Systems Advanced Linux

Disk Management

DE HOGESCHOOL MET HET NETWERK

Elfde-Liniestraat 24, 3500 Hasselt, www.pxl.be

Block devices

- Een SSD/harddisk 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

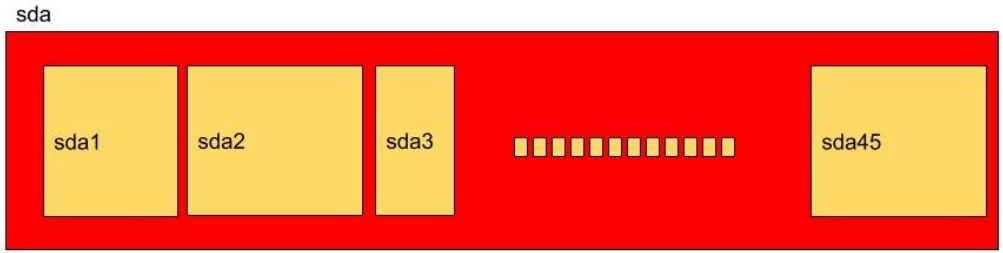
```
student@ubuntu-server:~$ lsblk -e 7
NAME   MAJ:MIN RM  SIZE RO TYPE MOUNTPOINTS
sda      8:0    0   20G  0 disk
├─sda1   8:1    0  953M  0 part /boot/efi
└─sda2   8:2    0 19.1G  0 part /
sr0     11:0    1 1024M  0 rom
```

`-e 7` zorgt er voor dat de loops voor de verschillende snaps niet zichtbaar zijn.

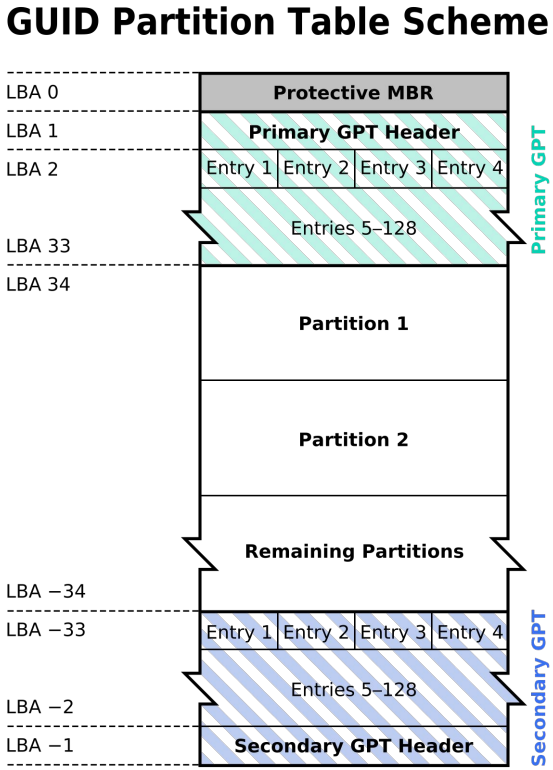
sda is de eerste sata/scsi-disk, **sdb** is de tweede
nvme0n1 is de eerste non-volatile memory express -disk, **nvme0n2** is de tweede
→ je kan ook **xvd** tegenkomen voor Cloud Virtual Disks

GPT partition-table

- Tot 128 partities



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



UUID

- UUID
  - **U**niversally **U**nique **ID**entifier
  - om objecten uniek aan te duiden
  - 128-bit

bv. `123e4567-e89b-12d3-a456-426614174000`

Tools for working with partitions

- **gdisk**

```
student@ubuntu-server:~$ sudo gdisk /dev/sda
GPT fdisk (gdisk) version 1.0.8
...
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
```

Tools for working with partitions

- **parted**
  - ook voor scripting

```
student@ubuntu-server:~$ sudo parted /dev/sda
[sudo] password for student:
GNU Parted 3.4
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...
  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 info
(parted)
```

Discovering disk devices and partitions

- `lsblk -e 7`

```
student@ubuntu-server:~$ lsblk -e 7
NAME   MAJ:MIN RM  SIZE RO TYPE MOUNTPOINTS
sda      8:0    0   20G  0 disk
├─sda1   8:1    0  953M  0 part /boot/efi
└─sda2   8:2    0 19.1G  0 part /
sr0     11:0    1 1024M  0 rom
```

