Module 2

Personal Computers – Hardware Overview

2.1 OBJECTIVES

Students will be able to:

- List the various Personal Computer (PC) case styles
- Summarize the functions of PC components
- Summarize the characteristics of mass storage devices
- List the different types of peripheral ports
- List the different types of legacy ports
- List the different types of input devices

2.2 OVERVIEW

This is the beginning of a long journey-building module upon module. This journey starts within the desktop personal computer (PC) and moves toward building and managing a local area network. In this module, we introduce the various components of the PC. Your individual PC will have several of these components, but will probably not have all of them. Your particular responsibilities will determine your requirements.

2.3 THE DESKTOP PERSONAL COMPUTER

The personal computer (PC) can be easily understood once we develop the concept that they can only do what we tell them to do. A computer loads and runs the software you install, just as you have installed it. It is vital for the proper parameters to be set during the installation to prevent future problems.

2.3.1 CASE STYLES

Today you have quite a few choices in a PC package or the case.

- **Tower** – Massive cases nearly two feet high with room for half a dozen disk drives. Usually reserved for servers.

- **Midi-tower –** Today's most popular package, an upright system with the same storage as what classic desktop: about four drive bays and six expansion slots – exactly what most people want and need.

- **Mini- or micro-tower –** A dwarfed tower meant for those not planning extensive expansion. A top choice when you plan to stick with what you bought and move on to another PC when your needs grow.
- **Desktop** – The classic case with about four drive bays and six to eight expansion slots that do double-duty as a monitor stand on your desktop.

- **Compact** - A desktop system with the most of the air drained out. Although it may slight on bay and slot or two, the compact system is substantially smaller than a conventional desktop. Often referred to as the pizza box.

- **Zero Footprint** – The latest trend – a notebook –size system anchored down, perhaps hidden inside a flat-panel monitor. Trendiness has its price – these smallest of systems currently cost more and have more limited (and more expensive) expansion options.

- **Notebook** – The traditional laptop package that now holds everything you'd find in a desktop package (along with a battery and monitor) in a 6 to 8 pound package. Both the most powerful and least expensive portable systems fit this package.

- **Subnotebook** – A 3 or 4 pound PC that cuts corners on screen size, keyboard size, disk drives, and so on, but is easier to carry. Best suited as a supplemental computer rather than a desktop replacement.

- **Handheld** – Handhelds with keyboards now overlap with sub notebooks but run Windows CE (instant on but not compatible with desktop Windows). Those that use pens (stylus) instead of keyboards are Personal Digital Assistants and serve best as a portable appointment books with note-taking ability (although new PDAs are remarkable information retrieval and display systems.

2.3.2 CASE EXTERIORS

A typical case will have empty slots (for additional devices) on the outside; the number is dependent on the size of the case. All cases will have a power button (can be in the front or rear of the case), reset buttons, drive access lights, etc. The rear of the cases will have openings for expansion cards and the ports. Laptops will also have slots on the side called PCMCIA slots for cards such as modems, network cards, etc.

The case does serve a purpose, of course. It protects the components inside from dust and damage. It also keeps in undesirable radio frequency (RF) noise generated by the PC. The most compelling reason for the case, however, is that it is required by US regulations set by the FCC. Citing interference from electronic components, the FCC decided that a computer's case must reflect RF energy to keep it from interfering with other devices, especially radio receivers. Two broad categories are defined: Class A and Class B. Class B devices satisfy the strictest regulations and are suitable for home use. Class A devices are those that do not fit into Class B and cannot legally be sold or used for personal (non-commercial) use in the US.

2.4 COMPONENTS INSIDE

The PC is made up of a few basic and essential components that inter-operate to provide powerful computing. These components consist of: the processor, memory, storage devices, user interfaces, a system in which to tie the components together, and the power supply.

2.4.1 THE POWER SUPPLY

Power Supply - The general public largely mis-understands the power supply. It is a fairly common electronic component, because of the prevalence of AC electrical power sources and the large number of components requiring regulated DC. All modern power supplies are of the switching type. Basically, a switching power supply minimizes the ripples associated with standard rectifiers.

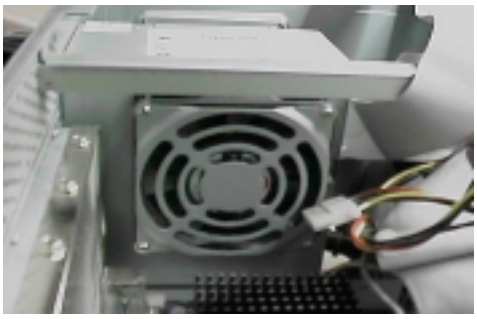

Figure 2-1. PC Power Supply

More often than not, your case will dictate the power supply you get. However, most case vendors will offer a wide range of power supply brands, sizes, shapes, quality, power, and voltage options. If you are attempting to replace the P/S, ensure the replacement has the same dimensions. This is just as important as the replacement having the same specifications. Today's power supplies are from 200 to 250 watts.

2.4.2 THE MOTHERBOARD

Motherboards: The motherboard (or sometimes called a system board) you have will determine many different things about your system. The basic technology underlying all personal computers is the printed circuit board. Traditionally, the centerpiece of most personal computers is a special printed circuit board. It is the physical and logical backbone of the entire system. In many PCs, the motherboard may be the entire system. The auxiliary printed circuit boards usually termed expansion boards, however, augment most machines. The circuitry located on these circuit boards – the motherboard particularly – defines the computer, its capabilities, it limitations and its personality. Where once motherboard designed was a free-for-all, new standards define the size, shape, and connections you can expect.

Because the motherboard defines each computer's functions and capabilities, and because every computer is different, it only stands to reason that every motherboard is different, too. Not exactly. Many different computers have the same motherboard designs inside. And oftentimes, a single computer model might have any of several different motherboards depending on when it came down the production line (and what motherboard the manufacturer got the best deal on.

The motherboard holds the most important elements of your PC, those that define its function and expandability. These include the microprocessor, BIOS, memory, mass storage, expansion slots, and ports.

