Introduction to Unix/Linux

Daniel Lucio

HPC Fundamentals Classes

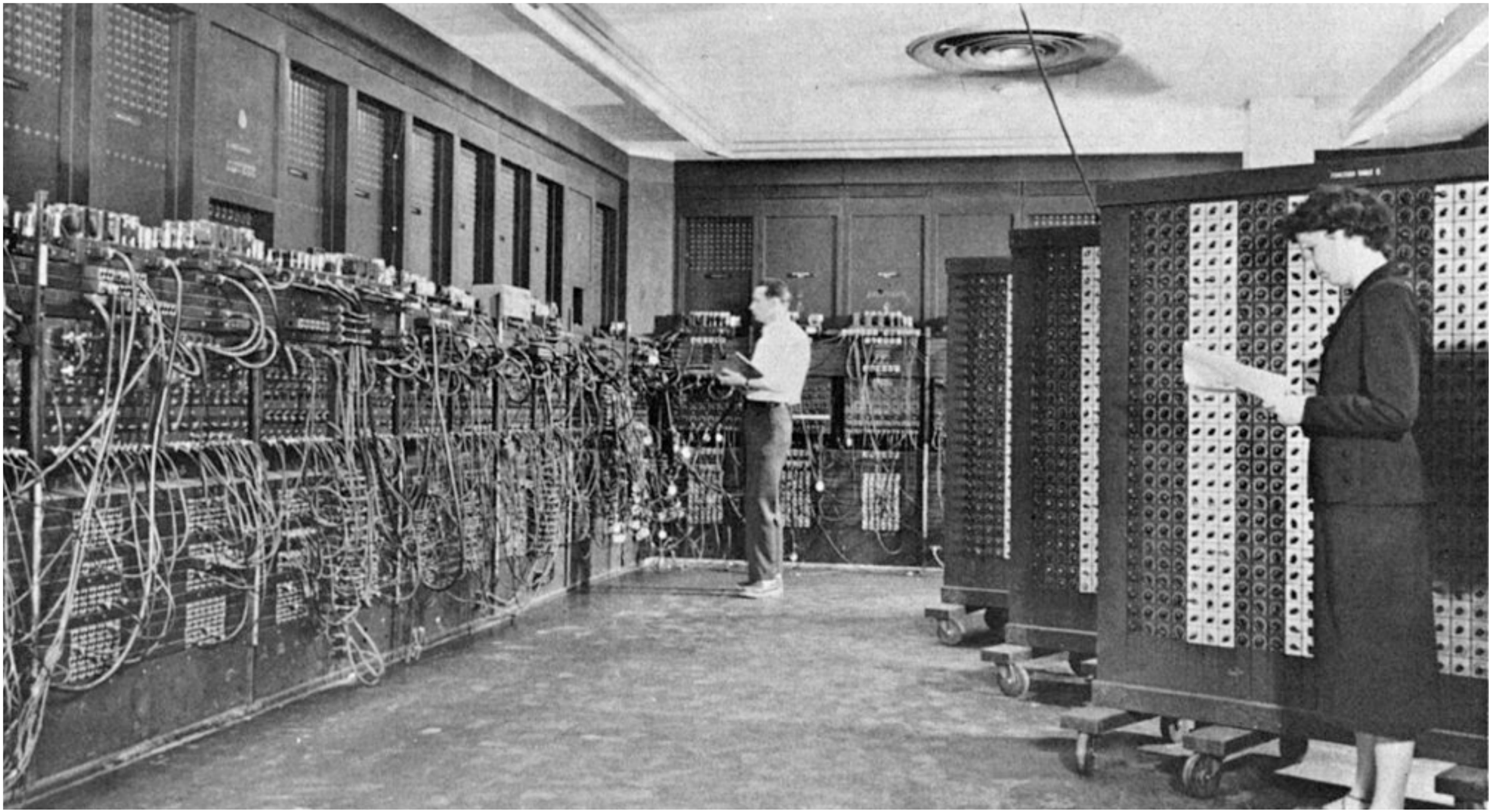
June 30, 2014

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

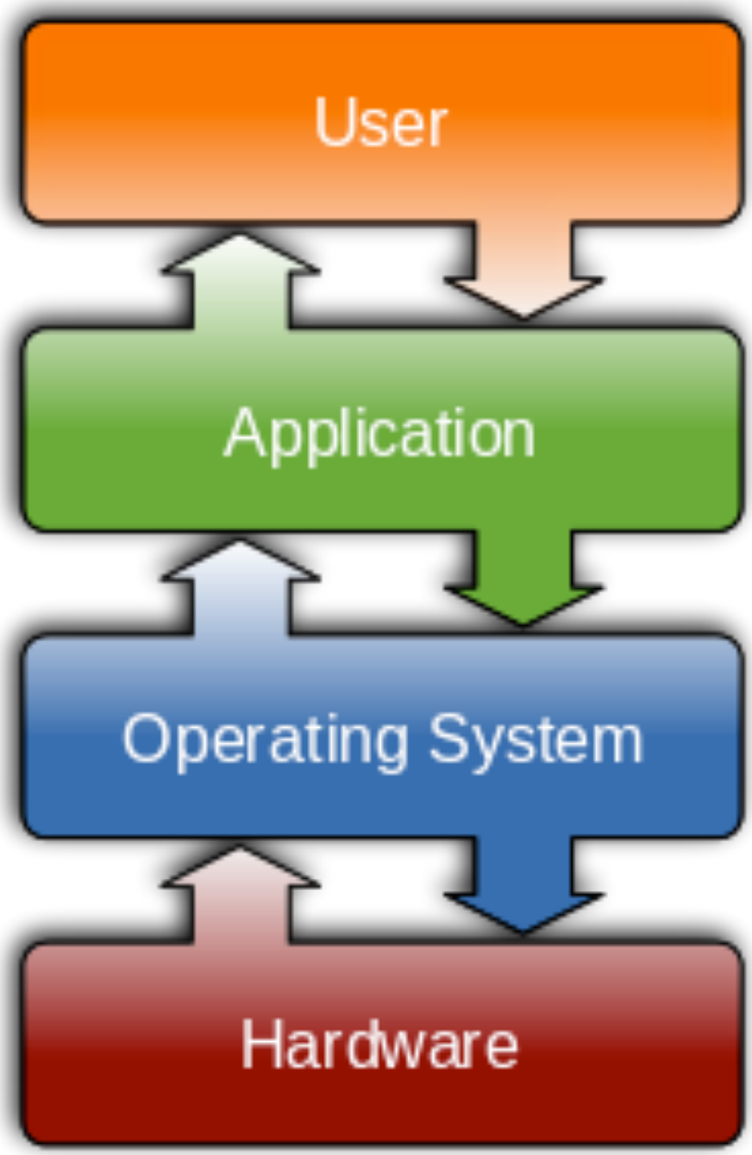
ENIAC - 1946



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.

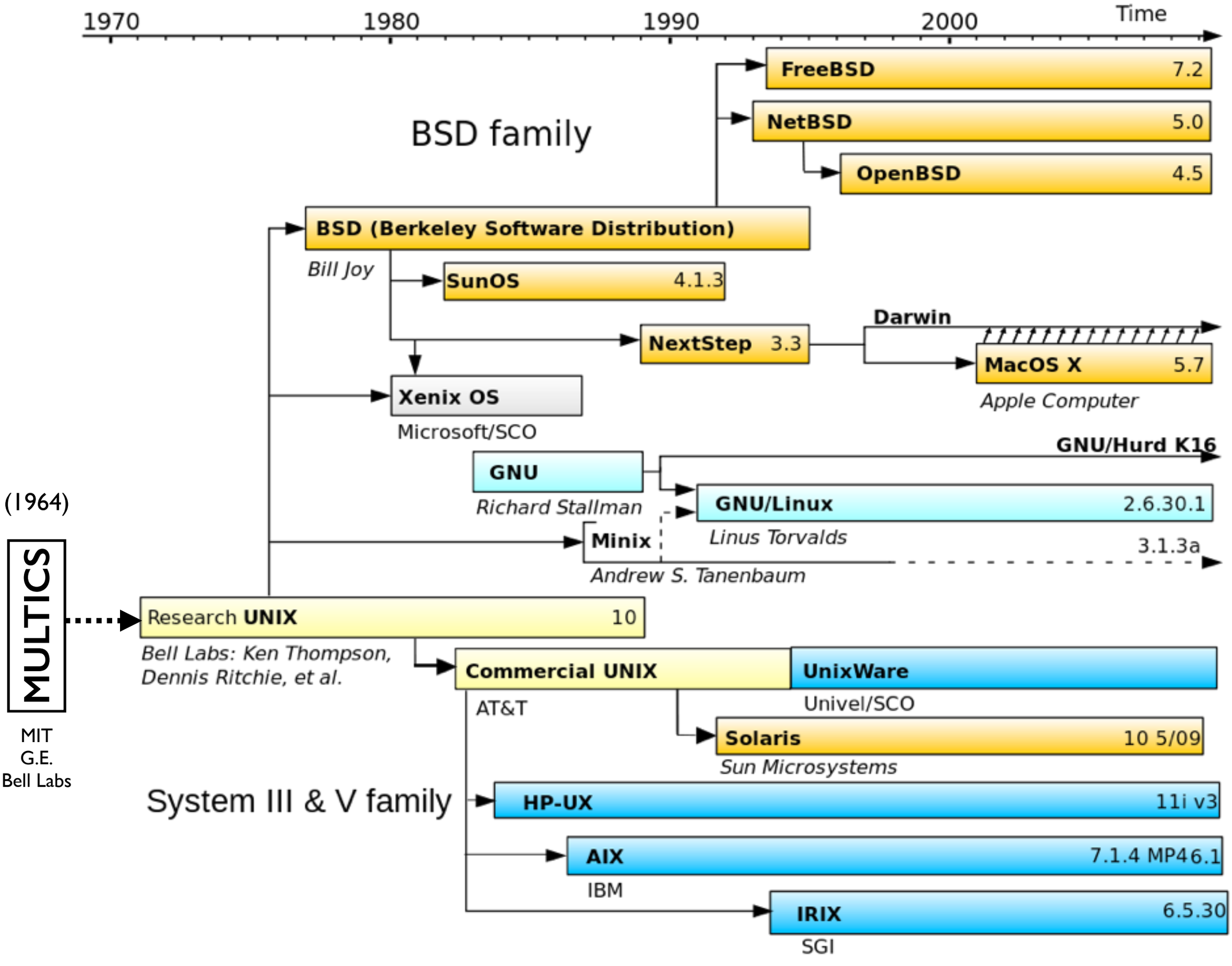
What is an Operating System?

