Computer Organization and Architecture

2 A Top-Level View of Computer Function and Interconnection

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Sep. 10, 2018

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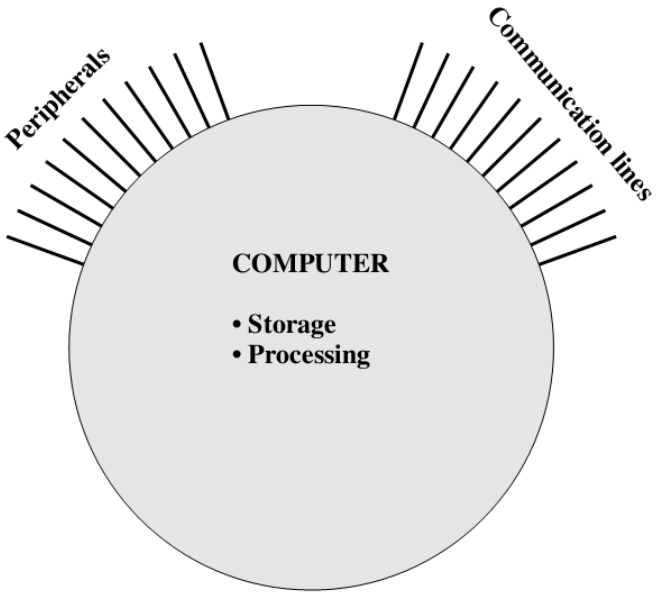
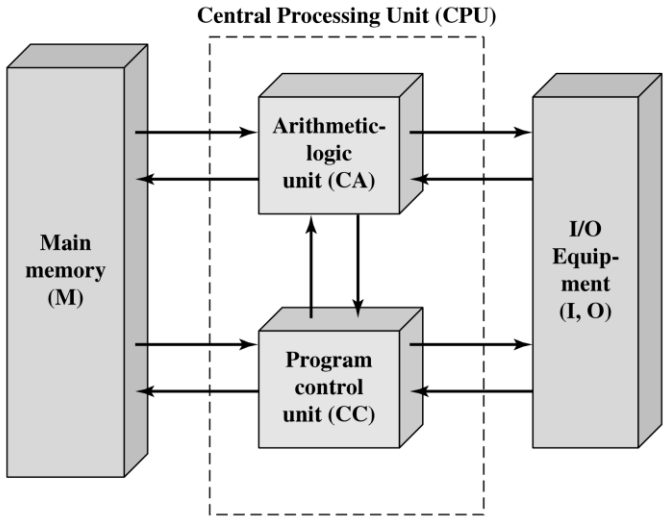
Review

- Concepts
  - Computer, architecture, organization
- The von Neumann machine
  - Idea: main memory storing programs and data
  - Components: central arithmetical, central control, memory, input / output
- Moore’s law and its consequence
- Computer performance
  - System clock, CPI, MIPS, MFLOPS, benchmarks

