







Introduction to Unix/Linux Daniel Lucio

Crash Course in SuperComputing

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NATIONAL INSTITUTE FOR COMPUTATIONAL SCIENCES

Overview

- Origins
- Features
- What is it?
- The Unix philosophy
- Architecture
- What is a terminal?
- Terminal Emulators

- Why learn it?
- Where to use it?
- What commands are available?
- The Unix shell
- The Unix Filesystem Tree
- GNU == Linux?
- More Information



Origins

ENIAC - 1946



Introduction to Unix

Electronic Numerical Integrator And Computer



What is an Operating System?

An operating system (O.S.) is software that manages computer hardware resources and provides common services for computer programs.

Examples of popular modern operating systems include Android, BSD, iOS, Linux, OS X, QNX, Microsoft Windows,Windows Phone, and IBM z/OS.





What is an Operating System?

- Basic services offered by an Operating System are:
- Kernel
- Program Execution
- Interrupts
- Modes
- Memory Management
- Virtual Memory
- Multitasking

- Multiuser
- Disk access and File system
- Device Drivers
- Networking
- Security
- User Interface



Origins

- Unix (officially trademarked as UNIX) is a multitasking, multi-user computer operating system originally developed in 1969 by a group of AT&T employees at Bell Labs.
- The Open Group, an industry standards consortium, owns the UNIX trademark.
- The term Unix is often used informally to denote any operating system that closely resembles the trademarked system, (Ex: Linux, BSD).





What is it?

- Unix is an operating system that was designed to be portable, multi-tasking and multi-user in a time-sharing configuration.
- Under Unix, the operating system consists of many utilities along with the master control program: the kernel.
- The kernel provides services to start and stop programs, handles the file system and other common "low level" tasks that most programs share, and schedules access to avoid conflicts when programs try to access the same resource or device simultaneously.





The Unix Philosophy

Unix systems are characterized by various concepts:

- the use of plain text for storing data;
- a hierarchical file system;
- treating devices and certain types of inter-process communication (IPC) as files;
- and the use of a large number of software tools, small programs that can be strung together through a command line interpreter using pipes, as opposed to using a single monolithic program that includes all of the same functionality. I.e., "the idea that the power of a system comes more from the relationships among programs than from the programs themselves."











User's view

Supercomputer





What is a Terminal?

- In the past, a computer terminal was an electronic or electromechanical hardware device that was used for entering data into, and display data from a computer or a computing system.
- The function of a terminal is confined to display and input of data.
- In the present, a personal computer can run terminal emulator software that replicates the function of a terminal, sometimes allowing concurrent use of local programs and access to a distant terminal host system.



What is a Terminal?



Dumb terminal

It includes all forms of keyboard/screen computer communication devices, including personal computers, diskless workstations, network computers, thin clients, and X terminals, the term dumb terminal is sometimes used to refer to any type of traditional computer terminal that communicates serially over a RS-232 connection that <u>does not locally process data or execute</u> <u>user programs</u>.



MacOS Emulator

	 StarCraft II Stickies Stufflt Expander System Preferences TeXShop TextEdit TextMate TextWrangler Tiler Time Machine Toast 10 Titanium Tofu Utilities VirtualBox VLC Vuze WaveBurner Xcode 	 Blueton Horner Blueton File Exchange Boot Camp Assistant ColorSync Utility Console DigitalColor Meter Disk Utility Grab Grapher Impulse Response Utility Keychain Access Migration Assistant Network Utility Podcast Capture Podcast Publisher QuickTime Player 7 KalD Utility System Information Terminal
1	Open in Finder	X X11

MacOS Terminal App

Terminal Emulators

000	☆ lucio — bash — 66×18	12
Last login: Wed Mar	13 15:39:45 on ttys002	
cactus: luclo\$		





Linux computer



Windows Client

http://www.chiark.greenend.org.uk/~sgtatham/putty/download.html

Opening putty.exe	X	
You have chosen to open:		
🗾 putty.exe		
which is a: Binary File (472 KB)		
from: http://the.earth.li		
Would you like to save this file?		
	Save File Cancel	
	×	
Open File - Security Warning		
The publisher could not be verified. A run this software?	Are you sure you want to	
Name: C:\Users\Downloads\	\putty.exe	
Publisher: Unknown Publisher		
Type: Application		
From: C:\Users\Downloads\	\putty,exe	
	Run Cancel	
Always ask before opening this file		
This file does not have a valid digital publisher. You should only run softw How can I decide what software to n	signature that verifies its vare from publishers you trust. un?	

