Chapter 8: Applied Networking

IT Essentials v6.0

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Chapter 8 - Sections & Objectives

- 8.1 Computer to Network Connection
  - Connect a computer to wired and wireless networks.
- 8.2 ISP Connection Technologies
  - Explain the purpose and characteristics of ISP connection technologies.
- 8.3 Internet Technologies
  - Explain Cloud concepts and networked-host services.
- 8.4 Common Preventive Maintenance Techniques Used for Networks
  - Explain how to perform preventive maintenance on networks using common techniques.
- 8.5 Basic Troubleshooting Process for Networks
  - Explain how to troubleshoot networks.
- 8.6 Chapter Summary

8.1 Computer to Network Connection

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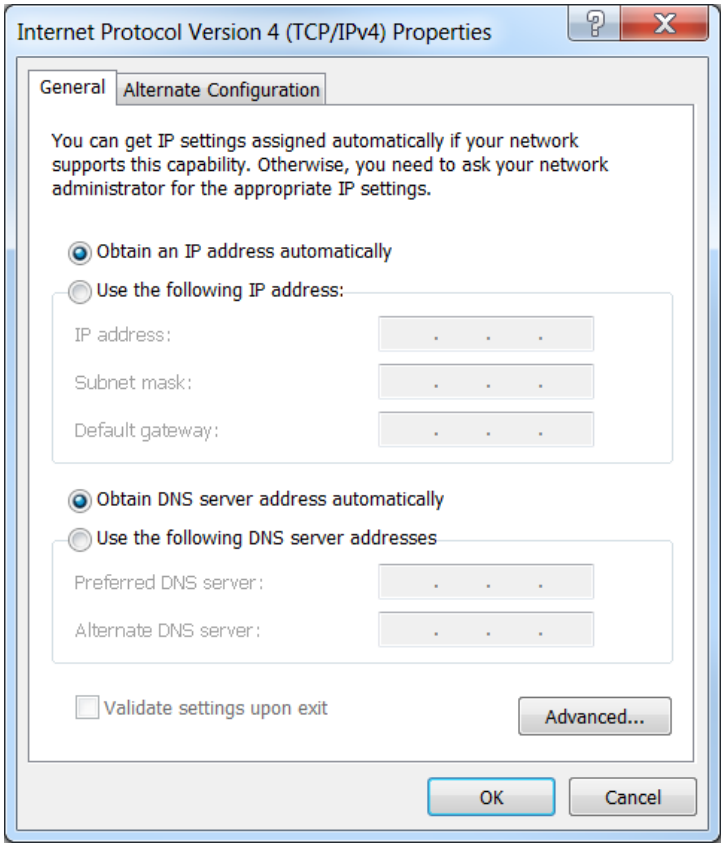
Networking Cards

- A wired or wireless network interface card (NIC) is required to connect to the network.
- After it is installed, IP settings must be configured either manually or dynamically.
- You can also configure advanced settings, such as speed, duplex, Wake on LAN, and quality of service (QoS).



Selecting a NIC

- Most network interfaces for desktop computers are either integrated into the motherboard or are an expansion card that fits into an expansion slot.
- Most laptop network interfaces are either integrated into the motherboard or fit into a PC Card or ExpressBus expansion slot.
- USB network adapters plug into a USB port and can be used with both desktops and laptops.
- Most NICs will have two LEDs:
  - Indicates the presence of a connection
  - Indicates that data transfer activity is present

Install or Update a NIC Driver

- Manufacturers publish new driver software for NICs.
  - May enhance the functionality of the NIC.
  - May be needed for operating system compatibility.
- When installing a new driver manually, disable the virus protection and close all applications.
- Select Start > Control Panel > Device Manager
- If a new NIC driver does not perform as expected after it has been installed, the driver can be uninstalled, or rolled back, to the previous driver.

Configure the NIC

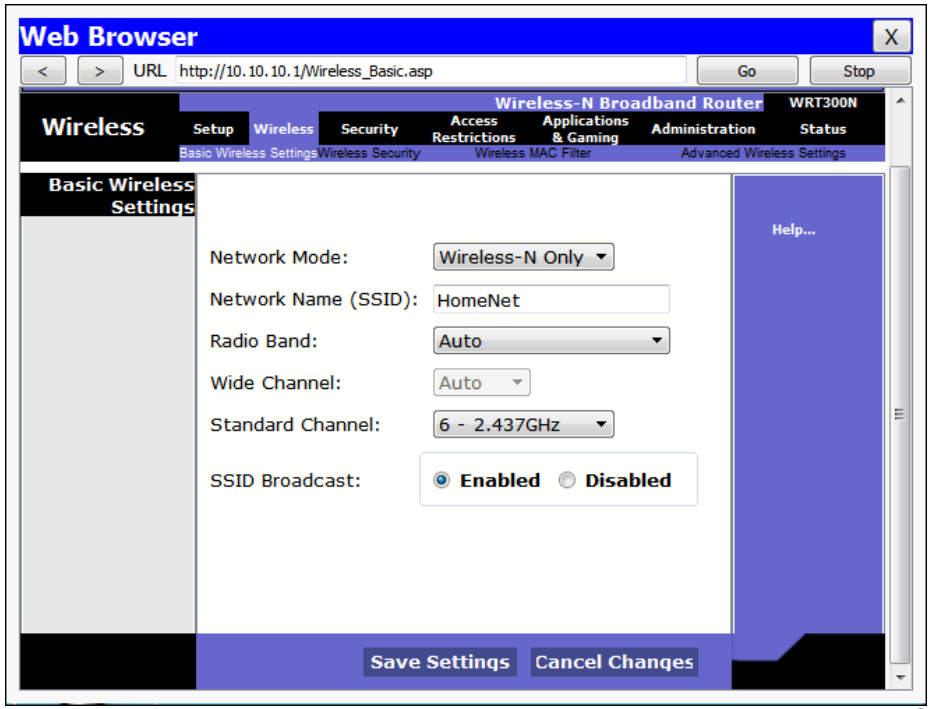
- Every NIC must be configured with the following information:
  - Protocols
  - IP address
  - MAC address
- Alternate IP configuration in Windows simplifies moving between a network that requires using DHCP and a network that uses static IP settings. Windows uses the alternate IP configuration assigned to the NIC if no access to DHCP
- **Network Profiles** are used to provide an easy way to configure or apply network functions based on the type of network to be joined.

