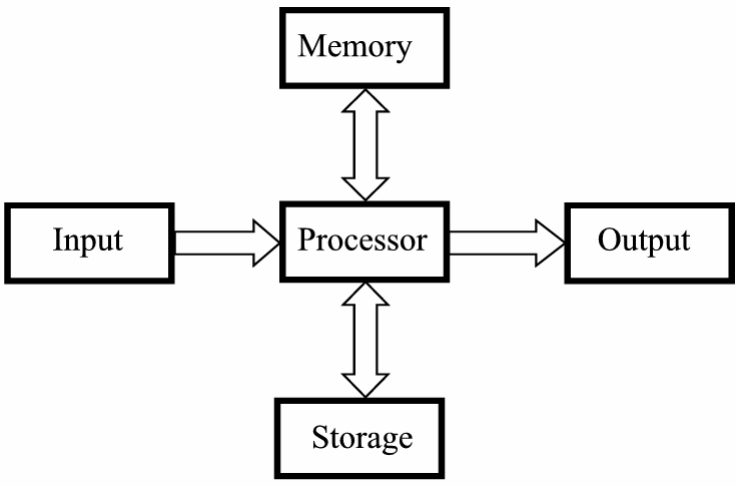
Introduction To Computers: Hardware

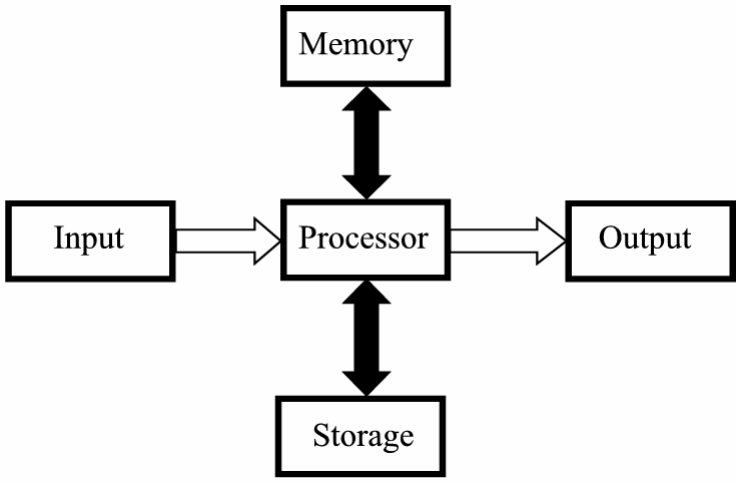
In this section of notes you will learn what are the basic parts of a computer and how they work.

High Level View Of A Computer



Buses

•Connect the different parts of the computer together



James Tam

Buses (2)

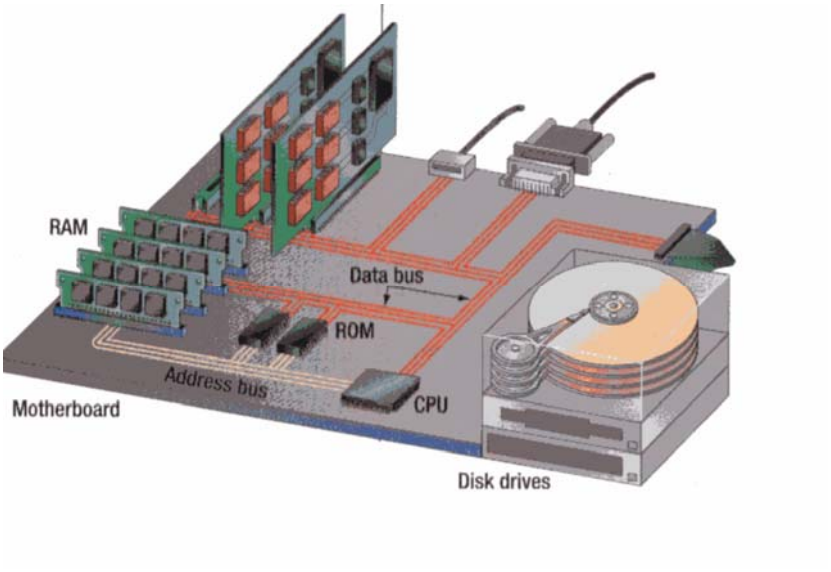


Image from Peter Norton's Computing Fundamentals (3rd Edition) by Norton P.

