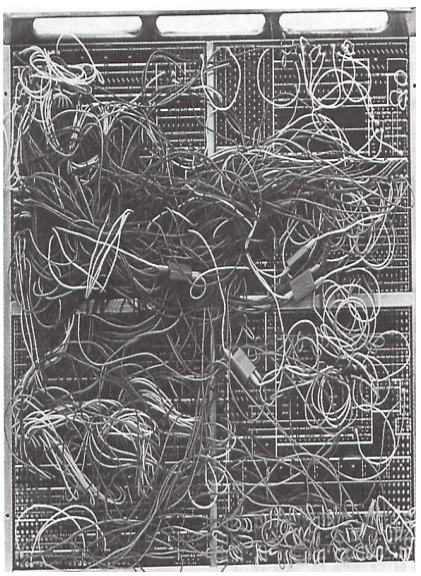
Introduction to computers

You will learn what are the basic components of a computer system and the rudiments of how those components work.

James Tam

Are Computers Really So Confusing?



James Tam

How Does A Computer Work?

- Simple: something is either in one state or another.

On / off

Pitted / smooth

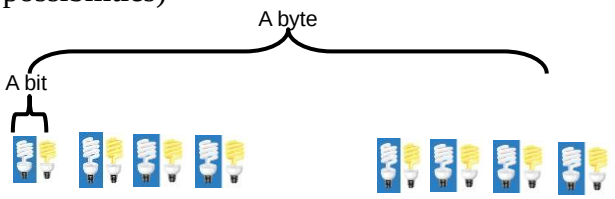
- All parts of modern computers work this way.
- This two state approach is referred to as binary (bi = two, for 2 states).

Off / on

James Tam

Beyond The Bit

- By itself a bit is useless (it can't store a useful amount of information = only 2 possible states)
- Bits must be combined together before information can be stored
  - Q: How many states can be represented with 2 bits? 3 bits? 4 bits?
- The next (commonly used) unit of storage is a byte = 8 bits (256 possibilities)



James Tam

Related Side Note

- In case you wondered what was *really* happening inside the computer when it isn't doing what you want it to do (e.g., print a document, save a file, run a program etc. etc. etc.)

From www.overing89.wordpress.com/

James Tam

Counting: Large Units Of Measurement

- Kilo: One thousand 1,000
- Mega: One million 1,000,000
- Giga: One billion 1,000,000,000
- Tera: One trillion 1,000,000,000,000

James Tam

The Computer: Large Units Of Measurement

- The amount of information that can be stored and transferred is typically measured in bytes rather than bits.
- Kilobyte (KB) ~ a thousand bytes ($1,024 = 2^{10}$)

 X 1,000

- Megabyte (MB) ~ a million bytes ($1,048,576 = 2^{20}$)

 X 1,000,000

- A typical image may range from ~20,000 Bytes / 20 KB to several million bytes (MB).
- Audio files (e.g., MP3) are several Megabytes in size.
- Streaming Internet video (compressed) ~several hundred Megabytes for a full movie.

James Tam

Large Units Of Measurement (2)

- Gigabyte (GB) ~ a billion bytes ($1,073,741,824 = 2^{30}$)

 X 1,000,000,000

~ 30 minutes of DVD quality video (~1/4 of the information stored on a typical DVD)

- Terabyte (TB) ~ a trillion bytes ($1,099,511,627,776 = 2^{40}$)

 X 1,000,000,000,000

~ 200 regular DVD's (~32 Blu-ray) of information

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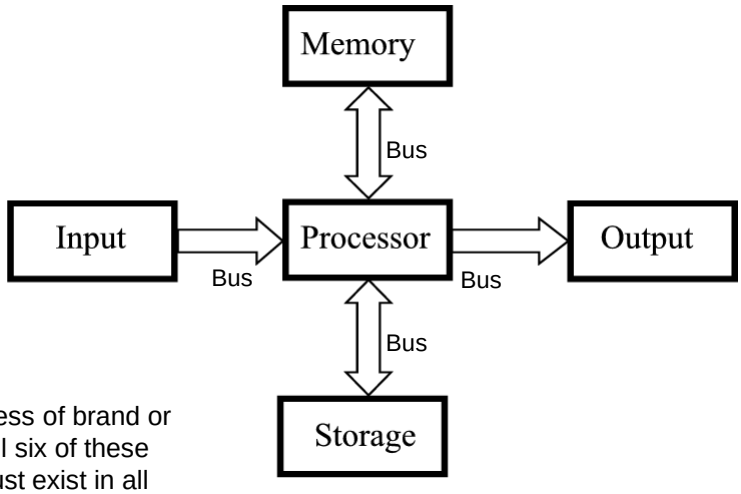
High Level View Of A Computer