Advanced NIC Settings

- **Duplex and Speed**
  - Duplex and speed settings for a NIC can slow down data transfer rates on a computer if they are not matched with the device to which they are connected.
- **Wake on LAN**
  - WoL settings are used to wake up a networked computer from a very low power mode state.
- **Quality of Service**
  - QoS, also called 802.1q QoS, is a variety of techniques that control the flow of network traffic, improve transmission speeds, and improve real-time communications traffic.

Wireless and Wired Router Configurations

- To connect to a network, attach a straight-through Ethernet cable to the NIC port.
- The other end connects to a router or to a telecommunications port that is wired so that data will reach the router.
- For wireless connections, configure the router with the following:
  - Network Mode (set the 802.11 standard)
  - Network Name (SSID)
  - Channel (important when there are multiple APs in the network)
  - Wireless Security (should be WPA2)



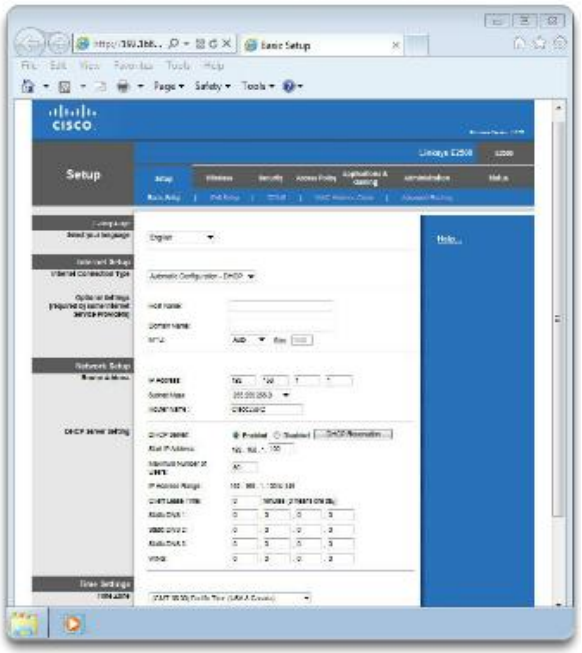
Connecting to the Router

- After connecting the network cable, activity should be verified by looking at the LEDs.
- Set the network location.
- Log into the router via web browser using 192.168.0.1.
  - This is the factory default on many routers.

Basic Router Setup

- It is good practice to change the following default settings:
  - Router Name
  - Default IP address and network
  - Default password
  - SSID name
  - Wireless password
  - Strong encryption and authentication
  - Network Device Access Permissions
  - Basic QoS

E2500 Router Setup Page



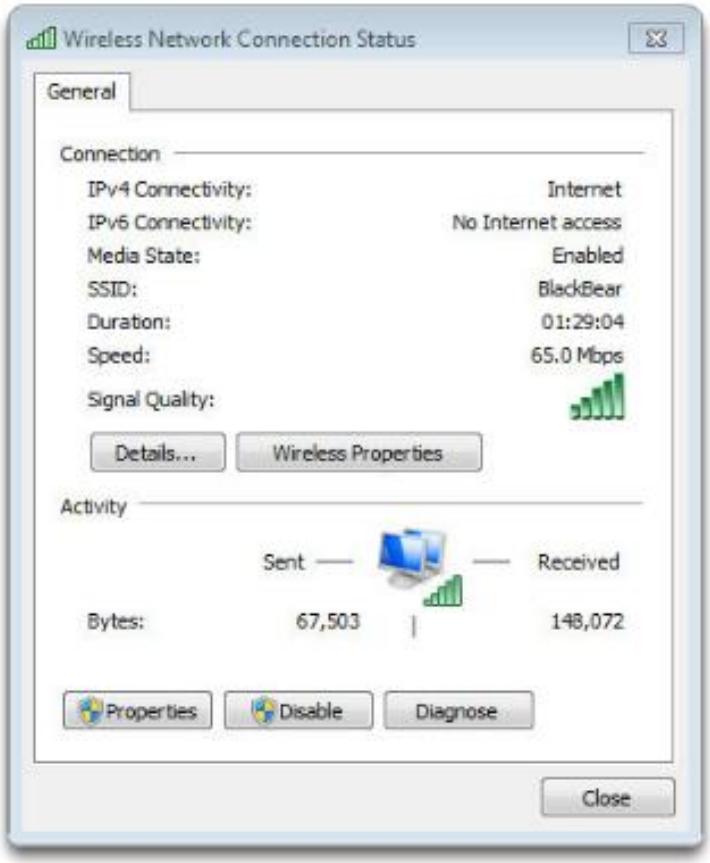
Basic Wireless Settings

- Configure basic settings to secure and increase the speed of the wireless network:
  - **Network mode** - A mixed-mode allows 802.11b, 802.11g, and 802.11n devices.
  - **Service Set Identifier (SSID)** - The name of the wireless network.
  - **Channel** - 1, 6 and 11 do not overlap and should be used to avoid interference from other nearby wireless devices. Use one of these three channels for best results.
  - Wireless security modes
    - **Wired Equivalent Privacy (WEP)**
    - **Temporal Key Integrity Protocol (TKIP)**
    - **Advanced Encryption Standard (AES)**
    - **Wi-Fi Protected Access (WPA)**
    - **Wi-Fi Protected Access 2 (WPA2)**

