Linux System Administration

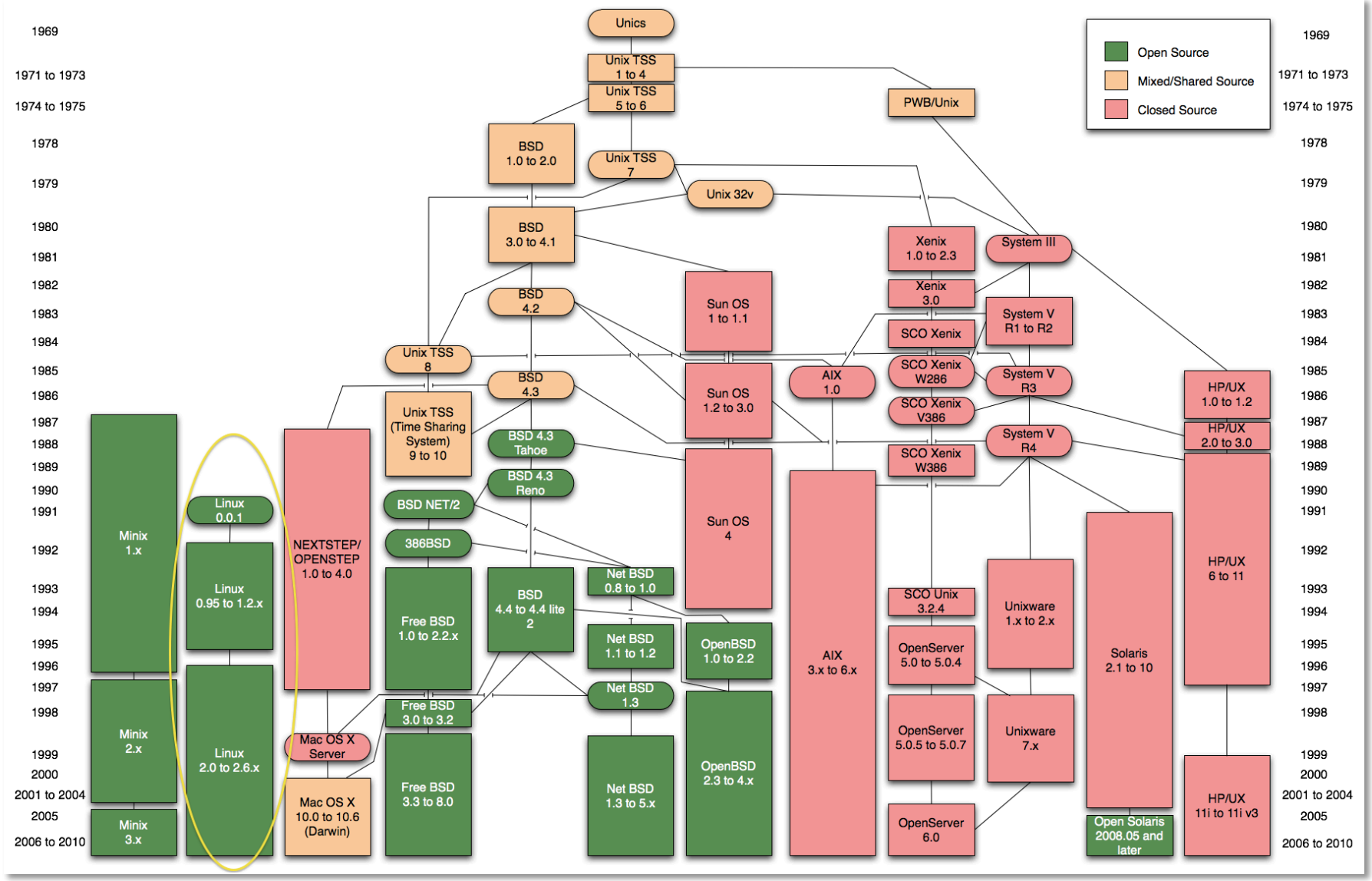
Getting started with Linux

Modules

1. Linux overview
2. Command Line Interface or the “CLI”
3. Permissions
4. Editors
5. Ubuntu Linux and more commands

Module 1: Linux Overview

UNIX History



Unix vs. Linux

Are they the same?

