

Computer Architecture

INTRODUCTION

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Basic CPU Architecture

- ▶ *What does Computer Architecture mean?*
- ▶ Computer architecture is a specification detailing how a set of software and hardware technology standards interact to form a computer system or platform. In short, computer architecture refers to how a computer system is designed and what technologies it is compatible with.

The three main categories of computer architecture

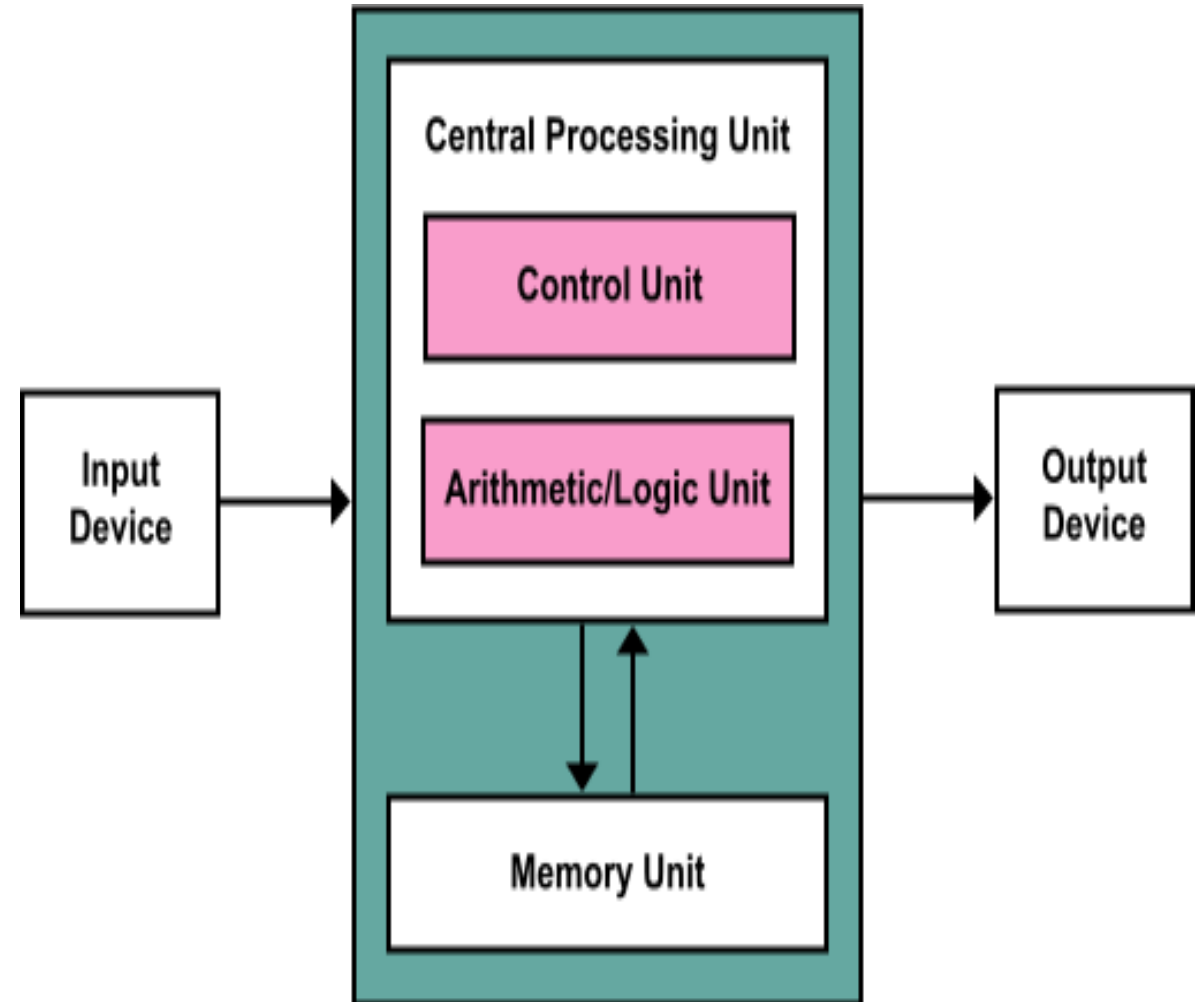
- ▶ **System Design:** This includes all hardware components in the system, including data processors aside from the CPU, such as the graphics processing unit and direct memory access. It also includes memory controllers, data paths and miscellaneous things like multiprocessing and virtualization.
- ▶ **Instruction Set Architecture (ISA):** This is the embedded programming language of the central processing unit. It defines the CPU's functions and capabilities based on what programming it can perform or process. This includes the word size, processor register types, memory addressing modes, data formats and the instruction set that programmers use.
- ▶ **Microarchitecture:** Otherwise known as computer organization, this type of architecture defines the data paths, data processing and storage elements, as well as how they should be implemented in the ISA