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).


1970
1980
1990
2000
Time
BSD family
FreeBSD 7.2
NetBSD 5.0
OpenBSD 4.5
BSD (Berkeley Software Distribution)
Bill Joy
SunOS 4.1.3
Darwin
NextStep 3.3
MacOS X 5.7
Apple Computer
Xenix OS
Microsoft/SCO
GNU/Hurd K16
GNU
Richard Stallman
GNU/Linux 2.6.30.1
Linus Torvalds
Minix 3.1.3a
Andrew S. Tanenbaum
(1964)
MULTICS
MIT
G.E.
Bell Labs
Research UNIX 10
Bell Labs: Ken Thompson,
Dennis Ritchie, et al.
Commercial UNIX
UnixWare
Univel/SCO
AT&T
Solaris 10 5/09
Sun Microsystems
System III & V family
HP-UX 11i v3
AIX 7.1.4 MP46.1
IBM
IRIX 6.5.30
SGI

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.

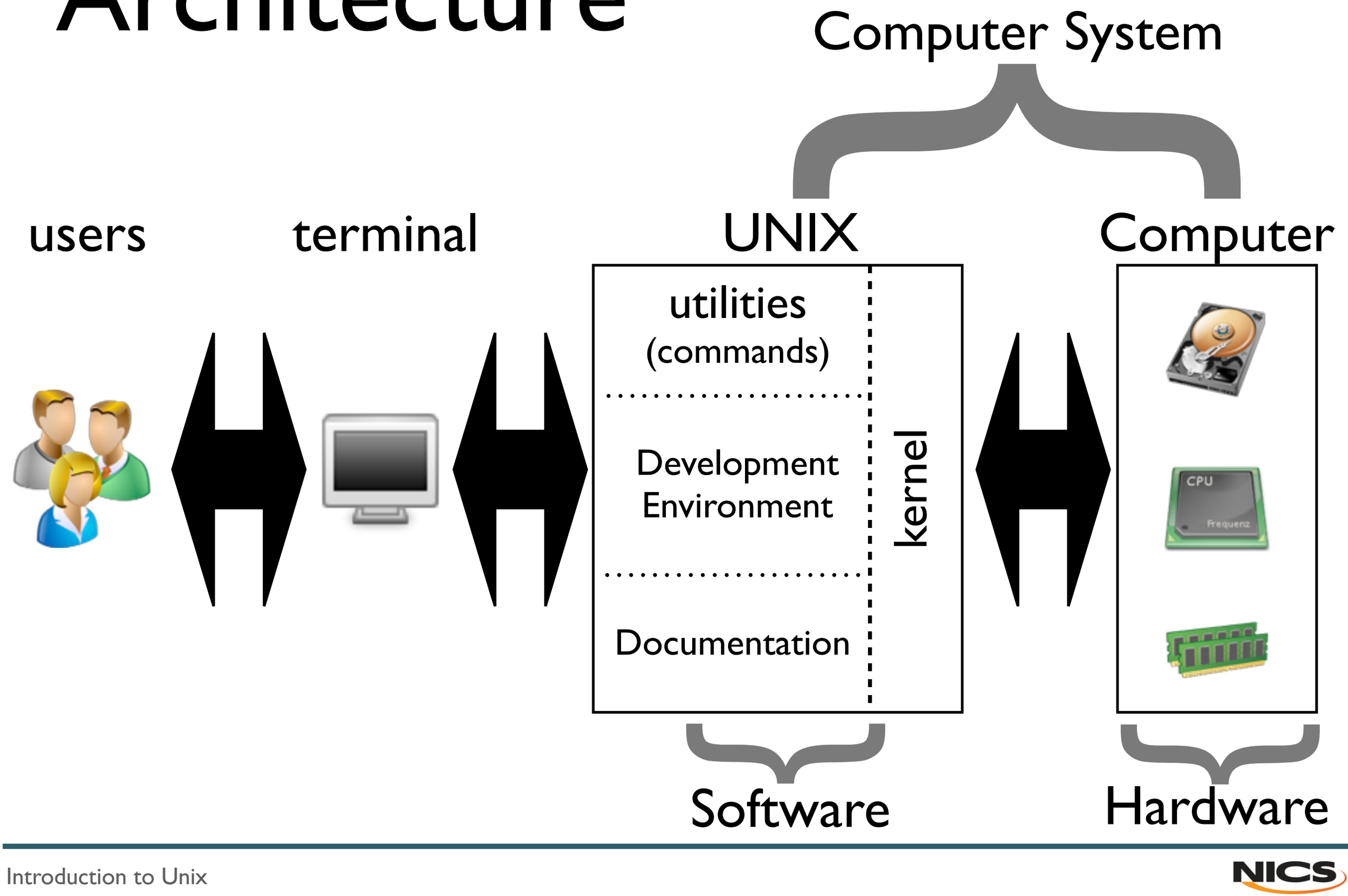
The Unix Philosophy

vs

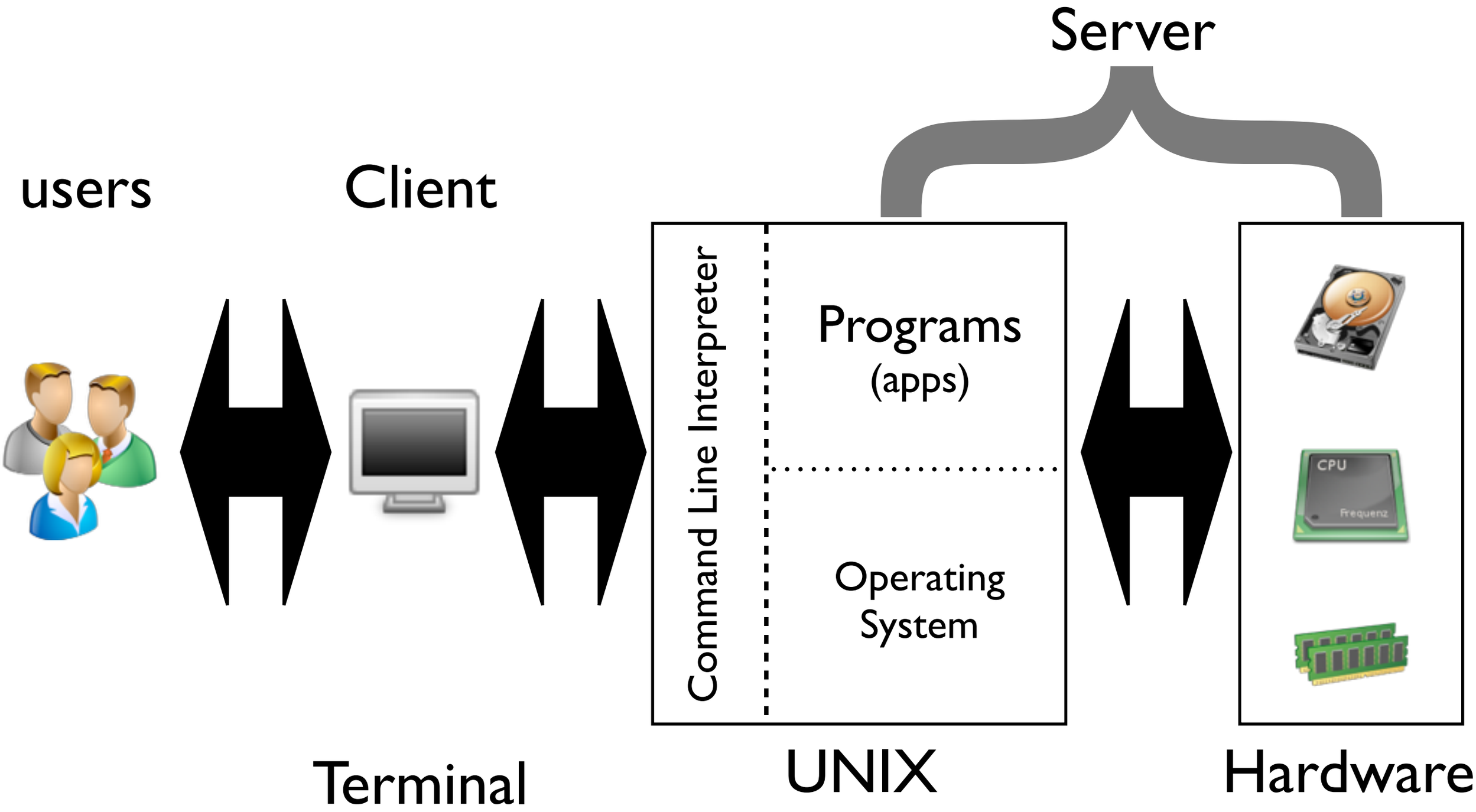
Simple and Elegant Design

- Unix is simple: Only implements a few hundred system calls and all are well defined.
- Everything is a "file": Provides a "universal" interface.
- Is written in C: Makes it accessible and portable.
- Has fast process creation through the fork() operation whereby a process creates a copy of itself.
- Provides a simple yet robust interprocess communication (IPC) primitives.
- Supports all modern features like multitasking, multithreading, virtual memory, demand paging, shared libraries, TCP/IP networking,…

