Chapter 2

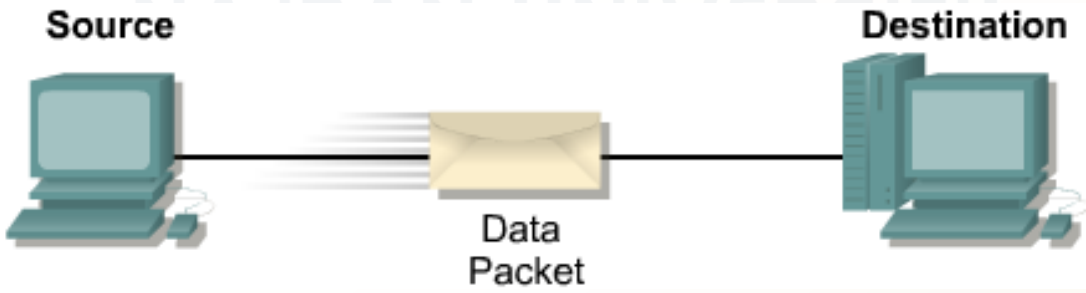
Network Models

Network Models

1 Layered Tasks
2 The OSI Model
3 Layers in the OSI Model
4 TCP/IP Protocol Suite
5 Addressing

Introduction

- Network is a combination of Hardware and Software that sends data from one location to another
  - Hardware: physical equipment that carries signals from one point to another
  - Software: instructions that make possible the services that we expect from a network



Introduction

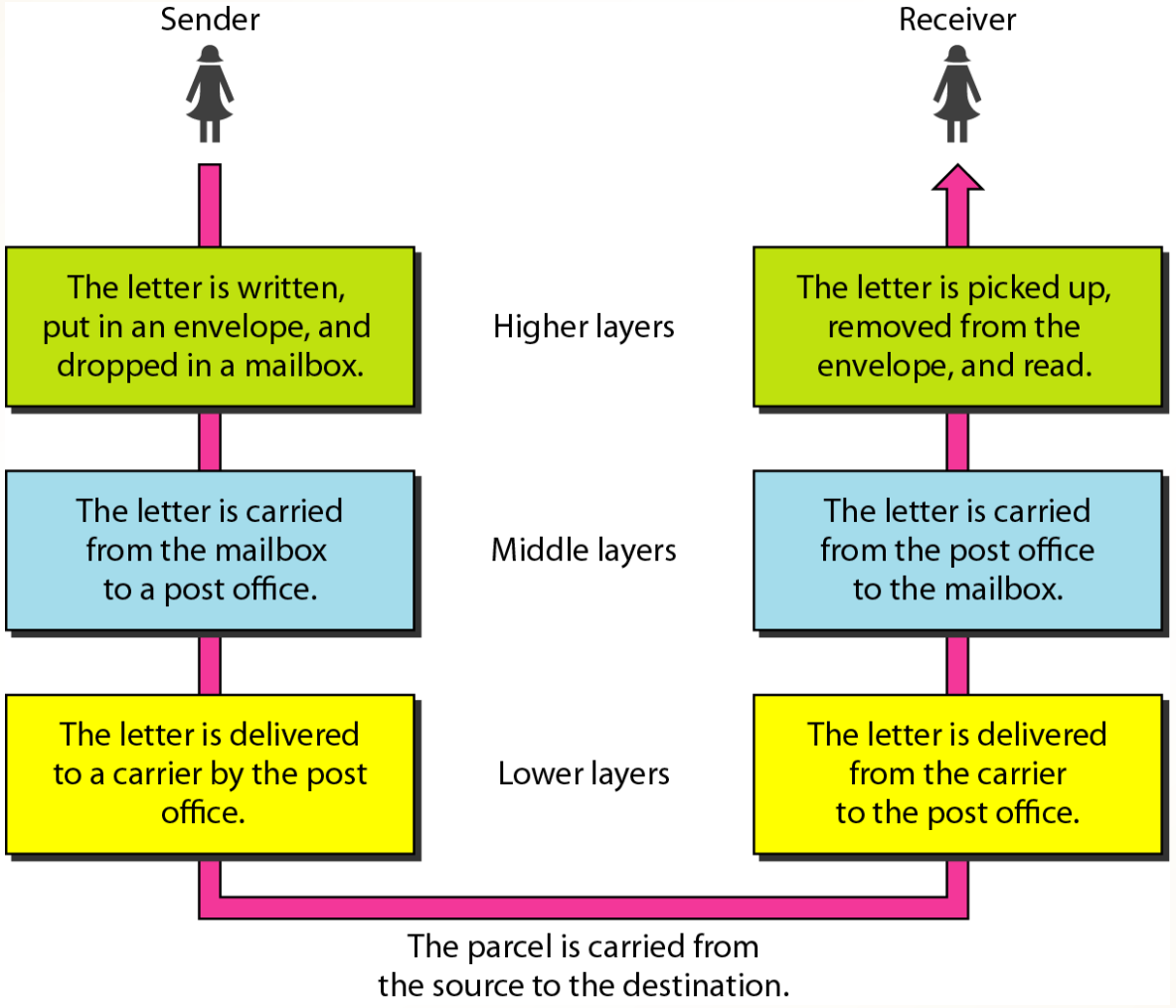
- Task of Sending an e-mail using computer network:
  - Can be broken into several tasks, each is performed by a separate software package
  - Each software package uses the services of another software package
  - At lowest layer, a signal or a set of signals is sent from the source computer to the destination computer

