
Reverse Engineering Online Challenge:

Analysis of the Dell XPS M1530



Team 3383A

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Table Of Contents

Table Of Contents.....	1
Summary Report.....	3
Our Process.....	5
Safety Procedure.....	6
Disassembly Procedure.....	7
Parts Chart.....	13
Pie Chart.....	14
Components.....	15
1. CD Drive.....	15
2. Fingerprint Scanner.....	17
3. Keyboard.....	18
4. Touch Bar.....	20
5. Li-on Battery.....	21
6. Monitor.....	23
7. Motherboard.....	24
I. RAM.....	25
II. USB.....	26
III. CPU.....	27
IV. BIOS System.....	28
V. Mouse and keyboard connectors.....	29
VI. Chip Set.....	29
VII. Cooling System.....	30
VIII. CMOS Battery.....	31
IX. Adapter Cards and Expansion Slot.....	32
X. Storage Devices (HDD).....	35
XI. Power Connector.....	37
XII. Front Panel Connector.....	37
8. Speaker.....	38
9. Switchboard.....	41
10. Switch Sensor Circuit Board.....	43
11. Touchpad.....	44
Deeper Analysis.....	46

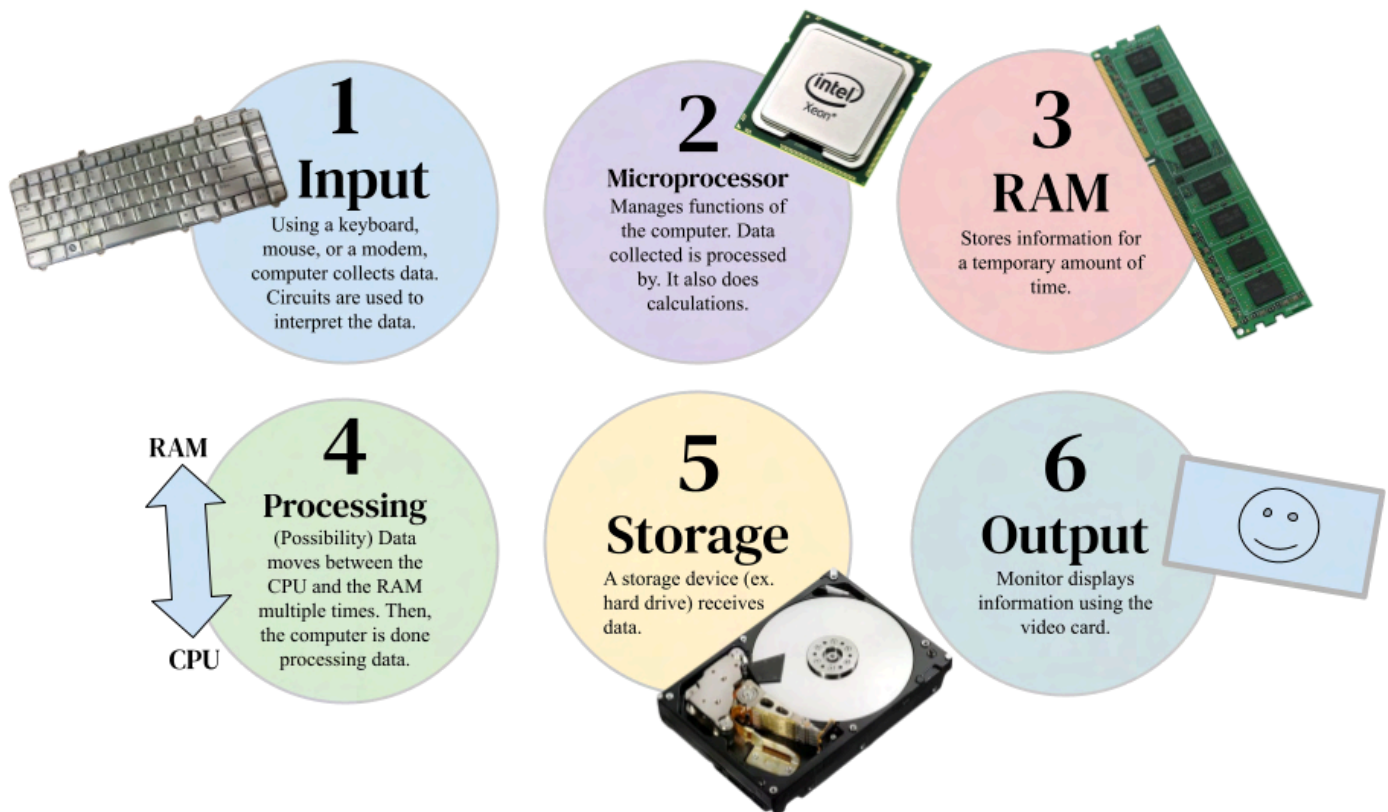
1. Li-on Battery Pack.....	46
I. What is Lithium?.....	46
II. How does it Work?.....	47
2. HDD.....	48
I. How does the HDD Work?.....	48
Binary Code.....	48
Measurements of HDD.....	49
Detail and Measurements of HDD.....	50
II. The History of HDD.....	51
3. CD Player.....	52
Polycarbonate Plastic.....	52
4. Cooling Fan.....	53
How is the Cooling Fan Made?.....	53
5. Switchboard.....	55
What is the Process of Wi-Fi?.....	55
Radio Waves.....	55
6. The Evolution of Laptops Over Time.....	56
Timeline.....	56
Further Details about the Laptops.....	57
Comparison of the Dell laptop and Other Laptops.....	58
Conclusion.....	59
Citations.....	60

Summary Report

Technology is the base of our future. We are surrounded by technology everywhere we go, making it important to go back to the earlier forms of technology. Using technology, we can learn how our present and future had started, which is why we chose to disassemble and analyze a laptop from about 16 years ago. We disassembled the Dell XPS M1530, known to the public since November 27, 2007.

Of course, technology has greatly changed and advanced over the years, yet it still made us wonder, “Is the technology really that different? How similar is it? What components used in this laptop are used nowadays?” To answer these questions, we started disassembling and researching.

Disassembling was not an easy task, as many components were strongly glued and screwed in, but eventually we were able to do it as a team. In the end, we were able to find eleven components, and were eager to learn about the components and how they help with our



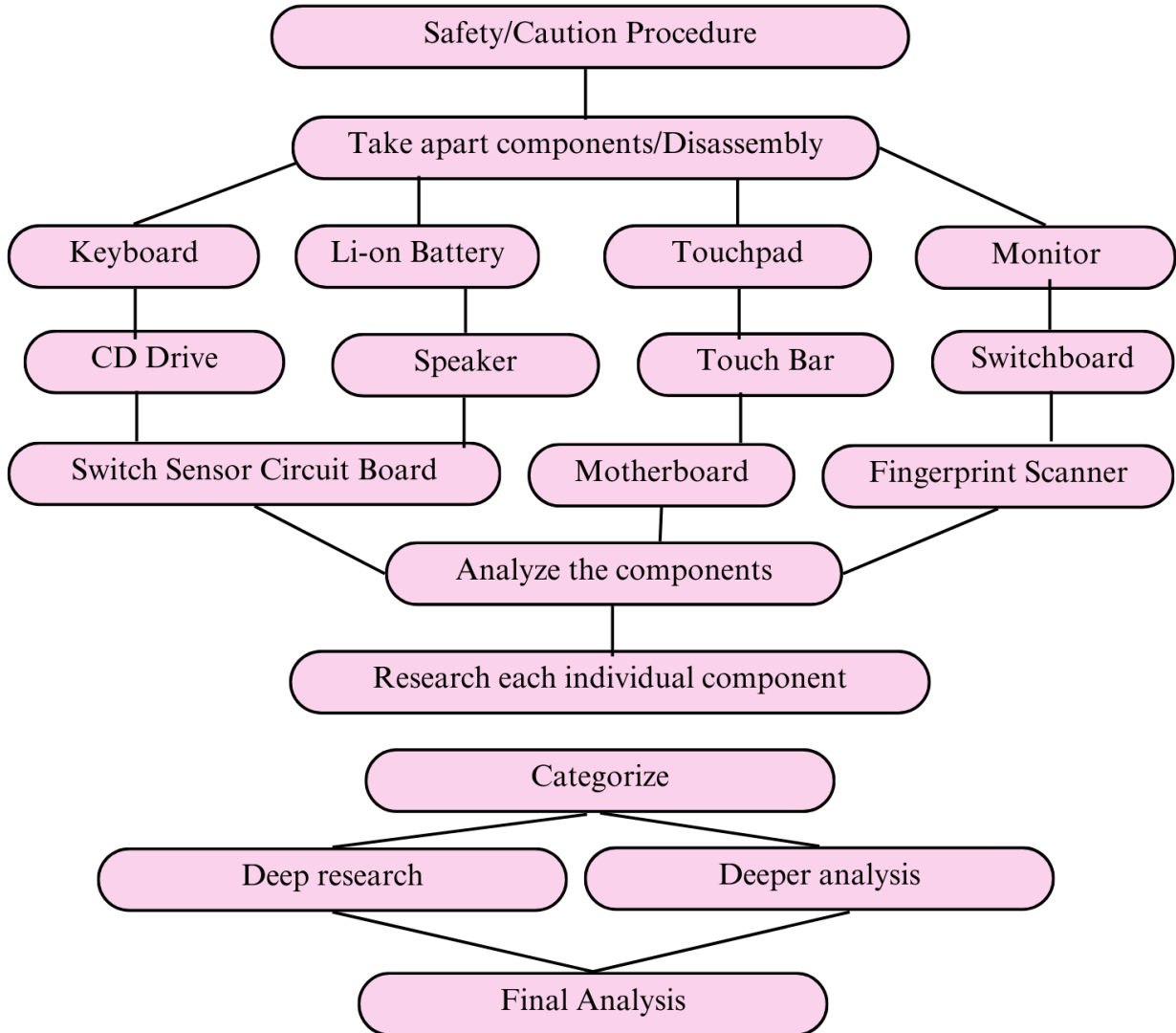
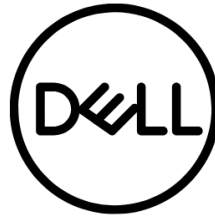
daily life. First, a computer generally goes through six steps to function and in this report, we will discuss further details of it.

Throughout the process of this online challenge, our team was able to gain a lot of knowledge and experience, from how to disassemble a computer, and to what each component in a computer does. It wasn't the easiest task, as the computer is very big, and holds a lot of information, but as a team, we were able to do it. Not only did we learn how computers work, but also that not many people actually post online how a computer works/processes actions. Due to that, we had some difficulties finding information, but we are glad now that we know the basic workings, and hope it'll help us later in life.

As we explored some of the components, we discovered that most computers utilize a basic type of code called binary code, which is a two-number system that uses the numbers zero and one. These numbers are used in combinations to represent numbers, letters, or other types of information.

Besides that, we also learned some other stuff, which you would discover in this report. We hope that our discoveries would fascinate you as much as it fascinated us.

Our Process



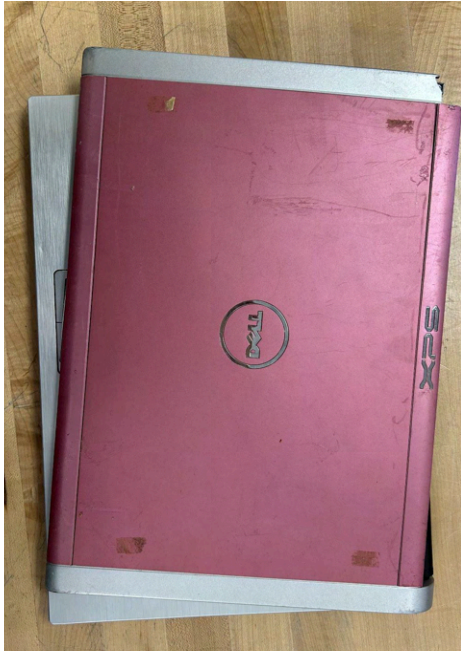
Safety Procedure





To ensure that no harm or injury would be caused from disassembling, we first followed the safety procedure by providing ourselves **face masks, cleaning tools, goggles, screwdrivers, and flatheads** that fit the size of the screws.

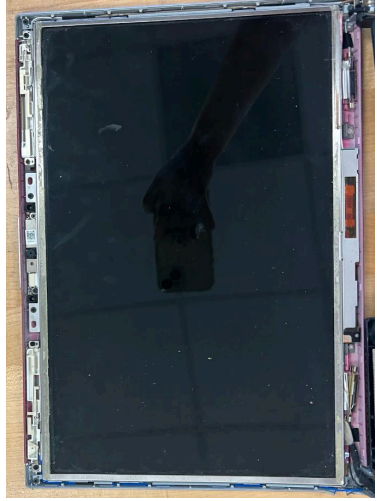

Disassembly Procedure

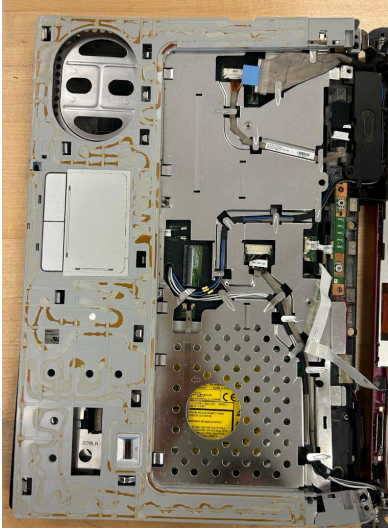

Starting Photos





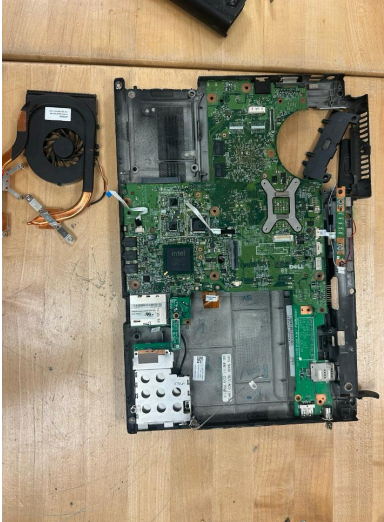
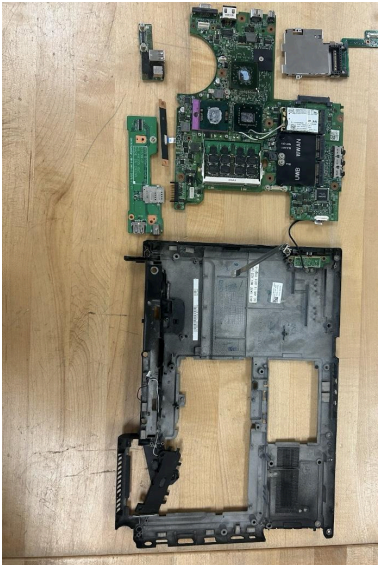
Reverse Engineering Online Challenge: 3383A

Step Number	Description	Photo
1	Took off part of the back cover and battery that were attached with different types of screws.	
2	Took off part of the keyboard cover by prying off the top cover with a flathead.	

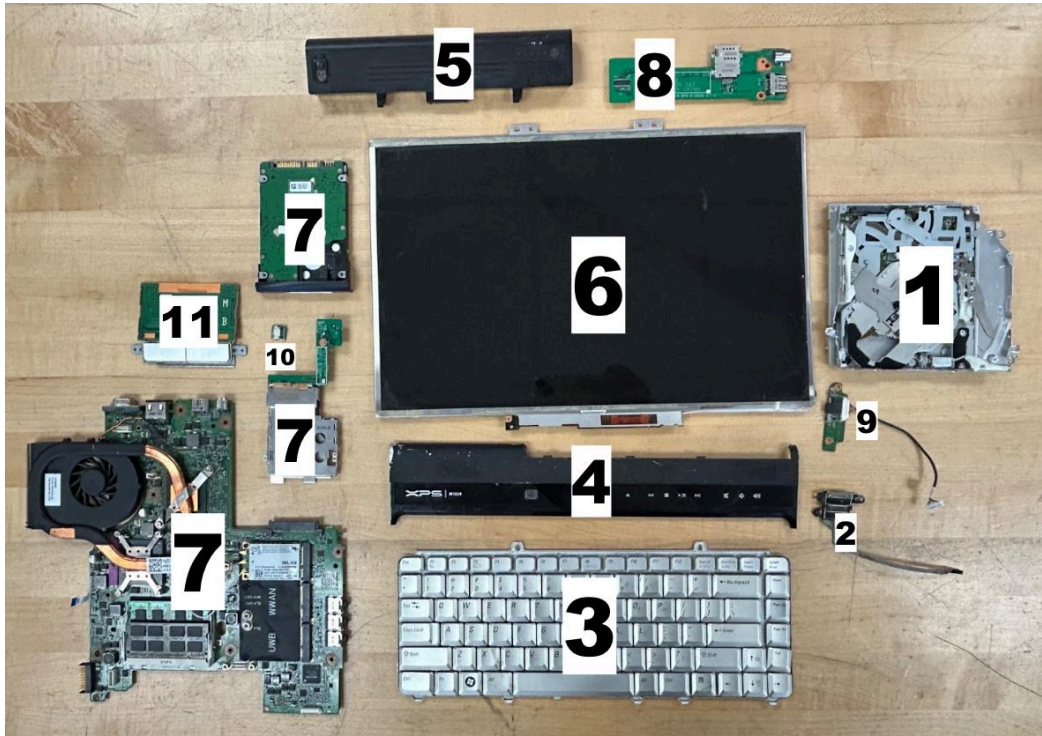
3	<p>Removed monitor from the rest of the components by breaking the connecting part to the rest of the device.</p>	
4	<p>Removed keyboard shortcut by breaking off the connecting sides that held it together.</p>	

5	Removed keyboard by removing screws prying it off using a flathead.	 A photograph showing the internal chassis of a laptop with the keyboard removed. The keyboard's metal frame is visible at the top, and the internal components like the battery, motherboard, and cooling system are exposed below.
6	Removed cover by removing the screws and unbending the metal.	 A photograph showing the laptop chassis with the top cover removed. The cover is placed above the main chassis, revealing the internal components such as the motherboard, RAM, and battery.