Category:	ation 🔀	
 Session Logging Terminal Keyboard Bell Features Window Appearance Behaviour Translation Selection Colours Connection Data Proxy Telnet Rlogin SSH Kex 	 Basic options for your PuTTY session Specify your connection by host name or IP address Host Name (or IP address) Pot dbserver 22 Protocol: Raw Telnet Rlogin SSH Load, save or delete a stored session Saved Sessions Database server Default Settings Load Delete Close window on exit: 	акеп.птсз.иск.е
Auth X11 Tunnels	Always ONever Only on clean exit	





Is there a GUI for Unix?



Example of a graphical user interface using XII and KDE.





Source: http://www.top500.org/statistics/list/

Why, learn it?

Have you noticed that in the movies when the super-hacker wants to break into a super-ultra secure computer the only way to really get it done is by typing on a keyboard??

Try http://hackertyper.com/

Why, learn it?

- A command line interface can be can be a powerful expressive way of communicating with a computer.
- Graphical user interfaces (GUI) make easy tasks easy, while command line interfaces make difficult tasks possible!
- Learning the command line can be challenging and takes real effort. BUT, not that it's so hard, but, rather it's so vast.
- Unlike many other computer skills, knowledge of the command line is long lasting. The skills learned today will be useful 10 years from now.

Why, learn it?

 Android is a Linux-based operating system designed primarily for touchscreen mobile devices such as smartphones and tablet computers.

- Login to a Unix system like 'kraken' or any other NICS/ UT/XSEDE resource.
- Download and boot from a Linux LiveCD either from a CD/DVD or USB drive.
 - http://www.puppylinux.com/
 - http://www.knopper.net/knoppix/index-en.html
 - <u>http://www.ubuntu.com/</u>

- Install Cygwin: a collection of tools which provide a Linux look and feel environment for Windows.
 - <u>http://cygwin.com/index.html</u>
 - https://newton.utk.edu/bin/view/Main/Workshop0InstallingCygwin
- Online terminal emulator
 - <u>http://bellard.org/jslinux/</u>
 - <u>http://simpleshell.com/</u>

000	Javascript PC	Emulator	12
Free Linux shell access ×	Javascrip	ot PC Emulator ×	+
Image: Second	inux/ ☆ マ C ^e	🖳 👻 🔞 🕶 Google	e 🔍 🖶 🍙 🖾 ד 😫
TCP: Hash tables configured TCP reno registered Total HugeTLB memory allocate io scheduler noop registered io scheduler anticipatory reg- io scheduler deadline registered Real Time Clock Driver v1.128 JS clipboard: I/O at 0x03c0 Serial: 8250/16550 driver \$Reserial8250: ttyS0 at I/O 0x33 RAMDISK driver initialized: I loop: loaded (max 8 devices) Uniform Multi-Platform E-IDE ide: Assuming 50MHz system bunda: JSLinux HARDDISK, ATA DI ide0 at 0x1f0-0x1f7,0x3f6 on hda: max request size: 128KiF hda: 116736 sectors (59 MB) wo hda: unknown partition tables TCP cubic registered NET: Registered protocol fami Using IPI Shortcut mode Time: pit clocksource has beev VFS: Mounted root (ext2 files Freeing unused kernel memory: Booted in 5.344 s Welcome to JS/Linux /var/root #	<pre>(established 1 ed, 0 gistered ered (default) ac evision: 1.90 f8 (irq = 4) i 16 RAM disks o driver Revisi is speed for P ISK drive irq 14 a w/256KiB Cache ily 1 ily 17 en installed. system) readon : 128k freed</pre>	024 bind 512) \$ 4 ports, IRQ sh s a XScale f 4096K size 1024 on: 7.00alpha2 10 modes; overrid a, CHS=115/16/63	aring disabled blocksize le with idebus=xx

What type of commands are available?

- Communication
- Comparison
- File Management
- Printing
- Programming
- Searching

- Shells
- Shell programming
- Storage
- System status
- Text processing

Communication

- ftp Insecure interactive file transfer program
- login Sign on to Unix
- mailx Read and send email
- scp Secure file transfer
- sftp Secure interactive file transfer
- slogin Sign on to remote Unix using secure shell
- ssh Connect to another system, securely
- telnet Connect to another system, INSECURELY

Comparisons

- cmp Compare two files, byte by byte
- comm Compare items in two sorted files
- diff Compare two files, line by line
- diff3 Compare three files
- dircmp Compare directories
- sdiff Compare two files, side by side

File Management

- cd Change directory
- chgrp Change file group
- chmod Change access modes on files
- chown Change file owner
- cksum Print a file checksum
- cp Copy files
- csplit Break files at specific locations
- file Determine a file's type
- head Show the first few lines of a file
- less Advanced file viewer
- 1n Create symbolic links
- locate Locate a given file using a database

File Management (cont)

