Part III - Hardware...

Electronics devices today are mainly digital in design. There are some parts that are Analog.

Definition: **HARDWARE** – **Physical** components of your computer. Hardware today commonly uses *digitally* coded, stored and processed programs and data.   Pay special attention to the *speed* and *amount of data* each device can store or process.

Definition: **SOFTWARE** – Digitally coded instructions are stored as 1's and 0's on **permanent** storage devices. They **Resides on** and are used by the physical components. Software is also called Apps, Applications, Tools or Programs. When needed, they are copied into **temporary** digital memory (RAM) to be accessible by a digital CPU for execution.

Definition: **DATA** – Data is stored and processes in the 1's and 0's of the binary/digital format. Data, such as text, images and sound, is commonly converted into the binary/digital format when entered/saved onto a device.

Definition: **Information Processing** – Consists of four areas: **Input**, **Process**, **and Output and Storage**. Each area has specific hardware for that function. Data is imputed/coded, processed, stored and outputted.
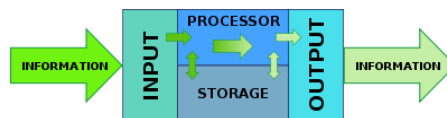
Below we discuss the different types of devices that perform the input, process, storage and output functions.

Definition: **Convergence** – The digital age has made possible the combination of **numerous** distinct devices to be combined into **one** device.   What a converged device can do today: Phone, Text, Email, Internet, Camera, Video Camera, Music, Games, Watching Videos and other Apps.

Watch This Video: **Convergence** - http://www.youtube.com/watch?v=dN1Yvox4aKo
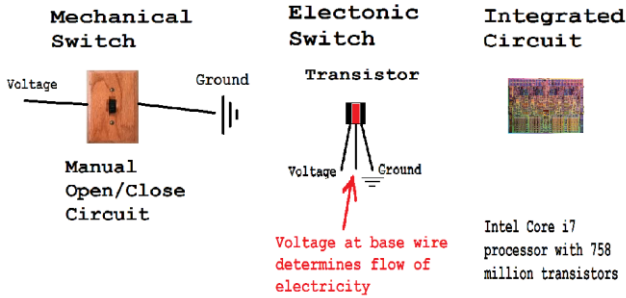
Early Computers: Of interest may be the history of computing devices. The earliest mechanical computers were actually constructed by the Greeks over 2000 years ago. The Western World went into a Dark-Age for over 1000 years. It was not until the 1800's that the achievements of the early Greeks were recreated.

Worlds earliest know computer: The **Antikythera** Computer

      7 minute (video)   https://www.youtube.com/watch?v=6kM59m3UJ-o

      1 hour video (Optional) https://www.youtube.com/watch?v=SeH5ESGl8u8

Switch - On or Off (Binary Device)

Mechanical Switch

Voltage — Ground

Manual Open/Close Circuit

Electonic Switch

Transistor

Voltage — Ground

Voltage at base wire determines flow of electricity

Integrated Circuit

Intel Core i7 processor with 758 million transistors

Today, the **Transistor** is the electronic switch device that has revolutionized the world of electronics. The transistor is a **SWITCH**, that has 2 States, ON or OFF… sound familiar 2 = Binary = Digital. Today, with the miniaturization of the transistor, you can get BILLIONS of transistors in one square inch. Integrated Circuits have made the Computer, the Smart Phone, the Internet, Etc. possible.

Most important invention in last 100 years.

Video: **Transistor** - http://www.youtube.com/watch?v=ZuA14MjKq3M

Modern computers *Moore's Law*: 18 month double computer power, and reduce cost by half. The Free market the ONLY way to Empower the Individual.

Video Watch Me: Moore's Law: http://www.youtube.com/watch?v=OZDlltmDXNc
http://www.youtube.com/watch?v=AWcV-eoJqT8

The Future of Computers: **Quantum Computers**: http://www.youtube.com/watch?v=sICXOwOwS4E

Physical Implementations for computer hardware

All in One Desktop

Now becoming the standard desktop implementation.

Newer models becoming easier to upgrade components.

