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Abstract:

This study guide will help you to prepare for Linux/Unix Exam RH300, Red Hat Certified Engineer. Exam topics include Hardware and Installation, Configuration and Administration, Kernel Services, Networking Services, X Window System, Security, Routers, Firewalls, Clusters and Troubleshooting. The exam has three components: Debug (2.5 hrs), Multiple Choice (1 hr) and Server Install and Network Services Setup (2.5 hrs.)

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Contents:

Pre-Install

- Determine your Linux system's role in your network: WWW, FTP, NEWS, ISP, development workstation, thin client, enterprise server, application server, database server, etc.

Collect hardware information: check out Red Hat 5.x **HCL**. Be familiar with the model and parameter of your hardware devices: keyboard, monitor (horizontal/vertical frequencies), mouse type (serial, PS/2, or bus mouse), protocol (Microsoft, Logitech, MouseMan, etc.), and number of buttons; printer, hard drive (IDE, EIDE, SCSI, Cylinder/head/sector geometry), sound card, video card, PC-Card (PCMCIA) etc.

- If you have IDE drives, you should check your computer's BIOS to see if you are accessing them in *LBA* mode.
- Collect network information: hostname, domain name, IP address, netmask, default gateway, primary and secondary name server, NFS server (optional), FTP server (optional).
- Be familiar with what packages that Red Hat comes with, so you can choose these during installation.
- Read the Linux hardware HOWTO (in Red Hat CD:\DOC\HOWTO) to clarify the hardware compatibility issue.
- Review IRQ settings and plan the IRQ layout. This table lists the standard IRQ layouts:

Interrupt Line	Device	Comments
0	Timer	
1	Keyboard	
2	Cascade to IRQ9	On some systems, IRQ2 is the gateway to IRQs 9~15; avoid it if possible
3	COM2	Can also be COM4, but only one of the two
4	COM1	Can also be COM3, but only one of the two
5	XT hard disk controller, LPT2	Hard disk interface used only on XTs, or alternatively for LPT2 on the unusual machine with LPT2. This is free on most modern PCs, and is the "catch-all" IRQ for bus mice, sound cards, LAN boards, etc.
6	Floppy disk controller	
7	LPT1	
8	Clock	
9	Possible cascade to IRQ2	May not be available

10		Generally available
11		Generally available
12	Motherboard InPort	If your PC/laptop has a built-in mouse port, it probably sits here
13	Math Coprocessor	This interrupt is required even if your CPU has a numeric coprocessor built in
14	Hard Disk	
15	Unused	Generally available

- Hardware requirement for Red Hat 5.x installation:

Hardware Device	Minimum	Suggest	Comments
Processor	i386 SX without X i386 DX with X	P166 MMX	It's hard to find a processor older than a P166 in today's market.
Hard Drive	60 MB	1 GB	600 MB for a complete installation
Memory	4 MB	8 MB without X 16 MB with X	

- Create installation boot disk and supplemental diskette using **rawrite** program - location on CD is: \dosutils\rawrite.exe
- If Linux is to coexist with other OSs, create available hard drive space using **fips** utility (a program similar to Partition Magic). Location on CD: \dosutils\fips.exe
- Linux's primary file system is EXT2, and SWAP (for SWAP files).
- Linux supports plug and play.

Installation and Troubleshooting

- Use **F3** key to go to expert mode - disables most of the auto probing and auto detection.
- Use **F4** key, and both boot and supplemental disks to repair a damaged system.
- Use **F6** key to pass some options to the kernel at the boot time. Example: **boot: linux mem=128M** will instruct the kernel to use 128MB system RAM.
- Red Hat 5.x Linux Kernel file name is **vmlinuz.** It's on the Boot disk and is less than 500 KB.
- **initrd.img** file is first loaded by system
- To install on the machine without CD-ROM: copy \RedHat\ directory tree from CD-ROM over Network to the hard drive before install.