7	<p>Peeled off the black stickers to reveal the motherboard.</p>	
8	<p>Removed CD Player by going through multiple layers of removing the screws.</p>	

9	<p>Removed the cooling system by removing the screws to disconnect the cooling system and motherboard.</p>	
10	<p>Removed motherboard and a few other components by removing screws and metal parts.</p>	

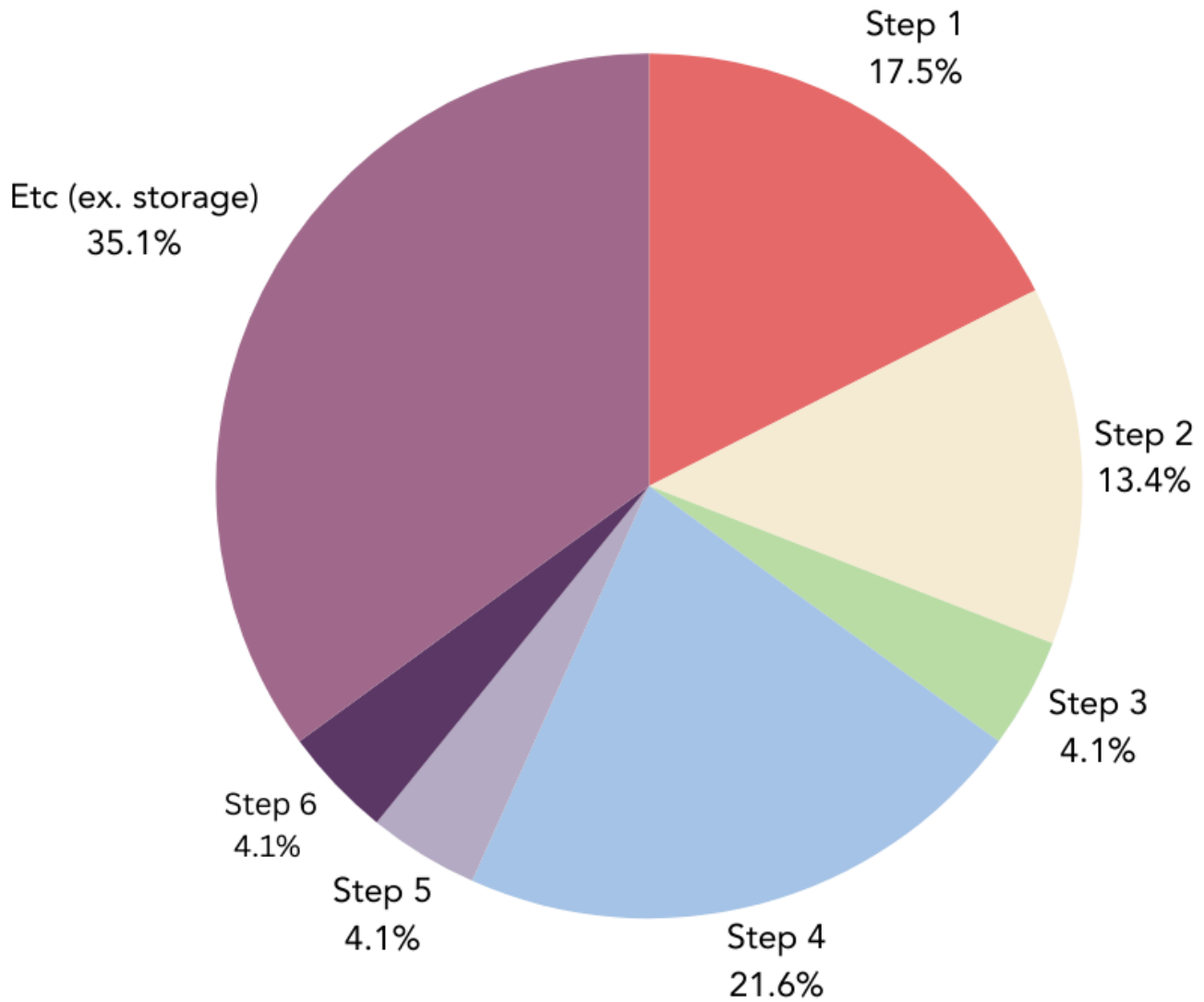
Parts Chart



1- CD Player	2- Fingerprint Scanner	3- Keyboard	4- Touch Bar
5- Li-on Battery	6- Monitor	7- Motherboard	7- Express Card (Part of Motherboard)
8- Speaker	9- Switchboard	10- Switch Sensor Circuit Board	11- Touchpad

Pie Chart

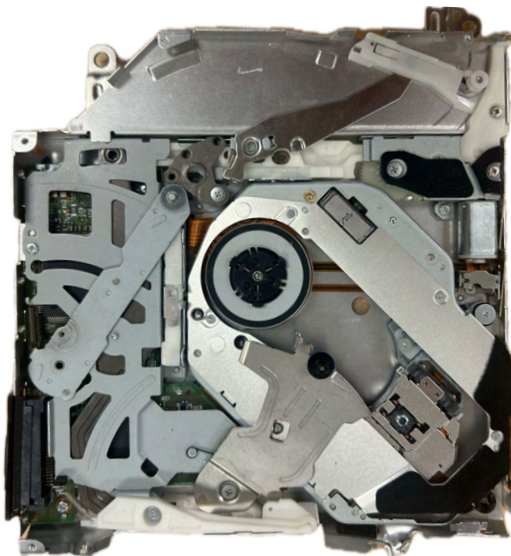
This is the pie chart of the components we have found. Step numbers refer to 6 steps from summary. "Etc" is anything that doesn't categorize in the 6 steps from the summary (ex. storage).



Components

1. CD Drive

Brief Information	Step # of 6 steps from Summary (If not, what else?)	Researcher (Team member that researched on component)
The CD player, also called the CD drive, is capable of reading the contents in a CD.	4	Eunice Lee



- A CD is a short term meaning compact disc.
- A CD is crafted out of a type of plastic called *polycarbonate plastic* and has a reflective metallic layer.
- Different CDs play different contents. Some CDs are used for playing music, videos, documentaries, movies, photos, writing, and storing data.
- Although their contents all differ, they all play an audio, video, or any other type of digital data.

- The eject button on the touchbar ejects the CD drive out of the computer, in which it is stored.
- A CD player has three major components— the drive motor, the laser and lens system, and a tracking

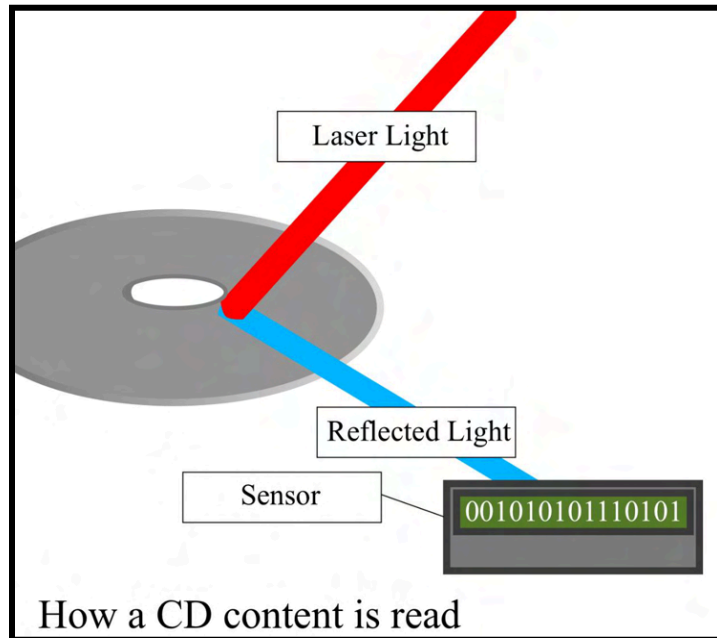


mechanism.

- The drive motor spins the disc in the CD player. It is controlled to spin it at a speed from

between 200 to 500 rpm (revolutions per minute), depending on which track it is reading.

- The laser and lens system reads the reflected light on a CD by pointing a laser on it.
- The tracking mechanism moves the laser so that it can follow the spiral track of the CD.
- A CD has some non-reflective areas and other areas are reflective.
- In binary code (a code using the numbers 0 and 1), the non-reflective areas represent the number 0 while the reflective spaces represent 1.
- A sensor reads the non-reflective and reflective areas and converts them into 0 and 1, creating an audio, video, or any other type of data.

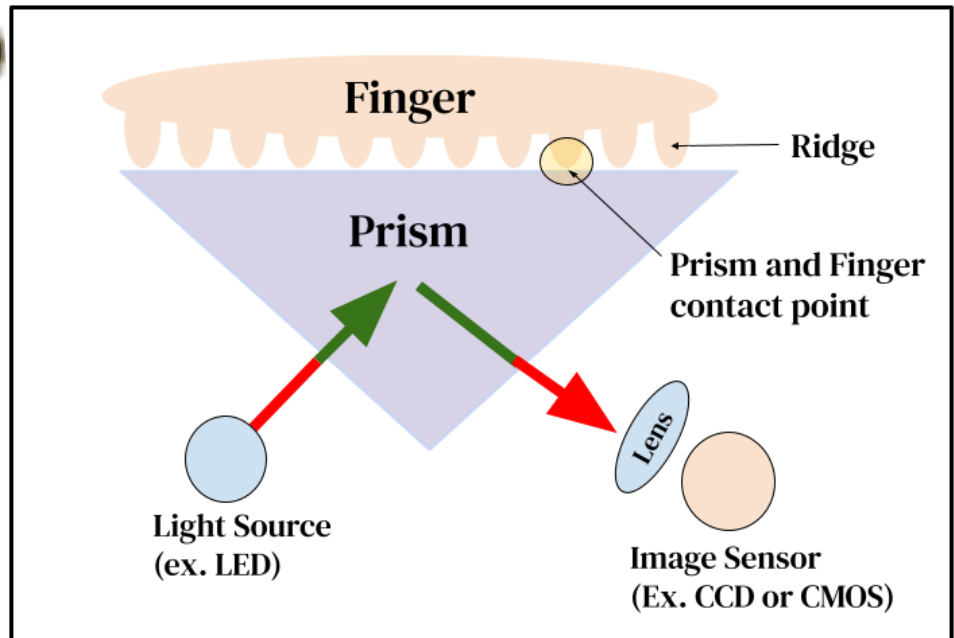


2. Fingerprint Scanner

Brief Information	Step # of 6 steps from Summary (If not, what else?)	Researcher (Team member that researched on component)
Fingerprints are identified by fingerprint scanners for security reasons.	1	Megan Chung



- The Dell XPS M1530 most likely uses the optical scanner instead of the capacitive fingerprint scanner.
- Optical scanners use digital photos taken using bright lights.
- A digital image is created using a light-sensitive microchip. Ridges on our fingers are read by the microchip, and transform it to a code made of 1's and 0's.



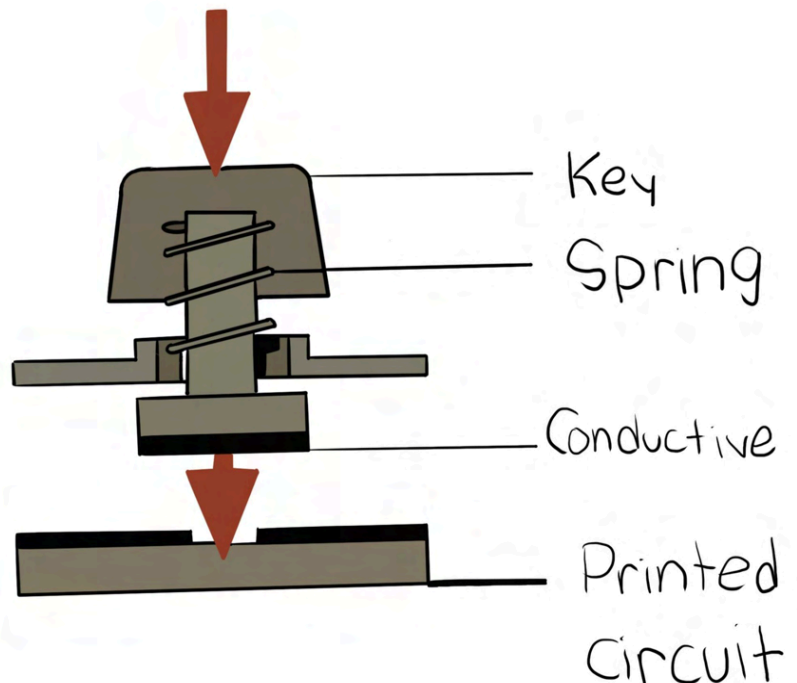
How a fingerprint scanner works model
(Prism is the fingerprint scanner surface)

3. Keyboard

Function	Step # of 6 steps from Summary (If not, what else?)	Researcher (Team member that researched on component)
What it includes: Its own processor and circuitry that carries information from the processor (Like a mini computer).	1	Hailey Chung

How it works:

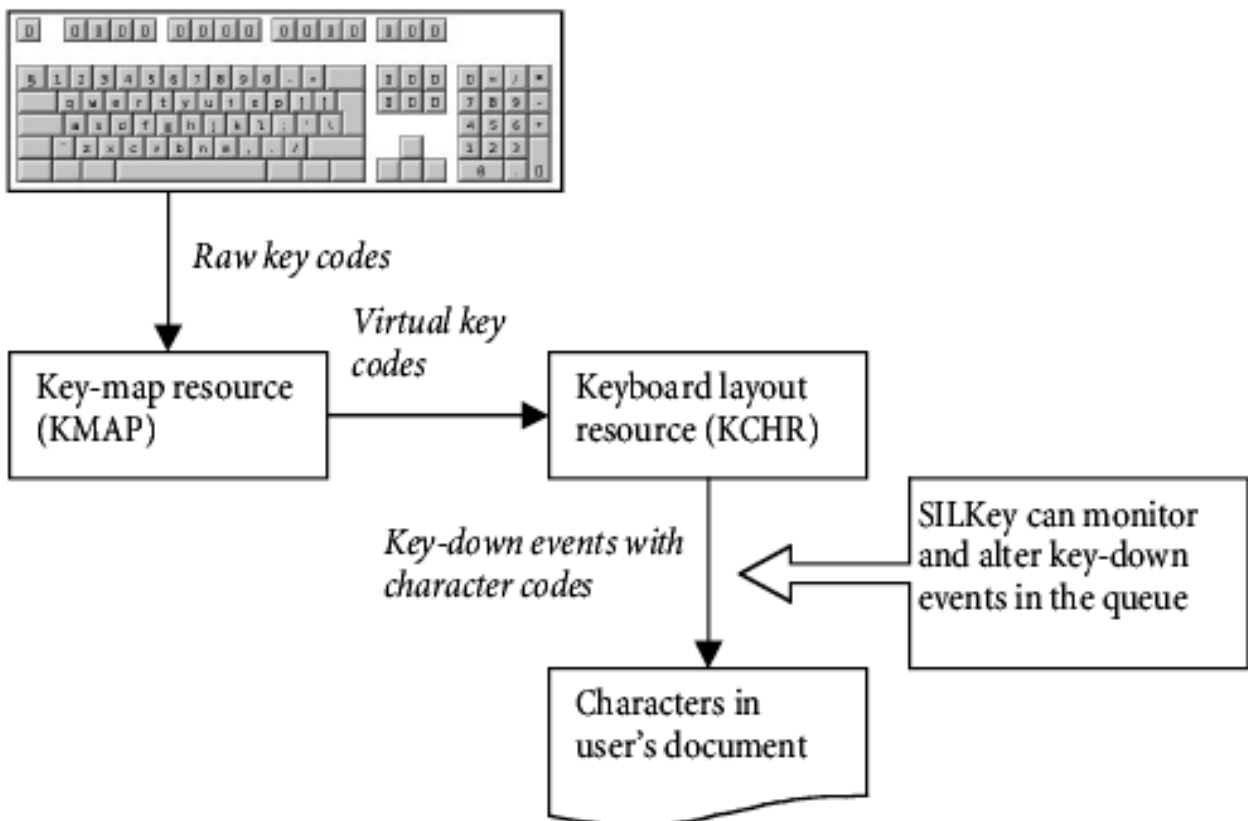
- Key matrix is a grid of circuits under keys.
- All keyboards except capacitive models have each circuit broken at a point below each key.
- When a key is pressed, it presses the switch, completing the circuit and allowing tiny current to flow.
- Mechanical action of the switch vibrates (bounce) and processor filters out.
- If pressed and hold the key, the processor recognizes the equivalent of pressing the key repeatedly.
- When the processor finds the circuit closed, it compares the location of the circuit on the key matrix to a character map called ROM (Read-Only Memory).
- Character map: Comparison chart/Lookup table.
- Tells processor position of each key in matrix and each keystroke/combination of keystroke represents.
- Example: Character map lets the processor know that pressing a key by itself shows a small letter “a”.



- Shift and press together shows capital “A”.

