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Chapter 2

by

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NETWORK TERMINOLOGY

BITS 2343 | Computer Network

Objectives

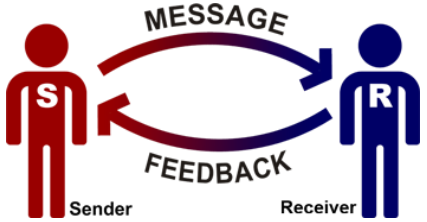
- Describe the structure of a network, including the devices and media that are necessary for successful communications.
- Explain the function of protocols in network communications.
- Explain the advantages of using a layered model to describe network functionality.
- Describe the role of each layer in two recognized network models: The TCP/IP model and the OSI model.
- Describe the importance of addressing and naming schemes in network communications.

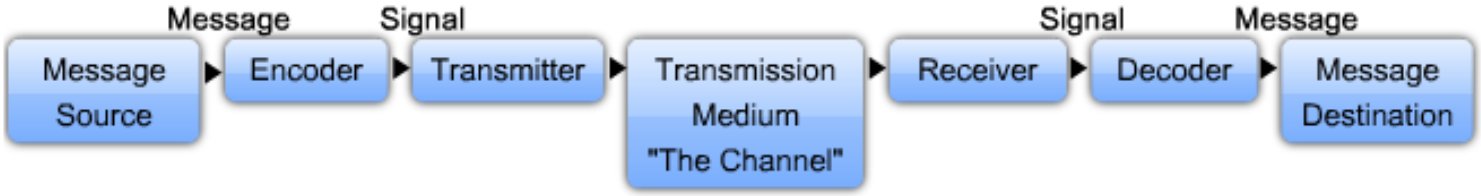
Platform for Communications

Elements, Components and Media

Elements of Communication

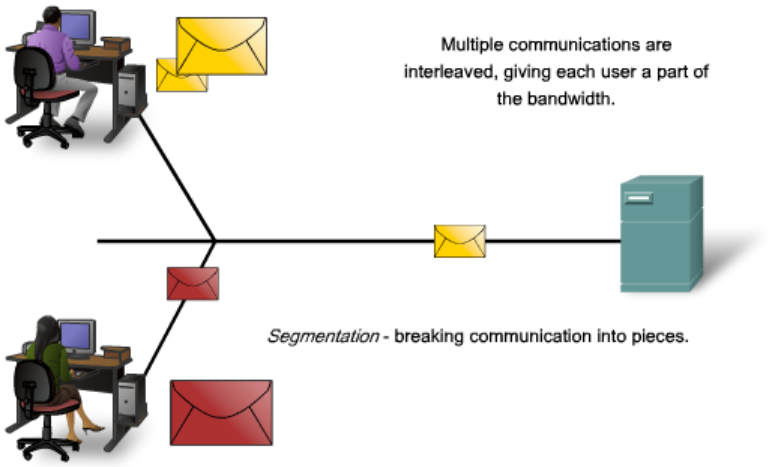
- Message source or sender
  - People or electronic devices that send a message to other individuals or devices
- Destination or receiver of the message
  - The message is received and interpreted
- Channel
  - Consists of the media that provides the pathway over which the message can travel from source to destination.





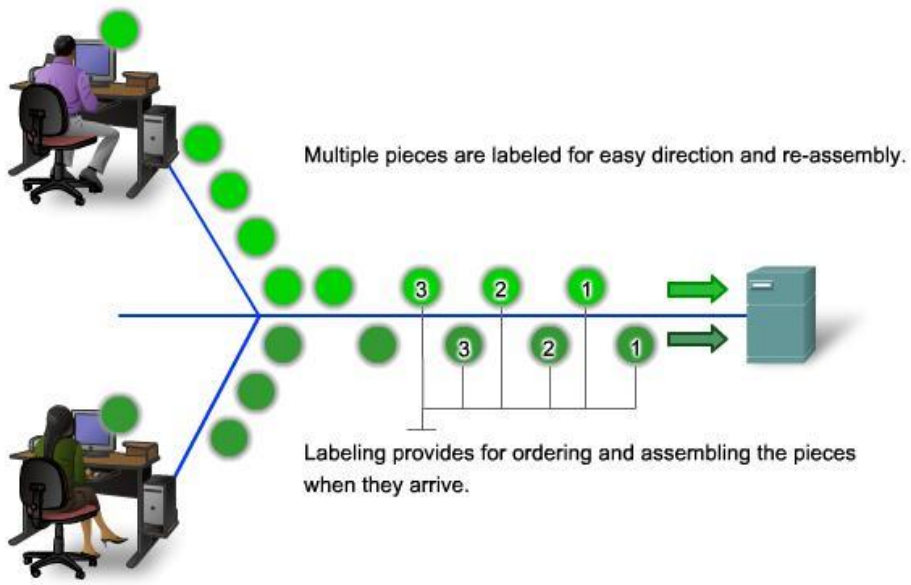
Communicating the Messages

- Segmentation
  - Divided the data into smaller, more manageable pieces called **segments**
  - Many different conversation can be interleaved on the network, giving each user a part or the bandwidth – **multiplexing**
  - Increases the reliability of network communication



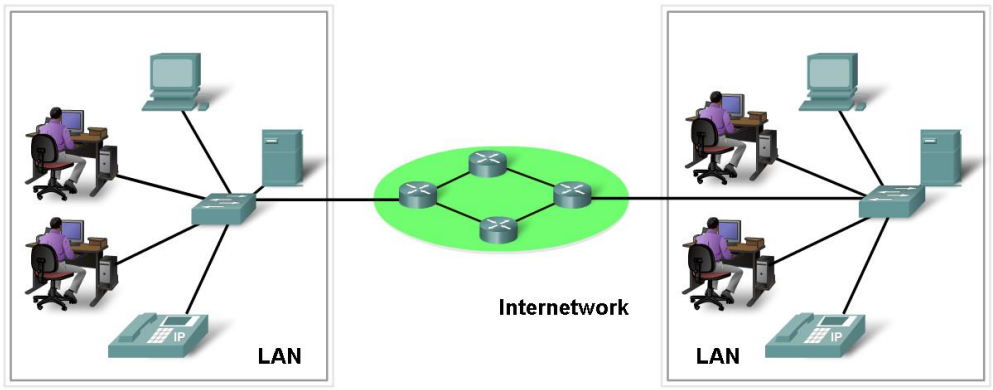
Communicating the Messages

- Segmenting and multiplexing a message requires additional processes
  - Addressing and labeling each segment at the source
  - Reassembling the segments into its original message at the destination.