1. Layered Tasks

- We use the concept of **Layers** in our daily life

- Example: Two friends who communicates through postal mail

Layered Tasks



Tasks involved in sending a letter

Layered Tasks

- Hierarchy: Task must be done in the order given in the hierarchy
  - Sender site from up to down (↓)
  - Receiver site from down to up (↑)
- Services: Sender site each layer uses the services of the layer immediately below it

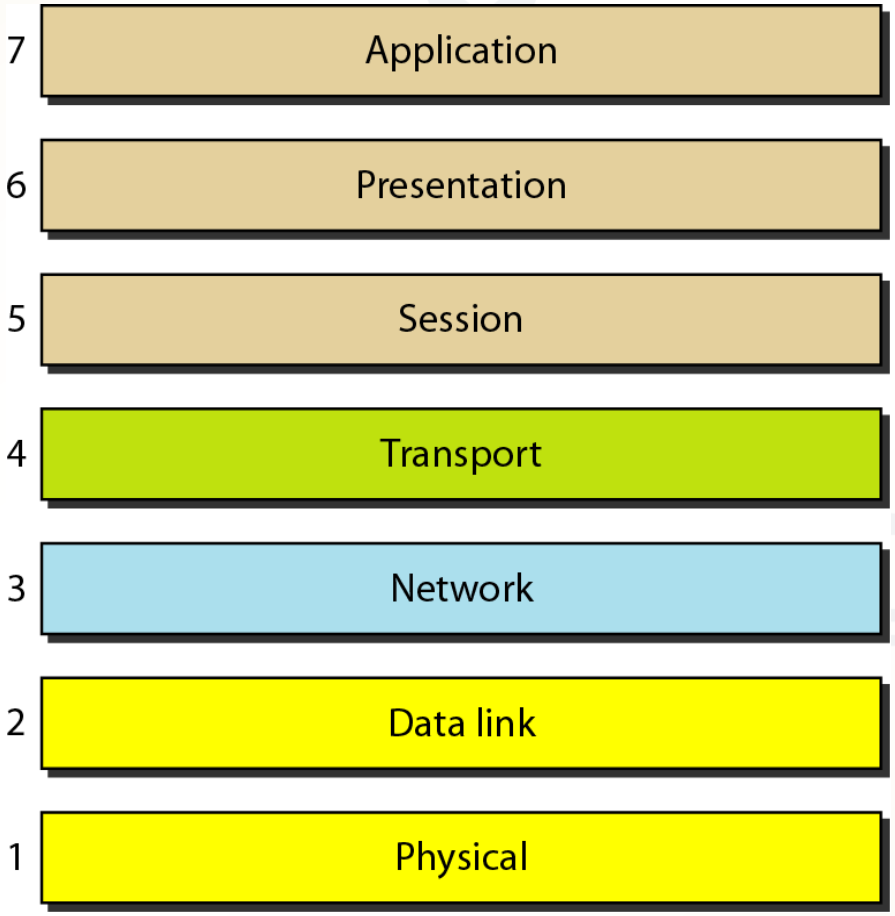
2.The OSI Model

- **ISO**: **I**nternational **S**tandards **O**rganization
- **OSI**: **O**pen **S**ystems **I**nterconnection model
- An open system is a set of protocols that allows any two different systems to communicate regardless of their underlying architecture and without requiring changes to the logic underlying hardware and software

