

Ateneo Cervini-Eliazo Network

Unix/Linux System Basics



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Unix/Linux System

Parts of the Operating System

- ★ Kernel (Core of the Operating System)
- ★ Devices (/dev)
- ★ Process Information (/proc)
- ★ Standard Libraries (C Libraries)
- ★ System Utilities and Daemons
- ★ Userspace Applications

Unix/Linux System

Important Parts of the kernel:

- ★ Memory Management
- ★ Process Management
- ★ Device Driver Support

Unix/Linux System

Major Services

- ★ init
- ★ User Management
- ★ Periodic Command Execution
- ★ Graphical User Interface
- ★ Networking
- ★ Others ...

Unix/Linux System

init

- ★ the first application that is run
- ★ the single most important service in a UNIX system
- ★ makes sure *gettys* is working
- ★ spawns initial processes and daemons
- ★ adopt orphan processes
- ★ killing unused processes
- ★ mounting/unmounting all filesystems

RunLevels

runlevels

Services and daemons are executed depending on the "runlevel" that your machine is operating on, which corresponds to the links in the directories `/etc/rc.d/rc#.d/` where `#` is a number from 0 to 6.

These six run levels are:

- ★ 0 - Halt
- ★ 1 - Single User Mode
- ★ 2 - Multiuser, without NFS (The same as 3, if you do not have networking)
- ★ 3 - Full Multiuser Mode
- ★ 4 - unused, can be setup for networking in a different location,

etc.

- ★ 5 - Full Multiuser Mode with XWindows (foundation of GUI)
- ★ 6 - Reboot (your machine switches to this one when you use ctrl-alt-delete)

Typically your machine runs at runlevel 3 or runlevel 5 for normal operation.

Unix/Linux System

User Management

- ★ enables user authentication
- ★ maintains access controls
- ★ enables process and filesystem accounting

Unix/Linux System

Periodic Command Execution

- ★ handled by the *cron* and *at* daemons
- ★ enables the system and users to schedule the execution of commands and programs
- ★ useful for doing routine and system maintenance

Unix/Linux System

Graphical User Interface

★ is divided into parts mainly:

Windowing System - handles the low display routines

Window Manager - handles user interaction

★ usually the X Windows Systems

Linux System

Networking

- ★ essential component of a Unix system today
- ★ provides different services (http, ftp, etc...)
- ★ enable connectivity to different hosts

Filesystem

The Unix Filesystem

- ★ The filesystem is divided into many parts; usually along the lines of a root filesystem with /bin, /lib, /etc, /dev, and a few others
- ★ The Unix filesystem structure groups files according to purpose, i.e., all commands are in one place, all data files in another, documentation in a third, and so on.

Filesystem

The roles of the different parts of the directory tree:

- ★ The root filesystem – Contains the files that are necessary for booting the system up, and to bring it up to such a state that the other filesystems may be mounted.
- ★ The /usr filesystem – Contains all commands, libraries, manual pages, and other unchanging files needed.
- ★ The /var filesystem – Contains files that change, such as spool directories (for mail, news, printers, etc), log files, formatted manual pages, and temporary files.
- ★ The /home filesystem – Contains the users' home directories, i.e., all the real data on the system.

Filesystem

The root filesystem

- ★ Should generally be small.
- ★ Contains very critical files.
- ★ Infrequently modified filesystem has a better chance of not getting corrupted.

Filesystem

Subdirectories in the root filesystems:

Subdirectory	Description
/bin	Commands needed during bootup that might be used by normal users.
/sbin	Like /bin, but the commands are not intended for normal users, although they may use them if necessary and allowed.
/etc	Configuration files specific to the machine.
/root	The home directory for user root.
/lib	Shared libraries needed by the programs on the root filesystem.
/lib/modules	Loadable kernel modules, especially those that are needed to boot the system when recovering from disasters.
/dev	Device files.
/tmp	Temporary files.
/boot	Files used by the bootstrap loader, e.g., LILO.
/mnt	Mount point for temporary mounts by the system administrator.
/proc, /usr, /var, /home	Mount points for the other filesystems.

