Linux Admin

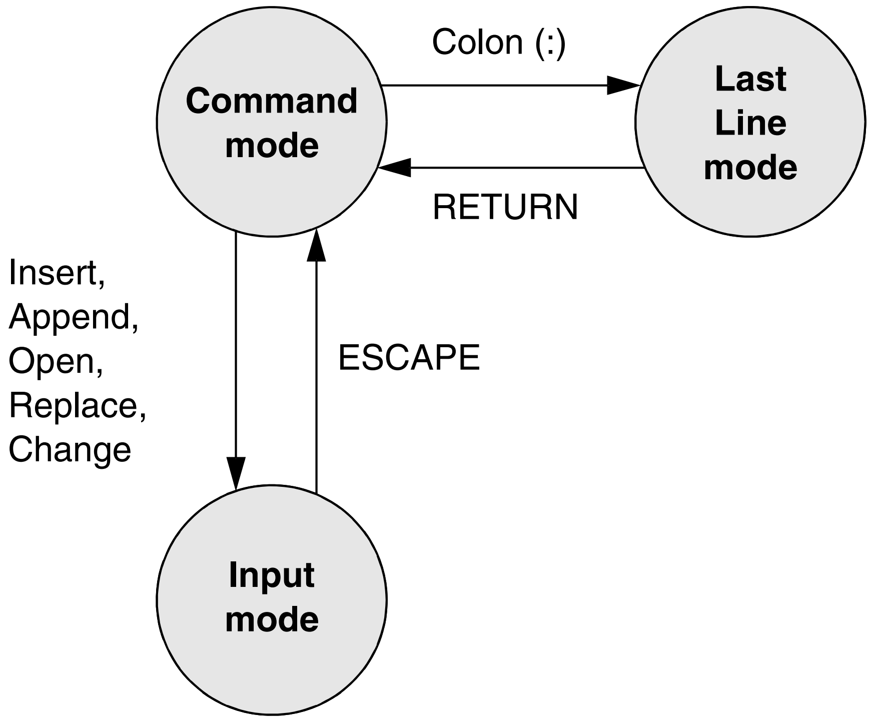
Class 2 - File System Administration

By Ian Robert Blair, M.Sc.

Agenda

- Vi Text Editor
- Text Editing
- Permissions and ACLs
- Filesystem Admin

VIM Text Editor



Command	Description
vi file	Open file in text Editor
x, dw, dd	Delete character, word, and line
y, yy	Copy word, line
p	paste
u, :redo	undo and redo
i, a	Insert and append
o, O	Open a blank line below, above the current line
:q!, :wq!	Exit and Save then exit
:help	get help

Text Commands

Command	Description	Popular Options
cut	Cut lines from a file	-d -f n
diff file1 file2	Displays the differences between two files or folders	-i (ignore case), -r (recursive)
paste	paste file together	
join	join files by column	
split infile outfile	split large file	-b (bytes) -l (lines)
cat/tac file	Displays the contents of a text file	
grep	Searches file(s) for a string	

Text Commands

Command	Description	Popular Options
head file	Displays the lines at the topof a file	-xx *(number of lines)*
tail file	Displays the lines at the end of a file	-xx, -f
sort file	Display a file in order	
uniq file	Removes duplicate lines from a file	
wc file	Count words, lines, or characters in file Example: cat long_book | wc -l	-l (lines), -w (words), -m (characters)

Important Directories 1

Command	Description
/	The root directory, present in all Linux filesystem structures, is the ancestor of all files in the filesystem
/bin	Essential command binaries and files needed to bring the system up and run it when it first comes up in single-user mode
/boot	Contains all the files needed to boot the system
/dev	Contains all files that represent peripheral devices, such as disk drives, terminals, and printers
/etc	Holds administrative, configuration, and other system files
/home	User home directories
/lib	Shared libraries
/lib/modules	Loadable kernel modules
/mnt	Mount point for temporarily mounting filesystems
/opt	Add-on (optional) software packages
/proc	Kernel and process information virtual filesystem
/root	Home directory for the root account

Important Directories 2

Command	Description
/tmp	Temporary files
/usr	Traditionally includes subdirectories that contain information used by the system
/usr/bin	Contains the standard Linux utility programs
/usr/include	Header files included by C programs
/usr/lib	Libraries
/usr/local	Holds locally important files and directories that are added to the system. Subdirectories can include bin, games, include, lib, sbin, share, and src.
/usr/share/doc, info, man	Documentation, Info, man pages
/usr/src	Source code
/sbin, /usr/sbin	Utilities used for system administration are stored in /sbin and /usr/sbin. The /sbin directory includes utilities needed during the booting process, and /usr/sbin holds utilities used after the system is up and running

Important Directories 3

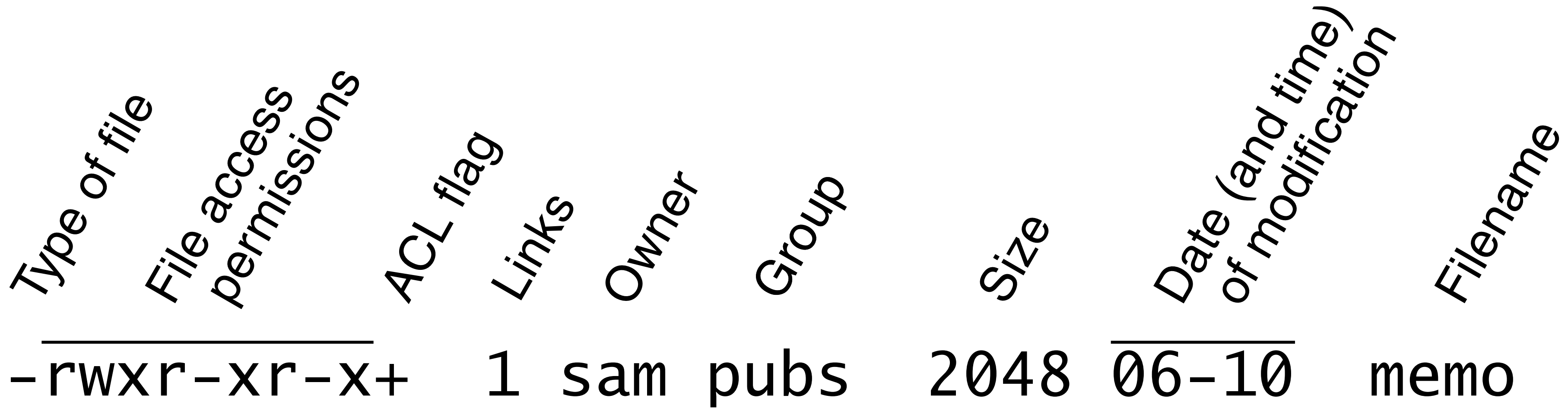
Command	Description
/var	Files with contents that vary as the system runs are kept in subdirectories under /var. The most common examples are temporary files, system log files, spooled files, and user mailbox files. Subdirectories can include cache, lib, lock, log, mail, opt, run, spool, tmp, and yp.
/var/log	Log files
/var/spool	Spooled application data, like anacron, at, cron, lpd, mail, mqueue, samba, and other directories