- ls List files or contents of directories
- md5sum Print a file checksum using MD5 algorithm
- mkdir Create a directory
- more Display contents of files by screen
- mv Move or rename files
- pwd Print working (current) directory
- rm Remove files
- rmdir Remove (empty) directories
- split Split files evenly
- tail Show the last few lines of a file
 - Count lines, words and characters

WC

Printing Commands

lpr Sen	d to t	che pri	nter
---------	--------	---------	------

- BSL Get printer status
 - lpq lprm Cancel a printer request
 - Format and paginate for printing pr

>	cancel	Cancel a printer request
E	lp	Send to printer
ste	lpstat	Get printer status
S	pr	Format and paginate for printing

Programming

- cc C compiler
- ctags C function references (for vi)
- ld Linker
- lex Lexical analyzer generator
- make Execute commands in a specific order
- od Dump input in various formats
- splint C program analyzer
- strace Trace signals and system calls
- strip Remove data from an object file
- truss Trace signals and system calls

yacc Parser generator. Can be used with lex.

Searching

- egrep Extended version of grep
- fgrep Search files for literal words
- find Search filenames or directories
- grep Search contents of files for a pattern
- strings Display text strings found in binary files

Shells (Command line interpreters)

راند ا	bash	GNU 's Bourne Again Shell
Fan	ksh	The Korn shell
Je	pdksh	Public domain Korn shell
	sh	Original Bourne shell
BO BO	zsh	The Z-shell
<u>ک</u> ا		
	csh	The original BSD C shell
ر ا م	tcsh	Tenex shell (csh on steroids)

Shell Programming

- basename Return filename of a pathname.
- dirname Return directory portion of a pathname
- echo Write arguments to the standard output
- expr Evaluate expression
- id Return user identity
- line Read a line of input
- printf Formatted output
- sleep Suspend execution for an interval of time
 - Test a condition

test

Storage

- bunzip2 Expand compressed files .bz2
- bzip2 Compression program
- cpio Copy archives in or out
- gunzip Expand compressed files .gz and .Z
- gzcat Uncompress files on the fly
- gzip File compression program
- tar File/tree directory archiver
- zcat Uncompress files on the fly

System Status

- at Execute commands later
- crontab Execute commands (periodically) at certain time
- date Display or set date
- df Show free disk space and mounted disks
- du Show disk usage
- env Show environment variables
- finger Display information about users
- kill Terminate a running program
- ps Show processes
- stty Set or display terminal settings

who Show who is logged on

Text Processing

awk	Pattern-directed scanning and processing language
cat	Concatenate files or display them
cut	Select columns for display
ex	Line editor (underlying vi)
fmt	Simple text formatter
iconv	Character set conversion
join	Merge different columns into a database
paste	Merge columns or switch order
sed	Non-interactive text editor
sort	Sort or merge files
tr	Translate characters
uniq	Find repeated or unique lines in a file
vi	Visual text editor
xargs	Process many arguments in manageable portions

Text Editing on Unix

- There are screen text editors like vi, vim, ex, emacs, pico, nano,..
- There are graphical text editors like gVim, gEdit, Eclipse, emacs,..
- You can process text files via utilities or custom programs with tools like: sed, awk, gawk, troff, nroff, ...

Bash commands (Linux)

alias	crontab	false	if	mknod	ram	strace	unchar
apropos	csplit	fdformat	ifconfig	more	rcp	su	unshar
apt-get	cut	fdisk	ifdown	mount	read	sudo	untimo
aptitude	date	fg	ifup	mtools	readarray	sum	uperadd
aspell	dc	fgrep	import	mtr	readonly	suspend	userdel
awk	dd	file	install	mv	reboot	symlink	usermod
basename	ddrescue	find	jobs	mmv	rename	sync	usermou
bash	declare	fmt	join	netstat	renice	tail	users
bc	df	fold	kill	nice	remsync	tar	uuencode
bg	diff	for	killall	nl	return	tee	uuuecoue
break	diff3	format	less	nohup	rev	test	v vdir
builtin	dig	free	let	notify-send	rm	time	wi
bzip2	dir	fsck	ln	nslookup	rmdir	times	vr vrmgtat
cal	dircolors	ftp	local	open	rsync	touch	wai+
case	dirname	function	locate	ор	screen	top	watch
cat	dirs	fuser	logname	passwd	scp	traceroute	WC
cd	dmesg	gawk	logout	paste	sdiff	trap	whereig
cfdisk	du	getopts	look	pathchk	sed	tr	which
chgrp	echo	grep	lpc	ping	select	true	while
chmod	egrep	groupadd	lpr	pkill	seq	tsort	who
chown	eject	groupdel	lprint	popd	set	tty	whoami
chroot	enable	groupmod	lprintd	pr	sftp	type	waet
chkconfig	env	groups	lprintq	printcap	shift	ulimit	write
cksum	ethtool	gzip	lprm	printenv	shopt	umask	xaras
clear	eval	hash	ls	printf	shutdown	umount	xda-open
cmp	exec	head	lsof	ps	sleep	unalias	ves
comm	exit	help	make	pushd	slocate	uname	yeb
command	expect	history	man	pwd	sort	unexpand	•
continue	expand	hostname	mkdir	quota	source	uniq	###
ср	export	iconv	mkfifo	quotacheck	split	units	
cron	exprx`	id	mkisofs	quotactl	ssh	unset	

