Disk Management

Disk devices and partitions

File systems and mounting

DE HOGESCHOOL
MET HET NETWERK

Hogeschool PXL – Dep. PXL-IT – Elfde-Liniestraat 26 – B-3500 Hasselt
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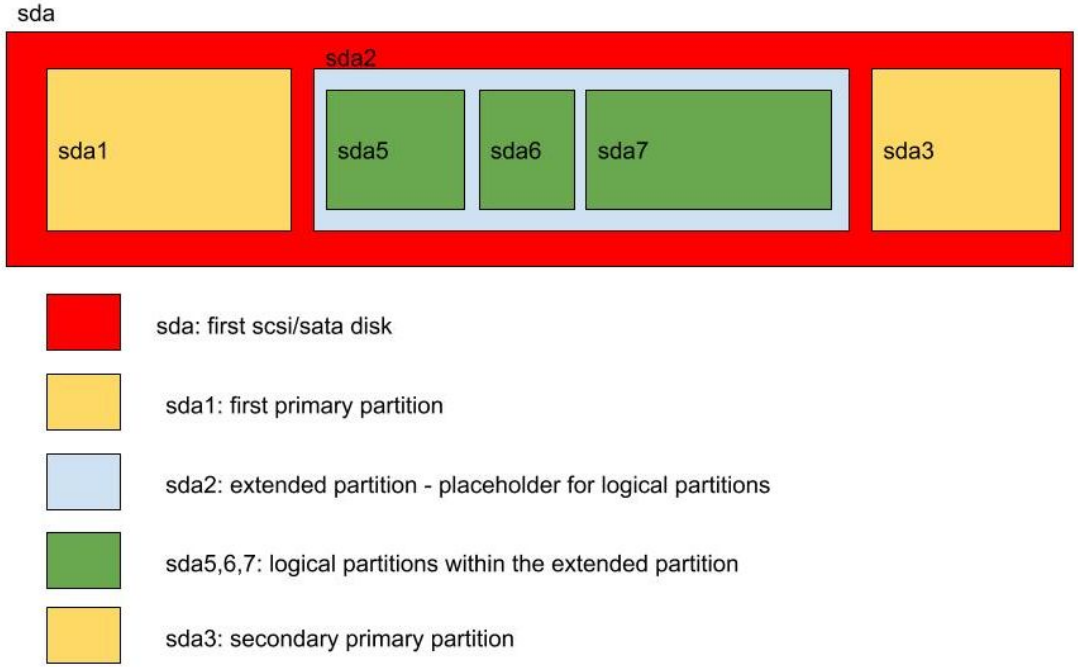
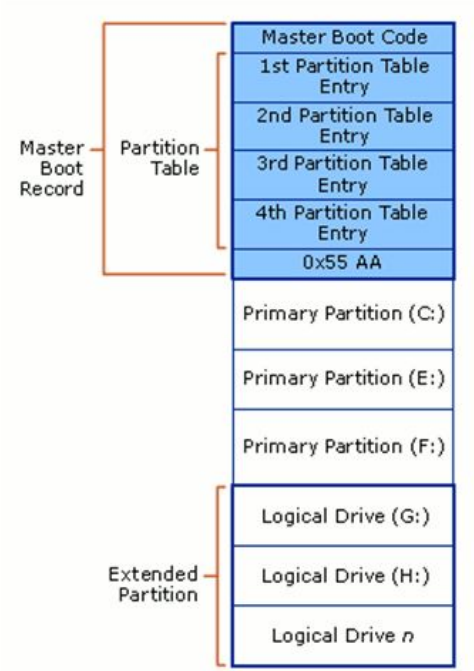
MSDOS/MBR partition-table

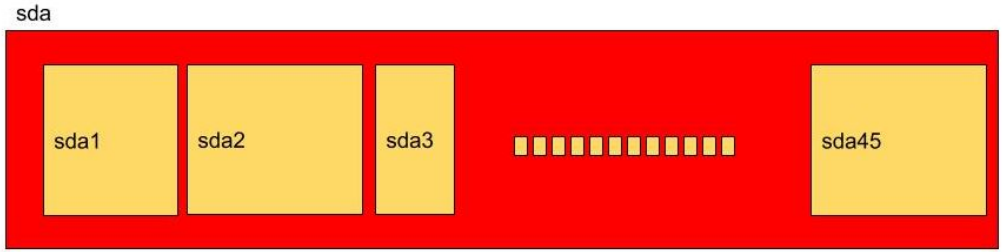
- Primary, extended and logical partitions

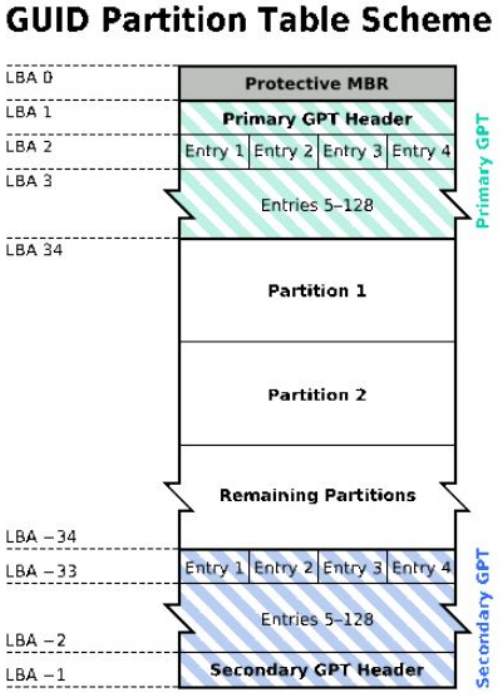




GPT partition-table

- Geen primary, extended and logical partitions





- Werkt met UEFI
- Partities mogen > 2TB
- Partities max 9.44ZB

Block devices

- Een harde schijf is een block device
  - Gegevens worden uitgelezen en/of opgeslagen per blok (In tegenstelling tot een character device zoals een muis)
- lsblk
  - Toont een lijst van block devices

```
student@studentbuntudesktop01:~$ lsblk | grep -v loop
NAME        MAJ:MIN RM   SIZE RO TYPE MOUNTPOINT
sda           8:0    0    20G  0 disk
└─sda1        8:1    0    20G  0 part /
sr0          11:0    1     2G  0 rom
nvme0n1     259:0    0    20G  0 disk
├─nvme0n1p1 259:3    0    10G  0 part
└─nvme0n1p2 259:4    0    10G  0 part
```

