

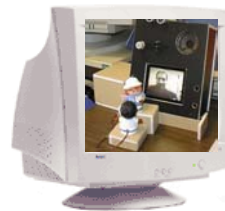
Introduction To Computers: Hardware

In this section of notes you will learn about the basic parts of a computer and how they work.

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What Is Hardware?

- A computer is made up of hardware.
- Hardware consists of the physical components of a computer system e.g., a monitor, keyboard, mouse and the computer itself.



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Basic Units Of Measurement

Bit  on OR  off

- Binary digit
- Smallest unit of measurement
- Two possible values

Byte 

- 8 bits

Word

- The number of adjacent bits that can be stored and manipulated as a unit
- 32, 64 for home computers, 128 for faster machines or specialized systems

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Large Units Of Measurement (Memory, Storage)

- Note: powers of two are used because computer memory and storage are based on the basic unit (bit).
- Kilobyte (KB) – a thousand bytes ($1,024 = 2^{10}$)
- Megabyte (MB) - a million ($1,048,576 = 2^{20}$)
- Gigabyte (GB) – a billion ($1,073,741,824 = 2^{30}$)
 - ~ A complete set of encyclopedias requires about 600 MB of storage
- Terabyte (TB) – a trillion ($1,099,511,627,776 = 2^{40}$)
 - ~ 20 million four-drawer filing cabinets full of text
 - ~ 200 DVD's of information

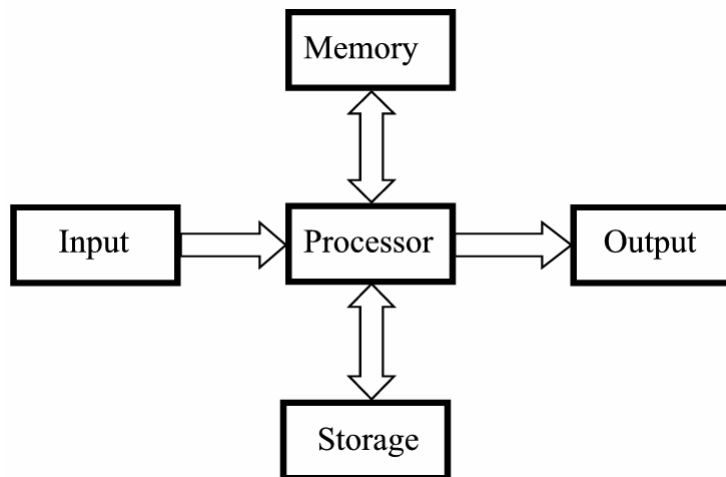
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Small Units Of Measurement (Processor And Memory Speed)

- Millisecond (ms) – a thousandth of a second ($1/1,000 = 10^{-3}$)
- Microsecond (μ s) - a millionth of a second ($1/1,000,000 = 10^{-6}$)
- Nanosecond (ns) – a billionth of a second ($1/1,000,000,000 = 10^{-9}$)

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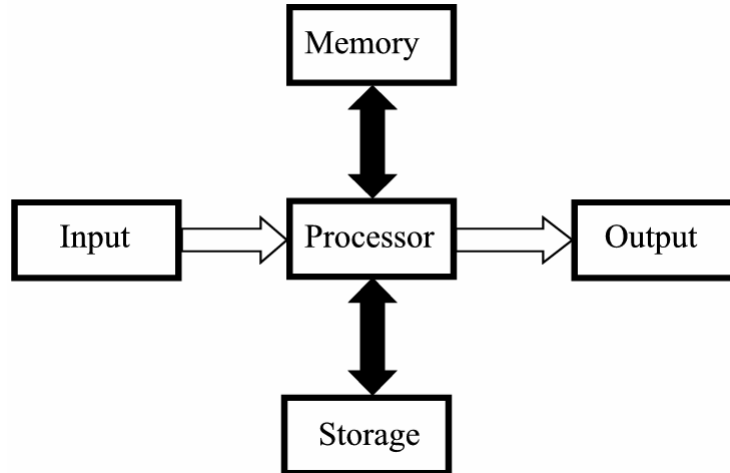
High Level View Of A Computer



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Buses

- Connect the different parts of the computer together



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Buses (2)

