

Hardware Class Notes ver. 3

Class Notes for students who haven't quite got round to purchasing the books!
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Introduction

Overall these factors of CPU, Memory and their rapid growth over the last decade have shifted the make up of the Information Technology (IT) world. The early days (over 30 years ago) saw the **Mainframe** as the definition of a computer. Large physical machines, number crunching at comparatively fast speeds employed by governments and conglomerates. Gradually this system is being streamlined by ever more capable **Mini Computers** which have similar brain power (processing speed) but are smaller and cheaper, two of the pioneering hardware players are SGI and Sun workstations. Certain machines employ Parallel technology, which enables two processors to be used by the computer for faster access to data. Although some of these machines are housed at NYU, this class will not be going anywhere near them!

Lastly the spread of computers to the point of critical mass has been achieved by consumers and home users getting involved in **Micro Computers**, the desktop PC. These are even smaller than the Mini computers and slower, cheaper but fine for home, small business and assignment use. Apple pioneered the Microcomputer in the 80's with their ease of use (point and click) interface. This **GUI** (graphical user interface) was revolutionary and found a ready audience in Publishing, Graphic and Design houses. The IBM PC caught up and surpassed the Mac as the main choice for home PC, and was cloned. This meant IBM allowed other companies (Gateway, Dell, Compaq, HP, Packard Bell) to make their own brand name computers that spoke the same internal computer language as IBM's, this operating system – DOS (disk operating system) enabled the clone machines to run software and open files saved on an IBM. Today, although Mac and IBM (clones) use different operating systems, for the user the interfaces are increasingly similar and switching between platforms is no longer an issue.

As Desktop PC's become ever more prevalent (home ownership is now at over 30% penetration) we can expect to be using them, buying them or at least considering to purchase one. In this light an overview of the hardware nuts and bolts of a PC is presented. These are nuts and bolt basic and applicable to whatever platform you use at home.

This semester much time has been spent on the net. Students saw the pre-requisite of going online was a computer, a modem, a phone line and an ISP provider. The computer part of that equation is what will be focused on in this lecture.

The main internal engine of the computer is the Motherboard. The motherboard contains the CPU and the Memory. These are the minimum components to get the computer up and running, but to which can be added any number of Peripherals.

We will look at these 3 sections

1. CPU
 2. Memory
 3. Peripherals
 4. Binary Notation
 5. Appendix
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1) The CPU

DIAGRAM

The **Central Processing Unit** (CPU) is what lies inside the casing of the machine. It is the brain of the machine that reads and executes programs, by carrying out instructions given to it by the software and the user. Its infrastructure is essentially electronic circuitry in the form of a single chip; in fact the CPU boils down to a microprocessor.

Not all these microprocessors are the same, the factors that gauge the quality of the chips are framed in the terms *clock speed*, *MIPS*, and *I/O speed*, which refers to the speed information/data, can be read and written to disk. The clock speed refers to the units of MegaHertz (MHz). Often in stores this is the selling point. 'The machine has a speed of 450 MHz,' The term MIPS refers to millions instructions per second, the norm now is for machines to operate at 6000 MIPS which is over 6000 times the speed of the original computer used to put a man on the moon.

The **Microprocessor** makes up the Central Processing Unit as the machine's brain, messenger and boss. This processor utilizes other hardware components such as RAM, disk drives, monitors acts as its feeler to the end user, by taking what ever the user inputs to the CPU and then display it back to on the screen. The computer can have additional processors e.g. when working with video or sound, the cards have special processors to alleviate the strain on the CPU (even the mouse).

The two main manufacturers of the microprocessors are — Intel - Pentium MMX, Pentium Pro and Pentium II and Motorola (for Mac) with the PowerPC chip. And in a nutshell, business is booming as the processing power of a chip doubles every 18 months!

Operating System

The Operating System of a CPU is like the internal language the Computer System speaks to itself regarding how it will execute the basic tasks (before even trying to run your Word program). It defines how the machine will organize the hard disk, in terms of file storage and retrieval. Without this basic Operating System each application software program such as Telnet, Pagemill, GifBuilder, etc would involve extra work as programmers would need to program all these basic functions, from how to save and open files to how to display the results on screen, into each program. Microsoft writes the most widely used operating system for PC's, the **DOS** system (disk operating system) is what sits behind the Graphical User Interface of Windows 98 etc, and what makes its point and click interactivity easier to use compared to the command line driven commands, we have all experienced in Telnet.

