing `/etc/updatedb.conf`, say

   ```
   # cp /etc/updatedb.conf /etc/updatedb.conf.orig ↩
   ```

   edit `/etc/updatedb.conf` to perform the same actions as in step (4).
7. When you have finished this exercise restore your original `/etc/updatedb.conf`.

8.3 Lab

8.4 Questions

Topic 110

X

Objective 110.1

Install & Configure XFree86

1.1 Overview

1.1.1 Weight: []

1.1.2 Statement of Objective:

Candidate should be able to configure and install X and an X font server. This objective includes verifying that the video card and monitor are supported by an X server, as well as customizing and tuning X for the videocard and monitor. It also includes installing an X font server, installing fonts, and configuring X to use the font server (may require a manual edit of /etc/X11/XF86Config in the ”Files” section)

1.1.3 Key files, terms, and utilities:

```
XF86Setup
xf86config
xvidtune
/etc/X11/XF86Config
.Xresources
```

1.1.4 Resources:

1.2 X Window System

1.2.1 The Linux Desktop GUI

- On Linux, the graphical desktop is controlled by 4 different types of software:
  - The X server - hardware interface
  - A window manager - windows, icons etc
  - Desktop manager - file manager, control panel etc.
  - The application itself (the x-client)
- Only the X server & X-client are mandatory

1.2.2 Window Managers

- Some window managers are:
  - twm - Tab Window Manager - very light weight
  - AfterStep - Light resource usage
  - Blackbox - Fast & simple
  - Enlightenment - Resource intensive
  - FVWM - Not so popular anymore
  - IceWM - Emulates OS/2 & windows
  - Sawfish - default for Gnome
  - Window Maker

1.2.3 Desktop Environments

- The two most popular Linux Desktops are:
  - KDE
  - Gnome

1.2.4 Starting X

- The X server is an executable called 'X'
- Usually a link:

```
$ ls -l `which X`
lrwxrwxrwx    ...   /usr/bin/X11/X -> XFree86
```

- You can start X in several ways:
  - X directly - (not very useful)
  - xinit - X & one X-term client
  - startx - X & desktop (KDE or Gnome)

1.2.5 X Server Screen references

When X starts, it associates itself with a *display & screen*. The syntax for this is:
`':display.screen'`

- Display is 0 for the first X server, 1 for the next etc.
- Screen is 0 for the first screen connected to a multihead video card or multiple video cards
- The default for display & screen are both 0

Example:
`:0.1`
The second screen (head) on X server 0
`:1.0 or :1`
The first screen on the second X server

1.2.6 Starting X directly

The syntax for X is:

```
X [:display.screen] [options]
```

Examples:

- Start X on display 0, screen 0:

  ```
  $ X ↩
  ```

- Start X on display 1, screen 1:

  ```
  $ X :1 ↩
  ```

- Start X on display 1, screen 1:

  ```
  $ X :1.1 ↩
  ```

1.2.7 Starting X using xinit

The syntax for xinit is:

```
xinit [[client] options ] [--[server] [display] options ]
```

Examples:

- Start X and one xterm on display 0, screen 0:

  ```
  $ xinit ↩
  ```

  Start X and 1 xterm on the second display:

  ```
  $ xinit -- :1 ↩
  ```

Start X and xcalc on the second display:

```
$ xinit /usr/X11R6/bin/xcalc -- :1 ↩
```

Start X and kde on the second display:

```
$ xinit /usr/bin/startkde -- :1 ↩
```

1.2.8 Starting X using startx

- startx is a wrapper for X and your favourite desktop
- it has the same syntax as xinit
- On RedHat, default desktop is in `/etc/sysconfig/desktop`

Examples:

- Start X and the default desktop on display 0, screen 0

  ```
  $ startx ↩
  ```

- Start X and desktop on the second display in 16 bit colour

  ```
  $ startx -- :1 -depth 16 ↩
  ```

- Start X and the kde desktop on the second display

  ```
  $ startx /usr/bin/startkde -- :1 ↩
  ```

1.2.9 Running X-clients remotely

- An X-client can be told to direct its output to a given display in one of two ways:
  - By using the DISPLAY environment variable
  - By using the -display option on the command line
- A remote display is specified using the syntax:

  `hostname:display.screen`

  Example:

  `node12.c222:1.0`

  Refers to the first screen on the second display of host node12.c222
- Using the -display option

  ```
  $ xcalc -display node12.c222:1.0 ↩
  ```

- Using the DISPLAY environment variable

  ```
  $ export DISPLAY=node12.c222:1.0 ↩
  $ xcalc ↩
  ```

Both methods will run xcalc on the second display of host node12.c222. Note that in the second case, the DISPLAY variable is exported so it will apply to all X-clients started on that terminal.

