Introduction To Computers: Hardware

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

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.

Basic Units Of Measurement

Bit 

- *Bi*nary digi*t*
- 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 the most powerful

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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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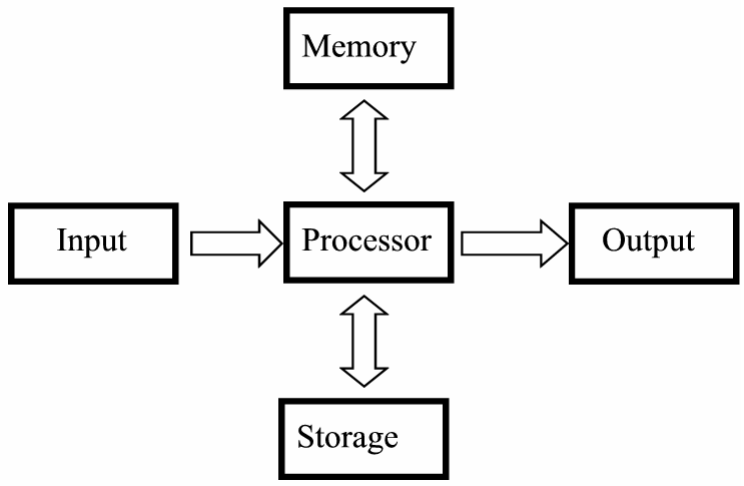
Small Units Of Measurement (Processor And Memory Speed)

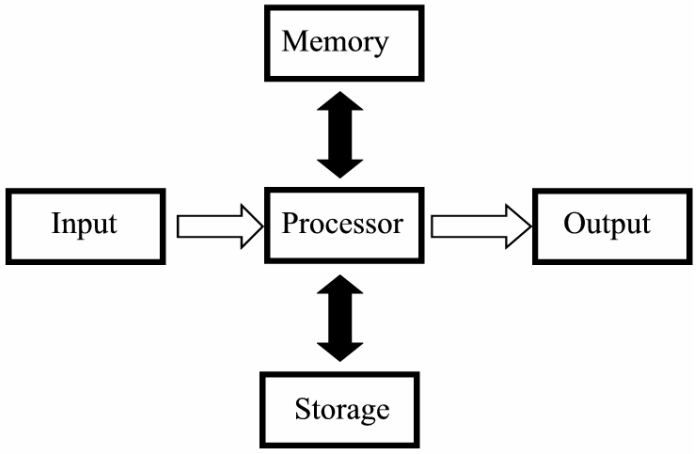
- Millisecond (ms) – a thousandth of a second ($1/1,000 = 10^{-3}$)
- Microsecond (μs) - a millionth of a second ($1/1,000,000 = 10^{-6}$)
- Nanosecond (ns) – a billionth of a second ($1/1,000,000,000 = 10^{-9}$)

High Level View Of A Computer



Buses

•Connect the different parts of the computer together



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Buses (2)