- If IDE CD-ROM is not being detected, restart the installation process, key in instruction to kernel: **boot: linux hdX=cdrom** (X=a if CD-ROM is in ide0 master; X=b if CD-ROM is in ide0 slave; X=c if CD-ROM is in ide1 master; X=d if CD-ROM is in ide1 slave. Where ide0=primary channel and ide1=secondary channel).
- Partition disk using **Disk Druid** during installation. Know what is the Mount Point, Device, Requested, Actual, Type, and how to specify the particular parameter for them. Know Driver summary, especially what **Geom [C/H/S]** means. (Cylinders, Heads, Sectors).
- **/** and **swap** are default partitions to specify when using Disk Druid.
- Partition disk using **fdisk** during installation. Be familiar with following commands and their usages:

Command	Usage
m	display help menu
p	list current partition table
t	change system partition ID
n	add new partition
d	delete current partition
l	list known partition types
q	quit without saving changes
w	write changes and quit

- **Linux partitions** - It's recommended to create multiple partitions for Linux instead of using a single partition.

Partition Name	Comment
swap (82)	**Swap** partitions are used to support virtual memory. If the system has 16 MB of RAM or less, you must create a swap partition. Even if you have more RAM, swap is still necessary. The minimum size of a swap partition should be equal to your physical RAM, or 16 MB (whichever is larger). Red Hat recommends 32 MB for workstation installation and 64 for server installation
root (83)	Root partition is where the root directory resides. It only needs to contain things necessary to boot your system, as well as system configuration files. 50~80 MB works well for most systems
/usr	This is where most software on Linux systems resides. This partition should be between 200~500 MB, depending on how many packages you plan to install. Any RPM-based package you

	install later will use this space
/home	This is where users' home directories go
/milo	Alpha users that will be using MILO to boot their systems should create a 1.5 MB DOS partition where MILO can be copied after the installation is complete
/usr/local	Traditionally, this partition has been used to hold things you wish to keep separate from the rest of your Linux system
/usr/src	Linux kernel sources and sources for RPM-Based packages are stored here
/tmp	For temporary files

- Create ext2 (Second Extended filesystem) Linux filesystem partition using the **mke2fs** (make filesystem) command.
  Syntax:
  mke2fs -c <partition> <size>
  Example:
  mke2fs -c /dev/hda3 162344
  (162344 is the size in blocks.)
- Other than the ext2 file system, Xia file system, Extended filesystem, and Minix filesystem are available for Linux. To create those filesystems, use **mkxfs** (for Xia), **mkfs** (for Minix), and **mkefs** (for extended file system).
- Enable swap space for installation using mkswap command.
  Syntax:
  mkswap -c <partition> <size>.
  Example:
  mkswap -c /dev/hda1 13565
- Most PC BIOSs can't handle more than **1024 cylinders** on a disk drive. You can't create DOS or Linux partitions or filesystems that go beyond the 1023rd cylinder (SCO allows the user to do anything beyond the 1024 limit). Red Hat Linux can use partitions beyond the 1024 limit, but it can't boot from them.
- Before the end of installation, you will be prompted to create a Linux boot disk - a disk that is different from the one created by using rawrite. The bootable disk enables users to access the system at anytime, especially if the normal boot
- (Create the boot disk after system installation.)
- Configure a modem during installation. **/dev/ttys0** equivalent to COM1, **/dev/ttys1** equivalent to COM2.
- Configure a mouse during installation. If the mouse is a serial mouse, choose the port. **/dev/S0** corresponds to COM1, **/dev/S1** corresponds to COM2, and so on. Don't select the same port as used by a modem.
- Set the boot device. If Linux will coexist with other OSs (such as DOS, NT), don't install **LILO** (Linux Loader) and overwrite the hard drive's **MBR** (master boot disk).

