

System Administration 1

Prepared by Dr. Ahmed Omar

IT391

System Administration 1

Lecture 8



Linux File System

Lecture 8

IT391

System Administration 1

Prepared by
Dr. Ahmed Omar

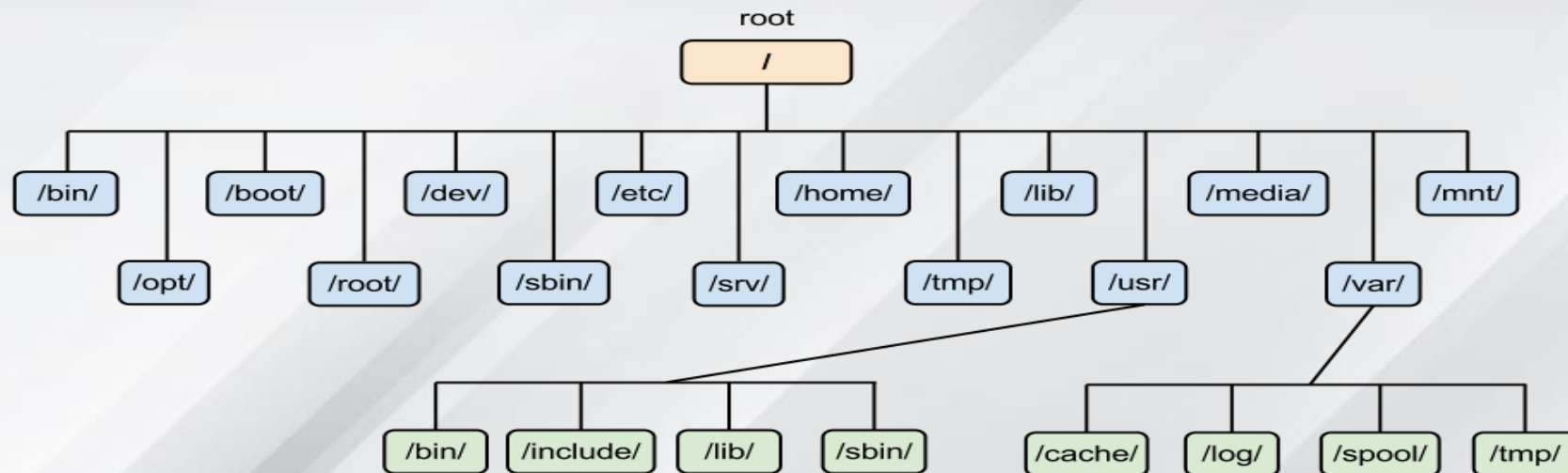


Agenda

- ☐ Linux File System Hierarchy
- ☐ The Filesystem Hierarchy Standard (FHS)
- ☐ Basic Command Structure
- ☐ Command, Options, and Arguments
- ☐ File System Navigation and Manipulation Commands

