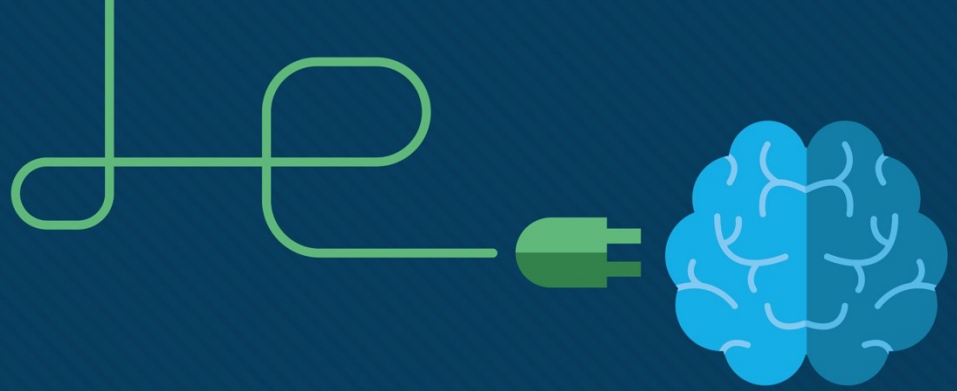


Module 1: Networking Today

Introduction to Networks v7.0
(ITN)

Module Objectives

Module Title: Networking Today

Module Objective: Explain the advances in modern technologies.

Topic Title	Topic Objective
Networks Affect our Lives	Explain how networks affect our daily lives.
Network Components	Explain how host and network devices are used.
Network Representations and Topologies	Explain network representations and how they are used in network topologies.
Common Types of Networks	Compare the characteristics of common types of networks.
Internet Connections	Explain how LANs and WANs interconnect to the internet.
Reliable Networks	Describe the four basic requirements of a reliable network.
Network Trends	Explain how trends such as BYOD, online collaboration, video, and cloud computing are changing the way we interact.
Network Security	Identify some basic security threats and solution for all networks.

1.1 Networks Affect Our Lives

Networks Connect Us

Communication is almost as important to us as our reliance on air, water, food, and shelter. In today's world, through the use of networks, we are connected like never before.

No Boundaries

- World without boundaries
- Global communities
- Human network

1.2 Network Components

Host Roles

Every computer on a network is called a host or end device.

Servers are computers that provide information to end devices:

- email servers
- web servers
- file server

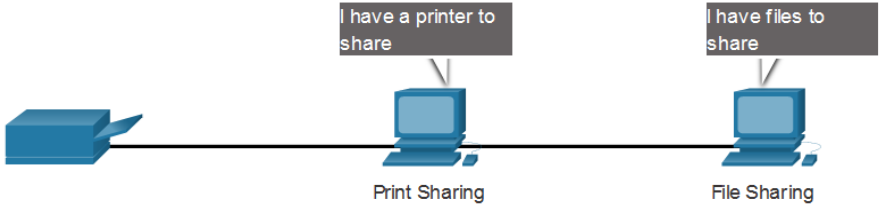
Clients are computers that send requests to the servers to retrieve information:

- web page from a web server
- email from an email server

Server Type	Description
Email	Email server runs email server software. Clients use client software to access email.
Web	Web server runs web server software. Clients use browser software to access web pages.
File	File server stores corporate and user files. The client devices access these files.

Peer-to-Peer

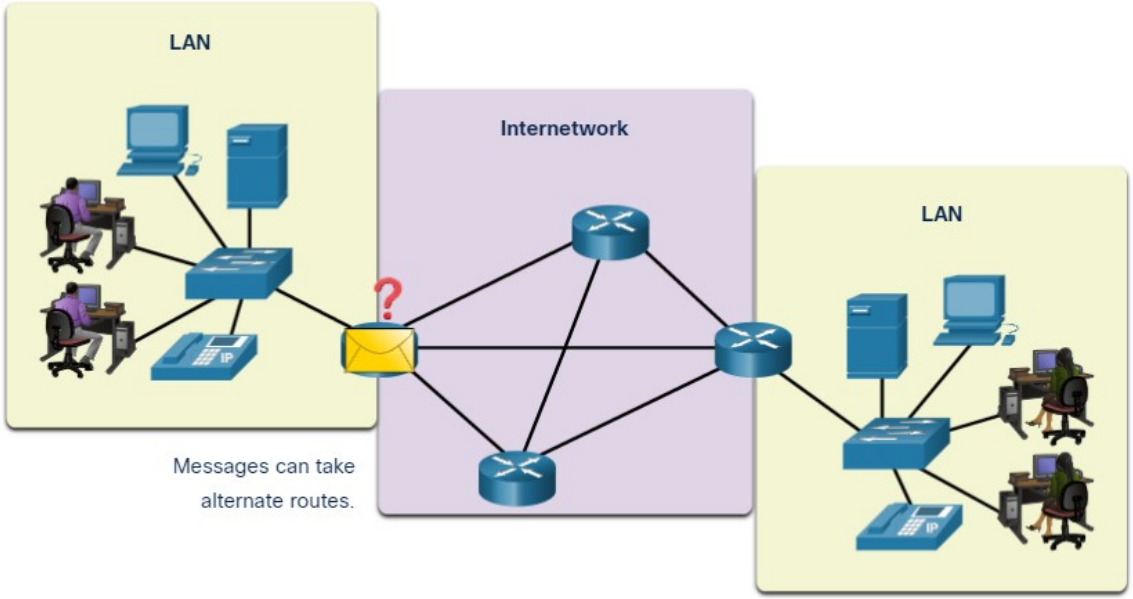
It is possible to have a device be a client and a server in a Peer-to-Peer Network. This type of network design is only recommended for very small networks.



Advantages	Disadvantages
Easy to set up	No centralized administration
Less complex	Not as secure
Lower cost	Not scalable
Used for simple tasks: transferring files and sharing printers	Slower performance

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.

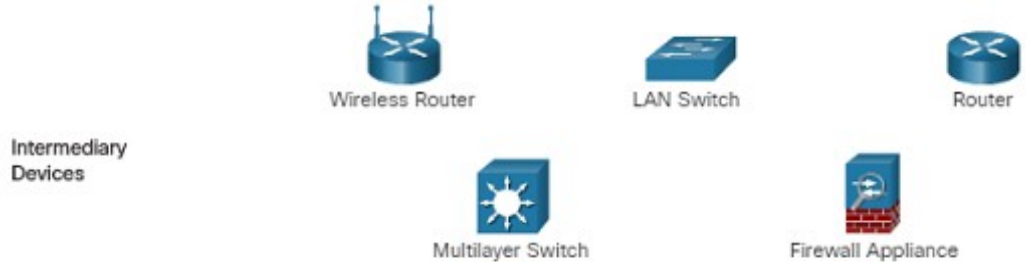


Intermediary Network Devices

An intermediary device interconnects end devices. Examples include switches, wireless access points, routers, and firewalls.

Management of data as it flows through a network is also the role of an intermediary device, including:

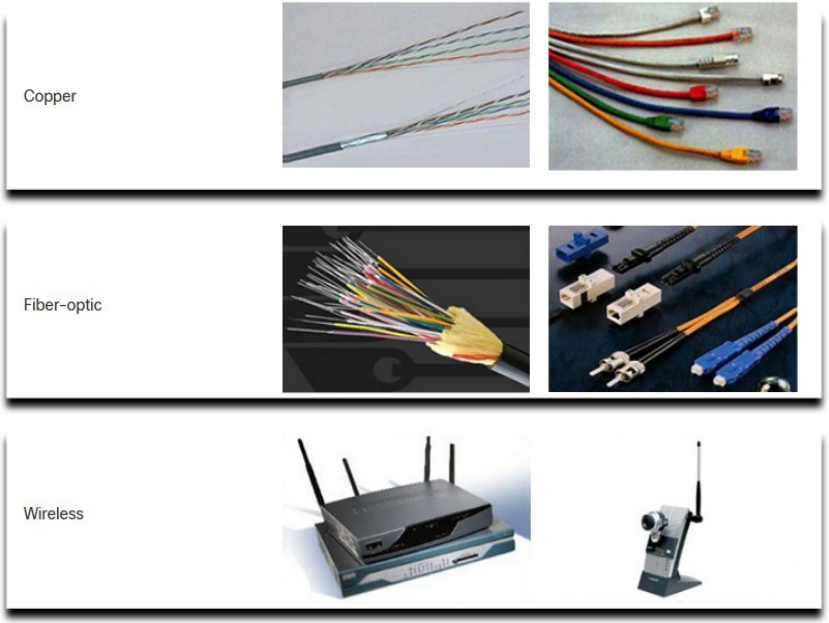
- Regenerate and retransmit data signals.
- Maintain information about what pathways exist in the network.
- Notify other devices of errors and communication failures.



