Introduction to Linux
Session 1 - Basics

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Outline

- What is Linux?
- Why use Linux?
- What happens when you log in?
- Shells and environment
- Commands
- Filesystem basics
- Processes
- More about shells

Slides available via http at

github.com/ResearchComputing/Final_Tutorials/blob/master/IntroLinux.pdf

What is Linux?

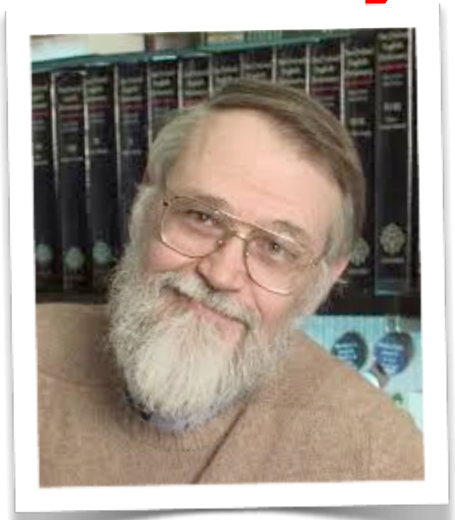
- Part of the Unix family of operating systems.
- Started in early ‘90s by Linus Torvalds.
- Technically refers only to the kernel; software from the GNU project and elsewhere is layered on top to form a complete OS. Most is open source.
- Several distributions are available – from enterprise-grade, like RHEL or SUSE, to more consumer-focused, like Ubuntu.
- Runs on everything from embedded systems to supercomputers.

Why Use Linux?

- Linux command-line syntax may seem overwhelming to the new user, but:
- It's the default operating system on virtually all HPC systems
- It's extremely flexible
- It tries not to get in your way
- It's fast and powerful
- It was designed by programmers and thus has many potent tools for software development

- You can get started with a few basic commands and build from there

History of Linux

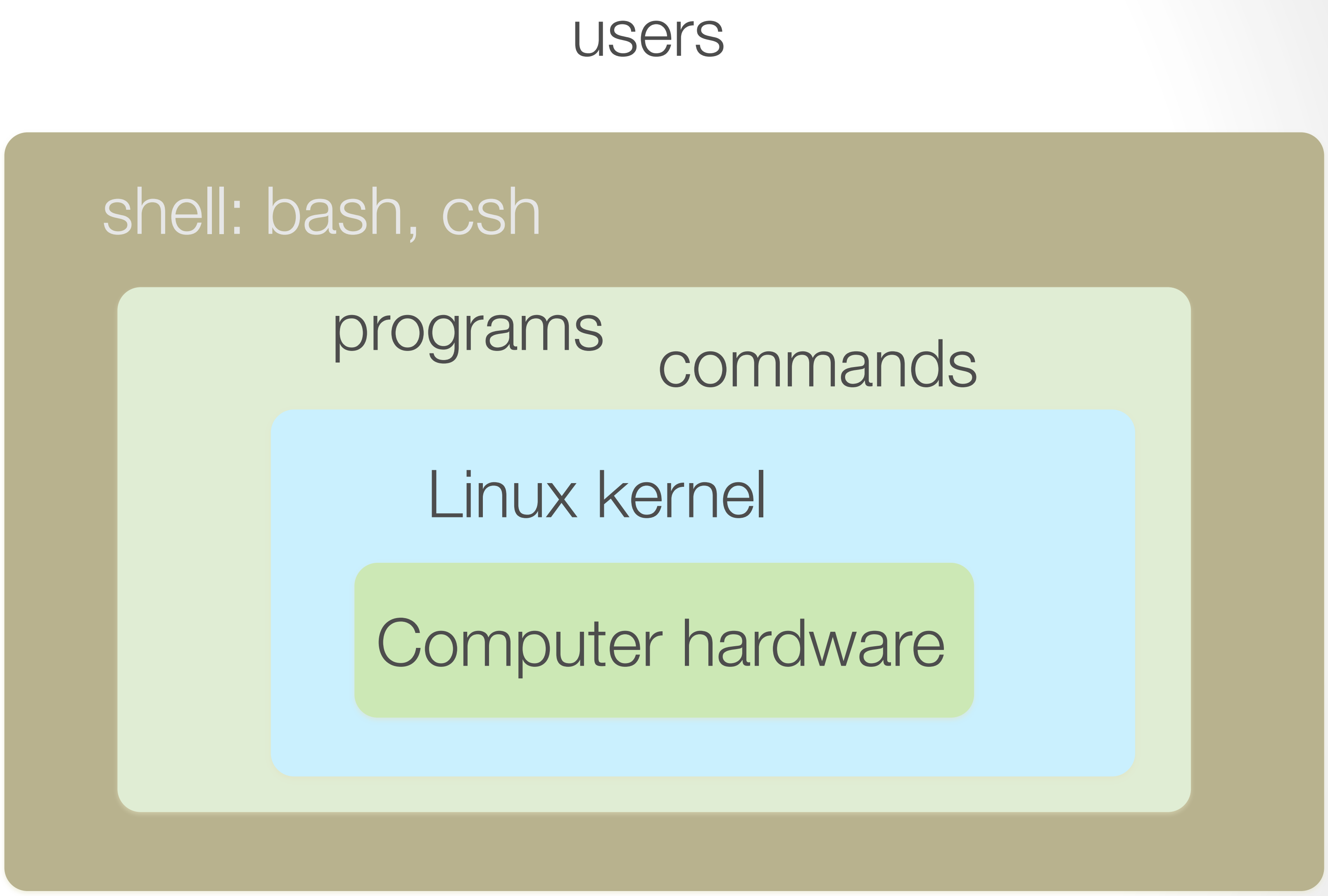


Brian Kernighan
1970
“space travel” to Unix

Dennis Ritchie
1971
C

Richard Stallman
1983
Gnu Not Unix

Linus Torvalds
1991
Linux kernel for personal computers


users
shell: bash, csh
programs
commands
Linux kernel
Computer hardware

How do you log in?

