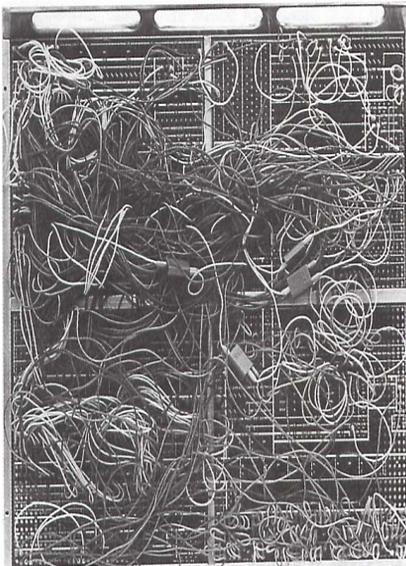


Introduction to computers

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).

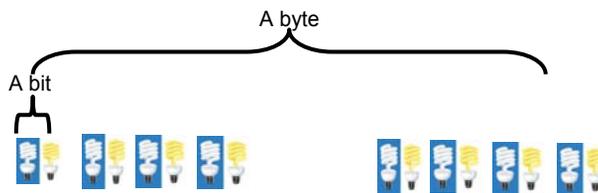


Off / on

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 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.oving89.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.
- 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 over 1 million bytes (1 MB)

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)

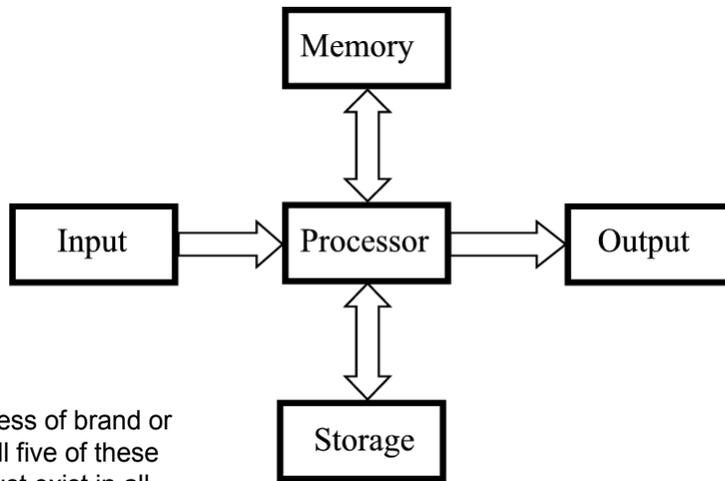
- Terabyte (TB) ~ a trillion bytes ($1,099,511,627,776 = 2^{40}$)

 X 1,000,000,000,000

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

James Tam

High Level View Of A Computer

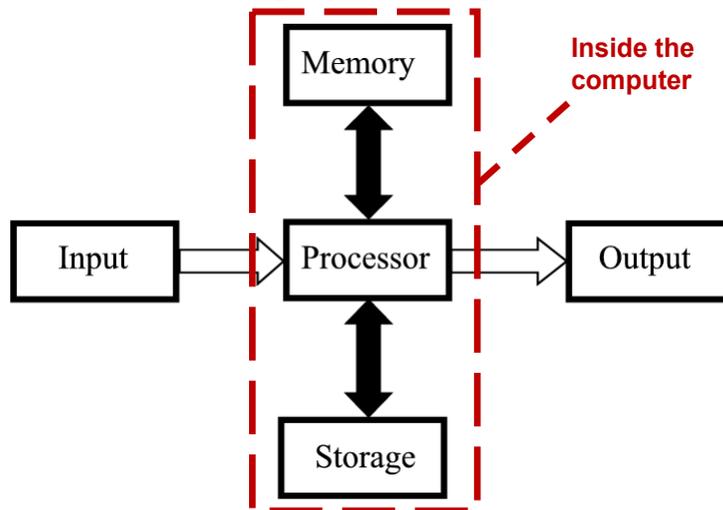


Regardless of brand or model all five of these parts must exist in all complete computer systems

