Cailin's LPIC-102 summary

This document ain't much special :) Just a summary of all the stuff I'm learning about Linux that I didn't already know from Solaris. Do not use this summary exclusively to study for your LPIC certification! It doesn't cover everything you need to know and most definitely is not a good replacement for a complete book.

This summary was based on the following two books and a lot of mucking about using a basic Linux install.

- Ross Brunson – "Exam cram 2: LPIC 1", 0-7897-3127-4
- Roderick W. Smith – "LPIC 1 study guide", 978-0-7821-4425-3

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Objectives and their chapters in the books

Objective	Smith book	Brunson book	Topic
105	6	14	kernel
106	6	10	boot & runlev
107	9	16	printing
108	7	11	docu
109	6	15	shell & script
111	8	12 & 13	admin tasks
112	9	17	networking
113	9 & 10	18	services
114	7	19	security

Since the objectives are jumbled across various chapters in each book I will not be covering each objective separately. Instead I'll just write chapters based on the many "bigger" subjects that are covered by the LPIC-102. I'm sorry if this is a bit confusing.

The kernel and modules

A monolythic kernel = everything built in
A modular kernel = essentials only, plus optional expansions

The **uname** command

-a	= --all	= single line with fields ordered as follows below.
-s	= --kernelname	= name for the kernel (Linux)
-n	= --nodename	= the host's name
-r	= --kernel-release	= the kernel's version number
-v	= --kernel-version	= the kernel's release date
-m	= --machine	= system architecture
-p	= --processor	= CPU type
-i	= --hardware-platform	= e.g. **Authentic/AMD**
-o	= --operating-system	= e.g. **GNU/Linux**

For example:
```
Linux ics 2.6.8 #1 SMP Tue Sep 21 11:45:32 CEST 2004 i686 unknown
```

For example:
```
Darwin kilala 7.9.0 Darwin Kernel Version 7.9.0: Wed Mar 30 20:11:17 PST 2005; root:xnu/xnu-517.12.7.obj~1/RELEASE_PPC  Power Macintosh powerpc
```

Most OSes support the uname command, hence its usefulness in cross-platform scripting. Not all versions support the one-letter options mind you. And apparently –i and –o aren't supported in all versions either.

Options for **lsmod**
From the manpage:

> *Shows information about all loaded modules.*
>
> *The format is name, size, use-count, list of referring modules. The information displayed is identical to that available from **/proc/modules**.*
>
> *If the module controls its own unloading via a "can_unload" routine then the user count displayed by **lsmod** is always -1, irrespective of the real use count.*

The **modinfo** command
Can be used on occasion to learn more of a module. Running without parameters gives you all information, while adding **–F $field** just returns that specific field. Possible values for **$field** are: author, description, license, depends and vermagic.

Environment variables
$MODPATH overrides the contents of **/etc/modules.conf**.
$MODULECONF overrides the usage of **/etc/modules.conf** entirely.

Module file versus module name

The module named **floppy** makes use of the file called **floppy.ko**.

Information on the **depmod** command

depmod determines all cross-dependencies between loadable modules, to ensure that loading these modules can be an automatic process.

From the **man**-page:

> ***depmod*** *will not flag an error if a module without a GPL compatible license refers to a GPL only symbol (EXPORT_SYMBOL_GPL in the kernel). However* ***insmod*** *will refuse to resolve GPL only symbols for non-GPL modules so the actual load will fail.*

Files used:

- **/etc/modules.conf**
- **/lib/modules/*/modules.dep,**
- **/lib/modules/***

-a = update dependency file (run at boot time through an rc-script)
-A = update dependency file, only if there are changed modules
-C = alternate configuration file
-b = base directory for /lib/modules
-r = allow non-root owned modules

Options for **insmod**

Loads a single module and requires the full path to the module file.

-f = --force = force if mismatch in kernel and module version
-k = --autoclean = allow kernel to unload unused modules
-m= --map = show modules map, for debugging
-n = --noload = dry run
-p = --probe = verify that module could be loaded
-r = --root = allow non-root owned modules

Options for **modprobe**

Loads a module and its dependencies and requires the module name. The use of this command requires **/etc/modprobe.conf**.

-a = --all = load all matching modules, not just the first
-c = --showconfig = show current configuration
-d = --debug = show debugging information for the stack
-f = --force = load, even if the kernel version doesn't match
-k = --autoclean = allow kernel to unload unused modules
-l = --list $regexp = show all modules matching the regexp
-n = --show = dry run (aka --dry-run)
-r = --remove = unload specific module, or autoclean all
-t = --type = load all of this type (part of directory path)
e.g. **–t drivers/net**
-C = --config = alternate configuration file
-v = --verbose = verbose mode
= --show-depends = show all dependencies for one module

Options for **rmmod**

Removes an unused module and requires the module's name.

-a = --autoclean = mark unused modules for autoclean
clean currently marked modules
-r = --stacts = remove a complete modules stack
-f = --force = unload even if in use. Requires kernel option CONFIG_MODULE_FORCE_UNLOAD
-v = --verbose = verbose mode
-w= --wait = wait for the module to quiesce

Files related to modules

- **/lib/modules/$kernver/modules.dep**
  Lists all module dependencies and is rebuilt by the **depmod** command, manually or when the kernel is rebuild.
- **/etc/modules.conf**
  Replaces **/etc/conf.modules** as a repository for aliases, options and more.
- **/etc/modules.d/** and the **modules-update** command
  Used by Debian and Gentoo to rebuild dependencies.

Passing options to modules

- Automatically through **/etc/modules.conf**.
- Manually through **insmod** and **depmod**.
- Options differ per driver, so refer to the relevant documentation. Linux kernel driver options can be found in **/usr/src/Linux/Documentation**.

Kernel version numbers < 2.6

2. = major version number
4. = odd numbers are development, even numbers are stable
9 = minor upgrade

Depending on where you got it, the same version of a kernel can contain different features due to patching.

Kernel version numbers ≥ 2.6

2. = major version number
6. = minor version number
11. = significant upgrade to official codebase
10 = minor upgrade

Getting a new kernel

- Download from kernel.org.
- Import public key: **gpg --keyserver wwwkeys.pgp.net --recv-keys 0x517D0F0E**
- Verify download: **gpg --verify linux*bz2.sign linux*.bz2**
- You can get it from our distro's website, but it will be modified. On the upside this means that the configuration will match your current kernel config quite closely.