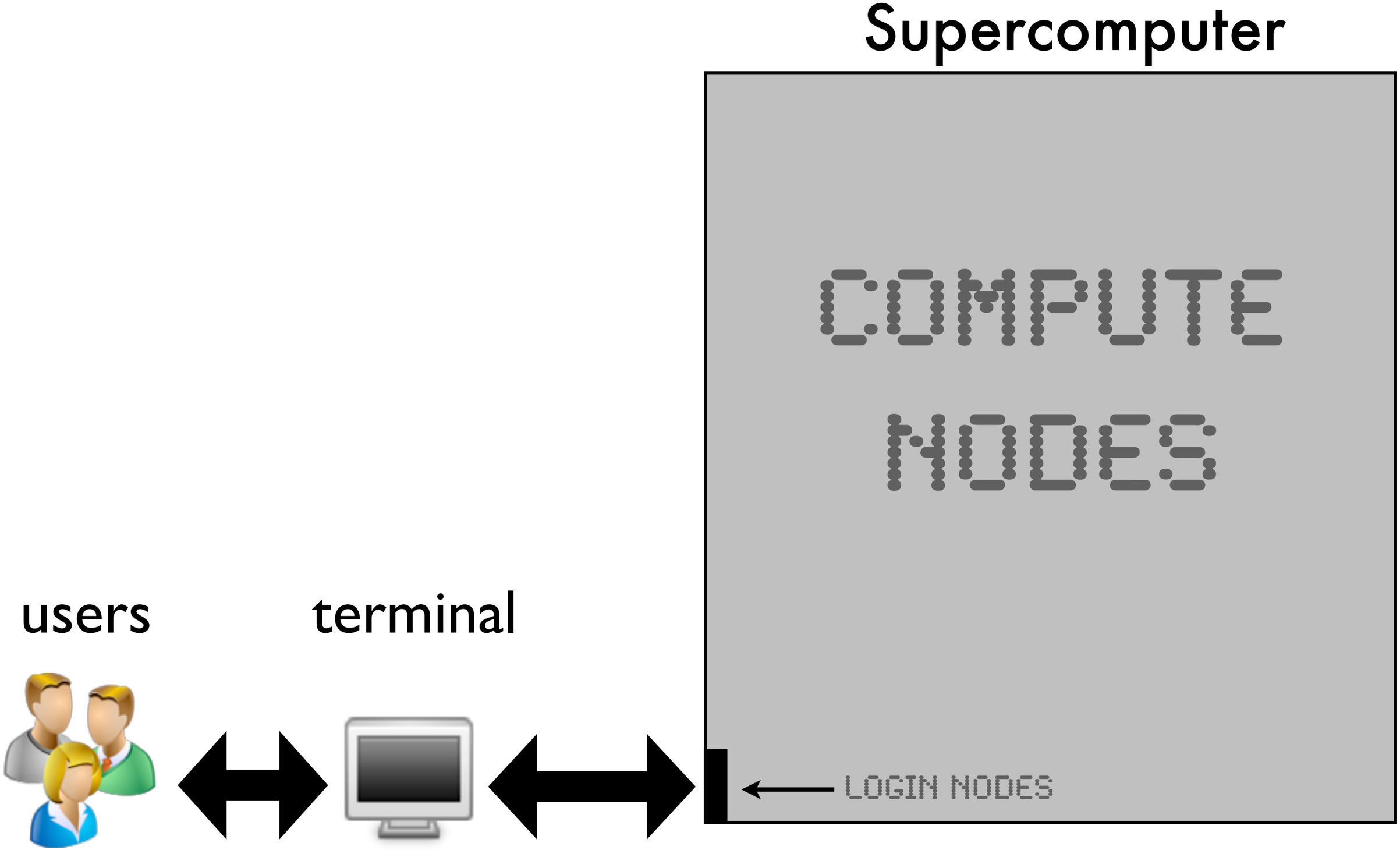
Architecture



User's view


Server
users
Client
Command Line Interpreter
Programs
(apps)
Operating
System
CPU
Frequenz
Terminal
UNIX
Hardware

User's view



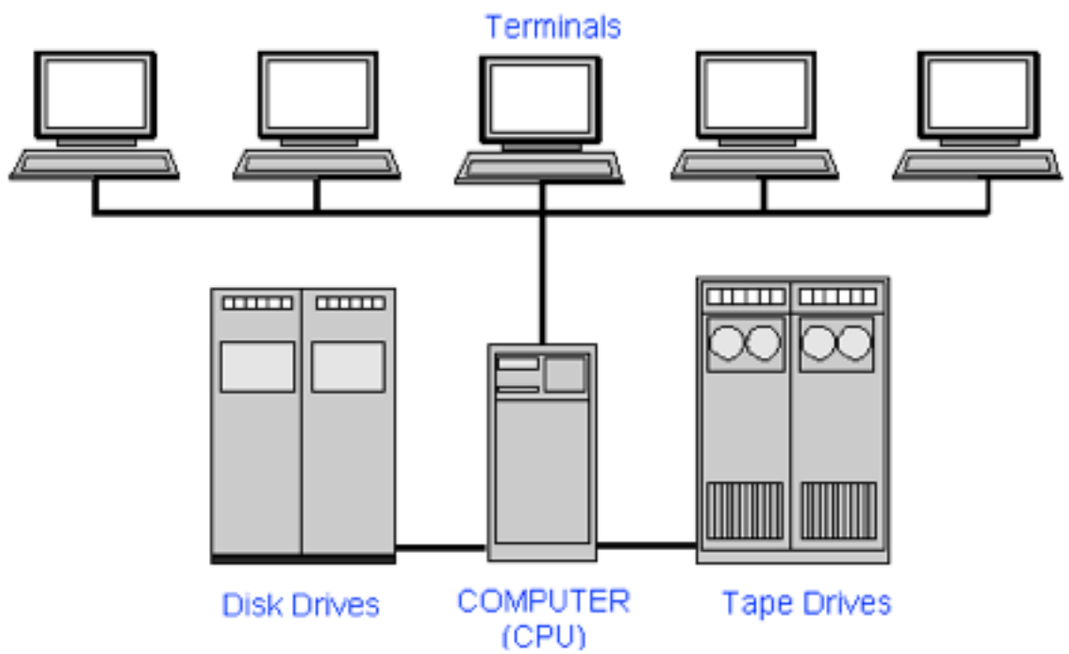
What is a Terminal?

- 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.

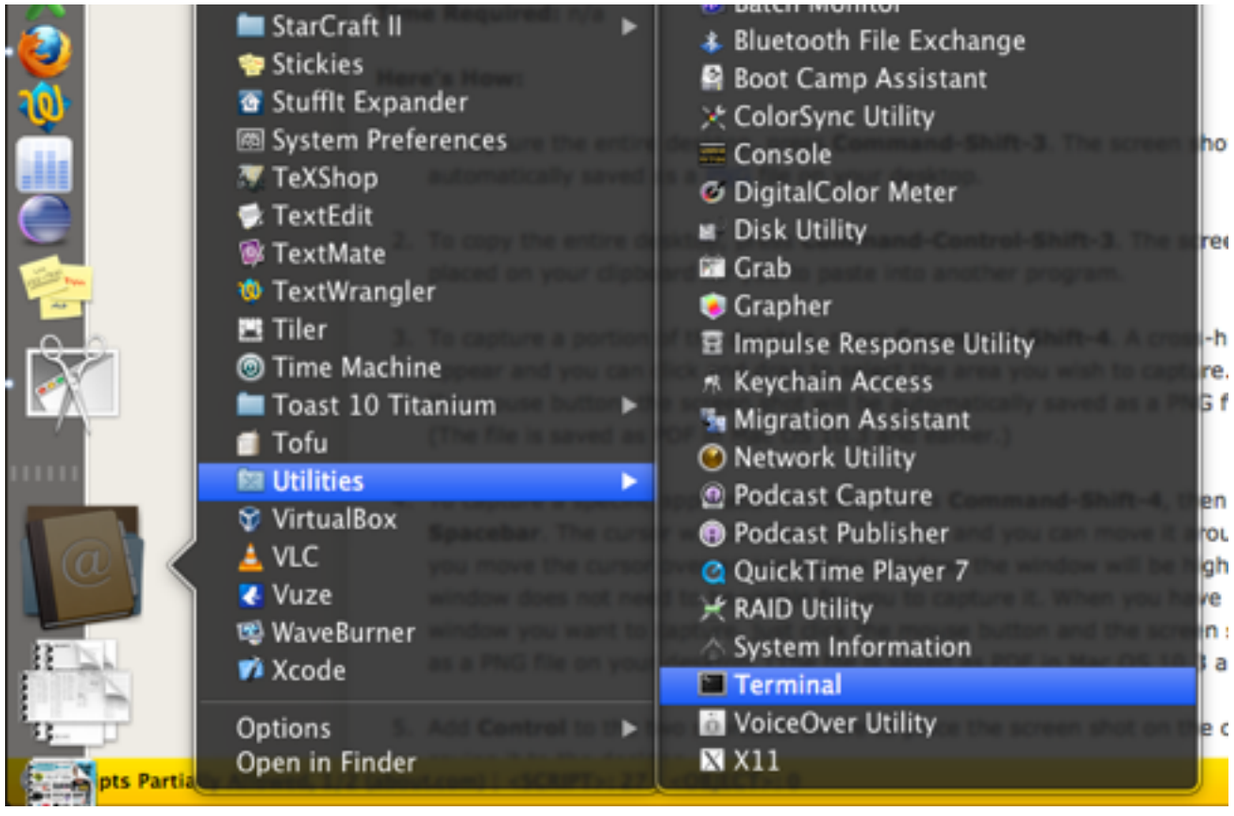
What is a Terminal?

