

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

Types Of Computers

- Desktop:

- Fits on or near the desktop
- General purpose computer: schoolwork, office, entertainment, Internet



- Laptop/notebook

- *Almost* as much power as a desktop computer but provides portability



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Types Of Computers (2)

•Netbook

- Originally intended as a smaller and inexpensive laptop for: going on the Internet, composing email and it was meant only for light office tasks.



Notebook



Netbook

- Features that support portability:

- Small and light
- A built-in high speed wireless connection
- Can accept input from many types of devices that would likely be employed when outside of the office/home (e.g., digital camera memory)
- Some may have features to make them more durable

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Types Of Computers (3)

- Drawbacks of networks:

- A typical netbook is 3 – 5 times slower than a typical notebook
 - It's graphics are more limited
 - Missing a built in CD/DVD drive
 - Smaller keyboard
-
- One further note is that some of these limitations mean that a typical netbook is significantly less expensive than a typical notebook.
 - (While you pay a premium for portability when choosing a notebook over a desktop, you are receiving a discount when buying a netbook vs. a notebook).

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Types Of Computers (4)

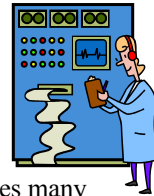


- **Workstation**

- It looks very similar to a desktop computer.
- Inside it's more powerful and used for specialized applications (drawing detailed graphics, running complex simulations etc.).
- Much like a desktop computer it's typically meant to be used by one person at a time.

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Types Of Computers (5)

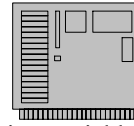


- **Main frame**

- Similar to workstations they're used for specialized situations.
- Often many users will be simultaneously using the mainframe.
- Needed when reliability is important (e.g., a company that handles many online purchases, for institutional users).
- It may not be much more powerful than a desktop computer but the increased reliability substantially increases the cost.

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Types Of Computers (6)



- Super computer

- An extremely powerful computer that can perform calculations quickly.
- Very expensive.

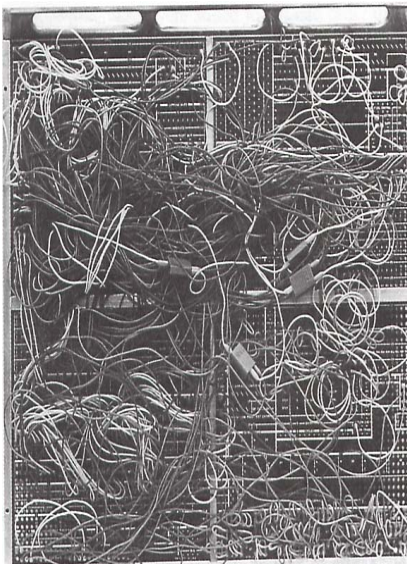


- PDA (personal digital assistant)

- A handheld computing device.
- They provide some of the power of a full computer but are only slightly larger than a mobile phone.

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Are Computers Really So Confusing?



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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).

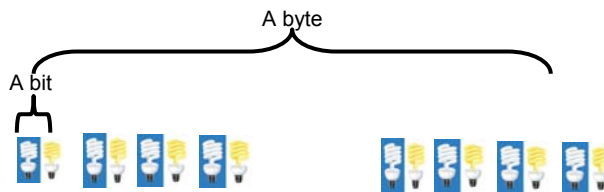


Off / on

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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)



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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/

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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

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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)

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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)

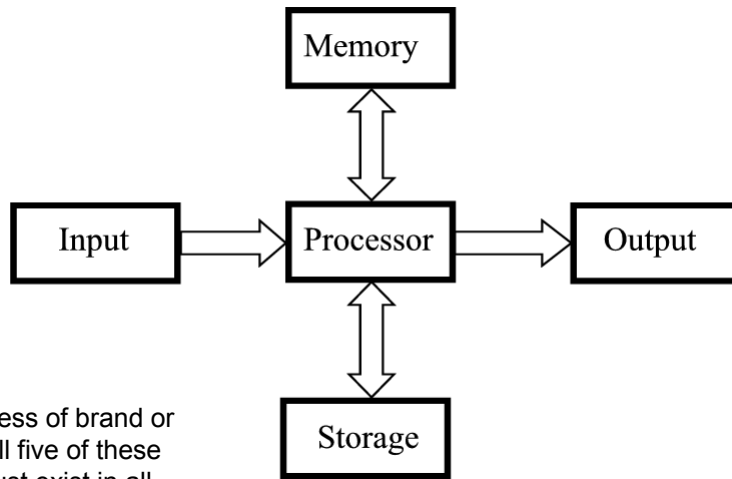
- Terabyte (TB) ~ a trillion bytes ($1,099,511,627,776 = 2^{40}$)

