Introduction to Computers

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What is a computer?

What is a computer?

- Retrieve and store
- Process
- Input and output

Types of computers

- Microcomputer (personal)
- Minicomputer (server)
- Mainframe computer (server rack)
- Supercomputer (multiple racks)

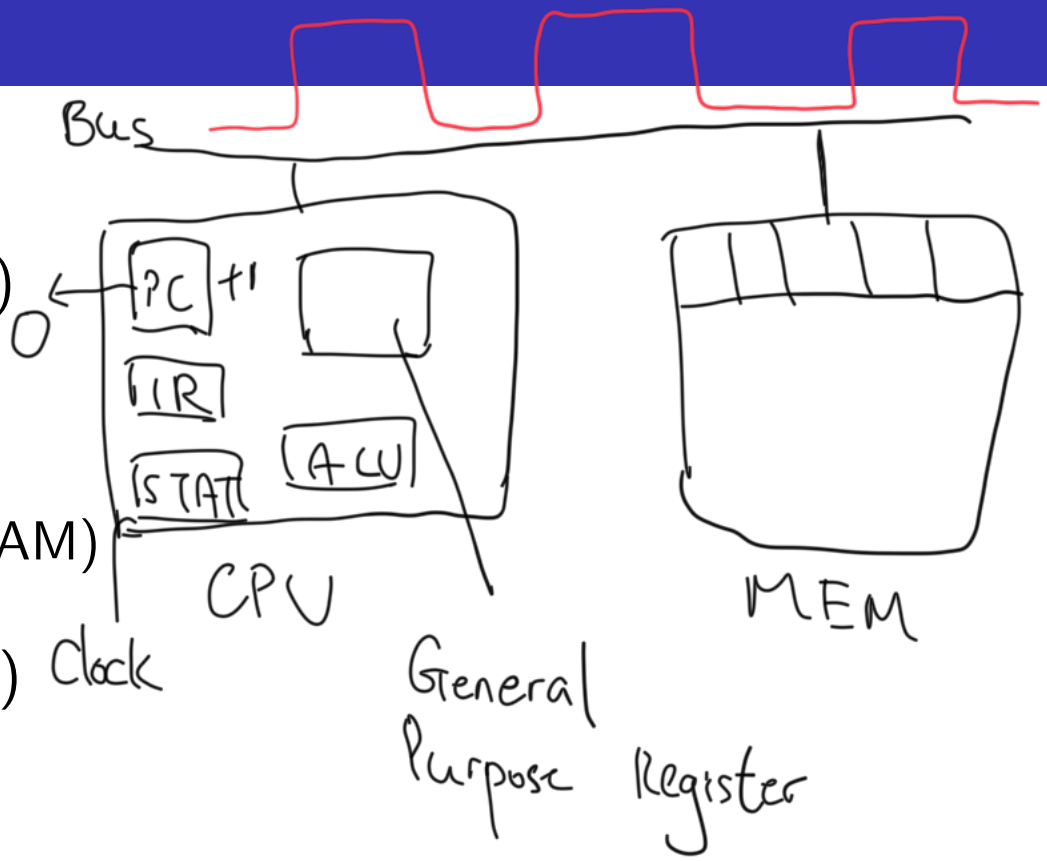
https://en.wikipedia.org/wiki/Classes_of_computers

Hardware vs Software

Software Hierarchy

- User Applications (high-level)
- Operating System
- Device Drivers
- Hardware (lowest level)

Computer Hardware



Central Processing Unit (CPU)

Memory

- Read Only Memory (ROM)
- Random Access Memory (RAM)

Storage (e.g. Hard Disk, DVD)

Input (e.g. mouse, keyboard)

Output (e.g. display, printer)

Communication (e.g Wi-Fi devices)

Bus

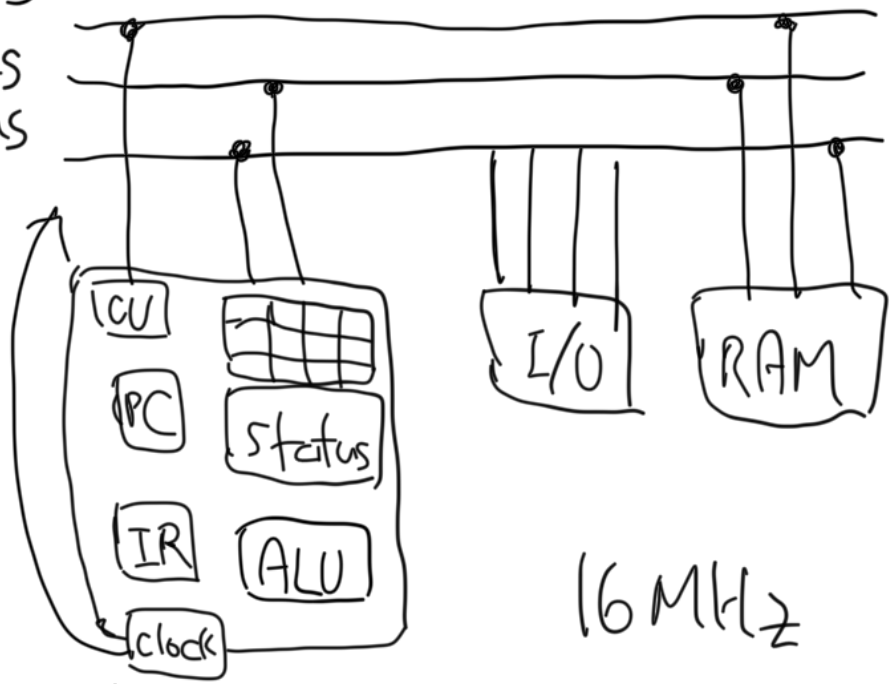
LATCH – Flip Flop

And, OR can represent all logic gate

Computer Hardware

(Can be in/outside CPU)

