TRƯỜNG ĐẠI HỌC CÔNG NGHỆ THÔNG TIN – ĐHQG-HCM
Khoa Mạng máy tính & Truyền thông

Cơ sở hạ tầng mạng

NT132 – Quản trị mạng và hệ thống

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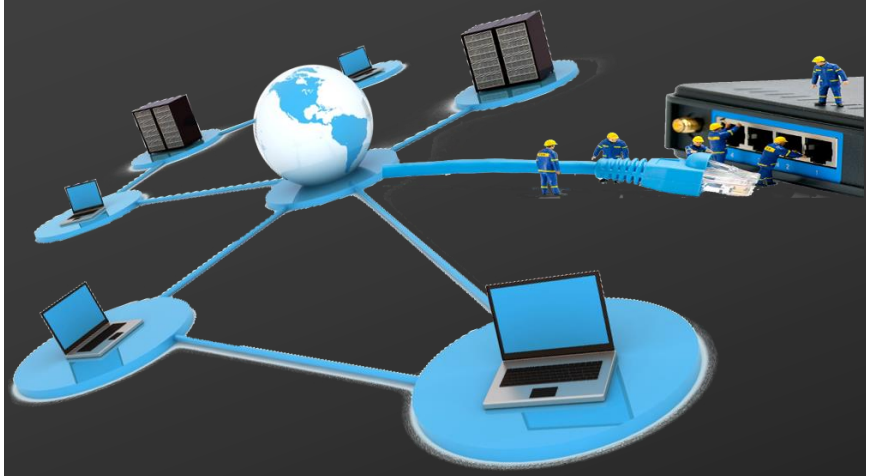


Nội dung

Cơ sở hạ tầng mạng

Hôm nay học gì?

1. Các thành phần mạng
2. Giao thức mạng
3. Đóng gói dữ liệu
4. Cấu hình thiết bị

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

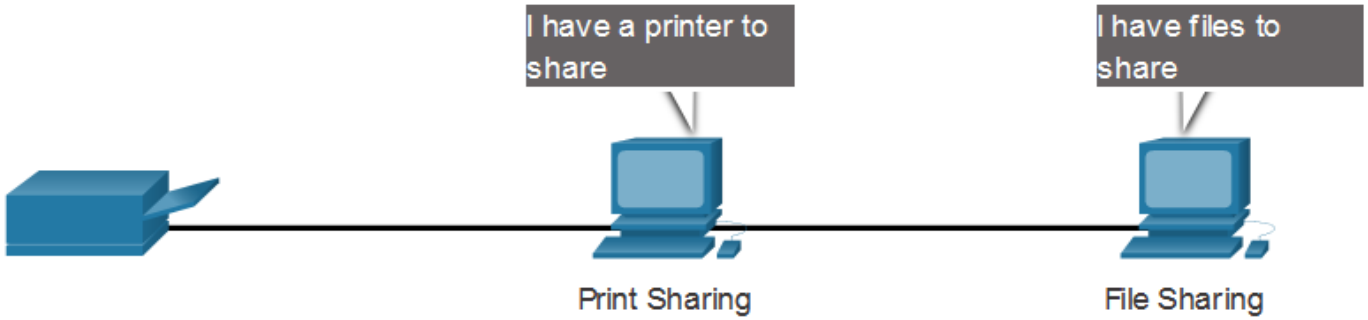
Clients are computers that send requests to the servers to retrieve information:

- 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

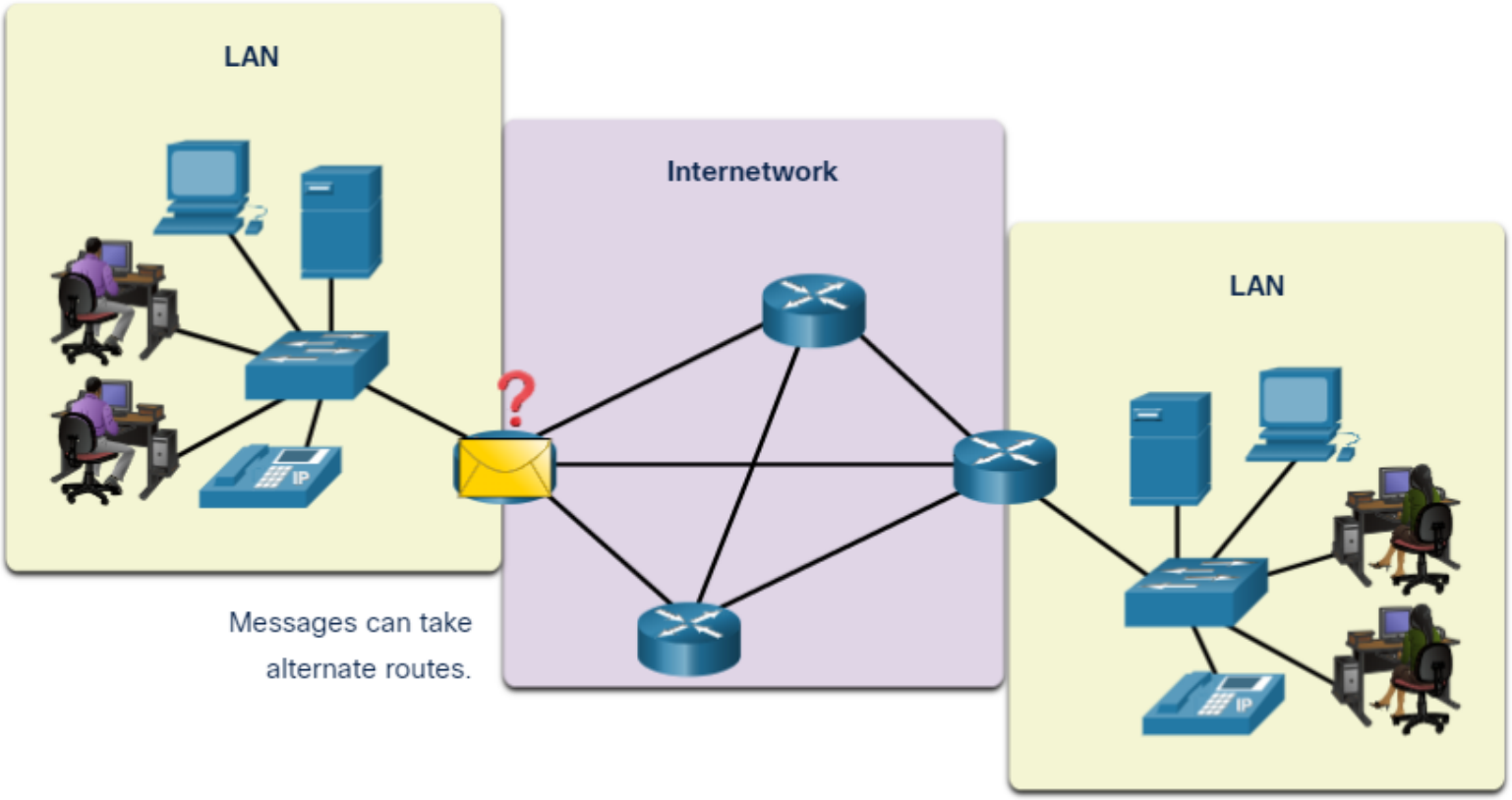
It is possible to have a device be a client and a server in a Peer-to-Peer Network. This type of network design is only recommended for very small networks.



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.

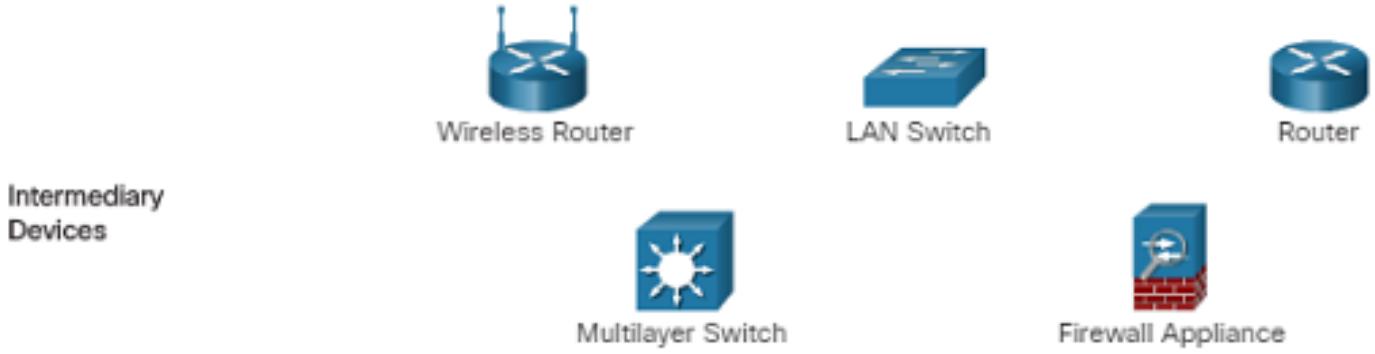


Intermediary Network Devices

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:

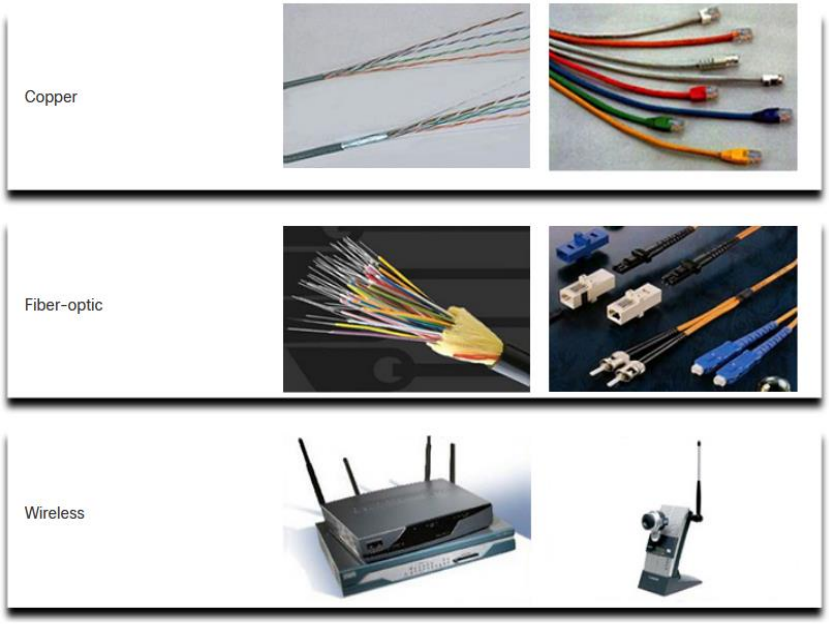
- Regenerate and retransmit data signals.
- Maintain information about what pathways exist in the network.
- Notify other devices of errors and communication failures.



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.



