IT ESSENTIALS
FACULTY OF COMPUTING & INFORMATICS--- MUBS
BBC PROGRAM

PC COMPONENTS: HARDWARE

Learning objectives:

By the end of this chapter, learners will be able to;

i. Choose the right computer hardware fit for purpose
ii. Apply the concepts to achieve balanced performance and efficiency of computer systems.

In this chapter, we shall have a breakdown of the major hardware components while showing how they work and what to look out for when working with such components.

We begin by covering the concept of Central Processing Unit (CPU) and Memory.

CPU: The CPU is always regarded as the brain of the PC. It is basically responsible for fetching and executing instructions and data. The CPU is fundamentally divided into two units namely the Control Unit (CU) and Arithmetic/Logic Unit (ALU). The CU coordinates, controls and executes instructions. The ALU performs math operations and logic applications like comparing values. We can note that there is a close relationship between CPU and Memory. In fact, the CPU fetches data and instructions from memory. This memory can be either primary memory commonly known as Random Access Memory (RAM) or cache memory. One of the other parts of the CPU is register. The register can also be seen as part of memory. There are a number of registers (memory allocation register, instructions register, program counter register) and they do perform different functions.

The size of the register is very crucial since it is related to the CPU architecture (bits). This brings us to x32 bits and x64 bits CPU that we see in the modern computers. What does the x32 bits and x64 bits CPU mean. Those figures are just telling us the size of the register i.e., for accessing memory, the register uses 32 bits and 64 bits respectively. Consider the first CPUs made by intel, the 8086 and 80386. Originally, the 8086 was 16 bits long. The 80386 CPU was 32 bits long. Today, there are CPUs that are 64 bits long (register) abbreviated as x64. Note that 32-bit long CPUs can also be written as x86. The 86 comes from the 80386 architecture. It doesn't denote that the size of the register is 86 bits long.

Quiz 1: Is x64 two times faster than x32 or x86. Give reasons for your answer

There is a close relationship between CPU architecture and the Operating system architecture. Software developers build applications and programs targeting the CPU architecture. Operating system developers also target the CPU architecture. Operating systems like Ubuntu, Linux and Windows come in two flavors namely x86 and x64. We have already discussed what those figures mean. x86 (32 bits)

version of the operating systems should be installed on the x86 CPU while the 64-bits Operating system should be installed on x64 CPU architecture. The CPU architecture dictates the amount of RAM to be used which is directly related to the operating system architecture. For instance, when you want to use more than 4GB of RAM, then 64-bit version of the operating system is your pick. A 32-bit operating system can make use of only 4GB of RAM. This may be sufficient for some computer users who run simple applications like Libre office, Microsoft Office, surfing the web, playing video and audio. However, if want your computer to be a gaming machine or rendering content or use it for computer programming, you need a 64-bit CPU and OS. Remember that some programs are RAM hungry.

Quiz 2: Does x86 take more instructions and data from RAM. Give reason(s) to support your answer.

Expound on RAM concepts

RAM holds data and instructions to be executed. This function ends as soon as the computer is powered off. Every time a program or application needs to be started, the operating system has to allocate it RAM. Using the task manager in a Windows machine, we can be able to see which programs or applications are running and how much RAM each is consuming. There are basically two types of RAM namely Static RAM (SRAM) and Dynamic RAM (DRAM). Technical concepts like the number of transistor or capacitors and refreshing is outside the scope of this chapter or even course. However, the table below summarizes the differences between the two kinds of RAM.

Factor to be compared	**SRAM**	**DRAM**
What it's used for or as	Cache memory	Main memory
Speed	High speed	Slow
Cost	Expensive	Less costly
Amount of data it can store	Less	More

From the table above, it is clear that users of computer systems can have control over how much memory they need to have on their computer i.e., buy DRAM chip(s) of your choice. There are two kinds of DRAM namely Asynchronous whose RAM and CPU clock are not synchronized and Synchronous DRAM where both CPU clock and RAM clocks are in tandem and synchronized.

Quiz 3: Think of the implications of having unsynchronized clocks in the above definitions.

