



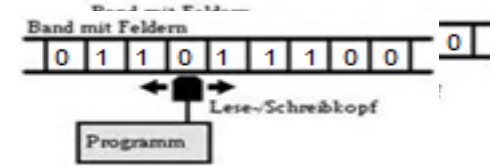
Berner Fachhochschule  
Haute école spécialisée bernoise  
Bern University of Applied Sciences

# IT Principles

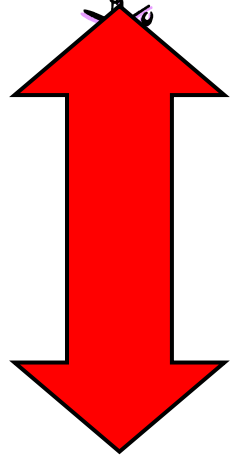
## Introduction to the basics of computer science

Beatrice Amrhein / [beatrice.amrhein@bfh.ch](mailto:beatrice.amrhein@bfh.ch)

# The Tradeoff



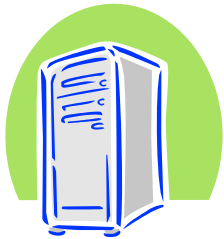
Needs, problems, questions, ...



????

## Communication problem

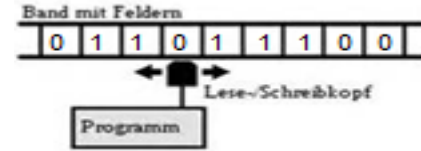
- How does a PC work?
- How to communicate with a PC?
- What is a PC able to do?



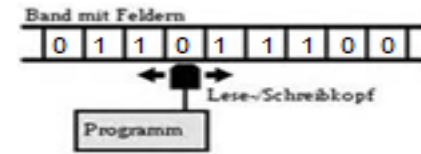
Works only with binary data (10010111)

# Data vs. Information

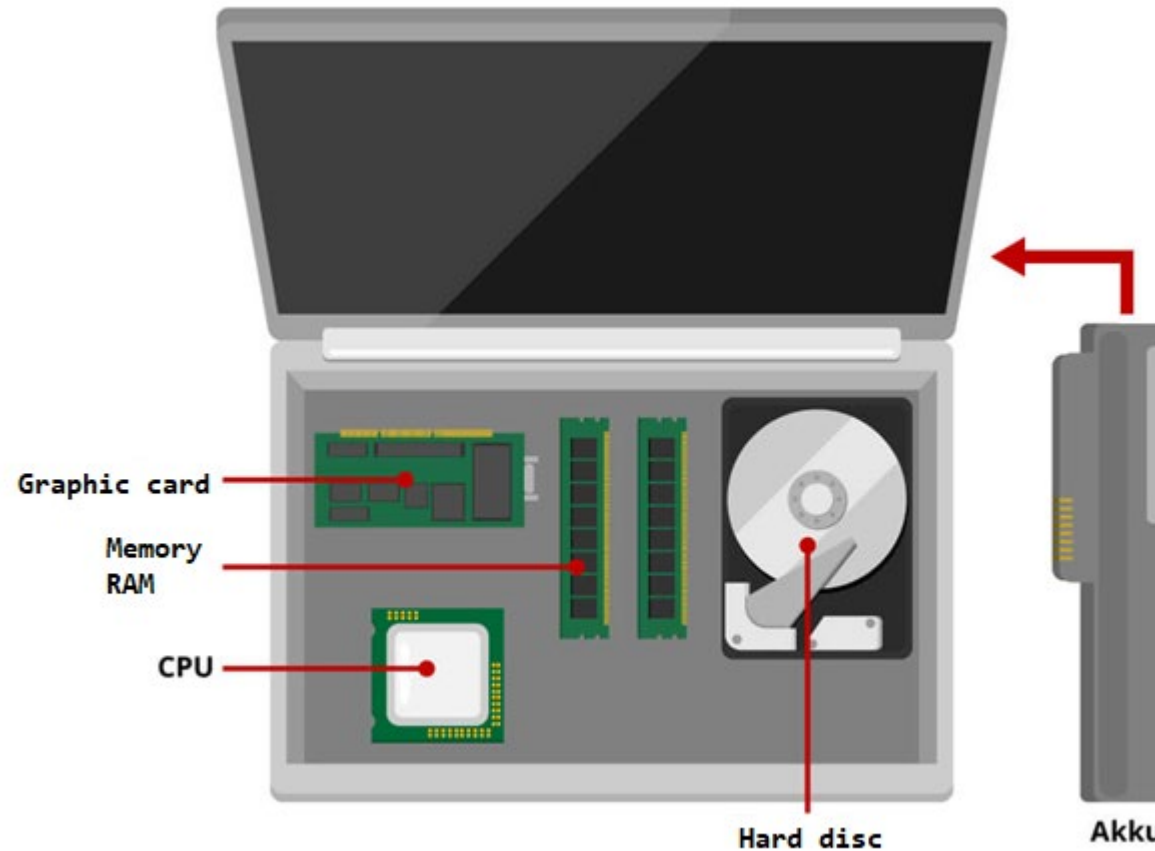
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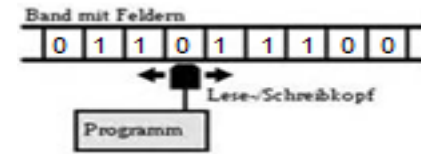
- Data
  - Raw, unorganized facts
  - Can be in the form of text, graphics, audio, or video
- Information
  - Data that has been processed into a meaningful form
- Data processing
  - Converting data into information



