

MODULE 1: Computer Systems Foundations

Lecture 1.4

The von Neumann Model

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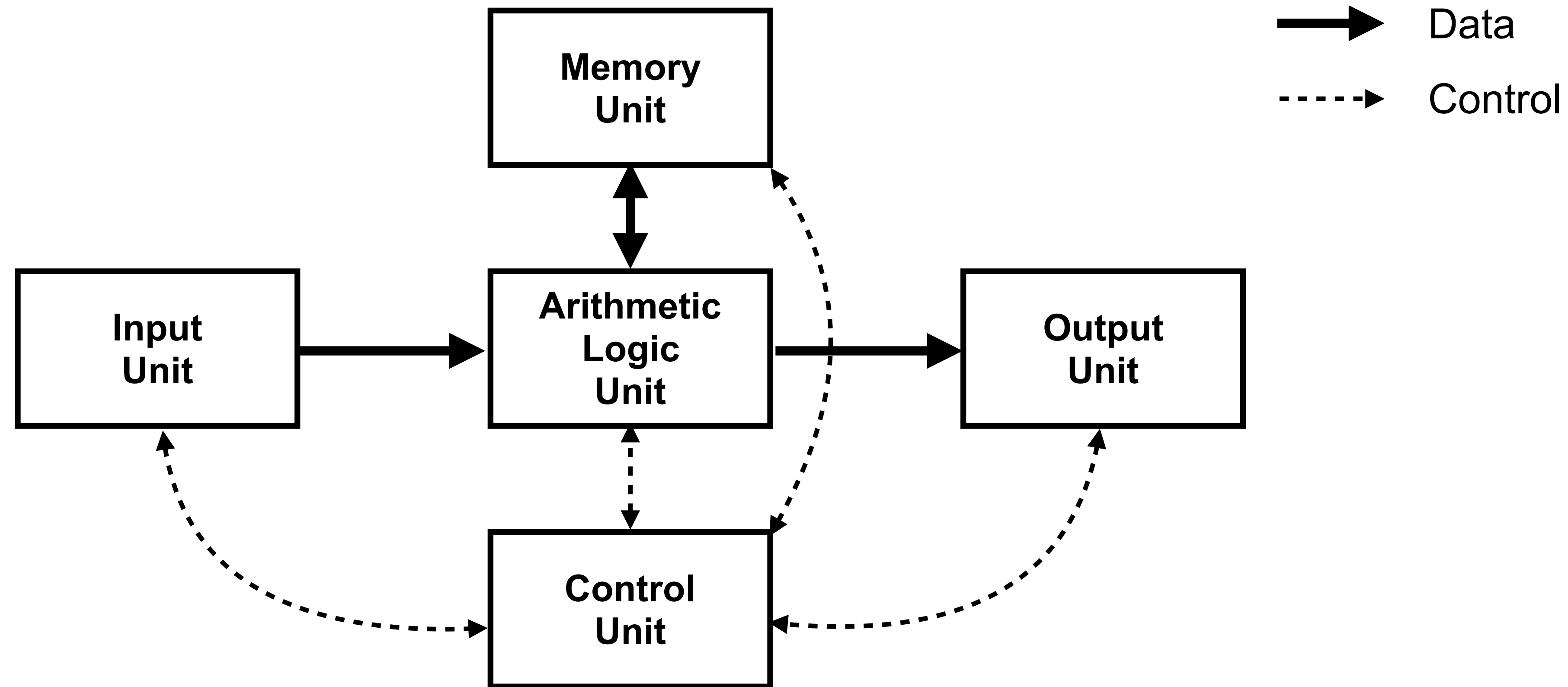
Lecture 1.4 Objectives

- Describe the key features of the von Neumann architecture
- Describe the function of a system bus and of the address, data, and control busses
- Describe the components of a typical PC