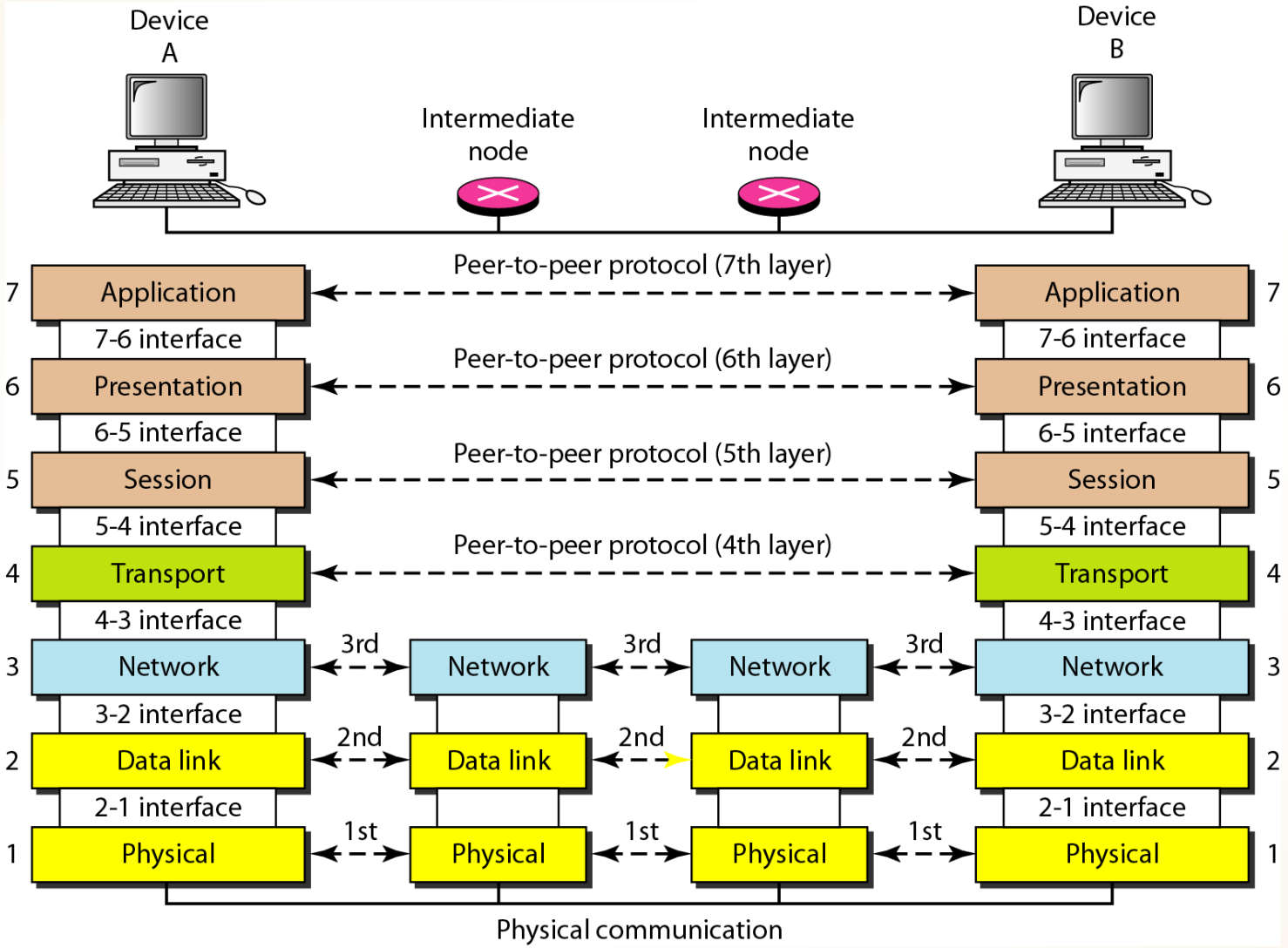
ISO is the organization. OSI is the model.

