2. Network Models

Disclaimer

All illustrations and diagrams are taken from the same book.

Existing Power-point presentations by the same author are used in creating new presentations

Outline

Concept of Protocol Layering

- Scenarios
- Principles of Protocol Layering
- Logical Connections

Layers of the TCP/IP Protocol Suite

- Layered Architecture
- Layers and Description
- Encapsulation and Decapsulation
- Addressing
- Multiplexing and Demultiplexing

OSI Model

- OSI Versus TCP/IP
- Lack of OSI Model's Success

Protocol Layering

Scenarios

Principles

Logical Connections

Protocol Layering: Scenarios

In communication and networking, protocol defines the rules that all communicating parties must follow

Communicating parties include

- Sender
- Receiver
- Intermediate devices

Simple communication may need only one simple protocol

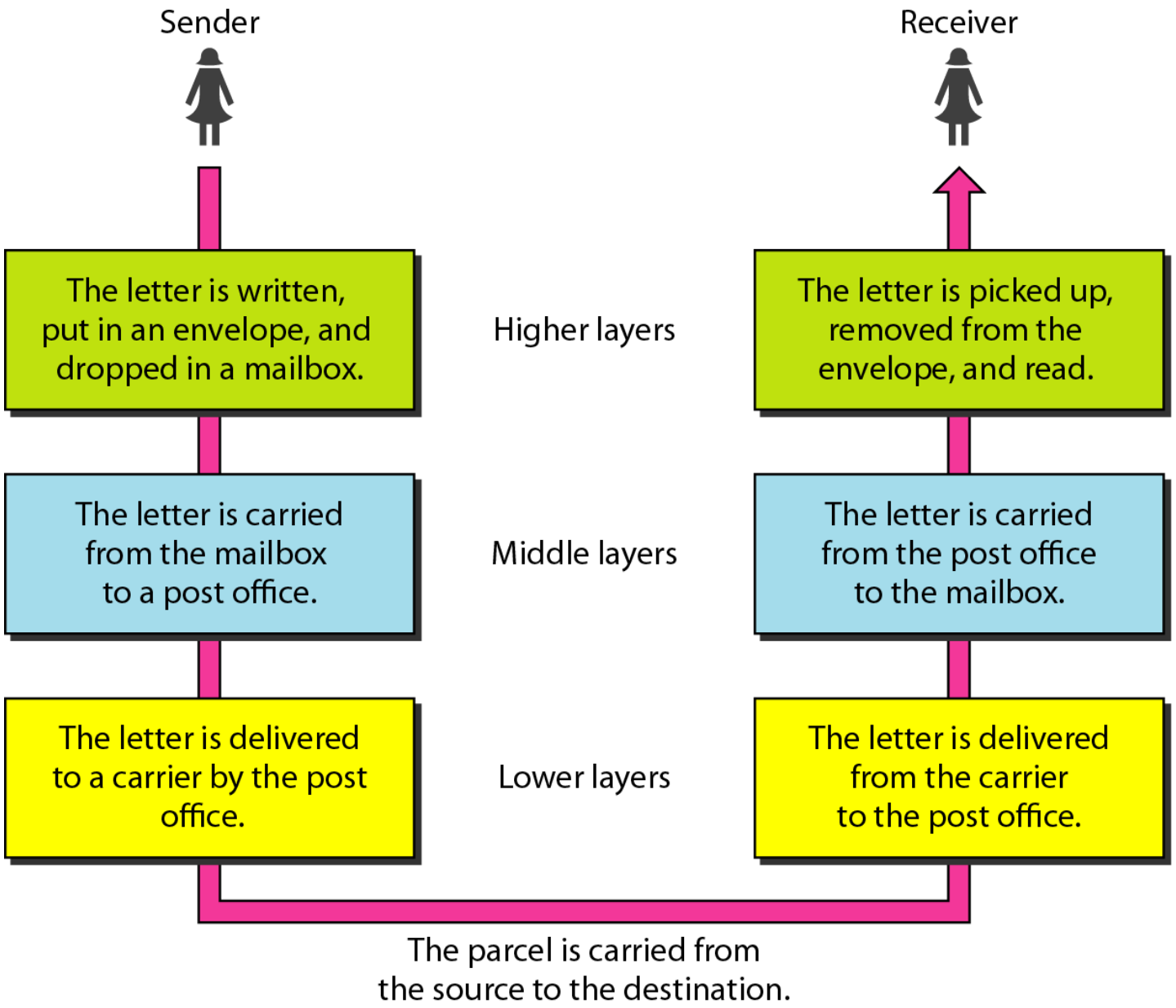
Complex communication needs to divide tasks between different layers

- So need a protocol at each layer
  - Protocol layering

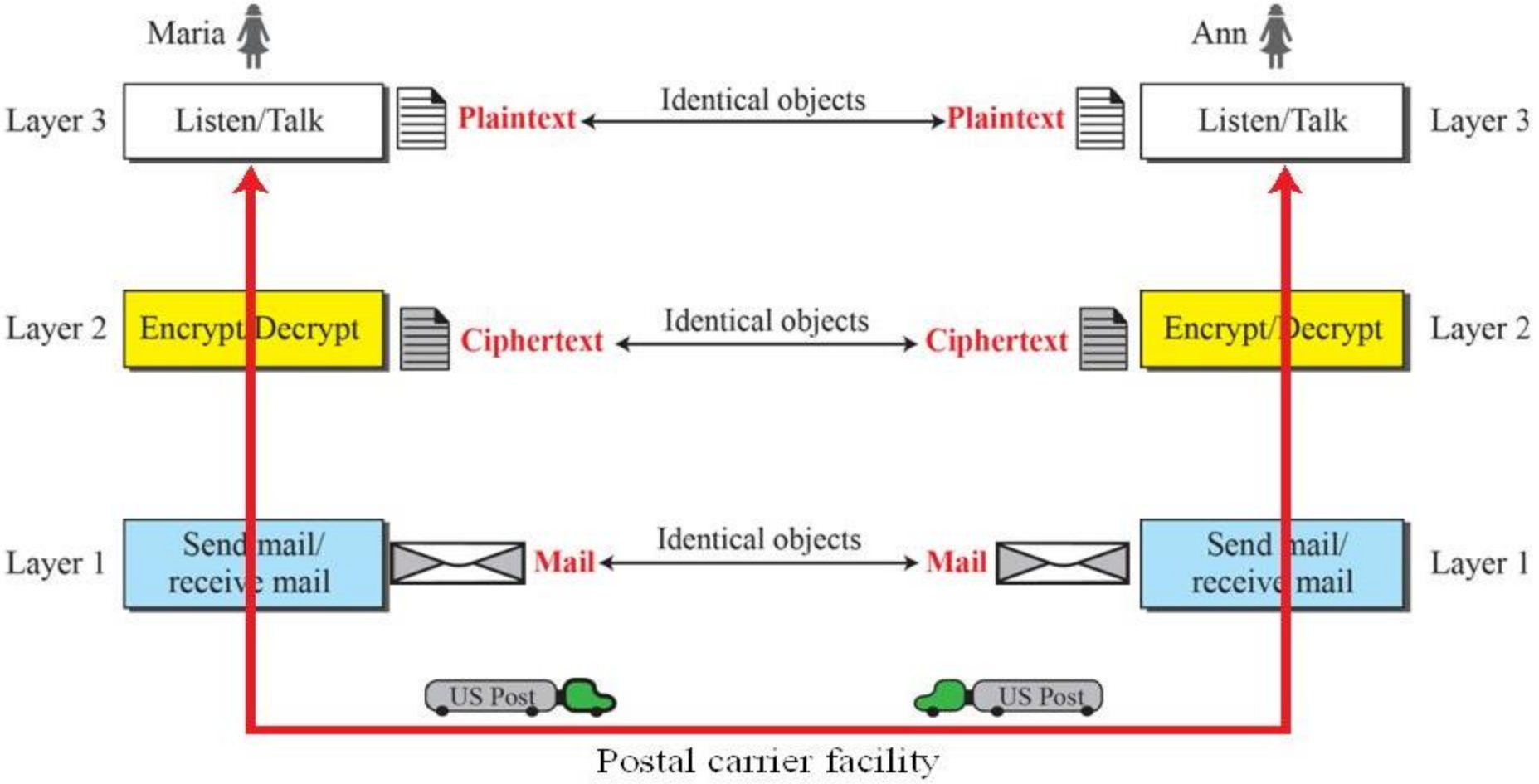
A single-layer protocol

Set of rules Maria and Ann would follow:

- Greet each other when they meet
- Know that they should confine their vocabulary to the level of their friendship
- Refrain from speaking when the other party is speaking
- Conversation should be a dialog
- Exchange some nice words when they leave



Protocol Layering used in postal communication as an example



A three-layer protocol

Protocol Layering: Scenarios

Enables us to divide a complex task into several smaller and simpler tasks

Modular implementation (Modularity) enables layered replacements only

Layer is black box with inputs and outputs, without concern about how inputs are changed to outputs

If two machines provide the same outputs when given the same inputs, they can replace each other

Advantages:

- Separate services from implementation
  - Layer receives set of services from lower layer and give services to the upper layer
- Intermediate devices may need only some layers, but not all layers

Protocol layering: Principles of Protocol Layering

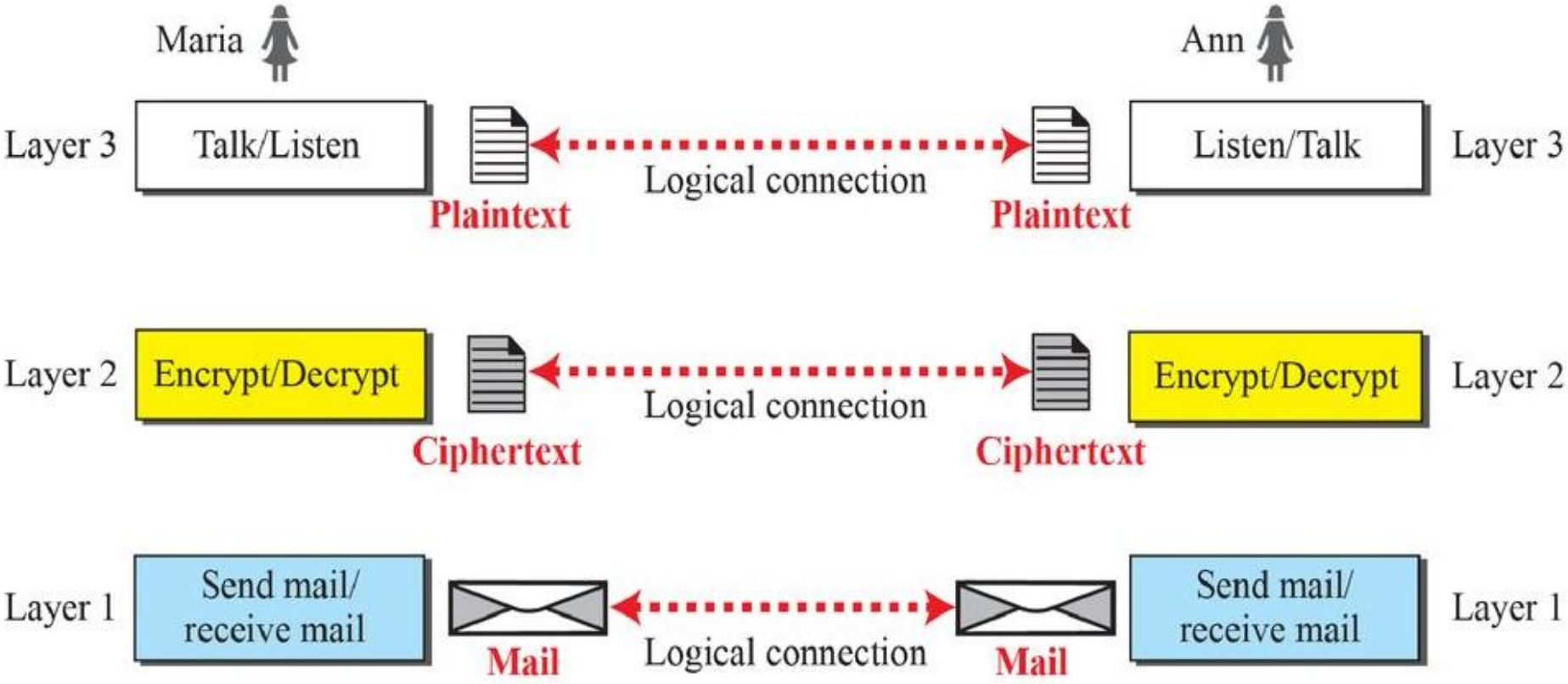
First Principle

- Bidirectional communication needs to make each layer so that it is able to perform two opposite tasks, one in each direction