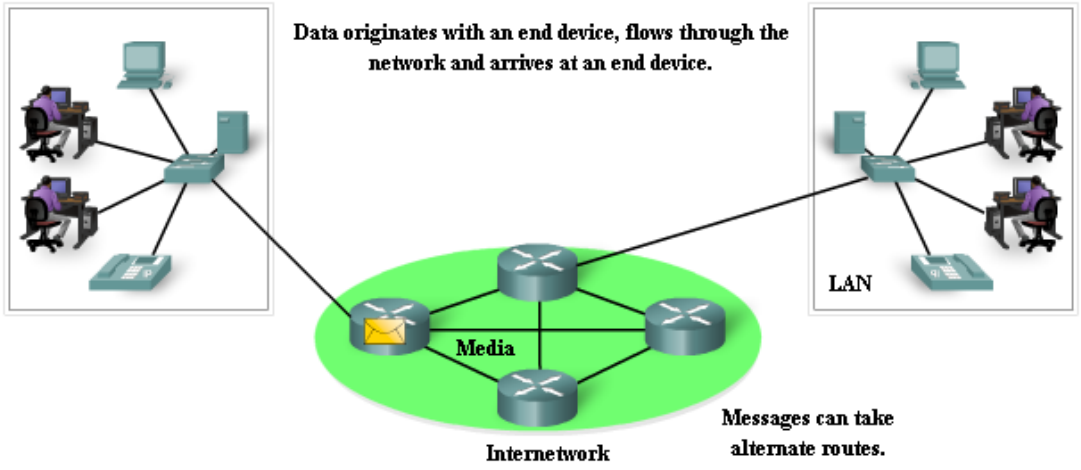
Components of the Network

- Networks use devices, media and services
- Hardware or physical elements
  - Devices and media
- Software that run on the networked devices
  - Services such as applications and processes that provide the functionality to direct and move the message through the network



End Devices

- An end device refer to a piece of equipment that is either the source or the destination of a message on a network
  - The interface between the human and the network
  - Also known as a host. Eg. -Computers, printers, VoIP Phones
  - Each host is identified by an address
  - Role of end devices : Client, Server or Client & Server



Intermediary Devices

- Provide connectivity and ensure data flows across the network
- Connect individual hosts to the network and can connect multiple individual networks to form an internetwork
- Use the destination host address to determine the path the messages take through the network
- Examples: Hubs, switches, access points, routers, modems, firewalls, etc

Intermediary Devices

- Processes
  - Regenerate and retransmit data signals
  - Maintain information about what pathways or routes exist through the network and the internetwork
  - Notify other devices of errors and communication failures
  - Direct data along alternate routes when there is a link failure
  - Classify and direct message according to QoS priorities
  - Permit or deny the flow of data based on setting

Network Media

- Modern networks primarily use three types of media
  - Copper
  - Glass or plastic fiber
  - Wireless
- The signal encoding method is different for each media type
  - Data is encoded onto electrical pulses on copper wires
  - Fiber optic transmission rely on pulses of light, within either infrared or visible light ranges
  - Pattern of electromagnetic waves represent the various bit values in wireless transmission

Network Media

- Examples of network media

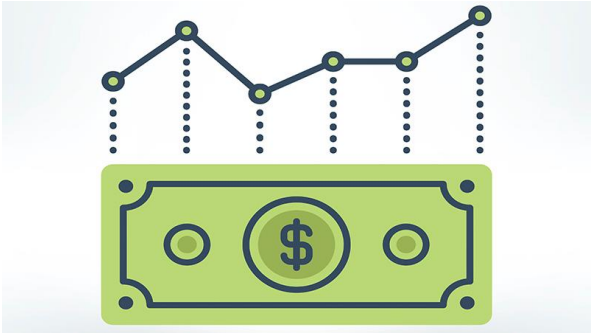
Copper

Fiber Optics

Wireless

Network Media

- Selecting a network media
  - The distance the media can successfully carry a signal
  - The environment in which the media is installed
  - The amount of data and the speed at which it must be transmitted
  - The cost of the media and installation



Network Infrastructures

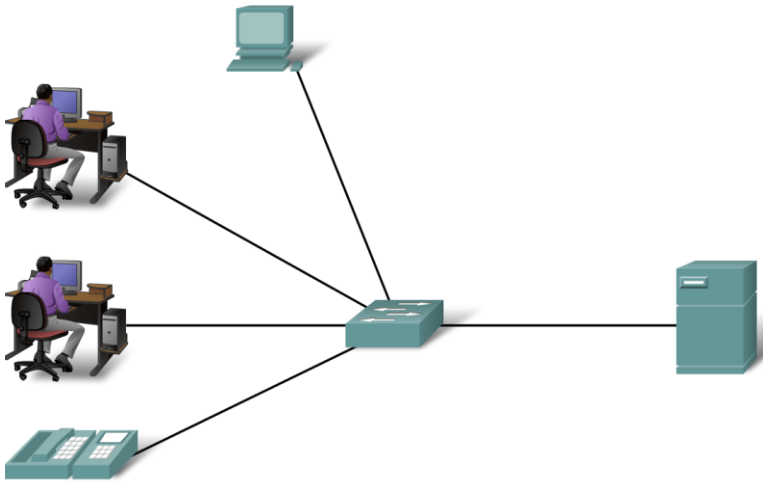
LANs, WANs, and Internetworks

Network Infrastructures

- Network infrastructures can be vary in terms of"
  - The size of the area covered
  - The number of users connected
  - The number and type of services available
- Common types of network infrastructures
  - LANs
  - WANs
  - Internet

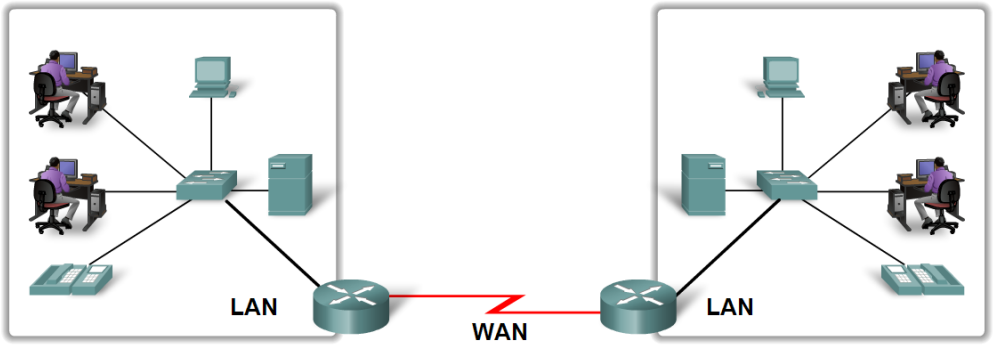
Local-Area Networks

- A LAN usually spans a small geographical area
  - Provides services and applications to people within a common organization structure, such as a home, building or campus
  - Usually administered by single organization
  - Security and access control policies are enforced on the network level



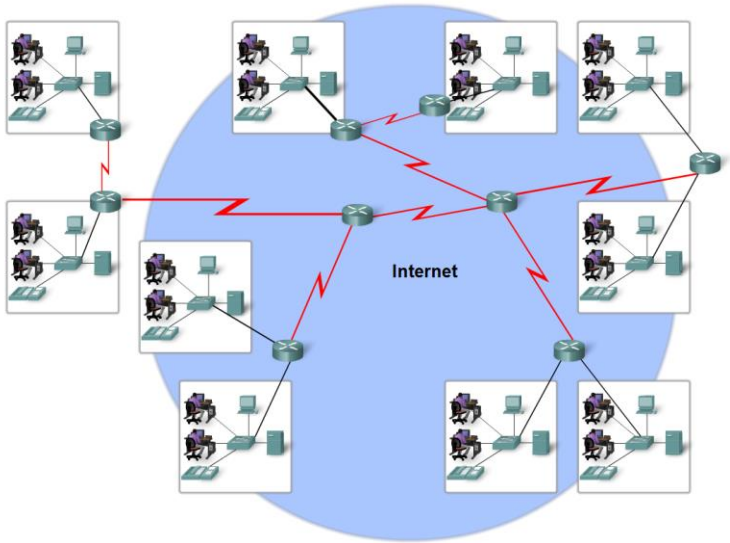
Wide-Area Networks

- Telecommunication Service Provider (TSP) networks are used to interconnect an organization's LAN that are located geographically for apart
  - TSPs operate large regional networks that span long distance
  - The TSP networks are referred to as wide area networks
- WANs use specially designed network devices to makes the interconnections between LANs

