CD4002/CN4002
Computer Systems and Networks

Topic:
Networks Fundamentals

Objectives

- Explain the basic characteristics of a network.

- Define different types of networks.

- Explain how LANS and WANs interconnect to the internet.

- Describe the four basic requirements of a reliable network.

What is a Computer Network?

- Computer Network is a group of computers that are connected to each other for the purpose of communication and sharing information and resources.

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

  - Media

 - Services
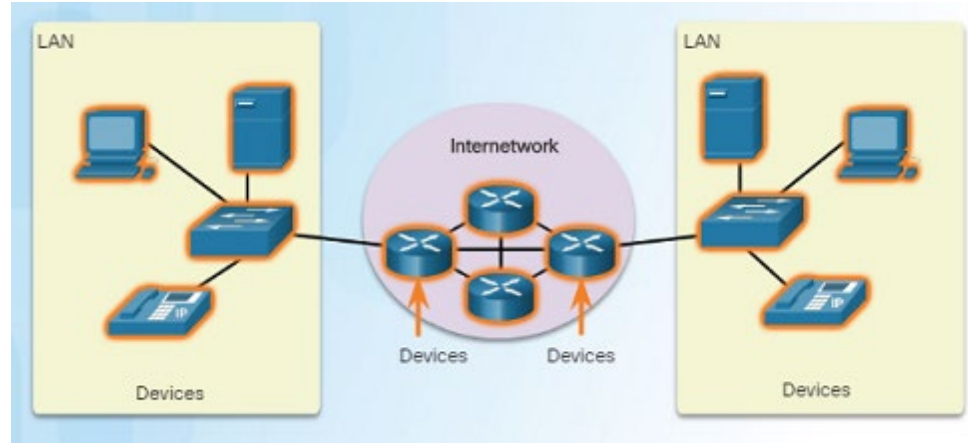
Network Components

- **End Devices**
  - An end device is where a message originates from or where it is received.
  - Data originates with an end device, flows through the network, and arrives at an end device

LAN

Internetwork

LAN

Media

Messages can take alternate routes.
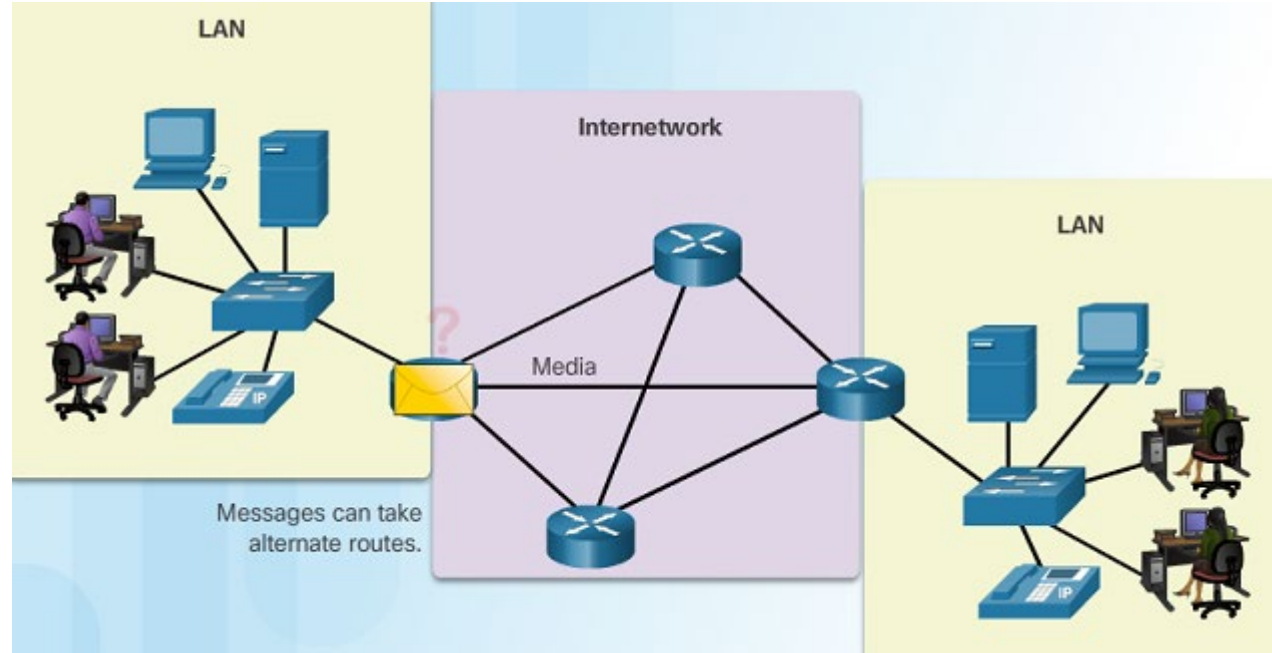
Intermediary Network Devices

- 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.