Network Representations and Topologies

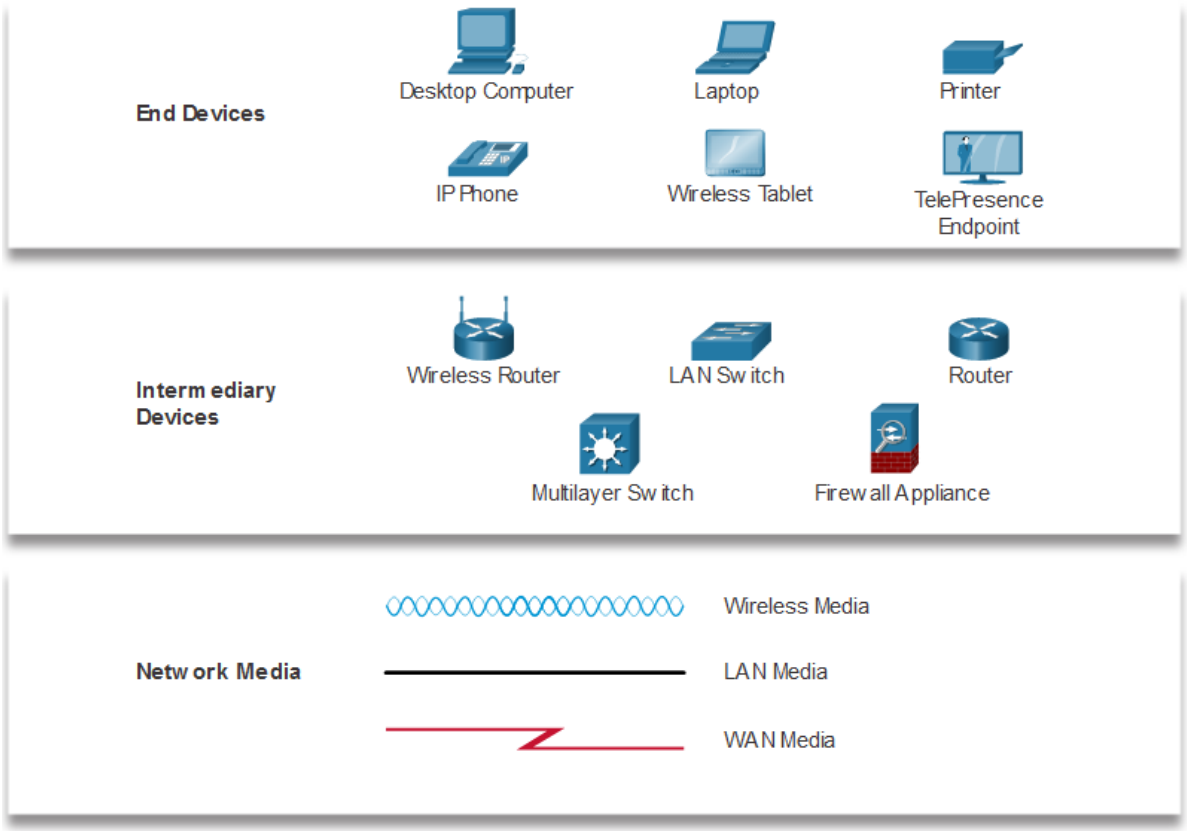
Network Representations

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

Important terms to know include:

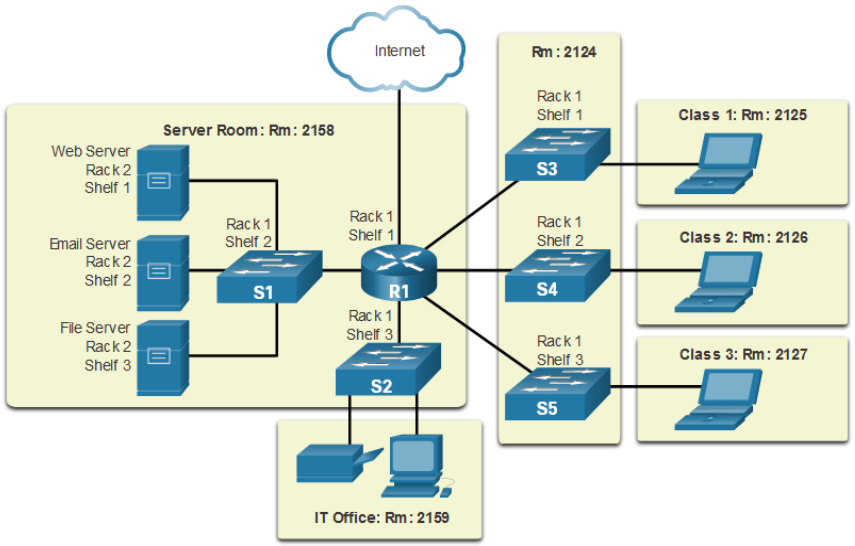
- Network Interface Card (NIC)
- Physical Port
- Interface

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

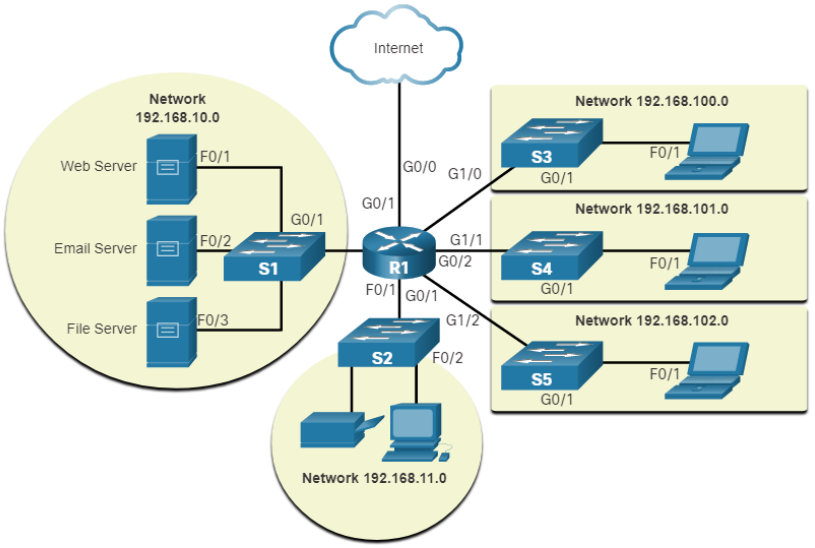


Topology Diagrams

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.



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

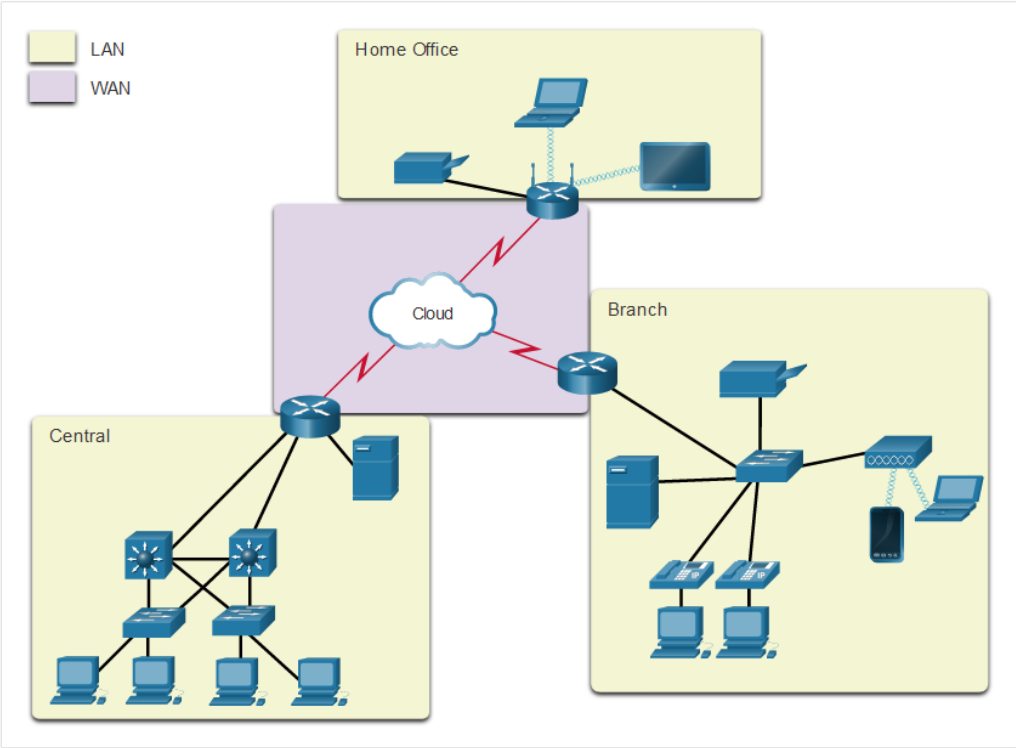
LANs and WANs

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

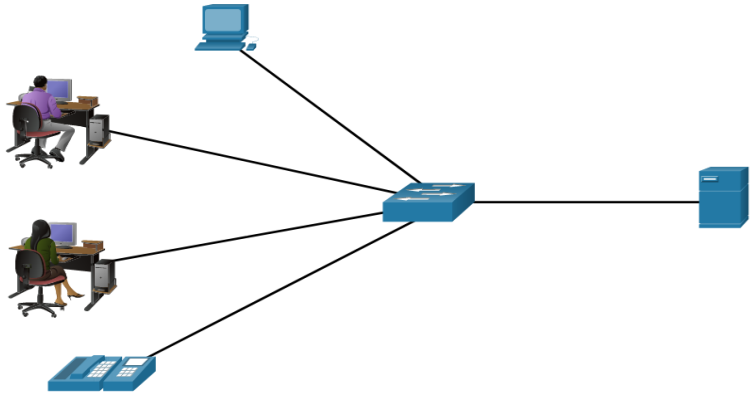
Two most common types of networks:

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

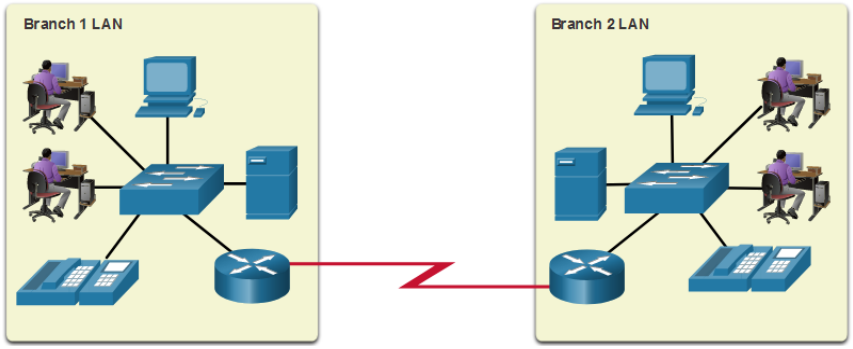


LANs and WANs (cont.)

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.

