

Chapter 1: Introduction to Networks

CCNA Routing and Switching
Introduction to Networks v6.0



Chapter 1 - Sections & Objectives

▪ 1.1 Globally Connected

- Explain how multiple networks are used in every day life.
- Explain how networks affect the way we interact, learn, work and play.
- Explain how host devices can be used as clients, servers, or both.

▪ 1.2 LANs, WANs, and the Internet

- Explain how topologies and devices are connected in a small to medium-sized business network.
- Explain the use of network devices..
- Compare the devices and topologies of a LAN to the devices and topologies of a WAN.
- Describe the basic structure of the Internet.
- Explain how LANs and WANs interconnect to the Internet.

▪ 1.3 The Network as a Platform

- Explain the basic characteristics of a network that supports communication in a small to medium-sized business.
- Explain the concept of a converged network.
- Describe the four basic requirements of a reliable network.

Chapter 1 - Sections & Objectives (Cont.)

▪ 1.4 The Changing Network Environment

- Explain trends in networking that will affect the use of networks in small to medium-sized businesses.
- Explain how trends such as BYOD, online collaboration, video, and cloud computing are changing the way we interact.
- Explain how networking technologies are changing the home environment.
- Identify some basic security threats and solutions for both small and large networks.
- Explain why it is important to understand the switching and routing infrastructure of a network.



Router



Wireless Router



PIX Firewall Left



Router with Firewall



Workgroup Switch



Route/Switch Processor



Firewall



Firewall Appliance



Printer



File/
Application Server



PC



Laptop



IP Phone



Satellite



Satellite Dish



Telephone Switch



Hub



Tablet



House



Small Business



Headquarters



Cloud



Internet

Line: Ethernet



Line: Serial



Wireless Connectivity

1.1 Globally Connected

Networks in Our Daily Lives

- Welcome to a world where we are more powerful together, than we ever could be apart. Welcome to the human network.
- The creation and interconnection of robust **data networks** has had a profound effect on communication, and has become the new platform on which modern communications occur.
- In today's world, through the use of networks, we are connected like never before. People with ideas can communicate instantly with others to make those ideas a reality. News events and discoveries are known worldwide in seconds. Individuals can even connect and play games with friends separated by oceans and continents.
- Everyone can connect, share, and make a difference.



Technology Then and Now

- We live in a world we barely imagined 20 years ago. What wouldn't we have without the Internet? What will be possible in the future using the network as the platform? Imagine a world without the Internet. No more Google, YouTube, instant messaging, Facebook, Wikipedia, online gaming, Netflix, iTunes, and easy access to current information. How different would our lives be without all of this?
- In the course of a day, resources that are available through the Internet can help you
 - Post and share your photographs, home videos, and experiences with friends or with the world
 - Access and submit school work
 - Communicate with friends, family, and peers using email, instant messaging, or Internet phone Calls
 - Find the least congested route to your destination, displaying weather and traffic video from webcams
 - Watch videos, movies, or television episodes on demand
 - Play online games with friends
 - Decide what to wear using online current weather conditions
 - Check your bank balance and pay bills electronically



Networking Today

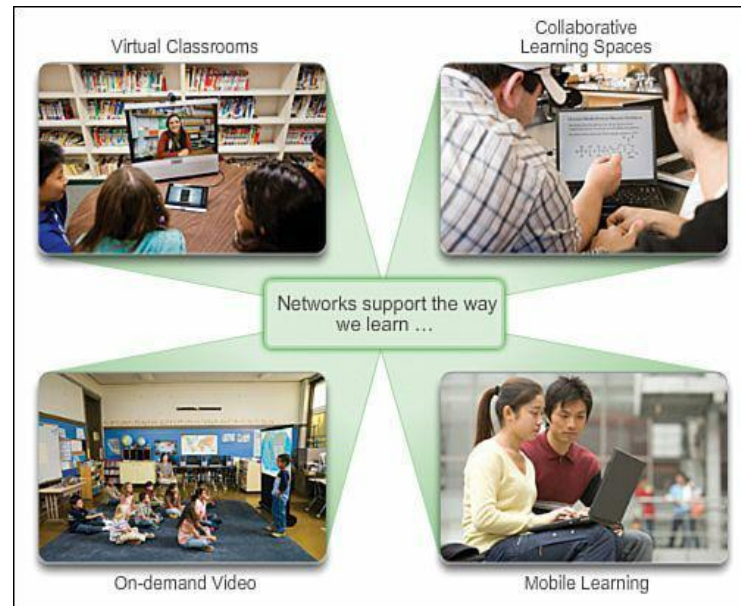
No Boundaries

- Advancements in networking technologies are helping create a world without boundaries.
- The immediate nature of communications over the Internet encourages global communities.
- Cisco refers to the impact of the Internet and networks on people the “human network”.



Networks Support the Way We Learn

- **Networks Support the Way We Communicate (1.1.1.5)**
- Networks eliminate geographic and time-zone boundaries, allowing us to easily communicate with individuals from around the world.
- The globalization of the Internet has ushered in new forms of communication that empower individuals to create information that can be accessed by a global audience.
- Do you remember sitting in a classroom, like this?
- You don't have to be in school anymore to take a class. You don't have to be in a classroom to have a teacher.



Networks Support the Way We Work

- The globalization of the Internet has empowered individuals to create information that can be accessed globally.
- Forms of communication:
 - Texting (instant real-time communication, file transfer, voice and video communication.)
 - Social Media (create and share user-generated content with friends, family, peers)
 - Collaboration Tools (give people the opportunity to work together on shared documents.)
 - Blogs (Weblogs are web pages that are easy to update and edit.)
 - Wikis (web pages that groups of people can edit and view together)
 - Podcasting (audio-based medium that originally enabled people to record audio and convert it for use to a wide audience)
 - Peer-to-peer (P2P) file sharing (allows people to share files with each other without having to store and download them from a central server)

Networks Support the Way We Work

- Networks provide fast, reliable access to business resources regardless of the geographic location of the employee.
- Data networks have evolved into helping support the way we work.
- Online learning opportunities decrease costly and time consuming travel.
- Employee training is becoming more cost effective.
- In the business world, data networks were initially used by businesses to internally record and manage financial information, customer information, and employee payroll systems.
- These business
- networks evolved to enable the transmission of many different types of information services,
- including email, video, messaging, and telephony.

Networking Today

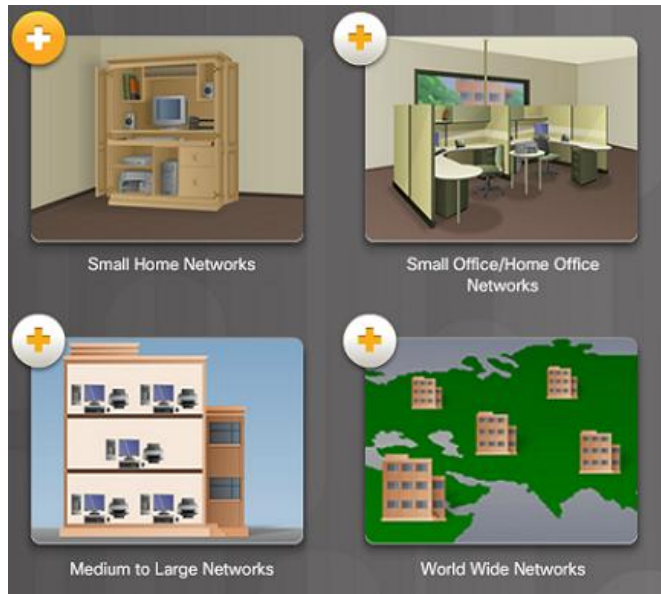
Networks Support the Way We Play

- We listen to music, watch movies, read books, and download material for future offline access.
- Networks allow online gaming in ways that were not possible 20 years ago.
- Offline activities have also been enhanced by networks including global communities for a wide range of hobbies and interests.
- How do you play on the Internet?



Providing Resources in a Network

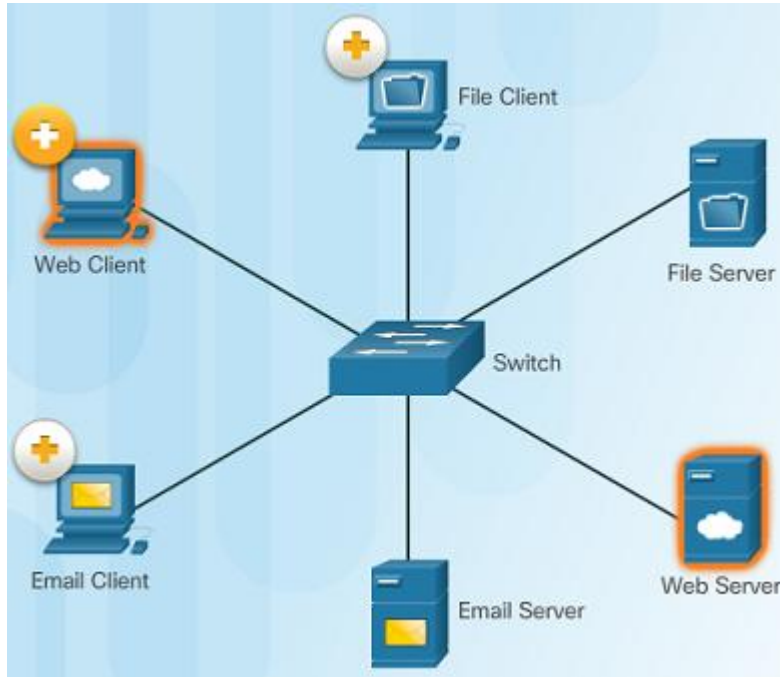
Networks of Many Sizes



- **Small Home Networks** – connect a few computers to each other and the Internet and enable sharing of resources, such as printers, documents, pictures, and music between a few local computers
- **Small Office/Home Office** – enables computer within a home or remote office to connect to a corporate to connect to a corporate network or other centralized resources.
- **Medium to Large Networks** – many locations with hundreds or thousands of interconnected computers and can be used on an even broader scale to allow employees to provide consolidation, storage, and access to information on network servers.
- **World Wide Networks** – connects hundreds of millions of computers world-wide – such as the Internet. It is literally a collection of interconnected private and public networks

Providing Resources in a Network

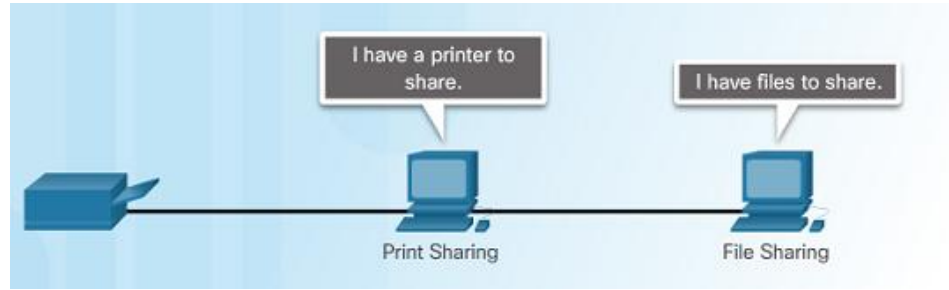
Clients and Servers



- Every computer connected to a network is called a host or end device.
- Servers are computers that provide information to end devices on the network.
 - Email servers
 - Web servers
 - File server
- Clients are computers that send requests to the servers to retrieve information such as a web page from a web server or email from an email server.
 - Internet Browsers (Edge, Firefox, Chrome)
 - MS Outlook Express