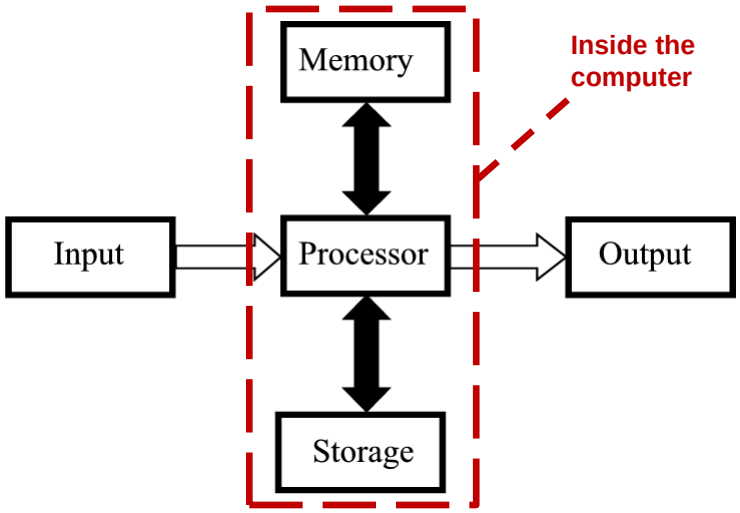


Regardless of brand or model all six of these parts must exist in all complete computer systems

James Tam

Computer Buses

•Connect the internal parts of the computer



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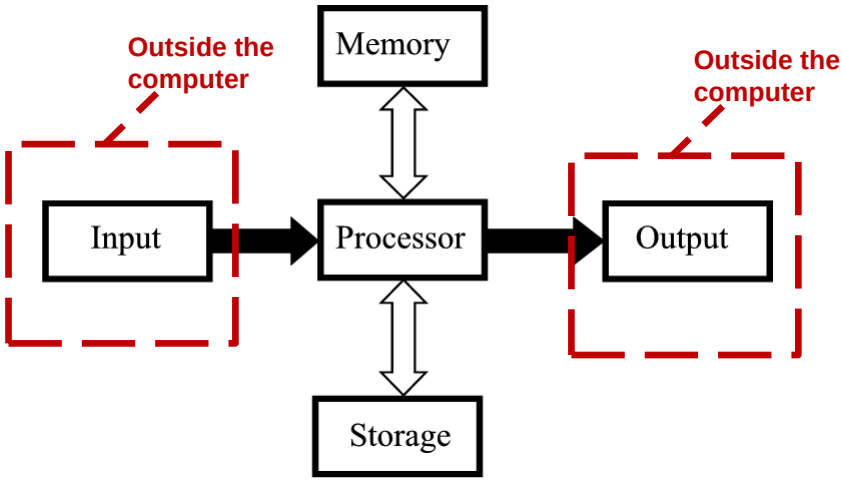
Ports

•Connects the computer to the outside



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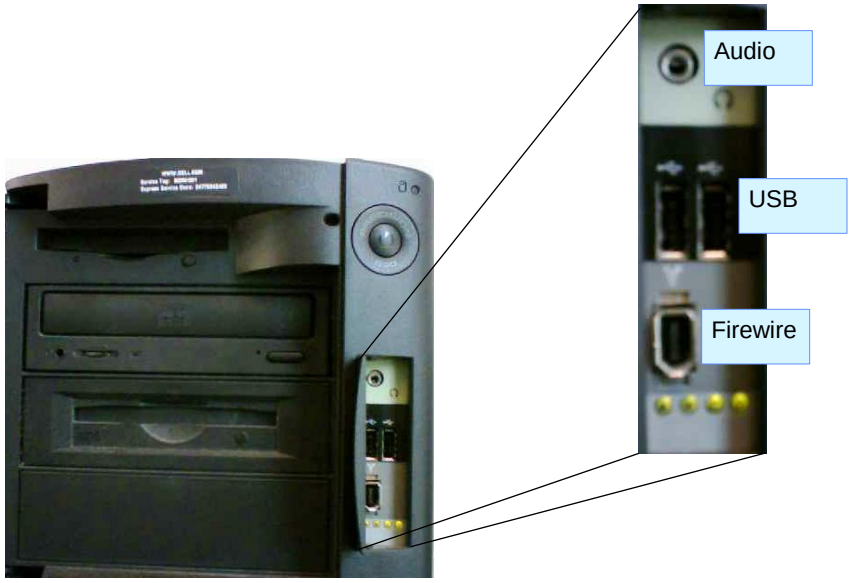
Example Ports (Older)



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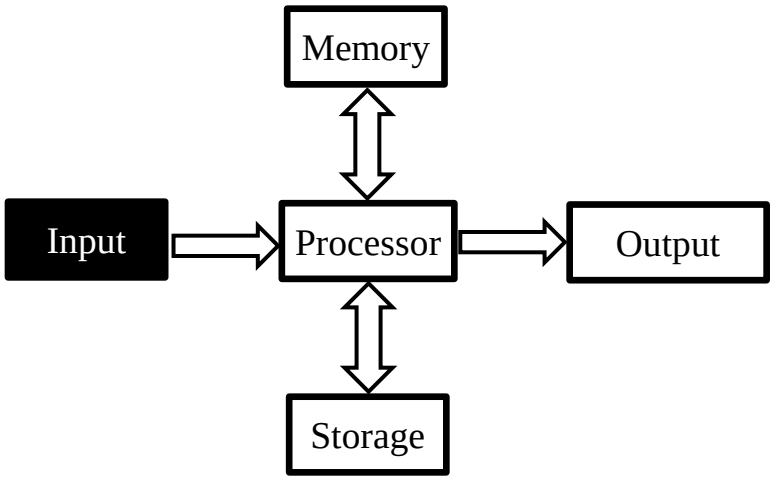
Input



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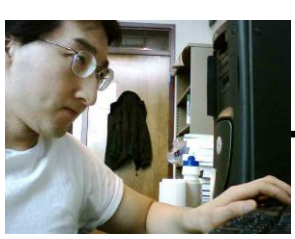
Input Devices

•Used by a person to communicate to a computer.