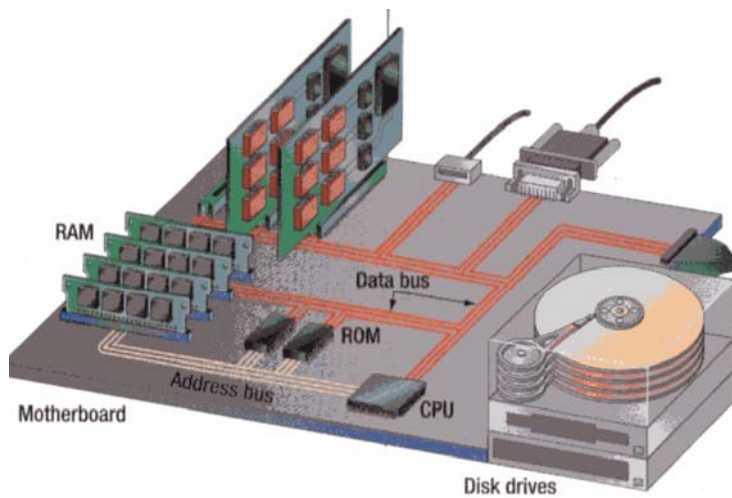
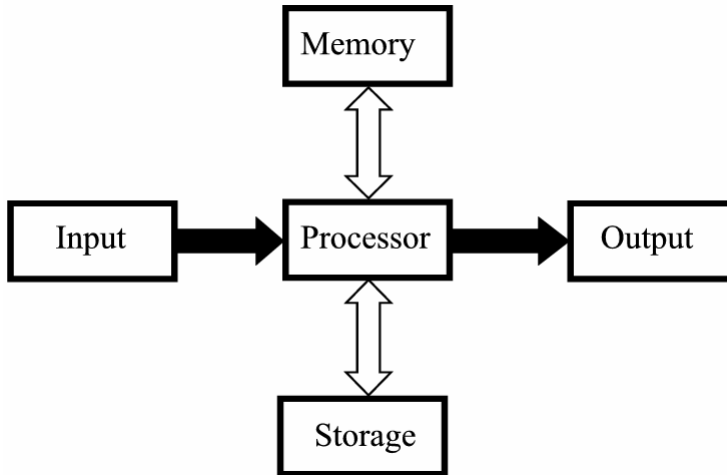


Image from Peter Norton's Computing Fundamentals (3rd Edition) by Norton P.

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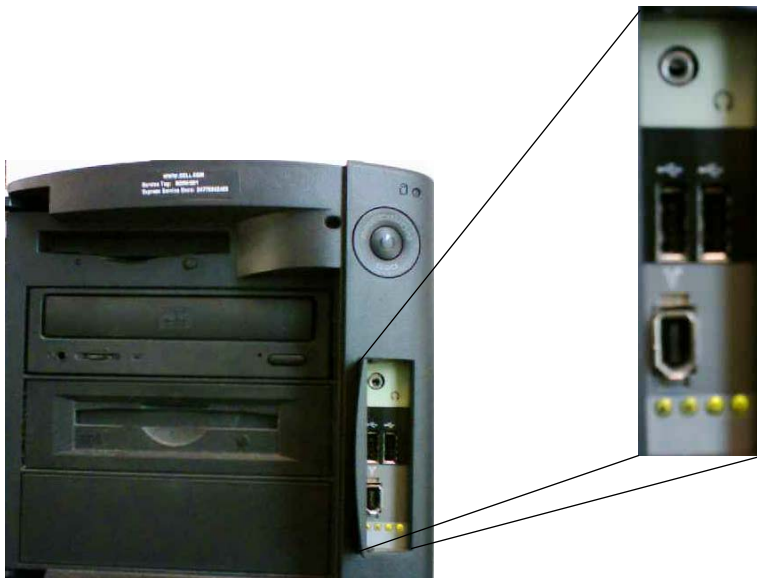
Ports

