

Linux for System Services Administrators

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1 Course overview

Administrators of production services machines need to understand the operating system they use. This class covers the necessary Linux fundamentals and basic Linux administration tasks that these administrators need. This class stresses troubleshooting problems that an administrator is likely to encounter.

2 Course objectives

A student attending this course will learn:

- the different open software licenses and development styles.
- how to install the operating system
- how to find more information about commands, configuration files, etc
- useful Linux tools and how to combine them to solve problems
- file and directory permissions, including those on directories,
- the *vi* editor
- *bash* initialization, command history, command editing, and aliases
- regular expressions and searching
- identifying, monitoring, and terminating processes
- *bash* shell programming
- Linux user information and the files where it is stored
- how to query, install, update, and remove packaged software
- how disks are partitioned on Linux
- the layout of the filesystem and tools for working with it
- mounting and unmounting filesystems
- how to run jobs at regular intervals
- how to control logging and log file rotation
- how the system boots and how to customize this process
- how to configure static and dynamic IP addresses
- network services such as *ssh*, NFS, NIS, and the automounter

- the common methods for performing backups on Linux

If the class has time, the students will also learn:

- system performance monitoring
- disk quotas
- logical volume management
- software RAID
- network monitoring, testing, and tuning

3 Student background

If you are attending this class, then we assume that

- You have experience working with other computer systems.
- Knowing a programming language will make shell programming much easier.

4 Logistics

The class lasts five days. The student computers need to run Red Hat Enterprise 5 or CentOS 5. It has been tested with 5.1 and 5.2. The class uses the following software:

- A CD DVD or USB memory to mount; the installation CDs/DVD work fine for this
- All backup software we use is on the OS distribution CDs
- Gnome for a desktop environment (on distribution CDs)
- Kernel source (from Internet or source CDs or DVDs; **not** on the normal distribution media)
- LVM tools (on distribution media)
- OS distribution CD 1 or Knoppix CD
- OS installation media
- The test partition created at install time
- *gkrellm* (on class web site)
- *iptraf* (if covered in this class)
- *nmap* (on distribution media)
- *ttcp* (on class web site)
- *xosview* (on class web site)
- a DHCP and DNS server for the class
- a package to install and upgrade (the instructor needs to be prepared for this)
- a partition mounted as */test* (set up at OS install time)
- a second disk or USB drive
- an NIS server on the instructor machine with an account the students will log into (if this class covers NIS)
- *bonnie* or *bonnie++* (on class web site)

- class network configuration information
- disk quota utilities (on distribution media)
- either Internet access or a local CentOS repository (the instructor needs to be prepared for this)
- ext[23]fs utilities (on OS distribution CDs)
- free space to create a volume
- jfs utilities (on OS distribution CDs)
- mdadm (on distribution media)
- reiserfs utilities (on OS distribution CDs)
- static IP addresses (these do not need to be routable)
- un-allocated space left at install time.
- xfs utilities (on OS distribution CDs)

The class network needs to be such that the student machines can act as a server. If the class machines are on virtual machine software such as VMware or VirtualBox, bridged networking is required.

The class needs a web server for the class web site. The instructor's laptop may be this web server; otherwise the machine provided in the classroom for the instructor is a good choice. This machine obviously will need web server software installed.

5 Class outline

1. Introduction (Lecture: 15; Lab: 0)
 - (a) Class Introductions
 - (b) Class Logistics
 - i. Class schedule
 - ii. Breaks
 - iii. Question policy
 - iv. Break room and restroom locations
 - v. Assumptions about your background
 - (c) Typographic conventions
 - (d) What the class covers
2. GNU/Linux introduction (Lecture: 20; Lab: 0)
 - (a) The Unix philosophy
 - (b) Open-source software licenses
 - (c) Linux compared with Microsoft Windows
 - (d) Linux versus Unix
 - (e) Summary
3. Red Hat OS Installation (Lecture: 25; Lab: 75)
 - (a) Hardware requirements

