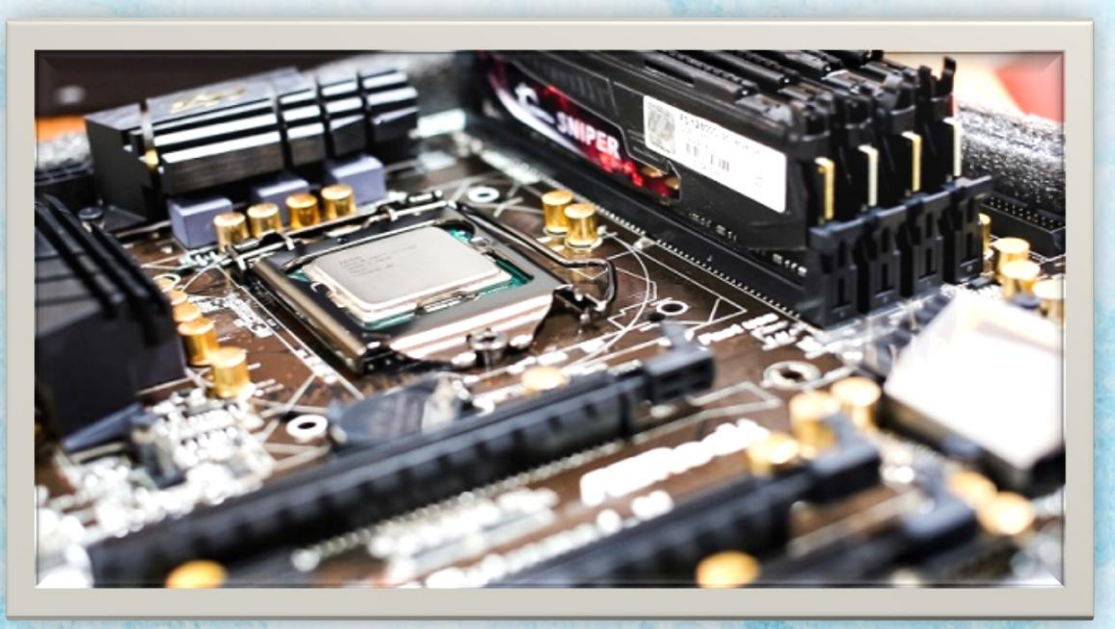
III SEMESTER

ELECTIVE – III SKILL DEVELOPMENT

HARDWARE & PC MAINTENANCE



BCACE236

Mangalore University

UNIT- I

1.1 THE COMPLETE PC

A typical PC is more than one device, and you need all of the parts (or at least most) to make the PC work. The most important part of the PC is the box that usually sits under your desk: the one that all of the other parts connect to, called the system unit. **All of the processing and storage takes place in the system unit.** All of the other parts of the PC the printer, the keyboard, the monitor-connect to the system unit and are known collectively as peripherals. Figure shows a typical desktop PC, with the system unit and peripherals as separate pieces.

Figure 3.6 Typical desktop computer with peripherals

1.2 EXTERNAL CONNECTIONS

Most computers have a standard set of peripherals to provide input andoutput. You'll see some variation in color, bells, and whistles, but here's the standard set:

Monitor: The big television thing that provides a visual output for the computer.

Keyboard Keypad for providing keyed input. Based on a typewriter

Mouse Pointing device used to control a graphical pointer on the monitor for input.

SpeakersProvide sound output.

Printer Provides printed paper output.

1.3 DEVICES AND THEIR CONNECTORS

let's turn to the devices common to almost every PC to lean which connectors go with which device.

All of the connectors on the back of the PC are just that: connectors. Behind those connectors are the actual devices that support whatever peripherals plug into those connectors. These devices might be built into the computer such as a keyboard port.

Cards Versus Onboard

Add-on expansion cards that a tech installed into the PC.

Most PCs have special expansion slots inside the system unitthat enable you to add more devices on expansion cards. Figure shows a typical card. If you want some new device that your system unit doesn't have built into the PC, you just go to the store, buya card version of that device, and snap it in.

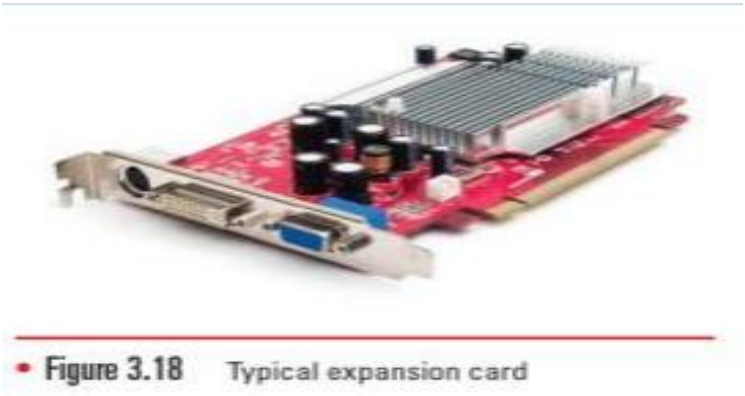


Figure 3.18 Typical expansion card

Keyboard

Keyboard always connect to your computer by either a **mini-DIN port or a USB port.** Many keyboards ship with an adapter so you can use either port. Most keyboard plugs and mini-DIN keyboard ports are colored purple.

Figure 3.19 Keyboard plug and port

Monitor

A monitor connects to the video connector on the system unit. We usually see one of two types of video connectors: the older, 15-pin female DB **Video Graphics Array (VGA)** connector or the unique **digital visual interface (DV)** connector. VGA connectors are colored blue, whereas DVI connectors Figure are white. Many video cards have both types of connectors or two VGA or two DVI connectors. Other video cards also add S-Video, component, or composite ports. Video cards with two connectors support two monitors, a very cool setup to have!

Figure 3.20 Video card with (from left to right) S-Video, DVI, and VGA ports

The newest video connector is called **High-Definition Multimedia Inter-face (HDMI),**HDMI brings a number of enhancements, such as the ability to carry both video and sound on the same cable.Primarily designed for home theaters, computers with HDMI connectorsgrow more common every year.

Figure 3.21 HDMI connector

Sound

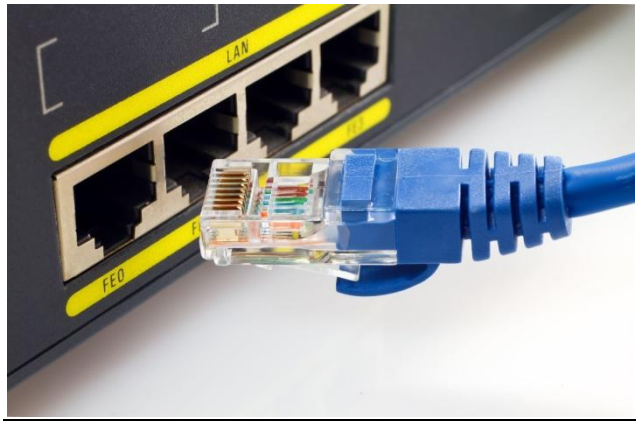
The sound device in a computer performs two functions. First, it takes digital information and turns it into sound, outputting the sound through speakers. Second, it takes sound that is input through a microphone or some other audio source and turns it into digital data.

To play and record sounds, your sound device needs to connect to a set of speakers and a microphone more. All PCs have at least two miniature audio jacks: one for a microphone and another for stereo speakers. Better cards provide extra miniatureaudio jacks for surround sound.

Figure 3.22 Typical bank of 1/8-inch audio jacks

Network

Networks are groups of connected PCs that share information. The PCs most commonly connect via some type of cabling that usually looks like an extra-thick phone cable. Figure shows a typical RJ-45 network connector.



Mouse

Most folks are pretty comfortable with the function of a mouse-it enables you to select graphical items on a graphical screen. A PC mouse has at least two buttons, while a better mouse provides a scroll.

Printer

For many years, printers anly used a special connector called a**parallel port**. Parallel ports use a 25-pin female DB (5-L connector that's usually colored fuchsia.

• Figure 3.29 Parallel port

After almost 30 years of domination by parallel ports, most printers now come with USB.

Joystick

Joysticks weren't supposed to be used just for games. When the folks at IBM added the two-row, 15-pim female DB joystick connector to PCs, they envisioned joysticks as hard-working input devices, just as the mouse istoday.

Figure 3.30 Joystick

eSATA

More and more P'Cs are showing up with eSATA ports t:1..the one shown in Figure. Some external hard drives and optical drives can connect via eSATA.

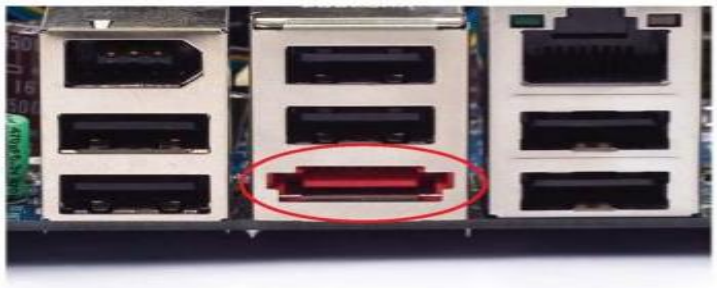


Figure 3.31 eSATA port

Mini-DIN Connectors

Most PCs sport the European-designed mini-DIN connectors. The original DeutscheIndustries Norm (DIN) connector was replaced by mini-DIN a long time ago, so you'll only see mini-DIN connectors on your PC. Older-style keyboards and mice plugged into DIN ports. You l hear many older techs refer to a mini-DIN keyboard connector as a PS/2 connector.

Figure 3.9 DIN (top) and mini-DIN (bottom) connectors

The standard mini-DIN connector has six pins and has been used for many devices aside from mice and keyboards. Some ancient video cards used the mini-DIN

connector for output to a television, for example, and a lot of speaker sets use it to connect satellites to a subwoofer or to a control box. In uses other than keyboard or mouse, the mini-DIN gets yet another name, DIN-6.

USB Connectors

Universal serial bus (USB) provides the most common general-purpose connection for PCs. You'll find USB versions of many devices, such as mice, keyboards, scanners, cameras, and printers. USB connections come in three sizes: A, B, and mini-B. The USBA connector's distinctive rectangular shape makes it easily recognizable.

Figure 3.10 USB A connector and port

You never see a USB B connector on your computer. USB B connecters for the other end of the USB cable, where it attaches to the USB device.

Figure 3.11 USB B connector

Figure 3.12 USB mini-B connector

The USB B connector's relatively large size makes it less than optimal for small devices such as cameras, so the USB folks also make the smaller mini-B-style connector shown in Figure.

USB has a number of features that make it particularly popular on PCs. First, USB devices are hot-swappable, which means you can insert or remove them without restarting your PC. Almost every other type of connector requires you to turn the system off, insert or remove the connector and then turn the system back on. Hot-swapping completely eliminates this process.

Second, many USB devices get their electrical power through the USBconnection,so they don't need batteries or a plug for an electrical outlet.

FireWire Connectors

FireWire, also known as IEEE 1394, moves data at incredibly high speeds, making it the perfect connection tor highly Specialized applications such as streaming video from a digital video camera onto a hard drive. FireWire consists of a 6-wire connector, as shown in Figure, or a 9-wire connector for devices that need more speed and power. A smaller 4-pin version is usually seen on peripherals. Like USB, FireWire devices are hot-swappable.

It wasn't that long ago that a typical FPC used at least three or more different DB connectors. Over the past few years, the PC world has moved away from DB connectors. A typical modern system has only one or two, usually for video.

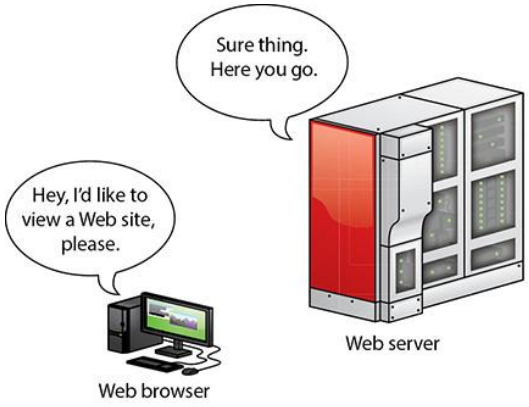
• Figure 3.16 RJ-11 (top) and RJ-45 (bottom)

RJ Connectors

You have more than likely seen an RI connector, whether or not you knew it by that name. The little plastic plug used to Connect your telephone cord to the jack (techs don't use the word "port to describe R connectors) is a classic example of an RJ plug. Modern PCs use only two types of RJ jacks: the RJ-11 and the RJ-45. The phone jack is an RJ-11. It is used almost exclusively for modems. The slightly wider RJ-45 jack is used for your network connection.

1.4 INTRODUCTION TO NETWORKING HARDWARE

Each networked host fulfills a certain *role*. A remote computer called a **Web server** stores the files that make up a Web site. The Web server uses server programs to store and share the data. So the role of the Web server is to provide access to Web sites. Two popular Web server programs are Apache HTTP Server and Microsoft Internet Information Services (IIS). When you access a Web site, your **Web browser** (likely Internet Explorer, Mozilla Firefox, Google Chrome, or Microsoft Edge) asks the Web server to share the Web page files and then displays them. Because your computer asks for the Web page, we call it the **client**. That's the role of the local host in this example. The remote computer that serves the Web site is a **server**.



To share and access resources, a network must have the following:

1. Something that defines and standardizes the design and operation of cabling, network cards, and the interconnection of multiple computers
2. An addressing method that enables clients to find servers and enables servers to send data to clients, no matter the size of the network
3. Some method of sharing resources and accessing those shared resources

1.5 NETWORK INTERFACE CARD (NIC)

What is NIC and how to install the hardware onto a system?

A NIC (Network Interface Card) is also called as network card, network adapter and LAN Adapter is a piece of computer hardware designed to allow computers to communicate over a computer network. It allows users to connect to each other either through wired or wireless network.

Although other network technologies exist, Ethernet has come inexistence since the mid-1990s. Every Ethernet network card has a unique 48-bit serial number called a MAC address, which is stored in ROM (Read Only Memory) carried on the card. Every computer on an Ethernet network must have a card with a unique MAC address. No two cards ever manufactured share the same address.

A network card typically has a twisted pair port where the network cable is connected, and a few LEDs to inform the user of whether the network is active.

How to fix a NIC onto a system?

Always follow the manufacturer's instructions that were supplied with your modem. A NIC is easy to install. The only considerations for installation are that you have an available slot and that the NIC is designed for the slot type you have. Most systems use a PCI (Peripheral Component Interface) slot for a NIC.

Fig 1.1.2.4 PCI (Peripheral Component)

Check that you have an available slot and the slot type, before purchasing a NIC.

Steps:

1. Unplug (Power Off) the system.

   2. Remove the cover of the case/cabinet of the CPU (Control Processing Unit). 3. Remove the cover plate adjacent to the slot for your NIC to be fixed. Refer fig 1.1.2.5.

3. Remove the cover plate adjacent to the slot for your NIC to be fixed.
Refer fig 1.1.2.5.

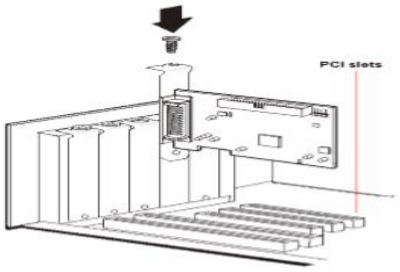


Fig 1.1.2.5 How to mount the Network Interface Card (NIC) onto the motherboard.

4. Align the NIC over the slot with the jack facing the outside of the system.
5. Set the NIC into the slot and press down firmly. Make sure the mounting bracket is properly aligned with any slot that might be present. It may be necessary to gently rock the card from end to end to secure it in the slot. The gold contacts at the bottom of the NIC should nearly or completely disappear into the slot. The card should be level and straight.
6. Secure the NIC mounting bracket to the case with a screw (or replace the securing mechanism your case uses.
7. Replace the cover.
8. Plug in the system.
9. Plug in the Ethernet wire to the RJ-45 jack and plug the other end into the modem, hub, and router or if using a crossover wire, connect directly to another system

1.6 CRIMPING

The process of inserting a Cat5 cable into a RJ45 jack and fixing them firmly is called Crimping.

The steps for crimping are:

1. Begin by stripping the outer insulation covering from the end of the cable. Remove about an inch of covering.
2. Cut down the amount of exposed cable. The process of installing the RJ-45 connector will be easier if you have plenty of exposed cable to work with.
3. Once the outer layer of the wire is removed, you'll see pairs of wire are twisted together (hence the name twisted-pair cable). Untwist these wires.
4. Once all the wires have been separated, pull them backward, so that you can cut off the exposed plastic core. Refer fig 2.25(1).

5. Now that the core has been removed, your next task is to straighten the wires that were previously twisted.

Next arrange the wires in an order by following the standardized color code. Refer fig 2.25(2).

6. Next fix the wires inside the RJ45 jack properly. Refer fig 2.25(3).

7. The crimping tool is used to crimp a network cable, so that the wires are firmly fixed inside the RJ45 jack. Refer fig 2.25 (4).

8. Make sure that the wires are arranged in the proper order.

Refer fig 2.25(2).

9. Test the crimped cable by using the testing tool to verify so that the network cable can be used in a LAN

There are Two type of cable crimping available

1. Straight cable coloring order. 2. Cross-cable .

1.Crimp and Test Straight cable:

To Crimp, test and connect 4 PC's with a straight cable. Also, check the network connectivity.

Crimping: Using the crimping tool both ends of the RJ45 cable needs to be crimped. Make sure that the cables are fixed inside the jack perfectly and then crimped.

At the time of crimping one should be conscious of IEEE standard color code format. There are 2 types of wires **T-568A and T-568B**.

APPENDIX-A

Color Coding Format for T-568A

Wire No(From Left to Right)	Wire Color
1	White & Green (g)
2	Only Green (G)
3	White & Orange (o)
4	Only Blue (B)
5	White & Blue (b)
6	Only Orange (O)
7	White & Brown (br)
8	Only Brown (BR)

APPENDIX B

Color Coding Format for T-568B

Wire No(From Left to Right)	Wire Color
1	White & Orange (o)
2	Only Orange (O)
3	White & Green
4	Only Blue (B)
5	White & Blue (b)
6	Only Green (G)
7	White & Brown (br)
8	Only Brown (BR)

Connecting: By using a Cross-over network cable 2 systems can be connected directly without a switch or a hub.

Connect 2 PC's by using a Cross-over cable and check whether the crimped cable is perfect for use.

1.7 SETTING UP OF A LOCAL AREA NETWORK

User Account Creation

User Accounts

Every user account has a user name and a password. A user name is a text string that identifies the user account assigned to a system. Three examples of possible user names are “Mike1” or “john.smith” or “some.person@hotmail.com.” Associated with every user name is a password: a unique key known only by the system and the person using that user name. This user name and password are encrypted on the system—and only those with a user name and password are allowed access to the system via the login process.

Every Windows system stores the user accounts as an encrypted database of user names and passwords. Windows calls each record in this database a **local user account.**

Creating a user account (local or global) not only adds a user name to a database, it also generates several folders on a computer. In Windows, for example, each user account gets unique personal folders, such as Documents, Desktop, Pictures, Music, and more. By default, only a person logged in as a specific user can access the personal folders for that user account. So, the next step is to secure that local user account.

Passwords

Passwords help secure user accounts. Protect your passwords. Never give out passwords over the phone. If someone learns your user name and password, he or she can log on to your computer. Even if the user account has only limited permissions—perhaps it can only read files, not edit them—you still have a security breach.

Make your users choose good passwords. I once attended a security seminar, and the speaker had everyone stand up. She then began to ask questions about our

passwords—if we responded yes to the question, we were to sit down. She began to ask questions like these:

“Do you use the name of your spouse as a password?”

“Do you use your pet’s name?”

By the time she had asked about 15 questions, only 6 people out of some 300 were still standing. The reality is that most of us choose passwords that are amazingly easy to hack. Make sure users have a **strong password**: at least eight characters in length, including letters, numbers, and non-alphanumeric symbols.

Create a local user account

1. Select **Start** > **Settings** > **Accounts** and then select **Family & other users.** (In some editions of Windows you'll see **Other users**.)

2. Select **Add someone else to this PC**.

3. Select **I don't have this person's sign-in information**, and on the next page, select **Add a user without a Microsoft account**.

4. Enter a user name, password, password hint or choose security questions, and then select **Next**.

Change a local user account to an administrator account

1. Select **Start** >**Settings** > **Accounts** , and then, under **Family & other users**, select the account owner name, then select **Change account type**.

2. Under **Account type**, select **Administrator**, and then select **OK**.

3. Sign in with the new administrator account.

Configuring the IP Address:

Network protocol software takes the incoming data received by the network card, keeps it organized, sends it to the application that needs it, and then takes outgoing data from the application and hands it to the NIC to be sent out over the network. All networks use some network protocol.

The **Transmission Control Protocol/Internet Protocol (TCP/IP)** is the primary protocol of most modern networks, including the Internet. For a computing device to access the Internet, it must have TCP/IP loaded and configured properly.

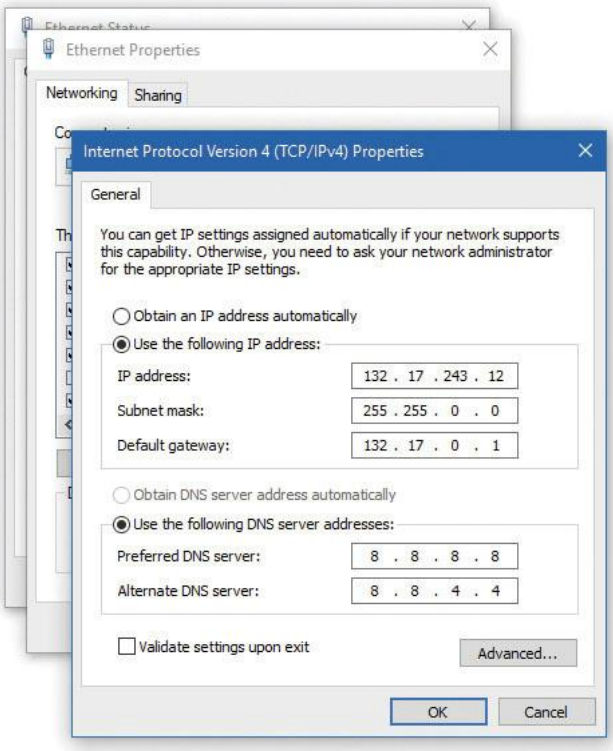
Configuring TCP/IP

By default, TCP/IP is configured to receive an IP address automatically from a DHCP server on the network (and automatically assign a corresponding subnet mask). As far as the CompTIA A+ certification exams are concerned, Network+ techs and administrators give you the IP address, subnet mask, and default gateway information and you plug them into the PC. Occasionally, you might need to configure an *alternative IP address in Windows*, either for the computer or for something upstream, like the DNS server. Here's how to do it manually:

1. In Windows, open the Control Panel and go to the Network and Sharing Center applet. Click Change adapter settings. After that, double-click the Local Area Network icon.