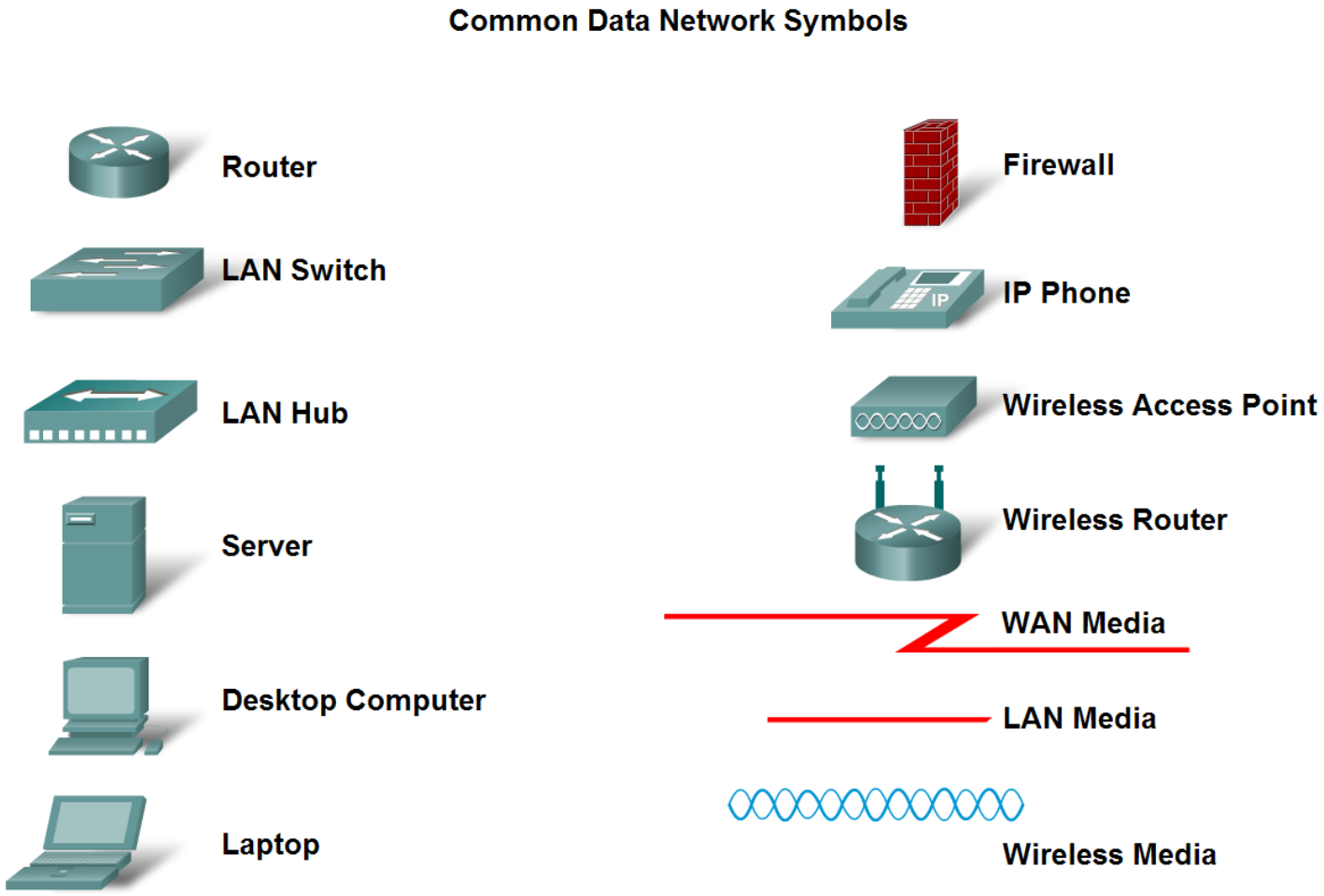


The Internet – A Network of Networks

- a global mesh of interconnected networks
- Owned by large public and private organizations
- LANs and WANs maybe connected into internetworks
- The internet is an example of a public-accessible internetwork



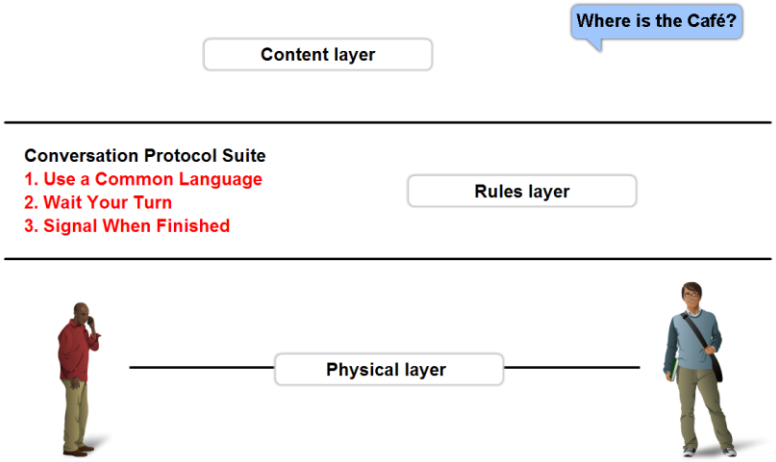
Network Representations



Protocols

Rules That Govern Communications

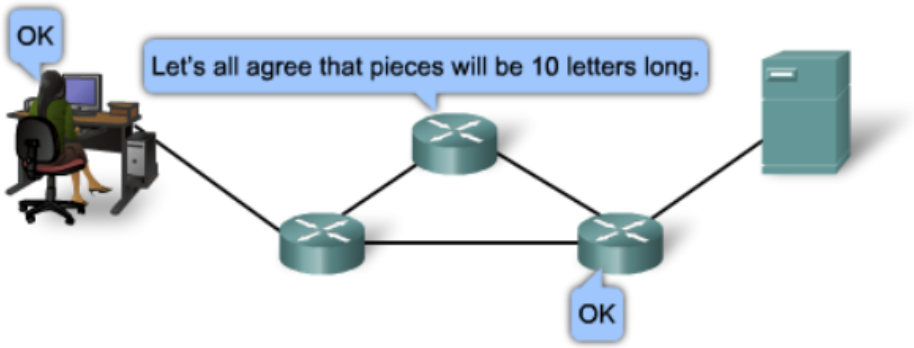
- Protocol is a set of predetermined rules
- Implemented in software that is loaded on each host and network device
- A group of inter-related protocols that are necessary to perform a communication function is called a **Protocol Suite**



Network Protocols

Format

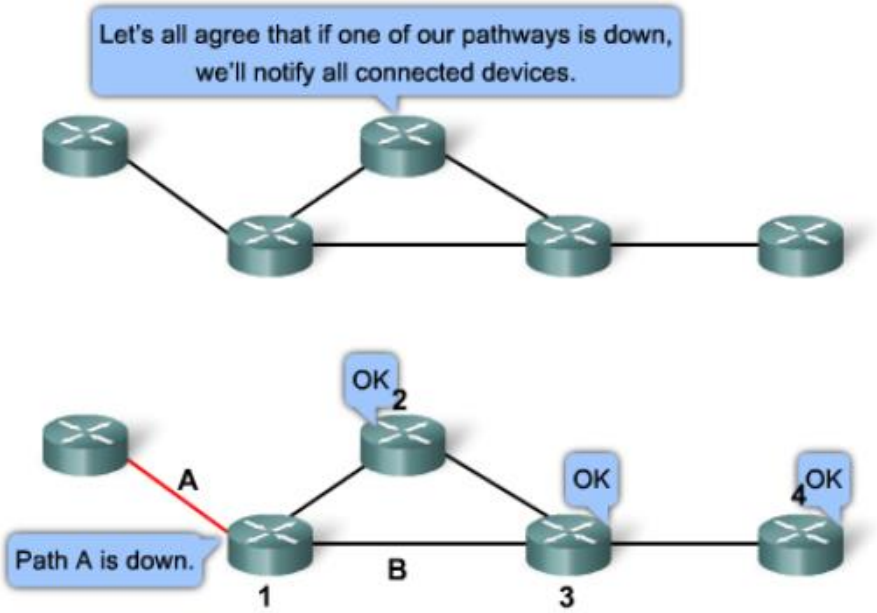
- The **format** or structure of the message.
  - How much data to put into each segment
  - Defines the sizes of each **Protocol Data Unit (PDU)**