Common Types of Networks

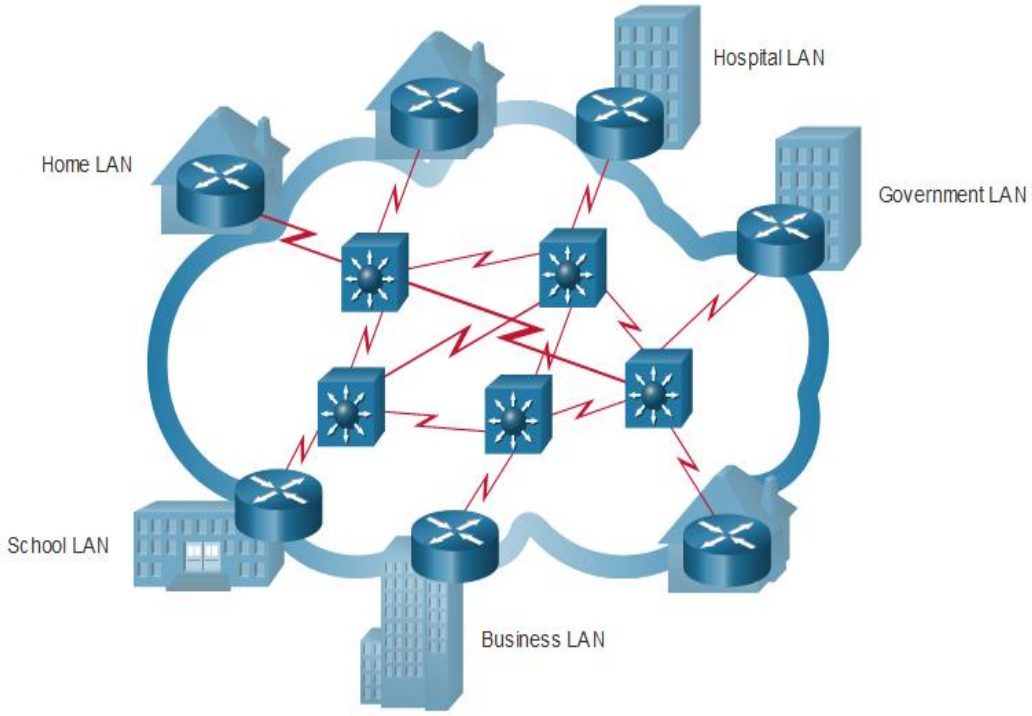
The Internet

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

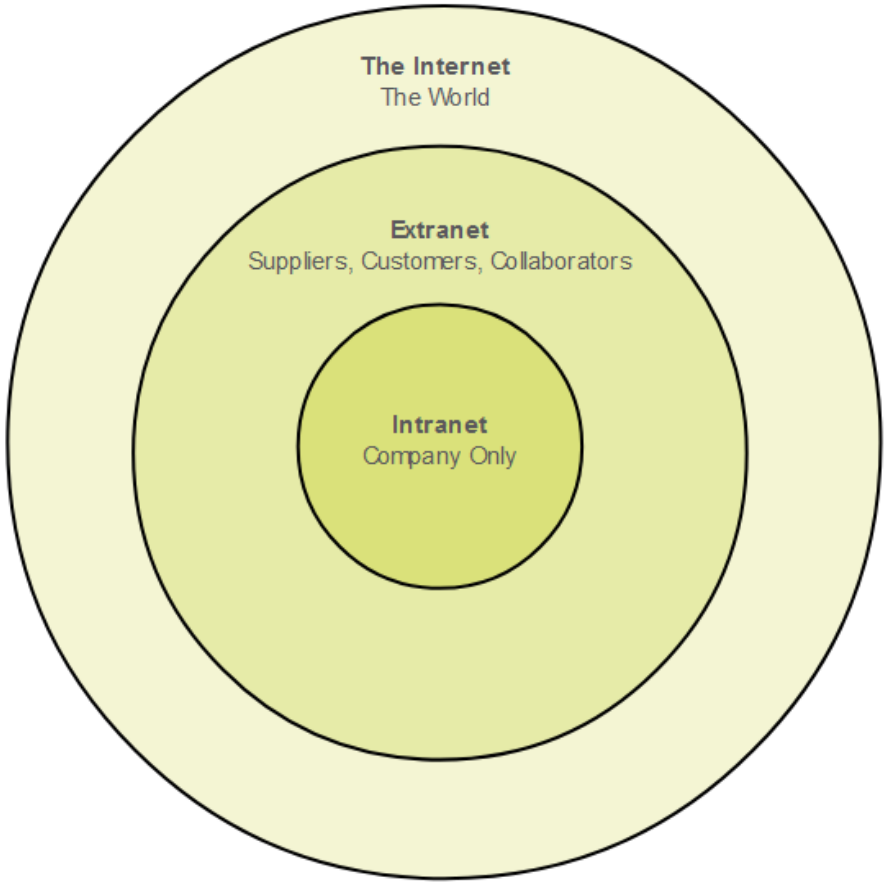
- LANs are connected to each other using WANs.
- WANs may use copper wires, fiber optic cables, and wireless transmissions.

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

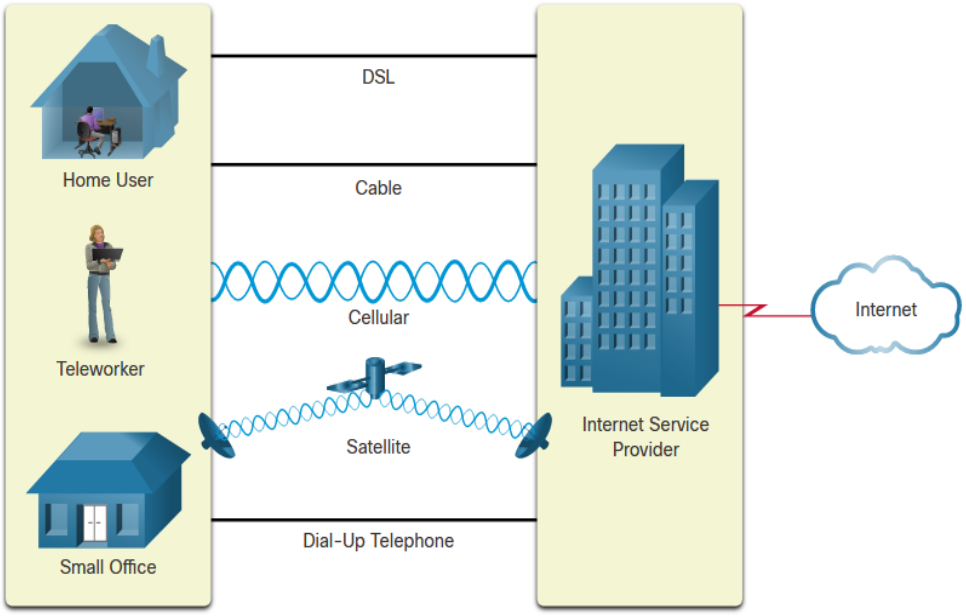


An intranet is a private collection of LANs and WANs internal to an organization that is meant to be accessible only to the organizations members or others with authorization.

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.

Internet Connections

Home and Small Office Internet Connections

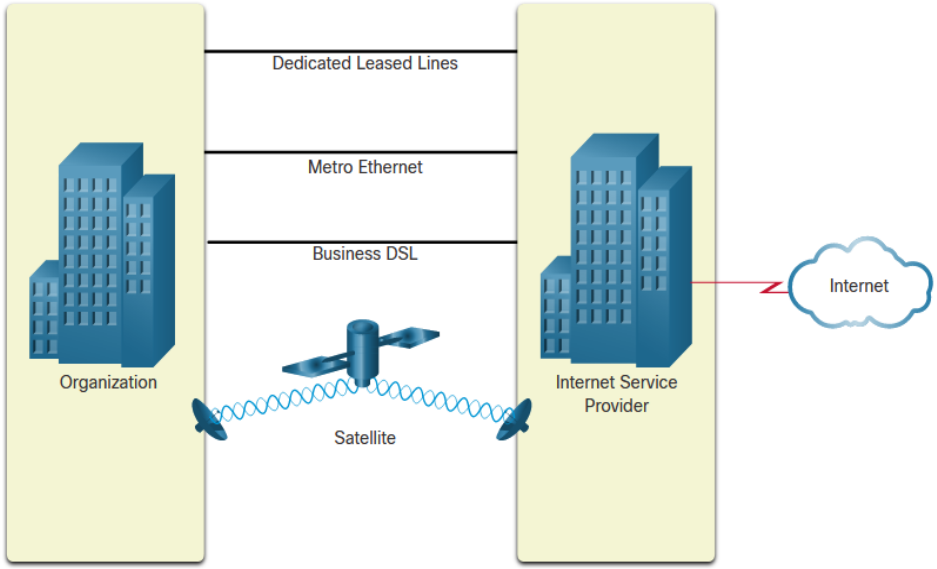


Connection	Description
Cable	high bandwidth, always on, internet offered by cable television service providers.
DSL	high bandwidth, always on, internet connection that runs over a telephone line.
Cellular	uses a cell phone network to connect to the internet.
Satellite	major benefit to rural areas without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

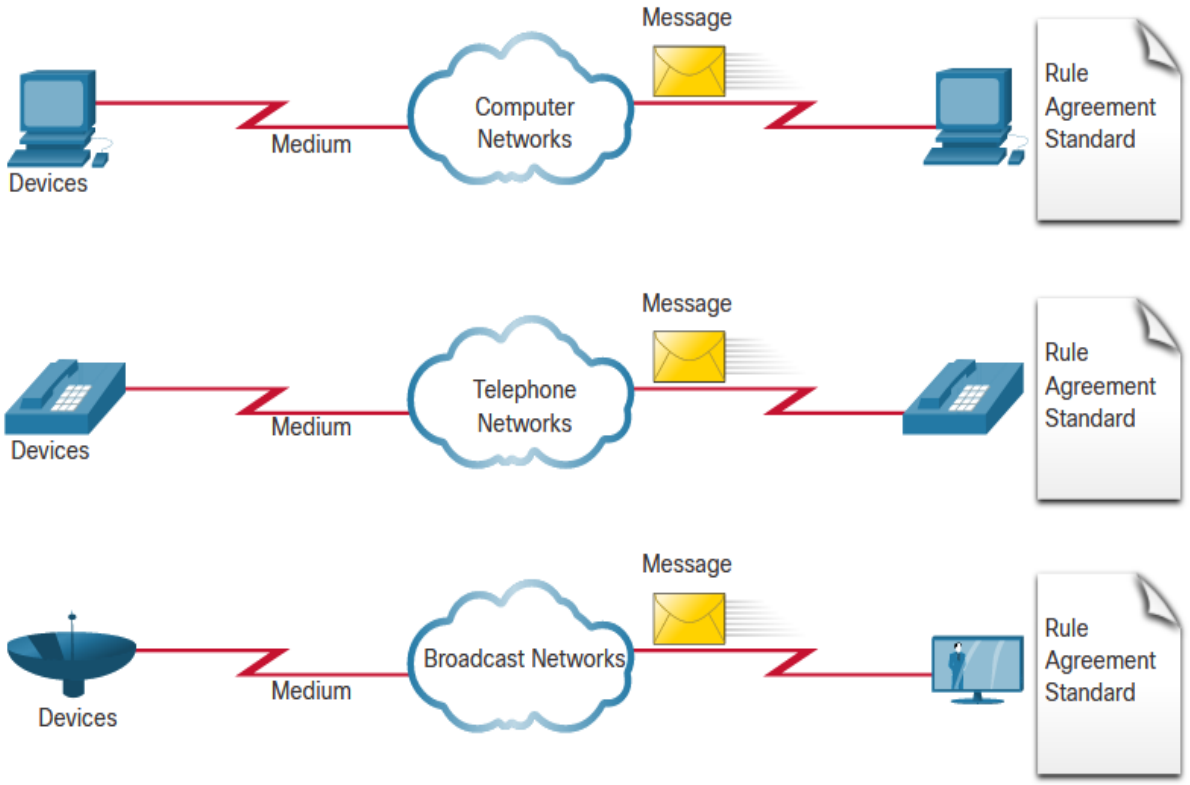


Type of Connection	Description
Dedicated Leased Line	These are reserved circuits within the service provider's network that connect distant offices with private voice and/or data networking.
Ethernet WAN	This extends LAN access technology into the WAN.
DSL	Business DSL is available in various formats 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.