Desktop Modular Computer

The main Desk top implementation for the last several decades, but it is being challenged by the All in One Desktop configuration. First gained wide acceptance in the 1980's with the IBM PC. The Advantage of modular design is the ability to easily and cheaply upgrade components.

Laptop Portable Computer

Popular portable computer for the last several decades, but being challenged by Pad and Smart Phone computers.   Expensive to upgrade components.

Tablet/Pad Portable Computer

Portable computer. All in one configuration. Unable to upgrade components.

Smart Phone

The small size and the convergence of numerous devices in to the smart phone, has lead to the rapid increase for anything smart phone. With Smart Phones, you are unable to upgrade components.

Hardware

Video Watch Me – Computer Architecture http://www.youtube.com/watch?v=HEjPop-aK_w

Check out: Custom Devices - http://www.datamancer.com/

Peripherals are any device that connects to and works with a computer. The Device can be connected externally or internally. They can be divided into 3 categories: Input, Storage and Output.

Another term for just 'Input' and 'Output' Devices is '**Human Interface Devices'** (HID) that use the Universal Serial Bus (**USB**) to send and receive data.

An important characteristic of hardware is *amount* of data it can store, transmit or process. It will be good to learn about the **_Unit of measure_** for data.

Definition: **BYTE** - A sequence of eight (8) bits. It is the unit of measurement for data. It is used to measure the amount of data stored or moved.   Programmer Alert: *Understanding the BYTE will be needed when you 'declare variables' or 'reserve RAM' as you write computer programs later in the class*.

Video Watch Me: What is a BYTE - http://www.youtube.com/watch?v=DWs2MUp8KbU

The number of bytes is commonly abbreviated using the following metric system terms.

|				
Tera (T)	- 1 trillion	example:	2TB HDD
Giga (G)	- 1 billion	example:	4GB RAM
Mega (M)	- 1 million	example:	100MB Data Transfer Speed
Kilo (K)	- 1 thousand	example:	Seldom used today.

INPUT Devices
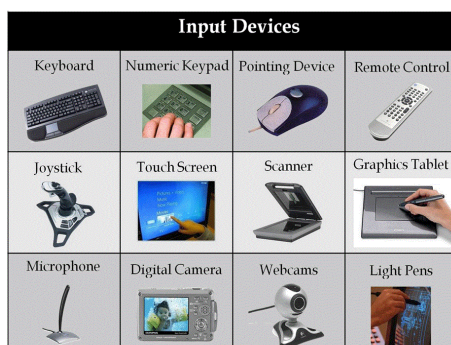
The heart of the Computer is the Processing/Manipulation of data. But the data must be *first **Inputted*** to the computer, so something can be processed.

There many different input devices. We will take a quick look at the Keyboard and the Mouse.

Each input device sends data to the computer.

The keyboard still remains the most commonly used and versatile input device for the desktop and laptop computers.
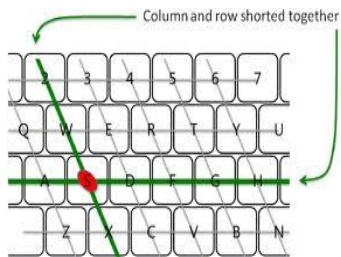

How does the keyboard work:

When a key is pressed, it activates a switch that causes a specific circuit to close and electricity to flow along that route. The route is a specific path in an electrical X-Y matrix where a voltage is provided sequentially to the Y lines and, when a key is depressed, detected sequentially by scanning the X lines. This produces and Keycode, also called a scancode. Key codes are number assigned to each individual physical key on the keyboard.
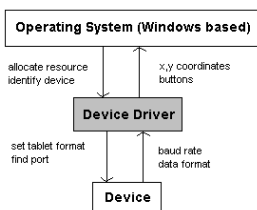
The Keyboard Controller receives the key-codes and passes the data to the computer via cables or wireless connectivity. In the main system, the USB Keyboard Device Driver processes it. The USB Keyboard driver is part of the Operating System Device Driver software. A device driver handles the communication between the Hardware – OS – and Apps. Today, all Operating Systems come with abundant drivers.
(More about the Operating System in the next module)

MOUSE

The mouse is the second most common input device to a Computer. Moving the mouse translates into encoding data packs that capturing motion in an X and Y directional components in a 2 dimensional plane. This accuracy of this motion can be measured well with an Optical mouse, but a new Laser Mouse can give smaller intervals of movement, thus greater accuracy and control. This movement data is encoded into *data* packet and sent to the computer, and is translated into movement on the GUI Screen. Additionally, there are two mechanical buttons on the mouse, that when clicked, that also send left or right button click encoded data packets to the computer. The data packets are received by the Mouse driver in the computer, which translates the data for use by the Operating System(OS). The OS may send data to an Application.