Providing Resources in a Network

Peer-to-Peer



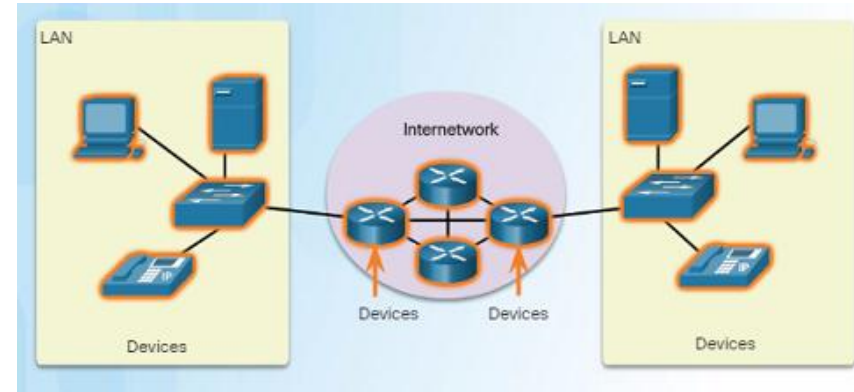
- Client and server software usually run on separate computers.
- However, in small businesses or homes, it is typical for a client to also function as the server. These networks are called peer-to-peer networks.
- These networks can be used for simple tasks such as transferring files and sharing printers.
- Peer-to-peer networks have no centralized administration, are not as secure or scalable as client-server networks,
- Peer-to-peer networking advantages: easy to set up, less complex, and lower cost.
- Disadvantages: no centralized administration, not as secure, not scalable, and slower performance.

1.2 LANs, WANs, and the Internet

Network Components

Overview of Network Components

A network can be as simple as a single cable connecting two computers or as complex as a collection of networks that span the globe.



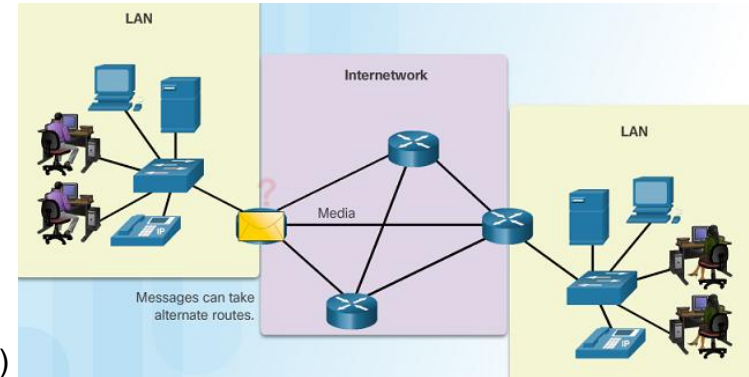
- Network infrastructure contains **three broad categories of network components**:
 - **Devices and Media** are the physical elements, or hardware, of the network. Hardware is often the visible components of the network platform such as a laptop, PC, switch, router, wireless access point, or the cabling used to connect the devices.
 - **Network components** are used to provide services and processes. These are the communication programs, called software, that run on the networked devices.
 - **Services** include many of the common network applications people use every day, like email-hosting services and web-hosting services.

LANs, WANs, and the Internet

Network Components

▪ End Devices

- An end device is where a message originates from or where it is received.
- These devices form the interface between users and the underlying communication network.
- Data originates with an end device, flows through the network, and arrives at an end device
- Some examples of end devices are
 - Computers (work stations, laptops, file servers, web servers)
 - Network printers
 - **VoIP** phones
 - **TelePresence** endpoints
 - Security cameras
 - Mobile handheld devices (such as smartphones, tablets, PDAs, and wireless debit/credit card readers and bar-code scanners)



Intermediary Network Devices

- An intermediary device interconnects end devices in a network. Examples include: switches, wireless access points, routers, and firewalls.
- The management of data as it flows through a network is also the role of an intermediary device including:
 - Regenerate and retransmit data signals.
 - Maintain information about what pathways exist through the network and internetwork.
 - Notify other devices of errors and communication failures.
 - Examples of intermediary network devices are :
 - Network access (switches and wireless access points)
 - Internetworking (routers)
 - Security (firewalls)

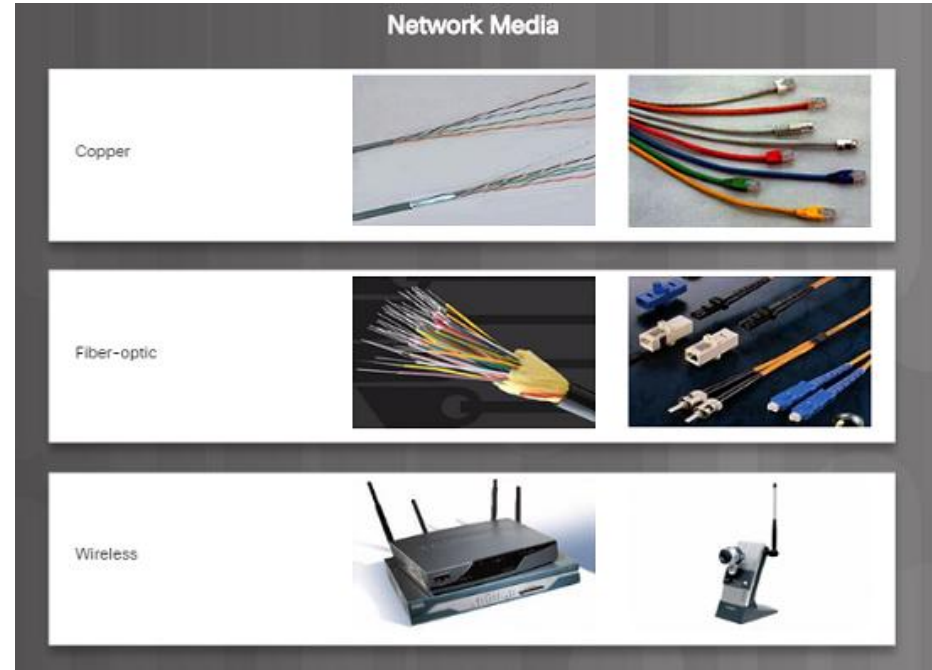
Intermediary
Devices



Network Components

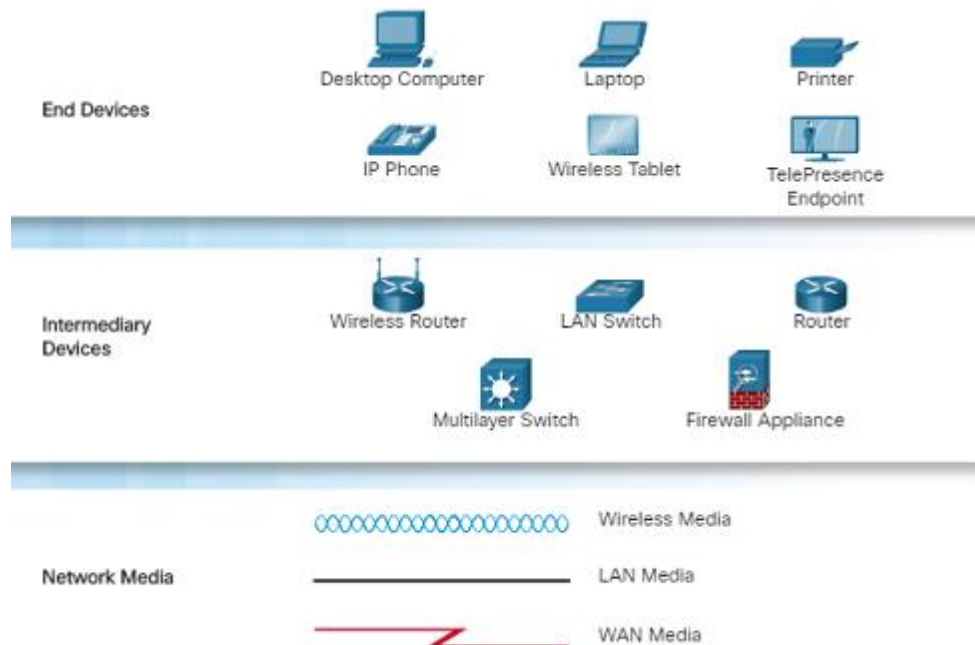
Network Media

- Communication across a network is carried through a medium which allows a message to travel from source to destination.
- Networks typically use three types of media:
 - Metallic wires within cables**, such as copper (the data is encoded into electrical impulses that match specific patterns.)
 - Glass, such as fiber optic cables** (rely on pulses of light, within either infrared or visible light ranges)
 - Wireless transmission** (patterns of electromagnetic waves depict the various bit values)



Network Representations

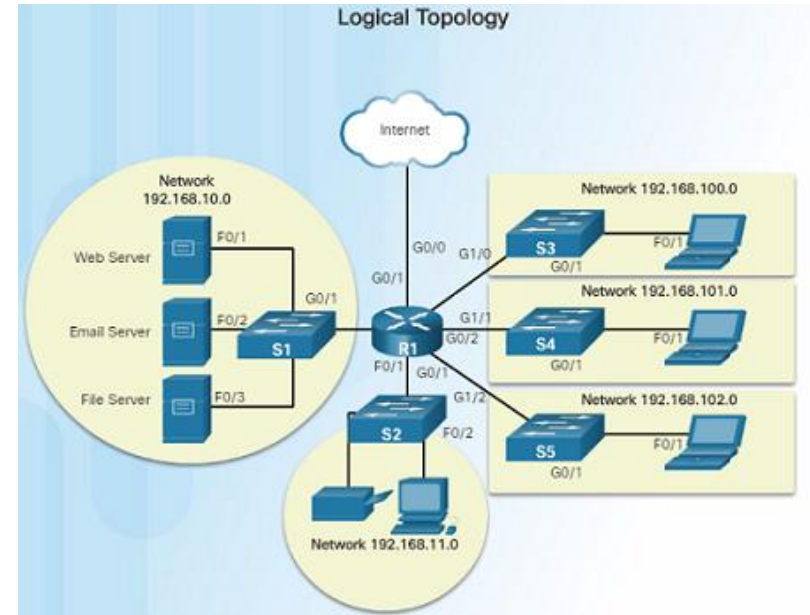
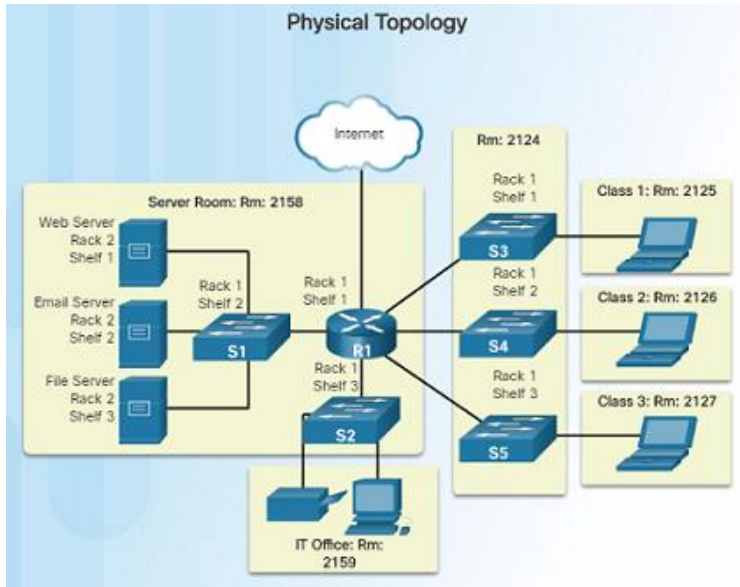
- Network diagrams, often called topology diagrams, use symbols to represent devices within the network.
- In addition to the device representations on the right, it is important to remember and understand the following terms:
 - **Network interface card (NIC)** provides the physical connection to the network at the PC or other host device. The medium connecting the PC to the networking device plugs directly into the NIC.
 - **Physical port:** A connector or outlet on a networking device where the medium is connected to a host or other networking device.
 - **Interface:** Specialized ports on an internetworking device that connect to individual networks. The ports on a router are referred to as *network interfaces*.