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Basic Units Of Measurement

Bit  on OR off

- *Bi*nary digi*t*
- Smallest unit of measurement
- Two possible values

Byte 

- 8 bits

Word

- The word size of a computer is 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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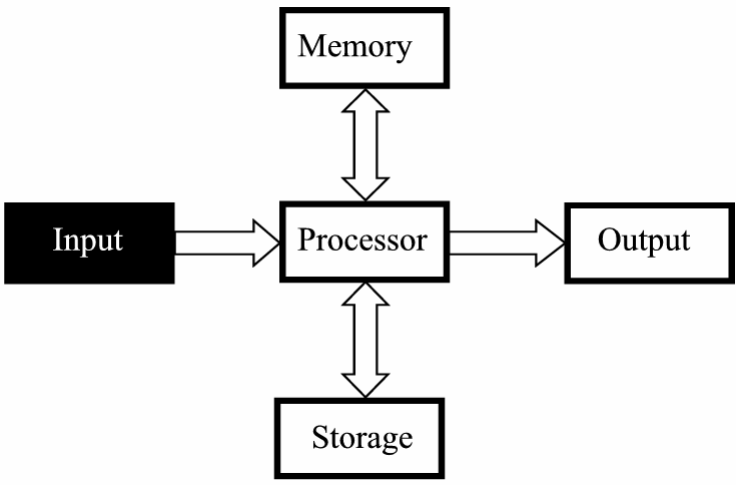
Input



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Input Devices

•Used by a person to communicate to a computer.

Person to computer

Example Input Devices

•Keyboard 

•Mouse 

•Etc.

How Keyboard Input Works

Keyboard: A key is pressed

The electrical impulse is sent via a wired or wireless connection

Keyboard controller: based on the electrical impulses it determines which key or combination of keys was pressed

A	p	p	l	e	...

Keyboard buffer: stores the keystrokes

The keyboard controller transmits an interrupt request

Operating system

How Keyboard Input Works

Operating system:

Q: Is the key combination a (an operating) system level command e.g., <alt>-<ctrl>-<del>?

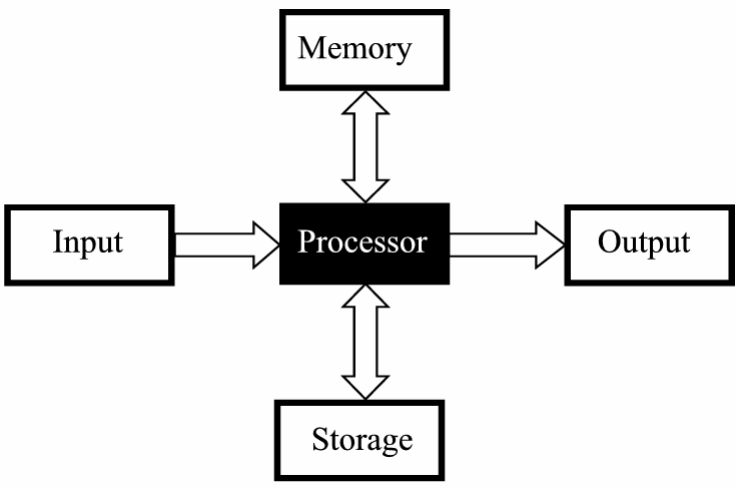
Yes

Execute operating system instruction

No

Pass the key combination onto current application

Processor



Processor

•The brains of a computer

Image from:
www.howstuffworks.com

•A common desktop processor

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 ($1/1{,}000{,}000{,}000 = 10^{-9}$)

