Information Communication Technologies

Lecture 3. Hardware Systems

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Agenda

Hardware System
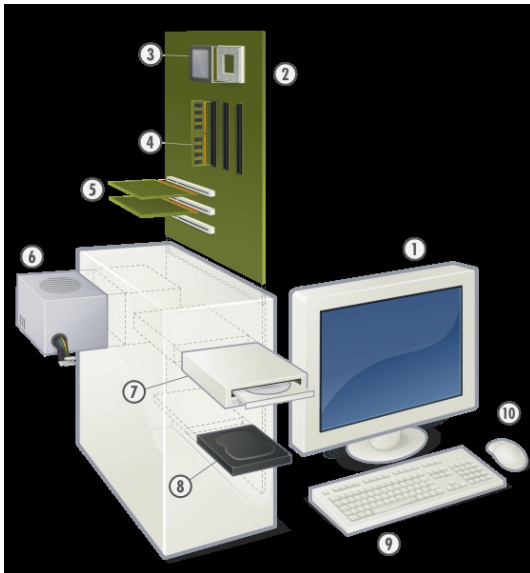
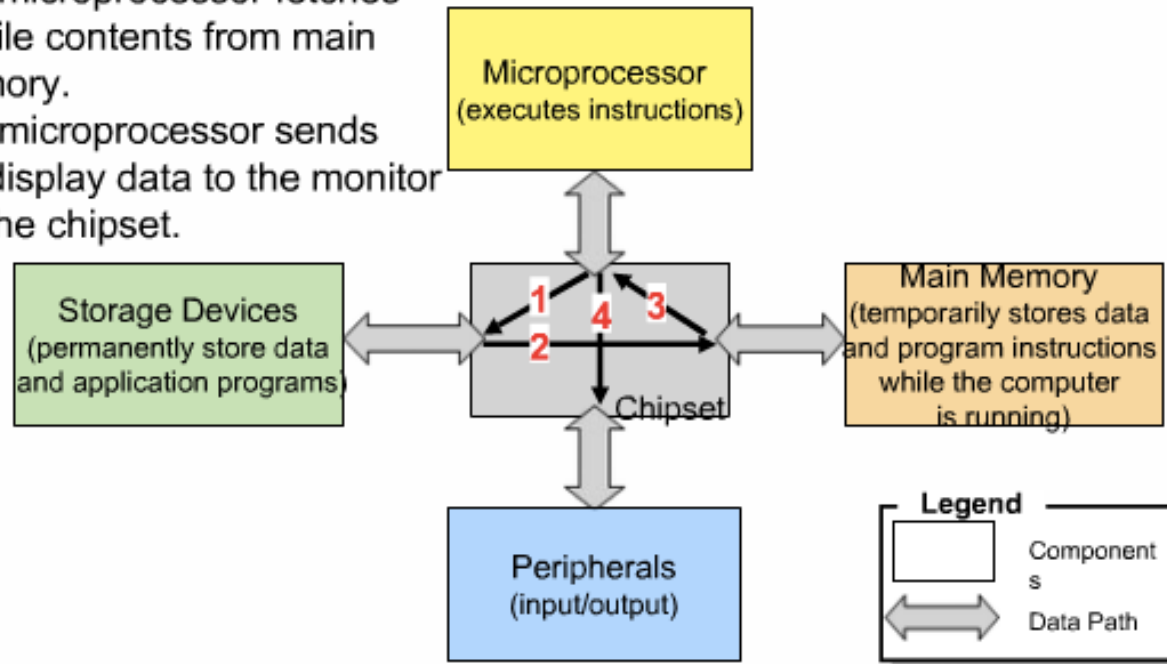- Hardware a device that is physically connected to your computer or something that can be physically touched.

