PREPARING FOR A+ CERTIFICATION
A COURSE IN PC HARDWARE, SOFTWARE, MAINTENANCE AND REPAIR

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Chapter 1. Introduction to A+ Certification

A+ Certification is a testing program that certifies the competency of entry-level (6 months experience) computer service technicians. It is sponsored by CompTIA, the Computing Technical Industry Association. The A+ test contains situational and identification types of questions. All of the questions on the test are multiple choice, most with only one correct answer for each question. The test covers a broad range of hardware and software technologies, but is not bound to any vendor-specific products.

The program is backed by major computer hardware and software vendors, distributors, resellers and publications. A+ certification signifies that the certified individual possesses the knowledge and skills essential for a successful entry-level (6 months experience) computer service technician, as defined by experts from companies from across the industry. A+ certification is recognized worldwide.

Who may take the certification tests?

A+ Certification is open to anyone. The A+ exam is targeted for entry-level computer service technicians with at least 6 months on-the-job experience (or equivalent training). No specific requirements are necessary, except for payment of the fee. You can contact CompTIA by phone at 1/630-678-8300. When you call to register for the test, please have your Social Security Number, a major credit card number, and your ZIP Code available. You will be told over the phone of the nearest locations available for you to take the test. The test is offered at all times of the day, night and weekends. You also can purchase the vouchers needed to take the A+ examination online at: https://store.comptia.org/default.aspx.

There are two sections of the examination: the Essentials exam, and the IT Specialist exam. Each exam determines your competency with aspects of PC maintenance, repair, operation and troubleshooting. You may take the Essentials and IT Specialist exams together, or separately. Once you have taken one of the tests, you have thirty (30) days to take and pass the other exam in order to become certified. The test objectives for these two examinations are found in Chapters 16 and 17 of this book.

The A+ test is available throughout the world in a variety of languages (Spanish, French, German, and Japanese,). If you have any questions, please call CompTIA Certification Customer Service at (630) 268-1818. Also, it is CompTIA's policy to make reasonable accommodations for individuals with disabilities who live in the United States. If you need special accommodations, please contact your test vendor 30 days before scheduling your exam.

Purpose of this book

This book is intended to prepare the reader to take and pass the A+ certification examination. No previous knowledge of computers is required, but a working knowledge of how to use an IBM-compatible PC and/or an Apple Macintosh is helpful. The textbook will endeavor to take complex technical concepts and explain them in the most simple manner possible. Visuals and graphic examples will also be included to make concepts and objects easy to visualize and understand.

This course book is one part of a DVD-ROM course disk made available to my students. The disk also holds a variety of freeware software packages and helpful literature that will enable the student to build and develop the skills needed to become a successful computer repair technician. Please contact the author if you would like to obtain a copy of the disk.

Disclaimer: all copyright references to name-brand or corporately-branded products within this text (i.e., Microsoft Windows ©) belong to and are the property of the corporations which own them.
Chapter 2. Overview of Basic Hardware Parts

There are a number of different parts inside the typical PC. Each part looks different, and each serves a specific purpose. In this section of the text, we will illustrate and describe all of the different parts within a PC.

Central Processing Units (CPUs)

The Central Processing Unit (CPU) chip is the heart of the computer and its ability to process data and manage tasks within the entire computer.

There are MANY types of CPU chips found on motherboards. This list gives a history of some of the types of CPU chips that are (or have been) installed on different motherboards over the past 20 years.

<table>
<thead>
<tr>
<th>CPU TYPE</th>
<th>INTERNAL MATH CO-PROCESSOR</th>
<th>INTERNAL REGISTER</th>
<th>DATA BUS WIDTH</th>
<th>MEMORY ADDRESSING</th>
<th>MAX. RAM RECOGNIZED</th>
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<tr>
<td>8088</td>
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<tr>
<td>PENTIUM 60/66</td>
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<tr>
<td>PENTIUM 75-200</td>
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<td>PENTIUM MMX</td>
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<td>PENTIUM PRO</td>
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<td>PENTIUM II MMX</td>
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<td>Memory</td>
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<td>PENTIUM III</td>
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**AMD CPU TYPES**

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<th>Memory</th>
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<td>AM486DX4-100, 120</td>
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**CYRIX CPU TYPES**

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<th>64-bit</th>
<th>36-bit</th>
<th>Memory</th>
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<td>6x86-PR120 - 200</td>
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<td>64-bit</td>
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<tr>
<td>6x86MX-PR166 - PR 233</td>
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<td>64-bit</td>
<td>36-bit</td>
<td>64GB</td>
</tr>
</tbody>
</table>

For an exhaustive list of current (and obsolete) CPU types, visit the Intel corporation website ([http://www.intel.com](http://www.intel.com)) or the AMD corporation website ([http://www.amd.com](http://www.amd.com)).

Below is a picture of a typical CPU chip.

![CPU Chip Image]

For the A+ examination, you will need to be able to answer the following kinds of questions:

- What are the major types of CPUs that have been used historically in PCs, and how do they differ?
Hyper-Threading CPUs

Hyperthreading is a technology developed by Intel that enables multithreaded software applications to execute threads in parallel on a single multi-core processor instead of processing threads in a linear fashion. Older systems took advantage of dual-processing threading in software by splitting instructions into multiple streams so that more than one processor could act upon them at once.

Multiple-core CPUs

Current technology processor chips now are being designed so that they contain two or more full-blown CPU units into one single chip.

Dual-core refers to a CPU that includes two complete execution cores per physical processor. It has combined two processors and their caches and cache controllers onto a single integrated circuit (silicon chip). Dual-core processors are well-suited for multitasking environments because there are two complete execution cores instead of one, each with an independent interface to the front-side bus. Since each core has its own cache, the operating system has sufficient resources to handle most compute intensive tasks in parallel.

Multi-core is similar to dual-core in that it is an expansion to the dual-core technology which allows for more than two separate processors.

On-chip (Level 1) and External (Level 2) Cache

A memory cache, sometimes called a cache store or RAM cache, is a portion of memory made of high-speed static RAM (SRAM) instead of the slower and cheaper dynamic RAM (DRAM) used for main memory. Memory caching is effective because most programs access the same data or instructions over and over. By keeping as much of this information as possible in SRAM, the computer avoids accessing the slower DRAM.

Some memory caches are built into the architecture of microprocessors. The Intel 80486 microprocessor, for example, contains an 8K memory cache, and the Pentium has a 16K cache. Such internal caches are often called Level 1 (L1) caches. Most modern PCs also come with external cache memory on the system board, called Level 2 (L2) caches. These caches sit between the CPU and the DRAM. Like L1 caches, L2 caches are composed of SRAM but they are much larger.

32bit vs. 64 bit Processors (and Operating Systems)

32-bit refers to the number of bits (the smallest unit of information on a machine) that can be processed or transmitted in parallel, or the number of bits used for single element in a data format. The term when used in conjunction with a microprocessor indicates the width of the registers; a special high-speed storage area within the CPU. A 32-bit microprocessor can process data and memory addresses that are represented by 32 bits.

64-bit therefore refers to a processor with registers that store 64-bit numbers. A generalization would be to suggest that 64-bit architecture would double the amount of data a CPU can process per clock cycle. Users would note a performance increase because a 64-bit CPU can handle more memory and larger files. One of the most attractive features of 64-bit processors is the amount of memory the system can support. 64-bit architecture will allow systems to address up to 1 terabyte (1000GB) of memory. In today's 32-bit desktop systems, you can have up to 4GB of RAM (provided your motherboard that can handle that much RAM) which is split between the applications and the operating system (OS).
The majority of desktop computers today don't even have 4GB of memory installed, and most small business and home desktop computer software applications do not require that much memory either. As more complex software and 3D games become available however, we could actually see this become a limitation, but for the average home user that is still very far down the road indeed.

Unfortunately, most benefits of a 64-bit CPU will go unnoticed without the key components of a 64-bit operating system and 64-bit software and drivers which are able to take advantage of 64-bit processor features. Additionally for the average home computer user, 32-bits is more than adequate computing power.

When making the transition from 32-bit to 64-bit desktop PCs, users won't actually see Web browsers and word processing programs run faster. Benefits of 64-bit processors would be seen with more demanding applications such as video encoding, scientific research, searching massive databases; tasks where being able to load massive amounts of data into the system's memory is required.

While talk of 64-bit architecture may make one think this is a new technology, 64-bit computing has been used over the past ten years in supercomputing and database management systems. Many companies and organizations with the need to access huge amounts of data have already made the transition to using 64-bit servers, since a 64-bit server can support a greater number of larger files and could effectively load large enterprise databases to into memory allowing for faster searches and data retrieval. Additionally, using a 64-bit server means organizations can support more simultaneous users on each server potentially removing the need for extra hardware as one 64-bit server could replace the use of several 32-bit servers on a network.

It is in scientific and data management industries where the limitations of the 4GB memory of a 32-bit system have been reached and the need for 64-bit processing becomes apparent. Some of the major software developers in the database management systems business, such as Oracle and SQL Server, to name just two, offer 64-bit versions of their database management systems.

While 64-bit servers were once used only by those organizations with massive amounts of data and big budgets, we do see 64-bit enabled systems hitting the mainstream market. It is only a matter of time until 64-bit software and retail OS packages become more widely available, thereby making 64-bit computing an attractive solution for business and home computing needs.
Motherboards and Bus Connections

Motherboards (also called system boards)

The motherboard (or system board) is the main board, or the heart of the computer. A motherboard (or mainboard) is a multi-layered, precision-made printed circuit board that provides the connectivity between the many components of a Personal Computer (PC). These connections (commonly referred to as the “Bus”) provide the required paths for data flow, programmatic information flow and power to the different components of a PC.

The central processor chip (CPU) is installed into a socket on the motherboard. All of the adapter cards (like a video card, a modem, or a sound card) plug into the motherboard. It is the largest single board in the computer.

Bus Connections on the Motherboard

There are a number of slots on the typical motherboard that can be used to install a variety of adapter cards, such as video cards, sound cards and modems, into your PC. These slots are called bus connections. These connections are not keyed to any specific device, so you can place an adapter card into any of the appropriate type of bus connector slots on the motherboard.

There are several major types of bus connectors:

Industry Standard Architecture (ISA) [now obsolete]

When the personal computer (PC) was first introduced by IBM, an 8-bit bus connector was used on it that became known as the Industry Standard Architecture, or ISA, bus connection. When the AT-class of PCs were introduced, IBM modified the ISA bus connection slightly so that it would accept adapter cards with an 8-bit connector or a 16-bit bus connector. This type of 8/16-bit bus connector is still being used widely with motherboards being manufactured today.

Having ISA bus connectors on newer motherboards ensures that older devices or devices that do not require a faster bus connection type (such as a modem) can still be used on current systems.

The ISA bus connector is functionally obsolete; no new systems are being manufactured with ISA bus connections on them.
This type of bus connector is black in color, and looks like what is shown in the picture below.

![Bus Connector Image]

**Extended Industry Standard Architecture (EISA) [now obsolete]**

The Extended Industry Standard Architecture (EISA) bus is an extension of the 16-bit ISA bus developed by IBM for the AT-class computer. The EISA design was led by COMPAQ Corporation. Later, eight other manufacturers (AST, Epson, Hewlett-Packard, NEC, Olivetti, Tandy, Wyse, and Zenith) joined COMPAQ in a consortium founded September 13, 1988. This group became known as the "gang of nine." The EISA design was patterned largely after IBM’s Micro Channel Architecture (MCA) in the PS/2 systems, but unlike MCA, EISA allows for backward compatibility with older plug-in adapters.

The connector is the same length as the ISA 16-bit bus connector, but it is taller in height. Internally, the EISA connector is divided into two parts: an upper section, and a lower section. The upper section allows a traditional 8-bit or 16-bit adapter card to plug into the EISA bus connector. Plastic stays inside of the bus connector prevent ISA cards from descending into the lower section of the connector. However, the EISA bus connections on the adapter card have been designed to insert into the connector on the board, making contact with the lower segment of the bus connector and providing a full 32 bits worth of data transfer lines.

This type of bus connector is brown in color, and looks like what is shown in the graphic below. **The EISA bus connector is functionally obsolete; no new systems are being manufactured with EISA bus connections on them.**

**Video Electronics Standards Association (VESA) Local Bus [now obsolete]**

As PC technology progressed, users and software designers began to demand higher levels of performance from all aspects of the PCs architecture. Video cards and disk interfaces had to deliver faster performance so that graphically intensive programs like Windows could operate at an acceptable level. However, users did not want to pay the premium price for 32-bit EISA-based computers, and manufacturers did not want to pay royalties to the EISA consortium for manufacturing PCs with EISA technology in them. Eventually, the Video Electronics Standards Association (VESA) developed a type of 32-bit bus connector that was cheap to manufacture and provided the speed and performance that users demanded.

The VESA Local Bus connector is a brown connector that sits at the end of a traditional 16-bit ISA bus connector. This brown connector provides the additional data lines needed to transmit 32 bits of data on what would normally be only a 16-bit data connection. However, it had one major improvement over the EISA bus connection that made it superior.
With EISA bus connectors, data must pass through the Direct Memory Access (DMA) controller chip before accessing the CPU. The DMA chip on the motherboard acts like a traffic cop, controlling the flow of data as it passes from one place to another on your PC. The DMA chip operates at 7.14 MHZ, which is the maximum speed of the old 8088-2 CPU. This creates an enormous slowdown of data as it passes through this chip.

VESLA Local Bus connectors pass data directly to the CPU, bypassing the DMA chip altogether. In order to do that, the data must be traveling along the bus (also known as the "front-side bus") at the operating speed of the CPU. Most CPUs of that era operated at 25 or 33 MHZ, which was significantly faster than 7.14 MHZ. (NOTE: starting with the 80486DX/2, all CPUs could accept data at one speed, and then process the data at anywhere from 1.5 times that speed to 5 times that speed. This process is known as "clock multiplying". For example, a 100 MHZ CPU would accept data at 50 MHZ, and then use a clock multiplier of 2 to achieve the 100 MHZ speed.)

By bypassing the DMA chip entirely and by operating at the speed of the CPU, PC users saw a dramatic increase in the speed at which graphics-intensive and disk-intensive programs performed. PC manufacturers also liked the VESA Local Bus, because it quickly became the de facto standard for 32-bit devices, such as video cards, drive interfaces, and SCSI host adapters.

This type of bus connector is black AND brown in color, and looks like what is shown in the picture below. **The VESA local-bus connector is functionally obsolete; no new systems are being manufactured with VESA local-bus connections on them.**

Peripheral Component Interconnect (PCI)

With the introduction of the Pentium processor, Intel took the lead in developing a new type of bus connector that would be appropriate for the newer classes of CPUs and the increased processing speeds that would be realized on newer motherboards. The PCI bus connector actually taps into the system bus, rather than tapping into the processor bus (as does the VESA Local Bus connector). Information on the PCI bus travels at a speed of 132 megabytes per second, which is a dramatic increase in throughput speed. It also has the ability to handle 32-bit and 64-bit data transfers. PCI bus connections have become the de facto standard for current technology motherboards.

This type of bus connector is white in color, and looks like what is shown in the picture below.
Accelerated Graphics Port (AGP)

The Accelerated Graphics Port (AGP) is a special type of high-speed video bus slot that is used exclusively for high-end video cards. It has the ability to transfer 32 bits of data at 66MHz speed, with up to a clock multiplier of up to four times. At that rate of speed, an AGP connection can transfer 1,066MB of data per second. AGP ports also give a direct connection to the system RAM, thus reducing the need for large sums of video memory. AGP ports are appropriate for high speed rendering of images, 3-D video, and other types of high speed video production.

This type of bus connector is brown in color, and looks like what is shown in the picture below.

PCI-Express (PCI-E) and PCI-X Bus Connections

PCI-Express (PCI-E) is an I/O interconnect bus standard (which includes a protocol and a layered architecture) that expands on and doubles the data transfer rates of original PCI. PCI Express is a two-way, serial connection that carries data in packets along two pairs of point-to-point data lanes, compared to the single parallel data bus of traditional PCI that routes data at a set rate. Initial bit rates for PCI Express reach 2.5Gb/s per lane direction, which equate to data transfer rates of approximately 200MB/s. PCI Express was developed so that high-speed interconnects such as 1394b, USB 2.0, InfiniBand and Gigabit Ethernet would have an I/O architecture suitable for their transfer high speeds. PCI Express, also known as 3GIO (for third-generation Input/Output) is compatible with existing PCI systems.

By comparison, PCI-X uses a parallel interconnect along a bus that is shared with other PCI-X devices, just like PCI. In fact, PCI-X is best thought of as "PCI-eX tended", as it is simply an extension of the legacy PCI 32-bit format, with which it is backward-compatible. It differs mainly in the fact that the bus is now 64-bits wide, and runs at higher frequencies (now up to 533MHz, compared to 66MHz - the fastest PCI frequency).

PCI-Express, on the other hand, uses a serial interconnect along a switched bus dedicated exclusively to that slot. In this respect, and most others, it uses radically new architecture, having little to do with old PCI. Furthermore, PCI-Express has the unique capability of multiplying up individual data "lanes", to produce aggregate interconnects that can deliver up to 16 times the bandwidth of a single lane. This is why you will always see PCI-Express slots referred to as "PCI-Express*4" or "PCI-Express*16" etc.

These types of bus connectors look like what is shown in the picture below:
For the A+ examination, you will need to be able to answer the following kinds of questions:

- What are the major types of bus connectors found on PC motherboards; how do they differ?

**CPU Socket Types**

There are a variety of types of sockets on current-technology motherboards that allow the user to install differing types of CPU chips. Here is a list of some of the CPU socket types that have been used in the past few years:

**Socket 7 (including Sockets 1 - 6)**

Throughout the history of the 80486 and Pentium series of CPUs, manufacturers developed and refined a series of "zero-insertion-force" (or ZIF) sockets that would allow for a CPU chip to be safely installed onto the motherboard without bending the pins on the CPU chip itself.

On a typical ZIF socket, a lever is located on the side of the socket; when the lever is raised, the CPU can be inserted without having to press the chip into place; when the lever is lowered and locked into place, the CPU is firmly attached to the socket.

Sockets 1 through 6 offered refinements and adaptations for differing types of CPU chips. Sockets 1 - 3 accepted 80486-type CPUs and Intel Overdrive chips, and Sockets 4 - 7 accepted Pentium CPUs and Pentium-class CPUs made by other manufacturers (such as AMD and Cyrix). Socket 7 is the last of that particular series of ZIF sockets. A Socket 7 ZIF socket allows Intel Pentium and Celeron, AMD K6 and K6-2 3D, Cyrix M2 and IBM CPU chips to be installed onto that motherboard. By setting switches or jumpers, one can properly set the CPU core voltage, CPU clock speed, and clock multiplier appropriate for that CPU.

**Socket 370**

Socket 370 is a further adaptation of the Socket 7 ZIF socket that allows newer, faster CPUs to be installed upon them. A broader range of CPUs is accommodated with this type of ZIF socket.

**Slot 1 and Slot 2 Sockets**

Slot 1 is intended for Intel Pentium 2 and Celeron CPUs that are mounted on cartridge modules.

Slot 2 is intended for Pentium 3 and 4, Pentium 2, Xeon and Celeron CPU cartridge modules.

**Slot A and Socket A Connectors**

Slot A sockets are used with AMD Athlon chips. Slot A is functionally similar to the Slot 1 and Slot 2 sockets for Intel Pentium 2 / Pentium 3 cartridges. Socket A is used with Athlon and Duron CPU chips that are not cartridge-based, but are PGA-based (pin-grid array).

For a list of additional CPU socket types from the 80486-class CPUs to date, refer to Appendix A at the end of this course book. This list is subject to change over time.
CPU Speeds, Clock Multipliers and Voltages

When installing a CPU onto a motherboard, care must be exercised to make sure that the motherboard has been configured properly for the type of CPU being installed on it. Failure to properly configure the motherboard can result in a damaged CPU chip. When configuring the motherboard, three things must be set for the CPU to operate properly:

1) The CPU speed must be set. The speed of the CPU will range between 60 MHZ and 833MHz. This will also be the speed of the "front end bus"; this is the bus between the CPU and the system RAM. When using synchronous dynamic Random Access Memory (SDRAM), the RAM and CPU will run synchronously, and as such both must be set for the same megahertz speed.

2) The clock multiplier must be set. CPUs accept data from the bus at one speed, and process the data several times faster than it accepts the data. For example, an AMD K6-500MHz processor runs at 100MHz for the data input speed, with a clock multiplier of 5. That is how the 500MHz speed rating is set for the chip.

3) The CPU voltage level must be set. CPUs can run on voltages varying from 5V DC down to 2.2V DC. You must consult the documentation for your CPU chip to determine the proper voltage level, and then set the motherboard accordingly.

Configuring the motherboard can be done in a number of ways. Older motherboards have jumpers and/or switches built onto them that allow the board to be configured properly. Newer motherboards can be configured from within the Complementary Metal-Oxide Semiconductor (CMOS) setup program. On these newer motherboards, the voltage is automatically configured; the motherboard queries the CPU, and then automatically sets the proper voltage level. The user then sets the CPU speed and clock multiplier from within the CMOS setup program.

It is important in this configuration process that the user consults both the motherboard documentation and the documentation for the CPU chip. Over-clocking a chip can cause increased heating of the chip, which can cause the chip to fail. Providing the chip with too much voltage for even a short period of time will also cause the CPU to fail.

Heat Sinks and CPU Cooling Fans

It is very important that the user installs a combined heat sink and CPU cooling fan properly upon the chip before operating the chip. CPU chips become hot very quickly, and CPU failure will begin to occur if the chip temperature exceeds 120 degrees Fahrenheit. The CPU chip will reach this temperature within 2 to 3 minutes without the benefit of a cooling fan and heat sink. Therefore, a heat sink with a cooling fan is vital to the proper operation of the CPU chip. Further, it is wise to apply heat sink compound to the top of the CPU before installing the heat sink. This white silicone grease ensures that all of the heat generated by the CPU will be transferred to the heat sink. Heat sink compound is available at most any electronics store, and costs only a few dollars, but it will ensure a long life for your CPU chip.

Finally, the cooling fan portion of the heat sink should be checked periodically for dust buildup. As dust accumulates in your PC over time, the CPU cooling fan can become clogged with dust. This dust buildup can slow and eventually stop your cooling fan from operating. This will cause increased heating on the CPU, which may lead to failure of the chip. Keeping the cooling fan free of dust buildup will ensure proper operation of the fan and reduced operating temperatures for the CPU. If the fan has been rendered inoperative because of dust buildup, and if removing the dust buildup does not correct the problem, replace the cooling fan/heat sink as soon as possible.
Cases and power supplies

Computer cases come in several different types and sizes. Older AT-style cases will accept traditional AT-sized motherboards, and AT-style cases are usually manufactured in both desktop and tower form factors. ATX-style cases will accept the newer style ATX-style motherboards. ATX form-factor motherboards are more rectangular than AT-style motherboards, and are designed to minimize the number of cables cluttering the inside of the case. ATX motherboards have the serial, parallel, PS/2 and USB ports built directly onto the motherboard, as shown in the illustration below.

![Diagram of motherboards and connectors](Image)

The green and the purple connectors are the PS/2 connectors used by Keyboard and mouse respectively. Immediately right of the PS/2 connectors are two USB 2.0 connectors, The red female connector (with 25 holes) is a parallel port and below that are the two serial male ports with nine pins.

There is also a type of motherboard form factor called NLX; it uses a riser card to allow for the addition of expansion cards to the system. These types of motherboards are usually seen in more proprietary systems, and they require an NLX-style case to hold them.

Computer cases come in desktop and tower configurations. Tower cases can be mini-sized, mid-sized, or full sized; the larger cases allow the user to add additional drives or devices. Desktop cases vary much less in size. NLX-style cases are designed for desktops, and are smaller in height than traditional desktop cases. Larger cases usually have more powerful power supplies, in order to accommodate additional devices installed into the system.

The power supply in these cases provides electrical power to motherboard, disk drives, and occasionally to the monitor also by a connector in the back of the power supply. The power supply also has a fan on it to cool the computer (and power supply) by drawing air through the front panel into the power supply and blowing it out the back of the unit. Power supplies are rated in terms of wattage; most typical power supplies provide 300 - 450 watts of available power for devices within the PC's case. This amount will supply a system board, 8 cards inserted into its sockets, and 4 drives (floppy, hard, ZIP or CD-ROM drives). The more wattage a power supply can handle, the more devices can be installed into the system.

Many power supplies are circuit-breaker protected; that is, if there is a short somewhere on the system board or if a power cable has accidentally been attached wrong (which usually means forcing the plug into a device the wrong way), a circuit breaker will disconnect power and not create any damage to the system or its components. However, many power supplies are cheaply made, and do not offer circuit-breaker protection to the user. Check with the manufacturer or vendor before buying a case and power supply to see if the supply has built-in circuit-breaker protection.

AT-power supply connectors to the motherboard can be plugged in backwards, while ATX-power supply connectors to the motherboard can only be installed one way. Power supply connectors that attach to drives will only fit on the device one way; they cannot be forced on without damaging the unit.

Types of memory

Memory is installed onto typical motherboards by snapping Single In-line Memory Modules (SIMMs) or Dual In-line Memory Modules (DIMMs) into sockets on the motherboard. Several main types of memory modules are shown below:
72-pin SIMMs

Older Pentium-based systems use 72-pin SIMMs, installed in banks of two at a time. There is also a left-hand notch and offset dimple near the center of the SIMM to ensure proper installation. Many 72-pin SIMMs are non-parity memory; that is, they do NOT have a specific chip built in for memory testing and error detection. There are several types of 72-pin SIMMs, including fast-page memory, extended data output (EDO) memory, and synchronous dynamic RAM (SDRAM). Determining the type of memory is not easily done by sight alone; a good memory testing machine or memory vendor can identify the type of SIMM memory.

168-pin DIMMs

Newer Pentium systems, as well as AMD Athlon and Duron systems use 168-pin DIMMs, which can be installed one at a time. The three-part connector at the bottom of the DIMM ensures proper installation of the unit into it's socket. Most DIMMs are EDO or SDRAM in type; identification of a DIMM's type by sight alone is not straight-forward. Usually a memory tester or knowledgeable memory vendor is needed to properly identify the type of memory contained in a DIMM.

Memory is timed as to how fast it will reliably operate. This timing information is recorded on the chips found on the SIMM or DIMM. Usually the timing marks will look something like this:

512MB, DDR, 400, CL3

The marks shown above indicate that the memory capacity is 512 megabytes, double data rate style, operating at 400 megahertz, with a clock multiplier of three.

When installing memory units into a motherboard, you must install devices of the same speed; installing mismatched memory units will very likely cause problems. A simple inspection of the memory units will prevent you from making such a mistake when installing new memory. If you find that another technician has made a mistake and installed mismatched memory, simply replace some of the memory units in the system until all of them are running at the same speed.

Within these types of modules, the several different varieties of memory are discussed below.

Parity memory

This type of memory uses a method of error checking in which an extra bit is used to indicate whether an even or odd number of binary 1 bits were stored in memory. When parity is used, a parity bit is added to each transmitted character. The bit's value is 0 or 1, to make the total number of 1s in the character even or odd, depending on which type of parity is used. Most older parity SIMMs have an extra memory chip installed on them to handle parity checking issues. This type of memory is also called fast-page memory.
Non-parity memory

This type of memory does not use a parity checking mechanism to test the validity of the data stored in it. The operating system and BIOS use other methods to test and determine if the memory is operating properly and accurately storing information. As with parity memory, this type of memory is also called fast-page memory.

Extended Data Out (EDO) memory

This type of memory operates more quickly than fast-page memory. The RAM chips on the SIMM or DIMM allow for timing overlaps between successive reads/writes, which improves memory cycle and access time.

Synchronous Dynamic Random Access Memory (SDRAM)

This type of RAM runs at the same speed as the main system bus, which can significantly enhance system performance. For example, EDO memory may run at 60 nanoseconds (ns), while SDRAM can run at 10 or 8 nanoseconds, depending upon the motherboard. Double-Data-Rate (DDR) DIMMS transfer twice as much information at one time as compared to typical SDRAM DIMMs.

Static Random Access Memory (SRAM)

Short for static random access memory, and pronounced ess-ram. SRAM is a type of memory that is faster and more reliable than the more common DRAM (dynamic RAM). The term static is derived from the fact that it doesn't need to be refreshed like dynamic RAM.

RAMBUS

This type of memory is also known as RDRAM, for RAMBUS Dynamic Random Access Memory. This high-speed memory transfers data at 1GB per second or faster. This is a significant speed upgrade to even SDRAM. Memory modules with RDRAM chips on them are also called RIMMs, which stands for RAMBUS InLine Memory Modules. RAMBUS memory is effectively obsolete, as many manufacturers did not choose to adopt this style of memory as a standard.

SODIMM

Small Outline Dual In-line Memory Modules (SODIMMs) are smaller-sized DIMM memory modules are designed to be installed into laptop or portable computers. They are comparable to DIMMs for desktop computers, but simply smaller in size.

Installing memory

When installing memory on a motherboard, one must fill a "bank" of memory at a time for the memory to be recognized by the system. For example, with 72-pin SIMMs, the user must install 2 SIMMs at a time onto the system board. DIMMs can be installed either one or two at a time, depending upon the system board design. Also, most motherboards have several banks that can be filled; you must fill the first bank (usually numbered Bank 0 or Bank 1) before filling the other banks with memory.

You will need to check the documentation for your motherboard to determine which is the first bank of sockets on the board.

Memory devices like SIMMS, DIMMs and SODIMMs are designed so that they will install only ONE way into their sockets on the system board. They cannot be installed backwards or the wrong way.
Floppy drives, ZIP drives and LS-120 drives

A 3.5-inch floppy drive is used to make data portable, so that it can be transferred from one PC to another. However, the capacity of current floppy disks is only 1.44MB, which is very small by today’s standards. Still, floppy disks can be used to boot a PC, and they can be used as a medium for backing up data as well as storing application data files.

3.5-inch floppy disks are essentially obsolete, as their storage capacity has been far exceeded by writable CD, DVD and flash-drive technology.

EXTREMELY old PCs may have a 5.25-inch floppy drive built into them. These drives are now obsolete, and the disks required to use them are not available for purchase in stores any further.

Other re-writable disk media exist to make your data portable. Obsolete ZIP disks, created by the Iomega Corporation, allow you to store either 100MB or 250MB of data onto a disk slightly larger than a traditional floppy disk.

Obsolete LS-120 drives, created by Imation Corporation, allowed the user to store 120MB of data onto a special disk that is the same size as a 3.5-inch floppy disk, and they also allowed the use of traditional 3.5-inch 1.44MB disks in the drive as well.

Both of these drives are available in external and internal versions; internal drives are mounted inside the PC's case, and external drives are connected to the PC via the parallel port or a special adapter card. ZIP drives and LS-120 drives are IDE-class devices, and plug into the same cable as your hard drive and/or CD-ROM drive.

ZIP disks and LS-120 drives are essentially obsolete, as their storage capacity has been far exceeded by writable CD, DVD and flash-drive technology. You may encounter some of these drive types in older computers brought in for repair.

Below is an illustration of a typical floppy drive, and an Iomega ZIP drive.
Hard Drives (IDE, EIDE, UltraATA, SCSI and SATA types)

A hard drive stores large quantities of data for use at a later time. Your operating system, application software and personal data all will reside on your hard drive. The drive will connect to either an IDE interface on the system board of your computer, or in the case of Small Computer Systems Interface (SCSI) drives, you will need a special controller called a SCSI host adapter.

Below is an illustration of a typical hard drive.

Below is an illustration of a typical hard drive.

The following is a review of the major hard drive types:

**MFM and RLL Drives: (Obsolete)**

Modified Frequency Modulation (MFM) and Run-Length Limited (RLL) drives have separate controller cards that connect to the hard disk. RLL controllers can store up to 30% more data on the same disk than MFM controllers. The MFM or RLL drive controller uses a 34-pin controller cable AND a 20-pin data cable to transmit data. These drives are large in size, small in data-holding capacity, and are now obsolete within the computing community.

**IDE/EIDE Drives:**

Integrated Drive Electronics (IDE) drives have the hard disk controller built into the drive unit itself, and data is passed to a drive interface on the system board. Uses 40-pin ribbon cable to transmit data. Enhanced IDE (EIDE or Enhanced ATA) drives have disk capacities greater than 528 megabytes. These drives still are widely used in PCs today.

**UltraATA/UltraDMA Drives:**

Similar to Enhanced IDE drives, but they use an 80-conductor cable and an additional Direct Memory Access (DMA) channel to transfer more data faster than typical EIDE drives. Newer drives use UltraATA/UltraDMA technology, and controller interfaces on motherboards that accommodate this technology are now widely available. Different implementations of UltraATA/UltraDMA allow for 33, 66 or 100 MB of data transfer per second.

Note that IDE/EIDE and UltraATA/DMA drives must be jumpered to a Master, Slave or Cable Select position on each drive, so that the drive controllers will operate properly. This point is discussed in more detail later in this text.
SCSI Drives: Small Computer Systems Interface (SCSI) drives use a SCSI host adapter (controller) interface, and they can transfer data at a much faster rate than EIDE or UltraATA. SCSI drives are also more expensive. SCSI drives use 50-pin or 68-pin cables to transmit data. There are several implementations of SCSI: SCSI 1, SCSI 2, Fast SCSI, SCSI Wide, UltraSCSI, and Low-Voltage Differential. Each implementation provides faster transfer of data and increased data bandwidth. Drives are identified by setting SCSI ID jumpers on each device; SCSI ID numbers range from 0 through 6. Further, the last (highest numbered) device in the chain (or cable) must be "terminated"; that is, a terminating resistor must be installed (or a terminator jumper set to enabled) to indicate to the host adapter which unit is the last drive on the chain.

Below is a description of the various kinds of SCSI types.

**Single ended SCSI:** Transmits "normal" electrical signals. Uses open collector to the SCSI bus. The maximum length for SCSI-1 is a 6 meter cable. Most devices are single ended.

**Differential SCSI:** Uses two wires to drive one signal. The maximum cable length is 25 meters. Electrically incompatible with single ended devices. Used with SCSI-1 and upwards.

**Apple SCSI:** The single ended 50 pins cable has been reduced to 25 pins by tying most of the ground wires together. DB25 connector (like a parallel port). Often used as the external SCSI connector.

**Asynchronous SCSI:** A way of sending data over the SCSI-bus. The initiator sends a command or data over the bus and then waits until it receives a reply (e.g. an ACKnowledge). All commands are send asynchronously over the 8 bit part of the SCSI-bus.

**Synchronous SCSI.** Rather then waiting for an ACK, devices that both support synchronous SCSI can send multiple bytes over the bus. This improves throughput, especially if you use long cables.

**Fast SCSI:** Fast SCSI allows faster timing on the bus (10MHz instead of 5MHz). On a 8 bit SCSI-bus this increases the "theoretical" maximum speed from 5MB/s to 10MB/s.

**Ultra SCSI:** Allows up to 20MHz signals on the bus.

**Wide SCSI:** Uses an extra cable (or 68 pin P cable) to send the data 16 or 32 bits wide. This allows for double or quadruple speed over the SCSI-bus. Note that no "single" drive reaches these speeds, but groups of several drives can.
**RAID**: A Redundant Array of Independent Disks is a set of drives connected to a special dual ported SCSI adapter that allows certain types of access optimization. A RAID 0 array stripes the data across multiple drives to decrease data latency. A RAID 1 array mirrors the data on multiple drives for increased data integrity. A RAID 5 array uses extra drives in a distributed manner to store parity information that can be used to apply data correction and recover any data in the event of any individual disk failure. This provides high reliability.

So what type of SCSI port does the host adapter have? Is it 8-bit (narrow) or 16-bit (wide) and is it single-ended SCSI or differential (High Voltage Differential, or HVD) SCSI? Here are two things you can do to determine this information:

1. To determine if it is an 8-bit or 16-bit system, simply look to see if the SCSI connector has 50 pins or 68 pins. The 50-pin connector is an 8-bit system and the 68-pin connector is a 16-bit system. For convenience, check the "SCSI BUS CONNECTORS" drawing below. Note that older Macintosh computers use a 25-pin connector and are always single-ended.

2. To determine if the SCSI host is single-ended or differential (HVD) requires the use of an ohmmeter. Make sure the power to the computer is turned off. Pull the cable connector off the host's SCSI port and measure the resistance between pins 2 and 24 on high-density or Centronics-type 50-pin connector or between pins 2 and 33 on a 68-pin connector. If you ever run into a DB-50 type SCSI connector, measure between pins 3 and 49. If the resistance is a few tenths of an ohm or less, it is a single-ended SCSI port. If it is more than a few tenths of an ohm (probably something over 1 ohm), it is a differential (HVD) SCSI port. This technique can also be used to determine if the port on a SCSI peripheral is single-ended or differential (HVD).

**Serial ATA (SATA):**

**Hard Drives**

Often abbreviated as SATA or S-ATA, these drives evolved from the Parallel ATA (or IDE/EIDE) physical storage interface. Serial ATA is a serial link -- a single cable with a minimum of four wires creates a point-to-point connection between devices. Transfer rates for Serial ATA begin at 150MBps. One of the main design advantages of Serial ATA is that the thinner serial cables facilitate more efficient airflow inside a form factor and also allow for smaller chassis designs. In contrast, IDE cables used in parallel ATA systems are bulkier than Serial ATA cables and can only extend to 40cm long, while Serial ATA cables can extend up to one meter.

SATA drives typically have greater storage capacities than do Parallel ATA drives; most SATA drives begin at 250GB capacities, and many exceed 1 Terabyte (TB) of capacity.
SATA drives also have the advantage of not requiring to be jumpered to the Master, Slave or Cable Select configurations used in Parallel ATA (PATA) drives. A SATA drive connects directly to the SATA interface on the system board or controller card. There is one data cable connection from each drive to a single SATA interface connection; drives are not daisy chained together, as with PATA hard drives.

By comparison, PATA drives are daisy-chained along a ribbon cable with one plug to the system board or interface card and 2 connectors along the length of the cable. Because each PATA drive has a controller board on it, each drive must be set to indicate whether it is the Master drive (the one that controls both units along the cable length), or the Slave drive (the one that is controlled by another drive on the cable), or to the Cable Select position (the drive at the end of the cable controls any other drives along the ribbon cable).

Many customers over the years have had difficulty understanding this concept when installing additional hard drives (or CD-ROM drives) in a computer, and the various drive manufacturers never settled on a consistent pattern for setting drive jumpers. Often one must look upon the label on the drive (if such a label exists) for the jumper-setting scheme, or contact the manufacturer (via the Web) for the proper instructions. SATA drives remove that obstacle for the customer.
CD-ROM and DVD-ROM drives, ZIP drives and Tape Drives

CD-ROM drives read data from Compact Discs (CDs); up to 700MB of data can be stored on 1 CD. Original CD-ROM drives use READ-ONLY technology; therefore, you can't write to a Compact Disc in a plain CD-ROM drive. However, CD-R drives can read and write data onto blank CD disks, and CD-RW drives can read, write and rewrite data onto blank CD disks.

DVD-RW drives now have become the standard, since they can read and write a significantly-larger amount of data than original CD-ROM disks. A DVD disk will hold up to 4.7 GB of data, and a dual-layer DVD disk will hold up to 9.4GB of data. Newer Blu-Ray drives and the disks they use will hold even more data in the same physical amount of space.

DVD-RW drives and the disk media used in them have come down significantly in price over the past few years. At the time this text was written, a dual-layer DVD-RW drive can be purchased for under $30.00. CD and DVD drives use the IDE, SCSI or SATA drive interfaces.

Below is an illustration of a typical CD-ROM drive; DVD-ROM drives will look the same, except there will be a label on the disk drawer indicating the drive's capacity.

Other rewritable disk media have become commonplace that make your data portable. ZIP disks, created by the Iomega Corporation, allow you to store either 100MB or 250MB of data onto a disk slightly larger than a traditional floppy disk. These drives are available in external and internal versions; internal drives are mounted inside the PC's case to an IDE or SCSI cable connection, and external drives are connected to the PC via the parallel port or a special adapter card.

ZIP drives are now functionally obsolete, as they have been surpassed by other disk storage media.

Tape drives are designed primarily to backup critical data on a hard disk in the event of a hard disk failure. Tape drives can be used to backup an entire hard disk, or only portions of the disk, and this process is controlled by backup software such as Microsoft Backup. Over the years, the ability of a tape backup device to store large sums of data has grown significantly.

Tape drives can backup gigabytes of data, whereas a few years ago these drives could hold only a few hundred megabytes of data. Tape drives are not normally used for typical data storage such as hard drives and floppy drives, mainly because of the length of time it takes to retrieve a file from tape. Tape drives are generally SCSI devices, but can be IDE style devices.

Tape drives are used primarily in industrial or business settings, and are not used by the average consumer. With the advent of inexpensive, larger-capacity hard drives, tape drives are becoming closer to obsolescence every day.
Video Hardware (SVGA/VGA, PCI and AGP types, obsolete types)

A video card is an adapter card that sends video signals to the monitor; there are 5 main kinds of video cards:

Obsolete Video Card Types

Hercules: Monochrome & high-resolution graphics. Displays one color in 720 x 350 pixel format.

CGA: Color Graphics Adapters (CGA) display only a few colors & low-resolution graphics; displays 16 colors in 320 x 200 format, or 4 colors in 640 x 200 format.

EGA: Enhanced Graphics Adapters (EGA) display more colors and high-resolution graphics; displays up to 16 colors in 640 x 350 format, as well as the CGA formats

Current Video Card Types

VGA/SVGA: Video Graphic Adapters (VGA) and Super Video Graphics Adapters (SVGA) output a higher number of colors and much higher-resolution graphics. Video resolutions can be adjusted, from 640 x 480 pixel format up to 1680 x 1200 format, with color palettes ranging from 16 colors up to 32,767,000 colors. The amount of colors and resolution format are dependent upon the video production chip and amount of video RAM on the video card. VGA/SVGA cards come in ISA and PCI bus connector configurations.

AGP: Accelerated Graphics Port (AGP) cards provide the same video formats as with VGA/SVGA, but adapted to work on a special AGP socket found on newer motherboards.

The Accelerated Graphics Port (AGP) is a special type of high-speed video bus slot that is used exclusively for high-end video cards. It has the ability to transfer 32 bits of data at 66MHz speed, with up to a clock multiplier of up to four times. At that rate of speed, an AGP connection can transfer 1,066MB of data per second. AGP ports also give a direct connection to the system RAM, thus reducing the need for large sums of video memory. AGP ports are appropriate for high speed rendering of images, 3-D video, and other types of high speed video production.

PCI-E/PCI-X: The PCI Express (or PCI-E) is a two-way, serial connection that carries data in packets along two pairs of point-to-point data lanes, compared to the single parallel data bus of traditional PCI that routes data at a set rate. Initial bit rates for PCI Express reach 2.5Gb/s per lane direction, which equate to data transfer rates of approximately 200MB/s. PCI Express was developed so that high-speed interconnects such as 1394b, USB 2.0, InfiniBand and Gigabit Ethernet would have an I/O architecture suitable for their transfer high speeds.

PCI Express, also known as 3GIO (for third-generation Input/Output) is compatible with existing PCI systems

By comparison, PCI-X uses a parallel interconnect along a bus that is shared with other PCI-X devices, just like PCI. In fact, PCI-X is best thought of as "PCI-eX tended", as it is simply an extension of the legacy PCI 32-bit format, with which it is backward-compatible. It differs mainly in the fact that the bus is now 64-bits wide, and runs at higher frequencies (now up to 533MHz, compared to 66MHz - the fastest PCI frequency).
Video resolution, pixels, dot pitch and refresh rates

Video resolution for all of these video card types is measured in terms of picture elements, or pixels. The more pixels on the screen at a time, the higher the video resolution (also called the aspect ratio). And while higher resolution does allow for larger images on the screen at one time, normal screen fonts and desktop icons become smaller as the aspect ratio increases. Most monitors will display between 800 by 600 resolution as a minimum, with 1024 by 768 resolution as a typical value.

Monitors are measured as to the number of pixels they can display in terms of their dot pitch; this is the measurement of the distance between any 2 pixels displayed on the screen. The smaller the dot pitch (or distance between pixels), the more pixels can be displayed on the screen at one time. The dot pitch is a function of the metal mesh within the monitor; it cannot be changed or adjusted by the user.

Also, video cards transmit signals to monitors in such a way that the image on the screen is “refreshed” or re-drawn a number of times per second. This is referred to as the “refresh rate”. Older monitors will have a refresh rate of 60Hz or 72Hz; that is, the video image is redrawn 60 or 72 times per second. Newer monitors will refresh near 90Hz, and HD-TV screens (which can be used with typical, newer PCs) can have refresh rates up to 240Hz.

It is important that your video card and your monitor work together properly, so that you can see the images on the screen. If your video card outputs signal at a refresh rate that the monitor cannot support, the image on the screen will spin uncontrollably, or your monitor will simply go blank. These factors can be controlled in the Display Properties icon in the Windows Control Panel.

Below is an illustration of a typical video card.
Video Connector Types

**HDMI**

Short for High-Definition Multimedia Interface, it is the first industry-supported uncompressed, all-digital audio/video interface. It's a single cable and user-friendly connector that replaces the maze of cabling behind the home entertainment center. HDMI provides an interface between any audio/video source, such as a set-top box, DVD player, or A/V receiver and an audio and/or video monitor, such as a digital television (DTV), over a single cable. HDMI supports standard, enhanced, or high-definition video, plus multi-channel digital audio on a single cable. It transmits all ATSC HDTV standards and supports 8-channel digital audio with bandwidth to spare to accommodate future enhancements and requirements. [Source: Adapted from HDMI.org]

HDMI was defined to carry 8 channels, of 192kHz, 24-bit uncompressed audio, which exceeds all current consumer media formats. In addition, HDMI can carry any flavor of compressed audio format such as Dolby or DTS. HDMI has the capacity to support existing high-definition video formats such as 720p, 1080i, and 1080p, along with support of enhanced definition formats like 480p, as well as standard definition formats such as NTSC or PAL.

**S-Video**

Short for Super-Video, a technology for transmitting video signals over a cable by dividing the video information into two separate signals: one for color (chrominance), and the other for brightness (luminance). When sent to a television, this produces sharper images than composite video, where the video information is transmitted as a single signal over one wire. This is because televisions are designed to display separate Luminance (Y) and Chrominance (C) signals. (The terms Y/C video and S-Video are the same.)

Computer monitors, on the other hand, are designed for RGB signals. Most digital video devices, such as digital cameras and game machines, produce video in RGB format. The images look best, therefore, when output on a computer monitor. When output on a television, however, they look better in S-Video format than in composite format.

To use S-Video, the device sending the signals must support S-Video output and the device receiving the signals must have an S-Video input jack. You also need a special S-Video cable to connect the two devices.

**Component / RGB**

Component RGB uses a set of RCA cables to transmit the video signal from a device (like a video card or a unit such as an xBox or PlayStation 3) to a television monitor or similar display. Once cable, the yellow one, transmits the video signal, and the red and white cables transmit the left and right audio channels from the component to the display device.

**DVI**

Short for Digital Visual Interface, a digital interface standard created by the Digital Display Working Group (DDWG) to convert analog signals into digital signals to accommodate both analog and digital monitors. Data is transmitted using the transition minimized differential signaling (TMDS) protocol, providing a digital signal from the PC’s graphics subsystem to the display. The standard specifies a single plug and connector that encompass both the new digital and legacy VGA interfaces, as well as a digital-only plug connector. DVI handles bandwidths in excess of 160 MHZ and thus supports UXGA and HDTV with a single set of links. Higher resolutions can be supported with a dual set of links.
Audio Hardware / Sound Card

A sound card provides stereo sound from your PC, through external speakers. It also allows for playback of various audio format sounds, MIDI (Musical Instrument Digital Interface) sounds, and also allows you to capture and record sounds from a microphone or other input device. Sound cards come configured in ISA and PCI bus connector configurations, and all current technology cards are designed to use a Plug-and-Play (PnP) format. Virtually all cards now come in a PCI bus format.

Many system boards have the sound card already built into them; users can choose to use the built-in sound card, or install a better sound card into an existing PCI connection on the motherboard.

A sound card looks like what is pictured below:
Communications hardware

Modems

A modem is a type of communications device that lets you connect your PC to another PC, or to the Internet, via a connection to a traditional telephone line. Modems are limited in terms of the speed at which they transmit data. Current technology modems transmit up to 56,000 bits of data per second (Kbps); note that the Federal Communications Commission (FCC) limits modem transmission speeds on phone lines to 53Kbps.

Modems have two RJ-11 style telephone jacks on them; one that connects to the wall jack, and one that allows a telephone to be connected directly to the modem. The phone can be used normally while the modem is NOT in use; when the modem is in use, the connection for the modem's telephone jack is disabled.

“Dial-up” modems have become essentially obsolete, and should be used only if no other broadband (high-speed) connections are available to the customer.

A modem looks like what is pictured below:

"Cable modems" are actually network interface cards that transmit at least 10 megabits of data per second over what is normally either a cable television line or high-speed telephone connection line. Cable modems are very popular in areas where broadband Internet access is available; such access is available in many parts of the United States at this time.

Network Interface Cards (NICs)

A network interface card (NIC) lets you connect your computer to a network of other computers. Virtually all network cards use twisted-pair network cable, which is an 8-wire multiple-line telephone-style cable. NICs typically have only one RJ-45 connector jack in the back of them; RJ-45 jacks are larger than RJ-11 jacks, which are used for home telephone lines. NICs are not attached to telephone connections, but to a hub or a router which allows data to be passed between PCs on the network (or to the Internet).

Network interface cards transmit data at 10 megabit-per second (Mbit), 100, and 1000 Mbit speeds. Most network cards have indicator lights on them to show a connection to the hub or router, and also the speed at which the data is transmitted and received.
A network interface card looks like what is pictured below:
Serial, parallel, USB and Firewire ports

PCs provide you with a number of input/output (I/O) ports that allow you to attach external devices such as mice, printers and scanners. Below is a discussion of the major kinds of ports.

Serial port

A serial port connects serial devices (mouse, modem, plotter, digitizer) to your computer; serial ports send 1 bit of data at a time along a single data pathway, waiting for acknowledgment before sending additional data. In this way, very accurate transfer of data can take place. Serial ports are male connectors on the back of your computer, and have either 9 or 25 pins in the connector, as shown in the illustration below.

Parallel port

A parallel port connects parallel devices like a printer to computer; parallel ports send 8 bits of data (1 byte) at a time, rather than one bit of data at a time. Standard parallel ports (SPPs) transmit data unidirectionally from the PC to the printer (or other device); enhanced parallel ports (EPPs) transmit data in both directions. Enhanced communications devices (ECPs) transmit more data bi-directionally than do enhanced parallel ports, because they add a direct memory access (DMA) channel of data transfer capability to the port, which doubles the amount of data that can be transmitted through the port. Parallel ports are female connectors on the back of your computer, and have a 25-socket connector, as shown in the illustration below.

Universal Serial Bus (USB) port (Versions 1, 2 and 3)

USB is a built-in feature of most current motherboard PC chip sets, as well as operating systems. Version 1.0 of the USB specification was released in January of 1996 by the USB Implementers Forum (USB-IF) and was followed up by version 1.1 in September of 1998. A theoretical maximum of 127 devices per controller is specified. Both versions 1.0 and 1.1 support a maximum transfer speed of 12 Megabits per second (Mbps) and can fall back to a lower-speed 1.5Mbps if necessary.

USB version 2.0 was released in 2000, upping the theoretical maximum transfer rate by a factor of 14 to 480Mbps dubbed "Hi-Speed". USB 2.0 devices are backwards-compatible with USB 1.x devices and controllers, and can fall back to 12Mbps or 1.5Mbps speed in order to coexist with older devices. Nearly all new products on the market are USB 2.0-compatible.

Both USB 1.x and USB 2.0 allow the use of two separate types of connectors Type A and Type B depending on the requirements of the device itself. Type A connectors are almost always used on the host side (computer or hub), while Type B connectors are smaller and are frequently found on the device side in printers, scanners, and other similar hardware.

Many PCs now use the USB interface as the primary way to connect both the keyboard and mouse.
Both types of connectors can provide up to 500mA (milliamps) of power to connected devices, though devices that require more than 100mA should be self-powered as each USB port generally has a maximum of 500mA of power to share between all devices. A device that draws all of its required power from the USB bus is referred to as a "bus-powered" device.

In 2007, Intel demonstrated SuperSpeed USB at the Intel Developer Forum. Version 1.0 of the USB 3.0 specification was completed in November 2008. As such, the USB Implementers Forum (USB-IF) has taken over managing the specifications and publishes the relevant technical documents necessary to allow the world of developers and hardware manufacturers to begin to develop products around the USB 3.0 protocol.

In summary, USB 3.0 promises the following:

- Higher transfer rates (up to 4.8 Gbps)
- Increased maximum bus power and increased device current draw to better accommodate power-hungry devices
- New power management features
- Full-duplex data transfers and support for new transfer types
- New connectors and cables for higher speed data transfer...although they are backwards compatible with USB 2.0 devices and computers

By eliminating add-in cards and separate power supplies, USB can help make PC peripheral devices more affordable than they otherwise would be. In addition, USB's "hot-swapping" capability allows business users to easily attach and detach peripherals. PCI-USB add-in cards provide an independent USB bus to which even more peripherals can be connected.

A USB connector looks like what is pictured below:

![USB Connector](image)

**PS/2 port**

Typical PC systems use PS/2-style connectors for both the keyboard and for the mouse, or they use USB connectors for these devices. IBM designed this type of interface for their PS/2 computer systems, all of which are now obsolete. Only the style of keyboard connector remains today. Many of these connectors are now color-coded, so as to ensure that the keyboard is installed in the keyboard plug and the mouse into the mouse plug.

Plugging a mouse into a keyboard port (or vice versa) will cause an error message to display on the computer at power-up, even though the plug is firmly connected to the (wrong) connector.

A PS/2 connector looks like what is pictured below:

![PS/2 Connector](image)
Firewire

In December of 1995, the IEEE released an official Firewire specification, dubbed IEEE 1394. This specification, sometimes referred to as 'Firewire 400', describes a hot-swappable peripheral interface with transfer speeds of 100 Mbps, 200 Mbps, and 400 Mbps. During the late 1990s, this standard found its way into Sony electronics (mainly digital camcorders) under the title 'i.LINK'. In January of 1999, Apple released what was probably the first personal computer system to include Firewire ports by default: the Blue PowerMac G3. All Macintosh models from then on have included Firewire connectivity.

Firewire cables come in two variations 4-pin and 6-pin. 6-pin cables provide up to 30V of power, allowing for fully bus-powered devices. 4-pin cables do not provide power.

In April of 2002, the IEEE released an updated Firewire standard, dubbed IEEE 1394b. IEEE 1394b allows for theoretical maximum transfer rates of up to 3.2Gbps. Apple commercially released a subset of this new standard under the title 'Firewire 800' in 2003.

Firewire 800 devices support a maximum transfer speed of around 800Mbps. Firewire 800 adds a new cable type, using 9-pin cables (also called 'beta' cables), which support the full speed of Firewire 800.

Firewire 800 is backwards-compatible with Firewire 400 when 'bilingual' (9-pin to 6- or 4-pin) cables are used. Firewire 400 devices will still run at Firewire 400 speeds, even when connected to a Firewire 800 host.

In general usage, USB-connected devices are well suited for peripherals such as printers, scanners, and portable flash drives. Firewire is the preferred data transfer interface for digital imaging and video, and it is a much faster interface for external storage devices such as hard drives and CD/DVD burners.

A Typical Firewire connector looks like what is pictured below:

![Firewire Connector](image)

Keyboards, mice and other input devices

Keyboards are the primary input device used on a typical computer. Most keyboards have between 101 and 104 keys, and have either a USB connector or a PS/2-style connector.

A mouse is the second-most important input device on a PC. It allows the user to manipulate icons, features and text within a graphical user interface, or GUI. Mice typically have 2 buttons on them, and some have a wheel that can be used to scroll down through text on a page on a document. Mice either use a USB connection, or a PS/2-style connector identical to the keyboard connector.

Scanners are used to transfer text or images into a useable format on the PC. Scanners can use optical character recognition (OCR) to translate a typed page into useable text for a word processing program, and they can convert pictures into .JPG or similar picture format that can be used with programs such as Microsoft Photo Editor. Scanners can attach to your PC via a parallel port, serial port, a SCSI host adapter, or through a USB connector.
Interrupt Requests (IRQs), DMA Channels and Port Addresses

Interrupt request levels (or IRQs) allow your PC to prioritize multiple accesses to the CPU.

DMA channels are dedicated high-speed data bus pathways on the motherboard of your PC that allow data to travel from point A to point B within your PC.

Port addresses are like mailboxes; they are locations in memory to which information is both picked up and dropped off.

If any of these settings are incorrect, your device (sound card, CD-ROM drive, fax modem) will NOT function properly.

Here is a list of the standard interrupt levels and port addresses for parallel and serial ports:

<table>
<thead>
<tr>
<th>TYPE OF PORT</th>
<th>IRQ NUMBER</th>
<th>PORT ADDRESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SERIAL PORTS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COM 1:</td>
<td>IRQ 4</td>
<td>3F8 H</td>
</tr>
<tr>
<td>COM 2:</td>
<td>IRQ 3</td>
<td>2F8 H</td>
</tr>
<tr>
<td>COM 3:</td>
<td>IRQ 4</td>
<td>3E8 H</td>
</tr>
<tr>
<td>COM 4:</td>
<td>IRQ 3</td>
<td>2E8 H</td>
</tr>
<tr>
<td>PARALLEL PORTS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LPT 1:</td>
<td>IRQ 7</td>
<td>378 H</td>
</tr>
<tr>
<td>LPT 2:</td>
<td>IRQ 5</td>
<td>278 H</td>
</tr>
<tr>
<td>LPT 3:</td>
<td>IRQ 7, or 5, or NONE</td>
<td>3BC H</td>
</tr>
</tbody>
</table>

COM 1: and COM 3: share IRQ 4, and COM 2: and COM 4: share IRQ 3. However, these COM ports each use unique port addresses, to make sure that each port is uniquely identified.

LPT 3: can share IRQ 7 or 5, but it MUST have a port address that is unique from LPT 1: or LPT 2:. In some systems LPT 3: will operate with no IRQ level; your software package will need to know how to directly address the port address being used for LPT 3:.
Below is a chart that shows the standard interrupt settings for typical PCs, showing IRQs 0 through 15.

<table>
<thead>
<tr>
<th>IRQ LEVEL</th>
<th>STANDARD DEVICE</th>
<th>ALTERNATE DEVICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRQ 0</td>
<td>System timer</td>
<td>None</td>
</tr>
<tr>
<td>IRQ 1</td>
<td>Keyboard controller</td>
<td>None</td>
</tr>
<tr>
<td>IRQ 2</td>
<td>2nd IRQ controller cascade</td>
<td>None</td>
</tr>
<tr>
<td>IRQ 3</td>
<td>COM2:</td>
<td>COM4:</td>
</tr>
<tr>
<td>IRQ 4</td>
<td>COM1:</td>
<td>COM3:</td>
</tr>
<tr>
<td>IRQ 5</td>
<td>Sound card</td>
<td>LPT2:</td>
</tr>
<tr>
<td>IRQ 6</td>
<td>Floppy disk controller</td>
<td>None</td>
</tr>
<tr>
<td>IRQ 7</td>
<td>LPT1:</td>
<td>LPT3:</td>
</tr>
<tr>
<td>IRQ 8</td>
<td>Real-time clock</td>
<td>None</td>
</tr>
<tr>
<td>IRQ 9</td>
<td>Cascaded to IRQ2</td>
<td>Network interface card</td>
</tr>
<tr>
<td>IRQ 10</td>
<td>Available</td>
<td>USB controller / NIC</td>
</tr>
<tr>
<td>IRQ 11</td>
<td>Available</td>
<td>SCSI host adapter</td>
</tr>
<tr>
<td>IRQ 12</td>
<td>PS/2 mouse port</td>
<td>NIC</td>
</tr>
<tr>
<td>IRQ 13</td>
<td>Math Coprocessor</td>
<td>None</td>
</tr>
<tr>
<td>IRQ 14</td>
<td>Primary IDE interface</td>
<td>None</td>
</tr>
<tr>
<td>IRQ 15</td>
<td>Secondary IDE interface</td>
<td>None</td>
</tr>
</tbody>
</table>

Generally on a PC, the higher the IRQ number, the higher priority is assigned to that device when there is a contention for resources.

For example: if a PC locks up when you save a document, and you press CTRL-ALT-DEL on your keyboard and nothing happens, it may be that the keyboard (operating at IRQ 1) doesn’t have priority to stop a process on your hard drive interface at IRQ 14.

A list of DMA channel assignments is found on the next page.
Below is a chart that shows the standard DMA channel settings for typical PCs, showing DMA channels 0 through 7. The chart also shows which DMA channels are typically in use.

<table>
<thead>
<tr>
<th>DMA CHANNEL</th>
<th>DEVICE USED</th>
<th>DATA TRANSFER</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMA 0</td>
<td>Available</td>
<td>8-Bit</td>
</tr>
<tr>
<td>DMA 1</td>
<td>Sound card</td>
<td>8-Bit</td>
</tr>
<tr>
<td>DMA 2</td>
<td>Floppy disk controller</td>
<td>8-Bit</td>
</tr>
<tr>
<td>DMA 3</td>
<td>Available</td>
<td>8-bit</td>
</tr>
<tr>
<td>DMA 4</td>
<td>1st DMA Controller cascade</td>
<td>16-bit</td>
</tr>
<tr>
<td>DMA 5</td>
<td>Sound card</td>
<td>16-bit</td>
</tr>
<tr>
<td>DMA 6</td>
<td>Available</td>
<td>16-bit</td>
</tr>
<tr>
<td>DMA 7</td>
<td>Available</td>
<td>16-bit</td>
</tr>
</tbody>
</table>

For the A+ examination, you will need to be able to answer the following kinds of questions:

- What are the port address and IRQ settings for COM1: through COM4:, and also LPT1: through LPT3:.
- What are the standard IRQ and DMA channel assignments in a typical PC, as described in the previous few pages?
Memory Usage in the DOS - Windows ME Environment (Obsolete)

When running operating systems from DOS through Windows ME, memory has been subdivided into several ranges: conventional memory, reserved (or upper) memory, and extended memory. The chart below describes how memory is allocated on a typical PC.

<table>
<thead>
<tr>
<th>Segment</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Extended memory area. It is the area of memory ABOVE 1 MB installed on your motherboard. This area of memory is found in AT-class computers, including 286 through Pentium-class computers. <strong>It is NOT found in old (obsolete) XT-class (8088) computers.</strong> The program HIMEM.SYS must be loaded into memory in order to access and use extended memory. The amount of extended memory in your PC depends on the way your motherboard is designed; check your hardware manual to determine how much memory your PC will accept.</td>
</tr>
<tr>
<td>B</td>
<td>Reserved memory area. It is the area of memory between 640 KB and 1 MB. There is a memory block here that is 64K in size which is used by expanded memory drivers for memory swapping; it is called the EMS window. The rest of the area is used by your video card, ROM BIOS, and other hardware devices.</td>
</tr>
<tr>
<td>A</td>
<td>DOS/Conventional memory area. This area of memory begins at 0K and ends at 640KB. All of your DOS programs run in this area of memory primarily. Windows programs use this area first also, and then they will use extended (or expanded memory) as well. DOS/Windows 9x is made up of three main boot files, and two other files which you create. These files are listed below in the order in which they load into memory:</td>
</tr>
<tr>
<td></td>
<td>a) IO.SYS</td>
</tr>
<tr>
<td></td>
<td>b) MSDOS.SYS</td>
</tr>
<tr>
<td></td>
<td>c) CONFIG.SYS User-defined</td>
</tr>
<tr>
<td></td>
<td>d) COMMAND.COM</td>
</tr>
<tr>
<td></td>
<td>e) AUTOEXEC.BAT User-defined</td>
</tr>
</tbody>
</table>
There is, in fact, another type of memory that is potentially used on an OLDER PC: expanded memory. By definition, expanded memory is always located on a separate card plugged into a bus connection on the motherboard. There are virtually no PCs currently in use today that actually have a separate memory card installed on them. However, certain game programs require the use of expanded memory to run properly.

Microsoft has provided us with a program that allows your extended memory to emulate expanded memory. This program is called EMM386.EXE. It creates a 64k area in reserved memory called the EMS window. Data is then passed from conventional memory, through the EMS window, into expanded memory in 64kb blocks. This process is relatively slow in comparison to what HIMEM.SYS does to allow the PC to directly access extended memory.

The EMM386 driver is loaded via the CONFIG.SYS file as the PC boots up; the statement DEVICE=C:\WINDOWS\EMM386.EXE will load the driver and cause extended memory to be used also as expanded memory.

**These divisions in memory become meaningless in a Windows 2000 and higher environment; these operating systems were developed using the 80386 CPU as the minimum processor capable of supporting the operating system.**

Current technology processors and newer operating systems (such as Windows XP, Vista or Windows 7) use advanced memory management techniques that make these arbitrary memory divisions much less relevant to users and software/hardware developers.

By comparison, operating systems such as MS-DOS through Windows 9x have, as their minimum processor, the old 8088 XT-class processor as the basis for operation. Although Windows 9x does not operate on a system with less than an 80386SX processor, it still supports old DOS applications written for the 8088 XT-class CPU. These classes of CPUs, and these operating systems, have long since become obsolete.

**The A+ examinations no longer ask any questions concerning memory usage in the DOS environment.** This information is provided so that if you encounter an older computer with memory management issues, you will have some information to understand and resolve the problems.

**NOTES**
Steps to Preparing A Hard Disk for Use In A PC

There are several distinct steps you must follow to prepare a hard disk for use in your PC, whether it’s a single hard drive or an additional drive being installed in the unit. These steps are listed below:

Detecting the Hard Drive in the CMOS Setup Program

You first must go into the CMOS Setup program on the PC, and enter the hard disk specifications into CMOS RAM, so that the PC will recognize, test and use the hard drive. The computer will not recognize or use the hard drive until you enter the technical specifications for the drive into the computer's Setup program, and store this information into CMOS RAM.

Typically you will use the auto-detection feature found in current-technology setup programs. The Setup program will query any hard drive(s) properly connected to the ribbon data cable, obtaining the technical specifications contained in the drive’s “diagnostic cylinder.”

On older systems, you may need to enter these specifications manually. Specifically, you need to enter the number of “cylinders” (concentric circles magnetically marked onto the hard drive), how many read/write heads the drive has, and how many sectors per track the drive is divided into. The setup program may want to know if there is a write-precompensation cylinder (used for buffering when writing data to the disk), and also where the "landing zone" is located (where the heads are parked at power down). All of these specifications normally are written on the label of the drive, and also are available from the drive manufacturer's web site.

Save the changes you made to the CMOS Setup program, exit Setup, and then the PC will reboot.

Understanding the Factory “Low-level Format” of the Disk

Before you obtained the hard drive, the factory performed a "low-level" format on the device, so that the disk controller can read and write to the physical media. The low-level format places the initial magnetic markings throughout the disk, so that data can be accessed in a sequential fashion by the drive controller (and any operating system you choose to use). If you have an IDE or SATA hard disk, you will NOT have to low-level format the disk; this format is already done at the factory for you. Normally, you will never perform a low-level format on IDE or SATA drives. Some IDE and SATA drives actually prevent low-level formatting after leaving the factory. Most SCSI disks come low-level formatted from the factory, but occasionally you may have to low-level format them in the field.

As mentioned above, you never will need to perform a low-level format of the hard drive in the field, EXCEPT if some dire kind of problem has damaged the low-level format characteristics of the drive (like some forms of aggressive viruses), or if there are serious problems reading or writing data to the drive. Typically you would replace a drive that has problems with the low-level formatting, but sometimes that is not an option. Additionally, you need a special program from the manufacturer (like Disk Manager, Speedstor, Checkit, Disk Technician, etc.) to perform the low-level format. ONLY USE THE MANUFACTURER’S SPECIFIC PROGRAM to initiate a low-level format in the field.