- Yes, at least in terms of operating system interfaces
- Linux was developed independently from Unix
- Unix is much older (1969 vs. 1991)

Scalability and reliability

- Both scale very well and work well under heavy load (this is an understatement)

Flexibility

- Both emphasize small, interchangeable components

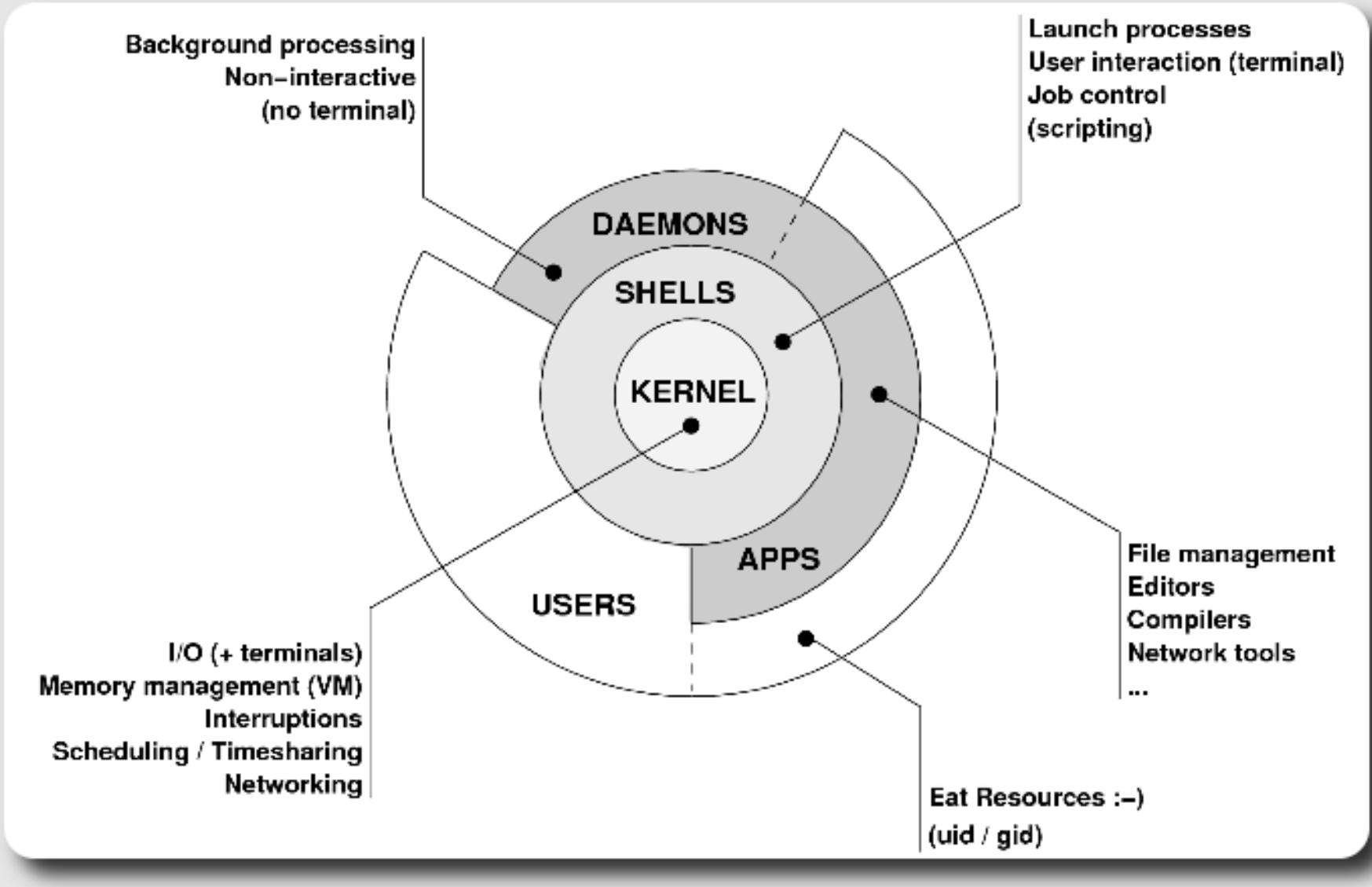
Manageability

- Remote logins rather than GUI
- Scripting is integral

Security

- Due to modular design has a reasonable security model
- Linux and its applications are not without blame