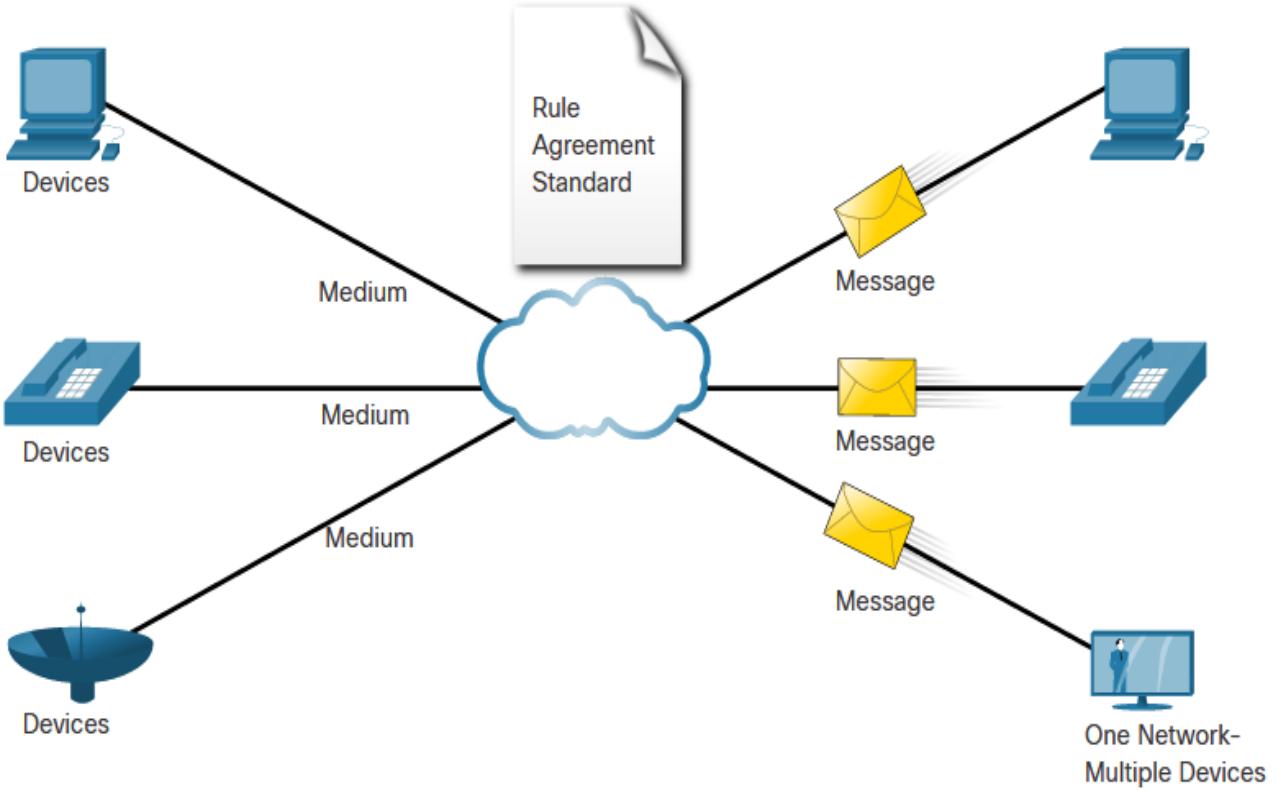


The Converging Network (Cont.)

Converged data networks carry multiple services on one link including:

- data
- voice
- video

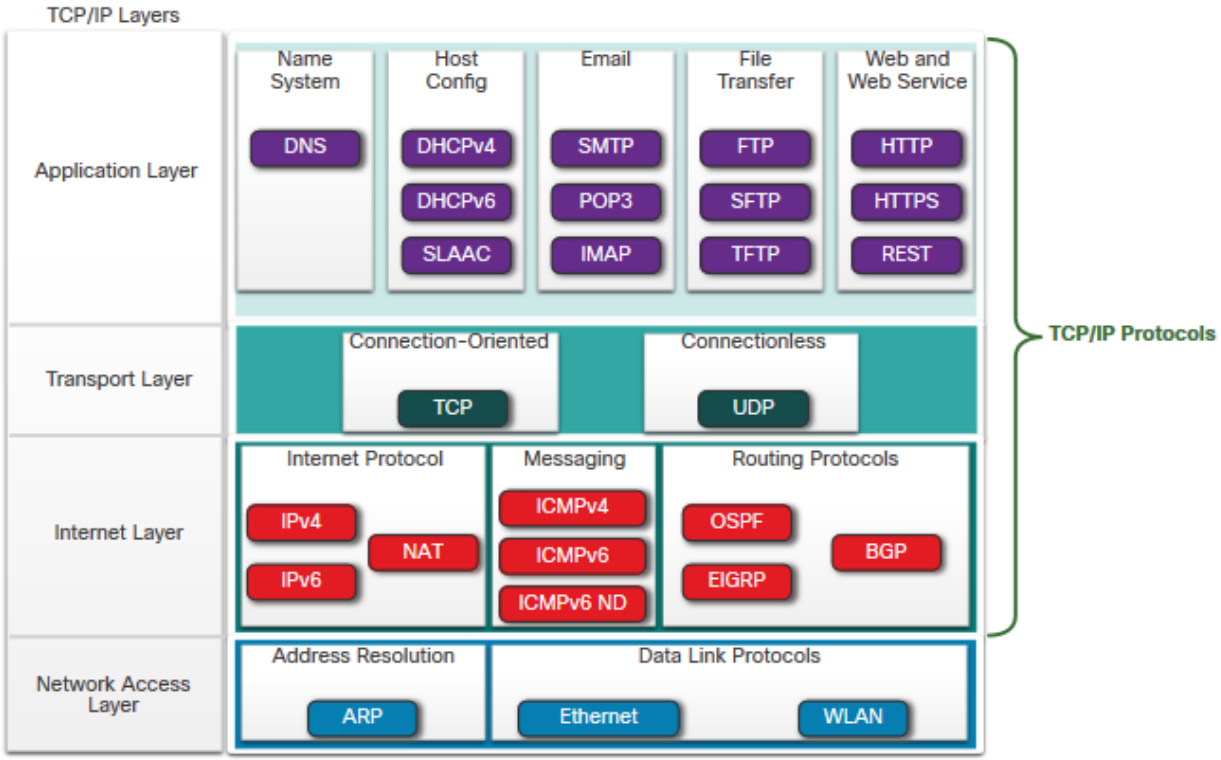
Converged networks can deliver data, voice, and video over the same network infrastructure. The network infrastructure uses the same set of rules and standards.



Protocol Suites

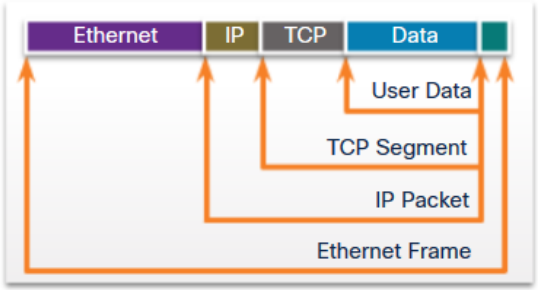
TCP/IP Protocol Suite

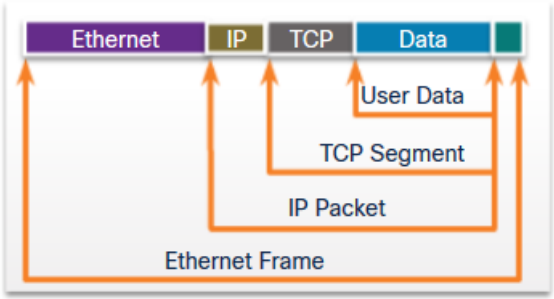
- TCP/IP is the protocol suite used by the internet and includes many protocols.
- TCP/IP is:
  - An open standard protocol suite that is freely available to the public and can be used by any vendor
  - A standards-based protocol suite that is endorsed by the networking industry and approved by a standards organization to ensure interoperability

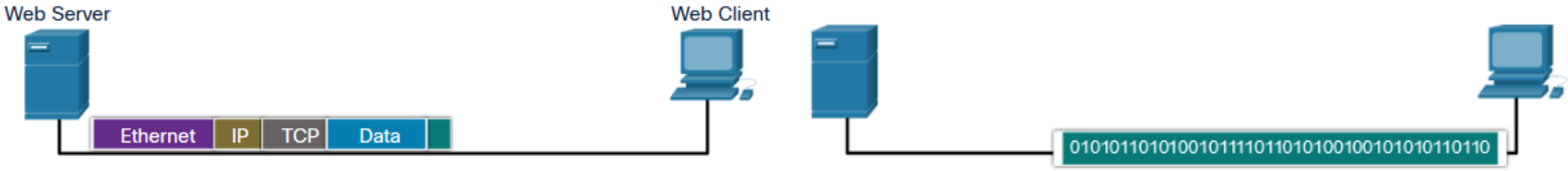


TCP/IP Communication Process

- A web server encapsulating and sending a web page to a client.
- A client de-encapsulating the web page for the web browser

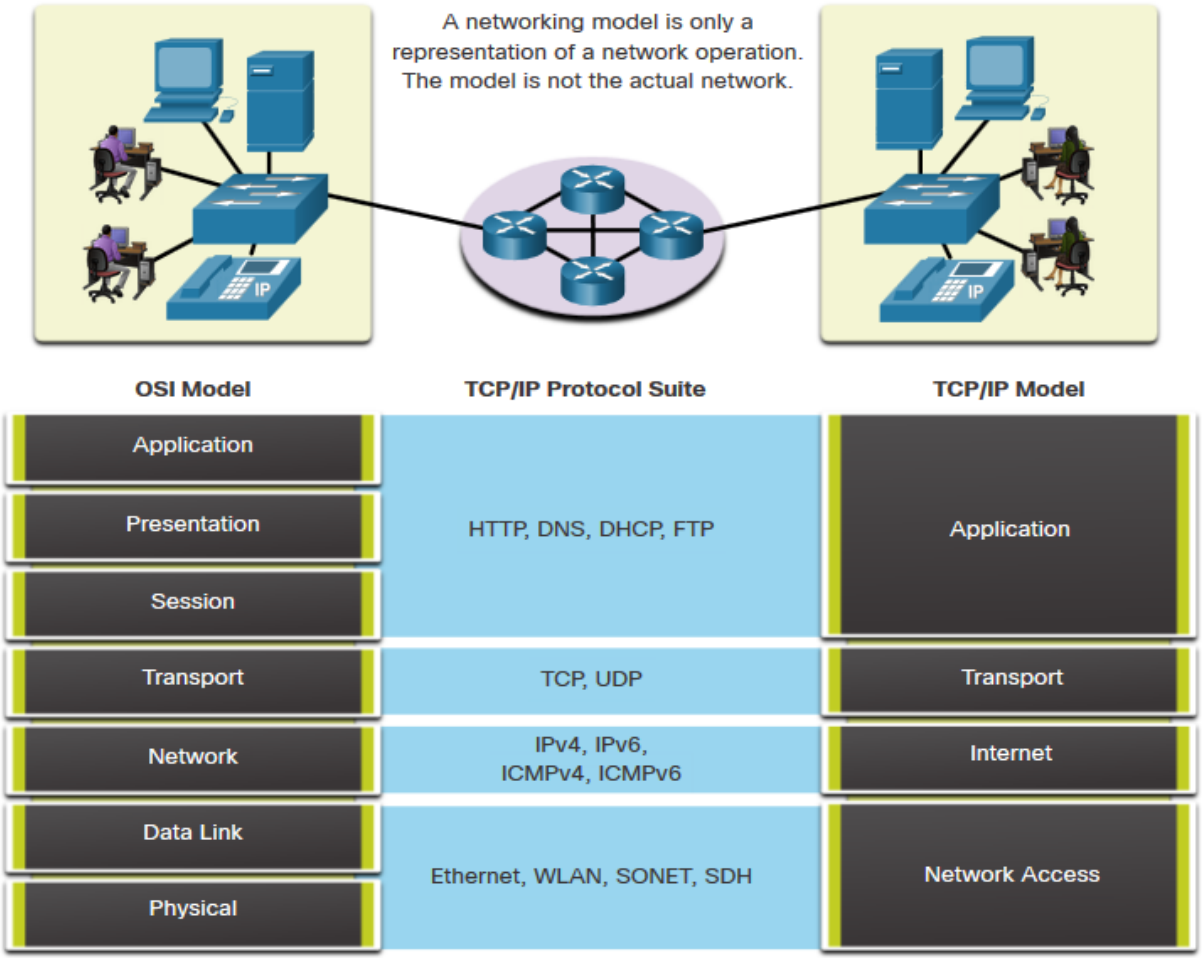






Reference Models

The Benefits of Using a Layered Model



Complex concepts such as how a network operates can be difficult to explain and understand. For this reason, a layered model is used.

