A+ Practical Application

Mega Guide

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A+ Practical Application (220-702) MegaGuide

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Abstract

To become a certified CompTIA A+ professional, a candidate must pass two exams. The first exam is CompTIA A+ Essentials, exam number 220-701. The CompTIA A+ 220-702 exam, Practical Application, is the second exam required and is the focus of this guide. As of June of 2011, this guide has been updated to include material related to the Windows 7 upgrade.

What to Know

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. Candidates who are ready for this exam will have the skills required to:

- install, configure, upgrade, and maintain PC workstations running the Windows operating system

- troubleshoot small office/home office (SOHO) networks

Job titles in some organizations that are descriptive of certified A+ candidates include: Enterprise technician, IT administrator, Field service technician, and PC or Support technician.

Tips

This guide is not intended to be an all-inclusive reference for technicians. Rather, this could be considered the "Cliffs Notes" to a very broad and inclusive area of study. It is advised that a technician with little-to-no experience in the field, preparing for this exam, purchase an A+ Reference Guide. The guide should be used for quick reference and study. Also, it is recommended that the technician also purchase the study exam questions that serve as a companion to this guide.

Domain 1.0: Hardware
Storage Devices

A storage device is, broadly defined, any component your computer uses to permanently store information. This is done in a variety of ways by a variety of different components, but generally speaking, storage devices are split into two categories: **fixed** and **removable.**

- **Hard Disk Drive** (HDD) – a fixed, non-volatile storage device that stores information on the magnetic surface of hard disk platters.

  ‣ Hard disks are measured in terms of capacity (typically in GB) and in speed (revolutions per minute, or RPMs).

  ‣ Today, a typical workstation's hard drive might have between 40 and 200 GB of storage space rotating at 7,200 to 10,000 RPMs.

  ‣ Connected to the computer by one of several different connections:

    - **ATA** – Standard on most desktop computers; IDE and EIDE; cable is a flat, wide ribbon.

    - **Serial ATA** – Provides for faster communication speeds between hard drive and motherboard; it is *not* backward compatible with the ATA form factor.

    - **SCSI** – Interface allowing the connection of several devices in a chain.

  ‣ **RAID** (Redundant Array of Independent Disks) – a system utilizing multiple hard disks in tandem to share data across the drives. It helps provide data security and recoverability, protecting against hard drive failure.

- **Floppy Disk Drive** (FDD) - removable storage utilizing a thin, flexible magnetic storage medium, encased in a plastic shell to read and write data.

  ‣ While over time drive capacities have changed, today's standard floppy disk drive size is 1.44 MB.

  ‣ Floppy disk drives are quickly going out of standard use, due to the higher capacity, and much cheaper, writeable compact disks.

- **CD-R** and **DVD-R** (or RW, for rewriteable) – removable storage that takes advantage of the higher capacity of optical disks to store information. Optical drives are, typically, IDE or SCSI devices.

  ‣ CD-R (and DVD-R) drives utilize a red-light laser to "burn" data onto blank optical discs.

- CD-R and DVD-R media come in several different types:

  - **CD-RW** – Rewriteable discs, with a standard size of 700MBs.

  - **DVD-R** – Also write-once discs, DVDs have a standard capacity of 4.7 GB. This format includes the **DVD-RW**, the rewriteable form.

  - **DVD+R** – Simply another write-once format, not currently approved by the DVD Forum. It also has a rewriteable form, **DVD+RW,** and a double layer disc with a capacity of almost 8.55 GBs, referred to as **DVD+RW DL**.

  - **Blu-Ray** – Is an optical disc storage medium that is designed to replace the standard DVD format. It stores up to 25 GB of data per single layered disc, and 50 GB per dual layered disc.

- Drive speeds are as varied as media types and are issued as multiples of the original read speed of the device. CD-ROMs start at 150KB/s, and DVD-ROMs start at 1352.54KB/s. Thus, a 52x CD-ROM reads at 7800KB/s, and a 16x DVD-ROM reads at 21,640KB/s.

- Other removable storage options include:

  - **Tape Drives** – sequential-access data media composed of a strip of magnetic or punched tape. Usually used for archival storage due to the long shelf-life of the medium.

  - **Solid State Drives** – such as thumb, flash and SD drives. Volatile storage (like RAM) utilized for extremely quick access speeds. These are usually used in small, hand-held devices.

  - **USB** – a serial connection used to link, typically, external devices to the computer. These can be hard drives and optical drives, and are utilized for a variety of reasons but are usually used to take advantage of the ease of operability and installation. USB external devices are plug-and-play.

Selection Criteria

Every technician, before installing a new storage device, should ask the following questions:

- What problem is the device being purchased going to solve?

- Will this device replace, or add on to, an existing device?

- Will this device be an internal or external device?

- What type of controller will the device be hooked to?

- Are there any space or cable limitations?

- Will the device be SCSI or IDE? Which type of SCSI or IDE?

- IDE drive types include the Serial Advanced Technology Attachment (SATA), which is a method designed to move data to and from the hard drive at a rate approaching 600 MB per second (due in 2007).

- Wide Ultra SCSI 2 technology will move data at a rate of 80 MB/s.

Installation of Internal Storage Devices

Consider the following during installation:

- Exact installation will vary depending on the case.

- Install any rails to the correct side of device.

- Determine if device is plug-and-play, or if manual configuration is required.

- If the device is IDE, is it set to master/slave or cable select?

- If the device is SCSI, does the device ID need to be set?

- Note the location of Pin 1 on device, mainboard and cable.

- If the cable is not keyed, the red stripe on the cable indicates Pin 1.

- After making any manual configuration changes, put device in the appropriate slot and attach cables.

- Plug in power connector.

Configuration of Internal Storage Devices

Most internal storage devices are plug-and-play. Otherwise, if the system does not locate and install the device, the system may need to be configured to recognize the device through BIOS.

Some drives may need to be reformatted. This can be done from **Control Panel > Administrative Tools > Computer Management**. Click on the **Storage** dropdown menu and click the **Disk Management** icon. The screen will look like this:
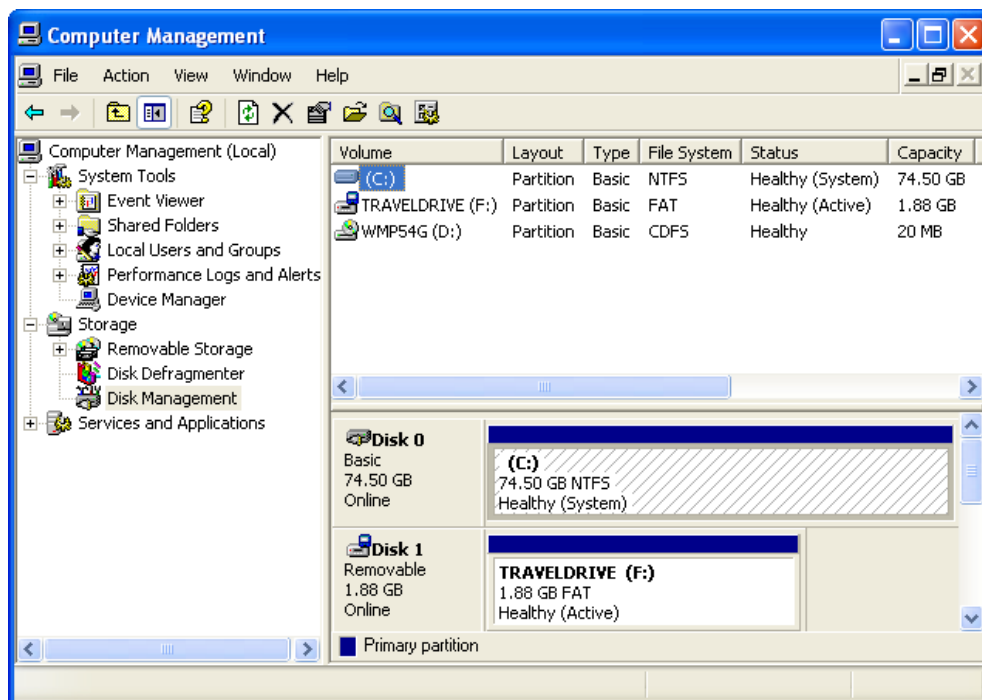
Figure 1: Computer Management console

If necessary, click on the drive and **create a partition**, then **format** that partition. You can also use the console to check the drive lettering if **My Computer** does not show the newly installed drive. Some systems will stop registering internal drives after drive letter E.

Installation of External Storage Devices

External storage devices will usually come with a USB, Firewire or SCSI interface. For an external SCSI device, depending on the device, the computer may have to be shutdown, the device cable plugged into the appropriate adapter, and then the computer powered back on. USB and Firewire devices are usually hot swappable and plug-and-play. After inserting the cable, power up the device, if necessary, and device should be recognized by the computer.

Removal of Storage Devices

Removal of external storage devices connected with Firewire or USB cables usually means simply powering off the device, if necessary, and unplugging the device. Removal of an external SCSI device may require a system shutdown.

Removal of an internal device will require a system shutdown before you can remove the drive from the system. Of course, any data stored on a disconnected drive will no longer be available.

Troubleshooting with a Customer

As a phone support technician, you will be limited in the number of things you can instruct a user to do over the phone, especially in regard to storage devices. Here are some issues that can be resolved.

- Have the user check any external storage devices for power and proper connectivity.

- If the user still cannot access the device, have them uninstall and reinstall the drivers and check the manufacturer's website for firmware and driver updates.

- If the user is having problems with access time or corrupted files, have them run chkdsk and/or defragment.

  - A deep scan with chkdsk can reveal any physical failures associated with the disk, requiring servicing from a hardware technician.

    - Have the user open **My Computer**.

    - **Right-click** on the drive to be scanned.

    - Click **Properties** followed by **Tools**.

    - Under **Error Checking**, choose **Check Now.**

    - Suggest that the user click both boxes, and then start checking the disk.

  - Defragmenting can improve access speeds.

    - Following the same procedure listed above, have the user click on **Defragment Now.** under the **Tools** tab in **Disk Properties**.

    - Defragmentation can take some time, so it is wise to suggest that the user call back when Defragment is finished.

- **If the drive is making any clicking or buzzing noises, the drive is bad and needs to be replaced**. Refer the user to the appropriate department of your support team.

- Optical and Tape storage devices may need to be cleaned.

  ‣ Cleaning an optical drive, such as a DVD-ROM, is typically as easy as using a blast of compressed air.

  ‣ Remind the user to *never use audio CD cleaning disks in a PC drive*. These disks have brushes that can and will damage the laser array.

  ‣ Tape storage should be cleaned with the appropriate tape head cleaner. Have the user contact the device's manufacturer for the best cleaning device.

Motherboards

Motherboards (or mainboards) are one of the most important components in a computer. They provide the backbone of communication between all devices installed on a computer, and as such, it is important to understand how the various components on a motherboard function.

- **Form Factor** – refers to several characteristics of a motherboard, including its size and format (which in turn relates to the size and format of the computer case), as well as the particular interfaces that allow communication with other devices.

  ‣ **ATX** (Advanced Technology Extended) – the industry standard motherboard form factor.

  ‣ **BTX** – a newer version of ATX, focusing on a lower profile and providing better thermal regulation. BTX is currently being used in Gateway and Dell computers.

  ‣ **Micro ATX** and **NLX** – smaller versions of the ATX built for smaller, workstation oriented computers.

- **Components**

  ‣ Most motherboards include a variety of integrated input/output components. These are usually sound, video, parallel and serial ports, and USB connections. Some motherboards also provide integrated modems, network interface cards and IEEE 1394 (or firewire) connections.

  ‣ **Memory Slots** – refers to the available slots for RAM modules, and come, typically, in two styles:

    • **RIMM** – This is the industry standard for RDRAM memory. Possesses a 32-bit bus length.

    • **DIMM** – Dual In-line Memory Module. This doubles the bus length to 64-bits, providing higher bandwidth for access speeds.

  ‣ **Processor Sockets** – refers to the socket type for the processor chip. ATX motherboards can potentially come with one of several different socket types:

    • **Socket 478** – Used for Intel's Pentium 4 and Celeron chips. Supports high bus speeds, DDR, RD, and SD RAM.

    • **Socket A** – Used for AMD's line of processors. While this is still in wide use, it has been ultimately replaced by the **Socket 939** for high-end AMD processors, and the **Socket 754** for budget processors.

‣ **External Cache Memory** – refers to small amounts of volatile memory located near the CPU to provide faster access times to memory modules, by duplicating frequently used locations in the RAM modules.

‣ **Bus Architecture** – refers to the connection medium through which peripheral cards connect to the motherboard.

‣ Peripheral cards connect to the computer bus through a variety of **bus slots**:

- **PCI** – Most commonly used bus slot; most expansion cards utilize the PCI bus (with the exception of graphics cards).

- **AGP** – PCI-derived standard with higher bus speeds utilized for 3D graphics rendering.

- **PCI-E** – *Express* PCI slot developed more recently which utilizes a much faster serial communications protocol.

‣ **EIDE** (or **PATA**) and **SATA** – standards for connecting storage media to the motherboard.

- **EIDE** – utilizes a parallel connection and a shared bus consisting of a master device and a slave device.

- **SATA** – theoretically, faster. However, its largest benefits over EIDE are smaller power and interface cables and the ability to hotplug SATA devices. This is due, in part, to the dedicated cable and host controller for the serial device. A dedicated host controller means that the information passed along the bus can be more quickly assimilated or disassembled, resulting in faster speeds.

‣ **SCSI** (Small Computer System Interface) – commonly used to connect hard, optical, and tape drives; however, these can be expanded to connect a wide range of devices, including scanners and printers. There are several SCSI standards. Generally speaking, SCSI provides a higher range of data management and protection capabilities than the ATA standard. Refer to *Figure 2*, **SCSI Types** for a listing of SCSI standards and their associated speeds.

SCSI Type	Bus Speed	Bus Width	Transfer Rate	Max Number of Devices
Regular SCSI-1	5 MHz	8 bit	5 MB/s	8
Wide SCSI-2	5 MHz	16 bit	10 MB/s	16
Fast SCSI-2	10 MHz	8 bit	10 MB/s	8
Fast Wide SCSI-2	10 MHz	16 bit	20 MB/s	16
Ultra SCSI-3	20 MHz	8 bit	20 MB/s	8
Ultra Wide SCSI-3	20 MHz	16 bit	40 MB/s	16
Ultra 2 SCSI-3	40 MHz	8 bit	40 MB/s	8
Ultra2 Wide SCSI-3	40 MHz	16 bit	80 MB/s	16
Ultra3 SCSI-3	40 MHz	16 bit	160 MB/s	16
Ultra4 SCSI-3	80 MHz	16 bit	320 Mb/s	16

Figure 2: SCSI types

▸ Chipset – refers to the specialized motherboard chips handling communications between outlying devices and the processor. These come in two classes:

- *Northbridge* – located closest to the processor, which handles communication between RAM and AGP and PCI-E slots.

- *Southbridge* – located furthest from the processor, handling slower devices, such as PCI, IDE, USB, etc.

▸ **Basic Input/Output System** (BIOS) – a hard-wired software code the computer uses to prepare the machine for control by the operating system.

- BIOS utilizes a version of non-volatile memory to store these settings, referred to as **CMOS**, and connected to a small battery.

- In this context, **Firmware** refers to the actual software hard-coded on the BIOS, which can be updated via a process referred to as "flashing."

Motherboard Selection, Installation, and Upgrade

Motherboards (alternatively, mainboards) are the backbone of any computer system. Without a working or properly installed motherboard, the computer is just an inert chunk of plastic.

The latest motherboard technology is called PCI Express or PCIe. In PCIe, the shared bus is replaced with a shared switch. Each device in the system will have exclusive access to the switch, and the switch will be able to create point-to-point exclusive communications between devices.

When choosing a motherboard, it is important to carefully consider the following concepts.

Selection of motherboards
Consider the following when selecting a new or replacement motherboard:

- The footprint, or size requirements, of the computer case

- Compatibility with other devices

  ▸ CPU/Processor

  ▸ Power supply

  ▸ Storage devices

- Compatibility or type of BIOS

- Memory needs of the system,

  ▸ How much memory can the motherboard handle?

  ▸ How many modules can the motherboard physically hold?

- Number of expansion slots

- Number and types of ports

    ‣ USB slots

    ‣ Firewire slots

    ‣ Serial ports

    ‣ Parallel ports

    ‣ Keyboard and mouse ports

- What integrated peripherals are included on the motherboard?

    ‣ Network card

    ‣ Video card

    ‣ Sound

- Disk controllers (both IDE and, if required, RAID)

- Are there drivers available for all the on-board components that match the operating system you want to use?

- Is the motherboard going to be used in a media center PC? If so, are the television/cable connections available?

Installation of a Motherboard

There are several things to consider when installing a motherboard:

- Read manual before beginning installation.

    ‣ Note manual settings which may improve compatibility with other components.

    ‣ Examine motherboard schematic for key cable connections: Floppy and IDE or SCSI controllers, the LED's for hard disk activity and power, etc.

- Determine the location of pin 1 for each cable connection.

    ‣ Pin 1 will be designated on the motherboard with a square at the base of the pin.

    ‣ The cable connector will usually have an arrow to designate pin 1.

    ‣ Match the arrow to the square for proper installation.

- Install plastic standoffs to the case to keep motherboard from direct contact with it.

    ‣ These should be installed in key places, such as in corners and near expansion slots.

    ‣ Make sure standoffs match the requisite holes on the motherboard.

- The CPU and heatsink should be installed prior to motherboard installation.

- Check memory module locations. If these will be in difficult to reach locations (under drive arrays, power supply, etc.), you should install these before installing motherboard, as well.

- Any difficult to manage cable attachments should also be made prior to motherboard installation.

- Attach motherboard to standoffs by using screws of appropriate size and non-conductive washers.

- Once motherboard has been secured, attach power supply cables to motherboard. Power supply cables are keyed for simple installation.

- The motherboard is now ready for expansion cards, hard disks, optical drives, etc.

Motherboard Upgrades

Hardware components contained on the motherboard are not usually end user upgradeable. However, BIOS and the drivers which manage hardware components *can* be upgraded.

- BIOS upgrades:

  ‣ Download BIOS upgrade.

  ‣ Copy upgrade to a floppy or bootable CD.

  ‣ Boot computer with the floppy/CD and upgrade should start automatically. **Do not stop the upgrade process**.

- Driver upgrades:

  ‣ Download driver and expand compressed file.

  ‣ Navigate to **System Properties > Hardware > Device Manager** to locate the device to be upgraded. Double click the device and choose the Driver Tab to get the following screen:
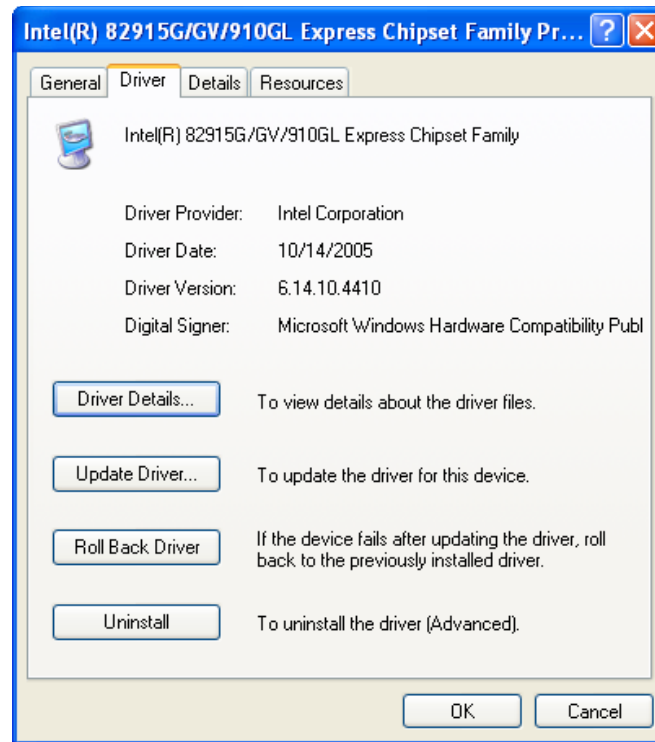
Figure 3: Investigating driver details

- Click on **Update Driver** and follow the wizard.

Power Supplies

A power supply's main purpose is to both *convert* AC power, typically between 120 and 240 volts (V), into useable power and to *convey* that useable power adequately throughout all of a computer's various components.

- Though power supplies come in a wide variety of form factors for different uses, most conform to the ATX standard.

- Power supplies are rated based on their maximum output power, measured in watts (W); most fall between 200 W and 500 W.

- Output leads, from the unit, supply power to the various devices.

Purchasing Power Supplies

- The first consideration is the footprint of the computer case. Any ATX power supply should fit in any ATX case.

- Consider power supply specifications, such as wattage, voltage and the number of connections available for internal devices.

- Not all power supplies are created equal — higher prices mean better quality components.

Installation of Power Supplies

Power supplies for PCs range in size from 200 to over 1000 watts. To replace a defective power supply or to upgrade to a larger capacity power supply, purchase a similar form factor power supply of equal or greater wattage.

Upgrade/install a power supply

1. Disconnect all power connectors from devices.

2. Disconnect ATX power connector from motherboard.

3. Unscrew and remove the old power supply from the PC.

4. Insert and attach the new power supply.

5. Connect all new power connectors to devices.

6. Connect ATX power connector from the motherboard.

7. Plug the computer power cord into the power socket on the back of the case (specifically, the back of the power supply).

    a. Although the default setting should be 110V – 120V (standard for North America), some power supplies can be switched to 220V – 240V.

    b. Double-check the back of the power supply and ensure the switch, if present, is set to 110V – 120V if used in North America.

8. Power on the PC.

Processors

If one can visualize the motherboard as the backbone of a computer system, then it is appropriate to imagine the processor as the brain of a computer system. The central processing unit (CPU) performs all data processing and instruction interpretation that is vital to the operation of a computer.

- Virtually all personal computers utilize one of two brands of processor chips:

    ‣ **AMD** and **Intel.**

    ‣ In reality, there is very little difference between the two chips, aside from basic architecture and pin structure and the general acknowledgement that Intel processors run slightly cooler than AMD processors.

    ‣ Processor choice should ultimately be made based on price and features.

- CPUs can potentially support a number of various chip technologies, described below:

    ‣ **Hyper-threading** – the utilization of otherwise idle execution units to improve the over-all reaction and response time of the CPU.

    ‣ **Dual-core** – refers to a single processor which possesses two independent microprocessors.

    ‣ **Throttling** – also known as clamping, cuts the amount of CPU time used on applications which stall the computer.

> ‣ **Micro Code** (MMX) – a CPU instruction set, designed by Intel, which allows for the CPU to "package" larger instructions into smaller pieces, or microprograms.

> ‣ **Overclocking** – the process of overriding a CPUs designed clock speed in favor of faster clock speeds, which in turn provides better performance.

> ‣ **Cache** – a designated set of smaller, faster memory units, utilized by the CPU, to perform frequently utilized instructions faster.

> ‣ **Voltage Regulator Module (VRM)** – the device which provides the proper amount of power to a CPU.

> ‣ Most processors today come in a **32-bit** format, with **64-bit** processors slowly finding use in academic and corporate institutions. The essential difference between the two formats lies in their ability to handle mathematical calculations. 64-bit processors can simply handle larger numbers and can be more efficient with smaller numbers.

A note on CPU speed
The speed of a CPU is a somewhat amorphous subject. The clock speed, expressed in terms of cycles per second, or *hertz*, is an expression of how fast a CPU performs its most basic functions. Of course, most processors run in excess of a billion cycles per second, or in GHz. At these speeds, the clock speed is really only helpful in comparing processors in the same family (i.e. between two Pentium 4 chips, or two Athlons). Other factors also contribute to a CPU's overall speed and performance, such as the kind and quantity of cache memory or the size of the data bus. A software benchmark test is the only real reliable way to compare the speeds of processor chips.

If the motherboard is the backbone of any PC, the Processor is the brain. Processors can be purchased that are single or dual core. Dual core processors theoretically provide twice the processing power of the single core cousins. Consider the following concepts.

Installation of the CPU

First, consider the type of CPU being used in the installation. AMD CPUs and Intel socket 478 CPUs have pins attached to the CPU. Intel's socket 775 CPUs attach to pins on the motherboard. The following section details installation procedures for both types:

To install the **AMD** or **Intel Socket 478**

- Ground yourself with a wrist strap and open the case.

- Lift socket lever up until it locks upright.

- Align CPU notch with the same notch on the motherboard sockets.

- Match up pins on the CPU with the motherboard slot and let the CPU down; do not force the CPU down.

- Pressing the socket lever down finishes seating the CPU; slide the lever under the retaining clip.

- Heatsink and fan should be installed next.

- Align the hooks on the heatsink with the brackets around the CPU socket and hook one side first, followed by the next. It should click into place.

- Connect the CPU fan to the power supply.

To install the **Intel Socket 775**

- Remove the cover on the motherboard socket.

- Lift the lever and metal flap, providing enough room to set the CPU in place.

- Match the notch in the corner of the socket with the same on the CPU.

- Set the CPU in the socket, lower the metal flap, close, and lock the socket lever.

- The heatsink fits into four holes and is secured by twisting four locking clips.

Memory

RAM, or simply memory, is volatile storage space the computer uses to load active programs. Since RAM is accessed randomly, rather than sequentially, programs loaded into memory can be loaded quickly and used more efficiently. Since proper RAM choice and installation is vital to proper PC operation, it is important for technicians to understand the difference between various types of RAM and the technologies they use. Refer to *Figure 4* for a list of memory types and their pin sizes.