# Hardware components of a computer

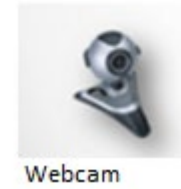
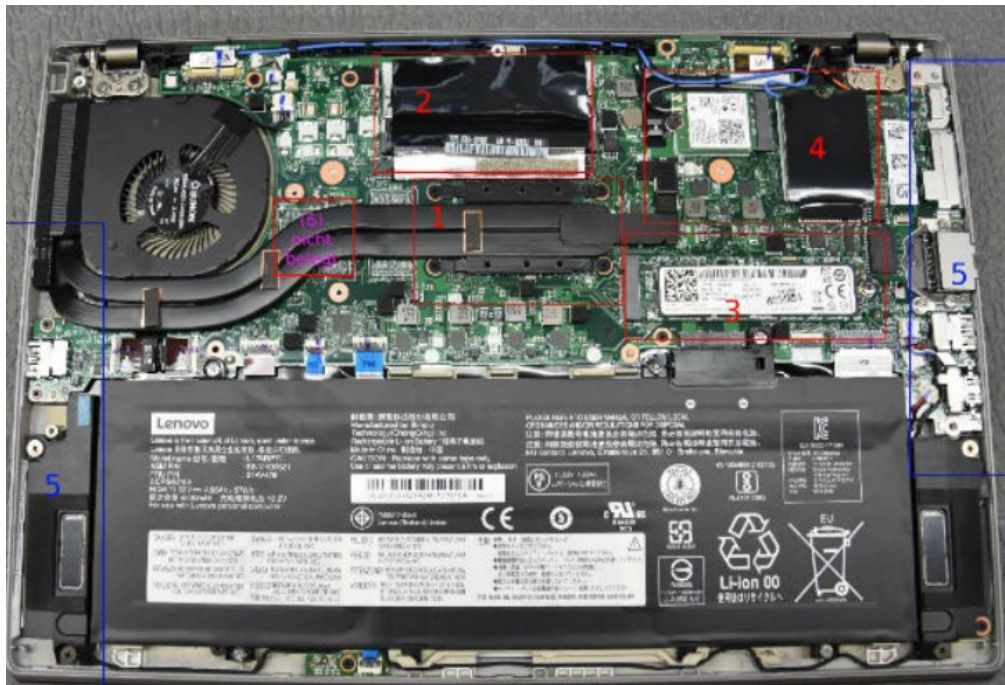


# Internal structure of a computer



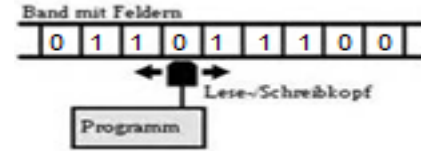
## Central unit and peripherals

### Laptop with central unit

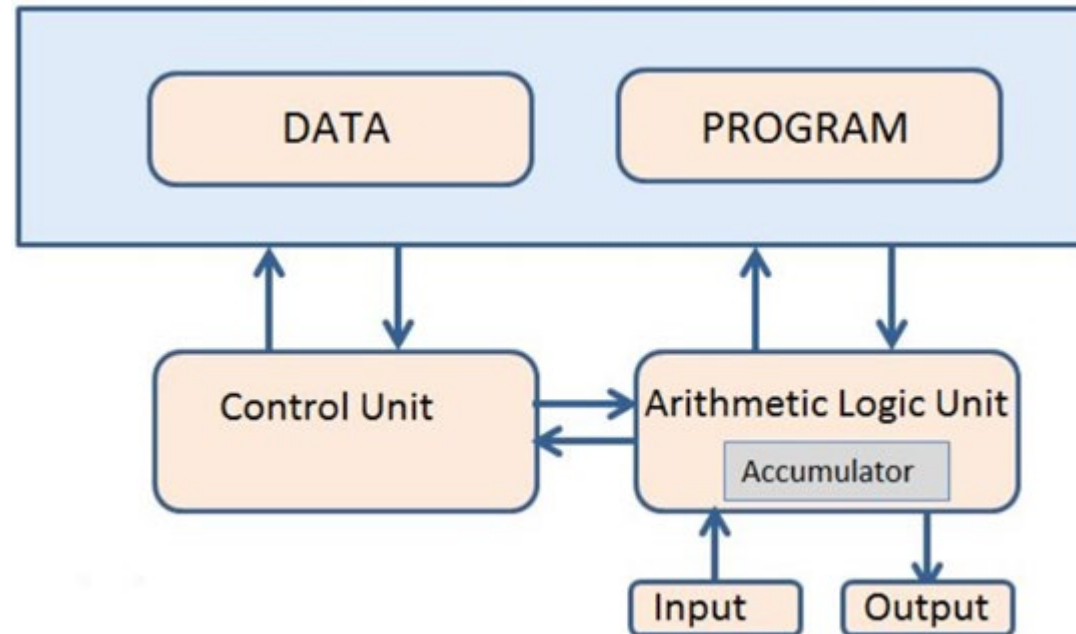


## Periphery

# Von Neumann Architecture

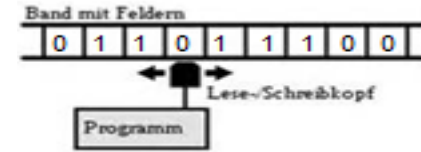


- The basic components of a von-Neumann computer. The memory contains both data and program code.



Von Neumann Architecture (VNA)

# Von Neumann Architecture (VNA)



## Structure

- The basic units are located on the motherboard (mainboard).