Testing Connectivity

- Use Windows GUI

Wireless Network Connection Status Window

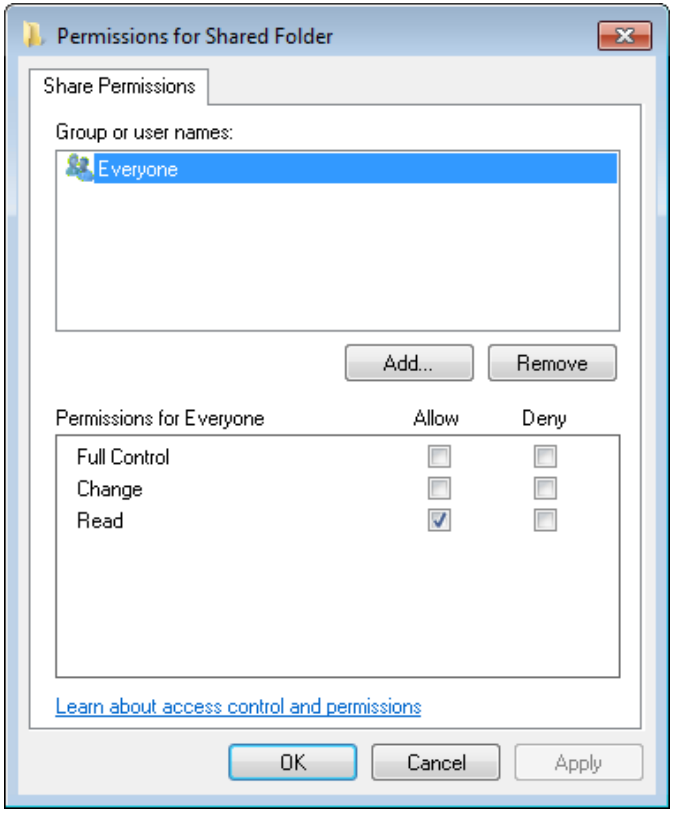


Testing Connectivity

- Using Windows CLI
  - **Ipconfig –** displays basic configuration for all network adapters.
  - **Ping –** tests basic connectivity between devices.
  - **Net commands –** manage network computers, servers, and resources.
  - **Tracert –** trace the routes that packets take from your computer to a destination host.
  - **Nslookup –** tests and troubleshoots DNS servers.

Network Sharing

- All Windows computers on a network must be part of either a domain or a workgroup.
- Before computers can share resources, they must share the same domain name or workgroup name.
- Mapping a local drive is a useful way to access a single file, specific folders, or an entire drive between different operating systems over a network.
- Determine which resources will be shared over the network and the type of permissions users will have to the resources.
  - Read - user can view data in files and run programs
  - Change - user can add files and subfolders, change the data in files, and delete subfolders and files
  - Full Control - user can change permissions of files and folders



Sharing Resources in Windows 7 and Up

- Sharing and Discovery, located in the Network and Sharing Center, manages the settings for a home network.
  - Network discovery
  - File sharing
  - Public folder sharing
  - Printer sharing
  - Password protected sharing
  - Media sharing
- Access by using the following path:
- Start > Control Panel > Network and Sharing Center

Network Shares and Drive Mapping

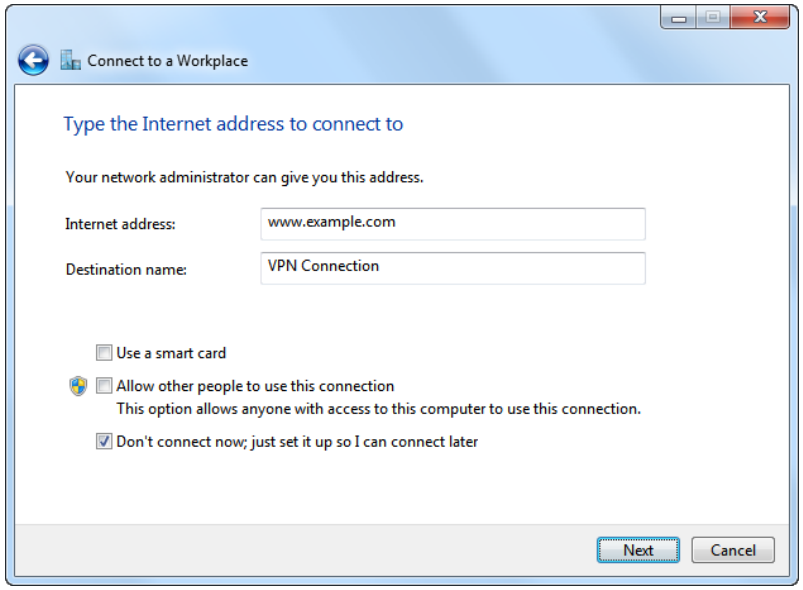
- Mapping a drive, which is done by assigning a letter (A to Z) to the resource on a remote drive, allows you to use the remote drive as if it was a local drive.
- The following are the permissions that can be assigned to the file or folder
  - **Read –** user can view and run program files
  - **Change –** In addition to Read permissions, the user can add files and subfolders, change the data in files, and delete subfolders and files
  - **Full Control** - In addition to Change and Read permissions, the user can change the permission of files and folders in an NTFS partition and take ownership of files and folders.