2.4.2.1 BASIC INPUT/OUTPUT SYSTEM

BIOS: This could be a single chip or circuit board added to the motherboard, but chances are this piece of hardware (which holds critical software) is one of the weak points of your computer. BIOS is the term for the software stored on a Read Only Memory (ROM) chip. Your ROM may be EEPROM, EPROM or PROM. This software, the BIOS, runs during system boot. If possible, get flash BIOS. This way, since you already have Internet access, you can download newer versions when required to fix bugs. This type of chip is an EEPROM. Popular BIOS add-ons are SCSI BIOS, hard disk auto-detection, hard disk formatter, and Plug 'n Play.

2.4.2.2 THE CENTRAL PROCESSING UNIT

PROCESSOR: The microprocessor is the heart and brain inside every personal computer. This tiny chip of silicon determines the speed and power of the entire computer by handling most, if not all, of the data processing in the machine. The microprocessor determines the ultimate power of any PC. Relentless development has made chip and systems even more powerful.

Figure 2-2. PC CPU

If you are making recommendations for a new PC, you should consider that every new PC should have a fifth-generation (or better) microprocessor.

You have several choices of microprocessors:

- Celeron – Intel's entry-level microprocessor with a smaller but fast cache.
- Mobile Celeron – Intel's low-power bargain chip for notebook systems with surprisingly fast performance.
- Mobile Pentium II – Intel's current high-end notebook processor.
- Pentium III – Intel's current top-of-the-line microprocessor for individual users.
- Pentium II – Intel's old flagship, still competitive as a desktop processor, lagging only in multimedia performance.
- Xeon – Intel's premier processor aimed at servers.

- K6-2 – Once AMD's top processor, now their price leader that's popular on the desk and in notebook systems.

- K6-3 – Currently AMD's best chip with a unique three-level integral cache.

- MII – A processor comparable to the Pentium II from Cyrix.

Today's processors that you will be mainly exposed to are called Pentiums. The most prevalent processors today and Pentium IIs and IIIs and can operate a speed up to a speed of 1GHz and even higher. Technology is advancing rapidly. Only four years ago the maximum speed you could get on a processor was 166MHz. Also today we have the Athlon processor, which operates at speed of 1GHz.

2.4.3 MEMORY

Memory, commonly referred to as RAM (Random Access Memory), is always a hot topic, mainly because the more memory a PC has, the more the PC can do, and the faster it can do it. Two basic memory names to be familiar with are ROM and RAM.

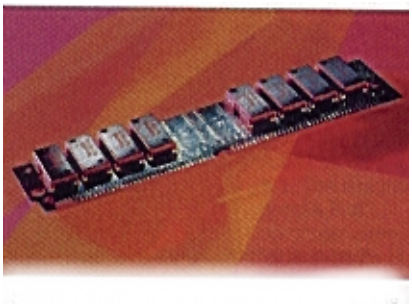

Figure 2-3. PC Serial Inline Memory Modules

- **ROM:** Read Only Memory is memory the manufacturer stores small programs in to make the PC function. A common program stored in read only memory is the basic input/output system (BIOS). The BIOS is activated at turn on and, as far as the user is concerned, is absolutely nothing to worry about.

- **RAM:** Random Access Memory is the memory available to the user. It comes as two operating types - dynamic and static. The major difference between the two is that dynamic memory (DRAM) needs a refresh cycle to hold its stored data, where static memory (SRAM) does not need a refresh cycle.

2.4.3.1 TYPES OF MEMORY

The memory configuration of RAM most users have heard about is the SIMM, or Single In-Line Memory Module. A SIMM is a circuit card with the memory chips mounted on it, and it usually has a 72-pin edge connector, which can be easily added or removed. In general, the SIMM is nine bits wide, or 1x9. This simply means there are eight bits of memory storage plus one bit of memory used to check parity. SIMMs is installed in pairs. To add 32 MB of RAM to a system you would install 2 16MB SIMMs or 4 8MB SIMMs.

Figure 2-4. DIMM Chip

The majority of computers today use 168-pin, dual inline memory module (DIMM). These pins come in increments of 4, 8, 16, 32, 64,128, 256, 512 (possibly others depending on the manufacturer). DIMMs are easily installed. Notches in the edge connector of the DIMM prevent your sliding smaller SIMMs with fewer connections into a DIMM socket. Instead of a notch on the side of the DIMM, the asymmetrical arrangement of the notches on the DIMM prevents its inadvertent improper insertion into its socket. Some DIMMs have holes to allow you to latch the modules into their sockets, although some DIMMs lack these holes. . It is most important to ensure you have the proper type of DIMM for your computer system. Always check your computer manual before purchasing or installing additional memory. DIMMs are installed in single units. To upgrade a system from 32 MB to 64 MB you would add 1 32MB DIMM.

A new type of memory called Rambus InLine Memory Modules (RIMM) is available and operates at a much faster speed than the SIMMs and DIMMs. It is a module with 184 pins and requires a higher operating voltage, therefore requires a total different design of bus. Keep watch on technical periodicals to learn more about this new memory.

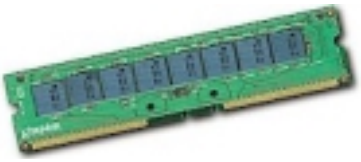

Figure 2-5. RIMM Chip

Notebook computers use similar memory, but often in smaller packages to fit into the smaller cases.

Another common form of memory in PCs is cache memory. Cache memory (pronounced like cash) is a working area invisible to the user. It is a special high-speed memory that matches microprocessor speed to slower memory systems. Most microprocessors have built in memory caches although some still use external or secondary (or tertiary) cache memory. Cache memory uses an entire different technology from the main memory in your PC.

A typical type of memory, called CMOS EEPROMs (Complimentary Metal Oxide Semiconductor Electrically Erasable Programmable Read Only Memory), holds the system configuration to identify the hardware inside the PC. There is a battery in the PC that helps the CMOS retain its data. A very common failure is for the battery to run down, causing the system to loose its configuration. To solve this problem, replace the battery and then set up the CMOS.

2.4.3.2 MEMORY ISSUES

When adding memory to your PC or when judging between PCs to buy, the following issues should be considered:

- **Speed –** Describes how quickly your memory passes data to your microprocessor. Today's fast PCs need memory that's faster than every before. Today's quickest memory is ready within eight nanoseconds.

