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About this document

Version 3 by Alan McKinnon
I needed an exam preparation guide for my students once they had completed their Linux training and wanted to prepare to write the LPI level 1 exams. I found version 2 of this guide by Michel Bisson on the LPI website (http://www.lpi.org) and it suited my needs.
The content of this guide is essentially still the same as Michel wrote it. I have merely reformatted it, changed the order of some sections and fixed some typos and grammar errors.
Any queries about this guide should be directed to me:
alan@afribiz.co.za
This guide is re-released under the same terms as the original – see below.

Version 2 by Michel Bisson
This document was produced to help candidates pass the LPI 101 exam. I have created it essentially as a reference document and not as a tutorial. That’s why in general, it doesn’t have many explanations for the subjects treated. I usually use it in my courses as exam preparation. To my knowledge it covers the most important aspects of the topics asked in the exam, but it’s layout and content organization is not perfect. Helped by this document and with enough practice, most of my students passed the exam. In some topics I have added more information than is needed for the LPI 101 exam. When in doubt, refer to the description of the requirements located at the beginning of each topic.
This is a free document. You may distribute, modify, or improve it for personal or commercial use as you wish. I take no responsibility of any kind for the accuracy of the information in this document, nor for the success or failure of any participants in passing the exam.
I would appreciate it that if you make modifications to this document, you send me a copy of the new version.
Please let me know of any errors or inaccuracies in the information in this document, that would help me improve it. Feedback of any kind is welcome. If anybody wants to contribute to this document, you’re very welcome, please contact me at
michel@linuxint.com
I hope it will help you to prepare for the LPI 101 exam and remember, that practice, practice, and more practice is the key.
Regarding the LPI 101 Exam

This is a required exam for LPI certification Level 1. It covers basic system administration skills that are common across all distributions of Linux.

Each objective is assigned a weighting value. The weights range roughly from 1 to 10, and indicate the relative importance of each objective. Objectives with higher weights will be covered in the exam with more questions.

Approximate number of questions per topic

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<td>Linux Installation &amp; Package management</td>
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<td>Devices, Linux Filesystems, Filesystem Hierarchy Standard</td>
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Weight per topic

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<td>1.101.1 Configure Fundamental BIOS Settings</td>
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<td>1.101.4 Setup SCSI Devices</td>
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<td>or</td>
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Tips on writing the exam

Most questions that require you to fill-in the blanks, don’t require any options. eg. cat or ls
or cp (without options)

Use your experience and common sense to deciding what is important and what is not
when studying. When in doubt, just read the description of the requirements located at the
beginning of each topic again.

I recommend you create a checklist of topics for yourself and to review it once in a while.
This can help avoid spending too much time in one subject at the expense of other
important subjects.

Note the weight of each topic and spend the equivalent amount of time on it.

When doing the exam, I recommend you first answer the questions that you are sure of
and then go back to the other ones afterwards.

Read the questions thoroughly and make sure you understand them well. Then read ALL
the answers carefully before answering. I almost got caught a few times, answering
something I was sure couldn’t be anything else, but when I read the other answers I saw
which one was really the correct answer.

The exam is difficult and needs concentration and a good memory. It is not recommended
to eat a heavy meal before the exam.

There is no need to rush through the exam and risk overlooking something. There is more
than enough time to answer all the questions. When you’re finished and there is still time
left, review your answers once.
Topic 101: Hardware & Architecture

Total weight for this topic 8

1.101.1 Configure Fundamental BIOS Settings ................................................................. 1
1.101.3 Configure Modem and Sound cards ................................................................. 1
1.101.4 Setup SCSI Devices ..................................................................................... 1
1.101.5 Setup different PC expansion cards ............................................................. 3
1.101.6 Configure Communication Devices ................................................................ 1
1.101.7 Configure USB devices ............................................................................. 1

Summary

General hardware
Processor, BIOS, RAM, Address Bus system, Data Bus system
Address and IRQ conflicts
   IRQ Table
       Used by system: 1,2,6,8,14,15
       Mostly free: 5,9,10,11,13
       May be freeable: 3,4,7,12

IRQ Sharing
   PCI Mostly OK, ISA – Not sharable
DMA
   8 DMA Channels.
   DMA 4 is always busy.
   Normal use: DMA 1,2 or 3.
   Watch for conflicts in DMA!!
Setting Hardware ADDR, IRQ, DMA
   Peripherals Integrated in Motherboard:
       via BIOS
   Old ISA expansion boards:
       Jumpers and DIP Switches on boards
   Newer ISA expansions boards:
       Jumpers(ADDR)and software (IRQ)
   ISA Plug-And-Play expansion boards:
       BIOS or OS PNP feature
   PCI expansion cards:
       Via BIOS and OS using PCI bus
   Memory Base of certain PCI cards for RAM or BIOS
Direct on the cards

**Setting and reading the hardware and system time**

```bash
date
  Show current system date and time

date -s "15:34"
  Set the System date and time

hwclock
  Show the hardware clock time setting

hwclock --localtime
  Hardware clock stores local time

hwclock --utc
  Hardware clock stores utc time

hwclock --set --date="9/22/2002 16:45:05"
  Set the hardware clock and time

hwclock -hctosys
  Sets the system time to current hardware clock

hwclock --systohc
  Sets the hardware clock to current system time

setclock 09/18/2003 21:13:00
  Sets the hardware and system clock in one command to Thu Sep 18 21:13:00 2003
```

**Time Variables in /etc/sysconfig**

- `HWCLOCK="--localtime"` for localtime mode
- `HWCLOCK="-u"` for utc time mode

When SuSE boots-up it sets the time from the script `/etc/init.d/boot`

**Files that have some relation to time are**

- `/usr/lib/zoneinfo/localtime` --> `/etc/localtime` (binary file)
- `/etc/adjtime` (temporary file used to adjust the time regularly)

**Hardware-related commands**

- `ksysctrl`
  
  Is good for displaying the found system devices a-la-Windows.
**Topic 101: Hardware & Architecture**

- **hwinfo**
  Shows a lot of info about automatically found hardware. (SuSE)
- **lsdev**
  Shows a list of recognized devices and their I/O Addr, IRQ and DMA
- **procinfo**
  Shows a list of recognized devices and their I/O Addr and IRQ
- **MAKEDEV**
  Command to create devices
- **losetup**
  Set up and control loop devices

**KERNEL MODULES (general)**

To list all the Kernel modules already loaded:

- `lsmod`
- `cat /proc/modules`

To get more info about a module:

- `modinfo <modulename>`

To load a kernel module:

- `modprobe`
- `insmod`

  *modprobe* is recommended because it also checks the dependencies of the module.

To remove a kernel module:

- `modprobe -r <modulename>`
  - without the `.o`
- `rmmod <modulename>`
  - without the `.o`

To list all loadable kernel modules that wouldn't load properly because of missing symbols (unfulfilled dependencies):

- `depmod`

  *see man depmod* for more info on module dependencies

Configuration files for hardware modules:

- `/etc/modules.conf`
  - Older configuration used by *modprobe* to change the way a module is loaded or unloaded. Although this file is an older format it provides a lot of functions.
- `/etc/modprobe.conf`
  - Newer configuration file for *modprobe* command which is used for the same purpose as `/etc/modules.conf` (older).
Topic 101: Hardware & Architecture

Note: I have not determined what the results will be if both the above configuration files are present on the system.

Listing options used for loaded modules from /etc/modprobe.conf:

modprobe -c

Getting information on hardware

USB

lsusb
  Lists all connected USB devices
/sbin/hotplug
  Script; handles hot-pluggable PCI & USB devices.
rchotplug [start|stop]
  Starts/Stops USB and PCI configurator.
usbmodules --device /proc/bus/usb/<NNN>/<nnn>
  Lists kernel modules corresponding to USB devices currently plugged into the computer. Example:
  usbmodules --device /proc/bus/usb/001/009

PCI

lspci
  List all PCI devices
cat /proc/pci
  List all PCI devices
setpci
  Configure PCI devices
pcitweak
  Read/write/list PCI config space
scandpci
  Scan/probe PCI buses
/sbin/hotplug
  SuSE cript to handle hot-pluggable PCI and USB devices
rchotplug [start|stop]
  Starts/Stops USB and PCI configurator

PCMCIA

cardinfo
  X-Program to list and control PCMCIA cards
Topic 101: Hardware & Architecture

cardctl
   ASCII program to control the PCMCIA cards
dump_cis
   ASCII program to list PCMCIA cards and their parameters
cardmgr
   Daemon that loads and unloads PCMCIA kernel modules for inserted cards.
/etc/init.d/pcmcia
   Script to load PCMCIA cardmgr as daemon

PNP

lspnp
   To list Plug and Play BIOS device nodes and resources.
/etc/isapnp.conf
   File used by isapnp. See also man setpnp for info on controlling PnP device resources.
isapnp /etc/isapnp.conf
   Set the PNP devices according to /etc/isapnp.conf

SCSI

sg_map
   Displays mapping between sg and other SCSI devices.
cat /proc/scsi/scsi
   Displays information about all possible SCSI devices: hdx, srx, sgx, scdx
scsiinfo -l
   List of active SCSI device in system.
   eg. /dev/sda /dev/scd0 etc.
sg_reset
   exercises SCSI device/bus/host reset capability
scsi_info
   SCSI device description tool
sg_test_rwbuf
   Tests the SCSI host adapter by issuing write and read operations on a device's buffer and calculating checksums.
lsscsi
   list all SCSI devices (or hosts) currently on system
mover
   utility to control SCSI media changers
sg_scan
does a SCSI bus scan and prints the results to STDOUT
sg_senddiag
    performs a SCSI SEND DIAGNOSTIC command
sg_logs
    reads SCSI LOG SENSE pages
scsidev
    populate /dev/scsi with device names that are persistent against SCSI configuration changes.
sg_start
    starts (spins-up) or stops (spins down) SCSI devices
sg_map
    displays mapping between sg and other SCSI devices
scsiinfo
    query information from a SCSI device
sg_readcap
    calls a READ CAPACITY command on a SCSI device
sg_rbuf
    reads data using SCSI READ BUFFER command
sg_inq
    outputs data retrieved from the SCSI INQUIRY command
sg_modes
    outputs mode sense information for a SCSI generic device
xmover
    X11 frontend for SCSI media changers
scsi_devfs_scan
    Scan SCSI devices within a devfs tree
sane-find-scanner
    find SCSI and USB scanners and their device files
scsiFormat
    low level format a SCSI disk device

SERIAL

  cat /proc/tty/drivers
      Display detected serial ports.
Topic 101: Hardware & Architecture

**CDROMS**

```bash
cat /proc/sys/dev/cdrom/info
```

The CD-ROM device names and their capabilities. Note: SCSI CDROMs can be scdx

**I/O ADDRESSES**

```bash
cat /proc/ioports
```

I/O Addresses used by which device.

**I/O MEMORY**

```bash
cat /proc/iomem
```

Memory Address usage.

**INTERRUPTS**

```bash
cat /proc/interrupts
```

Interrupt usage

**DMA**

```bash
cat /proc/dma
```

DMA channels in use.

**CPU**

```bash
cat /proc/cpuinfo
```

CPU hardware information

**DEVICES**

```bash
cat /proc/devices
```

Character & Block devices used and their IDs.

```bash
echo lsdev
```

Displays recognized devicesIRQ, DMA and IO.

**KERNEL OPTIONS**

```bash
cat /proc/cmdline
```

Kernel options given at boot time

**FILESYSTEMS**

```bash
cat /proc/filesystems
```

Filesystem types recognized by Linux. 'nodev' = it doesn't have any physical device.
System Memory

The /proc file system.
Displays the kernel's internal workings. Mostly ReadOnly.
Each process gets a directory in /proc (named after the PID). Content is:
  cmdline
    What started the process
  cwd
    Symlink to dir where user was when he started the command
  environ
    Environment of process.
  exe
    Symlink to the running program (full path)
  root
    root dir for the process. (may be changed using command chroot)
  fd
    file descriptors (eg. 0,1,2,255. used in prgm 1>&2 etc.)

Hardware Parameters
  interrupts
    IRQ used by peripherals
  iports
    IO Address used by peripherals
  dma
    DMA used by peripherals
  iomem
    Video RAM/ROM, System RAM/ROM, PCI system memory, VESA Frame buffer, reserved areas.

Other hardware information
  cpuinfo
    Processor type/model, speed, internal cache size, etc.
  partitions
    List of known local PC partitions with major and minor numbers.
  pci
    Scan of peripherals on PCI bus and AGP slot.

Kernel and software information
Topic 101: Hardware & Architecture

`cmdline`
Kernel start command and parameters.

`filesystems`
List of file systems known by the kernel.

`meminfo`
Info about usage of available memory.

`modules`
List of loaded modules.

`mounts`
List of mounted file systems. Here are also the mounted file systems that were mounted with the option `-n` and hidden from `/etc/mtab` and `df` command.

`version`
Present kernel version.

Other important directories in `/proc`:

`bus`
Info about system buses found in systems.

`ide`
Info about IDE controllers and devices.

`scsi`
Info about SCSI controllers and devices.

`net`
Network info like ARP Info, Routing table etc.

`sys`
WRITEABLE system control table.

**Plug and Play**

A PNP card has an internal list of Addresses, IRQs and DMAs that it can use if requested. Linux is NOT automatically PNP compatible. It must be done manually. Two programs are available for this:

- `pnpdump`
  Scans the ISA bus for PNP cards and displays the possible settings of each PNP card found.

- `isapnp`
  Reads a PNP configuration file and sets the PNP cards accordingly.

**Manual Process:**

1. Collect possible settings from PNP cards. Scans addresses 0x0273 to 0x03f3
   `pnpdump > /etc/isapnp.conf`
2. Edit the file and activate the desired settings of each PNP card.
3. Set the PNP cards as per /etc/isapnp.conf. Must be done at every boot.

```bash
isapnp /etc/isapnp.conf
```

Use this command under SuSE

```bash
isapnp tools /etc/isapnp.conf
```

Use this command under Debian

Use the following in step 2 while editing /etc/isapnp.conf:

**IO ADDRESS:**

- First IO base address possible: Minimum IO base address 0x0240
- Last IO base address possible: Maximum IO base address 0x03e0
- Address block size: Number of IO addresses required: 32
- Look at the already used IO addresses in system: cat /proc/ioports

Make a list of possible IO base addresses for this card.

- (First IO base address possible + Address block size) etc
  - eg. 240, 260, 280, 2A0, 2c0, ..., ..., 3e0

Choose a free address, write it in the following line and uncomment the line:

- (IO 0 (BASE 0x340))

**IRQ:**

Proceed the same way as above for IQRs and at the end uncomment the line:

- (INT 0 (IRQ xx (MODE +E))) (xx=chosen IRQ)

Finally activate the card by uncommenting the line:

- (ACT Y)
1.101.1 Configure Fundamental BIOS Settings

**Description:** 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.

**Weight:** 1

Key files, terms, and utilities:
- /proc/iports
- /proc/interrupts
- /proc/dma
- /proc/pci

**Purpose of BIOS**

The BIOS is a middleman program (in ROM) between hardware architecture (main board) and the operating system. Linux deals directly with some hardware (eg. IDE Controller) for speed and better control.

**CMOS Set-up program**

Triggered at boot-time by certain possible key combinations:

Examples:
- DEL (Entf),
- F2,
- <Ctrl-Alt-ESC> etc.

**Hard disk Set-up**

Although the hard disk controller is accessed directly by Linux, some HD settings in CMOS are still important.

- HD cylinders have physically less sectors at the inside of the disk than at the outside.
- LBA (Large Block Address) logically reduces the number of cylinders and increases the number of heads.
- LBA is important if number of physical cylinders is more than 1024 even if Linux doesn't use the BIOS to access the HD.

Reasons:

- fdisk reads the BIOS for HD Parameters
- lilo and GRUB are loaded from the BIOS.

**BIOS error handling**

Normally:
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Halt on all errors
booting does not continue if any type of error occurs

Linux server without keyboard:
Halt on all errors but keyboard.

**Peripherals settings**
Turn off any unused device. eg. COM ports, Mouse, IDE channels if SCSI used, etc

**Reserving IRQs for older ISA cards**
These settings will be applied to older cards, and will not used by the Plug and Play system.
1.101.3 Configure Modem and Sound cards

**Description:** 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

**Weight:** 1

**Key files, terms, and utilities:**
- not applicable

**Modems**

Check the hardware compatibility list from your distribution.

A good source of hardware info is the Hardware-HOWTO

Normal (Hayes compatible) modems are controlled with AT commands

Watch out for WinModems - they are not real hardware modems. They use Windows drivers to simulate the AT command set. This section does not apply to winmodems. More about this at www.linmodems.org

**Sound Cards**

LPI concentrates on OSS sound technique. (Open Sound System)

Each sound board type needs its own kernel module.

Program for sound card installation (RedHat and others):

```bash
sndconfig
```

It scans possible sound cards IO ports and is menu driven.

Standard I/O port for soundcard is: **********

It handles the PNP and older ISA sound cards as well.
**1.101.4 Setup SCSI Devices**

**Description:** 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.

**Weight:** 1

Key files, terms, and utilities:
- SCSI ID
- /proc/scsi/
- scsi_info

**Notes**

SCSI = Small Computer System Interface

Purpose: Learning to set-up the SCSI devices with respect to BIOS, SCSI-ID, booting

Use of SCSI: Still in server industry, offers reliability, endurance, Hot-Plug features.

Tools: SCSI-ID, /proc/scsi, scsi_info

**SCSI Architecture**

Number of devices with SCSI, including the SCSI controller itself:
- Standard: 8
- Wide: 16

**Properties and rules of SCSI**

- Cable joining the devices is 50 wires wide
- No 'T' branching in the cable
- Each end of the cable must be terminated by 330 Ohms to GND and 220 Ohms to +5V
- Minimum 10cm of cable between SCSI devices
- Maximum length of 50 strand cable: 3 Meters (>4 devices Max:1.5 Meters)
- End of the cable must have a terminated device attached to it.

**Types of SCSI**

- Standard(SCSI-1): 8 Devices 10 MHz Maximum
- SCSI-2, FAST-SCSI-2, Wide-SCSI-2(68 strand cable, 16 bit bus): Faster, command set is better
- SCSI-3 even faster but still in development (no meaning for LPI)
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**SCSI speed table**

<table>
<thead>
<tr>
<th>Bus width</th>
<th>Cable Width</th>
<th>Standard</th>
<th>Fast</th>
<th>Ultra</th>
<th># of Devices</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-Bit</td>
<td>50 Strands</td>
<td>5 MB/sec</td>
<td>10 MB/sec</td>
<td>20 MB/sec</td>
<td>7+Ctrlr</td>
</tr>
<tr>
<td>Wide-16-Bit</td>
<td>68 Strands</td>
<td>10 MB/sec</td>
<td>20 MB/sec</td>
<td>40 MB/sec</td>
<td>15+Ctrlr</td>
</tr>
</tbody>
</table>

Possible names alike Ultra-Wide- or Fast-Wide, etc are possible

**Addressing SCSI devices**

SCSI-ID = 0 to 7 or 0 to 15
The SCSI Controller with the highest priority = highest ID: 7 or 15
If booting from SCSI then boot HD must be ID 0
Each SCSI-ID can contain LUNs (Logical Unit Number)
Each CSCI cable (Bus) also receives a number (0,1,2 etc)
Each SCSI device can then be identified as follows:
  BusNumber, SCSI-ID, LUN
  Normally 0,x,0 eg. /dev/sda is on 0,0,0

**SCSI Onboard BIOS**

Separate and unknown from system BIOS
Used to boot SCSI drives and change controller parameters
Cheap Controllers don't usually have On-Board BIOS. More expensive ones do.
Newer Controllers even allows software to assign SCSI-IDs to devices.

Role of the Controller:
  Assignment of SCSI-IDs to devices
  Selecting the data transfer rate of devices
  Selection of boot drive

**Booting from SCSI drive**

Controller must have an onboard BIOS
In SCSI onboard BIOS: Set the boot drive
In System BIOS: Set boot drive sequence to 'SCSI'

**SCSI in Linux**

/proc/scsi directory contains all SCSI devices as a sub-directory
Each sub-directory contains files named by SCSI-BUS number (0,1,2)
Theses files contain the list of devices attached to this bus.
The file /proc/scsi/scsi contains the list of all found SCSI devices.
Naming of SCSI devices

Hard disks are named sda, sdb ... in the sequence they are found
Removable ZIP and USB Chip readers are also in the hard disk class
SCSI CD-ROMS have 2 names at the same time: srx & scdx (x=0,1,2,3,..)
Each device is also identified by SCSI-BUS,SCSI-ID,LUN
Program scsi_info shows info on individual device:

    scsi_info /dev/sd0
**1.101.5 Setup different PC expansion cards**

**Description:** 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.

**Weight:** 3

**Key files, terms, and utilities:**
- `/proc/dma`
- `/proc/interrupts`
- `/proc/ioports`
- `/proc/pci`
- `pnpdump(8)`
- `isapnp(8)`
- `lspci(8)`

**Tools**

```
/proc/dma
/proc/interrupts
/proc/ioports
/proc/pci
    Information files
    pnpdump
    isapnp
    lspci
    Programs
```

**PCI**

PCI devices are identified by a unique ID just like MAC address in network cards. Linux saves these PCI IDs in the following files:

```
/usr/share/pci.ids
SuSE
/usr/share/hwdata/pci.ids
    RedHat & Debian
/usr/share/mics/pci.ids
    Old Debian distributions
update-pciids
    this command updates the list from Internet into /usr/share/mics/pci.ids.new or equivalent as per distribution.
```

Linux supports PCI (Bus ID=00) devices fully without needing manual settings.
AGP is a separate PCI bus (Bus ID=01) reserved for Graphic Cards, having only one slot. Made for undisturbed data transfer between the graphic chips and the CPU.

PCI Bus system is addressed similarly to SCSI:

BusNr:SlotNr:FunctionNr(Device Nr.)

lspci is used to list the PCI devices in the system.
lspci finds the manufacturers info from the file /usr/share/pci.ids.
lspci -n display vendor codes as numbers instead of looking them up in pci.ids.

Kernels after 2.1.82 have more info about devices on PCI-Bus in /proc/pci.

Serial ports known as COM1, COM2 etc in DOS, are known in Linux as: ttyS0, ttyS1 etc.
Parallel Printer ports known as lpt1, lpt2 in DOS, are known in Linux: lp0, lp1 etc.
1.101.6 Configure Communication Devices

**Description:** 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, DMA’s, 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 correct modem settings for outbound PPP connection(s).

**Weight:** 1

**Key files, terms, and utilities:**
- `/proc/dma`
- `/proc/interrupts`
- `/proc/ioports`
- `setserial(8)`

**Tools**
- `/proc/dma`
- `/proc/ioports`
- `/proc/interrupts`
- `setserial(8)`

`setserial` is from the `setserial` package for SuSE, RedHat & Debian. `minicom` is one of the modem terminal programs for Linux.

`setserial /dev/ttySx`

`setserial /dev/cuax`

Shows the settings of the serial port, where \( x \) is the port number.

`setserial /dev/ttySx <parameters>`

Sets the serial port to the supplied parameters.

Parameters are:
- `port <PortNr>`: IO Port number
- `irq <IRQ>`: IRQ number
- `uart <UART_Type>`: UART(Universal Asynchronous Receiver Transmitter)

Possible values are: none, 8250, 16450, 16550, 16550, 16550A, 16650V2, 16654, 16750, 16850, 16950, 16954.

`none`=Turn device OFF

Most older applications know only up to 38400 Baud. To allow for faster speeds even though the application asks for 38400 Baud, extra parameters to `setserial` set flags in the hardware that translates requests from applications of 38.4Kb to higher speeds in the UART.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Speed requested by Application</th>
<th>Real UART speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>spd_normal</td>
<td>38.4Kb</td>
<td>38.4Kb</td>
</tr>
<tr>
<td>spd_hi</td>
<td>38.4Kb</td>
<td>57.6Kb</td>
</tr>
<tr>
<td>spd_vhi</td>
<td>38.4Kb</td>
<td>115Kb</td>
</tr>
</tbody>
</table>
### Modem AT Commands

Hayes compatible commands that controls most modems.

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT</td>
<td>Sets the baud rate between Modem and PC</td>
</tr>
<tr>
<td>ATD &lt;number&gt;</td>
<td>Dial the Number (Nr.)</td>
</tr>
<tr>
<td>ATH0</td>
<td>HangUp</td>
</tr>
<tr>
<td>ATH1</td>
<td>Answer the phone (Opposite of HangUp)</td>
</tr>
<tr>
<td>ATX0</td>
<td>Dial blind, CONNECT when connection OK</td>
</tr>
<tr>
<td>ATX1</td>
<td>Dial blind, CONNECT speed when connection OK</td>
</tr>
<tr>
<td>ATX2</td>
<td>Wait for DIALTONE and CONNECT speed when connection OK</td>
</tr>
<tr>
<td>ATX3</td>
<td>Dial blind, CONNECT speed when connection OK or BUZY</td>
</tr>
<tr>
<td>ATX4</td>
<td>Wait for DIALTONE and CONNECT speed when connection OK</td>
</tr>
<tr>
<td>ATX5</td>
<td>Dial blind, CONNECT speed when connection OK, BUSY, VOICE</td>
</tr>
<tr>
<td>ATX6</td>
<td>Wait for DIALTONE and CONNECT speed when connection OK, BUSY, VOICE</td>
</tr>
<tr>
<td>ATZ</td>
<td>Reset the modem.</td>
</tr>
<tr>
<td>AT&amp;F</td>
<td>Reset the internal modem configuration to factory settings.</td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Speed requested by Application</th>
<th>Real UART speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>spd_shi</td>
<td>38.4Kb</td>
<td>230Kb</td>
</tr>
<tr>
<td>spd_warp</td>
<td>38.4Kb</td>
<td>460Kb</td>
</tr>
</tbody>
</table>
1.101.7 Configure USB devices

**Description:** 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.

**Weight:** 1

Key files, terms, and utilities:
- `lspci(8)`
- `usb-uhci.o`
- `usb-ohci.o`
- `/etc/usbmgr/`
- `usbmodules`
- `/etc/hotplug`

**Summary**

Main USB module is `usbcore` (although often already integrated in kernel)

There are 2 types of USB controllers:

- **OHCI**
  - Open Host Controller Interface (Compaq)

- **UHCI**
  - Universal Host Controller Interface (Intel)

All USB devices are compatible with both OHCI and UHCI.

USB chipset usage per motherboard manufacturer:

<table>
<thead>
<tr>
<th>OHCI</th>
<th>UHCI</th>
<th>EHCI (USB 2.0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compaq</td>
<td>Intel</td>
<td>Intel</td>
</tr>
<tr>
<td>Ali</td>
<td>VIA</td>
<td>VIA</td>
</tr>
<tr>
<td>NEC</td>
<td></td>
<td>NEC</td>
</tr>
<tr>
<td>Opti Chipset</td>
<td></td>
<td>Philips</td>
</tr>
</tbody>
</table>

```
lspci
less /proc/pci
```

To recognize the USB controller type:

The possible USB modules are: `ohci.o`, `uhci.o` or `ehci-hcd.o`

To autoload USB at boot-time, add this entry to `/etc/modules.conf`:

```
alias usb uhci
```

To autoload (post-install) other submodules as well, add entries like these to `/etc/modules.conf`:

```
alias usb uhci
post-install uhci modprobe printer
```
**USBDevFS Filesystem**

This dynamic filesystem (like /proc) is normally mounted at /proc/bus/usb.

Its /etc/fstab entry is as follows:
```
none /proc/bus/usb usbddevfs defaults 0 0
```

After the mounting, the content (2 files) of /proc/bus/usb looks like this:
```
-r--r--r--  1 root root 0 2003-10-18 00:02 devices
-r--r--r--  1 root root 0 2003-10-18 00:02 drivers
```

After loading the driver (usb-ohci or usb-uhci) the content of this directory grows to include 1 numbered (001,002 etc) directory for each USB device. The files in these numbered directories are in binary format.

**Architecture of USB Modules**

hid.o (HID = Human Interface Device) and input.o (Input Core) are only for a USB keyboard (usbkbd.o), Mouse (usbmouse.o) or Joystick otherwise they are not needed.

Other USB modules:
```
printers  printer.o
storage   usb-storage.o
```

USB devices can be listed with the `lsusb` command.

When printer.o is loaded it creates devices /dev/usb/lp0 ..lp1.
**List of current USB modules**

```bash
find /lib/modules/ -name "usb*" -exec basename {} \;
```

- usb-ohci.o
- usbserial.o
- usb-uhci.o
- usb-storage.o
- usbcore.o
- usb-midi.o
- usbkbd.o
- usbldcd.o
- usbmouse.o
- usbnet.o
- usbvideo.o
- usbvnet5.o
- usbvnet5_2958.o
- usbvnetr.o

**Dynamically loading USB Modules**

Two dynamic systems are available to load the proper USB module when a USB device is inserted.

