The hidden Inner workings of computer hardware: A beginner’s guide

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# Introduction

The computer is something we all take for granted. For many of us, using a computer is as simple as walking in the park, or drinking your morning coffee.

Take a minute to think just how a device handles everything thrown at it. To fully understand and appreciate computers, they must be examined from the inside rather than the outside. It all comes down to the hidden internal parts. In truth, thousands of exhaustive man-hours go into developing the internal parts for each and every machine.

The internal parts in a typical computer are connected to a conductive rectangular plate called the motherboard. From there, the parts work tirelessly together to keep the machine running up to speed.

This terminology can be confusing to some, but that is why this report exists. This report will concisely explain the roles of each fundamental computer part and how they complement each other to power a computer. It will also clarify when to upgrade each part to keep a machine running at its best.

# The Processors

The processors are the heart of any computer. Without them, a computer is like a useless brick. This section will review the roles of each processor alongside their related parts.

CPU: The CPU (central processing unit) is a major component of any computer. It is typically a chip that is shaped like a small square. A CPU carries out instructions for a computer and makes lightning fast calculations. Without a CPU, nothing could get done on a computer.

To demonstrate the power of CPUs, the fastest CPUs today can calculate the first million digits of pi in 4 seconds. CPUs do this by utilizing the latest technology in cores, which are described below. [[1]](#_Bibliography)[[2]](#_Bibliography)

Cores: A core is a singular processing unit that carries out instructions and makes calculations. Cores can be described as the brains of a CPU. Every CPU contains at least one core. As CPUs contain more cores, they can handle additional tasks more efficiently.

Everything done on a computer has to be processed by cores. Whether a computer is instructed to type in a Microsoft Word document or run the latest games, cores make it happen.

A core follows a few operations to execute an instruction, known as the instruction cycle. The three major steps are fetch, decode, and execute. The first step, fetch, is where the core fetches stored instructions that are waiting to be processed. The second step, decode, is where the core fundamentally analyzes the instructions and decides what must be done with them. The third step, execute, is where the instructions are performed.

The Three Main Steps

More work can be done in a cycle depending on the amount of cores working together. Also, a cycle can be completed faster depending on the brain-power of each core. However, just because a cycle can be done faster does not always mean more work is done. For example, a single-core CPU may complete a cycle 4 billion times in a second, but a dual-core processor that completes a cycle 2.5 billion times a second gets 25% more work done in the same time interval. Because a dual-core processor executes two instructions with each cycle, the dual-core processor in this example will net the equivalent of 5 billion instructions in a second. As more instructions can be executed in a single second, a computer will be able to run faster. [[3]](#_Sources)[[4]](#_Sources)

On a side note, a recent innovation with cores and CPUs is a process called **hyper-threading**. Hyper-threading is a technique that tricks a single core into behaving like two. This allows for twice the amount of instructions to run at a time for the single core, improving the computer’s ability to multitask and solve problems.[[5]](#_Bibliography)

CPU Socket: A CPU socket is a conductive case that encases the CPU. This configuration lets power reach the CPU and enables the CPU to connect with the rest of the computer. There are multiple kinds of CPU sockets, with two of the most common kinds being land grid arrays and pin grid arrays. [[6]](#_Bibliography)

Land Grid Array: The term “land grid array” applies to a kind of CPU socket containing pins on its surface. The pins securely latch a compatible CPU onto the socket. [[6]](#_Bibliography)

Pin Grid Array: The term “pin grid array” applies to a kind of CPU socket with small holes on its surface instead of pins. A CPU that contains pins on it can snap onto the socket. A pin grid array configuration is like the opposite of a land grid array, as the pins and inlets between the CPU and the socket are swapped. [[6]](#_Bibliography)

Chipset: The chipset is a set of components and circuits inside a computer that organizes the flow of data between the memory, processor, and other parts. It is sometimes known as the memory controller. A good chipset helps stabilize a computer and its operating system by effectively managing data needs between components. The typical chipset has two bridges with varying speeds of data flow respectively. The north bridge (fast bridge) connects the processor directly with high-intensity parts like graphics and memory. Meanwhile, the south bridge (slow bridge) focuses on supplying data to input and output devices. [[2]](#_Bibliography)

The chipset is a vital part because it allows all the internal parts to connect and work together efficiently. Think of the chipset as a leader of a team. It knows what is best for each internal part and can expertly manage the quantity of data flow between them as needed.