2. Click the Properties button, highlight Internet Protocol Version 4 (TCP/IPv4), and click the Properties button.

3. In the Properties dialog box, click the radio button next to Use the following IP address.



4. Enter the IP address in the appropriate fields.

5. Press the TAB key to skip down to the Subnet mask field. Note that the subnet mask is entered automatically, although you can type over this if you want to enter a different subnet mask.

6. Optionally, enter the IP address for a default gateway.

7. Optionally, enter the IP addresses of a Preferred DNS server and an Alternate DNS server.

8. Click the OK button to close the Properties dialog box.

9. Click the Close button to exit the Local Area Connection Status dialog box.

MAC Addressing

To identify MAC Address of a system.

• Double click on the network icon that is available on the tool-bar. Click on the Support tab,

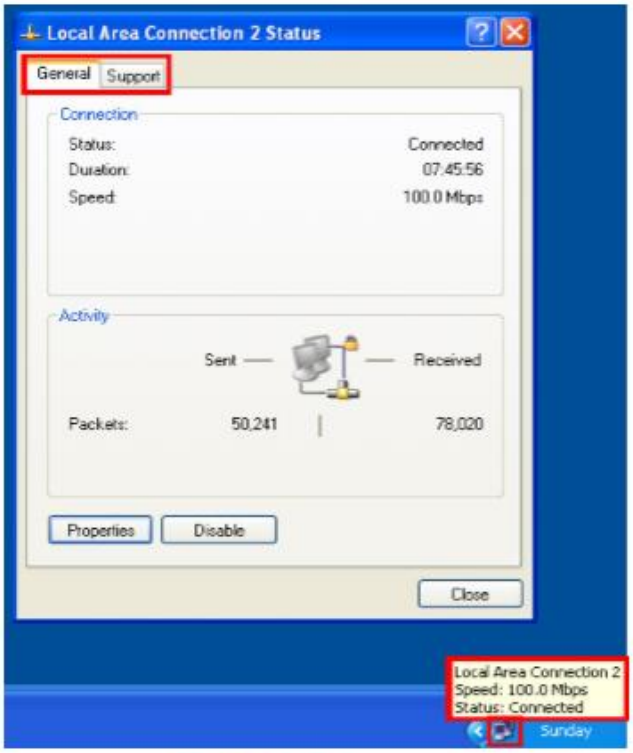


Fig 2.2.1.1 LAN status window.

• Click on Details button,

MAC Address is also called as the Physical/LAN Address. When the details button is clicked, the MAC address of your system is obtained. Refer the

figure available below.

Fig 2.2.1.2 Network connection details window.

An alternate way of finding the MAC Address is as follows,

- Click Start-> Run (or press Windows button + r),

Fig 2.2.1.3 Run command.

- Type “cmd” and click on OK to open the command prompt.

Fig 2.2.1.4 Run command window

- Type ipconfig/all to obtain the MAC addresses of that system,

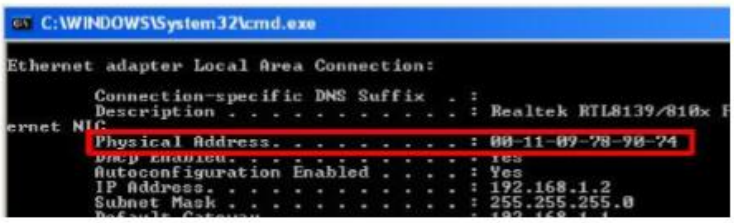


Fig 2.2.1.5 Ipconfig details

ARP

ARP is nothing but Address Resolution Protocol and its job is to match MAC address to IP address . In system A's ARP table, the information of system B and it's MAC address is stored. Similarly, if system A talks to system C, we'll have the same information of system C stored on the ARP table. System B replied to system A and therefore will have stored the relevant information.

Refer fig 2.2.3.1 and 2.2.3.2.

Fig 2.2.3.1 ARP definition in cmd.

Run arp - a in the command prompt, which will report on all the information that it has stored on the ARP table during the usage of the network for that system. The ARP table is a dynamic system table, it is built-up at the time of communicating with the different systems.

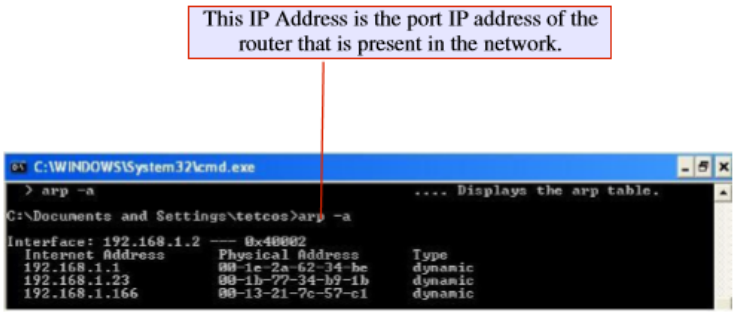


Fig 2.2.3.2 ARP table.

After a period of time, if system A no longer speaks to system B the system will age out (i.e. The ARP table disappears. And the procedure has to be followed from step1) the entry in the ARP table. Hence “No ARP Entries Found” message is displayed in the command prompt.

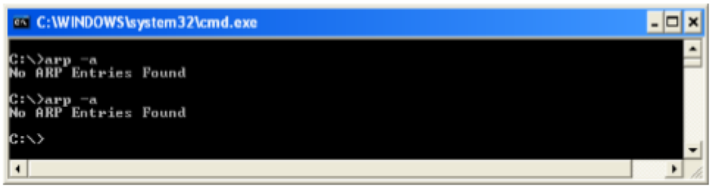


Fig 2.2.3.3 Error when no systems are found in LAN.

1.8 ESSENTIAL NETWORKING COMMANDS

Commands such as ping, ipconfig, tracertetc

1.Understanding Ping Command.

Ping is used primarily to find out if a computer is reachable. Ping accomplishes this task by sending out a special packet called the Internet Control Message Protocol (ICMP) echo request packet. ICMP packets are special IP messages that are used to send network information between two hosts (computers, routers, switches, etc.). When a machine receives an echo request, it responds with an echo reply.

Follow the Steps given below,

- In a Windows XP environment, click on Start Run. Type command into the dialog box, then click OK.
- In the resulting command line window, type ping hostname, where hostname can be a domain name, a machine name or an IP address.
- Press Enter button on the keyboard. Some of the common outputs obtained are as follows,

- **Request Timed out -**
  - The Request Timed Out error message is very common when you use the ping command.
  - This error message is obtained when,
    ■the host/source system has not received the acknowledgment/response from the destination system.
    ■the destination system has not responded to the source in thedesignated time.

The following example shows the output of an host system trying to ping an invalid IP address:

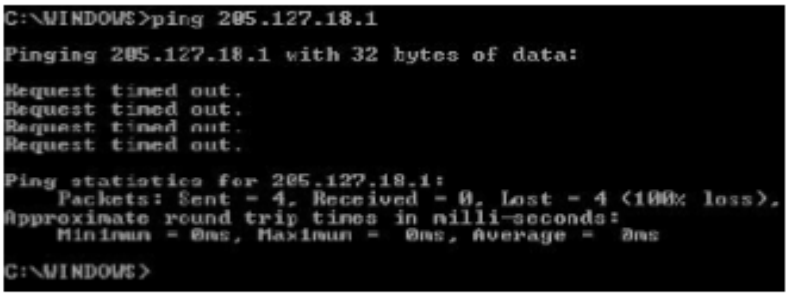


Fig 3.1.1.3 Pinging of an invalid IP

Explanation:

One ICMP (Internet Control Message Protocol - is a message control and error-reporting protocol between a host server and a gateway to the Internet.) Echo request packet is sent every second to the destination system. When the ping program gets an echo reply back from the remote host (destination system), it prints out the response, giving several pieces of information:

- IP address of where the Echo Reply came from (usually this should be the IP address of destination)
- Number of bytes of data sent
- Round trip time it took for a packet to go to and from the remote host
- Time-to-live (TTL) field

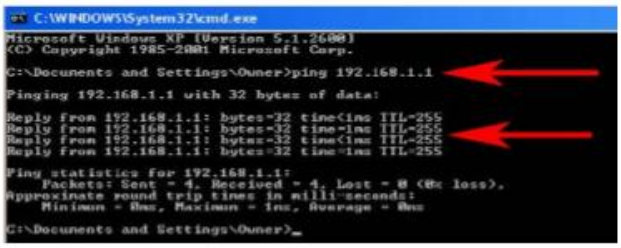


Fig 3.1.1.4 Pinging an IP address which is giving a '+ve' response.

Destination host unreachable - When a router cannot route or a host cannot deliver the packets, the packets are discarded and the router or the host sends a Destination host unreachable message back to the source host that initiated the packets. This message will come up when there are network problems, possibly due to a hardware failure

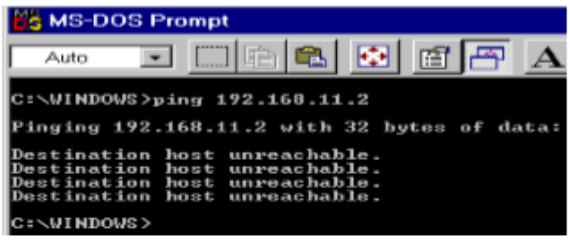


Fig 3.1.1.6 A varying ping response from the destination.

- Other devices,
  - Printer
  - Scanner
  - Fax, etc.

Understanding Ping Command's options

Ping Command Options	
Item	**Explanation**
-t	Using this option will ping the *target* until you force it to stop by using Ctrl+C.
-a	This ping command option will resolve, if possible, the hostname of an IP address *target*.
-n *count*	This option sets the number of ICMP Echo Requests to send, from 1 to 4294967295. The ping command will send 4 by default if **-n** isn't used.
-l *size*	Use this option to set the size, in bytes, of the echo request packet from 32 to 65,527. The ping command will send a 32-byte echo request if you don't use the **-l** option.
-f	Use this ping command option to prevent ICMP Echo Requests from being fragmented by routers between you and the *target*. The **-f** option is most often used to troubleshoot Path Maximum Transmission Unit (PMTU) issues.
-i *TTL*	This option sets the Time to Live (TTL) value, the maximum of which is 255.
-v *TOS*	This option allows you to set a Type of Service (TOS) value. Beginning in Windows 7, this option no longer functions but still exists for compatibility reasons.
-r *count*	Use this ping command option to specify the number of hops between your computer and the *target* computer or device that you'd like to be recorded and displayed. The maximum value for *count* is 9, so use the tracert command instead if you're interested in viewing all the hops between two devices.
-s *count*	Use this option to report the time, in Internet Timestamp format, that each echo request is received and echo reply is sent. The maximum value for *count* is 4, meaning that only the first four hops can be time stamped.
-w *timeout*	Specifying a *timeout* value when executing the ping command adjusts the amount of time, in milliseconds, that ping waits for each reply. If you don't use the **-w** option, the default timeout value of 4000 is used, which is 4 seconds.
target	This is the destination you wish to ping, either an IP address or a hostname.

2. NetStat Command

Click Start Run Type cmd, to enter into the command prompt. The different networking commands are as follows, 1. NetStat Command: Monitors Internet connections on your computer. It shows the information on all active TCP and UDP connections, local and remote ports, connection states and the owning process

Syntax: NETSTAT [-a] [-e] [-n] [-s] [-p proto] [-r] [interval]

Commands	Explanation
-a	Displays all connections and listening ports.
-e	Displays Ethernet statistics. This may be combined with the -s option.
-n	Displays addresses and port numbers in numerical form.
-p	Proto Shows connections for the protocol specified by proto; proto may be TCP or UDP. If used with the -s option to display per-protocol statistics, proto may be TCP, UDP, or IP.
-r	Displays the routing table.
-s	Displays per-protocol statistics. By default, statistics are shown for TCP, UDP and IP; the -p option may be used to specify a subset of the default.
interval	Redisplays selected statistics, pausing interval seconds between each display. Press CTRL+C to stop redisplaying statistics. If omitted, netstat will print the current configuration information once.

3 .IPConfigCommand :

Shows network, adapters and interfaces configuration. IPConfig (Internet Protocol Configuration) allows you to renew DHCP (The Dynamic Host Configuration Protocol is an Internet protocol for automating the configurationof computers that use TCP/IP) configuration or send the command to DHCP server to release and discard the IP address configuration. This tool is very useful on computers that are configured to obtain an IP address automatically.

The Syntax, Options and examples for “IPConfig” are given below. This is
Obtained by typing in “ipconfig/?” in the command prompt.

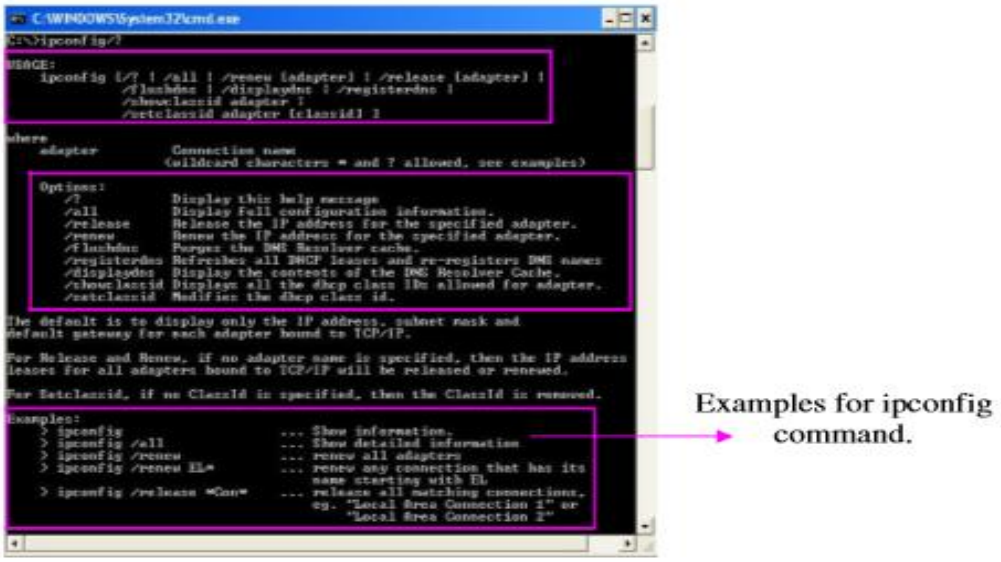


Fig 3.1.3.3 How to use an "ipconfig help".

When "ipconfig" alone is typed in the command prompt the information similar to the one below comes up,

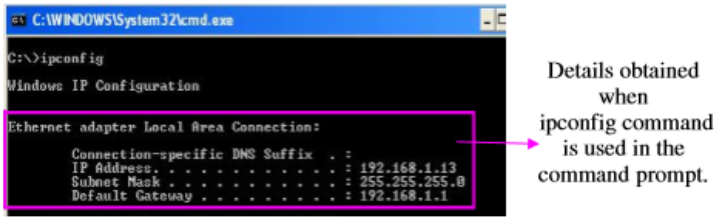


Fig 3.1.3.4 How to use an "ipconfig

4. Tracert Command: This command is used to visually see a network packet being sent and received and the amount of hops required for that packet to get to its destination.

Syntax and Options of the tracert command is available below,

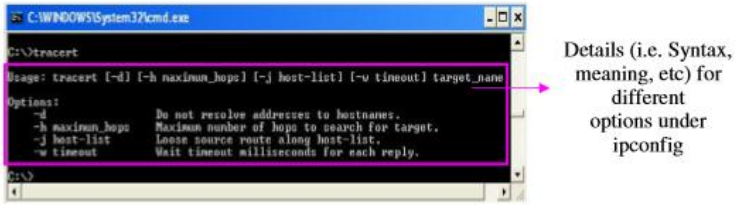


Fig 3.1.3.5 Details of a Tracert

5. Net Command: The net command is used to view the network or send messages or network settings, etc. Some of the Net commands are explained below,

Net Send: Sends messages to other users, computers, or messaging names on the network. The Messenger service must be running to receive messages.

You can send a message only to an name that is active on the network. If the message is sent to a username, that user must be logged on and running the Messenger service to receive the message.

Net View: This command is used to view the systems that are available in the network.

Displays a list of computers in a specified workgroup or the shared resources available on a specified computer.

1.9 MICROPROCESSOR

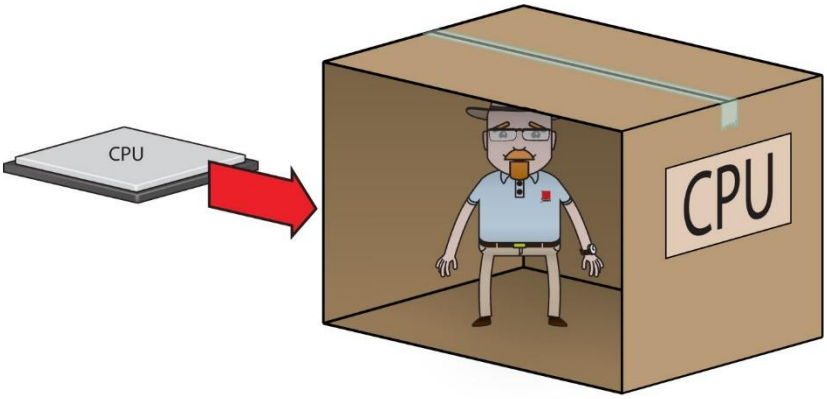
The **central processing unit (CPU)** does most of the calculations that make your computer...well, a computer. The CPU, also known as a **microprocessor**, invariably hides on the motherboard below a large heat sink and often a fan assembly as well. CPU makers name their microprocessors in a fashion similar to the automobile industry: CPUs get a make and a model, such as Intel Core i7 or AMD FX-8350 Black Edition. But what's happening inside the CPU to make it able to do the amazing things asked of it every time you step up to the keyboard?

CPU Core Components

A CPU functions more like a very powerful calculator than like a brain—but, oh, what a calculator! Today's CPUs add, subtract, multiply, divide, and move billions of numbers per second. Processing that much information so quickly makes any CPU look intelligent. It's simply the speed of the CPU, rather than actual intelligence, that enables computers to perform feats such as accessing the Internet, playing visually stunning games, or editing photos.

The Man in the Box

Let's begin by visualizing the CPU as a man in a box. This is one clever guy. He can perform virtually any mathematical function, manipulate data, and give answers *very quickly*.



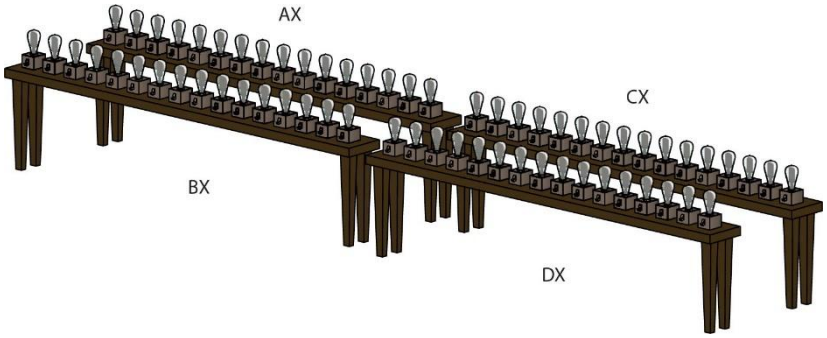
Before he can work with us, we must come up with a way to exchange information with him

Imagine that we install a set of 16 light bulbs, 8 inside his box and 8 outside his box. Each of the 8 light bulbs inside the box connects to one of the 8 bulbs outside the box to form a pair. Each pair of light bulbs is always either on or off. You can control the 8 pairs of bulbs by using a set of 8 switches outside the box, and the Man in the Box can also control them by using an identical set of 8 switches inside the box. This light-bulb communication device is called the **external data bus (EDB)**.

In computers, wires repeatedly turn on and off. As a result, we can use this "1 and 0," or **binary**, system to describe the state of these wires at any given moment. (See, and you just thought computer geeks spoke in binary to confuse normal people. Ha!) There's much more to binary numbering in computing, but this is a great place to start.

Registers

The Man in the Box provides good insight into the workspace inside a CPU. The EDB gives you a way to communicate with the Man in the Box so you can give him work to do. But to do this work, he needs a worktable; in fact, he needs at least four worktables. Each of these four worktables has 16 light bulbs. These light bulbs are not in pairs; they're just 16 light bulbs lined up straight across the table. Each light bulb is controlled by a single switch, operated only by the Man in the Box. By creating on/off patterns like the ones on the EDB, the Man in the Box can use these four sets of light bulbs to work math problems. In a real computer, these worktables are called **registers** and store internal commands and data.



All CPUs contain a large number of registers, but for the moment let's concentrate on the four most common ones: the *general-purpose registers*. Intel named them AX, BX, CX, and DX.

for example, 10000111 means Move the number 7 into the AX register. These commands are called the microprocessor's machine language.

By placing machine language commands—called *lines of code*—onto the EDB one at a time, you can instruct the Man in the Box to do specific tasks. All of the machine language commands that the CPU understands make up the CPU's **instruction set**.

Clock

To add two numbers, you pressed a number key, the + key, and another number key, but then to make the calculator do the calculation and give you the answer, you had to pull down the crank. That was the signal that you had finished entering data and instructions and were ready for the calculator to give you an answer.

A CPU also has a type of crank. To return to the Man in the Box, imagine there's a bell inside the box activated by a button on the outside of the box. Each time you press the button to sound the bell, the Man in the Box reads the next set of lights on the EDB. Of course, a real computer doesn't use a bell. The bell on a real CPU is a special wire called the **clock wire** (most diagrams label the clock wire CLK). A charge on the CLK wire tells the CPU that another piece of information is waiting to be processed.

The maximum number of clock cycles that a CPU can handle in a given period of time is referred to as its **clock speed**. The clock speed is the fastest speed at which a CPU can operate, determined by the CPU manufacturer. The Intel 8088 processor had a clock speed of 4.77 MHz (4.77 million cycles per second), extremely slow by modern standards, but still a pretty big number compared to using a pencil and paper. CPUs today run at speeds in excess of 3 GHz (3 billion cycles per second).

1 hertz (1 Hz) = 1 cycle per second

1 megahertz (1 MHz) = 1 million cycles per second

1 gigahertz (1 GHz) = 1 billion cycles per second

Memory

Computers need some other device that takes copies of programs from the hard drive and then sends them, one line at a time, to the CPU quickly enough to keep up with its demands. Because each line of code is nothing more than a pattern of eight ones and zeros, any device that can store ones and zeros eight-across will do. Devices that in any way hold ones and zeros that the CPU accesses are known generically as **memory**.

Memory and RAM

Memory must store not only programs, but also data. The CPU needs to be able to read and write to this storage medium. Additionally, this system must enable the CPU to jump to *any* line of stored code as easily as to any other line of code. All of this must be done at or at least near the clock speed of the CPU. Fortunately, this magical device has existed for many years: **random access memory (RAM)**.