- **hotplug**
  - Oversees all hotpluggable devices: USB, PCMCIA, FireWire(ieee1394)
- **usbmgr**
  - Oversees only USB devices.

**hotplug**

At boot time the hotplug daemon is started via the script `/etc/init.d/hotplug`.

When a new device is inserted, the kernel senses it, then passes an agent name as parameter to the daemon listed in the file: `/proc/sys/kernel/hotplug` (normally `/sbin/hotplug`).

The kernel then fills in the Environment Variable `DEVICES` with the info about the device, and `ACTION` indicating if the device was plugged or unplugged.

The hotplug daemon starts the proper agent script.

The agent script reads the content of the `DEVICES` and `ACTION` variables as well as possibly other variables provided by the kernel. It uses also the program `usbmodules` to find-out about the device inserted.

The specific 'agents' scripts are:

<table>
<thead>
<tr>
<th>Device</th>
<th>Agent Script</th>
</tr>
</thead>
<tbody>
<tr>
<td>USB</td>
<td><code>/etc/hotplug/usb.agent</code></td>
</tr>
<tr>
<td>PCMCIA</td>
<td><code>/etc/hotplug/pci.agent</code></td>
</tr>
<tr>
<td>Firewire (IEEE1394)</td>
<td><code>/etc/hotplug/ieee1394.agent</code></td>
</tr>
<tr>
<td>Network system</td>
<td><code>/etc/hotplug/net.agent</code></td>
</tr>
</tbody>
</table>

Files involved:

<table>
<thead>
<tr>
<th>File</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>/lib/modules/*/modules.*map</code></td>
<td>depmod output</td>
</tr>
<tr>
<td><code>/proc/sys/kernel/hotplug</code></td>
<td>specifies hotplug program path</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>Path</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>/lib/modules/*/modules.*map</td>
<td>depmod output</td>
</tr>
<tr>
<td>/sbin/hotplug</td>
<td>hotplug program (default path name)</td>
</tr>
<tr>
<td>/etc/hotplug/*</td>
<td>hotplug files</td>
</tr>
<tr>
<td>/etc/hotplug/NAME.agent</td>
<td>hotplug subsystem-specific agents</td>
</tr>
<tr>
<td>/etc/hotplug/NAME*</td>
<td>subsystem-specific files, for agents</td>
</tr>
<tr>
<td>/etc/hotplug/NAME/DRIVER</td>
<td>driver setup scripts, invoked by agents</td>
</tr>
<tr>
<td>/etc/hotplug/usb/DRIVER.usermap</td>
<td>depmod data for user-mode drivers</td>
</tr>
<tr>
<td>/etc/init.d/hotplug</td>
<td>hotplug system service script. Also used at boot time to load and configure hot-plug devices that are already plugged in.</td>
</tr>
</tbody>
</table>

#### USB Manager (usbmgr)

A daemon that will load the proper module according to 2 parameters given by the kernel:

- **USB-Vendor-ID** and **USB-Device-ID**

It uses the following configuration files:

<table>
<thead>
<tr>
<th>Path</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>/etc/usbmgr/usbmgr.conf</td>
<td>List of Vendor-ID/Device-ID and module names</td>
</tr>
<tr>
<td>/etc/usbmgr/preload.conf</td>
<td>List of modules to load when usbmgr starts.</td>
</tr>
<tr>
<td>/etc/usbmgr/host</td>
<td>List of module names of the USB controller. Either <code>usb-ohci</code> or <code>usb-uhci</code>.</td>
</tr>
</tbody>
</table>

**usbmgr** needs the following conditions to be met:

- The kernel must be USB capable (`usbcore`)
- `USBDEVFS` must be supported
- The needed modules must be available.
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1.102.2 Install a boot manager..................................................................1
1.102.3 Make and install programs from source........................................5
1.102.4 Manage shared libraries..................................................................3
1.102.5 Use Debian package management.................................................8
or
1.102.6 Use Red Hat Package Manager (RPM)...........................................8

Summary
TODO
1.102.1 Design hard disk layout

Description: 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.

Weight: 5

Key files, terms, and utilities:
- / (root) filesystem
- /var filesystem
- /home filesystem
- swap space
- mount points
- partitions
- cylinder 1024

File Hierarchy Standard (FHS)

Lays out a standard for the filesystem structure that Linux systems are expected to adhere to.

Why multiple partitions in Linux?

Multiple hard disks can be used
Easier backups
Quotas are active per partition
Mount partitions Read-only for protection
Possible limit of Boot Manager (<1024 cylinders)

File tree structure

<table>
<thead>
<tr>
<th>Path</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>/bin, /dev/, /etc, /lib, /sbin</td>
<td>Mandatory. Note: A /root directory is recommended in case root must perform a rescue</td>
</tr>
<tr>
<td>/usr</td>
<td>Can be ReadOnly in it's own partition.</td>
</tr>
<tr>
<td>/home</td>
<td>Recommended as a separate partition. Reason: quotas, non-interference with the rest of the system, and fast system recovery</td>
</tr>
<tr>
<td>/tmp</td>
<td>Recommended as a separate partition. Reason: quotas, non-interference with the rest of the system.</td>
</tr>
<tr>
<td>/var</td>
<td>Highly recommended: When full, doesn't interfere with the rest of the system.</td>
</tr>
<tr>
<td>/var/lib</td>
<td>Modifiable settings</td>
</tr>
<tr>
<td>/var/lock</td>
<td>Lock files for programs and daemons</td>
</tr>
<tr>
<td>/var/log</td>
<td>Log files of system, daemons and programs</td>
</tr>
<tr>
<td>/var/run</td>
<td>PIDs of daemons and programs (if needed)</td>
</tr>
<tr>
<td>/var/spool</td>
<td>Queues for printing, mail etc.</td>
</tr>
</tbody>
</table>
Topic 102: Linux Installation & Package Management

<table>
<thead>
<tr>
<th>Directory</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>/bin, /dev/, /etc, /lib, /sbin</td>
<td>Mandatory. Note: A /root directory is recommended in case root must perform a rescue</td>
</tr>
<tr>
<td>/var/tmp</td>
<td>Space for temporary files.Writable by anybody.</td>
</tr>
</tbody>
</table>

**Swap Partitions**

Created and managed by: fdisk, mkswap, swapon, /etc/fstab

Creating a swap file (64MB):

```bash
dd if=/dev/zero of=/path/of/swapfile bs=1024 count=64000
mkswap /path/of/swapfile 64000
swapon [-p 42] /path/of/swapfile
```

Entry in /etc/fstab

```bash
/path/of/swapfile none swap
```

To see all the swap files

```bash
[cat /proc/swaps]
```
1.102.2 Install a boot manager

**Description:** 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).

**Weight:** 1

Key files, terms, and utilities:
- /etc/lilo.conf
- /boot/grub/grub.conf
- lilo
- grub-install
- MBR
- superblock
- first stage boot loader

**MBR (<512 bytes):** Partition table and Boot sector

<table>
<thead>
<tr>
<th>Stage 1</th>
<th>Program in MBR or Bootsector loads the bootmanager from the hard disk. (performs direct disk access)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 2</td>
<td>Presents menu and waits</td>
</tr>
<tr>
<td>Stage 3</td>
<td>Starts the selected operating system</td>
</tr>
</tbody>
</table>

**LILO**

<table>
<thead>
<tr>
<th>File</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>/etc/lilo.conf</td>
<td>Main and only config file.</td>
</tr>
<tr>
<td>/boot/boot.b</td>
<td>Boot Menu file</td>
</tr>
<tr>
<td>/boot/boot-menu.b</td>
<td>Other possible menu elements</td>
</tr>
<tr>
<td>/boot/message</td>
<td></td>
</tr>
<tr>
<td>/boot/boot-bmp.b</td>
<td></td>
</tr>
<tr>
<td>/boot/map</td>
<td>Physical Address and size of kernel files.</td>
</tr>
<tr>
<td>/sbin/lilo</td>
<td>Program that reads config file and writes the first stage bootloader to MBR. Uses BIOS functions and creates /boot/map</td>
</tr>
</tbody>
</table>

Note: After any change to /etc/lilo.conf or any location or size of any file in /boot directory lilo MUST be rerun.

```
lilo -u
```

Rewrites the previous boot manager in MBR (eg. windows MBR)

**LILO display codes**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nothing</td>
<td>The partition booted is not Boot-activated or no bootmanager.</td>
</tr>
<tr>
<td>L&lt;ErrorNr&gt;</td>
<td>Second part of LILO cannot be loaded and &lt;ErrorNr&gt; is the reason.</td>
</tr>
<tr>
<td>LI</td>
<td>Second part of lilo is loaded but is probably invalid. Reason: lilo was probably not run after changes in /boot or config file.</td>
</tr>
<tr>
<td>LIL</td>
<td>Second part of LILO is loaded but the content of /boot/map is wrong. Reason: Media error or wrong media geometry.</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>LIL?</th>
<th>Second part of LILO is loaded but it is garbage. Reason: file /boot/boot.b has moved or changed.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIL-</td>
<td>Second part of LILO is loaded but the /boot/map is garbage. Reason: file /boot/map has moved or changed.</td>
</tr>
<tr>
<td>LILO</td>
<td>All OK. LILO has loaded properly.</td>
</tr>
</tbody>
</table>

**Settings in /etc/lilo.conf**

<table>
<thead>
<tr>
<th>General settings</th>
<th>NO RAM check when rebooting.</th>
</tr>
</thead>
<tbody>
<tr>
<td>append=“reboot=warm”</td>
<td>Where the LILO part1 should be written. hda=MBR, hda1=Boot sector of hda1 etc.</td>
</tr>
<tr>
<td>boot=/dev/hda</td>
<td>HD has physically more than 1024 cylinders and LILO should be using LBA mode. Only valid if BIOS supports LBA32</td>
</tr>
<tr>
<td>lba32</td>
<td>Message loaded in MBR with part1 of lilo.conf</td>
</tr>
<tr>
<td>message=/boot/message</td>
<td>LILO will wait for user selection.</td>
</tr>
<tr>
<td>prompt</td>
<td>Boot default system when timeout occurs. 300 = 30 seconds</td>
</tr>
<tr>
<td>timeout=300</td>
<td>Location of the kernel to load.</td>
</tr>
<tr>
<td>image = /boot/bzlinuz</td>
<td>Location of ramdrive file: temporary file system.</td>
</tr>
<tr>
<td>root = /dev/hda2</td>
<td>Name of menu item.</td>
</tr>
<tr>
<td>initrd = /boot/initrd</td>
<td>Location of a non-Linux OS. Goes to that partition and loads the boot sector it finds there. Normally used with Windows.</td>
</tr>
<tr>
<td>label = linux</td>
<td>Location of the first HD found in system (hd0,0) is the first partition of the first hard drive; normally /dev/hda1.</td>
</tr>
<tr>
<td>other = /dev/hda3</td>
<td>NO static binary menu (/boot/boot.b). Instead it's /boot/grub/menu.lst /boot/grub/grub.conf can also be used as menu/config file.</td>
</tr>
</tbody>
</table>

**GRUB (GRand Unified Bootloader)**

Hard disks are numbered as (hd0) - the first HD found in system (hd0,0) is the first partition of the first hard drive; normally /dev/hda1.

**Entries in GRUB menu/config file**

<table>
<thead>
<tr>
<th>General settings</th>
<th>First menu item starts if no selection done before timeout.</th>
</tr>
</thead>
<tbody>
<tr>
<td>default=0</td>
<td>Timeout of 10 seconds will occur if no selection is made by user.</td>
</tr>
<tr>
<td>timeout=10</td>
<td>The menu image will be taken from /dev/hda1 in this path.</td>
</tr>
<tr>
<td>splashimage=(hd0,0)/boot/grub/splash.xpm.gz</td>
<td></td>
</tr>
</tbody>
</table>
**Individual OS sections**

<table>
<thead>
<tr>
<th>title</th>
<th>Menu item text</th>
</tr>
</thead>
<tbody>
<tr>
<td>root (hd0,0)</td>
<td>First partition of first found Hard Drive is used for the dir ‘/’</td>
</tr>
<tr>
<td>kernel /boot/bzlinuz ro root=/dev/hda1</td>
<td>The kernel is /boot/bzlinuz and some parameters like ro and root=/dev/hda1 is given to the kernel when started.</td>
</tr>
<tr>
<td>initrd</td>
<td>Ramdrive for booting (if used by kernel)</td>
</tr>
<tr>
<td>map (hd0,1) (hd0,0)</td>
<td>Used to swap the assignment of physical partitions. Useful to let Windows 98 boot from a partition which is not the first one (picky fellow!!) and make it think that it is.</td>
</tr>
<tr>
<td>map (hd0,0) (hd0,1)</td>
<td></td>
</tr>
<tr>
<td>rootnoverify (hd0,1)</td>
<td>Set GRUB’s root device without mounting.</td>
</tr>
<tr>
<td>chainloader +1</td>
<td>Jump to the Boot Sector of the root partition and hope a boot loader is there waiting</td>
</tr>
<tr>
<td>makeactive</td>
<td>Make the partition active.</td>
</tr>
</tbody>
</table>

To boot from a CD/Floppy/HD and use the root directory of another Linux as its own root dir (/) then use the kernel parameter:

```
root=/dev/hda4
```

**How does GRUB work?**

Stage1 file is written in the MBR.

It contains the physical address of the fssys_stage1_5. (fssys=filesystem)

GRUB Booting sequence:

1. MBR (stage1) is loaded
2. stage1 loads fssys_stage1_5 (filesystem converter)
3. fssys_stage1_5 loads stage2 file
4. stage2 loads the menu.lst

After boot menu item selection is done, stage2 loads the kernel (vmlinuz) and possibly the initrd
1.102.3 Make and install programs from source

**Description:** 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 customizations to the Makefile, for example changing paths or adding extra include directories.

**Weight:** 5

Key files, terms, and utilities:
- gunzip
- gzip
- bzip2
- tar
- configure
- Makefile
- make

**Tools and files used**
- gzip
- gunzip
- bzip2
- tar
- configure
- Makefile
- make

**Difference between scripts and compiled programs**
The CPU only understands binary instructions. Programs must be translated from the programming language to binary. A compiled program is done once and program file is binary. With a script, each line is translated to binary then executed as it runs.

**Verifying the validity of the package's content**
Get the MD5 checksum file from the location where you downloaded the file.
Put the tar file and the checksum file in the current directory
```
md5sum --check <checksumfilename>
```

**Standard file extensions for packages**

<table>
<thead>
<tr>
<th>Type of file</th>
<th>Extension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tarred files</td>
<td>*.tar</td>
</tr>
<tr>
<td>Compressed tarred files</td>
<td>*.tar.gz or *.tar.bz2 or *.tgz</td>
</tr>
<tr>
<td>Zipped files</td>
<td>*.gz</td>
</tr>
<tr>
<td>Bzipped files</td>
<td>*.bz2</td>
</tr>
</tbody>
</table>

**Unpacking packages**
Compressed tar files (a new directory will be created in destination directory):
```
cd <DestinationDirectory>
```
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```
tar fvxz <tarfile>.tar.gz   or   zcat <tarfile>.tar.gz | tar xvf -
tar fvxj <tarfile>.tar.bz2  or   bzcat <tarfile>.tar.bz2 | tar xvf -
```

Uncompressed tar files:
```
tar fxc tarfile.tar
```

Compressed files:
```
gunzip <file>.gz   ---->  File (original <file>.gz is overwritten)
bunzip2 <file>.bz2  ---->  File (original <file>.bz2 is overwritten)
bzip2 -d <file>.bz2  ---->  File (original <file>.bz2 is overwritten)
```

**Packing files**

Uncompressed tar files:
```
tar fvc newfile.tar /dir/to/pack
```

Compressed tar files:
```
tar fvcz newfile.tar.gz /dir/to/pack
  tar fvcj newfile.tar.bz2 /dir/to/pack
```

Compressed files
```
gzip filename   ---->  <filename>.gz   (original <filename> is overwritten)
bzip2 filename  ---->  <filename>.bz2  (original <filename> is overwritten)
```

**Compilation process**
```
cd <SourceBaseDirectory>
./configure
  This script studies system environment and creates Makefile
make   or   make all
  Reads Makefile and start the compiling of the source files.
make clean
  Deletes all the already compiled binary files so that the next make starts afresh.
make install
  Installs the compiled files and possibly others in the system. Normally only possible to run as root.
```

Note: make examines the timestamps of the various files to determine whether the binary file should be recompiled or not. It looks to see if the source has been changed since last compile.

Modifying Makefile manually

Changes to the Makefile would normally be done to adjust the installation paths.
These changeable parameters are normally at the beginning of the Makefile. They are in the normal bash variable assignment format: var=value
1.102.4 Manage shared libraries

Description: 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.

Weight: 3

Key files, terms, and utilities:
- ldd
- ldconfig
- /etc/ld.so.conf
- LD_LIBRARY_PATH

Libraries are SHARED between running programs within RAM. So only one copy of a shared library is needed to be loaded in RAM for all programs using it.

Sequence of events
bash tells the kernel to start a program
The kernel starts the Dynamic Library Linker ld.so
ld.so searches for all libraries needed for the program in the following order
- Looks in the ':' separated paths listed in the shell environment variable LD_LIBRARY_PATH
- Looks in the paths listed in the library cache /etc/ld.so.cache
- Looks in /lib and /usr/lib
ld.so loads itself
ld.so loads the program in memory and passes control on to the program

Tools and files used

<table>
<thead>
<tr>
<th>Tools/files used</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LD_LIBRARY_PATH</td>
<td>Bash environment variable containing list of paths of libraries to search.</td>
</tr>
<tr>
<td>ldd /path/to/program</td>
<td>Lists all the libraries a program needs.</td>
</tr>
<tr>
<td>/lib</td>
<td>Standard directories where are most libraries are installed</td>
</tr>
<tr>
<td>/usr/lib</td>
<td></td>
</tr>
<tr>
<td>/usr/local/lib</td>
<td></td>
</tr>
<tr>
<td>ldconfig</td>
<td>Program that keeps track of all libraries in system. When a library is installed in a directory other than one of the above standard library locations then we need to: Enter new library path in /etc/ld.so.conf Run ldconfig. This updates the library path cache: /etc/ld.so.cache</td>
</tr>
<tr>
<td>/etc/ld.so.conf</td>
<td>Configuration file of ldconfig</td>
</tr>
<tr>
<td>/etc/ld.so.cache</td>
<td>Library path cache</td>
</tr>
</tbody>
</table>
1.102.5 Use Debian package management

**Description:** Candidates should be able to perform package management skills using the Debian package manager. 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).

**Weight:** 8

Key files, terms, and utilities:
- unpack
- configure
- /etc/dpkg/dpkg.cfg
- /var/lib/dpkg/*
- /etc/apt/apt.conf
- /etc/apt/sources.list
- dpkg
- dselect
- dpkg-reconfigure
- apt-get
- alien

TODO
1.102.6 Use Red Hat Package Manager (RPM)

Description: 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.

Weight: 8

Key files, terms, and utilities:
- /etc/rpmrc
- /usr/lib/rpm/*
- rpm
- grep

Filename format of RPM packages

PackageName-VersionNumber.Architecture.rpm

Content of RPM packages

Information about the package
List of files to install
List of Dependencies

4 Scripts: Before Installation, Before De-Installation, After Installation, After De-Installation

Files to install

RPM database

<table>
<thead>
<tr>
<th>/var/lib/rpm/*</th>
<th>Directory of RPM Database of installed packages (in binary format)</th>
</tr>
</thead>
<tbody>
<tr>
<td>/usr/lib/rpm/*</td>
<td>Directory of RPM tools needed to manage RPM packages</td>
</tr>
<tr>
<td>rpm --rebuilddb</td>
<td>To rebuild the RPM Database</td>
</tr>
</tbody>
</table>

Syntax

rpm Action [Options] Packagename[.rpm]

Action

<table>
<thead>
<tr>
<th>Short Format</th>
<th>Long Format</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>-i</td>
<td>--install</td>
<td>Install the package. Works only when no older package is already installed.</td>
</tr>
<tr>
<td>-U</td>
<td>--upgrade</td>
<td>Upgrade the package. Works like Install but will also erase an older version of the package.</td>
</tr>
</tbody>
</table>
### Short Format | Long Format | Description
--- | --- | ---
-F | --freshen | Upgrade the package. Works only when an older version of the package is already installed.
-e | --erase | Uninstall the package.

### Installation Options

| Short Format | Long Format | Description |
--- | --- | ---
--nodeps | Installs and does not check dependencies. |
--noscripts | No Pre/Post-Install scripts will be run. |
--test | Do not install, just simulate installation. |
--excludedocs | Install but without the documentation. |
--replacepkgs | Install all even if some packages are already installed. |
--replacefiles | Overwrite already installed files if they exist. |
--oldpackage | Allow downgrading a package version. |
--force | Install all no matter what. It can be seen as the same as
--replacepkgs
--replacefiles
--oldpackage |

### De-Installation Options

| Short Format | Long Format | Description |
--- | --- | ---
--nodeps | De-installs and does not check dependencies. |
--noscripts | No Pre/Post-de-install scripts will be run. |
--test | Do not de-install, just simulate de-installation. |
--allmatches | De-install all packages names that matches pattern. In this case no errors would be produced if the pattern matched 2 or more packages. |

### Package queries

Use the -q --query option plus other query options listed below. If a query is made on installed packages the package name needs to be naked without the version or revision number or .rpm. If a query is made for an RPM file, then the actual file name including the .rpm must be given as the package name.

| Short Format | Long Format | Description |
--- | --- | ---
-q[options] | --query | Queries info on the package (without .rpm in the name) |
i | --info | Information header of package. |
l | --list | List of all files |
<table>
<thead>
<tr>
<th>Short Format</th>
<th>Long Format</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>c</td>
<td>--configfiles</td>
<td>List of Configuration files.</td>
</tr>
<tr>
<td>d</td>
<td>--docfiles</td>
<td>List of Documentation files.</td>
</tr>
<tr>
<td></td>
<td>--provides</td>
<td>Programs/Libs provided by the package.</td>
</tr>
<tr>
<td>R</td>
<td>--requires</td>
<td>List of files on which this package depends.</td>
</tr>
<tr>
<td></td>
<td>--changelog</td>
<td>Display log of package changes.</td>
</tr>
<tr>
<td></td>
<td>--scripts</td>
<td>Displays all 4 Install/Uninstall scripts.</td>
</tr>
<tr>
<td></td>
<td>--dump</td>
<td>List of all files and their attributes.</td>
</tr>
<tr>
<td></td>
<td>--filesbypkg</td>
<td>Same as --list + package name per line</td>
</tr>
<tr>
<td></td>
<td>--last</td>
<td>Date of last installations of the package.</td>
</tr>
<tr>
<td></td>
<td>--state</td>
<td>--LIST + Files Installation status:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>normal, not installed or replaced</td>
</tr>
<tr>
<td></td>
<td>--qf %{QUERYTAG} or</td>
<td>Extracts specific items from info header.</td>
</tr>
<tr>
<td></td>
<td>--queryformat % {QUERYTAG}</td>
<td>eg. rpm -q --qf %{DESCRIPTION} apache</td>
</tr>
<tr>
<td></td>
<td></td>
<td>eg. rpm -qa --qf &quot;%{NAME}\n&quot;</td>
</tr>
<tr>
<td></td>
<td>--querytags</td>
<td>Lists the QUERYTAGs usable in --queryformat.</td>
</tr>
</tbody>
</table>

**Query Package selection (combined with -q option)**

<table>
<thead>
<tr>
<th>Short Format</th>
<th>Long Format</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>--all</td>
<td>Query all installed packages</td>
</tr>
<tr>
<td>f</td>
<td>--file filename</td>
<td>Query installed package owning file (incl. path)</td>
</tr>
<tr>
<td>p</td>
<td>--package</td>
<td>Query Specific uninstalled packages (.rpm)</td>
</tr>
<tr>
<td></td>
<td>--whatrequires</td>
<td>Query all installed packages that depend on this one.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>rpm -q --whatrequires --qf &quot;%{NAME}\n&quot; apache</td>
</tr>
<tr>
<td></td>
<td>--whatprovides</td>
<td>program or libname(incl. path)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Query all installed packages that provides this program or library.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>rpm -q --whatprovides --qf &quot;%{NAME}% {VERSION}% {RELEASE}\n&quot; /bin/sed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Same output as rpm -qf /bin/sed</td>
</tr>
<tr>
<td>g group</td>
<td>--group group</td>
<td>All installed packages belonging to group</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Note: rpm -qa --qf &quot;%{GROUP}\n&quot;</td>
</tr>
</tbody>
</table>
Examples

```
rpm -qil PackageName
    Information and install file list of package.

rpm -qa | sort | less
    Display all installed packages(all .rpm files)

rpm -qai | grep -2 "^Release" | less
    Same as above but more complete info.

rpm -hiv PackageName.rpm
    Install with progress bar (hash #)

rpm -hiv --replacefiles PackageName.rpm
    Install on top of existing package with progress bar (hash #)

rpm -hUv PackageName.rpm
    Upgrade with progress bar (hash #)

rpm -hUv --force PackageName.rpm
    Upgrades and overwrite existing package even if conflict or lack of dependencies exists.

rpm -qf  filename(incl PATH)
    Tells which packet this file belongs to

rpm -qdf filename(incl PATH)
    Tells which help documents came with this file
```

Querying rpm packages that are not installed

```
rpm -qpi PackageName.rpm
    header information of this package.

rpm -qpl PackageName.rpm
    List of files where this package installs
```

Advanced Examples

```
rpm -qa --qf "%{NAME} : %{SUMMARY}\n" | sort | less
    To display a list of all already installed packages and their summary description:

rpm -qai | awk -F: ' /Name|\Version/ {print $1,$2} /\Version/ \{print "\"} | cut -b-30 | grep -l $1
    To search for an already installed PackageName by pattern:

rpm -qp --filesbypkg *.rpm | grep filename
    To search through non installed RPM files for a filename:
```
Verifying integrity of packages

```
rpm -V PackageName
```
Verify integrity of the installed packages

```
rpm -Va
```
Verify integrity of all installed packages

The result of both of these above commands will be shown as follows:

One line per file is displayed.

Each line contains a status field (8 chars), a file type (1 char) and a filename.

```
S 5....T  c /etc/samba/smbpasswd
```

Meaning of Status field:

<table>
<thead>
<tr>
<th>.</th>
<th>OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>Size of file has changed</td>
</tr>
<tr>
<td>U</td>
<td>File Owner has changed</td>
</tr>
<tr>
<td>M</td>
<td>Access rights has changed</td>
</tr>
<tr>
<td>G</td>
<td>Group of file has changed</td>
</tr>
<tr>
<td>S</td>
<td>MD5 Checksum doesn't match</td>
</tr>
<tr>
<td>T</td>
<td>Timestamp has changed</td>
</tr>
<tr>
<td>L</td>
<td>ReadLink system call failed</td>
</tr>
<tr>
<td>D</td>
<td>Major/Minor numbers of device has changed</td>
</tr>
</tbody>
</table>

Meaning of filetype

| <space> | Normal File |
| c       | Configuration file |
| ?       | Couldn't check (maybe because read access failed) |

PGP and GPG Signature test

Syntax:

```
rpm --checksig Packagefilename.rpm
```

result should be:

```
Packagefilename.rpm md5 gpg OK
```

Extract from RPM Man page

QUERYING AND VERIFYING PACKAGES

```
rpm {-q|--query} [select-options] [query-options]
rpm {-K|--checksig} [-noGPG] [-noGPG] [-noMD5] PACKAGE_FILE ...```

40
rpm {-V|--verify} [select-options] [--nodeps] [--nofiles] \ 
    [--nomd5] [--noscripts]

INSTALLING, UPGRADEING, AND REMOVING PACKAGES

rpm {-i|--install} [install-options] PACKAGE_FILE ...
rpm {-U|--upgrade} [install-options] PACKAGE_FILE ...
rpm {-F|--freshen} [install-options] PACKAGE_FILE ...
rpm {-e|--erase} [--allmatches] [--nodeps] [--noscripts] \ 
    [--notriggers] [--repackage] [--test] PACKAGE_NAME ...

MISCELLANEOUS

rpm {--initdb|--rebuilddb}
rpm {--querytags|--showrc}
rpm {--addsign|--resign} PACKAGE_FILE ...
rpm {--setperms|--setugids} PACKAGE_NAME ...