Permissions

- Three types of users can access a file: the **owner** of the file, a member of a **group** that the file is associated with, and **others**

- A user can attempt to access an ordinary file in three ways: by trying to **read** from, **write** to, or **execute** it

- Execute permissions for a directory allows a user to **cd** into that directory



```
-rwxr-xr-x+  1 sam pubs  2048 06-10  memo
```

Permission Commands

Usage	Description	Popular Options
chmod permission file	Change access permissions	u, a, o, g, +, -, =, r, w, x, s or 4 (read), 2 (write), 1 (execute)
chown user file	Change ownership of file or folder	-r
chgrp group file	Change group of file or folder	-r
setuid	The process executing the file takes on the privileges of the file's owner	4000
setgid	The process executing the file the privileges of the group the file is associated with	2000

Examples:

```
chmod o-rx check_spell
chmod 600 letter.0210
chmod 4755 myprog1
chmod o+r /home/max/info
```

Special Permissions

- **SGUID** on directories - file inherit the parent directories group, instead of the primary group of the owner

- **Sticky bit** on directories - prevents files from being deleted, except by root or owner (recommended for shared directories)

- For more info: http://www.linux.com/learn/tutorials/309527-understanding-linux-file-permissions

Additional Utilities

- The umask shell builtin specifies the mask the system uses to set up access permissions when it creates a file
  - umask [mask]

ACLs

- **ACLs (Access Control Lists)** provide finer-grained control over which users can access specific directories and files than do traditional Linux permissions

- An ACL comprises a set of rules, that specify how a specific user or group can access the file that the ACL is associated with

- There are two kinds of rules: **access rules** and **default rules**

ACLs, cont.

- An **access rule** specifies access information for a single file or directory

- A **default ACL** pertains to a directory only; it specifies default access information (an ACL) for any file in the directory that is not given an explicit ACL.

- To preserve ACLs use **cp** with **-a** or **-p** option, most other utilities don’t support ACLs (tar, cpio, dump, etc.)

ACL Commands

Usage	Description	Popular Options
getfacl	Show ACLs	
setfacl	Set, modify, or delete ACLs	-d (default) -x (remove)/-m (modify) ugo:name:permission files

Examples:

```
setfacl --modify u:sam:rw- report or setfacl --modify u:sam:6 report
setfacl -x u:sam report
setfacl -d -m g:pubs:r-x,g:adm:rwx dir
```

Links

- A link is a pointer to a file

- A **hard link** is a pointer to a file (the directory entry points to the inode), whereas a **symbolic or soft link** is an indirect pointer to a file (the directory entry contains the pathname of the pointed-to file—a pointer to the hard link to the file)

- **rm** removes a link

Link Commands

Usage	Description	Popular Options
ln	Create links	-s

Examples:

```
ln draft /home/max/letter
ln -s /home/max/grades /tmp/grades.old
```

Devices

- Device files include both **block** and **character** special files and represent device drivers that allow the system to communicate with peripheral devices, such as terminals, printers, and hard disks
- Device files appear in the **/dev** directory and its subdirectories
- After running **ls -l /dev**, the first character of each line is always –, b, c, d, l, or p, representing the file type—ordinary (plain), block, character, directory, symbolic link, or named pipe, respectively

Popular File Systems

File Systems	Description
ext2	A standard linux filesystem
ext3	A journaling extension to the ext2 filesystem
ext4	An extension to the ext3; provides improved performance over ext3 the filesystem.
iso9660/UDF	Standard filesystem for CDs and DVDs
vfat	Developed by Microsoft, a standard that allows long filenames on FAT partitions
NTFS	Microsoft's current file system
reiserfs	A fast journaling file system based on balanced-tree algorithms with optimized disk space utilization and quick crash recovery.
xfs	A high-performance journaling file system developed by Silicon Graphics Incorporated originally for its IRIX family of systems. It supports very large file and partition sizes
btrfs	New file system created by Oracle; large files, RAID, snapshots, compression, multiple devices, resizing, and online defragmentation

Mounting File Systems

- The **mount** utility connects directory hierarchies—typically filesystems—to the Linux directory hierarchy
- This directory, **mount point**, must exist before you can mount a filesystem
- Its contents disappear as long as a filesystem is mounted on it and reappear when you unmount the filesystem
- Without any arguments, mount lists the mounted filesystems
- The **umount** utility unmounts a filesystem as long as it does not contain any files or directories that are in use (open)

Mount Points 1

- **Mounting** a filesystem associates the filesystem with a directory in the directory hierarchy

- A filesystem can be mounted on any directory (**mount point**) in the directory hierarchy

- For example, the **/dev/sda2** partition can be mounted on **/home** when the system boots allowing you to access it as the /home directory

- One filesystem does not affect other filesystems

- One filesystem on a drive might be corrupt and unreadable, while other filesystems function normally