 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

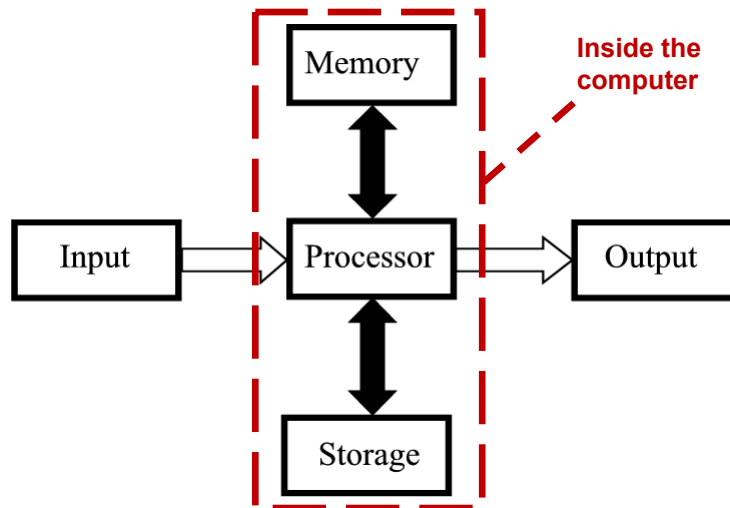


Regardless of brand or model all five of these parts must exist in all complete computer systems

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Computer Buses

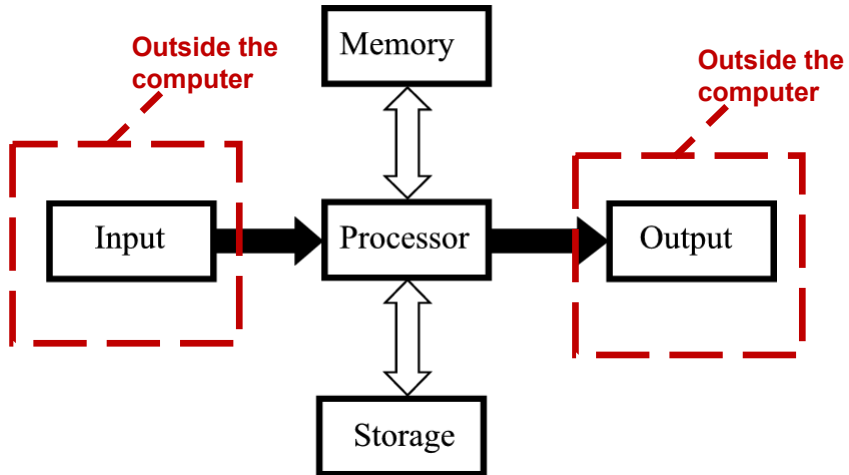
- Connect the internal parts of the computer



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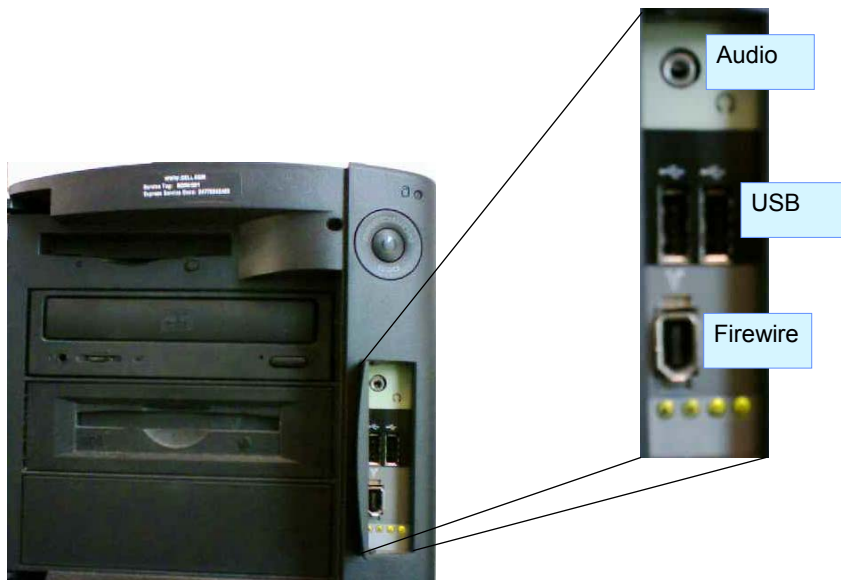
Ports

- Connects the computer to the outside



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Ports



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Ports On Modern Computers

- USB v2.0

- Speed: 480 Mbps.
- Typical devices that use this port: mouse, keyboard, printers, scanners, game controllers, digital cameras and camcorders, storage devices.



USB port



USB cable

- FireWire

- Speed 400 Mbps.
- Typical devices that use this port: digital cameras and camcorders, storage devices.