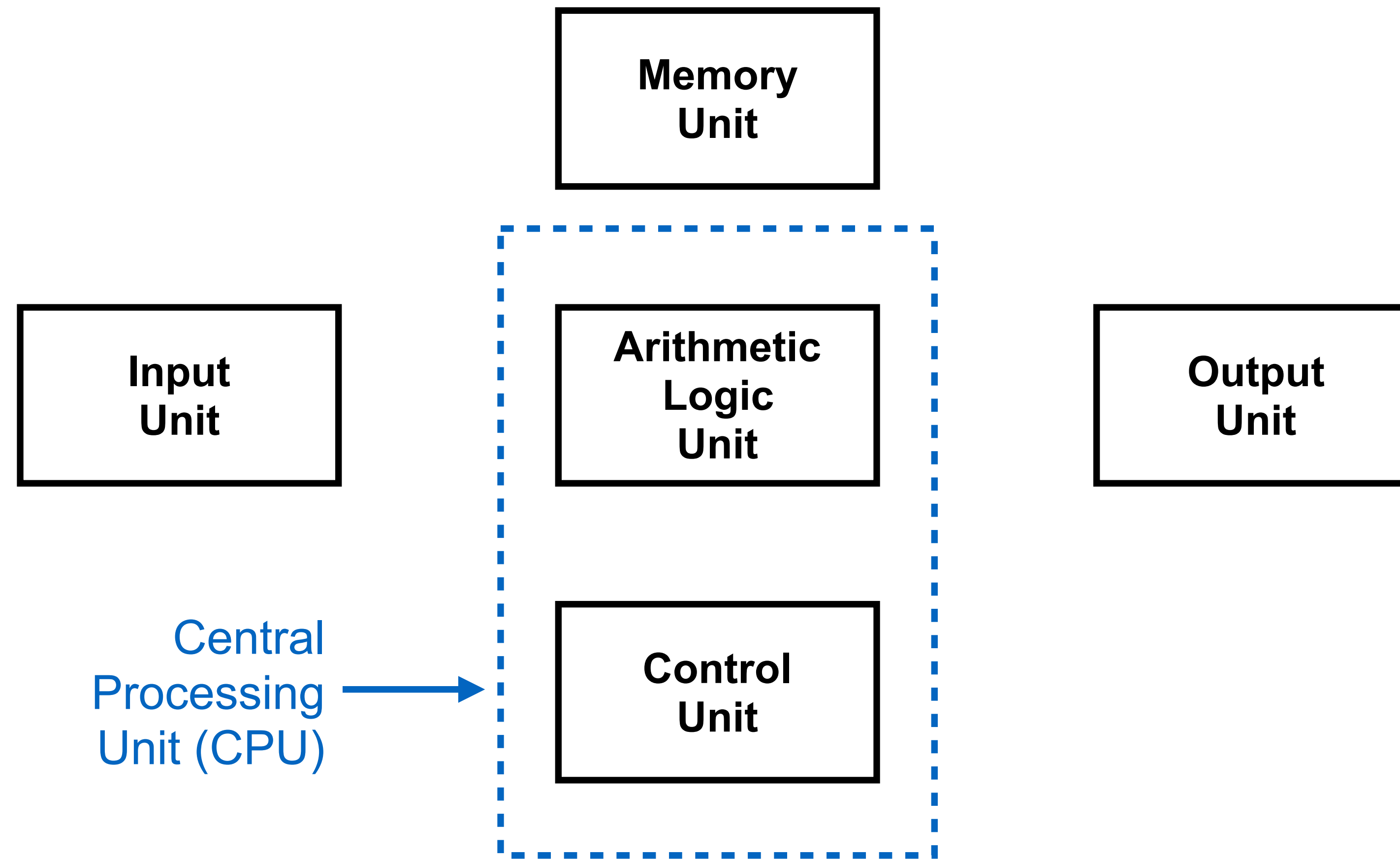
The von Neumann Architecture

- Most computers today follow the “von Neumann machine” model
 - Attributed to John von Neumann (1903-1957) at Princeton’s Institute for Advanced Studies and his collaborators at the University of Pennsylvania
- Five basic components
 - Arithmetic logic unit (ALU)
 - Memory
 - Input unit
 - Output unit
 - Control unit

von Neumann Data and Control



Central Processing Unit



CHECK POINT

As a checkpoint of your understanding, please pause the video and make sure you can:

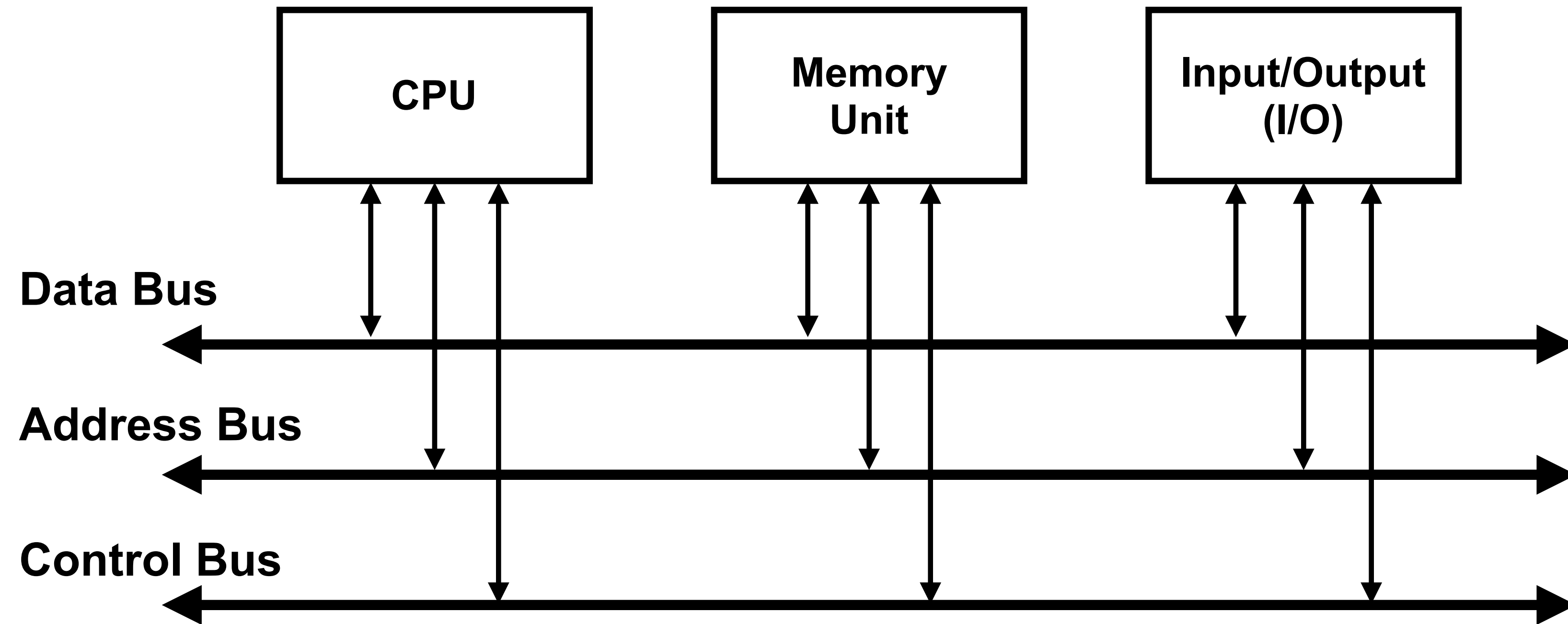
- Describe the key features of the von Neumann architecture

If you have any difficulties, please review the lecture video before continuing.

System Bus

- Rather than using different point-to-point connections for data and control between the units, data and control signals are carried on a single system bus
- System bus composed of:
 - Data bus to carry information being transmitted
 - Control bus to indicate how data is being sent and to provide synchronization
 - Address bus to identify the destination for the data

Simplified Diagram of a System Bus



System Bus Implementation

- Busses are implemented by a collection of “wires,” with one wire carrying one signal
- Example:
 - 32 wires for the data bus
 - 32 wires for the address bus
 - 8 wires for the control bus
- Some low performance systems share or multiplex multiple bus signals across a single wire
- Some high performance systems utilize multiple busses

Typical Computer Systems

- Typical computers today utilize the bus-based von Neumann architecture
- Structure
 - System bus implemented on the “motherboard,” a printed circuit board (PCB)
 - CPU attached to the motherboard
 - Memory attached to the motherboard
 - Input/output devices attached to the motherboard
 - Expansion slots provide bus connections for other devices, such as network interface cards (NICs)

Components of a Typical PC

- Motherboard—the printed circuit board that implements the bus and other functions
- Storage devices, such as a hard disk, floppy disk, CD-ROM reader, etc.
- System unit—holds the motherboard and internal storage devices and other peripherals
- Keyboard
- Monitor
- Other peripherals

Architectural Enhancements

- Cache memory to decrease the time to fetch data and instructions from the memory to the CPU
- Pipelining to have different phases of multiple instruction executions active at the same time
- Superscalar operation to have multiple instructions executing the same phase at the same time
- Prediction hardware to accelerate execution
- Reduced control logic overhead
- Co-processors for math, graphics, I/O, etc.

Technology Enhancements

- Faster integrated circuits
- Denser integrated circuits to provide more logic in the same area
- Denser memory devices to store more information in the same area
- Faster busses and network connections

CHECK POINT

As a checkpoint of your understanding, please pause the video and make sure you can:

- Describe the function of a system bus and of the address, data, and control busses
- Describe the components of a typical PC

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Summary

- Most computers follow the von Neumann model
 - Arithmetic logic unit (ALU)
 - Memory
 - Input unit and output unit (Input/Output)
 - Control unit
- System bus connects the units
 - Data bus
 - Address bus
 - Control bus
- Enhancements improve performance, lower cost

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