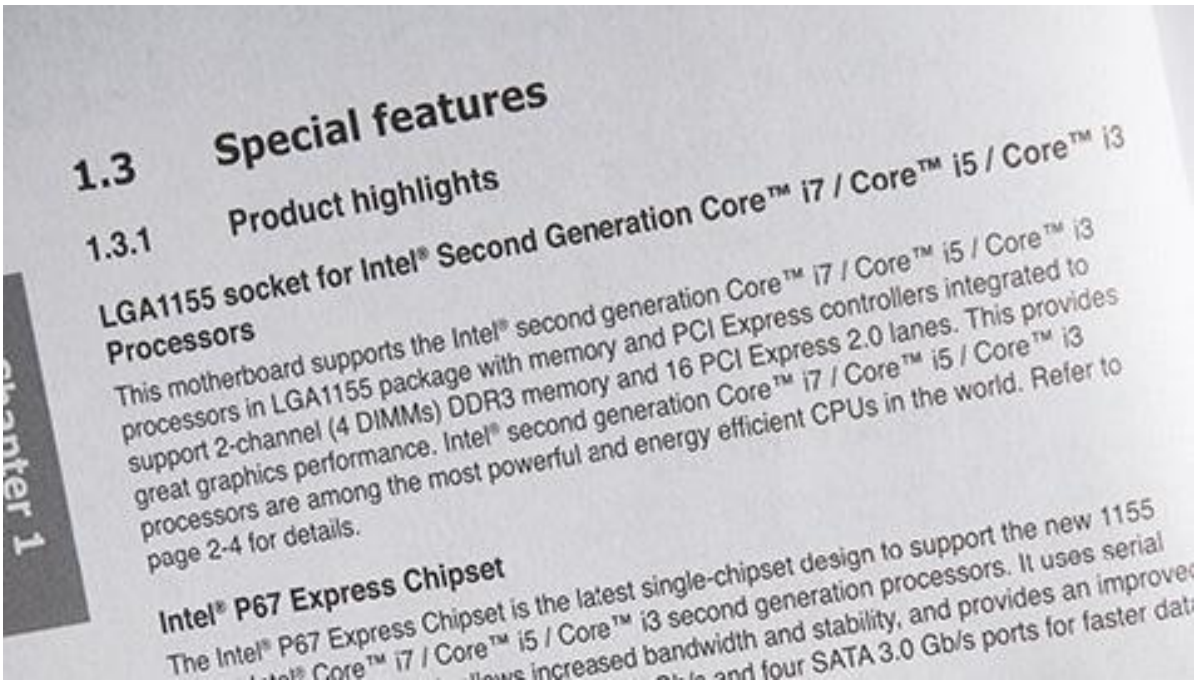
Computers use **dynamic RAM (DRAM)** for the main system memory. DRAM needs both a constant electrical charge and a periodic refresh of the circuits; otherwise, it loses data—that's what makes it dynamic rather than static in content.

1.10 SELECTING AND INSTALLING CPUS

Now that you know how CPUs work, it's time to get practical. This last section discusses selecting the proper CPU, installing several types of processors, and troubleshooting the few problems techs face with CPUs.

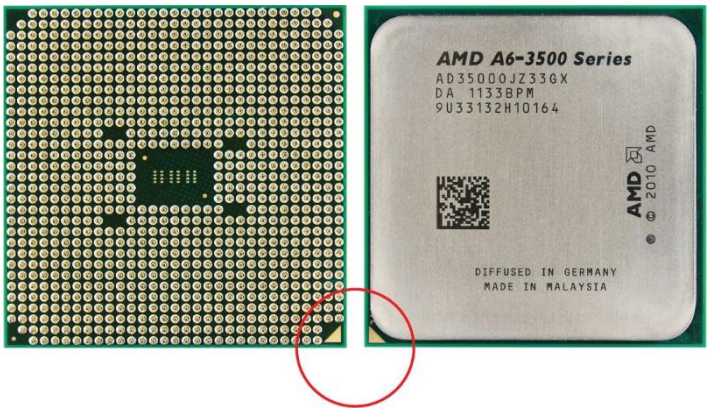
Selecting a CPU

When selecting a CPU, you need to make certain you get one that the motherboard can accommodate. Or, if you're buying a motherboard along with the CPU, then get the right CPU for the intended purpose. You need to have a lot more knowledge of all the pieces around the CPU to get the full picture, so we'll wait until then to discuss the "why" of a particular processor. Figure shows a manual for an ASUS motherboard open to reveal the supported processors and the socket type.

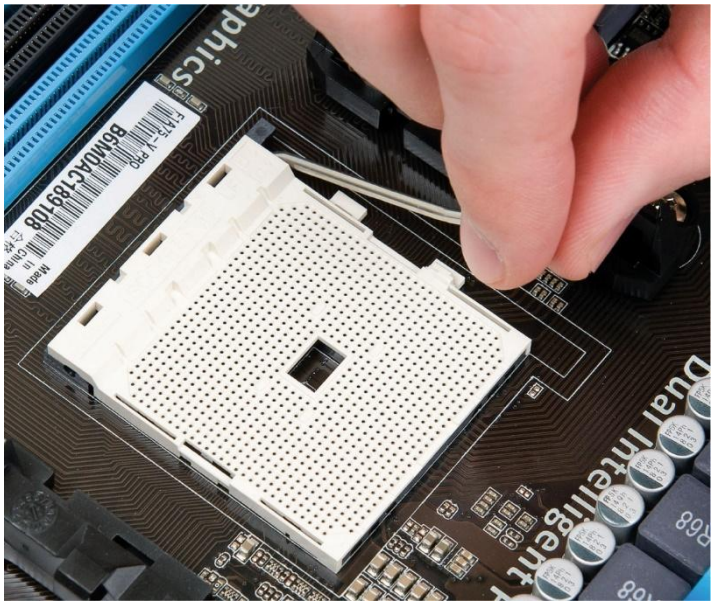


Installing

All CPUs and sockets are keyed so you can't (easily) insert them incorrectly. Look at the underside of the CPU in Figure_ (left). Note that the pins do not make a perfect square, because a few are missing. Now look at the top of the CPU (right). See the little mark at the corner? The socket also has tiny markings so you can line the CPU up properly with the socket.



In both socket styles, you release the retaining mechanism by pushing the little lever down slightly and then away from the socket. You next raise the arm fully, and then move the retaining bracket



Cooling

CPUs work very hard and thus require power to function. In electrical terms, CPUs consume *wattage*, or *watts*, a unit of electrical power, just like a 100-watt light bulb consumes power whenever it's on. (See Chapter 8, "Power Supplies," for more details about electricity.) Have you ever touched a light bulb after it's been on for a while? Ouch! CPUs heat up, too.

To increase the capability of the CPUs to handle complex code, CPU manufacturers have added a lot of microscopic transistors over the years. The more transistors the CPU has, the more power they need and thus the hotter they get. CPUs don't tolerate heat well, and modern processors need active cooling solutions just to function at all. Almost every CPU uses a combination of a heat-sink and fan assembly to wick heat away from the CPU. Figure shows the standard Intel **heat sink** and fan. Here are some cooling options:

Troubleshooting CPUs

Troubleshooting CPU issues falls into two categories: overheating and catastrophic failures. Once a CPU is installed properly and functioning, it rarely causes problems. The only exception is when you ask a CPU to do too much too quickly.

The vast majority of problems with CPUs come from faulty installation or environmental issues that cause overheating.

Symptoms of Overheating

Here's a checklist of possible problems that you need to address when faced with a CPU installation problem:

1. Too much thermal paste can impede the flow of heat from the CPU to the heat sink and cause the CPU to heat up rapidly. All modern CPUs have built-in fail-safes that tell them to shut down before getting damaged by heat.
2. Not enough thermal paste or thermal paste spread unevenly can cause the CPU to heat up and consequently shut itself down.
3. Failure to connect the fan power to the motherboard can cause the CPU to heat up and shut itself down.

The fan and heat-sink installation failures can be tricky the first few times you encounter them.

The CPU needs adequate ventilation. The CPU fan is essential, of course, but the inside of the case also needs to get hot air out through one or more exhaust fans and cool air in through the front vent. If the intake vent is clogged or the exhaust fans stop working or are blocked somehow, the inside of the case can heat up and overwhelm the CPU cooling devices. This will result in a system running slowly or spontaneously rebooting.

1.11 RAM

Random access memory (RAM) stores programs and data currently beingused by the CPU. The maximum amount of programs and data that a piece of RAM can store is measured in units called bytes. Modern PCs have many millions, even billions, of bytes of RAM, so RAM is measured in units called megabytes (MB) or gigabytes (GB). An average PC will have from 1 to 4 GB of RAM although PCs may have more or less. Each piece of RAM is calleda stick. One common type of stick found in today's PC is

called a dual inline memorymodule (DIMM). Figure shows two examples of DIMMs used in PCs.

• Figure 3.38 Two DIMMs

Your PC takes only one type of DIMM, and you must know the type so you can add or replace RAM when needed.

1.12 TYPES OF RAM

Development of newer, wider, and faster CPUs and MCCSs motivates DRAM manufacturers to invent new DRAM technologies that deliver enough data at a single pop to optimize the flow of data into and out of the CPU.

SDRAM

Most modern systems use some form of **synchronous DRAM (SDRAM)**. SDRAM is still DRAM, but it is synchronous-tied to the system clock, just like the CPU and MCC, so the MCC knows when data is ready to be grabbed from SDRAM. This results in little wasted time.

SDRAM made its debut in 1996 on a stick called a **dual inline memory module (DIMM).** The early SDRAM DIMMs came in a wide variety of pinsizes. The most common pin sizes found on desktops were the 168-pinvariety. Laptop DIMMs came in 68-pin, 144-pin, or 172-pinmicro-DIMM packages; and the 72-pin, 144-pin, or 200-pin small-outlineDIMM (SO-DIMM) form factors. With the exception ofthe 32-bit 72-pin SO-DIMM, all these DIMM varieties delivered 64-bit-widedata to match the 64-bit data bus of every CPU since the original Pentium.

• **Figure 4.9** 144-pin micro-DIMM (photo courtesy of Micron Technology, Inc.)

• **Figure 4.10** A (168-pin) DIMM above a (144-pin) SO-DIMM

To take advantage of SDRAM, you needed a PC designed to use SDRAM. Ifyou had a system with slots for 168-pin DIMMs, for example, your systemused SDRAM. A DIMM in any one of the DIMM slots could fill the 64-bitbus, so each slot was called a bank. You could install one, two, or more sticksand the system would work. Note that on laptops that used the 72-pin SO-DIMM, you needed to install two sticks of RAM to make a full bank, becauseeach stick only provided half the bus width.

RDRAM

When Intel was developing the Pentium 4, they knew that regular SDRAM just wasn't going to be fast enough to handle the quad-pumped 4000-MHz front side bus. Intel announced plans to replace SDRAM with a very fast, newtype of RAM developed by Rambus, Inc., called Rambus DRAM, or simplyRDRAM. Hailed by Intel as the next great leap in DRAMtechnology, RDRAM could handle speeds up to 800 MHz, which gave Intel plenty of room to improve the Pentium 4.

• **Figure 4.11** RDRAM

RDRAM was greatly anticipated by the industry for years, but industry support for RDRAM proved less than enthusiastic due to significant delays in development and a price many times that of SDRAM. Despite this grudging support, almost all major PC makers sold systems that used RDRAM-for a while. From a tech's standpoint, RDRAM shared almost all of the characteristic of SDRAM. A stick of RDRAM was called a RIMM. In this case, however, the letters didn't actually stand for anything; they just rhymed: SIMMs, DIMMs, and RIMMs, get it **Installing**

Installing DIMIMs

First, attach an anti-static wrist strap or touch some bare metal on the power supply to ground yourself and avoid ESD. Then swing the side tabs on the RAM slots down from the upright position. Pick up a stick of RAM-don't touch those contacts-and line up the notch or notches with the raised portion(s) of the DIMM socket. A good hard push down is usually all you need to ensure a solid connection. Make sure that the DIMM snaps into position to show it is completely seated. Also, notice that the one or two side tabs move in to reflect a tight connection.

• **Figure 4.32** Inserting a DIMM

1.13 TROUBLESHOOTING RAM

System lockups and page faults (they often go hand in hand) in Windows can indicate a problem with RAM**. A system lockup** is when the computer stops functioning. A **page fault** is a milder error that can be caused by memory issues but not necessarily system RAM problems.Certainly page faults look like RAM issues because Windows generates frightening errormessages filled with long strings of hexadecimal digits, such as "KRNL386 caused a page fault a 03F2:25A003BC." Just because the error message contains a memory address however, does not mean that you have a problem with your RAM. Write down the address. If it repeats in later error messages, you probably have a bad RAM stick. if Windows displays different memory locations, you need to look elsewhere for the culprit.

Every once in a while, something potentially catastrophic happens within the PC, some little electron hits the big red panic button, and the operating system has to shut down certain functions before it can save data This panic button inside the PC is called a **non-maskable interrupt (NMI),**more simply defined as an interruption the CPU cannot ignore. An NMI manifests as **a proprietary crash screen**. In Windows 7, for example, the crash screen is what techs call the **Blue Screen of Death** (BSoD) a bright blue screen with a scary-sounding error message on it.

Figure 4.37 Blue Screen of Death

Windows 8/8.1/10 display a blue screen with a sad face and the words to the effect of Windows has a problem. Restart the machine. A mac OS machine might display a spnning rainbow wheel sometimes called **the Spinning Pinwheel of Death (SPoD)** or, more likely, will simply restart.

Finally, intermittent memory errors can come from a variety of sources including a dying power supply, electrical interference, buggy applications, buggy hardware, and so on.

1.14 BIOS

The PU doesn't magically or otherwise automatically know how to talk with any device; it needs some sort of support programming loaded into memory that teaches it about a particular device. This programming is called **Basic Input/output services (BIOS).** The programs dedicated to enabling the CPU to communicate with devices are called services. This goes well beyond the keyboard, by the way. In fact, every device on the computer needs BIOS! But let's continue with the keyboard for now.

Bringing BIOS to the PC

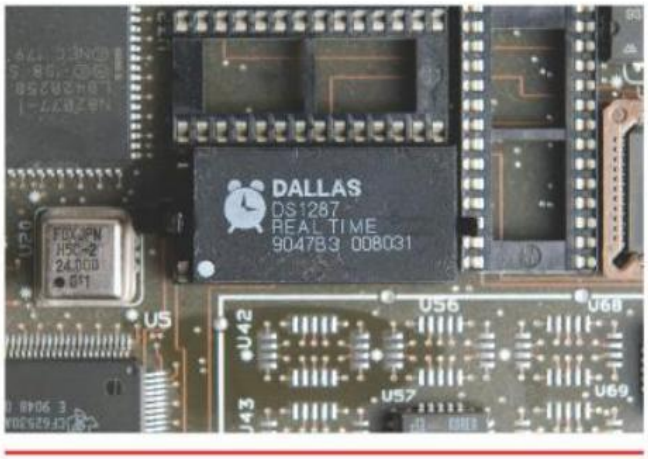
The CPU must have access to BIOS for the most important hardware on your PC: not only the keyboard, but also the monitor, mass storage drives, optical drives, USB ports, and RAM. This code can't be stored on a hard drive or optical disc- these important devices need to be ready at any time the CPU calls them even before installing a mass storage device or an operating system.

The perfect place to store the support programming is on the motherboard. That settles one issue, but another looms: What storage mediumshould the motherboard

use? DRAM won't work, because all of the datawould be erased every time you turned off the computer. You need some type of permanent program storage device that does not depend on other peripherals to work. And you need that storage device to sit on the motherboard.

CMOS and RTC

Because the BIOS firmware is stored in ROM,and ROM is read only, it needs a place to store all its settings so they don't have to be re-entered every time you boo t your computer. That place is a tiny bit of RAM hooked up to a small battery to keep it working with the PC off. We call this memory the **complementary metal-oxide semiconductor (CMOS)** chip. Inaddition to storing all the various BIOS settings, US the CMOS also handles the system's real-time clock (RTC) so you don't have to keep setting the antime on every boot.

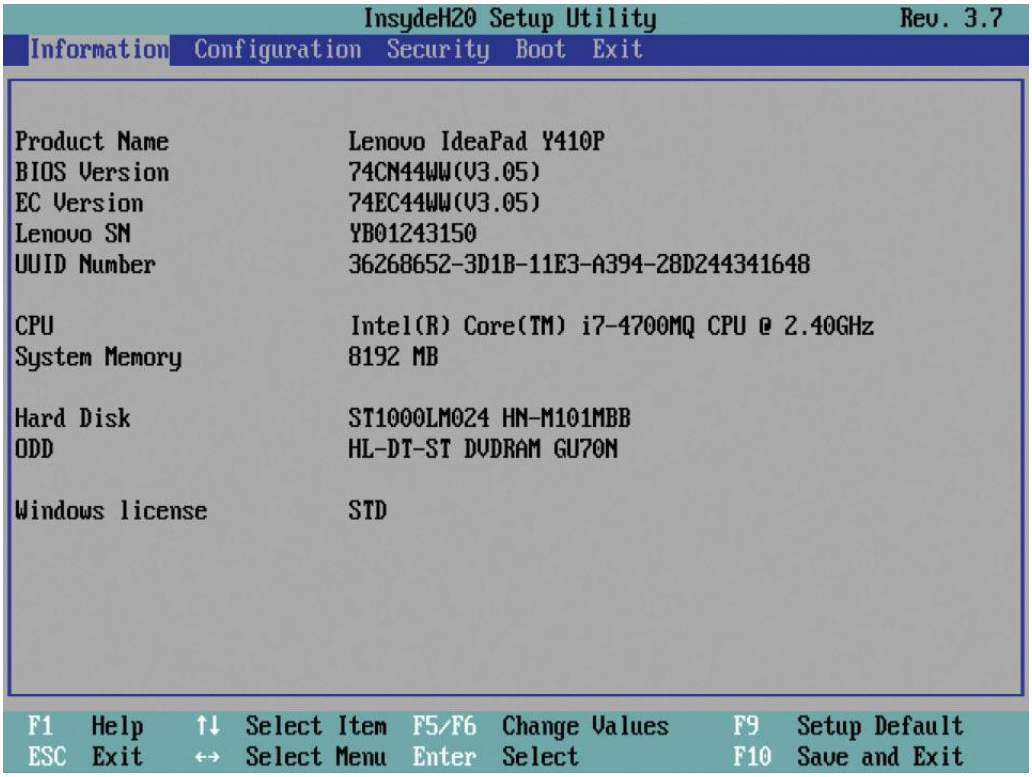


If the data stored in CMOS about a piece of hardware is different from the specs of the actual hardware, the computer cannot access that piece of hardware (or use its fancier features). It is crucial that this information be correct. If you change any of the previously mentioned hardware, you must update CMOS to reflect those changes. You need to know, therefore, how to change the data in CMOS.

Text-Based UEFI Intel-Based Setup Utility

In this second walkthrough, we'll switch to a UEFI motherboard on an Intel-based portable computer. As we go through the screens, pay attention to the options listed on each. I'll call out features that the graphical AMD-based UEFI didn't have.

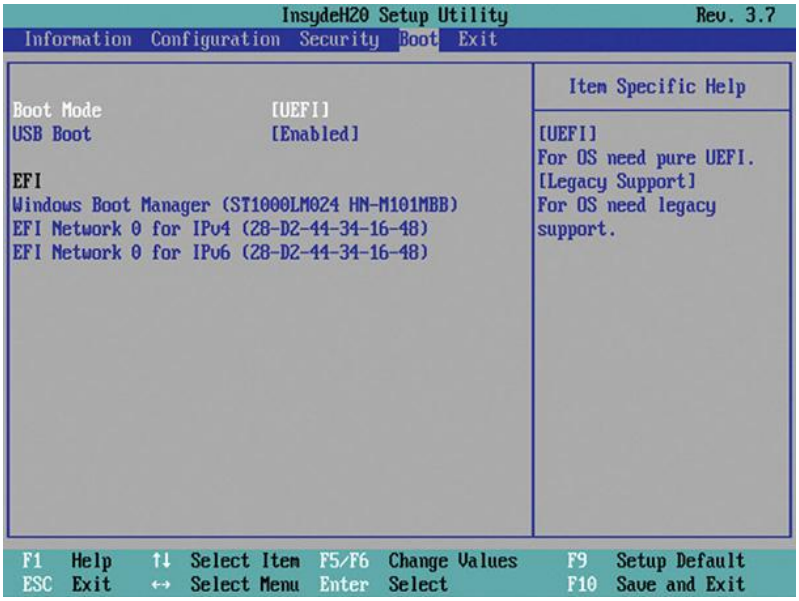
The Information tab offers straightforward information about the CPU and RAM amount, and cryptic information about the hard drive. Other tabs do more.



The Configuration tab shows a number of built-in devices that you configure or enable/disable here. Because this is a portable, it has an option to turn on/off wireless networking capabilities.

A *virtual machine* is a powerful type of program that enables you to run a second (or third or fourth), software-based machine inside your physical PC. It re-creates the motherboard, hard drives, RAM, network adapters, and more, and is just as powerful as a real PC. To run these virtual machines, however, you'll need a very powerful PC—you are trying to run multiple PCs at the same time, after all.

The Boot tab enables you to set **boot options** to determine which bootable device gets priority. Here is where you provide support for booting to a USB device as well. It looks a little different from the graphical example presented earlier. See "The Boot Process" later in this chapter for more explanation.



1.15 POST CARDS

Beep codes, numeric codes, and text error codes, although helpful, can sometimes be misleading. Worse than that, an inoperative device can some-times disrupt the POST, forcing the machine into an endless loop. This causes the PC to act dead- no beeps and nothing on the screen. In this case,you needa device, called a POST card, to monitor the POST and identify which piece of hardware iscausing the trouble.

• Figure 5.31 POST card in action

POST cards are simple cards that snap into expansion slots on your system. A small, two- character light-emitting diode (LED) readout on the card indicates which device the POST is currently testing.

POST cards used to be essential tools for techs, but today I use them only when I have a "dead" PC to determine at which level it's dead. If the POST card shows no reading, I know the problem is before the POST and must be related to the power, the CPU, the RAM, or the motherboard. If

1.16 MOTHERBOARDS

The motherboard provides the foundation for the personal computer. Everypiece of hardware, from the CPU to the lowliest expansion card, directly oindirectly plugs into the motherboard. The motherboard contains the wires-called traces-that make up the buses of the system. It holds the vast majority of the ports used by the peripherals, and it distributes the power from the power supply, Without the motherboard, you literally have no PC.

