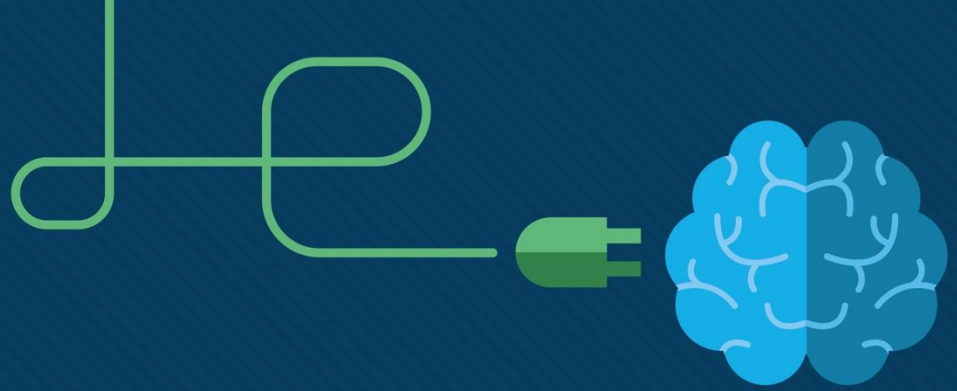


# Protocols and Models

Introduction to Networks 7.0
(ITN)

# 3.1 The Rules

# Communications Fundamentals

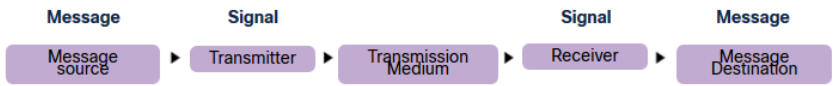
Networks can vary in size and complexity. It is not enough to have a connection, devices must agree on “how” to communicate.

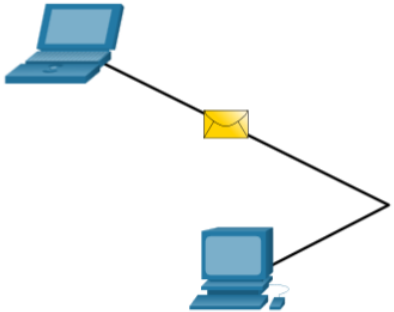
There are three elements to any communication:

- There will be a source (sender).
- There will be a destination (receiver).
- There will be a channel (media) that provides for the path of communications to occur.

# Communications Protocols

- All communications are governed by protocols.
- Protocols are the rules that communications will follow.
- These rules will vary depending on the protocol.

# Rule Establishment

- Individuals must use established rules or agreements to govern the conversation.
- The first message is difficult to read because it is not formatted properly. The second shows the message properly formatted

```
humans communication between govern rules. It is verydifficult tounderstand messages that are not
correctly formatted and donot follow the established rules and protocols. A estrutura da
gramatica, da lingua, da pontuacao e do sentence faz a configuracao humana compreensivel por
muitos individuos diferentes.
```

```
Rules govern communication between humans. It is very difficult to understand messages that are
not correctly formatted and do not follow the established rules and protocols. The structure of
the grammar, the language, the punctuation and the sentence make the configuration humanly
understandable for many different individuals.
```

# Rule Establishment (Cont.)

Protocols must account for the following requirements:

- An identified sender and receiver
- Common language and grammar
- Speed and timing of delivery
- Confirmation or acknowledgment requirements

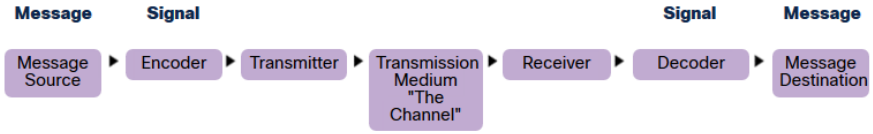
# Network Protocol Requirements

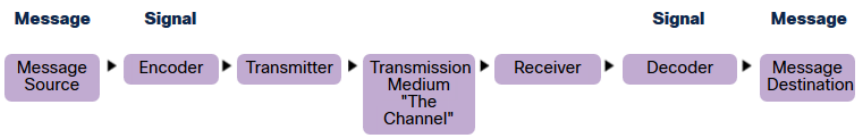
Common computer protocols must be in agreement and include the following requirements:

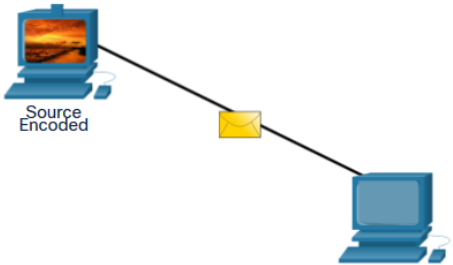
- Message encoding
- Message formatting and encapsulation
- Message size
- Message timing
- Message delivery options

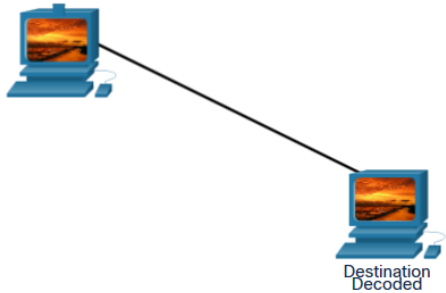
# Message Encoding

- Encoding is the process of converting information into another acceptable form for transmission.
- Decoding reverses this process to interpret the information.