Filesystem

The /etc directory

- ★ The /etc directory contains a lot of files.
- ★ Many networking configuration files are in /etc as well.

Subdirectory	Description
/etc/rc or /etc/rc.d or /etc/rc?.d	Scripts or directories of scripts to run at startup or when changing the run level.
/etc/passwd	The user database, with fields giving the username, real name, home directory, encrypted password, and other information about each user.
/etc/fdprm	Floppy disk parameter table.

Filesystem

The /etc directory continued

Subdirectory	Description
/etc/fstab	Lists the filesystems mounted automatically at startup by the mount -a command (in /etc/rc or equivalent startup file).
/etc/group	Similar to /etc/passwd, but describes groups instead of users.
/etc/inittab	Configuration file for init.
/etc/issue	Output by getty before the login prompt.
/etc/magic	The configuration file for file.
/etc/motd	The message of the day, automatically output after a successful login.
/etc/mtab	List of currently mounted filesystems.
/etc/shadow	Shadow passwords move the encrypted password from /etc/passwd into /etc/shadow; the latter is not readable by anyone except root.

Filesystem

The /etc directory continued

Subdirectory	Description
/etc/login.defs	Configuration file for the login command.
/etc/printcap	Like /etc/termcap, but intended for printers.
/etc/profile, /etc/csh.login, /etc/csh.cshrc	Files executed at login or startup time by the Bourne or C shells.
/etc/securetty	Identifies secure terminals, i.e., the terminals from which root is allowed to log in.
/etc/shells	Lists trusted shells.
/etc/termcap	The terminal capability database. Describes by what “escape sequences” various terminals can be controlled.

Filesystem

The /dev directory

The /dev directory contains the special device files for all the devices.

Filesystem

The /usr filesystem

This filesystem is often large, since all programs are installed there.

Subdirectory	Description
/usr/X11R6	The X Window System, all files.
/usr/X386	Similar to /usr/X11R6, but for X11 Release 5.
/usr/bin	Almost all user commands. Some commands are in /bin or in /usr/local/bin.
/usr/sbin	System administration commands that are not needed on the root filesystem, e.g., most server programs.
/usr/man, /usr/info, /usr/doc	Manual pages, GNU Info documents, and miscellaneous other documentation files, respectively.
/usr/include	Header files for the C programming language.
/usr/lib	Unchanging data files for programs and subsystems, including some site-wide configuration files.
/usr/local	The place for locally installed software and other files.

Filesystem

The /var filesystem

The /var contains data that is changed when the system is running normally. It is specific for each system, i.e., not shared over the network with other computers.

Subdirectory	Description
/var/catman	A cache for man pages that are formatted on demand.
/var/lib	Files that change while the system is running normally.
/var/local	Variable data for programs that are installed in /usr/local (i.e., programs that have been installed by the system administrator).

Filesystem

The /var filesystem continued

Subdirectory	Description
/var/lock	Lock files.
/var/log	Log files from various programs, especially login (/var/log/wtmp, which logs all logins and logouts into the system) and syslog (/var/log/messages, where all kernel and system program message are usually stored).
/var/run	Files that contain information about the system that is valid until the system is next booted.
/var/spool	Directories for mail, news, printer queues, and other queued work.
/var/tmp	Temporary files that are large or that need to exist for a longer time than what is allowed for /tmp.