SELECT-OPTIONS

[PACKAGE_NAME] [-a,--all] [-f,--file FILE] [-g,--group GROUP] 
    [-p,--package PACK-AGE_FILE] [--querybynumber NUMBER] 
    [--triggeredby PACKAGE_NAME] [--whatprovides CAPABILITY] 
    [--whatrequires CAPABILITY]

QUERY-OPTIONS

[--changelog] [-c,--configfiles] [-d,--docfiles] [--dump] 
    [--filesbypkg] [-i,--info] [--last] [-l,--list] 
    [--provides] [-qf,--queryformat QUERYFMT] [-R,--requires] 
    [--scripts] [-s,--state] [--triggers,--triggerscripts]

INSTALL-OPTIONS

[--allfiles] [--badreloc] [--excluderoot OLDPATH] [--excludedocs] 
    [--force] [-h,--hash] [--ignoresize] [--ignorearch] 
    [--ignoreos] [--includedocs] [--justdb] [--nodeps] 
    [--noorder] [--noscripts] [--notriggers] [--oldpackage] 
    [--percent] [-p,--prefix NEWPATH] [--relocate OLDPATH=NEWPATH] 
    [--repackage] [--replacefiles][--replacepkg] [--test]

Note: Options for Building packages are left out here. See man page for further info.

Other source of info are:

http://www.rpm.org

The programs kpackage, KpackViewer and rpm
Topic 103: GNU & Unix Commands

Total weight for this topic

1.103.1 Work on the command line.................................................................5
1.103.2 Process text streams using filters.......................................................6
1.103.3 Perform basic file management..........................................................3
1.103.4 Use streams, pipes, and redirects.......................................................5
1.103.5 Create, monitor, and kill processes......................................................5
1.103.6 Modify process execution priorities....................................................3
1.103.7 Search text files using regular expressions.........................................3
1.103.8 Perform basic file editing operations using vi.................................1

Summary

TODO
1.103.1 Work on the command line

Description: Candidates 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.

Weight: 5

Key files, terms, and utilities:
- .
- bash
- echo
- env
- exec
- export
- man
- pwd
- set
- unset
- ~/.bash_history
- ~/.profile

Command format (command, options and parameters)
- short (-) and long (--)- form options.
- short form options combinations

Entering commands
- Which are in the PATH
- Which are not in the PATH
- '.' as part of PATH and ./command
- Where am I?: pwd

Prompt ($PS1) and Incomplete command syntax ($PS2)

Entering command sequences
- With ';' ' &'

Shell (local) and Environment (exported) variables

Exported variables (Environment variables)

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>env</td>
<td>Lists all environment variables</td>
</tr>
<tr>
<td>printenv</td>
<td>Same as env</td>
</tr>
<tr>
<td>export</td>
<td>Lists all exported (environment) variables</td>
</tr>
<tr>
<td>declare -x variable[=value]</td>
<td>Sets the environment variable</td>
</tr>
<tr>
<td>export variable[=value]</td>
<td>Sets the environment variable</td>
</tr>
</tbody>
</table>
Setting and unsetting variables

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>set</code></td>
<td>Lists all local and environment variables incl. functions</td>
</tr>
<tr>
<td><code>set variable=value</code></td>
<td>Sets the environment variable</td>
</tr>
<tr>
<td><code>unset variable</code></td>
<td>Unsets (removes) an environment variable</td>
</tr>
</tbody>
</table>

Read-Only Variables (variable cannot be changed or unset)

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>readonly</code></td>
<td>Lists all read-only variables</td>
</tr>
<tr>
<td><code>readonly variable</code></td>
<td>Sets the variable to read-only</td>
</tr>
</tbody>
</table>

$TERM (present terminal type)

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>screen</code></td>
<td>Console in 'screen' mode</td>
</tr>
<tr>
<td><code>dumb</code></td>
<td>From cron</td>
</tr>
<tr>
<td><code>linux</code></td>
<td>From tty1-tty6</td>
</tr>
<tr>
<td><code>xterm</code></td>
<td>Xserver terminal</td>
</tr>
</tbody>
</table>

Terminal info Database

- `/etc/termcap`
  - Old file, still used by SuSE
- `/etc/terminfo/*`
  - New file names used by Debian

Command substitution

- `command`
  - Old syntax
- `$command`
  - New syntax

E.g.

- `echo "My present directory is `pwd`"`
- `ls -la /lib/modules/$(uname -r)/`*

Command history and editing

Command history navigation

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>set +o history</code></td>
<td>Turns history recording OFF</td>
</tr>
<tr>
<td><code>set -o history</code></td>
<td>Turns history recording ON</td>
</tr>
<tr>
<td><code>HISTFILE</code></td>
<td>Variable containing the history file name. Normally <code>~/.bash_history</code></td>
</tr>
<tr>
<td>Variable</td>
<td>Description</td>
</tr>
<tr>
<td>---------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>$HISTFILESIZE</td>
<td>Variable containing the maximum number of commands the history file can contain. Default=500</td>
</tr>
<tr>
<td>$HISTSIZE</td>
<td>Variable containing the maximum number of commands in history. Default=500</td>
</tr>
</tbody>
</table>

- **history** Displays the whole history
- **history 10** Displays the last 10 lines of history
- **fc -l -10** Displays the last 10 lines of history
- **fc -l Pattern** Search the history for Pattern and display the result
- **<Ctrl>-r** Reverse search in history
- **history -c** Clears the whole history
- **!!** Most recent command
- **!n** Command n in the history
- **!-n** Backwards command n in history
- **!? string** Last recent command containing with string
- **^string1^string2** Quick substitution string1 to string2
- **<Ctrl>-l** Clear screen
- **<Ctrl>-b** Back one character (also left arrow)
- **<Ctrl>-f** Forward one character (also right arrow)
- **<Ctrl>-a** Go to beginning of line (also Pos1 key)
- **<Ctrl>-e** Go to end of line (also End key)
- **<Ctrl>-k** Delete text from cursor to end of line
- **<Ctrl>-d** Delete a character on the right (or under cursor)
- **<Alt>-d** Delete from cursor to end of current word
- **<Ctrl>-y** Paste text previously cut (deleted)

### Command Line Editing commands

E-macs editing commands: readline library

<table>
<thead>
<tr>
<th>Command</th>
<th>Short format</th>
<th>Long format</th>
</tr>
</thead>
<tbody>
<tr>
<td>ls</td>
<td>-R</td>
<td>--recursive</td>
</tr>
<tr>
<td>chown</td>
<td>-R</td>
<td>--recursive</td>
</tr>
<tr>
<td>chmod</td>
<td>-R</td>
<td>--recursive</td>
</tr>
</tbody>
</table>
## Topic 103: GNU & Unix Commands

<table>
<thead>
<tr>
<th>Command</th>
<th>Options</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>chgrp</td>
<td>-R</td>
<td>--recursive</td>
</tr>
<tr>
<td>grep</td>
<td>-r</td>
<td>--recursive</td>
</tr>
<tr>
<td>cp</td>
<td>-r and -R</td>
<td>--recursive</td>
</tr>
<tr>
<td>rm</td>
<td>-r and -R</td>
<td>--recursive</td>
</tr>
</tbody>
</table>

### man and info

**man [n] command**

Call up the man page for a command. **n** represents the man page type (1-9)

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Executable programs or shell commands</td>
</tr>
<tr>
<td>2</td>
<td>System calls (functions provided by the kernel)</td>
</tr>
<tr>
<td>3</td>
<td>Library calls (functions within program libraries)</td>
</tr>
<tr>
<td>4</td>
<td>Special files (usually found in /dev)</td>
</tr>
<tr>
<td>5</td>
<td>File formats and conventions eg. /etc/passwd</td>
</tr>
<tr>
<td>6</td>
<td>Games</td>
</tr>
<tr>
<td>7</td>
<td>Miscellaneous (including macro packages and conventions), e.g. man(7), groff(7)</td>
</tr>
<tr>
<td>8</td>
<td>System administration commands (usually only for root)</td>
</tr>
<tr>
<td>9</td>
<td>Kernel routines [Non standard]</td>
</tr>
</tbody>
</table>
1.103.2 Process text streams using filters

Description: Candidates 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.

Weight: 6

Key files, terms, and utilities:
- cat
- cut
- expand
- fmt
- head
- join
- nl
- od
- paste
- pr
- sed
- sort
- split
- tac
- tail
- tr
- unexpand
- uniq
- wc

Commands list

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>cut</td>
<td>Extracts columns/fields from files</td>
</tr>
<tr>
<td>expand</td>
<td>Expands TABs to SPACES in text files</td>
</tr>
<tr>
<td>fmt</td>
<td>Format of text files</td>
</tr>
<tr>
<td>head</td>
<td>Display first x lines of text file</td>
</tr>
<tr>
<td>join</td>
<td>Joins lines of a data file on common fields</td>
</tr>
<tr>
<td>nl</td>
<td>Number the lines of a text file</td>
</tr>
<tr>
<td>od</td>
<td>Display file content in Octal, Hex or Decimal.</td>
</tr>
<tr>
<td>paste</td>
<td>Pastes corresponding lines of 2 text files</td>
</tr>
<tr>
<td>pr</td>
<td>Convert text files ready for printing</td>
</tr>
<tr>
<td>split</td>
<td>Splits large files into multiple smaller files</td>
</tr>
<tr>
<td>cat</td>
<td>Concatenate files / Display files content</td>
</tr>
<tr>
<td>tac</td>
<td>Displays content of text file bottom to top</td>
</tr>
<tr>
<td>tail</td>
<td>Display last x lines of text file</td>
</tr>
<tr>
<td>tr</td>
<td>Translate or delete characters of file</td>
</tr>
<tr>
<td>wc</td>
<td>Counts number of chars, words, lines of files</td>
</tr>
<tr>
<td>xargs</td>
<td>Extends the argument list of a command</td>
</tr>
<tr>
<td>Command</td>
<td>Description</td>
</tr>
<tr>
<td>-----------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>sed</td>
<td>Stream file editor</td>
</tr>
<tr>
<td>sort</td>
<td>Sorting content of files</td>
</tr>
<tr>
<td>grep</td>
<td>Filtering/extracting text from files</td>
</tr>
<tr>
<td>more</td>
<td>Display content of files - Page Forward</td>
</tr>
<tr>
<td>less</td>
<td>Display content of files - Lines Forward/Backward</td>
</tr>
</tbody>
</table>

**Command Examples**

**cut -dx -fy**

```plaintext
cut -d: -f1,6 /etc/passwd (Extract field 1 and 6)
```

Extracts columns from file: field(y) separator(x)

**expand**

```plaintext
expand /etc/init.d/at > ~/atnew
```

Expands (converts) TABs to SPACEs in text files.

**unexpand**

```plaintext
unexpand -a /etc/services > ~/serv ; vi ~/serv
```

Opposite of expand: Converts SPACEs to TABs in text files.

**fmt**

```plaintext
fmt -w50 /usr/share/doc/packages/apache/ABOUT_APACHE
```

Format text files before printing (for continuous text only). Each line must have at least one space within it.

**head [-|+]n|x**

Display first x lines of text file (default 10)

```plaintext
head -40 /etc/services
```

Displays the first 40 lines of the file.

**join**

```plaintext
join -t: -11 -21 /etc/passwd /etc/shadow
```

Joins lines of a data file on common fields

**nl**

Number the lines of a text file.

```plaintext
nl -ba filename
```

Numbers empty lines as well
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Default options:

v1 -i1 -l1 -sTAB -w6 -nrrn -hn -bt -fn

Examples

nl -s" - " /etc/services
   Number the lines, adding " - " after line number
nl -bp"^#" file1
   Numbers only the lines starting with '#'

**od -bih -t x**

Display file content in Octal (-b), Decimal(-i), Hexadecimal(-h). Example:

`od -h /bin/ping`

x = Format type

- a
  same as -t a, select named characters
- b
  same as -t oC, select octal bytes
- c
  same as -t c, select ASCII characters or \ escapes
- d
  same as -t u2, select unsigned decimal shorts
- f
  same as -t fF, select floats
- h
  same as -t x2, select hexadecimal shorts
- i
  same as -t d2, select decimal shorts
- l
  same as -t d4, select decimal longs
- o
  same as -t o2, select octal shorts
- x
  same as -t x2, select hexadecimal shorts

Note: -x is not the same as -tx

**paste**

Paste corresponding lines of 2 text files

Example 1:
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paste /etc/passwd /etc/shadow

Example 2:

cut -d: -f1 /etc/passwd > file1
cut -d: -f3 /etc/passwd > file2
paste -d: file1 file2 > file3

pr

Convert text files for printing. Example:

pr /etc/services | less

split -lx -by[b|k|m]

Splits files into multiple files containing (x) lines, (y) bytes, kilobytes or megabytes.

Syntax:

split [options] filename prefix

Example 1:

split -l100 /etc/services serv

creates servaa servbb etc. To get the original back

cat serv?? > servicesnew

Example 2:

split -b1440k /bin/rpm rpms

(for backups to diskettes). creates rpmsaa rpmsab etc. To get the original back

cat rpms?? > rpmnew

cat

Displays content of text file top to bottom and exits.

Example 1:

cat -n /etc/hosts

Show all lines of file with line numbers(-n)

Example 2:

cat -b /etc/hosts

Numbers only the non-empty lines

tac

Displays content of text file bottom to top and exits (reverse of cat)

tac /etc/passwd

List starts with the last users created in system
**tail [-|+][n]x**
Display last x lines of text file (default 10)
Example 1:
```
tail -30 /etc/services
```
Display last 30 lines
Example 2:
```
tail +100 /etc/services
```
Bypass first 100 lines and display the rest till end of file
Example 3:
```
tail -fs5 --retry /var/log/httpd/error_log
```
Read the last 10 lines of the file every 5 sec. and keep retrying even if the file is not available

**tr -d**
Translate or delete characters of file
```
tr "a-z" "A-Z" < /etc/motd
translates a-z to A-Z
tr -d "#" < /etc/services | less
deletes all #
```

**wc -l|c|w**
Counts number of lines, words or chars of text file. Without options it counts all lines, words and chars.
```
wc /etc/motd
```

**xargs**
Reads text from pipe and provides it as parameter(s) to specified command - up to max 64kB per command launch.
```
find /etc -name *.conf | xargs cat > /root/confs
```
Finds all .conf files in /etc and accumulates their contents all in one file called /root/confs.

**sed**
Stream file editor
```
sed 's/#/;-/g' /etc/services
sed '12,$s/Versions/Revisions/g'
```
Start global(g) substitution at line 12 till end of file ($)
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**sort -ky[n] -tx**
Sort text file by field(y) with field separator(x) default sep.:<space>

\[ \text{ls -la | sort -k5n} \]
\[ \text{sorted by file size: field 5} \]
\[ \text{ls -la | sort -n +0.32} \]
\[ \text{Same result as above: excludes characters 0 to 32 in sorting} \]

**grep [-virns]**
Extract all lines of text where pattern is [not] found

\[ \text{grep -ins "^f.p.*SSL$" /etc/services} \]
\[ \text{Display all lines of file where pattern (ignoring case (-i)) is found with its line numbers (-n) and no error messages (-s)} \]
\[ \text{ps -ax | grep httpd | grep -v grep} \]
\[ \text{Display all instances of processes where httpd is found excluding (-v) the grep httpd command itself} \]

**more**
Forwards only display of text file content

\[ \text{more -30 /etc/services} \]
\[ \text{Scrolls display next 30 lines when pressing space bar, press enter to scroll to the next line} \]

**less**
Scrollable display of text file/pipe content. Press v to edit the file

\[ \text{less -X +G /etc/services} \]
\[ \text{Go to the end of the file (+G) and leave the display as is (-X) when leaving less.} \]
\[ \text{less -phttps /etc/services} \]
\[ \text{Load file and go to first occurrence of search pattern https} \]

**uniq**
Filters consecutive line repetitions of a file.

\[ \text{rpm -qa --qf "%{LICENSE}\n" | sort | uniq | less} \]
or
\[ \text{rpm -qa --qf "%{LICENSE}\n" | sort -u | less} \]
\[ \text{Display all the licences types used by installed packages.} \]

**awk -Fx**
Programmable text formatter fields delimited (x)
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    awk -F: '{ print $1,\\"\t\", $3 }' /etc/passwd
**1.103.3 Perform basic file management**

**Description:** Candidates 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.

**Weight:** 3

Key files, terms, and utilities:
- `cp`
- `find`
- `mkdir`
- `mv`
- `ls`
- `rm`
- `rmdir`
- `touch`
- file globbing

### cd
- `cd /<newdir>`
  - Change directory using absolute path
- `cd <newdir>`
  - Change directory using relative path
- `cd ~foo`
  - Changes to the home directory of user foo

### ls
- `ls [dir|file]`
  - List content of directory or file information.
- `ls -lai /etc`
  - Long format lists of files inc. inode numbers

### cp
- `cp source destination`
  - Copy files or directories
- `cp source1 source2 ... .`
  - Copy all files in the current directory
- `cp /dev/null newemptyfile`
  - Create a new empty file
mv

mv source destination
Move or rename file or directories
mv -f file1 file2
-f is the default. Allows overwriting of file2 if it already exists
mv -i file1 file2
Request confirmation before overwriting

mkdir
Create directories. Options:
- p|--parents
    Creates full paths, existing or not
-m 755
    To set the access rights mode

rmdir
Deletes Directories. Options:
- p|--parents
    Deletes parent directories specified on command line. Parent directories must be empty (contain no files).

touch
Change file modification time of a file.
Can also be used to create an empty file:
touch file1

File naming wildcards (globbing)
* ? [...] [...-...] [!]...

Finding files with find
See man find
1.103.4 Use streams, pipes, and redirects

**Description:** Candidates 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.

**Weight:** 5

Key files, terms, and utilities:
- tee
- xargs
- `< & <<
- `>` & `>>`
- `!`

**Standard I/O**

STDIN
File handle 0. Programs get input from this file, unless otherwise specified

STDOUT 1
File handle 1. Programs send output to this file, unless otherwise specified

STDERR
File handle 2. Programs send error output to this file, unless otherwise specified.

**pipes ('|')**

Send the output of the first command to the input of the second command.

Note: '|' redirects only the STDOUT and NOT the STDERR

```
prg1 2>&1 | prg2
```

Redirects STDOUT and STDERR

**| xargs**

Uses the output of one program as list of arguments for another program.

```
[prgm1] | xargs prgm2
```

same as

```
[prgm2] $(prgm1)
```

The difference is that xargs will deliver the arguments in chunks of 64kBytes to prgm2 and run prgm2 multiple times until all arguments (output of prgm1) are used up.

Example:
```
find /etc -name "issue*" 2>/dev/null | xargs grep -c "Mandrake"
```

Prints a tally of the number of file matching /etc/issue* that contain the word "Mandrake".
find outputs a list of files that match "/etc/issue*", and xargs sends each of those filenames in turn as a parameter to grep. grep will run as many times as there are matching filenames.

**Redirection**

```
>  >>  <<  <  1>  2>  &>  2>&1
```

>  
First overwrites existing file / creates new file, then processes the command, then writes the STDOUT of command into the file.

```
  sed 's/#;/g' file1 > file1
  Overwrites file1 with an empty one !!!
  >newfile
  Same as touch newfile
```

>>  
Similar to ‘>’, but appends output to the file if it already exists

<  
Redirects STDIN from a file instead of the keyboard.

```
  prgm < file1
  Reads its input from file1.
```

<<  
'here-document'

```
  prgm << EOF Text goes here ....
  EOF
  prgm gets its input from text between first EOF and last EOF
```

**Combining outputs**

```
  prgm 2>&1 1>file
  prgm &>file
  Both commands combine STDOUT and STDERR to be sent to file
```

**tee**

```
  program | tee filename
  Redirects to STDOUT and filename
  prg1 | tee file1 | prg2|tee file2 | prg3 >file3
  gives the same result as the following detached commands:
```
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prg1 > file1
prg2 < file1 > file2
prg3 < file2 > file3
1.103.5 Create, monitor, and kill processes

**Description:** Candidates 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.

**Weight: 5**

Key files, terms, and utilities:
- &
- bg
- fg
- jobs
- kill
- nohup
- ps
- top

**PID:** Process ID, a unique 16-bit integer identifier given to a process by the kernel when it starts.

**PPID:** Parent Process ID – the PID of a process’s parent.

**Process Viewing Commands**

```plaintext
ps
   Show process table
```

Examples:

```plaintext
ps waux
   All processes with user in a wide format
ps caux
   All processes with user with true command name. Practical for killall command.
ps -fe
   All processes (-e) with full listing (-f)
ps -la
   All processes (-a) excluding session leaders
ps -eo "%p &P %n %y %x %c"
   Formatted output as:
   PID   PPID   NICE   TTY   TIME      COMMAND
   %p    %P     %n     %y    %x        %c
ps
top
   Show process tree
```
Interactively show most processor 'time hungry' processes

**Signalling active processes**

`kill SIGxxx`

Send signals to a process

Example:

`kill SIGHUP 1329`

same as

`kill HUP 1329`
`kill -1 1329`

`nohup prgm`

Runs `prgm` with HUP signal immunity. `STDOUT` and `STDERR` is sent to `/nohup.out` or `$HOME/nohup.out`

`kill -l`

List of signals possible

**Terminating processes**

`kill [-9]`

Brutal killing of a process

`killall`

Kill many processes with the same name with one command

`xkill`

X Program to kill a process owning a window

`pkill`

See man `pkill`

`skill [signal] [option] parameter`

Allows sending signals to multiple processes at the same time.

**skill** Options(optional) & parameters:

-t `terminal`

Affects all processes running off a specific terminal. (ttyx or pts/x)

-u `username1 [username2....]`

Affects all process belonging to one or more users.

-p `PID1 [PID2 ...]`

Affects all process owning the PID(s).

-c `CommandName`

Affects process having the `CommandName`

examples:
Topic 103: GNU & Unix Commands

skill -KILL -v pts/*
    Kill and list (-v) all processes on new-style PTY devices

skill -STOP viro lm davem
    Stop 3 users: viro lm and davem

She11 job control and '&'

bg [%n]
    Resume current or stopped job n in the background

fg [%n]
    Move current or background job n into foreground

jobs [option]
    Display status of all jobs

Options:
    -n
        Status since last job change
    -r
        List of running jobs only
    -s
        List stopped jobs only
    -l
        display status of all jobs and their process ID's
    -p
        display process ID's of all jobs

jobs -x command
    Replace job n in command with corresponding process group id, then execute command

kill [-signal] %n
    Send specified signal to job n (default 15)

stop %n
    Stop job n

stty [-t]tostop
    Allow/prevent background jobs from generating output

suspend
    Suspend execution of current shell

wait
    Wait for all background jobs to complete

wait %n
Wait for background job n to complete

Ctrl-z

Stop current job

disown [option] [%n]

Disown the last activated (+) background job or job %n. Disowned job will not die when shell dies.

Options

- `a`
  Disown all the background jobs

- `r`
  Disown only the running jobs

- `h`
  Disown active job (+) from shell only when shell is closed:

Job Name Format

```
%%, %+
    current job

%n
    job n

%-.
    previous job

%string
    job whose name begins with string

%?string
    job that matches part or all of string
```
1.103.6 Modify process execution priorities

**Description:** Candidates 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.

**Weight:** 3

Key files, terms, and utilities:
- **nice**
- **ps**
- **renice**
- **top**

Possible nice values: 19(min) to -20(max)

Users can only change to a lower priority than the current one.

Priority when normally starting a program: 0

```bash
nice
Start a job with pre-defined priority
   nice --8 prgm
      Start prgm with priority -8
nice -11 prgm
      Start prgm with priority 11
nice -n-12 prgm
      Start prgm with priority 12
```

```bash
renice
Change priority of a running process
   renice -6 1247
      Change priority of prgm w/ PID-1247 to -6
   renice -8 1247
      Change priority of prgm w/ PID-1247 to 8
```

```bash
snice
Change priority of a multiple running processes by category. Syntax:
   snice [newpriority] [options] category
   e.g.
      snice +7 seti crack
         Slow down seti and crack
      snice -17 root bash
         Give priority to root's shell
```
1.103.7 Search text files using regular expressions

**Description:** Candidates 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.

**Weight:** 3

Key files, terms, and utilities:
- grep
- regexp
- sed

**grep**
Search for patterns in text. Syntax:
```
grep "regexp" filename
```
See also: grep -F, grep -E

**sed**
Edit text using patterns. Ranges are declared as start, end
```
sed '1,$s/^#/##/'
```
Substitute from line 1 till end($) of document
```
sed -f sedsrc file1
```
Uses sed commands in sedsrc
```
sed -e 'cmd1' -e 'cmd2' file1
```
Multiple commands
```
sed 's/pattern/replacement/g'
```
Global substitution
```
sed '/pattern/d'
```
Delete matching lines or grep -v "pattern"
```
sed 's/\1(.*\2)/(.*\1)/1_2/'
```
Using Variables(1 \2)
Last example inserts '_' between first 2 words in all lines.

Regular expressions (regex)
```
List: . * ^ $ \< \> \b \B [..] \ (..) {..} + ? |
```
1.103.8 Perform basic file editing operations using vi

**Description:** Candidates should be able to edit text files using vi. This objective includes vi navigation, basic vi modes, inserting, editing, deleting, copying, and finding text.