Figure 6.2 Typical motherboard

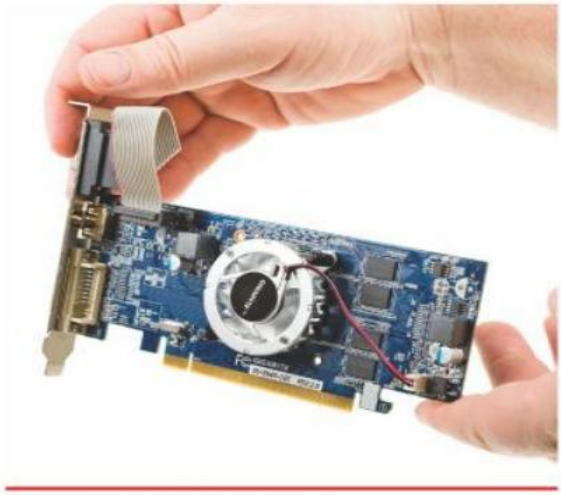
1.17 INSTALLING EXPANSION CARDS

Installing an expansion card successfully another one of those bread-and butter tasks for the PC tech-requires at least four steps.First, you need to know that the card works with your system and your operating system. Second, you have to insert the card in an expansion slot properly and without damaging the card or the motherboard. Third, you need to provide drivers for the operating system proper drivers for the specific OS. Fourth, you should always verify that thecard functions properly before you walk away from the PC.

Physical Installation

To install an expansion card successfully, you need to take steps to avoiddamaging the card, the motherboard,or both. This means knowing how to handle a card andavoiding electrostatic discharge (ESD) or any other electrical issue. You also need to place the card firmly and completely into an available expansion slot.

Optimally, a card should always be in one of two places: in a computer or in an anti-static bag. When inserting or removing a card, be careful to hold the card only by its edges. Do not hold the card by the sot connectors or touch any components on the board.



• Figure 6.26 Where to handle a card

many cards use the screw connection to ground the card to the case.

Device Drivers

For almost all expansion cards, that BIOS comes in the form of device drivers software Support programs-loaded automatically by the operating system or manually from an optical disc provided by the card manufacturer.

Installing device drivers is fairlystraightforward. Youshould use the correctdrivers kind of obvious, but you'd be surprised how many techs mess this app and, if you re Upgrading, you might have to unload currentdrivers before loading new drivers. Finally, if you have a problem, you may need to uninstallthe drivers you just loaded or roll back to earlier, more stable drivers.

1.18 UPGRADING AND INSTALLING MOTHERBOARDS

To most techs, the concept of adding or replacing a motherboard can be extremely intimidating. It really shouldn't be; motherboardinstallationis a common and necessary part of P repair. It is inexpensive and easy, although it can sometimes be a little tedious and messy because of the large number of parts involved. This Section covers the process of installation and replacement and shows you some of the tricks that make this necessaryProcess easy to handle.

Choosing the Motherboard and Case

Choosing a motherboard and case can prove quite a challenge for any tech, whether newly minted or a seasoned veteran. You first have to figure out the type of motherboard you wait, such as AMD- or Intel-based. then you need to think about the form factor, whichof course influences the type of case you'll need. Third, how rich in features is the motherboard and howtough is it to configure? You have to read the motherboard manual to find Out. Finally.youneed to select the case that matches your space needs, budget, and form factor. Now look at each step in a little more detail.

First, determine what motherboard you need. What CPU are youusing? Will the motherboard work with that CPLU? Because most of us buy the CPU and the motherboard at the same time, make the seller guarantee that the CPU will work with the motherboard. How much RAM da you intend to install ? Are extra RAM sockets available for future upgrades??

These wires have specific pin connections to the motherboard. Although you can refer to the motherboardBook for their location, usually a quick inspection of the motherboard willsuffice for an experienced tech.

Figure 6.41 Motherboard wire connections labeled on the motherboard

You need to follow a few rules when installing these wires. First, the lights are LEDS, not light bulbs; they have a positive side and a negative side. If they don't work one

way, turn the connector around and try the other. Second, when in doubt, guess. Incorrect installation only results in the device not working; it won't damage the computer. Refer to the motherboard book for the correct installation. The third and last rule is that. With the exception of the soft power switch on an ATX system, you do not need any of these wires for the computer to run.

No hard-and-fast rule exists for determining the function of each wire. Often the function of each wire is printed on the connector. If not, track each wire to the LED or switch to determine its function.

Finally, install the motherboard into the case fully and secure it with the appropriate screws. Once you get the motherboard mounted in the case, with the CPU and RAM properly installed, it's time to insert the power connections and test it. A POST card can be helpful with the system test because you won't have to add the speaker, a video card, monitor, and keyboard to verify that the system is booting. If you have a POST card, start the system, and watch to see if the POST takes place-you should see a number of POST codes before the POST stops. If you don't have a POST card, install a keyboard, speaker, video card, and monitor. Boot the system and see if the BIOS information shows up on the screen. If it does, you're probably okay. If it doesn't, it's time to refer to the motherboard book to see where you made a mistake.

If you get no power at all, check to make sure you plugged in all the necessary power connectors. If you get power to fans but get nothing on the screen, you could have several problems. The CPU, RAM, or video card might not be connected to the motherboard properly. The only way to determine the problems is to test. Check the easy connections first (RAM and video) before removing and reseating the CPU

1.19 INSTALLING AND MAINTAINING POWER SUPPLIES

Although installing and maintaining power supplies takes a little less maththan selecting the proper power supply for a system, they remain essentialskills for any tech. Installing takes but a moment, and maintaining is almostas simple. Let's take à look.

Installing

The typical power supply connects to the PC with four standard computer screws, mounted in the back of the case (see Figure). Unscrew the four screws and the power supply lifts out easily (see Figure). Insert a new power supplythat fits the case and attach it by using the same four Screws.

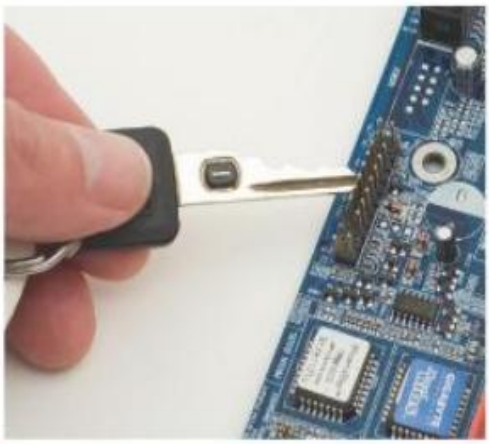
• Figure 7.28 Mounting screws for power supply

• Figure 7.29 Removing power supply from system unit

Handling ATX power supplies requires special consideration. Understand that an ATX power supply never turns off. As long as that power supply stays connected to a power outlet, the power supply will continue to supply 5V to the motherboard. Always unplug an ATX system before you do any work!

For years, techs bickered about the merits of leaving a PC plugged in or unplugged when servicing it. ATX settled this issue forever. Many ATX power supplies provide a real on/off switch on the back of the PSU. If you really need the system shut down with no power to the motherboard, use this switch when working on an ATX system, you may find using the power button inconvenient because you're not using a case or you haven't bothered to plug the power button's leads, motherboard. That means there is no power button.One trickwhen in that situation is to Lusea metal key or a screwdriver to contact the two wires to start and stop the system. Your first task after acquiring a new power supply is simply making sure it works. Insert the motherboard power connectors before starting the system. If you have video cards with power connectors, plug them in too. Other connectors such as hard drives can wait until you have one successful boot-or if you're cocky, just plug everything in!

• Figure 7.30 On/off switch for an ATX system



• Figure 7.31 Shorting the soft on/off jumpers

Cooling

Heat and computers are not the best of friends. Cooling is therefore a vital consideration when building a computer. Electricity equals heat. Computers, being electrical devices, generate heat as they operate, and too much heat can seriously damage a computer's internal components.

• Figure 7.32 Power supply fan

The power supply fan provides the basic cooling for the PC. It not only cools the voltage regulator circuits within the power supply but also provides a constant flow of outside air throughout the interior of the

computer case. A dead power supply fan can rapidly cause tremendous problems, even equipment failure. If you ever turn on a computer and it boots just fine but you notice that it seems unusually quiet, check to see if the power supply fan has died. If it has, quickly turn off the PC and replace the power supply.

Some power supplies come with a built-in sensor to help regulate the airflow. If the system gets too hot, the power supply fan spins faster.

Case fans are large, square fans that snap into special brackets on the case or screw directly to the case, providing extra cooling for key components. Most cases come with a case fan, and no modem computer should really be without one or two.

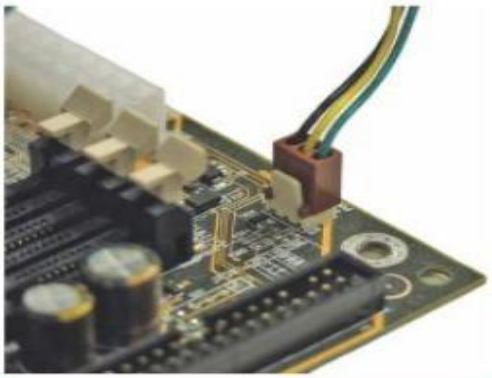


Figure 7.33 3-wire fan sensor connector

Figure 7.34 Case fan

The single biggest issue related to case Fans is where to plug them in Case fans may come with standard Molex connectors, which are easy to plug in, or they may come with special three-pronged power connectorsthat need to connect to the motherboard. You can get adapters to plug three- pronged connectors into Molex connectors or vice versa.

Modular Power Supplies

It's getting more and more popular to make PCs look good on both the inside and the outside. Unused power cables dangling around inside PCs creates a not-so-pretty picture and can impede airflow. To help stylish people, manufacturers created power supplies with modular cables.

Modular cables are pretty cool, because you add only the lines you need for your system. On the other hand, some techs claim that modular cables hurt efficiency because the modular connectors add resistance to the lines.You make the choice: Is a slight reduction in efficiency worth a clean look?

Temperature and Efficiency

Watch out for power supplies that list their operating temperature at 25” C-about room temperature. A power supply that provides 500 W at 25” Cwill supply substantially less in warmer temperatures, and the inside of your PC is usually 15 C

(59 F) warmer than the outside air. Sadly many power supply makers-even those who make good power supplies-fudge this fact.

Figure 7.41 Modular-cable power supply

1.20 HARD DRIVE TECHNOLOGIES

Magnetic Hard Drives

A traditional **hard disk drive (HDD)** is composed of individual disks, or *platters*, with read/write heads on actuator arms controlled by a servo motor—all contained in a sealed case that prevents contamination by outside air..

The aluminum platters are coated with a magnetic medium. Two tiny read/write heads service each platter, one to read the top of the platter and the other to read the

bottom of the platter. Many folks refer to traditional HDDs as **magnetic hard drives**, or sometimes *platter-based hard drives*.

pindle (or Rotational) Speed

Hard drives run at a set **spindle speed**, with the spinning platters measured in *revolutions per minute (RPM)*. Older drives ran at a speed of 3600 RPM, but new drives are hitting 15,000 RPM. The faster the spindle speed, the faster the controller can store and retrieve data. Here are the common speeds: 5400, 7200, 10,000, and 15,000 RPM.

Faster drives mean better system performance, but they can also cause the computer to overheat. This is especially true in tight cases, such as minitowers, and in cases containing many drives. Two 5400-RPM drives might run forever, snugly tucked together in your old case. But slap a hot new 15,000 RPM drive in that same case and watch your system start crashing right and left!

Solid-State Drives

Booting up a computer takes time in part because a traditional hard drive needs to first spin up before the read/write heads can retrieve data off the drive and load it into RAM. All of the moving metal parts of a platter-based drive use a lot of power, create a lot of heat, take up space, wear down over time, and take a lot of nanoseconds to get things done. A **solid-state drive (SSD)** addresses all of these issues nicely.

In technical terms, solid-state technology and devices are based on the combination of semiconductors and transistors used to create electrical components with no moving parts. That's a mouthful! In simple terms, SSDs use memory chips to store data instead of all those pesky metal spinning parts used in platter-based hard drives.

Parallel and Serial ATA

Over the years, many interfaces have existed for hard drives, with such names as ST-506 and ESDI. Don't worry about what these abbreviations stood for; neither the CompTIA A+ certification exams nor the computer world at large have an interest in these prehistoric interfaces. Starting around 1990, an interface called **advanced technology attachment (ATA)** appeared that now virtually monopolizes the hard drive market. ATA hard drives are often referred to as **integrated drive electronics (IDE)** drives.

ATA drives come in two basic flavors. The older **parallel ATA (PATA)** drives send data in parallel, on a wide 40- or 80-wire data cable called a ribbon cable. PATA drives dominated the industry for more than a decade but have been replaced by **serial ATA (SATA)** drives that send data in serial, using only one wire for data transfers.

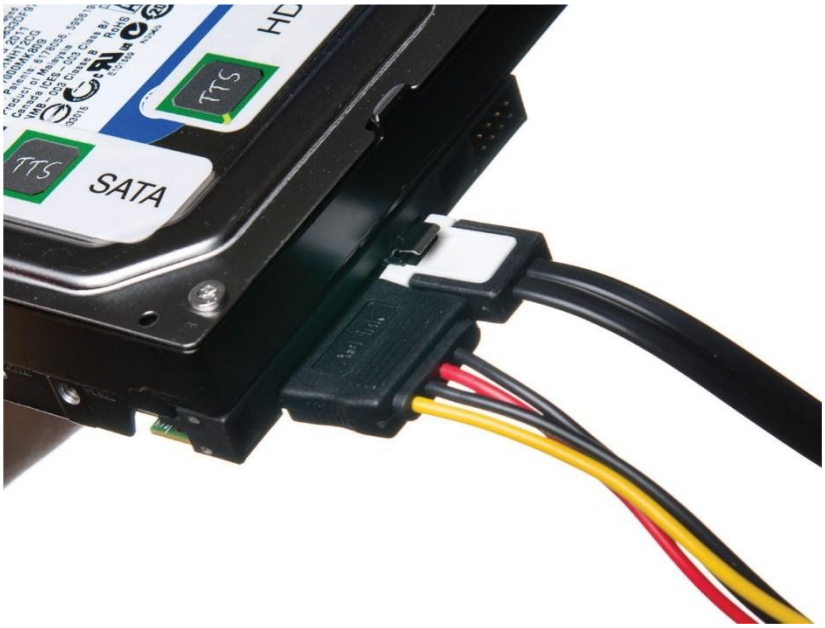
1.20 INSTALLING DRIVES

Installing a drive is a fairly simple process if you take the time to make sure you have the right drive for your system, configure the drive and system setup properly, and do a few quick tests to see if it's running properly.

Cabling SATA Drives

Installing SATA hard disk drives is much easier than installing PATA devices because there's no master, slave, or cable select configuration to mess with. In fact, there are no jumper settings to worry about at all, as SATA supports only a single device per controller channel. Simply connect the power and plug in the controller cable as shown in Figure the OS automatically detects the drive and it's ready to go. The

keying on SATA controller and power cables makes it impossible to install either incorrectly.



1.22 BIOS SUPPORT: CONFIGURING CMOSAND INSTALLING DRIVERS

Every device in your FC needs BIOS support, whether it's traditional BIOS or UEFI.. Hard drive controllersare no exception. Motherboards Provide support for the SATA hard drive controllers via the system BIOS, butthey requireconfiguration in CMOS for the specific hard drives attached.

In the old days, you had to fire up CMOS and manually enterhard drive information whenever you installed a new drive. Today, this processis automated.

Configuring Controllers

As a step in configuring controllers, make certain they 're enabled. Most controllersremain active, ready to automatically detect new drives, but you can disable them. Scan through your CMOS settings to locate thecontroller on/off options (see Figure for typical settings} This is also the to check whether the onboard RAID controllers work in both RAIDand non-RAID settings.

Figure 8.29 Typical controller settings in CMOS

Autodetection

If the controllers are enabled and the drive is properly connected, the drive should appear in CMOS through a process called **autodetection**. Autodetection is a powerful and handy feature that takes almost all the work out of configuring hard drives. Motherboards use a numbering system. tem to determine how drives are listed-and every motherboard uses its own numbering system! One common numbering method uses the term channels for each controller. The first boot device is channel 1, the second is channel 2, and so on. So instead ot names of drives, you see numbers IS. Look at Figure.

Whew! Lots of hard drives! This motherboard supports six SATA connections. Each connection has a number, With an M.2 S5D on SATA 0, hard drives on SATA1 and SATA 2, and the optical drive on SATA 3. Each wasauto detected and configured by thee BIOS without any input from me. Oh,to live in the future!

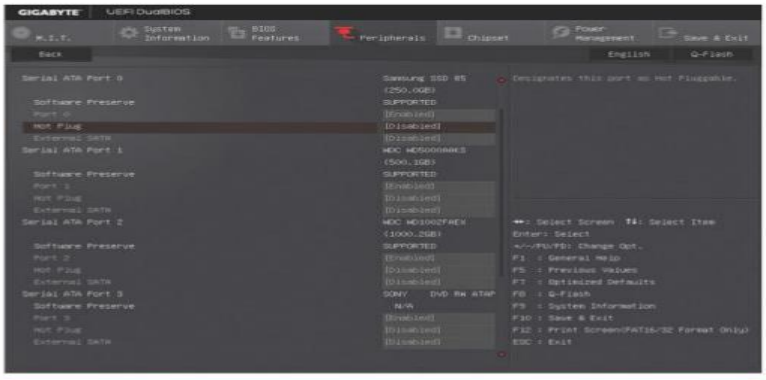


Figure 8.30 Standard CMOS features

Boot Order

If you want your computer to run, it's going to need an operating system to boot. You assign boot order priority to drives and devices in CMOS. Figure shows a typical boot-order screen, with a first, second, and thirdboot option. Mandyusers like to boot first from the optical drive and then from a hard drive. This enables them to put in a bootable optical disc if they're having problems with the system. Of course, you can set it to boot first from your hard drive and then go into CMOS and change it when you need to-it's your choice.

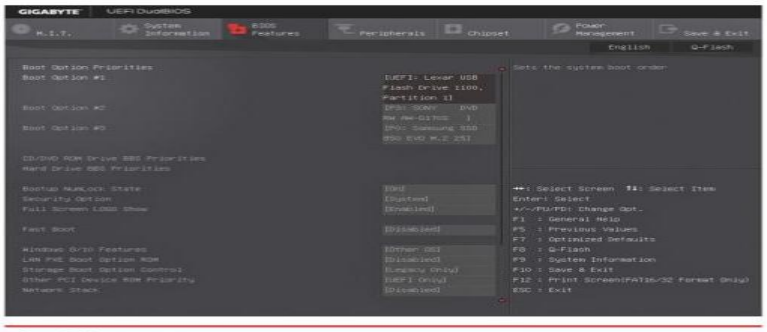


Figure 8.31 Boot order

Most modern CMOS setup utilities include a second screen for determining the boot order of your hard drives. You might want to set up a boot order that goes optical drive, followed by hard drive, and then USB thumb drive, but what if you have more than one hard drive? This screen enables you to set which hard drive goes first. If you havea different operating system on each hard drive, this can be very helpful.

Enabling AHCI

On motherboards that support AHCI, you implement it in CMOS. You'llgenerally have up to three options/modes/HBA configurations: IDE/SATA or compatibility mode, AHCI or RA1D. Don't install modern operating systems in compatibility mode; it's included with some motherboards to Support ancient (Windows XP) or odd (some Linux distros, perhaps?) operating systems. AHC works best for current HDDs and SSDs, so make sure the HBA configuration is set to AHCI.

Troubleshooting Hard Drive Installation

The best friend a tech has when it comes to troubleshooting hard drive installation is the autodetection feature of the CMOS setup utility. Whena drive doesn't work, the most obvious question, especially during installation, is "Did I plug it in correctly? Or did I plug both data and power in correctly?"" With autodetection, the answer is simple: If the system doesn't see the drive, something is wrong with the hardware configuration. Either a device has physically failed or, more likely, you didn't give the hard drive power, plugged a cable in improperly, or messed up some other connectivity issue. To troubleshoot hard drives, simply work your way through each step to figure out what went wrong.

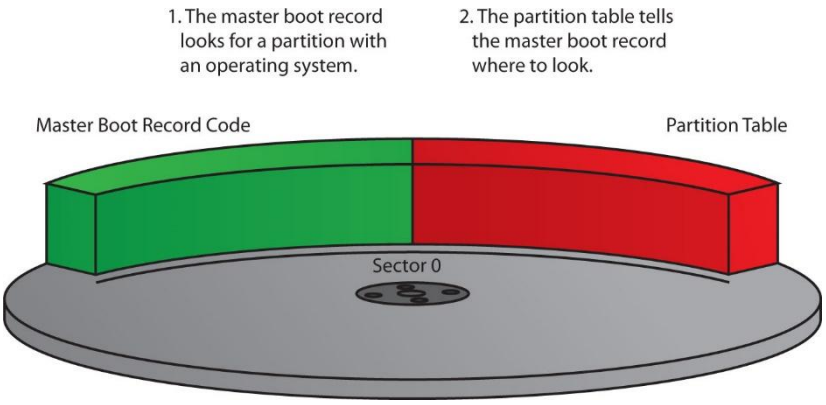
Make sure the BIOS recognizes the hard drive. Use the CMOS setup program to check. Check the physical connections, then run through these issues in CMOS. Is the controller enabled? Similarly, can the motherboard support the type of drive you're installing? If not, you have a couple ofoptions. You may be able to flash the BIOS with

an upgraded BIOS from themanufacturer or get a hard drive controller that goes into an expansion slot.

Master Boot Record

The first sector of an MBR hard drive contains the **master boot record (MBR)**. To clarify, hard drives that use the MBR partitioning scheme have a tiny bit of data that is also called the "master boot record." While your computer boots up, BIOS looks at the first sector of your hard drive for instructions. At this point, it doesn't matter which OS you use or how many partitions you have. Without this bit of code, your OS will never load.

The master boot record also contains the **partition table**, which describes the number and size of partitions on the disk. MBR partition tables support up to four partitions—the partition table is large enough to store entries for only four partitions. The instructions in the master boot record use this table to determine which partition contains the active operating system.



After the MBR locates the appropriate partition, the **partition boot sector** loads the OS on that partition. The partition boot sector stores information important to its partition, such as the location of the OS boot files

MBR partition tables support two types of partitions: primary partitions and extended partitions. **Primary partitions** are designed to support bootable operating systems. **Extended partitions** are not bootable. A single MBR disk may have up to four primary partitions or up to three primary partitions and one extended partition.

Primary partitions are usually assigned drive letters and appear in Windows Explorer/File Explorer (once you format them). The first lettered primary partition in Windows is always C:. After that, you can label the partitions D: through Z:.

Only primary partitions can boot operating systems. On an MBR disk, you can easily install four different operating systems, each on its own primary partition, and boot to your choice each time you fire up the computer.