Filesystem

The /proc filesystem

this filesystem contains a illusionary filesystem

is the memory footprint of your system

varies from UNIX implementation

Subdirectory	Description
/proc/1	A directory with information about process number 1.
/proc/cpuinfo	Information about the processor, such as its type, make, model, and performance.
/proc/devices	List of device drivers configured into the currently running kernel.
/proc/dma	Shows which DMA channels are being used at the moment.
/proc/filesystems	Filesystems configured into the kernel.
/proc/interrupts	Shows which interrupts are in use, and how many of each there have been.
/proc/ioports	Which I/O ports are in use at the moment.
/proc/kcore	An image of the physical memory of the system.
/proc/kmsg	Messages output by the kernel.
/proc/ksyms	Symbol table for the kernel.

Filesystem

The /proc filesystem continued

Subdirectory	Description
/proc/loadavg	The 'load average' of the system; three meaningless indicators of how much work the system has to do at the moment.
/proc/meminfo	Information about memory usage, both physical and swap.
/proc/modules	Which kernel modules are loaded at the moment.
/proc/net	Status information about network protocols.
/proc/self	A symbolic link to the process directory of the program that is looking at /proc.
/proc/stat	Various statistics about the system, such as the number of page faults since the system was booted.
/proc/uptime	The time the system has been up.
/proc/version	The kernel version.

Filesystem

Important Linux Files

File	Description
/boot/vmlinuz*	Linux kernel
/etc/conf.modules	Aliases and options for loadable kernel modules
/etc/fstab	Filesystems mounted or available for mounting
/etc/group	Group information
/etc/hosts	Map of IP numbers to hostnames
/etc/hosts.allow	Hosts allowed to access Internet services
/etc/hosts.deny	Hosts forbidden to access Internet services
/etc/passwd	Default User Password File
/etc/shadow	Default Shadow File

Filesystem

Important Linux Files continued

File	Description
/etc/inetd.conf and /etc/xinetd.d	Configuration for the inetd daemon, which controls access to Internet services
/etc/inittab	Configuration for the init daemon, which controls executing processes
/etc/issue	Terminal Display Screen
/etc/lilo.conf	Boot Loader Configuration File
/etc/login.defs	Options for useradd and related commands
/etc/mtab	Mounted filesystems
/etc/printcap	Printer options and capabilities
/etc/profile	Default environment for users of BASH shell

Filesystem

Important Linux Files continued

File	Description
/etc/rc*.d	Scripts for system and process startup and shutdown
/etc/rc.boot	Scripts for system boot
/etc/skel	Skeleton files used to establish new user accounts
/etc/terminfo	Terminal capabilities and options
/etc/X11/XF86Config	X configuration file
/var/log/messages	System log
/var/spool/cron	Directory for at and cron configuration files

Basic Commands

Starting & Stopping

Command	Description
shutdown -h now	Shutdown the system now and do not reboot
halt	Stop all processes - same as above
shutdown -r 5	Shutdown the system in 5 minutes and reboot
shutdown -r now	Shutdown the system now and reboot
reboot	Stop all processes and then reboot - same as above
startx	Start the X system

Basic Commands

Accessing & mounting file systems

Command	Description
<code>mount -t iso9660 /dev/cdrom /mnt/cdrom</code>	Mount the device cdrom and call it cdrom under the /mnt directory
<code>mount -t msdos /dev/hdd /mnt/ddrive</code>	Mount hard disk "d" as a msdos file system and call it ddrive under the /mnt directory
<code>mount -t vfat /dev/hda1 /mnt/cdrive</code>	Mount hard disk "a" as a VFAT file system and call it cdrive under the /mnt directory
<code>umount /mnt/cdrom</code>	Unmount the cdrom

Basic Commands

Finding files and text within files

Command	Description
<code>find / -name fname</code>	Starting with the root directory, look for the file called fname
<code>find / -name "*fname*"</code>	Starting with the root directory, look for the file containing the string fname
<code>locate missingfilename</code>	Find a file called missingfilename using the locate command - this assumes you have already used the command updatedb (see next)
<code>updatedb</code>	Create or update the database of files on all file systems attached to the linux root directory
<code>which missingfilename</code>	Show the subdirectory containing the executable file called missingfilename
<code>grep textstringtofind /dir</code>	Starting with the directory called dir, look for and list all files containing textstringtofind