James Tam

Computer Buses

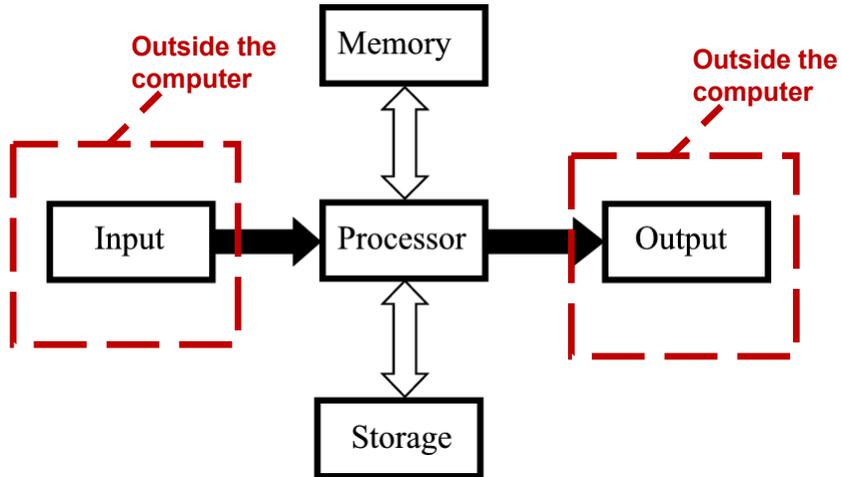
- Connect the internal parts of the computer



James Tam

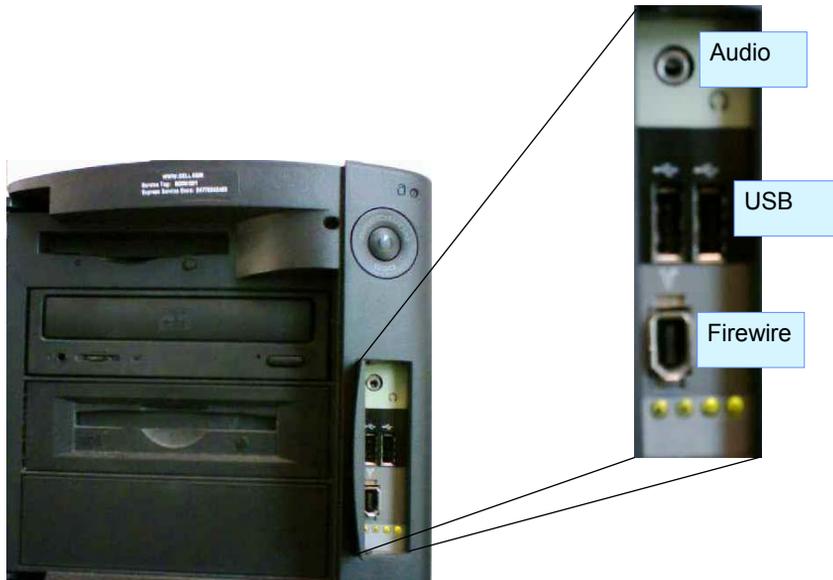
Ports

- Connects the computer to the outside



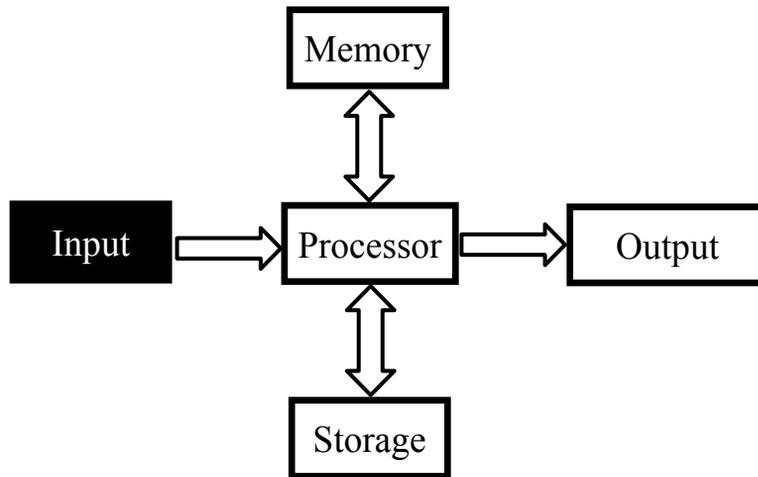
James Tam

Ports



James Tam

Input



James Tam

Input Devices

- Used by a person to communicate to a computer.