Configuring the kernel

The **make** command has four important options:

- **config**, which asks you an unending list of questions.
- **menuconfig**, which presents you with a CLI menu.
- **oldconfig**, which loads your old configuration file and asks about new options.
- **xconfig**, which presents you with a GUI menu.

The most important options to configure are:

- CPU type, for CPU optimizations.
- Hard disk controllers. The default ATA is slow so pick the proper driver. SATA is filed under SCSI.
- File systems. Be sure to pick the ones you need and to bake the root file system right into the kernel (must not be a module).
- USB. The use of a keyboard and mouse requires the use of USB and USB HID.

Before kernel 2.6 you needed to run separate **make** commands to build the kernel; these days that's changed and you can run a single command.

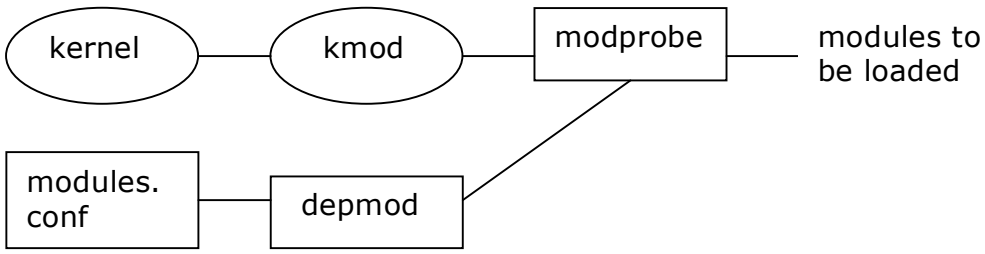
The resulting kernel image can be found in **/usr/src/linux/arch/$arch/boot/** and is called either **bzImage**, **vmlinuz** or **vmlinux**.

How to install the new kernel

- Copy the kernel image into **/boot** and give it a proper name. For example, call is **bzImage-2.6.11.10-scsi** for a kernel with SCSI support.
- Reconfigure your boot loader
- Copy **/usr/src/linux/System.map** to **/boot/System.map**.
- Run **make modules_install**.

Various loose ends

To see a nice tree view of all available modules, run: tree –d /lib/modules.



The autoclean flag means that a module will be automatically unloaded after X seconds of inactivity.

Upgrading your kernel through patches means that you won't have to reconfigure.

Patches are NOT cumulative. You will need to apply them all in order.

Boot loaders

The **/etc/lilo.conf** file
Contains global options, followed by stanzas per kernel image.

boot = loader location, **/dev/hdn** = MBR, **/dev/hdnx** = partition
default = default OS label to boot, else boot the first stanza
prompt = wait for user selection
timeout = wait for N 1/10th seconds till booting the default OS
lba32 = allow image above the 1024th cylinder
vga = video text mode, should be left alone
root = **/dev/hdnx**, the root partition for the OS
password = password required to boot this OS

A number of options only apply to images:
image = kernel image file
other = partition with custom boot loader, required for DOS, Windows, OS/2, BeOS and all BSDs
label = name for the stanza, to be used at the boot prompt
append = extra kernel options in double quotes, one option per line. very useful option: **"init=/bin/sh"** in case of corruption.

The **lilo** command
After modifying the configuration file you should rerun **lilo** in order to modify the boot loader.

-C = alternate configuration file
-t = test, don't write
-v = verbose mode
-b = override "boot=" line in **lilo.conf**

The **/boot/grub/menu.lst** and **grub.conf** files
Grub doesn't use device names as Linux does. **/dev/hda1** becomes **(hd0,0)**, **/dev/hdb3** becomes **(hd1,4)** and so on. In the case of a mixed SCSI and SATA environment the SATA disks are usually numbered before the SCSI disks.

default = the number of the OS's title (first = 0)
timeout = wait N seconds at the prompt
spashimage = background image at the prompt. the path is relative to "root="

The following options only apply to images:
title = image label, may contain spaces
root = grub root, the partition for **/boot**
kernel = image file + kernel options, all options on one line. "root=" in this case points to the partition for **/**
rootnoverify = same as "root=", used for non-Linux OSes.
chainloader+1=non-Linux OS boot loader at first sector of "rootnoverify="
init = alternative init command, eg **/bin/sh**.

Installing grub for the first time

This is only needed after installing, or after making serious modifications to the system.

- **grub-install /dev/hda**, or
- **grub-install '(hd0)'**

Boot messages and logs

The **dmesg** command

/var/log/messages

/var/log/boot.log (Red Hat)

/var/log/syslog

/var/log/boot (Debian)

/var/log/dmesg

The boot process

BIOS -> BIOS instructions -> primary boot loader -> secondary boot loader (optional) -> kernel -> devices and root file system -> init

The boot process and system startup

Linux's run levels

0	shutdown hardware	4	undefined
1	single user mode	5	multi-user + X11 + XDM
2	undefined	6	reboot
3	multi-user mode		

Debian uses run level 2 for multi-user mode + X11 + XDM. Gentoo allows for many run levels with names instead of numbers.

The **/etc/inittab** file
Each line is built as follows: **[1-4 char id]:[levels]:[action]:[process]**

Possible values for $action are: wait, respawn, once, boot, bootwait, off, ondemand (for levels a, b and c), initdefault, sysinit (before boot and bootwait), powerwait (before power down), powerfail (before power down), powerokwait, powerfailnow, ctrlaltdel and kbrequest.

After making changes to **inittab** you will need to restart the **init** daemon, either by running **telinit q** or **kill –HUP 1**.

System V boot scripts
The location for the run level scripts varies: **/etc/rc?.d**, **/etc/init.d/rc?.d** or **/etc/rc.d/rc?.d**. This is rather annoying of course.

The location where the scripts are actually stored also varies: **/etc/rc.d**, **/etc/init.d**, **/etc/init.d/rc.d**.

There are multiple tools at your disposal for managing the run level scripts. Aside from making the modifications by hand you can also use **chkconfig**, **ntsysv**, **update-rc.d** and **rc-update**.

The **chkconfig** command
--list = current configuration
--level= turn on/off a service for level X
--add = add a new service with suggested levels from the config file

The **ntsysv** command
--level= CLI menu for run level X

The **shutdown** command

-r	reboot	-h	halt	-c	cancel
+N	wait N minutes	MSG	wall message	-F	force fsck
-t N	Nsec before MSG	-f	no force fsck		
-a	use **/etc/shutdown.allow**				

Various loose ends

Instead of rebooting you can also just bounce a run level. This saves time and keeps your uptime, which could save your ass in an SLA-battle.