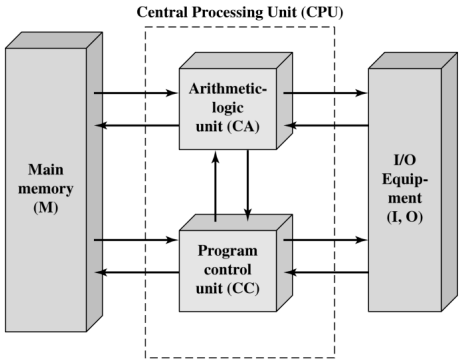
Computer



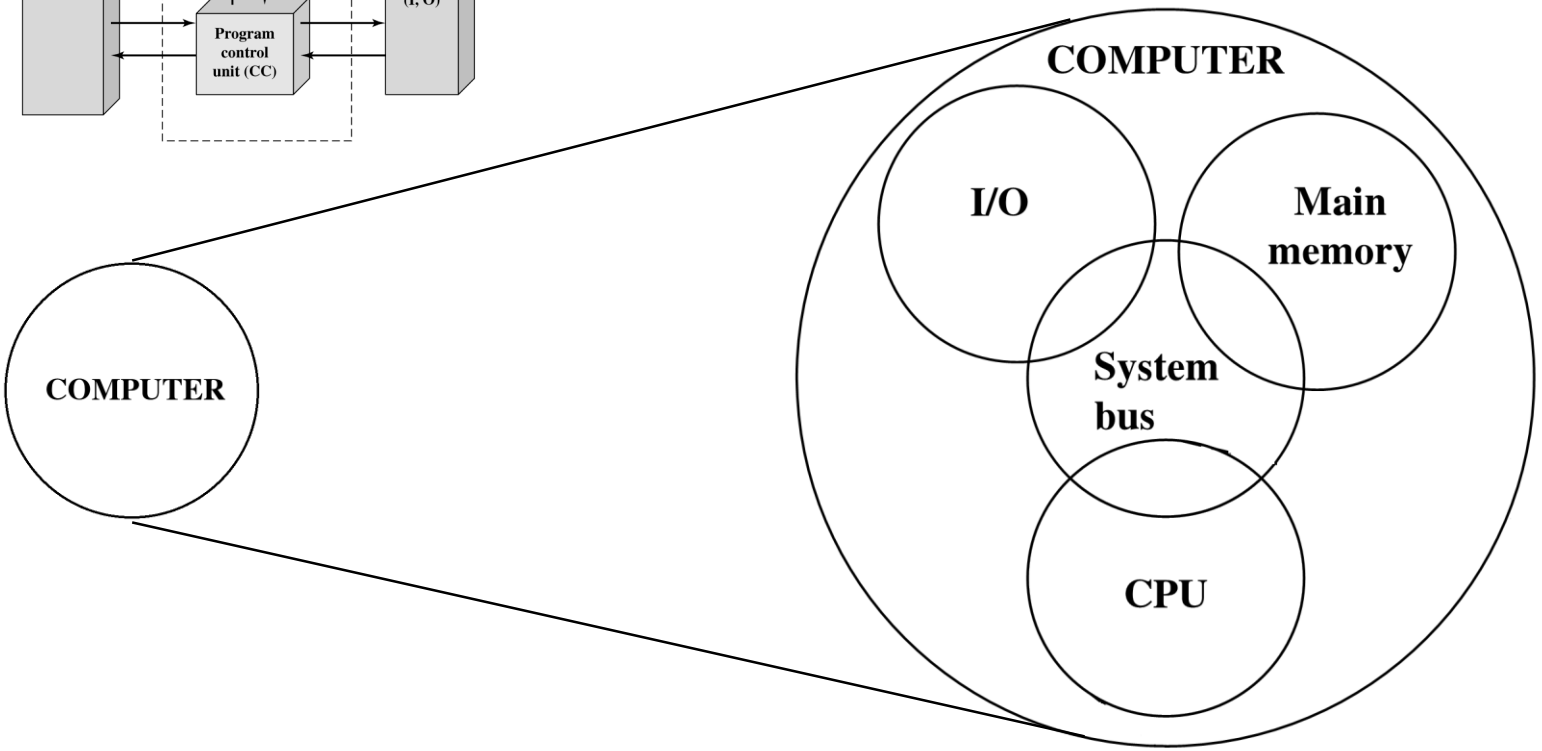


the von Neumann machine

A Top-Level Overview

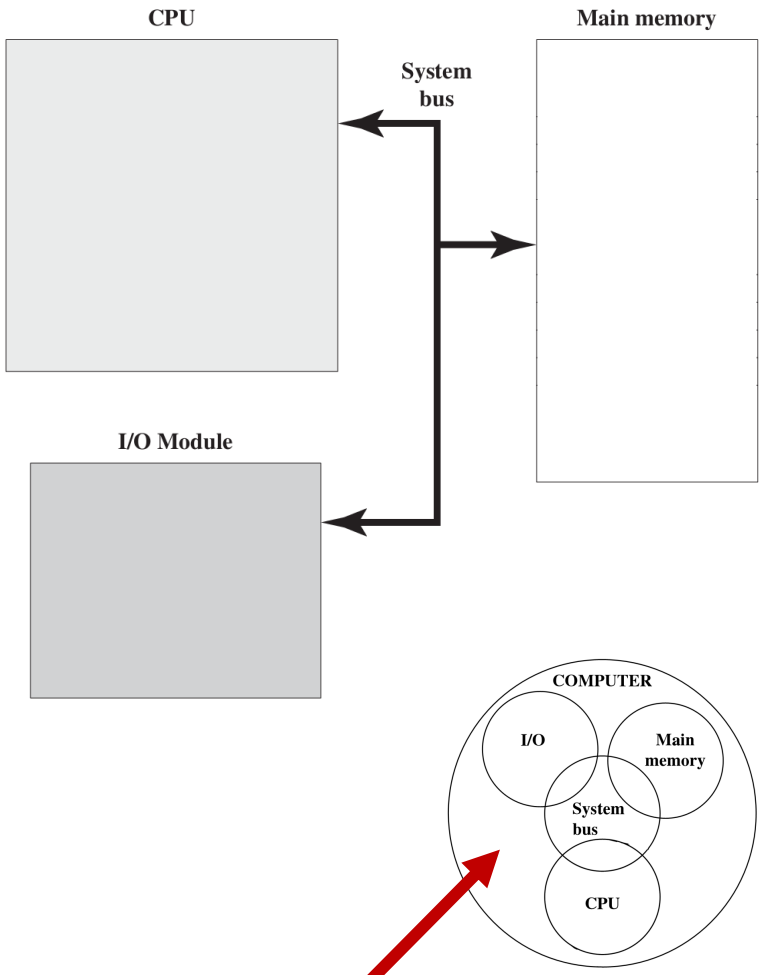


the von Neumann machine



Computer Components

- Data and instructions are stored in a single read-write memory
- The contents of this memory are addressable by location, without regard to the type of data contained there
- Execution occurs in a sequential fashion (unless explicitly modified) from one instruction to the next



Incommensurate Scaling

Computer Components: Memory

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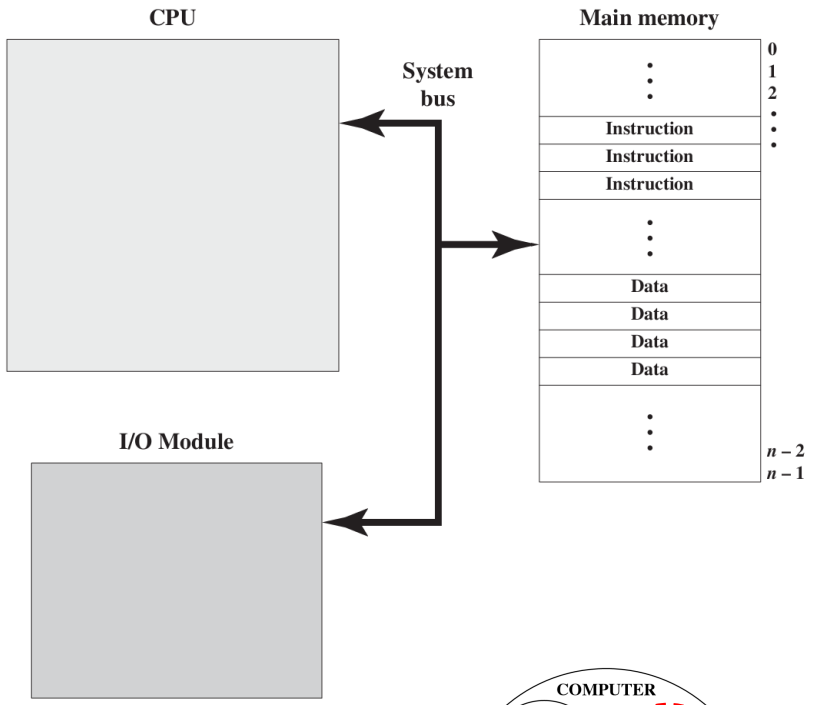
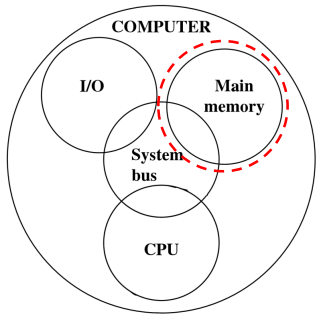
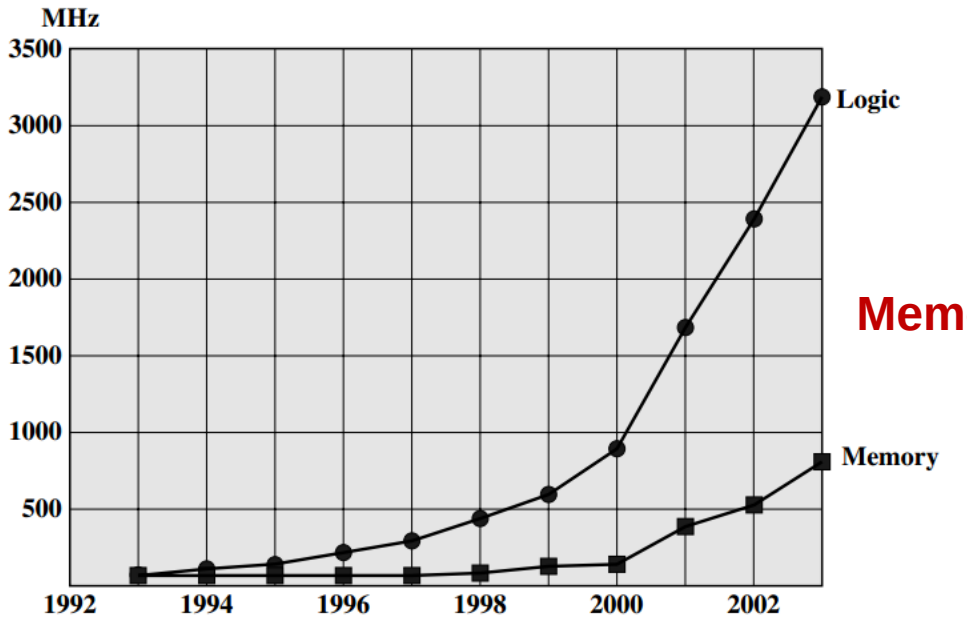




