GACRC

Introduction to Linux Basics

Part-I

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Outline

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

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What is GACRC?

Who Are We?

- **G**eorgia **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 (**OVPIT**)
- 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**

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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)

    } UNIX standard shells

    - ✓ Bourne-Again Shell (bash) → Linux default shell

  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*

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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

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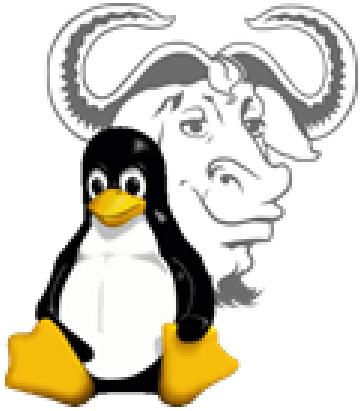
What is Linux OS – Brief History of GNU Project

- 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:

redhat fedora debian ubuntu SUSE

- 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*)

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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

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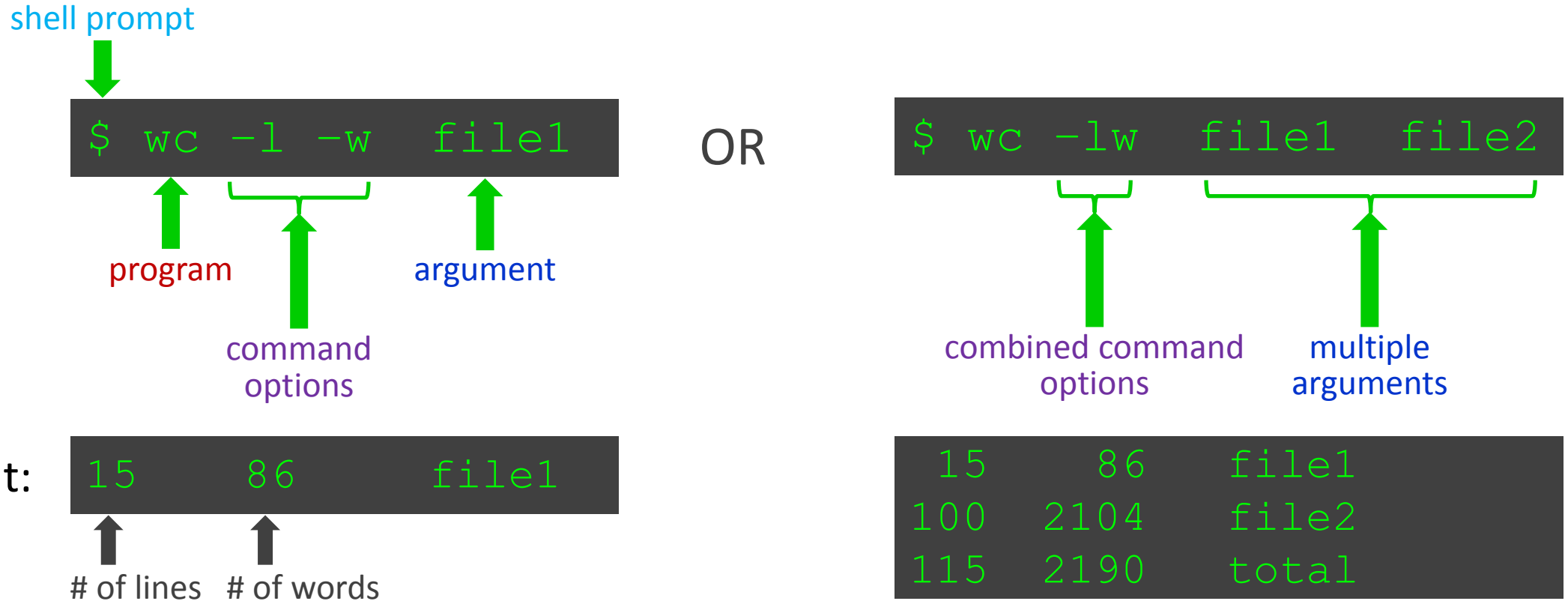
Linux Command, Shell and Filesystem Concepts

- 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*:



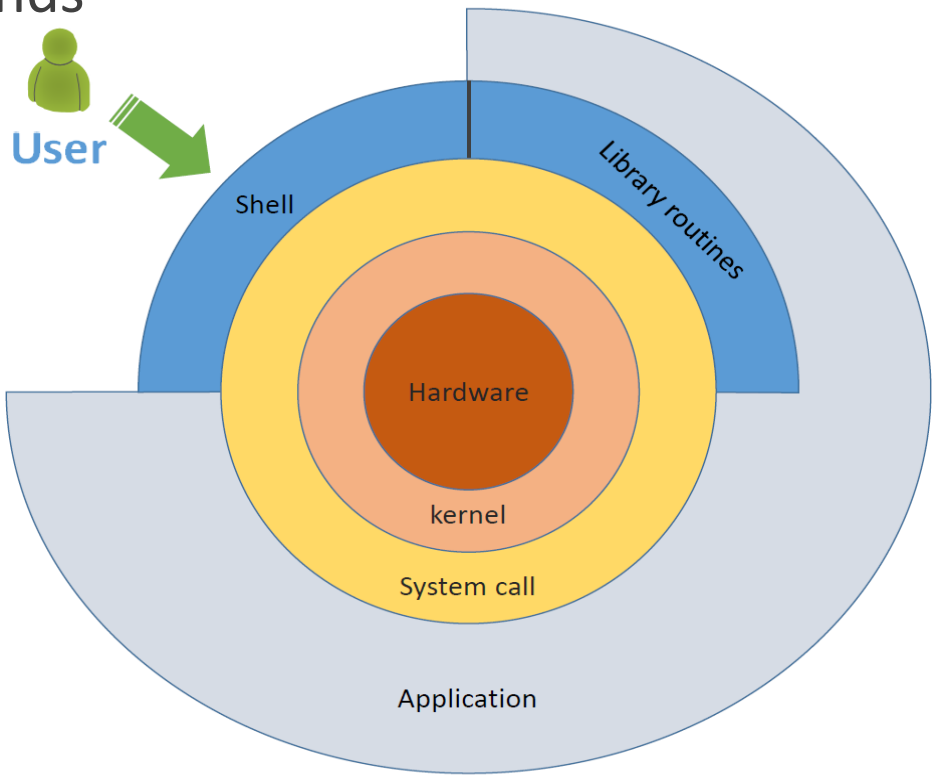
Linux Command, Shell and Filesystem

- 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	shell window	Terminal
Local windows	shell window	Cygwin
Remote Linux machine	a shell will run immediately when log in	