Running daemons and applications should use .pid files in **`/var/run`** or **`/var/lock/subsys`**. This will allow for better bookkeeping and killing.

The **`chkconfig`** command also shows services monitored by inetd.

Run levels s and S run the scripts before completing the transfer to run level 1.

Making a boot disk: **`mkbootdisk --device /dev/fd0 $kernver`**
Or on Debian: **`mkboot /boot/vmlinuz`**

The user environment and scripting

/bin/sh is often not an actual shell but a link to the default shell for Linux.

User environment configuration files

/etc/profile and **/etc/profile.d**
~/.bash_login and **~/.profile**
~/.bash_profile
~/.bash_logout

/etc/bashrc and **/etc/bash.bashrc**
~/.bashrc

The **test** command

-n	non-zero	-z	zero
=	strings equal	!=	strings not equal
-eq	integer equal	-ne	integer not equal

-lt, -le, -ge, -gt less than, less equal, greater than, greater equal
-nt, -ot, file is newer than, older than

-b	block device	-c	character device
-d	directory	-e	exists
-f	normal file	-g	set-GID file
-G	owned by $group	-k	sticky-bit file
-L	symlink	-O	owned by $user
-p	pipe	-r	readable
-s	bigger than 0 bytes	-S	socket
-u	set-UID file	-w	writable
-x	executable		

Quoting

" allows for variable expansion
' disallows variable expansion and prints the string exactly

Functions

declare –F	show all defined functions
declare –f $funct	show contents of function
type –all $funct	show as much information as possible
unset $funct	disable a function

Creating a patch

- **diff –Naur $file1 $file2 > patchfile**
- **cat $patchfile | patch**

The second command takes **$patchfile** and applies all noted changes to the original $file1. After this **$file1** and **$file2** should be identical.

Beware file paths! And used **zcat** or **bzcat** for compressed patches.

Various loose ends

It's a good idea to run the following command immediately after installing: **`find / -perm +7000 –exec ls –l {} > /root/specialbits.txt`**. Then at regular intervals run the command again and search for new files.

Handy command for numbered loops: **`seq`** -> **`for n in $(seq –w 1 20)`**

Besides the familiar while-loop, there's also the until-loop.

To escape an alias run **`\$ALIAS`**, eg **`\ls`**.

The –F flag to **`ls`** suffixed names with their type:

/	directory	=	socket
*	executable	|	fifo, or pipe
@	symbolic link		

To run a script inside your current shell: **`source $script`**.

Basic networking

For completion's sake please also read parts of my NSCA summary on TCP/IP. This covers everything from frame layout to timing and windows. Go to http://www.kilala.nl/Sysadmin for the file.

The **nslookup** command
The **nslookup** command is deprecated. It should no longer be used.

The **host** command
Syntax: **host [options] query [server]**

-a	verbose for type ANY	-d/-v	debug / verbose
-C	show SOA for auth servers	-l	list, do a zone transfer
-R	number of retries	-r	non-recursive
-T	use TCP instead of UDP	-t	query type
-w	wait forever	-W	wait N seconds

Valid query types are: CNAME, NS, SOA, SIG, KEY, AXFR, etc. For a hostname the default action is to look for an A record, for an IP address the default is to look for a PTR record.

The **dig** command
Syntax: **dig [@server] [options] query [type] [query options]**

-b	set source IP for query	-f	batch lookup from $file
-p	set port number	-t	query type
-x	reverse lookup		

Valid query types are: ANY, A, MX, CNAME, SIG, KEY, AXFR, etc.

+[no]tcp	force UDP or TCP
+domain=	set domain name search order
+[no]search	use or ignore /etc/resolv.conf search order
+[no]recursive	disable recursion
+[no]nssearch	show SOA record for authorative servers
+[no]trace	trace query path across DNS servers
+[no]short	default behaviour is to print a verbose answer
+[no]identify	default behaviour is to show which server answered
+[no]comments	default behaviour is to print comments
+[no]stats	default behaviour is to print query statistics
…	
+[no]all	disable / enable all answer sections

I guess you'd get the most useful info if you do **+noall +answer**.

The **whois** command
Syntax: **whois [options] object**

-H	hide legal disclaimer	-p	port
-h	connect to host	-V	verbose mode

DHCP
There are three common DHCP clients: **pump**, **dhclient** and **dhcpcd**.

The **dhclient** daemon
Makes use of **/etc/dhclient.conf**, **/var/run/dhclient.pid**, **/sbin/dhclient-script** and **/var/state/dhcp/dhclient.leases**.

-d debug / run in foreground (when used from **inittab**)
-q quiet mode, show only errors
-r explicitly release the lease, informing the server
-1 tries once, then fail

Telling the daemon which interfaces can be done:
- from the command line by passing a name
- from the command line by not passing any names
- from **/etc/dhclient.conf**

Old leases are kept in the database as a fallback mechanism when the DHCP server dies. Non-expired leases are then tried one by one. New leases get appended at the bottom of the file.

The **dhcpcd** daemon
Starts through either the SysV init scripts, **/etc/sysconfig/network-scripts/ifup** (Red Hat), or **/etc/network/interfaces** (Debian).

Renew your lease: **dhcpcd –k**

Red Hat NIC configuration
Use **/etc/sysconfig/network-scripts/ifcfg-$NIC** or the **netconfig** utility.

DEVICE=ethN
BOOTPROTO=[dhcp|static]
IPADDR=$ip-addr
NETMASK=$netmask
NETWORK=$network-addr (optional)
BROADCAST=$broadcast-addr (optional)
GATEWAY=$router-ip
ONBOOT=[yes|no]

Debian NIC configuration

Use **/etc/network/interfaces**, or the **netcardconfig** utility.

iface $NIC [inet|ipx|inet6] [static|dhcp]
    address $ip-addr
    netmask $netmask
    broadcast $broadcast-addr
    network $network-addr
    gateway $router-ip

/etc/init.d/networking restart

The **route** command

route [add|del] [-net|-host] target [netmask $NM] [gateway $GW] reject [dev $interface]

Sometimes the gateway keyword gets replaced with gw. Depends on the version of the **route** command I guess.