 There are many other input devices. Each generates data that are sent to the computer. The device driver, for that type of device, translates the data so that the Operating System can understand instructions and process the data and pass it on to the Applications.

There are many other input devices, each having their own device driver.
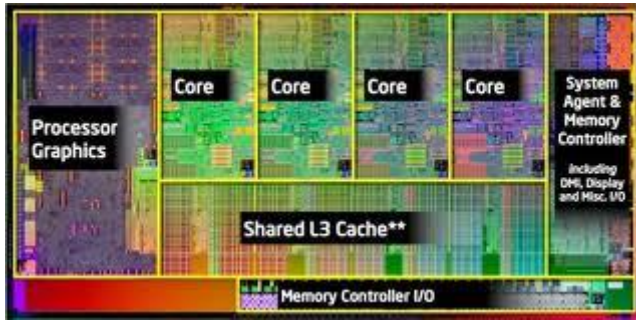
Central Processing Unit (CPU) -   The processing unit receives instructions and data, from the RAM.

Each CPU type has a distinct Physical architecture.
http://en.wikipedia.org/wiki/Comparison_of_CPU_architectures

Video Watch me: Download & Install CPU ID Software:
http://www.youtube.com/watch?v=W9Pq32f2rsQ

Four(4) Common Elements of all CPU architectures are:

- The **number of bits** that can move in parallel. (See Data Bus and Address Bus) Today there are 32 & 64 bit CPUs.
- The **speed the bits** of data can move in the CPU and be processed.
- **Cache** – amount of memory built into CPU. Receives data from RAM, so data is more quickly available, thus being closer to the CPU, it speeds up processing. Also called L1 cache.
- **Core** – Single core or multi core – The number of CPU on one chip. Can Speed up processing if more than one core is utilized.   You can assign a program/process to run on a specific core.

The Number of Bits and their Speed in a CPU.

Let's compare a **CPU** to a **Freeway**. Let the number of **bits** be like the number of lanes on a freeway. Let the speed limit on the freeway be like the speed of the bits moving in the CPU.

If the road was only ONE (1) lane and the speed limit was 5 mph, than the number of cars moving along that road would be rather low. If the road was 6 lanes and the speed limit was 100 mph, than the number of cars moving along that road would be very high.

In comparison, if the number of bits in the CPU were small, and the speed were slow, than the amount of data processed by the CPU would be low. And, if the number of bits in the CPU was larger, and the speed limit was fast, than the amount of data processed by the CPU would be very high. In comparison,

Today, new computers are sold with a 64 bit CPU and speeds over 2GHz. This is like a very wide road with a tremendous speed. Compare this with early CPU's of 8 bits and 10MHz. Today's CPU's are well over 1000 times faster the early CPU designs.

Multi Core Architecture

The two or more CPU's on *one* silicon chip are intended to speed up your computer.

Graphical Processing Unit (Same as CPU but dedicated to processing and sending data to your monitor)

Some CPUs' are now designed to have the GPU built on to the CPU chip. This speeds up processing and reduces cost.

Remember a CPU is an Integrated Circuit containing hundreds of millions or more recently over a billion transistors switches. These switches need to be turned on and off. There are different patterns of switches that do different things.

In the next module, on Operating systems and Programming, we will discuss the different levels of programming languages:

Programmer Alert: *When you write programs, you will be creating code that will instruct the CPU to perform many of it's various operations:* Fetch, Jump, perform arithmetic operations and more.
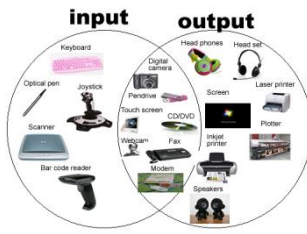
There are many output devices.
Each has its own device driver.