Capacitive switches:

- Non-mechanical because they do not physically complete circuits like most keyboard technologies.
- Instead current flows constantly through all parts of the key matrix.
- Each key is spring loaded and a tiny plate to the bottom of it.
- When a key is pressed, its plate moves closer.
- The amount of current flowing through the matrix changes.
- Processor detects change and interprets the key press for location.
- Capacitive switch keyboards are expensive, but they have longer life than any other keyboards.
- Don't have problems with bounce since two surfaces never come into contact.



4. Touch Bar

Function	Step # of 6 steps from Summary (If not, what else?)	Researcher (Team member that researched on component)
The function of the keyboard shortcut, also known as the touch bar, is used to offer people quick access on the laptop to people.	1	Eunice Lee



- The Touch Bar is usually located above the keyboard and under the monitor.

- The buttons on the keyboard shortcut includes:

- The power button to power the laptop on or off.
- The home button to return you to the main page/the homepage of a program.
- The eject button to “eject” the disk tray, or the CD player out of the laptop.
- A button for playing the previous track or rewinding.
- The stop button to “stop” a video or a recorded audio.
- A button for playing/ pausing something recorded or a video.
- A button to play the next track or fast forwarding button.
- The mute button to silence the volume completely.
- A button to decrease the volume by one.
- A button to make the volume increase by one.
- **Note* The stop button and the play/pause button both involve pausing a video or a recorded audio, but they are also different because the stop button is used to stop something, then, it restarts the video/audio from the beginning, but the play/pause button is used to pause something, but it stays at the section where you left off when you play it again.*

5. Li-on Battery

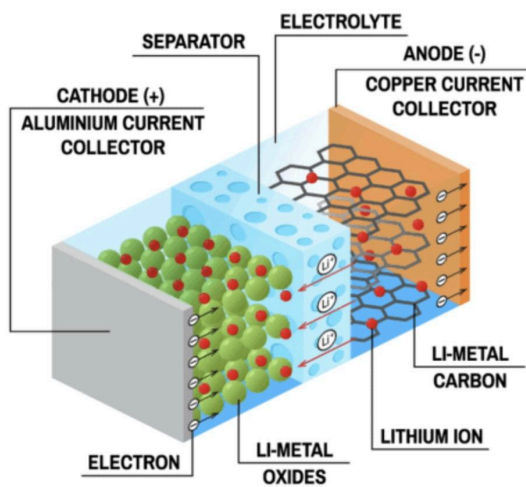
Function	Step # of 6 steps from Summary (If not, what else?)	Researcher (Team member that researched on component)
The Li-on Battery is the key for the system to start. It charges the laptop by converting the chemical energy and changing it into electricity.	Battery	Lauren Kim



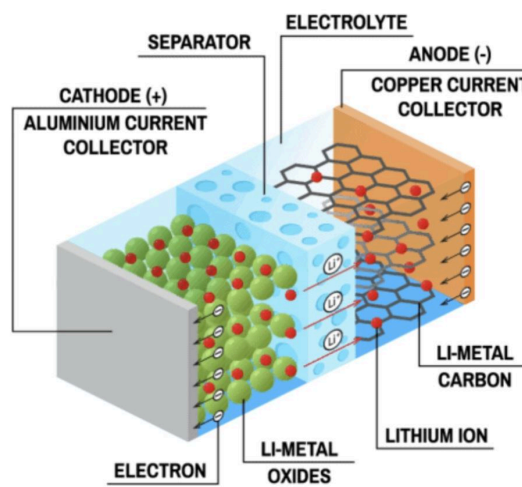
- Some of the most commonly used Li-ion batteries are in laptops and devices.
- It is one of the most energetic rechargeable batteries available.
- It is made of lithium and carbon, lots of energy is stored in the atomic bonds.
- There is high density in the lithium-ion batteries.

LITHIUM-ION BATTERY

DISCHARGE

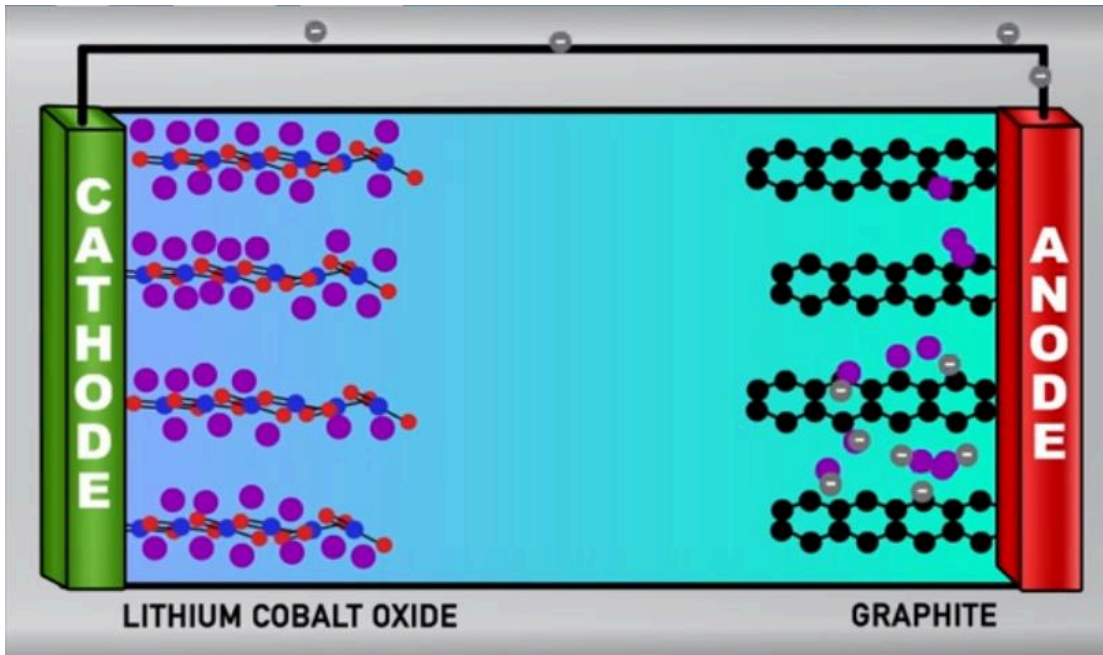


CHARGE



- A battery works by converting chemical energy and converting it into electricity.

- In the electrochemical cells, it consists of two types of electrodes, the anode and cathode.
- When these two electrodes are connected by a circuit, they eventually allow the negative anode to move into the cathode (this is the movement of the electrolytes) the cathode, the positive atom, travels through to the anode.
- The cathode and anode balances the battery energy, making electricity.
- Heat increases the pace of the movements of the cathode and anode, which make the battery lose its battery life faster.



6. Monitor

Function	Step # of 6 steps from Summary (If not, what else?)	Researcher (Team member that researched on component)
The main use of a monitor is to display images, text, videos, and information.	6	Kayden Fann

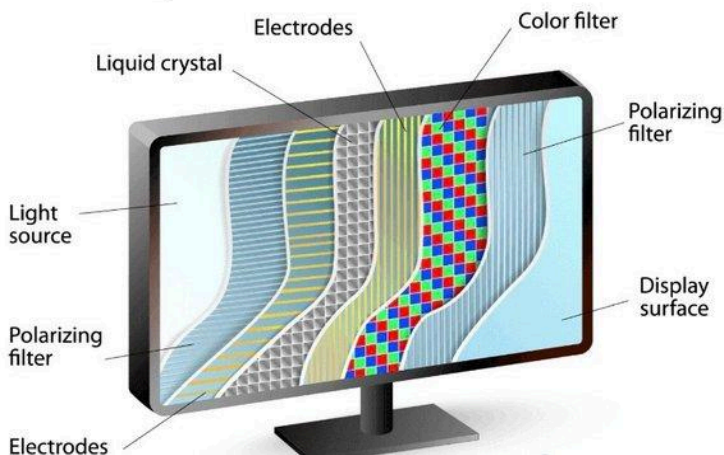
- The monitor is generated from the computer using the computer's video card.
- It is referred to as the main output device.
- There are multiple different kinds of monitors.
- The one being used on our Dell laptop is a flat panel monitor.

Flat Panel Monitor:

- It is more portable and takes up less room.
- It uses less energy than CRT monitors.
- The monitor does not produce hazardous radiation.
- Makes this monitor more efficient.



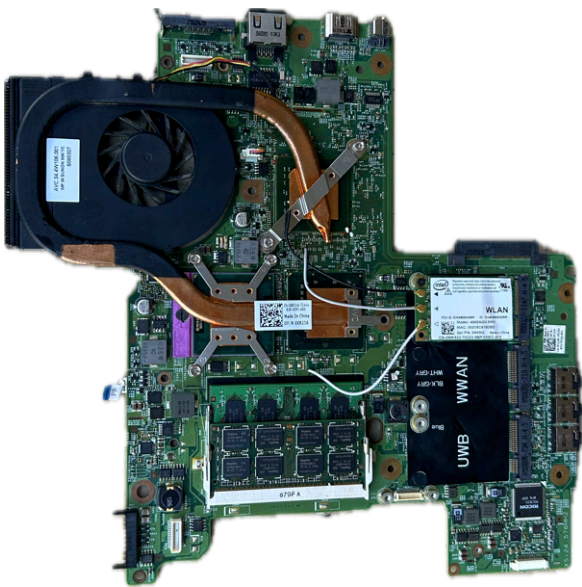
LIQUID CRYSTAL DISPLAY



What it includes:

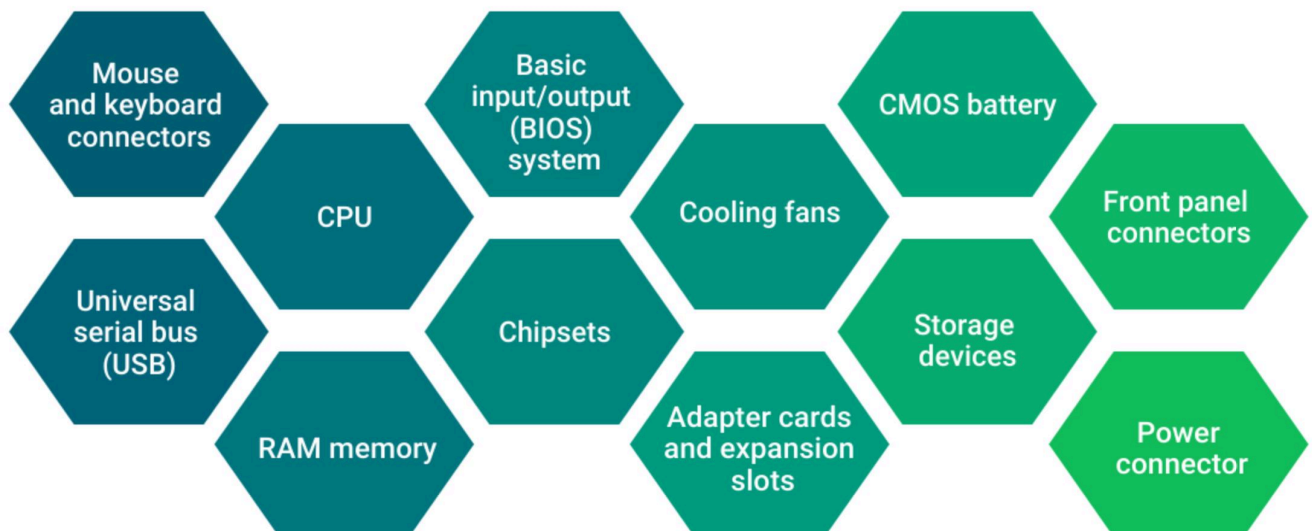
- The display is composed of many different parts.
- A liquid crystal material to show as a reflective display.
- Glass substrates close to liquid crystal.
- Other transparent electrodes (ITO) are used in smaller regions where light can be selectively blocked.
- Many different color filters which make colors on the monitor screen show.
- Thin film transistors on the glass.

7. Motherboard



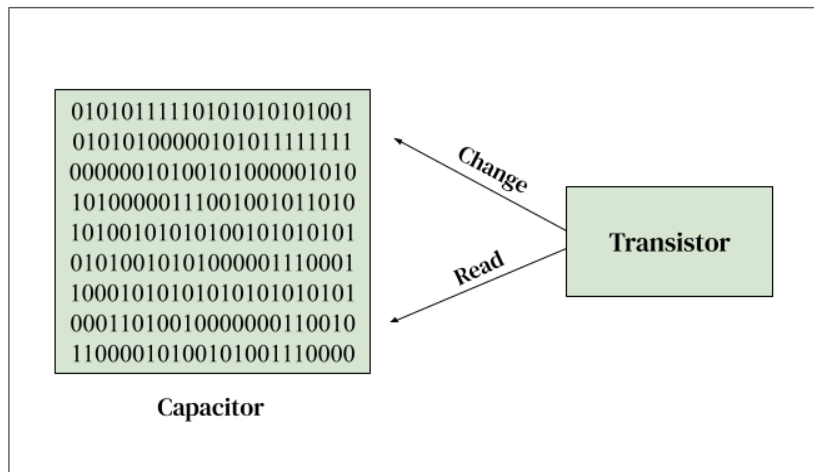
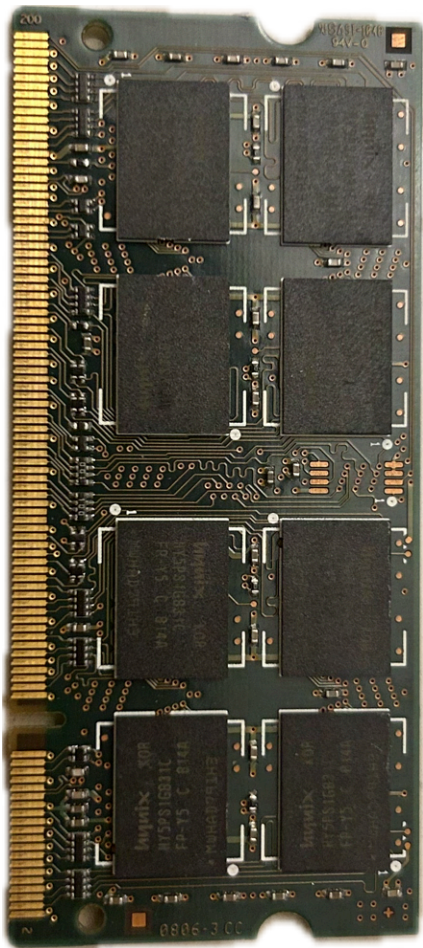
- A circuit board
- In order for the computer to be able to function, the motherboard is needed.
- Most times, fiber glass and copper is utilized to make the motherboard.
- Connects multiple components together so the components can communicate to work in an orderly manner.
- 12 components make up the motherboard:

Key Components of a Motherboard



I. RAM

Basic Information	Step # of 6 steps from Summary (If not, what else?)	Researcher (Team member that researched on component)
RAM, an acronym for random access memory, stores information that the CPU can access for a temporary amount of time (information is gone after the computer turns off).	3	Megan Chung



Model of how a RAM works

- Utilizing RAM Slots, the RAM and the motherboard are connected together.
- This computer uses a specific type of RAM called DRAM (dynamic random access memory).
- It utilizes a transistor along with a capacitor, and they make a memory cell.
- Each memory cell is data.
- Utilizing the binary code, the capacitor is able to contain information, and the capacitor is read/changed by the control circuitry.
- The transistor controls the control circuitry.

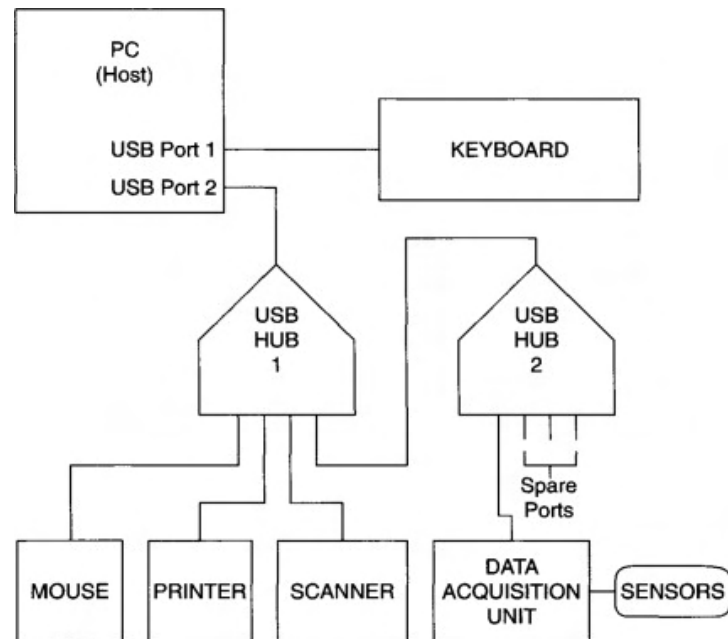
II. USB

Function	Step # of 6 steps from Summary (If not, what else?)	Researcher (Team member that researched on component)
Universal serial bus, also known as the USB, is a connector between the computer and other devices, to transfer information or power.	Connector	Megan Chung, Hailey Chung

Pin Number	Cable Colour	Function
1	Red	V_{BUS} (5 volts)
2	White	D-
3	Green	D+
4	Black	Ground

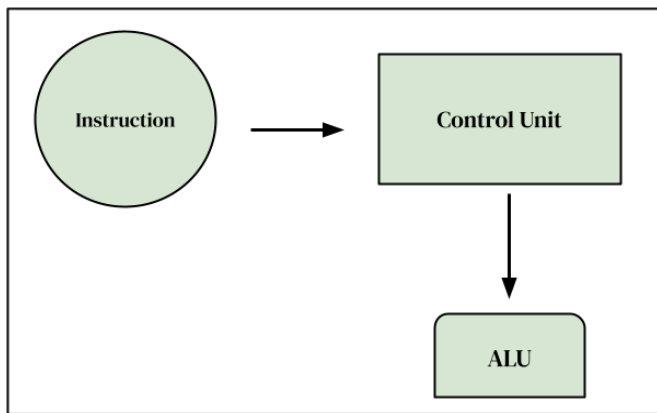
- A USB is able to do it using two wires that transfer data and power.
- They also use the help of metal strips.
- They are two systems, which work on communication between devices.