The OSI Model

- Layered Architecture:7 ordered layers (**P D N T S P A**)



The OSI Model



The interaction between layers in the OSI model

The OSI Model

- Intermediate nodes involve only the first 3 layers
- Each layer groups networking functions with related uses
- Each layer defines a family of functions distinct from those of the other layers
- This design creates an architecture that is both comprehensive and flexible
- OSI model allows complete interoperability between otherwise incompatible systems

The OSI Model

- Within a single machine, each layer calls upon the services of the layer just below it
- Between machines, layer x on one machine communicates with layer x on another machine
- Communication is governed by an agreed-upon series of rules and conventions called protocols

The OSI Model

- Peer-to-Peer Processes
  - At the physical layer, communication is direct
  - Each layer in the sending device adds its own information to the message it receives from the layer just above it and places the whole package to the layer below it
  - At layer 1 the entire package is converted to a form that can be transmitted to the receiving device
  - At the receiving device machine, the message is unwrapped layer by layer, with each process receiving and removing the data meant for it

The OSI Model

- Interfaces Between Layers
  - Passing of data through layers is made possible by an interface between each pair of adjacent layers
  - Each interface defines the information and services a layer must provide for the layer above it
  - Well-defined interfaces and layer functions provide modularity to a network
  - Implementation of the functions of a layer can be modified or replaced without requiring changes to the surrounding layers

The OSI Model

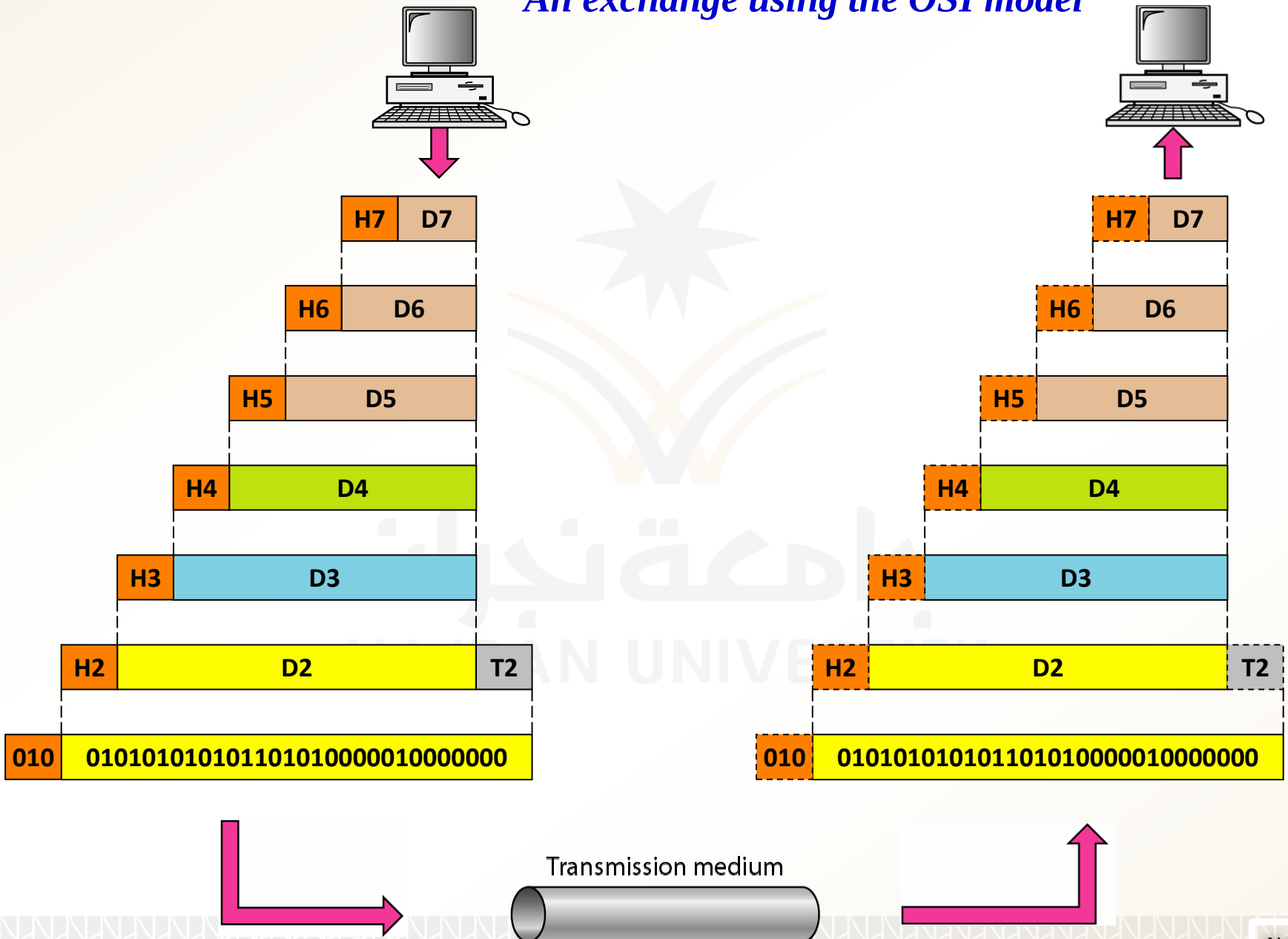
- Organization of the Layers
  - Layers can be thought of as three subgroups
    - Layers 1,2 and 3: Network support layers: deal with the physical aspects of moving data from one device to another
    - Layers 5, 6 and 7: User support layers: allow interoperability among unrelated software systems
    - Layer 4: links the two subgroups and ensures that what the lower layers have transmitted is in a form that the upper layers can use
    - At each layer a header (H) and or a trailer (T) is added to the data