Network Media

Communication across a network is carried through a medium which allows a message to travel from source to destination.

Media Types	Description
Metal wires within cables	Uses electrical impulses
Glass or plastic fibers within cables (fiber-optic cable)	Uses pulses of light.
Wireless transmission	Uses modulation of specific frequencies of electromagnetic waves.



1.3 Network Representations and Topologies

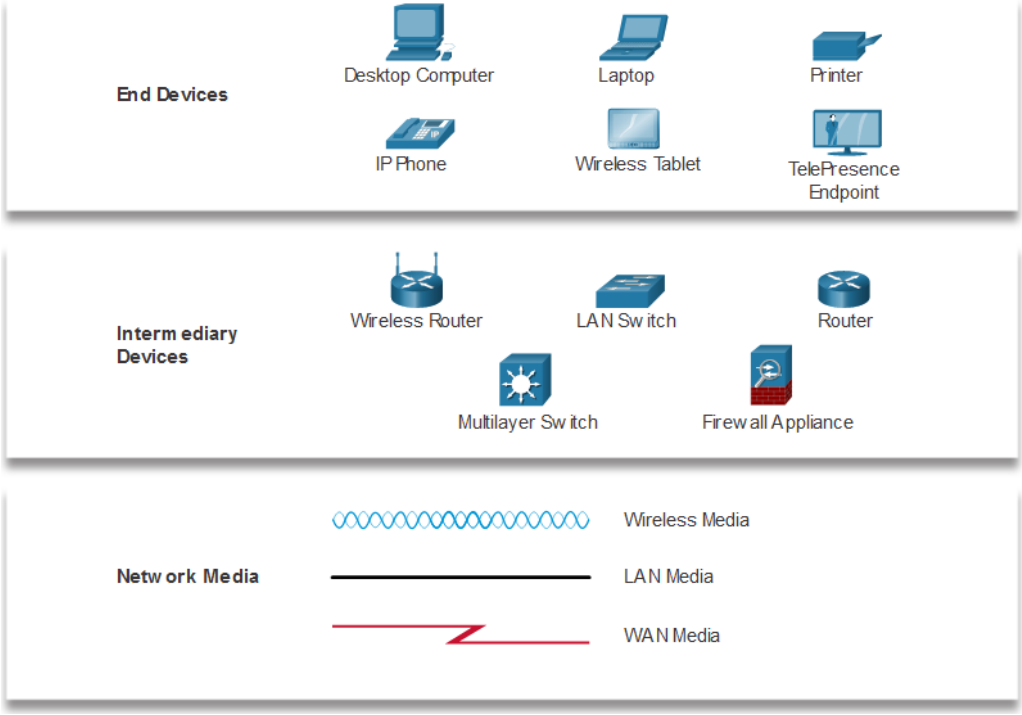
Network Representations

Network diagrams, often called topology diagrams, use symbols to represent devices within the network.

Important terms to know include:

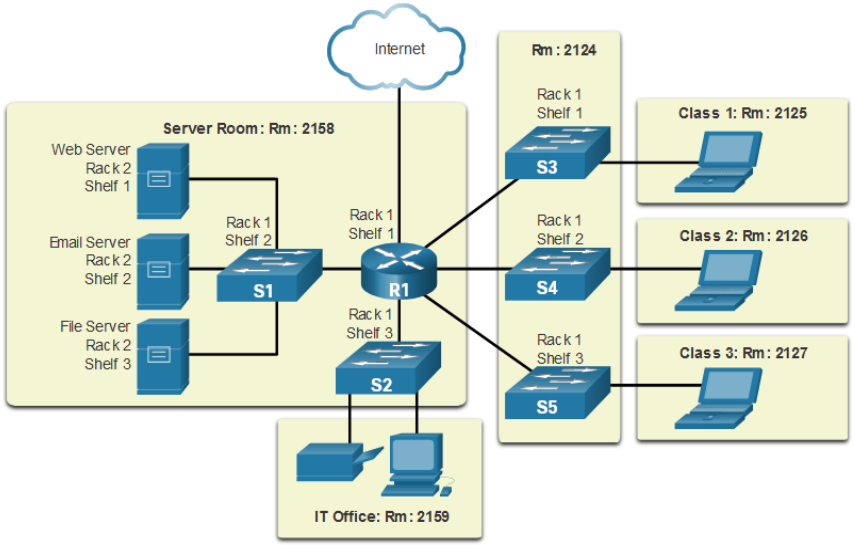
- Network Interface Card (NIC)
- Physical Port
- Interface

Note: Often, the terms port and interface are used interchangeably

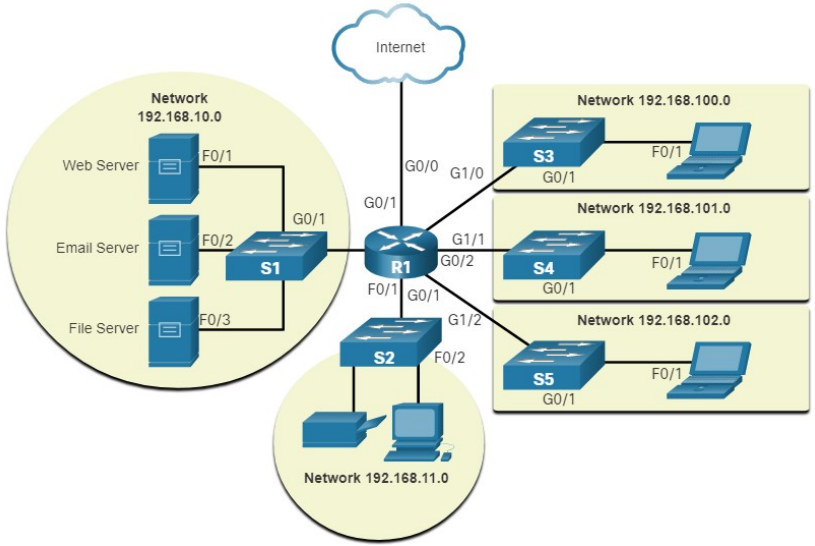


Topology Diagrams

Physical topology diagrams illustrate the physical location of intermediary devices and cable installation.



Logical topology diagrams illustrate devices, ports, and the addressing scheme of the network.