- They also host controllers like a computer PC or phones.
- They connect bordered devices like cameras, mice, keyboards, printers, scanners, media devices, hard drives, and flash drives.



III. CPU

Function	Step # of 6 steps from Summary (If not, what else?)	Researcher (Team member that researched on component)
CPU is an acronym for central processing unit. It is the brain of the computer.	2, 4	Megan Chung

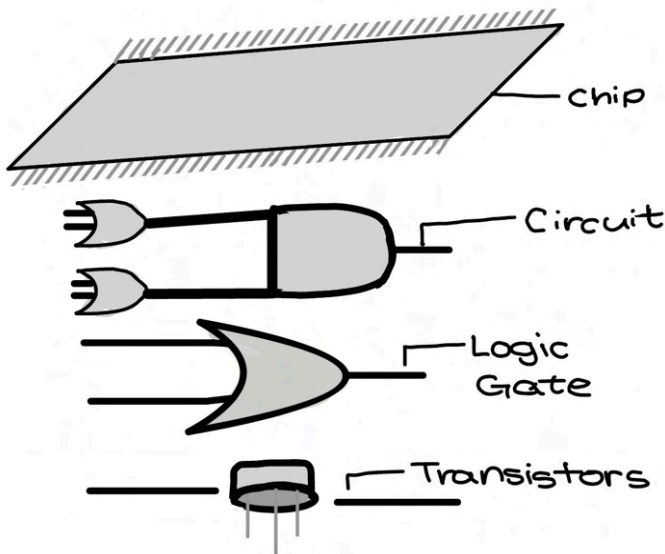


Model of how a CPU works



- The CPU is made of layers, the chip, the circuit, logic gate, and transistors.

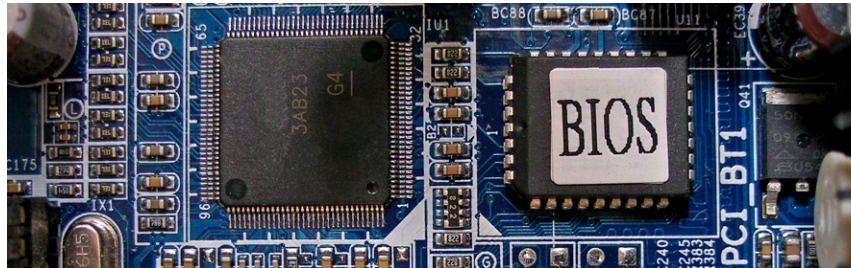
- Executes instructions.
 - The CPU gets instructed by the instructions on what to do.
 - Control unit decodes instructions.
 - Decoded information/instruction transferred to ALU. In ALU, the instructions happen.



IV. BIOS System

Basic Information	Step # of 6 steps from Summary (If not, what else?)	Researcher (Team member that researched on component)
Acronym for Basic Input/Output system.	2	Megan Chung

- Microprocessor
- Firmware
- Is like the “confirmer” of the computer.
- Has 4 functions:



1	2	3	4
POST , an acronym for Power-on self-test. POST is when the computer’s hardware is tested, prior to the OS being loaded.	Detecting the OS , it is also a bootstrap loader.	Software/drivers are detected by the BIOS (specifically the software/drivers that the OS will interface after it activates).	Sets up the CMOS , acronym for complementary metal-oxide semiconductor. Thanks to that action, hardware/system settings can be changed by users. The CMOS is a memory of the BIOS’ that is non-volatile.

- The location of the BIOS is the EPROM chip, EPROM being an acronym for erasable programmable read-only memory.
- The BIOS program is granted control when the computer is turned on.
- Then, the BIOS checks if components necessary for the computer’s functioning are placed correctly, and works.

V. Mouse and keyboard connectors

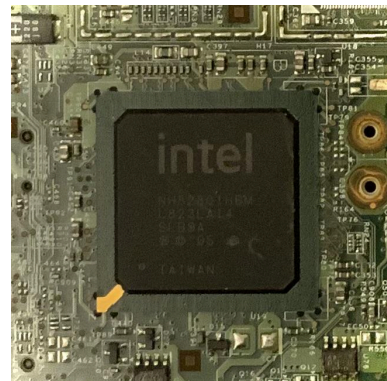
Basic Information	Step # of 6 steps from Summary (If not, what else?)	Researcher (Team member that researched on component)
It enables the laptop to receive data from the laptop.	4	Megan Chung

- Function: Enables the laptop to receive data from the laptop.
- There are several types of keyboard/mouse connectors. One of them includes the USB. Details about the USB (which is a keyboard/mouse connector) are on page 26.
- Please go to page 26 for information on the keyboard/mouse connector, and the USB.

VI. Chip Set

Basic Information	Step # of 6 steps from Summary (If not, what else?)	Researcher (Team member that researched on component)
Multiple chips in a set.	Enhancer	Megan Chung

- In the past, when chipsets weren't existing, chips would be randomly placed on the motherboard, which led to issues.
- So, chips are now gathered into a set.
- Multiple chips were gathered into a fewer number of chips, and those chips condensed are in a chipset.



VII. Cooling System

Basic Information	Step # of 6 steps from Summary (If not, what else?)	Researcher (Team member that researched on component)
The cooling system moves heat from the engine.	Enhancer	Kayden Fann

Serves three main important functions:

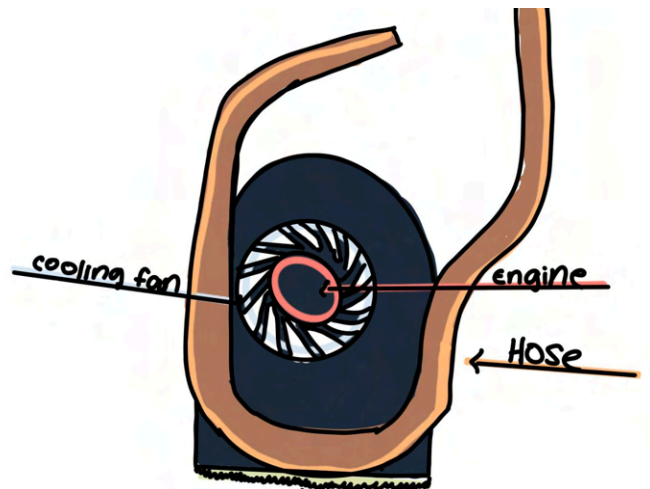
- 1. Removes excess heat from the engine.
- 2. Maintains the engine operating temperature to have it work most efficiently.
- 3. Brings the engine to the right operating temperature.

Composed of six main parts

- The engine
- A radiator
- A water pump
- A cooling fan
- Hoses
- Thermostat

What the process does:

- Heat is transferred to the coolant through the engine by the water pump.
- Hoses carry a hot coolant to the radiator.
- Heat is transferred to air that is pulled past the engine.
- coolant is carried back to the water pump.
- Heating up process:
- The engine can get cold and the engine operates differently.
- The engine is designed to warm up quickly.
- When the engine reaches the right temperature (operating temperature) the engine needs to be maintained at the temperature.
- The thermostat is used to read the proper temperature.
- Without the thermostat, the engine would lose heat.
- The thermostat adjusts flows to the radiator to maintain a stable temperature.
- When the engine becomes too hot , the engine becomes completely dependent on the radiator to make the temperature stable.



VIII. CMOS Battery

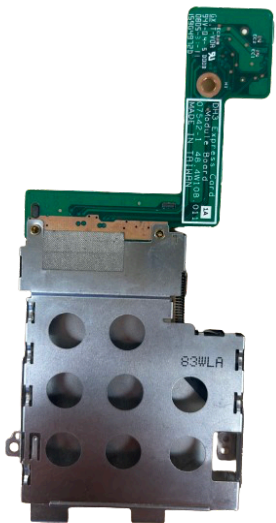
Basic Information	Step # of 6 steps from Summary (If not, what else?)	Researcher (Team member that researched on component)
The BIOS firmware is activated by the CMOS battery.	Battery	Megan Chung



- Computer's clock
- Lithium battery
- Please look at page 21 for further details on how a lithium battery works

IX. Adapter Cards and Expansion Slot

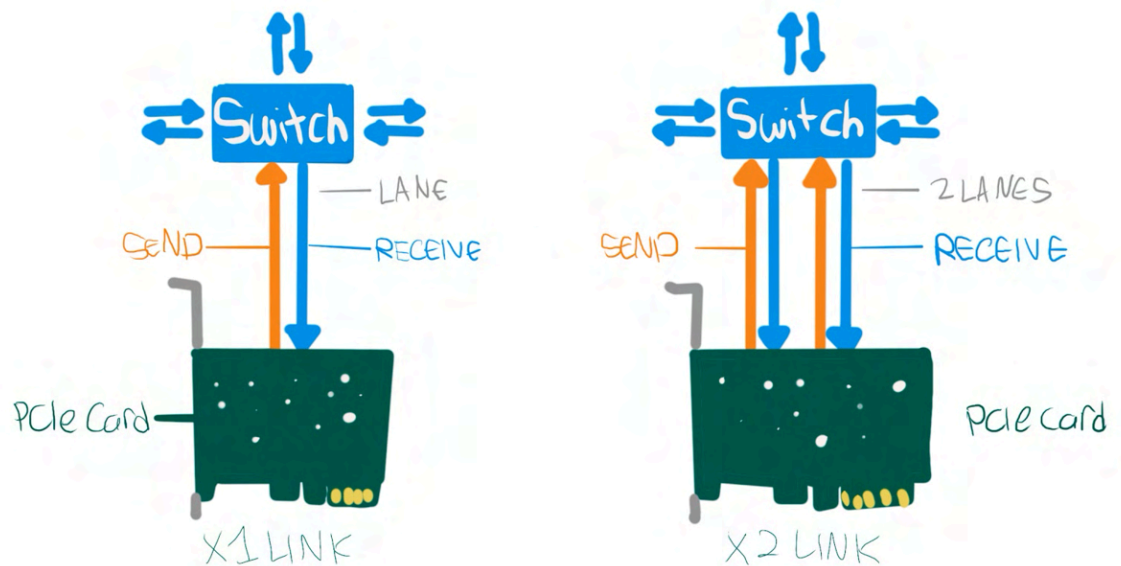
Basic Information	Step # of 6 steps from Summary (If not, what else?)	Researcher (Team member that researched on component)
Adapter cards and expansion slots are like partners. The functionality of the computer is enhanced by the adapter card, and the expansion slot allows that to happen (connects adapter and the motherboard).	4	Hailey Chung, Lauren Kim, and Megan Chung



Adapter Cards (PCI Express Card)

- PCI slots are an integral part of computer's architecture that people take for granted.
- PCI has functional ways to connect sound, video, and network cards to a motherboard.
- However, PCI has a shortcoming.
- As processors, video cards, sound cards, and networks got faster/powerful, PCI stayed the same.
- Fixed width of 32 bits and handles 5 devices at time.

- Newer 64 bit PCI-X bus provides much more

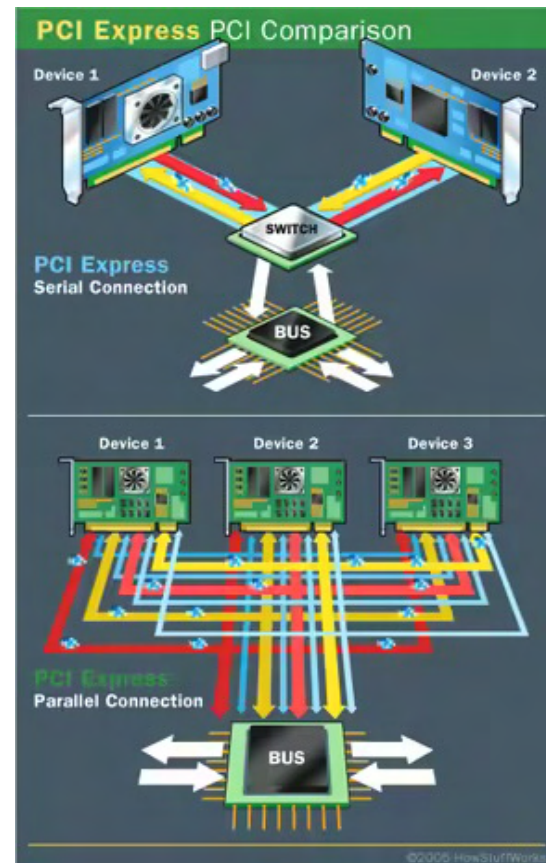
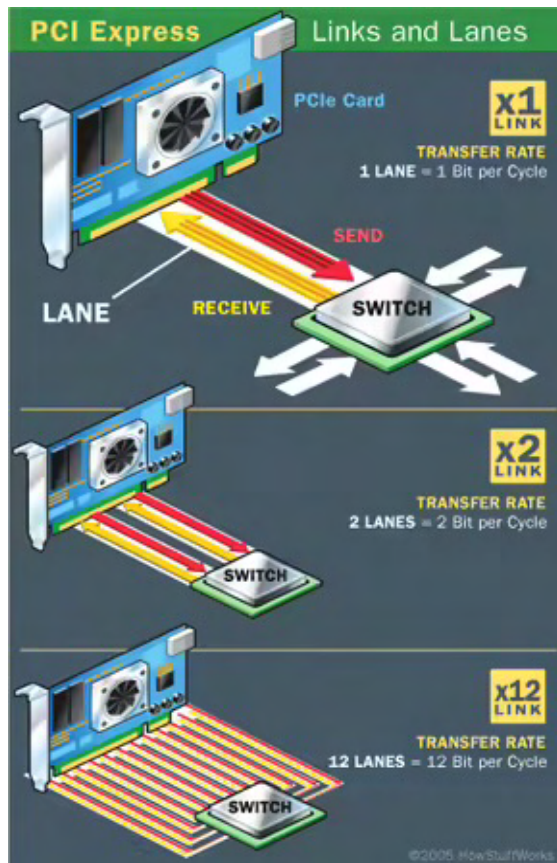


bandwidth, but greater width compounds some of PCI's other problems.

- PCI Express is a new protocol that eliminates lots of shortcomings, more bandwidth, and is compatible with existing operating systems.

High-Speed Serial Connection

- Data moved into serial connections.
- Computers separated data into packets and then moved packets from one place to another.
- Connections are reliable, but slow.
- That's why



manufacturers used parallel connections to send many pieces of data simultaneously.

- Parallel connection does have problems though because as speeds get higher and higher (Example: Wires can interfere electromagnetically) so the pendulum swings back toward highly-optimized serial connections. Improvements in hardware and the process of dividing, labeling, and reassembling packets have led to faster serial connections like USB 2.0 and FireWire.
- PCI Express is serial connections operating more like a network than a bus. Instead of buses that handle data from multiple sources, PCIe has a switch that controls few point-to-point serial connections.
- The connections fan out from the switch, leading to devices where data needs to go.
- Every device has its own dedicated connection, so devices no longer share bandwidth like a normal bus.
- When the computer starts, PCIe determines what devices are plugged in the motherboard.
- Identify links between devices creating a map of traffic will go/negotiate width of each link.
- Identification of device and connection is the same protocol PCI uses.
- PCIe doesn't require any changes to software operating systems.
- Lane of PCI express connection contains two pairs of wires: one to send and one to

receive.

- Packets of data move across lanes at rate one bit per cycle.
- Ax1: Smallest PCIe connection, one lane with four wires, and carries one bit per cycle in every direction.
- Ax2: Contains eight wires and transmits two bits at once.
- Ax4: Contains four bits.
- Others are x12, 1x16, and x32.



- 32-bit PCI has a maximum speed of 33 MHz and allows maximum 133 MB of data to pass through the bus per second.
- 64-bit PCI-X has twice the bus width of PCI.
- Different PCI-X allow different rates of data transfer from 512 Mb to 1 GB data per second.
- Single PCI Express lanes can handle 200 MB of traffic in every direction per second.
- Ax16 PCIe connectors can move 6.4 GB data per second in each direction.
- At these speeds, ax1 connection can handle gigabit Ethernet connection. It can also handle audio and storage applications as well.
- Ax16 connections can be handled easily by the powerful graphics adapters.

- **Expansion Slots**

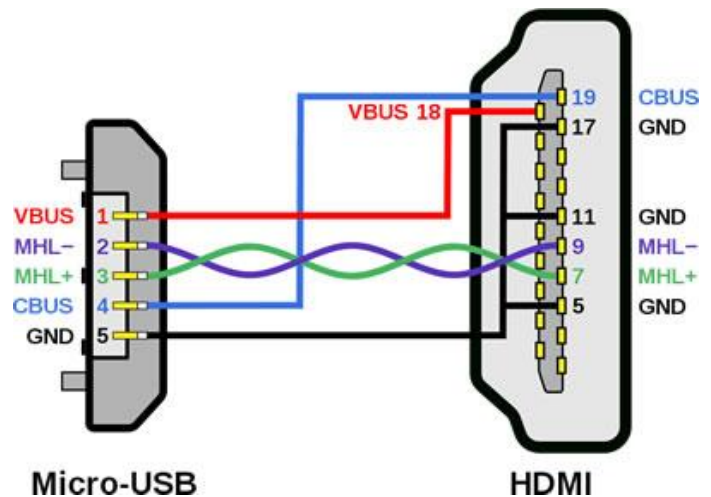
- How an expansion slot works:
- Expansion buses utilized.
- Data sent through the bus.
- If the bus is wide, then a larger amount of data can be sent.
- Old

computers use the parallel bus, while more modern models use the

serial bus. In the serial bus, the bus's width doesn't determine the amount of information able to be transferred.

