

Introduction to Linux Basics

Part-I

Georgia Advanced Computing Resource Center

University of Georgia

Zhuofei Hou, HPC Trainer

zhuofei@uga.edu

Outline

- What is GACRC?
- What is Linux?
- Linux Command, Shell and Filesystem Concepts
- Linux Common Commands

What is GACRC?

Who Are We?

- Georgia **A**dvanced **C**omputing **R**esource **C**enter
- Collaboration between the Office of Vice President for Research (**OVPR**) and the Office of the Vice President for Information Technology (**OVPIIT**)
- Guided by a faculty advisory committee (GACRC-AC)

Why Are We Here?

- To provide computing hardware and network infrastructure in support of high-performance computing (**HPC**) at UGA

Where Are We?

- <http://gacrc.uga.edu> (Web) <http://wiki.gacrc.uga.edu> (Wiki)
- https://wiki.gacrc.uga.edu/wiki/Getting_Help (Support)
- <https://blog.gacrc.uga.edu> (Blog) <http://forums.gacrc.uga.edu> (Forums)

GACRC Users September 2015

Colleges & Schools	Depts	PIs	Users
Franklin College of Arts and Sciences	14	117	661
College of Agricultural & Environmental Sciences	9	29	128
College of Engineering	1	12	33
School of Forestry & Natural Resources	1	12	31
College of Veterinary Medicine	4	12	29
College of Public Health	2	8	28
College of Education	2	5	20
Terry College of Business	3	5	10
School of Ecology	1	8	22
School of Public and International Affairs	1	3	3
College of Pharmacy	2	3	5
	40	214	970
Centers & Institutes	9	19	59
TOTALS:	49	233	1029

GACRC Users September 2015

Centers & Institutes	PIs	Users
Center for Applied Isotope Study	1	1
Center for Computational Quantum Chemistry	3	10
Complex Carbohydrate Research Center	6	28
Georgia Genomics Facility	1	5
Institute of Bioinformatics	1	1
Savannah River Ecology Laboratory	3	9
Skidaway Institute of Oceanography	2	2
Center for Family Research	1	1
Carl Vinson Institute of Government	1	2
	19	59

What is Linux?

- What is Operating System (OS)?
- What is Linux OS?
- Brief History of Linux OS
- Why Linux OS?

What is Linux – Operating System

- Operating System (OS) :
 - ✓ Program initially loaded at booting time, to manage all the other application programs on a computer
 - ✓ Software interface between computer hardware and its human user
- Needed for ALL computers to be operated
- Needed to run software and control hardware
- Popular OSes:



What is Linux – Linux OS

- Linux OS is a full-fledged OS with **4** major parts:
 - I. **Kernel**: Low-level OS, handling files, disks, RAM, networking, etc.
 - II. **Supplied Programs**: Web browsing, Audio, Video, DVD burning.....
 - III. **The Shell**: A command-line user interface for a user to type and execute commands:
 - ✓ Bourne Shell (sh)
 - ✓ Korn Shell (ksh)
 - ✓ C Shell (csh)
 - ✓ Bourne-Again Shell (bash) → Linux default shell

} UNIX standard shells
 - IV. **X**: A graphical system providing graphical user interface(GUI)

What is Linux OS – Brief History

- Originally was a **kernel** only, nothing else
- Combined with the various **software** and **compilers** from **GNU Project** to form an OS, called as **GNU/Linux** OS:

Linux Kernel + GNU Components → GNU/Linux OS → Linux OS

- So, *History of Linux = History of Linux Kernel + History of GNU*



What is Linux OS – Brief History of Linux Kernel

- Developed in **1991** by *Linus Torvalds*, a second year student, at the *University of Helsinki, Finland*
- Developed as a clone of **UNIX OS**, which is cheaper, can run on PC, and is **nonproprietary**
- **Linux 0.02** released in 1991 consists of only the kernel and 3 utilities:
 - ✓ Bash : a command-line interface (CLI)
 - ✓ update : a utility to flush file system buffers
 - ✓ gcc : a C++ compiler