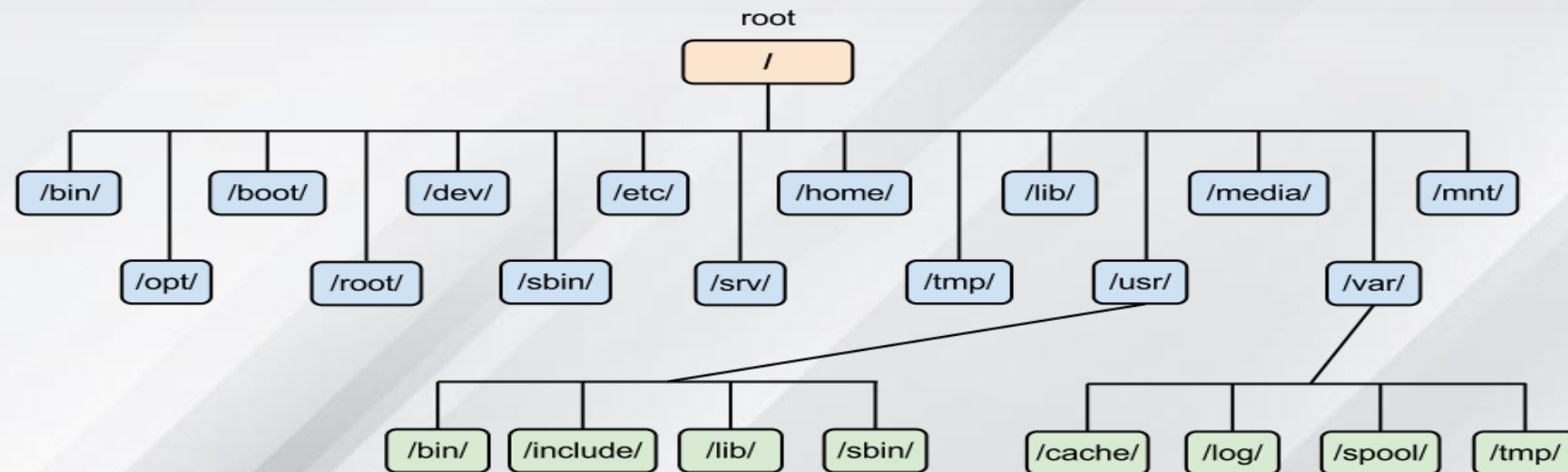
Linux File System Hierarchy

- ✓ All files on a Linux system are stored on **file systems** which are organized into a **single inverted tree** of directories, known as a file system hierarchy.
- ✓ In the inverted tree, **root** lies at the **top** and the branches of directories and sub-directories stretch below the root.



Linux File System Hierarchy

- ✓ Understanding the Linux file system hierarchy is essential for effective **system administration, troubleshooting, and security management.**



Linux File System Hierarchy

- ✓ The Filesystem Hierarchy Standard (**FHS**) is a reference describing the conventions used for the layout of Unix-like systems.
- ✓ Current version: FHS 3.0, released on June 3, 2015.
- ✓ **Purpose:** To standardize the directory structure and file locations across Unix-like operating systems, ensuring consistency and compatibility

```
/ (root)
├─ /bin/ - Essential command binaries
├─ /sbin/ - System binaries
├─ /etc/ - Configuration files
├─ /home/ - User home directories
├─ /usr/ - User programs and data
├─ /var/ - Variable data files
└─ /proc/, /dev/, /tmp/ - Special directories
```

Linux File System Hierarchy

Key Benefits:

- ✓ Ensures consistency across different Linux distributions
- ✓ Provides predictability for software developers and system administrators
- ✓ Facilitates interoperability between different Unix-like systems
- ✓ Standardizes locations of important files and directories

FHS Structure Overview

- 📁 / - Single root directory
- |
- ├ /bin, /sbin - Essential binaries
- ├ /etc - Host-specific configuration
- ├ /home - User home directories
- ├ /usr - User programs & data
- └ /var - Variable data files

Linux File System Hierarchy

Root Directory (/)

- is the **topmost** directory in the Linux filesystem hierarchy. All other files and directories are descendants of this directory.
- Represented by a forward **slash /**
- All other directories and files appear under the root directory, even if they are stored on different physical or virtual devices.
- Only the **root user** has **write** permission in the root directory, ensuring system stability and security.

Linux File System Hierarchy

User Directories (/home)

The **/home** directory contains personal directories for every user on the system, providing each with a dedicated space for their files and configurations.

Typical /home Structure

```

📁 /home
|
├─ /home/user1 - First user's directory
|   └─ Documents, Pictures, Downloads...
|       └─ .bashrc, .profile, .config...
├─ /home/user2 - Second user's directory
└─ /home/user3 - Third user's directory
```

Linux File System Hierarchy

User Directories (/home)

Key Characteristics:

- Each user gets a personal subdirectory (e.g., **/home/username**)
- User directories are private by default with restricted permissions
- Contains user-specific configuration files (dot files like .bashrc)
- Often mounted as a separate partition for easier backups and upgrades

Typical /home Structure

```

📁 /home
|
├─ /home/user1 - First user's directory
|   └─ Documents, Pictures, Downloads...
|       └─ .bashrc, .profile, .config...
├─ /home/user2 - Second user's directory
└─ /home/user3 - Third user's directory
  
```

Linux File System Hierarchy

Core System Directories

Core system directories contain **essential** binaries and libraries needed for **basic system functionality**.

