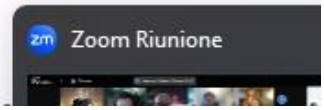
Chapter 01
Introduction

Three Main OS Components

- **Kernel** - manages operation of the computer.
- **Shell** - provides for interaction between the user and the computer.
- **Filesystem** - provides a way to organize and manage all information on a computer's disk(s).

Applications

- Applications make requests to the kernel and receive resources, such as memory, CPU, and disk, in return.
- Applications should follow the kernel's *Application Programming Interface (API)*.



Linux is Open Source

- Historically, most software has been issued under a closed-source license.
- This means that you may have the right to use the executable program or machine code, but cannot see the source code.
- The development of Linux closely parallels the rise of *open source software*.
- One tenet of open source philosophy is that you have a right to access the source code and to modify it as you wish.

Introduction

- Linux is the *kernel* of the system.
- The kernel and suite of tools that are packaged with it is called a *distribution*.

Hardware Platforms

- Linux first ran on a computer similar to it's inventor's: a 386 with a specific hard drive controller.
- The types of hardware grew from the humble Intel chip to eventually support even supercomputers.
- Eventually, cellular phones and tablets adopted Linux.
- Aside from phones and tablets, Linux can be found in many consumer devices such as wireless routers.

The Shell

- The shell is a program that allows the user to type commands, options, and arguments.
- Two most common types of interfaces are the Graphical User Interface (GUI) and Command Line Interface (CLI).
- Advantages to using a CLI, include:
  - Command repetition
  - Command flexibility
  - Resources
  - Scripting
  - Remote Access
  - Development

Bash Shell

- Many shell programs exist.
- Most popular shell is the “Bash” (Bourne Again Shell).
- Users interact with a system by executing *commands* which are interpreted by the shell and transformed into actions by the kernel.

```
sysadmin@localhost:~$ ls
Desktop Documents Downloads Music Pictures Public Templates Videos
```

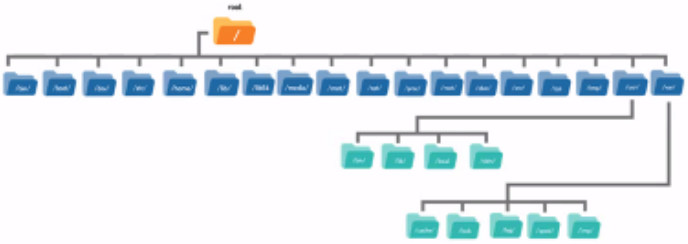
- The Bash shell has numerous built-in commands and features including: aliases, re-executing commands, wildcard matching, input/output redirection, pipes and background processing.

Accessing the Shell

- From a Graphical User Interface (GUI)
  - Open a terminal program
- From a Command Line Interface (CLI)

Filesystem

- A hierarchy of directories and files with the root / directory at the top of the directory tree.
- A structure created on a disk partition that organizes directories, subdirectories and files.



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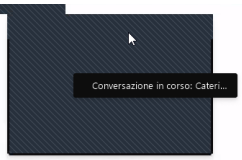
Chapter 02
Using the Shell



What is a Command?

- A program executed on the command line.
- Sources of commands include:
  - Internal (built-in shell) commands
  - External commands stored in binary files
  - Aliases
  - Functions
  - Scripts

Aliases

- An *alias* can be used to map longer commands to shorter key sequences.
- To determine what aliases are set on the current shell use the `alias` command.
- New aliases can be created using the following format:

```
alias name=command
```

- Aliases created this way only persist while the shell is open. Once the shell is closed, the new aliases are lost.

Basic Command Syntax

- Command syntax:

```
command [options…] [arguments…]
```

- Commands, options and arguments are all case-sensitive.
- To execute a command, the first step is to type the name of the command.

```
sysadmin@localhost:~$ ls
Desktop  Documents  Downloads Music  Pictures Public Templates  Videos
```


Specifying Arguments

- Typically, *arguments* follow options.

```
command [options] [arguments]
```

- Arguments can be file or directory names.
- Some commands *require* arguments (i.e. the touch and cp commands).
- If an argument contains special (non-alphanumeric) characters, use single quotes ‘ ’ around the argument.