* sda1 is een primaire partitie
  —> in een dos-partitietabel
    —> Maximum 4 primaire partities waarvan er ééntje een extended kan zijn met oneindig veel logische partities (startend vanaf sdx5)

sda is de eerste sata/scsi-disk, sdb is de tweede
nvme0n1 is de eerste non-volatile memory express -disk, nvme0n2 is de tweede
→ je kan ook xvd tegenkomen voor Cloud Virtual Disks
→ je kan ook nog hda tegenkomen voor 'oudere' PATA/IDE-disks

UUID

- UUID
  - Universally Unique Identifier
  - om objecten uniek aan te duiden
  - 128bit

Achterhalen van UUID

- blkid

```
student@ubuntudesktop01:~$ sudo blkid | grep -v loop
/dev/sda1: UUID="f8e87c70-f11a-4e0c-952b-441c717236d4" TYPE="ext4" PARTUUID="ae236018-01"
```

- ls -l

```
student@ubuntudesktop01:~$ ls -l /dev/disk/by-uuid/
total 0
lrwxrwxrwx 1 root root 10 Okt 17 13:08 f8e87c70-f11a-4e0c-952b-441c717236d4 -> ../../sda1
```

Block devices - Achterhalen van UUID

file -s

```
student@ubuntudesktop01:~$ sudo file -s /dev/sd*
/dev/sda:  DOS/MBR boot sector
/dev/sda1: Linux rev 1.0 ext4 filesystem data, UUID=f8e87c70-f11a-4e0c-952b-441c717236d4 (needs journa
l recovery) (extents) (64bit) (large files) (huge files)
```

Discovering disk devices

- fdisk -l
  - Geeft lijst v. alle HDs en hun partities (sudo!)

```
student@ubuntudesktop01:~$ sudo fdisk -l | grep -A10 -w "/dev/sda"
Disk /dev/sda: 20 GiB, 21474836480 bytes, 41943040 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
Disklabel type: dos
Disk identifier: 0xae236018

Device     Boot Start      End  Sectors Size Id Type
/dev/sda1  *     2048 41940991 41938944  20G 83 Linux
```

Discovering disk devices

- dmesg
  - Geeft lijst v. alle kernel boot messages
    - Dus ook de detectie van HDs gedurende het bootproces

```
student@ubuntudesktop01:~$ dmesg | grep 'sd[a-z]'
[    3.105366] sd 2:0:0:0: [sda] 41943040 512-byte logical blocks: (21.5 GB/20.0 GiB)
[    3.105435] sd 2:0:0:0: [sda] Write Protect is off
[    3.105438] sd 2:0:0:0: [sda] Mode Sense: 61 00 00 00
[    3.105581] sd 2:0:0:0: [sda] Cache data unavailable
[    3.105583] sd 2:0:0:0: [sda] Assuming drive cache: write through
[    3.111187]  sda: sda1
[    3.111627] sd 2:0:0:0: [sda] Attached SCSI disk
[    3.626062] EXT4-fs (sda1): mounted filesystem with ordered data mode. Opts: (null)
[    4.217480] EXT4-fs (sda1): re-mounted. Opts: errors=remount-ro
```

Discovering disk devices

- lshw
  - Geeft een lijst van alle hardware
    - Met de juiste opties kan je de info van HD’s bekomen

```
student@ubuntudesktop01:~$ sudo lshw -class volume | grep -A4 -B1 description
  *-volume
       description: EXT4 volume
       vendor: Linux
       physical id: 1
       bus info: scsi@2:0.0.0,1
       logical name: /dev/sda1
```

```
sudo apt install lsscsi
```

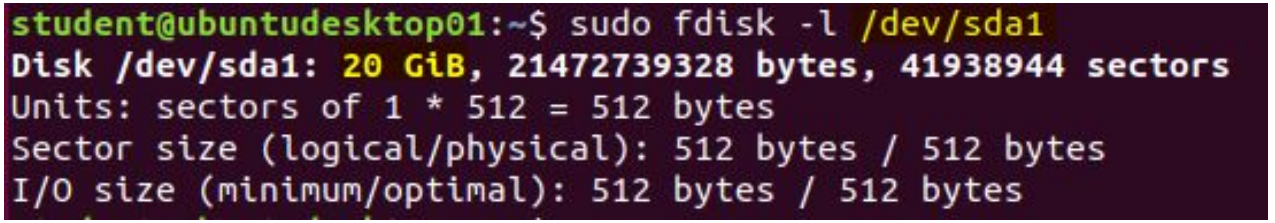
Discovering disk devices

- lsscsi
  - Geeft een lijst van SCSI-devices

```
student@ubuntudesktop01:~$ lsscsi
[2:0:0:0]    disk    VMware,  VMware Virtual S 1.0   /dev/sda
[4:0:0:0]    cd/dvd  NECVMWar VMware SATA CD01 1.00  /dev/sr0
```

Discovering partitions

- fdisk -l /dev/sda?
  - Geeft een overzicht van de configuraties v/e partitie



Discovering partitions

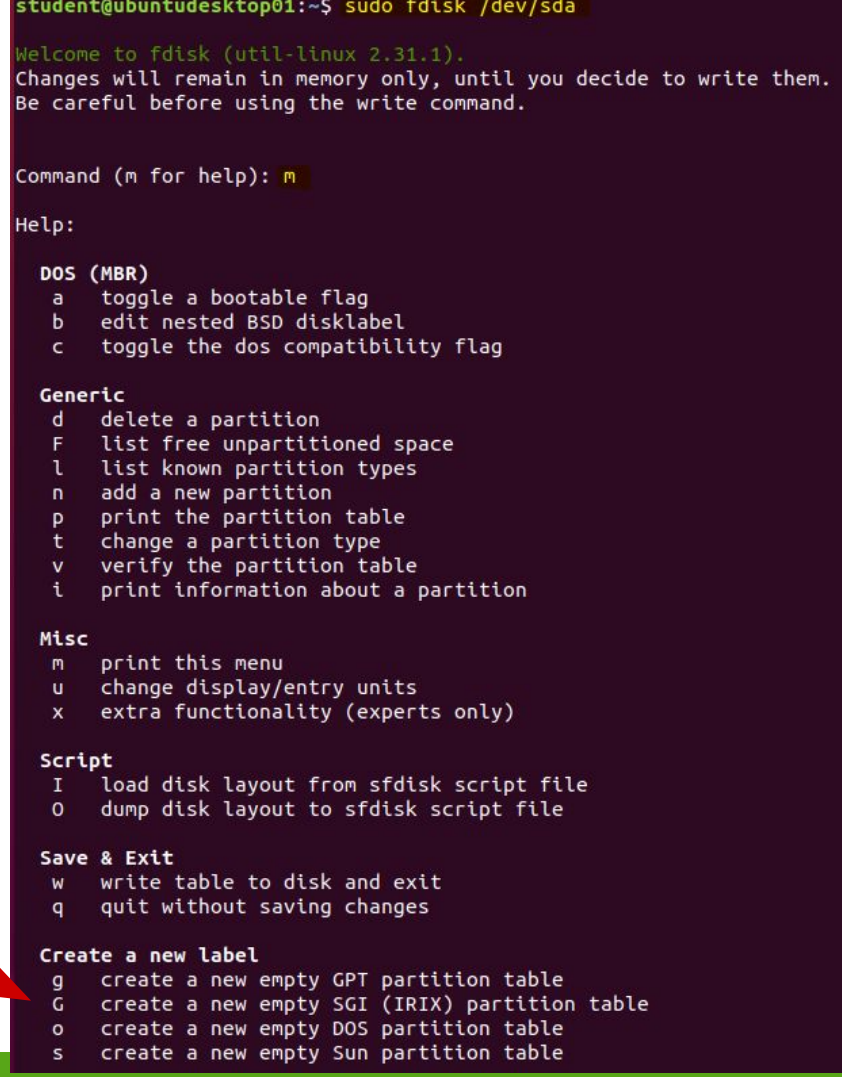
- /proc/partitions
  - In /proc staat info van de kernel in files en folders
    - In /proc/partitions staat informatie over de partities die door de kernel gekend zijn

```
student@ubuntudesktop01:~$ cat /proc/partitions | grep -v loop
major minor  #blocks  name

   8        0   20971520 sda
   8        1   20969472 sda1
  11        0    1048575 sr0
```