Network Components

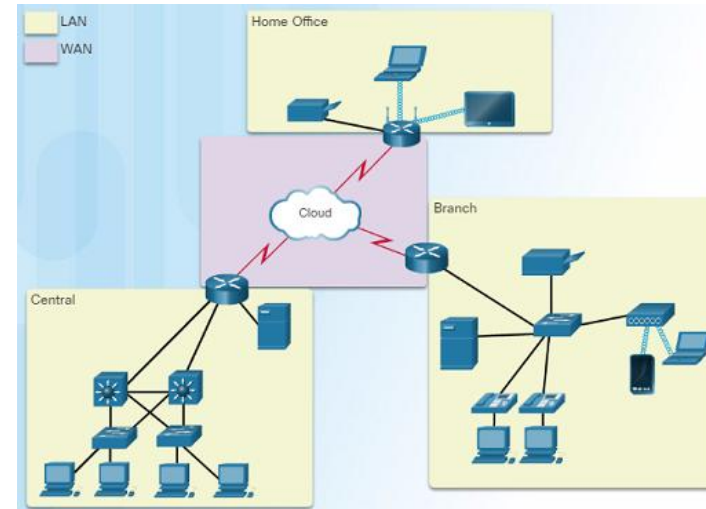
Topology Diagrams

- **Physical topology diagrams** identify the physical location of intermediary devices, configured ports, and cable installation.
- **Logical topology diagrams** identify devices, ports, and IP addressing scheme.



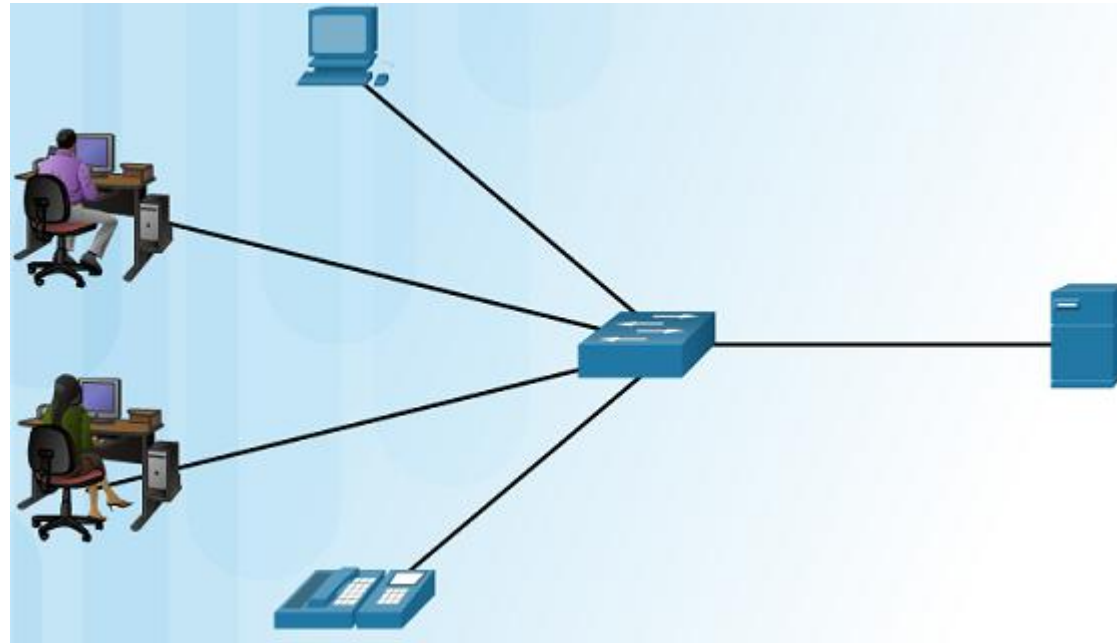
Types of Networks

- Two most common types of networks:
 - Local Area Network (LAN)** – spans a small geographic area owned or operated by an individual or IT department.
 - Wide Area Network (WAN)** – spans a large geographic area typically involving a telecommunications service provider.
- Other types of networks:
 - Metropolitan-area network (MAN):** A network infrastructure that spans a physical area larger than a LAN but smaller than a WAN (for example, a city). MANs are typically operated by a single entity such as a large organization.
 - Wireless LAN (WLAN):** Similar to a LAN but wirelessly interconnects users and endpoints in a small geographical area.
 - Storage-area network (SAN):** A network infrastructure designed to support file servers and provide data storage, retrieval, and replication. It involves high-end servers, multiple disk arrays, and Fibre Channel interconnection technology.



Local Area Networks

- Local-area networks (LAN) are a network infrastructure that spans a small geographical area.



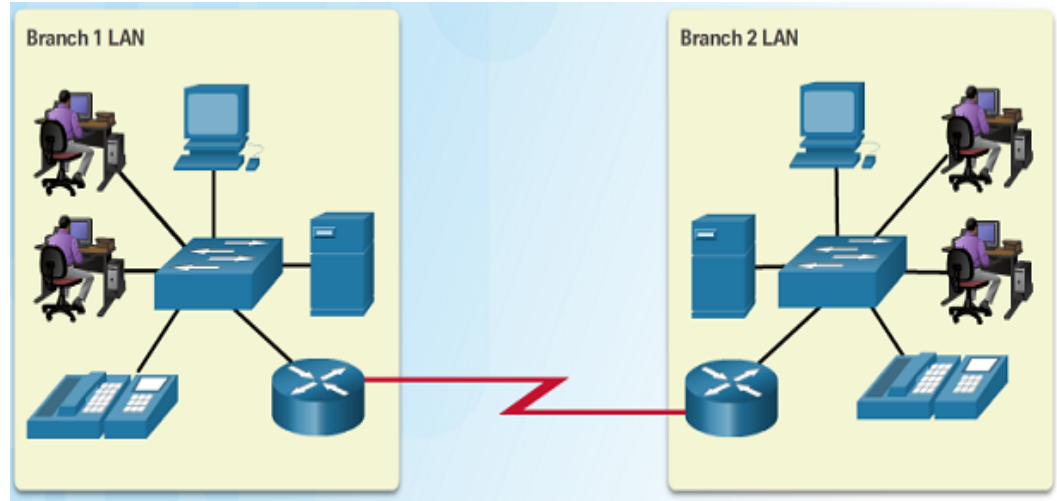
- Three characteristics of LANs:
 - Spans a small geographic area such as a home, school, office building, or campus.
 - Usually administered by a single organization or individual.
 - Provides high speed bandwidth to end and intermediary devices within the network.

Wide Area Networks

- Wide-area networks (WAN) are a network infrastructure that spans a wide geographical area.
- WANs are typically managed by service providers (SP) or Internet service providers (ISP).

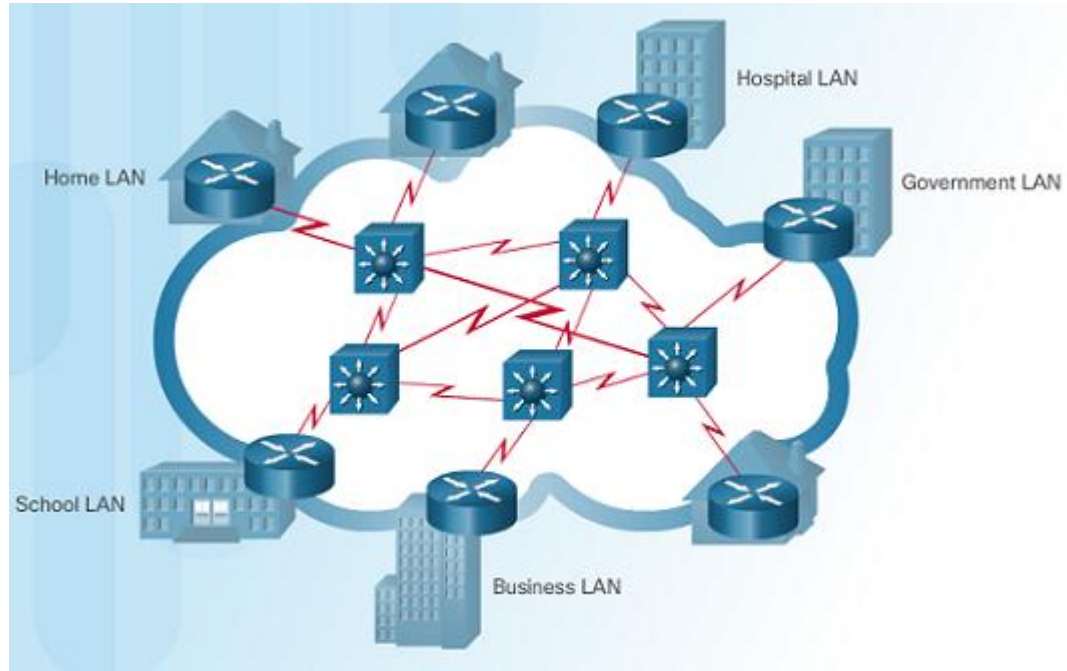
- Three characteristics of WANs:

- WANs interconnect LANs over wide geographical areas such as between cities, states, or countries.
- Usually administered by multiple service providers.
- WANs typically provide slower speed links between LANs.