- **Front Side Bus –** The channel through which data moves from memory to your microprocessor. The faster the bus, the fast your PC runs. Modern PCs have front side buses that run from 66 to 133 MHz.

- **Technology –** Tells how the memory is fabricated and used. Today's PCs require synchronous memory, but soon a new technology called RAMBUS will soon be the top choice.

- **Capacity –** Describes how many bytes (usually in millions) a module of memory can store.

- **Package –** The physical form of memory that determines whether it will fit into your PC. Most desktop and notebook PCs are standard-size modules, but the two applications often observe different standards.

- **Module Addressing –** Tells how many address lines reach into a module and how many modules you need to make a single bank of memory. Today's modules are mostly four-bytes or eight-bytes wide, requiring two (for four-byte) or one per 64-bit bank.

- **Cache Memory –** Special high speed memory that matches microprocessor speed to slower memory systems

2.4.3.3 ACCESSING MEMORY

Memory works like an elaborate set of pigeonholes used by post office workers to sort local mail. A memory location called an address is assigned to each of information to be stored. Each address corresponds to one pigeonhole, unambiguously identifying the location of each unit of storage. The address is a label, not the storage location itself (which is actually one of those tiny electronic capacitors, latches, or fuses).

The amount of data stored at each memory location depends on the basic storage unit, which varies with the design of the computer system. Generally, each location contains the same number of bits that the computer processes at one time – so an 8-bit computer (like the original PC) stores a byte at each address and a 32-bit machine keeps a full double-word at each address.

2.4.3.4 MEMORY REQUIREMENTS

How much memory your PC needs, depends on what you want to do. **Error! Reference source not found.** displays what are the recommended levels needed by various operating systems. However, certain applications might increase the amount needed.

Operating System	Minimum Requirements	Recommended Requirements
Windows 95 – Release A	4 MB	16 MB
Windows 95 – OSR2 and later	16 MB	32 MB
Windows 98	16 MB	32 MB
Windows NT	16 MB	32 to 64 MB
Windows 2000	64 MB	128 MB

Table 2-1, Memory Requirements

2.4.4 EXPANSION BUS

Your PC's expansion bus allows your system to grow. It provides a high-speed connection for internal peripherals that enhance the capabilities of your PC. Standardized buses spawned an entire industry dedicated to making interchangeable PC expansion boards. Today PC makers are cutting the last ties with past and, after nearly 20 years, foregoing the original PC expansion bus called the ISA for a faster, more versatile (and more complex) standard for today and the immediate future, termed PCI. Both the standard "desktop" systems and notebooks have expansion buses, bus-style expansions for desktops and card-style expansions for notebooks.

2.4.4.1 BUS-STYLE EXPANSION

2.4.4.1.1 PERIPHERAL COMPONENT INTERCONNECT (PCI)

The main expansion bus in modern PCs, PCI slots allow you to slide in almost any expansion board into your PC. The PCI bus doesn't directly interface to the CPU. Rather, it communicates with CPU via a "bridge circuit" that can act as a buffer between the specifics of a particular CPU and the bus. It is a 64-bit bus. PCI supports a data path appropriate for the newer Pentium-based computers. It also supports a 32-bit path that allows you to use PCI cards in older 486 machines. PCI runs to 33 MHz, however the net throughput of a PCI bus can be as large as 132 MBps with a 32-bit board, or 264 MBps with a 64-bit board. PCI supports bus mastering and is Plug and Play compatible.

2.4.4.1.2 ACCELERATED GRAPHICS PORT (AGP)

Provides a higher speed link to your PC's graphic display system. AGP lets your PC display data up to eight times faster than through PCI.

2.4.4.1.3 INDUSTRY STANDARD ARCHITECTURE (ISA)

ISA is the slots that follow the old expansion standard and allow you to use "legacy" boards in your newer PC – for example, to accommodate old boards for which there is no modern high-speed alternative.

2.4.4.1.4 ENHANCED INDUSTRY STANDARD ARCHITECTURE (EISA)

EISA is a faster, wider form of ISA that has been replaced by PCI. However, most systems today still have EISA slots to accommodate older "legacy" cards. EISA cards can be but does not have to be Plug and Play compatible. Each EISA card has to have dedicated IRQs, DMAs, and I/O addresses.

2.4.4.1.5 MICRO CHANNEL ARCHITECTURE (MCA)

This type of slot was an IBM proprietary improvement on ISA that paved the way for new bus designs but had little market impact. With MCA there was a configuration utility that was used and the disk had to be saved to make changes to the configuration.

2.4.4.1.6 VESA LOCAL BUS (VL BUS)

VESA was an extension of ISA designed to make video systems (primarily) faster but was quickly overtaken by industry acceptance of PCI as the high-speed standard.

2.4.4.2 CARD-STYLE EXPANSION

2.4.4.2.1 PC CARD (PCMCIA)

The PC Card puts ISA expansion on a credit-card size module that's chiefly used in older notebook PCs.

2.4.4.2.2 CARDBUS

The Card Bus puts PCI-style expansion on a credit-card size module that's the standard among modern notebook PCs.

2.4.4.2.3 COMPACTFLASH

The Compact Flash card is miniaturized version of the PC Card optimized for flash memory that's popular in digital cameras and some Personal Display Assistants (PDAs).

2.4.4.2.4 SOLID STATE FLOPPY DISK (SMARTMEDIA)

A tiny package that lets you interchange flash memory chips like expansion cards that are popular with digital cameras.

2.4.4.3 EXPANSION CARDS

Expansion cards or boards are sometimes called accessory boards. These boards are inserted in the expansion bus slots and include things like video cards, network interface cards, sound cards, modems, etc.

Figure 2-6. PC EISA Network Card

- **THE NETWORK INTERFACE ADAPTER** - The network interface adapter is the hardware that connects your PC to the network. It is a form of host adapter, a board that you slide into an expansion slot. The host adapter function also can be integrated into the circuitry of the motherboard. There are a hundred different manufacturers of the Network Interface Card (NIC), all of which have different particularities. The most important advice here is to ensure you have the proper drivers. The Windows 95 or 98 drivers are not the same as the driver for Windows NT. Once you establish your connections and configure a new setting, you will have a 10 or 100 MBps connection between the two computers. This is at least six times faster than a T-1, and at least ninety times faster than a serial port, and at least one-tenth the speed of a SCSI-2.