- Computer hardware refers to the physical parts or components of a computer such as monitor, keyboard, hard drive disk, mouse, printers, graphic cards, sound cards, memory, motherboard and chips, etc all of which are physical objects that you can actually touch.
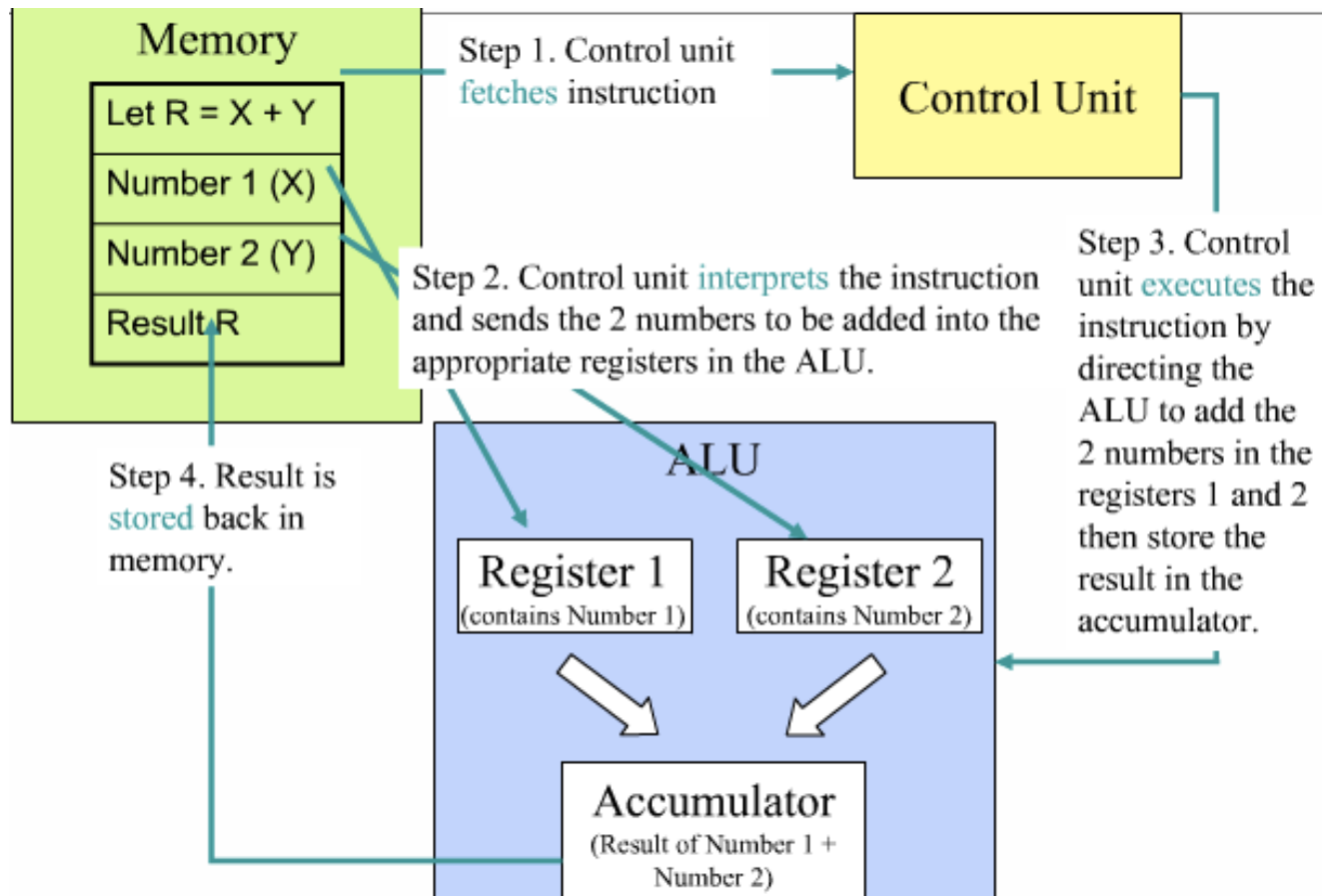
Hardware Components
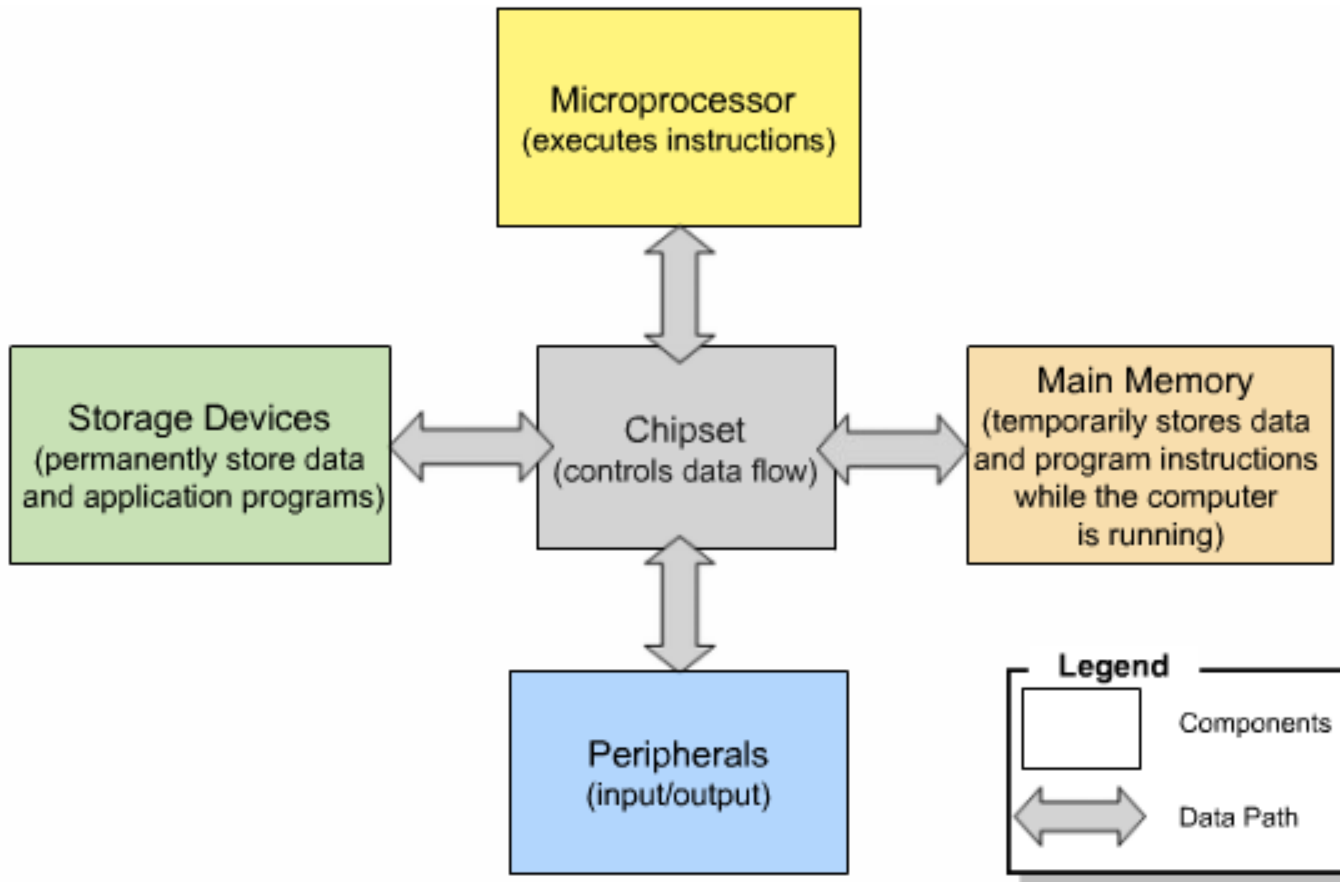
How a file is displayed

1. The microprocessor sends instructions to the storage devices (via the chipset) requesting the specified file to be loaded into main memory.
2. The storage devices send the file through the chipset to main memory.
3. The microprocessor fetches the file contents from main memory.
4. The microprocessor sends the display data to the monitor via the chipset.

Microprocessor
(executes instructions)

Storage Devices
(permanently store data and application programs)

1 4 3
2

Chipset

Main Memory
(temporarily stores data and program instructions while the computer is running)

Peripherals
(input/output)

Legend

Components

Data Path

Fetch-Execute Cycle

Memory

| Let R = X + Y |
| Number 1 (X) |
| Number 2 (Y) |
| Result R |

Step 1. Control unit fetches instruction

Control Unit

Step 2. Control unit interprets the instruction and sends the 2 numbers to be added into the appropriate registers in the ALU.

Step 3. Control unit executes the instruction by directing the ALU to add the 2 numbers in the registers 1 and 2 then store the result in the accumulator.

Step 4. Result is stored back in memory.

ALU

Register 1
(contains Number 1)

Register 2
(contains Number 2)

Accumulator
(Result of Number 1 + Number 2)

Microprocessor

Microprocessor

- **Microprocessor** (processor) is an integrated circuit designed to carries out the instructions of a computer program by performing the basic arithmetical, logical, and input/output operations of the system.

- It is the most important, and usually the most expensive, component of a computer.

- You can usually identify the microprocessor because it is the largest chip on the system board, although it might be hidden under a cooling fan.

- Intel and AMD are the leaders in the PC marke

Microprocessor

Intel® Core 2 Duo 3.33 GHz, 1333 MHz FSB, 6 MB Cache

- A microprocessor's performance is affected by several factors, including clock speed, bus speed, word size, cache size, instruction set, and processing techniques.

- 3.33 GHz - an indicates the speed of the **microprocessor clock** — a timing device that sets the pace for executing instructions.

- **Megahertz** (MHz) means a million cycles per second. **Gigahertz** (GHz) means a billion cycles per second.

- A cycle is the smallest unit of time in a microprocessor's universe.