Remote Connections

- **Remote Desktop** allows technicians to view and control a computer from a remote location.
- **Remote Assistance** allows technicians to assist customers with problems from a remote location.

Virtual Private Network (VPN)

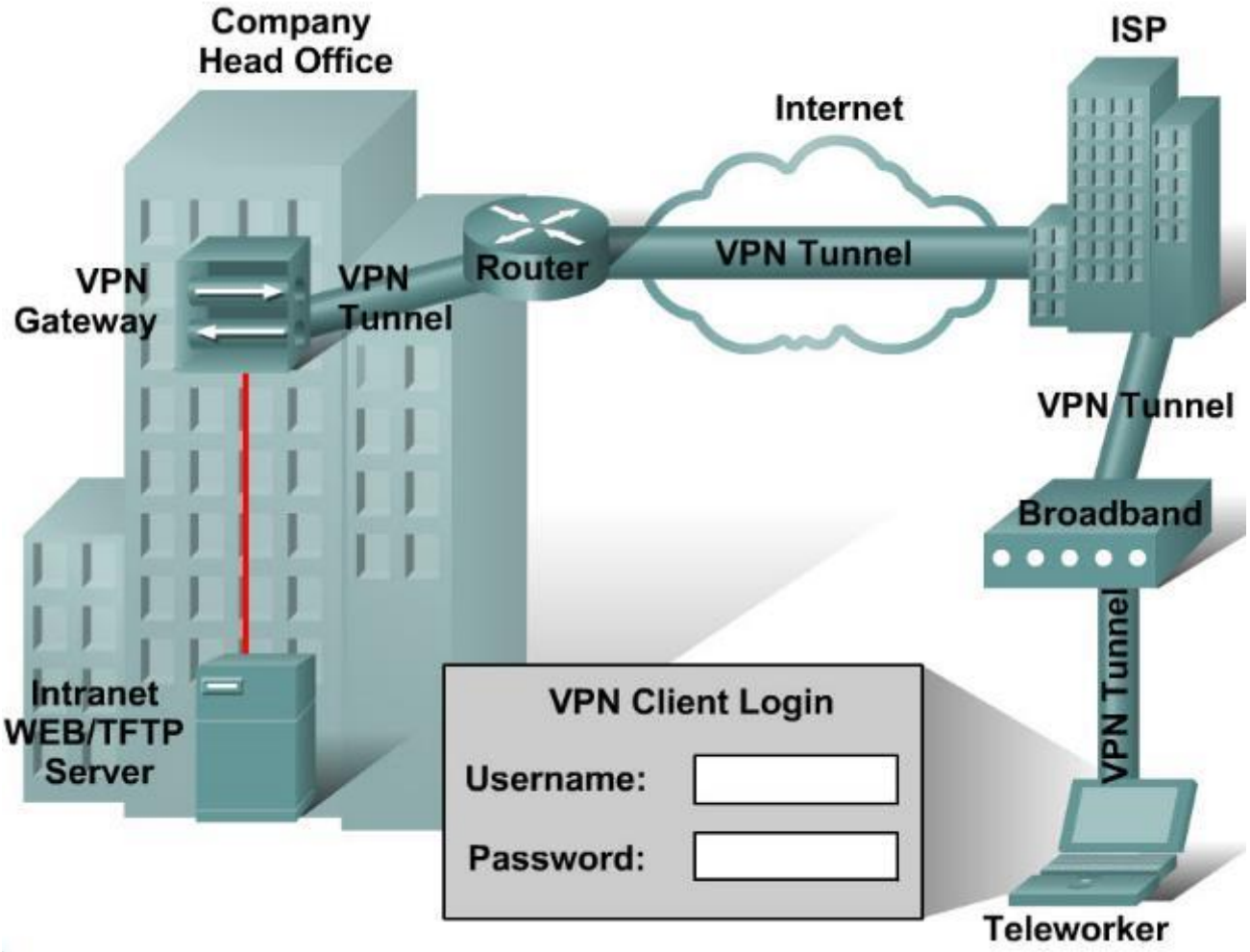
- **Virtual Private Network (VPN) –** a private network that connects remote sites or users together over a public network, like the internet.
- When connected via the VPN, users have access to all services and resources as if they were physically connected to their corporate LAN.



- Remote-access users must install the VPN client software which encrypts data before sending it over the Internet.
- VPN gateways establish, manage, and control VPN connections (also known as VPN tunnels).
- Secures confidential data when connecting to business services over unsecured connections.

Virtual Private Network (VPN)

- A Virtual Private Network (VPN) is a private network that uses a public network, like the Internet, to connect remote sites or users together



8.2 ISP Connection Technologies

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Internet Protocols

- Different applications have different transport reliability requirements
- TCP/IP provides two transport layer protocols:
  - **Transmission Control Protocol (TCP)**
    - Provides reliable delivery ensuring that all of the data arrives at the destination.
    - Uses acknowledged delivery and other processes to ensure delivery
    - Makes larger demands on the network – more overhead
  - **User Datagram Protocol (UDP)**
    - Provides just the basic functions for delivery – no reliability (datagrams are just sent)
    - Less overhead
    - Fewer delays in transmission

Internet Protocols

- TCP or UDP ???
  - There is a trade-off between the value of reliability and the burden it places on the network.
  - Application developers choose the transport protocol based on the requirements of their applications.
  - Port numbers - used by TCP and UDP to differentiate between applications and communication streams.
  - Checksum - checked to give assurance that data is not corrupted.

