

Computers

A basic introduction into computer hardware and
a practical guide to using computers

Section I

INTRODUCTION TO COMPUTER HARDWARE

Technical Specifications

- Hardware: the physical ‘touchable/hard’ components of a computer
 - Software (many are often referred to as “Apps”) : the programs that control or run the hardware
- Rather than presenting a long list of hardware specifications and how things work for it’s own sake, the focus will be on providing some of the information you will see when actually buying a machine.
 - However due to brevity - a complete computer buyer’s guide would constitute a complete (continuing education) lecture only a subset of some of the more pertinent/common specifications will be covered.
- (This is very basic material to bring everyone up to a basic level)
 - Later sections can be more challenging (e.g.. VBA programming)

Example Technical Specifications

- Paraphrased from an online electronics retailer:
 - “Equipped with an Intel Core i7 processor, 12GB RAM, and NVIDIA GeForce GTX 1050 graphics, this PC offers reliable performance whether you’re streaming HD videos or editing photos.” ([3.6 GHz 4th generation Intel Core i7-4790, 8 GB RAM](#))
 - 3.6GHz Intel Core i7-7700 processor ([3.6 GHz Intel Core i7-4790](#))
 - “1TB hard drive large digital warehouse to store all your files, photos, videos, music, and much more” ([1 TB hard drive](#))
 - “6 USB ports, including 2 USB 3.0 ports, let you plug in peripherals, while an HDMI output...” ([Some USB 3.0 ports, most USB 2.0](#))
 - “HDMI output delivers crisp high-quality visuals and high-fidelity audio to a home theatre or monitor through a single cable connection”
 - FYI: \$1,139.99 ([\\$949 in 2015 \\$](#))
 - Last accessed from www.bestbuy.ca August 2018 ([June 2015](#))

Which Type Of Computer Is Best For You?

- No single category, model (let alone manufacturer) is best for everyone
- Ask yourself how you will use your machine, what things are the most important to you:
 - Portability?
 - Touch screen capability?
 - Will you run programs that will 'push' your system e.g., video editing, 3D gaming, image and 3D graphic editing or will you use your computer mainly for common tasks (e.g., word processing, spreadsheets)
 - Web browsing: may require more memory (RAM).

Tablets

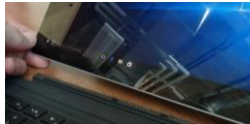
- Examples: iPad, there are several Android models, many of the Windows versions tend to be tablet-laptop variants.
- The **lightest and most portable multi-touch computer**
 - Touch interface:
 - Good/bad issues
 - “Oops!”
- **Better for 'light' work**
 - Price : performance ratio not the best among the categories



Laptops/Notebooks



- Compared to tablets:
 - **Larger display** area, bigger and heavier
 - **Adds a CD or DVD as well as a physical keyboard** but may **include touch** capability as well
 - “2 in 1” laptops: combine power of laptop and portability of tablet



- Compared to desktops:
 - Portability (obviously better)
 - **Not as good price/performance,**
 - Future expandability, choice of hardware more limited (**the hardware you start off with is largely what you will end up with**).

“Specialized/Variant Laptops”

- Ultrabooks e.g. Asus Zenbook, Microsoft Surface
 - **Ultra = thinner and lighter** (increased portability) **but exclude some hardware** e.g.. Ethernet (physical network connection), CD/DVD
 - All things being equal *cost tends to be higher than a laptop* (manufacturing in exact, smaller, detail)
- Netbooks e.g. Acer Travelmate
 - A **cheaper** but **more portable** form of a laptop (smaller and lower quality display, overall less powerful hardware) with a **built in physical keyboard** but no CD/DVD.
 - Much less common with the rise of tablets.
 - Unlike Chromebooks (next page) **most/all typical desktop programs** (e.g.. Office, games, Photoshop) **can be run on a netbook** (some may be slow)

Comparison of netbooks vs. tablets

- http://www.ehow.com/info_8721028_difference-between-tablet-pc-netbook.html
- <http://www.pcadvisor.co.uk/buying-advice/tablets/3450587/netbook-vs-tablet/>
- <http://blogs.canoe.ca/canoetech/signs-of-the-times/netbooks-vs-tablets/>

“Specialized/Variant Laptops” (2)

- Chromebook¹
 - Runs via Google Chrome OS (operating system)
 - Designed for users with a **constant Internet connection**
 - Documents and programs are **stored online** rather than on the computer
 - Local storage is limited e.g.. flash drive
 - Requires a **less powerful portable computer (often much less expensive)**, it's *for users who primarily use a computer browser* (Chrome) and online applications (e.g.. Google docs) rather than commonly used programs (e.g.. Office)

References:

1. <https://www.digitaltrends.com/computing/chromebook-vs-laptop/>
2. Technology in Action (15 e): Evans, Martin, Poatsy

Desktop Computers

- **Everything is separate** (monitor, computer, keyboard and parts like memory and drives may be swapped/upgraded more easily)
 - Allows for mixing and matching but more complex connections and it's not portable).
 - Faulty components can be more easily replaced.
 - E.g. spilling liquid on a laptop may be a drastic mistake, not so much with a separate desktop keyboard
- **Larger ‘foot print’ (size):**
 - *More space required*
 - One benefit: *greater expandability*
- Compared to portable laptops and tablets:
Reduced cost to buy/more options