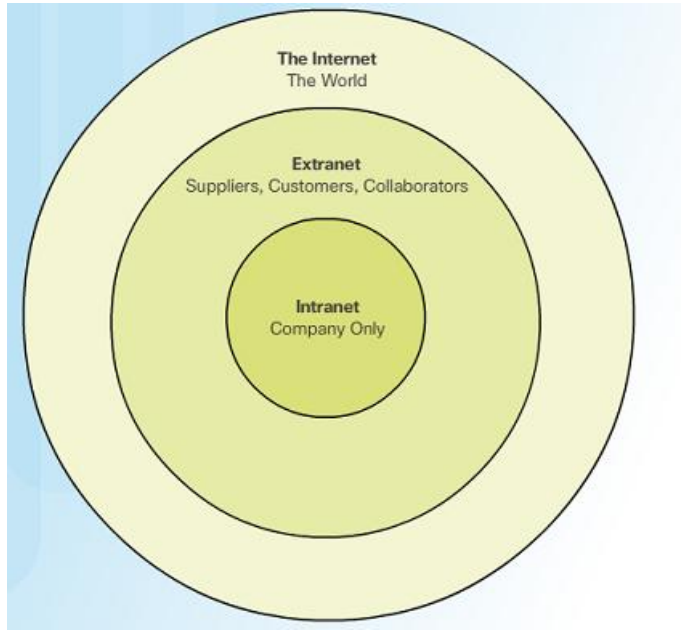
The Internet

- The Internet is a worldwide collection of interconnected LANs and WANs.
- LANs are connected to each other using WANs.
- WANs are then connected to each other using copper wires, fiber optic cables, and wireless transmissions.
- The Internet is not owned by any individual or group, however, the following groups were developed to help maintain structure:
 - Internet Engineering Task Force (IETF)
 - Internet Corporation for Assigned Names and Numbers (ICANN)
 - Internet Architecture Board (IAB)



The Internet, Intranets, and Extranets

Intranets and Extranets



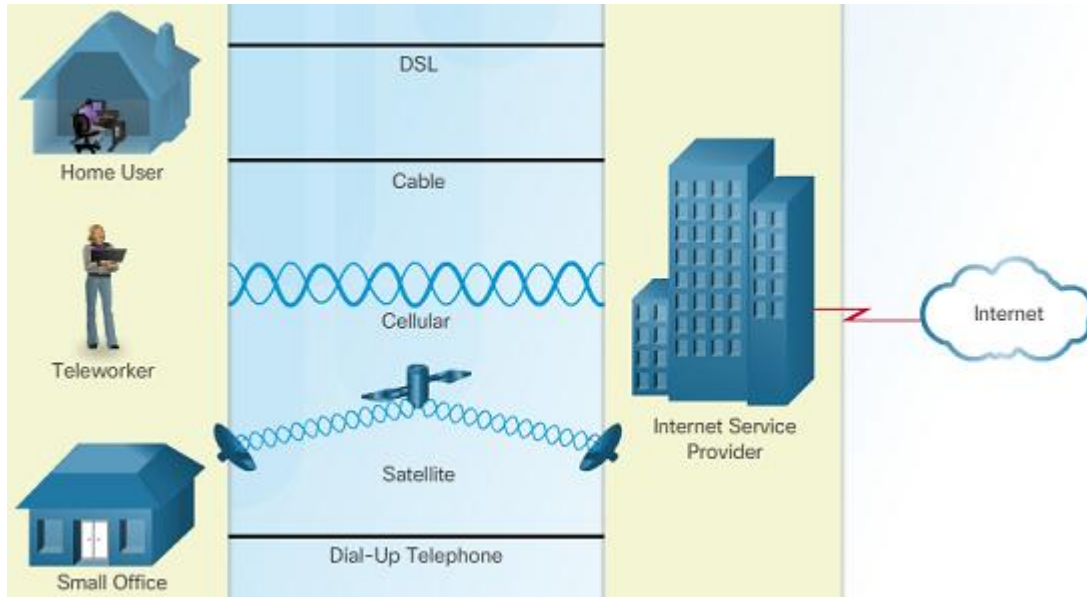
- Unlike the Internet, an intranet refers to a private connection of LANs and WANs that belongs to an organization, and is designed to be accessible only by the organization's members, employees, or others with authorization. Intranets are basically an internet that is usually only accessible from within the organization.
- An organization might use an extranet to provide secure access to their network for individuals who work for a different organization that need access to their data on their network. E.g.
 - A company providing access to outside suppliers/contractors
 - A local office of education providing budget and personnel information to the schools in its district.

Internet Access Technologies



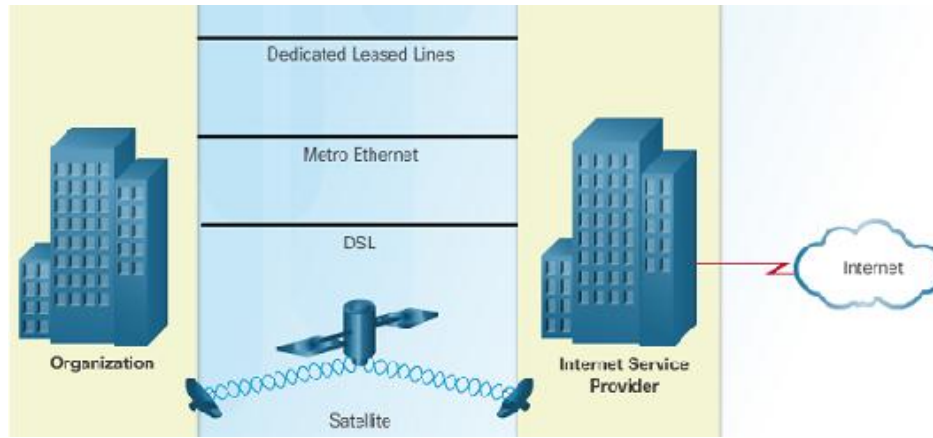
- There are many ways to connect users and organizations to the Internet:
 - Popular services for home users and small offices include broadband cable, broadband digital subscriber line (DSL), wireless WANs, and mobile services.
 - Organizations need faster connections to support IP phones, video conferencing and data center storage.
 - Business-class interconnections are usually provided by service providers (SP) and may include: business DSL, leased lines, and Metro Ethernet.

Home and Small Office Internet Connections



- **Cable** – high bandwidth, always on, Internet connection offered by cable television service providers.
- **DSL** – high bandwidth, always on, Internet connection that runs over a telephone line.
- **Cellular** – uses a cell phone network to connect to the Internet; only available where you can get a cellular signal.
- **Satellite** – major benefit to rural areas without Internet Service Providers.
- **Dial-up telephone** – an inexpensive, low bandwidth option using a modem.

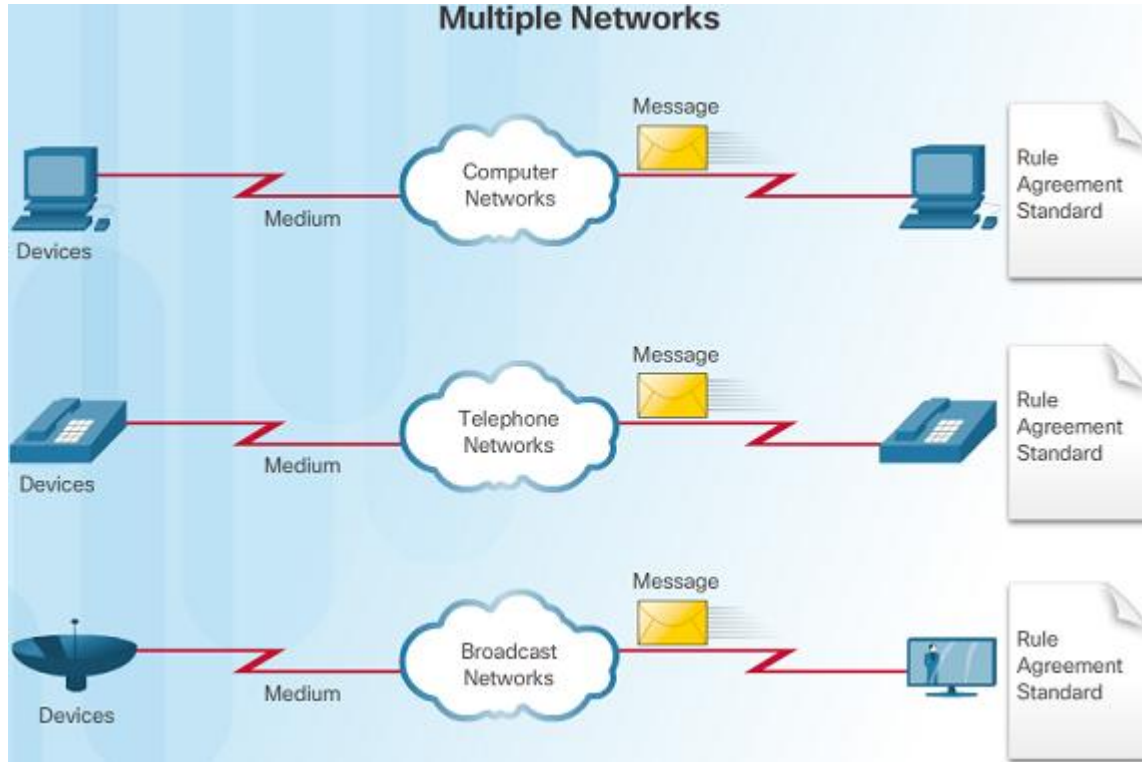
Businesses Internet Connections



- Corporate business connections may require higher bandwidth, dedicated connections, or managed services. Typical connection options for businesses:
 - Dedicated Leased Line** – reserved circuits within the service provider's network that connect distant offices with private voice and/or data networking. Common leased line circuits include T1 (1.54 Mbps) and T3 (44.7 Mbps) / E1 (2 Mbps) and E3 (34 Mbps).
 - Ethernet WAN** – extends LAN access technology into the WAN. over a dedicated copper or fiber connection providing bandwidth speeds of 10 Mbps to 10 Gbps
 - DSL** – Business DSL is available in various formats including Symmetric Digital Subscriber Lines (SDSL) with have downstream rates that range from 1.5 to 9 Mbps
 - Satellite** – can provide a connection when a wired solution is not available.

