Lecture 5

”OS Installation and hardening”

Administration of computer systems, 2008

Lecture goals

- Know the basics of binary encoding and the binary numeral system
- Secondary/permanent storage
- Know how to install and secure an OS.
- Preparation for exercise 3
  - Partitioning hard drives, installing OS

Numeral systems

- Positional number formats
- Radix, or base, defines multiplier between each position
- Decimal number system has radix 10
- 10 symbols used to represent numbers

$155 = 1*10^2+5*10^1+5*10^0$

Base 2, binary numeral system

- The binary numeral system uses base 2 instead
- Two symbols used to represent numbers
- Value of each position is defined using base 2

$101(b) = 1*2^2 + 0*2^1 + 1*2^0 = 4+0+1 = 5(d)$

Base 2

- The number of unique combinations of *n* binary positions is 2^n
- E.g. 16 bits can be combined in 2^{16} = 65536 unique ways.

0000000000000000
0000000000000001
0000000000000010
0000000000000011
0000000000000101
0000000000000111
...

Storing information

- Information encoded in binary format
- Binary representation is the underlying representation used in all stages of computation.
- Gradually abstracted in various layers

Binary representation

- In the computer world a single binary symbol is called a *bit*
- 8 bits together makes up one *byte*
  - 8 bits can be combined in $2^8 = 256$ ways (enough to encode e.g. western writing symbols)

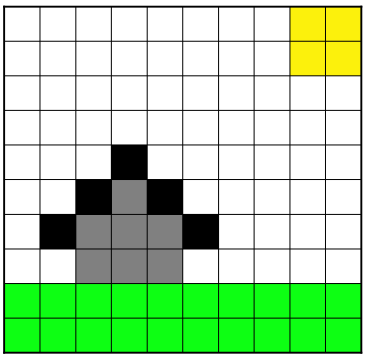
Popular bit-lengths

8 bits = 1 "*byte*"
4 bits = ½ byte = 1 "*nibble*"

16 bits = 2 bytes = 1 "*16-bit word*"

32 bits = 4 bytes = 1 "*32-bit word*"

Example



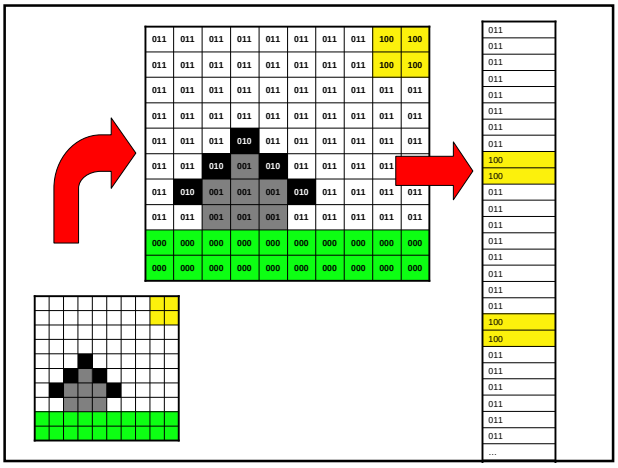
Encode the information

- We have used 5 colors (green, grey, black, white, yellow)
- How many bits do we need to use per pixel?

$$2^3 = 8$$

Encoding table

Code	Color
000	Green
001	Grey
010	Black
011	White
100	Yellow
101	-
110	-
111	-



Store the encoded data

- 100 pixels, 3 bits per pixel
- How many bytes?

100*3 = 300 bits = 300/8 bytes = 37.5 bytes

Larger numbers

- Let the confusion begin!
  - Units are taken from the SI-system e.g.:

Kilo	**1000^1**
Mega	**1000^2**
Giga	**1000^3**
Tera	**1000^4**
Peta	**1000^5**

  - 1 Megabyte = 1 000 000 bytes

However…

…watch out

- Mega in the binary context sometimes refers to the closest *binary* multiplier
- E.g. Megabyte can be either:

$1000^2 = 1\ 000\ 000$ bytes

or

$2^{20} = 1024^2 = 1\ 048\ 576$ bytes

SI vs. binary

- Might not matter for smaller numbers
- But gets gradually “worse” e.g.