- ❑ **/bin** (binaries)

Essential user command binaries

- ❑ **/sbin** (system binaries)

System administration binaries - Primarily used by root/superuser

- ❑ **/lib** (libraries)

Essential shared libraries and kernel modules

Linux File System Hierarchy

Configuration Directories (/etc)

The **/etc** directory contains system-wide configuration files and shell scripts used to boot and initialize system settings:

- System configuration files
- Startup and shutdown shell scripts
- User and group information
- Network configuration

Linux File System Hierarchy

Variable Data Directories (/var)

The **/var** directory stores files that change frequently during system operation, keeping dynamic data separate from static system files.

- **/var/log** - System and application log files
- **/var/spool** - Print queues, mail queues, and other queued work
- **/var/lib** - Variable state information and databases
- **/var/www** - Web server data files
- **/var/cache** - Application cache data

Linux File System Hierarchy

device files (/dev)

Contains device files that act as interfaces to physical and virtual devices.

- Special files representing hardware devices
- **/dev/sda** represents the first hard drive
- **/dev/null** discards all written data

Linux File System Hierarchy

Unix System Resources (/usr)

The **/usr** directory contains read-only user data and system-wide applications, libraries, and documentation.

Key Components:

- ❑ **/usr/bin** - User command binaries for regular system operation
- ❑ **/usr/sbin** - System administration binaries for regular operation
- ❑ **/usr/lib** - Libraries for programs in /usr/bin and /usr/sbin
- ❑ **/usr/share** - Architecture-independent data shared across systems
- ❑ **/usr/local** - Custom local software installed by system administrator

Linux File System Hierarchy

Special Virtual Directories

These special directories serve unique purposes in the Linux filesystem, providing interfaces to system resources.

❑ **/proc**

A virtual filesystem providing process and kernel information as files.

❑ **/sys**

Contains information about devices, drivers, and kernel features. Provides a more structured view of kernel objects than /proc.

Linux File System Hierarchy

Other Important Directories

☐ **/boot**

Boot loader files, kernel images

☐ **/media, /mnt**

Mount points for removable media and temporary filesystems

☐ **/opt**

Optional application software packages

☐ **/srv**

Data for services provided by the system

Linux File System Hierarchy

Best Practices

- ✓ Keep system and user data **separate** (use **/home** for user files)
- ✓ Never store user files in system directories like **/bin**, **/sbin**, or **/etc**
- ✓ Regularly back up critical configuration files in **/etc**
- ✓ Be cautious when modifying files in **/boot** to avoid system boot failures
- ✓ Monitor **/var/log** for system issues and security concerns
- ✓ Clean **/tmp** periodically to free up disk space

Linux File System Hierarchy

pwd stands for "**Print Working Directory**" and is a fundamental Linux/Unix command that displays the absolute path of your current location in the file system.

Root/home/username

```
ahmed@debiansrv1:~$ pwd  
/home/ahmed
```

Basic Command Structure

command [options] [arguments]

Components:

- ❑ **command** - The program or utility to execute
- ❑ **options** - Flags that modify the command's behavior (optional)
- ❑ **arguments** - Files, directories, or other data the command operates on (optional)

Basic Command Structure

`command [options] [arguments]`

Short Options

Single character preceded by a single dash (-)

- `ls -l` # Long format
- `ls -a` # Show hidden files
- `ls -la` # Combine both options

Basic Command Structure

command [options] [arguments]

Arguments

Arguments are the targets or inputs for commands:

- **ls /home** # Directory argument
- **ls -l /home/user1** # Directory argument
- **ls /home/user1 -l**