Discovering disk devices

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

```
student@ubuntu-server:~$ sudo dmesg | grep 'sd[a-z]'
[    8.088410] sd 32:0:0:0: [sda] 41943040 512-byte logical blocks: (21.5 GB/20.0 GiB)
[    8.089120] sd 32:0:0:0: [sda] Write Protect is off
[    8.089414] sd 32:0:0:0: [sda] Mode Sense: 61 00 00 00
[    8.090240] sd 32:0:0:0: [sda] Cache data unavailable
[    8.090548] sd 32:0:0:0: [sda] Assuming drive cache: write through
[    8.101110]  sda: sda1 sda2
[    8.103012] sd 32:0:0:0: [sda] Attached SCSI disk
[    9.601943] EXT4-fs (sda2): mounted filesystem with ordered data mode. Opts: (null).
Quota mode: none.
[   10.612037] EXT4-fs (sda2): re-mounted. Opts: (null). Quota mode: none.
```

```
sudo apt install lsscsi
```

Discovering disk devices

- **`lsscsi`**
  - Geeft een lijst van SCSI-devices

```
student@ubuntu-server:~$ lsscsi
[3:0:0:0]    cd/dvd  NECVMWar VMware SATA CD01 1.00  /dev/sr0
[32:0:0:0]   disk    VMware,  VMware Virtual S 1.0   /dev/sda
```

Info about a partition

- **`gdisk -l /dev/sda?`**
  - Geeft een overzicht van de configuratie v/e partitie

```
student@ubuntu-server:~$ sudo gdisk -l /dev/sda2
GPT fdisk (gdisk) version 1.0.8

...

Creating new GPT entries in memory.
Disk /dev/sda2: 41936896 sectors, 19.1 GiB
Sector size (logical/physical): 512/512 bytes
Disk identifier (GUID): BA15438B-6094-4BE3-81D2-928EF880DE86
Partition table holds up to 128 entries
...
Total free space is 41936829 sectors (19.1 GiB)
Number  Start (sector)    End (sector)  Size       Code  Name
```

Info about a partition

- **`gdisk -l /dev/sda`**
  - Geeft een overzicht van de configuraties v partities

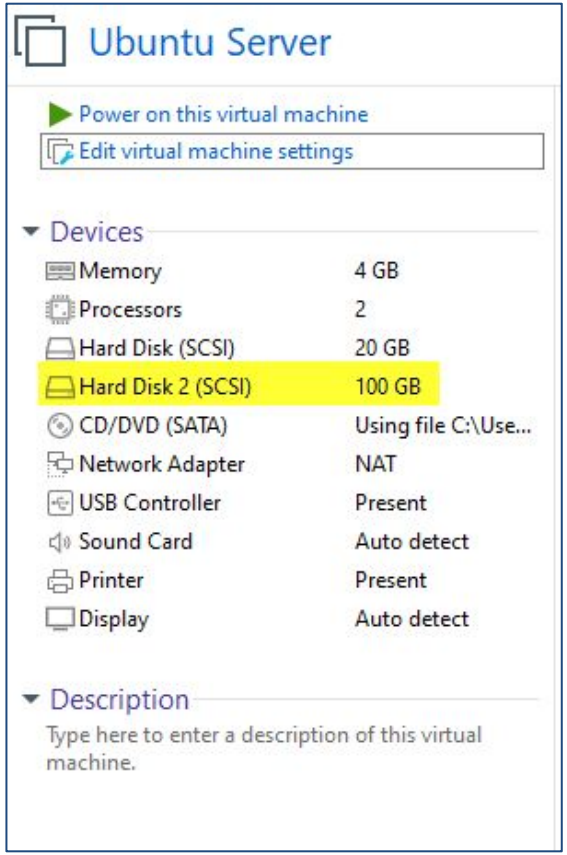
```
student@ubuntu-server:~$ sudo gdisk -l /dev/sda
GPT fdisk (gdisk) version 1.0.8
...
Number  Start (sector)    End (sector)  Size       Code  Name
   1            2048         1953791   953.0 MiB   EF00
   2         1953792        41940991   19.1 GiB    8300
student@ubuntu-server:~$
```

`sda1` → Type Code: `EF00` → BIOS boot partition
`sda1` → Type Code: `8300` → linux system partition