Basic Commands

The X Window System

Command	Description
Xvidtune	Run the X graphics tuning utility
XF86Setup	Run the X configuration menu with automatic probing of graphics cards
Xconfigurator	Run another X configuration menu with automatic probing of graphics cards
xf86config	Run a text based X configuration menu

Basic Commands

Moving, copying, deleting & viewing files

Command	Description
ls -l	List files in current directory using long format
ls -F	List files in current directory and indicate the file type
ls -laC	List all files in current directory in long format and display in columns.
rm name	Remove a file or directory called name
rm -rf name	Kill off an entire directory and all it's includes files and subdirectories
cp filename /home/dirname	Copy the file called filename to the /home/dirname directory
mv filename /home/dirname	Move the file called filename to the /home/dirname directory

Basic Commands

Moving, copying, deleting & viewing files continued

Command	Description
cat filetoview	Display the file called filetoview
man -k keyword	Display man pages containing keyword
more filetoview	Display the file called filetoview one page at a time, proceed to next page using the spacebar
head filetoview	Display the first 10 lines of the file called filetoview
head -20 filetoview	Display the first 20 lines of the file called filetoview
tail filetoview	Display the last 10 lines of the file called filetoview
tail -20 filetoview	Display the last 20 lines of the file called filetoview

Basic Commands

Installing software for RPM-based Linux Distributions

Command	Description
<code>rpm -ihv name.rpm</code>	Install the rpm package called name
<code>rpm -Uhv name.rpm</code>	Upgrade the rpm package called name
<code>rpm -e package</code>	Delete the rpm package called package
<code>rpm -l package</code>	List the files in the package called package
<code>rpm -ql package</code>	List the files and state the installed version of the package called package
<code>rpm -i --force package</code>	Reinstall the rpm package called name having deleted parts of it (not deleting using rpm -e)
<code>tar -zxvf archive.tar.gz</code> or <code>tar -zxvf archive.tgz</code>	Decompress the files contained in the zipped and tarred archive called archive
<code>./configure</code>	Execute the script preparing the installed files for compiling.

Basic Commands

User Administration

Command	Description
adduser accountname	Create a new user call accountname
userdel accountname	Remove a user from the system
passwd accountname	Give accountname a new password
su	Log in as superuser from current login

Basic Commands

Little Known Tips and Tricks

Command	Description
<code>ifconfig</code>	List ip addresses for all devices on the machine
<code>apropos subject</code>	List manual pages for subject
<code>usermount</code>	Executes graphical application for mounting and unmounting file systems
<code>e2fsck hda5</code>	Execute the filesystem check utility on partition hda5
<code>fdformat /dev/fd0H1440</code>	Format the floppy disk in device fd0
<code>tar -cMf /dev/fd0</code>	Backup the contents of the current directory and subdirectories to multiple floppy disks
<code>tail -f /var/log/messages</code>	Display the last 10 lines of the system log.
<code>cat /var/log/dmesg</code>	Display the file containing the boot time messages - useful for locating problems. Alternatively, use the <code>dmesg</code> command.

Basic Commands

Little known tips and tricks

Command	Description
*	wildcard - represents everything. eg. cp from/* to will copy all files in the from directory to the to directory
?	Single character wildcard. eg. cp config.? /configs will copy all files beginning with the name config. in the current directory to the directory named configs.
[xyz]	Choice of character wildcards. eg. ls [xyz]* will list all files in the current directory starting with the letter x, y, or z.
linux single	At the lilo prompt, start in single user mode. This is useful if you have forgotten your password. Boot in single user mode, then run the passwd command.
ps	List current processes
kill 123	Kill a specific process eg. kill 123

Basic Commands

Configuration files and what they do

Command	Description
/etc/profile	System wide environment variables for all users.
/etc/fstab	List of devices and their associated mount points. Edit this file to add cdroms, DOS partitions and floppy drives at startup.
/etc/motd	Message of the day broadcast to all users at login.
/etc/rc.d/rc.local	Bash script that is executed at the end of login process. Similar to autoexec.bat in DOS.
/etc/HOSTNAME	Contains full hostname including domain.
/etc/cron.*	There are 4 directories that automatically execute all scripts within the directory at intervals of hour, day, week or month.