The Unix/Linux System



Kernel

The "core" of the operating system

Device drivers

- communicate with your hardware
- block devices, character devices, network devices, pseudo devices (/dev/null)

Filesystems

- organize block devices into files and directories

Memory management

Timeslicing (multitasking)

Networking stacks - esp. TCP/IP

Enforces security model

Shells

Command line interface for executing programs

- Windows equivalent: command.com or command.exe

Also programming languages for scripting

- DOS/Windows equivalent: batch files, WSF, VBScript

Choice of similar but slightly different shells

- **sh:** the "Bourne Shell". Standardised in POSIX
- **csh:** the "C Shell". Not standard, but includes command history
- **bash:** the "Bourne-Again Shell". Combines POSIX standard with command history.
- Others: **ksh**, **tcsh**, **zsh**

User processes

- The programs that you choose to run
- Frequently-used programs tend to have short cryptic names
  - "**`ls`**" = list files
  - "**`cp`**" = copy file
  - "**`rm`**" = remove (delete) file
- Lots of stuff included in most base systems
  - editors, compilers, system admin tools
- Lots more stuff available to install too
  - Using the Debian/Ubuntu repositories

System processes

Programs that run in the background; also known as "daemons" ==>  *

Examples:

- **cron**: executes programs at certain times of day
- **syslogd**: takes log messages and writes them to files
- **inetd**: accepts incoming TCP/IP connections and starts programs for each one
- **sshd**: accepts incoming logins
- **sendmail** (or other MTA daemon like Postfix): accepts incoming mail

* ”Sparky” from the FreeBSD world

Security model

Numeric IDs

user id (uid 0 = "*root*", the superuser)
group id
supplementary groups

Mapped to names

/etc/passwd, /etc/group (plain text files)

Suitable security rules enforced

e.g. you cannot kill a process running as a different user,
unless you are "*root*"

Filesystem security

Each file and directory has three sets of permissions

- For the file's uid (user)
- For the file's gid (group)
- For everyone else (other)

Each set of permissions has three bits: **rwx**

- File: **r**=read, **w**=write, **x**=execute
- Directory: **r**=list directory contents, **w**=create/delete files within this directory, **x**=enter directory (e**x**ecutable)

Filesystem security

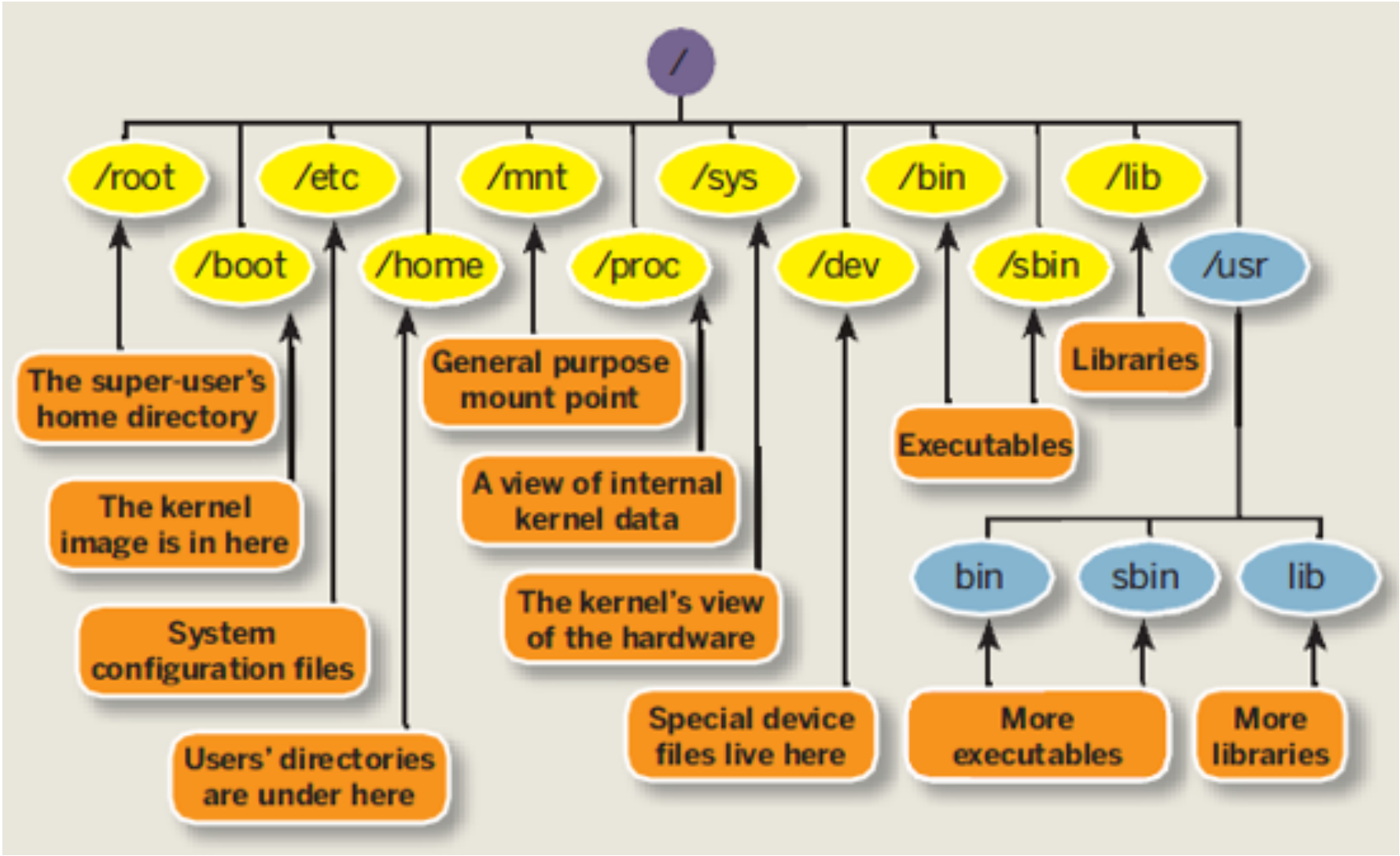
The permission flags are read as follows left to right:

