Introduction to Linux

Research Computing
UNIVERSITY OF COLORADO **BOULDER**

Be Boulder.

Introduction to Linux

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Slides available for download from

https://github.com/ResearchComputing/CU_DENVER_HPC_2019

Outline

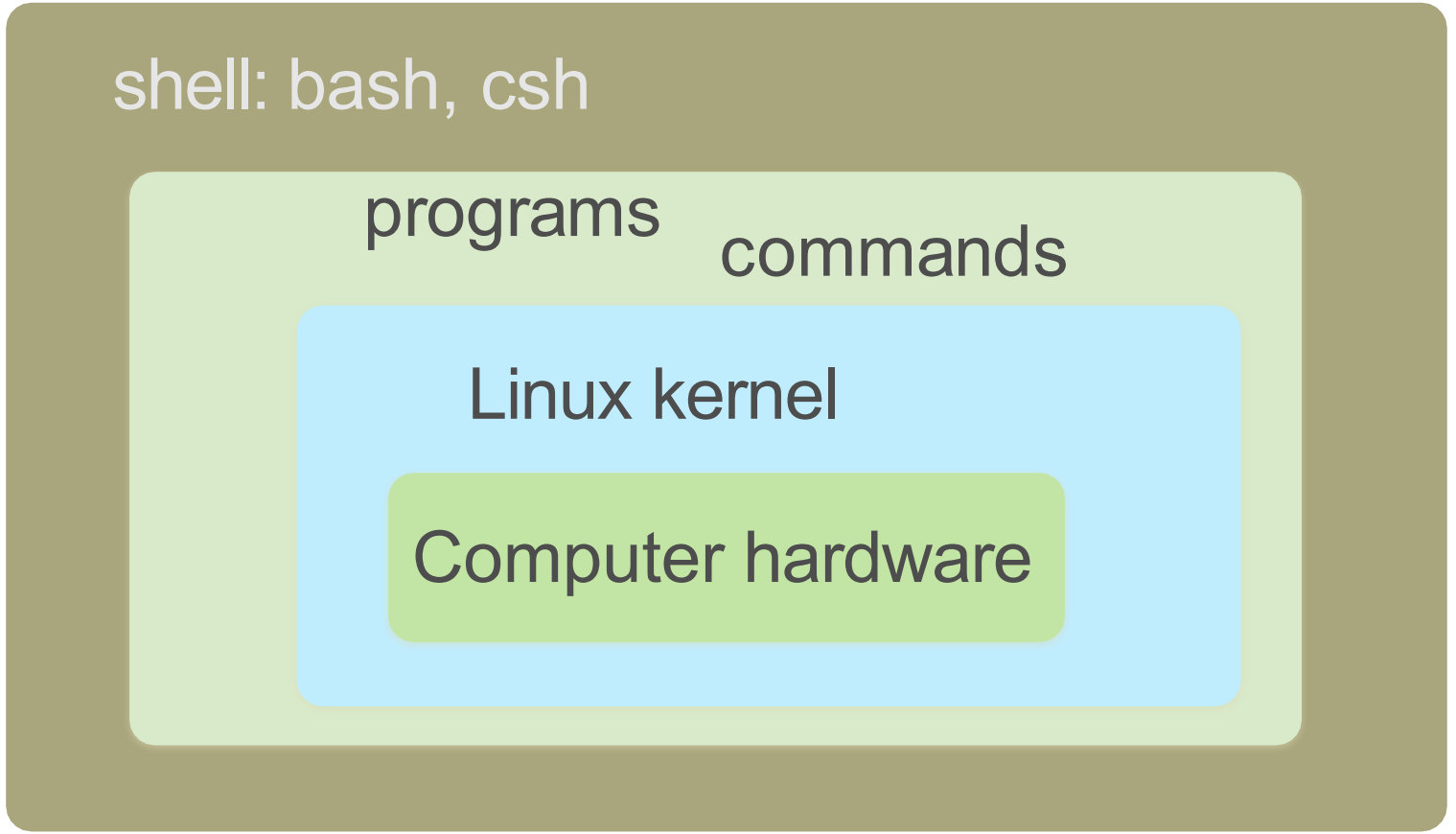
- What is Linux?
- Why use Linux?
- What happens when you log in?
- Commands
- Files / Directories / Filesystems
- Processes
- Shells and environment
- More about shells

- Slides available via http at:
https://github.com/ResearchComputing/CU_DENVER_HPC_2019

What is Linux?

- Part of the Unix family of operating systems.
- Started in early ‘90s by Linus Torvalds.
- Typically refers only to the kernel with software from the GNU project and elsewhere 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.

Users


shell: bash, csh
programs
commands
Linux kernel
Computer hardware

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!

How do you log in?