## Operations

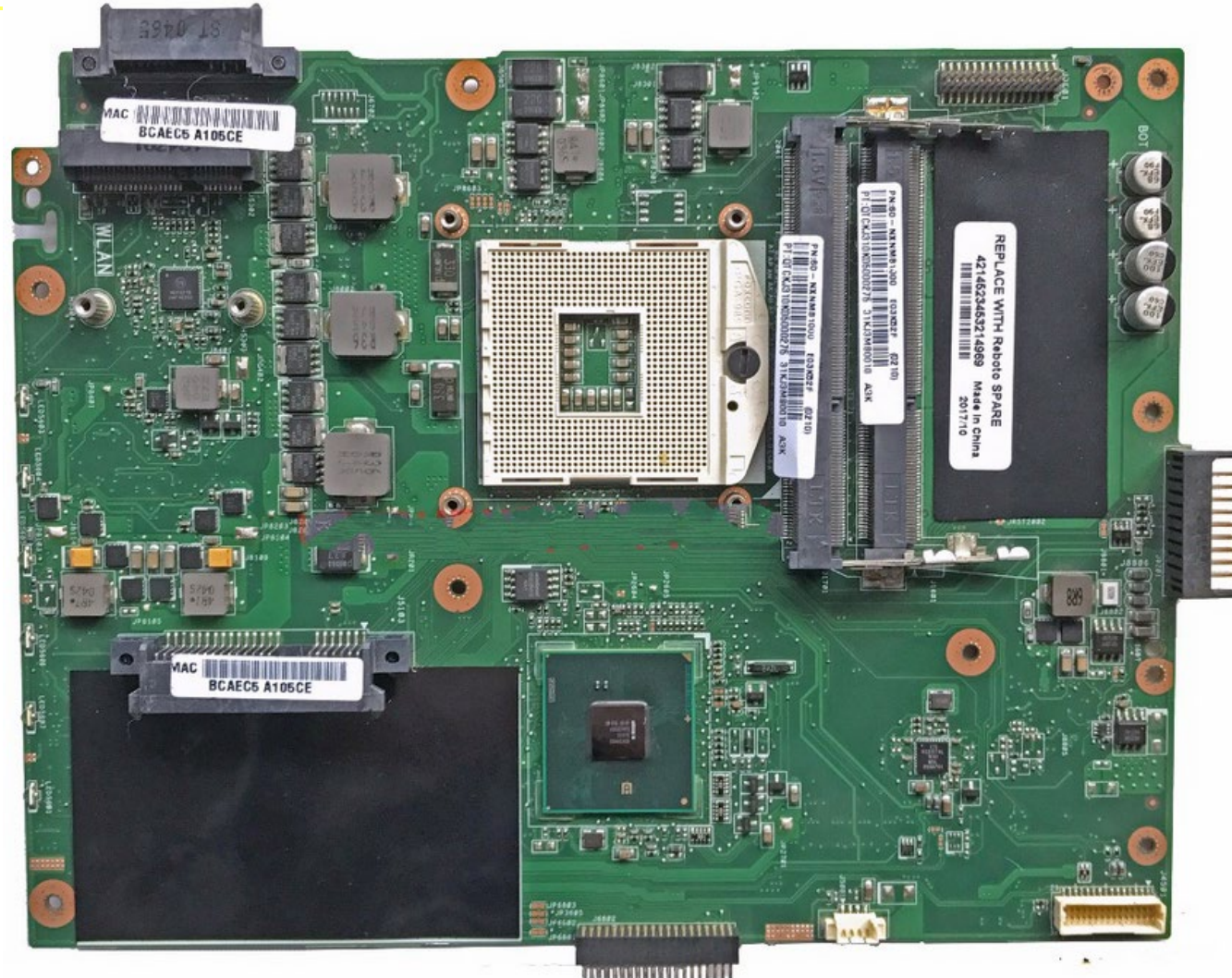
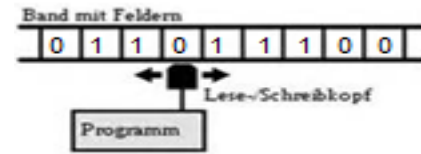
- The operations specified in form of machine instructions (assembly code) are applied to the content of the specified memory cell

```
SUB32  PROC           ; procedure begins here
      CMP  AX,97       ; compare AX to 97
      JL   DONE        ; if less, jump to DONE
      CMP  AX,122      ; compare AX to 122
      JG   DONE        ; if greater, jump to DONE
      SUB  AX,32       ; subtract 32 from AX
DONE:  RET             ; return to main program
SUB32  ENDP           ; procedure ends here
```

