Linux For Embedded Systems

For Arabs

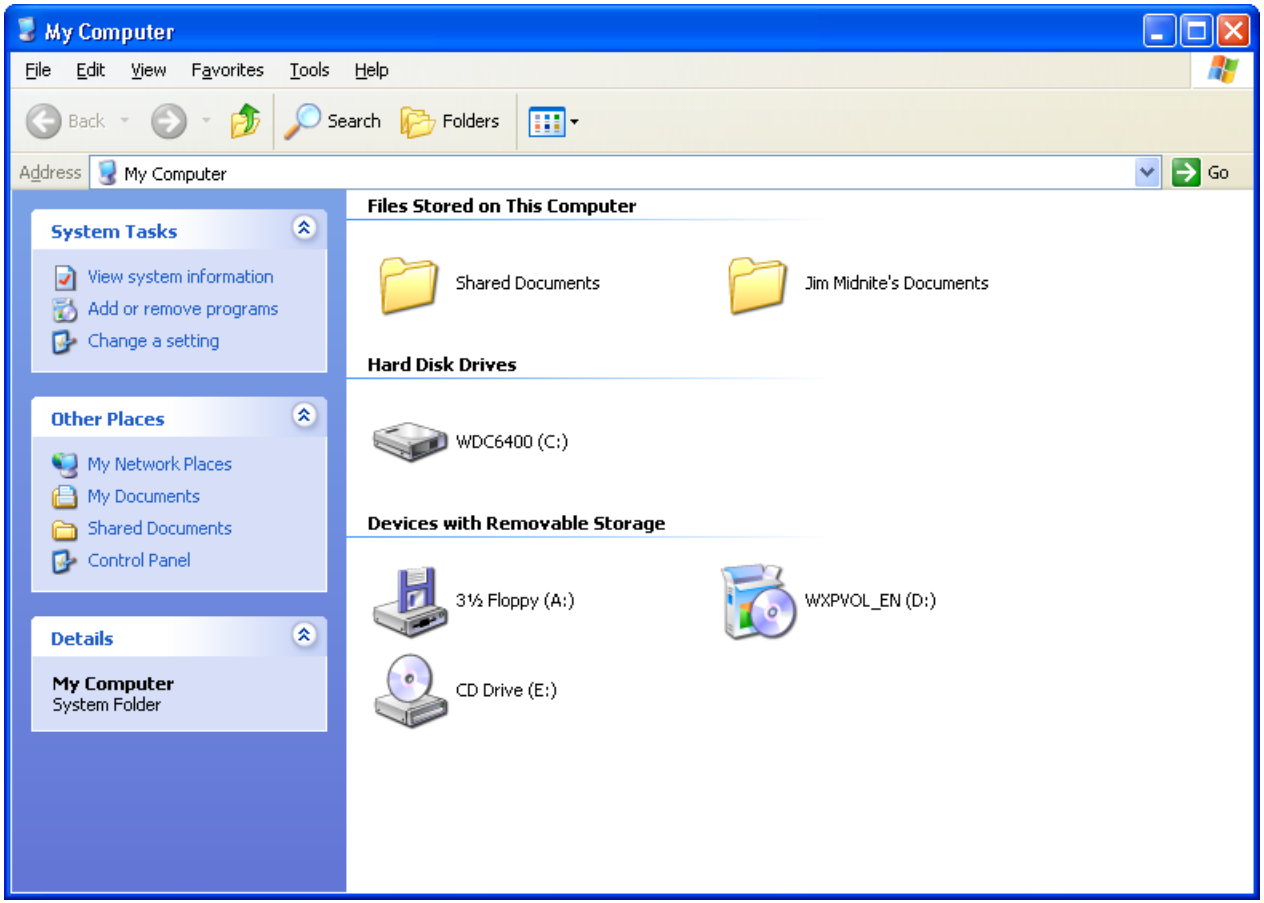
Course 102:

Understanding Linux

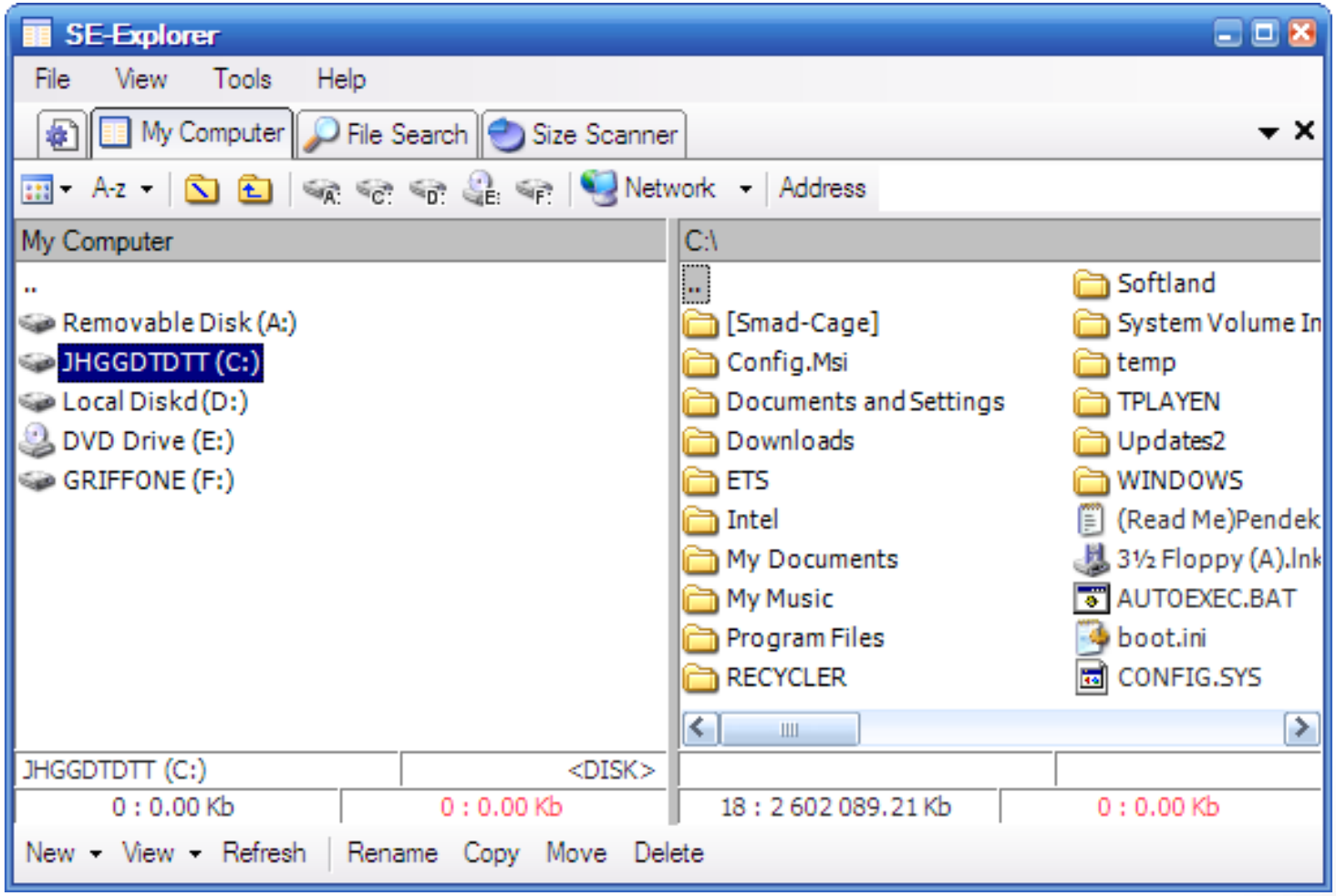
Ahmed ElArabawy

Lecture 26: FileSystems in Linux (Part 1)