RAM Type	Pin Size
DRAM	72-pin SIMM
SDRAM	168-pin DIMM
DDR	184-pin DIMM
DDR-2	240-pin DIMM
RAMBUS	184-pin RIMM

Figure 4: RAM types

Memory Types

- **SRAM** – Static memory that retains information as long as power is applied to it; this is used almost exclusively in CMOS applications.

- **DRAM** – Dynamic memory that requires refreshing in order to retain information; this is the most common type of RAM, and all other types of system memory RAM are based on this concept.

- **SDRAM** – DRAM which synchronizes with clock signals from the system bus and processor, making it more efficient.

- **Double Data Rate** (DDR) – SDRAM which transfers information twice on the same clock signal, effectively doubling its bandwidth. **DDR-2** works on the same principle and has some improvements to further increase bandwidth and transfer speed.

- **RAMBUS** – Another double data rate DRAM designed specifically by the Rambus Corporation, this type of RAM operates slightly faster than previous DRAM formats. It is also very expensive, produces much more heat and has a slower latency time.

- **Dual-Channel Memory** – This type of memory is enhanced, on motherboards which support it, with two 64-bit data channels, resulting in an incredible 128-bit bandwidth. This type of memory must be installed in matched sets. Motherboards supporting this type of memory will have color-coded memory slots.
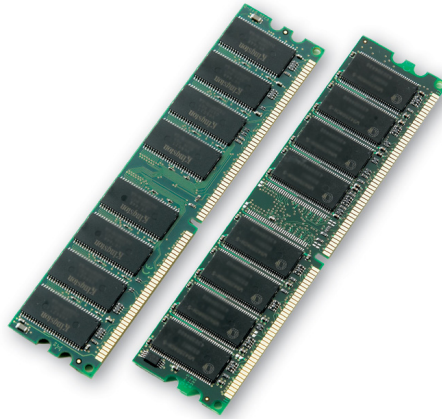
Figure 5: RAM modules

Operational Characteristics

- **Memory Chips** – the individual memory chips on the RAM module and come 8, 16, 32 or 64-bit in size. Generally speaking, higher quality RAM modules use larger and fewer memory chips.

- **Parity** – a simple form of error checking that attaches a bit to transferred data. Parity is not error correcting, so data deemed corrupt by the parity bit is discarded and must be retransmitted.

- **ECC** – uses slightly more information to not only detect errors, but correct them at the point of transmission. Because the instructions are more complex, ECC RAM can be somewhat slower than non-ECC RAM and will also be more expensive, due to the complexity of construction.

- Sometimes RAM modules come rated as either **single- or double-sided**. Contrary to popular opinion, this has nothing to do with the placement of the memory chips. Rather, it has to do with how much of the RAM module is given over to transmission space. A single-sided RAM appears to the motherboard as one 64-bit area, regardless of how many chips are actually on the module. A double-sided RAM appears as two 64-bit areas.

Common SDRAM Memory Module Speeds and Formats

Format	Frequency	Bandwidth	Pins	Volts
PC-66	66 MHz	0.5 GB/s	168	3.3
PC-100	100 MHz	0.8 GB/s	168	3.3
PC-133	133 MHz	1 GB/s	168	3.3
PC-1600 / DDR-200	100 MHz	1.6 GB/s	184	2.5
PC-2100 / DDR-266	133 MHz	2.1 GB/s	184	2.5
PC-2700 / DDR-333	166 MHz	2.7 GB/s	184	2.5
PC-3200 / DDR-400	200 MHz	3.2 GB/s	184	2.5
PC2-3200 / DDR2-400	200 MHz	3.2 GB/s	240	1.8
PC2-4200 / DDR2-533	266 MHz	4.3 GB/s	240	1.8
PC2-5300 / DDR2-667	333 MHz	5.3 GB/s	240	1.8
PC2-6400 / DDR2-800	400 MHz	6.4 GB/s	240	1.8

Figure 6: RAM characteristics

Laptop Memory Modules
Laptop SO-DIMMs use the same memory technology as desktop computers. However, their small size uses fewer pins. While the modules above feature 168, 184, and 240 pins, their laptop SO-DIMM equivalents use only 144 or 200 pins.

Rambus Memory Modules
Direct Rambus DRAM, often called RDRAM, is a format of memory that uses Rambus Inline Memory Modules (RIMMs). Once popular on early Pentium 4 systems, RDRAM could provide 1.2 GB/s to 6.4 GB/s of bandwidth. DDR and DDR2 SDRAM have since replaced RDRAM in new high-performance motherboards.

Troubleshooting Memory

Memory

- The symptoms of memory problems can be extremely varied. If bad memory is suspected, a hardware or software memory tester can accurately diagnose it.

- Older RAM modules will require installed modules to be in matched sets. If this is true for the computer, ensure that the modules are the same speed and size, and are installed in the correct slot.

- Make sure modules are properly seated.

- Listen for BIOS Beep Codes. The following table details some BIOS beep codes for memory failures.

Beep Code	Meaning
AMI BIOS	
1 Beep	Memory Refresh Failure
2 Beeps	Memory Parity Error
3 Beeps	Base 64k Memory Failure
Award BIOS	
Endlessly Repeating Beeps	Memory Error
Phoenix BIOS (dashes indicate a pause)	
1 – 3 – 1	Memory Refresh Failure
1 – 3 – 2	Base 64k Memory Failure
1 – 4 – 2	Parity Error
4 – 3 – 1	RAM Test Failure

Figure 7: Memory-related BIOS beep codes

Purchasing Memory

- Check the type and speed of memory the motherboard uses.

- Note the maximum amount of memory the motherboard can access and physically hold.

- If purchasing dual core memory, be aware of the following caveats.

- The DIMM configuration must be matched in each channel in the following ways:

  ‣ The modules must be the same size (512MB, 1GB, etc.).

  ‣ The modules must share the same DRAM technology, such as 128 megabit, 256 megabit or 512 megabit.

  ‣ The modules must be the same DRAM bus width.

  ‣ The modules should each be either single-sided or double-sided.

  ‣ Memory channel A and memory channel B must be matched.

Installing Memory

1. Remove any old memory by pressing down on the clips located at each end of the memory socket, which will eject the modules.

2. Locate the lowest numbered open slot (i.e. DIMM 0, DIMM 1, etc.).

3. Align the notches at the bottom of the module so it matches the configuration of the slot.

4. With the ejector clips open, slide the memory into the slot and press down.

5. The module will force the ejector clips to close, locking the memory module in place.

6. Turn computer back on, insuring that the BIOS recognizes the new memory.

Upgrading Memory

Take note of the number of open memory slots, the maximum amount of memory the system will hold, and the type and speed of memory currently in the system. If you are adding, instead of replacing, you want the new memory to be the same speed and type as the old.

Virtual Memory

To most end-users, virtual memory is the most occult feature of Windows. It's not that it is difficult to change or use, only that most users don't know what virtual memory is exactly or how to properly set it up on their computers.

Essentially, virtual memory is Windows' way of taking some operating system tasks off of the actual physical memory's workload. It does this by partitioning off hard drive space and dumping information into a special file called the **swap** or **paging file**. It is important to understand that, though virtual memory adds to the computer's overall memory, it does not take the place of physical RAM. Virtual memory is limited by its inclusion on the hard drive, which cannot be accessed as quickly as regular RAM. Making sure that the paging file is set to the proper size and settled in a good place can drastically improve the performance of a PC. Consider the following:

- In general, virtual memory should be set somewhere between **2x** and **2.5x physical memory**.

- The page file, if possible, should be placed on the same partition as the operating system.

- To access Virtual Memory settings, use the following procedure:

  ‣ **Right-click My Computer** and choose **Properties.**

  ‣ Click the **Advanced Tab**.
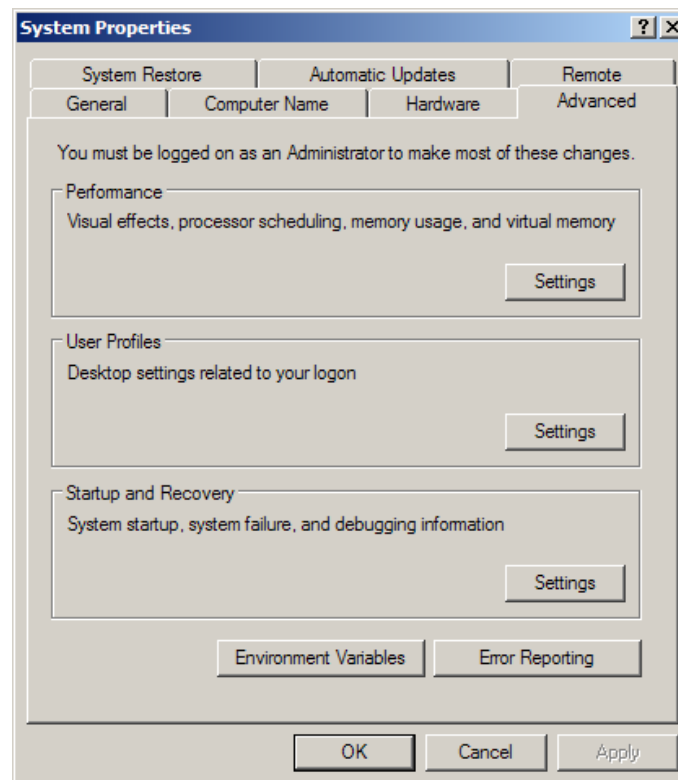
Figure 8: System Properties dialog box

> ▸ In the first box, under **Performance**, click the **Settings** button.
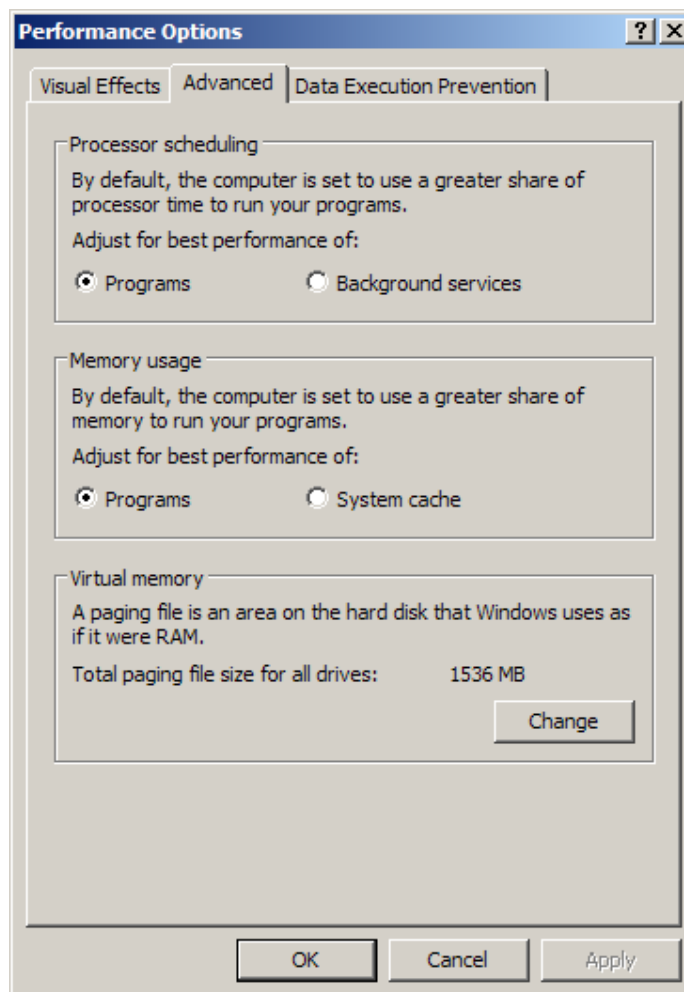
Figure 9: Performance Options dialog box

> ▸ In the bottom box, under **Virtual Memory**, click the **Change** button.
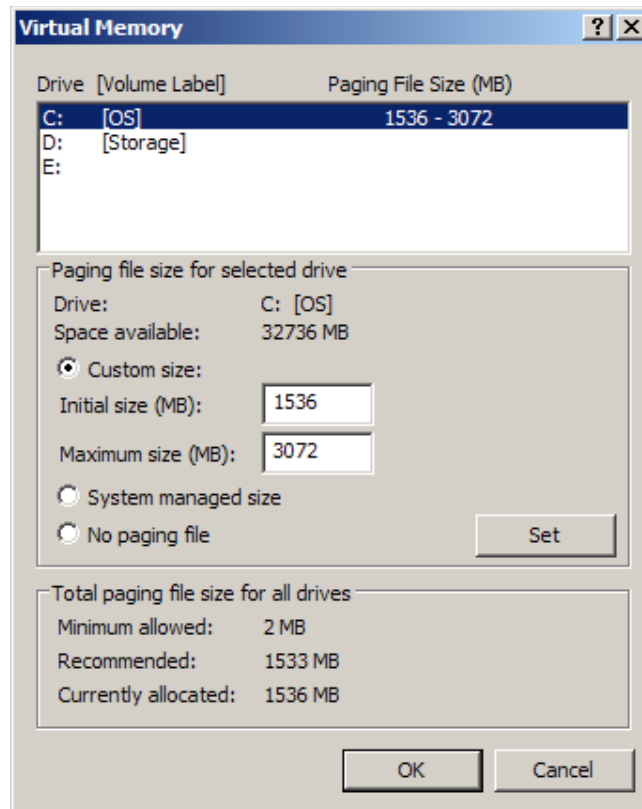
Figure 10: Virtual Memory dialog box

▸ Guide the user through the process of changing the virtual memory file size. The computer will ask for a restart before any changes are made permanent.

Adapter Cards

Adapter or expansion cards allow the user to create extra functionality and inputs for a computer. Below are some examples of common adapter cards.

- **Video Cards** – adds an extra processor and RAM devoted to processing video information. They come in three types, related to the type of motherboard slot types: **PCI, PCI-E** and **AGP**.

- Multimedia cards come in a wide variety of uses and standards.

  ▸ **Sound Cards** – these typically add some extra sound functionality, above and beyond basic sound production, such as surround-sound capabilities, digital audio processing, etc.

  ▸ **TV Tuner Cards** – these act like a cable box for your computer, accepting input from coaxial cable or antenna, to produce television signals on screen.

- **Input/Output Cards** – adds extra ports and connections, either internally or externally. **SCSI**, **USB**, **FireWire** and **Serial** I/O cards are among the most common.

- **Communications Adapter Cards** – network identification cards (NICs) and modems are good examples; these cards allow the computer to transmit and receive data from other computers and networks.

Purchasing Adapter Cards

In choosing the proper adapter card, ask:

- What problem does the new adapter solve?

- Is the cost of the device in line with the potential solution?

- What are the qualities that differentiate between devices?

- How do these qualities affect the solution?

- What hardware will the adapter support?

- What are the advantages/disadvantages between the different types of adapters?

Installation of Adapter Cards

- Open the computer and locate an empty slot, following all of the best installation practices.

- Remove any plates from the appropriate opening.

- Firmly push the adapter connectors into the slot, securing the adapter when it is properly seated.

- Attach any internal devices to the adapter, following the instructions in the manual.

- Put top back on case.

- Attach any external devices to the adapter, following the instructions in the manual.

- Turn computer on. If the card is plug and play compatible, Windows should find a driver.

- If there is a specialty driver for the card, install per instructions in the manual.

Configuration of adapter cards

Configuration may be done in a variety of ways: **Control Panel, Add Hardware; My Computer > Properties > Hardware > Device Manager;** or, sometimes, the BIOS on the adapter card itself may need to be updated. In that case, refer to the BIOS Upgrade procedure under the **Motherboard** section above.

The last bastion of end-user installable upgrades and changes is the adapter card. Adapter cards will follow one of three standardizations, **PCI**, **AGP** and **PCI-E** (which stands for PCI-Express and is a newcomer to the adapter card arena). AGP cards are used exclusively for video cards, whereas PCI and PCI-E can be used for anything from RAID controllers to sound cards. Keep the following guidelines in mind when instructing a user how to add, remove or configure these devices:

- **Explain best practices to your user!** This is *extremely* important.

  ‣ Have the user ground him or herself from causing electrostatic discharge by either wearing an ESD bracelet or keeping one hand in contact with the case while performing hardware service.

  ‣ Have the user install the card in an open slot with as much room to maneuver as possible.

  ‣ Instruct the user to press firmly on the top of the board until it slides into place.

  ‣ If the user meets resistance, have him or her lift the card up, reseat it and try again.

  ‣ The user should then screw the expansion card into place. Removing a card should be the reverse of the same process.

- **Install the card in the correct slot.** Explaining this to the user will be your easiest job.

  ‣ PCI slots are the familiar long and usually white-colored ones.

  ‣ AGP are smaller and typically brown or black.

  ‣ PCIe slots are typically either white or yellow and will *usually* be longer and thinner than their slower cousins.

  ‣ PCIe slots can come in a few different speeds. 1x and 4x speeds will be shorter than the regular 32-bit PCI slot.

- **Make sure the card is configured properly.** Again, most modern versions of Windows will recognize the card and install drivers when it can, as expansion slots are PnP compatible. Where this fails, have the user inspect the **Device Manager** and look for exclamation points or question marks. These are device or driver prompts.

  ‣ Have the user **right-click** on the ailing device and choose "Update Driver."
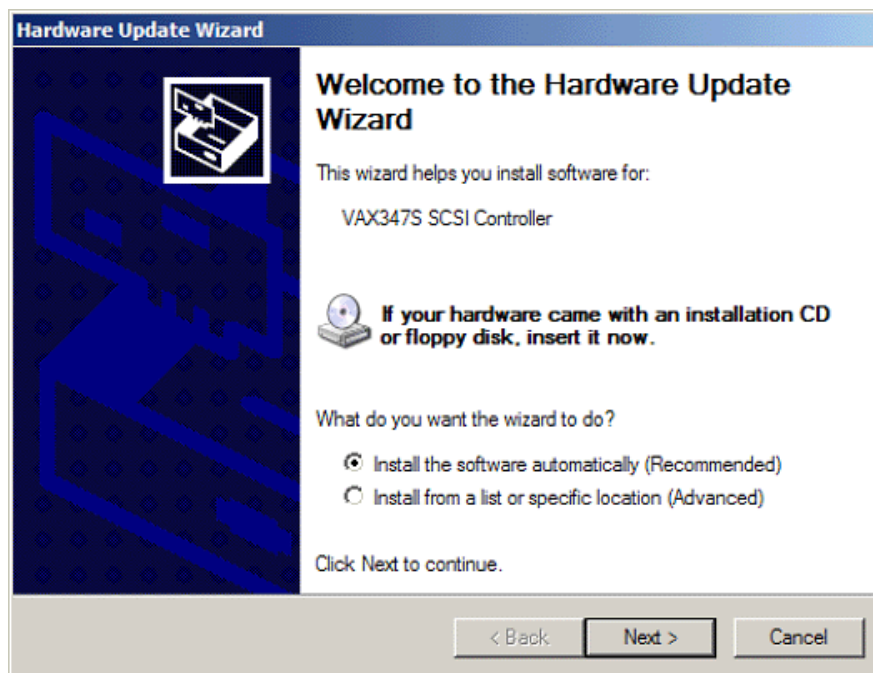
Figure 11: Hardware Update Wizard

  ‣ If a driver diskette was included with the hardware, the user should insert it now.

  ‣ When Windows prompts for the location of the driver, have the user navigate to the disk drive where the diskette is loaded.

  ‣ Windows will take care of the rest.

Ports and Cabling

Inevitably, in servicing personal computers, a technician will have to deal with a wide variety of ports and cables.

Figure 12: Common connector form factors

Port	Description	
USB	Provides hot-swapping of a wide variety of connected peripherals. Comes in two speeds: 1.1 and 2. Version 2 has a higher transfer speed.	
Parallel	Sends every bit in a value set simultaneously; being phased out by USB, though still sometimes used for printer connections.	
Serial	Sends bits in a value set in series down the cable; also being phased out by faster standards; used for mice, keyboards, terminals and modems.	
FireWire	The IEEE 1394 connection offers high-speed communications and is used for anything from digital camcorders to data storage devices.	
RJ45	The CAT-5 cable connection for Ethernet.	
RJ11	The cable connection for telephone lines used in modem communications.	
Mini-DIN	Represents a range of connections, all identified by the number of pins the connection uses; the most common type is Mini-DIN 6, or PS/2 used in mice and keyboards.	
Centronics	A parallel connection that can transmit 8 bits simultaneously. Also being phased out by USB, and is indistinguishable from a regular parallel connector.	
Multimedia	Another broad range of connections:	
	1/8" – Headphone, microphone, speaker jack	SPDIF – carries compressed digital audio to and from the sound card and optical drive

Figure 13: Port descriptions

Cooling Systems

Every component of a computer produces heat as a by-product of electrical conductivity. Heat will permanently damage internal components, especially the processor. Therefore, special considerations should be made to ensure the computer operates at an optimal temperature. Below are some characteristics of cooling systems, found in personal computers:

- **Fans –** mounted above the CPU and on the case, direct heat away from the processor and then out of the case.

- **Heat sinks –** objects, usually made of copper or aluminum, which absorb and dissipate heat produced by internal components. Paired with CPU and case fans, a heat sink can maintain a larger temperature gradient, replacing warmed air quickly and efficiently.

- **Thermal compound –** ceramic, silicone or metal compound which increases the thermal conductivity of both the CPU and the heatsink.

- **Liquid cooling systems –** complex apparatus that continually cycle water over CPU units, carrying heat away to radiators, which in turn cool the water and pass it back over the CPU. These systems, at their most basic, will consist of the tubing, a pump and a radiator.

Most cooling systems are no more complicated than the heatsink and fan that come with purchase. However, some higher end machines (or machines stored in places where the environment cannot be readily controlled) will require much more advanced systems, in order to maintain a working operating temperature without damage to internal components. This section details the best practices for choosing and installing an advanced cooling system.

Purchasing a Cooling System

Ask the following questions before purchasing a new cooling device:

- What problem does the new device solve?

- Will it be used to cool just the CPU, or other devices as well?

- Is the cost of the device in line with the potential solution?

- What are the qualities that differentiate between devices?

- How do these qualities affect the solution?

- What are the considerations for installation?

- Will you use a liquid based solution, or can the problem be solved by a higher output fan?

Installing a *Water-based* Cooling System

Extra fan installation is, typically, a matter of attaching the fan to the chassis and connecting any power cables. Water-based cooling systems are slightly more complicated. In either case, always refer to the device's manual before beginning installation, for any specialized instruction.

- There is no "standard" installation method for liquid cooling systems. Always refer to the manual **first.**

- The device will have multiple components:

  ‣ Radiator, pump, reservoir, water block, tubing, and the actual liquid.

- The radiator has a fan on it to cool liquid as it passes through the system.

- The water block is the component that sits on top of the device requiring cooling, and it is used to draw heat from the device and into the liquid.

Laptop Components
Fundamental Principles

Before learning laptop-specific components and functions, it is important to understand the various overall types and uses of laptops. In general, laptops come in four styles or types:

- **Ultraportables –** the smallest and one of the more expensive models, utilizing power-saving components and weighing less than a few pounds. These are used almost exclusively by the business traveler set.

- **Thin-and-Lights –** somewhat larger than the above, sporting a larger screen and more functionality than ultraportable laptops.

- **Medium-Sized –** the most common. They will weigh 6.5 to 7lbs and usually have somewhat larger screens and a longer battery life.

- **Desktop Replacements –** the largest of the four types. These are designed to be relatively stationary, due to their large size, which, in turn, provides space for more powerful components and the largest screens. Desktop replacement laptops usually have a short battery life.

Laptop Form Factors

Unlike desktop computers, laptops have no industry-wide standard form factor. Manufacturers utilize their own motherboard designs, which, in turn, make laptops both difficult and expensive to upgrade. However, hard drives and memory in laptops are easily user-upgradeable and, therefore, do possess a form factor:

- **Hard Drives**

  ‣ 2.5" Form Factor.

  ‣ Some are hot swappable (accessed by a screwed-in panel on the underside of the machine.

  ‣ Most range from 40-80GB, with some reaching 100GB.

  ‣ Speeds typically around 54-7200 RPMs, but expect to see 10,000 RPM notebook hard drives in the next few years.

- **Memory**

    ‣ Small Outline Dual Inline Memory Module (SO-DIMM). Comes in three versions:

        • 100 pins (32 bit)

        • 144 pins (64 bit)

        • 200 pins (64 bit)

    ‣ Note that these modules can also be found in high-end office printers and routers or other networking hardware.
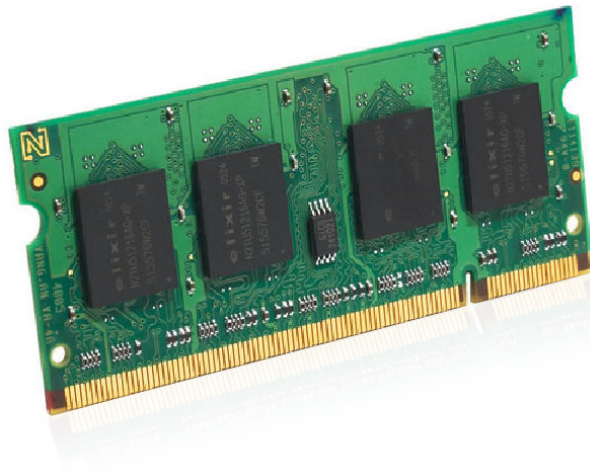
Figure 14: SODIMM module

Laptop Peripherals

Due to their small size and relatively limited upgradeability, several different peripheral devices have evolved in order to improve and increase the productivity and usability of laptops. These are discussed below:

- **Docking Station –** a device which allows the user to accomplish two goals:

    ‣ Use the laptop as a desktop computer: docking stations are usually attached to monitors, keyboards, mice and other desktop computer peripherals.