MONITOR – Display information in a visual format received from a computer Graphic Card(or GPU).

Two (2) important Characteristics of a monitor

1) **Screen Size -** It is measured in the diagonal.

Today, it common to buy computer monitors over 19''.

Increased screen space make using the Computer easier.

Pixel.   The smallest unit of color on a screen**.** The Image on monitor is composed of a 2 by 2 matrix of pixels. The pixel is also called a dot. The number of dots across and the number of row of dots down is called the Resolution.
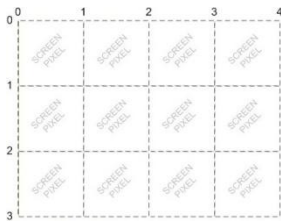
Common Screen Resolutions are:

1920 x 1200,   1680 x 1050,   1280 x 800   (Row x Column)

Programmers should understand the each pixel on the screen has an address.

The Row at the top is 0, and you add 1 to for the next row below and so on down to the last row.

The Column at the top left starts at 0, and you add one for the column right and so on to the last column.

Look close at your computer monitor. Get a magnifying class, if you need to. Can you see the individual pixels ?

2) Resolution - Image Clarity.   The higher the number dots, the higher the clarity of the image.

 The resolution of monitors can be adjusted. When you turn you computer on, you can find the option to change your monitor's resolution.

What is my screen Resolution: http://www.whatismyscreenresolution.com/

Programmers in the know:

When you are doing graphics programming, or programming involving certain areas on the screen, knowing how to address/locate a point or a region on the screen is useful.

When you move the mouse, the mouse position is specified by which pixel it is positioned on.

An object, like an icon, or a button on a web page is specified by it pixel position on the screen.

Each storage device has a Device Driver.
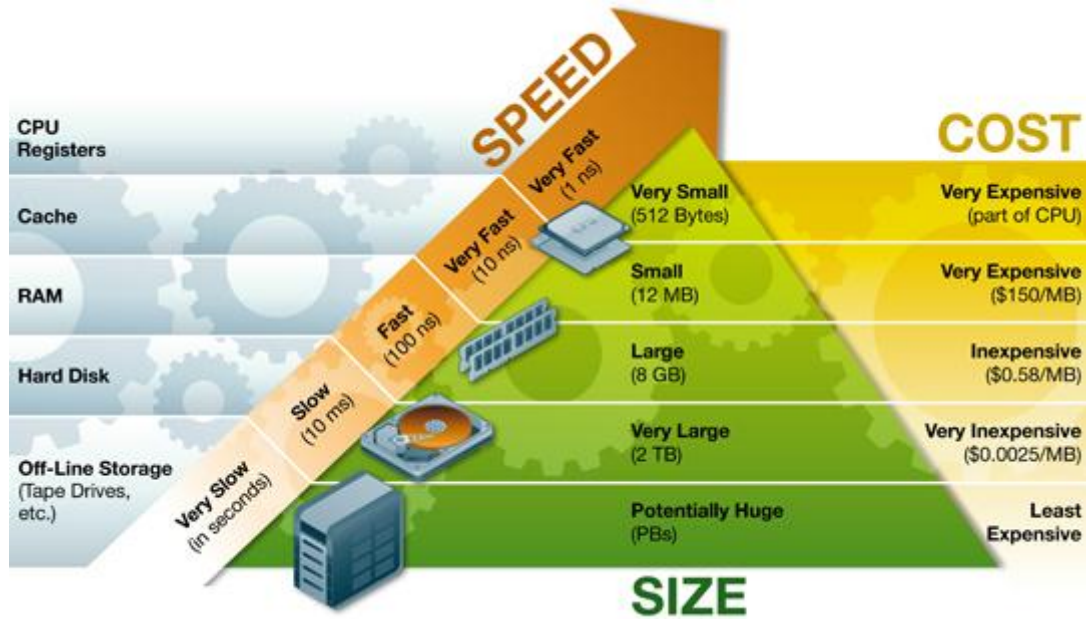
PERMANENT Storage – This means that when the power is turned off, the **data will not be erased**.

