

Computers

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

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)

A Sample Of Online Buying Guides

- There's many sources available but here is a *small sample*:
- Laptops
 - General purpose:
 - <https://www.digitaltrends.com/computing/laptop-buying-guide/>
 - Gaming
 - <https://www.pcgamer.com/best-gaming-laptop/>
- Desktop computers
 - Best general purpose:
 - <https://www.pcmag.com/picks/the-best-desktop-computers>
 - <https://www.digitaltrends.com/computing/best-desktop-computers/>
 - Inexpensive:
 - <https://www.digitaltrends.com/dtdeals/best-cheap-desktop-computer-deals/>
 - Gaming
 - <https://www.pcgamer.com/best-gaming-pc/>
 - <https://www.cnet.com/news/best-gaming-laptop-for-2020/> (Desk and laptop)

Example Technical Specifications

- Paraphrased from an online electronics retailer:
 - P330 30CY0017US Workstation - 1 x Core i7 i7-9700 - 16 GB RAM - 512 GB SSD - Raven Black - Windows 10 Pro 64-bit (“Equipped with an Intel Core i7 processor, 12GB RAM, and NVIDIA GeForce GTX 1050 graphics...”)
 - Intel Core i7-9700 [JT, information not available by default: 3.0/4.7 GHz] (3.6GHz Intel Core i7-7700 processor)
 - 16 GB of RAM (12 GB of RAM)
 - 512 GB SSD (1 TB hard drive)
 - 9 USB ports [JT, information not available by default: 6 USB 3.1, 2 USB 2.0], 3 video ports [JT, information not available by default: Display port x2, HDMI] (“6 USB ports, including 2 USB 3.0 ports, let you plug in peripherals, while an HDMI output... delivers crisp high-quality visuals and high-fidelity audio to a home theatre ”)
 - FYI: \$1,482.99 (\$1139.99 in 2018 \$)
 - Last accessed from www.bestbuy.ca August 2020 (August 2018)

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).
 - Do you buy new computers often or do you prefer spending more but buying less frequently?

Tablets

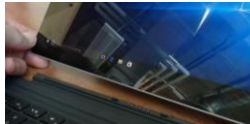
- Examples: iPad, there are several Android models, many of the Windows versions tend to be tablet-laptop variants.
- The **lightest and most portable multi-touch computer**
 - Touch interface:
 - Good/bad issues
 - “Oops!”
- **Better for ‘light’ work**
 - Price : performance ratio not the best among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



- 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 **Ultrabooks tend to cost more than a regular 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).
 - Now in 2020 many but not all netbooks run Chrome (cheaper)

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.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., MS-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):**
 - Drawback: *More space required*
 - One benefit: *greater expandability*
- Compared to portable laptops and tablets:
Reduced cost to get more options





“All-In-One-Computers”

- Examples: Apple iMac, Premium 2020 Dell Inspiron, MS Surface Studio
 - **As the name implies everything is included together (computer and monitor)**
 - Laptops and tablets aren’t classified as “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 they’re *not expandable* (<https://bestreviews.com/best-all-in-one-computers>), *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 (e.g. kilogram, kilometer etc.)
- Mega: One million 1,000,000
- Giga: One billion 1,000,000,000
- Tera: One trillion 1,000,000,000,000
- Example usage (from advertisements specifying computer speed): 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 or shorter Word documents with no 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

- Typical phone pictures are single digit MB in size.
- 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 ~a billion bytes ($1,073,741,824 = 2^{30}$)

 X 1,000,000,000






- (Several hundred to one thousand: camera images or audio files)
- ~ 30 minutes of DVD quality video (~1/4 of the information stored on a standard DVD)

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











 X 1,000,000,000,000

- Several hundred thousand to one million: 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 hour = 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 Chinese	VLC media file (.m...)	684,111 KB	15m 29s, 1920x1080 resolution (1 hour ~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 (2020 Ad)

Processor: Intel Core i7-9700 (clock speed not provided approach not unique to Best Buy):

- Costco: Intel® Core™ i5-9400
- Some other retailers still provide clock speed: The Source, Staples, London Drugs etc.

Computer from advertisement (2020 Ad)

Processor: Intel Core i7-9700 (default clock speed = 3.0 GHz)

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 (2020 Ad)
Processor: Intel Core i7-9700

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

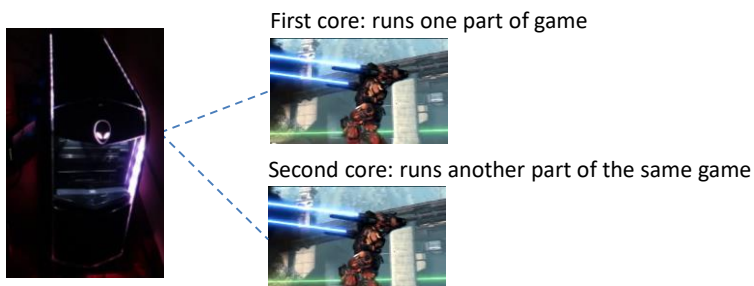


Processors: Multi-Core (3)