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 does not locally process data or execute user programs.

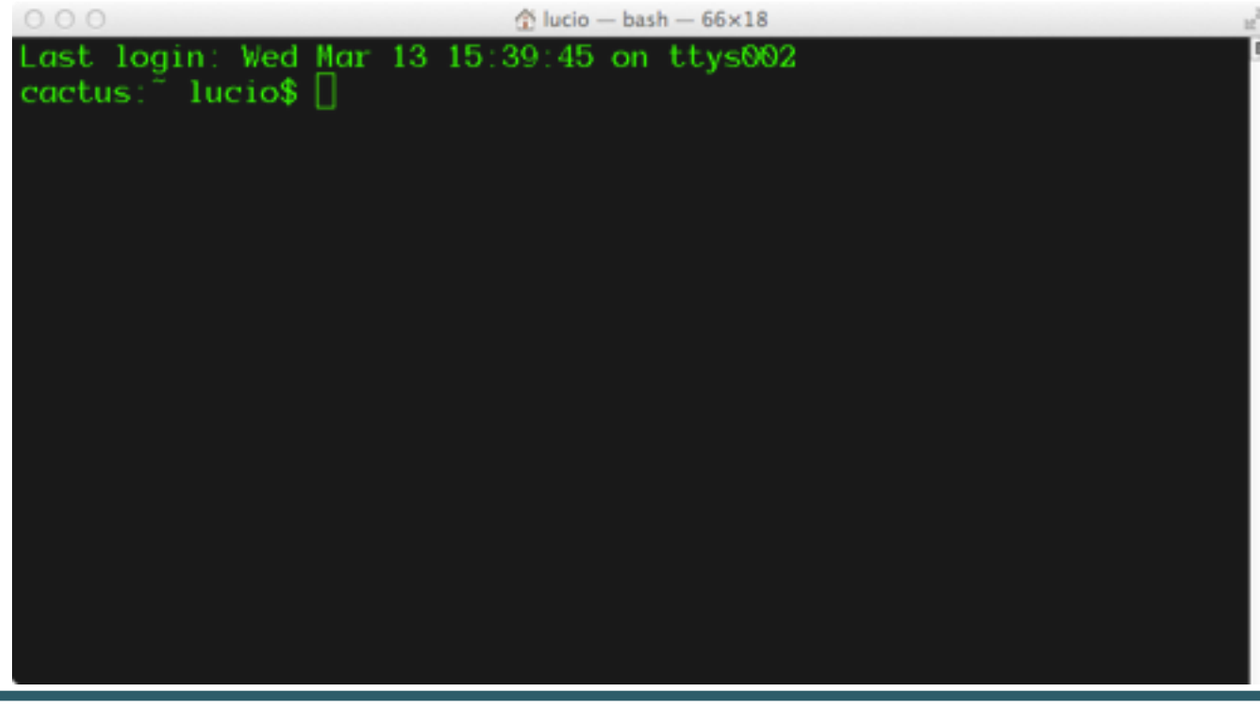


MacOS Emulator



MacOS Terminal App

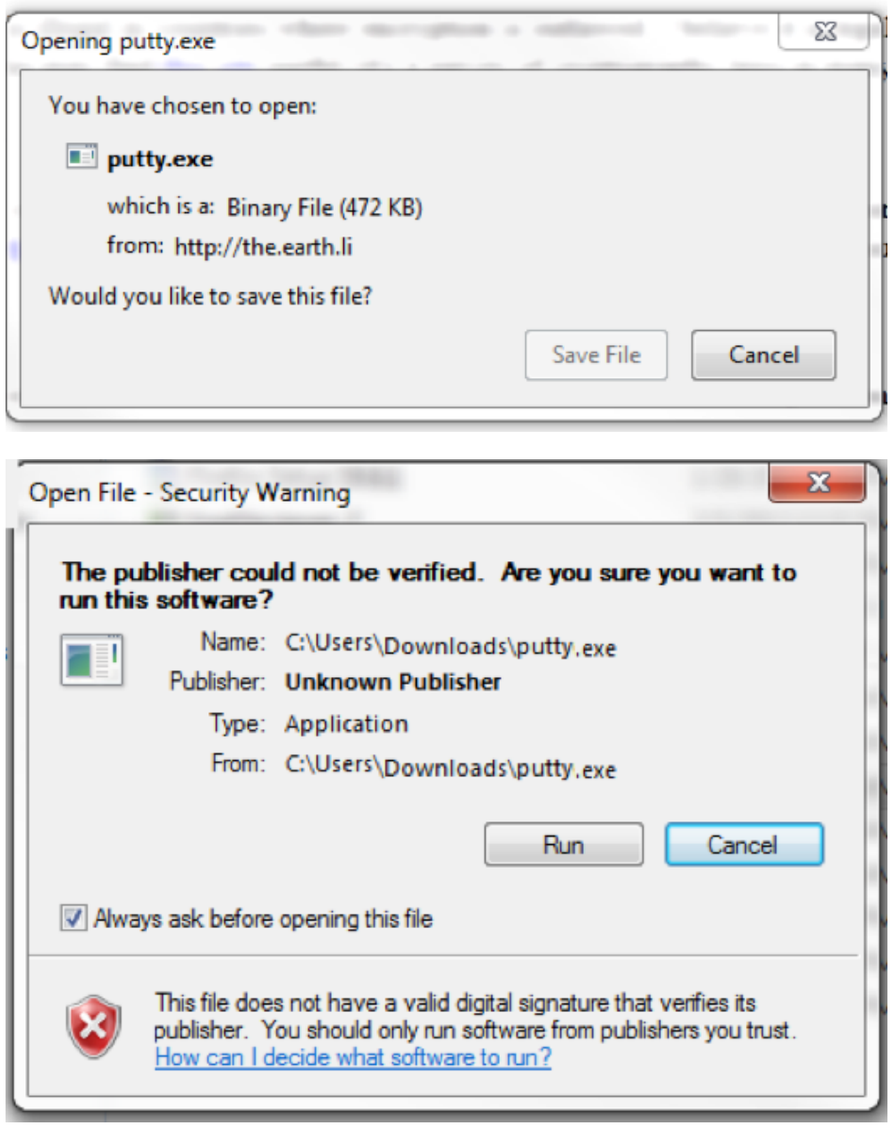
Terminal Emulators