Processor Speed

- Determined by:
  1. Type of processor e.g., Intel: Celeron, Pentium, AMD: Athlon, Opteron
  2. 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)

The Processor And The Computer

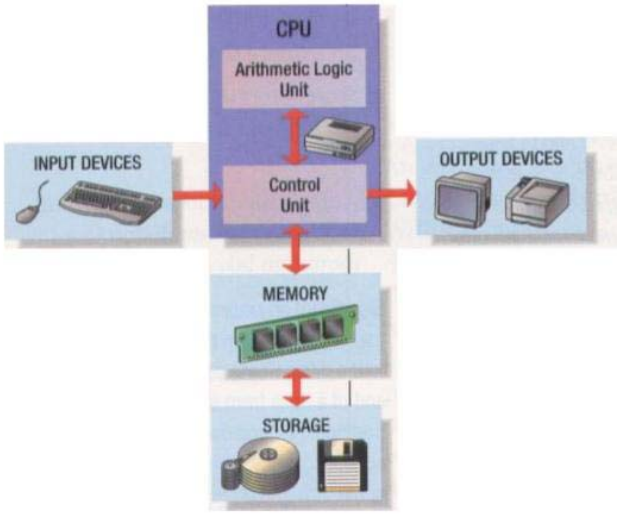
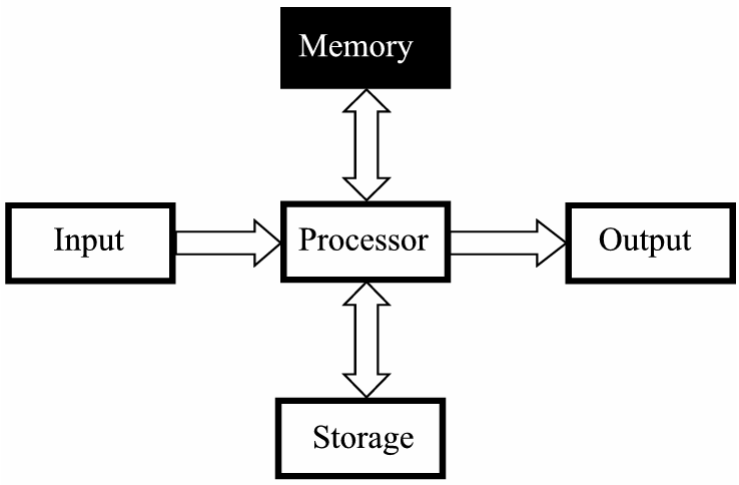


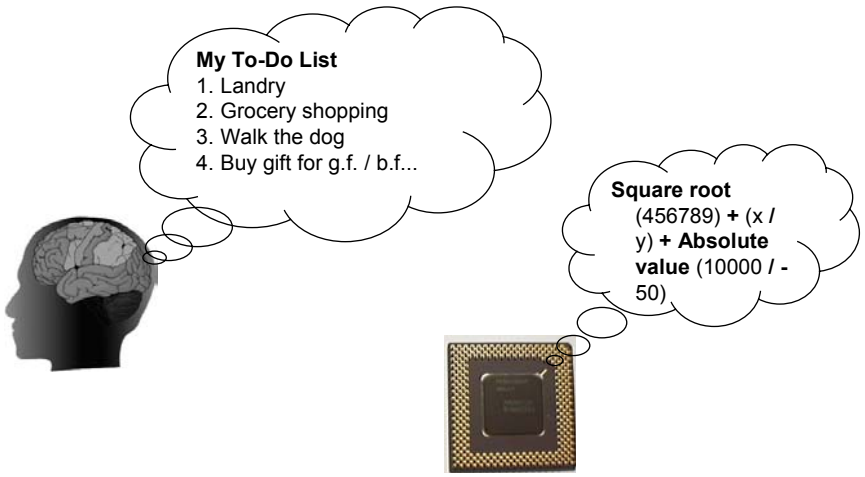
Image from Peter Norton's Computing Fundamentals (3rd Edition) by Norton P.