To enable routing through the kernel

- **echo "1" > /proc/sys/net/ipv4/ip_forward**
- **/etc/systcl.conf** -> net.ipv4.ip_forward=1 (depends on distro)
- **/etc/sysconfig/sysctl** -> IP_FORWARD=1 (depends on distro)

The **traceroute** command

-g	gateway to use	-i	interface to use
-p	destination port	-f	initial TTL
-I	use ICMP instead of UDP	-m	set max TTL
-s	source address		

The **tcpdump** command

-a	convert IP to names	-c	exit after N packets
-d	dump packet matching code	-e	print link-level header
-F	$file contains filter expressions	-I	listen on interface
-n	don't convert to names	-N	don't print domain names
-p	don't use promiscuous mode	-q	quick / short output
-r	read packets from $file	-t	don't print time stamps
-w	write packets to $file		

The **netstat** command

-i	= --interface	= similar output to ifconfig
-r	= --route	= similar output to route
-M	= --masquerade	= info on NAT connections
-p	= --program	= info on programs using connections
-l	= --listening	= all listening ports
-s	= --statistics	= show protocol statistics
-t	=	= TCP statistics
-c	=	= refreshing statistics, like **top**

The **/etc/inetd.conf** file

Format: **service sockettype proto [wait|nowait] user server parameters**

In case of TCP wrappers: the server name will always be **/usr/sbin/tcpd** and the parameter will be the full server path plus its arguments, eg **/usr/sbin/in.ftpd -i**.

The **xinetd** daemon

Xinetd improves upon the old **inetd** and includes comparable security measure to TCP Wrappers. It's main configuration file is **/etc/xinetd.conf** and it stores its sub-config files (each server has its own file) in **/etc/xinetd.d**.

Format for a service description:

```
service $name
{
      socket_type=
      protocol=
      wait=[no|yes]
      user=
      server=
      server_args=
      [disable=[no|yes]]
}
```

Other options:

instances	maximum amount of daemons
logtype	where to log
log_on_success	what to log
log_on_failure	what to log
cps	more than $N requests per seconds disables xinetd for $X seconds
only_from	hostname ACL, same as TCP Wrappers
bind	listen on $ip
interface	listen on $interface
no_access	deny these IPs
access_times	clock times to allow

TCP Wrappers

The format of **hosts.allow** and **hosts.deny** is as follows:

```
daemons:    hosts : option : option
```

Valid values for daemons are: ALL, $service and $service-list
Valid values for hosts are: hostname, fqhn, .$domain, @$netgroup, $net/$netmask
and /$file

Hosts.allow is read first, then **hosts.deny**. They are read anew for each request. They are read from top to bottom, searching for the first match.

The EXCEPT keyword does exactly that.

You can check your syntax with **tcpdchk**. **tcpdmatch** predicts how a certain client will be handled.

Options include:

severity $fac.$lev	set facility and priority for syslog
twist	send output of $command back to client
spawn	run $command

Commonly used TCP/IP ports

20/21	ftp	139	Netbios
22	Ssh	143	Imap2
23	telnet	161	Snmp
25	Smtp	177	Xdmcp
53	Dns	220	Imap3
67	Dhcp	389	Ldap
69	Tftp	443	https
80	http	445	Msds (smb)
88	Kerberos	514	Syslog
109/110	Pop	515	Spooler
111	Portmap	636	Ldaps
113	Auth/ident	749	Kerberos admin
119	nntp	5800-5899	Vnc over http
123	Ntp	5900-5099	Vnc
137	Netbios	6000-6099	X11
138	Netbios		

PPP secret files

Format of **/etc/ppp/pap-secrets** and **./chap-secrets**:
$username $server $password $ip

$server is normally left as an asterisk (*).
$ip is normally left blank since you'll be assigned one.

PPP scripts

ppp-on, ppp-on-dialer, ppp-off

There are examples in **/usr/share/doc/ppp*/scripts**. Copy them to **/usr/local/bin** and modify them.

ppp-on:
TELEPHONE is the phone number.
USERNAME & PASSWORD are dummies.
DIALER_SCRIPT is the full path to ppp-on-dialer.
Verify parameters for pppd.

ppp-on-dialer:
If PAP/CHAP, remove the lines with $ACCOUNT and $PASSWORD. Also removing trailing backslashes after CONNECT.

The **wvdial** command

Uses **/etc/wvdial.conf**, which has sections heads like **[$name]**. You can call a certain configuration by running: **wvdial $name**.

Per section you can configure the following:

Modem	Phone
Baud	Username
Init	Password
Init2	Auto reconnect [on|off]

Printing

Queues
One system can have multiple print queues for each defined printer. This accommodates various paper sizes and duplexing units. This cannot be handled in a way similar to Windows, since most of those options are handled by drivers.

The print queues are usually to be found in **`/var/spool/lpd`** and **`/var/spool/cups`**.

Tasks of the printing system
- accepts jobs from **`lpr`**
- accepts jobs from remote computers
- monitors print queues
- directs jobs from queues to printers

Even local jobs are submitted through the network stack. Hence, every LPD and CUPS system can both be client and a server.

LPD cannot inform applications of a printer's capabilities: the application just dumps Postscript and the printer is supposed to cope. CUPS can provide printer specific details and makes for a more elegant process.

Comparing printing work flows
Windows:
Application -> driver -> queue -> printer

Unix:
Applications -> output -> lpr -> lpd -> queue -> filter -> printer

The output of an application depends on how it's been configured. Possibilities are Postscript, RAW, CPL and graphical.

The filter translates the output into a form that the printer itself will understand. Ghostscript is one example, others include RHS-Printfilters, Apsfilter, MagicFilter and CUPS' own filters.

Ghostscript files can be very large. A 10kB Postscript can become a 40 MB bitmap. N dpi x size x colours = large!

The **/etc/printcap** file

The default printer is called lp.

Each component of the file is a long line delimited by colons.

```
$name1|$name2|..|$nameN:\
        :lp=/dev/lp0:\                  # device file
        :br#57600:                      # baud rate
        :rm=:\                          # remote machine
        :rp=:\                          # remote queue
        :sd=/var/spool/lpd/lp:\         # spool dir
        :mx#0:\                         # max job size in bytes
        :sh:\                           # suppress header
        :if=/var/spool/lpd/lp/printfilter:  # input filter
```

Other options include:

ml=	max chars per job	af	accounting file
sh	shell for filters (/bin/sh)		

The baud rate setting is ignored for parallel, USB and network printers.