Person to
computer



James Tam

Example Input Devices

•Keyboard



•Mouse



•Stylus

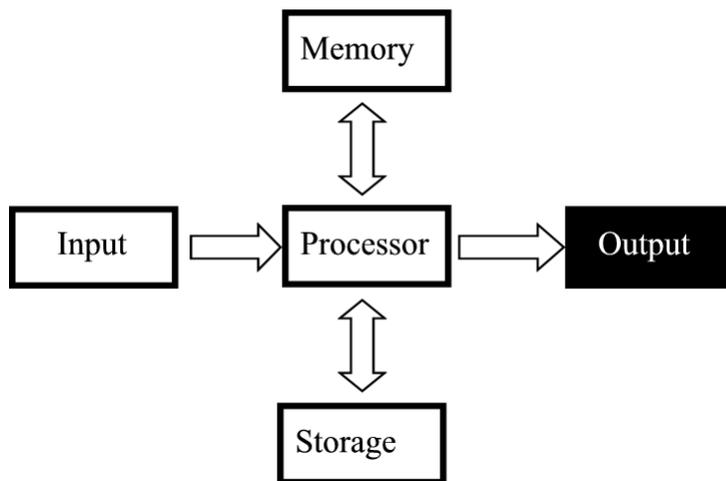


•Touch screen



James Tam

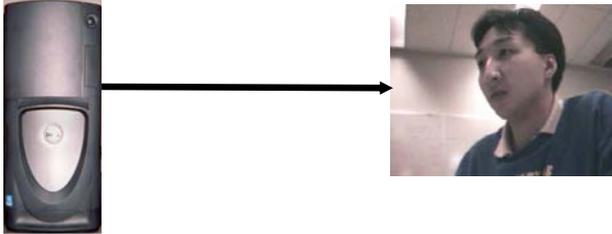
Output



James Tam

Output Devices

- Communicating information from the computer.



James Tam

The Most Common Output Device: The Monitor



James Tam

How Information Is Shown On Monitors

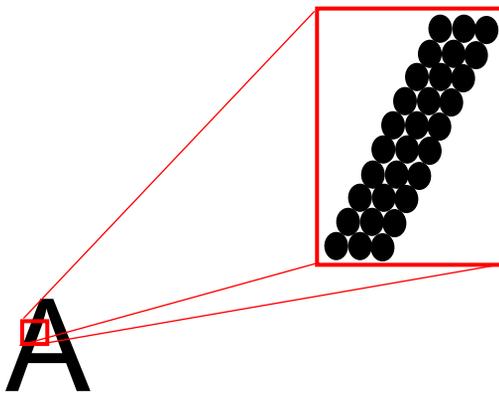
- Images and text are drawn with tiny dots (Pixels: *P*icture *e*lements)

A

James Tam

How Information Is Shown On Monitors

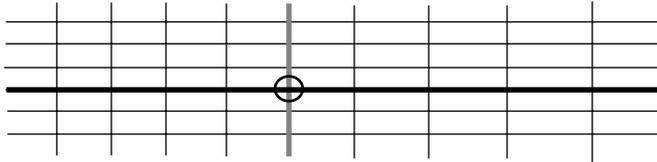
- Images and text are drawn with tiny dots (Pixels: *P*icture *e*lements)



James Tam

LCD Monitors

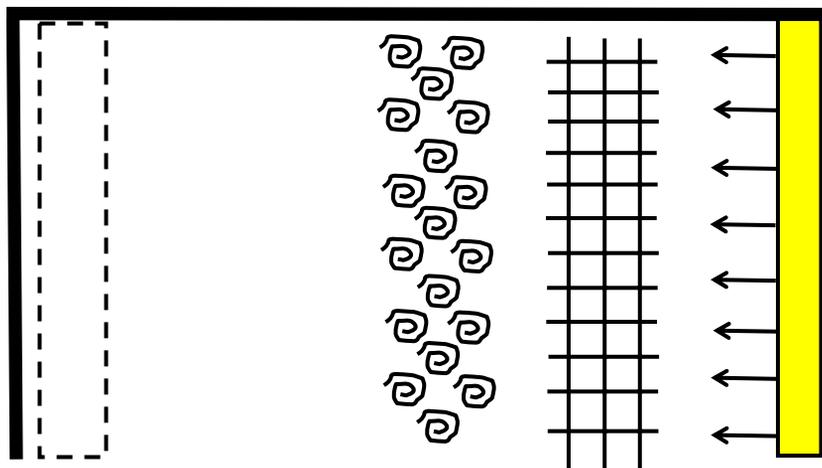
- Employ a conductive grid for each row and column.
- The meeting of a row and column allows light to be emitted (a pixel can be seen).