Memory



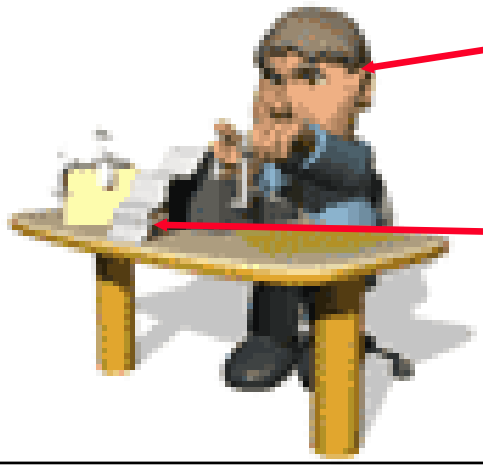
Memory

•The processor has a small amount of memory that is fast but very low in capacity



Memory

•It is used as temporary storage for storing information and instructors that won't fit in the processor but is needed now



Processor: 'brains' that performs the calculations

Memory: stores information needed by the processor

Memory: High-Level View

- Storing information in memory is based on bits (on/off state)

 on OR off

- Since bits cannot store enough information bits are combined into bytes

Large Units Of Measurement (Memory, Storage)

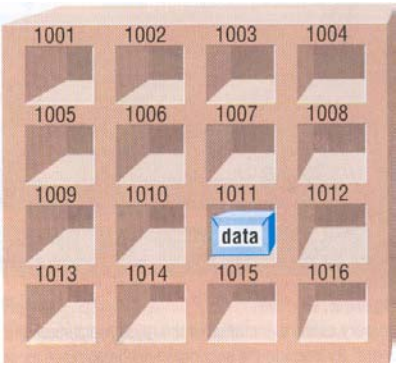
- Note: powers of two are used because computer memory and storage are based on the basic unit (bit).
- Kilobyte (KB) – a thousand bytes ($1{,}024 = 2^{10}$)
- Megabyte (MB) - a million ($1{,}048{,}576 = 2^{20}$)
- Gigabyte (GB) – a billion ($1{,}073{,}741{,}824 = 2^{30}$)
  - ~ A complete set of encyclopedias requires about 700 MB of storage
  - ~ 30 minutes of video (~1/4 of the information stored on a typical DVD)
- 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

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)



Random access doesn't mean chaotic or haphazard but it means that access does not have to be sequential but can occur anywhere

Picture from Computers in your future by Pfaffenberger B

How Does DRAM Work?

•Acts like a leaky bucket

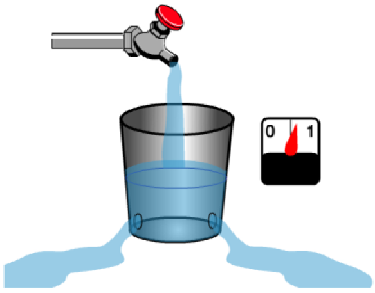


Image from www.howstuffworks.com

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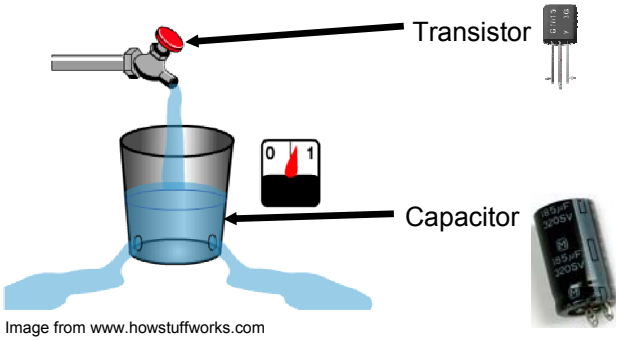
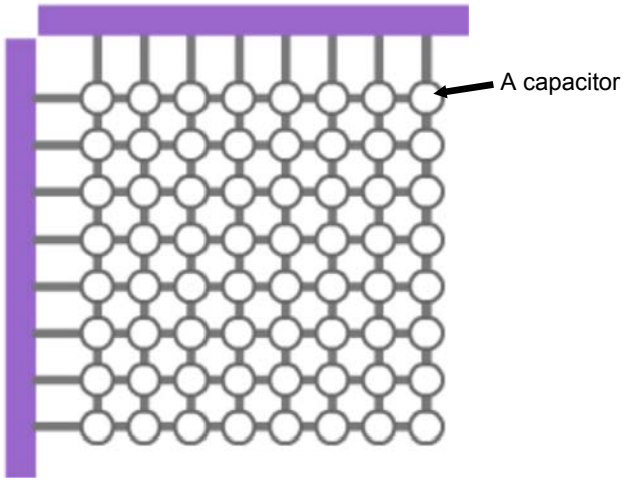