Von Neumann Architecture

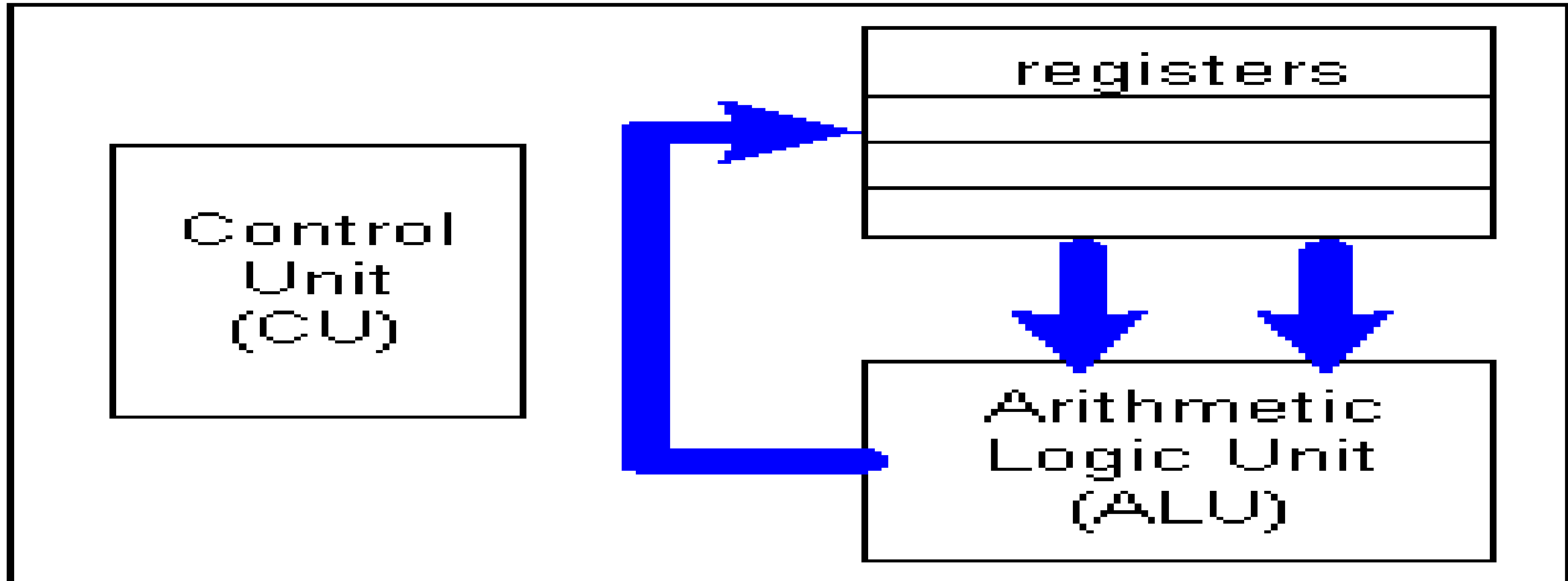
- ▶ All modern computers have the same basic layout, known as the von Neumann architecture. This layout divides the hardware of a computer into three main components: memory, Central Processing Unit (CPU), and input/output devices.