“All-In-One-Computers”

- Examples: Apple iMac, Dell Precision 5720, MS Surface Studio
 - **As the name implies everything is included together (computer and monitor)**
 - Laptops and tablets aren’t “All-In-One” because they don’t have a monitor casing that looks like desktop setup
 - Many employ **touchscreen technology**
 - Commonly chosen when:
 - A **desktop is desired but space is tight**
 - Some portability is desired (rule of thumb: can move within your a house rather movable outside).
 - With few exceptions *not expandable, largely just drives and memory can change* (pro: *no hardware conflicts that you may get by mixing and matching with desktops*).
 - **Visually appealing**

Images (all accessed or produced in 2015, credits going left to right)

- Apple computer: Courtesy of James Tam
- HP computer: <http://gadgetynews.com/hp-omni-hd-allinone-pc-beats-audio-quadcore-power>
- Inside the case: <http://www.tomshardware.co.uk/xps-one-27-touchscreen-all-in-one,review-32666-3.html>

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
- Example usage (from the computer advertisements shown earlier): 3.6 GHz processor (G = Giga, Hz = processor oscillation speed)
- Large units of measurement will be discussed again when processors and storage devices are covered

Basic Units Of Storage

- On the computer all information is stored in binary (2 states e.g., on/off, pitted surface/smooth surface on a CD/DVD, connected/disconnected electrical connection on a flash drive)
- A single off/on combination is referred to as a 'bit' (*binary digit*)



off



on

- 8 bits grouped together is referred to as a 'byte'



Large Units Of Measurement And Storage

- 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

- Low quality preview 'thumbnail' images may range from a few thousand to tens of thousands of bytes in size.
- 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 (single digit) bytes (MB).
- Audio files (e.g., MP3) are several Megabytes in size.
- Streaming Internet video (compressed, standard definition) ~several hundred Megabytes perhaps one thousand Megabytes for a full movie.

Large Units Of Measurement And Storage (2)

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

        X 1,000,000,000

Several hundred camera images or audio files
 ~ 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

Several hundred thousand images or audio files
 ~ 200 regular DVD's (~32 Blu-ray) of information

File Sizes: Example Images

Name	Date	Tags	Size
 img004.bmp	6/6/2013 1:18 PM		24,685 KB
 img004.jpg	4/6/2011 5:23 PM		2,768 KB
 img005.jpg	4/6/2011 5:25 PM		2,813 KB
 img006.jpg	6/1/2012 1:40 PM		786 KB
 img007.jpg	9/5/2012 6:53 PM		633 KB

File Sizes: Audio Files

	01 Dragon Theme-A Father's Nightmare... Randy Edelman	Album: Dragon: The Bruce Lee Story Genre: Soundtrack	Length: 00:03:35 Size: 4.96 MB
	02 Yip Man's Kwoon.wma Randy Edelman	Album: Dragon: The Bruce Lee Story Genre: Soundtrack	Length: 00:02:28 Size: 3.41 MB
	03 Lee Hoi Chuen's Love.wma Randy Edelman	Album: Dragon: The Bruce Lee Story Genre: Soundtrack	Length: 00:02:11 Size: 3.03 MB
	04 Bruce and Linda.wma Randy Edelman	Album: Dragon: The Bruce Lee Story Genre: Soundtrack	Length: 00:02:46 Size: 3.81 MB
	05 The Challenge Fight Warm-Up.wma Randy Edelman	Album: Dragon: The Bruce Lee Story Genre: Soundtrack	Length: 00:02:15 Size: 3.11 MB
	06 Sailing on the South China Sea.wma Randy Edelman	Album: Dragon: The Bruce Lee Story Genre: Soundtrack	Length: 00:02:14 Size: 3.10 MB
	07 Fists of Fury.wma Randy Edelman	Album: Dragon: The Bruce Lee Story Genre: Soundtrack	Length: 00:01:18 Size: 1.81 MB
	08 The Tao of Jeet Kune Do.wma Randy Edelman	Album: Dragon: The Bruce Lee Story Genre: Soundtrack	Length: 00:02:17 Size: 3.16 MB
	09 Victory at Ed Parker's.wma Randy Edelman	Album: Dragon: The Bruce Lee Story Genre: Soundtrack	Length: 00:01:34 Size: 2.17 MB
	10 Chopsaki.wma Randy Edelman	Album: Dragon: The Bruce Lee Story Genre: Soundtrack	Length: 00:01:13 Size: 1.69 MB
	11 Brandon.wma Randy Edelman	Album: Dragon: The Bruce Lee Story Genre: Soundtrack	Length: 00:02:06 Size: 2.90 MB
	12 The Mountain of Gold.wma Randy Edelman	Album: Dragon: The Bruce Lee Story Genre: Soundtrack	Length: 00:00:46 Size: 1.07 MB