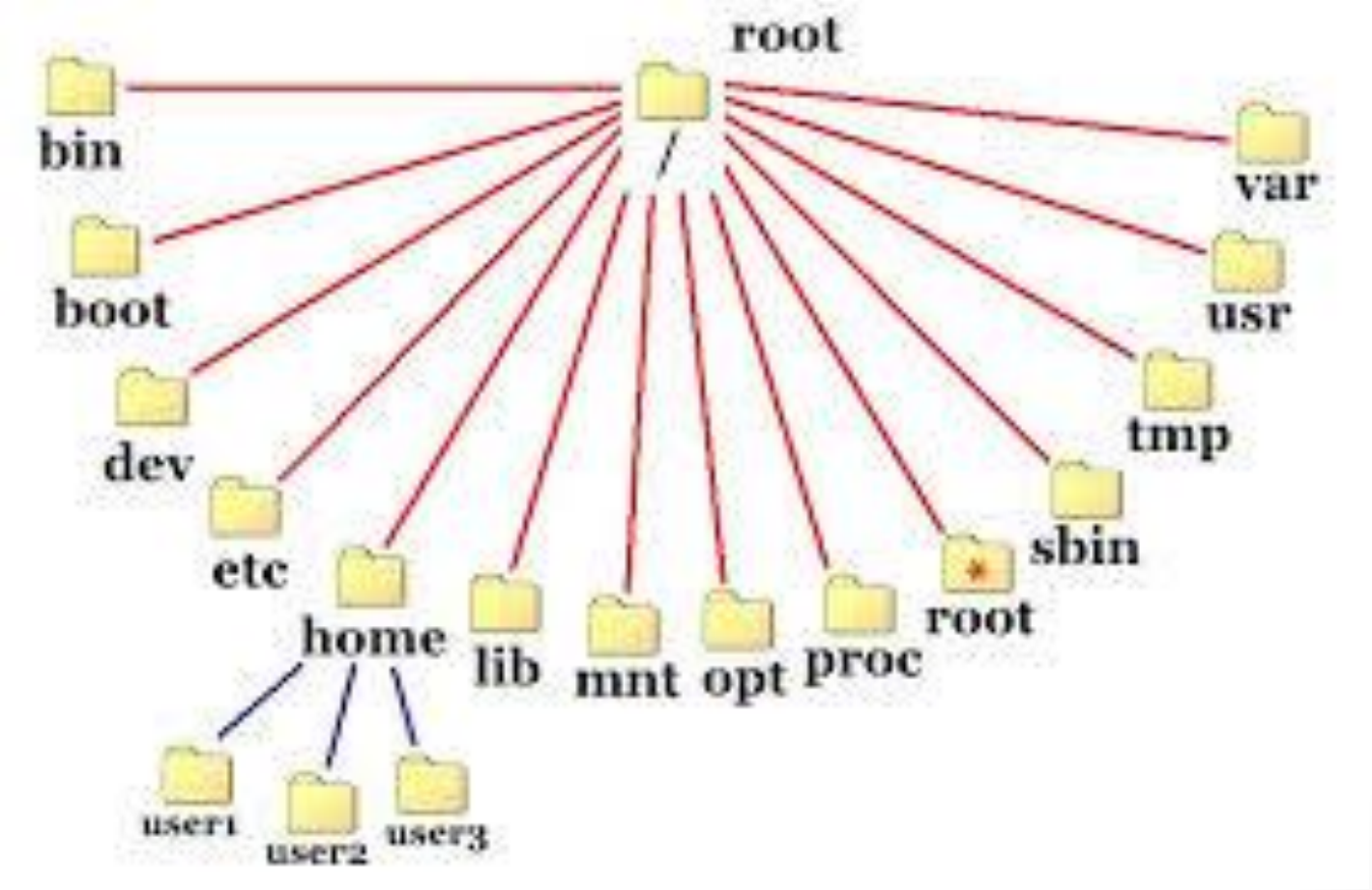
File System Layout (Windows)



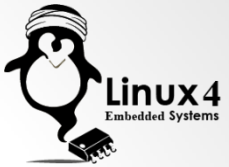
File System Layout (Windows)



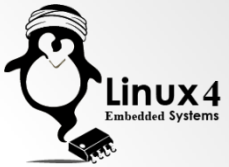
File System Layout (Linux)



Linux File Hierarchy
A Review on Previous Knowledge

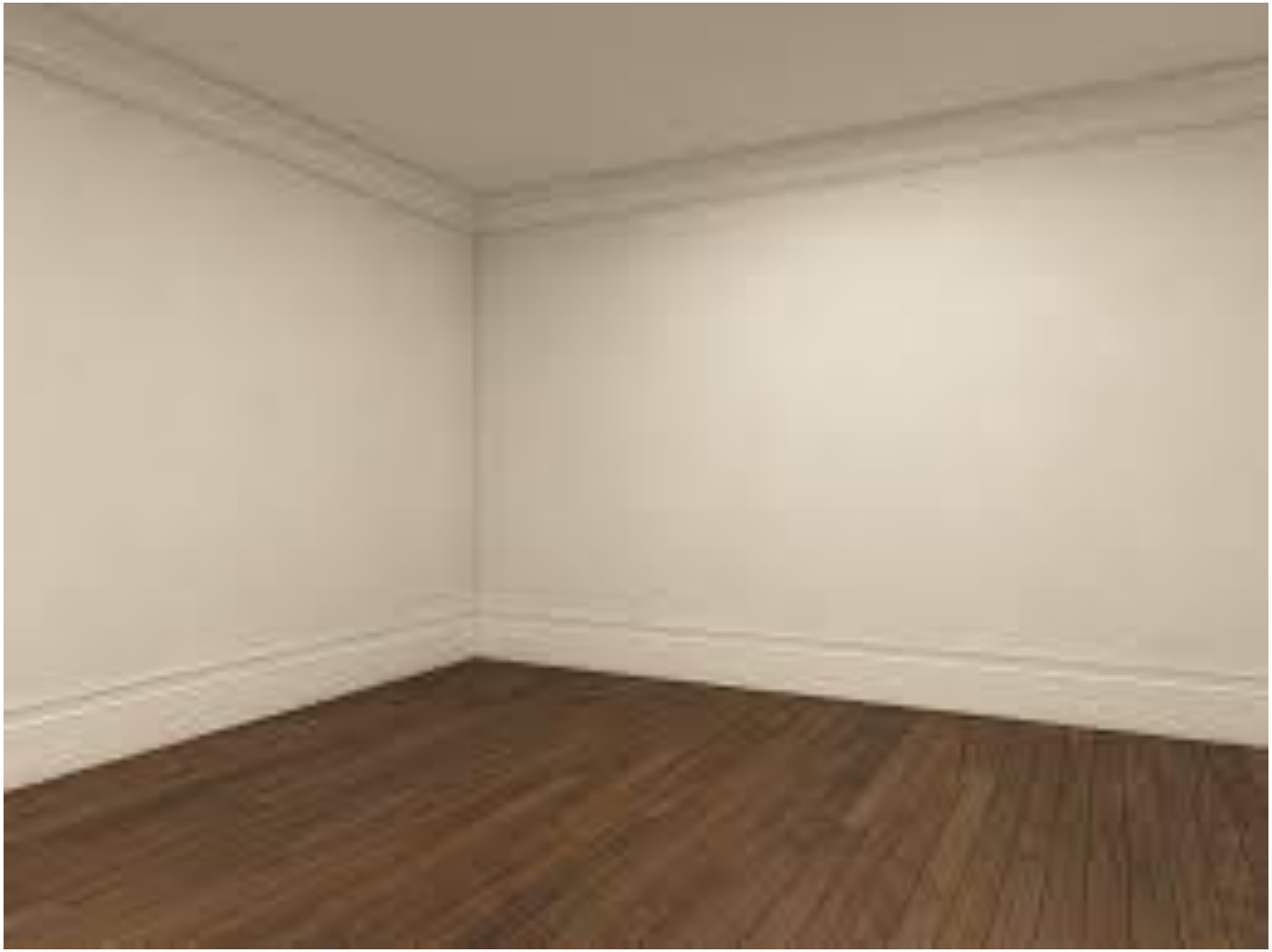


- In Windows,
  - Each partition of each storage device will have its own separate tree.. (C, D, E,…)
  - Plugging a flash or a portable hard-disk results in a new tree
- Linux has a unified File Hierarchy
- This means that no matter how many storage devices we have, we will only have one file tree
- The file tree starts with the root (/)
- There is a standard on the high level of the structure of the File Hierarchy, this structure is mostly followed by most Linux Distributions
- This hierarchy may contain sub-trees from multiple storage devices of different natures
  - Hard Disk partitions
  - Flash Drives
  - CD/DVD Driver
  - SD Card