- Het major-number geeft aan welke driver gebruikt moet worden voor het uitlezen van het device
- Het minor-number wordt meegegeven als parameter aan de driver

Tools for working with partitions

- fdisk
  - Standaard-tool in de shell
  - voor msdos en gpt partitietabellen



Tools for working with partitions

- gdisk
  - voor gpt partitietabellen

```
student@ubdesk1804:~$ sudo gdisk /dev/nvme0n1
GPT fdisk (gdisk) version 1.0.3

Partition table scan:
  MBR: protective
  BSD: not present
  APM: not present
  GPT: present

Found valid GPT with protective MBR; using GPT.

Command (? for help): help
b       back up GPT data to a file
c       change a partition's name
d       delete a partition
i       show detailed information on a partition
l       list known partition types
n       add a new partition
o       create a new empty GUID partition table (GPT)
p       print the partition table
q       quit without saving changes
r       recovery and transformation options (experts only)
s       sort partitions
t       change a partition's type code
v       verify disk
w       write table to disk and exit
x       extra functionality (experts only)
?       print this menu

Command (? for help):
```

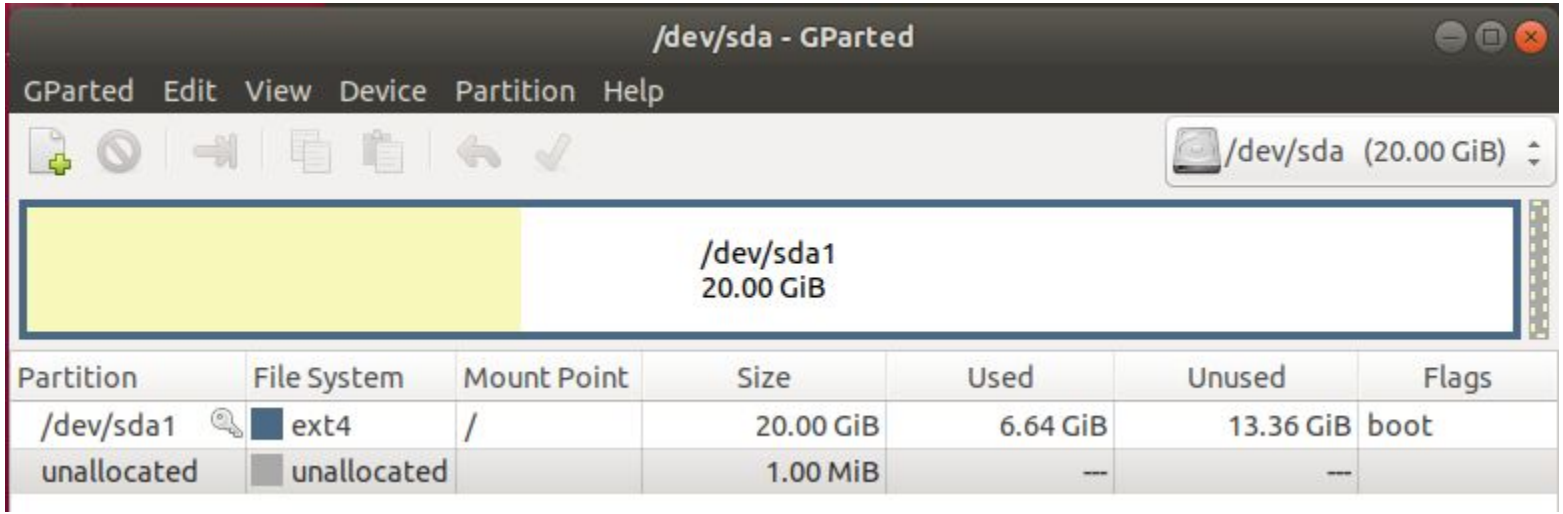
Tools for working with partitions

- parted:
  - voor msdos/mbr en gpt
  - ook voor scripting

```
student@ubuntudesktop01:~$ sudo parted /dev/sda
GNU Parted 3.2
Using /dev/sda
Welcome to GNU Parted! Type 'help' to view a list of commands.
(parted) help
  align-check TYPE N                        check partition N for TYPE(min|opt) alignment
  help [COMMAND]                           print general help, or help on COMMAND
  mklabel,mktable LABEL-TYPE               create a new disklabel (partition table)
  mkpart PART-TYPE [FS-TYPE] START END     make a partition
  name NUMBER NAME                         name partition NUMBER as NAME
  print [devices|free|list,all|NUMBER]     display the partition table, available devices, free space,
        all found partitions, or a particular partition
  quit                                     exit program
  rescue START END                         rescue a lost partition near START and END
  resizepart NUMBER END                    resize partition NUMBER
  rm NUMBER                                delete partition NUMBER
  select DEVICE                            choose the device to edit
  disk_set FLAG STATE                      change the FLAG on selected device
  disk_toggle [FLAG]                       toggle the state of FLAG on selected device
  set NUMBER FLAG STATE                    change the FLAG on partition NUMBER
  toggle [NUMBER [FLAG]]                   toggle the state of FLAG on partition NUMBER
  unit UNIT                                set the default unit to UNIT
  version                                  display the version number and copyright information of GNU
        Parted
(parted)
```