Intermediary Devices

Wireless Router

LAN Switch

Router

Multilayer Switch

Firewall Appliance
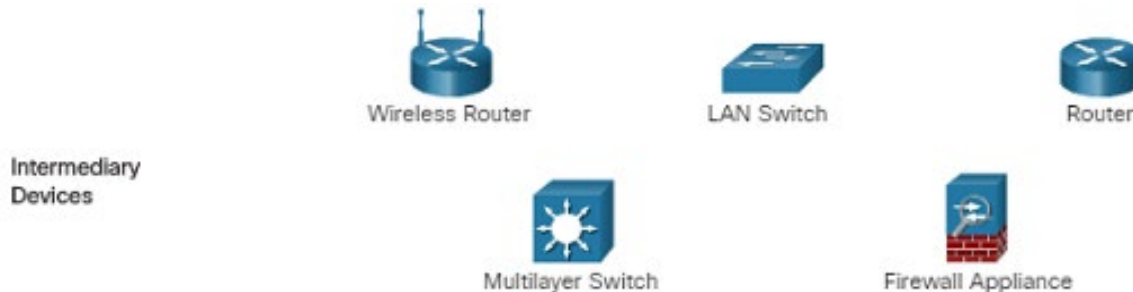
Network Media

- 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

  - Glass, such as fiber optic cables

  - Wireless transmission
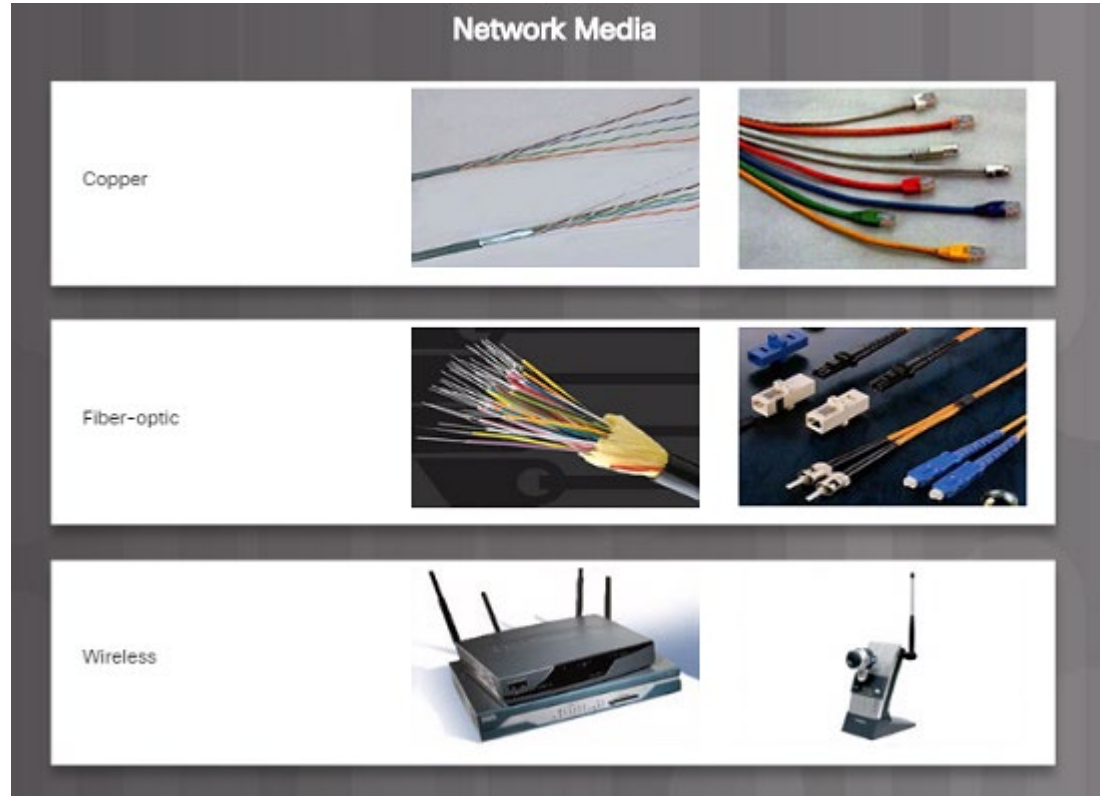
Network Representations

- Network diagrams are often called topology diagrams.

- In addition to the device representations on the right, it is important to remember and understand the following terms:

  - Network Interface Card (NIC)

  - Physical Port

  - Interface

Topology Diagrams

- Note the key differences between the two topology diagrams (physical location of devices vs. ports and network addressing schemes)
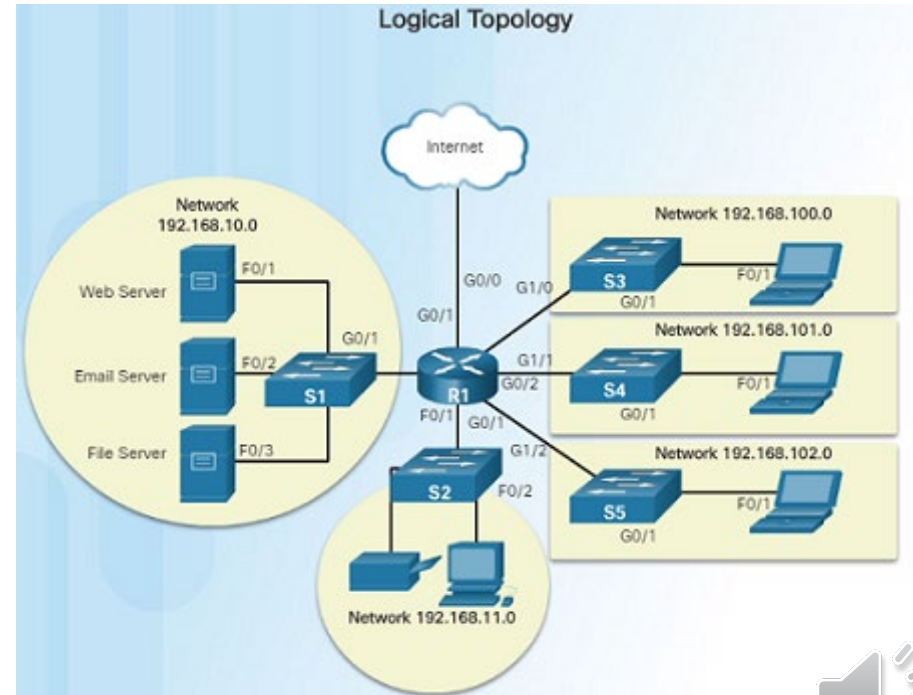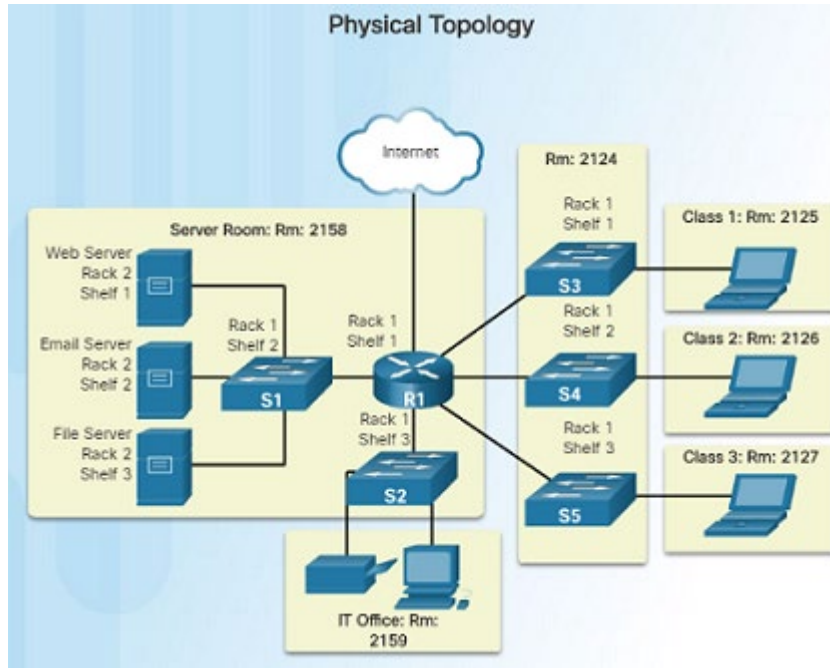
Types of Networks