While writing this chapter, the RAM that computers use is SDRAM and are of four categories: DDR1, DDR2, DDR3 and DDR4. DDR stands for Double Data Rates. As we move from one generation to another say DDR1 to DDR2, everything in terms of efficiency in performance gets better and better. To arrive at the Mega Transfer Per Second, multiply the Input / Output Bus Clock rate by two. DIP (Dual inline Package): These are the very first old packages of RAM chips. They were replaced with

SIMM (Single inline Modules). The SIMM memory chips had pins on only one side of the chip. Next are DIMM (Dual inline Modules) whose pins are on both sides of the memory chip and support 64-bit data bus. Its predecessor supported only 32-bit though one would achieve 64-bit technology by using two 32-bit technology in a parallel fashion. This is possible because we can install more than one RAM chip in modern computers. All the above-mentioned RAM chips are specifically designed for workstations and desktops. Laptops use SO-DIMM (Small outline - Dual inline Modules). How about the Smartphones that we use? If you use a Smartphone, then you must have come across the words CPU and RAM.

Quiz 4: Find a computer and open certain applications or programs. Visualize the amount of memory being consumed by each application.

Quiz 5: Can a laptop DDR RAM chip work in a desktop computer. Justify your answer

Performance Tuning: Relative Performance

From our discussion above, we can deduce that RAM is a very special kind of memory. Recommending a choice of computer system without considering the concept of RAM and CPU architecture is detrimental. RAM and CPU can define the performance of your computer system other factors remaining constant. We mentioned in the beginning that some applications or programs are RAM hungry. By this we mean programs that consume more RAM and tend to suffocate the rest of other applications. Think of an application whose minimum system requirement specifically RAM is 4GB. If your computer has 4GB of RAM installed, then when such application is started, obviously the operating system has to allocate it the existing RAM size. It may be very hard for the rest of the applications to even load or start. With this in mind, it is crucial for us to install an application after we have seen the minimum system requirements like RAM in this case. Most software developers indicate how much RAM will be consumed by such an application. It is good practice to close applications that we are not using to free up the memory.

Quiz 6: From your most used application on the computer, go online and find out its minimum system requirements. Focus on RAM requirements.

Let's turn to the CPU. When you turn to the media whether printed, online or Television ads, you will find words like i3, i5 and i7. Today, the majority of computers use CPU from Intel or AMD. The number of cores and the clock speed are two important concepts in CPU and we can base on them to evaluate CPU performance. So, what does i3, i5 and i7 mean? The numbers in question does not mean that an i3 computer has 3 cores or processors, i5 has 5 cores and i7 having 7 cores. The numbers are just an indication of relative performance. Generally, i7 outperforms i5 and i3, while i5 outperforms i3 but not i7.

Quiz 7: Consider the following factors for CPU relative performance: Cost, number of cores, size of the cache memory, technologies like hyperthreading and overclocking, rate i3, i5 and i7.

Quiz 8: When someone needs a gaming machine, would you recommend an i3, i5 or i7? What clock speed would you recommend for such a purpose?

BUSES

These transmit power, instructions and data from one device to another. There are two categories of buses namely the internal and external buses. Internal buses are used to connect hardware components in the system case i.e., all internal components. System buses which connect the CPU to main memory are typically internal buses. External buses are used to connect external devices usually peripheral devices like printers and the like. These control the different Input/output devices. Some call them expansion buses. This is because they provide connectivity to the different additional devices.

Quiz 9: Check out the following expansion buses: ISA, EISA, PCI, PCI Express, PCMCIA, AGP, SCSI and USB.

INPUT/OUTPUT (I/O) devices

There are a number of (I/O) devices. Without them, we would not be able to carry out any data processing tasks as users. In fact, the CPU will not have data and instructions to work on. All the data that is input or output is carried by the specific bus or buses. One of the greatest challenges is that you find a number of I/O devices all needing attention from the CPU. These I/O devices have differing speeds for data transmission. The speed at which devices like Keyboard, Mouse and Speaker transmit data is slower than a Local Area Network device or Universal Serial Bus (USB). However, the CPU has to process data and instructions from all these I/O devices whose speeds are different and require processing tasks at the same time.