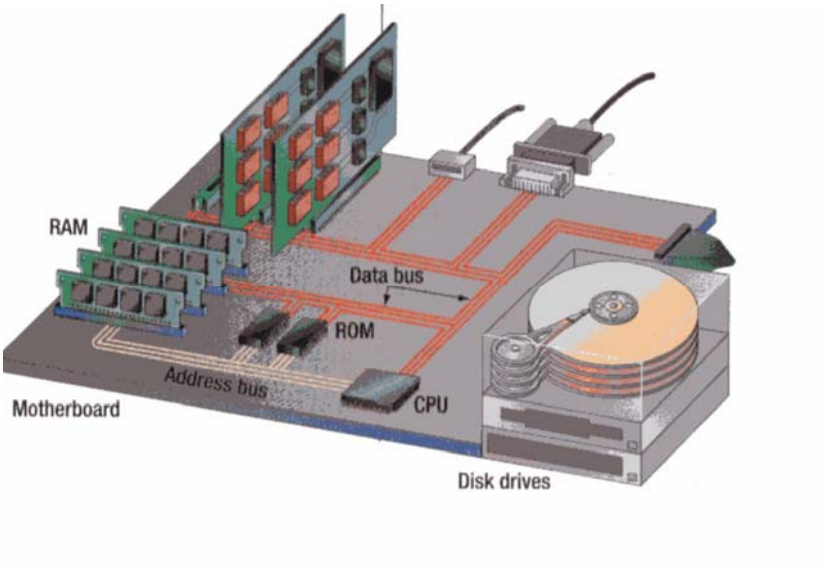

Image from Peter Norton's Computing Fundamentals (3rd Edition) by Norton P.

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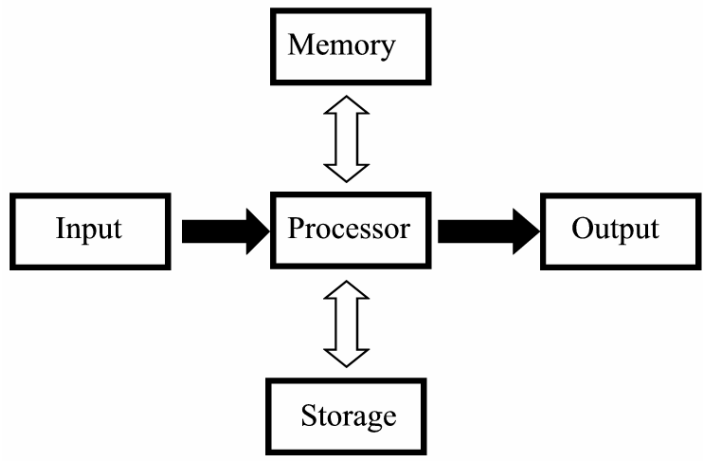
Ports

•Connects the computer to the outside



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Ports

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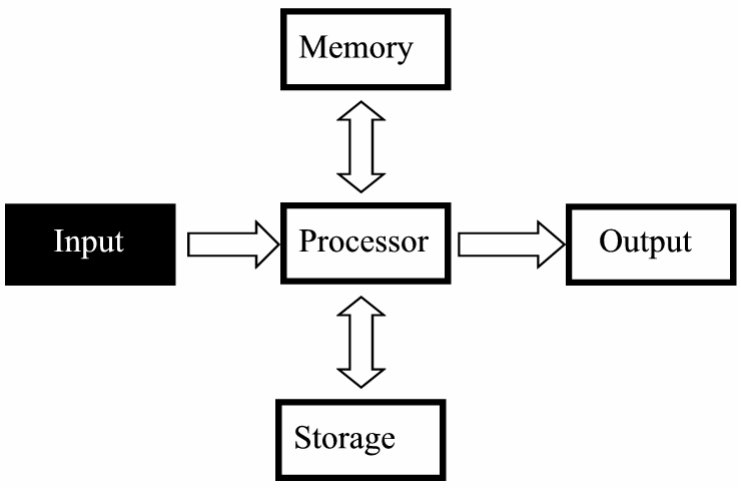
Input



Input Devices

•Used by a person to communicate to a computer.

Person to computer

Example Input Devices

•Keyboard 

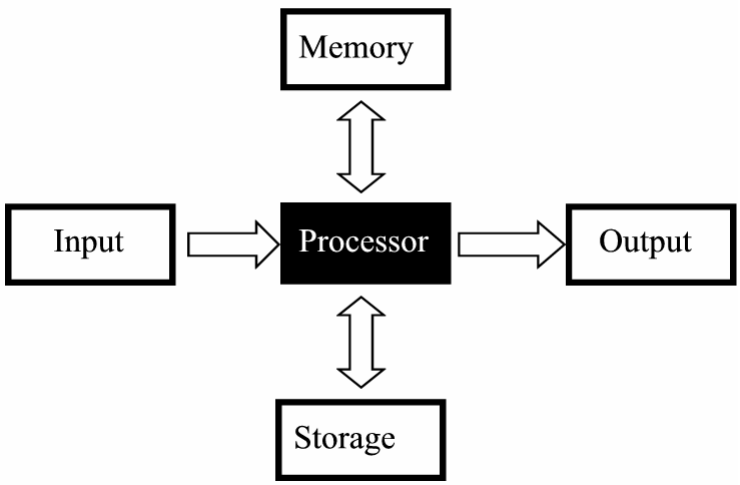
•Mouse 

•Need not be mundane!

