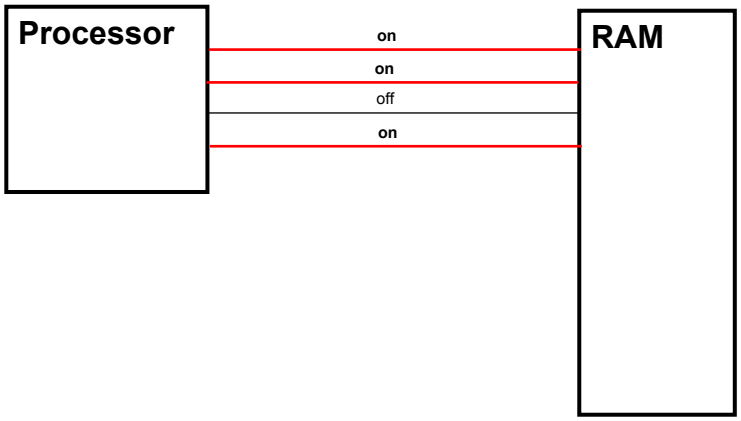
Advanced Topics In Hardware

You will learn the inner workings of the hardware components introduced in the previous section.

Computer Buses: How Information Is Transmitted

- Carries information between the different parts of the computer.
- Information is transmitted via electrical currents on wires.



Recall: There Are Two Types Of Buses

- Data buses: carry the information.
- Address buses: determine where the information is sent.

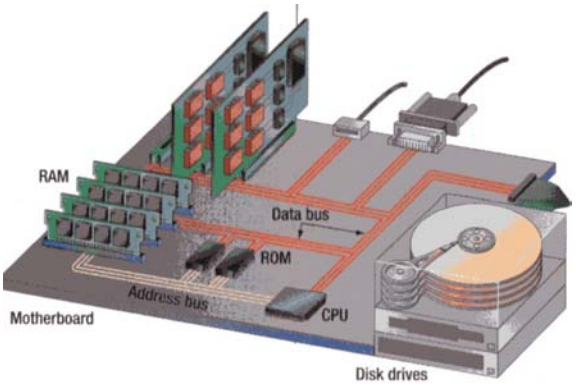


Image from Peter Norton's Computing Fundamentals (3rd Edition) by Norton P.

Word Size

- **Word size:**
  - It's the width of a bus (number of wires).
  - Typical word size for home computers is 32 bits (although support for 64 bit buses is becoming more common).
  - Very powerful computers may have a word size of 128 bits.
- **Data bus:**
  - The word size of the data bus determines *how much information* can be transported.
- **Address bus:**
  - The word size of the address bus determines how many locations that information can be sent to.

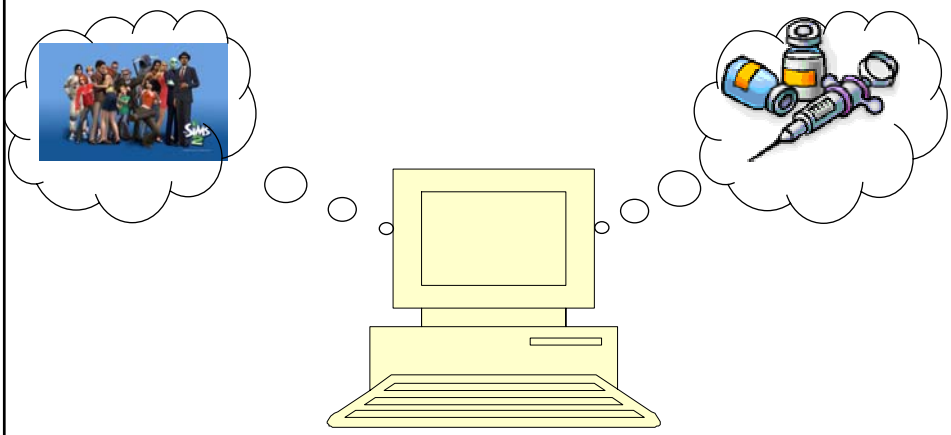
Factors That Determine Processing Speed

- What you know: traditional measures
  - Processor model
  - Clock speed
- Clock speed maximums have been approaching a limit:
  - Heat
  - Power consumption
- Consequently it's become less of determining factor in the processing speed of a computer.
- Other factors:
  - Hyper Threading
  - Number of processing cores
  - Processor cache
  - Front side bus speed