Two layered models describe network operations:

- Open System Interconnection (OSI) Reference Model
- TCP/IP Reference Model

The Benefits of Using a Layered Model (Cont.)

These are the benefits of using a layered model:

- Assist in protocol design because protocols that operate at a specific layer have defined information that they act upon and a defined interface to the layers above and below
- Foster competition because products from different vendors can work together
- Prevent technology or capability changes in one layer from affecting other layers above and below
- Provide a common language to describe networking functions and capabilities

The OSI Reference Model

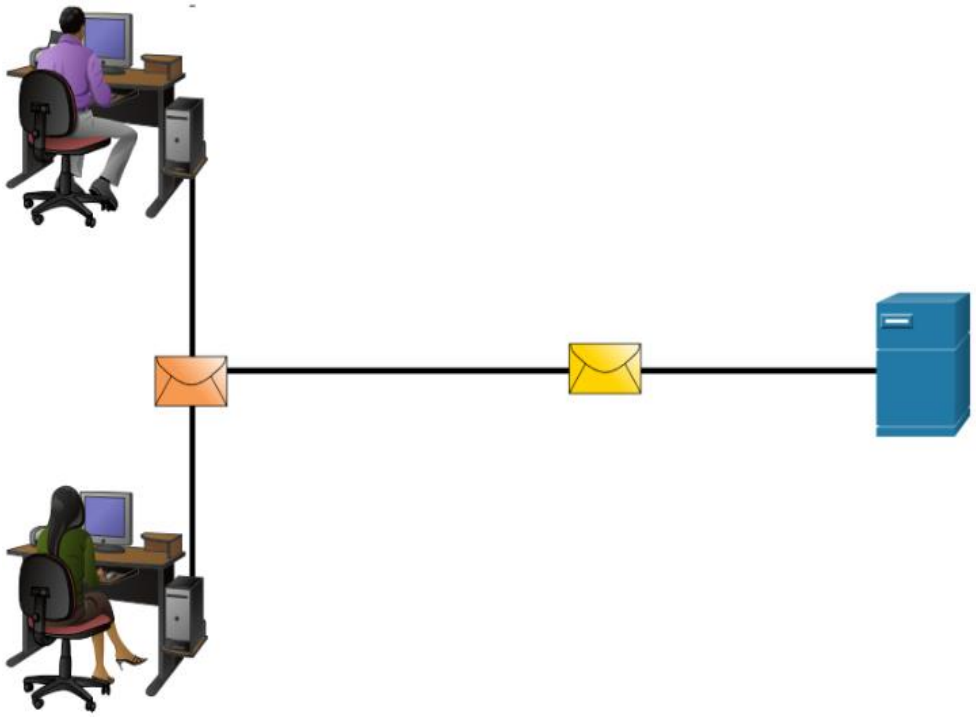
OSI Model Layer	Description
7 - Application	Contains protocols used for process-to-process communications.
6 - Presentation	Provides for common representation of the data transferred between application layer services.
5 - Session	Provides services to the presentation layer and to manage data exchange.
4 - Transport	Defines services to segment, transfer, and reassemble the data for individual communications.
3 - Network	Provides services to exchange the individual pieces of data over the network.
2 - Data Link	Describes methods for exchanging data frames over a common media.
1 - Physical	Describes the means to activate, maintain, and de-activate physical connections.

The TCP/IP Reference Model

TCP/IP Model Layer	Description
Application	Represents data to the user, plus encoding and dialog control.
Transport	Supports communication between various devices across diverse networks.
Internet	Determines the best path through the network.
Network Access	Controls the hardware devices and media that make up the network.

Data Encapsulation

Segmenting Messages



Segmenting is the process of breaking up messages into smaller units. Multiplexing is the processes of taking multiple streams of segmented data and interleaving them together.

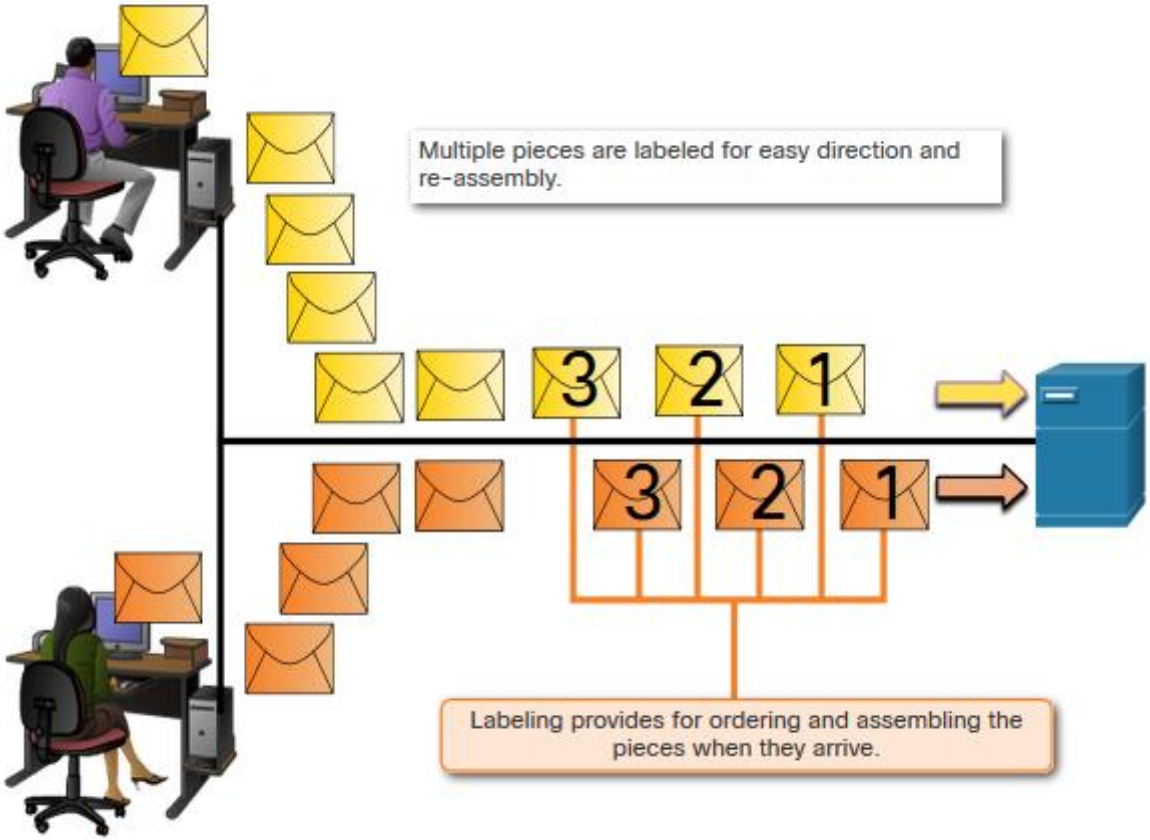
Segmenting messages has two primary benefits:

- **Increases speed** - Large amounts of data can be sent over the network without tying up a communications link.
- **Increases efficiency** - Only segments which fail to reach the destination need to be retransmitted, not the entire data stream.

Sequencing

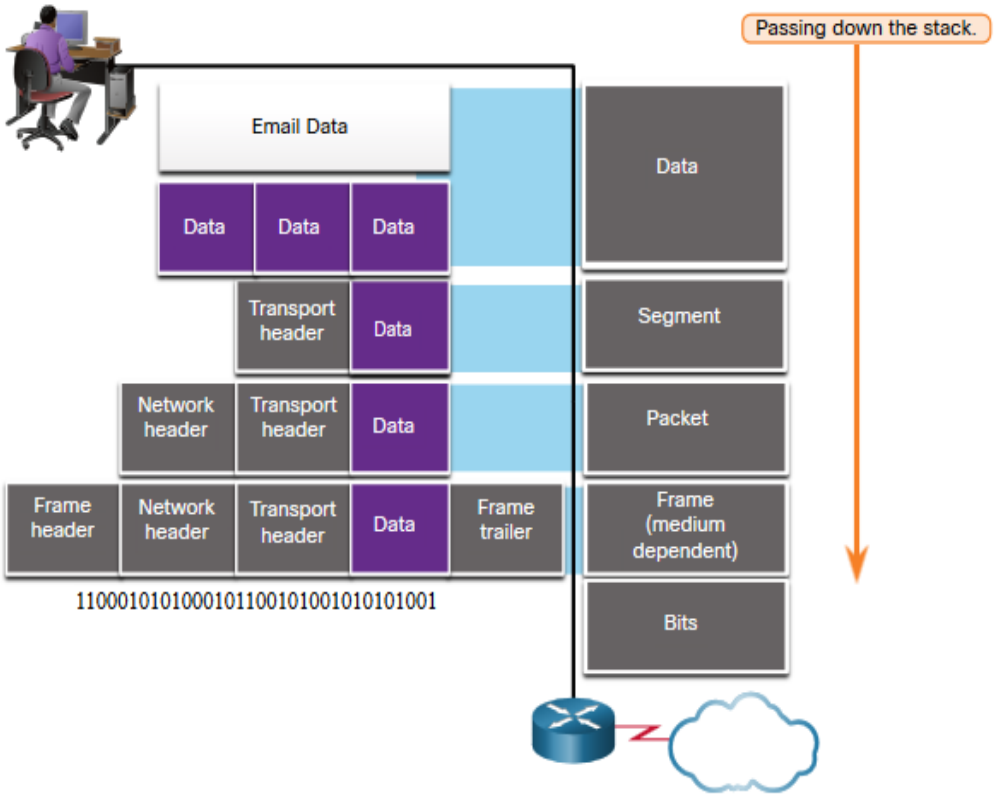
Sequencing messages is the process of numbering the segments so that the message may be reassembled at the destination.

TCP is responsible for sequencing the individual segments.