Image from www.howstuffworks.com

DRAM: A Collection Of Capacitors



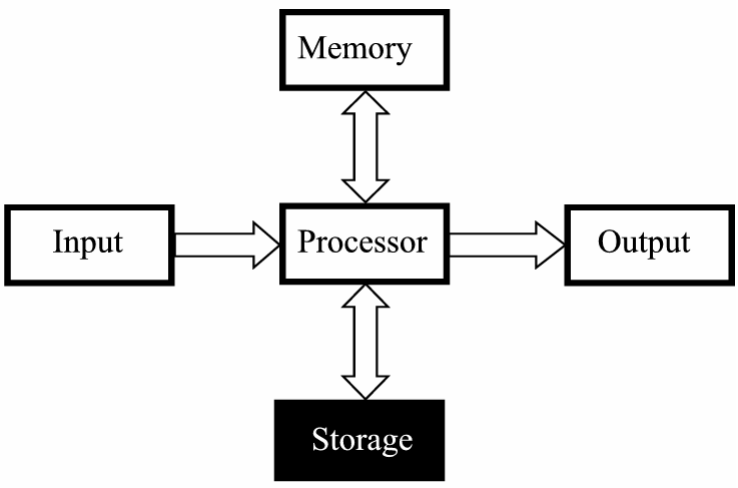
Conceptual view of DRAM

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)

- The information stored is needed now
- Keep the information for a shorter period of time (usually volatile)
- Faster
- More expensive
- Low storage capacity (~1/4 of a DVD for 1 GB)

Storage (e.g., Hard disk)

- The information stored is not needed immediately
- The information is retained longer (non-volatile)
- Slower
- Cheaper
- Higher storage capacity (~50 DVD's for 200 GB)

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

1. Magnetic Drives: Storage Capacities

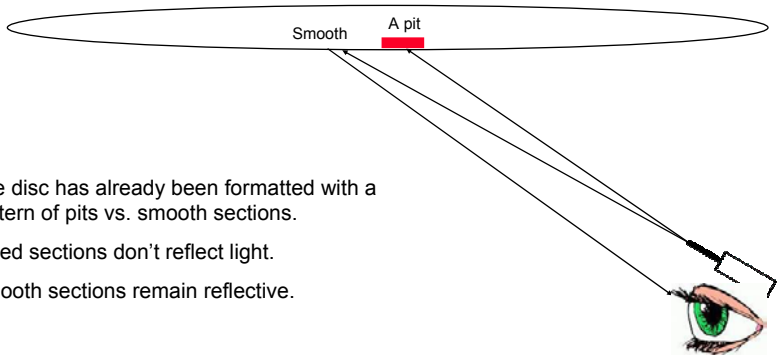
- Floppy disks
  - ~ 1 MB
- Zip disks
  - 100, 250, 750 MB
- Hard drives
  - ~80 GB – 2 TB

2. Optical Drives

- Use lasers to store and retrieve information (CD's and DVD's)
- Categories:
  - Can only read information off the disc (CD-ROM, DVD-ROM)
  - Can read and also *r*ecord information to the disk (CD-R, DVD-R, DVD+R)
  - Can read, record and also *r*e-*w*rite information multiple times (CD-RW, DVD-RW, DVD+RW)
- Storage capacities:
  - CD ~ 700 MB
  - DVD ~ 4 GB (drives with much larger capacities are just becoming more common)

Optical Drives: Reading Information

CD-ROM, DVD-ROM



- The disc has already been formatted with a pattern of pits vs. smooth sections.
- Pitted sections don't reflect light.
- Smooth sections remain reflective.