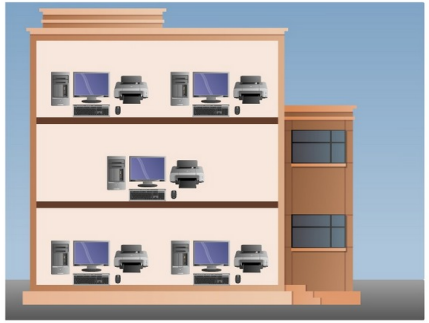


1.4 Common Types of Networks

Networks of Many Sizes

Small Home

SOHO



Medium/Large

World Wide

- Small Home Networks – connect a few computers to each other and the Internet
- Small Office/Home Office – enables computer within a home or remote office to connect to a corporate network
- Medium to Large Networks – many locations with hundreds or thousands of interconnected computers
- World Wide Networks – connects hundreds of millions of computers world-wide – such as the internet

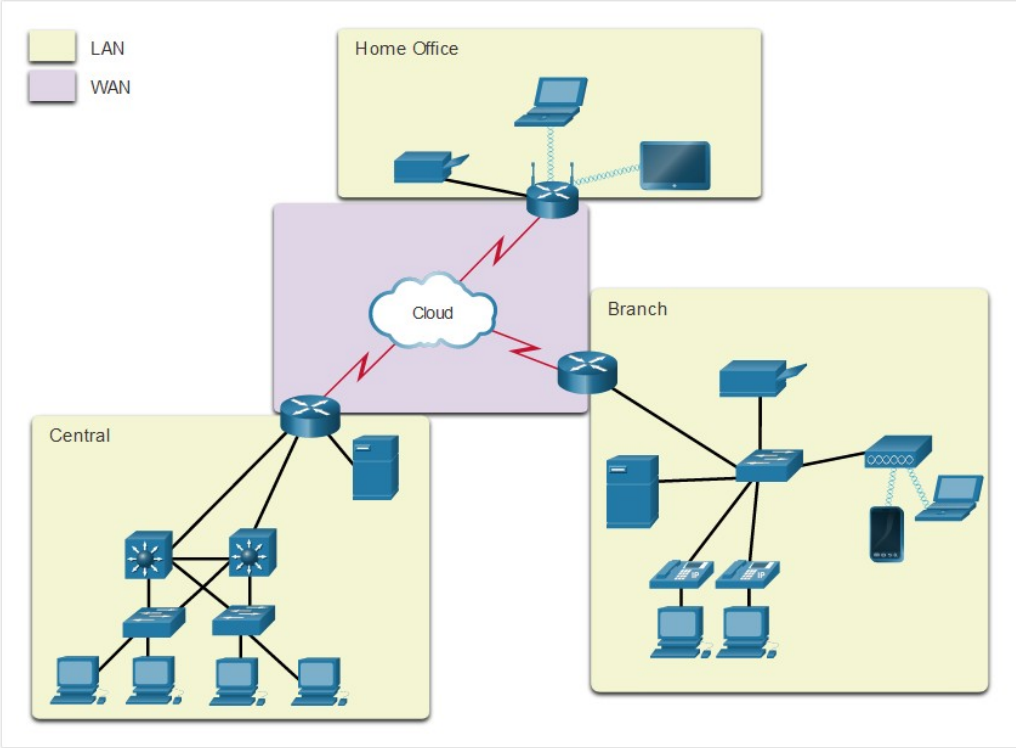
LANs and WANs

Network infrastructures vary greatly in terms of:

- Size of the area covered
- Number of users connected
- Number and types of services available
- Area of responsibility

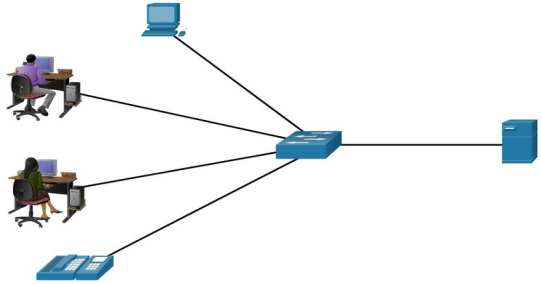
Two most common types of networks:

- Local Area Network (LAN)
- Wide Area Network (WAN).

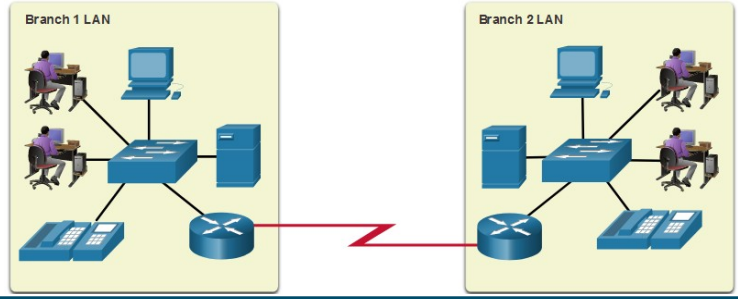


LANs and WANs (cont.)

A LAN is a network infrastructure that spans a small geographical area.



A WAN is a network infrastructure that spans a wide geographical area.



LAN	WAN
Interconnect end devices in a limited area.	Interconnect LANs over wide geographical areas.
Administered by a single organization or individual.	Typically administered by one or more service providers.
Provide high-speed bandwidth to internal devices.	Typically provide slower speed links between LANs.

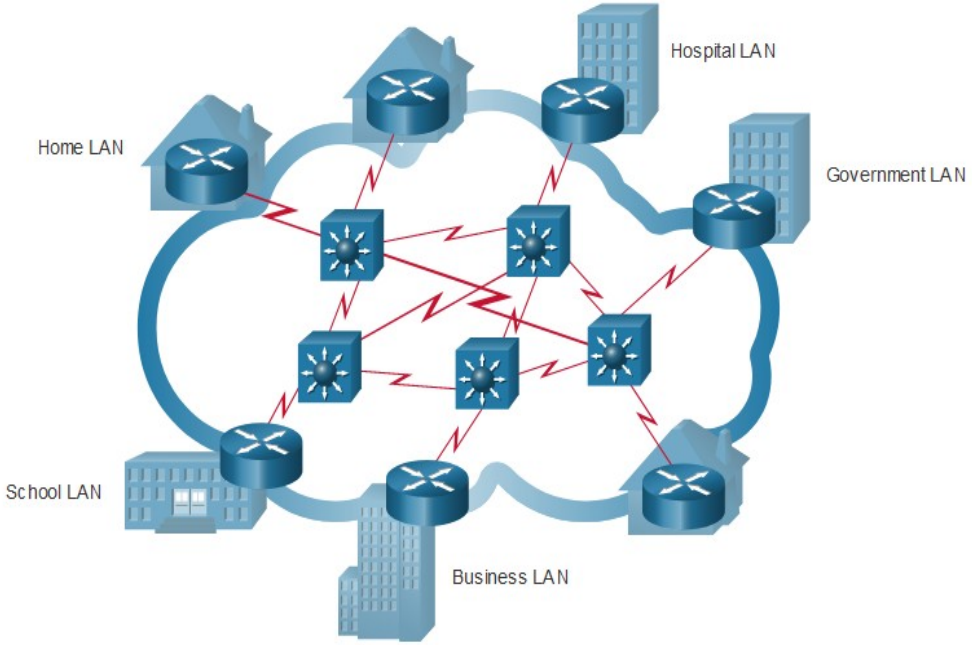
The Internet

The internet is a worldwide collection of interconnected LANs and WANs.

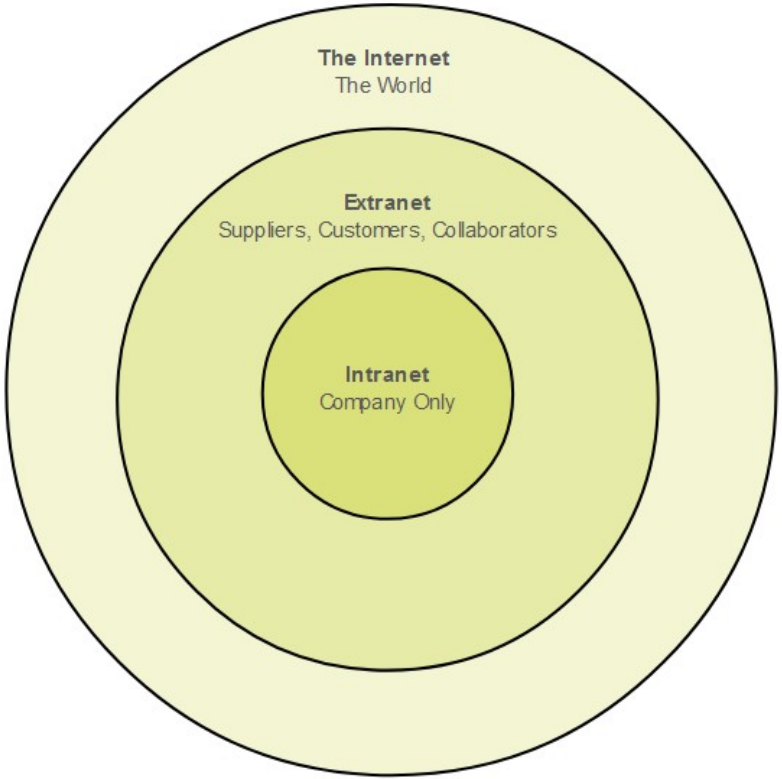
- LANs are connected to each other using WANs.
- WANs may use copper wires, fiber optic cables, and wireless transmissions.