- The clock speed is not equal to the number of instructions a processor can execute in one second.
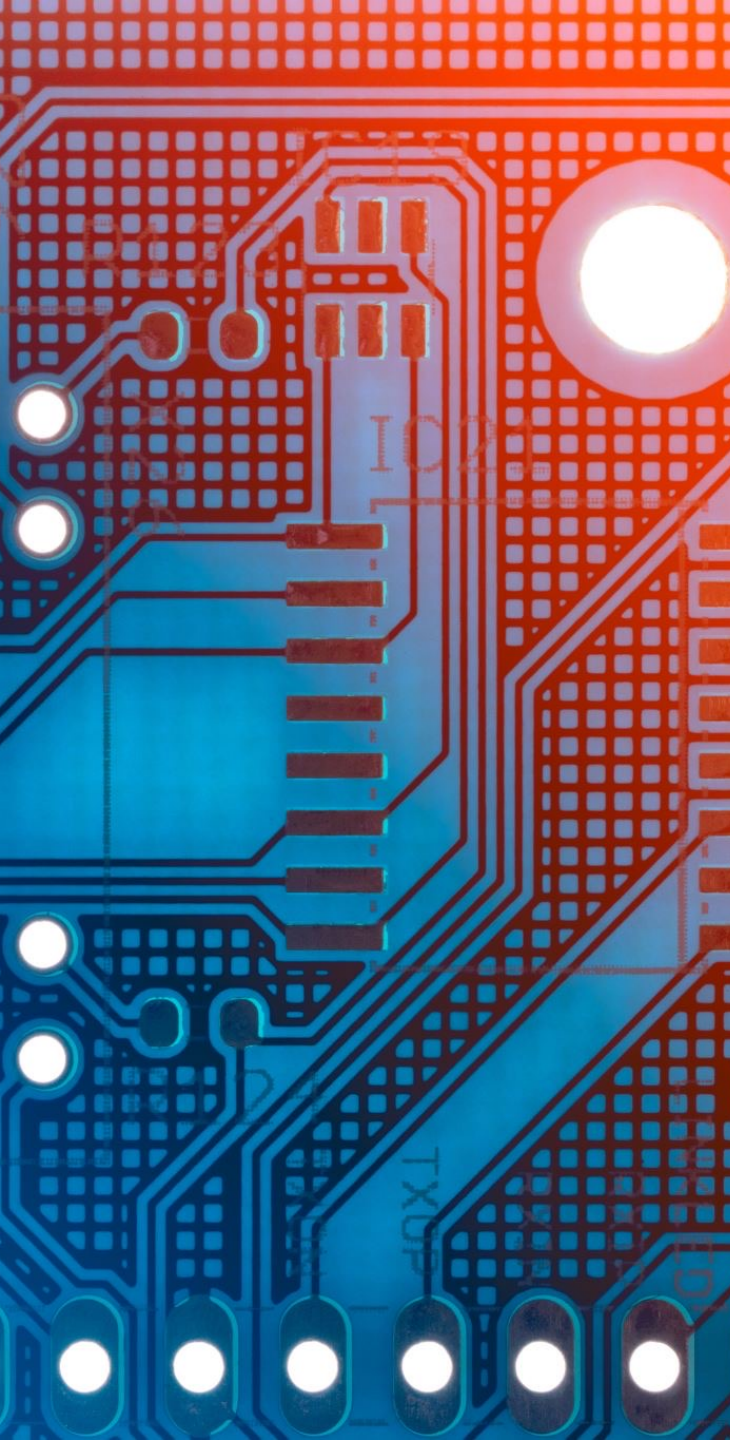
Processor Numbers (PN)

- Do not correspond to a particular clock speed but they can indicate speed relative to other processors within the same family.

- Intel Core i7-940 processor has a higher processor number and is faster than the Core i7-920.

- An Intel Celeron E1500 processor is not faster than the Core i7-940. Even though 1500 is a larger number than 940, the Celeron processor and Core i7 are in different processor families.

FSB

Front Side Bus, a term that refers to the circuitry that transports data to and from the microprocessor.

A fast front side bus moves data quickly and allows the processor to work at full capacity.

Measured in megahertz and ranges from 200 MHz to 1600 MHz.

Intel® Core 2 Duo 3.33 GHz, **1333 MHz FSB**, 6 MB Cache

What impact does word size have on performance?

- **Word size** refers to the number of bits that a microprocessor can manipulate at one time.

- Word size is based on the size of registers in the ALU and the capacity of circuits that lead to those registers.

- A processor with a 32-bit word size, has 32-bit registers, processes 32 bits at a time, and is referred to as a 32-bit processor.

- Processors with a larger word size can process more data during each processor cycle—a factor that leads to increased computer performance.

- Today's personal computers typically contain 32-bit or 64-bit processors.

Cache

Cache is special high-speed memory that allows a microprocessor to access data more rapidly than from memory located elsewhere on the system board.

A large cache can increase computer performance. Some computer ads specify cache type and capacity.

A **Level 1 cache** (L1) is built into the processor chip, whereas a **Level 2 cache** (L2) is located on a separate chip and takes a little more time to get data to the processor. Cache capacity is usually measured in megabytes.

CISC and RISC

CISC (complex instruction set computer) technology - complex of instructions, each requiring several clock cycles for execution

RISC (reduced instruction set computer) technology - a microprocessor with a limited set of simple instructions

A RISC processor performs most instructions faster than a CISC processor. It might, however, require more of these simple instructions to complete a task than a CISC processor requires for the same task. Most processors in today's personal computers use CISC technology.