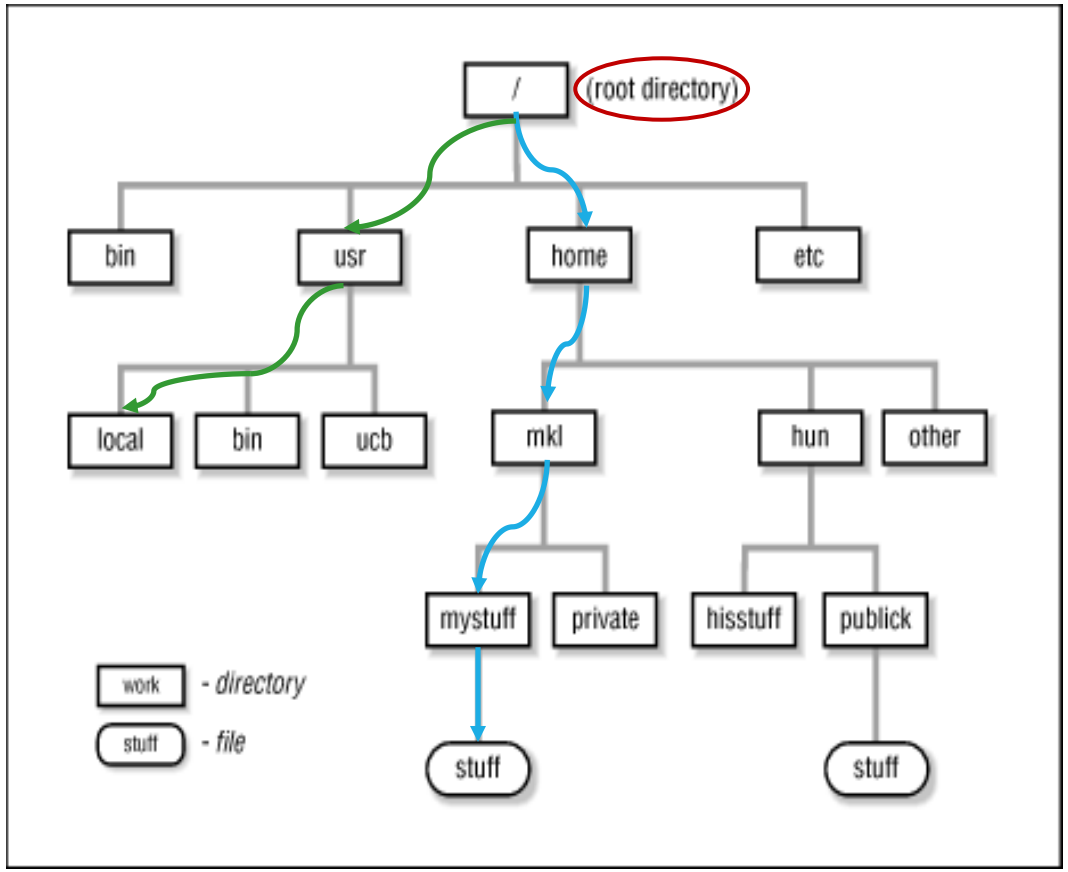


Linux Command, Shell and Filesystem

- 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

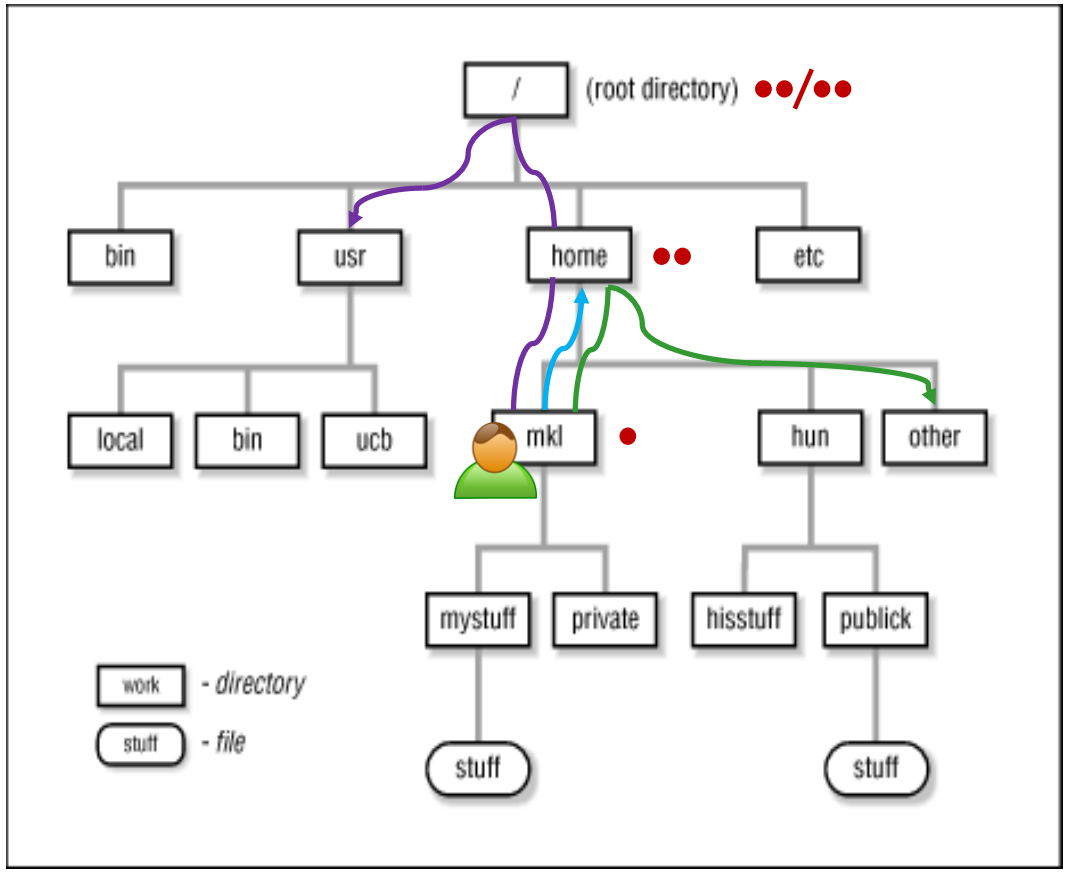
    E.g. If current directory is /home/mkl

    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 

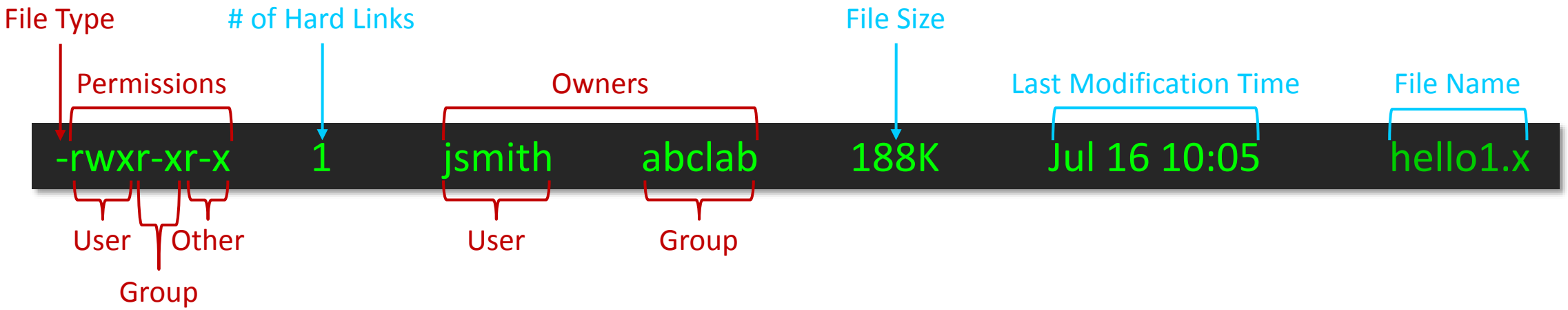
Linux Common Commands – Basic File Operations

- `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

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

`cp file1 file2`	Copy a file into another
`cp file directory`	Copy a file into a directory
`cp -i file1 file2`	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

`mv file1 file2`	Rename a file
`mv file directory`	Move a file into a directory
`mv -i file1 file2`	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 

`rm file`	Remove a file
`rm -i file`	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 ./data
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
```

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Thank You!