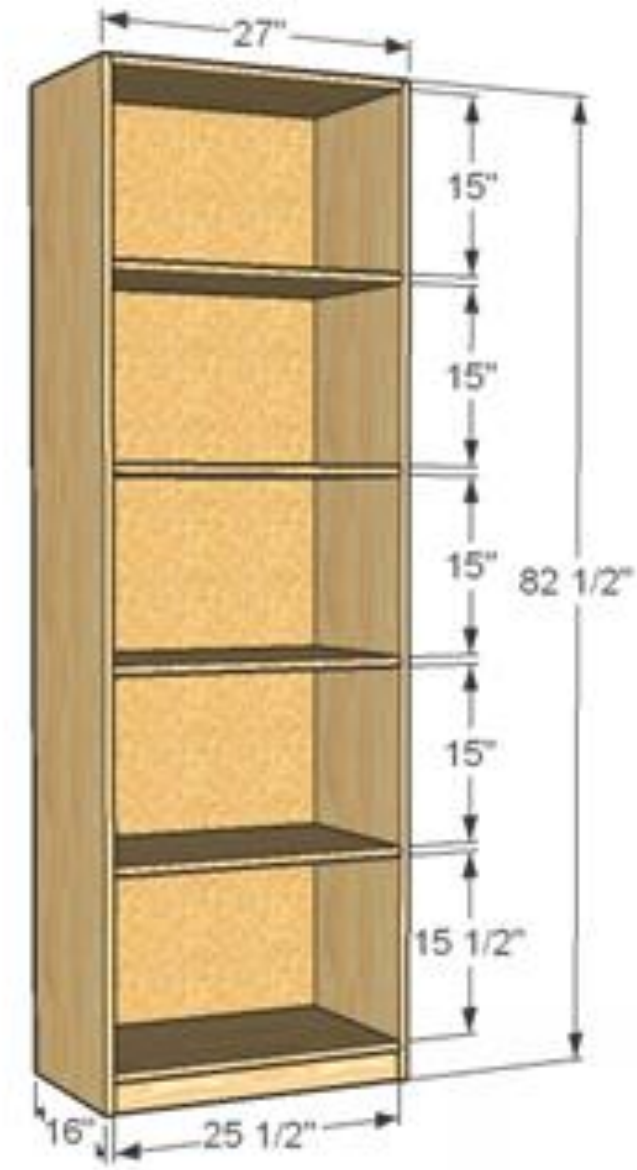


So How Does Storage Happen…

Empty Storage Area



Partitioning

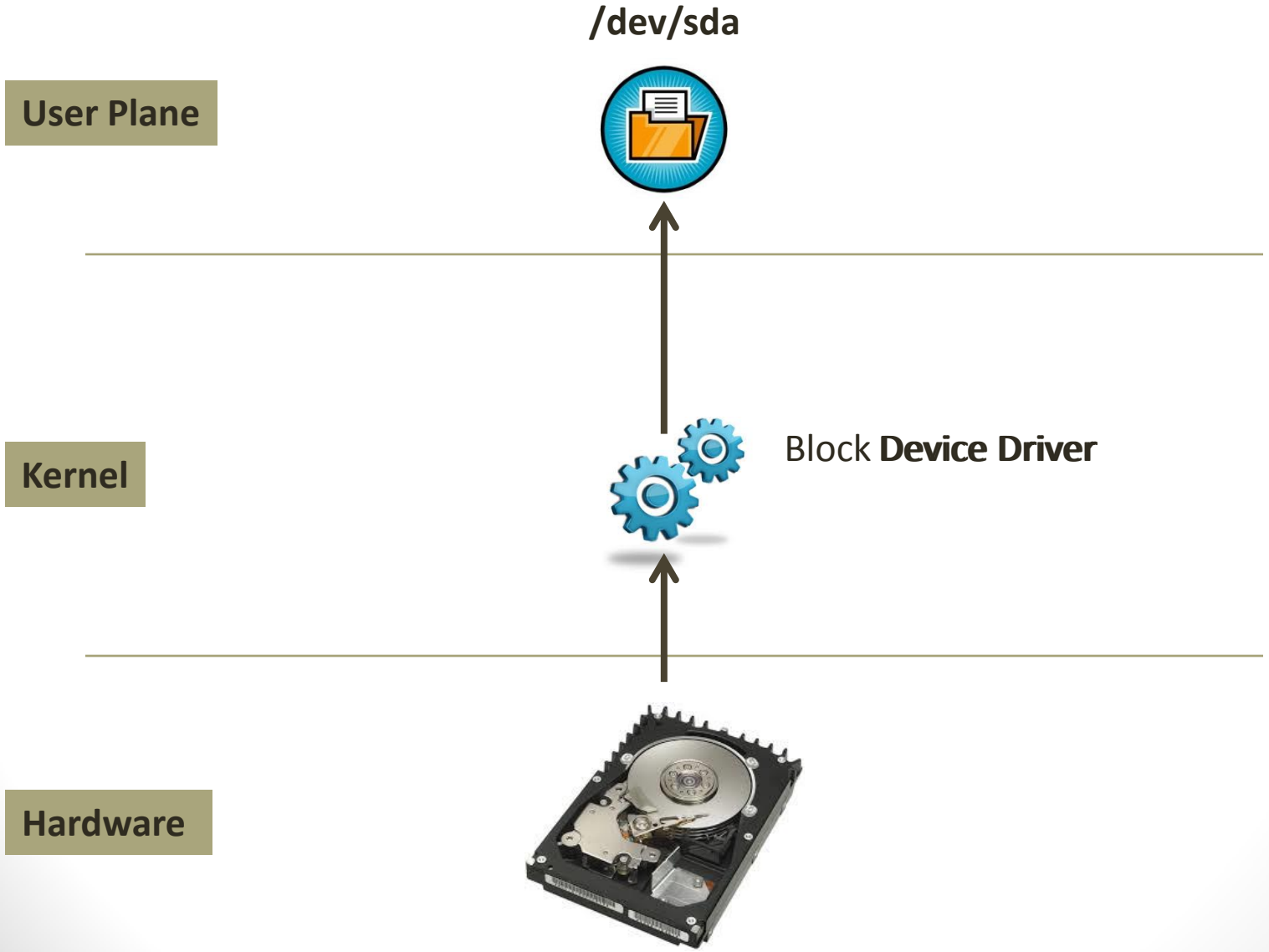


Build & Install File-Systems

Mount the Keys in the desired Place

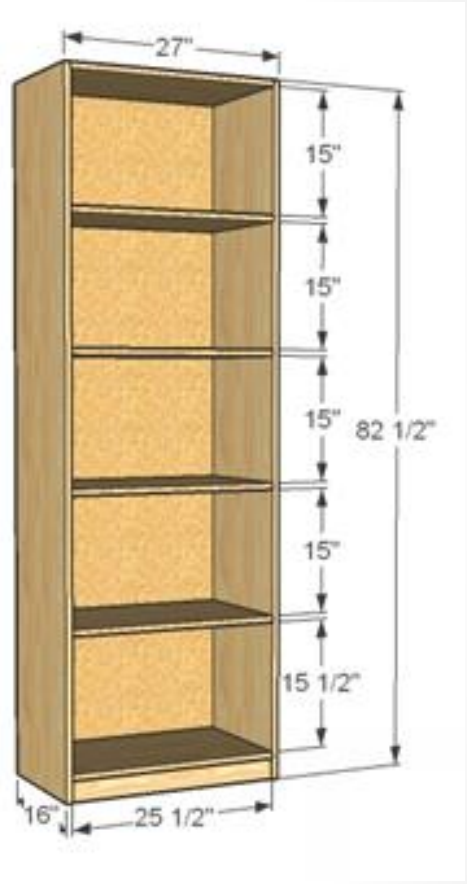
Step 1: Get a Storage Device

Storage Device is a Hardware Device

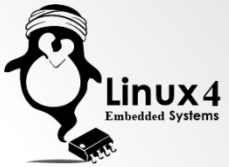


Step 2: Partition the Storage Device

```
ubuntu@ubuntu:~$ sudo fdisk -l

Disk /dev/sda: 500.1 GB, 500107862016 bytes
255 heads, 63 sectors/track, 60801 cylinders, total 976773168 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk identifier: 0x6bbf3753

   Device Boot      Start         End      Blocks   Id  System
/dev/sda1            2048    25655804    12826878+  27  Hidden NTFS WinRE
/dev/sda2   *    25655808    25896779      120486    7  HPFS/NTFS/exFAT
/dev/sda3        25896960   528586688   251344864+   7  HPFS/NTFS/exFAT
/dev/sda4       528586750   976768064   224090657+   f  W95 Ext'd (LBA)
/dev/sda5       672657678   976768064   152055193+   7  HPFS/NTFS/exFAT

Disk /dev/sdb: 16.0 GB, 16043212800 bytes
255 heads, 63 sectors/track, 1950 cylinders, total 31334400 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk identifier: 0xc7793f67

   Device Boot      Start         End      Blocks   Id  System
/dev/sdb1   *          63    31334399    15667168+   c  W95 FAT32 (LBA)
ubuntu@ubuntu:~$
```