Network Protocols

Process

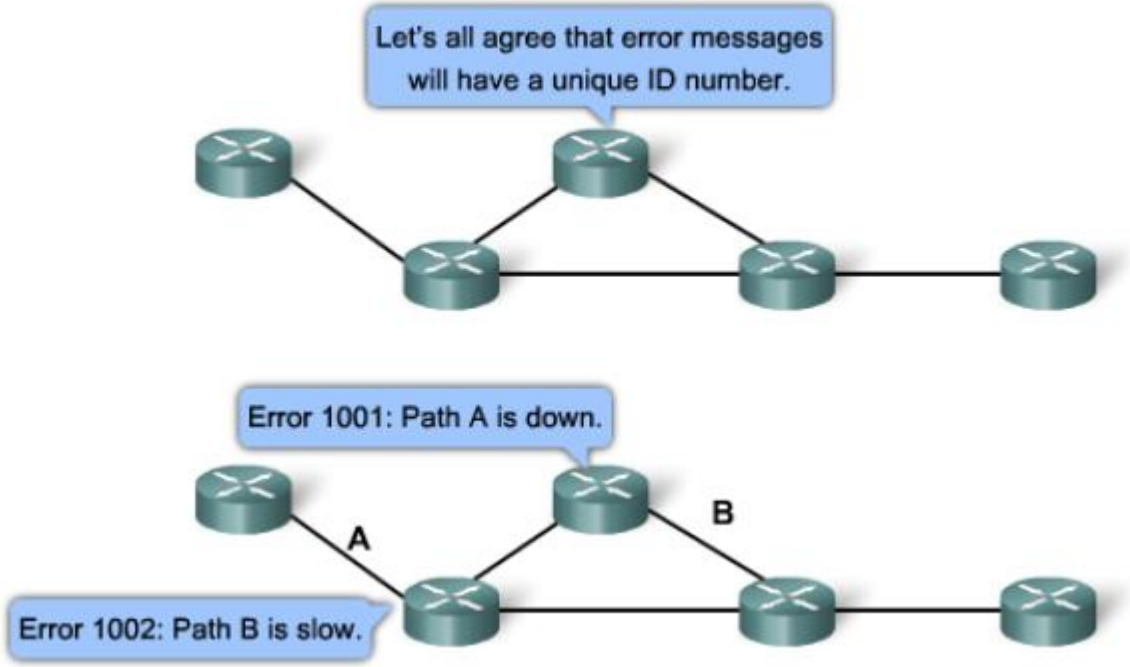
- The **process** by which intermediary devices share information about the **path** to the destination



Network Protocols

Error Messages

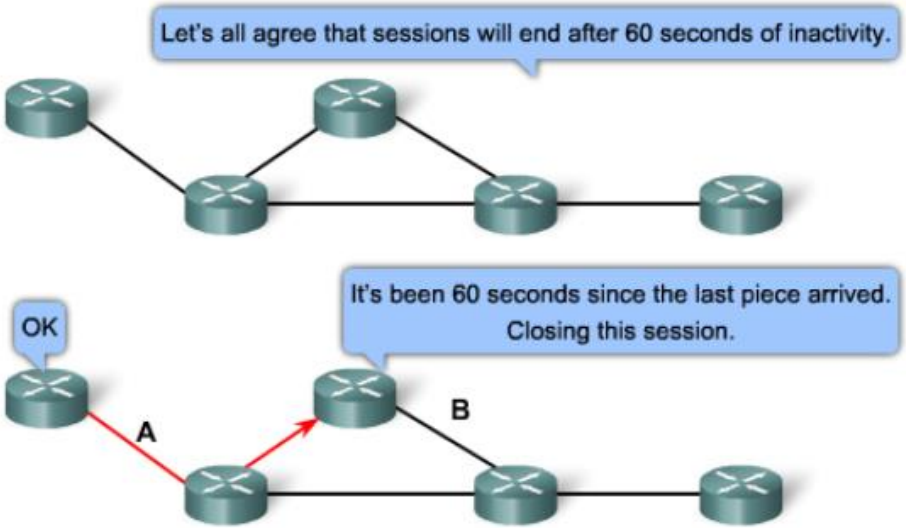
- The method to handle error and system messages between intermediary devices



Network Protocols

Termination

- The process to setup and terminate communications or data transfers between hosts
  - Define the duration of inactivity or idle timeout to terminate a connection

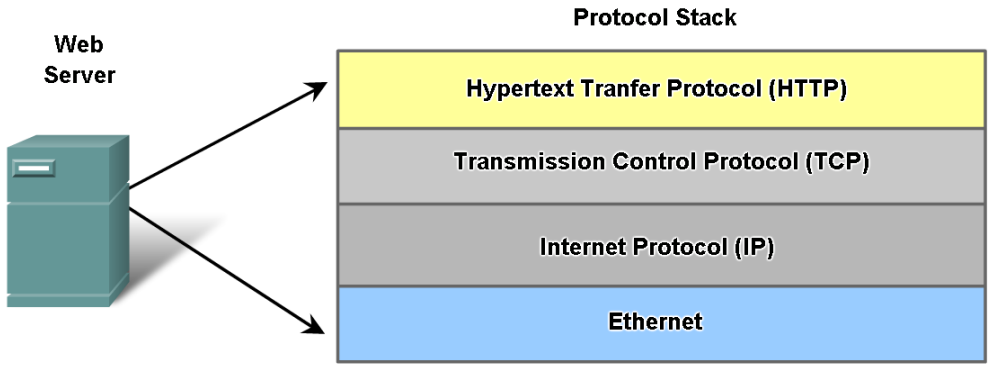


Industry Standards

- A **standard** is a process that has been endorsed by the networking industry and officially approved by a standard organization
  - IEEE (Institute of Electrical and Electronic Engineers)
  - IETF (Internet Engineering Task Force)
- The use of standards in developing and implementing protocols ensures that products from different manufacturers can work together for efficient communication

Interaction of Protocols

- Application Protocol
- Transport Protocol
- Internetwork Protocol
- Network Access Protocol



Interaction of Protocols

- Application Protocol
  - HTTP defined **the content and formatting** of the requests and responses exchanged between the client and the server

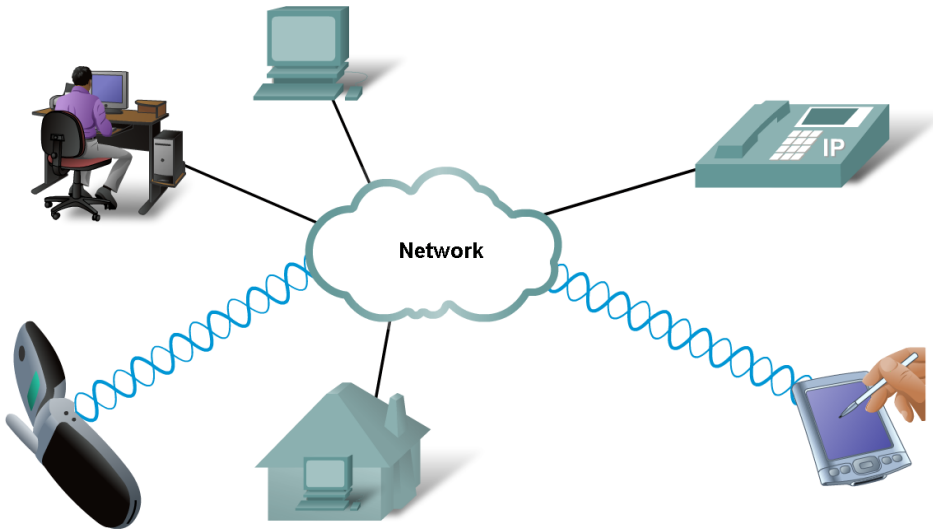
- Transport Protocol
  - TCP messages the individual conversations and divides to HTTP messages into smaller pieces called **segments**
  - TCP is also responsible for controlling the **size and rate** at which messages are exchanged.