Serial, Pipelining, and Parallel processing technology
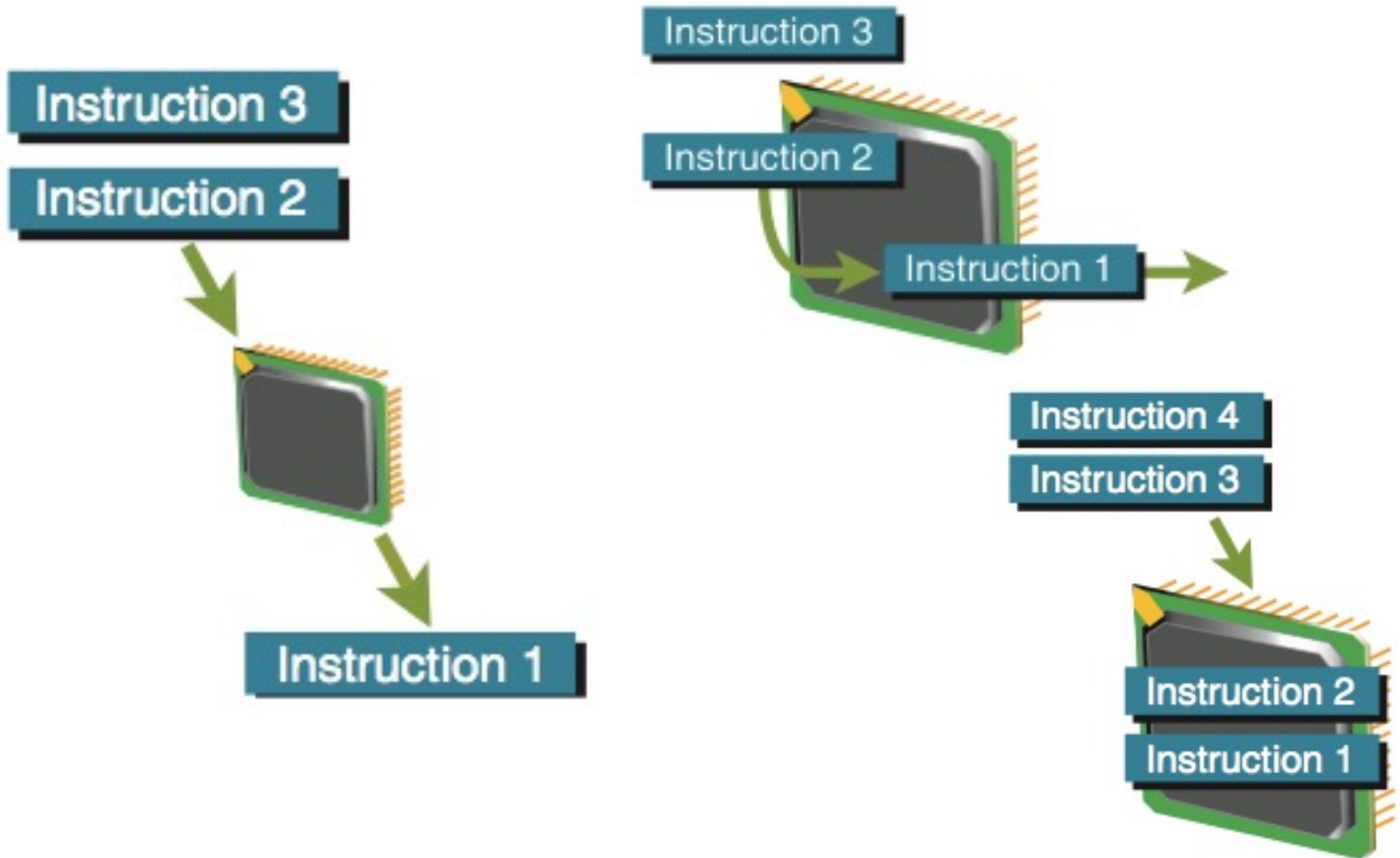
Types of Memory
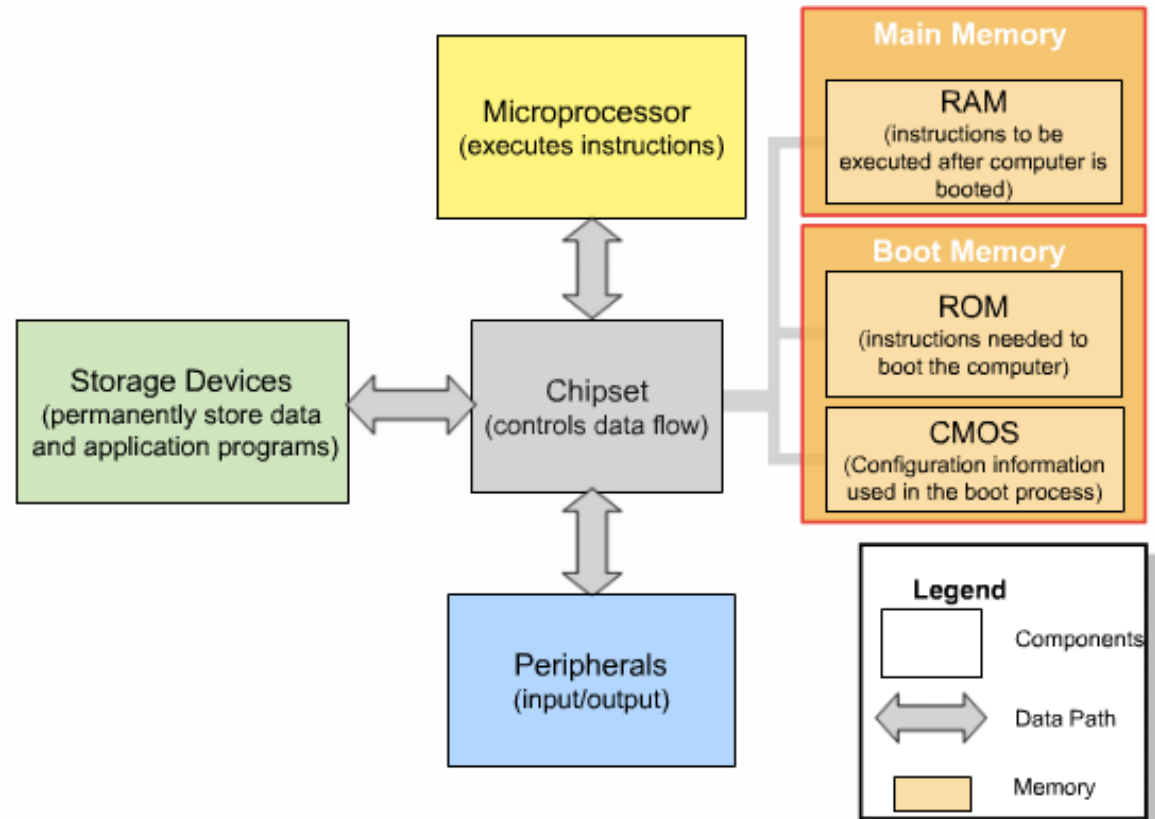
Main memory

- The computer can manipulate only data that is in main memory.

- Every program you execute and every file you access must be copied from a storage device into main memory.

- The amount of main memory on a computer is crucial because it determines how many programs can be executed at one time and how much data can be readily available to a program.

RAM

- **RAM** (random access memory) is a temporary holding area for data, application program instructions, and the operating system.
- In a personal computer, RAM is usually several chips or small circuit boards that plug into the system board within the computer's system unit.

RAM

- **Capacity** is the maximum number of bits or bytes that can be stored. The capacity of RAM is typically measured in megabytes (MB). Many computers have RAM capacity of 128 MB or more.

- **Latency** is the delay between the time when the memory receives an address and the time when the first bit of data is available from the memory device. This delay is also referred to as **access time**. Latency is typically measured in nanoseconds (ns), billionth of a second (10-9 sec). Latency measures the speed of RAM.