James Tam

LCD Monitors (2)

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



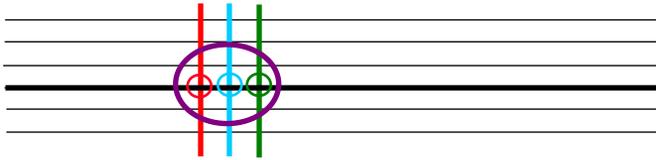
Front

Back

James Tam

Colour LCD Monitors

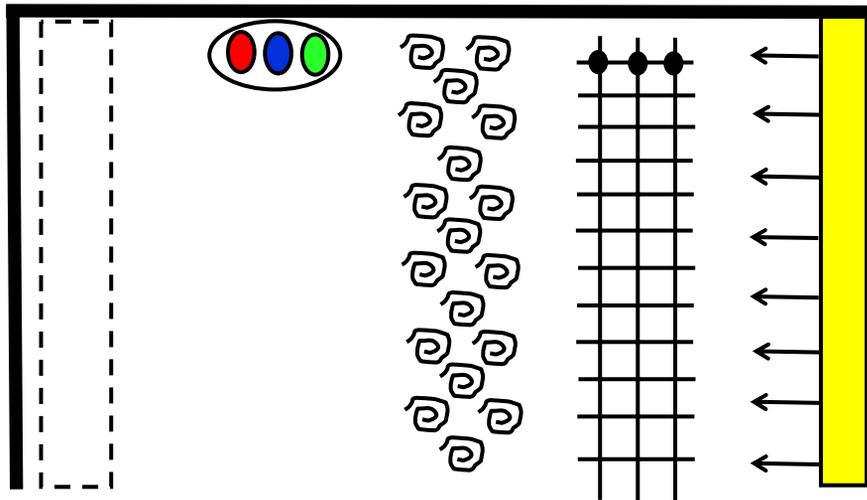
- Use three sub pixels:
 - One wire for each row
 - One wire for each sub-pixel
 - One colour filter for each colour (red, blue, green)



James Tam

Colour LCD Monitors (2)

- An extra layer is needed to produce the color pixels



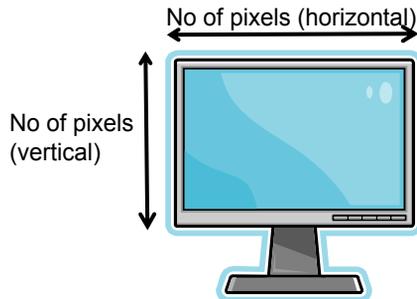
Front

Back

James Tam

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.
 - 1024 x 600 (Common max for netbooks)

James Tam

Monitor Resolution: Tradeoff

- Keep in mind that a higher resolution may result in a sharper display but objects will be smaller.

James Tam

My Desktop: 800x600



James Tam

My Desktop: 1600x1200



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)

James Tam

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



Original image



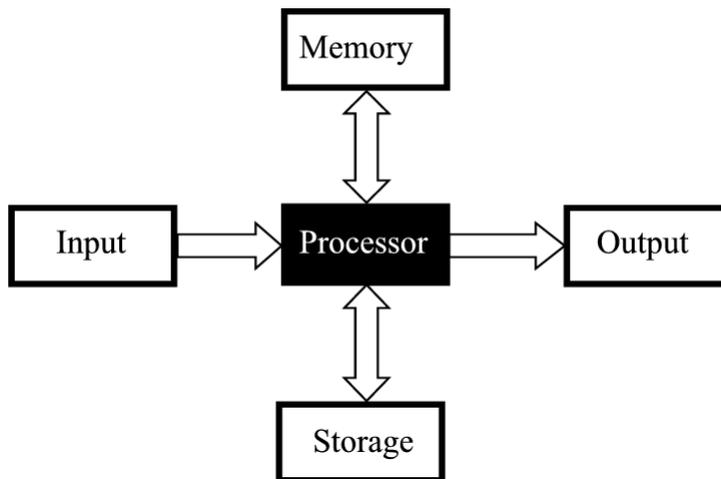
Image at non-native resolution



Thumbnail image at non-native resolution

James Tam

Processor



James Tam

Processor (2)

- With desktop and laptops it's commonly referred to as the Central Processing Unit (CPU).



- 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

Some Determinants Of Processor Speed

- The processor model
- The clock speed

James Tam

Processor Models

- The two main CPU manufacturers are AMD and Intel, the following models are the ones manufactured by Intel listed from the slowest to the fastest:
- Celeron**
 - Produced at the same time as the Pentium processors (below) they were developed as a less expensive, slower alternative.
 - If everything else is the same a Pentium will be faster than a Celeron.
- Pentium 4:**
 - Similar base architecture to the Celeron processor but additional features make the Pentium 4 faster (all things being equal).

