Disks and file systems

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I. Basic concepts

- Physical disks for storage
  - IDE, SCSI, USB, SATA, LVM, ….
  - Represent in file system /dev/hdX, /dev/sdX, /dev/fdX
  - X is alphabet character

Partitions

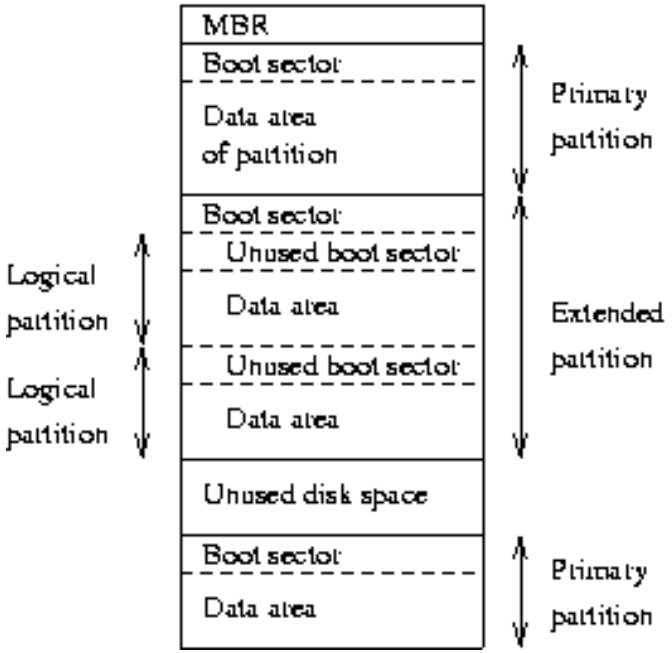
- Physical disks can be divided to multiple partitions
- OS can access parititions as logical disks
- Linux OS manages partitions as files, block device type
- Represented as dev/XY
  - X is the name of the disk
  - Y is the partition number in the disk
- Partitions of LVM or RAID can have different names

File systems

- A method and data structure that the operating system uses to control how data is stored and retrieved
  - Ex: NTFS, EXT2, EXT3, SWAP, ……..
- NTFS: file system for Windows OS. Can be read by new Linux kernels
- Linux file system
  - EXT2: 2nd Extended file system
  - EXT3: 3rd Extended file system
  - EXT4: 4th Extended file system

Structure of a disk

- Master boot record
- Boot record
- Primary partition (max 4)
- Extended Partition
- Logical Partition



II. Manage disks and partitions

- Tools: pdisk, fdisk, parted
- Operations
  - Show information of partitions
  - Delete a partition
  - Change the configuration of a partition
  - Create a new partition
  - Write changes to MBR

III. Manage file systems

- Create/Format a file system
- Check the file system
- Optimise the file system
- Use a file system