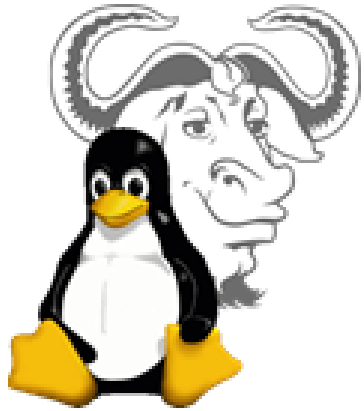


What is Linux OS – Brief History of GNU Project

- Started in **1983** by *Richard Stallman*. Launched in **1984** with a mission to develop a complete **UNIX-like** OS which is **FREE** for copying and modification
- **GNU** means “**GNU's Not Unix**”
- However, **NO** functional kernel developed by GNU itself
- Linux kernel was **the BEST fit** as the kernel for the GNU Project, SO



What is Linux OS – Brief History



- Today, Linux OS is used by millions and available in the form of various Linux distributions:



- Linux is the most used OS on servers:
 - ✓ As of February 2010, **6 out of 10** most reliable web hosting companies
 - ✓ As of November 2014, **485 (97%)** out of top 500 supercomputers
- Linux OS is supported by many big companies, such as IBM, Google, Sun, Novell, Oracle, HP, Dell, etc.

(Data are cited from <http://en.wikipedia.org/wiki/Linux>)

What is Linux OS – Why Linux?

- Viruses FREE
- Very STABLE
- FREE Linux OS
- Never gets slow
- No need to defrag hard disk
- Highest degree to customize user's working environment
- Comes with most of the required software pre-installed
- Update all software with minimum labor

Linux Command, Shell and Filesystem Concepts

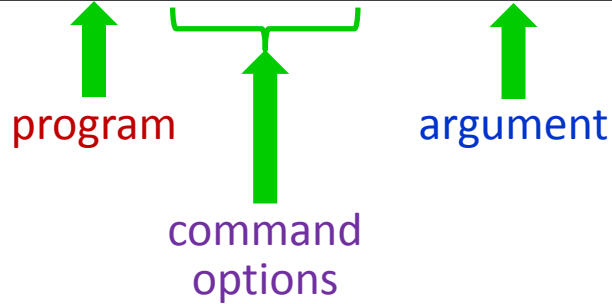
- What is a Command?
- What is a Shell?
- What is Filesystem?

Linux Command, Shell and Filesystem

- What's a Command → A Linux command typically consists of a *program* followed by *command options* and *arguments*, typed within a *shell*:

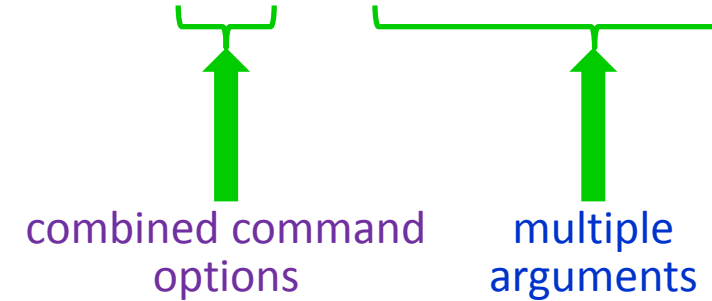
shell prompt

```
$ wc -l -w file1
```



OR

```
$ wc -lw file1 file2
```



Output:

```
15      86      file1
```



```
15      86      file1
100     2104     file2
115     2190     total
```