- 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)

    - Wireless LAN (WLAN)
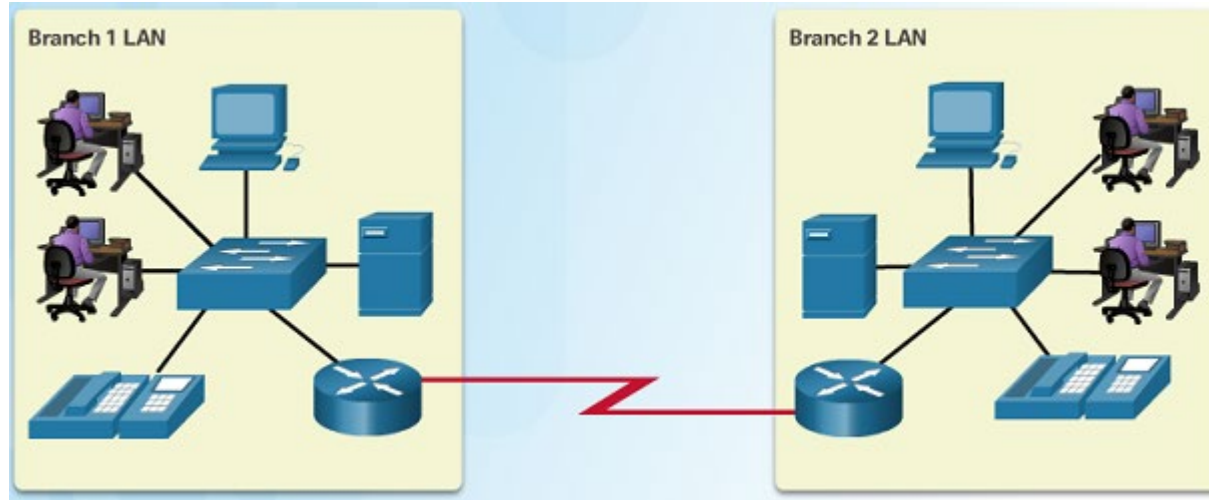
    - Storage Area Network (SAN)
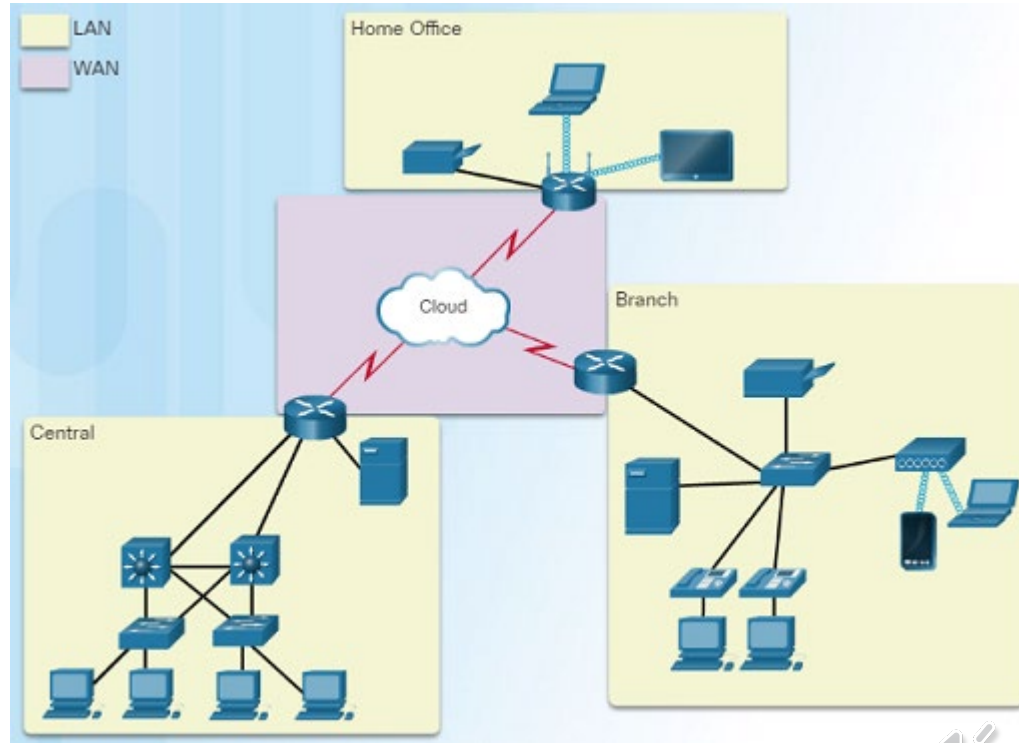
Local Area Networks
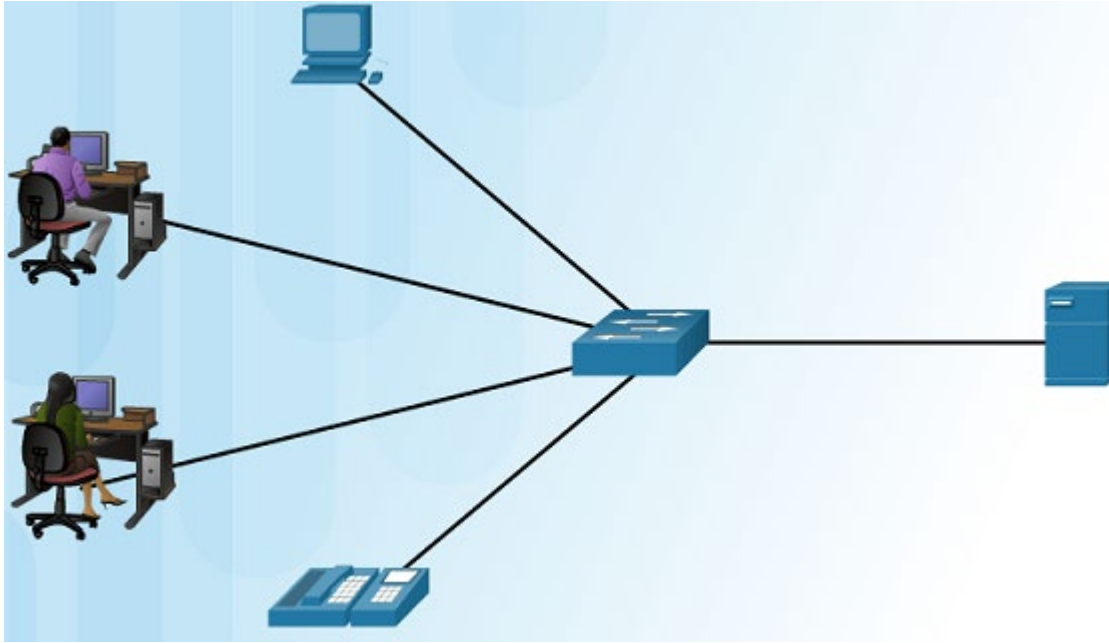
- Three characteristics of LANs:
  - Spans a small geographic area such as a home, school, office building, or campus.
  - Usually administered by a single organization or individual.
  - Provides high speed bandwidth to end and intermediary devices within the network.
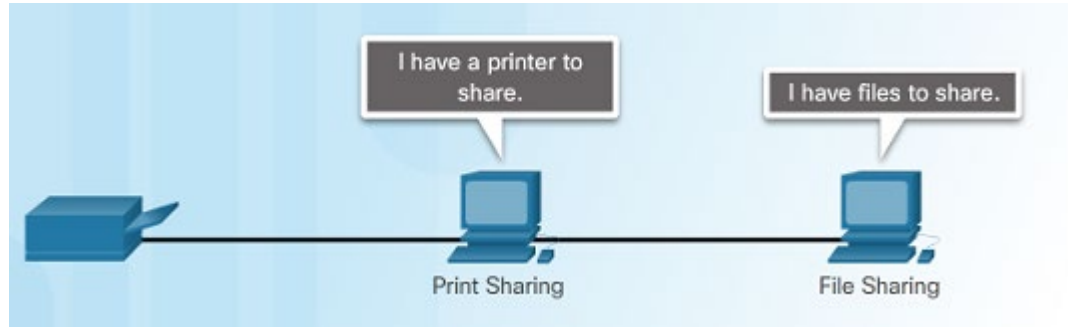
Wide Area Networks