Von Neumann Architecture

Memory provides storage for data and program instructions. The CPU is in charge of fetching (reading) instructions and data from memory, executing the instructions, and then storing the resulting values back in memory.



CPU Subunits

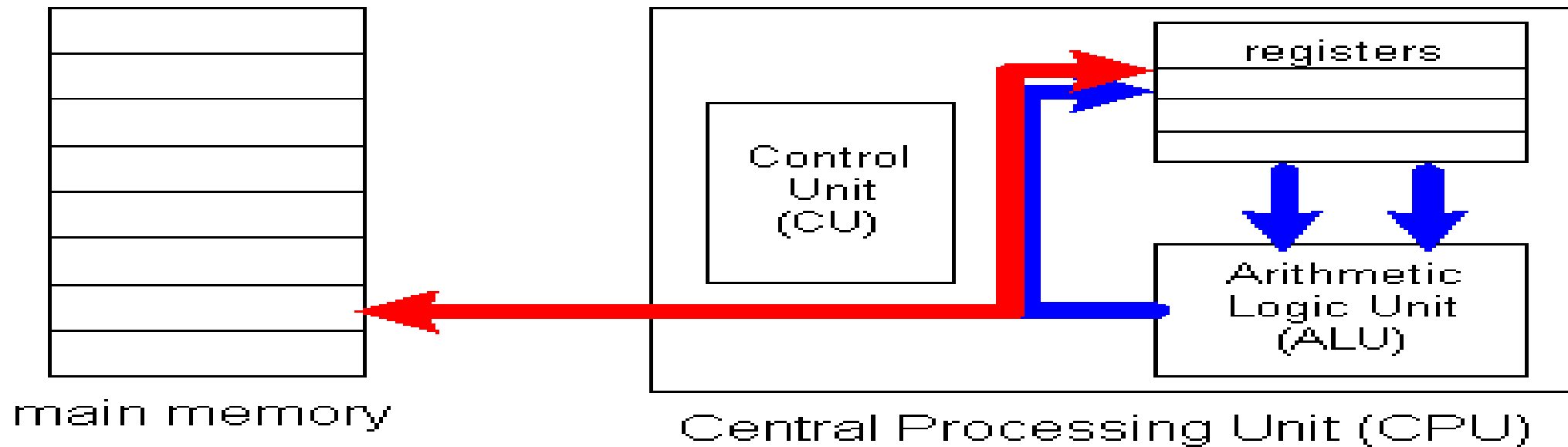


CPU Datapath Cycles

- ▶ The path that data follows within the CPU, traveling along buses from registers to the ALU and then back to registers, is known as the *CPU datapath*. All of the tasks performed by a computer, from formatting a document to displaying pages in a Web browser, are broken down into sequences of simple operations; the computer executes each individual operation by moving data from the registers to the ALU, performing computations on that data within the ALU, and then storing the result in the registers. A single rotation around the CPU datapath is referred to as a *CPU datapath cycle*, or *CPU cycle*.