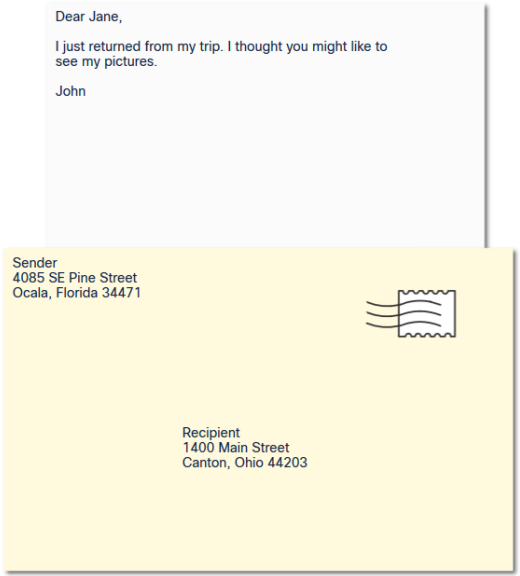



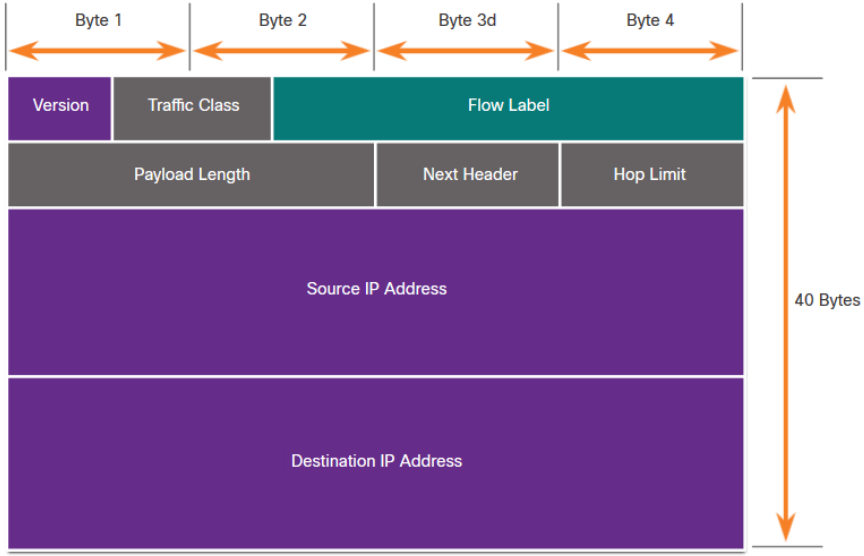



# Message Formatting and Encapsulation

- When a message is sent, it must use a specific format or structure.
- Message formats depend on the type of message and the channel that is used to deliver the message.

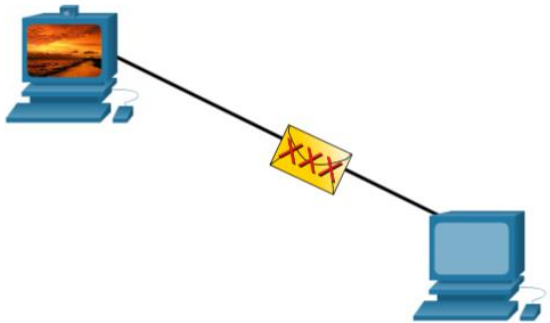


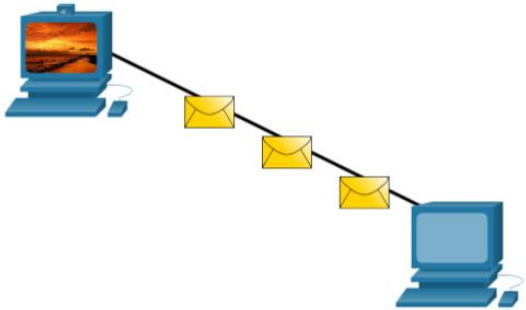



# Message Size

Encoding between hosts must be in an appropriate format for the medium.

- Messages sent across the network are converted to bits
- The bits are encoded into a pattern of light, sound, or electrical impulses.
- The destination host must decode the signals to interpret the message.





# Message Timing

Message timing includes the following:

**Flow Control –** Manages the rate of data transmission and defines how much information can be sent and the speed at which it can be delivered.

**Response Timeout –** Manages how long a device waits when it does not hear a reply from the destination.

**Access method -** Determines when someone can send a message.

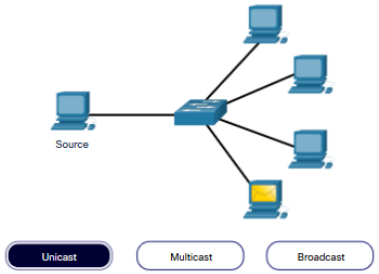
- There may be various rules governing issues like “collisions”. This is when more than one device sends traffic at the same time and the messages become corrupt.
- Some protocols are proactive and attempt to prevent collisions; other protocols are reactive and establish a recovery method after the collision occurs.

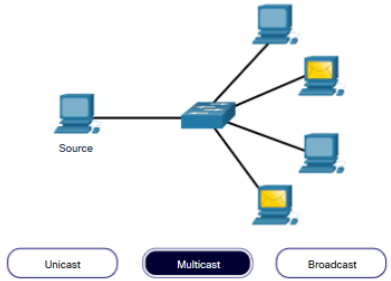
# Message Delivery Options

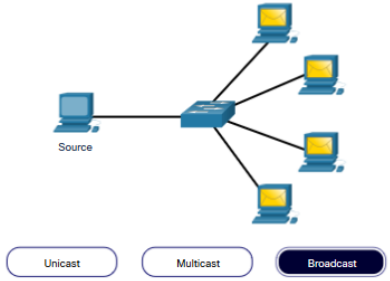
Message delivery may one of the following methods:

- **Unicast –** one to one communication
- **Multicast –** one to many, typically not all
- **Broadcast** – one to all

**Note:** Broadcasts are used in IPv4 networks, but are not an option for IPv6. Later we will also see “Anycast” as an additional delivery option for IPv6.