From http://www.jouse.com/

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

Processor



Processor

•The brains of a computer

www.howstuffworks.com

•A common desktop processor

Processor Speed

•Determined by:

- Type of processor e.g., Pentium IV, 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)
  - 3.6 Ghz = 3.6 billion pulses sent out each second (0.27 ns between pulses)

The Processor And The Computer

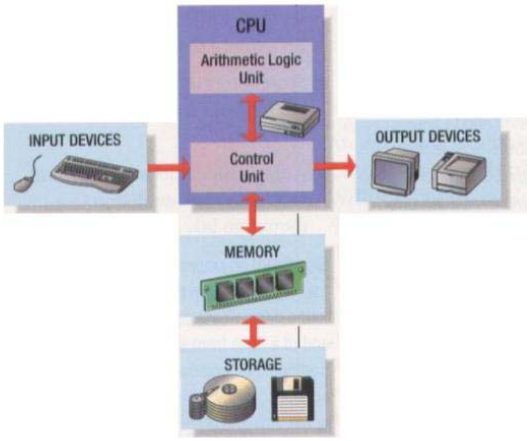
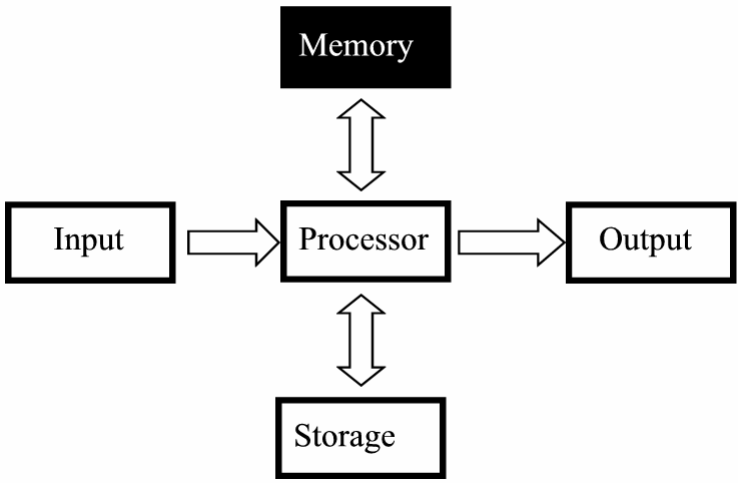


Image from Peter Norton's Computing Fundamentals (3rd Edition) by Norton P.

Memory

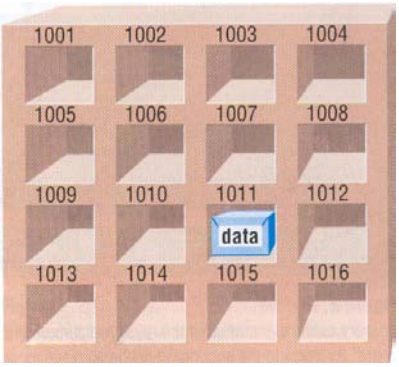


RAM

- *R*andom *A*ccess *M*emory
- Volatile
- Used for temporary storage
- Typical ranges 256 MB - 4 GB

RAM (2)

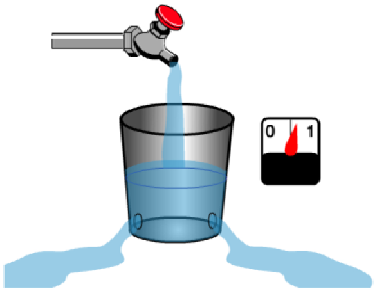
- Random access means direct access to any part of memory
- A common form of RAM is DRAM (Dynamic RAM)



Picture from Computers in your future by Pfaffenberger B

How Does DRAM Work?