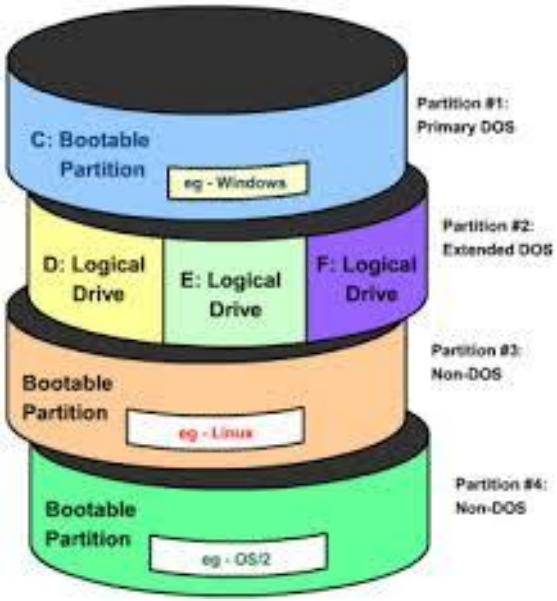
Manage Disk Partitions



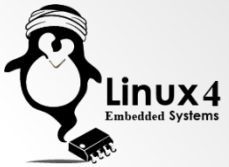
- The Disk can then be segmented into one or more partitions
- Each partition occupies physically a part of the disk storage area
- Partitions are isolated from each other, and each one acts as if it is a separate disk, and will have its own device file
- Why do we need to have multiple partitions ?
  - This enables us to have a different filesystem type in each partition which enable the following,
    - Some partitions will be read only, others will be writable
    - Some partitions will have the data compressed, others will have them without compression
    - Some partitions will have their data encrypted, others will have their files in clear text
  - Isolation of data on different partitions,
    - Corruption of one partition does not affect other partitions
    - For example it is advised to have **/var** directory in a separate partition to make sure that explosion of log file sizes and other spoolers does not affect the system operation

Partition Categories

- Partitions can be:
  - **Primary Partitions:**
    - They can be set to be bootable
    - You can install a bootable OS on it
    - Count is limited
  - **Logical Partitions:**
    - Can not be bootable
    - No OS can be installed on them
    - Only useful to carry data
    - Still they provide isolation of data
    - They result from the segmentation of a primary partition (named an extended partition) into multiple logical partitions
  - **Swap Partition**

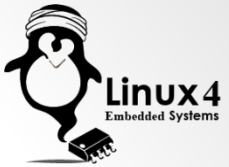


SWAP Partition



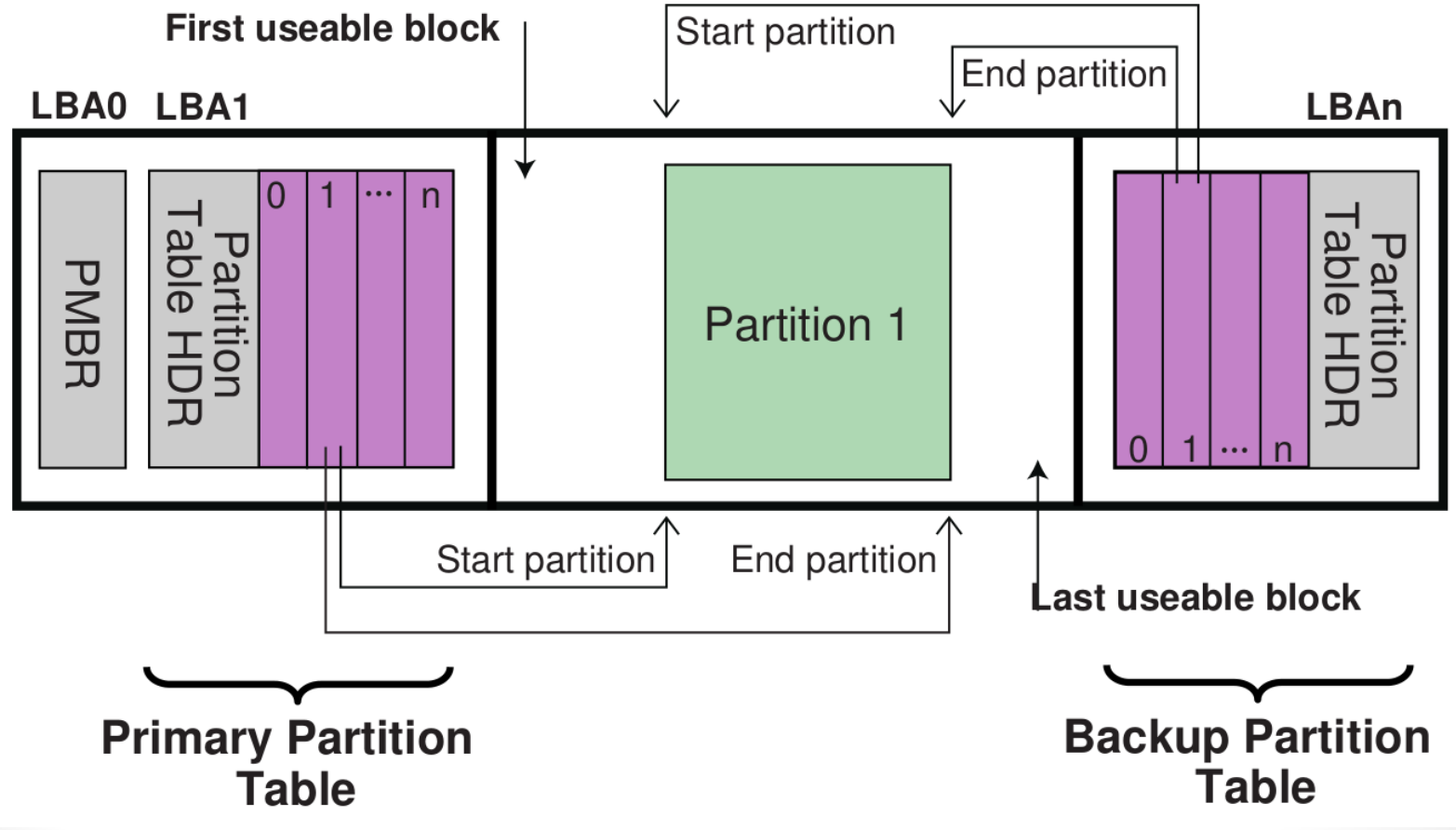
- The SWAP partition is a partition that is only accessible by the system
- The system use one or more swap partitions to extend its physical memory
- In case of high memory utilization, memory pages that is not accessed frequently can be moved from the physical memory into the swap partition
- However, the access time for it is much higher than that of memory
- User can not access this partition or put his own filesystem in it
- It is recommended to have swap space double the amount of physical memory in the system
- An example on a system with 512 MB of RAM:
  - 1st possibility: one swap partition of 1 GB
  - 2nd possibility: two swap partitions of 512 MB
  - 3rd possibility: with two hard disks: 1 partition of 512 MB on each disk. This last option will give the best results when a lot of I/O is to be expected
- In general, using multiple swap partitions will speed up access time (specially if they are located at different physical storage devices)