Basic Commands

Configuration files and what they do continued

Command	Description
/etc/hosts	A list of all know host names and IP addresses on the machine.
/etc/httpd/conf	Paramters for the Apache web server
/etc/inittab	Specifies the run level that the machine should boot into.
/etc/resolv.conf	Defines IP addresses of DNS servers.
/etc/smb.conf	Config file for the SAMBA server. Allows file and print sharing with Microsoft clients.
/.Xdefaults	Define configuration for some X-applications. refers to user's home directory.
/etc/X11/XF86Config	Config file for X-Windows.
/.xinitrc	Defines the windows manager loaded by X. refers to user's home directory.

Basic Commands

File permissions

If the command `ls -l` is given, a long list of file names is displayed.

The first column in this list details the permissions applying to the file. If a permission is missing for a owner, group or other, it is represented by - eg. `drwxr-x-x`

Command	Description
Read = 4, Write = 2, Execute = 1	File permissions are altered by giving the <code>chmod</code> command and the appropriate octal code for each user type. Eg.
<code>chmod 7 6 4 filename</code>	will make the file called filename R+W+X for the owner, R+W for the group and R for others.
<code>chmod 7 5 5</code>	Full permission for the owner, read and execute access for the group and others.
<code>chmod +x filename</code>	Make the file called filename executable to all users.

Basic Commands

X Shortcuts - (mainly for Redhat)

Command	Description
Control — Alt + or -	Increase or decrease the screen resolution. eg. from 640x480 to 800x600
Alt — escape	Display list of active windows
Shift—Control F8	Resize the selected window
Right click on desktop background	Display menu
Shift—Control Altr	Refresh the screen
Shift—Control AltX	Start an xterm session

Basic Commands

Printing

Command	Description
<code>/etc/rc.d/init.d/lpd start</code>	Start the print daemon
<code>/etc/rc.d/init.d/lpd stop</code>	Stop the print daemon
<code>/etc/rc.d/init.d/lpd status</code>	Display status of the print daemon
<code>lpq</code>	Display jobs in print queue
<code>lprm</code>	Remove jobs from queue
<code>lpr</code>	Print a file
<code>lpc</code>	Printer control tool
<code>man subject — lpr</code>	Print the manual page called subject as plain text
<code>Man -t subject — lpr</code>	Print the manual page called subject as Postscript output
<code>Printtool</code>	Start X printer setup interface

X Window

The X Window System is an advanced, network transparent, windowing, graphical environment, developed at the Massachusetts Institute of Technology, and first released in 1984. Getting Started

X Window

The X Window System: History and Architecture

- ★ The X Window System was developed in the Laboratory for Computer Science at the Massachusetts Institute of Technology, as part of project Athena in cooperation with DEC, and first released in 1984.
- ★ Many of the ideas that went into X Window also came from research at Xerox Corporation's Palo Alto Research Center (PARC), where they were working on computers like the Parc and the Star in the late seventies.
- ★ X Window is built upon a great many toolkits, or libraries.
- ★ It's called X Window, not X Windows!

X Window

Anatomy of Your Desktop There are a few basic principles and terms you should familiarize yourself with to make using X much more straightforward.

- ★ The screen is your whole “desktop”, and the words may be used interchangeably.
- ★ The root window is the background of your screen.
- ★ The window manager is the main interface between the X Window system and the user.
- ★ The pointer is the arrow or indicator of any given shape which represents the location your mouse (or other pointing device) corresponds to on the screen.