Partitioning

Stap 1: Herkennen van de hd

```
student@ubuntu-server:~$ lsblk -e 7
NAME   MAJ:MIN RM  SIZE RO TYPE MOUNTPOINTS
sda      8:0    0   20G  0 disk
├─sda1   8:1    0  953M  0 part /boot/efi
└─sda2   8:2    0 19.1G  0 part /
sdb      8:16   0  100G  0 disk
sr0     11:0    1 1024M  0 rom
```



Extra harddisk van 100GB toegevoegd via VMWare Settings voor Ubuntu Server

Partitioning

Stap 2: De harde schijf openen met **gdisk**

```
student@ubuntu-server:~$ sudo gdisk /dev/sdb
GPT fdisk (gdisk) version 1.0.8

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

Creating new GPT entries in memory.

Command (? for help):
```

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.

Partitioning

Stap 3: Bekijken van de huidige partitie-tabel

```
Command (? for help): p
Disk /dev/sdb: 209715200 sectors, 100.0 GiB
Model: VMware Virtual S
Sector size (logical/physical): 512/512 bytes
Disk identifier (GUID): 4FFC583D-6AF4-4CBE-9C79-5E7C129CC0EB
Partition table holds up to 128 entries
Main partition table begins at sector 2 and ends at sector 33
First usable sector is 34, last usable sector is 209715166
Partitions will be aligned on 2048-sector boundaries
Total free space is 209715133 sectors (100.0 GiB)

Number  Start (sector)    End (sector)  Size       Code  Name

Command (? for help):
```

Er zijn momenteel nog geen partities aanwezig

Partitioning

Stap 4: Toevoegen van partities

```
Command (? for help): n
Partition number (1-128, default 1): <enter>
First sector (34-209715166, default = 2048) or {+-}size{KMGTP}: <enter>
Last sector (2048-209715166, default = 209715166) or {+-}size{KMGTP}: +40G
Current type is 8300 (Linux filesystem)
Hex code or GUID (L to show codes, Enter = 8300): <enter>
Changed type of partition to 'Linux filesystem'

Command (? for help):
```

We voegen een partitie toe van 40 Gigabyte.

Partitioning

Stap 5: Overzicht van de nieuwe partitietabel

```
Command (? for help): p
Disk /dev/sdb: 209715200 sectors, 100.0 GiB
Model: VMware Virtual S
Sector size (logical/physical): 512/512 bytes
Disk identifier (GUID): 4FFC583D-6AF4-4CBE-9C79-5E7C129CC0EB
Partition table holds up to 128 entries
Main partition table begins at sector 2 and ends at sector 33
First usable sector is 34, last usable sector is 209715166
Partitions will be aligned on 2048-sector boundaries
Total free space is 125829053 sectors (60.0 GiB)

Number  Start (sector)    End (sector)  Size       Code  Name
   1            2048        83888127   40.0 GiB    8300  Linux filesystem

Command (? for help):
```

Partitioning

Stap 6: Info van de nieuwe partitietabel

```
Command (? for help): i
Using 1
Partition GUID code: 0FC63DAF-8483-4772-8E79-3D69D8477DE4 (Linux filesystem)
Partition unique GUID: CAA100E5-5499-48DF-A0F2-CFD98F77565F
First sector: 2048 (at 1024.0 KiB)
Last sector: 83888127 (at 40.0 GiB)
Partition size: 83886080 sectors (40.0 GiB)
Attribute flags: 0000000000000000
Partition name: 'Linux filesystem'
```

```
student@ubuntu-server:~$ ls -l /dev/disk/by-partuuid/
total 0
lrwxrwxrwx 1 root root 10 Oct  7 06:08 bb9da16c-b934-415e-b39a-9ee2458adae8 -> ../../sda2
lrwxrwxrwx 1 root root 10 Oct  7 06:08 bbefc57e-ddff-451d-ac5e-c4069ba08fc3 -> ../../sda1
lrwxrwxrwx 1 root root 10 Oct  7 06:25 caa100e5-5499-48df-a0f2-cfd98f77565f -> ../../sdb1
```