- 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.

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.

- 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.

Clients and Servers
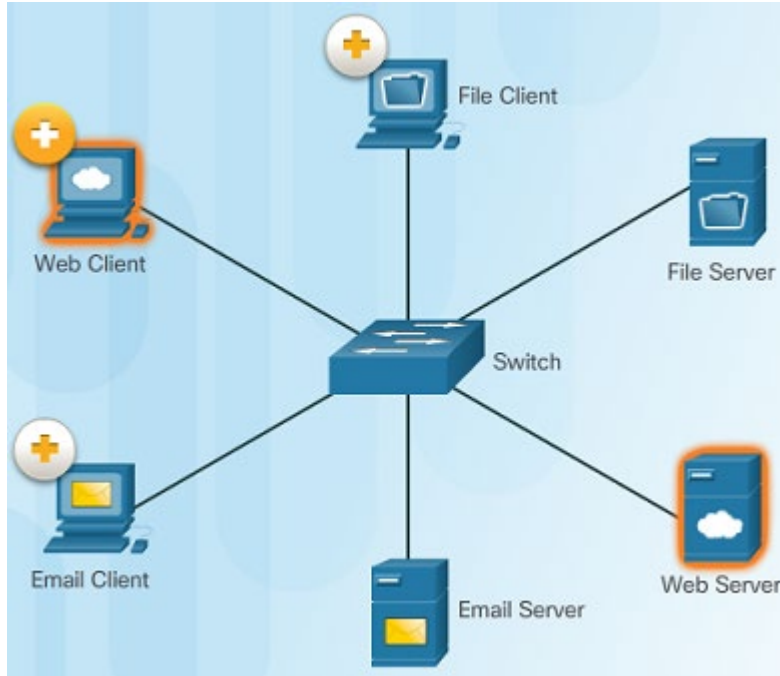
- Every computer connected to a network is called a host or end device.

- Servers are computers that provide information to end devices on the network. For example, email servers, web servers, or 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.
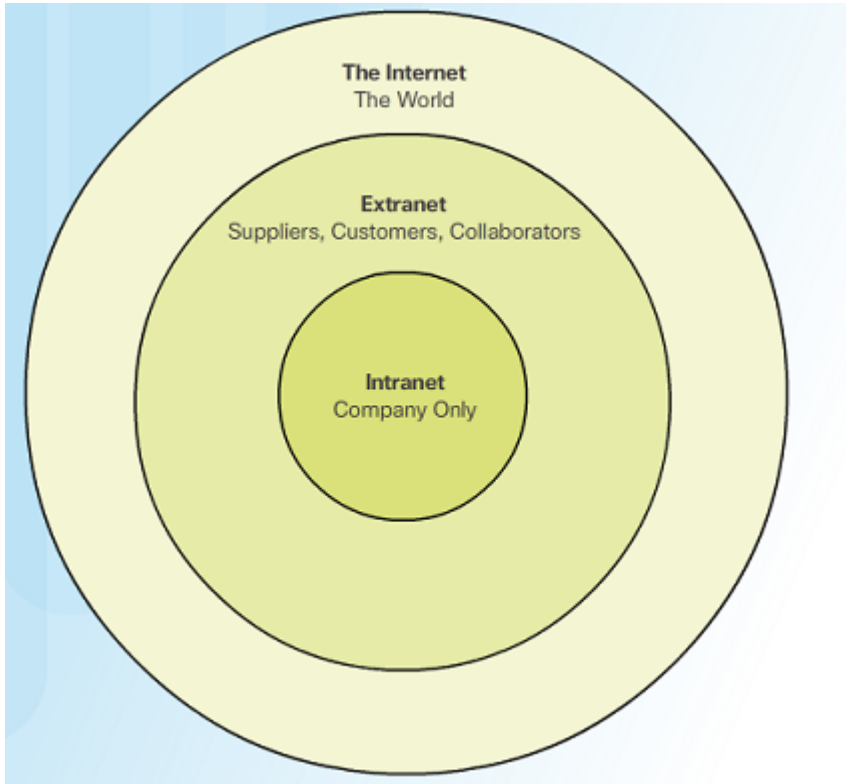
The Internet