- (b) Installer options
 - (c) Disk partitioning
 - (d) Network configuration
 - (e) GNU/Linux as a guest OS
 - i. VMware notes
 - ii. VirtualBox notes
 - (f) Kickstart
 - i. Summary of CentOS 5 Installation
 - (g) Lab
4. Basics (Lecture: 20; Lab: 20)
- (a) Logging in and out
 - (b) Typing and correcting mistakes
 - i. In dialog boxes
 - ii. In a terminal window
 - (c) Changing your password
 - (d) An overview of the Gnome Desktop
 - i. The decoration around windows
 - ii. The panel
 - iii. The Terminal Emulator
 - (e) An introduction to the Gnome file manager
 - (f) Command-line structure
 - (g) Some simple commands
 - (h) Displaying the contents of a file in a terminal
 - (i) Lab
5. Finding the answer (Lecture: 15; Lab: 40)
- (a) General hints
 - (b) The help system
 - (c) The manual pages
 - (d) GNU info
 - i. Some *info* commands
 - (e) Summary
 - (f) Lab
6. File manipulation (Lecture: 30; Lab: 50)
- (a) An Overview of the UNIX filesystem
 - i. Pathnames
 - ii. Directories
 - iii. Filenames
 - (b) Listing files
 - (c) Renaming and Copying Files

- (d) Removing Files
 - (e) The *file* command
 - (f) Creating and removing directories
 - (g) Links
 - (h) *chown* and *chgrp*
 - (i) Lab
7. File and directory permissions (Lecture: 15; Lab: 15)
- (a) Introduction
 - (b) Looking at File Permissions
 - (c) Changing Permissions
 - (d) Lab
8. The vi editor (Lecture: 20; Lab: 30)
- (a) Introduction
 - (b) Getting in and out
 - (c) *vi* modes
 - (d) Moving around
 - (e) Adding text
 - (f) Deleting text
 - (g) More
 - (h) Lab
9. The shell (Lecture: 55; Lab: 55)
- (a) Introduction
 - (b) Metacharacters
 - i. Examples
 - (c) Redirecting I/O
 - i. Examples
 - (d) Pipes
 - (e) History and command line editing (*ksh* and *bash*)
 - (f) Shell startup and customization (*bash*)
 - (g) Aliases
 - (h) Additional *bash* features
 - (i) Lab
10. Searching (Lecture: 30; Lab: 40)
- (a) Introduction to the *grep* family
 - (b) Regular expressions
 - i. Constructing regular expressions
 - ii. Metacharacters
 - iii. Beginning and end of lines
 - iv. Character classes

- v. Repetitions
 - vi. Grouping and “OR”
 - vii. Example
 - viii. Example
 - ix. Summary of regular expression characters
- (c) Summary
- (d) Lab
- 11. Some useful tools (Lecture: 40; Lab: 45)
 - (a) *head* and *tail*
 - (b) *less*
 - (c) *cut*
 - (d) *diff*
 - (e) *sort*
 - i. Example
 - (f) *uniq*
 - (g) *cat*
 - (h) *wc*
 - (i) Summary
 - (j) Lab
- 12. Processes (Lecture: 30; Lab: 25)
 - (a) Process information
 - (b) Job control
 - (c) *nice*
 - (d) Looking at processes
 - i. *ps*
 - (e) *top*
 - (f) Killing processes
 - (g) Lab
- 13. Basic bash programming, part I (Lecture: 30; Lab: 40)
 - (a) Variables
 - i. Environment Variables
 - ii. Pre-defined Variables
 - (b) Comments and spaces
 - (c) Shell Scripts
 - (d) Quoting
 - (e) Lab
- 14. Basic bash programming, part II (Lecture: 30; Lab: 50)
 - (a) Exit status and **\$?**
 - (b) Expressions