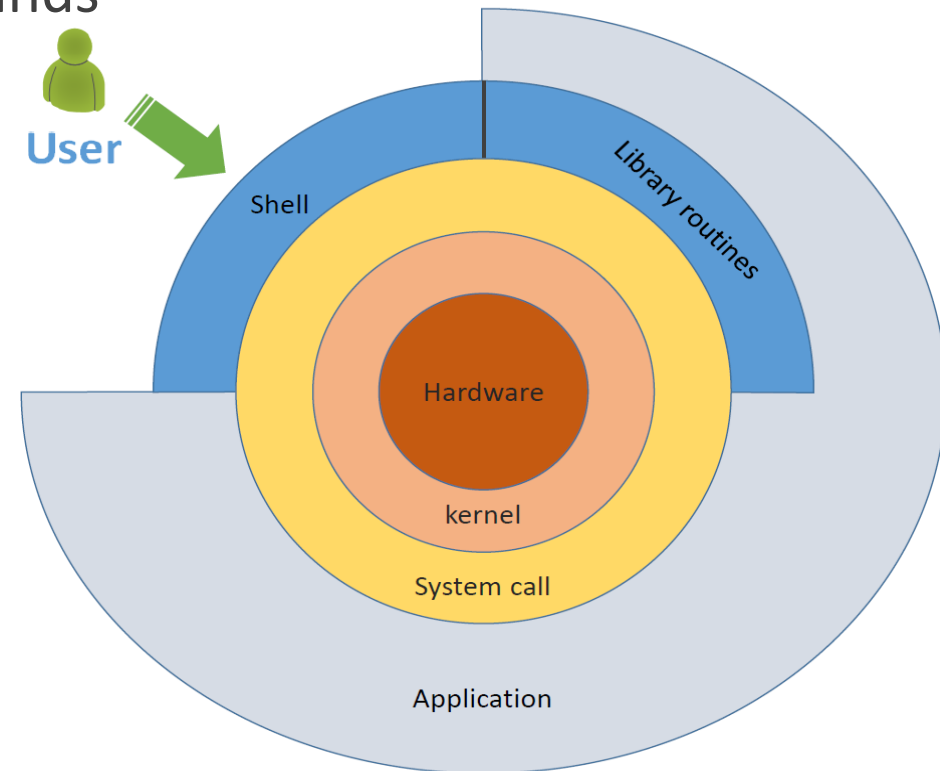
Linux Command, Shell and Filesystem

- What's a Command → A Linux command typically consists of a *program* followed by *command options* and *arguments*, typed within a *shell*:
 - ✓ 3 general formats of *command options*:
 - i. with no value : `wc -l -w`
 - ii. with a value: `blastx -thread 4`
 - iii. combined: `wc -lw`
 - ✓ 5 Tips:
 - i. Linux command is ALWAYS **case sensitive**!
 - ii. Press **TAB** key to autocomplete a command or filename → Auto-completion
 - iii. Press **↑** and **↓** arrow keys to look up previous commands → Command history
 - iv. Press **CTRL+c** to terminate a command
 - v. How to use a command? Use command option `--help`, e.g., `wc --help`
Use `man` command, e.g., `man wc`

Linux Command, Shell and Filesystem

- What's a Shell → A place to type and run commands on a Linux system:
 - ✓ **Command-line user interface** for typing commands
 - ✓ **Command interpreter** to interpret & run commands
 - ✓ **Programming environment** for scripting
- Linux default: **Bourne-Again Shell (bash)**
- To open a shell on:

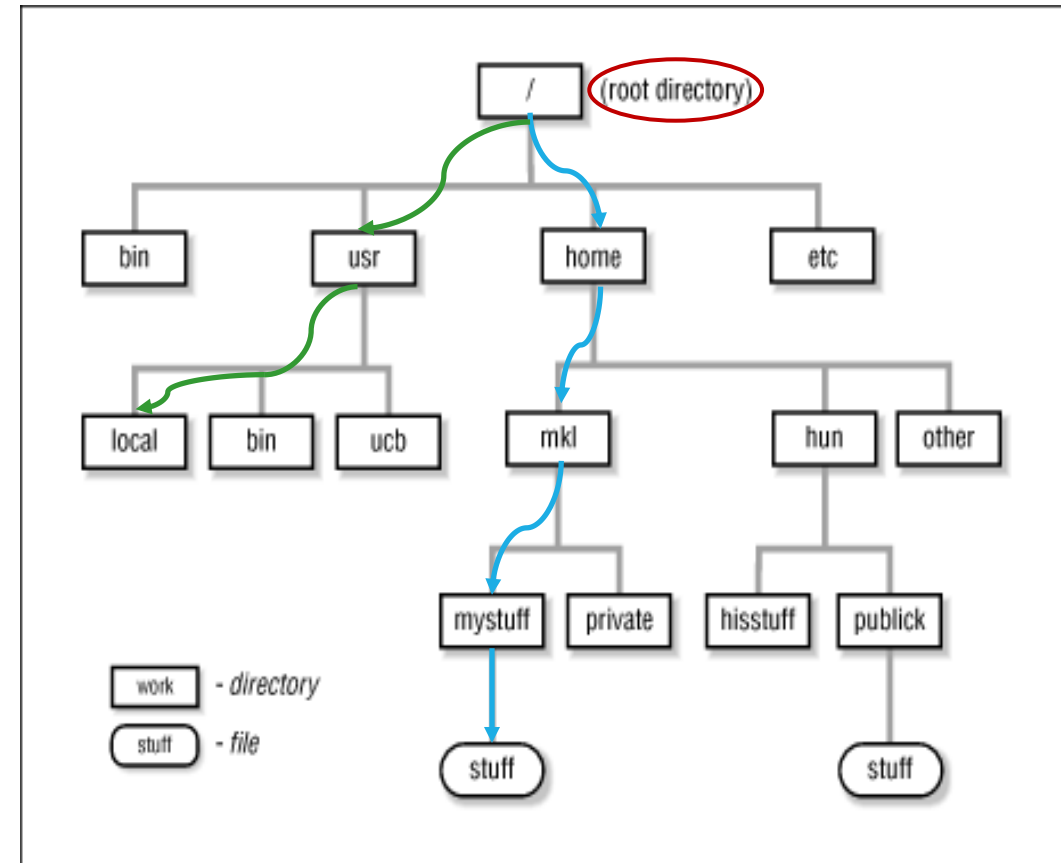
Local Linux/Mac	Terminal (a utility)
Local Windows	Cygwin (a Linux emulation layer)
Remote Linux	a shell will run immediately when log in by SSH Secure Shell Client or PuTTY



Linux Command, Shell and Filesystem

➤ What's Filesystem → A internal data structure that OS uses to organize files on disk:

- ✓ Tree-structured & hierarchical
- ✓ Topmost directory: **root directory (/)**
- ✓ Each directory has one parent(except for /), may contain 0 or more **subdirectories**
- ✓ Files are collected in **directories**
- ✓ Files and directories are accessed by **path**:
path 1: /home/mkl/mystuff/stuff
path 2: /usr/local/
- ✓ A path beginning with /: an **absolute** path



Linux Command, Shell and Filesystem

➤ What's Filesystem → A internal data structure that OS uses to organize files on disk:

✓ Two special directories:

- (a single dot) : your **current** directory
- .. (two dots in a row) : **parent** directory