The spool dir is the location of the queue, usually named after the printer's primary name. It's owned by root:root, with permissions 700.

Printing filters

Most filters come with their own configuration tools. Apsfilter for example has **/usr/share/apsfilter/SETUP**. Using these tools you can identify model, port/remote queu, paper size, etc. Apsfilter uses **/etc/apsfilter/apsfilterrc**.

As was said earlier you can create multiple queues in **/etc/printcap**, just to accommodate for multiple filters and filter settings.

GIMP has its own printing drivers and thus usually outputs in RAW format.

CUPS configuration

All configuration files can be found in **/etc/cups**. Everything in CUPS can be configured using the web GUI, with the exception of the GUI itself and remote printing.

printers.conf

```
section head    = <[Default]Printer $name>
section end     = </Printer>
```

/etc/cups/ppd/$name contains additional options for the specific model. PPD in this case stands for *Postscript Printer Definition*. These files can be acquired from the manufacturer or are included with CUPS.

CUPS network browsing

The advantage of CUPS: it uses Internet Printing Protocol, which supports browsing the network for printers. To enable browsing as a client, edit cupsd.conf and add "Browsing on".

The IPP part of CUPS also comes with ACL options in **cupsd.conf**.
Order [Deny, Allow | Allow, Deny]
Deny from [All | $address]
BrowseAllow from [All | $address]
Allow from [All | $address]

$address can also be a network address (IP/netmask notation). If you set @LOCAL as the $address, then you're allowing all local subnets access.

These ACL's can be applied to **/printers**, to **/** and to **/admin** in **cupsd.conf**.

CUPS global options

Browsing [on|off]
BrowseAddress $broadcastaddress

Getting more CUPS definitions

- Your distribution's website
- The FooMatic website (linuxprinting.org)
- GIMP Print
- EPS Print Pro

Networking and security

CUPS runs on port 631 by default. This port can also be used for the web interface, which unfortunately requires the root account and does NOT provide encryption.

Printing to Windows' shared printers requires the following URI **smb://$user:$passwd@$host/$share**. This requires local filters because they usually do not support Postscript (unless it's a Linux box running an SMB server).

The **lpr** command

-P	queue name	-r	delete original file
-h	suppress banner	-J	job name
-m	mail $user when complete	-#	print # copies
-b	disable filter	-K#	print # copies
-V	verbose mode		

Multi-page printing is also an option: **mpage –Pqueue -# $file**. Here, # is the amount of pages you want printed on one sheet of paper.

The **lp** command is usually a symbolic link to the **lpr** command. Also, **lpstat**, **lpinfo**, **lpmove** and the likes are not real commands. These are often aliases and are NOT valid answers on the exam.

The **lpq** command

-P	queue name	-a	all queues
-l	verbose mode	-L	Über-verbose mode
-t	repeat every N secs	-all	verbose, split into lines

Shows job number, job owner, job file, job size and extras.

The **lprm** command

-P	queueu name	$job	job number
$user	all for $user	-a	all for $user
-a all	all jobs	-U	all for $UID
-D	debugging mode	-V	verbose mode

The **lpc** command

-P	queue	-a	-P all
-S	server	-U	run as $user
-V	version info	-D	debug mode

abort	stop all	start	resume all
disable	disable new jobs	down	disable print queue
enable	enable new jobs	stop	same as disable
topq	move job to top	up	enable print queue
status	show status	defaultq	show default queue
defaults	show all defaults	hold	accept jobs, don't run
release	release all held jobs	kill	kill LPD for queue
client	show local printcap	redirect	forward jobs to $prntr

Additionally, stop and start also affect the lpd itself. CUPS' version of lpc only supports the status command.

Controlling CUPS queues uses command names that you usually pass to lpc on its own command line, eg: enable, start, stop, etc.

The **lpmove** command

Moves a job to a different queue.

Various loose ends

USB printers are usually /dev/usb/lpN.

Sendmail

Three tasks regarding e-mail

MTA transport between servers: sendmail, exim and postfix
MDA delivery to user account: procmail and mail
MUA enable user to get mail: various mail clients

Configuration files

sendmail.cf	Primary configuration file. Relay options, hostname, etc. Found in /etc/mail.
the m4 file	Used to generate the .cf file. Usually ends in **.mc**.
aliases	Holds username translations. Stored in **/etc** or in /etc/mail. The **newaliases** command converts it into **aliases.mc** and **aliases.db**.
access	Controls mail relaying. In **/etc** or in **/etc/mail**.
local-host-names	All names in this list are treated as if they were the local host. Mail for these boxen is delivered locally.

Configuring Sendmail

Run: **m4 $file > sendmail.cf**
/etc/init.d/sendmail reload

The **sendmail.cf** file

Lines starting in "dnl" are comments.

The value for most options is enclosed in a backquote and a quote, eg MASQUERADE_AS(`$name'). Please make absolutely sure that you don't mix this up!

Making sendmail only available for local programs: DAEMON_OPTIONS(`Port=SMTP,Addr=127.0.0.1,Name=MTA')

The use of **local-host-names** requires: FEATURE(`use_cw_file'). The use of the **acces** file requires: FEATURE(`access_db').

Using a relay server for sending your e-mail

Remove: MAILER(local) and MAILER(smtp)
Add: FEATURE(`nullclient', `$server')
Or add: FEATURE(`SMART_HOST', `$server')

Forwarding e-mail

Either use the **aliases** file or **~/.forward** (which contains one name or e-mail address).

Format of the **aliases** file:

```
$name: $target1,$target2,….,$targetN
```

Valid targets are: $user, /$file, |$command, :include:$FILE, and $address.

The included file contains a list of e-mail addresses.

The **mailq** command

Lists the contents of the mail queue. Pipe it to **wc –l** to see how many messages are waiting to be sent. If things are stuck, run **sendmail –q** to get things going again.

The **access** file

```
localhost.localdomain          RELAY
localhost                      RELAY
127.0.0.1                      RELAY
172.25.98                      RELAY        # local network
```

Mail queues

/var/spool/mqueue	undelivered, remote mail
/var/spool/mail	undelivered, local mail

Various loose ends

Sendmail has other, dangerous relaying options like **relay_entire_domain** and **promiscuous_relay**. Needless to say, these shouldn't be turned on.