If you must perform the low-level format on a hard drive, you will need to know the technical specifications of the disk. Specifically, you will need to know the actual cylinder, head and sector-per-track (SPT) values for that hard drive. You also may need to know the write precompensation cylinder, the reduced write cylinder, and the landing zone location. You also will need to know at what rate the hard drive controller should interleave the disk; interleave is the rate at which data is laid down in sectors on the hard disk. All of the disk specifications can be found in your drive’s manual, or on the drive manufacturer’s web site.
Partitioning the Hard Drive

Next, you must partition the hard drive. The disk partitioning process places markings at the beginning and end of the drive that tell any operating system how much disk space is available.

Typically a drive is partitioned as one single volume, but you can (for example) take a 500GB drive and create two disk partitions (a C: and a D: partition) on the single device. Some professionals like this approach; creating two partitions lets you use one for the operating system, and one for data (or another operating system like Linux). Typically Windows and other Microsoft operating systems create one single disk partition as the default behavior.

If you are using MS-DOS 6.22 or below, or if you are using Windows 95 through ME, you must use the DOS program called FDISK to partition the disk. FDISK will partition the disk and then create the logical drive letter assignment(s). FDISK allows you to divide your physical disk into several logical drives, or just partition it into one single drive.

If you use the OSR 2 version of Windows 95, Windows 98 or Windows ME, FDISK will let you partition a hard disk of virtually any size (up to 4 terabytes) as one single partition, using the FAT32 file system. Older versions of FDISK will only allow a partition size of up to 2 GB, because it uses the FAT16 file system. If you cannot get FDISK to recognize your entire hard drive, it may be that you have an older version of FDISK, and you need to obtain and use a newer version of version of the program.

With Windows 2000 and above, the installation CD (or DVD) automates the disk partitioning and formatting process. By answering the prompts in the Windows installation setup program, the hard disk by default will be partitioned to use the full amount of available space on the drive. You can specify a smaller amount of disk space than the maximum size, if you wish, during this process.

Formatting the Hard Drive

Finally, you have to perform the operating-system-level format of the drive. This process uses the magnetic markings laid down on the disk surface during the factory low-level format. It creates a file allocation table / master file table and the master boot record on the disk, and then it verifies that the disk space is capable of storing data safely.

If you are using MS-DOS 6.22 or below, or if you are using Windows 95 through Windows ME, you must use the DOS program called FORMAT to perform this operation. After you have run FDISK to partition the drive, you will enter the following command from the A:\ prompt:

**FORMAT C: /S /V** [Press Enter]

This command formats the disk, puts the DOS system files on it (so that it is bootable), and the /V switch allows you to put a name on the disk.

With Windows 2000 and above, the installation CD (or DVD) automates the disk formatting process. You may be prompted to select the type of file system to use (either FAT32 or NTFS). In most cases NTFS should be used, as it is the native file system for Windows 2000 and above. You also will be prompted to select the typical full format option, or the quick format option.

A traditional full disk format on a larger drive (anything bigger than 100GB) could take upwards of 30 minutes to complete, and much larger drives will take quite some time to format. **If you have a brand-new hard drive, or a drive that you believe is in good condition, use the quick format option.** A quick format typically takes less than 30 seconds to complete, even on very large drives.
Loading the Operating System on the Drive

Finally, you must load the Windows operating system onto the disk, so that the computer will have the necessary interface for you to run the PC.

With Windows 2000 and above, Windows will be installed immediately after the disk partitioning and formatting is completed. The installation process for Windows should take between 20 and 45 minutes to complete, depending upon the speed of the processor, the amount of RAM in the PC, and the version of Windows being installed. Newer versions of Windows take up more disk space and have more operating system features, and will take longer to install than previous versions.

For Windows 95, 98 and ME users, you should copy the contents of the \WIN95 directory (or \WIN98 or \WINME directory) from the installation CD onto the hard disk, and then run SETUP.EXE from the hard disk. This is the preferred method of installing Windows for this course. All of the necessary "cabinet files" that are used to install Windows 95, 98 or ME are located in these folders on the installation CD.

The SETUP.EXE program can be run from the CD-ROM drive, but anytime the user re-configures the system, he/she will be prompted to insert the installation CD to access the cabinet files that hold the compressed installation files. By installing these cabinet files from the CD-ROM disk to the hard drive and then performing the installation directly from the hard disk, Windows automatically will look to the hard disk anytime the system is reconfigured.

Once you have done these things, you will have a usable hard disk in your computer.

Adding A Second Hard Drive To An Existing System

If you have installed a second hard drive into the PC (to provide additional disk space), you will need to do the following things:

- Ensure that each of the two drives have the master-slave jumpers configured correctly (for IDE drives), or the ID and disk termination jumpers set correctly for SCSI drives (SATA drives need no jumpers to be configured properly);
- Detect the second hard drive in the CMOS Setup program, as was done for the first drive; and
- Partition and format the drive

You do NOT need to reinstall the operating system when adding a second hard drive. The existing operating system on the first drive will give you all the necessary tools to partition and format the second drive.

With DOS 6.22 and below, or with Windows 95 through ME, you will use FDISK and FORMAT to partition and format the drive, just as is described in the previous pages. Be sure to select the SECOND drive when running FDISK, and be sure not to format the C: drive, but the newly-added drive letter partition. A mistake at this point could wipe out your existing data on your first drive, so read and heed the prompts shown on the screen when using FDISK and FORMAT.

With Windows 2000 and above, you will use the Disk Management application to partition and format the second drive. Right-click on My Computer, and select the Manage option from the drop-down menu. In the Management Console window, click on the Disk Management option. In the dialog box that appears, right-click on the unpartitioned disk, and select the Partition Disk (or Prepare Disk) option. The disk partitioning (or preparation) wizard will guide you through the partitioning and formatting process. Use the Quick Format option when formatting the second drive.
If you need to partition and format an external hard disk connected to your PC through a USB or FireWire connection, the process is the same as the one described in the previous paragraph. The only difference you will notice in partitioning and formatting an external USB/FireWire hard drive is that it does not need to be detected in the CMOS Setup program. Once the drive is connected to the USB or FireWire connection and is recognized by Windows, you then can use the Disk Management application to prepare the drive.

**Classroom Boot Disks for Use in Lab Sessions**

In order to assist you in preparing a hard disk for use, we have specially-created boot disks that will let you boot the computer from the floppy drive. The bootable floppy disk also loads the necessary drivers so that your CD-ROM drive will be recognized, and it also has the newer version of FDISK installed on it. This disk is needed ONLY if you are intending to install Windows 95 through Windows ME.

Please request one of these disks from the lab staff if you do not have a copy of this bootable floppy disk.

For the A+ examination, you will need to be able to answer the following kinds of questions:

- What are the steps involved in preparing a hard drive for use?
- What does FDISK do? How do you partition a hard disk in Windows 2000 and above?
- What is a partition table, and how is it created?
- How do you use the FORMAT command to prepare a hard disk for use?
- How do you format a hard disk in Windows 2000 and above?
- How do you format a second hard disk in Windows 2000 and above?
- How do you install an operating system onto a hard disk (for any of the operating systems mentioned above)?

**NOTES**
Chapter 3. Overview of POST, CMOS Setup Programs and Error Codes

POST is the Power-On Self Test, which your computer performs every time you turn it on and/or reboot it. ALL IBM-compatible PCs perform this same type of test at power-up, in the same order as what was done with the original IBM PC. This test ensures that all of the major components of the PC are working properly before the user begins to perform normal work with the unit.

The Power-On Self Test (POST) is a program built into the ROM BIOS on your PC’s motherboard. When power is applied to your PC, the CPU resets itself, clears out any leftover or miscellaneous data, and looks to an address in memory called F000; this is where the ROM BIOS is located in the PC’s memory map. The CPU executes the first program in the ROM BIOS’ memory, and that program is the POST.

In order to do a comprehensive check on your PC, the Read-Only Memory Basic Input-Output System (ROM BIOS) requires specific information about the exact types of components installed on your PC. In particular, it needs to know the types of floppy and hard drives which are installed, the type of video card, the amount of RAM, the date and time, as well as other information related to how the PC should load the operating system.

You (or the technician who built your PC) needs to input this information into the SETUP PROGRAM; this program is also built into the ROM BIOS chip along with the POST. You can access this Setup program by pressing a combination of keys (i.e., Control-Alt-Escape, the Delete key, F1 or F2, and so on) when prompted during the POST. These programs are fairly intuitive, and one can navigate through the program by using the arrow keys, the Enter key to select options, and the Escape key to back up one level.

The information needed by the POST to accurately check your system is stored into a special RAM chip on the motherboard called CMOS RAM. CMOS stands for Complementary Metal-Oxide Semiconductor; this type of RAM chip will hold information if a small quantity of electricity is delivered to it.

To accommodate this, a small battery is attached to every IBM-compatible motherboard. This has been the case from the early 80286-based systems on through motherboards being built today. These batteries deliver enough electricity to the CMOS chip so that it retains the PC configuration information stored in it, even when the power to the PC has been turned off or disconnected.

These batteries that power the CMOS chips have a life span of anywhere between 2 and 5 years. When the batteries die, they need to be replaced. These batteries usually cost less than $10.00 at a computer retailer, office supplies outlet, electronics store or computer show.

Further, the information in the CMOS RAM vanishes when the battery dies, and the table of system configuration stored in CMOS needs to be updated before the computer will operate properly.

This does NOT mean that you have lost any of the information on your hard disk; it only means that you cannot access the data on the hard disk UNTIL you re-enter the information in CMOS RAM, so that the PC can test and recognize each device. Once you re-run the Setup program and enter the correct information for the kinds of components inside your computer, the system will return to normal, and all of the devices in your PC will work as expected.
Accessing and Configuring the CMOS Setup Program

So, HOW do you know how to properly run this setup program?

First, gather all the available documentation about your computer. Specifically, what are the exact specifications of your hard disk, how much RAM has been installed, what type of floppy drive is installed, and so forth. Next, locate the owner’s manual and see if there is any information in it on how to correctly run the Setup program, and what may be the default settings that ensure proper operation of the computer. You may also want to contact the manufacturer’s technical support area, or contact a computer technician that can instruct you on how to properly run the program.

You can access the CMOS setup program when as the PC is going through POST by pressing a certain key (or set of keys) when prompted on the screen. Many setup programs are accessed by pressing the Delete key, or Ctrl-Alt-Esc together, or the F1 key, or the F2 key, or the F10 key.

Pressing the Delete key gets you into the setup program for AMI and Award BIOS. Phoenix BIOS uses the F1 key, or F2, or Ctrl-Alt-Esc, or Ctrl-Alt-S. Dell computers usually use the F2 key to access the setup program, while HP/Compaq computers use the F10 key. Check the system documentation to see which keystroke sequence will let you access the setup program.

If you have BIOS from another manufacturer, look at the screen during POST for a message explaining what keystroke you should use to enter the setup program. If there is no message on the screen, consult the system documentation for how to access the setup program.

Standard Setup

Here is where you will set date, time, floppy/hard drive types, video type, and memory size. You also may be able to set the hard drive auto-detection feature to on or off.

Use the left/right arrow keys to move from field to field on the screen. Use the PageUp/PageDown keys, or the plus/minus keys to modify the values in each field. The Enter and Esc keys move you up or down one level within the setup program. These rules apply in virtually all setup program screens.

Advanced/Extended Setup

The advanced setup lets you set the boot sequence, or perform a full or partial memory test, or enable/disable shadow RAM, or enable/disable cache memory, or enable features like block mode and LBA mode, or to set wait states on the CPU or memory.

If you don't know how to set up these features, there should be a keystroke you can press that reloads the factory default settings (look at the bottom of the screen for details). You can try modifying different settings to get better performance on your PC. There is no magic formula ... trial and error works best. Refer to the system board documentation for guidelines on how to set these features.

Integrated Peripherals

Virtually all motherboards have the drive interfaces and I/O ports built into the motherboard. This portion of the setup program lets you enable or disable any of these built-in devices.
IDE HDD Auto-Detect

This feature allows you to read the drive parameters from the IDE hard drive's diagnostic cylinder into the setup program. Use this feature to input the drive specifications, and to assure that the drive is connected and functioning properly.

Virtually all manufacturers now use auto-detection to determine a hard drive’s technical specifications. Make sure the setting in these programs is set to the “Auto” feature; if the setup program shows the value here as “Off,” a hard drive will not be recognized until it is changed to Auto.

Power Management (Green) Features

This option allows you to enable features that shut down certain PC components after a set period of inactivity. You can select which devices get powered-down and when in this screen.

You can configure the power management features within the CMOS Setup program and also within the Windows operating system. Below is a list of the key features, and how they differ one from another:

**Suspend mode**: this feature causes the system to enter a low-power state. Information on system configuration, open applications, and active files is stored in main memory (RAM), while most of the system's other components are turned off. A system in suspend mode can use as little as 5 watts of power, with most of it going to main memory for data maintenance.

If left in suspend mode, a system may be programmed to waken, so it can perform tasks at any given time. If the power is interrupted, then the system will undergo a normal reboot, restoring full power to the machine and losing any information not saved to the hard disk.

**Wake on LAN**: Many times, IT personnel prefer to maintain client systems after the employees have gone home. Even if these tasks are automated, client machines must be left on. In the past, if they were not left on, personnel had to manually turn them on. With the wake-on-LAN feature, client systems can be remotely and automatically powered up.

Wake-on-LAN technology resides in a PC's managed network adapter and motherboard. The two are attached via a wake-on-LAN cable terminated by a 3-pin connector on each side.

When the system is turned off, the managed network adapter uses an alternate power source to monitor the network and watch for a wake-up packet from the server. Once it receives a packet, it alerts the system to power up and accept any maintenance task it is given.

Wake-on-LAN is a part of Intel's Wired for Management System and is a result of the Intel-IBM Advanced Manageability Alliance. Wake-on-LAN is also called remote wake-up.

**Sleep timers**: this energy-saving mode shuts down all unnecessary components after a certain period of inactivity. Many battery-operated devices, such as notebook computers, support a sleep mode.

When a notebook computer goes into sleep mode, it shuts down the display screen and disk drive. Once awakened, the computer returns to its former operating status. Windows allows you to set the sleep timers for the display, hard drive, and the main system. For the main system timer, the computer can go either into suspend mode or into hibernation mode.
**Hibernate mode**: this power management mode conserves electricity by powering down the system. In hibernate mode the current state of the system is saved to the hard drive, and the system will power down. When a user turns the system power back on, the saved information is read from the hard disk, restoring the last used settings. Hibernate mode is similar to sleep mode, however in sleep mode the power cannot be shut off.

**Standby mode**: Similar to suspend mode, standby mode switches your entire computer to a low-power state (when it is idle) where devices, such as the monitor and hard disks, turn off and your computer uses less power. When you want to use the computer again, it comes out of standby quickly, and your desktop is restored exactly as you left it. Standby is particularly useful for conserving battery power in portable computers. Because Standby does not save your desktop state to disk, a power failure while on Standby can cause you to lose unsaved information.

**Exiting the Setup Program**

You can either save the values you have just changed, or you can exit the program without saving the changes. Both options should be apparent to you on the main setup program screen. When you select to exit the setup program.

**For the A+ examination, you will need to be able to answer the following kinds of questions:**

- What can be set up in the CMOS setup program, and what are the major features in a CMOS setup program?
- How do I access a CMOS setup program; which keystrokes will let me run Setup?
The Power-On Self Test, and Error Codes / Messages

Below is a chart that lists exactly what the Power-On Self Test (POST) checks; these checks are the same on ALL brands of IBM-compatible computers.

- **100 Series:** Motherboard checks
- **200 Series:** Memory chip checks
- **300 Series:** Keyboard checks
- **400 Series:** Monochrome monitor checks
- **500 Series:** Color monitor (CGA) checks
- **600 Series:** Floppy Disk Drive checks
- **700 Series:** Math Co-processor checks
- **900-1000 Series:** Parallel Port Adapter Checks
- **1100-1200 Series:** Serial Port Adapter Checks
- **1300 Series:** Game Port Adapter Checks
- **1400 Series:** Printer Checks
- **1700 Series:** Hard Disk/Disk Controller Checks

If something is wrong with your computer, an error code will be displayed on the top of your screen. For example, any error between 201 and 299 means that there is a problem with your RAM memory; any error between 601 and 699 means there is a problem with your floppy disk drive and/or floppy disk controller. You will be prompted to press the "F1" key to continue booting the computer; normally, you will want to power-down the PC and repair the problem before continuing to use it.

On newer computers, these error codes may be replaced with English-language error messages, such as “Keyboard error or no keyboard present.” However, many manufacturers still use error code messages to report hardware problems. This forces the consumer to haul the computer into the repair shop, because they don’t understand the meaning of the error codes. On the course DVD, there is an exhaustive list of IBM-compatible error codes and what each code means. For the A+ examination, you simply need to memorize the major error code categories shown in the list above.

**What happens if the computer just beeps at you?**

You may also hear a series of beeps when you turn on the computer, IF SOMETHING IS WRONG. Normally, you hear only one short beep. The one short beep (or two short beeps if you have a Compaq computer), indicates that the POST has completed, and it found no hardware errors with the tested components.

If there are hardware problems AND the PC cannot display an error code or message to the screen, the computer will beep in a predefined series of beeps to indicate exactly what is wrong with your PC. This beeping is not random, and it can instruct you about exactly what is wrong with your PC.

Here are some of the most common DOS Audio Error codes mean:

- **No display, no beeps:** No power
- **Continuous beep:** Power supply failure
- **Repeating short beeps:** Power supply failure
- **Two beeps:** Unspecified problem; read message on screen for further details (such as keyboard error, drive mis-configuration)

**One long and two short beeps (or three short beeps, or eight short beeps):** Display adapter (video card) failure
Different manufacturers of PCs and BIOS chips have differing sets of beep codes, some having more extensive beep codes than others. Phoenix BIOS has the most extensive set of beep error codes, but AMI BIOS and Award BIOS have a long list of beep codes. Depending upon your motherboard and BIOS manufacturer, a series of beeps may mean different things.

The BIOS Companion reference book has an extensive list of PC error codes, listed by ROM BIOS manufacturer and PC manufacturers. Also, the websites for the major BIOS manufacturers (such as AMI, Award and Phoenix) have this same information available upon them.

For the A+ examination, you will need to be able to answer the following kinds of questions:

- What does POST stand for, and what does it do?
- What are the major ranges of error codes? For example, an error code between 301 and 399 indicates an error with exactly WHAT on your computer? (Hint: it’s the keyboard)
Steps in the Boot Process

The following is a description of what happens to your PC, from the time that you turn it on to the time that is finished booting up the operating system.

1) When the PC is powered up, the CPU resets itself, clears out any left-over data, and looks to an address in memory called F000 ...that is where the ROM BIOS chip is located. The ROM BIOS chip is what makes your PC IBM-compatible. When the CPU finds the ROM BIOS chip, it invokes the first program found in memory, which is POST: the Power-On Self Test. This self-test ensures that all of your components are operating properly BEFORE you begin working with the computer.

2) As POST checks your computer, it looks to a record of data stored in CMOS RAM that tells what kinds of components are in your PC. Specifically, it records what type of video card, floppy drives, hard disk, memory and so forth are contained in your PC. POST will test your computer based on what it believes is in your PC ... if the information is missing or incorrect, the PC may not be able to recognize or use certain components in your system. It's important to keep a record of what specifically is inside your computer, and that you have a record of what is written into CMOS RAM.

3) If POST finds that there is a problem with your PC, it will display an error message or an error code that tells specifically what is wrong with the unit. If it cannot display such a message, it will beep in a specific pattern that indicates exactly what is wrong. If everything is OK with the computer, POST will sound one beep to the system speaker, indicating that all of the tests passed normally with no errors.

4) The ROM BIOS will then look to the boot sector of either a floppy disk or a hard disk to find the boot loader program of your operating system. If it can't find this file in that location, the PC will give an error message to the screen. When it does find the file, it loads the file into RAM, and then your operating system takes charge of the computer. NTLDR is the boot loader program for Windows NT through Windows 7. Linux uses a file called GRUB to begin its boot process.

5) Windows then loads the files called BOOT.INI, NTDETECT.COM, NTOSKRNL.EXE, SYSTEM and HAL.DLL to bring up the operating system. BOOT.INI is used whenever you have multiple operating systems to boot your PC. NTDETECT.COM detects the various hardware devices in the PC. NTOSKRNL is the operating system kernel, which contains the majority of the operating system instructions. SYSTEM and HAL.DLL customize Windows to operate on any given PC. Every PC will have different hardware configurations, and these programs ensure that Windows will look and work the same on all platforms.

6) Then, WINLOGON.EXE and EXPLORER.EXE are loaded; these programs provide the user interface common to Windows, and also allow you as a user to log onto the system.

If any of these steps do not occur in a normal manner, your PC may not boot up as you would expect. Knowing the steps in the boot process will help you when trouble-shooting or analyzing problems with your PC.

For the A+ examination, you will need to be able to answer the following kinds of questions:

0 What are the steps in the boot process, and what files are loaded into memory during boot-up, and in what order do these files load?
Troubleshooting BIOS and CMOS Setup-Related Problems

The BIOS setup program on most PCs is intended to allow the user to easily and quickly set up the most important parameters necessary for the POST (Power-On Self Test) to run correctly. Most of these types of things can be set by an average PC technician without great difficulty. However, there are a number of BIOS Setup issues that are not quite so straightforward.

For example, the Advanced CMOS Setup allows you to enable things like built-in virus protection, shadow RAM regions, boot sequences, RAM timing and wait states, and so forth. The Plug-and-Play and PCI Configuration Setup lets you set how PCI bus connections and devices should operate, whether you have installed a Plug-and-Play compatible operating system, and so forth.

Each motherboard's settings and options may be different, and depending upon the motherboard "chipset" you have (the set of IRQ, DMA, and keyboard controllers that are permanently mounted onto the system board), different revisions of the same board or BIOS may have different features. The motherboard chipset, also referred to as the "Northbridge" and "Southbridge" chips perform specific input-output management tasks:

- The Northbridge chip synchronously controls the flow of data between the CPU and the system RAM.
- The Southbridge chip controls the flow of data between devices plugged into the bus connectors on the motherboard (PCI and ISA) and the Northbridge chip.

So HOW do you set a motherboard up correctly, or for maximum performance?

Documentation

Before attempting to modify any "non-standard" parameters of a CMOS setup program, you should consult the documentation that came with the system board. If there is no documentation available, at least go to the web site for the BIOS manufacturer and attempt to locate some helpful information about that board, and the revision level of the BIOS chip. Here are the web addresses for some of the major BIOS manufacturers:

**Award**: [www.award.com](http://www.award.com)  **Phoenix**: [www.phoenix.com](http://www.phoenix.com)  **AMI**: [www.ami.com](http://www.ami.com)  **Microid Research**: [www.mrbios.com](http://www.mrbios.com)

Try to have some paper documentation about the product before making any changes, if that is at all possible.

Recordation

Make a paper record of what the BIOS settings are for each sub-section of the setup program BEFORE you begin tinkering with the settings. At least this way, you will be able to get back to square one if you make any mistakes in working with the setup program. You may be able to print out a copy of each of these sub-sections by using the PrintScreen (or Shift - PrintScreen) button on your keyboard. Try printing out these settings before going to the trouble of writing them down on a piece of paper.

There are also utilities that let you save the CMOS values to a disk file, and then restore those values by booting from a floppy disk and running the restore program for the CMOS values. See your instructor for details on how to obtain such a utility for yourself.
Experimentation

It has been said that experimentation is the basis for all good research. This instance is no different. In order to find the maximum level of performance for your BIOS and chipset, you will have to tweak the settings, reboot the computer, and see what happens. If it works, then bravo ... if it doesn't, then go back and undo that change you just made. The key is: make only one change at a time, in order to make sure that you can analyze correctly the improvement or impairment of the system's performance.

With some BIOS products, there will be a selection in the Setup program that allows you to choose the "original" settings from the manufacturer, the "optimal" settings, or the "fail-safe" settings from the manufacturer. You may want to try these options in the Setup program, and notice what changes were made in each sub-section of the program, before venturing out on your own.

By the way, **DON'T PUT ANY PASSWORDS INTO THE SETUP PROGRAM UNLESS ABSOLUTELY NECESSARY.** You may be able to clear the password (and all the rest of the CMOS data) by temporarily moving a jumper on the system board or removing the CMOS battery. But if you can't do that, you may be stuck with a system board that has a password that you can't eliminate, ESPECIALLY when you have forgotten the password. The password can prevent BOTH your booting to the operating system AND entering the CMOS Setup program as well. There are better ways of safeguarding your data than with a CMOS password.

Education

The Expert's Creed is stated as follows: Ask the one who has the experience. Many local vendors have been doing BIOS troubleshooting and configuring longer than you have, so it pays to consult them for their advice. Your presence here in this class is testimony to this idea. Once you have done the job of CMOS configuration several (or more) times, you will learn (as the experts have) that there are certain features that always should be turned on or off in a CMOS setup program (i.e., setting PCI configuration to Auto, making sure the shadow RAM settings are correct, turning off the Boot sector virus protection before installing your operating system, etc.). The more you do this kind of work, the more you experiment, the better you will get at this process. But start by asking your local parts supplier or computer guru a question like ...

"Is there anything I should know about setting up this system board before I buy it?".

Standard and Advanced CMOS Setup Options

The Standard CMOS Setup program in all BIOS products allows you to input the most critical specifications for your computer, such as the floppy drive types, the hard drive auto-detection feature, the date, the time, the memory size, and so forth. Anyone with a minimum of repair training can input this information with little difficulty. The information in this segment of the setup program, especially the hard drive parameters, must be exact and correct, or else the device(s) will not be recognized or work properly. If the hard drive device type is set to "Not Installed", the drive will not be recognized.

The Advanced CMOS Setup allows you to manipulate other issues that relate to booting correctly and speed optimization. This includes such things as setting the boot sequence (CD-ROM then C:, or C: then A:, etc.), enabling specific shadow RAM ranges, enabling boot sector virus protection, enabling a floppy drive seek at boot time, enabling cache memory (both external and internal CPU caches), enabling the quick or full Power-On Self Test (POST), system CPU speed, enabling RAM parity checking, and various password checking options.
Advanced Chipset Setup Options

The Advanced Chipset Setup options allow you to control the motherboard chipset (DMA and IRQ controllers, keyboard controllers), the way memory is addressed and refreshed, the way memory is tested, the wait states for memory, CPU and bus connections, the way ISA bus connections address devices, and other such features. In order to make changes in this portion of the setup program, documentation for the motherboard or advice from and experienced technician is required before making substantial changes.

Power Management Options

The Power Management options let you enable or disable the power-saving (or Green) features of the motherboard. Such motherboards can issue commands to specific devices (i.e., the hard disk, the monitor) to power-down (or go to sleep) after a set number of minutes of inactivity. Many of these features are set by device or by IRQ level. If your system seems to stop operating properly after 10 - 20 minutes, you may be encountering a situation where power management features are powering down your system.

PNP/PCI Setup Issues

The PNP/PCI Setup portion of the program allows you to control the configuration of the PCI bus connections on the motherboard, and the way Plug-and-Play devices are polled and configured. You can also tell the system board that a PNP-capable operating system (like Windows 2000 and above) is installed, the speed and method by which PCI devices are to be addressed, enabling PCI VGA Palette snoop (allowing a multimedia device to check the video card to see what color palette is being used), whether data from PCI devices will move in streams or blocks, how the built-in drive interfaces will pass data along the PCI bus, and also system monitoring features such as fan speed, CPU temperature, and voltages on the motherboard. Using the Automatic option is the best choice for most systems.

Integrated Peripherals

This portion of the setup program allows you to enable, disable and/or configure the built-in peripheral devices on your motherboard, such as the floppy drive controller, IDE interfaces, serial/parallel and PS/2 ports, and any other built in devices such as sound cards, video cards, SATA or SCSI host adapters, and so forth. Devices can be both enabled and configured to operate at a specific configuration (i.e., the first serial port can be configured to work as COM1:, COM3: or disabled; the parallel port can be set to work in standard parallel port (SPP), enhanced parallel port (EPP), or enhanced communications port (ECP) mode.). Make sure that these system board devices are configured properly, or else the devices may conflict with other devices installed in the bus connections on the board.

Auto Detection Features

This portion of the setup program allows you to automatically detect the installed hard drives in your system. The Cylinder/Heads/Sectore-per-track (CHS) parameters from the detected hard drives are passed to the Standard CMOS Setup part of the program, and if logical block addressing (LBA) mode or some other form of sector translation is needed to access the drive as a single partition, those options will be made available to the user at detection time. If the drive cables are not attached correctly, or if the master/slave jumpers are set incorrectly, or if the drive is defective, the drive will not be detected.
Custom configurations

The CMOS Setup program will normally come with an option to load the factory default settings for the entire program, an option to load the values used for the previous boot, perhaps an option for "optimal performance", and also perhaps an option for "fail-safe operation". Beyond that, you are able to tweak any of these settings on your own beyond what the manufacturer provides for you with these canned configurations.

A note from the author: There is a book that is worth it's weight in GOLD as it relates to BIOS features. It's called The BIOS Companion, and it's written by Phil Croucher. His book can be obtained over the Internet at www.electrocution.com . I strongly recommend your obtaining this book as a permanent desk reference about BIOS and CMOS Setup issues. The ISBN number for this book is provided at the end of this course book, on page 236.

NOTES
Chapter 4. Procedures for Testing Equipment

Repairing a faulty PC can be a challenge, but there are ways to systematically test and check a PC to determine the nature of the problem and apply the proper solution. Begin by using these following ten rules when repairing or trouble-shooting a computer:

1) **Gather together your toolkit and any necessary documentation for that specific computer.** You may also want to have these course notes available and/or any other good resources for technical specifications and system disassembly guidelines.

2) **Check for power FIRST, before doing anything else.** 10 - 15 percent of all trouble calls are for nothing more than a popped circuit breaker or a loose power plug. Check these things BEFORE doing anything else.

3) **Check your external connections to the computer.** Specifically, check the mouse, keyboard, monitor, modem and/or printer cables, making sure that all are secure and installed in the right sockets.

4) **If the computer is still malfunctioning, go ahead then and open the case.** Check to see that all of the cards are fully pressed down into the bus connections, that any socketed chips are fully pressed into their sockets, and that all cable connections are fully attached. Make sure that the drive cables are attached so that the colored stripe on the cable is positioned next to pin 1 on the connector.

5) **Clean any dust or foreign material out of the case while it is open.** Dust can cause overheating problems and electrical shorts. This is especially a problem with power supply cooling fans and CPU heat sinks. All of this needs to be cleaned out before you close up the case. Use compressed air and non-conductive materials to clean out the inside of the case. Take precautions to avoid inhaling excess dust, and consider using protective eyeware if necessary.

6) **Try to boot the computer to the hard drive, or to a bootable CD/DVD disk if necessary.** Sometimes the hard disk will become corrupted by a user, or by a virus. If you can’t access the hard drive directly, have a bootable CD or DVD disk available (like your operating system installation disk). Have a good disk diagnostic program available, and a good virus checking program as well. If your data is severely damaged, you may need to wipe the disk and reload the data from original or system recovery CD/DVD disks. Also, if your PC will boot to a USB drive (such as a flash drive or external hard drive), see if the system will respond and boot from these devices.

7) **Check the CMOS setup program, and correct any configuration problems.** If the information in CMOS RAM about your PC’s configuration has been changed, or if the battery has died, your computer will not boot correctly, or it will not recognize certain components. Keep a copy of your setup program information handy, so that if something changes, you can correct the problem. Replacement CMOS batteries are usually less than $15.00, and are readily available from computer and electrical stores. Such batteries should last about 2-5 years.
8) **Look for unwelcome changes.** Someone may have turned the brightness down on a monitor, or the LAN staff may have changed your PC’s configuration without your knowledge (or approval), or an installation program may have corrupted something in your software. Look for recent changes in your system’s operation. You may need to run an uninstaller program to remedy software-related problems.

9) **Isolate the problem to one piece of hardware, or one software package.** The problem you are encountering may occur only in one software package, which means the problem has a very limited scope. If the problem occurs in all programs, then it’s a systemic problem. Refer to software and operating system manuals as needed, and have the original software disks available, in case a driver needs to be reloaded. If the system just won’t fire up, remove all non-essential components, and see if you can cause the problem to re-appear by re-installing components one-at-a-time. This process is usually quite helpful in trouble-shooting even the most stubborn problems.

10) **When all else fails, read the manual.** There may be something unique about your computer that requires special attention as directed by the manufacturer.

Listed on the next few pages are step-by-step instructions for testing and troubleshooting the major components within a PC.
HARD DRIVE TESTING GUIDELINES

1) Locate the hard drive in the system; notice the appearance of the hard drive. **There are several kinds of hard drives:** IDE/EIDE, SCSI and SATA hard drives. In current technology PCs, you will likely only see IDE and Enhanced IDE drives (with 40-pin data cable connectors), or SATA hard drives (with a small cable that connects each drive to the system board interface).

Systems with SCSI drives have a 50-pin or 68-pin interface cable which attaches to the hard drive and SCSI host adapter (drive interface) card.

Notice the model number and manufacturer of the drive; use that information to identify the correct cylinder/head/sector per track specifications for that hard drive. Refer to the web site for that drive manufacturer to find the proper information on that drive. This information will be indicated on the label on newer hard drives.

The auto-detection feature in the CMOS setup program will retrieve the drive's technical specifications directly from the diagnostic cylinder of the drive, thus relieving you from having to manually input this information into the Setup program.

Also, make sure that the master/slave jumpers are set correctly on the IDE-style drive (or the SCSI ID jumpers and terminating resistor are set for SCSI drives). For IDE-style drives, the jumpers can be set for **single, master or slave** operation. If the drive is the only device on that cable, make sure the drive is set either for single-drive or master-drive operation.

On some computers (HP/Compaqs or Dells), you can use the “cable-select” jumper position for both drives. When set for cable select, the drive connected at the END of the cable is the master drive, and it’s controller will override the controller on the drive connected to the middle cable connector.

Visit the web site for specific drive manufacturers to find the proper jumper setting information on that particular drive, if that information is not obvious or available on the drive label. This is especially true when setting the ID jumpers for a SCSI hard drive.

2) Plug the hard drive into the drive cable and power supply cable within the PC (if not already installed), and turn on both the monitor and PC. **NOTE:** if you plug the data cable onto the drive backwards, the drive will likely not spin up. Most IDE data cables are keyed, so that you cannot plug them in backwards. All power connections are keyed, so that they will plug in only one way.

The drive should whir and spin up when power and data cables are attached properly. If the drive does not spin up, remove the drive the system, VIGOROUSLY shake the drive for 10-15 seconds, and reinstall the drive into the system. If the drive does not spin up after this process, the drive is defective and needs to be replaced.

3) Run the ROM BIOS setup program and set the correct drive type. Use the "Hard Drive Auto-Detection" routine in the Setup program to input the drive specifications into the CMOS RAM.
4) Boot the computer, and try to access the drive. If the computer gives you the error message that says "Invalid drive specification", you will need to partition and format the drive, typically with a Windows installation CD or DVD.

**DO NOT** attempt to perform a low-level format of the drive (using Disk Manager, MicroScope 2000 or some other program) unless you are given SPECIFIC instruction to do so from the manufacturer's technical support staff. The low-level format was applied to the drive at the factory, and it makes the drive readable by any operating system.

Specific software, made by that drive manufacturer, can perform such a format; generic programs tend to damage or ruin the drive's formatting characteristics. A low-level format will PERMANENTLY remove the data from a hard disk, and there is no utility software that will let you recover data from a drive that has been reformatted in this manner.

Make sure that you have the proper software to do the job properly; manufacturers have specific programs they distribute that will safely low-level format a drive from that manufacturer. Redoing the low-level-formatting on a drive should be the last possible resort when installing a used hard drive into a system. Refer to pages 34 through 37 of this text for more information on how to prepare a hard disk for use.

5) Use some kind of software to test the hard drive's operation; (Disk Manager, Microscope 2000, etc.). In fact, loading an operating system is a great test for a hard drive. If the drive won't accept an operating system installation, the drive may have serious problems.

6) If the hard drive does not work correctly, double-check and make sure that the hard drive is correctly attached to the PC, and that the setup program has the correct specifications for that particular drive. If the drive is making LOTS of noise, or if the drive becomes VERY HOT after a short period of operation, or if the drive refuses to spin up, then the drive is probably defective.

7) If you're unsure of whether a hard drive is OK or not, contact the drive manufacturer's technical support staff for further assistance.
FLOPPY DRIVE TESTING GUIDELINES

1) Locate the floppy drive in the system; notice the appearance of the drive. It should have a 34-pin data cable and a 4-pin power cable attached to it; if this is not the case, properly attach the cables. The part of cable with the "twist" on it (a method that differentiates the A: and B: drives) should be attached to the A: drive, and if there is a second floppy drive, the other (middle) data connector should be attached to that drive.

2) Run the ROM BIOS setup program and set the correct drive type. Make sure that the "Floppy drive A Type" is set to 1.44 MB. If there is a second floppy drive in the system, indicate that as well in the setup program.

3) If the floppy drive's disk access light stays solid-on all the time and never goes off, this indicates that the floppy drive data cable has been installed backwards. Check for pin 1 on the drive's data cable connector and pin 1 on the floppy drive controller connection on the system board, and make the necessary corrections.

4) Boot the computer, and try to access the drive. If the computer gives you the error message that says "General failure reading drive A:" when reading a known good disk, replace the data cable. If the drive continues to fail with a known-good data cable installed, then either the floppy drive or the drive controller on the system board is defective. Replace the drive with a known-good or new drive; if error messages continue to appear, or if the PC will not boot to the floppy drive, then the drive controller on the system board is defective.

Use some kind of diagnostic software to test the floppy drive's operation, such as Checkit or Microscope. In fact, booting the PC with a bootable floppy disk is a great test for a floppy drive. If the drive won't boot with a good operating system diskette or boot disk, the drive has serious problems.

5) If you're unsure of whether a floppy drive is OK or not, contact the drive manufacturer's technical support staff for further assistance.

NOTE: Floppy drives are essentially obsolete on current-technology computers. However, some users continue to retain important data on floppy disks. Encourage the customer to migrate this data to some other data storage media, like a USB flash drive or a writable CD or DVD.

Many retail stores no longer sell floppy disks, and most PC manufacturers will not install a floppy drive in a new PC, unless the customer specifically requests to do so.
MONITOR / VIDEO CARD TESTING GUIDELINES

1) Notice the appearance of the monitor. If the cable has a 9-pin connector, it's either Monochrome, CGA, or EGA. These are old, obsolete monitor types.

If there is a label on the monitor with 3-colors on it and it has a 9-pin cable connector, then it's probably CGA or EGA. These are old, obsolete monitor types.
If the monitor has the word "Enhanced" on it and it has a 9-pin cable connector, it's probably an EGA monitor. This also is an old, obsolete monitor type.

If you encounter one of these old, obsolete monitor types, take it to a recycling center, so that it can be disposed of in an environmentally-responsible manner.

2) If the monitor cable has a 15-pin connector, it is a VGA/SVGA monitor.

If the monitor cable has a wider connector with more than 15 pins, it is an SVGA monitor with a DVI (Digital Visual Interface) connector.

3) Plug the monitor into the PC's video card connector; turn on the monitor first, and then the PC. Also make sure that the monitor’s power connection is installed correctly.

 NOTE: the cable connectors are keyed so that they fit onto the video card ONE WAY. DO NOT force the cable onto the video card. Notice how the cable is keyed, and insert it onto the video card connector gently. If you force the cable on backwards, you may damage the gold pins on the connectors beyond your ability to repair them.

4) If you hear a series of beep codes (i.e., one long and two short beeps) upon powering up the PC and nothing appears on the screen, then the video card is probably defective or not operating properly. Open the case of the system, then remove and replace the video card to reseat it into the bus connection. If the beep codes persist, then the video card is most likely defective. Replace the video card with a new or known-good card, connect the monitor cable to the card, and continue the testing process.

5) Use some kind of diagnostic software to test the monitor's display capability (Checkit, PC Probe, MicroScope 2000, etc.). Note any messages that the diagnostic software gives you during the testing of your monitor and video card.

6) If the monitor does not display correctly, double-check and make sure that the monitor is attached correctly to the video card. If there is "burn-in" on the screen (ghost images of letters or other images visible on the CRT screen when it is turned off), or if the monitor does not display colors properly, or if the screen appears fuzzy, then the monitor is defective.

7) For both CRT and flat-panel LCD monitors, make sure that the power plug is firmly and completely connected to the monitor. If the LCD monitor has an AC adapter, use a volt-ohm bench meter to ensure the adapter is working properly.

8) If the LCD screen (or the CRT screen) is cracked or physically damaged, do not attempt to power up the monitor. Take it to a recycling center, so that it can be disposed of in an environmentally-responsible manner.

9) If you're unsure of whether the monitor (or video card) is OK or not, contact the monitor (or video card) manufacturer's technical support staff for further assistance.
KEYBOARD TESTING GUIDELINES

1) Locate a keyboard; notice the appearance of the keyboard. **There are 2 current kinds of keyboards: PS/2 and USB keyboards.** Even wireless keyboards will connect to either a PS/2 or USB connection interface on the PC.

Keyboards with 5-pin DIN connector (that are larger than PS/2 connectors) are old and essentially obsolete. If your PC uses an older 5-pin DIN keyboard, replacing such a keyboard may be difficult. Adapters are available to convert PS/2-style keyboards to a 5-pin DIN interface for use in older computers.

2) Plug the keyboard into the PC and turn on both the monitor and PC. Make sure that your PS/2-style keyboard is plugged into the keyboard connection on the system board, and not the mouse connection.

The same rule applies with PS/2 mice: they must be plugged into the mouse plug, even though the connection will fit into the keyboard plug. Many keyboards (and mice) have color-coded connectors, or pictures to show you which device plugs into which connector.

**DO NOT FORCE THE CONNECTORS** into the sockets, and do not try to twist them in or out of the connections on the system board. Breaking the keyboard connector on the system board will require replacing the system board entirely; there is no simple fix for this problem.

For USB keyboards, use any available USB port on the PC (front or back) to connect the keyboard.

3) Use some kind of software to test the keyboard's operation (Checkit, MicroScope 2000, etc.) You can also launch a word processing application, and simply press all of the keys, **one at a time**, to test the keyboard.

4) If the keyboard does not work correctly (i.e., one or more of the keys do not operate), double-check and make sure that the keyboard is attached properly to the PC. Also, make sure that the keyboard is free from anything that might interfere with the operation of any keys (i.e., food crumbs, paper shreds, dust, etc.); use compressed air to clean out the keyboard.

6) If the keyboard is REALLY defective, simply replace the keyboard. It is more cost-effective to replace the keyboard than to attempt to repair the unit.

7) If you're unsure of whether a keyboard is OK or not, contact the keyboard manufacturer's technical support staff for assistance.
FAX/MODEM TESTING GUIDELINES

1) Locate the fax/modem inside your PC; it is the device that has 2 RJ-11 telephone jacks on it. Make sure it is firmly installed into the bus connector.

2) Boot the PC into Windows. Right-click on My Computer, and then select the Properties option; this will display the System Properties icon. Click on the Hardware tab, and then click on the button for Device Manager. Your modem should appear in the Device Manager dialog box. If it does not appear, or if it is listed as an “Other Device,” you will need to run the driver installation program to properly install the fax/modem.

   If the fax/modem does appear in the dialog box, double-click on it in the Device Manager. Click on the Diagnostics tab, and then click on the Query Modem button. A screen of information gathered from the fax/modem should appear. If you receive the error message "The modem failed to respond", then the fax/modem is not operating properly.

3) If you are attempting to re-install the fax/modem, make sure that the fax/modem is not listed in the Windows Device Manager under the "Other Devices" heading. If it is listed there, then the fax/modem has not been properly installed; delete it from the Other Devices heading by clicking once on the modem listing, and then clicking the "Remove" button. The fax/modem must be listed under the "Modems" heading in the Device Manager. If the fax/modem is not listed under the Modems heading, run the driver installation program to properly install the fax/modem.

4) Be sure to use the proper driver for the fax/modem; this driver is typically provided by the manufacturer when purchasing the fax/modem. It is possible that Windows may have a compatible driver for the fax/modem, but it is best to use the driver provided by the manufacturer. The driver installation wizard will prompt you as you install the software driver for the fax/modem. If you do not have the driver, contact the fax/modem's manufacturer to obtain the driver (usually from their web site).

5) Make sure that the telephone cord is properly attached to both the fax/modem and to the wall jack; otherwise, the fax/modem will not be able to make the connection to the telephone line and the Internet. If the telephone cable is questionable, replace it with a known-good telephone cable. If the cable is connected from the wall jack to the “Phone” plug on the modem, switch the cable to the other connector.

6) If the fax/modem works but cannot make the connection to the Internet or to your Internet service provider (ISP), then a problem may exist with your Dial-up Networking configuration. Contact your ISP's technical support staff for assistance. You may need to recreate or reconfigure your dial-up networking icon's settings, or reinstall TCP/IP on your PC.

   NOTE: dial-up networking to the Internet is nearly obsolete, and essentially unworkable for most computer users. Recommend strongly to the customer that they should explore finding broadband options for Internet connectivity (such as DSL, FiOS, cable broadband, or cellular mobile broadband connections).

7) If you're unsure of whether the fax/modem is OK or not, contact the fax/modem manufacturer's technical support staff for further assistance.
SOUND CARD TESTING GUIDELINES

1) Locate the sound card inside your PC; it is the device that has audio jacks and a game port connector on it. Make sure it is firmly installed into the bus connector. In some cases, the sound card is built into the system board.

   Also, make sure that the speaker connection is plugged into the speaker jack, and not into some other jack. Further, make sure that the internal audio cable is connected from the CD-ROM drive to the connection to the sound card (or system board). Also make sure that the speakers are powered up, and the volume level is turned up.

2) Boot the PC into Windows. Right-click on My Computer, and then select the Properties option; this will display the System Properties icon. Click on the Hardware tab, and then click on the button for Device Manager. Your sound card should appear in the Device Manager dialog box. If it does not appear, or if it is listed as an “Other Device,” you will need to run the driver installation program to properly install the sound card.

3) If you are attempting to re-install the sound card, make sure that the sound card is not listed in the Windows Device Manager under the "Other Devices" heading. If it is listed there, then the sound card has not been properly installed; delete it from the Other Devices heading by clicking once on the device listing, and then clicking the "Remove" button.

   The sound card must be listed under the "Sound, video and game controllers" heading in the Device Manager. If the sound card is not listed under the "Sound, video and game controllers" heading, run the driver installation program to properly install the sound card.

4) Be sure to use the proper driver for the sound card; this driver is typically provided by the manufacturer when purchasing the sound card. It is possible that Windows may have a compatible driver for the sound card, but it is best to use the driver provided by the manufacturer.

   The driver installation wizard will prompt you to install the software driver for the sound card. If you do not have the driver, contact the sound card’s manufacturer to obtain the driver (usually from their web site).

5) Make sure that the speakers are connected to the speaker jack, that the speakers are plugged into power (if powered), and that the volume is turned up to an appropriate level. Also, make sure that the volume control application in Windows has not been turned down or set to "Mute". The Windows volume control is accessed by right-clicking on the speaker icon in the system tray (next to the clock), or from the Windows Start menu.

   Attempt to play an audio CD (just drop an audio CD into the CD-ROM drive), or play a sound from the Sounds icon under the Control Panel to test the sound card and speakers. If you hear no sounds, and you are certain that the device has been installed properly, then the sound card is defective.

6) If you're unsure of whether the sound card is OK or not, contact the sound card manufacturer's technical support staff for further assistance.
NETWORK INTERFACE CARD (NIC) TESTING GUIDELINES

1) Locate the NIC inside your PC; it is the device that has 1 RJ-45 twisted pair jack on it (and/or a BNC coaxial cable connector on some older cards). Make sure the card is firmly installed into the bus connector. Some system boards will have the NIC built into them.

DO NOT FORCE THE CONNECTORS into the socket, and do not try to twist them in or out of the connections on the system board. Breaking the NIC connector on the system board may require replacing the system board entirely to correct this problem.

2) Boot the PC into Windows. Right-click on My Computer, and then select the Properties option; this will display the System Properties icon. Click on the Hardware tab, and then click on the button for Device Manager. Your NIC should appear in the Device Manager dialog box. If it does not appear, or if it is listed as an “Other Device,” you will need to run the driver installation program to properly install the NIC.

3) If you are attempting to re-install the NIC, make sure that the NIC is not listed in the Windows Device Manager under the "Other Devices" heading. If it is listed there, then the NIC has not been properly installed; delete it from the Other Devices heading by clicking once on the modem listing, and then clicking the "Remove" button. The NIC must be listed under the "Network adapters" heading in the Device Manager. If the NIC is not listed under the Network adapters heading, run the driver installation program to properly install the NIC.

4) Be sure to use the proper driver for the NIC; this driver is typically provided by the manufacturer when purchasing the NIC. It is possible that Windows may have a compatible driver for the NIC, but it is best to use the driver provided by the manufacturer. The driver installation wizard will prompt you to install the software driver for the NIC. If you do not have the driver, contact the NIC's manufacturer to obtain the driver (usually from their web site).

5) Make sure that the network cable is properly attached to both the NIC and to the wall jack, router, or hub; otherwise, the NIC will not be able to make the connection to the network and/or to the Internet. If the network cable is questionable, replace it with a known-good cable.

6) Some NICs come with a diagnostic program provided by the manufacturer. You should run this diagnostic (if available) to ensure that the NIC is working properly.

7) Most NICs have "link lights" that show if your cable is properly connected to the hub or router. Other lights on the NIC may indicate the data transmission speed of your NIC. If these lights do not illuminate, check the cable connections again, and ensure that the correct software driver for the NIC is properly loaded.

It is possible for the cable connector in the NIC to be damaged, which results in a lack of a proper connection. If this is the case, replace the NIC with another known-good unit.

8) If the NIC appears to be working but cannot make the connection to the network, then a problem exists with your Networking client software configuration. Contact your technical support staff for assistance. You may need to reinstall or reconfigure your network client software, or check your TCP/IP settings, or scan your PC for malicious software that is compromising your PC’s ability to access the network or Internet.

9) If you're unsure of whether the NIC is OK or not, contact the NIC manufacturer's technical support staff for further assistance.
MEMORY TESTING GUIDELINES

1) Insert the RAM to be tested into a known-good PC. Note that each system board requires specific type of RAM; be sure to install the proper type of RAM, and make sure your do not install mismatched types of RAM at the same time.

2) Enter the CMOS Setup program. Make sure the Power-on Self Test is NOT performing the “Quick Boot” or similar option; this typically bypasses all of the major memory tests performed at POST. Save the settings in the CMOS Setup program, and allow the PC to reboot.

3) Let the PC boot to the Windows operating system. If the RAM is working properly, you should not encounter any error messages.

   If you see the “Blue Screen of Death” type of error message while booting, or if Windows fails shortly after loading, defective RAM may be the cause.

4) Boot the PC using a diagnostic software program (such as MicroScope 2000) to test the memory. Such programs can be run from a floppy disk, CD or USB flash drive. Launch the diagnostic program, and run the memory testing portion of the program. It should be able to detect any defects in the system RAM.

5) If after running the memory diagnostic no memory errors are detected, run the memory test again in batch mode. Repeated runs of a memory test over a 20 - 30 minute period will detect errors that occur as the memory is stressed and as the temperature of the RAM increases over time.

6) If memory errors are detected, replace the SIMMs or DIMMs with known-good memory. If no memory errors are detected, run a complete virus scan on the hard drive; some operating system errors brought on by viruses or malware can act like memory errors.

7) If the replacement RAM does not correct the memory problem, ensure that the memory SIMMs or DIMMs are securely seated in their sockets. If the problem persists, there may be a problem with the system board and/or the memory sockets.

8) If you're unsure of whether the memory and/or motherboard is OK or not, contact the memory and/or the motherboard manufacturer's technical support staff for further assistance.
Chapter 5. Procedures for Installing Components

Part of your work as a PC repair technician involves the installation of new or replacement components. It is important to know how to install devices, and how to do the work in the proper order. This next section of the text gives step-by-step instructions on how to install the following types of major devices:

- Hard drives
- CD-ROM drives
- Sound cards
- Fax/modems
- Network interface cards
- Replacement/additional memory

Whenever possible, have available on hand the driver disks and documentation for the device you will be installing. When Windows detects a new device, it will prompt you to load the vendor-supplied device driver, if a driver for the device is not already available to the system. Knowing the brand and model of device you are installing, along with where the driver is located on the installation disk, will speed the process of installing a new device correctly.

It is also valuable to know how to contact the hardware vendor and/or the manufacturer for information and assistance when installing new devices into your computer. If you require assistance in installing a device, the manufacturer or vendor should be able to quickly guide you through any problems.

The installation checksheets that follow are laid out in the following format:

- Tools and parts needed
- Software needed
- Step-by-step instructions
- Installation tips
HARD DISK INSTALLATION CHECKSHEET

Tools and parts needed:
- Flat/Phillips screwdrivers, and an ESD wrist-strap
- Screws, and perhaps drive mounting rails
- Hard drive(s)
- Correct drive cables (IDE, SCSI or SATA)

Software needed:
- Windows installation CD or DVD, Linux installation CD, or other operating system install disk
- Any desired application software

Step-by-step instructions:
1) Open the computer case;
2) If installing an IDE drive, check and/or set the master/slave jumpers on both the old AND new drives; the new (second) drive likely will be set to slave or cable-select, and the drive currently installed will be set to master or cable-select;
   For SCSI drives, set the SCSI ID jumpers to a unique SCSI ID number, and set termination on or off (depending if it is the highest-numbered or last drive in the chain);
   For SATA drives, attach the data cable from the back of the drive to the SATA interface on the system board (no jumpers need to be set on SATA drives);
3) Write down the storage capacity and drive parameters (cylinders, heads, sectors per track, etc.) before mounting drive into PC (consult drive's documentation or company's website if needed);
4) Physically mount the drive into case; use screws and/or drive rails as needed;
5) Attach the cable to the drive(s); be sure to attach the power cable from the power supply;
6) Power up the PC; enter the BIOS setup program and enter the drive parameters into CMOS. Use the hard drive auto-detection feature to enter this information into the setup program for you automatically. Note that SCSI drives should be set in the CMOS Setup program to Off or Drive Type 0 - Not Installed; the SCSI host adapter will identify the drives.
7) Before exiting the BIOS Setup program, make sure the PC is set to boot from the CD/DVD drive FIRST; this is necessary to run the operating system installation CD (or DVD);
8) Exit the Setup program; save the revised information to CMOS and reboot the PC;
9) Boot the PC from the Windows (or Linux) installation CD or DVD;
10) Follow the prompts to partition and format the drive, and then install the operating system;
11) If you are installing a second hard drive in an existing Windows-based system, right-click upon My Computer, and select the Manage option. In the Management Console, select the Disk Management tool, then right-click on the new (unformatted) drive in the dialog box, and select the Partition Drive option. Once the drive is partitioned, you then can right-click on the partition and select the Format option. Use the “Quick Format” option for new drives.
12) Install any required application software as needed;

13) Replace the computer case - do NOT install the cover until you know the drive is working properly.

Installation tips:

1) Hard drives larger than 528 MB need to use the LBA (logical block addressing) mode feature in the system BIOS for the whole drive to be recognized. ALL PCs have some form of LBA mode built into the BIOS.

However, some system BIOS products have an older version of the LBA mode feature that only will recognize drives up to 127GB. If this is the case, and you are looking to install a drive larger than 127GB, you will need to upgrade the BIOS version with software from the PC or system board manufacturer, or use a smaller hard drive that the current BIOS product will accept.

2) If the number of bad sectors on the drive exceeds 5 percent of the total disk space, replace the drive - it's defective. Also, if you get repeated messages where the screen says "Trying to recover allocation unit (some number)", there are problems with the physical surface of the hard drive, and it should be replaced.

3) Be sure to have the 800-number for the drive manufacturer available for technical support if needed. If the drive is still under warranty, contact the manufacturer to obtain a Return Merchandise Authorization (RMA) number, which is needed for the drive to be replaced.

4) Refer to pages 34 - 37 in this text for additional information on the steps required to prepare a hard disk for use.
SOUND CARD INSTALLATION CHECKSHEET

Tools and parts needed:
- Flat/Phillips screwdrivers, and an ESD wrist-strap
- Screws
- Sound card
- Audio cable to attach CD/DVD-ROM drive to sound card
- Speakers

Software needed:
- Installation disk for the new sound card
- An audio CD disk (for testing purposes)

Step-by-step instructions:

1) Open the computer case;

2) Install the new sound card in any free 16-bit black ISA or white PCI bus connection (depending upon the type of bus connection on the card);

3) Attach the audio cable from the CD/DVD-ROM drive to the sound card;

4) Attach the speakers to the speaker connection on the sound card. Make sure the speakers are powered up, and that the volume control is turned up;

5) Power up the PC; run the sound card installation/setup program from the installation CD, or when prompted by the Windows Add New Hardware Wizard; when the install program is finished, reboot the PC;

6) Test the sound card by playing an audio CD, or play back any wave or MIDI files installed on the PC (some samples can be found in the My Music folder). Windows also will generate sounds when it boots up ... listen for these sounds;

7) Replace the computer case - do NOT install the cover until you know the card is working properly.

Installation tips:

1) Be sure to plug the speakers into the right connector on the back of the sound card; also, be sure to check the volume of the speakers (either through the sound card software, or by adjusting the volume control on the speaker or card);

2) Be sure to have the 800-number for the drive manufacturer available for technical support if needed.

3) Many system boards have the sound cards built in. Ensure that the sound card is enabled in the CMOS Setup program; otherwise, the sound card will not function properly.

4) Make sure your have the PROPER driver for the device, and that the driver is compatible to the operating system currently in use on the PC. Improper drivers will prevent the device from operating correctly.
CD/DVD-ROM DRIVE INSTALLATION CHECKSHEET

Tools and parts needed:
- Flat/Phillips screwdrivers, and an ESD wrist-strap
- Screws, and perhaps drive mounting rails
- CD/DVD-ROM drive
- Correct drive cables (IDE, SATA or SCSI)
- Audio cable to attach CD-ROM drive to sound card

Software needed:
- An audio CD and a data CD-ROM disk (for testing purposes)
- Installation CD for DVD playback and/or disk-mastering software

Step-by-step instructions:

1) Open the computer case;

2) If installing an IDE-class CD/DVD-ROM drive, set the master/slave jumpers on both the old AND new drives (normally you will set the jumper to slave on the CD-ROM drive); For SCSI drives, set the SCSI ID jumpers to a unique ID number, and set termination on or off (depending if it is the highest-numbered or last drive in the chain); For SATA drives, attach the data cable from the back of the drive to the SATA interface on the system board (no jumpers need to be set on SATA drives);

3) Attach the CD/DVD-ROM drive to either the primary or secondary IDE interface cable, or install a cable from the SATA CD/DVD drive to the SATA interface on the controller or system board; if the CD/DVD-ROM drive is a SCSI type, attach the data cable to the SCSI host adapter;

4) Attach the audio cable from the CD-ROM drive to the sound card; be sure to attach the power cable from the power supply;

5) Physically mount the drive into the case; use screws and/or drive rails as needed;

6) Power up the PC; run the CD/DVD-ROM installation/setup program for the DVD playback or disk-mastering software; when the install programs are finished, reboot the PC;

7) Test the CD/DVD-ROM drive by installing a program or reading a file from a CD or DVD data disk, or play an audio CD on the new drive, or play a movie DVD, or try to write a new data disk on the drive;

8) Replace the computer case - do NOT install the cover until you know the drive is working properly.

Installation tips:

1) Be sure to note where pin 1 is on the cable connector - plugging in the cable backwards may cause the hard drive to shut down. Most cables are keyed to ensure proper installation, but some are not. Also, be sure to set the master/slave jumper on the drive.

2) Be sure to have the 800-number for the drive manufacturer available for technical support if needed.
FAX/MODEM INSTALLATION CHECKSHEET

Tools and parts needed:
- Flat/Phillips screwdrivers, and an ESD wrist-strap
- Screws
- Fax/modem
- Telephone cable (to wall jack)

Software needed:
- Installation disk for the new fax/modem

Step-by-step instructions:

1) Open the computer case;

2) All modems are now Plug-and-Play compliant, so there will be no jumpers or switches to set; the installation script that runs with the "Add New Hardware Wizard" will install the modem to the correct parameters for you;

3) Install the new fax/modem in any free 16-bit black ISA bus connection or white PCI bus connection (depending upon the type of bus connection on the card);

4) Attach the telephone cable from the wall jack to the jack marked "LINE", and attach your existing telephone to the jack marked "PHONE";

5) Power up the PC; the operating system should detect a new modem; insert the driver installation disk into the CD-ROM drive. Run the driver installation program, and make sure the operating system locates the correct driver for the fax/modem;

6) Install any fax/modem software or on-line software you desire; then, test the fax/modem by attempting to go on-line with the modem software you just installed;

7) Replace the computer case - do NOT install the cover until you know the card is working properly.

Installation tips:

1) Be sure to plug the telephone cable into the proper jack on the fax/modem, and into the wall jack as well;

2) Be sure to have the 800-numbers for the modem manufacturer and/or on-line service available for technical support if needed;

3) If you had a modem previously installed in the PC, delete the previous modem configuration BEFORE you install the new modem; otherwise, the new modem may not be recognized correctly.

4) Use the modem diagnostic available in the Device Manager to test your new modem. On the icon in the Device Manager for your modem, click on the Diagnostics tab, and then click on the "Query Modem" button. If your modem is not working, a screen will appear telling you that the modem failed to respond; otherwise, you will see a screen of information gathered from the ROM chip on your modem indicating your modem is working.
NETWORK INTERFACE CARD INSTALLATION CHECKSHEET

Tools and parts needed:
- Flat/Phillips screwdrivers, and an ESD wrist-strap
- Screws
- Network interface card (NIC)
- RJ-45 network cable (to attach to network wall jack or hub)

Software needed:
- Driver installation disk for the new network interface card
- Network client installation software, and/or your Windows installation CD
- Diagnostic software (if included with your NIC)

Step-by-step instructions:

1) Open the computer case;

2) All NICs are now Plug-and-Play compliant, so there will be no jumpers or switches to set; the installation script that runs with the "Add New Hardware Wizard" will install the NIC to the correct parameters for you;

3) Install the new NIC in any free 16-bit black ISA bus connection or white PCI bus connection (depending upon the type of bus connection on the card);

4) Attach the network cable to the RJ-45 jack on the NIC, and make sure the other end is attached to the hub, router or network wall jack;

5) Power up the PC; the operating system should detect a new NIC; insert the driver installation disk into the CD/DVD-ROM drive, and make sure the operating system locates the correct driver for the NIC;

6) Test the NIC by attempting to log onto the network or access the Internet. Also, you can run the command IPCONFIG from the Command window to see if you have obtained an IP address for your NIC;

7) Replace the computer case - do NOT install the cover until you know the card is working properly.

Installation tips:

1) Be sure to plug the network cable into the jack on the NIC, and into the hub, router or network wall jack as well. Make sure the link lights are illuminated, indicating a proper connection to your router or hub;

2) Be sure to have the 800-numbers for the NIC manufacturer and/or on-line service available for technical support if needed;

3) If you had a NIC previously installed in Windows, delete the previous NIC configuration BEFORE you install the new NIC; otherwise, the new device may not be recognized correctly.

4) Run any diagnostics that came with the NIC, if available, to test the device. Simply getting onto the Internet or logging into the network is a good test.
MEMORY INSTALLATION CHECKSHEET

Tools and parts needed:
- Flat/Phillips screwdrivers, and an ESD wrist-strap
- Memory SIMM, SODIMM or DIMM units

Software needed:
- Diagnostic software, such as MicroScope 2000 (or a comparable diagnostic)

Step-by-step instructions:
1) Open the computer case;
2) Locate the available slots for the new memory; if all of the slots are filled, you will need to replace the existing memory with similar SIMMs or DIMMs of higher capacity;
3) SIMMs and SODIMMs are notched so that they only insert into the socket one way; insert the SIMM/SODIMM at an angle, making sure that the memory is fitting into the socket, and tilt the SIMM/SODIMM until it locks into the socket in a upright position.
4) DIMMs have two or three different-sized segments on the bottom of them, ensuring that they only insert one way into the socket; place the DIMM directly into the socket, and press one corner down into the socket, and then the other corner. When they insert properly, the two arms on the DIMM socket will lock upright and keep the DIMM from coming out of the socket;
5) Power up the PC; the Setup program and the operating system should detect a new memory; enter the setup program for the PC, verify that it sees all of the new memory, save the new configuration and exit the setup program.
6) If the computer gives you an error message about "unreliable XMS memory", this indicates that your memory is defective, mismatched with your existing memory, or not configured properly in the BIOS. Reboot the PC, enter the Setup program, and look for any memory timing setup features under the "Advanced Chipset Setup" portion of the Setup program, and make sure that the values are proper for the type of memory installed in the PC.

Installation tips:
1) Be sure to match the new memory up with the existing memory in the system; all of the memory units should be of the same type and speed (but not necessarily from the same manufacturer). If they are not, problems are likely to occur.
2) Have the memory tested by the vendor BEFORE completing the sale; most memory vendors will test the new memory for you at no charge before completing the sale.
3) Be sure to have the 800-numbers for the modem manufacturer and/or on-line service available for technical support if needed. Most memory comes with a LIFETIME warranty;
4) Booting and running Windows for 30 - 60 minutes is typically an adequate test of whether your new memory is working properly.
Chapter 6. Troubleshooting Guidelines

A major part of the A+ certification program revolves around the technician’s ability to assess the condition of a PC, identify the problem with the PC, and then apply the proper solution to the problem. Sometimes the problem is located with the hardware, sometimes the problem is with the software, sometimes it can be a combination of the two, and sometimes the problem is because of user error. Your job is to determine, as quickly as possible, the nature of the problem and implement the proper solution. In this section of the text, we will cover material that will help you to become an adept PC problem troubleshooter.

Diagnostic software

A good piece of diagnostic software can quickly identify a problem with a defective piece of hardware, or at least let you determine that the problem is with something other than the hardware of the PC. Diagnostic software is as important to the technician as a set of tools or an ESD strap. There are several utilities that are worthy of consideration that can help you to accurately troubleshoot and diagnose problems with a computer. They are described below.

Note that the author has no financial or fiduciary investments related to the recommended diagnostic programs described in this chapter of the text.