Partition Table

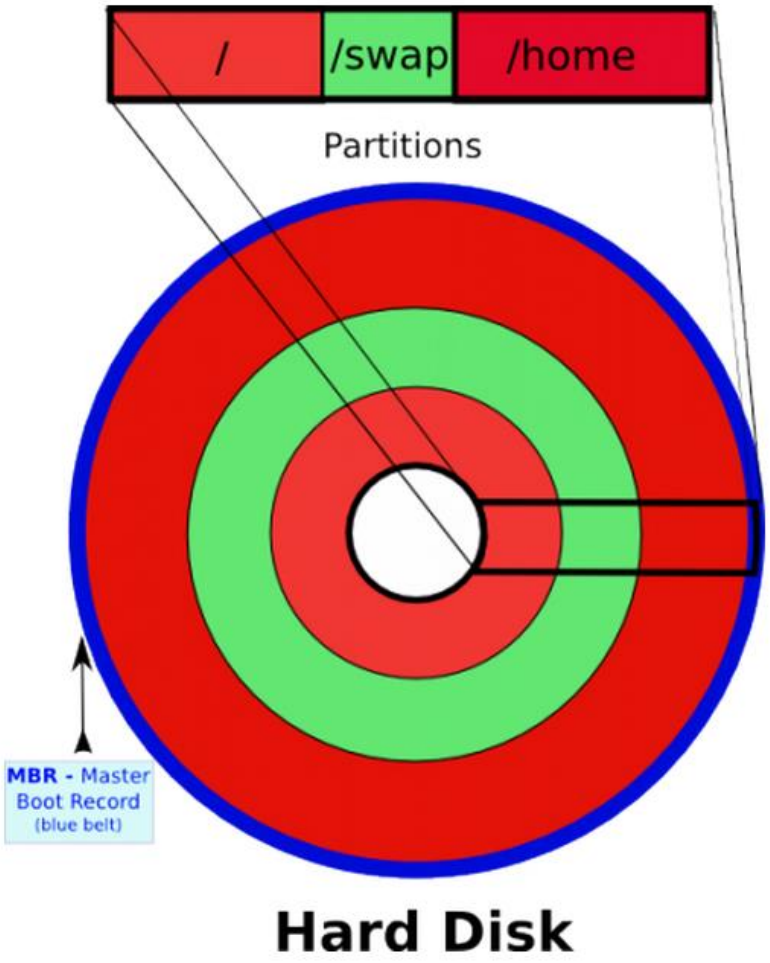


- The Partition table is a table located at a known place in the disk
- It contains description of the partitions on the disk
  - Start Location
  - Length (or End Location)
  - Type (Primary/Logical)
  - Other Info
- There are multiple formats for the partition table, most popular are,
  - **Master Boot Record (MBR)**
    - Supports disks up to 2 TB size
    - Supports up to 4 Primary partitions (maximum of 4 OS's in a multi-boot environment)
    - Most common format
  - **GUID Partition Table (GPT)**
    - Supports disks of much larger size
    - Supports more primary partitions (up to 128)

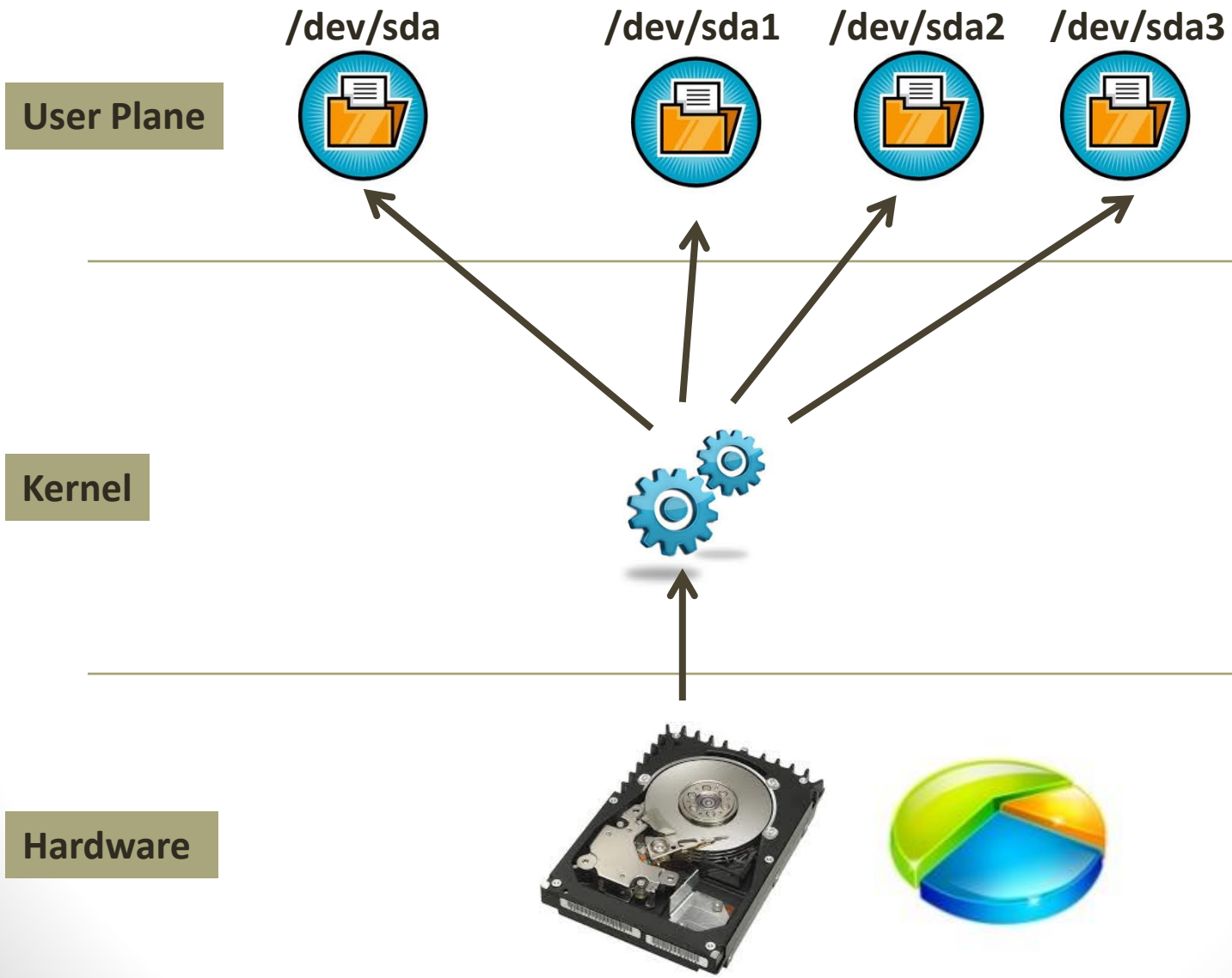
Partition Table Example (GPT)



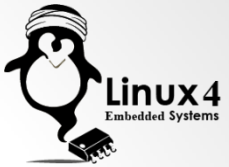
Partitions and Partition Table



Partition Device Files



Manage Disk Partitions (fdisk Command)