The OSI Model

- Organization of the Layers
  - The upper OSI layers (4, 5, 6 and 7) are implemented in software
  - Lower layers (1, 2, and 3) are implemented in hardware and software except for the physical layer which is mostly hardware

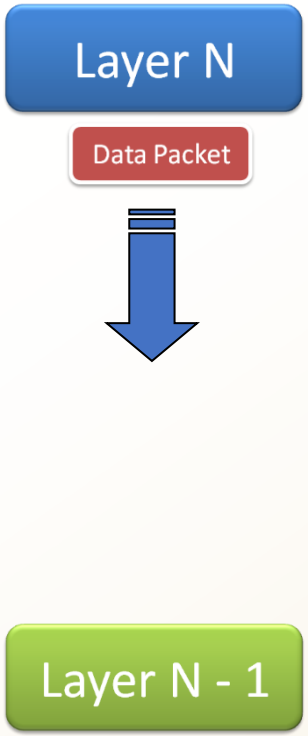
An exchange of Data

An exchange using the OSI model



The OSI Model

- Encapsulation
  - A packet: data and header and maybe trailer)
  - The data portion of a packet at level N-1 carries the whole packet from level N
  - Level N-1 is not aware of which part of the packet is data, header, or trailer
  - For level N-1, the whole packet coming from level N is treated as one integral unit