E.g. If current directory is `/home/mkl`

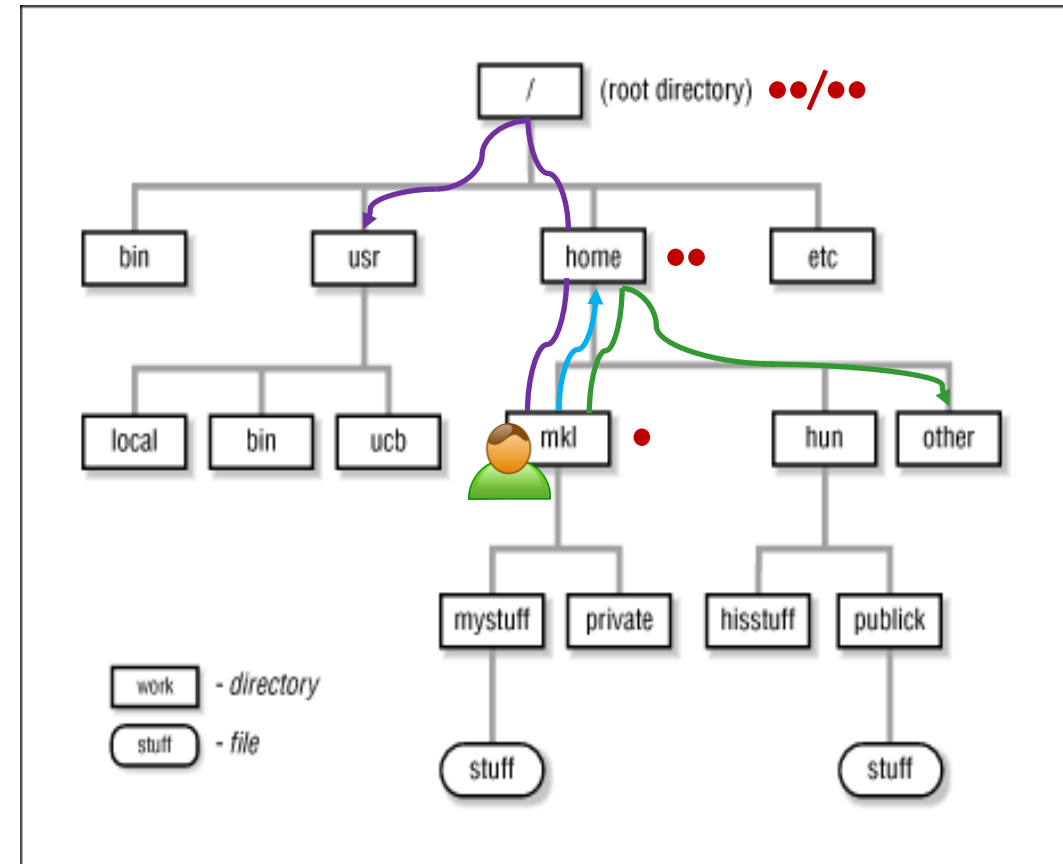
path 1: `go .` = `go /home/mkl`

path 2: `go ..` = `go /home`

path 3: `go ../other` = `go /home/other`

path 4: `go ../../usr` = `go /usr`

✓ A path not beginning with `/`: a **relative** path



Linux Command, Shell and Filesystem

- What's Filesystem → A internal data structure that OS uses to organize files on disk:
 - ✓ Filename naming convention:
 - i. Good characters: A ~ Z or a ~ z, 0 ~ 9, _ (Underscore), . (Period), - (Dash)
 - ii. Bad characters: special characters, e.g., \$, *, ?, /, |, #, &, <, > and **whitespace**
 - iii. Linux filename is ALWAYS **case sensitive**!
 - iv. Not like Windows, **no file extension** needed in Linux!
 - v. Max length of a filename is usually **255** characters
 - ✓ Examples:
 - i. Good: **matrixdata1**, **matric_data_1**, **matrix.data.1**, **_testFile**, **20150720**, etc.
 - ii. Bad: **xy*z**, **x>y**, **\$myfile**, **matrix|data**, **datafile&**, **matrix data**, etc.

Linux Common Commands


- Basic File Operations
- Directory Operations
- File Viewing
- Other



Please do NOT do command practice on Login node of GACRC clusters!

(For more complete list, please refer to GACRC Wiki:
https://wiki.gacrc.uga.edu/wiki/Command_List)

Linux Common Commands – Basic File Operations

- `ls` : List files and subdirectories in a directory
- `cp` : Copy a file into another or a directory
- `mv` : Rename or move a file into a directory
- `rm` : Remove a file 

Linux Common Commands – Basic File Operations

➤ `ls` : List files and subdirectories in a directory

`ls -l` List files with a long information listing

`ls -a` List all files, including *hidden configuration files*, whose names begin with a dot, called as “*dot files*”