- Connects the computer to the outside

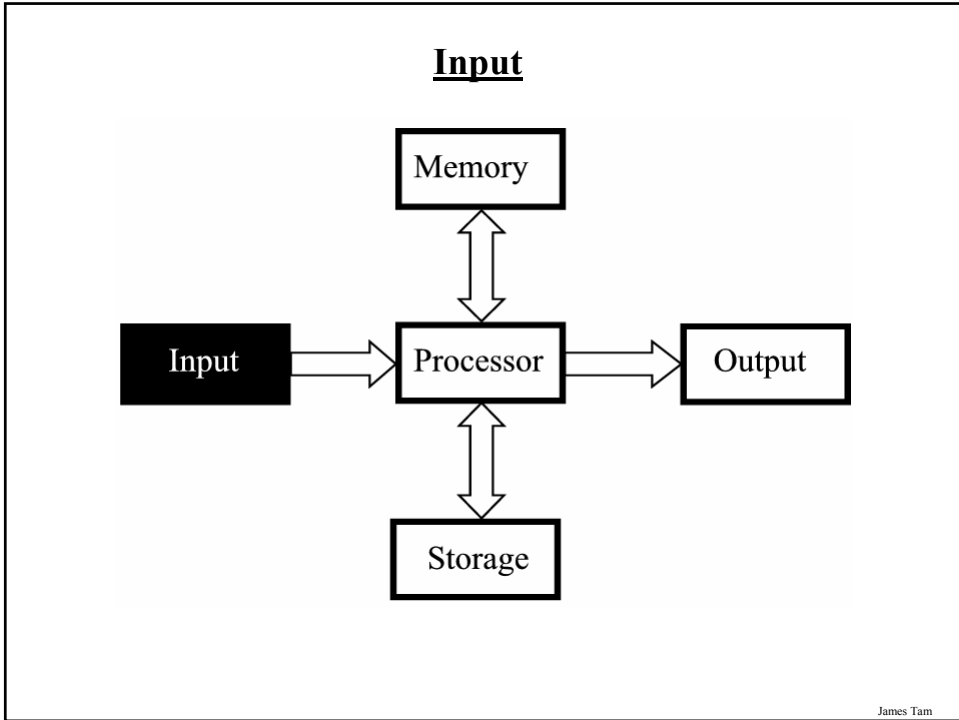


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Ports



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Input Devices

- Used by a person to communicate to a computer.

Person to computer

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Example Input Devices

- Keyboard



- Mouse



- Need not be mundane!



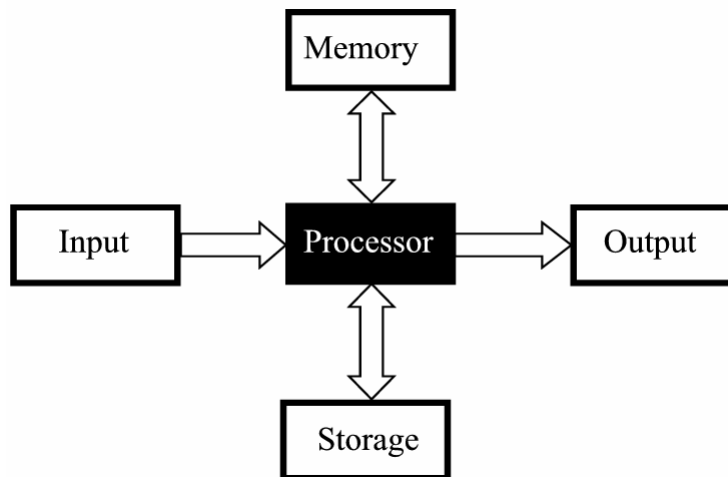
From <http://www.jouse.com/>



Parker, J.R., Baumbach, M., *Visual Hand Pose Identification for Intelligent User Interfaces*. Vision Interface 2003, Halifax, Nova Scotia, Canada Jun 11-13, 2003

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Processor



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Processor

- The brains of a computer



Image from:
www.howstuffworks.com

- A common desktop processor



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Processor Speed

- Determined by:
 - Type of processor e.g., Intel: Celeron, Pentium, AMD: Athlon, Opteron
 - Clock speed
 - 1 Hz = 1 pulse is sent out each second (1 second passes between each pulse)
 - 10 Hz = 10 pulses are sent out each second (0.1 seconds passes between each pulse)
 - :
 - 25 MHz = 25 million pulses sent out each second (0.000 000 04 seconds between each pulse or 40 ns between pulses)
 - 3.8 Ghz = 3.8 billion pulses sent out each second (0.26 ns between pulses)

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The Processor And The Computer