**Weight:** 1

**Key files, terms, and utilities:**
- `vi`
- `/`, `?`
- `h, j, k, l`
- `G, H, L`
- `i, c, d, dd, p, o, a`
- `ZZ, :w!, :q!, :e!`
- `:`

<table>
<thead>
<tr>
<th>Action</th>
<th>Keystroke</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Search</strong></td>
<td><code>/&lt;pattern&gt;</code></td>
<td>Search forwards for <code>&lt;pattern&gt;</code></td>
</tr>
<tr>
<td></td>
<td><code>?&lt;pattern&gt;</code></td>
<td>Search backwards for <code>&lt;pattern&gt;</code></td>
</tr>
<tr>
<td><strong>Repeat Search</strong></td>
<td><code>/</code></td>
<td>forwards</td>
</tr>
<tr>
<td></td>
<td><code>?</code></td>
<td>backwards</td>
</tr>
<tr>
<td><strong>Goto</strong></td>
<td><code>n</code></td>
<td>forward next found</td>
</tr>
<tr>
<td></td>
<td><code>N</code></td>
<td>Backward next found</td>
</tr>
<tr>
<td><strong>Cursor move</strong></td>
<td><code>l</code></td>
<td>forward</td>
</tr>
<tr>
<td></td>
<td><code>h</code></td>
<td>backward</td>
</tr>
<tr>
<td></td>
<td><code>k</code></td>
<td>up</td>
</tr>
<tr>
<td></td>
<td><code>j</code></td>
<td>down</td>
</tr>
<tr>
<td></td>
<td><code>w,W</code></td>
<td>Forward one word</td>
</tr>
<tr>
<td></td>
<td><code>b,B</code></td>
<td>Backward one word</td>
</tr>
<tr>
<td></td>
<td><code>e</code></td>
<td>End of current word</td>
</tr>
<tr>
<td></td>
<td><code>0</code></td>
<td>Beginning of line</td>
</tr>
<tr>
<td></td>
<td><code>$</code></td>
<td>End of line</td>
</tr>
<tr>
<td><strong>Goto</strong></td>
<td><code>0</code></td>
<td>Beginning of line</td>
</tr>
<tr>
<td></td>
<td><code>$</code></td>
<td>End of line</td>
</tr>
<tr>
<td></td>
<td><code>H</code></td>
<td>Top of screen</td>
</tr>
<tr>
<td></td>
<td><code>L</code></td>
<td>Bottom of screen</td>
</tr>
<tr>
<td></td>
<td><code>:1</code></td>
<td>First line</td>
</tr>
<tr>
<td></td>
<td><code>G</code></td>
<td>Last line</td>
</tr>
<tr>
<td></td>
<td><code>23</code></td>
<td>Line 23</td>
</tr>
<tr>
<td><strong>Editing</strong></td>
<td><code>&lt;esc&gt;</code></td>
<td>Command mode</td>
</tr>
<tr>
<td></td>
<td><code>i</code></td>
<td>Insert mode</td>
</tr>
<tr>
<td></td>
<td><code>:sp</code></td>
<td>Split screen in 2</td>
</tr>
<tr>
<td></td>
<td><code>&lt;Ctrl&gt;w w</code></td>
<td>Change to other split window</td>
</tr>
<tr>
<td>Action</td>
<td>Keystroke</td>
<td>Comments</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-----------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Delete &amp; clipboard</td>
<td>x</td>
<td>Deletes the char on the right or under the cursor (DEL)</td>
</tr>
<tr>
<td></td>
<td>d</td>
<td>Delete current char or line till (incl.) next cursor move.</td>
</tr>
<tr>
<td></td>
<td>dl</td>
<td>Delete next char. on the right. Same as x</td>
</tr>
<tr>
<td></td>
<td>dk</td>
<td>Delete current line &amp; one line above</td>
</tr>
<tr>
<td></td>
<td>d0</td>
<td>Delete from cursor till begin of line.</td>
</tr>
<tr>
<td></td>
<td>d$</td>
<td>Delete from cursor till end of line.</td>
</tr>
<tr>
<td></td>
<td>c</td>
<td>Same as d but starts inserting after</td>
</tr>
<tr>
<td></td>
<td>ch</td>
<td>Delete 1 char backward then insert mode.</td>
</tr>
<tr>
<td></td>
<td>cj</td>
<td>Delete current line then insert mode.</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>Delete till end of line and then insert mode.</td>
</tr>
<tr>
<td></td>
<td>dd</td>
<td>Delete lines</td>
</tr>
<tr>
<td></td>
<td>dd</td>
<td>Delete current line</td>
</tr>
<tr>
<td></td>
<td>3dd</td>
<td>Delete 3 lines (incl. current line)</td>
</tr>
<tr>
<td>Clipboard Copy and Paste</td>
<td>yy, nyy</td>
<td>Copy current line, n lines to clipboard</td>
</tr>
<tr>
<td></td>
<td>p, P</td>
<td>Paste Clipboard before, after cursor position</td>
</tr>
<tr>
<td>Start editing</td>
<td>i, a, A</td>
<td>Insert text before, after cursor, at end of line</td>
</tr>
<tr>
<td>(insert mode)</td>
<td>o, 0</td>
<td>Open new line for text below, above cursor</td>
</tr>
<tr>
<td>Undoing actions</td>
<td>u, &lt;Ctrl&gt;r</td>
<td>Undo last action in command mode.</td>
</tr>
<tr>
<td></td>
<td>&lt;Alt&gt;u</td>
<td>Undo last action in insert command mode.</td>
</tr>
<tr>
<td>Saving/switching file</td>
<td>:wq</td>
<td>Save file and exit</td>
</tr>
<tr>
<td></td>
<td>:x</td>
<td>Save file, Save file (overwriting files)</td>
</tr>
<tr>
<td></td>
<td>ZZ</td>
<td>Save file under....(no overwrite)</td>
</tr>
<tr>
<td></td>
<td>:w!</td>
<td>Save file under....(can overwrite)</td>
</tr>
<tr>
<td></td>
<td>file</td>
<td>Save file under....(no overwrite)</td>
</tr>
<tr>
<td></td>
<td>:x</td>
<td>Save file under....(can overwrite)</td>
</tr>
<tr>
<td></td>
<td>:n</td>
<td>Show the next, previous buffer</td>
</tr>
<tr>
<td></td>
<td>:N</td>
<td>Show name of current file</td>
</tr>
<tr>
<td>Load/Reload/Quit file</td>
<td>:e</td>
<td>Loads a new file if current file is saved.</td>
</tr>
<tr>
<td></td>
<td>file</td>
<td>Loads a new file even if current file is not saved.</td>
</tr>
<tr>
<td></td>
<td>:e!</td>
<td>Insert the content of file at cursor position</td>
</tr>
<tr>
<td></td>
<td>file</td>
<td>Run shell command (cmd) and come back to current file editing.</td>
</tr>
<tr>
<td></td>
<td>:r</td>
<td>Load last saved version of this file</td>
</tr>
<tr>
<td></td>
<td>! cmd</td>
<td>Quit without saving</td>
</tr>
</tbody>
</table>
| Substitutions           | :1,$s/pattern/replacement/g | same as sed | Runs the range of text through shell command (filter) and replace the original with the results.
**Topic 104: Devices, Linux Filesystems, FHS**

Total weight for this topic  24

1.104.1  Create partitions and filesystems................................................................. 3
1.104.2  Maintain the integrity of filesystems............................................................... 3
1.104.3  Control mounting and unmounting filesystems............................................... 3
1.104.4  Managing disk quota....................................................................................... 3
1.104.5  Use file permissions to control access to files.................................................. 5
1.104.6  Manage file ownership.................................................................................... 1
1.104.7  Create and change hard and symbolic links.................................................... 1
1.104.8  Find system files and place files in the correct location............................... 5

**Summary**

**I-nodes**

A fixed number of inodes are created when a filesystem is created depending on the size of the hard disk.

Directories are files (type 'd') containing filenames and their respective inodes.

Storage element on disk are called clusters under MS-DOS, and called blocks under Linux.

The normal size of blocks is 1024 Bytes

Other possible sizes are 512, 1024 & 2048 Bytes

Each Linux filesystem partition contains:

- 1 Boot block
- 1 SuperBlock
- inodes area
- Data area

**Content of boot Block**

Boot sector normally used to store a Boot Manager

**Content of Super Block (partial)**

Depending on filesystem, includes:

- Number of blocks in filesystem
- Size of Blocks
- Address of first free Data Block
- Address of first free iNode
- Various status flags
  
  ```
  tune2fs -l /dev/hda2
  ```

  Full content of superblock of partition.

**Content of Normal inodes**

Type and access rights
Number of hard links
Topic 104: Devices, Linux Filesystems, FHS

UID
GID
Filesize in bytes
mtime (last content modified)
ctime(last properties modified)
atime(last time accessed)
Address of Block 0
....
Address of Block 9
Address of single-indirection block
Address of double-indirection block
Address of triple-indirection block
Block 0 to 9: Block containing data
Single-indirection block: Block listing up to 128 Data Blocks
Double-indirection block: Block listing up to 128 Single-indirection Blocks
Triple-indirection block: Block listing up to 128 Double-indirection Blocks

**EXT2 Filesystem**

The main difference between other filesystems and the EXT2 is the content of the inodes which are slightly different to accommodate future expansion and special features.

Content of EXT2 inodes:

<table>
<thead>
<tr>
<th>permissions</th>
<th>Nr. of Hard links</th>
<th>owner(UID)</th>
<th>group(GID)</th>
</tr>
</thead>
<tbody>
<tr>
<td>size</td>
<td>properties change time(ctime)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>modification time(mtime)</td>
<td>access time(atime)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>deletion time(dtime)</td>
<td>blockcount</td>
<td></td>
<td></td>
</tr>
<tr>
<td>flags(attributes)</td>
<td>file version (NFS)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>file ACL</td>
<td>dir ACL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>fragment addr.</td>
<td>fr. size</td>
<td>frag. nr</td>
<td>reserved</td>
</tr>
<tr>
<td>1. block data</td>
<td>2. block data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. block data</td>
<td>4. block data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. block data</td>
<td>6. block data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. block data</td>
<td>8. block data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. block data</td>
<td>10. block data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. block data</td>
<td>12. block data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>simple indirect</td>
<td>double indirect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>triple indirect</td>
<td>reserved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>reserved</td>
<td>reserved</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Some differences between EXT2 and normal filesystem**

Deletion Time entry: Helpful for un-deleting files

Field for 12 attributes(flags): A,a,c,d,i,S,s,u.

Useful are:

Append (+a)

Allows only to append to it via redirection(>>)
Topic 104: Devices, Linux Filesystems, FHS

**Immutable (+i)**
- Not changeable, no new hardlinks, not deletable

**Safe-delete (+s)**
- Fills file with '0s' before deleting it.

chattr attribute filename
- Changes the file's attributes. Root only

chattr +i file
- Turns attribute i ON

chattr -i file
- Turns attribute i OFF

lsattr filename
- Lists a file's attributes

File Version Entry: Can be used by NFS server.

File ACL and Dir ACL: (Access Control List) for better access control.

Support for fragmented files

12 Direct Block Addresses instead of 10 (standard)

The Superblock has multiple backups of itself at the start of some block groups. I found between 6 to 10 copies (backups) in 3 to 10 GB Partitions

Ext2 superblock has extra entries:

Valid-Flag Entry: if ON means the filesystem was not unmounted properly. e2fsck uses this flag to know if it should do a full check.

    e2fsck -f

    forces the full check.

Max-Mounts before full check and mount-count Entries: Used by e2fsck. If mount-count=Max-Mounts before full check then e2fsck does a full check at boot time.

Percent of full partition space reserved for root Entry: Normally 5%.

tune2fs can manipulate these above superblock entries.

Warning: Partition should NOT be mounted as ReadWrite if changing any of these entries.

### Journaling Filesystems

<table>
<thead>
<tr>
<th>Filesystem</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXT3:</td>
<td>Is an EXT2 filesystem with a journal file and journalling functions.</td>
</tr>
<tr>
<td>Reiserfs:</td>
<td>Stores a report of all transactions bigger than 1 block. Up to 10 times faster than EXT3 when reading.</td>
</tr>
<tr>
<td>Xfs:</td>
<td>Ported from IRIX system. Meant for handling very large files. Max 9,000 Peta Bytes. (9 mega mega mega bytes!)</td>
</tr>
</tbody>
</table>

### 1.104.1 Create partitions and filesystems

**Description:** 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.

**Weight: 3**

Key files, terms, and utilities:
- fdisks
- mkfs

**Notes**

Max number of Primary partitions per hard disks: 4
Max number of extended partitions per hard disk: 1
Maximum number of logical partitions per hard disk: 11

Partitions names:

```
hda----IDE-Ctrl1-------hdb      hdc----IDE Ctrl 2------hdd
   master     slave     master     slave
hda1 (pri/ext)     
hda2 (pri/ext)     
hda3 (pri/ext)     
hda4 (pri/ext)     
       hda5 (logical)     
       hda6 (logical)     
          ...............     
       hda15 (logical)     
```

**Partitioning**

```
fdisks -l
    Display all hard disks and partitions recognized in the system.

fdisks /dev/hda
    Partition hard disk hda.

fdisks commands:
```

```
Creating a new partition:

\texttt{\textbf{n} --\textbf{}\rightarrow\textbf{primary}-->.....}

Changing its partition system id:

\texttt{\textbf{t}--\textbf{}-->\textbf{l(list)}--\rightarrow83(linux) or 82(swap)}

List partitions:

\texttt{\textbf{p} Shows the partition table}

When all finished:\texttt{(warning: last change to verify and correct if needed )}

\texttt{\textbf{w} Writes the partition table on disk!!!}

Note: Linux does not need the activation of the bootable flag, but Windows does. So if Windows is installed and the flag is on for its partition, then leave it there.

\textbf{Creating a filesystem.}

\texttt{mkfs -t filesystem [options] device [blocks]}

or

\texttt{mke2fs [options] device [blocks] (for ext2 filesystem)}

Possible commands and their synonyms:

<table>
<thead>
<tr>
<th>Command</th>
<th>Synonyms</th>
</tr>
</thead>
<tbody>
<tr>
<td>\texttt{mke2fs}</td>
<td>\texttt{mkfs.ext2} = \texttt{mkfs -t ext2}</td>
</tr>
<tr>
<td>\texttt{mkfs.ext3}</td>
<td>\texttt{mkfs.ext2 -j} = \texttt{mkfs -t ext3}</td>
</tr>
<tr>
<td>\texttt{mkdosfs}</td>
<td>\texttt{mkfs.msdos} = \texttt{mkfs.vfat} = \texttt{mkfs -t vfat}</td>
</tr>
<tr>
<td>\texttt{mkfs.xfs}</td>
<td>\texttt{mkfs -t xfs}</td>
</tr>
<tr>
<td>\texttt{mkfs.bfs}, \texttt{mkfs.minix},, \texttt{mkfs.xiafs}</td>
<td></td>
</tr>
</tbody>
</table>

filesystems:

\texttt{ext2,ext3,vfat,msdos,reiserfs,xfs,minix,bfs,xiafs}

Options:

\texttt{-b}

Block size. Valid values: 1024, 2048, 4096

\textbf{71}
Before creating the filesystem, check the device for bad blocks

Specify the number(n) of bytes per inode. Min = Block size. This helps to calculate the number of inodes to create. Number of i-nodes is dependent on the size of partition.

Specify the absolute number(n) of i-nodes to create.

device:
/dev/xxxx  xxxx=hda1.... hdc4 etc.

blocks:
Optional. Size in blocks of the filesystem to create. If not given the size is auto detected.

mkreiserfs  options  device
or
mkfs -t reiserfs  " "  " "
or
mkfs.reiserfs  " "  " "

For making a reiser filesystem.

tune2fs -j device
Conversion an ext2 to ext3 filesystem.
**1.104.2 Maintain the integrity of filesystems**

**Description:** 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.

**Weight:** 3

Key files, terms, and utilities:
- `du`
- `df`
- `fsck`
- `e2fsck`
- `mke2fs`
- `debugfs`
- `dumpe2fs`
- `tune2fs`

**Disk Usage**

`du`
- `du` is recursive by default.
- `du -sh /root`
  Display amount of space used by /root directory
- `du -h --max-depth=0 /home`
  Amount of space used by /home (non recursive)

**Disk Free**

`df`
- `df` List (in kilobytes) free & used space on mounted partitions
- `df -h`
  Same as above but in human readable format (K,M,G)
- `df -i /dev/hda3`
  Show number of free inodes on hda3
  Note: `df -i` doesn't show inode info for reiserfs or XFS, since they create inodes dynamically.

**File system check**

`fsck`
- `fsck` Check file system

Shortcut aliases for `fsck`:

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>e2fsck</code></td>
<td><code>fsck.ext2</code> For EXT2 and EXT3</td>
</tr>
<tr>
<td><code>reiserfsck</code></td>
<td><code>For Reiserfs</code></td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>Tool</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>fsck.minix</td>
<td>For minix</td>
</tr>
<tr>
<td>fsck.msdos</td>
<td>For Ms DOS FAT</td>
</tr>
<tr>
<td>fsck.vfat</td>
<td>For DOS VFAT</td>
</tr>
<tr>
<td>fsck.xfs</td>
<td>For XFS</td>
</tr>
</tbody>
</table>

Note: fsck should only be run on a non-mounted or read-only mounted filesystem.

Syntax:

```
fsck options filesystem
```

Options: (mostly for the ext2/ext3 filesystem)

- `-A` Checks all filesystems listed for check in /etc/fstab
- `-f` Force checking even if the Valid-Flag is not set(filesystem ok)
- `-p` Auto Repair without asking
- `-n` NO-Simulation. No writing of any changes on disk
- `-y` YES- Answer yes to any questions coming up. Dangerous!

File system debugging
deguf

Interactive command driven debugging program.
Created to fully control and manipulate the ext2 filesystems.
Default is in read-only mode. -w option overrides this.
Command help shows all valid commands.

File system info dump
dumpe2fs

Displays lots of information about the structure of the ext2 filesystem.
Incl: Superblock content, free inodes categorized per block groups
Location(offsets) of the superblock backups, etc.

Can be useful to be saved in a file and used to recover a damaged system.

File system tweaking
tune2fs

Allows manipulation of some of the parameters of the ext2 filesystem located in the superblock. Here are a few examples:

```
tune2fs -l /dev/hda5
    List the content of the superblock
tune2fs -j /dev/hda3
    Converts the ext2 filesystem to ext3
tune2fs -c 30 /dev/hda2
    Change the max-mount-count to 30
tune2fs -C 0 /dev/hda9
```
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Reset the number of mounts counter to 0.

Extra examples:

dumpe2fs /dev/hda7 | grep '[mM]ount count'
dumpe2fs 1.19, 13-Jul-2000 for EXT2 FS 0.5b, 95/08/09
   Mount count: 7
   Maximum mount count: 20

tune2fs -C 9 /dev/hda6

tune2fs 1.19, 13-Jul-2000 for EXT2 FS 0.5b, 95/08/09
   Setting current mount count to 9
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1.104.3 Control mounting and unmounting filesystems

**Description:** 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.

**Weight:** 3

Key files, terms, and utilities:
- `/etc/fstab`
- `mount`
- `umount`

Syntax of mount command

```
mount -t <fstype> <SourceDevice> <MountPoint>
```

Example:

```
mount /dev/hdc /cdrom
```

```
mount -a
```

Try to mount all the devices listed in `fstab` as it happens at boot time.

/etc/fstab file format

<table>
<thead>
<tr>
<th>Device order</th>
<th>Mount point</th>
<th>Filesystem</th>
<th>Options</th>
<th>Dump</th>
<th>fsck</th>
</tr>
</thead>
<tbody>
<tr>
<td>/dev/hda1</td>
<td>/boot</td>
<td>ext2</td>
<td>defaults</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>/dev/hdb1</td>
<td>/</td>
<td>ext2</td>
<td>defaults</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>/dev/hdb3</td>
<td>swap</td>
<td>swap</td>
<td>defaults</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>/dev/cdrom</td>
<td>/cdrom</td>
<td>iso9660</td>
<td>ro,noauto,user</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>/dev/floppy</td>
<td>/floppy</td>
<td>auto</td>
<td>noauto,user</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>/dev/hdc1</td>
<td>/windows</td>
<td>vfat</td>
<td>user,umask=000</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Default options

```
rw,suid,dev,exec,auto,nouser,async,atime
```

(Async=buffered)

List of all options

<table>
<thead>
<tr>
<th>auto</th>
<th>noauto</th>
<th>Mounting at boot time ?</th>
</tr>
</thead>
<tbody>
<tr>
<td>exec</td>
<td>noexec</td>
<td>Execute binaries found on device ?</td>
</tr>
<tr>
<td>sync</td>
<td>async</td>
<td>Buffered data when writing ?</td>
</tr>
<tr>
<td>atime</td>
<td>noatime</td>
<td>Update inode access time when accessed ?</td>
</tr>
<tr>
<td>dev</td>
<td>nodule</td>
<td>Accept special character and block devices ?</td>
</tr>
<tr>
<td>suid</td>
<td>nosuid</td>
<td>Allow suid on mounted file system ?</td>
</tr>
<tr>
<td>user</td>
<td>nouser</td>
<td>Allow user to mount device ?</td>
</tr>
<tr>
<td>rw</td>
<td>ro</td>
<td>Read/Write(rw) or Read only(ro) ?</td>
</tr>
<tr>
<td>remount</td>
<td></td>
<td>Remount the already mounted device.</td>
</tr>
<tr>
<td>umask</td>
<td></td>
<td>Sets the umask for writing on the partition (good for vfat)</td>
</tr>
</tbody>
</table>

Notes:
The option user implies: noexec,nosuid and nodev unless overridden by subsequent contradictory options.

Normal options for vfat Partition:
  user,umask=000

The option mount -w ... is the same as mount -o rw

Almost all options can also be entered using mount -o. Example:
  mount -o ro,umask=000 -t vfat /dev/hdd /windows

Display already mounted devices
  mount
    Most complete info
  cat /etc/mtab
    Not always refreshed immediately
  cat /proc/mounts
    Always current
  df -h
    Mounted devices and space used/free
1.104.4 Managing disk quota

Description: 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.

Weight: 3

Key files, terms, and utilities:
- *quota*
- *edquota*
- *repquota*
- *quotaon*

Summary

The user is allowed to cross the soft limit for the length of time limited by the grace period, after which he's not allowed to write anything on the partition.

The hard limit may never be exceeded by the user.

The quota limits may be expressed in number of 1k blocks or in number of inodes (total number of files and directories) or both.

Procedure for installing quotas

Edit /etc/fstab and enter *usrquota*, *grpquota* in options field for filesystem

```
/dev/hda3 /home ext2 defaults,usrquota,grpquota 1 1
```

Remount the filesystem

```
mount -o remount /dev/hda3
```

Initialize the quota databases files(*aquota.user*, *aquota.group*)

```
quotacheck -avugm
```

Set quota for each user:

```
edquota -u paul
```

or

```
edquota paul
```

Edit grace period for all the users:

```
edquota -tu
```

Turn quotas ON:

```
quotaon -u /dev/hda3
```

Check quota for user:

```
quota paul
```

Create a quota report for all users:

```
repquota -u /dev/hda3
```

Create a quota report for all groups:
repquota -g /dev/hda3

Turn quotas OFF(when needed)
quotaoff -u /dev/hda3

**Detailed preparation of quotas**

Enter the following options in `/etc/fstab` for the partitions that must use quotas.

```
/dev/hda2 /srv/www ext2 defaults,usrquota,grpquota 1 1
/dev/hda3 /home ext2 defaults,usrquota,grpquota 1 1
```

Remount the filesystems:

```
mount -o remount /srv/www
mount -o remount /home
```

Enter the following command to verify existing used space by each user and group:

```
quotacheck -avugm
```

This command will also update two files in the `/home` directory:

```
quota.group, and quota.user
```

if version 2 of quotas is used then the two files will be:

```
aquota.group, and aquota.user
```

Start editing the quota for each user:

```
edquota -u john
```

or

```
edquota john
```

Edits the filesystem quota for the user john. The quota editor(vi) will appear and will allow changes to the soft and hard quota for user john.

Note: The value 0 for soft or hard quota means **N O  L I M I T**.

```
+-------------------------------------------------------------------
| Filesystem    blocks  soft  hard  inodes  soft  hard |
| /dev/hda7     3288  4000  6000  649   2000  3000 |
+-------------------------------------------------------------------
```

This above example means that john:

- Already uses 3288 blocks(kb) of data on /dev/hda7 in 649 inodes (files)
- The soft quota is set to 4000 kB and hard to 6000 kB
- The soft limit is set to 2000 inodes and hard limit to 3000 inodes

```
edquota -tu
```

Edits grace period for all users. It is not possible to set grace period for individual users:

(month(s),day(s),hour(s),min(utes),sec(onds))
To copy the quota for other users with the same limit values, easiest way is:

    edquota -p john patrick

This command will give patrick the same quota limits as john.

To verify the status of the quota for the user john use the commands:

    su -
    quota john

The result:

    +------------------------------------------------------------------+
    | Disk quotas for user john (uid 5001):                            |
    | Filesystem blocks quota limit grace files quota limit grace      |
    | /dev/hda7 3288 4000 6000 649 2000 3000                           |
    +------------------------------------------------------------------+

This means that the user john has 649 files using 3288 Kb of hard disk space.
His soft limit is 4000 Kb or 2000 inodes and hard limit is 6000 kb or 3000 inodes

**Repquota**

Repquota produces summarized quota information for a file system. Here is a sample of the output that repquota gives:

    # repquota -a
    *** Report for user quotas on device /dev/hda7
    Block grace time: 7days; Inode grace time: 5days
    Block limits File limits
    User used soft hard grace used soft hard grace
    root  -- 175419 0 0 14679 0 0
    john ++ 6000 4000 6000 650 2000 3000
    uucp  -- 729 0 0 23 0 0
    user1 -- 13046 15360 19200 806 1500 2250

repquota -g /home

Report of groups quota

repquota -u /home (same as repquota /home)

Report of users quota

**Quotaon and Quotaoff**

    quotaon -u /dev/hda2

    turns ON quota accounting in kernel for users(-u)
quotaoff -u /dev/hda2

turns it OFF.

Actually both files are similar. They are executed at system startup and shutdown.

**Files involved with disk quotas**

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>quota (1)</td>
<td>Display disk usage and limits. quota reports the quotas of all filesystems listed in /etc/mtab. For mounted NFS filesystems, a call to rpc.rquotad on the server machine is performed to get the information.</td>
</tr>
<tr>
<td>setquota (8)</td>
<td>Set disk quotas with one command without editing like edquota</td>
</tr>
<tr>
<td>edquota (8)</td>
<td>Edit user quotas</td>
</tr>
<tr>
<td>quotaoff (8)/</td>
<td>Turn filesystem quotas on and off</td>
</tr>
<tr>
<td>[quotaon]</td>
<td></td>
</tr>
<tr>
<td>quotacheck (8)</td>
<td>Scan a file system for disk usage, create and check the files aquota.user and aquota.group</td>
</tr>
<tr>
<td>repquota (8)</td>
<td>Summarize quotas for a filesystem</td>
</tr>
</tbody>
</table>
1.104.5 Use file permissions to control access to files

Description: 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.

Weight: 5

Key files, terms, and utilities:
- chmod
- umask
- chattr

File type

These are displayed against the left margin in ls -l listings

<table>
<thead>
<tr>
<th>Character</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>Regular files</td>
</tr>
<tr>
<td>l</td>
<td>Symbolic Links (eg. /sbin/init.d/rc2.d... all files)</td>
</tr>
<tr>
<td>d</td>
<td>Directories and sub-directories</td>
</tr>
<tr>
<td>b</td>
<td>Block Device Files (eg. /dev/hda1...)</td>
</tr>
<tr>
<td>c</td>
<td>Character Device Files (eg. /dev/tty1....)</td>
</tr>
<tr>
<td>p</td>
<td>FIFO Named pipes (eg. /dev/log, /dev/xconsole)</td>
</tr>
<tr>
<td>s</td>
<td>??? (eg. /var/spool/postfix/private/bounce...)</td>
</tr>
</tbody>
</table>

File and directory names that start with a Dot (.) are hidden from display by certain programs like ls etc.

Files and directory access rights

Access rights are restrictions applied to the content of a file or directory. They don’t restrict the deletion of a file or directory. Only the parent directory's access rights controls that.

Changing a file's access rights

Syntax:

```bash
chmod [-R] [ugoa][+=-][rwx stXugo] or [0000 to 7777] file
```

Examples:

```bash
chmod u+w,g-x,o=wx file1
chmod 750 file2
chmod 4755 program1
  SUID=ON
chmod u+s,g+s,o+t program2
  SUID=ON, SGID=ON, StickyBit=ON
```
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```bash
cchmod -R u=rwX,g=rX,o=rX dir1
```

Recursively set 755 for directories and 644 for files.

**Directory access rights**

The read (r) without the search (x) access rights for directories makes no sense and the read is ignored.

Any file in a directory set to write access for everybody can be erased by anybody, regardless of who the current user is.

### Extra access rights

<table>
<thead>
<tr>
<th>SUID (s)</th>
<th>SGID (s)</th>
<th>Sticky Bit (t)</th>
<th>user</th>
<th>group</th>
<th>others</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>2</td>
<td>1</td>
<td>r</td>
<td>w</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

SUID and SGID for programs (-rwsrwsrwx) (-rwSrwsrwx)

- **SUID=ON**: Effective user is the owner of the program
- **SGID=ON**: Effective group is the group owner of the program

**SGID for Directories**

Forces subdirectories and files created in it to have the same group as the directory's group independent of the creating user's group. Subdirectories created within this directory will inherit the same SGID.

**Sticky Bit for Directories**

Files in the directory can only be deleted by their owner even if the directory is set to write access for all. Sticky bit is normally set on /tmp to prevent another user's processes from deleting your files.

- **Note 1**: Normally any file (belonging to the user or not) under a directory set to write access for group or others can be erased by any user.
- **Note 2**: The owner of the directory can erase any file in it even if the sticky bit is set.

**Sticky Bit for programs**:

- Allows a running program to be stored in ram (buffers) until the system goes down.
- **Advantage**: Programs load faster.
- **Disadvantage**: Uses lots of RAM

Note: Sticky bit for programs is obsolete. Linux has never used it and no modern Unix has used it for years – swap memory does the same thing more effectively

```bash
cchmod o+t
```

Sets the sticky bit

```bash
cresult = (-rwxrwxrwxT) or (-rwxrwxrwxT)
```

```bash
cchmod u+t
```

Sets the SUID

```bash
cresult = (-rwsrwxrwxT) or (-rwSrwxrwxT)
```

```bash
cchmod u+t
```
Sets the SGID  

result = (-rwxrwsrwt) or (-rwxrwSrwt)

Note: When adding a sticky-bit to a file/dir with an x for Others, the sticky-bit is displayed as t otherwise as T if the x was not present. The same applies to SUID and SGID (-rwSrwsrwt)

**Attributes (chattr & lsattr)**

Setting the 'append only' attribute on a directory or file.

```
    chattr +a filename or directoryname
```

User must necessarily not be root

A file with this attribute may be appended to, but may not be deleted, and the existing contents of the file may not be overwritten. If a directory has this attribute, any files or directories within it may be modified as normal, but no files may be deleted.