1.2.10 Controlling access to the X server

- By default, an X server will only accept connections from clients running on the same host as the server.
- Remote access can be granted using the `xhost` command
  - `xhost +` - Disable access control (any host is OK)
  - `xhost -` - Enable access control (only listed hosts)
  - `xhost +hostname` - Allow hostname to connect
  - `xhost -hostname` - Dissallow hostname from connecting
- xhost uses host based access control
- xhost must be run on the X server.

1.2.11 Testing access to the X server

- As a client, you can see if you have permission to connect to a remote X server by:
  - Setting & exporting the DISPLAY variable to the desired X server
  - running xhost without any arguments
- Example:- See if node12.c222 is available to us for display

```
$ export DISPLAY=node12.c222:1.0 ↩
$ xhost ↩
xhost:  unable to open display "node12.c222:.0"
```

1.2.12 The X server

- There are two versions of the X server:
- X version 3:
  - Uses the configuration file `/etc/X11/XF86Config`
  - Has different X executables for different cards
- X version 4:
  - Uses the configuration file `/etc/X11/XF86Config-4`
  - Has only one executable for all video cards (XFree86)
- To tell which version you are running do the following:

  Example:

```
$ ls -l `which X` ↩

lrwxrwxrwx   .... /usr/bin/X11/X -> XF86_SVGA
```

  Using X version 3 on an SVGA card

```
$ ls -l `which X` ↩
```

```
lwxrwxrwx    .... /usr/bin/X11/X -> XFree86
```

Using X version 4.

1.2.13 Version 3 drivers

The version 3 drivers are specific to a particular card type. Some of the more common drivers are:

- XF86_3DL - 3D Labs video cards
- XF86_8514 - 8514 video cards
- XF86_AGX - AGX video cards
- XF86_FB - Generic frame buffer device for non-specific cards
- XF86_Mach64 - ATI Mach 64 video cards
- XF86_S3 - S3 based video cards
- XF86_S3V - S3 virge video cards
- XF86_SVGA - VESA Super VGA cards
- XF86_VGA16 - 16 colour VGA cards

1.2.14 The X server

- is the interface to the graphics card
- allows X clients to display information
- can run multiple instances on a single card
- accepts **local or remote** X-clients

1.3 Lab

1.3.1 X Server - Lab

General Notes:

- The Gnome desktop X-client is `/usr/bin/gnome-session`
- The KDE desktop X-client is `/usr/bin/startkde`

Exercise:

1. Using `xinit`, startup the following three X sessions: (You will need 3 'normal user' consoles)
   (a) The KDE desktop on display `:0`
   (b) The Gnome desktop on display `:1`
   (c) An Xterm on display `:2`
2. Toggle between each of the 3 displays using `<ALT-CTL-F7>`, `<ALT-CTL-F8>` and `<ALT-CTL-F9>`.
3. On display 2, (the 3rd display) startup twm in the background followed by a second xterm.

   ```
   $ twm & ↩
   $ xterm & ↩
   ```

4. On your KDE desktop, open up an xterm and disable access control on that X server:

   ```
   $ xhost + ↩
   ```

5. On display 2 in the second xterm, setup the `DISPLAY` variable to point to your partners X-server running the KDE desktop (display :0):

   ```
   $ export DISPLAY=nodeXX.c222:0 ↩
   ```

   (Where XX is your partner's node number)
6. Now on that same terminal, run the xcalc command and confirm that xcalc launches on your partners KDE desktop.
7. Again on the same terminal, take a screendump of your partners KDE desktop:

   ```
   $ xwd -root >temp ↩
   ```

8. Now move over to the first xterm and restore the screen dump of your partners KDE desktop to your own screen:

   ```
   $ xwud -in temp ↩
   ```

1.4 Questions

Objective 110.2

Setup a Display Manager

2.1 Overview

2.1.1 Weight: []

2.1.2 Statement of Objective:

Candidate should be able setup and customize a Display manager. This objective includes turning the display manager on or off and changing the display manager greeting. This objective includes changing default bitplanes for the display manager. It also includes configuring display managers for use by X-stations. This objective covers the display managers XDM (X Display Manger), GDM (Gnome Display Manager) and KDM (KDE Display Manager).