Linux File System Hierarchy

ls -l (Long format) - Shows detailed information including permissions, ownership, size, and modification date:

```
ahmed@debiansrv1:~$ ls -l
total 32
drwxr-xr-x 2 ahmed ahmed 4096 Jul 21 19:10 Desktop
drwxr-xr-x 2 ahmed ahmed 4096 Jul 21 19:10 Documents
drwxr-xr-x 2 ahmed ahmed 4096 Jul 21 19:10 Downloads
drwxr-xr-x 2 ahmed ahmed 4096 Jul 21 19:10 Music
drwxr-xr-x 2 ahmed ahmed 4096 Jul 21 19:10 Pictures
drwxr-xr-x 2 ahmed ahmed 4096 Jul 21 19:10 Public
drwxr-xr-x 2 ahmed ahmed 4096 Jul 21 19:10 Templates
drwxr-xr-x 2 ahmed ahmed 4096 Jul 21 19:10 Videos
```

```
-rw-r--r-- 1 user group 1024 Jan 15 10:30 filename
├── file permissions
├── number of hard links
├── file owner
├── group owner
├── file size in bytes
└── modification date/time
    └── filename
```

Linux File System Hierarchy

File permissions

drwxr-xr-x

d : Indicates this is a directory

- : Indicates this is a file

Owner Permissions (User): rwx

r - Read: Can list directory contents

w - Write: Can create, delete, rename files in directory

x - Execute: Can enter/access the directory (cd into it)

Group Permissions: r-x

2 - Link Count

For directories, this typically represents the number of subdirectories. A count of **2** usually means the directory is empty (no subdirectories).

Linux File System Hierarchy

ls /

lists the contents of the **root** directory, showing you the top-level directories of the Linux file system hierarchy.

```
ahmed@debiansrv1:~$ ls root
ls: cannot access 'root': No such file or directory
ahmed@debiansrv1:~$ ls /
bin    dev    home    initrd.img.old  lib64    media  opt    root  sbin
boot   etc    initrd.img  lib        lost+found  mnt    proc   run   srv
ahmed@debiansrv1:~$
```

Linux File System Hierarchy

ls /usr

lists the contents of the /usr directory

```
ahmed@debiansrv1:~$ ls /
bin    dev    home    initrd.img.old  lib64    media    opt    root    sbin    sys    usr
boot   etc    initrd.img  lib          lost+found  mnt      proc    run    srv    tmp    var
ahmed@debiansrv1:~$ ls usr
ls: cannot access 'usr': No such file or directory
ahmed@debiansrv1:~$ ls /usr
bin  games  include  lib  lib64  libexec  local  sbin  share  src
ahmed@debiansrv1:~$
```

Linux File System Hierarchy

cd

The cd command stands for "**Change Directory**" and is used to navigate between directories in the Linux file system.

cd # Takes you to your home directory

cd ~ # Same as above (~ represents home)

cd / #Go to the root directory

cd .. # Go up one directory level

cd - # Go back to previous directory

cd /path/to/directory # Go to specific directory

```
ahmed@debiansrv1:~$ cd /  
ahmed@debiansrv1:/$ cd /usr  
ahmed@debiansrv1:/usr$
```

```
ahmed@debiansrv1:/usr$ cd /home/ahmed/  
ahmed@debiansrv1:~$
```

Linux File System Hierarchy

An **absolute path** specifies the complete location of a file or directory from the root directory (/). It always starts with a forward slash.

A **relative path** specifies the location of a file or directory relative to your current working directory. It does NOT start with a forward slash.

```
ahmed@debiansrv1:~$ cd /home/ahmed/Desktop  
ahmed@debiansrv1:~/Desktop$ cd ..
```

```
ahmed@debiansrv1:~$ cd Desktop/  
ahmed@debiansrv1:~/Desktop$
```

Linux File System Hierarchy

Create file

The **touch** command is used to create empty files and update file timestamps in Linux.

If the file already exists, touch updates its access and modification **times** to the current time

```
ahmed@debiansrv1:~$ touch file1
ahmed@debiansrv1:~$ ls
Desktop Documents Downloads file1
ahmed@debiansrv1:~$
```

```
total 32
drwxr-xr-x 2 ahmed ahmed 4096 Jul 21 19:10 Desktop
drwxr-xr-x 2 ahmed ahmed 4096 Jul 21 19:10 Documents
drwxr-xr-x 2 ahmed ahmed 4096 Jul 21 19:10 Downloads
-rw-r--r-- 1 ahmed ahmed 0 Jul 29 21:25 file1
drwxr-xr-x 2 ahmed ahmed 4096 Jul 21 19:10 Music
drwxr-xr-x 2 ahmed ahmed 4096 Jul 21 19:10 Pictures
```