- 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)
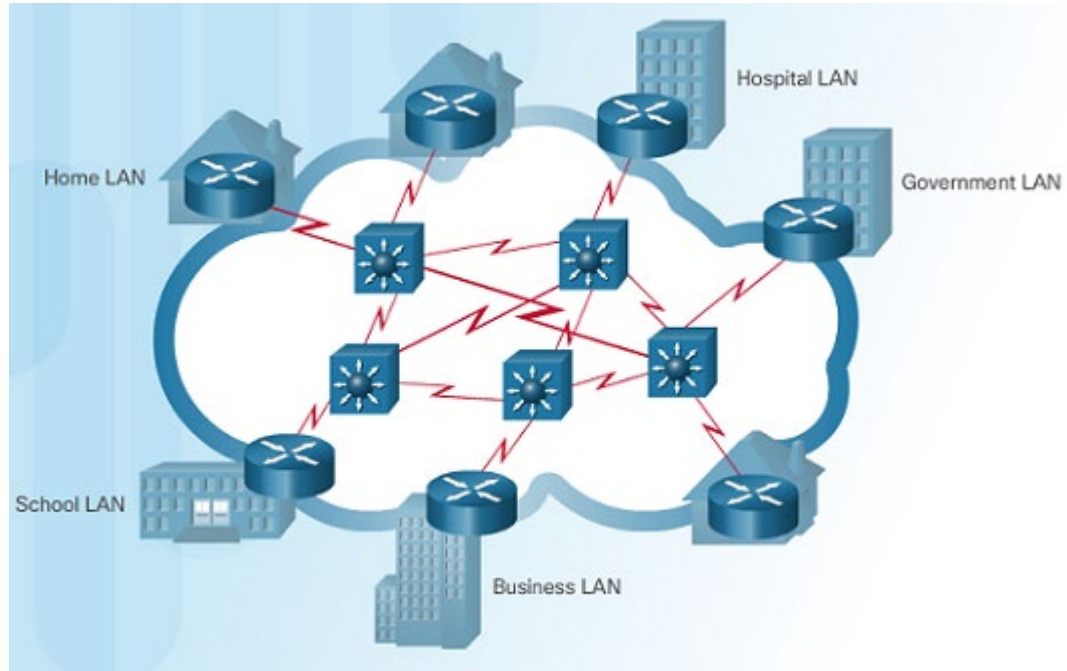
Intranets and Extranets

The Internet
The World

Extranet
Suppliers, Customers, Collaborators

Intranet
Company Only

- Unlike the Internet, an intranet is a private collection of LANs and WANs internal to an organization that is meant to be accessible only to the organizations members or others with authorization.

- 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.

Home and Small Office Internet Connections
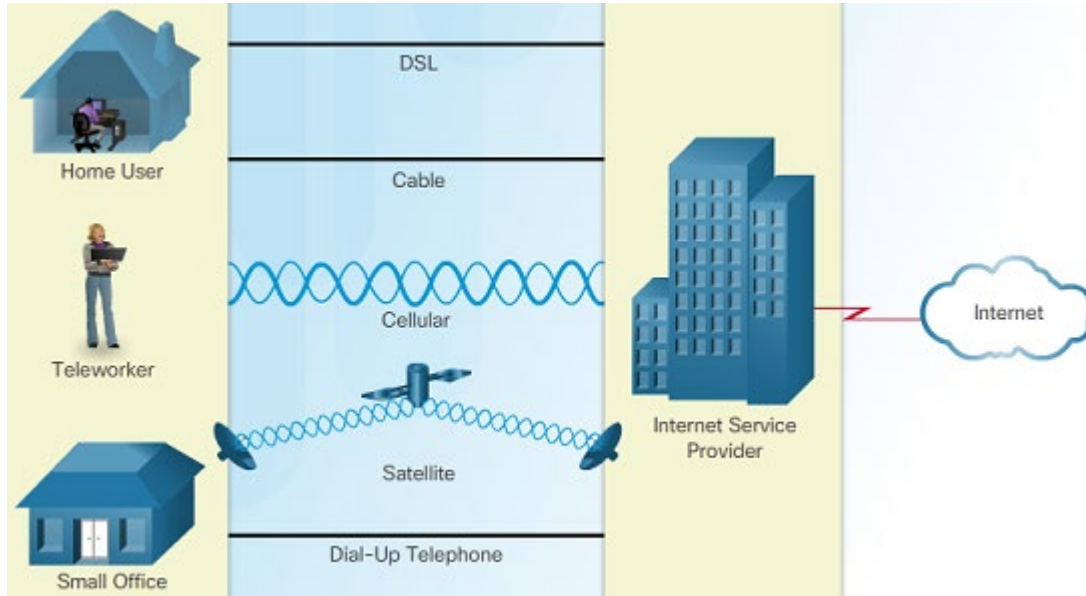
- Cable – high bandwidth, always on, Internet connection offered by cable television service providers.

- 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
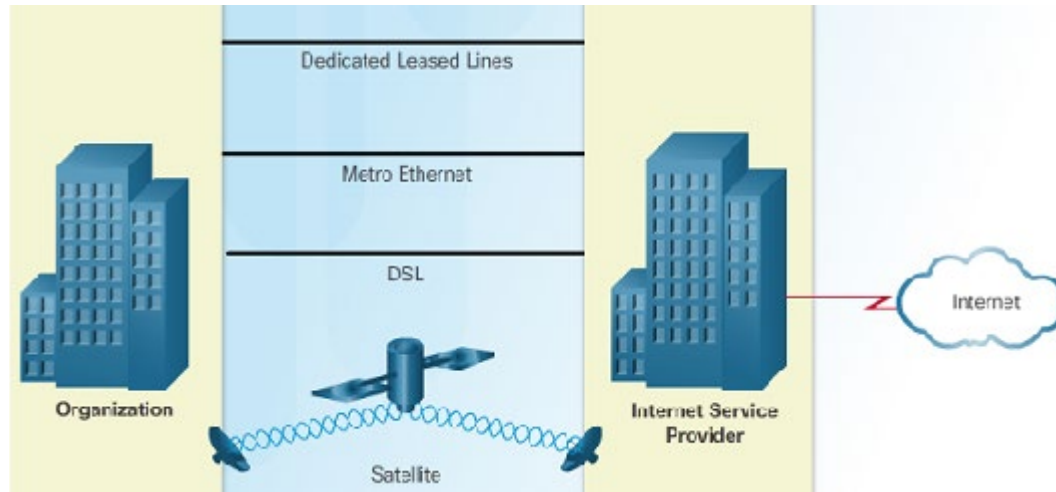
- Corporate business connections may require higher bandwidth, dedicated connections, or managed services. Typical connection options for businesses:

  - Dedicated Leased Line – reserved circuits within the service provider's network that connect distant offices with private voice and/or data networking.