Partitioning

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

```
Command (? for help): l
Type search string, or <Enter> to show all codes: <enter>
0700 Microsoft basic data                  0701 Microsoft Storage Replica
0702 ArcaOS Type 1                         0c01 Microsoft reserved
2700 Windows RE                            3000 ONIE boot
3001 ONIE config                           3900 Plan 9
4100 PowerPC PReP boot                     4200 Windows LDM data
4201 Windows LDM metadata                  4202 Windows Storage Spaces
7501 IBM GPFS                              7f00 ChromeOS kernel
7f01 ChromeOS root                         7f02 ChromeOS reserved
8200 Linux swap                            8300 Linux filesystem
8301 Linux reserved                        8302 Linux /home
8303 Linux x86 root (/)                    8304 Linux x86-64 root (/)
8305 Linux ARM64 root (/)                  8306 Linux /srv
8307 Linux ARM32 root (/)                  8308 L
8309 Linux LUKS                            830a L
830b Linux x86 root verity                 830c L
830d Linux ARM32 root verity               830e L
830f Linux IA-64 root verity               8310 L
8311 Linux /var/tmp                        8312 L
8313 Linux x86 /usr                        8314 L
8315 Linux ARM32 /usr                      8316 L
8317 Linux IA-64 /usr                      8318 L
Press the <Enter> key to see more codes, q to q
```

```
Command (? for help): t
Using 1
Current type is 8300 (Linux filesystem)
Hex code or GUID (L to show codes, Enter = 8300): 8300
Changed type of partition to 'Linux filesystem'

Command (? for help):
```

Partitioning

Stap 8: Opslaan van de nieuwe partitietabel

```
Command (? for help): w

Final checks complete. About to write GPT data. THIS WILL OVERWRITE EXISTING
PARTITIONS!!

Do you want to proceed? (Y/N): y
OK; writing new GUID partition table (GPT) to /dev/sdb.
The operation has completed successfully.
student@ubuntu-server:~$
```

De partitie-wijzigingen zijn opgeslagen

Partitioning

Overzicht van de disk na wijzigingen

```
student@ubuntu-server:~$ sudo gdisk -l /dev/sdb
GPT fdisk (gdisk) version 1.0.8

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

Found valid GPT with protective MBR; using GPT.
Disk /dev/sdb: 209715200 sectors, 100.0 GiB
Model: VMware Virtual S
Sector size (logical/physical): 512/512 bytes
Disk identifier (GUID): 4FFC583D-6AF4-4CBE-9C79-5E7C129CC0EB
Partition table holds up to 128 entries
Main partition table begins at sector 2 and ends at sector 33
First usable sector is 34, last usable sector is 209715166
Partitions will be aligned on 2048-sector boundaries
Total free space is 125829053 sectors (60.0 GiB)

Number  Start (sector)    End (sector)  Size       Code  Name
   1            2048        83888127   40.0 GiB    8300  Linux filesystem
```

Filesystems

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

```
       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).
```

Putting a filesystem on a partition

- **mkfs**

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

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@ubuntu-server:~$ sudo mkfs.ext4 /dev/sdb1
mke2fs 1.46.5 (30-Dec-2021)
Creating filesystem with 10485760 4k blocks and 2621440 inodes
Filesystem UUID: 5a0ed288-5de7-4e30-9934-19a784e0e60b
Superblock backups stored on blocks:
        32768, 98304, 163840, 229376, 294912, 819200, 884736, 1605632, 2654208,
        4096000, 7962624

Allocating group tables: done
Writing inode tables: done
Creating journal (65536 blocks): done
Writing superblocks and filesystem accounting information: done
```

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 geen drive letters in Linux

Mounting a filesystem

Stap 1: We maken, indien nodig, een directory

```
student@ubuntu-server:~$ sudo mkdir /var/ftp
```

Stap 2: We mounten het filesysteem op het mountpoint

```
student@ubuntu-server:~$ 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@ubuntu-server:~$ ls -ld /var/ftp/
drwxr-xr-x 3 root root 4096 Oct  7 06:23 /var/ftp/
student@ubuntu-server:~$ sudo chmod a+w /var/ftp/
student@ubuntu-server:~$ ls -ld /var/ftp/
drwxrwxrwx 3 root root 4096 Oct  7 06:23 /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@ubuntu-server:~$ lsblk | grep -e NAME -e sdb
NAME   MAJ:MIN RM  SIZE RO TYPE MOUNTPOINTS
sdb      8:16   0  100G  0 disk
└─sdb1   8:17   0   40G  0 part /var/ftp
student@ubuntu-server:~$ sudo umount /var/ftp
student@ubuntu-server:~$ lsblk | grep -e NAME -e sdb
NAME   MAJ:MIN RM  SIZE RO TYPE MOUNTPOINTS
sdb      8:16   0  100G  0 disk
└─sdb1   8:17   0   40G  0 part
student@ubuntu-server:~$ sudo mount /dev/sdb1 /var/ftp/
student@ubuntu-server:~$ lsblk | grep -e NAME -e sdb
NAME   MAJ:MIN RM  SIZE RO TYPE MOUNTPOINTS
sdb      8:16   0  100G  0 disk
└─sdb1   8:17   0   40G  0 part /var/ftp
student@ubuntu-server:~$ sudo umount /dev/sdb1
student@ubuntu-server:~$ lsblk | grep -e NAME -e sdb
NAME   MAJ:MIN RM  SIZE RO TYPE MOUNTPOINTS
sdb      8:16   0  100G  0 disk
└─sdb1   8:17   0   40G  0 part
student@ubuntu-server:~$
```

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

Displaying mounted file systems

- `lsblk`
  - overzicht van alle block devices

