Module 5 - The System Unit

- Careers in IT
  - Brain - Computer Interfaces

General Notes

System Unit

System Unit: The container that houses most of the electronic components that make up a computer system.

- Also known as the **system chassis**
- Some are located in a separate case, whereas others share a case with other parts of the computer system.

The five most common types of personal computers:

- Cell phones
- Tablets
- Laptops
- Desktops
- Wearable computers

Smartphones

- Smartphones are almost all monitor, with the system unit, secondary storage, and all electronic components located behind the monitor.

Tablets

- Also known as **tablet computers**
- Cannot be connected to phone networks
- The smallest tablets *(mini tablets)* are a little larger than the largest cell phones.

Laptops

- Laptops have their system units housed with selected secondary storage and input devices.

- Their monitors are separate from the rest of the computer, attached to the system unit with a hinge.
- Specialized laptops:
  - **Two-in-on laptops**
    - 
    - Include a touchscreen and the ability to fold flat like a tablet computer.
  - **Gaming laptops**
    - Include high-end graphics hardware and very fast processors.
  - **Ultrabooks**
    - 
    - Also known as **ultra-portables** or **mini notebooks**
    - Lighter and thinner with longer battery life than most laptops.

Desktops

- Most powerful type of personal computer.
- **all-in-one desktops** have their monitor and system unit housed together in the same case.
- Desktop system units that are in a separate case and are vertically places are referred to as a **tower unit** or **tower computer**.

Wearable Computers

- Also known as a **wearable device**.
- One of the first evolutionary steps to the Internet of Things (IoT)
- Contain an embedded computer on a chip.
- The most common wearable computers are smartwatches and activity trackers.
    - **Smartwatches** like Apple's Watch act as a watch, fitness monitor, and communication device.
    - **Activity Trackers** like Garmin Vivoactive 4 monitors daily exercise and sleep patterns.
        - Also connects wirelessly to desktops, laptops, and smartphones to record
          and share their data.

Components

Personal computers (cell phones, laptops, tablets, wearables, and desktops) all share the same components:

- System boards
- Microprocessors
- Memory

System Board

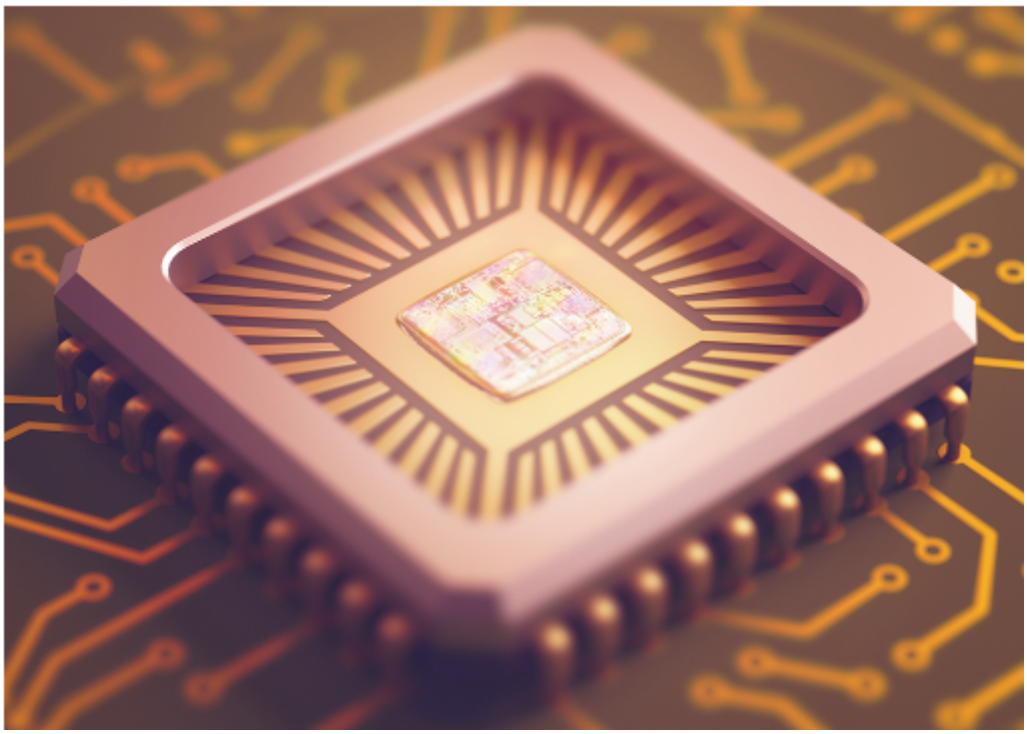
The **System board** controls communications for the entire computer system. All devices and components connect to the system board, including external devices and internal components.