James Tam

Processor Models (2)

- Core family of processors**
 - They're newer than the Pentium 4 and generally faster.
 - Many have multiple processing cores (2 or 4) which makes it even faster if you run multiple programs at the same time or for programs that are written specifically to run faster on multiple cores (e.g., some games or drawing programs like Photoshop)
 - More on this later).
- Laptop processors:**
 - Some of the processors used in desktop computers are also used in laptops
 - Centrino technology: includes the above processors but incorporates other technology that is useful for a laptop user:
 - Uses less power (extends laptop battery life)
 - Faster playback of high definition video
 - Built in hardware for fast wireless connections

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

- The second traditional measure of the computational speed of a computer.
- For each clock 'cycle' an instruction 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)
 - 3.8 GHz = 3.8 billion pulses sent out each second (0.26 ns between pulses)

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'

James Tam

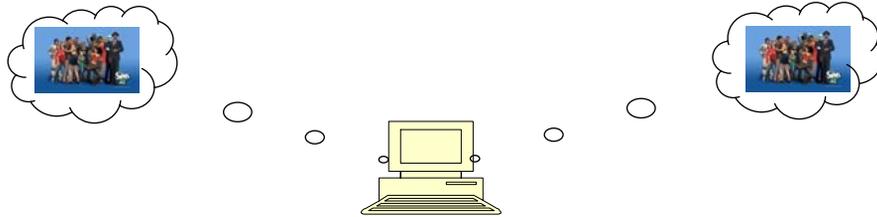
Common Processor Clock Speeds

- Budget processors
 - Laptop: ~1.06 – 2.8 GHz (Netbooks are around 0.9 – 1.6 GHz)
 - Desktop: 1.8 – 3 GHz
- Higher end processors
 - 2.33 – 3.5 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) cores.
- Each core is capable of executing its own set of instructions.



James Tam

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.
- 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 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

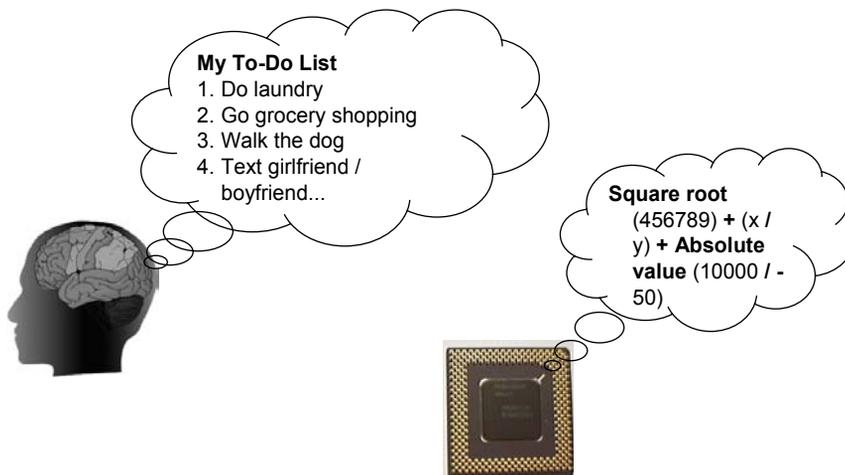
Do You Need Multiple Processing Cores? (2)

- 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).

James Tam

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)



James Tam

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

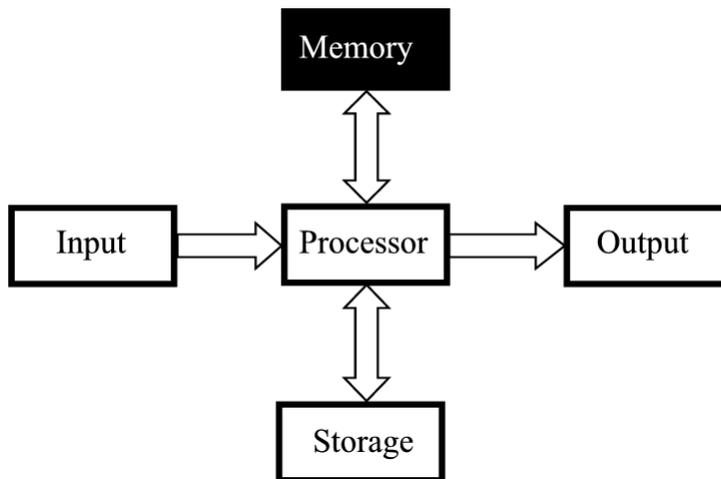
$(456789) + (x / y) + \text{Absolute value } (10000 / -50)$



Computers:
No oops allowed!
Something else is
needed.