Also called non-**Non-volatile.**

Hard Disk Drive (HDD). Literally, metal or ceramic 'iron oxide' coated disks that spin. 'Iron Oxide' can be magnetized. You can magnetize two (2) states on the surface of the disk; hence you can encode binary represented data.

Watch me: HDD http://www.youtube.com/watch?v=Mz6kJyz4UV0
Watch me: HDD http://www.youtube.com/watch?v=a98oOqCUm0s

The key characteristics of HDD are the **Amount of data** you can store on the disk and the **speed** you read and write the data. Today HDD drive store 1 **Terabyte** of data or more.

Watch me: **PC** - How much can my disk store - http://www.youtube.com/watch?v=76wqsuIBXmk
Watch me: **MAC**- How much can my disk store - http://www.youtube.com/watch?v=KhJ4Inxivf8

Data can be fragmented, spread out on the disk causing a significant decrease in reading speed. The Windows Operating system provides a program called Disk DeFragmenter to reposition data on a disk, so it is next to each other. It is highly recommended run this program periodically.

Watch me: Defragment your disk - http://www.youtube.com/watch?v=8tyZalXkMXU

Solid State Drives (SSD). There are no moving parts for the new SSD drives. They are very similar to Flash Drives. The main difference is that the storage capacity of a SSD drive is much larger then a Flash Drive. Also, the speed of a SSD driver is considerably **faster** than the speed of a HDD, since there are no moving parts. The storage capacity of a typical SSD drive is considerably less than a HDD, and much more expensive.

Watch me: SSD - http://www.youtube.com/watch?v=viac3j6MeII

Flash Drive. The flash drive is like a small capacity SSD drive. They are also called Jump Drives or Thumb Drives. The speed of reading and writing date is quite fast, since there are no moving parts. They are entirely digital circuitry - solid state. Another advantage of Flash drives is that they are portable.

Software to inspect you Permanent Storage Devices:

Check out their Manufacture, Model number, Max capacity and current 'Temperature'…

PC: DiskCheckUp Download PC: http://www.pcworld.com/article/232679/diskcheckup.html

Video Watch Me: http://www.youtube.com/watch?v=7-6ynzBRsaI

MAC: Video Watch Me: http://www.youtube.com/watch?v=90EiWbfWu5E

TEMPORARY Storage – This means that when the power is turned off, **the data will disappear**. It is not Recoverable.

Main MEMORY is different from the MEMORY (L1 cache) on the CPU…

Random Access Memory (RAM). RAM is temporary memory that is essential to the proper functioning of your computer. The key thing about RAM is the *Amount of data* each module can store.

Programmer Heads up: *When you start programming, you will be writing code requesting the allocation/usage of memory. Also, you will be assigning values to each storage location.*

Video Watch me: RAM Explained http://www.youtube.com/watch?v=Ye6W6mMSPl0

Video Watch me: RAM HISTORY http://www.youtube.com/watch?v=rK-Tg_RJ69s&list=TLeEtS591tCz4

There is a relationship between the CPU running on your computer and how much RAM that can be used on your PC.

Remember CPU and RAM are binary or base 2 hardware designs… Each byte of RAM has an address. The maximum number of addresses your CPU can access is determined by the number of number of bytes in the CPU.

SO, If you have a **32 bit** CPU, then the maximum RAM is 2^{32} = 4,294,967,296 bytes of RAM

AND, If you have a **64 bit** CPU, then the maximum RAM is 2^{64} = 18,446,744,073,709,551,616 bytes of RAM

PC: RAM Map Software download: http://technet.microsoft.com/en-us/sysinternals/ff700229.aspx

MAC: Activity Monitor http://support.apple.com/kb/HT1342

Video Watch Me: **MAX memory Limits** http://www.youtube.com/watch?v=PFNyyGMZYS0&list=PL8B6962AEF2843CA1

Assignment:

Two Separate Parts.

- o "My *Current Computer* Detailed specifications" - Complete given file found online.

    - Look up model number information online
    - Look in Owner's manual
    - Use the Utilities that are part of your OS
    - Download and install the utilities mentioned above

- o "My *Dream Computer* Detailed specifications" - Complete given file found online.

Complete the specification for your current System and Dream systems.

Required: Use the provided word documents for both.

Save and turn in to appropriate week online.