RAM
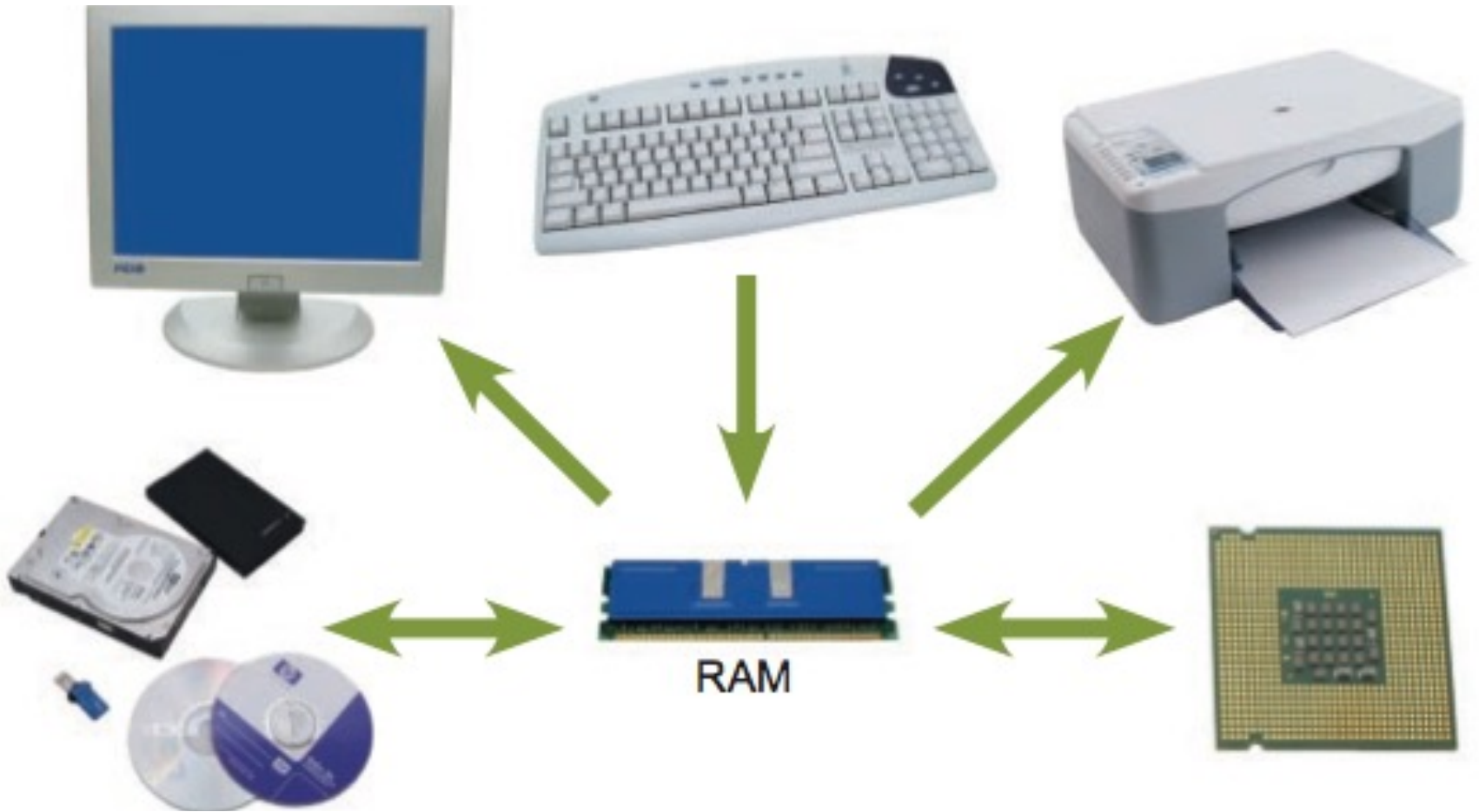
RAM vs Hard Disk

- RAM holds data in circuitry that's directly connected to the system board

- Hard-disk storage places data on magnetic media

- RAM is temporary storage

- Hard-disk storage is more permanent

- RAM usually has less storage capacity than hard-disk storage.

DRAM

- *DRAM* - Dynamic RAM is a common type of RAM.
  - Made of an integrated circuit (IC), composed of millions of transistors and capacitors.
  - Capacitor holds electrons. An empty capacitor represents a zero, and a non-empty capacitor represents a one. Each capacitor can register either a zero or a one for a memory cell, storing one bit of data.
  - The transistor is like a switch that controls whether the capacitor's state (charged or not charged, 1 or 0) is to be read or changed.

DRAM

- However, a capacitor is like a cup that leaks, in order to keep its charge, the memory control needs to be recharged or refreshed periodically. Therefore, it is called the dynamic RAM because its state is not constant.

- Refreshing capacitors also takes time and slows down memory.

SDRAM

- *SDRAM* (Synchronous Dynamic RAM)

  - Used in many personal computers

  - Fast and relatively inexpensive

  - Synchronized to the clock so that data can be sent to the CPU at each tick of the clock, increasing the number of instructions the processor can execute within a given time

DDR SDRAM

- *DDR SDRAM* (Double Data Rate SDRAM)

  – Transfers twice the amount of data per clock cycle compared to SDRAM

  – Capacity is up to 2 GB

RDRAM

- ***RDRAM*** (Rambus Dynamic RAM)

    – Higher bandwidth than SDRAM

    – More expensive compared to SDRAM

    – Enhances the performance of applications that access large amounts of data through memory, i.e. real-time video and video editing

SRAM

- *SRAM* (Static RAM)
  - Uses transistors to store data
  - Because SRAM does not use capacitors, reading data from SRAM does not require recharging the capacitors. Therefore, it is faster than DRAM.
  - Holds fewer bits and costs more compared to DRAM of the same size
  - Used in the cache because it is fast and cache does not require a large memory capacity

RAM Comparisons

Type of RAM	Capacity	Price
SDRAM	@@	$
DDR SDRAM	@@@	$
RDRAM	@@@	$$
SRAM	@	$$$

ROM

- **ROM** (read-only memory) - holds the computer's startup routine.

- ROM is housed in a single integrated circuit—usually a fairly large.

- Plugged into the system board.

- Permanent and non-volatile

- ROM holds "hard-wired" instructions that are a permanent part of the circuitry and remain in place even when the computer power is turned off.