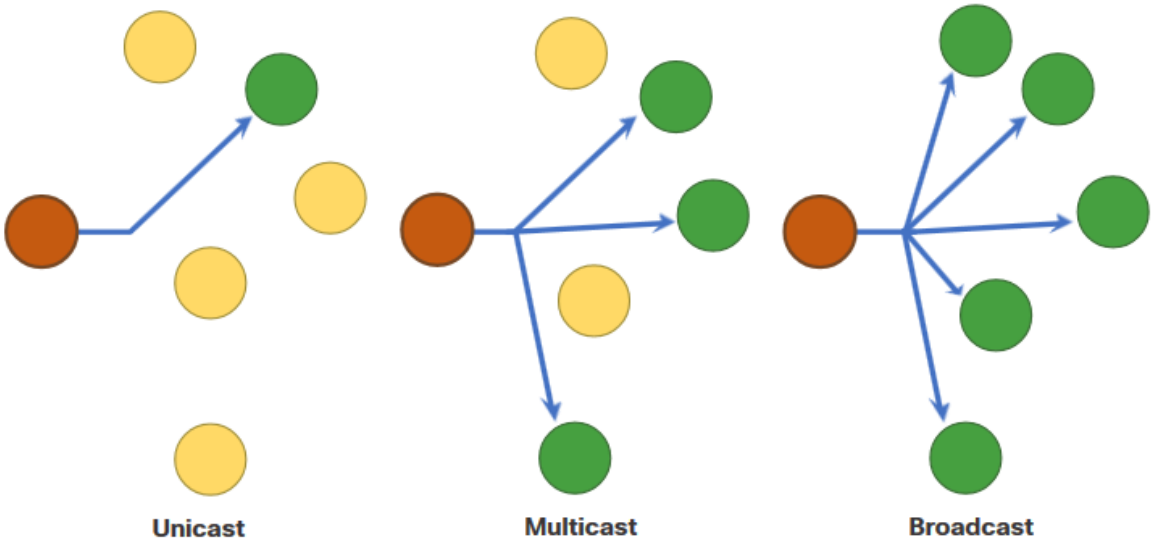


# A Note About the Node Icon

- Documents may use the node icon , typically a circle, to represent all devices.
- The figure illustrates the use of the node icon for delivery options.



# 3.2 Protocols

# Network Protocol Overview

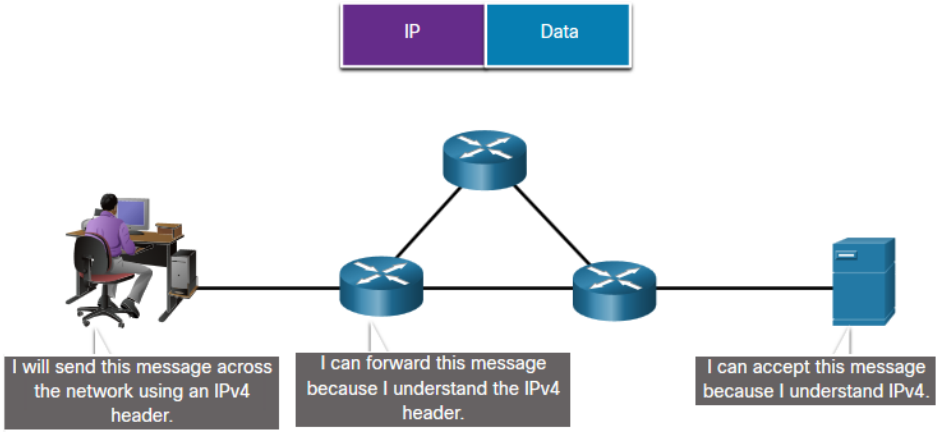
Network protocols define a common set of rules.

- Can be implemented on devices in:
  - Software
  - Hardware
  - Both
- Protocols have their own:
  - Function
  - Format
  - Rules

| Protocol Type | Description |
|---|---|
| Network Communications | enable two or more devices to communicate over one or more networks |
| Network Security | secure data to provide authentication, data integrity, and data encryption |
| Routing | enable routers to exchange route information, compare path information, and select best path |
| Service Discovery | used for the automatic detection of devices or services |

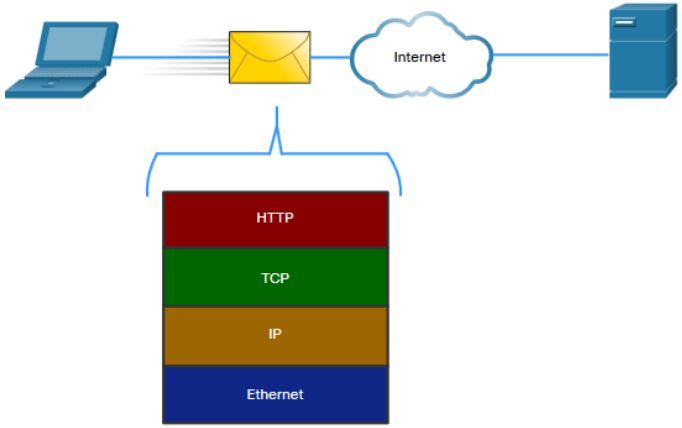
# Network Protocol Functions

- Devices use agreed-upon protocols to communicate .
- Protocols may have may have one or functions.




| Function | Description |
|---|---|
| Addressing | Identifies sender and receiver |
| Reliability | Provides guaranteed delivery |
| Flow Control | Ensures data flows at an efficient rate |
| Sequencing | Uniquely labels each transmitted segment of data |
| Error Detection | Determines if data became corrupted during transmission |
| Application Interface | Process-to-process communications between network applications |

# Protocol Interaction




- Networks require the use of several protocols.
- Each protocol has its own function and format.

| Protocol | Function |
|---|---|
| **Hypertext Transfer Protocol (HTTP)** | ▪ Governs the way a web server and a web client interact<br>▪ Defines content and format |
| **Transmission Control Protocol (TCP)** | ▪ Manages the individual conversations<br>▪ Provides guaranteed delivery<br>▪ Manages flow control |
| **Internet Protocol (IP)** | Delivers messages globally from the sender to the receiver |
| **Ethernet** | Delivers messages from one NIC to another NIC on the same Ethernet Local Area Network (LAN) |

# 3.3 Protocol Suites

# Network Protocol Suites

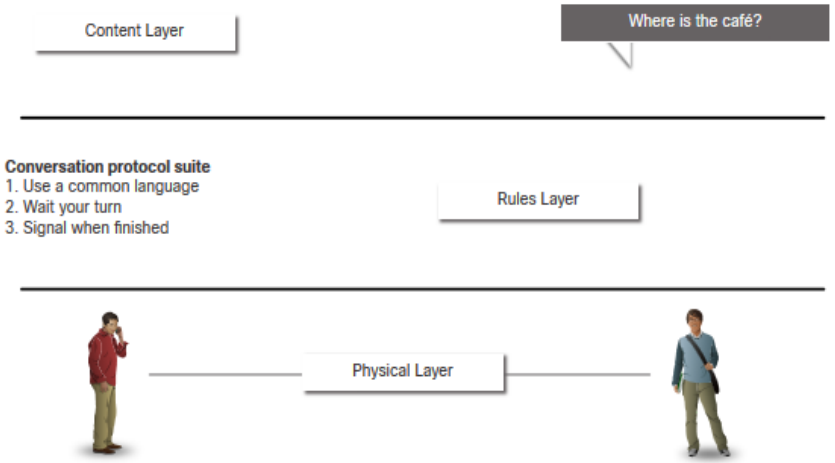
Protocols must be able to work with other protocols.