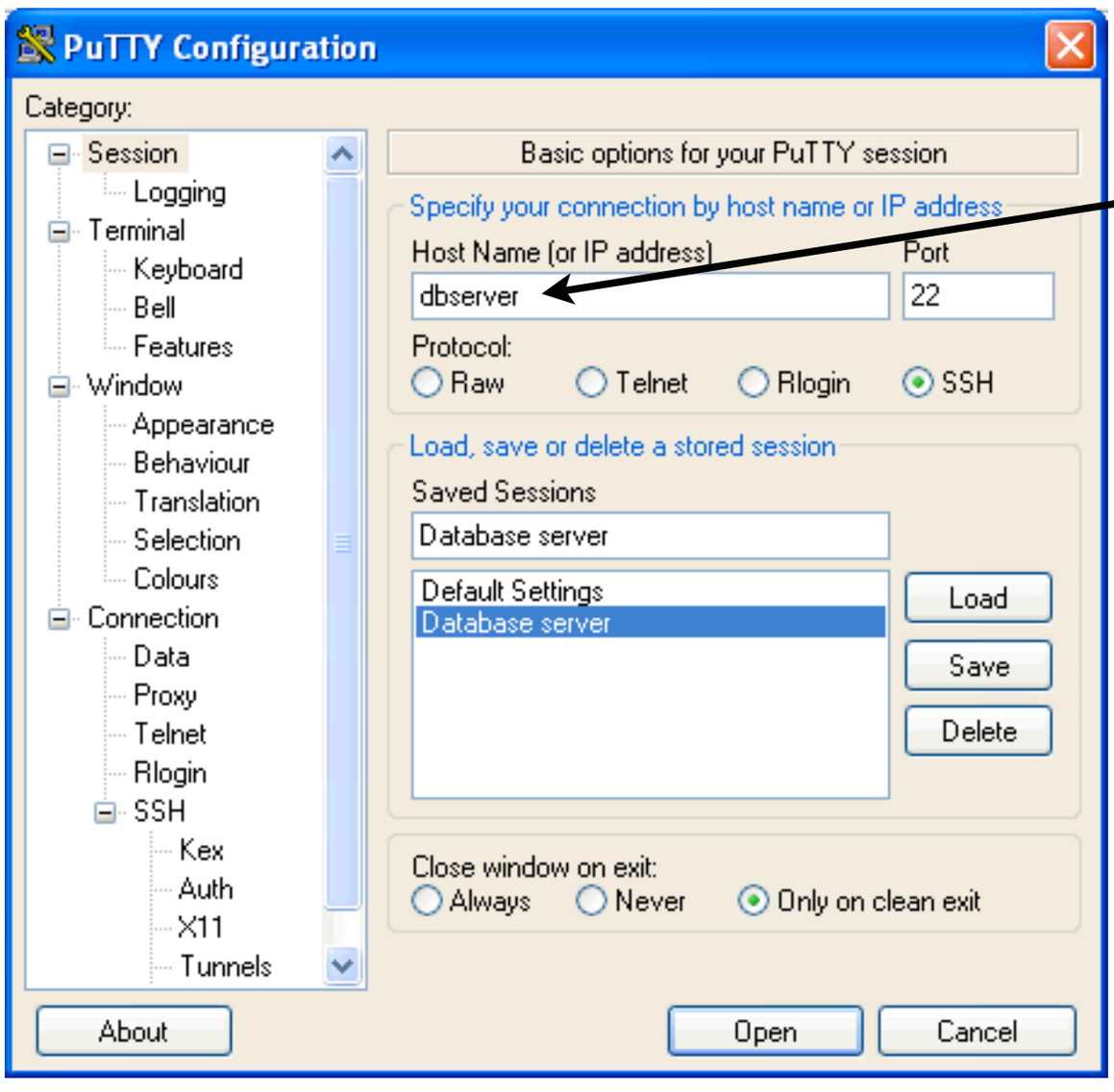


Linux computer

Windows Client

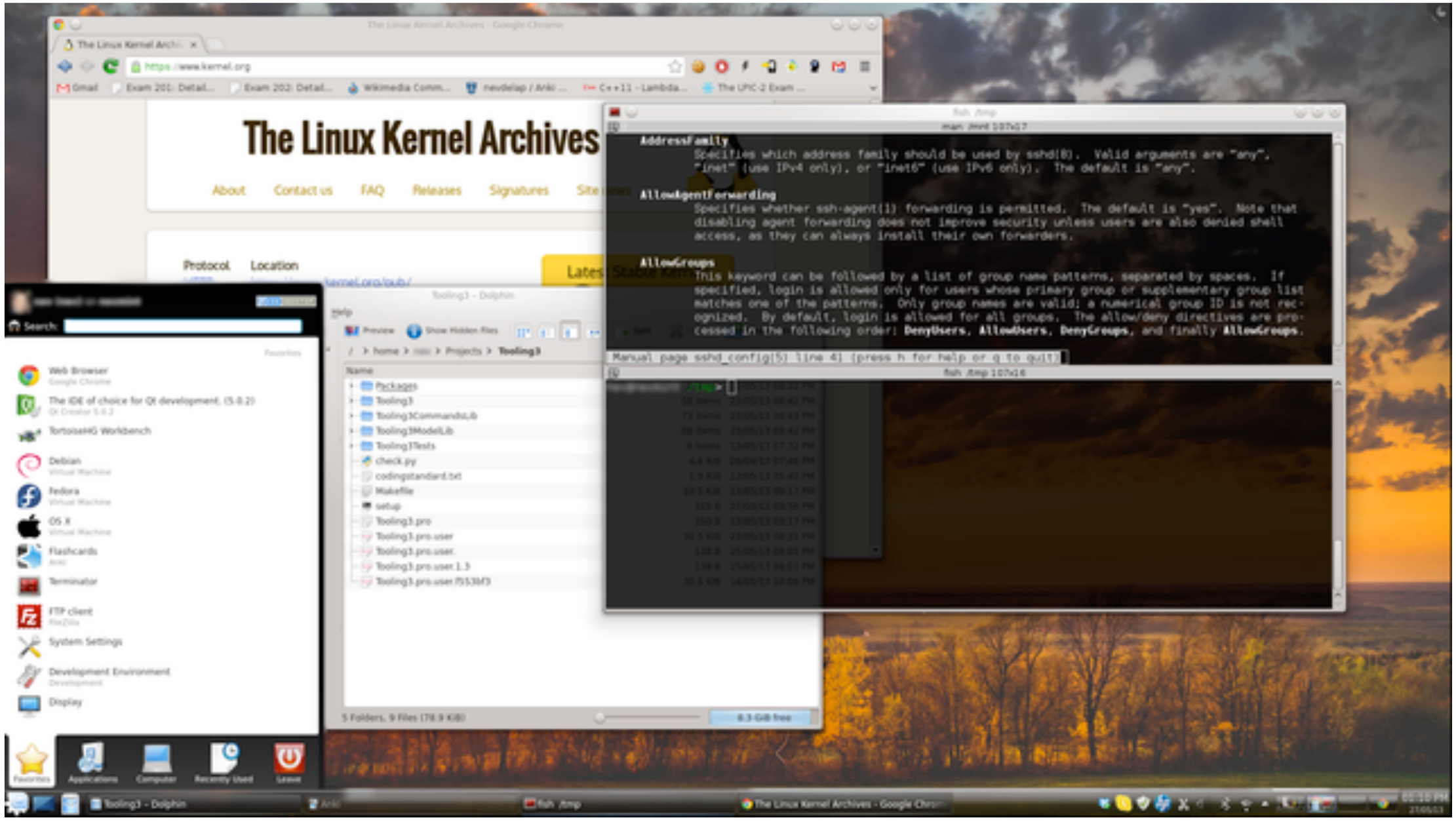
http://www.chiark.greenend.org.uk/~sgtatham/putty/download.html





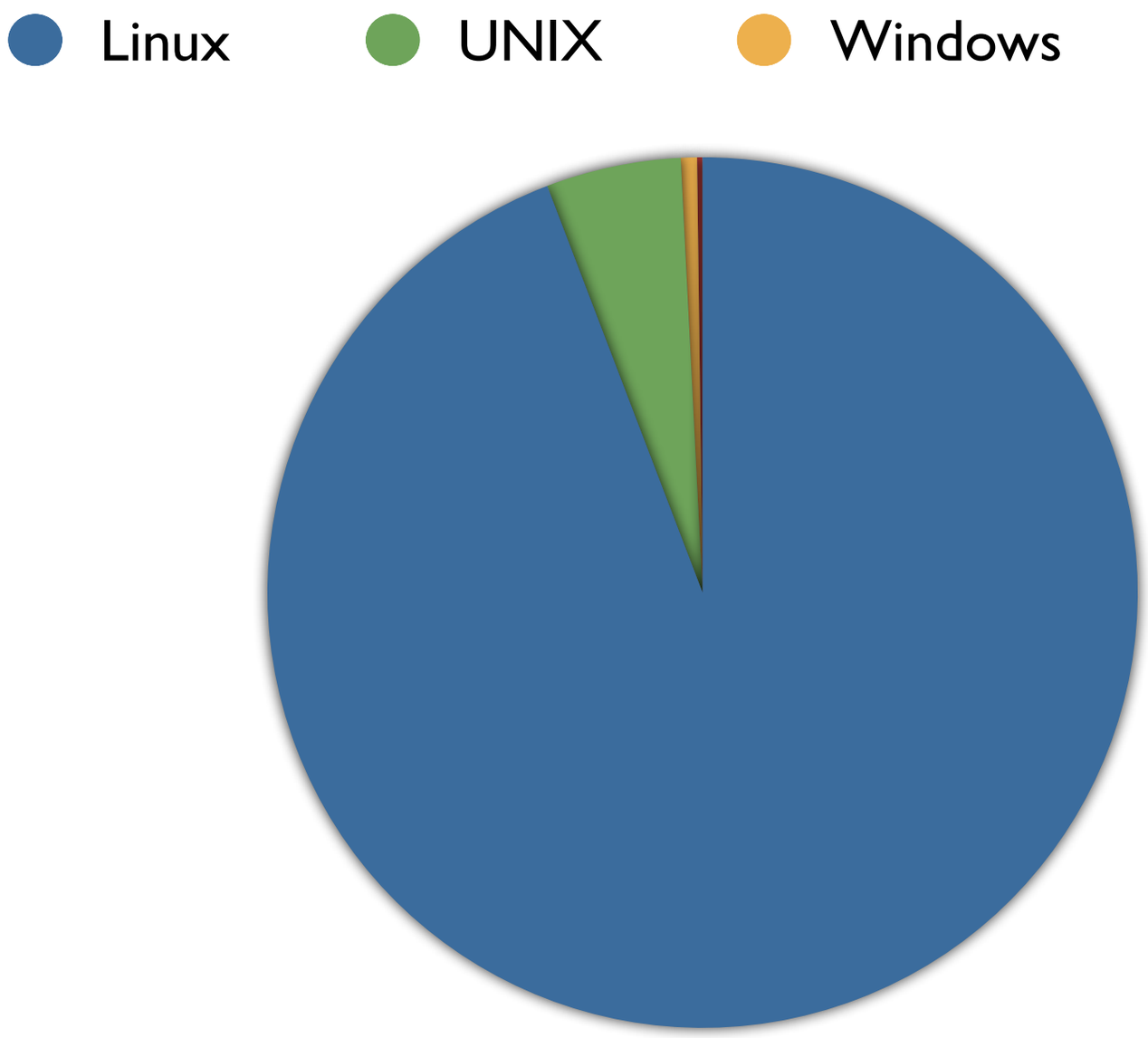
mars.nics.utk.edu

Is there a GUI for Unix?