- Also known as the **mainboard** or **motherboard**
- A flat circuit board covered with a variety of electric components:
    - sockets
    - slots
    - bus lines

The system board acts as a data path and traffic monitor, allowing the various components to communicate efficiently with one another.

- Located behind the screen for cell phones, tablets, and wearable computers

- Located at the bottom of the system unit or along one side for laptops and desktops.



- *Chip mounted onto a chip carrier*

Sockets

Provide a connection point for small electronic parts called chips.

- **Chips** consist of tiny circuit boards etched onto squares of sandlike material called silicon.
    - Also called a **silicon chip**, **semiconductor**, or **integrated circuit**.

    - Typically mounted onto **chip carriers** that plug directly into sockets on the system board or onto cards that are then plugged into slots on the system board.
- Sockets are used to connect the system board to a variety of different types of chips.

Slots

Slots provide a connection point for specialized cards or circuit boards.

- The cards, such as a wireless networking card, provide expansion capability for a computer system.

Bus Lines

Bus lines provide pathways that support communication among the various electronic components that are either located on the system board or attached to the system board.

Microprocessor

The **central processing unit (CPU)** or **processor** is contained on a single chip called the **microprocessor**.

- *brains* of the computer.

The CPU has two basic components:

- **Control Unit**
    - Tells the rest of the computer system how to carry out a program's instructions.
    - Directs the movement of electronic signals between memory, which temporarily
      holds data, instructions, and processed information, and the arithmetic-logic unit.
    - Also directs these control signals between th CPU and input / output devices.
- **Arithmetic-logic Unit**
    - Usually called the **ALU**.

- Performs **arithmetic** and **logical** operations.
  - **Arithmetic operation:** Fundamental math operation such as addition, subtraction, multiplication, or division.
  - **Logical operation:** Consist of comparisons such as: **=**, **<**, ***, ***>**.

Microprocessor Chips

There are two major categories for microprocessors developed today:

- Mobile
  - Used in cell phones and tablets.
- Desktop
  - Used in computers and laptops.

Chip processing capabilities are expressed in **word*** sizes.

- A **word** is the number of bits (32 or 64) that can be accessed at one time by a CPU
- Eight bits group together to form a byte.
- A 32-bit computer can access 4 bytes at a time.
- A 64-bit computer can access 8 bytes at a time.

Popular Mobile Microprocessors

Processor	Manufacturer
A14 Bionic	Apple
Snapdragon 888	Qualcomm
Exynos 2100	Samsung

Popular Desktop Microprocessors

Processor	Manufacturer
Ryzen 5000	AMD
M1	Apple
Alder Lake	Intel

The **clock speed** of a microprocessor is related to the number of times a CPU can fetch and process data or instructions in a second.

- Older personal computers process data and instructions in millionths of a second, or microseconds
- Modern personal computers process data and instructions in billionths of a second, or nanoseconds.
- Supercomputers operate at speeds measured in picoseconds (1000 times faster than personal computers).
- In the future, we can expect speeds measuring in femtoseconds (1000 times faster than a supercomputer).

Some microprocessors can handle multiple instructions per cycle or tick of the clock; This means that speed comparisons can only be made between processors that work the same way.