`-rw-r--r--`	for regular files,
`drwxr-xr-x`	for directories

We will see permissions in detail later in the day.

Any questions?

Sample Linux File System



http://www.tuxradar.com/content/take-linux-filesystem-tour

Standard filesystem layout

/bin	essential binaries
/boot	kernel and boot support
/dev	device access nodes
/proc	pseudo-filesystem with config/system info
/etc	configuration data
/etc/default	package startup defaults
/etc/init.d	startup scripts
/home/*username*	user's "home" directory
/lib	essential libraries
/sbin	essential sysadmin tools
/tmp	temporary files
/usr	programs & appl. data
/var	changing files (logs, E-mail messages, queues, …)

Don't confuse the the "root account" (/root) with the "root" ("/") partition.

Log file: who & what's doing what

The most critical place to solve problems

- System messages, including:
  - Problems
  - Security issues
  - Configuration errors
  - Access issues
- Service messages, including:
  - Same as above

When something does not work…

…Look in your log files first!

Log files (a few examples)

```
/var
   /var/log
   /var/log/apache2
   /var/log/apache2/access.log
   /var/log/apache3/error.log
   /var/log/auth.log
   /var/log/boot.log
   /var/log/dmesg
   /var/log/kern.log
   /var/log/mail.info
   /var/log/mail.err
   /var/log/mail.log
   /var/log/messages
   /var/log/mysql
   /var/log/syslog
```

How Does Linux boot?

- The *BIOS* loads and runs the *MBR*:
  - The ***M**aster **B**oot **R**ecord* points to a default partition, or lets you select the boot partition
- MBR code then loads the boot loader, such as GRUB
- Boot loader reads configuration parameters (/boot) presents the user with options on how to boot system
- kernel is loaded and started, filesystems are mounted, modules are loaded
- init(8) process is started
- system daemons are started

http://en.wikipedia.org/wiki/Linux_startup_process

Any questions?

?

Packages & Exercises

We'll reinforce some of these concepts using exercises...

Right now please connect to your virtual Linux machine using SSH. Your instructor and workshop assistants will assist you with this:

- Windows ssh client available at
  http://noc.ws.nsrc.org/downloads/putty.exe
- ssh sysadm@pcX.ws.nsrc.org
  - User: *sysadm*
  - Host: *pcX.ws.nsrc.org*
- Accept the SSH key when asked
- Use password given in class
- `# exit`

Packages & Exercises

We'll run a few commands to get started:

- `ls` (list files / directories)
- `pwd` (current working directory)
- `man man` (manual or help)
- …
- …
- …

Module 2: Command Line Interface

The format of a command

```
command [options] parameters
```

“Traditionally, UNIX command-line options consist of a dash, followed by one or more lowercase letters. The GNU utilities added a double-dash, followed by a complete word or compound word.”