    ‣ Recharge the battery: most docking stations, if nothing else, provide this most basic functionality.

- **Port Replicator –** a device which provides extra communications ports to the laptop. These will typically be serial, parallel, extra USB and/or KVM connections. While functionally similar to a docking station, port replicators do not recharge batteries and will be much smaller.

- **Media Bays –** allows for the connection of one or more external media devices. These can be either fixed or removable, with most media bays focusing on providing CD and DVD-R capability.

- It should be noted that the majority of these devices are being outmoded, in favor of laptops that already possess the functionality of the above devices. For instance, dual-purpose optical drives, some of which can read, write and rewrite on every available medium, have made media bays obsolete.

Expansion Slots

Laptops, in general, are not designed to be opened and upgraded like PCs. However, without some form of upgradeability, these expensive machines would quickly become obsolete. For this purpose, most laptops have some form of expansion slot, similar to the PC's PCI and AGP slots, for expanded functionality.

- **PCMCIA I** – This was the first type of expansion card for a laptop. It was used solely for SRAM and flash memory upgrades.

- **PCMCIA II** – Developed later, type II cards introduced I/O support on top of flash memory functions.

- **PCMCIA III** – Provided for further expansion of functionality, and fully focused on I/O functions.

- **CardBus** – First introduced in 1995, CardBus expansions were a massive improvement over the previous PCMCIA devices. CardBus essentially provided a 32-bit, 33MHz PCI bus for expanded functionality, as well as bus mastering abilities previously only available in PCs.

- **ExpressCard** – These are the newest expansion slot cards. ExpressCards have a direct connection to the motherboard via a PCI-E or USB 2.0 connection that allows them to take advantage of a much improved data throughput speed (500 MB/s). ExpressCards also have a lower power requirement.

- **Mini PCI** – Developed almost exclusively for integrated communications peripherals (such as modems and network cards), Mini PCI operates just like the PCI 2.2 standard, developed for standard PCs. Laptops typically possess only one of these slots.

Ports

Like desktop PCs, laptops will also have a wide variety of communications ports, connecting a wide variety of devices and peripherals. This can include **serial**, **parallel**, **USB** and **FireWire**, though most laptops will have a much larger emphasis on USB connections. For a discussion on these various ports, refer to **Domain 1**, **Ports and Cabling**.

Power

One of the chief concerns of laptop users is power. Laptops are designed to be run without wires, promoting a mobile working environment. Therefore, it is important for a technician to understand different power technologies and devices offered by laptop technology.

- **Batteries** – Laptops will use one of three different types of rechargeable battery:

  - **Nickel Metal Hydride (NiMH) –** The first laptop battery, with a fast recharge rate and a relatively short lifespan.

  - **Lithium Ion (Li-Ion)** – Newer and most common rechargeable battery, it has a longer battery life and a better energy-to-weight ratio.

  - **Lithium Polymer (Li-Poly)** – Newest rechargeable battery, it doesn't require a metal cell casing, allowing for a lighter battery that can be manufactured into virtually any shape. It has broad applications in small devices as Li-Poly batteries can be made extremely thin.

LCD and Video Technologies

LCD technology was, originally, what set laptops apart from desktop computers and made them portable. They utilize any number of color pixels, consisting of a layer of liquid crystals, arrayed in front of a light source or a reflector. LCD screens are thinner, working without the bulky cathode ray tube that provides display on CRT monitors.

- Early LCD screens utilized **passive-matrix addressing**, where every row or column of pixels was connected to one electrical circuit. Without the benefit of a constant electrical charge, pixels in passive-matrix addressing must retain their state between refreshes.

- Newer, high-resolution LCD screens use **active-matrix addressing**. In active-matrix addressing, a thin layer of transistors is added to color filters, allowing each pixel to be connected to its own transistor, which, in turn, allows the display to access one pixel at a time, increasing both the sharpness and brightness of the display. Refer to the following table for a list of the various video technologies available to active-matrix displays.

Technology	Abbr.	Resolution	Pixels
Extended Graphics Array	XGA	1024x768	786,432
Super Extended Graphics Array	SXGA+	1400x1050	1,470,000
Ultra Extended Graphics Array	UXGA	1600x1200	1,920,000
Widescreen Ultra Extended Graphics Array	WUXGA	1920x1200	2,304,000

Figure 15: Graphics technologies

- When choosing between LCD screens, in addition to resolution and video technology, there are two other important terms to know and understand:

    ‣ **Contrast Ratio** – the ratio of the luminosity between the lightest and darkest color the screen can produce. *Static* contrast ratio is the ratio at any given instant, while *dynamic* contrast ratio is the ratio over time.

    ‣ **Native Resolution** – the fixed resolution of any LCD device. CRT monitors can produce a variety of resolutions, LCD screens possess a fixed raster and must therefore use interpolation (which causes quality loss) to display images in anything *other* than their native resolution.

Input Devices

Laptops and portable devices take advantage of a wide variety of human input devices. Due in part to their portability, input devices for laptops, PDAs, smart phones, etc. tend to focus on producing enhanced functionality while keeping the footprint of the system small. Below is a discussion of the more common laptop input devices:

- **Fn Key –** the ubiquitous laptop input device. The key allows access to **Num Pad** functions and some laptop specific commands, such as display controls, volume, hibernate, etc. See *Figure 16* below.

Figure 16: "Old School" laptop keyboard

- Laptops support a wide variety of **Pointing Devices**:

  - **Point Stick** (IBM's TrackPoint™) – A rubberized cap which responds to applied force. Located, usually, between the B,G and H keys.

  - **Touch Pad** – Another very common pointing device, which uses sensors to detect the moving capacitance of a user's finger. Modern touch pads have a variety of "hot spots" serving purposes such as scroll bar control and zooming.

  - **Stylus** (or digitizer) – Simply an inkless pen used to interact with touch screens to protect the screen from the natural oils of the finger and provide a finer degree of control.

Power Management

As previously stated in the above sections, power management is one of the chief concerns of any mobile device. Specifically, this is the management of battery power. This section details how a user can configure and optimize laptop usage of power.

- **ACPI** – Advanced Configuration and Power Interface is an open industry standard for power management which superseded Advanced Power Management. Most notably, ACPI took power management out of BIOS and gave that ability to the OS. See the above section, **Mobile Motherboards**, for a point-by-point and visual breakdown of OS elements of power management. ACPI defines seven states for mobile computers:

  - **G0 Working –** This is the natural state for the computer. Everything is on.

▸ **G1 Sleeping** – This state is further divided into four different sleeping states:

. **S1 Suspend** – Power hungry sleep mode where processor and RAM caches are flushed, but power is maintained. Devices which are not required to have power will be powered down. This state is slowly going out of common use.

. **S2 Suspend** – Same as above, but the CPU is powered down. This is almost completely out of standard use.

. **S3 Standby** – All information about the system (CPU state, open documents, etc.) is cached to RAM, and everything else is powered down.

. **S3 Hibernate** – Most powerful sleep feature. The current state of operation is cached to a folder on the root disk drive, including the contents of RAM modules. All power to the system is then cut off.

▸ **G2 Soft Off** – This is simply a power down initiated by the operating system. Power is still running to the system, so that it can be quickly booted.

▸ **G3 Hard or Mechanical Off** – This is what happens when the power button is pressed for the required five seconds, and it is a complete power down.

Diagnostics and Troubleshooting Techniques

. **Verify AC power** (e.g. LED's, swap AC Adapter)

▸ Check that wall outlet is viable and working with a multimeter.

▸ If you are using a power strip, try resetting the breaker to ensure power.

▸ Try a known good adapter in the outlet to verify the adapter is working.

. **Verify DC power**

▸ Laptop batteries can lose their charge over time.

▸ Battery retailers can check for lost charge.

▸ Try charging the battery in a known good laptop to ensure the charging mechanism is not the issue.

. **Remove unneeded peripherals**

▸ There may be conflicts among peripherals.

▸ Remove all unnecessary devices, and see if the situation improves.

▸ If it improves, start adding peripherals back, doing so one at a time until the problem reappears.

▸ Remove the offending device.

- **Plug in external monitor**

    ‣ Use the external monitor to determine if the display problem is the adapter or the LCD.

    ‣ If the external monitor produces video, then the LCD screen is the problem – it will need to be replaced.

    ‣ If there is no video, then the adapter is the problem – replace it.

- **Toggle function keys/Check LCD cutoff switch**

    ‣ A user may easily blank the LCD screen by an accidental key press.

    ‣ Refer to the following table for LCD-related Function keys:

Key	Function
Fn + F3	Turn off the LCD display, blanking the screen; any key will return the LCD.
Fn + F4	Toggle computer into standby mode; the Fn key alone returns the computer to normal operation.
Fn + F7	Switch between the LCD and an external device. Pressing these keys multiple times will cycle through a combination of patterns: CRT, LCD+CRT, LCD.
Fn + F8	Switch the computer screen size.
Fn + F12	Put the computer into hibernation mode. To return to normal operation, press the power key for less than 4 seconds.

Figure 17: Laptop keyboard function keys

- **Verify backlight functionality and pixilation**

    ‣ Each portable device will have a backlight.

    ‣ Check to make sure the light works and icons are visible.

- **Stylus issues** (e.g. digitizer problems)

    ‣ The digitizer may be misaligned if stylus use does not produce expected results.

    ‣ Resynchronize the digitizer with the PDA's native utility.

    ‣ It simply requires touching the stylus to various areas of the screen.

- **Unique laptop keypad issues**

    ‣ Make sure users know that the laptop keypad is substantially different than the desktop keypad.

PC Technician Tools

Every computer technician needs a PC toolkit. The most commonly used tool is the Phillips screwdriver; most device screws, adapter screws, case and motherboard screws use a standard Phillips head.
Other tools in a PC kit generally include:

- **ESD pad and wrist strap** — ESD pads and wrist straps are crucial for protecting sensitive electronic components from electrostatic discharge. Only a couple hundred volts are required to destroy these devices, yet humans do not perceive static shocks below 1,500 volts.

- **Assorted screwdrivers** — an assortment of medium and small screwdrivers is essential. Some specialized case screws use Torx heads, so having a Torx driver and bits is highly recommended. Many notebooks and peripheral devices also use Torx screws.

- **Plastic putty knife** — a plastic putty knife is an inexpensive tool useful for carefully removing plastic bezels and other snap-on components without damaging their surface.

- **Tweezers, hemostat** — these are useful for picking up dropped screws and jumpers, particularly inside mostly assembled PCs. Regular tweezers for short-distance work and a parts retriever (a retractable claw that is opened and closed by squeezing a coiled spring) are recommended. An IC extractor/puller (for removing chips from circuit boards) is also recommended if you will be doing solder work or need to remove a BIOS chip.

- **Containers** — handy for holding loose pieces, such as screws, blanking plates and other small parts.

- **Flashlight** — a penlight is useful for highlighting silk-screened diagrams and finding dropped parts, especially in machines that are partially or mostly assembled.

- **Magnifying glass** — small jumpers and fine print on motherboards can often be more easily read with the use of a magnifying glass.

- **Compressed air can, natural bristle brush, and/or PC vacuum** — all three of these are useful for basic maintenance and in cleaning dust and dirt from a machine before beginning repairs/upgrades. A PC vacuum is specially designed to reduce the amount of static electricity generated at the nozzle opening.

- **Multimeter** — also known as a DVM, is a handheld measuring device that combines several basic functions including current voltage, current flow (amps), and electrical resistance (ohms). Multimeters are not as commonly used today but are still useful when troubleshooting power supplies, switches and other electrical components.

- **Wire ties** — sometimes called zip ties, these plastic straps can be used to bundle cables inside a PC case to help improve airflow and provide for a cleaner appearance.

- **Needle-nose pliers** — a set of pliers with a long narrow gripping surface is handy for moving small parts, such as jumpers.

- **Markers, pens, and notepads** — markers are useful for labeling components, while pens and notepads can be used to take notes of component placement, configurations and other aspects of the current project.

- **Windows startup discs/bootable discs** — An assortment of bootable discs, such as Windows installer CDs and troubleshooting and diagnostics CDs are very useful. Be sure to only install the user/customer's legal, authorized copy of Windows from the original Windows installer discs, using the user/customer's original license key.

- **Data transfer cables and adapters** — Ethernet cables (straight and crossover), USB cables, and Firewire cables are all useful for transferring data between machines and for testing the functionality of peripheral devices.

- **Spare screws and jumpers** — Keep extra screws and jumpers handy. Variety packs of these components can be purchased from computer supply stores.

- **Cleaning products** — Due to electrical sensitivity, care must be exercised whenever using liquids on or near a computer system. Compressed air, PC vacuums, lint-free swabs or pads and isopropyl alcohol are the best choices for cleaning a computer. Pure water and ammonia-free glass cleaner can be used on display monitors.

Printer Troubleshooting

Invariably, printers will encounter problems and require troubleshooting and diagnostics. Often, technicians may find themselves working with printers more than computers, as printers have many moving and replaceable parts. The following section discusses the best practices for diagnosing and troubleshooting printer and scanner problems.

Gathering Information

- **Identify the symptom**. Determine whether or not the problem is physical (i.e., paper jams, empty ink cartridges, etc.) or software related (i.e., out of date or corrupted drivers, printer spool errors, etc.).

- **Review error codes**. Depending on the nature of the problem, the computer or the device may generate an error code. These are non-standardized, so refer to the device's manual for specific error code meanings. An event log can reveal any computer-related software errors, and refer to any reports filed by the user.

- **Print or Scan Test Page**. Specific information about device calibration can be gained from a test page. Alternatively, if the test page doesn't print, the problem is likely with the computer.

- **Use Diagnostic Utilities**.

Review and Analyze Data

- **Establish Probable Cause**. Use common sense to determine what could be causing the symptoms identified above. For instance, on an ink jet printer, spotty production is probably low or empty ink cartridges. Blank pages from a laser printer more than likely denote an empty toner cartridge.

- **Review Service Documentation**. Manuals can be the best source of information for problem solving. Device-specific error codes are usually found in manuals.

- **Define and Isolate Problem**. Use Internet resources such as knowledge bases and tech support forums to further isolate the problem. Verify that the problem is software related or hardware related, that proper connectivity is established and that physical impedances, such as paper jams, are cleared.

Identifying Solutions

- **Define the Specific Cause** and apply any necessary fixes, such as driver or firmware updates.

- **Replace Consumables**, if necessary. Refer to the printer's manual for instructions on how to replace ink and toner cartridges.

- **Verify Functionality** with a test page/scan. It's important to also get the user to accept that the problem is fixed, and the device is operational as per the user's expectations.

Resolving Printer and Scanner Problems

- Hardware problems

  - Is the device plugged in?

  - Is the device on-line?

  - Does the device have paper?

  - Is the device properly installed?

  - Can the device communicate with the computer?

  - Are there error messages/flashing or colored lights/beep codes giving you an indication of what the problem could be?

  - Is there paper jammed in the printer?

  - Is the proper type of paper loaded in the printer?

  - Is the document capable of being scanned?

  - Is the resolution of the scanner capable of providing the output that is expected?

  - Is the document a color document and the scanner a black and white or low resolution scanner?

- Software problems

  - PCL Driver printing to a Post Script printer produces no output. Change the driver.

  - PS Driver printing to a PCL printer produces page after page of smiley faces and other ASCII graphical characters. Change the driver.

  - Is the correct printer selected, or is the user sending job after job to the wrong printer?

  - Is the software appropriate for the task?

  - Is the operating system using the correct driver for the device?

  - Can other applications use the printer?

Tools for Repairing Printer and Scanner Issues

- **Multimeter** – used to test power levels at various locations within the printer or scanner.

- **Screwdrivers** – used to gain access to interior components.

- **Cleaning solutions** – used to clean fuser rollers, corona wires, scanner tops, glass tops, etc.

- **Extension magnet** – used to remove loose screws in hard-to-reach places.

- **Test patterns** – hard copy and file copy of a test pattern. Useful for testing scanners (hard copy) and printer output (file copy).

Preventative Maintenance of Printers and Scanners
Performing Scheduled Maintenance

- Each device will come with a vendor-defined maintenance schedule, usually page count driven.

    - Toner replacement will depend on number of pages printed and the types of images recorded. Very complex pictures or drawings may require much more toner than a simple text based document.

    - Change fuser rollers and drums at specified intervals. For best results, some items should be changed together. Corona wires may need to be changed whenever the toner is changed. Make sure this rotation is followed.

    - After completing scheduled maintenance, be sure to reset the page count so you know when it needs to be done again.

- Ensure a suitable environment.

    - Laser printers generate heat, they need to be in a well ventilated area.

    - The laser printing process generates its own static electrical discharges. Make sure the area has enough humidity to minimize static electrical discharges from the surrounding environment.

    - Printers, especially printers that use primarily recycled paper, generate lots of paper dust. These need to be cleaned up regularly, or a fire could occur.

    - Scanners rely on bright light and a closed lid. If you have to leave a lid open and the ambient light is bright, poor results will occur.

- Use recommended supplies.

  ‣ Many companies, in an attempt to lower costs, will look to less expensive alternatives to printer supplies. This can take the form of:

    . Refilled toner cartridges

    . Refilled ink cartridges

    . Recycled paper

  ‣ While the practice is viable and can save money, tradeoffs in quality and performance may occur.

  ‣ Lesser quality supplies may also cause a reduced life cycle or a shorter time span between maintenance cycles.

Gathering Information

While information gathering best practices are discussed in more detail in **Domain 6, Communication and Professionalism**, in general, consider the following steps you can use to better diagnose a printer problem:

- **Ask open-ended questions.** Would you mind describing the problem to me? How did you expect the output to turn out? May I see an example of the problem?

- **Determine if any changes have been made.** New driver installs, new application installs and changes to the Windows operating system can all have an effect on the performance of a printer or scanner.

- **Is the printer networked?** Check to see if the problem occurs across all computers connected to the printer or just the one computer.

- **How prolific is the problem?** Does it occur on every document printed from this printer, just on specific types of documents or from specific applications?

Troubleshooting Some Common Printer Problems

- **Out of Paper: Load Paper**. The most obvious and common printer problem; simply load new paper into the correct tray. Multi-tray printers may need paper in all of their trays, depending on initial setup, before they will function.

- **Clearing the queue**. During a print job, Windows will put a system tray icon in the lower right-hand corner of the screen. Double clicking this icon will open the queue. Any jammed documents or those listed with errors can be canceled by clicking on the job and pressing **delete**.

- **Restart the print spooler**. As discussed in **Domain 2, Operating Systems**, the printer queue may become stalled in a high-traffic environment. Follow the steps discussed in the **Printer Spool** section to clear the queue and restart the spooler service.

- **Recycle Printer Power**. This may be necessary to clear the printer's internal print queue. Simply press and hold the power button until the machine turns off. Wait about thirty seconds before powering the printer back on, to ensure that the printer's internal memory has been cleared.

- **Inspect for paper jams**. Most printers will tell you when they have a printer jam. In the case of a printer jam, have the user inspect the printer for the access openings on the printer. There is usually at least one underneath the print head and one behind the printer chassis.

- **Check for visual indicators**. Look at the print quality; are there lines on the page, smudging or intermittent ink? This may indicate the need to replace ink cartridges. Is the printing off-kilter or, in some way, poorly aligned? You may need to have the user recalibrate the print head, which can be done through the printer's included software.

Implementing Solutions/Steps to
Solve the Identified Printer/Scanner Problems
General order of solution/troubleshooting for printers

Printer not working
1. Check that printer is switched on.
2. Check that printer is plugged in.
3. Check that printer is online.
4. Check the cable connection.
5. Check installed driver.
6. Check if printer is on switch box (should only be used in special circumstances).
7. Check/change BIOS printer type setting.

Paper Jam
- Can be caused by cheap paper.
- Can be caused by using the wrong type of paper.
- Can be caused by paper that was stored or loaded improperly.
- Can be caused by incorrectly seated roller or stuck sensors.

Mem Overflow error or bottom of page not printed
- Generally means PC or printer needs more memory.

Print output slow
- Upgrade printer.
- Add more memory to printer.

Output garbled or corrupted
- Update printer driver.
- Check BIOS settings.
- Check printer settings (printer language, font settings).

Poor quality

- Toner/ink/ribbon low.

- Cheap/incorrect paper.

Blank pages on laser printer

- OPC drum improperly seated or damaged.

- Corona transfer wire improperly seated or damaged.

Networked printer problems

- Check printer to make sure it is shared.

- Check printer to ensure it is properly configured (IP address, name).

- Check that correct/latest printer driver is installed.

- Check that print server has enough space for print spooler.

- Check that spooler service is not disabled or stalled.

General Order of Solution/Troubleshooting for Scanners

1. Check scanner power connections.

2. Check if scanner lamp is turning on.

3. Check scanner/computer connections. Ensure scanner is connected directly to computer, not through a hub.

4. Check for background software if issue happens in operating system. Turn off all background software and try scanning again. Other programs could be conflicting with scanner software for resources.

5. If scanner uses parallel interface, check BIOS settings to ensure bidirectional (or EPP and/or ECP modes) is enabled.

6. Check manufacturer Website for driver/firmware updates. Most manufacturers update their drivers regularly to address technical issues and provide updated features.

Identifying Appropriate Tools Used for Troubleshooting and Repairing Printer/Scanner Problems

Tools for printers
Working on printers generally requires the same tools that are used when working on PCs and laptops. The most commonly used tool is a Phillips screwdriver. As with many laptops, Torx screws are often used as well.

Tools for scanners
Scanners generally do not have user-replaceable parts. The relative simplicity of the devices and the relative cost of replacement vs. repair make it unlikely that hardware technicians will have much to do in scanner repair. Tools that may be helpful include compressed air, isopropyl alcohol, glass cleaner, lint-free swabs or pads, and scanner test images.

Performing Preventative Maintenance of Printer and Scanner Issues
Keep device clean
Use compressed air to blow out dust and dirt from vents. Clean back of device as well. Use a printer cleaning sheet, if available, to clean the paper pathway. For scanners, the glass scanning bed should be cleaned regularly, using non-ammonia glass cleaners or cleaning solution.

Perform vendor-recommended maintenance tasks
Printers generally require test or maintenance cycles every set number of pages. HP LaserJet printers, for example, require a maintenance kit including rollers and a fuser assembly. Scanners do not generally have such maintenance needs, but an occasional calibration is recommended. See the manufacturer's documentation for more details.

Ensure Suitable Operating Environment
Use the device in a proper environment
Most devices have a set operating temperature, humidity and atmospheric pressure range they work best in. Guidelines are published in the vendor's documentation. Wherever possible, ensure the device is kept in an area that isn't subject to extreme temperatures, humidity and pollution.

Use vendor-recommended supplies whenever possible
Most vendors have a set of supplies that are engineered to work optimally with the device. It is generally best to use those supplies (toner/ink/ribbons, print heads, paper, etc.) whenever possible.

Domain 2.0: Operating Systems
Command-Line Tools

- **Disk Management Utilities**

  ‣ **DEFRAG** – utility used to recover from drive fragmentation.

    - Drive fragmentation occurs over time and with usage, as files are written and deleted from the hard drive, fragments of files become strewn across the disk, lowering access speeds and reducing overall efficiency.

    - Defrag can be performed through the command console by typing defrag and the drive the technician wants defragmented.

    - Windows has a graphical defrag. Navigate to **Start > Accessories > System Tools > Disk Defragmenter.**

    - All of the command line options available to this utility are included within the graphical interface of Disk Defragmenter.

  ‣ **NTBACKUP** – once a command line utility, NTBACKUP has been completely absorbed into the Windows GUI. Please refer to the section on **Automated System Recovery (ASR)** above.

‣ **CHKDSK** – a utility that verifies a disk's integrity by sifting through drive sectors searching for bad or corrupted sectors.

- As with defrag, chkdsk can be run very easily from the Windows Shell.

- Open **My Computer**; **right-click** on the appropriate drive and choose **Properties**.

- Under the **Tools** tab, choose "**Check Now…**," and a small window, as in *Figure 18*, appears. Click **Start**, and the computer will begin the check.
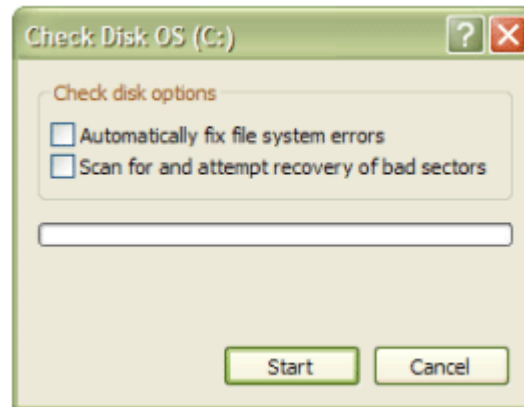
Figure 18: Windows Check Disk utility

- Should Windows detect some hard disk problem during boot, the user will be presented with a blue screen, and Windows will begin running the chkdsk routine.

- It is strongly encouraged to allow the system to complete the check.

‣ **FORMAT** – utility used to erase all data on a partition and/or change the file system format of that disk.

- Format can be used both in the GUI and in the console.

- The GUI method is helpful for disks that are not bootable or are not carrying the operating system.

- **Right click** on the drive which is to be formatted.