Tools for working with partitions

- gparted:
  - GUI interface op de Desktop



Extra harddisk van 5GB toegevoegd via VMWare Settings voor Ubuntu Desktop

Partitioning (MSDOS/MBR partitietabel)

Stap 1: Herkennen van de harde schijven

```
student@ubuntudesktop01:~$ sudo fdisk -l /dev/sd*
Disk /dev/sda: 20 GiB, 21474836480 bytes, 41943040 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
Disklabel type: dos
Disk identifier: 0xae236018

Device     Boot Start      End  Sectors Size Id Type
/dev/sda1  *     2048 41940991 41938944  20G 83 Linux


Disk /dev/sda1: 20 GiB, 21472739328 bytes, 41938944 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 /dev/sdb: 5 GiB, 5368709120 bytes, 10485760 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
```

Partitioning (MSDOS/MBR partitietabel)

Stap 2: De harde schijf openen met fdisk

Partitioning (MSDOS/MBR partitietabel)

Stap 3: Bekijken van de huidige partitie-tabel

```
Command (m for help): p
Disk /dev/sdb: 5 GiB, 5368709120 bytes, 10485760 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
Disklabel type: dos
Disk identifier: 0x36c9a8f9

Command (m for help):
```

Er zijn momenteel nog geen partities aanwezig

Partitioning (MSDOS/MBR partitietabel)

Stap 4: Bekijken van de vrije ruimte

```
Command (m for help): F
Unpartitioned space /dev/sdb: 5 GiB, 5367660544 bytes, 10483712 sectors
Units: sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes

Start      End  Sectors Size
 2048 10485759 10483712   5G

Command (m for help):
```

Er is momenteel 5GB aan vrije ruimte

Partitioning (MSDOS/MBR partitietabel)

Stap 5: Toevoegen van partities

```
Command (m for help): n
Partition type
   p   primary (0 primary, 0 extended, 4 free)
   e   extended (container for logical partitions)
Select (default p): p
Partition number (1-4, default 1): 1
First sector (2048-10485759, default 2048):
Last sector, +sectors or +size{K,M,G,T,P} (2048-10485759, default 10485759): +2G

Created a new partition 1 of type 'Linux' and of size 2 GiB.

Command (m for help):
```

We voegen een partitie toe van 2 Gigabyte

Partitioning (MSDOS/MBR partitietabel)

Stap 6: Overzicht van de nieuwe partitietabel

```
Command (m for help): p
Disk /dev/sdb: 5 GiB, 5368709120 bytes, 10485760 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
Disklabel type: dos
Disk identifier: 0x36c9a8f9

Device     Boot Start     End Sectors Size Id Type
/dev/sdb1        2048 4196351 4194304   2G 83 Linux

Command (m for help):
```

Partitioning (MSDOS/MBR partitietabel)

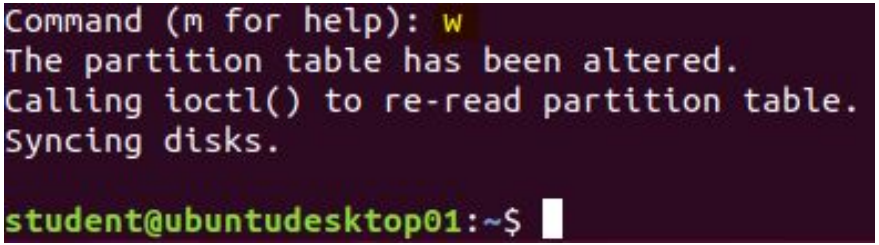
Stap 7: Eventueel het type (=label) van partitie

```
Command (m for help): l

 0  Empty           24  NEC DOS         81  Minix / old Lin bf  Solaris
 1  FAT12           27  Hidden NTFS Win 82  Linux swap / So c1  DRDOS/sec (FAT-
 2  XENIX root      39  Plan 9          83  Linux           c4  DRDOS/sec (FAT-
 3  XENIX usr       3c  PartitionMagic  84  OS/2 hidden or  c6  DRDOS/sec (FAT-
 4  FAT16 <32M      40  Venix 80286     85  Linux extended  c7  Syrinx
 5  Extended        41  PPC PReP Boot   86  NTFS volume set da  Non-FS data
 6  FAT16           42  SFS             87  NTFS volume set db
 7  HPFS/NTFS/exFAT 4d  QNX4.x          88  Linux plaintext de
 8  AIX             4e  QNX4.x 2nd part 8e  Linux LVM       df
 9  AIX bootable    4f  QNX4.x 3rd part 93  Amoeba          e1
 a  OS/2 Boot Manag 50  OnTrack DM      94  Amoeba BBT      e3
 b  W95 FAT32       51  OnTrack DM6 Aux 9f  BSD/OS          e4
 c  W95 FAT32 (LBA) 52  CP/M            a0  IBM Thinkpad hi ea
 e  W95 FAT16 (LBA) 53  OnTrack DM6 Aux a5  FreeBSD         eb
 f  W95 Ext'd (LBA) 54  OnTrackDM6      a6  OpenBSD         ee
10  OPUS            55  EZ-Drive        a7  NeXTSTEP        ef
11  Hidden FAT12    56  Golden Bow      a8  Darwin UFS      f0
12  Compaq diagnost 5c  Priam Edisk     a9  NetBSD          f1
14  Hidden FAT16 <3 61  SpeedStor       ab  Darwin boot     f4  SpeedStor
16  Hidden FAT16    63  GNU HURD or Sys af  HFS / HFS+      f2  DOS secondary
17  Hidden HPFS/NTF 64  Novell Netware  b7  BSDI fs         fb  VMware VMFS
18  AST SmartSleep  65  Novell Netware  b8  BSDI swap       fc  VMware VMKCORE
1b  Hidden W95 FAT3 70  DiskSecure Mult bb  Boot Wizard hid fd  Linux raid auto
1c  Hidden W95 FAT3 75  PC/IX           bc  Acronis FAT32 L fe  LANstep
1e  Hidden W95 FAT1 80  Old Minix       be  Solaris boot    ff  BBT

Command (m for help):
```

```
Command (m for help): t
Selected partition 1
Partition type (type L to list all types): 83
Changed type of partition 'Linux' to 'Linux'.

Command (m for help):
```

Partitioning (MSDOS/MBR partitietabel)

