



UNIVERSITÀ
CATTOLICA
del Sacro Cuore

REVIEW OF THE BASICS: COMPUTER ARCHITECTURE



Disclaimer: this is an oversimplified overview of a complex topic, distilled for what matters most for our cloud computing course



Hardware and Software

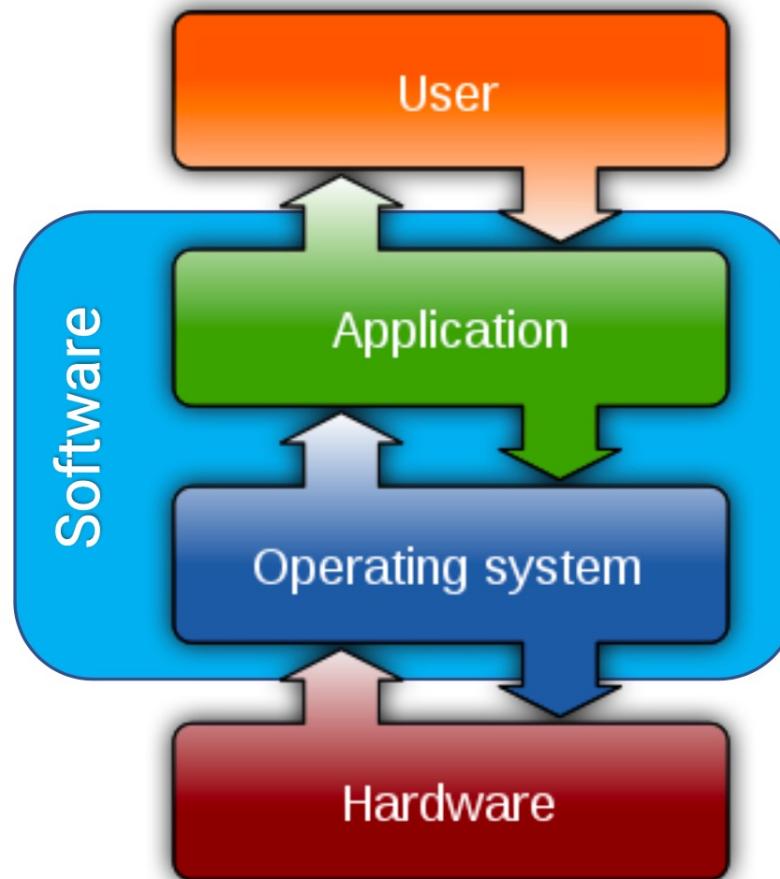
Computing is made by **hardware** and **software**.

- **Hardware** is the physical components of a computer system
- **Software** is a general term for the various programs used to operate a computer system

NOTE: hardware can be simulated by software (“*virtualization*”)