Battery: The battery stores a handful of settings and the boot-up information for a computer. If the battery dies, it will be impossible to boot up the system. A sign of a weak or dying battery is a sluggish system clock. [[2]](#_Bibliography)

Heat Sink: A heat sink is a kind of cooling system used for computers. A heat sink in particular traps heat. In many computers today, the internal parts can undoubtedly generate a lot of heat. This makes it important that a heat sink or another kind of cooling device is placed inside a system. Without a heat sink or any other cooling system, a computer can easily overheat, even from doing simple tasks such as checking e-mails. If any internal part overheats, it can permanently damage or wreck the entire system. [[7]](#_Sources)

# The Memory

There are all kinds of memory types on the market today. With terms such as ROM, DDR3, and RAM floating around, it can be hard to tell what is what and which is which. This section clarifies terms and items that relate to computer memory and what they mean.

RAM: RAM stands for random access memory. RAM temporarily stores data and instructions from programs and tasks while they are not being used until needed. RAM continues to hold onto the data and instructions in the background until needed by the CPU or until the system is shut off.

RAM allows a computer and its user to manage many programs running at once. Say a user is running Facebook, e-mail, Microsoft Word, and Skype all at the same time. While the user is occupied with Microsoft Word, for example, the data and instructions from all the other programs are temporarily stored in the RAM. When the user switches from Microsoft Word to Facebook, for instance, the CPU calls back the data for Facebook while it sends Microsoft Word’s data back into the RAM. The RAM and the CPU share and exchange data loads together to ensure a system is fast and stable. [[9]](#_References)

Most computers on the market today come installed with 4 gigabytes (4 billion bytes) of RAM. The more gigabytes there are, the more information and data the RAM can store. With more RAM, a computer will be able to handle a larger quantity of higher-intensity programs at once.

RAM comes loaded with a varying amount of memory channels. Memory channels for RAM is the equivalent of cores for CPUs.

A memory channel is a term for 64 data wires inside RAM. These data wires are used to transfer between the CPU and the RAM. The more memory channels there are, the more data can be transferred at once.

The majority of RAM is either single channel, double channel, or quad channel. Double channel RAM, for example, has 128 data wires instead of 64. Double channel RAM has double the communication speed of single channel RAM, while quad channel RAM quadruples the speed. [[10]](#_References_1)

RAM Types: There are different kinds of RAM on the market. Two kinds are DRAM and SRAM. DRAM stands for dynamic RAM while SRAM stands for dynamic RAM. DRAM requires the data held to be refreshed occasionally to avoid being lost. Contrarily, SRAM can hold onto data indefinitely as long as the power supply is not lost. SRAM is faster, more reliable, and less power-hungry than DRAM, but DRAM’s cheaper cost leads it to be the more popular choice for home computers. [[11]](#_References)

Expanding from DRAM, SDRAM is the latest DRAM innovation. SDRAM stands for synchronous dynamic RAM. Living up to its name, SDRAM synchronizes itself to the CPU’s speed. Because the RAM runs at the same speed as the CPU, the CPU and RAM can now instantly transfer data between each other. This allows the CPU to reach its maximum potential. [[12]](#_References)

DDR SDRAM is the next generation of SDRAM. DDR stands for double data rate. DDR transfers twice the amount of data between each instruction cycle compared to ordinary SDRAM. As technology continues to improve, newer versions of DDR SDRAM known as DDR2, DDR3, and DDR4 continue to be produced. Each new generation of DDR SDRAM brings reductions in power consumption, increases in reliability, and increases in speed. [[12]](#_References)

Parity RAM: Parity RAM is a special type of RAM that is quite different from the rest. Parity RAM adds an extra bit of data into its memory for every byte of data (1 byte = 8 bits). The extra bit is used to validate that each byte stored has no errors. If the extra bit doesn’t match, there is an error within the data.