Mount Points 2

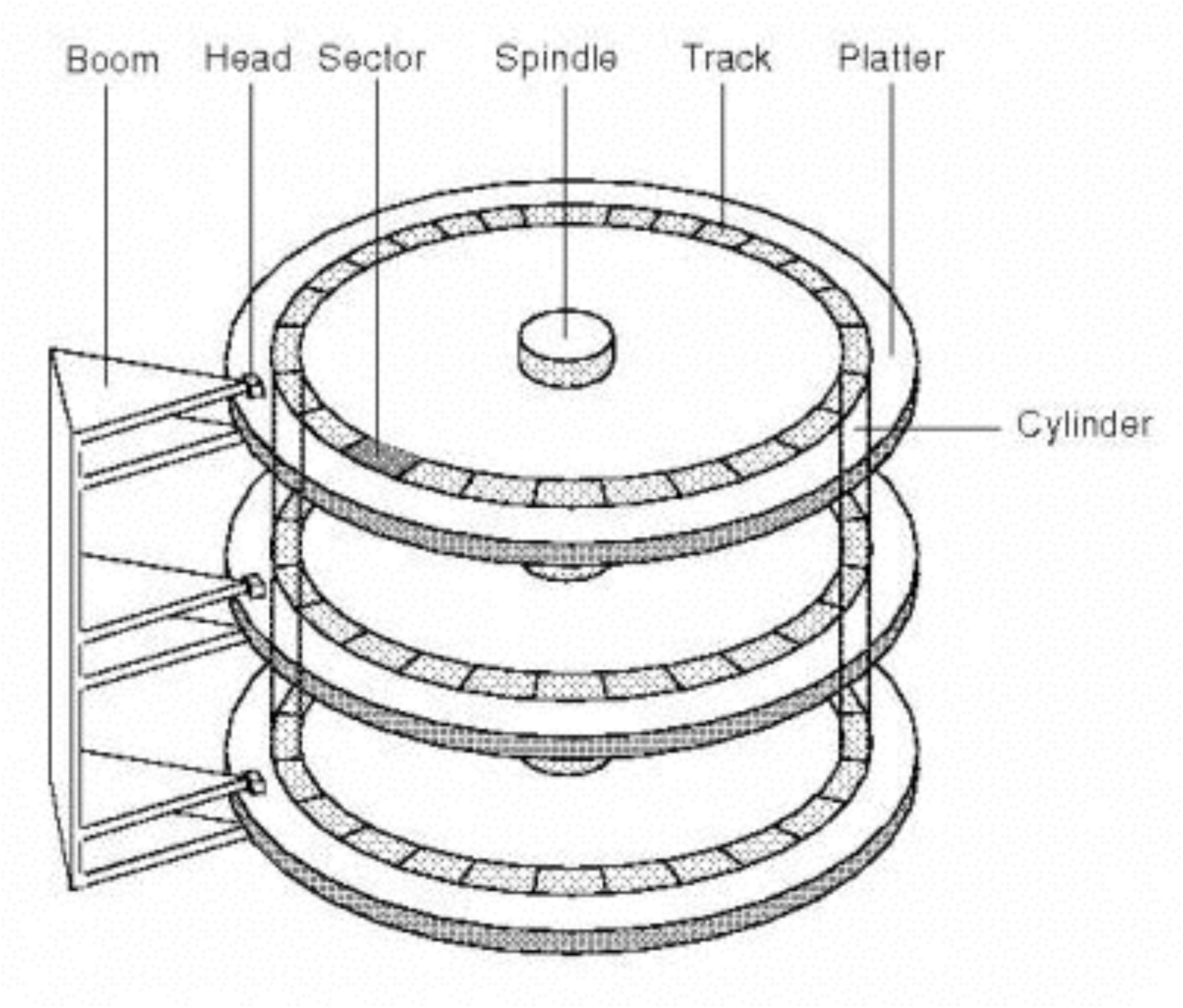
Mount Point	Description
/ (root)	Any directories you do not create filesystems for automatically become part of the root (/) filesystem
(swap)	Space for swapping programs out of RAM; Used when a system hibernates; minimum 1.5x the size of RAM; Not mounted
/boot	Holds the kernel and other data the system needs when it boots; ext2
/var	data in this partition changes frequently; holds the bulk of system logs, package information, and accounting data
/home	user home directories

FileSystem Commands

Command	Description	Popular Options
mount /fs /mp	Mount a filesystem(fs) on a mount point (mp)	-t (file system type)
umount /mp	Remove a mount file systems	
tune2fs filesystem	Displays and modifies filesystem parameters on ext2, ext3, and ext4 filesystems	
fsck filesystem	Verifies the integrity of filesystems and, if possible, repairs problems it finds	-A (check all file systems in fstab), -R (don't check root)

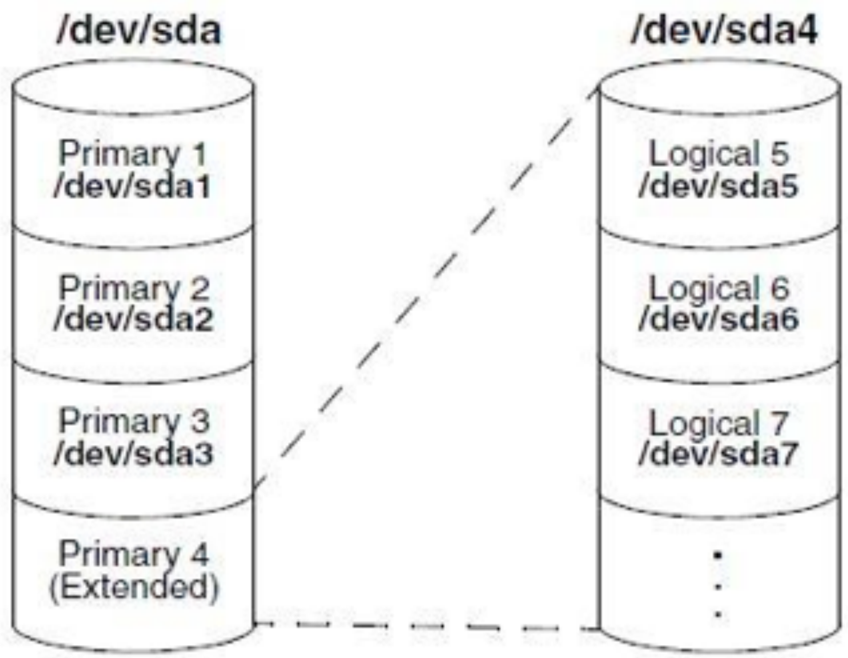
# tune2fs -c 8 -i 15 /dev/sda1 # forces a fsck every 8 boots or 15 days, which ever occurs first
# tune2fs -l /dev/sdb1   #reads information about the partition

Hard Drive Anatomy



Partitions 1

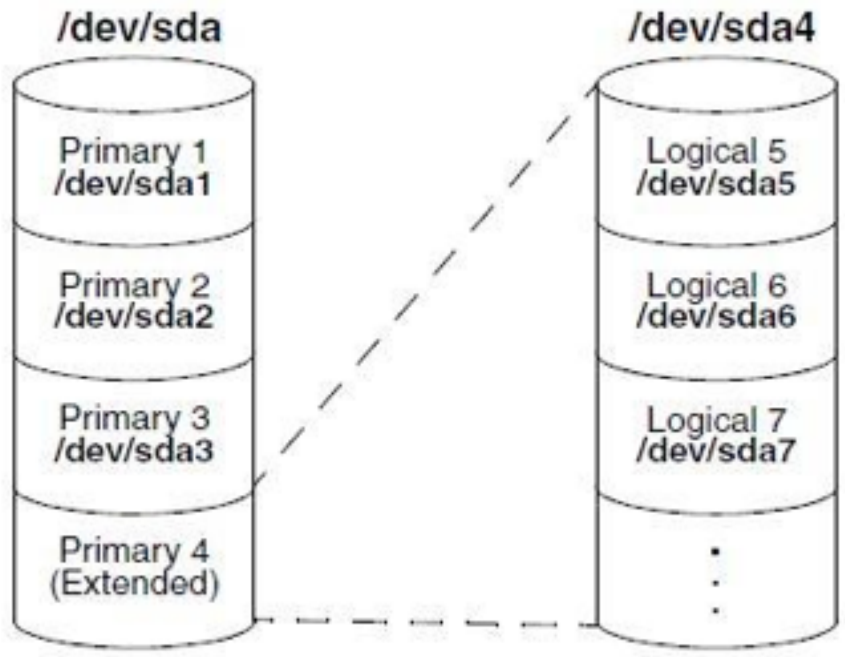
- A **partition,** or slice, is a logical section of a hard disk that has a device name, such as **/dev/sda1**
- A **partition table** holds information about the partitions on a hard disk
- Before you can use a partition, a **filesystem** needs to be written
- A filesystem is data structure that holds **inodes** that map locations on the disk that store files to the names of the files
- You can use the **mkfs** utility to manually create a filesystem on a partition