TCP and UDP Protocols and Ports

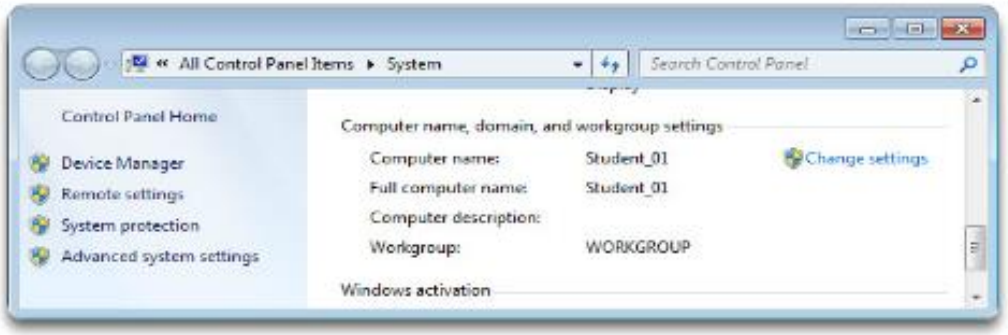
- A port is a numeric identifier used to keep track of specific conversations. Every message that a host sends contains both a source and destination port.

Common Network Protocols and Ports

Protocol	Port	Description
TCP/IP	NA	A suite of protocols used to transport data on the Internet
NetBEUI/ NetBIOS	137, 139, 150	A small, fast protocol designed for a workgroup network that requires no connection to the Internet
HTTP	80	A communication protocol that establishes a request/response connection on the Internet
HTTPS	443	Uses authentication and encryption to secure data as it travels between the client and Web server
FTP	20/21	Provides services for file transfer and manipulation
SSH	22	Securely connects to a remote network device
Telnet	23	Connects to a remote network device
POP3	110	Downloads email messages from an email server
IMAP	143	Downloads email messages from an email server
SMTP	25	Sends mail in a TCP/IP network

Domain and Workgroup

- **Domain** - group of computers and electronic devices with a common set of rules and procedures administered as a unit.
- **Workgroup** - collection of workstations and servers on a LAN that are designed to communicate and exchange data with one another.



Windows 7 Homegroup

- Windows 7 computers that belong to the same workgroup can also belong to a homegroup.
- There can only be one homegroup per workgroup on a network.
- Computers can only be a member of one homegroup at a time.
- Homegroups allow for easy sharing of resources between members.
- The homegroup option is not available in Windows Vista and earlier.
- A standard user account with a network location profile of Home will allow a user to become a member of a homegroup.

Digital Subscriber Line (DSL)

- An "always-on" technology; there is no need to dial up each time to connect to the Internet.
- Uses the existing copper telephone lines to provide high-speed data communication between end users and telephone companies.
- Asymmetric DSL (ADSL) is currently the most commonly used DSL technology.
  - Has a fast downstream speed, up to 48 Mbps.
  - Upload rate of ADSL is slower.
  - Not the best solution for hosting a web server of FTP server.

DSL Types

Type	Description
ADSL	Asymmetric DSL is most common. Downstream speed from 384 Kbps to 6 Mbps. Upstream speeds lower than downstream speeds.
HDSL	High Data Rate DSL provides equal bandwidth in both directions.
SDSL	Symmetric DSL provides the same speed, up to 3 Mbps, for uploads and downloads.
VDSL	Very High Data Rate DSL is capable of bandwidths between 13 and 52 Mbps downstream, and 16 Mbps upstream.
IDSL	ISDN DSL is DSL over ISDN lines. Uses ordinary phone lines. Requires ISDN adapters.

Line of Sight Wireless Internet Services

- Line of sight wireless Internet is an always-on service that uses radio signals for transmitting Internet access.
- Radio signals are sent from a tower to the receiver that the customer connects to a computer or network device.
- A clear path between the transmission tower and customer is required. The tower may connect to other towers or directly to an Internet backbone connection.
- The distance the radio signal can travel and still be strong enough to provide a clear signal depends on the frequency of the signal. Lower frequency of 900 MHz can travel up to 40 miles (65 km), while a higher frequency of 5.7 GHz can only travel 2 miles (3 km).
- Extreme weather condition, trees, and tall buildings can affect signal strength and performance.

WiMAX

- **Worldwide Interoperability for Microwave Access (WiMAX)** - 4G broadband, high-speed, mobile Internet access for mobile devices.
- IEEE 802.16e
- Download speeds up to 70 Mb/s and distances up to 30 miles.
- Uses low wavelength transmission, between 2 GHz to 11 GHz.
- **Fixed WiMAX** - A point-to-point or point-to-multipoint service with speeds up to 72 Mb/s and a range of 30 miles (50 km).
- **Mobile WiMAX** - A mobile service, like Wi-Fi, but with higher speeds and a longer transmission range.