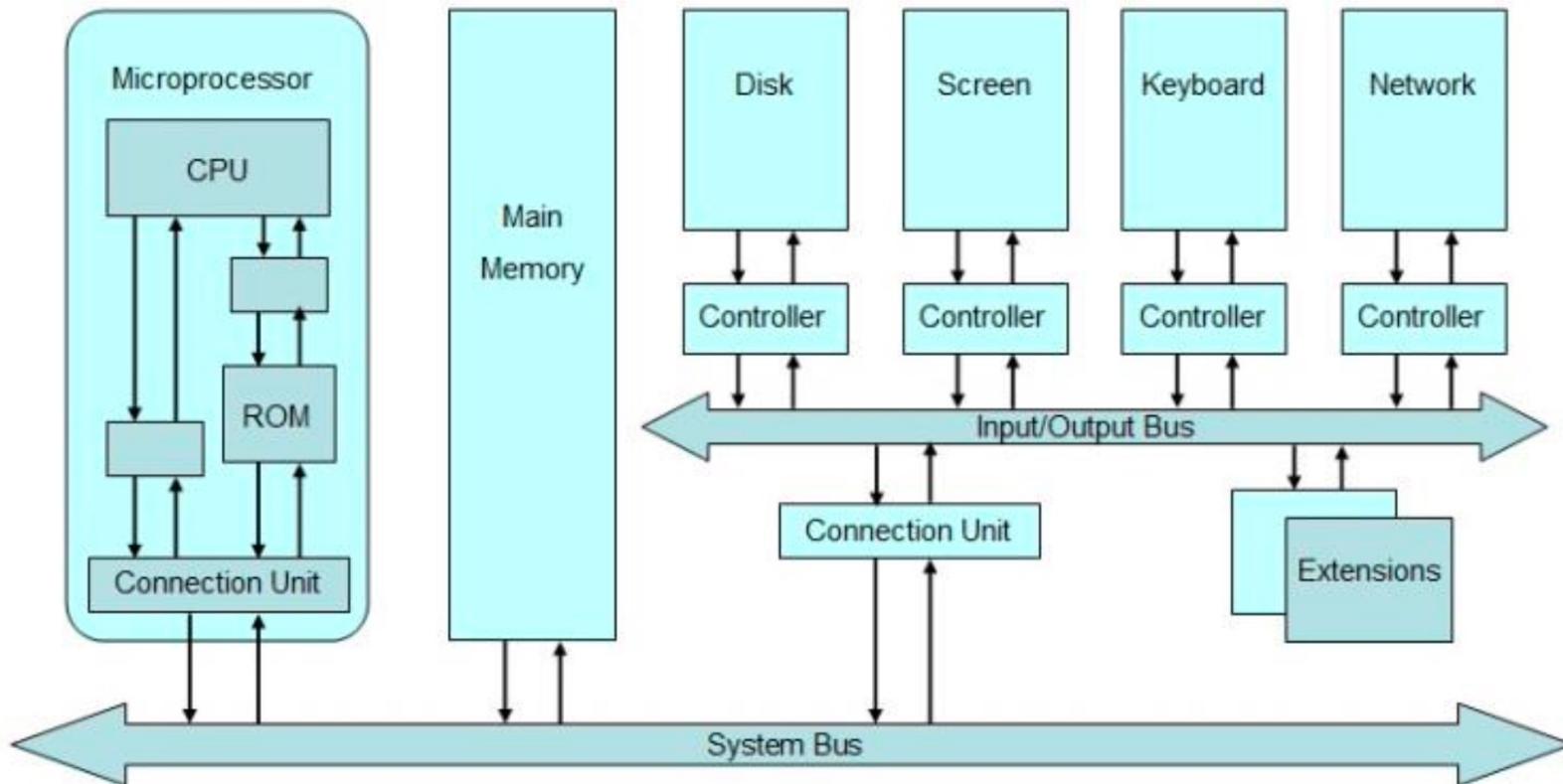
Interfaces between components



Golftheman / CC BY-SA (<https://creativecommons.org/licenses/by-sa/3.0>)
https://en.wikipedia.org/wiki/File:Operating_system_placement.svg



Main hardware components





Software and data

- Software is made by **programs** that elaborate data
- Programs are made by a sequence of **instructions** (e.g., *load*, *store*, *add*, *multiply*, ...)
- Instructions are written with many “*programming languages*” and ultimately compiled to **machine code**
- Programs and data are both stored in the memory (“**von Neumann architecture**”)
- Data is digitally encoded



Instruction cycle

The **fetch-execute cycle** is the cycle that the central processing unit (CPU) follows.

1. Fetch Stage: The next instruction is fetched from the memory and stored into the *instruction register*.

2. (Decode Stage)

3. Execute Stage: The control unit of the CPU passes the decoded information as a sequence of control signals to the relevant function units of the CPU to perform the actions required by the instruction, such as reading values from registers, passing them to the ALU (arithmetic and logic unit) to perform mathematical or logic functions on them, and writing the result back to a register.