MicroScope 2000

MicroScope 2000 is, in this author’s opinion, the best diagnostic program available to the PC technician today. The breadth of capabilities and its independence from any particular operating system makes it the diagnostic software of choice for the serious PC technician. Below is an extensive list of the features in MicroScope 2000:

- Micro2000, Inc. created a proprietary operating system (MS2000) written in assembly language and specifically designed for hardware diagnostics. This allows for direct access to the hardware for all tests. Because it entirely eliminates the DOS and Windows translations, there are none of the inaccuracies common to all O/S dependant diagnostics. With O/S independence, Micro-Scope can be run on any PC regardless of the operating system Micro-Scope’s own O/S overrides Windows, DOS, Unix/Linux, OS/2, and any other operating system.
- Automatically interrogates and displays the actual hardware configuration of the PC, and simultaneously displays the CMOS and POST information, and automatically flags all inaccurate settings.
- Directly queries the hardware to identify the exact device such as CPU, NPU, BIOS name and version, detailed fixed disk information, video information, and port information. Information is extremely detailed to include items such as hard drive manufacturer name and model number. System information spans 3 full screens of vital information. Now incorporates data from DMI, Plug & Play, and PCI resources. Support added for all the latest CPU’s from Intel and AMD.
- Gathers information pooled from the DMI (Desktop Management Information) area of the BIOS, the DMI screens show extended system information such as bus types supported on the system board, maximum speed and voltage settings for the CPU, and cache size and type. Know how many free DIMM sockets are available or what kind of RAM is in the system without having to open the case.
• Complete I/O port scanning identifies all I/O port usage even if two or more devices are using the same resources. Specific device-type routines identify device type, IRQ usage, and DMA usage. This is absolutely essential for upgrading and adding hardware. Checks PCI and Plug & Play devices.
• Shows detailed information on all IDE devices including model, serial number, and firmware version.
• Shows detailed information including manufacturer name, product name, and SCSI bus width support.
• Provides actual locations on all installed and active Plug and Play devices.
• Provides all PCI devices on the bus and provides basic parameters for each listed device including device number, ID, type, subtype, and device attributes.
• Micro-Scope identifies the USB host controller on the motherboard if one is present. NEW! Tests the host controller's functionality on the system board. Works with Universal and Open Host USB controllers.
• This feature allows manufacturers and service organizations to verify the hardware configuration of a system by comparing against a master configuration file created with Micro-Scope.
• Allows continuous or pass-bound running of all tests or series of tests, and automatically generates a full diagnostic report which can be saved to a diskette or output to the printer. New printer-friendly report now generates reports for printers with narrower margins.
• 100% accurate testing of the CPU, NPU, 16 IRQ channels, 8 DMA channels, Real Time Clock, Keyboard controller, Clock Timer Chip, PS/2 Mouse controller, and speaker.
• Base memory can be tested prior to loading the entire diagnostic program, so even errors under 64k, which would prevent other diagnostic programs and operating systems from loading, can be found.
• Micro-Scope has extensive testing of the memory with no upper limit. Memory test uses special cache avoidance steps to ensure the problem lies in the memory and not in the cache. A wide array of tests are designed to find even obscure memory problems including physically mis-linked and refresh issues. Tests include Pseudo-Random, Xor'ed Address Test, Bit Test, Proximity Test, and Pattern Test. Tests have been revised to allow more control of test length.
• Accurately tests video adapter to the extent of the capabilities of the card regardless of monitor limitations, and all video memory without size limitations. Micro-Scope now tests video RAMDAC (if supported by the video card), screen focus testing, and extended VESA testing.
• Feature allows Micro-Scope screen images to be captured to an ASCII text file. This improves the ease with which diagnostic information may be collected.
• Performs or initiates a low-level format on all drive types (MFM, RLL, ESDI, SCSI, and all IDE drives). This includes factory-type initialization of all IDE drives, as well as access to true factory-style format routines. This feature will Low Level Format drives even if the BIOS LBA functions are enabled. All EIDE drives now fully supported.
• Accurately restores master boot records in DOS machines which have been corrupted or damaged by viruses. Displays and edits in decimal format any boot sector and volume boot on any hard drive, allowing technician to edit the proper information. Includes editors for both floppy and hard disk for displaying and editing any data anywhere. Support for Fat 32 has been added, allowing the display and editing of FAT 32 partition structures. Advanced search functions for the Fixed Disk Editor have also been added. The new search function will allow the user to define a physical range to search for data on the drive.
• Accurately tests all Internal and External cache memory. All cache sub-systems are tested to identify the exact failure. Micro-Scope will also determine if the cache controller within the system is active. Extensive pattern tests test cache as thoroughly as Micro-Scope’s Extended Memory tests.
• Performs Read, Write, and Butterfly Seek tests on any fixed disk. Also displays and edits physical parameters, partition parameters, and CMOS parameters on any drive. This is not a database and does not have to be updated. Distinguishes the drive controller from the drive mechanism, (impossible under DOS) and finds any physical or electronic defect on the drive or the controller. Allows for relocating Track 0 on supported IDE drives. Safe Write Test allows user to perform a write test without destroying any data on the drive.
• Accurately tests any portion of a floppy drive, including read, write, format, safe write, and butterfly seek tests. Tests all media formats up to 2.88mb and includes a user-defined option for higher media formats.
• Accurately tests all Internal and External cache memory. All the memory and cache sub-systems are tested separately to identify the exact failure. Micro-Scope will also determine if the cache controller within the system is active. This test has been enhanced to now run under DOS or Windows.
• Complete and accurate testing of mouse, joystick, keyboard, printer, and sleep button.
• Provides the most extensive and accurate port testing available, far surpassing the capabilities of DOS or Windows based diagnostics. Any possible error will be detected and identified. All ports tested, regardless of IRQ or I/O port assignment. All lines are tested on the external tests with the included loopback connectors. Instantly identifies UART capabilities. Also test FIFO capabilities of any serial port having these capabilities. Micro-Scope detects the interrupt a serial or parallel device is actually using, regardless of how it is believed to be configured.
• Tests modems in connected or non-connected mode, including major AT modem commands. Retrieves modem's information directly from the modem's chipset.
• Performs Read and Seek tests of CD-ROM, CD-ROMs in DVD drives, and CD-R drives. Soundblaster (including Soundblaster compatibles), and Adlib tests include full synthesizer tests. These include frequency tests as well as volume and gain control testing for left, right, and stereo channels on all Soundblaster and Adlib cards.
• SCSI Testing includes testing the Read, Write, and Seek capabilities of SCSI drives.
• Tests Read and Seek functions of removable drives including LS-120, Iomega ZIP, and IDE CD-ROM drives. IDE CD-ROM drives can even be tested without drivers.
• Allows the user to directly make BIOS data calls to retrieve information. Invaluable in locating specific information within the BIOS itself.
• The benchmarks in Micro-Scope are based upon the Real Time Clock (RTC), and not on making a comparison to another system like other utilities on the market. Because of our direct hardware access we are not subject to significant I/O delay introduced by the BIOS.
• Display and edit CMOS settings. Very useful for setting up older machines for which the original setup diskette is no longer available.
• Most companies only offer 30 days of free support. After that you’re on your own or you have to pay a fee. Micro 2000 gives free lifetime technical support for all diagnostic products.


**CheckIt Utilities**

CheckIt Diagnostics extends beyond your PC. Now you can diagnose problems with your hard drive and find problems with USB, FireWire and other ports, as well as routers. CheckIt Diagnostics also tests connections to the latest hardware and plug-and-play devices like web, video and digital cameras, MP3 players, wireless modems, Windows Mobile devices, printers, scanners and more.
For performance-oriented users, CheckIt's comprehensive benchmark feature compares the system to other PC's to gauge relative execution speed. In addition, an all-new Stress Test feature simultaneously exercises core components of the PC to seek out potential problems in multi-tasking use. Concurrent operation of the hardware diagnostics thoroughly puts a PC through its paces, and can help to assess whether a machine is capable of reliable Windows computing. CheckIt combines all these features to provide you with the strongest 32-bit diagnostics available today.

**Hardware Tests**
After thoroughly examining the system hardware, CheckIt can then put it to the test. Included are individual diagnostic tools for testing the motherboard, drives, memory, I/O ports and more!

Discover issues with USB, FireWire and other ports, as well as routers. Test connections to hardware and plug-and-play devices such as web, video and digital cameras, MP3 players, wireless modems, Windows Mobile devices, printers, scanners and more. CheckIt Diagnostics also repairs Codecs, Drivers, and system software registry.

**System Tune-Up**
CheckIt brings together Windows utilities in one place to: Find and fix hard drive errors, speed up program launches, clean up your Start menu & improve Windows load times.

**Excellent in Hardware Detection and Reporting**
CheckIt will thoroughly interrogate the system hardware and report the findings to you in an easy to understand format. It will also help you set up new hardware to run correctly and efficiently.

**Quick Problem Solvers**
With CheckIt you don't need to be a computer expert to solve problems. The built-in Troubleshooter automatically flags problem areas. Then by asking you a series of questions, helps guide you to the root of the problem - quickly and easily.

**Windows XP through Windows 7 Support**
CheckIt provides a suite of tools to diagnose and troubleshoot system hardware under Windows XP through Windows 7. Use CheckIt on a server or workstation to make sure valuable data is being handled safely.

To obtain further information about CheckIt Utilities, visit their website at [http://www.smithmicro.com/checkit/](http://www.smithmicro.com/checkit/).

**Problem solving guidelines**
Repairing a faulty PC can be a challenge, but there are ways to systematically test and check a PC to determine the nature of the problem and apply the proper solution. Begin by using these following ten rules when repairing or trouble-shooting a computer (this section is repeated from earlier in the text):

1) **Gather together your toolkit and any necessary documentation for that specific computer.** You may also want to have these course notes available and/or any other good resources for technical specifications and system disassembly guidelines.

2) **Check for power FIRST, before doing anything else.** 10 - 15 percent of all trouble calls are for nothing more than a popped circuit breaker or a loose plug. Check these things BEFORE doing anything else.
3) **Check your external connections to the computer.** Specifically, check the mouse, keyboard, monitor, modem and/or printer cables, making sure that all are secure and installed in the right sockets.

4) **If the computer is still malfunctioning, go ahead then and open the case.** Check to see that all of the cards are fully pressed down into the bus connections, that any socketed chips are fully pressed into their sockets, and that all cable connections are fully attached. Make sure that the drive cables are attached so that the colored stripe on the cable is positioned next to pin 1 on the connector.

5) **Clean any dust or foreign material out of the case while it is open.** Dust can cause overheating problems and electrical shorts. This is especially a problem with power supply cooling fans and CPU heat sinks. All of this needs to be cleaned out before you close up the case. Use compressed air and non-conductive materials to clean out the inside of the case. Take precautions to avoid inhaling excess dust, and consider using protective eyewear if necessary.

6) **Try to boot the computer to the hard drive, or to a bootable CD/DVD disk if necessary.** Sometimes the hard disk will become corrupted by a user, or by a virus. If you can't access the hard drive directly, have a bootable CD or DVD disk available (like your operating system installation disk). Have a good disk diagnostic program available, and a good virus checking program as well. If your data is severely damaged, you may need to wipe the disk and reload the data from original or system recovery CD/DVD disks. Also, if your PC will boot to a USB drive (such as a flash drive or external hard drive), see if the system will respond and boot from these devices.

7) **Check the CMOS setup program, and correct any configuration problems.** If the information in CMOS RAM about your PC's configuration has been changed, or if the battery has died, your computer will not boot correctly, or it will not recognize certain components. Keep a copy of your setup program information handy, so that if something changes, you can correct the problem. Replacement CMOS batteries are usually less than $15.00, and are readily available from computer and electrical stores. Such batteries should last about 2-5 years.

8) **Look for unwelcome changes.** Someone may have turned the brightness down on a monitor, or the LAN staff may have changed your PC's configuration without your knowledge (or approval), or an installation program may have corrupted something in your software. Look for recent changes in your system's operation. You may need to run an uninstaller program to remedy software-related problems.

9) **Isolate the problem to one piece of hardware, or one software package.** The problem you are encountering may occur only in one software package, which means the problem has a very limited scope. If the problem occurs in all programs, then it's a systemic problem. Refer to software and operating system manuals as needed, and have the original software disks available, in case a driver needs to be reloaded. If the system just won't fire up, remove all non-essential components, and see if you can cause the problem to re-appear by re-installing components one-at-a-time. This process is usually quite helpful in trouble-shooting even the most stubborn problems.

10) **When all else fails, read the manual.** There may be something unique about your computer that requires special attention as directed by the manufacturer.
Proprietary Systems vs. Conservatively Designed Systems

Proprietary computers systems present a variety of challenges to the repair technician. Proprietary systems require parts made specifically by a certain vendor for a specific type of computer they have manufactured. For example, many Compaq computers require Compaq hard drives or Compaq memory when upgrading a system or replacing a defective part. These types of problems are common with the major computer manufacturers such as Hewlett-Packard, Compaq, Dell, Toshiba or IBM.

Further, many manufacturers have designed their computers so that most or all of the devices for that system have been built into the system board. Such computers may have sound cards, video cards and/or network interface cards built into the motherboard. This is fine until the system breaks ... the cost of replacing such motherboards out-of-warranty usually exceeds the cost of the computer system itself.

Manufacturers like Dell and HP/Compaq routinely make such systems (as do the manufacturers mentioned in the previous paragraph). In order to obtain replacement parts in many cases, you must become an authorized repair and parts facility for that manufacturer, and this usually involves paying a fee of several thousand dollars to the company, and then holding several thousand dollars worth of parts inventory in addition to the fee. You may encounter a variety of problems when attempting to service proprietary systems.

Many local computer "home-brewers" build conservatively-designed PCs. These companies build PCs using name-brand parts that are designed to be put into standard PC cases, and will accept a wide range of computer components such as video cards, sound cards, modems and network interface cards. There is nothing proprietary in any of these systems ... they are intended to be competitive with better-known name-brand PCs, many of which have similar components built into them. In fact, they offer the computing customer tremendous options when looking to build a customized system that exactly fits the user's needs. Whenever possible, encourage a potential consumer that conservatively-designed systems offer significant advantages over proprietary, name-brand systems.

NOTES
Many people nowadays prefer to build their own custom-designed PC, rather than buying a pre-built PC made by a major company or local PC vendor. Building your own customized PC has a number of advantages over purchasing pre-built name-brand computers. Custom PCs can be less expensive than pre-built name-brand PCs. However, depending upon the kinds of components you put into a custom PC, the cost can exceed a name-brand PC being sold at a sale price. So why would you want to build your own PC?

Conservatively-designed PCs give you more customization options, and are cheaper to repair than non-conservatively designed PCs

A conservatively-designed PC doesn't have a lot of extra devices built into the motherboard, such as:

- Video cards
- Network cards
- SCSI host adapters
- Sound cards

It is better, from a repair standpoint, to have these devices plugged into the bus connectors of the motherboard as separate devices than to have them integrated into the motherboard. Why? These individual devices are easy to replace and much less expensive than replacing an entire motherboard for the failure of a single part on that motherboard.

Admittedly most motherboards have many of these devices built into them nowadays. However, the argument for having separate cards for different system components is still a valid one. The author recommends that if you do purchase a motherboard as a part of building or upgrading a PC, you should get one that has as few peripheral components as possible.

The user can decide which brands, what level of quality, and what level of cost they wish to spend on their system.

With a custom built PC, the user can decide which brands and models of devices are installed into the system, and he/she can decide what level of quality is built into the PC. One can buy an inexpensive component now, and purchase a more expensive component at a later time when funds become available.

The same name-brand components found in pre-built name-brand PCs are also found in custom-built PCs.

Some people, when purchasing a PC, consider a name brand on the front of the case as a guarantee of a quality computer. This is not necessarily true. The same kinds of name-brand components, such as memory, hard drives, and motherboards, are found in custom-built PCs. In fact, customers who build their own PCs usually do extensive research to find out which brands of components are the best, so that they can build them into their new computer. If you know the quality of a name-brand component and how it compares with other brands, you can make intelligent decisions about what you do or don't want in your PC.
There are some simple rules you should use when you are preparing to buy and/or build your own PC:

1) **Know what you want BEFORE you go looking or buying.** Many people get convinced they need a more expensive or "powerful" computer, when in fact they do not. People who do word processing for a living do not need a 3GHz Pentium-based computer necessarily; a 1GHz-based PC will do just fine when buying new. DECIDE WHAT YOU WANT THE COMPUTER FOR BEFORE YOU BUY IT! Let your software choices and intended uses of the PC drive your purchasing choices, not what some salesman says. If necessary, bring a knowledgeable person along who can help to sort out the truth from the noise.

2) **Comparison shop different stores: DON'T buy on impulse.** Write down what you want to buy, being as specific as you can. Compare the prices quoted by the vendor; call the company if necessary and have them give you a price quote. Many will even fax you a price quote. If you like a system and it's $40 more than a competitor's price, see if they will match the price - many will do this. Take at least 2 weeks to go through this process.

3) **Get ALL promises for service & support IN WRITING before buying the PC.** Verbal agreements between you and the salesman are never binding in a court of law, if things should get to that point. Therefore, get any warranties, service agreements, and support agreements IN WRITING before you buy your PC. Speak to a supervisor or manager if necessary, but don't accept any verbal agreements as binding commitments.

4) **If you have a vendor build the PC for you, test the computer before it leaves the store.** Nothing is more frustrating to the new computer owner than to find that the 3.0Ghz Pentium system will only run at 2.0Ghz, or that your DVD drive doesn't work, or that your monitor has squiggly lines all over it when you leave it on for more than 10 minutes. The store should have already tested the computer before you pick it up, but this isn't always necessarily the case. It only takes 5-10 minutes to assemble the system and test everything; insist on doing this. Use a diagnostic program to check and evaluate the operation of your computer. If something's not right, insist that the vendor correct the problem BEFORE it leaves the store. Use the same rules when buying a used computer from someone's home: run diagnostic software on it BEFORE you pay for the unit.

5) **Properly configure your application software BEFORE you venture into the PC world.** The main reason new PC owners get so frustrated is that they don't know how to get in and out of their new application programs. Have the store or some well-trained PC maintenance person set up the programs on your hard disk. By doing this, you will be able to use your programs immediately. Recommend that the user take introductory classes at a community college or training facility, so that they can get the maximum benefit from their new computer.

Above all, CAVEAT EMPTOR (Let the buyer beware!).

On the next page is a basic checklist for building a PC from scratch. Use this as a guideline for the basic assembly of your new computer.
NEW PC BUILDING CHECKSHEET

Tools and parts needed:
- Flat/Phillips screwdrivers, and an ESD wrist-strap
- Needlenose pliers and/or wire cutter
- Case/power supply (including screws, plastic standoffs, and drive mounting hardware)
- Motherboard and CPU, floppy and hard drives, memory, drive cables, audio cables, video card, CD-ROM drive, sound card, fax/modem, CPU cooling fan

Software needed:
- Some kind of diagnostic or system testing program
- A Windows or Linux operating system installation CD or DVD
- Any desired application software
- Installation disks for the new sound card, CD/DVD-ROM drive, video card, and other devices
- An audio CD, data CD-ROM, and a DVD-ROM disk (for testing purposes)

Step-by-step instructions:

1) Open the computer case;
2) Mount motherboard to case using plastic standoffs, as well as bronze standoffs and screws (be sure to use screws only on grounding points - use plastic standoffs elsewhere); the motherboard MUST be flat, steady, and not grounded out against the case;
3) Attach the power supply connection to the motherboard, and attach the speaker connection; test the motherboard to see that it is working correctly (it should give 3 long beeps, provided that no memory is installed); power down the PC;
4) Install the SIMMs or DIMMS (memory modules) onto the motherboard, and apply power again; you should get an audio error code (a series of beeps) indicating there is no video card installed; if there is no change, check the installation of the SIMMs or DIMMs; if correct, power down the PC;
5) Install the video card, and attach the monitor; power up the PC and watch the monitor to see that POST is testing the PC; if there is no change, check and/or replace the video card; if correct, power down the PC;
6) Mount all drives to the case; attach drive cables to the drives, and then attach the cables to the interface card or motherboard; be sure to install the cables so that the stripe on the cable is closest to pin 1 on the connector; be sure to attach power cables to all drives;
7) Power up the PC, and enter the CMOS setup program; enter into the program the exact types of hardware found in the PC (specifically video, memory size, floppy/hard drive parameters, etc.); save the information to CMOS RAM and reboot the PC;
8) Boot the PC from the Windows (or Linux) installation CD or DVD; begin the operating system installation process, partition and format the hard drives, and install the drivers for any other installed equipment (CD/DVD-ROM, sound card, video card, fax/modem, etc.);

* Use the installation checksheets found in chapter 5 of this text for installing hard drives, CD-ROM drives, sound cards and fax/modems; these check sheets will assist you in the PC building process. Also, refer to pages 34 through 37 of this text for a list of the steps involved in preparing a hard disk for use.

9) Run some kind of diagnostic software to ensure that the PC is working properly; also, run a burn-in test program for 12-36 hours to check the system under load conditions;
10) Replace the computer case - do NOT install the cover until you know the system is working properly.
Installation tips:

1) Take things one step at a time. Do not rush, and do not proceed to the next step until you are sure that what you just installed is working properly;

2) Make notes of what you do, and observe the little things; for example, notice that the wires to the dashboard lights on the case usually are labeled to show what they are, and that the motherboard (and/or the motherboard documentation) indicates where the wires should be plugged; notice beep codes, error messages on the screen, and funny smells;

3) Be sure to have the 800-numbers for the hardware manufacturers available (whenever possible) for technical support if needed. Also, have the name and telephone number of the hardware vendors for the devices you are installing in your PC; if any troubles occur, contact the vendor for assistance.

4) Refer to the various installation checksheets for different devices (hard disks, sound cards, etc.) to assist you in each step of the PC building process.

Some additional tips concerning the proper way to install a motherboard to the case:

**Plastic Standoffs**

When you install a motherboard, DON'T screw it directly down to the chassis of the case!

You mount it to the case, using the little plastic standoffs provided when you buy the case and power supply (if you don't have any, let me know, and I'll get you some). These standoffs keep the board from shorting out against the case, and they provide enough stability to the board so that you can push cards into the bus connections. If you don't install the standoffs correctly, any of the following things could happen:

- The board touches against the case and shorts out, potentially damaging the motherboard and other installed components
- You crack the motherboard when installing the cards into the bus connections
- You allow the board to warp into an unnatural position by leaving it unsupported

The plastic standoffs have 2 ends to them: one that snaps into the holes on the motherboard, and one end that goes into little slots or grooves on the case. The idea is to have the bottom part of the standoffs slide into the pre-made holes on the case.

If you find that there is a need for a plastic standoff, BUT there is no hole on the case for it, cut the bottom off of the standoff, and let the standoff rest on the chassis. This will ensure that the motherboard doesn't touch the case.

**Grounding Points**

On most motherboards, there are CERTAIN holes that are designed as grounding points, that are intended for you to screw the motherboard down to a metal standoff on the case. These grounding point holes usually have a silvery-appearance around them. They are designed to take either a metal screw or a plastic standoff when mounting the board. When using a new case, you will find a bronze metal standoff (or two) in the package of screws that comes with the case. You will usually need to mount only one of these bronze standoffs on the case, and mount the motherboard with a metal screw at that point only.

If you mount a metal standoff and a screw into a hole that is NOT a grounding point, you can short out the motherboard and PERMANENTLY damage it. Be very careful to notice the appearance of the holes in the motherboard, and never screw the board down to a hole that is not a grounding point.
Power Supply Connections

On ATX-style power supplies, the main 20-wire plug to the system board has been designed into a single connector, so that the user has only one connection to make on the system board. Further, the connector has been keyed so as to go onto the system board only one way. If the connector does not appear to be plugging in correctly, try turning the connector around. If your power supply has an additional 4-wire plug to the system board, it too has been designed to connect only one way. Make sure to install both the 20-wire and the 4-wire connectors before powering up the system.

Mount the motherboard and apply power first ...

When installing the motherboard to the case, use the proper guidelines for mounting the motherboard to the chassis. Then, attach the power supply connections and the PC speaker ONLY: no RAM, no video card, etc. Power the system up and listen for 3 low-toned beeps. If you hear these beeps, the motherboard is OK (it powers up and finds the CPU). If you hear no beeps, check your power and speaker connections, ensure the CPU is installed OK, and make sure the board is not grounding out. If this does not resolve the problem, replace the motherboard.

Then, install the memory ...

Install the memory to the motherboard; be sure to put it in the right DIMM sockets (look for the designation "BANK 0"). You may need to set some jumpers on the board to get the memory to be recognized properly; also, many boards require more than one DIMM on the board at a time.

Once you install the memory, power up the system and listen for a different set of beeps (usually 2 high short beeps and 7 or 8 lower-toned short beeps). These beeps are telling you that the video card cannot be found (mainly because it hasn't been installed yet!). If you get such a beep sequence, you can continue and install the video card. If you still get the three low beeps as before, check and re-install the memory. If the memory is installed correctly and you continue to get only the three low beeps, replace the memory.

Then, install the video card and monitor ...

When you have the motherboard and memory installed correctly, then you can install the video card into the system and attach a monitor. When properly installed, you should be able to see the computer going through POST on the screen. If not, then you may have a problem with the video card (check for 1 long and 3 short beeps) or the monitor. If the system hangs after installing the video card, the video card is probably defective, or not installed correctly. If you see no video on the screen after checking the video card, then either the monitor is off (or without power), or the monitor is defective.

Then, install the drives and drive controllers ...

Once you have motherboard, RAM, and video installed properly, attach the drives to the drive controller/interface. Be sure to get the cable stripes attached next to pin 1 on the interface connectors. Also, be sure to attach power cables to the drives. You may now also install the keyboard.
Then, power up and run the CMOS Setup program on the BIOS ...

When the drives are fully connected, then run the Setup program. Watch the screen to tell you what keystrokes to use in order to enter the Setup program. Use the "Auto-detect" feature to detect the IDE-class hard drive(s) in your system. If the auto-detect feature does NOT find the hard drive(s), then power down and re-check your connections. If the computer still cannot find the hard drives (or floppy drives), then either your cables are bad, the controller is bad, the power to the drives is bad, or the drives themselves are bad.

If the drives are recognized by the auto-detect feature, save the setup information and reboot. You can now begin loading the operating system onto the PC, and begin software loading as well. Refer to pages 34 through 37 of this text for more information on the steps involved in preparing a hard disk for use in a PC.

NOTES
Chapter 8. Printers

This section of the text will discuss the operation, maintenance and repair procedures for the three main types of printers in the market today: Dot matrix printers, ink-jet printers, thermal printers and laser printers. There will be a number of questions on the A+ examination about how certain types of printers operate, how they are to be serviced in the field, and how you should properly install a printer onto a computer system.

Impact / Dot matrix printers

Dot-matrix (impact) printers use an electromagnet to fire a series of wire pins against an inked ribbon, which in turn impacts upon the paper which is mounted on a platen (a hard rubber roller). Dot matrix printers use either 9, 18 or 24 pins to fire from the print head onto the ribbon and paper; the more pins in the print head, the better the quality of printing. 18 and 24 pin dot matrix printers are considered letter-quality printers, while 9-pin printers are considered near-letter-quality printers. Even though ink jet printers and laser printers are commonplace now, dot matrix printers still serve useful purposes in the computing community. Many businesses use dot matrix printers to print multi-part carbonless forms, so that both the vendor and customer have duplicate copies of a form in one printing pass.

Ink jet printers

Ink jet printers use a piezo-electric crystal or similar mechanism to shoot a stream of pressurized ink from a nozzle onto the paper. The quality of ink jet printers can rival laser printers, and ink jet printers can also produce color printing output as well. The major drawback of ink jet printers is that the ink jet nozzle can become clogged over time, and the ink cartridges usually will not print more than 100 pages before needing to be refilled or replaced. Further, most inks used by ink jet printers are water-soluble, and can run if the page becomes wet.

Thermal printers

As the name implies, thermal printers use heat to transfer an impression onto special kinds of paper. You probably encounter thermal printers everyday: many receipt printers at point-of-sale terminals are thermal printers. Also, older fax machines that used rolls of paper typically are thermal printers.

There are two main kinds of thermal printers:

Thermal wax transfer: a printer that adheres a wax-based ink onto paper. A thermal printhead melts wax-based ink from the transfer ribbon onto the paper. When cool, the wax is permanent. This type of thermal printer uses an equivalent panel of ink for each page to be printed, no matter if a full page or only one line of print is transferred.

Monochrome printers have a black page for each page to be printed, while color printers have either three (CMY) or four (CMYK) colored panels for each page. Unlike thermal dye transfer printers, also called dye sublimation printers, these printers print images as dots, which means that images must be dithered first. As a result, images are not quite photo-realistic, although they are very good. The big advantages of these printers over thermal dye transfer printers are that they don't require special paper and they are faster.

Direct thermal: a printer that prints the image by burning dots onto coated paper when the paper passes over a line of heating elements. Early fax machines used direct thermal printing, as do receipt printers commonly used at point-of-sale (POS) terminals.
Laser printers

Laser printers use an photo-electrostatic process to deposit and fuse onto a piece of paper an image transmitted from the computer. Paper and toner are given opposite electrostatic charges, which causes the toner to adhere to the page. A heat roller melts the toner into the paper, to permanently affix the image to the paper as it is ejected from the printer.

Stages in the Laser Printing Process

There are six distinct stages involved in creating a printed page with a laser printer. Listed below is a description of each of these six stages. These are required knowledge for the A+ examinations:

1) Conditioning Phase

In this phase, a uniform negative electrical charge is applied to the drum unit within the laser printer (or within the toner cartridge). At the same time, a uniform negative charge is also applied to the paper as it passes by the corona wire (or corona transfer roller) within the printer. This will permit the image to be electrostatically transmitted from the drum to the page during the transfer stage, when positively-charged toner will be attracted to the page.

2) Writing (or Exposing) Phase

In this phase, the laser diode within the printer writes (or exposes) an image to the drum; this image is what will be written out to the paper, once the toner is applied to the drum and then transferred to the paper.

3) Developing Phase

In this phase, the portion of the drum that was written to by the laser is exposed to toner. The toner is attracted to the image written on the drum by the laser, and the toner image is created. The toner dust has a positive charge, and will be attracted to the drum.

4) Transfer Phase

In this phase, the image on the drum (which is just toner dust arranged into a pattern) is electrostatically transferred from the drum to the paper. Specifically, the positively-charged toner is attracted to the negatively-charged paper, and the image is laid out upon the paper. The charge on the paper has a greater potential than the charge on the drum, and so the image is transferred to the paper.

5) Fusing Phase

In this phase, the paper (with the toner applied to it) is quickly heated by the fuser assembly, and the toner image is pressed into and melted onto the paper. In this way, the image is permanently preserved on the page.

6) Cleaning Phase

In this phase, the drum unit is cleaned of any excess toner, and the negative charge on the drum is neutralized. Also, on the heat roller in the fuser assembly, a cleaning bar cleans and lubricates the heat roller to ensure that heat will be applied evenly on the next page.
Some versions of the A+ practice exams place the cleaning phase at the beginning of the six-step process, instead of at the end ... in any event, the six stages themselves are all the same.

Here are some typical problems you might encounter with a faulty laser printer:

**Conditioning Problems:** No image is written to the page, since the electrical charges were not applied correctly.

**Writing Problems:** Image is poorly laid out, spotty, has gaps in it, or the image is absent. If laser is “solid on”, then whole page will be black.

**Developing Problems:** Poor image, weak image, spots on page or excess toner problems.

**Transfer Problems:** No image is written to page; clumps of toner spot the page.

**Fusing Problems:** Image wipes off the page.

**Cleaning Problems:** Residual images are printed on page; excess toner builds up inside printer.

Always refer to the laser printer’s technical or user guides for guidance on printer error codes and repair procedures ... not all laser printers are made alike.

**Basic Printer Troubleshooting Guidelines**

**Troubleshooting laser printer problems**

- Clean out excess toner with a printer-certified vacuum cleaner
- Check for and remove paper dust and paper shreds
- Make sure paper pick-up rollers are clean, and that they have no flat spots; replace if necessary
- Use denatured alcohol, not rubbing alcohol, to clean pickup rollers
- Use compressed air to blow dust away from optical and mechanical sensors
- Vacuum or clean the ozone filter of dust and particulate matter
- Check toner cartridge; replace if necessary
- Check darkness/contrast adjustment; make any necessary corrections
- Print a test page for the customer to show proper operation
- If the Windows printer driver for that make of printer does not work correctly, use an HP LaserJet III driver; virtually all laser printers have an HP LaserJet III emulation mode that should work with that printer
- If you are having printer driver problems, contact the manufacturer of that printer for information on how to get a correct or updated driver for Windows (either Windows 2000, XP, Vista or Windows 7 ... one driver does NOT fit all shades of Windows!). These drivers are usually available off the Internet, from the company's web site.

**Troubleshooting dot matrix and ink jet printer problems**

- Check the print head, especially if the print quality is poor. If the head has a lot of ink buildup on it, clean the head with denatured alcohol and a soft toothbrush. Make sure the pins in the dot matrix print head move freely. Make sure the jet nozzles on the ink-jet printer are clean.
- Check the ribbon in the dot-matrix printer; if the ribbon appears worn in spots, or if the print quality is light or imperfect, replace the ribbon. Re-inking the ribbon should be a last alternative. **CompTIA does NOT recommend the re-inking of printer ribbons.**
- Check the ink cartridge in the ink-jet printer. If the print quality is poor and the print head appears clean, replace the cartridge. Note that some ink cartridges can be re-filled, but also know that some inks are of poor quality. The printing will never be better than the quality of ink you put in the printer. **CompTIA does NOT recommend the use of refilled ink cartridges.**
- Use denatured alcohol, not rubbing alcohol, to clean pickup rollers
Check for stray bits of paper. Small shreds of paper will cause paper jams if not removed. Also, recommend that users buy decent quality paper; cheaper recycled paper leaves paper dust which causes paper jams and affects the performance of optical or mechanical sensors within the printer.

Make the printer print a test page; show the customer that the printer is working correctly.

Make sure the software you use is specifying the correct printer driver; using the wrong printer driver will cause poor/slow printing, or no printing at all.

Other Important Tips

Make sure you have the manuals for the printer when servicing it; printers may have complex paper paths inside them, or special programming interfaces that require attention to fix the problem.

Check the pickup rollers; if they have flat spots or don't pick up the paper correctly, clean them with denatured alcohol. If the problem persists, replace the pickup rollers.

Check any sensors within the printer; a malfunctioning sensor (optical or mechanical) can shut down the printer completely. Clean optical sensors with denatured alcohol, and blow dust away from any kind of sensor. Replace the sensor if it has become defective.

Call the printer manufacturer for technical assistance when necessary.

Installing Printer Drivers

Microsoft has gone to great lengths to provide in the operating system a wide variety of drivers for hundreds of different printers. With the advent of plug-and-play capable printers, you may find that Windows already has a driver that will work with your printer.

HOWEVER, you may find that the Original Equipment Manufacturer (OEM) printer driver will give better quality printing and more reliable operation than the Microsoft-supplied driver that comes with the operating system. It is recommended that you use the OEM printer driver disk when installing a new printer on your PC or network. Further, for USB-style printers, you likely will need to run this installation CD BEFORE attaching the printer to the computer. This will ensure that the printer is properly recognized by the operating system, and it will reduce the likelihood of errors and problems during the installation process.

If you do not have the printer driver installation CD/DVD, contact the manufacturer or visit the manufacturer’s website to download the necessary software.

If you have an all-in-one (AIO) printer, you may find that the device will use a portion of your system memory, because the AIO printer does not have any built-in memory. Traditional printers (ink-jet and laser) generally have a fixed amount of memory installed on them, and many have the capability of adding additional memory to them. By adding memory to a printer, you increase the printer’s speed and overall performance when generating complex images on a given page. However, many AIO printers simply rely upon your system memory in the PC to buffer the print job to the device. If your PC becomes significantly slower after installing an AIO printer, you may need to install additional memory on the system board to compensate for this issue.
Problems with Ink-Jet Printers

One of the worst things a user can do with a ink-jet printer is to sporadically use it. When an ink cartridge is allowed to print for a time and then sit idle for a week or more, ink can form clogs in the cartridge and the nozzle assembly. Some printers have a “cleaning feature” that can reduce or remove clogs from the nozzle assembly, but many do not. If you encounter a printer that is clogged with old ink, remove the ink cartridge, and use some denatured alcohol or an ammonia-based window cleaner in the cartridge carrier within the printer to clean out any encrusted ink deposits. You may need to gently clean the ink cartridge before reinserting it into the printer as well.

Also, CompTIA and the A+ test specifications do NOT recommend the use of refilled or remanufactured ink (or laser toner) cartridges. If a customer is manually refilling ink cartridges, or if they are using remanufactured cartridges of poor quality, you likely will have problems with leaking ink within the printer.

If you find a printer has a problem with ink leakage within the device, immediately remove the ink cartridge. Use some ammonia-based spray cleaner and lots of paper towels (and q-tips for tight spaces) to clean up the leaked ink. It will be very messy, so wear clothing that is appropriate to dirty work. Once the mess is cleaned up, install a new, OEM ink cartridge and print several test pages. The first few pages will reveal where any additional cleaning need to be performed. Guide the customer towards a vendor that can provide reasonably-priced OEM cartridges, and/or reliable remanufactured ink cartridges.

Finally, never leave paper sitting in an ink-jet (or laser) printer for weeks or months on end. The paper will absorb moisture from the air, and likely cause paper jams. Also, the inserted paper may cause a flat spot to develop on the pickup rollers. If the printer is to remain out-of-service for more than two weeks, remove the paper from the unit.

NOTES
Chapter 9. Laptops and Portable Computers

Laptop computers are becoming more and more popular with users. Not only have these types of computers become smaller and more lightweight, they also have become as powerful and flexible as traditional desktop computers. The advantages of laptop computers are easy to see: they weigh less than 5 pounds, they can be transported by one person almost anywhere, they can connect to the Internet and traditional networks, they can be as fast as desktop computers, and their price is not necessarily much more than a desktop computer and monitor.

There are disadvantages associated with laptop computers as well. Because they are easily taken from one place to another, they are more prone to being dropped or suffering various kinds of physical abuse. Repairs to laptop computers can be very expensive, because of the proprietary nature of laptops. No two laptops are exactly the same, and as such replacement (or upgrade) parts can be difficult to obtain. The LCD screens installed in laptop can be broken easily, and replacement costs are high. Most of the time, if the laptop must be repaired, one must take the laptop to an authorized service center for that brand of computer; this means the labor and parts costs will be high, and third-party parts (such as memory or hard disks) will not be available for you to have installed.

Despite these problems, laptop computers continue to grow in popularity. In this section of the text, we will briefly discuss some of the key differences between laptop and desktop computers.

PC Card (PCMCIA) and USB Peripherals

Many laptops have PC card connectors built into them. These connections are also known as PCMCIA connectors. PCMCIA stands for the Personal Computer Memory Card International Association, a group that developed the standard for adapter cards laptop and portable computers. These adapter cards are about the size of a credit card. PC Card devices include fax/modems, expansion memory, network interface cards (NICs), radio transceivers, hard disks, and solid-state storage devices.

There are three types of PC Card devices: Type 1 are the thinnest, Type 2 are slightly thicker, and Type 3 are the thickest. PC Cards may be thicker because of the type of integrated circuitry built into them; the more complex the device, the larger it becomes. Modems, hard drives and NICs are more likely to be Type 3 devices, while memory cards may only be Type 1 devices.

In many cases, USB ports are replacing PCMCIA ports as the option of choice for laptops. USB Wireless NICs can be obtained inexpensively for use with laptops (or desktop PCs), just as PCMCIA wireless NICs have been available for years. Some manufacturers have discontinued building laptops with PCMCIA connectors in favor of USB adapters. Extra USB ports also allow the user to attach flash drives and external CD/DVD-ROM drives to the laptop.

Batteries and AC Adapters

Laptop computers utilize batteries to keep them running for several hours at a time. The typical laptop battery will operate the computer for 3 to 3.5 hours. Nickel-cadmium (NiCd) batteries are the heaviest batteries available. NiCd batteries have a problem in that they have a "memory effect"; that is, unless you drain the battery all the way down to zero, the battery may not fully recharge, and this can lessen the charge life of the battery. Nickel Metal Hydride (NiMH) batteries are generally the lightest in weight. NiMH batteries do not generally suffer from "memory effects", and as such recharge fully when plugged into the AC adapter or charger assembly. Newer battery technology should further extend the operating capabilities of laptop computers.
Laptop batteries should have a life span of 18-24 months when used on a regular basis, and longer if they are used more occasionally. Replacement batteries can be obtained from the manufacturer, as well as from various retailers on the Internet. Whenever possible, avoid keeping a laptop continually connected to the AC adapter, particularly when the laptop is not in use. Continually charging a laptop battery while the unit is not in use will have a detrimental effect on the overall charge-holding capability of the battery. When a laptop battery is replaced with a new one, be sure to recycle and dispose of the old one in an environmentally-responsible manner.

AC adapters allow the laptop to be powered directly from the wall current. The adapter converts the 110 volts of alternating current into direct current which both powers the laptop and charges the battery. AC adapters generate a fair amount of heat, and are prone to fail when exposed to excess line voltage or surges.

If a laptop fails to recharge properly or does not power up properly, you should use a volt-ohm meter to check the voltage being put out by the AC adapter. If it is not outputting the specified voltage, you will need to get another adapter. The voltage that the adapter outputs should be specified on the adapter itself, or specified in the documentation for the laptop.

Unfortunately, many manufacturers make their adapters to be proprietary, so that you must purchase a replacement adapter from the laptop manufacturer. Be sure that the adapter you purchase exactly matches the plug and the required output voltage; otherwise, if the voltage is incorrect, you could potentially damage the laptop.

Also, be aware that some users tend to be aggressive when plugging and un-plugging the AC adapter plug into the side or back of the laptop. Inserting the power cord too forcefully will cause this plug to break off from it’s electrical connections on the system board. If the AC adapter plug within the laptop breaks off, it is NOT a simple repair.

Typically the laptop will have to be sent back to the manufacturer for a “depot repair,” which will cost up to $250.00 and take 7-14 business days to complete. The AC adapter plug on the laptop’s system board is only soldered onto the board; it is not screwed or bolted down. The high-precision soldering equipment needed to make this type of repair can cost in excess of $2,000.00. This is not a typical repair you can do with a 15-watt soldering iron.

**LCD Screens**

Laptops usually can be connected to an external monitor, but their primary display device is the liquid crystal display (LCD) panel built into the unit. LCD displays use a liquid crystal mix sealed between two pieces of polarized glass. The polarity of the liquid crystal changes because of electrical currents passing through the liquid that changes the amount of light that passes through the display.

LCD screens must use either reflected light or a backlight to illuminate them, mainly because these displays do not generate any light. There are two main kinds of LCD panels currently in use today: active-matrix panels and thin-film transistor (TFT) display panels. Both types of displays provide true color display and fast refresh rates. Some display screens even will interface with a stylus pointing device, or will accept touch input from your fingers.

LCD screens are highly susceptible to damage from twisting or bending the display. Further, poking fingers into the display can cause damage to the unit. Therefore, great care should be taken to protect the LCD display from impact damage, twisting, and other types of abuse. Once the screen is damaged, the unit must be replaced; it cannot be repaired. Replacing a laptop LCD screen can cost more than the price of the entire laptop, and an exact replacement must be obtained from the manufacturer or reseller.
A common problem with LCD screens is that the backlight within the unit will fail. The backlight enables the user to see the display, as the light shines through the liquid crystal matrix to illuminate the images on the screen. Typically when the backlight fails, the entire LCD display must be replaced. Further, when an LCD screen becomes cracked or develops solid lines through the display, it indicates that the unit is damaged beyond repair, and must be replaced.

Most laptops enable the user to plug in an external VGA-style video device, like a monitor or projector, so it can be used in meeting or classroom presentations. The user can enable the external display device by using a combination of function keys on the keyboard. For example: a Dell laptop will toggle between the laptop display, the external display unit, and simultaneous displays on both when the user holds down the blue Fn key and presses the F8 key as well. Other laptop manufacturers use a similar strategy, like holding down the Fn key and pressing F5 for HP/Compaq laptops.

Finally, most laptops will shut off the LCD display panel when the unit is closed. A small switch above the keyboard senses when the lid is closed, and cuts off power to the display. If you encounter a situation where a laptop’s LCD display does not illuminate, check the cutoff switch and make sure it is in the up position, and not stuck in the down or closed position. Also check the Fn and function-key combinations to ensure the laptop is diverting video to the LCD screen.

Upgrading Laptops

Upgrading (or repairing) a laptop can be difficult. Usually laptops have been designed by the manufacturer to be proprietary, requiring the user to purchase upgrade parts from only that manufacturer. Further, some manufacturers of laptops do not sell upgrade or replacement parts to the user community; parts can only be obtained by an authorized repair facility for that manufacturer. When buying a new laptop, it may be advisable to ask about how easy it will be to upgrade the laptop (i.e., more memory, a bigger hard drive) at a later point; it may be cheaper to obtain the upgrade when purchasing the laptop, rather than waiting 1 to 2 years later, when the parts may be less accessible and potentially more expensive.

Servicing Laptops

Servicing a laptop either can be a joy, or a sorrow. Some laptops, like Dells, are designed so that an average computer technician can replace a hard drive, keyboard, pointing interface or RAM with little difficulty. However, some laptops (like Toshiba or HP laptops) are extremely difficult to open and access key components. In all cases, it is very important to obtain the disassembly instructions from the manufacturer for each laptop being serviced. Virtually all laptops have little plastic pieces that hold portions of the outer case together; if those are broken off during disassembly, it is quite difficult to properly reassemble the unit. Also, laptop screws are much smaller that the ones used in desktop PCs; if they are lost or dropped, they are hard to find or replace.

If parts for the laptop are difficult to obtain from the manufacturer, try looking on the Internet to get the parts you need. Also check with any local vendors that specialize in servicing laptops; they can provide you with replacement parts and advice on how to service a given unit.

Many laptops must be returned to the manufacturer for depot repairs, especially if there are problems with the system board, AC adapter plug, or other on-board devices that are not serviceable by the typical repair technician. Some manufacturers do not make replacement parts available to the public, and some repair procedures require the full disassembly and re-assembly of the unit. Contact the laptop manufacturer to obtain information on depot repair procedures and costs.
Occasionally a laptop will develop a problem with the built-in wireless networking adapter. In some instances, the laptop has a switch on the side of the unit that enables or disables the wireless adapter. Check to see that the switch is in the ON position if you cannot receive a wireless signal.

Also, check to see if the wireless adapter has become loose or disconnected inside the laptop case. Most wireless adapters plug into the laptop using a connector interface similar to a SODIMM socket. Further, there are two antenna wires that must both be connected to the wireless card for it to function properly. Make sure the wireless adapter is properly installed, the antenna wires are firmly connected, and the driver software is up-to-date and correct for the device. Uninstall and re-install the driver software if you believe the laptop has been corrupted by malware or some form of virus. In some cases, wiping the operating system and reloading it back again is the only certain way to re-awaken a malfunctioning wireless network adapter.

**Personal Desktop Assistants (PDAs)**

There is a class of small, handheld computers called personal digital assistants, or PDAs. These units allow the person to have an address book, date book, journal, to do list, notepad, and other such accessories that would be on a traditional day-timer or paper organizer. Further, these PDAs can let you read and respond to your e-mail. This is done by synchronizing the PDA to the person’s desktop computer.

Popular PDAs include the BlackBerry, the Apple iPhone, the Google Droid phone, and the Palm Pre, Some of these PDAs use the Palm operating system developed by the Palm Corporation, while others use a compact version of the Windows operating system called Windows Mobile. These types of digital assistants are very popular because of their small size, their impressive features, and their ability to interface with desktop computers, e-mail systems and also the Internet.

Many PDAs have synchronization software that must be installed on a PC or laptop to enable the sharing of data between the two devices. Also, many PDAs are capable of synchronizing with Internet-based data, such as a Google web-based calendar or Yahoo web-based email systems. Many PDAs have mobile broadband or third-generation (3G) Internet access capabilities that allow them to access the Web as easily as on a laptop or desktop PC.

However, there is little one can do to service or repair a damaged or defective PDA short of sending it back to the manufacturer or cellular phone provider. As a technician, you can assist the customer in learning how to use the PDA, installing and configuring the synchronization software or other applications, and trouble-shooting connection problems. But repairing one of these devices is beyond the range and scope of most traditional computer repair technicians.

NOTES
Chapter 10. Power Conditioning with UPSes and Surge Suppressors

The voltage you get from the wall socket is NOT always what you expect ...

There are periodic fluctuations in voltage from devices going on and off in your building, problems in the transmission line, electrical storms, bad or faulty transformers, etc. Sometimes these fluctuations in voltage may exceed several thousand volts. When this happens, bad things can happen to good computers (or any other kinds of electrical devices). Let's begin with an understanding the different types of about electrical power.

What is Alternating Current and Direct Current?

Current is the flow of electrical charges (usually electrons) in an electrical circuit. When you hook a light bulb to a flashlight battery, the current flows from the positive terminal to the negative terminal, always in the same direction. This is called DIRECT CURRENT, or DC for short.

Electrical current from a standard 110 volt household outlet changes direction 60 times each second (50 times per second in Europe, where they use 220 volt current). Because the current flows first in one direction and then the other, this is called ALTERNATING CURRENT, or AC for short. The power companies use alternating current because it can be transformed to higher and lower voltages (with transformers) allowing them to transmit and distribute power with lower losses. You can see these transformers on the tops of utility poles.

On the standard 3-prong plug, the upper-left prong is the "hot" prong, or the prong upon which the AC voltage is transmitted. The "neutral" prong, which alternates the current between itself and the hot prong, is the upper-right prong. The bottom prong is a ground wire that leads to an earth ground; it is used to shunt excess voltage from the hot and/or neutral prongs to ground, especially when a surge suppressor unit is in use.

When the 110V current from your wall outlet reaches your PC's power supply, the voltage is transformed into both 12VDC AND 5VDC for use in your computer. The motors in certain components within your PC (your hard drive and floppy drive motors, for example) require 12VDC, while the motherboard and other boards within your computer require only 5VDC. You may also note that on some PC power supplies there is a switch that lets the unit operate on either 110VAC or 220VAC, depending upon where you live.

The problem comes when a lightning strike or a faulty transformer introduces a much higher level of voltage onto the line than is normal. Your power supply may not be able to handle the excess voltage, and it may pass on some of this excess voltage to the components in your PC before the unit shorts out or overloads. When this happens, damage to your PC and it's components usually occurs. Normally the damage is such that the electrocuted components need to be replaced.

Surge Suppressor

A surge suppressor provides a way to deal with voltage spikes. The surge suppressor has a metal-oxide varistor (MOV) that will shunt excess voltages above a certain limit to the ground wire of your three-prong AC power cord, where the voltage will be transmitted harmlessly to ground, thereby saving your PC. Surge suppressors can deal with excess voltage problems, but they do not help with loss of voltage problems. A surge suppressor should be used on ALL electronic devices, including computers and their peripherals, at ALL times, without exception. Electrical surges are one of the primary causes of computer hardware failures.
When buying a surge suppressor, the most important thing to check for is the **clamping voltage of the unit**. The clamping voltage is that point when excess voltage will be diverted to ground. A good suppressor will have a clamping voltage of approximately 330 volts, and will have a Underwriter's Laboratory (UL) listing of UL 1449. This is sufficient to protect your PC from harmful excess voltage. 330 volts is 50 percent above the highest nominal input line voltage of 220VAC.

Reliable surge suppressor are made by the following companies:

- APC - TrippLite - Curtis

As long as the suppressor has the UL 1449 rating and a 330 volt clamping voltage, it will serve you well. These should cost you between $15 and $40 in the local stores.

When purchasing a surge suppressor, buy one that also has suppression capabilities for your **telephone line and/or FiOS / DSL / cable modem line**. A lightning strike can pass through your telephone / DSL / cable modem line just as easily as it can pass through your electric utility line. When that bolt of electricity hits your PC through your modem or NIC, it has the same or greater potential to damage components in your computer as does a surge through your electric utility line. A surge suppressor that has telephone / DSL / cable line suppression should only cost $5 - 10 more than a regular surge suppressor, and it will greatly enhance the protection factor for your PC.

**Uninterruptible Power Supplies**

An **uninterruptible power supply (UPS)** has the same kind of technology built into it as does a surge suppressor, but it also contains a large battery in it as well. The battery in the UPS will allow your PC to continue to operate if power has been cut off to your building. The battery in the UPS and the transformer built into it provides 110VAC to your computer (and any other components attached to it). HOWEVER, the voltage will last only for a few minutes (5 - 30 minutes), depending on the capacity of the battery. The more expensive the UPS, the better the battery in it, and the longer it will provide 110VAC to your computer.

A UPS allows you to shut off your PC in a normal fashion in the event of a power failure. Higher-end units will automatically shut off your PC for you if you are unable to get to the computer in time, before the battery runs out. An UPS will cost at least $100 for a low-end model, and high-performance versions can cost hundreds or thousands of dollars.

Your purchase of an UPS should be based upon how many devices you need to keep powered up during an electric utility failure, how long you want backup power to sustain your devices, and how much your budget can afford. UPS units are measured in how many watts they can deliver to your devices.

To determine the level of UPS that you need, add up the wattage requirements of the devices plugged into your UPS. You can find the wattage requirements of your devices on the manufacturer's label on the back of the PC, monitor, printer, or other device. Then, buy an UPS that delivers an equal or greater amount of wattage than your devices require. The greater the wattage, the longer the UPS will last and the more devices it will support.
If you have intermittent voltage failures in your area (i.e., the power frequently cuts off for only a second), consider buying an UPS. It will save you immense amounts of grief when using your PC, since all the information stored in RAM is wiped out when power is cut off. Intermittent power problems like these occur in rural areas, or in areas where new construction is taking place and power is temporarily disconnected in order to attach new service.

An UPS is an absolute necessity when running any kind of network-based or web-based server equipment. If power is cut off to such a server so that it abends (that is, it shuts down abnormally), the potential for data loss is significant. Any kind of computer that provides shared drive or data access to customers on a network or via the Internet MUST be connected to an UPS, so that the server can be shut down in a proper fashion in the event of a power failure.

If you do purchase an UPS, be sure to connect it to a surge suppressor, and do not plug it directly to a raw, unprotected AC wall jack. You want the UPS to have the same protection as any other electrical device. Further, if you do encounter a nasty electrical surge, you would much rather spend $20.00 to replace a surge suppressor than $100.00 or more to replace a damaged UPS.

**Power conditioners**

There is also a type of device called a power conditioner. These devices have a transformer built into them that supplies a clean, unvarying stream of steady voltage. They have the ability to handle surges, and they also deal with low-voltage or brown-out conditions on the line. They ensure that you get a constant stream of 110V AC with extremely little variation. These devices cost anywhere from $75 on up, and they can be most helpful in areas where there are constant variations in the line voltage from your electricity provider. Power conditioners are not necessary in most business and home settings where clean, steady voltage is consistently available. Note that power conditioners are not discussed or asked about on the current A+ examination.

For the A+ examination, you will need to be able to answer the following kinds of questions:

- What is a surge suppressor? How does it work?
- What is clamping voltage? What is the proper clamping voltage for computer and electrical devices?
- What does the UL 1449 rating for surge suppressors mean?
- Which part of a 110VAC plug is the "hot" prong, which is the "neutral" prong, and which is the ground wire?
- What is an Uninterruptible Power Supply?
- How are UPS units measured, and how do you know if your UPS will support the devices plugged into it?

Major DOS (command-prompt) Commands

Despite the rumors to the contrary, DOS is still alive and well, lurking beneath the graphical interface in Windows 9x. This portion of the text will cover the major command prompt DOS-level commands.

You may still run into situations where customers have refused or neglected to update their operating system software. This information should assist you in dealing with issues on these older platforms.

The ATTRIB Command

The ATTRIB command lets you both view and change the attributes of a file or directory. Files and folders can have up to four attributes: Read-only (the file cannot be edited or deleted), system (the file is needed to boot the system), hidden (the file is not visible when performing a DIR command), and archive (whether the file will be backed up by a system backup program).

For example: ATTRIB +R C:\CONFIG.SYS makes the file read-only, while ATTRIB -R C:\CONFIG.SYS takes the read-only attribute off of the file. The R attribute makes a file read-only, the S attribute makes a file a “system file” used for booting the PC, the H attribute makes a file hidden, and the A attribute marks a file for archiving with backup software.

Simply typing ATTRIB at the DOS prompt will show all of the files in that folder, and the attributes for each file and directory.

The CHKDSK Command

The CHKDSK command checks your hard disk for free space, and eliminates lost clusters of data. CHKDSK was the predecessor to SCANDISK. Running the command CHKDSK /F will eliminate lost clusters from your hard disk, turning this wasted space into files ending in the extension .CHK. Any files in your root directory with the .CHK extension can be deleted, which will free up additional disk space.

Running CHKDSK /? will show you all of the options available with the CHKDSK command.

The COPY Command

The COPY command will let you copy files from one place to another, and from disk to disk. For example: the command COPY A:\FILENAME.EXT C:\ will let you copy a file from a floppy disk to a hard disk. COPY A:*.* C:\ copies all files from a floppy disk (or sub-directory) to a hard disk. COPY C:\DIRNAME\*.* A: copies all files from a hard disk sub-directory to a floppy disk. The /V option performs a verify operation as the files are copied, and the /Y option will prevent any question prompts from being displayed during the copy operation.

Running COPY /? will show you all of the options available with the COPY command.

The DEFRAG Utility

The DEFRAG utility re-orders files on a hard disk, re-assembling fragmented files and optimizing hard disk performance. This utility should only be run from the Windows graphical interface; click on Start, then Programs, then Accessories, then System Tools, and then Disk Defragmenter to run the application. Only DOS 6.0 through 6.22 has a version of DEFRAG that runs from the DOS prompt.
The DEL and ERASE Commands

The DEL (or the ERASE) commands will let you delete files in a disk or directory. For example: the command DEL FILENAME.EXT lets you delete a file. DEL *.\* deletes all of the files in a disk or directory. DEL *.TXT deletes all of the files in a disk or directory with the extension TXT. Using ERASE instead of DEL will produce the same result.

Running DEL /? (or ERASE /?) will show you all of the options available with the DEL (or ERASE) command.

The DIR command

The DIR command at the DOS prompt gives a directory of the disk and/or subdirectory you are currently in. DIR/W gives the same information as above, but displays it WIDE across the screen. DIR/P - Gives a directory of the disk and/or subdirectory 1 page at a time. DIR/S lets you search your hard drive for a given filename; for example: the command DIR/S RESUME.DOC will search the entire hard disk for the file named RESUME.DOC.

Running DIR /? will show you all of the options available with the COPY command.

Directory Commands MD, CD and RD

The MD (or MKDIR) command makes a sub-directory on a floppy or hard disk.

The CD (Change directory) command lets you change directories on a floppy or hard disk; the CD\ command lets you change directories back to the root directory of a floppy or hard disk.

The RD (or RMDIR) command lets you delete a sub-directory on a floppy or hard disk; however, the directory MUST be empty (without files or other directories) before you can delete the directory. The DELTREE command deletes both directories and files simultaneously; exercise care when using DELTREE, since files cannot be recovered if the directory they existed in have been deleted.

Running MD /?, CD /?, RD /? or DELTREE /? will show you all of the options available with the these commands.

The EDIT Utility

The Edit utility allows the user to manually edit text files such as CONFIG.SYS, AUTOEXEC.BAT, WIN.INI and SYSTEM.INI. Edit is a text-based utility program, but it supports a mouse and it has drop-down menus like other Windows counterparts such as Notepad, Wordpad, or SYSEDIT.

Running EDIT /? will show you all of the options available with the EDIT command.
The EXTRACT Utility

The EXTRACT utility to uncompress Microsoft-compressed files, so that the files can be used on the system. Most Microsoft installation programs use EXTRACT to uncompress the system or application files from the compressed files on the installation disk.

Running EXTRACT /? will show you all of the options available with the EXTRACT command.

The FDISK Disk Partitioning Command

FDISK is used to create, erase, or view a partition table on a hard disk. Normally, you will use FDISK when you first prepare a hard disk for use, or when you wish to wipe all the data off of a disk and completely re-format the disk.

When running FDISK on a hard disk, you may choose to divide (or partition) the disk into one single partition, or into several smaller segments. Use this following procedure when creating a segmented hard drive: you will first create a Primary DOS partition (a bootable partition), and then make the partition active (informing the PC to attempt booting to the drive).

Then, you will create an Extended DOS partition (a non-booting partition), and create logical drives within that partition (assigning drive letters to segments of the partition). You will then format the drive, individually formatting each partition on the disk. If you wish to remove the partitions at a later time, you will need to delete the logical drives, then the Extended DOS partition, then the Primary DOS partition in order to get back to a blank hard disk.

Re-writing the Master Boot Record

There is an undocumented feature in the FDISK command that allows you to re-write the Master Boot Record in the partition table WITHOUT destroying the data on the disk. You will use this command if you believe that a virus has damaged the partition table on the hard disk, and you want to attempt a rescue of the data before dumping the hard disk and reloading your operating system. This command is shown below:

FDISK /MBR

Running this command from the DOS prompt will rewrite the Master Boot record; the process takes less than two seconds to complete, and no success or failure messages are displayed to the screen when the command is finished.

Once you run FDISK /MBR, you also may want to run the command SYS C: (Enter) to restore the boot files into the boot sector of the hard disk. Once you have performed both of these commands, power down the computer to wipe any potential virus from memory. Then, power up the computer and see if the system will boot to the hard disk. In many cases, this procedure will restore the hard disk to a booting state without a reformat and reload of the operating system.
Using FDISK With FAT32 in Windows 95 and 98

If you are using a boot disk from Windows 95/OSR2 or Windows 98, the version of FDISK that came with the operating system will allow you to create a disk partition larger than 2 gigabytes (2GB). Previous versions of DOS and Windows 95 would only support disk partitions up to 2GB in size. These large partition sizes are possible because the new version of FDISK creates an environment where a 32-bit file allocation table (or FAT) can be used by the operating system. You will know if you have the correct version of FDISK if you receive a fairly long explanatory message after invoking the FDISK utility from the DOS prompt. At the bottom of the message screen, there is a question that asks:

Do you wish to use large disk support? [Y/N]

If you answer "Yes" to this question, you will enable Win 95 or Win 98 to use a 32-bit FAT, and have a single disk partition larger than 2GB. Answering "No" will let you create a standard 16-bit FAT with partition support up to 2GB.

Running FDISK /? will show you all of the options available with the FDISK command.

The FORMAT Command

The DOS FORMAT command lets you format floppy or hard disks (and other media, such as ZIP drives). However, there are a number of options available that make the FORMAT utility more useful. Listed below are some of these options:

```
FORMAT C: /S /V Formats a hard disk, making it bootable; the /V switch lets you put a volume name on the disk
FORMAT A: /S Formats a floppy disk, making it bootable
FORMAT A: /F:360 /U Formats floppy disk to 360k in a 5.25" high density drive; the /U switch performs an unconditional format (without checking the disk media)
FORMAT B: /F:720 /U Formats floppy disk to 720k in a 3.5" high density drive.
FORMAT A: /Q Performs a quick format of a previously-formatted disk (also works on a hard disk).
```

Running FORMAT /? will show you all of the options available with the FORMAT command.

The MEM Command

The MEM command shows how much conventional, reserved, extended and expanded memory is being used in your system at that time.

MEM /? shows all of the options available with the MEM command.
The MSCDEX Command

The MSCDEX command lets DOS assign a drive letter to a CD-ROM drive; for this program to operate properly, a driver for the CD-ROM drive must be loaded in the CONFIG.SYS file at boot-up. MSCDEX will assign the next available letter for the CD-ROM drive. Using the /R: option with MSCDEX forces the assignment of a specific drive letter for the CD-ROM drive.

Running MSCDEX /? will show you all of the options available with the MSCDEX command.

The MSD Utility

The MSD utility gives the user a summary of the hardware configuration of your PC. This utility is provided with Microsoft operating systems starting with DOS 6.0.

The SETVER Utility

The SETVER utility allows older programs to operate with newer versions of the operating system. Some programs will not work with anything but a specific version of the operating system, such as DOS version 5.0. SETVER actually "lies" to operating-version-specific programs, telling the program what it wants to hear as to which operating system version is currently running. SETVER is loaded in the CONFIG.SYS file as a device driver; for example, DEVICE=C:\WINDOWS\SETVER.EXE.

The SCANDISK Command

The SCANDISK command checks your floppy or hard disk thoroughly for physical and logical formatting errors, correcting any errors it finds. It can even perform a surface scan on the physical disk media, marking as bad any sectors that have serious defects upon them.

You may notice that in Windows 95 and 98 that the DOS version of SCANDISK will run if your PC locks up, and is unable to shut down normally. Be very cautious about agreeing to SCANDISK's request to "fix" any problems found while examining your disk ... it's best to run the Windows-based version of the program once you are in Windows 95. If all SCANDISK wants to do is clean up temporary files or reclaim unused disk space, agreeing to the DOS-level SCANDISK's repair request should be just fine.

Running SCANDISK /? will show you all of the options available with the SCANDISK command.

The SMARTDRV Utility

SMARTDRV.EXE is a 16-bit utility that uses a portion of your extended memory as a disk cache. This program can improve the drive access time and system performance when the computer is running in MS-DOS mode. However, SMARTDRV should not be run in conjunction with Windows 9x; a 32-bit disk caching program called DBLBUFF.SYS is built into Windows 9x to perform the same task as SMARTDRV. Use SMARTDRV only in a DOS-based environment.
The SYS Command

The SYS command writes the two hidden system files and COMMAND.COM to the boot sector of a floppy disk or hard disk, thereby making it bootable. This process does not wipe out the existing data on the disk. For example: running SYS A: from the DOS prompt will place the system files onto the disk in the A: drive, making it bootable.

Running SYS /? will show you all of the options available with the SYS command.

The VER Command

The VER command shows you which version of the operating system is currently running. Simply type VER at the DOS prompt to obtain the version information.

The XCOPY Command

The XCOPY command will let you copy both files AND directories from one place to another, and from disk to disk. For example: the command XCOPY A:*.* C:\ /S /E /V will let you copy all files and any directories from a floppy disk to a hard disk. The /S option tells XCOPY to copy subdirectories as well as files; the /E option will copy even empty directories from one place to another, and the /V option verifies that each file is written correctly before continuing.

Running XCOPY /? will show you all of the options available with the COPY command.

The CONFIG.SYS and AUTOEXEC.BAT Files

On the following pages are typical examples of a CONFIG.SYS and AUTOEXEC.BAT file.

CONFIG.SYS is used by the operating system to configure your system (using 16-bit drivers) to recognize and use specific devices in your system, such as a CD-ROM drive or a sound card.

AUTOEXEC.BAT is used by the operating system to run user-defined startup routines each time the computer boots up. For example, the DOS-level virus checking utility may run because there is a line in the AUTOEXEC.BAT that calls that program up each time the computer boots.
### EXAMPLE OF A TYPICAL CONFIG.SYS FILE

<table>
<thead>
<tr>
<th>DOS Commands</th>
<th>Explanation of Commands</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Menu]</td>
<td></td>
</tr>
<tr>
<td>MENUITEM=YCDROM, Load CD-Rom Drivers</td>
<td>Displays &quot;multi-boot&quot; menu</td>
</tr>
<tr>
<td>MENUITEM=NCDROM, Do NOT Load CD-ROM Drivers</td>
<td>Multi-boot option #1</td>
</tr>
<tr>
<td>MENUDefault=NCDROM, 10</td>
<td>Multi-boot option #2</td>
</tr>
<tr>
<td>[Common]</td>
<td></td>
</tr>
<tr>
<td>DEVICE=C:\WINDOWS\HIMEM.SYS</td>
<td>Extended memory driver</td>
</tr>
<tr>
<td>DEVICE=C:\WINDOWS\EMM386.EXE NOEMS</td>
<td>Expanded/UMB memory driver</td>
</tr>
<tr>
<td>DOS=UMB</td>
<td>Loads DOS kernel in UMB area</td>
</tr>
<tr>
<td>DOS=HIGH</td>
<td>Loads DOS kernel in High Memory Area (if needed)</td>
</tr>
<tr>
<td>BUFFERS=10,0</td>
<td>Creates 10 512-byte disk cache buffers</td>
</tr>
<tr>
<td>FILES=50</td>
<td>Creating a 50-line table to keep track of up to 50 files loaded in memory</td>
</tr>
<tr>
<td>FCBS=4,0</td>
<td>Creates 4 &quot;look-ahead&quot; buffers, used for program branching/prediction</td>
</tr>
<tr>
<td>STACKS=9,256</td>
<td>Creates 9 256-byte stacks to hold information when devices are interrupted</td>
</tr>
<tr>
<td>DEVICEHIGH=C:\DOS\SETVER.EXE</td>
<td>Allows older DOS programs to work with newer versions of the operating system</td>
</tr>
<tr>
<td>DEVICEHIGH=C:\WINDOWS\IFSHLP.SYS</td>
<td>Program that supports Windows networking environment</td>
</tr>
<tr>
<td>SHELL=C:\COMMAND.COM /E:1024 /P</td>
<td>Explicitly states name of command processor; sets environment size to 1024 bytes (instead of default 128 bytes)</td>
</tr>
<tr>
<td>LASTDRIVE=F</td>
<td>Explicitly states last logical drive in system</td>
</tr>
<tr>
<td>[YCDROM]</td>
<td></td>
</tr>
<tr>
<td>DEVICEHIGH=C:\MTMCDAI.SYS /D:MSCD001 /P:170,15</td>
<td>Loads CD-ROM driver (when user indicates in menu to load driver)</td>
</tr>
<tr>
<td>[NCDROM]</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** In Windows 95 and 98, pressing F8 at boot-up will cause Windows to display a generic "multi-boot" option screen. Use this whenever diagnosing or trouble-shooting boot-up problems.
EXAMPLE OF A TYPICAL AUTOEXEC.BAT FILE

DOS Commands

@ECHO OFF

CALL C:\NWCLIENT\STARTNET.BAT

PROMPT $P$G
PATH=C:\WINDOWS;C:\DOS;C:\;C:\NWCLIENT;

:YCDROM

LH C:\DOS\MSCDEX.EXE /D:MSCD001 /M:10 /L:R

GOTO CONT

:NCDROM

:CONT

LH /L:2,6384 C:\DOS\DOSKEY

SET MOUSE=C:\MSMOUSE
LH C:\MSMOUSE\MOUSE

SET TEMP=C:\TEMP

SET RES=VGA

CLS

C:\NET\BIN\WGTCPIP.EXE -C=C:\NWCLIENT\NET.CFG

ECHO.