Second Principle

- Two objects under each layer at both sites should be identical

Protocol Layering: Logical Connections



TCP/IP Protocol Suite

Layered Architecture

Layers in TCP/IP Protocol Suite

Description of Each Layer

Encapsulation and Decapsulation

Addressing

Multiplexing and Demultiplexing

TCP/IP Protocol Suite: Layered Architecture

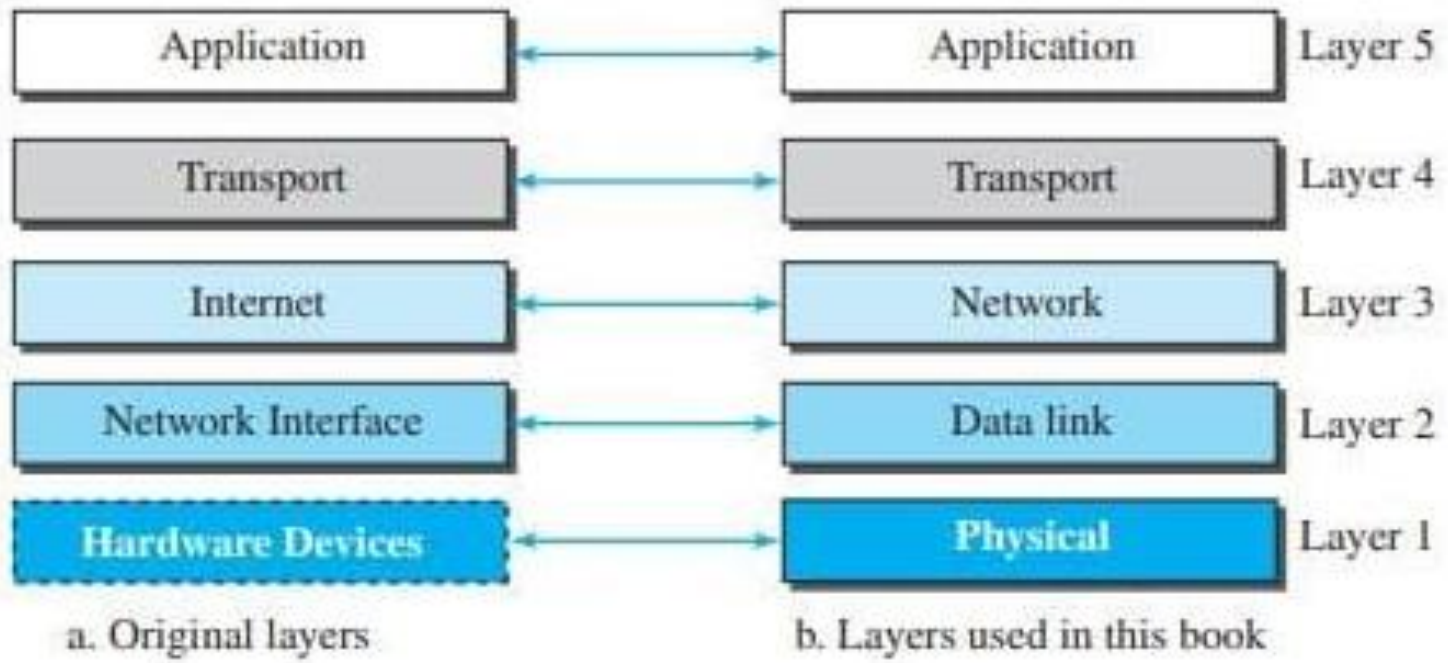
Transmission Control Protocol / Internet Protocol (TCP/IP)

- Protocol suite used in the Internet today
- Hierarchical protocol made up of interactive modules, each of which provides a specific functionality
  - Each upper level protocol is supported by the services provided by one or more lower level protocols

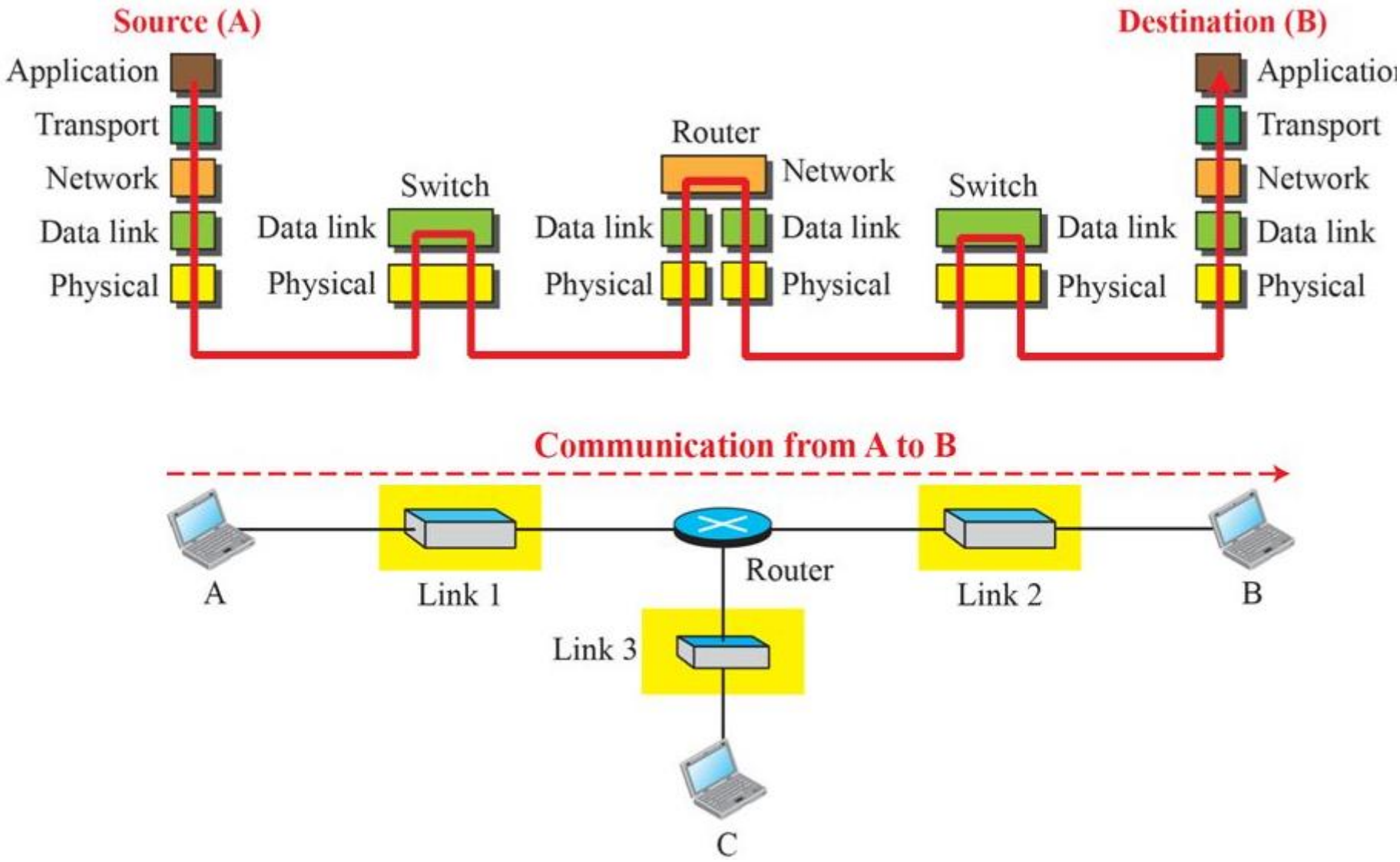
Original TCP/IP protocol suite was defined as four software layers built upon the hardware