Other Broadband Technologies

- **Cellular** – enables the transfer of voice, video, and data.
  - Recommend connection when people need access the Internet from many different locations.
  - 3G - Data speeds between 144 Kbs and 2 Mbs
  - 4G - Data speeds from 5.8 Mbs and up
- **Cable** - uses coaxial cable lines originally designed to carry cable television, a cable modem connects your computer to the cable company.
  - Capable of the fast transfer rates
- **Satellite** - uses a satellite dish for two-way communication.
- **Fiber Broadband** - provides the fastest connection speeds and bandwidth.

Selecting an ISP

- Four main considerations:
  - Cost
  - Speed
  - Reliability
  - Availability

Type	Advantages	Disadvantages	Speed
POTS	Widely available	Very slow speeds cannot receive phone calls while connected	MAX 56 kbps
ISDN	Higher speeds than POTS	Still much slower than other broadband technologies	BRI - up to 128 kbps PRI - up to 2.048 Mb/s
DSL	Low cost	Distance from CO impacts speed	24 kbps - 100 Mb/s
Cable	Very high speed	Slow upload speeds	27 kbps - 160 Mb/s
Satellite	Available where DSL and cable are not	More expensive than other broadband technologies, and it is susceptible to weather conditions	9 kbps - 24 Mb/s
Cellular	Available to mobile users	Not accessible every where	20 kbps and up depending on the technology used

8.3 Internet Technologies

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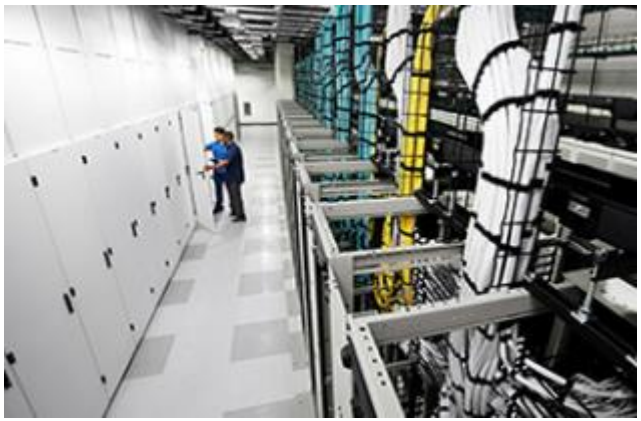
Data Centers and Cloud Computing

- Data center is a data storage and processing facility run by an in-house IT department or leased offsite.
- Cloud computing is an off-premise service that offers on-demand access to a shared pool of configurable computing resources.
- The three main Cloud services models are:
  - **Software as a Service (SaaS)** – best when an organization that does not have the technical knowledge to host and maintain applications at their local site.
  - **Platform as a Service (PaaS)**
  - **Infrastructure as a Service (IaaS)**

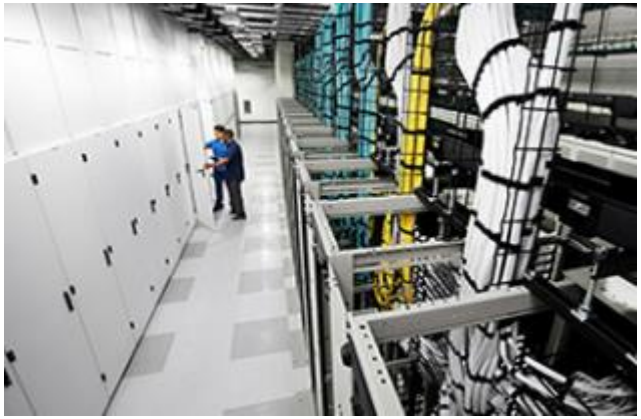
Data Centers and Cloud Computing

- Advantages of cloud:
  - The company only needs to pay for the amount of processing and storage capacity that it uses.
  - The company can increase processing and storage capacity as needed and then decrease capacity when it is no longer needed.
  - As the amount of data that the company uses increases, it becomes impractical for the data to be stored and processed in a single-tenant data center.



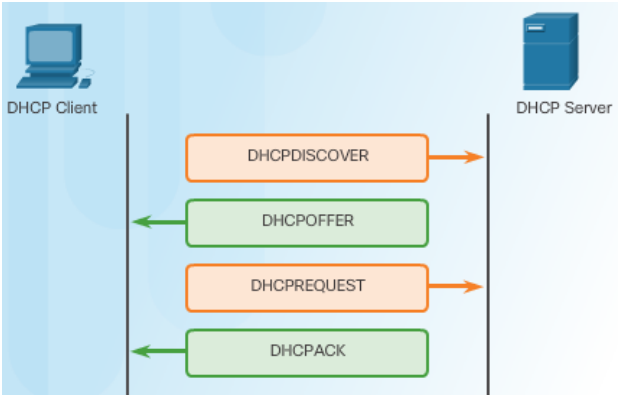
Data Centers and Cloud Computing

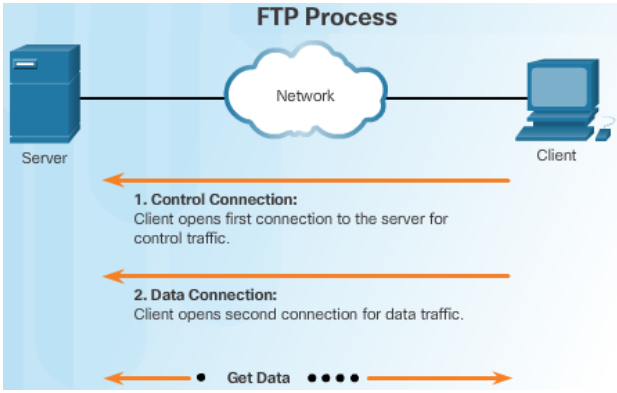
- The four Cloud deployment models are:
  - **Community Cloud** – built to meet a specific need
  - **Public Cloud** – services made available to the general population
  - **Hybrid Cloud** – made up of two or more clouds connected via a single architecture
  - **Private Cloud** – intended for a specific organization or entity, such as the government