Specifying Options

- *Options* can be used with commands to expand or modify the way a command behaves.

```
command [options] [arguments]
```

- *Short options* are specified with a hyphen - followed by a single character (ie -a).
- *Long options* for commands are preceded by a double hyphen -- (i.e. --all).
- The *lone double hyphen* -- option can be used to indicate the end of all options for the command.
- BSD style options do not use hyphens, just a single character (i.e. a)

Display System Information

- The `uname` command displays useful system information.
- There are many options available for the `uname` command. For example:
  - `-a`, `--all` - displays all information about the system
  - `-s`, `--kernel-name` - displays Kernel name
  - `-n`, `--node-name` - displays network node name
  - `-r`, `--kernel-release` - displays Kernel release
  - `-v`, `--kernel-version` - displays Kernel version

Current Directory

- The `pwd` command displays the current working directory.

```
sysadmin@localhost:~$ pwd
/home/sysadmin
sysadmin@localhost:~$ cd Documents/
sysadmin@localhost:~/Documents$ pwd
/home/sysadmin/Documents
```

Command Information

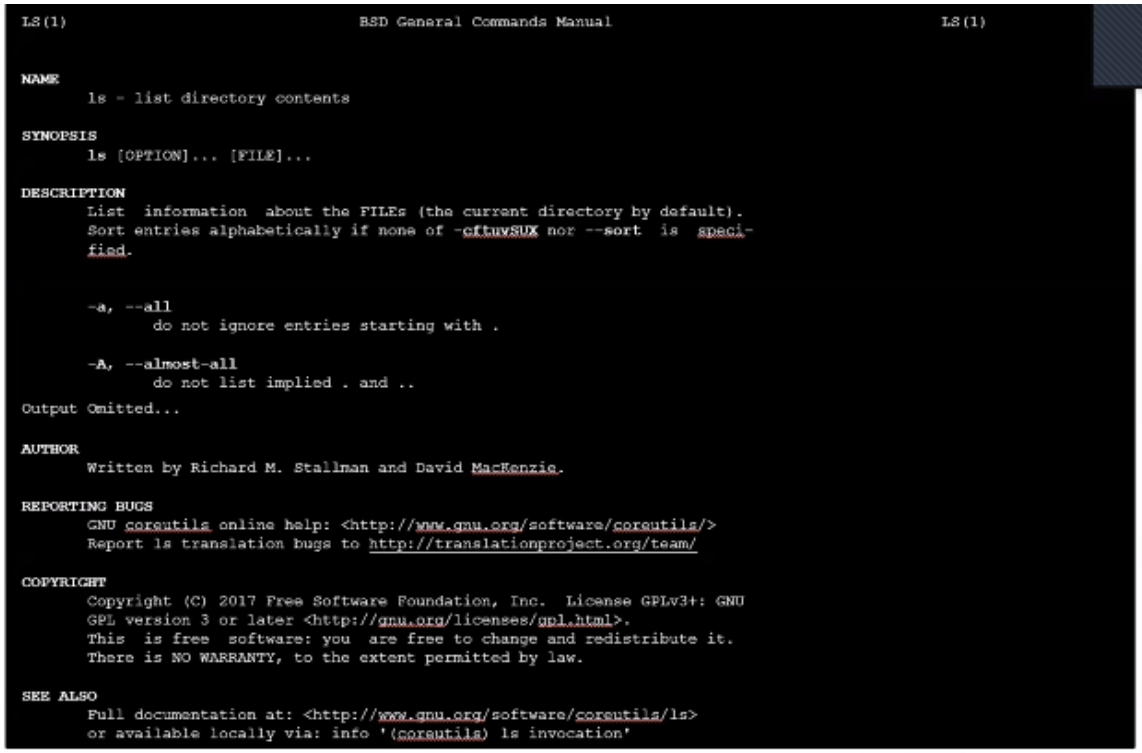
- The `type` command displays information about a command type.

```
sysadmin@localhost:~$ type -a ls
ls is aliased to `ls --color-auto'
ls is /bin/ls
```

- This command is helpful for getting information about commands, the -a option will return all locations the files reside on the system.
- The `which` command searches for the location of a command in the system by searching the `PATH` variable.