- ★ The window is a frame in which any given application resides which is “managed” by the window manager.
- ★ Menus and icons behave in X similar to the way they behave in other windowing systems, and the same general principles apply.

X Window

Using the X Window System

- ★ Using the X Window System means interacting with Linux on several different levels.
- ★ X itself simply provides the graphics for displaying components of a graphical user interface: X draws the screen, draws objects on the screen, and tracks user input actions such as keyboard input and mouse operations.
- ★ To organize all of this into familiar objects like windows, menus, and scrollbars, X relies on a separate program called a window manager.
- ★ A window manager alone won't necessarily assure tight integration between applications running under X; that higher

degree of integration comes from something called a desktop environment.

- ★ While X itself is a single program, X under Linux supports several popular window managers, and two popular desktop environments.

X Window

Keyboard Operations

- ★ X was designed for use with a mouse.
- ★ If your mouse isn't functioning, you'll find it quite challenging or even impossible to use most X programs.
- ★ Similarly, X provides a few important functions that you can access only via the keyboard:
 - ★ Using virtual consoles
 - ★ Switching video modes
- ★ In addition, you can use the keyboard to terminate X.

Switching Video Modes

- ★ By pressing Shift-Alt-+ (using the plus key on the numeric keypad), you command X to switch to the next video mode in sequence.
- ★ The similar key sequence Shift-Alt- (using the minus key on the numeric keypad) causes X to switch to the previous video model.

Using Virtual Consoles with X

- ★ To switch from graphical mode to a virtual console running in text mode, type Ctrl-Alt-F n, where F n is a function key and n is the number of the desired virtual console.
- ★ X uses virtual console 7, so only virtual consoles 1-6 are accessible while running X.
- ★ To switch from a virtual console back to X, type Alt-F7. Nothing is lost when you switch from X to a virtual console or back, so you can move freely between the graphical and text operating modes.

Terminating X

- ★ You can terminate X by typing Ctrl-Alt-Backspace.
- ★ While X is running, you cannot use the Ctrl-Alt-Del sequence to reboot your system.
- ★ To reboot your system, you can terminate X and then use the Ctrl-Alt-Del sequence, or access a terminal window and enter the command: `shutdown -r now`
- ★ The shutdown command terminates X and then reboots your system.

X Window

Terminal Windows

- ★ In X you need not switch to a virtual console simply to have access to the command line.
- ★ X enables you to open a terminal window.
- ★ A terminal window resembles the familiar Microsoft Windows MS-DOS Prompt window; like the Linux shell, it lets you type commands and view command output.

X Window

Pop-Up Menus

- ★ Most window managers install with a default set of common programs that can be accessed by left- or right-clicking with the mouse on the desktop.
- ★ Most window managers, for example, let you click on the desktop and select a terminal window program from the pop-up menu that appears.
- ★ However, the pop-up menu displayed by a window manager may display program names rather than program functions.

X Window

Mouse Operations Mouse operations under X are similar to mouse operations under Microsoft Windows, although you perform them differently. The most common mouse operations are:

- ★ Copying and pasting text
- ★ Using scrollbars

X Window

Copying and Pasting Text

- ★ To copy and paste text, you must first mark the text.
- ★ To paste the text, properly position the insertion point and press the middle mouse button. If your mouse has only two buttons, simultaneously press the left and right buttons to simulate pressing the middle mouse button.