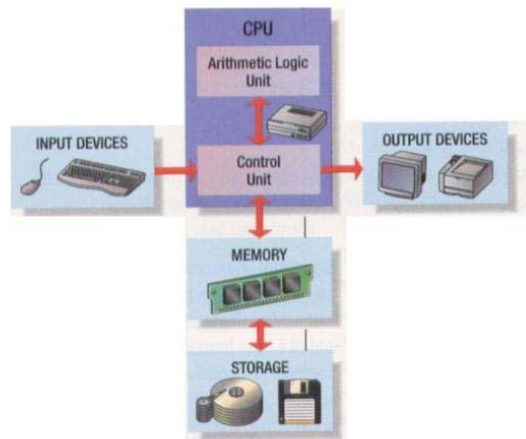
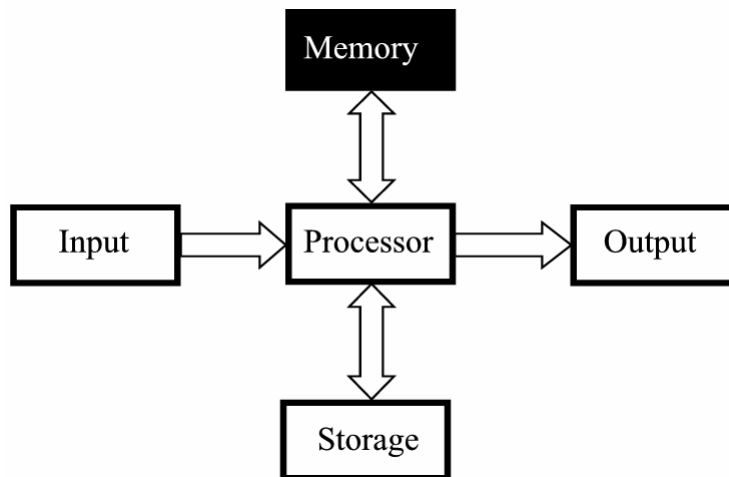


Image from Peter Norton's Computing Fundamentals (3rd Edition) by Norton P.

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Memory



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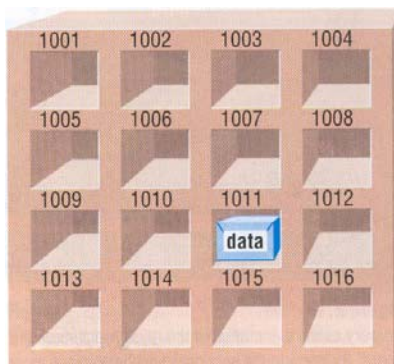
RAM

- Random Access Memory
- Volatile
- Used for temporary storage
- Typical ranges 256 MB - 4 GB

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RAM (2)

- Random access means direct access to any part of memory
- A common form of RAM is DRAM (Dynamic RAM)



Picture from Computers in your future by Pfaffenberger B

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How Does DRAM Work?

- Acts like a leaky bucket



Image from www.howstuffworks.com

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How Does DRAM Work?

- Acts like a leaky bucket

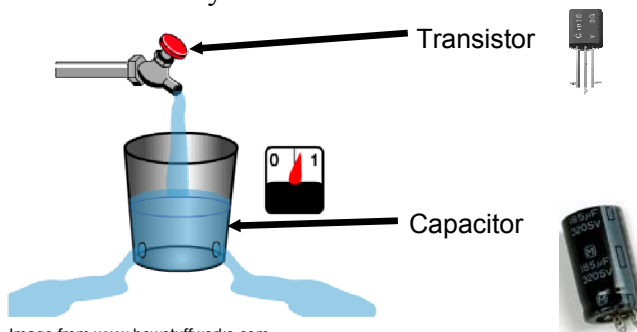
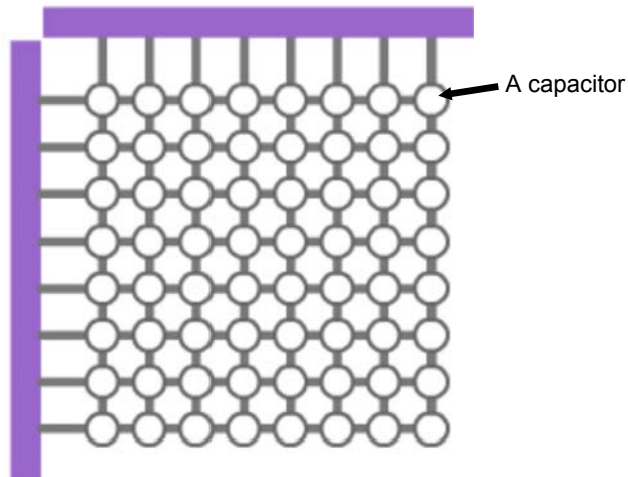