- i. Expressions (using *test*)
 - ii. String expressions (*bash* and *ksh*)
 - iii. File expressions
 - iv. Arithmetic expressions (*bash* and *ksh*)
 - (c) if
 - i. Examples
 - (d) case
 - (e) Lab
15. Basic bash programming, part III (Lecture: 20; Lab: 45)
- (a) for
 - (b) while
 - (c) Functions
 - i. Function arguments
 - ii. Example
 - iii. Output from running the example
 - iv. Local variables
 - (d) Debugging Shell Scripts
 - (e) Lab
16. User Information (Lecture: 40; Lab: 50)
- (a) User and group information files
 - i. ***/etc/passwd***
 - ii. ***/etc/shadow***
 - iii. ***/etc/group***
 - (b) Adding and deleting users
 - i. GUI
 - ii. *vipw*
 - (c) Password aging
 - i. *chage* command-line arguments
 - (d) ***login.defs***
 - (e) PAM
 - i. Example
 - (f) ***nsswitch.conf***
 - (g) *su* and the root account
 - (h) *sudo*
 - i. *sudo* configuration
 - (i) Troubleshooting hints
 - (j) Summary
 - (k) Lab
17. RPM Packages (Lecture: 40; Lab: 50)

- (a) RPM overview
 - i. Names, labels, and file names
 - (b) Working with *rpm*
 - i. Querying packages
 - ii. Verifying package signatures
 - iii. Verifying installed packages
 - iv. Installing packages
 - v. Upgrading packages
 - vi. Removing packages
 - vii. Other RPM information
 - (c) *yum*
 - i. Yum repositories
 - ii. Repository configuration
 - iii. Installing software with *yum*
 - iv. Searching for software
 - v. Updating
 - vi. Removing software
 - vii. *yum* and proxies
 - (d) Keeping your system patched
 - (e) Summary
 - (f) Lab
18. Partitions and filesystems (Lecture: 40; Lab: 55)
- (a) Special files (devices)
 - i. Disk special files
 - (b) Partitions
 - i. Extended partitions
 - ii. *fdisk*
 - (c) Filesystem labels
 - (d) Mounting filesystems
 - i. *mount* and *umount*
 - ii. Boot time filesystem mounting
 - (e) Inodes
 - (f) The structure of a directory
 - (g) Adding a disk
 - (h) *fsck*
 - (i) Dealing with filesystem problems
 - (j) Summary
 - (k) Lab
19. Filesystem tools (Lecture: 20; Lab: 30)
- (a) *df*

- (b) *du*
 - (c) *locate* and *slocate*
 - (d) *find*
 - (e) Summary
 - (f) Lab
20. Useful sysadmin tools (Lecture: 40; Lab: 65)
- (a) *lsof* and *fuser*
 - (b) *rsync*
 - i. Some *rsync* options
 - (c) *cron*
 - i. The ***crontab*** file
 - (d) Logging and log files
 - i. The syntax of ***syslog.conf***
 - (e) Log file rotation
 - i. *logrotate* directives
 - (f) The ***/proc*** filesystem
 - (g) *sysctl*
 - (h) Summary
 - (i) Lab
21. Booting (Lecture: 45; Lab: 60)
- (a) The hardware boot process
 - i. How Linux on an Intel x86 architecture machine boots
 - (b) *grub*
 - i. Overview
 - ii. File specification to *grub*
 - iii. Commands
 - iv. Example
 - (c) Initial ramdisks
 - (d) Booting single user
 - (e) *init* and startup scripts
 - i. Run levels
 - ii. Interactive boot
 - iii. *chkconfig*
 - iv. *service*
 - (f) Boot floppies/CDs
 - i. Booting rescue mode
 - (g) Shutting down the system
 - (h) Troubleshooting
 - (i) Summary