James Tam

Processors Without Hyper-Threading

- Execution may be slower because when multiple programs are running because the processor must switch it's attention.
- Example running a game and an anti-virus program:



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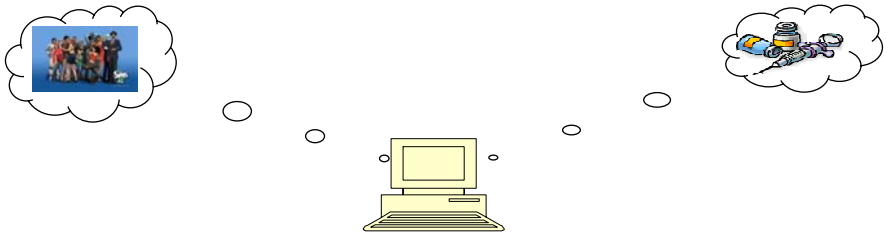
Hyper-Threading Technology

- Splits the instructions to be executed by the processor, which may increase the speed of the computer when running multiple applications).
- Example running a game and an anti-virus program:



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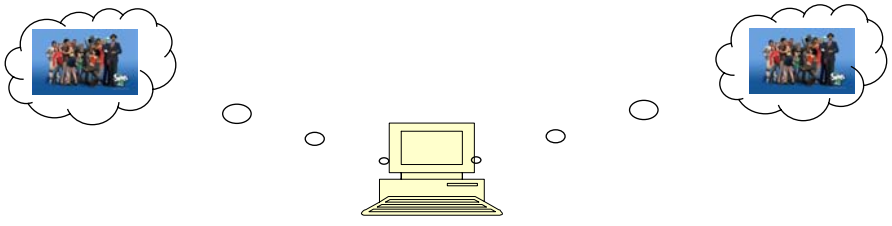
Multi-Core Technology

- A core is the part of the processor that's capable of executing instructions and has some space to store information.
- The processor is split into multiple (dual = two, quad = four) 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.
- 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.
    - The single processor intensive program that you do run is not optimized to run on a multi-core processor.

Do You Need Multiple Processing Cores? (2)

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

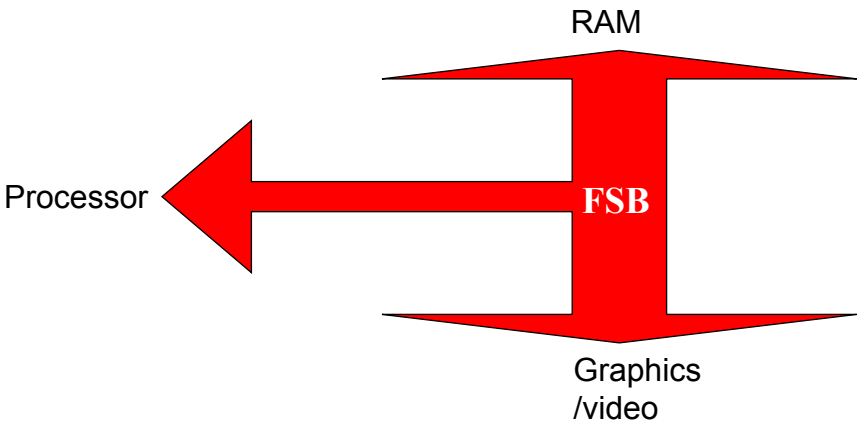
The Processor Cache

- The cache is fast memory that's either on or near the processor.
- The processor and RAM operate at different speeds: The cache bridges the speed difference between the processor and RAM.
- There's different "levels" of processor caches (L1, L2, L3) but the one that typically has the greatest effect on speed is the L2 cache:
  - (Very) old processors: no cache
  - Budget processors: ~2 – 6 MB L2 cache
  - Higher end processors: ~4 – 12 MB L2 cache