Control bus
Address bus
Data bus



16 MHz

Clock

- synchronization (cycles)
- determines speed (frequency)

CPU

PC=0

- Control Unit
- Registers
  - Program Counter (PC)
  - Instruction Register (IR)
  - Condition Code Register (status)
- Arithmetic + Logic (ALU)

Bus

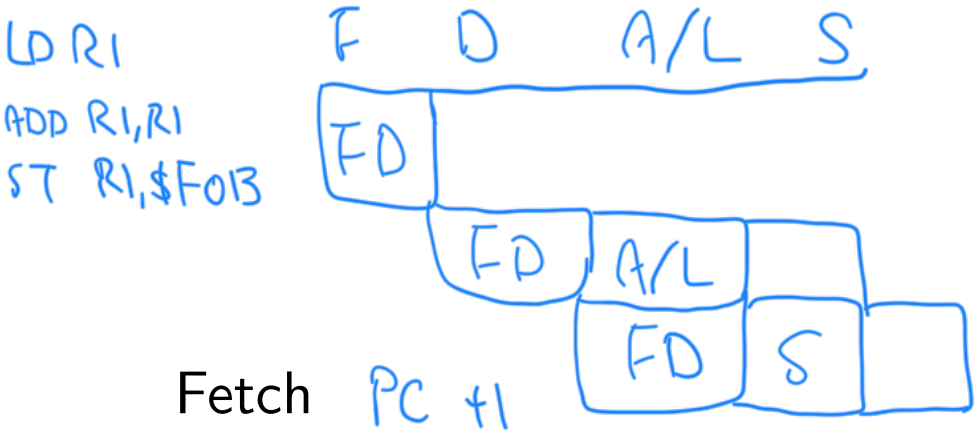
- Control
- Address
- Data
- Serial vs Parallel

Assembly Language

101 S d
OP source d

+	R1 R2
LDI	R1, 0
LD	R1 $F163 ; from memory

Execution Cycle

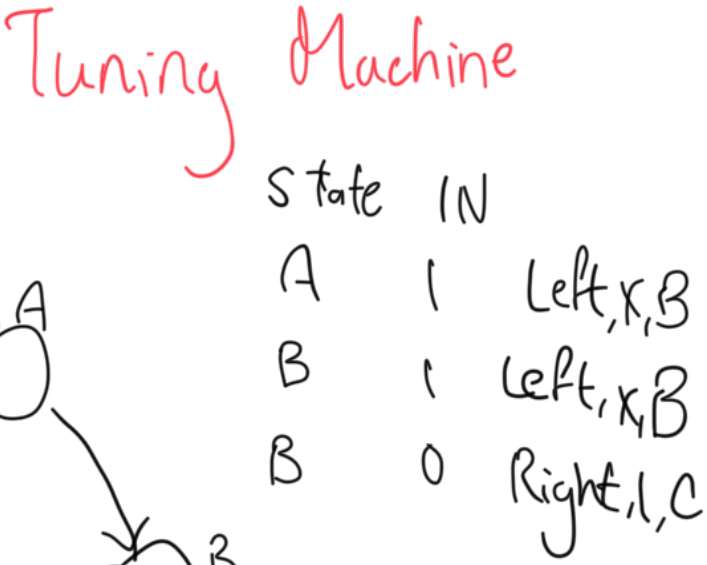


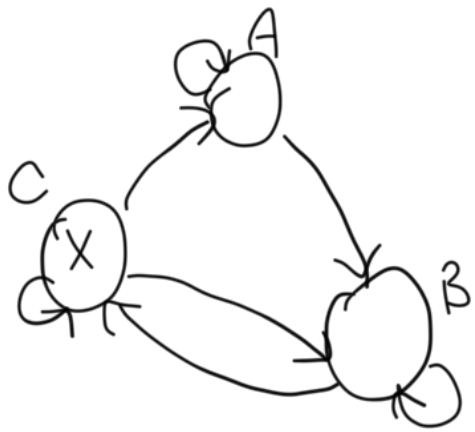
Fetch

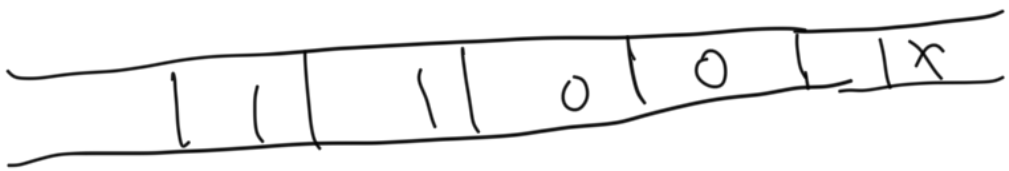
Decode

Execute

Store/retrieve







Classification: RISC vs CISC

Complex Instruction Set Computer (CISC)