Computer Components: Memory (cont.)

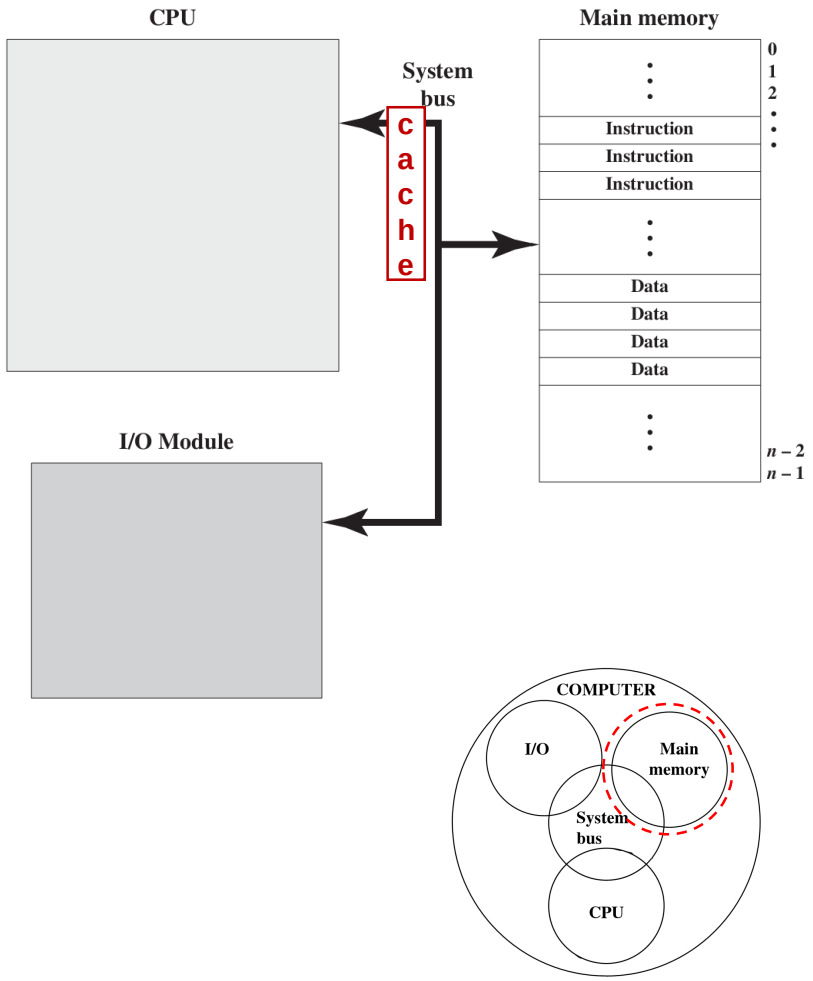
- Problem
  - The speed of transferring data between main memory and CPU fails to keep up with the speed of CPU



Memory Wall

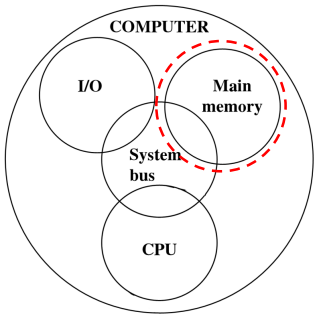
Computer Components: Memory (cont.)

- Solution
  - Add a cache or other buffering scheme to reduce the frequency of memory access and increase data transfer rate
  - Increase the number of bits retrieved one-time
  - …