F:LOGIN Serv1\username

Explanations of commands

Commands will not be displayed to the screen as they are executed

Loads Novell IPX & NETX

Prompt definition

Path definition

"YES" path to load CD-ROM driver

Loads CD-ROM driver; makes CD-ROM drive appear as R:\ >

Path if CD-ROM driver is not to be loaded

Main part of the AUTOEXEC.BAT

Lets you repeat last 20 DOS commands

Sets MOUSE memory variable

Loads mouse driver

Specifies location for temp files

Sets RES memory variable

Clears the screen

Loads Novell TCP/IP driver

Displays blank line on screen

Logs into Novell server called Serv1
DOS-Level Changes for Windows 95, 98 and Millennium Edition (ME)

In Windows 95 and 98, the lines for MSCDEX.EXE, SMARTDRV.EXE and MOUSE.EXE will be remarked out of the AUTOEXEC.BAT file by the Windows installer ... Windows 9x has built-in 32-bit driver support for these programs, and the 16-bit (real mode) drivers do not need to be loaded at a DOS level for these devices to operate in Windows.

Also, in Windows 9x, pressing F8 at boot-up will cause Windows to display a generic "multi-boot" option screen. Options to boot into "safe mode", which loads the minimum driver set for Windows, and options to boot to the DOS prompt are available by pressing F8. Use this whenever diagnosing or trouble-shooting boot-up problems.

This above information is provided as a guide and help to you, if you encounter a PC that still is using an obsolete Microsoft operating system version.

NOTES
There are a number of aspects of the Windows operating system and graphical user interface (GUI) that will be covered on the A+ exam. This portion of the text covers those parts of Windows that are key to your success in passing the exam.

Control Panel

The Windows Control Panel allows the user to configure various aspects of the operating system, add new hardware to the system, and add and/or remove software from your system. The Display icon lets you change your video driver and screen configuration. The Keyboard and Mouse icons let you control the operation of these devices. The Network icon allows you to add and configure networking hardware and software so that you can interact with local area networks and dial up connections. The Sounds icon allows you to associate certain system events (like the system start and shutdown) with sound files, so that the sound will play when that event occurs. The Users icon allows you to have customized configurations for different users of the same computer. The System icon lets you see a summary of the recognized system components, and through the Device Manager, it lets you add or remove components from your system configuration.

My Computer

The "My Computer" icon allows the user to run a variant of Windows Explorer. Double-clicking on My Computer icon will allow you to see all of the available disk drives, the Printers folder where your configured printers are listed, the Windows Control Panel, and the Dial-up Networking folder where your dial-up connections are located. Double-clicking on the drive icons lets you browse through the folders and files on each drive, allowing you to copy, cut, paste, move and delete both files and directories. The Add Printer Wizard is contained in the Printers folder. It allows you to add a printer quickly and easily. The Add New Connection Wizard in the Dial Up Networking folder allows you to create new dial up connection icons.

The RUN Command

The RUN command lets you launch programs that are not listed on the Start menu, nor is there an icon on the Windows desktop for a given program.

By clicking on Start, then selecting Run, and then typing in the name (preferably the directory location and the name) of the program, you can launch any program that is available to Windows. For example: clicking on Start, then clicking on Run, and then typing MSCONFIG into the dialog box and clicking OK will launch the Windows System Configuration Editor.

Windows Explorer

Explorer is the one program that is at the heart of the operating system. It is the “shell program” that provides the familiar interface that all of us have become accustomed to using. Explorer lets you browse through all of the available drives and directories, allowing you to copy, cut, paste, move and delete files and directories.

Explorer is one of the core programs that makes Windows operate. The desktop appears because Explorer is running. When you double-click on My Computer, another view of Explorer opens. When you right-click on My Computer and select the Explore option, yet another view of Explorer appears. Every application on your PC operates in conjunction with Explorer.
Windows Backup

Windows Backup is a graphical tool for protecting data from accidental loss or hardware and media failures. Backup makes it easy for you to use a tape drive or other media types to back up and restore your important files on either the Windows file system (NTFS) or file allocation table (FAT) file system.

The following list provides an overview of some of the things you can do with this graphical tool to protect your data:

- Back up and restore both local and remote files on NTFS or FAT volumes from your own computer using an attached tape drive.
- Select files for backing up or restoring by volume, directory, or individual filename, and view detailed file information, such as size or modification date.
- Select an optional verification pass to ensure reliable backups or restorations.
- Perform any of the following common backup operations: Normal, Copy, Incremental, Differential, and Daily Copy.
- Place multiple backup sets on a tape, and either append new backup sets or overwrite the whole tape with the new ones.
- Span multiple tapes with both backup sets and files, since there is no file-size restriction.
- Create a batch file to automate repeated backups of drives.
- Review a full catalog of backup sets and individual file and directory information so you can select files to be restored.
- Control the destination drive and directory for a restore operation, and receive appropriate options for action you can take when a restore would overwrite a more recent file.
- Save log information on tape operations to a file. Also view tape-operation information in the Windows Event Viewer.

Disk Management

Disk Management is a graphical tool for managing disks. This tool encompasses and extends the functionality of character-based disk management tools (such as the old MS-DOS FDISK utility). It is found within the Microsoft Management Console which is discussed later in this chapter.

The following list provides an overview of some of the things you can do with this graphical tool:

- Create and delete partitions on a hard disk and logical drives within an extended partition.
- Format and label volumes.
- Read status information about disks such as the partition sizes and the amount of free space that is available for creating additional partitions.
- Read status information about Windows NTFS and FAT16/32 volumes such as the drive-letter assignment, volume label, file system type, and size.
- Make and change drive-letter assignments for hard disk volumes as well as CD-ROM devices.
- Create and delete volume sets.
- Extend volumes and volume sets.
- Create and delete stripe sets.

Partitioning the internal hard disk on a new computer is done during initial setup when you load the Windows operating software. Making changes to that disk or partitioning an additional new hard disk is done using Disk Management.

Disk Management cannot be used to further partition the system partition because it contains files required to operate Windows itself.
Event Viewer

Event Viewer is the tool you can use to monitor events in your system. You can use Event Viewer to view and manage System, Security, and Application event logs. You can also archive event logs. The event-logging service starts automatically when you run Windows. You can stop event logging with the Services tool in Control Panel.

Performance Monitor

Performance Monitor is a graphical tool for measuring the performance of your own computer or other computers on a network. On each computer, you can view the behavior of objects, such as processors, memory, cache, threads, and processes. Each of these objects has an associated set of counters that provide information about device usage, queue lengths, delays, and information used to measure throughput and internal congestion.

It provides charting, alerting, and reporting capabilities that reflect both current activity and ongoing logging. You can open, browse, and chart log files later as if they reflected current activity.

The following overview lists how you use Performance Monitor to view the performance of objects:

- Simultaneously view data from any number of computers.
- View and dynamically change charts reflecting current activity and showing counter values that are updated at a user-defined frequency.
- Export data from charts, logs, alert logs, and reports to spreadsheet or database programs for further manipulation and printing.
- Add system alerts that list events in the Alert Log and notify you either by reverting to Alert view, logging the event in Event Viewer's Application log, or issuing a network alert.
- Run a predefined program either every time or only the first time a counter value goes over or under a user-defined value.
- Create log files containing data about objects on different computers.
- Append selected sections of existing log files to a single file, forming a long-term archive.
- View current-activity reports or create reports from existing log files.
- Save individual chart, alert, log, and report settings, or save the entire workspace setup to reuse when needed.

Local Users and Groups

Local Users and Groups is a tool you can use to manage account security for a computer running Windows. With this application you can:

- Create and manage user accounts.
- Create and manage groups.
- Manage the security policies.

The application window displays two lists: The upper list of user accounts and the lower list of groups. One or more user accounts (or one group) can be selected and then managed using commands on the User menu.
**DirectX Diagnostic Tool (DXDIAG.EXE)**

You can diagnose and resolve DirectX video display problems using the DirectX Diagnostic Tool and the Multimedia and Games Troubleshooter. The DirectX Diagnostic Tool helps you test the functionality of DirectX, to diagnose problems, and to adjust the level of hardware support used by DirectX, which can be used to avoid issues on some multimedia drives. The DirectX Diagnostic Tool (Dxdiag.exe) is installed with DirectX and can be run by clicking Start, clicking Run, and then typing dxdiag.

For information about using the DirectX Diagnostic tool, click the Help button within the DirectX Diagnostic application.

**Microsoft Management Console (MMC)**

In Windows, there is a single consolidated screen that lets you manage user accounts through the User Manager, configure devices through the Device Manager, manage and format disks through the Disk Management option (known in Windows NT as Disk Administrator), and manage the current set of running services. The Computer Management screen brings all of the major system management utilities together into one screen. To access the Computer Management screen, right-click on My Computer, and then select the Manage option.

**REGEDIT and REGEDT32**

Windows comes with a Registry editing tool that can help you to repair or edit a faulty registry. The program is called REGEDIT.EXE. It is a fairly simple database editor, and it lets you search the Registry for specific text strings (by pressing Ctrl - F). For example: if Windows gives you error messages that certain .DLL files could not be found on your PC, you can use REGEDIT to go into the Registry and delete out all mentions of that now-missing VxD file, thereby eliminating the error messages at system boot-up time.

Another Windows Registry editor, REGEDT32.EXE, is available to modify the Registry manually. It displays the Registry hives as a series of folders. You can use either registry editor, but Microsoft (and the author) recommend using REGEDIT.EXE.

**MSCONFIG**

The System Configuration utility (MSCONFIG) automates the routine troubleshooting steps that Microsoft Customer Support Services professionals use when they diagnose system configuration issues. When you use this utility to modify the system configuration, you can select check boxes to eliminate issues that do not apply to your configuration. This process reduces the risk of typing errors that you may make when you use any text editor, such as Notepad. You must be logged on as an administrator or as a member of the Administrators group to use the System Configuration utility.

When you use the System Configuration utility, you can easily reset or change the configuration settings in Windows to include preferences for the following files and settings:

- The System.ini file
- The Win.ini file
- The Boot.ini file
- Programs that are set to load during the startup process (these programs are specified in the Startup folder and in the registry)
- Environment settings
- International settings
IPCONFIG (/all /release /renew)

IPCONFIG is a command line tool used to control the network connections on Windows NT/2000/XP/Vista/Windows 7 machines. Typing IPCONFIG and pressing Enter at the command prompt will display your current IP network settings, including your IP address, your subnet mask, your default network gateway, and your connection-specific DNS suffix for all of your network adapters.

There are three main command options that provide additional information or functions for IPCONFIG: /all, /release, and /renew. The /all option shows all IP related information for your network connections, more than just with the plain IPCONFIG command. The /release option drops your DHCP-obtained IP address, and the /renew option obtains a fresh IP address from the DHCP server.

PING

Ping is a utility that determines whether a specific IP address is accessible. It works by sending a packet to the specified IP address and waiting for a reply. PING is used primarily to troubleshoot Internet connections. Although there are many freeware and shareware Ping utilities available for personal computers, the Microsoft-supplied Ping utility works just fine.

NET

NET is a prefix to a series of DOS-level commands that let you access, connect to, print, configure and view networking resources on a Microsoft network. For example: the command NET USE H:= [some server name and disk directory] will give you a networked H: drive on your PC. NET PRINT will let you print a file to a networked printer, and so forth. Typing NET /? At the DOS prompt will show you all of the available sub-commands for the NET command. The key sub-commands are:

ACCOUNTS, COMPUTER, CONFIG, CONTINUE, FILE, GROUP, HELP, HELPMSG, LOCALGROUP, NAME, PAUSE, PRINT, SEND, SESSION, SHARE, START, STATISTICS, STOP, TIME, USE, USER, and VIEW.

TRACERT

Tracert is a utility that traces a packet from your computer to an Internet host, showing how many hops the packet requires to reach the host and how long each hop takes. If you're visiting a Web site and pages are appearing slowly, you can use traceroute to figure out where the longest delays are occurring.

The original traceroute is a UNIX utility, but nearly all platforms have something similar. Windows includes a traceroute utility called tracert. In Windows, you can run tracert by selecting Start->Run…, and then entering tracert followed by the domain name of the host. For example:

tracert academic.pgcc.edu

Traceroute utilities work by sending packets with low time-to-live (TTL) fields. The TTL value specifies how many hops the packet is allowed before it is returned. When a packet can't reach its destination because the TTL value is too low, the last host returns the packet and identifies itself. By sending a series of packets and incrementing the TTL value with each successive packet, traceroute finds out who all the intermediary hosts are.
NSLOOKUP

Displays information that you can use to diagnose Domain Name System (DNS) infrastructure. Before using this tool, you should be familiar with how DNS works. The Nslookup command-line tool is available only if you have installed the TCP/IP protocol.

System File Checker (SFC)

System File Checker scans and verifies the versions of all protected system files after you restart your computer. This process will reinstall known-good versions of all Windows system files over any files that have been damaged, corrupted, or are incompatible versions from an earlier release of Windows.

To run SFC, click on the Start button, then select Run, and in the Run box enter the following command:

SFC /scannow [Enter]

You will need to have a copy of your Windows installation CD (or DVD) in your optical drive when SFC is running; the application will read the known-good files from the CD and copy them over any invalid system files on your hard disk. The PC will reboot when SFC is completed.
An Overview of The Windows Registry

The Windows Registry provides a single, unified database for storing system and application configuration data in a hierarchical form. Because the Registry contains all the settings required to configure memory, hardware peripherals, and Windows-supplied network components, you may find that it is no longer necessary to configure settings in startup configuration files and initialization (.INI) files. Because settings are stored in a central location, you can provide both local and remote support for system configuration using Windows-based tools.

The Registry is similar to the INI files used under previous versions of Windows, with each key in the Registry similar to a bracketed heading in an INI file and with Registry values similar to entries under the INI headings. However, Registry keys can contain subkeys, while INI files do not support nested headings. Registry values can also consist of binary data, rather than the simple strings used in INI files.

Although Microsoft discourages using INI files in favor of Registry entries, some applications (particularly older 16-bit Windows-based applications) still use INI files. Windows supports INI files solely for compatibility with those applications and related tools (such as setup programs).

The Registry provides the following benefits in Windows:

A single source provides data for enumerating and configuring the hardware, applications, device drivers, and operating system control parameters. The configuration information can be recovered easily in the event of system failure. Users and administrators can configure computer options by using standard Control Panel tools and other administrative tools, reducing the likelihood of syntactic errors in configuration information.

A set of network-independent functions can be used to set and query configuration information, allowing system administrators to examine configuration data on remote networked computers. The operating system automatically backs up the last good configuration used to start the computer.

Because user-specific Registry information can be maintained on a central network server when user profiles are enabled, users can have access to personal desktop and network access preferences when logging on to any computer, and settings for multiple users can be maintained on a single computer. Also, system policies (called Group Policy Objects or GPOs) can be used to enforce certain Registry settings for individuals, workgroups, or all users.

Main Registry Components

There are several classes (or hives) of registries within the single Windows Registry. Each class deals with a specific aspect of how Windows associates files with applications, and configuration settings with users and hardware. Listed below are the major hive classes within the Windows Registry:

- HKEY_CLASSES_ROOT
- HKEY_CURRENT_USER
- HKEY_LOCAL_MACHINE
- HKEY_USERS
- HKEY_CURRENT_CONFIG

The registry hive called HKEY_DYN_DATA exists only in Windows 9x.
What functions do these parts of the Registry perform?

**HKEY_CLASSES_ROOT**

This part of the Registry provides Windows with the information it needs to associate different types of files with the applications for which they belong. Files in a DOS/Windows environment have a file extension, usually 3 characters in length, that let the operating system associate the file to an application with which it is opened.

For example, .DLL files are called and used by application software, or can be downloaded from the Internet; .AVI files are video files that the Windows Media Player (MPLAYER.EXE) will display for you. If you double click on the icon for an .AVI file, MPLAYER would load automatically and play the file, because the Registry associates that file with that application.

**HKEY_CURRENT_USER**

This part of the Registry provides Windows with the "personal" desktop configuration information needed for the currently logged-in user of Windows. Windows gives you the ability to have multiple configurations of the same installation of Windows for different users of the same machine, so each person's desktop will be configured to their liking. This includes desktop schemes, sounds, colors, icons, keyboard layout, networking configuration, and available software.

**HKEY_LOCAL_MACHINE**

This part of the Registry provides Windows with the non-user-specific, hardware based aspects of the host (or current) computer. For example, the HARDWARE branch of this subtree is where Windows stores all of the information about Plug-and-Play based hardware in your computer. Your network hardware configuration, hardware requirements of application software, audio and video controls, drive controller and video card configuration, and your PCI bus configuration information is all included in this part of the Registry.

**HKEY_USERS**

This part of the Registry provides Windows with the list and configuration information for all registered users of Windows on that PC. In this instance, registered means anyone who has logged into the PC (NOT necessarily onto the network) and has done anything under the desktop interface. The same kinds of information found in HKEY_CURRENT_USER will be found for all recognized users under the HKEY_USERS subtree.

**HKEY_CURRENT_CONFIG**

This part of the Registry provides Windows with the current machine's hardware and Plug-and-Play configuration. This is set (or reconfigured) through the use of .INF (information) files used when Windows installs new devices into the PC. The Windows configuration manager is primarily responsible for controlling this aspect of the Registry, working together with the Plug-and-Play BIOS, the device drivers and VxDs (virtual device drivers), the software enumerators that poll each Plug-and-Play device, any resource arbitrators on the system board, and the application programming interfaces (APIs) that allow software to interface with the hardware.
**HKEY_DYN_DATA** [Exists ONLY in Windows 9x]

This part of the Registry provides Windows with the information it needs to use dynamic (virtual) device drivers, or VxDs. Dynamic drivers are loaded only when an application calls to a specific resource on your PC (modem, sound card, etc.); these drivers may not necessarily be loaded when Windows boots up. The VXDLDRL module of Windows handles the loading of VxDs when needed by the operating system and/or the specific device. Also, this part of the Registry keeps track of information on the kernel of Windows that has been loaded into RAM, the Virtual FAT that has been loaded into RAM, and the Virtual Memory Manager module of Windows.

**Restoring the Registry Files in Windows 2000 and Windows XP / Vista / Windows 7**

This section describes how to back up, edit, and restore the registry. Microsoft recommends that before you edit the registry, you back up the registry and understand how to restore it if a problem occurs.

**How to Back Up the Windows 2000 Registry**

Before you edit the registry, export the keys in the registry that you plan to edit, or back up the whole registry. If a problem occurs, you can then follow the steps shown below to restore the registry to its previous state.

**Exporting Registry Keys**

You can follow these steps to export a registry key before you edit it:

**NOTE:** Do not follow these steps to export a whole registry hive (for example, HKEY_CURRENT_USER). If you must back up whole registry hives, back up the whole registry instead.

- Click Start, and then click Run.
- In the Open box, type regedt32, and then click OK.
- Locate and then click the key that contains the values that you want to edit.
- On the Registry menu, click Save Key.
- In the Save inbox, select a location in which to save the .reg file, type a file name in the File name box, and then click Save.

**How to Back Up the Entire Windows Registry**

Follow these steps to export the entire Registry to a .REG file:

- Click Start, and then click Run.
- In the Open box, type regedit, and then click OK.
- Make sure that My Computer is highlighted in the Registry editor.
- Click on the File drop-down menu, and click the Export option.
- In the Save inbox, select a location in which to save the .reg file, type a file name in the File name box, and then click Save.

**Note:** this technique actually works in all Windows versions.
To back up the whole registry, you also can use the Microsoft Backup utility to create an Emergency Repair Disk (ERD), or back up the System State (which includes the registry, the COM+ Class Registration database, and your boot files).

For additional information about using the Backup utility to create an ERD, click the following article number to view the article in the Microsoft Knowledge Base: 231777

( http://support.microsoft.com/kb/231777/ ) How to create an emergency repair disk in Windows 2000

For additional information about using the Backup utility to back up the system state, click the following article number to view the article in the Microsoft Knowledge Base: 240363

( http://support.microsoft.com/kb/240363/ ) How to use the Backup program to back up and restore the system state in Windows 2000

How to Back Up the Windows XP / Vista / Windows 7 Registry

• Use the System Restore utility from the Start menu. Click on Start, then click on Programs (or All Programs) / Accessories/ System Tools, and select System Restore.
• (You also can click on Start, then Run, and type %SystemRoot%\system32\restore\rstrui.exe, and then click OK.)
• On the Welcome to System Restore page, click Create a restore point, and then click Next .
• On the Create a Restore Point page, type a name for the restore point and then click Create
• After the restore point has been created, click Close.
• Note: If System Restore is turned off, you will receive a message that asks whether you want to turn on System Restore now. Click Yes. Then, in the System Properties dialog box, click to clear the Turn off System Restore check box, click OK, and then repeat this step.

To Restore the Windows XP / Vista / Windows 7 Registry

• You also can use System Restore to undo registry changes in Windows XP, Windows Vista or Windows 7
• Click on Start, then click on Programs (or All Programs) / Accessories/ System Tools, and select System Restore.
• (You also can click on Start, then Run, and type %SystemRoot%\System32\Restore\Rstrui.exe, and then click OK.)
• On the Welcome to System Restore page, click Restore my computer to an earlier time (if it is not already selected), and then click Next .
• On the Select a Restore Point page, click the system checkpoint. In the On this list select the restore point area, click an entry that is named "Guided Help (Registry Backup)," and then click Next. If a System Restore message appears that lists configuration changes that System Restore will make, click OK.
• On the Confirm Restore Point Selection page, click Next. System Restore restores the previous Windows configuration and then restarts the computer.
• Log on to the computer. When the System Restore confirmation page appears, click OK.
Using Regedit to Edit Your Registry

Windows comes with a Registry editing tool that can help you to repair or edit a faulty registry. The program is called REGEDIT.EXE. It is a fairly simple database editor, and it lets you search the Registry for specific text strings (by pressing Ctrl - F). For example: if Windows gives you error messages that certain .DLL files could not be found on your PC, you can use REGEDIT to go into the Registry and delete out all mentions of that now-missing VxD file, thereby eliminating the error messages at system boot-up time.

Another Windows Registry editor, REGEDT32.EXE, is available to modify the Registry manually. It displays the Registry hives as a series of folders. You can use either registry editor, but Microsoft (and the author) recommend using REGEDIT.EXE.

BE CAREFUL, HOWEVER, WHEN RUNNING REGEDIT ... even the experts at Microsoft recommend that you not use Regedit unless you know exactly what you are doing. Usually, it's better to reinstall the missing software, or uninstall the errant software, rather than messing around with the Registry. When you uninstall a software application, the uninstaller edits the Registry for you, removing all mentions of any VxDs or drivers that will no longer be needed. It's much better to let the software developer's uninstaller change the Registry, rather than you, especially since they know what Registry entries were made in the first place.

Please use this guide when editing a Registry, and don't add or delete anything unless you are absolutely sure that it's the right thing to do.

For the A+ examination, you will need to know what the Windows Registry is, what are the major classes (or hives) within the Registry, how to edit the Registry (use Regedit), and how to restore your backup registry in the case of emergency.

Re-Registering Programs Using Windows Explorer and .REG Files

From time to time, you may find that certain programs will begin to malfunction because the Registry entries for that program have become corrupt. The corruption may come from a virus, from another installed program with competing Registry values (i.e., Internet Explorer vs. Firefox), from user error, or from other miscellaneous problems (disk space corruption, installer failure, etc.). When this occurs, there is a process you can use to re-register a program in the Windows Registry without forcing a reload of the operating system. This process should restore a program to normal operation.

To re-register a program in Windows, right-click on Start, then launch Windows Explorer. Select Tools from the menu bar, then select Find, then select Files/Folders, and then search for any files on the hard disk that end in .REG. Find the .REG file that correlates to the affected program, and then re-register affected program by double-clicking on the selected .REG file. This should restore the program to normal operation. If it does not, contact the program’s technical support staff for assistance.
A Discussion of Various File Systems Used in Microsoft Operating Systems

FAT16 and FAT32 File Systems - Hard Drives

From DOS version 4.0 through the "A" release of Windows 95, there was one major type of partition table and file system for hard disks: the FAT16 file system. The FAT16 file system had two major problems; large allocation unit sizes, and limited disk size addressing. As hard disks grew in size, the allocation unit (the basic storage unit on hard disks) grew in size, finally topping out at 32,767 bytes per unit. If someone stored a 150-byte in a 32,767-byte allocation unit, the user would lose 32,716 bytes as wasted space, since DOS (and Windows 95) cannot put another file into an allocation unit that has a complete file (or portion of a complete file) in it. Further, FAT16 file systems can only address 2 gigabytes (GB) of disk space at a time. As hard disks grew beyond the 2GB barrier, this meant partitioning drives into multiple 2GB or smaller partitions.

With the "B" release of Windows 95, a new type of file system was introduced. The FAT32 file system corrected some of the major problems with FAT16 file systems. FAT32 file systems use allocation units of 4,096 bytes per unit, rather than 32,767 bytes. This meant much less wasted space on a hard disk, and better utilization of the entire disk space. Further, FAT32 file systems can address up to 4 terabytes (TB) of disk space, which is an enormous amount of disk space. There are virtually no compatibility problems with older applications running in a FAT32 file system environment. Further, with the introduction of Windows 98, a utility was included that allowed a FAT16 file system to be converted to FAT32 with no need to reformat the drive and reinstall the operating system.

The only problem with FAT32 file systems is that Windows NT version 4.0 does not recognize FAT32 file systems. Windows NT 4.0 only recognizes the FAT16, NTFS (the file system for Windows NT and above), and the CDFS (CD-ROM file system) file system types. If your hard disk was formatted as FAT32, you would have to reformat the drive to FAT16 or NTFS in order to install Windows NT 4.0 on the system. Windows 2000 / XP / Vista / Windows 7 is capable of reading a FAT32 disk, as well as FAT16, previous versions of NTFS, and CDFS file systems.

CDFS File System - CD/DVD-ROM Drives

Short for CD-ROM File System, CDFS is a 32-bit program that runs in protected mode that allows Windows-based operating systems to read and write data to optical drives. In addition, uses the VCACHE driver to control the CD-ROM disk cache, which results in much smoother disc playback.

Comparisons and Contrasts Between NTFS and FAT file systems

Windows NT/2000/XP/Vista/Windows 7 uses the NTFS (NT File System) file system for hard disks, which allows users and administrators to implement file and folder-level security, disk quotas, disk compression and file encryption. Windows 9x and it's FAT16 or FAT32 file systems do not permit for such added levels of security.

Further, Windows NT does not recognize the FAT32 file system developed for Windows 9x. Windows NT does recognize the FAT16 file system, but it is unable to implement the kinds of security levels possible in an NTFS disk partition. The FAT16 file system does support the simultaneous loading of Windows 9x and Windows NT on the same partition, permitting then a dual-boot configuration, but Windows 9x does not recognize NTFS disk partitions.

However, Windows 2000/XP/Vista/Windows 7 does recognize the FAT32 file system that Windows NT did not recognize. The file system for Windows NT has been called NTFS version 4 by Microsoft, NTFS 5.0 for Windows 2000, NTFS 5.1 for Windows XP, and NTFS 6.0 for Windows Vista / 7.
Boot Sequence for Windows NT / 2000 / XP / Vista / Windows 7

Here is the boot sequence for Windows NT through Windows 7:

1) The program NTLDR begins the boot process. It is located in the boot sector of the hard drive, and it will allow for the computer to be booted to either Windows or to DOS-based operating systems (such as Windows 9x and/or DOS). This is the Windows bootloader program.

2) BOOT.INI is used to determine how the computer will boot up, and which operating system will be used. BOOT.INI is also used to create a Boot Loader Menu that is displayed on the screen prior to the rest of the operating system loading. The default setting is that Windows (NT/2000/XP/Vista/Windows 7) will be the default operating system, and the user has 30 seconds to make a choice of which operating system to boot with.

3) The program BOOTSECT.DOS is loaded by NTLDR only if an operating system other than Windows is loaded. NTLDR determines this by what choice is made at the Boot Loader Menu.

4) NTDETECT.COM is loaded; it examines the hardware available in the system, and passes this information to NTLDR for it to add to the Windows Registry. Pressing the spacebar at this point bypasses the hardware detection process and invokes the last known good hardware profile (from the last time Windows booted up; the operating system keeps a record of the last good hardware profile).

5) NTBOOTDD.SYS is loaded if there are non-booting SCSI devices in the system that need to be recognized. If there is a SCSI boot device, the SCSI BIOS loads the necessary code for Windows to recognize it. However, non-booting SCSI devices require a device driver at the operating system level for them to operate. NTBOOTDD.SYS provides Windows with the code needed to use these SCSI devices.

6) The program NTOSKRNL.EXE loads into memory; this is the operating system kernel. In Windows NT, a blue screen is displayed; in Windows 2000 through Windows 7, the Windows logo is displayed.

7) The file HAL.DLL is loaded. This loads the Hardware Abstraction Layer, which is the system-level code that makes Windows portable to various system platforms.

8) The program SYSTEM is loaded; it loads the system configuration settings to control device drivers and services loaded as Windows initializes.

9) Finally, any necessary device drivers are loaded to make specific devices (i.e., video card, modem, sound card) operate. In Windows, the Plug-and-Play manager loads the necessary drivers, and prompts the user to install a driver for any new devices detected in the system.

10) Then, WINLOGON.EXE and EXPLORER.EXE are loaded; these programs provide the user interface common to Windows, and also allow you as a user to log onto the system. Pressing Ctrl-Alt-Delete brings up the login screen, which allows users to gain access to the system.
Trouble-Shooting Operating System Installations

What to Do When Windows Doesn't Install Properly

Normally, the operating system of your choice should install itself on your computer just fine, with a minimum of problems. A specialized script file, called an .INF file, contains the instructions needed for the install program to correctly run on your computer, and it has instructions to follow if it encounters specific issues or problems while installing the operating system. However, there may be specific problems on your computer that the script file cannot overcome, and the install program may bomb (quit abruptly) on you unexpectedly. When that happens, you should explore the following issues before calling Microsoft (or your vendor) for assistance. Below are some possible reasons why Windows will not install properly.

System Board Mis-configuration

If your system board has something mis-configured in the CMOS Setup program, your operating system (or other software) install program may bomb on you. Use the instructions contained in this guide on CMOS Setup Configuration for assistance in correcting this type of problem. Many times, using the "Original" default factory settings will solve this type of problem. If it does not, you may want to explore some of these issues listed below.

CPU Speed Over-Clocking

Making a CPU operate at a speed that is faster than rated is easy to do, but it may cause specific kinds of failures on your PC, especially when an operating system install disk is attempting to identify exactly what type of components you have in your PC. You may also cause the CPU to overheat, which will permanently damage the CPU and possibly the motherboard as well. Make sure that any CPU timing jumpers, including voltage jumpers, have been set correctly on your PC before doing any software installations.

**CPUs must be set to a specific megahertz speed, a specific clock multiplier, and a specific voltage level** ... make sure you have set your system board correctly before proceeding very far with any software (or hardware) installations. Use the documentation from your system board, and also from your CPU manufacturer, to ensure that these settings are correct.

Memory Mismatches, Mis-timed Memory, and Memory Failures

Random Access Memory (RAM) can be very finicky, and so can certain types of motherboards. When adding memory to a system, it is important that you install memory SIMMs (Single In-line Memory Module) or DIMMs (Dual In-line Memory Module) that match each other in type and speed. The SIMMs or DIMMs don't have to have the same memory size, but they must run at the same speed, and they must be the same type (i.e., fast page, EDO, synchronous DRAM, etc.). Also, you should never install both SIMMs and DIMMs on the same system board, UNLESS the manufacturer's documentation explicitly states that it is OK so to do. Usually DIMMs run at 10 - 20 nanoseconds, while the fastest SIMMs run at 55 - 70 nanoseconds. Pushing those SIMMs to keep pace with the much-faster DIMMs will certainly cause memory failures, and may cause the over-heating of the SIMMs as well.
Secondly, the CMOS Setup program may have an option under the Advanced Chipset Features where you can set the memory timing. It is usually best to set this option to AUTO, and let the motherboard automatically determine the speed of the memory units. If you do set this option manually, set the value to exactly what the memory speed is rated. The factory that manufactured the memory will have marked the speed rating on the chips, usually with something like "-6" or "-60" (for 60 nanoseconds). If the system board will not let you set the speed correctly, select a speed that is SLOWER than the chips are rated. Faster SIMMs can go slower, but slower SIMMs can't reliably go faster.

Finally, do NOT assume that since the memory is new, it must be in good working condition. If you encounter memory that you suspect is defective, use a memory tester to check the SIMM or DIMM in question. If such a tester is not available, install the memory into a known-good system board and see whether it works correctly or not. Return any defective memory to your vendor for replacement.

**Cache Memory Failures**

Cache memory is just as likely to fail as traditional SIMMs or DIMMs. Many Level 2 cache (also known as the external cache) memory units are made as proprietary plug-in modules, or are chips that plug into sockets on the motherboard, or may even be soldered into the system board. Level 1 cache (also known as the internal cache) is built into the CPU itself; if that cache is blown (usually from overheating), the CPU must be replaced.

Cache memory failures manifest themselves as an inability to get to an A: or C: prompt, even when it seems that the system is attempting to boot normally. Also, cache memory failures can cause random lockups and illegal operation errors while in Windows.

If you suspect that there may be a cache memory failure in the system board, start by disabling the Level 2 cache in the Advanced CMOS Setup part of the BIOS Setup program. If the cache cannot be disabled in the setup program, simply remove the cache memory from the system board. If this resolves the problem, replace the Level 2 cache, re-enable the cache in the Setup program, then test the system again. If the system still fails with a known good Level 2 (or L2) cache unit, the system board should be replaced, or you can look at some other options listed in this section of the curriculum.

**Hard Disk Problems**

As with memory units, obtaining a new hard disk is not an assurance that the unit is in perfect working condition. The best first way to determine if a drive is working correctly is to perform an auto-detect of the drive from the CMOS Setup program. If the drive is correctly detected, make sure to select the option for logical block addressing (LBA) mode if applicable, and make sure that the specifications match up to the manufacturer's documentation. If the drive is not detected, then the drive is not connected to the drive cable (or power cable) correctly, or the drive's master/slave jumpers are not set correctly, or the drive is not operating at all, or the drive interface may not be functioning correctly.

If the drive is detected but disk problems persist, run SCANDISK on the disk to determine the nature of the problem. If uncorrectable errors exist on the disk in significant numbers (five percent or more of the total disk space), or if the drive continually develops new disk flaws, replace the drive.

If the drive is under warranty, be sure to contact your vendor or drive manufacturer for assistance in replacing the drive. Most hard disks have a 2 - 3 year warranty on them, so be sure to look at the manufacture date to see if you are still in the warranty period. Contact the drive manufacturer for details on how to return an in-warranty drive.
If the disk still has unusual errors on it, dump everything off the disk, reinstall the operating system, and then scan the disk for viruses. Be sure to use clean, non-viral, write-protected disks when installing the operating system or checking for viruses.

**CD-ROM Read Failures and Install Disk Failures**

Many newer CD-ROM drives have problems with vibration when operating at maximum speed. These problems will cause intermittent read failures ... if such failures happen when you are installing an operating system or application software, the install program may bomb on you. The only way to prevent or recover from such problems is to buy well-known brand-name CD-ROM drives that have a good reputation for consistent operation. Buying cheap CD-ROM drives may end up costing you valuable time and endless frustration when installing your operating system.

Also, if you have problems with the CD-ROM drive not being read correctly, be sure to use the driver software that actually came with the drive. A Toshiba or Mitsumi brand driver may work on a "no-name" drive, but occasionally these drivers will fail to operate your "no-name" drive ... using the manufacturer-supplied drivers should remedy the problem.

Further, you may find that your operating system or application software has been duplicated onto cheap, flimsy or defective CD-ROM disks (or floppy disks). Make sure that the data surface of your CD-ROM disks are clean, fingerprint-free, and have as few scratches as possible. If there are imperfections in the disk media, obtain replacement disks from the manufacturer or vendor. A little bit of Pledge furniture polish on the CD may clean up a balky install disk, but be sure to wipe the disk totally clean before using it in the drive.

**System Board or Major Component Failures**

Your install process may uncover for you some flaw in the system board, or some major component, like a drive interface or video card. When you suspect that this is happening, use a good general-purpose PC diagnostic program to assure yourself that all of the system components are working properly. If something is defective, note this and return the component to your vendor or manufacturer for replacement. Also, notice if something is getting hot on the system board; this is usually a good indicator that something is defective.

**Video RAM Failure on a Video Card**

Occasionally, your install process may find that the video RAM on the video card is defective. This manifests itself as an inability to display video correctly, or an inability to use the entire color palette, or when Windows will only boot to safe mode, or you get a constant error message that your video card is incorrectly configured. When you suspect that this is happening, use a good general-purpose PC diagnostic program to assure yourself that the video card is working properly. You can also swap in a known-good video card to see if the problem goes away. If something is defective with the video card, note this and return the component to your vendor or manufacturer for replacement.

**Windows Incorrectly Installs Components or Features**

Many times Windows will incorrectly install a component in your system when you first load the operating system. For example, many times you will find that off-brand sound cards will be installed as "Other Devices" instead of "Sound, video and game controllers". When that happens, delete the mentions of the mis-installed device from the "Other Devices" section of the Windows Device Manager, and then run the driver install disk for that device that came from the hardware manufacturer. This will typically solve the problem, and allow the affected device to operate normally.
Windows Upgrade Problems

Windows can be a real mess if you are not prepared with the right driver software for your computer. Many Windows users are now reporting that when they install an upgrade to the operating system, the sound card, modem or video card drivers on their computers go haywire. That is because many of the core .DLL files and driver files that came with the previous Windows version don't (or may not) work with the newer Windows operating system or the updated drivers that came with the upgrade.

Each Windows operating system version will have an entirely new set of Dynamic Link Library (.DLL) files that have the same names as their older Windows counterparts. Even though the new Windows DLL files have the same names as their previous version's counterparts, these files are not necessarily compatible with certain drivers or install scripts. Make sure that you have drivers that are designed to work in your current (or upgraded) Windows environment. You will need to check with your hardware vendor or manufacturer to make sure that everything is in order before doing any installation work.

Viruses

A virus, especially a boot sector virus or a stealth virus, can easily corrupt an operating system or application install program. Be sure that your install disks are clean before beginning the installation; check the disks on a known-clean system with a reputable anti-virus program (AVG Anti Virus, for example). If necessary, run an anti-virus program on your hard disk (and a SCANDISK, if possible) before doing an operating system installation.

Further, be sure to disable any virus-protecting terminate-and-stay-resident (TSR) programs before doing any kind of software installation ... many software installation programs appear to be viral to the TSR program, and may cause the install program to bomb.

Using Original System Install Disks

Whenever possible, use only the original system disks to install any software program. This ensures that no strange errors crop up when loading your software. If you do use backup diskettes, make sure that they are exactly the same as the original disks.

Upgrade Disks vs. Full-Install (OEM) Disks

There are two different types of software installation disks available from the manufacturer: original equipment manufacturer full-install disks, and upgrade disks. Full-install, original equipment manufacturer (OEM) disks presuppose that you have no software of any kind on your hard disk, or that you do not have the previous revision of the specific software on your hard disk. Upgrade disks are for those persons who have a previous version of the software on their hard disk already, and who only need to move up to the most current version of the software.

Make sure you know which software package you need to do the installation, since the two packages are NOT interchangeable. You cannot do a full install of any Windows version from the upgrade disk, and you cannot upgrade any Windows version with an OEM full-install disk. Once you obtain the correct disk, you will be able to successfully install your operating system or application.
LBA Mode Translations

Logical Block Addressing (LBA) mode allows the user to lie to the BIOS about the architecture (or geometry) of the hard disk, so that the entire disk can be addressed as a single partition. Normally, hard disks with more than 1024 cylinders cannot be addressed as a single unit, and must be partitioned and addressed with special software, such as what comes with OnTrack's Disk Manager product. LBA mode lets the user (and computer) reduce the number of cylinders reported in the CMOS Setup, while increasing the number of read/write heads by the same proportion in the setup program. By doing this, you can have drives that are larger than 512 megabytes (the maximum of what could be addressed without LBA mode) addressed as single partitions on your PC.

In order for this feature to work correctly, you must enable LBA mode in the CMOS Setup program BEFORE performing an FDISK and FORMAT on the hard disk. If you don't do this, FDISK will partition the disk only to 512MB in size, and you will need to delete the partition table, reboot, and re-FDISK the drive in order to correct the problem. Most current PCs enable LBA mode by default.

Hard drives larger than 528 MB need to use the LBA (logical block addressing) mode feature in the system BIOS for the whole drive to be recognized. ALL PCs have some form of LBA mode built into the BIOS.

However, some system BIOS products have an older version of the LBA mode feature that only will recognize drives up to 127GB. If this is the case, you will need to upgrade the BIOS version with software from the PC or system board manufacturer, or use a smaller drive that the current BIOS product will accept.

Using EZ-Drive and Other Such Programs

For those motherboards that do not have an up-to-date LBA mode version (or the BIOS cannot be upgraded), there is a program called EZ-Drive that can potentially provide a solution. EZ-Drive provides at a software level the same LBA translation capabilities that are found in the ROM BIOS firmware. It will allow motherboards with older LBA versions to access and use hard drives larger than originally designed. Many hard drive manufacturers provide a copy of EZ-Drive when you purchase a new drive.

HOWEVER, EZ-Drive may give you significant problems when running Windows, especially if your PC becomes infected with a boot sector virus. In many cases, you will lose ALL your data on the disk, because the boot sector virus significantly corrupts the LBA translation table written to the boot sector.

As a general rule, NEVER use EZ-Drive to install a hard disk on a computer UNLESS you know that the motherboard does not support the LBA version you need, and you have no other options for upgrading the system. Also, be sure to read the EZ-Drive documentation carefully BEFORE installing the drive and/or your operating system on that drive. Further, the ONLY way of getting rid of the EZ-Drive software on the hard disk (short of a low-level format) is to use the EZ-Drive disk to UNINSTALL the software. Therefore, if you get a copy of the EZ-Drive install disk, be sure to keep it, since you may need it to uninstall the software at a future date on some poor soul's PC.
Service Packs from Microsoft

Instead of issuing revised versions of Windows (or other application programs), Microsoft made available to the customer via their web site programs called service packs, which when run will update Windows with revised versions of specific files that have had reported problems. These service packs are available from Microsoft at no charge for Windows XP, Vista, Windows 7, and for the Microsoft Office XP/2003/2007 suites. Service packs for older operating systems and application suites are still available on the Internet, but Microsoft no longer makes these resources available on their website.

These files are self-extracting archive files that will automatically unpack and then install the proper components on your PC. If you encounter unusual problems on your PC, it is possible that running a service pack upgrade may fix the problem.

Visit the Microsoft web site at http://www.microsoft.com for more details.
Differences Between the Various Windows Operating Systems

If you listen solely to Microsoft for information on the differences between operating systems, you may only get a portion of the story. For example, Microsoft has information and charts on their website that contrasts Windows XP, Vista, and Windows 7. A link to that chart is shown below:


Of course, Microsoft says the newest version of Windows is CLEARLY superior to the previous versions. I would recommend doing a Google, Yahoo or Bing search on the phrase “comparing Windows 7, Vista and XP,” This will yield hundreds of results from various sources that will give you a more well-rounded presentation.

But how can you determine for yourself the differences between the various Windows operating systems? In the course, we will take three identical computers and install Windows on each of them. Then, we will perform identical tasks on all three computers, to see how each performs in real time. Once this is done, we will perform upgrades on the designated Windows Vista and Windows 7 computers, to see what is required to bring them up to an acceptable performance level.

Minimum Installation Specifications for Windows Operating Systems

Microsoft provides on their website the minimum hardware specifications needed to install and run a given Windows operating system version. Below are the MINIMUM specifications needed to run Windows XP, Windows Vista, and Windows 7:

Windows XP (Home and Professional)

- PC with 300 megahertz or higher processor clock speed recommended; 233 MHZ minimum required (single or dual processor system);* Intel Pentium/Celeron family, or AMD K6/Athlon/Duron family, or compatible processor recommended
- 128 megabytes (MB) of RAM or higher recommended (64 MB minimum supported; may limit performance and some features)
- 1.5 gigabytes (GB) of available hard disk space*
- Super VGA (800 x 600) or higher-resolution video adapter and monitor
- CD-ROM or DVD drive
- Keyboard and Microsoft Mouse or compatible pointing device

NOTE: XP Home / Professional runs best with at least 512MB of RAM and at least a 1.0GHz CPU.

Windows Vista Home Basic

- 1 GHz 32-bit (x86) or 64-bit (x64) processor
- 512 MB of system memory
- 20 GB hard drive with at least 15 GB of available space
- Support for DirectX 9 graphics and 32 MB of graphics memory
- DVD-ROM drive
- Audio Output
- Internet access (fees may apply)

NOTE: Vista Home Basic runs best with at least 1.5GB of RAM and at least a 1.5GHz CPU.
Windows Vista Home Premium / Business / Ultimate

- 1 GHz 32-bit (x86) or 64-bit (x64) processor
- 1 GB of system memory
- 40 GB hard drive with at least 15 GB of available space
- Support for DirectX 9 graphics with:
  - WDDM Driver
  - 128 MB of graphics memory (minimum)
  - Pixel Shader 2.0 in hardware
  - 32 bits per pixel
- DVD-ROM drive
- Audio Output
- Internet access (fees may apply)

NOTE: Vista Home Premium / Business / Ultimate runs best with at least 2GB of RAM and at least a 1.8GHz CPU.

Windows 7 (all versions)

- 1 gigahertz (GHz) or faster 32-bit (x86) or 64-bit (x64) processor
- 1 gigabyte (GB) RAM (32-bit) or 2 GB RAM (64-bit)
- 16 GB available hard disk space (32-bit) or 20 GB (64-bit)
- DirectX 9 graphics device with WDDM 1.0 or higher driver

Additional requirements to use certain features:
- Internet access (fees may apply)
- Depending on resolution, video playback may require additional memory and advanced graphics hardware
- For some Windows Media Center functionality a TV tuner and additional hardware may be required
- Windows Touch and Tablet PCs require specific hardware
- HomeGroup requires a network and PCs running Windows 7
- DVD/CD authoring requires a compatible optical drive
- BitLocker requires Trusted Platform Module (TPM) 1.2
- BitLocker To Go requires a USB flash drive
- Windows XP Mode requires an additional 1 GB of RAM, an additional 15 GB of available hard disk space, and a processor capable of hardware virtualization with Intel VT or AMD-V turned on
- Music and sound require audio output

Product functionality and graphics may vary based on your system configuration. Some features may require advanced or additional hardware.

NOTE: Windows 7 runs best with at least 2GB of RAM and at least a 2.0GHz CPU.

Microsoft does make available at no charge from their website the Windows Vista and Windows 7 Upgrade Advisor applications. These Upgrade Advisors will give you a more detailed understanding of whether your PC can run Windows 7 or Windows Vista. The author strongly recommends that you run these Upgrade Advisor applications BEFORE following through with an operating system upgrade.
Special Features in Windows Vista and Windows 7

There are some particular “bells-and-whistles” that make Windows Vista and Windows 7 different from previous versions of the operating system, and also are subjects covered on the A+ examination:

User Account Control (UAC)

In Windows Vista and Windows 7, User Account Control is a feature that was designed to prevent unauthorized changes to your computer. When functions that could potentially affect your computer’s operation are made, UAC will prompt for permission or an administrator’s password before continuing with the task. There are four different alert messages associated with User Account Control:

- Windows needs your permission to continue
- A program needs your permission to continue
- An unidentified program wants access to your computer
- This program has been blocked

UAC can be disabled by the user by going to the User Accounts Control Panel applet, and un-checking the box that enables UAC. In Windows 7, the applet gives a slider-style control to turn UAC up, down, or off. UAC was perhaps the single feature that turned people away from Windows Vista when it was introduced.

AeroGlass

The name given to the user interface (UI) for Windows Vista operating system. The interface is referred to as Aero Basic, and Vista also offers a second version called Aero Glass which provides even more graphics intensive features but requires a 3D video card that supports DirectX 9, and it must have a Longhorn Display driver Model (LDDM) driver. The Aero interface introduces translucent title bars, rounded edges, and stylish color schemes, amongst other features. Many older video cards that ran Windows XP are unable to display Vista with the AeroGlass feature.

Sidebars

Windows Sidebar is a pane on the side of the Windows Vista (or Windows 7) desktop that organizes gadgets (small applications with a wide variety of possible uses) and makes them easy to access. Sidebar gadgets include a clock, an RSS (Really Simple Syndication) reader for getting news updates, a weather update gadget, and so forth. Gadgets may be nice, but they do take up system resources that can be used for other applications.

NOTES
Chapter 12. Application Software

Once an operating system has been installed, application software will be installed to the computer's hard disk. This is a typical task for a computer technician, as well as for the typical user. This section of the text will instruct you in how to install properly different types of application software.

How to install application software

Installing software has become relatively simple, especially with the advent of the CD-ROM drive. For many programs, simply dropping the installation CD into the CD-ROM drive will cause the installation program to begin. The program SETUP.EXE launches a script that takes care of installing of that application's program files, and it also makes the necessary changes to the Windows Registry.

The preferred method, however, to install a new application is to go to the Windows Control Panel, double-click on the "Add/Remove Programs" icon, and click on the "Install" button. The dialog box looks like what is shown below:

Installing software in this way ensures that if you wish to remove the application at a later time, you will be able to do so by finding the name of the application in the list and clicking the "Add/Remove" button in this dialog box. Uninstalling applications by using the Add/Remove Programs dialog box ensures that the application files are removed from the hard disk, and also that all mentions of the program are removed from the Windows Registry.

How to uninstall application software

Uninstalling software should always be done from the "Add/Remove Programs" dialog box from within the Control Panel. The Windows Uninstaller removes all of an application's program files, all mentions of the program from the Start menu, and removes all references to the program from the Windows Registry.

Occasionally the Windows Uninstaller does less than a complete job of removing a program from your system. If you find that the Windows Uninstaller does not properly uninstall an application from your system, a third-party program like McAfee Uninstaller does an excellent job of removing an application from the computer. The McAfee Uninstaller has a record of the install scripts for thousands of programs, so it knows what to remove and how to return your system to the state it was in before the application was installed.
Troubleshooting Application Software Problems

There are as many problems involved with software usage as there are software programs available on the market today. This particular segment of the course will not attempt to solve every possible software problem you might encounter as a technician ... no technical manual ever could. However, this section of the course will cover how to trouble-shoot application software-related problems of the kinds found in the text below.

Bad Install Programs

Not every software installation program does a perfect job of putting a new application on your PC. In fact, some installers are downright treacherous. A good installation program should do the following things:

- Create a temporary directory that will be used for the software installation, and then delete the directory from the disk when the installation is completed.
- Check to make sure that it is not overwriting newer files with older ones, thus potentially corrupting the entire system (a warning message should appear if this issue arises).
- Check to be sure that you really want to reinstall the software if the program currently exists on the hard disk.
- Backup the system Registry files to make sure that if something does go wrong, the damage can be undone quickly and easily.
- Load an uninstaller on the PC for that application, so that the program can be smoothly removed if necessary.

If an install program doesn't do all these things, then there is a serious possibility that your install program could create a problem on your PC while installing the software. You should read the documentation for the install program before attempting to do the software installation, and try the installer on a non-production PC if you have any serious questions. Also, a good backup of the system may be in order if you aren't sure of the quality of the software or install program.

As a rule, you should always install new software onto a PC from the "Add/Remove Programs" icon in Windows. Installing software this way ensures that you have the ability to uninstall the product if something should go wrong with your PC after your new software is installed. In Windows, click on Start, then Settings, Control Panel, Add/Remove Programs, then Add New Programs, then give the name and location of the install program and press Enter. Follow the directions on the screen to correctly install the program.

To uninstall the program, simply return to the Add/Remove Programs icon, select the name of the program you wish to uninstall, and click the "Add/Remove" button. The Windows uninstaller will take care of the rest for you, returning the Windows Registry to the state it was in before the software was installed, and removing all related files from your hard disk.

Service Packs from Microsoft

Instead of issuing revised versions of Windows (or other application programs), Microsoft made available to the customer via their web site programs called service packs, which when run will update Windows with revised versions of specific files that have had reported problems. These service packs are available from Microsoft at no charge for Windows XP, Vista, Windows 7, and for the Microsoft Office XP/2003/2007 suites. Service packs for older operating systems and application suites are still available on the Internet, but Microsoft no longer makes these resources available on their website.
These files are self-extracting archive files that will automatically unpack and then install the proper components on your PC. If you encounter unusual problems on your PC, it is possible that running a service pack upgrade may fix the problem.

Visit the Microsoft web site at http://www.microsoft.com for more details.

**Conflicting DLL File Versions, and 16-bit vs. 32-bit DLLs**

.DLL files are Dynamic Link Libraries, that contain much of the program code that makes a Windows application work. Each version of Windows came out with its own set of .DLL files. If you accidentally replace a newer Windows .DLL file with one from a previous Windows version, Windows AND the application you just installed will both fail to operate. As a preventative measure, you may want to store somewhere a copy of all of the proper .DLL files for your version of Windows (and applications) in a safe place, just in case something happens to replace one of your .DLL files by accident.

You may also find that within a Windows version, there may have been some updating of .DLL files by Microsoft (or other software vendors) without your knowledge. The general rule is that it is always best to use the most up-to-date version of a .DLL file, unless you know that some kind of software conflict is taking place that would move you to replace a newer file with an older one.

Technical support representatives from different companies may instruct you from time to time to replace such files if an application is malfunctioning. Also, service packs and patches will update critical .DLL files, sometimes fixing the problem, and sometimes creating more of a problem. Be sure to contact the software manufacturer for assistance if you encounter such problems.

**User Error**

User error is probably the most common reason for computer or application software failure. If a person does not know "the rules of the road" concerning how to use a computer or a typical Windows application, more than likely they will do something destructive to the computer without knowing that they did it, or meaning to do so in the first place. Some of the more common mistakes that users will make include:

- not saving their work regularly
- not backing up their work on a regular basis
- saving files to the hard disk instead of a floppy disk, or vice versa
- forgetting the location of a file, or the name of a file
- forgetting your password
- using the same name for two different files, overwriting one with another
- overwriting good files with bad / blank ones
- deleting files / icons unintentionally
- launching more than one instance of a program, because of impatience with the computer
- printing to a turned-off (or off-line) printer, or to the wrong printer port
- not knowing how to use the "undo" feature in Windows applications
- not having an anti-virus program on your computer
- randomly hitting buttons or keys while the computer is processing some information
- pressing the reset key while the hard disk is writing data to the disk
- failing to read the instructions that appear on the screen
- failing to read the manual
- having a general paranoia of the computer
As a technician, you have the power to fix (or at least determine) the nature of the user error. Your most important task, however, is to ensure that the user learns from their experience, and does not repeat the same mistake again. You should have available a number of reference works you can suggest that will help the user to get up the learning curve concerning the use of a computer product.

You should also know of several places where a novice computer user can go to get the training they need to become more skilled in the computing arts. Many local community colleges provide excellent computer courses at a reasonable cost. Always recommend to users that they take time for training in computer use and the specific software applications they use regularly. The price of one class can be much less costly than several repeat repair calls on your part, and more satisfying to the user than just fixing repeated problems.

NOTES
Chapter 13. Viruses, Spyware / Malware, and Data Security

What exactly is a computer virus?

A computer virus is a program that attacks key components of your operating system, application programs and/or data files. These programs employ "stealth" capabilities so that you may be unaware that you have a virus, are passing the virus to someone else, or are about to lose critical data from your hard drive or floppy disks. Viruses are passed from disk to disk, or through the Internet to your floppy or hard disk, or they can be transmitted via e-mail messages.

Even shrink-wrapped software from the factory can have viruses upon them, and history has proven this fact out many times. Any disk that touches your computer, even a CD-ROM disk, may potentially have a virus upon it, so you must treat every disk you touch as suspect, and run a virus scan upon each disk BEFORE running any programs on it or viewing any documents upon it.

How do Viruses Affect Your PC?

Viruses will affect your PC in several different ways . . .

1) **The Boot Sector:** The boot sector is where your operating system files reside on your floppy or hard disk. A virus will go to that location on your disk and corrupt these files (NTLDR, NTDETECT.COM) so that your PC will NOT boot up as expected. **EXAMPLE:** the STONED virus.

2) **The File Allocation Table:** The File Allocation Table (FAT) is a list of all the files on your floppy or hard disk, and where the files are physically located on the disk. A virus will corrupt the FAT so that you cannot locate or access your files. **EXAMPLE:** the CASCADE virus.

3) **The Partition Table:** The partition table on your HARD DISK tells the operating system how big your hard disk is, and what percentage of it is used by the O/S. A virus can corrupt your partition table, which wipes out ALL of your files in an instant. **EXAMPLE:** the MICHELANGELO virus.

4) **.COM and .EXE Files:** Files with these extensions are EXECUTABLE files, which perform a specific action. A virus can attach itself to one of these kinds of files and corrupt the way it operates. These same kinds of viruses can infect .OVL or overlay files, which work along with .COM and .EXE files. **EXAMPLE:** the JERUSALEM virus.

5) **Macro Viruses** A macro virus will execute a set of instructions that have a destructive effect on your Windows registry, configuration files, or your data files. These viruses can be transmitted when you receive data files from someone else’s computer (like a resume file or a spreadsheet), or they can be transmitted by e-mail messages. **EXAMPLE:** the WM-CONCEPT virus.
6) **E-Mail Viruses**  
E-mail viruses act much like macro viruses, but are transmitted to you by e-mail as an "attachment" (a secondary message sent to you along with the main e-mail message). Many e-mail viruses are classified as "Trojan horses" since they appear to be normal kinds of messages but they carry a destructive load.  
**EXAMPLE:** the ILOVEYOU virus.

7) **Logic Bombs**  
Logic bombs include a timing device so they will go off at a particular date and time, or when a particular system event takes place (like formatting a floppy disk or performing a scan of your hard disk).  
**EXAMPLE:** the FRIDAYTHE13TH virus.

8) **Joke Programs**  
A joke program does something to change or mess up the appearance of information on your screen, or affect adversely the operation of your computer. Joke programs are not destructive, and are usually intended as a prank or a practical joke.  
**EXAMPLE:** the JAN12000 virus.

9) **Polymorphic Viruses**  
A polymorphic virus may take any of the forms listed above, but the virus will mutate into different forms upon every new PC on which the virus infects. It does this in order to evade detection and being destroyed by an anti-virus program.  
**EXAMPLE:** the SATAN BUG virus.

For the A+ examination, you will need to be able to answer the following kinds of questions:

- What is a computer virus, and how can it be transmitted?
- What are the major types of viruses, and how do they affect your computer?

3 Things a Good Virus Protection Program Should Do

A virus program that is worth anything should be able to do the following three things reliably:

1) **SCAN for viruses:**  
A good program should be able to check your floppy and hard disks for viruses, as well as the RAM of your computer, and detect the presence of a virus in the locations and ways mentioned above.

2) **CLEAN up the virus:**  
A good program must be able to get rid of the virus it finds in any of these places mentioned above; otherwise, it's useless.

3) **PROTECT YOU from viruses:**  
A good program must have the ability to load a piece of the program into memory at boot-up time, to protect you from getting a virus in the first place. This type of program is called a "Terminate-and-Stay-Resident" (TSR) program. This program will scan all files being accessed from disk or loaded into memory; if it finds a virus, it will alert you and clean it up.
An example of a good anti-virus program is AVG Free Anti Virus. This freeware program is available from the instructor's course DVD. It has the ability to be updated periodically, so that the programs will detect and protect you from all the newest strains of viruses. These updates are called "signature files" or "definition files", and they contain a database of information that the antivirus program uses to detect and eliminate viruses from your PC. You should update your signature files at least once a month, for maximum protection. If you have a broadband Internet connection, you should update your anti-virus application as frequently as possible. The application likely will update automatically, unless you indicate not to do so when installing the program.

Programs like Symantec / Norton Anti-virus and McAfee Internet Security are costly, use a lot of system overhead to operate, require an annual service fee to continue getting signature file updates, and they miss many common viruses. Also, companies like Verizon and Comcast provide anti-virus and Internet security software to their customers for a monthly service charge; most of these applications are ineffective and not worth the cost. If you must use one of these programs, make sure the application is continually kept up-to-date.

For the A+ examination, you will need to be able to answer the following kinds of questions:

- What three things should a good virus protection product do?
- What is a "signature file", and what does it do for the antivirus program?
- How often should you update your signature files for your antivirus product?

**What is Spyware/Malware and Adware?**

Spyware (also called malware) refers to any software that covertly gathers user information through the user's Internet connection without his or her knowledge, usually for advertising purposes. Spyware applications are typically bundled as a hidden component of freeware or shareware programs that can be downloaded from the Internet; however, it should be noted that the majority of shareware and freeware applications do not come with spyware.

Once installed, the spyware monitors user activity on the Internet and transmits that information in the background to someone else. Spyware can also gather information about e-mail addresses and even passwords and credit card numbers.

Spyware is similar to a Trojan horse in that users unwittingly install the product when they install something else. A common way to become a victim of spyware is to download certain peer-to-peer file swapping products that are available today.

Aside from the questions of ethics and privacy, spyware steals from the user by using the computer's memory resources and also by eating bandwidth as it sends information back to the spyware's home base via the user's Internet connection. Because spyware is using memory and system resources, the applications running in the background can lead to system crashes or general system instability.

Because spyware exists as independent executable programs, they have the ability to monitor keystrokes, scan files on the hard drive, snoop other applications, such as chat programs or word processors, install other spyware programs, read cookies, change the default home page on the Web browser, consistently relaying this information back to the spyware author who will either use it for advertising/marketing purposes or sell the information to another party.
Licensing agreements that accompany software downloads sometimes warn the user that a spyware program will be installed along with the requested software, but the licensing agreements may not always be read completely because the notice of a spyware installation is often couched in obtuse, hard-to-read legal disclaimers.

Adware is a form of spyware that collects information about the user in order to display advertisements in the Web browser based on the information it collects from the user's browsing patterns.

Adware is considered a legitimate alternative offered to consumers who do not wish to pay for software. Programs, games or utilities can be designed and distributed as freeware. Sometimes freeware blocks features and functions of the software until you pay to register it. Today we have a growing number of software developers who offer their goods as "sponsored" freeware until you pay to register. Generally most or all features of the freeware are enabled but you will be viewing sponsored advertisements while the software is being used. The advertisements usually run in a small section of the software interface or as a pop-up ad box on your desktop. When you stop running the software, the ads should disappear. This allows consumers to try the software before they buy and you always have the option of disabling the ads by purchasing a registration key.

In many cases, adware is a legitimate revenue source for companies who offer their software free to users. A perfect example of this would be the popular e-mail program, Eudora. You can choose to purchase Eudora or run the software in sponsored mode. In sponsored mode Eudora will display an ad window in the program and up to three sponsored toolbar links.

Eudora adware is not malicious; it reportedly doesn't track your habits or provide information about you to a third party. This type of adware is simply serving up random paid ads within the program. When you quit the program the ads will stop running on your system.

Grayware

Grayware is a general term sometimes used as a classification for applications that behave in a manner that is annoying or undesirable, and yet less serious or troublesome than malware. Grayware encompasses spyware, adware, dialers, joke programs, remote access tools, and any other unwelcome files and programs apart from viruses that are designed to harm the performance of computers on your network.

Grayware refers to applications or files that are not classified as viruses or Trojan horse programs, but can still negatively affect the performance of the computers on your network and introduce significant security risks to your organization. Often grayware performs a variety of undesired actions such as irritating users with pop-up windows, tracking user habits and unnecessarily exposing computer vulnerabilities to attack.

Dealing With Spyware

While one may not realize they have installed spyware, there are some signs that it exists on your computer. If you notice any changes to your Web browser that you did not make such as extra toolbars or different homepage settings, as well as changes to your security settings and favorites list, you could have spyware running on your system.
Other signs of a spyware infection include pop-up ads which aren't related to a Web site you're viewing; usually spyware advertisements are adult content in nature and are not displayed in the same fashion as legitimate ads you would normally see on your favorite Web sites. You may also see advertisements when you're not browsing the Web. Clicking hyperlinks which do not work (or take you somewhere you didn't expect), a sluggish system, or your system taking longer to load the Windows desktop are all signs that your computer may be infected with spyware.

With the onset of spyware comes a number of anti-spyware software packages to rid your system of these unwanted and malicious programs. Anti-spyware software works by identifying any spyware installed on your system and removing it. Since spyware is installed like any other application on your system it will leave traces of itself in the system registry and in other places on your computer. Anti-spyware software will look for evidence of these files and delete them if found.

Reputable and effective anti-spyware applications include programs such as AdAware, Malwarebytes Anti-Malware, Spybot Search-and-Destroy, and Microsoft's Windows Defender. You can run one or two of these programs simultaneously on your PC without any adverse effects upon system performance. On the other hand, you cannot run more than one anti-virus application on your PC at the same time. Each anti-virus program will perceive the other anti-virus program as a virus threat, and your system will slow to a crawl in short order.

It is important to remember that not all companies who claim their software contains adware are really offering adware. There is always a chance that adware is spyware in disguise so to speak, and that programs with embedded spyware may not state its existence at all. Programs like Antivirus 360 (made to look like Norton 360), Antivirus 2010 and Internet Security 2010 (made to look like Norton Internet Security 2010) appear to the average user to be legitimate programs, when in fact they are the worst kind of spyware. They will pester the user until they pay the $29.00 fee over the Internet, only to find that their computer is now totally corrupted and the money has gone towards illicit activities. Removing these spyware programs is difficult at best; if left unchecked for more than a few days, they can completely ruin the operating system and user data on a hard drive.

Always stay on the side of caution and be sure to research privacy policies and licensing agreements that come with freeware. You should also become familiar with Internet lists of companies reported to be using spyware. Much like a firewall or anti-virus program, anti-spyware software is crucial to maintain optimal protection and security on your computer and network.

The instructor’s course DVD has a number of effective anti-spyware applications included on it, so that you can install them on any PC. These will ensure that any PC you use is free from malware and rogue software. These programs also are freely available on the Internet, and can be shared without concerns for software piracy issues.

**Encryption technologies**

Encryption is the process of transforming information (referred to as plaintext) using an algorithm (called cipher) to make it unreadable to anyone except those possessing special knowledge, usually referred to as a key. The result of the process is encrypted information (in cryptography, referred to as ciphertext). In many contexts, the word encryption also implicitly refers to the reverse process, decryption (e.g. “software for encryption” can typically also perform decryption), to make the encrypted information readable again (i.e. to make it unencrypted).
Encryption has long been used by militaries and governments to facilitate secret communication. Encryption is now commonly used in protecting information within many kinds of civilian systems. In recent years there have been numerous reports of confidential data such as customers' personal records being exposed through loss or theft of laptops or backup drives. Encrypting such files helps to protect them should physical security measures fail. Digital rights management systems which prevent unauthorized use or reproduction of copyrighted material and protect software against reverse engineering are another somewhat different example of using encryption on data at rest.