Interaction of Protocols

- Internetwork Protocol
  - IP is responsible for taking the formatted segments from TCP, **encapsulating** them into packets, assigning the appropriate **IP addresses** and selecting the **best path** to destination
- Network Access Protocols
  - Describes the data link management and the physical transmission of the data on the media.
  - Data-link management protocols **encapsulates** the packets into **frames**
  - The physical media standards and protocols govern how the **signals** are **sent** over the media and how they are **interpreted** by the receiving end device

Technology-Independent Protocols

- Many diverse types of devices can communicate using the same sets of protocols
- This is because protocols specify network functionality, not the underlying technology to support this functionality



Using Layered Models

TCP/IP model

OSI model

The Benefits of a Layered Model

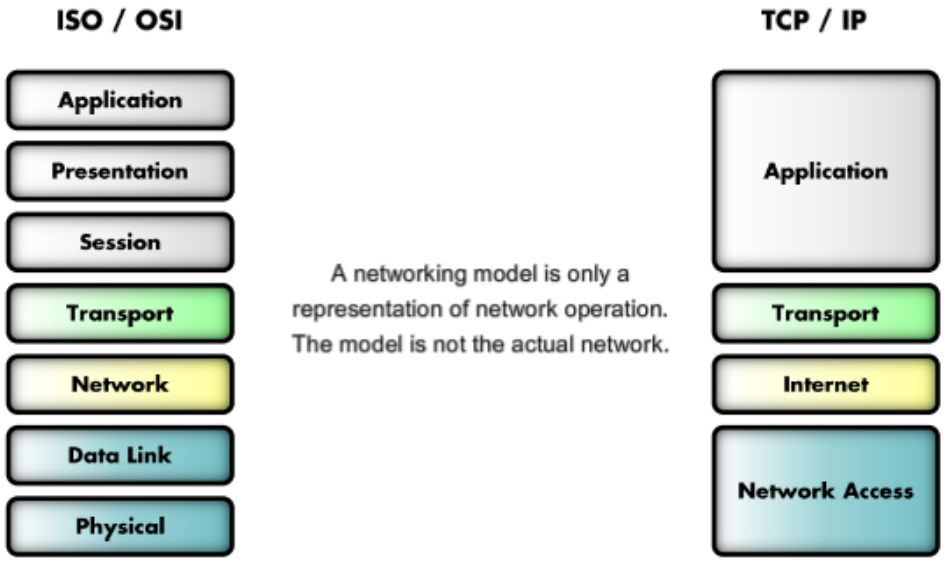
- Assists in protocol design
  - Protocol that operate at a specific layer have defined information that they act upon and a defined interface to the layers above and below
- Fosters competition
  - Product from different vendors can work together
- Prevent technology or capabilities changes in one layer from affecting other layers above and below
- Provides a common language to describe networking functions and capabilities

Protocol and Reference Models

- A protocol model provides a model that closely matches the structure of a particular protocol suite
  - Transmission Control Protocol/Internet Protocol (TCP/IP) model
- A reference model provides a common reference for maintaining consistency within all types of network protocols and services
  - It is not intended to be an implementation specification or to provide a sufficient level of detail to define precisely the services of the network architecture
  - The primary purpose is to aid in clearer understanding of the functions and processes involved
  - Open System Interconnection (OSI) model

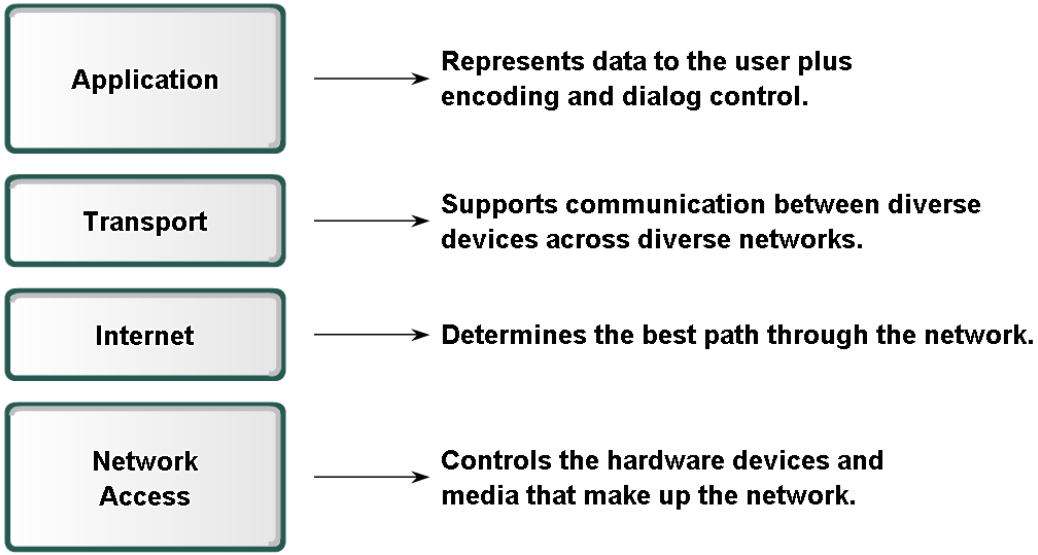
Protocol and Reference Models

- TCP/IP model
  - The functions that occur at layer of protocols within the TCP/IP suite
- OSI model
  - Used for network design, operation specifications and troubleshooting

