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
What is GACRC?

Who Are We?
- Georgia Advanced Computing Resource Center
- 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](http://gacrc.uga.edu) (Web)
- [http://wiki.gacrc.uga.edu](http://wiki.gacrc.uga.edu) (Wiki)
- [https://wiki.gacrc.uga.edu/wiki/Getting_Help](https://wiki.gacrc.uga.edu/wiki/Getting_Help) (Support)
- [https://blog.gacrc.uga.edu](https://blog.gacrc.uga.edu) (Blog)
- [http://forums.gacrc.uga.edu](http://forums.gacrc.uga.edu) (Forums)
# GACRC Users September 2015

<table>
<thead>
<tr>
<th>Colleges &amp; Schools</th>
<th>Depts</th>
<th>PIs</th>
<th>Users</th>
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</thead>
<tbody>
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<td>Franklin College of Arts and Sciences</td>
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<td>117</td>
<td>661</td>
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<tr>
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<td>9</td>
<td>29</td>
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<td><strong>Centers &amp; Institutes</strong></td>
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<td><strong>TOTALS:</strong></td>
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<tr>
<td>Centers &amp; Institutes</td>
<td>PIs</td>
<td>Users</td>
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<td></td>
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<tr>
<td>Center for Computational Quantum Chemistry</td>
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<td>Complex Carbohydrate Research Center</td>
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<td>Georgia Genomics Facility</td>
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<tr>
<td>Institute of Bioinformatics</td>
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<tr>
<td>Savannah River Ecology Laboratory</td>
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<td></td>
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<tr>
<td>Carl Vinson Institute of Government</td>
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<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>19</strong></td>
<td><strong>59</strong></td>
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</table>
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
  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?
What’s a Command ➔ A Linux command typically consists of a program followed by command options and arguments, typed within a shell:

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

OR

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

Output:

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

# of lines  # of words
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:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Linux/Mac</td>
<td><strong>Terminal</strong> (a utility)</td>
</tr>
<tr>
<td>Local Windows</td>
<td><strong>Cygwin</strong> (a Linux emulation layer)</td>
</tr>
<tr>
<td>Remote Linux</td>
<td>a shell will run immediately when log in by <strong>SSH Secure Shell Client</strong> or <strong>PuTTY</strong></td>
</tr>
</tbody>
</table>
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
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

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

Please do NOT do command practice on Login node of GACRC clusters!
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
-drw-xr-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
-rw------- 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
```
<table>
<thead>
<tr>
<th>File Name</th>
<th>File Type</th>
<th>Permissions</th>
<th>User</th>
<th>Group</th>
<th>Other</th>
<th># of Hard Links</th>
<th>File Size</th>
<th>Last Modification Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>hello1.x</td>
<td>-rw-r-xr-x</td>
<td>755</td>
<td>jsmith</td>
<td>abclab</td>
<td></td>
<td>1</td>
<td>188K</td>
<td>Jul 16 10:05</td>
</tr>
</tbody>
</table>

**File Type:**
- `r` for Regular File
- `d` for Directory

**Permissions:**
- `r` for Read (4)
- `w` for Write (2)
- `x` for Execute (1)

**User:** (r+w+x)=7

**Group:** (r+x)=5

**Other:** (r+x)=5

*To change permissions:* `chmod` command

*hello1.x* is a regular file with permissions of **755**
# Linux Common Commands – Basic File Operations

- **\( \text{cp} \)**: Copy a file into another or a directory

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>cp file1 file2</code></td>
<td>Copy a file into another</td>
</tr>
<tr>
<td><code>cp file directory</code></td>
<td>Copy a file into a directory</td>
</tr>
<tr>
<td><code>cp -i file1 file2</code></td>
<td>Copy with interactive mode, ask before overwriting</td>
</tr>
</tbody>
</table>

```bash
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  # interactive mode is always safe!
```


Linux Common Commands – Basic File Operations

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

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>mv file1 file2</code></td>
<td>Rename a file</td>
</tr>
<tr>
<td><code>mv file directory</code></td>
<td>Move a file into a directory</td>
</tr>
<tr>
<td><code>mv -i file1 file2</code></td>
<td>Move with interactive mode, ask before overwriting</td>
</tr>
</tbody>
</table>

  ```
  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  ➜ 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
  ➔ 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
  
<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>cd dirname</code></td>
<td>Change to the dirname directory</td>
</tr>
</tbody>
</table>

- **pwd**: Print absolute path of your current working directory
  
<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>pwd</code></td>
<td>an absolute path is printed!</td>
</tr>
</tbody>
</table>

Examples:

- `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!
## Linux Common Commands – Directory Operations

- **mkdir**: Create a directory
  
  **Syntax**: `mkdir dirname`

  **Example**: `zcluster$ mkdir data1`

- **rmdir**: Delete an empty directory
  
  **Syntax**: `rmdir dirname`

  **Example**: `zcluster$ rmdir data1`

- **rm -r**: Delete a nonempty directory and its contents
  
  **Syntax**: `rm -ri dirname`

  **Example**: `zcluster$ rm -ri data1`
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

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>cat file</code></td>
<td>Print contents of file1 to standard output</td>
</tr>
<tr>
<td><code>cat file1 file2</code></td>
<td>Print contents of files to standard output, concatenating them</td>
</tr>
</tbody>
</table>

```
zcluster$ cat file1
Hello, this is file1.
zcluster$ cat file2
Hello, this is file2.
zcluster $ cat file1 file2
Hello, this is file1. Hello, this is file2.
```

- `cat`: Print contents of `file1` and `file2` with concatenation
# 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

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>file file1</code></td>
<td>Report the type of the file file1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Directory</th>
<th><code>./data</code></th>
<th><code>./data</code>: directory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language source file</td>
<td><code>hello1.c</code></td>
<td><code>hello1.c</code>: ASCII C program text</td>
</tr>
<tr>
<td>Executable file</td>
<td><code>hello1.x</code></td>
<td><code>hello1.x</code>: ELF 64-bit LSB executable, AMD x86-64, version 1 (SYSV), for GNU/Linux 2.6.9, dynamically linked (uses shared libs), not stripped</td>
</tr>
<tr>
<td>ASCII text file</td>
<td><code>README</code></td>
<td><code>README</code>: ASCII text</td>
</tr>
<tr>
<td>Shell script</td>
<td><code>sub1.sh</code></td>
<td><code>sub1.sh</code>: Bourne-Again shell script text executable</td>
</tr>
</tbody>
</table>
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!