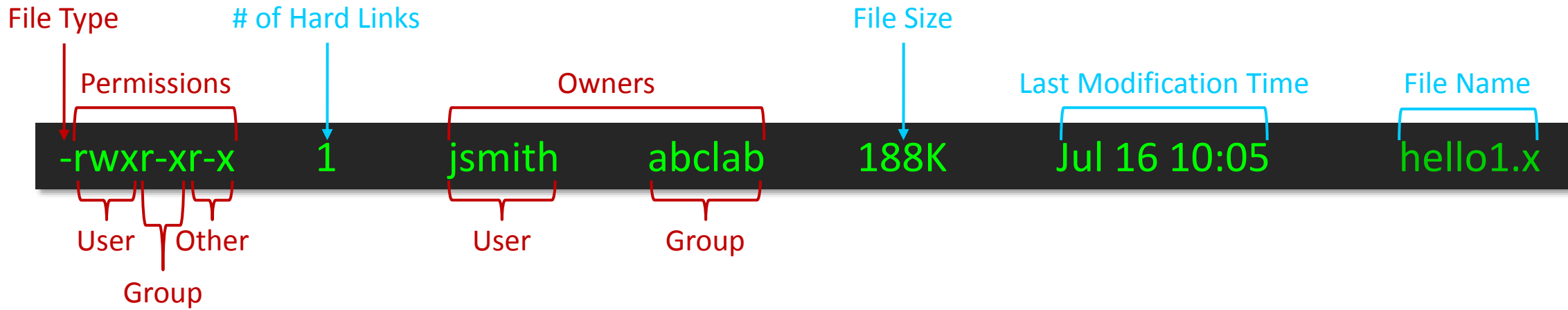
`ls -h` List files with sizes in human readable format

`ls -lh` Combination of -l and -h

```
zcluster$ ls -lha
-rw-r--r--  1 jsmith  abclab   336   Jul 16 10:06  .bashrc  ← dot file
drwxr-xr-x  2 jsmith  abclab  4.0K   Jul 16 10:05  data     ← subdirectory
-rw-----  1 jsmith  abclab   402   Jul 16 10:05  hello1.c ← C source code
-rwxr-xr-x  1 jsmith  abclab  188K   Jul 16 10:05  hello1.x ← C binary
-rw-r--r--  1 jsmith  abclab   252   Jul 16 10:05  README  ← readme file
-rw-r--r--  1 jsmith  abclab   131   Jul 16 10:05  sub1.sh  ← shell script
```



Linux Common Commands – Basic File Operations



File Type: `-` for Regular File `d` for Directory
 Permissions: `r` for Read (4) `w` for Write (2) `x` for Execute (1)

To change permissions:
`chmod` command

User: $(r+w+x)=7$ Group: $(r+x)=5$ Other: $(r+x)=5$ \rightarrow `hello1.x` is a regular file with permissions of `755`

Linux Common Commands – Basic File Operations

- `cp` : Copy a file into another or a directory

<code>cp file1 file2</code>	Copy a file into another
-----------------------------	--------------------------

<code>cp file directory</code>	Copy a file into a directory
--------------------------------	------------------------------

<code>cp -i file1 file2</code>	Copy with interactive mode, ask before overwriting
--------------------------------	----------------------------------------------------

```
zcluster$ cp hello1.c hello2.c
```

← `hello2.c` is a new file copied from `hello1.c`

```
zcluster$ cp hello1.c ./data
```

← `./data` is a subdirectory

```
zcluster$ cp -i hello1.c hello2.c
cp: overwrite `hello2.c'? n
zcluster$
```

← interactive mode is always safe!

Linux Common Commands – Basic File Operations

- **mv** : Rename or move a file into a directory

<code>mv file1 file2</code>	Rename a file
-----------------------------	---------------

<code>mv file directory</code>	Move a file into a directory
--------------------------------	------------------------------

<code>mv -i file1 file2</code>	Move with interactive mode, ask before overwriting
--------------------------------	----------------------------------------------------

```
zcluster$ mv hello1.c hello2.c
```

← **hello2.c** is the file renamed from **hello1.c**

```
zcluster$ mv hello1.c ./data
```

← **./data** is a subdirectory

```
zcluster$ mv -i hello1.c hello2.c
mv: overwrite `hello2.c'? n
zcluster$
```

← interactive mode is always safe!

Linux Common Commands – Basic File Operations

- `rm` : Remove a file 

<code>rm file</code>	Remove a file
----------------------	---------------

<code>rm -i file</code>	Remove with interactive mode, ask before deleting a file
-------------------------	----------------------------------------------------------


```
zcluster$ rm hello2.c
```

← `hello2.c` is removed from current directory

```
zcluster$ rm -i hello2.c
rm: remove regular file `hello2.c'? n
zcluster$
```

← interactive mode is always safe!