Example of a graphical user interface using X11 and KDE.

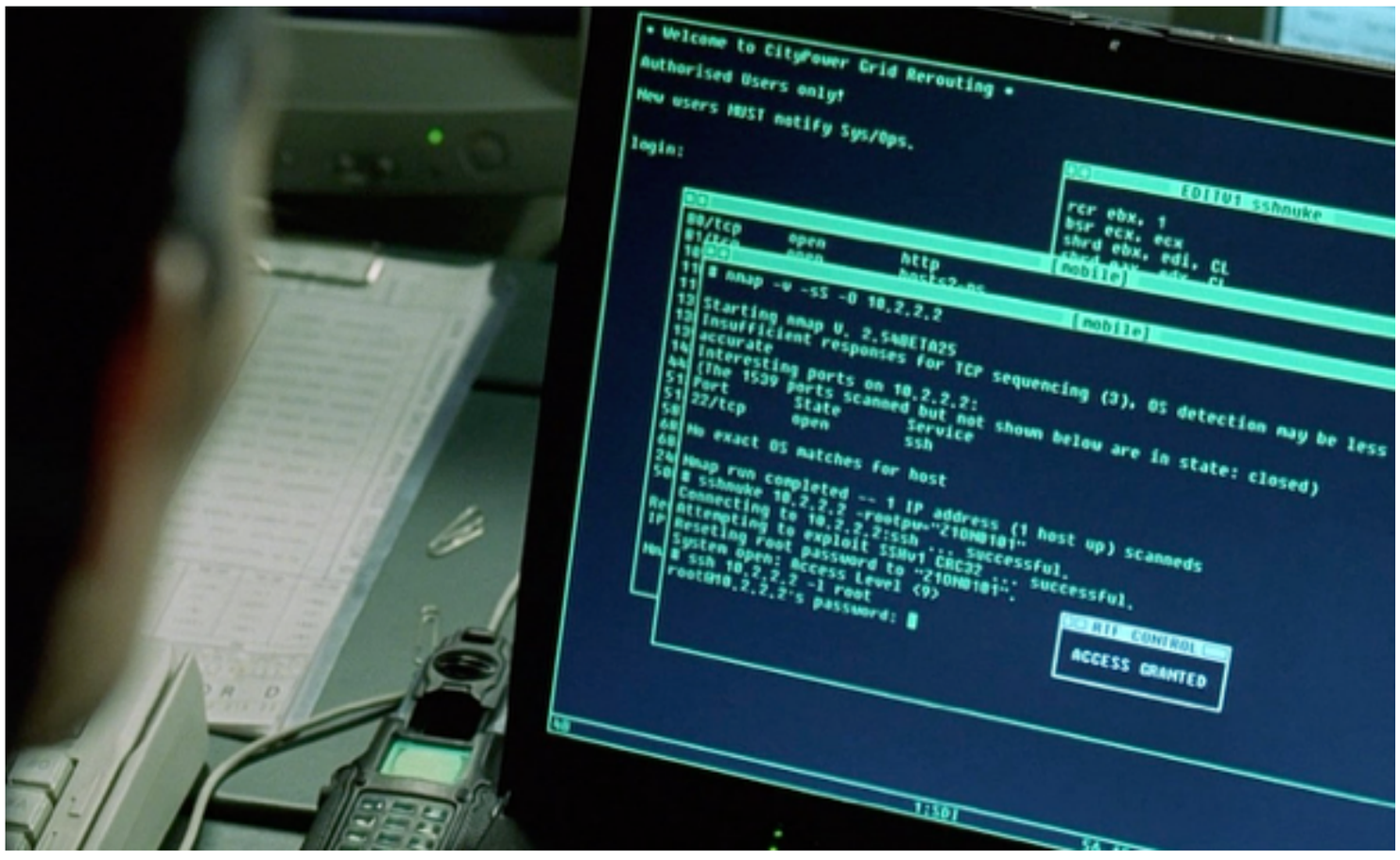
Why, learn it?



As of June 2013, 95.2% of the Top500 computers use a Linux-like O.S.

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?

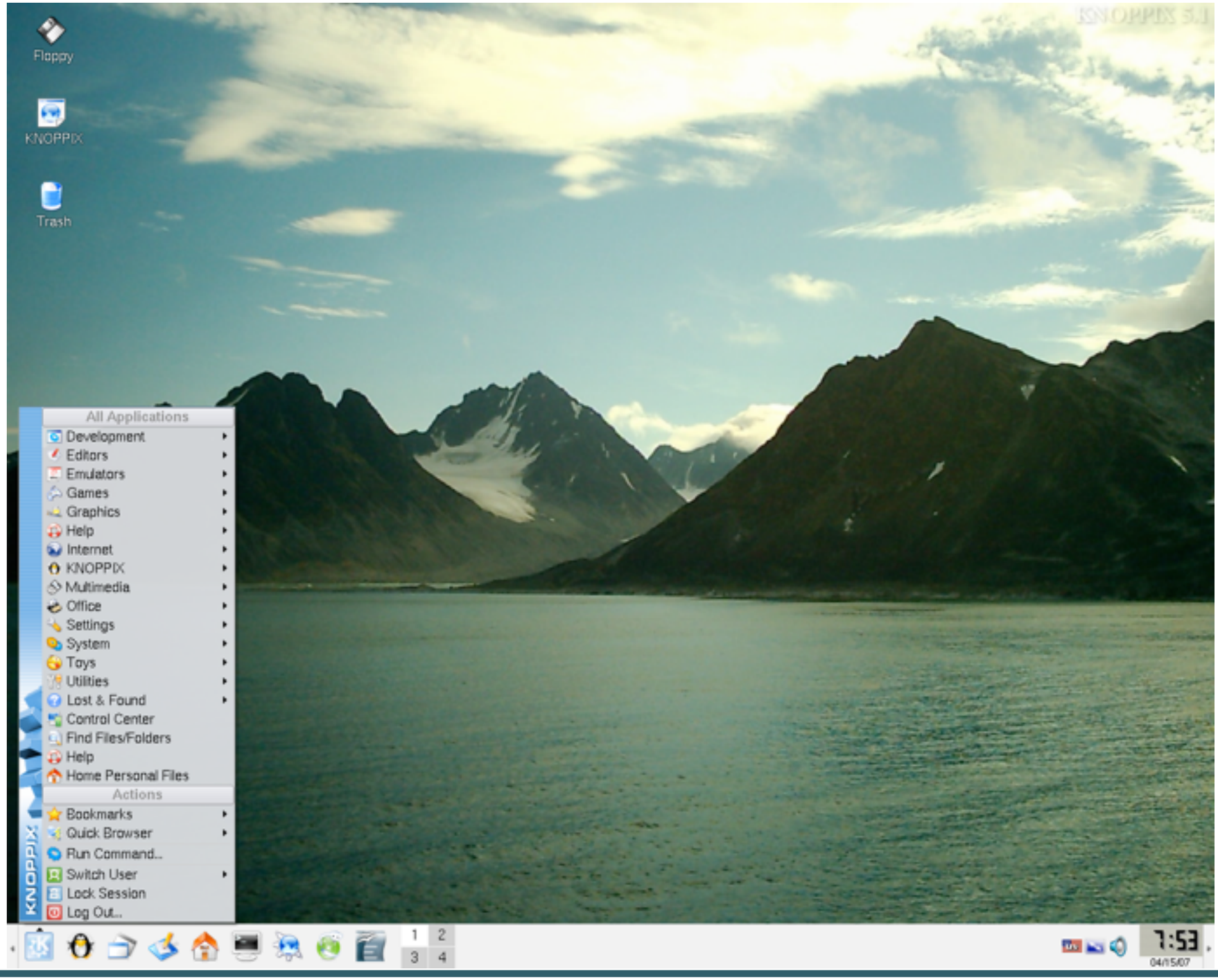
- Android is a Linux-based operating system designed primarily for touchscreen mobile devices such as smartphones and tablet computers.

- The iOS kernel is based on Darwin OS. Darwin forms the core set of components upon which OS X and iOS are based. It is compatible with the Single UNIX Specification version 3 (SUSv3) and POSIX UNIX applications and utilities.

Where to use it?