File Sizes: Videos

- Lengths of the videos range from ~20 seconds to 15 minutes

Name	Type	Size	
 Tam wooden man form.wmv	Windows Media A...	5,381 KB	22s, 320x240 resolution (1 hr. = 880 MB)
 Old CPSC 203 assignment solution.mov	MOV File	12,484 KB	
 Tam lion dance.wmv	Windows Media A...	13,850 KB	
 Légion étrangère -Le Boudin.flv	VLC media file (.flv)	13,931 KB	
 Wong Fei Hung music video.mp4	VLC media file (.m...	18,664 KB	
 Wing Chun fighting.flv	VLC media file (.flv)	46,759 KB	
 Jing Wo Chinese New Years 2013 Chines	VLC media file (.m...	684,111 KB	15m 29s, 1920x1080 resolution (1 hr. ~2.7 GB)

Most Important Hardware (When Choosing A Computer)

- (This refers to hardware that distinguishes one computer from another computer, other pieces such as hardware such as some sort of network connection are also *crucial but not significantly different* from computer-to-computer).
- **Processor** (CPU – or the APU for some AMD models)
- **Memory** (RAM)
- **Storage** (hard drive)
- **'Hardware intensive'**: software may fully/mostly utilize the computer hardware e.g.. 3D graphical editors, video editing software, some games etc.

Main Processor (CPU: Central Processing Unit)



ARM processor

- The 'brains' of the computer:
 - Determines program execution speed (not just calculation speed)
- Benefits of a faster CPU
 - Programs are loaded faster (includes computer startup time)
 - Editing/viewing videos and ripping music/videos to your computer may be faster and more free of 'glitches'
 - (Of course!) Calculations are completed more quickly (e.g., evaluating the results of a spreadsheet)

CPU Clock speed

- Aside from the processor model it's the most common technical specification
- It's the speed at which the processor operates (oscillation rate)
- Typical home-type computers (e.g., laptops, desktops) operate at low single digit unit Giga-clock speeds ~1 to 4 GHz
 - Note: Other than clock speeds there's other factors that determines how fast a processor will run a program but all other things being equal a processor with a higher clock speed will run faster.

Computer from advertisement (2018 Ad)

Processor: 3.6 GHz Intel Core processor

Processor Manufacturers

- Intel
 - For more information (last accessed August 2018):
<https://www.intel.com/content/www/us/en/processors/processor-numbers.html>
- AMD
 - For more information (last accessed August 2018):
<https://www.amd.com/en/products/processors-desktop>
- AMD vs. Intel: look at the speed tests performed with different software running (benchmarks).
 - E.g., <http://www.tomshardware.com/t/cpus/>
- The links are available for your reference if you want more information.
- However brand definitely *does matter* in that you can't freely mix and match between Intel and AMD.

Multi-Core Processors

- A processor's 'core' is the part that allows computations and instructions to be executed
- (Don't confuse the processor part with the model name of some Intel processors e.g., Intel: Core i3, Core i5, Core i7 etc.)
 - AMD manufacturers multi-core processors as well
- The number of cores determines how many tasks that a computer can execute at the same time.
- Single core computer:
 - Only appears to work on multiple tasks simultaneously.

Computer from advertisement (2018 Ad)
Processor: 3.6 GHz Intel Core processor

Video editing



Pause



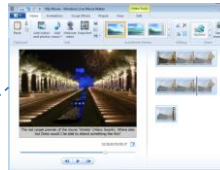
Playing a video game



Processors: Multi-Core (2)

- Dual-core processors: can work on two tasks simultaneously

First processing core:
Video editing



Second processing core:
Playing a video game



Processors: Multi-Core (3)

- Other multi-core processors:
 - Quad core : 4 processing cores
 - 6 core
 - 8 core
 - Extreme machines (expensive)
 - 12 core (e.g., MacBook pro)
 - 18 core (e.g. Intel Xeon processor)
 - <https://money.cnn.com/2017/12/14/technology/imac-pro-on-sale/index.html>
 - For more information: comparing dual vs. quad core processors (i.e. in general what's the benefit of more vs. fewer cores)
 - <http://www.pcmag.com/article2/0,2817,2406293,00.asp>

Processors: Multi-Core (4)

- Having a processor with multiple cores can speed up execution even if only a single hardware intensive program is running.
 - The program is written specifically to take advantage of multi-core technology.
 - Check the 'system requirements' or 'technical requirements' on the packaging or website e.g., Photoshop, Excel, Crysis: www.ea.com/games/crysis/crysis