Two very typical examples are:

`-h`

`--help`

and

`-v`

`--version`

Command parameters

The ***parameter*** is what the command ***acts on***.

Often there are multiple parameters.

In Unix UPPERCASE and lowercase for both options and parameters matter.

Spaces ___ are ___ critical ___ .

"`-- help`" is wrong.

"`--help`" is right.

Some command examples

Let's start simple:

Display a list of files:

```
ls
```

Display a list of files in a long listing format:

```
ls -l
```

Display a list of all files in a long listing format with human-readable file sizes:

```
ls -alh
```

Some command examples cont.

Some equivalent ways to do "`ls -alh`":

```
ls -lah
ls -l -a -h
ls -l –all --human-readable
```

Note that there is no double-dash option for "`-l`". You can figure this out by typing:

```
man ls
```

Or by typing:

```
ls --help
```

Spot the deliberate mistake. Why does it work?

Where's the parameter?

We typed the "`ls`" command with several options, but no parameter. Do you think "`ls`" uses a parameter?

What is the parameter for "`ls -l`"?

It is "." -- our current directory.

"`ls -l`" and "`ls -l .`" are the same.

We'll discuss files and directories later.

A disconcerting Linux feature

If a command executes successfully there is no output returned from the command execution. *this is normal*.

That is, if you type:

```
cp file1 file2
```

The result is that you get your command prompt back. *Nothing means success*.

Let's give this a try...

A disconcerting Linux feature

Try doing the following on your machine:

```
$ cd                    [cd = change dir]
$ touch file1           [touch = create/update]
$ cp file1 file2        [cp = copy]
```

- The “$” indicates the command prompt for a normal user.
- A “#” usually means you are the *root* user.

Using pipes

In Unix it is very easy to use the result of one command as the input for another.

To do this we use the pipe symbol “|”. For example:

```
ls -l /sbin | sort
ls -l /sbin | sort | more
```

What will these commands do?

Stopping command output

Stopping commands with continuous output:

Terminate foreground program: CTRL+C

```
$ ping yahoo.com
PING yahoo.com (67.195.160.76): 56 data bytes
64 bytes from 67.195.160.76: icmp_seq=0 ttl=45 time=221.053 ms
64 bytes from 67.195.160.76: icmp_seq=1 ttl=45 time=224.145 ms
^C      ← here press CTRL + C
```

Terminate paging like “less <filename>”

```
$ less /etc/passwd
sysadm:x:1000:1000:System Administrator,,,:/home/sysadm:/bin/bash
postfix:x:104:113::/var/spool/postfix:/bin/false
mysql:x:105:115:MySQL Server,,,:/var/lib/mysql:/bin/false
(END)      ← press the “q” key
```

Find and recover past commands

For last few commands use the up-arrow.

Don't re-type a long command if you just typed it.

Instead use the up arrow and adjust the command.

Copy and paste commands

In Unix/Linux once you highlight something it is *already* in your copy buffer.

To copy/paste in Linux/Unix do:

- Highlight text with left mouse cursor. It is now copied (like *ctrl-c* in Windows).
- Move mouse/cursor where you want (any window), and press the *middle* mouse button. This is paste (like *ctrl-v*).

In Windows / Mac use the traditional ctrl-c / ctrl-v

Viewing Files (part I)

Several ways to view a file:

1. `cat <filename>`
2. `more <filename`
3. `less <filename>`

Obtaining “help”

To get help explaining commands you can do:

- `man <command>`
- `<command> --help`

man stands for “man”ual.

More on “man”

- `man man`

More on Linux directory structure:

- `man hier`

Module 3: Permissions

Goal

Understand the following:

- The Linux / Unix security model
- How a program is allowed to run
- Where user and group information is stored
- Details of file permissions

Users and Groups

Linux understands Users and Groups

A user can belong to several groups

A file can belong to only one user and one group at a time

A particular user, the superuser *“root”* has extra privileges (uid = “0” in /etc/passwd)

Only root can change the ownership of a file

Users and Groups cont.