Create a file system

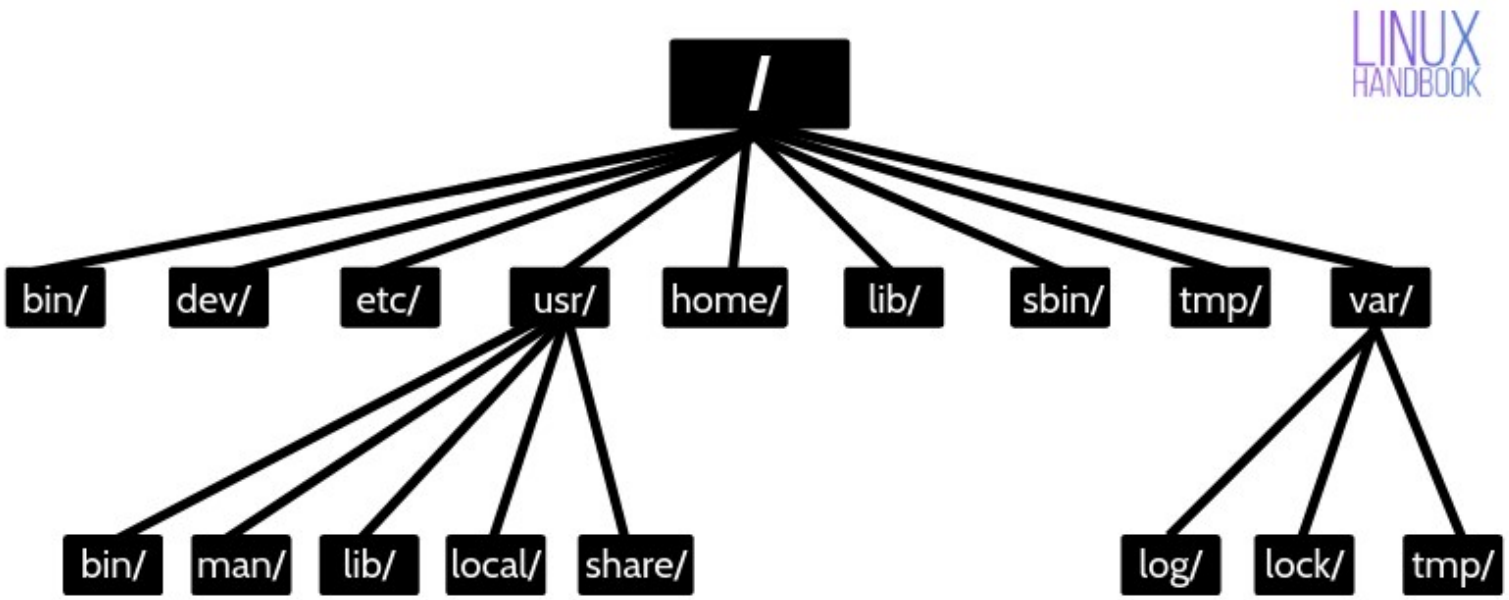
- mkfs
  - Create a file system on an empty partition
  - Use –t to specify the file system type
- It will link to the equivalent commands to create file systems for Linux
- mk2fs, mkfs.ext2 to create ext2 file system
- mk2fs -j, mkfs.ext3 to create ext3 file system

Format an ext2 file system

- -b block size
- -i byte numbers for one inode
- -c Number of mounts
- -j journal?
- -m reserve
- -r number of reserved blocks
- -g, -u group and users can use reserved storage

How to use file system

- Use command mount
  - Mount point
  - Mount device
  - File system
  - Other criteria
    - Read, write, quotas, ……
- /etc/mtab
  - The list of mounted file systems it is maintained by the mount and unmount programs
- umount: release the device
- fuser: processes are using files


/
bin/
dev/
etc/
usr/
home/
lib/
sbin/
tmp/
var/
bin/
man/
lib/
local/
share/
log/
lock/
tmp/

Options of mount command

option	Ý nghĩa
-t	File system type (ext2, ext3, vfat, ntfs, nfs, cifs, ...)
rw/ ro	Readonly, read-write
usrquota,grpquota	User and group quota
users/nousers	Allow users to mount/umount
exec/noexec	Allow to run executable files on the partition after mounting
sync/async	Synchronise/Asynchronise updates
suid/nosuid	
user=, password=	Provide username and password to connect with remote storage devices (network)
loop	Allow to work with virtual disks (files)

Mount when booting

- /etc/fstab: a list of filesystems to be mounted at boot time
- Example

```
[root@localhost ~]# cat /etc/fstab
#device                         mount point       fs      option dump chk
/dev/VolGroup00/LogVol00        /                       ext3    defaults      1 1
LABEL=/boot                     /boot             ext3    defaults      1 2
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
/dev/VolGroup00/LogVol01 swap                     swap    defaults        0 0
```

Operations to use a new disk

- Create new partitions by using fdisk.
- Format file systems for each partition by using mkfs (ext2/3/4)
- Label the partition by the command e2label.
- Create the mount point
- Try to mount
- Add a line to /etc/fstab if needed

Operations on disks

- df
  - Show information of disks
- dd
  - copy from a disk to another one
- du
  - Summarise storage and usage

Command dd

- dd: copy data at low level →block
- Can copy the whole partition/disk to a file and reversed
- Can be used to backup, copy or move partitions
- Require the same hardware backgrounds at the source and destination
- No data compression
- Speed is fast