- Host-to-network, internet, transport and application

Today, TCP/IP is thought of as a five-layer model

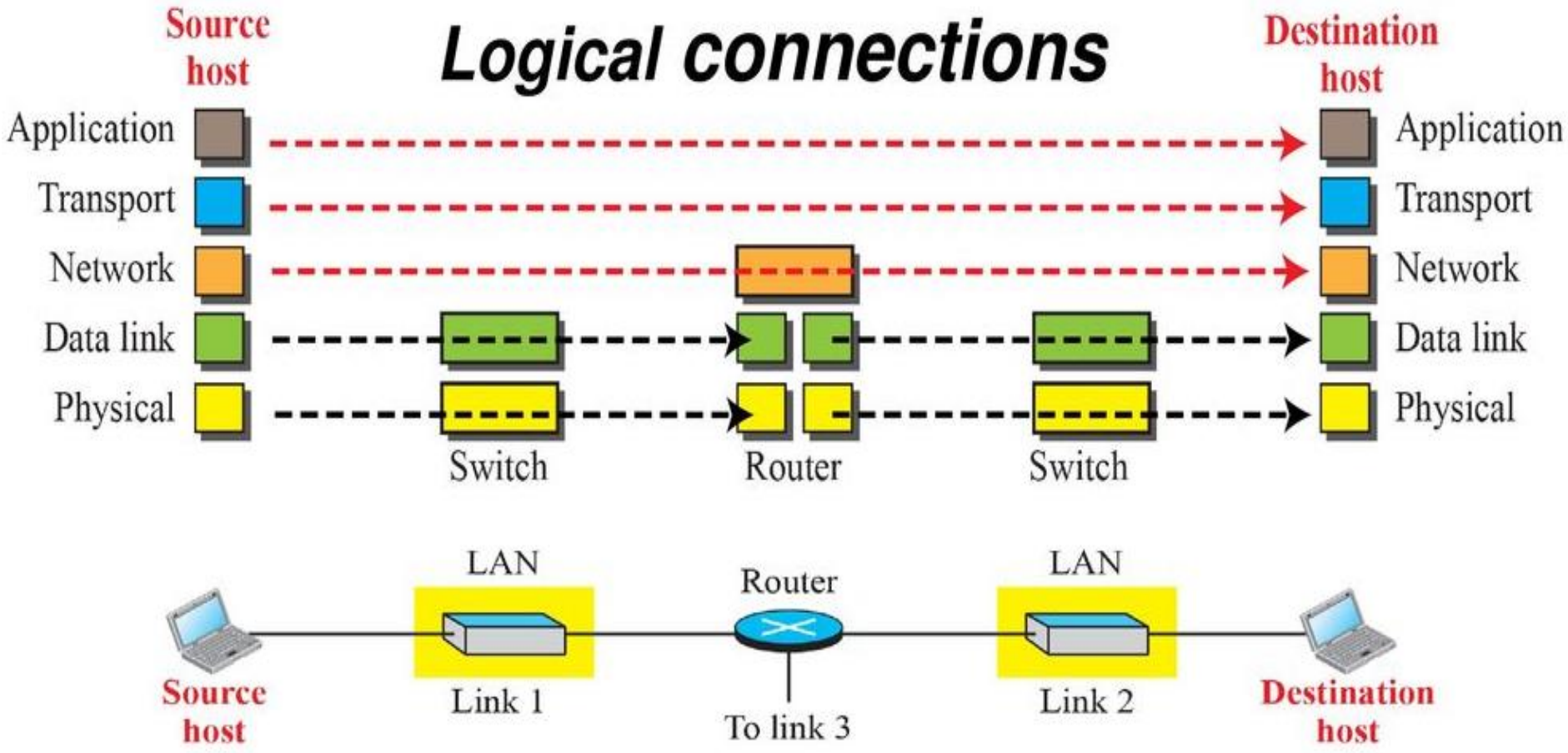


TCP/IP Protocol Suite



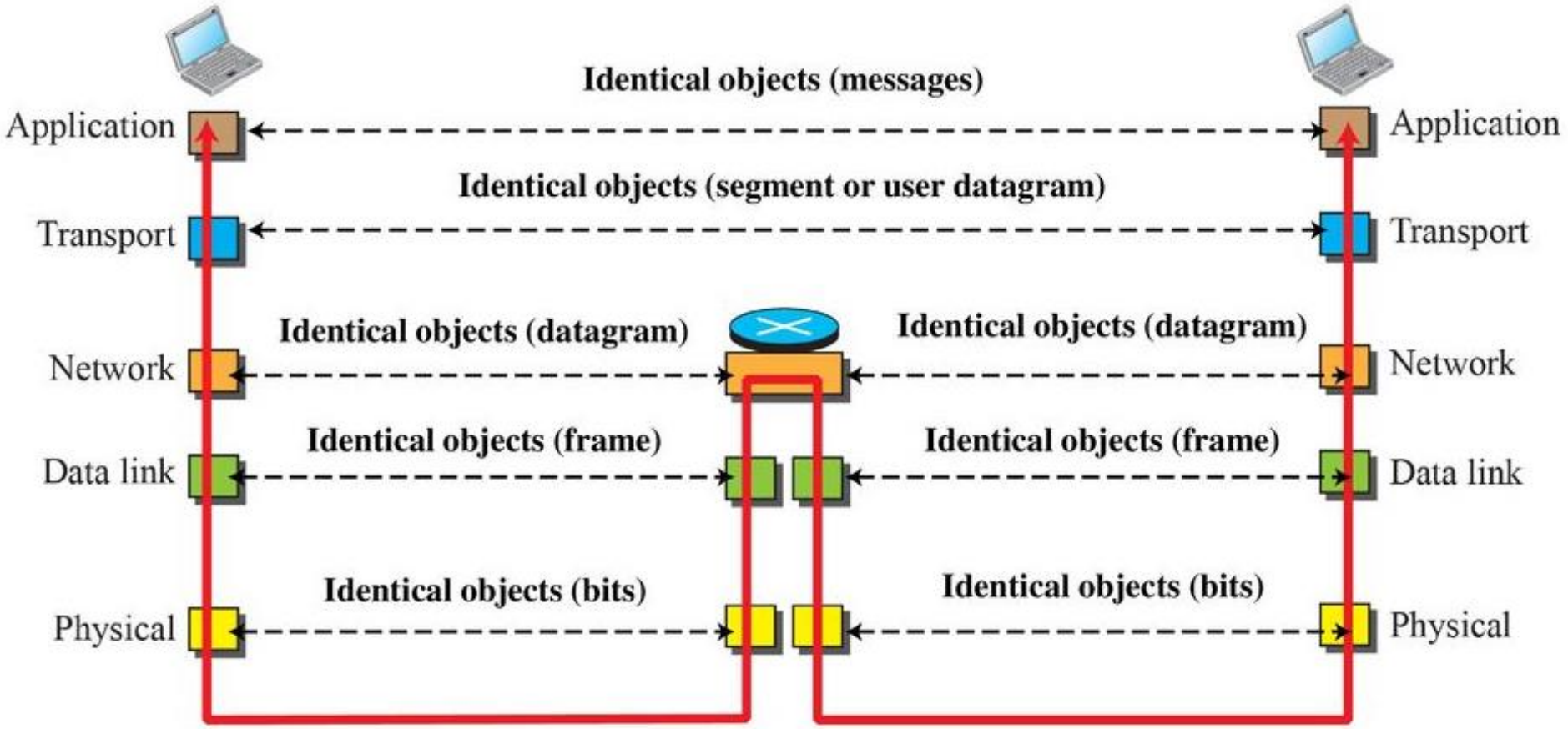
Communication through an Internet

TCP/IP Protocol Suite: Layers in the TCP/IP Protocol Suite



Logical connections between layers of the TCP/IP protocol suite

Notes: We have not shown switches because they don't change objects.



Identical objects in the TCP/IP Protocol Suite

TCP/IP Protocol Suite: Description of each Layer

Physical Layer

- Responsible for carrying individual bits in a frame across the link
- At Physical Layer, communication is logical communication as
  - There is another hidden layer, the transmission medium – transmits signals
  - Bits received in a frame from data-link layer are transformed and sent through the transmission media
  - Several protocols transform bits to a signal

TCP/IP Protocol Suite: Description of each Layer

Data-link Layer

- Internet is made up of several links (LANs and WANs) connected by routers
- Overlapping sets of links between host and destination
- Routers choose best links
  - Data-link layer takes the datagram and moves it across the link using various protocols for the specific type of link
- Takes a datagram and encapsulates it in a packet called a frame
- Link layer provides complete error detection and correction or only error correction

TCP/IP Protocol Suite: Description of each Layer

Network Layer

- Responsible for creating a connection between source computer and destination computer
- Communication is host-to-host
- Separate network layer to have modular implementation
- Internet Protocol
  - Routing
  - defines format of datagram, structure of addresses and routes packet from source to destination
  - Connectionless protocol
  - No flow control, error control and congestion control

TCP/IP Protocol Suite: Description of each Layer

Network Layer

- Includes unicast and multicast routing protocols
- Creates forwarding tables for routers to help them in routing process
- Other protocols that help IP in delivery
  - Internet Control Message Protocol (ICMP) helps IP to report some problems when routing a packet
  - Internet Group Management Protocol (IGMP) helps IP in multicasting
  - Dynamic Host Configuration Protocol (DHCP) helps IP to get network-layer network layer address for a host
  - Address Resolution Protocol (ARP) helps IP to find link layer address of a host or router when its network layer address is given

TCP/IP Protocol Suite: Description of each Layer

Transport Layer (I/II)

- Gets message from application program and deliver it to corresponding application program on the destination host
- Independent of application layer
- Transmission Control Protocol (TCP)
  - Connection oriented protocol
  - Establishes a logical connection between transport layers at two hosts before transferring data
  - Creates logical pipe between two TCPs for transferring stream of bytes
  - Provides Flow control, error control and congestion control

TCP/IP Protocol Suite: Description of each Layer

Transport Layer (II/II)

- User Datagram Protocol (UDP)
  - Connectionless protocol
  - Transmits user datagrams without creating logical connection
  - Each datagram is independent entity
  - Does not provide flow, error or congestion control
  - Small overhead and hence applicable for sending short messages
- Stream Control Transmission Protocol (SCTP)
  - Designed to respond to new applications emerging in multimedia

TCP/IP Protocol Suite: Description of each Layer

Application Layer

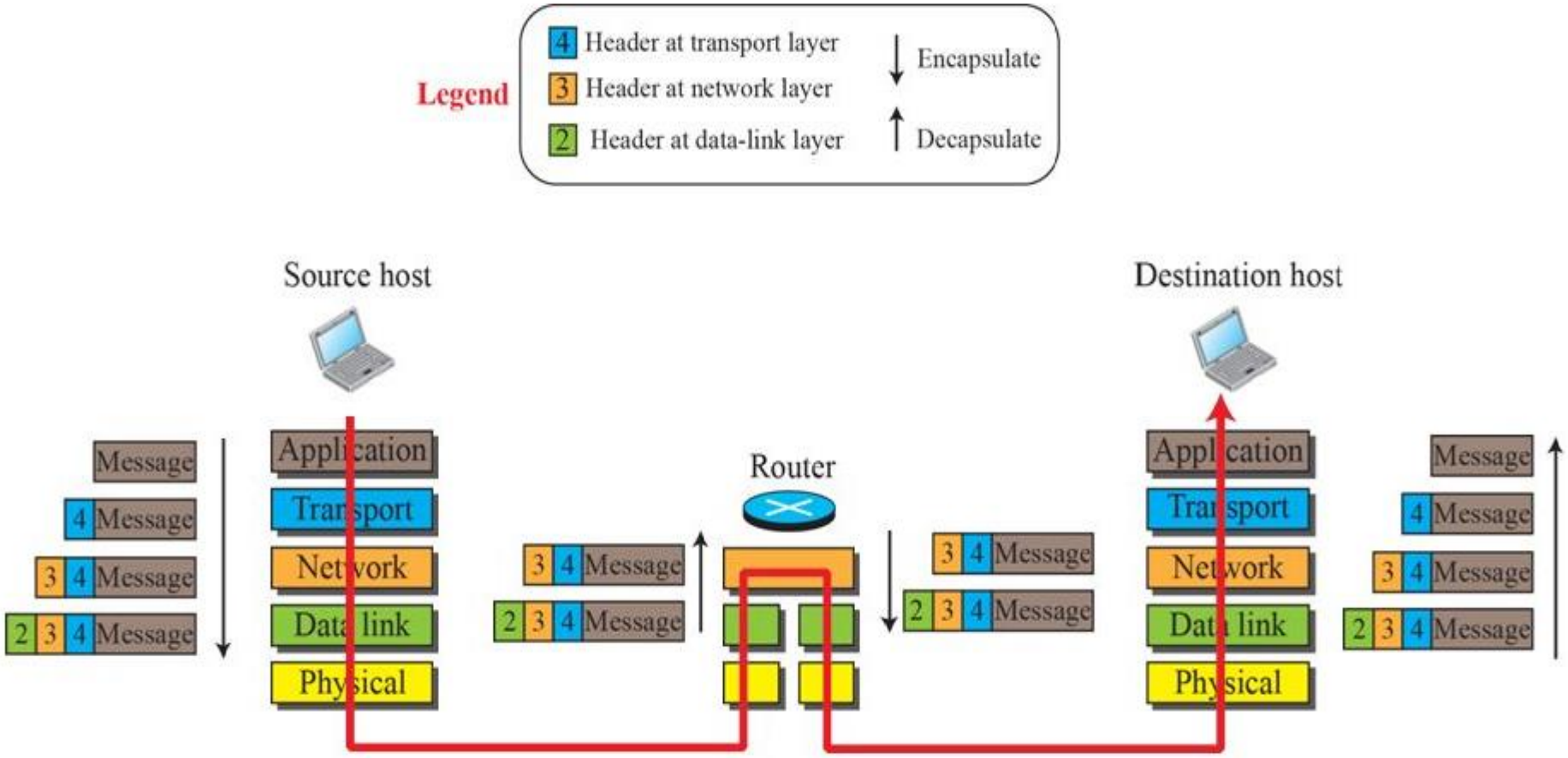
- Communication between two processes
- Process sends a request to other process and receives a response
- Duty - Process to process communication
- Hypertext Transfer Protocol (HTTP)
  - Vehicle for accessing World Wide Web
- Simple Mail Transfer Protocol (SMTP)
  - Used in e-mail service
- File Transfer Protocol (FTP)
  - Used for transferring files from one host to another