- instructions range in complexity
- instructions can take several clock cycles

Reduced Instruction Set Computer (RISC)

- very simple instructions
- minimizes number of cycles per instruction

Classification: Princeton vs Harvard

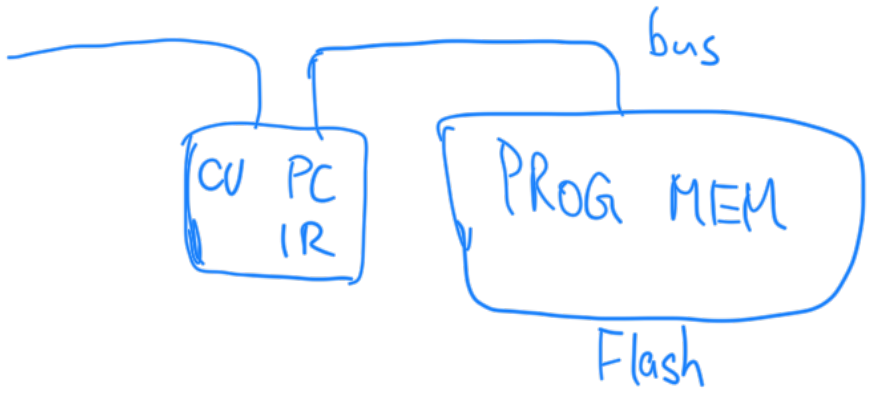
Princeton Architecture (a.k.a. von Neumann) As Above example

- Developed by John von Neumann
- Program is stored in data memory
- Slower but cheaper

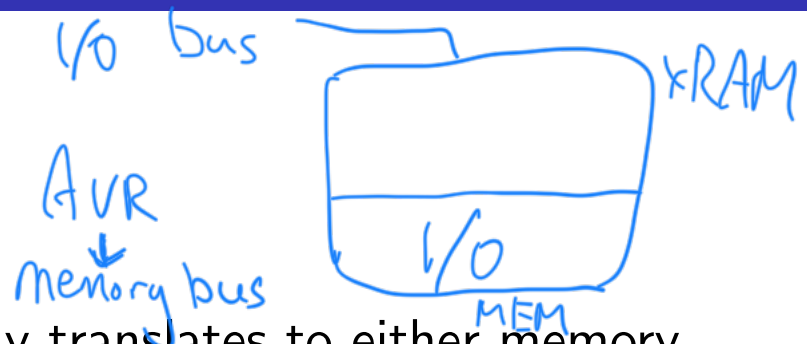
Store in same memory

Harvard Architecture AVR

- Memory for programs is separate from data
- Two separate buses (simultaneous instruction fetch and data access)
- Faster but at costs



Main Bus Types



Memory mapped I/O

- Single bus between CPU and others
- Address on the address bus eventually translates to either memory location or I/O device
- e.g. room 623 vs room 249

  6^{th} floor, door 23

  2^{nd} floor, door 49

  first digit distinguishes between types of location (floor)

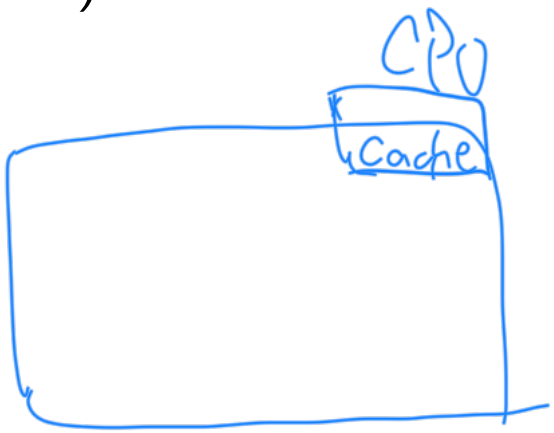
Port I/O

- CPU to memory bus is separate from CPU to peripherals
- separate sets of instructions
- possibly different size of buses
- each bus is still composed of control, address, and data

Memory Hierarchy

Highest level (farthest from the CPU, slowest access)

- Tape
- Disk
- Memory
- Cache
- Registers



Lowest level (closest to the CPU, fastest access)

Computer Organization and Architecture

Computer architecture refers to those attributes of a system visible to a programmer or, put another way, those attributes that have a direct impact on the logical execution of a program.
(Also known as ISA) Design Instruction

Computer organization refers to operational units and their interconnections that realize the architectural specifications.

How to put things together

From page 2 of Computer Organization and Architecture by W. Stallings

Moore's Law

Relation to other courses

CSC 110 - basic programming skills

CSC230 - computer architecture at functionality level

CSC350 - how to design processors

CSC355 - how to design digital logic elements

CSC360 - how operating systems manage software execution