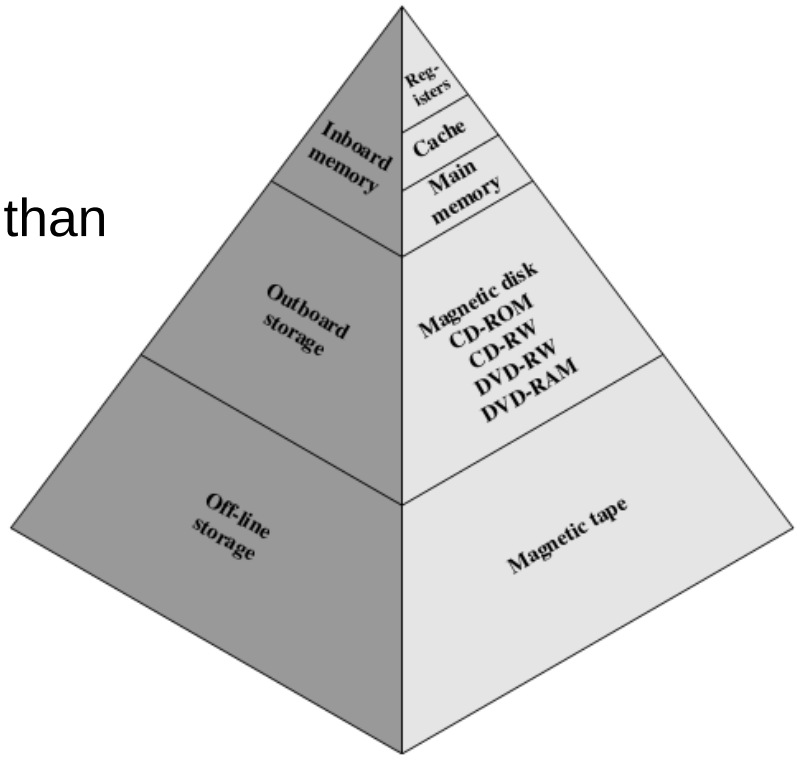
Computer Components: Memory (cont.)

- Constraints
  - Capacity: larger is better
  - Speed: keep up with the processor
  - Cost: reasonable to other components
- Relationship between constraints
  - Shorter access time, greater cost per bit



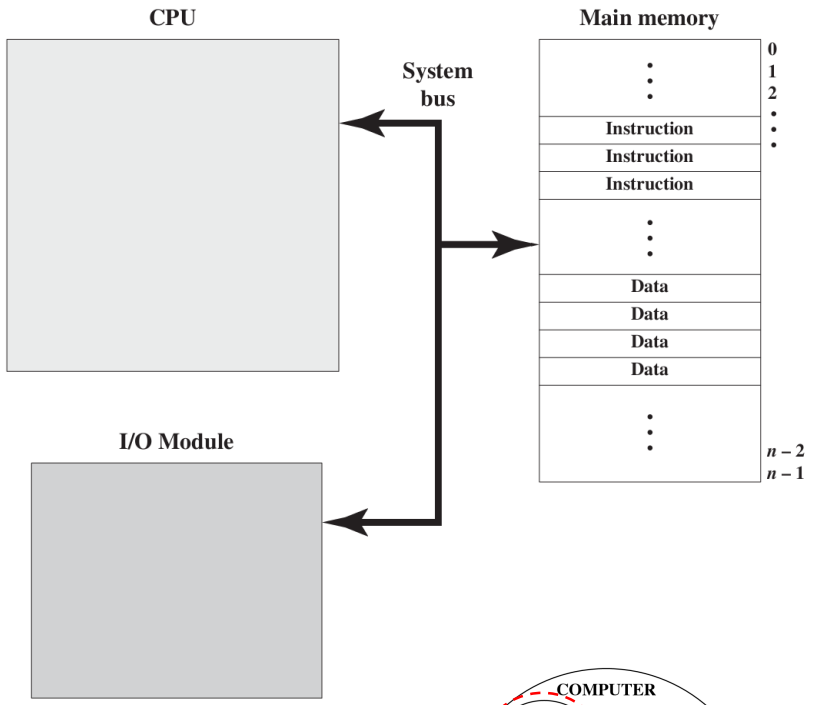
Computer Components: Memory (cont.)

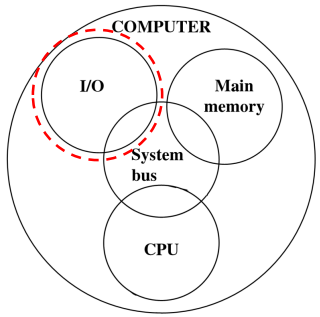
- Requirement
  - Large capacity for data storage
  - High speed for performance
- Solution
  - Employ a memory hierarchy than rely on a single memory component



Computer Components: I/O

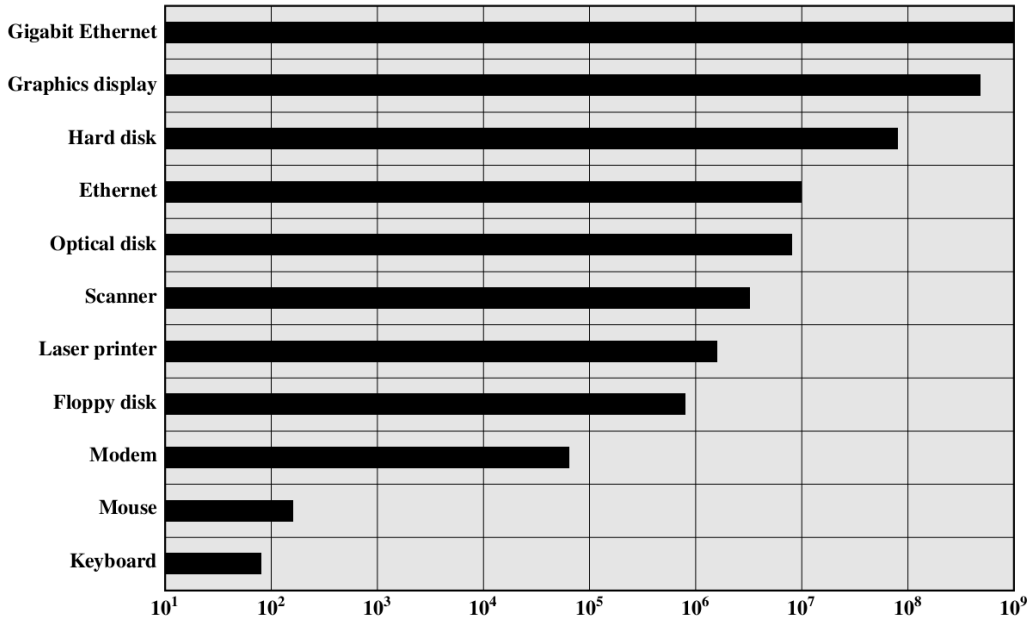
- Exchange data gathered from external sources with CPU and memory