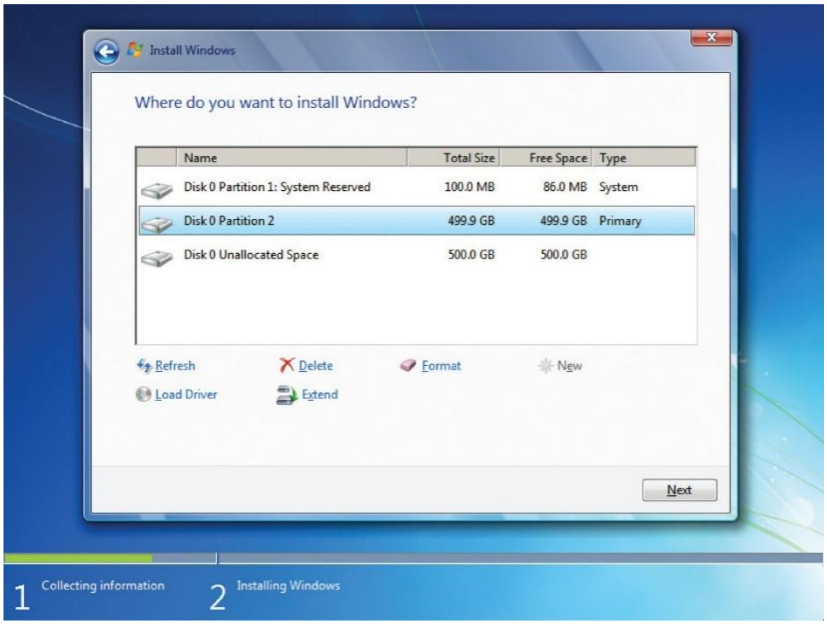
Every primary partition on a single drive has a special setting stored in the partition table called *active* that determines the **active partition**. During boot-up, the BIOS/POST reads the MBR to find the active partition and boots the operating system on that partition. Only one partition can be active at a time because you can run only one OS at a time

1.23 PARTITIONING AND FORMATTING PROCESS

When you boot up Windows installation media and the installation program detects a hard drive that is not yet partitioned, it prompts you through a sequence of steps to partition and format the hard drive.

The process of partitioning and formatting with the current versions of Windows is pretty straightforward. You'll go through a couple of installation screens where you select things such as language and get prompted for a product key and acceptance of the license agreement. Eventually you'll get to the *Where do you want to install Windows?* Dialog box.

If you want to do any custom partitioning or delete existing partitions, you click on Drive options (advanced) in the Where do you want to install Windows? dialog box. To create a new partition, click the New button. Type in an amount in gigabytes that you want to use for a new partition, then click Apply. In Windows 7, you will get a notice that Windows might create additional partitions for system files. When you click OK, Windows will create the 100-MB System Reserved partition as well as the partition you specified. Any leftover drive space will be listed as

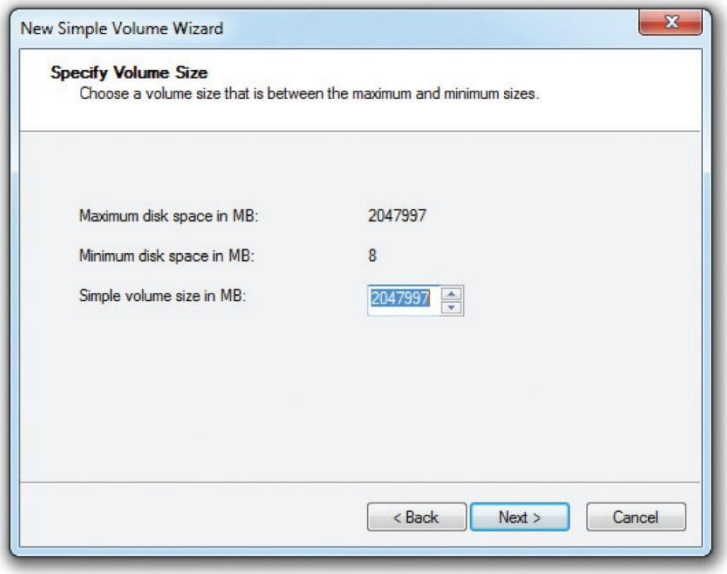


Unallocated Spacepartition and Unallocated Space

Once you create a new partition, click the Format button. The installer won't ask you what file system to use. Newer Windows versions can read FAT and FAT32 drives, but they won't install to such a partition by default.

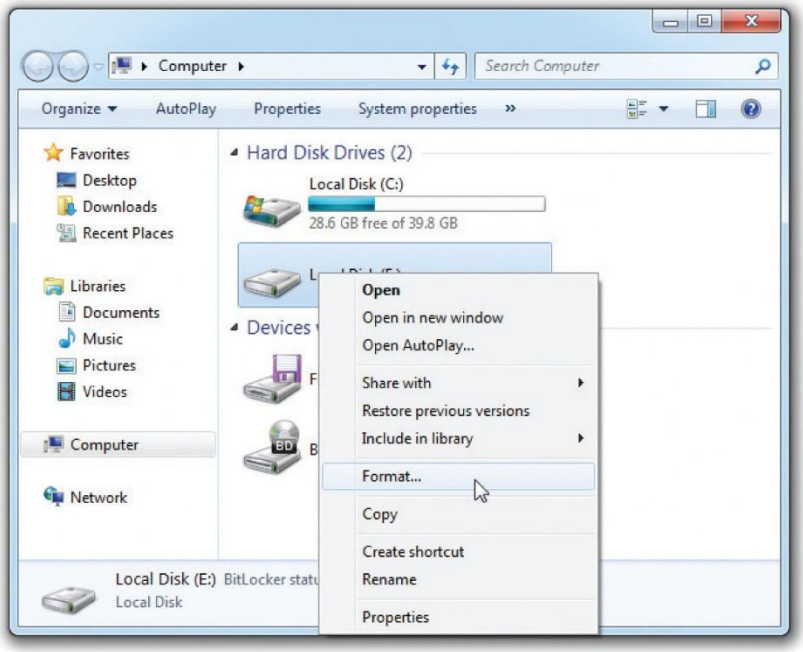
Creating Partitions and Volumes in Disk Management

To create partitions or volumes, right-click the unallocated part of the drive and select New Simple Volume. Disk Management runs the New Simple Volume Wizard. You'll go straight to the sizing screen.



Formatting a Partition

You can format any Windows partition/volume in Windows Explorer/File Explorer. Just right-click on the drive name and choose Format. You'll see a dialog box that asks for the type of file system you want to use, the cluster size, and a volume label. You can also do a quick format or compress the volume. The Quick Format option tells Windows not to test the clusters and is a handy option when you're in a hurry—and feeling lucky. The Enable Compression option tells Windows to give users the capability to compress folders or files. It works well but slows down your hard drive.



1.24 INSTALLING REMOVABLE MEDIA

Understanding USB

The **USB host controller**, an integrated circuit that is usually built into the chipset, controls every USB device that connects to it. Inside the host controller is a **USB root hub**: the part of the host controller that makes the physical connection to the USB ports. Every USB root hub is really just a bus—similar in many ways to an expansion bus.

Serial Ports

Techs at times have to support or service older gear, such as installed point-of-sale systems or networking components soldiering on in the background. Many of these

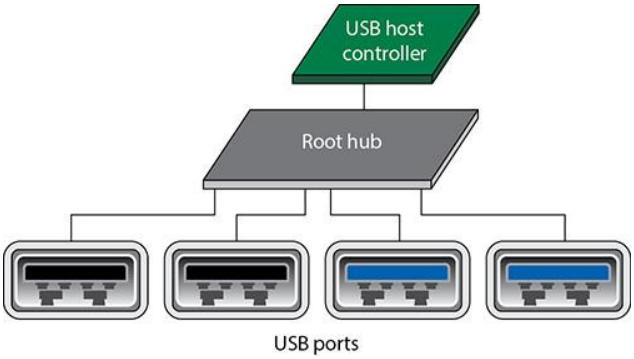
old devices connect to computers using *serial connections*, which use the Recommended Standard 232 (RS-232), introduced way back in 1960. A *serial port* manifests as a 9-pin, D-shell male socket, called a *DB-9* or an *RS-232*.

USB Ports

Universal serial bus (USB) connects almost every type of peripheral one might consider today. Most folks have used USB ports and USB devices, but let's go beyond the user level and approach USB as techs.

Understanding USB

The core of USB is the **USB host controller**, an integrated circuit normally built into the chipset. The host controller acts as the interface between the system and every USB device that connects to it. Connected to the host controller is a **USB root hub**, the part of the host controller that makes the physical connection to the USB ports. Every USB root hub is a bus, similar in many ways to an expansion bus. Figure shows one possible diagram of the relationship between the host controller, root hub, and USB ports.



A single host controller supports up to 127 USB devices, though real-life circumstances create sharper limits. Even if a host controller supports a certain number of USB ports, there's no guarantee that the motherboard maker will supply that many ports. To give a common example, the AMD X370 chipset supports 16 USB ports, but only a few motherboard makers supply that many USB ports.

USB Cables and Connectors

When USB 1.1 was introduced, the standard defined two types of connectors: USB A and USB B. USB A connectors plug upstream toward the host controller (which is why you see them on the PC) and USB B connectors plug downstream into USB devices.

The A and B plugs come in sizes: “standard” USB A/USB B, mini USB A/mini USB B, and micro USB A/micro USB B. The mini and micro USB A connectors were basically ignored; most devices come hard wired. The mini USB B and micro USB B connect smaller devices such as cameras and smartphones.

Understanding USB

The **USB host controller**, an integrated circuit that is usually built into the chipset, controls every USB device that connects to it. Inside the host controller is a **USB root hub**: the part of the host controller that makes the physical connection to the USB ports. Every USB root hub is really just a bus—similar in many ways to an expansion bus. shows a diagram of the relationship between the host controller, root hub, and USB ports.

Unit 2

2.1 INSTALLING AND UPGRADING WINDOWS

Once you have the hardware lined up for whichever specialized PC you want to build, it's time to install an operating system.

Media Sources

At its most basic, a **Windows installation has two steps**.
First, **boot the system from the OS installation media**.
Second, **answer the installation wizard's initial queries and let it do its thing.**
Windows offers a surprising number of **boot methods**, giving you many options to get the process started. The most common way to start—historically at least—is to **insert a Windows installation DVD, change the boot order in the system setup utility**, and power up the system.
Alternatively, you can boot to a storage device inserted into a USB port. That includes flash drives, external hard drives, or external solid-state drives. Any number of *external/hot-swappable drives* will do the job.

Types of Installation

You can install Windows in several ways. A **clean installation** of an OS involves **installing it onto an empty hard drive or completely replacing an existing installation**.
An **upgrade installation** means **installing an OS on top of an earlier installed version**, thus inheriting all previous hardware and software settings.
You can **combine versions of Windows by creating a multiboot installation.**

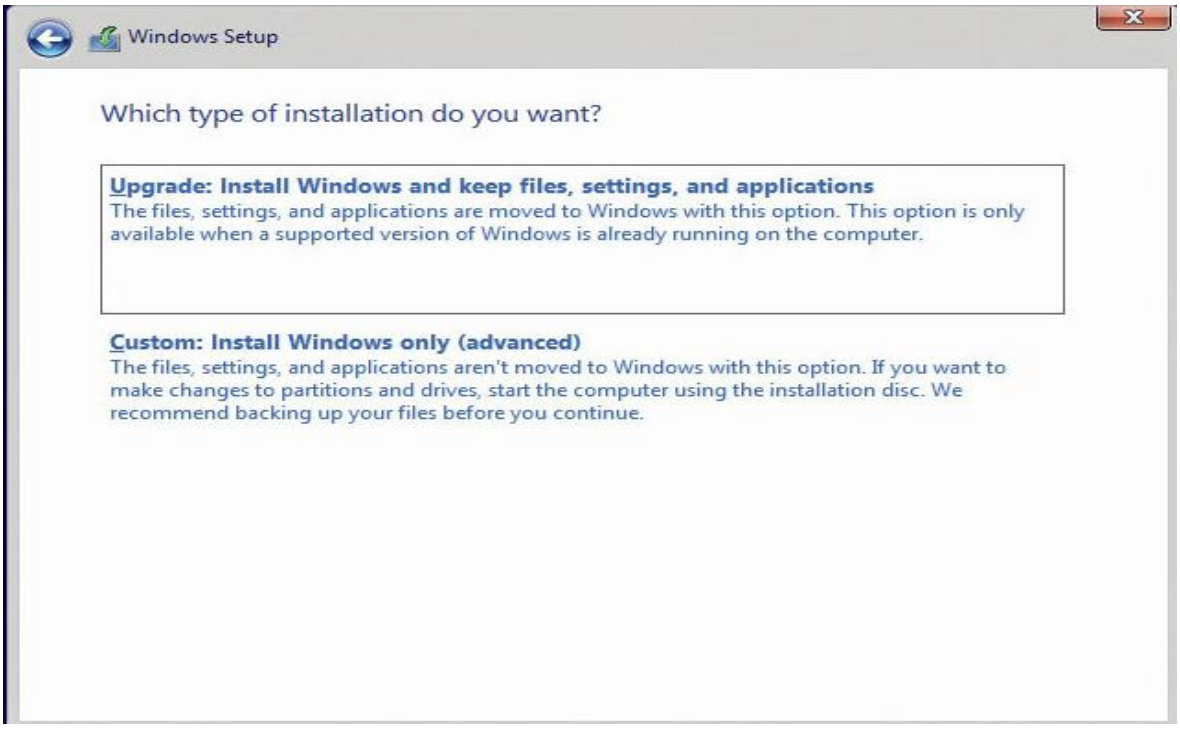
Clean Installation

A clean installation means your installation ignores a previous installation of Windows, **wiping out the old version as the new version of Windows installs.** A clean installation is also performed on a new system with a **completely blank mass storage drive**. The **advantage** of doing a clean installation is that you **don't carry problems from the old OS over to the new one**. The **disadvantage** is that you **need to back up and then restore all your data**, reinstall all your applications, and reconfigure the desktop and each application to the user's preferences. You typically perform a clean installation by setting CMOS to boot from the optical drive or USB before the hard drive or SSD. You then boot off a Windows installation disc/drive, and Windows gives you the opportunity to partition and format the hard drive or SSD during the installation process.

Upgrade Installation

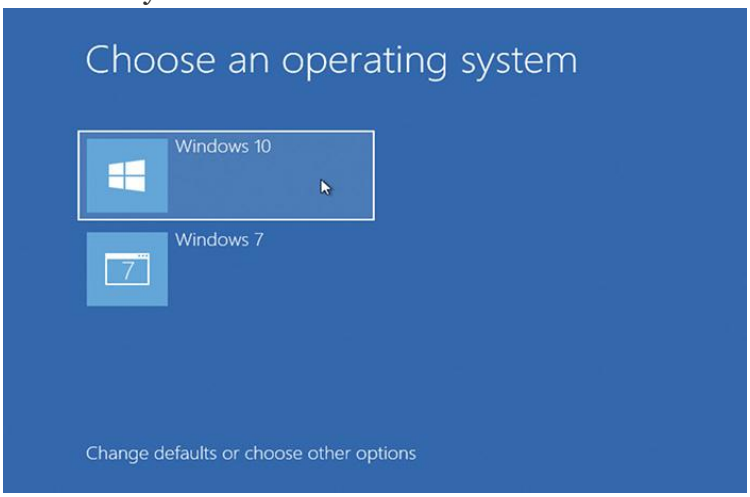
In an upgrade installation, the new OS installs into the same folders as the old OS, or in tech speak, the **new installs *on top of* the old**. The **new OS replaces the old**

OS, but retains data and applications and also inherits all of the personal settings (such as font styles, desktop themes, and so on). The best part is that you don't have to reinstall your favorite programs. Bellow figure shows the start of the Windows 10 installation, asking if you want an upgrade installation.



Multiboot Installation

A third option that you need to be aware of is the dual-boot or multiboot installation. This means your **system has more than one Windows installation and you may choose which installation to use when you boot your computer**. Every time your computer boots, you'll get a menu asking you which version of Windows you wish to boot.

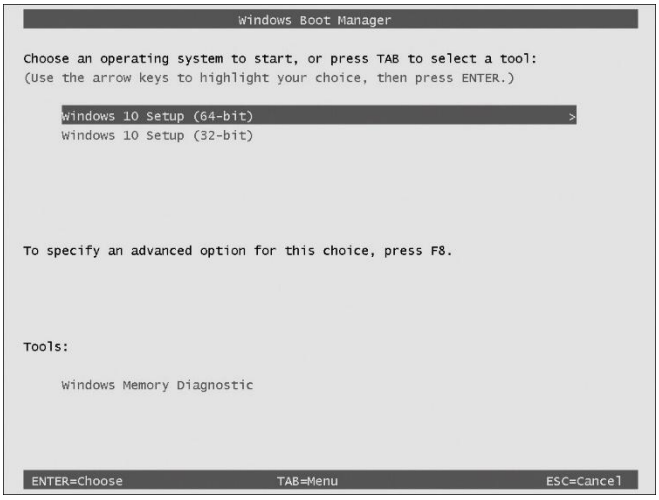


The OS Installation Process

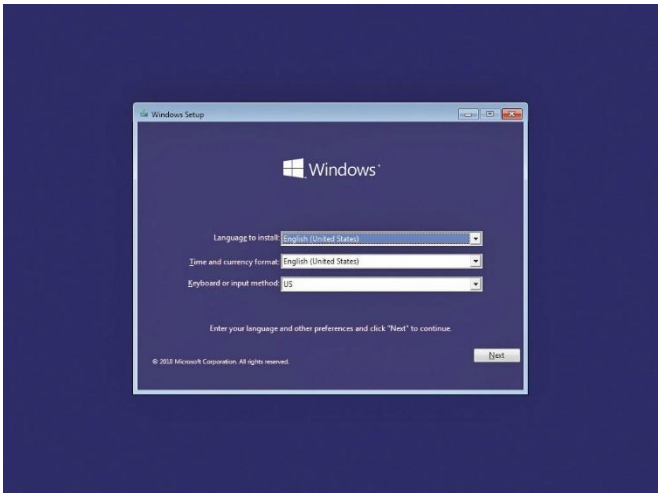
At the most basic level, installing any operating system follows a standard set of steps. You turn on the computer, **insert an operating system disc/disk into the optical drive or USB port, or access the media some other way, and follow the installation wizard until you have everything completed**. Along the way, you'll accept the **End User License Agreement** (EULA)—the terms and conditions for using the OS—and enter the product key that says you're not a pirate.

Windows 10 Clean Installation Process

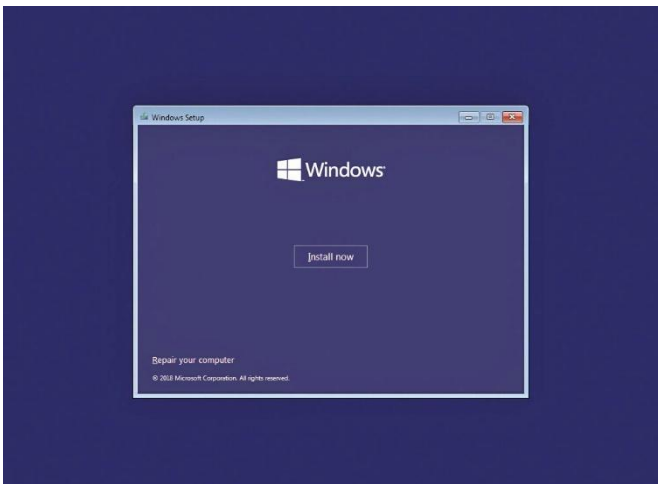
Start by booting your computer from some sort of Windows 10 installation media. When you've booted into the installer, **the first screen you see asks you if you want 32-bit or 64-bit Windows**. Since almost all CPUs support 64-bit, select that option



Your next screen asks for language, time and currency, and keyboard settings,



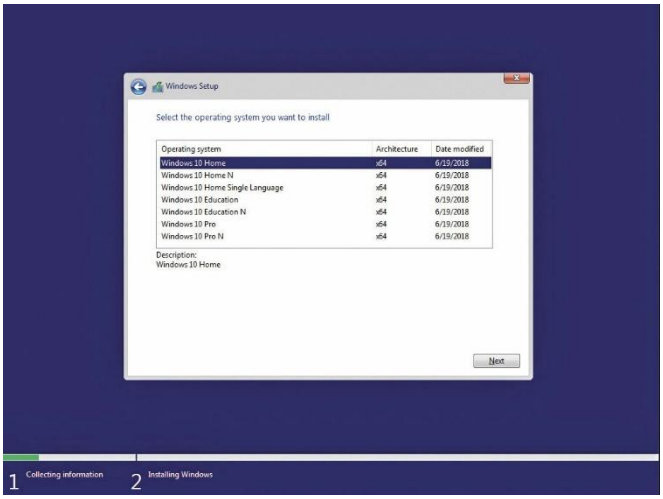
The next screen starts the installation process, but note the lower-left corner. This screen also enables techs to start the installation disc's repair tools. click Install now.



The next screen prompts you to enter your product key before you do anything else. The product key comes with the installation media.

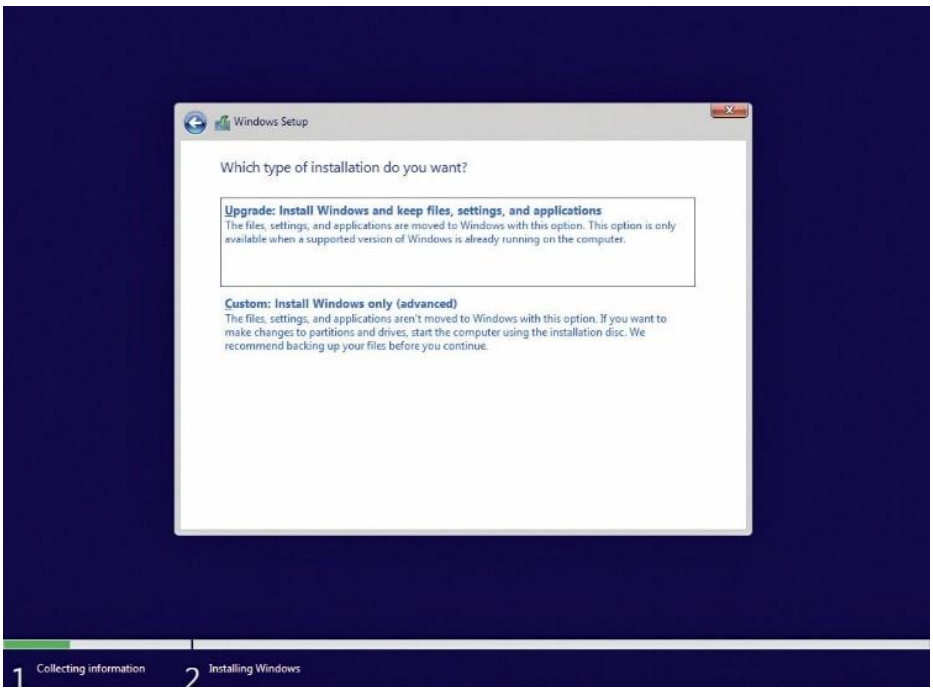
Every Windows installation disc/disk contains all of the available editions within a version. The product key not only verifies the legitimacy of your purchase; it also tells the installer which edition you purchased.

If you click the *I don't have a product key* link (or leave the product key blank and click the Next button in versions before Windows 10), you will be taken to a screen asking you which version of Windows you would like to install.

