

Managing Linux Storage

Storage device

- Persistent physical device that hold your data
 - HDDs, SSDs, USBs, external storage devices, and legacy storage devices.
 - Device should be connected to the bus (udev – dynamic device creation)
- Linux storage is different from Windows in concept and terminology.
 - In Windows storage devices and directories are tightly coupled – we know where C: or B: partitions are and what folders live on them.
 - In Linux directory name is completely decoupled from the device.
 - You can keep same directory name, but change underlying infrastructure. Replace small drive with larger drive that consists of several logical volumes.
- Filesystem types:
 - FAT family – older type that has limited capabilities today (USB drives, etc)
 - Ext type (backwards compatible) – journaling, supports large files.
 - Xfs – common on RHEL, CentOS, journaling, large file support.
- Strength of Linux kernel is the ability to understand multiple filesystem types.
 - Also a choice for Digital Forensics
- Files and directories in FS are stored as inodes
 - Inode – objects that store metadata about file or directory, block storage locations
 - Inode table maps unique numbers to file or directory names
 - Some FSs set a limit on how many inodes can be created.
- What happens when we try to open a file?
 - cat file.txt
 - lookup inode number
 - check inode for permissions
 - go get data blocks
- Journaling does not increase or decrease latency or speed, but increases robustness of the FS. Have to write twice – to the journal, and then to the drive. Worth the trade-off.
- Virtual FS – software interface between Linux kernel and real file systems.
 - It is all in memory, not on physical storage.

- Not persistent.
- Can mount a CDROM filesystem and make it VFS via a loopback device.
- Encrypted HDD with decrypted FS above it as a VFS.
- Device names dynamically created and not always predictable.
 - Traditionally – device names fixed, cloud – dynamically alloc'd
 - Device names should be predictable. This is what FS label is.
 - FS label allows to map sw name to hw device by labeling FS that sits on top of that device, so you can reference it by its name, not device.
 - Allows us to have something dynamic and predictable at the same time.
- FS are identified by UUIDs that are not intelligible to people – long string of numbers.

Partitions

- Sections of physical storage drive that logically acts as separate drive.
- Allows to convert large drive into smaller subdivisions that are easier to manage.
- Must be formatted and assigned a file system first.
- Identified using partition table.
- Most OSs support them.
- Should segregate different components of the tree for security reasons.

Partitioning scheme

IBM-PC MBR

allows 4 primary partitions (storage was measured in K, M, or G sizes at the time)

partition table contains partition boundaries - metadata that describes the drive.

Instead of 1 primary can have 1 extended partition where we can create several logical partitions

Primary partition

can contain 1 FS or logical drive

swap and /boot, root /, and /var

Extended partition

can have only 1 extended

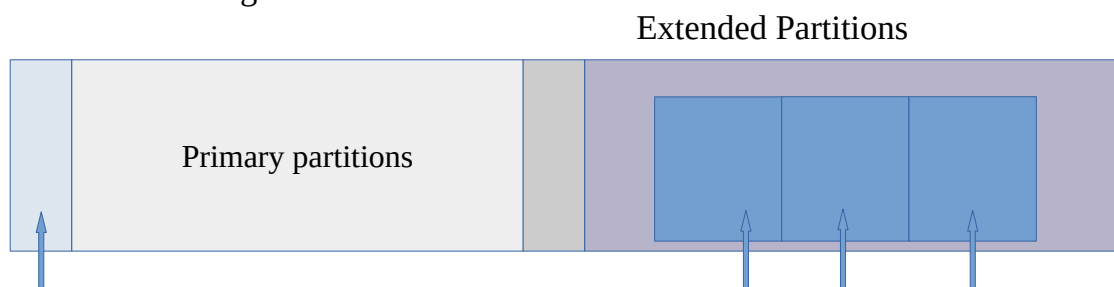
Has its own partition table

Can be subdivided into several logical drives each with a different fs

Logical partitions

Created within extended partition

Max 12 is a good rule



Partition table – list of partitions

Swap space – a partition used as a secondary RAM

Unused files are moved from RAM to swap

Size = 2xRAM, and no more → a lot of overhead.

Another solution – add RAM, - not always possible.

Should be no overlaps and no gaps between partitions.

List in */proc/partitions* with major and minor numbers

Fdisk Utility

Menu-driven command line interactive utility for root, sudoers

Dangerous tool, use with extreme caution

Allows to create, modify, and delete partitions

Should do it right the first time, so no need to alter them later

Allows to create and modify partition table

Understands DOS partition table

Lets you specify partition size

```
$ sudo fdisk -l
```

(may get a GPT warning)

```
$w → will save changes
```

options:

p – print (list) partitions

n – new partition

d – delete partitions

w – write changes to disk permanently

q – quit without changes

BIOS – MBR table

UEFI – GPT table

GNU parted

Another tool, similar to the fdisk

Slightly different menu

`partprobe` command updates without reboot after changes were made to disk partitions

fstab command

File that stores device. Partition. Fs info

lives in */etc/fstab*

only root can edit

one line per fs
very careful editing, or system may not boot.

Mount points

- Directory or point at which an external file system is attached to become accessible.
 - Normally mounted to an empty directory.
 - If mounted to non-empty directory, content of that directory is invisible until the external fs is unmounted.
 - Many options, defaults are most common.

Storage devices are block devices
Input devices are character devices

\$lsblk - lists tree-like picture of all storage devices
\$blkid - flat picture of devices

Fsck tool

Checks integrity (correctness and validity) of the file system.

Most system run it at boot.

Compares data and metadata and resolves mismatch.

Errors can be caused by shutdown and power loss without power backup.

Should unmount filesystem to perform the check.

\$df -h → lists all mounted filesystems