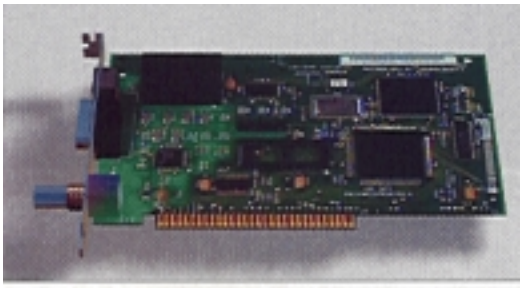

Figure 2-7. PCI Network Adapter Card

- **MODEMS** - Your MODEM is a modulator demodulator, which converts digital signals to analog signals and back. They are necessary to enable your computer system to be able to communicate over the Plain Old Telephone System (POTS). A few years ago, a 14.4kbps or 28.8kbps seemed to be fast enough. Nevertheless, just like the speed of computers, MODEMs have also increased in speed. Today, you will buy nothing less than a 33.6kbps or 57.6kbps. At this point, MODEMs have reached the limitations of POTS. POTS use an 8-bit signal with one bit for signaling. Therefore, only seven bits of useable data, with eight times sampling, equals 56kbps. In order to increase your speed, another type of MODEM and line will be needed, such as DSL, ISDN, T1 or T3.

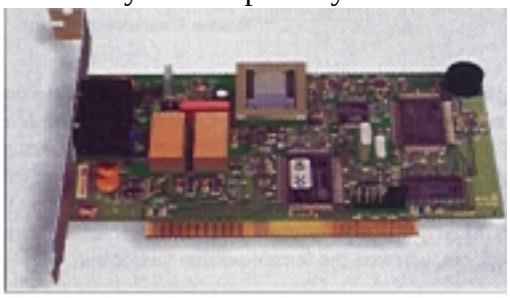

Figure 2-8. PCI Modem Card

- **VIDEO CARDS** - All computers use a display adapter to provide the interface between the computer itself and its monitor. These adapters are manufactured by many different vendors and will have different drivers. As with any other device, always ensure you have the proper driver for the video card you are using.

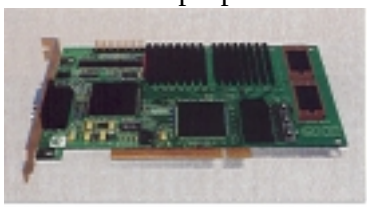

Figure 2-9. PCI Graphics Adapter (Video Card)

The video card contains video memory to hold video images received from the CPU until it is processed for the monitor. Then the video board examines the data and creates a digital image signal. This digital signal is converted to an analog signal and is sent through the connector to the monitor. Two other tidbits in regards to video cards: First, they are distinguished by their resolution. The numbers of pixels a video card can put on the monitor, as well as the number of colors the card can put on those pixels, determine their resolution. Second tidbit is the presence of an accelerator chip. An accelerator chip can significantly speed up the video operations.

- **SOUND CARDS** - Clearly, the basic sound system in PCs is inadequate for the needs of modern multimedia. Getting something better requires additional circuitry. Traditionally, all the required electronics get packaged on a single expansion card termed a soundboard. Higher-quality audio has become such a necessity in modern PCs that most new notebook machines include all of the circuitry of a soundboard on their motherboards. Many new desktop PCs and replacement motherboards also make all of the functions of a soundboard an integral part of their systems.

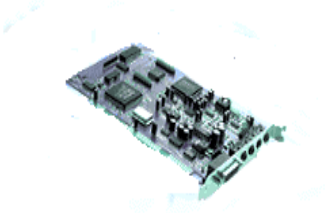

Figure 2-10. Sound Card

Soundboards may include additional functions, one of which is required by the various multimedia PC specifications – a MIDI interface. This additional connection lets you link your PC to electronic musical instruments, for example, allowing your PC to serve as a sequencer or going the other way, connecting a keyboard to control the sound board's synthesizer. Some makers of soundboards want their products to act as single-slot multimedia upgrades, so they include CD drive interfaces on their soundboards. Soundboards can be distinguished in several ways. The most important of these divisions are the three Cs of soundboards – compatibility, connections, and quality. Compatibility determines the software with which a given soundboard will work. The connections the board supports determines what you plug in, usually MIDI and CD devices. Quality influences how satisfied you will be with the results, essentially whether you will be delighted or dismayed by your foray into multimedia.

2.4.5 STORAGE INTERFACES

An interface links two disparate devices together. The most important of these link your PC to its mass storage devices. The design of the interface not only determines how your PC controls the device but also sets the limits on the performance of the overall system. The two most widely used mass storage interfaces are AT Attachment (ATA) and SCSI, each which have its own advantages and complications.

2.4.5.1 AT ATTACHMENT (ATA)

Another name for the ATA interface is Integrated Drive Electronics (IDE). In modern PCs, the various progeny of AT Attachments are more popular than the original. Although AT Attachment started life as single standard, the need for speed bus has motivated the industry to revise it several times, resulting in a number of variations on the AT theme. Today's ATA-2, ATAPI, EIDE, Fast ATA, Fast ATA-2, ATA-3, ATA-4, ATA-5, ATA/66, UDMA, and UDMA/66 interfaces are all elaborations on the original AT Attachment design.
Enhanced IDE (EIDE) is a package of four improvements to the original ATA standard. ATA Packet Interface (ATAPI) was the result of the effort to extend the reach of the ATA ports to tapes and CD-ROM drives. In the past, CD-ROM drives and tapes used a SCSI interface and the ATAPI interface was intended to help keep the number of connectors needed in a PC to a minimum.

IDE is a good interface, but it needs a bit of room to stretch and grow. That is the job of EIDE, or Enhanced IDE. EIDE is a Western Digital product, but other companies offer similar interfaces. The big benefits of EIDE are:

- EIDE supports large block addressing (LBA) translation support drives larger than 504MB, allowing BIOS support for drives up to 8GB.

- EIDE offers higher data transfer rates. It can interface with your system either via PIO, which can handle up to 11.1MB per second, or through DMA, at a maximum rate of 13.3MB per second.