First core: runs one part of game



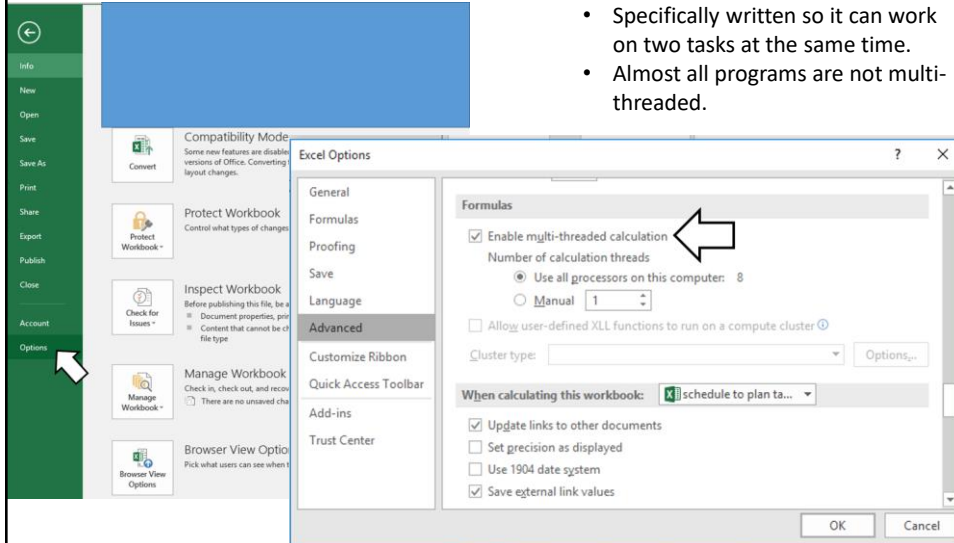
Second core: runs another part of the same game



Example Program, MS-Excel: Optimal Performance With Multiple Cores

Multi-threaded program:

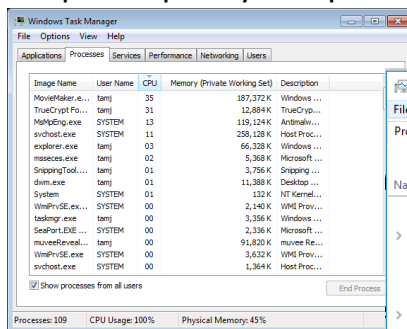
- Specifically written so it can work on two tasks at the same time.
- Almost all programs are not multi-threaded.



Will Multiple Cores Always Be Faster?

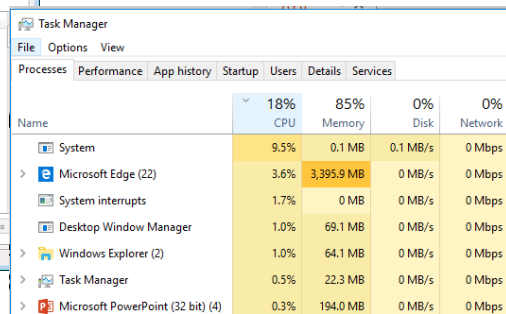
- Simple answer: it depends
- Advanced answer: look at actual computer usage e.g., Task manager (Windows), Activity Monitor (MAC OS-X)

Multiple cores: probably will help



Windows Task Manager Performance tab showing CPU usage at 100%.

Multiple cores: little or no effect



Windows Task Manager Performance tab showing CPU usage at 18% and memory usage at 85%.

Name	CPU	Memory	Disk	Network
System	9.5%	0.1 MB	0.1 MB/s	0 Mbps
Microsoft Edge (22)	3.6%	3,395.9 MB	0 MB/s	0 Mbps
System interrupts	1.7%	0 MB	0 MB/s	0 Mbps
Desktop Window Manager	1.0%	69.1 MB	0 MB/s	0 Mbps
Windows Explorer (2)	1.0%	64.1 MB	0 MB/s	0 Mbps
Task Manager	0.5%	22.3 MB	0 MB/s	0 Mbps
Microsoft PowerPoint (32 bit) (4)	0.3%	194.0 MB	0 MB/s	0 Mbps

Intel Processor Models¹

- Another important factor determining execution speed
- Intel processor models:
 - Pentium and Celeron (*netbooks*):
 - Very old low end chips
 - Unless you're cash strapped avoid computers with these processors
 - (JT: until part way through 2013 I was running a ~**12-15 year old version** of a Celeron for my main computer tasks...painfully!)
 - Core i3 (*used/refurbished computers*):
 - Dual core processors
 - For budget computers, good for basic every day computer use (word processing, browsing the web – you might want to avoid viewing videos extensively especially HD video)

Sources:

- <http://www.cnet.com/topics/desktops/buying-guide/>
- <http://ark.intel.com/>
- <http://www.intel.com/content/www/us/en/processors/processor-numbers.html>

Intel Processor Models (2)

- Core i5 (more expensive used computers, new computers on clearance) **Tam min (2015)**
 - Mainstream quad core processor line (a handful of lower end ones are dual core)
- Core i7 (entry for most new desktops) **← Tam min (2018)**
- For more information about Intel processor models:
 - <http://ark.intel.com/>
 - <http://www.intel.com/content/www/us/en/processors/processor-numbers.html>

Computer from advertisement:

Processor: 3.6GHz Intel Core i7-**7700** processor

Computer processor from 2015 ad:

3.6GHz Intel Core i7-**4790** processor

There's many **versions** of the i7 model

Memory (RAM)



- When a computer program is executing the instructions as well as any data currently needed (e.g., images, videos) is loaded into RAM from the storage device (usually the hard drive).
- RAM is temporary storage (gone when you shut off or restart your computer).
- Significantly faster than any storage device.
- More expensive on a per unit basis than a storage device such as a hard drive.
- The memory capacity of today's computers are typically specified in single or low double digit Gigabytes (recall that's billions of bytes) .

How Much RAM?