Memory

IDE'S

ROM

Battery

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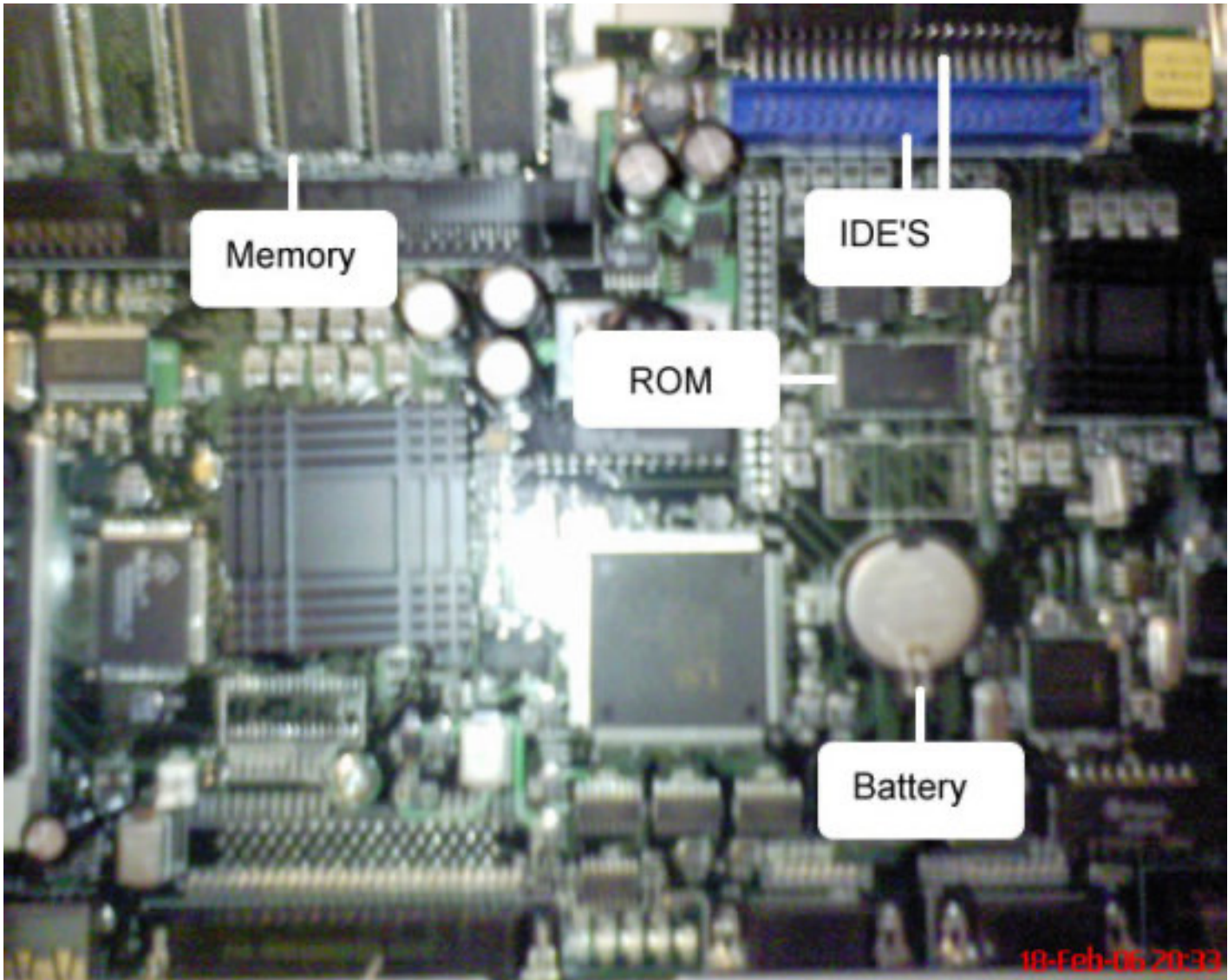
Differences between ROM and RAM

ROM	RAM
Non-volitile - Data is never lost	Volitile - Data is lost if the computer crashes or is turned off.
Data is permenant - it can never be changed	Data is temporary - it is only there as long as the computer is on and it can be changed
Data can only be read	Data can be written to or read from.

EEPROM

- **EEPROM** (electrically erasable programmable read-only memory) is a non-volatile chip that requires no power to hold data.

- EEPROM replaces CMOS technology that required power from a small battery integrated into the system board.

- EEPROM holds computer configuration settings, such as the date and time, hard disk capacity, number of floppy disk drives, and RAM capacity.
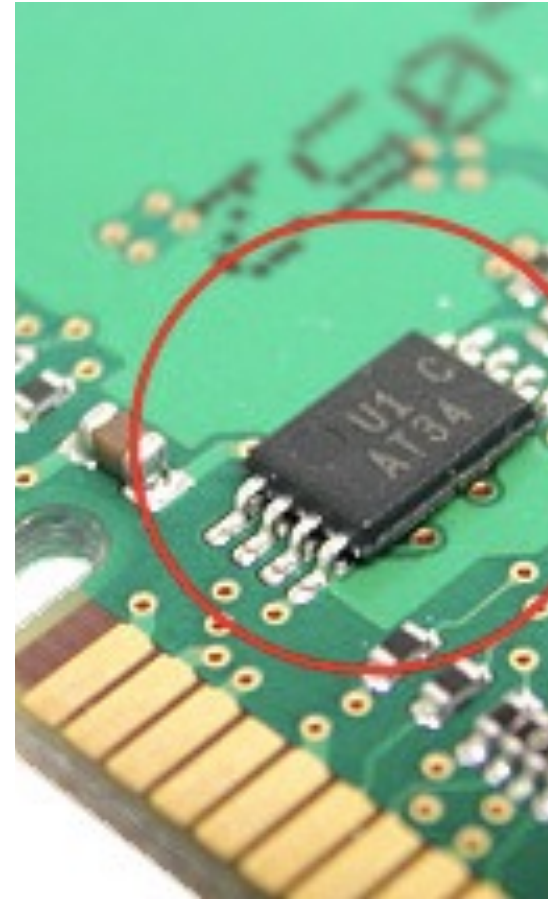
PhoenixBIOS Setup Utility

Main	Advanced	Power	Boot	Exit

		Item Specific Help
System Time:	[10:40:48]	
System Date:	[03/03/2009]	<Tab>, <Shift-Tab>, or
Language:	[English (US)]	<Enter> selects field.
Primary Master	[Maxtor STM 980215AM]	
Primary Slave	[None]	
Secondary Master	[LG CD-RW CED-8080B- (SM)]	
Secondary Slave	[LG DVD-ROM DRD-8120B]	
Installed Memory	1024 MB	
Memory Bank 0	512 MB SDRAM	
Memory Bank 1	512 MB SDRAM	
BIOS Revision	F.28 12/07/08	
CPU Type	AMD Athlon (tm) 64 X2	
CPU Speed	2200 MHz	

F1	Help	↑↓	Select Item	-/+	Change Values	F5	Setup Defaults
Esc	Exit	←→	Select Menu	Enter	Select Submenu	F10	Save and Exit