James Tam

Front-Side Bus Speed

- Determines how quickly information can be transferred to/from some of the other parts of the computer to the processor.
- Measured in MHz



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Common Front Side Bus Speeds

- Budget processors
  - (Laptop): 800 – 1033 MHz
  - (Desktop): 800 – 1333 MHz
- Higher-end processors
  - 1066, 1333, 1600 MHz

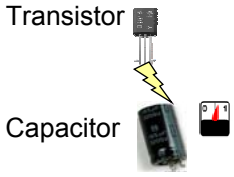
RAM: Storing Information

- Information is stored in RAM, the basic unit of storage is the bit: (memory is in one state or the other).
- Model used:
  - If the 'storage container' is at a certain level or above then the container is treated as if it were on one state (full).
  - If the container is below that cutoff level then it's regarded as being in the other state (empty).

From: www.hotwstuffworks.com

RAM: Storing Information (2)

- Actual model employed:
  - Power levels are used to determine state in RAM.
  - Each bit requires a transistor and capacitor pair.
  - The transistor controls the flow of electricity to the capacitor which stores the power.



DRAM: Main memory is Dynamic RAM (dynamic because the power must be periodically refreshed).

Static RAM (SRAM)

- Static: Stores information based on power levels (on/off) but unlike Dynamic RAM it does not need to be refreshed (which takes time) so SRAM is faster than DRAM.
- As long as the computer is powered, SRAM can retain information about which state it's currently in.
- SRAM is more expensive and is used in a more limited fashion, typically just in faster memory (e.g., cache).

Types Of DRAM

1. SD-RAM (Synchronous dynamic random access memory)
   - Synchronous: Timed with the processor
   - Widely available since the 1990's
2. DDR (Double data rate) SD-RAM
   - 2001+
   - Doubles the transfer rate of regular SD-RAM
3. DDR2 SD-RAM
   - 2003+
   - Doubles again the transfer rate of DDR SD-RAM
4. DDR3 SD-RAM
   - Latter half of 2007
   - Doubles again the transfer rate of DDR2 SD-RAM

James Tam

Storage: Hard Drives

- Typical ranges: ~250 GB – 1 TB (desktops), ~120 GB – 500 GB (laptops).
- Rotational speeds: 5400, 7200, 10000+ rpm

- Type of interface: IDE/ATA (older), SATA (newer)

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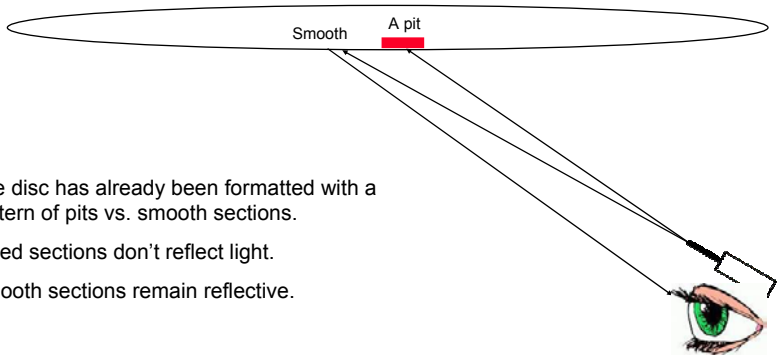
Optical Drives: Reading Information