Image from www.howstuffworks.com

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DRAM: A Collection Of Capacitors



Conceptual view of DRAM



Actual DRAM

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The Word Size Of The Computer Determines The Maximum Amount of RAM

•Recall

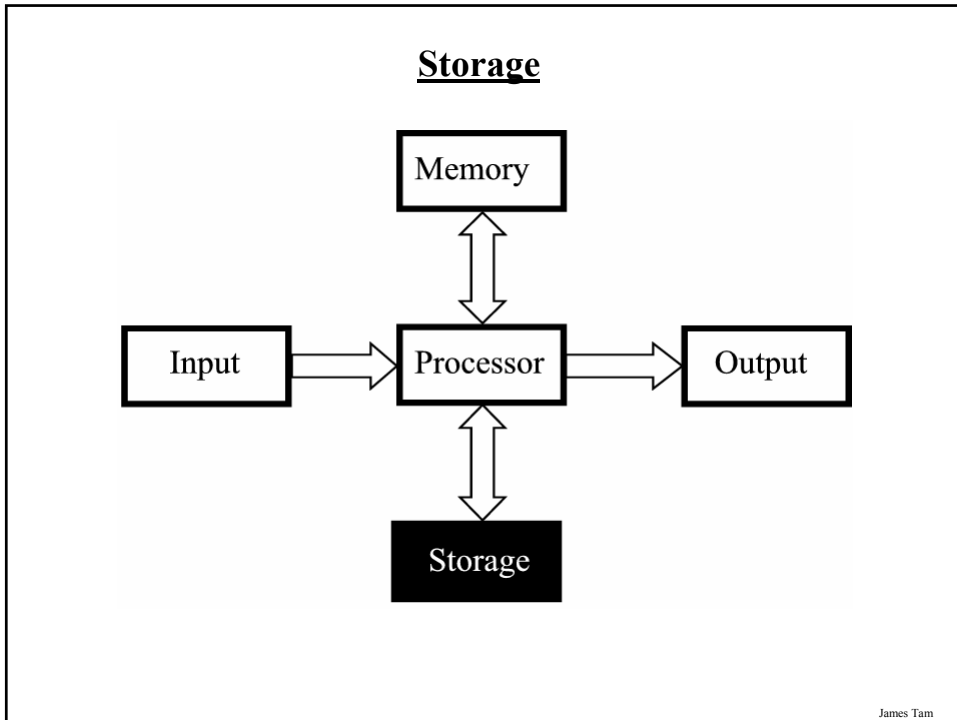
- 2^{30} ~ 1 billion

- 2^{31} ~ 2 billion

- 2^{32} ~ 4 billion

- This means that with a 32 bit computer the maximum amount of memory allowable is 4 billion (4 GB).

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Storage Vs. Memory

Memory (e.g., RAM)

- Keep the information for a shorter period of time (usually volatile)
- Faster
- More expensive

Storage (e.g., Hard disk)

- The information is retained longer (non-volatile)
- Slower
- Cheaper

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Categories Of Storage

1. Magnetic
 - Floppy disks
 - Zip disks
 - Hard drives
2. Optical
 - CD-ROM
 - DVD
3. Solid state storage devices
 - USB Key (a very common form of solid state storage)

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1. Magnetic Drives



Pictures from www.howstuffworks.com

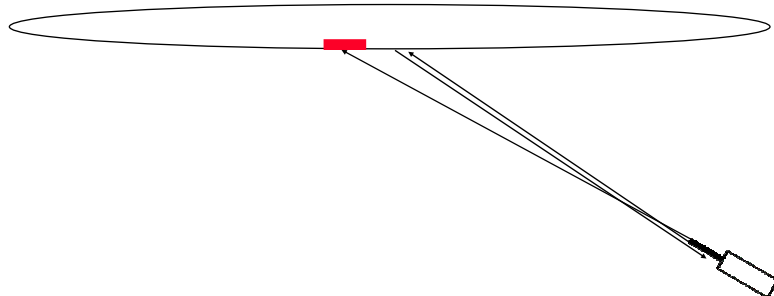
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1. Magnetic Drives: Storage Capacities

- Floppy disks
 - ~ 1 MB
- Zip disks
 - 100, 250, 750 MB
- Hard drives
 - ~80 – 400 GB