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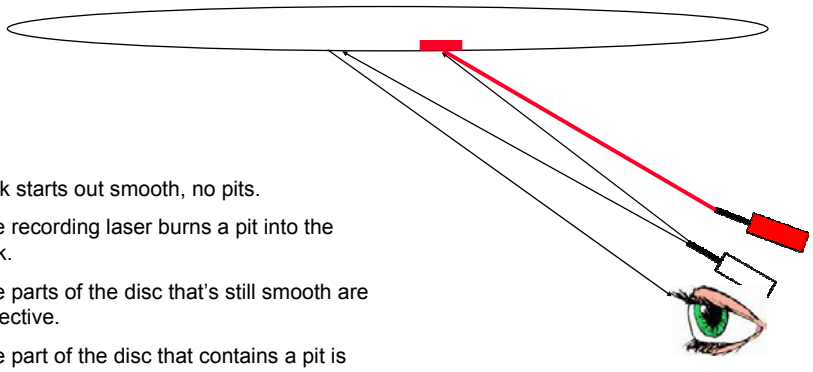
Optical Drives: *R*ecording And Reading Information

CD-R, DVD-R, DVD+R



- Disk starts out smooth, no pits.
- The recording laser burns a pit into the disk.
- The parts of the disc that's still smooth are reflective.
- The part of the disc that contains a pit is non-reflective.

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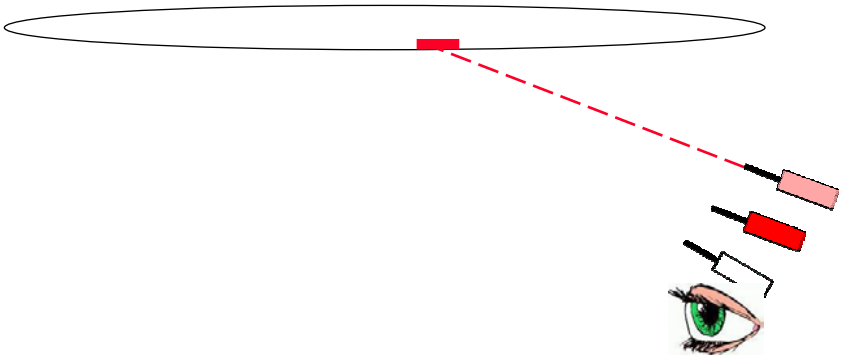
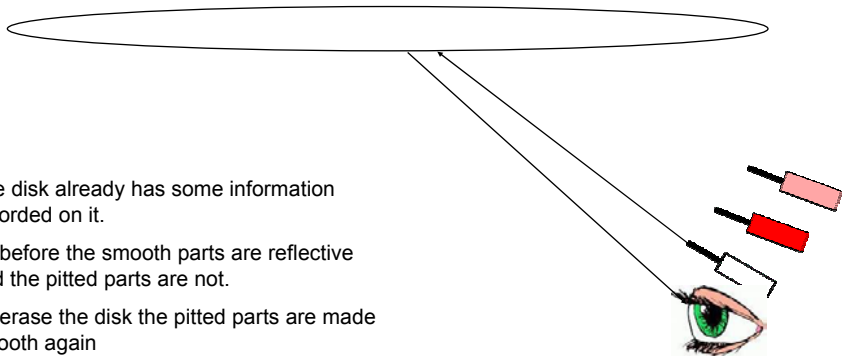
Optical Drives: *R*e-*W*riting