  - Ethernet WAN – extends LAN access technology into the WAN.

  - DSL – Business DSL is available in various formats including Symmetric Digital Subscriber Lines (SDSL).

  - Satellite – can provide a connection when a wired solution is not available.

Traditional Separate Networks
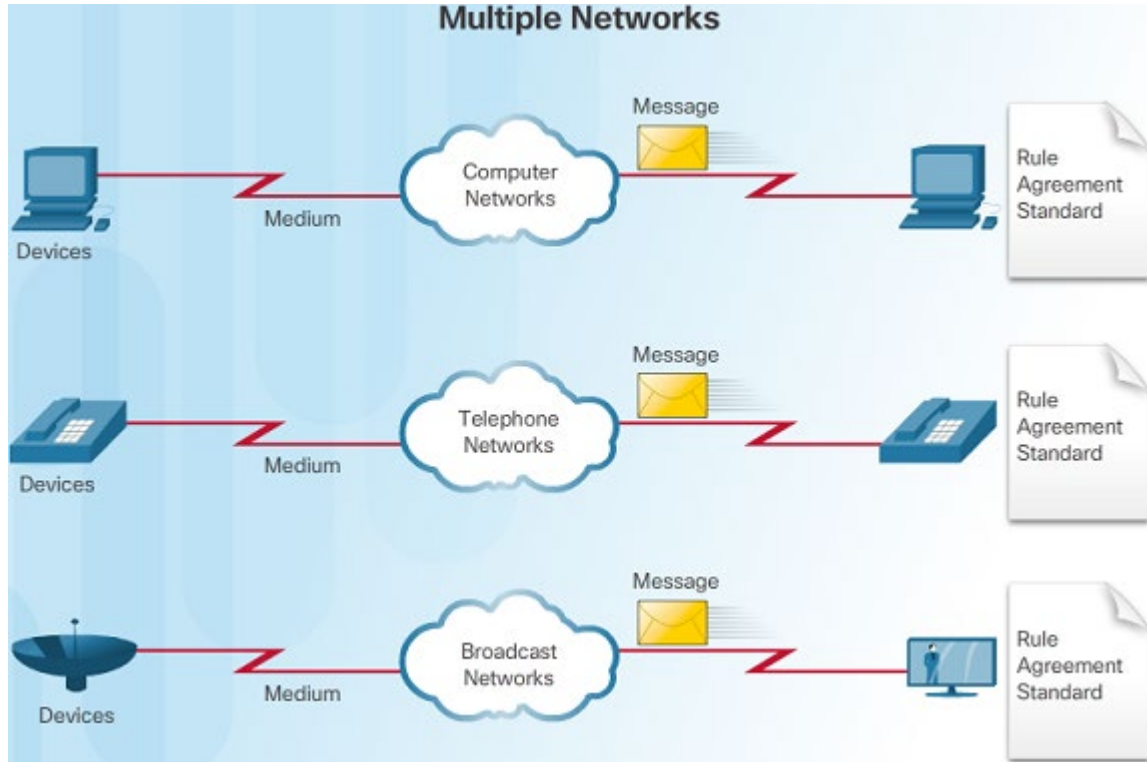
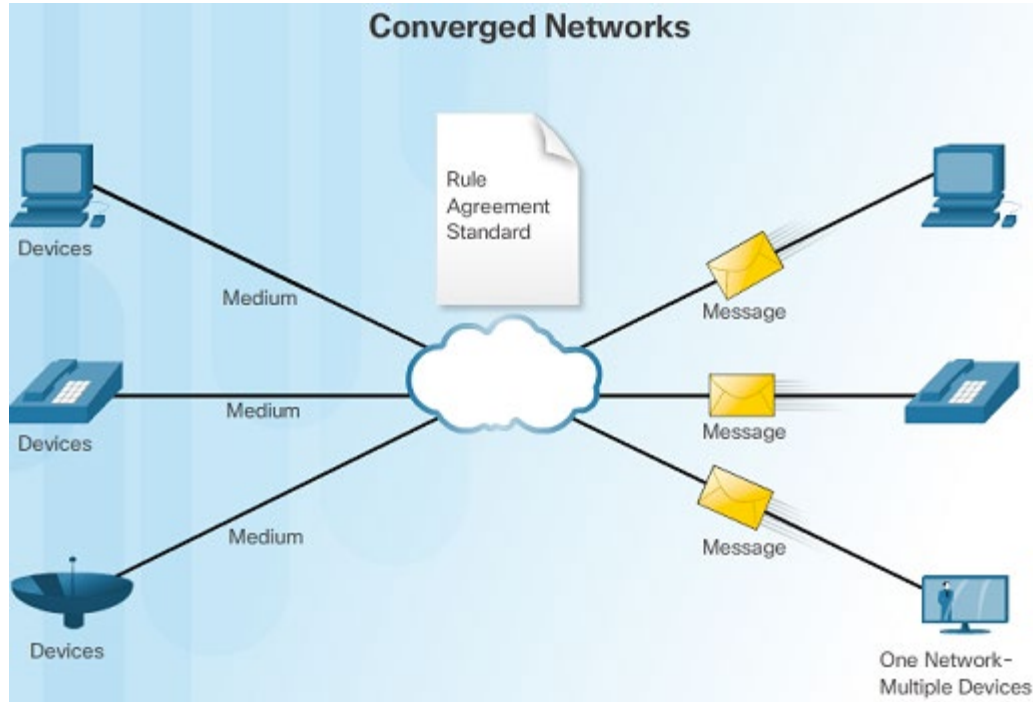**Multiple Networks**

- 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.