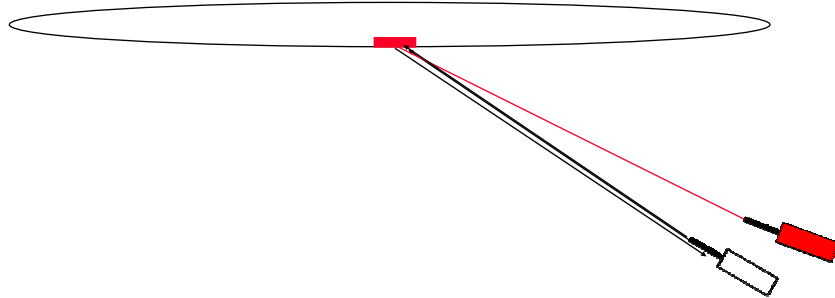
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2. Optical Drives: Reading Information



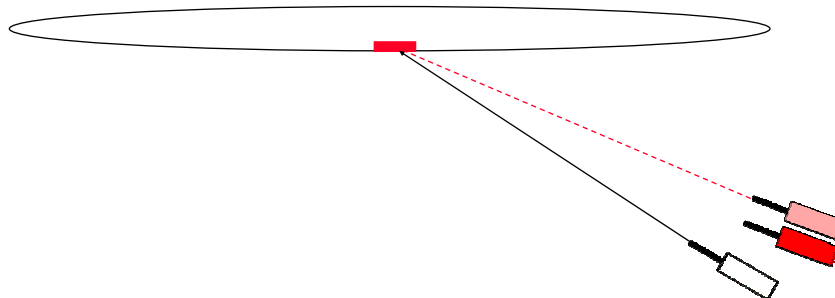
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2. Optical Drives: Recording and Reading Information



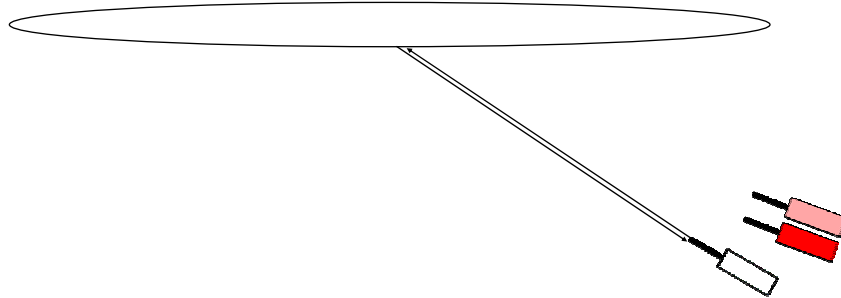
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2. Optical Drives: Re-Writing



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2. Optical Drives: Re-Writing



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2. Optical Drives

- CD's
 - ~ 700 MB storage
 - CD-ROM (read only)
 - CD-R: (record) to a CD
 - CD-RW: can write and erase CD to reuse it (re-writable)
- DVD-ROM
 - Over 4 GB storage (varies with format)
 - DVD- ROM (read only)
 - Many recordable formats (e.g., DVD-R, DVD-RW; DVD+R, DVD+RW)

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3. Solid State Storage Devices

- Portable but can store a large amount of information (64 MB – 4 GB)



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3. Solid State Storage Devices

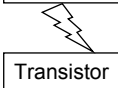
- Require no moving parts but instead uses transistors



- Use a pair of transistors to store each bit of information

**Connected:
stores '1'**

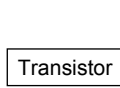
Transistor



Transistor

**Disconnected:
stores '0'**

Transistor

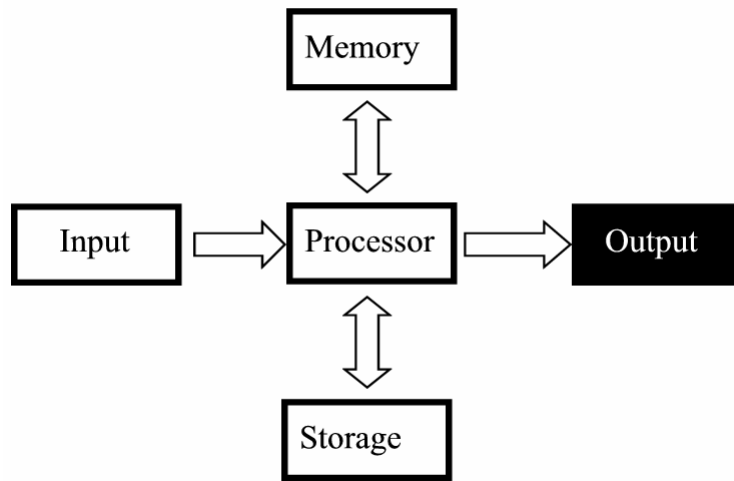


Transistor

- An electrical current can be used to connect and disconnect the transistors
- The pair transistors will remain in their current state (connected or disconnected) until an electrical charge is applied.