Data Encapsulation

Protocol Data Units

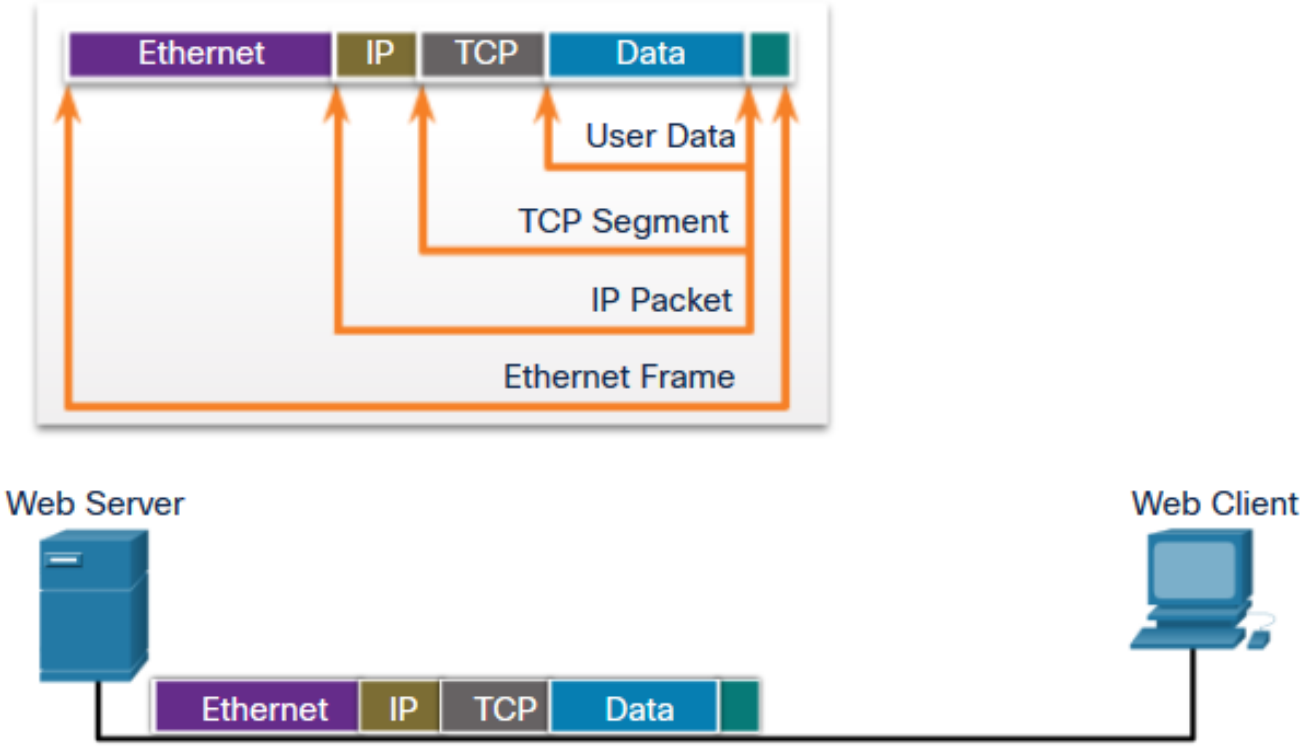


Encapsulation is the process where protocols add their information to the data.

- At each stage of the process, a PDU has a different name to reflect its new functions.
- There is no universal naming convention for PDUs, in this course, the PDUs are named according to the protocols of the TCP/IP suite.
- PDUs passing down the stack are as follows:
  1. Data (Data Stream)
  2. Segment
  3. Packet
  4. Frame
  5. Bits (Bit Stream)

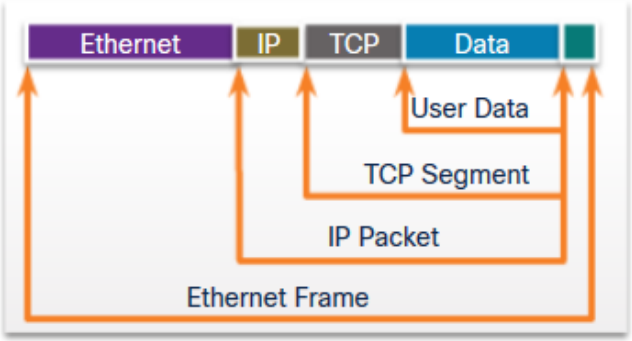
Encapsulation Example

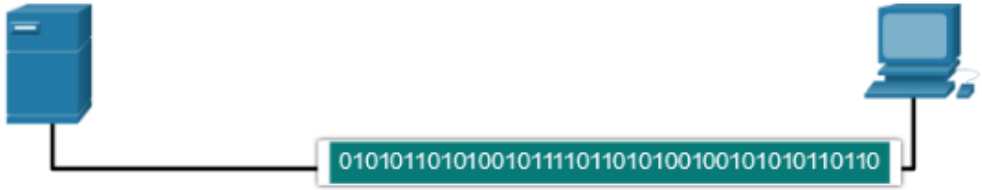
- Encapsulation is a top down process.
- The level above does its process and then passes it down to the next level of the model. This process is repeated by each layer until it is sent out as a bit stream.



De-encapsulation Example

- Data is de-encapsulated as it moves up the stack.
- When a layer completes its process, that layer strips off its header and passes it up to the next level to be processed. This is repeated at each layer until it is a data stream that the application can process.
  1. Received as Bits (Bit Stream)
  2. Frame
  3. Packet
  4. Segment
  5. Data (Data Stream)



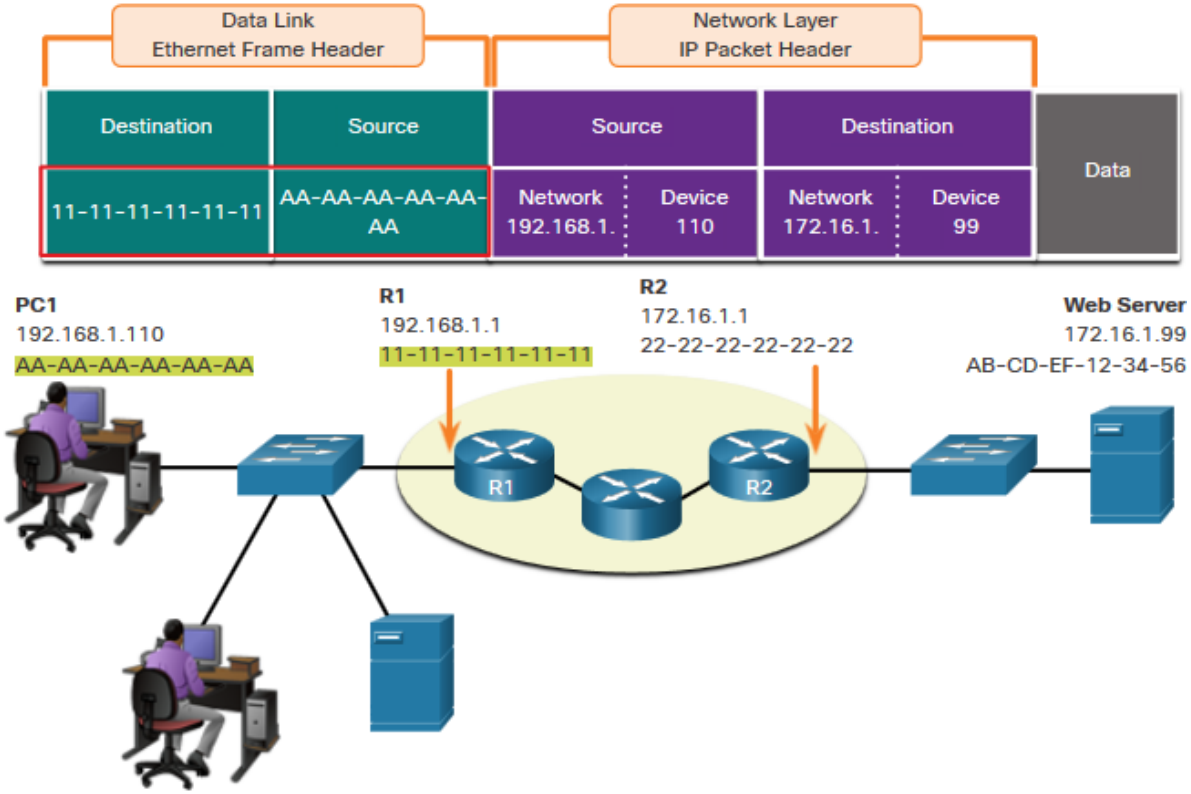


Data Access

Role of the Data Link Layer Addresses: Different IP Networks

When the final destination is remote, Layer 3 will provide Layer 2 with the local default gateway IP address, also known as the router address.

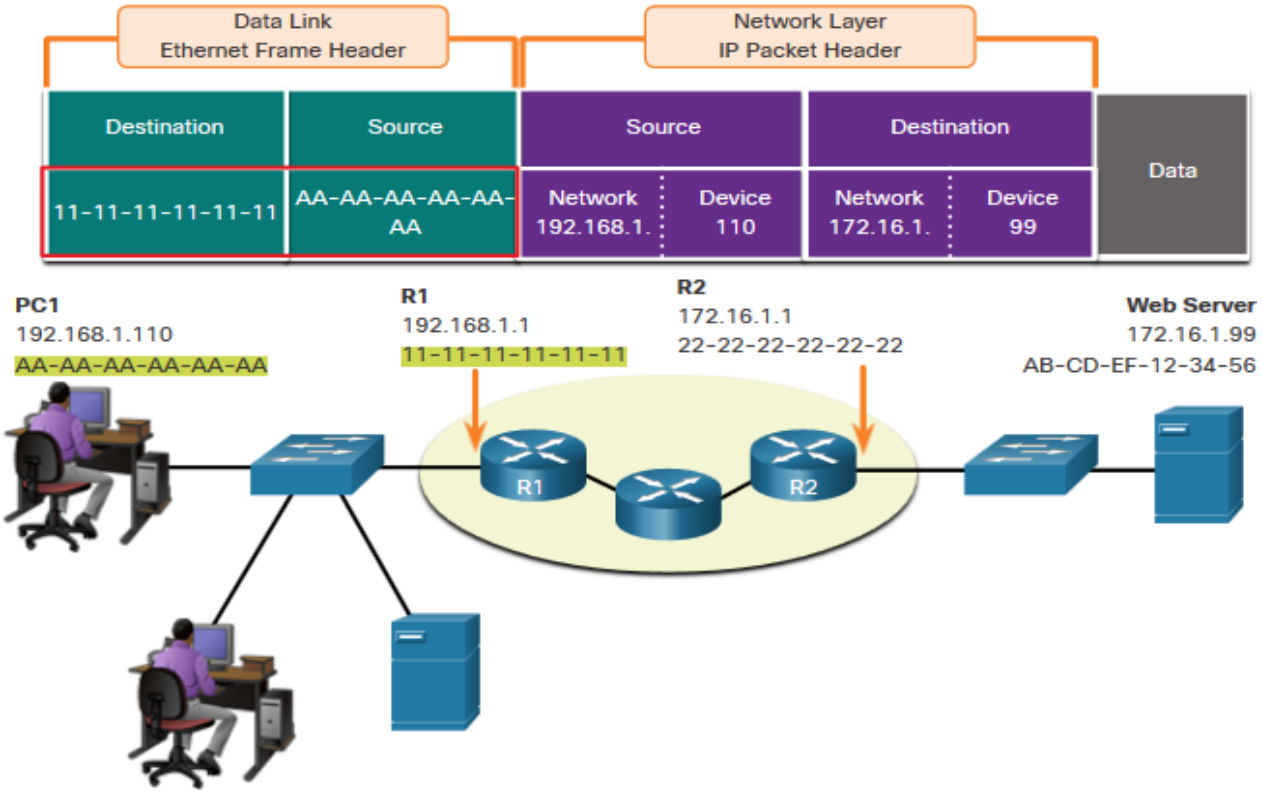
- The default gateway (DGW) is the router interface IP address that is part of this LAN and will be the “door” or “gateway” to all other remote locations.
- All devices on the LAN must be told about this address or their traffic will be confined to the LAN only.
- Once Layer 2 on PC1 forwards to the default gateway (Router), the router then can start the routing process of getting the information to actual destination.



Role of the Data Link Layer Addresses: Different IP Networks (Cont.)