1.3 The Network as a Platform

Traditional Separate Networks

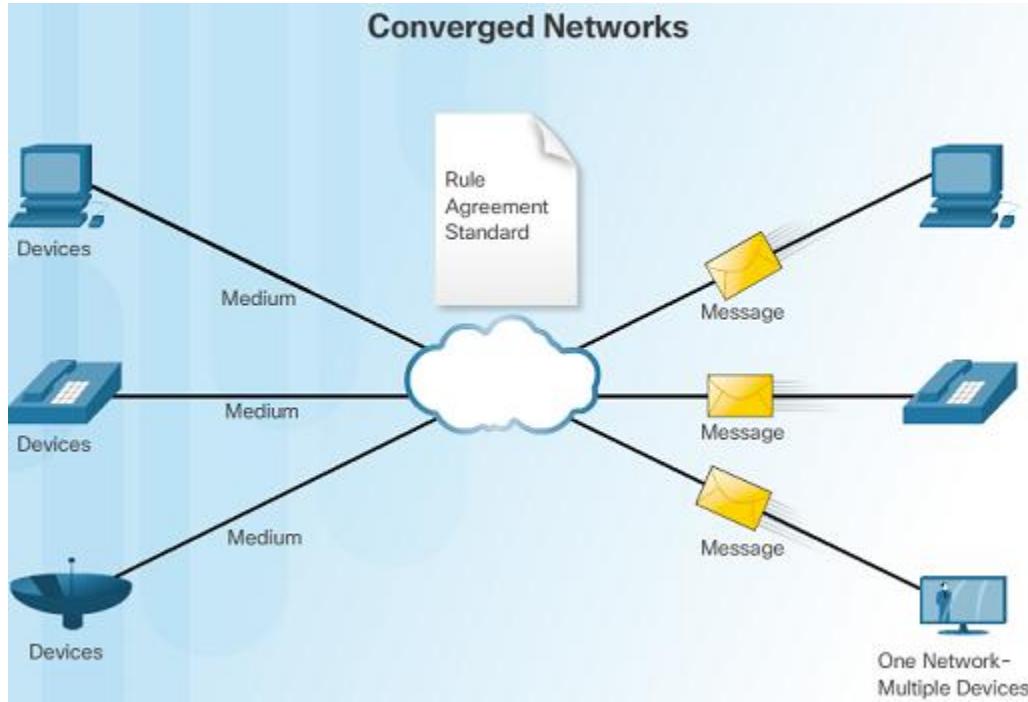


Multiple Networks

- An example of multiple networks might be a school 30 years ago. Some classrooms were cabled for data networks. Those same classrooms were cabled for telephone networks, and also cabled separately for video.
- Each of these networks used different technologies to carry the communication signals using a different set of rules and standards.

Converged Networks

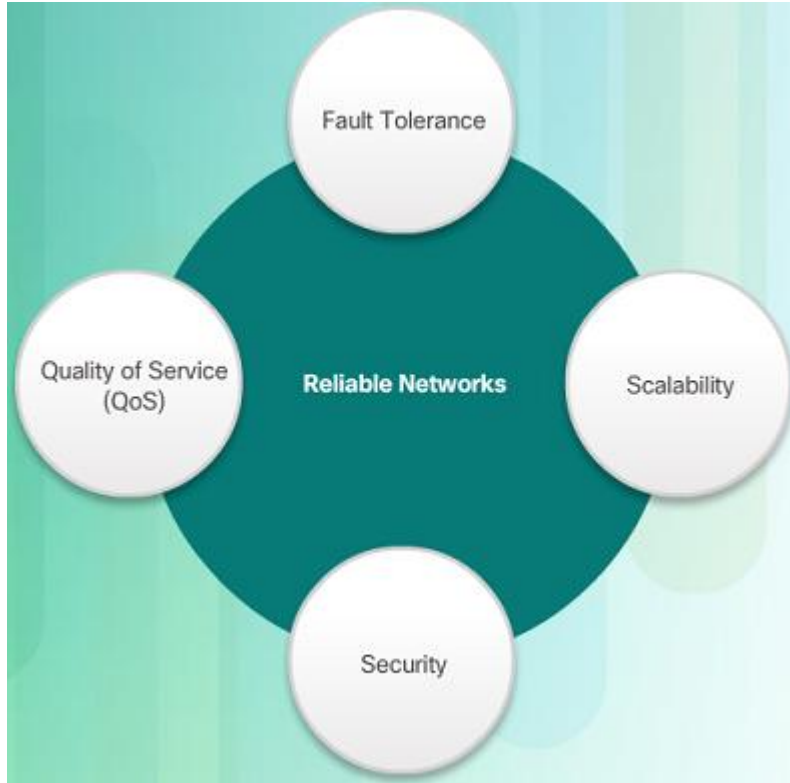
The Converging Network



Converged Network

- Converged data networks carry multiple services on one link including data, voice, and video.
- Unlike dedicated networks, converged networks can deliver data, voice, and video between different types of devices over the same network infrastructure.
- The network infrastructure uses the same set of rules and standards.

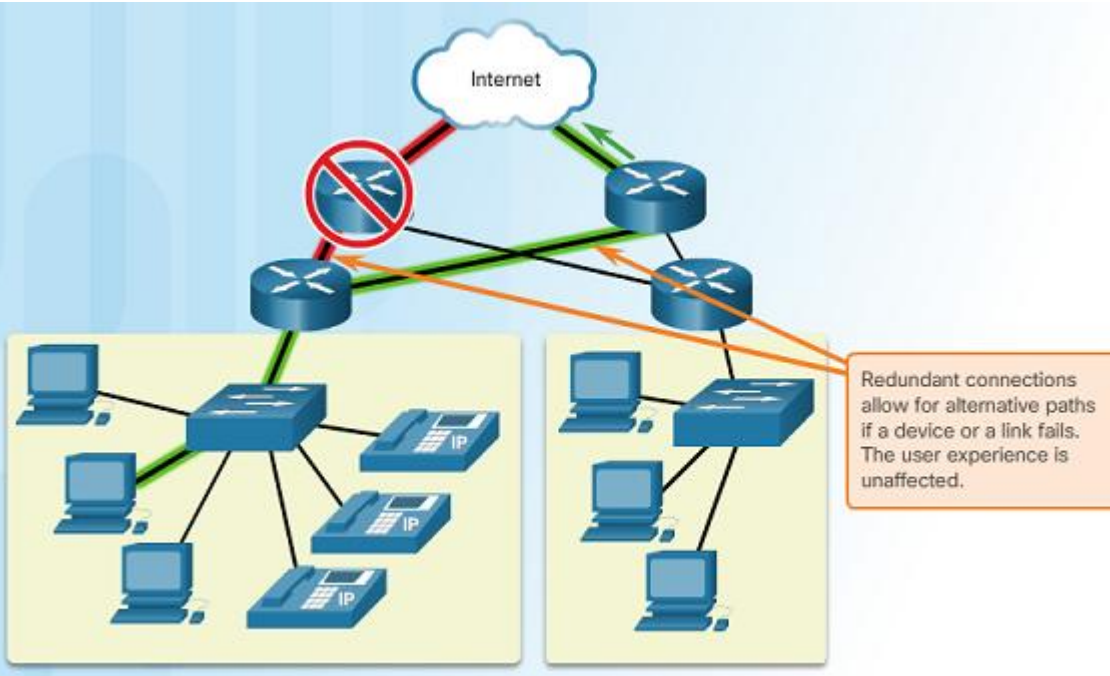
Network Architecture



- The term *network architecture* refers to the technologies that support the infrastructure and the programmed services and rules, or protocols, that move messages across the network.
- There are four basic characteristics that the underlying architectures need to address to meet user expectations:
 - Fault Tolerance
 - Scalability
 - Quality of Service (QoS)
 - Security

Reliable Network

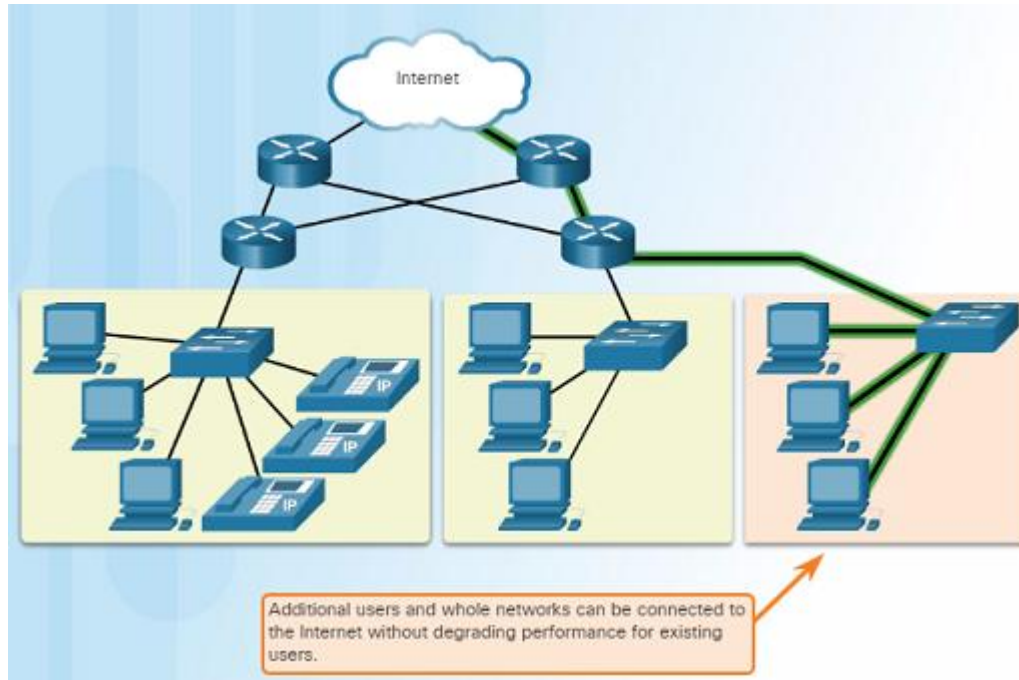
Fault Tolerance



- A fault tolerant network limits the impact of a failure by limiting the number of affected devices.
- Multiple paths are required for fault tolerance.
- Reliable networks provide redundancy by implementing a **packet switched network**. Packet switching splits traffic into packets that are routed over a network. Each packet could theoretically take a different path to the destination.
- This is not possible with **circuit-switched** networks which establish dedicated circuits.

Reliable Network

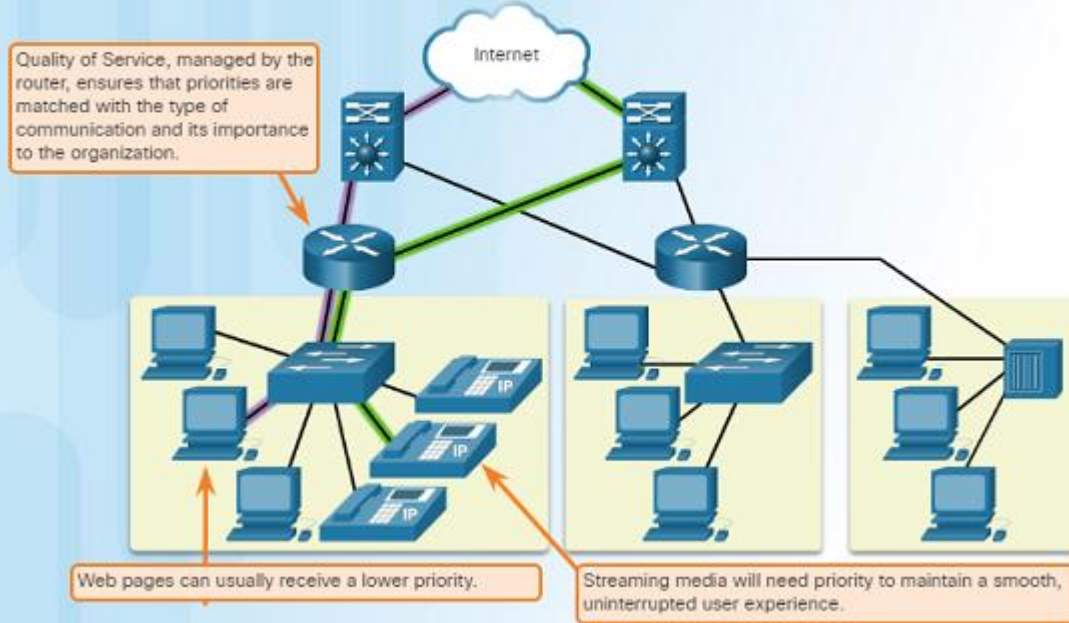
Scalability



- A scalable network can expand quickly and easily to support new users and applications without impacting the performance of services to existing users.
- Network designers follow accepted standards and protocols in order to make the networks scalable.
- Scalability also refers to the ability to accept new products and applications.