Protocol suite:

- A group of inter-related protocols necessary to perform a communication function
- Sets of rules that work together to help solve a problem

The protocols are viewed in terms of layers:

- Higher Layers
- Lower Layers- concerned with moving data and provide services to upper layers

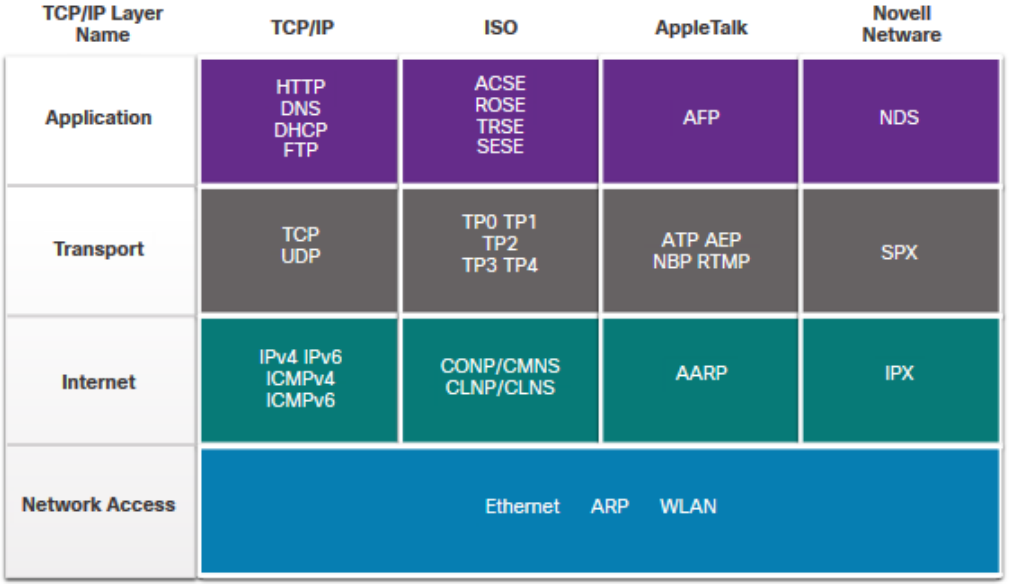



Protocol suites are sets of rules that work together to help solve a problem.

# Evolution of Protocol Suites

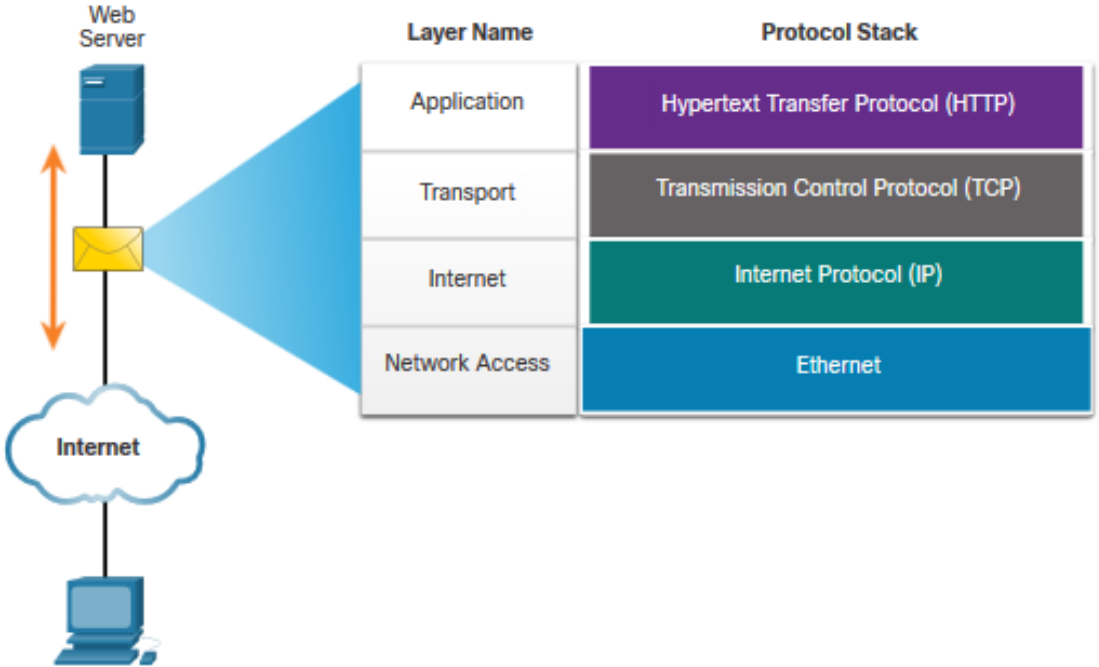
There are several protocol suites.

- **Internet Protocol Suite or TCP/IP-** The most common protocol suite and maintained by the Internet Engineering Task Force (IETF)
- **Open Systems Interconnection (OSI) protocols-** Developed by the International Organization for Standardization (ISO) and the International Telecommunications Union (ITU)
- **AppleTalk-** Proprietary suite release by Apple Inc.
- **Novell NetWare-** Proprietary suite developed by Novell Inc.