Stap 8: Opslaan van de nieuwe partitietabel



De partitie-wijzigingen zijn opgeslagen

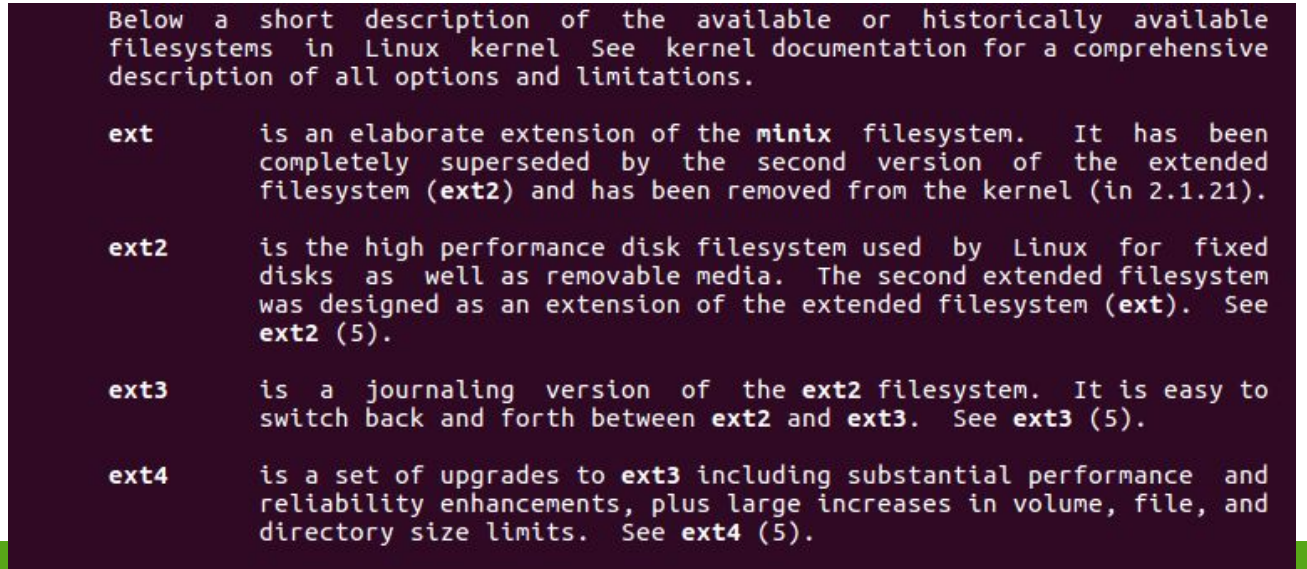
Partitietabel maintenance

- Een Partitietabel backuppen en restoren
  - Kan geback-upt worden met sfdisk
    - sfdisk -d /dev/sdx > partitietabel.sdx.sfdisk
  - Kan gerestored worden met sfdisk
    - sfdisk /dev/sdx < partitietabel.sdx.sfdisk
  - Nadien partprobe uitvoeren om de kernel te forceren om opnieuw de partitietabel uit te lezen

Opgelet: via dd kan de partitietabel ook geback-upt worden, maar dan neem je geen instellingen van de logische partities mee!

Filesystems

- Filesystems
  - Meer info vind je in de man pages (man fs)
  - De huidige versie van ext is ext4



Below a short description of the available or historically available filesystems in Linux kernel See kernel documentation for a comprehensive description of all options and limitations.

ext is an elaborate extension of the **minix** filesystem. It has been completely superseded by the second version of the extended filesystem (**ext2**) and has been removed from the kernel (in 2.1.21).

ext2 is the high performance disk filesystem used by Linux for fixed disks as well as removable media. The second extended filesystem was designed as an extension of the extended filesystem (**ext**). See **ext2** (5).

ext3 is a journaling version of the **ext2** filesystem. It is easy to switch back and forth between **ext2** and **ext3**. See **ext3** (5).

ext4 is a set of upgrades to **ext3** including substantial performance and reliability enhancements, plus large increases in volume, file, and directory size limits. See **ext4** (5).

```
student@ubuntudesktop01:~$ cat /proc/filesystems
nodev   sysfs
nodev   rootfs
nodev   ramfs
nodev   bdev
nodev   proc
nodev   cpuset
nodev   cgroup
nodev   cgroup2
nodev   tmpfs
nodev   devtmpfs
nodev   configfs
nodev   debugfs
nodev   tracefs
nodev   securityfs
nodev   sockfs
nodev   dax
nodev   bpf
nodev   pipefs
nodev   hugetlbfs
nodev   devpts
        ext3
        ext2
        ext4
        squashfs
        vfat
nodev   ecryptfs
        fuseblk
nodev   fuse
nodev   fusectl
nodev   pstore
nodev   mqueue
nodev   autofs
student@ubuntudesktop01:~$
```

Filesystems

- Een overzicht van welke Filesystems je kan toekennen

```
student@ubuntudesktop01:~$ cat /proc/filesystems | grep -v nodev
        ext3
        ext2
        ext4
        squashfs
        vfat
        fuseblk
student@ubuntudesktop01:~$
```

nodev: not mounted on a block device

Putting a filesystem on a partition

- mkfs
  - Make filesystem: hiermee kunnen we een partitie voorzien van een filesystem

```
student@ubuntudesktop01:~$ ls  /sbin/mkfs* | column
/sbin/mkfs              /sbin/mkfs.fat
/sbin/mkfs.bfs          /sbin/mkfs.minix
/sbin/mkfs.cramfs       /sbin/mkfs.msdos
/sbin/mkfs.ext2         /sbin/mkfs.ntfs
/sbin/mkfs.ext3         /sbin/mkfs.vfat
/sbin/mkfs.ext4
student@ubuntudesktop01:~$
```

mkfs kan ook een volledige disk (zonder partities) ineens voorzien van een filesysteem. Dit gebeurt meestal bij virtuele disks in een virtuele omgeving of in de cloud waar slechts 1 partitie wordt gebruikt en disks heel dikwijls groter of kleiner worden gemaakt on the fly.