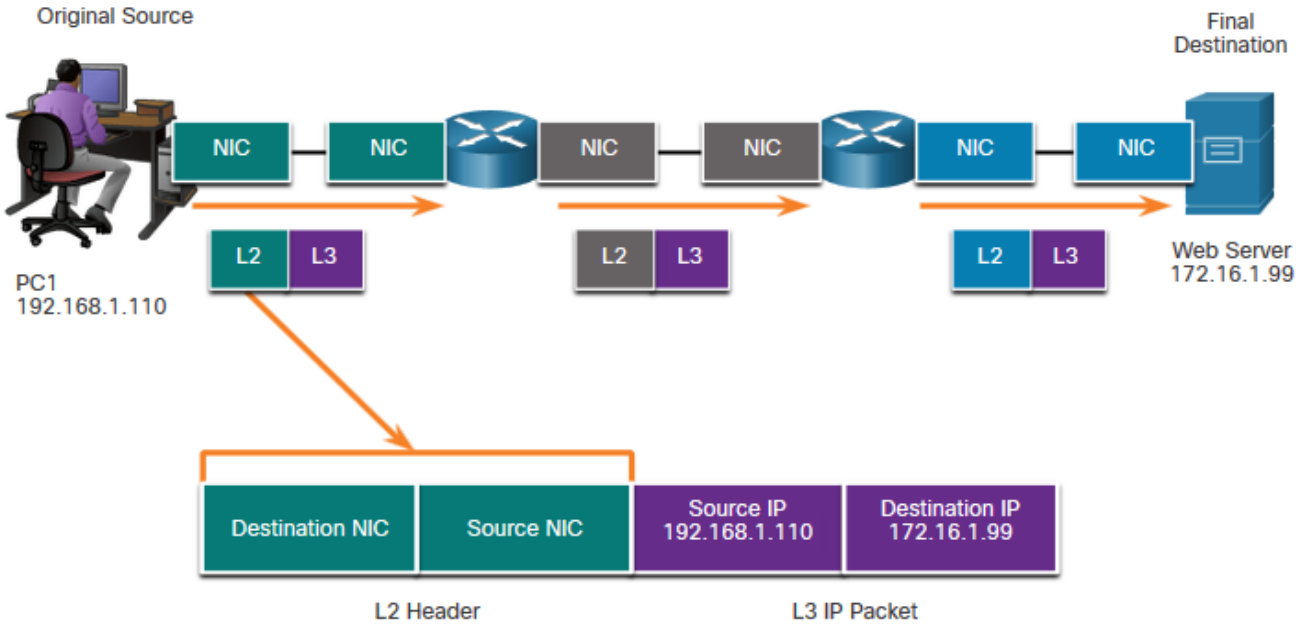
- The data link addressing is local addressing so it will have a source and destination for each link.
- The MAC addressing for the first segment is :
  - Source – AA-AA-AA-AA-AA-AA (PC1) Sends the frame.
  - Destination – 11-11-11-11-11-11 (R1- Default Gateway MAC) Receives the frame.

Note: While the L2 local addressing will change from link to link or hop to hop, the L3 addressing remains the same.



Data Link Addresses

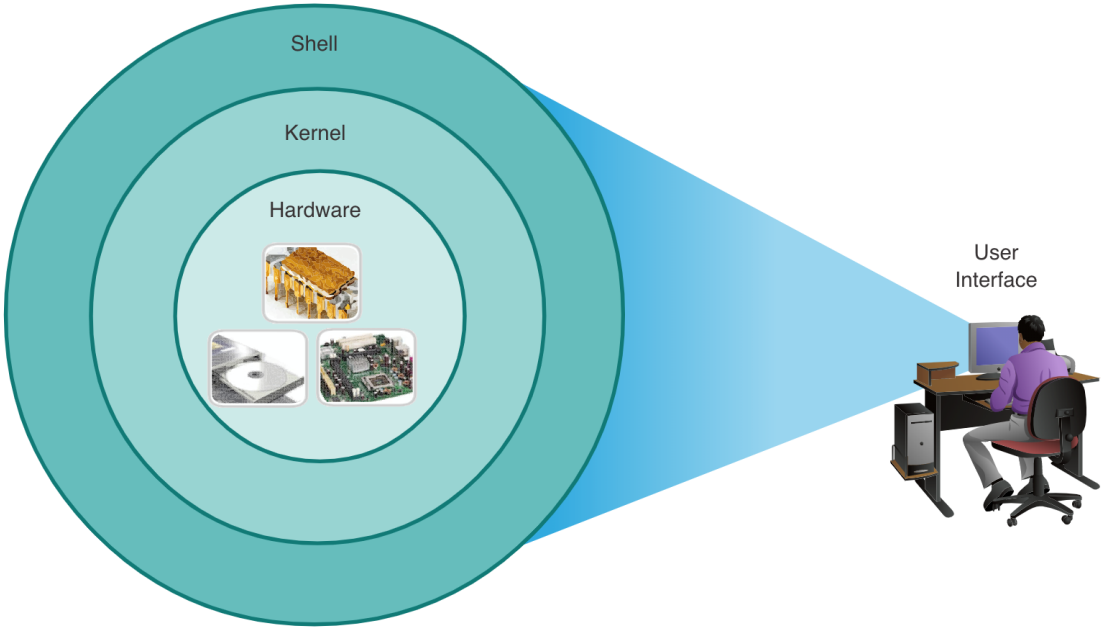
- Since data link addressing is local addressing, it will have a source and destination for each segment or hop of the journey to the destination.
- The MAC addressing for the first segment is:
  - Source – (PC1 NIC) sends frame
  - Destination – (First Router- DGW interface) receives frame



Cisco IOS Access

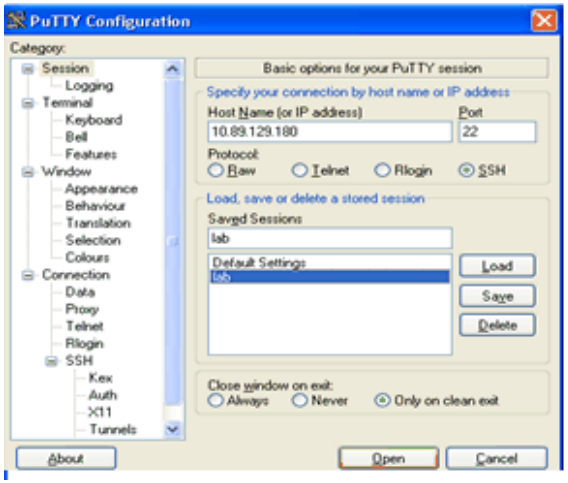
Operating Systems

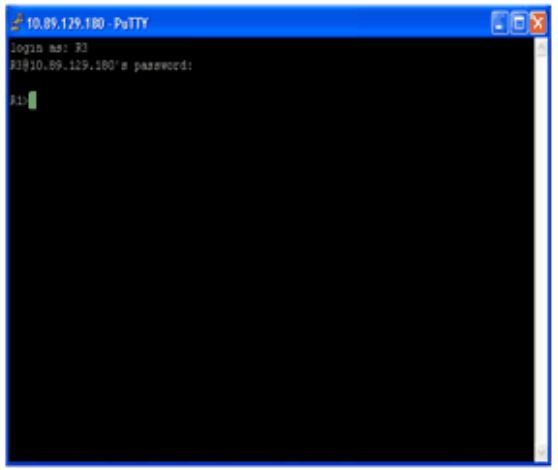
- **Shell** - The user interface that allows users to request specific tasks from the computer. These requests can be made either through the CLI or GUI interfaces.
- **Kernel** - Communicates between the hardware and software of a computer and manages how hardware resources are used to meet software requirements.
- **Hardware** - The physical part of a computer including underlying electronics.



Access Methods

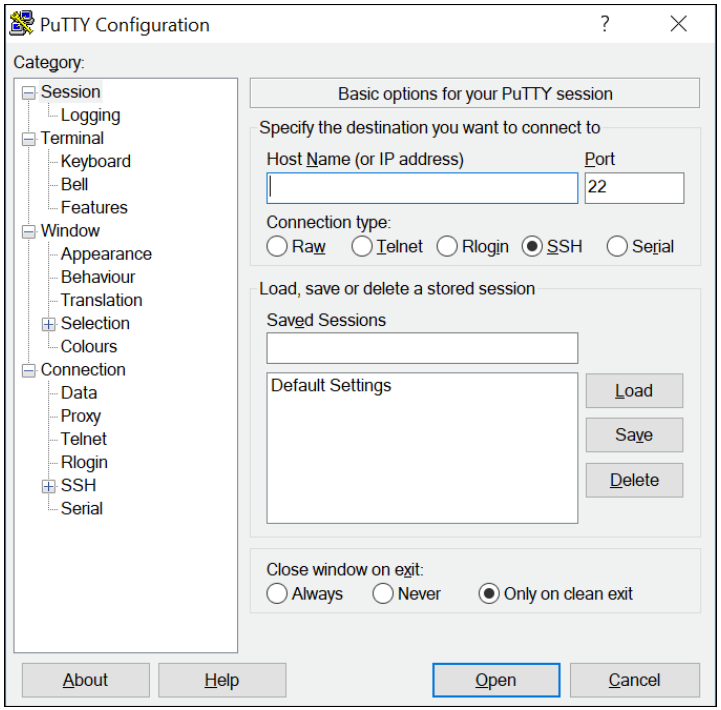
- **Console** – A physical management port used to access a device in order to provide maintenance, such as performing the initial configurations.
- **Secure Shell (SSH)** – Establishes a secure remote CLI connection to a device, through a virtual interface, over a network. (Note: This is the recommended method for remotely connecting to a device.)
- **Telnet** – Establishes an insecure remote CLI connection to a device over the network. (Note: User authentication, passwords and commands are sent over the network in plaintext.)

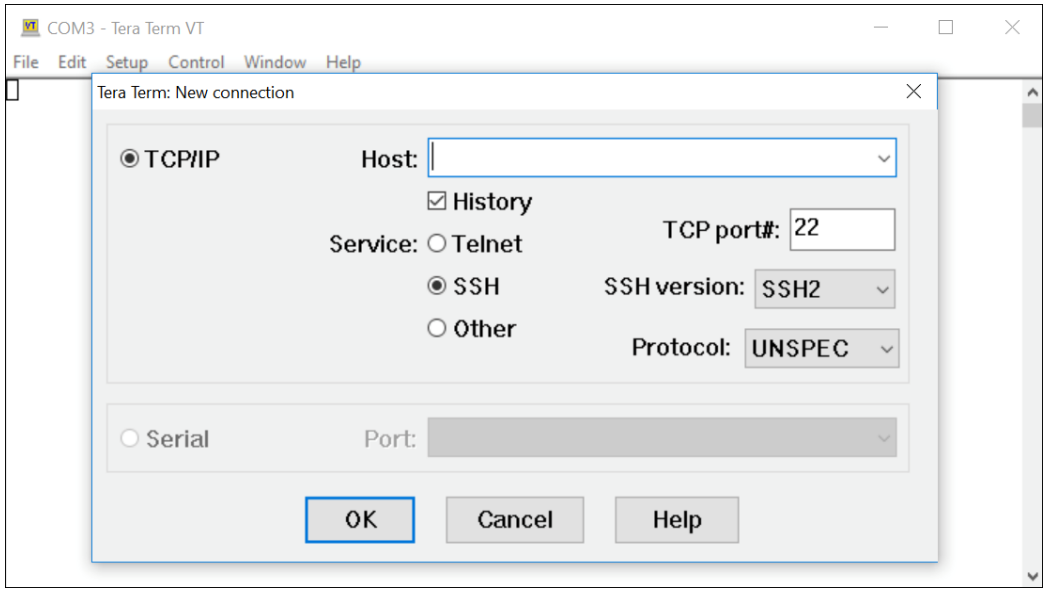




Terminal Emulation Programs

- Terminal emulation programs are used to connect to a network device by either a console port or by an SSH/Telnet connection.
- There are several terminal emulation programs to chose from such as PuTTY, Tera Term and SecureCRT.