- Acts like a leaky bucket



From www.howstuffworks.com

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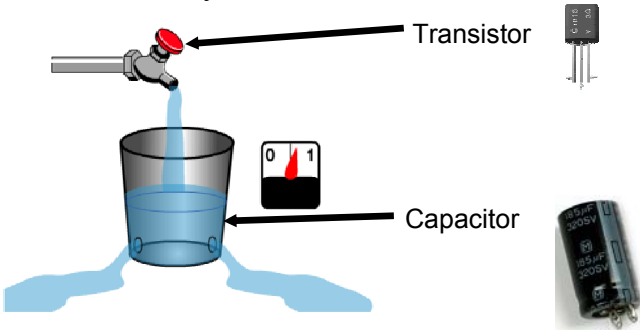
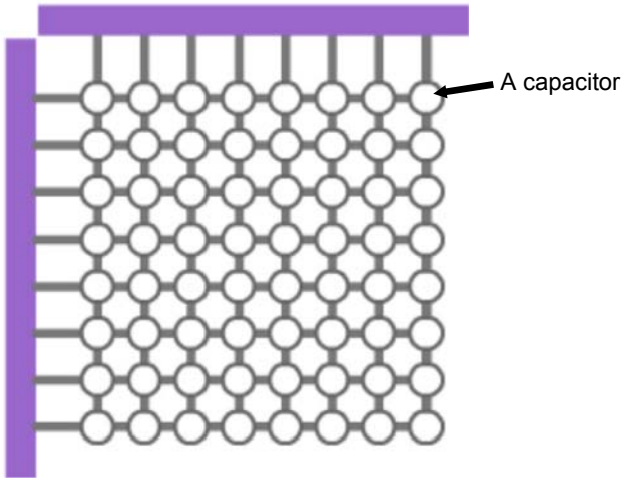


From www.howstuffworks.com

DRAM: A Collection Of Capacitors



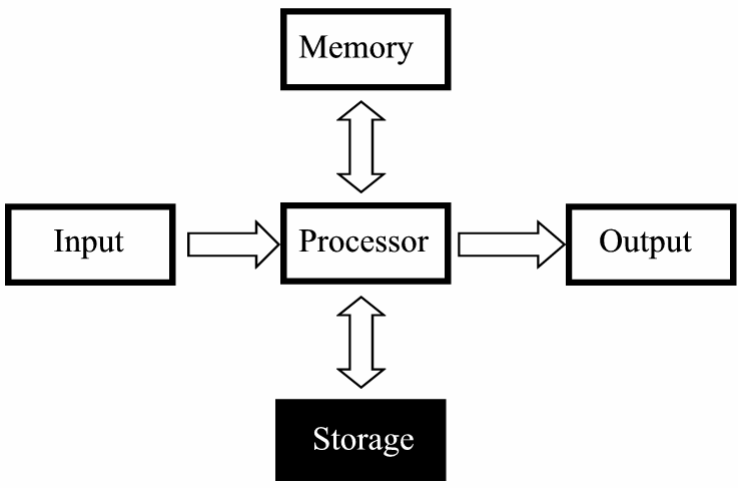
Conceptual view of DRAM

Actual DRAM

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

- Recall
  - $2^{30} \sim 1$ billion
  - $2^{31} \sim 2$ billion
  - $2^{32} \sim 4$ billion
  - This means that with a 32 bit computer the maximum amount of memory allowable is 4 billion (4 GB).