The sound card is another type of adapter card.

- The sound card sends and receives audio data on a computer based system.
- Translates the data and code that the computer uses to analog the sound which the user can hear through the speakers, headphone etc.



- Sound card is embedded into the motherboard.
- This card's memory is connected to the motherboard using ports.

X. Storage Devices (HDD)

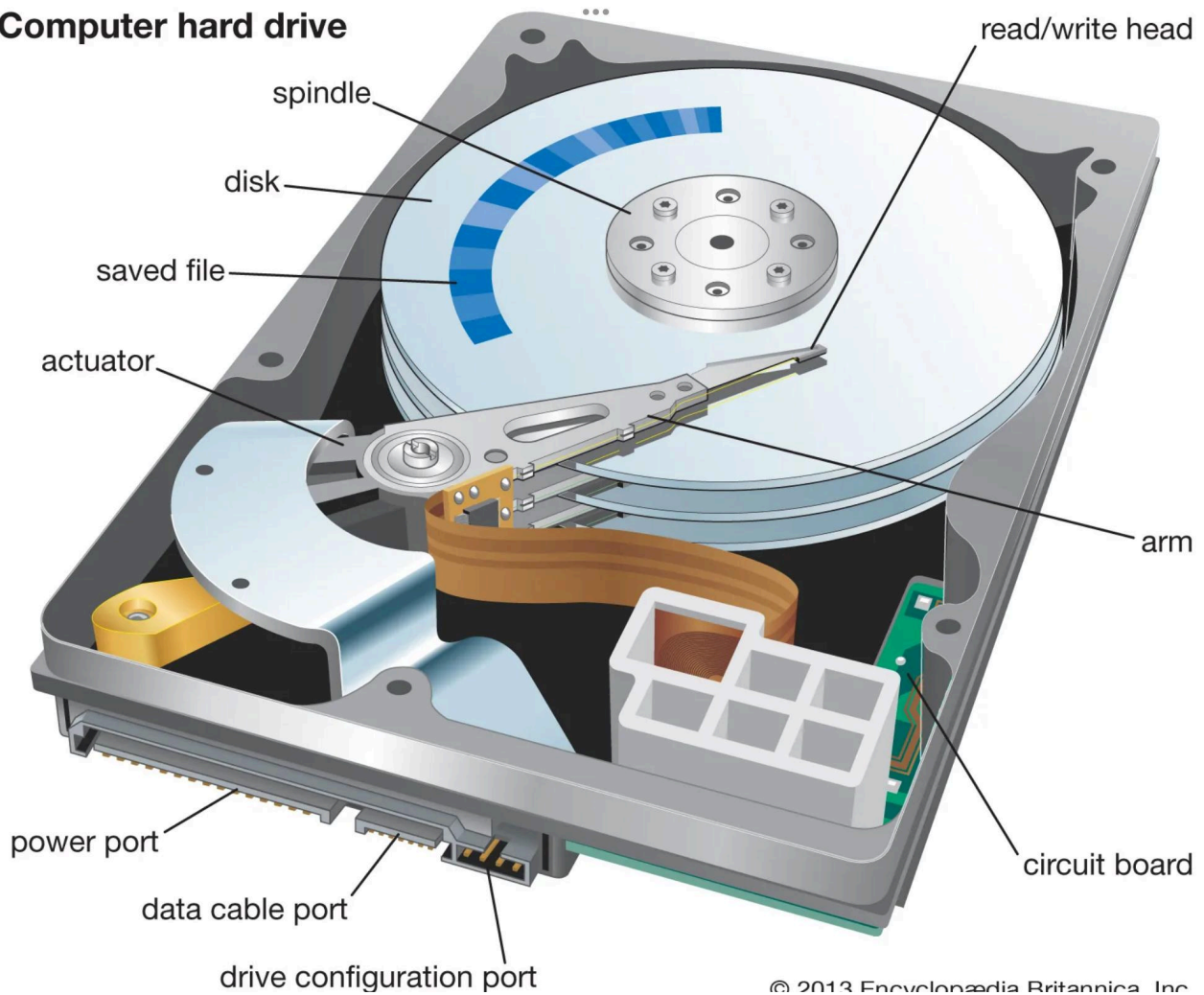
Basic Information	Step # of 6 steps from Summary (If not, what else?)	Researcher (Team member that researched on component)
This storage system uses matters for performance, such as power usage and reliability	5	Lauren Kim

- This type of HDD, which according to dell.com calls it as a traditional storage device, “uses mechanical platters and a moving read/write head to access data”.
- It keeps all the operating, application files, images, music files, video files, and documents.
- HDD are electric storage devices that “use magnetic storage on a series of physical platters to store and retrieve digital data”.

	Hard disk drive (HDD)
Form-factor	<ul style="list-style-type: none"> • 3.5” Serial-ATA (SATA) mostly used in desktops and all-in-ones • 2.5” Serial-ATA (SATA) mostly used in laptops
Read/Write speed	<ul style="list-style-type: none"> • Slower
Energy efficiency	<ul style="list-style-type: none"> • Uses more energy

- Compared to the SSD, it has higher storage power, but slower read and write speeds.
 - Inside the HDD, it contains moving components in the drive. The size usually varies from 3.5inch and 2.5 forms. The 3.5 is usually used in desktops and 2.5 is used in laptops.

Computer hard drive



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XI. Power Connector

Basic Information	Step # of 6 steps from Summary (If not, what else?)	Researcher (Team member that researched on component)
Gives electricity.	Connector	Megan Chung

Please look at page 26 for an explanation on how it works (USB).

XII. Front Panel Connector

Basic Information	Step # of 6 steps from Summary (If not, what else?)	Researcher (Team member that researched on component)
LED, power/reset button, and internal speaker are joined together by the front panel connectors.	Connector	Megan Chung

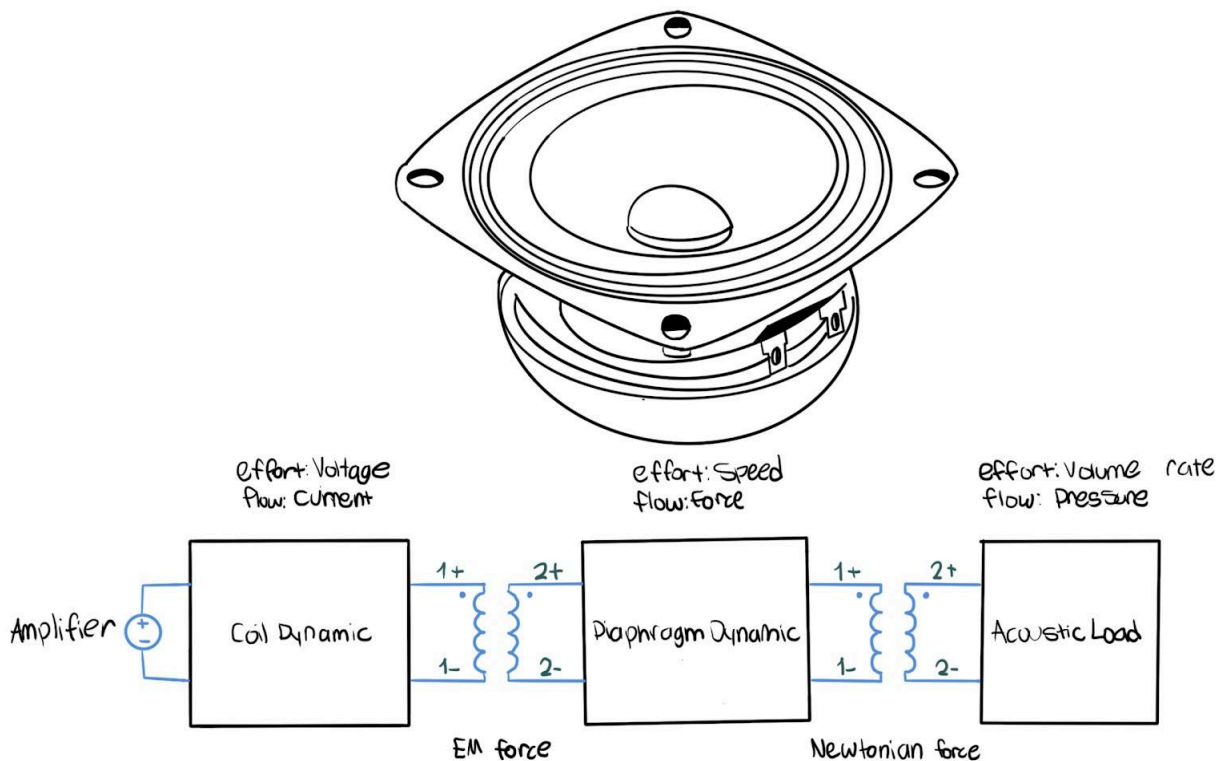
- The front panel connector has ports where cables can get plugged in.
- A type of cable they use is the USB3.
- Please look at page 26 for an explanation on its function.

8. Speaker

Basic Information	Step # of 6 steps from Summary (If not, what else?)	Researcher (Team member that researched on component)
The speaker helps the computer produce sound.	4	Hailey Chung

HOW DO SPEAKERS WORK?

- Converts gathered electrical energy into mechanical energy.
- When air is compressed by mechanical energy, motion is converted into sound pressure level/sound energy. (SPL)



- In speaker system, electrical current goes to the system's voice coil.
- Makes electrical field that's associated with magnetic field found in speaker.
- Similar charges repel and opposite charge be found in production of sound in audio

system.

- When audio signals travel through a voice coil, musical waveforms rise and fall.
- Essential when the repelling and attraction of voice coil with permanent magnet.
- Produces the back and forth motion of the voice coil.
- Gives cone-like structure.
- From switching motion, pressure wave are in air = Sound.

HOW DO SPEAKERS PRODUCE SOUND?

Step Number	Details
1	<ul style="list-style-type: none">● After you power the sound system from zero, output voltage serves as a representation of the initial music waveform.● Generated electrical current passes through the sound system's voice coil by bouncing alternating between negative and positive sides.
2	<ul style="list-style-type: none">● Result: Magnetic field is produced and surrounds voice coil. Very similar to the magnetic found in the speaker frame.
3	<ul style="list-style-type: none">● Diaphragm/Cone proceeds by moving forward=air pressure.● Air pressure produces audio that people hear as sound.
4	<ul style="list-style-type: none">● Electrical signal voltage towards the upper sine wave of the musical signal changes to a bigger electrical current. It also allows an increase in the magnetic field strength of the voice coil.
5	<ul style="list-style-type: none">● Increase allows cone to project bigger.

6	<ul style="list-style-type: none"> • After the signal flows to the highest output, it declines. • Electrical current declines bringing diaphragm close to initial off position at zero voltage.
7	<ul style="list-style-type: none"> • Signal reaches zero position or zero voltage crossover threshold and diaphragm returns where it began.
8	<ul style="list-style-type: none"> • Signal starts in reverse and changes into negative voltage. • During changes, electrical current goes from the negative area of the voice coil to the positive area. • Produce magnetic field in reversed polarity.
9	<ul style="list-style-type: none"> • Magnetic field of the voice coil is opposite to the magnet found in the speaker. • Attractions begin and the diaphragm starts to travel from the front side to the back. • This is the opposite of the original path back to the front.
10	<ul style="list-style-type: none"> • As an electrical signal proceeds oath, the diaphragm travels reverse. • Produce the sound wave's other half which was made through air motion
11	<ul style="list-style-type: none"> • Stereo output/system amp will return to the initial point at zero, where the following signal starts to form as electrical signal voltage begins to rise. • Cycle again and keep repeating when the audio system is in play. • Speakers are powered by electrical signals that transform into mechanical energy that produce air motion, creates sound.

9. Switchboard

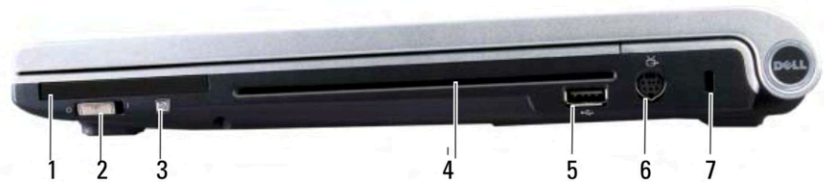
Basic Information	Step # of 6 steps from Summary (If not, what else?)	Researcher (Team member that researched on component)
The function of the switchboard is mainly to turn the Wi-Fi on or off , and locate available networks in one's vicinity .	Wi-Fi Switch/Network Locator.	Eunice Lee

- The Dell DH3 Wi-Fi Catcher Network Locator/Wireless Switchboard is located at the bottom right corner of a laptop.

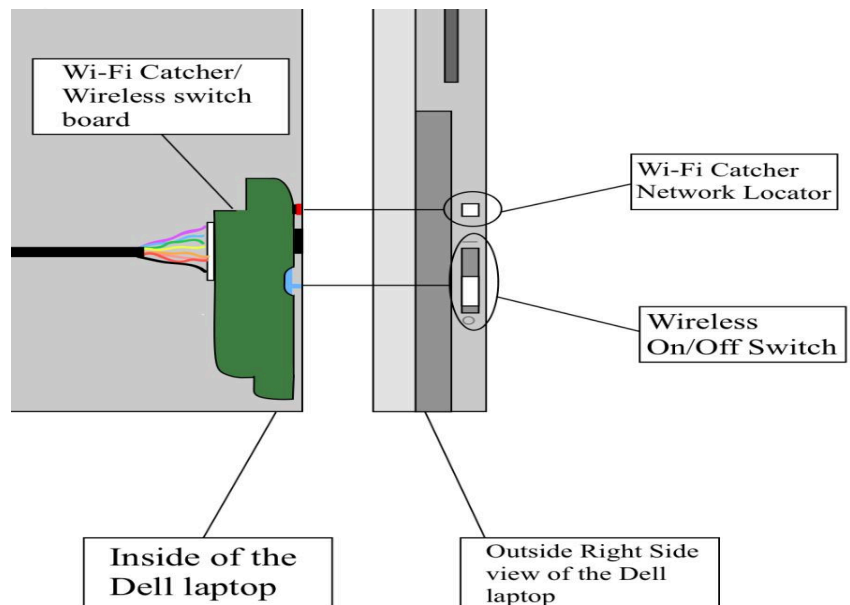
- On the component, there is a button and a switch. The button is the Wi-Fi Catcher Network Locator, and the switch is the Wireless On/Off switch.

- The Wi-Fi Catcher Network Locator button scans for wireless networks in one's vicinity. It functions when the button is pressed, regardless of whether the laptop is on or off, in hibernation mode, or in

Right Side View



- | | |
|----------------------------------|--------------------------|
| 1 ExpressCard slot | 2 Wireless On/Off switch |
| 3 Wi-Fi Catcher™ Network Locator | 4 optical drive |
| 5 USB connector | 6 S-Video connector |
| 7 security cable slot | |



- standby mode. A box on the monitor pops up and shows all detected networks.
- The Wireless Switchboard is simply a switch. This controls the Wi-Fi to be enabled or disabled.

10. Switch Sensor Circuit Board

Basic Information	Step # of 6 steps from Summary (If not, what else?)	Researcher (Team member that researched on component)
It manages the flow of the electrical currents.	2	Kayden Fann

What is it?

- An electromagnetic switch.



- Controls the flow of electrical currents.

What is it made of?

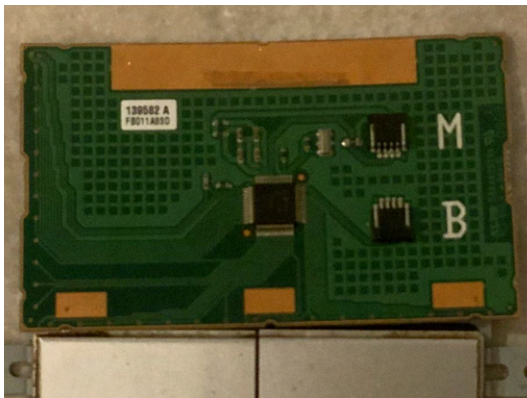
- Can be made from two or more ferrous reeds.
- Ferrous reeds are one type of electrical switch.
- It can be turned off or on by magnetism.
- The most common type is two thin flexible ferromagnetic metal wires or blades.
 - When the two reeds are in contact, electricity can flow around the circuit.