$ fdisk -l

$ fdisk <device Name>

- This command is responsible for displaying and management of disk partitions

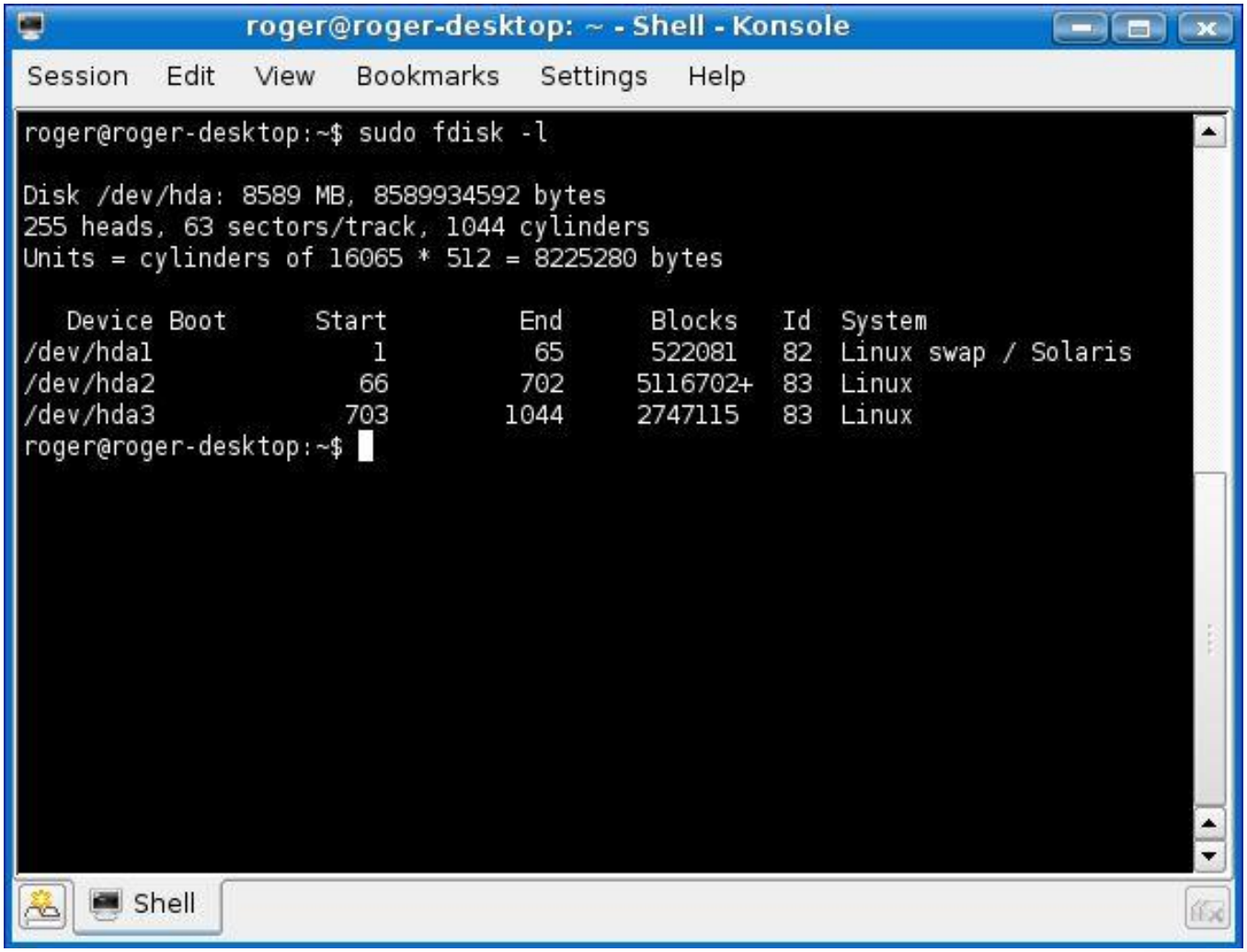
  $ sudo fdisk -l

  $ sudo fdisk -l /dev/sda

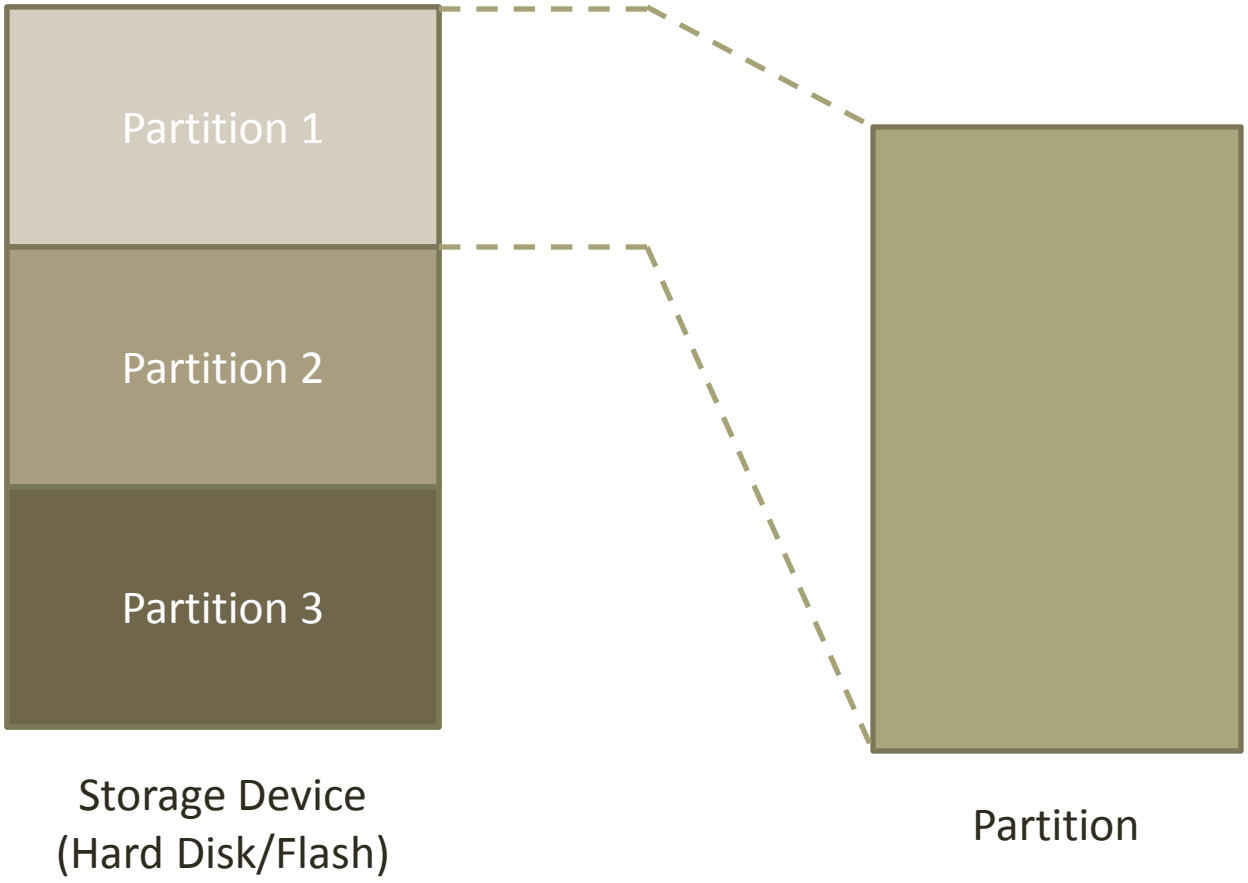
  $ sudo fdisk /dev/sda

- Using this command you can,
  - Display disk partitions
  - Create new partitions
  - Delete existing partitions
  - Change the size of existing partitions
- This is achieved by reading/writing in the partition table
- Note that ***fdisk*** does not support the **GPT partition table** format, for that use the ***parted*** command

Manage Disk Partitioin (fdisk Command)

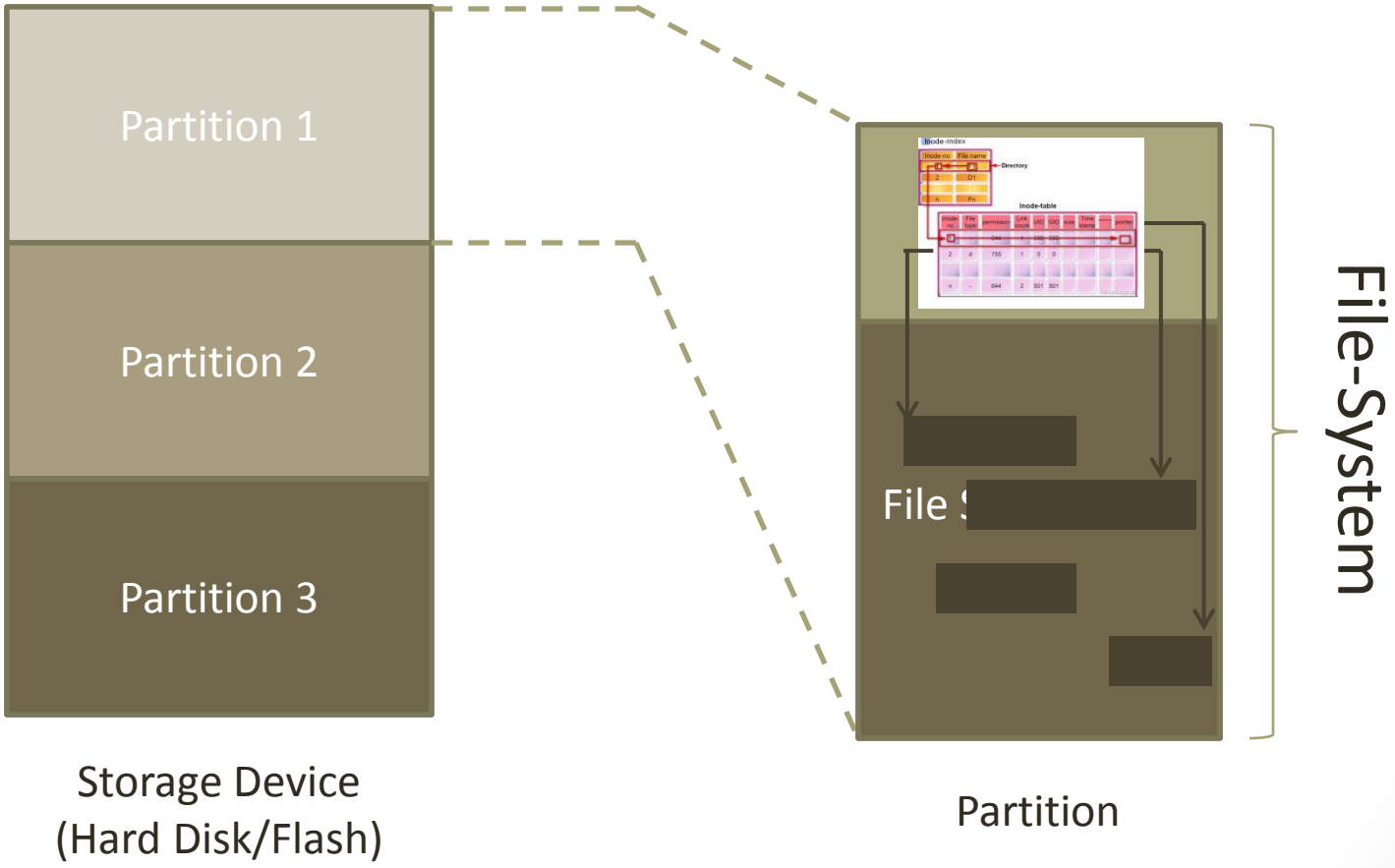


Great… So can we store Files Now ??