Linux Common Commands – Directory Operations

- `cd` : Change your current working directory
- `pwd` : Print absolute path of your current working directory
- `mkdir` : Create a directory
- `rmdir` : Delete an empty directory
- `rm -r` : Delete a nonempty directory and its contents 

Linux Common Commands – Directory Operations

- `cd` : Change your current working directory

`cd dirname` Change to the `dirname` directory

`zcluster$ cd ./date` ← change to a subdirectory `./date`

`zcluster$ cd ..` ← change to parent directory

`zcluster$ cd ~/test` ← change to a subdirectory `./test` in home directory (`~`)

`zcluster$ cd /home/abclab/jsmith/test` ← an absolute path is used!

- `pwd` : Print absolute path of your current working directory

`zcluster$ pwd`
`/home/abclab/jsmith/test/data` ← an absolute path is printed!

Linux Common Commands – Directory Operations

- `mkdir` : Create a directory

`mkdir dirname` Make a directory with the name of `dirname`

`zcluster$ mkdir data1` ← Create a subdirectory in current working directory

- `rmdir` : Delete an empty directory

`rmdir dirname` Remove an empty directory

`zcluster$ rmdir data1` ← data1 is an empty directory!

- `rm -r` : Delete a nonempty directory and its contents 

`rmdir -ri dirname` Remove with interactive mode, ask before removing

`zcluster$ rm -ri data1` ← interactive mode is always safe!

Linux Common Commands – File Viewing

- `cat` : Print files to standard output, concatenating them
- `less` : View text files, one screen at a time, scroll down/up
- `more` : View text files, one screen at a time, scroll down only

Linux Common Commands – File Viewing

- `cat` : Print files to standard output, concatenating them

```
cat file
```

Print contents of file1 to standard output

```
cat file1 file2
```

Print contents of files to standard output, concatenating them

```
zcluster$ cat file1
```

← print contents of `file1`

```
Hello, this is file1.
```

```
zcluster$ cat file2
```

← print contents of `file2`

```
Hello, this is file2.
```

```
zcluster $ cat file1 file2
```

← print contents of `file1` and `file2` with concatenation

```
Hello, this is file1.
```

```
Hello, this is file2.
```


Linux Common Commands – File Viewing

- `less` : View text files, one screen at a time, scroll down and up

`less file`

View text one “page” at a time, *spacebar* to scroll down, key *b* to scroll up, key *q* to quit

```
zcluster$ less file1
```

- `more` : View text files, one screen at a time, scroll down only

`more file`

View text one “page” at a time, *spacebar* to scroll down,

```
zcluster$ more file1
```

Linux Common Commands – Other

- `file` : Determine the type of a file
- `dos2unix` : Convert DOS/Windows file to Linux format
- `mac2unix` : Convert Mac file to Linux format

Linux Common Commands – Other

- `file` : Report the type of a file

```
file file1
```

```
Report the type of the file file1
```

```
zcluster$ file data                ← directory ./data
data: directory
zcluster$ file hello1.c            ← programming language source file hello1.c
hello1.c: ASCII C program text
zcluster$ file hello1.x            ← executable file hello1.x
hello1.x: ELF 64-bit LSB executable, AMD x86-64, version 1 (SYSV), for GNU/Linux 2.6.9,
dynamically linked (uses shared libs), not stripped
zcluster$ file README              ← ASCII text file README
README: ASCII text
zcluster$ file sub1.sh             ← shell script sub1.sh
sub1.sh: Bourne-Again shell script text executable
```

Linux Common Commands – Other

- `dos2unix` : Convert DOS/Windows file to Linux format

`dos2unix file1` Removes DOS/Windows line endings in file1

```
zcluster$ dos2unix file1
```

- `mac2unix` : Convert Mac file to Linux format

`mac2unix file1` Removes Mac line endings in file1

```
zcluster$ mac2unix file1
```

Thank You!

A solid blue horizontal bar spans the entire width of the slide at the bottom.