Person to computer

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Example Input Devices

- Keyboard

- Mouse

- Stylus

- Touch screen

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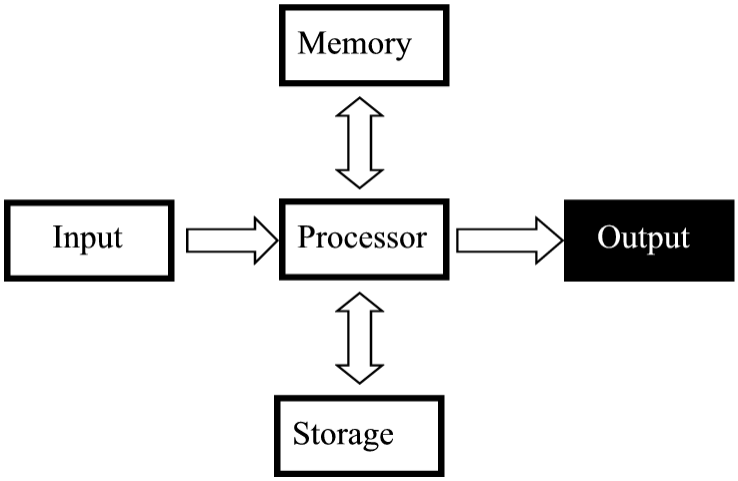
Output



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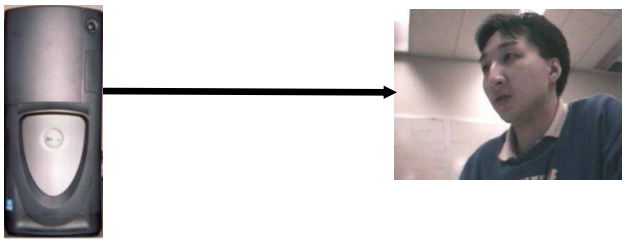
Output Devices

•Communicating information from the computer.



James Tam

The Most Common Output Device: The Monitor

James Tam

How Information Is Shown On Monitors

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

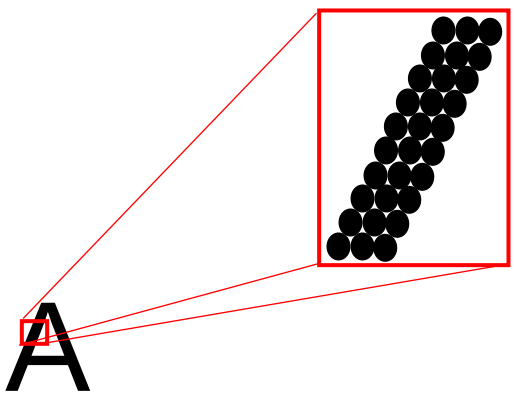
A

James Tam

How Information Is Shown On Monitors

•Images and text are drawn with tiny dots (or rectangles)

•The dots are referred to as ‘pixels’: *Pi*cture *el*ement*s)*



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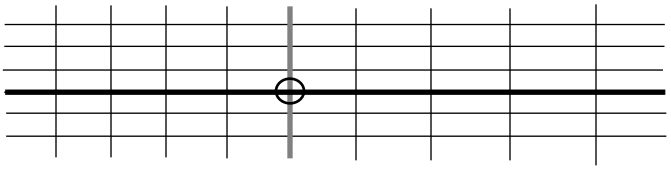
LCD Monitors

- 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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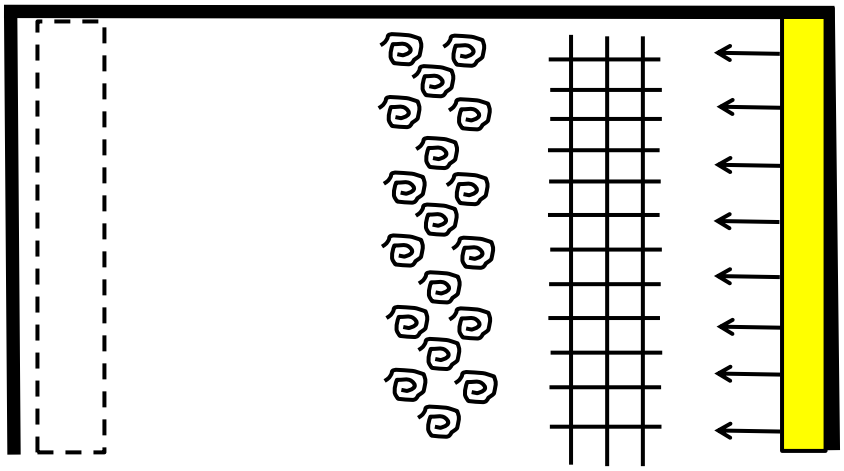
LCD Monitors (2)

- The creation of images and text requires several layers to produce the necessary pixels.