Parity RAM has become less common over the years as RAM technology evolved to become more reliable. With RAM technology being so reliable today, the extra bits used to validate the data are often unused. [[13]](#_References_1)

ECC RAM is a more advanced version of Parity RAM. ECC stands for error correction code. ECC RAM is great for high-end workstation and servers as it provides very reliable data transfers. The reliability results in an increase in system stability and a decrease in crashes. For high-end workstations and servers, a crash can cost its owners thousands or millions of dollars.

However, ECC RAM is slower than other kinds of RAM, so it is not typically used in home computers. Home computers get by just fine with normal RAM. [[14]](#_References_1)

ROM: ROM stands for read only memory. The data stored in ROM can only be read and executed. Data stored within ROM is permanent. It does not require a power connection to retain the data. ROM is frequently used to hold boot-up instructions so the computer knows what to do when turned on. [[15]](#_References_1) [[16]](#_Sources)

Types of ROM: There are many different kinds of ROM on the market with varying uses. The first kind is called PROM. PROM stands for programmable ROM. Unlike normal ROM formats which come with information stored on it, PROM comes packaged with no data stored on it. Anything the consumer wants can be added to a PROM format. However, once the data is transmitted on it, it cannot be erased or changed. A well-known example of a PROM format is CD-ROM. Anytime

EPROM takes the limitations of PROM and removes them. EPROM stands for erasable programmable ROM. By exposing it to ultraviolet light, the contents on it can be erased. This allows the ROM to be written many times over.

EEPROM is another kind of erasable ROM, but instead only requires electricity instead of ultra-violet light to erase its contents. This makes it much easier and accessible to rewrite it. It also removes the restrictions of EPROM and other forms of ROM. The entire memory does not have to be erased to make changes unlike in other forms of ROM.

EEPROM stands for electrically erasable programmable ROM. The development of EEPROM led to the development of flash memory, which will be described below. [[17]](#_Sources)[[18]](#_Sources)

Flash Memory: Flash memory is a type of EEPROM that is specially designed to be faster than EEPROM. It accomplishes this by writing data in chunks, usually around 512 bytes in size each. Where EEPROM can only erase or change 1 byte at a time, Flash memory can alter up to 512 bytes at once. [[18]](#_Sources)

Flash memory is a common choice in various consumer devices, like smartphones and cameras. Flash memory is often chosen because it can permanently store data without a power supply, like any form of ROM, while still being relatively easy to organize and erase data within it. [[19]](#_References_1)

Cache: A cache is a place where a small amount of data can be temporarily stored. Caching is a term used in computing where active data is stored in caches so they can be quickly accessed and loaded.

A CPU has a cache in it. It is used to temporarily store small information and be able to access it as quickly as possible. Many web browsers take advantage of the CPU cache with their own cache functions. Each webpage visited is temporarily stored in the cache and retrieved when the page is revisited. That’s why a website loads so fast when pressing the back button to go back to it. [[20]](#_Sources)

Caches differ from RAM in many ways. RAM is a physical component that goes directly into the motherboard and helps store large amounts of data at once. Caches store and retrieve data much faster, but they can only store small amounts of data.

# Options for Upgrades

It is important that a user works with a computer that can handle their needs. If a computer feels sluggish and painful to use, an upgrade should be considered. Often, there is no need to buy a brand new computer. Simply upgrading an existing machine will save a lot of money. This section covers the upgrade options for each processor.