500 000 000 000 byte HD = 500 GB using SI definition of “Giga”

but only $\frac{500*1000^3}{2^{30}}$ =465.66 “GB” when using base 2 definition of “Giga”

- Windows 2000 prints the size in “GB” using the binary system (your drive has not shrunk!)

Standardization

- The International Electrotechnical Commission (IEC) tried to make sense of it in 1999. Solution: Use new prefixes for base 2!

Kibi	**1024^1**
Mebi	**1024^2**
Gibi	**1024^3**
Tebi	**1024^4**
Pebi	**1024^5**

- E.g. 1 Mebibyte (MiB) = 1 048 576 bytes

Finding your bytes

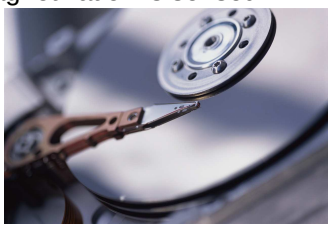
- Assume byte-addressable memory
- An address refers to a stored byte
- Bit-width of address defines maximum addressable storage.

8 bit address = 2^8 = 256 places (~2kB)

16 bit address = 2^{16} = 65536 places (~500kB)

Magnetic storage

- The magnetic properties of the medium are changed when writing. When reading the magnetization is sensed.



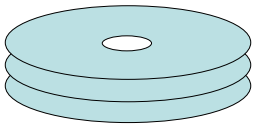
Optical disc writing

- Write-once discs: The laser permanently changes the reflectivity of dye on the disc
- Rewritable discs: Do not use dye. Instead the reflectivity of a metallic layer is changed by heating it at different temperatures (using a laser)

Optical disc reading

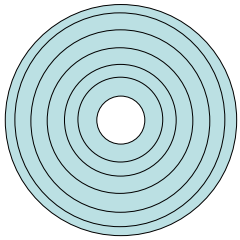
- Shine a laser onto a reflective disk and interpret what is reflected back

Hard drives



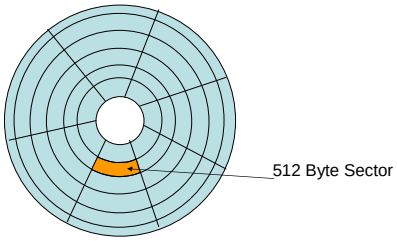
Data is stored on several platters

Tracks



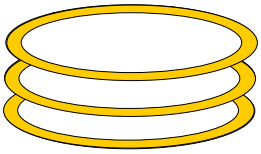
On each platter data is recorded in *tracks*, several thousand per disk

Sectors



Each track is logically divided into *sectors* (sometimes called block)

Cylinders



A set of tracks on all platters is called a *cylinder.*

Addressing a HD

- Cylinder-Head-Sector (CHS)
  - Traditionally used for ATA/IDE
  - BIOS limits on number of addressable sectors
- Logical Block Addressing (LBA)
  - Just number all the sectors starting from 0
  - Independent of physical storage mechanism
  - Works well for other types of storage

Partitioning

- Splitting a storage medium into smaller parts, *partitions*.
- Up to 4 *primary partitions*, as defined by the MBR.

Extended partition

- One of the four primary partitions can be an *extended* partition
- Within the extended partition *logical* partitions can be created

Preparing OS installation

- Partition your drive(s)
  - OS installer tools
  - Free-standing tools
- Format the partitions
  - Prepares a partition for use
  - Creates a *filesystem*

Begin installation

- Make sure you have all necessary *installation media*.
  - CDs
  - DVDs
  - License keys
- Set the correct *boot order*
  - E.g. CD first

During the installation

- Select (or create) which partition to install the operating system on
- Localization
  - Keyboard, language, timezone
- Initial users and passwords
  - Administrator
- Basic networking
  - Static/dynamic IP address

After the installation

- Install updates/service packs
- Use secure passwords
  - No common words
  - As long as possible
- Firewall
- Password protect the BIOS settings
- Install virus/malware checkers

After the installation (2)

- Make an inventory of what services are running and listening to the network
  - Port-scan your freshly installed machine

Review

- Binary numeral system
  - Bits, bytes
- Binary encoding example
- Hard drives
  - Cylinders, heads, sectors
- Partitioning
  - Primary/extended
- OS installation