```
student@ubuntu-server:~$ lsblk -e 7,11
NAME   MAJ:MIN RM  SIZE RO TYPE MOUNTPOINTS
sda      8:0    0   20G  0 disk
├─sda1   8:1    0  953M  0 part /boot/efi
└─sda2   8:2    0 19.1G  0 part /
sdb      8:16   0  100G  0 disk
└─sdb1   8:17   0   40G  0 part
```

Displaying mounted file systems

- **mount**
  - overzicht van alle block devices

```
student@ubuntu-server:~$ mount | grep /dev/sd
/dev/sda1 on /boot/efi type vfat
(rw,relatime,fmask=0022,dmask=0022,codepage=437,iocha
rset=iso8859-1,shortname=mixed,errors=remount-ro)
/dev/sda2 on / type ext4 (rw,relatime)
/dev/sdb1 on /var/ftp type ext4 (rw,relatime)
```

- **du**
  - disk usage: groottes van directories of partities

```
student@ubuntu-server:~$ sudo du -hs 2> /dev/null
8.9G    /
```

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

blkid kent nieuwe partities nog niet onmiddellijk. Gebruik dan 'sudo blkid' of 'ls -l /dev/disk/by-uuid/'

Permanent mounts

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

```
student@ubuntu-server:~$ cat /etc/fstab
# /etc/fstab: static file system information.
...
# <file system> <mount point>   <type>  <options>       <dump>  <pass>
# / was on /dev/sda2 during curtin installation
/dev/disk/by-uuid/babbbc78-a60c-4189-b899-65f80531793b / ext4 defaults 0 1
# /boot/efi was on /dev/sda1 during curtin installation
/dev/disk/by-uuid/6EC8-C861 /boot/efi vfat defaults 0 1
/swap.img       none    swap    sw      0       0
```

```
student@ubuntu-server:~$ blkid | grep sda
/dev/sda2: UUID="babbbc78-a60c-4189-b899-65f80531793b" BLOCK_SIZE="4096" TYPE="ext4"
PARTUUID="bb9da16c-b934-415e-b39a-9ee2458adae8"
/dev/sda1: UUID="6EC8-C861" BLOCK_SIZE="512" TYPE="vfat" PARTUUID="bbefc57e-ddff-451d-ac5e-c4069ba08fc3"
```

Adding permanent mounts

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

```
# /etc/fstab: static file system information.
...
# <file system> <mount point>   <type>  <options>       <dump>  <pass>
# / was on /dev/sda2 during curtin installation
/dev/disk/by-uuid/babbbc78-a60c-4189-b899-65f80531793b / ext4 defaults 0 1
# /boot/efi was on /dev/sda1 during curtin installation
/dev/disk/by-uuid/6EC8-C861 /boot/efi vfat defaults 0 1
/swap.img       none    swap    sw      0       0
/dev/disk/by-uuid/5a0ed288-5de7-4e30-9934-19a784e0e60b /var/ftp ext4 defaults 0 0
# or -->  /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@ubuntu-server:~$ ls -l /dev/disk/by-uuid/ | grep sdb1
lrwxrwxrwx 1 root root 10 Oct 11 08:08 5a0ed288-5de7-4e30-9934-19a784e0e60b -> ../../sdb1
```

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

```
student@ubuntu-server:~$ sudo mount /var/ftp/
```

`blkid` kent nieuwe partities nog niet onmiddellijk. Gebruik dan 'sudo blkid' of 'ls -l /dev/disk/by-uuid/'

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