- 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
  - http://www.ubuntu.com/

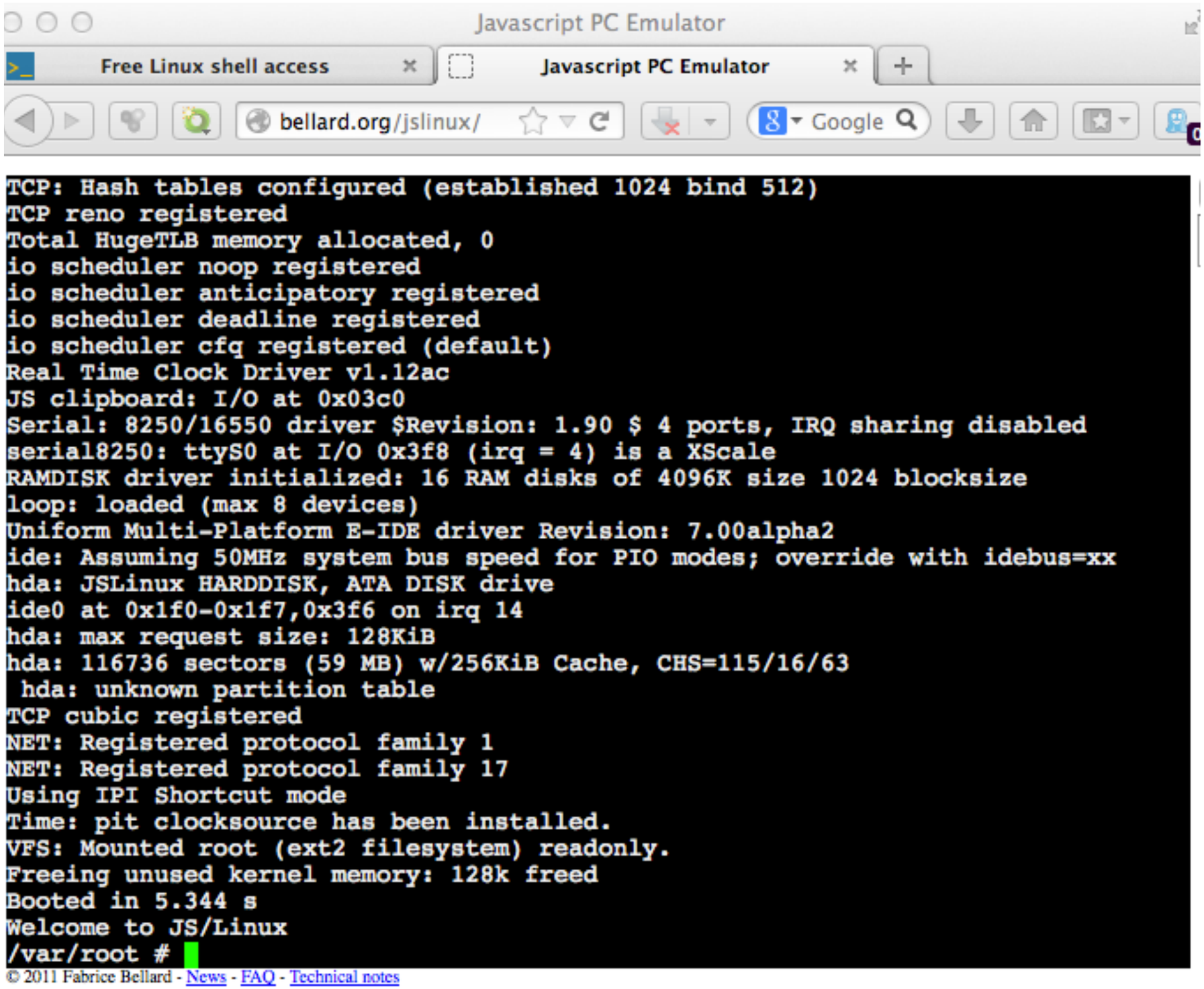
Where to use it?



Where to use it?

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

Where to use it?



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
`ln`	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
`wc`	Count lines, words and characters

Printing Commands

BSD	`lpr`	Send to the printer
	`lpq`	Get printer status
	`lprm`	Cancel a printer request
	`pr`	Format and paginate for printing
System V	`cancel`	Cancel a printer request
	`lp`	Send to printer
	`lpstat`	Get printer status
	`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)

Bourne Family	`bash`	GNU 's Bourne Again Shell
	`ksh`	The Korn shell
	`pdksh`	Public domain Korn shell
	`sh`	Original Bourne shell
	`zsh`	The Z-shell
C family	`csh`	The original BSD C shell
	`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`	Test a condition

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

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 Command Line Interpreter.

The Unix Shell Features

- Cursor movement with keyboard arrow keys.