Unit	Speed
Microsecond	Millionth of a second
Nanosecond	Billionth of a second
Picosecond	Trillionth of a second
Femtosecond	Quadrillionth of a second

Multicore processors provide two or more separate and independent CPUs.

- For multicore processors to be used effectively, computers divide tasks into parts that can be distributed across each core - an operation called **parallel processing**.

Specialty Processors

Coprocessors (a popular specialty processor) are specialty chips designed to improve specific computing operations.

- A standard feature in gaming computers is a **graphics coprocessor** *(also known as a **GPU [Graphics Processing Unit]**)*
  - Designed to handle specialized tasks such as displaying 3D images and encrypting data.
- Many cars have more than 100 separate specialty processors to control nearly everything from fuel efficiency to satellite entertainment and tracking systems.
- Most cell phones and tablets have specialty processors to efficiently show and store videos.

Memory

Memory is a holding area for data, instructions, and information.

- Memory is contained on chips connected to the system board.

There are three types of memory chips:

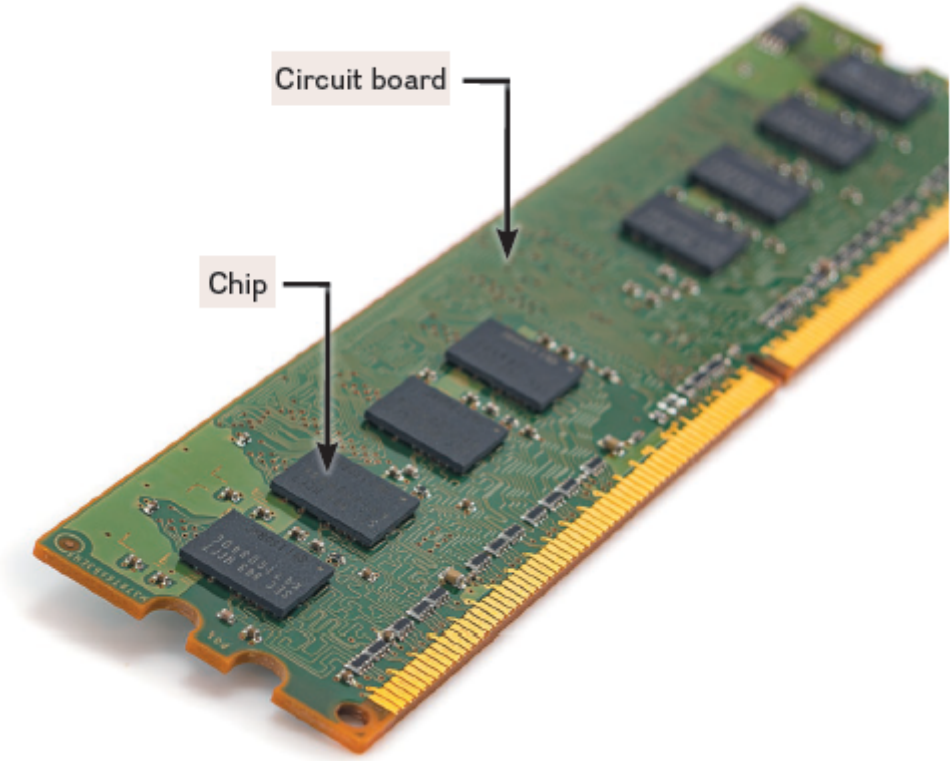
- **Random-access memory (RAM)**
- **Read-only memory (ROM)**
- **Flash memory**

Type	Use
RAM	Programs and data
ROM	Fixed start-up instructions
Flash	Flexible start-up instructions

RAM

RAM chips hold the program (sequence of instructions) and data that the CPU is presently processing.

- Temporary or volatile storage because everything in most types of RAM is lost when the computer turns off (by any means).



- *RAM chips mounted on circuit board*

Cache memory improves processing by acting as a temporary high-speed holding area between the memory and the CPU.

- The computer detects which information in RAM is most frequently used and then copies that information into the cache.
- When needed, the CPU can quickly access the information from the cache.