Amount of RAM	Primary computer usage
< 4 GB	Basic: web browsing, email, word processing
4 – 8 GB	Multitasking: running a few applications simultaneously, playing simple/lower end games, watching regular (lower definition) movies, simple photo editing.
10 GB and above	Multitasking with regular applications or even with hardware-intensive applications such as games with higher resolution graphics (rules of thumb: "first person shooter" and/or 3D games rather than simpler adventure, role-playing, strategy games), video editing, 3D or extensive image editing (e.g., Photoshop), HD (high definition) entertainment

Tam
Min (8) →

Computer from the advertisement:
Memory: 12 GB of RAM

Computer from 2015:
Memory 8 GB

How Much RAM? (2)

- If you do browse the web extensively then consider getting more memory (RAM) especially if the pages include multi-media, many advertisements.
 - Sometimes it may not be obvious that a web page is running programs (or other hardware intensive tasks).
 - This may lead to questions such as “Why is my web browser so slow?”
 - Use tools such as the Task Manager and Activity monitor to evaluate how much memory that your browser uses.
 - Do this more than once while going online (memory usage can fluxgate greatly).
 - Tam’s rule of thumb: 8 GB is your bare-bones minimum (sometimes this will not be enough).

Storage (Hard Drive)



- All data that’s needed in the long term must be kept in some form of storage device.
 - Storage (hard drive): something that **isn’t currently needed** but **needed at some point** in the future.
 - Memory (RAM): something that is currently used must be stored here.
 - Types of hard drives (storage devices):
 - Magnetic hard drives (common abbreviation as ‘HDD’)
 - Stores information via magnetism
 - Solid state hard drives (common abbreviation as ‘SSD’)
 - Stores information without moving parts
 - The typical storage capacity of hard drives is measured in hundreds of Gigabytes or single digit Terabytes

Comparison Of Hard Drive Types

Magnetic hard drive (HDD)

- Slower
- Less expensive
- Hard drives with the highest capacities are only magnetic
- Less 'durable' (may be affected by magnetic fields, physical jarring, temperature extremes)

Solid state hard drive (SSD)

- Faster (roughly double)
- More expensive
- Lower maximum storage capacity
- More durable (no moving parts)
- Smaller and lighter (an issue with portables)

- Typical SSD capacity ~256 - 512 GB
- Typical HDD capacity ~ 1 TB

Computer from advertisement/2015:
Storage: 1TB 7200 RPM hard drive

Capacity	Images (number): assume 2 MB per image	Music (hours): assumes 2 MB per minute	Movies (hours): assumes 70 MB/hour	HD Movies (hours): assumes 2.4 GB/hour	
256 GB	128,000	2,133	3657	107	
512 GB	256,000	4,267	7314	213	
1 TB	500,000	8,333	14,286	417	(SSD) Tam range
2 TB	1,000,000	16,667	28,571	833	
4 TB	2,000,000	33,333	57,143	1667	
8 TB	4,000,000	66,667	114,286	3,333	(HDD) Tam range
12 TB (down to 32)	6,000,000	100,000	171,429	5,000	

How Much Can You Actually Store?

- Assume that your typical image or audio file is 2 MB apiece
 - 1 TB drive ~ 1,000,000,000,000 bytes
 - 2 MB file 2,000,000
- Number of files (1st work out the simple case 1 MB file, 1,000,000 bytes)
 - 1,000,000,000,000 (drive capacity)
 - Divide by file size 1,000,000 bytes (average size will do)
 - = 1,000,000 files each 1 MB in size (for simplicity so we just cancel out zeros)
- Number of files 2 MB file size
 - $1,000,000 / 2 = 500,000$ images or music files

Don't Forget: Space Is Not All Free

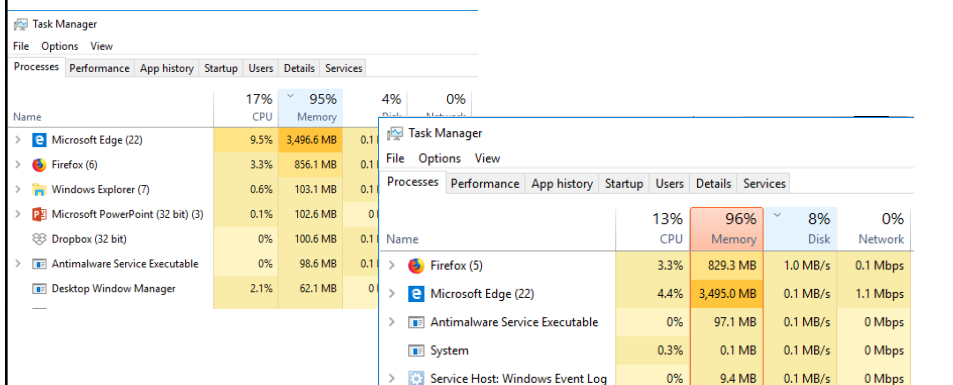
- Formatting a hard drive uses up some of it's capacity
 - E.g. 1 TB drive becomes 930 GB (70 GB not free)
- The operating system takes up space
 - Example: Windows 7 or 8.1 (source: <http://windows.microsoft.com>)
 - 16 GB (32 bit), 20 GB (64 bit)
 - Windows 10 (Home version)
 - 20 GB
 - Productivity (work) application (source: <https://products.office.com>)
 - Example: MS-Office Professional Plus 2013 = 3 GB
 - A game (source: <http://elderscrollsonline.info/system-requirements>)
 - Elder Scrolls = 60 GB
- With just Windows and 2 programs installed 153 GB has been used up (~15.3% of a 1 TB drive)

Hard Drive Tips

- Bigger is often better: even higher capacity drives have come down significantly in price.
- But for magnetic drives balance: storage capacity vs. speed (higher capacity drives tend to have lower rpm – slower revolution speed)
 - 7,200 to 10,000 RPM
- Or combine an SSD for speed with a magnetic drive for its high storage capacity (store smaller files than are less frequently accessed here).