Regularly check for unsafe settings in **sendmail.cf** and in the **access** file.

The **mailstats** command will return loads of interesting information.

Apache

Configuration files

The location for the config files varies wildly: **/etc/apache**, **/etc/apache2**, **/etc/httpd**, or **/etc/httpd2**.

The name of the config file itself also varies: **httpd.conf**, **httpd2.conf**, **apache.conf**, or **apache2.conf**.

Search for the default location by running: **rpm –ql apache | grep conf**

Daemon control

/etc/init.d/apache, **/etc/init.d/httpd**, or **apachectl**.

The apachectl command knows the following options: start, stop, graceful (restart), configtest and fullstatus. Fullstatus requires the lynx browser and the mod_status module.

Format of the main configuration file

```
directive   value
directive   value value
<block>
directive   value
</block>
```

Interesting directives

LoadModule	enable optional features
Include	load additional file at this point
User	run as $user
Group	run as $group
DocumentRoot	location used to search for files for $server-instance
UserDir	folder in homedir for person DocRoot (requires userdir_module)
BindAddress	either *, or a list of IP addresses to listen on
Listen	port to listen on
ServerAdmin	admin e-mail address
ServerRoot	configuration directory
Servertype	[standalone | inetd]
StartServers	number of children started at boot
MaxClients	number of clients before returning "Server busy"
Redirect	redirect old URL to new URL
DirectoryIndex	set valid names for index.* files.
[Min|Max]SpareServers	number of additional children to keep in RAM for surges in traffic

If you don't use it, kill **cgi_module**.

Old configuration files

access.conf	access control lists
srm.conf	parameters and directives

Various loose ends

Starting from version 2, Apache cannot be run from the **inetd** daemons.

Apache runs on daemon as root, while its children (running as a different user) handle all the incoming requests.

NFS server

The use of NFS requires that all users involved have the same numeric UID across all systems involved.

The **/etc/exports** file
$dir $host($options) $host($options) …

Valid values for $host are: hostname, fqhn, *.$domain, ip address, $net/$netmask, or @$netgroup (NIS and NIS+).

DO NOT put spaces between hosts and options! This royally fucks you over! Why? Because an option without hosts is understood to apply to ALL hosts.

Interesting options (comma separated)

secure	only allow requests from ports <1024
ro/rw	read only / read write
sync/async	write to disk before responding (or not)
root_squash	use $anonuid/$anongid for remote root users (default)
no_root_squash	antonym of the above
all_squash	similar, but for all remote users
anonuid	the UID for the above options
anongid	the GID for the above options

Rereading the configuration
Run: **exportfs –ra**, or **/etc/init.d/nfs** reload.

NFS daemons

portmap	general RPC daemon
rpc.nfsd	nfs daemon
rpc.mountd	incoming mount requests
rpc.rquotad	quota support for NFS
rpc.lockd	locking of in-use files
rpc.statd	manage handing locks after a crash

Mounting of NFS exports
Either manually with **mount**, or through **/etc/fstab**.

NFS options in the **/etc/fstab** file

rsize/wsize	read and write block sizes. default is 4096
hard	hang and wait if mount is unavailable
soft	error and exit if mount is unavailable
udp / tcp	for which protocol to use. tcp is slower but reliable

Samba server

Samba uses NetBIOS names, instead of TCP/IP hostnames. It's better if you keep them in sync.

Samba daemons

smbd	file and printer sharing
nmbd	NetBIOS resolution
swat	web gui (runs from inetd)

Samba configuration

Either **/etc/smb.conf** or **/etc/samba.db/smb.conf**.

Each section starts with [$name]. The defaults section starts with [global].

Comment lines start with a # or with a ;.

Interesting options:

workgroup	NetBIOS workgroup name / domain
netbios name	NetBIOS hostname
security	[Share|User|Server|Domain]
encrypt passwords	[Yes|No]
local master	[Yes|No], usually no
domain master	[Yes|No], usually no
wins server	IP of NetBIOS name server
name resolve order	[Wins, lmhosts, bcast, host]

The [homes] block is special as it is used to automatically share all home directories.

Interesting sharing options:

available	[Yes|No]
comment	description
read only	[Yes|No]
writable	[Yes|No]
path	directory to share (same as directory option)
printable	[Yes|No]
printer	name for local queue (same as printer name)
server	comment string
hosts allow	ACL
guest account	just that
password server	Windows domain controller
interfaces	listen on these NICs

NetBIOS name resolution

Wins	WINS server
lmhosts	**/etc/smb/lmhosts**
bcast	NetBIOS broadcast
host	**nsswitch.conf**

nsswitch.conf allows you to set: **hosts files dns wins**

Security

Samba's password encryption is incompatible with Linux. Hence Samba requires its own password file or database. PAM can be used to use the Samba database instead of the normal Linux passwd file, but… Who would want that? :(

Linux's local file permissions supercede Samba's ACLs.

Explicitly defined shares take precedence over generic ones.

Various loose ends

Samba shared printers are Postscript printers, unless you specify a RAW queue.

SWAT runs on port 901. Samba itself on ports 137, 138 and 139.

Using SWAT completely overwrites all your customizations made to the text configuration files.

The **testparms** command tests your configuration for you.

You can monitor connections using **smbstatus**.

You can list remote shares with **smbclient –L $host**.

Fstab entries are as follows:

```
//$host/$share    $mount      smb   user=user 1 1
```

DNS server

For completion's sake please also read parts of my NSCA summary on DNS. This covers everything basic configuration to record types. Go to http://www.kilala.nl/Sysadmin for the file.

The **/etc/named.conf** file
Used to be called named.**boot in previous versions of Bind.**

A forwarding server only requires the following

```
options {
      directory "/var/named";
      forwarder {
            $IP1;
            $IP2;
      };
};
```

In Bind 4 this was:

```
forwarders $IP1 $ip2
options forward-only
```

Other configuration options
Instead of forward only you can use "forward first". If forwarding fails Bind will do a normal lookup.

Want DHCP to announce the local DNS address? Edit **/etc/dhcpd.conf** and add: **option domain-name-servers $IP;**

SSH server

Configuration files
Files are stored in **/etc/ssh**.

ssh_config	client configuration
sshd_config	server configuration

Interesting options:

protocol	preferably set to 2
Permit Root Login	preferably set to no
X11 Forwarding	yes is nice

Keys
An SSH server has six keys: 2 RSA1, 2 RSA and 2 DSA.