Setting the 'immutable' attribute on a directory or file.

```
    chattr +i filename or directoryname
```

User must be root

A file or directory with this attribute may not be modified, deleted, renamed, or (hard) linked

Display Attributes of files and directories

```
    lsattr
```

List the special attributes of files and directories

<table>
<thead>
<tr>
<th>Attributes list</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Atime record is not modified. Prevents too much disk access for laptops. Still in testing mode</td>
</tr>
<tr>
<td>a</td>
<td>Sets it to append mode only (can not erase it) Only root can set this attribute</td>
</tr>
<tr>
<td>c</td>
<td>The kernel compresses this file before writing to disk, and decompresses it when reading it from disk. NOT Implemented yet by kernel</td>
</tr>
<tr>
<td>d</td>
<td>Will not be backed up by the program &quot;dump&quot;</td>
</tr>
<tr>
<td>i</td>
<td>Cannot be modified, erased, renamed or hard linked. Only root can change this attribute</td>
</tr>
<tr>
<td>s</td>
<td>When this file is erased, the blocks it used are over-written with '0' to prevent recovery at a later date.</td>
</tr>
<tr>
<td>S</td>
<td>Any change to this file will be immediately written to the disk instead of in the file system buffer. (equivalent to 'sync' mount option)</td>
</tr>
<tr>
<td>u</td>
<td>When this file is deleted, its content are saved. It can therefore be undeleted later. NOT implemented yet by kernel.</td>
</tr>
</tbody>
</table>

**umask for new files and directories**

Sets default access rights for newly created files and directories:
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New file access rights \(= 666 \text{!} \mid \text{umask} \text{(!}=\text{Logical NOR}) \)
New directory access rights \(= 777 \text{!} \mid \text{umask} \)

Note: umask specifies which attributes will NOT be applied

Examples:

<table>
<thead>
<tr>
<th>umask</th>
<th>New files (access rights 666)</th>
<th>New Directories (access rights 777)</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>-rw-r--r--</td>
<td>-rwxr-xr-x</td>
</tr>
<tr>
<td>135</td>
<td>-rw-r----w-</td>
<td>-rw-r----w-</td>
</tr>
<tr>
<td>216</td>
<td>-r--rw----</td>
<td>-r-xrw----x</td>
</tr>
</tbody>
</table>
1.104.6 Manage file ownership

**Description:** 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.

**Weight:** 1

Key files, terms, and utilities:
- `chown`
- `chgrp`
- `chmod`

**chown**

Changes user and group ownership of a file or directory

**Syntax**

```
chown [options] [user][:group] filename
chown [options] [user][:group] dirname
```

**Examples:**

- `chown user:group filename`
  - Change user and group ownership of file
- `chown user filename`
  - Change user ownership of file
- `chown user. filename`
  - Change user and **his** group ownership of file
- `chown user: filename`
  - Change user and **his** group ownership of file
- `chown .group filename`
  - Change group ownership of file

**Important Options:** (from man page)

- `-R` --recursive
  - Recursively affects all files and directories inside directory trees
- `--dereference`
  - Affect the referent of each symbolic link, rather than the symbolic link itself.
- `-h`, `--no-dereference`
  - Affect symbolic links instead of any referenced file. (available only on systems that can change the ownership of a symlink)
- `--from=CURRENT_OWNER:CURRENT_GROUP`
  - Change the owner and/or group of each file only if its current owner and/or group match those specified here. Either may be omitted, in which case a match is not required for the omitted attribute.
- `-f`, `--silent`, `--quiet`
Suppress most error messages
-c, --changes
Like verbose but report only when a change is made
--reference=RFILE
Use RFILE's owner and group rather than the specified OWNER:GROUP values.
-v, --verbose
Output a diagnostic for every file processed

IMPORTANT: root is the only user allowed to change ownership (chown) of files or directories.

chgrp
Change group ownership of a file or directory
Syntax:
chgrp [options] newgroup filename
Examples:
chgrp -R ftp /srv/www
Changes recursively all the files and directories inside the dir. /srv/www to be owned by group ftp
chgrp -R --reference=/home/hans /srv/ftp
Changes recursively the group ownership of all the files and directories contained in /srv/ftp to the group owning the directory /home/hans
Options:
-R, --recursive
Operate on files and directories recursively
--dereference
Affect the referent of each symbolic link, rather than the symbolic link itself
-h, --no-dereference
Affect symbolic links instead of any referenced file (available only on systems that can change the ownership of a symlink)
-f, --silent, --quiet
Suppress most error messages
--reference=RFILE
Use RFILE's group rather than the specified GROUP value
-v, --verbose
Output a diagnostic for every file processed
-c, --changes
Like verbose but report only when a change is made
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**chmod**

Change the access rights of a files or directories

TODO
1.104.7 Create and change hard and symbolic links

**Description:** 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.

**Weight:** 1

Key files, terms, and utilities:

- `ln`

Creating a Symbolic link:

```
ln [options] -s source destination
or
cp -s source destination
```

Examples:

```
ln -s /bin/cat /home/hans/bin/cat
```

Creates a new symbolic link called `/home/hans/bin/cat` pointing to `/bin/cat`

Creating a Hard Link:

```
ln source destination
or
cp -l source destination
```

Examples:

```
ln /bin/ping /home/hans/bin/ping
```

Creates a new hard link called `/home/hans/bin/ping` pointing to `/bin/ping`

**Options:**

- `-f, --force`
  Remove existing destination files
- `-i, --interactive`
  Prompt whether to remove destinations
- `-s, --symbolic`
  Make symbolic links instead of hard links
- `--target-directory=DIRECTORY`
  Specify the DIRECTORY in which to create the links
- `-v, --verbose`
  Print name of each file before linking

**Important Notes:**

Although the man page says that it is possible to make a hard link to a directory, in reality it is not possible ... yet. Better to use the “bind” option when mounting:

```
mount /SourceDir /MountPoint -o bind
```
Hard links are limited to the same partition as the original file
Symbolic links are NOT limited to the same partition as the original file

```
cp source destination
```
Copies the referenced file (the file that the sym link points to) when the source is a symbolic link.

Example:
```
cp linktest3 linktest5
```
(linktest3 is a symbolic link to linktest)
Copies the content of linktest to linktest5 as a normal file.

The second field of the command `ls -l filename` shows how many files are hard linked to that inode.

```
ls -l linktest*
-rw-r--r-- 3 michel video 0 2003-11-20 08:45 linktest
-rw-r--r-- 3 michel video 0 2003-11-20 08:45 linktest2
-rw-r--r-- 3 michel video 0 2003-11-20 08:45 linktest3
```

The command `stat filename` also shows how many files are hard linked to that inode.

```
stat linktest
File: 'linktest'
  Size: 0  Blocks: 0  IO Block: 4096  regular empty file
  Device: 305h/773d  Inode: 876319  Links: 2
  Access: (0644/-rw-r--r--) Uid: (  500/  michel)  Gid: ( 33/  video)
  Access: 2003-11-20 08:45:10 0000000000 +0100
  Modify: 2003-11-20 08:45:10 0000000000 +0100
  Change: 2003-11-20 08:45:22 0000000000 +0100
```
1.104.8 Find system files and place files in the correct location

**Description:** Candidates should be thoroughly 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.

**Weight:** 5

**Key files, terms, and utilities:**
- `find`
- `locate`
- `slocate`
- `updatedb`
- `whereis`
- `which`
- `/etc/updatedb.conf`

**find**

Recursively searches the filesystem to find files.

**Syntax:**

```
find startdirectory [search_criteria_options] [-exec command \;]
```

**Examples:**

```
find . type d -maxdepth 1
```

Finds all directories located in the current directory.

```
cd /etc/ ; find . -name "*XF*"
```

Recursively finds all files in directory `/etc` whose names include the pattern 'XF'.

```
find /opt/kde -maxdepth 2 -type f -name "*edit"
```

Searches `/opt/kde` and subdirectories up to 2 levels deep for files whose names end with the word 'edit'.

```
find . -follow -cmin -5
```

Search the current directory for files whose properties were changed less than 5 minutes ago.

**Timestamp syntax:**

- `-cmin +5` Properties of file changed more than 5 minutes ago
- `-amin -6` Content of file accessed less than 6 minutes ago
- `-mmin +8` Content of file modified more than 8 minutes ago
- `-ctime +5` Properties of file changed more than 5 days ago
- `-atime -7` Content of file accessed less than 7 days ago
- `-mtime -3` Content of file modified less than 3 days ago

```
find /etc -type f -name '*.conf' -exec grep -H "hosts" {} \\;
```

Searches the `/etc` directory for files with the extension `.conf`. Executes grep on those files looking for the string “hosts”. When found, also displays the filename it was found in.
find /etc -type f -name '*.conf' -ok grep -H "hosts" {} \;

Same actions as above except that -ok option asks find to prompt for confirmation (with y) of the command before executing it.

**locate**

Locate files in the whole system using a database of filenames.

Syntax:

```
locate filename
```

Searches the locate database for the filename
This database is in /var/lib/locatedb
It is updated via the command: updatedb [options]
The configuration file for updatedb is /etc/updatedb.conf

Options:

- `-d path, --database=path`
  Instead of searching the default file name database, search the file name databases in path, which is a colon-separated list of database file names. You can also use the environment variable LOCATE_PATH to set the list of database files to search.
  The option overrides the environment variable if both are used.

- `-e, --existing`
  Only print out such names that currently exist (instead of such names that existed when the database was created).
  Note that this may slow down the program a lot, if there are many matches in the database.

- `-i, --ignore-case`
  Ignore case distinctions in both the pattern and the file names.

**slocate**

Secure version of locate

Secure Locate provides the same features as locate but it will also store file permissions and ownership so that users will not see files they do not have access to.

Syntax:

```
slocate [options] filename
```

The slocate database is not the same as the locate database. It needs to be built by issuing the slocate command with proper options:

**Database Build Options:**

- `-u`
  Create slocate database starting at path /

- `-U <dir>`
  Create slocate database starting at path <dir>

- `-e <dir1,dir2,...>`
Exclude directories from slocate database

-f <fstype1,...>

Exclude files on specific file systems from the slocate database.

-c

Parse /etc/updatedb.conf when updating the slocate database.

-l <level>

Security level:
0 Turns security checks off. This will make searches faster.
1 Turns security checks on. This is the default.

-o <file>, --output=<file>

Specifies the database to create.

-v, --verbose

Verbose mode. Display files when creating database.

Slocate Search Options:

-i

Does a case insensitive search.

-q

Quiet mode. Error messages are suppressed.

-n <num>

Limit the amount of results shown to <num>.

-r <regexp>, --regexp=<regexp>

Search the database using a basic POSIX regular expression.

-d <path>, --database=<path>

Specifies the path of databases to search.

**whereis**

Search for a program and possibly its man pages from a predefined path.

Syntax:

whereis filename

Searches a predefined (hard coded) list of directories for the filename and man pages. They must be in the path predefined during compilation of whereis program.

**which**

Search for the first occurrence of a program in the PATH.

Syntax:

which filename
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Searches the PATH for the first occurrence of the filename. The filename can be a list of files.

type -p filename

Same as above which filename
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**Total weight for this topic**

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<thead>
<tr>
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**Summary**

TODO
1.110.1 Install & Configure XFree86

Description: 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).

Weight: 5

Key files, terms, and utilities:
- XF86Setup
- xf86config
- xvidtune
- /etc/X11/XF86Config
- /etc/.Xresources
- ~/.Xresources

X Server

The X-Server offers an empty display where programs that support the X-Protocol will be displayed and controlled via the mouse and keyboard. The X-Server takes control of the local Graphic card, monitor, mouse and keyboard and possibly other devices like joystick, graphic tablet etc. The X-Server is a network service for local or remote clients (X-Programs).

The X-Server has been developed for many hardware platforms. Most X-Server implementations are proprietary. XFree86 is free software, and is the one explained below.

XFree86 Version 3 contained several executable X Servers for different resolutions and colour depths.

XFree86 Version 4 selects the correct resolution and colour depth at run so there is only one executable.

XF86Config file

/etc/X11/XF86Config is the main XFree86 configuration file.

XF86Config search path:

When X is started as a normal user:
- /etc/X11/$XF86CONFIG
- /usr/X11R6/etc/X11/$XF86CONFIG
  Then Common search path

When X is started as the root user:
- $XF86CONFIG
- /etc/X11/$XF86CONFIG
- /usr/X11R6/etc/X11/$XF86CONFIG
- $HOME/XF86Config
  Then Common search path

Common search path:
- /etc/X11/XF86Config-4
- /etc/X11/XF86Config
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/etc/XF86Config
/usr/X11R6/etc/X11/XF86Config.<hostname>
/usr/X11R6/etc/X11/XF86Config-4
/usr/X11R6/etc/X11/XF86Config
/usr/X11R6/lib/X11/XF86Config.<hostname>
/usr/X11R6/lib/X11/XF86Config-4
/usr/X11R6/lib/X11/XF86Config

Note: In the above 2 paths /X-Rootdir is normally /usr/X11R6/

Depending on distributions the configuration files of X-Server Version 3 and Version 4 are located in different locations. Often used locations and names are:

| Version 3 | /etc/XF86Config
|           | /etc/X11/XF86Config |
| Version 4 | /etc/X11/XF86Config
|           | /etc/X11/XF86Config-4 |

**XF86 Configuration programs**

These are helper programs that write an XF86Config file

<table>
<thead>
<tr>
<th>xf86config</th>
<th>First text-based configuration program. Provided and supported by the XFree86 development team. Belongs to standard X-Server packages.</th>
</tr>
</thead>
<tbody>
<tr>
<td>XF86Setup</td>
<td>Graphic-based (640x480-VGA 16 colors) configuration program. Also provided and supported by XFree86 development team.</td>
</tr>
<tr>
<td>xf86cfg</td>
<td>Graphic-based configuration program. More complex and more for advanced administrators. Provides the possibility of dynamically tring some of the settings by pressing an 'Apply' button. Provides auto-detection of graphic cards. Also provided and supported by XFree86 development team.</td>
</tr>
<tr>
<td>SAX</td>
<td>SuSE graphics-based configuration programs for XFree86 Version 3. Provides auto-detection of graphic cards.</td>
</tr>
<tr>
<td>SAX2</td>
<td>SuSE graphics-based configuration programs for XFree86 Version 4. Provides auto-detection of graphic cards.</td>
</tr>
<tr>
<td>Xconfigurator</td>
<td>RedHat text-based configuration programs. Improved version of xf86config. It does auto-detection of graphic cards. Works in interactive mode or in automatic-install mode.</td>
</tr>
<tr>
<td>dexconf</td>
<td>Background Debian system installation program. No user startable program. To reconfigure the X-Server execute: dpkg-reconfigure xserver-xfree86</td>
</tr>
</tbody>
</table>

All of the above configuration programs do 2 things:
- Configuration of the XF86Config file.
- Creation of a symbolic link to the configured X-Server (Version 3 only)

**Layout of the XF86Config file**

Sections:
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<table>
<thead>
<tr>
<th>Files</th>
<th>Location of fonts</th>
</tr>
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<td>ServerFlags</td>
<td>Server flags</td>
</tr>
<tr>
<td>Module</td>
<td>Dynamic module loading</td>
</tr>
<tr>
<td>InputDevice</td>
<td>Input device description (Version 4)</td>
</tr>
<tr>
<td>Device</td>
<td>Graphics device description</td>
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<tr>
<td>VideoAdaptor</td>
<td>Xv video adapter description</td>
</tr>
<tr>
<td>Monitor</td>
<td>Monitor description</td>
</tr>
<tr>
<td>Modes</td>
<td>Video modes descriptions</td>
</tr>
<tr>
<td>Screen</td>
<td>Screen configuration</td>
</tr>
<tr>
<td>ServerLayout</td>
<td>Overall layout</td>
</tr>
<tr>
<td>DRI</td>
<td>DRI-specific configuration</td>
</tr>
<tr>
<td>Vendor</td>
<td>Vendor-specific configuration</td>
</tr>
<tr>
<td>Keyboard</td>
<td>Keyboard configuration (Version 3)</td>
</tr>
<tr>
<td>Pointer</td>
<td>Mouse configuration (Version 3)</td>
</tr>
</tbody>
</table>

### Running the X-Server

Create a sym link to the configured X Server

Version 3

```
/usr/X11R6/bin/X ==> /var/X11R6/bin/X ==> /
usr/X11R6/bin/XF86_Servertype
```

Version 4

```
/usr/X11R6/bin/X ==> /var/X11R6/bin/XFree86
```

Start the Xserver and window manager:

```
startx (script)
```

Fine Tune the monitor settings:

- Manually with monitor's buttons
- Via the xvidtune program

### Controlling X-Server settings

Dynamic settings:

The X-Server can be dynamically (non permanently) controlled with the xset command

```
xset r rate 250 30
```

Immediately change the keyboard's delay (250 ms) and repeat rate (30/s)

User controlled settings:

X-Server can also be controlled to provide certain configurations when X-client programs are started using the `~/.Xresources` file.

Note: In SuSE `~/.Xresources` is a symbolic link to `~/.Xdefaults`

Sequence for reading resource files:
Global config files for each separate X-program are first read from the directory: /usr/lib/X11/app-defaults/* and then the ~/.Xresources file is read. Any user- and machine-specific resources may be specified by setting the XENVIRONMENT environment variable to the name of a resource file to be loaded by all applications. If this variable is not defined, a file named ~/.Xdefaults-hostname is looked for instead, where hostname is the name of the host where the application is executing.

File format for resources files

~/.Xresources

X-ProgramName*attribute: value

Example: (commented lines start with a '!')

xterm*background:    LightYellow2
xterm.eightBitInput: true
! xterm*font: -adobe-courier-bold-r-normal--14-140-75-75-m-90-iso8859-1

These parameters can be overridden by starting an X-Program with arguments.

xterm -fn 9x15bold -geometry 100x40+30+40 -bg LightYellow2 \
-T "Test_Xterm" -sb -rightbar

X11 Fonts and Fonts server

Fonts are listed in XF86Config by the keyword FontPath in the Files section

FontPath "/usr/X11R6/lib/X11/fonts/TrueType"
FontPath "/usr/X11R6/lib/X11/fonts/75dpi:unscaled"

Font servers can also be listed but MUST be first in the list:

FontPath "unix:/7100"

Font server on local Unix socket – runs on port 7100

xset

Temporarily change the X-Server's FontPath settings as it runs:

xset +fp /usr/X11R6/lib/X11/fonts/TrueType
or
xset fp+/usr/X11R6/lib/X11/fonts/TrueType

Adds a FontPath

xset -fp /usr/X11R6/lib/X11/fonts/TrueType
or
xset fp-/usr/X11R6/lib/X11/fonts/TrueType

Deletes a FontPath

Setting-up a Font server (xfs)

xfs is the standard Font Server which listens for requests on port 7100. (do not confuse
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the name of the font server (xfs) with the filesystem from SGI (XFS) – note the capitalization

Settings of client XF86Config configuration file:

```
FontPath "unix:/7100"
   Local Font server on Unix socket
#FontPath "tcp/myserver.fd.com:7100"
   Remote font server
```

xfs configuration file:

```
/etc/X11/fs/config
or
/etc/X11/xfs.conf
```

Starting the font server as a daemon:

```
xfs -config /etc/X11/fs/config -daemon
```

Example xfs configuration file:
no-listen = tcp
port = 7100
client-limit = 10
clone-self = on
use-syslog = on
deferglyphs = 16
catalogue = /usr/X11R6/lib/X11/fonts/misc:unscaled,
          /usr/X11R6/lib/X11/fonts/75dpi:unscaled,
          /usr/X11R6/lib/X11/fonts/100dpi:unscaled,
          /usr/X11R6/lib/X11/fonts/japanese:unscaled,
          /usr/X11R6/lib/X11/fonts/baekmuk:unscaled,
          /usr/X11R6/lib/X11/fonts/Type1,
          /usr/X11R6/lib/X11/fonts/URW,
          /usr/X11R6/lib/X11/fonts/Speedo,
          /usr/X11R6/lib/X11/fonts/CID,
          /usr/X11R6/lib/X11/fonts/PEX,
          /usr/X11R6/lib/X11/fonts/cyrillic,
          /usr/X11R6/lib/X11/fonts/latin2/misc,
          /usr/X11R6/lib/X11/fonts/latin2/75dpi,
          /usr/X11R6/lib/X11/fonts/latin2/100dpi,
          /usr/X11R6/lib/X11/fonts/latin2/Type1,
          /usr/X11R6/lib/X11/fonts/latin7/75dpi,
          /usr/X11R6/lib/X11/fonts/latin7/100dpi,
          /usr/X11R6/lib/X11/fonts/latin7/Type1,
          /usr/X11R6/lib/X11/fonts/uni,
          /usr/X11R6/lib/X11/fonts/cygnus,
          /usr/X11R6/lib/X11/fonts/10dpi,
          /usr/X11R6/lib/X11/fonts/20dpi,
          /usr/X11R6/lib/X11/fonts/hellas/misc,
          /usr/X11R6/lib/X11/fonts/hellas/75dpi,
          /usr/X11R6/lib/X11/fonts/hellas/100dpi,
          /usr/X11R6/lib/X11/fonts/hellas/Type1

# in decipoints
default-point-size = 120
default-resolutions = 75,75,100,100
# font cache control, specified in KB
cache-hi-mark = 2048
cache-low-mark = 1433
cache-balance = 70

Format of font names

<table>
<thead>
<tr>
<th>Author</th>
<th>Weight</th>
<th>Width</th>
<th>Pixels</th>
<th>XRes</th>
<th>Spacing</th>
<th>ISO-Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>-b&amp;h-lucida-medium-r-normal-sans-18-180-75-75-p-106-iso8859-1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fontname              Attribute Style Points YRes Average Options
(i or * =Italic)   (1/72 in) Width (r =roman)

Installing new fonts

New fonts need some preparation before they can be used. Besides the font files (with
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extensions .bdf .snf .pcf) located in the font directories, some extra files need attention:

fonts.dir

Contains the number of fonts available in this directory (on first line) and one line per
font description. The format is:

First line: Number of fonts listed in this file. (eg. 439)
Rest of file: FontFilename Font_Description

Example:

439
putbi.pfa -adobe-Utopia-bold-i-normal—0-0-0-0-p-0-adobe-standard
putbi.pfa -adobe-Utopia-bold-i-normal—0-0-0-0-p-0-iso10646-1
putbi.pfa -adobe-Utopia-bold-i-normal—0-0-0-0-p-0-iso8859-1
...

To create this file the program mkfontdir must be run

Syntax:
mkfontdir /path/to/font/directory

Valid font types: PCF (.pcf), SNF (.snf) and BDF (.bdf)

fonts.alias

List entered by manually assigning a non existing font name to an existing one. Format:

alias_name existing_name

Example:

fixed        -misc-fixed-medium-r-semicondensed—13-120-75-75-c-60-
iso8859-1
variable     -*.helvetica-bold-r-normal.--120.--*-.-*-iso8859-1
5x7          -misc-fixed-medium-r-normal—7-70-75-75-c-50-iso8859-1
5x8          -misc-fixed-medium-r-normal—8-80-75-75-c-50-iso8859-1
x9           -misc-fixed-medium-r-normal—9-90-75-75-c-60-iso8859-1
6x10         -misc-fixed-medium-r-normal—10-100-75-75-c-60-iso8859-1
6x12         -misc-fixed-medium-r-semicondensed—12-110-75-75-c-60-
iso8859-1
6x13         -misc-fixed-medium-r-semicondensed—13-120-75-75-c-60-
iso8859-1
6x13bold     -misc-fixed-bold-r-semicondensed—13-120-75-75-c-60-
iso8859-1
...

fonts.scale

List of fonts that are scalable. The format is:

First line: Number of fonts listed in this file.(eg. 439)
Rest of file: FontFilename Font_Description

Example

439
putbi.pfa -adobe-Utopia-bold-i-normal—0-0-0-0-p-0-adobe-standard
putbi.pfa -adobe-Utopia-bold-i-normal—0-0-0-0-p-0-iso10646-1
putbi.pfa -adobe-Utopia-bold-i-normal—0-0-0-0-p-0-iso8859-1
...

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110.2 Set up a display manager

Description: 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 Manager), GDM (Gnome Display Manager) and KDM (KDE Display Manager).

Weight: 3
Key files, terms, and utilities:
- /etc/inittab
- /etc/X11/xdm/*
- /etc/X11/kdm/*
- /etc/X11/gdm/*

Starting an X session
An X session can be started in 2 ways:

Log in from a virtual terminal (text based) and then run the script startx.

startx in turns starts xinit.

xinit configuration file:

```bash
$HOME/.xinitrc
```

if found otherwise

```bash
/var/X11R6/lib/xinit/xinitrc
```

Via an X-Display-Manager (XDM): The user log-in in is done graphically.

The display manager is started at boot time (runlevel 5) in the background as a daemon and provides graphical logins to users.

Note: For this we need to make sure that default runlevel is set to 5 in /etc/inittab

Display managers

Popular display managers are

<table>
<thead>
<tr>
<th>Name</th>
<th>Config file directory</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>xdm</td>
<td>/etc/X11/xdm/</td>
<td>Provided by XFree86</td>
</tr>
<tr>
<td>kdm</td>
<td>kde_rootdir/share/config/kdm/</td>
<td>Provided by KDE</td>
</tr>
<tr>
<td>gdm</td>
<td>gnome_rootdir/gdm/</td>
<td>Provided by Gnome</td>
</tr>
</tbody>
</table>

kde_rootdir
Main root directory for kde desktop system. For kde3 it is:

```
/etc/opt/kde3
```

gnome_rootdir
Main root directory for Gnome desktop system. For Gnome 2 it is:

```
/etc/opt/gnome
```
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Properties of the Display Managers

kdm is based on xdm and uses many of its configuration files.
gdm is a new development and is therefore independent from xdm.

**xdm configuration**

xdm is a typical X11 program and offers only a logo, background and login fields. The parameters to change its behaviour are in:

`/etc/X11/xdm/Xresources`

Example:

```
xlogin*greeting: Welcome at CLIENTHOST
xlogin*namePrompt: \040\040\040\040\040\040\040Login:
xlogin*fail: Login incorrect
xlogin*login.greetFont: -FAMILY-bold-SLANT-normal-*140*-.*.*
iso8859-1
xlogin*login.promptFont: -FAMILY-bold-r-normal-*120*-.*.*
iso8859-1
xlogin*login.Font: -FAMILY-medium-r-normal-*120*-.*.*
iso8859-1
xlogin*logoFilename /xxxxx.xpm
xlogin*borderWidth
xlogin*useShape: true
xlogin*greetColor: CadetBlue
xlogin*failColor: red
xlogin*borderWidth: 0
xlogin*frameWidth: 5
xlogin*innerFramesWidth: 2
xlogin*Foreground: black
xlogin*Background: #c0c0c0
xlogin*shdColor: #828282
xlogin*hiColor: #e0e0e0
```

xdm runs a script called `/etc/X11/xdm/Xsetup` each time it presents a login window. There we can run programs that change the background etc.

Some examples of programs: `xpmroot`, `xsetbg` etc

```
/usr/sbin/xpmroot /etc/X11/xdm/background.xpm
```

**kdm configuration**

kdm works quite similar to xdm and uses many of its configuration files in:

`/etc/X11/xdm/

The main kdm configuration file is:

```
kde_rootdir/share/config/kdm/kdmrc
```

The pictures of the users shown in kdm login are (valid formats: .xpm or .png)

```
kde_rootdir/share/apps/kdm/pics/users/username.png
```

The default is `default.png`
gdm configuration

gdm has its own configuration files separate from xdm/kdm. Main configuration file:

    gnome_rootdir/gdm/gdm.conf

Method of configuring gdm.conf:

    manual (editor) and (much better) through the config program: gdmconfig

Other tool for configuring individual user's pictures in gdm login:

    gdmphotosetup

Running XTerminals using xdm/kdm

Note 1: The display port number (:2 etc) can be chosen at will from the client as long as
the same port is not chosen multiple times in the same client host. This number can also
be eg. :2.0 which means the first graphic card used (0). Since it's mostly the case we only
use eg. :2 and it's enough.

Note 2: For these configuration files changes to take effect kdm/xdm needs to be
restarted.

Activate XDMCP (XDM Control Protocol)

Edit /etc/X11/xdm/xdm-config, add a '!' at the beginning of the following line (normally the
last line):

    !DisplayManager.requestPort: 0

Edit the file /etc/opt/kde3/share/config/kdm/kdmrc: to enable Xdmcp and restrict the
shutdown to only Root

    [Xdmcp]
    Enable=true
    [X-*:-Core]
    AllowShutdown=Root

Allow access through the network

Edit /etc/X11/xdm/xaccess:

For direct query from a client

On server:

Enter or activate (remove the '#') the following lines:

    *                   #Allow any host to remotely login
    or
    *.linux.local       #Allow any host from my domain
    or
    myhost.linux.local  #allow only myhost to remotely login

The client uses a command like

    X -query kdmserver :1
Topic 110: The X Window System

For Broadcast or indirect queries from clients
On server:
   Enter or activate (remove the '#') the following lines:
   *
   or
   *.linux.local
   or
   myhost.linux.local
  CHOOSER BROADCAST

The client uses the command:
   X -broadcast :2
   or
   X -indirect kdmserver :2

For Unattended x-login
xdm/kdm actively initiates the contact with the client. The client doesn't have to make a request: He only needs to start his X-Server on the right display port is necessary.

On server:
   Edit the file
   kde_rootdir/share/config/kdm/Xservers
   enter the following line:
   XTerminalName:2 foreign
   where  XTerminalName=Client Host name or IPNr.

The client uses the command:
   X :2

gdm XDMCP configuration
Use the program
   gdmconfig ---> Expert sub-menu ---> Activate XDMCP
or
Edit the file gnome_rootdir/gdm/gdm.conf
   Enable the Xdmcp:
   [xdmcp]
   Enable=true
1.110.4 Install & Customize a Window Manager Environment

**Description:** 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.), verifying and resolving library dependency issues for X applications, exporting X-display to a client workstation.