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- Specify system boot up from boot floppy disk or from LILO.
- Choose the **LILO** installation to boot your system in different ways. Install bootloader to MBR vs. First sector of boot partition. process fails. This disk is an emergency boot disk.
- Configure LILO by modifying the **/etc/lilo.conf** file.
- Use the **pkgtool** utility to install new software, remove existing software, or view installed files in a package.
- The following services should be turned on for a system to be fully bootable: **atd**, **crond**, **inet**, **kerneld**, **keytable**, **network**, and **syslog**.
- Install printers during installation. Specify printer queue (lp by default) and spool directory.
- Use the X Windows utility - **printtool** to add, edit, or delete printer after installation.
- Floppy disk problems - errors such as read error, file not found and tar: read error are disk medium related problems that usually occur on the floppy disk. If so, replace the floppy disk.
- Hard disk and disk controller related problems - while Linux boots, it runs a partition check. If it does not display correct partition information, check the cables inside you PC and make sure a power connector is connected to each disk drive. Also check the partition table (using fdisk for example).
- For device conflict problems - collect information on IRQ (Interrupt) and DMA (Direct Memory Address). Check for conflicting problems. Use the DOS MSD utility or Norton utility.
- Default options entered to the LILO boot command will be passed to the Linux kernel every time it boots.
- Review your computer's BIOS settings. If your computer accesses a hard drive in LBA mode, check **Use linear mode**.
- **Loadlin** can load Linux from MS-DOS; it requires a copy of the Linux kernel (and an initial ram disk, if you have a SCSI adapter) to be available on an MS-DOS partition. The only way to accomplish this is to boot your Red Hat Linux system using some other method (e.g., from LILO on a diskette) and then copy the kernel to an MS-DOS partition.
- When installing Linux to coexist with Microsoft Windows NT use the **bootpart** utility.
- Choosing an installation class (for Red Hat 5.2 only): Workstation (automatically erase all Linux partitions from your computer's hard drives); Server (automatically erase all partitions from your computer's hard drives); Custom (gives you complete control over partitioning-related issues. If you have installed Red Hat Linux in the past, the custom-class installation is most similar to past installations.)
- Know the differences among CDROM, FTP, NFS, SAMBA, and Hard Disk installation.
- Checking the installation log file.

- View boot time information such as console install screens, virtual consoles, **dmesg**. Use page up/page down at the console.
- Understand the standard boot process.
- Verify the installation status: login as root and view dmesg.
- Generate the text file and automate the installation using **kickstart** mode.
- Install Linux in **RAID** configuration.
- Troubleshoot hardware conflict problems during Linux installation.
- Configure Linux installation on laptop with PCMCIA card and APM (Automatic Power Management) system.
- Understand the kernel **daemon**, **etc/conf.modules** and module parameters. Understand **/llib/modules/..**. directory structure and contents.

System Configuration

- Checking file system type using **/etc/fstab** file, knowing its layout and meaning.
- Knowing basic user environment (etc/skel/) and home directories.
- Using rpm to 1) validating a package signature; 2) add and remove Linux components; 3) add updates, 4) verify packages (install or not); 5) check what package a file is in.
- Creating and using custom RPMs. 1) install source rpms; 2) verify /usr/src/redhat directory structure; 3) change compile time options for a source RPM; 4) rebuild custom source and binary rpms; 5) build an rpm from a tar archive.
- Adding, deleting and modifying users.
- Configure keyboard using **kbconfig** utilities.
- Mounting hard disks, floppy disks, and removable media using **mount** command.
- Configuring sound card using **sndconfig** utility.
- Knowing virtual consoles, daemons, **netsysv**, **chkconfig** utilities.
- Setting up and managing disk quotas:
    1. Installing quota RPM
    2. Modifying /etc/rc.d/rc.sysinit file
    3. Modifying etc/fstab
    4. Creating quota.user file for each partition
    5. Using edquota to set up per user disk quotas
    6. Creating default quota settings
    7. Generating quota reports
    8. Configuring quotas on nfs filesystems
    9. Understanding monolithic vs. modular kernel concepts
- Updating linux **kernel** to newer version, kernel **rpm's** and **tar** file. Understanding kernel source tree and documentation.