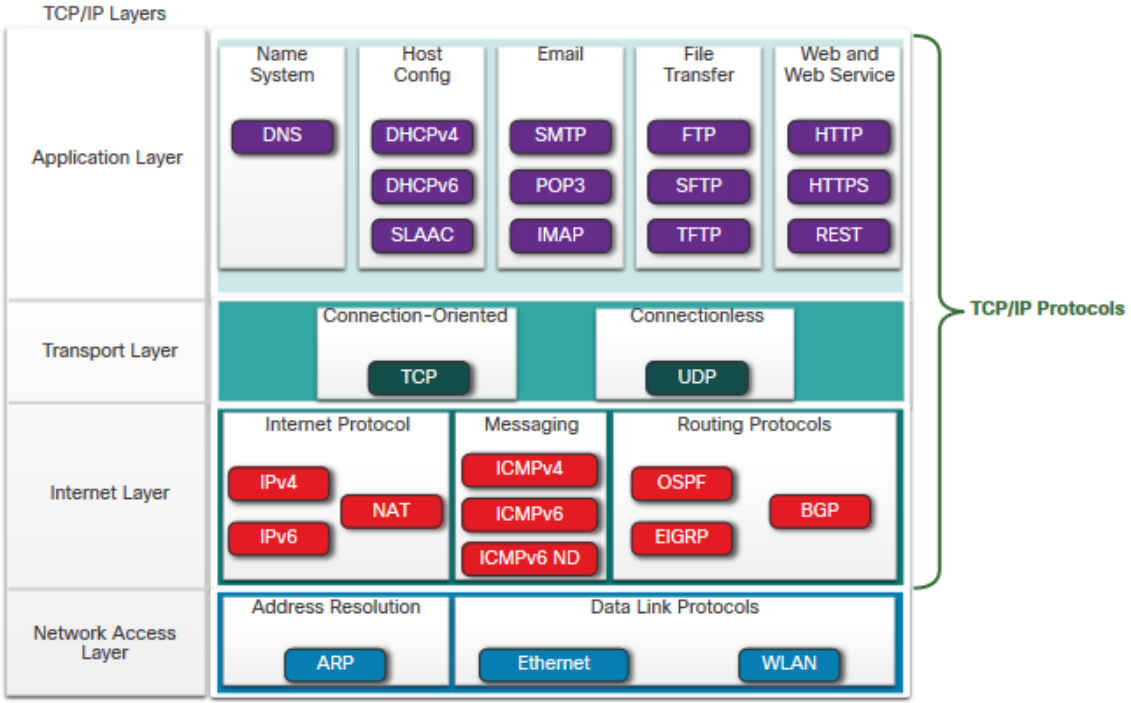
# TCP/IP Protocol Example

- TCP/IP protocols operate at the application, transport, and internet layers.
- The most common network access layer LAN protocols are Ethernet and WLAN (wireless LAN).



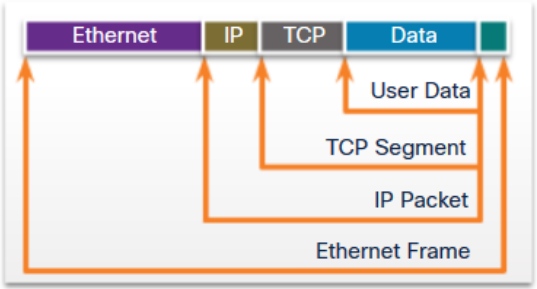
# TCP/IP Protocol Suite

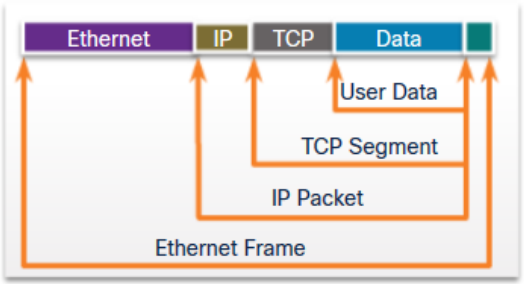
- TCP/IP is the protocol suite used by the internet and includes many protocols.
- TCP/IP is:
  - An open standard protocol suite that is freely available to the public and can be used by any vendor
  - A standards-based protocol suite that is endorsed by the networking industry and approved by a standards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




# 3.4 Standards Organizations

# Open Standards

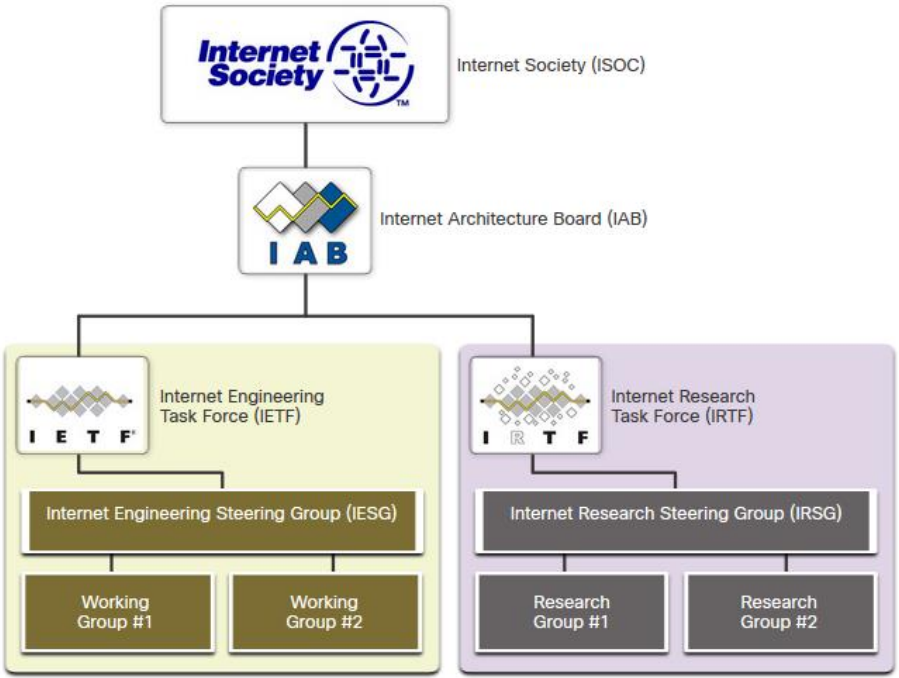

Open standards encourage:

- interoperability
- competition
- innovation

Standards organizations are:

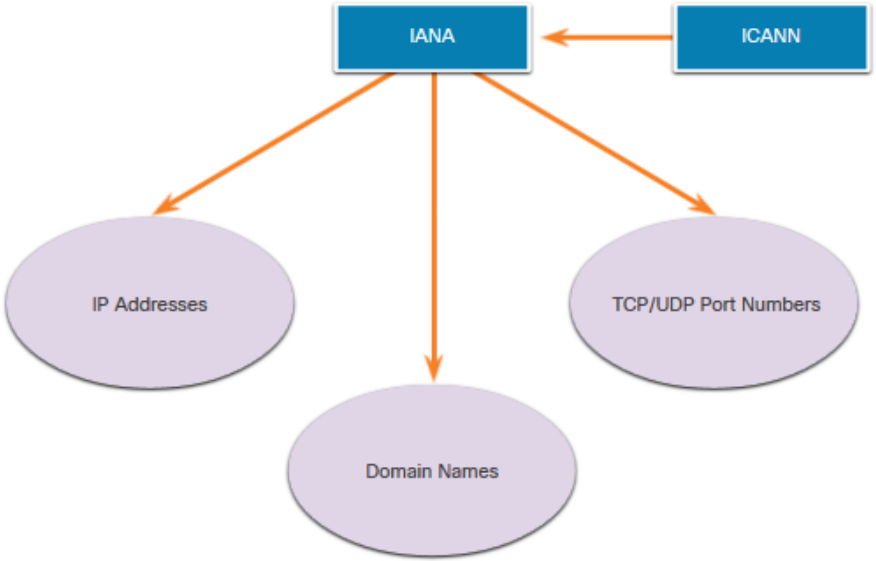
- vendor-neutral
- non-profit organizations
- established to develop and promote the concept of open standards.

# Internet Standards




- **Internet Society (ISOC)** - Promotes the open development and evolution of internet
- **Internet Architecture Board (IAB)** - Responsible for management and development of internet standards
- **Internet Engineering Task Force (IETF)** - Develops, updates, and maintains internet and TCP/IP technologies
- **Internet Research Task Force (IRTF)** - Focused on long-term research related to internet and TCP/IP protocols

# Internet Standards (Cont.)




Standards organizations involved with the development and support of TCP/IP

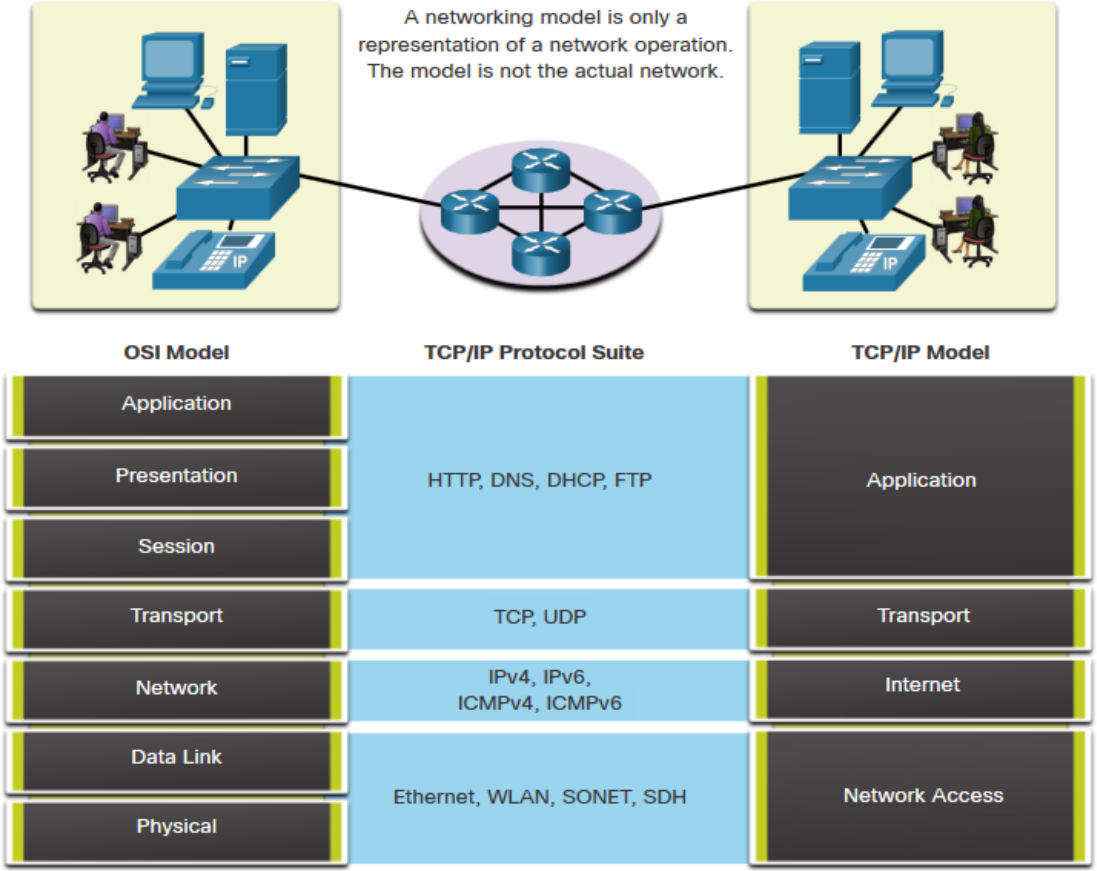
- **Internet Corporation for Assigned Names and Numbers (ICANN)** - Coordinates IP address allocation, the management of domain names, and assignment of other information
- **Internet Assigned Numbers Authority (IANA)** - Oversees and manages IP address allocation, domain name management, and protocol identifiers for ICANN

# Electronic and Communications Standards

- **Institute of Electrical and Electronics Engineers** (**IEEE**, pronounced “I-triple-E”) - dedicated to creating standards in power and energy, healthcare, telecommunications, and networking
- **Electronic Industries Alliance (EIA)** - develops standards relating to electrical wiring, connectors, and the 19-inch racks used to mount networking equipment
- **Telecommunications Industry Association (TIA)** - develops communication standards in radio equipment, cellular towers, Voice over IP (VoIP) devices, satellite communications, and more
- **International Telecommunications Union-Telecommunication Standardization Sector (ITU-T**) - defines standards for video compression, Internet Protocol Television (IPTV), and broadband communications, such as a digital subscriber line (DSL)