**Weight:** 5

**Key files, terms, and utilities:**
- `.xinitrc`
- `.Xdefaults`
- `xhost`
- `DISPLAY` environment variable

**Window manager**

The window managers allow application windows to be moved, resized or iconified. Most display a window title bar, some also display a menu system or allow drag-&-drop between applications.

Common window managers

- `twm`
- `mwm`
- `olwm`
- `fvwm`
- `kwin`
- `windowmaker`,
- `etc`

Configuration files of window managers:

Different for each one but most seem to have a `.xxxxrc` format. They are normally in the `$HOME` directory. Examples:

- `.mwmrc`
- `.fvwm2rc`
- `.olwmrc`
- `etc`

**Configuration of X Clients (X programs)**

Many X Clients will accept many of the following X11 standard parameters:

```
 xterm -T "Title" -fn 9x15 -display :0 -geometry 100x40+30+40
```

**-geometry**

This option positions and sizes the window when starting an X Client

Syntax:

```
 -geometry <Hsize>x<Vsize><Hpos><Vpos>
```

- `<Hsize>` and `<Vsize>` are numbered in characters
Topic 110: The X Window System

<Hpos> '+ ' is down, '- ' is up (in screen pixels). E.g. +10 is down 10 pixels
<Vpos> '+ ' is right, '- ' is left (in screen pixels). E.g. +10 is right 10 pixels

Examples:
-geometry 1x1+0+0
  1 char Horiz, 1 char Vert, top left corner
-geometry 5x20-10+30
  5 characters wide horizontally,
  20 characters tall vertically,
  Positioned in top right corner
    10 pixels horizontally to the left
    30 pixels down vertically

Note: The geometry can also be set for individual X clients by editing ~/.Xresources.
Example:
Xterm*geometry: 90x30

Selecting a font for X Clients

-fn fontname
Specifies a font to use in the window
Short list of some fixed-sized fonts:
  7x14  6x10  6x13  8x13  9x15  10x20
  xterm -fn 10x20
  or
  xterm -fn -misc-fixed-medium-r-normal--20-200-75-75-c-100-iso8859-1

Note: Fonts can also be set for individual X clients by editing ~/.Xresources
Xterm*font: 90x30

~/.Xresources or ~/.Xdefaults file
Note: in SuSE ~/.Xresources is a symbolic link to ~/.Xdefaults
File syntax:
  ProgramName*Resource: Value
Examples of Xterm settings in ~/.Xresources
Actualizing changes made in the ~/.Xresources file without restarting the X Server:

xrdb -merge .Xresources

**Starting an X session with startx**

Log in from a virtual terminal (text based) and then run the script startx.

startx in turns starts xinit.

xinit startx the X Server then starts the xinitrc script file ($HOME/.xinitrc if found otherwise /var/X11R6/lib/xinit/xinitrc)

Content of xinitrc script:

System wide configured key definitions are loaded. Definitions are in:

/etc/X11/Xmodmap

and

~/.Xmodmap

System wide configured Resources definitions are loaded. Definitions are in:

/etc/X11/Xresources,

~/.Xresources,

~/.Xdefaults

A user's manually entered programs may start here

The selected window manager is started.

**Starting an X session with xdm/kdm/gdm**

When a user does login via a display manager, a similar process to startx will occur; the difference is the script that will be run is:

/etc/X11/xdm/Xsession

and

~/.Xsession

(if it exists)

Note: Some distributions are running the ~/.xinitrc from Xsession to keep the same environment consistent.
X11 on the network

Preparing the X Client

Since almost all X Client programs can use the argument -display :xx, we can start a client program and send its output to any existing X server that will allow the connection.

All X Client programs need to know where the X Server intended to host the program is located. This information is given to the program when we start it either via the above argument (-display :xx.xx) or via the environment variable DISPLAY.

To do so the following command prepares the content of this variable:

    export DISPLAY=X-ServerHost:xx

then run the X client program.

Preparing the X-Server

X-Servers by default allow only the localuser's programs to be displayed. For other users or hosts to be allowed to display their X-Client programs on it, the X-Server needs to be told to do so. The notification is done with command xhost.

Syntax:

    xhost [+|-] ClientHostName

Examples:

    xhost + localhost
    Allows other users X-clients on the local host to use this X-server.
    xhost +
    Allows everybody from anywhere to use this X-Server. Dangerous!!!
    xhost + myfriend
    Allows XClient programs on the host myfriend to use this local X-Server.
    xhost – bugger
    Disallows host “bugger” to use this X-Server.

Note 1: Only the owner of the X-Server process is allowed to issue the xhost command.

Permanently allowing access to an X-Server

There are 2 regular methods to permanently a list of hosts access to the local X-Server:

1. Edit the file enter the command xhost for all the hosts allowed in ~/.xinitrc script, or
2. Create a file called /etc/Xn.hosts and enter all the hosts allowed to use the local X-Server. (n=X-Server display port number.)

Checking library dependencies for X-Client programs

In the matter of library dependencies, there is no difference between normal programs and X-Client programs. The program ldd does the job.
Glossary of Terms

This list contains the complete list of terms assumed by LPI tests. Knowledge of these terms will be important in preparing for LPI exams, but no exam question should depend on knowledge gleaned solely from this list.

Note that the list will be updated occasionally (so it is not yet exhaustive). If you have any additions or comments, please let us know.

The purpose of this list is to delineate the terms (jargon and acronyms) that will be used in the LPI Linux certification exams. Before writing or reviewing items, please review this list (and check it out periodically afterwards as updates occur).

Any jargon term or acronym which does not appear on this list, or is in the "deprecated alternatives" column, should NOT be used in an LPI test.

If this is not perfectly clear or if you need help deciding whether something is jargon or an acronym, please contact an appropriate LPI coordinator, the list maintainer or us.

Other useful and authoritative glossaries of terms can be found in these RFC's:

- RFC1208: A Glossary of Networking Terms
- RFC1983: Internet User's Glossary
- RFC2828: Internet Security Glossary (also see http://freesoft.org/CIE/RFC/Orig/rfc2828.txt)

For explanation of PC hardware components, see:

http://www.pcguide.com/ref/

<table>
<thead>
<tr>
<th>Term</th>
<th>Deprecated Alternatives</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>*NIX</td>
<td></td>
<td>A term for any operating system resembling UNIX(R)(TM), including Linux and a large number of free and commercial systems; also UN*X.</td>
</tr>
<tr>
<td>10Base2</td>
<td></td>
<td>So-called Thin Ethernet, using RG-58 coax cables and BNC connectors to construct a chain of cables, which must be terminated by resistors; supports a maximum (theoretical) transmission of 10 Mbit/s.</td>
</tr>
<tr>
<td>10Base5</td>
<td></td>
<td>The older Thick Ethernet, which used vampire taps into a single cable; supports a maximum (theoretical) transmission of 10 Mbit/s.</td>
</tr>
<tr>
<td>10BaseT</td>
<td></td>
<td>Ethernet over UTP cables, using hubs to produce a star topology; supports a maximum (theoretical) transmission of 10 Mbit/s.</td>
</tr>
<tr>
<td>100BaseT</td>
<td></td>
<td>Ethernet over UTP cables, using hubs to produce a star topology; supports a maximum (theoretical) transmission of 100 Mbit/s.</td>
</tr>
<tr>
<td>access</td>
<td></td>
<td>To connect to and utilize a device (computer, printer) or file.</td>
</tr>
<tr>
<td>account</td>
<td></td>
<td>The symbol or number that refers to a user for accounting purposes.</td>
</tr>
<tr>
<td>Term</td>
<td>Deprecated Alternatives</td>
<td>Comment</td>
</tr>
<tr>
<td>--------------</td>
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<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>address [1]</td>
<td></td>
<td>A location in memory; specifically, the I/O-port used by a device to communicate with the processor.</td>
</tr>
<tr>
<td>address [2]</td>
<td></td>
<td>A unique identifier assigned to an interface on a network-attached device such as a network interface card. Notice: a host can have multiple interfaces, hence multiple addresses.</td>
</tr>
<tr>
<td>address [3]</td>
<td></td>
<td>The name</td>
</tr>
<tr>
<td>administer</td>
<td></td>
<td>(to make it work. ;-) To control the operation and use of a computer or other device; the task of a system administrator.</td>
</tr>
<tr>
<td>algorithm</td>
<td></td>
<td>A formal description of a procedure that, when suitable input is entered, will generate output as a result that satisfies specific requirements.</td>
</tr>
<tr>
<td>alias [1]</td>
<td></td>
<td>Within a shell, a substitute word for a command string (e.g.: alias dir = &quot;ls --color&quot;).</td>
</tr>
<tr>
<td>alias [3]</td>
<td></td>
<td>Refers to another name given to an e-mail account, in order to accept mail for one e-mail address and forward it to another.</td>
</tr>
<tr>
<td>ALT</td>
<td></td>
<td>the Alternative key on a keyboard</td>
</tr>
<tr>
<td>analog</td>
<td></td>
<td>Refers to a physical measure that can take any value within a continuous range; e.g., the voltage used to encode loudness when transmitting a signal over a conventional copper telephone line. cf. digital.</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National</td>
<td>A standards body responsible for many protocols.</td>
</tr>
<tr>
<td></td>
<td>Standards Institute</td>
<td></td>
</tr>
<tr>
<td>API</td>
<td>Application Programming</td>
<td>A specification which allows simple access to functionality of a library or other system resources when writing a program; operating system functionality is made available through an API.</td>
</tr>
<tr>
<td></td>
<td>Interface</td>
<td></td>
</tr>
<tr>
<td>application</td>
<td></td>
<td>A program that runs on top of an operating system.</td>
</tr>
<tr>
<td>application</td>
<td>layer</td>
<td>The name of the top layer of both the seven-layer ISO/OSI model, and the four-layer TCP/IP protocol stack; although some of the functionality of the session and presentation layers of the former may be assigned to the latter. It includes protocols such as telnet, FTP, HTTP, SMTP, etc.</td>
</tr>
<tr>
<td>archive [1]</td>
<td></td>
<td>A backup of data to be preserved.</td>
</tr>
<tr>
<td>archive [2]</td>
<td>tarball</td>
<td>A file that contains one or more components and an index (e.g. in tar, cpio, rpm or deb format).</td>
</tr>
<tr>
<td>Term</td>
<td>Deprecated Alternatives</td>
<td>Comment</td>
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<tr>
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</tr>
<tr>
<td>argument</td>
<td></td>
<td>A piece of information passed to a command or function (usually typed in behind it), that modifies its behaviour, or that is operated upon by the command or function. e.g. in <code>cat motd</code>, &quot;motd&quot; is the argument. cf. parameter.</td>
</tr>
<tr>
<td>ARP</td>
<td>Address Resolution Protocol, arp</td>
<td>See RFC826. A low-level protocol which, given an IP address on the local network, returns the Ethernet MAC address of the corresponding interface. cf. RARP.</td>
</tr>
<tr>
<td>ASCII</td>
<td>American national Standard Code for Information Interchange</td>
<td>A specification of characters widely used in the UNIX world and beyond.</td>
</tr>
<tr>
<td>aspect ratio</td>
<td></td>
<td>The ratio between the width and the height of a pixel on a computer display.</td>
</tr>
<tr>
<td>assembler</td>
<td></td>
<td>A program that compiles programs written in assembly language into object code.</td>
</tr>
<tr>
<td>assembly language</td>
<td>assembler</td>
<td>A low-level computer language that can be translated directly to the object code of the computer processor.</td>
</tr>
<tr>
<td>ATA</td>
<td>AT Attachment</td>
<td>A popular 16-bit interface standard that extends the ISA bus of the IBM PC-AT to attach peripherals; it has evolved through over 5 generations; the original ATA is better known as IDE.</td>
</tr>
<tr>
<td>ATAPI</td>
<td>AT Attachment Packet Interface</td>
<td>An enhancement of the ATA protocol to be able to connect CD drives etc.</td>
</tr>
<tr>
<td>Authors</td>
<td>Super heroes, men and women of gold</td>
<td>This list was compiled by (in alpha order): Les Bell, David DeLano, Alan Mead, Tom Peters, Richard Rager.</td>
</tr>
<tr>
<td>background [1]</td>
<td></td>
<td>A state of process execution which does not produce output to the terminal (execution may stop if the process tries to write to the terminal); it is common to run system processes and long running user applications in the background; cf. foreground [1].</td>
</tr>
<tr>
<td>backup [1] (noun)</td>
<td></td>
<td>A copy of essential data stored on- or off-site as insurance against failures of system hardware, software or user.</td>
</tr>
<tr>
<td>backup [2] (verb)</td>
<td></td>
<td>To make a backup.</td>
</tr>
<tr>
<td>binary [1] (adj)</td>
<td></td>
<td>taking two discrete values (e.g. bits), as opposed to decimal (= taking ten discrete values).</td>
</tr>
<tr>
<td>binary [2] (noun)</td>
<td></td>
<td>A file that is not intended to be read by humans but by applications or the operating system; especially in plural (&quot;binaries&quot;) for compiled sources; cf. text.</td>
</tr>
<tr>
<td>Term</td>
<td>Deprecated Alternatives</td>
<td>Comment</td>
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</tr>
<tr>
<td>BIOS</td>
<td>Basic Input/Output</td>
<td>A simple, low-level operating system which supplies a uniform API to higher-level operating systems; BIOS is generally implemented in ROM of some sort.</td>
</tr>
<tr>
<td>bit</td>
<td></td>
<td>The smallest entity of information: can have one of two states (0-1, on-off, open-closed, etc.).</td>
</tr>
<tr>
<td>bitplanes</td>
<td>bit planes, bit-planes</td>
<td>The number of bits available for each display pixel to code for visual appearance (color, proximity, etc.).</td>
</tr>
<tr>
<td>block device</td>
<td></td>
<td>A device that exchanges data with the operating system in sizable blocks (e.g., 512 bytes) at a time.</td>
</tr>
<tr>
<td>boot loader</td>
<td></td>
<td>Software, usually installed on the MBR of Intel machines, which exists to load the operating system kernel and begin its functioning.</td>
</tr>
<tr>
<td>boot</td>
<td></td>
<td>To cause the operating system to begin to function. Takes its name from &quot;pulling oneself up by the bootstraps&quot;, a whimsical analogy applied to the BIOS loading itself and then running the &quot;boot loader&quot;. (Also reboot).</td>
</tr>
<tr>
<td>BOOTP</td>
<td></td>
<td>See RFC951; cf. DHCP.</td>
</tr>
<tr>
<td>bridge</td>
<td></td>
<td>A device that propagates packets between two computer networks; it operates at the second, data link layer within the ISO/OSI model, and broadcasts packets based on the address, but does not do routing. cf. repeater, router.</td>
</tr>
<tr>
<td>broadcast</td>
<td>(noun)</td>
<td>A frame or datagram addressed to all interfaces on a network.</td>
</tr>
<tr>
<td>BSD</td>
<td>Berkeley Systems</td>
<td>A variant of UNIX originally developed at the University of California, Berkeley. The BSD TCP/IP stack is the model for most subsequent TCP/IP implementations.</td>
</tr>
<tr>
<td>Distribution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>buffer</td>
<td></td>
<td>temporary storage; cf. cache</td>
</tr>
<tr>
<td>BUGTRAQ</td>
<td></td>
<td>A mailing list for discussions regarding network security (daemons, programs, operating systems, routers).</td>
</tr>
<tr>
<td>build</td>
<td></td>
<td>To run a sequence of compile and link steps to produce a new version of an executable program.</td>
</tr>
<tr>
<td>bus</td>
<td></td>
<td>A cable for transmitting signals between various components within one computer system.</td>
</tr>
<tr>
<td>byte</td>
<td></td>
<td>A data type of 8 bits.</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>A compiled computer language closely associated with UNIX.</td>
</tr>
<tr>
<td>C++</td>
<td></td>
<td>An object-oriented computer language derived from C, that needs a compiler.</td>
</tr>
</tbody>
</table>
### Glossary of Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Deprecated Alternatives</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>cache</td>
<td></td>
<td>Any readily accessible storage area used to keep data handy which is (somehow) indicated to be needed again shortly; the purpose being to speed up the access of that data and improve system performance. Specifically: the fast computer memory that is used as a buffer for data and program instructions between the CPU and the slower main memory (cf. RAM).</td>
</tr>
<tr>
<td>caching-only DNS</td>
<td></td>
<td>A domain name server that does not have any domains files.</td>
</tr>
<tr>
<td>Caldera OpenLinux</td>
<td>Caldera, OpenLinux, CSOL</td>
<td>A commercial Linux distribution.</td>
</tr>
<tr>
<td>card</td>
<td></td>
<td>Any device that can be plugged into a computer expansion slot.</td>
</tr>
<tr>
<td>CD-ROM</td>
<td>Compact Disc Read Only Memory</td>
<td>A removable medium of considerable popularity which comes in several variations, the most popular being ISO9660.</td>
</tr>
<tr>
<td>CERT</td>
<td>Computer Emergency Response Team</td>
<td>A team of people that study Internet security, and provide incident response services; see <a href="http://www.cert.org/">http://www.cert.org/</a></td>
</tr>
<tr>
<td>cf.</td>
<td></td>
<td>&quot;confer&quot;, which means &quot;consult&quot; in the meaning of &quot;also see&quot; or &quot;compare&quot;. N.B.: Avoid this. Use only in parenthetical examples (cf. e.g., i.e.) but avoid &quot;cf.&quot; by putting examples in text like this. Also see &quot;e.g.&quot;, &quot;i.e.&quot;.</td>
</tr>
<tr>
<td>CGI</td>
<td>Common Gateway Interface</td>
<td>A standard for allowing server applications to be executed as part of a HTTP request.</td>
</tr>
<tr>
<td>CHAP</td>
<td>Challenge Handshake Authentication Protocol</td>
<td></td>
</tr>
<tr>
<td>char</td>
<td>character</td>
<td>C data type (usually one byte) used to store letters (cf. character).</td>
</tr>
<tr>
<td>character</td>
<td>char</td>
<td>A letter or sign usually represented by 1 byte in ASCII code.</td>
</tr>
<tr>
<td>character device</td>
<td></td>
<td>A device which exchanges data with the operating system in one character (or byte or even word) at a time.</td>
</tr>
<tr>
<td>child process</td>
<td></td>
<td>Any process created by another, so-called parent process; usually used in reference to a particular parent process.</td>
</tr>
<tr>
<td>CIDR</td>
<td>Classless Inter-Domain Routing</td>
<td>See RFC1519; cf. variable length subnet mask</td>
</tr>
<tr>
<td>CIFS</td>
<td>Common Internet File System</td>
<td>Microsoft’s successor to SMB, a suite of protocols for sharing file and print services (among Windows machines or UN*X machines running CIFS servers like Samba).</td>
</tr>
<tr>
<td>Term</td>
<td>Deprecated Alternatives</td>
<td>Comment</td>
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</tr>
<tr>
<td>clean</td>
<td></td>
<td>In reference to a drive being mounted, clean means that the drive was unmounted properly and thus (theoretically) does not need to be checked; otherwise a drive is dirty</td>
</tr>
<tr>
<td>client</td>
<td></td>
<td>A computer or process which connects to and receives a service from a server computer or process.</td>
</tr>
<tr>
<td>coax</td>
<td>co-axial cable</td>
<td>Cable with inner and outer conductors used for TV cables and for Ethernet LANs, where the computers usually have T-joints to attach to a single chain of cables which needs to be terminated by resistors.</td>
</tr>
<tr>
<td>colormap</td>
<td>color map, color-map, color table</td>
<td>A table used to encode a palette of colors for images.</td>
</tr>
<tr>
<td>command line interface</td>
<td>CLI</td>
<td>An interactive user interface which allows commands to be given to a computer program or shell through a text-based terminal (or terminal emulator in a window within a graphical user interface).</td>
</tr>
<tr>
<td>compiler</td>
<td></td>
<td>A program which examines program source code and translates it into an equivalent object code file; cf. interpreter.</td>
</tr>
<tr>
<td>compression</td>
<td></td>
<td>Removal of redundant information from a file or data stream, to reduce its size, the storage space it needs, or the time needed for transmission. Lossy compression actually discards information that is considered not essential, and is only appropriate for data like images or sound.</td>
</tr>
<tr>
<td>computer</td>
<td></td>
<td>A digital, electronic, general-purpose, programmable, information processing automate.</td>
</tr>
<tr>
<td>console</td>
<td></td>
<td>The primary, directly attached, user interface of a computer. Some system administration functions may only be performed at a console.</td>
</tr>
<tr>
<td>control panel</td>
<td></td>
<td>A collection of buttons, switches, lights or display used to configure and control a router, printer, computer or other device.</td>
</tr>
<tr>
<td>core dump</td>
<td>coredump</td>
<td>The content of memory written to a file on disk (usually called &quot;core&quot;) when a program crashes.</td>
</tr>
<tr>
<td>corrupted</td>
<td></td>
<td>damaged (said of a file or disk contents)</td>
</tr>
<tr>
<td>CPU</td>
<td>Central Processing Unit</td>
<td>The main component that makes a computer work; these days usually a &quot;micro-processor&quot; on a single silicon chip (cf. processor).</td>
</tr>
<tr>
<td>crack</td>
<td></td>
<td>To gain access to a computer system without proper authorization (e.g. by guessing a legitimate user's password), and possibly interfere with its normal operation or integrity.</td>
</tr>
<tr>
<td>Term</td>
<td>Deprecated Alternatives</td>
<td>Comment</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>cracker [1]</td>
<td></td>
<td>Someone who tries to crack; cf. hacker.</td>
</tr>
<tr>
<td>cracker [2]</td>
<td>crack</td>
<td>A software program used to crack, for instance by guessing passwords.</td>
</tr>
<tr>
<td>crash</td>
<td></td>
<td>A sudden stop of normal operation. Supposedly, the original hard drives would sometimes experience a catastrophic failure in which the read/write heads would crash into the media, possibly sending the media flying; hence a crash is an unintentional termination of software or hardware due to some failure or error - especially a termination in a final, catastrophic, or unpleasant way.</td>
</tr>
<tr>
<td>CSLIP</td>
<td>Compressed Serial Line IP</td>
<td>SLIP with added VJ compression of IP headers. See RFC1144.</td>
</tr>
<tr>
<td>CTRL</td>
<td></td>
<td>the Control key on a keyboard</td>
</tr>
<tr>
<td>current working directory</td>
<td>cwd</td>
<td>A number of tracks located at the same radius on the several surfaces of a hard disk. A hard disk with four platters has eight surfaces, so that at each position of the read-write heads, eight tracks can be read without head movement and these eight tracks form a cylinder.</td>
</tr>
<tr>
<td>daemon</td>
<td></td>
<td>A program that runs in the background to offer system services.</td>
</tr>
<tr>
<td>data</td>
<td></td>
<td>&quot;that which is given&quot;, for instance as input to a computer; cf. information.</td>
</tr>
<tr>
<td>data link layer</td>
<td></td>
<td>Layer two of the ISO/OSI seven-layer model. Responsible for establishing an error-free communication path between network nodes over the physical link layer, it frames messages for transmission, checks the integrity of received messages, manages access to and use of the media, and ensures proper sequencing of transmitted data. These functions are generally provided by a network card driver. The IEEE in its 802.x series of standards splits this layer in two: the LLC layer and the underlying MAC layer.</td>
</tr>
<tr>
<td>database [2]</td>
<td></td>
<td>A program to manage a database and extract information from it.</td>
</tr>
<tr>
<td>datagram</td>
<td></td>
<td>packet, especially as used in UDP (Note: not IP-specific - other protocols use the term datagram in their documentation).</td>
</tr>
</tbody>
</table>
# Glossary of Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Deprecated Alternatives</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Debian</td>
<td>DEBorah &amp; IAN (Murdock)</td>
<td>A GNU/Linux distribution built by a volunteer organization.</td>
</tr>
<tr>
<td>default</td>
<td></td>
<td>The value of a parameter that a program uses if it is not explicitly given a value.</td>
</tr>
<tr>
<td>DEL</td>
<td></td>
<td>the Delete key on a keyboard</td>
</tr>
<tr>
<td>delete</td>
<td></td>
<td>remove or erase a file</td>
</tr>
<tr>
<td>dependency</td>
<td></td>
<td>A state in which other libraries</td>
</tr>
<tr>
<td>DES</td>
<td>Data Encryption Standard</td>
<td>A USA government-sanctioned standard for the encryption of data now considered insecure to high-end brute force attacks.</td>
</tr>
<tr>
<td>desktop</td>
<td></td>
<td>The screen from which all programs are started and run on X.</td>
</tr>
<tr>
<td>device [1]</td>
<td></td>
<td>A &quot;peripheral&quot; piece of hardware that is an optional part or can be attached to a computer (even one that is actually housed within the computer’s casing): interface cards, drives, printers etc.</td>
</tr>
<tr>
<td>device [2]</td>
<td></td>
<td>The software interface used within Unix (Linux) to represent a computer peripheral: interface cards, drives, printers, etc.; see the / dev/ directory .</td>
</tr>
<tr>
<td>DHCP</td>
<td>Dynamic Host Configuration Protocol</td>
<td>Provides for automatic downloading of IP address and other configuration data from a server to a client. Allows for reuse of IP addresses so that the number of hosts can exceed the number of available IP addresses. See RFC2131, cf. BOOTP.</td>
</tr>
<tr>
<td>dial-in, dial-up,</td>
<td>Refers to a connection made over the Public Switched Telephone Network (PSTN), as opposed to a permanent, or leased-line, connection.</td>
<td></td>
</tr>
<tr>
<td>dial-out (adj)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>die</td>
<td></td>
<td>To cease execution, especially in a final or complete manner.</td>
</tr>
<tr>
<td>digital</td>
<td></td>
<td>Refers to an entity that can assume only a limited number of discrete states and not an arbitrary value; e.g. binary. cf. analog.</td>
</tr>
<tr>
<td>directory</td>
<td></td>
<td>A special type of file which contains information about other files, such as file name, location, permissions, size etc.</td>
</tr>
<tr>
<td>dirty</td>
<td></td>
<td>not clean</td>
</tr>
<tr>
<td>disk</td>
<td></td>
<td>Rotating magnetic media which supports direct or random access; cf. floppy disk, hard disk.</td>
</tr>
<tr>
<td>Term</td>
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<td>Comment</td>
</tr>
<tr>
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</tr>
<tr>
<td>display</td>
<td>screen</td>
<td>A human readable device to display text, graphics or other data.</td>
</tr>
<tr>
<td>distribution</td>
<td></td>
<td>A (usually) complete collection of software needed to operate a computer including the Linux kernel and various utilities and applications.</td>
</tr>
<tr>
<td>DMA</td>
<td>Direct Memory Access</td>
<td>A hardware protocol which allows a special controller circuit (DMA controller) to transfer a block of data from a peripheral device's buffer memory directly to main memory without CPU involvement; cf. PIO.</td>
</tr>
<tr>
<td>DNS</td>
<td>Domain Name System</td>
<td>A hierarchically-structured distributed directory service which translates human-intelligible names like <a href="http://www.lpi.org">www.lpi.org</a> into the corresponding IP addresses. See RFC's 1034 and 1035 and also 1032 and 1033.</td>
</tr>
<tr>
<td>documentation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>domain name</td>
<td>DNS, nameserver</td>
<td></td>
</tr>
<tr>
<td>server</td>
<td></td>
<td></td>
</tr>
<tr>
<td>domain [1]</td>
<td></td>
<td>One or more computer networks that serve an organizational group.</td>
</tr>
<tr>
<td>domain [2]</td>
<td></td>
<td>The name assigned to a network domain.</td>
</tr>
<tr>
<td>drive</td>
<td></td>
<td>Any device that can store and retrieve data in a relatively permanent fashion on media (which may be removable or built into the device).</td>
</tr>
<tr>
<td>driver</td>
<td></td>
<td></td>
</tr>
<tr>
<td>dynamic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e.g.</td>
<td></td>
<td>&quot;for example&quot; (Latin: &quot;exemplum gratii&quot;). N.B.: Avoid this. Use only in parenthetical examples (e.g., like this) but avoid &quot;e.g.&quot; by putting examples in text like this. Do not confuse with &quot;i.e.&quot;. Also see &quot;cf.&quot;.</td>
</tr>
<tr>
<td>editor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EIDE</td>
<td>Enhanced IDE</td>
<td>Western Digitals proprietary extension of the IDE interface standard with ATA-2 and ATAPI features, used to connect hard drives and CD-ROMS to a PC.</td>
</tr>
<tr>
<td>e-mail</td>
<td>email, electronic mail</td>
<td></td>
</tr>
<tr>
<td>emulate</td>
<td></td>
<td>To simulate the actions of a device or program so that the simulation can actually perform the same functions as the original.</td>
</tr>
<tr>
<td>emulator</td>
<td></td>
<td>A program that emulates the functions of some device or other program.</td>
</tr>
<tr>
<td>environment</td>
<td></td>
<td>A collection of variables associated with a process so that it knows about the user preferences and configuration of the system; they are inherited by a child process.</td>
</tr>
<tr>
<td>Term</td>
<td>Deprecated Alternatives</td>
<td>Comment</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>environment variables</td>
<td>envars, environmental variables</td>
<td>The variables that define an environment.</td>
</tr>
<tr>
<td>ergonomic</td>
<td></td>
<td>easy to use by humans</td>
</tr>
<tr>
<td>ESC</td>
<td></td>
<td>the Escape key on a keyboard</td>
</tr>
<tr>
<td>Ethernet</td>
<td></td>
<td>A type of LAN computer network interface using coax (10Base2 or 10Base5) or UTP cables (10BaseT or 100BaseT). The specifications are described in IEEE standard 802.2. cf. MAC.</td>
</tr>
<tr>
<td>event</td>
<td></td>
<td></td>
</tr>
<tr>
<td>execute</td>
<td></td>
<td>To set to work (a program); cf. run.</td>
</tr>
<tr>
<td>execute permission</td>
<td></td>
<td>Permission set on a file on a Unix filesystem so that it may be run as a program by the &quot;operating system.</td>
</tr>
<tr>
<td>executable</td>
<td></td>
<td>A file that is a binary or a script that can be run as a program (may assume execute permission).</td>
</tr>
<tr>
<td>export</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FAT</td>
<td>File Allocation Table</td>
<td>A simple filesystem using a table to index files on a block device (floppy or hard disk). It comes in the varieties of FAT-12 (MS-DOS), FAT-16 (MS-DOS, MS-Windows 3.x) and &quot;FAT-32&quot; (MS-Windows 9x).</td>
</tr>
<tr>
<td>FHS</td>
<td>Filesystem Hierarchy Standard</td>
<td>A proposed standard for the location of files on a Unix system. See <a href="http://www.pathname.com/fhs/">http://www.pathname.com/fhs/</a>.</td>
</tr>
<tr>
<td>file</td>
<td></td>
<td>A named sequence or stream of bytes at a known location in storage.</td>
</tr>
<tr>
<td>filesystem</td>
<td>file system</td>
<td>The data structures placed on a logical disk or partition (by mkfs) which allow the operating system to record information about files stored there.</td>
</tr>
<tr>
<td>filter</td>
<td></td>
<td>To remove unwanted data.</td>
</tr>
<tr>
<td>firewall</td>
<td></td>
<td>A gateway that restricts data communication between the &quot;inside&quot; network and the Internet &quot;outside&quot; the firewall.</td>
</tr>
<tr>
<td>floating-point (adj)</td>
<td></td>
<td>used with numbers that may represent a fraction; cf. integer</td>
</tr>
<tr>
<td>floppy disk</td>
<td>floppy, diskette</td>
<td>A magnetic storage medium with a flexible disk inside; cf. hard disk.</td>
</tr>
<tr>
<td>floppy drive</td>
<td>floppy</td>
<td>A device that can read and write floppy disks.</td>
</tr>
<tr>
<td>font</td>
<td></td>
<td>The shape of each of the letters in a character set.</td>
</tr>
<tr>
<td>foreground [1]</td>
<td></td>
<td>The context in which a process is having access to a terminal for output, i.e. is not running in the background.</td>
</tr>
</tbody>
</table>
**Glossary of Terms**