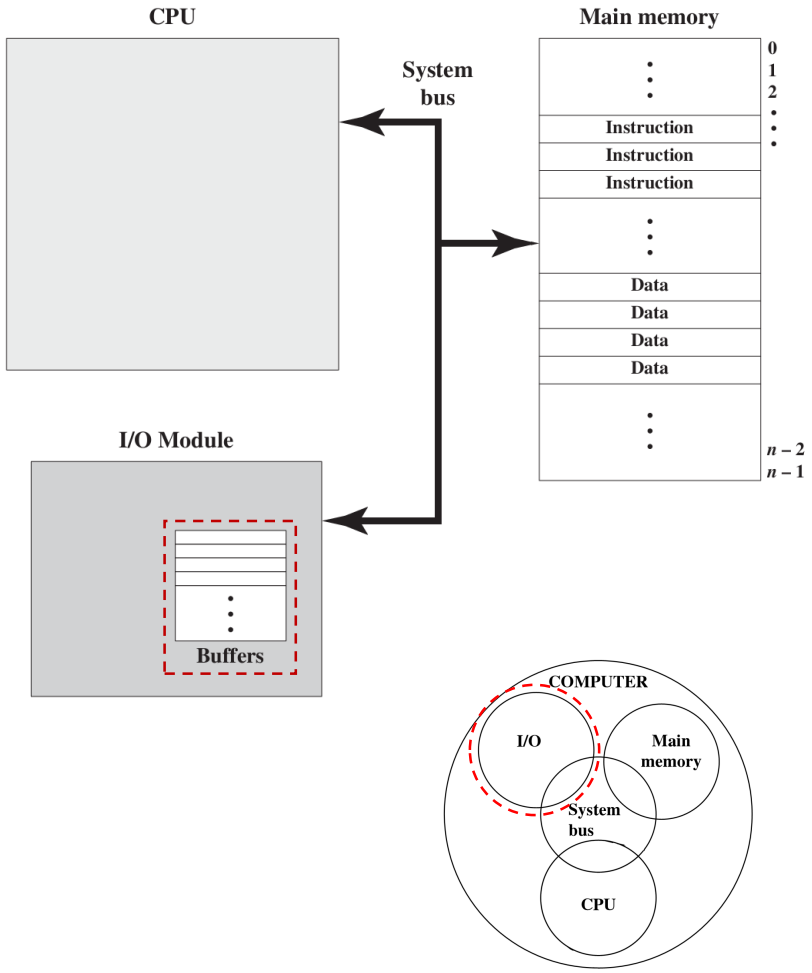
Computer Components: I/O (cont.)

- Problem
  - I/O performance cannot keep up with the increase of CPU speed



Computer Components: I/O (cont.)

- Solution
  - Buffering
  - New interface techniques
  - …



Computer Components: CPU

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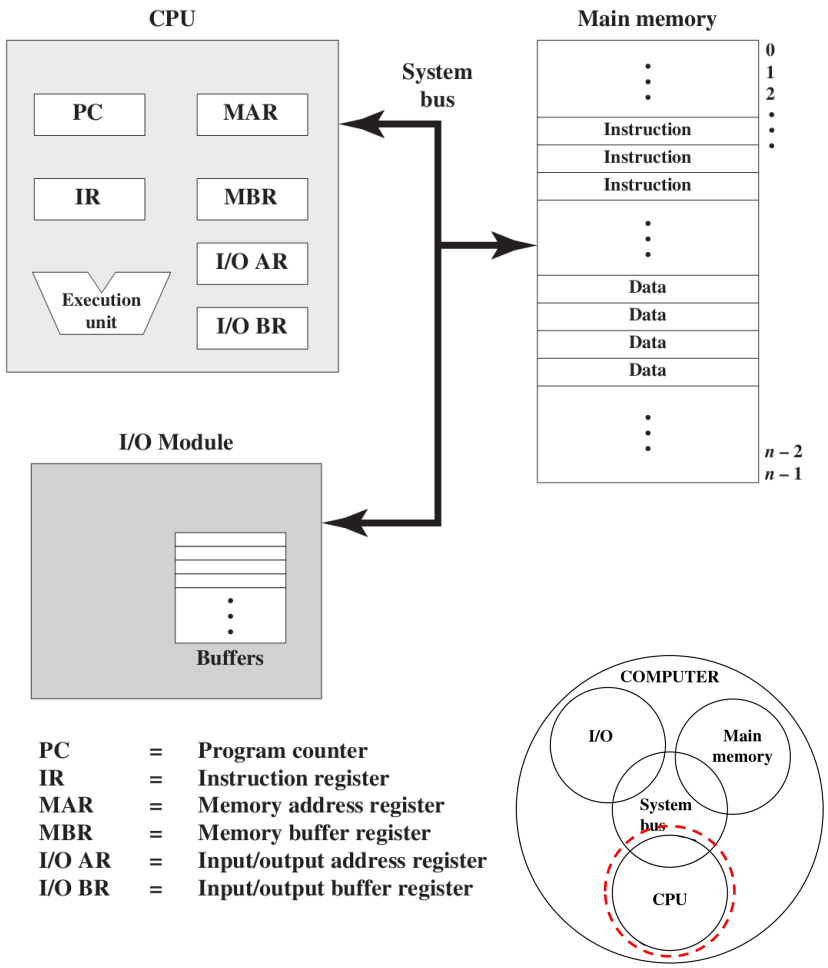
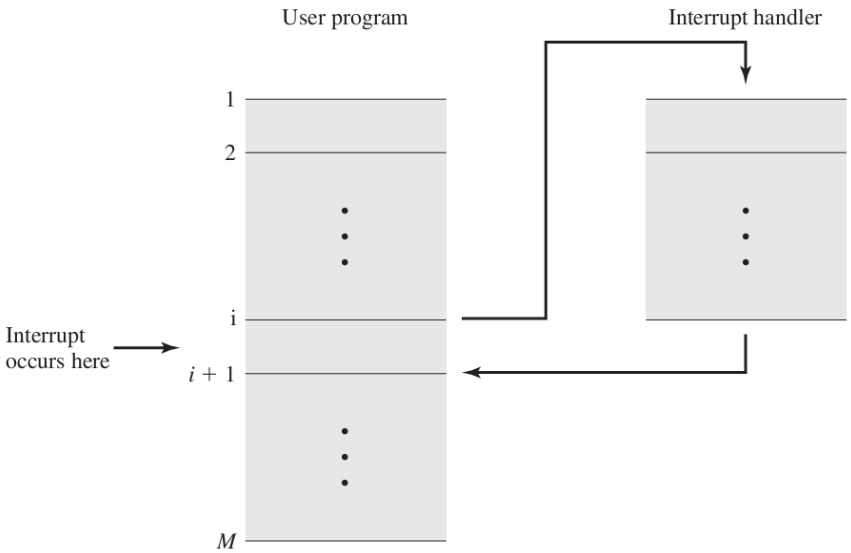