Has two main types:

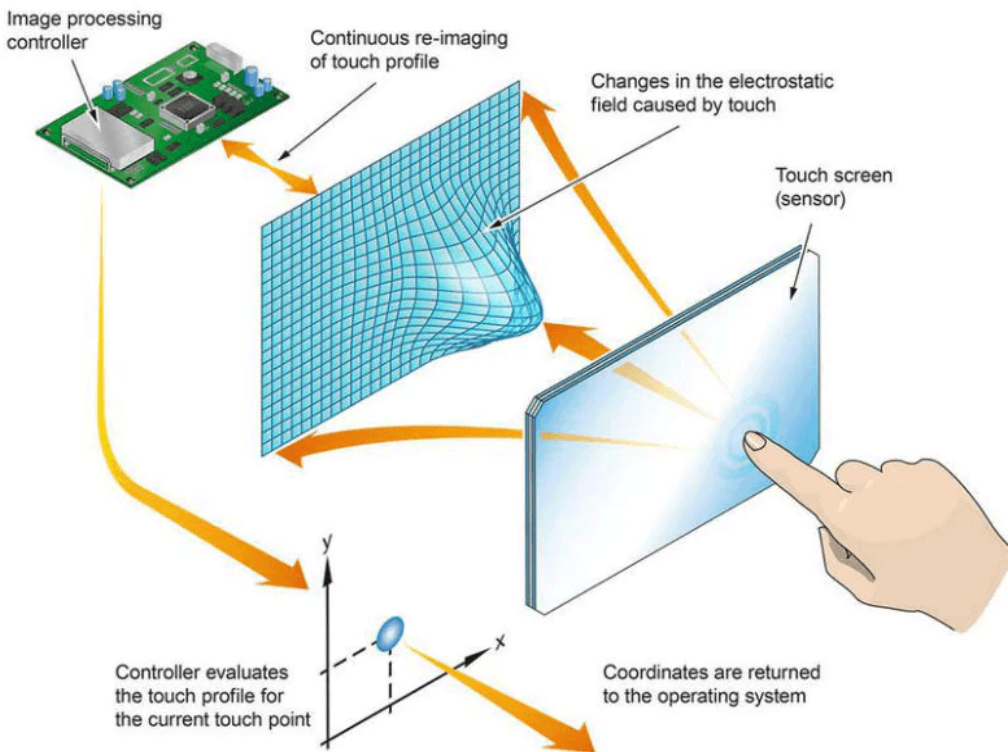
- “Normally open” and “normally closed.”
 - The reeds are positioned, so that they are not touching.
 - Some magnets are used with reed switches.
 - One type is neodymium magnets.
- It is one of the strongest magnets available.
 - Selecting a magnet for a reed switch needs multiple factors.
 - For example:
 - Shape
 - Strength
 - Switch sensitivity
 - Distance
 - Angle

11. Touchpad

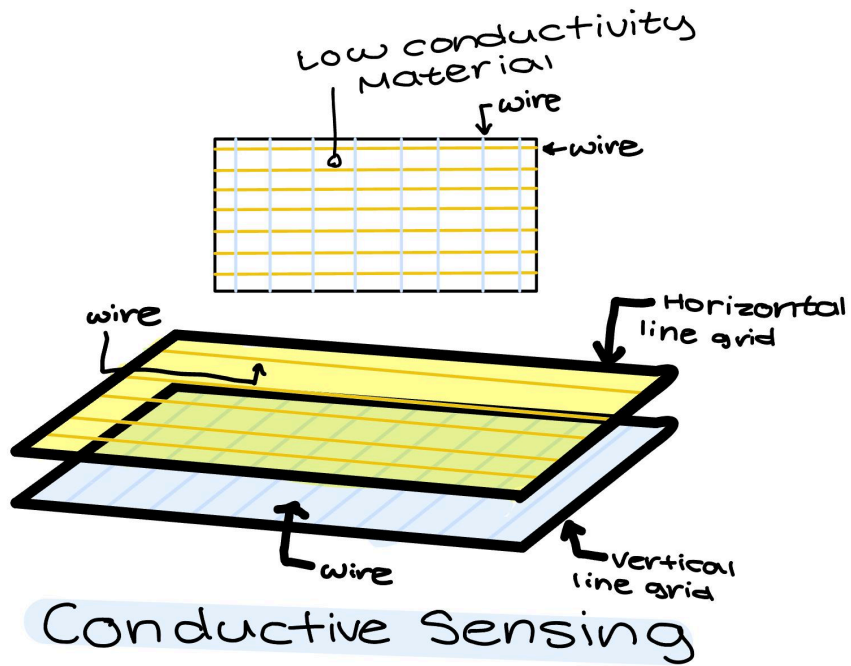
Basic Information	Step # of 6 steps from Summary (If not, what else?)	Researcher (Team member that researched on component)
Helps us move the cursor displayed on the monitor to achieve a certain task (ex. Click on a certain button).	1	Megan Chung



- Most touchpads use one of the two forms of sensing: conductive and capacitive sensing (information from 2010).
- Unknown which one the Dell XPS M1530 uses.
- Conductive sensing:
 - Use two grids layered together, both with wires, yet one of them the wires are placed horizontally, while the other is placed vertically.
 - In order to ensure that electricity won't travel when no contact is made by humans, low conductivity materials exist.



- However, when contact is made, the low conductivity material becomes thinner, electricity is able to travel, making the cursor able to move around the screen.



- Capacitive sensing: Uses ground and sensor. Increase in system capacitance happens when the finger and touchpad are close to each other.

Deeper Analysis

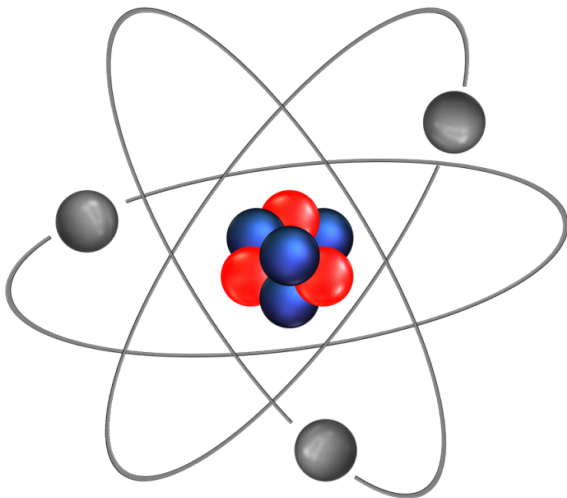
1. Li-on Battery Pack

I. What is Lithium?

- Lithium is a chemical element that is included in the Group 1 (Ia) in the periodic table.
- It is known to be one of the lightest of the solid elements.

- The metal is very soft.
- According to Britannia.com, “because of its light weight and large negative electrochemical potential, lithium metal, either pure or in the presence of other elements, serves as the anode (negative electrode) in many non rechargeable lithium primary batteries.”

Element Properties	
atomic number	3
atomic weight	6.941
melting point	180.5 °C (356.9 °F)
boiling point	1,342 °C (2,448 °F)
specific gravity	0.534 at 20 °C (68 °F)
oxidation state	+1
electron configuration	2-1 or 1s ² 2s ¹



Lithium

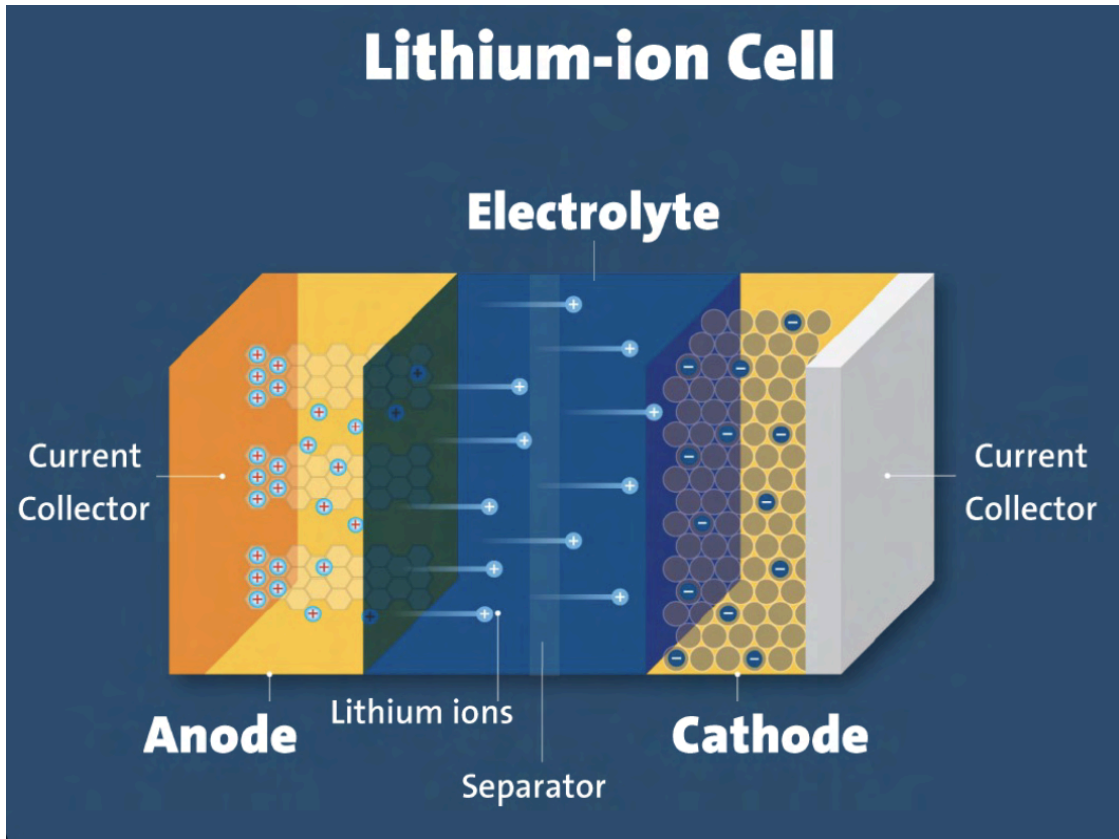
atomic number	3	[6.938, 6.997]	atomic weight
symbol	Li		acid-base properties of higher-valence oxides
electron configuration	[He]2s ¹		crystal structure
name	lithium		physical state at 20 °C (68 °F)

	Alkali metals		Solid
	Body-centred cubic		Strongly basic

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II. How does it Work?

- According to the website energy.gov, “While the battery is discharging and providing an electric current, the anode releases lithium ions to the cathode, generating a flow of electrons from one side to the other. When plugging in the device, the opposite happens: Lithium ions are released by the cathode and received by the anode.”

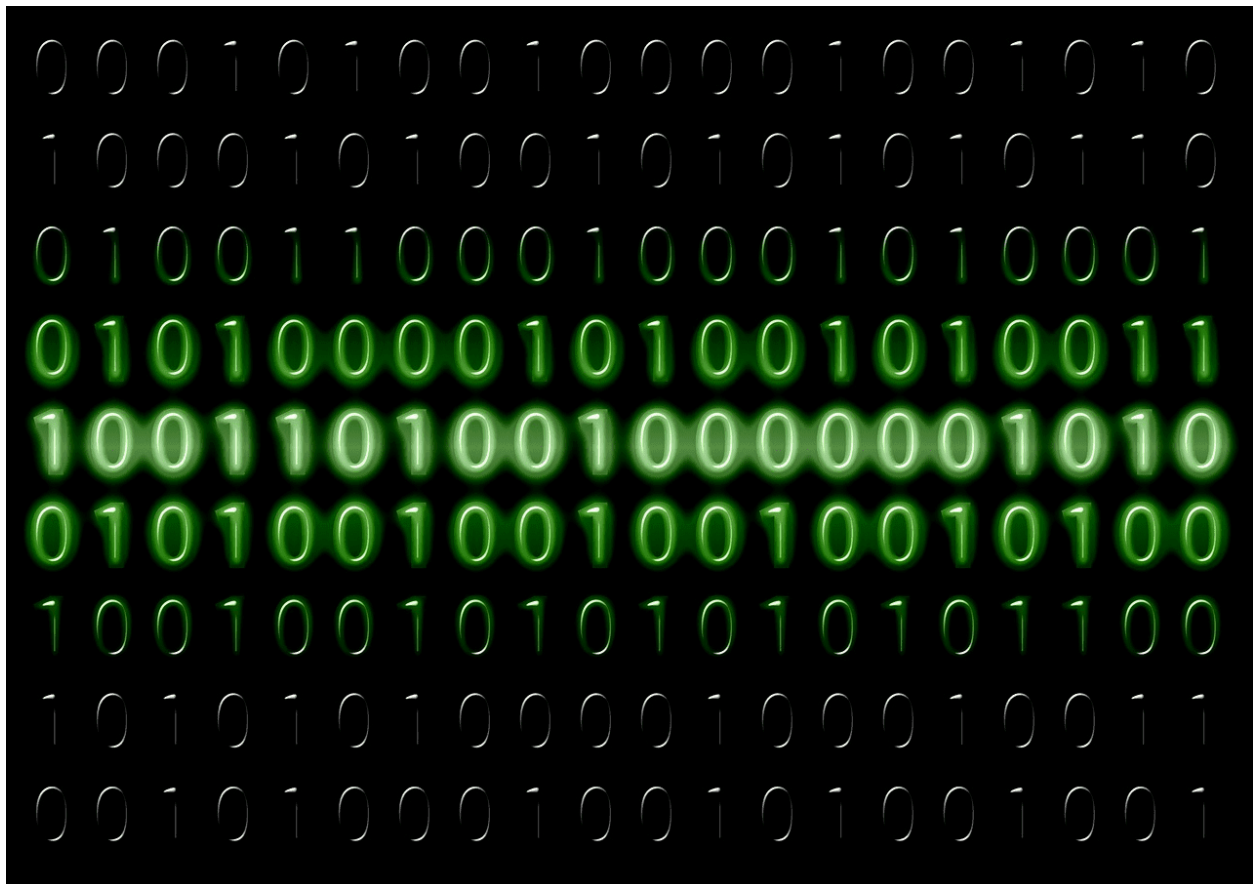


2. HDD

I. How does the HDD Work?

- The stored data on a hard drive is used on a binary code using 1s and 0s.
- On the disks, the information is more spread out on the magnetic layer and they are read and written.
- According to an article called ontrack.com emphasized that they “are read or written by the read heads that 'float' above the surface thanks to the layer of air produced by the ultra fast rotation of the disk.”

Binary Code



Measurements of HDD

Category	HDD	SSD
Access time (ms)	10	0.1
Read speed (MB/s)	50 - 100	200 - 500
Weight (g)	500	50
Power consumption (W)	6	2 - 3

Detail and Measurements of HDD

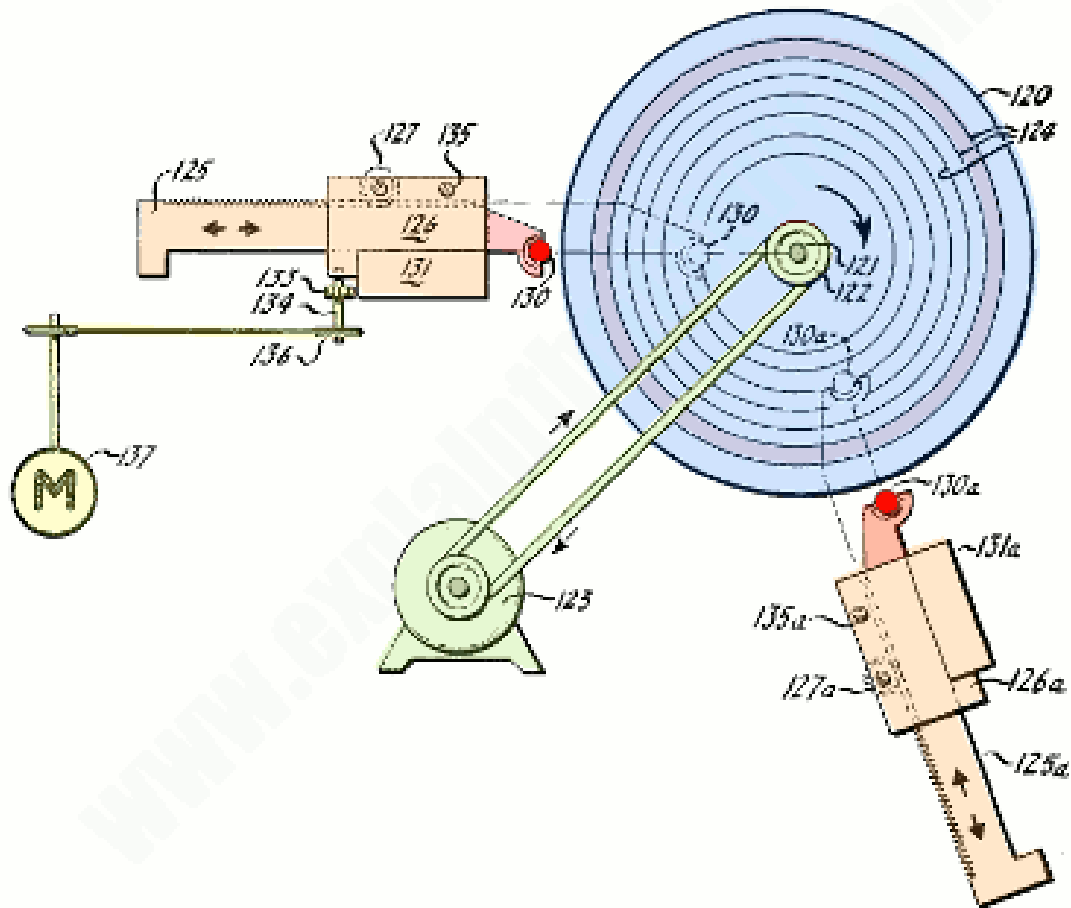
March 24, 1970

W. A. GODDARD ET AL

3,503,060

DIRECT ACCESS MAGNETIC DISC STORAGE DEVICE

Original Filed Dec. 24, 1954



Courtesy US Patent & Trademark Office

www.explainthatstuff.com

II. The History of HDD

- On September 13, 1956, a company called IBM produced the very first harddrive.
- Not many people thought that the harddrive would have a huge effect in the future.
- Few years later, the first PC hard drives were invented.
- The PC could hold more data of 4MB and a faster transfer speed of 625 Kb/s.
- Later on, the RLL coding method was introduced from the interface ST506.
- The new version was able to hold more capacity and even a faster speed to process.