- EIDE is intended to compete with SCSI and, therefore, supports CD-ROMs and tape drives. These drives and CD-ROMs must be EIDE devices, however.

Using the ATA (or EIDE) interface, you can put two ATA devices off one port. There are typically two ports on the motherboard. Each ATA device has settings to be a master or a slave and these are usually set with jumper settings.

2.4.5.2 SMALL COMPUTER SYSTEM INTERFACE (SCSI)

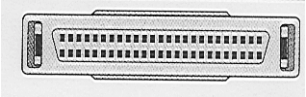

Figure 2-11. SCSI2 Connector

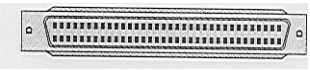

Figure 2-12. SCSI3 Connector

Figure 2-13. SCSI I Connector

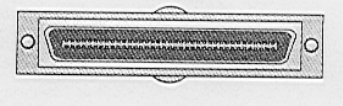

Figure 2-14. SCSI5 Connector

SCSI (pronounced "scuzzy") is a system-level interface that provides what is essentially a complete expansion bus into which to plug peripherals. SCSI isn't simply a connection that links a device or two to your PC. Rather, it functions like a sub-bus. SCSI devices can exchange data between themselves without the intervention of the host computer's microprocessor. In fact, they can act across the SCSI bus even while other transfers are shifting across the host computer's normal expansion bus.

There are several types of SCSI that you might hear, like Fast SCSI, Fast/Wide SCSI, Ultra SCSI, Ultra2 SCSI, etc. The differences in these different types of SCSI are bus speed, peak transfer rates, commands, etc.

Originally SCSI was simply a means to add hard disk drives to minicomputers, however, SCSI has evolved into a complete interconnection system that can link hard disk drives, CD ROM players, scanners, and even arrays of hard disks to any kind of computer. Today, SCSI is the preferred interface for hard drives in Server based systems.

Unlike ATA, SCSI ports are not on the average PC motherboard. They usually are added through an expansion card. A single channel can support up to 8 devices or wide SCSI can support up to 15 devices. Every SCSI unit is assigned a SCSI address, which can be set by a jumper on the drive. In the latest SCSI systems that operate under the plug-and-play aegis, you don't have to worry about these numbers through SCSI Configured AutoMagically (SCAM). SCAM queries each SCSI device and assigns a non-conflicting ID numbers to each one it finds. Addressing starts with 0 through 7 or 15, with the highest number being the highest priority and is usually reserved for the SCSI host adapter. Devices are connected one device to the next (device 1 is connected to device 2 which is connected to device 3, etc) in a chain method. You will commonly hear this referred to as daisy chained. Table 2-2, summarizes the best choices for device ID assignments in SCSI systems.

Wide SCSI ID	Narrow SCSI ID	Priority	Usual Assignment
0	0	Lowest	Boot hard disk drive
1	1	Low	Second hard disk drive
2-14	2-6	Ascending	Removable media devices
15	7	Highest	SCSI host adapter

Table 2-2, Typical SCSI ID Assignments

Eventually, all SCSI daisy chains must come to an end. You will have one last device to which you have no more peripherals to connect. To prevent spurious signals bouncing back and forth across the daisy chain, the SCSI standard requires that you properly terminate the entire SCSI system. The SCAM system can automatically activate the proper terminations in a SCSI system.

Since SCSI comes in many flavors that you're likely to have devices that follow two or more standards that you'll want to hook together in a single chain. With modern host adapters that allow you to configure the transfer characteristics assigned to each SCSI ID, you can freely mix standards with a reasonable chance that you will get everything to work together. You might need adapter cables, which has one type of connector on end and another type on another end.

2.4.5.3 FLOPPY DISK INTERFACE

The floppy disk connection stands as the one stalwart in disk interfaces. Circuitry, signals, connectors, and cabling for floppy disk drives have changed minimally even after more than a decade and a half. With little effort, you could plug a 160KB floppy disk drive left over from the very first PC into a modern Pentium III Xeon computer.

Part of the reason for this immutability is that the function of the floppy disk hasn't changed over the years. The floppy disk remains a boot device, a data exchange system, and a backup system. At one time, it was your only choice for each of these functions. The world has, of course changed in the intervening years, and the floppy disk is at best the fallback choice for each of these functions.

Note that the interface used by floppy disk drives is undergoing transition. New, high-capacity drives may use the ATA or SCSI interfaces. External floppy disk drives used by some sub-notebook PCs are shifting to the USB interfaces. Some external drives use a parallel port. Eventually, one or several of these interfaces may entirely supplant the conventional floppy disk interface, but for now, nearly every new PC has a floppy interface buried somewhere inside.

The floppy disk controller on the motherboard can handle two devices. To determine which device is drive A and which is drive B is done through the floppy disk cable.

2.4.6 MASS STORAGE DEVICES

Mass storage is where you put the data that you need to keep at hand but that will not fit into memory. Designed to hold and retrieve megabytes at a moment's notice, mass storage traditionally has been the realm of magnetic disks, but other technologies and formats now serve specialized purposes and await their chances to move into the mainstream.

Storage is measured in units called bytes. Table 2-3, shows large storage units and how many bytes each type is.

Unit	Abbreviation	Size in Units	Size in Bytes
Kilobyte	KB or K	1,024 bytes	1,024
Megabyte	MB or M	1,024 kilobytes	1,048,576
Gigabyte	GB	1,024 megabytes	1,073,741,824
Terabyte	TB	1,024 gigabytes	1.099,511,627,776
Petabyte	PB	1,024 terabytes	1,125,899,9006,843,624
Exabyte	EB	1,024 petabytes	1,152,921,504,607,870,976
Zettabyte	AB	1,024 exabytes	1,180,591,620,718,458,879,424
Yottabyte	YB	1,024 zettabytes	1,208,925,819,615,701,892,530,176

Table 2-3, Names and Abbreviations of Large Storage Units

2.4.6.1 TYPES OF STORAGE

- **Floppy disk -** The floppy disk is the premiere data exchange medium for PCs and the most popular back up system. Except for a few notebook computers, all PCs come with at least one floppy disk drive as standard equipment. Although floppy disk drives come in a variety of sizes and capacities (disks measure for 2.5 to 8 inches in diameter and store from 160KB up to 120MB, each), all work essentially the same way. Some of the current drives today are the 3.5 and 5.25 inch floppy, the LS-120 or often known as the SuperDisk, the ZIP drive.