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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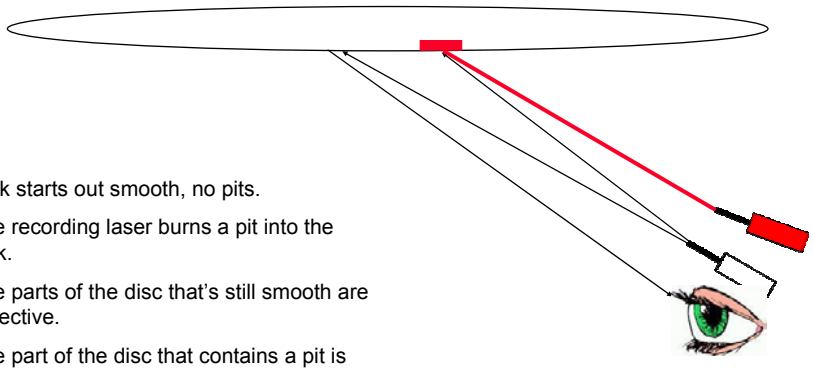
Optical Drives: *R*ecording And Reading Information

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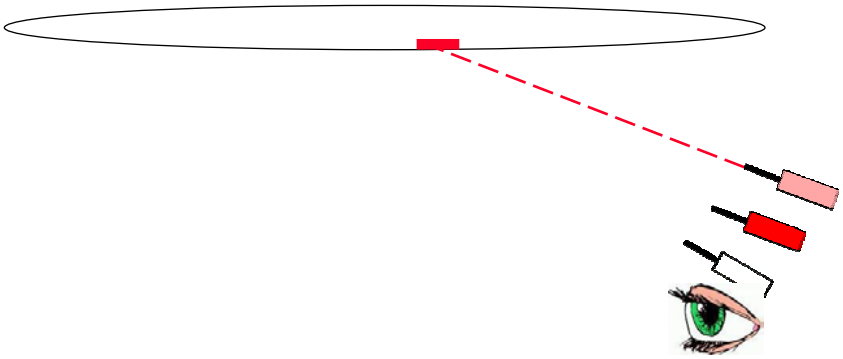
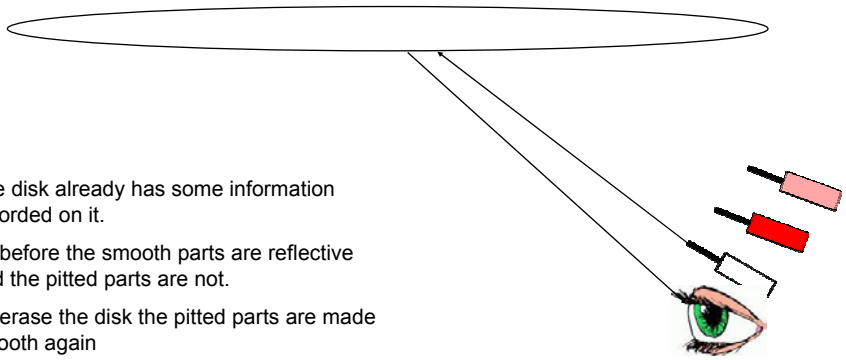
Optical Drives: *R*e-*W*riting

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

CD/DVD Drives

- Some considerations:
  - Speed
  - Single layer/single sided and dual layer/double sided
  - Next generation DVD: Blu-ray, HD-DVD (discontinued)

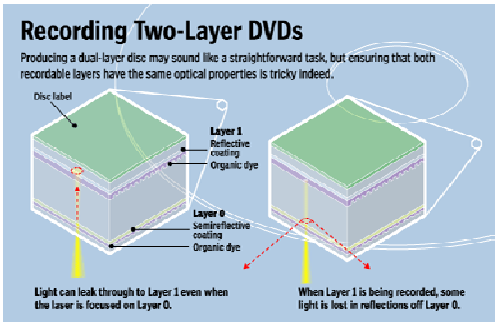
CD/DVD: Speed

- **CD Speeds:**
  - Stated in the form of 3 numbers e.g., 52x32x52
  - These three numbers state the maximums for:
    - (Write speed) x (Re-write speed) x (Read speed)

- **DVD Speeds:**
  - Sometimes they are listed in the same format as CD speeds
  - Other times they are listed in the form of two numbers e.g., 16x16
    - (Write speed with 'plus' DVD discs) x (Write speed with 'minus' DVD discs)
  - Or they may be listed as a single number e.g., x16
    - (Write speed with 'plus' or 'minus' DVD discs