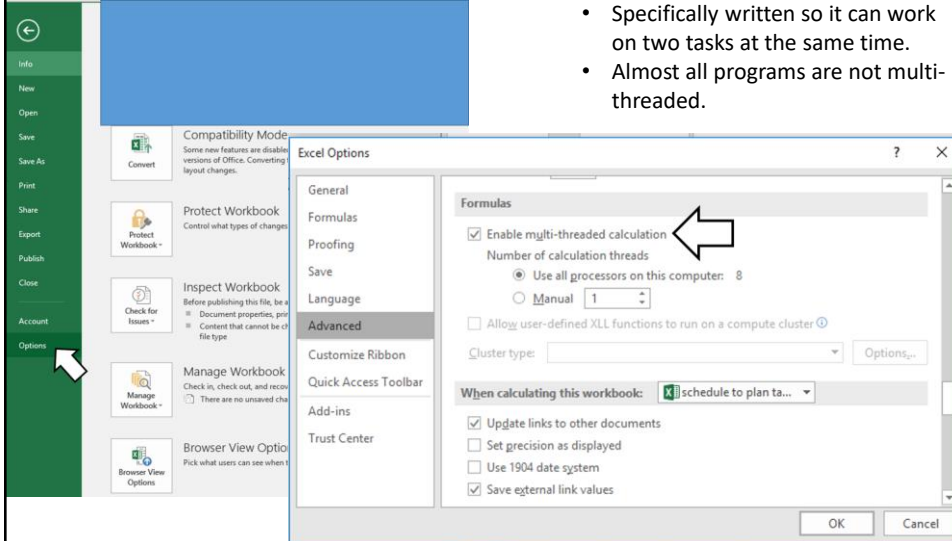
- Other multi-core processors:
 - Quad core : 4 processing cores
 - 6 core
 - 8 core
 - Extreme machines (expensive)
 - 12 core (e.g., MacBook pro)
 - 18 core (e.g. Intel Xeon processor)
 - <https://money.cnn.com/2017/12/14/technology/imac-pro-on-sale/index.html>
 - For more information: comparing dual 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



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

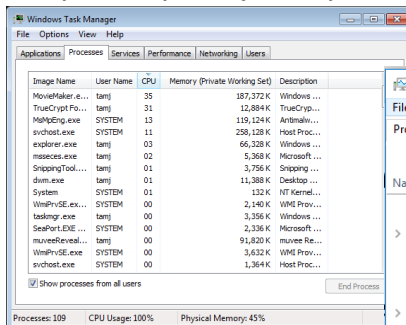
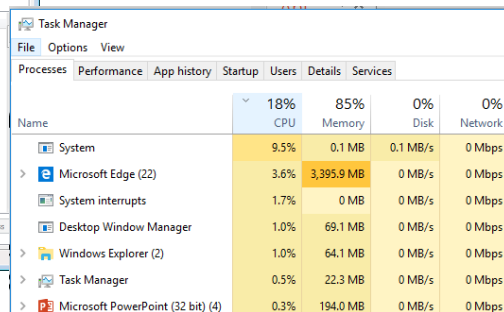


Image Name	User Name	CPU	Memory (Private Working Set)	Description
MovieMaker.e...	tamj	35	187,372 K	Windows ...
TrueCrypt Fo...	tamj	31	12,884 K	TrueCryp...
MdMpEng.exe	SYSTEM	13	119,124 K	Antimalw...
svchost.exe	SYSTEM	11	258,128 K	Host Proc...
explorer.exe	tamj	03	66,320 K	Windows ...
mssc.exe	tamj	02	5,368 K	Microsoft ...
SnippingTool...	tamj	01	3,756 K	Snipping ...
dmv.exe	tamj	01	11,388 K	Desktop ...
System	SYSTEM	01	122 K	NT kernel...
WinPrvSE.ex...	SYSTEM	00	2,140 K	WMI Prov...
taskmgr.exe	tamj	00	3,356 K	Windows ...
SeaPort.EXE ...	SYSTEM	00	2,336 K	Microsoft ...
move.exe	tamj	00	91,820 K	mouse Re...
WinPrvSE.ex...	SYSTEM	00	3,632 K	WMI Prov...
svchost.exe	SYSTEM	00	1,364 K	Host Proc...