Command dd

dd count=xxx if=/dev/hda of=/dev/hdb2

count: numbers of block

if: source

of: destination

dd count=xxx if=/dev/hda1 of=/dev/hdb2

dd count=xxx if=/dev/hda of=/dev/hdb

dd count=xxx if=/dev/hda1 of=/dev/hdb1

dd count=xxx if=/dev/hda of=f1

dd count=xxx if=f1 of=/dev/hda

Create and manage virtual memory

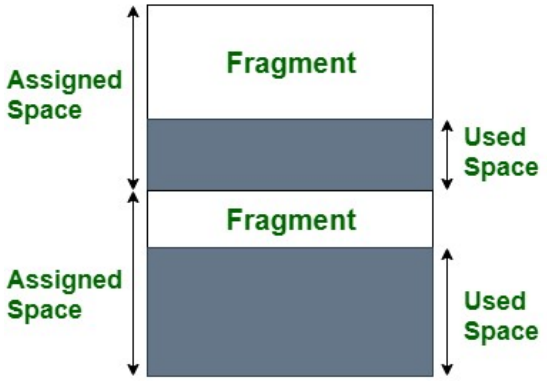
- Concept of virtual memory
  - Memory on hard disks when main memory is not enough for programs
- Virtual memory on Linux
  - Separate partitions, created when installing OS
- Use files for virtual memory
  - Paritions are managed as files
  - mkswap /test/swap.img; swapon /test/swap.img
- Use partitions as virtual memory
  - Change partition for swap partition
  - mkswap /dev/sda5; swapon /dev/sda5
- Can use multiple virtual memories
- Modify /etc/fstab to turn on swap when booting
  - /etc/fstab

/etc/fstab for multiple virtual memory

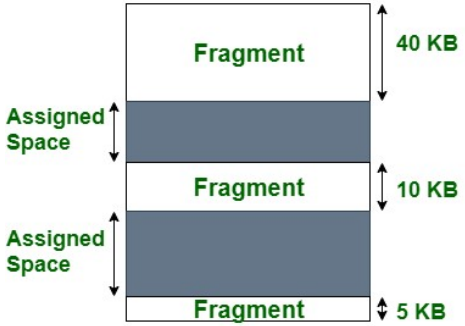
```
/dev/VolGroup00/LogVol00 /                       ext3    defaults        1 1
LABEL=/boot              /boot                   ext3    defaults        1 2
tmpfs                    /dev/shm                tmpfs   defaults        0 0
devpts                   /dev/pts                devpts  gid=5,mode=620  0 0
sysfs                    /sys                    sysfs   defaults        0 0
proc                     /proc                   proc    defaults        0 0
/dev/VolGroup00/LogVol01 swap                    swap    defaults        0 0
/k52-test/swap.img       swap                    swap    defaults        0 0
```

Disk fragmentation

- internal defragmentation
  - the memory is split into mounted sized blocks
  - the mounted sized block is allotted to the method
  - the memory allotted to the method is somewhat larger than the memory requested
- external defragmentation
  - the process's memory request cannot be fulfilled because the memory offered is during a non-contiguous manner
- Linux
  - 5% storage space reserved
  - After closing files, it will release unused space
  - No need to run de-fragmentation



Internal Fragmentation



Process 07 needs 50KB memory space

IV. Quotas

- Concepts
  - Quotas for users and groups
  - Limitation of inodes and blocks
  - Hard and soft limitation

Turn on the quota mode

- Prepare for the quota mode
- Mount with quota option
- Make sure that users accessing to the file system have the right privileges
- Change quota information
- Check the changes

Turn on the quota mode

- Mount a file system with quota option
  - mount –o usrquota,grpqouta /dev/sda1 /test
- Create necessary files for managing quotas
  - touch /test/aquota.user; touch /test/aquota.group
- Modify created files to the right format
  - quotacheck –f /test
- Change quotas of each user
  - edquota –u ngoctn
- Turn on/off quotas
  - quotaon, quotaoff
- List current quotas in the current system
  - repquota; repquota -a

Change quotas

- Change quota of a user or group
  - edquota –u trunghq;
  - edquota –g grp1
- Turn on/off quotas
  - quotaon; quotaoff