CD/DVD: Multi-Layer, Multi-Sided

- Double sided:
  - Allows information to be written on both sides of the disc
- Dual layer ("-DL")
  - An extra layer of dye is added to allow for a larger amount of information to be written.



www.pcmag.com

DVD: Capacities

Type	Capacity
Single sided, single layer	4.7GB
Single sided, dual layer	8.5GB
Double sided, single layer	8.75GB
Double sided, dual layer on one side	9.4 GB
Double sided, dual layer on both sides	15.9GB

A Next Generation DVD Format: Blu-Ray

- Uses a different light frequency for the laser.
- Results in high capacity storage:
  - 25 GB (single layer)
  - 50 GB (dual layer)
- Backward (but not forward) compatibility is possible

James Tam

Solid State Storage Devices: How They Work

- Portables can store a large amount of information (~1 – 64 GB)

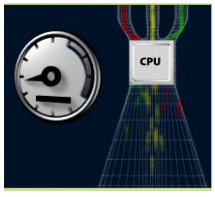
James Tam

Graphics/Video Cards

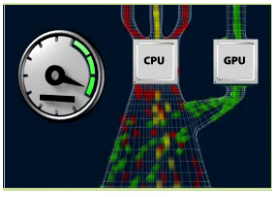
- Sometimes they're built into the main part of the computer (integrated graphics) and not a separate card.
  - Integrated graphics: sufficient for applications that don't display complex graphics e.g., word processing, browsing pages with just text and images on the web.
- Other types of applications require dedicated hardware for graphics (separate graphic/video card):
  - Games: Drawing high quality graphics and producing realistic looking animations is obviously crucial for running some of the newest games.
  - Productivity software e.g., 3D drawing programs, video editing, CAD programs etc.
- Also it can be an important consideration if you upgrade your operating system to Windows Vista.

Some Considerations When Buying A Graphic/Video Card

1. It's mostly about U...The GPU (*G*raphic *P*rocessing *U*nit)



Without a GPU



With a GPU

Images from Nvidia

- Typical speeds ~550 – 730 MHz

Some Considerations When Buying A Graphic/Video Card (2)

2. Don't forget about memory (of the graphics/video card).
   a) Video cards also have dedicated memory (VRAM).
   b) All things being equal a video card with a fast GPU will deliver better performance than one with a slower GPU but more memory.
   c) However with GPU's being equal the video card with additional memory may deliver superior performance.
   d) Typical ranges 256 MB – 1 GB.

Some Considerations When Buying A Graphic/Video Card (3)