Putting a filesystem on a partition

- mkfs
  - Make filesystem: hiermee kunnen we een partitie voorzien van een filesystem

```
student@ubuntudesktop01:~$ sudo mkfs.ext4 /dev/sdb1
mke2fs 1.44.1 (24-Mar-2018)
Creating filesystem with 524288 4k blocks and 131072 inodes
Filesystem UUID: 2af9a675-41b2-44ee-887d-d38348f23fbb
Superblock backups stored on blocks:
        32768, 98304, 163840, 229376, 294912

Allocating group tables: done
Writing inode tables: done
Creating journal (16384 blocks): done
Writing superblocks and filesystem accounting information: done

student@ubuntudesktop01:~$
```

Tuning a file system

- tune2fs
  - Om parameters van ext2, ext3 en ext4 te zien en eventueel aan te passen

```
student@ubuntudesktop01:~$ sudo tune2fs -l /dev/sdb1
tune2fs 1.44.1 (24-Mar-2018)
Filesystem volume name:   <none>
Last mounted on:          <not available>
Filesystem UUID:          2af9a675-41b2-44ee-887d-d38348f23fbb
Filesystem magic number:  0xEF53
Filesystem revision #:    1 (dynamic)
Filesystem features:      has_journal ext_attr resize_inode dir_ind
file huge_file dir_nlink extra_isize metadata_csum
Filesystem flags:         signed_directory_hash
Default mount options:    user_xattr acl
Filesystem state:         clean
Errors behavior:          Continue
Filesystem OS type:       Linux
Inode count:              131072
Block count:              524288
Reserved block count:     26214
Free blocks:              498132
Free inodes:              131061
First block:              0
Block size:               4096
Fragment size:            4096
Group descriptor size:    64
Reserved GDT blocks:      255
Blocks per group:         32768
Fragments per group:      32768
Inodes per group:         8192
Inode blocks per group:   512
Flex block group size:    16
Filesystem created:       Wed Oct 17 16:04:35 2018
Last mount time:          n/a
```

Tuning a file system

- tune2fs & reserved blocks

Standaard wordt 5% van een filesysteem gereserveerd voor bestanden van root en daemons die als root draaien

```
student@ubuntudesktop01:~$ sudo tune2fs -l /dev/sdb1 | grep -e Block -e Reserved
Block count:              524288
Reserved block count:     26214
Block size:               4096
Reserved GDT blocks:      255
Blocks per group:         32768
Reserved blocks uid:      0 (user root)
Reserved blocks gid:      0 (group root)
student@ubuntudesktop01:~$
```

Dit zodat services en het inloggen met root steeds zal blijven werken als het filesysteem voor de rest is volgelopen

Voor heel grote filesystemen is 5% echter te veel.
We kunnen dit als volgt aanpassen

```
student@ubuntudesktop01:~$ sudo tune2fs -m 2 /dev/sdb1
tune2fs 1.44.1 (24-Mar-2018)
Setting reserved blocks percentage to 2% (10485 blocks)
student@ubuntudesktop01:~$ sudo tune2fs -l /dev/sdb1 | grep -e Block -e Reserved
Block count:              524288
Reserved block count:     10485
Block size:               4096
Reserved GDT blocks:      255
Blocks per group:         32768
Reserved blocks uid:      0 (user root)
Reserved blocks gid:      0 (group root)
student@ubuntudesktop01:~$
```

Indien we dit zouden doen met een filesysteem dat gemount is, dan zouden we het verschil in vrije ruimte van voor en na het commando kunnen bekijken met df -h

Checking a filesystem

- fsck
  - Hiermee kunnen we een filesysteem onderzoeken op fouten, nadat we het hebben ge-unmount!

```
student@ubuntudesktop01:~$ sudo fsck /dev/sda1
fsck from util-linux 2.31.1
e2fsck 1.44.1 (24-Mar-2018)
/dev/sda1 is mounted.
e2fsck: Cannot continue, aborting.
```

Checken van een gemount filesysteem lukt niet!

```
student@ubuntudesktop01:~$ sudo fsck /dev/sdb1
fsck from util-linux 2.31.1
e2fsck 1.44.1 (24-Mar-2018)
/dev/sdb1: clean, 11/131072 files, 26156/524288 blocks
```

Checken van een niet-gemount filesysteem lukt wel!

De laatste kolom in /etc/fstab wordt gebruikt om aan te geven of een filesysteem automatisch moet worden gechecked bij het opstarten van de computer.

0: Niet checken 1:checken(root filesystem) 2:checken(other filesystem)

Nummers 1 en 2 omdat deze filesystemen (op eenzelfde harde schijf) dan na elkaar worden gechecked en niet gelijktijdig = vlugger opgestart.

Mounting

- mount
  - wordt gebruikt om een filesysteem beschikbaar te maken via een directory
  - deze directory noemen we dan het mountpoint
  - een mountpoint is dus een directory ergens onder de root van de boomstructuur (/.../.../.../directory)
  - via het mountpoint werken we dus met het filesysteem
  - er zijn dus geen schijfletters in Linux

Mounting a filesystem

Stap 1: We maken, indien nodig, een directory

```
student@ubuntudesktop01:~$ sudo mkdir /var/ftp
```

Stap 2: We mounten het filesysteem op het mountpoint

```
student@ubuntudesktop01:~$ sudo mount -t ext4 /dev/sdb1 /var/ftp/
```

De -t optie is **optioneel** voor alle filesystems die worden teruggevonden in /proc/filesystems. Deze worden **automatisch** herkend.

Stap 3: We geven het mountpoint de juiste rechten

```
student@ubuntudesktop01:~$ sudo chmod o+rw /var/ftp/
student@ubuntudesktop01:~$ ls -ld /var/ftp/
drwxr-xrwx 3 root root 4096 Okt 17 16:04 /var/ftp/
```

Eventueel ook ownership aanpassen via chown <uid>:<gid> /var/ftp

Unmounting a filesystem

- umount
  - Wordt gebruikt om een gemount filesysteem te unmounten

```
student@ubuntudesktop01:~$ sudo lsblk | grep -e NAME -e sdb
NAME   MAJ:MIN RM   SIZE RO TYPE MOUNTPOINT
sdb      8:16   0     5G  0 disk
└─sdb1   8:17   0     2G  0 part /var/ftp
student@ubuntudesktop01:~$ sudo umount /var/ftp
student@ubuntudesktop01:~$ sudo lsblk | grep -e NAME -e sdb
NAME   MAJ:MIN RM   SIZE RO TYPE MOUNTPOINT
sdb      8:16   0     5G  0 disk
└─sdb1   8:17   0     2G  0 part
student@ubuntudesktop01:~$ sudo mount -t ext4 /dev/sdb1 /var/ftp/
student@ubuntudesktop01:~$ sudo lsblk | grep -e NAME -e sdb
NAME   MAJ:MIN RM   SIZE RO TYPE MOUNTPOINT
sdb      8:16   0     5G  0 disk
└─sdb1   8:17   0     2G  0 part /var/ftp
student@ubuntudesktop01:~$ sudo umount /dev/sdb1
student@ubuntudesktop01:~$ sudo lsblk | grep -e NAME -e sdb
NAME   MAJ:MIN RM   SIZE RO TYPE MOUNTPOINT
sdb      8:16   0     5G  0 disk
└─sdb1   8:17   0     2G  0 part
student@ubuntudesktop01:~$
```

