

ICS3U: Introduction to Computer Science

Computer Hardware (Updated 2019)

J. Garvin



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Outside of a Computer

Most computer components are housed in a box, or **case**.

Cases come in different shapes and sizes, called **form-factors**.

There are different form-factors for different purposes, including desktop computers, laptops, netbooks, servers, etc.

Some people mistakenly refer to the case as the CPU, but this is an entirely different component inside of the case.

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Outside of a Computer



Typical desktop case, before components are installed.

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Inside of a Computer

Inside its case, a modern desktop computer typically has:

- a **motherboard**, which connects the **central processing unit** (CPU), **read-only memory** (ROM), **random-access memory** (RAM), and other parts;
- a **hard disk drive** (HDD) or **solid-state drive** (SSD), to provide storage for programs and data;
- an **optical disc drive**, which reads/writes CDs, DVDs;
- a **floppy disk drive**, if the computer is older;
- **storage controllers**, which control the HDD, SSD, optical and floppy drives;
- a **graphics controller**, to produce output for a monitor;
- **interface controllers** (parallel, serial, USB, etc.) to connect to external textbfperipherals; and
- a **power supply** to provide power for the components.

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Inside of a Computer

The **motherboard** is a **printed circuit board** (PCB), which connects most major internal components.

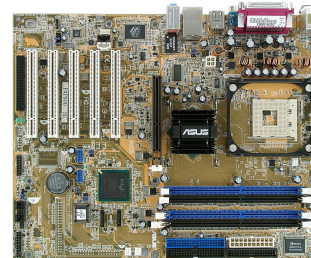
This includes any **microprocessors**, **integrated circuits** (ICs), and on-board controllers.

The motherboard also provides connections for common peripherals, such as keyboards, mice, and USB-connected devices.

Like cases, different motherboards have different form-factors.

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Inside of a Computer



ASUS P4P800 ATX Motherboard

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Inside of a Computer

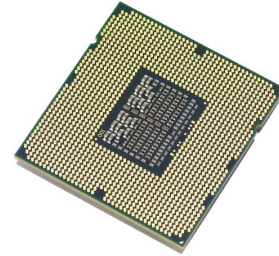
The **central processing unit (CPU)** is the “brain” of the computer.

It **executes** program instructions to run a program.

The CPU is located on a single microprocessor chip. MOAR.

Popular CPU vendors are Intel (Pentium, i-series), AMD (A-series) and Qualcomm (mobile devices and tablets).

Inside of a Computer



Intel Core i7 CPU

Inside of a Computer

CPUs may be different sizes, and will require a compatible motherboard.

They may operate at different speeds. Typically, faster processors are more expensive than slower ones.

Each CPU has a built-in clock, and the speed at which the CPU operated is called the **clock rate**.

Modern desktop computers typically have a clock rate of 1.5 GHz to 4 GHz. Some are faster, but this requires a greater amount of cooling to offset the heat generated by the processor.

Some CPUs contain multiple **cores**, which allow multiple tasks to be run in parallel.

Inside of a Computer

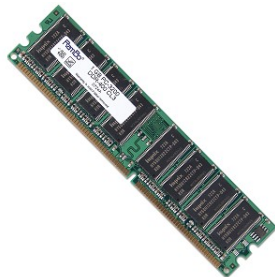
Memory is a temporary holding-place for program instructions and data, often keeping them only as long as a program is in operation.

Main memory, or **primary memory**, is **volatile**. Turning the computer off will erase the data from memory.

The memory that most people are familiar with is called **Random-Access Memory (RAM)**, because it is possible to access random memory locations in a non-sequential way.

Most modern consumer-grade computers have 4 or 8 GB of RAM, while servers and more powerful workstations may contain more.

Inside of a Computer



A typical “stick” of RAM

Inside of a Computer

Secondary memory includes magnetic hard drives, solid-state drives, floppy disks, flash media, etc.

It holds information that is too large for storage in main memory, or that needs more permanent storage (it is **non-volatile**).

Secondary memory is slow compared to RAM, but is virtually unlimited in capacity.

Information in secondary memory can only be accessed by the CPU if it is first transferred to main memory. This is by design.

Inside of a Computer

Hard disk drives consist of one or more **metallic platters**, and a **read/write head** that magnetizes individual sectors to store data.

Program instructions or data are stored until they are overwritten by new instructions or data.

Modern consumer-grade computers have hard disk drive capacities of 500 GB to 1 TB (laptops) or 1-2 TB (desktops). Some desktop computers, Network-Attached Storage (NAS) computers, and servers contain multiple hard disk drives.

Newer hard drives may be *solid-state* drives, similar to flash memory. These are usually smaller in capacity (128 GB to 1 TB), but are faster.

Inside of a Computer

HDD vs SSD



A magnetic hard drive (left) and solid-state drive (right)

Input/Output (I/O)

I/O devices allow the computer to communicate with the outside world.

The computer receives input through the keyboard or another input device. This input is transferred into memory (RAM), and then processed by calculating, comparing, or copying it.

The computer outputs the results of the processing onto a screen, a disk, or over a communications channel.

Some typical I/O devices include:

- data: floppy disk (largely obsolete), CD/DVD burner
- input: keyboard, mouse, joystick, optical scanner, light pen, touch panel, or microphone
- output: CRT monitor, LCD panel, printer, speakers
- communication: modems, network units

Input/Output (I/O)



Common input and output devices

Input/Output (I/O)

Input/output devices each have their own controller. The CPU communicates with input/output devices via this controller.

Associated with the controller is a memory area called a **buffer**. Data buffering compensates for any differences in speed between the CPU or main memory when data is transferred to most peripheral devices.

All output is sent by the CPU to the buffer for re-transmission by the device controller to the device. Similarly input from devices is sent to the buffer from where the CPU can transfer it at high speed to main memory.

Sound and Video

Some computers have dedicated **sound and video controllers**, to display graphics and text to a monitor.

Other computers may use separate cards, which have more memory and on-board processors.

These allow for more powerful graphics (high-end games, video rendering) or sound-processing capabilities (multi-track editing, effects).

Input/Output (I/O)



An nVidia graphics card, with cooling fan

Networking

To connect to other computers, or a network, most computers have some **networking hardware**.

Computers may use separate cards, or have network hardware integrated on the motherboard.

Some computers connect to networks via wires (CAT-5), while some connect wirelessly.

Networking



A standard cable modem

System Bus

All communication between the major components of the computer occurs via the **system bus**.

It is collection of cables and connectors that carries data or signals from one internal component (CPU, memory, input/output device) to another.

The system bus is composed of three dedicated buses: the data bus, address bus, and control bus.

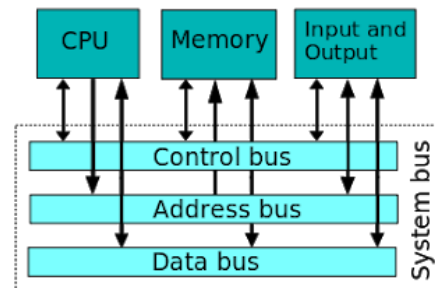
The system bus speed is important, since a slow bus may restrict the speed of the CPU.

System Bus

Possible transfers of information via the system bus include:

- Transmitting data from main memory to the CPU.
- Transmitting input data from a keyboard to main memory.
- Transmitting information from secondary memory to main memory.

System Bus



Components connected by the system bus