Networked Host Services

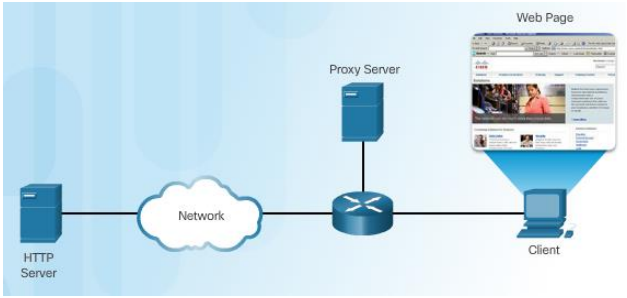
- Hosts need a variety of services to securely access resources on the network and the Internet.
  - **Dynamic Host Configuration Protocol (DHCP)** dynamically assigns IP addressing information to hosts. (first service used on the PC.
  - **Domain Name Service (DNS)** is the method computers use to translate domain names into IP addresses.
  - Hypertext Transfer Protocol (HTTP) or the secure HTTP (HTTPS) are used by hosts to access web resources
  - **File Transfer Protocol (FTP)** allows hosts to transfer data between a client and a server. Secure file transfer options include File Transfer Protocol Secure (FTPS), SSH File Transfer Protocol (SFTP), and Secure Copy (SCP)
  - **Simple Mail Transfer Protocol (SMTP), Post Office Protocol (POP),** and **Internet Message Access Protocol (IMAP)** are the protocols hosts used to send and receive email.

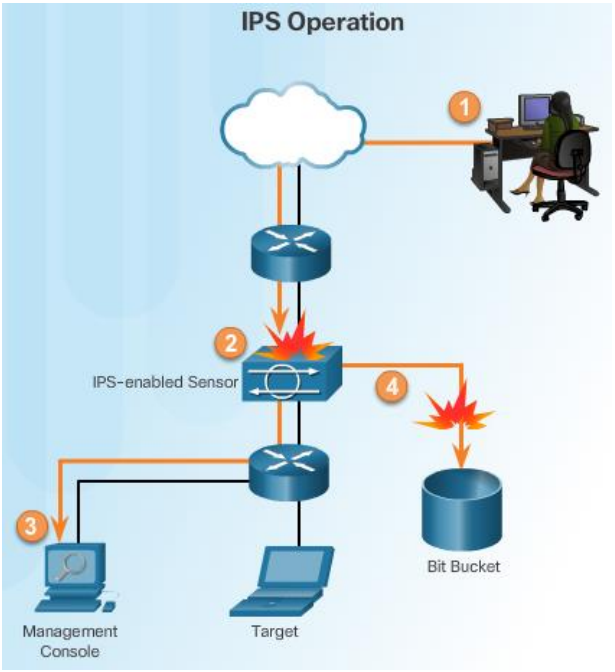




Networked Host Services (cont.)

- Hosts need a variety of services to securely access resources on the network and the Internet.
  - **Print servers** enable multiple computer users to access a single printer
  - **Proxy servers** are popularly used to act as storage or cache for web pages that are frequently accessed by hosts on the internal network.
  - **AAA** is a way to control who is permitted to access a network (authenticate), what they can do while they are there (authorize), and track what actions they perform while accessing the network (accounting).
  - **Intrusion Detection Systems (IDSs)** passively monitor traffic on the network while Intrusion Prevention Systems (IPSs) can detect and immediately address a network problem.
  - **Universal Threat Management (UTM)** include all the functionality of an IDS/IPS as well as stateful firewall services.





Network Devices

Network-attached storage (NAS)

- Consists of one or more hard drives, an Ethernet connection, and an embedded operating system
- The NAS device connects to the network, allowing users on the network to access and share files, stream media, and back up data to a central location

Network Devices

- **VoIP phones** - carry telephone calls over the data networks and Internet.
- **Hardware firewalls** - use various techniques for determining what is permitted or denied access to a network segment.
- **Internet appliance** – web TV, game consoles, Blu-ray players etc.
- **Purchasing Authentic Networking Devices** - Computer and network problems can be related to counterfeit components.

Physical Media

Cable System	Speed	Cables and Connectors	Maximum Cable Length
10Base2 (ThinNet)	10 Mbps	Coaxial uses a BNC or F connector. RG-6 cable	185 Meters (607 ft)
10Base5 (ThickNet)	10Mbps	Coaxial uses an AUI 15-pin D-shaped connector	500 Meters (1640 ft)
10BaseT (Twisted-Pair)	10 Mbps	UTP uses an RJ-45 connector	100 Meters (328 ft)
100BaseTX (Twisted-Pair)	100 Mbps	UTP uses an RJ-45 connector	100 Meters (328 ft)
10BaseF 10BaseFL 100BaseFL 100BaseFX 1000BaseFX (Fiber-Optic)	10 Mbps, 100 Mbps, or 1 Gbps	Fiber-Optic cable uses an ST, SC, LC connector	Multi-Mode up to 2000 Meters (6562 ft) Single-Mode up to 3000 Meters (9842 ft)

8.4 Common Preventive Maintenance Techniques Used for Networks

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Network Maintenance

- Preventive maintenance for networks includes the condition of cables, network devices, servers, and computers to make sure that they are kept clean and are in good working order.
- You should develop a plan to perform scheduled maintenance and cleaning at regular intervals.
- Inform the network administrator if you notice any of these issues to prevent unnecessary network downtime.
- Performing preventative maintenance at regular intervals reduces in network downtime.