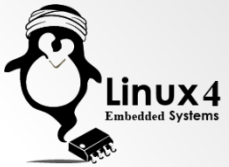


Step 3: Build & Install a File-System

Install a File-System

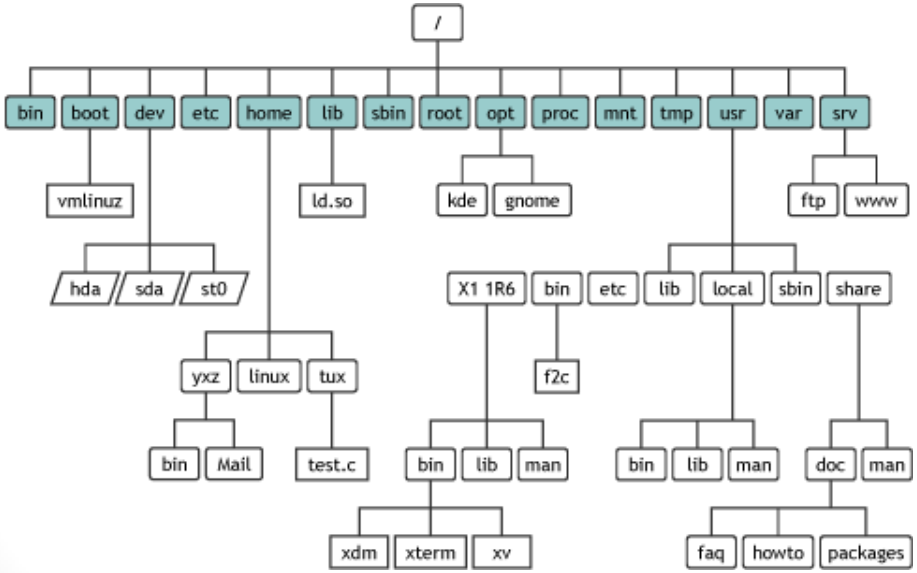


File-System Types

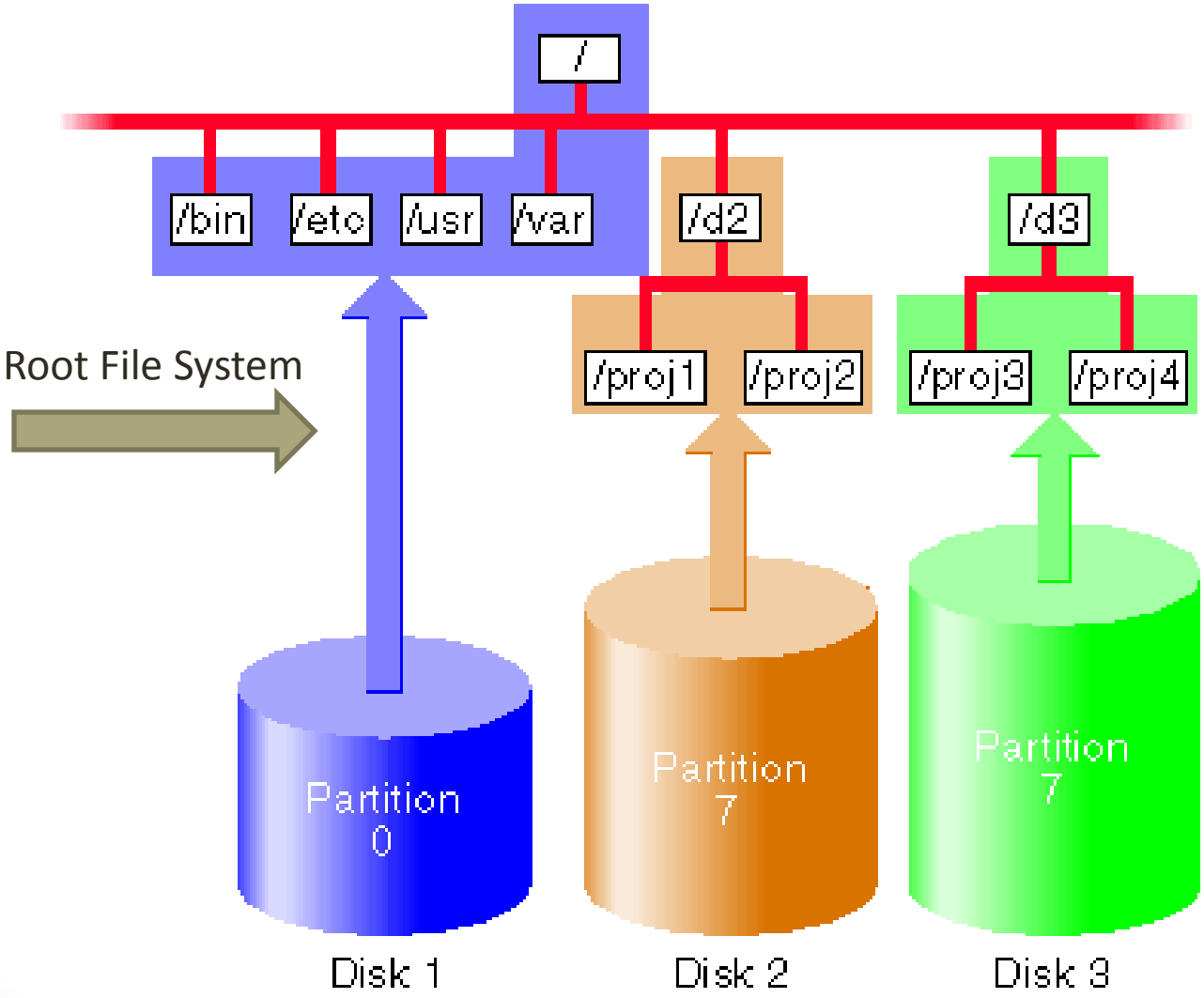


- There are different types of file systems
- We select the most suitable type for our needs based on,
  - Storage Media type (hard disk, flash memory, network, …)
  - Read only or Read/Write
  - Supported File Sizes
  - Optimize for Performance
  - Optimize for file Sizes (performs Compression)
  - Optimize for Security (Performs Encryption)
  - Supports data recovery after failures (Journaling)
  - Other Criteria
- There are some filesystems of special nature (such as **procfs**, **sysfs**)
- Some of the commonly used filesystem types are (**ext2**, **ext3**, **ext4**, **NTFS**, **FAT**, **JFSS2**, **NFS**, **…**)