TCP/IP Protocol Suite: Description of each Layer

Application Layer

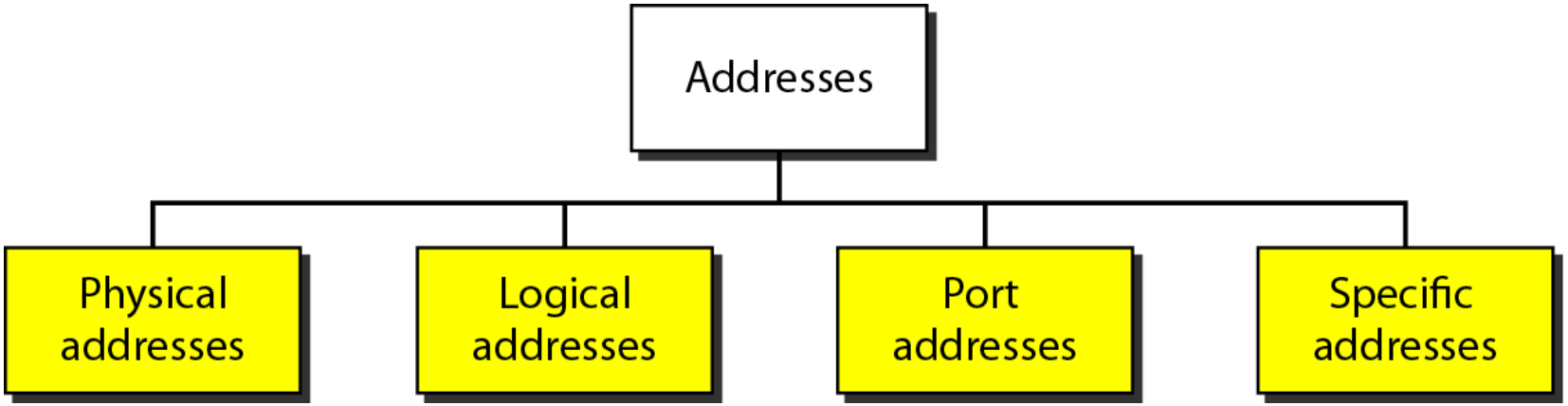
- Terminal Network (TELNET) and Secure Shell (SSH)
  - Used for accessing a site remotely
- Simple Network Management Protocol (SNMP)
  - Administrator uses to manage Internet at global and local levels
- Domain Name System (DNS)
  - Used by other protocols to find the network-layer address of a computer
- Internet Group Management Protocol
  - Collects membership in a group

TCP/IP Protocol Suite: Encapsulation and Decapsulation



Encapsulation / Decapsulation

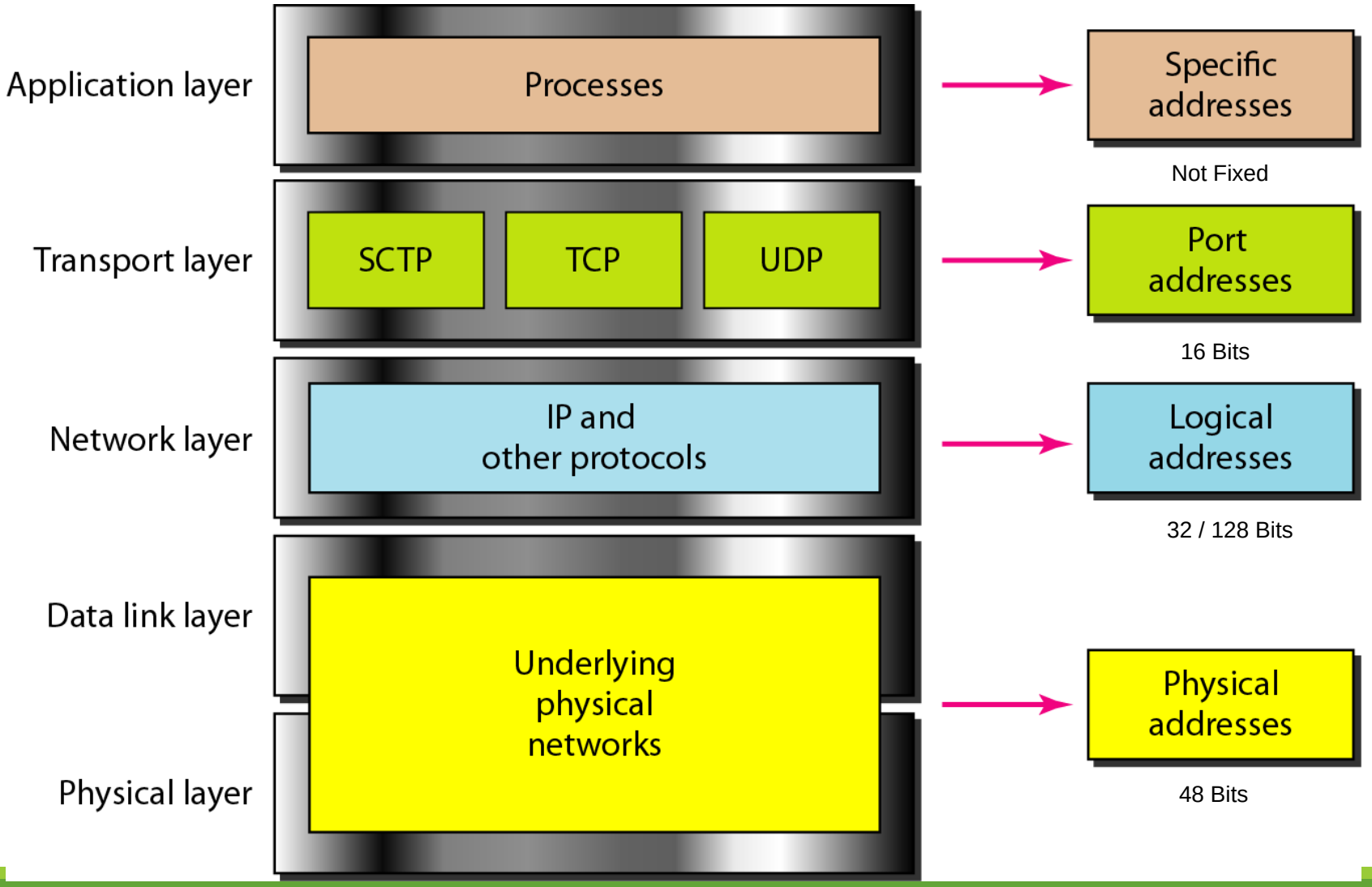
TCP/IP Protocol Suite: Addressing



MAC Address

IP Address

TCP/IP Protocol Suite: Addressing



The OSI Model

OSI Model

OSI Versus TCP/IP

Lack of OSI Model’s success

The OSI Model

International Organization for Standardization (ISO – established in 1947)

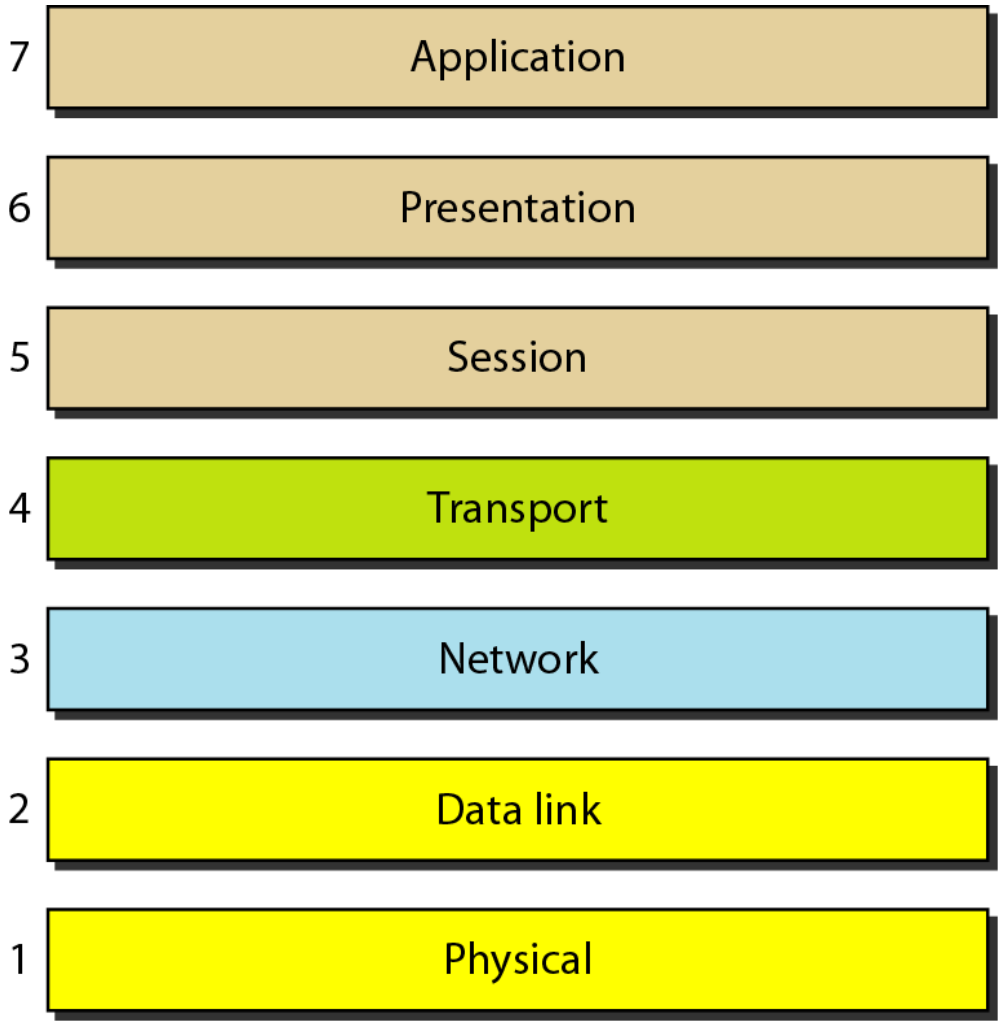
- a multinational body
- Dedicated to worldwide agreement on international standards
- ¾ of countries are represented in the ISO
- ISO standard that covers all aspects of network communications is the Open System Interconnection (OSI) Model

Open system is set of protocols that allow any two different systems to communicate regardless of their underlying architecture

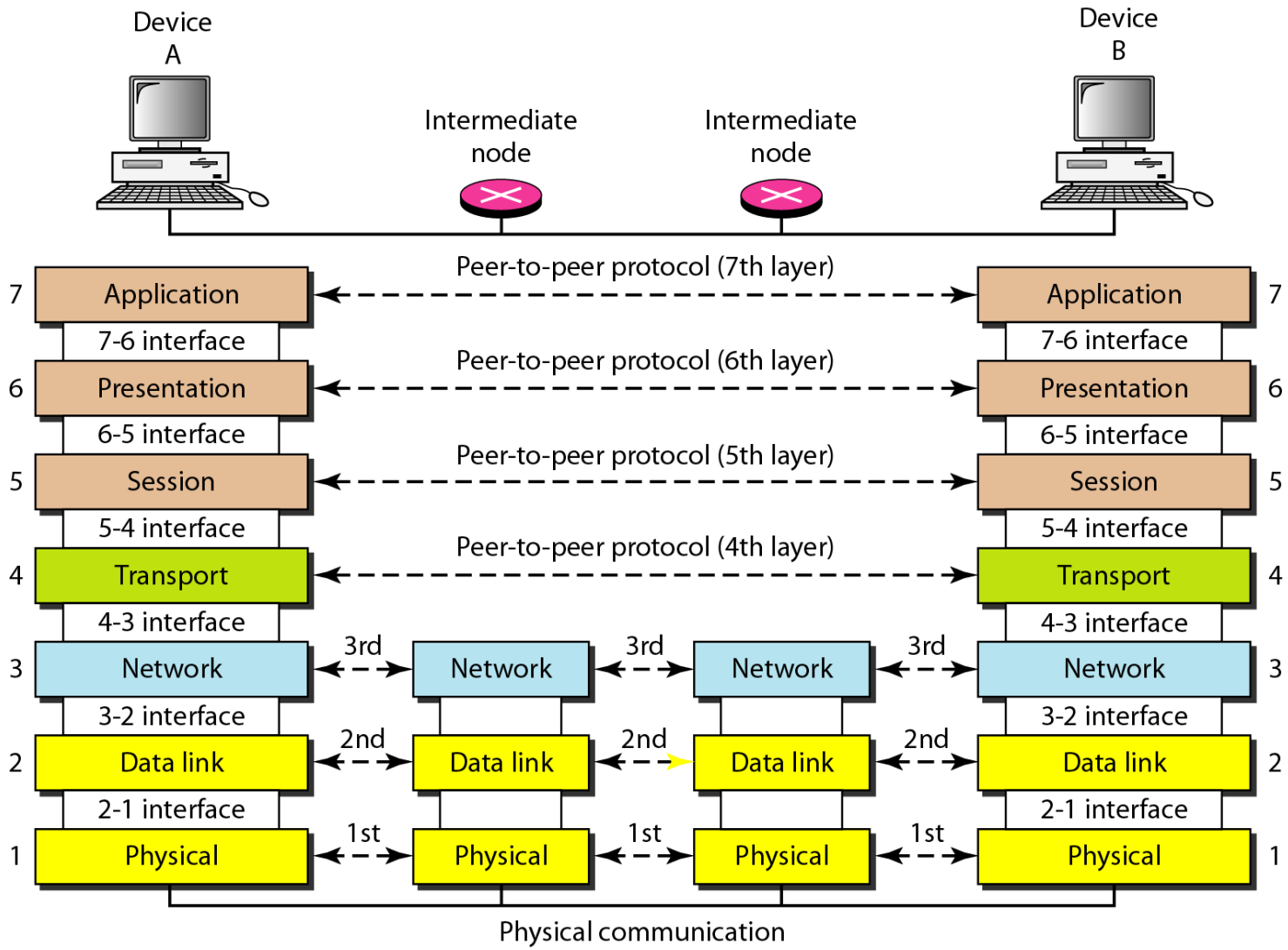
Shows how to facilitate communication between different systems without requiring changes to the logic of underlying hardware and software