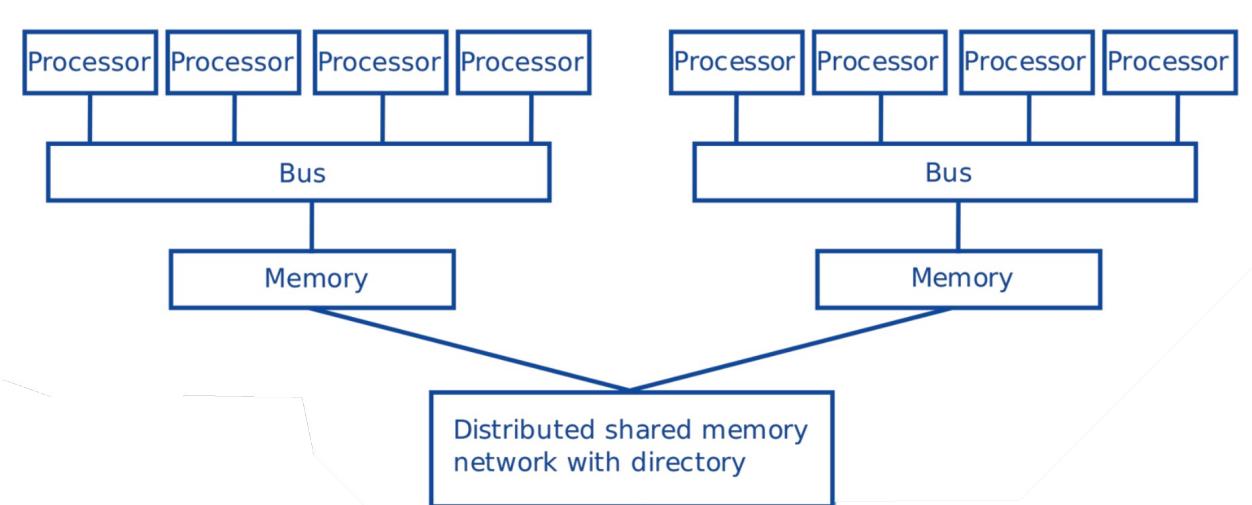
simpler CPUs → **sequential execution** of one instruction cycle

modern CPUs → **concurrent execution** of many instruction cycles



Parallel computing

Parallel computing is a type of computation where many calculations or the execution of processes are carried out simultaneously.



Example: A logical view of a non-uniform memory access (NUMA) architecture.



Performance Metrics

- **Processing:** MIPS (Million Instructions Per Second), FLOPS (Floating-Point Operations Per Second)
- **CPU:** clock frequency (Hz), number of processors/cores
- **Memory/storage:** capacity (Byte)
- **Communication** (bus, network): bandwidth/throughput (bit/s)
- many many others...

Overall main metric: **execution time** (s)

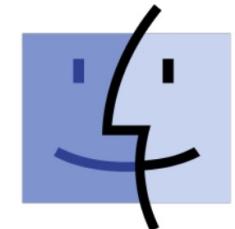
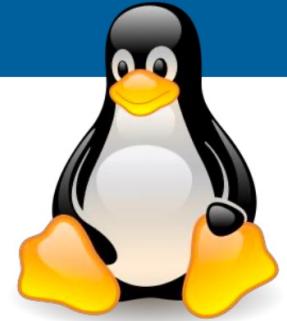


Operating Systems

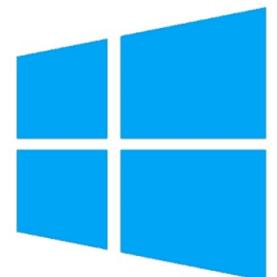
Operating system coordinates the activity between the applications and the hardware.

Major functions:

- Controlling operations (control program)
- Coordinates or supervises the activity of the computer system.
- Decides where programs and data should be stored in the computer memory.
- Handles communications among the computer components, applications software and the user.
- Controls the saving and retrieving of files to and from disks in the disk drive.
- Performs all its controlling tasks without the involvement or awareness of the user.
- Input/output management
- The I/O manager coordinates the computers communication with outside world, flow of data to the display screen and other output devices (printers/ plotters) and from the keyboard or other input devices.
- Handles the flow of data to and from the disk drives (file management).
- Handles the process of preparing a disk for use, the copying, renaming, erasing task of a file.
- Command Processing (command Interpreter)