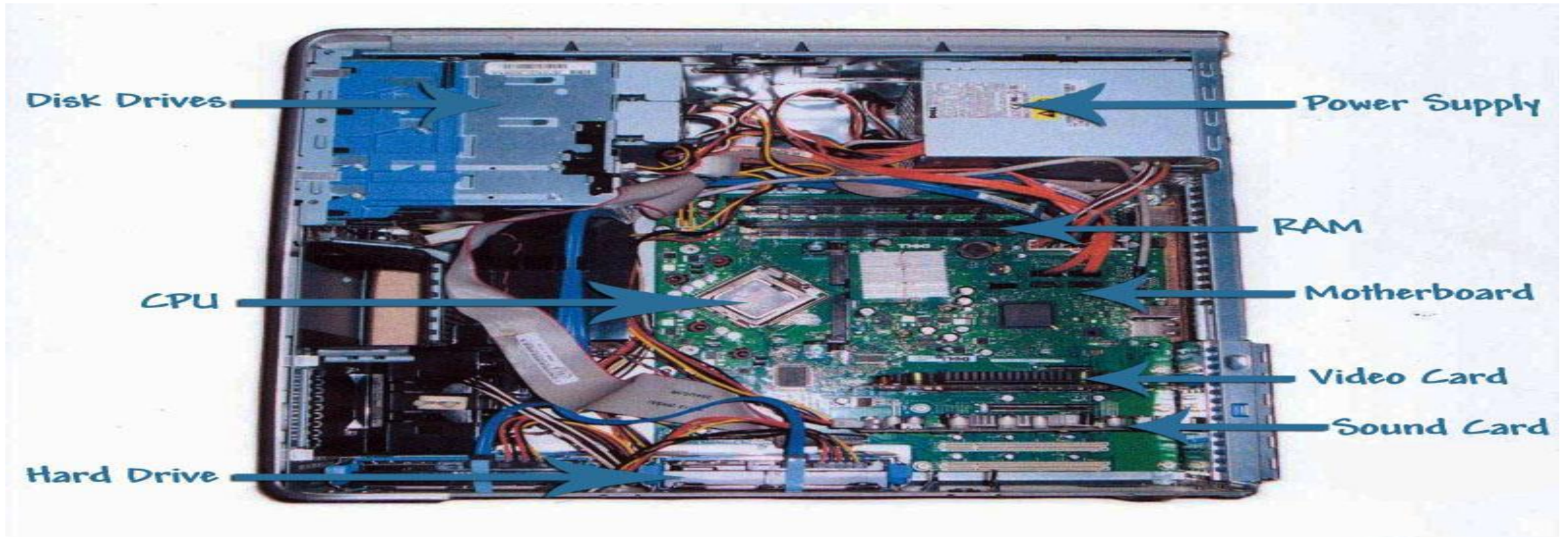
CPU and Main Memory

- Blue arrows represent the CPU datapath, whereas
- Red arrow represents the bus that connects main memory to the registers.



A bus connects Main Memory to the CPU

Basic Computer Components



Every computer Consists of the following basic components

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- ▶ **Computer Case** - Where all of the components are stored.
- ▶ **CPU**- It is basically the brain of your computer. The CPU is used to process everything from basic to complex functions in a computer.
- ▶ **RAM** - RAM is memory that attaches to the motherboard. RAM is hardware used to temporarily store and access data.
- ▶ **Motherboard**- It is the most important component in a computer system. All of the other hardware in a computer system connect to the motherboard.
- ▶ **Power Supply** - A Power Supply is the sends power to all of the other hardware so they can operate.

Continuation: Basic components

- ▶ **Hard Drive** - A Hard Drive is used for permanently storing files and programs.
- ▶ **Disk Drives** - Disk Drives can be a floppy drive, CD drive, DVD drive or other possible file storage devices that are used in a computer
- ▶ **Video Card** - A Video Card is the part of a computer system that converts binary code from the CPU so you can view it on a monitor.
- ▶ **Monitor** - The part of a computer that allows you to see what the computer is processing.
- ▶ **Keyboard** - A keyboard allows a computer user to enter text commands into a computer system.
- ▶ **Mouse**- it allows a computer user to use a point and click interface to enter commands.