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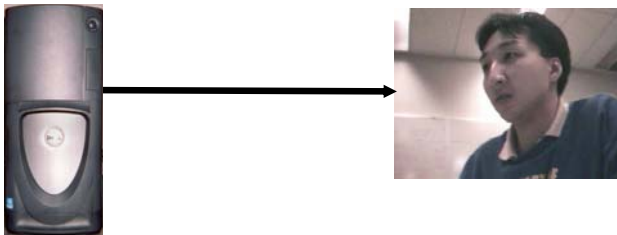
Output



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Output Devices

- Displays information from the computer to a person.



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The Most Common Output Device: The Monitor

- Common monitor technologies:
 1. CRT (Cathode Ray Tube)



2. LCD (Liquid Crystal Display)



3. Plasma displays



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How Images Are Drawn On Monitors

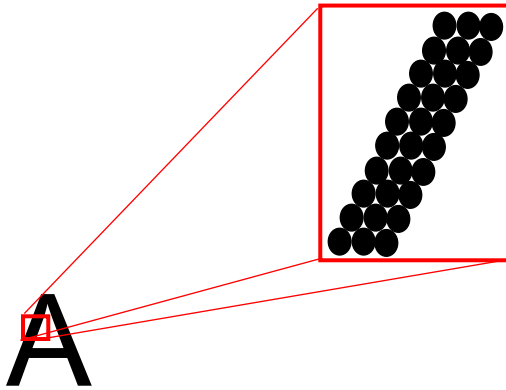
- Images and text are drawn with tiny dots (Pixels: *Picture elements*)

A

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How Images Are Drawn On Monitors

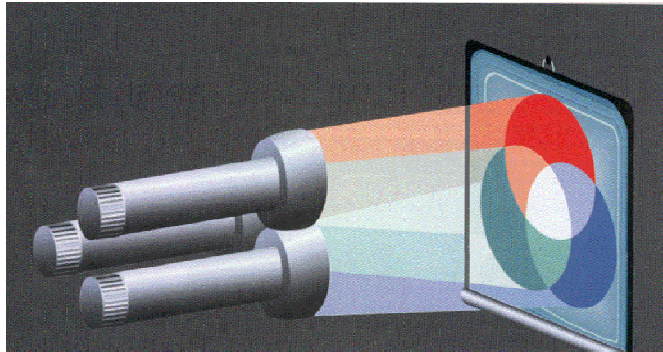
- Images and text are drawn with tiny dots (Pixels: *P*icture *e*lements)



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1. CRT Monitors

- The pixels are drawn with light 'guns'

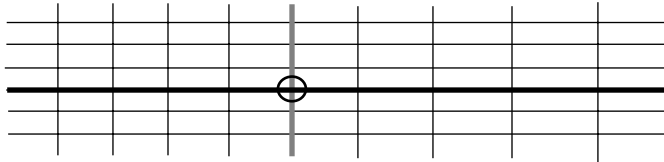


Picture from Computer Confluence by Beekman G.

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2. LCD Monitors

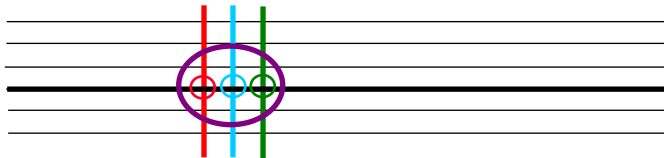
- Employ a conductive grid for each row and column
- The meeting of a row and column allows light to be emitted (a pixel can be seen)