Basis for creation of protocols in the OSI stack

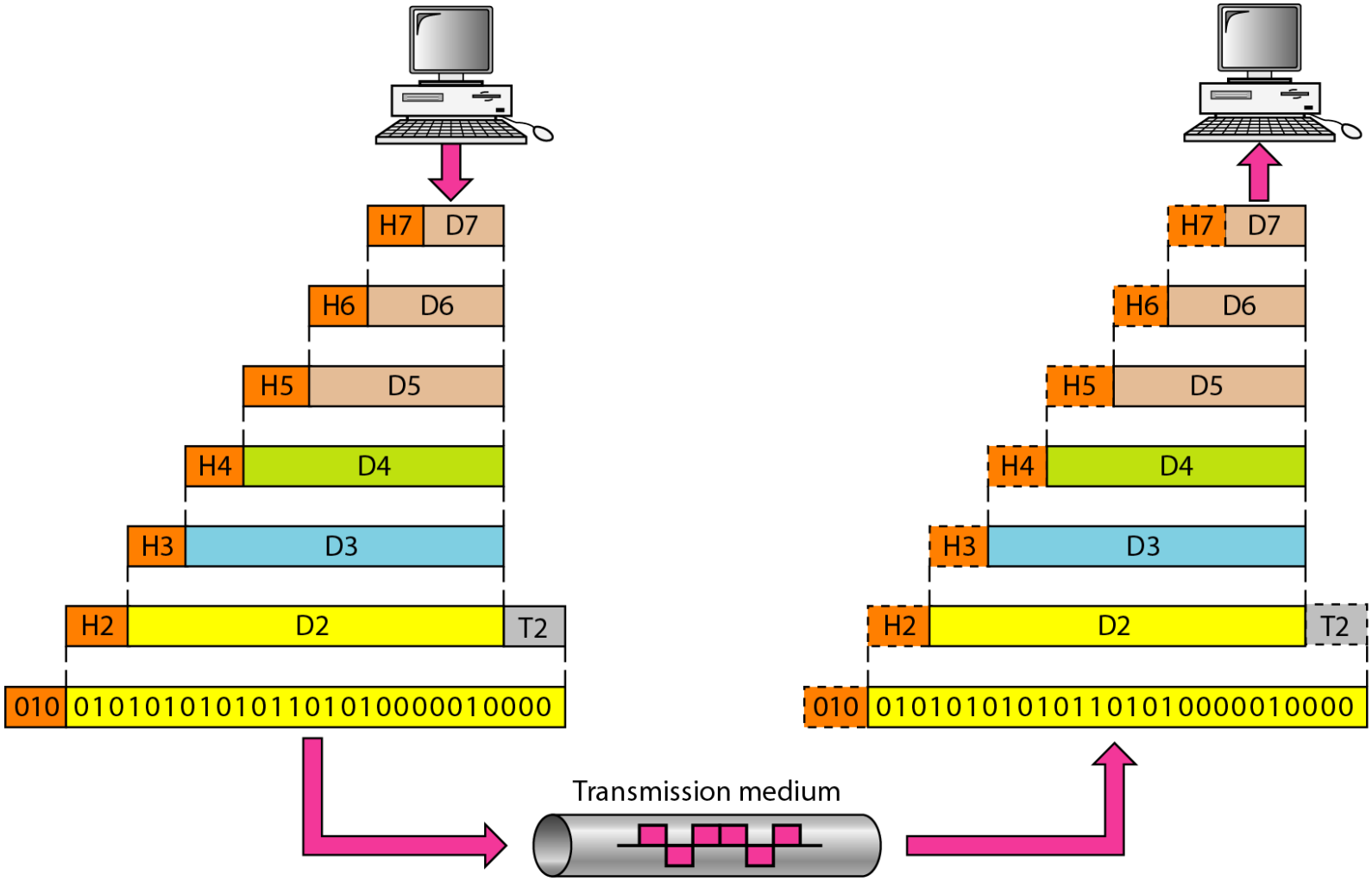
ISO is the organization.
OSI is the model.