3. CD Player

A CD is crafted out of a type of plastic called *polycarbonate plastic* and has a reflective metallic layer.

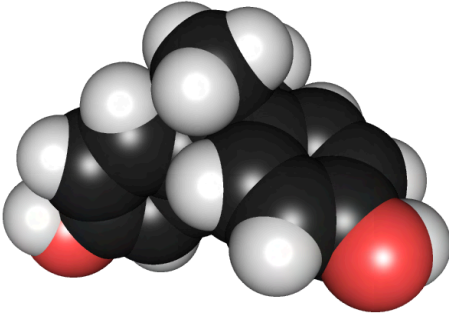
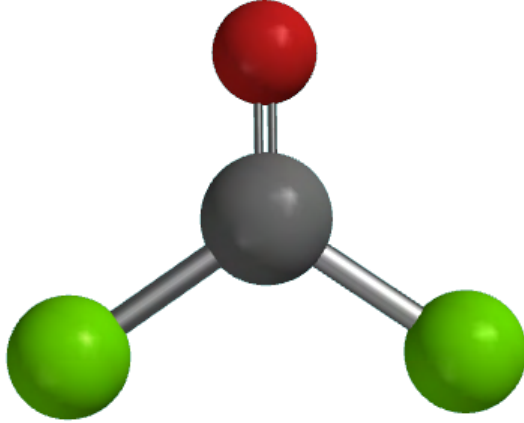
Polycarbonate Plastic

- 2 materials make up polycarbonate: Bisphenol A and phosgene.



Left: Shows Bisphenol A and phosgene

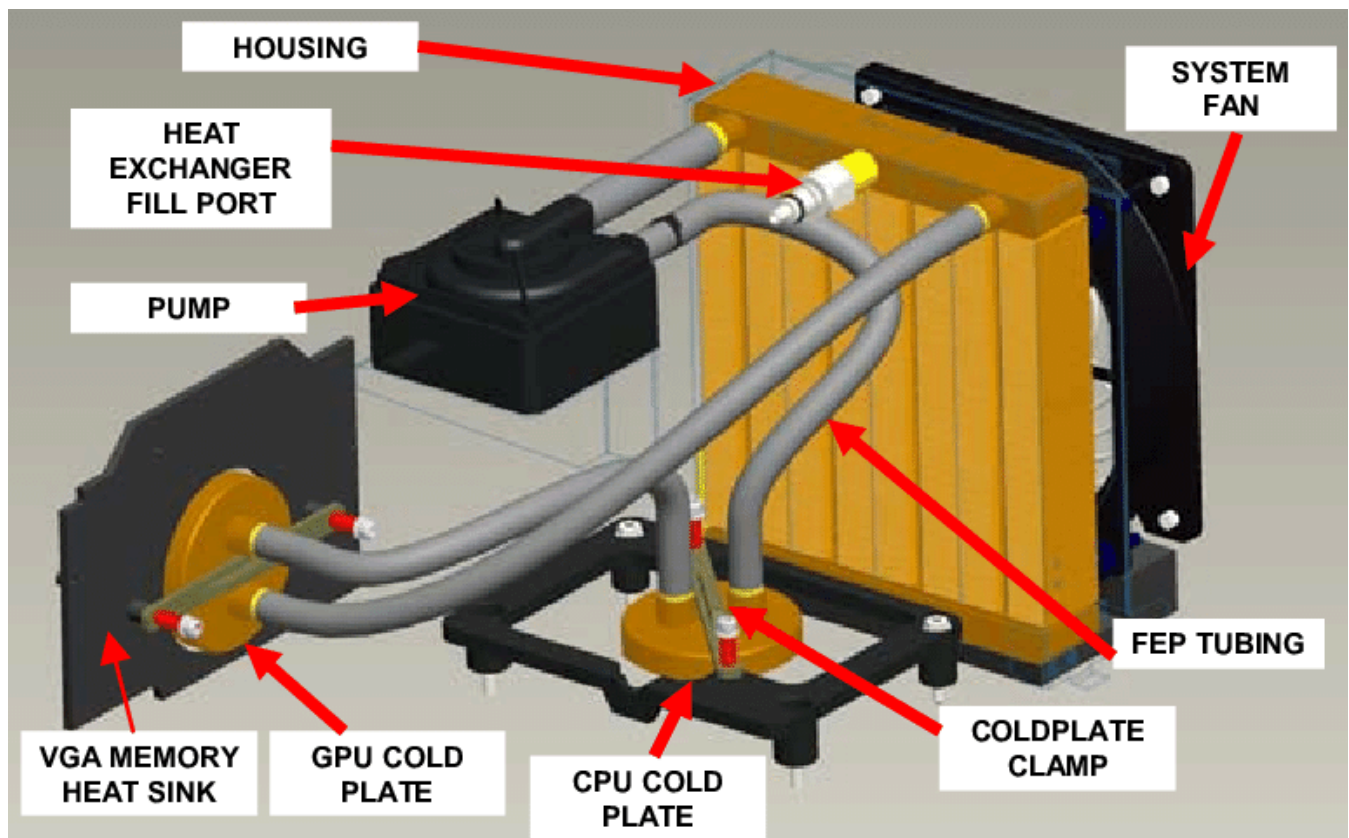
Right: Shows Polycarbonate

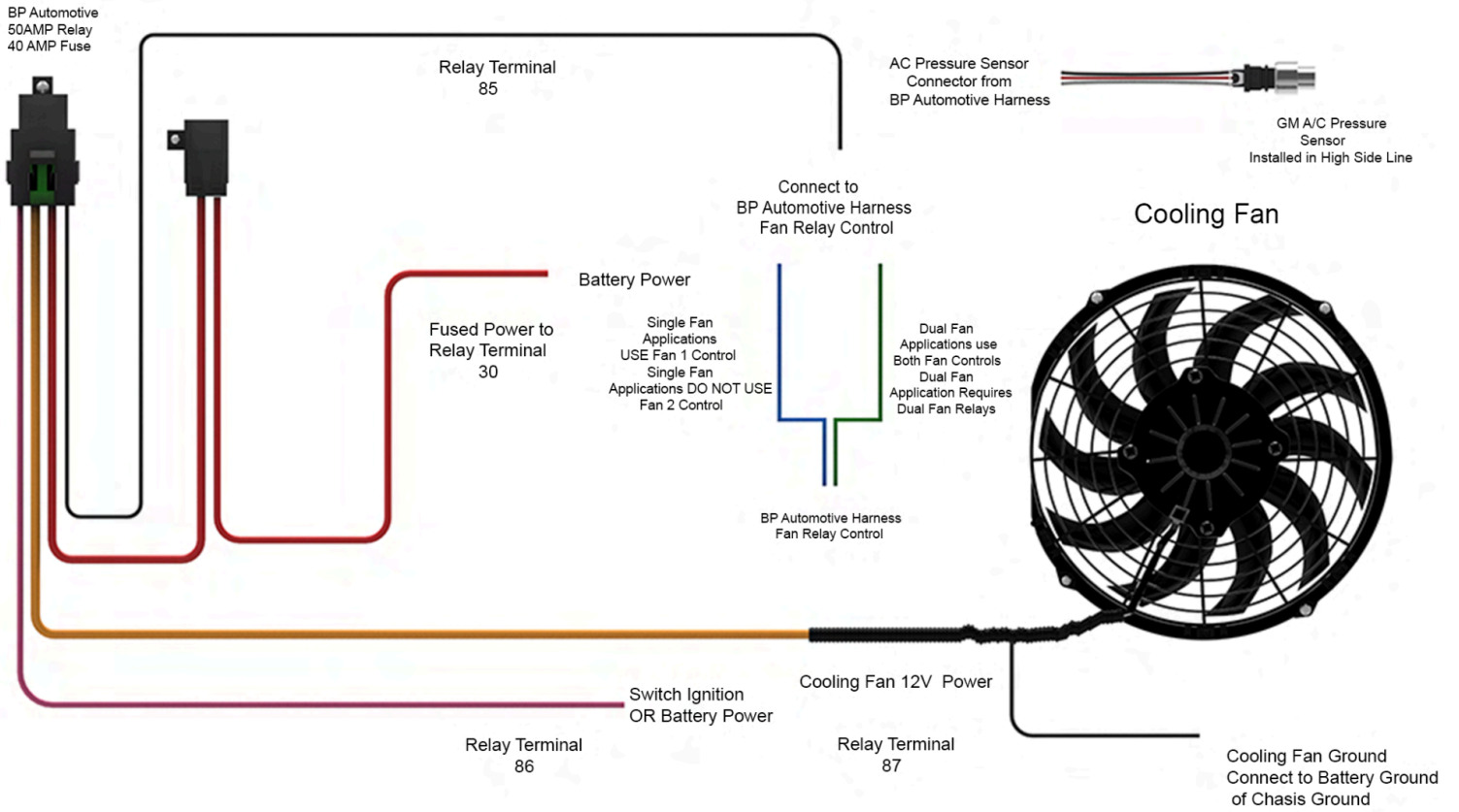
Bisphenol A	Phosgene
 <p>Chemical Compound</p>	 <p>Gas</p>

4. Cooling Fan

How is the Cooling Fan Made?

- Cooling fans use two phases of brushless motors to not create much electrical noise and make fans have an extended life span.
- With the stator which is a winding on the inside and the rotor which is a magnet on the outside are used together to create the cooling fan.
- From there, circuit models are developed and flux paths are described. (Flux paths is a material made out of magnets and the air gap is from the remaining part of the flux.)
- The model results in a torque which obtains using magnetic energy with angle that changes.
- The torque is compared to the measurements that were experienced.





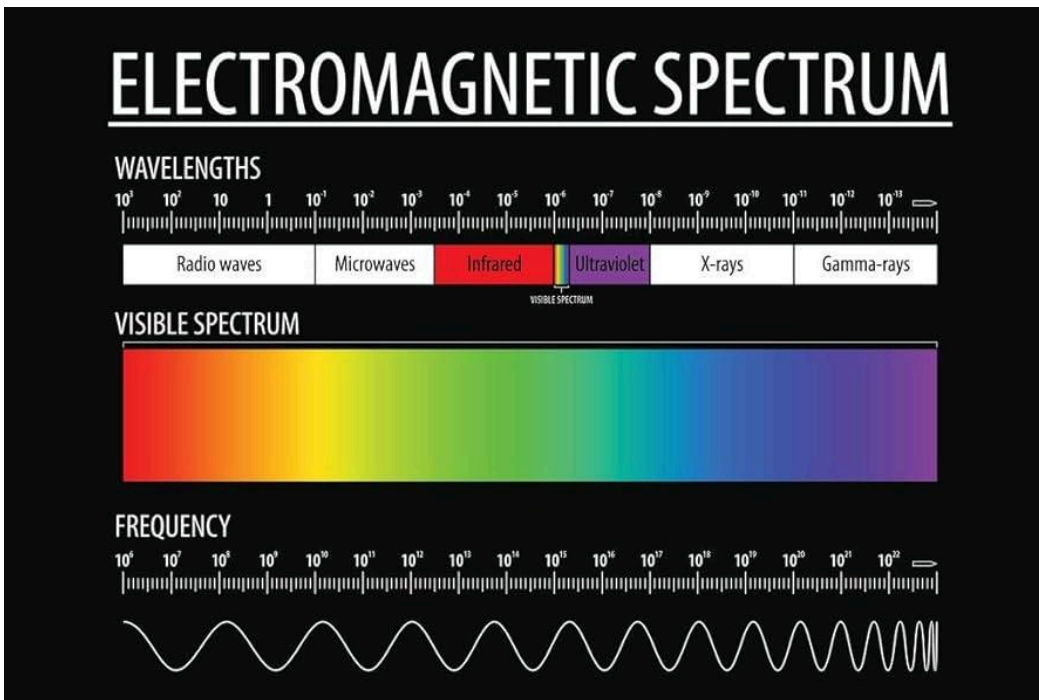
5. Switchboard

What is the Process of Wi-Fi?

- Wi-Fi is a short term for *Wireless Fidelity*, or the wireless standard IEEE 802.11. Wi-Fi is simply a wireless technology that is used to connect devices to the internet.
- There are two ways Wi-Fi is processed.
- The first way starts off when Wi-Fi transmits data using radio waves. A wireless adapter in a device then converts the data into radio signals and sends it out through an antenna.
- The second way is when the router, which helps connect devices to the Internet, takes data from the Internet, converts it to a radio signal, and sends it back to the device to be decoded.

Radio Waves

- As said before, Wi-Fi transmits data using radio waves. Radio waves are a **type of electromagnetic radiation in the electromagnetic spectrum**



- Radio waves **allow wireless transmission of information.**

- Radio waves are waves that are invisible to the human eye.

- They have the longest wavelengths in the electromagnetic spectrum, and have the lowest frequency.

Examples of other objects that use radio waves:

- Television
- Microwave ovens
- Vacuums
- Cell phones

6. The Evolution of Laptops Over Time

Timeline

Over the years, laptops have advanced greatly, having new changes with every new model. Here is the timeline of how the first computers developed to become the convenient devices we utilize every day in our life.



MCM/70, the first portable laptop, released in 1974.



Osborne 1, the first square-screen laptop, released in 1981.



Tandy Radio Shack (TRS) Model 100, the first remotely affordable laptop.



Macintosh Portable, the first Mac portable, released in 1989.



Poqet PC, the first the first Netbook look-alike, released in 1989.

Macbook Air, the thinnest laptop, released in 2008.



Lenovo X41, the first tablet, released in 2005.



IBM ThinkPad, released in 2005.



Macintosh PowerBook, released in 1994.

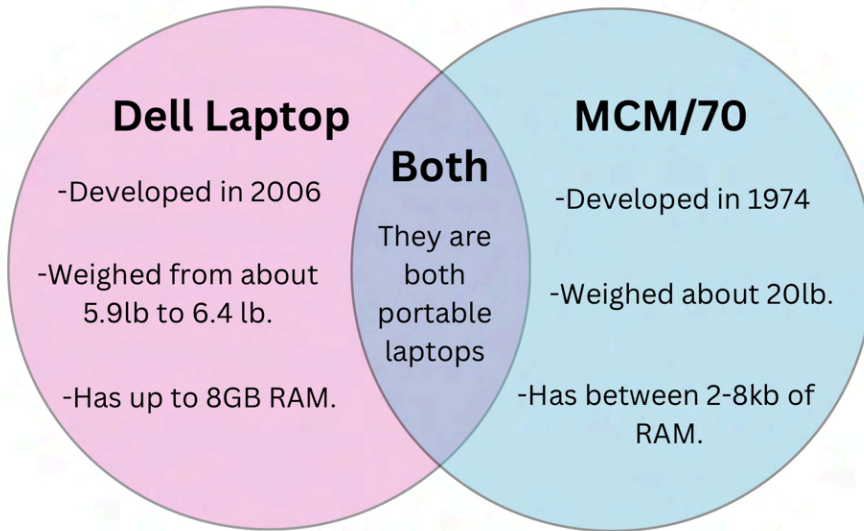
The Evolution of Laptops from 1974-present

Further Details about the Laptops

- **Note:** The units of measure used in this section are Hertz (hz) and kilobytes (kb).
- **MCM/70:** This laptop was the world's first portable microcomputer created by Mers Kutt. It came with its own operating system software: AVS.
- **Osborne 1:** The Osborne 1 was designed by the Osborne Computer Corporation. It was known as the first popular and the first portable computer with a square screen.
- **Tandy Radio Shack (TRS) Model 100:** This model was created by the company Radio Shack. It was one of the first portable laptops that was at an affordable price.
- **Macintosh Portable:** The Macintosh Portable was developed by Apple Company, Inc. Its battery lasted an amazing ten hours until it ran out, but it weighed 17 pounds and was expensive (\$6500).
- **Poqet PC:** The Poqet PC was created by the company Poqet Computer Corporation. It could run on two AA batteries for weeks or months, due to its advanced power management features like shutting off the CPU when it was not in use.
- **Macintosh PowerBook 500:** This laptop developed by the Apple Company, Inc. It was the first computer to include a touchpad.
- **IBM ThinkPad:** The IBM ThinkPad was created by computer scientist Ted Selker. It included a fingerprint scanner to completely secure the laptop.
- **Lenovo X41:** This model was developed by the company Lenovo. It included a tablet conversion feature that was unique.
- **MacBook Air:** The MacBook Air was designed by the Apple company. It is currently the thinnest laptop to date.

Comparison of the Dell laptop and Other Laptops

- The Dell M1530 laptop is the most similar to the MacBook Air by Apple.



We compared how similar and different our Dell laptop is from the MCM/70, the oldest laptop in the timeline, to see how much technology has advanced over the years.

This is the evolution of laptops that began from a simple MCM/70, and continues to this day to design the next life-changing model.

Conclusion

Concluding this report, our knowledge of computers have vastly improved, and gave us the opportunity to learn more about technology. Throughout our experience in learning about the importance of technology, we learned the history of computers has exceedingly improved. And not only have our understanding of technology has improved, but we have also learned about many aspects of science through research and analysis. We hope to keep this learning experience towards the future, and we thank you for giving us the opportunity to gain further knowledge. Thank you for reading our report.