Example assembly code



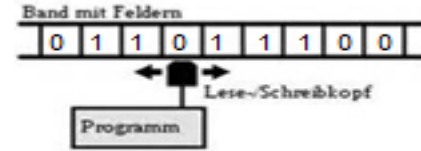
# The central unit



The motherboard or mainboard

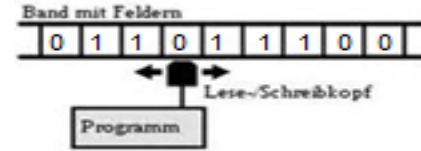


# The central unit



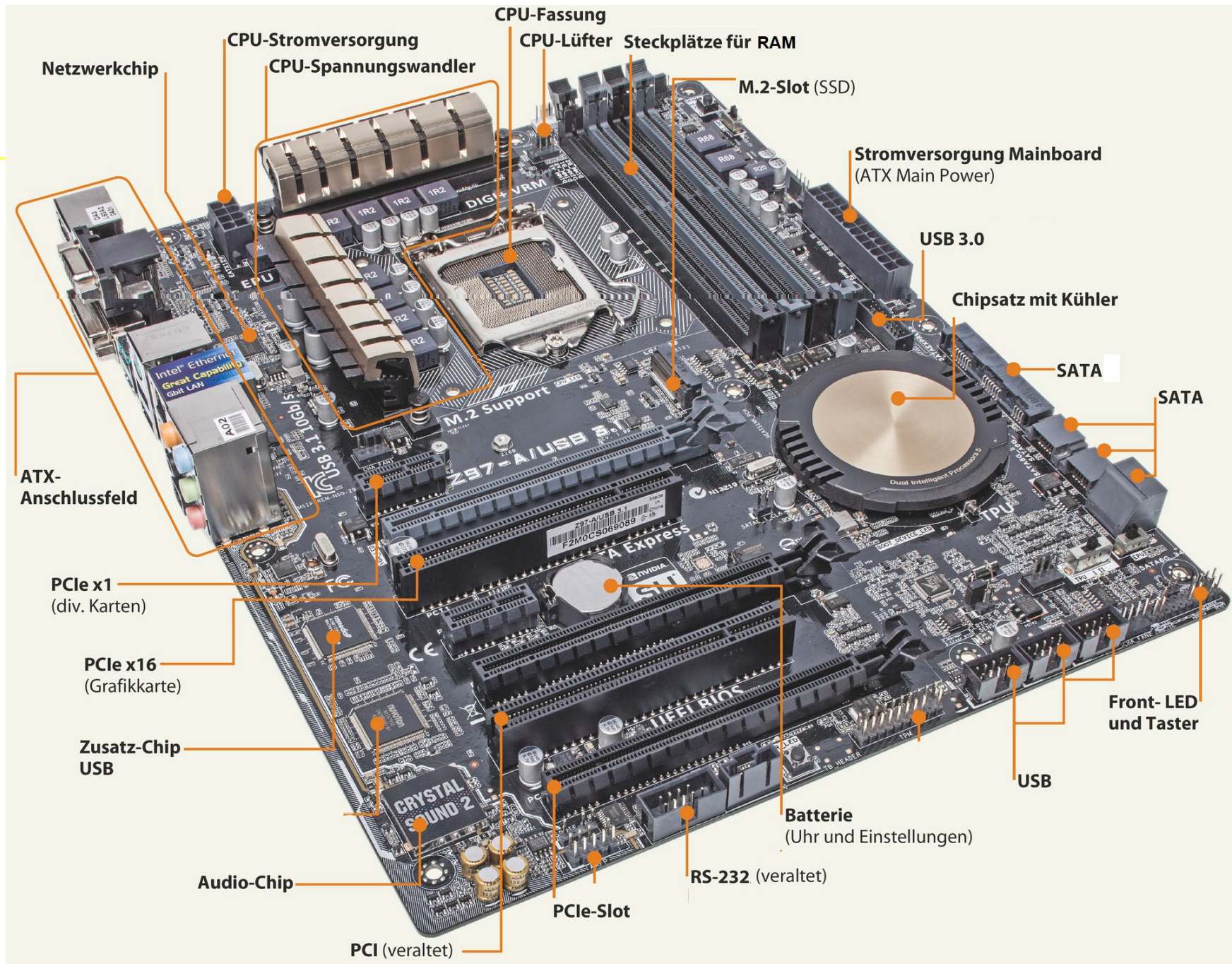
- The central unit consists mainly of the components of the motherboard (mainboard)
- The essential components on a motherboard are:
  - The micro processor (CPU, Central Processing Unit), which is responsible for running the programs as well as for controlling and managing the hardware. This is the heart of a computer.
  - RAM / Memory (RAM, Random Access Memory) contains the program that is currently running, as well as the necessary data.

# The central unit



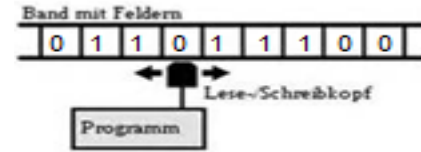
- The ROM usually contains a program (BIOS) that checks the most important hardware components when turned on and then boots the operating system of the hard disk.
- Buses and interfaces are used for the communication
  - between the individual components of the motherboard
  - Between the motherboard and peripherals, such as graphics cards, network cards, hard drives, printers, etc..
- The Chipset (Northbridge, Southbridge) controls the clock and builds the interface between the CPU and the I/O (e.g., RAM, graphics cards or network card).