User information in `/etc/passwd`

Password info is in `/etc/shadow`

Group information is in `/etc/group`

`/etc/passwd` and `/etc/group` divide data fields using ":"

/etc/passwd:

```
joeuser:x:1000:1000:Joe User,,,:/home/joeuser:/bin/bash
```

/etc/group:

```
joeuser:x:1000:
```

A program runs...

A program may be run by a user, when the system starts or by another process.

Before the program can execute the kernel inspects several things:

- Is the file containing the program accessible to the user or group of the process that wants to run it?
- Does the file containing the program permit execution by that user or group (or anybody)?
- In most cases, while executing, a program inherits the privileges of the user/process who started it.

A program in detail

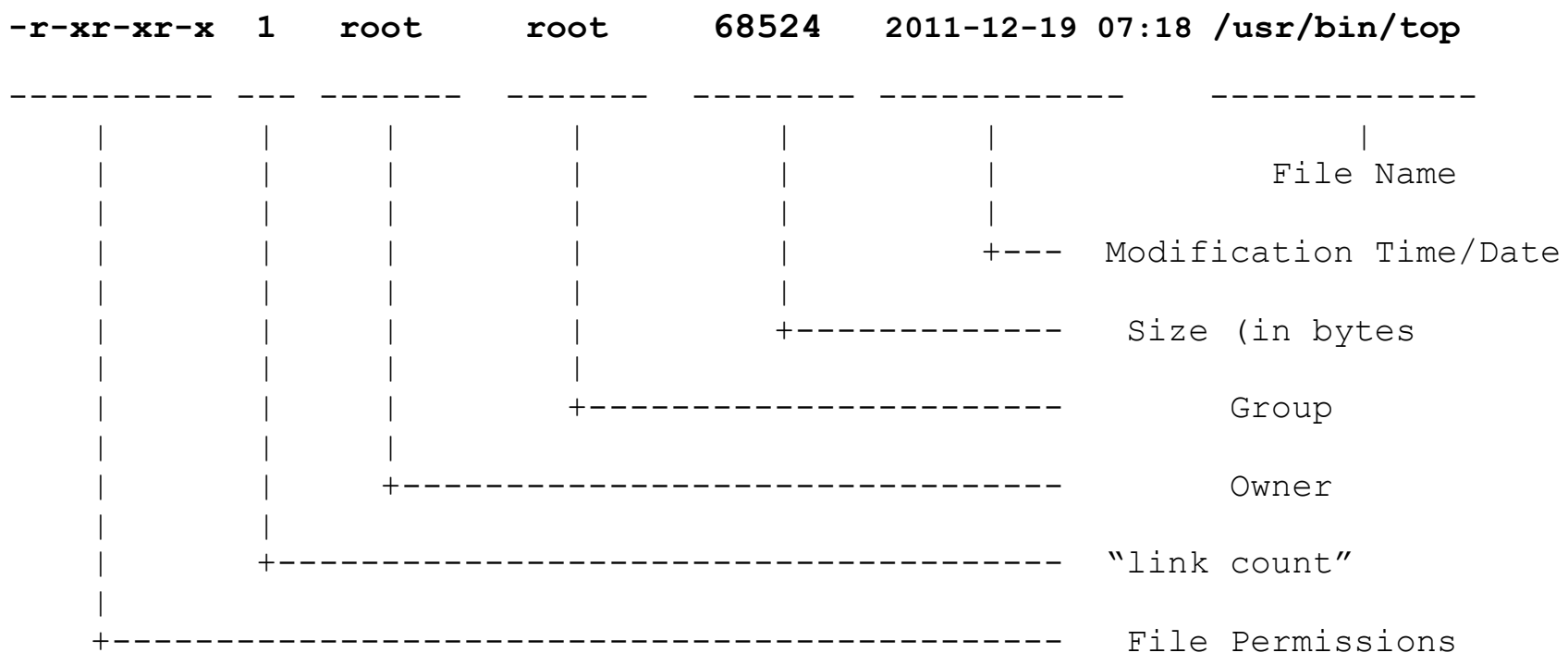
When we type:

```
ls -l /usr/bin/top
```

We'll see:

```
-rwxr-xr-x 1 root root 68524 2011-12-19 07:18 /usr/bin/top
```

What does all this mean?



Group

The name of the group that has permissions in addition to the file's owner.

Owner

The name of the user who owns the file.