- Click **Format**. A screen, such as in *Figure 19*, appears:
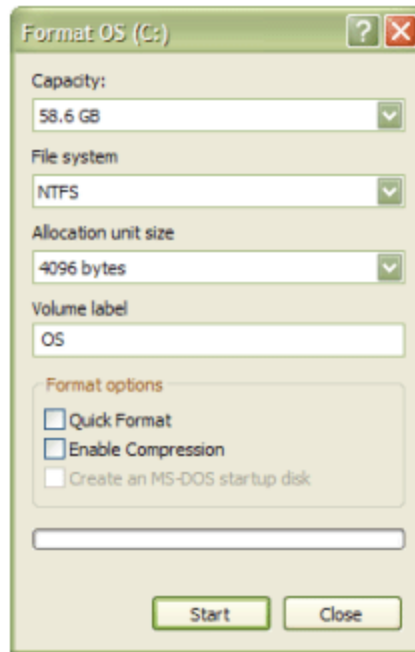
Figure 19: Formatting a volume in Windows

- Choose the appropriate file system, and label the disk. It is not recommended to change any of the other options.

- The console method is helpful for recovering a disk for operating system installs.

- Refer to the chart, *Figure 20*, for usage and a list of format subcommands.

Usage: FORMAT *volume* /FS:*filesystem* /V:*label* /Q	
Subcommand	**Effect**
/FS:*filesystem*	Defines the file system for the format. Acceptable variables are: FAT, FAT32, NTFS
/V:*label*	Specifies the volume label. Example: /V:Storage
/Q	Formats the disk in quick mode, rather than checking the disk for integrity issues.

Figure 20: FORMAT command syntax

- **System Management Tools**

  - **Device Manager** – a helpful application for viewing installed hardware device drivers and checking for device driver problems, such as conflicts or missing drivers.

    - The device manager can be accessed by navigating to **Start > Control Panel > System**. Click the **Hardware** tab and then the **Device Manager** button.
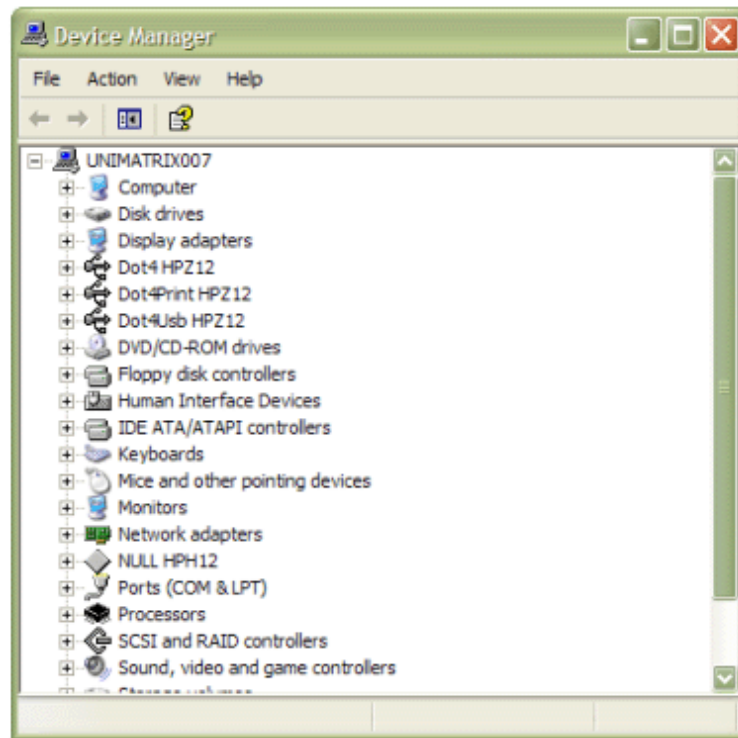
Figure 21: Device Manager

- A missing, corrupted or otherwise malfunctioning driver will show next to the device in question as a small yellow exclamation mark.

- Follow the instructions listed in the **Loading a Device Driver** section, above.

‣ **Task Manager** – another helpful application, which can be used to terminate resource-sapping programs, monitor network traffic, start and stop running processes or manage logged in users.

- Can be accessed by pressing **CTRL+ALT+DEL** or **CTRL+ALT+ESC**.

- Alternatively, right clicking the task bar and selecting **Task Manager** will also load the task manager.

- To terminate a running program, select it, and press **End Task**.

- To terminate a process, click the **Processes** tab, choose the appropriate process and click **End Process**.
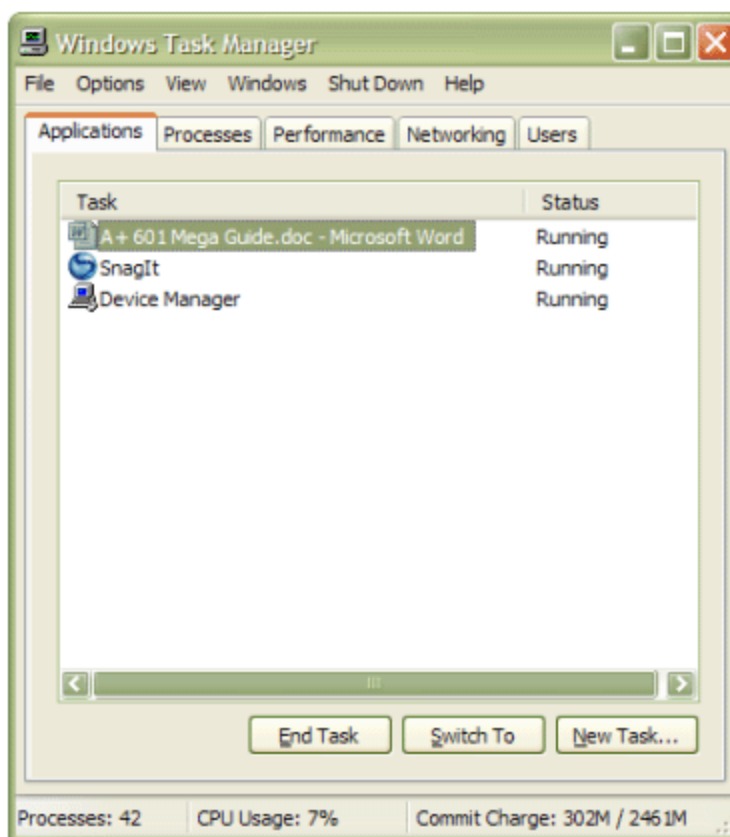
Figure 22: Task Manager

▸ **MSCONFIG.EXE –** this helpful graphical utility allows the user to edit system configuration information. Refer to the following, *Figure 23*.
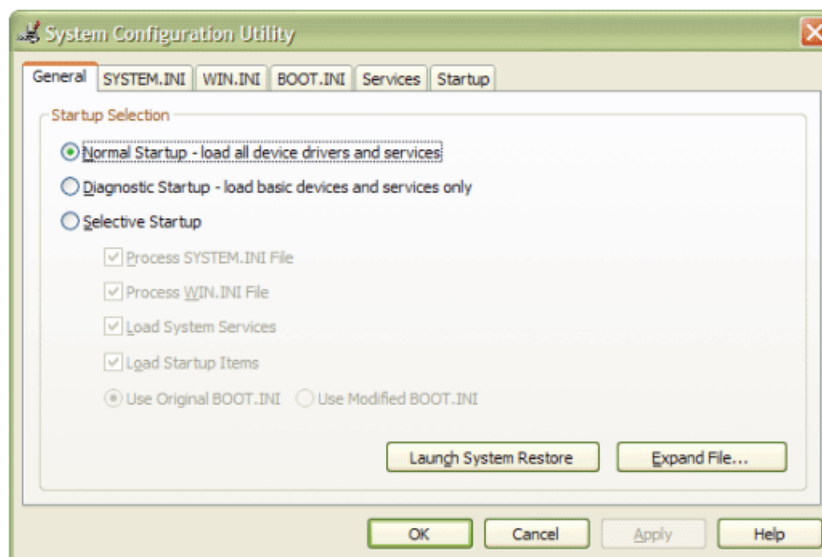
Figure 23: System Configuration Utility

- **Diagnostic Startup** — similar to Safe Mode, in that only the drivers and services needed to run Windows will load.

- **Selective Startup** — allows the user to choose which system file is processed during boot. This is helpful when a corrupted system file is suspected.

- **Services and Startup Tabs** — allow the user to choose which services and applications load on startup.

- **File Management Tools**

  ▸ **Windows Explorer** – as previously discussed, Explorer is the basic way to navigate through Windows' files and folders. From Explorer, the user can create, delete, move or copy folders and files.

 ▸ **Attrib.exe** – attrib.exe is a console command that allows the user to add file attributes. Alternatively, file attributes can be added to a file by right clicking it and choosing **Properties**, then selecting the appropriate attribute from the list at the bottom of the window.

- **Command line tools** (e.g. IPCONFIG.EXE, PING.EXE, TRACERT.EXE, NSLOOKUP.EXE)

  ▸ **IPCONFIG** — used to show the network card configuration and also to release and renew a DHCP provided address. Common switches are /all /release or /renew.

  ▸ **PING** — proves that two computers can communicate.

  ▸ **TRACERT** — traces the route a packet takes from its source to its destination.

  ▸ **NSLOOKUP** — used to locate the name space and information about a particular domain.

  ▸ Refer to Domain 3 for a detailed list of these command line functions and any relevant switches and options.

- **Cable testing device** – used to insure that all the cable leads are secure and that there are no breaks in the cable.

The following series of charts and descriptions contains the most common command-line functions. It is intrinsic to the proper administration of a Windows installation to know and understand these management functions, their proper usage and most common **switches**, or program options.

CMD - starts a new instance of the Windows XP command interpreter.

Usage: CMD [/C] [/K] [/S] [/Q] [/D] [/A] [/U] [/T:fg] [*command_string*]

Switch	Description
/C	Carries out the command specified by *command_string* and then terminates
/S	Modifies the treatment of *command_string* after /C or /K
/Q	Turns echo off
/D	Disables execution of AutoRun commands from registry
/A	Causes the output of internal commands to a pipe or file to be ANSI
/U	Causes the output of internal commands to a pipe or file to be Unicode
/T:fg	Sets the foreground/background colors

Figure 24: CMD command syntax

DIR – displays a list of files and subdirectories in a directory.

Usage: DIR [drive:][path][filename] [/A[[:]attributes]] [/B] [/C] [/D] [/L] [/N] [/O[[:]sortorder]] [/P] [/Q] [/S] [/T[[:]timefield]] [/W] [/X] [/4]

Switch	Description	
/A	Displays files with specified attributes	
/D	Same as wide but files are list sorted by column	
/O	Lists by files in a sorted order, defined by the following subcommands (adding a hyphen to any of these subcommands will reverse the stated order):	
	N – Sort alphabetically by name	**S** – Sort in ascending order by size
	E – Sort alphabetically by extension	**D** – Sort by date/time, old to new
	G – Group directories first	
/P	Pauses after each screen of information	
/S	Displays the owner of the file	
/Q	Displays files in specified directory and all subdirectories	

Figure 25: DIR command syntax

ATTRIB – displays or changes the attributes of a file or directory. The plus sign (+) sets the listed attribute, and the minus sign (-) clears the listed attribute.

> **Usage:** ATTRIB [+R | -R] [+A | -A] [+S | -S] [+H | -H] [drive:][path][filename]
> [/S [/D]]

Attribute/Switch	Description
R	Read-only file attribute
A	Archive file attribute
S	System file attribute
H	Hidden file attribute
/S	Processes matching files in the current folder and all subfolders
/D	Processes folders as well as files

Figure 26: ATTRIB command syntax

EDIT – opens the MS-DOS text editor.

> **Usage:** EDIT [/B] [/H] [/R] [/S] [/<nnn>] [/?] [file(s)]

Switch	Description
/B	Forces EDIT to run in monochrome
/H	Displays the maximum number of lines the hardware can display
/R	Loads the file(s) in read-only mode
/S	Forces the use of short filenames
/<nnn>	Loads the binary file and wraps lines at nnn characters wide
/?	Displays the help screen for EDIT
[file(s)]	Specifies the file(s) to load. Wildcards can be used

Figure 27: EDIT command syntax

COPY – copies one or more files to another location.

> **Usage:** COPY [/D] [/V] [/N] [/Y | /-Y] [/Z] [/A | /B] *source* [/A | /B]
> [+ *source* [/A | /B] [+ …]] [*destination* [/A | /B]]

Switch	Description
source	Specifies the file(s) to be copied
/D	Allows the destination file to be decrypted upon creation
/V	Verifies that new files are written correctly
/N	Uses the short filename, when available, for files with non-8dot3 names
/Y	Suppresses prompting for overwriting existing files
/A	Indicates an ASCII text file
/B	Indicates a binary file
destination	Specifies the directory and/or filename for the new file(s)

Figure 28: COPY command syntax

XCOPY – copies files and entire directory trees.

> **Usage:** XCOPY *source* [*destination*] [/P] [/V] [/Q] [/F] [/H] [/R] [/K] [/Y]
> [/EXCLUDE:*file1, file2*…]

Switch	Description
source	Specifies the source file(s) and/or directory tree(s) to be copied
destination	Specifies the location and/or name for the new files
/P	Prompts the user before creating each destination file
/V	Verifies that each new file is copied correctly
/Q	Suppresses display of xcopy messages
/F	Displays the full source and destination file names while copying
/H	Copies hidden and system files in the source directory tree
/R	Overwrites read-only files
/K	Copies attributes with files. Xcopy normally resets read-only attributes
/Y	Suppresses prompting for overwriting existing files
/EXCLUDE: *file1, file 2*…	Excludes a set of files from the copy operation

Figure 29: XCOPY command syntax

FORMAT – formats a disk for use with Windows XP.

> **Usage**: FORMAT volume [/FS:*filesystem*] [/V:*label*] [/Q] [/C] [/X]
> FORMAT volume [/V:*label*] [/Q]
> FORMAT volume [/Q]

Switch	Description
/FS:*filesystem*	Specifies the file system for the format (FAT, FAT32 or NTFS)
/V:*label*	Specifies a label for the formatted volume
/Q	Performs a quick format
/C	Files created in the new volume are compressed by default (NTFS)
/X	Forces the volume to dismount first, if necessary. All opened handles to the volume will no longer be valid

Figure 30: FORMAT command syntax

IPCONFIG – displays or sets configuration of TCP/IP for network interfaces.

Optional Switches	Description
/?	Displays the help message for ipconfig
/all	Displays full configuration information
/release	Releases the IP address for the specified adapter
/renew	Renews the IP address for the specified adapter

Figure 31: IPCONFIG command syntax

PING – a protocol for testing IP connectivity with another host.

> **Usage:** ping [-t] [-a] [-n *count*] [-l *size*] [-w *timeout*] *hostname*

Command Options	Description
-t	Pings the specified host until
-a	Resolves addresses into host names
-n *count*	Specifies the number of echo requests to send
-l *size*	Specifies the buffer size of the packet sent
-w *timeout*	Specifies the timeout (ms) to wait for each reply
hostname	The host which is being tested for IP connectivity

Figure 32: PING command syntax

MD – used for creating new directories. MD and MKDIR are the same command and can be used interchangeably.

> **Usage:** MD [drive:][path]

CD – changes directories, or displays the name of the current directory. CD and CHDIR are the same command and can be used interchangeably.

> **Usage:** CD [/D] [drive:][path]

The ".." switch can be used to change to the parent directory of a tree. CD [drive:] will display the current directory in the specified drive. Use the /D to change the drive as well as the current directory.

RD – removes (deletes) a directory. RD and RMDIR are the same command.

> **Usage:** RD [/S] [/Q] [drive:]path
>
> /S – removes all directories and files in the specified directory in addition to the directory itself. Used to remove a directory tree.
>
> /Q – enables Quiet mode, which will not ask if it is okay to remove a directory tree with /S.

For further information regarding any of the previous commands, issuing the command **HELP** at the command prompt, followed by the requested command, will give a brief description of the command, followed by *all* of the command line switches. **HELP** by itself will show a list of available command-line functions.

Windows Directory Structures
Windows XP and Windows 2000 Operating System Files

The following section details essential operating system files, their characteristics, locations and purposes.

- **NTLDR**, or *NT Loader* is the basic system file used for the loading of the Windows NT kernel on NT-based operating systems. It is located in the %systemroot% folder and relies on both BOOT. INI and NTDETECT.COM (described below), to load the operating system.

- **BOOT.INI** is the configuration file used by NTLDR to load the operating system. It will also be located in the %systemroot% folder.

- **NTDETECT.COM** is used to detect and load the various hardware devices necessary for operating system function. It utilizes *Hardware Profiles* stored in the HKLM\HARDWARE\ DESCRIPTION registry key and supports multiple profiles for machines that change hardware settings and layouts often.

- **NTBOOTDD.SYS** is an alternate loader file, used when the main disk is SCSI-based rather than IDE-based, and cannot be handled by the computer's BIOS firmware.

- **Registry data files**, discussed in more detail above, in the Essential Components section, are located in the %SystemRoot%\System32\Config\ folder.

Windows Vista, Windows Server 2008, and Windows 7 Operating System Files

When the computer is powered on, either the BIOS or the EFI is loaded. With BIOS, the Master Boot Record of the boot disk is accessed, followed by the boot sector of the appropriate hard disk partition. This boot sector then loads the rest of the boot blocks. The files that play a part in this process include:

- **Windows Boot Manager (BOOTMGR)** - reads the boot configuration data and displays an operating system menu (if applicable). In some respects, it can be compared to NTLDR in prior versions of Windows NT.

- **Boot Configuration Data (BCD)** – replaces the old boot.ini files that was used by NTLDR. It is used by the new Windows Boot Manager.

- **Winload.exe** - load the operating system kernel (ntoskrnl.exe) and required boot-related device drivers. This is also equivalent to the operating system loader function of NTLDR in prior versions of Windows NT.

Disks, Directories and Files

- **Disks** – In general, this term refers to the hard disks used for storage on a computer. Available hard disks can be viewed either from **Windows Explorer** or the **My Computer** window. **Partitions** are logical separations on a hard disk. They are categorized as followed:

    ‣ **Active** partitions are those partitions which can be actively booted to.

    ‣ The **primary** partition is the partition on which the main operating system is stored, and *must* be assigned drive letter C: on Windows-based machines.

    ‣ **Extended** partitions are those which carry any other disk space not assigned as primary.

    ‣ **Logical** partitions are extra partitions made from the extended partition.

- **File Systems –** as previously discussed, a file system is the method by which the operating system manages and organizes files and data. The chief purpose of the system is to enable a level of file security and ease-of-access.

    ‣ **FAT32**

        • A relatively uncomplicated file system which is still used in Home user editions of Windows XP.

        • Lack of complexity allows FAT32 to share data with disparate operating systems, making it an ideal file system for dual boot computers.

        • Unfortunately, FAT32 is limited by its maximum single file size of 4 GB and a maximum drive size of 32 GB.

    ‣ **NTFS**

        • Long-running file system used by NT-based Windows operating systems.

        • Supports much larger drives and file sizes, as well as a host of security features, such as innate file encryption.

        • Utilizes hidden and inaccessible **metadata** files, which store all the information about every file on the system.

- **Directory Structures** – a directory is simply an organizational tool that is much like a hanging file folder in a file cabinet, only much more complicated. Directories on a computer can hold both files and other directories.

    ‣ A directory, all of its subdirectories, and all of the files in these directories, is referred to as a **tree**.

    ‣ In general, create a folder by **right clicking** on an empty space, choosing **New…** and selecting **Folder**.

    ‣ Move and copy folders by dragging and dropping and using the copy/paste option, respectively.

    ‣ The console can still be used to manage folders. Refer to the chart, *Figure 33* for a list of console directory management commands and their command-line switches:

Command	Usage	Switches
dir	Used to view files and subfolders in a folder	/w – Displays files in "wide" format /a – Displays files with attributes listed
cd	Used to change active directories	N/A
md	Used to make folders	N/A
copy	Copies files and directories	/V – Verifies written files /-Y – Prompts the user for overwrites
rd	Removes and deletes folders	/S – Removes the entire directory tree

Figure 33: Directory management console commands

- **Files** – files are the actual data stored on a computer, used either directly by the user, such as with a text file, or by an application, as with a jpeg picture file.

    ‣ Files are created by the various applications used on a computer. For instance, this document is a file that was created by Microsoft Word.

    ‣ Files are usually denoted by a unique name and an identifying **extension**.

        • The extension allows both the user and the operating system to recognize the file by type.

        • The operating system then creates **associations** between the extension and the appropriate application.

        • This allows the user to double click a required file and have the associated application open and display its contents.

    ‣ Files are also given various **attributes**, which are special markers of identification for various operating system uses. The following is a list of the basic file attributes and their uses:

        • **Hidden** – file is normally hidden from the user but can be accessed, changed or deleted.

        • **Read-Only** – the file can only be accessed, not changed or deleted.

- **Archive Ready** – the file is ready to be archived.

- **Indexed** – windows Indexing Service will index this file.

- **Compressed –** file is compressed to save disk space.

- **Encrypted** – file is encrypted to secure the contents of the data.

- **System** – a special designation for Windows NT system files, which cannot be accessed, seen, changed or deleted. This is for system-stability issues.

  ‣ **Permissions** – allows a network administrator to rate files in terms of which types of users can access the files and what can be done to the files. For instance, files can be reserved for only the system administrator, for the "power users" or for everyone on the network.

System Utilities and Tools
Locate and use Operating System Utilities and Available Switches
For Example:

- **Disk management tools**

  ‣ **DEFRAG** — a program which allows the user to defragment a hard disk drive.

    - Defragmentation is a method of disk optimization whereby files on a disk drive are made contiguous so that they can be read without unnecessary searching on the part of the drive heads.

    - The program is located in C:\Windows\System32, so it can be run from anywhere in the command shell structure.

    - Alternatively, Defrag can be found in **Start > Programs > Accessories > System Tools**.

    Usage: DEFRAG *volume* [-a] [-f] [-v] [-?]

Command Option	Description
Volume	The volume letter or mount point to be defragmented
-a	Analyze only, no defragmentation
-f	Force defragmentation, regardless of free space
-v	Toggles verbose output
-?	Displays help text

Figure 34: DEFRAG command syntax

‣ **NTBACKUP** — a program native to the Windows NT environment which performs backup operations.

  • NTBACKUP can be used either in a batch file or on the command line.

  • NTBACKUP is located in C:\Windows\System32, and in later versions of Windows NT (i.e., 2000 and Windows XP) is contained in a GUI interface which is located in **Start > Programs > Accessories > System Tools**.

• **System management tools**

  ‣ **Device Manager** – the device manager is accessed from **Control Panel > System > Hardware > Device Manager**, and is used to check the status of devices and resources. Device Manager can be found by typing Device Manager in the Vista or Windows 7 Start Search window.

    • It can also be used to install, update or roll back drivers, or to install or remove hardware devices:

      • The **Task Manager** is accessed by pressing and holding CTRL-ALT-DEL.

      • The Task Manager is used to monitor system resources and usages, to activate or terminate services, processes and applications.

      • The Task Manager can, alternatively, be used to shut down, restart or send the computer into hibernation.

  ‣ **MSCONFIG.EXE** — used to specify the type of startup for the computer, to view and edit system.ini, win.ini, and boot.ini, to start and stop services, and to edit and configure programs that launch at startup. The System Configuration window can be opened on a Windows Vista or Windows 7 computer by typing **System Configuration** in the **Start Search** window and selecting it from the results.

    • MSCONFIG can also be used to launch a system restore or to expand compressed files.

    • MSCONFIG can be accessed from **Start > Run > and typing MSCONFIG** in the dialogue box.

  ‣ **REGEDIT.EXE** (or REGEDT32.EXE) — used to access and edit the Windows Registry.

    • Accessed from **Start > Run > Regedit.exe or REGEDT32.exe**.

    • You can open the **Regedit** window on a Windows Vista or Windows 7 computer by typing Regedit in the Start Search window and clicking the result.

  ‣ **CMD** — starts a command line interface, or CLI. Accessed from **Start > Run > CMD**. On a Windows Vista or Windows 7 computer, in the Start Search window, type command prompt to locate this command.

  ‣ **Event Viewer** — provides access to and organization of the Application, Security, System and (if applicable) Media Center log files.