FireWire port



FireWire cable

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Ports On Modern Computers (2)

- FireWire 800

- Speed 800 Mbps
- Typical devices that use this port: digital cameras and camcorders, storage devices



FireWire 800 port



FireWire 800 cable

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Ports On Modern Computers (3)

- Ethernet/Network
 - Speed 100 Mbps
 - Typical devices that use this port: cable modems, network connections
- Gigabit Ethernet
 - Speed 1000 Mbps
 - Typical devices that use this port: cable modems, network connections



Ethernet/Giga port



Ethernet/ Giga cable

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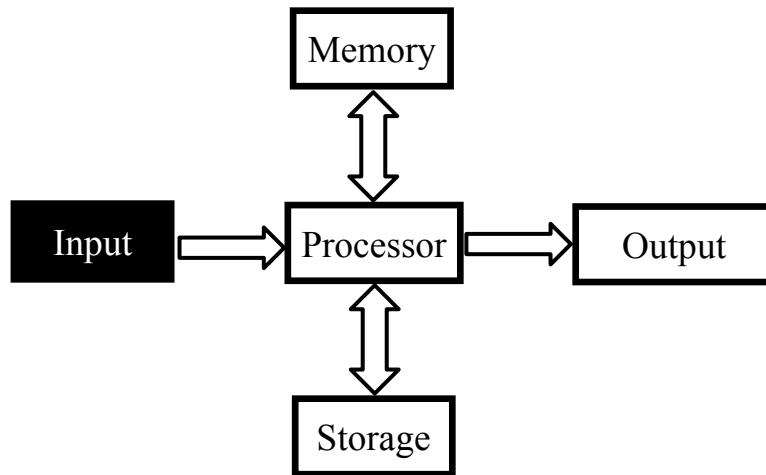
Ports On Computers (4)

- Wireless Ports
 - IrDA (Infrared):
 - Maximum speed of 4 Mbps
 - Require a direct line-of-sight
 - Bluetooth:
 - Maximum speed of 3 Mbps
 - Doesn't require a line of sight (max ~30 feet)
 - Used in place of wired (cable) connections between devices (laptops, PDA's, printers)
 - Wi-Fi (Wireless fidelity):
 - Maximum speed over 10 times that of Bluetooth or infrared
 - Doesn't require a line of sight and may allow for longer ranges than Bluetooth (300 feet)
 - Typically used to provide a Internet connection or to connect a large network



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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

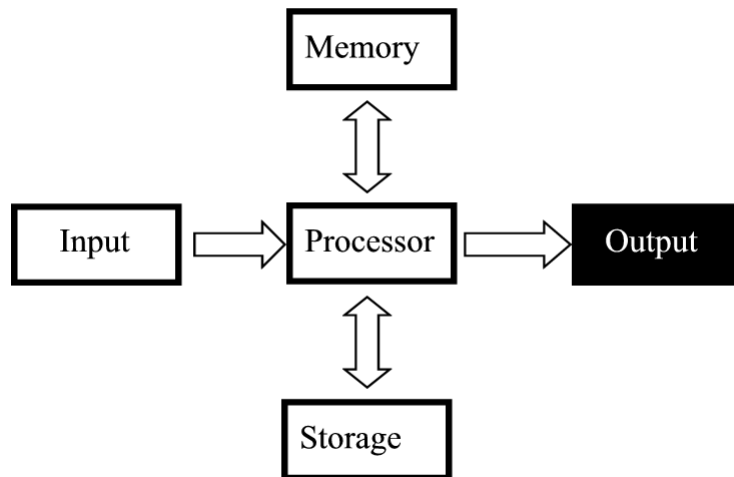


•Touch screen



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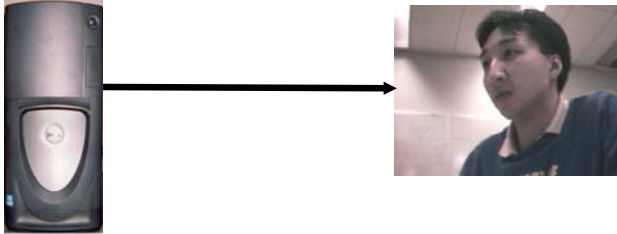
Output



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Output Devices

- Communicating information from the computer.



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The Most Common Output Device: The Monitor



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How Information Is Shown On Monitors

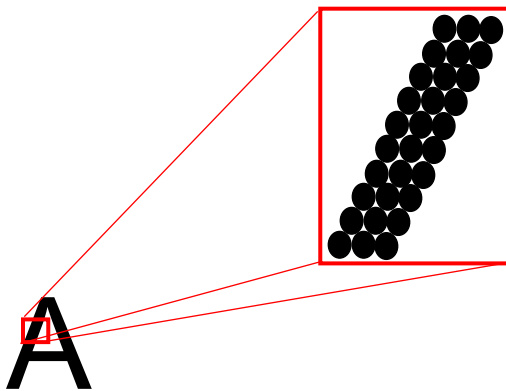
- Images and text are drawn with tiny dots (Pixels: *P*icture *e*lements)

A

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How Information Is Shown On Monitors