NETWORK COMMUNICATION DEVICES

Computer networking has revolutionized the way we communicate. Gone are the days when you sit down and write a letter using pen and paper, insert it into an envelope and have it sent or mailed to a recipient. With computer networking, all letters now can be faxed or emailed with just a click. There are a number of devices responsible for such. These include interconnecting devices like switches, routers, servers, network cables, Network interface cards (NICs) and so forth. Routers learn existence of networks and route packets to their destination. You probably have come across telecom service providers selling routers which provide both wireless and wired services. Switches switch frames to end devices like computers, servers, printers and act as a central connecting point for such. Servers just respond to your requests. All data or information you access is stored on a certain computing machine which is later accessed by a number of people or clients. When you go online to watch a video on

YouTube, you actually interacting with YouTube server. NICs on the other hand allow us to connect to the wired or wireless network. When you pick an ethernet cable or internet cable, you will have to plug it in a certain port on your computer. The cable has a connector called RJ-45 (Registered Jack) 45 that you plug into the port that is part of the NIC. The in-depth discussion about network devices is outside the scope of this course.

STORAGE

The word storage and memory have been used interchangeably to mean the same thing. In this chapter storage is linked to external devices that hold information or data. Such devices include Solid State Drives (SSD), Hard Disk Drive (HDD), Flash Drives, Optical Drives like CDs and DVDs etc. though there are a number of storage media, we shall focus on Solid State Drives (SSD) and Hard Disk Drives (HDD). The debate on whether to get a SSD and HDD is still on going. This is because each disk drive has some competitive advantages over the other. For example, SSD is very fast, does not produce any noise, little heat and are relatively immune to failure due to physical shock and vibration. Meanwhile, the HDD uses platters which keeps on rotating. Each platter has two usable sides, marked in concentric circles called tracks. The tracks are divided into a number of segments called sectors, each holding 512 bytes of data. HDD read and write data takes place as the disk is spinning or rotating. The speed at which the disk spins to read or write data is termed as Revolution Per Minute (RPM). The general rule of thumb is that the faster the spinning the faster the Hard Disk. This is why we mentioned earlier that three hardware components namely RAM, CPU and HDD can define how fast your computer can be other factors remaining constant.

MOTHERBOARD

One of the most important hardware components is the Motherboard. Actually, all other components have an attachment to the Motherboard i.e., one of the bus ends. The form factor is crucial in motherboard selection. Since all components will have an attachment to the motherboard, one has to be careful when making this choice. This is specifically for one who is building a customized PC. Ideally, when building a customized PC, begin with the motherboard. This will guide you on the size and shape of the rest of the components including the systems case. The motherboard also contains a number of expansion slots. This means more than one hardware component like Video or Sound cards and NICs can be connected to it.

Assignment: Read about the different form factor e.g., AT, ATX etc.

BIOS or UEFI

Before one sees the operating system loading, your computer loads a small program or software called the BIOS or UEFI. This small program resides on a chip on the motherboard. The function of this

program is to test the state of the hardware to ensure that they all functioning properly before the operating system loads. Some call this POST (Power-On-Self-Test). For example, when the process

runs and finds a problem with RAM whether it has gone bad or not fitted properly in its slot, the user will be notified say in terms of a beep sound. When discussing BIOS, the concept of Master Boot Record (MBR) comes in play. MBR is a boot sector that holds information on how the logical partitions, containing file systems, are organized on that medium. There are a number of drawbacks with MBR ranging from supporting not more than 2 Terabytes of storage space to limiting the number and size of partitions you can create on the hard disk. With such drawbacks, a more efficient technology has been introduced named Unified Extensible Firmware Interface (UEFI). UEFI is supposed to replace BIOS. As a matter of fact, newer PCs are using this technology while providing backward compatibility for BIOS. Some features of UEFI include but not limited to being faster than BIOS, accommodating more logical drives and or partitions, adding level of security like secure boot which ensures that everything should be digitally signed i.e., recognized and genuine from a vendor. This is good for preventing malicious software programs from running. UEFI uses GUID Partition Table (GPT) as opposed to MBR. GUID stands for Globally Unique Identifiers. You can configure various settings like the clock settings, boot order i.e., which device should the operating system be loaded from, virtualization and so forth in the BIOS or. To get to the BIOS or UEFI, press F2, Esc, F12 or F10 when the computer is just starting before the screen for the operating system shows up. The keys stated above may vary from one computer manufacturer to another.

Quiz: Compare and contrast BIOS with UEFI

Assignment: Read about CMOS battery, Northbridge and Southbridge

Reference

Irv Englander (2009). The architecture of computer hardware, systems software and networking. An IT approach, Fourth Edition. John Wiley & Sons