IOS Navigation

Primary Command Modes

User EXEC Mode:

- Allows access to only a limited number of basic monitoring commands
- Identified by the CLI prompt that ends with the **>** symbol

```
Router>

Switch>
```

Privileged EXEC Mode:

- Allows access to all commands and features
- Identified by the CLI prompt that ends with the # symbol

```
Router#

Switch#
```

Configuration Mode and Subconfiguration Modes

Global Configuration Mode:

- Used to access configuration options on the device

```
Switch(config)#
```

Line Configuration Mode:

- Used to configure console, SSH, Telnet or AUX access

```
Switch(config-line)#
```

Interface Configuration Mode:

- Used to configure a switch port or router interface

```
Switch(config-if)#
```

Navigation Between IOS Modes

- **Privileged EXEC Mode:**
  - To move from user EXEC mode to privilege EXEC mode, use the **enabled** command.

```
Switch> enable
Switch#
```

- **Global Configuration Mode:**
  - To move in and out of global configuration mode, use the **configure terminal** command. To return to privilege EXEC mode, use the **exit** command.

```
Switch(config)#
Switch(config)#exit
Switch#
```

- **Line Configuration Mode:**
  - To move in and out of line configuration mode, use the **line** command followed by the management line type. To return to global configuration mode, use the **exit** command.

```
Switch(config)#line console 0
Switch(config-line)#exit
Switch(config)#
```

Navigation Between IOS Modes (Cont.)

Subconfiguration Modes:

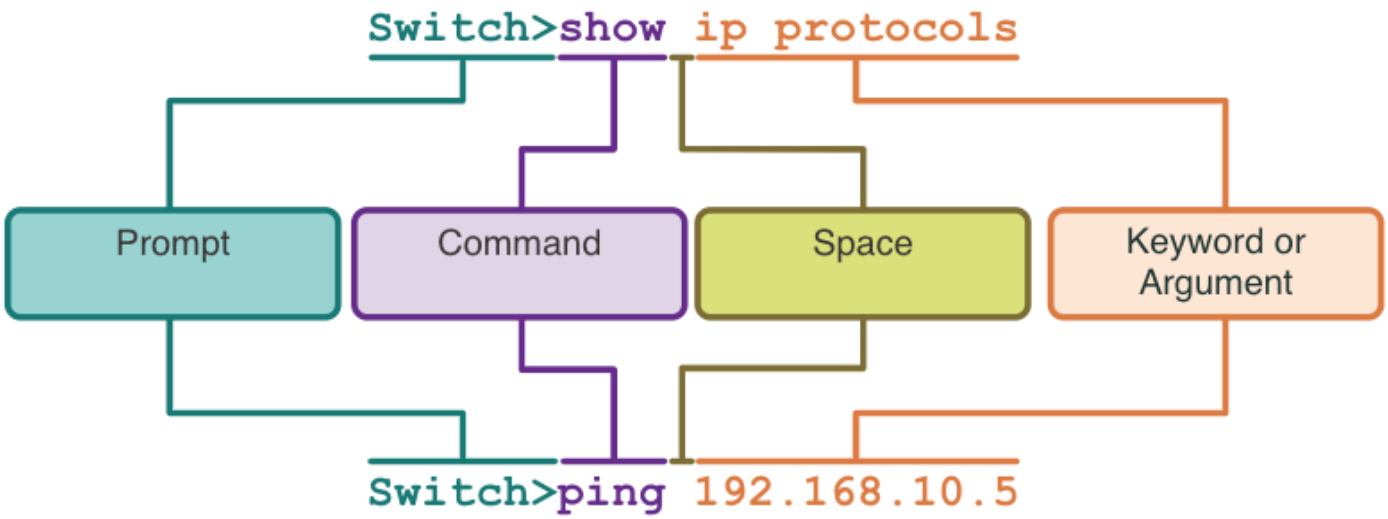
- To move out of any subconfiguration mode to get back to global configuration mode, use the **exit** command. To return to privilege EXEC mode, use the **end** command or key combination **Ctrl +Z**.
- To move directly from one subconfiguration mode to another, type in the desired subconfiguration mode command. In the example, the command prompt changes from **(config-line)#** to **(config-if)#**.

```
Switch(config)#line console 0
Switch(config-line)#end
Switch#
```

```
Switch(config-line)#interface FastEthernet 0/1
Switch(config-if)#
```

The Command Structure

Basic IOS Command Structure



- **Keyword** – This is a specific parameter defined in the operating system (in the figure, **ip protocols**).
- **Argument** - This is not predefined; it is a value or variable defined by the user (in the figure, **192.168.10.5**).

IOS Help Features

The IOS has two forms of help available: context-sensitive help and command syntax check.

- Context-sensitive help enables you to quickly find answers to these questions:
  - Which commands are available in each command mode?
  - Which commands start with specific characters or group of characters?
  - Which arguments and keywords are available to particular commands?

```
Router#ping ?
  WORD  Ping destination address or hostname
  ip    IP echo
  ipv6  IPv6 echo
```

- Command syntax check verifies that a valid command was entered by the user.
  - If the interpreter cannot understand the command being entered, it will provide feedback describing what is wrong with the command.

```
Switch#interface fastEthernet 0/1
                 ^
% Invalid input detected at '^' marker.
```

Hot Keys and Shortcuts

- The table below is a brief list of keystrokes to enhance command line editing.

Keystroke	Description
Tab	Completes a partial command name entry.
Backspace	Erases the character to the left of the cursor.
Left Arrow or **Ctrl+B**	Moves the cursor one character to the left.
Right Arrow or **Ctrl+F**	Moves the cursor one character to the right.
Up Arrow or **Ctrl+P**	Recalls the commands in the history buffer, beginning with the most recent commands.

Hot Keys and Shortcuts (Cont.)

- When a command output produces more text than can be displayed in a terminal window, the IOS will display a **"--More--"** prompt. The table below describes the keystrokes that can be used when this prompt is displayed.

Keystroke	Description
Enter Key	Displays the next line.
Space Bar	Displays the next screen.
Any other key	Ends the display string, returning to privileged EXEC mode.

- The table below lists commands that can be used to exit out of an operation.

Keystroke	Description
Ctrl-C	When in any configuration mode, ends the configuration mode and returns to privileged EXEC mode.
Ctrl-Z	When in any configuration mode, ends the configuration mode and returns to privileged EXEC mode.
Ctrl-Shift-6	All-purpose break sequence used to abort DNS lookups, traceroutes, pings, etc.

Basic Device Configuration

Device Names

- The first configuration command on any device should be to give it a unique hostname.
- By default, all devices are assigned a factory default name. For example, a Cisco IOS switch is "Switch."

- Guideline for naming devices:
  - Start with a letter
  - Contain no spaces
  - End with a letter or digit
  - Use only letters, digits, and dashes
  - Be less than 64 characters in length

```
Switch# configure terminal
Switch(config)# hostname Sw-Floor-1
Sw-Floor-1(config)#
```

Note: To return the switch to the default prompt, use the **no hostname** global config command.

Password Guidelines

- The use of weak or easily guessed passwords are a security concern.
- All networking devices should limit administrative access by securing privileged EXEC, user EXEC, and remote Telnet access with passwords. In addition, all passwords should be encrypted and legal notifications provided.
- Password Guidelines:
  - Use passwords that are more than eight characters in length.
  - Use a combination of upper and lowercase letters, numbers, special characters, and/or numeric sequences.
  - Avoid using the same password for all devices.
  - Do not use common words because they are easily guessed.

Configure Passwords

Securing user EXEC mode access:

- First enter line console configuration mode using the **line console 0** command in global configuration mode.
- Next, specify the user EXEC mode password using the **password** *password* command.
- Finally, enable user EXEC access using the **login** command.

```
Sw-Floor-1# configure terminal
Sw-Floor-1(config)# line console 0
Sw-Floor-1(config-line)# password cisco
Sw-Floor-1(config-line)# login
Sw-Floor-1(config-line)# end
Sw-Floor-1#
```

Securing privileged EXEC mode access:

- First enter global configuration mode.
- Next, use the **enable secret** *password* command.

```
Sw-Floor-1# configure terminal
Sw-Floor-1(config)# enable secret class
Sw-Floor-1(config)# exit
Sw-Floor-1#
```

Configure Passwords (Cont.)

Securing VTY line access:

- First enter line VTY configuration mode using the **line vty 0 15** command in global configuration mode.
- Next, specify the VTY password using the **password** *password* command.
- Finally, enable VTY access using the **login** command.

```
Sw-Floor-1# configure terminal
Sw-Floor-1(config)# line vty 0 15
Sw-Floor-1(config-line)# password cisco
Sw-Floor-1(config-line)# login
Sw-Floor-1(config-line)# end
Sw-Floor-1#
```

- Note: VTY lines enable remote access using Telnet or SSH to the device. Many Cisco switches support up to 16 VTY lines that are numbered 0 to 15.

Encrypt Passwords

- The startup-config and running-config files display most passwords in plaintext.
- To encrypt all plaintext passwords, use the **service password-encryption** global config command.

```
Sw-Floor-1# configure terminal
Sw-Floor-1(config)# service password-encryption
Sw-Floor-1(config)# exit
Sw-Floor-1#
```

- Use the **show running-config** command to verify that the passwords on the device are now encrypted.

```
Sw-Floor-1# show running-config
!

!
line con 0
password 7 094F471A1A0A
login
!
Line vty 0 4
Password 7 03095A0F034F38435B49150A1819
Login
!
!
end
```

Banner Messages

- A banner message is important to warn unauthorized personnel from attempting to access the device.
- To create a banner message of the day on a network device, use the **banner motd** # *the message of the day* # global config command.

Note: The "**#**" in the command syntax is called the delimiting character. It is entered before and after the message.

```
Sw-Floor-1# configure terminal
Sw-Floor-1(config)# banner motd #Authorized Access Only!#
```

The banner will be displayed on attempts to access the device.

```
Press RETURN to get started.



Authorized Access Only!

User Access Verification

Password:
```

Save Configurations

Configuration Files

- There are two system files that store the device configuration:
  - **startup-config** - This is the saved configuration file that is stored in NVRAM. It contains all the commands that will be used by the device upon startup or reboot. Flash does not lose its contents when the device is powered off.
  - **running-config** - This is stored in Random Access Memory (RAM). It reflects the current configuration. Modifying a running configuration affects the operation of a Cisco device immediately. RAM is volatile memory. It loses all of its content when the device is powered off or restarted.
  - To save changes made to the running configuration to the startup configuration file, use the **copy running-config startup-config** privileged EXEC mode command.

```
Router#show startup-config
Using 624 bytes
!
version 15.4
no service timestamps log datetime msec
no service timestamps debug datetime msec
no service password-encryption
```

```
Router#show running-config
Building configuration...

Current configuration : 624 bytes
!
version 15.4
no service timestamps log datetime msec
no service timestamps debug datetime msec
no service password-encryption
```

Save Configurations

Alter the Running Configurations

If changes made to the running config do not have the desired effect and the running-config has not yet been saved, you can restore the device to its previous configuration. To do this you can:

- Remove the changed commands individually.
- Reload the device using the **reload** command in privilege EXEC mode. *Note: This will cause the device to briefly go offline, leading to network downtime.*

```
Router# reload
Proceed with reload? [confirm]
Initializing Hardware ...
```

If the undesired changes were saved to the startup-config, it may be necessary to clear all the configurations using the **erase startup-config** command in privilege EXEC mode.

- After erasing the startup-config, reload the device to clear the running-config file from RAM.

```
Router# erase startup-config
Erasing the nvram filesystem will remove all configuration files! Continue? [confirm]
[OK]
Erase of nvram: complete
%SYS-7-NV_BLOCK_INIT: Initialized the geometry of nvram
Router#
```

Today end, **See you next week!**