Partitions 2

- A typical disk is divided into **three primary partitions (1-3)** and **one extended partition (4)**

- Once you establish the extended partition, you can subdivide it into additional logical partitions (numbered 5 or greater)



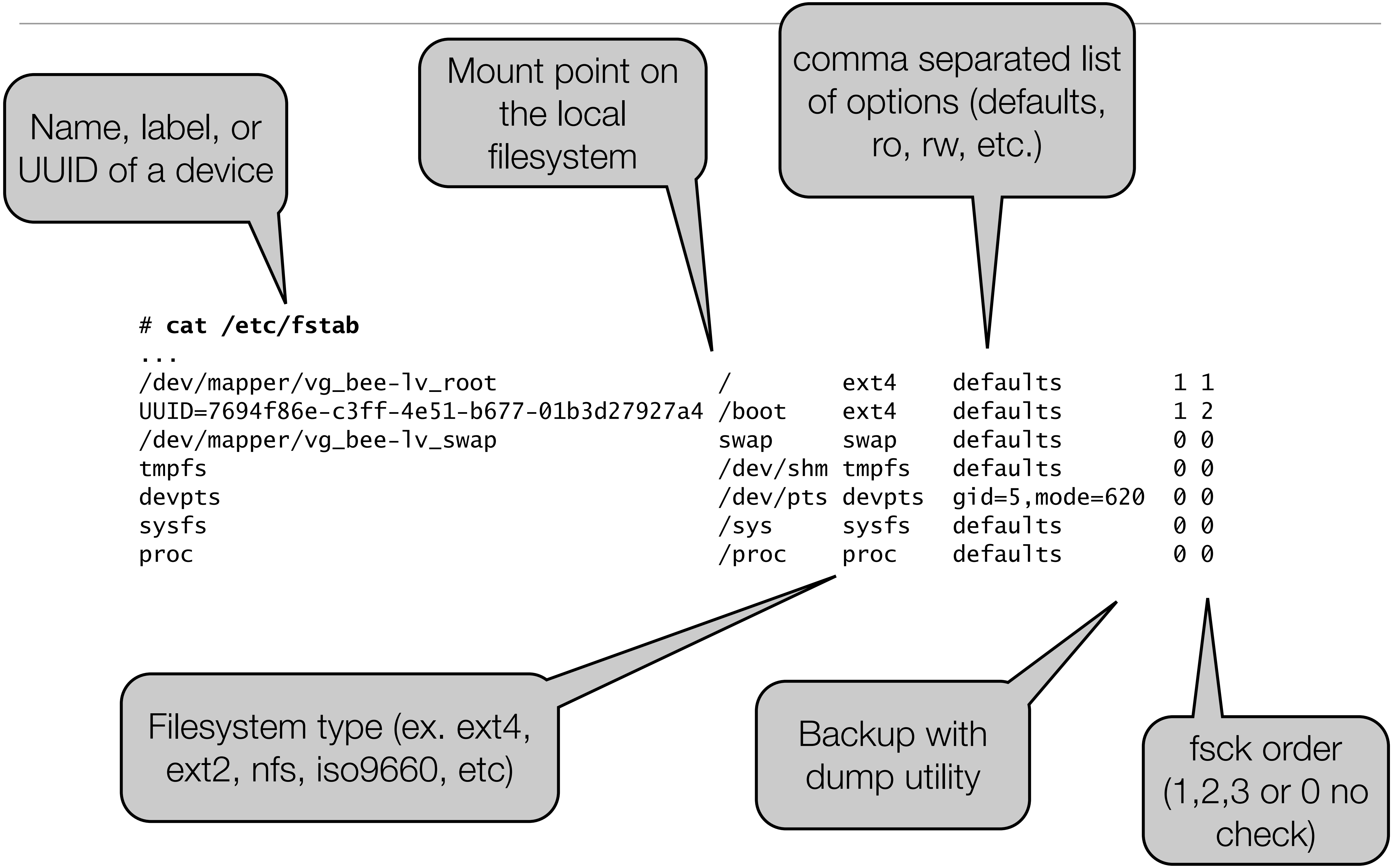
Disk Management

- The **parted** (partition editor) utility reports on and manipulates hard disk partitions from the command line
- The **palimpsest** utility allows you to perform the same tasks using a GUI
- parted **/dev/sdb**
  - mklabel, mktable
  - mkpart
- Create filesystem
  - mkfs -t ext4 /dev/sdb1

Disk Management

- The **e2label** utility displays or creates a volume label on an ext2, ext3, or ext4 filesystem
  - e2label device [newlabel]
- The **blkid** utility displays labels, UUID value, and filesystem type for block devices

/etc/fstab



Name, label, or UUID of a device

Mount point on the local filesystem

comma separated list of options (defaults, ro, rw, etc.)

```
# cat /etc/fstab
...
/dev/mapper/vg_bee-lv_root                     /        ext4    defaults        1 1
UUID=7694f86e-c3ff-4e51-b677-01b3d27927a4 /boot    ext4    defaults        1 2
/dev/mapper/vg_bee-lv_swap                     swap     swap    defaults        0 0
tmpfs                                          /dev/shm tmpfs   defaults        0 0
devpts                                         /dev/pts devpts  gid=5,mode=620  0 0
sysfs                                          /sys     sysfs   defaults        0 0
proc                                           /proc    proc    defaults        0 0
```

Filesystem type (ex. ext4, ext2, nfs, iso9660, etc)

Backup with dump utility

fsck order (1,2,3 or 0 no check)

du/df

- **df** - Display overall disk utilization information for mounted filesystems on file
    - df -h
- **du** - Display disk utilization information for directories
    - du -sh /home/*