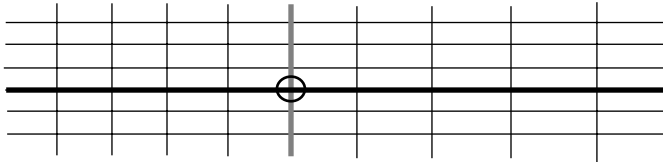
- Images and text are drawn with tiny dots (Pixels: *P*icture *e*lements)



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LCD Monitors

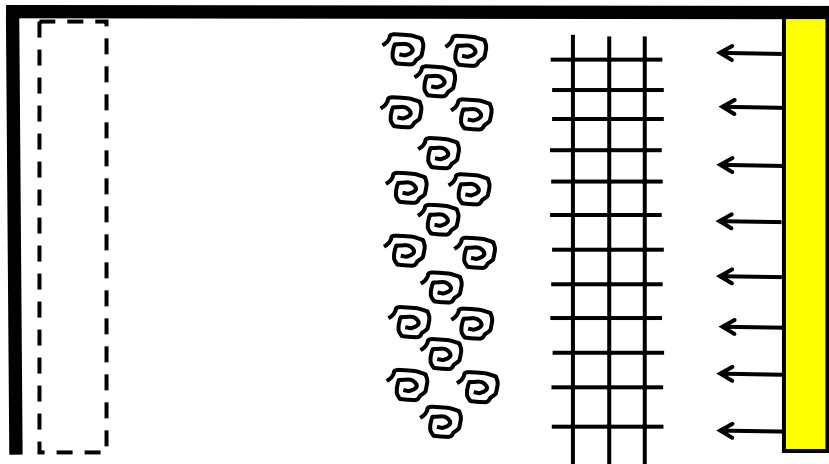
- Employ a conductive grid for each row and column.
- The meeting of a row and column allows light to be emitted (a pixel can be seen).



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LCD Monitors (2)

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



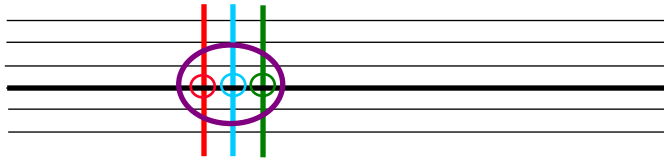
Front

Back

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Colour LCD Monitors

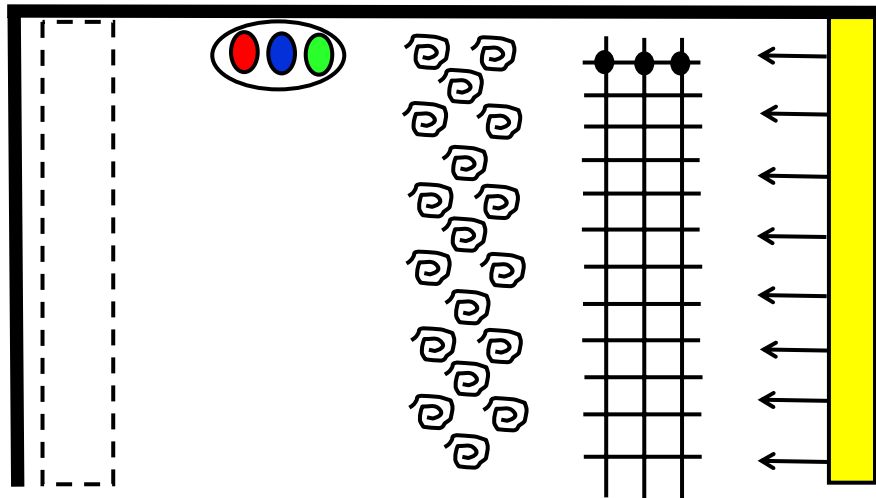
- Use three sub pixels:
 - One wire for each row
 - One wire for each sub-pixel
 - One colour filter for each colour (red, blue, green)



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Colour LCD Monitors (2)

- An extra layer is needed to produce the color pixels



Front

Back

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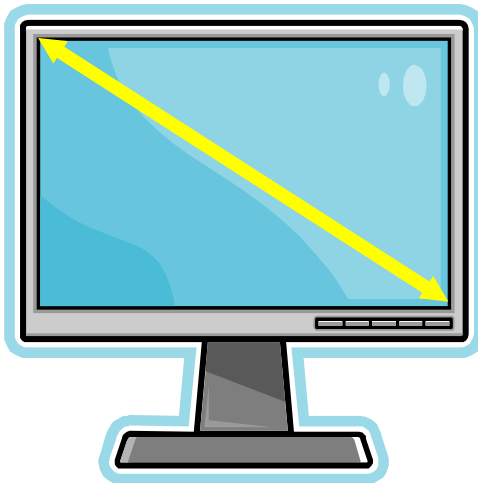
Common Characteristics Of Monitors

- Size
- Resolution
- Aspect ratio

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Computer Monitors: Size

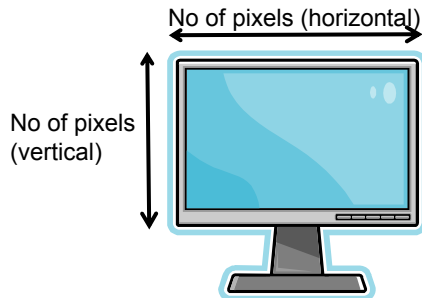
- Measured diagonally



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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.
 - 1024 x 600 (Common max for netbooks)

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Monitor Resolution: Tradeoff

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

James Tam

Monitor Resolution: Tradeoff

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

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My Desktop: 800x600



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My Desktop: 1600x1200



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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).