Encryption is also used to protect data in transit, for example data being transferred via networks or the Internet, in e-commerce systems, mobile telephones, wireless microphones, wireless intercom systems, Bluetooth devices and bank automatic teller machines. There have been numerous reports of data in transit being intercepted in recent years. Encrypting data in transit also helps to secure it as it is often difficult to physically secure all access to networks.

Well-known encryption applications include Pretty Good Privacy (PGP), Secret Agent, and the BitLocker application distributed with Microsoft operating systems.

**Data wiping, hard drive destruction, and hard drive recycling**

Simply erasing all the data on your hard drive and formatting it is not sufficient to ensure your files are totally destroyed. You can spend hours going through your hard drive and deleting all the files and documents you want, but using the delete key on your keyboard in Windows basically only removes the shortcuts to the files making them invisible to users. Deleted files still reside on the hard drive and applications like Recuva (contained on the course DVD) will allow anyone to recover the deleted data.

Formatting the hard drive is a bit more secure than simply erasing the files. Formatting a disk does not erase the data on the disk, only the address tables. It makes it much more difficult to recover the files. However a computer specialist would be able to recover most or all the data that was on the disk before the reformat.

For those who accidentally reformat a hard disk, being able to recover most or all the data that was on the disk is a good thing. However, if you're preparing a system for retirement to charity or any other organization, this obviously makes you more vulnerable to data theft.

For some businesses and individual users, a disk format may be something you consider secure enough, depending, of course, on the type of data and information you saved to your computer. As long as people understand that formatting is not a 100 percent secure way to completely remove all data from your computer, then they are able to make the choice between formatting and even more secure methods. If you have decided a disk format is a good choice, at the very least to do a full format rather than a quick format.

Even more secure than reformatting is a process called disk wiping. The term disk wiping is not only used in reference to hard drives but any storage device such as CDs, RAIDs, thumb drives and others. Disk wiping is a secure method of ensuring that all data and software on your computer and storage devices is irrecoverably deleted before recycling or donating the equipment. Because previously stored data can be brought back with the right software and applications, the disk wiping process will actually overwrite your entire hard drive with random data, several times in fact. Once you format you'll find it all but impossible to retrieve the data which was on the drive before the overwrite.
While disk wiping algorithms differ from product to product, they all will generally write the entire disk with a pattern of random numbers (zero or one). After the wipe is completed, a reformat of the disk is necessary to reinstall the operating system. The more times the disk is overwritten and formatted the more secure the disk wipe is, but the trade-off is the extra time to perform additional rewrites. Disk wiping applications typically will overwrite the master boot record, partition table, and every sector of the hard drive.

The government standard (DoD 5220.22-M), considered a medium security level, specifies three iterations to completely overwrite a hard drive six times. Each iteration makes two write-passes over the entire drive; the first pass inscribes ones (1) over the drive surface and the second inscribes zeros (0) onto the surface. After the third iteration, a government designated code of 246 is written across the drive, then it is verified by a final pass that uses a read-verify process.

There are a variety of products available for different operating systems that you can purchase, or freely downloaded online to perform more secure disk wipes. On the course DVD, the instructor has provided the disk wiping application called Darik’s Boot and Nuke (DBAN). It will load to a floppy disk, CD or USB flash drive, and it will perform a military-specification wipe of any type or re-writable data storage device.

**Using A Hardware and/or Software Firewall**

Firewalls are designed to prevent unauthorized access to or from a private network. Firewalls can be implemented in both hardware and software, or a combination of both. Firewalls are frequently used to prevent unauthorized Internet users from accessing private networks connected to the Internet, especially intranets. All messages entering or leaving the intranet pass through the firewall, which examines each message and blocks those that do not meet the specified security criteria. There are several types of firewall techniques:

- **Packet filter:** Looks at each packet entering or leaving the network and accepts or rejects it based on user-defined rules. Packet filtering is fairly effective and transparent to users, but it is difficult to configure. In addition, it is susceptible to IP spoofing.
- **Application gateway:** Applies security mechanisms to specific applications, such as FTP and Telnet servers. This is very effective, but can impose a performance degradation.
- **Circuit-level gateway:** Applies security mechanisms when a TCP or UDP connection is established. Once the connection has been made, packets can flow between the hosts without further checking.
- **Proxy server:** Intercepts all messages entering and leaving the network. The proxy server effectively hides the true network addresses.

In practice, many firewalls use two or more of these techniques in concert.

A firewall is considered a first line of defense in protecting private information. Windows XP and above provides a software firewall within the standard operating system. Further, commercial and home routers also contain a firewall application in the firmware.

**Port Security**

Hardware and software firewalls will allow the customer to control which TCP/IP ports are open or closed. In TCP/IP and UDP networks, a port is an endpoint to a logical connection and the way a client program specifies a specific server program on a computer in a network. Some ports have numbers that are preassigned to them.
Port numbers range from 0 to 65536, but only ports numbers 0 to 1024 are reserved for privileged services and designated as well-known ports. Knowing the correct port numbers will enable you to trouble-shoot connection problems or failures, especially if a TCP/IP port has been closed or disabled by a router.

Here are some of the commonly-used TCP/IP sub-protocols, and the port assignments they use:

<table>
<thead>
<tr>
<th>Sub-Protocol</th>
<th>Port Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>FTP:</td>
<td>20, 21</td>
</tr>
<tr>
<td>HTTP:</td>
<td>80</td>
</tr>
<tr>
<td>HTTPS:</td>
<td>443</td>
</tr>
<tr>
<td>IMAP:</td>
<td>143</td>
</tr>
<tr>
<td>POP3:</td>
<td>110</td>
</tr>
<tr>
<td>SMTP:</td>
<td>25</td>
</tr>
<tr>
<td>TELNET:</td>
<td>23</td>
</tr>
</tbody>
</table>

By turning on or off specific IP ports, you can permit or prohibit specific kinds of access to your computer through a firewall application or firewalled router.

**Password and Authentication Technologies**

When using a PC and/or logging onto Windows, you will access the computer through a user account that has a specific username and profile. This allows Windows to be customized for each person that uses the PC. Along with that username, there is ALWAYS a password with the account, even if the password is just blank. Passwords can ensure that only the authorized persons can access the data or account on a PC or network.

If the password is forgotten, the user will not be able to log onto the PC or network, and someone who has sufficient rights (or proper software application) will have to log on to the computer and reset your password. Typically, Windows and other secured applications will NOT disclose a forgotten password, but will allow another user to reset a forgotten password.

In many government and corporate settings, elaborate password rules are used to ensure that hackers cannot access sensitive data. Here is an example of how one Federal agency sets the guidelines for password complexity:

- All passwords must be unique (no two people can use the same password)
- A password cannot be reused for a year or within the last 16 password changes, whichever is longer, and passwords must be changed every sixty (60) days
- All passwords must be at least 12 characters long
- All passwords must contain at least one number and no more than five numbers
- All passwords must contain at least one special character and no more that two special characters
- All passwords must contain at least one alphabetic character (which can be uppercase or lowercase)
- All passwords must contain at least six unique characters
Biometrics

In computer security, biometrics refers to authentication techniques that rely on measurable physical characteristics that can be automatically checked. Instead of using a keyed password, a biometric means of authentication (such as a fingerprint) can be used instead. Biometric “passwords” There are several types of biometric identification schemes:

- face: the analysis of facial characteristics
- fingerprint: the analysis of an individual’s unique fingerprints
- hand geometry: the analysis of the shape of the hand and the length of the fingers
- retina: the analysis of the capillary vessels located at the back of the eye
- iris: the analysis of the colored ring that surrounds the eye’s pupil
- signature: the analysis of the way a person signs his name.
- vein: the analysis of pattern of veins in the back if the hand and the wrist
- voice: the analysis of the tone, pitch, cadence and frequency of a person’s voice.

Smart cards

A “smart card” is a small electronic device about the size of a credit card that contains electronic memory, and possibly an embedded integrated circuit (IC). Smart cards containing an IC are sometimes called Integrated Circuit Cards (ICCs). Smart cards are used for a variety of purposes, including:

- Storing a patient’s medical records
- Storing digital cash
- Generating network IDs (similar to a token)

To use a smart card, either to pull information from it or add data to it, you need a smart card reader, a small device into which you insert the smart card. Smart cards are often used in secure installations such as in the Defense Department or the intelligence agencies to provide a second-level of authentication to a building location or a computer system.

Compliance With Security Regulations

In data storage terminology, the word compliance is used to refer to industry-wide government regulations and rules that cite how data is managed and the need for organizations to be in compliance with those regulations. The term encompasses data storage, data archiving, data encryption, and also data retrieval. Compliance has become a major concern for organizations and businesses, due largely in part to increasing regulatory requirements which often require organizations to invest in new technologies in order to address compliance issues.

There are more than 8,500 state and federal regulations concerning records management in the United States, as well as additional voluntary standards. *Some of the specific regulatory compliance issues organizations have to contend with are the Sarbanes-Oxley Act for all public corporations, the Health Insurance Portability and Accountability Act (HIPAA) for corporations in the healthcare industry and SEC regulations for retention of all electronic correspondence with clients.
Social Engineering Threats

In the realm of computers, social engineering refers to the act of obtaining or attempting to obtain otherwise secure data by conning an individual into revealing secure information. Social engineering is successful because its victims innately want to trust other people and are naturally helpful. The victims of social engineering are tricked into releasing information that they do not realize will be used to attack a computer network.

For example, an employee in an enterprise may be tricked into revealing an employee identification number to someone who is pretending to be someone he trusts or representing someone he trusts. While that employee number may not seem valuable to the employee, which makes it easier for him to reveal the information in the first place, the social engineer can use that employee number in conjunction with other information that has been gathered to get closer to finding a way into the enterprise’s network.

For another example, phishing is a type of security attack that relies on social engineering in that it lures the victim into revealing information based on the human tendency to believe in the security of a brand name because they associate the brand name with trustworthiness.

Secure Sockets Layer and Secure HTTP Connections Over the Internet

SSL is short for Secure Sockets Layer, a protocol developed by Netscape for transmitting private documents via the Internet. SSL uses a cryptographic system that uses two keys to encrypt data - a public key known to everyone and a private or secret key known only to the recipient of the message. Both Netscape Navigator and Internet Explorer support SSL, and many Web sites use the protocol to obtain confidential user information, such as credit card numbers. By convention, URLs that require an SSL connection start with https: instead of http:.

Another protocol for transmitting data securely over the World Wide Web is Secure HTTP (HTTPS). Whereas SSL creates a secure connection between a client and a server, over which any amount of data can be sent securely, HTTPS is designed to transmit individual messages securely. SSL and HTTPS, therefore, can be seen as complementary rather than competing technologies. Both protocols have been approved by the Internet Engineering Task Force (IETF) as a standard.

BIOS Security on the PC

On a typical PC, there are security features that can be enabled that will protect the computer from unauthorized use or tampering with the internal components. Many PCs have an intrusion detection switch that will alert a technician to the fact that someone has opened the case without permission. The CMOS Setup program can be setup to require a password to enter the setup program itself, and/or to boot the operating system. The author strongly recommends against using such BIOS-based password methods. In some cases, particularly with laptop computers, there is no CMOS or password reset jumper, and removing the CMOS battery will not remove the password. The user, in such situations, must contact the manufacturer for assistance in correcting this situation.

On the operating system level, Windows allows the user to lock the workstation by pressing CTRL-ALT-DEL simultaneously, and selecting the Lock Workstation option in the dialog box that appears on the screen. Pressing CTRL-ALT-DEL again will prompt the user to enter the account password, thereby unlocking the workstation.

NOTES
Chapter 14. Local Area and Dial-Up Networking

Local Area Networking

A **network** is a means whereby intelligent end-user PCs can share common resources, such as:

- **A file server:** a computer with large hard disks that all network users share; your application software and data will likely reside on this file server, not on your PC's hard disk.

- **A print server:** a computer dedicated to buffering print jobs sent by network users to centralized or shared printers.

- **A communications server:** a computer dedicated to allowing outside users access to the network, usually through a telephone line.

- **An e-mail server:** A computer dedicated to providing e-mail (electronic mail) to users of the network.

In a network, the end-user PCs are intelligent; that is, the terminals have a CPU in them that allows them, NOT a centralized CPU, to do the computing work. This is called **distributed processing**. You have the ability to store your data on a local hard disk or floppy disk, and your application software can be loaded from either a local disk, or from the file server. The file server does NOT process the data; your local PC does.

In **centralized processing**, the terminals are not intelligent (they have NO CPU within them), and a centralized CPU is shared by all users. You store your data in a centralized data storage facility, and run your programs from the centralized CPU, sharing CPU time with all other users. You generally cannot save your data to a local disk drive. When the centralized CPU goes down, so does everyone.

Local area networks are exactly that: local. They are distributed over a small area, and allow a number of users to share common resources. Generally, a LAN is limited to 255 users per LAN.

LANs can connect with other LANs to form a Wide Area Network (WAN), or can connect to mainframe on minicomputers through devices like routers or bridges. This is how people can communicate from one network in Washington to users on another network somewhere else, like in Seattle. Such a connection could be made through leased phone lines, dedicated transmission lines, or by satellite.
What Exactly Is A Server?

A File Server:

A file server is nothing more than a fast PC that has the following kinds of devices in it:

- A large amount of Random Access Memory (RAM), usually 16-32 gigabytes or above;
- Large hard drives (also called volumes), usually above 1 terabyte (TB), with fast access times (usually 10 ms or less) that are highly reliable and can take the stress of multiple users accessing the drives for long periods of time;
- A decent network card, usually running at 1 gigabit per second (Gbps); and
- The Windows Server operating system (or the file server portion of Novell Netware or some other network operating system) loaded onto it, so that multiple users will have access to the drives on the file server.

The server has one function in life: giving you access to files and information stored in it's hard disks.

A Print Server:

A print server is nothing more than a average or faster-than-average PC (low-end Pentium or better) that has the following kinds of devices in it:

- An average amount of Random Access Memory (RAM), usually 2 - 4 gigabytes;
- Garden variety hard drives (usually above 120 GB) with average access times (usually 12 ms or less) that are reliable enough to take the stress of multiple users accessing the drives for long periods of time;
- A decent network card, usually running at 100 Mbps or 1 Gbps; and
- The print spooler portion of some other network operating system loaded onto it, so that multiple users will be able to send print jobs to the server. The shared printer usually will be attached to the print server, but this is not necessarily always the case.

The print server has one function in life: giving you the ability to share a network printer with multiple users on the network system.

A Communications Server:

A communications server is a specialized type of PC that has the ability to allow outside users to connect to the network from remote locations. This allows remote users the same kinds of network capabilities as those connected to the network in-house.

Older communications servers that enabled dial-up access to a network were called chatterboxes. Each device within the communications server contains a self-contained PC on a card, with a modem of some type built into the card. Chatterboxes were somewhat expensive, but they gave remote users a great deal of flexibility to process data in the field.

With the advent of broadband Internet access, communications servers generally provide Virtual Private Networking (VPN) access to internal network resources in a secured fashion. These servers enable companies to offer options like telework to their employees, and allow individuals to access internal system data while on business travel.
An E-Mail Server:

A e-mail server is a higher-end PC (like the file server mentioned above) that has the host electronic mail (e-mail) package running upon it. E-mail allows you to send messages and files from one network user to another. The mail server needs to have fairly large hard drives to accommodate all of the messages being sent to and from users within the network. Periodically the list of mail messages may need to be purged, to eliminate old messages that should have been deleted from the system long ago. One would do this in order to free up disk space on the mail server for new messages. Email applications like Microsoft Exchange and Lotus Notes give administrators and users the option to delete and archive mail messages automatically when a message gets to a certain age.

Major Types of Network Topologies

Ethernet Bus

An Ethernet Bus network is like a "highway for data." Data is passed in a "party-line" fashion; each PC waits for quiet on the line, then transmits the message down the line to the next station. Each PC or workstation on the bus checks to see if a message is traveling along the bus before sending their messages. All messages pass through all workstations on their way to their destination. A terminator (or terminating resistor) is placed at both ends of the cable so that the devices on the network can determine the end of the signal run. Twisted-pair (10BaseT) or ethernet cable may be used in this scheme. A broken cable or un-terminated cable run, however, can crash the entire network.

StarLAN (including ARCNet)

An StarLAN (or ARCNet) network sends messages from the file server to an intelligent hub, which routes the network message to the proper PC or workstation. StarLAN networks pass tokens which are specifically for one and only one PC on the network. The failure of one PC or cable line from hub to PC will not cause a system-wide network failure, as with an Ethernet bus network. Twisted-pair (10BaseT) or coaxial ethernet cable is generally used with such a network. This system passes data much like the phone company routes telephone calls, through the use of the hubs as switching devices.

Token Ring

Token ring network send messages in the form of tokens from one PC/workstation to another, in an "assembly-line" fashion. If there is a break in the cable, the token is then passed in the opposite direction towards the receiving PC. The ring topology allows verification that a message has been received by the proper PC. Extensive monitoring of the network is possible in a ring topology. Failure of a single workstation or a break in the network line will not cause a system-wide network failure. Additional rings can be accessed through bridges, which control the flow of information between the two ring networks.

There are three things that can cause a networked PC to fail to connect in any of these types of topologies:

- Bad network cable; this is responsible for at least 50 percent of networking failures;
- Bad (defective) Network Interface Card (NIC); and
- Networking software is not configured correctly for that PC
How do Networks Pass Data from One Place to Another?

Ethernet Networks

Ethernet networks pass data in a "party-line" fashion. That means the network waits for quiet on the communications line, and then it "shouts as loud as it can, hoping to be heard". The more users there are on the network, the more crowded and confused the communications line becomes, and the less efficient the network becomes as well. Data is passed from one PC to another, with the NIC in each PC re-broadcasting the signal as it goes along the line.

StarLAN and Token-ring Networks

StarLAN and token-ring networks pass data in an "assembly-line" fashion. That means that the network passes data in the form of tokens at a consistent, regular rate of speed. The same number of tokens are passed at the same speed whether there are 5 nodes or 150 nodes on the network. Tokens are "marked" as to who is the intended recipient of the token. Token-passing is bi-directional; if the recipient can't receive the token via one route of cable, the network will send the token in the opposite direction of the cable in an attempt to find the recipient.

Media Access Control (MAC) Address Numbers

All data transmitted on networks are coded with a 16-digit media access control (MAC) address that indicates the intended recipient of the information. This MAC address is unique to each network interface card (NIC); no two NICs anywhere have the same MAC address. The network software uses this MAC address in its work to transmit data from one place to another.

How Will My Computer Operate if It's Connected to a LAN?

For the most part, your computer will operate on a LAN just as it would without a LAN. You will log onto a disk drive (that is actually a network drive), change directories to the place where your application software is located, and execute your program just as you would if the software were on your hard drive inside your PC.

Several things will have to happen, though, in order for you to gain access to your network drive(s):

1) You will have to load and run some kind of driver software that makes your PC able to use the network card plugged into the bus connection inside your PC. Drivers will need to be loaded in Windows to enable the network card.

2) You will need to run the network operating system client programs and protocols needed to initialize your network card for use by the operating system, identify your PC as a legitimate node on the network, and allow an identified user to log into the network. In a Windows environment, the Microsoft networking client is installed by default with the rest of the operating system. Also loaded are the protocols (language equivalents for networks) needed so that data can be exchanged from one place to another. These protocols include TCP/IP, along with older (obsolete) networking protocols such as NetBEUI and Novell IPX/SPX.

3) Your network administrator will have to map specific drive designations to you, grant you rights to access files in the drive and directory, and use specific commands to route your print requests to a networked printer.

4) You will most likely access most of your application software on the network drives available to you after you have logged into the network.
For the most part, everything is the same on a network drive as it is on a local hard drive. You can obtain a directory of files on your network drive and subdirectory; you can copy files from one place to another; deleting and renaming files works in the same way. The idea of a network drive is to give you as identical an environment on a network drive as you do on a local hard drive.

What Happens When the Server Breaks Down?

EVERYTHING STOPS!

More specifically, when the file server breaks down, no one is able to access their programs or data. Further, you may not be able to save your work out to the file server, or even to your local hard disk as a last resort. The scenario is much like when the lights all go out in a dark theater: no one knows where to go, and everyone steps on each other trying to get out. The file server is the most important link in data access, retrieval and storage. If it goes down, all of these processes stop as well. It’s just like when your hard disk quits in the middle of a computing session; when it fails, great is the fall thereof.

When the print server breaks down, all of the print jobs in the print queue will be destroyed. Once the print server is re-booted, you may then re-send your print job back to the server, where it will process the job for you.

When the communications server breaks down, your line into the network is lost. You will not be able to re-establish your outside link to the network until the communications server is brought back on-line.

When the e-mail server breaks down, you will be unable to access the e-mail service on the LAN. Depending on the severity of the problem, you may lose some or all of your mail messages, especially those that were sent just before the crash. If the hard disk on the mail server is severely damaged, you will very likely lose some or all of your e-mail messages. If it’s just a problem with a locked-up mail server or a temporary communications problem, you will likely be back in business in short order, with little or no loss of mail.

Data Backups with Mirroring, Duplexing and Striping

Most servers have some means of backing up their hard disks, which are also called volumes. Most file servers duplex their disks; this is where 2 hard disks (each with a separate disk controller) make mirror image copies for all data transactions going onto the server. Some servers use mirroring; this is where 1 disk controller creates two mirror image copies of each file on 2 separate hard disks. The problem with mirroring comes when the 1 disk controller crashes, and both drives go off-line. Duplexing allows the backup disk drive to continue working while the primary controller or hard disk is off-line or being repaired.

Striping is a technique for spreading data over multiple disk drives. Disk striping can speed up operations that retrieve data from disk storage. The computer system breaks a body of data into units and spreads these units across the available disks. Systems that implement disk striping generally allow the user to select the data unit size or stripe width.
Disk striping is available in two types. Single user striping uses relatively large data units, and improves performance on a single-user workstation by allowing parallel transfers from different disks. Multi-user striping uses smaller data units and improves performance in a multi-user environment by allowing simultaneous (or overlapping) read operations on multiple disk drives.

Disk striping stores each data unit in only one place and does not offer protection from disk failure.

**IF I Unplug or Disconnect My Network Cable, What Happens to the LAN?**

Generally, very bad things happen when you make a break in the network cable.

**If you have an Ethernet bus network:**

Breaking the cable line has disastrous effects on the network. In an Ethernet bus network, a cable break can cause a system-wide crash that affects EVERYONE on the network. A coaxial bus cable line has a terminator at the end of the line, which reflects signals back to the server(s). If the server cannot locate the end of the cable line or receive back the reflected signal, the server becomes unable to communicate with any device located on the network. Signals from PCs attempting to communicate with the server either get lost down the broken cable line, or collide with the signals from other PCs attempting to communicate on the LAN.

Even a momentary break in connection can crash an entire network of PCs. Therefore, DON’T DO IT! If you are simply disconnecting your PC from the LAN, and you are NOT creating a break in the line, that is acceptable. Just unplugging your PC from the LAN will not crash the system; creating a break in a coaxial cable line WILL crash the network.

Most Ethernet bus networks now use hubs or routers to create direct connections between these devices and individual PCs. This creates a situation where Ethernet bus networks are more stable and less prone to serious failures if a disconnection takes place. If there is a break in a network cable between the hub/router and a PC, only one PC is affected. However, creating a cable break to a hub or router will cause a number of users on a network to suffer disconnection. Care must be exercised whenever performing cable maintenance, to reduce or eliminate the potential for customers being disconnected from critical resources.

**If you have an StarLAN or Token Ring network:**

Breaking the line in one of these types of LANs will generally not have the same kind of disastrous effects as with an Ethernet LAN. Since these LANs communicate through the passing of tokens from PC to PC through the use of a networking hub, having a cable break becomes less of an issue. If a PC drops out of the loop, the LAN bypasses that PC and passes the token to the next available PC. If you are the PC for which the token is designated, and your PC is the one that goes off-line, the token is returned to the server as undeliverable. In an StarLAN setting, if you break the cable between the server and the hub, you may cause serious problems for the rest of the network, and could potentially crash the network.

In any setting, if you break the line from the file server to the rest of the network, you create a major system failure.

As a general rule, never disconnect or create a break in any network cable line during prime use hours, always inform all users before making a break in the line, and attempt to isolate the cable run from the rest of the LAN before making breaks or repairs to the line.
Can Computer Viruses Be Spread Through A LAN, and Can My Computer Be Infected?

Absolutely.

Viruses are passed from disk to disk. Your network disk drive is no different than a USB flash drive or hard drive in your PC, with respect to passing viruses. If you copy an infected file from your hard disk to a network disk, the network drive will be infected AND anyone copying that file from the server to their hard disk or other disk drives will become infected as well.

Therefore, it is vital that you or your network administrator include in either your AUTOEXEC.BAT or SYSTEM LOGIN SCRIPT some type of virus protection program that will scan your hard disk for viruses, and remain memory-resident during your computing session to alert you to any virus threats to your computer during your session.

There are many good virus protection programs available on the market today, such as the AVG Anti-virus program.

It is also important for you to emphasize to your users to be aware of computer viruses, and instruct them NOT to load anything from a floppy disk up to a server or local hard disk until the disk has been scanned by a virus protection program. Also, users should routinely scan the files on their network drives for viruses, just as a precaution.

How Do I Install a Network Interface Card?

There are several steps involved in installing a network interface card (or NIC) into a PC:

1) Open the computer case;
2) If the NIC is Plug-and-Play compliant, there will be no jumpers or switches to set; the installation script that runs with the "Add New Hardware Wizard" will install the modem to the correct parameters for you;
3) Install the new NIC in any free 16-bit ISA black bus connection or white PCI bus connection;
4) Attach the network cable to the RJ-45 jack on the NIC, and make sure the other end is attached to the network wall jack;
5) Power up the PC; if you are Windows 2000 or above, the operating system should detect a new NIC; insert the driver installation disk into the CD/DVD-ROM drive, and make sure the operating system locates the correct driver for the NIC;
6) Install any network client software you desire, such as the Novell Netware client (the Microsoft Networking client is installed by default when installing the operating system); then, make sure that you configure the TCP/IP networking protocol for the type of client you will be using; then, test the NIC by attempting to log onto the network;
7) Replace the computer case - do NOT install the cover until you know the card is working properly.

Refer to the Network Interface Card Installation checksheet in Chapter 5 of this book for further details on this topic.
Basics of Configuring IP Addressing and TCP/IP Properties (DHCP, DNS)

Dynamic Host Configuration Protocol (DHCP) is a protocol for assigning dynamic IP addresses to devices on a network. With dynamic addressing, a device can have a different IP address every time it connects to the network. In some systems, the device's IP address can even change while it is still connected. DHCP also supports a mix of static and dynamic IP addresses.

Dynamic addressing simplifies network administration because the software keeps track of IP addresses rather than requiring an administrator to manage the task. This means that a new computer can be added to a network without the hassle of manually assigning it a unique IP address. Many ISPs use dynamic IP addressing for dial-up users.

Windows-based PCs and Macs running the Mac operating system have DHCP enabled by default. The DHCP client software on the PC interacts with a DHCP server (or service) to obtain an IP address for that computer. Most commercial routers assign DHCP addresses to the PCs connected to them; this is especially true for home or small-office routers that assign private IP addresses in the 192.168 range to all computers in the home or business. DHCP can be enabled or disabled for the PC by opening the TCP/IP Properties tab in the Network connection Control Panel applet. When DHCP is disabled, the user must input a static (unchanging) IP address in the TCP/IP Properties tab.

Domain Name System (or Service or Server) is an Internet service that translates domain names into IP addresses. Because domain names are alphabetic, they're easier to remember. The Internet however, is really based on IP addresses. Every time you use a domain name, therefore, a DNS service must translate the name into the corresponding IP address. For example, the domain name www.mydomain.com might translate to 198.105.232.4.

The DNS system is, in fact, its own network. If one DNS server doesn't know how to translate a particular domain name, it asks another one, and so on, until the correct IP address is returned.

Bandwidth and Latency

Bandwidth can be defined as a range within a band of available transmission frequencies or wavelengths. It also can be defined as the amount of data that can be transmitted in a fixed amount of time. For digital devices, the bandwidth is usually expressed in bits per second (bps) or bytes per second. For analog devices, the bandwidth is expressed in cycles per second, or Hertz (Hz).

The bandwidth is particularly important for I/O devices. For example, a fast disk drive can be hampered by a bus with a low bandwidth. This is the main reason that new buses, such as AGP, have been developed for the PC.

For networks, bandwidth is the amount of data that can be transmitted on a given type of cable or other transmission method (like wireless). For example, fiber optic cable has more bandwidth capability than does coaxial cable or CAT-5 or CAT-6 twisted-pair network cable. Knowing the bandwidth capability of a cable or wireless technology helps you to determine if there is (or is not) enough capacity to support the number of users on a given network system.

In networking, latency refers to the amount of time it takes a packet to travel from source to destination. Together, latency and bandwidth define the speed and capacity of a network.

In VoIP terminology, latency refers to a delay in packet delivery. VoIP latency is a service issue that is usually based on physical distance, hops, or voice to data conversion.
Status Indicators

On the back of a typical network interface card (NIC), there are several LED lights that will tell you the following:

Link indicator: the light illuminates when a good cable connection is made from the NIC to the hub, switch or router; the light does not illuminate if the cable connection is broken, or if the NIC is not functioning (usually because the driver is not loaded, or the power to the system is off).

Speed indicator: the LED(s) will indicate whether the NIC is transmitting data at 10Mbps, 100Mbps, or 1000Mbps; Some NICs use one LED, while others have a separate LED for each speed level.

Full-duplex and Half-duplex Transmission

Full-duplex refers to the transmission of data in two directions simultaneously. For example, a telephone is a full-duplex device because both parties can talk at once. In contrast, a walkie-talkie is a half-duplex device because only one party can transmit at a time.

Most NICs (and even older dial-up modems) have a “software switch” that lets you choose between full-duplex and half-duplex modes. The typical NIC can automatically switch between these two modes, depending upon how the data is being transmitted by the switch or router to the PC.

In full-duplex mode on a chat or telnet program, data you transmit does not appear on your screen until it has been received and sent back by the other party. This enables you to validate that the data has been accurately transmitted. If your display screen shows two of each character, it probably means that your modem is set to half-duplex mode when it should be in full-duplex mode.

Basics of Workgroups and Domains

A workgroup is a collection of individuals working together on a task. Workgroup computing occurs when all the individuals have computers connected to a network that allows them to send e-mail to one another, share data files, and schedule meetings. A workgroup has a name (such as MSHOME or WORKGROUP), and each computer can “join” the group by changing their network settings in the “Computer name” tab in the System Properties Control Panel applet. Workgroups are by their design a “peer-to-peer” networking environment; a centralized server is not necessary, and people can share files, disk and printing resources within the group without having to log into a server.

A domain is a group of computers and devices on a network that are administered as a unit with common rules and procedures. Within the Internet, domains are defined by the IP address. All devices sharing a common part of the IP address are said to be in the same domain. In Windows networking, domain-based networks have a centralized server referred to as the domain controller. A user must specify the domain in the “Computer name” tab in the System Properties Control Panel applet, and must log into the domain controller in order to use any of the resources within the network. Further, the user must have a username and password combination setup beforehand by the system administrator in order to log into the domain-based network.
Common Ports Used in TCP/IP for HTTP, FTP, POP, SMTP, TELNET, HTTPS

In TCP/IP and UDP networks, a port is an endpoint to a logical connection and the way a client program specifies a specific server program on a computer in a network. Some ports have numbers that are preassigned to them. Port numbers range from 0 to 65536, but only ports numbers 0 to 1024 are reserved for privileged services and designated as well-known ports. Knowing the correct port numbers will enable you to trouble-shoot connection problems or failures, especially if a TCP/IP port has been closed or disabled by a router.

Here are some of the commonly-used TCP/IP sub-protocols, and the port assignments they use:

<table>
<thead>
<tr>
<th>Sub-Protocol</th>
<th>Port Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>FTP:</td>
<td>20, 21</td>
</tr>
<tr>
<td>HTTP:</td>
<td>80</td>
</tr>
<tr>
<td>HTTPS:</td>
<td>443</td>
</tr>
<tr>
<td>IMAP:</td>
<td>143</td>
</tr>
<tr>
<td>POP3:</td>
<td>110</td>
</tr>
<tr>
<td>SMTP:</td>
<td>25</td>
</tr>
<tr>
<td>TELNET:</td>
<td>23</td>
</tr>
</tbody>
</table>

Differences Between a Hub, Switch and Router

A **hub** is a common connection point for devices in a network. Hubs are commonly used to connect segments of a LAN. A hub contains multiple ports. When a packet arrives at one port, it is copied to the other ports so that all segments of the LAN can see all packets.

A passive hub serves simply as a conduit for the data, enabling it to go from one device (or segment) to another. So-called intelligent hubs include additional features that enables an administrator to monitor the traffic passing through the hub and to configure each port in the hub. Intelligent hubs are also called manageable hubs.

A third type of hub, called a switching hub, actually reads the destination address of each packet and then forwards the packet to the correct port.

A **switch** is a device that filters and forwards packets between LAN segments. Switches operate at the data link layer (layer 2) and sometimes the network layer (layer 3) of the OSI Reference Model and therefore support any packet protocol. LANs that use switches to join segments are called switched LANs or, in the case of Ethernet networks, switched Ethernet LANs.

A **router** is a device that forwards data packets along networks. A router is connected to at least two networks, commonly two LANs or WANs or a LAN and its ISP’s network. Routers are located at gateways, the places where two or more networks connect.

Routers use headers and forwarding tables to determine the best path for forwarding the packets, and they use protocols such as ICMP to communicate with each other and configure the best route between any two hosts. Very little filtering of data is done through routers.
Virtual Private Networks (VPN)

Short for virtual private network, a VPN is a network that is constructed by using public wires to connect nodes. For example, there are a number of systems that enable you to create networks using the Internet as the medium for transporting data. These systems use encryption and other security mechanisms to ensure that only authorized users can access the network and that the data cannot be intercepted.

Companies and organizations will use a VPN to communicate confidentially over a public network and to send voice, video or data. It is also an excellent option for remote workers and organizations with global offices and partners to share data in a private manner.

A VPN is designed to provide a secure, encrypted tunnel in which to transmit the data between the remote user and the company network. The information transmitted between the two locations via the encrypted tunnel cannot be read by anyone else.

VPN security contains several elements to secure both the company's private network and the outside network, usually the Internet, through which the remote user connects through. The first step to security is usually a firewall. You will have a firewall site between the client (which is the remote user workstation) and the host server, which is the connection point to the private network. The remote user will establish an authenticated connection with the firewall.

Encryption is also an important component of a secure VPN. Encryption works by having all data sent from one computer encrypted in such a way that only the computer it is sending to can decrypt the data. Types of encryption commonly used include public-key encryption which is a system that uses two keys: a public key known to everyone and a private or secret key known only to the recipient of the message. The other commonly used encryption system is a Symmetric-key encryption system in which the sender and receiver of a message share a single, common key that is used to encrypt and decrypt the message.

With a VPN you'll need to establish a network connection that is based on the idea of tunneling. There are two main types of tunneling used in virtual private networks. Voluntary tunneling is where the client makes a connection to the service provider then the VPN client creates the tunnel to the VPN server once the connection has been made. In compulsory tunneling the service provider manages the VPN connection and brokers the connection between that client and a VPN server.

There are three main network protocols for use with VPN tunnels, which are generally incompatible with each other. They include the following:

IPSec
A set of protocols developed by the IETF to support secure exchange of packets at the IP layer. IPSec has been deployed widely to implement VPNs. IPSec supports two encryption modes: Transport and Tunnel. Transport mode encrypts only the data portion (payload) of each packet, but leaves the header untouched. The more secure Tunnel mode encrypts both the header and the payload. On the receiving side, an IPSec-compliant device decrypts each packet. For IPSec to work, the sending and receiving devices must share a public key. This is accomplished through a protocol known as Internet Security Association and Key Management Protocol/Oakley (ISAKMP/Oakley), which allows the receiver to obtain a public key and authenticate the sender using digital certificates.
PPTP
Short for Point-to-Point Tunneling Protocol, a new technology for creating VPNs, developed jointly by Microsoft, U.S. Robotics and several remote access vendor companies, known collectively as the PPTP Forum. A VPN is a private network of computers that uses the public Internet to connect some nodes. Because the Internet is essentially an open network, PPTP is used to ensure that messages transmitted from one VPN node to another are secure. With PPTP, users can dial in to their corporate network via the Internet.

L2TP
Short for Layer Two (2) Tunneling Protocol, an extension to the PPP protocol that enables ISPs to operate Virtual Private Networks (VPNs). L2TP merges the best features of two other tunneling protocols: PPTP from Microsoft and L2F from Cisco Systems. Like PPTP, L2TP requires that the ISP's routers support the protocol.

Basics of IP Address Class Identification

Since it is necessary for all IP addresses on the Internet to be unique, a system was created for dividing up the available addresses and share them amongst those organizations. A central authority was established for this purpose, and a scheme developed for it to effectively allocate addresses.

The developers of IP recognized that organizations come in different sizes and would therefore need varying numbers of IP addresses on the Internet. They devised a system whereby the IP address space would be divided into classes, each of which contained a portion of the total addresses and were dedicated to specific uses. Some would be devoted to large networks on the Internet, while others would be for smaller organizations, and still others reserved for special purposes.

There are 5 classes of IP addresses: Class A, B, C, D and E. Class E addresses are reserved for experimental uses, and Class D addresses are used for IP multicasting.

For large amounts of data, IP multicasting is more efficient than normal Internet transmissions because the server can broadcast a message to many recipients simultaneously. Unlike traditional Internet traffic that requires separate connections for each source-destination pair, IP multicasting allows many recipients to share the same source. This means that just one set of packets is transmitted for all the destinations.

Class A addresses are used for unicast addressing for very large organizations with hundreds of thousands or millions of hosts to connect to the Internet. Class A addresses comprise about 50 percent of the total number of IP addresses. The IP address itself has 8 data bits in the network ID, and 24 data bits in the host portion of the ID.

Class B addresses are used for unicast addressing for medium-to-large organizations with many hundreds to thousands of hosts to connect to the Internet. Class B addresses comprise about 25 percent of the total number of IP addresses. The IP address itself has 16 data bits in the network ID, and 16 data bits in the host portion of the ID.

Class C addresses are used for unicast addressing for smaller organizations with no more than about 250 hosts to connect to the Internet. Class C addresses comprise about 12.5 percent of the total number of IP addresses. The IP address itself has 24 data bits in the network ID, and 8 data bits in the host portion of the ID.

All public IP addresses are distributed through a centralized and administered source, to ensure that no address conflicts occur on a national or global basis.
What are the Major Networking Protocols?

TCP/IP - the current standard networking protocol

TCP/IP stands for Transmission Control Protocol / Internet Protocol. Both the Microsoft and the Novell networking clients can use TCP/IP. TCP/IP can be used for local area networks, wide area networks, virtual private networks, and it is the protocol used on the Internet. Within the TCP/IP protocol are a set of utilities that allow the user to do a variety of things over a network or the Internet:

- HTTP: this is an acronym for Hypertext Transfer Protocol. This protocol enables users to create text documents with links that let the user go from one point on the Internet to another.
- HTML: this is an acronym for Hypertext Markup Language. This type of text works together with the Hypertext Transfer Protocol to allow users to click on links within a text document that will transfer you to another text document on the Internet.
- FTP: this is an acronym for File Transfer Protocol. FTP allows the user to log onto sites on the Internet that have files available for download, and it also allows the user to place files onto such Internet sites.
- PING: this utility lets you send a 32-byte packet to a remote site on the Internet, in order to test your PC's ability to communicate over the Internet. The remote site, once it receives the packet, returns a 32-byte packet to the computer which sent it.
- IPCONFIG: this is a text-based utility run from the MS-DOS command prompt in Windows 2000 through Windows 7; it provides the user with all of the relevant IP addressing information currently in place on your PC.
- TRACERT: this utility lets the user trace the route data takes from a remote host to your PC.
- NSLOOKUP: this utility lets you perform a name search lookup for a specific Internet web site.

NetBIOS: Short for Network Basic Input Output System, NetBIOS is an application programming interface (API) that augments the DOS BIOS by adding special functions for local-area networks. Almost all Windows-based LANs for PCs are based on the NetBIOS. Some LAN manufacturers have even extended it, adding additional network capabilities.

Older, Obsolete Protocols

IPX/SPX

The Novell networking client uses the IPX/SPX protocol. IPX is a datagram protocol used for connectionless communications. Higher level protocols such as SPX (and NCP) are used for additional error recovery services. This protocol is routeable, and is suitable for large networks. However, IPX/SPX cannot be used on the Internet. Therefore, IPX/SPX has seen a decline in use in the past few years.

NetBEUI

NetBEUI stands for NetBIOS Enhanced User Interface. The Microsoft networking client can use the NetBEUI protocol. This protocol is suitable for small networks of 2 to 20 users. However, this protocol is not routeable; that is, it cannot pass through a router and connect to larger networks. NetBEUI also transmits a great deal of data across the backbone, which slows the performance of the entire network. NetBEUI, therefore, is not widely used within the networking community.
Universal Naming Convention Names

On many networks, rather than assigning a drive letter to a network volume (such as H:), network operating systems (including Novell Netware and Microsoft networking) allow the use of universal naming convention (UNC) names for network volumes. A UNC name might look like the following:

\server1\disk1\dirname1:

UNC names are used in a Windows environment, in a Netware environment, and also in a Unix/Linux environment. UNC names allows Windows users to access data on disk volumes from various operating system platforms.
Definitions of Common Networking Terms

Listed below is a group of terms you will need to know in order to pass the networking segment of the A+ examination. Additional definitions are found in Chapter 15 of this book.

10Base2

One of several adaptations of the Ethernet (IEEE 802.3) standard for Local Area Networks (LANs). The 10Base-2 standard (also called Thinnet) uses 50 ohm coaxial cable (RG-58 A/U) with maximum lengths of 185 meters. This cable is thinner and more flexible than that used for the 10Base-5 standard. The RG-58 A/U cable is both less expensive and easier to place.

Cables in the 10Base-2 system connect with BNC connectors. The Network Interface Card (NIC) in a computer requires a T-connector where you can attach two cables to adjacent computers. Any unused connection must have a 50 ohm terminator.

The 10Base-2 system operates at 10 Mbps and uses baseband transmission methods.

10BaseT

One of several adaptations of the Ethernet (IEEE 802.3) standard for Local Area Networks (LANs). The 10Base-T standard (also called Twisted Pair Ethernet) uses a twisted-pair cable with maximum lengths of 100 meters. The cable is thinner and more flexible than the coaxial cable used for the 10Base-2 or 10Base-5 standards.

Cables in the 10Base-T system connect with RJ-45 connectors. A star topology is common with 12 or more computers connected directly to a hub or concentrator.

The 10Base-T system operates at 10 Mbps and uses baseband transmission methods.

100BaseT

A networking standard that supports data transfer rates up to 100 Mbps (100 megabits per second). 100BASE-T is based on the older Ethernet standard. Because it is 10 times faster than Ethernet, it is often referred to as Fast Ethernet. Officially, the 100BASE-T standard is IEEE 802.3u.

Like Ethernet, 100BASE-T is based on the CSMA/CD LAN access method. There are several different cabling schemes that can be used with 100BASE-T, including:

- 100BASE-TX: two pairs of high-quality twisted-pair wires
- 100BASE-T4: four pairs of normal-quality twisted-pair wires
- 100BASE-FX: fiber optic cables

ATM

ATM is short for Asynchronous Transfer Mode, a network technology based on transferring data in cells or packets of a fixed size. The cell used with ATM is relatively small compared to units used with older technologies. The small, constant cell size allows ATM equipment to transmit video, audio, and computer data over the same network, and assure that no single type of data hogs the line.
Current implementations of ATM support data transfer rates of from 25 to 622 Mbps (megabits per second). This compares to a maximum of 100 Mbps for Ethernet, the current technology used for most LANs.

ATM creates a fixed channel, or route, between two points whenever data transfer begins. This differs from TCP/IP, in which messages are divided into packets and each packet can take a different route from source to destination. This difference makes it easier to track and bill data usage across an ATM network, but it makes it less adaptable to sudden surges in network traffic.

When purchasing ATM service, you generally have a choice of four different types of service:

Constant Bit Rate (CBR) specifies a fixed bit rate so that data is sent in a steady stream. This is analogous to a leased line.

Variable Bit Rate (VBR) provides a specified throughput capacity but data is not sent evenly. This is a popular choice for voice and videoconferencing data.

Unspecified Bit Rate (UBR) does not guarantee any throughput levels. This is used for applications, such as file transfer, that can tolerate delays.

Available Bit Rate (ABR) provides a guaranteed minimum capacity but allows data to be bursted at higher capacities when the network is free.

**ARP**

Once a common encapsulation mechanism has been selected for Ethernet, hosts must still convert a 32-bit IP address into a 48-bit Ethernet address. The Address Resolution Protocol (ARP), documented in RFC 826, is used to do this. It has also been adapted for other media, such as FDDI.

ARP works by broadcasting a packet to all hosts attached to an Ethernet. The packet contains the IP address the sender is interested in communicating with. Most hosts ignore the packet. The target machine, recognizing that the IP address in the packet matches its own, returns an answer.

Hosts typically keep a cache of ARP responses, based on the assumption that IP-to-hardware address mapping rarely change.

**ARP Bridging and Routing**

ARP is transparent to bridging, since bridging will propagate ARP broadcasts like any other Ethernet broadcast, and will transparently bridge the replies.

A router does not propagate Ethernet broadcasts, because the router is a Network Level device, and Ethernet is a Data Link Level protocol. Therefore, an Internet host must use its routing protocols to select an appropriate router, that can be reached via Ethernet ARPs. After ARPing for the IP address of the router, the packet (targeted at some other Destination Address) is transmitted to the Ethernet address of the router.
Proxy ARP

Proxy ARP is a technique that is can be used by routers to handle traffic between hosts that don’t expect to use a router as described above. Probably the most common case of its use would be the gradual subnetting of a larger network. Those hosts not yet converted to the new system would expect to transmit directly to hosts now placed behind a router.

A router using Proxy ARP recognizes ARP requests for hosts on the "other side" of the router that can't reply for themselves. The router answers for those addresses with an ARP reply matching the remote IP address with the router's Ethernet address (in essence, a lie).

Proxy ARP is best thought of as a temporary transition mechanism, and its use should not be encouraged as part of a stable solution. There are a number of potential problems with its use, including the inability of hosts to fall back on alternate routers if a network component fails, and the possibility of race conditions and bizarre traffic patterns if the bridged and routed network segments are not clearly delineated.

Baseband transmission

The original band of frequencies of a signal before it is modulated for transmission at a higher frequency. The signal is typically multiplexed and sent on a carrier with other signals at the same time.

Bluetooth

Bluetooth is a short-range radio technology aimed at simplifying communications among Internet devices and between devices and the Internet. It also aims to simplify data synchronization between Internet devices and other computers.

Products with Bluetooth technology must be qualified and pass interoperability testing by the Bluetooth Special Interest Group prior to release. Bluetooth's founding members include Ericsson, IBM, Intel, Nokia and Toshiba.

Bridge

A device that connects two local-area networks (LANs), or two segments of the same LAN. The two LANs being connected can be alike or dissimilar. For example, a bridge can connect an Ethernet with a Token-Ring network.

Unlike routers, bridges are protocol-independent. They simply forward packets without analyzing and re-routing messages. Consequently, they're faster than routers, but also less versatile.

Broadband transmission

A type of data transmission in which a single medium (wire) can carry several channels at once. Cable TV, for example, uses broadband transmission. In contrast, baseband transmission allows only one signal at a time. Broadband signals can be transmitted by coaxial cable, fiber optic cable, satellite and cellular communications.

Most communications between computers, including the majority of local-area networks, use baseband communications. An exception is B-ISDN networks, which employ broadband transmission.
**Brouter**

Short for bridge router, and pronounced brau-ter, a device that functions as both a router and a bridge. A brouter understands how to route specific types of packets, such as TCP/IP packets. Any other packets it receives are simply forwarded to other network(s) connected to the device (this is the bridge function).

**CSU/DSU**

CSU/DSU is short for Channel Service Unit/Data Service Unit. The CSU is a device that performs protective and diagnostic functions for a telecommunications line. The DSU is a device that connects a terminal to a digital line. Typically, the two devices are packaged as a single unit. You can think of it as a very high-powered and expensive modem. Such a device is required for both ends of a T-1 or T-3 connection, and the units at both ends must be set to the same communications standard.

**Dial-up Networking**

Dial-up networking enables you to connect your computer to a network or the Internet via a modem. If your computer is not connected to a LAN and you want to connect to the Internet, you need to configure Dial-Up Networking (DUN) to dial a Point of Presence (POP) connection, and log into your Internet Service Provider (ISP). Your ISP will need to provide certain information, such as the gateway address and your computer's IP address.

Dial-up networking is quickly being phased out of existence, as the presence of fast, cheap and widely available broadband connections grows throughout the world. Unless you have no other way to connect to the Internet, dial-up networking should be avoided, because of its comparatively slow performance.

**DSL**

DSL refers collectively to all types of digital subscriber lines, the two main categories being ADSL and SDSL. Two other types of xDSL technologies are High-data-rate DSL (HDSL) and Very high DSL (VDSL).

DSL technologies use sophisticated modulation schemes to pack data onto copper wires. They are sometimes referred to as last-mile technologies because they are used only for connections from a telephone switching station to a home or office, not between switching stations.

xDSL is similar to ISDN inasmuch as both operate over existing copper telephone lines (POTS) and both require the short runs to a central telephone office (usually less than 20,000 feet). However, xDSL offers much higher speeds - up to 32 Mbps for upstream traffic, and from 32 Kbps to over 1 Mbps for downstream traffic.
Fiber Optic Cable

Fiber optic cable uses glass (or plastic) threads (fibers) to transmit data. A fiber optic cable consists of a bundle of glass threads, each of which is capable of transmitting messages modulated onto light waves.

Fiber optics has several advantages over traditional metal communications lines:

- Fiber optic cables have a much greater bandwidth than metal cables. This means that they can carry more data.
- Fiber optic cables are less susceptible than metal cables to interference.
- Fiber optic cables are much thinner and lighter than metal wires.
- Data can be transmitted digitally (the natural form for computer data) rather than analogically.
- The main disadvantage of fiber optics is that the cables are expensive to install. In addition, they are more fragile than wire and are difficult to splice.

Fiber optics is a particularly popular technology for local-area networks. In addition, telephone companies are steadily replacing traditional telephone lines with fiber optic cables. In the future, almost all communications will employ fiber optics.

FDDI

FDDI stands for Fiber Distributed Data Interface, a set of ANSI protocols for sending digital data over fiber optic cable. FDDI networks are token-passing networks, and support data rates of up to 100 Mbps (100 million bits) per second. FDDI networks are typically used as backbones for wide-area networks.

An extension to FDDI, called FDDI-2, supports the transmission of voice and video information as well as data. Another variation of FDDI, called FDDI Full Duplex Technology (FFDT) uses the same network infrastructure but can potentially support data rates up to 200 Mbps.

Hub

A common connection point for devices in a network. Hubs are commonly used to connect segments of a LAN. A hub contains multiple ports. When a packet arrives at one port, it is copied to the other ports so that all segments of the LAN can see all packets.

A passive hub serves simply as a conduit for the data, enabling it to go from one device (or segment) to another. So-called intelligent hubs include additional features that enables an administrator to monitor the traffic passing through the hub and to configure each port in the hub. Intelligent hubs are also called manageable hubs.

A third type of hub, called a switching hub (or simply a “switch”), actually reads the destination address of each packet and then forwards the packet to the correct port.

ICMP

Short for Internet Control Message Protocol, an extension to the Internet Protocol (IP) defined by RFC 792. ICMP supports packets containing error, control, and informational messages. The PING command, for example, uses ICMP to test an Internet connection.
ISDN

ISDN stands for Integrated Services Digital Network, an international communications standard for sending voice, video, and data over digital telephone lines or normal telephone wires. ISDN supports data transfer rates of 64Kbps (64,000 bits per second). Most ISDN lines offered by telephone companies give you two lines at once, called B channels. You can use one line for voice and the other for data, or you can use both lines for data to give you data rates of 128 Kbps, three times the data rate provided by today's fastest modems.

The original version of ISDN employs baseband transmission. Another version, called B-ISDN, uses broadband transmission and is able to support transmission rates of 1.5 Mbps. B-ISDN requires fiber optic cables and is not widely available.

Frame Relay

Frame relay is a packet-switching protocol for connecting devices on a Wide Area Network (WAN). Frame Relay networks in the U.S. support data transfer rates at T-1 (1.544 Mbps) and T-3 (45 Mbps) speeds. In fact, you can think of Frame Relay as a way of utilizing existing T-1 and T-3 lines owned by a service provider. Most telephone companies now provide Frame Relay service for customers who want connections at 56 Kbps to T-1 speeds. (In Europe, Frame Relay speeds vary from 64 Kbps to 2 Mbps.

In the U.S., Frame Relay is quite popular because it is relatively inexpensive. However, it is being replaced in some areas by faster technologies, such as ATM.

MAC Address Filtering

MAC Filtering (or EUI filtering, or layer 2 address filtering) refers to a security access control methodology whereby the 48-bit address assigned to each network card is used to determine access to the network.

MAC addresses are uniquely assigned to each card, so using MAC filtering on a network permits and denies network access to specific devices through the use of blacklists and whitelists. While the restriction of network access through the use of lists is straightforward, an individual person is not identified by a MAC address, rather a device only, so an authorized person will need to have a whitelist entry for each device that he or she would use to access the network.

While giving a wireless network some additional protection, MAC Filtering can be circumvented by scanning a valid MAC (via the command airodump-ng) and then changing the own MAC into a validated one. This can be done in the Windows Registry or by using command-line tools on a Linux platform.

MAU

MAU is short for Multistation Access Unit (also abbreviated as MSAU), a token-ring network device that physically connects network computers in a star topology while retaining the logical ring structure. One of the problems with the token-ring topology is that a single non-operating node can break the ring. The MAU solves this problem because it has the ability to short out non-operating nodes and maintain the ring structure. A MAU is a special type of hub.
Repeater

A network device used to regenerate or replicate a signal. Repeaters are used in transmission systems to regenerate analog or digital signals distorted by transmission loss. Analog repeaters frequently can only amplify the signal while digital repeaters can reconstruct a signal to near its original quality.

In a data network, a repeater can relay messages between subnetworks that use different protocols or cable types. Hubs can operate as repeaters by relaying messages to all connected computers. A repeater cannot do the intelligent routing performed by bridges and routers.

RJ-11

RJ-11 connectors are used for connecting traditional home telephone equipment.

RJ-45

Short for Registered Jack-45, an eight-wire connector used commonly to connect computers onto a local-area networks (LAN), especially Ethernet’s. RJ-45 connectors look similar to the ubiquitous RJ-11 connectors used for connecting telephone equipment, but they are somewhat wider.

Plenum cable

Cable that is run in the plenum spaces of buildings. In building construction, the plenum is the space that is used for air circulation in heating and air conditioning systems, typically between the structural ceiling and the suspended ceiling or under a raised floor. The plenum space is typically used to house the communication cables for the building's computer and telephone network(s). However, use of plenum areas for cable storage poses a serious hazard in the event of a fire as once the fire reaches the plenum space there are few barriers to contain the smoke and flames. Plenum cable is coated with a fire-retardant coating (usually Teflon) so that in case of a fire it does not give off toxic gasses and smoke as it burns. Twisted-pair and coaxial versions of cable are made in plenum versions.

Router

A device that connects any number of LANs.

Routers use headers and a forwarding table to determine where packets go, and they use ICMP to communicate with each other and configure the best route between any two hosts.

Very little filtering of data is done through routers. Routers do not care about the type of data they handle.

POP3

POP3 is short for Post Office Protocol, a protocol used to retrieve e-mail from a mail server. Most e-mail applications (sometimes called an e-mail client) use the POP protocol, although some can use the newer IMAP (Internet Message Access Protocol).

There are two versions of POP. The first, called POP2, became a standard in the mid-80's and requires SMTP to send messages. The newer version, POP3, can be used with or without SMTP.
PSTN or POTS

Short for Public Switched Telephone Network, which refers to the international telephone system based on copper wires carrying analog voice data. This is in contrast to newer telephone networks based on digital technologies, such as ISDN and FDDI. Telephone service carried by the PSTN is often called plain old telephone service (POTS).

SNMP

SNMP is short for Simple Network Management Protocol, a set of protocols for managing complex networks. The first versions of SNMP were developed in the early 1980s. SNMP works by sending messages, called protocol data units (PDUs), to different parts of a network. SNMP-compliant devices, called agents, store data about themselves in Management Information Bases (MIBs) and return this data to the SNMP requesters.

SNMP 1 reports only whether a device is functioning properly. The industry has attempted to define a new set of protocols called SNMP 2 that would provide additional information, but the standardization efforts have not been successful. Instead, network managers have turned to a related technology called RMON that provides more detailed information about network usage.

SMTP

SMTP stands for Simple Mail Transfer Protocol, a protocol for sending e-mail messages between servers. Most e-mail systems that send mail over the Internet use SMTP to send messages from one server to another; the messages can then be retrieved with an e-mail client using either POP or IMAP. In addition, SMTP is generally used to send messages from a mail client to a mail server. This is why you need to specify both the POP or IMAP server and the SMTP server when you configure your e-mail application.

Reverse ARP (RARP)

Reverse ARP, document in RFC 903, is a fairly simple bootstrapping protocol that allows a workstation to broadcast using its Ethernet address, and expect a server to reply, telling it its IP address.

SSID

SSID is short for service set identifier, a 32-character unique identifier attached to the header of packets sent over a WLAN that acts as a password when a mobile device tries to connect to the BSS. The SSID differentiates one WLAN from another, so all access points and all devices attempting to connect to a specific WLAN must use the same SSID. A device will not be permitted to join the BSS unless it can provide the unique SSID. Because an SSID can be sniffed in plain text from a packet it does not supply any security to the network.

An SSID is also referred to as a network name because essentially it is a name that identifies a wireless network.
STP

1) Acronym for Spanning Tree Protocol. STP, a link management protocol, is part of the IEEE 802.1 standard for media access control bridges. Using the spanning tree algorithm, STP provides path redundancy while preventing undesirable loops in a network that are created by multiple active paths between stations. Loops occur when there are alternate routes between hosts. To establish path redundancy, STP creates a tree that spans all of the switches in an extended network, forcing redundant paths into a standby, or blocked, state. STP allows only one active path at a time between any two network devices (this prevents the loops) but establishes the redundant links as a backup if the initial link should fail. If STP costs change, or if one network segment in the STP becomes unreachable, the spanning tree algorithm reconfigures the spanning tree topology and reestablishes the link by activating the standby path. Without spanning tree in place, it is possible that both connections may be simultaneously live, which could result in an endless loop of traffic on the LAN.

2) Short for Shielded Twisted Pair cable, a popular type of cable that consists of 4 sets of two unshielded wires twisted around each other, with a foil wrapper surrounding the cable. Due to its low cost, STP cabling is used extensively for local-area networks (LANs) and telephone connections where signal loss problems may exist.

T1 Line

A T1 line is a dedicated phone connection supporting data rates of 1.544Mbits per second. A T-1 line actually consists of 24 individual channels, each of which supports 64Kbits per second. Each 64Kbit/second channel can be configured to carry voice or data traffic. Most telephone companies allow you to buy just some of these individual channels, known as fractional T-1 access.

T-1 lines are a popular leased line option for businesses connecting to the Internet and for Internet Service Providers (ISPs) connecting to the Internet backbone. The Internet backbone itself consists of faster T-3 connections.

T-1 lines are sometimes referred to as DS1 lines.

T3 Line

A T3 line is a dedicated phone connection supporting data rates of about 43 Mbps. A T-3 line actually consists of 672 individual channels, each of which supports 64 Kbps.

T-3 lines are used mainly by Internet Service Providers (ISPs) connecting to the Internet backbone and for the backbone itself.

T-3 lines are sometimes referred to as DS3 lines.

Telnet

Telnet is a protocol which is used to establish a connection with a remote machine. For example, telnet can be used to connect your PC to a Unix workstation via the Internet. With Telnet, you can work from your PC as if it were a terminal physically attached to another machine. Windows has a Telnet client built into the TCP/IP suite; click on Start, then Run, then type "Telnet" in the dialog box and click OK. You will need to know the name of the remote computer, also called a host, in order to connect to it. Also, you will need to have an account on the remote computer in order to begin a communications session.
UDP

UDP stands for User Datagram Protocol, which is a connectionless protocol that, like TCP, runs on top of IP networks. Unlike TCP/IP, UDP/IP provides very few error recovery services, offering instead a direct way to send and receive datagrams over an IP network. It's used primarily for broadcasting messages over a network.

UTP

Short for Unshielded Twisted Pair, a popular type of cable that consists of four pairs of two unshielded wires twisted around each other. Due to its low cost, UTP cabling is used extensively for local-area networks (LANs) and telephone connections. UTP cabling does not offer as high bandwidth or as good protection from interference as coaxial or fiber optic cables, but it is less expensive and easier to work with.

VoIP

Short for Voice over Internet Protocol, a category of hardware and software that enables people to use the Internet as the transmission medium for telephone calls by sending voice data in packets using IP rather than by traditional circuit transmissions of the PSTN (the plain old telephone system). One advantage of VoIP is that the telephone calls over the Internet do not incur a surcharge beyond what the user is paying for Internet access, much in the same way that the user doesn't pay for sending individual e-mails over the Internet. Skype and NetMeeting are examples of applications that use VoIP technology.

WEP

Short for Wired Equivalent Privacy, a security protocol for wireless local area networks (WLANs) defined in the 802.11b standard. WEP is designed to provide the same level of security as that of a wired LAN. LANs are inherently more secure than WLANs because LANs are somewhat protected by the physicalities of their structure, having some or all part of the network inside a building that can be protected from unauthorized access. WLANs, which are over radio waves, do not have the same physical structure and therefore are more vulnerable to tampering. WEP aims to provide security by encrypting data over radio waves so that it is protected as it is transmitted from one end point to another. However, it has been found that WEP is not as secure as once believed. WEP is used at the two lowest layers of the OSI model - the data link and physical layers; it therefore does not offer end-to-end security.

WPA

Short for Wi-Fi Protected Access, a Wi-Fi standard that was designed to improve upon the security features of WEP. The technology is designed to work with existing Wi-Fi products that have been enabled with WEP (i.e., as a software upgrade to existing hardware), but the technology includes two improvements over WEP:

- Improved data encryption through the temporal key integrity protocol (TKIP). TKIP scrambles the keys using a hashing algorithm and, by adding an integrity-checking feature, ensures that the keys haven’t been tampered with.
- User authentication, which is generally missing in WEP, through the extensible authentication protocol (EAP). WEP regulates access to a wireless network based on a computer’s hardware-specific MAC address, which is relatively simple to be sniffed out and stolen. EAP is built on a more secure public-key encryption system to ensure that only authorized network users can access the network.
It should be noted that WPA is an interim standard that will be replaced with the IEEE’s 802.11i standard upon its completion.

**Wireless Networking**

Wireless networking falls under the 802.11 standard laid down by the Institute of Electrical and Electronics Engineers (IEEE). Within the 802.11 wireless networking standard, there are several different versions:

- **802.11** — applies to wireless LANs and provides 1 or 2 Mbps transmission in the 2.4 GHz band using either frequency hopping spread spectrum (FHSS) or direct sequence spread spectrum (DSSS).
- **802.11a** — an extension to 802.11 that applies to wireless LANs and provides up to 54-Mbps in the 5GHz band. 802.11a uses an orthogonal frequency division multiplexing encoding scheme rather than FHSS or DSSS.
- **802.11b** (also referred to as 802.11 High Rate or Wi-Fi) — an extension to 802.11 that applies to wireless LANS and provides 11 Mbps transmission (with a fallback to 5.5, 2 and 1-Mbps) in the 2.4 GHz band. 802.11b uses only DSSS. 802.11b was a 1999 ratification to the original 802.11 standard, allowing wireless functionality comparable to Ethernet.
- **802.11e** — a wireless draft standard that defines the Quality of Service (QoS) support for LANs, and is an enhancement to the 802.11a and 802.11b wireless LAN (WLAN) specifications. 802.11e adds QoS features and multimedia support to the existing IEEE 802.11b and IEEE 802.11a wireless standards, while maintaining full backward compatibility with these standards.
- **802.11g** — applies to wireless LANs and is used for transmission over short distances at up to 54-Mbps in the 2.4 GHz bands.
- **802.11n** — 802.11n builds upon previous 802.11 standards by adding multiple-input multiple-output (MIMO). The additional transmitter and receiver antennas allow for increased data throughput through spatial multiplexing and increased range by exploiting the spatial diversity through coding schemes like Alamouti coding. The real speed would be 100 Mbit/s (even 250 Mbit/s in PHY level), and so up to 4-5 times faster than 802.11g.
- **802.11r** — 802.11r, also called Fast Basic Service Set (BSS) Transition, supports VoWi-Fi handoff between access points to enable VoIP roaming on a Wi-Fi network with 802.1X authentication.
- **802.1X** — Not to be confused with 802.11x (which is the term used to describe the family of 802.11 standards) 802.1X is an IEEE standard for port-based Network Access Control that allows network administrators to restricted use of IEEE 802 LAN service access points to secure communication between authenticated and authorized devices.

**NOTES**
The OSI Model

The OSI, or Open System Interconnection, model defines a networking framework for implementing protocols in seven layers. Control is passed from one layer to the next, starting at the application layer in one station, proceeding to the bottom layer, over the channel to the next station and back up the hierarchy.

Application (Layer 7)

This layer supports application and end-user processes. Communication partners are identified, quality of service is identified, user authentication and privacy are considered, and any constraints on data syntax are identified. Everything at this layer is application-specific. This layer provides application services for file transfers, e-mail, and other network software services.

Presentation (Layer 6)

This layer provides independence from differences in data representation (e.g., encryption) by translating from application to network format, and vice versa. This layer formats and encrypts data to be sent across a network, providing freedom from compatibility problems. It is sometimes called the syntax layer.

Session (Layer 5)

This layer establishes, manages and terminates connections between applications. The session layer sets up, coordinates, and terminates conversations, exchanges, and dialogues between the applications at each end. It deals with session and connection coordination.

Transport (Layer 4)

This layer provides transparent transfer of data between end systems, or hosts, and is responsible for end-to-end error recovery and flow control. It ensures complete data transfer.

Network (Layer 3)

This layer provides switching and routing technologies, creating logical paths, known as virtual circuits, for transmitting data from node to node. Routing and forwarding are functions of this layer, as well as addressing, internetworking, error handling, congestion control and packet sequencing.

Data Link (Layer 2)

At this layer, data packets are encoded and decoded into bits. It furnishes transmission protocol knowledge and management and handles errors in the physical layer, flow control and frame synchronization. The data link layer is divided into two sublayers: The Media Access Control (MAC) layer and the Logical Link Control (LLC) layer. The MAC sublayer controls how a computer on the network gains access to the data and permission to transmit it. The LLC layer controls frame synchronization, flow control and error checking.

Physical (Layer 1)

This layer conveys the bit stream - electrical impulse, light or radio signal -- through the network at the electrical and mechanical level. It provides the hardware means of sending and receiving data on a carrier, including defining cables, cards and physical aspects.
Dial-Up Networking Issues

The next few pages of the text deal with issues you may encounter when connecting to the Internet via a dial-up networking connection. Such dial-up connections allow you to gain access to other computers, and also to the Internet. Note that dial-up networking is becoming obsolete with the advent of broadband Internet connectivity. If you encounter customers that still are using dial-up networking systems, encourage them strongly to investigate and purchase a high-speed, broadband Internet connection. Most dial-up Internet service providers are scaling back or shutting down their modem-based connection services.

Modem Communication Terminology

Here is a list of terms commonly used in conjunction with modems and dial-up networking.