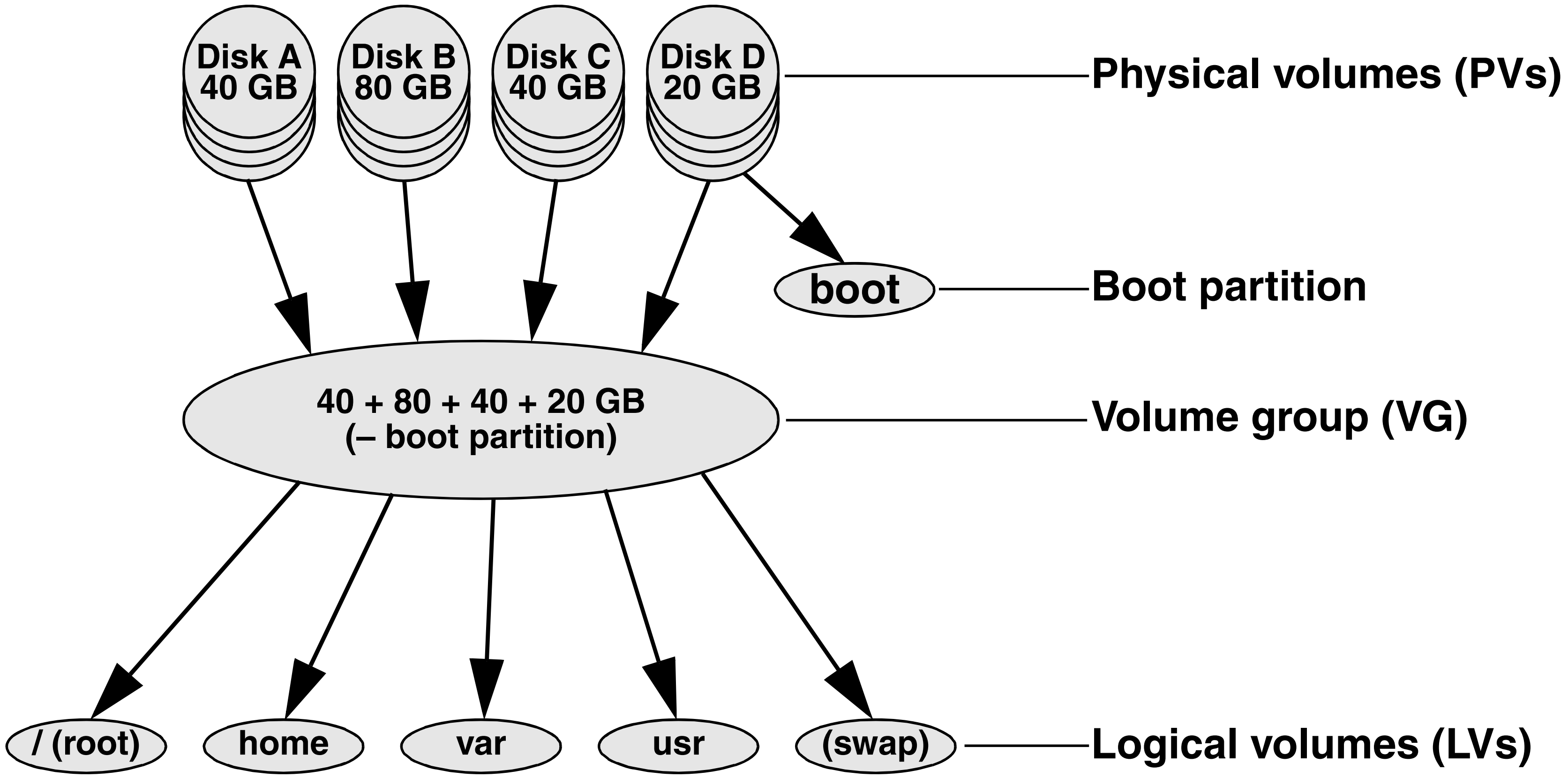
Additional Utilities 2

- The **lsof (list open files)** utility displays the names of open files
  - lsof -s -p pid
- The **stat** utility displays information about a file or filesystem
  - stat -f /dev/sda
- The **lsshw, lsusb, lspci** utility (lshw package, Fedora only) lists system hardware

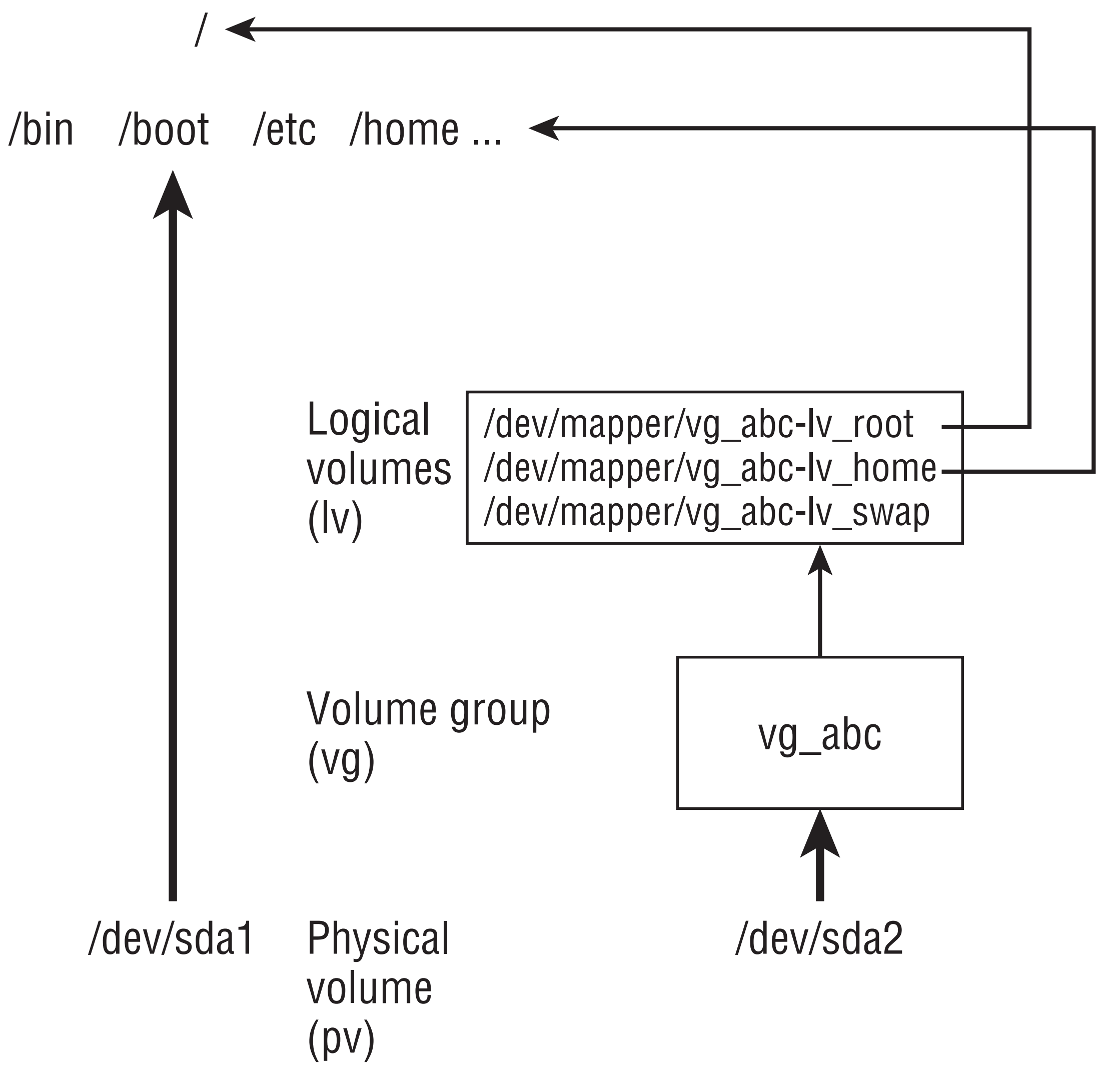
LVM 1

- The **Logical Volume Manager** allows you to change the size of logical volumes on the fly