Sections Within Man Pages

- The format of each man page is broken into sub-sections:
  - `NAME` = Brief description.
  - `SYNOPSIS` = How command is executed.
  - `DESCRIPTION` = Provides a more detailed description of the command.
  - `OPTIONS` = The options for the command.
  - `FILES` = Which files are used for the command.
  - `AUTHOR`= Provides the name of the person who created the man page and (sometimes) how to contact the person.



```
LS(1)                          BSD General Commands Manual                          LS(1)


NAME
       ls - list directory contents

SYNOPSIS
       ls [OPTION]... [FILE]...

DESCRIPTION
       List  information  about the FILEs (the current directory by default).
       Sort entries alphabetically if none of -cftuvSUX nor --sort  is  speci-
       fied.


       -a, --all
              do not ignore entries starting with .

       -A, --almost-all
              do not list implied . and ..
Output Omitted...

AUTHOR
       Written by Richard M. Stallman and David MacKenzie.

REPORTING BUGS
       GNU coreutils online help: <http://www.gnu.org/software/coreutils/>
       Report ls translation bugs to http://translationproject.org/team/

COPYRIGHT
       Copyright (C) 2017 Free Software Foundation, Inc.  License GPLv3+: GNU
       GPL version 3 or later <http://gnu.org/licenses/gpl.html>.
       This  is free  software: you  are free to change and redistribute it.
       There is NO WARRANTY, to the extent permitted by law.

SEE ALSO
       Full documentation at: <http://www.gnu.org/software/coreutils/ls>
       or available locally via: info '(coreutils) ls invocation'
```


Searching by Name or Keyword

- To return all man pages that match a *name*:

```
man -f name
```

```
sysadmin@localhost:~$ man -f passwd
```

- To return all man pages that match a *keyword*:

```
man -k keyword
```

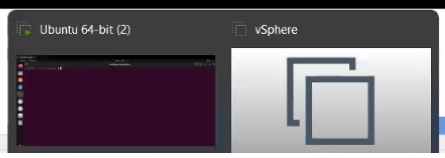
```
sysadmin@localhost:~$ man -k password
```


Command Completion

- The Bash shell provides the ability to complete commands and their arguments automatically.

- Type a few characters of a command (or its file name argument) and then press the **Tab** key twice, this will provide a list of files that match.

```
sysadmin@localhost:~$ ca
cal                 capsh               cat                 cautious-launcher
calendar            captoinfo           catchsegv
caller              case catman
```



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  - NAME = Brief description.
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  - AUTHOR= Provides the name of the person who created the man page and (sometimes) how to contact the person.

Searching by Name or Keyword

- To return all man pages that match a *name*:

```
man -f name
```

```
sysadmin@localhost:~$ man -f passwd
```

- To return all man pages that match a *keyword*:

```
man -k keyword
```

```
sysadmin@localhost:~$ man -k password
```


NDG

Chapter 06
Finding Files

NDG

Filesystem Hierarchy Standard

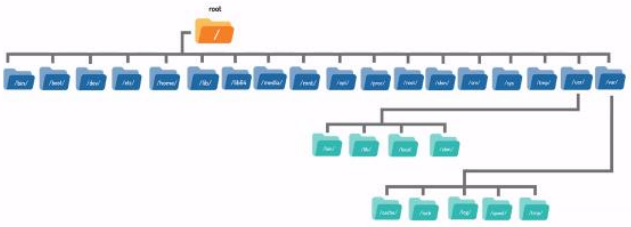
- The Filesystem Hierarchy Standard (FHS) is standard that specifies standard directories and their content for use with a filesystem.
- Learning FHS helps you know what directories to expect to find and what to find in them.
- FHS allows programmers to write programs that will be able to work across a wide variety of systems that conform to this standard.