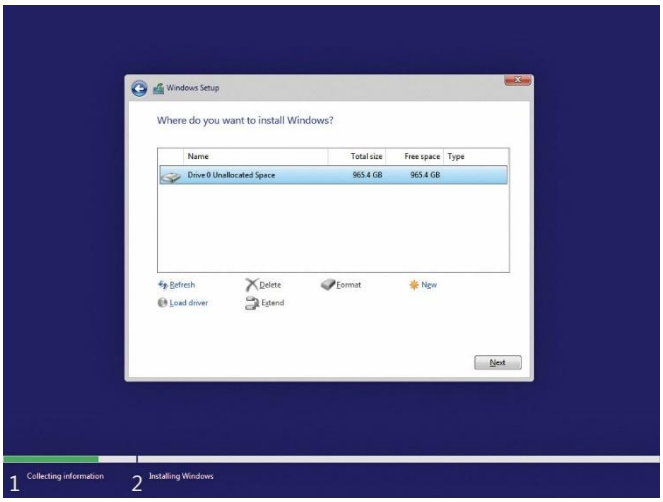


you will no longer be able to boot to the desktop without entering a valid product key that matches the edition of Windows you installed. After the product key screen, you'll find Microsoft's EULA,

On the next page, you get to decide whether you'd like to do an **upgrade installation or a clean installation.**



Bellow Figure shows how **you can partition hard drives and choose a destination partition for Windows**. From this screen, you can click the New link [or Drive options (advanced) link in pre–Windows 10 versions] to display a variety of partitioning options.



Once you've partitioned drives and selected a partition into which to install Windows, the installation process takes over, copying files, expanding files, installing features, and just generally doing lots of computerish things.

When Windows has finished unpacking and installing itself, it lights up the oh-so-irritating Cortana to help you finish up the installation.

where you configure a system to work in a workgroup (personal use) or in an organization.

Next asks you to **set up a user name and password** for your main user account. All operating systems require the creation of this account.

2.2TROUBLESHOOTING INSTALLATION PROBLEMS

The term "installation problem" is rather deceptive. The installation process itself almost never fails. Usually, something else fails during the process that is generally interpreted as an "install failure." Let's look at some typical installation problems and how to correct them.

Media Errors

If you're going to have a problem with a Windows installation, have a **media error, like a scratched DVD or a corrupted USB drive**. It's always better to have the error right off the bat as opposed to when the installation is nearly complete.

RAID Array Not Detected If Windows fails to detect a RAID array during installation, this could be caused by **Windows not having the proper driver for the hard drive or RAID controller.** If the hard drives show up properly in the RAID controller setup utility, then it's almost certainly a driver issue. Get the driver disc from the manufacturer and run setup again. Press F6 when prompted very early in the Windows installation process. Nothing happens right away when you push F6, but later in the process you'll be prompted to install drivers.

No Boot Device Present When Booting Off the Windows Installation Disc Either the installation media is bad or the system setup is not set to look at that installation media first. Access the system setup utility as discussed in Chapter 5, "Firmware."

Graphical Mode Errors

Once the graphical part of the installation begins, errors can come from a number of sources, such as hardware or driver problems. **Failure to detect hardware properly by any version of Windows Setup** can be avoided by simply researching compatibility beforehand. Or, if you decided to skip that step, you might be lucky and only have a hardware detection error involving a noncritical hardware device. You can troubleshoot this problem at your leisure.

Every Windows installation depends on Windows Setup properly detecting the computer type (motherboard and BIOS stuff, in particular) and installing the correct hardware support. Microsoft designed Windows to run on several hardware platforms using a layer of software tailored specifically for the hardware, called the **hardware abstraction layer (HAL)**.

Lockups During Installation

Lockups are one of the most challenging problems that can take place during installation, because they don't give you a clue as to what's causing the problem. Here are a few things to check if you get a lockup during installation.

Disc, Drive, or Image Errors Bad media can mess up an installation during the installation process. **Bad optical discs, optical drives, or hard drives may cause lockups**. Similarly, faults on a USB-based drive can stop an installation in its tracks. Finally, **problems with a downloaded ISO image—also part of the media—can cause lockups**. Check each media component. Check the optical disc for scratches or dirt, and clean it up or replace it. Try a known-good disc in the drive. If you get the same error, you may need to replace the drive or perhaps the ISO.

Log Files Windows versions before Windows 10 generate a number of **special text files called log files** that track the progress of certain processes. **Windows creates different log files for different purposes**. The Windows installation process creates about 20 log files, organized by installation phase. Each phase creates a setuperr.log file to track any errors during that phase of the installation. Windows 10 creates a setup.etl file (among others) in the %WINDIR%/Panther folder that you can open with Event Viewer.

2.3 POST INSTALLATION TASKS

Patches, Service Packs, and Updates

Someone once described an airliner as consisting of millions of parts flying in close formation. I think that's also a good description for an operating system. And we can even carry that analogy further by thinking about all of the maintenance required to keep an airliner safely flying. Like an airliner, the parts (programming code) of your OS were created by different people, and some parts may even have been contracted out. Although **each component is tested as much as possible, and the assembled OS is also tested, it's not possible to test for every possible combination of events. Sometimes a piece is simply found to be defective. The fix for such a problem is a corrective program called a patch.**

In the past, Microsoft provided patches for individual problems. They also accumulated patches up to some sort of critical mass and then bundled them together as a service pack, but Windows 7 was the last version to get one. Today, Windows simply sends individual updates to your system via the Internet.

Immediately after installing Windows, Windows should install the latest updates on the computer. The easiest way to accomplish this task it to turn on *Windows Update*.

Upgrading Drivers

During installation, you may decide to go with the default drivers that come with Windows and then upgrade them to the latest drivers after the fact. This is a good strategy because installation is a complicated task that you can simplify by installing old but adequate drivers. Maybe those newest drivers are just a week old—waiting **until after the Windows installation to install new drivers gives you a usable driver to go back to if the new driver turns out to be a lemon**.

Restoring User Data Files (If Applicable)

Remember when you backed up the user data files before your upgrade installation? You don't? Well, check again, because now is the time to restore that data. Your method of restoring depends on how you backed up the files in the first place. If you used a third-party backup program, you need to install it before you can restore those files, but if you used Backup and Restore, you are in luck, because they are installed by default. If you did something simpler, such as copying to optical discs, USB or other external drive, or a network location, all you have to do is copy the files back to the local hard drive.

Install Essential Software

The final step in the installation process is to install the software that makes the computer work the way you or your client wants. If you install software that requires a license key, have it ready. Similarly, if you install subscription software such as Microsoft Office 365, make sure you have accurate user names and passwords available.

WINDOWS 7

2.4 THE WINDOWS INTERFACE

All versions of Windows share certain characteristics, configuration files, and general look and feel. Here's some good news: **You'll find the same, or nearly the same, utilities in almost all versions of Windows**, and once you master one version-both GUI and command-line interface-you'll pretty much have them all covered. **This section covers the essentials: where to find things, how to maneuver, and what common utilities are available.**Where versions of Windows differ in concept or detail, I'll point that out along the way. You'll get to the underlying structure of Windows in the subsequent two sections of this chapter. For now, let's look at the common user interface.

User Interface

Windows offers a set of utilities, or interfaces, that every user should know about-both how and why to access them. And since every user should know about them, certainly every CompTIA A+ certified tech should as well! Let's take a quick tour of the typical Windows GUI.

Logon

Logging onto a Windows computer is something we all do,but few of us take time to appreciate the process. Your username and password define what you can do on your computer. Every version of Windows supports multiple users on a single machine, so the starting point for any tour of the Windows user interface starts with the logon screen. Figure shows the Windows XP logon screen.

• Figure 4.16 Windows XP logon screen

Windows XP introduced a new type of logon called the **Welcome Screen**. If you'reusing Windows XP Home or MediaCenter, this is the only logon scree you will see.
All editions of Windows Vista and Windows 7 use an improved version of Windows XP's Welcome screen.

Figure 2.19 Windows 7 Welcome screen

Desktop

The Windows **desktop is your primary interface to the computer**. The desktop is always there, underneath whatever applications youopen.
Clearly the Windows Vista and Windows 7 desktops differ a lot compared to the Windows XP desktop. What you're seeing is something called the Aero desktop. The Aero desktop adds a number of impressive aesthetic features to your desktop that Microsoft claims makes the user experience more enjoyable and productive. I'm not going to get into an argument on the value of the Aero desktop, but it is an important part of the modern Windows interface. Most of the Aero features are more about looks than adding.

Taskbar and Start Menu

The taskbar runs along the bottom of all Windows desktops and includes up to four sections. Although the taskbar sits at the bottom of the desktop by default, you can move it to either side or to the top of the screen.

Figure 4.26 Select one of the Aero themes to activate the Aero Desktop in Windows 7.

Windows 7 takes the Quick Launch toolbar and marries it to the running program area thumbnails; creating pinned applications. You can pin application icons directly

onto the running application area. When you open one of these pinned applications, its icon changes to show that it is now open. If you open an application that isn't pinned to the task- bar, its icon still shows up, but will disappear when you close it. If you've ever used the Apple OS X dock (perish the thought!), then you've used this type of feature.

The Many Faces of Windows Explorer

Windows Explorer enables you to manipulate files and folders stored on all the drives in or connected to your computer. Microsoft presents the tool in a variety of ways to help you focus quickly on what you want to accomplish. If you want to see the contents of an optical disc, for example, you can open **Computer** (Windows Vista/7) by double- clicking the icon on the desktop or selecting the icon from the Start menu to have Windows Explorer open with the drives displayed. To display the contents of a drive or folder, double-click it.

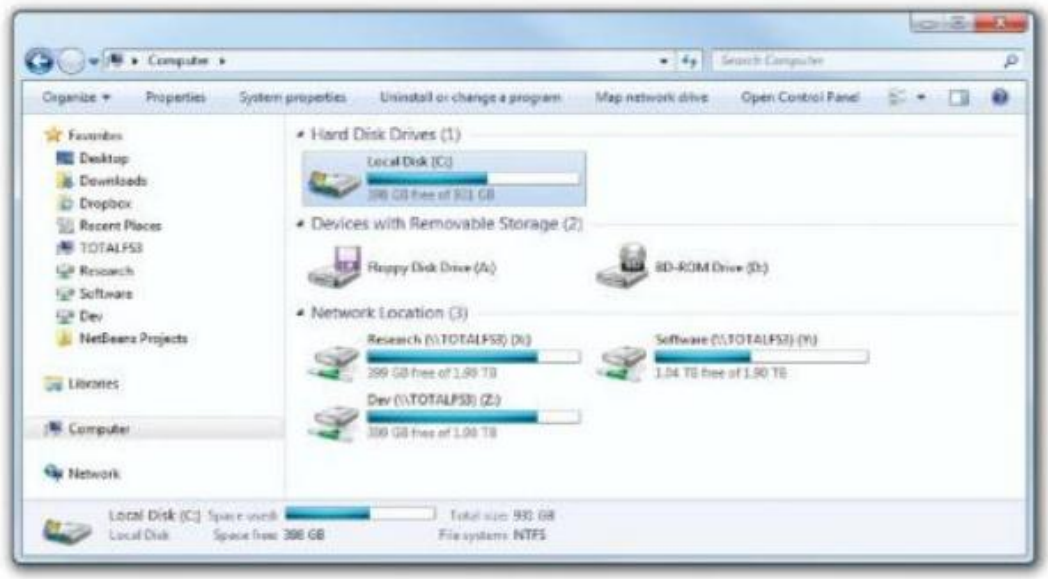


Figure 4.34 Windows Explorer in Windows 7 displaying the drives installed and showing tasks

My Documents, My [Whatever]All versions of Windows provide a **specialfolder structure for each user account so users have their own places** to store personal data.

User's Files Windows Vista and Windows 7 take the equivalent of My Documents to a whole new level with the User's Files.

Windows 7 Libraries Windows 7 introduced only one new-but very useful Feature to Windows Explorer: libraries. The idea behind libraries is based on two fairly straightforward assumptions:

- **People tend to need the same data over and over**
- **The data you need for one job/ project/ function/ whatever is rarely** Stored in a single folder.

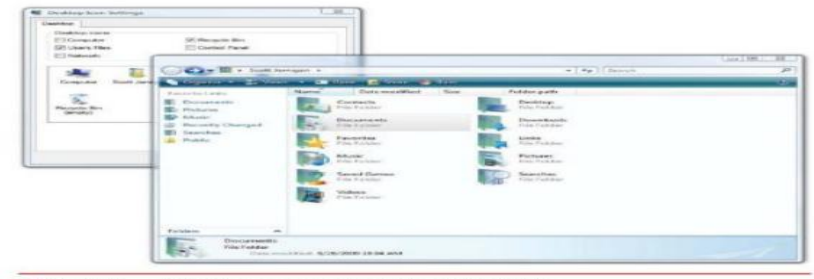


Figure 4.41 Typical user accounts folder in Windows Vista

Libraries aggregate folders from multiple locations and place them in a single easy-to-find spot in Windows Explorer. The files and folders don't actually move. The library just creates links to them.

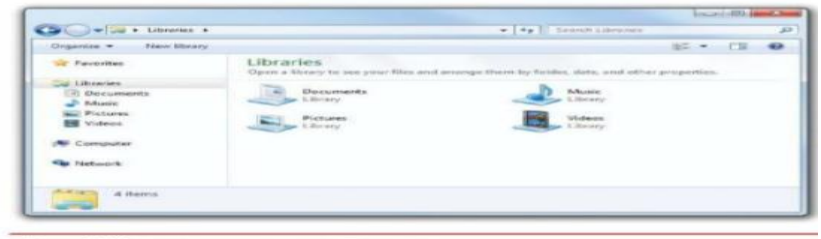


Figure 4.42 Libraries in Windows Explorer

By default, every user has at least four libraries: Documnents, Music, Pictures, and Videos. These libraries consist of two folders: the user's My Whateverfolder for that type of data plus the Public Whatever folder under C:\Users \ Public. (You 1l learn more about these a little later in the chapter) Let's clarify this subtle but critical concept.

Libraries are not folders but collections of existing folders.

Recyclebin

In windows, a file is not erased when you delete it. Windows adds a levelOf protection in the form of a special folder called the Recycle Bin. When youDelete a file in Windows, the file moves into the Recycle Bin. It stays there until you empty the Recycle Bin or restore the file, or until the Recycle Bin reaches a preset size and starts erasing its oldest contents.

My Network Places/Network

Systems tied to a network, either via a network cable or by a modem, have a folder called My Network Places in Windows XP or simply Network in Windows Vista/7. This folder shows all the current network connections available to you. You'll learn abo2020/8/28w11:36 Places/Network in Chapter 22.

Windows Sidebar

Windows Vista comes with a GUI feature called the Windows Sidebar, a tool that sits on one side of the desktop and enables smal1 helper applications- called Microsoft Gadgets-to run.You can display a clock, for example, or a dynamic weather update. Vista comes with a handful of Gadgets, but developers have gone crazy with them, enabling you to add all sorts of useful tools, such as the Twitter feed and word of Warcraft search and realm status Gadgets in.

Windows 7 also includes Gadgets, but removes the Sidebar concept. You can place Windows 7 Gadgets anywhere on your desktop.
SHIFT Bypass the automatic-run feature for optical media (by pressing and holding down the SHIFT key while you insert opticalmedia)
ALT-SPACE Display the main window's System menu (from thismenu you can restore, move, resize, minimize, maximize, or closethewindaw)
ALT-ENTEROpen the properties for the selected object

Working with Text

Copy CTRL-C
Cut CTRL-X
Paste CTRL-v
Undo CTRL-Z

Windows Key Shortcuts

These shortcuts use the special Windows key:
WINDOWS KEY Start menu
WINDOWS KEY-D show desktop
WINDOWS KEY-E Windows Explorer
WINDOWS KEY-L Lock the computer
WINDOWS KEY-TAB Cycle through taskbar buttons (or Flip 3D with Windows Aero in Vista/7)
WINDOWS KEY-PAUSE/BREAK Open the System Properties dialog box

2.5 OPERATING SYSTEM FOLDERS

The modern versions of Windows organize essential files and folders in a relatively similar fashion. All have a primary system folder for storing most Windows internal tools and files. All have a set of folders for programs and user files. Yet once you start to get into details, you'll find some very large differences. It's very important for you to know in some detail the location and function of many common folders and their contents.

System Folder

System Root is the tech name given to the folder in which Windows has been installed. Windows XP Vista, and 7 all use C:\windows as the defaultsystem Root. Be warned: this is the default folder, but you can change whereWindows is installed during the installation process.
The system folder contains many subfolders, too numerous to mention here, but CompTIA wants you to know the names of a number of these sub- folders as well as what goes in them. Let's run through the subfolders you should recognize and define (these folders are in all versions of Windows):

- **%System Root% \Fonts**All of the fonts installed in Windows live here.
- **%SystemRoot\offline Files (Offline Web Pages in Windows 7)**

When you tell your Web browser to save Web pagesfor offline viewing, theare stored in this folder. This is another folder that Windows automatically deletes if it needs the space.

- **%SystemRoot%\System32**This is the real Windows! All of the most critical programs that make Windows run are stored here. 64-bit editions of Windows also store critical files in SystemRoot%\SyswOw64
- **%SystemRoot%\Temp**Anytime Windows or an application running on Windows needs to create temporary files, they are placed here. Windows deletes these files automatically as needed, so never place an important file in this folder.

Program and Personal Document Folders

Windows has a number of important folders that help organize your programs and documents. hey sit in the root directory at the same level as the system folder, and of course they have variations in name depending on the version of Windows. We'll assumethat your computer is using a C: drive -a pretty safe assumption, although there actually is a way to install all of Windows on a second hard-drive partition.

C:\Pragram Files (All Versions)

By default, most programs install some or all of their essential files into a Subfolder of the Program Files folder. If you installed a program, it should haveits own folder in here. Individual companies decide how to label their subfolders. files within it.

C:\Program Files (x86)

The 64-bit editions of Windows Vista and Windows 7 create two directory Strictanes tor program files. The 64-bit applications go into the :\ProgratETFiles folder, whereas the 32-bit applications go into the C:Program Files xS6) folder. The separation makes it easy to find the proper version of whatever application seek.

2.6 TECH UTILITIES

Windows offers a huge number of utilities that enable techs to configure the OS. optimize and tweak settings, install hardware, and more. The trick is toknow where to go to find them. This section shows the most common locations in windows where you can access utilities: right click, control panel, Device Manager, System tools, command line, Microsoft Management.

Figure 4.47 Contents of a typical \Users\<User Name> folder in Vista

Every icon you see in the Control Panel is actually a file with the extension .CPL. Any time you get an error opening the Control Panel, you can betyou have a corrupted

CPL file. These are a pain to fix. You have to renameall of your CPL files with another extension (f use CPB) and then renamethem back to .CPL one at a time, each time reopening the Control Panel, until you find the CPL file that's causing the lockup.
You can use the Control Panel applets to do an amazing array of things to a Windows system, and each applet displays text that helps explain itsfunctions.

Device Manager
With Device Manager, you can examine and configure all of the hardware and drivers in a Windows PC.

• Figure 4.55 Windows XP System applet with the Hardware tab selected

• Figure 4.56 Windows Vista System applet with the Device Manager menu option circled

The method to open devise manager is to right-click My Computer/Computer and select Manage. This opens a window called Computer Management, where you see Device Manager listed on theleft side of the screen, under System Tools. Just click onDevice Manager and it opens.

Device Manager displays every device that Windows recognizes, organized in special group's called types., Alldevices of the same type are grouped under the sametype heading. to see the devices of a particular type, you must open that type's group.
Device Manager isn't just for dealing with problems. It also enables you to update drivers with a simple click of the mouse.

• Figure 4.58 Problem device

• Figure 4.62 System Tools menu options

The CompTIA A+ certification exams therefore test you on a variety of paths to appropriate tools.

To access System Tools in all three versions of Windows, go to Start All Programs Accessories System Tools. Each versionof Windows shares many of the same tools, but each includes itsOwn utilities as well. Ill note which version of Windows uses eachparticular system tool.

Activate Windows (All)

Windows XP unveiled a copy-protection scheme called **activation**. **Activation is a process where your computer sends Microsoft aunique code generated on your machine based on the Install CD/DVD's product key and a number of hardware features,** such asthe amount of RAM, the CPU processor model, and other ones andzeros in your PC. Normally, activation is done at install time, but if youchoose not to activate at install or if you make "substantial"changes to the hardware, you'll need to use the Activate Windowsutility. With the Activate Windows utility, you canactivate over the Internet or over the telephone.

Backup (Windows XP)

The Backup utility enables you to back up selected files and folders to removable media such as tape drives.

Backup Status and Configuration ((Windows Vista)

Vista does not enable you to back up files on your computer selectively. You can only back up personal data with the Backup Status and Configuration Tool or, if you have Vista Business, Ultimate, or Enterprise, performa complete PC backup by using Windows Complete PC Backup. If youwant to pick and choose the file to back up, you need to buy a third-partytool. This tool allows you to back up to optical media, a hard drive, or anetworked drive.

Character Map (All)

Ever been using a program only to discover you need to enter a strange character such as the euro character (E) but your word processor doesn'tsupport it? That's when you need the Character Map. It enables you to copyany Unicode character into the Clipboard.

Disk Cleanup (All)

Disk Cleanup looks for unneeded files on your computer, which is handy when your hard drive starts to get full and you need space. Every versionof Windows since XP starts this program whenever your hard drive getsbelow 200 MB of free disk space.

Disk Defragmenter (XP and Vista)

You use Disk Defragmenter to make your hard drive run faster-you ll see more details on this handy tool in Chapter 12. You can access this utility inthe same way you access Device Manager; you also find Disk Defragmenterin the Computer Management Console. A simpler method is to select StartAll Programs I Accessories System Tools you'll find Disk Defragmenter listed there. You can also right-click on any drive in My Computeror Computer, select Properties, and click the Tools Filetab, where you'll find a convenient Defragment Now button.

Files and Settings Transfer Wizard (Windows XP)

Suppose you have an old computer full of files and settings, and you just bought yourself a brand newcomputer. You want to copy everything from yourold computer onto your new computer what to do? Microsoft touts the Files and Settings Transfer Wizardas just the tool you need. This utility copies your desktop files and folders and, most conveniently, your settings from Internet Explorer andOutlook express; however, it won't copy over your programs, not even the Microsoft ones, and it won'tcopy settings for any programs other than internetExplorer and Outlook Express. If you need to copy Everything from an old computer to a new one, you' h probably want to use a disk-imaging Norton Ghost.