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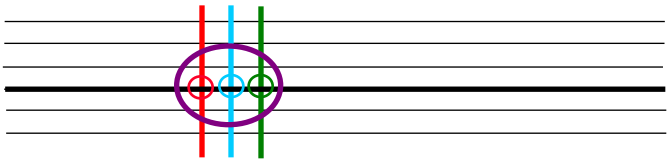
Colour LCD Monitors

- 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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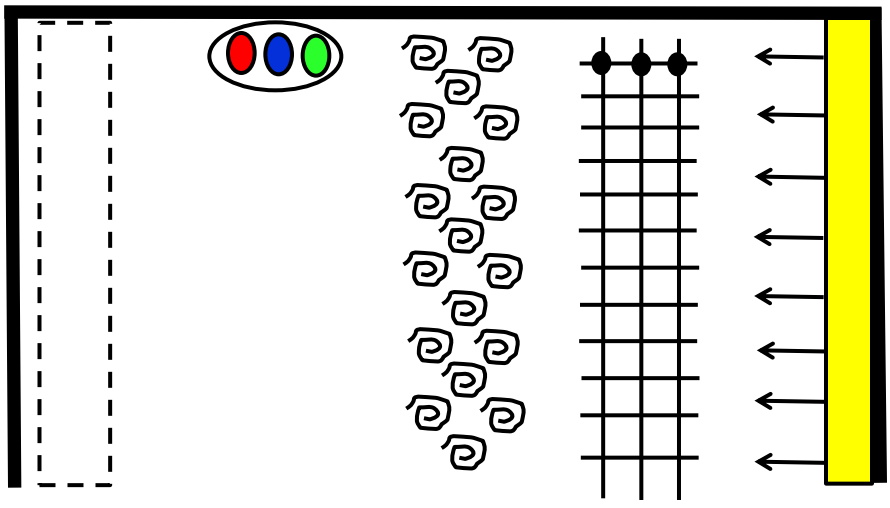
Colour LCD Monitors (2)

- An extra layer is needed to produce the color pixels



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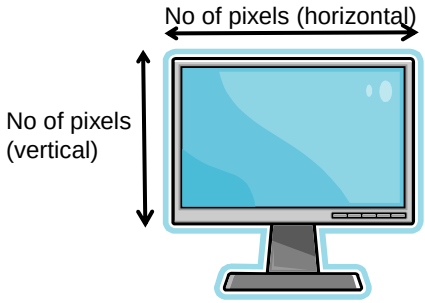
Computer Monitors: Resolution

- It's determined by the number of horizontal pixels X the number of vertical pixels.



- For a given monitor size, the higher the resolution the sharper the image.
- Common resolutions:
  - 800 x 600, 1280 x 1024...1600x1200 (regular non-widescreen)
  - 1280 x 800, 1366 x 768…1680 x 1050 (widescreen systems)

James Tam

Computer Resolution: LCD Monitors

- Native resolution: is the best (only) resolution for displaying information. (Other resolutions may be possible by simulating the resolution or graphical effects).

James Tam

A Game Running At The Native Resolution: Sharp

Icewind Dale © Black Isle (from www.gamespot.com)

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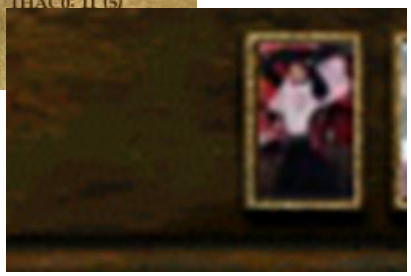
A Game Not Running At The Monitor's Native Resolution: Reduced Quality

Original image

Image at non-native resolution



Thumbnail image at non-native resolution

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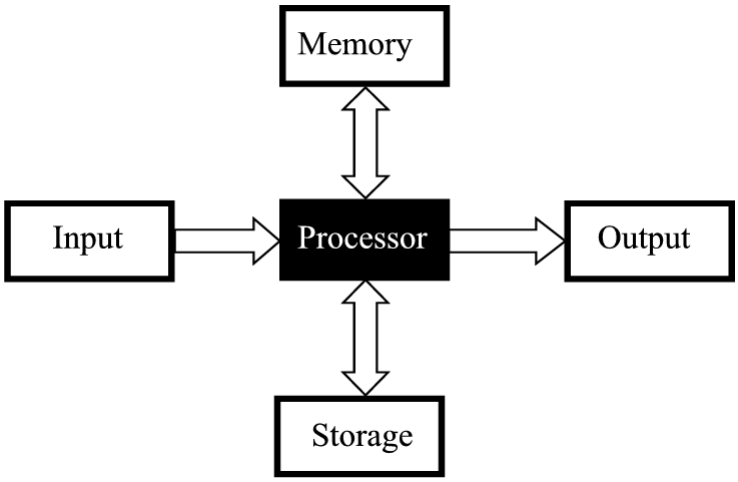
Processor



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Processor (2)

- With desktop and laptops it's commonly referred to as the Central Processing Unit (CPU).
  - There are other processors in a typical desktop or laptop computer.

- Acts as the 'brains' of the computer that comes into play as programs are running e.g., performing calculations on a spreadsheet, playing a video, manipulating files…more details to come.