The operating system works by using convention known as **ASCII** (American Standard Code for Information Interchange) where numbers represent letters, e.g. 'A' is ASCII '65' etc. this is **binary notation**, an internal computer language, enabling the computer to take the letter 'A' which I have typed on the keyboard and represent it in binary. This machine language is not the type of code most programmers work in, as anyone who has experienced **HTML**, we work easier with scripting code that is somewhat similar to English. This has lead to the process where the norm is to program in a **high level language** (similar to English and HTML) such as Pascal, Basic, Fortran, Cobol, or C. This **source code** is then compiled by an **interpreter** or **compiler** into **object** or **micro code** which the computer can understand as its all zeros and ones (binary).

2) The Memory

DIAGRAM

There is more than one memory that the computer uses, not dissimilar to people and their long term and short term memories. The computer's short-term memory is the **Main Memory** and the long term set is **Secondary Memory**.

Main Memory is attached to the CPU and is like a blank slate once the machine is switched on. Then the computer boots up, and the system software is loaded in the main memory in its own section called the **ROM** (read only memory). Once the computer has finished booting up, it is ready to run a program like Photoshop. A software application is launched and is executed in the Main Memory, again in its own section called **RAM** (random access memory) from which the machine can read and write to.

This part of the memory is important and what is often used as a feature as the bigger the RAM the more programs the computer can run simultaneously. 32 MB of RAM is now standard, but additional RAM can be purchased and installed. There is a third section to the main memory that is small and plays a part in helping the machines run programs/instructions faster and that is the **Cache** memory.

In summary the Main Memory is smaller and faster than the secondary memory but loses all data once the machine is switched. So where does data get saved?

The Secondary Memory is of a more permanent nature and where files, programs etc are stored. The unit of measurement used in disk storage is Bytes (8 bits), Kilobytes (about 1000 bytes, or a byte to the power of 10), Megabytes (1 Kilobytes squared) and Gigabytes (1000 Megabytes), Terabytes (1000 Gigabytes) and Petabytes (more zeros than you can imagine!).

The most popular medium for saving work and the one that automatically comes with almost every home PC is the Hard disks (magnetic or optical). The hard disk (like other storage mediums) first gets **formatted** before it can be functional, like putting empty filing cabinets into an office, this process creates the sectors and tracks where your data of image files, web pages etc will be stored and retrieved. The average hard disk normally holds 4 GB (compared to 10 MB only ten years ago. Today hard drives are so cheap and small that its possible to have more than one in your computer such as drive arrays, useful for quick access through large amounts of data, some even use 2 microprocessors to double the brain power of the machine.

There are other forms of secondary memory apart from the Hardisk, some of which are the Floppy, Zip (about 90 MB), Jaz (1 GB), SyQuest, DAT tape (1 GB), magneto-optical disk (the '1 GB floppy'), floptical (the '20 MB floppy'). Using laser technology -CD ROM (650 MB), and DVD (digital versatile disk) 17 gig are write once only at the moment (WORM write once, read many). Factors worth considering in this permanent memory storage medium are the capacity, mobility, cost, writeability and the speed with which the CPU can access information stored on them.

Slow Hardrive?

Over time a computer can become slow, in that it will take longer to react to mouse clicks, text typed in etc. Defragmenting (optimization) for speed can sometimes solve this problem. The process will put all the parts of a file(s) into once place on the hard disk, so the drive does not need to scurry around looking for the fragments. This saves access time for the computer to find and retrieve data.

3) The Peripherals Input/Output Devices BIOS (basic input/output system)

DIAGRAM

Any device outside the greater portion of the PC are input or output devices e.g. keyboard, monitor, mouse, joystick, scanner, digital camera, sound card, modems, printer, storage player mediums like Floppy, Zip, Jaz, Lazerdisk, CD- ROM, and DVD.

The part of the computer that co-ordinates this 'data highway' as extra pieces are attached to the computer and send information to the CPU is called the **Bus**. The Bus transports data among the processor, memory and the other components. Physically the bus is integrated in the computer, part of the motherboards, microchips, expansion cards etc. The idea is basic; a slot into which you plug other pieces of equipment to work with the computer (via the motherboard).

For example an external CD-ROM may be needed to play a game. The CD ROM drive requires a **computer port** to plug in. The two main types of port are, **Parallel** ports usually for the printer and **Serial** ports which are slower and often used for modems, mice, coffee mats, etc.