- To a remote system, use Secure Shell (SSH)

- From Windows – GUI SSH app such as PuTTY
- From Linux, Mac OS X terminal, or Windows GUI such as Cyberduck, PuTTY or Gitbash – ssh on the command line

```
ssh <username>@login.xsede.org
```

- Once you are logged on, type the following:

```
gsissh rmacc-summit
ssh scompile
```

What happens when you log in?

- Login is authenticated (password or key)
- Shell starts
- Environment is set up
- “Message of the Day” prints
- Prompt

What identifies a Linux user?

- Username / UUID
- Group / GID
- Password (or other authentication info)
- Default shell
- Home directory (ie, home "folder" on disk)

Linux commands

- command [flag1] [flag-arg1] [flag2] [flag-arg2] [target(s)]

```
tar -c -f archive.tar mydir
```

- Flags may not mean the same thing when used with different commands
- A flag argument must be paired with it corresponding flag before specifying another flag
- 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

The most import Linux command…

man

Syntax:

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

Examples:

```
man tar
man -k change
```

Example: `ls`

`ls` (list) is a command the lists all contents of the current directory or a directory the user specifies.

- Command syntax: `ls <flag> <flag arguments> <directory>`
- Flags:
  - -l Displays extended information about each file

    ```
    ls -l /home/username
    ```

  - -a Displays hidden files in a given directory

    ```
    ls -a
    ```

Example: ssh

ssh (secure shell) is a command that allows a user to remotely access a linux server.

- Command syntax: `ssh <flag> <flag arguments> <server>`
- Flags:
  - `-X` Allows X-windows to be forwarded back to your local display

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

  - `-o TCPKeepAlive=yes` Sends occasional communication to the SSH server even when you're not typing, so firewalls along the network path won't drop your "idle" connection

```
ssh -o TCPKeepAlive=yes username@login.rc.colorado.edu
```

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 contents)
- `cp` – copies a file
- `mv` – moves (or renames) a file or directory
- `ls` – lists the contents of a directory (`ls -l` gives detailed listing)
- `chmod` – 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 real time 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