- To a remote system, use Secure Shell (SSH)
- From Windows – GUI app such as PuTTY
- From Linux – ssh on the command line

  ```
  ssh -X username@login.rc.colorado.edu
  ```

- From Mac OS X – ssh from the Terminal, or GUI such as Cyberduck or Fugu

What happens when you log in?

- Login is authenticated (password or key)
- Assigned to a tty
- Shell starts
- Environment is set up
- Prompt

What identifies a Linux user?

- Username / UUID
- Group / GID
- Password (or other authentication info)
- GECOS
- Default shell
- Home directory

Shells

The shell parses and interprets typed input; passes results to the rest of the OS; returns response as appropriate

- Bourne (sh) – early and rudimentary
- Bourne-again (bash) – has many user-friendly extensions; default in Linux
- C (csh) – has C-like syntax
- T (tcsh) – extended version of C
- Korn (ksh) – early extension of Bourne; was heavily used for programming
- Z (zsh) – includes features of bash and tcsh

Shell features

- Tab completion
- History and command-line editing
- Scripting and programming
- Built-in utilities

Environment

- Set up using shell and environment variables
  - shell: only effective in the current shell itself
  - environment: carry forward to subsequent commands or shells
- Set default values at login time using `.bash_profile` (or `.profile`). Non-login interactive shells will read `.bashrc` instead. Use `.my.bashrc` in RC!
- Initialization scripts should not produce output!
- `set var_name[=value]` (shell)
- `export VAR_NAME[=value]` (environment)
- `env` (shows current variables)

Useful variables

- `PATH`: directories to search for commands
- `HOME`: home directory
- `DISPLAY`: screen where graphical output will appear
- `MANPATH`: directories to search for manual pages
- `LANG`: current language encoding
- `PWD`: current working directory
- `USER`: username
- `LD_LIBRARY_PATH`: directories to search for shared objects (dynamically-loaded libs)
- `LM_LICENSE_FILE`: files to search for FlexLM software licenses

Anatomy of a Linux command

- command [flags] [flag arguments] [target(s)]
- `tar -c -f archive.tar mydir`
- Flags do not mean the same thing for different commands
- The same command may have different flags in different kinds of Unix (esp. Linux vs BSD)
- Case is important!
- Order of flags may be important

Most important Linux command

man

```
man <command>
man -k <keyword>
```

File- and directory-related commands

pwd – prints full path to current directory

cd – changes directory; can use full or relative path as target

mkdir – creates a subdirectory in the current directory

rmdir – removes an empty directory

rm – removes a file (`rm –r` removes a directory and all of its contents)

cp – copies a file

mv – moves (or renames) a file

ls – lists the contents of a directory (`ls –l` gives detailed listing)

chmod/chown – change permissions or ownership

df – displays filesystems and their sizes

du – shows disk usage (`du –sk` shows size of a directory and all of its contents in KB)

Process- and program-related commands

ps – lists processes (`ps –ef` lists all running processes)

top – shows processes currently using the CPU

kill – sends a signal to a process (kills process by default). Target is Process-ID; found in 2nd column of `ps –ef` output.

jobs – shows jobs currently in background

time – shows how much wall time and CPU time a process has used

nice – changes the priority of a process to get CPU time

File-viewing commands

less – displays a file one screen at a time

cat – prints entire file to the screen

head – prints the first few lines of a file

tail – prints the last few lines of a file (with –f shows in realtime the end of a file that may be changing)

diff – shows differences between two files

grep – prints lines containing a string or other regular expression

tee – prints the output of a command and also copies the output to a file

sort – sorts lines in a file

find – searches for files that meet specified criteria

wc – count words, lines, or characters in a file

The Linux Filesystem

- System of arranging files on disk
- Consists of directories (folders) that can contain files or other directories
- Levels in full paths separated by *forward* slashes, e.g. /home/nunez/scripts/analyze_data.sh
- Case-sensitive; spaces in names discouraged
- `.`, `..` , and ~ are shorthand.

Much more on this in a future session!

Navigating the filesystem

- Examples:
  - ls
  - mkdir
  - cd
  - rm
- Permissions (modes)

File editing

- **nano** – simple and intuitive to get started with; not powerful; keyboard driven
- **vi/vim** – universal; keyboard driven; powerful but some learning curve required
- **emacs** – keyboard or GUI versions; helpful extensions for programmers; well-documented
- **OpenOffice / LibreOffice** – for WYSIWYG

http://xkcd.com/378/

Processes

- A process is a unique task; it may have threads
- Examples:
  - Foreground vs background   (&)
  - jobs command
  - Ctl-C vs Ctl-Z ; bg
  - kill

More about shells

- Input and output redirection
  - Send output from a command to a new file with `>`
  - Append output to an existing file with `>>`
  - Use a file as input to a command with `<`
- Pipes: `|` sends output of one command to another command

```
  ps -ef | grep ruprech
```

- Quoting – save this for a future session!

Thank you!

A good introductory online tutorial:

http://www.ee.surrey.ac.uk/Teaching/Unix/index.html