Het umount-commando aanvaardt zowel het mountpoint als het device als parameter

Displaying mounted file systems

- mount-commando
  - Dit is de makkelijkste vorm

```
student@ubuntudesktop01:~$ mount | grep sd[ab]
/dev/sda1 on / type ext4 (rw,relatime,errors=remount-ro,data=ordered)
/dev/sdb1 on /var/ftp type ext4 (rw,relatime,data=ordered)
student@ubuntudesktop01:~$
```

- /proc/mounts
  - Dit zijn de mounts die de kernel kent

```
student@ubuntudesktop01:~$ grep -e sd[ab] -e uuid /proc/mounts
/dev/sda1 / ext4 rw,relatime,errors=remount-ro,data=ordered 0 0
/dev/sdb1 /var/ftp ext4 rw,relatime,data=ordered 0 0
student@ubuntudesktop01:~$
```

Displaying mounted file systems

- /etc/mtab
  - Bestand dat onderhouden wordt door mount zelf

```
student@ubuntudesktop01:~$ grep sd[ab] /etc/mtab
/dev/sda1 / ext4 rw,relatime,errors=remount-ro,data=ordered 0 0
/dev/sdb1 /var/ftp ext4 rw,relatime,data=ordered 0 0
student@ubuntudesktop01:~$
```

- df-commando
  - Geeft de vrije ruimte aan

```
student@ubuntudesktop01:~$ df -h | grep sd[ab]
/dev/sda1        20G  6,3G   13G  34% /
/dev/sdb1       2,0G  6,0M  1,9G   1% /var/ftp
student@ubuntudesktop01:~$
```

Displaying mounted file systems

- lsblk
  - Geeft een overzicht van alle block devices

```
student@ubuntudesktop01:~$ lsblk | grep "part /"
└─sda1   8:1    0    20G  0 part /
└─sdb1   8:17   0     2G  0 part /var/ftp
student@ubuntudesktop01:~$
```

- du
  - disk usage geeft je de groottes van directories of partities

```
student@ubuntudesktop01:~$ sudo du -hs / 2> /dev/null
8,2G    /
student@ubuntudesktop01:~$
```

→ h: human readable
→ s: summarize (display only a total)

Permanent mounts

- /etc/fstab
  - Bevat de file system table, die aangeeft welke filesystems automatisch moeten worden gemount bij het booten

```
student@ubuntudesktop01:~$ cat /etc/fstab
# /etc/fstab: static file system information.
#
# Use 'blkid' to print the universally unique identifier for a
# device; this may be used with UUID= as a more robust way to name devices
# that works even if disks are added and removed. See fstab(5).
#
# <file system> <mount point>   <type>  <options>       <dump>  <pass>
# / was on /dev/sda1 during installation
UUID=f8e87c70-f11a-4e0c-952b-441c717236d4 /               ext4    errors=remount-ro 0       1
/swapfile                                 none            swap    sw                0       0
student@ubuntudesktop01:~$
```

Adding permanent mounts

- /etc/fstab
  - Je kan hier zelf mounts in gaan toevoegen

```
# /etc/fstab: static file system information.
#
# Use 'blkid' to print the universally unique identifier for a
# device; this may be used with UUID= as a more robust way to name devices
# that works even if disks are added and removed. See fstab(5).
#
# <file system> <mount point>   <type>  <options>       <dump>  <pass>
# / was on /dev/sda1 during installation
UUID=f8e87c70-f11a-4e0c-952b-441c717236d4 /               ext4    errors=remount-ro 0       1
/swapfile                                 none            swap    sw                0       0
/dev/sdb1       /var/ftp        ext4    defaults        0       0
```

Telkens de pc start zal nu /dev/sdb1 gemount worden op /var/ftp

4e veld → defaults: use default options → rw, suid, dev, exec, auto, nouser and async

UUID kan je ook gebruiken → is veiliger bij Virtuele Machines:

```
student@ubuntudesktop01:~$ sudo blkid | grep -e "sd[ab]"
/dev/sda1: UUID="f8e87c70-f11a-4e0c-952b-441c717236d4" TYPE="ext4" PARTUUID="ae236018-01"
/dev/sdb1: UUID="d257d04e-18c7-48f1-ba4e-f19991dacb12" TYPE="ext4" PARTUUID="5964ad78-01"
```

Mounten kan **nu** ook handmatig met een verkorte vorm

```
student@ubuntudesktop01:~$ sudo mount /var/ftp/
```

Securing mounts

```
student@ubuntudesktop01:~$ sudo mount -o ro /dev/sdb1 /var/ftp/
```

OF

```
student@ubuntudesktop01:~$ sudo mount -o ro,remount /dev/sdb1 /var/ftp/
```

```
student@ubuntudesktop01:~$ mkdir /var/ftp/testdir
mkdir: cannot create directory ‘/var/ftp/testdir’: Read-only file system
```

- ro
  - Mounten als read only
- noexec
  - Geen enkele binary of script kan uitgevoerd worden
- nosuid
  - Er wordt geen rekening gehouden met setuid-bits
- noacl
  - Er kunnen geen acl-rechten gelegd worden

Erasing a hard disk

- badblocks
  - Wordt gebruikt om bad blocks op te zoeken
  - Kan ook gebruikt worden om alle data veilig te wissen door iedere blok van de schijf 4 maal te overschrijven

```
student@ubuntudesktop01:~$ sudo badblocks -ws /dev/sdb
/dev/sdb is apparently in use by the system; it's not safe to run badblocks!
student@ubuntudesktop01:~$ sudo umount /dev/sdb1
student@ubuntudesktop01:~$ sudo badblocks -ws /dev/sdb
Testing with pattern 0xaa:  42.57% done, 0:08 elapsed. (0/0/0 errors)
```

-w: write-mode
-s: show progress

Iedere blok van de harde schijf zal uiteindelijk overschreven zijn met de patronen 0xaa, 0x55, 0xff en 0x00