- With LVM, if you make a mistake in setting up LVs or if your needs change, you can make LVs either smaller or larger without affecting user data



LVM



/
/bin /boot /etc /home ...
Logical volumes (lv)
/dev/mapper/vg_abc-lv_root
/dev/mapper/vg_abc-lv_home
/dev/mapper/vg_abc-lv_swap
Volume group (vg)
vg_abc
/dev/sda1
Physical volume (pv)
/dev/sda2

LVM 2

Command	Description
pvcreate	Initializes volume for use with LVM
pvdisplay/pvs	Displays information on the physical volume
pvremove	Removes physical volume from a partition

LVM 3

Command	Description
vgcreate	create a volume group
vgextend	Add physical volumes to volume group
vgreduce	Remove physical volumes
vgdisplay/vgs	Displays information on the physical volume
vgremove	Removes volume group
vgrename	Renames a group

LVM 4

Command	Description
lvcreate	Create logical volumes
lvreduce, lvextend, lvresize	Grows/Shrinks volume
lvdisplay/lvs	Display logical volume information
lvrename	Renames volume
lvremove	Removes physical volume from a partition
lvscan	Scans disk partitions for LVM data structures

Create a Logical Volume 1

- pvcreate /dev/sdb1
- vgextend VolGroup /dev/sdb1
- lvcreate -L 1G -n backup VolGroup
- mkdir /mnt/backup
- mount /dev/VolGroup/backup /mnt/backup
- df -hx tmpfs

Create a Logical Volume 2

- To create a snapshot of a volume:
  - lvcreate -L 10G -s -n snappy /dev/speaker/PCLOS
- To restore a snapshot (reboot required):
  - lvconvert --merge /dev/speaker/snappy

Hardware

- Server failures directly impact a company's revenues, financial performance, productivity, and reputation
- The severity of a failure can range from not being able to back up data for a couple of days, to being out of business while the server is down
- The ultimate impact of server failure depends on how critical the application is to the organization

Oracle
SPARC T4-4 Server
4 x 8-Core, 3Ghz Sparc CPUs

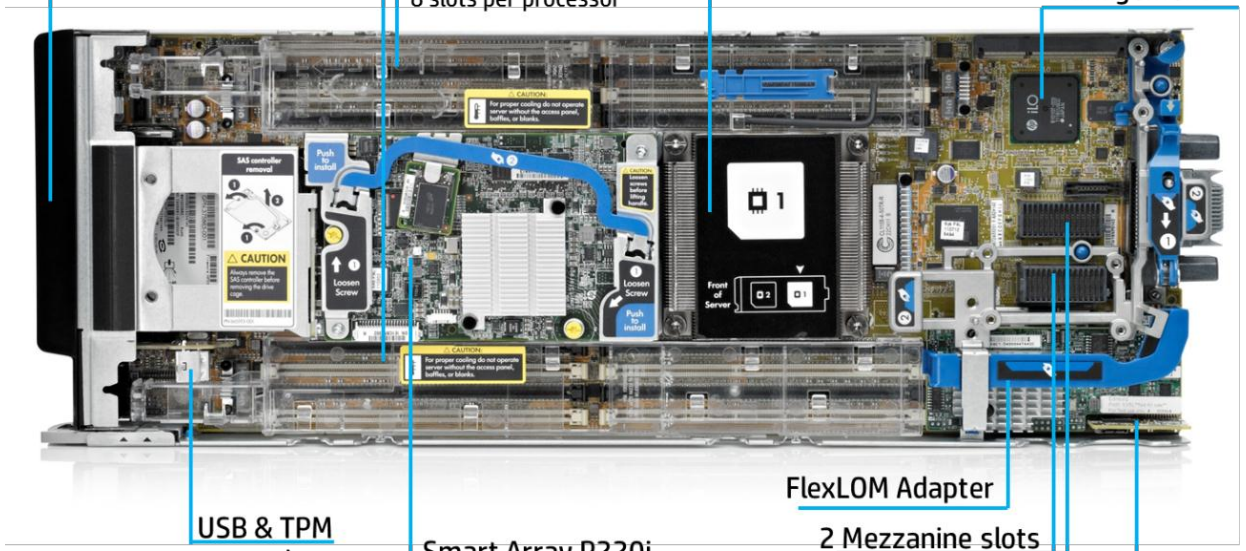
High Availability and Fault Tolerance

- **Back-end** servers must have a high level of redundancy
- Use of more costly technologies, including hardware items such as:
    - Multiple power supplies
    - An Uninterruptible Power Supply (UPS)
    - Hot-swappable PCI slots
    - Hot-swappable hard disks
    - Multiple network cards
- **Fault tolerance** involves a server system's capability to successfully respond to a sudden software or hardware failure

Scale Up/Out

- Two common methods are used to upgrade servers
- They are referred to as either scale up or scale out:
  - In a **scale-up** operation, components are added to the server computer, making it more powerful (CPU, Memory, Storage, etc.)
  - In **scale-out** operations, additional servers are installed, load-balancing techniques are implemented, and increased out-of-chassis redundancy is also employed
- Three primary factors that server system administrators take into account when deciding between scale-up or scale-out scenarios are capacity, reliability, and cost

Server Blades



Two hot-plug drive bays
SATA/SAS/SSD (2.0TB)

16 DIMM slots
To 1600MHz DDR3;
8 slots per processor

1 or 2 Intel Xeon E5-2600
To 8 core each and130W

iLO 4 On System Management

USB & TPM connectors

Smart Array P220i
RAID 0/1; 512MB FWBC

FlexLOM Adapter

2 Mezzanine slots
x16 PCIe Gen 3

Micro SDHC connector

Midsize Server Hardware

HP DL580 G7 Server
2 or 4 Intel Xeon 10-core or 8-core CPUs 2.40 GHz
2TB Maximum Memory
Quad Port 1Gb Ethernet Network Adaptor or Dual 10Gb Ethernet
HP Smart Array Controller w/ 1GB Cache
8 Hot plug SAS/SSD Drives (1TB SAS/800GB SSD)
Price Range $9000-40,000+USD