# The Central Unit

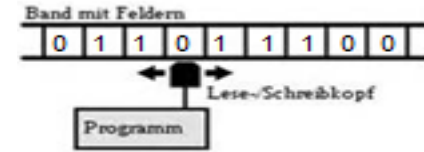




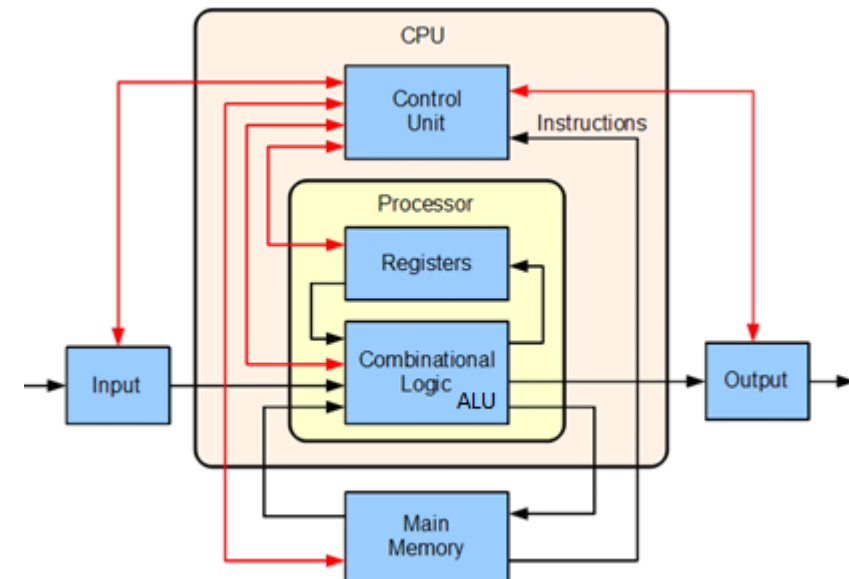
# The processor (CPU)



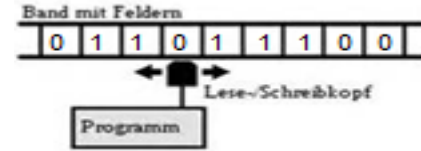
# How a processor works



- The command counter points to the next machine command.
- The command is transferred from memory to the command register via the data bus. The command is analyzed and then executed.
- Depending on the command, reading data from memory, controlling peripheral interfaces, calculation in the ALU, or performing a jump is executed simultaneously.



# The memory (RAM)



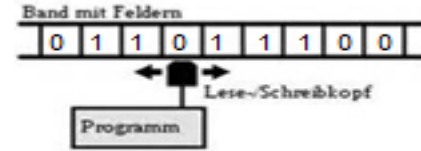
## Random Access Memory



- RAM is used to store (volatile) data.
- In case of a power interruption, the RAM contents are lost.
- RAM is used to store the program code and data, as the number of registers in the CPU is small (caching).



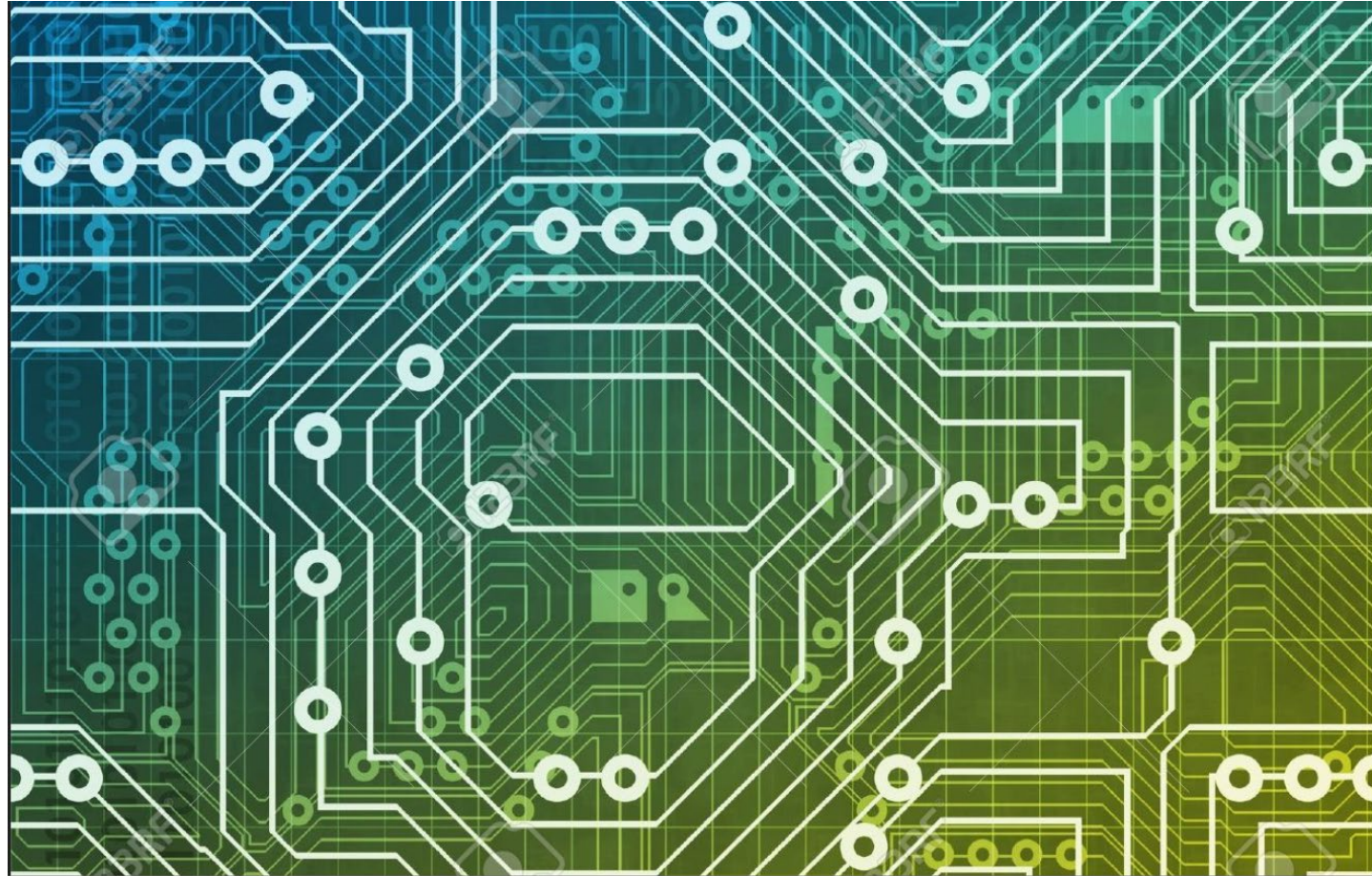
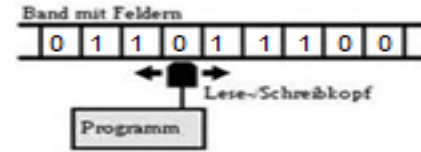
# BIOS / UEFI