The Unix Shell

- The shell is the user interface to Unix.
- There is always a default one, but you can choose from different ones with different features.
- The shell is simply a program that allows the system to understand your commands. That is why is called a <u>Command Line</u> <u>Interpreter</u>.

The Unix Shell Features

• Cursor movement with keyboard arrow keys.

• Command history

• Automatic completion

Command line session

user004@sshell ~ \$ user004@sshell ~ \$ fdsfdsf bash: fdsfdsf: command not found user004@sshell ~ \$ date Thu Oct 24 14:38:15 UTC 2013 user004@sshell ~ \$ cal **October 2013** Su Mo Tu We Th Fr Sa 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 user004@sshell ~ \$ whoami user004 user004@sshell ~ \$ exit

Purpose of the Command-line interface?

- Is a program that takes keyboard commands and passes them to the operating system to carry out.
- Customization of your Unix session: You can setup variables, run initialization files, run startup commands, etc.
- Programming: Shells allow you to create small programs called shells scripts that help automate tasks.

Filesystem tree

All the files are organized into what is called a <u>hierarchical</u> <u>directory structure</u>, i.e. organized in a tree-like pattern of directories. The first directory is called the root directory.

Absolute and Relative Pathnames

Pathname Shortcuts Symbols

current directory

Home directory

Root directory

File Management Change directory

- chgrp Change file group
- chmod Change access modes on files
- chown Change file owner
- cksum Print a file checksum
- cp Copy files
- csplit Break files at specific locations
- file Determine a file's type
- head Show the first few lines of a file
 - Advanced file viewer
 - Create symbolic links
- locate Locate a given file using a database

cd

less

ln

File Management (cont)

- **1s** List files or contents of directories
- md5sum Print a file checksum using MD5 algorithm
- mkdir Create a directory
- more Display contents of files by screen
- mv Move or rename files
- pwd Print working (current) directory
- rm Remove files
- rmdir Remove (empty) directories
- split Split files evenly
- tail Show the last few lines of a file

Count lines, words and characters

WC

Unix vs Linux vs GNU

UNIX

Is an operating system developed and owned by AT&T

Is a Unix-like operating system assembled under the model of free and open source software. The core component is the kernel developed by Linus Torvalds.

VS

Is a project started by Richard Stallman, with the goal of creating a a complete unixcompatible system: compilers, libraries, utilities, ...

VS

More information

http://www.gnu.org/ http://www.linux.org/ Unix man pages <u>http://www.ubuntu.com/</u> <u>http://linuxcommand.org</u>

Getting examples for this course

```
$ wget http://www.nics.tennessee.edu/~lucio/crashCourse.tgz
--2013-03-15 08:14:28-- http://www.nics.tennessee.edu/~lucio/crashCourse.tgz
$ ls -1 crashCourse.tgz
-rw-r--r-- 1 lucio staff 1587590 Mar 15 08:06 crashCourse.tgz
$ gunzip crashCourse.tgz
$ ls -l crashCourse.tar
-rw-r--r-- 1 lucio staff 4956160 Mar 15 08:06 crashCourse.tar
$ tar -xvf crashCourse.tar
x crash/MPI/pi_mpi.c
x crash/MPI/pi_mpi
```



```
$ head list.txt
  alias Create an alias •
  apropos Search Help manual pages (man -k)
 apt-get Search for and install software packages (Debian/Ubuntu)
 aptitude Search for and install software packages (Debian/Ubuntu)
 aspell Spell Checker
 awk Find and Replace text, database sort/validate/index
b
 basename Strip directory and suffix from filenames
 bash GNU Bourne-Again SHell
          Arbitrary precision calculator language
 bc
$ cut -d ' ' -f3 list.txt | sed '/^.$/d' | head
alias
apropos
apt-get
aptitude
aspell
awk
basename
bash
bc
bq
```


Command syntax

\$ command [<options>] [<file> | <argument> ...]

Examples:

tar {-r | -u} -f archive-file [options] [files | directories]

cp [-R [-H | -L | -P]] [-fi | -n] [-apvX] source_file target_file

ps [-AaCcEefhjlMmrSTvwXx] [-0 fmt | -0 fmt] [-G gid[,gid...]]

NICS