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A Game Running At The Native Resolution: Sharp



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

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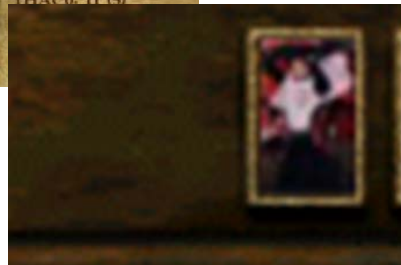
A Game Not Running At The Monitor's Native Resolution: Reduced Quality



Original image



Image at non-native resolution



Thumbnail image at non-native resolution

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Aspect Ratio

- Determined by the ratio of the horizontal and the vertical resolution.
- Full screen: 4:3 is common for productivity and even gaming e.g., 1024x768, 1600x1200 etc.
- Widescreen: 16:9, 16:10 e.g., 1280 x 800, 1680 x 1050

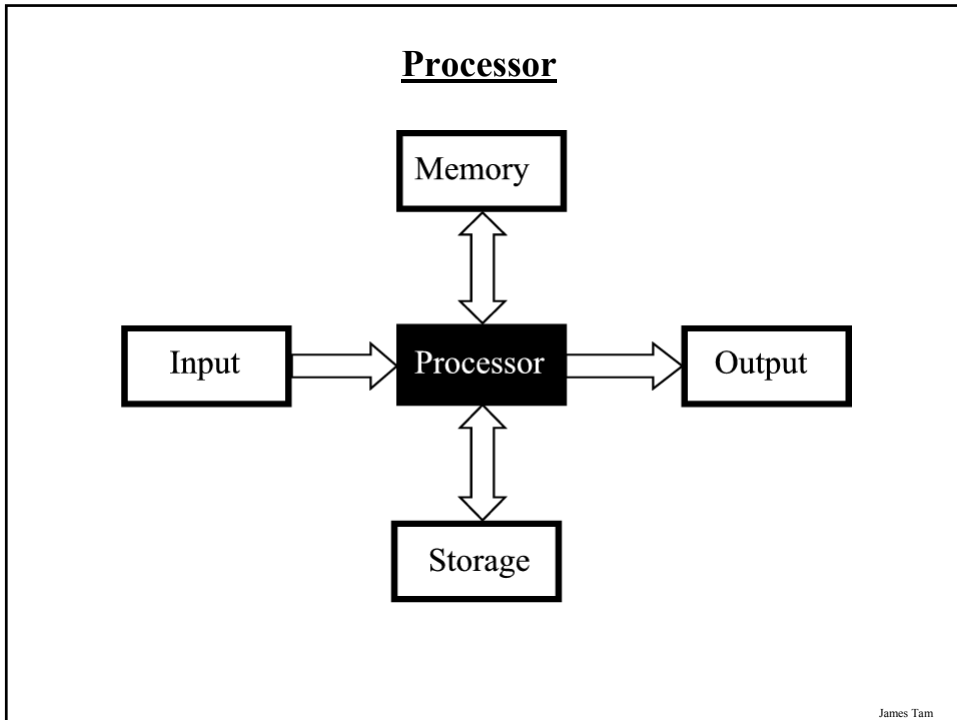
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Viewing A Widescreen Video On A Full Screen Display



Screenshots from Terminator 2: Judgment Day © Universal

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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.

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Some Determinants Of Processor Speed

- The processor model
- The clock speed

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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).

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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: one billionth ($1 / 1,000,000,000$)

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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)

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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’

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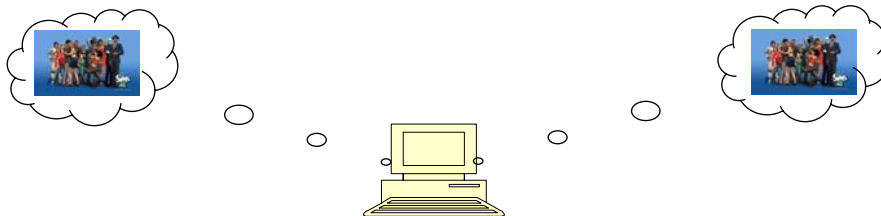
Common Processor Clock Speeds

- Budget processors
 - Laptop: 1.06 – 2.6 GHz (Netbooks are around 0.9 – 1.6 GHz)
 - Desktop: 1.8 – 3 GHz
- Higher end processors
 - 2.33 – 3 GHz

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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.