- Configuring kernel scripts, compiling and installing a custom kernel or kernel modules.
- Updating LILO.
- Using **mkinitrd** and mkbootdisk **utilities**.
- Understanding kernel configuration options
    1. The standard Red Hat kernel configuration
    2. Code maturity level options
    3. Loadable module support options
    4. General set up options
    5. Floppy, IDE and other block device options
    6. Non IDE/SCSI CDROM support options
    7. Networking and network device options
    8. SCSI support options and low level drivers
    9. ISDN options
    10. File system options
    11. Character device options (serial and parallel ports, mice, QIC tapes, APM)
    12. Sound system support options
    13. Kernel profiling support
- Configuring system-wide shell configuration for Bourne and bash shells - **/etc/bashrc, /etc/profile, /etc/profile.d** - see Linux Shell section.
- Understanding the cron system - the **system crontab** and components, the **user crontabs**.

X Windows System

- Know how to check X Server supported hardware.
- Know how to check the X11 packages installation status by using the rpm and grep command. Example: **rpm -qa | grep ^X**
- Know how to install X Windows packages using rpm command. Example: **rpm -ivh Xconfig***
- Know how to detect the video card chipset, amount of memory and RAMDAC chipset using **SuperProbe** utility.
- Know how to configure X Windows using the **Xconfiguator** program and **XF86setup**. Select the correct chipset and RAMDAC.
- Know how to configure a custom monitor by modifying the **/etc/X11/XF86Config** file.
- Know how to start X Windows using **startx** command.
- Know how to configure the system to start automatically in X Windows by modifying **/etc/inittab** file. Understand run levels and default run level and modifying the system startup script **/etc/rc.d/rc.sysinit**
- Know how to change video setting by modifying **start.out** file.
- Know how to exit from X Server using **Ctrl-Alt-Bkspace**

- Know how to troubleshoot the filesystem problem that causes a blank screen, using **fsck** command.
- Know how to troubleshoot mouse related problems using the **mouseconfig** program.
- Know how to troubleshoot mouse related problems by modifying the **/etc/sysconfig/mouse** file.
- Know how to troubleshoot the gpm problem that causes mouse malfunction, how to stop the gpm program by running **/etc/rc.d/init.d/gpm stop**
- Know how to toggle **gpm** off using **ntsysv** command.
- Know this place to get Linux documentation: **/usr/doc/HOWTO**.
- Know the window manager configuration file locations (see below)
- Know how to install and configure the **fvwm** virtual window manager by modify the configuration file **system.fvwmrc** in the **/etc/X11/fvwm** directory.
- Know how to install and configure the **fvwm2** Window manager by modifying the **/etc/X11/fvwm2/system.fvwm2rc** file and its symbolic link in **/usr/X11R6/lib/X11/fvwm2.**
- Know how to install and configure **twm** (Tab window manager) by modifying the configuration file **system.twmrc** in the **/etc/X11/twm** directory.
- Know how to install and configure **mwm** (motif window manager) by editing the .mwmrc file in the home directory. Get the source file from **/usr/lib/X11/system.mwmrc**.
- Know how to install and configure **lwm** (LessTif mwm window manager) by modifying the **.mwmrc** resource file in the home directory, and the **Mwm** file under the LessTif directory.
- Know how to install and configure **CDE** (the Common Desktop Environment). Know how CDE differs from other windows manager (X Display manager - **xdm**.)
- Know how to install and configure **KDE** (the K Desktop Environment) using rpm.
- Know about other X11 Window managers - Enlightenment, mlvwm, wm2
- Know how to change terminal settings of **xterm**, **nxterm**, and **rxvt** terminal. Select proper font settings using **Ctrl-RightClick** and the **xfontsel** command.
- Know how to use the X11 command line options (X Toolkit) to set geometry settings, foreground, background color, mouse and cursor modes, etc.

Linux Shells and Commands / Utilities

- Determine which shell the user has been assigned - look at the contents of /etc/passwd file.