Storage



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

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)

1. Magnetic Drives

Pictures from www.howstuffworks.com

1. Magnetic Drives: Storage Capacities

- Floppy disks
  - ~ 1 MB
- Zip disks
  - 100, 250, 750 MB
- Hard drives
  - ~80 – 300 GB

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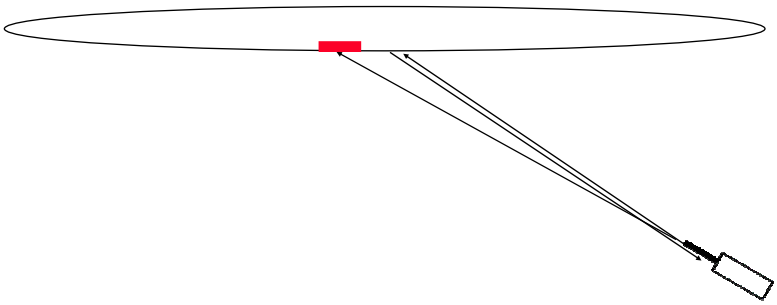
2. Optical Drives: Reading Information



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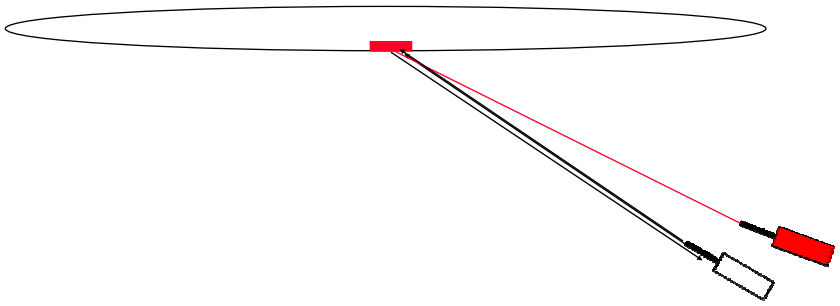
2. Optical Drives: Recording and Reading Information



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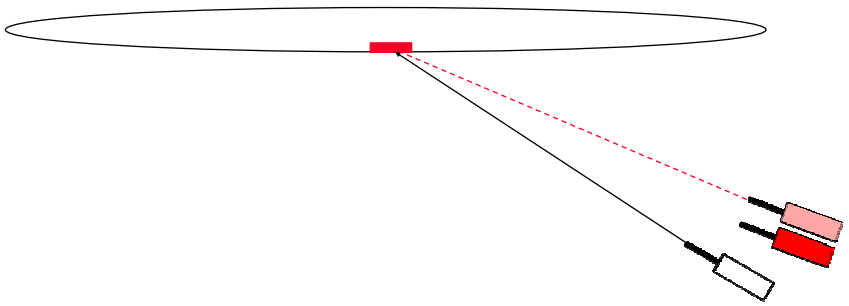
2. Optical Drives: Re-Writing



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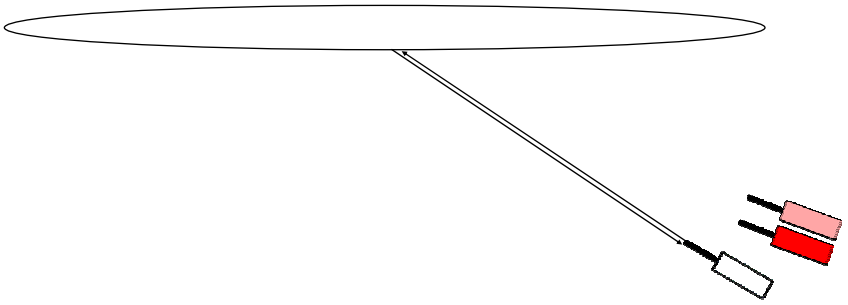
2. Optical Drives: Re-Writing



2. Optical Drives

•CD's
- ~ 700 MB storage
- CD-ROM (read only)
- CD-R: (**r**ecord) to a CD
- CD-RW: can write and erase CD to reuse it (**r**e-**w**ritable)

•DVD-ROM
- Over 4 GB storage (varies with format)
- DVD- ROM (read only)
- Many recordable formats (e.g., DVD-R, CD-RW; DVD+R, DVD+RW)

3. Solid State Storage Devices

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

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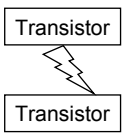
3. Solid State Storage Devices

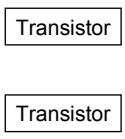
•Require no moving parts but instead uses transistors