File Permissions

The first character is the type of file. A "-" indicates a regular (ordinary) file. A "d” indicate a directory. Second set of 3 characters represent the read, write, and execution rights of the file's owner. Next 3 represent the rights of the file's group, and the final 3 represent the rights granted to everybody else.

(Example modified from **http://www.linuxcommand.org/lts0030.php**)

Access rights

Files are owned by a *user* and a *group* (ownership)

Files have permissions for the user, the group, and *other*

“*other*” permission is often referred to as “world”

The permissions are *Read, Write* and *Execute* (r, w, x)

The user who owns a file is always allowed to change its permissions

Some special cases

When looking at the output from "`ls -l`" in the first column you might see:

```
d = directory
- = regular file
l = symbolic link
s = Unix domain socket
p = named pipe
c = character device file
b = block device file
```

Some special cases cont

In the Owner, Group and other columns you might see:

`s = setuid`	[when in Owner column]
`s = setgid`	[when in Group column]
`t = sticky bit`	[when at end]

Some References

http://www.tuxfiles.org/linuxhelp/filepermissions.html

http://www.cs.uregina.ca/Links/class-info/330/Linux/linux.html

http://www.onlamp.com/pub/a/bsd/2000/09/06/FreeBSD_Basics.html

File permissions

There are two ways to set permissions when using the `chmod` command:

Symbolic mode:

testfile has permissions of `-r--r--r--`

```
                                    u   g   o*
$ chmod g+x testfile        ==>  -r--r-xr--
$ chmod u+wx testfile       ==>  -rwxr-xr--
$ chmod ug-x testfile       ==>  -rw--r--r—
u=user, g=group, o=other (world)
```

Inherited permissions

Two critical points:

1. The permissions of a directory affect whether someone can see its contents or add or remove files in it.
2. The permissions on a file determine what a user can do to the data in the file.

Example:

If you don't have write permission for a directory, then you can't delete a file in the directory. If you have write access to the file you can update the data in the file.

Conclusion

To reinforce these concepts let's do some exercises.

In addition, a very nice reference on using the `chmod` command is:

An Introduction to Unix Permissions -- Part Two

By Dru Lavigne (note, this is for FreeBSD)

http://www.onlamp.com/pub/a/bsd/2000/09/13/FreeBSD_Basics.html

Module 4: Editors

Goals

- Be able to edit a file using vi
- Use some of vi's more advanced features
- Begin to understand the “language” of configuration files
- Use alternate editors: ee, joe, pico, nano, emacs, xemacs, gedit, etc.

vi Philosophy

- It's available!
- Wait, what was that? Oh yeah, it's available!
- It's has some very powerful features.
- It's ubiquitous in UNIX and Linux (`visudo`, `vipw`, `vigr`, etc.)
- Not that hard to learn after initial learning curve.
- Impress your friends and family with your arcane knowledge of computers.

Why is vi “so hard to use”?

Like all things it's not really – once you are used to how it works.

The ***critical*** vi concept:

1. vi has two modes
2. These modes are ***insert*** and ***command***

Let's see how we use these...

vi command and insert modes

Swapping modes

- When you open a file in vi you are in *command mode* by default.
- If you wish to edit the file *you need to switch to insert mode first*.
- To exit *insert mode* press the ESCape key.
- If you get used to this concept you are halfway done to becoming a competent vi user.

vi insert mode

Two common ways to enter insert mode upon opening a file include:

- Press the “i” key to start entering text directly after your cursor.
- Press the “o” key to add a new line *below* you cursor and to start adding text on the new line.
- Remember, to exit *insert mode* press the ESCape key at any time.

vi command mode

Many, many commands in vi, but some of the most common and useful are:

- Press “**x**” to delete a character at a time.
- Press “**dd**” quickly to press the line you are on.
- Press “/”, and text to search for and press <ENTER>.
  - Press “n” to find the next occurrence of text.
  - Press “N” to find previous occurrences of text.

Saving a file or “How to exit vi”

1. In vi press the *ESC*ape key to verify you are in command mode.
2. Depending on what you want to do press:

:w → write the file to disk

:wq → write the file to disk, then quit

:q → quit the file (only works if no changes)

:q! → quit and lose any changes made

:w! → override r/o file permission if you are owner or *root* and write the file to disk.

:wq! → override r/o file permission if you are owner or *root* and write the file to disk and quit.