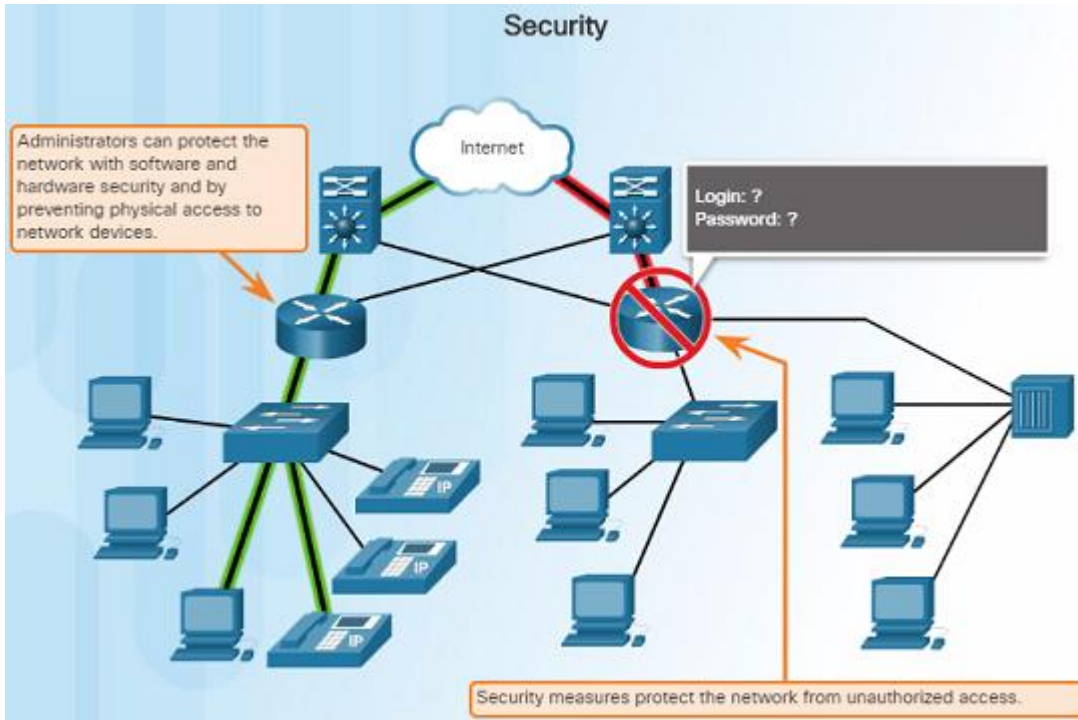
Reliable Network

Quality of Service



- Voice and live video transmissions require higher expectations for those services being delivered.
- Have you ever watched a live video with constant breaks and pauses? This is caused when there is a higher demand for bandwidth than available – and QoS isn't configured.
- Quality of Service (QoS) is the primary mechanism used to ensure reliable delivery of content for all users.
- With a QoS policy in place, the router can more easily manage the flow of data and voice traffic.

Reliable Network Security



- There are two main types of network security that must be addressed:
 - **Network infrastructure security**
 - Physical security of network devices
 - Preventing unauthorized access to the management software on those devices
 - **Information Security**
 - Protection of the information or data transmitted over the network
- **Three goals of network security:**
 - **Confidentiality** – only intended recipients can read the data
 - **Integrity** – assurance that the data has not be altered with during transmission
 - **Availability** – assurance of timely and reliable access to data for authorized users

1.4 The Changing Network Environment

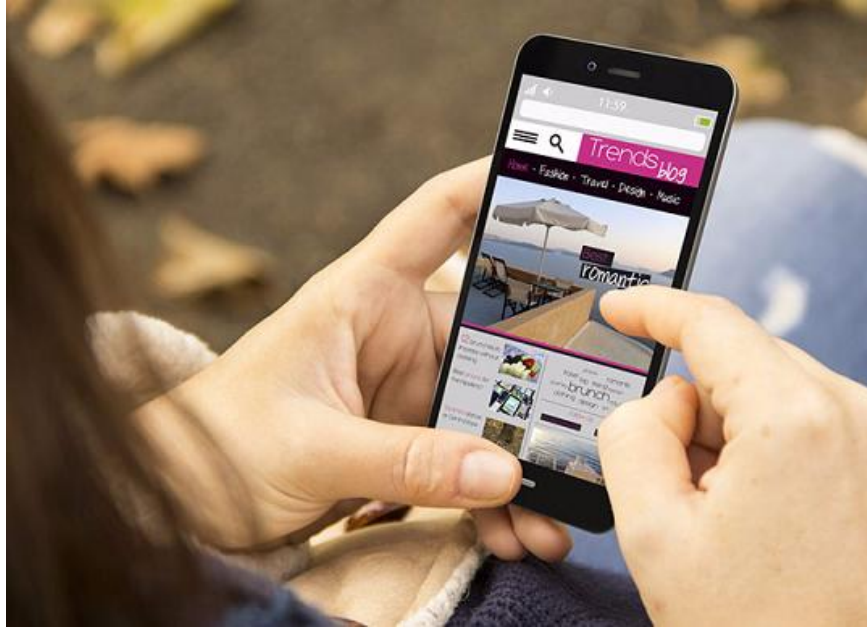
Network Trends

New Trends



- The role of the network must adjust and continually transform in order to be able to keep up with new technologies and end user devices as they constantly come to the market.
- Several new networking trends that effect organizations and consumers:
 - Bring Your Own Device (BYOD)
 - Online collaboration
 - Video communications
 - Cloud computing

Bring Your Own Device



- Bring Your Own Device (BYOD) is a major global trend that allows users to use their own devices giving them more opportunities and greater flexibility.
- BYOD allows end users to have the freedom to use personal tools to access information and communicate using their:
 - Laptops
 - Netbooks
 - Tablets
 - Smartphones
 - E-readers

Online Collaboration



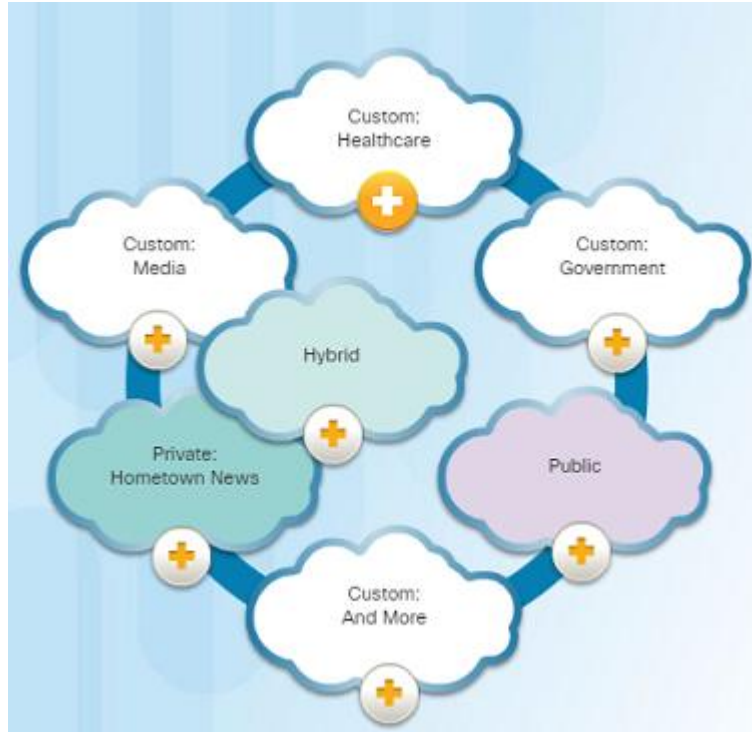
- Individuals want to collaborate and work with others over the network on joint projects.
- Collaboration tools including Cisco WebEx (shown in the figure) gives users a way to instantly connect, interact and achieve their objectives.
- Collaboration is a very high priority for businesses and in education.
 - For businesses, collaboration is a critical and strategic priority to remain competitive.
 - In education, students need to collaborate with assist each other in learning, to develop team skills used in the workforce, and to work together on team-based projects.

Video Communication

- Cisco TelePresence powers the new way of working where everyone, everywhere, can be more productive through face to face collaboration.
- Around the world each day, we transform organizations by transforming our customer experiences.
- Video is being used for communications, collaboration, and entertainment. Video calls are becoming more popular, facilitating communications as part of the human network.
- Video calls and videoconferencing are proving particularly powerful for sales processes and for doing business. Video is a useful tool for conducting business at a distance, both locally and globally.
- Video helps businesses create a competitive advantage, lower costs, and reduce the impact on the environment by reducing the need to travel.

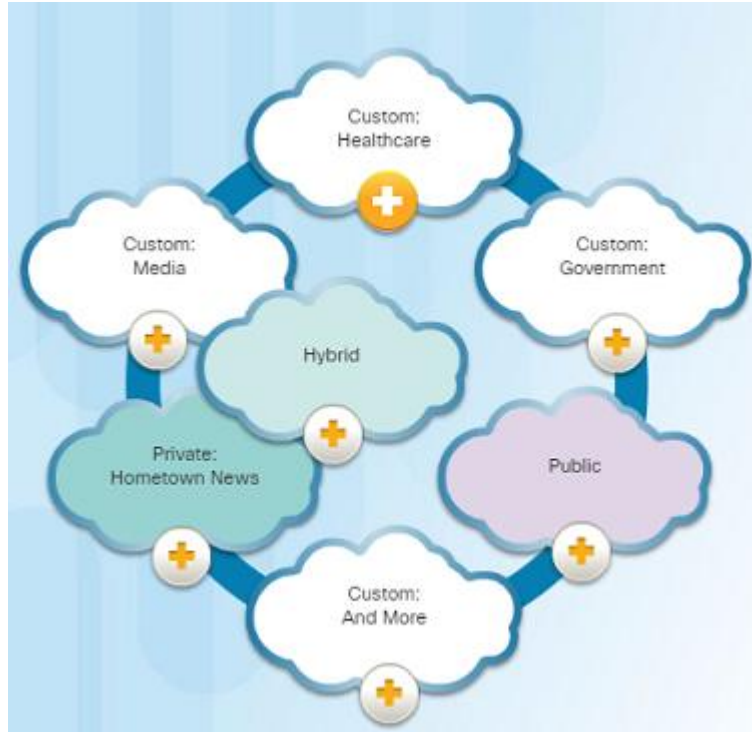


Cloud Computing



- Cloud computing is a global trend that allows us to store personal files or backup our data on servers over the Internet.
- Applications such as word processing and photo editing can also be accessed using the Cloud.
- Cloud computing also allows businesses to extend their capabilities on demand and delivered automatically to any device anywhere in the world.
- Cloud computing is made possible by data centers. Smaller companies that can't afford their own data centers, lease server and storage services from larger data center organizations in the Cloud.

