

# Informatics 1

## BIOS, Operating systems

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# BIOS (Basic Input/Output System)

- What comes before the operating system? How does a computer know from where to load the operating system? How does a computer without an operating system know how to use a monitor or a keyboard?
- The first thing that comes online once a computer starts is the **BIOS**.
- This is a minimal system integrated into the **motherboard**, its main task is to initialize the computer.
- There are **drivers** stored inside the BIOS for the use of basic input / output devices
  - drivers are software that describes to the machine how a component works
- The BIOS finds the highest priority HDD and starts to load the operating system.

# BIOS (Basic Input/Output System)

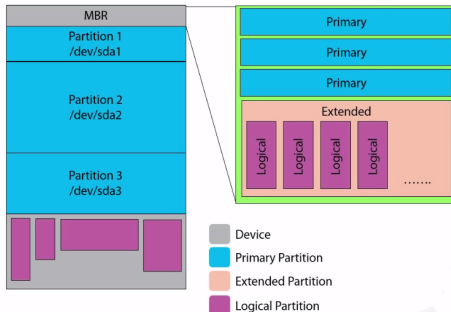


# MBR (Master Boot Record)

- The first step in loading the operating system is when the BIOS reads the first 512 bytes of the chosen HDD, this is called the **MBR**.
- The first part of the MBR is a short code (**bootstrap** code), which describes the steps of starting the operating system.
- The next part is the **partition table**
- The third and last part of the MBR is the **magical number**, which is the same for all computers (**0xAA55** = **0b1010101001010101**, this is a failsafe, a way to check if the MBR is valid.
- Until this point the starting procedure of the machine is independent of the operating system.

- After the MBR there can be one or more partitions
- There can be at most 4 **primary partitions**.
- It is recommended to install your operating system on a primary partition (Windows can only be installed there).

**MBR Partition Scheme**



# Extended partition

- The extended partition counts as a primary partition, so there can be at most 3 primary and 1 extended partition on a storage device.
- It can contain however many **logical partition** this is a possible way to have more than 4 partitions.
- It can only be located at the end of the storage device, no primary partition can follow it.
- Windows usually creates a **recovery partition** on install, which comes before the partition of the operating system, should the operating system fail, it will try to recover itself using this partition.
- Linux uses multiple partitions (usually 4), one of them is the previously mentioned **virtual memory**. This is where the unused part of the memory can be stored (swapping, paging).

# Example for a graphical partition manager

**/dev/sdb - GParted**

GParted Edit View Device Partition Help

/dev/sdb (465.76 GiB)

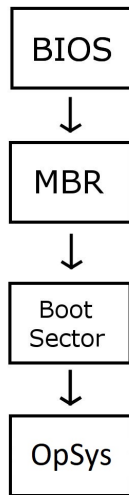
/dev/sdb7 47.49 GiB /dev/sdb8 293.65 GiB /dev/sdb6 68.35 GiB

Partition	File System	Mount Point	Label	Size	Used	Unused	Flags
/dev/sdb1	ext4	/		18.86 GiB	3.04 GiB	15.82 GiB	boot
▼ /dev/sdb2	extended			446.90 GiB	---	---	
/dev/sdb7	ntfs		Back Up Data	47.49 GiB	---	---	
/dev/sdb8	ext4	/media/Big_L	Big L	293.65 GiB	124.88 GiB	168.77 GiB	
/dev/sdb9	ntfs	/media/Documents	Documents	34.18 GiB	5.10 GiB	29.08 GiB	
/dev/sdb6	ext4	/home		68.35 GiB	1.57 GiB	66.79 GiB	
/dev/sdb5	linux-swap			3.22 GiB	---	---	

0 operations pending

# Boot Sector

- At the beginning of every primary partition is a **Boot Sector**, the MBR stores the location of this sector and this is what starts to load the operating system.
- Similarly to the MBR this is a 512 byte sector as well, which provides the necessary instructions to start the operating system, this stores a magical number as well.
- On linux systems the Boot Sector is actually empty and the operating system is loaded in another way, this is why it is possible to install linux onto a logical partition.
- If the machine's storage device contains more than one operating system and the MBR contains the necessary instructions, then it is possible to choose which one to load at every start.





# File system

A protocol how the files are stored on a partition.

Operating system	WINDOWS	LINUX	MAC	Mobile storage
File system	NTFS	ext4	HFS+	FAT32 or NTFS

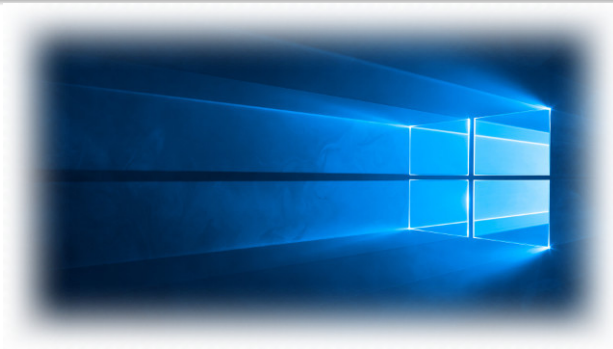
- FAT32 is an older format
- it is used mostly for compatibility reasons

# Tasks of the operating system

- Operating system (OS): core program, which
  - directly controls the hardware (memory, peripherals,...),
  - provides a unified environment for applications,
  - organizes the execution of these applications,
  - handles possible program failures,
  - handles files,
  - provides basic protection to the machine,
  - logs important operation events. . .
- The OS is part of the **system programs**
- Another system programs for example are anti-viruses, file compressors, file encrypters, file explorers, network programs, task manager...



# Windows summary



- File system: NTFS
- Source code: closed
- Used on most PCs
- Developed in batches, there is always an actively developed branch (Windows 10), while the older versions only get smaller fixes and security updates (Windows 7, 8.1), or nothing at all (Windows XP)



- File system: ext4
- Source code: open
- Most widespread on servers, but also used on personal computers
- Development is on multiple branches, there are a number of different distributions, there are branches specialized for research or programming (SUSE) and there are those for simple users (Linux Mint, Ubuntu).

# Android summary



**Cupcake**  
Android 1.5



**Donut**  
Android 1.6



**Eclair**  
Android 2.0/2.1



**Froyo**  
Android 2.2.x



**Gingerbread**  
Android 2.3.x



**Honeycomb**  
Android 3.x



**Ice Cream Sandwich**  
Android 4.0.x



**Jelly Bean**  
Android 4.1.x



**KitKat**  
Android 4.4.x



**Lollipop**  
Android 5.0



**Marshmallow**  
android 6.0



**Nougat**  
android 7.0

- File system: varies, optimized for flash memory: yaffs2, vfat (SD-card), (Samsung: Flash-Friendly File System f2fs),...
- Source code: open
- Mostly used on mobile phones, tablets, smart watches, TVs, cars,...

- Older processors have 32 bit registers
  - they can compute with bigger numbers, but that requires more elementary operations
- This allowed only  $2^{32} = 4\text{GiByte}$  memory to address (memory address is the ordinal number of a memory cell)
- Every program (and OS too) can run only on compatible CPU
  - this is why you have to know which is your computer
  - on 64 bit Windows you can run 32 bit programs
  - Linux and Mac uses only 64 bit for a long time now.
- With 64 bit addresses one can have *16 exbibyte* memory, in theory
  - Most 64 bit desktop processors use 48 bit physical addressing
  - this allows to use at most 256 TiB memory
  - in that case programs still operate on 64 bit numbers