3. DirectX 10 support...especially if you have Vista.
4. Type of interface: PCI (very old), AGP, PCI-E (newest)

Putting It All Together

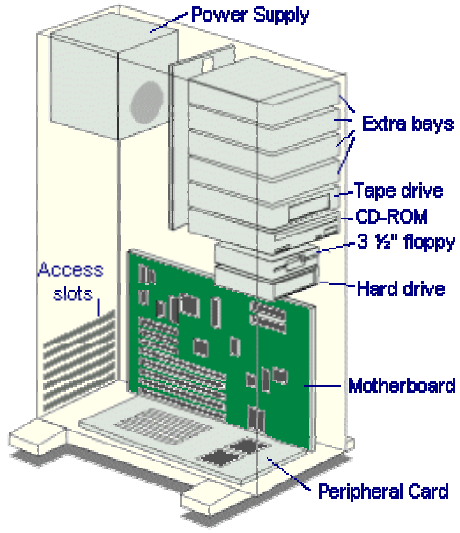


Diagram from http://www.jegsworks.com

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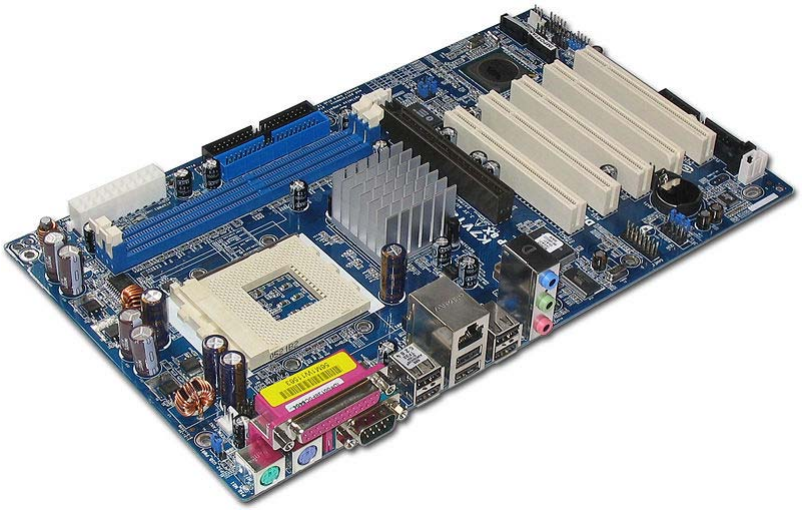
The Motherboard



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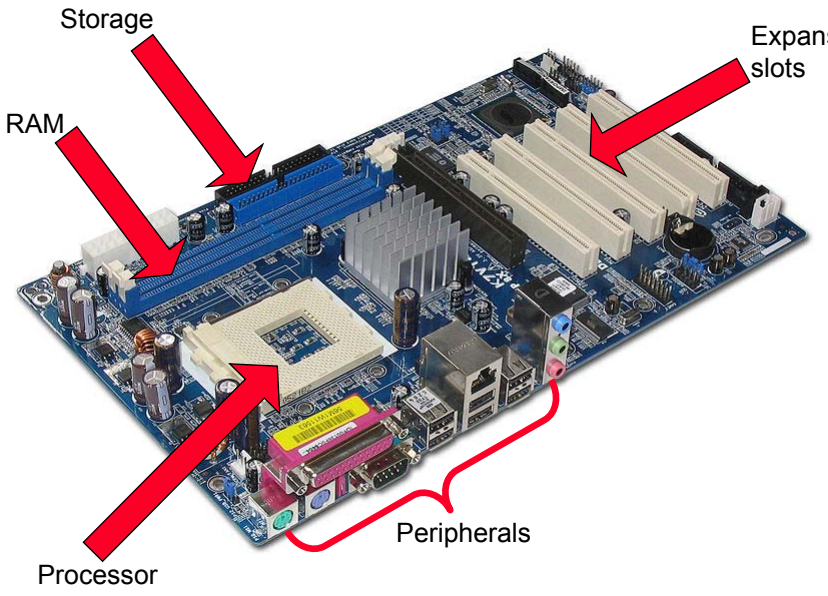
The Motherboard



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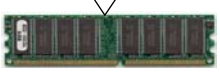
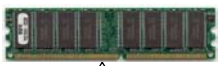
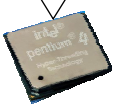
Relating The Speed Of The Computer To Its Components

Storage:
Hard drive





Memory:
RAM



Processor
cache

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You Should Now Know

- What are the two types of buses and the purpose of each
- How a data bus transmits information using different combinations of on and off (bit states)
- How the word size of the address and data bus effect the capabilities of a computer
- What are the factors that effect processing speed beyond the model and clock speed
  - When technology such as hyper threading and multi-core processors increase speed when running a single program and when running multiple programs, and when they have no effect
- How is a bit stored in RAM
- What is the difference between SRAM and DRAM

James Tam

You Should Now Know (2)

- The amount of memory that typically comes with a modern computer
- What are the different types of DRAM and the approximate speed of each
- Some important technical characteristics of hard drives
- The approximate storage capacities of the various storage devices
- How optical drives retrieve, store and erase information on discs
- Technical considerations to when buying an optical drive
- Approximate storage capacities of different optical drives
- How flash memory works

James Tam

You Should Now Know (3)

- Some of the important considerations when buying a graphics/video card
- How the different parts of the computer are related to each other and how speed is determined by multiple hardware devices
- What is a motherboard