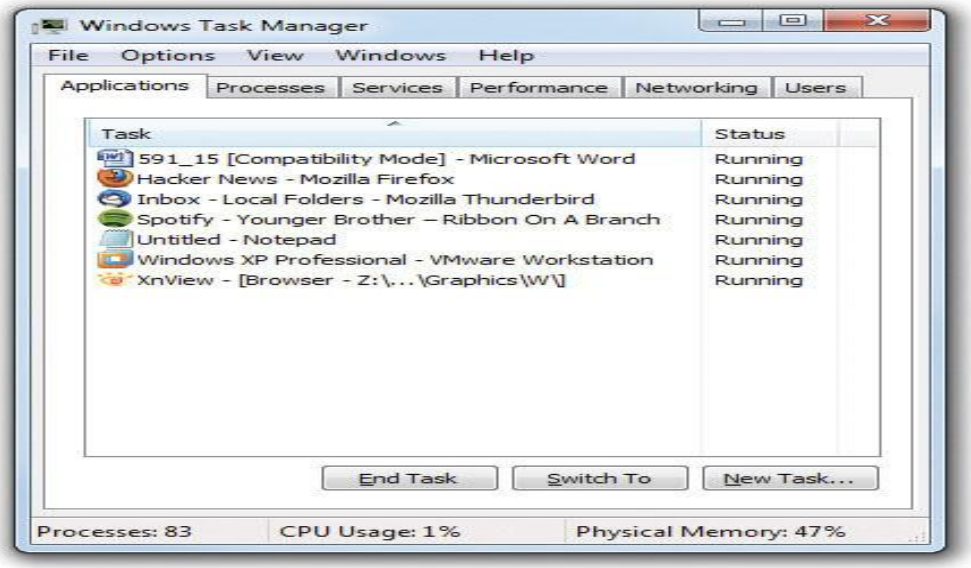
Windows Easy Transfer (Windows Vista/7)

Windows Easy Transfer is an aggressively updated version of the Files and Settings Transfer Wizard. It does everything the older version does and addsthe capability to copy user accounts and other settings.

Figure 4.66 Windows Easy Transfer

2.7 TASK MANAGER

Microsoft offers the **Windows Task Manager as the one-stop-shop for anything you need to do with applications, processes, and services**. The Microsoft development team significantly redesigned Task Manager for Windows 8. We'll look at the tool in Windows 7 first, then examine the Task Manager in Windows 8/8.1/10.



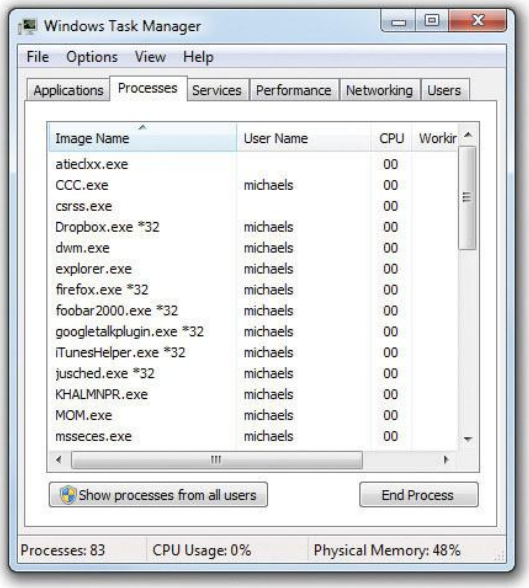
The quickest way to open the Task Manager is to press CTRL-SHIFT-ESC. There are two other ways to open the Task Manager that you might see on the CompTIA A+ exams: go to Start | Search, type **taskmgr**, and press ENTER; or press CTRL-ALT-DELETE and select Task Manager.

Applications The **Applications** tab shows all the running applications on your system. If you're having trouble getting an application to close normally, this is the place to go. To force an application to shut down, select the naughty application and click End Task, or right-click on the application and select End Task from the context menu. Be careful when using this feature! There is no "Are you sure?" prompt, and it's easy to accidently close the wrong application.

There are two other handy buttons on the Applications tab:

- Switch To enables you to bring any program to the front (very handy when you have a large number of applications running).
- New Task enables you to run programs if you know the executable. Click New Task, type **cmd**, and press ENTER, for example, to open the command-line interface.

Processes If you really want to tap the power of the Task Manager, you need to click the **Processes** tab. Since everything is a process, and the Processes tab shows you every running process, this is the one place that enables you to see everything running on your computer.



All processes have certain common features that you should recognize:

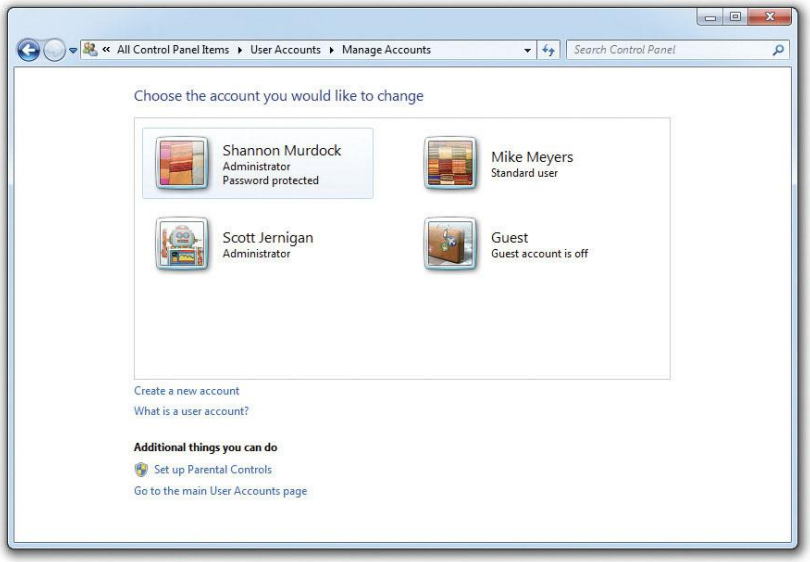
- A process is named after its executable file, which usually ends in .exe but can also end with other extensions.
- All processes have a user name to identify who started the process. A process started by Windows has the user name System.
- All processes have a process identifier (PID). To identify a process, you use the PID, not the process name. The Task Manager doesn't show the PID by default. Click View | Select Columns and select the PID (Process Identifier) checkbox to see the PIDs

Services You can use the **Services** tab in the Task Manager to work with services directly. Here, you can stop or start services, and you can go to the associated process.

Performance For optimization purposes, the Task Manager is a great tool for investigating how hard your RAM and CPU are working at any given moment and why. Click the **Performance** tab to reveal a handy screen with the most commonly used information: CPU usage, available physical memory, size of the disk cache, and other details about memory and processes. shows a system with an eight-core processor, which is why you see eight graphs under CPU Usage History. A system with a single-core processor would have a single graph.

2.8 MANAGING USERS IN WINDOWS 7

Windows 7 offers a utility called the **User Accounts** applet in the Control Panel. To create a user account, open the User Accounts applet and select *Manage another account* to see something like.



Click *Create a new account* to see your options for making a new account. Note that this applet only enables you to make administrator accounts (in the Administrators group) or standard users (in the Users group).

2.9 MAINTAINING WINDOWS

Operating systems need patching; mass storage devices must be kept organized and running well. Registries and temporary files need the occasional cleaning. In the past many of these jobs were handled manually. Today, operating systems handle many if not most of these jobs automatically.

Patch Management

There's no such thing as a perfect operating system. First, all operating system makers come up with new or improved features. Second, bad actors discover weaknesses and generate malware to take advantage of those weaknesses. The process of keeping software updated in a safe and timely fashion is known as **patch management**.

From the moment Microsoft releases a new version of Windows, malware attacks, code errors, new hardware, new features, and many other issues compel Microsoft to provide updates, known more generically as **patches**, to the operating system.

Microsoft's primary distribution tool for handling patch management is a Settings tool or Control Panel applet called **Windows Update**.

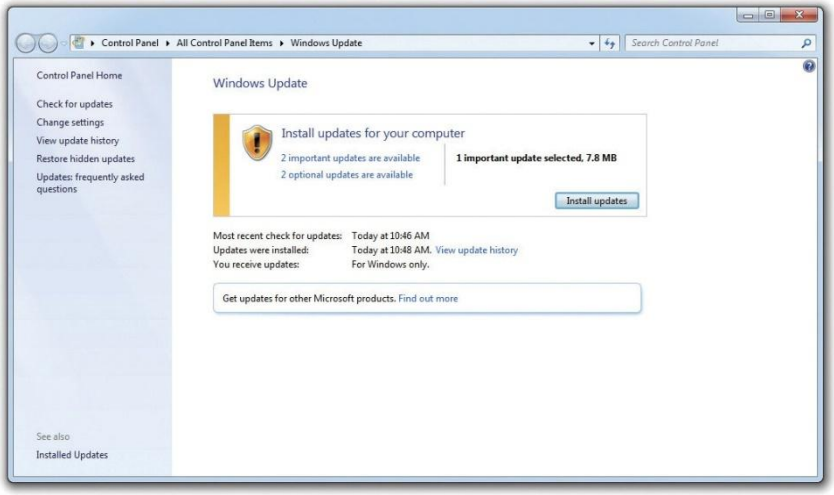
In Windows 7, Windows Update separates fixes into distinct types: updates and service packs. **Updates** in Windows 7 are individual fixes that come out fairly often, on the order of once a week or so. Individual updates are usually fairly small, rarely more than a few megabytes. A **service pack** is a large bundle of updates plus anything else Microsoft might choose to add.

Windows Update can run automatically, so you'll probably see new updates to install every time you open the applet. Windows 7 divides updates into three common types:

- **Important** These updates address security or stability issues and are the most critical. You can configure Windows Update to install these updates automatically.

- **Recommended** A recommended update is an added feature or enhancement that is not critical. You can configure Windows Update to install these updates automatically.

- **Optional** These include device drivers, language packs, and other nonessential updates. You must install these updates manually.



Registry Maintenance

The Registry is a huge database that Windows updates every time you add a new application or hardware or make changes to existing applications or hardware. As a result, the Registry tends to be clogged with entries that are no longer valid. These usually don't cause any problems directly, but they can slow down your system.

Interestingly, Microsoft does not provide a utility to clean up the Registry. To clean your Registry, you need to turn to a third-party utility. Quite a few Registry cleaner programs are out there, but my favorite is the freeware CCleaner by Piriform. You can download the latest copy at www.piriform.com/ccleaner/.

Disk Maintenance Utilities

Every modern OS has one or more utilities designed to maintain hard disk drives (HDDs) and solid-state drives (SSDs), though Windows requires a little more manual action than macOS or Linux.

Error Checking and Disk Defragmentation in Windows

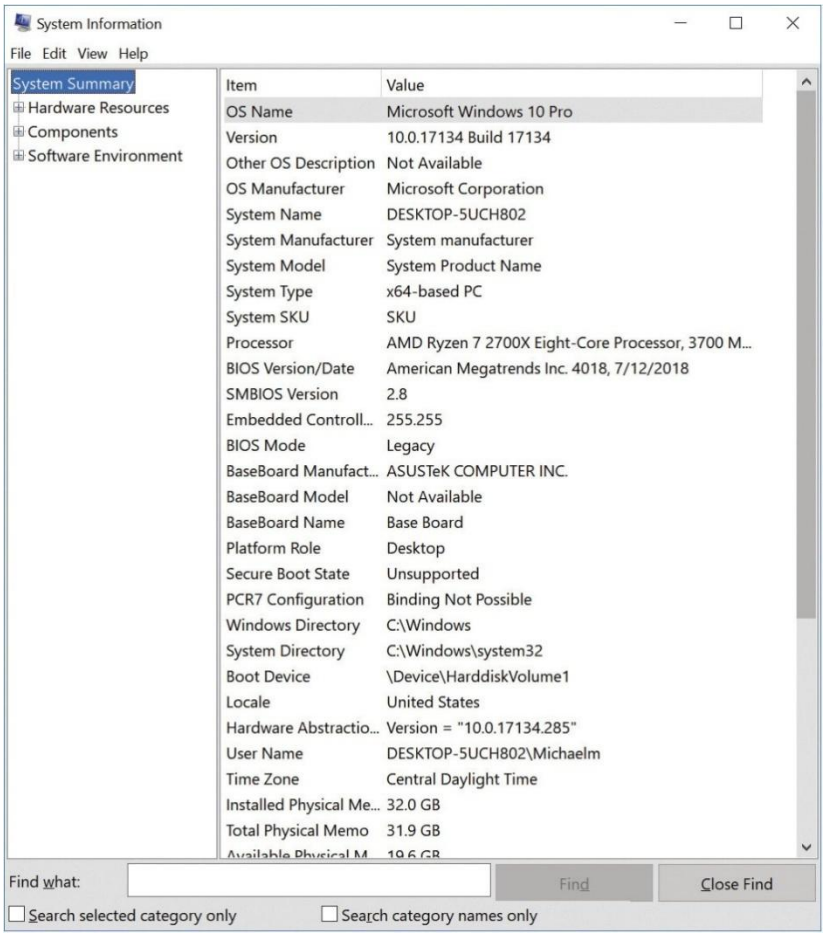
When you can't find a software reason (and there are many possible ones) for a problem such as a system freezing on shutdown, the problem might be the actual physical mass storage drive. You can test the drive with **Error checking**. You can run Error checking by using the *chkdsk* command from an elevated command prompt.

Disk Defragmenter keeps hard drives running efficiently by reorganizing files scattered into pieces on your hard drive into tight, linear complete files.

Handy Windows Administration Tools

System Information

Windows comes with a built-in utility known as the **System Information tool** that collects information about hardware resources, components, and the software environment. When it finishes doing that, it provides a tidy little report, enabling you to troubleshoot and diagnose any issues and conflicts. As with many other tools, you can access this tool from the Start | Search bar; simply enter msinfo32.



2.10 OPTIMIZING WINDOWS

Anything you do that makes Windows better than it was before, such as adding a piece of software or hardware to make something run better, is an *optimization*.

Installing and Removing Software

Optimizing by installing and removing software is part of the normal life of any computing device. Each time you add or remove software, you make changes and decisions that can affect the system beyond whatever the program does, so it pays to know how to do it right.

Installation Concepts

Installing software in any OS requires consideration of several issues. First, what are the system requirements? Does the target computer have sufficient drive space for the app? Does it have enough RAM to run the program well? Does the version of OS running on the system match the OS requirements for compatibility with the application?

For a long time, most software was distributed on some sort of removable media, such as a floppy disk (from my youth) to an optical disc, such as a CD-ROM or DVD-ROM. These days, most application software comes from the Internet, so a network download is the process.

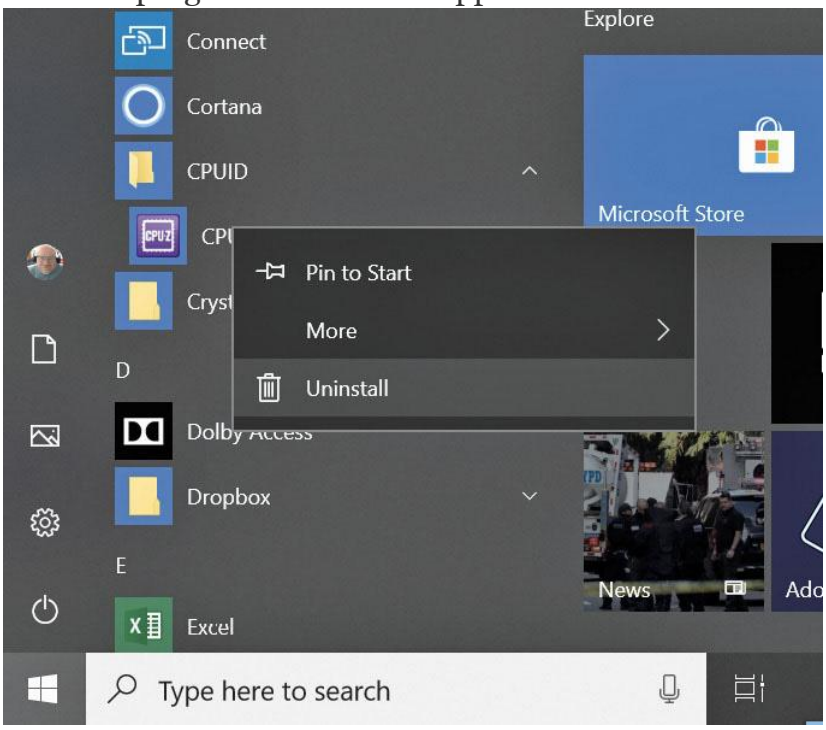
The user account trying to install the software has to have administrative or root privileges.

If you can't download or access an application over the Internet, it'll probably come on an optical disc. Windows supports **Autorun**, a feature that enables the operating system to look for and read a special file called—wait for it—autorun.inf. Immediately after a removable media device (optical disc or thumb drive) is inserted into your computer, whatever program is listed in autorun.inf runs automatically.

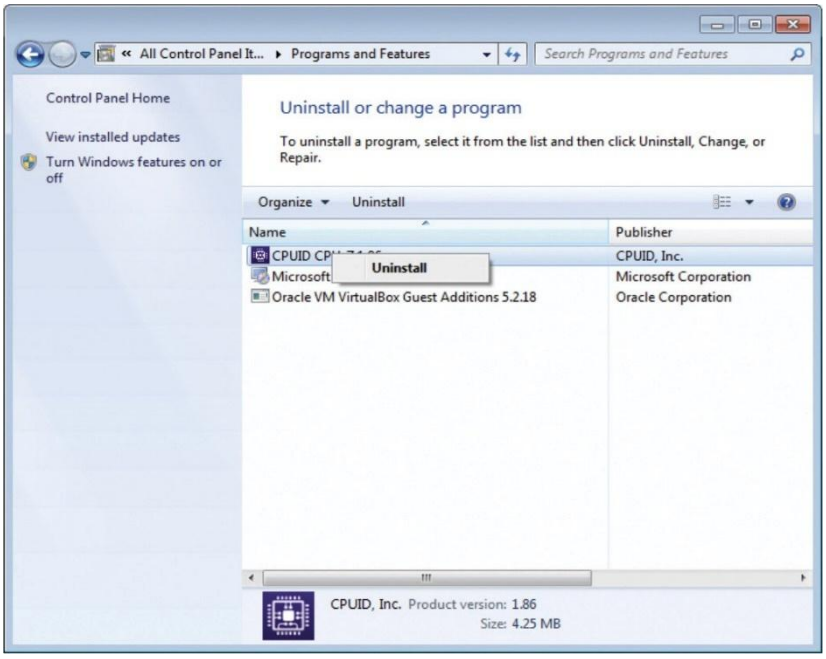
1. To start an installation manually, double-click on the disc icon in Explorer or File Explorer.
2. If you are using an administrator account, you can simply click Yes or Continue and finish the installation
3. You typically must accept the terms of a software license before you can install an application. These steps are not optional; the installation simply won't proceed until you accept all terms the software manufacturer requires.

Removing Software

Each installed program takes up space on a computer's hard drive, and programs that you no longer need waste space that could be used for other purposes. Removing unnecessary programs is an important piece of optimization.
the application's own uninstall program, when possible. You normally find the uninstall program listed in the application's folder in the Start menu,



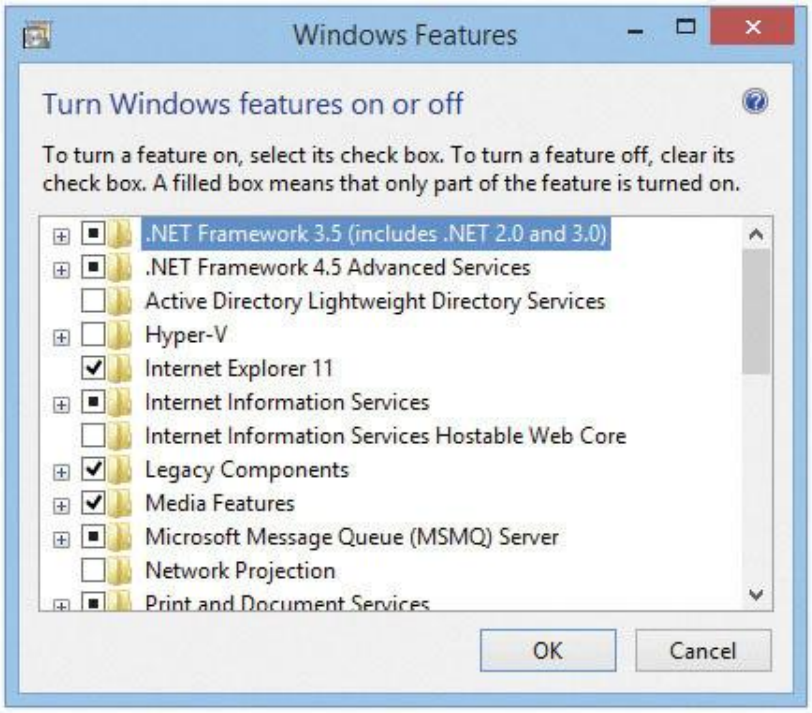
If an uninstall program is not available, use the **Programs and Features** applet in Control Panel or **Apps & features** in Settings (Windows 10) to remove the software. You select the program you want to remove and click the Uninstall/Change button or Change/Remove button. Windows displays a message warning you that the program will be permanently removed from your PC. If you're certain you want to continue, click Yes.



Adding or Removing Windows Components/Features

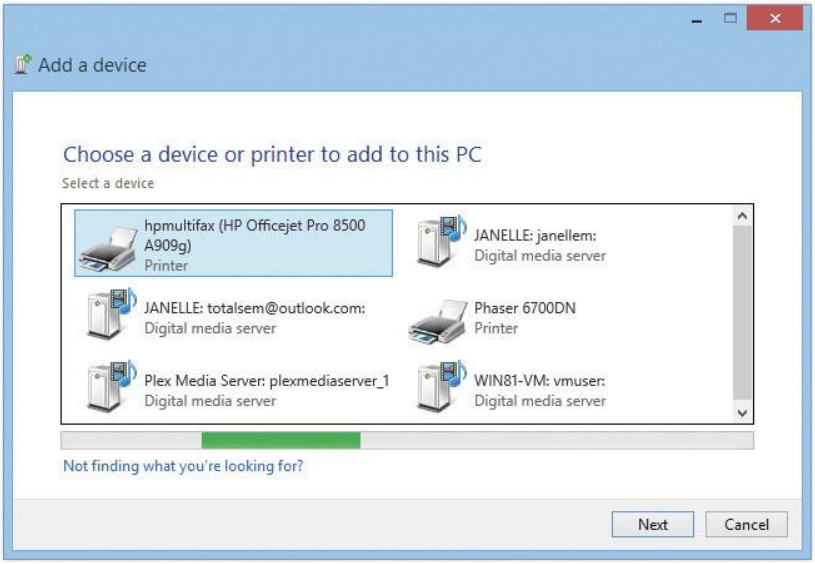
When you installed Windows, it included certain features by default. It installed Notepad, network support, and games on your computer. You can remove these Windows components from your system if you like, and add other components as well.

Open the Programs and Features applet in the Control Panel, and then click the *Turn Windows features on or off* option on the Tasks list. Click Yes or Continue if prompted by UAC and you will be presented with the Windows Features dialog box. To toggle a feature on or off, simply click its checkbox.