Amount Of Memory Affecting Computer Performance

- Sometimes a computer may be slow because of an older/cheaper processor.
- The amount of RAM/memory can also drastically affect speed.
 - Class discussion: How?



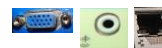
Optical (Employ Lasers) Drives

- CD/DVD?
 - Do you play or rip music/videos?
 - If the answer is no then you might settle with a single inexpensive DVD drive
 - (Although many programs allow for Internet download some require an optical drive to install)

Ports

USB 3.0 ports
HDMI output crisp high-quality visuals
and high-fidelity audio to a home theatre
or monitor

- External connections.
- USB (standard): get as many ports as possible, 'hub' devices don't always work as well as advertised.
- USB 3.0: useful to have when backing up large amounts of data.
 - Roughly x10 speed: in theory it's 480 Mbps vs. 5 Gbps)
- HDMI: allow display on a TV monitor or connections to some peripherals (cable box, game consoles)
- SD: can be useful for connecting to some peripherals (devices that use SD cards such as cameras, e-readers, tablets) or as extra storage space (Chromebooks).
- (Other important ports e.g., video, audio, network are standard in computers of today)



Recap Of This Section: Things You Should Now Know

- The different category of computers and computing devices: tablets, notebooks/laptops, ultrabooks, netbook, desktop all-in-ones as well as some of their strengths
- The large units of measurement and how they apply to computer specifications
- The basic units of storage: bits and bytes and how the groupings of bytes applies to hardware
- Processor clock speed and reasonable values for computers of today
- The effect of multiple processing cores on speed

Recap Of This Section: Things You Should Now Know

- What is the function of RAM, how does it work, how it related to storage, what are reasonable amounts for computers of today
- What the two main types of storage technology (magnetic and solid state) and how they compare, what is a reasonable amount for today's computer usage
- Characteristics of memory vs. storage
- Common computer ports

Section II

A PRACTICAL GUIDE TO USING COMPUTERS

Computer Operating System (OS)

- A special type of software that runs the computer
 - Intermediary between the physical hardware and other software (Office, games, anti-virus etc.)
- Examples:
 - Microsoft Windows: Windows 10, 8.1, 8, 7, Vista, XP, ME, 98, 95 etc.
 - Apple^{1, 2}: macOS (Sierra, High Sierra), OS X (e.g.. Mountain Lion, Yosemite, El Capitan), Mac OS X (10.0/Cheetah, Panther, Tiger, Leopard, Snow Leopard, Lion)
 - Linux, a variation of the UNIX operating system (Apple's operating system is based on/a version of UNIX)^{1,2}: e.g., Google Chrome, Valve's SteamOS (still in beta?), Android (no longer just for phones)

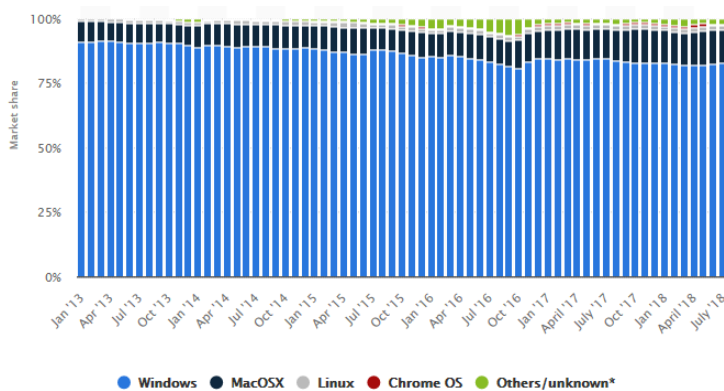
¹ Online Sources (Last accessed August 2018): <https://www.apple.com>, <https://www.quora.com/>

²Technology in Action (15E) (Evans, Martin, Poatsy), Chapter 5

Sample Exam Question

- Which of the following is an operating system developed fully or primarily by Microsoft?
 - a. Windows 7
 - b. Windows 10
 - c. Chrome
 - d. Sierra
 - e. (a) & (b)

Operating System: Market Share¹



- How does market share of the OS affect you as a user?
 - Software available (especially for more obscure software such as niche games or productivity programs).
 - Computer security.

¹ From <https://www.statista.com/statistics/218089/global-market-share-of-windows-7/> (Statista is part of Dell)

Characteristics Of Operating Systems Affecting Security

- No operating system is 100% safe!
- Malicious programs (e.g., virus) are a specialized form of software.
- (Previously mentioned): popular operating systems makes for a popular target of the creators of malicious programs.
- Other ways that operating system choice can affect security.
 - Apple:
 - Strictly controls the installation and spread of malicious programs (it has a very tough approval process before a program can be added to the Apple Store).¹
 - Microsoft:
 - JT's observation:
 - For 'convenience' Microsoft may allow programmers and even users to tweak/configure software more easily.
 - Sometimes this flexibility results in unexpected security flaws.