    • Accessed from **Start > Control Panel > Administrative Tools > Event Viewer**.
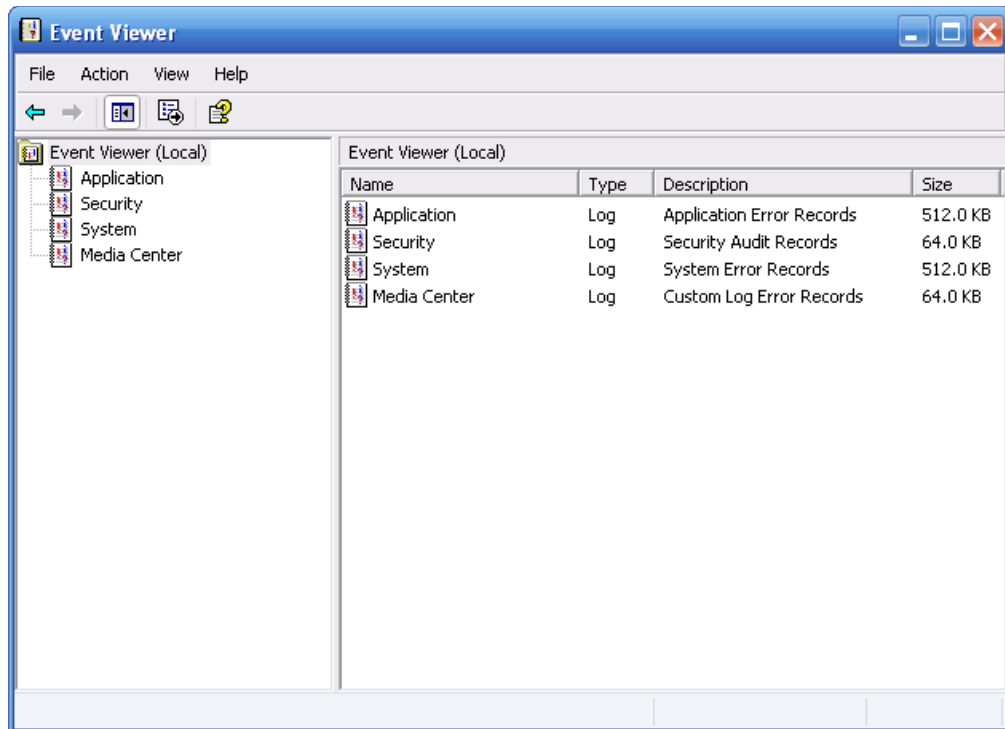
Figure 35: Event Viewer

▸ **System Restore** — used to restore your entire computer to a previous state, without losing personal data files. As with other tools in Windows Vista and Windows 7, you can locate them easily from the **Start Search** window.

- It automatically creates restore points, which allows the user to return the system to that point. These points can also be created manually.

- Accessed from **Start > Control Panel > System > System Restore** to make sure it is enabled.

- To access the System Restore Wizard, click **Start > Help and Support > Performance and Maintenance > Using System Restore to undo changes > Run the System Restore Wizard**.
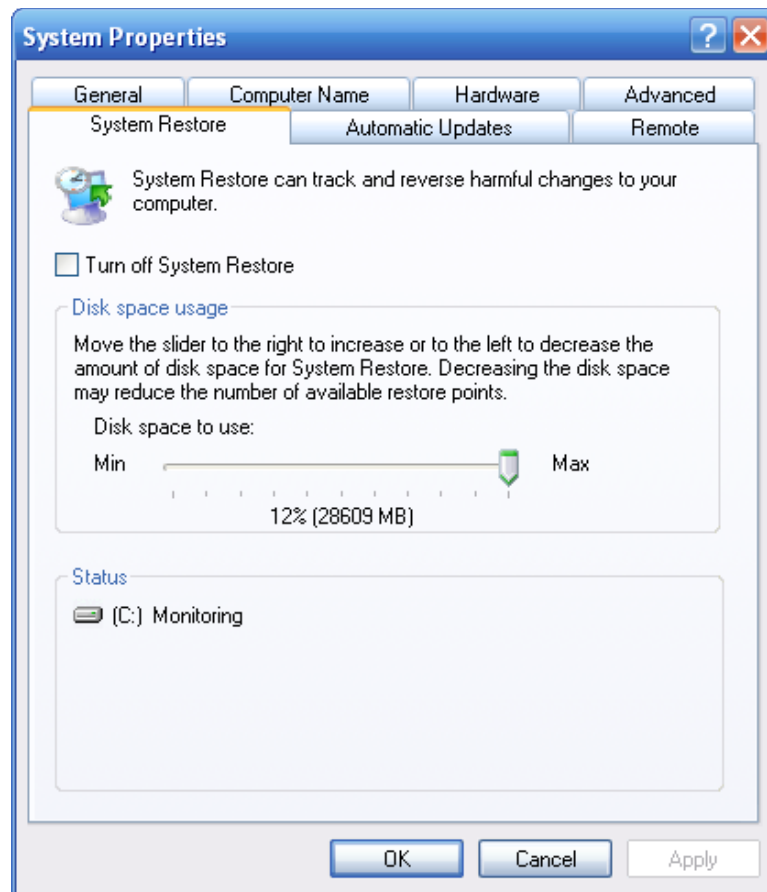
Figure 36: System Restore configuration

▸ **Remote Desktop** – allows others to remotely control your desktop, or allows you to remotely control others desktops. This feature is turned off by default. To locate Remote Desktop settings in a Windows Vista or Windows 7 computer, type **Remote Desktop** in the **Start Search** window and select it in the results.

- To enable this feature, navigate to **Start > Control Panel > System > Remote**.

- Selecting the **"Allow Remote Assistance invitations to be sent from this computer"** option allows the user to invite Help Desk personnel to take control of their desktop.

- Selecting the **"Allow users to remotely connect to this computer"** option gives others the ability to share system resources.
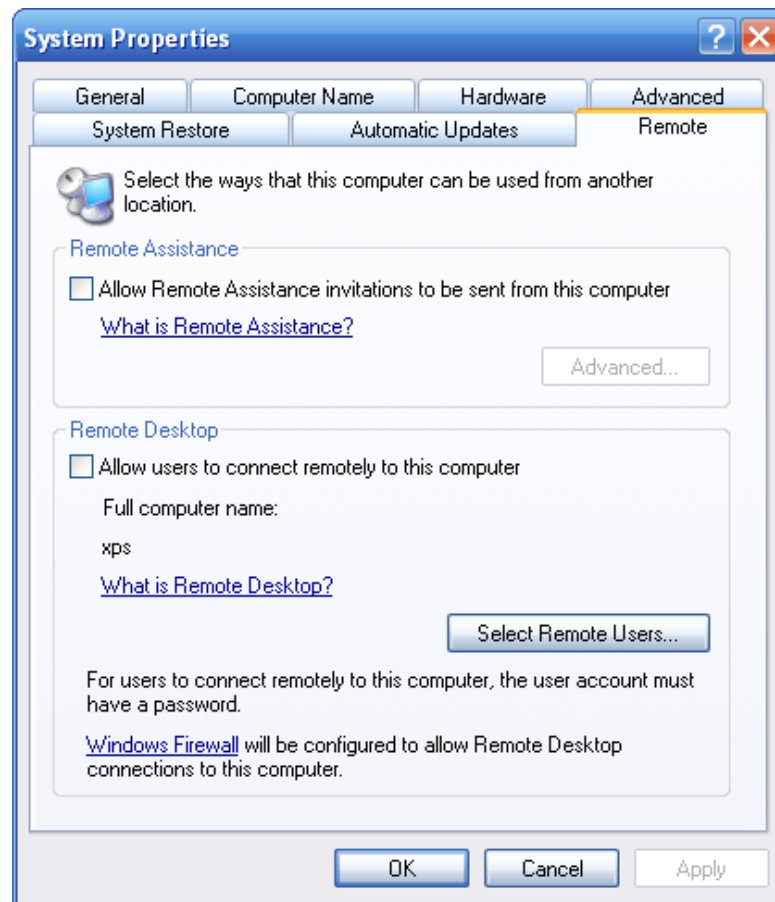
Figure 37: Remote Assistance, Remote Desktop configuration

- **File Management Tools**

  ‣ **Windows Explorer (Explorer)** – used to manage and browse local and remote directories, as well as accessing system information, adding or removing programs and changing settings.

    - Explorer can be accessed by double clicking on My Computer or any other folder icon. You can also open Windows Explorer by right-clicking the **Start** button in Windows Vista or Windows 7 and clicking **Explore All Users** and **Open Windows Explorer**, respectively.

    - Alternatively, Windows Explorer can be opened directly by navigating to **Start** > **Programs** > **Accessories** > **Windows Explorer**.
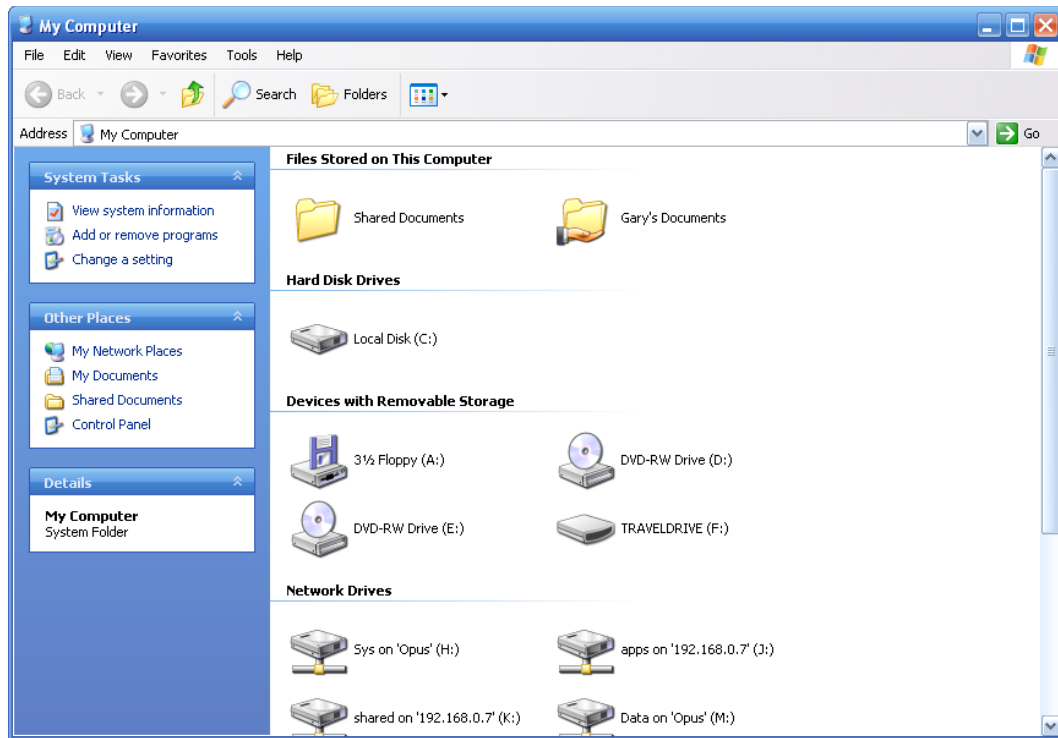
Figure 38: My Computer

> ▸ **ATTRIB.EXE** — accessed from the command line and is used to display or change file attributes.

> • For a full listing of file attributes and ATTRIB.EXE command line switches, refer to *Figure 26* earlier in this chapter.

Operating System Troubleshooting
Boot Methods and Sequences

In order to properly troubleshoot computer problems, Windows has several boot methods that provide different configurations.

- **Safe Mode** — a stripped Windows boot that only has the most necessary drivers and services loaded for Windows operating. This is useful to determine if the problem is hardware or software in nature. Safe mode itself has several options:

  - ▸ **Safe Mode with Command Prompt**. This option boots safe mode but uses the command console, instead of the GUI.

  - ▸ **Safe Mode with Networking**. This allows the user to access network resources for troubleshooting, such as uncorrupted restore files or Internet access for research.

  - ▸ **Last Known Good Configuration**. This option boots into Windows normally, but with the last known hardware configuration that worked with Windows. This is useful for determining if recently added or changed hardware devices are causing malfunctions.

- **Recovery Console** — allows system administrators to perform a limited range of repair tasks using a text interface similar to the command console. The recovery console can be accessed by booting from the Windows (2000 or XP) CD-ROM and choosing the recovery console option, **R**, when prompted. The Recovery Console can be accessed on a Windows 7 computer by pressing **F8** during boot up, and clicking **Repair** your computer. From within the console, administrators can:

  ‣ create and remove directories, and copy, erase, display, and rename files;

  ‣ enable and disable services;

  ‣ format volumes;

  ‣ expand files from the compressed format in which they are stored on the installation CD-ROM, and

  ‣ perform a full CHKDSK scan to repair corrupted disks and files, especially if the computer cannot be started properly.

- **Restore Points** — provide points in the past, usually defined automatically by Windows when new software is installed or changes to the operating system are made.

  ‣ These restore points can provide a fall-back point, if the system becomes radically corrupted.

  ‣ To access the restore point wizard, navigate to **Start > Help and Support > System Restore**.

  ‣ The user can either define a new restore point, or restore the system to a previous point.

  ‣ The system restoration calendar shows when restore points were created.

  ‣ Choose an appropriate point, and click **Restore**.

  ‣ The system will then reboot and will have reverted to its state *that day*.

  ‣ Only software and hardware configurations will have changed; stored files are not added or deleted.

- **Automated System Recovery (ASR)** – a utility that actually performs two functions: backup and recovery.

  ‣ The backup utility is located in Windows Backup, accessed through **Start > Accessories > System Tools > Backup** on a Window XP computer.

  ‣ On a Windows Vista or Windows 7 PC, if the computer is bootable, click **Start**, and in the Start Search window, type **System Restore**. If the computer cannot be booted, choose **System Restore** from the Recovery Console.

  ‣ The wizard will back up the system state, services, all operating-system associated disks, restore information and the backup file itself.

  ‣ ASR backups can be scheduled by clicking the **Schedule Jobs** tab in the **Advanced View** of Windows Backup and should be made regularly.

‣ Access ASR recovery by pressing **F2** during startup. ASR startup will appear similar to Windows Installation. ASR information is located, and Windows restores the system using this backup information.

- **Emergency Repair Disks** – used to check for disk integrity errors and can be used to repair a corrupted operating environment or boot sector. To create emergency repair disks, follow the following steps:

  ‣ Navigate to **Start > Programs > Accessories > System Tools > Backup**.

  ‣ Open the **Tools** menu and choose **Create Emergency Repair Disks**.

Diagnostic Techniques

These techniques are helpful when determining what the problem is, where it is originating from and how the problem can be fixed.

- **Identify the problem.** Question the user thoroughly about recent changes made to the computer, including any hardware or software that was recently installed or changes made to the operating system. Ask what the user was doing or using when the problem first occurred.

- **Analyze the problem**. Narrow down a list of possible causes of the problem, based on experience, training and observation. Determine if, ultimately, the problem is hardware or software in nature.

- **Test components**. Test affected hardware components by unplugging or otherwise disabling supposedly malfunctioning hardware. If the problem disappears, then the device is likely the issue. Examine software configurations for any conflicts or problems that may be arising from software installations or uses. Inspect the Device Manager for any device driver conflicts, and consult vendor documentation if necessary.

- **Evaluate the results**. Research the problem thoroughly in manuals, on the Internet and through technical support lines if necessary. Using the evaluation, correct the problem by applying information gained during research.

- **Document the results**. As discussed previously in this guide, a well-stocked service journal can help solve similar problems in the future.

Common Operational Issues

The following section covers ubiquitous Windows problems and errors and possible solutions to these problems.

- Perhaps the most recognizable and infamous Windows issue is the **stop error**, sometimes referred to as the Blue Screen of Death, *Figure 39*.

  ‣ This usually indicates that either the Windows kernel or an application accessing the Windows kernel attempted an illegal operation.

  ‣ This could, potentially, represent any number of problems. Follow the troubleshooting steps above.

  ‣ Ensure that Windows is updated with the latest service packs and security updates and that all software and hardware is updated with the latest patches and firmware updates.

Figure 39: Windows STOP error, AKA "Blue Screen of Death"

- A **system lockup** will occur when Windows runs out of available resources to perform operations. No programs will respond to user input.

  ‣ Sometimes, the user can access the task manager (**CTRL+ALT+DEL**) and terminate programs sapping computer resources. If this occurs often, it may be helpful to enable CPU throttling.

  ‣ If the system does not respond to the task manager, it will be necessary to manually restart the machine.

  ‣ Either upgrading the system's memory or reducing the number of active programs will, usually, solve this problem.

- **Input/Output** errors can be caused by improper driver installs. Download and install the correct and most up-to-date driver for the input/output device.

- **Application Installs** may become corrupted, either by a corrupting of the Windows installer, or because the installation medium itself is corrupted.

  ‣ In the first case, download and reinstall the latest version of Windows installer.

  ‣ In the second case, first uninstall the program. If the installation medium *is* corrupted, a new disk or download may need to be acquired. Otherwise, simply try reinstalling the software.

- **Application Fails to Load**

    ‣ This can be caused by a wide variety of problems, ranging from low system resources to software incompatibility.

    ‣ Ensure that the computer meets the minimum operating requirements of the application.

    ‣ Also, make sure that the user has the proper permissions to install, run and access the application.

    ‣ If all else fails, uninstall and reinstall the application – the original installation may have become corrupted.

- **Windows Specific Printing Errors**

    ‣ In the case of a **stalled printer spool**, try stopping and restarting the service.

        · Navigate to **Start > Control Panel > Administrative Tools > Computer Management**.

        · In the console tree, click **Services**.

        · Find the **Print Spooler**, click **Stop** to cease the service, and then **Start** to restart it.

        · The print spooler may also stall if the disk on which it resides is low on free space. Try clearing out some unused files.

    ‣ If the printer prints nonsensical characters, grid lines over the text or the program in which the user is trying to print crashes on a print request, the problem may be with the **printer driver**. Ensure an appropriate and up-to-date driver is installed.

Common Error Messages and Codes

- **Boot Errors** (Invalid boot disk, boot disk inaccessible, missing NTLDR)

    ‣ All of the above errors indicate that the boot.ini file necessary for Windows load is either missing or corrupted.

    ‣ In either case, it will be necessary to create a new boot.ini from the ASR. Follow the instructions listed in the above section on ASR to access the console.

    ‣ The command **bootcfg /rebuild** will search available resources and re-create a fresh boot.ini.

- **Startup Messages** (Device/service failed to start, device/program in registry not found)

    ‣ In the event of a startup error message, the message itself will be recorded in the **Event Viewer**.

    ‣ Navigate to **Start > Accessories > System Tools > Event Viewer**.

    ‣ Record the specific error message, and use Microsoft's Knowledge Base to troubleshoot the problem.

- **Registry Errors**

  ‣ Registry errors can come in a wide variety, as Windows is constantly accessing and updating the database.

  ‣ **Regedit.exe** and **regedt32.exe** access and edit the registry.

  ‣ Refer to Windows Knowledge Base before performing any registry edits.

  ‣ There are also a good number of third party programs that will scan the registry for errors and automatically fix them.

- **Windows Reporting**

  ‣ Windows XP supports an automatic error reporting software.

  ‣ If an error occurs and Windows detects it, the information will be sent to Microsoft over an available internet connection.

  ‣ Navigate to **Start > Control Panel > System**. Click the **Advanced** tab and choose **Error Reporting**.

  ‣ From here, the user can administer the type of error reporting that the system takes part in.

Operating System Recovery

Boot Methods
See discussion of booting to Safe Mode, above.

Recovery Console
The Recovery console is used to enable or disable services, format drivers and read or write information to local drive. It can be used to repair a corrupted or failing operating system by copying files from floppy or CD to local hard drive, or to stop a service from starting.

Start Recovery Console:
- Run from Setup CD, or install during the initial installation.
- Recovery Console commands:

  ‣ **Attrib** – Changes attributes of a file or directory.

  ‣ **Batch** – Runs as a batch file.

  ‣ **Bootcfg** – Edit and recover the boot.ini file.

  ‣ **Chkdsk** – Check disk used to report the status of a disk.

  ‣ **Disable** – Disables a service or driver.

  ‣ **Diskpart** – Manages hard driver partitions.

  ‣ **Enable** – Starts a service or driver.

▸　**Exit** – Closes Recovery Console, restarts your computer.

▸　**Expand** – Extracts a file.

▸　**Fixboot** – Writes new boot sector onto the partition.

▸　**Fixmbr** – Repair master boot record.

▸　**Format** – Format disk.

▸　**Help** – Displays list of commands.

▸　**Listsvc** – Lists services/drivers.

▸　**Logon** – Log on to installation.

▸　**Map** – Displays the drive letters.

▸　**More** – Displays contents of a text file.

▸　**Net Use** – Connects a network share to a drive letter.

▸　**Set** – Displays/sets environment variables.

▸　**Systemroot** – Sets the current directory to the systemroot directory.

▸　**Type** – Displays contents of a text file.

Automated System Restore (ASR)
The ASR is a two part process: backup and restore. The backup is done with the ASR wizard, located in Backup. It backs up the system state, system services and all the disks that are associated with the OS and includes a file that has information about the backup, the disk configurations, and how to accomplish a restore. The ASR sets should be created on a regular basis.

- Restore accessed by pressing F2 during text part of startup.

- ASR reads disk configuration and restores disk signatures, volumes and partitions for those disks needed to start the system.

- ASR then does a simple Windows install and starts the restoration using ASR information.

- **To create an ASR Backup**:

    1.　Start Backup

    2.　Click Advanced Mode

    3.　Choose **Tools > ASR Wizard**

- **To recover an ASR Backup**:

    1.　Gather the ASR floppy disk, backup media, and original OS installation CD

    2.　Boot to OS installation CD

    3.　Press F2 during text mode of setup

    4.　Insert ASR floppy

    5.　Follow directions on the screen

Emergency Repair Disk
Emergency repair disk inspects and repairs the computers startup environment, checks system files and replaces missing or corrupted files. It also repairs boot sector.

- To create an ERD in Windows 2000:

    ‣ Accessed from: **Start > Programs > Accessories > System Tools > Backup**

    ‣ From the Tools menu choose Create Emergency Repair Disk

The Windows Stop Error
The stop error is Windows' most legendary and notorious error, known colloquially as "The Blue Screen of Death."

- More often than not, this indicates an illegal operation performed by an application or device accessing the Windows kernel or by the kernel itself.

- The majority of the information contained in a stop error is too technical to be remotely useful; however, it may be helpful to copy down what file caused the error and at what address. Often, the Microsoft Knowledge Base will have a solution to the issue.

- You should ask the customer if he or she changed the hardware or software configuration recently, as any change might have caused the conflict resulting in the stop error. Try having the customer reverse the change by restoring the computer using a Restore Point.

- Also, make sure that the version of Windows being used is updated with the latest hotfixes and service packs and that all hardware is updated with the latest drivers and firmware updates.

- Windows 7 doesn't have "Blue Screens of Death." Instead, the application is closed, a notification is given, and Windows looks for a solution. If it can't find a solution right away, it may, at some point, offer a solution in the Action Center if a solution is eventually found.

Auto-Restart Errors
These errors are actually the same errors as stop errors; however, the user has an option flagged that causes the computer to automatically restart when there is a serious problem. If the problem is very serious, the computer can get stuck in a loop and constantly restart.

- Auto-restart can be turned off from within Windows by accessing the **System Properties** dialog box.

- Click on the **Advanced Tab**, followed by the **Settings Button** under the **Startup and Recovery** heading.

- In the bottom box, **System failure**, uncheck the **Automatically Restart** checkbox.

- When the error occurs again, this time as a stop error, record the information and research the problem.

System Lock-Ups
System lock-ups occur when a computer's resources have been completely drained by applications and services. The computer will not respond to a user's inputs, usually requiring a restart.

- If possible, have the user open the Task Manager by pressing **CTRL+ALT+DEL** or by **Right-clicking** the task bar and selecting **Task Manager** from the context menu. Then, try closing out some programs or shutting off some resource-hogging services.

- If the user can't get Windows to respond to CTRL+ALT+DEL, a manual restart will be necessary.

- Once back into Windows, have the user disable some services and startup programs and restart the machine.

- Upgrading the memory on a resource-starved computer can also help the situation.

Device Driver Failures
This is another very common Windows problem. Device driver failures can be caused by a number of problems, including corrupted driver files, viruses, conflicting device drivers, out-of-date drivers and out-of-date firmware.

- First and foremost, have the user download the device's latest drivers and firmware updates.

- Walk the user through the process of removing a device's driver:

  ‣ Navigate to **Start > Control Panel > System** and then click on the **Hardware Tab**, followed by the **Device Manager**.

  ‣ The offending device should have an exclamation point next to it.

  ‣ **Right-click** the device and choose **Uninstall**. Once the device is uninstalled, have the user run the driver package downloaded from the manufacturer's website. This should solve the problem.

Application Failures
For end-users, this can be the most frustrating type of failure. Application failures are generally split into two categories: **Install** and **Load Failures**.

- **Install Failures** – caused by a variety of problems. Have the user run through the following fixes:

  ‣ First, check and make sure the computer meets the minimum system requirements for the software.

  ‣ Next, try simply uninstalling and reinstalling the software.

  ‣ If this fails, check to make sure Windows is completely updated with the latest service packs and hotfixes.

  ‣ If a large number of programs have been installed on the machine, sometimes the Windows Installer package gets corrupted. Have the user download a new version.

  ‣ The media from which the program is being installed might be damaged or corrupted in some way. If possible, try having the user install the software from a "known good" disc.

  ‣ If all else fails, the computer's RAM might be corrupted. Have the user download one of the many freeware RAM testers available on the Internet.

- **Load Failures** – also be caused by a variety of issues. The computer could be running low on resources, or the program could have caused an illegal operation. Try the following to solve a load failure:

  ‣ Instruct the user to close down some programs while using the software that had the load failure. If the program continues to work fine, then it is likely a resource issue.

> ▸ If this doesn't work, again, make sure both the software and Windows have the latest updates installed. You may also want to instruct the user to uninstall and reinstall the program.

> ▸ Some load failures are actually permission violations (where the program tried to write data where the user wasn't allowed to write data). Make sure the user has all the proper permissions to access and use the software.

Domain 3.0: Networking
Client-Side Connectivity Troubleshooting

Networking is the practice of connecting two or more computers into a group, for the purposes of resource sharing. The networks themselves come in all shapes and sizes. The Internet is one massive network, made up of hundreds of millions of computers, connecting in a variety of ways, over a variety of mediums. Because this can be rather complex and sense networking (*especially* the Internet) is such an indelible aspect of computing, it is important for the A+ Certified Technician to know and understand these concepts.