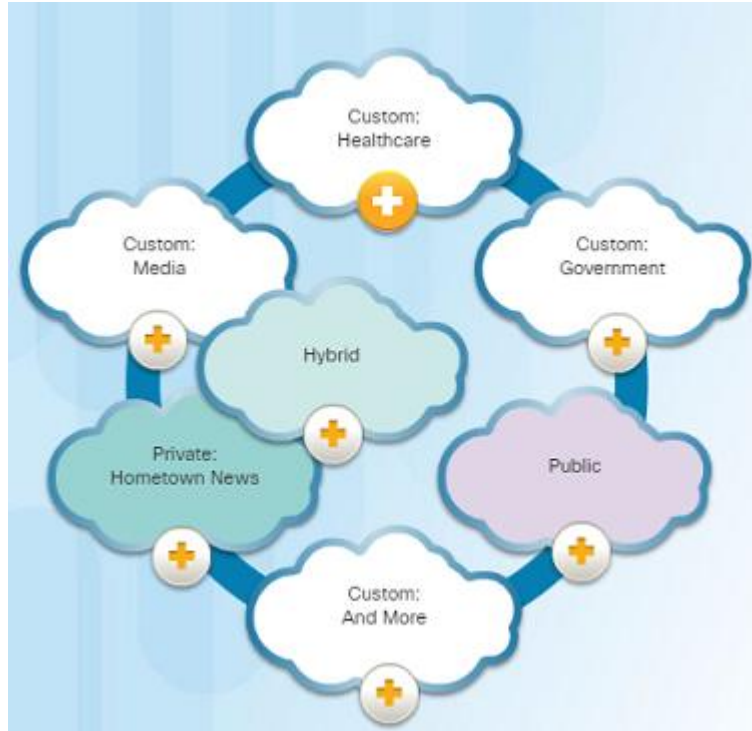
Cloud Computing (Cont.)



Benefits.

- **Organizational flexibility:** Users can access the information anytime and anywhere using a web browser.
- **Agility and rapid deployment:** The IT department can focus on delivering the tools to mine, analyze, and share the information and knowledge from databases, files, and people.
- **Reduced cost of infrastructure:** Technology is moved from on-site to a cloud provider, eliminating the cost of hardware and applications.
- **Refocus of IT resources:** The cost savings of hardware and applications can be applied elsewhere.
- **Creation of new business models:** Applications and resources are easily accessible, so companies can react quickly to customer needs. This helps them set strategies to promote innovation while potentially entering new markets

Cloud Computing (Cont.)



■ Four types of Clouds:

• **Public Clouds**

- Services and applications are made available to the general public through a pay-per-use model or for free.

• **Private Clouds**

- Applications and services are intended for a specific organization or entity such as the government.

• **Hybrid Clouds**

- Made up of two or more Cloud types – for example, part custom and part public. Each part remains a distinctive object but both are connected using the same architecture.

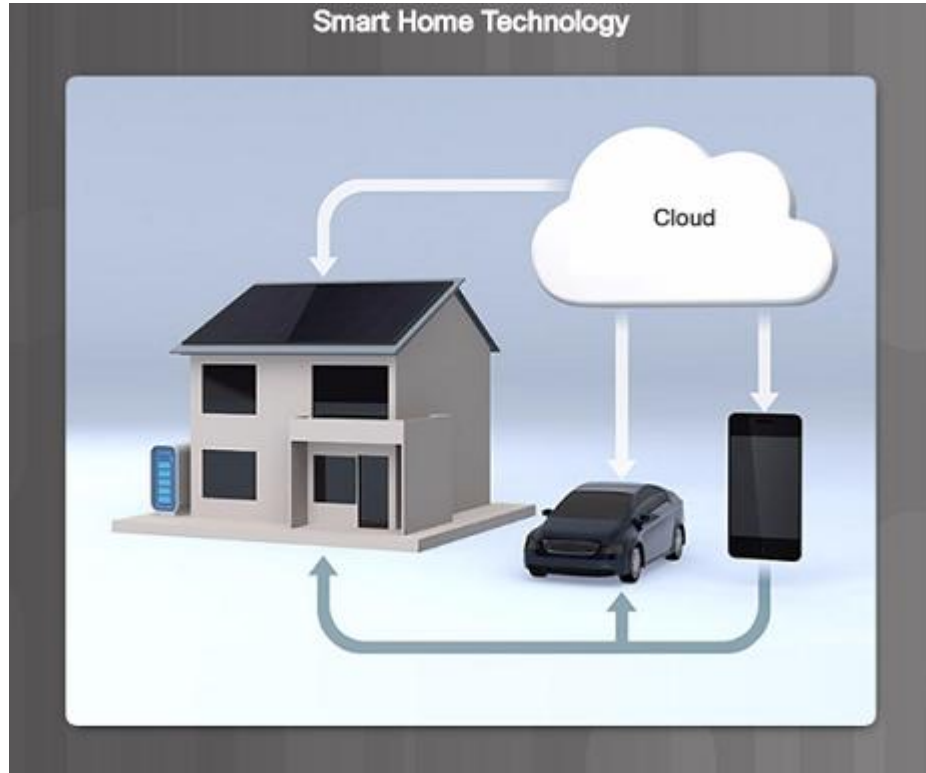
• **Custom Clouds**

- They are built to meet the needs of a specific industry, such as healthcare or media. Custom clouds can be private or public.

Data Centers

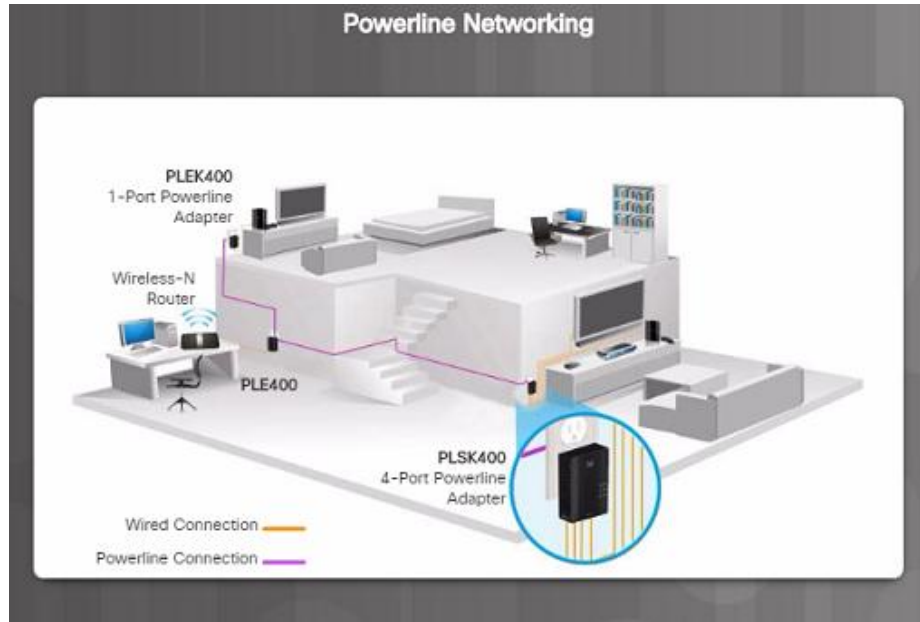
- Cloud computing is possible because of data centers. A data center is a facility used to house computer systems and associated components, including
 - Redundant data communications connections
 - High-speed virtual servers (sometimes referred to as server farms or server clusters)
 - Redundant storage systems (typically use SAN technology)
 - Redundant or backup power supplies
 - Environmental controls (for example, air conditioning and fire suppression)
 - Security devices
- Modern data centers make use of cloud computing and virtualization to efficiently handle large data transactions.
- Virtualization is the creation of a virtual version of something, such as a hardware platform, operating system (OS), storage device, or network resources.
- While a physical computer is an actual discrete device, a virtual machine consists of a set of files and programs running on an actual physical system.

Technology Trends in the Home



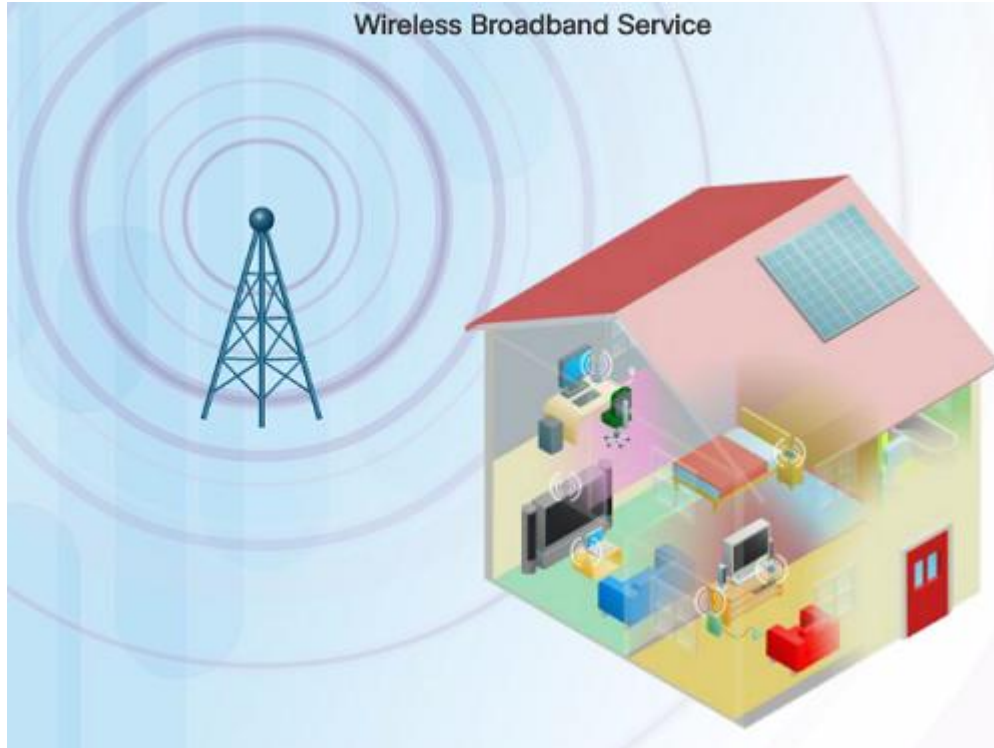
- Smart home technology is a growing trend that allows technology to be integrated into every-day appliances which allows them to interconnect with other devices.
- This is technology that is integrated into everyday appliances, allowing them to interconnect with other devices, making them more “smart” or automated.
- Ovens might know what time to cook a meal for you by communicating with your calendar on what time you are scheduled to be home.