Large Server Hardware

HP DL980 G7 Server
8 x Intel Xeon 10-core or 8-core CPUs 2.40 GHz
4TB Maximum Memory
Quad Port 1Gb Ethernet Network Adaptor or Dual 10Gb Ethernet
HP Smart Array Controller w/ 1GB Cache
8 Hot plug SAS/SSD Drives (1TB SAS/800GB SSD)

Datacenter

Microsoft

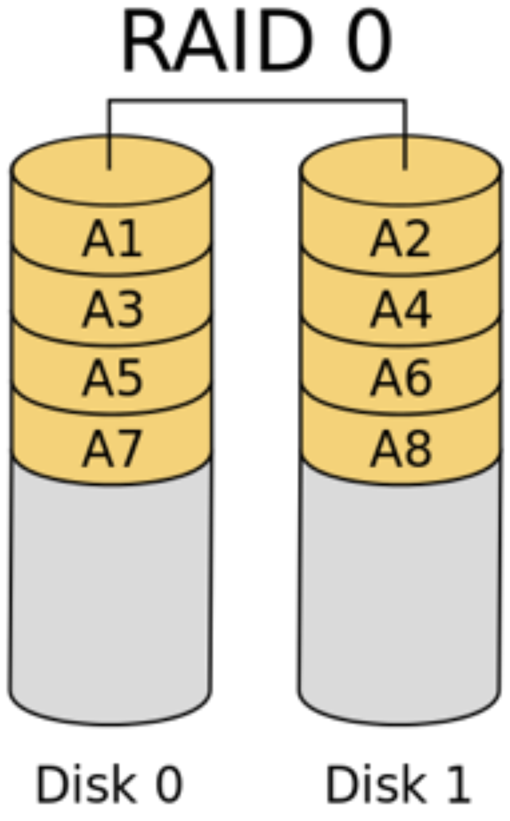
Google

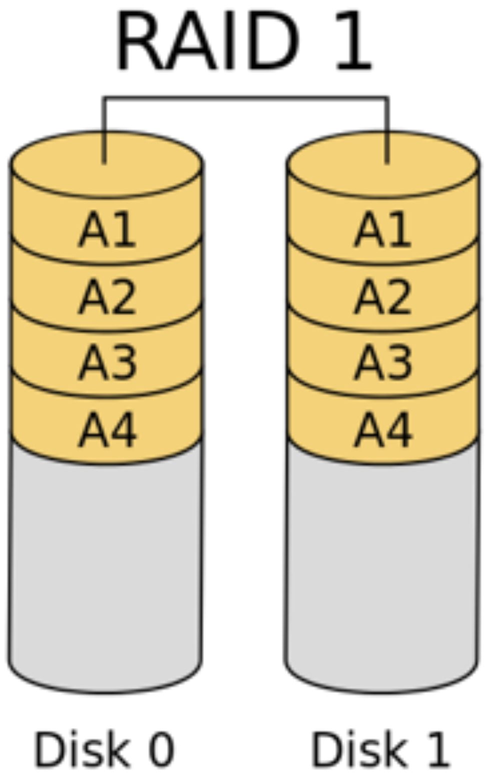
- A **data center** is a facility used to house computer systems and associated components, such as telecommunications and storage systems

- It generally includes redundant or backup power supplies, redundant data communications connections, environmental controls (air conditioning fire) and security devices

RAID, pt. 1

- **RAID level 0** (striping)—Improves performance but offers no redundancy
- **RAID level 1** (mirroring)—Provides simple redundancy, improving data reliability
- **RAID level 10** (mirroring and striping)—A combination of RAID 1 and RAID 0 (also called RAID 1+0)