BIOS (Basic Input-Output System) / UEFI (Unified Extensible Firmware Interface)

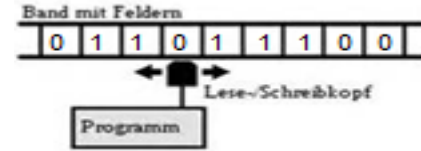
- ... is a chip that is located on the motherboard and contains the firmware.
- Firmware is the basic control logic to start the computer.
  - When the computer is booted, the initialization program from the BIOS or UEFI is run.
  - The BIOS / UEFI performs certain tests, displays the control messages, loads the operating system from the hard drive and starts it.

# Busses and Interfaces



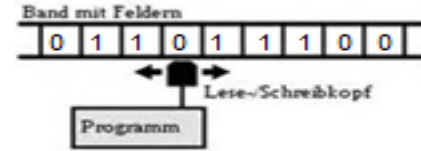
Circuits Background

# Buses and interfaces

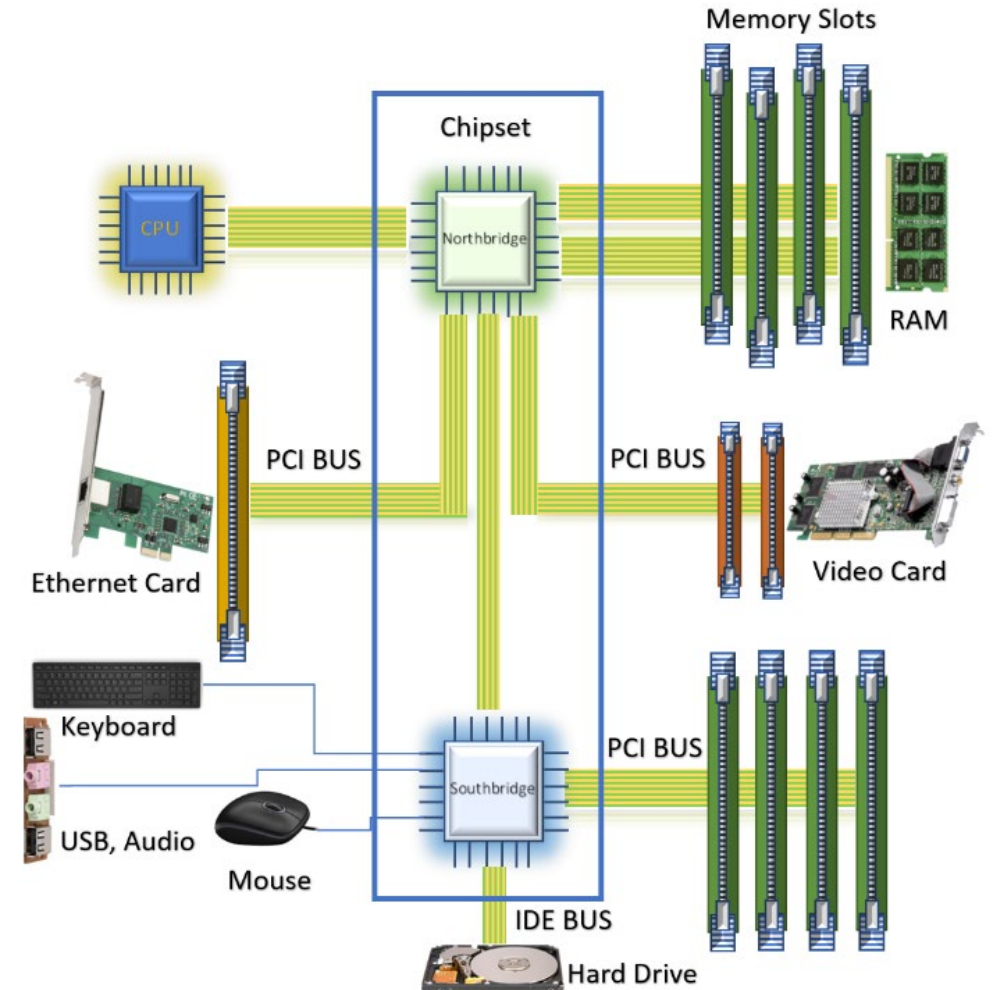


- Buses and interfaces are required for the communication between the individual components of the motherboard and for connecting all types of peripherals, such as the graphic cards, hard drives, printers, network, etc.
- The internal bus system is responsible for the transport of data between the units on the motherboard, the processor, memory and input/output units.