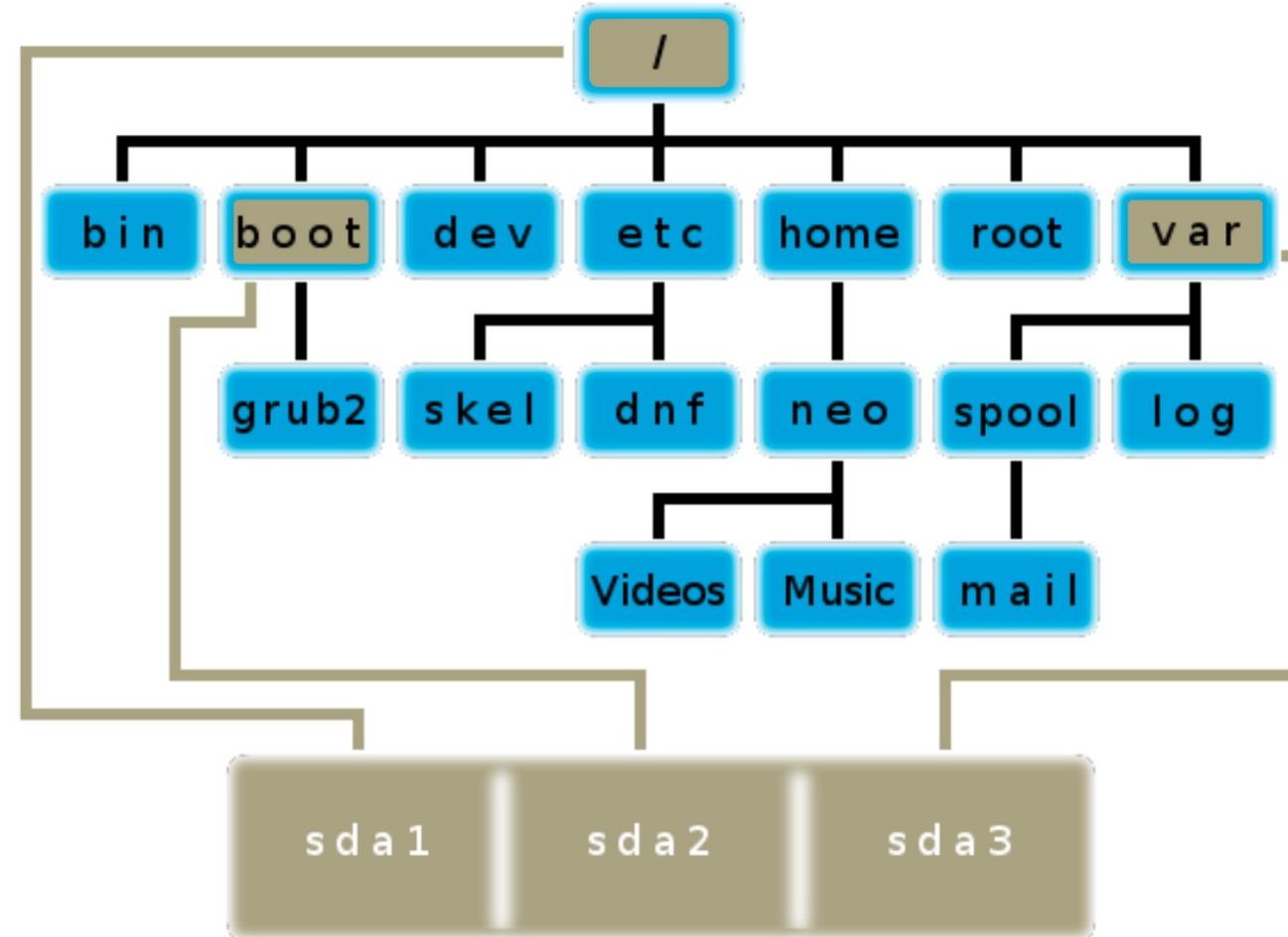


MacTM OS





File system





Questions?