- **The Traditional Floppy Disk -** PCs have used two primary types of floppy disk, the 5.25-inch and the 3.5-inch. The storage capacity of these disks have ranged from 160 KB to 2.88 MBs, however, today's 3.5-inch floppy has the storage capacity of 1.44 MB. The 2.88 MB floppy did not catch on. Table 2-4 gives characteristics of the 3.5-inch Floppy Disk.

Capacity	Units	360KB	720KB	1.44MB	2.88MB
Sides	Number	1	2	2	2
Tracks	Number	80	80	80	80
Sectors per Track	Number	9	9	18	36
Sector Size	Bits	512	512	512	512
Rotation Rate	RPM	300	300	300	300
Data Transfer Rate	Kbps	500	500	500	1000
Bit Density (max)	BPI	8,717	8,717	17,434	34,868
Track Density	TPI	135	135	135	135
Coercivity	Oersteds	650	650	720	1200

Table 2-4, 3.5 Inch Floppy Disk Characteristics

- **LS-120 Disks** - LS-120 Disks is now promoted at the SuperDisk which was first marketed in March 1996. The SuperDisk resembles and 3.5 floppy diskette and is backward compatible with standard 1.44MB floppy disks. The drives can both read and write standard floppies and these floppies can be read in standard floppy drives. However, the 120MB disks cannot be read in standard floppy drives.

- **IOMEGA Zip Drives and Jaz Drives** - The ZIP drive has a storage capacity of 100MB and now 250MB. The 100MB ZIP disk can be read in the 250 MB drives, but the 250MB disks cannot be read in the 100MB drives. ZIP disks are proprietary and therefore, cannot be used in other drives. The disks are in a sense, cartridges, and about the same size as a 3.5 floppy. ZIP Drives come in several interfaces, parallel, EIDE ATAPI, SCSI and USB. The JAZ drive has a storage capacity of 1 GB and 2 GB. They follow the same rules as the 2 GB drives, but not the other way can read the ZIP as in the 1GB cartridges. JAZ drives only come in the SCSI interface.

2.4.6.2 THE HARD DISK DRIVE

The hard disk is the premiere mass storage device for today's PCs. No other peripheral can approach the usefulness of the hard disk's combination of speed, capacity and straightforward user installation. Your PCs hard disk stores your files and extends the RAM capacity of your PC with virtual memory. It deals in megabytes, hundreds or thousands of them. In one second, the disk must be able to remember or disgorge the information equivalent of the entire contents of a physics book or novel. And it must be equally capable of casting aside its memories and replacing with revised versions to keep your system up to date.

Issues you will want to consider when selecting a hard drive to replace your current drive, add an additional drive, or what type of drive to get in a new system.

- **Interface** – Does your system use SCSI or ATA type devices?

- **Data Type** – An interface sub-issue. Modern interfaces let you plug-in drives matching any revision-level of the interface, but you'll only get top performance only if both the drive and PC match the same standard level. A UDMA/66 drive is wasted on a PC that supports only UDMA/33; just as an Ultra 2 SCSI drive is wasted in a plain Ultra SCSI system.

Figure 2-15. PC Hard Drive

- **Connector** – Part of the interface but a separate issue, particularly with SCSI drives.

- **Capacity** – Buy the biggest drive you can afford. An extra gigabyte or two will stave off your outgrowing the drive for a few weeks or months.

- **Speed** – Although not as much as an issue as it once was, you still should consider a faster drive. The easiest (though not necessarily best) modern performance measure is rotation rate. A 7200-RPM drive is superior; a 10,000-RPM drive will make you the envy of others. A 5600-RPM drive is still a very acceptable rate.

- **Package** – A new or upgrade drive must fit where you want it. Although the issue is partially critical in the tight confines of notebook PCs, small desktop systems may limit your drive choices as well.

- **BIOS** – Not in the drive but in your PC – your BIOS must allow you to use the full capacity of your hard disk drive. Older BIOS may constrain you from addressing all the bytes on the drives.

Keep in mind that hard drives have warranties - not your data. A warranty offers no excuse for not maintaining a back up.

2.4.6.3 THE COMPACT DISK

- **CD-ROM–** The CD-ROM head starts reading at the center while the CD spins fast, and continues reading to the outer edge where the CD spins much slower. Drive makers describe the speed of the product using the "X" factor. The base speed of an audio CD drive is 1x. A 2X drive spins twice as fast. A 12x drive spins 12 times faster and so on. After about 12x the rotations rates for CDs become awesome. When reading from the inside of a disk, a 2X rate amounts to about 4800 RPM. At the outer edge, the disc spins at half the rate. Higher speed factors (10x, 36x, 50x, etc) are comparably faster. Reputable computer makers are beginning to describe variable speed drives by listing both their slowest and fastest speed, such as 23/24x. The faster the drive, the longer it takes to spin up the drive and inversely, the longer it takes for it takes to quit spinning. CDs store approximately 650MB.

- **DVD Drives –** The x-factor for Digital Versatile Disc (DVD) drives is not the same as for the CD drives. As with the CD, the DVD speed ratings are pegged to the base data rate of the original video-only DVD system. For a given data rate, the CD must spin about twice as fast as a DVD to produce the same data rate. Every DVD "x" is worth about six "xs" from a CD drive. DVD capacity is approximately 1.4GB.

CDs can be read from DVD drives; however, you cannot read DVD disks in a normal CD drive.

Issues to consider when judging CD and DVD drive in new PCs or to consider drives as upgrades or replacements are:

- **Format –** DVD does everything that CD does (or at least in playing back).

- **Speed** – Faster is better. Look for at least a 24x CD drive or a 2x to 5x minimum DVD drive.

- **Interface** – ATAPI drives are cheaper but SCSI CD drives do better digital audio extraction. You can also get CD and DVD drives that use the USB interface.

- **Video Decoder** – Required for watching DVD movies; irrelevant for CDs. Hardware decoders faster than software and produce better images – but hardware costs more.