¹ <https://developer.apple.com/app-store/review/guidelines/>

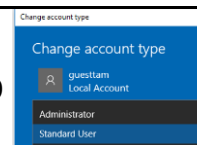
Keeping Up The Health And Wellness Of Your Computer

- Note: CPSC 203 is not a computer repair course
 - For more in-depth details: try trade school course e.g., SAIT
- User accounts:
 - Administrator, standard user
- General maintenance
 - Disk Cleanup
 - Defragmenting your drives

Keeping Up The Health And Wellness Of Your Computer (2)

- Preparing for disaster
 - Backing up your files
 - Manual
 - Full, incremental & differential backups
 - Example utility: SyncToy
 - Cloning your drive
- Recovering after things go wrong
 - System restore
 - Recovering deleted files

User Accounts: General Rules Of Thumb



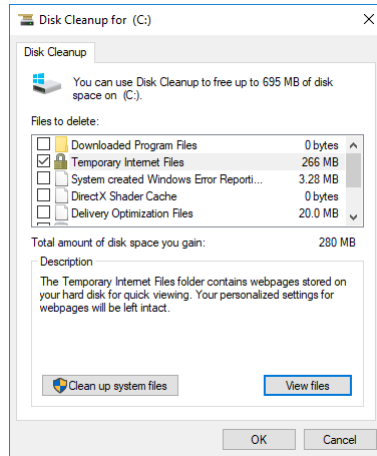
- Standard user capabilities
 - Can run programs
 - Create, edit, delete most files and folders
- Administrator account capabilities¹
 - Change security settings
 - Install new software and hardware
 - Access all files and folders on the computer (including Windows system files and files of other users)
 - May modify, create and delete other user accounts
- It's best to restrict your day-to-day computer usage to an account that only has standard user access.
 - If you need to make restricted changes you should see a prompt to enter the password for the administrator account.

¹ <https://www.trusteer.com>

General Computer Maintenance

1. Disk Cleanup

- Useful when running out of hard drive space

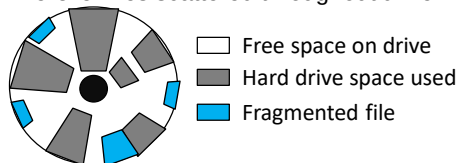


General Computer Maintenance (2)

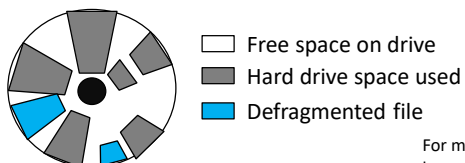
2. Defragmenting (“Defragging”/”Optimize drive”) your drives (JT: this is more for HDD type drives)

- It’s recommended that you run the defragmenter utility after deleting a large number of files (such as when Disk Cleanup has run).

Before: files scattered throughout drive



After: files have been consolidated



For more information:
<https://computer.howstuffworks.com/question548.htm>

Preparing For Disaster: Backup Your Files

- Copying files (e.g. Office documents, pictures, videos etc.) to a backup location.
- **Don't backup files on the same drive**
 - e.g. **FROM: C:\documents\users\James Tam**
TO: C:\James Tam backups
- The backup location should be another drive, ideally one that you only attach to your computer during the backup process
- What about a 'cloud' backup e.g. Dropbox, Google Drive, iCloud? Benefits? Possible issues?
- If you backup nothing else at least backup your assignments!
 - Reminder: **Forgetting to backup/failed backup of your work is not a sufficient reason for getting an extension.**

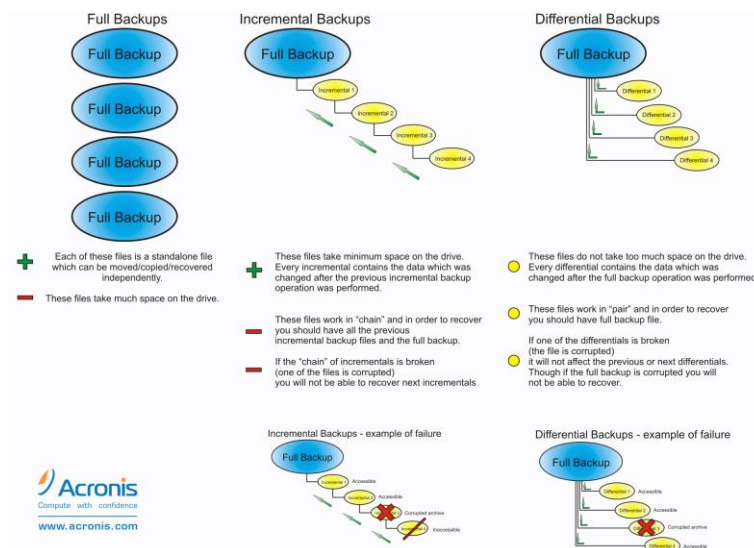
Preparing For Disaster: Automated Backups