**BBS**

Bulletin Board System. A BBS allows you to interact with another computer via your modem, allowing you to send/receive electronic mail (e-mail), download & upload data, and access various kinds of programs. There are free and pay-for-access BBS systems run by individuals located throughout the world. BBS systems were the predecessors to larger on-line systems such as Compuserve, Prodigy, and America On-Line which charge monthly usage fees.

**BPS**

Bits Per Second; the rate at which data is transferred via a modem; sometimes inaccurately called the baud rate. Standard telephone modems generally available today transfer data at speeds up to 56,000 BPS. "Cable modems" and "DSL (digital subscriber line) modems" are generally network interface cards, and not true modems; cable and/or DSL modems transmit up to 10Mbps.

**Data Transfer Protocol**

A means of checking to see that your data has been transferred correctly; Common transfer protocols include XMODEM, YMODEM, KERMIT, COMPUSERVE B, and ASCII. Refer to the Glossary of Terms in this text for further definitions of these data transfer protocols.

**Download**

Transferring data to your computer from the computer with which you are communicating.

**Duplexing**

Setting your data communications channel so that it carries data in 1 or 2 directions; half duplex allows data to travel in 1 direction only; full duplexing allows data to go in both directions.

**Echo**

The return of transmitted data to your screen.
Modem

A device that converts digital data to analog data that can be transmitted across a telephone line; the receiving end converts analog data back to digital data. Modem stands for MOdulator-DEModulator.

Parity

A means of checking data at the modem level to assure that data has been transferred accurately. It involves the addition of overhead bits to ensure that the total number of 1s in a grouping of bits is always either even for even parity, or odd for odd parity. This permits detection of single errors. No parity means that parity checking is not performed.

RS-232

The IEEE technical name for a serial port.

Stop bits

The last bit after a word, used to indicate the end of the word. There are both start and stop bits before and after each word. Stop bits can be 1 or 2 bits long, depending on how the user wants their communications session to be. One is no better than another. Unix systems typically use 7-bit words and 2 stop bits, while PC communications applications use 8-bit words with 1 stop bit.

Terminal Emulation

Making your PC operate like one of several fairly common types of data (dumb) terminals. Common emulations include VT-52, VT-100, ANSI-BBS, IBM 3101, and Wyse 100.

Upload

Transferring data from your computer to the computer with which you are communicating.

Words

A "word" can be 7 or 8 bits long, depending upon the user and how he/she wants their communications session to be. One is no better than another. Unix systems typically use 7-bit words in communications sessions, while PC-based systems use 8-bit words.
Browser Software

Once you have connected to an Internet Service Provider (ISP), you will use some type of browser software to navigate to different places on the Internet. The two main browsers available on the market today are Microsoft's Internet Explorer, Mozilla Firefox, and other third-party browsers such as Google Chrome. These applications allow you to browse through HTML documents on the web, and they utilize hypertext links within the documents to take you to different locations on the Internet once you click on the link.

Browsers can also tie into e-mail servers and newsgroup servers; usually your ISP will provide you with the name of your Post Office Protocol 3 (POP3), Simple Mail Transport Protocol (SMTP) or Internet Mail Access Protocol (IMAP) server, so that you can access your e-mail and or discussion groups with the newsgroup part of the Internet. Both of these browsers are available for download from the Internet; going to www.microsoft.com will enable you to obtain the latest copy of Internet Explorer, and going to www.mozilla.com will allow you to download the newest version of Mozilla Firefox.

Domain Names

The Internet has been divided into various domains, so as to make it easier for people to find different sites on the Internet. For example:

- the .COM domain is for companies
- the .MIL domain is for military sites
- the .ORG domain is for non-profit organizations
- the .GOV domain is for governmental entities
- the .NET domain is for Internet-based companies
- the .EDU domain is for educational institutions
- the .INFO domain is for organizations providing information via the Web
- the .BIZ domain is for companies and for-profit businesses

Internet website names, such as www.washingtonpost.com, are pseudonyms for websites with a static (unchanging) IP address. Routers on the Internet have tables of information that resolve the domain name for a web site to an IP address that can be reached on the Internet. Browser software can find websites by IP address or by domain names.

Searching and Finding things on the Internet

Browser software offers two distinct tools to help you locate information: Internet "search" tools and page "find" tools. A search tool helps you locate information such as web pages and discussion group messages that resides on the Internet network. A find tool locates particular words or phrases within the page that you're currently viewing.
To search for information over the Internet with a browser

1. Click the Search button on the toolbar. This displays a page offering access to Internet search engines and other search services. Select a search engine from the list ... a popular search site is called Yahoo, and it's found at http://www.yahoo.com. The other major search engine is Google, and it can be found at http://www.google.com.
2. Follow the instructions on the search engine site. Typically, you'll type in search text, click a button, then wait for the engine to locate occurrences of the text among a database of web pages.
3. Examine the search results. These are usually presented as a list of links to pages containing the text you requested.
4. For additional Internet exploration, click the Guide button on the toolbar to display a pop-up menu listing Internet directory items. These directories can guide you to various Internet sites and services.

To find information in the current page

1. Open the Edit menu and choose Find in Page.
2. In the resulting dialog box, type the text you want to find, then click Find Next. Located text is highlighted and, if necessary, the page scrolls to the text's position.
3. Click the Edit menu's Find Again item to search for more occurrences.

The Edit menus of the Bookmarks window and Message window have similar commands, Find in Bookmarks and Find in Message, respectively.

Using a URL to identify page locations

To understand how a single page is kept distinct in a world of electronic pages, you should recognize its URL, short for Uniform Resource Locator. Every page has a unique URL. Not only does each page have a unique URL, but also each image and frame on a page. You can access a page, an image, or an individual frame by supplying its URL.

A URL is text used for identifying and addressing an item in a computer network. In short, a URL provides location information and your browser displays a URL in the location field. Most often you don't need to know a page's URL because the location information is included as part of a highlighted link; your browser already knows the URL when you click highlighted text, click a toolbar button, or select a menu item. But sometimes you won't have a link and instead have only the text of the URL (perhaps from a friend or a newspaper article).

To enter a URL

Type the URL directly into the location text field. Alternatively, you can choose Open Page from the File menu and type the URL in the resulting dialog box. (On the Mac OS, select the pull-right menu item Open, then choose Location in Navigator or Location in Composer to enter a URL.)

By entering a page's URL, your browser can bring you the specified page just as if you had clicked a link.
Here are some sample URLs:

http://www.google.com
news:news.announce.newusers
http://academic.pgcc.edu/~wlloyd/rta

To identify URL components

Browsers use the URL text to find a particular item, such as a page, among all the computers connected to the Internet. Within the URL text are components that specify the protocol, server, and pathname of an item. Notice in the URL

http://www.google.com/index.html

that the protocol is followed by a colon (http:), the server is preceded by two slashes (///www.google.com), and each segment of the pathname (only one here) is preceded by a single slash (/index.html).

The first component, the protocol, identifies a manner for interpreting computer information. Many Internet pages use HTTP (short for HyperText Transfer Protocol). Other common protocols you might come across include file (also known as ftp, which is short for File Transfer Protocol), news (the protocol used by Usenet discussion groups), and gopher (an alternative transfer protocol).

The second component, the server, identifies the computer system that stores the information you seek (such as home.netscape.com). Each server on the Internet has a unique name that identifies the location of the server.

The last component, the pathname, identifies the location of an item on the server. For example, a pathname usually specifies the name of the file identifying the page (such as /welcome.html), possibly preceded by one or more directory/folder names that contain the file (such as /home/welcome.html).

Some pathnames use special characters. If you are typing a URL into the location field, you'll need to enter the characters that exactly match the URL. For example, some pathnames contain the tilde character (~), which designates a particular home directory on a server.

Using Links to Pages

A link is a connection from one page to another. You find a link by looking for one or more words highlighted with color, underlining, or both in the content area of a page. Images and icons with colored borders also serve as links. A link within a page that contains frames can be a connection that displays one or more new pages within frames, or an entirely new top-level page replacing all frames.
To use a link in a browser

1. Point the mouse cursor over a link. The URL location of the link appears in the status message area at the bottom-left of the window.
2. Click once on the highlighted text, image, or icon. This transfers page content from a server location to your location.
3. After you click a link, the Netscape company logo animates to show you that the transfer of the page to your computer is in progress.
4. Examine the status message area and progress bar at the bottom of the window to receive feedback about the progress of a transfer.

To identify followed and unfollowed links

An unfollowed link is a connection to a page that you have not yet viewed. By default, unfollowed links are blue. A followed link is a connection to a page that you have viewed. By default, followed links are purple.

You can change the colors used to denote unfollowed and followed links; from the Edit menu, choose Preferences, then select the Colors panel. If you have a black-and-white monitor, unfollowed and followed links are highlighted only with underlining and not differentiated.

To stop a page transfer in progress

Click the Stop button. Alternately, you can stop a link's action by choosing Stop Loading from the Go menu.

You can stop a transfer whenever the loading process takes longer than you like. This might happen if the content of the page is large or if the server computer is sluggish. Sometimes the page specified by a link just isn't available. You'll usually get a message if a connection was not made or a page not found.

Links to Content inside Pages

When you bring a page to your screen, you'll see the whole page or, if the content is extensive, only a portion. (Scroll bars let you see the rest.) Often the portion you see is the beginning of the page, but sometimes a link brings you content from the page's middle or end. A link can display a new page or display a different portion of the same page (in effect, automatically scrolling for you). For example, the beginning of a page might include a table of contents that links each chapter title to its respective content further down the page.

"Mailto" Links and Internet Addresses

Yet another kind of link doesn't display a page at all. A "mailto" link whose URL begins with mailto: produces the Message Composition window for sending mail (with the recipient's address automatically filled in).
Whereas a URL identifies a server's page location on the Internet, an Internet address identifies a user's mailbox location. Here are the components of the Internet address `aname@aserver.com`:

- `aname` identifies a user.
- `@` symbol (pronounced "at") separates the user name from the location of the server computer.
- `aserver.com` identifies the location of the server computer.

Addresses use lowercase letters without any spaces. The name of a location contains at least a string and, typically, a three-letter suffix, set apart by a dot (the period is pronounced "dot"). The name of a location might require several subparts to identify the server (a host name and zero or more subdomains), each separated by dots. For example, the address `aname@aserver.bserver.com` uses a subdomain.

The three-letter suffix in the location name helps identify the kind of organization operating the server. (Some locations use a two-letter geographical suffix.) As mentioned earlier in this chapter, here are the common suffixes and organizational affiliation:

- `.com` (commercial)
- `.edu` (educational)
- `.gov` (government)
- `.mil` (military)
- `.net` (networking)
- `.org` (noncommercial)
- `.info` (informational)
- `.biz` (business)

Mail addresses from outside the United States often use a two-letter suffix designating a country. Here are some examples:

- `.jp` (Japan)
- `.uk` (United Kingdom)
- `.nl` (the Netherlands)
- `.ca` (Canada)

**Using the Navigation Toolbar in a Browser**

To use toolbar buttons for navigation and page control:

Click one of the following buttons. Buttons on the toolbar provide quick access to commonly used features.

**Back**

Click this button to display the previous page in the history list. Hold down the button to display a pop-up menu containing the pages you can go back to in the history list. A history list contains a hierarchy of pages you've already viewed. You can view a subset of the history list in the Go menu or view the entire list by choosing History from the browser's drop-down menu.
Forward

Click this button to display the next page in the history list. Hold down the button to display a pop-up menu containing the history list (the pages you can go forward to). If you've retrieved a page by using the Back button or a history menu item, using Forward displays the preceding page. Forward is only available after you use Back or a history item.

Reload

Click this button to redisplay the current browser page, reflecting any changes made since the original loading. To reload, your browser checks the network server to see if any change to the page has occurred. If there's no change, the original page is retrieved from a cache. If there's a change, the updated page is retrieved from the network server. If you press the Reload button while holding down the Shift key (Option key on the Mac OS), Navigator retrieves the page from the network server regardless of whether the page has been updated (the cache is not used).

Home

Click this button to display the home page designated in the Navigator preferences panel. The default page is the Netscape home page.

Search

Click this button to display a page containing a directory of Internet search engine sites and services.

Print

Click this button to print the content area of the currently displayed page. A dialog box lets you select printing characteristics.

Security

Click this button to display the Security Info window. This page lets you view and interact with elements such as encryption status, personal and site certificates, security-related applications, and passwords.

Stop

Click this button to halt any ongoing transfer of page information.

Revisiting a Page Using Bookmarks

(On the Mac OS, the Bookmarks menu is available from the menu bar. The Bookmarks window is opened from within the Apple Safari or Firefox browser.)
Bookmarks offer a convenient means of page retrieval. You store your bookmarks in a list. Once you add a bookmark to your list, the item stays until you remove it or change lists. The permanence and accessibility of bookmarks make them invaluable for personalizing your Internet access.

Browsers offer many options for creating a bookmark list. Basic options let you add and access a page through a pop-up menu on the location toolbar or through the browser's drop-down menu. The simplest way to obtain direct access to a favorite page is to open the Bookmarks menu and choose Add Bookmarks. This adds the current page as an item in the Bookmarks menu.

More advanced options, available from the Bookmarks window, let you create hierarchical menus, partial menu displays, multiple and shared bookmark files, list descriptions, and list searches. The Bookmarks window lists your bookmarks and offers a set of menu items to help you organize your list. In addition, many drag-and-drop options are available for creating and filing your bookmarks.

The bookmark list you create is represented by a bookmark file on your hard disk. Each item in the list contains the title of the page (which you can choose in a menu), the associated URL (which lets Navigator retrieve the page), and some additional date information.

The same Bookmarks menu is displayed by either the pop-up menu in the location toolbar or the browser's drop-down menu.

To display the Bookmarks menu

To display the Bookmarks menu using a pop-up menu, position the mouse cursor over the Bookmarks button in the location toolbar, and press the mouse button. To display the Bookmarks menu using the main menu bar, click on the Bookmarks drop-down menu. The Bookmarks item displays a submenu.

Add Bookmark

Add the title of the currently displayed page as the last item in the bookmark list. The Bookmarks menu grows as you add bookmarks.

File Bookmark

The pull-right File Bookmark menu item lets you add the current Navigator page to a selected bookmark folder. The items in this menu are bookmark folders.

To edit or delete bookmarks using the Bookmarks menu

Choose Edit Bookmarks to open the Bookmarks window. You can drag and drop bookmark icons or use the window's menu items to arrange the display of your bookmarks and bookmark folders.

To delete a bookmark, select the bookmark icon in the Bookmarks window, then press the Delete key (or choose Delete from the Edit menu).

To display bookmarks using the Bookmarks menu

Choose one of the following items shown on the next page:
Bookmark items

These items are the bookmarks you've created. Choose an item to display the bookmarked page. Each time you add a bookmark, the page's title is added to this menu and links to the bookmarked page.

Guide

The pull-right Guide menu item is a preset group of bookmarks built into your browser. These bookmarks offer tools and links for finding Internet information. They're the same as the items offered by the Guide button in the navigation toolbar.

Navigating to Pages

The Go menu allows you to navigate among pages. The menu contains the following items:

Back

Displays the previous page in the history (or frame history) list. A history list references a line of links you have viewed; a frame history references a line of frames you have viewed within a frameset.

Forward

Displays the next page in the history (or frame history) list. If you have used Back or a history menu item to bring back a page, Forward displays the page that's ahead in the history list. Forward is only available after you've used Back or a history item.

Home

Displays the home page whose location is specified in the browser, available by opening the Edit menu and choosing Preferences.

History items

The Go menu includes menu items corresponding to each page in the history list. Choose a page's title to display the page. Choose History from the browser's drop-down menu to view the history list.

If you need more information on how to find things on the Internet or how to use an Internet browser, access the help utilities found in either Mozilla Firefox or Microsoft Internet Explorer.

Sending and Receiving Electronic Mail Messages on Your Computer

Electronic mail (e-mail) is like regular mail in many ways. However, an e-mail message is transmitted instantly across the Internet, and it costs nothing to send the message. With many e-mail programs, you can attach files (computer programs, pictures, word processing files, etc.) to go along with the e-mail message. Also, you can forward or send the same e-mail message to more than one person at a time, through the use of a mailing list. Anyone who can access the Internet can get e-mail, and sending a message to Australia is just as easy as sending mail to someone next door. Most e-mail packages are as easy to use as standard word processing packages, and even include features such as spell checking.
Create New Messages

To create a new mail message, start up the e-mail program ... we'll use Microsoft Outlook as an example. There are several main groups on the program interface: the Inbox, the Sent Mail folder, the Drafts folder, and so on. There is a button at the top of the screen that lets you create a new email message. Click on this button to begin creating a mail message. You will need to address the message, but for now we'll skip that part. Simply begin typing in your message in the space provided. Email programs work just like a word processor, so just go ahead and type your message.

Address Messages

Once you have written your message, you will need to specify the e-mail address of the person (or persons) to which you wish to send the message. Just as with the regular mail system, providing an incorrect address will ensure that the letter does NOT get through. Getting the correct address is key to making sure the message goes through. A correct e-mail address will look something like this:

wlloyd@census.gov
william.allen.lloyd@ccmail.census.gov
researchtech@juno.com

The first part of the e-mail address (the part before the "@" sign) indicates the name (or account name) of the person who has an account on that e-mail service. The last part indicates the organization that is providing the person with an e-mail account. Make sure that you know the exact e-mail name when addressing your message.

You can send the same message to multiple persons at the same time. You can simply address the message to all the individuals to which you wish to send the message, or you can create a "mailing list" to a group of individuals that can be used over again when needed. You can create a mailing list through the Juno program, and save the list to your hard disk. Your instructor will demonstrate in class how this is done.

Attach Files to Messages

In virtually all e-mail programs, you can attach any kind of file to an e-mail message, and transmit a copy of that file with your message to the intended recipient. If your mail service supports this feature (some do not), you would click on the "Attach" button, and then select the name of the file from wherever it is located on your hard disk. When you send the e-mail message, a copy of the file you selected will be sent with your message.

There is one thing to note when sending files to people over the Internet: large files may take a long time to send through your e-mail service, and may take a long time to retrieve for the recipient. Be considerate of this when sending files along with your mail message.

Send and Receive Messages

When you connect to your e-mail host server (that's the computer that is providing you with e-mail service), your e-mail program will check to see if you have any new messages waiting for you since you last logged into the server. If you do, the messages will be transmitted from the server to your computer and stored on your hard disk. You will then be able to retrieve the mail messages and read them.
At the same time, the e-mail server will check to see if you have any messages on your computer that need to be transferred to the server and sent over the Internet. Your e-mail program will handle that automatically when you log into the server.

Read Messages

Once your e-mail service forwards your e-mail messages to your hard disk, you may read your mail messages at your leisure. If you wish, you may print out your messages to your local printer.

Reply to and Forward Messages

If a mail message arrive that requires a response, you are able to reply back to the message's sender, or your can forward the message on to other readers. Simply use the "Reply" option in your mail program to send a return message; the e-mail program will automatically enter that person's e-mail address into the address field. Type in your response, and send the message when you are done.

To forward the message to others, use the "Forward" option in your e-mail program. Specify the name of the person (or persons) to whom you wish the message to be sent. If you wish, you may also add a note to the message you are sending. When you are finished, click on the "Send" button (or use the "Send" option) to mail your message.

Print Messages

Printing your mail message is as easy as selecting the "Print" option from the drop-down menu, or clicking on the "Print" button in your e-mail program. Make sure your printer is turned on before trying to print your messages.

Deleting, Saving and Storing Messages

As time goes by, your inbox of mail messages may become rather large. You probably will not want to keep EVERY message you received, so you may want to review your mail messages about once a week. Upon this review, you will likely decide to delete some messages, and permanently store others to your hard disk.

To delete a mail message, simply click once on the desired message on the message list, and then press the Delete key. You can also select multiple messages for deletion by holding down the Shift key and clicking on the desired files, and then pressing the Delete key.

To save a mail message as a file on your hard disk, open the mail message by double-clicking on it, then click on File, then click on Save from the drop-down menu. Once you have saved the message to a file on your hard disk, you can then delete the message from your inbox.

Find Messages and Addresses

Most e-mail programs will let you search for a message by the name of the sender, by the subject of the message, or by searching for specific text within the message. Simply access the search feature within the e-mail program, then input the desired name or words for which you wish to search, and press Enter ... the search engine will momentarily give you the results of the search.
Spam, and how to deal with it

Spam in the nickname for unsolicited e-mail, just like the junk mail that comes to you via the US Postal Service. If you receive spam, respond back to the individual or company and let them know that you no longer wish to receive their unsolicited e-mail. There are also a number of anti-spam sites on the Internet that can help you if you receive an inordinate amount of spam e-mail.

What is an ISP?

An ISP is an Internet Service Provider. ISPs provide users with a gateway by which they can access the Internet to use the world-wide web, transfer files via the File Transfer Protocol (FTP), or to send email. ISPs provide to their clients a software package (or they use the dial-up software within Windows) that creates either a Serial Link to the Internet Protocol (SLIP) connection or a Point-to-Point over Ethernet Protocol (PPPoE) connection between the home (or office) computer and the ISP. TCP/IP is the data transfer protocol used over SLIP or PPPoE connections, because TCP/IP is the sole protocol used to transfer data over the Internet.

There are thousands of ISPs worldwide; some are large corporations, such as Verizon and Comcast, and some are smaller, local service providers. ISPs charge a monthly (or hourly) fee to connect your computer to the ISP and the Internet.

NOTES
Chapter 15. Glossary of Terms

This portion of the text provides the definitions for hundreds of different terms related to personal computing, computer hardware, software, and applications. The author recommends to the reader that if there are terms missing from the glossary that should be included, please let him know, and they will be included in the next edition of the text.

The glossary begins on the next page.
80286
An Intel microprocessor with 16-bit registers, a 16-bit data bus, and a 24-bit address bus. Can operate in real and protected virtual modes.

80287
An Intel math coprocessor designed to perform floating-point math with much greater speed and precision than the main CPU. The 80287 can be installed in most 286- and some 386DX-based systems, and adds more than 50 new instructions to what is available in the primary CPU alone.

80386DX
An Intel microprocessor with 32-bit registers, a 32-bit data bus, and a 32-bit address bus. This processor can operate in real, protected virtual, and virtual real modes.

80387DX
An Intel math coprocessor designed to perform floating-point math with much greater speed and precision than the main CPU. The 80387DX can be installed in most 386DX-based systems, and adds more than 50 new instructions to what is available in the primary CPU alone.

80386SX
An Intel microprocessor with 32-bit registers, a 16-bit data bus, and a 24-bit address bus. This processor, designed as a low-cost version of the 386DX, can operate in real, protected virtual, and virtual real modes.

80387SX
An Intel math coprocessor designed to perform floating-point math with much greater speed and precision than the main CPU. The 80387SX can be installed in most 386SX-based systems, and adds more than 50 new instructions to what is available in the primary CPU alone.

80486DX
An Intel microprocessor with 32-bit registers, a 32-bit data bus, and a 32-bit address bus. The 486DX has a built-in cache controller with 8K of cache memory as well as a built-in math co-processor equivalent to a 387DX. The 486DX can operate in real, protected virtual, and virtual real modes.

80486DX2
A version of the 486DX with an internal clock doubling circuit that causes the chip to run at twice the motherboard clock speed. If the motherboard clock is 33MHz, then the DX2 chip will run at 66MHz. The DX2 designation applies to chips sold through the OEM market, while a retail version of the DX2 is sold as an Overdrive processor.

80486SX
An Intel microprocessor with 32-bit registers, a 32-bit data bus, and a 32-bit address bus. The 486SX is the same as the 486DX except that it lacks the built-in math coprocessor function, and was designed as a low-cost version of the 486DX. The 486SX can operate in real, protected virtual, and virtual real modes.
80487SX
An Intel microprocessor with 32-bit registers, a 32-bit data bus, and a 32-bit address bus. The 487SX has a built-in cache controller with 8K of cache memory as well as a built-in math coprocessor equivalent to a 387DX. The 486DX can operate in real, protected virtual, and virtual real modes. This processor is a complete processor and math coprocessor unit, not just a math coprocessor. The 487SX is designed to upgrade systems with the 486SX processor, which lacks the math coprocessor function. When a 487SX is installed in a system, it shuts down the 486SX and takes over the system. In effect, the 487SX is a full-blown 486DX modified to be installed as an upgrade for 486SX systems.

8086
An Intel microprocessor with 16-bit registers, a 16-bit data bus, and a 20-bit address bus. This processor can operate only in real mode.

8087
An Intel math coprocessor designed to perform floating-point math with much greater speed and precision than the main CPU. The 8087 can be installed in most 8086- and 8088-based systems, and adds more than 50 new instructions to what is available in the primary CPU alone.

8088
An Intel microprocessor with 16-bit registers, an 8-bit data bus, and a 20-bit address bus. This processor can operate only in real mode, and was designed as a low-cost version of the 8086.

8514/A
An analog video display adapter from IBM for the PS/2 line of personal computers. Compared to previous display adapters such as EGA and VGA, it provides a high resolution of 1024x768 pixels with as many as 256 colors or 64 shades of gray. It provides a video coprocessor that performs two-dimensional graphics functions internally, thus relieving the CPU of graphics tasks. It is an interlaced monitor: It scans every other line every time the screen is refreshed.

Abend
Short for abnormal end. Used when the execution of a program or task is terminated unexpectedly because of a bug or crash.

AC
Alternating current. The frequency is measured in cycles per seconds (cps), or hertz. The standard value running through the wall outlet is 120 volts at 60 Hertz, through a fuse or circuit breaker that usually can handle about 20 amps.

Accelerator board
An add-in board replacing the computer's CPU with circuitry that enables the system to run faster.

Access time
The time that elapses from the instant information is requested to the point that delivery is completed. Usually described in nanoseconds for memory chips. The IBM PC requires memory chips with an access time of 200 nanoseconds, and the AT requires 150-nanosecond chips. For hard disk drives, access time is described in milliseconds. Most manufacturers rate average access time on a hard disk as the time required for a seek across one-third of the total number of cylinders plus one-half of the time for a single revolution of the disk platters (latency).
Accumulator
A register (temporary storage) in which the result of an operation is formed.

Acronym
An acronym is a word or group of letters formed from the first or first few letters of a series of words. For example, CPU is an acronym for Central Processing Unit. This glossary contains definitions for many acronyms popular in the personal computer industry.

Active high
Designates a digital signal that has to go to a high value to produce an effect. Synonymous with positive true.

Active low
Designates a digital signal that has to go to a low value to produce an effect. Synonymous with negative true.

Actuator
The device that moves a disk drive's read/write heads across the platter surfaces. Also known as an access mechanism.

Adapter
The device that serves as an interface between the system unit and the devices attached to it. Used by IBM to be synonymous with circuit board, circuit card, or card.

Address
Refers to where a particular piece of data or other information is found in the computer. Also can refer to the location of a set of instructions.

Address bus
One or more electrical conductors used to carry the binary-coded address from the microprocessor throughout the rest of the system.

Alphanumeric characters
A character set that contains only letters (A-Z) and digits (0-9). Other characters, such as punctuation marks, also may be allowed.

Ampere
The basic unit for measuring electrical current. Also called amp.

Analog loopback
A modem self-test in which data from the keyboard is sent to the modem's transmitter, modulated into analog form, looped back to the receiver, demodulated into digital form, and returned to the screen for verification.

Analog signals
Continuously variable signals in which the slightest change may be significant. Analog circuits are more subject to distortion and noise but are capable of handling complex signals with relatively simple circuitry. An alternative to analog is digital, in which signals are in only one of two states.
AND
A logic operator having the property that if \( P \) is a statement, \( Q \) is a statement, \( R \) is a statement,..., then the AND of \( P,Q,R,... \) is true if all statements are true and is false if any statement is false.

AND gate
A logic gate in which the output is 1 only if all inputs are 1.

ANSI
Acronym for American National Standards Institute, a non-governmental organization founded in 1918 to propose, modify, approve, and publish data processing standards for voluntary use in the United States. Also the U.S. representative to the International Standards Organization (ISO) in Paris and the International Electrotechnical Commission (IEC). For more information, contact ANSI, 1430 Broadway, New York, NY 10018.

Answer mode
A state in which the modem transmits at the predefined high frequency of the communications channel and receives at the low frequency. The transmit/receive frequencies are the reverse of the calling modem, which is in originate mode.

APA
All points addressable. A mode in which all points of a displayable image can be controlled by the user or a program.

API
An acronym for application program interface. A system call (routine) that gives programmers access to the services provided by the operating system. In IBM-class systems, the ROM BIOS and DOS together present an API that programmers can use to control system hardware.

APIPA
Short for Automatic Private IP Addressing, a feature of later Windows operating systems. With APIPA, DHCP clients can automatically self-configure an IP address and subnet mask when a DHCP server isn't available. When a DHCP client boots up, it first looks for a DHCP server in order to obtain an IP address and subnet mask. If the client is unable to find the information, it uses APIPA to automatically configure itself with an IP address from a range that has been reserved especially for Microsoft. The IP address range is 169.254.0.1 through 169.254.255.254. The client also configures itself with a default class B subnet mask of 255.255.0.0. A client uses the self-configured IP address until a DHCP server becomes available.

The APIPA service also checks regularly for the presence of a DHCP server (every five minutes, according to Microsoft). If it detects a DHCP server on the network, APIPA stops, and the DHCP server replaces the APIPA networking addresses with dynamically assigned addresses.

APIPA is meant for nonrouted small business environments, usually less than 25 clients.

Arbitration
A method by which multiple devices attached to a single bus can bid or arbitrate to get control of that bus.

Archive bit
The bit in a file's attribute byte that sets the archive attribute. Tells whether the file has been changed since it last was backed up.
Archive medium
A storage medium (floppy disk, tape cartridge, or removable cartridge) to hold files that need not be accessible instantly.

ARCnet
An acronym for Attached Resource Computer Network, a baseband, token-passing local area network technology offering a flexible bus/star topology for connecting personal computers. Operates at 2.5 megabits per second, is one of the oldest LAN systems, and has become popular in low-cost networks. Originally developed by John Murphy, of Datapoint Corporation, although ARCnet interface cards are available from a variety of vendors.

Areal Density
Areal Density is a calculation of the Bit Density (Bits Per Inch, or BPI) multiplied by the Track Density (Tracks Per Inch, or TPI), which results in a figure indicating how many bits per square inch are present on the disk surface.

ARQ
Automatic repeat request. A general term for error-control protocols that feature error detection and automatic retransmission of defective blocks of data.

ASCII
An acronym for American Standard Code for Information Interchange, a standard seven-bit code created in 1965 by Robert W. Bemer to achieve compatibility among various types of data processing equipment. The standard ASCII character set consists of 128 decimal numbers, ranging from 0 through 127, assigned to letters, numbers, punctuation marks, and the most common special characters. In 1981 IBM introduced the extended ASCII character set with the IBM PC, extending the code to eight bits and adding characters from 128 through 255 to represent additional special mathematical, graphics, and foreign characters.

ASCII character
A 1-byte character from the ASCII character set, including alphabetic and numeric characters, punctuation symbols, and various graphics characters.

ASME
An acronym for the American Society of Mechanical Engineers.

Assemble
To translate a program expressed in an assembler language into a computer machine language.

Assembler language
A computer-oriented language whose instructions are usually in one-to-one correspondence with machine language instructions.

Asymmetrical modulation
A duplex transmission technique that splits the communications channel into one high-speed channel and one slower channel. During a call under asymmetrical modulation, the modem with the greatest amount of data to transmit is allocated the high-speed channel. The modem with less data is allocated the slow, or back, channel (450 bps). The modems dynamically reverse the channels during a call if the volume of data transfer changes.
Asynchronous communication
Data transmission in which the length of time between transmitted characters may vary. Timing is dependent on the actual time for the transfer to take place, as opposed to synchronous communication, which is timed rigidly by an external clock signal. Because the receiving modem must be signaled about when the data bits of a character begin and end, start and stop bits are added to each character.

ATA
An acronym for AT Attachment interface, an IDE disk interface standard introduced in March 1989 that defines a compatible register set and a 40-pin connector and its associated signals.

Attribute byte
A byte of information, held in the directory entry of any file, that describes various attributes of the file, such as whether it is read-only or has been backed up since it last was changed. Attributes can be set by the DOS ATTRIB command.

Audio
A signal that can be heard, such as through the speaker of the PC. Many PC diagnostics tests use both visual (on-screen) codes and audio signals.

Audio frequencies
Frequencies that can be heard by the human ear (approximately 20 to 20,000 hertz).

Auto answer
A feature in modems enabling them to answer incoming calls over the phone lines without the use of a telephone receiver.

Auto dial
A feature in modems enabling them to dial phone numbers without the use of a telephone transmitter.

AUTOEXEC.BAT
A special batch file that DOS executes at start-up. Contains any number of DOS commands that are executed automatically.

Automatic head parking
Disk drive head parking performed whenever the drive is powered off. Found in all hard disk drives with a voice-coil actuator.

Average Access Time
The average time it takes a disk drive to begin reading any data placed anywhere on the drive. This includes the Average Seek time, which is when the heads are moved, as well as the Average Latency, which is the average amount of time required for any given data sector to pass underneath the heads. Together these make up the Average Access Time.

Average Latency
The average time required for any byte of data stored on a disk to rotate under the disk drive's read/write head. Equal to one-half the time required for a single rotation of a platter.
Average Seek Time
Average seek time for a drive is the average amount of time it takes to move the heads from one random cylinder location to another, usually including any head settling time. In many cases, the average seek is tested across one third of the total number of cylinders for consistency in measurement.

AVI
AVI is an acronym for Audio Video Interleave, a storage technique developed by Microsoft for their "Video for Windows" product that combines audio and video into a single frame or track, saving valuable disk space and keeping audio in synchronization with the corresponding video.

Backup
The process of duplicating a file or library onto a separate piece of media. Good insurance against loss of an original.

Backup disk
Contains information copied from another disk. Used to make sure that original information is not destroyed or altered.

Bad sector
A disk sector that cannot hold data reliably because of a media flaw or damaged format markings.

Bad track table
A label affixed to the casing of a hard disk drive that tells which tracks are flawed and cannot hold data. The listing is entered into the low-level formatting program.

Balanced signal
A term referring to signals consisting of equal currents moving in opposite directions. When balanced or nearly balanced signals pass through twisted pair lines, the electromagnetic interference effects such as crosstalk caused by the two opposite currents largely cancel each other out. Differential signaling is a method that uses balanced signals.

Balun
Short for balanced/unbalanced. A type of transformer that enables balanced cables to be joined with unbalanced cables. For example, a twisted pair (balanced) cable can be joined with a coaxial cable (unbalanced) if the proper balun transformer is used.

Bandwidth
Generally the measure of the range of frequencies within a radiation band required to transmit a particular signal. Measures in millions of cycles per second the difference between the lowest and highest signal frequencies. The bandwidth of a computer monitor is a measure of the rate that a monitor can handle information from the display adapter. The wider the bandwidth, the more information the monitor can carry, and the greater the resolution.

Bank
The collection of memory chips that make up a block of memory readable by the processor in a single bus cycle. This block therefore must be as large as the data bus of the particular microprocessor. In IBM systems, the processor data bus is usually 8, 16, or 32 bits, plus a parity bit for each 8 bits, resulting in a total of 9, 18, or 36 bits for each bank.
Bar code
The code used on consumer products and inventory parts for identification purposes. Consists of bars of varying thicknesses to represent characters and numerals that are read with an optical reader. The most common version is called the Universal Product Code (UPC).

Baseband
The transmission of digital signals over a limited distance. ARCnet and EtherNet local area networks utilize baseband signaling. Contrasts with broadband transmission, which refers to the transmission of analog signals over a greater distance.

BASIC
An acronym for Beginner's All-purpose Symbolic Instruction Code, a popular computer programming language. Originally developed by John Kemeny and Thomas Kurtz, in the mid-1960s at Dartmouth College. Normally an interpretive language, meaning that each statement is translated and executed as it is encountered; but can be a compiled language, in which all the program statements are compiled before execution.

Batch file
A set of commands stored in a disk file for execution by the operating system. A special batch file called AUTOEXEC.BAT is executed by IBM DOS each time the system is started. All DOS batch files have a BAT file extension.

Baud
A unit of signaling speed denoting the number of discrete signal elements that can be transmitted per second. The word baud is derived from the name of J.M.E. Baudot (1845-1903), a French pioneer in the field of printing telegraphy and the inventor of Baudot code. Although technically inaccurate, baud rate commonly is used to mean bit rate. Because each signal element or baud may translate into many individual bits, bits per second (bps) normally differs from baud rate. A rate of 2400 baud means that 2400 frequency or signal changes per second are being sent, but each frequency change may signal several bits of information. Most people are surprised to learn that 2400 and 1200 bps modems transmit at 600 baud, and that 9600 and 14400 bps modems transmit at 2400 baud.

Baudot code
A 5-bit code used in many types of data communications including teletype (TTY), radio teletype (RTTY), and telecommunications devices for the deaf (TDD). Baudot code has been revised and extended several times.

Bay
An opening in a computer cabinet that holds disk drives.

BBS
An acronym for bulletin board system, a computer that operates with a program and a modem to enable other computers with modems to communicate with it, often on a round-the-clock basis. Thousands of IBM- and Apple-related bulletin board systems offer a wealth of information and public-domain software that can be downloaded.

Bezel
A cosmetic panel that covers the face of a drive or some other device.

Bezier Curve
A mathematical method for describing a curve, often used in illustration and CAD programs to draw complex shapes.
Bidirectional
Refers to lines over which data can move in two directions, like a data bus or a telephone line. Also
refers to the capability of a printer to print from right to left and from left to right
alternately.

Binary
Refers to the computer numbering system that consists of two numerals, 0 and 1. Also called base-2.

BIOS
Basic input-output system. The part of an operating system that handles the communications between
the computer and its peripherals. Often burned into read-only memory (ROM) chips.

Bisynchronous
Binary synchronous control. An earlier protocol developed by IBM for software applications and
communicating devices operation in synchronous environments. The protocol defines operations at the
link level of communications--for example, the format of data frames exchanged between modems over
a phone line.

Bit
A binary digit. Represented logically by 0 or 1 and electrically by 0 volts and (typically) 5 volts. Other
methods are used to represent binary digits physically (tones, different voltages, lights, and so on), but
the logic is always the same.

Bit Density
Expressed as Bits Per Inch (BPI), bit density defines how many bits can be written onto one linear inch
of a track. Sometimes also called linear density.

Bit map
A method of storing graphics information in memory in which a bit devoted to each pixel (picture
element) on-screen indicates whether that pixel is on or off. A bit map contains a bit for
each point or dot on a video display screen and allows for fine resolution because any point or pixel
on-screen can be addressed. A greater number of bits can be used to describe each pixel's
color, intensity, and other display characteristics.

Block
A string of records, words, or characters formed for technical or logic reasons and to be treated as an
entity.

Block diagram
The logical structure or layout of a system in graphics form. Does not necessarily match the physical
layout and does not specify all the components and their interconnections.

BNC
An acronym for British National Connector, a type of connector plug and jack system. Originally
designed in England for television set antennas, the BNC is a type of connector designed for use with
coaxial cabling. Male and female BNCs are available. Although the term is redundant, BNCs usually
are referred to as BNC connectors. Often used in local area network cabling systems that use coaxial
cable, such as EtherNet and ARCnet, and also used frequently for video cabling systems.

Boolean operation
Any operation in which each of the operands and the result take one of two values.
Boot
Load a program into the PC. The term comes from the phrase "pulling up by the bootstrap."

Boot record
A one-sector record that tells the computer's built-in operating system (BIOS) the most fundamental facts about a disk and DOS. Instructs the computer how to load the operating system files into memory, thus booting the machine.

Bootstrap
A technique or device designed to bring itself into a desired state by means of its own action.

BPS
Bits per second. The number of binary digits, or bits, transmitted per second. Sometimes confused with baud.

Bridge
In local area networks, an interconnection between two networks. Also the hardware equipment used to establish such an interconnection.

Broadband
A term used to describe analog transmission. Requires modems for connecting terminals and computers to the network. Using frequency division multiplexing, many different signals or sets of data can be transmitted simultaneously. The alternate transmission scheme is baseband, or digital, transmission.

Bubble memory
A special type of nonvolatile read/write memory introduced by Intel in which magnetic regions are suspended in crystal film and data is maintained when the power is off. A typical bubble memory chip contains about 512K, or more than 4 million bubbles. Failed to catch on because of slow access times measured in several milliseconds. Has found a niche use as solid-state disk emulators in environments in which conventional drives are unacceptable, such as military or factory use.

Buffer
A block of memory used as a holding tank to store data temporarily. Often positioned between a slower peripheral device and the faster computer. All data moving between the peripheral and the computer passes through the buffer. A buffer enables the data to be read from or written to the peripheral in larger chunks, which improves performance. A buffer that is x bytes in size usually holds the last x bytes of data that moved between the peripheral and CPU. This method contrasts with that of a cache, which adds intelligence to the buffer so that the most often accessed data rather than the last accessed data remains in the buffer (cache). A cache can improve performance greatly over a plain buffer.

Bug
An error or defect in a program.

Burn-in
The operation of a circuit or equipment to stabilize components and to screen for failures.
Bus
A linear electrical signal pathway over which power, data, and other signals travel and are capable of connection to three or more attachments. A bus is generally considered to be distinct from radial or point-to-point signal connections. The term bus comes from the Latin "omnibus" meaning "for all." When used to describe a topology, bus always implies a linear structure.

Bus master
An intelligent device that when attached to the PCI bus can bid for and gain control of the bus to perform its specific task.

Byte
A collection of bits that makes up a character or other designation. Generally, a byte is eight data bits plus one parity (error-checking) bit.

Cache
An intelligent buffer. By using an intelligent algorithm, a cache contains the data that is accessed most often between a slower peripheral device and the faster CPU.

CAM
An acronym for Common Access Method, a committee formed in 1988 consisting of a number of computer peripheral suppliers and dedicated to developing standards for a common software interface between SCSI peripherals and host adapters. The CAM committee also has set a standard for IDE drives called the ATA interface.

Capacitor
A device consisting of two plates separated by insulating material and designed to store an electrical charge.

Card
A printed circuit board containing electronic components that form an entire circuit, usually designed to plug into a connector or slot. Sometimes also called an adapter.

Carpal tunnel syndrome
A painful hand injury that gets its name from the narrow tunnel in the wrist which connects ligament and bone. When undue pressure is put on the tendons, they can swell and compress the median nerve, which carries impulses from the brain to the hand, causing numbness, weakness, tingling, and burning in the fingers and hands. Computer users get carpal tunnel syndrome primarily from improper keyboard ergonomics that result in undue strain on the wrist and hand.

Carrier
A continuous frequency signal capable of being either modulated or impressed with another information-carrying signal. The reference signal used for the transmission or reception of data. The most common use of this signal with computers involves modem communications over phone lines. The carrier is used as a signal on which the information is superimposed.

Carrier detect signal
A modem interface signal which indicates to the attached data terminal equipment (DTE) that it is receiving a signal from the distant modem. Defined in the RS-232 specification. Same as the received line-signal detector.
Cathode ray tube
A device that contains electrodes surrounded by a glass sphere or cylinder and displays information by creating a beam of electrons that strike a phosphor coating inside the display unit.

CAV
CAV is an acronym for Constant Angular Velocity, an optical disk recording format where the data is recorded on the disk in concentric circles. CAV disks are rotated at a constant speed. This is similar to the recording technique used on floppy disk drives. CAV limits the total recorded capacity compared to CLV (Constant Linear Velocity), which is also used in optical recording.

CCITT
An acronym for the Comite Consultatif Internationale de Telegraphique et Telephonique (in English, the International Telegraph and Telephone Consultative Committee or the Consultative Committee for International Telegraph and Telephone). An international committee organized by the United Nations to set international communications recommendations, which frequently are adopted as standards, and to develop interface, modem, and data network recommendations. The Bell 212A standard for 1200 bps communication in North America, for example, is observed internationally as CCITT V.22. For 2400 bps communication, most U.S. manufacturers observe V.22bis, and V.32 and V.32bis are standards for 9600 and 14400 bps, respectively. Work is now under way to define a new standard for 19200 bps called V.32fast.

CCS
An acronym for the Common Command Set, a set of SCSI commands specified in the ANSI SCSI-1 Standard X3.131-1986 Addendum 4.B. All SCSI devices must be capable of using the CCS in order to be fully compatible with the ANSI SCSI-1 standard.

CD-DA
CD-DA is an acronym for Compact Disc Digital Audio. CD-DA is also known as "Red Book Audio", and is the digital sound format used by audio CDs. CD-DA uses a sampling rate of 44.1KHz and stores 16 bits of information for each sample. CD audio is not played through the computer, but through a special chip in the CD-ROM drive. Fifteen minutes of CD-DA sound can require about 80 MB. The highest quality sound that can be utilized by Multimedia PC is the CD-DA format at 44.1KHz sample rate.

CD-R
CD-R is an acronym for Compact Disk Recordable, sometimes also called CD-Writable. CD-R disks are compact disks that can be recorded several times and read as many times as desired. CD-R is part of the Orange Book Standard defined by ISO. CD-R technology is used for mass production of multimedia applications. CD-R disks can be compatible with CD-ROM, CD-ROM XA and CD audio. Orange Book specifies multi-session capabilities, which allows data recording on the disk at different times in several recording sessions. Kodak's Photo CD is an example of CD-R technology, and fits up to 100 digital photographs on a single CD. Multi-session capability allows several rolls of 35MM film to be added to a single disk on different occasions.

CD-ROM
An acronym for compact disc read-only memory. A computer peripheral device that employs compact disc (CD) technology to store large amounts of data for later retrieval. Phillips and Sony developed CD-ROM in 1983. Current CD-ROM discs hold approximately 600M of information. CD-ROM drives are much slower than conventional hard disks, with normal average-access times of 380 milliseconds or greater and data transfer rates of about 1.2 megabits per second. Most CD-ROM drives use the SCSI (Small Computer Systems Interface) bus for connection to a system.
CD-ROM XA
CD-ROM XA is an acronym for Compact Disk Read Only Memory eXtended Architecture. The XA standard was developed jointly by Sony, Philips and Microsoft in 1988 and is now part of the Yellow Book Standard. XA is a built in feature of newer CD-ROM drives which supports simultaneous sound playback with data transfer. Non-XA drives support either sound playback OR data transfer, but not both simultaneously. XA also provides for data compression right on the disk, which can also increase data transfer rates.

Ceramic substrate
A thin, flat, fired ceramic part used to hold an IC chip (usually made of beryllium oxide or aluminum oxide).

CGA
An acronym for Color Graphics Adapter, a type of PC video display adapter introduced by IBM on August 12, 1981, that supports text and graphics. Text is supported at a maximum resolution of 80x25 characters in 16 colors with a character box of 8x8 pixels. Graphics is supported at a maximum resolution of 320x200 pixels in 16 colors or 640x200 pixels in 2 colors. The CGA outputs a TTL (digital) signal with a horizontal scanning frequency of 15.75 KHz, and supports TTL color or NTSC composite displays. See also pixel.

Channel
A path along which signals can be sent.

Character
A representation, coded in binary digits, of a letter, number, or other symbol.

Checksum
Short for summation check, a technique for determining whether a package of data is valid. The package, a string of binary digits, is added up and compared with the expected number.

Chip
Another name for an IC, or integrated circuit. Housed in a plastic or ceramic carrier device with pins for making electrical connections. See also ceramic substrate and chip carrier.

Chip carrier
A ceramic or plastic package that carries an integrated circuit, or IC.

Circuit
A complete electronic path.

Circuit board
The collection of circuits gathered on a sheet of plastic, usually with all electrical contacts made through a strip of pins. The circuit board usually is made by chemically etching metal-coated plastic.

CISC
An acronym for complex instruction-set computer. Refers to traditional computers that operate with large sets of processor instructions. Most modern computers, including the Intel 80xxx processors, are in this category. CISC processors have expanded instruction sets that are complex in nature and require several to many execution cycles to complete. This structure contrasts with RISC (reduced instruction-set computer) processors, which have far fewer instructions that execute quickly.
Clean room
A dust-free room in which certain electronic components (such as hard disk drives) must be manufactured and serviced to prevent contamination. Rooms are rated by Class numbers. A Class 100 clean room must have fewer than 100 particles larger than .5 microns per cubic foot of space.

Clock
The source of a computer's timing signals. Synchronizes every operation of the CPU.

Clock speed
A measurement of the rate at which the clock signal for a device oscillates, usually expressed in millions of cycles per second (MHz).

Clone
An IBM-compatible computer system that physically as well as electrically emulates the design of one of IBM's personal computer systems, usually the AT or XT. For example, an AT clone has parts (motherboard, power supply, and so on) that are physically interchangeable with the same parts in the IBM AT system.

Cluster
Also called allocation unit. A group of sectors on a disk that forms a fundamental unit of storage to the operating system. Cluster or allocation unit size is determined by DOS when the disk is formatted.

CLV
CLV is an acronym for Constant Linear Velocity, an optical recording format where the spacing of data is consistent throughout the disk, and the rotational speed of the disk varies depending on what track is being read. Additionally, more sectors of data are placed on the outer tracks compared to the inner tracks of the disk, which is similar to Zone Recording on hard drives. CLV drives will adjust the rotational speed to maintain a constant track velocity as the diameter of the track changes. CLV drives rotate faster near the center of the disk and slower towards the edge. Rotational adjustment maximizes the amount of data that can be stored on a disk. CD-DA audio and CD-ROM use CLV recording.

CMOS
Complementary Metal-Oxide Semiconductor. A type of chip design that requires little power to operate. In an AT-type system, a battery-powered CMOS memory and clock chip is used to store and maintain the clock setting and system configuration information.

Coated media
Hard disk platters coated with a reddish iron-oxide medium on which data is recorded.

Coaxial cable
Also called coax cable. A data-transmission medium noted for its wide bandwidth, immunity to interference, and high cost compared to twisted pair wire. Signals are transmitted inside a fully shielded environment, in which an inner conductor is surrounded by a solid insulating material and then an outer conductor or shield. Used in many local area network systems such as EtherNet and ARCnet.

COBOL
An acronym for Common business-oriented language, a high-level computer programming language. The business world's preferred programming language on mainframe computer systems, it has never achieved popularity on smaller computers.
Code page switching
A DOS feature in versions 3.3 and later that changes the characters displayed on-screen or printed on an output device. Primarily used to support foreign-language characters. Requires an EGA or better video system and an IBM-compatible graphics printer.

Coercivity
A measurement in units of oersteads of the amount of magnetic energy to switch or coerce the flux change in the magnetic recording media. High-coercivity disk media requires a stronger write current.

COM port
A port on a PC that conforms to the RS-232 standard.

Command
An instruction that tells the computer to start, stop, or continue an operation.

COMMAND.COM
An operating system file that is loaded last when the computer is booted. The command interpreter or user interface and program-loader portion of DOS.

Common
The ground or return path for an electrical signal. If a wire, usually is colored black.

Common mode noise
Noise or electrical disturbances that can be measured between a current- or signal-carrying line and its associated ground. Common mode noise is frequently introduced to signals between separate computer equipment components through the power distribution circuits. It can be a problem when single-ended signals are used to connect different equipment or components that are powered by different circuits.

Compiler
A program that translates a program written in a high-level language into its equivalent machine language. The output from a compiler is called an object program.

Composite video
Television picture information and sync pulses combined. The IBM Color Graphics Adapter (CGA) outputs a composite video signal.

Computer
Device capable of accepting data, applying prescribed processes to this data, and displaying the results or information produced.

CONFIG.SYS
A file that can be created to tell DOS how to configure itself when the machine starts up. Can load device drivers, set the number of DOS buffers, and so on.

Configuration file
A file kept by application software to record various aspects of the software’s configuration, such as the printer it uses.

Console
The unit, such as a terminal or a keyboard, in your system with which you communicate with the computer.
Contiguous
Touching or joined at the edge or boundary, in one piece.

Continuity
In electronics, an unbroken pathway. Testing for continuity normally means testing to determine whether a wire or other conductor is complete and unbroken (by measuring 0 ohms). A broken wire shows infinite resistance (or infinite ohms).

Control cable
The wider of the two cables that connect an ST-506/412 or ESDI hard disk drive to a controller card. A 34-pin cable that carries commands and acknowledgments between the drive and controller.

Controller
The electronics that control a device such as a hard disk drive and intermediate the passage of data between the device and the computer.

Controller card
An adapter holding the control electronics for one or more devices such as hard disks. Ordinarily occupies one of the computer's slots, or is built into the motherboard.

Convergence
Describes the capability of a color monitor to focus the three colored electron beams on a single point. Poor convergence causes the characters on-screen to appear fuzzy and can cause headaches and eyestrain.

Coprocessor
An additional computer processing unit designed to handle specific tasks in conjunction with the main or central processing unit. See also CPU.

Core
An old-fashioned term for computer memory.

CP/M
An acronym for Control Program/Microcomputer, an operating system created by Gary Kildall, the founder of Digital Research. Created for the old 8-bit microcomputers that used the 8080, 8085, and Z-80 microprocessors. Was the dominant operating system in the late 1970s and early 1980s for small computers used in a business environment.

CPS
Characters per second. A data transfer rate generally estimated from the bit rate and the character length. At 2400 bps, for example, 8-bit characters with start and stop bits (for a total of 10 bits per character) are transmitted at a rate of approximately 240 characters per second (cps). Some protocols, such as V.42 and MNP, employ advanced techniques such as longer transmission frames and data compression to increase cps.

CPU
Central processing unit. The computer's microprocessor chip, the brains of the outfit. Typically, an IC using VLSI (very-large-scale integration) technology to pack several different functions into a tiny area. The most common electronic device in the CPU is the transistor, of which several thousand to several million or more are found.
Crash
A malfunction that brings work to a halt. A system crash usually is caused by a software malfunction, and ordinarily you can restart the system by rebooting the machine. A head crash, however, entails physical damage to a disk and probable data loss.

CRC
An acronym for cyclic redundancy checking, an error-detection technique consisting of a cyclic algorithm performed on each block or frame of data by both sending and receiving modems. The sending modem inserts the results of its computation in each data block in the form of a CRC code. The receiving modem compares its results with the received CRC code and responds with either a positive or negative acknowledgment. In the ARQ protocol implemented in high-speed modems, the receiving modem accepts no more data until a defective block is received correctly.

Crosstalk
The electromagnetic coupling of a signal on one line with another nearby signal line. Cross talk is caused by electromagnetic induction, where a signal traveling through a wire creates a magnetic field that then induces a current in other nearby wires.

CRT
Cathode-ray tube. A term used to describe a television or monitor screen tube.

Current
The flow of electrons, measured in amperes. See ampere.

Cursor
The small flashing hyphen that appears on-screen to indicate the point at which any input from the keyboard will be placed.

Cylinder
The set of tracks on a disk that are on each side of all the disk platters in a stack and are the same distance from the center of the disk. The total number of tracks that can be read without moving the heads. A floppy drive with two heads usually has 160 tracks, which are accessible as 80 cylinders. A typical 20M hard disk has 2 platters with 4 heads and 615 cylinders, in which each cylinder is 4 tracks.

Daisy chain
Stringing up components in such a manner that the signals move serially from one to the other. Most microcomputer multiple disk drive systems are daisy-chained. The SCSI bus system is a daisy-chain arrangement, in which the signals move from computer to disk drives to tape units, and so on.

Daisywheel printer
An impact printer that prints fully formed characters one at a time by rotating a circular print element composed of a series of individual spokes, each containing two characters that radiate from a center hub. Produces letter-quality output.

DAT
An acronym for digital audio tape, a small cassette tape for storing large amounts of digital information. Also sometimes called 4mm tape. DAT technology emerged in Europe and Japan in 1986 as a way to produce high-quality, digital audio recordings. One DAT cassette can hold approximately 1.3 gigabytes of data.
Data
Groups of facts processed into information. A graphic or textural representation of facts, concepts, numbers, letters, symbols, or instructions used for communication or processing.

Data cable
Any cable that connects a hard disk or CD/DVD drive to a controller interface or card.

Data communications
A type of communication in which computers and terminals can exchange data over an electronic medium.

Data compression
Data compression is a technique where mathematical algorithms are applied to the data in a file to eliminate redundancies and therefore reduce the size of the file. There are two types of compression: Lossy and Lossless. Lossy compression deletes some of the original (uncompressed) data needed to reconstruct a file, and is normally used only for graphic image or sound files, where the loss of some resolution or information is acceptable. Lossless compression maintains completely the integrity of the original file, allowing it to be reconstructed exactly, and is most commonly used for program or data files.

Data separator
A device that separates data and clock signals from a single encoded signal pattern. Usually the same device does both data separation and combination and is sometimes called an "endec" for Encoder/Decoder.

Data transfer rate
The maximum rate at which data can be transferred from one device to another.

DC
Direct current, such as that provided by a power supply or batteries.

DC-600
Data Cartridge 600, a data-storage medium invented by 3M in 1971 that uses a quarter-inch-wide tape 600 feet in length.

DCE
Data communications equipment. The hardware that does the communication; usually a dial-up modem that establishes and controls the data link through the telephone network. See also DTE.

DDE
An acronym for Dynamic Data Exchange, a form of interprocess communications used by Microsoft Windows to support the exchange of commands and data between two applications running simultaneously. This capability has been enhanced further with Object Linking and Embedding (OLE).

DEBUG
The name of a utility program included with DOS and used for specialized purposes such as altering memory locations, tracing program execution, patching programs and disk sectors, and performing other low-level tasks.
Dedicated line
A user-installed telephone line used to connect a specified number of computers or terminals within a limited area, such as a single building. The line is a cable rather than a public-access telephone line. The communications channel also may be referred to as nonswitched because calls do not go through telephone company switching equipment.

Dedicated servo surface
In voice-coil-actuated hard disk drives, one side of one platter given over to servo data that is used to guide and position the read/write heads.

Default
Any setting assumed at start-up or reset by the computer's software and attached devices and operational until changed by the user. An assumption the computer makes when no other parameters are specified. When you type DIR without specifying the drive to search, for example, the computer assumes that you want it to search the default drive. The term is used in software to describe any action the computer or program takes on its own with imbedded values.

Density
The amount of data that can be packed into a certain area on a specific storage media.

Device driver
A memory-resident program, loaded by CONFIG.SYS, that controls a device, such as a CD-ROM drive or network interface card.

Dhrystone
A benchmark program used as a standard figure of merit indicating aspects of a computer system's performance in areas other than floating-point math performance. Because the program does not use any floating-point operations, performs no I/O, and makes no operating system calls, it is most applicable to measuring the processor performance of a system. The original Dhrystone program was developed in 1984 and was written in Ada, although the C and Pascal versions became more popular by 1989.

Diagnostics
Programs used to check the operation of a computer system. These programs enable the operator to check the entire system for any problems and to indicate in what area the problems lie.

Differential
An electrical signaling method where a pair of lines are used for each signal in "push-pull" fashion. In most cases differential signals are balanced so that the same current flows on each line in opposite directions. This is unlike Single-ended signals which use only one line per signal referenced to a single ground. Differential signals have a large tolerance for common-mode noise, and little cross-talk when used with twisted pair wires even in long cables. Differential signaling is expensive because two pins are required for each signal.

Digital loopback
A test that checks the RS-232 interface on a modem and the cable that connects the terminal or computer and the modem. The modem receives data (in the form of digital signals) from the computer or terminal and immediately returns the data to the screen for verification.

Digital signals
Discrete, uniform signals. In this book, the term refers to the binary digits 0 and 1.
Digitize
Digitizing refers to transforming an analog wave to a digital signal that a computer can store. Conversion to digital data and back is performed by a Digital to Analog Converter (DAC), often a single chip device. How closely a digitized sample represents an analog wave depends on the number of times the amplitude of a wave is measured and recorded, or the rate of digitization, as well as the number of different levels that can be specified at each instance. The number of possible signal levels is dictated by the resolution in bits.

DIMM
Dual in-line memory module. An array of memory chips on a small PC board with 2 rows of I/O contacts.

DIP
Dual In-line Package. A family of rectangular, integrated-circuit flat packages that have leads on the two longer sides. Package material is plastic or ceramic.

DIP switch
A tiny switch (or group of switches) on a circuit board. Named for the form factor of the carrier device in which the switch is housed.

Direct memory access
A process by which data moves between a disk drive (or other device) and system memory without direct control of the central processing unit (CPU), thus freeing it up for other tasks.

Directory
An area of a disk that stores the titles given to the files saved on the disk and serves as a table of contents for those files. Contains data that identifies the name of a file, the size, the attributes (system, hidden, read-only, and so on), the date and time of creation, and a pointer to the location of the file. Each entry in a directory is 32 bytes long.

DOS
An acronym for disk operating system. A collection of programs stored on the DOS disk that contain routines enabling the system and user to manage information and the hardware resources of the computer. DOS must be loaded into the computer before other programs can be started.

Diskette
A floppy disk. Made of a flexible material coated with a magnetic substance, the disk spins inside its protective jacket, and the read/write head comes in contact with the recording surface to read or write data.

Dithering
Dithering is the process of creating more colors and shades from a given color palette. In monochrome displays or printers, dithering will vary the black and white dot patterns to simulate shades of gray. Gray scale dithering is used to produce different shades of gray when the device can only produce limited levels of black or white outputs. Color screens or printers use dithering to create colors by mixing and varying the dot sizing and spacing.

DLL
An acronym for Dynamic Link Library, an executable driver program module for Microsoft Windows that can be loaded on demand and linked in at run time, and subsequently unloaded when the driver is no longer needed.
DMA
Direct memory access. A circuit by which a high-speed transfer of information may be facilitated between a device and system memory. This transfer is managed by a specialized processor that relieves the burden of managing the transfer from the main CPU.

Dot pitch
A measurement of the width of the dots that make up a pixel. The smaller the dot pitch, the sharper the image.

Dot-matrix printer
An impact printer that prints characters composed of dots. Prints characters one at a time by pressing the ends of selected wires against an inked ribbon and paper.

Double density (DD)
An indication of the storage capacity of a floppy drive or disk in which eight or nine sectors per track are recorded using MFM encoding.

Down-time
Operating time lost because of a computer malfunction.

DPMI
An acronym for DOS Protected Mode Interface, an industry standard interface that allows DOS applications to execute program code in the protected mode of the 286 or higher Intel processor. The DPMI specification is available from Intel.

Drive
A mechanical device that manipulates data storage media.

DTE
Data terminal (or terminating) equipment. The device, usually a computer or terminal, that generates or is the final destination of data. See also DCE.

Duplex
Indicates a communications channel capable of carrying signals in both directions.

DVI
DVI is an acronym for Digital Video Interactive, a standard that was originally developed at RCA Laboratories, and sold to Intel in 1988. DVI integrates digital motion, still video, sound, graphics and special effects in a compressed format. DVI is a highly sophisticated hardware compression technique used in interactive multimedia applications.

Dvorak keyboard
A keyboard design by August Dvorak that was patented in 1936 and approved by ANSI in 1982. Provides increased speed and comfort and reduces the rate of errors by placing the most frequently used letters in the center for use by the strongest fingers. Finger motions and awkward strokes are reduced by more than 90 percent in comparison with the familiar QWERTY keyboard. The Dvorak keyboard has the five vowel keys, AOEUI, together under the left hand in the center row, and the five most frequently used consonants, DHTNS, under the fingers of the right hand.
EBCDIC
An acronym for Extended Binary Coded Decimal Interchange Code, an IBM developed 8-bit code for the representation of characters. It allows 256 possible character combinations within a single byte. EBCDIC is the standard code on IBM mini-computers and mainframes, but not on the IBM microcomputers, where ASCII is used instead.

Edit
The process of rearranging data or information.

EGA
An acronym for Enhanced Graphics Adapter, a type of PC video display adapter first introduced by IBM on September 10, 1984, that supports text and graphics. Text is supported at a maximum resolution of 80x25 characters in 16 colors with a character box of 8x14 pixels. Graphics is supported at a maximum resolution of 640x350 pixels in 16 (from a palette of 64) colors. The EGA outputs a TTL (digital) signal with a horizontal scanning frequency of 15.75, 18.432, or 21.85 KHz, and supports TTL color or TTL monochrome displays.

EIA
Electronic Industries Association, which defines electronic standards in the United States.

EISA
An acronym for Extended Industry Standard Architecture, an extension of the Industry Standard Architecture (ISA) bus developed by IBM for the AT. The EISA design was led by COMPAQ Corporation. Later, eight other manufacturers (AST, Epson, Hewlett-Packard, NEC, Olivetti, Tandy, Wyse, and Zenith) joined COMPAQ in a consortium founded September 13, 1988. This group became known as the "gang of nine." The EISA design was patterned largely after IBMÆs Micro Channel Architecture (MCA) in the PS/2 systems, but unlike MCA, EISA allows for backward compatibility with older plug-in adapters.

Electronic mail / E-mail
A method of transferring messages form one computer to another.

Electrostatic discharge (ESD)
Static electricity, a sudden flow of electricity between two objects at different electrical potentials. ESD is a primary cause of integrated circuit damage or failure.

Embedded servo data
Magnetic markings embedded between or inside tracks on disk drives that use voice-coil actuators. These markings enable the actuator to fine-tune the position of the read/write heads.

EMM
An acronym for Expanded Memory Manager, a driver that provides a software interface to expanded memory. EMMs were originally created for expanded memory boards, but can also use the memory management capabilities of the 386 or higher processors to emulate an Expanded Memory board. EMM386.EXE is an example of an EMM that comes with DOS.

EMS
An acronym for Expanded Memory Specification. Sometimes also called the LIM spec. because it was developed by Lotus, Intel, and Microsoft. Provides a way for microcomputers running under DOS to access additional memory. EMS memory management provides access to a maximum of 32M of expanded memory through a small (usually 64K) window in conventional memory. EMS is a cumbersome access scheme designed primarily for pre-286 systems that could not access extended memory.

Emulator
A piece of test apparatus that emulates or imitates the function of a particular chip.

Encoding
The protocol by which data is carried or stored by a medium.

Encryption
The translation of data into unreadable codes to maintain security.

Endec (Encoder/Decoder)
A device that takes data and clock signals and combines or encodes them using a particular encoding scheme into a single signal for transmission or storage. The same device also later separates or decodes the data and clock signals during a receive or read operation. Sometimes called a Data separator.

EPROM
Erasable programmable read-only memory. A type of read-only memory (ROM) in which the data pattern can be erased to allow a new pattern. Usually is erased by ultraviolet light and recorded by a higher than normal voltage programming signal.

Equalization
A compensation circuit designed into modems to counteract certain distortions introduced by the telephone channel. Two types are used: fixed (compromise) equalizers and those that adapt to channel conditions (adaptive). Good-quality modems use adaptive equalization.

Error control
Various techniques that check the reliability of characters (parity) or blocks of data. V.42, MNP, and HST error-control protocols use error detection (CRC) and retransmission of errored frames (ARQ).

Error message
A word or combination of words to indicate to the user that an error has occurred somewhere in the program.

ESDI
An acronym for Enhanced Small Device Interface, a hardware standard developed by Maxtor and standardized by a consortium of 22 disk drive manufacturers on January 26, 1983. A group of 27 manufacturers formed the ESDI steering committee on September 15, 1986, to enhance and improve the specification. A high-performance interface used primarily with hard disks, ESDI provides for a maximum data transfer rate to and from a hard disk of between 10 and 24 megabits per second.

EtherNet
A type of network protocol developed in the late 1970s by Bob Metcalf, at Xerox Corporation, and endorsed by the IEEE. One of the oldest LAN communications protocols in the personal computing industry. EtherNet networks use a collision-detection protocol to manage contention.

Expanded memory
Otherwise known as EMS memory, memory that conforms to the EMS specification. Requires a special device driver and conforms to a standard developed by Lotus, Intel, and Microsoft.
Extended memory
Direct processor-addressable memory that is addressed by an Intel (or compatible) 286, 386, 486 or Pentium processor in the region beyond the first megabyte. Addressable only in the processor's protected mode of operation.

Extended partition
A nonbootable DOS partition containing DOS volumes. Starting with DOS V3.3, the DOS FDISK program can create two partitions that serve DOS: an ordinary, bootable partition (called the primary partition) and an extended partition, which may contain as many as 23 volumes from D: through Z:.

Extra-high density (ED)
An indication of the storage capacity of a floppy drive or disk in which 36 sectors per track are recorded using a vertical recording technique with MFM encoding.