Basic Concepts

Addressing

Every computer accessing the Internet (and the same holds true for every computer on a network) must possess a unique **Internet Protocol** (IP) **Address** with which it can be identified over the network. This address is very much like a street address. As with many computer standards, the IP address has undergone several revisions since its inception. This guide will cover the latest two:

- **IPv4** – Supports 32-bit (or 4 byte) addresses. This is the dominant standard today, and appears in the familiar xxx.xxx.xxx.xxx (called **dot-decimal**) format.

- **IPv6** – This standard is still in development, but due to the severe shortage of addresses available to IPv4 (2^{32}), IPv6 will inevitably become dominant once development is finished. IPv6 addresses are 128 bits wide, which increases the number of available addresses to about $3x10^{38}$. Rather than the dot-decimal format, IPv6 will use eight groups of four hexadecimal digits: 2001:0db8:85a3:08d3:1319:8a2e:0370:7334.

Because none of these formats are especially meaningful to human operators, especially in the case of IPv6, IP addresses resolve into **hostnames** (or domain names). For instance, google.com is the hostname for the IP address 64.233.167.99. The process of resolving hostnames into IP addresses and back again is left to a **Domain Naming Service** (DNS). A more in-depth discussion of the **IP** protocol is included in the section **Protocols**, below.

Bandwidth

Bandwidth, in terms of networking, is simply the throughput speed of data over a particular connection. In dial-up networking, this term is synonymous with **baud**.

Protocols

Protocols are the life-blood of any network system. Much like device drivers, they provide the means of translating the raw information sent over data lines across the network, into a language understandable to the computer and, eventually, to the user. As with most computer components, protocols are subject to a standard. The **OSI Stack** is the standard by which protocols are created, and it defines a seven-layer stack that describes the process of information translation from hardware to software:

1. **Physical Layer** – This is where all the electrical and physical specifications are contained; it defines cable specifications. Networking *hardware* operates at this level.

2. **Data Link Layer** – Provides error correction over Layer 1, as well as the means by which data is transferred between network entities.

3. **Networking Layer** – Provides the means by which data is transferred from a source to a destination, as well as routing procedures.

4. **Transport Layer** – Provides for the transparent transfer of data between end users.

5. **Session Layer** – Initializes, maintains and terminates the dialogue (or session) between local and remote computers.

6. **Presentation Layer** – Transforms data into something recognizable by the application.

7. **Application Layer** – Provides the means by which users access the information that has thusly traveled through all of the previous layers. This is where HTTP, SMTP, FTP, etc. operate.

The most common protocol, **TCP/IP** (Transmission Control Protocol/ Internet Protocol; the name is derived from the two most important protocols within the suite) is actually a suite, or stack, of protocols that cover the layers of the OSI stack.
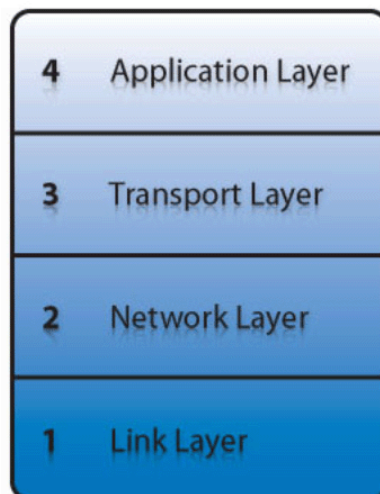

Figure 40: TCP/IP model

The earliest versions of the internet protocol, developed by the Department of Defense, had a very small amount of available addresses. In order to address this, ARPANET created the practice of subnetworking IP networks. A **subnet** is, simply, a division of a larger network. In the addressing scheme created by the DOD for the quickly expanding ARPANET, this was called a **classful subnet**, as it relied on various classes to separate addresses into three different sized networks.

Other Protocols within the TCP/IP Stack:

- **IPX/SPX** – short for Internet Packet Exchange/ Sequenced Packet Exchange, both protocols are used almost exclusively by Novell networks and in local area networking. IPX operates at the network layer and is a packet protocol used for connectionless communications. SPX is a transport layer protocol used primarily by client/server applications.

- **NWLink** – a protocol very similar to IPX/SPX, used in Microsoft NT networks for resolving NetBIOS names.

- **NetBIOS** – short for Network Basic Input/Output System, NetBIOS is a session-layer protocol that allows applications, on separate computers, to communicate over a LAN. It provides name resolution and registration, session services for connection-oriented communication and packet distribution.

- **NetBEUI** – an extension of NetBIOS (Network BIOS Extended User Interface), NetBEUI is a non-routable protocol operating at the network and transport layers and is responsible for implementing the services provided by NetBIOS.

Duplex
A duplex communication is one which can send and receive. A television is not a duplex device, whereas a telephone or your computer's Network Interface Card are duplex devices. All duplex devices are split into two types:

- **Half-Duplex** – devices can only send or receive at one time. A walkie-talkie would be a half-duplex device. Older computer modems could only either transmit or receive, but never both at the same time.

- **Full-Duplex –** devices can transfer information and send information at the same time, down the same medium. This literally describes every form of computer communications used commonly today.

The Fundamental Principles of Networks
Basic Network Protocols and Terminologies

Testing tip: Study each acronym and their meanings carefully. A great mnemonic device for remembering how these protocols are used is to simply reverse their definition. For example, SMTP, is Simple Mail Transfer Protocol, a protocol that transfers mail simply.

- **ISP** – Internet Service Provider. Companies like RoadRunner, AOL, Earthlink and others that provide access to the Internet.

- **TCP / IP** – Transmission Control Protocol/Internet Protocol. These two protocols actually represent an entire suite of protocols which is almost universally used for connection to the Internet.

  ‣ TCP is a connection oriented transport protocol. IP is a connectionless protocol.

> ‣ In order to communicate on the Internet, a computer needs to have an IP address assigned, like 192.168.0.154. This address is broken into two segments, a network address and a host address.

> ‣ The division between the network address and the host address is determined by a **subnet mask**. In this case, the default subnet mask would be 255.255.255.0.

> ‣ In addition, the address must have the address of a **gateway**. A gateway is a router that provides access from the local subnet to the rest of the intranet or to the Internet.

> ‣ To resolve computer names like www.preplogic.com to an IP address, the computer must query a Domain Name Service to find that information.

> ‣ In a small Windows network, computers share names and addresses using the Windows Internet Naming Service (WINS).

> ‣ Static IP address means someone has manually provided all of this information.

> ‣ Automatic address assignment is provided by the Dynamic Host Configuration Protocol (DHCP).

- **IPX / SPX** (NWLink) – Internet Packet Exchange (IPX) is a legacy connectionless protocol that is used primarily on Novell NetWare networks. Sequenced Packet Exchange (SPX) is a connection oriented protocol also used on NetWare networks. NWLink is the Microsoft implementation of IPX/SPX.

- **NETBIOS / NETBEUI** –NetBIOS is non-routing application programming interface (API) protocol used with workgroup computers using DOS, OS/2, or some versions of UNIX. NetBEUI is NetBIOS Extended User Interface, or Microsoft's version of NetBIOS. NetBEUI was a routable protocol, as long as the token ring source routing was used.

- **SMTP** – Simple Mail Transport Protocol (SMTP) is the protocol used to send and receive email across the Internet.

- **IMAP** – Internet Message Access Protocol. This is one way to access Internet based email, using a client, such as Outlook Express or Eudora.

- **HTML** – HyperText Markup Language. The most basic coding language for putting together and displaying web pages.

- **HTTP** – HyperText Transfer Protocol. A protocol used to transfer web pages across the Internet.

- **HTTPS** – HyperText Transfer Protocol Secure. A protocol used to transfer web pages across the Internet using a secure port. It does this by using SSL.

- **SSL** – Secure Sockets Layer. Developed by Netscape as a way to transfer information across the Internet securely and privately.

- **Telnet** – Protocol designed to let users access and use remote computers.

- **FTP** – File Transfer Protocol. A connection oriented protocol designed to assist in the transfer of files from one computer to another computer.

- **DNS** – Domain Name System. A service designed to store, organize and resolve computer host names, like www.preplogic.com, into IP addresses. Domains are broken down into name spaces like .com, .net, .edu, .biz, .ca, etc.

Diagnostic Tools and Troubleshooting Techniques

The following tools and procedures can help you diagnose just about every network problem that can be handled over the phone.

Network Command Line Tools

Refer to the following charts for detailed information on the four most important, network-related command line functions.

IPCONIG – displays information about the network adapter as well as providing the ability to release leased IP address and query new ones from the DHCP server.

Usage: ipconfig [/all | /release *adapter* | /renew *adapter*]

Switch	Description
/all	Displays all information about connection and adapter.
/release	Releases the connection's IP address. You can specify the *adapter*.
/renew	Queries the configured DHCP server for a new IP address. You can specify the *adapter*.

Figure 41: IPCONFIG usage parameters

PING – used to establish a connection between two computers.

Usage: ping [-t] [-a] *address*

Switch	Description
address	The IP address or hostname you wish to ping.
-t	Instructs ping to send packets until it is stopped with CTRL-C.
-a	Resolves addresses to hostnames in the ping report.

Figure 42: PING usage parameters

TRACERT – traces the route of a packet sent from the computer to a designated target IP address.

Usage: tracert [-d] [-h *maxhops*] [-w *time*] *target*

Switch	Description
-d	Instructs Tracert to display the host names as addresses.
-h *maxhops*	Specifies the number hops for Tracert to use.
-w *time*	Instructs Tracert to wait *time* for each reply along the route.
target	The target IP address for the route trace.

Figure 43: TRACERT usage parameters

NSLOOKUP – used to locate information about a particular domain.

>   **Usage:** nslookup *hostname*

Troubleshooting Basic Network Issues

Driver and Network Interface Problems

- Ensure that all cables are properly plugged in and that green lights show on the network interface card, the router and the modem (if applicable).

- Review the **Device Manager** for any driver conflicts related to the NIC. If any exist, make sure to walk the user through uninstalling the current driver and reinstalling a fresh one, preferably the most updated one, from the manufacturer.

- Ensure that the NIC has the latest firmware updates, as well.

Protocol Configuration Issues

- Take the following steps to ensure that the user's computer has the **TCP/IP Settings** properly configured.

    ‣ Checking with the recommended setup for the user's internet service provider, ensure that TCP/IP is configured either to a static IP address or one dynamically updated from a DHCP server, whichever is appropriate.

    ‣ Utilize **ipconfig** to ensure that the adapter has an IP address. **Ping** can be used to determine whether or not the IP address is enabling a connection to the Internet.

    ‣ Try using **ipconfig /release** and **/renew** to refresh the IP address.

    ‣ If all else fails, you can uninstall and reinstall the TCP/IP protocol from within the **Connection Properties Dialog Box**.

- **IPX/SPX** enabled networks have a special, proprietary ping utility called **ipxping**. This can be used to ensure a connection to a Netware server.

Network Permissions Issues

- If the environment is a home network setup and the user cannot access shared resources on another computer, inspect the **Permissions** for the shared resource.

- If simple file sharing is enabled, make sure to check the box next to **Allow Network Users to Change My Files**.
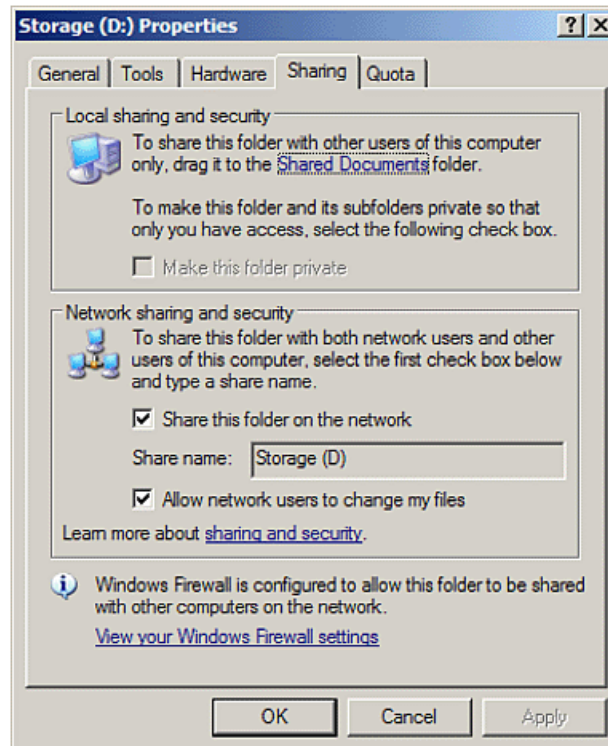
Figure 44: Sharing a volume in Windows

- If simple file sharing is disabled, you will have to manually select the other computer's user name and make sure all permissions are checked in the list at the bottom of the dialog.

- Pay special attention to the **Deny** permission; this permission will supersede any allowed permission. In other words, a user might be allowed to read, write and change files, but if the **Deny All** checkbox is clicked, than the user will, effectively, have no permissions.

- If this is a corporate environment, it may be necessary to refer the user to the InfoSec department of your support team.

Firewall Configuration Issues

- Check to make sure the firewall is not blocking access to something that is safe. If an appropriate website or resource is being blocked, have the user navigate to **Start > Control Panel > Network Connections** and then to click on the **Firewall Settings** on the left-hand pane. Then click on **Exceptions**.
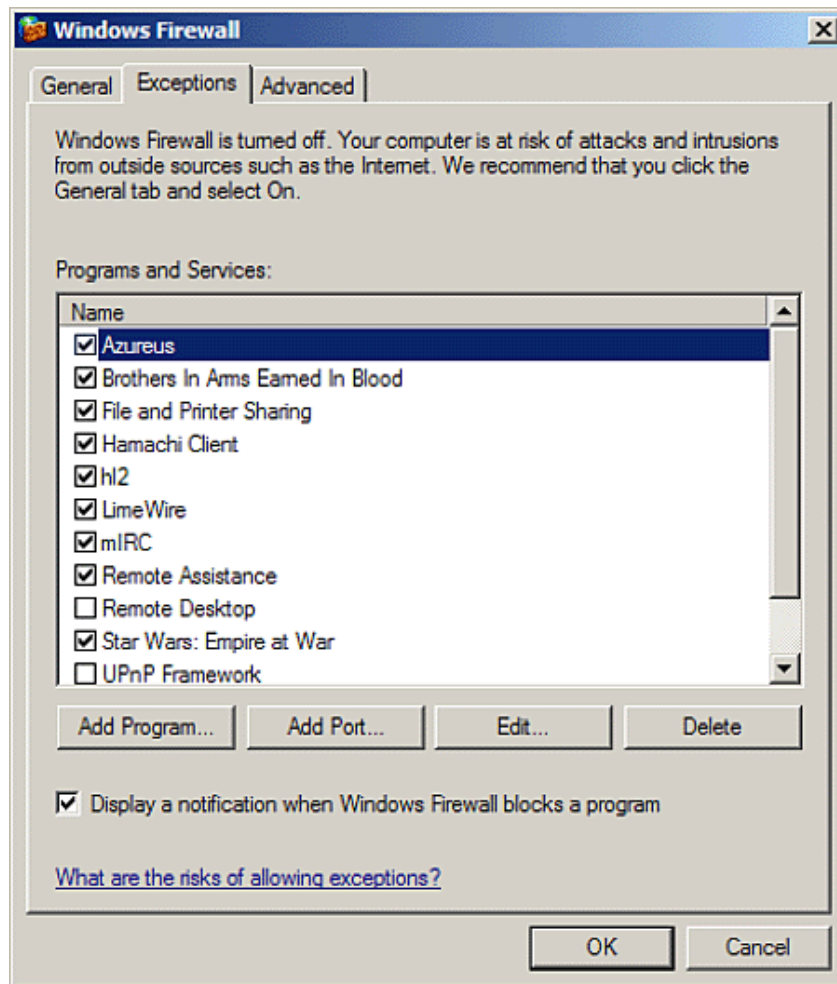
Figure 45: Configuring Windows Firewall

- From here, you can walk the user through adding a port or program for Windows Firewall to ignore.

- This should clear up any resource blocking issues. Just remember to close any ports or programs that are not in use or don't need access to the network.

Electrical Interference Issues
Remember that in an office environment, there can be any number of electrical devices that can cause interference on Ethernet cables, usually manifesting in packet and general network efficiency loss. Ensure that all cabling is away from fluorescent lights and heavy machinery.

SOHO Network Installation and Configuration
Connectivity Technologies

- **Dial-up networking** – using a modem and the public switched telephone network to connect to a remote network or the Internet. Speeds will be limited by the capabilities of the modems involved.

- **Broadband** (e.g. DSL, cable, satellite) – broadband is a method of communicating where the carrier can manage multiple sessions at the same time. Broadband connections include:

    ▸ **Digital Subscriber Line** (DSL) – digital communication technology developed in the 1990's by telephone companies to provide Internet access using pre-installed telephone wire. Residential DSL speeds are 1.5 Mbps.

    ▸ **Cable** – cable modems send and receive digital data across existing television cable networks to access remote networks. Cable modems are capable of higher speeds than are usually found using DSL.

    ▸ **Satellite** – digital information is transferred using satellite connections.

- **ISDN** – Integrated Service Digital Network. Another type of broadband that can use the existing telephone network. ISDN creates a digital network, which removes the need to switch the signal from analog to digital and back again. ISDN came in two fashions:

    ▸ **Basic Rate Interface** (BRI) – two B (bearer) carrier channels at 64 Kbps, and D (data) channel for control and signal information at 16 Kbps.

    ▸ **Primary Rate Interface** (PRI) – 23 B channels and 1 D channel, all operating at 64Kbps.

- **Wireless** (all 802.11) – digital communications that take place without the use of any copper or fiber cabling, using radio waves. The standards for wireless networking are the 802.11 standards:

Standard	Components
802.11 – 1999	Wireless LAN medium access control (MAC) and physical layer specifications
802.11a – 1999	Amendment adding the physical layer for the 5 GHz band
802.11b	Amendment adding the physical layer for the 2.4 GHz band
802.11d	Amendment for adding more regulatory domains
802.11e	Quality of Service additions
802.11f	Insuring that access points were regulated to make sure that a connection could be maintained when moving between cells that are managed by access points from different manufacturers
802.11g	Further high speed physical layers in the 2.4 GHz range
802.11i	Adds security enhancements

Figure 46: IEEE 802.11 wireless standards

- **LAN/WAN/PAN** – Local Area Network/ Wide Area Network.

  ‣ A **LAN** is a group of computers in a confined space that are cabled together so that each computer can share network resources. LANS can be wireless too, or at least they have wireless clients. So, add "LANs can have wireless routers and wireless clients, but generally, Ethernet is involved and there is a wired component.

  ‣ A **WAN** is a network spread out over a geographically large area. The network is made up of smaller LAN's linked together using a common communications protocol.

  ‣ A **PAN** or Personal Area Network is one created between a laptop and a wireless keyboard, or a mobile device, portable Wi-Fi hardware, and a resulting Wi-Fi hotspot.

- **Infrared** – light-wave based technology that operates in a point-to-point or peer-to-peer range that does not exceed one meter and an angle to 30 degrees. Infrared connects and synchronizes PDA's, or to printers for data transfer.

- **Bluetooth** – protocol of a short range (up to 10 meters) radio link that uses frequency hopping technology to interconnect a variety of devices, including mice, PDA's, or keyboards, and can also create an Internet Connection sharing portal.

- **Cellular** – the use of a special PCMCIA card and a subscription to a cellular wireless network service makes it possible for a laptop to wirelessly connect to the Internet, and thereby get access to all the private networks that make up the Internet.

- **VoIP** – Voice over IP. This technology utilizes current networking standards to provide telephone over the Internet. Using VoIP, a user can take a landline phone (as opposed to a cellular phone) anywhere and have phone service using their local number.

Wireless Security

Because wireless networks are, essentially, transmitted freely over the airwaves, it is extremely easy to utilize this broadcast for malicious use. Therefore, careful attention should be paid to the security of any wireless network.

- Wireless networks utilize unique **encryption keys**, which provide a measure of security over computers attempting to access the wireless network. If the computer doesn't possess the key, it will be denied access. The encryption comes in two formats:

  ‣ **Wireless Equivalent Privacy (WEP)** – basic security standard included in the 802.11 standard; possesses a 128-bit encryption, entered as a string of 26 hexadecimal characters. Limited key size expresses some security concerns.

  ‣ **WiFi Protected Access (WPA)** – the other standard, developed in response to the weaknesses of WEP. Utilizes longer keys and error-checking suites to maintain a higher level security. WPA technologies have been continually improved on each year, and new security options are available. You may see WPA 2, WPA-PSK, and other options. Wireless security is a very broad field, and changes often, so make sure to review the new technologies often to stay on top of the changes. All WPA requires a passcode though, so you'll still have to configure the various WPA technologies in the same manner.

- **Wireless Access Points –** provide areas of connectivity, require special security considerations, as they innately "trust" every device attempting connection.

  ‣ **Enable MAC Address Filtering**. This feature will limit access to specific MAC addresses, allowing only certain users to gain access.

  ‣ The **SSID** for the wireless network should be changed from its default, and its broadcast over the network should be turned off. This is a weak form of security and should never be used by itself.

  ‣ Using a **static IP address**, instead of allowing the **DHCP** to obtain one, is another way of adding cheap and easy security to a wireless network, as it will reduce the number of sniffable packets being sent from a machine.

  ‣ **Passwords** should be changed often, and **usernames** should remain unique.

  ‣ It is extremely important to **update the firmware** on all network hardware, to take advantage of the latest security updates for that device.

  ‣ Finally, a **firewall** should be used on any wireless network to prevent access into the computer itself.

Figure 47: A wireless access point (AP)

Network Cables

As discussed briefly in the section above, it is important to understand the various differences between network cables, especially in a wired network environment. This section offers some additional information on network cables, including types of twisted pair and the differences between types of fiber optic cabling.

- **Plenum / PVC** – Plenum cabling is simply cabling that is present in the spaces used for the circulation of heating or air conditioning systems and is heavily regulated by fire codes. This space is typically between a structural ceiling and a suspending ceiling, or underneath a raised floor.

- **UTP** – Unshielded Twisted Pair cabling is the ubiquitous networking cable that most technicians will see connecting computers to Ethernets. Twists in the cable reduce electromagnetic interference and crosstalk in the cable. UTP comes in 3 types:

    - **CAT-3 –** Category 3 UTP, which is now obsolete (though the only cable type recognized by the international standards committee which regulates network cable types), was capable of a throughput of up to 10 Mb/s.

    - **CAT-5** – Category 5 and its later enhancement, Cat-5e, provided speeds of up to 100 Mb/s. The enhanced version was made to be compatible with Gigabit Ethernet and reduce far-end crosstalk.

    - **CAT-6** – Category 6 is the newest standard for Gigabit Ethernet and is capable of speeds up to 10 Gb/s.

- **STP** – Shielded Twisted Pair cabling adds a metal shield to each pair of twisted copper wires. This adds another level of electromagnetic interference protection and was originally developed for IBM's Token Ring network.

- **Fiber Optics** – comes in two different types, determined largely by the way light propagates across the cable:

    - **Single-mode** – utilizes only the lowest order wavelength to transmit light. This type is best for transmitting over long distances (up to 60km) with extremely high data rates, because more information can be passed along the wire per unit time.

    - **Multi-mode** – slower cabling and only works over short distances but is also less expensive than single-mode fiber. Multi-mode fiber is also larger, almost ten times the diameter of single-mode fiber.

Refer to the following table for the various connections used by network cables.

Name	Appearance	Cable Type
RJ-45		Category 3-7 network cables
RJ-11		Phone line cables
USB		USB Cord
IEEE 1394/FireWire		FireWire serial cable

Figure 48: Network cable form factors

Domain 4.0: Security
Virus and Malware Prevention and Detection

- The Internet is full of **malicious software**, software which seeks to infect, rob, access without authentication or otherwise adversely affect a computer or network system:

  - **Viruses** – designed to not only propagate themselves within a system, as the name implies, but usually to sap system resources or corrupt system files and spread themselves to other systems. They require the execution of the program which they infect to become active.

  - **Trojans** – a type of virus used to gain access to a computer by pretending to be a benign piece of software.

  - **Worms** – another type of virus that is self-contained and not reliant on an infected program. They sap bandwidth in order to propagate to other systems.

  - **Spam** – unsolicited advertisement that comes in the form of banner advertisements, pop-up ads or e-mail.

  - **Adware** – very much a virus that performs the same duty as spam: it installs itself on a computer system and then feeds the user advertisements over the Internet, usually as pop-up ads.

> ‣ **Spyware** – similar to adware, in that it is a program and is used for advertisement. In addition, spyware tracks a user's web use and history to "tailor" the advertisements.

> ‣ **Greyware** – a blanket term covering both adware and spyware, and is generally defined as any program that is annoying. In addition to ad- and spyware, greyware can be dialing programs, joke programs, hacking software and remote access software.

- **Software Firewalls** – programs which operate between the network and the computer (logically, not literally) to block unwanted network access and use. A set of **rules** is used to determine what sorts of access is malicious and what is benign. These rules can be manipulated by the user to achieve the appropriate level of security for a specific computing environment.

- **File System Security** – Another important security consideration. Unless you need to dual boot between a very early OS and a newer one, use NTFS. FAT 32 is inherently less secure than NTFS, does not support file encryption, and lacks many other security enhancements and options available with an NTFS formatted drive.