# 3.5 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

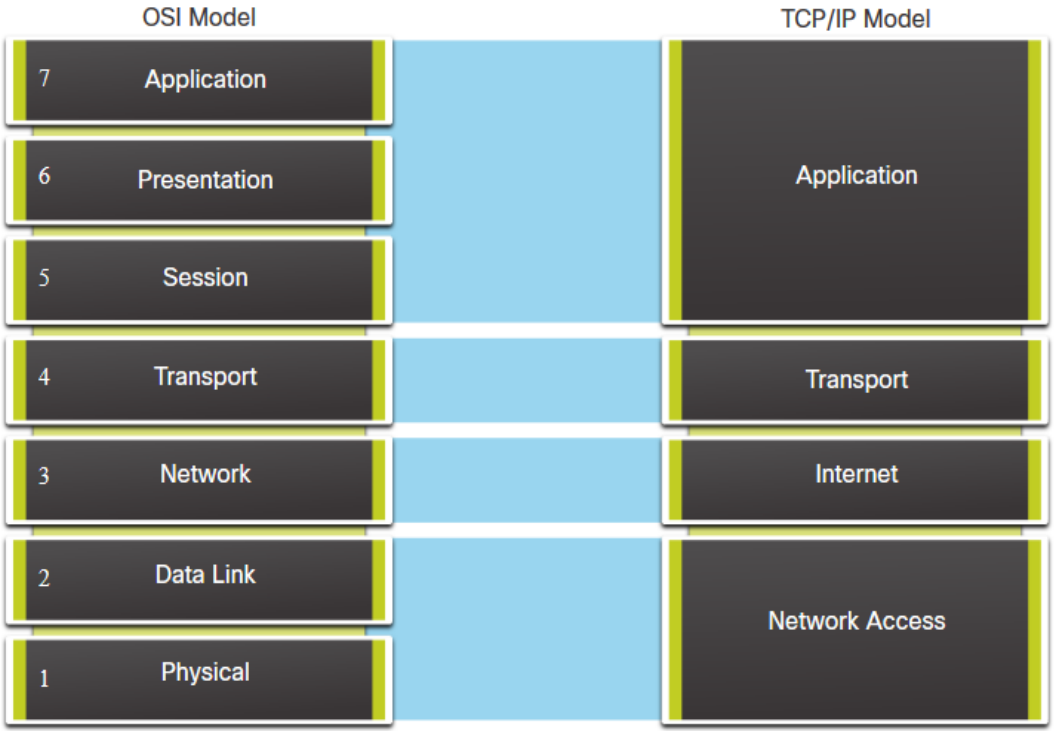
# The OSI Reference Model

| 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. |

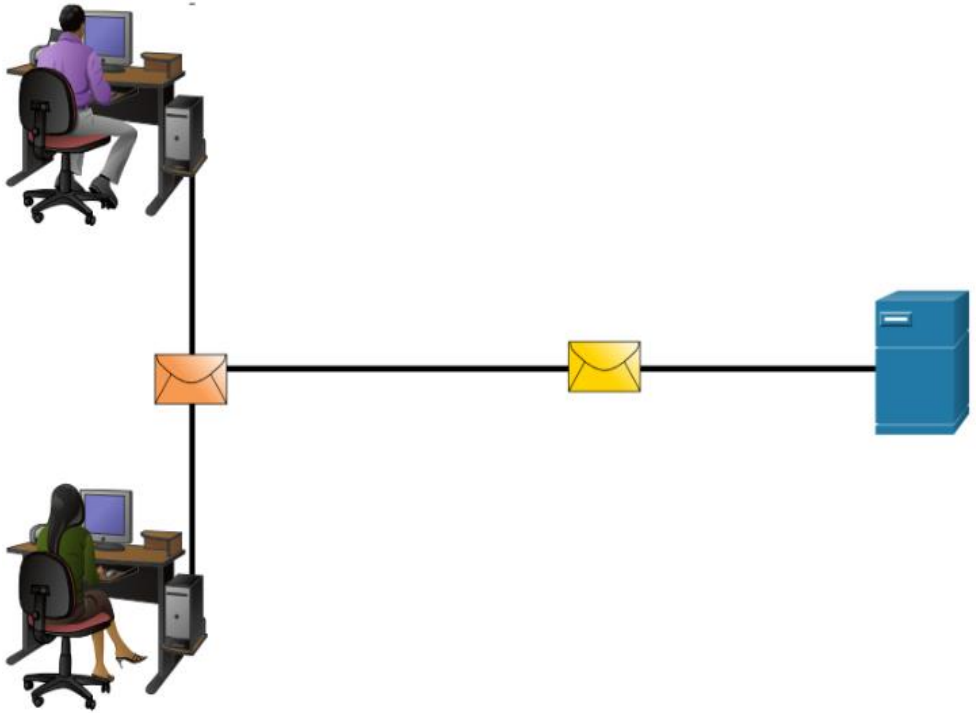
# OSI and TCP/IP Model Comparison




- The OSI model divides the network access layer and the application layer of the TCP/IP model into multiple layers.
- The TCP/IP protocol suite does not specify which protocols to use when transmitting over a physical medium.
- OSI Layers 1 and 2 discuss the necessary procedures to access the media and the physical means to send data over a network.