2.1.3 Key files, terms, and utilities:

```
/etc/inittab
/etc/X11/xdm/*
/etc/X11/kdm/*
/etc/X11/gdm/*
```

2.1.4 Resources:

:

:

2.2 Notes

2.2.1 Display Managers

- Manages connection to local or remote X sessions
- Similar function to getty & login
- Different types are:
  - KDM - KDE Display Manager
  - GDM - Gnome Display Manager
  - XDM - X Display Manager (base X system)

2.2.2 Life Cycle of a DM

- When a display manager is started, it:
  - Starts up X servers on each display configured
  - Displays a GUI login window
  - Authenticates user / password
  - Starts selected X-session (KDE, Gnome, Xterm..)
- When the X-session ends it:
  - Resets the X server
  - Repeats the process above (optional)

2.2.3 Local & Remote X sessions

- A user logging in through XDM can:
  - Log into their local system
  - Log into another system running XDM
- For remote logins, XDMCP (X Display Manager Control Protocol) is used
- A remote X login can be established to:
  - A specific host
  - Any available host (broadcast)
  - A host chosen from a list

2.2.4 Direct Remote X login - Client Side

- To log into a specific host:

  $ **X [display] -query <server-name>** ↩

  Example:

  $ **X :1 -query node10.c222** ↩

  This will startup an X server on the second display of your local machine. The X session established will run on the host node10.c222

- This assumes that node10.c222 has allowed access to the client in its xdm-config.

2.2.5 Broadcast Remote X login - Client Side

- To log into any host runnig xdm:

  $ **X [display] -broadcast** ↩

  Example:

  $ **X :1 -broadcast** ↩

  This will startup an X server on the second display of your local machine. The X session established will run on any host that responds to the broadcast request.

- This assumes that xdm on the server machines have been configured to listen to broadcast requests.

2.2.6 Chooser Remote X login - Client Side

- To log into a host by selecting it from a chooser list:

  $ **X [display] -indirect <server-name>** ↩

  Example:

  $ **X :1 -indirect foozle.c222** ↩

  This will startup an X server on the second display of your local machine. A list of hosts available for logon will be generated by foozle.c222. An X session will then be established on the host selected from the list.

- This assumes that xdm on foozle.c222 has been configured to provide clients with a chooser

2.2.7 Configuring XDM

- XDM has its configuration files in `/etc/X11/xdm`
- `xdm-config` controls xdm functionality
- `Xaccess` controls which clients can access XDM
- man xdm gives full documentation to both files

2.2.8 Configuring Xaccess

- Xaccess has 4 different syntaxes:
  - `pattern` - Controls direct & broadcast access
  - `pattern <host-list>` - Forwarding of indirect access
  - `pattern CHOOSER BROADCAST` - To use a chooser
  - `pattern CHOOSER <host-list>` - To use a chooser with a specific list

2.2.9 Xaccess - Direct & Broadcast

- To control direct and broadcast access to XDM simply specify a list of hosts that are allowed to connect:

  Example `/etc/X11/xdm/Xaccess`:

  ```
  !badguy.c222
  *.c222
  ```

  This says allow all hosts in the c222 domain except for the host badguy.c222 to connect to XDM.

2.2.10 Xaccess - Providing a chooser

- To have XDM provide a predefined list of available hosts for all indirect requests:

  Example `/etc/X11/xdm/Xaccess`:

  ```
  admin.c222    CHOOSER    BROADCAST
  *.c222        CHOOSER    node1.c222 node2.c222
  ```

  This says that admin.c222 will get a list of hosts discovered on the network by using a broadcast to choose from. Anyone else in the c222 domain will get a list with only node1 and node2 in the list.

2.2.11 xdm-config - Enabling chooser requests

- In order to use the chooser, the following line needs to be removed from `/etc/X11/xdm/xdm-config`:

  ```
  ! SECURITY: do not listen for XDMCP or Chooser requests
  ! Comment out this line if you want to manage X terminals with xdm
  DisplayManager.requestPort:   0
  ```

- Note that a comment in this file starts with a '!'.

2.3 Lab

2.4 Questions

Objective 110.4

Install & Customize a Window Manager Environment

4.1 Overview

4.1.1 Weight: []

4.1.2 Statement of Objective:

Candidate should be able to customize a system-wide desktop environment and/or window manager, to demonstrate an understanding of customization procedures for window manager menus and/or desktop panel menus. this objective includes selecting and configuring the desired x-terminal (xterm, rxvt, aterm etc.), verifing and resolving library dependency issues for X applications, exporting X-display to a client workstation.