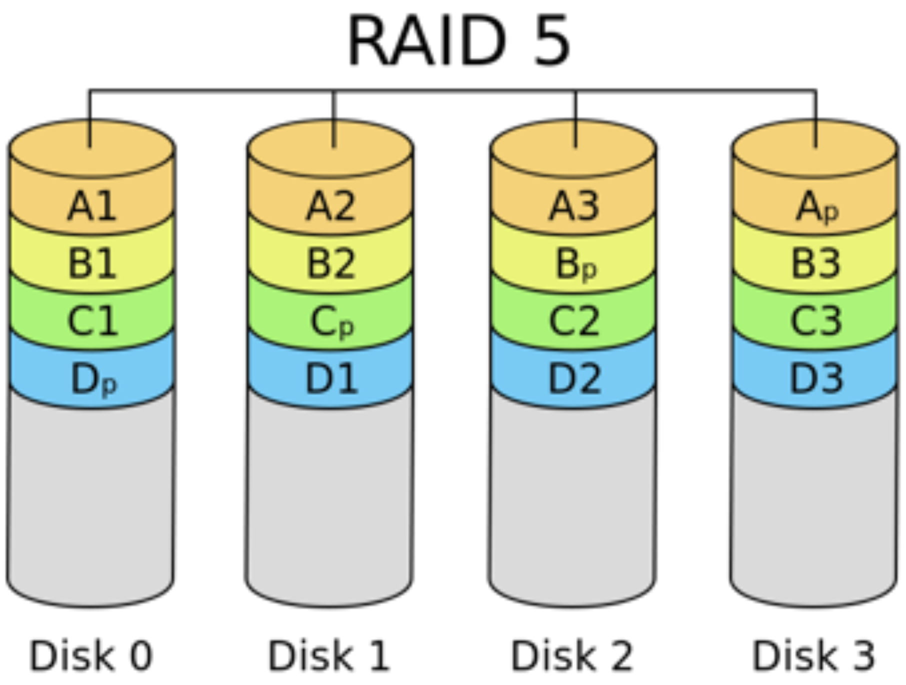


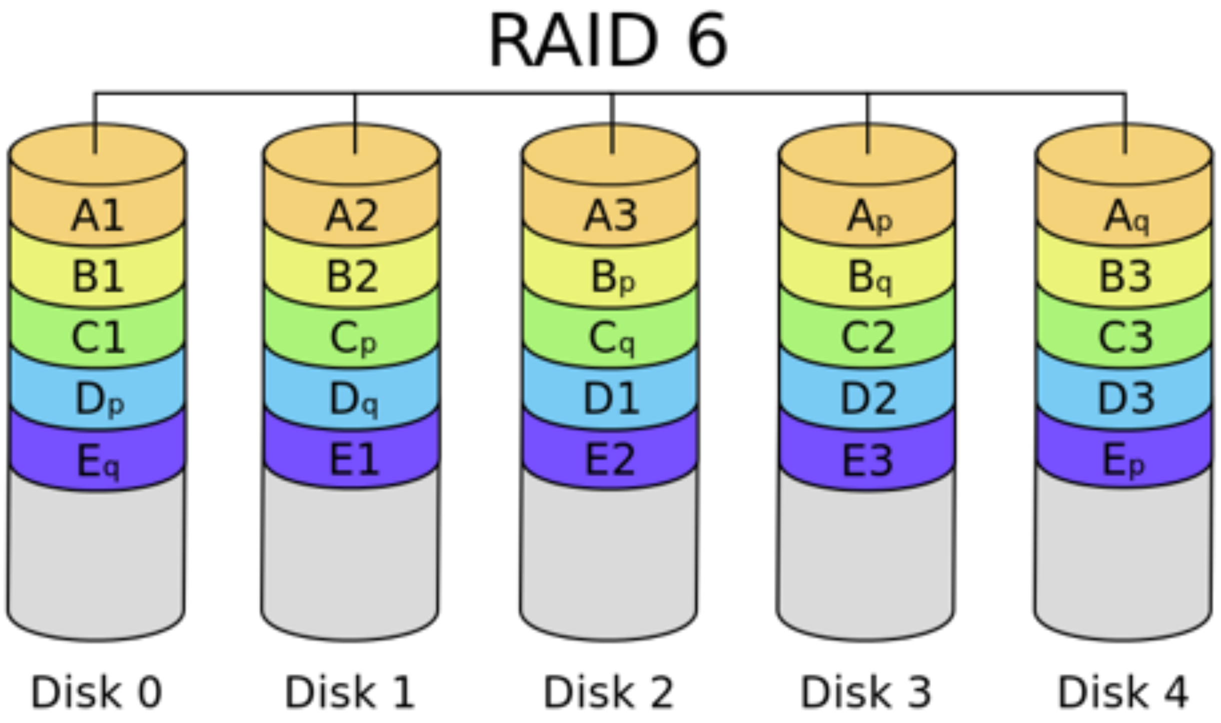


RAID, pt 2

- **RAID level 5** (disk striping with parity)—Provides redundancy and improves performance (most notably, read performance)

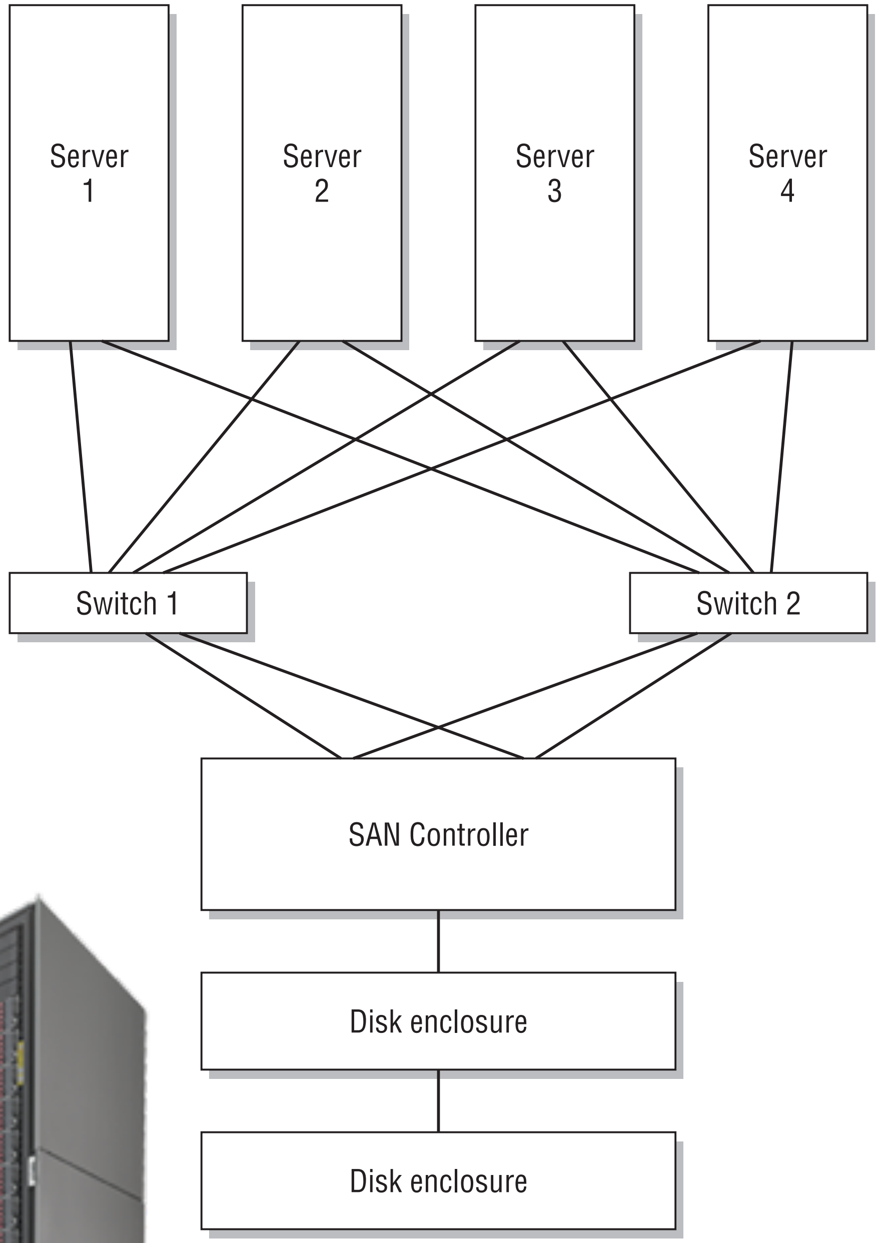
- **RAID level 6** (disk striping with double parity)—Improves upon level 5 RAID by protecting data when two disks fail at once





Storage Area Networks

- A **Storage Area Network (SAN)** is a high-speed subnetwork of shared storage devices
- Consists of system unit containing a number of disk drives for storing data and networking devices
- Connected through a server, or a cluster of servers, acting as access points for the clients
- Block data transfers over a SAN have performance advantages
- Many commercial enterprises use SAN-attached disks for their mass storage requirements



HP EVA P6550 Dual Controller Fibre Channel Array (720TB)

SAN, pt. 2

- Usually uses Fiber-channel or iSCSI (Ethernet) network technology
- Out-of-band
- Centralized tape and disk backup systems

HP StoreEver MSL6480
500TB Capacity/80 Slot
8Gb Fiber-channel

Lab

- Using Virtual Box create new hard drive and add it to your current system so that it re-connects at boot

- Optional: Create logical volumes on the new drive

Homework

- Read Chapters 7, 9, 27, Appendix A
- Do page 182, Exercise 1
- Do page 221, Exercise 2, 10
- Do page 528, Exercise 1-4

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