- **Writability** – CD-R drives let you make your own CDs but CD-RW do that and more, so CD-RW is the better choice. Writable DVD is now becoming available, but the standards are changing rapidly for DVD.

2.4.6.4 THE DISPLAY SYSTEM

Your PC's display system allows you to see exactly what your PC is doing as it works. Because it gives you instant visual feedback, the display system makes your PC interactive. The display system also affects the speed of your PC and your pleasure (or pain) in using your machine. PCs use a number of different technologies in creating their displays, and the choice determines what you see, how sharply you see it, and how quickly the image appears.

2.4.6.4.1 DISPLAY ADAPTERS

The hardware that changes your pulsing digital PC's thoughts into the signals that can be displayed by a monitor is called the display adapter. Over the years, the display adapter has itself adapted to the demands of PC users, gaining color and graphics abilities as well as increasing its resolution and range of buses. A number of standards – and standard setters – have evolved, each improving the quality of what you see on your monitor screen.

Some the basic features of display adapters are:

- **Accelerator** – The actual chip that doe the work on generating the onscreen image. The type of chips (2D or 3D as well as brand and model) ultimately controls the performance of the video system.

- **Memory** – Used by the accelerator to create and store the onscreen image. More is better, allowing more colors and higher resolutions. Most modern PCs start with 4 MB of display memory.

- **Bandwidth** – The electronic limit on the displayable video signals. Higher bandwidths allow the video system to display sharper images and update them more often.

- **Resolution** – The measurement of the sharpness of the image of a graphics board can produce. All PCs start with 640 by 480 pixels (VGA) and may go as high as 1600 by 1200 pixels.

- **Bus Interface** – How the video system links to the rest of your PC's circuitry. Faster bus interfaces allow for faster screen updates. The lowest common denominator is PIC. AGP is better (and usually standard) but 2x and 4x AGP improve performance.

- **Video Interface** – How a graphics board links to your display. Most PCs now use analog output through a VGA connector but digital interfaces are becoming popular for flat panel displays.

Video cards attempt to provide a wide spectrum of digital color depths, up to 8 bits per color (256 different shades of red, blue, and green), giving 16.7 million colors.

2.4.6.4.2 DISPLAYS (MONITORS)

A display is the keyhole you peer through to spy on what your PC is doing. You can't do your work without a display, and you can't work well without a good one. The final quality of what you see – the detail, sharpness, and color – depends on the display you use. Today's computer displays increasingly rely on new technologies to achieve flat screens and high resolutions.

Things to consider when deciding on what type of display to use are:

- **Technology** - Your choice are the traditional Cathode Ray Tube (CRT) and flat panel. The former is bulky and cheap, the latter, expensive, thin and electrically frugal.

- **Screen Size** – Bigger lets you see more detail at higher resolutions. Most people consider 17-inch displays necessary for resolutions higher than 1024 x 768 (which is the standard for 15-inch flat panel displays).

- **Resolution** – Most monitor makers usually mean addressability when describing resolution. In other words, the number of pixels a monitor can display, at least in theory.

- **Dot, slot, or pixel** – The distance between the physical elements of the display, usually the smallest detail a monitor can display. The smaller the display, the finer the pitch required for a given resolution to be displayed. The dot pitch is the actual size of each dot on your screen. A large dot pitch makes the screen image appear grainy, while a small dot pitch makes the image appear smoother. Common pitch sizes are .28 or .26 mm.

- **Sharpness** – The quality of the image that you can actually see.

- **Refresh rate** – How often the onscreen images get repainted. Low rates may appear to flicker. High resolution may force you to use lower refresh rates. Most people consider 70 Hz adequate, 75 Hz, better.

- **Connectors** – The jacks on the back of the monitor. Standard VGA jacks work okay to about 1280 X 1024 resolution. Separate BNC jacks better handle analog signals at high resolutions. Flat panel displays work better with digital interfaces.

2.4.7 AUDIO

The noise-making spectrum of PCs ranges from the beeps and squeaks of the tiny internal speaker to an aural rush equal in quality to today's best stereo CDs. PCs can generate, manipulate, record, and play back sounds of all sorts and even control other noisemakers such as music synthesizers. Today's high-quality sound capability distinguishes multimedia PCs from ordinary, visual-bound systems.

Some of the most important audio features of a modern PC are:

- **Basic sound system** – Allows your PC to beep.

- **Sound Board** – Gives your PC the ability to capture and reproduce sounds and music. May be integrated into your motherboard.

- **Microphone** – Captures live sound. May be used to record music, make voice annotations, or turn you PC into a speakerphone.

- **Loudspeakers** – Give your PC a voice so you can hear – or feel – the sounds and effects generated by your programs.

- **CD Drive** – Lets your PC play pre-recorded discs (and, of course, stores data files). A CD-R drive lets you record CDs for your stereo system.

- **Synthesizer** – Soundboard feature that allows your PC to create new musical sounds.

- **MIDI** – Allows you to control external electronic musical instruments with your PC.

- **MP3** – Standard file format for compressed music that lets you turn your PC into a jukebox.

2.5 PERIPHERAL PORTS

Ports provide the link between your PC and external peripherals. Although many current PCs include traditional ports adapted from other applications –the legacy serial and parallel designs –

the ports of choice in the future follow standards designed specifically for PCs. All of these serial communications take advantage of modern electronics for automatic configuration with a minimum of hassle. Your choices include USB for versatility, Fire Wire for speed and IRDA for wireless connectability.

2.5.1 UNIVERSAL SERIAL BUS (USB)

USB is today's general-purpose choice. It combines moderate performance with a goof-proof connection system. As its name implies, USB acts as a true bus that can link up to 127 devices to your PC without worries about matching connectors and cables. Speed takes a quantum leap over legacy ports with peak data rate of 12 megabits per second as well as a low speed mode that operates at 1.5 megabits per second. USB was designed to be a low-cost interface, cheap enough for every PC.