Linux File System Hierarchy

Write the file content

1. nano file1
2. Ctrl +O
3. Enter
4. Ctrl +X

```

ahmed@debiansrv1: ~
GNU nano 7.2 file1 *
hello in system admin 1

^G Help          ^O Write Out     ^W Where Is     ^K Cut          ^T Execute      ^C Location
^X Exit          ^R Read File     ^\ Replace      ^U Paste        ^J Justify      ^_ Go To Line
  
```

Linux File System Hierarchy

Read a file

❏ cat

The cat command stands for "concatenate" and is one of the most versatile and commonly used commands in Linux. It **reads** files and **displays** their content, among other useful functions.

```
ahmed@debiansrv1:~$ cat file1
hello in System Admin 1
ahmed@debiansrv1:~$
```

Linux File System Hierarchy

Create a directory

- ❑ The **mkdir** command stands for "**make directory**" and is used to create directories (folders) in Linux. It's an essential command for organizing files and creating directory structures.

mkdir directory_name # Create single directory

mkdir dir1 dir2 dir3 # Create multiple directories

mkdir -p dir3/dir4 # This will create all missing directories i.e. dir3 and dir4

```
ahmed@debiansrv1:~$ mkdir dir1
ahmed@debiansrv1:~$ ls
Desktop  dir1  Documents  Downloads  file1  Music
ahmed@debiansrv1:~$
```

Linux File System Hierarchy

Create a directory

- ❑ The `ls -R` command performs a recursive listing that displays the contents of the current directory and all its subdirectories in a hierarchical manner.

```
ahmed@debiansrv1:~$ mkdir -p dir3/dir4
ahmed@debiansrv1:~$ ls -R
.:
Desktop  dir1  dir3  Documents  Downloads  file1  Music  Pictures

./Desktop:

./dir1:

./dir3:
dir4

./dir3/dir4:

./Documents:

./Downloads:
```

Linux File System Hierarchy

Create a directory

- ❑ Create parent directory **work** and child directory **project**

```
ahmed@debiansrv1:~$ mkdir -p work/project
ahmed@debiansrv1:~$ ls
Desktop  dir1  dir3  Documents  Downloads  file1  Music  Pictures
ahmed@debiansrv1:~$ ls work
project
ahmed@debiansrv1:~$
```

Linux File System Hierarchy

Create a directory

- ❑ Create two children directories **project2** and **project3**

```
ahmed@debiansrv1:~$ mkdir work/project2 work/project3
ahmed@debiansrv1:~$ ls work
project  project2  project3
ahmed@debiansrv1:~$
```

Linux File System Hierarchy

Copy a file

- ❑ The `cp` command stands for "copy" and is used to copy files and directories in Linux. It's one of the most fundamental file management commands.

- ❑ `cp [options] source destination`

Copy file to another directory

`cp file1 /work/project/`

```
ahmed@debiansrv1:~$ cp file1 work/project
ahmed@debiansrv1:~$ ls work/project
file1
ahmed@debiansrv1:~$
```

```
ahmed@debiansrv1:~/work/project$ cat file1
hello in System Admin 1
ahmed@debiansrv1:~/work/project$
```

Linux File System Hierarchy

Copy file with new name

`cp filename newname`

```
ahmed@debiansrv1:~$ cp file1 work/project/file2
```

```
ahmed@debiansrv1:~$ ls work/project
```

```
file1  file2
```

```
ahmed@debiansrv1:~$ █
```

Linux File System Hierarchy

Copy entire directory

```
cp -r source_directory/ destination_directory/
```

Copy multiple directories

```
cp -r dir1/ dir2/ dir3/ /destination/
```

```
ahmed@debiansrv1:~$ cp -r work/project3 work/project
```

```
ahmed@debiansrv1:~$ ls work/project
```

```
file1  file2  project3
```

Linux File System Hierarchy

Copy Directory Contents (Not the Directory Itself)

❑ Method 1: Using `./` (Recommended)