You generate these keys using:
ssh-keygen –q –t $type –f $file –C '' –N ''

SSH agent

- **ssh-agent $SHELL**
- **ssh-add**, followed by your passphrase

Documentation

Searching through man-pages

whatis	**man –f**	searches one line summaries
apropos	**man –k**	searches name and detail descriptions
	man –a	successively view all pages for $query

Setting up a man search path

One time	**man –path $path**
Always	**/etc/man.conf**, MANPATH=$path One line per man-directory MANSECT 1:1p:8:2:3….. sets the search order

Man sections

1 executables and commands	6 games
2 system calls	7 miscellaneous
3 library calls	8 system administration commands
4 special files	9 kernel routines
5 file formats and conventions	

The info browser

Run: **info $command**

arrows	navigation	enter	select link
$word	a link	n/p	next/prev topic
u/l/t	up/last/top	q	quit

Other documentation

/usr/share/doc is a veritable grab-bag of random stuff thrown together.

Online resources

- Linux documentation project = http://tlpd.org
- The website for that piece of software
- Your distro's website
- Google ;)

Communicating with your users

/etc/issue
/etc/motd
wall
write (one-way)
/etc/issue.net
shutdown
talk (two-way)

Security

Linux firewalls

2.0.x	ipfwadm
2.2.x	ipchains
2.4.x	iptables
2.6.x	iptables

Firewall configuration

- manual, through scripted commands
- gui, like Firestarter or Guarddog
- through a helpful website, http://linux-firewall-tools.com/linux

The **`iptables`** tables

- nat
- mangle
- filter

The filter chains

- INPUT, to local processes
- FORWARD, for routed traffic
- OUTPUT, from local processes

Chain policies

Chain policies can be set to three targets:

- ACCEPT, allow traffic (default default value)
- DROP, ignore, results in "link down"
- REJECT, refuse, results in "host up, but port not available"

The **`iptables`** command

-L	list current config	-t	table
-F	flush $chain	-P	set policy for $chain to $target

-A $chain $criteria –j $target = add rule

Possible criteria

-p	= --protocol
-s	= --source
-sport	= --source-port
-d	= --destination
-dport	= --destination-port
-I	= --in-interface
-O	= --out-interface
-m	= --state

Possible states

NEW, RELATED, ESTABLISHED and INVALID.

Dumping your configuration

- **iptables-save** dumps your ruleset to **/etc/sysconfig/iptables**.
- this file is used at the next reboot to reload (Red Hat and Debian).
- **iptables-restore < $file** restores your configuration

Firewall stuff in **/proc/net**

ip_fwchains	ip_fwnames
ip_tables_matches	ip_tables_names
ip_tables_targets	ip_masquerade

Finding open ports

- Check your SysV scripts and super server
- Use **netstat –lp**
- Use a scanner like **nmap** or **nessus**

Finding risky files

permission	file	directory
1000	non-swappable	non-owners can't delete
2000	run as $group	force $group own on all files
4000	run as $user	-

It's a good idea to run the following command immediately after installing: **find / -perm +7000 –exec ls –l {} > /root/specialbits.txt**. Then at regular intervals run the command again and search for new files.

The + in the above **find** command indicates that it should find all files that have any of the bits set, hence 1000, 2000, 4000, 6000 and 7000.

Tripwire

/etc/tripwire/twcfg.txt and **./twpol.txt** are plain text files that are parsed into binary files by **tripwire --init**. The resulting files are **tw.cfg** and **tw.pol**.

Loading a new configuration asks for a password, which also protects the database making it tamper proof.

Run **tripwire --update** after an official change to the system.
Run **tripwire --check** to keep track of changes made to the system.

Verifying RPM packages

rpm –V $package verifies checksums and other stuff for you.

--verify is the same	-Va checks all packages

Eight characters per file tell you what's changed

1 size	5 link path
2 mode	6 user ownership
3 MD5 sum	7 group ownership
4 major / minor number	8 time

`rpm –K $package` verifies the GPG key of a package file. Getting the proper key can be done as follows: **`gpg --recv-keys --keyserver $server $key-id`**.

Unlike Tripwire's the RPM database is NOT protected.

Sources for security information

CERT	general security and latest threats
US-CERT	same as CERT, but local to USA
CIAC	US DoE = less general info, more on threats
CVE	dictionary of exploit names, little to no details
SecurityFocus	general info, host to the BugTraq ML
Linux Security	similar to CERT, but focuses on Linux
$distribution	patches and alerts for your distribution
$product	patches and alerts for your applications

It's a good idea to subscribe to RSS feeds for the relevant websites. That makes gathering the new information very easy.

Updating your system

- **`apt-get upgrade`** and **`apt-get dist-upgrade`**, -s is a trial run
- Red Hat and Fedora use Update Agent
- Suse has YAST

Enable shadow passwords

- **`pwck`**, followed by **`pwconv`**
- **`grpck`**, followed by **`grpconv`**

PAM limits

Format of **`/etc/security/limits.conf`**: **`$domain $type $item $value`**

$domain	$user, @$group, or *
$type	hard, soft, or –
$item	core, data, fsize, nofile (number of open files), rss, stack cpu, nproc, maxlogins, or priority
$value	the value, depends on the metric

Various loose ends

The **`chrootkit`** tool (http://chrootkit.org) helps you find root kits.

`/etc/securetty` and **`/etc/usertty`** define TTYs that root can login to and set TTY parameters for normal users: days, times and source systems.

System administration

The **useradd** command

-c	comment	-m	make home directory
-d	home directory	-k	skeleton directory
-e	expire	-M	don't make homedir
-f	inactive	-p	encrypted password
-g	primary group	-s	shell
-G	secondary group	-u	UID
-r	system account	-n	no group for itself

-D show defaults from **/etc/default/useradd**
-D $option $value set default value

The **/etc/login.defs** file

CONSOLE	a colon delimited list of ports that root can login on
ENVIRON_FILE	a file containing lines of env. variables to set at login
ENV_PATH	the default $PATH for all users except root
ENV_SUPATH	the default $PATH for root
FAILLOG_ENAB	if enabled, logs login failures in **/var/log/faillog**
FAIL_DELAY	delay in seconds after a failed login
LOGIN_RETRIES	the number of login attempts allowed before it exits
NOLOGINS_FILE	the path to the file that blocks remote logins
ULIMIT	system wide file size limit
UMASK	system wide **umask** setting
MD5_CRYPT_ENAB	enables MD5 **passwd** encryption
MAIL_CHECK_ENAB	if enabled a user's mailbox is checked at login
CRACKLIB_DICTPATH	dictionary path for **crack**

The **passwd** command

-l	lock	-d	remove password
-k	update expired account	-S	display password info
-u	unlock	-f	force unlock wo. password

The **usermod** command
Supports most **usersadd** options.