James Tam

Counting: Small Units Of Measurement

- Milli: one thousandth (1 / 1,000)
- Micro: one millionth (1 / 1,000,000)
- Nano: on billionth (1 / 1,000,000,000)

James Tam

Processor Clock Speed

- A common measure of the computational speed of a computer.
- For each clock 'cycle' an instruction[1] is executed (pulsed) by the computer.
  - 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)
  - 4.0 Ghz = 4.0 billion pulses sent out each second (0.25 ns between pulses)

1 To be more specific it's one microinstruction per clock pulse

James Tam

Benefits Of A Faster Processor

- Calculations are performed faster (e.g., to evaluate the results of a large spreadsheet)
- Programs are loaded faster (includes the time to start up your computer)
- Viewing videos and ripping music/videos to your computer may be faster and more free of 'glitches'
- Note: there are other processor characteristics that determine processor speed.
- A discussion of most of these topics is beyond the scope of this class but if you are interested here's a few sites that may be of interest:
  - http://www.tomshardware.com/
  - www.howstuffworks.com
  - http://www.pcmag.com/

James Tam

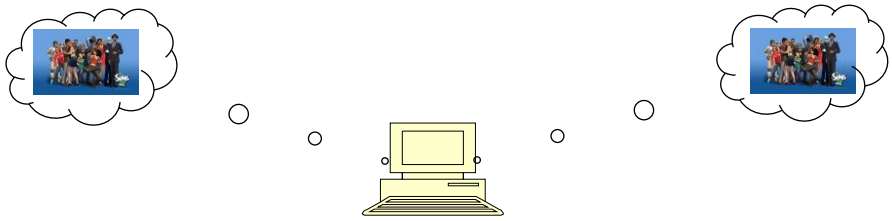
Common Processor Clock Speeds

- Budget processors
  - Laptop: ~1.7 GHz ~3 GHz (Cheap netbooks are around 1.6 GHz)
  - Desktop: ~3 GHz - ~4 GHz

James Tam

Multi-Core Technology

- One of the newer determinants of processor speed.
- A core is the part of the processor that's capable of executing instructions and has some memory to store information.
- The processor is split into multiple (dual = two, quad = four, six = six) cores.
- Each core is capable of executing it's own set of instructions.



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Do You Need Multiple Processing Cores?

- Going from a single core to a multi-core system *will not* automatically result in an increase in speed. (Nor will increasing the number of processor cores).
- Two situations where speed will increase:
  1. You simultaneously run two or more programs that are processor intensive.
  2. You run a single program that is processor intensive and it is written specifically for a multi-core processor.
- When having multiple/more cores won't increase speed:
  - Opposite of the above:
    - You don't run multiple processor intensive programs at the same time. (You only run a single calculation-heavy program at a time).
    - The single processor intensive program that you do run is not optimized to run on a multi-core processor.

James Tam

Do You Need Multiple Processing Cores? (2)

- Examples of processor intensive tasks:
  - Video editing (saving).
  - Playing videos.
  - Ripping CD's / DVD's
  - Running security software (e.g., anti-virus scan).
  - Many of the newer computer games are processor intensive (at least to a degree).

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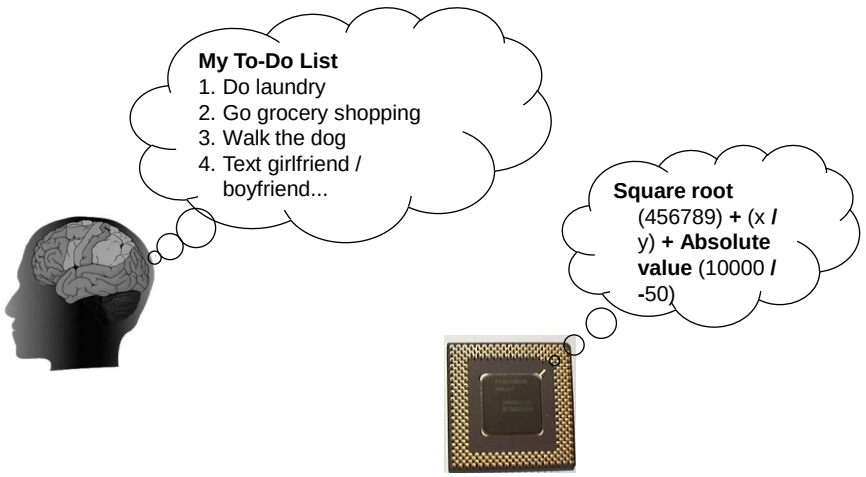
Storage Of Information: Processors

•The processor has a small amount of memory that is fast but very low in storage capacity (analogous to short-term memory)



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Storage Of Information: Processors (2)

- Very often this limited storage space is insufficient.

People:
Oops forgot to study for the final exam!!!

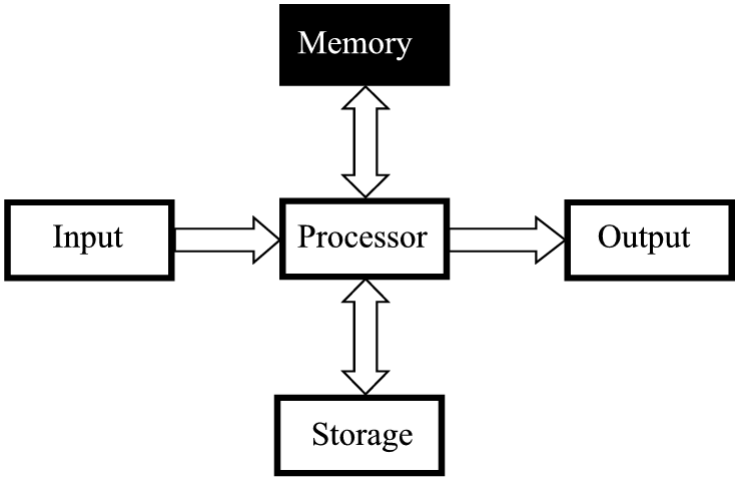
My To-Do List
1. Do laundry
2. Go grocery shopping
3. Walk the dog
4. Text girlfriend / boyfriend...