X Window

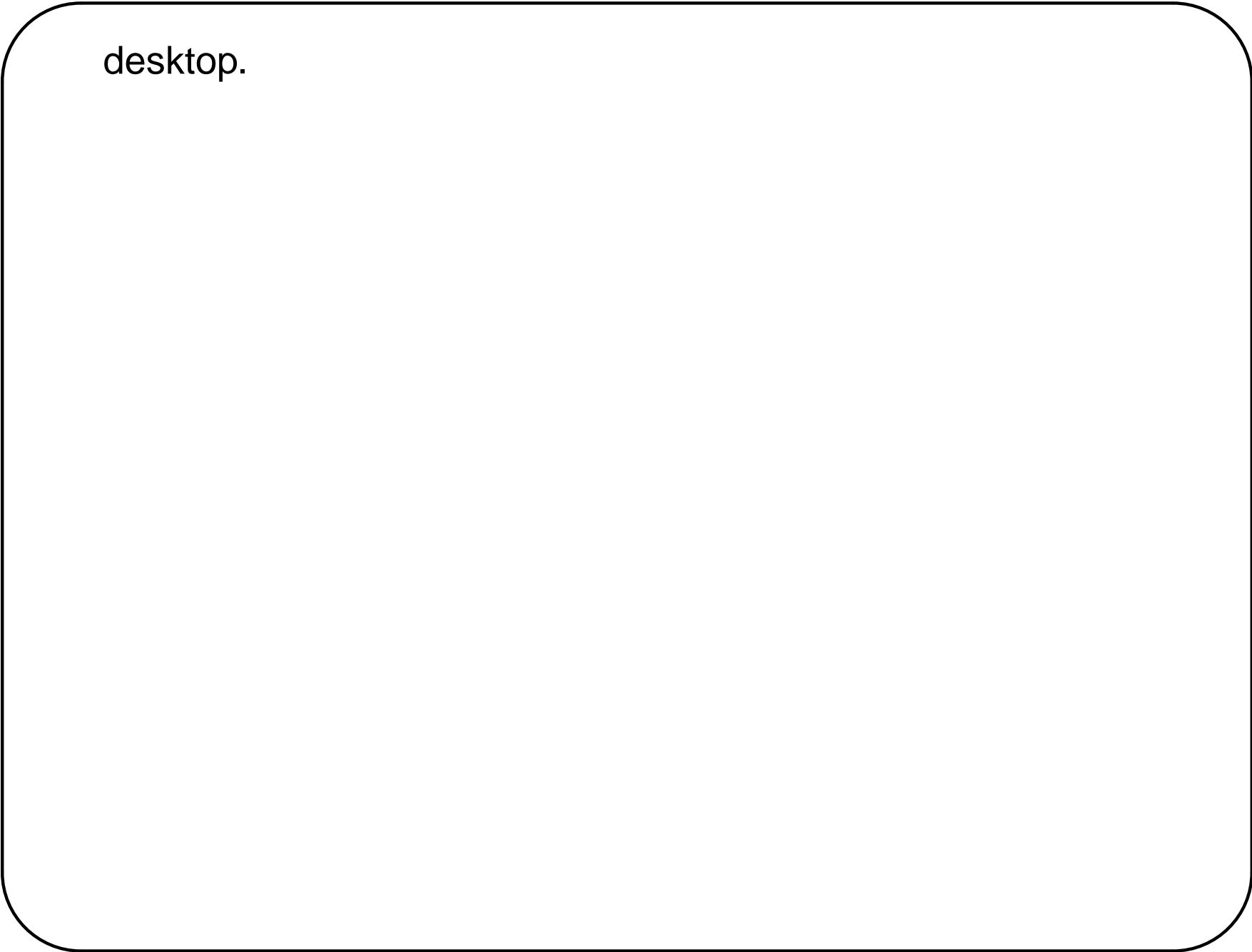
Using Scrollbars

- ★ To page forward using an X scrollbar, you click the left mouse button on the scrollbar. Clicking near the top of the scrollbar scrolls forward a short distance, as little as a single line. Clicking near the bottom of the scrollbar scrolls the window by a page.
- ★ To page backward, you click the right mouse button on the scrollbar. Again, clicking near the top of the scrollbar scrolls a short distance, as little as a single line. Clicking near the bottom of the scrollbar scrolls the window by a page.
- ★ Some X programs redefine the operation of scrollbars to correspond to that provided by Microsoft Windows.