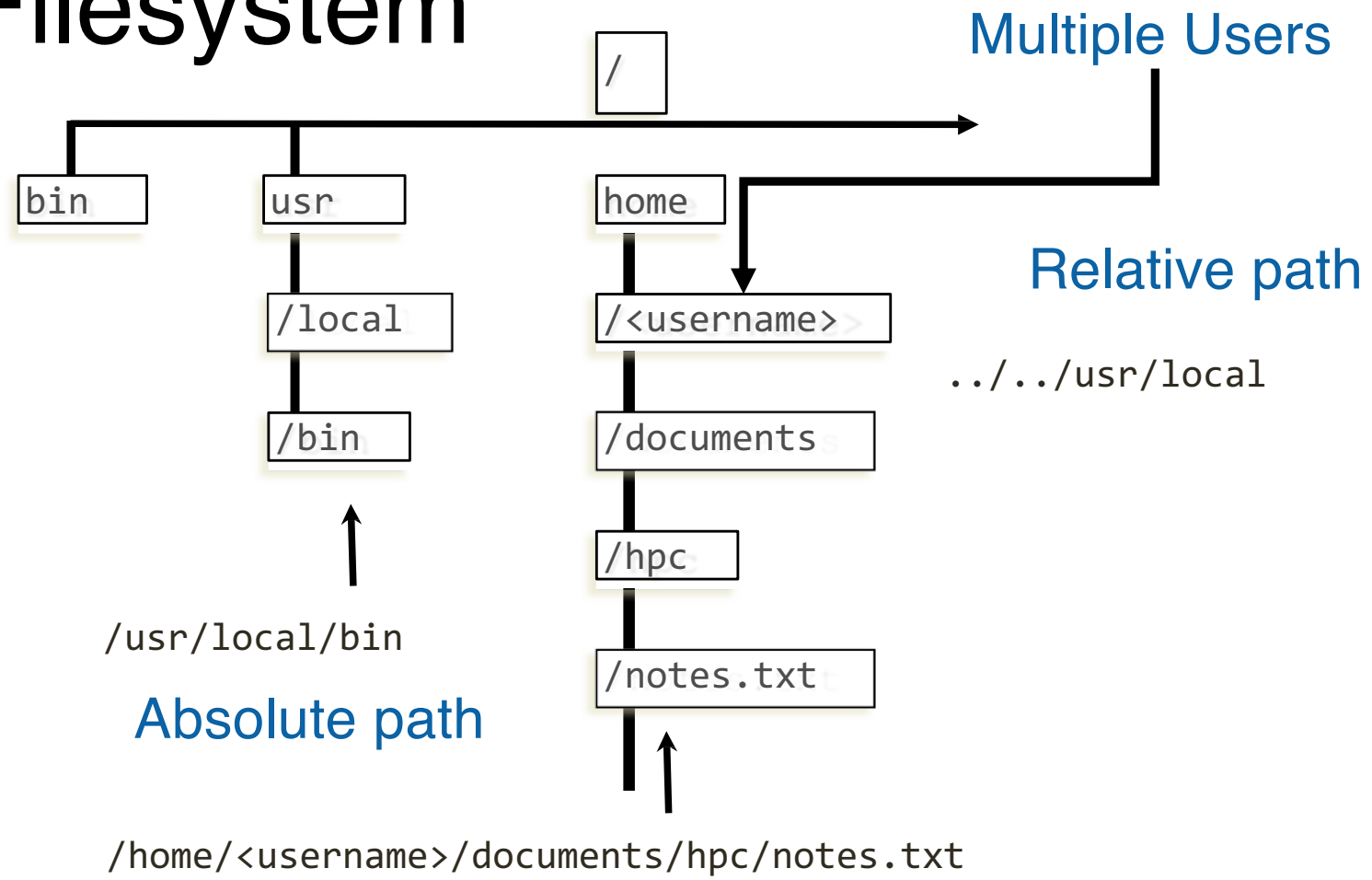
The Linux Filesystem

- 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
- Some shorthand:
- `.` (the current directory)
- `..` (the directory one level above)
- `~` (home directory)
- `-` (previous directory, when used with `cd`)

Filesystem


/
bin
usr
home
/local
/bin
/<username>
/documents
/hpc
/notes.txt
Multiple Users
Relative path
../../usr/local
/usr/local/bin
Absolute path
/home/<username>/documents/hpc/notes.txt

Navigating the filesystem

- Most important commands:
  - `cd <target>` change directory
  - `ls <target>` list directory
  - `pwd` print working directory

Exercise 1

1. Change to your home directory
2. Change to the directory: `CU_DENVER_HPC_2019`
3. Print the path to your current directory
4. Change to the directory: `Linux`
5. Print a "long" listing of the contents of this directory
6. List the contents of the `testdata` directory without changing into that directory
7. Change into the `testdata` directory
8. Change into the `scripts` directory using a single command
9. Change to your home directory and create a new directory (you can pick the name). How can you be sure the new directory is there? Rename the new dir.

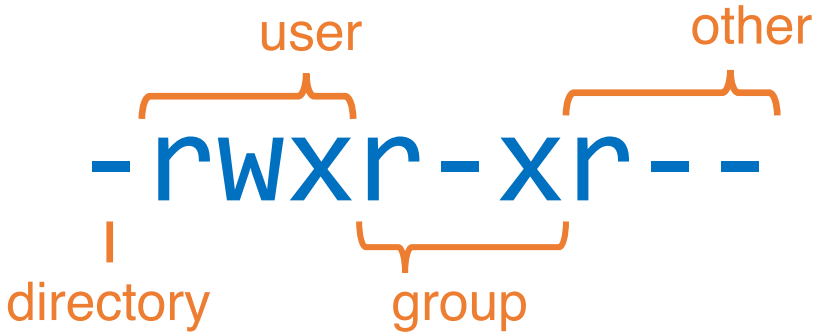
File editing

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

Call any of these on the command line to open the text editor!

Modes (aka permissions)

- View permissions
- 3 classes of users:
  - User (u), *aka "owner"*
  - Group (g)
  - Other (o)
- 3 types of permissions:
  - Read (r)
  - Write (w)
  - Execute (x)



Modes (continued)

The `chmod` commandchanges modes:

- To add write and execute permission for your group:

```
chmod g+wx filename
```

- To remove execute permission for others:

```
chmod o-x filename
```

- To set only read and execute for your group and others:

```
chmod go=rx filename
```

Exercise 2

1. Change directory to `~/Fundamentals_HPC_Summer2019/IntroLinux/scripts`
2. Use `cat` to show the contents of `hello.sh`
3. Try to run `hello.sh` by typing its name at the command line
4. Add execute permission to `hello.sh` using `chmod`
5. Can you run it now?
6. Is there a path issue? What are two ways you could get the script to run?

Processes

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

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 csh
- 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.

`set var_name[=value]`	(shell)
`export VAR_NAME[=value]`	(environment)
`env`	(shows current variables)
`$VAR_NAME`	(refers to value of variable)

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)

Exercise 3

1. Print your current `PATH` and `LD_LIBRARY_PATH` environment variables
2. Type: `which icc`
   …to try to find the path to the Intel C Compiler command
3. Type: `module load intel`
   …to set up your environment to use the Intel compilers
4. Print your current `PATH` and `LD_LIBRARY_PATH` environment variables again. What has changed? What does `which icc` say now? Why?

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 $USER
```

Shell Wildcards and Special Characters

- `*` - matches zero or more characters
- `?` - matches a single character
- `#` - comment; rest of the line is ignored
- `\` - escape; don't interpret the next character

Thank you!

Please fill out the survey! http://tinyurl.com/curc-survey18

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