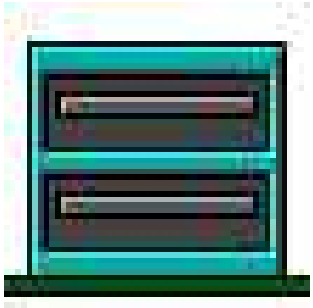

Figure 2-17. USB Ports

Figure 2-16. USB Connector

2.5.2 FIREWIRE (IEEE 1394)

FireWire races far ahead of USB, starting almost 10 times faster and racing to rates normally reserved for UHF television stations. Pushing serial technology further still, FireWire has a starting data rate of 100 megabits per second. It is more expensive to implement than USB, its fits with the new SCSI-3 scheme of things and offers a reliable means of linking high-speed peripherals such as hard disks and real-time video system to PCs.

2.5.3 INFRARED DEVELOPERS ASSOCIATION (IRDA)

IRDA is an acronym for sanctioning organization, the Infrared Developers Association, is a wireless connection system with modest performance. Although based on legacy serial technology, it adds such modern concepts as automatic identification and improved performance.

2.6 LEGACY PORTS

The traditional way of connecting peripherals to your PC has been using serial or parallel ports. Although the two largest corporations controlling what goes into PCs – Intel and Microsoft – have ordained that traditional ports will go the way of all things, they persist like other quaint

notions, say freedom of expression. Most PCs still have these legacy ports and hundreds of millions of peripherals require them to link your PC.

2.6.1 LEGACY SERIAL PORTS

Other names for these ports include Async ports, comm ports, modem ports, RS232 ports, etc. It can be connected internally or externally. External ports connect using one of two different cables , a 9 pin or a 25 pint connector. Most systems come with a default of two comm ports, however, additional ports can be added (i.e. expansion cards, internal modems). These ports are referred to as COM1, COM2, COM3, COM4. Some of the uses of serial ports are for modems, mice, printers, digital cameras, etc.

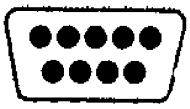

Figure 2-18. DB9 Connector

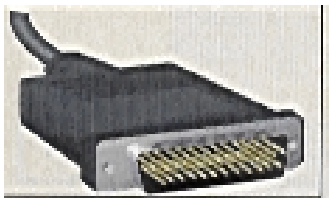

Figure 2-19. DB25 Cable End

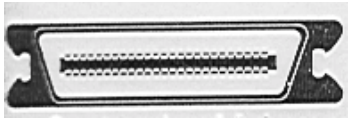

Figure 2-221. Centronics Connector

Figure 2-20. DB 9 Cable End

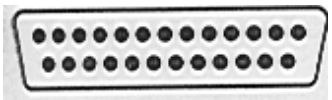

Figure 2-212. DB25 Connector

2.6.2 PARALLEL PORTS

Another way we think of parallel ports is as printer ports, however, many devices can use parallel ports. Some of these are ZIP drives, scanners, CD drives, etc. The connectors for parallel ports can be a 25 pin connector or a centronics connector.

2.7 INPUT DEVICES

Input devices are the means by which you move information into your PC – the primary means by which you interact with your personal computer. The various available devices span an entire range of technologies, from the tactile to the vocal.

Figure 2-23. IO Ports

2.7.1 KEYBOARDS

You can purchase a Windows 95 104-key keyboard from any computer superstore for about $15-$25.

You will probably go through keyboards about once every two years..

Some important issues in Keyboard Design are:

- **Touch** – The force required to activate keys can be light (soft) or heavy (hard) with or without a snap-over feel (tactile feedback). The best combination is what feels right to you.

- **Layout** - The arrangement of keys for desktop keyboards is nearly universal but notebooks designs vary enough to be maddening in moving between machines. Most people prefer the familiar, although you can learn to live with anything.

- **Ergonomics** – Plain flat keyboards can cause or encourage repetitive stress injury angled ergonomic designs may soothe hands that tire from long bouts of continuous keystroking.

- **Interface** – The PS/2 (six pin) interface has become almost universal among removable keyboards, but in the PC industry wants you to move to USB. Be sure the match the interface when replacing your keyboard. You can get adapters to switch between interface types.

- **Cable** – Short coiled cables may make lightweight keyboards snap from your hands. Long cables give more freedom in operation. You can totally liberate yourself with a wireless keyboard.

2.7.2 POINTING DEVICES

Pointers now come in all kinds of forms. Whatever your preference, you should be able to find a suitable pointing device. Remember that a good frequent cleaning will eliminate 90 percent of the problems you will encounter. The most popular PC pointing devices are:

- **Mouse** – The first and most popular pointing device but requires desktop real estate and moving your hand from the keyboard (good for ergonomics but bad for typing efficiency). Prolonged use can tire your whole arm.

- **Trackball** – Takes up less space and requires less movement to navigate through screens and programs, and it generally causes less fatigue during prolonged use. Designs are diverse, so you must choose one that fits your hand and style.

- **TouchPad** – Perhaps the most popular notebook computer pointing device. Good designs work well but beware of poor implementations that cause inadvertent mouse movement and key activation.

- **Trackpoint** – Designed for typing efficiency – your fingers need never leave the home row when moving the mouse – but some people find it clumsy and unnatural

- **Joystick** – Not really a pointing device but a game controller. Modern controllers can be as elaborate as a starship bridge – which is perfect if that's the onscreen world you intend to control.

2.8 RESOURCES

The Winn L. Rosch Hardware Bible 5th Edition, Winn Rosch, Que Publishing
The Indispensable PC Hardware Book 2nd Edition, Hans-Peter Messmer; Addision-Wesley
Troubleshooting, Maintaining, and Repairing PC Millennium Edition, Stephen J. Bigelow, McGraw Hill

2.9 SUMMARY

In this module, we introduced the various parts of the Personal Computer. Your individual system will be made up of most of these components, but will probably not have all of them. We discussed different type of interfaces, storage devices, memory types and requirements, etc.

2.10 REVIEW QUESTIONS

1. Name all of the different PC case styles.

2. How many DIMMs are required to add additional RAM to a computer? How many SIMMs?

3. Summarize the differences between RIMMs, DIMMs, and SIMMs chips.

4. What is the most important factor to consider when installing a Network Interface Card?

5. Describe the characteristics of the Universal Serial Bus, Fire Wire, and IrDA peripheral ports.

6. List the functions of serial and parallel ports.

7. Explain why input devices are one of the most important parts of your computer.

8. Name the most popular PC pointing devices.