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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.
- 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.

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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)



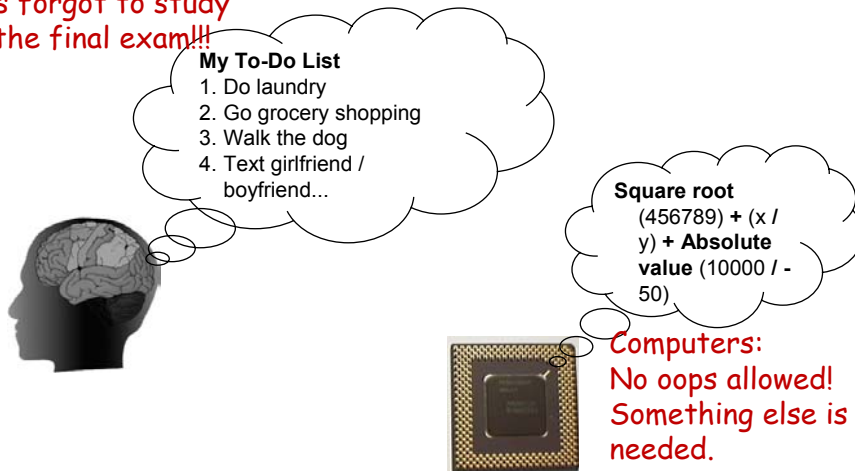
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Storage Of Information: Processors (2)

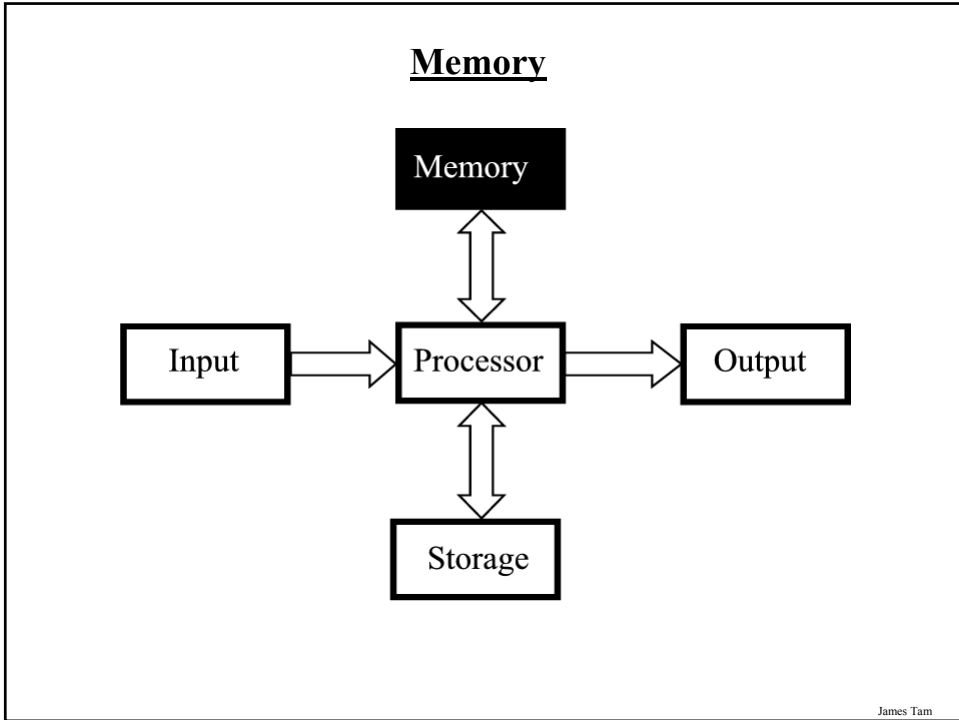
- Very often this limited storage space is insufficient.

People:

Oops forgot to study
for the final exam!!!



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

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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

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How Much RAM?

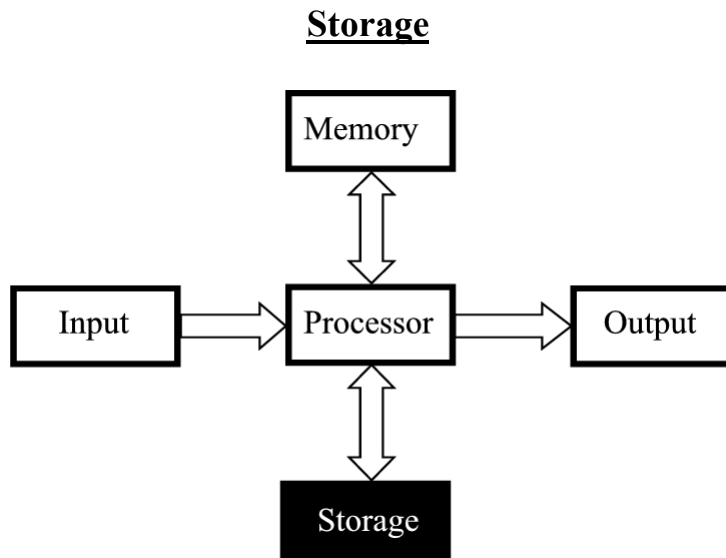
- Systems vary widely depending on price but the typical starting values range from 1 GB – 6 GB.
- The maximum RAM that can be installed on a home desktop computer is typically around 4 GB – 8 GB.