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

Connected: stores '1'



Disconnected: stores '0'



•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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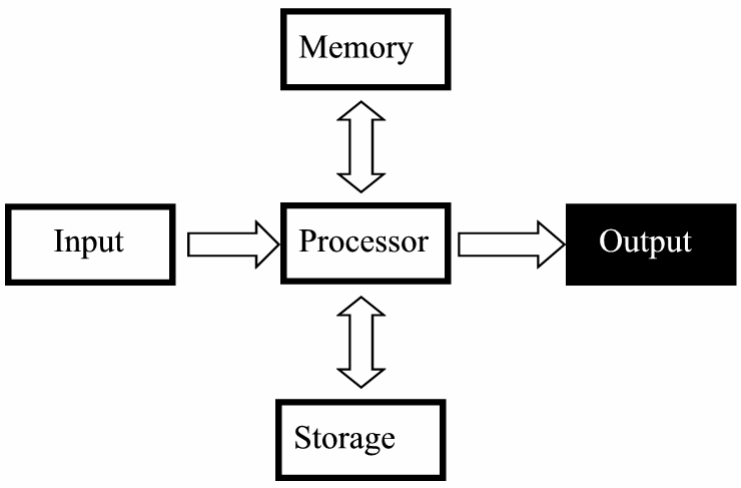
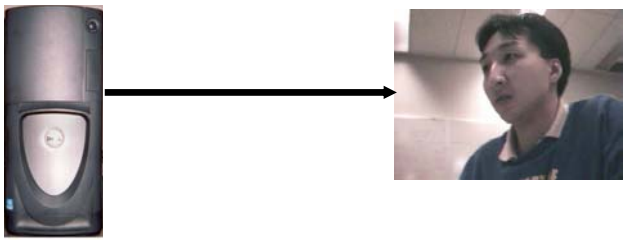
Output



Output Devices

•Displays information from the computer to a person.



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: *Pi*cture *el*ement*s)*

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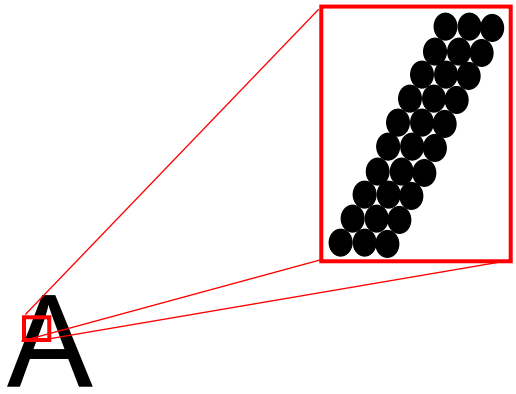
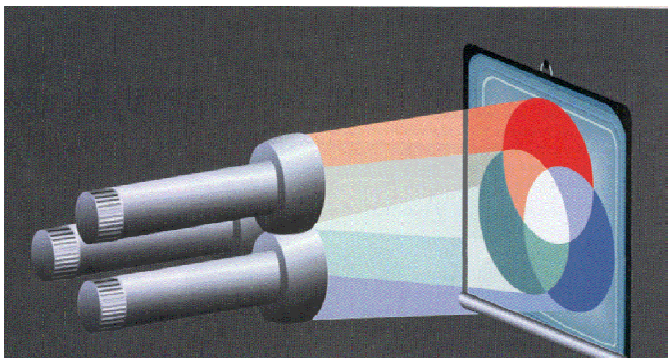
How Images Are Drawn On Monitors

•Images and text are drawn with tiny dots (Pixels: *Pi*cture *el*ement*s)*



1. CRT Monitors

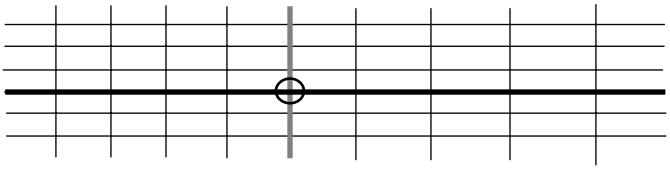
•The pixels are drawn with light 'guns'



Picture from Computer Confluence by Beekman G.