FIFO
An acronym for first-in first-out, a method of storing and retrieving items from a list, table, or stack such that the first element stored is the first one retrieved.

File
A collection of information kept somewhere other than in random-access memory.

File allocation table
A table held near the outer edge of a disk that tells which sectors are allocated to each file and in what order.

File attribute
Information held in the attribute byte of a file's directory entry.

File defragmentation
The process of rearranging disk sectors so that files are compacted on consecutive sectors in adjacent tracks.

File name
The name given to the disk file. Must be one to eight characters long and may be followed by a file-name extension, which can be one to three characters long. Can be made up of any combination of letters and numbers but should be descriptive of the information contained in the file. Starting with Windows95, filenames can be as many as 255 characters in length.

Firmware
Software contained in a read-only memory (ROM) device. A cross between hardware and software.

Fixed disk
Also called a hard disk, a disk that cannot be removed from its controlling hardware or housing. Made of rigid material with a magnetic coating and used for the mass storage and retrieval of data.

Floppy tape
A tape standard that uses drives connecting to an ordinary floppy disk controller.

Flow control
A mechanism that compensates for differences in the flow of data input to and output from a modem or other device.
FM encoding
Frequency modulation encoding. An outdated method of encoding data on the disk surface that uses up half the disk space with timing signals.

Form factor
The physical dimensions of a device. Two devices with the same form factor are physically interchangeable. The IBM PC, XT, and XT Model 286, for example, all use power supplies that are internally different but have exactly the same form factor.

FORMAT.COM
The DOS format program that performs both low- and high-level formatting on floppy disks but only high-level formatting on hard disks.

Formatted capacity
The total number of bytes of data that can fit on a formatted disk. The unformatted capacity is higher because space is lost defining the boundaries between sectors.

Formatting
Preparing a disk so that the computer can read or write to it. Checks the disk for defects and constructs an organizational system to manage information on the disk.

FORTRAN
An acronym for formula translator, a high-level programming language for programs dealing primarily with mathematical formulas and expressions, similar to algebra and used primarily in scientific and technical applications. One of the oldest languages but still widely used because of its compact notation, the many mathematical subroutines available, and the ease with which arrays, matrices, and loops can be handled. FORTRAN was written in 1954 by John Backus at IBM, and the first successful FORTRAN program was executed by Harlan Herrick.

Frame
A data communications term for a block of data with header and trailer information attached. The added information usually includes a frame number, block size data, error-check codes, and start/end indicators.

Freeware
Copyrighted software given away for free by the author. Although it is available for free, the author retains the copyright, which means that you cannot do anything with it that is not expressly allowed by the author. Usually, the author allows people to use the software, but not sell it.

Full duplex
Signal flow in both directions at the same time. In microcomputer communications, also may refer to the suppression of the on-line local echo.

Full-height drive
A drive unit that is 3.25 inches high, 5.75 inches wide, and 8.00 inches deep.

Function keys
Special-purpose keys that can be programmed to perform various operations. Serve many different functions depending on the program being used.
Gas-plasma display
Commonly used in portable systems, a type of display that operates by exciting a gas, usually neon or an argon-neon mixture, through the application of a voltage. When sufficient voltage is applied at the intersection of two electrodes, the gas glows an orange-red. Because gas-plasma displays generate light, they require no backlighting.

Gateway
A node on a network that serves as an entrance to another network. In enterprises, the gateway is the computer that routes the traffic from a workstation to the outside network that is serving the Web pages. In homes, the gateway is the ISP that connects the user to the internet.

In enterprises, the gateway node often acts as a proxy server and a firewall. The gateway is also associated with both a router, which use headers and forwarding tables to determine where packets are sent, and a switch, which provides the actual path for the packet in and out of the gateway.

Giga
A multiplier indicating 1 billion (1,000,000,000) of some unit. Abbreviated as g or G. When used to indicate a number of bytes of memory storage, the multiplier definition changes to 1,073,741,824. One gigabit, for example, equals 1,000,000,000 bits, and one gigabyte equals 1,073,741,824 bytes.

Gigabyte
A unit of information storage equal to 1,073,741,824 bytes.

Global backup
A backup of all information on a hard disk, including the directory tree structure.

Green Book
Green Book is the standard for Compact Disc-Interactive (CD-I). Philips developed CD-I technology for the consumer market, to be connected to a television instead of a computer monitor. CD-I is not a computer system, but a consumer device. CD-I disks require special code and are not compatible with standard CD-ROM. A CD-ROM cannot be played on the CD-I machine, but Red Book audio can be played on CD-I devices.

GUI
An acronym for Graphical User Interface, a type of program interface that allows users to choose commands and functions by pointing to a graphical icon using either a keyboard or pointing device such as a mouse. Windows and OS/2 are popular GUls available for PC systems.

Half duplex
Signal flow in both directions but only one way at a time. In microcomputer communications, may refer to activation of the on-line local echo, which causes the modem to send a copy of the transmitted data to the screen of the sending computer.

Half-height drive
A drive unit that is 1.625 inches high, and either 5.75 or 4.00 inches wide and 4.00 or 8.00 inches deep.

Halftone
Halftoning is a process that uses dithering to simulate a continuous tone image such as a photograph or shaded drawing using various sizes of dots. Newspapers, magazines and many books use halftoning. The human eye will merge the dots to give the impression of gray shades.
Hard disk
A high-capacity disk storage unit characterized by a normally nonremovable rigid substrate media. The platters in a hard disk normally are constructed of aluminum or glass.

Hard error
An error in reading or writing data that is caused by damaged hardware.

Hardware
Physical components that make up a microcomputer, monitor, printer, and so on.

HDLC
High-Level Data Link Control. A standard protocol developed by the International Standards Organization (ISO) for software applications and communicating devices operating in synchronous environments. Defines operations at the link level of communications—for example, the format of data frames exchanged between modems over a phone line.

Head
A small electromagnetic device inside a drive that reads, records, and erases data on the media.

Head actuator
The device that moves read/write heads across a disk drive's platters. Most drives use a stepper-motor or a voice-coil actuator. See drive and head.

Head crash
A (usually) rare occurrence in which a read/write head strikes a platter surface with sufficient force to damage the magnetic medium.

Head parking
A procedure in which a disk drive's read/write heads are moved to an unused track so that they will not damage data in the event of a head crash or other failure. See drive and head.

Head seek
The movement of a drive's read/write heads to a particular track. See also drive and head.

Heat sink
A mass of metal attached to a chip carrier or socket for the purpose of dissipating heat.

Helical scan
A type of recording technology that has vastly increased the capacity of tape drives. Invented for use in broadcast systems and now used in VCRs. Conventional longitudinal recording records a track of data straight across the width of a single-track tape. Helical scan recording packs more data on the tape by positioning the tape at an angle to the recording heads. The heads spin to record diagonal stripes of information on the tape.

Hexadecimal number
A number encoded in base-16, such that digits include the letters A through F as well as the numerals 0 through 9 (for example, 8BF3, which equals 35,827 in base-10).

Hidden file
A file that is not displayed in DOS directory listings because the file's attribute byte holds a special setting.
High density (HD)
An indication of the storage capacity of a floppy drive or disk in which 15 or 18 sectors per track are recorded using MFM encoding.

High-level formatting
Formatting performed by the DOS FORMAT.COM program. Among other things, it creates the root directory and file allocation tables. See also file allocation table.

History file
A file created by utility software to keep track of earlier use of the software. Many backup programs, for example, keep history files describing earlier backup sessions. The program you are using now has a history file that allows you to "back up" to previous topics.

HMA
An acronym for High Memory Area, the first 64K of extended memory which is controlled typically by the HIMEM.SYS device driver. Real mode programs can be loaded into the HMA to conserve conventional memory. Normally DOS 5.0 and higher use the HMA exclusively to reduce the DOS conventional memory footprint.

HPT
High-pressure tin. A PLCC socket that promotes high forces between socket contacts and PLCC contacts for a good connection.

HST
High-speed technology. The USRobotics proprietary high-speed modem-signaling scheme, developed as an interim protocol until the V.32 protocol could be implemented in a cost-effective manner. Incorporates trellis-coded modulation for greater immunity from variable phone-line conditions, and asymmetrical modulation for more efficient use of the phone channel at speeds of 4800 bps and above. The forward channel transmits at either 9600 bps (older designs) or 14400 bps, and the reverse channel transmits at 450 bps. This technique eliminated the need for the V.32 echo-cancellation hardware that was more costly at the time HST was developed. HST also incorporates MNP-compatible error-control procedures adapted to the asymmetrical modulation.

Hz
A mnemonic for hertz, a frequency measurement unit used internationally to indicate one cycle per second.

I/O
Input/output. A circuit path that enables independent communications between the processor and external devices.

IBMBIO.COM
One of the IBM DOS system files required to boot the machine. The first file loaded from disk during the boot. Contains extensions to the ROM BIOS. Called IO.SYS for Microsoft operating systems.

IBMDOS.COM
One of the IBM DOS system files required to boot the machine. Contains the primary DOS routines. Loaded by IBMBIO.COM, it in turns loads COMMAND.COM. Called MSDOS.SYS for Microsoft operating systems.
IC
An acronym for integrated circuit, a complete electronic circuit contained on a single chip. May consist of only a few transistors, capacitors, diodes, or resistors, or thousands of them, and generally is classified according to the complexity of the circuitry and the approximate number of circuits on the chip. SSI (small-scale integration) equals 2 to 10 circuits. MSI (medium-scale integration) equals 10 to 100 circuits. LSI (large-scale integration) equals 100 to 1,000 circuits. VLSI (very-large-scale integration) equals 1,000 to 10,000 circuits. ULSI (ultra-large-scale integration) equals more than 10,000 circuits.

IDE
An acronym for integrated drive electronics. Describes a hard disk with the disk controller circuitry integrated within it. The first IDE drives commonly were called hard cards. Also refers to the ATA interface standard, the standard for attaching hard disk drives to ISA bus IBM-compatible computers. IDE drives typically operate as though they were standard ST-506/412 drives. See also ATA.

Incremental backup
A backup of all files that have changed since the last backup.

Initiator
A device attached to the SCSI bus that sends a command to another device (the target) on the SCSI bus. The SCSI host adapter plugged into the system bus is an example of an SCSI initiator.

Inkjet printer
A type of printer that sprays one or more colors of ink on the paper. Can produce output with quality approaching that of a laser printer at a lower cost.

Input
Data sent to the computer from the keyboard, the telephone, the video camera, another computer, paddles, joysticks, and so on.

Instruction
Program step that tells the computer what to do for a single operation.

Interface
A communications device or protocol that enables one device to communicate with another. Matches the output of one device to the input of the other device.

Interlacing
Interlacing is a method of scanning alternate lines of pixels on a display screen. The odd lines are scanned first from top to bottom and left to right. The electron gun goes back to the top and makes a second pass scanning the even lines. Interlacing requires two scan passes to construct a single image. Because of this additional scanning, interlaced screens are often seen to flicker unless a long persistence phosphor is used in the display.

Interleave ratio
The number of sectors that pass beneath the read/write heads before the next numbered sector arrives. When the interleave ratio is 3:1, for example, a sector is read, two pass by, and then the next is read. A proper interleave ratio, laid down during low-level formatting, enables the disk to transfer information without excessive revolutions due to missed sectors. See sector and head.
Internal command
In DOS, a command contained in COMMAND.COM so that no other file must be loaded in order to perform the command. DIR and COPY are two examples of internal commands.

Internal drive
A disk or tape drive mounted inside one of a computer's disk drive bays (or a hard disk card, which is installed in one of the computer's slots).

Interpreter
A translator program for a high-level language that translates and executes the program at the same time. The program statements that are interpreted remain in their original source language, the way the programmer wrote them—that is, the program does not need to be compiled before execution. Interpreted programs run slower than compiled programs and always must be run with the interpreter loaded in memory.

Interrupt
A suspension of a process, such as the execution of a computer program, caused by an event external to that process and performed in such a way that the process can be resumed. An interrupt can be caused by internal or external conditions such as a signal indicating that a device or program has completed a transfer of data.

Interrupt vector
A pointer in a table that gives the location of a set of instructions that the computer should execute when a particular interrupt occurs.

IO.SYS
One of the MS-DOS system files required to boot the machine. The first file loaded from disk during the boot. Contains extensions to the ROM BIOS. Called IBMBIO.COM in IBM operating systems.

IRQ
An acronym for interrupt request. Physical connections between external hardware devices and the interrupt controllers. When a device such as a floppy controller or a printer needs the attention of the CPU, an IRQ line is used to get the attention of the system to perform a task. On PC and XT IBM-compatible systems, 8 IRQ lines are included, numbered IRQ0 through IRQ7. On the AT and PS/2 systems, 16 IRQ lines are numbered IRQ0 through IRQ15. IRQ lines must be used by only a single adapter in the ISA bus systems, but Micro Channel Architecture (MCA) adapters can share interrupts.

ISDN
An acronym for Integrated Services Digital Network, an international telecommunications standard that enables a communications channel to carry digital data simultaneously with voice and video information.

ISO

ISO 9660
ISO 9660 is an international standard that defines file systems for CD-ROM disks, independent of the operating system. ISO (International Standards Organization) 9660 has two levels. Level one provides for DOS file system compatibility, while Level two allows file names of up to 32 characters.
ISP

Short for Internet Service Provider, a company that provides access to the Internet. For a monthly fee, the service provider gives you a software package, username, password and access phone number. Equipped with a modem and telephone line or a network card and broadband connection, you can then log on to the Internet and browse the World Wide Web and USENET, and send and receive e-mail.

In addition to serving individuals, ISPs also serve large companies, providing a direct connection from the company's networks to the Internet. ISPs themselves are connected to one another through Network Access Points (NAPs).

ISPs are also called IAPs (Internet Access Providers).

J-lead
J-shaped leads on chip carriers. Can be surface-mounted on a PC board or plugged into a socket that then is mounted on a PC board, usually on .050-inch centers.

JEDEC

JPEG or JPG
JPEG is an acronym for the Joint Photographic Experts Group, a lossy data compression standard that was originally designed for still images, but can also compress real-time video (30 frames per second) and animation. Lossy compression permanently discards unnecessary data, resulting in some loss of precision.

Jumper
A small, plastic-covered, metal clip that slips over two pins protruding from a circuit board. Sometimes also called a shunt. When in place, the jumper connects the pins electrically and closes the circuit. By doing so, it connects the two terminals of a switch, turning it on.

Kermit
A protocol designed for transferring files between microcomputers and mainframes. Developed by Frank DaCruz and Bill Catchings, at Columbia University (and named after the talking frog on The Muppet Show). Widely accepted in the academic world. The complete Kermit protocol manual and the source for various versions is available from Kermit Distribution, Columbia University Center for Computing Activities, 612 West 115 Street, New York, NY 10025, (212) 854-3703.

Key disk
In software copy protection, a distribution floppy disk that must be present in a floppy disk drive for an application program to run.

Keyboard macro
A series of keystrokes automatically input when a single key is pressed.

Kilo
A multiplier indicating one thousand (1,000) of some unit. Abbreviated as k or K. When used to indicate a number of bytes of memory storage, the multiplier definition changes to 1,024. One kilobit, for example, equals 1,000 bits, and one kilobyte equals 1,024 bytes.
Kilobyte
A unit of information storage equal to 1,024 bytes.

Landing zone
An unused track on a disk surface on which the read/write heads can land when power is shut off. The place that a parking program or a drive with an autopark mechanism parks the heads. See also head.

LAPM
Link-access procedure for modems, an error-control protocol incorporated in CCITT Recommendation V.42. Like the MNP and HST protocols, uses cyclic redundancy checking (CRC) and retransmission of corrupted data (ARQ) to ensure data reliability.

Laptop computer
A computer system smaller than a briefcase but larger than a notebook, and that usually has a clamshell design in which the keyboard and display are on separate halves of the system, which are hinged together. These systems normally run on battery power.

Laser printer
A type of printer that is a combination of an electrostatic copying machine and a computer printer. The output data from the computer is converted by an interface into a raster feed, similar to the impulses that a TV picture tube receives. The impulses cause the laser beam to scan a small drum that carries a positive electrical charge. Where the laser hits, the drum is discharged. A toner, which also carries a positive charge, then is applied to the drum. This toner, a fine black powder, sticks only to the areas of the drum that have been discharged electrically. As it rotates, the drum deposits the toner on a negatively charged sheet of paper. Another roller then heats and bonds the toner to the page.

Latency
The amount of time required for a disk drive to rotate half of a revolution. Represents the average amount of time to locate a specific sector after the heads have arrived at a specific track. Latency is part of the average access time for a drive.

LCC
Leadless chip carrier. A type of integrated circuit package that has input and output pads rather than leads on its perimeter.

LCD
An acronym for liquid crystal display, a display that uses liquid crystal sealed between two pieces of polarized glass. The polarity of the liquid crystal is changed by an electric current to vary the amount of light that can pass through. Because LCD displays do not generate light, they depend on either the reflection of ambient light or backlighting the screen. The best type of LCD, the active-matrix or thin-film transistor (TFT) LCD, offers fast screen updates and true color capability.

LED
An acronym for light-emitting diode, a semiconductor diode that emits light when a current is passed through it.

LIF
Low insertion force. A type of socket that requires only a minimum of force to insert a chip carrier.

Light pen
A hand-held input device with a light-sensitive probe or stylus, connected to the computer's graphics adapter board by a cable. Used for writing or sketching on-screen or as a pointing device tool for making selections. Unlike mice, not widely supported by software applications.

Local echo
A modem feature that enables the modem to send copies of keyboard commands and transmitted data to the screen. When the modem is in command mode (not on-line to another system), the local echo normally is invoked through an ATE1 command, which causes the modem to display your typed commands. When the modem is on-line to another system, the local echo is invoked by an ATF0 command, which causes the modem to display the data it transmits to the remote system.

**Logical drive**
A drive as named by a DOS drive specifier, such as C: or D:. Under DOS 3.3 or later, a single physical drive can act as several logical drives, each with its own specifier.

**Loopback address**
A loopback address is a special IP number (127.0.0.1) that is designated for the software loopback interface of a machine. The loopback interface has no hardware associated with it, and it is not physically connected to a network.

The loopback interface allows IT professionals to test IP software without worrying about broken or corrupted drivers or hardware.

**Lost clusters**
Clusters that have been marked accidentally as unavailable in the file allocation table even though they belong to no file listed in a directory.

**Low-level formatting**
Formatting that divides tracks into sectors on the platter surfaces. Places sector-identifying information before and after each sector and fills each sector with null data (usually hex F6). Specifies the sector interleave and marks defective tracks by placing invalid checksum figures in each sector on a defective track. See formatting.

**LUN**
An acronym for logical unit number, a number given to a device (a logical unit) attached to a SCSI physical unit and not directly to the SCSI bus. Although as many as eight logical units can be attached to a single physical unit, normally a single logical unit is a built-in part of a single physical unit. A SCSI hard disk, for example, has a built-in SCSI bus adapter that is assigned a physical unit number or SCSI ID, and the controller and drive portions of the hard disk are assigned a logical unit number (usually 0).

**Magnetic domain**
A tiny segment of a track just large enough to hold one of the magnetic flux reversals that encode data on a disk surface.

**Magneto-optical recording**
An erasable optical disk recording technique that uses a laser beam to heat pits on the disk surface to the point at which a magnet can make flux changes.

**Malware**
Short for malicious software, software designed specifically to damage or disrupt a system, such as a virus or a Trojan horse.

**Master partition boot sector**
On hard disks, a one-sector record that gives essential information about the disk and tells the starting locations of the various partitions. Always the first physical sector of the disk.
MCA
An acronym for Micro Channel Architecture. Developed by IBM for the PS/2 line of computers and introduced on April 2, 1987. Features include a 16- or 32-bit bus width and multiple master control. By allowing several processors to arbitrate for resources on a single bus, the MCA is optimized for multitasking, multiprocessor systems. Offers switchless configuration of adapters, which eliminates one of the biggest headaches of installing older adapters.

MCGA
An acronym for MultiColor Graphics Array, a type of PC video display circuit introduced by IBM on April 2, 1987, that supports text and graphics. Text is supported at a maximum resolution of 80x25 characters in 16 colors with a character box of 8x16 pixels. Graphics is supported at a maximum resolution of 320x200 pixels in 256 (from a palette of 262,144) colors or 640x480 pixels in 2 colors. The MCGA outputs an analog signal with a horizontal scanning frequency of 31.5 KHz, and supports analog color or analog monochrome displays.

MCI
MCI is an acronym that stands for Media Control Interface, a device-independent specification for controlling multimedia devices and files. MCI is a part of the multimedia extensions and offers a standard interface set of device control commands, making it easy to program multimedia applications. MCI commands are used for audio recording and playback and animation playback. Videodisk players and other optional devices are controlled by MCI. Device types include CD audio, digital audio tape players, scanners, MIDI sequencers, videotape players or recorder and audio devices that play digitized waveform files. MCI classifies compound and simple device drivers. Compound drivers require a device element (usually a file and a path) during operation. Simple devices do not require a device element for playback.

MDA
An acronym for Monochrome Display Adapter, a type of PC video display adapter introduced by IBM on August 12, 1981, that supports text only. Text is supported at a maximum resolution of 80x25 characters in four colors with a character box of 9x14 pixels. Colors, in this case, indicates black, white, bright white, and underlined. Graphics modes are not supported. The MDA outputs a digital signal with a horizontal scanning frequency of 18.432 KHz, and supports TTL monochrome displays. The IBM MDA also included a parallel printer port.

Medium
The magnetic coating or plating that covers a disk or tape.

Mega
A multiplier indicating 1 million (1,000,000) of some unit. Abbreviated as m or M. When used to indicate a number of bytes of memory storage, the multiplier definition changes to 1,048,576. One megabit, for example, equals 1,000,000 bits, and one megabyte equals 1,048,576 bytes.

Megabyte
A unit of information storage equal to 1,048,576 bytes.

Memory
Any component in a computer system that stores information for future use.

Memory caching
A service provided by extremely fast memory chips that keeps copies of the most recent memory accesses. When the CPU makes a subsequent access, the value is supplied by the fast memory rather than by relatively slow system memory.
Memory-resident program
A program that remains in memory after it has been loaded, consuming memory that otherwise might be used by application software.

Menu software
Utility software that makes a computer easier to use by replacing DOS commands with a series of menu selections.

MFM
Modified Frequency Modulation encoding. A method of encoding data on the surface of a disk. The coding of a bit of data varies by the coding of the preceding bit to preserve clocking information.

MHZ
An abbreviation for megahertz, a unit of measurement for indicating the frequency of one million cycles per second. One hertz (Hz) is equal to one cycle per second. Named after Heinrich R. Hertz, a German physicist who first detected electromagnetic waves in 1883.

MI/MIC
Mode Indicate/Mode Indicate Common, also called forced or manual originate. Provided for installations in which equipment other than the modem does the dialing. In such installations, the modem operates in dumb mode (no auto-dial capability) yet must go off-hook in originate mode to connect with answering modems.

Micro
A prefix indicating one millionth (1/1,000,000 or .000001) of some unit. Abbreviated as u.

Microprocessor
A solid-state central processing unit much like a computer on a chip. An integrated circuit that accepts coded instructions for execution.

Microsecond
A unit of time equal to one millionth (1/1,000,000 or .000001) of a second. Abbreviated as us.

MIDI
An acronym for Musical Instrument Digital Interface, an interface and file format standard for connecting a musical instrument to a microcomputer and storing musical instrument data. Multiple musical instruments can be daisy-chained and played simultaneously with the help of the computer and related software. The various operations of the instruments can be captured, saved, edited, and played back. A MIDI file contains note information, timing (how long a note is held), volume and instrument type for as many as 16 channels. Sequencer programs are used to control MIDI functions such as recording, playback and editing. MIDI files store only note instructions and not actual sound data.

Milli
A prefix indicating one thousandth (1/1,000 or .001) of some unit. Abbreviated as m.

Millisecond
A unit of time equal to one thousandth (1/1,000 or .001) of a second. Abbreviated as ms.
MIPS
An acronym for million instructions per second. Refers to the average number of machine-language instructions a computer can perform or execute in one second. Because different processors can perform different functions in a single instruction, MIPS should be used only as a general measure of performance among different types of computers.

Mnemonic
A mnemonic is an abbreviated name for something, which is used in a manner similar to an acronym. Computer processor instructions are often abbreviated with a mnemonic such as JMP (Jump), CLR (Clear), STO (Store), INIT (Initialize). A mnemonic name for an instruction or an operation makes it easy to remember and convenient to use.

MNP
Microcom Networking Protocol. Asynchronous error-control and data-compression protocols developed by Microcom, Inc. and now in the public domain. Ensure error-free transmission through error detection (CRC) and retransmission of errored frames. MNP Levels 1 through 4 cover error control and have been incorporated into CCITT Recommendation V.42. MNP Level 5 includes data compression but is eclipsed in superiority by V.42bis, an international standard that is more efficient. Most high-speed modems will connect with MNP Level 5 if V.42bis is unavailable.

MO
MO is an acronym for Magneto Optical. MO drives utilize both magnetic and optical storage properties. MO technology is erasable and recordable, as opposed to CD-ROM (Read Only) and WORM (Write Once) drives. MO uses laser and magnetic field technology to record and erase data. The laser is used to heat an area on the disk which can then be recorded magnetically. MO drives are most commonly used in removable storage applications.

Modem
Modulator-demodulator. A device that converts electrical signals from a computer into an audio form transmittable over telephone lines, or vice versa. Modulates, or transforms, digital signals from a computer into the analog form that can be carried successfully on a phone line; also demodulates signals received from the phone line back to digital signals before passing them to the receiving computer.

Module
An assembly that contains a complete circuit or subcircuit.

Morphing
Morphing is a pseudo slang term for metamorphosis, the transformation of one object into another. Morphing is performed by software that analyzes two images and creates several in-between images such that one image appears to become the other. Originally requiring expensive, high powered computer hardware, morphing can now be done on PC systems with sophisticated software now available.

MOS
An acronym for Metal-Oxide Semiconductor. Refers to the three layers used in forming the gate structure of a field-effect transistor (FET). MOS circuits offer low power dissipation and enable transistors to be jammed close together before a critical heat problem arises. PMOS, the oldest type of MOS circuit, is a silicon-gate P-channel MOS process that uses currents made up of positive charges. NMOS is a silicon-gate N-channel MOS process that uses currents made up of negative charges and is at least twice as fast as PMOS. CMOS, Complementary MOS, is nearly immune to noise, runs off almost any power supply, and is an extremely low-power circuit technique.
Motherboard
The main circuit board in the computer. Also called planar, system board, or backplane.

MPEG
MPEG is an acronym for the Moving Pictures Experts Group, a lossy data compression standard for motion-video and audio. Lossy compression permanently discards unnecessary data, resulting in some loss of precision. MPEG compression produces about a 50% volume reduction in file size.

MSDOS.SYS
One of the MS-DOS system files required to boot the machine. Contains the primary DOS routines. Loaded by IO.SYS, it in turns loads COMMAND.COM. Called IBMCOM.COM in IBM operating systems.

MTBF
An acronym for mean time between failure, a statistically derived measure of the probable time a device will continue to operate before a hardware failure occurs, usually given in hours. Because no standard technique exists for measuring MTBF, a device from one manufacturer can be significantly more or significantly less reliable than a device with the same MTBF rating from another manufacturer.

MTTR
An acronym for mean time to repair, a measure of the probable time it will take a technician to service or repair a specific device, usually given in hours.

Multimedia
Multimedia is the integration of sound, graphic images, animation, motion video and/or text in one environment on a computer. It is a set of hardware and software technologies that are rapidly changing and enhancing the computing environment.

Multitask
Run several programs simultaneously.

Multiuser system
A system in which several computer terminals share the same central processing unit (CPU).

Nano
A prefix indicating one billionth (1/1,000,000,000 or .000000001) of some unit. Abbreviated as n.

Nanosecond
A unit of time equal to one billionth (1/1,000,000,000 or .000000001) of a second. Abbreviated as ns.

NAT
Short for Network Address Translation, an Internet standard that enables a local-area network (LAN) to use one set of IP addresses for internal traffic and a second set of addresses for external traffic. A NAT box located where the LAN meets the Internet makes all necessary IP address translations.

NAT serves three main purposes:

• Provides a type of firewall by hiding internal IP addresses
• Enables a company to use more internal IP addresses. Since they're used internally only, there's no possibility of conflict with IP addresses used by other companies and organizations.
• Allows a company to combine multiple ISDN connections into a single Internet connection.
Network
A system in which a number of independent computers are linked in order to share data and peripherals, such as hard disks and printers.

Nonvolatile memory (NVRAM)
Random-access memory whose data is retained when power is turned off. Sometimes nonvolatile RAM is retained without any power whatsoever, as in EEPROM or flash memory devices. In other cases the memory is maintained by a small battery. Nonvolatile RAM that is battery maintained is sometimes also called CMOS memory. CMOS NVRAM is used in IBM-compatible systems to store configuration information. True NVRAM often is used in intelligent modems to store a user-defined default configuration loaded into normal modem RAM at power-up.

Nonvolatile RAM disk
A RAM disk powered by a battery supply so that it continues to hold its data during a power outage.

NTSC
An acronym for the National Television Standards Committee, which governs the standard for television and video playback and recording in the United States. The NTSC was originally organized in 1941 when TV broadcasting first began on a wide scale. The original standard they created was called RS-170A, which is now simply referred to as NTSC. The NTSC standard provides for 525 scan lines of resolution and is transmitted at 60 half-frames per second. It is an interlaced signal, which means that it scans every other line each time the screen is refreshed. The signal is generated as a composite of red, green, and blue signals for color and includes an FM frequency for audio and a signal for stereo. Twenty years later, higher standards were adopted in Europe with the PAL and SECAM systems, both incompatible with the NTSC standard of North America. NTSC is also called composite video.

Null modem
A serial cable wired so that two data terminal equipment (DTE) devices, such as personal computers, or two data communication equipment (DCE) devices, such as modems or mice, can be connected. Also sometimes called a modem-eliminator. To make a null-modem cable with DB-25 connectors, you wire these pins together: 1-1, 2-3, 3-2, 4-5, 5-4, 6-20, 20-6, and 7-7.

Object hierarchy
Object hierarchy occurs in a graphical program when two or more objects are linked and one object's movement is dependent on the other object. This is known as a parent-child hierarchy. In an example using a human figure, the fingers would be child objects to the hand, which is a child object to the arm, which is a child to the shoulder and so on. Object hierarchy provides much control for an animator in moving complex figures.

OCR
An acronym for optical character recognition, an information-processing technology that converts human-readable text into computer data. Usually a scanner is used to read the text on a page, and OCR software converts the images to characters.

OEM
An acronym for original equipment manufacturer, any manufacturer that sells its product to a reseller. Usually refers to the original manufacturer of a particular device or component. Most COMPAQ hard disks, for example, are made by Conner Peripherals, who is considered the OEM.
OLE
An acronym for Object Linking and Embedding, an enhancement to the original Dynamic Data Exchange (DDE) protocol that allows you to embed or link data created in one application in a document created in another application, and subsequently edit that data directly from the final document.

On-line fallback
A feature that enables high-speed error-control modems to monitor line quality and fall back to the next lower speed if line quality degrades. The modems fall forward as line quality improves.

Operating system
A collection of programs for operating the computer. Operating systems perform housekeeping tasks such as input and output between the computer and peripherals and accepting and interpreting information from the keyboard. DOS and OS/2 are examples of popular operating systems.

Optical disk
A disk that encodes data as a series of reflective pits that are read (and sometimes written) by a laser beam.

Orange Book
Orange Book is the standard for recordable compact disks (like CD-ROM, but recordable instead of Read Only). Recordable compact disks are called CD-R and are becoming popular with the widespread use of multimedia. Publishers use CD-R when transferring paper books to electronic publishing tools. Part of the Orange Book standard defines rewritable Magneto Optical disks and another section defines optical Write Once Read Many (WORM) disks. Publishers usually record a master onto a CD-R WORM disk prior to mass distribution. Titles recorded on WORM can be played by any standard CD-ROM drive (Yellow Book).

Originate mode
A state in which the modem transmits at the predefined low frequency of the communications channel and receives at the high frequency. The transmit/receive frequencies are the reverse of the called modem, which is in answer mode.

OS/2
A universal operating system developed through a joint effort by IBM and Microsoft Corporation. OS/2 was intended as the successor to DOS (developed also by Microsoft and IBM) and Windows. OS/2 uses the protected mode operation of the processor to expand memory from 1M to 16M and to support fast, efficient multitasking. The OS/2 Presentation Manager, an integral part of the system, is a graphical interface similar to Microsoft Windows and the Apple Macintosh system. The latest version runs DOS, Windows, and OS/2-specific software.

Output
Information processed by the computer; or the act of sending that information to a mass storage device such as a video display, a printer, or a modem.

Overlay
Part of a program that is loaded into memory only when it is required.

Overrun
A situation in which data moves from one device faster than a second device can accept it.
Overwrite
To write data on top of existing data, thus erasing the existing data.

Package
A device that includes a chip mounted on a carrier and sealed.

PAL
An acronym for phase alternating line system. Invented in 1961 and refers to a system of TV broadcasting used in England and other European countries. With its 625-line picture delivered at 25 frames/second, PAL provides a better image and an improved color transmission over the NTSC system used in North America. PAL also can stand for Programmable Array Logic, a type of chip that has logic gates specified by a device programmer.

Palmtop computer
A computer system smaller than a notebook that is designed so that it can be held in one hand while being operated by the other.

Parallel
A method of transferring data characters in which the bits travel down parallel electrical paths simultaneously; for example, eight paths for eight-bit characters. Data is stored in computers in parallel form but may be converted to serial form for certain operations.

Parity
A method of error checking in which an extra bit is sent to the receiving device to indicate whether an even or odd number of binary 1 bits were transmitted. The receiving unit compares the received information with this bit and can obtain a reasonable judgment about the validity of the character. The same type of parity (even or odd) must be used by two communicating computers, or both may omit parity. When parity is used, a parity bit is added to each transmitted character. The bit's value is 0 or 1, to make the total number of 1s in the character even or odd, depending on which type of parity is used.

Park program
A program that executes a seek to the highest cylinder or just past the highest cylinder of a drive so that the potential of data loss is minimized if the drive is moved. See head parking.

Partition
A section of a hard disk devoted to a particular operating system. Most hard disks have only one partition, devoted to DOS. A hard disk can have as many as four partitions, each occupied by a different operating system. DOS V3.3 or higher can occupy two of these four partitions.

Pascal
A high-level programming language named for the French mathematician Blaise Pascal (1623-1662). Developed in the early 1970s by Niklaus Wirth for teaching programming and designed to support the concepts of structured programming. Easy to learn and often the first language taught in schools.

Pentium
The latests in a series of CPUs built by Intel; now being produced at under a million units per year. Intel began high-capacity production in late 1995. The 60+-Mhz Pentium was the first true 64-bit system.

Peripheral
Any piece of equipment used in computer systems that is an attachment to the computer. Disk drives, terminals, and printers are all examples of peripherals.
PGA
Pin-grid array. A chip package that has a large number of pins on the bottom designed for socket mounting. Also can mean Professional Graphics Adapter, a limited-production, high-resolution graphics card for XT and AT systems from IBM.

Photo CD
Photo CD is a technology developed by Eastman Kodak and Philips that provides for storing photographic images from 35mm film on a CD-R recordable compact disk. Images stored on the Photo CD may have resolutions as high as 2,048 x 3,072 pixels. Up to 100 true-color images (24-bit color) can be stored on one disk. Photo CD images are created by scanning 35mm film and digitally recording the images on compact disks (CDs). The digitized images are indexed (given a 4-digit code) and thumbnails of each image on the disk are shown on the front of the case along with its index number. Multi-session capability allows several rolls of 35mm film to be added to a single disk on different occasions.

Physical drive
A single disk drive. DOS defines logical drives, which are given a specifier, such as C: or D:. A single physical drive may be divided into multiple logical drives. Conversely, special software can span a single logical drive across two physical drives.

PIF
An acronym for Program Information File, a file that contains information about a non-Windows application specifying optimum settings for running the program under Windows.

Pixel
A mnemonic term meaning picture element. Any of the tiny elements that form a picture on a video display screen. Also called a pel.

Planar board
A term equivalent to motherboard, used by IBM in some of its literature.

Plated media
Hard disk platters plated with a form of thin metal film media on which data is recorded.

Platter
A disk contained in a hard disk drive. Most drives have two or more platters, each with data recorded on both sides.

PLCC

Port
Plug or socket that enables an external device such as a printer to be attached to the adapter card in the computer. Also a logical address used by a microprocessor for communications between itself and various devices.

Port address
One of a system of addresses used by the computer to access devices such as disk drives or printer ports. You may need to specify an unused port address when installing any adapter boards in a system unit.
Portable computer
A computer system smaller than a transportable system, but larger than a laptop system. Most portable systems conform to the lunchbox style popularized by COMPAQ, or the briefcase style popularized by IBM, each with a fold-down (removable) keyboard and built-in display. These systems characteristically run on AC power and not on batteries, include several expansion slots, and can be as powerful as full-blown desktop systems.

POS
An acronym for Programmable Option Select. The Micro Channel Architecture’s POS eliminates switches and jumpers from the system board and adapters by replacing them with programmable registers. Automatic configuration routines store the POS data in a battery-powered CMOS memory for system configuration and operations. The configuration utilities rely on adapter description (ADF) files that contain the setup data for each card. See MCA.

POST
Power-On Self Test. A series of tests run by the computer at power-on. Most computers scan and test many of their circuits and sound a beep from the internal speaker if this initial test indicates proper system performance.

PostScript
A page-description language developed primarily by John Warnock, of Adobe Systems, for converting and moving data to the laser-printed page. Instead of using the standard method of transmitting graphics or character information to a printer, telling it where to place dots one-by-one on a page, PostScript provides a way for the laser printer to interpret mathematically a full page of shapes and curves.

Power supply
An electrical/electronic circuit that supplies all operating voltage and current to the computer system.

Presentation Manager
The graphical, icon- and window-based software interface offered with IBM’s OS/2 operating system.

Primary partition
An ordinary, single-volume bootable partition. See also extended partition.

Processor speed
The clock rate at which a microprocessor processes data. The original IBM PC, for example, operates at 4.77 MHz (4.77 million cycles per second).

Program
A set of instructions or steps telling the computer how to handle a problem or task.

PROM
Programmable read-only memory. A type of memory chip that can be programmed to store information permanently--information that cannot be erased.

Proprietary
Anything invented by a company and not used by any other company. Especially applies to cases in which the inventing company goes to lengths to hide the specifications of the new invention. The opposite of standard.
Protected mode
A mode available in all Intel 80286- or 80386-compatible processors. In this mode, memory addressing is extended to 16 or 4096 megabytes, and restricted protection levels can be set to trap software crashes and control the system.

Protocol
A system of rules and procedures governing communications between two or more devices. Protocols vary, but communicating devices must follow the same protocol in order to exchange data. The data format, readiness to receive or send, error detection, and error correction are some of the operations that may be defined in protocols.

Proxy
A server that sits between a client application, such as a Web browser, and a real server. It intercepts all requests to the real server to see if it can fulfill the requests itself. If not, it forwards the request to the real server.

PUN
An acronym for physical unit number, a term used to describe a device attached directly to the SCSI bus. Also known as a SCSI ID. As many as eight SCSI devices can be attached to a single SCSI bus, and each must have a unique PUN or ID assigned from 7 to 0. Normally the SCSI host adapter is assigned the highest-priority ID, which is 7. A bootable hard disk is assigned an ID of 6, and other nonbootable drives are assigned lower priorities.

QAM
An acronym for quadrature amplitude modulation, a modulation technique used by high-speed modems that combines both phase and amplitude modulation. This technique enables multiple bits to be encoded in a single time interval. The V.32bis standard-codes six data bits plus an additional trellis coding bit for each signal change. An individual signal is evaluated with respect to phase and amplitude compared to the carrier wave. A plot of all possible QAM signal points is referred to as the signal constellation pattern. The V.32bis constellation pattern has 128 discrete signal points.

QIC
Quarter-Inch Committee. An industry association that sets hardware and software standards for tape-backup units that use quarter-inch-wide tapes.

QWERTY keyboard
The standard typewriter or computer keyboard, with the characters Q, W, E, R, T, and Y on the top row of alpha keys. Because of the haphazard placement of characters, this keyboard can hinder fast typing.

Rails
Plastic strips attached to the sides of disk drives mounted in IBM ATs and compatibles so that the drives can slide into place. These rails fit into channels in the side of each disk drive bay position.

RAM
An acronym for random-access memory, all memory accessible at any instant (randomly) by a microprocessor.
RAM disk
A phantom disk drive in which a section of system memory (RAM) is set aside to hold data, just as though it were a number of disk sectors. To DOS, a RAM disk looks like and functions like any other drive.

Random-access file
A file in which all data elements (or records) are of equal length and written in the file end to end, without delimiting characters between. Any element (or record) in the file can be found directly by calculating the record's offset in the file.

Read-only file
A file whose attribute setting in the file's directory entry tells DOS not to allow software to write into or over the file.

Read/write head
A tiny magnet that reads and writes data on a disk track.

Real mode
A mode available in all Intel 8086-compatible processors that enables compatibility with the original 8086. In this mode, memory addressing is limited to one megabyte.

Real time
When something is recorded or processed as it is happening in the outside world.

Red Book
Red Book is more commonly known as Compact Disc Digital Audio (CD-DA) and is one of four compact disk standards. Red Book got its name from the color of the manual used to describe the CD Audio specifications. The Red Book audio standard requires that digital audio is sampled at a 44.1KHz sample rate using 16 bits for each sample. This is the standard used by audio CDs and many CD ROMs. Sample rates this high require enormous amounts of disk space.

Refresh cycle
A cycle in which the computer accesses all memory locations stored by dynamic RAM chips so that the information remains intact. Dynamic RAM chips must be accessed several times a second, or else the information fades.

Register
Storage area in memory having a specified storage capacity, such as a bit, a byte, or a computer word, and intended for a special purpose.

Remote digital loopback
A test that checks the phone link and a remote modem's transmitter and receiver. Data entered from the keyboard is transmitted from the initiating modem, received by the remote modem's receiver, looped through its transmitter, and returned to the local screen for verification.

Remote echo
A copy of the data received by the remote system, returned to the sending system, and displayed on-screen. A function of the remote system.

Resolution
A reference to the size of the pixels used in graphics. In medium-resolution graphics, pixels are large. In high-resolution graphics, pixels are small.
RFI
An acronym for Radio Frequency Interference, a high frequency signal radiated by improperly shielded conductors, particularly when signal path lengths are comparable to or longer than the signal wavelengths. The Federal Communications Commission now regulates RFI in computer equipment sold in the US under FCC Regulations Part 15, Subpart J.

RISC
An acronym for Reduced Instruction Set Computer, as differentiated from CISC, Complex Instruction Set Computer. RISC processors have simple instruction sets requiring only one or a few execution cycles. These simple instructions can be utilized more effectively than CISC systems with appropriately designed software, resulting in faster operations.

RLL
1) An acronym for Run-Length Limited, a type of encoding that derives its name from the fact that the techniques used limit the distance (run length) between magnetic flux reversals on the disk platter. Several types of RLL encoding techniques exist, although only two are commonly used. (1,7)RLL encoding increases storage capacity by about 30 percent over MFM encoding and is most popular in the very highest capacity drives due to a better window margin, while (2,7)RLL encoding increases storage capacity by 50 percent over MFM encoding and is used in the majority of RLL implementations. Most IDE, ESDI, and SCSI hard disks use one of these forms of RLL encoding.

2) An acronym for Run length limited, a data encoding scheme which guarantees that there is some maximum period between signal transitions whatever the data. In this sense, RLL is roughly synonymous with self clocking. Nearly all serial recording is done using some form of RLL code, however the term is usually reserved for those more sophisticated group codes which allow comparatively long maximum runs between transitions, but also guarantee some minimum run length of at least two code bit periods between transitions, allowing higher storage densities.

RMA number
Return-merchandise authorization number. A number given to you by a vendor when you arrange to return an item for repairs. Used to track the item and the repair.

ROM
An acronym for read-only memory, a type of memory that has values permanently or semi-permanently burned in. These locations are used to hold important programs or data that must be available to the computer when the power initially is turned on.

ROM BIOS
An acronym for Read Only Memory-Basic Input Output System. A BIOS encoded in a form of read-only memory for protection. Often applied to important start-up programs that must be present in a system for it to operate.

Root directory
The main directory of any hard or floppy disk. Has a fixed size and location for a particular disk volume and cannot be resized dynamically the way subdirectories can.

Routine
Set of frequently used instructions. May be considered as a subdivision of a program with two or more instructions that are related functionally.
RS-232
An interface introduced in August 1969 by the Electronic Industries Association. The RS-232 interface standard provides an electrical description for connecting peripheral devices to PCs.

S-Video (Y/C)
Y/C video is a video signal in which the luminance and chrominance (Y/C) components are kept separate, providing greater control and quality of each image. The luminance (Y) channel controls light intensity. The greater the luminance, the lighter the color. Chrominance (C) contains hue (color) and saturation (depth) information on an image. Examples of Y/C (S-Video) include S-VHS (Super-VHS) and Hi8 (High band 8mm) video.

Scratch disk
A disk that contains no useful information and can be used as a test disk. IBM has a routine on the Advanced Diagnostics disks that creates a specially formatted scratch disk to be used for testing floppy drives.

SCSI
An acronym for Small Computer System Interface, a standard originally developed by Shugart Associates (then called SASI for Shugart Associates System Interface) and later approved by ANSI in 1986. Uses a 50-pin connector (or 68-pin connector) and permits multiple devices (up to eight including the host) to be connected in daisy-chain fashion.

SDLC
Synchronous Data Link Control. A protocol developed by IBM for software applications and communicating devices operation in IBM's Systems Network Architecture (SNA). Defines operations at the link level of communications; for example, the format of data frames exchanged between modems over a phone line.

SECAM
A mnemonic term for sequential and memory. Refers to a system of TV broadcasting used in France and in a modified form in the USSR. Uses an 819-line picture that provides a better resolution than the (British) PAL 625-line and (U.S.) NTSC 525-line formats.

Sector
A section of one track, defined with identification markings and an identification number. Most sectors hold 512 bytes of data.

Security software
Utility software that uses a system of passwords and other devices to restrict an individual’s access to subdirectories and files.

Seek time
The amount of time required for a disk drive to move the heads across one-third of the total number of cylinders. Represents the average time it takes to move the heads from one cylinder to another randomly selected cylinder. Seek time is a part of the average access time for a drive. See head seek.

Semiconductor
A substance, such as germanium or silicon, whose conductivity is poor at low temperatures but is improved by minute additions of certain substances or by the application of heat, light, or voltage. Depending on the temperature and pressure, a semiconductor can control a flow of electricity. Semiconductors are the basis of modern electronic-circuit technology.
Sequencer
A sequencer is a software program that controls MIDI (Musical Instrument Digital Interface) file messages and keeps track of music timing. Since MIDI files store note instructions instead of actual sounds, a sequencer is needed to play, record and edit MIDI sounds. Sequencer programs allow for recording and playback of MIDI files by storing the instrument, the note pitch (frequency), the duration in real time that each note is held and the loudness (amplitude) of each musical or sound effect note.

Sequential file
A file in which varying-length data elements are recorded end to end, with delimiting characters placed between each element. To find a particular element, you must read the whole file up to that element.

Serial
The transfer of data characters one bit at a time, sequentially, using a single electrical path.

Servo data
Magnetic markings written on disk platters to guide the read/write heads in drives that use voice-coil actuators.

Session (Single or Multi-Session)
A term used in CD-ROM recording to describe a recording event. In a single session, data is recorded on a CD-ROM disk and an index is created. If additional space is left on the disk, another session can be used to record additional files along with another index. The original index cannot be updated because recordable CD-ROM drives are normally Write Once Read Many (WORM) type drives. Many CD-ROM drives do not expect additional recording sessions and therefore will be unable to read the additional session data on the disk. The advent of Kodak's Photo CD propelled the desire for multisession CD-ROM XA (extended architecture) drives. The first generation of XA drives were capable of single session reads only. Multi-session CD-ROM XA drives will read all the indices created when images are recorded many times on the same CD-ROM XA drive.

Settling time
The time required for read/write heads to stop vibrating after they have been moved to a new track.

Shadow ROM
A copy of a system's slower access ROM BIOS placed in faster access RAM, usually during the start-up or boot procedure. This setup enables the system to access BIOS code without the penalty of additional wait states required by the slower ROM chips.

Shell
The generic name of any user interface software. COMMAND.COM is the standard shell for DOS. OS/2 comes with three shells: a DOS command shell, an OS/2 command shell, and the OS/2 Presentation Manager, a graphical shell. Explorer is the graphical shell for Windows 9x and Windows NT/2000.

Shock rating
A rating (usually expressed in G force units) of how much shock a disk drive can sustain without damage. Usually two different specifications exist for a drive powered on or off.

SIMM
Single in-line memory module. An array of memory chips on a small PC board with a single row of I/O contacts.
Single-ended
An electrical signaling method where a single line is used referenced to a ground path common to other signals. In a single-ended bus intended for moderately long distances there is commonly one ground line between groups of signal lines to provide some resistance to signal cross-talk. Single-ended signals only require one driver or receiver pin per signal, plus one ground pin per group of signals. Single-ended signals are vulnerable to common mode noise and cross talk, but are much less expensive than differential signaling methods.

SIP
Single In-line Package. A DIP-like package with only one row of leads.

Skinny dip
Twenty-four- and 28-position DIP devices with .300-inch row-to-row centerlines.

SMPTE Time Code
SMPTE is an acronym for the Society of Motion Picture and Television Engineers. The SMPTE time code is a standard used to identify individual video frames in the video editing process. SMPTE time code controls such functions as play, record, rewind and forward of video tapes. SMPTE time code displays video in terms of hours, minutes, seconds and frames for accurate video editing.

SODIMM
Small-order dual in-line memory module. An array of memory chips on a small PC board with 2 rows of I/O contacts, used in laptop computers.

SO-J
Small Outline J-lead. A small DIP package with J-shaped leads for surface mounting or socketing.

Soft error
An error in reading or writing data that occurs sporadically, usually because of a transient problem such as a power fluctuation.

Software
A series of instructions loaded in the computer’s memory that instructs the computer in how to accomplish a problem or task.

Spindle
The central post on which a disk drive’s platters are mounted.

Spyware
Any software that covertly gathers user information through the user’s Internet connection without his or her knowledge, usually for advertising purposes. Spyware applications are typically bundled as a hidden component of freeware or shareware programs that can be downloaded from the Internet; however, it should be noted that the majority of shareware and freeware applications do not come with spyware. Once installed, the spyware monitors user activity on the Internet and transmits that information in the background to someone else. Spyware can also gather information about e-mail addresses and even passwords and credit card numbers.

SQL
An acronym for structured query language. A standard relational database language used especially on midrange and mainframe computers.
ST-506/412
A hard disk interface invented by Seagate Technology and introduced in 1980 with the ST-506 5M hard drive. The ST-506 interface requires that the read/write head be stepped or moved across the disk one track at a time by carefully timed pulses. Because these pulses cause the read/write head’s stepper motor to advance a notch, they cannot be sent faster than the disk drive can move the heads. The ST-412 interface introduced with the ST-412 10M drive adds buffered seeking, which eliminates this problem. Instead of requiring the controller to slow the pulse rate to whatever the mechanism can handle, ST-412 simply counts the pulses as they come in and then decides how far to step the head to move the required number of tracks. ST-506/412 was formerly the interface of choice for IBM-compatible systems but has since been superseded by the ESDI, IDE, and SCSI interfaces.

Standby power supply
A backup power supply that quickly switches into operation during a power outage.

Start/stop bits
The signaling bits attached to a character before the character is transmitted during asynchronous transmission.

Starting cluster
The number of the first cluster occupied by a file. Listed in the directory entry of every file.

Stepper motor actuator
An assembly that moves disk drive read/write heads across platters by a sequence of small partial turns of a stepper motor.

Storage
Device or medium on or in which data can be entered or held, and retrieved at a later time.
Synonymous with memory.

Streaming
In tape backup, a condition in which data is transferred from the hard disk as quickly as the tape drive can record the data so that the drive does not start and stop or waste tape.

String
A sequence of characters composed of both alphabetical characters and numerals treated as a set in a program.

Subnet mask
Used to determine what subnet an IP address belongs to. An IP address has two components, the network address and the host address. Subnetting enables the network administrator to further divide the host part of the address into two or more subnets.

Subdirectory
A directory listed in another directory. Subdirectories themselves exist as files.

Subroutine
A segment of a program that can be executed by a single call. Also called program module.

Surface mount
Chip carriers and sockets designed to mount to the surface of a PC board. See chip carrier.
Surge protector
A device in the power line that feeds the computer, that provides minimal protection against voltage
spikes and other transients.

Synchronous communication
A form of communication in which blocks of data are sent at strictly timed intervals. Because the timing
is uniform, no start or stop bits are required. Compare with asynchronous communication. Some
mainframes support only synchronous communications unless a synchronous adapter and appropriate
software have been installed.

System crash
A situation in which the computer freezes up and refuses to proceed without rebooting. Usually caused
by faulty software. Unlike a hard disk crash, no permanent physical damage occurs.

System files
The two hidden DOS files IBMBIO.COM / IO.SYS and IBMDOS.COM / MSDOS.SYS; they represent
the interface between the BIOS and DOS (IBMBIO) and the interface between DOS and other
applications (IBMDOS).

System integrator
A computer consultant or vendor who tests available products and combines them into highly optimized
systems.

Target
A device attached to a SCSI bus that receives and processes commands sent from another device (the
initiator) on the SCSI bus. A SCSI hard disk is an example of a target.

TCM
An acronym for trellis-coded modulation, an error-detection and correction technique employed by
high-speed modems to enable higher-speed transmissions that are more resistant to line
impairments. In TCM encoding, the first two data bits of an encoded group are used to generate a third
TCM bit that is added to the group. For example, in V.32bis, the first two bits of a 6-bit group are used to generate the TCM bit, which then is placed as the first bit of a new 7-bit group. By
reversing the encoding at the other end, the receiving modem can determine whether the received
group is valid.

Temporary backup
A second copy of a work file, usually having the extension BAK. Created by application software so that
you easily can return to a previous version of your work. See backup.

Temporary file
A file temporarily (and usually invisibly) created by a program for its own use.

Tera
A multiplier indicating 1 trillion (1,000,000,000,000) of some unit. Abbreviated as t or T. When used to
indicate a number of bytes of memory storage, the multiplier definition changes to
1,099,511,627,776. One terabit, for example, equals 1,000,000,000,000 bits, and one terabyte equals
1,099,511,627,776 bytes.

Terabyte
A unit of information storage equal to 1,099,511,627,776 bytes.
Terminal
A device whose keyboard and display are used for sending and receiving data over a communications link. Differs from a microcomputer in that it has no internal processing capabilities. Used to enter data into or retrieve processed data from a system or network.

Terminal mode
An operational mode required for microcomputers to transmit data. In terminal mode, the computer acts as though it were a standard terminal such as a teletypewriter rather than a data processor. Keyboard entries go directly to the modem, whether the entry is a modem command or data to be transmitted over the phone lines. Received data is output directly to the screen. The more popular communications software products control terminal mode and enable more complex operations, including file transmission and saving received files.

Terminator
A piece of hardware that must be attached to both ends of an electrical bus. Functions to prevent the reflection or echoing of signals that reach the ends of the bus and to ensure that the correct impedance load is placed on the driver circuits on the bus.

Thin-film media
Hard disk platters that have a thin film (usually 3 millionths of an inch) of medium deposited on the aluminum substrate through a sputtering or plating process.

Through-hole
Chip carriers and sockets equipped with leads that extend through holes in a PC board. See chip carrier.

Throughput
The amount of user data transmitted per second without the overhead of protocol information such as start and stop bits or frame headers and trailers.

TIFF
An acronym for Tagged Image File Format, a way of storing and exchanging digital image data. Developed by Aldus Corporation, Microsoft Corporation, and major scanner vendors to help link scanned images with the popular desktop publishing applications. Supports three main types of image data: black-and-white data, halftones or dithered data, and gray-scale data.

Token ring
A type of local area network in which the workstations relay a packet of data called a token in a logical ring configuration. When a station wants to transmit, it takes possession of the token, attaches its data, then frees the token after the data has made a complete circuit of the electrical ring. IBM's token ring system is a standard network hardware implementation supported by many manufacturers. Because of the token-passing scheme, access to the network is controlled, unlike the EtherNet system, in which collisions of data can occur, wasting time. The token ring network also uses twisted-pair wiring.

TPI
Tracks per inch. Used as a measurement of magnetic track density. Standard 51/4-inch 360K floppy disks have a density of 48 TPI, and the 1.2M disks have a 96-TPI density. All 31/2-inch disks have a 135.4667-TPI density, and hard disks can have densities greater than 3,000 TPI.

Track
One of the many concentric circles that hold data on a disk surface. Consists of a single line of magnetic flux changes and is divided into some number of 512-byte sectors.
Track density
Expressed as Tracks Per Inch (TPI), track density defines how many tracks are recorded in one inch of space measured radially from the center of the disk. Sometimes also called radial density.

Track-to-track seek time
The time required for read/write heads to move between adjacent tracks.

Transportable computer
A computer system larger than a portable system, and similar in size and shape to a portable sewing machine. Most transportables conform to a design similar to the original COMPAQ portable, with a built-in CRT display. These systems are characteristically very heavy, and run only on AC power. Because of advances primarily in LCD and plasma-display technology, these systems are largely obsolete and have been replaced by portable systems.

Troubleshooting
The task of determining the cause of a problem.

True-Color Images
True-color images are also called 24-bit color images since each pixel is represented by 24 bits of data, allowing for 16.7 million colors. The number of colors possible is based on the number of bits used to represent the color. If 8-bits are used, there are 256 possible color values (2 to the 8th power). To obtain 16.7 million colors, each of the primary colors (red, green and blue) is represented by 8-bits per pixel, which allows for 256 possible shades for each of the primary red, green and blue colors or 256x256x256 = 16.7 million total colors.

TSR
An acronym for terminate-and-stay-resident, a program that remains in memory after being loaded. Because they remain in memory, TSR programs can be reactivated by a predefined keystroke sequence or other operation while another program is active. Usually called resident programs.

TTL
An acronym for transistor-to-transistor logic. Digital signals often are called TTL signals. A TTL display is a monitor that accepts digital input at standardized signal voltage levels.

Tweens
Tweens are the name given to a series of animation or video frames between the key frames. When one object is transformed (morphed) into another, the initial object and the final object are set on the computer. Tweens are the frames that transpose the first object into the final image.

Twisted pair
A type of wire in which two small insulated copper wires are wrapped or twisted around each other to minimize interference from other wires in the cable. Two types of twisted-pair cables are available: unshielded and shielded. Unshielded twisted-pair wiring commonly is used in telephone cables and provides little protection against interference. Shielded twisted-pair wiring is used in some networks or any application in which immunity from electrical interference is more important. Twisted-pair wire is easier to use with than coaxial cable and is cheaper as well.

UART
An acronym for Universal Asynchronous Receiver Transmitter, a chip device that controls the RS-232 serial port in a PC-compatible system. Originally developed by National Semiconductor, several UART versions are in PC-compatible systems: the 8250B is used in PC- or XT-class systems, and the 16450 and 16550A are used in AT-class systems.
Unformatted capacity
The total number of bytes of data that can be fit on a disk. The formatted capacity is lower because space is lost defining the boundaries between sectors.

UPC
An acronym for Universal Product Code, a ten-digit computer-readable bar code used in labeling retail products. The code in the form of vertical bars includes a five-digit manufacturer identification number and a five-digit product code number.

Update
To modify information already contained in a file or program with current information.

UPS
An acronym for uninterruptible power supply. A device that supplies power to the computer from batteries so that power will not stop, even momentarily, during a power outage. The batteries are recharged constantly from a wall socket.

Utility
Programs that carry out routine procedures to make computer use easier.

UTP
An acronym for unshielded twisted pair, a type of wire often used indoors to connect telephones or computer devices. Comes with two or four wires twisted inside a flexible plastic sheath or conduit and utilizes modular plugs and phone jacks.

V.21
A CCITT standard for modem communications at 300 bps. Modems made in the U.S. or Canada follow the Bell 103 standard but can be set to answer V.21 calls from overseas. The actual transmission rate is 300 baud and employs FSK (frequency shift keying) modulation, which encodes a single bit per baud.

V.22
A CCITT standard for modem communications at 1200 bps, with an optional fallback to 600 bps. V.22 is partially compatible with the Bell 212A standard observed in the United States and Canada. The actual transmission rate is 600 baud, using DPSK (differential-phase shift keying) to encode as much as 2 bits per baud.

V.22bis
A CCITT standard for modem communications at 2400 bps. Includes an automatic link-negotiation fallback to 1200 bps and compatibility with Bell 212A/V.22 modems. The actual transmission rate is 600 baud, using QAM (quadrature amplitude modulation) to encode as much as 4 bits per baud.

V.23
A CCITT standard for modem communications at 1200 or 600 bps with a 75-bps back channel. Used in the United Kingdom for some videotext systems.

V.25
A CCITT standard for modem communications that specifies an answer tone different from the Bell answer tone used in the U.S. and Canada. Most intelligent modems can be set with an ATB0 command so that they use the V.25 2100 Hz tone when answering overseas calls.
V.32
A CCITT standard for modem communications at 9600 bps and 4800 bps. V.32 modems fall back to 4800 bps when line quality is impaired and fall forward again to 9600 bps when line quality improves. The actual transmission rate is 2400 baud, using QAM (quadrature amplitude modulation) and optional TCM (trellis-coded modulation) to encode as much as 4 data bits per baud.

V.32bis
A CCITT standard that extends the standard V.32 connection range and supports 4800-, 7200-, 9600-, 12000-, and 14400-bps transmission rates. V.32bis modems fall back to the next lower speed when line quality is impaired, fall back further as necessary, and fall forward to the next higher speed when line quality improves. The actual transmission rate is 2400 baud, using QAM (quadrature amplitude modulation) and TCM (trellis-coded modulation) to encode as much as 6 data bits per baud.

V.32fast
A CCITT standard that extends the standard V.32bis connection range, supporting 28800-bps transmission rates as well as all the functions and rates of V.32bis.

V.32terbo
A proprietary standard proposed by several modem manufacturers which will be cheaper to implement than the standard V.32 fast protocol, but which will only support transmission speeds of up to 18800-bps. Since it is not an industry standard, it is not likely to have widespread industry support.

V.42
A CCITT standard for modem communications that defines a two-stage process of detection and negotiation for LAPM error control. Also supports MNP error-control protocol, Levels 1 through 4.

V.42bis
An extension of CCITT V.42 that defines a specific data-compression scheme for use with V.42 and MNP error control.

Vaccine
A type of program used to locate and eradicate virus code from infected programs or systems.

VCPI
An acronym for Virtual Control Program Interface, a 386 and higher processor memory management standard created by Phar Lap software in conjunction with other software developers. VCPI provides an interface between applications using DOS extenders and 386 memory managers.

VESA
An acronym for the Video Electronics Standards Association. Founded in the late 1980s by NEC Home Electronics and eight other leading video board manufacturers, with the main goal to standardize the electrical, timing, and programming issues surrounding 800-by-600 resolution video displays, commonly known as Super VGA. VESA has also developed the Video Local Bus (VL-Bus) standard for connecting high speed adapters directly to the local processor bus.

VGA
An acronym for Video Graphics Array, a type of PC video display circuit (and adapter) first introduced by IBM on April 2, 1987, that supports text and graphics. Text is supported at a maximum resolution of 80x25 characters in 16 colors with a character box of 9x16 pixels. Graphics is supported at a maximum resolution of 320x200 pixels in 256 (from a palette of 262,144) colors or 640x480 pixels in 16 colors. The VGA outputs an analog signal with a horizontal scanning frequency of 31.5 KHz, and supports analog color or analog monochrome displays.
Virtual disk
A RAM disk or phantom disk drive in which a section of system memory (usually RAM) is set aside to hold data, just as though it were a number of disk sectors. To DOS, a virtual disk looks like and functions like any other real drive.

Virtual memory
A technique by which operating systems (including OS/2) load more programs and data into memory than they can hold. Parts of the programs and data are kept on disk and constantly swapped back and forth into system memory. The applications software programs are unaware of this setup and act as though a large amount of memory is available.

Virtual real mode
A mode available in all Intel 80386-compatible processors. In this mode, memory addressing is limited to 4,096 megabytes, restricted protection levels can be set to trap software crashes and control the system, and individual real mode compatible sessions can be set up and maintained separately from one another.

Virus
A type of resident program designed to attach itself to other programs. Usually at some later time, when the virus is running, it causes an undesirable action to take place.

VMM
An acronym for Virtual Memory Manager, a facility in Windows enhanced mode that manages the task of swapping data in and out of 386 and higher processor virtual real mode memory space for multiple non-Windows applications running in virtual real mode.

Voice-coil actuator
A device that moves read/write heads across hard disk platters by magnetic interaction between coils of wire and a magnet. Functions somewhat like an audio speaker, from which the name originated.

Voltage regulator
A device that smooths out voltage irregularities in the power fed to the computer.

Volume
A portion of a disk signified by a single drive specifier. Under DOS V3.3 and later, a single hard disk can be partitioned into several volumes, each with its own logical drive specifier (C:, D:, E:, and so on).

Volume label
An identifier or name of up to 11 characters that names a disk.

VRAM
An acronym for video random-access memory. VRAM chips are modified DRAMs on video boards that enable simultaneous access by the host system's processor and the processor on the video board. A large amount of information thus can be transferred quickly between the video board and the system processor. Sometimes also called dual-ported RAM.

Wait states
Pause cycles during system operation that require the processor to wait one or more clock cycles until memory can respond to the processor's request. Enables the microprocessor to synchronize with lower-cost, slower memory. A system that runs with zero wait states requires none of these cycles because of the use of faster memory or a memory cache system.
Whetstone
A benchmark program developed in 1976 and designed to simulate arithmetic-intensive programs used in scientific computing. Remains completely CPU-bound and performs no I/O or system calls. Originally written in ALGOL, although the C and Pascal versions became more popular by the late 1980s. The speed at which a system performs floating-point operations often is measured in units of Whetstones.

Whitney technology
A term referring to a magnetic disk design which usually has oxide or thin film media, thin film read/write heads, low floating height sliders, and low mass actuator arms that together allow higher bit densities than the older Winchester technology. Whitney technology was first introduced with the IBM 3370 disk drive circa 1979.

Winchester drive
Any ordinary, nonremovable (or fixed) hard disk drive. The name originates from a particular IBM drive in the 1960s that had 30M of fixed and 30M of removable storage. This 30-30 drive matched the caliber figure for a popular series of rifles made by Winchester, so the slang term Winchester was applied to any fixed platter hard disk.

Winchester technology
The term "winchester" is loosely applied to mean any disk with a fixed or non-removable recording medium. More precisely, the term applies to a ferrite read/write head and slider design with oxide media that was first employed in the IBM 3340 disk drive, circa 1973. Most drives today actually use Whitney technology.

Wire Frames
Wire frames are the most common technique used to construct a 3-dimensional object for animation. A wire frame is given coordinates of length, height and width. Wire frames are then filled with textures, colors and movement. Transforming a wire frame into a textured object is called "rendering".

Word length
The number of bits in a data character without parity, start, or stop bits.

WORM
An acronym for write once, read many (or multiple). An optical mass-storage device capable of storing many megabytes of information but that can be written to only once on any given area of the disk. A WORM disk typically holds more than 200M of data. Because a WORM drive cannot write over an old version of a file, new copies of files are made and stored on other parts of the disk whenever a file is revised. WORM disks are used to store information when a history of older versions must be maintained. Recording on a WORM disk is performed by a laser writer that burns pits in a thin metallic film (usually tellurium) embedded in the disk. This burning process is called "ablation". WORM drives are frequently used for archiving data.