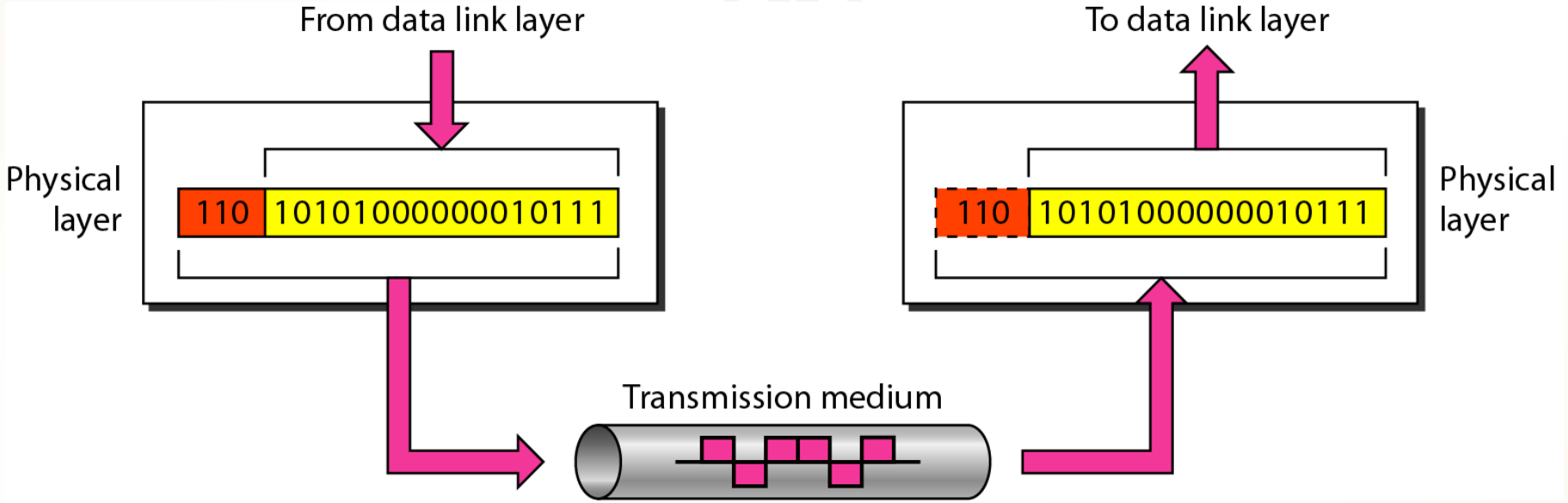


3 Layers in The OSI Model

- Physical Layer
  - Coordinates the functions required to carry a bit stream over the physical medium
  - Deals with the mechanical and electrical specifications of the interface and transmission medium
  - Defines the procedures and functions that physical devices and interfaces have to perform for transmission to occur