X Window

Virtual Desktop

- ★ Under X, your desktop can be larger than the size of your monitor.
- ★ For example, even if your monitor has a maximum resolution of 800x600, you might have a desktop of 1600x1200 or even 3200x2400.
- ★ Some desktop environments, including GNOME, provide a tool called a pager, which lets you move around the virtual desktop. The pager provides a thumbnail view of your virtual desktop; by clicking within the thumbnail, you center your actual desktop on the clicked location. Some window managers let you simply move the mouse to the edge of the desktop to scroll the virtual



desktop.

X Window

Window Managers

- ★ Window managers create the borders, icons, and menus that provide a simple-to-use interface.
- ★ Window managers also control the look and feel of X, letting you configure X to operate almost any way you desire.
- ★ Some Linux users who are accustomed to the look and feel of Microsoft Windows 9x use the FVWM window manager to establish a user interface that resembles that of Windows 9x, both in appearance and operation.

X Window

Popular Window Managers

Window Manager	Description
AfterStep	Resembles the user interface of the NEXT
BlackBox	A small, simple, efficient window manager
Enlightenment	A highly configurable window manager
FVWM	One of the most venerable and popular
ICEWM	Popular among users of Debian GNU/Linux.

X Window

Desktops

- ★ A desktop is a set of desktop tools and applications.
- ★ The Microsoft Windows 9x desktop includes applications such as the Windows Explorer, accessories such as Notepad, games such as FreeCell and Minesweeper, and utilities such as the Control Panel and its applets.
- ★ Although you can run X without a desktop, having a desktop helps you work more efficiently.
- ★ The two most popular desktops used with X are KDE and GNOME.

X Window

KDE

- ★ KDE (the K Desktop Environment) is a freely available desktop that includes KWM, the K Window Manager, as an integral component. KDE provides a file manager, a help system, a configuration utility and a variety of accessories and applications, including:
 - ★ Games such as Kmines, Kpoker, and Ktetris
 - ★ Graphical applications such as Kfract, a fractal generator, and Kview, an image viewer

- ★ Multimedia applications such as Kmix, a sound mixer, and Kmedia, a media player
- ★ Network applications such as Kmail, a mail client, Knu, a network utility, and Krn, a news client
- ★ New KDE accessories and applications are available almost weekly.
- ★ Work is underway on a complete open source office suite (KOffice) that runs under KDE. You can learn more about KDE and the status of KOffice by browsing the KDE web site at <http://www.kde.org/>.
- ★ Although KDE is freely redistributable, KDE uses the QT widget set to create user interface controls. This presents a problem, because QT is distributed under a non-free license that many

developers dislike.

X Window

GNOME

- ★ GNOME is a freely available desktop that can be used with any of several window managers, including Enlightenment.
- ★ Unlike KDE, GNOME is open source software.
- ★ One of GNOME's most interesting features is session awareness. When you re-enter GNOME, it reconfigures your desktop to match the state at the time you exited, by launching each application that was open when you exited. GNOME even restores each application to its former state by, for example, moving to the page that was open when you exited.

X Window

GNOME provides desktop tools similar to those of KDE, including:

- ★ Games such as FreeCell, Gnobots, Gnometriz, and Gnome Mines
- ★ The GNU Image Manipulation Program (GIMP)
- ★ Network applications such as Mailman, which helps you track your mailing lists; Talk, which lets you exchanged typed messages with another user in real time; and Synchronize, which lets you synchronize files on multiple systems
- ★ Multimedia applications such as Audio Mixer and CD Player

- ★ General applications such as gEdit, a text editor, Netscape Navigator, a Linux version of the popular browser, and Gnumeric, a spreadsheet
- ★ Utilities for configuring GNOME and your Linux system
- ★ GNOME developers, like KDE developers, release new applications regularly. Check the GNOME Web site at <http://www.gnome.org/> for the latest information.



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