James Tam

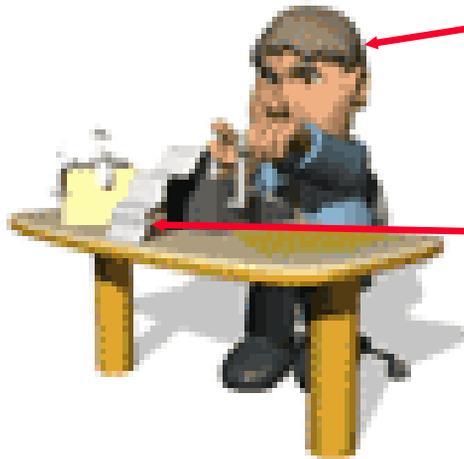
Memory



James Tam

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 store 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 (Random Access Memory)
- 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?

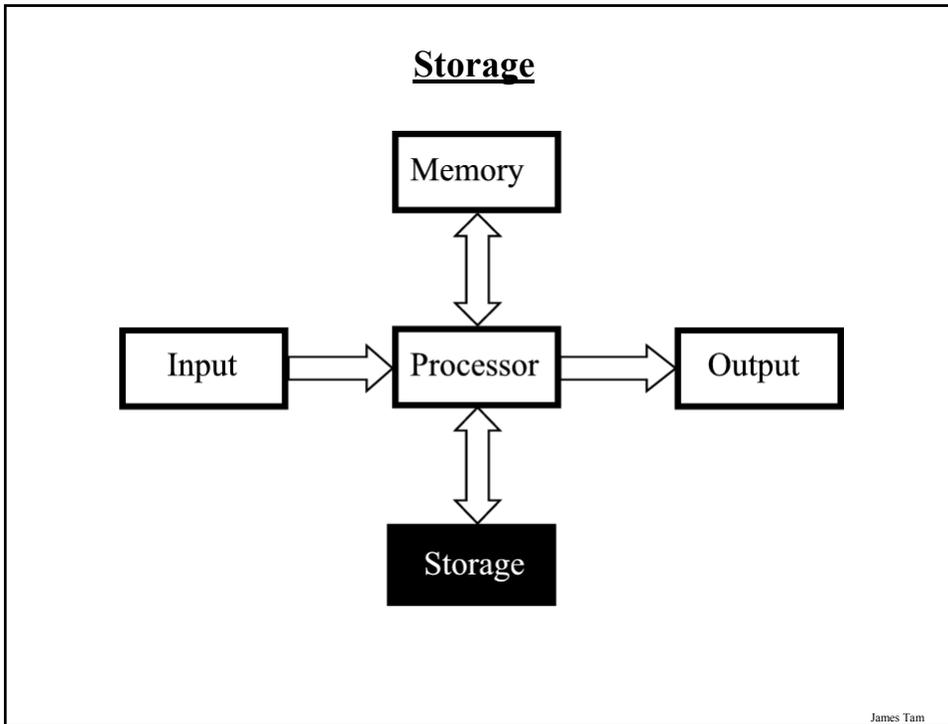
- Systems vary widely depending on price but the typical starting values range from 2 GB – 12 GB.

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 2 GB RAM:
 - Computer is turned on and Windows 7 is loaded (*minimum* of 1 GB to 2 GB of RAM – depending on whether the 32 or 64 bit version is installed)
 - 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)
 - 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 such as Viruses).
- 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)

James Tam






Storage Vs. Memory

<p>Storage (e.g., hard drive)</p> <ul style="list-style-type: none"> • Information is not needed immediately but will eventually be needed (e.g., a program is installed on the computer in case it's needed) 	<p>Memory (RAM)</p> <ul style="list-style-type: none"> • 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
 - Floppy and zip drives
2. Optical
 - CD
 - DVD
3. Solid State
 - Flash 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)

James Tam

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 record information to the disk (CD-R, DVD-R, DVD+R).
 - Can read, record and also re-write 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: Flash Memory

- Portables can store a large amount of information (~1/8 DVD – 4 DVD's of information)



- 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).