Peripherals
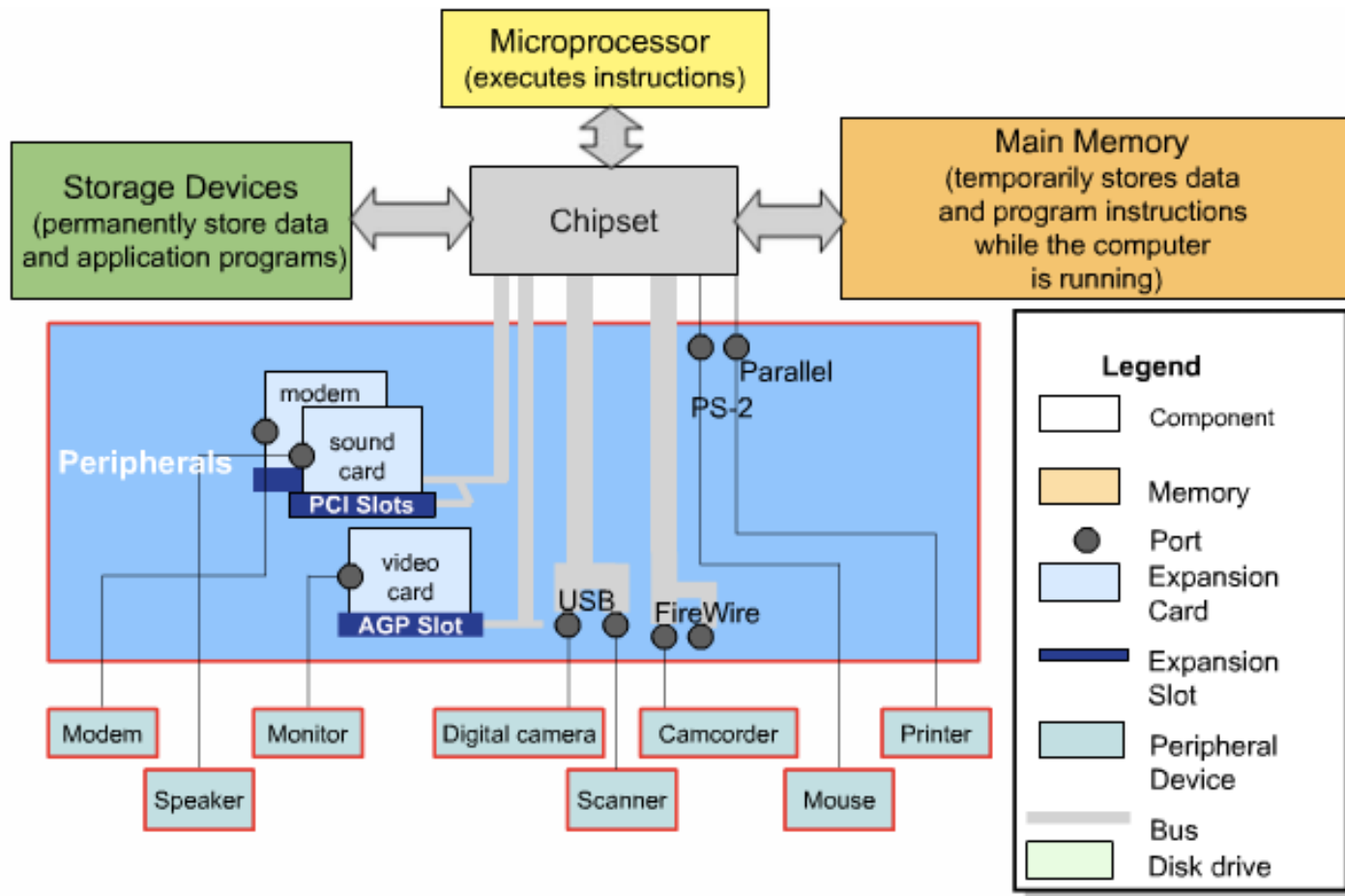
- Within a computer, data travels from one component to another over circuits called a **data bus**.

- One part of the data bus, referred to as the local bus or internal bus, runs between RAM and the microprocessor.

- The segment of the data bus to which peripheral devices connect is called the **expansion bus** or external bus.


Microprocessor — Local bus — RAM — Expansion bus — Expansion slots and expansion cards — Ports — Cable — Printer or other peripherals

Expansion bus — Hard disk drive
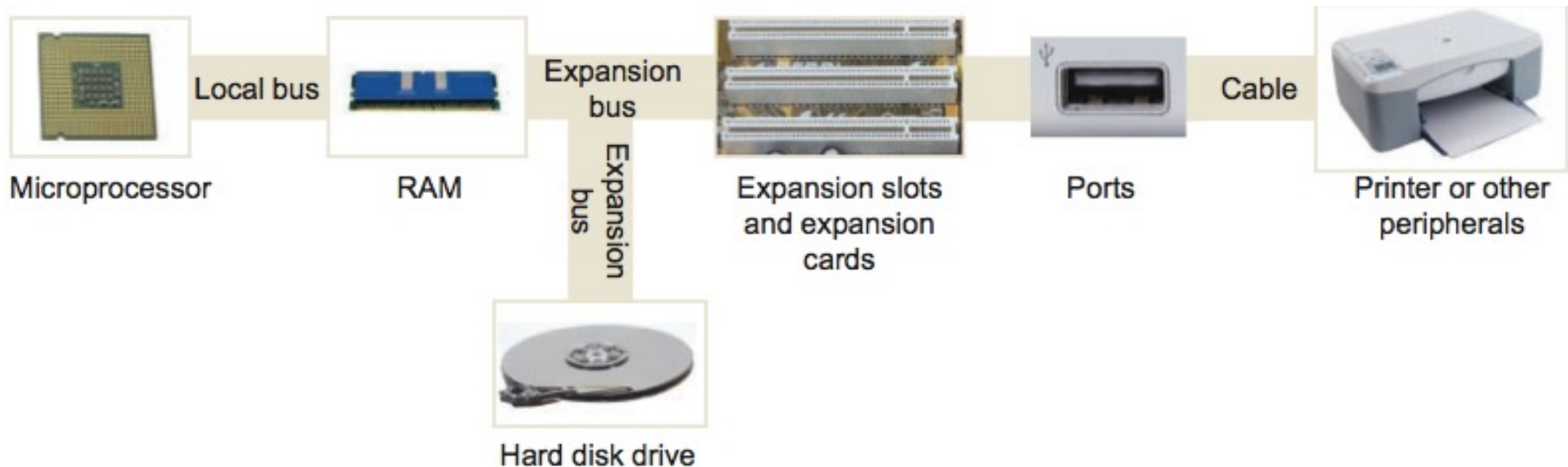
BUS

- Has a *width*, a *speed*, and a *transfer rate*.
  - The **width**, also called the **word size**, of a bus is measured in *bits*.
  - The **speed** of a bus is measured in hertz (Hz), or cycles per second.
  - **Transfer rate** is the measure of how much data may be moved from one device to another in one second.
    - Transfer rate can be increased by transferring data multiple times during a cycle or increasing the number of channels used to transfer data.

Expansion Slot, Card and Port

- An *expansion slot* is a slit-like socket on the motherboard into which a circuit board can be inserted.
- The circuit board is called the *expansion card*.
    - Used to extend the computer's capability
    - Examples: sound card, video card
    - Also provides *port(s)*, which are connector(s) between the expansion card and the peripheral device.