CD-RW, DVD-RW, DVD+RW



Optical Drives: *R*e-*W*riting

CD-RW, DVD-RW, DVD+RW



- The disk already has some information recorded on it.
- As before the smooth parts are reflective and the pitted parts are not.
- To erase the disk the pitted parts are made smooth again

3. Solid State Storage Devices

- Portable but can store a large amount of information (256 MB – 16 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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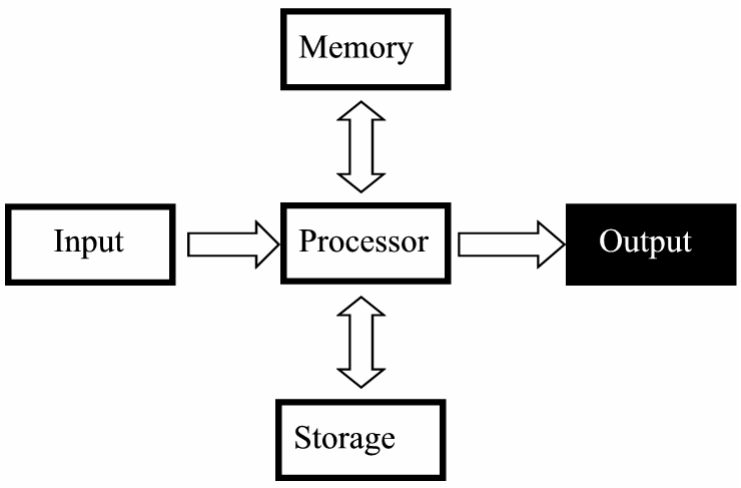
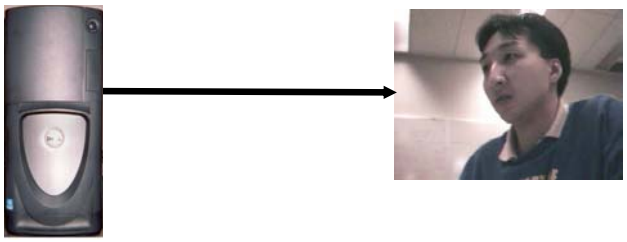
Output



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

James Tam

How Images Are Drawn On Monitors

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

A

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How Images Are Drawn On Monitors

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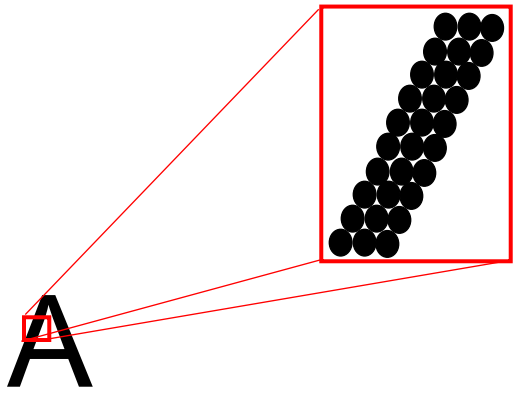
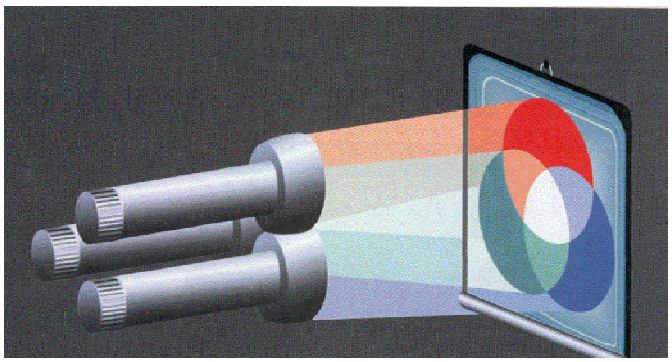


1. CRT Monitors

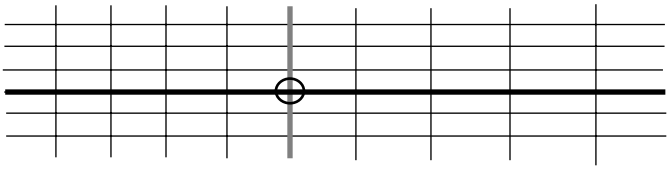
•The pixels are drawn with light 'guns'



Picture from Computer Confluence by Beekman G.