Processes: 109 CPU Usage: 100% Physical Memory: 45%

Multiple cores: little or no effect



Name	CPU	Memory	Disk	Network
System	18%	85%	0%	0%
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 'Models' (Brand Modifier)¹

- 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 **old** Celeron for my main computer tasks...painfully!)
 - Netbooks may use them
 - 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' (Brand Modifier) (2)

- Core i5 (more expensive used computers, new computers on clearance, online only)
 - 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 GHz Intel Core i7-~~9700~~ processor

Computer processor from 2018 Ad:
3.6GHz Intel Core i7-7700 processor

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

- With the brand modifier (e.g. i5 vs. i7) and the numbers that follow it, larger numbers are better.
- **Deciphering the Intel numbers:**
 - <https://www.intel.com/content/www/us/en/processors/processor-numbers.html?wapkw=what%20do%20the%20numbers%20mean%20for%20i7%20processors>

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).
 - “Volatile storage” requires continuous power to store information.
- 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?

Tam absolute
Min. (>8)
less can even
affect web
browsing →

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

Computer from the advertisement:
Memory: 16 GB of RAM

Computer from 2018:
Memory 12 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 other programs (which may be quite hardware intensive tasks).
 - This may lead to questions such as “Why is my web browser so slow?” when the problem may be due to an add-on/plugin to the browser.
 - Use tools such as the Task Manager and Activity monitor to evaluate how much memory that your browser (or other programs) uses.
 - Do this more than once while going online (memory usage can vary greatly).

Storage (Hard Drive)



- All data that's needed in the long term must be kept in some form of storage device.
 - Storage (hard drive): stores data or programs that **aren't currently needed** but **needed at some point** in the future.
 - Memory (RAM): stores data and programs **currently being used**.
 - 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 (i.e. solid)
 - 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 such as tablets and laptops)

Just How Sturdy Are Solid State Drives?

- (**Do not** try this at home)
- My *dog* ate my homework, or in this case seal.
 - <https://www.ctvnews.ca/world/working-usb-stick-found-in-frozen-seal-scat-1.4287192>
 - FYI: This is not a sufficiently good cause for an extension of a graded component.
 - (Remember extensions require a good reason which can be verified under reasonable conditions). >-<

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	} (HDD) Tam range
8 TB	4,000,000	66,667	114,286	3,333	
12 TB (down to 32)	6,000,000	100,000	171,429	5,000	

- Typical SSD capacity ~256 – 2 TB (2020: 4 TB possible)
- Typical HDD capacity ~ 1 – 16 TB (2020: 32 TB possible)

Computer from advertisements:
2020: Storage: 512 GB SSD
2018: 1 TB HDD)

How Much Can You Actually Store?

- Assume that an image or audio file is 2 MB in size
 - 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 2 MB files (divide by 2, above was for 1 MB files)
 - $1,000,000 / 2 = 500,000$ images or music files

Don't Forget: Space Is Not All Free

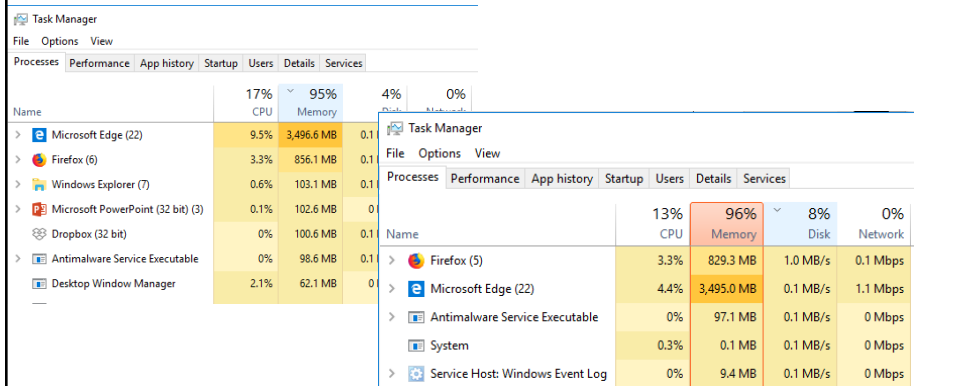
- Formatting a hard drive uses up some of it's capacity
 - E.g. 1 TB drive becomes 930 GB (70 GB not free)
- The operating system takes up space
 - Example: Windows 7 or 8.1 (source: <http://windows.microsoft.com>)
 - 16 GB (32 bit), 20 GB (64 bit)
 - Windows 10 (Home version)
 - 20 GB
 - Productivity (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?



Ports

2020: 9 USB ports, display port x2, HDMI

2018: 6 USB ports, HDMI video

- External connections.
- USB (standard): get as many ports as possible, 'hub' devices don't always work as well as advertised.
- USB 3.0 (3.1): useful to have when backing up large amounts of data.
 - Roughly x10 speed: in theory it's 480 Mbps vs. 5 Gbps vs. 10 Gbps)
- HDMI: allow display on a TV monitor or connections to some peripherals (cable box, game consoles)
- Display port: another popular form of video output
- 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, netbooks).
- (Other important ports e.g., audio, network (or wireless connection which doesn't require a physical port) 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 (2)

- 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