3 Layers in The OSI Model

- Physical Layer

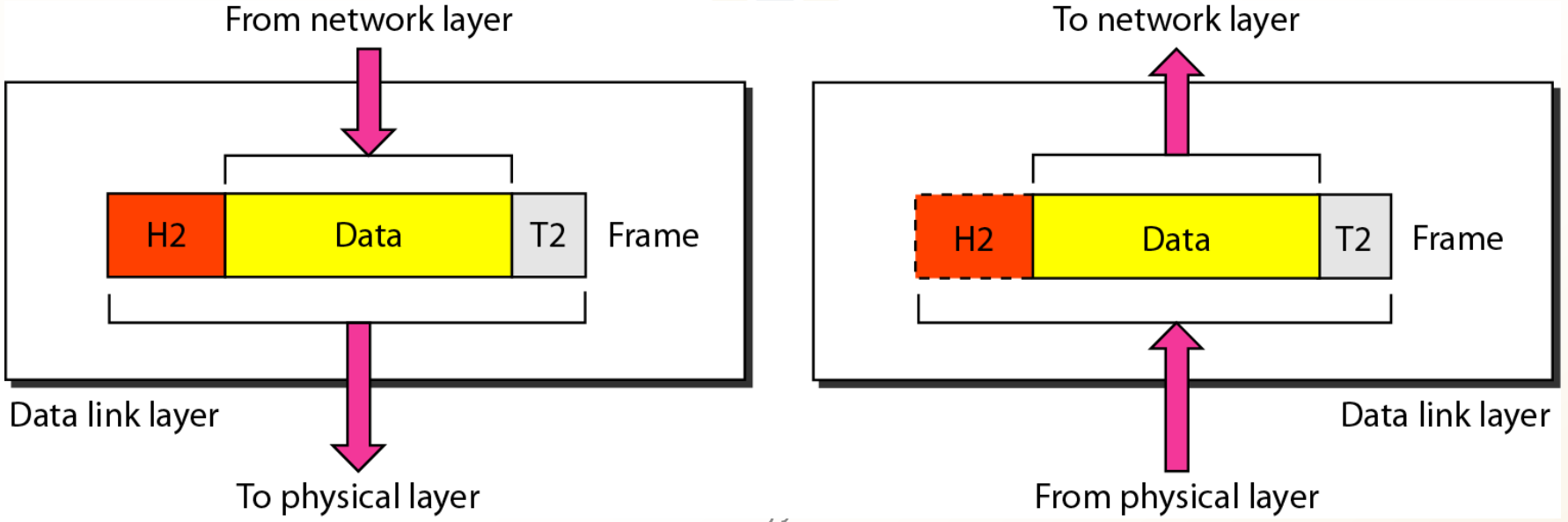


3 Layers in The OSI Model

- Physical Layer
  - Physical characteristics of interfaces and medium
  - Representation of bits (encoding: bits → signals)
  - Data rate (duration of a bit: how long it lasts)
  - Synchronization of bits (clocks)
  - Line configuration (connection of the devices to the media: point-to-point or multipoint)
  - Physical topology
  - Transmission mode (simplex / half-duplex / full-duplex)

3 Layers in The OSI Model

- Data Link Layer
  - Transform the physical layer, a raw transmission facility, to a reliable link
  - It makes the physical layer to appear error free to the upper layer



3 Layers in The OSI Model

- Data Link Layer

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

3 Layers in The OSI Model

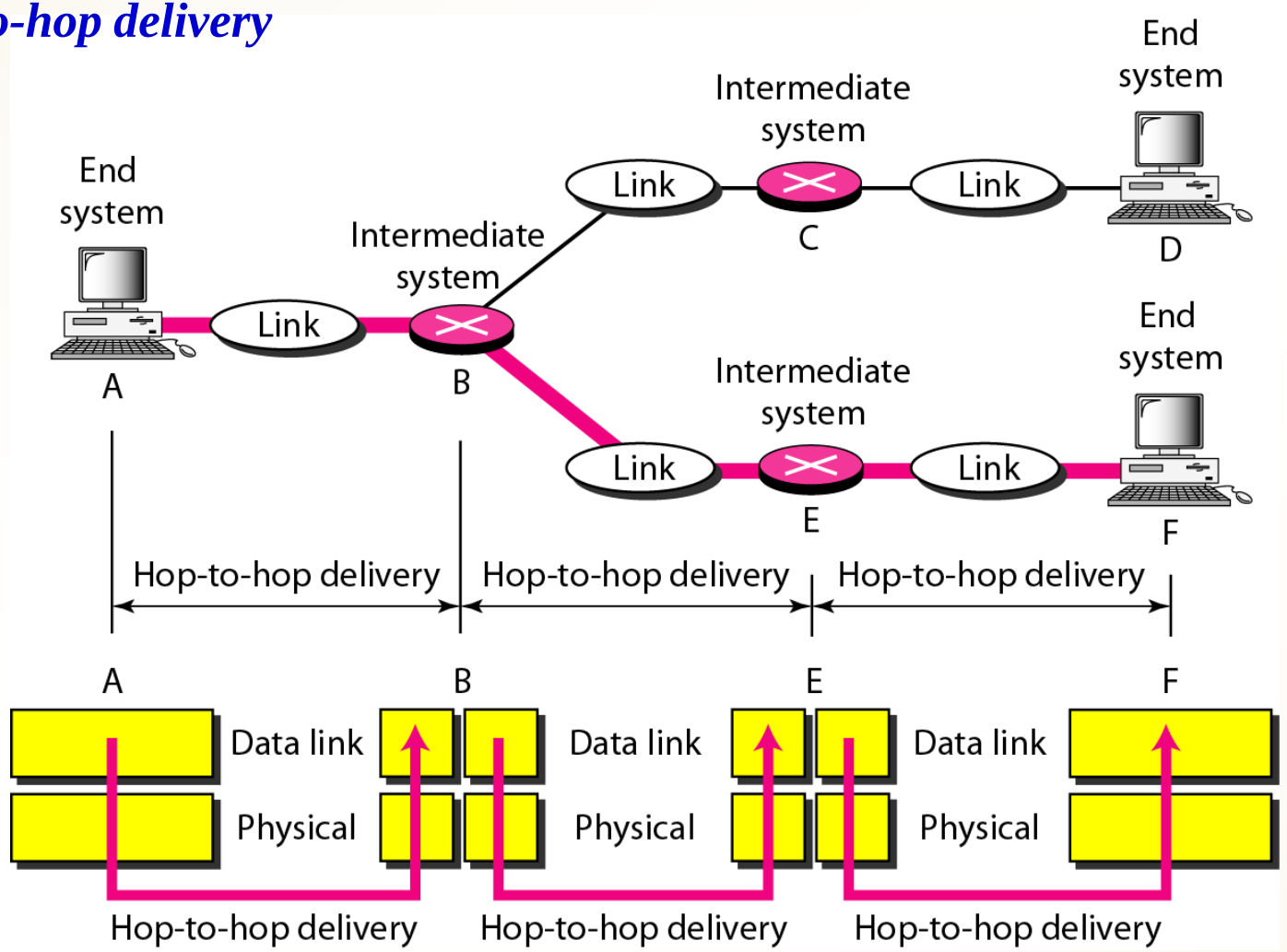
- Data Link Layer
  - Framing
    - Frames: manageable data units
  - Physical addressing
    - Add header to define sender and receiver of the frame
  - Flow control
    - Impose it to avoid overwhelming the receiver
      - data rate: receiver < sender