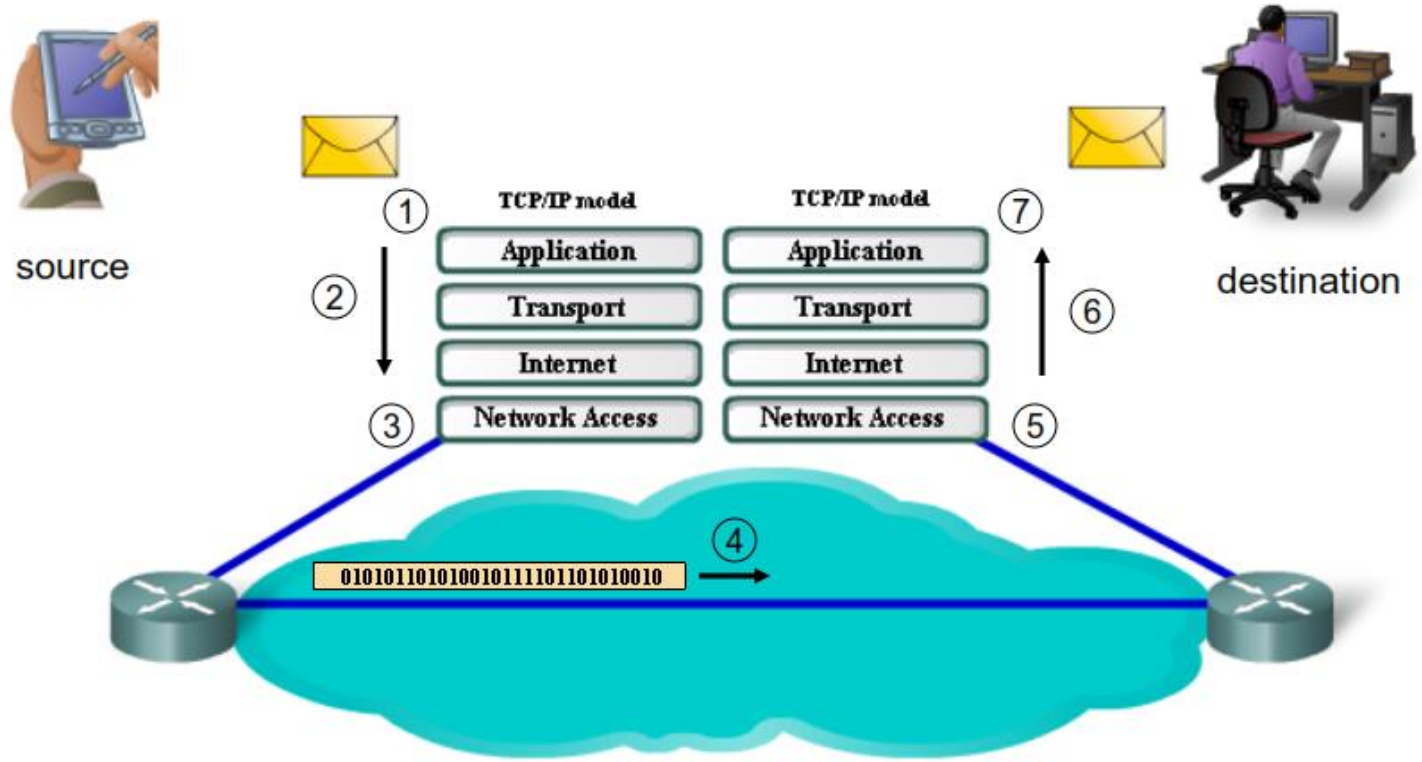


TCP/IP Model

- Defines four communication functions that protocols perform
- An open standard develop in the early 1970s
  - Defined in publicly-available document called Request For Comment (RFCs)

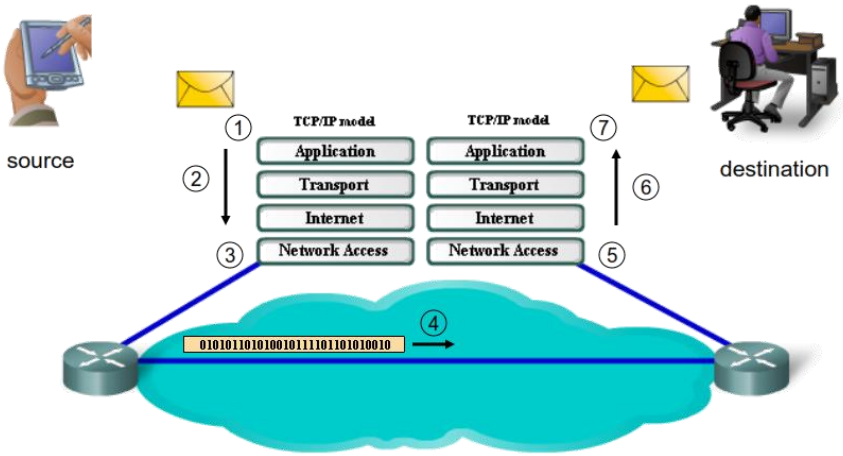


Communication Process



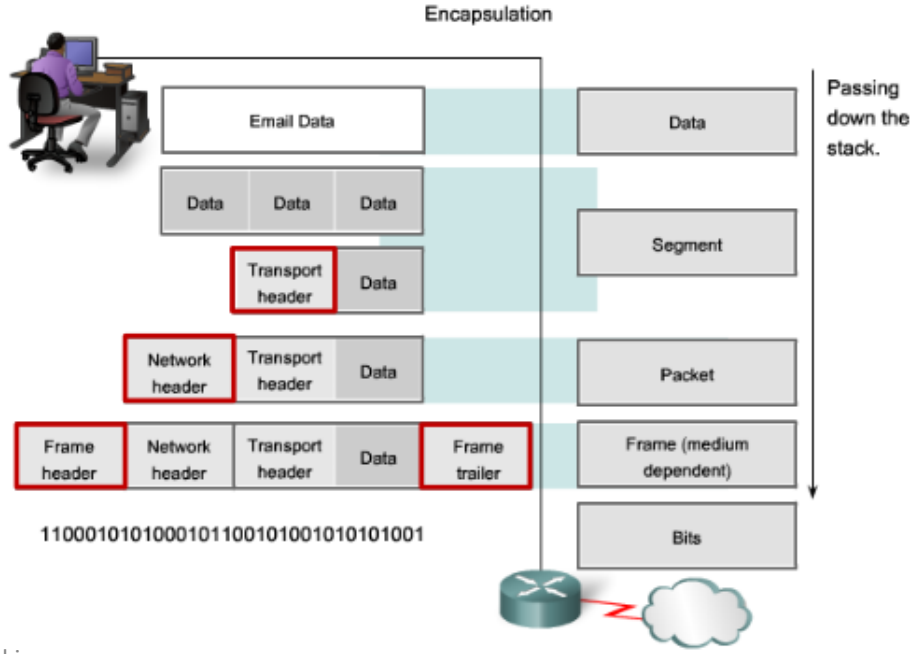
Communication Process

1. Creation of data at the application layer of the originating source end-device
2. Segmentation and encapsulation of data as it passes down the protocol stack in the source end-device
3. Generation of the data onto the media at the network access layer of the stack
4. Transportation of the data through the internetwork, which consists of media and any intermediary devices
5. Reception of the data at the network access layer of the destination end-device
6. Decapsulation and reassembly of the data as it passes up the stack in the destination device
7. Passing this data to the destination application at the application layer of the destination end device



Protocol Data Units and Encapsulation

- **Protocol Data Unit (PDU)** is the generic term for "data" at each level
- **Encapsulation** is the process of adding control information as it passes through the layered model