James Tam

Buying Storage For Your Computer

- Common storage capacities:
 - Hard drives: 160 GB to 4+ TB
 - CD's ~600 MB
 - DVD's ~4 GB to 50 GB
 - USB flash drives ~1 GB to 64+ GB

James Tam

Putting It All Together

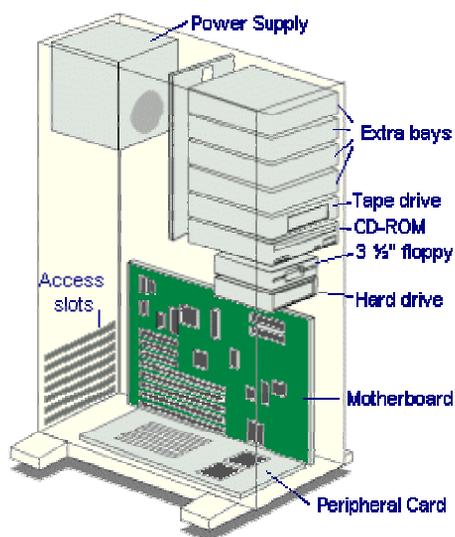


Diagram from <http://www.jegsworks.com>

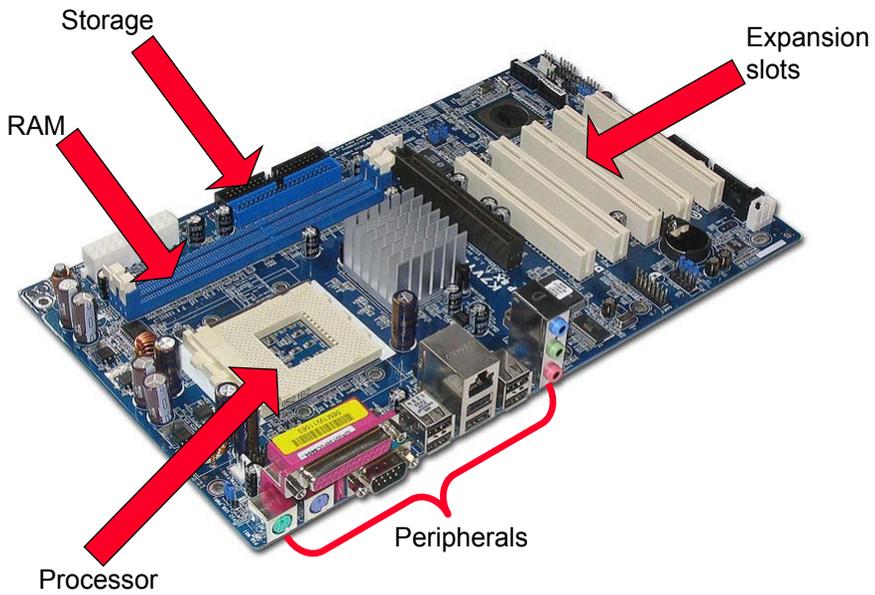
James Tam

The Motherboard



James Tam

The Motherboard



James Tam

Relating The Speed Of The Computer To Its Components



Storage:
Hard drive



Memory:
RAM



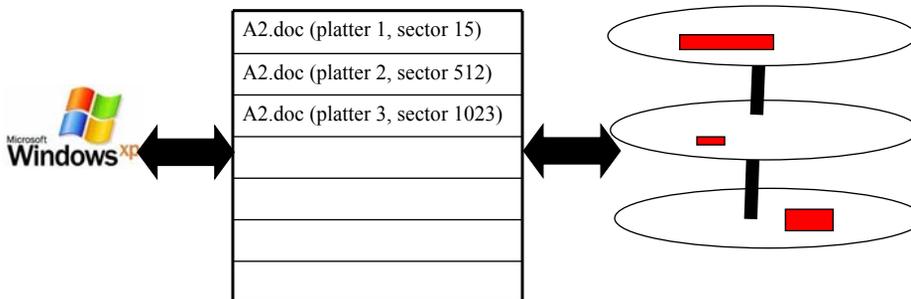
Processor
cache



James Tam

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

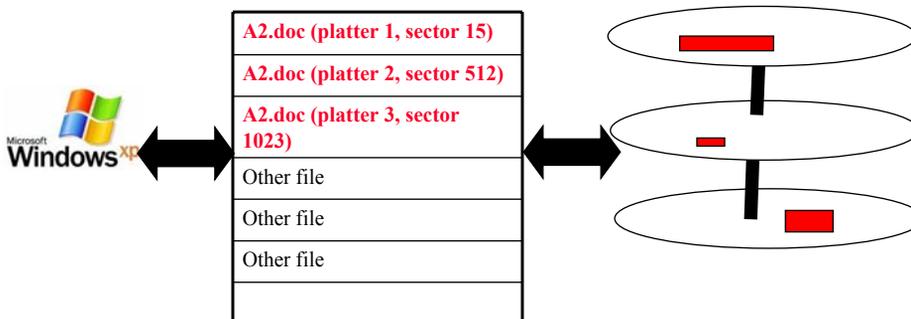
- While indexing files may speed up access it may lead to potential issues related to security.
- When is your file truly gone?
 - When it's in the recycle bin?
 - When the recycle bin has been emptied?
 - Other?

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

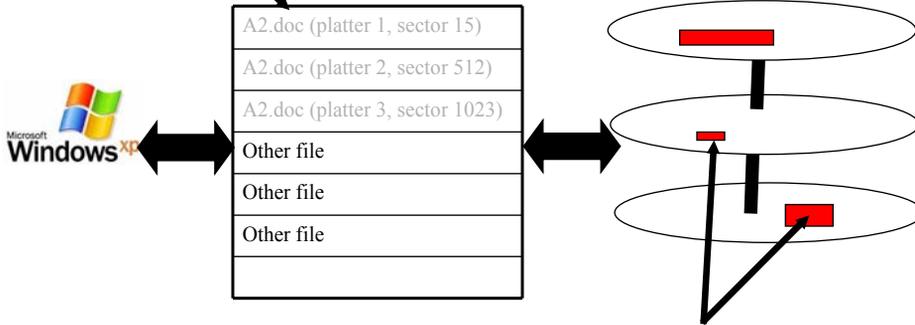


James Tam

File Recovery Programs (2)

- Deleted files are often not truly deleted!

Only the file index is deleted

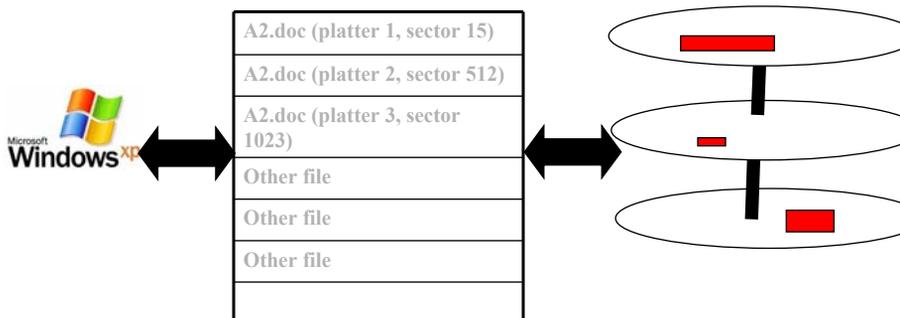


The file ***MAY*** still remain on disk where a program may reverse the deletion process by re-creating the index

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

Backup Programs

- Most operating systems include a backup utility as part of the operating system.
- The software to backup files may also come packaged with storage devices.
- Rules of thumb:
 - Backup important files as often as possible (monthly, weekly or even more often).
 - Backups *should not* be made on the same disk where the data is stored.
 - Use an external hard drive or flash drive that is only connected when the backup is taking place (to mitigate system failures or virus attacks). Disconnect it otherwise.

James Tam

Backup Programs (2)

- Rules of thumb (continued)

- For truly crucial data consider a second backup that is stored at another location separate from the computer (file attachments via email, CD/DVD's, USB flash drive etc.). Of course you may want to avoid putting private information in your email.
- After completing the backup check that the backup was successful – backups do periodically fail (reverse the backup process to check that it worked).

James Tam

After This Section You Should Now Know

- What are the five 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)
- The difference between buses and ports
- The difference between storage and memory
- How pixels are used to produce text and graphics on a monitor
- How LCD monitors create pixels
- What is meant by the display resolution of a computer and the impact of running at different resolutions
- What are some of the things that determine processor speed
- Some of the benefits of having a faster processor

James Tam

After This Section You Should Now Know (2)

- Approximate clock speeds of modern processors
- What is memory and its purpose in the computer
- How much memory is found in a typical computer and the typical maximums for the amount of memory that can be installed
- What are the common forms of storage and the characteristics of each
- The maximum capacity of the common forms of storage
- How do de-fragmentation and recovery programs work
- How indexing files affects computer security