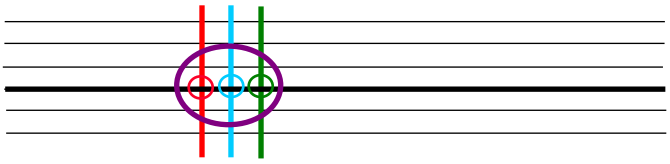
2. LCD Monitors

- 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)



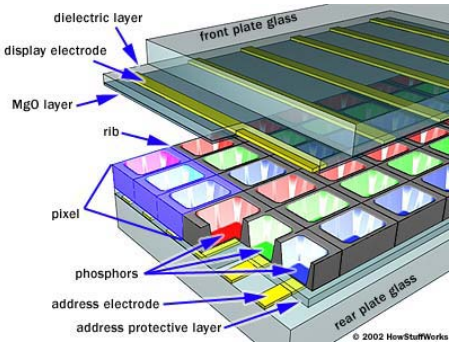
2. Colour LCD Monitors

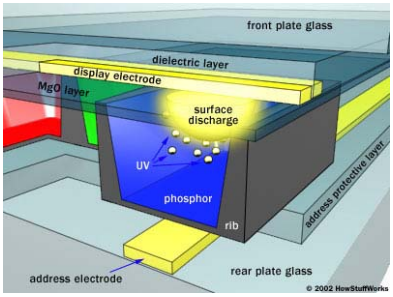
- Use three sub pixels:
  - One wire for each row
  - One wire for each sub-pixel
  - One colour filter for each colour (red, blue, green)



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

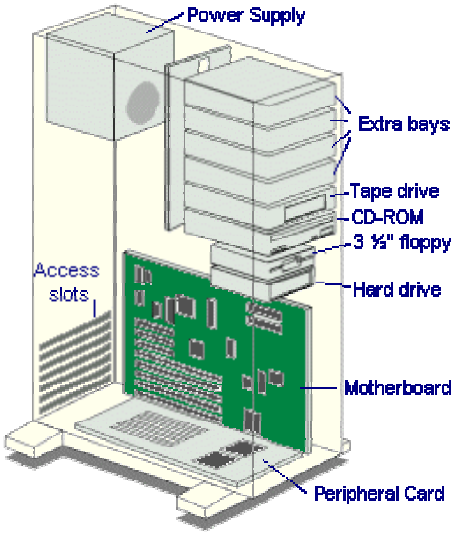

Diagram from http://www.jegsworks.com

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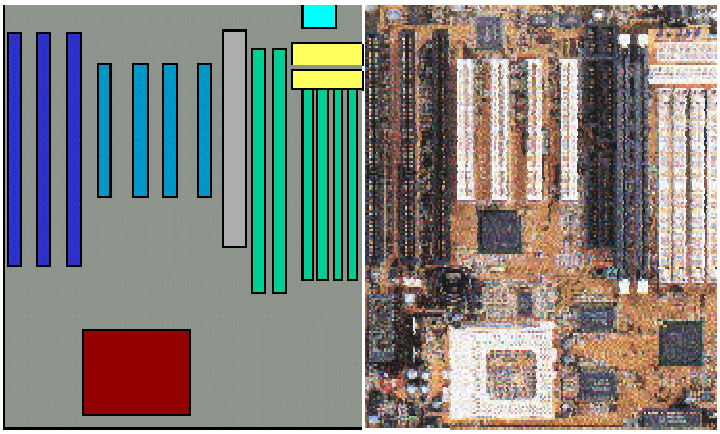
The Motherboard



ISA slots
PCI slots
Connectors
Memory chip slots
Keyboard plug
Power connectors
Processor socket

Diagram from http://www.jegsworks.com

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Relating The Speed Of The Computer To Its Components

Storage:
Hard drive

Memory:
RAM

Processor

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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