Unit	Capacity
Megabyte (MB)	1 Million bytes
Gigabyte (GB)	1 Billion bytes
Terabyte (TB)	1 Trillion bytes
Petabyte (PB)	1 Quadrillion bytes

If your computer does not have enough RAM to hold a program, it might be able to run the program using **virtual memory**.

- With virtual memory, large programs are divided into parts, and the parts arc stored on a secondary device, usually a hard disk.
- Each part is then read into RAM only when needed. In this way, computer systems are able to run very large programs.

ROM

ROM chips have information stored in them by the manufacturer.

- Not volatile.
- Cannot be changed by the user.
- Computer can read or retrieve data and programs write on the ROM chip, but not write - encode or change - the information or instructions in the ROM.

Flash Memory

Offers a combination of features of RAM and ROM.

- Can be updated with new information that does not get lost when power is turned off.
- Used to store the start-up instructions for a computer.
    - Information is called the system's **BIOS (Basic input/output system)**.
    - Includes specifics concerning the amount of RAM, the type of keyboard, mouse,
      and secondary storage devices connected to the system unit.
    - Changes made to the computer system are reflected in flash memory.

Expansion Cards and Slots

- **SD cards** are examples of expansion cards.
- Many personal computers allow users to expand their systems by providing expansion slots to the system board.

Some commonly used expansion cards:

- Graphics cards
- Network Interface Cards (NIC)
  - Network adapter cards
  - Used to connect a computer to a network
- Wireless network cards

Bus Lines

A **Bus line** is known as a **bus**. A bus is a pathway for bits representing data and instructions.

- The number of bits that can travel simultaneously down a bus is known as the **bus width**.
  - A 64-bit bus can move twice as much information at a time as a 32-bit bus.
- Many devices, such as expansion cards, will work with only one type of bus.
- Buses link the parts of the CPU to each other.
- Buses also link the CPU to various other components on the system board.

Every computer system has two basic categories of buses:

- **System buses**
  - Connects the CPU to memory on the system board.
- **Expansion buses**
  - Connects the CPU to other components on the system board, including expansion slots.

Expansion Buses

Computer systems usually have a combination of different types of expansion buses:

- **USB**
  - External USB devices are connected from one another to a common point or hub
    and then onto the USB bus.
  - USB bus then connects to the PCI bus on the system board.
  - Current USB standard is USB 3.4
- **FireWire**
  - Similar to USB buses, but more specialized. Primarily used to connect audio
    and video equipment to the system board.
- **PCI Express (PCIe)**
  - Does not share a single bus line or path with several devices like other buses, instead providing a single dedicated path for each connected device.

Ports

A **port** is a socket for external devices to connect to the system unit.

- Cell phones use ports to recharge their batteries.
- Some ports connect directly to the system board, while others connect to cards that are inserted into slots on the system board.
- Some ports are standard, others are more specialized.

Standard Ports

Most desktops and laptops come with a standard set of ports for connecting **peripherals**, or external devices, such as a monitor and keyboard.

The most common ports are:

- **Universal Serial Bus (USB)** Ports
- **USB-A**
- **USB-B**
  - Found on peripheral devices, like digital cameras and cell phones.
- **USB-C**
  - Newest USB port
  - Some support **Thunderbolt 3**, a high-speed version of the USB-C port.

- **High Definition Multimedia Interface (HDMI) Ports**
  - Provide high-definition video and audio.
- **Ethernet Ports**
  - Allows connecting multiple computers, or to a DSL or cable modem

Specialized Ports

The most common speciality ports:

- **DisplayPorts (DP)**
  - Audiovisual ports usually used to connect large monitors.
- **DVI (Digital Video Interface)**
  - Only send video signals and cannot send audio signals.
  - Connect digital monitors to your computer.
- **FireWire Ports**
  - Provide high-speed connections to specialized FireWire devices such as camcorders and storage devices.