Linux Shell Comparison Table

Shell Name	Ash	Bourne	Bash (Bourne Again)	Korn	C-shell	T-shell	Zsh
Author	Kenneth Almquist		Brian Fox/Chet Ramey	Eric Gisin		William Joy (plus 47 others)	Paul Falstad
Binary	ash	sh	bash	ksh	csh	tcsh	zsh
Built-in command	24		48	42		53	84
Command line options	10		12	20		18	50
Default Prompt		$		$	%	%	
Home Startup File		$HOME/.profile	$HOME/.bashrc	$HOME/Profile	$HOME/.cshrc	$HOME/.tcshrc or .chsrc	
Note		default Linux shell		Korn shell is a commercial Unix shell. In Linux, pdksh shell is named ksh.			ne of the largest Linux shells

- Understand what is an **environment variable** and where the configuration text file is located on your shell (example, for bash shell, is in /etc/profile). Specify the list of different environment variables by using **printenv** command.
- Understand **#PATH variable**. Know how to make temporary and permanent change of the #PATH variable. (Add the directory to your $PATH variable for the current login. Make a permanent change by adding the path to the profile file - say, **.bash_profile** in home directory.)
- Know what an **alias** is, and how to customize shells using an alias.
- Know how to run the program in the background. Example: **rxvt &**
- Know how to use **pipe** to redirect output of a program to a file, and redirect the content of the file to another program.

- Know how to build your own shell commands using **chmod** command. Assign shell variables to represent command line arguments to a shell command.

Basic Linux Commands and Utilities

Be familiar with the commands and utilities in this table. Check the man page for detailed usage, such as switch, pipe, etc.

Command	Usage	Note
man	get help	the Linux manual sections, man1 to man9, are in /usr/man directory.
cd	move to a different directory	know what **..** and **~** can do as parameters to the CD command.
pwd	print working directory	
find	search directories for matching files	-**print** switch; -**xdev** switch
whereis	find files from files directories	
locate	locate files from locate's database - **locatedb**	locatedb is in **/var/lib** directory
updatedb	update locatedb database	
whatis	get command summaries	
makewhatis	build the whatis database (db of command summaries)	makewhatis is in **/usr/sbin** directory
apropos	search for whatis database to get the program you want	**man -K** option does the same thing
ls	list files and directories	know the **-m, -x, -F, -a, -l, -R, -d** switches. Know how to use wildcards ***** and .
dir, vdir	list directories	
tree	list graphic directory	know the **-d** option
cat	list, create, and combine files	know the **-n, -l, *, >, >>** options and pipes. Know Ctrl-D to close file.
more	read files	
less	read files (allows scrolling, have more options than the more command)	use **zless** command to compress files
head, tail	read the beginning and the end of files	know the **-q** option

touch	create files	know how to create a file and redirect output to a new file (use with Ls for example.)
rm	delete files	know the **-r, -f, -i** options and wildcards
mkdir	create directories	know how to create multiple directories and create sub directories under existing directories
rmdir	removing directories	**-p** option
mv	rename files	
cp	copy files	
ln	create hard and symbolic links	**-s** option
mc	visual shell that display files	
grep, egrep, fgrep, zgrep	search inside files (zgrep can search compressed files)	**be very familiar with grep command**
tar	create archives	**-c, -w, -t, -f, -v, -x** options and combination
cpio	copy files in and out of tar or cpio archives	
gzip, gunzip	compress and uncompress files	be familiar with files that have a **.Z, .z, .gz, -gz, -z, _z** extension
compress	compress files	
ps	process status command	
kill	terminate a process	
Ctrl-z	put a running program into background in bash shell	
fg	bring back a program from background	return a specific program using job number or job name. Example: **fg %x** (x=job number, or job name)
pine	a Linux mail program	in KDE, use k-mail
job	get a list of suspended programs	
sc	a Linux spreadsheet program	
mount, umount	mount or unmount a file system	