For all commands which start with colon, you need to hit Enter at end

Other editors

ee

- ESC brings up the editor menu
- Cursors work as you expect

jed

- F10 brings up the editor menu
- Cursors work as you expect

joe

- Ctrl-k-h brings up the editor menu
- Ctrl-c aborts
- Cursors work as you expect

Conclusion

vi's most confusing feature is that it works in two modes and you must switch between them.

Questions?

Goal

- Core commands to admin a system
- Understanding Ubuntu-specific methods
  - Naming conventions
  - Release conventions (Server, Desktop and LTS)
  - Other flavors
  - The Debian way
  - Packaging system (how software is installed)
  - Meta-packages
  - Keeping up-to-date
  - Stopping and starting services
  - Additional system administration commands

Debian/Ubuntu Unique Items

Software management

Command Line

- **`dpkg`**
  - `dpkg --get-selections, dpkg-reconfigure, dpkg-query`
- **`apt`**
  - `apt-cache, apt-cache policy, apt-cache search apt-get, apt-get install, apt-get remove, apt-get purge, apt-get clean`
  - meta-packages (build-essentials, ubuntu-desktop)
- repositories – Controlled by */etc/apt/sources.list*
- **`aptitude`**
  - `aptitude search, aptitude clean, aptitude remove, aptitude purge`

Using apt

After initial install general cycle is:

1. `apt-get update`
2. `apt-get upgrade`

- Repeat 1. If new packages, repeat 2.
- Reboot only if new kernel image is installed.
- Services are restarted if updated.
- During install you can tell Ubuntu to automate this process.
- Desktop users generally use *synaptic* or *Ubuntu App Centre* to do this.

Services

Startup scripts

In /etc/init.d/ (System V)
In /etc/init/ (Ubuntu 12.04 LTS and Upstart)

NOTE! Upon install services run!

Controlling services

- `update-rc.d` (default method)
- Stop/Start/Restart/Reload/Status Services

```
# service <Service> <Action>
```

or, “old school”

```
# /etc/init.d/<service> <action>
```

Root account Access

- Use of the *root* account is discouraged.
- `sudo` is used to access root privileges from general user account instead.
- You can get around this very easily.

Should you run as root?

Your decision.

Accessing *root* account

Set *root* user password:

- Login as general user
- `sudo -s` (Opens a root shell in bash)
- passwd (Set a root password)

Should you do this?

Security hole!

- Ubuntu allows *root* user access via SSH by default. Setting the *root* user password opens exposes this vulnerability.

See what's running

Check for a process by name

- `ps auxwww | grep apache`

```
sysadm@pc102:~$ ps auxwww | grep apache
root      1029  0.0 24.5 137524 125184 ?       Ss   01:29   0:02 /usr/sbin/apache2 -k start
www-data  1062  0.0 23.1 134788 117836 ?       S    01:29   0:00 /usr/sbin/apache2 -k start
www-data  1087  0.0 23.8 414236 121236 ?       Sl   01:29   0:00 /usr/sbin/apache2 -k start
www-data  1088  0.0 23.8 414236 121240 ?       Sl   01:29   0:00 /usr/sbin/apache2 -k start
sysadm    1426  0.0  0.1   3320   804 ttyS0    S+   02:40   0:00 grep --color=auto apache
```

Stop the process by PID (Process ID). From above listing:

- `sudo kill 1029` (why this one?)
- `Sudo kill -9 1029` (force stop if hung)

```
sysadm@pc102:~$ ps auxwww | grep apache
sysadm    1430  0.0  0.1   3320   808 ttyS0    S+   02:46   0:00 grep --color=auto apache
```

Troubleshooting: Logfiles

Log files are critical to solve problems. They reside (largely) in /var/log/

Some popular log files include:

/var/log/messages or /var/log/syslog

/var/log/apache2/error.log

/var/log/mail.log

/etc/namedb/log/* (later in the week)

To view the last entry in a log file:

```
tail /var/log/messages
```

To view new entries as they happen:

```
tail -f /var/log/messages
```

There's More

But, hopefully enough to get us started...

Some Resources

http://www.ubuntu.com

http://ubuntuforums.org

http://www.debian.org

http://ubuntuguide.org

http://en.wikipedia.org/wiki/Debian

http://en.wikipedia.org/wiki/Ubuntu_(Linux_distribution)

GIYF (Google Is Your Friend)

Questions

?