The internet is not owned by any individual or group. The following groups were developed to help maintain structure on the internet:

- IETF
- ICANN
- IAB



Intranets and Extranets



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.

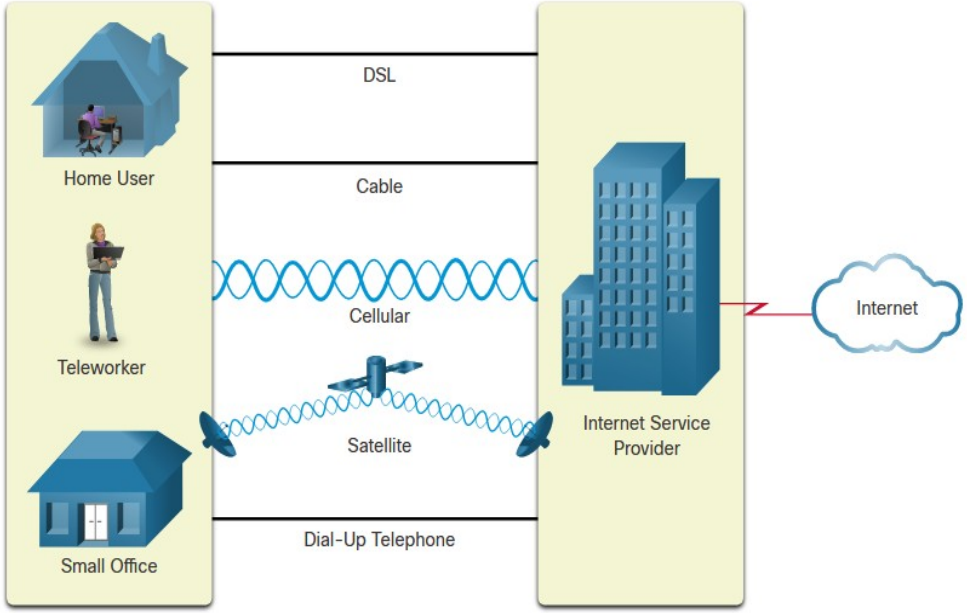
1.5 Internet Connections

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

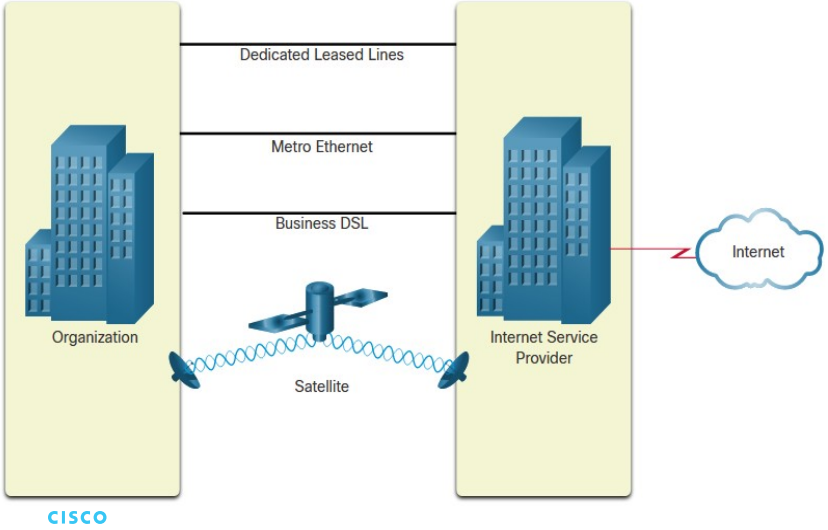


Connection	Description
Cable	high bandwidth, always on, internet offered by cable television service providers.
DSL	high bandwidth, always on, internet connection that runs over a telephone line.
Cellular	uses a cell phone network to connect to the internet.
Satellite	major benefit to rural areas without 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
- managed services

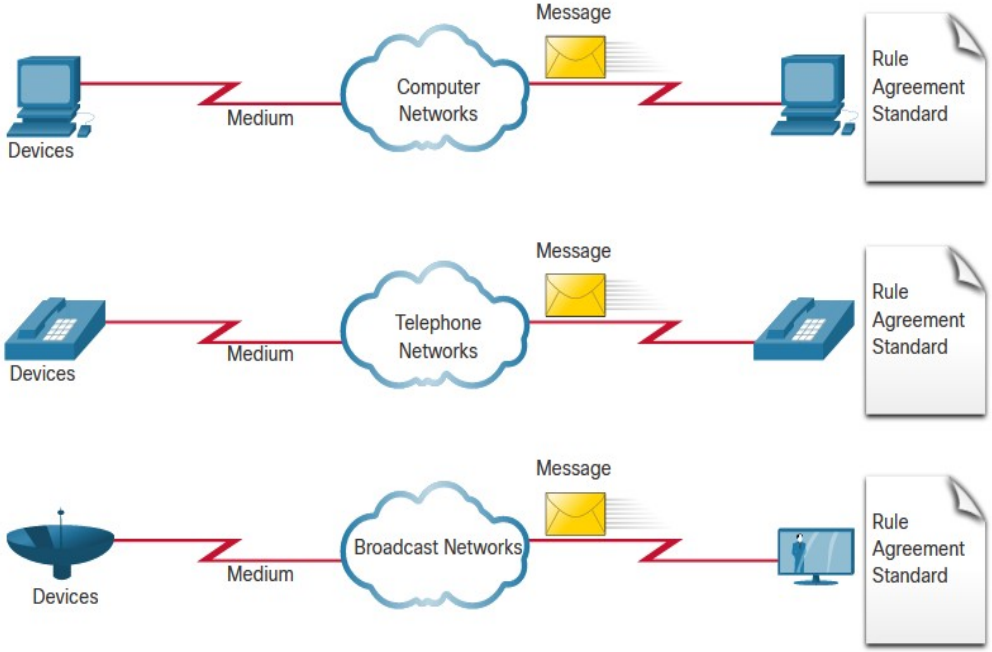


Type of Connection	Description
Dedicated Leased Line	These are reserved circuits within the service provider's network that connect distant offices with private voice and/or data networking.
Ethernet WAN	This extends LAN access technology into the WAN.
DSL	Business DSL is available in various formats including Symmetric Digital Subscriber Lines (SDSL).
Satellite	This can provide a connection when a wired solution is not available.

The Converging Network

Before converged networks, an organization would have been separately cabled for telephone, video, and data. Each of these networks would use different technologies to carry the signal.

Each of these technologies would use a different set of rules and standards.