History of FHS

- First known as known as the Filesystem Standard (FSSTND)
- Renamed FHS in 1997 with series 2.
- The final 2.3 version of this second series of this FHS standard was published in 2004.
- In 2011, a *draft version* of the third series of this standard was published.
- The Linux file structure is best visualized as an upside-down tree, with directories and files branching out from the top-level root / directory.

Filesystem Hierarchy Standard

- The FHS details many important directories.
- Administrators should know the directories on the next slides.



Important Directories

Directory	Purpose
/	The root of the primary filesystem hierarchy
/bin	Contain essential user executables
/boot	Contain the kernel and bootloader files
/dev	Populated with files representing attached devices
/etc	Configuration files specific to the host
/home	Common location for user home directories
/lib	Essential libraries to support /bin and /sbin executables
/mnt	Mount point for temporarily mounting a filesystem

Important Directories

Directory	Purpose
/opt	Optional third party add-on software
/root	Home directory for the root user
/sbin	Contains system or administrative executables
/usr/share/doc	Documentation for software packages
/usr/share/info	Information pages for software packages
/usr/share/locale	Locale information
/usr/share/man	Location for man pages
/usr/share/nls	Native language support files

Filesystem Hierarchy Standard

- A *shareable* directory, typically does not contain anything that would be unique to a particular system like a configuration file.
- A *static* directory usually doesn't change and may suggest that it might be mounted read-only.
- A *variable* directory is likely to change and would have to be available for both read and writes.

Finding Files and Commands

- A GUI typically provides a search tool that makes it possible to find files and applications.
- The CLI provides the `locate` and `find` commands which are useful for searching for a file within the filesystem.

locate Command

```
locate [OPTION]... PATTERN...
```

- The `locate` command searches a database that contains the location of the files on the filesystem.
- The `locate` command accepts a search string as an argument.

```
sysadmin@localhost:~$ locate passwd
/etc/passwd
/etc/passwd-
/etc/pam.d/chpasswd
/etc/pam.d/passwd
/etc/security/opasswd
```

- The `locate` command depends on a database which is updated using the `updatedb` command.

locate Command

- Advantages:
  - Fast because it searches a database of all files on the computer.
- Disadvantages:
  - New files are not in the database if it hasn't been updated.
  - You can only search for files by name versus other search criteria.

find Command

```
find [OPTIONS]... [starting-point...] [expression]
```

- The `find` command searches a live filesystem for specified files.
- The `find` command supports different search criteria options. The following table illustrates some examples of criteria:

`-iname FILE`	Case insensitive search by name.
`-mtime -3`	Files modified less than three days ago.
`-size +1M`	Files larger than 1 megabyte.
`-user jane`	Files owned by the user `jane`.

find Command

- Advantages:
  - Searches directories in real time so it doesn't suffer from problems associated with an outdated database.
  - Supports searching by various criteria.
- Disadvantages:
  - Slower than the `locate` command.

whereis Command

```
whereis [OPTION]... NAME...
```

- The `whereis` command displays the directory location and man page for the specified command.
- Searches only the directories defined by the `$PATH` variable.

```
sysadmin@localhost:~$ whereis grep
grep: /bin/grep /usr/share/man/man1/grep.1.gz /usr/share/info/grep.info.gz
```

- The `-s` option can be used to find source code that has been installed for a given command.
- The `-u` option can be used to identify commands that do not have an entry for a requested attribute.

which Command

```
which [OPTION]…. FILENAME…
```

- The `which` command displays the directory location(s) of a specified command or script.

```
sysadmin@localhost:~$ which bash
/bin/bash
```

- The `which` command returns the location of the real command.
- The `which` command searches only the directories defined by the `$PATH` variable.

type Command

```
type [OPTION]... NAME...
```

- The `type` command displays information about various commands.

```
sysadmin@localhost:~$ type echo
echo is a shell builtin
```

- Using the `-a` option can reveal the path of a command.

```
sysadmin@localhost:~$ type -a echo
echo is a shell builtin
echo is /bin/echo
```

- The `type` command supports other options and can lookup multiple commands simultaneously.