Sending Process

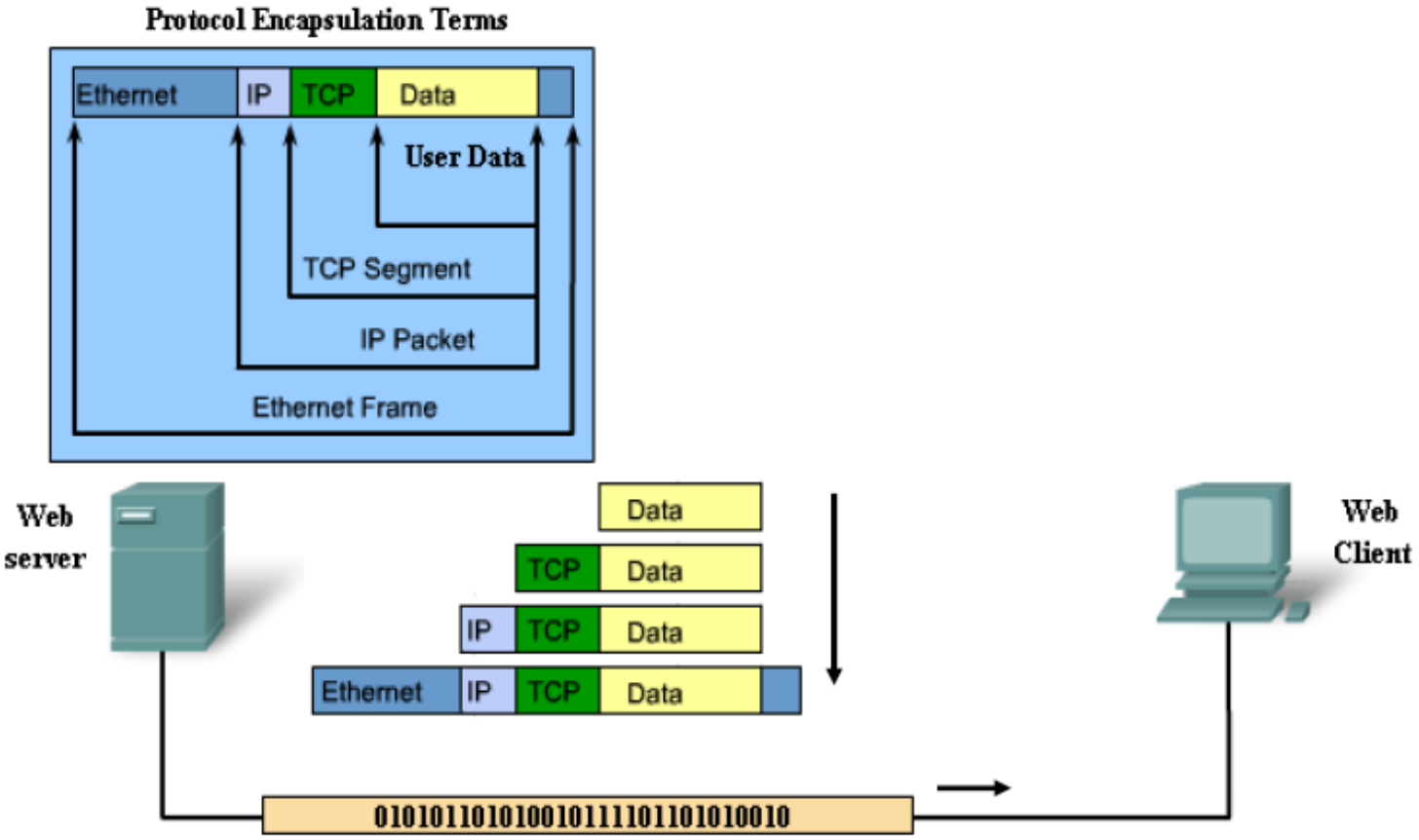
- The Application layer begins the process by delivering the data to the transport layer
- The Application data is broken into TCP segments and segment is given a label, called a **header**
  - The header contains information about which process running on the destination computer should receive the message
  - It also contains the information to enable the destination process to **reassemble** the segments
- The TCP segment is sent to the Internet layer and encapsulated within an IP packet, which adds an IP header
  - The IP header contains the source and destination IP addresses

Sending Process

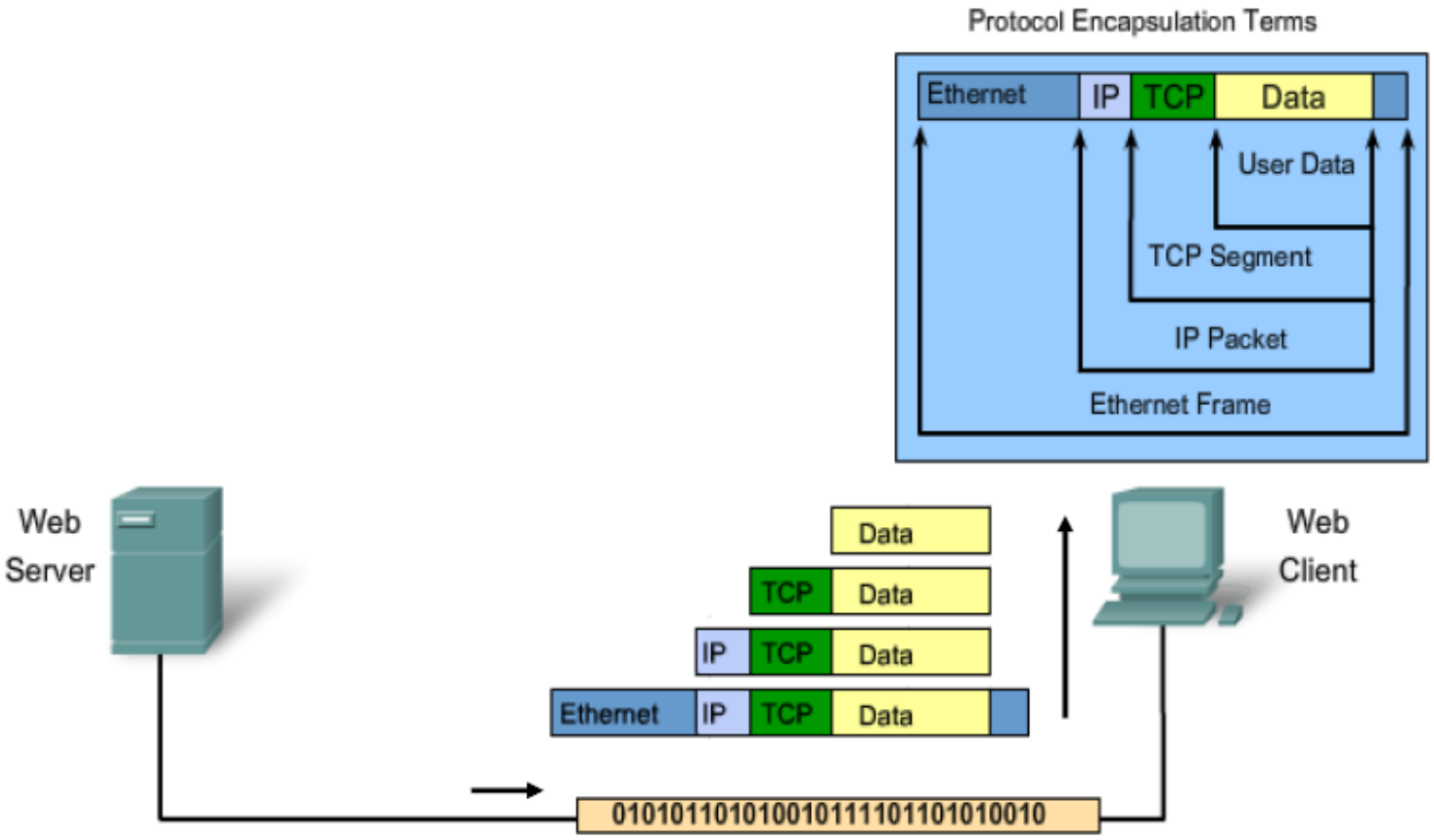
- The IP packet is sent to the Network Access layer where it is encapsulated with a frame header and trailer
  - Each frame header contains the source and destination physical address
  - The trailer contains error checking information

- Finally the bits are encoded onto the Ethernet media by the end-device Network Interface Card (NIC)