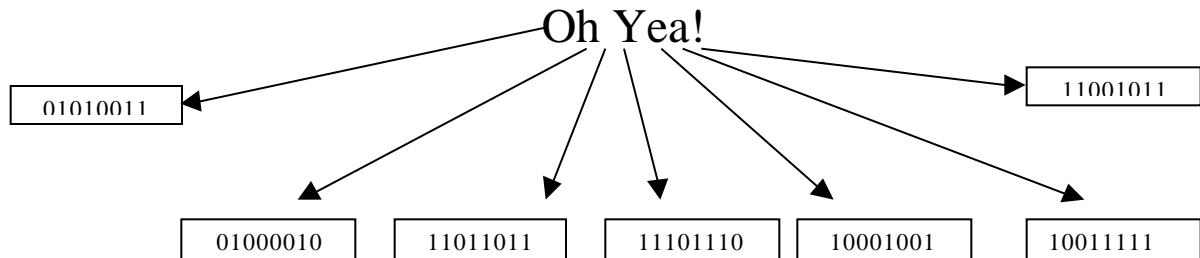
Often a computer comes with two of each, which then after adding printer, modems leaves no more sockets into which to plug in another BIOS. Many computers now provide a solution in the form of a **universal serial bus** – this allows a daisy chain link into which a number of peripherals can be plugged into the hub like an extension cord. Theoretically many (over 100) devices can be plugged into the usb, with only the need to install the relevant software drivers once and not have to restart the computer each time a new printer is plugged in, or a new joystick. The usb is faster than the older type of ports and thus will not become clogged with data.

DIAGRAM

4) Binary Notation or When is 10 is equal to 1010

Binary Digits is important if we bear in mind that the any computer is essentially a series of on/off switches. On or Off, Yes or No, 1 or 0, Two alternatives. This concept expressed number wise leads to the idea of a Binary Digit, a Bit which is just a 1 or 0. If we can put a number of these together in a string like 0100 we have four bits or a **Nybble**. If we extend the string to 8 bits:

01001110 we have a **Byte**. The byte is about the smallest amount of useful memory the computer can work with. It can put a single **character** into one byte. The character can be a letter, or exclamation or even space bar. So as a user I may type 'Oh Yea!' which the computer will see in zeros and ones according to the ASCII standard as:



Binary is counting to the base of 2. By that we mean, that instead of counting to the base of 10 and then 'carry one' we count to 2 and then 'carry one'. To examine how this works we shall look at the decimal system once again.

1000	100	10	1	are the main columns under which we could file number thus
7	0	0	0	is seven thousand (7x1000) = 7000
7	0	8	0	is seven thousand and eighty as 8 is in the 10 column.
		1	0	is ten (1x10) = 10

Imagine if we change the columns to the base 2

Counting from One to Twenty in Binary and Decimal

Binary	Decimal
0	0
1	1
10	2
11	2
100	4
101	5
110	6
111	7
1000	8
1001	9
1010	10
1011	11
1100	12
1101	13
1110	14
1111	15
10000	16
10001	17
10011	19
10100	20

Binary Calculation

The basic are not disimilar to adding in our decimal system.

$$0+0=0$$

$$0+1=1$$

$$1+1=10$$

eg.2.

fourteen plus seven equals twentyone

1110 plus 111 equals 10101

Appendix

Printers

Color ink jet - cheesy dot matrix type, the color is ok for home)

Color laser printer - better and slower utilizes print engines

Color thermal wax - quality printing

Dye sublimation – best: continuous tone printing like color photograph at 300 dpi

Solid ink - ditto!

Reference

How Computers Work

Ron White

ZD Press 1997

Cartoon guide to Computer Science

Larry Gonick

Barnes & Noble 1983

<http://www.cnet.com/>.

Objective

An overview of the main components of a Desktop PC, including a working vocabulary of the technical terms. This will enable students to become more informed consumers and users of computers.

The Next Level

If you felt this Hard Hat session makes you want to strap on a tool belt and go solder some circuits the next progression from this Computer Hardware lecture could possibly be a look at what enables the computer to connect to other machines on a global scale.

You may start browsing at sites, books, magazines that cover topics such as, Telecommunications - T1, T3, Cable Modem, ADSL, Wireless, Satellite; Voice and Data Communications, Networks and to build them, Routers and how they work etc.

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