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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 Vista is loaded (*minimum* of 512 MB to 1 GB – depending upon the version of Vista - of RAM required)
 - 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 things like 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)

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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.

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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).

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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.

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Storage Vs. Memory (4)



Storage (e.g., hard drive)

- Storing information is less expensive ~100 times less.

Memory (RAM)

- Storing information is more expensive.

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Common Forms Of Storage

1. Magnetic
 - Hard drives
 - Floppy and zip drives
2. Optical
 - CD
 - DVD
3. Solid State
 - Flash drives

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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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1. Magnetic Storage Devices

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

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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).

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Buying Storage For Your Computer

- Common storage capacities:
 - Hard drives: 40 GB to 2+ TB
 - CD's ~600 MB
 - DVD's ~4 GB to 50 GB
 - USB keys and USB drives ~1 GB to 64 GB

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Printers

- Inkjet



- Laser



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Printers: How They Work

- Inkjet:

- Sprays ink through tiny nozzles onto the paper.

- Laser:

- Uses electrical charges to transfer the toner onto the paper.

- Lasers are used to change the electrical charge.

- Heat is used to bond the toner to the paper.

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Inkjet Vs. Laser Printers

- Printing photographic style pictures: only inkjets can do it.
- Speed: Laser is faster.
- Cost of the printer: Inkjet printers cost less than laser printers.
- Cost per page printed: Inkjet printers tend to cost more over time because the per page cost is higher.

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Putting It All Together

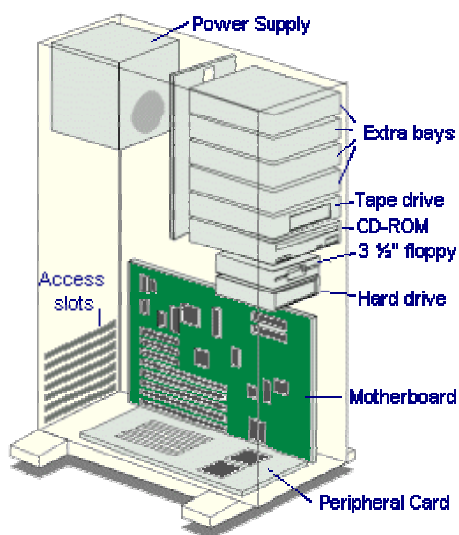


Diagram from <http://www.jegsworks.com>

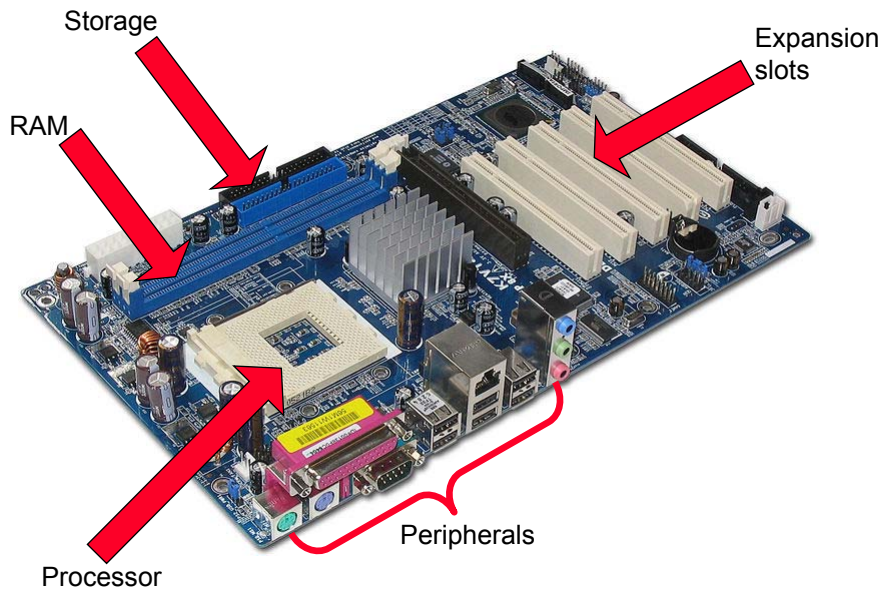
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The Motherboard



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The Motherboard



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Relating The Speed Of The Computer To Its Components