Use Antivirus Software

Antivirus software is used to prevent, detect, and remove malware, including computer viruses, worms, and Trojan horses. Such programs, which are also referred to as antimalware applications, may also prevent and remove adware and spyware.
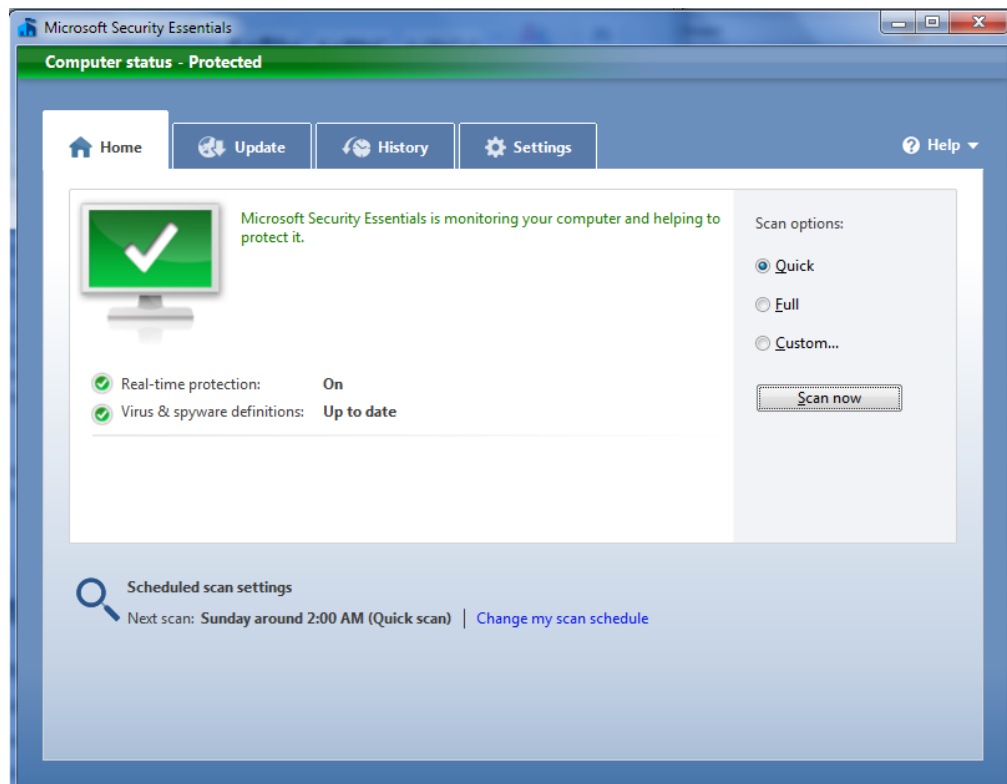

Figure 49: Microsoft Security Essentials antivirus software

Traditionally, antivirus software relies upon signatures to identify malware. This can be very effective, but cannot defend against malware unless samples have already been obtained and signatures created. Therefore, it is crucial to keep antimalware software signature files current through automatic or manual updating.

Antimalware programs inspect the Windows registry, the operating system files, and installed applications, and remove files and entries that match a list of known spyware components. Real-time protection from spyware/antivirus software scans disk files at download time and blocks the activity of components known to represent malware.

In some cases, the software may also intercept attempts to install start-up items or to hijack Web browser settings.
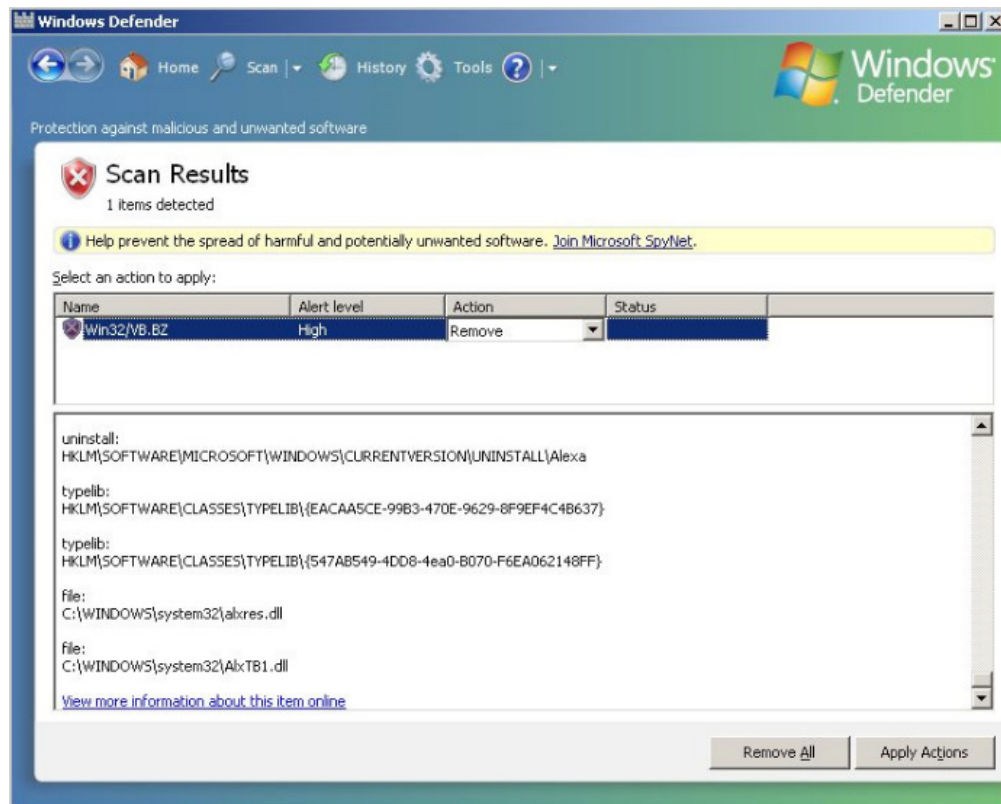

Figure 50: Windows Defender antispyware program

IT Security Troubleshooting
Demonstrate the Ability to Share Network Resources

- **Models** – the two network models in Microsoft networking are the **Domain** and the **Workgroup**.

  ‣ Workgroup is peer-to-peer network.

  ‣ Domain is a centrally administered network.

- **Configure permissions** – access to data and resources can be limited by file and folder level permissions. What's shown here is what you'll see on a Windows XP machine; later you'll see examples of how this looks on Windows 7.

  ‣ To grant access to data stored on the computer to users who are not using that computer, the computer administrator can create a "Share" that others (if given the appropriate permissions) can access and use.

  ‣ To create a share, right click on a folder, and click on **Share this folder**, as shown below:
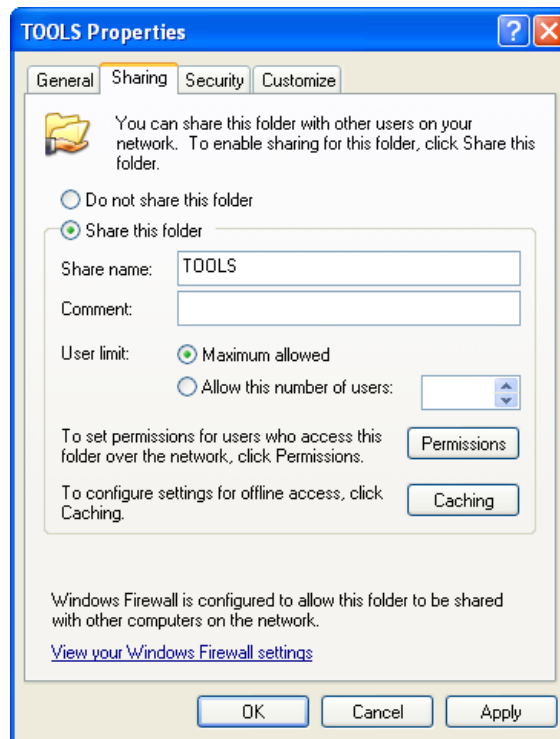
Figure 51: Sharing a folder in Windows

  ‣ This screen can be used for: Naming the share, describing the share, determining how many users can access this share at any time, setting permissions for users who access the folder from the network and configuring offline access.

▸ The user sharing the folder can grant or deny local access by clicking on the permissions tab, as shown below:
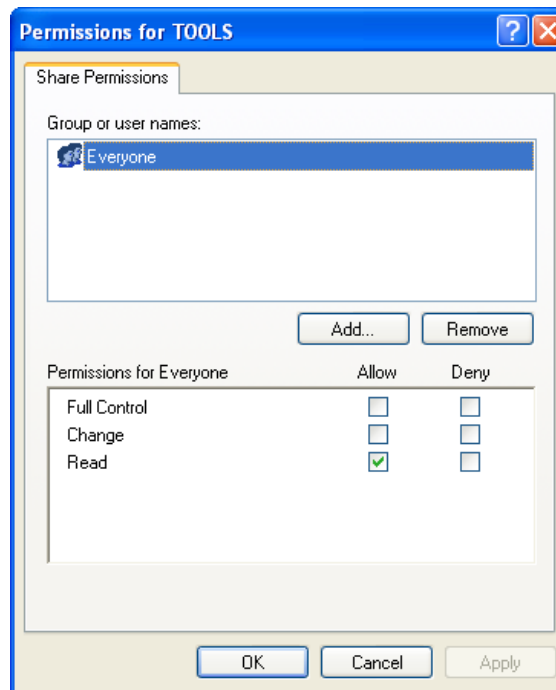
Figure 52: Setting share permissions on a folder

▸ As you can see, by default, the group Everyone can access the share, but all anyone can do is simply read or see the share.

▸ A **group** is simply a clustering of user accounts together to provide access to resources that each user in the group must share.

▸ Windows will allow the person sharing the folder much more flexibility with security.

▸ By clicking on the **Security Tab**, you receive the following screen:
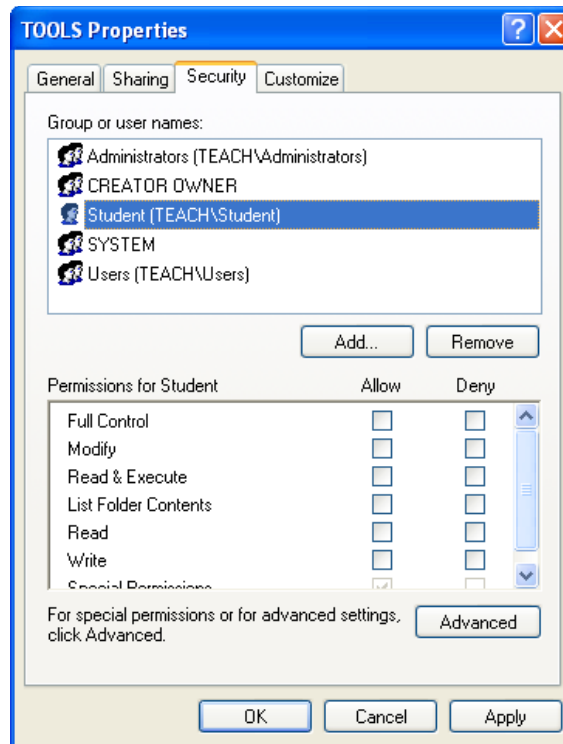
Figure 53: Setting NTFS permissions on a folder

> ‣ Notice that a much more granular approach can be taken from here.

On Windows Vista and Windows 7, sharing is quite a bit different. While you can still right-click a folder and click **Share** (or **Share With**) from the drop-down menu, what you see after that has changed dramatically.

The image here shows the **Share With** option from a Windows 7 computer. In this particular instance, the computer is connected to a LAN and a workgroup, and, part of a homegroup that contains other Windows 7 computers. (If you aren't familiar with homegroups, a homegroup is a feature included only on Windows 7 computers that, once configured, enables you to share data with other Windows 7 computers that are part of that homegroup quickly and easily. As you can see here, that includes sharing with **Nobody**, the **Homegroup**, or **Specific People**.) On a Windows Vista machine, you'll see Share and not Share With.
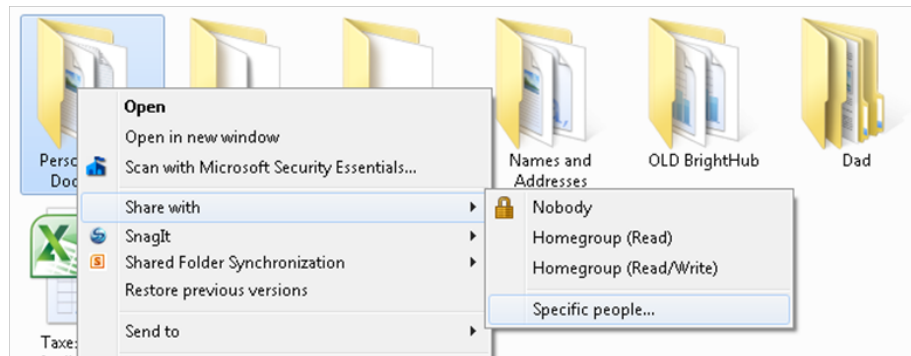
Figure 54

Because you won't likely encounter **homegroups** in workplaces, we'll choose **Specific People** here. What you see next will look the same on both Windows Vista and Windows 7 computers, and it won't matter if there is a **homegroup** configure or not.

When you click **Specific People**, the following window appears:
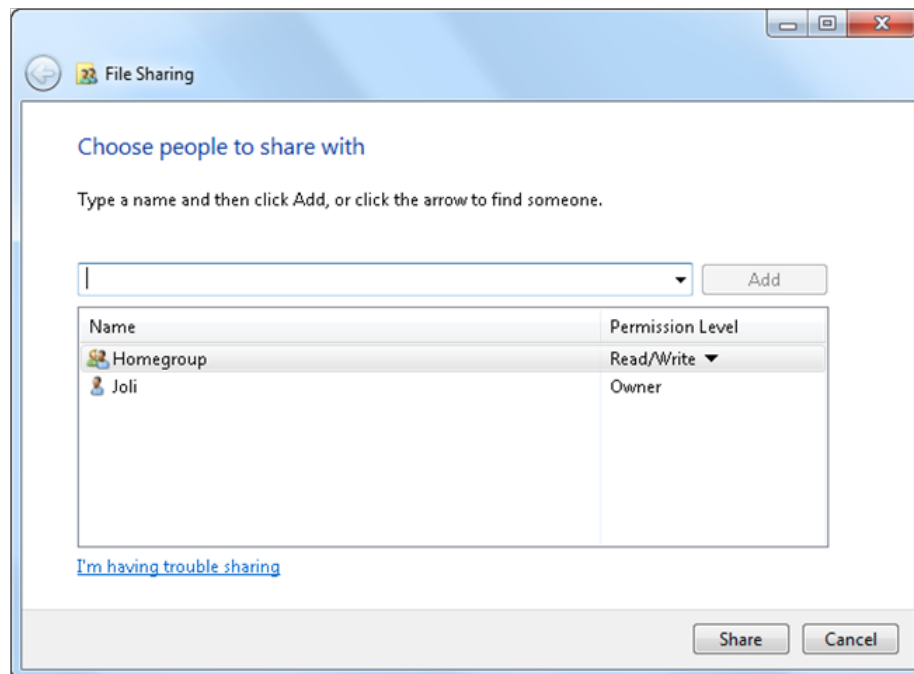
Figure 55

Now, you can type a name of a person, or click the down arrow to see users already configured on the PC. The user you want to add must have an account. Once you've added a user, you can configure the permissions.
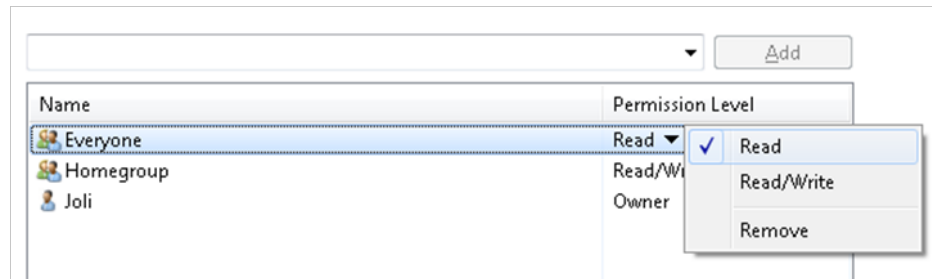
Figure 56: Setting NTFS permissions on a folder

- Capacities / limitations for sharing for each operating system

  ▸ **Windows XP/2000 Professional** – limited to share level permissions and certain local policies. Users may need to be added to each individual computer to get access.

  ▸ **Windows 2000 Server and Windows Server 2003** – domain-wide permissions can be put in place, and you have a much more flexible set of security policies to use.

  ▸ **Windows Vista/Windows 7 –** limited to share level permissions and certain local policies. Users may need to be added to each individual computer to gain access. In Windows 7, sharing is made easier through homegroups, but only Windows 7 computers are compatible. Vista computers cannot join homegroups.

User Account Control

User Account Control (UAC) is a security technology introduced in Windows Vista (and available in Windows Server 2008 and Windows 7) that is intended to improve the security of Microsoft Windows by limiting application software to standard user privileges until an administrator authorizes an increase in privilege level.

In other words, even local administrators run on the system with standard user privileges. When an administrator level is performed (for instance, installing a device driver, loading an application), then the UAC prompts the user either for administrator credentials or for confirmation that the action is desired.

Figure 57: User Account Control (UAC) elevation prompt in Windows Vista

Practice Questions
Chapter 1

1. You have a customer that has recently added an additional hard drive, DVD drive, and case fan to their PC. They report that since then the system won't boot. You examine the computer and verify that everything is installed correctly. What is the most cost effective solution?
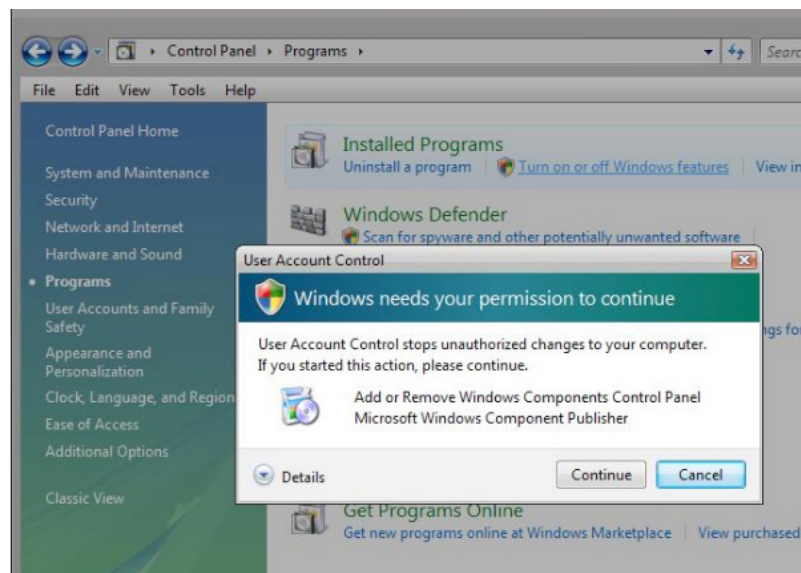   Select the best answer.

    ❍ A. Add a higher wattage power supply.

    ❍ B. Advise the customer that they must remove all the new devices.

    ❍ C. Advise the customer to purchase a completely new computer system.

    ❍ D. Advise the customer to replace both the hard drive and CD/DVD drive with units that do not spin as fast.

2. Which of the following describes how a Liquid Crystal Display [LCD] works?
    Select the best answer.

    ❍ A. An electric current passes through the liquid, causing some of the crystals to activate, whereas others do not.

    ❍ B. An electron gun sweeps a beam of light constantly across the back of the screen. With each sweep, phosphorescent dots in the back of the screen are activated.

    ❍ C. An electron gun sweeps a beam of light constantly across the back of the screen. With each sweep, liquid crystals dots in the back of the screen are activated.

    ❍ D. Phosphorescent dots are activated when an electronic signal passes over them.

3. You are the onsite computer tech, and you have just arrived at work. You have a frantic voicemail from the marketing department supervisor. His computer was working fine when he powered down last night but it refuses to boot at all this morning, and he has critical data on the hard drive he hasn't backed up anywhere. So now you are on your way to his office. What is the first step in diagnosing a completely dead computer at the client site that was working the day before? Select the best answer.

    ❍ A. Question the supervisor thoroughly about the symptoms.

    ❍ B. Replace the CMOS battery.

    ❍ C. Test the power supply.

    ❍ D. Check to see if the computer is plugged in at the electrical outlet in the wall, then at the connection point into the computer's power supply.

    ❍ E. Pop the case and reseat the SIMMs.

4. You recently fulfilled a request for the provision of a new laptop for a mobile user. After receiving the laptop, the user calls you and is angry that the laptop does NOT meet the specifications they requested. They specifically requested 512MB of RAM, and you are certain that the laptop does contain that amount. However the user reports that only 480MB of RAM is installed. How should you address this issue with the user? Select the best answer.

    ○ A. Tell the user to relax, and that everything will be OK. Explain that the memory stick installed in the machine must be faulty and you will replace it right away.

    ○ B. Assure the user that you verified that the system had 512MB of RAM before delivering it to them. Then tell the user that the operating system is reserving some memory for kernel processes.

    ○ C. Apologize to the user for the confusion caused by the discrepancy. Then explain that while the laptop does contain 512MB of RAM, it also has an SMA graphics adapter which uses a small portion of the system RAM for video memory.

    ○ D. Empathize with the user for the confusion created by the discrepancy. Then explain that while the laptop does contain 512MB of RAM, it also has an AGP graphics adapter which uses a small portion of the system RAM for video memory.

5. You have just completed a memory upgrade in a customer's laptop by installing a 512 MB RAM module. The laptop previously just had a single 128 MB RAM module installed. When you boot the machine after completing the memory upgrade, you find that the system shows only 576 MB RAM instead of 640 MB RAM. What has caused this? Select the best answer.

    ○ A. There is a defect in the new RAM module that you installed.

    ○ B. The new RAM module has been installed incorrectly.

    ○ C. The laptop has a video card that uses 64 MB of shared memory.

    ○ D. The 512 MB RAM memory module is installed in the wrong memory slot.

6. You need to connect the primary power connectors from the power supply to an ATX motherboard. Which type of connector[s] would you use? Select the best answer.

    ○ A. P8/P9.

    ○ B. P1.

    ○ C. Molex.

    ○ D. P4.

7.   You are a computer service technician for a cellular phone company. The company has many remote unmanned cell phone tower sites, each of which contains a typical desktop computer to control operations of the cellular equipment at the site. Your boss asks you to assure that the computer in each cell tower site can remain running during power outages lasting up to 45 minutes, without incurring unnecessary cost. You have determined that the computer will present a 250VA load on the UPS. How can you determine what size of Uninterruptible Power Supply to provision at each site? Select the best answer.

○ A. Use the following formula, Where S is the VA rating of a proposed UPS, and R is the resulting run time of the UPS running your equipment: [S / 250] x 1.5 x 10 =R.

○ B. Use the following formula, Where S is the VA rating of a proposed UPS, and R is the resulting run time of the UPS running your equipment: [S x 250] / [1.5 x 10] = R.

○ C. Use the following formula, Where S is the VA rating of a proposed UPS, and R is the resulting run time of the UPS running your equipment: [S / 250] X 2.5 X 10 =R.

○ D. Use the following formula, Where S is the VA rating of a proposed UPS, and R is the res equipment: [S / 10] x 1.5 x 250 =R.

8.   From the following list, which THREE items best describe an LCD display?
Choose the best THREE answers.

○ A. An LCD display uses more power than CRT monitors, so it has special power requirements like a high-output power strip.

○ B. LCD displays come in three types: active matrix, passive matrix and mixed matrix.

○ C. LCD monitors use a different type of input from CRT monitors, called DVI.

○ D. LCD monitors require backlighting in order to be seen.

○ E. The native resolution of an LCD monitor is determined by its display technology.

○ F. LCD monitors are more resilient than CRT monitors thanks to lighter construction and the ability to add protective glass screens.

9.   What are THREE important considerations when using wireless input devices?
Select the best THREE answers.

○ A. All wireless devices interfere with wireless networking.

○ B. Wireless input devices will need to have their batteries changed often.

○ C. Some wireless input devices need a line of sight to their receivers.

○ D. Wireless input devices need to be configured manually, because the technology is not native to most operating systems.

○ E. Wireless devices shouldn't be used near heavy electrical wiring and equipment or fluorescent bulbs.

○ F. Wireless devices require an existing wireless network to operate.

10.   A user reports that their computer was working fine last night. Today when they turn it on the monitor does NOT display any information. When you examine the computer you notice lights on the computer enclosure and keyboard. What steps should you try to resolve this problem? Select the best THREE answers.

❍ A. Check to see if the monitor is powered on.

❍ B. Check to see that the cables running from and to the monitor are properly seated and snug.

❍ C. Replace the monitor with a known good monitor.

❍ D. Replace the computer with a known good computer.

Chapter 2

1.   A user has asked you to help her decrease the amount of time it takes her machine to boot. She observes that unless she manually chooses an option, the computer stays on the Multi-boot list of operating systems for an extended period of time before proceeding with the default selection. She would like to know where she can change the amount of time it waits before proceeding. In which TWO places could she change this setting? Select TWO answers.

❍ A. In the Startup Options applet in Control Panel.

❍ B. In the Startup and Recovery Settings page under the Advanced tab of the System Properties.

❍ C. In the C:\NTLDR.inf file.

❍ D. In the C:\boot.ini file.

2.   Cabinet files [.cab] are compressed files used by Microsoft in distributing programs. These files can be uncompressed using Windows Explorer [if you have Internet Explorer v4 or above]. However, you need to work with .CAB files from the command line. Which utility is provided by Microsoft in the Windows 2000 Resource Kit that allows you to work with .CAB files from the command line? Select the best answer.

❍ A. DUMPEL.EXE.