Square root (456789) **+** (x **/** y) **+ Absolute value** (10000 **/** -50)

Computers:
No oops allowed!
Something else is needed.

James Tam

Memory



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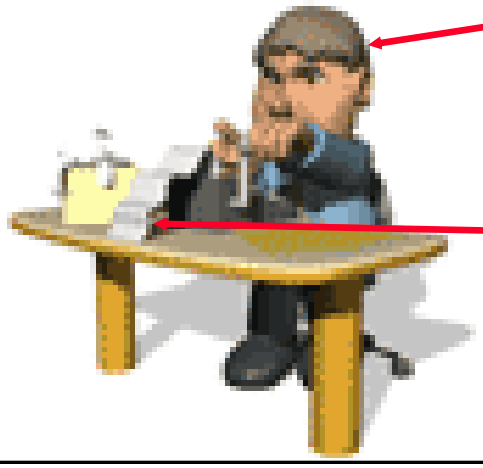
Memory

•It is used as temporary storage for the computer (analogous to scrap paper)



Processor: 'brains' that performs the calculations

Memory: stores information needed by the processor

James Tam

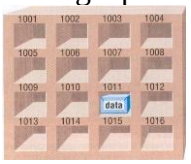
Memory (2)

•Main memory is used to stored information that is currently needed by the computer (e.g., a program running now) but won't fit into the processor's memory.

•A common type of computer memory is RAM (*R*andom *A*ccess *M*emory)

•RAM is volatile (information is stored so long as there is power).

•Memory is organized into numbered 'slots' with each slot storing a piece of information.



Picture from Computers in your future by Pfaffenberger B

James Tam

How Much RAM?

- Systems vary widely depending on price but the typical starting values range from 4 GB – 8 GB (values around 16 GB aren't uncommon however).

James Tam

Limitations Of Memory

- It can store more information than the processor's memory but it is still finite in size.
- Example showing memory being used for a computer with 4 GB RAM:
  - Computer is turned on and operating system is loaded (1 GB – 2+ GB of RAM required – depending upon the version of operating system)
  - The user runs a program to play a movie (~30 MB of RAM)
  - The movie player is of typical length, around two hours (~4 GB uncompressed)
  - Total Memory requirements: Over 5 GB of RAM (can't be all stored in RAM)
  - Note: This is a simplified example because most computers will be running many other programs at the same time (e.g., security software to protect the computer against malicious programs).

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Limitations Of Memory (2)

- Also recall that RAM is volatile and information stored there will be lost after the computer is shut off (something else is needed for long term storage)

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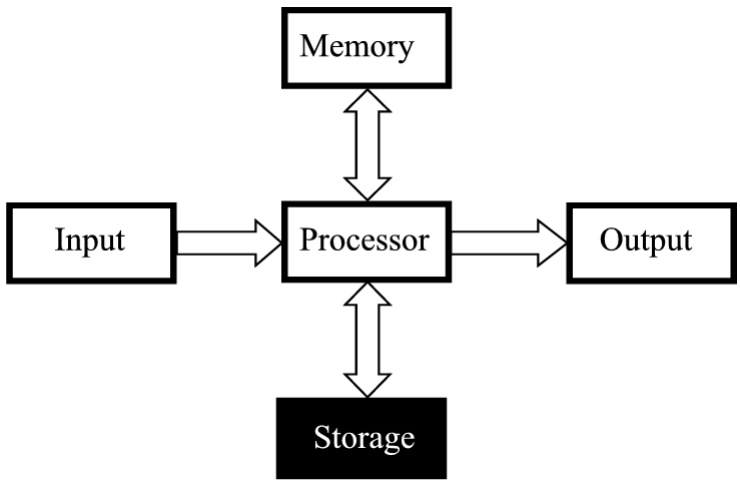
Storage



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Storage Vs. Memory

Storage (e.g., hard drive)

- Information is not needed immediately but will eventually be needed (e.g., a program is installed on the computer in case it's needed)

Memory (RAM)

- Information is required now e.g., a program that is currently running will be stored in memory.

James Tam

Storage Vs. Memory (2)

Storage (e.g., hard drive)

- The information is retained longer (e.g., a saved document).

Memory (RAM)

- The information stored here is volatile (e.g., a document you've worked on but not saved is gone when the computer is shut off).

James Tam

Storage Vs. Memory (3)

Storage (e.g., hard drive)

- Accessing the information is slower (~1,000,000+ times) but much more information can be stored (x10 to x1000+ times more than RAM).

Memory (RAM)

- Access to the information is fast but far less can be stored here.

James Tam

Storage Vs. Memory (4)

Storage (e.g., hard drive)

- Storing information is less expensive ~100 times less.

Memory (RAM)

- Storing information is more expensive.