- Use a program to perform a backup at regular intervals.
- Advantage over manual backups:
 - You may neglect a regular backup when you have to do it all yourself.
 - Automated backup programs may be able to backup files and folders that cannot be copied.
- Some example backup programs:
 - Acronis True image
 - Paragon Backup & Recovery
 - (Some operating systems may include a basic backup utility)

Types Of Automated Backups

- **Full backup:** **backup all** the specified files
 - Pro: Reliable data recovery
 - Con: Slowest method and uses the most disk space
- **Differential backup:** backup files that have changed **since the last full backup**
 - Pro: Less space needed & faster than a full backup
 - Con: uses more space than the incremental backup (grows over time until the next full backup) although less than the full backup
- **Incremental backup:** backup files that have changed **since the last incremental backup**
 - Pro: Requires the least space and fastest backup time of all three approaches
 - Con: If any backup files are corrupted then additional data could be lost

Illustrating Different Types Of Backups



<https://kb.acronis.com/content/1536>

Example: Effect Of Different Backup Methods

- On January 1, 2018 there's 4 files: a, b, c, d which were backed up on Dec 31, 2017
- Changes made after Dec 31, 2017
 - 'a' (hasn't changed since 2000)
 - 'b' (changed January 1, 2018)
 - 'c' (changed January 3, 2018)
 - 'd' (changed January 8, 2018)
- Backup schedule:
 - Full: every two weeks
 - Incremental & differential: end of each week

Example Exam Question: Backups

- Given the previous information:
 - Which files as well as what version of files will be included in the full backup on January 14, 2018?
 - Which files will be included in the incremental and differential backup on January 14, 2018?

Some Utilities For Automated Backup

- Windows:
 - SyncToy: a free tool from Microsoft which can be used for backups.
 - <https://www.microsoft.com/en-us/download/details.aspx?id=15155>
 - Win10: “File History utility”: must be first turned on (off by default)
- Mac:
 - Time Machine:
 - <https://support.apple.com/en-us/HT201250>
 - (From the website)
 - “Time Machine backs up all of your files to an external storage device so that you can restore them later or see how they looked in the past.”

Preparing For Disaster: Disk Cloning

- Backup of an entire drive.
 - How does this differ from a backup?
- Unlike a backup another hard drive is mandatory.
- Some example disk cloning programs:
 - Acronis True Image, Ghost, Clonezilla etc.

Recovering When Things Go Wrong: System Restore

- System Restore (from Windows help)
 - “...can help to fix problems that might be making your computer run slowly or stop responding. System restore does not affect any of your documents, pictures, or other personal data. Recently installed programs and drivers [JT: drivers=software that direct runs hardware] might be uninstalled”.
- System restore and “restore points”
 - “Restore points” automatically created by Windows as major changes (e.g. updates, new hardware added or hardware drivers changed, or installations of new programs etc.) are made to the computer.
 - Manual restore points can also be created.
 - System restore brings the computer to a previous restore point state
- Similar feature to System Restore but for altered data:
 - Right click on a folder or file and select from the menu the option “Restore previous versions”.
 - JT: Caution, you may come up with no previous versions to restore.

Recovering When Things Go Wrong: Recovering The Deleted

- When is a file truly ‘gone’ in Windows?
 1. Moved to the recycle bin.
 2. Above plus the recycle bin is emptied.
 3. Above plus the drive is then filled to capacity (each byte has been used).
 4. Drive undergoes a full (not quick) format.
- Utilities to recover deleted files must typically be installed and enabled before the deletion.
 - Also you **should not add/modify any files on that drive** (until you have tried to recover the file or files)!
 - If you are recovering a file or files on your ‘C’ drive (where Windows is installed) then use that computer as little as possible.
 - Example utilities: R-Studio (also may help if the drive goes bad), Undelete, Recuva.

Some Programs For Recovering Lost Data

- Deletion recovery programs
 - Migo Digital rescue
 - Undelete
 - Norton Ghost (this is the disk cloning tool mentioned previously)
 - File recovery for Windows
 - Search and recover
 - GetData
- Recovery of data from bad drives
 - R-studio
 - Recover my files

Recap Of This Section: Things You Should Now Know

- Operating system
 - It's role in the operation of a computer
 - Example operating systems developed by Microsoft, Apple and others
 - How the choice of operating system can affect computer security
- Computer accounts
 - What are the categories and capability of each type account
 - The relationship between computer accounts and computer security
- Some computer maintenance tasks: Disk Cleanup, defragmenting a drive.
 - What does each task do, how does each one work

Recap Of This Section: Things You Should Now Know (2)

- Some ways of preparing for disaster: backing up files (manual and automatic), disk cloning
 - What is the difference between a full vs. incremental backup as well as advantage and disadvantage of each.
 - What does it mean to 'clone' a drive and how does it differ from a backup
- Some ways of recovering when things go wrong:
 - When to use System Restore? What is the effect of a 'restore'?
 - Recovering deleting data:
 - How to make a file truly inaccessible in a computer? (Truly 'gone')
 - How recovery programs can recover deleted data/limitations

Images

- "Unless otherwise indicated, all images were produced by James Tam

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