- (j) Lab
- 22. Network Configuration (Lecture: 30; Lab: 45)
 - (a) Network configuration
 - i. DHCP client configuration
 - ii. Static network configuration
 - (b) DNS lookups
 - i. */etc/resolv.conf*
 - ii. *host*
 - (c) Virtual network interfaces
 - (d) *mii-tool* and *ethtool*
 - i. Examples
 - (e) *system-config-network*
 - (f) Troubleshooting
 - (g) Summary
 - (h) Lab
- 23. Network services (Lecture: 30; Lab: 45)
 - (a) *xinetd*
 - (b) *ssh*
 - i. Public key authentication
 - ii. Tunneling
 - (c) NFS
 - i. Client
 - ii. Server
 - (d) Automounter
 - (e) Troubleshooting
 - (f) Summary
 - (g) Lab
- 24. Backups (Lecture: 30; Lab: 45)
 - (a) Compression
 - (b) Incremental backups
 - (c) *tar*
 - i. Examples
 - (d) *dump* and *restore*
 - i. *dump*
 - ii. Example
 - iii. *restore*
 - iv. Interactive restore
 - v. Examples

- (e) *rsync*
 - i. Example
 - (f) Summary
 - (g) Lab
25. Disk Quotas (Lecture: 15; Lab: 35)
- (a) Overview
 - (b) Enabling quotas
 - i. */etc/fstab* changes
 - ii. Remount the filesystem
 - iii. Create the quota database
 - (c) Setting up user quotas
 - (d) User interaction with the quota system
 - (e) Other quota info
 - (f) Summary
 - (g) Lab
26. Logical Volume Management (Lecture: 45; Lab: 75)
- (a) LVM overview
 - (b) Using LVM
 - i. At install time
 - ii. After OS install
 - iii. *system-config-lvm*
 - (c) Extending logical volumes
 - i. Extending ext3 filesystems
 - ii. Extending Reiser filesystems
 - (d) Adding a disk to a volume group
 - (e) Removing a physical volume
 - (f) Reducing a logical volume
 - (g) Removing volumes
 - (h) Linear versus striping of extents
 - (i) Snapshots
 - (j) Other LVM info
 - (k) Summary
 - (l) Lab
27. Software RAID (Lecture: 35; Lab: 80)
- (a) Overview
 - i. RAID levels
 - ii. Linux software RAID features
 - (b) RAID-linear Configuration (using *mdadm*)
 - (c) RAID-1 Configuration (using *mdadm*)

- (d) RAID-5 configuration (using *mdadm*)
 - (e) Handling drive failure
 - i. Hot swap (as close as it gets with SW RAID)
 - (f) Other RAID info
 - i. Booting and RAID
 - (g) RAID and LVM
 - (h) Software RAID versus hardware RAID
 - (i) Summary
 - (j) Lab
28. Network monitoring, testing, and tuning (Lecture: 45; Lab: 80)
- (a) Network monitoring and testing tools
 - i. *tcpdump*
 - ii. *wireshark*
 - iii. *telnet*
 - iv. *netcat*
 - v. *netstat*
 - vi. *nmap*
 - (b) Tuning
 - i. Prerequisite assumptions
 - ii. Benchmarking
 - A. Example
 - iii. Parameters
 - A. Maximum Transmission Unit
 - B. Example
 - C. Bandwidth-Delay product
 - D. TCP parameters
 - E. IP fragmentation parameters
 - F. Other kernel parameters
 - (c) NFS performance
 - (d) Summary
 - (e) Lab
29. Performance monitoring (Lecture: 25; Lab: 25)
- (a) Introduction
 - (b) *ps* and threads
 - i. Example
 - (c) *sar*
 - (d) *free*
 - (e) *vmstat*
 - (f) *iostat*

- (g) *top*
- (h) Graphical tools
- (i) Troubleshooting
- (j) Summary
- (k) Lab

Appendices

A. Filesystems (Lecture: 35; Lab: 40)

- (a) Journaling overview
- (b) Common filesystems
 - i. ext2fs
 - ii. ext3fs
 - iii. ReiserFS
 - iv. JFS
 - v. XFS
 - vi. Filesystem comparison
- (c) Other filesystems
 - i. Intermezzo
 - ii. Veritas VxFS (commercial)
- (d) Special-purpose filesystems
 - i. tmpfs (virtual-memory-based)
 - A. Using tmpfs
 - ii. devfs for devices
 - iii. Bind mounts
 - iv. Loop filesystem
- (e) Summary
- (f) Lab