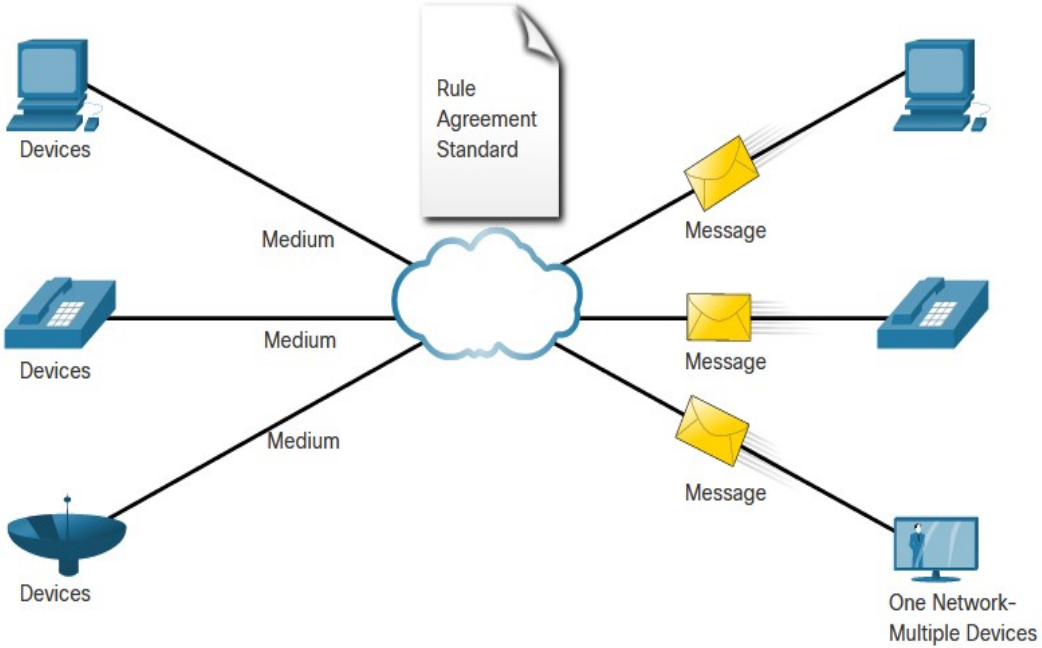


The Converging Network (Cont.)

Converged data networks carry multiple services on one link including:

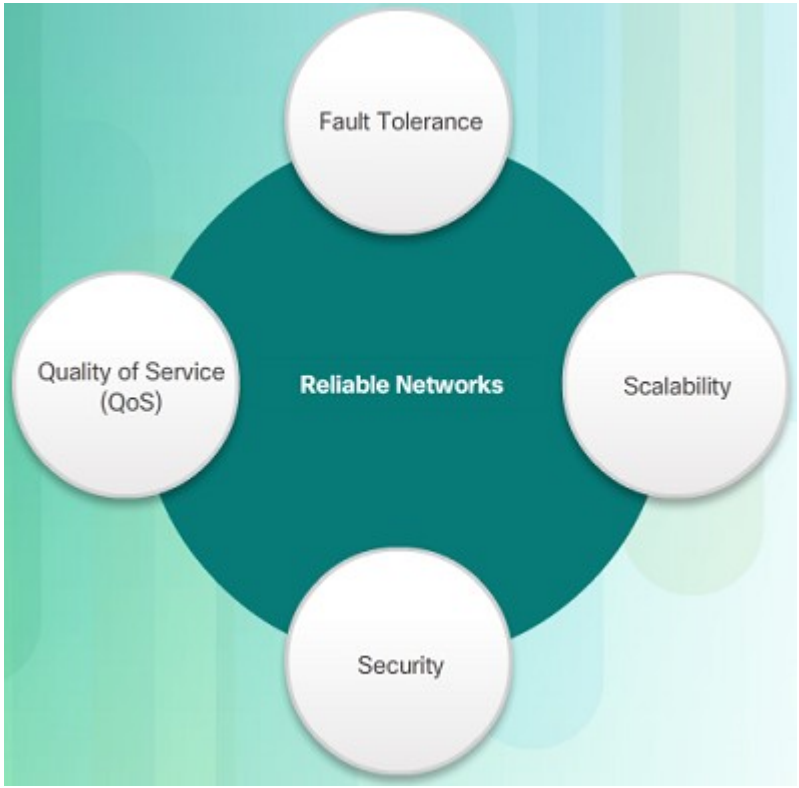
- data
- voice
- video

Converged networks can deliver data, voice, and video over the same network infrastructure. The network infrastructure uses the same set of rules and standards.



1.6 Reliable Networks

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

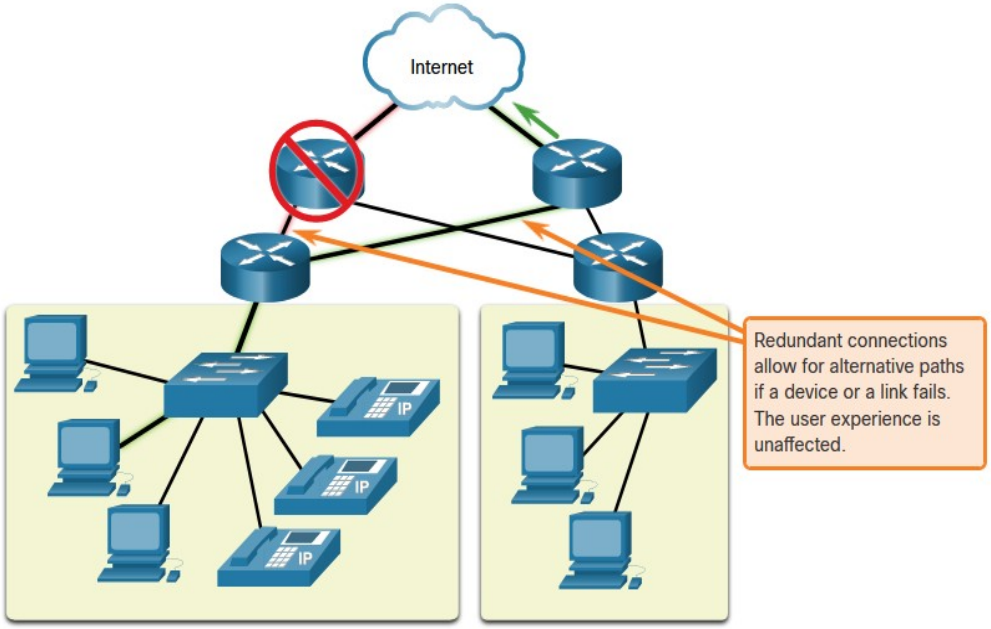
Fault Tolerance

A fault tolerant network limits the impact of a failure by limiting the number of affected devices. Multiple paths are required for fault tolerance.

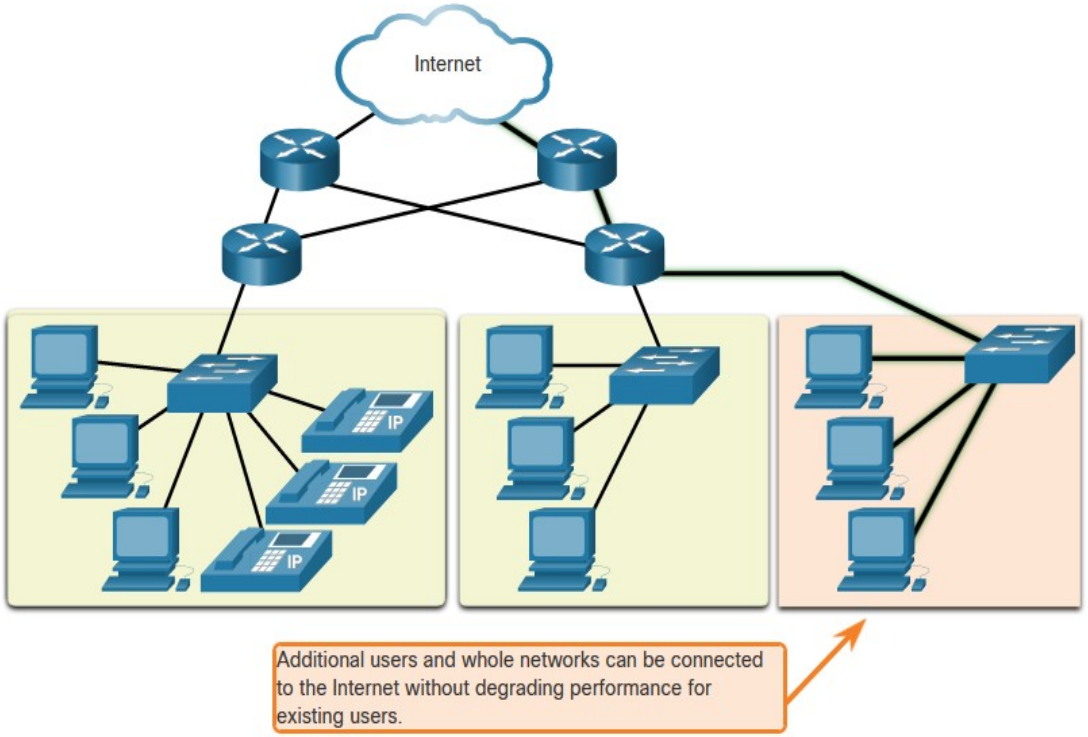
Reliable networks provide redundancy by implementing a packet switched network:

- 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



A scalable network can expand quickly and easily to support new users and applications without impacting the performance of services to existing users.