The OSI Model

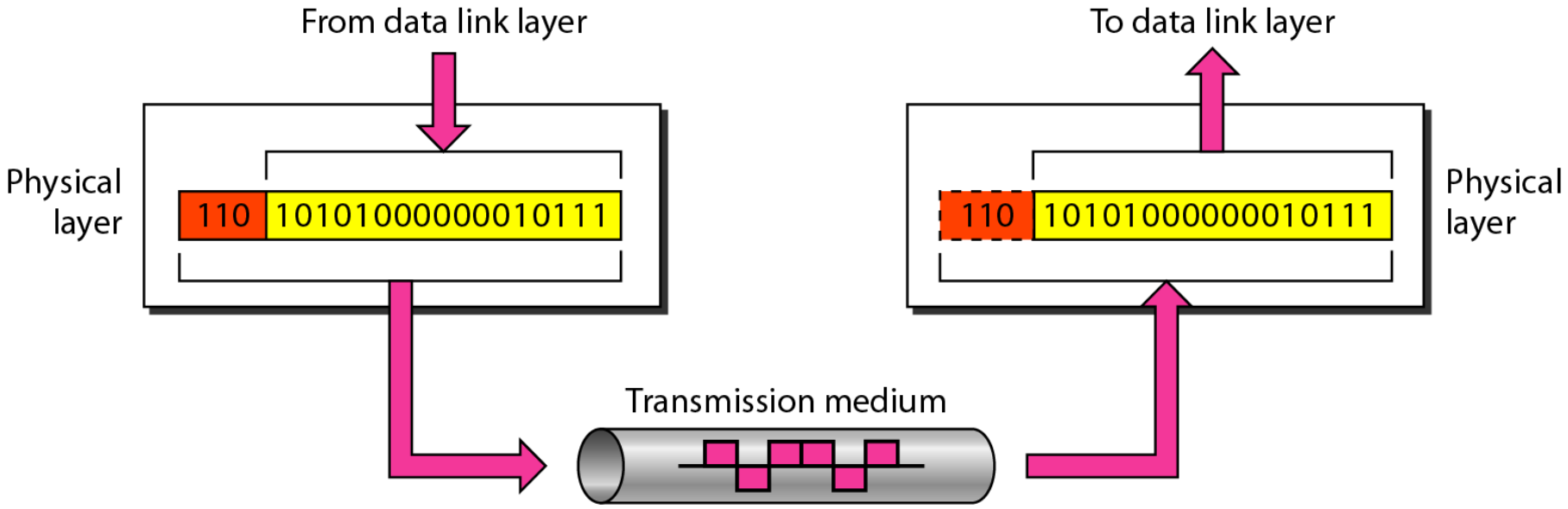


Interaction between layers in the OSI Model



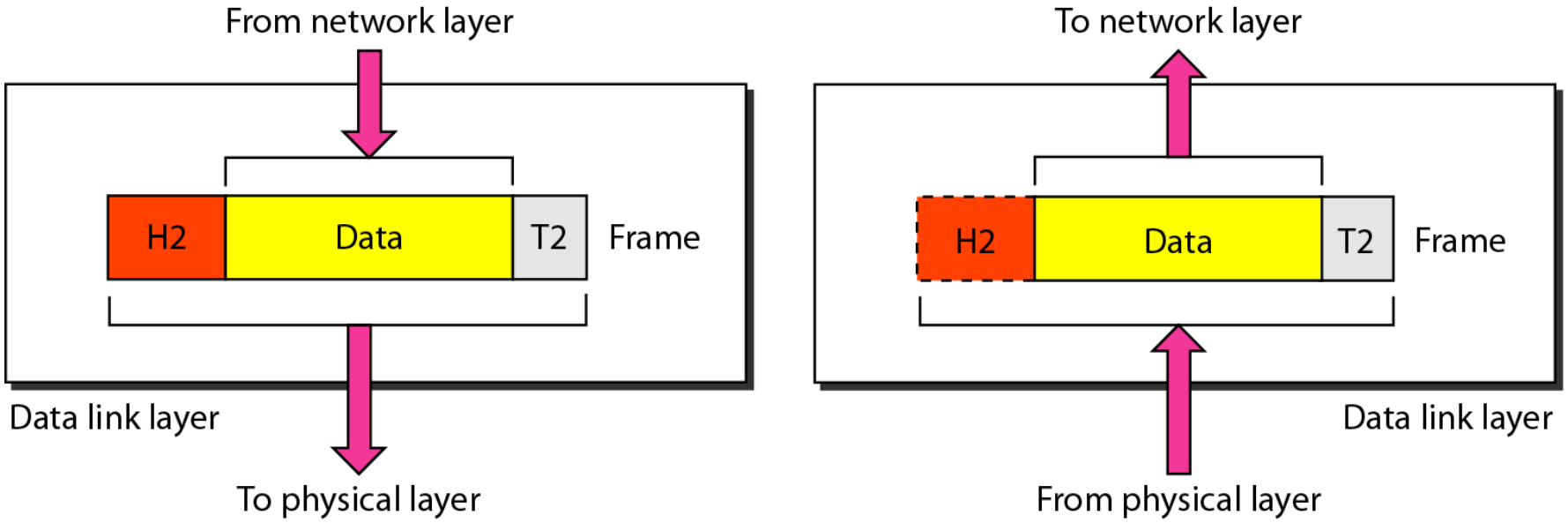
Exchange using OSI Model

OSI Model: Layers: Physical Layer



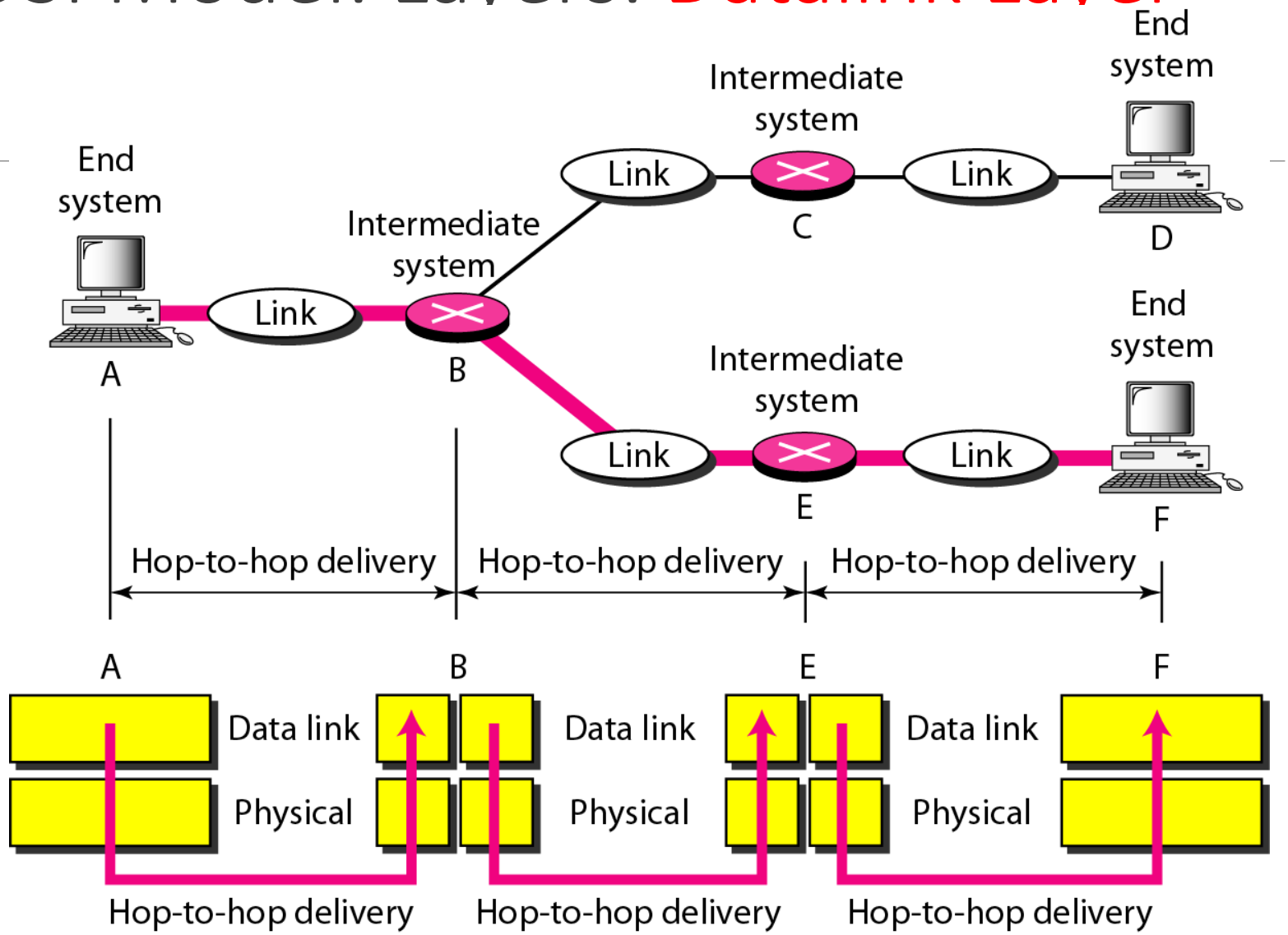
The physical layer is responsible for movements of individual bits from one hop (node) to the next.

OSI Model: Layers: Datalink Layer



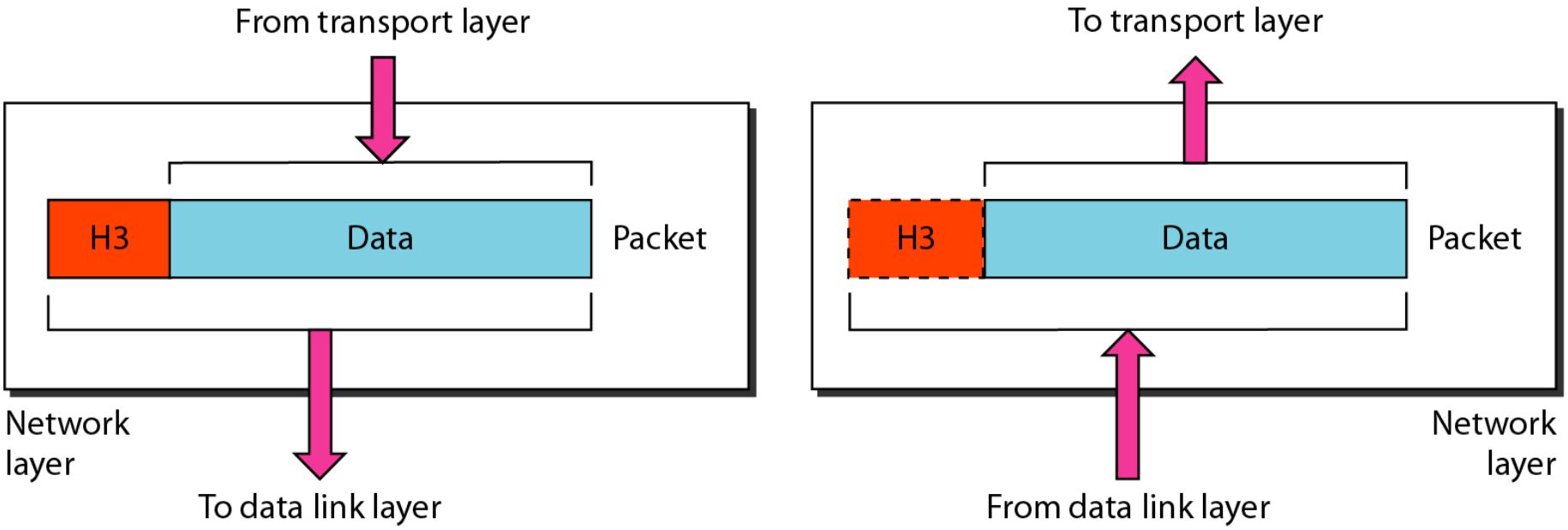
The data link layer is responsible for moving frames from one hop (node) to the next.

OSI Model: Layers: Datalink Layer



Hop-to-hop delivery

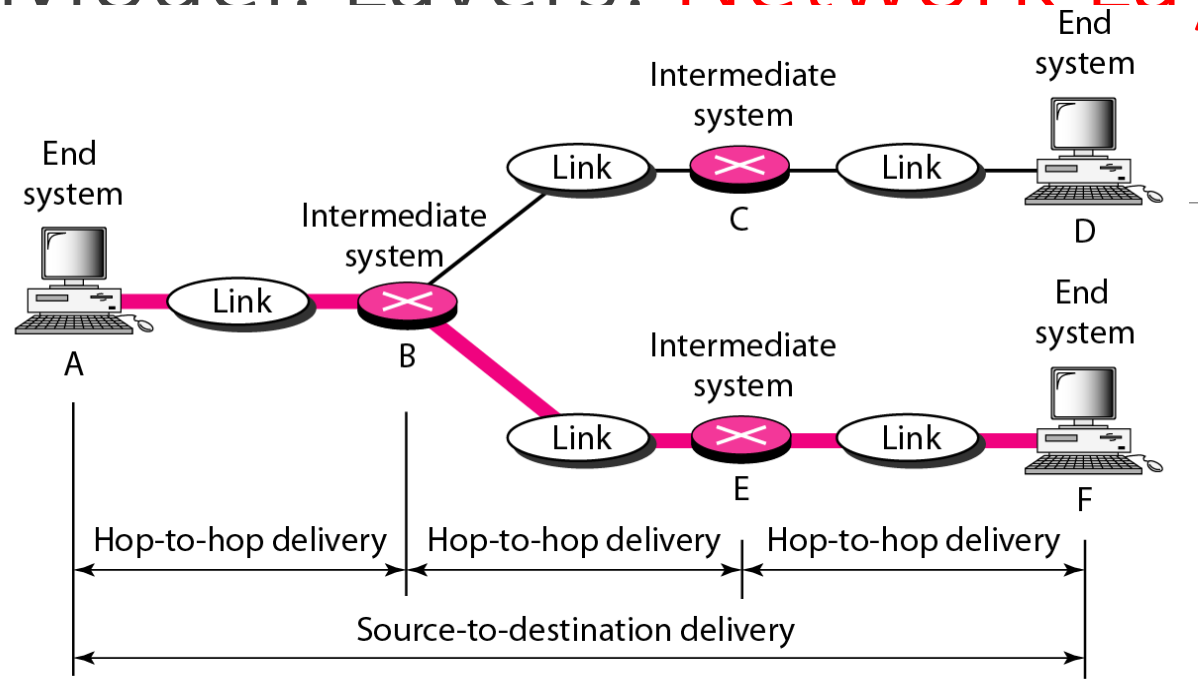
OSI Model: Layers: Network Layer

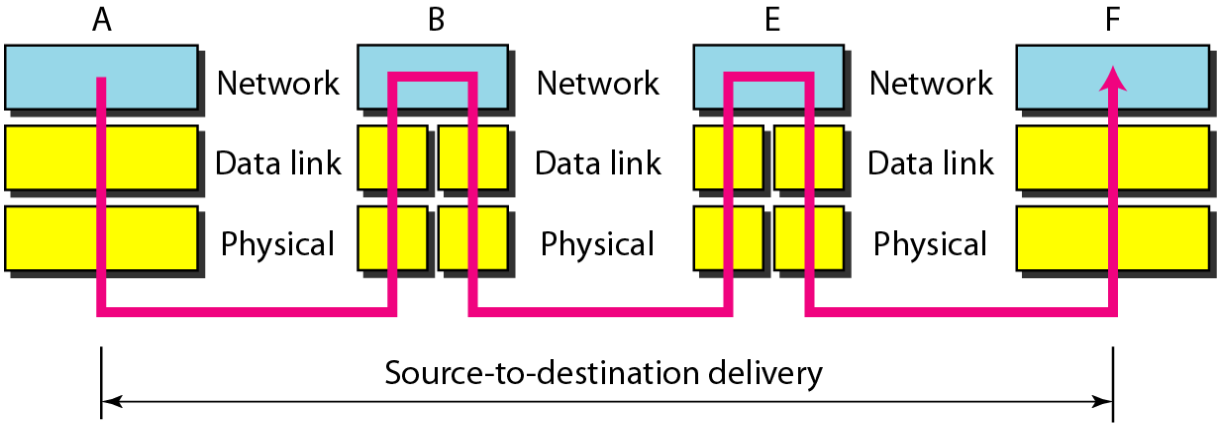


Packet = Datagram

The network layer is responsible for the delivery of individual packets from the source host to the destination host.