James Tam

Common Forms Of Storage

1. Magnetic
   - Hard drives (includes older types of drives: floppy, zip)
2. Optical
   - CD
   - DVD
3. Solid State
   - USB 'thumb'/'flash' drives
   - Solid state hard drives

James Tam

1. Magnetic Storage Devices

- Include floppy disks, zip disks, hard drives
- All use magnetism to store information:

- Like other storage devices it's non-volatile but is care must be taken to avoid magnetic fields, dusty or smoky environments, or physical jolts (the latter especially when reading or writing information)

James Tam

1. Magnetic Storage Devices

- Include floppy disks, zip disks, hard drives
- All use magnetism to store information:

- Like other storage devices it's non-volatile but is care must be taken to avoid magnetic fields, dusty or smoky environments, or physical jolts (the latter especially when reading or writing information)

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2. Optical Storage Devices

- Use lasers to store and retrieve information (CD's and DVD's).
- The storage capacity difference is approximately 1:8 (CD:DVD).
- 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).
- Optical storage devices aren't as susceptible to as many problems as magnetic devices but care must be taken not to scratch or otherwise damage the surface.

James Tam

3. Solid State Storage Devices

•Portables can store a large amount of information ~8 GB – 64 GB for 'portable' forms)

•Solid state devices are fairly sturdy (come in a protective case) but reasonable care must still be taken e.g., don't remove the device when information is being saved to it, keep the cap on when it's not in use).

•All other things being equal (e.g., two internal storage devices), solid state is faster than magnetic.

James Tam

Buying Storage For Your Computer

•Common storage capacities:

- (Magnetic) hard drives: several hundred GB to 6+ TB
- CD's ~600 MB
- DVD's ~4 GB to 50 GB
- USB keys and Solid state hard drives ~8 GB (portable) approximately up to the capacity of magnetic hard drive (solid state hard drives)

James Tam

Putting It All Together

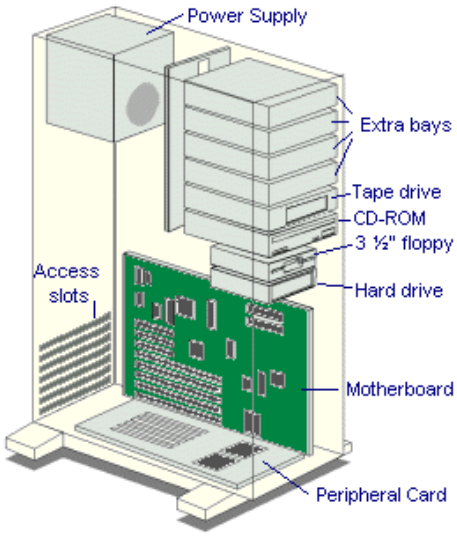

Diagram from http://www.jegsworks.com

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The Motherboard

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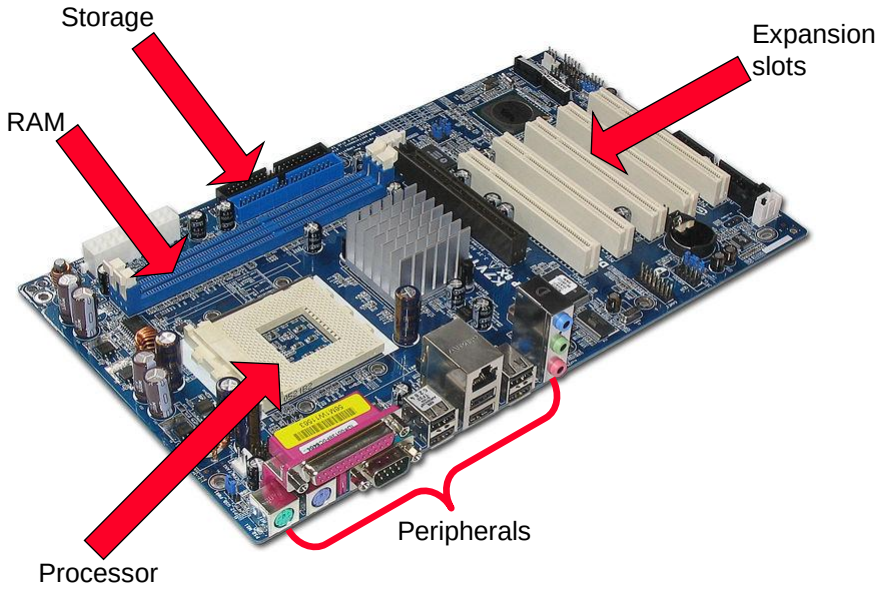
The Motherboard



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Relating The Speed Of The Computer To Its Components

Storage:
Hard drive

Memory:
RAM

Processor
cache

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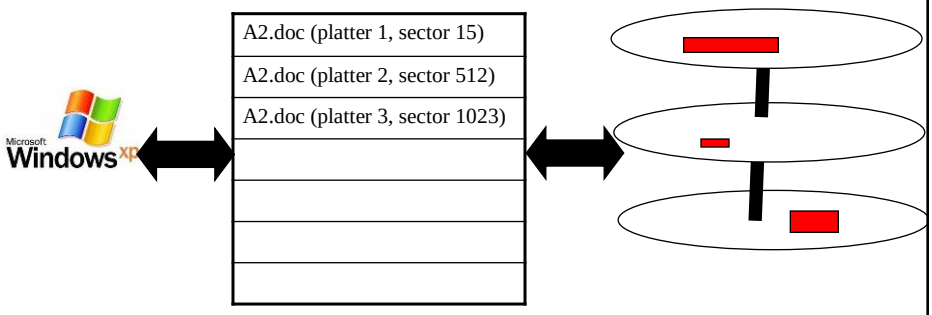
Indexing Hard Drives

•To speed up the retrieval of information from storage, information is 'indexed'.