Preventive Maintenance for Networks

- Common preventive maintenance techniques should continually be performed for a network to operate properly.
  - Keep network rooms clean and change air filters often.
  - Checking the various components of a network for wear.
  - Check the condition of network/patch cables because they are often moved, unplugged, and kicked.
  - Label the cables to save troubleshooting time later. Refer to wiring diagrams and always follow your company's cable labeling guidelines.
  - The **uninterruptible power supply (UPS)** should be tested to ensure that you have power in the case of an outage.
- Network maintenance also includes educating users on IT policies and procedures

8.5 Basic Troubleshooting Process for Networks

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Troubleshooting for Networks

Step 1 Identify the problem
Step 2 Establish a theory of probable causes
Step 3 Test the Theory to Determine cause
Step 4 Establish a Plan of Action to Resolve the Problem and Implement the Solution
Step 5 Verify Full System Functionality and Implement Preventative Measures
Step 6 Document Findings, Actions, and Outcomes

Step 1- Identify the Problem

- System Information
  - Manufacturer, model, OS, network environment, connection type
- Open-ended questions
  - What problems are you experiencing with your computer or network device?
  - What software has been changed recently on your computer?
  - What were you doing when the problem was identified?
  - What error messages have you received?
  - What type of network connection is the computer using?
- Closed-ended questions
  - Has anyone else used your computer recently?
  - Can you see any shared files or printers?
  - Have you changed your password recently?
  - Can you access the Internet?
  - Are you currently logged into the network?

Step 2 - Establish a Theory of Probable Causes

- Create a list of the most common reasons why the error would occur and list the easiest or most obvious causes at the top with the more complex causes at the bottom.
  - Loose cable connections
  - Improperly installed NIC
  - ISP is down
  - Low wireless signal strength
  - Invalid IP address

Step 3 - Test the Theory to Determine cause

- Testing your theories of probable causes one at a time, starting with the quickest and easiest.
  - Check that all cables are connected to the proper locations.
  - Disconnect and then reconnect cables and connectors.
  - Reboot the computer or network device.
  - Login as a different user.
  - Repair or re-enable the network connection.
  - Contact the network administrator.
  - Ping your default gateway.
  - Access remote web pages.
- If exact cause of the problem has not been determined after you have tested all your theories, establish a new theory of probable causes and test it.

Step 4 - Establish a Plan of Action to Resolve the Problem and Implement the Solution

- Sometimes quick procedures can determine the exact cause of the problem or even correct the problem.
- If a quick procedure does not correct the problem, you might need to research the problem further to establish the exact cause.
- Divide larger problems into smaller problems that can be analyzed and solved individually.

Step 4: Establish a Plan of Action to Resolve the Problem and Implement the Solution	
If no solution is achieved in the previous step, further research is needed to implement the solution	• Helpdesk repair logs • Other technicians • Manufacturer FAQ websites • Technical websites • News groups • Computer manuals • Device manuals • Online forums • Internet search

Step 5 - Verify Full System Functionality and Implement Preventative Measures

- Verifying full system functionality and implement any preventive measures if needed.
  - **Ipconfig /all** is used to display IP Address information.
  - **Ping** is used to check network connectivity.
  - **Nslookup** is used to query Internet domain name server.
  - **Tracert** is used to determine the route taken by packets when they travel across the network.
  - **Net View** is used to display a list of computers in a workgroup.
- Have the customer verify the solution and system functionality.

Step 6 - Document Findings, Actions, and Outcomes

- Discuss the solution with the customer.
- Have the customer confirm that the problem has been solved.
- Document the process.
  - Problem description
  - Solution
  - Components used
  - Amount of time spent in solving the problem

Common Problems and Solutions for Networks

- Network problems can be attributed to hardware, software, or configuration issues
- Common networking problems include:
  - Network cables are damaged or unplugged
    - Wrong duplex setting
  - Legitimate users are denied remote access
  - Device lacks sufficient addressing information
    - APIPA address assigned – check the NIC LED lights first and then the DHCP connection.
  - Users cannot access the Internet
    - The target web server is down.
    - DNS service is unavailable on the customer network.
  - User cannot map a drive or share a folder on the network
    - Check **Network Connection Details** in the Windows GUI for the appropriate network connection
  - Wireless issues
    - The wireless router is not broadcasting the SSID
    - The network does not support the wireless protocol in use by the laptop

8.6 Chapter Summary

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Summary

- This chapter introduced the operation of computer networks. The following concepts from this chapter are important to remember:
- Each device must have appropriate addressing in order to access network resources.
- Wired devices are attached to a network using an Ethernet cable. Wireless devices authenticate and associate with a wireless access point.
- Mapping a local drive is a useful way to access a single file, specific folders, or an entire drive between different operating systems over a network.
- VPNs allow private connections over public networks.
- Remote Desktop allows network administrators to remotely control a computer.
- Examples of broadband technologies include DSL, cable, and cellular.
- Data centers are facilities that provide data storage services.
- Cloud computing use data centers to provide cloud services in a variety of deployment models.
- Networked host services include DHCP, DNS, HTTP, FTP, SMTP, proxies, AAA, IPSs, and UTMs.
- Networks require a systematic preventive maintenance and troubleshooting methodology.


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