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2. Colour LCD Monitors

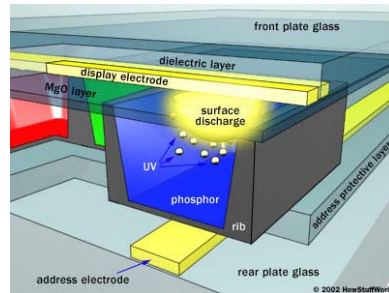
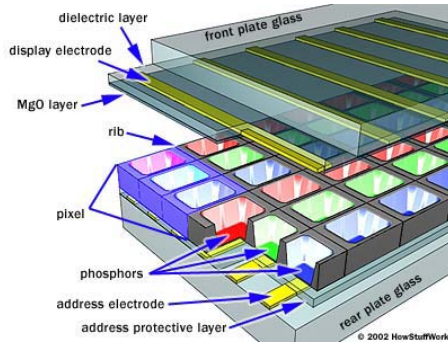
- Use three sub pixels:
 - One wire for each row
 - One wire for each sub-pixel
 - One colour filter for each colour (red, blue, green)



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3. Plasma Monitors

- Sub-pixels are “drawn” by passing an electrical current through a gas.
- Again each pixel is formed by three sub-pixels



Images from www.howstuffworks.com

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All The Basic Parts Together

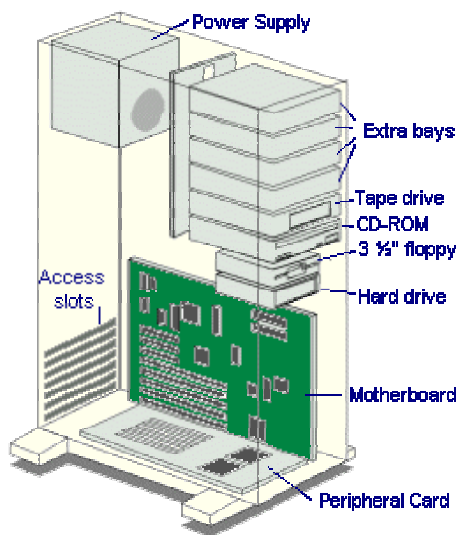


Diagram from <http://www.jegsworks.com>

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The Motherboard

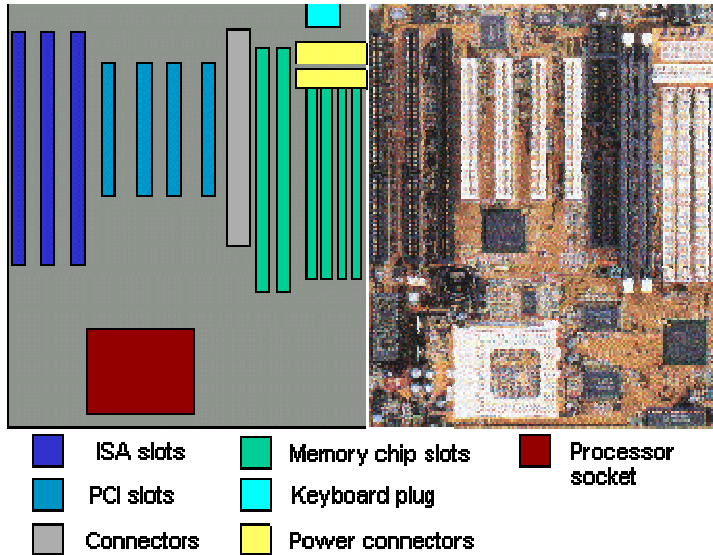
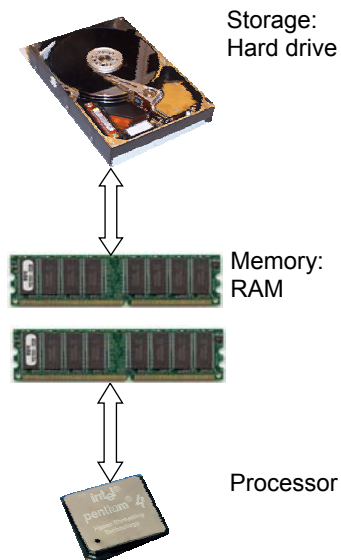


Diagram from <http://www.jegsworks.com>

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Relating The Speed Of The Computer To Its Components



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You Should Now Know

- What are common units of measurement
- What are the basic parts of the high level view of a computer
- Example input devices
- The role of the processor in a computer
- What determines processor speed
- What are the characteristics of RAM
- How does DRAM work
- The difference between storage and memory
- What are the different categories of storage devices as well as common examples of each
- How do different storage devices work
- The approximate storage capacity of memory and different storage devices
- How do computer monitors work
- How the different hardware components affects the speed of the system