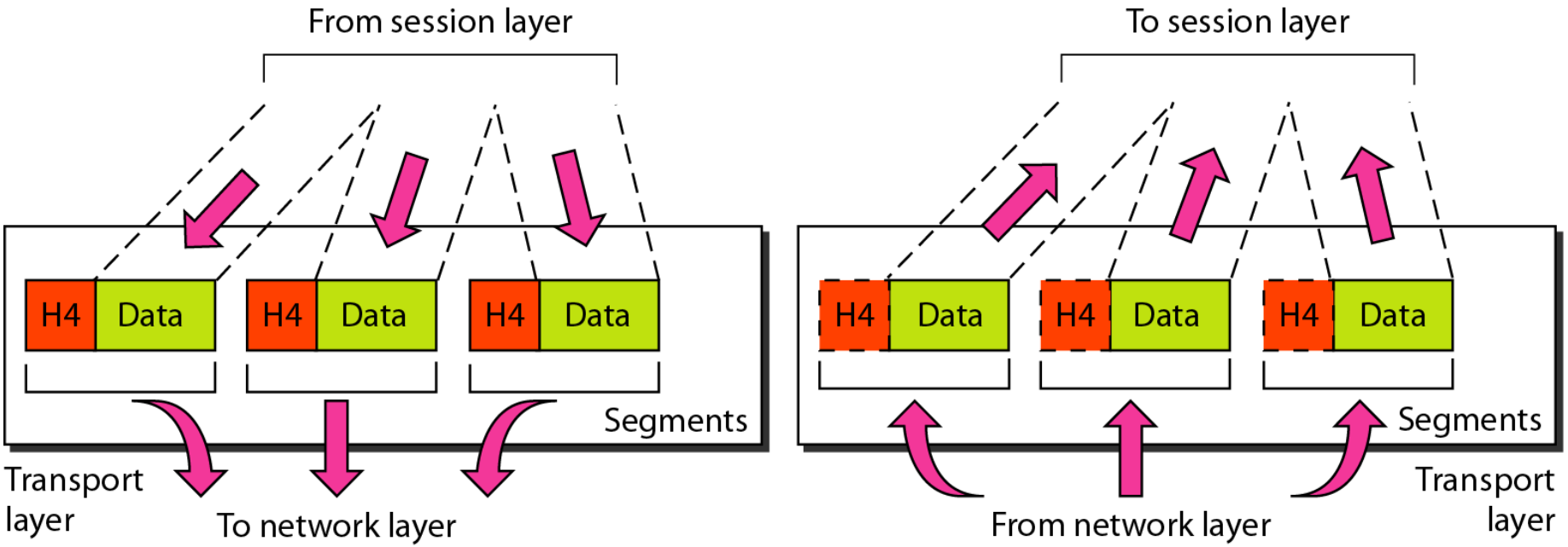
OSI Model: Layers: Network Layer





Source-to-destination delivery

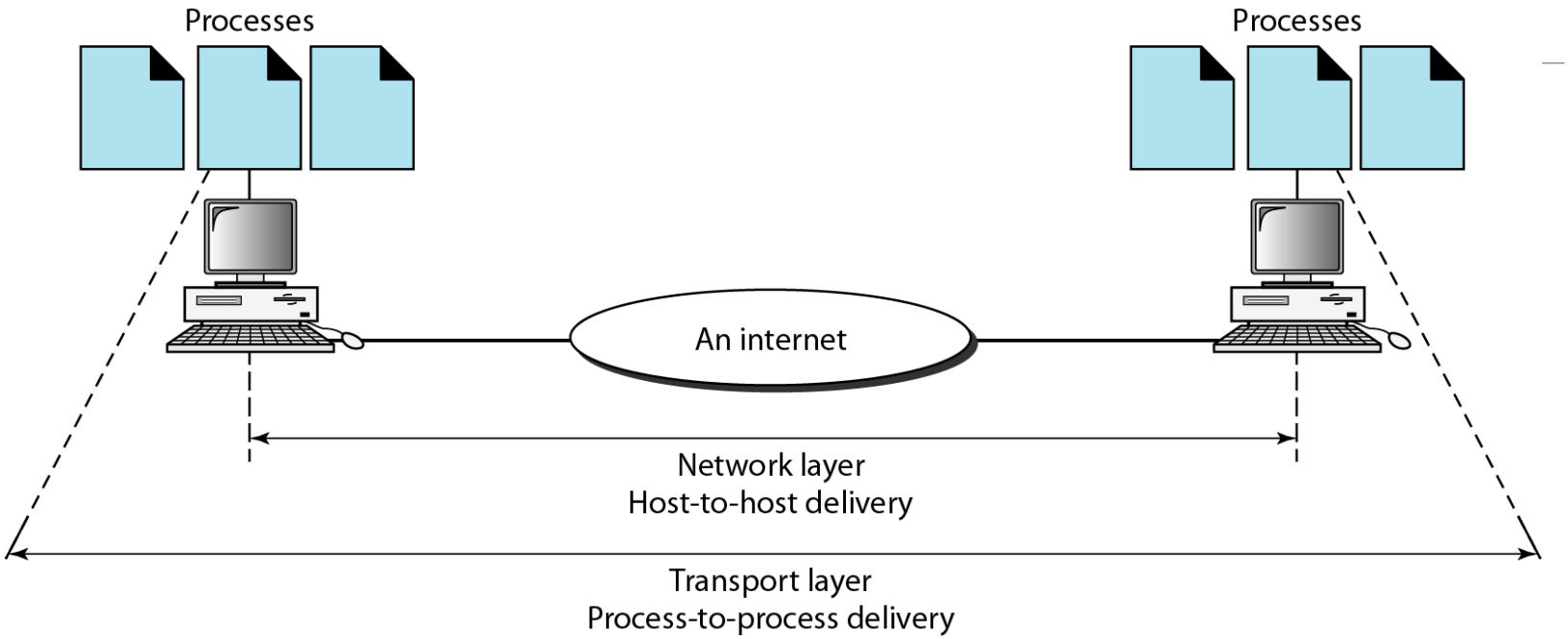
OSI Model: Layers: Transport Layer



Segments = User Datagrams

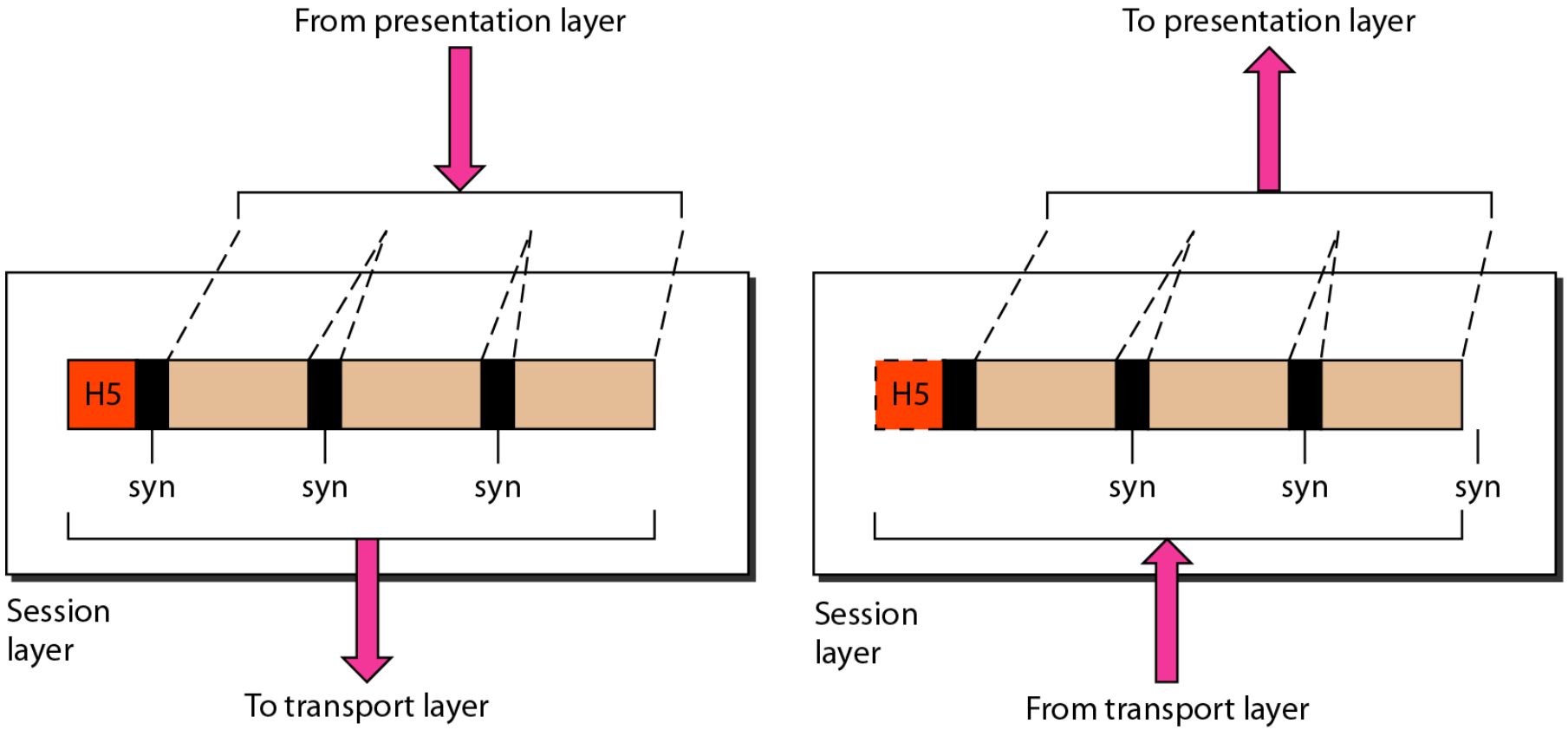
The transport layer is responsible for the delivery of a message from one process to another.

OSI Model: Layers: Transport Layer



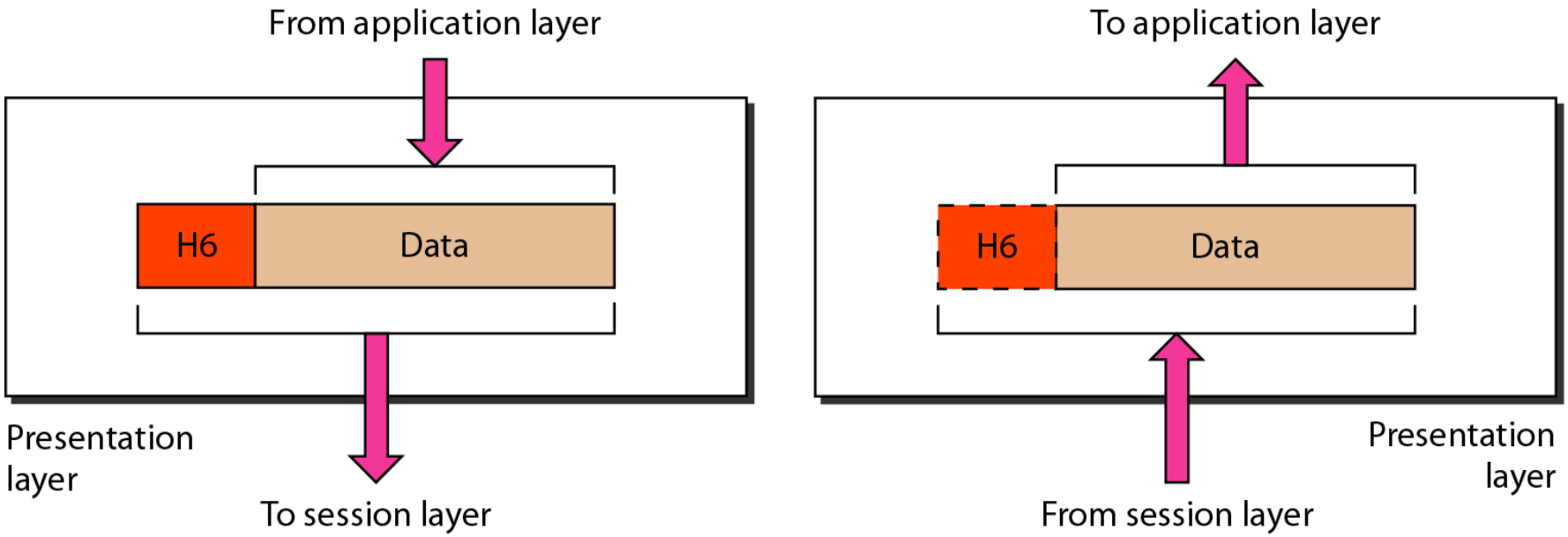
Reliable process-to-process delivery of the message