The Converging Network

Converged Networks

- 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.
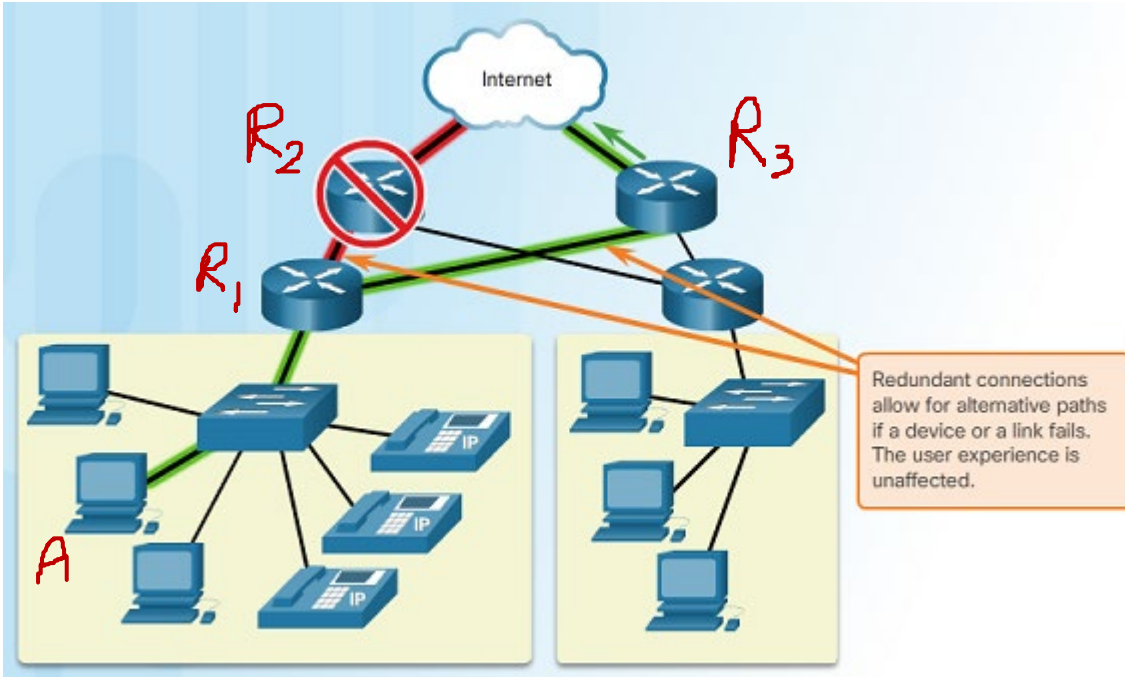
Network Architecture
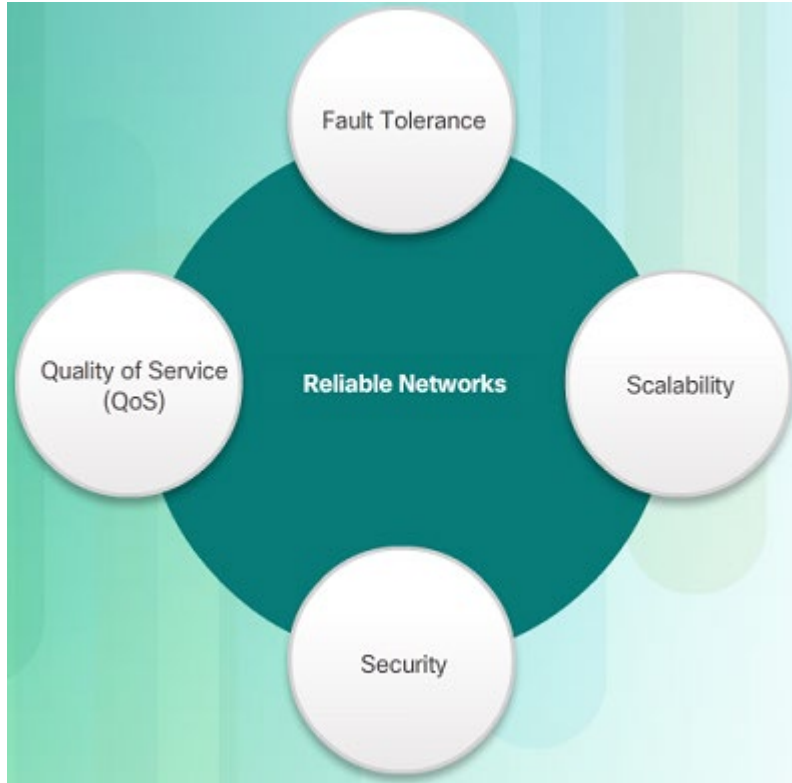
- Network Architecture refers to the technologies that support the infrastructure that moves data across the network.

- There are four basic characteristics that the underlying architectures need to address to meet user expectations:

  - Fault Tolerance

  - Scalability

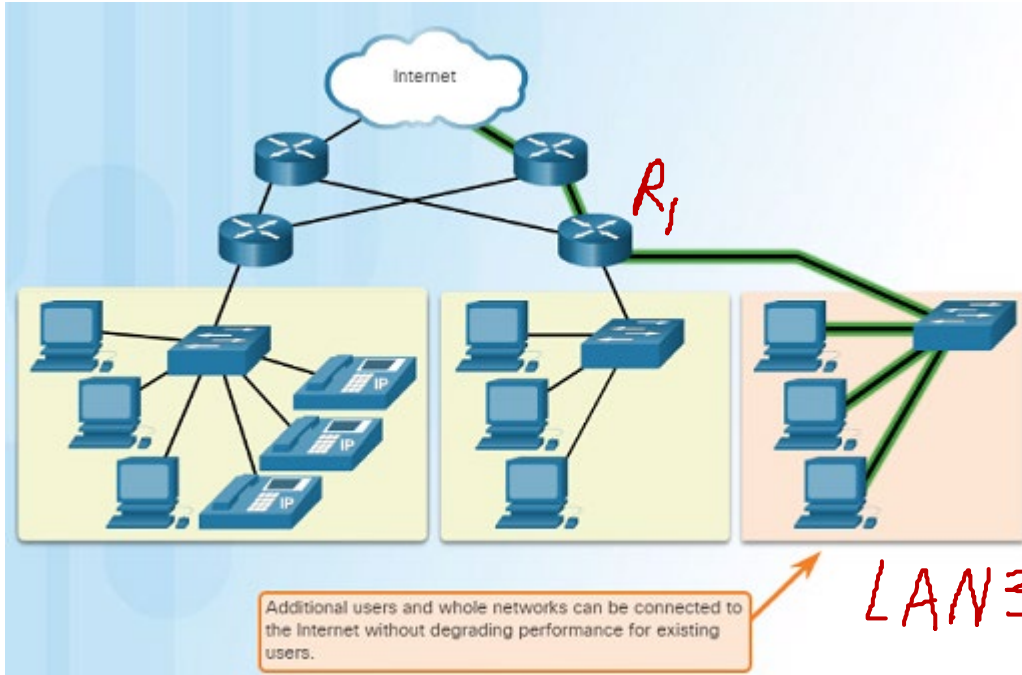 - Quality of Service (QoS)

  - Security

Fault Tolerance

Redundant connections allow for alternative paths if a device or a link fails. The user experience is unaffected.