Erasing a hard disk

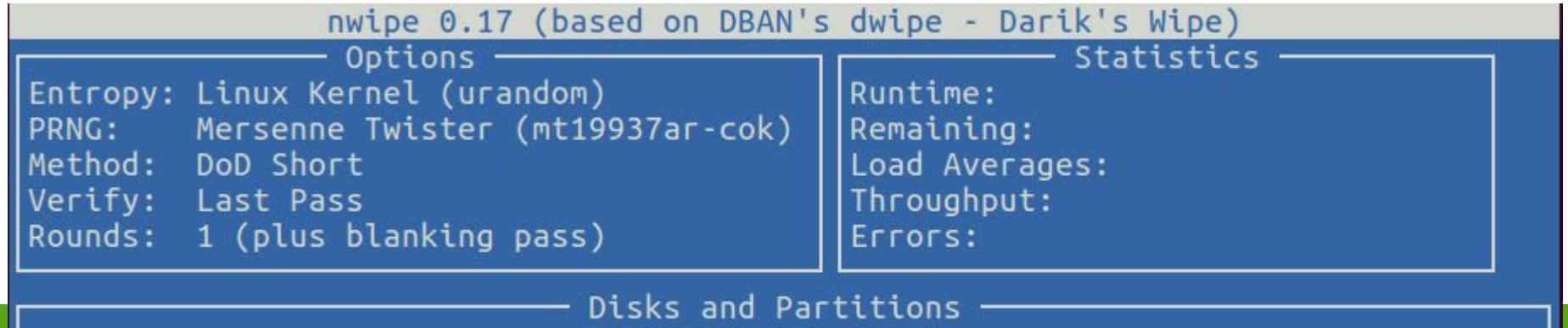
- dd
  - Wordt gebruikt om bestanden te kopiëren en te converteren
  - Kan ook gebruikt worden om de data van de schijf te overschrijven met nullen. De data wordt maar 1 keer overschreven

```
student@ubuntudesktop01:~$ sudo dd if=/dev/zero of=/dev/sdb
[sudo] password for student:
```

Erasing a hard disk

sudo !!

- SSD
  - de meeste ssd-schijven kunnen veilig gewist worden met tools die op de website van de fabrikant staan
  - nwipe
    - is een tool die ook voor ssd-schijven kan gebruikt worden



GPT-partitietabel in plaats van DOS/MBR

- GPT
  - Voor partities groter dan 2 TB
  - Tot 128 partities (geen extended)
  - wordt gebruikt met UEFI (ipv BIOS)
  - gebruik fdisk, gdisk of parted

```
GPT fdisk (gdisk) version 1.0.3

Partition table scan:
  MBR: protective
  BSD: not present
  APM: not present
  GPT: present

Found valid GPT with protective MBR; using GPT.
```

A GPT disk starts with a 512 byte large protective MBR (where an ordinary MBR would be) to prevent MBR-only partitioning tools from overwriting GPT disks.
This protective MBR contains an entry to an unexisting 2 TiB large partition (with code EE00). So that the MBR-only partitioning tool thinks the entire disk is already occupied

```
Command (? for help): ?
b       back up GPT data to a file
c       change a partition's name
d       delete a partition
i       show detailed information on a partition
l       list known partition types
n       add a new partition
o       create a new empty GUID partition table (GPT)
p       print the partition table
q       quit without saving changes
r       recovery and transformation options (experts only)
s       sort partitions
t       change a partition's type code
v       verify disk
w       write table to disk and exit
x       extra functionality (experts only)
?       print this menu
```

Troubleshooting tools

- lsof (list open files)

```
student@ubuntuServer:~$ tail -f /var/log/syslog &
[1] 2519
```

```
student@ubuntuServer:~$ jobs
[1]+  Running                 tail -f /var/log/syslog &
student@ubuntuServer:~$ sudo lsof | grep -E COMMAND\|tail.*student
COMMAND    PID  TID             USER   FD      TYPE             DEVICE SIZE/OFF      NODE NAME
tail      2519                 student  cwd       DIR                8,1     4096    926961 /home/stu
dent
tail      2519                 student  rtd       DIR                8,1     4096         2 /
tail      2519                 student  txt       REG                8,1    64432    262528 /usr/bin/
tail
tail      2519                 student  mem       REG                8,1  2981280    268092 /usr/lib/
locale/locale-archive
tail      2519                 student  mem       REG                8,1  1868984    393715 /lib/x86_
64-linux-gnu/libc-2.23.so
tail      2519                 student  mem       REG                8,1   162632    393691 /lib/x86_
64-linux-gnu/ld-2.23.so
tail      2519                 student    0u      CHR                4,1      0t0        20 /dev/tty1
tail      2519                 student    1u      CHR                4,1      0t0        20 /dev/tty1
tail      2519                 student    2u      CHR                4,1      0t0        20 /dev/tty1
tail      2519                 student    3r      REG                8,1  5544169    534526 /var/log/
syslog
tail      2519                 student    4r  a_inode               0,11        0      8121 inotify
```

cwd=current working directory rtd=root directory txt=text/binary mem=memory mapped file r=read w=write u=update (r+w)
DIR=directory REG=regular file CHR=character special file a_inode=anonymous inode

Troubleshooting tools

- fuser (filesystem user)
  - wie is met welke commando's aan het werken op een bepaald mountpoint

```
student@ubuntuServer:~$ tail -f /var/log/syslog &
[1] 2519
```

```
student@ubuntuServer:~$ jobs
[1]+  Running                 tail -f /var/log/syslog &
```

```
student@ubuntuServer:~$ ps
  PID TTY          TIME CMD
 2389 tty1     00:00:00 bash
 2519 tty1     00:00:00 tail
 2604 tty1     00:00:00 ps
```

```
student@ubuntuServer:~$ fuser -v -m / |& grep -E USER\|tail
                     USER        PID ACCESS COMMAND
                     student    2519 frce. tail
```

c: current dir
e: executable
f: open file
F: open file for writing
r: root dir
m: mapped file or shared library

-m: om het volledig mountpoint / te bekijken

Troubleshooting tools

- fuser (filesystem user)
  - om te achterhalen wie een bepaald bestand heeft geopend en met welk commando

```
student@ubuntuServer:~$ tail -f /var/log/syslog &
[1] 2519
```

```
student@ubuntuServer:~$ jobs
[1]+  Running                 tail -f /var/log/syslog &
```

```
student@ubuntuServer:~$ ps
  PID TTY          TIME CMD
 2389 tty1     00:00:00 bash
 2519 tty1     00:00:00 tail
 2604 tty1     00:00:00 ps
```

```
student@ubuntuServer:~$ fuser -v /var/log/syslog
                     USER        PID ACCESS COMMAND
/var/log/syslog:     student    2519 f.... tail
```

f=open file c=current dir e=executable being run r=root dir

```
student@ubuntuServer:~$ sudo apt-get install iotop
```

Troubleshooting tools

- iotop (io top usage info)
  - Geeft continue IO-statistieken met de hoogste bovenaan

```
student@ubuntuServer:~$ sudo iotop -o
```

```
Total DISK READ :       0.00 B/s | Total DISK WRITE :       0.00 B/s
Actual DISK READ:       0.00 B/s | Actual DISK WRITE:       0.00 B/s
  TID  PRIO  USER     DISK READ  DISK WRITE  SWAPIN     IO>    COMMAND
```

-o = enkel de processen laten zien die IO gebruiken

Recap

Hard disks

- Toevoegen
- Partitioneren
- Filesystem toekennen
- Mounten
- Wissen
- Troubleshooting