Citations

- <https://www.britannica.com/science/chemical-symbol>
- <https://www.energy.gov/energysaver/articles/how-lithium-ion-batteries-work#:~:text=While%20the%20battery%20is%20discharging,and%20received%20by%20the%20anode.>
- <https://www.ontrack.com/en-us/data-recovery/hard-drive/how-hard-drives-work#:~:text=>
- <https://www.ontrack.com/en-us/data-recovery/hard-drive/hard-disk-history-structure-operation>
- <https://primaryscienceonline.org.uk/glossary-of-terms/atoms/>
- https://www.researchgate.net/figure/Illustration-of-a-lithium-atom-Wikipedia_fig1_228381019
- [Data%20is%20stored%20on%20a,fast%20rotation%20of%20the%20disk.](#)
- [What-are-lithium-ion](#)
- [How-lithium-ion-batteries-work](#)
- [https://www.cdc.gov/niosh/topics/phosgene/default.html#:~:text=Phosgene%20\(COCl%E2%82%82\)%20is%20a%20colorless,harmed%20from%20exposure%20to%20phosgene](https://www.cdc.gov/niosh/topics/phosgene/default.html#:~:text=Phosgene%20(COCl%E2%82%82)%20is%20a%20colorless,harmed%20from%20exposure%20to%20phosgene)
- [.](#)
- <https://www.training.com.au/ed/5-reasons-to-consider-a-career-in-technology/>
- <http://www.chem.ucla.edu/~harding/IGOC/P/phosgene.html>
- https://dl.dell.com/manuals/all-products/esuprt_laptop/esuprt_xps_laptop/xps-m1530_owner%27s%20manual_en-us.pdf
- https://downloads.dell.com/manuals/all-products/esuprt_laptop/esuprt_xps_laptop/xps-m1530_service%20manual_en-us.pdf
- https://docs.google.com/document/d/11WNWYwPJwr9eX3F9a_AQ-DUiuifygiTEqobwbwt9LOys/edit
- <https://www.notebookcheck.net/Dell-XPS-M1530.7413.0.html>
- https://challenges.robotevents.com/uploads/0021267_original.pdf

- https://www.ifixit.com/Device/Dell_XPS_M1530#:~:text=The%20Dell%20XPS%20M1530%20was%20more%20similar%20to%20the%20M1330.
- <https://pngimg.com/image/94740>
- <https://www.timetoast.com/timelines/laptops>
- <https://www.historyofinformation.com/detail.php?entryid=4806#:~:text=The%20MCM%20F70%20was%20the%20first%20microcomputer%20that%20came%20bundled,the%20enhanced%20%22quad%22%20functions.>
- <https://www.montereylanguages.com/pdf-word-count-online-free-tool.html>
- <https://www.computerhistory.org/revolution/mobile-computing/18/317/1767>
- <https://www.coursera.org/articles/binary-code#:~:text=Binary%20code%20is%20the%20most,or%20other%20types%20of%20information.>
- <https://www.pngall.com/ram-png/>
- <https://www.pinterest.com/pin/675610381577476136/>
- <https://www.lifewire.com/power-button-and-on-off-symbols-2625969#:~:text=The%20power%20button%20is%20a,when%20they%20press%20it%20again.>
- https://dl.dell.com/manuals/all-products/esuprt_laptop/esuprt_xps_laptop/xps-m1530_owner%27s%20manual_en-us.pdf
- <https://www.lenovo.com/us/en/glossary/home-key/#:~:text=It%20is%20used%20to%20return,the%20Delete%20and%20End%20keys>
- <https://htu.edu/wp-content/uploads/2022/08/Dell-DVD-ROM-Drive.pdf>
- <https://discuss.streamlit.io/t/what-does-the-stop-button-by-the-menu-bar-do/22212#:~:text=As%20I%20understand%20it%20C%20the,might%20not%20respond%20right%20away>
- <https://computer.howstuffworks.com/keyboard2.htm>
- <https://www.vedantu.com/computer-science/monitor>
- <https://www.sciencedirect.com/topics/engineering/flat-panel-display#:~:text=The%20display%20consists%20of%20a,filters%20makes%20color%20LCDs%20possible.>
- <https://www.quora.com/How-do-computer-screens-work>
- <https://www.dell.com/community/en/conversations/storage-drives-media/who-makes-dell>

[s-oem-hard-drives/647e5a3cf4ccf8a8ded5a6ae](https://www.dell.com/support/contents/en-us/article/product-support/self-support-knowledgebase/data-storage-backup-and-recovery/support-for-hard-disk-drive#:~:text=A%20hard%20disk%20drive%20)

- <https://www.dell.com/support/contents/en-us/article/product-support/self-support-knowledgebase/data-storage-backup-and-recovery/support-for-hard-disk-drive#:~:text=A%20hard%20disk%20drive%20>
- <https://www.dell.com/support/kbdoc/en-us/000179003/understanding-and-troubleshooting-your-hard-drive-hdd-or-ssd>
- <https://www.britannica.com/technology/hard-disk>
- https://www.spiceworks.com/tech/hardware/articles/what-is-motherboard/#_003
- <https://www.hp.com/us-en/shop/tech-takes/what-does-a-motherboard-do#:~:text=The%20motherboard%20is%20the%20backbone,a%20computer%20to%20work%20well.>
- <https://www.cmd-ltd.com/advice-centre/usb-chargers-and-power-modules/usb-and-power-module-product-help/usb-data-transfer-guide/#:~:text=USB%20cables%20are%20capable%20of,can%20see%20four%20metal%20strips.>
- <https://computer.howstuffworks.com/ram.htm#:~:text=In%20the%20most%20common%20form,Work%20for%20information%20on%20bits>
- <https://www.memorystock.com/memory/DellXPSM1530.html#:~:text=M1530%20Laptop%20take%3F-,The%20Dell%20XPS%20M1530%20Laptop,PC%2D5300%20DDR2%20SDRAM%20SODIMMs.>
- <https://www.techtarget.com/whatis/definition/BIOS-basic-input-output-system>
- <https://www.merriam-webster.com/thesaurus/locate>
- <https://www.connectzone.com/blog/what-are-keyboard-connectors-and-how-does-it-work#:~:text=It%20is%20used%20to%20perform,the%20PC%20to%20the%20laptop.>
- <https://www.partitionwizard.com/partitionmagic/mouse-and-keyboard-connector-types.html>
- <https://www.baeldung.com/cs/chipset>
- <https://www.lenovo.com/ph/en/glossary/how-does-a-cpu-work/?orgRef=https%253A%252F%252Fwww.google.com%252F>
- <https://www.hp.com/us-en/shop/tech-takes/what-is-cmos-battery-how-to-remove-and-replace#:~:text=To%20recap,date%20and%20time%20are%20incorrect>

- <https://hasonss.com/blogs/cmos-battery/#:~:text=This%20small%20lithium%20battery%2C%20commonly,the%20computer%20is%20powered%20off>
- <https://www.deskdecode.com/cmos-battery/>
- <https://www.khanacademy.org/computing/computers-and-internet/xcae6f4a7ff015e7d:computers/xcae6f4a7ff015e7d:computer-components/a/central-processing-unit-cpu>
- <https://pcguide101.com/motherboard/what-are-front-panel-connectors/>
- <https://www.youtube.com/watch?v=nBJJj3FB2P8&t=41s>
- <https://www.pcinq.com/how-to-connect-motherboard-front-panel-headers/#:~:text=Other%20Front%2DPanel%20Connections,2.0%2C%20and%20HD%2DAudio.>
- <https://www.britannica.com/technology/cable-electronics>
- <https://www.arrow.com/en/research-and-events/articles/power-connectors-guide-basic-concepts#:~:text=Power%20connectors%20complete%20circuits%20by,power%20source%20in%20the%20wall.>
- <https://www.omnicharge.co/blogs/blog/what-is-usb-power-and-how-does-it-work-exactly#:~:text=USB%20power%20is%20a%20type,phones%2C%20tablets%2C%20and%20laptops.>
- <https://coggle.it/diagram/WdzuY2gXiQABP-mM/t/adapter-card>
- [https://www.techtarget.com/searchdatacenter/definition/PCI-Express#:~:text=Peripheral%20Component%20Interconnect%20Express%20\(PCIe%20or%20PCI%2DE\)%20is,as%20PCI%20and%20PCI%2DX.](https://www.techtarget.com/searchdatacenter/definition/PCI-Express#:~:text=Peripheral%20Component%20Interconnect%20Express%20(PCIe%20or%20PCI%2DE)%20is,as%20PCI%20and%20PCI%2DX.)
- <https://community.fs.com/article/pcie-card-selection-guide.html>
- <https://www.pearsonitcertification.com/articles/article.aspx?p=2731934&seqNum=21#:~:text=An%20expansion%20slot%20is%20used,expansion%20slots%20on%20a%20motherboard>
- <https://www.professormesser.com/professor-messer-archives/220-1001/motherboard-expansion-slots/#:~:text=We%20do%20that%20through%20a,the%20functionality%20of%20your%20motherboard.>
- https://en.wikipedia.org/wiki/USB_communications#:~:text=USB%20signals%20are%20transmitted%20using,%E2%88%92%2C%20in%20half%2Dduplex.

- <https://gadgetmates.com/what-is-a-chipset>
- https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.coursesidekick.com%2Fbusiness%2Fstudy-guides%2Fsanjacinto-computerapps-v2%2Freading-chipset&psig=AOvVaw1d_6WUxEo7wTxR3jCeQIes&ust=1706505766212000&source=images&cd=vfe&opi=89978449&ved=0CBMQjhxqFwoTCKCR48Or_4MDFQAAAAAdAAAAABA4
- <https://www.computerhope.com/jargon/c/chipset.htm>
- <https://www.beyondlogic.org/usbnutshell/usb2.shtml>
- <https://www.trentonsystems.com/blog/what-is-bios>
- <https://www.techtarget.com/searchstorage/definition/compact-disc>
- <https://www.techtarget.com/searchstorage/definition/compact-disc#:~:text=A%20compact%20disc%20is%20a%20other%20data%20in%20digital%20form.>
- <https://www.techtarget.com/searchstorage/definition/compact-disc#:~:text=As%20the%20disc%20rotates%2C%20the%20disc%20readability%20may%20be%20affected.>
- https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwi5rLLAhL6DAxW3DkQIHT4rDg8QFnoECB4QAw&url=https%3A%2F%2Fwww.britannica.com%2Ftechnology%2Fcompact-disc%23%3A~%3Atext%3DPhysical%2520characteristics%2C-compact%2520disc%2520manufacturing%26text%3DA%2520standard%2520CD%2520is%2520120%2Cprotective%2520coating%2520of%2520acrylic%2520plastic.&usg=AOvVaw2kzIfKKhICGC_W-5Xz4qvU&opi=89978449
- <https://electronics.howstuffworks.com/cd.htm#:~:text=Inside%20a%20CD%20player&text=The%20drive%20consists%20of%20three,0n%20and%20read%20the%20bumps.>
- <https://www.youtube.com/shorts/brpzG02V3sY>
- https://courses.cs.washington.edu/courses/cse370/01au/minirproject/BAH/bah_cdpage.html#:~:text=The%20first%20thing%20one%20would,opposite%20bumps%20are%20called%20Pits.
- <https://www.lifewire.com/what-is-binary-and-how-does-it-work-4692749>
- <https://scratch.mit.edu>
- <https://sunsetmicro.com/dell-xps-m1530-dh3-express-card-module-board-48-4w114-011-08586-1/>

- https://computer.howstuffworks.com/pci-express.htm?srch_tag=ignonuliu7xlibt77kk4ckjutu6iy3rj
- <https://community.fs.com/article/pcie-card-selection-guide.html>
- <https://www.caltech.edu/about/news/question-week-why-does-engine-cooling-system-have-thermostat-and-how-does-it-relate-coolant#:~:text=The%20cooling%20system%20serves%20three,temperature%20as%20quickly%20as%20possible.>
- <https://study.com/academy/lesson/what-is-a-sound-card-definition-function-types.html#:~:text=Lesson%20Summary-,A%20sound%20card%20is%20a%20computer%20component%20used%20to%20send,as%20a%20dedicated%20audio%20device.>
- <https://www.edrawsoft.com/article/usb-wiring-diagram.html>
- <https://us.soundcore.com/blogs/speaker/how-do-speakers-work-speakers-and-sound-production-explained#:~:text=To%20produce%20sound%2C%20speakers%20function,travel%20through%20coils%20of%20wire.>
- <https://open4416.medium.com/fundamentals-and-port-modeling-of-loudspeakers-1c1382c4591a>
- https://electronics.howstuffworks.com/everyday-tech/lithium-ion-battery.htm?srch_tag=jtrwo5otjeprx66zihk6uot67grdx7rn
- <https://www.youtube.com/watch?v=zUlBHMDCosI>
- <https://www.youtube.com/watch?v=MFUUoNN06I>
- <https://goenergylink.com/blog/4-benefits-of-lithium-ion-batteries/>
- <https://yourstory.com/2010/05/how-the-touchpad-works>
- <https://www.cardinalpeak.com/blog/the-art-and-science-of-capacitive-technologies>
- <https://www.arrow.com/en/research-and-events/articles/how-fingerprint-sensors-work>
- <https://www.techopedia.com/definition/29808/fingerprint-scanner>
- <https://www.parts-people.com/index.php?action=item&id=6528>
- <https://www.manualslib.com/manual/227729/Dell-Precision-M4300.html?page=60>
- https://dl.dell.com/manuals/all-products/esuprt_laptop/esuprt_xps_laptop/xps-m1530_owner%27s%20manual_en-us.pdf

- https://downloads.dell.com/manuals/all-products/esuprt_laptop/esuprt_xps_laptop/xps-m1530_service%20manual_en-us.pdf
- <https://www.youtube.com/watch?v=PuRMFvjZGi4&t=29s>
- <https://www.arrow.com/en/research-and-events/articles/the-reed-switch-ingeniously-simple-sensing>
- <https://uk.rs-online.com/web/content/discovery/ideas-and-advice/reed-switches-guide>
- <https://www.explainthatstuff.com/harddrive.html>
- <https://www.explainthatstuff.com/harddrive.html>
- <https://ieeexplore.ieee.org/document/965692>
- https://en.wikipedia.org/wiki/Polycarbonate#Electronic_components
- <https://omnexus.specialchem.com/selection-guide/polycarbonate-pc-plastic>
- <https://testbook.com/electrical-engineering/concepts-of-flux#:~:text=A%20large%20amount%20of%20flux,utilized%20for%20many%20useful%20purposes.>
- <https://www.verizon.com/articles/internet-essentials/wifi-definiton/#:~:text=Wi%2DFi%20is%20a%20wireless,you%20can%20see%20and%20use.>
- <https://www.usnews.com/360-reviews/privacy/what-is-wifi#:~:text=Many%20people%20think%20Wi%2DFi,as%20the%20Wireless%20Fidelity%20Alliance.>
- [https://www.optimum.com/articles/internet/what-is-wifi#:~:text=WiFi%20transmits%20ata%20using%20radio,the%20device%20to%20be%20decoded.](https://www.optimum.com/articles/internet/what-is-wifi#:~:text=WiFi%20transmits%20data%20using%20radio,the%20device%20to%20be%20decoded.)
- <https://www.cisco.com/c/en/us/solutions/small-business/resource-center/networking/how-does-a-router-work.html#:~:text=Routers%20connect%20computers%20and%20other,computers%20get%20priority%20over%20others.>
- <https://www.amazon.com/Electromagnetic-Spectrum-Educational-Reference-Poster/dp/B079H3262B>
- https://en.wikipedia.org/wiki/Bisphenol_A#Production
- https://scripts.sil.org/cms/scripts/page.php?id=keybrddesign&site_id=nrsi#gsc.tab=0
- <https://scied.ucar.edu/learning-zone/atmosphere/radio-waves#:~:text=Radio%20waves%20are%20a%20type,and%20receive%20radio%20frequency%20energy.>
- <https://midlandusa.com/blogs/blog/what-are-radio-waves-how-do-we-use-them>

- https://challenges.robotevents.com/uploads/0023890_original.pdf
- https://support.apple.com/kb/SP893?locale=en_US#:~:text=16GB%20or%2024GB%20unified%20memory,512GB%2C%201TB%2C%20or%202TB%20SSD
- <https://time.com/3398919/apple-first-portable-macintosh/>
- <https://history-computer.com/poqet-pc-guide/>
- <https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiE-tHfu4aEAxVuK0QIHQOrBmMQFnoECBAQAw&url=https%3A%2F%2Fwww.ibm.com%2Fhistory%2Fthinkpad%23%3A~%3Atext%3DIBM%2520computer%2520scientist%2520Ted%2520Selker%2C%20Some%2520questioned%2520its%2520efficacy.&usg=AOvVaw2EnhRseDOwOEbjcT8v8QeA&opi=89978449>
- https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjh-9mtvIaEAxX8JEOIHQrFBI0QFnoECCIOAQ&url=https%3A%2F%2Fappleinsider.com%2Farticles%2F21%2F10%2F21%2Fapples-powerbook-reinvented-the-laptop-thirty-years-ago&usg=AOvVaw3_yxjIFfVzd_e5r3iJc9Vg&opi=89978449
- <https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiWnobavIaEAxUIOkQIHbHQBzYQFnoECDwQAQ&url=https%3A%2F%2Fwww.engadget.com%2F2014-05-11-gadget-rewind-2005-lenovo-ibm-x41-tablet.html&usg=AOvVaw2a7hbSA7gnc8A22ZPn3qXK&opi=89978449>
- Used Canva
- Used Google Docs/Drawings
- Book: A Visual Guide to Technology
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