Step 4: Mount the File-System



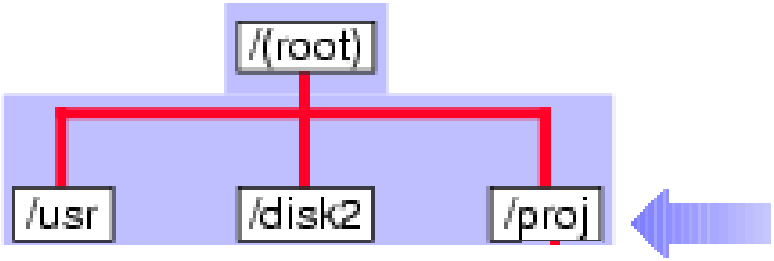
Mounting The FileSystem

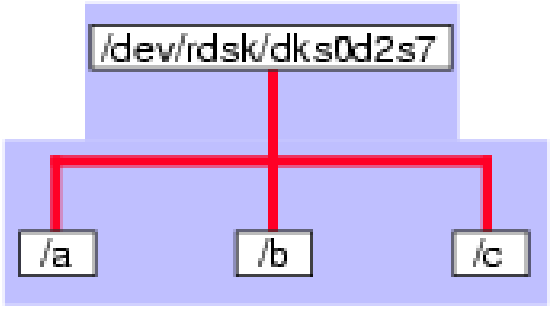


Root FileSystem

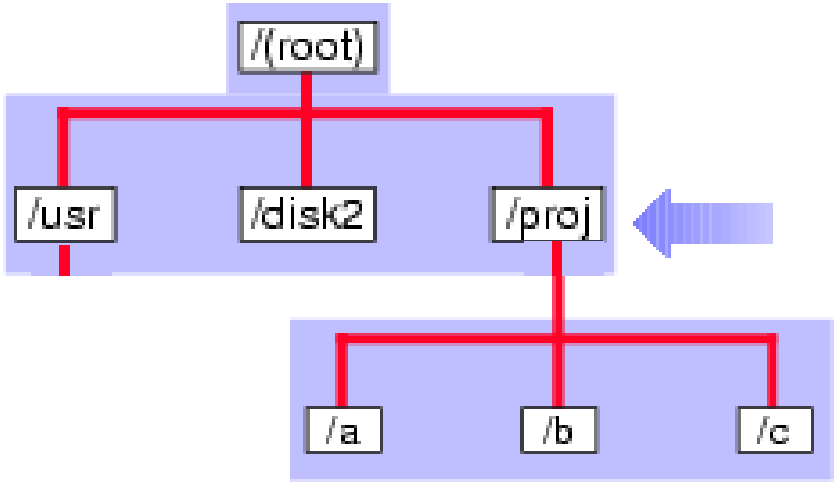
- The Root FileSystem is the filesystem that contains all the necessary files that is needed to start the system and make it operational
- It is mounted at startup of the kernel
- The mount point for the root filesystem is "*/*"
- This filesystem can not be un-mounted during operation
- Other Filesystems can be mounted and un-mounted after the root filesystem is mounted

Choosing The Mounting Point

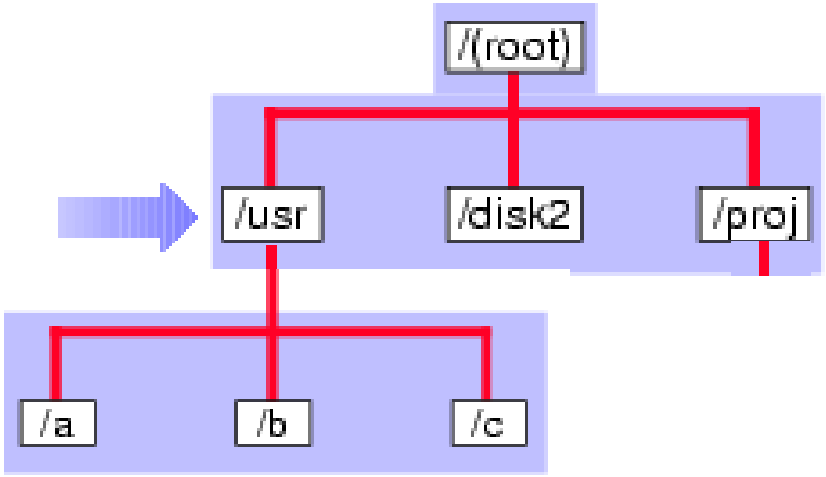




Choosing The Mounting Point



Choosing The Mounting Point



Mounting a filesystem

- When we mount a filesystem, we specify the mount point
- The mount point is the directory where we want to access the filesystem
- Before performing the mount, the directory need to be an empty directory
- Once, we perform the mount, the directory will contain the contents of the filesystem

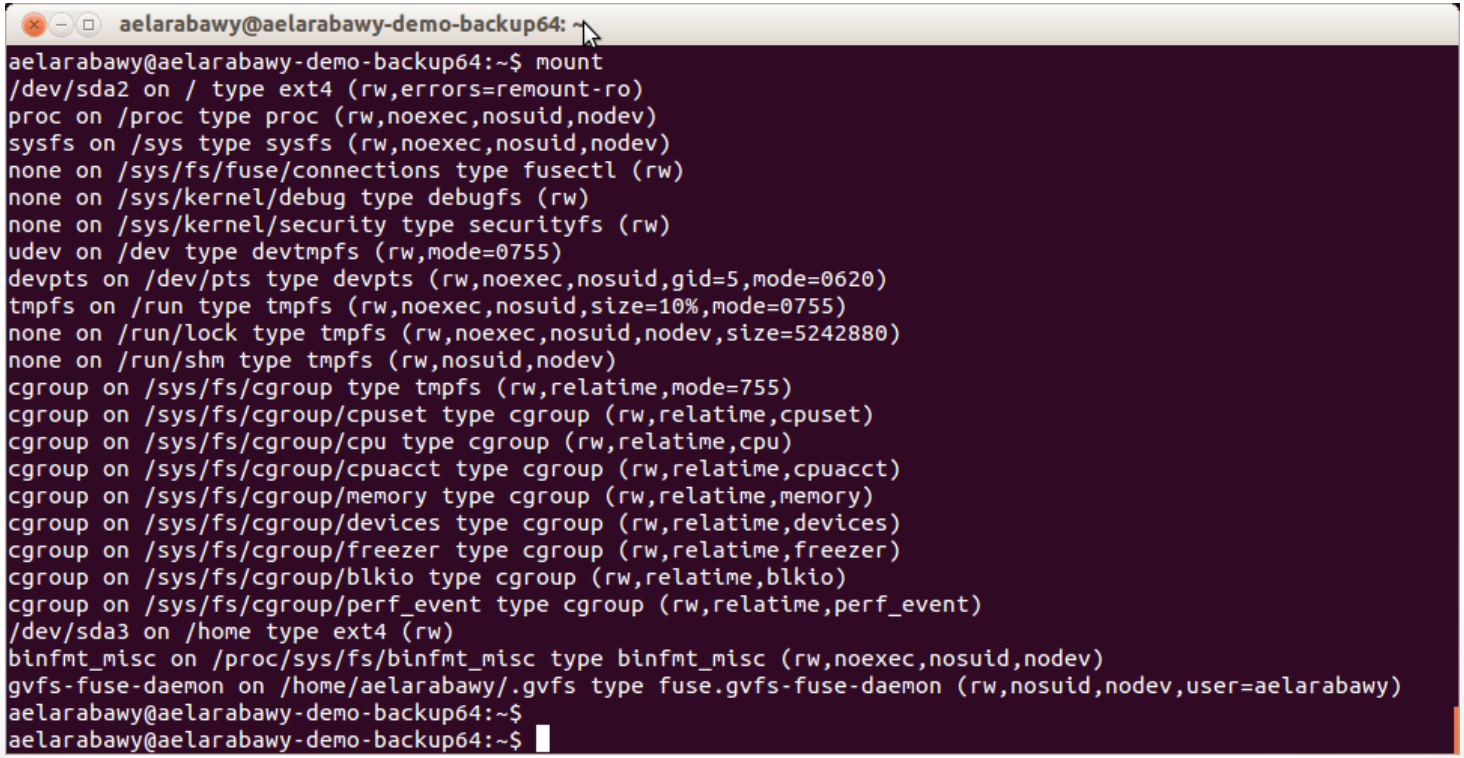
View Mounted File-Systems (mount Command)

$ mount

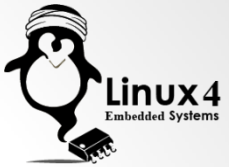
$ mount -l

$ mount -l -t <fs Type>

- This command displays the mounted filesystems along with their info including their mount point and associated device



Mounting a File-Systems (mount Command)



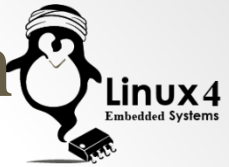
$ mount -t <fs Type> <device> <mount point>

- This command mounts the filesystem (of a certain type) for a certain block device file to a mounting point
- Examples:

  $ sudo mount -t ext4 /dev/sda1 /home/aelarabawy/project/

  $ sudo mount -t iso9660 -o ro /dev/sr0 /mnt

Mounting/Un-Mounting a filesystem (umount Command)



$ umount <device>

$ umount <mount point>

- This command unmounts the filesystem that was previously mounted. The filesystem can be identified by its,
  - Associated device (example ***/dev/sd1***)
  - Associated mount point (example ***/mnt/SdCard***)

/etc/fstab File

- The **/etc/fstab** file contains a list of filesystems along with their description
  - Mount point
  - Associated device
  - Filesystem type
- This file can be utilized by the mount command,
  - To mount a filesystem that is listed in **/etc/fstab** you don't have to list all its info, it is enough to specify its device name or its mount point

    $ sudo mount /dev/sd2

    $ sudo mount /mnt/my-SD-Card
    - The mount command will read the rest of the information from the /etc/fstab file
- To mount / unmount all filesystems listed in **/etc/fstab**

  $ sudo mount -a

  $ sudo umount -a

Linux 4 Embedded Systems

http://Linux4EmbeddedSystems.com