Expansion card

Port
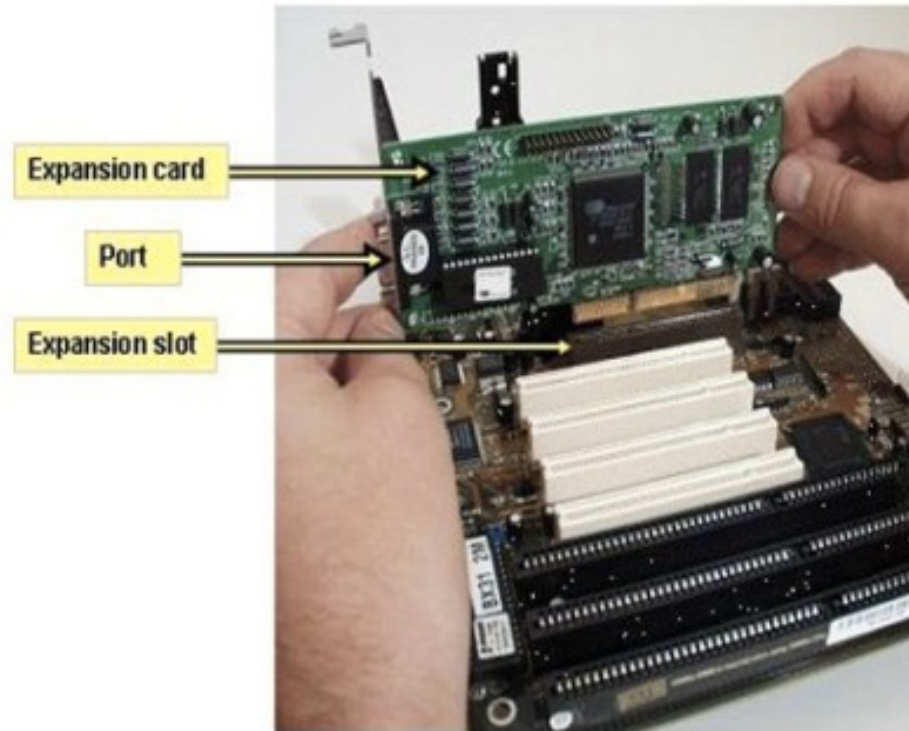
Expansion slot

Expansion Slots

- The two most common types of expansion slots are Peripheral Component Interconnect (PCI) and Accelerated Graphics Port (AGP).
- *PCI* (Peripheral Component Interconnect) slot
  - Can hold a variety of expansion cards such as a sound card or an Ethernet card
- *AGP* (Accelerated Graphics Port) slot
  - Primarily used for graphics cards
- *PCMCIA* (personal computer memory card international association) slot
  - Used for laptops in place of PCI slots
  - Relatively smaller than a PCI slot

Expansion Card

- Small circuit boards that control the peripheral devices
  - Graphics Cards
    - Takes signals from the processor and displays the graphics, images in the monitor
  - Sound Cards
    - Converts analog sound signals to digital and vice versa
  - Modem
   - Transmits data over phone or cable lines

Expansion Card

- Ethernet card
  - Serves as the interface to a Local Area Network (LAN)
  - Transfers data at a rate of 10 Mb/s
  - Newer versions of Ethernet called "Fast Ethernet" and "Gigabit Ethernet" support data rates of 100 Mb/s and 1 Gb/s (1000 Mb/s).

Expansion Port

- An **expansion port** is any connector that passes data in and out of a computer or peripheral device. It is similar to an electrical outlet because you can plug things in to make a connection.
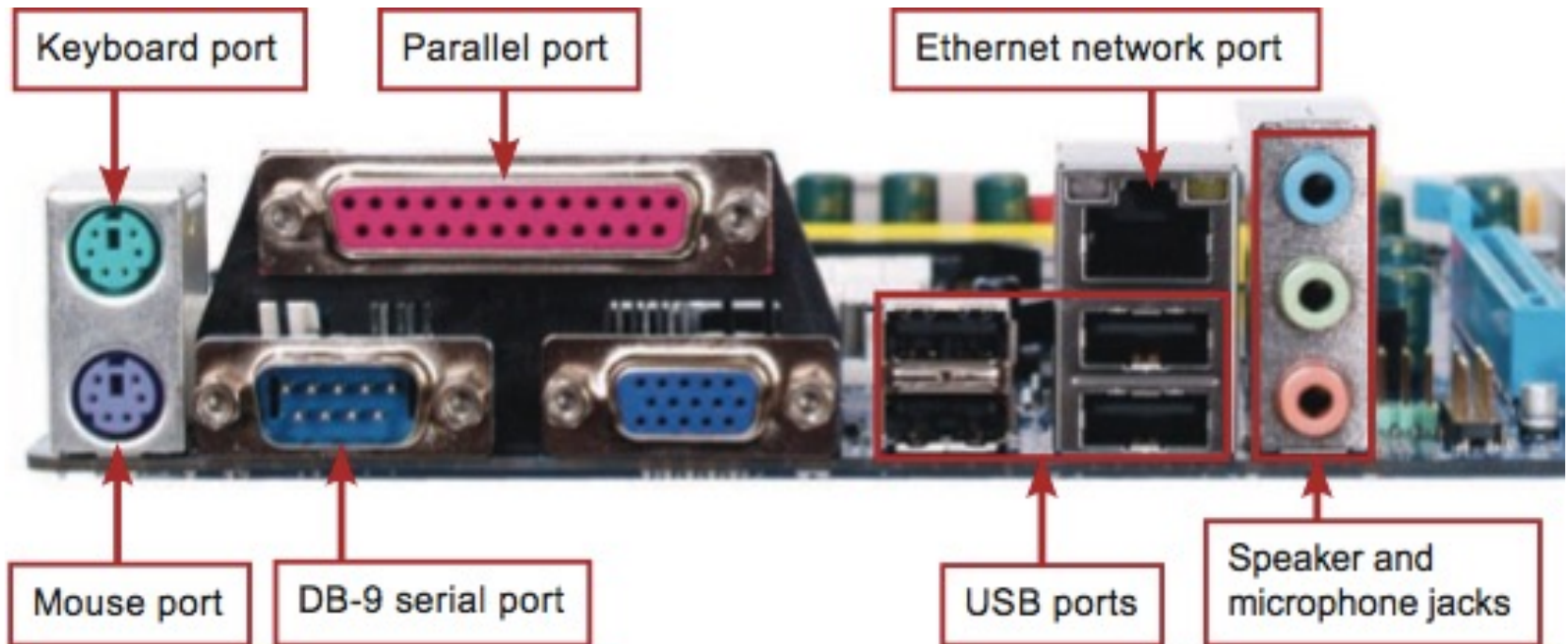
USB Hub

- FireWire lets you send data to and from high-bandwidth digital devices such as digital camcorders, and it's faster than USB.

- VGA, DVI, and HDMI ports are designed for audio visual devices. They are primarily used for connecting a monitor to a desktop computer, and for connecting an external monitor to a notebook computer

HDMI
(High-Definition
Multimedia
Interface)

FireWire
(IEEE 1394)

VGA
(Video Graphics
Array)

DVI
(Digital Visual
Interface)

Input devices

- Keyboard, mouse, touch-sensitive screens, trackballs, pointing sticks, trackpads, and joysticks. scanners, digital cameras, graphics tablets, microphones and electronic instruments.

Pointing stick

Trackpad

Trackball

Joystick

END of Lecture 3