4.1.3 Key files, terms, and utilities:

```
.Xdefaults
xhost
DISPLAY environment variable
```

4.1.4 Resources:

4.2 Notes

4.3 Lab

4.4 Questions

Appendix A

Debian Install

Appendix B

openMosix

B.1 Open Mosix

Open Mosix is a collection of software designed for clustering a set of machines. It comprises two parts:

- The kernel
- User land utilities

B.2 Obtaining packages

The following packages can be obtained from `www.openmosix.org`

1. openmosix-kernel-2.4.18-openmosix4.i386.rpm
2. openmosix-tools-0.2.4-1.i386.rpm

The optional gui viewer for openmosix can be obtained from:
`www.openmosixview.com/download.html`

1. openMosixview-1.2-rh73.rpm

B.3 Installing openmosix

For each of the machines in your cluster do the following:

- Install kernel: `# rpm -ivh openmosix-kernel-2.4.18-openmosix4.i386.rpm`
  If you are using grub, the installer should update the grub configuration files automatically. If using lilo, you will need to add to `/etc/lilo.conf` a stanza that looks something like:

```
image=/boot/vmlinuz-2.4.18-openmosix4
        label=linux-mosix
        read-only
        root=/dev/hda7
```

Then run `# lilo -v`

- Install the tools: `# rpm -Uvh openmosix-tools-0.2.4-1.i386.rpm`
- Edit Configuration file:

  Edit the file /etc/mosix.map to include the nodes in your cluster. For example:

```
# MOSIX-#     IP           number-of-nodes
# ======================================
1       192.168.222.1          16
```

  This says we have 16 nodes labelled 1 to 16 with IP addresses ranging from 192.168.222.1 to 192.168.222.16

- Install the GUI (optional)

```
# rpm -Uvh openMosixview-1.2-rh73.rpm
```

- Reboot the machine

  When the machine has rebooted, make sure you are running the openmosix kernel:

```
$ uname -a
Linux Node4 2.4.18-openmosix4 #1 ...
```

- Run mosmon from the command line and you should see a display of all nodes up in the cluster.

B.4 Testing Openmosix

How you test openmosix will depend upon what configuration of machines you have in your cluster. The two possibilities are:

- Machines are all of similar 'grunt'
- Machines have different 'grunt'

If your machines are all of similar CPU speed, the only way to see the performance gain is to test the difference between running two concurrent tasks on your 'home' node vs running them normally.

- Create a simple program that exercises the CPU. The simplest way to test openmosix is to run a simple C program called timewaster.c:

```
#include <stdio.h>
#include <time.h>
#include <sys/types.h>

int main(int argc, char **argv)
{
  int i, j;
```

```
    double val;
    time_t ts, elapse = 0, prev_elapse;

    ts = time((time_t *)NULL);
    for (i = 0; i < 101; i++) {
      for (j = 0; j < 9999999; j++)
        val = (double)(j+1) / (double)(i+1);
      if (!(i%10)) {
        prev_elapse = elapse;
        elapse = time((time_t *)NULL) - ts;
        printf("i=%d, val=%lg, %d s elapsed, %d s since last print\n"
               , i, val, elapse, elapse-prev_elapse);
      }
    }
    return 0;
  }
```

- Make the above program: (You don't need a makefile)

  `make timewaster.c`

- Open up two consoles and run an instance of timewaster on each console:

  `$ ./timewaster`

- Now try the same test by forcing each instance to run on your home node:

  `$ runhome ./timewaster`

B.5 Summary of Mosix Userland Utilities

The following tools are part of the openmosix-tools package:

```
mosctl       - OpenMosix system administrator's tools
mon [mosmon] - MOSIX load monitor
migrate      - request migration of a particular process on MOSIX
mps          - report multicomputer process status
mosrun       - run a command with particular node-allocation preferences
setpe        - OpenMosix node configuration
showmap      - Display current node configuration
```

Mosrun contains a subsuite of tools to perform various job allocation functions

```
mosrun [cpujob]    - Tell mosix this is a CPU intensive app
mosrun [iojob]     - Tell mosix this is an I/O intensive app
mosrun [nomig]     - Run job with node lock
mosrun [runhome]   - Run job on home CPU
mosrun [runon]     - Run job on particular node
mosrun [slowdecay] - Apply slow decay to stat algorithms
mosrun [fastdecay] - Apply fast decay to stat algorithms
mosrun [nodecay]   - Apply no decay to stat algorithms
```

B.6 Setting up the Mosix File System

OpenMosix contains its own network wide file system called mfs. With mfs you have access to the root filesystem of each node in your cluster.

To enable mfs, do the following

- Make a the directory `/mfs`

  ```
  #mkdir /mfs
  ```

- Edit `/etc/fstab` to include the following line:

  ```
  mfs_mnt /mfs mfs dfsa=1 0 0
  ```

- Mount the mfs filesystem

  ```
  #mount /mfs
  ```

  Now you can move around the root filesystem of any node in your cluster by changing directory to `/mfs/N` where N is the node number.

B.7 Lab

B.8 Questions