CPU Subunits

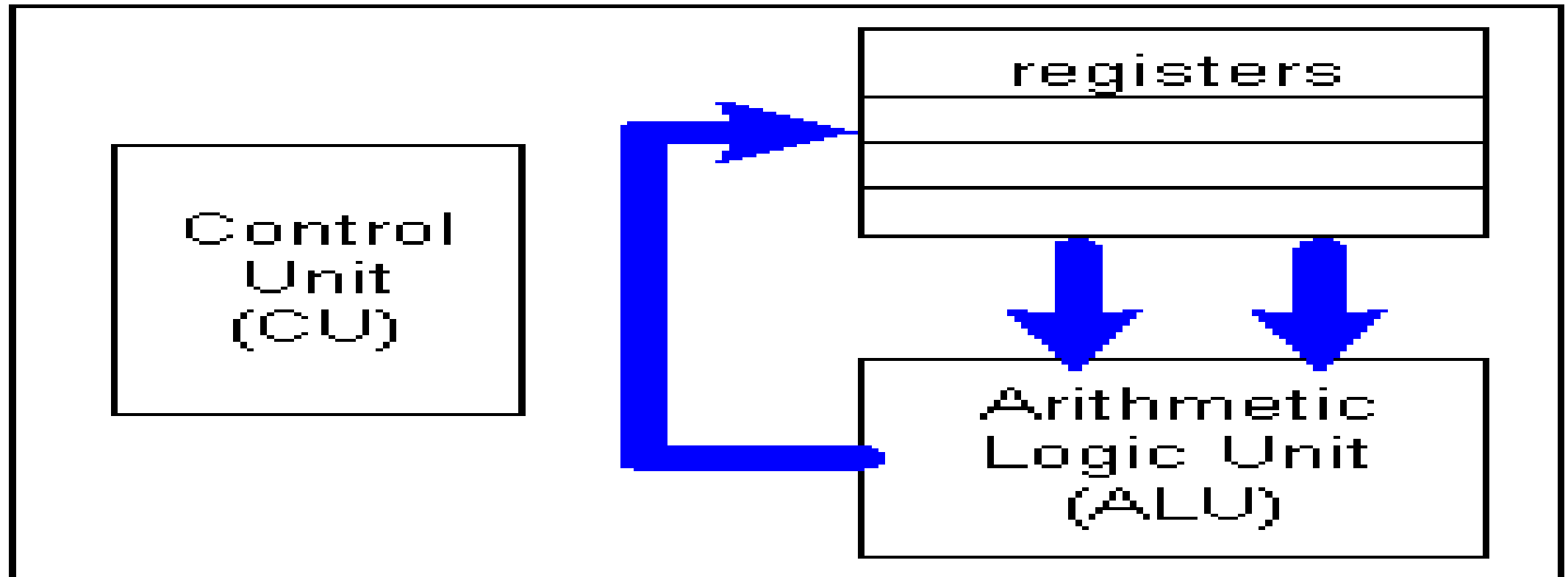
The CPU itself is comprised of several subunits, each playing a specific role in the processor's overall operation. These subunits are the Arithmetic Logic Unit (ALU), the registers, and the Control Unit.

- **The *Arithmetic Logic Unit (ALU)*** is the collection of circuitry that performs actual operations on data. Basic operations might include addition, subtraction, and bit manipulations (such as shifting or combining bits).

➤ ***Registers*** are memory locations that are built into the CPU. Since registers are integrated directly into the CPU circuitry, data in registers can be accessed much faster (as much as 5-10 times faster) than data in main memory can. However, due to the limited number of registers in the CPU (commonly 16 or 32), these memory locations are reserved for data that the CPU is currently using. To function efficiently, the computer must constantly copy data back and forth between registers and main memory. These transfers occur across collections of wires called *buses*, which connect the registers to the ALU and to main memory.

➤ **The *Control Unit (CU)*** can be thought of as "the brain within the brain," in that it oversees the various functions of the CPU. The Control Unit is the circuitry in charge of fetching data and instructions from main memory, as well as controlling the flow of data from the registers to the ALU and back to registers.

Central Processing Unit (CPU) subunits



System bus

- ▶ In computer architecture, a bus is a collection of wires through which data is transmitted from one part of a computer to another. This is a bus that connects all the internal computer components to the CPU and main memory.
- ▶ The size of a bus, known as its *width*, is important because it determines how much data can be transmitted at one time. For example, a 16-bit bus can transmit 16 bits of data, whereas a 32-bit bus can transmit 32 bits of data.
- ▶ Every bus has a clock speed measured in MHz. A fast bus allows data to be transferred faster, which makes applications run faster. On PCs, the old ISA bus is being replaced by faster buses such as PCI.

System bus

- ▶ All system buses consist of three parts – a data bus, an address bus, and a control bus. The data bus transfers actual data whereas the address bus transfers information about where the data should go. The control bus carries commands from the CPU and returns status signals from the devices.

System bus

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