# 3.6 Data Encapsulation

# Segmenting Messages

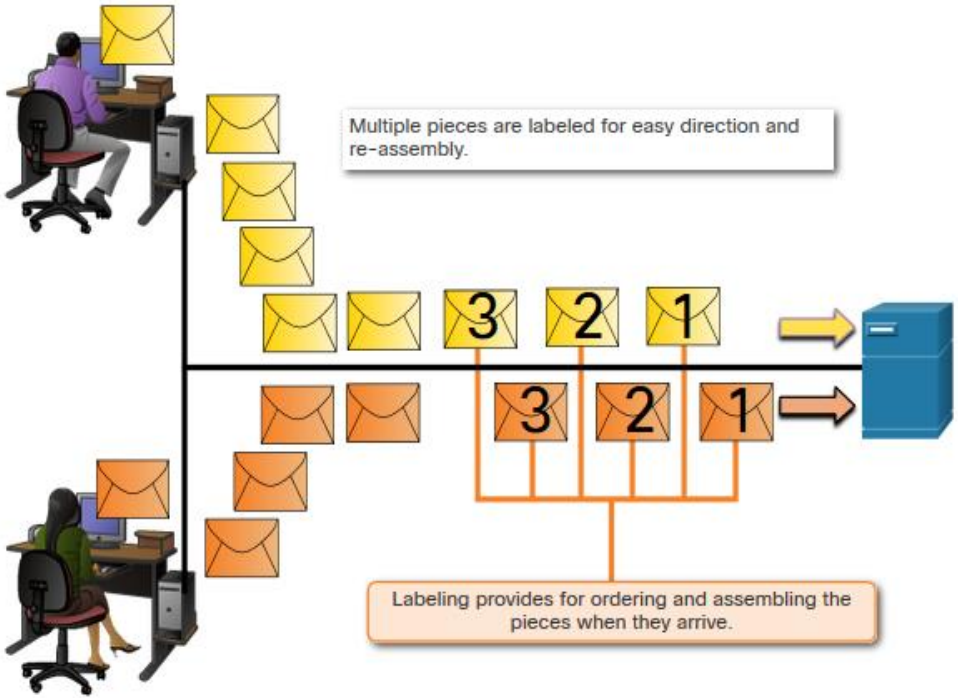


Segmenting is the process of breaking up messages into smaller units. Multiplexing is the processes of taking multiple streams of segmented data and interleaving them together.

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.

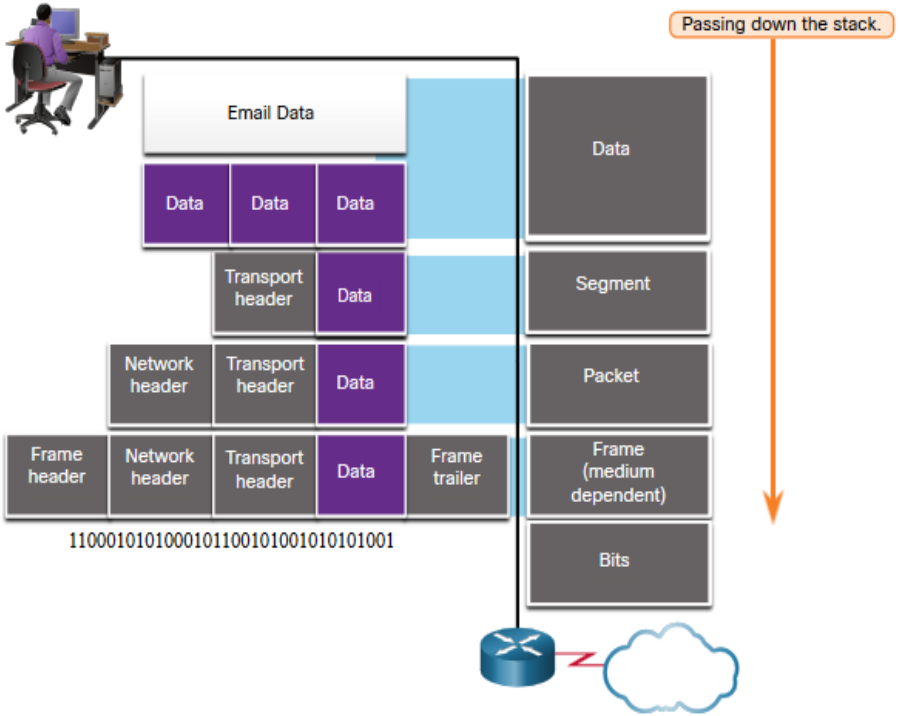
# Sequencing




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.

# Protocol Data Units

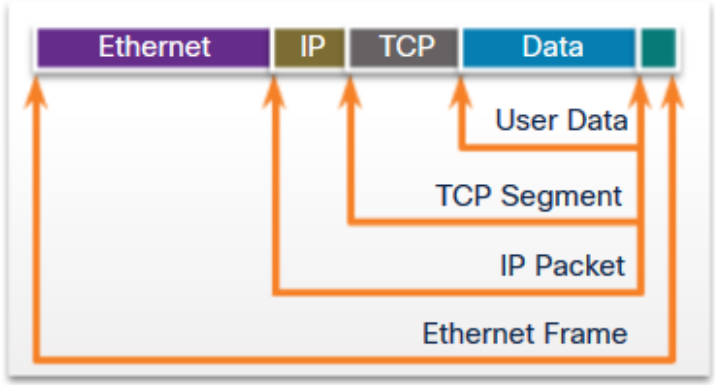


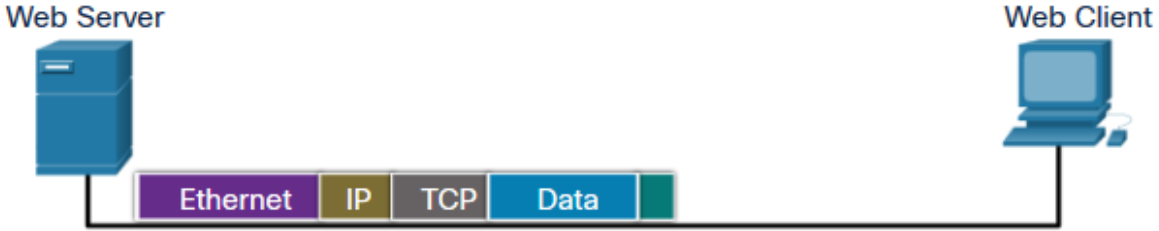

Encapsulation is the process where protocols add their information to the data.

- 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.

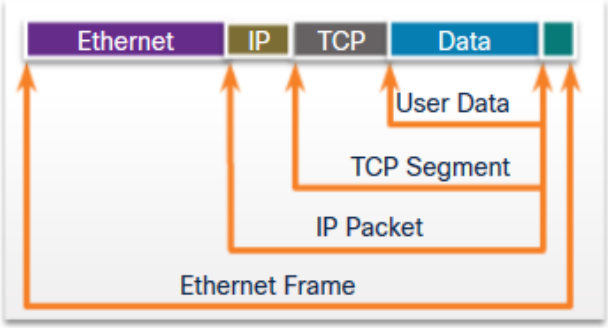


# De-encapsulation Example

- 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)





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