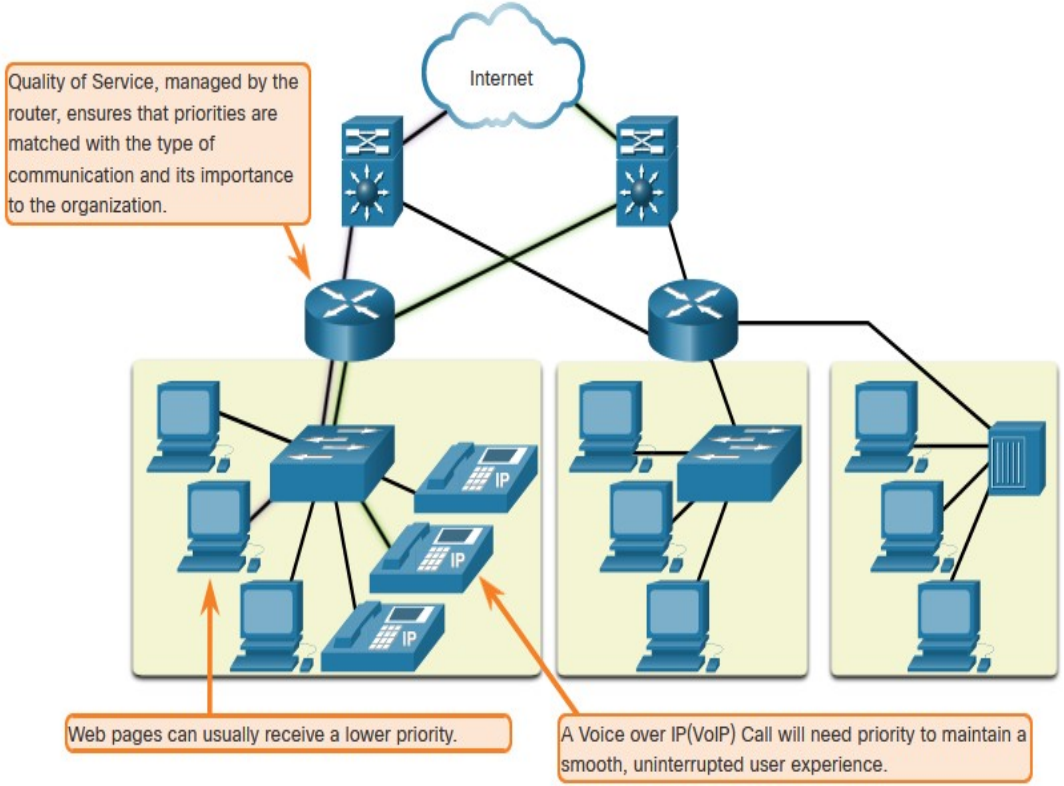
Network designers follow accepted standards and protocols in order to make the networks scalable.

Quality of Service

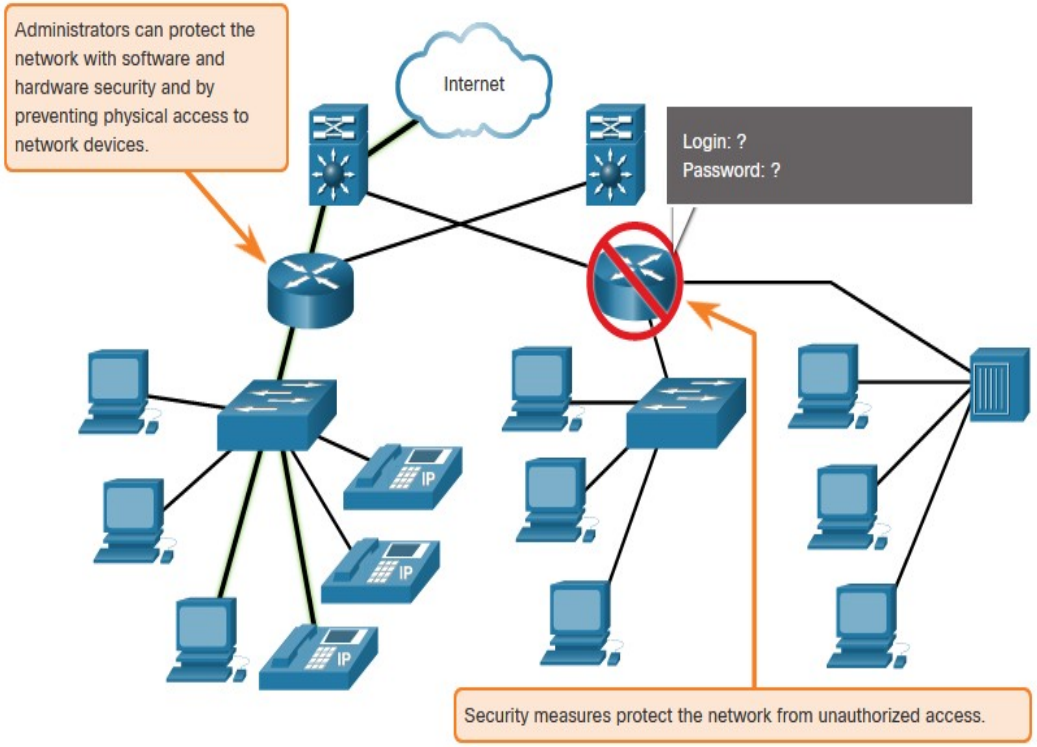
Voice and live video transmissions require higher expectations for those services being delivered.

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.



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 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