OSI Model: Layers: Session Layer



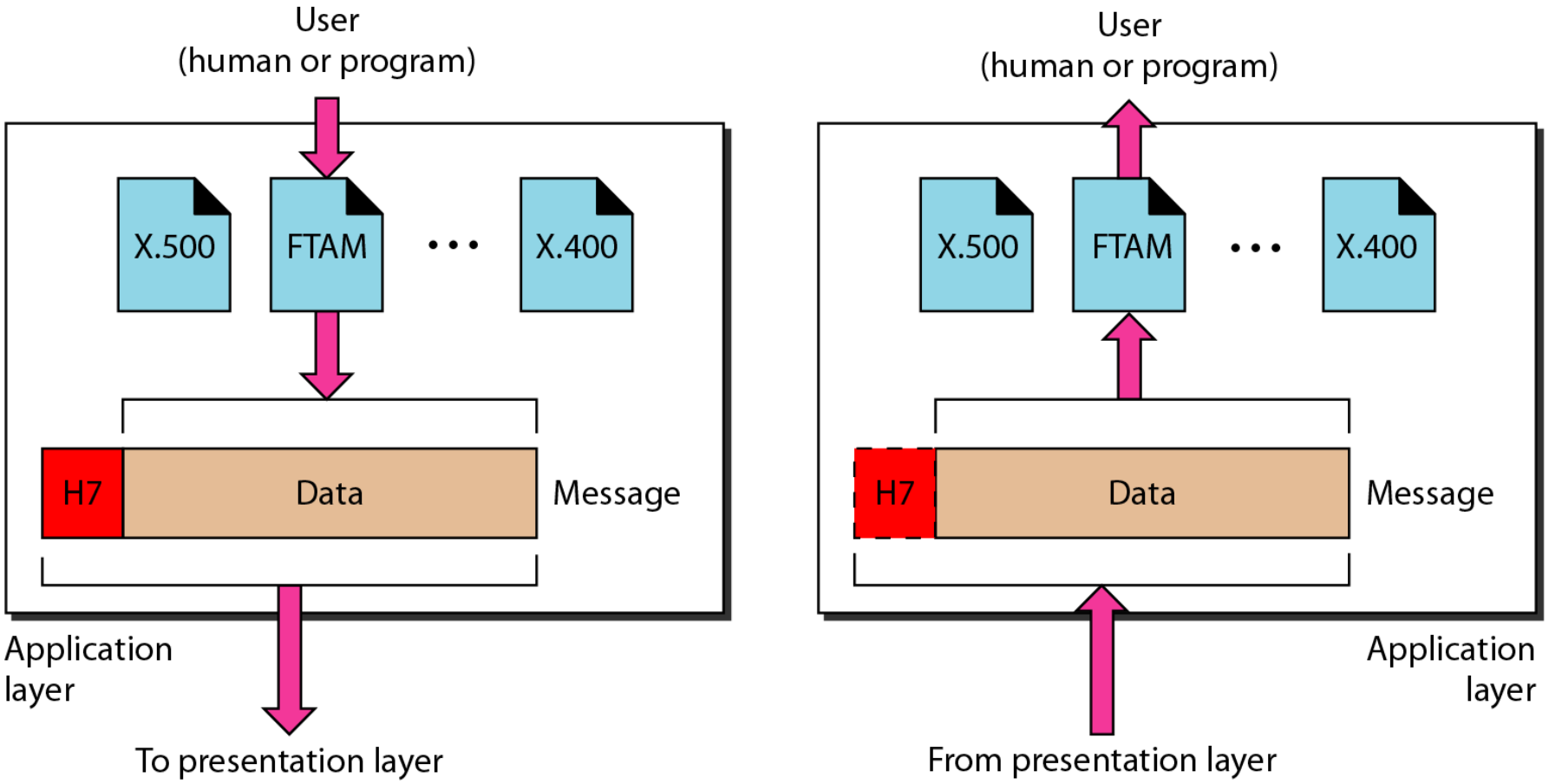
The session layer is responsible for dialog control and synchronization.

OSI Model: Layers: Presentation Layer



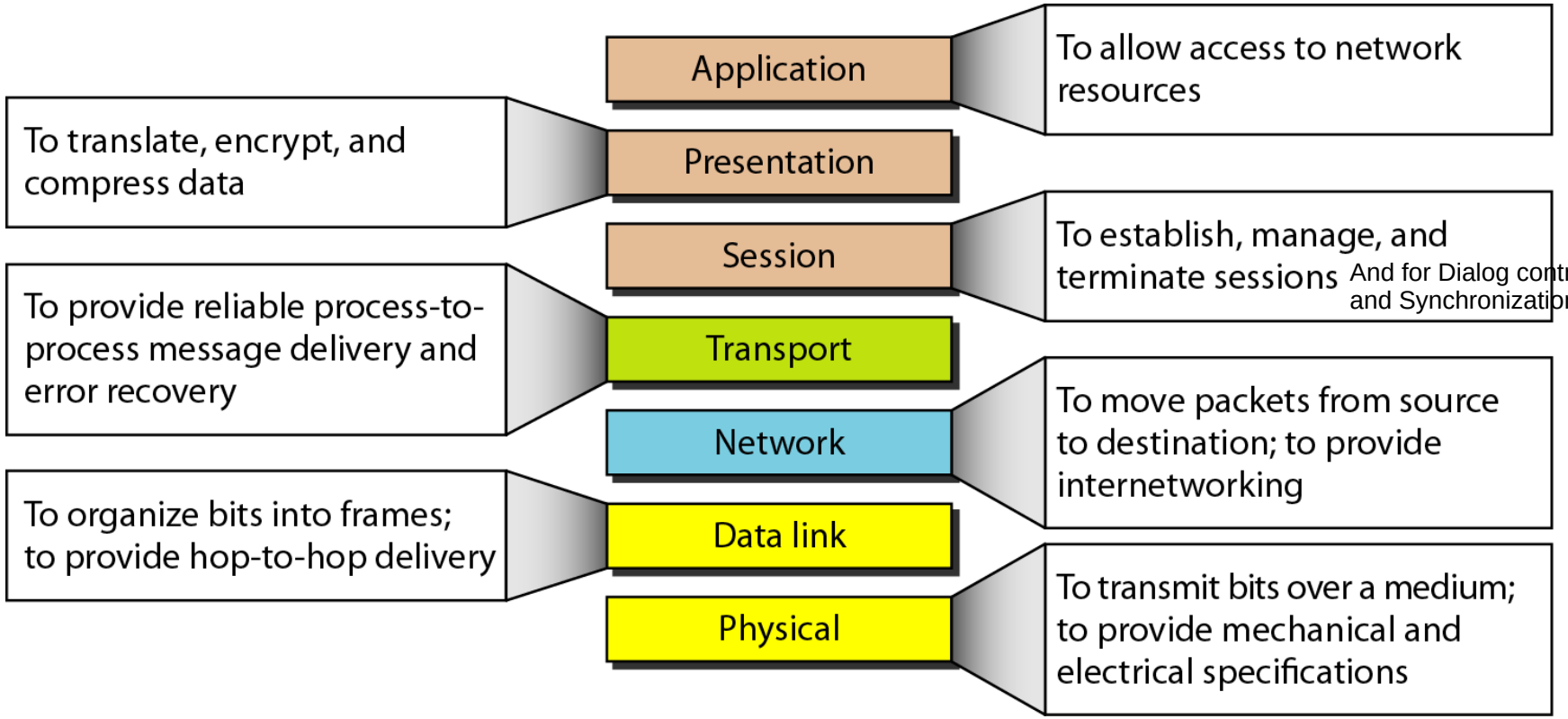
The presentation layer is responsible for translation, compression, and encryption.

OSI Model: Layers: Application Layer

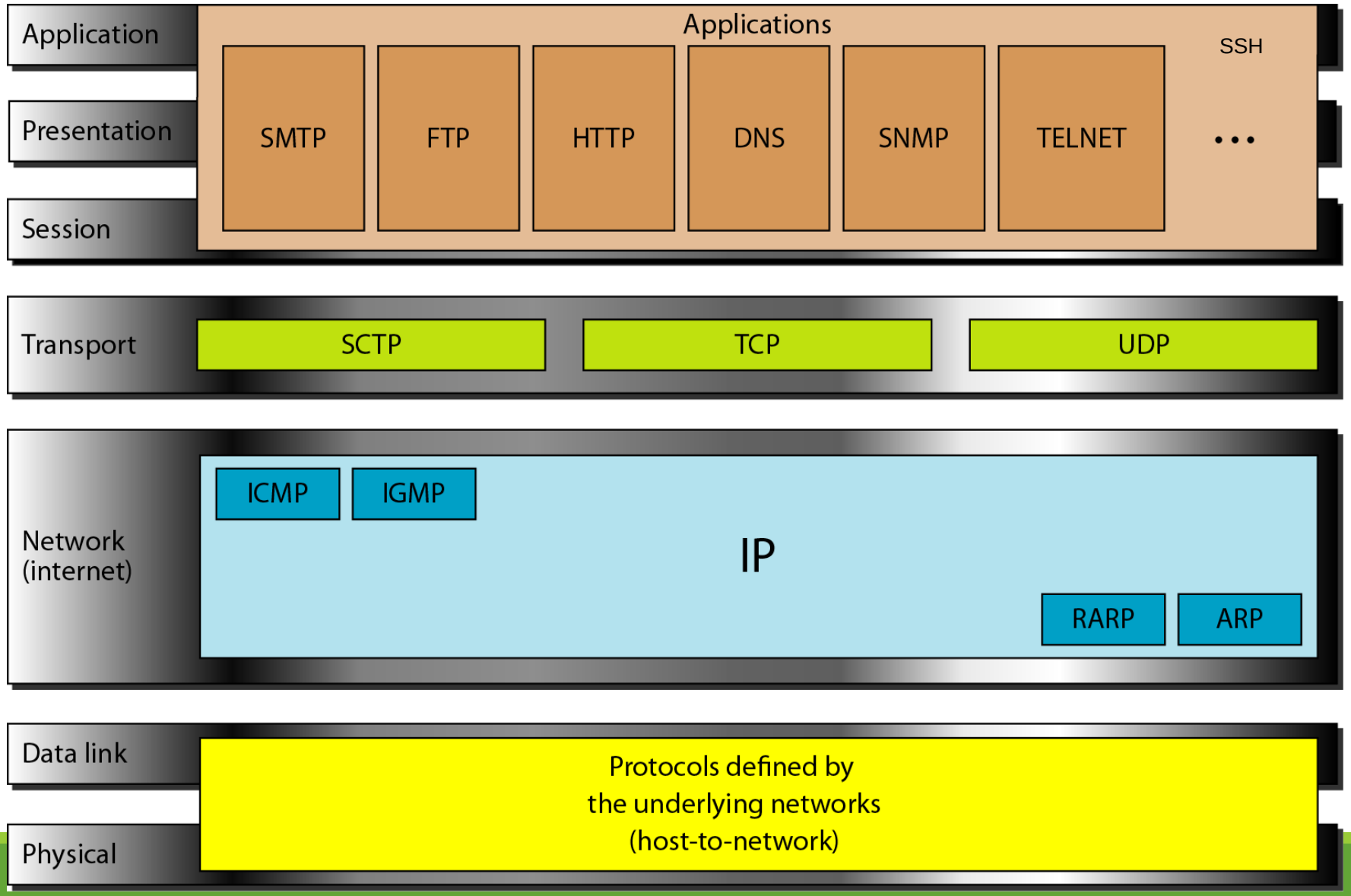


The application layer is responsible for providing services to the user.

OSI Model: Summary of Layers



OSI Model: TCP/IP and OSI



OSI Model: Lack of OSI Model's Success

OSI was completed when TCP/IP was fully in place

Lot of time and money had been spent on the suite

Some layers in OSI were never fully defined

OSI was implemented by an organization in a different application,

- Didn't show high enough performance to switch from TCP/IP to OSI

Thank you!!!

Questions are always welcome….