Warning! Working with the inside of a computer can be dangerous! Ensure that the power supply is disconnected and all cable/wiring in your way is disconnected as well. Read the owner’s manual and do some additional research to determine the steps to safely and effectively replace each part.

You can also take your machine to a computer shop and have it upgraded by a professional. This is a better and safer choice for beginners.

CPU: The CPU is a difficult part to upgrade or replace. The blame lies on the CPU socket. The socket limits the CPUs that will be compatible and will fit. Usually, the socket cannot be replaced itself.

An upgrade is within reason when the machine slows down while performing basic tasks, like social media and e-mail. To upgrade, the new CPU must be compatible with the same socket type as the last CPU. It may require a little research to figure out which CPUs are compatible and how to insert one into the computer. [[21]](#_References)

Sometimes, the CPU socket can make it impossible to remove the CPU. If this is the case, a new motherboard is needed. A new motherboard will also be needed if there are no other compatible CPUs in the current market. Ensure that the CPU socket on the new motherboard has the required socket type for the new CPU in mind. [[6]](#_Sources)[[22]](#_Sources)

Chipset: All chipsets are fused with the motherboard and typically cannot be replaced. A new motherboard must be purchased if the chipset must be replaced.

GPU: If a computer is requested to run movies and games but hiccups while doing so, it would benefit from a dedicated GPU. (Graphics Processing Unit). A GPU is a supercharged version of a CPU with up to thousands of miniature cores. A GPU and a CPU combine forces to create a computer that can handle anything thrown at it. A GPU dedicates itself to the extra power needed to run graphics and other high-intensity tasks, leaving the CPU open to manage more basic tasks. [[23]](#_Sources)

Heat Sink/Cooling Device: It is important that a cooling device expels enough heat to keep the system in safe operating temperatures. Sometimes, the intended functions performed on a computer can cause it to heat up beyond what the cooling device can manage. As more intensive actions are performed on a computer, a stronger cooling device is needed.

If a computer often heats to dangerous levels, a new cooling device is needed. There are many kinds of cooling systems on the market, including heat sinks, case fans, and liquid cooling kits. With a little research, pick the cooling system that would work best for your needs.

With a new cooling system, not only is the computer being saved from a blistering demise, but it will also make the system feel more stable while using it. With lower overall running temperatures, less stress will be put on the CPU and motherboard, leading to more stability. This also increases the lifespan of the computer, so it’s a good long-term investment. [[24]](#_References)

RAM: RAM is one of the easiest and cheapest parts to upgrade. If a computer struggles to handle one large task or a few smaller tasks at once, it could use a RAM upgrade.

A computer today should have an absolute minimum of 4 GB of RAM. To check how much RAM a computer has, first find the ‘this pc’ directory. Second, right-click on ‘this pc’. Then, click on properties. A list of all the computer’s specifications will pop up. If the computer has less than 4 GB of RAM, an upgrade is highly recommended.

When upgrading RAM, it is important to know that RAM comes in sticks. The typical motherboard has two slots for RAM sticks. If 4 GB of RAM is needed, for example, buy a set of two 2 GB sticks. Also, be wary that a motherboard typically accepts only 1 kind of RAM. If the last set of RAM was DDR2, for example, buy another set that is DDR2 to be safe.

If the computer will be used for social media, e-mail, and other casual tasks, 4 GB should suffice. If the computer will be used for gaming, video editing, and business, 8 GB is the minimum to consider. [[25]](#_References_1)

# Conclusion

To fully appreciate and understand computers, they must be examined from the inside rather than the outside. Just take a moment to think how amazing computers are. Anything can be done from surfing Facebook to movie-making thanks to the internal parts.

The internal parts are masters at working together to tackle a problem in their way. If one part gets tired or stressed, the others jump in without question and help out. Perhaps even we could learn a thing or two about co-operating from them.

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