Adding a New Device

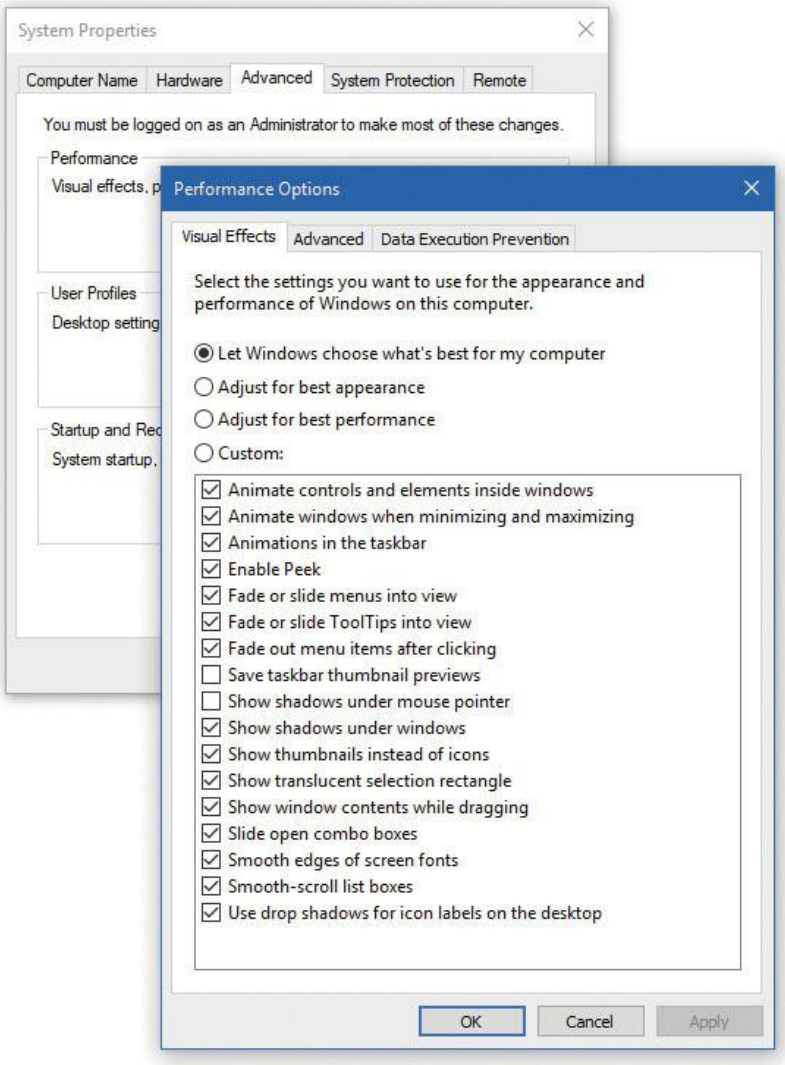
Windows should automatically detect any new device you install in your system. If Windows does not detect a newly connected device, use the *Add a device* option in the Devices and Printers applet in Windows to get the device recognized and drivers installed.



Performance Options

One optimization you can perform on all Windows versions is setting Performance Options. **Performance Options** are used to configure CPU, RAM, and virtual memory (page file) settings. To access these options right-click Computer or This PC and select Properties, and then click the Advanced system settings link in the Tasks list. On the Advanced tab, click the Settings button in the Performance section.

The Performance Options dialog box has three tabs: Visual Effects, Advanced, and Data Execution Prevention. The Visual Effects tab enables you to adjust visual effects that impact performance, such as animations, thumbnails, and transparencies. Try clicking the top three choices in turn and watch the list of settings.



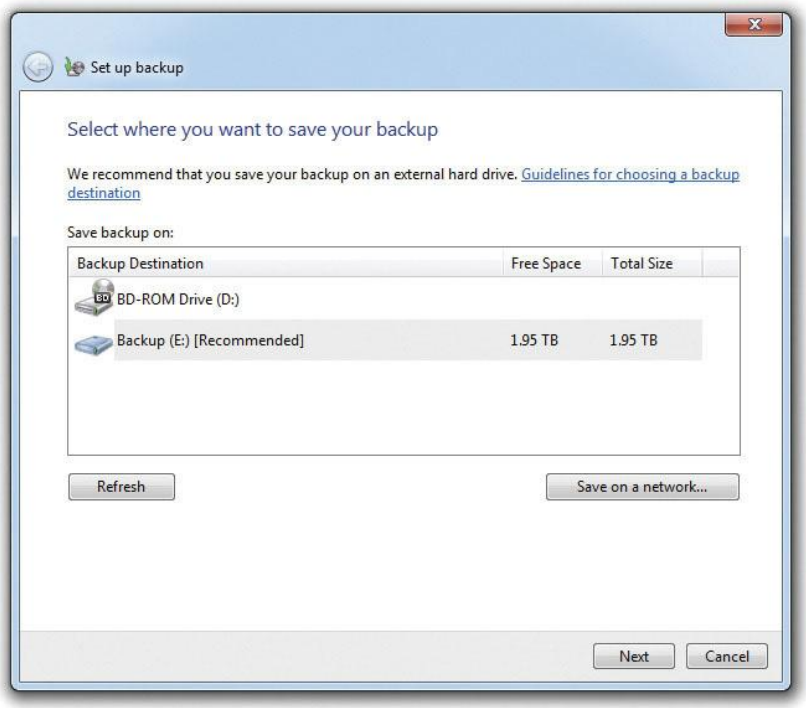
2.11 PREPARING FOR PROBLEMS

Techs need to prepare for problems. You must have critical system files and data backed up and tools in place for the inevitable glitches. Every modern operating system has options for backing up data and, as you might imagine, they all offer different features. Windows offers System Restore to recover from problems, too.

Backing Up Personal Data

The most important data on your computer is the personal data: your documents, e-mail messages and contacts, Web favourites, photographs, and other files. To handle backing up personal data, every version of Windows comes with some form of backup utility. macOS and Linux of course have backup tools as well.

Microsoft includes the automated and simple **Backup and Restore** Control Panel applet in Windows 7. The process begins by asking where you want to save your backup



there are two choices: *Let Windows choose* (*recommended*) and *Let me choose*.

If you select *Let Windows choose (recommended)*, you'll back up each user's personal data, but Windows 7 doesn't stop there. Assuming you have enough space in your backup location, Windows 7 will automatically add a system image that includes the entire Windows operating system, every installed program, all device drivers, and even the Registry.

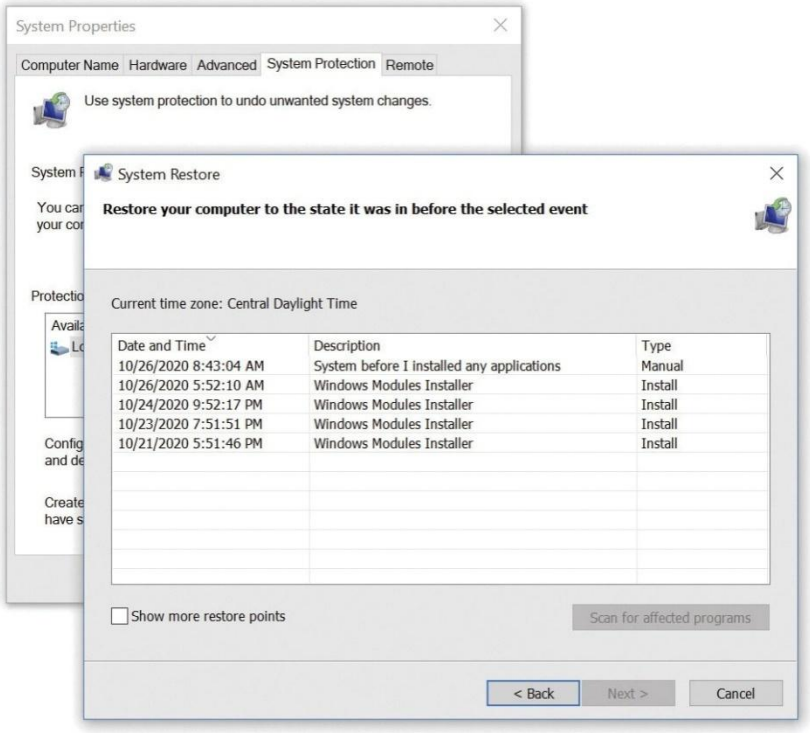
Selecting *Let me choose* is equally interesting. Windows 7 enables you to pick individual users' files to back up. This can be a handy situation when you store important files outside of the folders the *Let Windows choose* option covers.

System Restore in Windows

The **System Restore** tool enables you to create a **restore point**, a *snapshot* of a computer's configuration at a specific point in time. If the computer later crashes or has a corrupted OS, you can restore the system to its previous state, specifically *restoring system files and folders*.

When System Restore is turned on, it makes a number of restore points automatically. To make your own restore point, right-click Computer or This PC and select Properties, and then click the System protection link in the Tasks list. On the System Protection tab, click the Create button to open the dialog box shown in Figure. Name your restore point appropriately and then click Create.

The System Restore tool creates some of the restore points automatically, including every time you install new software. Thus, if installation of a program causes your computer to malfunction, simply restore the system to a time point prior to that installation, and the computer should work again.



2.12 FAILURE TO BOOT

When a computer fails to boot, you need to determine whether the problem relates to hardware or software.

Failure to Boot: Hardware or Configuration

Most failed-boot scenarios require you to determine where the fault occurred: with the hardware and configuration, or in Windows. This is a pretty straightforward problem.

Hardware problems can give you a blank screen on boot-up, so you follow the tried-and-true troubleshooting methodology for hardware. Make sure everything is plugged in and turned on.

If the user says that the screen says “No boot device detected” and the system worked fine before, it *could* mean something as simple as the computer has attempted to boot to an incorrect device, such as to something other than the primary hard drive.

Failure to Boot: Windows

Two critical boot files risk corruption in Windows, bootmgr and bcd, both of which you can fix with one tool, bcdedit. You can use this tool in the Windows Recovery Environment.

Getting to Windows RE

In Windows 7, you can access WinRE in three ways. First, you can boot from the Windows installation media and select Repair. Second, you can use the Repair Your Computer option on the Advanced Boot Options (F8) menu. Third, you can create a

system repair disc or system image before you have problems. Go to Control Panel | Backup and Restore and select *Create a system repair disc* or select *Create a system image*.

Windows Memory Diagnostic Bad RAM causes huge problems for any operating system, creating scenarios where computers get Blue Screens of Death (BSoDs), system lockups, and continuous reboots. In Windows 7, the Windows Recovery Environment enables you to click the Windows Memory Diagnostic link from the main WinRE screen. When clicked, it prompts you to *Restart now and check for problems (recommended)* or *Check for problems the next time I start my computer*

2.13 INSTALLING AND CONFIGURING A WIRED NETWORK

To have network connectivity, you need to have three things in place:

- **Connected NIC** The physical hardware that connects the computer system to the network media.
- **Properly configured IP addressing** Your device needs correct IP addressing for your network, either via DHCP or static.
- **Switch** Everything connects to a switch in a wired network.

Installing a NIC

The NIC is your computer system's link to the network, and installing one is the first step required to connect to a network. but every modern desktop computer has a built-in Gigabit NIC. Windows will automatically install a driver for the NIC at installation.

Full-Duplex and Half-Duplex

All modern NICs run in **full-duplex** mode, meaning they can send and receive data at the same time. The vast majority of NICs and switches use a feature called *autosensing* to accommodate very old devices that might attach to the network and need to run in half-duplex mode. **Half-duplex** means that the device can send and receive, but not at the same time.

Link Lights

Network interfaces have some type of light-emitting diode (LED) *status indicator* that gives information about the state of the NIC's link to whatever is on the other end of the connection.

Configuring IP Addressing

This one's easy. All operating systems by default will be set for DHCP and acquire IP addressing settings automatically. This is true for both IPv4 and IPv6 configuration options. On the off-chance scenario where you need to configure a client to use a static IP address, you can readily do so.

Sharing and Security

Windows systems can share all kinds of **resources** across your network: files, folders, entire drives, printers, faxes, Internet connections, and much more.

Network Organization

Once a network is created, users need to be able to share resources in some organized fashion. Operating systems need a way to determine which users can access resources such as folders and printers and how those resources can be used. Microsoft designed Windows networks to work in one of three categories: workgroups, domains, or homegroups.

2.14 CONNECTING TO THE INTERNET

Computers commonly connect to an ISP by using one of eight technologies that fit into four categories: dial-up, both analog and ISDN; dedicated, such as DSL, cable, and fiber; wireless, including Wi-Fi and cellular; and satellite.

Dial-Up

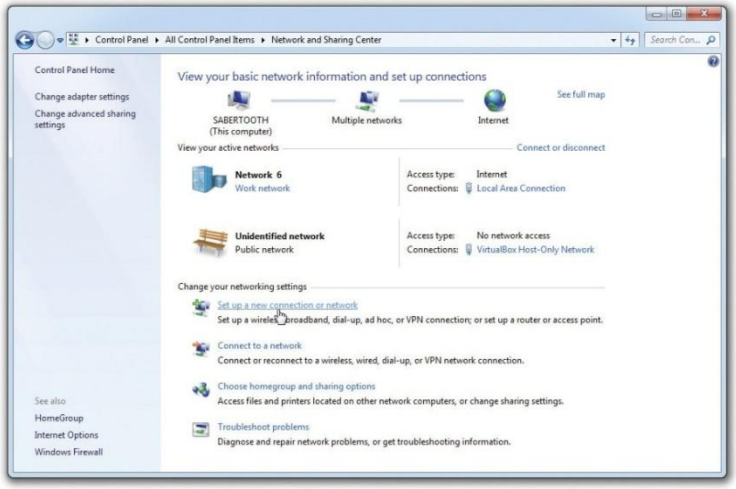
A dial-up connection to the Internet requires two pieces to work: hardware to dial the ISP, such as a modem or ISDN terminal adapter; and software to govern the connection, such as Microsoft's **Dial-up Networking (DUN)**. Let's look at the hardware first, and then we'll explore software configuration.

Modems

Creating a dial-up network required equipment that could turn digital data into an analog signal to send it over the telephone line, and then turn it back into digital data when it reached the other end of the connection. A device called a modem solved this dilemma.

Modems enable computers to talk to each other via standard commercial telephone lines by converting analog signals to digital signals, and vice versa. The term *modem* is short for modulator/demodulator, a description of transforming the signals. Telephone wires transfer data via analog signals that continuously change voltages on a wire. Computers hate analog signals.

Configuring Dial-Up To start configuring a dial-up connection, open the Network and Sharing Center applet and click *Set up a new connection or network*.

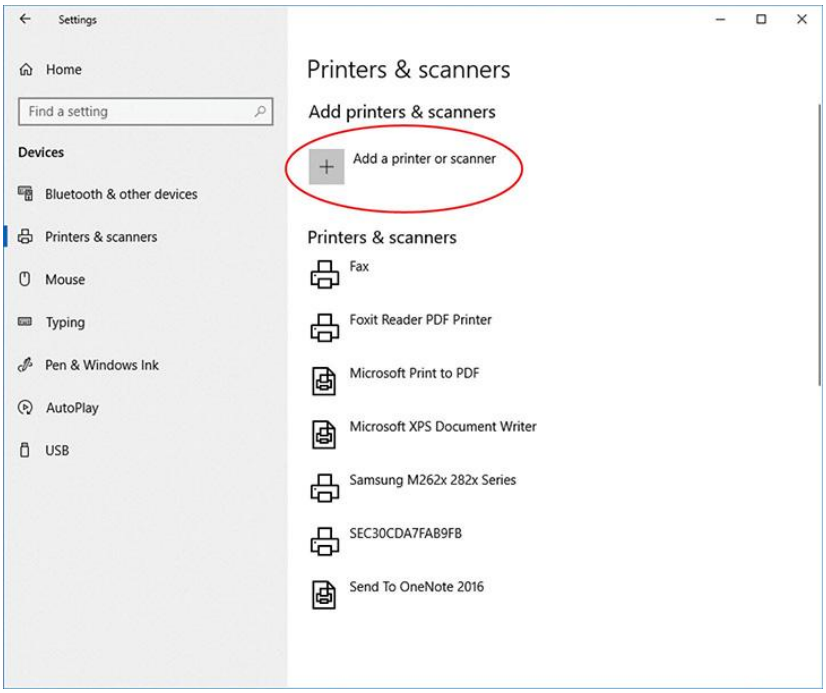


Select Connect to the Internet and enter your dial-up information.

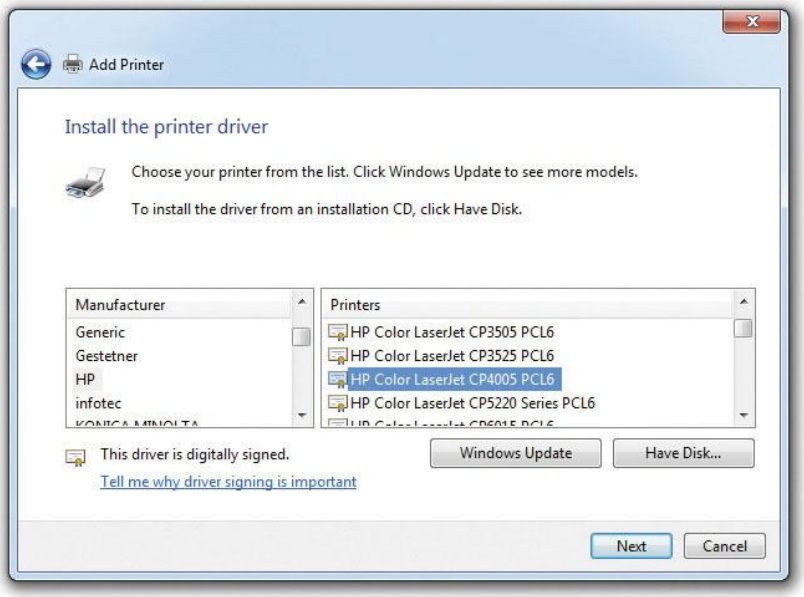
2.15 INSTALLING A PRINTERS IN WINDOWS

The general installation, configuration, and troubleshooting issues are basically identical in all modern versions of Windows. Here's a review of a typical Windows printer installation.

Most printers are plug and play, so installing a printer is reduced to simply plugging it in and loading the driver if needed. With USB printers, Windows won't even wait for you to do anything—Windows immediately detects and installs a printer once you connect it. If the system does not detect the printer in Windows 7/8/8.1, open the Devices and Printers applet in the Control Panel. As you might guess, you install a new printer by clicking the Add a printer icon/button. This starts the Add Printer Wizard.
Although you can use the Control Panel applet in Windows 10, most users will opt for the simpler Settings | Devices | Printers & scanners for setting up a printer. Click the *Add a printer or scanner* option to find a connectable printer.



Whether you use a USB port or a TCP/IP port, you'll need to select the proper driver manually. Windows includes a lot of printer drivers, but you can also use the handy Have Disk option to use the disc that came with the printer. If you use the driver included on the disc, Windows will require administrator privileges to proceed; otherwise, you won't be able to finish the installation. The Windows Update button enables you to grab the latest printer drivers via the Internet.



After clicking the Next button, you'll be asked if the new local printer should be the default printer and whether you want to share it with other computers on the network.

2.16 NETWORK SECURITY

Networks are under threat from the outside as well, so this section looks at issues involving Internet-borne attacks, firewalls, and wireless networking.

Malicious Software

The beauty of the Internet is the ease of accessing resources just about anywhere on the globe, all from the comfort of your favorite chair. This connection, however, runs both ways, and people from all over the world can potentially access your computer from the comfort of their evil lairs. The Internet is awash with malicious software that is, even at this moment, trying to infect your systems.

The term **malware** defines any program or code that's designed to do something on a system or network that you don't want done. Malware comes in quite a variety of guises, such as viruses, worms, ransomware, spyware, Trojan horses, keyloggers, and rootkits.

Forms of Malware

Virus A **virus** is a program that has two jobs: to replicate and to activate. **Replication** means it makes copies of itself, by injecting itself as extra code added to the end of executable programs, or by hiding out in a drive's boot sector. **Activation** is when a virus does something like corrupting data or stealing private information. A virus only replicates to other drives, such as thumb drives or optical media. It does not self-replicate across networks. A virus needs human action to spread.

Worm A **worm** functions similarly to a virus, except it does not need to attach itself to other programs to replicate. It can replicate on its own through networks, or even hardware like Thunderbolt accessories. If the infected computer is on a network, a worm will start scanning the network for other vulnerable systems to infect.

Trojan Horse A **Trojan horse** is a piece of malware that appears or pretends to do one thing while, at the same time, it does something evil. A Trojan horse may be a game, like poker, or ironically, a fake security program. The sky is the limit. Once installed, a Trojan horse can have a hold on the system as tenacious as any virus or worm; a key difference is that installed Trojan horses do not replicate.

Keylogger **Keylogger** malware does pretty much what you might imagine, recording the user's keystrokes and making that information available to the programmer. You'll find keylogging functions as part of other malware as well. Keyloggers are not solely evil; a lot of parental control tools use keyloggers.

Rootkit A **rootkit** is a program that takes advantage of very low-level operating system functions to hide itself from all but the most aggressive of anti-malware tools. Worse, a rootkit, by definition, gains privileged access to the computer. Rootkits can strike operating systems, hypervisors, and even firmware

Behavior

Knowing what form the malware takes is all well and good, but what really matters is how "mal" the malware will be when it's running rampant on a system. To get things started, let's dive into an old favorite: spyware.

Spyware **Spyware**—malicious software, generally installed without your knowledge—can use your computer's resources to run distributed computing applications, capture keystrokes to steal passwords, or worse.

Malware Prevention and Recovery

The only way to permanently protect your PC from malware is to disconnect it from the Internet and never permit any potentially infected software to touch your precious computer.

Dealing with Malware

You can deal with malware in several ways: anti-malware programs, training and awareness, patch/update management, and remediation.

Anti-Malware Programs

An **anti-malware program** such as a classic **antivirus program** protects your PC in two ways. It can be both sword and shield, working in an active seek-and-destroy mode and in a passive sentry mode. When ordered to seek and destroy, the program scans the computer's boot sector and files for viruses and, if it finds any, presents you with the available options for removing or disabling them. Antivirus programs can also operate as **virus shields** that passively monitor a computer's activity, checking for viruses only when certain events occur, such as a program execution or file download.

Antivirus programs use different techniques to combat different types of viruses. They detect boot sector viruses simply by comparing the drive's boot sector to a standard boot sector. This works because most boot sectors are basically the same. Some antivirus programs make a backup copy of the boot sector. If they detect a

virus, the programs use that backup copy to replace the infected boot sector. Executable viruses are a little more difficult to find because they can be on any file in the drive. To detect executable viruses, the antivirus program uses a library of signatures. A **signature** is the code pattern of a known virus. The antivirus program compares an executable file to its library of signatures. There have been instances where a perfectly clean program coincidentally held a virus signature. Usually the antivirus program's creator provides a patch to prevent further alarms.