<table>
<thead>
<tr>
<th>Term</th>
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</tr>
</thead>
<tbody>
<tr>
<td>foreground [2]</td>
<td></td>
<td>The color of text on a computer display (as opposed to the text's background).</td>
</tr>
<tr>
<td>foreground [3]</td>
<td></td>
<td>Refers to the window 'in front of' all others and with which the user is interacting.</td>
</tr>
<tr>
<td>fork (verb)</td>
<td></td>
<td>When an executing process creates an exact executing duplicate (except for the different PID) of itself; see child process, spawn.</td>
</tr>
<tr>
<td>format [1] (noun)</td>
<td></td>
<td>Specification regarding how data are stored.</td>
</tr>
<tr>
<td>format [2] (verb)</td>
<td></td>
<td>To apply the requisite format to storage media in preparation to making a filesystem.</td>
</tr>
<tr>
<td>forwarding</td>
<td></td>
<td>The act of receiving an e-mail and then resending it to another destination.</td>
</tr>
<tr>
<td>frame</td>
<td></td>
<td>A packet as assembled and transmitted over the physical layer of a network (e.g. Ethernet, Token Ring, etc.).</td>
</tr>
<tr>
<td>free [1]</td>
<td></td>
<td>Not costing anything.</td>
</tr>
<tr>
<td>free [2]</td>
<td></td>
<td>Not inhibited. As applied to source code it allows modification, study and adaptation, not inhibited by excessively restrictive commercial license terms. cf. GPL, Free Software Foundation.</td>
</tr>
<tr>
<td>FSF</td>
<td></td>
<td>Free Software Foundation: a tax-exempt charity that raises funds for work on the GNU project; see <a href="http://www.fsf.org">http://www.fsf.org</a>.</td>
</tr>
<tr>
<td>FSSTND</td>
<td>FileSystem StaNdarD</td>
<td>A standard for the location of files on a Linux system; replaced by the FHS.</td>
</tr>
<tr>
<td>FTP</td>
<td>File Transfer Protocol</td>
<td>A protocol for transferring files over the Internet and the software to accomplish the transfer. See RFC959.</td>
</tr>
<tr>
<td>gateway</td>
<td></td>
<td>A device or relay mechanism that connects two or more computer networks and which directs packets between the networks in an internet. In common usage today, a gateway is a general-purpose computer with a general-purpose operating system [e.g. Linux] which <em>may</em> be performing other functions, and in that role it operates at the third, network layer in the ISO/OSI model; while a router is a special-purpose computer with a special purpose operating system [e.g. IOS], generally from a specialist supplier [e.g. Cisco]). cf. bridge.</td>
</tr>
<tr>
<td>GB</td>
<td>giga-byte, gigabyte, GigaByte, GigaByte, Gb</td>
<td>1000 (or rarely 1024) MB (1,000,000,000 or 1,048,576,000 or 1,073,741,824 bytes)</td>
</tr>
<tr>
<td>GID</td>
<td></td>
<td>Group ID</td>
</tr>
</tbody>
</table>
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</thead>
<tbody>
<tr>
<td>global</td>
<td></td>
<td>A variable, configuration section, procedure etc. having a scope which is unlimited (i.e., applies everywhere unless contradicted locally)</td>
</tr>
<tr>
<td>GNU</td>
<td>GNU’s Not Unix</td>
<td>A Free Software Foundation project to build Unix(R)(TM)-compatible utilities and programs exclusively based on free program source code.</td>
</tr>
<tr>
<td>GPL</td>
<td>General Public License</td>
<td>A license for distribution of free software which permits copying, modification and redistribution. It was created by the Free Software Foundation for its projects like GNU, and has been applied to Linux as well. See <a href="http://www.gnu.org/copyleft/gpl.html">http://www.gnu.org/copyleft/gpl.html</a></td>
</tr>
<tr>
<td>graphics</td>
<td></td>
<td>images, pictures; in contrast to text</td>
</tr>
<tr>
<td>graphical user</td>
<td>GUI</td>
<td>An interactive interface using a graphics display. N.B.: refer to a &quot;graphical user interface&quot; only if there actually is a graphical interface (like X), and do not use it for interactive programs on text terminals (based on ncurses or slang). Use &quot;interactive interface&quot; as a catch-all. cf. command line interface.</td>
</tr>
<tr>
<td>group</td>
<td></td>
<td>Refers to a list of one or more users having the same access rights; see /etc/groups .</td>
</tr>
<tr>
<td>hack</td>
<td></td>
<td>To accomplish a result in an unorthodox way.</td>
</tr>
<tr>
<td>hacker</td>
<td></td>
<td>Someone who hacks: a title assigned to people with remarkable computing skills; cf. cracker.</td>
</tr>
<tr>
<td>hang</td>
<td></td>
<td>cf. crash</td>
</tr>
<tr>
<td>hard disk</td>
<td></td>
<td>A computer device that uses solid disks as magnetic medium to store data. cf. floppy disk.</td>
</tr>
<tr>
<td>hard link</td>
<td></td>
<td>In Unix filesystems, an entry in a directory that points to a file in another directory on the same disk or partition, and shares the inode of that file; cf. symbolic link.</td>
</tr>
<tr>
<td>hardware</td>
<td></td>
<td>All physical parts making up the computer (&quot;the parts that can be kicked&quot; ;-)</td>
</tr>
<tr>
<td>HDLC</td>
<td>High-level Data Link</td>
<td>ISO/IEC 3309 standard; relevant in PPP.</td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>high-level (adj)</td>
<td></td>
<td>Refers to a computer language with a higher level of abstraction from the computer architecture than a low-level language.</td>
</tr>
<tr>
<td>host</td>
<td></td>
<td>Any computer attached to an IP-based internet, especially computers that can act as a server to a client program or computer.</td>
</tr>
<tr>
<td>HOWTO</td>
<td></td>
<td>A series of documents, each on a particular topic, which form a significant portion of the documentation for Linux. HOWTO's originated with, and are generally published by, the Linux Documentation Project.</td>
</tr>
</tbody>
</table>
### Glossary of Terms

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<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTML</td>
<td>HyperText Markup Language</td>
<td>A standard for specifying the structure of a document indicated by tags in the document text; used on the World Wide Web with HTTP.</td>
</tr>
<tr>
<td>HTTP</td>
<td>HyperText Transfer Protocol</td>
<td>The succession of application layer protocols used for communication between a WWW browser and a WWW server. See RFC2616.</td>
</tr>
<tr>
<td>hub</td>
<td></td>
<td>Generally, a device connected to several other devices; specifically in computer networks, a repeater in the center of a network with star topology, usually with 10BaseT or 100BaseT Ethernet.</td>
</tr>
<tr>
<td>i.e.</td>
<td></td>
<td>&quot;that is&quot; (Latin: &quot;id est&quot;). N.B.: Avoid this. Use it only in parenthetical asides (i.e., asides like this one) and then only to clarify a point. Do not confuse with &quot;e.g.&quot;. Also see &quot;cf.&quot;.</td>
</tr>
<tr>
<td>I/O</td>
<td>Input/Output</td>
<td></td>
</tr>
<tr>
<td>ICMP</td>
<td>Internet Control Message Protocol</td>
<td>A required protocol (RFC792) for the notification of errors between gateways and hosts on IP-based internets. It operates at the level of the IP protocol in the internet layer. Interestingly, although ICMP is required (<em>must</em> be implemented), hosts and gateways are not required to generate ICMP messages, and hosts are not required to respond or react to incoming ICMP messages (in fact, mostly, they don't, relying on higher-level protocols like TCP to simply time-out and retransmit, so you can't say that ICMP handles errors). Also, because IP is a packet-oriented connectionless protocol, there's no concept of duration of transmissions.</td>
</tr>
<tr>
<td>ID</td>
<td></td>
<td>IDentifier</td>
</tr>
<tr>
<td>IDE</td>
<td>Integrated Drive Electronics</td>
<td>A popular interface to attach hard drives to PC's, where the electronics of the controller are integrated with the drive instead of on a separate PC card; also see ATA.</td>
</tr>
<tr>
<td>Integrated Development Environment IDE</td>
<td>A programming environment integrated into an application; rare on Linux.</td>
<td></td>
</tr>
<tr>
<td>idle</td>
<td></td>
<td>inactive; waiting for a task or a wake up call</td>
</tr>
<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronics Engineers</td>
<td>USA based, international organization of professional engineers; also an important standards body</td>
</tr>
<tr>
<td>IMAP [1]</td>
<td>Interactive Mail Access Protocol</td>
<td>See RFC1203</td>
</tr>
<tr>
<td>IMAP [2]</td>
<td>Internet Message Access Protocol</td>
<td>See RFC2060 on IMAP4 (beats me why there's two names for the same thing, with the same acronym yet).</td>
</tr>
<tr>
<td>Term</td>
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<td>Comment</td>
</tr>
<tr>
<td>--------------</td>
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<td>----------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>implement</td>
<td></td>
<td>To create an actual object (program, device) that conforms to abstract specifications.</td>
</tr>
<tr>
<td>include file</td>
<td></td>
<td>A file which contains constants and parameters, possibly shared between two or more programs, and included into the source code when these programs are compiled.</td>
</tr>
<tr>
<td>information</td>
<td>info</td>
<td>Something worth knowing, in contrast to just plain data.</td>
</tr>
<tr>
<td>inode</td>
<td></td>
<td>In Unix filesystems, a block of administrative data for a file on the disk partition.</td>
</tr>
<tr>
<td>input</td>
<td></td>
<td>Any data that are entered into a running program, or into a file.</td>
</tr>
<tr>
<td>install</td>
<td></td>
<td>Transferring a new program to a computer's permanent storage (e.g., hard disk) and performing any necessary configuration or administration.</td>
</tr>
<tr>
<td>integer</td>
<td></td>
<td>A data type used to represent a whole (integer, non-fraction) number within a limited range.</td>
</tr>
<tr>
<td>integrity</td>
<td>correctness</td>
<td>Adjective, meaning: having the property to be able to interact, i.e. respond to stimulation from the outside. Used in the context of programs or interfaces.</td>
</tr>
<tr>
<td>interactive</td>
<td></td>
<td>An interface between a computer and a user which allows them to interact and exchange input and output (commands and data).</td>
</tr>
<tr>
<td>interface</td>
<td>CLI and/or GUI</td>
<td>A connection (through a hardware device or through a software program) between different components of a computer system (usually performing some kind of translation between protocols internal to the components); used especially in the contexts of network communication, or communication between computer systems and their users.</td>
</tr>
<tr>
<td>Internet</td>
<td>internet, (the) net</td>
<td>The worldwide distributed network of computers linked by the Internet Protocol.</td>
</tr>
<tr>
<td>internet layer</td>
<td></td>
<td>The network layer in the TCP/IP protocol stack: this alternative name may be used to distinguish it from the underlying network access (physical) layer. cf. Internet Protocol.</td>
</tr>
<tr>
<td>Internet service provider</td>
<td>ISP, IAP, Internet Access Provider</td>
<td>A company which provides connections to the Internet.</td>
</tr>
<tr>
<td>interpreter</td>
<td></td>
<td>A program which examines a script or program source code and executes it, line by line; cf. compiler.</td>
</tr>
<tr>
<td>interrupt</td>
<td></td>
<td></td>
</tr>
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## Glossary of Terms

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<tr>
<td>intranet</td>
<td></td>
<td>A network (usually a LAN) based on IP but, unlike the Internet, allows only restricted access.</td>
</tr>
<tr>
<td>invoke</td>
<td></td>
<td>induce execution of; call</td>
</tr>
<tr>
<td>ioport</td>
<td>address</td>
<td>The memory address peripheral devices use to communicate with the CPU; see <code>/proc/ioports</code>.</td>
</tr>
<tr>
<td>IP</td>
<td>Internet Protocol</td>
<td>The network layer protocol used on IP-based internets. See RFC791.</td>
</tr>
<tr>
<td>IRQ</td>
<td>Interrupt ReQuest</td>
<td>An increasingly obsolete PC bus standard.</td>
</tr>
<tr>
<td>ISA</td>
<td>Industry Standard Architecture</td>
<td>A baseband protocol used by telephone companies to offer one, two or more B-channel (Bearer channel) lines of 64 Kbit/s each on a single copper pair of up to 5.5 km length. Each B-channel can be used to provide a high-quality voice line, or fax or data services.</td>
</tr>
<tr>
<td>ISDN</td>
<td>Integrated Services Digital Network</td>
<td>One of several bodies which exist to promote standards, including computer standards.</td>
</tr>
<tr>
<td>ISO</td>
<td>International Standards Organization</td>
<td>A task which has been sent to the background or has been submitted for later execution.</td>
</tr>
<tr>
<td>k</td>
<td>K, kilo</td>
<td>A factor of 1000, but with computers usually 1024 (2^10)</td>
</tr>
<tr>
<td>KB</td>
<td>kilo-byte, kilobyte, kb, kB</td>
<td>1024 bytes</td>
</tr>
<tr>
<td>kbit/s</td>
<td>kilobit per second, kbps, Kbps, Kbit/s</td>
<td>Data transfer rate in units of 1000 bits per second.</td>
</tr>
<tr>
<td>Kbyte/s</td>
<td>kilobyte per second, kbps, Kbps, KBps, KB/s, kbyte/s</td>
<td>Data transfer rate in units of 1024 bytes per second.</td>
</tr>
<tr>
<td>kernel</td>
<td></td>
<td>The core of an operating system, which provides multitasking (process creation, interprocess protection, interprocess communication), memory management, and basic I/O management.</td>
</tr>
<tr>
<td>key [1]</td>
<td></td>
<td>A token which is used to encrypt plain text or decrypt cipher text in an encryption system.</td>
</tr>
<tr>
<td>key [2]</td>
<td></td>
<td>A database field which may be used as the basis of a query.</td>
</tr>
<tr>
<td>key [3]</td>
<td></td>
<td>A marked switch on a keyboard which used to be a common computer input device before they were eaten by mice ;-).</td>
</tr>
<tr>
<td>keyboard</td>
<td></td>
<td>An input device having many keys marked with letters and other symbols.</td>
</tr>
<tr>
<td>LAN</td>
<td>Local Area Network</td>
<td>A small network, usually with one or a few segments, which supports broadcasting and direct connections between hosts; e.g. Ethernet, Token Ring, Appletalk and ARCNet; cf. WAN.</td>
</tr>
<tr>
<td>Term</td>
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<td>Comment</td>
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<tr>
<td>------------</td>
<td>--------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>LDP</td>
<td>Linux Documentation Project</td>
<td>A collection of (often related) subroutines to be linked to a program.</td>
</tr>
<tr>
<td>library</td>
<td></td>
<td>A boot loader: a program that loads the kernel so Linux can boot; can also boot other operating systems.</td>
</tr>
<tr>
<td>link</td>
<td></td>
<td>To bind a program to the subroutines it references (calls). These are typically located in object modules or libraries.</td>
</tr>
<tr>
<td>Linux</td>
<td>Linux Is Not UniX?</td>
<td>A Unix-like operating system first developed, still maintained by, and named after Linus Torvalds. It is freely available under the General Public License. But if you didn’t know all that already, what are you doing here?</td>
</tr>
<tr>
<td>LLC</td>
<td>Logical Link Control</td>
<td>An IEEE network standard (802.2) that fits within the ISO/OSI Layer 2: data link layer, on top of the MAC sub-layer. It deals with error detection, flow control, and frame formats.</td>
</tr>
<tr>
<td>load</td>
<td></td>
<td>To transfer from disk into memory.</td>
</tr>
<tr>
<td>local</td>
<td></td>
<td>within easy reach, on the local area network, not remote.</td>
</tr>
<tr>
<td>logfile</td>
<td>log</td>
<td>record of activities</td>
</tr>
<tr>
<td>logic</td>
<td></td>
<td>In the jargon of electronics engineers: the electronic components and circuitry of a device. This use of the term should be avoided because of the confusion with the conventional meaning of: abstract formal reasoning, which is involved in computer programming.</td>
</tr>
<tr>
<td>login</td>
<td></td>
<td></td>
</tr>
<tr>
<td>logoff</td>
<td></td>
<td></td>
</tr>
<tr>
<td>logon</td>
<td></td>
<td></td>
</tr>
<tr>
<td>logout</td>
<td></td>
<td></td>
</tr>
<tr>
<td>loopback</td>
<td></td>
<td></td>
</tr>
<tr>
<td>low-level</td>
<td></td>
<td>Refers to a computer language in which statements are similar to instructions for the processor (or: in which statements are more like object code than in a high-level language).</td>
</tr>
<tr>
<td>(adj)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LPI</td>
<td>Linux Professional Institute</td>
<td>Non-profit organization founded to create a widely supported certification program for Linux; see <a href="http://www.lpi.org/">http://www.lpi.org/</a></td>
</tr>
<tr>
<td>Term</td>
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</tr>
<tr>
<td>--------------</td>
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<td>-----------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>MAC</td>
<td>Media Access Control</td>
<td>A layer of IEEE network standards (#802.x) that fits within the ISO/OSI Layer 2: data link layer, below the LLC sub-layer. It deals with access methods, error detection, and transmission unit formats. Well-known IEEE MAC specifications are Ethernet in its various incarnations (#802.2) and Token Ring (#802.5?).</td>
</tr>
<tr>
<td>Mail User Agent</td>
<td>message user agent, MUA, UA, user agent</td>
<td>An end-user program used to access, process, read, archive, compose and send e-mail messages. See RFC1711. Such e-mail programs often include some &quot;MTA&quot; functionality, in particular the ability to use SMTP to send e-mail to an outgoing mail server, and POP3 or IMAP4 protocol to download mail from an inbound mail server. cf. Message Transfer Agent.</td>
</tr>
<tr>
<td>maintain</td>
<td></td>
<td>A document, often of book-length, discussing the design or operation of a software package or device.</td>
</tr>
<tr>
<td>manual [1] (noun)</td>
<td></td>
<td>by hand (as opposed to some more automated means)</td>
</tr>
<tr>
<td>masquerade</td>
<td></td>
<td>To pretend to be another host for the purposes of sharing one IP address among several local hosts hidden to the outside world for reasons of resource shortages or security. cf. NAT</td>
</tr>
<tr>
<td>MB</td>
<td>mega-byte, megabyte, meg, Mb</td>
<td>1000 (or sometimes 1024) KB (1,000,000 or 1,024,000 or 1,048,576 bytes).</td>
</tr>
<tr>
<td>Mbit/s</td>
<td>Megabit per second, Mbps</td>
<td>Data transfer rate in units of 1,000,000 bits per second.</td>
</tr>
<tr>
<td>MBR</td>
<td>Master Boot Record</td>
<td>An area of the outermost cylinder of a PC hard disk which contains the partition table. This contains four entries identifying the types, starting cylinder and sizes of up to four partitions on the hard disk. One of the entries is flagged as 'active'; this marks the partition from which the machine will boot. (Floppy disks don't have an MBR, since they don't have a partition table. Instead, they just have a boot sector (same as a logical disk), which contains a Media Descriptor Table (MDT) and bootstrap loader. The MDT describes the format of a floppy disk or logical disk).</td>
</tr>
<tr>
<td>media</td>
<td></td>
<td>The physical device by which data are transmitted or (more commonly) stored.</td>
</tr>
</tbody>
</table>
# Glossary of Terms

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<tbody>
<tr>
<td>memory</td>
<td></td>
<td>The place where a computer stores data and/or programs for direct access by the CPU: RAM or ROM (and also cache memory), not disks.</td>
</tr>
<tr>
<td>menu</td>
<td></td>
<td>(by L.B.?) A program which routes e-mail based on the RFC822 header and invokes the correct delivery agent, especially SMTP (RFC821) in order to route the mail towards its ultimate destination. For example: exim, qmail, sendmail, smail. Also see RFC1711 and Mail User Agent.</td>
</tr>
</tbody>
</table>
| Message Transfer Agent| mail transfer agent, mail transport agent, MTA, MDA, mail delivery agent, message delivery agent | The term "Mail Transport Agent" is used in the online "Network Administrator's Guide" to refer to rmail, which, of course, is used to process incoming mail from UUCP before passing it onto sendmail. This usage is at least confusing, if not incorrect.  

On MDA (Message Delivery Agent):  
This one really has me going. I'm not sure whether it is:  
"A protocol, or its implementing program, responsible for transferring messages from one host to another. For example, SMTP.";  
or:  
"A program responsible for delivering mail to the correct user mailbox on a host. For example, sendmail."  
I've been researching this in my paper library and on the net for the last half hour, and have not come up with any consistent or reasonably definitive examples. Personally, but based on what evidence I can't remember, I lean to the first definition, but Aileen Frisch uses the second in her "Essential System Administration" book. Hold on - after a search at http://www.imc.org, I've discovered RFC 1711, which defines MTA and UA, but has no mention of (M)DA. I think this one is what we in Australia would call "a furphy". - Hence the use of "MDA" is to be AVOIDED. |
| mini-HOWTO            | A slimmer, more focused document otherwise like a HOWTO.                                    |                                                                                                                                           |
| modem                 | MOdulator/DEModulator                                                                     | A device that converts between digital signals from the computer and analog signals for communication over a telephone line.                                                                          |
| monitor               |                                                                                          |                                                                                                                                           |
## Glossary of Terms