Powerline Networking



- Powerline networking is an emerging trend for home networking that uses existing electrical wiring to connect devices.
- Powerline networking can allow devices to connect to a LAN where data network cables or wireless communications are not a viable option.
- Using a standard powerline adapter, devices can connect to the LAN wherever there is an electrical outlet by sending data on certain frequencies.
- Powerline networking is especially useful when wireless access points cannot be used or cannot reach all the devices in the home.

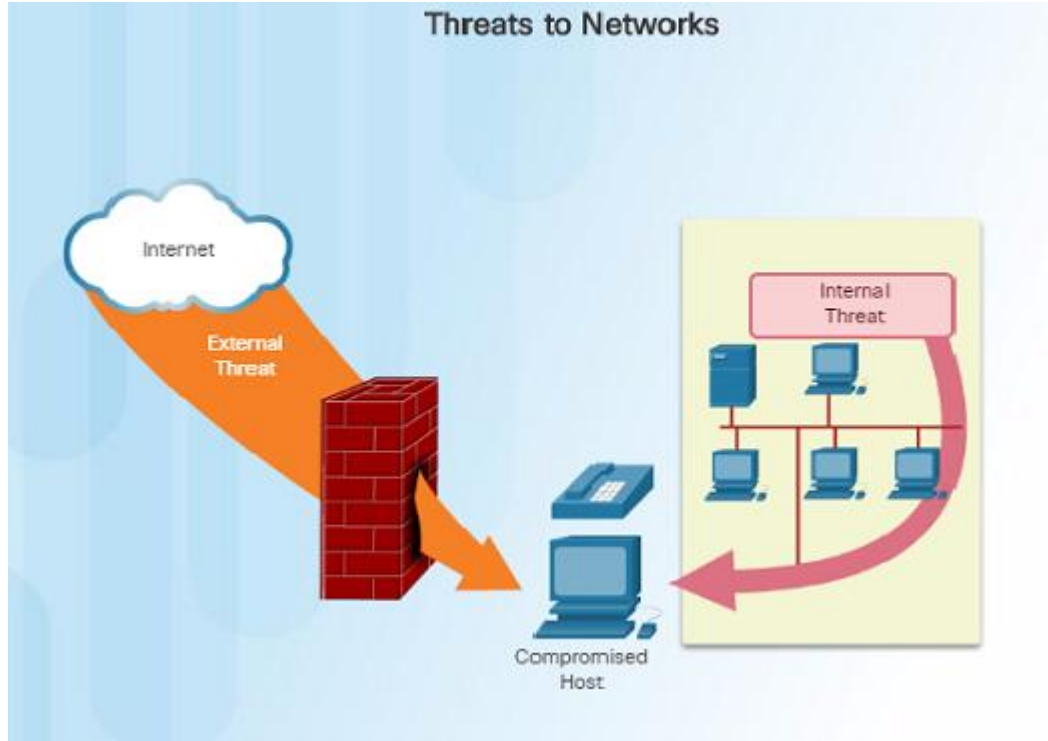
Wireless Broadband



- In addition to DSL and cable, wireless is another option used to connect homes and small businesses to the Internet.
- More commonly found in rural environments, a **Wireless Internet Service Provider (WISP)** is an ISP that connects subscribers to designated access points or hotspots.
- **Wireless broadband** is another solution for the home and small businesses.
 - Uses the same cellular technology used by a smart phone.
 - An antenna is installed outside the house providing wireless or wired connectivity for devices in the home.

Network Security

Security Threats



Network security is an integral part of networking regardless of the size of the network.

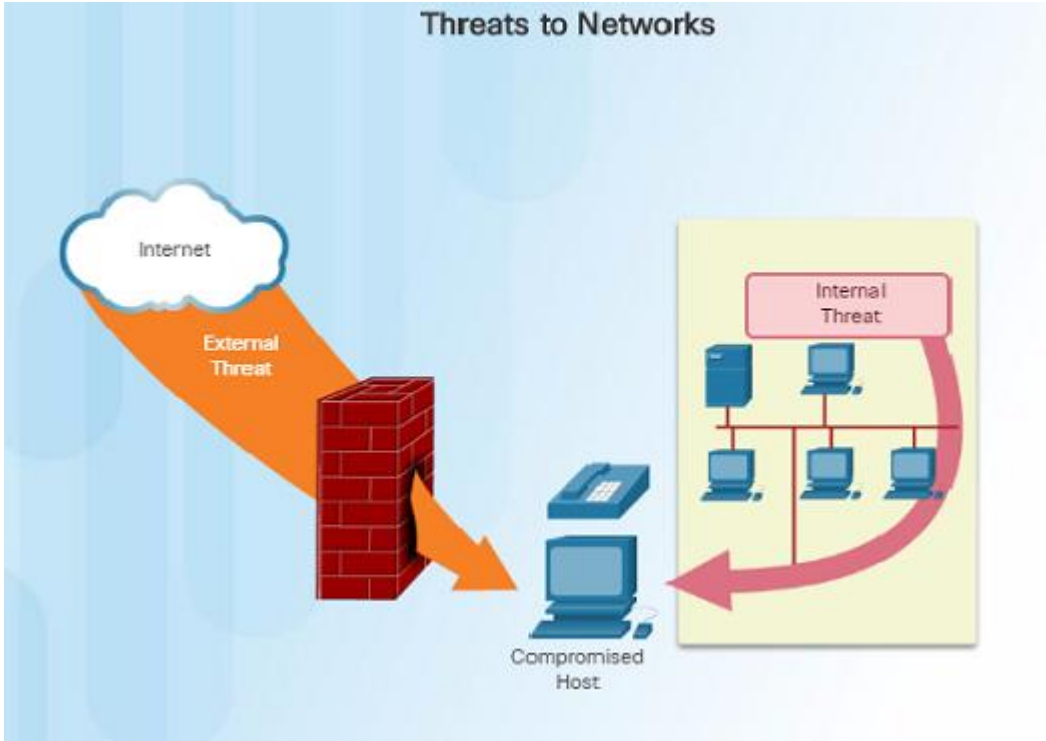
The network security that is implemented must take into account the environment while securing the data, but still allowing for quality of service that is expected of the network.

Securing a network involves many protocols, technologies, devices, tools, and techniques in order to secure data and mitigate threats.

Threat vectors might be external or internal.

Network Security

Security Threats (Cont.)



- External threats:
 - Viruses, worms, and Trojan horses
 - Spyware and adware
 - Zero-day attacks, also called zero-hour attacks
 - Hacker attacks
 - Denial of Service attacks
 - Data interception and theft
 - Identity Theft
- Internal threats:
 - Whether intentional or not, many studies show that the internal users of the network cause the most security breaches.
 - With BYOD strategies, corporate data is more vulnerable.

Network Security

Security Solutions



- Security must be implemented in multiple layers using more than one security solution.
- Network security components for home or small office network:
 - Antivirus and antispyware software should be installed on end devices.
 - Firewall filtering used to block unauthorized access to the network.

Security Solutions (Cont.)



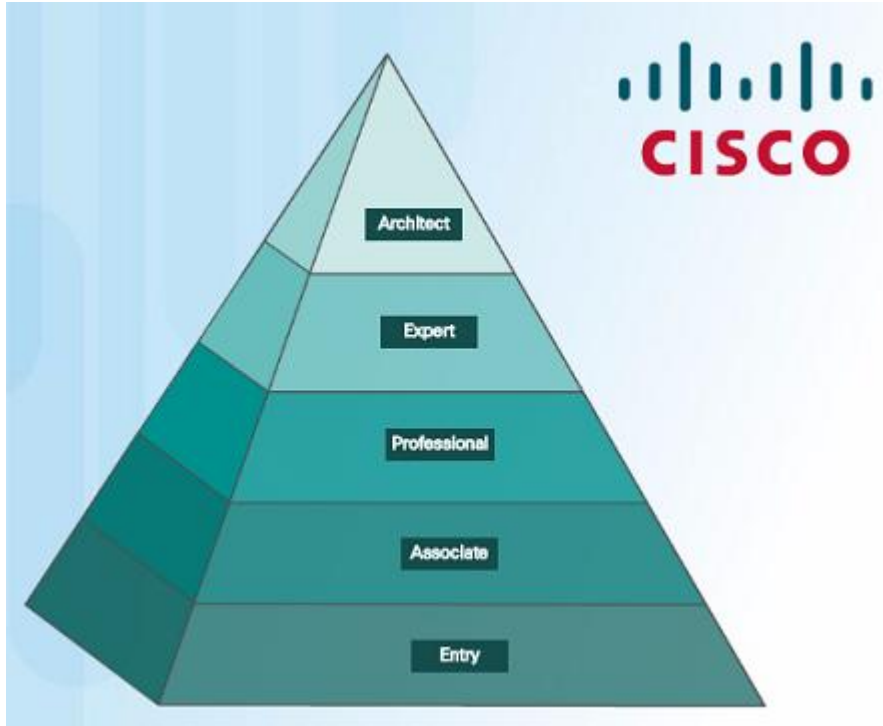
- Larger networks have additional security requirements:
- Dedicated firewall system to provide more advanced firewall capabilities.
- Access control lists (ACL) – used to further filter access and traffic forwarding.
- Intrusion prevention systems (IPS) – used to identify fast-spreading threats such as zero-day attacks.
- Virtual private networks (VPN) – used to provide secure access for remote workers.

Cisco Network Architecture



- In order for networks to function while efficiently supporting connections of people, devices, and information in a media rich converged environment, the network must be built upon a **standard network architecture**.
- Network architecture refers to the devices, connections, and products that are integrated to support the necessary technologies and applications.
- A well-planned network technology architecture helps ensure the connection of any device across any combination of networks while ensuring connectivity, it also increases cost efficiency by integrating network security and management, and improves business processes.
- The foundation of all network architectures including the Internet are routers and switches.

CCENT and CCNA Certification



- Cisco Certified Network Associate (CCNA)
 - Routing and Switching Certification
 - Requires you to pass two exams:
 - First exam: Cisco Certified Entry Network Technician (CCENT)
 - Second exam focuses on IPv4 and IPv6 routing and WAN technologies as well as LAN switching and infrastructure services/maintenance

1.5 Chapter Summary

Conclusion

Warriors of the Net

- The animated video below will help you visualize networking concepts.
- <http://www.warriorsofthe.net/>



Exploring the Network



- Networks and the Internet have dramatic impact on our lives.
- A network can consist of two devices, or can be as large as the Internet, consisting of millions of devices.
- The network infrastructure is the platform that supports the network.
- Networks must be:
 - Fault tolerant
 - Scalable
 - Support Quality of Service
 - Secure

Chapter 1: Introduction to Networks

- Explain how multiple networks are used in every day life.
- Explain how topologies and devices are connected in a small to medium-sized business network.
- Explain the basic characteristics of a network that support communication in a small to medium-sized business.
- Explain trends in networking that will affect the use of networks in small to medium-sized businesses.