Linux Networking

- Know central control files under **/etc/sysconfig** directory, /network-scripts subdirectory, the parameters and scripts in the files.
- Know how to configure the clock, mouse, static routes, keyboard, network and PCMCIA parameters by modifying files under **/etc/sysconfig** directory.
- Know how to configure the network interface using script files in /etc/sysconfig. ifup-type and ifdown-type are files that setup or deregister the interface. Types are lo (loopback), eth (Ethernet), sl (SLIP), ppp (PPP). Configuration is performed using the GUI program - **netcfg.**
- Know TCP/IP concepts: IPv4, IP octac, IP classes, subnet mask, default gateway, ICMP, FTP, ARP, router, sub-networking, default route, and CIDR (Classless InterDomain Routing), NNTP, etc.
- Know how to troubleshoot TCP/IP problems using utilities such as ping, **netstat -rn**, **arp**, **traceroute**, etc.
- Know how to configure IP parameters, enable the network interface, and check configuration of an existing network interface using **ifconfig** utility.
- Know how to use **telnet** and **rlogin** to connect Linux terminal from Windows machine.
- Know how to use Netscape and configure Netscape HTTP.
- Know basic Apache configuration for a simple web server.
- Know how to configure ftpd for anonymous ftp server.
- Learn about time synchronization
- Know how to configure PPP client using **netcfg** utility.
- Know how to configure an internal or external modem to connect to an ISP using PPP.
- Know how to configure **SMB** to act as a client and server for file and print services
- Know how to configure **NFS** as client and server.
- Know how to configure **sendmail** using SMTP, POP, and IMAP as a work station and how to modify the **aliases** file and **sendmail.cf** files.
- Understand how to turn on and turn off **anti-spam**.
- Know how to configure the Linux server to act as a boot and NFS host for Linux clients. Know how to start and stop NFS services.
- Understand **Bootp** and **DHCP** configuration, etc/exports, mounting and exporting file system via NFS.
- Be able to troubleshoot file locking issues.
- Know how to configure Linux and NT connectivity using **Samba**, and **IPX** (mars_nwe).
- Know how to configure network printing services, and add/remove local and remote printers.
- Understand **etc/printcap** file, **etc/host** file, **lpc**, **lpq**, and **lprm**.
- Know how to configure innd (**leafnode** service).

- Know how to use **xntp** and **rdate** to configure time services.
- Know how to configure Squid proxy server and web cache.

System Administration and Security

- Know how to maintain and preserve the consistency of common configuration files (password, group, hosts, services) using **NIS** (formally yellow pages - yp). Know RedHat's NIS components. Understand how to modify the **etc/nsswitch.conf** file.
- Know the basics of host security. Understand how to modify tcp_wrappers, **etc/hosts.allow** and **etc/hosts.deny**.
- Understand **PAM** (Pluggable Authentication Modules) and modifying files in the **etc/pam.d/** directory.
- Know IP aliasing and virtual hosts.
- Understand firewall policies - elementgs ipfwadm
- Understand **NAT** (Network Address Translation), **IP masquerading** and **IP forwarding**.
- Know how to configure **routing** and **static routes** and the etc/hosts file.
- Understand the interaction of PC CMOS clock time and Linux system time.
- Know how to set up and verify system logging: **syslog** and **klog**; **/etc/syslog.conf**; remote logging; monitoring logs using **swatch**; managing logs using **log rotate**.
- Understand emergency boot procedures.
- Understand system log entries.
- Understand how to tailor **etc/syslog.conf**.
- Understanding Sgid redhat scheme and cops.
- Know how to use tmpwatch.
- Know how to use syslog for debugging and tracking problems.
- Know how to obtain encryption packages in rpm format. Consider:
  1. Import and export restrictions on encryption software
  2. The ftp.replay.com site
  3. Validating RPMs with pgp
- Know how to use linuxconf utility.

> Special thanks to Rick Bao
> for contributing this Cramsession
> http://www.cyberramp.net/~rickbao/default_high.htm