Cables

Standard cables:

- USB
- HDMI
- Thunderbolt
- Ethernet

Power Supply

Computers require direct current (DC) to power their electronic components and to represent data and instructions.

- DC power can be provided by converting alternating current (AC) from outlets or batteries.
- Most cell phones and tablets are powered directly from batteries that are recharged using an **AC adapter** that converts AC to DC.
- Desktop computers have a **power supply unit** located within the system unit that provides power to drive all the system unit components.

Electronic Data and Instructions

Our voices create **analog** *(continuous)* signals. Computers can only recognize **digital** electronic signals. Before any processing can occur within the system unit, the computer must convert what we understand to what the system unit can electronically process.

Numeric Representation

The binary system only consists of 0 and 1, with each one individually being called a **bit** *(short for binary digit)*.

- **1** can be represented by a negative charge and **0** by no electric charge.
- Numbers, letters, and special characters are represented by bytes (bits combined into groups of eight).

Character Encoding

Character encoding standards assign a unique sequence of bits to each character.

- **ASCII (American Standard Code for Information Interchange)** was used in the past for personal computers, while mainframe computers used **EBCDIC (Extended Binary Coded Decimal Interchange Code)**. They were both limited.
  - ASCII only uses 7 bits, meaning that only 128 total characters can be represented.
    - Can not support languages like Chinese and Japanese
- **Unicode** eventually replaced ASCII.
  - The first 128 characters are assigned the same sequence of bits as ASCII to
    maintain compatibility with older ASCII-formatted information.
  - Unicode uses a variable number of bits to represent each character.
  - There's UTF-8 and UTF-16.
    - UTF-16 is the older standard. Each character would have a minimum of 16
      bits. UTF-8 can have a minimum of 8 bits, making it more efficient.

Careers in IT

Computer technicians repair and install computer components and systems.

- They work on personal computers, mainframe servers, printers, and many more.
- Responsible for setting up and maintaining computer networks.

Brain - Computer Interfaces

> Can you imagine a future when we become half human and half machine? Today, we
> use computer implants to help
> people hear and to control their heartbeat. Computer chips are being implanted into people with Parkinson's disease
> to help them control their movements and to reduce other impacts of the condition. But these devices are simple
> compared to the future of brain-computer interfaces imagined by the researchers and entrepreneurs of Silicon Valley.

The human brain stores information in neurons using electrical impulses. Using neural imaging, specialized equipment
can read the intensity and location of these impulses or thought patterns. This technology currently allows amputees
to control robotic limbs. This case and almost all other applications, however, require brain surgery and cumbersome
equipment. Researchers are currently trying to reduce the size and invasiveness of these technologies. Scientists at
Florida International University are investigating devices so small that they can travel through the bloodstream to the
brain. In the future, a simple shot may allow your computer to tell what you are thinking.

With improvements in the quality of neural imaging and neural hardware, we may soon be able to image all the brain's
electrical impulses. For example, when you think of turning on the house lights, a computer can take an image of your
brain thinking about turning on the house lights. Later, when you have that thought again, the computer can compare
your brain's image to previous images and realize that when those areas of the brain are active, you want the house
lights to turn on.

Not only may computers someday read your mind-they someday may write to it as well. Memories are stored in the
electrical impulses of the brain, and by injecting tiny magnetic particles

into the brain, scientists can stimulate neurons,
essentially creating memories. Currently, our understanding of how the brain operates is too limited, and our ability to
manipulate neurons is too coarse, to allow us to accurately transmit information. However, someday you may think, "I
would like to be able to speak French," and through neural stimulation, a computer would generate the memories
necessary for you to speak French.

Many ethicists are concerned by the potential use of such technologies to improve human abilities instead of treating
medical conditions. For example, with tiny chips being able to store so much, people could use brain implants to
improve their memory. This can lead to a variety of scenarios where the individual with the implants would have an
advantage over those who don't have them. However, others disagree, arguing that the integration of technology and
biology is to be expected and it is nothing more than the next step in human evolution. If such a technology became
widespread and affordable, would you opt to receive a chip implant?