1.7 Network Trends

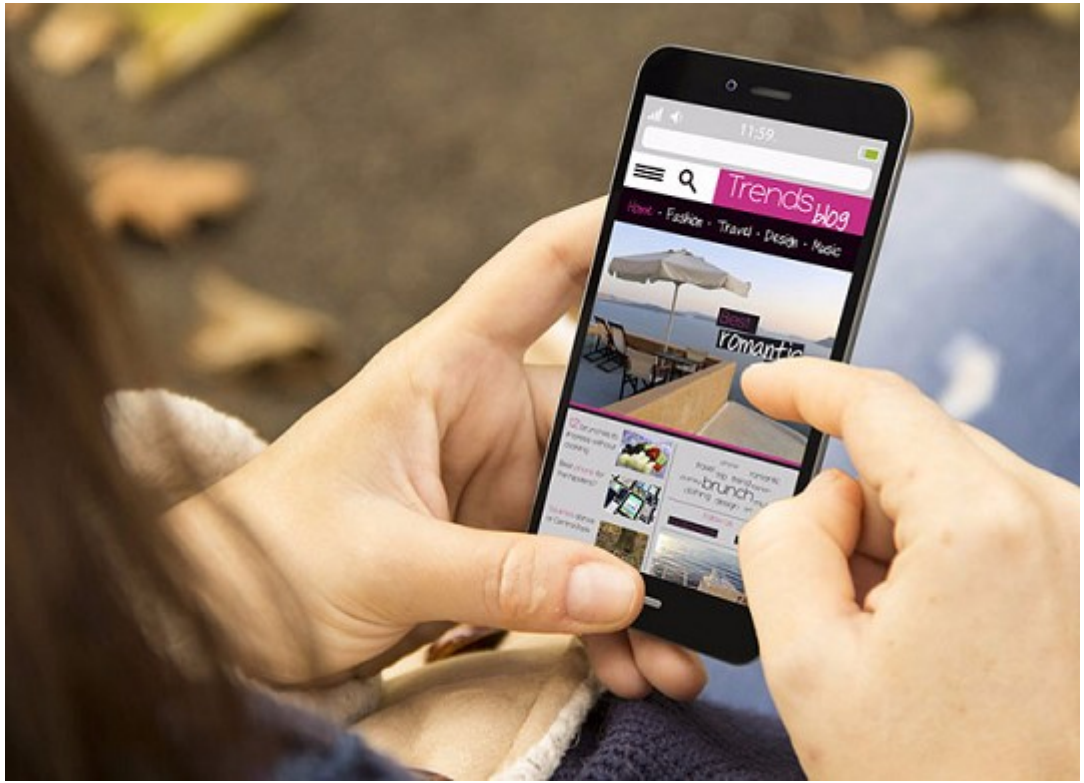
Recent Trends

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) 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

BYOD means any device, with any ownership, used anywhere.

Online Collaboration

- 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 and interact.
- Collaboration is a very high priority for businesses and in education.
- MS Teams, Zoom, Cisco Webex Teams is a multifunctional collaboration tool.
  - send instant messages
  - post images
  - post videos and links

Cloud Computing

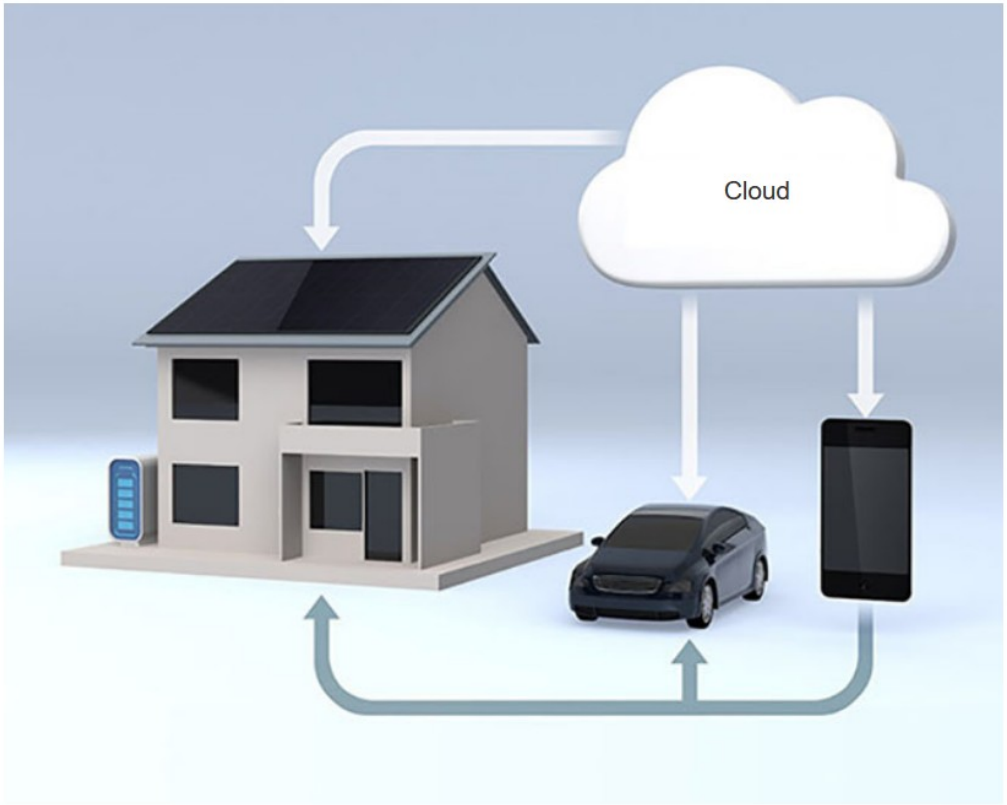
Cloud computing allows us to store personal files or backup our data on servers over the internet.

- Applications can also be accessed using the Cloud.
- Allows businesses to deliver to any device anywhere in the world.

Cloud computing is made possible by data centers.

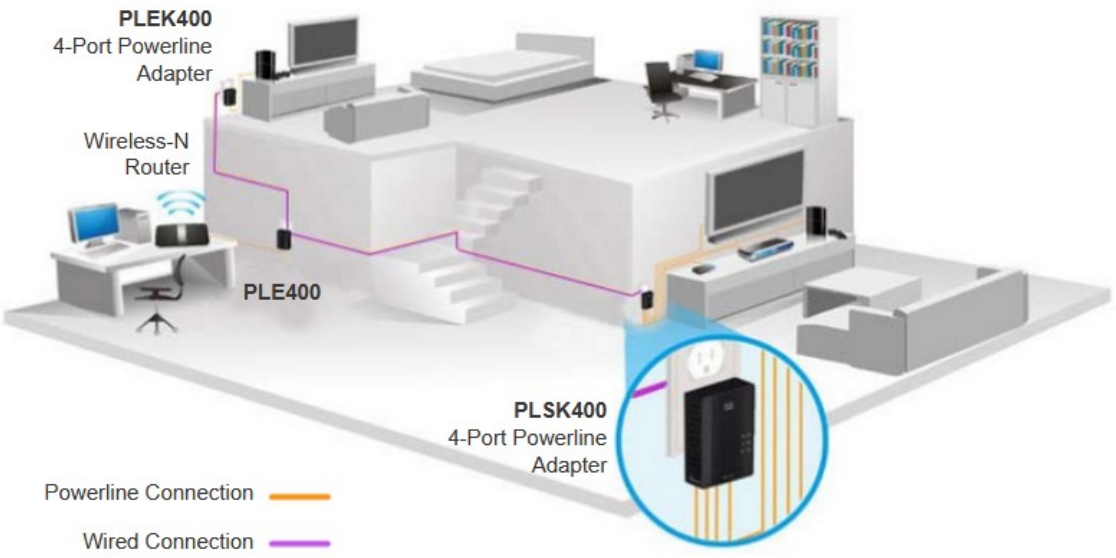
- Smaller companies that can't afford their own data centers, lease server and storage services from larger data center organizations in the Cloud.

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.
- 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.
- Smart home technology is currently being developed for all rooms within a house.

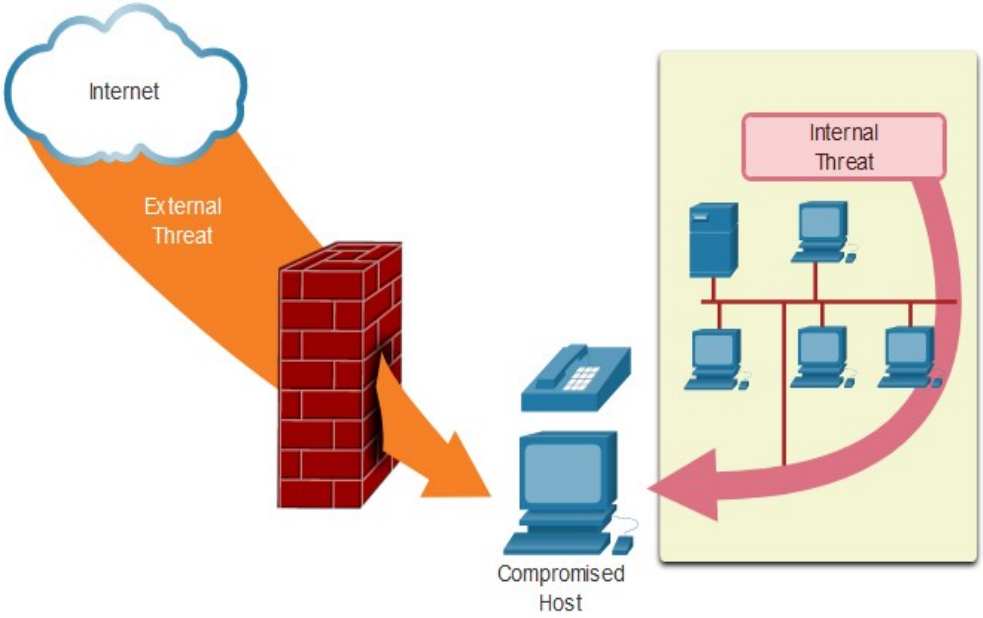
Powerline Networking



- 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 reach all the devices in the home.