Write precompensation
A modification applied to write data by a controller in order to alleviate partially the problem of bit shift, which causes adjacent 1s written on magnetic media to read as though they were further apart. When adjacent 1s are sensed by the controller, precompensation is used to write them closer together on the disk, thus enabling them to be read in the proper bit cell window. Drives with built-in controllers normally handle precompensation automatically. Precompensation normally is required for the inner cylinders of oxide media drives.
XGA
An acronym for eXtended Graphics Array, a type of PC video display circuit (and adapter) first introduced by IBM on October 30, 1990, that supports text and graphics. Text is supported at a maximum resolution of 132x60 characters in 16 colors with a character box of 8x6 pixels. Graphics is supported at a maximum resolution of 1024x768 pixels in 256 (from a palette of 262,144) colors or 640x480 pixels in 65536 colors. The XGA outputs an analog signal with a horizontal scanning frequency of 31.5 or 35.52 KHz, and supports analog color or analog monochrome displays.

XMM
An acronym for eXtended Memory Manager, a driver that controls access to Extended Memory on 286 and higher processor systems. HIMEM.SYS is an example of an XMM that comes with DOS.

Xmodem
A file-transfer protocol with error checking developed by Ward Christensen in the mid-1970s and placed in the public domain. Designed to transfer files between machines running the CP/M operating system and using 300- or 1200-bps modems. Until the late 1980s, because of its simplicity and public-domain status, Xmodem remained the most widely used microcomputer file-transfer protocol. In standard Xmodem, the transmitted blocks are 128 bytes. 1K-Xmodem is an extension to Xmodem that increases the block size to 1,024 bytes. Many newer file-transfer protocols that are much faster and more accurate than Xmodem have been developed, such as Ymodem and Zmodem.

XMS
An acronym for eXtended Memory Specification, a Microsoft developed standard that provides a way for real mode applications to access extended memory in a controlled fashion. The XMS standard is available from Microsoft.

XON/XOFF
Standard ASCII control characters used to tell an intelligent device to stop or resume transmitting data. In most systems, typing Ctrl-S sends the XOFF character. Most devices understand Ctrl-Q as XON; others interpret the pressing of any key after Ctrl-S as XON.

Y-connector
A Y-shaped splitter cable that divides a source input into two output signals.

Yellow Book
Yellow Book is the standard used by Compact Disc Read Only Memory (CD-ROM). Multimedia applications most commonly use the Yellow Book standard, which specifies how digital information is to be stored on the CD-ROM and read by a computer. EXtended Architecture (XA) is currently an extension of the Yellow Book which allows for the combination of different data types (audio and video, for example) onto one track in a CD ROM. Without XA, a CD-ROM can only access one data type at a time. All CD-ROM drives are now XA capable.

Ymodem
A file-transfer protocol first released as part of Chuck Forsberg's YAM (yet another modem) program. An extension to Xmodem, designed to overcome some of the limitations of the original. Enables information about the transmitted file, such as the file name and length, to be sent along with the file data and increases the size of a block from 128 to 1,024 bytes. Ymodem-batch adds the capability to transmit batches or groups of files without operator interruption. YmodemG is a variation that sends the entire file before waiting for an acknowledgment. If the receiving side detects an error in midstream, the transfer is aborted. YmodemG is designed for use with modems that have built-in error-correcting capabilities.
ZIF
Zero insertion force. Sockets that require no force for the insertion of a chip carrier. Usually accomplished through movable contacts and used primarily in test devices in which chips will be inserted and removed many times.

ZIP
Zigzag in-line package. A DIP package that has all leads on one edge in a zigzag pattern and mounts in a vertical plane.

Zmodem
A file-transfer protocol commissioned by Telenet and placed in the public domain. Like Ymodem, designed by Chuck Forsberg, and developed as an extension to Xmodem to overcome some of that original protocol's limitations. Among the key features are a 32-bit CRC offering a degree of error detection many times greater than Xmodem CRC, a server facility, batch transfers, and fast error recovery. One feature of Zmodem is the capability to continue transmitting a file from where it left off if the connection has been broken. Zmodem also was engineered specifically to avoid sending certain sequences, such as ESCape-carriage return-ESCape, that the Telenet network uses to control the connection. Its speed, accuracy, and file-recovery capabilities make Zmodem the leading protocol for high-speed modem file transfers.

NOTES

Introduction

In order to receive CompTIA A+ certification a candidate must pass two exams. The first exam is CompTIA A+ Essentials, exam number 220-701. The CompTIA A+ Essentials examination measures necessary competencies for an entry-level IT professional with the equivalent knowledge of at least 500 hours of hands-on experience in the lab or field.

Successful candidates will have the knowledge required to understand the fundamentals of computer technology, networking, and security, and will have the skills required to identify hardware, peripheral, networking, and security components. Successful candidates will understand the basic functionality of the operating system and basic troubleshooting methodology, practice proper safety procedures, and will effectively interact with customers and peers.

CompTIA A+ is ISO 17024 Accredited (Personnel Certification Accreditation) and, as such, undergoes regular reviews and updates to the exam objectives. The following CompTIA A+ Essentials objectives reflect the subject areas in the 2009 Edition of the exam and result from subject matter expert workshops and industry-wide survey results regarding the skills and knowledge required of an entry-level IT professional. The percentages in this document represent the relative importance of the subject areas (domains) in the associated body of knowledge, and together establish the foundation of an entry-level IT professional.

This examination blueprint includes domain weighting, test objectives, and example content. Example topics and concepts are included to clarify the test objectives and should not be construed as a comprehensive listing of all the content of this examination.

Candidates are encouraged to use this document to guide their studies. The contents of the examination blueprint help prioritize topics and provide a guide of what to expect on the CompTIA A+ Essentials exam.

The table below lists the domains measured by this examination and the extent to which they are represented. The CompTIA A+ Essentials (2009 Edition) exam is based on these objectives.

<table>
<thead>
<tr>
<th>Domain</th>
<th>% Of Examination</th>
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<tbody>
<tr>
<td>1.0</td>
<td>Hardware</td>
</tr>
<tr>
<td>2.0</td>
<td>Troubleshooting, Repair &amp; Maintenance</td>
</tr>
<tr>
<td>3.0</td>
<td>Operating System and Software</td>
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<tr>
<td>4.0</td>
<td>Networking</td>
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<tr>
<td>5.0</td>
<td>Security</td>
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<tr>
<td>6.0</td>
<td>Operational Procedure</td>
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<tr>
<td>Total</td>
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</tbody>
</table>
Response Limits
The examinee selects, from four (4) or more response options and the option(s) that best completes the statement or answers the question. Distracters or wrong answers are response options that examinees with incomplete knowledge or skill would likely choose, but are generally plausible responses fitting into the content area. Test item formats used in this examination are:

Multiple-choice: The examinee selects one option that best answers the question or completes a statement. The option can be embedded in a graphic where the examinee “points and clicks” on their selection choice to complete the test item.

Multiple-response: The examinee selects more than one option that best answers the question or completes a statement.

Sample Directions:
Read the statement or question and from the response options, select only the option(s) that represent the most correct or best answer(s).
1.0 Hardware

1.1 Categorize storage devices and backup media
   • FDD
   • HDD
     o Solid state vs. magnetic
   • Optical drives
     o CD / DVD / RW / Blu-Ray
   • Removable storage
     o Tape drive
     o Solid state (e.g. thumb drive, flash, SD cards, USB)
     o External CD-RW and hard drive
     o Hot swappable devices and non-hot swappable devices

1.2 Explain motherboard components, types and features
   • Form Factor
     o ATX / BTX,
     o micro ATX
     o NLX
   • I/O interfaces
     o Sound
     o Video
     o USB 1.1 and 2.0
     o Serial
     o IEEE 1394 / Firewire
     o Parallel
     o NIC
     o Modern
     o PS/2
   • Memory slots
     o RIMM
     o DIMM
     o SODIMM
     o SIMM
   • Processor sockets
   • Bus architecture
   • Bus slots
     o PCI
     o AGP
     o PCIe
     o AMR
     o CNR
     o PCMCIA
   • PATA
     o IDE
     o EIDE
   • SATA, eSATA
   • Contrast RAID (levels 0, 1, 5)
   • Chipsets
   • BIOS / CMOS / Firmware
     o POST
     o CMOS battery
   • Riser card / daughterboard
1.3 Classify power supplies types and characteristics
   • AC adapter
   • ATX proprietary
   • Voltage, wattage and capacity
   • Voltage selector switch
   • Pins (20, 24)

1.4 Explain the purpose and characteristics of CPUs and their features
   • Identify CPU types
     o AMD
     o Intel
   • Hyper threading
   • Multi core
     o Dual core
     o Triple core
     o Quad core
   • Onchip cache
     o L1
     o L2
   • Speed (real vs. actual)
   • 32bit vs. 64 bit

1.5 Explain cooling methods and devices
   • Heat sinks
   • CPU and case fans
   • Liquid cooling systems
   • Thermal compound

1.6 Compare and contrast memory types, characteristics and their purpose
   • Types
     o DRAM
     o SRAM
     o SDRAM
     o DDR / DDR2 / DDR3
     o RAMBUS
   • Parity vs. Non-parity
   • ECC vs. non-ECC
   • Single sided vs. double sided
   • Single channel vs. dual channel
   • Speed
     o PC100
     o PC133
     o PC2700
     o PC3200
     o DDR3-1600
     o DDR2-667
1.7 Distinguish between the different display devices and their characteristics
   - Projectors, CRT and LCD
   - LCD technologies
     - Resolution (e.g. XGA, SXGA+, UXGA, WUXGA)
     - Contrast ratio
     - Native resolution
   - Connector types
     - VGA
     - HDMi
     - S-Video
     - Component / RGB
     - DVI pin compatibility
   - Settings
     - Refresh rate
     - Resolution
     - Multi-monitor
     - Degauss

1.8 Install and configure peripherals and input devices
   - Mouse
   - Keyboard
   - Bar code reader
   - Multimedia (e.g. web and digital cameras, MIDI, microphones)
   - Biometric devices
   - Touch screen
   - KVM switch

1.9 Summarize the function and types of adapter cards
   - Video
     - PCI
     - PCIe
     - AGP
   - Multimedia
     - Sound card
     - TV tuner cards
     - Capture cards
   - I/O
     - SCSI
     - Serial
     - USB
     - Parallel
   - Communications
     - NIC
     - Modem
1.10 Install, configure and optimize laptop components and features

- Expansion devices
  - PCMCIA cards
  - PCI Express cards
  - Docking station
- Communication connections
  - Bluetooth
  - Infrared
  - Cellular WAN
  - Ethernet
  - Modem
- Power and electrical input devices
  - Auto-switching
  - Fixed input power supplies
  - Batteries
- Input devices
  - Stylus / digitizer
  - Function keys
  - Point devices (e.g. touch pad, point stick / track point)

1.11 Install and configure printers

- Differentiate between printer types
  - Laser
  - Inkjet
  - Thermal
  - Impact
- Local vs. network printers
- Printer drivers (compatibility)
- Consumables

2.0 Troubleshooting, Repair and Maintenance

2.1 Given a scenario, explain the troubleshooting theory

- Identify the problem
  - Question the user and identify user changes to computer and perform backups before making changes
- Establish a theory of probable cause (question the obvious)
- Test the theory to determine cause
  - Once theory is confirmed determine next steps to resolve problem
  - If theory is not confirmed re-establish new theory or escalate
- Establish a plan of action to resolve the problem and implement the solution
- Verify full system functionality and if applicable implement preventative measures
- Document findings, actions and outcomes
2.2 Given a scenario, explain and interpret common hardware and operating system symptoms and their causes

- OS related symptoms
  - Bluestream
  - System lock-up
  - Input/output device
  - Application install
  - Start or load
  - Windows specific printing problems
    - Print spool stalled
    - Incorrect / incompatible driver
- Hardware related symptoms
  - Excessive heat
  - Noise
  - Odors
  - Status light indicators
  - Alerts
  - Visible damage (e.g. cable, plastic)

- Use documentation and resources
  - User / installation manuals
  - Internet / web based
  - Training materials

2.3 Given a scenario, determine the troubleshooting methods and tools for printers

- Manage print jobs
- Print spooler
- Printer properties and settings
- Print a test page

2.4 Given a scenario, explain and interpret common laptop issues and determine the appropriate basic troubleshooting method

- Issues
  - Power conditions
  - Video
  - Keyboard
  - Pointer
  - Stylus
  - Wireless card issues

- Methods
  - Verify power (e.g. LEDs, swap AC adapter)
  - Remove unneeded peripherals
  - Plug in external monitor
  - Toggle Fn keys or hardware switches
  - Check LCD cutoff switch
  - Verify backlight functionality and pixilation
  - Check switch for built-in WIFI antennas or external antennas
2.5 Given a scenario, integrate common preventative maintenance techniques

- Physical inspection
- Updates
  - Driver
  - Firmware
  - OS
  - Security
- Scheduling preventative maintenance
  - Defrag
  - Scandisk
  - Check disk
  - Startup programs
- Use of appropriate repair tools and cleaning materials
  - Compressed air
  - Lint free cloth
  - Computer vacuum and compressors
- Power devices
  - Appropriate source such as power strip, surge protector or UPS
- Ensuring proper environment
- Backup procedures

3.0 Operating Systems and Software - Unless otherwise noted, operating systems referred to within include Microsoft Windows 2000, Windows XP Professional, XP Home, XP MediaCenter, Windows Vista Home, Home Premium, Business and Ultimate.

3.1 Compare and contrast the different Windows Operating Systems and their features

- Windows 2000, Windows XP 32bit vs. 64bit, Windows Vista 32 bit vs. 64bit
  - Side bar, Aero, UAC, minimum system requirements, system limits
  - Windows 2000 and newer – upgrade paths and requirements
  - Terminology (32bit vs. 64bit – x86 vs. x64)
  - Application compatibility, installed program locations (32bit vs. 64bit), Windows compatibility mode
  - User interface, start bar layout
3.2 Given a scenario, demonstrate proper use of user interfaces

- Windows Explorer
- My Computer
- Control Panel
- Command prompt utilities
  - telnet
  - ping
  - ipconfig
- Run line utilities
  - msconfig
  - msinfo32
  - Dxdiag
  - Cmd
  - REGEDIT
- My Network Places
- Task bar / systray
- Administrative tools
  - Performance monitor, Event Viewer, Services, Computer Management
- MMC
- Task Manager
- Start Menu

3.3 Explain the process and steps to install and configure the Windows OS

- File systems
  - FAT32 vs. NTFS
- Directory structures
  - Create folders
  - Navigate directory structures
- Files
  - Creation
  - Extensions
  - Attributes
  - Permissions
- Verification of hardware compatibility and minimum requirements
- Installation methods
  - Boot media such as CD, floppy or USB
  - Network installation
  - Install from image
  - Recover CD
  - Factory recovery partition
- Operating system installation options
  - File system type
  - Network configuration
  - Repair install
- Disk preparation order
  - Format drive
  - Partition
  - Start installation
- Device Manager
  - Verify
  - Install and update devices drivers
  - Driver signing
• User data migration – User State Migration Tool (USMT)
• Virtual memory
• Configure power management
  o Suspend
  o Wake on LAN
  o Sleep timers
  o Hibernate
  o Standby
• Demonstrate safe removal of peripherals

3.4 Explain the basics of boot sequences, methods and startup utilities
• Disk boot order / device priority
  o Types of boot devices (disk, network, USB, other)
• Boot options
  o Safe mode
  o Boot to restore point
  o Recovery options
    Automated System Recovery (ASR)
    Emergency Repair Disk (ERD)
    Recovery console

4.0 Networking

4.1 Summarize the basics of networking fundamentals, including technologies, devices and protocols
• Basics of configuring IP addressing and TCP/IP properties (DHCP, DNS)
• Bandwidth and latency
• Status indicators
• Protocols (TCP/IP, NETBIOS)
• Full-duplex, half-duplex
• Basics of workgroups and domains
• Common ports: HTTP, FTP, POP, SMTP, TELNET, HTTPS
• LAN / WAN
• Hub, switch and router
• Identify Virtual Private Networks (VPN)
• Basics class identification

4.2 Categorize network cables and connectors and their implementations
• Cables
  o Plenum / PVC
  o UTP (e.g. CAT3, CAT5 / 5e, CAT6)
  o STP
  o Fiber
  o Coaxial cable
• Connectors
  o RJ45
  o RJ11
4.3 Compare and contrast the different network types

- Broadband
  - DSL
  - Cable
  - Satellite
  - Fiber
- Dial-up
- Wireless
  - All 802.11 types
  - WEP
  - WPA
  - SSID
  - MAC filtering
  - DHCP settings
- Bluetooth
- Cellular

5.0 Security

5.1 Explain the basic principles of security concepts and technologies

- Encryption technologies
- Data wiping / hard drive destruction / hard drive recycling
- Software firewall
  - Port security
  - Exceptions
- Authentication technologies
  - User name
  - Password
  - Biometrics
  - Smart cards
- Basics of data sensitivity and data security
  - Compliance
  - Classifications
  - Social engineering

5.2 Summarize the following security features

- Wireless encryption
  - WEPx and WPAX
  - Client configuration (SSID)
- Malicious software protection
  - Viruses
  - Trojans
  - Worms
  - Spam
  - Spyware
  - Adware
  - Grayware
- BIOS Security
  - Drive lock
  - Passwords
  - Intrusion detection
  - TPM
• Password management / password complexity
• Locking workstation
  o Hardware
  o Operating system
• Biometrics
  o Fingerprint scanner

6.0 Operational Procedure

6.1 Outline the purpose of appropriate safety and environmental procedures and given a scenario apply them
• ESD
• EMI
  o Network interference
  o Magnets
• RFI
  o Cordless phone interference
  o Microwaves
• Electrical safety
  o CRT
  o Power supply
  o Inverter
  o Laser printers
  o Matching power requirements of equipment with power distribution and UPSs
• Material Safety Data Sheets (MSDS)
• Cable management
  o Avoiding trip hazards
• Physical safety
  o Heavy devices
  o Hot components
• Environmental – consider proper disposal procedures
6.2 Given a scenario, demonstrate the appropriate use of communication skills and professionalism in the workplace

- Use proper language – avoid jargon, acronyms, slang
- Maintain a positive attitude
- Listen and do not interrupt a customer
- Be culturally sensitive
- Be on time
  - If late contact the customer
- Avoid distractions
  - Personal calls
  - Talking to co-workers while interacting with customers
  - Personal interruptions
- Dealing with a difficult customer or situation
  - Avoid arguing with customers and/or being defensive
  - Do not minimize customers’ problems
  - Avoid being judgmental
  - Clarify customer statements
    - Ask open-ended questions to narrow the scope of the problem
    - Restate the issue or question to verify understanding
- Set and meet expectations / timeline and communicate status with the customer
  - Offer different repair / replacement options if applicable
  - Provide proper documentation on the services provided
  - Follow up with customer / user at a later date to verify satisfaction
- Deal appropriately with customers confidential materials
  - Located on computer, desktop, printer, etc.
**CompTIA A+ Acronyms**

**Introduction**

The following is a list of acronyms which appear on the CompTIA A+ exams. Candidates are encouraged to review the complete list and attain a working knowledge of all listed acronyms as a part of a comprehensive exam preparation program.

<table>
<thead>
<tr>
<th>ACRONYM SPELLED OUT</th>
<th>EXPLANATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC</td>
<td>alternating current</td>
</tr>
<tr>
<td>ACL</td>
<td>access control list</td>
</tr>
<tr>
<td>ACPI</td>
<td>advanced configuration and power interface</td>
</tr>
<tr>
<td>ACT</td>
<td>activity</td>
</tr>
<tr>
<td>ADSL</td>
<td>asymmetrical digital subscriber line</td>
</tr>
<tr>
<td>AGP</td>
<td>accelerated graphics port</td>
</tr>
<tr>
<td>AMD</td>
<td>advanced micro devices</td>
</tr>
<tr>
<td>APIPA</td>
<td>automatic private internet protocol addressing</td>
</tr>
<tr>
<td>APM</td>
<td>advanced power management</td>
</tr>
<tr>
<td>ARP</td>
<td>address resolution protocol</td>
</tr>
<tr>
<td>ASR</td>
<td>automated system recovery</td>
</tr>
<tr>
<td>AT</td>
<td>advanced technology</td>
</tr>
<tr>
<td>ATA</td>
<td>advanced technology attachment</td>
</tr>
<tr>
<td>ATAPI</td>
<td>advanced technology attachment packet interface</td>
</tr>
<tr>
<td>ATRM</td>
<td>asynchronous transfer mode</td>
</tr>
<tr>
<td>ATX</td>
<td>advanced technology extended</td>
</tr>
<tr>
<td>BIOS</td>
<td>basic input/output system</td>
</tr>
<tr>
<td>BNC</td>
<td>Bayonet-Neill-Concelman or British Naval Connector</td>
</tr>
<tr>
<td>BTX</td>
<td>balanced technology extended</td>
</tr>
<tr>
<td>CD</td>
<td>compact disc</td>
</tr>
<tr>
<td>CD-ROM</td>
<td>compact disc-read-only memory</td>
</tr>
<tr>
<td>CD-RW</td>
<td>compact disc-rewritable</td>
</tr>
<tr>
<td>CDFS</td>
<td>compact disc file system</td>
</tr>
<tr>
<td>CFS</td>
<td>Central File System, Common File System, Command File System</td>
</tr>
<tr>
<td>CMOS</td>
<td>complementary metal-oxide semiconductor</td>
</tr>
<tr>
<td>COMx</td>
<td>communication port (x=port number)</td>
</tr>
<tr>
<td>CPUx</td>
<td>central processing unit</td>
</tr>
<tr>
<td>CRT</td>
<td>cathode-ray tube</td>
</tr>
<tr>
<td>DAC</td>
<td>discretionary access control</td>
</tr>
<tr>
<td>DB-25</td>
<td>serial communications D-shell connector, 25 pins</td>
</tr>
<tr>
<td>DB-9</td>
<td>9 pin D shell connector</td>
</tr>
<tr>
<td>DC</td>
<td>direct current</td>
</tr>
<tr>
<td>DDOS</td>
<td>distributed denial of service</td>
</tr>
<tr>
<td>DDR</td>
<td>double data-rate</td>
</tr>
<tr>
<td>DDR RAM</td>
<td>double data-rate random access memory</td>
</tr>
<tr>
<td>DDR SDRAM</td>
<td>double data-rate synchronous dynamic random access memory</td>
</tr>
<tr>
<td>DFS</td>
<td>distributed file system</td>
</tr>
<tr>
<td>DHCP</td>
<td>dynamic host configuration protocol</td>
</tr>
<tr>
<td>DIMM</td>
<td>dual inline memory module</td>
</tr>
<tr>
<td>DIN</td>
<td>Deutsche Industrie Norm</td>
</tr>
<tr>
<td>DIP</td>
<td>dual inline package</td>
</tr>
<tr>
<td>DLT</td>
<td>digital linear tape</td>
</tr>
<tr>
<td>DLP</td>
<td>digital light processing</td>
</tr>
</tbody>
</table>
DMA direct memory access
DMZ demilitarized zone
DNS domain name service or domain name server
DOS denial of service
DOS disk operating system
DPMS display power management signaling
DRAM dynamic random access memory
DSL digital subscriber line
DVD digital video disc or digital versatile disc
DVD-RAM digital video disc-random access memory
DVD-ROM digital video disc-read only memory
DVD-R digital video disc-recordable
DVD-RW digital video disc-rewritable
DVI digital visual interface
ECC error correction code
ECP extended capabilities port
EEPROM electrically erasable programmable read-only memory
EFS encrypting file system
EIDE enhanced integrated drive electronics
EMI electromagnetic interference
EMP electromagnetic pulse
EPROM erasable programmable read-only memory
EPP enhanced parallel port
ERD emergency repair disk
ESD electrostatic discharge
EVGA extended video graphics adapter/array
EVDO evolution data optimized or evolution data only
FAT file allocation table
FAT12 12-bit file allocation table
FAT16 16-bit file allocation table
FAT32 32-bit file allocation table
FDD floppy disk drive
Fn Function (referring to the function key on a laptop)
FPM fast page-mode
FRU field replaceable unit
FSB Front Side Bus
FTP file transfer protocol
FQDN fully qualified domain name
Gb gigabit
GB gigabyte
GDI graphics device interface
Ghz gigahertz
GUI graphical user interface
GPS global positioning system
GSM global system for mobile communications
HAL hardware abstraction layer
HCL hardware compatibility list
HDD hard disk drive
HDMI high definition media interface
HPFS high performance file system
HTML hypertext markup language
HTTP hypertext transfer protocol
HTTPS hypertext transfer protocol over secure sockets layer
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>I/O</td>
<td>input/output</td>
</tr>
<tr>
<td>ICMP</td>
<td>internet control message protocol</td>
</tr>
<tr>
<td>ICR</td>
<td>intelligent character recognition</td>
</tr>
<tr>
<td>IDE</td>
<td>integrated drive electronics</td>
</tr>
<tr>
<td>IDS</td>
<td>Intrusion Detection System</td>
</tr>
<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronics Engineers</td>
</tr>
<tr>
<td>IIS</td>
<td>Internet Information Services</td>
</tr>
<tr>
<td>IMAP</td>
<td>internet mail access protocol</td>
</tr>
<tr>
<td>IP</td>
<td>internet protocol</td>
</tr>
<tr>
<td>IPCONFIG</td>
<td>internet protocol configuration</td>
</tr>
<tr>
<td>IPP</td>
<td>internet printing protocol</td>
</tr>
<tr>
<td>IPSEC</td>
<td>internet protocol security</td>
</tr>
<tr>
<td>IPX</td>
<td>internetwork packet exchange</td>
</tr>
<tr>
<td>IPX/SPX</td>
<td>internetwork packet exchange/sequenced packet exchange</td>
</tr>
<tr>
<td>IR</td>
<td>infrared</td>
</tr>
<tr>
<td>IrDA</td>
<td>Infrared Data Association</td>
</tr>
<tr>
<td>IRQ</td>
<td>interrupt request</td>
</tr>
<tr>
<td>ISA</td>
<td>industry standard architecture</td>
</tr>
<tr>
<td>ISDN</td>
<td>integrated services digital network</td>
</tr>
<tr>
<td>ISO</td>
<td>International Standards Organization</td>
</tr>
<tr>
<td>ISP</td>
<td>internet service provider</td>
</tr>
<tr>
<td>JBOD</td>
<td>just a bunch of disks</td>
</tr>
<tr>
<td>Kb</td>
<td>kilobit</td>
</tr>
<tr>
<td>KB</td>
<td>Kilobyte or knowledge base</td>
</tr>
<tr>
<td>LAN</td>
<td>local area network</td>
</tr>
<tr>
<td>LBA</td>
<td>logical block addressing</td>
</tr>
<tr>
<td>LC</td>
<td>Lucent connector</td>
</tr>
<tr>
<td>LCD</td>
<td>liquid crystal display</td>
</tr>
<tr>
<td>LDAP</td>
<td>lightweight directory access protocol</td>
</tr>
<tr>
<td>LED</td>
<td>light emitting diode</td>
</tr>
<tr>
<td>Li-on</td>
<td>lithium-ion</td>
</tr>
<tr>
<td>LPD/LPR</td>
<td>line printer daemon / line printer remote</td>
</tr>
<tr>
<td>LPT</td>
<td>line printer terminal</td>
</tr>
<tr>
<td>LPT1</td>
<td>line printer terminal 1</td>
</tr>
<tr>
<td>LVD</td>
<td>low voltage differential</td>
</tr>
<tr>
<td>MAC</td>
<td>media access control / mandatory access control</td>
</tr>
<tr>
<td>MAPI</td>
<td>messaging application programming interface</td>
</tr>
<tr>
<td>MAU</td>
<td>media access unit, media attachment unit</td>
</tr>
<tr>
<td>Mb</td>
<td>megabit</td>
</tr>
<tr>
<td>MB</td>
<td>megabyte</td>
</tr>
<tr>
<td>MBR</td>
<td>master boot record</td>
</tr>
<tr>
<td>MBSA</td>
<td>Microsoft Baseline Security Analyzer</td>
</tr>
<tr>
<td>MFD</td>
<td>multi-function device</td>
</tr>
<tr>
<td>MFP</td>
<td>multi-function product</td>
</tr>
<tr>
<td>MHZ</td>
<td>megahertz</td>
</tr>
<tr>
<td>MicroDIMM</td>
<td>micro dual inline memory module</td>
</tr>
<tr>
<td>MIDI</td>
<td>musical instrument digital interface</td>
</tr>
<tr>
<td>MIME</td>
<td>multipurpose internet mail extension</td>
</tr>
<tr>
<td>MLI</td>
<td>multiple link interface</td>
</tr>
<tr>
<td>MMC</td>
<td>Microsoft management console</td>
</tr>
<tr>
<td>MMX</td>
<td>multimedia extensions</td>
</tr>
</tbody>
</table>
MP3 Moving Picture Experts Group Audio Layer 3
MP4 Moving Picture Experts Group Audio Layer 4
MPEG Moving Picture Experts Group
MSCONFIG Microsoft configuration
MSDS material safety data sheet
MUI multilingual user interface
NAC network access control
NAS network-attached storage
NAT network address translation
NetBIOS networked basic input/output system
NetBEUI networked basic input/output system extended user interface
NFS network file system
NIC network interface card
NiCd nickel cadmium
NiMH nickel metal hydride
NLX new low-profile extended
NNTP network news transfer protocol
NTFS new technology file system
NTLDR new technology loader
NTP Network Time Protocol
OCR optical character recognition
OEM original equipment manufacturer
OS operating system
PAN personal area network
PATA parallel advanced technology attachment
PC personal computer
PCI peripheral component interconnect
PCIe peripheral component interconnect express
PCIX peripheral component interconnect extended
PCL printer control language
PCMCIA Personal Computer Memory Card International Association
PDA personal digital assistant
PGA pin grid array
PGA2 pin grid array 2
PIN personal identification number
PKI public key infrastructure
PnP plug and play
POP3 post office protocol 3
POST power-on self test
POTS plain old telephone service
PPP point-to-point protocol
PPTP point-to-point tunneling protocol
PRI primary rate interface
PROM programmable read-only memory
PS/2 personal system/2 connector
PSTN public switched telephone network
PSU power supply unit
PVC permanent virtual circuit
PXE preboot execution environment
QoS quality of service
RAID redundant array of independent (or inexpensive) discs
SVGA super video graphics array
SXGA super extended graphics array
TB terabyte
TCP transmission control protocol
TCP/IP transmission control protocol/internet protocol
TDR time domain reflectometer
TFTP trivial file transfer protocol
TPM trusted platform module
UAC user account control
UART universal asynchronous receiver transmitter
UDF user defined functions or universal disk format or universal data format
UDMA ultra direct memory access
UDP user datagram protocol
UNC universal naming convention
UPC universal product code
UPS uninterruptible power supply
URL uniform resource locator
USB universal serial bus
USMT user state migration tool
UTP unshielded twisted pair
UXGA ultra extended graphics array
VESA Video Electronics Standards Association
VFAT virtual file allocation table
VGA video graphics array
VoIP voice over internet protocol
VPN virtual private network
VRAM video random access memory
WAN wide area network
WAP wireless application protocol
WEP wired equivalent privacy
WIFI wireless fidelity
WINS windows internet name service
WLAN wireless local area network
WPA wireless protected access
WUXGA wide ultra extended graphics array
XGA extended graphics array
ZIF zero-insertion-force
ZIP zigzag inline package

NOTES
Chapter 17. Map of A+ IT Specialist Examination (220-702) Objectives

Introduction

In order to receive CompTIA A+ certification a candidate must pass two exams. The first exam is CompTIA A+ Essentials, exam number 220-701. Objectives for the CompTIA A+ Essentials examination are available at www.comptia.org. The CompTIA A+ 220-702 exam, Practical Application, is the second exam required in order for CompTIA A+ certification candidates to complete their certification in the 2009 Edition of CompTIA A+.

The CompTIA A+ Practical Application exam measures the necessary competencies for an entry-level IT professional who has hands-on experience in the lab or the field. Successful candidates will have the skills required to install, configure, upgrade, and maintain PC workstations, the Windows OS and SOHO networks. The successful candidate will utilize troubleshooting techniques and tools to effectively and efficiently resolve PC, OS, and network connectivity issues and implement security practices. Job titles in some organizations which are descriptive of the role of this individual may be: Enterprise technician, IT administrator, field service technician, PC or Support technician, etc. Ideally, the CompTIA A+ Practical Application candidate has already passed the CompTIA A+ Essentials examination.

CompTIA A+ is ISO 17024 Accredited (Personnel Certification Accreditation) and, as such, undergoes regular reviews and updates to the exam objectives. The following CompTIA A+ Practical Application objectives reflect the subject areas in the 2009 Edition of this exam, and result from subject matter expert workshops and industrywide survey results regarding the skills and knowledge required of an entry-level IT professional with some hands-on experience. The percentages in this document represent the relative importance of the subject areas (domains) in the associated body of knowledge, and together establish the foundation for an entry-level IT professional.

This examination blueprint includes domain weighting, test objectives, and example content. Example topics and concepts are included to clarify the test objectives and should not be construed as a comprehensive listing of all the content of this examination.

Candidates are encouraged to use this document to guide their studies. The contents of the examination blueprint help prioritize topics and provide a guide of what to expect on the CompTIA A+ Practical Application exam. The table below lists the domains measured by this examination and the extent to which they are represented. The CompTIA A+ Practical Application (2009 Edition) exam is based on these objectives.

<table>
<thead>
<tr>
<th>Domain Percentage of Examination</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 Hardware</td>
</tr>
<tr>
<td>2.0 Operating Systems</td>
</tr>
<tr>
<td>3.0 Networking</td>
</tr>
<tr>
<td>4.0 Security</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

**Note: The lists of examples provided in bulleted format below each objective are not exhaustive lists. Other examples of technologies, processes or tasks pertaining to each objective may also be included on the exam although not listed or covered in this objectives document.

CompTIA is constantly reviewing the content of our exams and updating test questions to be sure our exams are current and the security of the questions is protected. When necessary, we will publish updated exams based on existing exam objectives. Please know that all related exam preparation materials will still be valid.
1.0 Hardware

1.1 Given a scenario, install, configure and maintain personal computer components

- Storage devices
  - HDD
  - SATA
  - PATA
  - Solid state
  - FDD
  - Optical drives
    - CD / DVD / RW / Blu-Ray
  - Removable
  - External

- Motherboards
  - Jumper settings
  - CMOS battery
  - Advanced BIOS settings
  - Bus speeds
  - Chipsets
  - Firmware updates
  - Socket types
  - Expansion slots
  - Memory slots
  - Front panel connectors
  - I/O ports
    - Sound, video, USB 1.1, USB 2.0, serial, IEEE 1394 / Firewire, parallel, NIC, modem, PS/2

- Power supplies
  - Wattages and capacity
  - Connector types and quantity
  - Output voltage

- Processors
  - Socket types
  - Speed
  - Number of cores
  - Power consumption
  - Cache
  - Front side bus
  - 32bit vs. 64bit

- Memory
• Adapter cards
  o Graphics cards
  o Sound cards
  o Storage controllers
    RAID cards (RAID array – levels 0,1,5)
  eSATA cards
  o I/O cards
    Firewire
    USB
    Parallel
    Serial
  o Wired and wireless network cards
  o Capture cards (TV, video)
  o Media reader

• Cooling systems
  o Heat sinks
  o Thermal compound
  o CPU fans
  o Case fans

1.2 Given a scenario, detect problems, troubleshoot and repair/replace personal computer components
• Storage devices
  o HDD
    SATA
    PATA
    Solid state
  o FDD
  o Optical drives
    CD / DVD / RW / Blu-Ray
  o Removable
  o External
• Motherboards
  o Jumper settings
  o CMOS battery
  o Advanced BIOS settings
  o Bus speeds
  o Chipsets
  o Firmware updates
  o Socket types
  o Expansion slots
  o Memory slots
  o Front panel connectors
  o I/O ports
    Sound, video, USB 1.1, USB 2.0, serial, IEEE 1394 / Firewire, parallel, NIC, modem, PS/2)
• Power supplies
  o Wattages and capacity
  o Connector types and quantity
  o Output voltage
• Processors
  o Socket types
  o Speed
  o Number of cores
  o Power consumption
  o Cache
  o Front side bus
  o 32bit vs. 64bit
• Memory
• Adapter cards
  o Graphics cards - memory
  o Sound cards
  o Storage controllers
    RAID cards
    eSATA cards
  o I/O cards
    Firewire
    USB
    Parallel
    Serial
  o Wired and wireless network cards
  o Capture cards (TV, video)
  o Media reader
• Cooling systems
  o Heat sinks
  o Thermal compound
  o CPU fans
  o Case fans

1.3 Given a scenario, install, configure, detect problems, troubleshoot and repair/replace laptop components
• Components of the LCD including inverter, screen and video card
• Hard drive and memory
• Disassemble processes for proper re-assembly
  o Document and label cable and screw locations
  o Organize parts
  o Refer to manufacturer documentation
  o Use appropriate hand tools
• Recognize internal laptop expansion slot types
• Upgrade wireless cards and video card
• Replace keyboard, processor, plastics, pointer devices, heat sinks, fans, system board, CMOS battery, speakers
1.4 Given a scenario, select and use the following tools
   • Multimeter
   • Power supply tester
   • Specialty hardware / tools
   • Cable testers
   • Loop back plugs
   • Anti-static pad and wrist strap
   • Extension magnet

1.5 Given a scenario, detect and resolve common printer issues
   • Symptoms
     o Paper jams
     o Blank paper
     o Error codes
     o Out of memory error
     o Lines and smearing
     o Garbage printout
     o Ghosted image
     o No connectivity
   • Issue resolution
     o Replace fuser
     o Replace drum
     o Clear paper jam
     o Power cycle
     o Install maintenance kit (reset page count)
     o Set IP on printer
     o Clean printer

2.0 Operating Systems - unless otherwise noted, operating systems referred to within include
Microsoft Windows 2000, Windows XP Professional, XP Home, XP MediaCenter, Windows Vista
Home, Home Premium, Business and Ultimate.

2.1 Select the appropriate commands and options to troubleshoot and resolve problems
   • MSCONFIG
   • DIR
   • CHKDSK (/f /r)
   • EDIT
   • COPY (/a /v /y)
   • XCOPY
   • FORMAT
   • IPCONFIG (/all /release /renew)
   • PING (-t –l)
   • MD / CD / RD
   • NET
   • TRACERT
   • NSLOOKUP
   • [command name] /?
   • SFC
2.2 Differentiate between Windows Operating System directory structures (Windows 2000, XP and Vista)

- User file locations
- System file locations
- Fonts
- Temporary files
- Program files
- Offline files and folders

2.3 Given a scenario, select and use system utilities / tools and evaluate the results

- Disk management tools
  - DEFRAG
  - NTBACKUP
  - Check Disk
- Disk Manager
  - Active, primary, extended and logical partitions
  - Mount points
  - Mounting a drive
  - FAT32 and NTFS
  - Drive status
    - Foreign drive
    - Healthy
    - Formatting
    - Active unallocated
    - Failed
    - Dynamic
    - Offline
    - Online
- System monitor
- Administrative tools
  - Event Viewer
  - Computer Management
  - Services
  - Performance Monitor
- Devices Manager
  - Enable
  - Disable
  - Warnings
  - Indicators
- Task Manager
  - Process list
  - Resource usage
  - Process priority
  - Termination
- System Information
- System restore
- Remote Desktop Protocol (Remote Desktop / Remote Assistance)
- Task Scheduler
- Regional settings and language settings
2.4 Evaluate and resolve common issues
   • Operational Problems
     o Windows specific printing problems
       Print spool stalled
       Incorrect / incompatible driver / form printing
     o Auto-restart errors
     o Bluescreen error
     o System lock-up
     o Devices drivers failure (input / output devices)
     o Application install, start or load failure
     o Service fails to start
   • Error Messages and Conditions
     o Boot
       Invalid boot disk
       Inaccessible boot drive
       Missing NTLDR
     o Startup
       Device / service failed to start
       Device / program in registry not found
     o Event viewer (errors in the event log)
     o System Performance and Optimization
       Aero settings
       Indexing settings
       UAC
       Side bar settings
       Startup file maintenance
       Background processes

3.0 Networking

3.1 Troubleshoot client-side connectivity issues using appropriate tools
   • TCP/IP settings
     o Gateway
     o Subnet mask
     o DNS
     o DHCP (dynamic vs.static)
     o NAT (private and public)
   • Characteristics of TCP/IP
     o Loopback addresses
     o Automatic IP addressing
   • Mail protocol settings
     o SMTP
     o IMAP
     o POP
   • FTP settings
     o Ports
     o IP addresses
     o Exceptions
     o Programs
3.2 Install and configure a small office home office (SOHO) network

- Connection types
  - Dial-up
  - Broadband
    - DSL
    - Cable
    - Satellite
    - ISDN
  - Wireless
    - All 802.11
    - WEP
    - WPA
    - SSID
    - MAC filtering
    - DHCP settings
  - Routers / Access Points
    - Disable DHCP
    - Use static IP
    - Change SSID from default
    - Disable SSID broadcast
    - MAC filtering
    - Change default username and password
    - Update firmware
    - Firewall
      - LAN (10/100/1000BaseT, Speeds)
      - Bluetooth (1.0 vs. 2.0)
      - Cellular
      - Basic VoIP (consumer applications)
• Basics of hardware and software firewall configuration
  o Port assignment / setting up rules (exceptions)
  o Port forwarding / port triggering
• Physical installation
  o Wireless router placement
  o Cable length

4.0 Security

4.1 Given a scenario, prevent, troubleshoot and remove viruses and malware
• Use antivirus software
• Identify malware symptoms
• Quarantine infected systems
• Research malware types, symptoms and solutions (virus encyclopedias)
• Remediate infected systems
• Update antivirus software
  o Signature and engine updates
  o Automatic vs. manual
• Schedule scans
• Repair boot blocks
• Scan and removal techniques
  o Safe mode
  o Boot environment
• Educate end user

4.2 Implement security and troubleshoot common issues
• Operating systems
  o Local users and groups: Administrator, Power Users, Guest, Users
  o Vista User Access Control (UAC)
  o NTFS vs. Share permissions
    Allow vs. deny
    Difference between moving and copying folders and files
    File attributes
  o Shared files and folders
    Administrative shares vs. local shares
    Permission propagation
    Inheritance
  o System files and folders
  o Encryption (Bitlocker, EFS)
  o User authentication
• System
  o BIOS security
    Drive lock
    Passwords
    Intrusion detection
    TPM
**Recommended texts and preparation software**

Besides this book, the author recommends the following other textbooks as good preparatory materials for taking the A+ certification exam:


**CompTIA A+ 220-701 and 220-702 Practice Questions Exam Cram** (Paperback); published by Que Corporation (December 3, 2009); ISBN #0789742578.

**CompTIA A+ Complete Deluxe Study Guide: Exams 220-701 (Essentials) and 220-702 (Practical Application)** (Hardcover); published by Sybex (October 19, 2009); ISBN #0470486481.

**CompTIA A+ Certification All-In-One For Dummies** (Paperback); published by For Dummies; 2nd edition (October 19, 2009); ISBN #0470487380.


**The BIOS Companion**; written by Phil Croucher; published by Electrocution Technical Publishers; ISBN #0968192807.
WHAT IS RESEARCH TECHNOLOGY ASSOCIATES, INC.?

Research Technology Associates, Inc. is a non-profit corporation, as stated in Section 501(c)(3) of the IRS Code. Our IRS tax ID number is 52-1991918.

The goals of the Research Technology Associates, Inc. are simple:

• Locate and obtain surplus computer equipment in our community;
• Test and refurbish this equipment;
• Distribute this computer equipment to schools and various non-profit organizations in our community; and
• Provide quality training at an affordable cost to schools, charitable organizations, and the non-profit community.

Services provided by Research Technology Associates, Inc. include:

• Picking up unwanted and surplus PC equipment from individuals and corporations;
• Refurbishing computer equipment at our facilities;
• Placing this equipment in non-profit organizations throughout the world;
• Providing training and support to various organizations, and
• Teaching individuals computer repair techniques through the ENT 1840 (PC Hardware), ENT 2840 (PC Repair), ENT 2860 (Advanced PC Configuration and Troubleshooting), and DPR 396/397 (A+ Certification Preparation) courses offered at PG Community College.

Engineering students at Prince George's Community College and other local community colleges provide much of the labor, resources and volunteer time needed to test and repair this equipment. Our volunteer base comes from a broad cross-section of people from throughout our community. Our Board of Directors is comprised of business leaders and computer technicians from all over the Washington DC area.

Research Technology Associates, Inc., gives individuals and corporations a way to give back to the community:

• The training opportunities offered through PG Community College provide students valuable job skills for today's computer-oriented business market;
• Computers end up in deserving schools and non-profit corporations, not in landfills; and
• Individuals and corporations receive tax deductions for donating their surplus equipment.

Volunteers are needed to transport computers from donor organizations to our offices in Upper Marlboro MD, and to our repair facility at Prince George's Community College in Largo MD. We also need volunteers who can test, repair and prepare computers for distribution to various charitable organizations.

For further information about Research Technology Associates, Inc., or if you would like to volunteer your services, please contact Bill Lloyd, Corporation President, on 301/782-3585. You can email us at LLOYDWA@pgcc.edu.

Visit our website at http://academic.pgcc.edu/~wlloyd/rta.
GUIDELINES FOR OBTAINING EQUIPMENT FROM RESEARCH TECHNOLOGY ASSOCIATES

If you want to obtain computer equipment from Research Technology Associates, Inc., you will need to do the following things:

1) **Send your request to:**

   Research Technology Associates, Inc.
   12221 Van Brady Road
   Upper Marlboro, MD  20772-7924

   E-mail: LLOYDWA@pgcc.edu

   Our phone number is 301/782-3585.

2) **Provide us with your non-profit organization's name, address and phone number;**

3) **Provide us with a record of your non-profit or charitable organization status, such as:**

   o a 501(c)(3) form which your organization filed with the IRS, or
   o a photocopy of your state tax exempt number.

4) **Indicate as precisely as you can what you would like to receive.** We routinely receive the following kinds of PCs:

   o Pentium-class PCs with floppy and hard drives
   o VGA color monitors (CRT and LCD flat-panel)
   o Macintosh and iMac computers
   o Dot matrix, ink-jet and/or laser printers
   o Scanners and other miscellaneous computer equipment

   Requests for more advanced equipment than this may take some time to fill. Also, requests for multiple PCs may be delivered on a flow basis.

   Let us know if you need more than one PC, or if you just need a certain component (i.e., a monitor, a hard drive, a video card, etc.)

5) **Have patience.** Our waiting list is growing, just as our corporation is growing. Depending upon the request, you may have to wait several weeks to receive your PC. We are a volunteer organization: we receive no tax subsidies, and our volunteers and board members receive no compensation. We will fill your order for a PC as soon as possible.

6) **Make arrangements to pick up the PC when it's ready.** Once your PC is ready, you will make arrangements to pick it up. We can ship the PC to your location, but you will need to pay for the shipping. It's usually cheaper to come to our office and pick it up. Contact us at our main office for details.

7) **Write a check to Research Technology Associates, Inc.** We provide computers to non-profit organizations at greatly reduced prices. The contribution you provide for a computer defrays our costs in obtaining, refurbishing and delivering the PC to you. We receive no Federal, state or local funding for our program; therefore, we use the income generated from the sale of computers to sustain our work.

8) **Let us know of organizations that are disposing of surplus PC equipment.** We are always looking for organizations that are disposing of their surplus computer equipment. Companies and individuals that donate equipment to our organization receive a letter which can be used for tax deduction purposes with the IRS. The more PCs we receive, the faster we can get you the equipment you need.

If you have further questions, please call us at 301/782-3585. We look forward to serving you.

You also can visit our website at [http://academic.pgcc.edu/~wlloyd/rta](http://academic.pgcc.edu/~wlloyd/rta) for more information.
GUIDELINES FOR DONATING EQUIPMENT TO RESEARCH TECHNOLOGY ASSOCIATES

If you want to donate computer equipment to Research Technology Associates, Inc., you will need to do the following things ...

1) **Contact our organization at:**

   Research Technology Associates, Inc.
   12221 Van Brady Road
   Upper Marlboro, MD 20772-7924

   Our phone number is **301/782-3585**.

2) **Indicate as precisely as you can what you have to donate.** We routinely accept for donation the following kinds of equipment:

   - Pentium-class PCs with CD-ROM and hard drives
   - VGA color monitors (CRT and LCD flat-panel)
   - Keyboards and mice
   - Macintosh, and iMac computers
   - Dot matrix, ink-jet and/or laser printers
   - Scanners and/or other miscellaneous computer/office automation equipment
   - Software

   The more we know about the equipment you have AND the condition of the equipment, the better we can service people who are currently on our waiting list.

3) **Make arrangements with Research Technology Associates, Inc. to deliver the PCs to us, OR arrange for us to pick up the PCs from your location.** If you can deliver your PC to us, that would be most helpful. We CAN come to your site and pick up your equipment, also. Please contact us for details on picking up the equipment from your site. Volunteers with our organization will come to your site to pick up the equipment.

4) **Let us know if you would like a tax-deductible receipt for your records.** Research Technology Associates, Inc. is a non-profit corporation, as specified in Section 501(c)(3) of the IRS Tax Code. Persons or organizations contributing equipment to Research Technology Associates will, upon request, receive a letter acknowledging the donation which can be used for tax deduction purposes.

   Please let us know to whom the letter should be sent, including the person's or organization's name, address and ZIP code.

5) **Let us know of any other organizations that are disposing of surplus PC equipment.** We are always looking for organizations that are disposing of their surplus computer equipment. The more PCs we receive, the better we can serve the various non-profit organizations that look to us for assistance.

   If you or your organization will have additional equipment to donate in the future, please let us know. We can make arrangements to pick up the equipment at that time.
6) **Consider volunteering with Research Technology Associates, Inc.** We are always in need of persons who can do the following things:

- Test, repair and evaluate computer equipment
- Pick up and deliver computer equipment (trucks and/or station wagons are needed, too)
- Answer telephones and prepare correspondence for the mail

We encourage you or your organization's employees to contribute a few hours a week to the work of Research Technology Associates, Inc. Contact our office for details.

If you have further questions, please call us at 301/782-3585. We look forward to serving you.

You also can visit our website at [http://academic.pgcc.edu/~wlloyd/hta](http://academic.pgcc.edu/~wlloyd/hta) for more information.
### APPENDIX A: List of CPU Socket Types from the 80486-class CPU to Date (Revised March 2010)

On the table below is listed all socket and slot types created by Intel and AMD since the 80486 CPU, and examples of CPUs compatible with them. The information is shown in the following format:

<table>
<thead>
<tr>
<th>Socket</th>
<th>Pin Count</th>
<th>Example of Compatible CPUs</th>
<th>Pinout type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Socket 0</td>
<td>168</td>
<td>486 DX Pinout</td>
<td></td>
</tr>
<tr>
<td>Socket 1</td>
<td>169</td>
<td>486 DX</td>
<td>486 DX2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>486 SX</td>
<td>486 SX2 Pinout</td>
</tr>
<tr>
<td>Socket 2</td>
<td>238</td>
<td>486 DX</td>
<td>486 DX2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>486 SX</td>
<td>486 SX2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pentium Overdrive Pinout</td>
<td></td>
</tr>
<tr>
<td>Socket 3</td>
<td>237</td>
<td>486 DX</td>
<td>486 DX2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>486 DX4</td>
<td>486 SX</td>
</tr>
<tr>
<td></td>
<td></td>
<td>486 SX2</td>
<td>Pentium Overdrive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5x86 Pinout</td>
<td></td>
</tr>
<tr>
<td>Socket 4</td>
<td>273</td>
<td>Pentium-60 and Pentium-66 Pinout</td>
<td></td>
</tr>
<tr>
<td>Socket 5</td>
<td>320</td>
<td>Pentium-75 to Pentium-133 Pinout</td>
<td></td>
</tr>
</tbody>
</table>
Socket 6
235
486 DX
486 DX2
486 DX4
486 SX
486 SX2
Pentium Overdrive
5x86

Socket 7
321
Pentium-75 to Pentium-200
Pentium MMX
K5
K6
6x86
6x86MX
MII Pinout

Socket Super 7
321
K6-2
K6-III Pinout

Socket 8
387
Pentium Pro Pinout

Socket 370
370
Celeron
Pentium III FC-PGA
Cyrix III
C3 Pinout

Socket 423
423
Pentium 4 Pinout

Socket 463
463
Nx586 Pinout
Socket 478
478
Pentium 4
Celeron
Celeron D
Celeron M
Core Duo
Core Solo
Pentium 4 Extreme Edition
Pentium M
Mobile Pentium III
Mobile Celeron
Mobile Pentium 4 Pinout

Socket 479
(Socket M)
479
Core Duo
Core Solo
Pentium M
Mobile Pentium III
Mobile Celeron
Mobile
Pentium 4
Celeron M Pinout

Socket 775
(LGA775)
(Socket T)
775
Pentium 4
Pentium 4 Extreme Edition
Pentium D
Pentium Extreme Edition
Celeron D
Core 2 Duo
Core 2 Extreme Pinout

Socket 603
603
Xeon
Mobile Pentium 4 Pinout

Socket 604
604
Xeon Pinout

Socket 771
771
Xeon Pinout
Socket 418
418
Itanium Pinout

Socket 611
611
Itanium 2 Pinout

Socket 462
(Socket A)
453
Athlon
Duron
Athlon XP
Sempron Pinout

Socket 754
754
Athlon 64
Sempron
Turion 64 Pinout

Socket 939
939
Athlon 64
Athlon 64 FX
Athlon 64 X2
Opteron Pinout

Socket 940
940
Athlon 64 FX
Opteron Pinout

Socket AM2
940
Athlon 64
Athlon 64 FX
Sempron
Athlon 64 X2
Pinout

Socket AM2+
940
Athlon 64
Athlon 64 X2
Opteron
Phenom
Not available
Socket S1
638
Turion 64 X2 Pinout

Socket F
1,207
Opteron
Athlon 64 FX (7x models) Pinout

Slot 1
242
Pentium II
Pentium III (Cartridge)
Celeron SEPP (Cartridge) Pinout

Slot 2
330
Pentium II Xeon
Pentium III Xeon Pinout

Slot A
242
Athlon (Cartridge) Pinout
APPENDIX B:

PRACTICAL COMPUTER REPAIR SESSIONS AT THE MARKETPRO COMPUTER SHOWS

As mentioned in the course syllabus, several class days will be dedicated entirely to working “The Help Desk” at the MarketPro computer shows held throughout the Washington DC area.

At these computer shows, we offer a service where customers at the show bring in their problematic laptops and PCs, and we work to repair or diagnose the problems. This will provide you with an extraordinary opportunity to work on actual consumer PCs with issues such as viruses / malware, hardware failures, operating system corruption, application installation and removal, and laptop power problems. These days are considered lab sessions for the course, and attendance is expected at the computer show.

Specific step-by-step procedures should be used when greeting customers, questioning customers about the reported problems, making an initial determination of the exact problem, developing a plan of action to correct the problem, communicating the repair plan to the customer, implementing the repair, and assuring the customer of the corrective actions. In some cases, when a computer repair is not feasible or reasonable, the customer should be given options for equipment replacement that is within their budget. Listed below is the process for handling customers at the Help Desk:

Greeting Customers

When the customer comes into the Help Desk arena, don’t just start working on their PC. We need to greet the person, ask some basic questions to see if we can perform the work, make sure there aren’t other people waiting already in line, and collect some basic information from the customer before proceeding. Follow these steps when greeting a customer:

- Be inviting, polite and professional
- Ask the customer what seems to be the problem
- Provide the customer with the information sheet about our services and requested service charges
- Have the customer sign in on the clipboard, providing us with their name, phone number, and problem description
- Place a label on the PC or laptop with the customer’s name, phone number and reported problem
- Make sure at least one person is responsible for the work; put that person’s name on the sign-in clipboard, indicating who will be doing the work
- Place the computer or laptop in an available space on the table, and begin connecting the unit to power, monitor, keyboard and mouse
- If there is a line of people waiting for services, let the customers know there is a “triage person” who can sign them in; let the customer know there is a wait time involved, and allow them to leave the computer in a safe location
Questioning Customers About the Reported Problems

Once the computer is signed in and ready to be worked upon, discuss briefly with the customer what the reported problems are with the unit. Determine what is happening, when it happens, when it may have started happening, and whether the person made recent changes to their computer. Don't spend a long period of time asking questions; just get the basic facts from the customer. In the next step, you will begin testing the computer, and you can validate what the customer is reporting. You may find that what the customer reports is not in fact the actual problem, but their perception of what they think is wrong. It may be helpful to take down some simple notes of what the customer says to you, if things are busy at the show.

Making an Initial Determination of the Exact Problem

Power up the computer or laptop, and try to replicate the reported problem(s). Usually the problems will become apparent in a short period of time. The typical problems encountered at the Help Desk include the following:

- **Virus and malware infection of the computer**: the PC will be slow, fail to boot properly, display error messages, fail to load or run certain applications, or fail to boot at all.
- **System fails to power up at all**: power supply problems or a short in a major component are common situations. Laptops may have a broken AC adapter jack within the case of the laptop.
- **Hard disk drive failure**: the drive will make grinding or improper noises, or may not power up at all. Error messages from POST may indicate the problem. Drive cables may be mis-connected or damaged, and/or power cables may be damaged or not connected. Master-slave jumpers may be set incorrectly.
- **CD/DVD drive failure**: the drive may not spin up, or may spin without correctly reading the disk. Drive cables may be mis-connected or damaged, and/or power cables may be damaged or not connected. Master-slave jumpers may be set incorrectly. There may be Windows Registry problems that are preventing the drive from being recognized. Add-on software (like a DVD playback application or a disk mastering software) may not be installed, or incorrectly installed. The drive may have been subjected to misuse, abuse, or exposed to contaminants like dust or sticky fluids.
- **Memory problems**: memory DIMMs or SIMMs may have been overheated or damaged by static electricity. Improper or mis-matched memory may have been installed. Memory may not have been correctly inserted into their sockets. Dust in the sockets may be preventing the memory from being recognized.
- **USB connection problems**: USB devices were not properly ejected, potentially causing static discharges and damage to the system board. Drivers may need to be reloaded. Improper insertion of USB cables may have damaged the plug on the system board.
- **CPU or system board failures**: CPU overheating may have damaged the processor. Overall system overheating may have damaged the system board. Improper installation of devices while the system is powered up may have damaged the system board. Power supply connectors to the system board may not be totally connected, or disconnected by accident. A shorted-out device (like a modem or NIC) in a PCI bus connection could create a short along the device bus. Improper or incomplete ROM BIOS upgrades may have permanently damaged the system board.
- **Application software failures**: application will not run, or will not perform certain functions correctly. Uninstallation and reinstallation of the application is the proper solution.
• **Operating system failures**: an improperly performed operating system installation or upgrade could corrupt the PC’s ability to boot. Virus or malware infection may have corrupted the operating system to the point where it will not boot. Running a repair of the operating system is the first, best option. Wiping and reloading the entire operating system is the last but best option.

• **CRT Monitor failure or LCD failure on a laptop**: monitors should simply be replaced; do NOT attempt a repair. LCD screens on laptops can be replaced, but by an expert; cost to replace a laptop LCD can exceed the worth of the unit.

Use these guidelines, along with the information in this text, to make your initial determination of the computer problem. Have your hardware and software toolkits, along with the course DVD and any utility software, available to perform this work.

Do not rush, and do not let the customer badger you or “advise” you when performing your problem analysis. If the customer REALLY knew what was wrong, they would be fixing it themselves. Invite the customer to watch, or to visit the show while you are performing this analysis.

Consult with the instructor if there are any problems or unusual situations encountered during testing. Consult with your fellow students as well for advice and confirmation.

**Developing a Plan of Action to Correct the Problem**

Once you have determined the actual problem, figure out what needs to be done (and/or what needs to be purchased by the customer) to perform the repair. Double-check with the instructor and the Help Desk assistants to confirm that your plan is reasonable and sound. The descriptions of typical Help Desk problems shown above will guide you in what needs to be accomplished, in order to complete the repair.

**Communicating the Repair Plan to the Customer**

Before starting the repair process, consult with the customer. There may be replacement parts that need to be obtained at the computer show, at the customer’s expense. The cost of these parts may exceed the customer’s ability to complete the repair at this time. There may be customer data on the hard drive that should be preserved (or attempted to be preserved) during any re-installation of the operating system.

Explain to the customer all of what needs to be done to bring the system back to normal operation; do so in plain English. Ask the instructor or the Help Desk assistants to speak to the customer with you, if there is any misunderstanding or concern from the person. Obtain agreement from the customer before implementing your repair plan. If the customer chooses not to perform the repair, provide them with your recommendations of what needs to be done.

**Implementing the Repair**

If the repair requires the purchase of new or replacement components, go with the customer into the show, and assist them in purchasing the RIGHT equipment before starting the process. Do not assume that the customer knows what to purchase, or from whom. Ask the instructor or the Help Desk assistants to guide you to the correct vendors that will have the proper parts at a reasonable price. The customer is entirely responsible for the cost of the replacement parts, and any warranty considerations that convey with that part.
Perform the repair once you have all of the necessary parts, tools and software. Work diligently, without rushing or wasting time. Enjoy the experience, and don’t let yourself become stressed. Ask for assistance if needed. Invite the customer to watch, if it seems appropriate. Answer any customer questions if they arise.

Let the customer know approximately how long it will take to perform the repair. If the process takes longer than expected, let the customer know that they can pick up the computer the following day, or from the school in several days. **We want to complete all repairs by the end of the show, unless it is absolutely unavoidable.**

Repairs should be fully complete, and all aspects of the computer should be 100 percent operational. A 98 percent repair job is NOT complete; everything should work as designed. Do not consider the job completed until everything is finished and you are satisfied that the system is 100 percent correct. Ask the instructor and/or the Help Desk assistants for guidance, if you want to verify that everything is completed properly.

**Assuring the Customer of the Corrective Actions**

Once the repairs are completed, demonstrate to the customer that the system is working properly. Answer any questions, and refer any issues to the instructor or the Help Desk assistants for clarification. Remember: when the customer is satisfied, then we are satisfied. This is a major part of quality assurance in the IT service industry.

**Collecting the Service Charge**

We do ask for a $40.00 service charge for the work performed at the Help Desk. This price is significantly lower than what is charged for computer repairs in the field. This charge enables our non-profit organization, Research Technology Associates (RTA), to perform various kinds of charitable work in the local community, and also around the world. It also prevents people from viewing us as merely a free service and taking advantage of our offering.

The $40.00 service charge does not include the cost of additional parts, operating system software or application software. **We do not give away copyrighted software to customers for free**, such as Microsoft Office. We can reload operating systems if there is a Microsoft Certificate of Authenticity (COA) on the PC, or if the customer has an authentic copy of the operating system installation CD. We do provide and install free anti-virus, anti-spyware and utility software applications for our customers, and will install copyrighted applications if the customer has the **original** disks (not copies).

If a customer complains that $40.00 is too much to fix a computer, don’t even argue with them; the person **OBVIOUSLY** does not know how expensive computer repairs can become. They will discover that fact very shortly, when they try to have the computer serviced elsewhere. If someone simply does not have the $40.00, have the customer speak to the instructor. We are willing to waive a charge for someone with a genuine financial hardship.

The $40.00 service charge is considered to be a tax-deductible contribution; receipts are available upon request. The triage person at the Help Desk can provide the receipt to the customer. All monies should be given to the triage person, or to the instructor. Checks can be made payable to RTA, and cannot be pre-dated or post-dated. **We do not accept credit or debit cards of any kind.**
Providing Options for Equipment Replacement

If the computer or laptop is beyond repair or the repair price will cost more than the value of the unit, explain this to the customer, gently. Take the customer through the computer show and offer different alternatives for replacing the unit. The computer show has new, refurbished and used computer equipment that is sold at well below retail market prices. There will be many options for the customer to consider, so help them as best you can. Ask the instructor or one of the Help Desk assistants for guidance as needed.

NOTES
APPENDIX C: USING NORTON GHOST TO IMAGE A HARD DRIVE

Norton Ghost is one of a number of disk-imaging applications that allows you to make a mirror-image copy of one hard drive to another.

If you are preparing a number of identical computers, it does not make sense to go through the entire process of formatting the drive, installing and configuring the operating system and drivers, and then loading your applications on each individual PC. You can create one prototype machine, ensure that it is 100-percent ready for use, and then use Ghost to duplicate your prototype hard disk image to all of the other identical machines. Further, it takes only a few minutes to duplicate a disk using Ghost, as compared to hours preparing PCs individually.

In the course, we will demonstrate and perform disk-imaging tasks in the lab sessions by using Norton Ghost. We have bootable CD-ROM disks (that were created with the Norton Ghost Enterprise Edition application) that you can use to boot the PC, launch the Ghost application, and then duplicate one disk to another. Please ask the instructor or a lab assistant for a copy of these disks when the lab session begins, or when the need arises.

Below are instructions on how to image a hard drive using Norton Ghost:

• Prepare (or locate) your prototype PC, with the assistance of the instructor and lab assistants
• Locate a blank hard drive, or remove the hard drive from a PC that is to be imaged (or re-imaged)
• Open the case of the prototype PC, and connect the blank hard drive to an available IDE or SATA connection (remembering to set the IDE master-slave jumpers as needed)
• Power-up the prototype PC, and enter the CMOS Setup program
• Detect the blank hard drive, and make sure it is recognized by the Setup program
• Make sure that the PC’s boot sequence is set so that the CD-ROM drive is the first boot device
• Insert the bootable Ghost CD into the CD-ROM drive
• Save the settings in the CMOS Setup program, and reboot the PC
• The PC should boot to the CD-ROM disk; if an error message concerning the network adapter appears on the screen during this process, ignore the message and press any key to continue
• The Norton Ghost application will appear on the screen; press Enter or click OK to continue
• In the Ghost application, use the mouse or the arrow keys to select the following menu options:
  - Local
  - Disk
  - To Disk
• Press Enter or click on OK to select your source disk; it should be the drive shown on the top of the displayed list
• Press Enter or click on OK to select your destination disk; it should be the drive on the bottom of the list
• At the next screen, press the Tab key to reach the OK button, or use the mouse to click on OK
• When the warning message screen appears, click on the Yes button to start the disk imaging process
• The application will show the number of minutes remaining until the imaging process is completed, and will display a message when the process is finished

The Ghost application will copy everything from the source disk to the destination disk. If the destination disk is larger than the source, Ghost will format the additional space automatically in addition to copying all of the data. If the destination disk is SMALLER than the source disk, you must make sure that the disk is capable of holding all of the data from the source disk.
When the disk has completed the imaging process, remove it from the prototype PC and install it back into the computer from which it was removed. Power-up the PC with the newly-imaged hard drive; make sure that it boots properly, launches Windows successfully, and recognizes all of the hardware components.

**NOTE:** A disk imaged with Norton Ghost will NOT boot-up properly if it is installed in a PC that is not IDENTICAL to the prototype system. You may encounter a “Blue Screen of Death” error message in such an instance. Make sure that you are working with identical systems when using Ghost.

If you encounter any errors when using Norton Ghost, please ask for help from the instructor or one of the lab assistants.

**Obtaining a Copy of Norton Ghost for Personal Use**

The home (personal) version of Norton Ghost is available online at http://www.ghost.com/, or from a number of online and traditional retailers. The cost for the application usually is under $39.00. The home version will enable you to create bootable floppy, CD/DVD or USB flash disks that will let you image hard drives. Drives can even be imaged between PCs over a local area network, via the network card built into or installed in the PC. You will need to specify the brand and model of network card when creating the bootable disk, so that the application will be configured properly.

The Norton Ghost Enterprise Edition application, however, is VERY expensive. It is intended for use in larger corporate settings, and the price is determined by the number of end-user licenses. Further, Symantec Corporation aggressively monitors the enterprise version of this application, and will prosecute individuals and companies that violate the terms of the licensing agreements. The instructor has a license of the Enterprise Edition application for use only within an academic setting. Copies of this enterprise version of Ghost are not available from the instructor, for the reasons described above.

**NOTES**