❍ B. EXTRACT.EXE.

❍ C. PERMS.EXE.

❍ D. SETX.EXE.

3.   You boot your Windows 2000 Computer and receive the following message: NTLDR is missing Press any key to restart. You confirm that there is no disk in the floppy drive. Which of the following could be causing this problem? Choose all that apply.

❍ A. Outdated BIOS.

❍ B. Corrupt BOOT.INI.

❍ C. Corrupt NTLDR.

❍ D. Faulty floppy drive.

❍ E. Corrupt COMMAND.COM.

❍ F. Keyboard is not connected.

4.   A user in the research and development department wants to connect a portable external drive to her PC to store a library of sensitive and proprietary research data. She indicates that it will mainly be connected to her Windows 7 PC, but she will occasionally connect it to her Linux workstation or her new Apple Mac Mini just to be able to read the research files while using those other machines. She asks you which file system to format the portable drive with. What should you tell the user? Select the best answer.

   ○ A. Instruct the user to format the drive using FAT32.
   ○ B. Instruct the user to format the drive using NTFS.
   ○ C. Instruct the user to format the drive with HFS.
   ○ D. Instruct the user to format the disk using the ISO9660 format.

5.   A user has noticed that her Windows XP system is performing quite sluggishly. Upon inspecting the machine, you find a large number of applications running in the system tray. You have confirmed with the user that many of the programs are NOT necessary and wish to stop the programs from automatically starting each time the system starts up. Which of the following is NOT a place to check for entries that cause software programs to run automatically during startup? Select the best answer.

   ○ A. The Startup folders for this User or All Users.
   ○ B. In the Services Control applet.
   ○ C. In the HKey_Local_Machine\Software\Microsoft\Windows\CurrentVersion\Run registry key.
   ○ D. In the HKey_Current_User\Software\Microsoft\Windows\CurrentVersion\Run registry key.

6.   You are helping a user partition and format a hard drive. The user asks why, during the process, you had to select whether a partition was the primary or extended partition. How should you explain what a primary partition and an extended partition are to the user?
      Select the best answer.

   ○ A. Explain to the user that the primary partition is the partition on which the operating system is usually installed, and can only contain one logical drive. The extended partition can be divided into several logical drives, which are then formatted. Further explain that a logical drive is a drive letter which references a specific portion of the physical drive.

   ○ B. Explain to the user that the primary partition can be any partition except the partition on which the operating system is installed, and can only contain one logical drive. The extended partition can be divided into a maximum of one logical drive. Further explain that a logical drive is a drive letter which references a specific portion of the physical drive.

   ○ C. Explain to the user that the extended partition is the partition on which the operating system is usually installed and can only contain one logical drive. The primary partition can be divided into several logical drives, which are then formatted. Further explain that a logical drive is a drive letter which references a specific portion of the physical drive.

   ○ D. Explain to the user that the primary partition is the partition on which the operating system is usually installed and can only contain one logical drive. The extended partition can be divided into one logical drive only, which can never be formatted. Further explain that a logical drive is a drive letter which references a specific portion of the physical drive.

7.   A user calls back a second time in the same day. The user states he called earlier and asked you about a utility that would check his hard drive. The user states you instructed him to run CHKDSK, and it did in fact check his hard drive, but it did NOT fix the errors on his hard drive. What should you tell the user to do? Select the best answer.

   ❍ A. Instruct the user to issue the command scandisk/fix. CHKDSK only checks the hard drive, but it will not fix errors.
   ❍ B. Instruct the user to issue the command CHKDSK/FIX from the command prompt.
   ❍ C. Instruct the user to issue the command CHECKDISK/F from the command prompt.
   ❍ D. Instruct the user to issue the command CHKDSK/F from the command prompt.

8.   A user sometimes encounters issues with the appearance of user-specific desktop settings when running under Windows Aero in Windows Vista. What action should you take for this specific program? Choose the best TWO answers.

   ❍ A. Open application properties and under the Compatibility tab check Run this program in compatibility mode.
   ❍ B. Open application properties and under the Compatibility tab check Disable display scaling on high DPI settings.
   ❍ C. Open application properties and under the Compatibility tab check Disable visual themes.
   ❍ D. Open application properties and under the Compatibility tab check Disable desktop composition.
   ❍ E. Open application properties and under the Compatibility tab check Run this program as an administrator.

Chapter 3

1.   You have been tasked with reconfiguring a machine that once served as an application server to become a regular user workstation on a different network. Since it had been an application server, it was NOT configured to receive its IP configuration automatically through DHCP. When switching the host's IP configuration from static to automatic assignment, which of the following is LEAST likely to change? Select the best answer.

   ❍ A. The subnet mask.
   ❍ B. The DNS server.
   ❍ C. The gateway.
   ❍ D. The IP Address.

2.   What protocol is used to receive email over the Internet? Select the best answer.

   ❍ A. FTP.
   ❍ B. NetBEUI.
   ❍ C. SMTP.
   ❍ D. POP3.

3.   You are the network support technician on a network that uses both TCP/IP and IPX/SPX. A user has just received a new Windows XP computer and can surf the WEB on it, but can't connect to a file share on a legacy Novell Netware server. All other computers communicate perfectly. What is likely to be the problem? Select the best answer.

    ○ A. IPX/SPX and TCP/IP can not be used on the same system.

    ○ B. The Novell Server is not configured to share the files correctly.

    ○ C. DNS is not configured correctly on the client machine.

    ○ D. The NWLink protocol is not bound to the network adapter in Windows.

4.   Your network security utilizes MAC address filtering as part of its security scheme on a particular subnet. You wish to add a new Windows XP machine into the list of allowed MAC addresses, so that it may connect to that subnet. What command can you issue to discover the MAC address of the machine? Select the best answer.

    ○ A. Netstat /all.

    ○ B. NBTstat.

    ○ C. IFConfig /all.

    ○ D. IPConfig /all.

5.   An important system has failed and you are asked to restore it to service as quickly as possible. Every minute of downtime is costing the company money. You quickly ascertain that the only way to bring the system back up is to attempt to repair it using the Recovery Console. Which TWO of the following methods are used to access the Recovery Console?
Select the TWO best answers.

    ○ A. You access the Recovery Console by hitting F8 during the Windows boot up process.

    ○ B. You access the Recovery Console by booting off the installation CD.

    ○ C. Recovery Console can be installed as a menu option on the boot menu.

    ○ D. Recovery Console can be accessed by choosing the Startup And Recovery Settings button on the Advanced System Properties screen.

Chapter 4

1.   A user calls and asks for your help mapping a drive to a folder called "Sales" on a server called "server01." What steps should you instruct the user to take to configure this on his Windows 7 Home Premium system? Select the best answer.

    ○ A. Have the user right-click on My Network Places and select Map Network Drive. From there have the user click on Browse to locate server01 and expand it to find the share folder called "sales." Once the drive is mapped, select finish.

    ○ B. Have the user right-click on Network Neighborhood and select Map Network Drive. From there have the user click on Browse to locate server01 and expand it to find the share folder called "sales." Once the drive is mapped, select finish.

    ○ C. Open the Network and Sharing Center and click Map Network Drive. From the Edit menu select Map Network Drive.

    ○ D. Open the Computer window and click Map Network Drive from the menu bar.

2.   You are working as a support specialist in a large company. You get a call from a customer complaining that he cannot connect to any wireless network. You ask the customer if he can "see" any wireless networks, and he responds in the negative. Why might the user NOT be able to see any wireless networks? Select all possible answers.

   ❍ A. The wireless network is not available.
   ❍ B. The wireless network is not advertising the SSID and has encryption enabled.
   ❍ C. The wireless network card is configured with the wrong MAC address.
   ❍ D. The wireless network has MAC address filtering turned on.

Answers & Explanations
Chapter 1

1. Answer: A

Explanation A. Correct. If too many devices have been added to a computer, the power supply may not be able to supply the wattage needed by all the components. Replacing a lower wattage power supply with a higher wattage power supply will resolve the problem.

Explanation B. Incorrect. While this will most likely resolve the problem, it is not the best solution.

Explanation C. Incorrect. While this will most likely resolve the problem, it is not the least costly solution to the problem.

Explanation D. Incorrect. Reducing the components with units that do not spin as quickly will not reduce the amount of wattage pulled by those devices.

2. Answer: A

Explanation A. Correct. In an LCD, the crystals basically work in an on/off manner. When activated, light cannot pass through them. In a notebook, individual crystals are colorized, providing a color display.

Explanation B. Incorrect. This process describes a Cathode Ray Tube [CRT] display.

Explanation C. Incorrect. The above description confuses elements of CRT and LCD technology. With a CRT screen, An electron gun sweeps a beam of light constantly across the back of the screen. With each sweep, phosphorescent dots in the back of the screen are activated. With an LCD, the crystals basically work in an on/off manner. When activated, light cannot pass through them. Individual crystals can be colorized.

Explanation D. Incorrect. The above description confuses elements of CRT and LCD technology. With a CRT screen, An electron gun sweeps a beam of light constantly across the back of the screen. With each sweep, phosphorescent dots in the back of the screen are activated. With an LCD, the crystals basically work in an on/off manner. When activated, light cannot pass through them. Individual crystals can be colorized.

3. Answer: D

Explanation A. Incorrect - Interrogating the user isn't necessary just yet. As you continue troubleshooting and verify that the computer will not boot, you may have to make further inquiries, but initially you should give the user the benefit of the doubt. In any case, this user has given you enough information that you can at least begin problem solving.

Explanation B. Incorrect - Replacing the CMOS battery is overkill at this point, and would not cause complete failure to boot. Other symptoms, like the computer losing time, would have cropped up beforehand.

Explanation C. Incorrect - After verifying that the computer is plugged in, you should test the power supply.

Explanation D. Correct - Check to see if the computer is plugged in at the electrical outlet in the wall, then at the connection point into the computer's power supply. Based on what the user is describing, the computer is not getting any power. Thus, follow the path the power takes into the computer and that starts from the electrical outlet in the wall. Testing the power supply would be the next step.

Explanation E. Incorrect - The SIMMs are probably fine. If it were a memory problem, the computer would boot, it just wouldn't get very far.

4. Answer: C

Explanation A. Incorrect. While you do want to reassure the user that everything will be OK, telling an upset user to relax is not the best thing to do. Also, there is no indication the memory itself is faulty.

Explanation B. Incorrect. First, your "assurance" that the system has the right amount of RAM could be misconstrued by the user. They may think you are telling them they are wrong, or worse yet, lying about the amount of RAM in the system. Second, the reported amount of installed memory is not affected by software usage.

Explanation C. Correct. Always address/diffuse the user's emotions first. Better communication/user education when delivering the unit may have prevented the user from becoming upset. SMA [Shared Memory Architecture] video cards do use a small portion [sometimes configurable] of system memory as video memory.

Explanation D. Incorrect. It is right that you should address the user's emotions first. Hardware 27 However, merely agreeing that the discrepancy is confusing generally will not diffuse the user's anger. Sometimes the better approach is to "step in front of the bullet" and apologize for not preventing the confusion in the first place. Also, most AGP based video adapters include their own video memory and are not dependent on system RAM.

5. Answer: C

Explanation A. Incorrect. Generally, if there was a problem with a memory module, then the system would not recognize the unit at all instead of utilizing some of the module.

Explanation B. Incorrect. Incorrectly installed RAM modules would not be partially recognized by the laptop. Either none of the additional RAM would be shown or there would be a beep error code upon booting the laptop.

Explanation C. Correct. The laptop has an integrated video card which does not have dedicated memory but, instead, uses up to 64 MB of main memory allocated for video purposes. While a shared RAM system is less expensive, you have less RAM available for your operating system and running applications.

Explanation D. Incorrect. Most laptops have two memory slots, and most systems have no requirements that different memory modules be installed into a particular memory slot. Additionally, if the memory module were installed in the wrong memory slot, there would most likely be a beep error code upon booting the laptop or none of the additional RAM would be recognized by the system.

6. Answer: B

Explanation A. Incorrect. The P8/P9 power connectors were used with earlier AT power supplies used on the AT form factor motherboards. These connectors had to be installed with the black wires next to each other and were keyed so that they could only be installed in one direction.

Explanation B. Correct. All modern motherboards use a P1 socket to connect the power supply to the motherboard. This connector has a notch that prevents the connector from being attached in the wrong direction.

Explanation C. Incorrect. While Molex connectors are the most common type of power supply connector used in computers, they are used to supply either 5 or 12 volts of power to CD/DVD drives, hard drives, case cooling fans, and other internal devices.

Explanation D. Incorrect. The P4 connector is a 4-wire connector required by some CPU chips to provide additional 12-volt power to the motherboard. This connector does not supply the primary power to the motherboard.

7. Answer: A

Explanation A. Correct - First we divide the VA rating of the proposed UPS, for example 750VA, by the load it will be running [in this case 250VA]. Then we take that ratio and multiply it by a variable multiplier. If the ratio was less than three, the multiplier is 1.3. If it was three or more, the multiplier is 1.5. Then we multiply that figure by the advertised run time of the proposed UPS [when running at its maximum load]. This is typically about ten minutes. The resulting number is the estimated run time of the proposed UPS when running your equipment. So: 750/250=3 Therefore, 3x1.5x10=45 minutes.

Explanation B. Incorrect - The correct formula is [S / 250] x 1.5 x10 =R First we divide the VA rating of the proposed UPS, for example 750VA, by the load it will be running [in this case 250VA]. Then we take that ratio and multiply it by a variable multiplier. If the ratio was less than three, the multiplier is 1.3. If it was three or more, the multiplier is 1.5. Then we multiply that figure by the advertised run time of the proposed UPS [when running at its maximum load]. This is typically about ten minutes. The resulting number is the estimated run time of the proposed UPS when running your equipment. So: 750/250=3 Therefore, 3x1.5x10=45 minutes.

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8. Answers: C, D, E

Explanation A. Incorrect. Actually, LCD displays are prized for their low power output, which is what makes laptops possible. The crystals in the display can be activated by a very low electrical current, which produces the image.

Explanation B. Incorrect. Only the first two types describe LCD displays. An active matrix displays make up the majority of modern LCD displays. Passive matrix displays are usually monochrome and only a few lines in length, like pager or calculator screens.

Explanation C. Correct. In addition to the standard VGA connection, LCD monitors can utilize the DVI input connection, which is usually white in color. The standard VGA monitor connector is more often than not blue colored and a little larger than the DVI input.

Explanation D. Correct. The electrical current applied to the liquid crystal matrix is only strong enough to change its color. The LCD requires a backlight, usually from a very bright source [like a halogen or fluorescent bulb]. Newer LCD screens use LEDs to backlight the display.

Explanation E. Correct. LCD screens tend to work best under what is called their "native resolution." Each screen is tagged with an acronym which relates its display technology [SVGA, XGA, SXGA+, UXGA and QXGA] and this is paired with a native resolution [800x600, 1024x768, 1400x1050, 1600x1200 and 2048x1536, respectively].

Explanation F. Incorrect. While a glass screen can help prevent damage to LCD screens, these types of displays are actually more prone to damage than CRT screens. The lightweight construction may protect an LCD monitor from falling damage, but it is Hardware 30 extremely easy to damage the screen by applying too much pressure, spilling liquids, etc.

9. Answers: B, C, E

Explanation A. Incorrect. RF and Bluetooth devices do not interfere with wireless networks because RF devices work on a much smaller wavelength [between 27 and 900 MHz] than WiFi [which can be up to 5GHz], despite being radio wave devices. IrDA doesn't interefere because it uses a different technology.

Explanation B. Correct. You should advise customers who are using wireless input devices to use rechargeable batteries, as wireless devices can be more expensive in terms of battery purchases than normal input devices.

Explanation C. Correct. While it is true that RF devices do not need line-of-sight, other wireless input devices, such as IrDA do need line-of-sight to operate. Bluetooth may not need line-of-sight, but its effective range is usually very small.

Explanation D. Incorrect. Most, if not all wireless devices are plug-and-play compatible, and a large majority will be hot-swappable. It is important to check the Device Manager for any device driver conflicts, and to download the manufacturer's latest drivers.

Explanation E. Correct. The items listed above have a tendency to generate a large amount of electrical interference which will degrade the performance of any wireless device. Wireless input devices should be used in a place where there is little to no interference.

Explanation F. Incorrect. Wireless input devices, especially RF and Bluetooth, do not use the same radio wavelength that WiFi uses to transmit network information. Just like wireless networks can't interefere with wireless input transmissions, they also cannot share a wavelength.

10. Answers: A, B, C

Explanation A. Correct. One of the first items to check is to see if the problem component is powered on. In a surprising number of instances simply powering the device on will resolve the problem.

Explanation B. Correct. This is one of the first items you should check when dealing with a hardware issue. Plugs can easily be knocked loose or work loose due to thermal expansion and contraction. More often than not checking the cables will resolve a problem.

Explanation C. Correct. If the monitor is powered on and all cables are secure then you should try replacing the monitor with a known good monitor to determine if the problem is with the monitor or the computer.

Explanation D. Incorrect. This is a rather drastic step. You would do better to replace the monitor with a known good monitor. If the computer still does not display information then you should try replacing the display adapter in the computer next.

Chapter 2

1. Answers: B, D

Explanation A. Incorrect. There is no Startup Options applet in Control Panel.

Explanation B. Correct. The Startup and Recovery Settings page includes an option to change the amount of time the system waits for user input while displaying the List of Operating systems. Setting this to 5 seconds is usually sufficient.

Explanation C. Incorrect. There is no such file.

Explanation D. Correct. The boot.ini file, which is a hidden system file, contains the configuration information. Although typically modified through the Startup and Recovery Settings page, it can be modified manually.

2. Answer: B

Explanation A. Incorrect - The DUMP EVENT LOG tool [DUMPEL.EXE] is part of the Windows 2000 Resource Kit that is used to help you perform administrative tasks, automate software installation, and with other jobs.

Explanation B. Correct - The EXTRACT.EXE utility is part of the Windows 2000 Resource Kit, and is designed to allow you to extract files from a compressed .CAB file using the command line interface.

Explanation C. Incorrect - The PERMS.EXE utility is part of the Windows 2000 Resource Kit, and is designed to display a user's access permissions for a file or directory.

Explanation D. Incorrect - The SETX.EXE utility is part of the Windows 2000 Resource Kit, and is designed to set environmental variables in the user or computer environment.

3. Answers: A, B, C

Explanation A. Correct - The most common causes of the "NTLDR is missing" error, aside from a disk left in the floppy drive, is an outdated Basic Input Output System (BIOS) or a corruption in one or more Windows boot files (NTLDR, NTDETECT.COM or BOOT.INI). You solve this problem by verifying that your BIOS is current, and repairing the Windows 2000 startup environment. This could be as easy as editing the BOOT.INI file to point to the location of the system files.

Explanation B. Correct - The most common causes of the "NTLDR is missing" error, aside from a disk left in the floppy drive, is an outdated Basic Input Output System (BIOS) or a corruption in one or more Windows boot files (NTLDR, NTDETECT.COM or BOOT.INI). You solve this problem by verifying that your BIOS is current, and repairing the Windows 2000 startup environment. This could be as easy as editing the BOOT.INI file to point to the location of the system files.

Explanation C. Correct - The most common causes of the "NTLDR is missing" error, aside from a disk left in the floppy drive, is an outdated Basic Input Output System (BIOS) or a corruption in one or more Windows boot files (NTLDR, NTDETECT.COM or BOOT.INI). You solve this problem by verifying that your BIOS is current, and repairing the Windows 2000 startup environment. This could be as easy as editing the BOOT.INI file to point to the location of the system files.

Explanation D. Incorrect - A faulty floppy drive will usually cause problems when you try to store or retrieve data with a floppy diskette, but it will not generate the "NTLDR is missing" error.

Explanation E. Incorrect - A corrupt COMMAND.COM message usually will turn up this error message:" The following file is missing or corrupt: COMMAND.COM. Type the name of the Command Interpreter."

Explanation F. Incorrect - A keyboard not plugged in would generate a keyboard error, not a "NTLDR is missing" error.

4. Answer: B

Explanation A. Incorrect. While Fat32 is universally supported by nearly all major operating systems, it is not a secure file system. The user's research data was described as being sensitive and proprietary, indicating it needed to be secure.

Explanation B. Correct. NTFS is a secure file system, and a minimum of read-only support is included in most distributions of Linux [version 2.2 or higher] and Mac OS [version 10.3 or higher].

Explanation C. Incorrect. The HFS [Hierarchical File System] file system is the preferred file system for MAC OS, and is supported by Linux, but not Windows 7.

Explanation D. Incorrect. While the ISO9660 format is operating system-independent and universally recognized, this file system is used for CD-Rom discs and is not available as an option for formatting hard drives.

5. Answer: B

Explanation A. Incorrect. The Startup folders are one of the best places to check.

Explanation B. Correct. Although some services do have a user interface and potentially place an icon in the system tray, most do not.

Explanation C. Incorrect. This registry key includes entries for programs that will run at startup regardless of which user logs on.

Explanation D. Incorrect. This registry key includes entries for programs that will run at startup for this specific user.

6. Answer: A

Explanation A. Correct. The primary partition is the partition on which the operating system is usually installed, and can only contain one logical drive.

Explanation B. Incorrect. A primary partition is the partition the operating system boots from.

Explanation C. Incorrect. The primary partition can only contain one logical partition.

Explanation D. Incorrect. The extended partition can be divided into four logical partitions.

7. Answer: D

Explanation A. Incorrect. Scandisk is the disk utility included in Windows 95/98, not in Windows XP.

Explanation B. Incorrect. CHKDSK does not support a /FIX parameter.

Explanation C. Incorrect. The correct command is CHKDSK not CHECKDISK.

Explanation D. Correct. The CHKDSK/F command tells XP to fix all bad allocation units found during the scan of the drive.

8. Answers: B, C

Explanation A. Incorrect. This option operates the program using settings from a previous version of Windows.

Explanation B. Correct. This property disables automatic resizing of large-scale font sizes if it disturbs the appearance of application data.

Explanation C. Correct. This property turns off theme capabilities on a per-application basis.

Explanation D. Incorrect. This feature switches between effects rendering for applications that do not directly support them.

Explanation E. Incorrect. As the title implies, this will give administrative access to resources when the application runs, which is probably not what you want.

Chapter 3

1. Answer: B
Explanation A. Incorrect. The host is going to be on a different network, increasing the likelihood that the subnet mask will change.

Explanation B. Correct. Many organizations have only one or two DNS servers, making this the least likely thing to change when switching to DHCP.

Explanation C. Incorrect. The host's default gateway would certainly change if the host were moving to a different network.

Explanation D. Incorrect. This is the MOST likely thing to change as a result of switching to DHCP.

2. Answer: D
Explanation A. Incorrect - The FTP utility can be used to download/upload files to/from a web server.

Explanation B. Incorrect - NetBEUI is an enhanced version of the NetBIOS protocol used by network operating systems such as LAN Manager, and LAN Server.

Explanation C. Incorrect - Simple Mail Transfer Protocol [SMTP] is a protocol for sending e-mail messages between servers.

Explanation D. Correct - Post Office Protocol [POP/POP3] is a protocol used to retrieve e-mail from a mail server.

3. Answer: D
Explanation A. Incorrect. Windows XP supports the use of multiple protocols bound to an individual network adapter.

Explanation B. Incorrect. Other users are not experiencing the problem.

Explanation C. Incorrect. IPX/SPX does not use DNS for name resolution.

Explanation D. Correct. NWLink is Microsoft's implementation of IPX/SPX and must be bound to a network adapter for that interface to be able to connect to a legacy Novell Netware server running IPX/SPX.

4. Answer: D
Explanation A. Incorrect. This command shows all open connections and sessions on the local machine, but not its MAC address.

Explanation B. Incorrect. NBTstat is a command used for viewing protocol statistics for NetBIOS over TCP/IP connections.

Explanation C. Incorrect. IFConfig is used in Linux or UNIX environments to configure network interfaces.

Explanation D. Correct. IpConfig /all will show all network interface configuration information, including the MAC address of each interface.

5. Answers: B, C

Explanation A. Incorrect - This is not true. It can be run by booting off the installation CD or it can be installed as a menu option on the boot menu.

Explanation B. Correct - This is true. After booting from the installation CD, you are given an option to Repair an Existing Installation. This option will lead you to the Recovery Console.

Explanation C. Correct - This is true. Recovery Console can be installed as a menu option on the boot menu by running the command D:\i386\winnt32.exe /cmdcons from the installation CD, where D: is the drive letter of your cd-rom drive.

Explanation D. Incorrect - This is not true. Recovery Console is not an application that could be run, or should be run, within a working Windows XP Operating System. It is a tool of last resort, designed to revive systems that are incapable of booting or running properly.

Chapter 4

1. Answer: D

Explanation A. Incorrect. My Network Places was available in Windows XP and is not available in Windows 7.

Explanation B. Incorrect. My Network Neighborhood was available in Windows XP and is not available in Windows 7.

Explanation C. Incorrect. While in the Network and Sharing Center you can map a network drive from the Tools menu, but not the Edit menu.

Explanation D. Correct. You can map a network drive on a Windows 7 computer.

2. Answers: A, B

Explanation A. Correct. The wireless network could be down.

Explanation B. Correct. If the wireless network is not broadcasting the SSID, users will not see it when they are looking for wireless networks.

Explanation C. Incorrect. The MAC address is a hardware address that is hard coded into the interface and cannot easily be changed.

Explanation D. Incorrect. If it has MAC address filtering enabled, it will not allow the user to connect but will still be visible when the user browses for wireless networks.