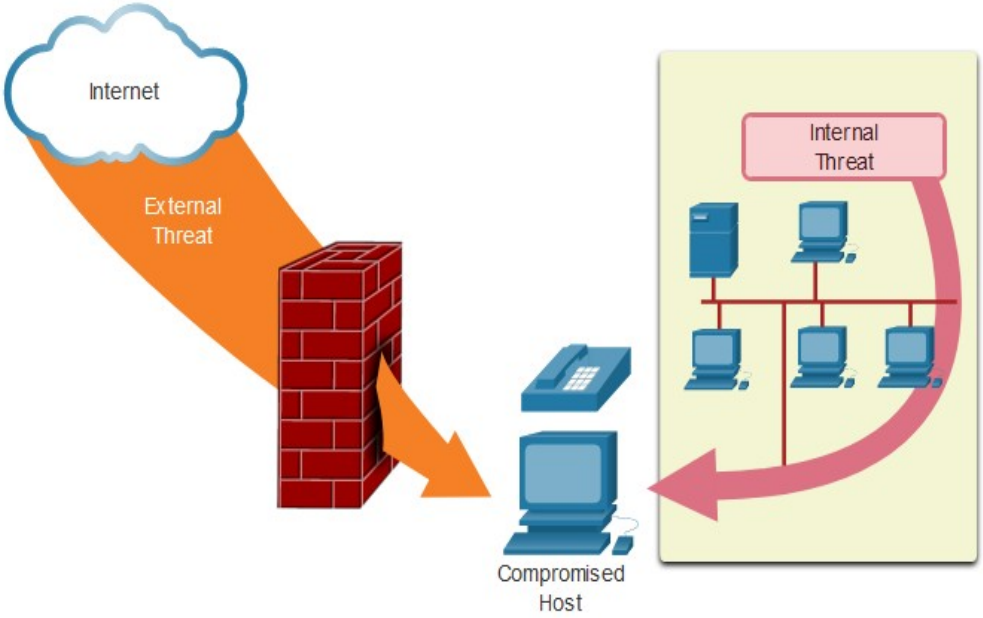
1.8 Network Security

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.

Security Threats (Cont.)



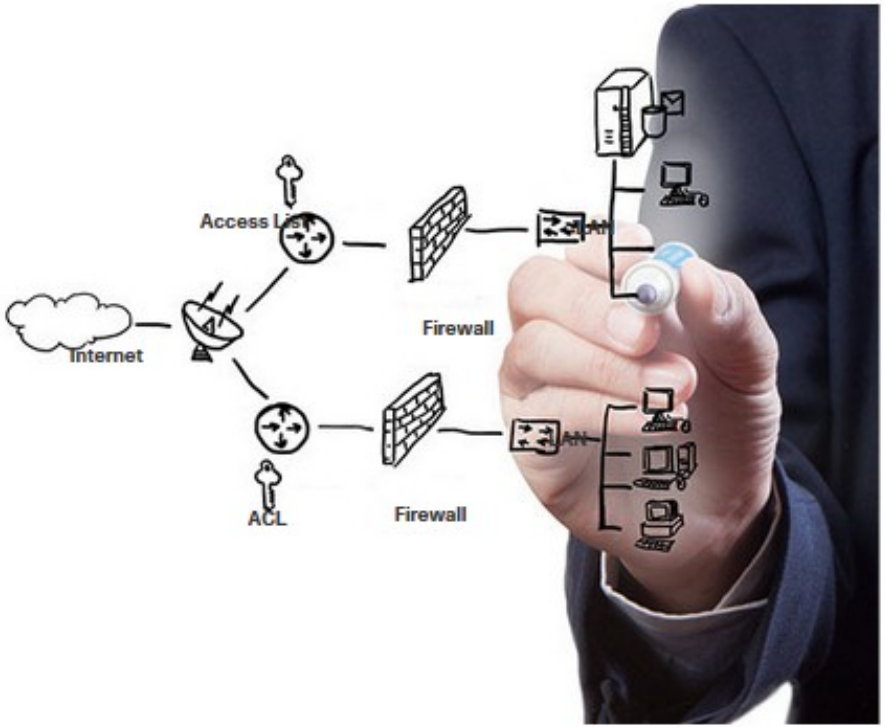
External Threats:

- Viruses, worms, and Trojan horses
- Spyware and adware
- Zero-day attacks
- Threat Actor attacks
- Denial of service attacks
- Data interception and theft
- Identity theft

Internal Threats:

- lost or stolen devices
- accidental misuse by employees
- malicious employees

Security Solutions

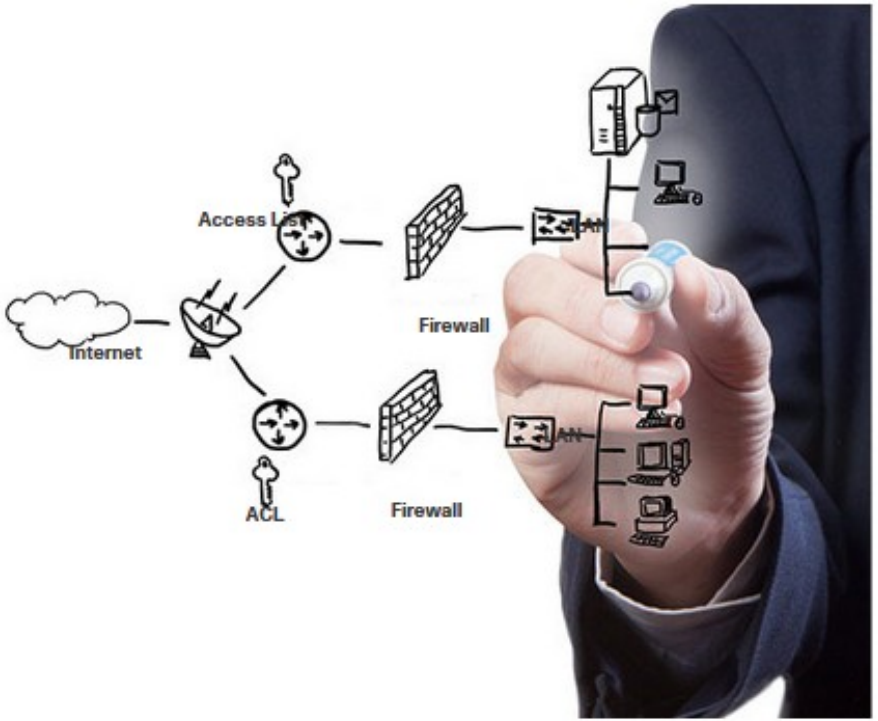


Security must be implemented in multiple layers using more than one security solution.

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
- Access control lists (ACL)
- Intrusion prevention systems (IPS)
- Virtual private networks (VPN)

The study of network security starts with a clear understanding of the underlying switching and routing infrastructure.

Some security research to watch or read

- **Final year Project - Flow-based Botnet Detection via Bio-Optimised Machine Learning Models:**
  Flow-based Botnet Detection via Bio-Optimised Machine Learning Models (youtube.com)

- **Some security research papers to read:**
  - The art of war driving and security threats: https://ieeexplore.ieee.org/document/1635452
  - Secure ARP and Secure DHCP Protocols to Mitigate Security Attacks: https://arxiv.org/abs/1410.4398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