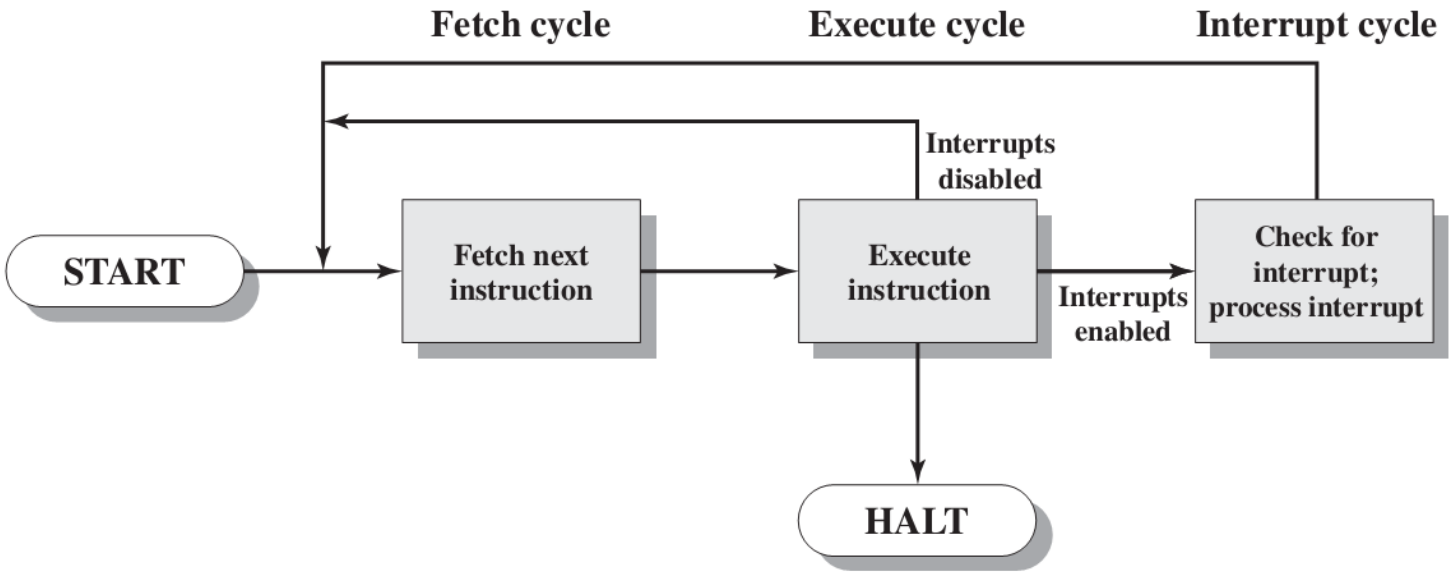
Computer Components: CPU (cont.)

- Problem
  - CPU remains idle when waiting for I/O devices
- Solution
  - Interrupt: a mechanism by which other modules (e.g. I/O) may interrupt normal sequence of processing



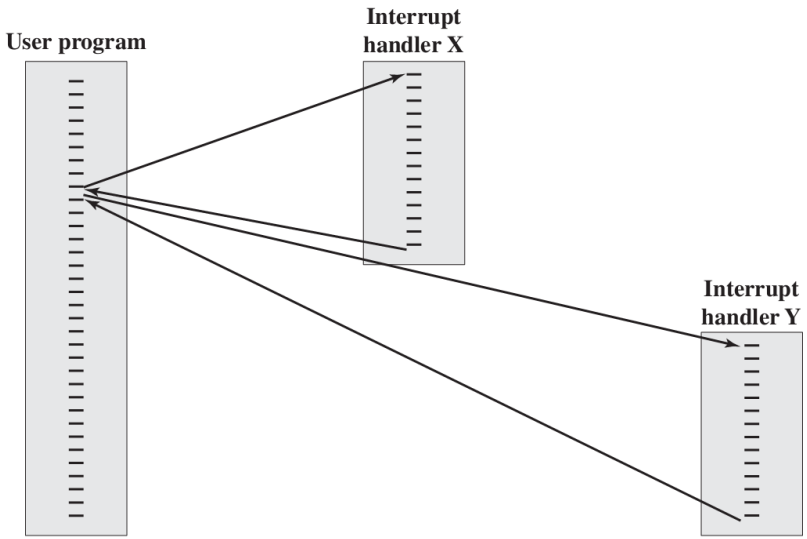
Computer Components: CPU (cont.)

- Interrupt detection
  - Add interrupt cycle into instruction cycle

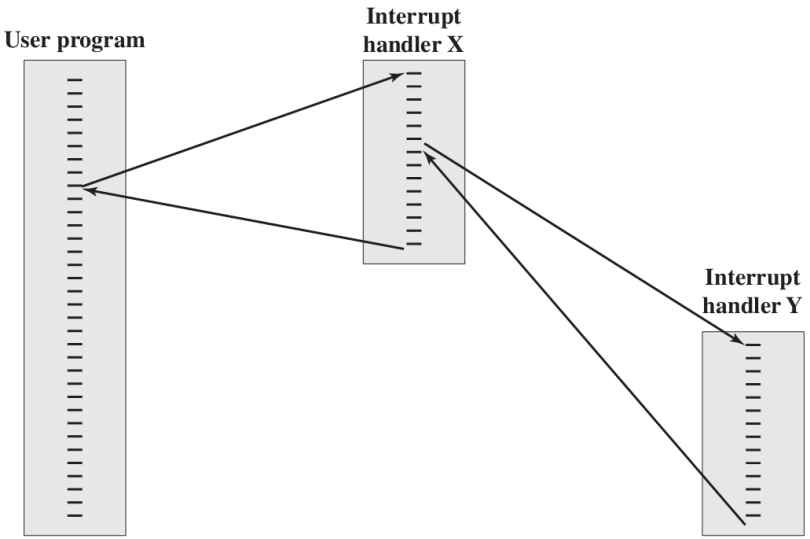


Computer Components: CPU (cont.)