- 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.

Scalability

Additional users and whole networks can be connected to the Internet without degrading performance for existing users.
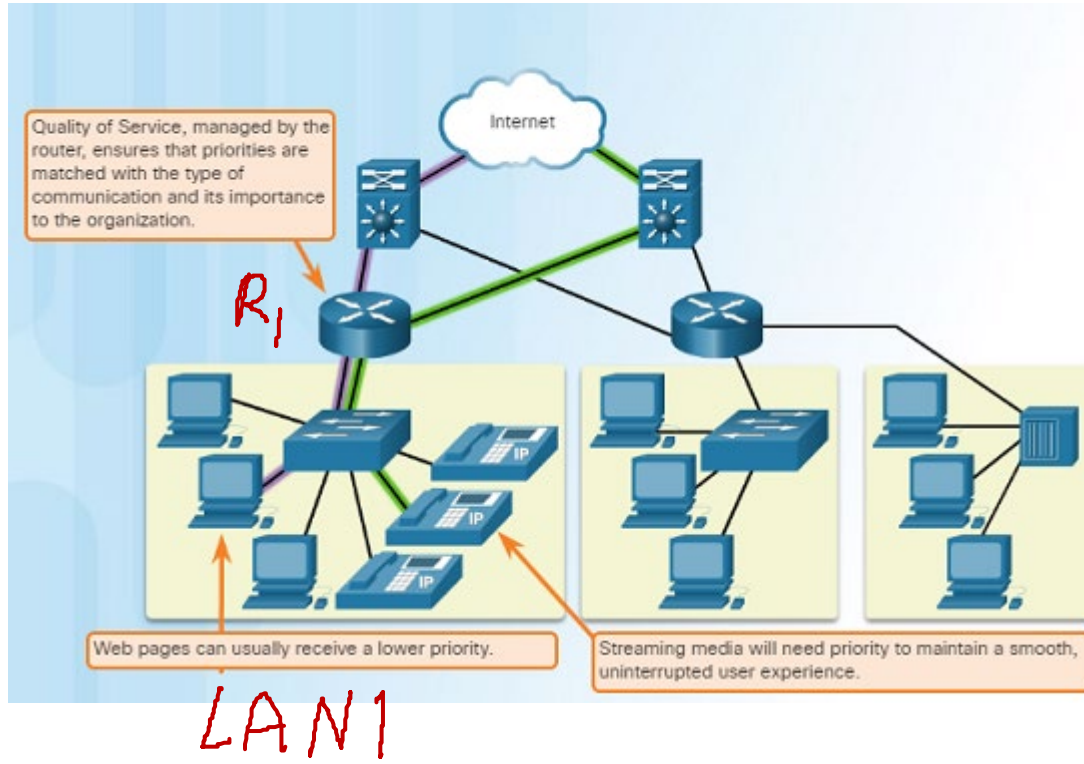
- A scalable network can expand quickly and easily to support new users and applications without impacting the performance of services to existing users.

- Network designers follow accepted standards and protocols in order to make the networks scalable.

Quality of Service

Quality of Service, managed by the router, ensures that priorities are matched with the type of communication and its importance to the organization.

R_1

Web pages can usually receive a lower priority.

Streaming media will need priority to maintain a smooth, uninterrupted user experience.

LAN1

- 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.

Security
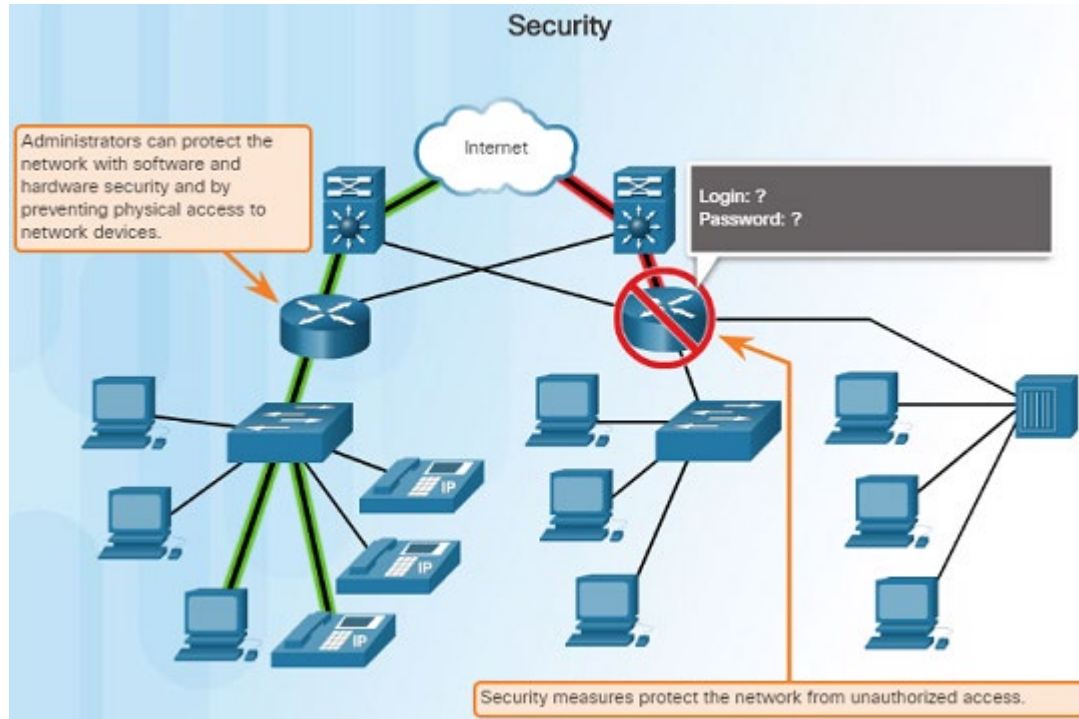
- There are two main types of network security that must be addressed:

  - 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:

  - **C**onfidentiality – only intended recipients can read the data
  - **I**ntegrity – assurance that the data has not be altered with during transmission
  - **A**vailability – assurance of timely and reliable access to data for authorized users