`cp -a /etc/. /home/project2/`

(.) means all contents of /etc directory

```
ahmed@debiansrv1:~$ cp -a /etc/. work/project2
cp: cannot open '/etc/./security/opasswd' for reading: Permission denied
cp: cannot open '/etc/./pwd.lock' for reading: Permission denied
cp: cannot open '/etc/./shadow-' for reading: Permission denied
cp: cannot open '/etc/./gshadow' for reading: Permission denied
cp: cannot access '/etc/./ssl/private': Permission denied
cp: cannot access '/etc/./cups/ssl': Permission denied
cp: cannot open '/etc/./cups/subscriptions.conf.0' for reading: Permission denied
cp: cannot open '/etc/./cups/subscriptions.conf' for reading: Permission denied
cp: cannot open '/etc/./sudoers' for reading: Permission denied
cp: cannot open '/etc/./sudoers.d/README' for reading: Permission denied
cp: cannot access '/etc/./polkit-1/rules.d': Permission denied
cp: cannot open '/etc/./fwupd/redfish.conf' for reading: Permission denied
cp: cannot open '/etc/./NetworkManager/system-connections/Wired connection 1' for
cp: cannot open '/etc/./ppp/ppp.secrets' for reading: Permission denied
```

Linux File System Hierarchy

Copy Directory Contents (Not the Directory Itself)

❑ Method 1: Using `./` (Recommended)

`cp -a /etc/. /home/project2/`

```
ahmed@debiansrv1:~$ ls work/project2
adduser.conf      discover.conf.d  issue.net         nftables.conf    services
adjtime           discover-modprobe.conf kernel            nsswitch.conf    sgml
alsa              dpkg             kernel-img.conf  openal            shells
alternatives      e2scrub.conf    ldap              openni2           skel
anacrontab        emacs            ld.so.cache      opt              snmp
apache2           environment      ld.so.conf       os-release        speech-dispatcher
apg.conf          environment.d    ld.so.conf.d     PackageKit        ssh
apparmor          ethertypes      libao.conf       pam.conf          ssl
apparmor.d        firefox-esr     libaudit.conf    pam.d             subgid
appstream.conf    fonts           libblockdev      papersize         subgid-
apt               fstab           libnl-3           passwd            subuid
avahi             fuse.conf       libreoffice      passwd-           sudo.conf
bash.bashrc       fwupd           lighttpd         perl              sudoers.d
bash_completion  gai.conf        locale.alias     pki               sudo_logsrvd.conf
bindresvport.blacklist gdm3            locale.gen       plymouth          sysctl.conf
binfmt.d          geoclue         localtime        polkit-1          sysctl.d
bluetooth         ghostscript     logcheck         profile           systemd
bogofilter.cf     glvnd           login.defs       protocols         terminfo
ca-certificates   gnome           logrotate.conf  nulse             timezone
chatscripts       gnome-chess     logrotate.d      nulse             timidity
```

Linux File System Hierarchy

The `mv` command stands for "**move**" and is used to move (**rename**) files and directories in Linux.

Rename a file

`mv oldname.txt newname.txt`

Move file to another directory

`mv file.txt /home/user/Documents/`

```
ahmed@debiansrv1:~$ ls work/  
project  project2  project3
```

```
ahmed@debiansrv1:~$ mv work/project work/project1  
ahmed@debiansrv1:~$ ls work/  
project1  project2  project3
```

Linux File System Hierarchy

Move file and rename it

`mv filename /des/newname`

```
ahmed@debiansrv1:~$ ls
Desktop  dir1  dir3  Documents  Downloads  file1  Music  Pictures  Public  Templates  Videos  work
ahmed@debiansrv1:~$ mv file1 work/project3/new_file
ahmed@debiansrv1:~$ ls work/project3
new_file
ahmed@debiansrv1:~$ ls
Desktop  dir1  dir3  Documents  Downloads  Music  Pictures  Public  Templates  Videos  work
```

Linux File System Hierarchy

Update (-u)

Move only when source is newer than destination:

Move only if source is newer

mv -u source destination

Update move for multiple files

mv -u *.txt updated_files/

Linux File System Hierarchy

Organize files by type

mv *.pdf documents/ # Moves all files ending with **.pdf** into the folder

mv *.jpg images/

mv *.mp3 music/



Thank You