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<tr>
<td>mouse</td>
<td></td>
<td>An input device which allows pointing to, selecting and activating objects, usually displayed in a graphical user interface.</td>
</tr>
<tr>
<td>MS-Windows NT</td>
<td>NT, Windows NT</td>
<td>A 32-bit operating system from Microsoft(C)(R)(TM).</td>
</tr>
<tr>
<td>MTU</td>
<td>Maximum Transfer Unit</td>
<td>Maximum size of an IP packet that will be accepted for transmission without fragmenting it into smaller datagrams. Usually an optimal size is determined automatically; typical sizes are 296 bytes (40 header + 256 data for phone lines), and 1500 bytes (the maximum for ethernet connections).</td>
</tr>
<tr>
<td>NAT</td>
<td>Network Address Translation</td>
<td>A generic description of the process whereby the IP address of a host on a private internet is translated into an IANA-assigned unique address on the wider Public Internet. This can be accomplished by several techniques: masquerading, circuit-level gateways such as SOCKS, transparent proxying or application-level gateways.</td>
</tr>
<tr>
<td>N.B.</td>
<td></td>
<td>&quot;take good notice&quot; (Latin: &quot;nota bene&quot;).</td>
</tr>
<tr>
<td>NetBEUI</td>
<td>NetBIOS Extended User Interface</td>
<td>The current implementation of the NetBIOS protocol used in MS-DOS, MS-Windows and OS/2.</td>
</tr>
<tr>
<td>NetBIOS over TCP/IP</td>
<td></td>
<td>A layer of code which implements the NetBIOS API, but utilizing TCP and UDP datagrams, which are of course encapsulated in IP datagrams. Since IP is routable, this overcomes the most significant limitation of NetBIOS. See RFC’s 1001, 1002, 1088.</td>
</tr>
<tr>
<td>NetBIOS</td>
<td>Network BIOS</td>
<td>A lightweight transport protocol developed by Sytek, IBM and Microsoft for use on personal computers. NetBIOS defines three things: the protocol on the wire (datagram formats); the code which implements the protocol; the API used to employ the protocol. The major example of an application which uses the NetBIOS API is Microsoft Networks, the workstation and server code implemented in MS-DOS 3.0 and later, OS/2 and various Windows incarnations - though other applications do exist. NetBIOS employs name registration and broadcast discovery, rather than addressing, and is consequently a non-routable protocol. cf. SMB, NetBIOS over TCP/IP.</td>
</tr>
<tr>
<td>netmask</td>
<td></td>
<td>network mask: the network part of an IP address; cf. variable length subnet mask</td>
</tr>
<tr>
<td>Term</td>
<td>Deprecated Alternatives</td>
<td>Comment</td>
</tr>
<tr>
<td>-----------------------</td>
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<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>network</td>
<td></td>
<td>An interconnected set of hosts and other network devices which share a common physical layer such as Ethernet, X.25, etc.; cf. LAN, WAN.</td>
</tr>
<tr>
<td>network access layer</td>
<td></td>
<td>The lowest layer of the TCP/IP protocol stack, also known as the &quot;physical&quot; or &quot;hardware&quot; layer. Consists of the cables, connectors and associated hardware such as driver chips to implement a network such as Ethernet or Token Ring, as well as the drivers for the hardware. It approximately spans the lowest two layers of the theoretical ISO/OSI network protocol stack: the physical and data link layers.</td>
</tr>
<tr>
<td>network interface card</td>
<td>NIC, Ethernet card, LAN adapter</td>
<td>An expansion board allowing a computer to access a network.</td>
</tr>
<tr>
<td>network layer</td>
<td></td>
<td>The layer of a network protocol stack that is concerned with addressing and delivery of datagrams across a network or internet. It is layer three in the IS O/OSI seven-layer model. In the TCP/IP protocol stack, the main network layer protocol is the Internet Protocol (IP); therefore this layer is also known as internet layer.</td>
</tr>
<tr>
<td>NFS</td>
<td>Network File System</td>
<td>A protocol (developed by Sun Microsystems) enabling a UN*X machine to mount a remote disk area as part of its local filesystem; widely considered of questionable security.</td>
</tr>
<tr>
<td>NIS</td>
<td>Network Information System</td>
<td>Protocols to provide network services (such as authentication) for NFS.</td>
</tr>
<tr>
<td>object code</td>
<td>machine code</td>
<td>Instructions that can be executed by the computer processor.</td>
</tr>
<tr>
<td>offline</td>
<td>off-line</td>
<td>not connected to a computer system or network; cf. online</td>
</tr>
<tr>
<td>online [1]</td>
<td>on-line</td>
<td>connected to a computer system or network; cf. offline</td>
</tr>
<tr>
<td>online [2]</td>
<td>on-line</td>
<td>stored on and accessible through a computer system or network</td>
</tr>
<tr>
<td>operating system</td>
<td>OS</td>
<td>Central set of programs that manage the various components and devices of the computer, and its interaction with application programs and users; e.g. MS-DOS, MS-Windows NT, MacOS, Unix, Linux.</td>
</tr>
</tbody>
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<tr>
<td>OSI</td>
<td>Open Systems Interconnection</td>
<td>The concept of a &quot;stack&quot; of protocols (hence &quot;TCP/IP stack&quot; as in &quot;This damn Microsoft TCP/IP stack is so broken...&quot;) is due to the OSI seven-layer model, even though TCP/IP has only about four distinct layers (certain layers are combined). See physical, data link, network, transport, session, presentation, and application layers (OSI model); network access, internet, transport, and application layers (TCP/IP stack).</td>
</tr>
<tr>
<td>outbound</td>
<td></td>
<td></td>
</tr>
<tr>
<td>output</td>
<td></td>
<td>Any data that are generated by a process.</td>
</tr>
<tr>
<td>owner</td>
<td></td>
<td>The account that has its UID number associated with a file.</td>
</tr>
<tr>
<td>package</td>
<td></td>
<td>A set of related files and programs; especially a single archive file (tar, rpm) that contains them.</td>
</tr>
<tr>
<td>packet</td>
<td></td>
<td>A quantum of data transmitted over a network; specifically: a unit of TCP traffic carrying the information necessary to deliver itself, especially using the UDP protocol (datagram).</td>
</tr>
<tr>
<td>PAP</td>
<td>Password Authentication Protocol</td>
<td></td>
</tr>
<tr>
<td>parallel</td>
<td></td>
<td>Several bits at the same time, over time (over multiple wires).</td>
</tr>
<tr>
<td>parameter</td>
<td></td>
<td>A variable with a specific value that has a meaning or function, which belongs to a program function or command; cf. argument.</td>
</tr>
<tr>
<td>parent process</td>
<td></td>
<td>A process that started one or more other, so-called child processes.</td>
</tr>
<tr>
<td>partition [1] (noun)</td>
<td></td>
<td>An arbitrary region of a storage device (almost always a hard drive) created by partitioning software before data were stored. Specifically on IBM PC-compatibles: one of up to four distinct areas on a hard drive which can be dedicated to different operating systems. One of the partition types, &quot;extended&quot;, supports further &quot;partitioning&quot; into a maximum of four logical disks.</td>
</tr>
<tr>
<td>partition [2] (verb)</td>
<td></td>
<td>To make a partition.</td>
</tr>
<tr>
<td>password</td>
<td></td>
<td>A token which authenticates a user at login time.</td>
</tr>
<tr>
<td>paste</td>
<td></td>
<td></td>
</tr>
<tr>
<td>patch level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>path</td>
<td></td>
<td></td>
</tr>
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<tbody>
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<td>PC</td>
<td>Personal Computer</td>
<td>A computer designed to be used by one individual at a time; specifically, one compatible with the architecture of the original IBM microcomputer.</td>
</tr>
<tr>
<td>PCI</td>
<td>Peripheral Components Interface</td>
<td>A PC bus to connect cards to the processor, replacing the original ISA bus.</td>
</tr>
<tr>
<td>peripheral</td>
<td></td>
<td>A device that is an optional attachment to the core components of a computer (CPU and memory).</td>
</tr>
<tr>
<td>permission</td>
<td></td>
<td>The lowest layer of the seven-layer ISO/OSI network protocol stack. Consists of the cables, connectors and associated hardware such as driver chips to implement a network such as Ethernet or Token Ring. The corresponding layer of the TCP/IP protocol stack is also known as &quot;hardware&quot; or network access layer and has a wider scope.</td>
</tr>
<tr>
<td>PID</td>
<td>process ID</td>
<td>A numerical identifier used to track processes by the kernel.</td>
</tr>
<tr>
<td>PIO</td>
<td>Programmed I/O</td>
<td>A technique whereby the CPU executes a tightly coded loop in which it copies data from a peripheral device’s buffer memory and writes it back out to main memory; used with earlier versions of ATA, but replaced by DMA.</td>
</tr>
<tr>
<td>pipe</td>
<td></td>
<td>A data structure which connects a file handle in one process to a file handle in another; by convention stdout of one process to stdin of the next. Established on the shell command line by the '</td>
</tr>
<tr>
<td>pixel</td>
<td></td>
<td>picture element: a dot, a grid point on a computer display, the smallest entity that can be drawn on a computer display.</td>
</tr>
<tr>
<td>PLIP</td>
<td>Parallel Line IP</td>
<td>IP protocol over a parallel cable (between two machines physically connected and not too distant).</td>
</tr>
<tr>
<td>PnP</td>
<td>Plug and Play</td>
<td></td>
</tr>
<tr>
<td>POMS</td>
<td>Program Objective Management System</td>
<td>Set of Python scripts to offer a web-interface to manage the LPI test objectives. See <a href="http://www.lpi.org/cgi-bin/poms.py">http://www.lpi.org/cgi-bin/poms.py</a>.</td>
</tr>
<tr>
<td>POP</td>
<td>Post Office Protocol</td>
<td>Protocol to retrieve mail from a mail server. See RFC1939 (POP3). Various software servers typically have names derived from 'pop' like ipop3d, ipop2d, and popper.</td>
</tr>
<tr>
<td>port [1] (noun)</td>
<td></td>
<td>The name given to an individual, numbered &quot;slot&quot; which is available to Internetworking software. For example, HTTP servers generally listen to port 80. See /etc/services; also see ioprt.</td>
</tr>
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<tr>
<td>port [2] (verb)</td>
<td></td>
<td>To adapt a computer program to operate in a new computing environment and/or in a new programming language.</td>
</tr>
<tr>
<td>POSIX compliant</td>
<td></td>
<td>A page description language developed and marketed by Adobe Inc. Widely implemented in laser printers, especially where high-quality output is required (e.g. photo typesetters) and, under Linux, widely emulated in software for non-Postscript printers.</td>
</tr>
<tr>
<td>Postscript</td>
<td></td>
<td>The PID of a process’ parent process (cf. PID, parent, child process).</td>
</tr>
<tr>
<td>PPP</td>
<td>Point-to-Point Protocol</td>
<td>A physical layer protocol (RFC1661) which can be used to encapsulate IP and other network protocols, making it an excellent way of extending LAN protocols to dial-in users. PPP comprises an HDLC-like framing protocol (RFC1662), a link control protocol, and a family of network control protocols, each of which corresponds to a network protocol which PPP can encapsulate. PPP can also use PAP or CHAP (RFC1994) for authentication.</td>
</tr>
<tr>
<td>presentation layer</td>
<td></td>
<td>The sixth layer of the ISO/OSI seven-layer model, which specifies character representation (e.g. ASCII) and graphics formats, such as NAPLPS (North American Presentation Layer Protocols). In TCP/IP, the presentation layer is subsumed into the application layer, but perhaps the closest equivalent standards are ASN.1, ANSI and HTML/XML.</td>
</tr>
<tr>
<td>priority</td>
<td></td>
<td>A running program; an instance of program execution.</td>
</tr>
<tr>
<td>process</td>
<td></td>
<td>The main component that makes a computer work; these days usually a &quot;micro-processor&quot; on a single silicon chip (cf. CPU).</td>
</tr>
<tr>
<td>processor</td>
<td></td>
<td>A sequence of instructions for the computer that implements an algorithm, especially when stored in a file in the form of either directly-executable object code, or source code for an interpreter or compiler. When loaded into memory and executed, the object-code program typically becomes a process.</td>
</tr>
<tr>
<td>program</td>
<td></td>
<td>An indication produced by a shell or application program that it is ready for further user commands or input.</td>
</tr>
</tbody>
</table>
## Glossary of Terms

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<thead>
<tr>
<th>Term</th>
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<tr>
<td>protocol</td>
<td></td>
<td>A definition of data structures and formats to be exchanged by two programs over a network.</td>
</tr>
<tr>
<td>proxy server</td>
<td></td>
<td>A computer process, usually as part of a firewall, that relays a protocol between client and server computer systems, by appearing to the client to be the server and appearing to the server to be the client (adapted from RFC2828).</td>
</tr>
<tr>
<td>queue</td>
<td></td>
<td>A data structure which implements a first-in, first-out list; e.g. print queue, which contains a list of jobs to be printed in order.</td>
</tr>
<tr>
<td>RAM</td>
<td>Random Access Memory</td>
<td>Volatile, writable memory that a computer uses as its main memory. Comes in flavors like EDO, ECC, SDRAM, etc. which are not equivalent but from the perspective of a sysadmin are very similar under normal use. cf. ROM.</td>
</tr>
<tr>
<td>RARP</td>
<td>Reverse Address Resolution Protocol, rarp</td>
<td>A low-level protocol which, given a hardware (Ethernet MAC) address on the local network, returns the corresponding IP address. cf. ARP.</td>
</tr>
<tr>
<td>read permission</td>
<td></td>
<td></td>
</tr>
<tr>
<td>README</td>
<td>readme</td>
<td>An important document that usually comes with a software package to call attention to important issues; usually has its name in capitals, so that it appears at the top of a directory listing.</td>
</tr>
<tr>
<td>Red Hat</td>
<td>RedHat, RH</td>
<td>A commercial Linux distribution.</td>
</tr>
<tr>
<td>redundant</td>
<td></td>
<td>superfluous; said of information in the contexts of compression, or the preservation of data integrity.</td>
</tr>
<tr>
<td>regular expression</td>
<td></td>
<td>A formal expression of a string pattern which can be searched for and processed by a pattern-matching program such as vi, grep, awk or perl.</td>
</tr>
<tr>
<td>repeater</td>
<td></td>
<td>A device that propagates signals between cables; in case of computer networks it operates at the first, physical layer within the ISO/OSI model, and does not do packet filtering or makes routing decisions. cf. hub, bridge, router.</td>
</tr>
<tr>
<td>resolution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>resource</td>
<td></td>
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</tr>
<tr>
<td>restore</td>
<td></td>
<td></td>
</tr>
<tr>
<td>return</td>
<td></td>
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</tr>
<tr>
<td>Term</td>
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<td>Comment</td>
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<tr>
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<td>-----------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>RFC</td>
<td>Request For Comments</td>
<td>Despite the name, a “de facto” official specification of Internet protocols and standards. See <a href="http://www.rfc-editor.org/">http://www.rfc-editor.org/</a> or <a href="http://www.cis.ohio-state.edu/hypertext/information/rfc.html">http://www.cis.ohio-state.edu/hypertext/information/rfc.html</a>.</td>
</tr>
<tr>
<td>ROM</td>
<td>Read Only Memory</td>
<td>Computer memory, usually involving some enduring medium like a silicon chip or a burnt laser disc which can be read but not altered; this is inconvenient when the data can change and, just to be confusing, some special ROMs can be modified under certain circumstances. cf. RAM.</td>
</tr>
<tr>
<td>root [1]</td>
<td></td>
<td>The administrative account (UID 0) on a *nix system that has all privileges; cf. superuser.</td>
</tr>
<tr>
<td>root [2]</td>
<td></td>
<td>The top-most or first or originating node or object (e.g.: root directory, &quot;/&quot;).</td>
</tr>
<tr>
<td>route [1] (noun)</td>
<td></td>
<td>The path across one or more networks from one host to another.</td>
</tr>
<tr>
<td>route [2] (verb)</td>
<td></td>
<td>To examine the destination network IP address in a datagram, and by consulting a table, direct the datagram to the next router along the path to the destination, or to the destination itself.</td>
</tr>
<tr>
<td>router</td>
<td></td>
<td>A gateway which directs IP datagrams between networks in an internet; it operates at the third, network layer in the ISO/OSI model, and assumes that the address implies a particular path (the route) to reach the destination. In common usage today, a gateway is a general-purpose computer with a general-purpose operating system [e.g. Linux] which <em>may</em> be performing other functions; while a router is a special-purpose computer with a special purpose operating system [e.g. IOS], generally from a specialist supplier [e.g. Cisco]). cf. bridge.</td>
</tr>
<tr>
<td>RPC</td>
<td>Remote Procedure Call</td>
<td></td>
</tr>
<tr>
<td>RPM</td>
<td>Red Hat Package Management</td>
<td>A system which eases installation, verification, upgrading, and uninstalling Linux packages. See the HOWTO for more information.</td>
</tr>
<tr>
<td>run</td>
<td></td>
<td>To let it work (a program); cf. execute.</td>
</tr>
<tr>
<td>runlevel</td>
<td>run-level</td>
<td>Mode of operation of a Unix system, offering different services on each level; see /etc/inittab.</td>
</tr>
<tr>
<td>scan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>script</td>
<td></td>
<td>A computer program that is written in an interpreted programming language, and therefore stays in human-readable text format; cf. executable, binary.</td>
</tr>
</tbody>
</table>
### Glossary of Terms

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<tr>
<td>SCSI</td>
<td>Small Computer Systems Interface</td>
<td>A multi-drop bus cable architecture particularly suitable for both internal and external attachment of mass storage devices such as hard drives, tape drives and CD-ROMS.</td>
</tr>
<tr>
<td>sector</td>
<td></td>
<td>A (limited) length of cable - segments can be joined by repeaters (rare), bridges (common), routers or switches (which are hardware logic bridges and routers).</td>
</tr>
<tr>
<td>segment</td>
<td></td>
<td>One bit after another, over time (over a single wire).</td>
</tr>
<tr>
<td>serial</td>
<td></td>
<td>A process, or a host computer, which provides a particular service to client processes; e.g. web server, print server.</td>
</tr>
<tr>
<td>server</td>
<td></td>
<td>A process which accepts requests and returns responses in an almost endless loop; a daemon.</td>
</tr>
<tr>
<td>service</td>
<td></td>
<td>The fifth ISO/OSI layer is the session control layer. It establishes and controls system-dependent aspects of communications sessions between specific nodes in the network. It bridges the gap between the services provided by the transport layer and the logical functions running on the operating system in a participating node. In the TCP/IP network stack, there is no session control layer, and its functions are partially implemented in the transport layer and partially in the application layer.</td>
</tr>
<tr>
<td>session layer</td>
<td></td>
<td>A program which mediates between the user and the operating system, typically accepting commands and invoking the corresponding programs. In the UNIX world, the term shell is conventionally applied to command-line driven interfaces with scripting capabilities, such as bash, csh and zsh; however, graphical shells exist, such as Windowmaker, KDE and GNOME.</td>
</tr>
<tr>
<td>shutdown</td>
<td></td>
<td>A logical interrupt to a process, which the process must generally deal with synchronously. A form of interprocess communications.</td>
</tr>
<tr>
<td>signal</td>
<td></td>
<td>A program which mediates between the user and the operating system, typically accepting commands and invoking the corresponding programs. In the UNIX world, the term shell is conventionally applied to command-line driven interfaces with scripting capabilities, such as bash, csh and zsh; however, graphical shells exist, such as Windowmaker, KDE and GNOME.</td>
</tr>
<tr>
<td>single mode</td>
<td></td>
<td>Single user mode, runlevel 1</td>
</tr>
<tr>
<td>Term</td>
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</tr>
<tr>
<td>SLIP</td>
<td>Serial Line IP</td>
<td>A way of encapsulating IP datagrams for transmission over asynchronous modem connections. See RFC1055, &quot;A Non-Standard for Transmission of IP Datagrams over Serial Lines&quot;; cf. PPP</td>
</tr>
<tr>
<td>SMB</td>
<td>Server Message Block</td>
<td>A Microsoft protocol developed to transport originally MS-DOS, later OS/2 and MS-Windows, API calls and their arguments across a NetBIOS LAN; primarily used under Linux as a protocol for file and print sharing with Windows machines</td>
</tr>
<tr>
<td>SMTP</td>
<td>Simple Mail Transfer Protocol</td>
<td>A conversational protocol used by mail servers for delivery of e-mail over the Internet. See RFC821.</td>
</tr>
<tr>
<td>SNR</td>
<td>Signal-to-Noise-Ratio</td>
<td>The relative amount of useful information in a signal, as compared to the noise it carries.</td>
</tr>
<tr>
<td>socket</td>
<td></td>
<td>A TCP application layer connection.</td>
</tr>
<tr>
<td>software</td>
<td>SW</td>
<td>computer programs</td>
</tr>
<tr>
<td>source code</td>
<td></td>
<td>The plain text (usually typed in by a human) specifying the detailed operation of a program, written in a programming language. It needs to be processed by a compiler to produce a program that can be run (executed) by the computer.</td>
</tr>
<tr>
<td>sources</td>
<td></td>
<td>The files containing the source code for a program or program system, from which the executable program or library can be built or ported to another computer platform.</td>
</tr>
<tr>
<td>spawn</td>
<td></td>
<td>To create a child process by means of a fork() and an exec().</td>
</tr>
<tr>
<td>spooler</td>
<td></td>
<td></td>
</tr>
<tr>
<td>static</td>
<td></td>
<td></td>
</tr>
<tr>
<td>stderr</td>
<td></td>
<td>The standard Unix error output device (by default to the terminal display).</td>
</tr>
<tr>
<td>stdin</td>
<td></td>
<td>The standard Unix input device (by default the terminal keyboard).</td>
</tr>
<tr>
<td>stdout</td>
<td></td>
<td>The standard Unix output device (by default the terminal display).</td>
</tr>
<tr>
<td>sticky bit</td>
<td></td>
<td>A permission bit on an executable file which causes the kernel to keep the memory image of the process after it has terminated, in order to avoid the overhead of reloading it when it is re-invoked.</td>
</tr>
<tr>
<td>Term</td>
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</tr>
<tr>
<td>stream</td>
<td></td>
<td>A sequence of data bytes with sequencing and flow control. The TCP/IP stream protocol is TCP. (Isn't there a System V stream concept as well as the network protocol? Does Linux implement it?)</td>
</tr>
<tr>
<td>subnet mask</td>
<td>mask</td>
<td>A value used in configuring the TCP/IP stack which specifies which part of a 32-bit IP address is the network address and which part the host address.</td>
</tr>
<tr>
<td>SUID</td>
<td>Set User ID, suid</td>
<td>A permission bit for files in Unix-compatible filesystems which causes the resultant process (i.e., assuming the file is executable) to enjoy access rights to other resources based on the UID of the user who owns the file, rather than the user who created the process.</td>
</tr>
<tr>
<td>superuser</td>
<td>super user, su, wheel</td>
<td>The user of the root account.</td>
</tr>
<tr>
<td>SuSE</td>
<td>S.u.S.E.</td>
<td>A commercial Linux distribution.</td>
</tr>
<tr>
<td>swap space</td>
<td>swap</td>
<td>virtual memory; called swap space because processes swap location between fast RAM and slow virtual memory if their priority changes.</td>
</tr>
<tr>
<td>switch [1]</td>
<td></td>
<td>a two-state (on</td>
</tr>
<tr>
<td>switch [2]</td>
<td></td>
<td>In computer networks, a bridge or router that uses dedicated hardware to quickly shunt packets through the network.</td>
</tr>
<tr>
<td>symlink</td>
<td>soft link</td>
<td>Symbolic link: in Unix filesystems, an entry in a directory that points to another file name in the filesystem; cf. hard link.</td>
</tr>
<tr>
<td>synchronize [1]</td>
<td></td>
<td>To make the events in two separate sequences happen at the same time (used in communications).</td>
</tr>
<tr>
<td>synchronize [2]</td>
<td></td>
<td>To make the content and state of data stored in two separate locations identical (e.g. cache, FTP sites).</td>
</tr>
<tr>
<td>syntax</td>
<td></td>
<td>The formal rules which determine how keywords or commands and their components need to be combined when writing the source code of a computer program or forming shell commands.</td>
</tr>
<tr>
<td>sysadmin</td>
<td>sysadm</td>
<td>system administrator: a person who administers a computer system and keeps it working.</td>
</tr>
<tr>
<td>system</td>
<td>box</td>
<td>A computer system; a term loosely used to refer to hardware and</td>
</tr>
<tr>
<td>TCP</td>
<td>Transmission Control Protocol</td>
<td>A session-oriented streaming transport protocol which provides sequencing, error detection and correction, flow control, congestion control and multiplexing; cf. UDP. See RFC793.</td>
</tr>
<tr>
<td>Term</td>
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<td>Comment</td>
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</tr>
<tr>
<td>TCP/IP</td>
<td>Transmission Control Protocol / Internet Protocol</td>
<td>A suite of protocols basic to Internet transmissions.</td>
</tr>
<tr>
<td>terminal</td>
<td>tty</td>
<td>The outlet of a computer, usually consisting of a display for output of text (or possibly graphics), and a keyboard (and possibly a mouse) for input, used as a device for interaction between the computer and a user. cf. workstation.</td>
</tr>
<tr>
<td>terminate</td>
<td></td>
<td>to disconnect, end, finish, quit, stop, etc.</td>
</tr>
<tr>
<td>terminator</td>
<td></td>
<td>A resistive load to indicate the end a chain of devices, usually a SCSI chain or a coax network chain.</td>
</tr>
<tr>
<td>text</td>
<td></td>
<td>A series of characters that can be displayed on a terminal display or printed on paper for human reading.</td>
</tr>
<tr>
<td>TIPS</td>
<td>Test Item Processing System</td>
<td>Set of Python scripts to offer a web-interface to manage the LPI test items. See <a href="http://www.lpi.org/cgi-bin/tips.py">http://www.lpi.org/cgi-bin/tips.py</a>.</td>
</tr>
<tr>
<td>TFTP</td>
<td>Trivial FTP</td>
<td>A protocol like FTP but much simpler and even less secure; used mainly for cracking computers and booting diskless network clients. See RFC1350.</td>
</tr>
<tr>
<td>third-party tools</td>
<td></td>
<td></td>
</tr>
<tr>
<td>topology</td>
<td></td>
<td>As used with computer networks: the schematic shape formed by the connections between the hosts.</td>
</tr>
<tr>
<td>transport layer</td>
<td></td>
<td>The transport layer is the central layer (#4) in the ISO/OSI seven-layer model. It provides end-to-end control of a communication session once the path has been established, allowing processes to exchange data reliably and sequentially, independent of which systems are communicating and their locations in the network. The transport layer in the TCP/IP stack is not defined in the same way; although TCP provides sequencing and error correction, UDP - which is also a transport layer protocol - does not have a session concept and is unreliable. The TCP/IP transport layer primarily provides multiplexing through the use of ports.</td>
</tr>
<tr>
<td>troubleshoot</td>
<td></td>
<td>The process of finding the reason(s) of the problem(s) with networking</td>
</tr>
<tr>
<td>tune</td>
<td></td>
<td>To make small changes to configuration in order to produce more efficient operation.</td>
</tr>
<tr>
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<td>Comment</td>
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</tr>
<tr>
<td>TurboLinux</td>
<td>Pacific HighTech Linux, PHT</td>
<td>A commercial Linux distribution.</td>
</tr>
<tr>
<td>UDP</td>
<td>User Datagram Protocol</td>
<td>A connection-less, unreliable, transport protocol which provides multiplexing and error detection for applications which require a low-cost protocol for one-shot transactions; cf. datagram, packet, TCP. See RFC768.</td>
</tr>
<tr>
<td>UID</td>
<td></td>
<td>User ID</td>
</tr>
<tr>
<td>UN*X</td>
<td></td>
<td>A term for any variant of the UNIX(R)(TM) operating system, including Linux and a large number of free and commercial systems; also *NIX.</td>
</tr>
<tr>
<td>uninstall</td>
<td></td>
<td>Remove hardware or software from a computer system.</td>
</tr>
<tr>
<td>unload</td>
<td></td>
<td>Remove services or software from a server so that more resources (CPU time, disk space, etc.) become available.</td>
</tr>
<tr>
<td>unreliable</td>
<td></td>
<td>In the TCP/IP sense of the term, a protocol which does not perform error correction (relying on &quot;upper&quot; layers to detect and correct errors, usually through retransmission).</td>
</tr>
<tr>
<td>upgrade</td>
<td></td>
<td>To update hardware or software to a better state.</td>
</tr>
<tr>
<td>URL</td>
<td>Universal Resource Locator</td>
<td>An identifier for an address on the Internet, preceded by the name of the protocol that must be used to reach that address (e.g.: ftp://ftp.kernel.org/).</td>
</tr>
<tr>
<td>USB</td>
<td>Universal Serial Bus</td>
<td>A recently developed bus standard for connecting peripheral devices in a chain.</td>
</tr>
<tr>
<td>user [1]</td>
<td></td>
<td>The person that is using the resources of a computer.</td>
</tr>
<tr>
<td>user [2]</td>
<td></td>
<td>A person’s account or process; identification listed in /etc/passwd.</td>
</tr>
<tr>
<td>user interface</td>
<td>UI, GUI</td>
<td>see interactive interface</td>
</tr>
<tr>
<td>user mask</td>
<td>mask</td>
<td></td>
</tr>
<tr>
<td>UTC</td>
<td>Coordinated Universal Time, GMT, Greenwich Mean Time</td>
<td>Official world time.</td>
</tr>
<tr>
<td>utility</td>
<td></td>
<td>A program to help you to do a task easier.</td>
</tr>
<tr>
<td>UTP</td>
<td>Unshielded Twisted Pair</td>
<td>Type of network cables with several parallel wires used for Ethernet. The network usually has a star topology with hubs and does not need terminators.</td>
</tr>
<tr>
<td>variable length subnet mask</td>
<td>VLSM</td>
<td>cf. CIDR</td>
</tr>
<tr>
<td>vendor</td>
<td></td>
<td>A company that provides a service or a product.</td>
</tr>
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<tr>
<td>virtual</td>
<td></td>
<td>Functionality provided without additional hardware</td>
</tr>
<tr>
<td>virtual console</td>
<td>virtual terminal, VT, VC</td>
<td></td>
</tr>
<tr>
<td>virtual memory</td>
<td>VM</td>
<td>Extra memory available on a system that is stored on a hard disk and is therefore essentially unlimited, although much slower than genuine RAM. Usually it is called swap space.</td>
</tr>
<tr>
<td>WAN</td>
<td>Wide Area Network</td>
<td>A network which links geographically widespread facilities (and often LANs at those locations) using point-to-point (leased line, SLIP, PPP) or packet-switched network (X.25, frame relay) links and which does not support the broadcast and direct connection capabilities of LANs.</td>
</tr>
<tr>
<td>widget</td>
<td></td>
<td>An placeholder used to represent any character or group of characters.</td>
</tr>
<tr>
<td>wildcard</td>
<td></td>
<td>A region on a graphical desktop, the user interface for I/O with a child process of the desktop.</td>
</tr>
<tr>
<td>window</td>
<td></td>
<td>A modem that only has a Digital Signal Processor and uses MS-Windows-specific software running on the CPU of the host computer to encode and decode data.</td>
</tr>
<tr>
<td>win-modem</td>
<td></td>
<td>A region on a graphical desktop, the user interface for I/O with a child process of the desktop.</td>
</tr>
<tr>
<td>WINS</td>
<td>Windows Internet Name Service</td>
<td>An automatic NetBIOS name database to resolve NetBIOS names to IP addresses.</td>
</tr>
<tr>
<td>word</td>
<td></td>
<td>A data type consisting of two or four (or a different number - you cannot tell) of bytes On i386 architectures, a word is four bytes (32 bits) in size.</td>
</tr>
<tr>
<td>workspace</td>
<td></td>
<td>Computer resources that are assigned to a computer user.</td>
</tr>
<tr>
<td>workstation</td>
<td></td>
<td>A computer, usually with a graphical display, for interactive use by an individual; cf. server.</td>
</tr>
<tr>
<td>write permission</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WWW</td>
<td>World Wide Web, (the) web</td>
<td>Global distributed archive of HTML documents linked through HTTP.</td>
</tr>
<tr>
<td>X</td>
<td>X-Windows</td>
<td>The X Window System: a graphical user interface originating at MIT and having several variations.</td>
</tr>
<tr>
<td>XML</td>
<td>eXtensible Markup Language</td>
<td></td>
</tr>
<tr>
<td>X-session</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X-terminal</td>
<td>X-station</td>
<td>cf. workstation</td>
</tr>
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<tr>
<td>Yellow Pages</td>
<td>YP</td>
<td>See NIS</td>
</tr>
</tbody>
</table>