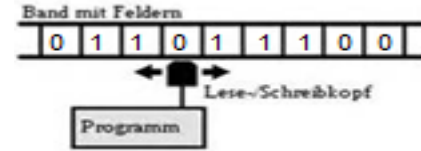
# Buses and interfaces



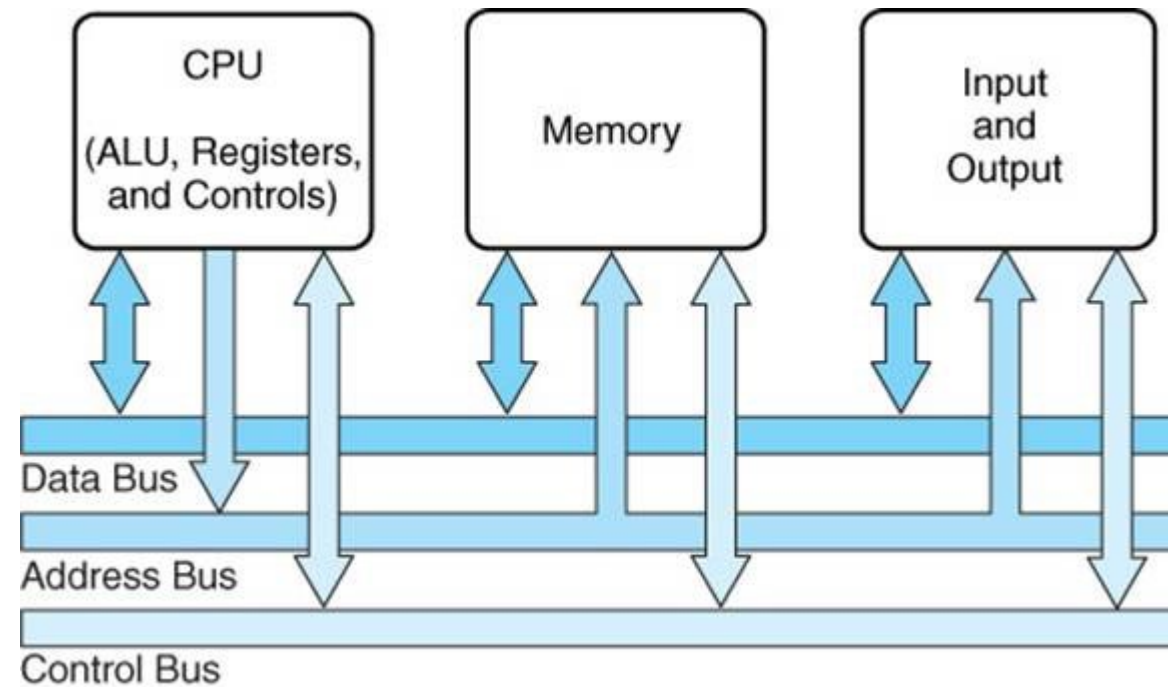
- A bus is a circuit that connects the different parts of the motherboard.
- The more data a bus can handle at one time, the faster it allows information to travel.
- The speed of the bus, measured in megahertz (MHz), refers to how much data can move across the bus simultaneously.
- Nowadays, the Northbridge is usually integrated in the CPU



# Schematic bus system



- Von Neumann Architecture





# External Interfaces

## USB, Keyboard and Mouse



## Storage / Disk



## Network / Communications



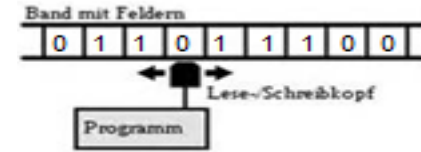
## Audio



## Video

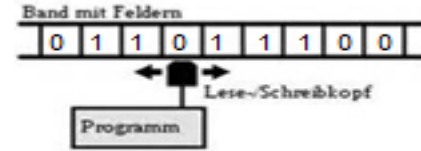


## Power





# External Interfaces: USB

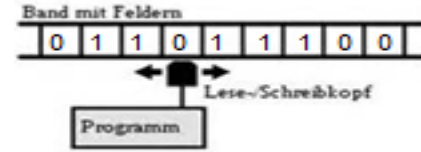


Universal Serial Bus (USB) is an industry standard for connecting peripheral devices to the computer. The advantage is the easy installation and handling (hot plugging, plug-and-play, a reboot is not necessary).



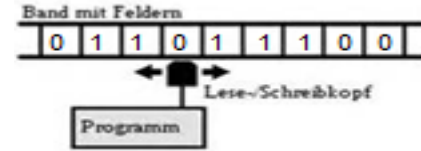
# External Interfaces: Wireless

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- Wireless interfaces
- Infrared connections: visual contact required (see remote control).
- Wireless connections (Bluetooth): Wireless connections with microwaves, only in the vicinity
- For higher data transfer rates: Wireless Networks (WLANs - Wireless LANs).

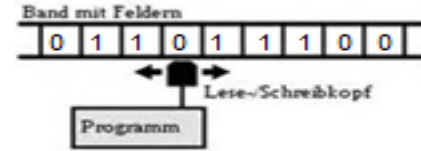
# Serial and parallel data transmission



- In serial data transfer, the individual bits are transmitted one after the other
- In parallel transmission, the bits are simultaneously transmitted on several adjacent lines (e.g. 8, 16, 32 or 64 bits).
- Serial data transmission requires less power and can be used for longer distances.
- Serial data transmission is therefore used more frequently than the parallel.

# Mass storage

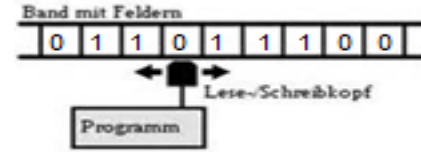
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Mass storage uses various methods.

- Magnetic data carriers:
  - The bits are saved by magnetic areas with opposite polarity.
    - > e.g. hard drives or backup tapes.
- Optical media:
  - The data is stored on a reflective metal surface, which is scanned by a laser beam.
  - The bits are represented by drilled holes (pits)
    - > CD/DVD.