$user –l $newname changes $user's login name

-L/-U lock or unlock -m move files to new homedir

The **chage** command

-l	show acct expiry info	-d	set last day passwd changed
-I	set inactive days	-E	set expiration date
-W	set warning days		

-m/-M set min/max days between **passwd** change

The **/etc/shadow** file
$user:$passwd:$last-pwd-chg:$min-days:$max-days:$warn-days:
$days-from-exp-to-deact:$exp-date:<empty>

The **userdel** command
-r remove homedir

The **groupadd** command

-g	GID	-r	private group
-o	allow duplicate GID	-f	allow duplicatie name

The **gpasswd** command

-a	add $user	-d	remove $user
-R	lock group, no new users	-r	remove passwd from group
-A	admin users $user-list	-M	-a and –A

The **/etc/syslog.conf** file
Format: **$facility.$priority** **$action**

Possible facilities are: auth, authpriv, cron, daemon, kern, lpr, mail, mark, news, security (deprec), syslog, user, uucp and local[0-7].

Possible priorities are: debug, info, warning, warn (deprec), error (deprec), err, crit, alert, emberg, and panic (deprec).

Possible actions are: /$file, /$device, $user, * (all users) or @$host.

=$prio only this priority !$prio all below $prio

Multiple selectors on one line are separated by a semi-colon.

The logger command inserts messages into syslog:
logger –p $fac.$pri $message

The **/etc/logrotate.conf** file
You have a list of options in the default section, or options per (list of) files in curly braces.

Options:

[daily|weekly|monthly]	the frequency for rotating
rotate N	keep N old copies
size N	rotate when size reaches N
create	create empty log file after rotation
compress	zip old files
compresscmd	[gzip|bzip2|compress]
dateext	use date instead of .0, .1, .2 and so on
nomail, or mail $address	mail old log file
prerotate	script before rotation
postrotate	script after rotation

/etc/logrotate.d can contain per-file or per-application configuration files.

Login log-files

/var/log/wtmp	login times and duration of users
/var/log/utmp	current information on logins
/var/log/lastlog	login dates, times and duractions

wtmp -> last, w, updwtmp
utmp -> finger, who, login, last
lastlog -> lastlog

System time

The system's software clock is always in UTC, the OS just presents the time differently to applications and users. This way all Linux boxen in the world agree on the same time. Kind of like Zulu time in the military.

/usr/share/timezone/ contains subdirs for the various regions of this world. Each region contains files for time zones, which are binary files and should not be edited. Link the proper file to **/etc/localtime**.

Tools to help: **tzsetup** and **tzselect**.

Setting the date: **date MMDDhhmmCCYY.ss**. Use –u, --utc, or –universal to set UTC time instead of local time.

The **hwclock** command

-r	= --show	= show current local time
	--set --newdate	= set time and date
	--systohc	= copy software clock to hardware
	--hctosys	= copy hardware clock to software

NTP commands

ntpq is an interactive NTP status tool. The **peers** command show current statistics.

Correcting the time can be done with **ntpdate $server** (deprecated), or by **ntpd –g**.

Editing **ntp.conf** and setting "restrict default ignore" will block clients from using your box as NTP server.

Other commands:

ntpdc	online reconfiguration of ntpd
ntptrace	trace a channel of servers to their original source
tickadj	change time-related kernel variables through /dev/kmem
ntptime	read kernel time variables
ntp-genkeys	generate public and private keys
ntp.drift	describes the local clock's error rate

Crontab time selection

*	all	n-p	all from n through p
n,o	at n and o	*/n	every N instances

@reboot	@monthly	@midnight
@daily	@annually	@yearly
@weekly		

When not using cron tabs per user the format changes to **`$times $user $command`**. This occurs in the daily/weekly/monthly files. These tables are stored in either **`/etc/cron.$interval/`** or **`/etc/cron.d/$interval/`**. These scripts are called by **`run-parts`** or **`cronloop`** in the normal crontab.

The **`anacron`** command

Anacron is a nice alternative that decides whether it should run a job based on the time since that job was last run. It uses **`/etc/anacrontab`**.

The format: $period $delay-from-start $identifier $command

The **`at`** command

`at [-f $file] $time`

$time can be: hh:mm [am|pm], noon/midnight/teatime, MMDDYY / MM/DD/YY / DD.MM.YY, now + n [minutes|hours|days|weeks|etc]

`atq` shows the queue of jobs. **`atrm`** removes a job. **`atrun`** depends on load, running a job when the system drops below a certain load.

The **`tar`** command

c	create	d	compare arcive to files
A	append	t	list contents
r	append non-tar files	x	extract
u	appends newer files		

Additional options:

C	cd to $dir before start	P	absolute paths
f	[host:]/$file	v	verbose
g	increment against $file	W	verify after write
l	only one file system	X	exclude all in list $file
M	multi-tape archive	z	gzip
L	tape length in kB	j	bzip2
p	preserve permissions		

--exclude $files

The **cpio** command

-o	= --create	= create an archive
-i	= --extract	= extract an archive
-p	= --pass-through	= copy directory tree to new location

Options:

-a	reset access time	-A	append to archive
-E	$file lists files to extract	-F	$file is the archive
-H	format [bin|crc|tar]	-I	$file is stdin
-O	$file is stdout	-t	list contents
-u	replace without asking	-v	verbose

The **dump** command

```
dump -f $file $filesystem
```

The restore command is its counter part. None of this is very reliable in kernels ≥ 2.4.x.

The **dd** command

if	$file or $device is input	of	$file or $device is output

dd backs up a partition, not a file system, thus it includes all the empty space which really is a waste. It is also impossible to restore single files unless the location you're backing up to can be mounted.

Various loose ends

Use **newgrp** command to change your current primary group.

The **~/.hushlogin** file ensures that your mailbox doesn't get checked and that the system doesn't show your last login information.