Storage:
Hard drive



Memory:
RAM



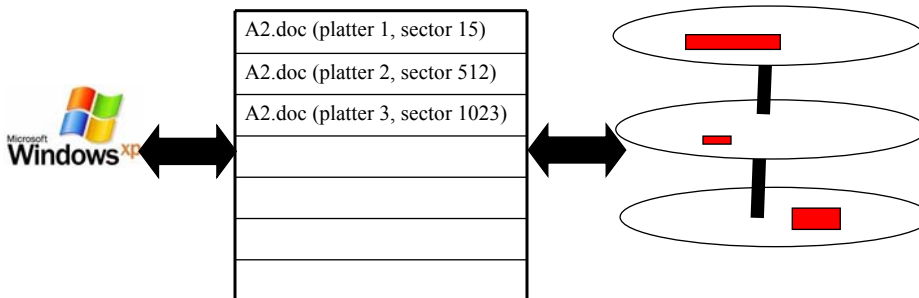
Processor
cache



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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.

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Indexing Files And Security

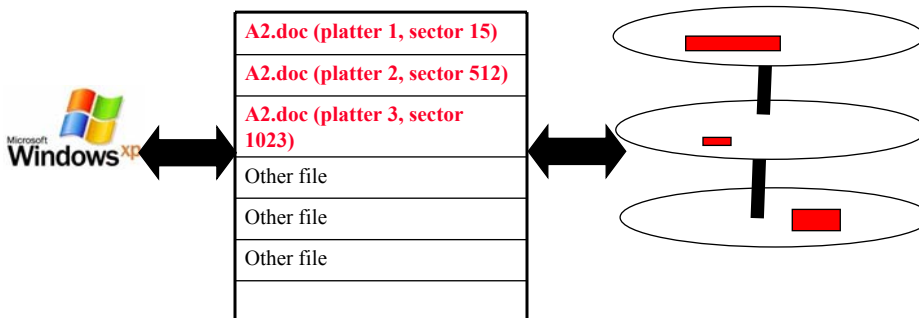
- While indexing files may speed up access it may lead to potential issues related to security.
- When is your file truly gone?
 - When it's in the recycle bin?
 - When the recycle bin has been emptied?
 - Other?

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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

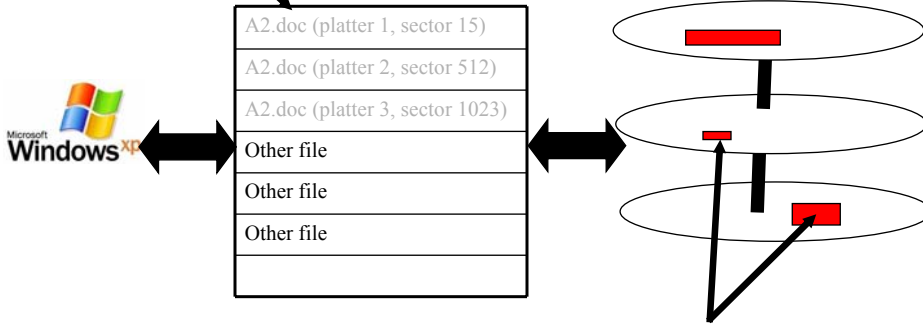


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File Recovery Programs (2)

- Deleted files are often not truly deleted!

Only the file index is deleted

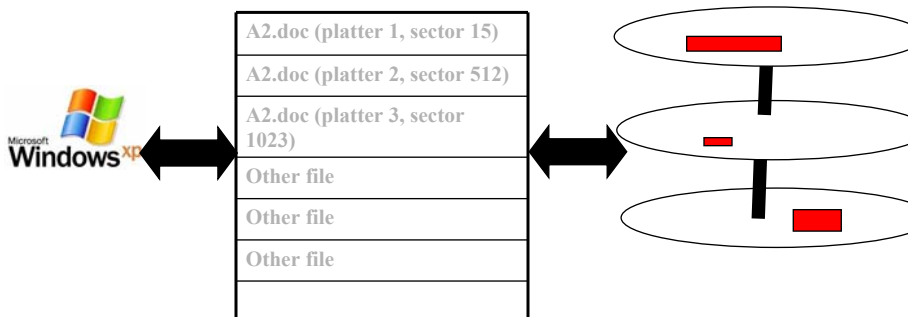


The file ***MAY*** still remain on disk where a program may reverse the deletion process by re-creating the index

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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.



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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.

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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 key 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

- The names and uses for the different types of computers (desktop, super computer etc.)
- 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)
- What is a computer bus
- What is a port and some of the characteristics of the more common ports
- The difference between storage and memory
- How pixels are used to produce text and graphics on a monitor

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After This Section You Should Now Know (2)

- How LCD monitors create pixels
- What are the common characteristics of computer monitors
- What are some of the things that determine processor speed
- Some of the benefits of having a faster processor
- 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

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After This Section You Should Now Know (3)

- What are the common forms of storage and the characteristics of each
- The maximum capacity of the common forms of storage
- How inkjet and laser printers work as well as their relative strengths and weaknesses
- How do de-fragmentation and recovery programs work
- How indexing files affects computer security

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