# Mass storage: SSD



Hard disks are increasingly replaced by much faster but more expensive solid-state disks (SSD).

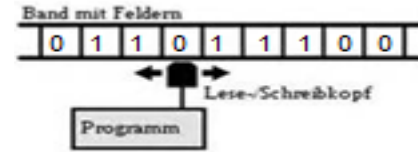
- SSD uses flash memory
- SSD has no mechanical components
  - no noise, less power needed, insensitive to rotations or shocks

The data is continuously moved internally in order to achieve a uniform “aging” → longer lifetime.

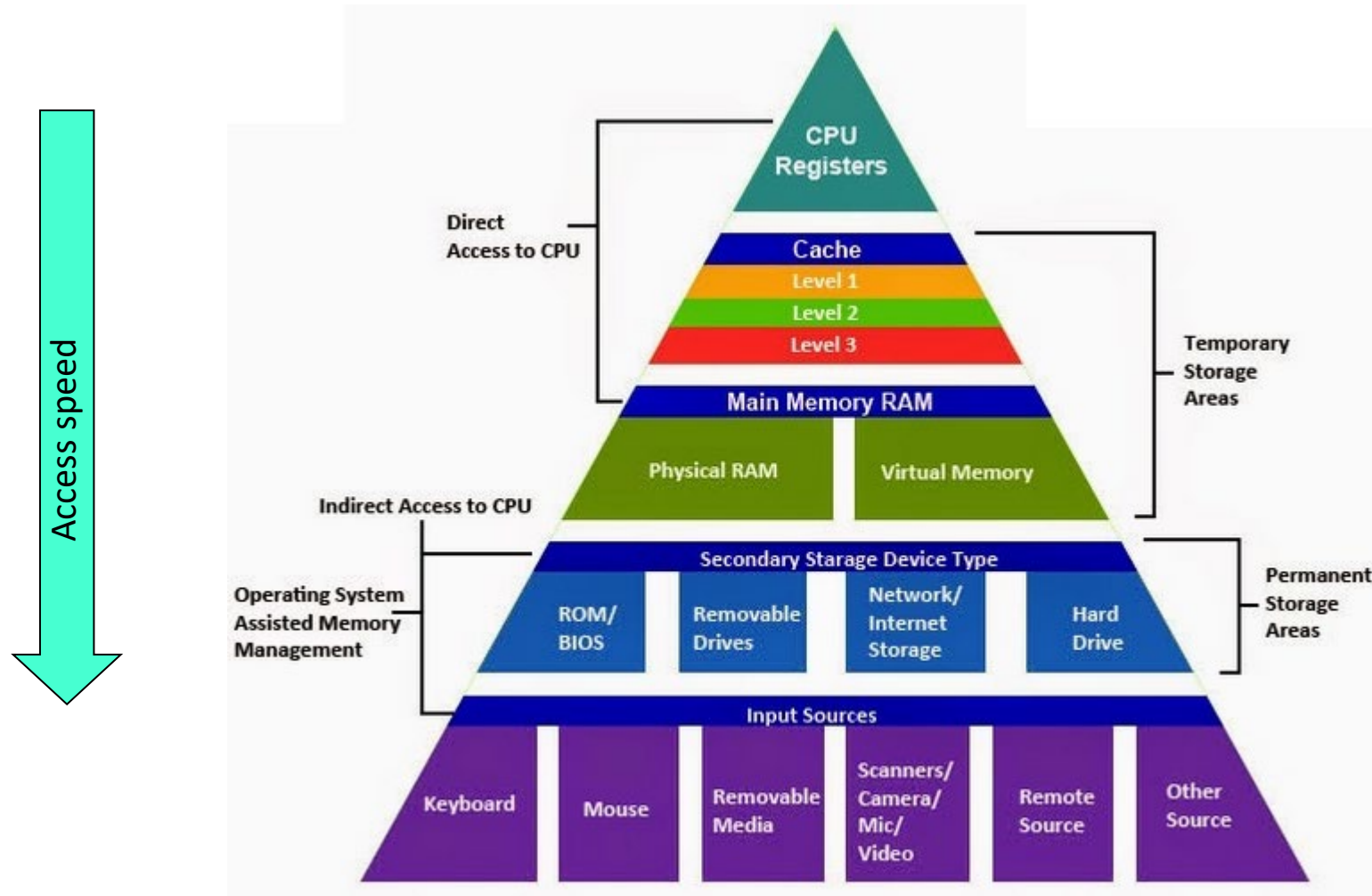
USB sticks are also flash memory chips.



# Mass storage

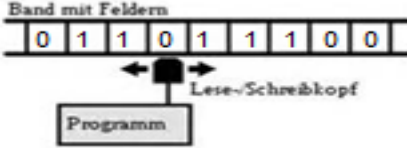


## Memory hierarchy



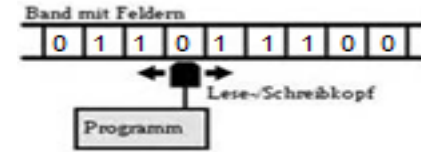


# Distributed Systems



# Distributed System

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In distributed systems, components are realized on different platforms and several components can cooperate with one another over a communication network.

- Hardware and software resources are shared.
- It is possible to use hardware and software of different vendors.
- Higher performance by concurrent processing.
- Throughput is easily increased by adding new resources.
- Fault tolerance through compensation.

→ But:

Enhanced complexity during maintenance and use!