Sending Process

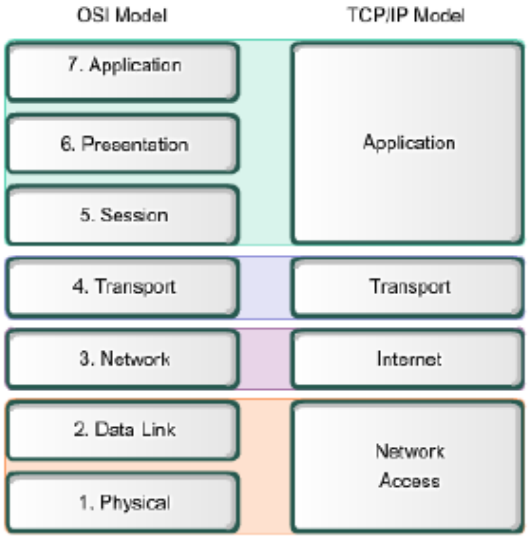


Receiving Process



Comparing the OSI Model to the TCP/IP Model

- The functions of the Application, Presentation and Session layers of the OSI model are combined into on Application layer in the TCP/IP model
- The Data Link and Physical layers of OSI model combine to make the Network Access layer of the TCP/IP model
- The key parallel between the two models occur at layer 3 and 4 of the OSI model
  - TCP operates at TL
  - IP operates at IL / NL



Network Addressing

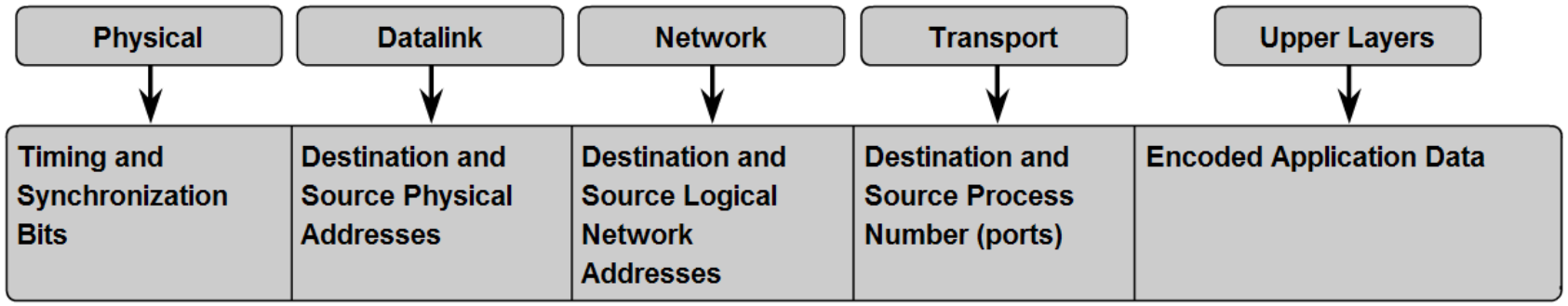
Physical addresses

Logical addresses

Service Port numbers

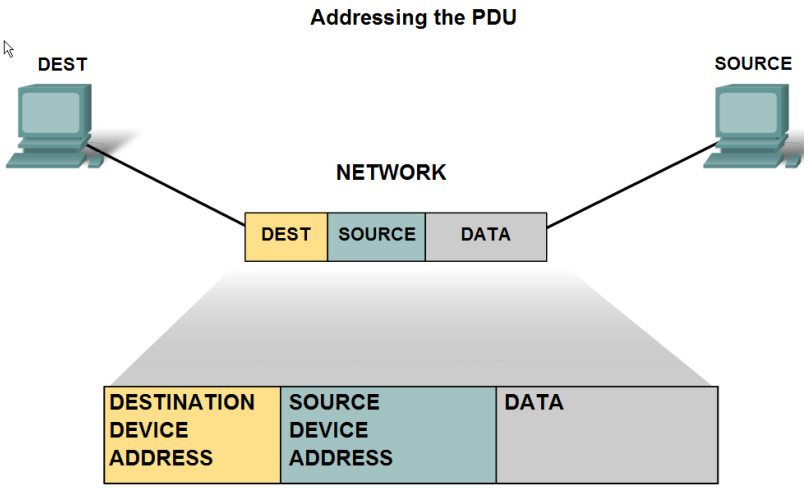
Addressing

- Various types of addresses are needed to successfully deliver the data from a source application running on one host to the correct destination application running on another
  - Data Link physical addresses
  - Network logical addresses
  - Transport service port numbers



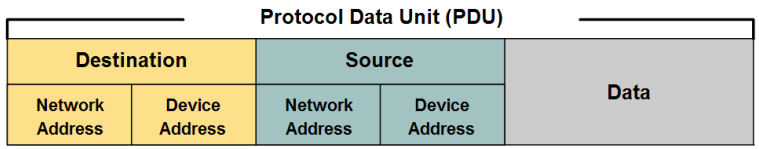
Getting Data to the End Device

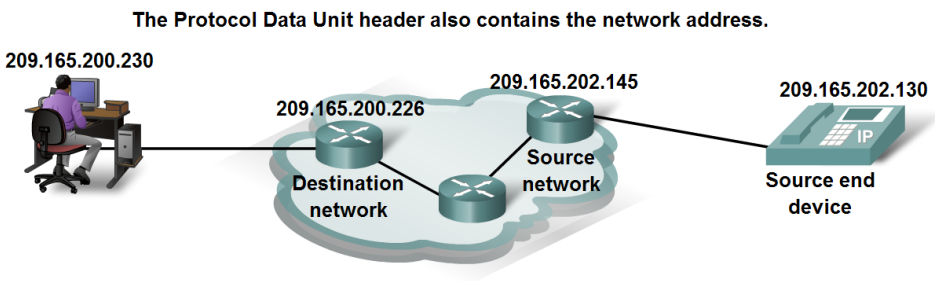
- This is the physical address of the host (or end device)
  - In a LAN using Ethernet, this address is called the Media Access Control (MAC) address
  - Layer 2 addresses are used to communicate between device on a single local network



Getting Data Through the Internetwork

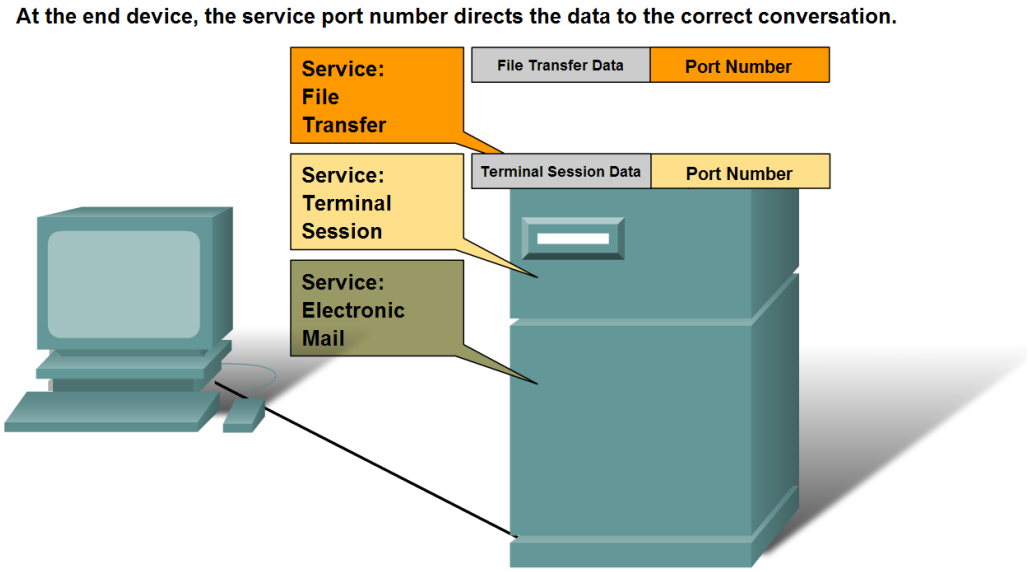
- This is the logical address
- Layer 3 addresses are primarily used to move data from local network to another local network
  - Enable intermediary network device to locate hosts on different networks





Getting Data to the Right Application

- At layer 4, the information contained in the PDU header **identifies** the specific process or **service** running on the destination host device
  - The separately running programs are examples of individual processes



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