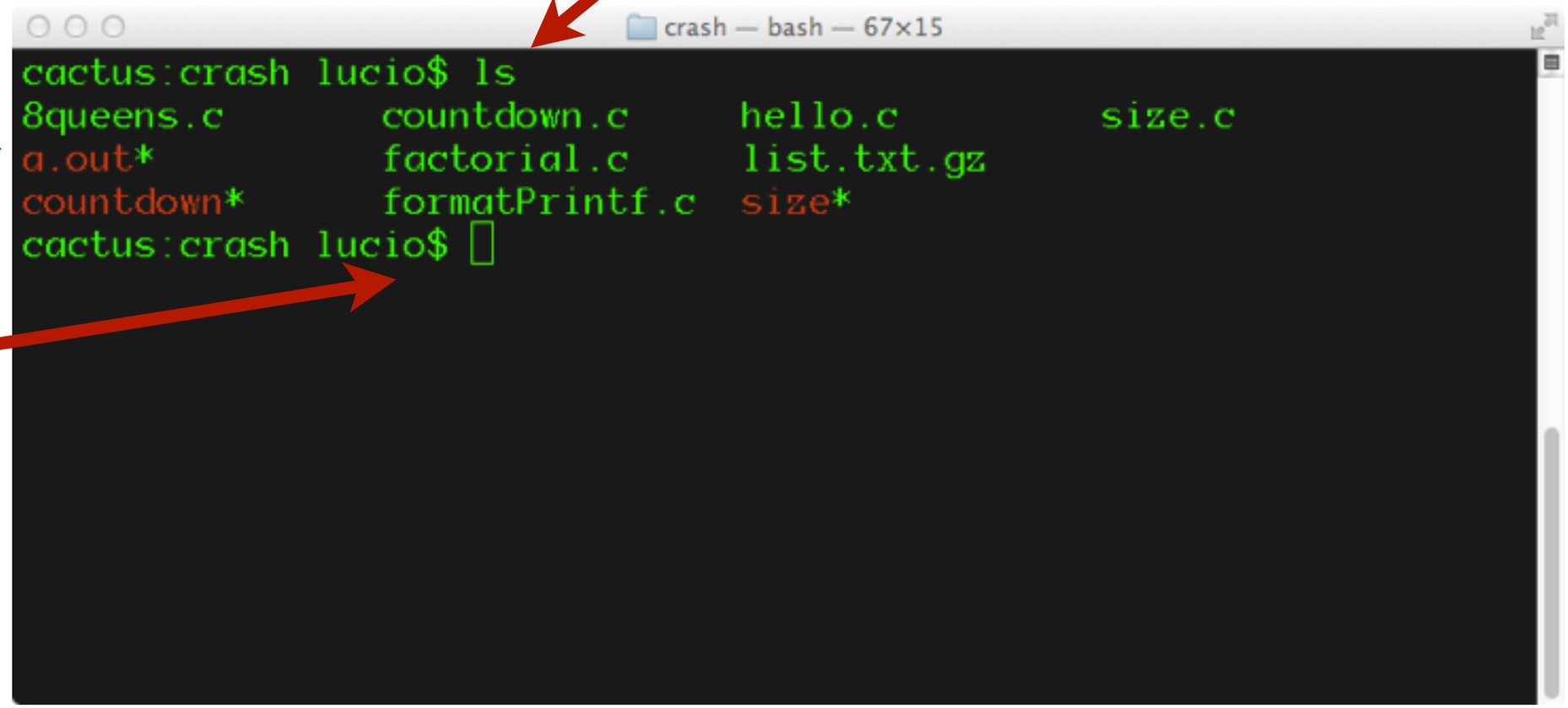
- Command history

- Automatic completion

Command line session

Command

Results from command



Prompt

Terminal Window

Command line session

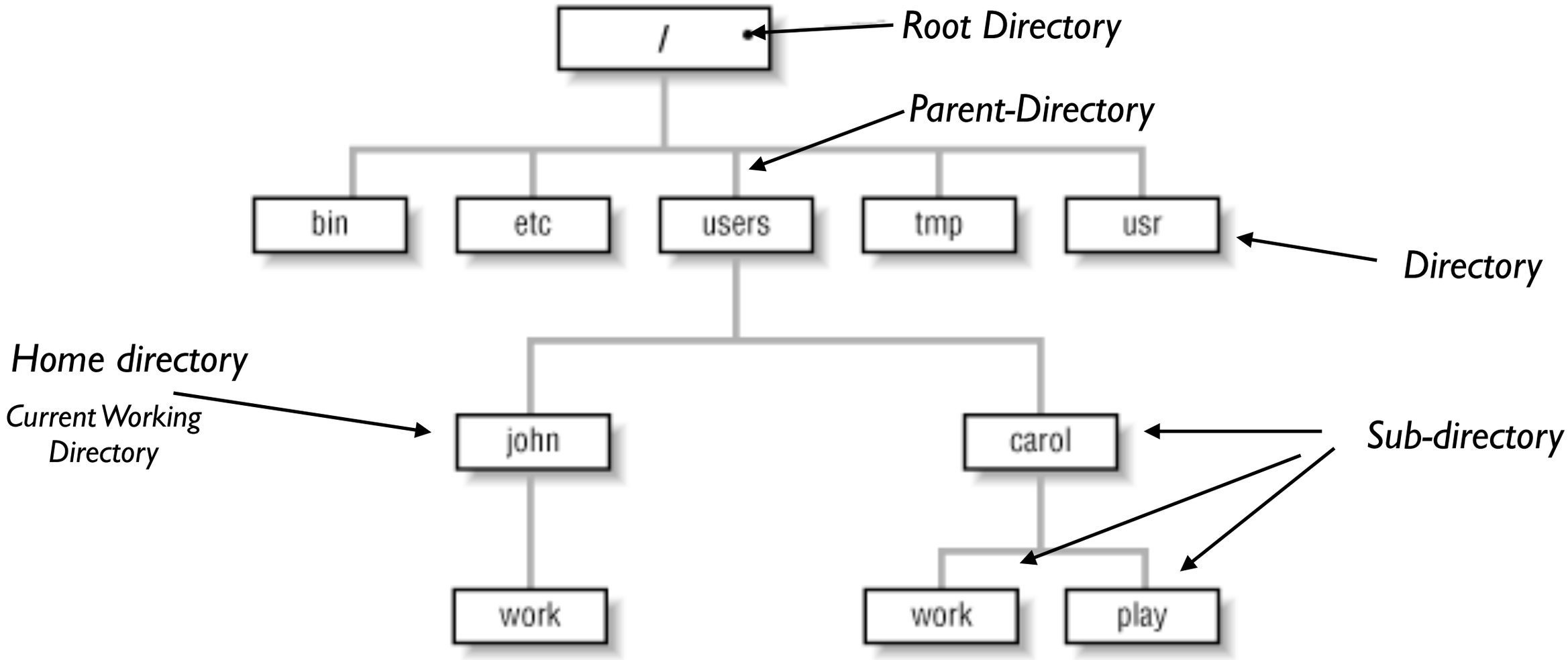
```
user004@sshell ~ $
user004@sshell ~ $ fdsfdsf
bash: fdsfdsf: command not found
user004@sshell ~ $ date
Thu Oct 24 14:38:15 UTC 2013
user004@sshell ~ $ cal
     October 2013
Su Mo Tu We Th Fr Sa
          1  2  3  4  5
 6  7  8  9 10 11 12
13 14 15 16 17 18 19
20 21 22 23 24 25 26
27 28 29 30 31

user004@sshell ~ $ whoami
user004
user004@sshell ~ $ exit
```

Purpose of the Command-line interface?

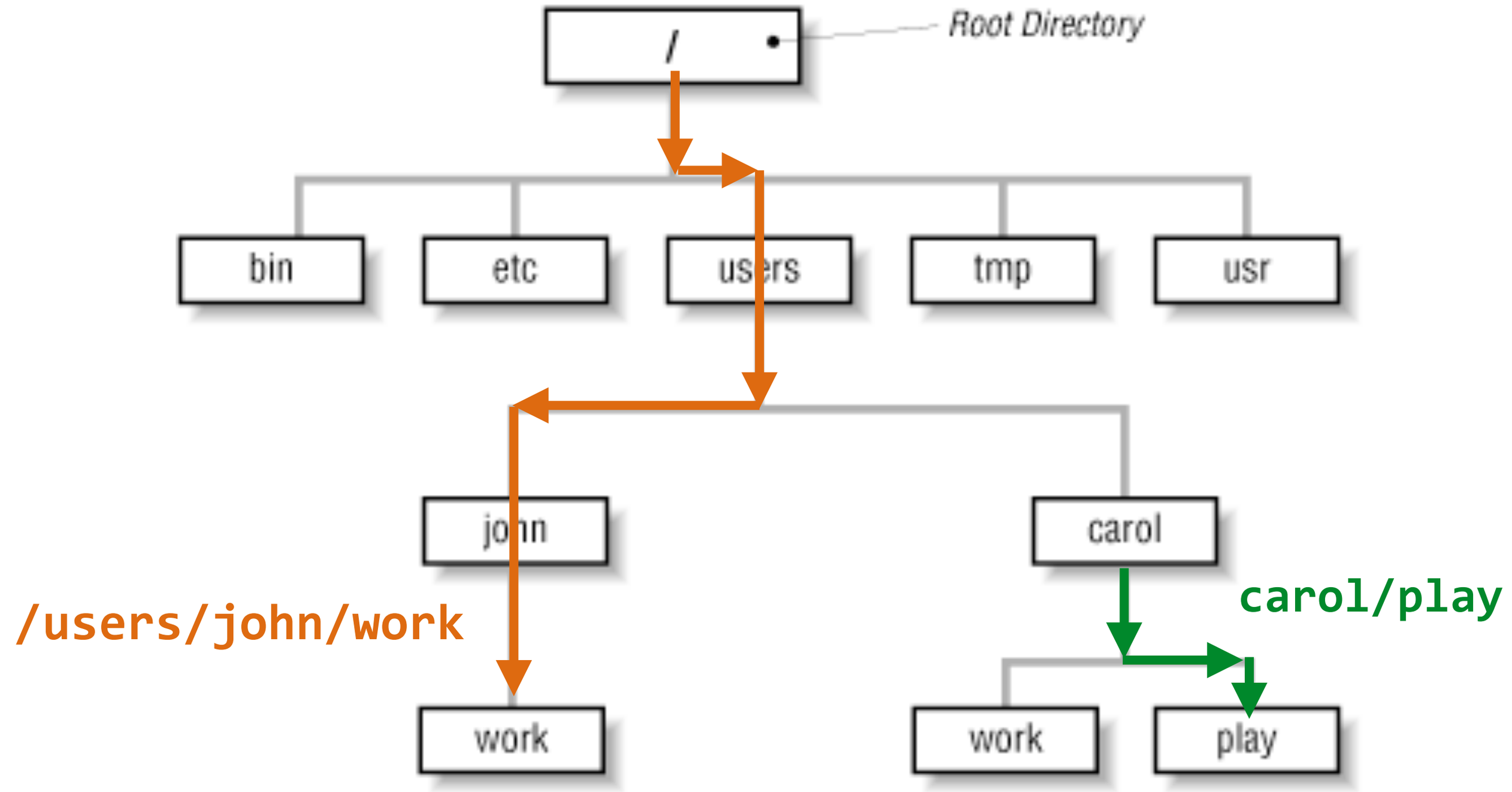
- Is a program that takes keyboard commands and passes them to the operating system to carry out.
- Customization of your Unix session: You can setup variables, run initialization files, run startup commands, etc.
- Programming: Shells allow you to create small programs called shells scripts that help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

Filesystem tree

All the files are organized into what is called a hierarchical directory structure, 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`

`..` ← `parent directory`

`~` ← `Home directory`

`/` ← `Root directory`

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**
`ln`	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
`wc`	Count lines, words and characters

Unix *vs* Linux *vs* GNU

UNIX

Is an operating system developed and owned by AT&T

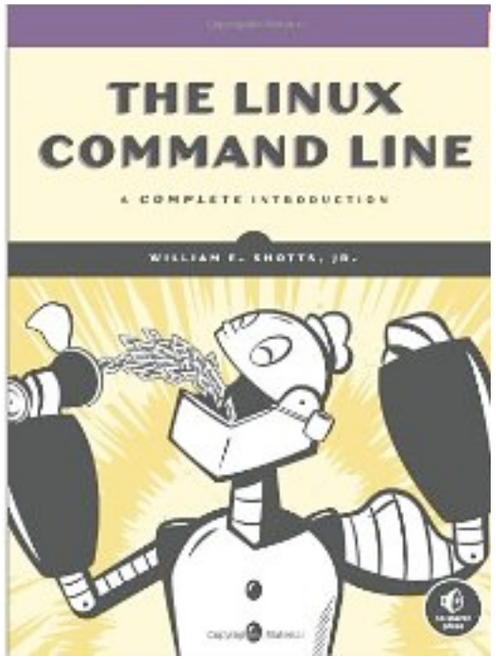
vs

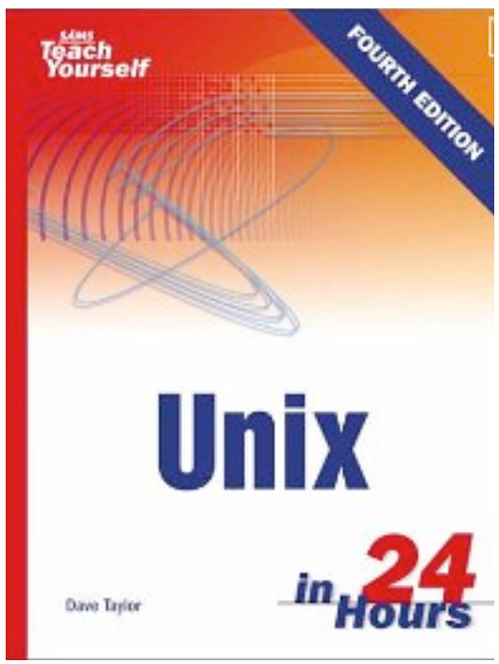
Is a Unix-like operating system assembled under the model of free and open source software. The core component is the kernel developed by Linus Torvalds.

vs

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

More information





http://www.gnu.org/

http://www.linux.org/

Unix man pages

http://www.ubuntu.com/

http://linuxcommand.org