•When the operating system searches the hard drive it actually searches the index to the drive rather than the drive itself.

James Tam

Indexing Files And Security

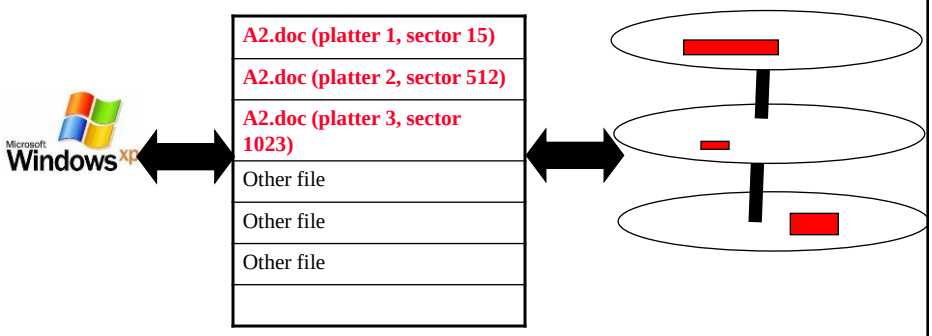
- While indexing files may speed up access it may lead to potential issues related to security.
- When is your file truly gone?
  - When it's in the recycle bin?
  - When the recycle bin has been emptied?
  - Other?

James Tam

File Recovery Programs

- May allow accidentally deleted files to be "undeleted" or files on a bad disk to be recovered.
- They are NOT meant to replace your regular backup of files.

Recall: files are indexed to increased access time



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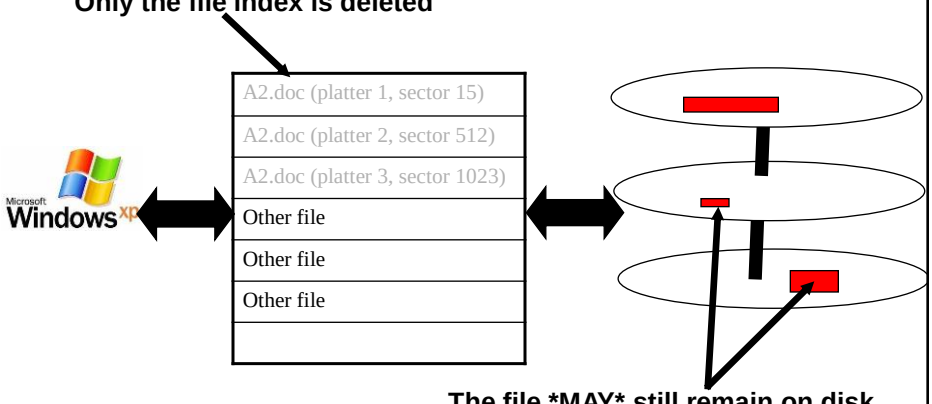
File Recovery Programs (2)

- Deleted files are often not truly deleted!

Only the file index is deleted

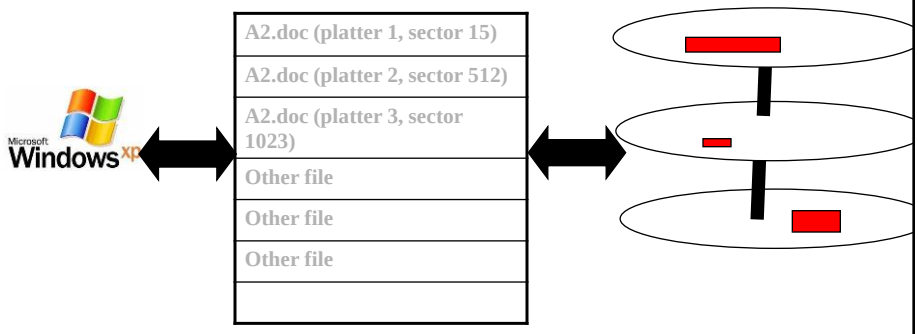


The file *MAY* still remain on disk where a program may reverse the deletion process by re-creating the index

James Tam

File Recovery Programs (3)

•*SOMETIMES* when the contents of the disk is no longer accessible, the data is undamaged and it's only the disk index that has been corrupted.



James Tam

Some Example Computer Programs To Recover Files

•Recover deleted files
- Undelete
- Pandora recovery

•Recover information from a bad drive
- R-Studio
- Spotmau PowerSuite

•Programs that can do both
- Virtuallab data recovery
- File scavenger data recovery

James Tam

After This Section You Should Now Know

- What are the six components of the high level conceptual computer and the purpose of each part
- Large and small units of measurement for the computer
- Units of storage on the computer (from bit to Terabyte)
- What is a computer bus and what is a computer port
- Common input devices
- How LCD monitors create pixels
- How pixels are used to produce text and graphics on a monitor
- How does processor clock speed work
- Approximate clock speeds of modern processors
- Some of the benefits of having a faster processor

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After This Section You Should Now Know (2)

- What is memory and its purpose in the computer
- How much memory is found in a typical computer
- The difference between storage and memory
- What are the common forms of storage and how each one works
- The maximum capacity of the common forms of storage
- How do de-fragmentation and recovery programs work
- How indexing files affects computer security

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