- Multiple interrupts

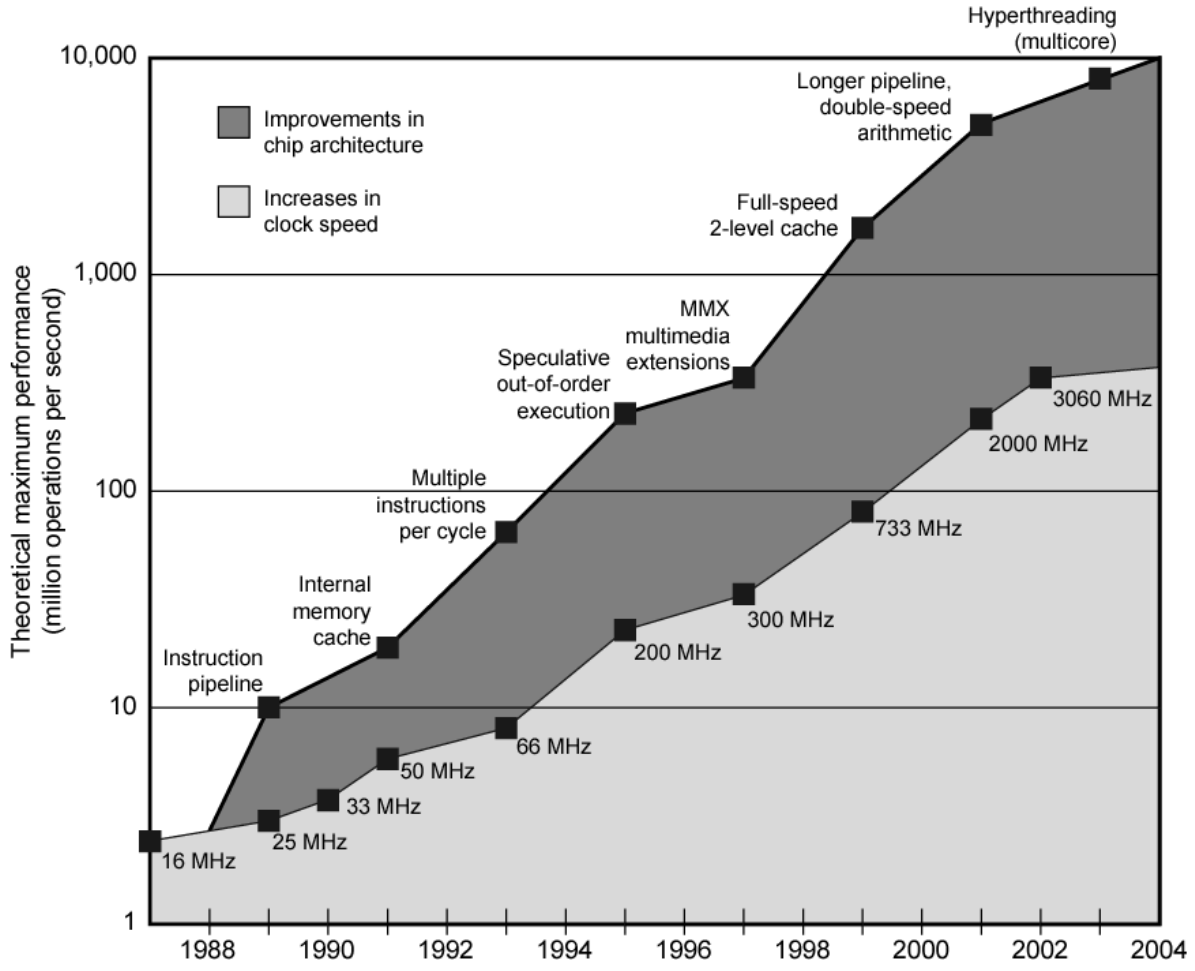


Sequential interrupt processing



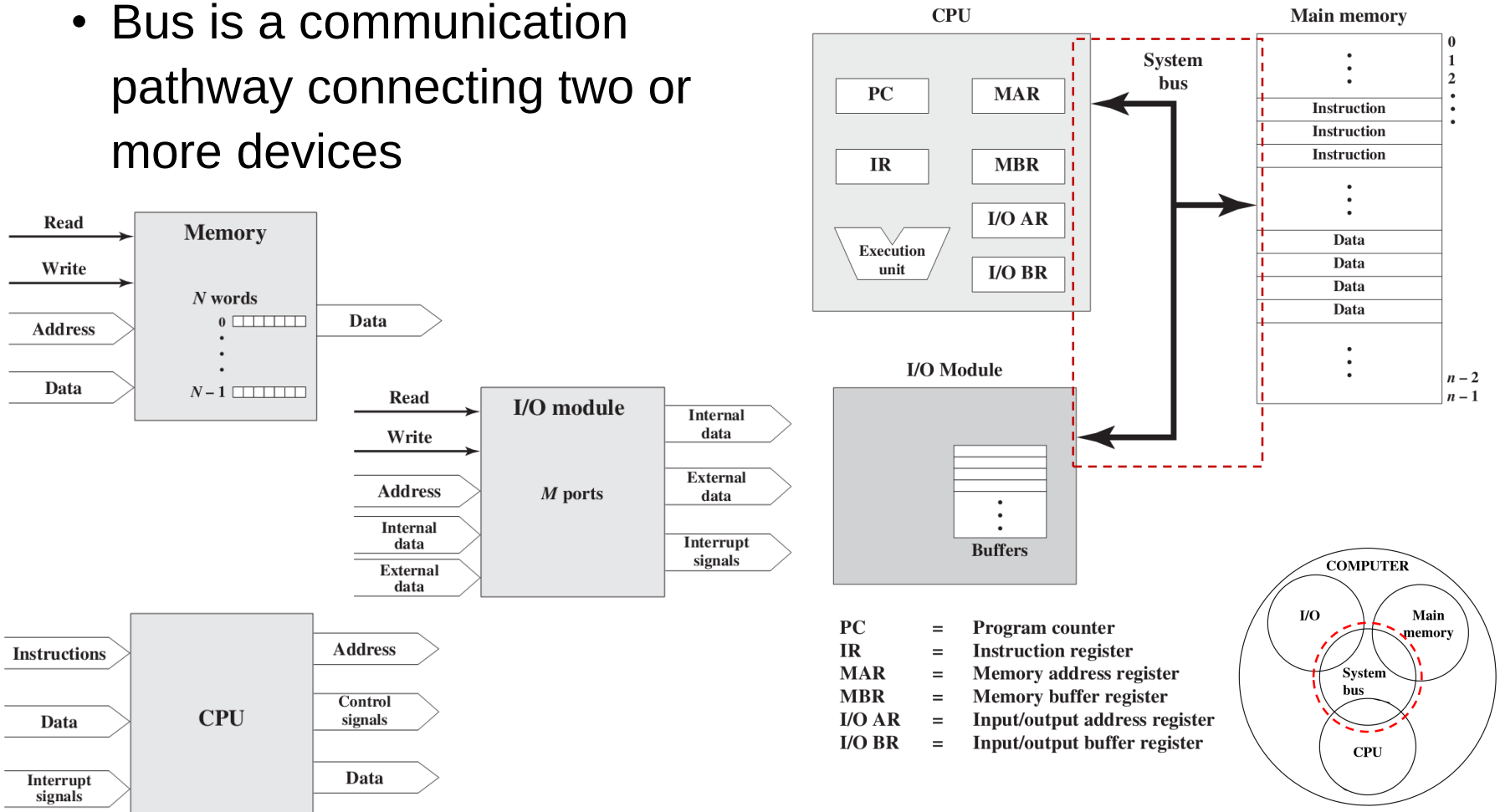
Nested interrupt processing

Computer Components: CPU (cont.)



Computer Components: Bus

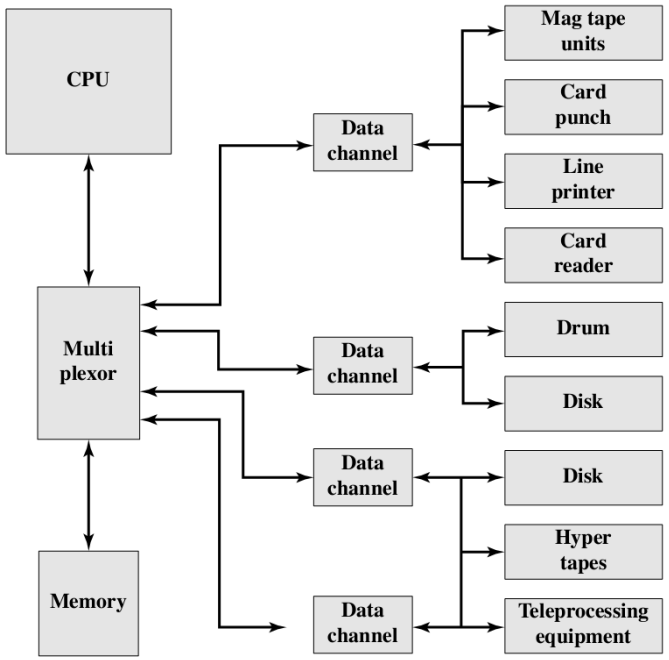
- Bus is a communication pathway connecting two or more devices



Computer Components: Bus (cont.)

- Interconnection solution

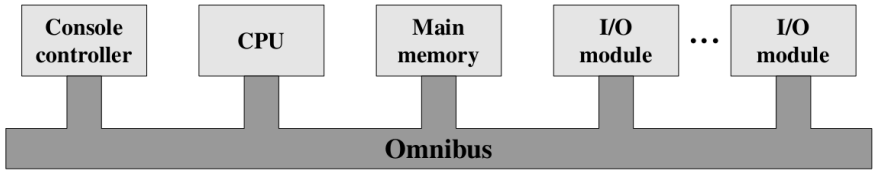
Multiplexor



IBM 7094

Bus

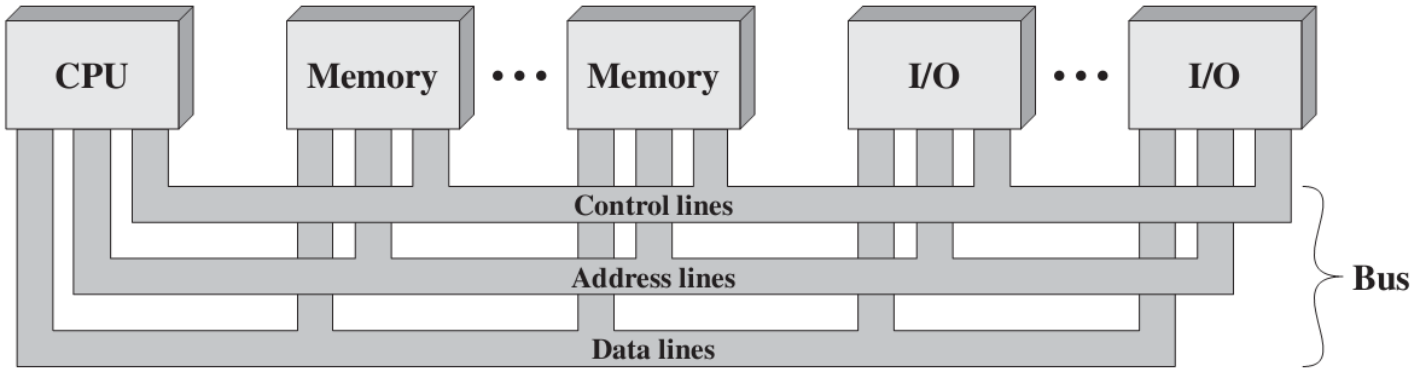
a shared transmission medium
simplify the interconnection layout and the control of processor



PDP-8

Computer Components: Bus (cont.)

- Data transfer type
  - Any bus lines can be classified into three functional groups
    - Data lines: move data between system modules
    - Address lines: designate the source or destination of the data on the data bus and address I/O ports
    - Control lines: control the access to and the use of the data and address lines



Summary

- A top-level view of computer
- Computer component
  - Memory: cache, memory hierarchy
  - I/O: buffer
  - CPU: interrupt
  - Bus: type

Thank You

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