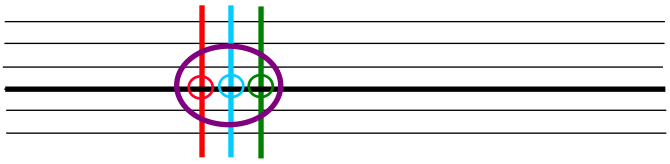
2. LCD Monitors

- 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)



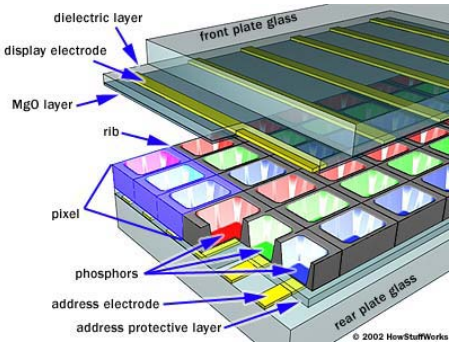
2. Colour LCD Monitors

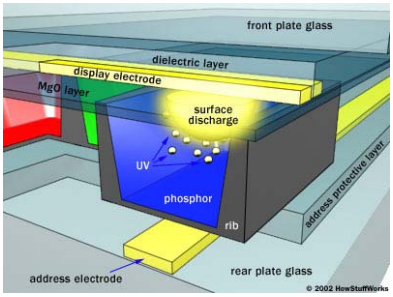
- Use three sub pixels:
  - One wire for each row
  - One wire for each sub-pixel
  - One colour filter for each colour (red, blue, green)



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

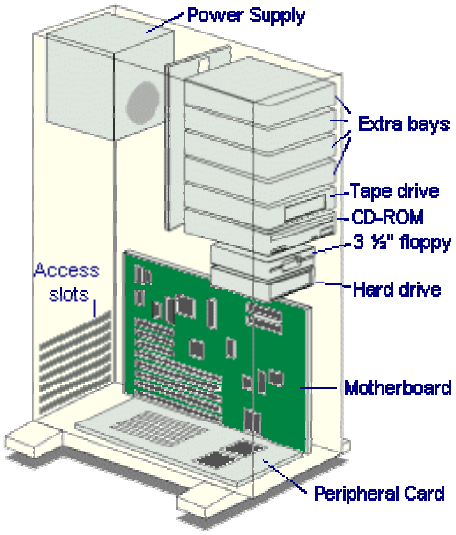

Diagram from http://www.jegsworks.com

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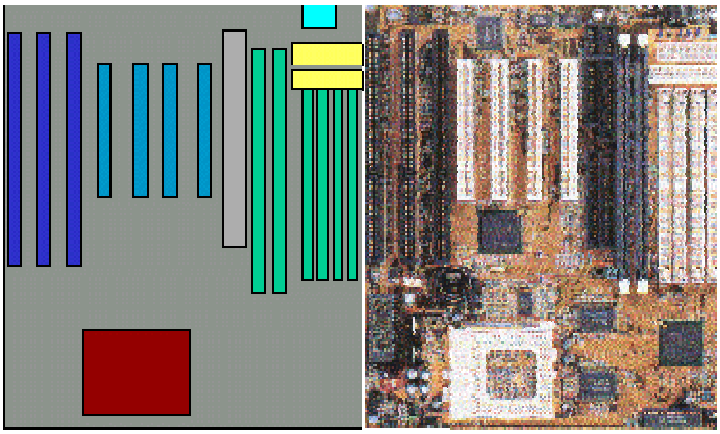
The Motherboard



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

James Tam

You Should Now Know

- What are common units of measurement for the computer
- 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