3 Layers in The OSI Model

- Data Link Layer
  - Error control
    - Mechanisms to detect and retransmit damaged or lost frames and to recognize duplicate frames
    - Achieved through trailer added to the end of the frame
  - Access control
    - When two or more devices connected to the same link decide which device has control over the link at any given time

3 Layers in The OSI Model

Hop-to-hop delivery



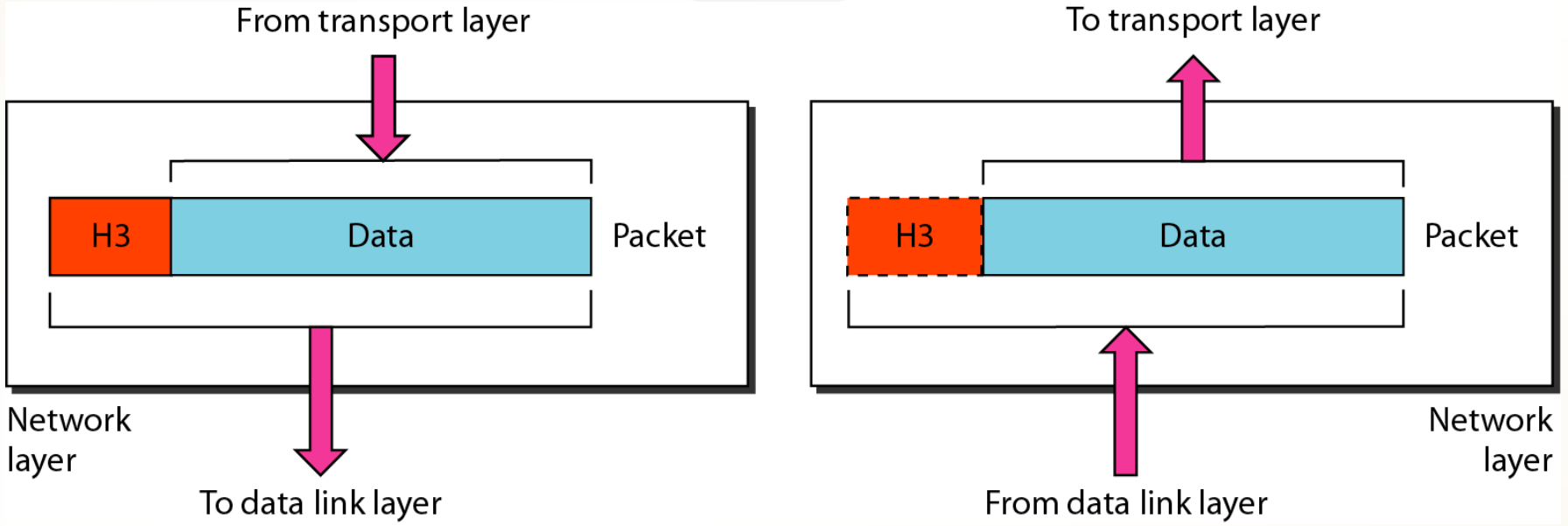
3 Layers in The OSI Model

- Network Layer
  - Responsible for the source-to-destination delivery of a packet possibly across multiple networks (links)
  - Ensures that each packet gets from its point of origin to its final destination
  - No need for network layer if systems are on the same networks

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

3 Layers in The OSI Model

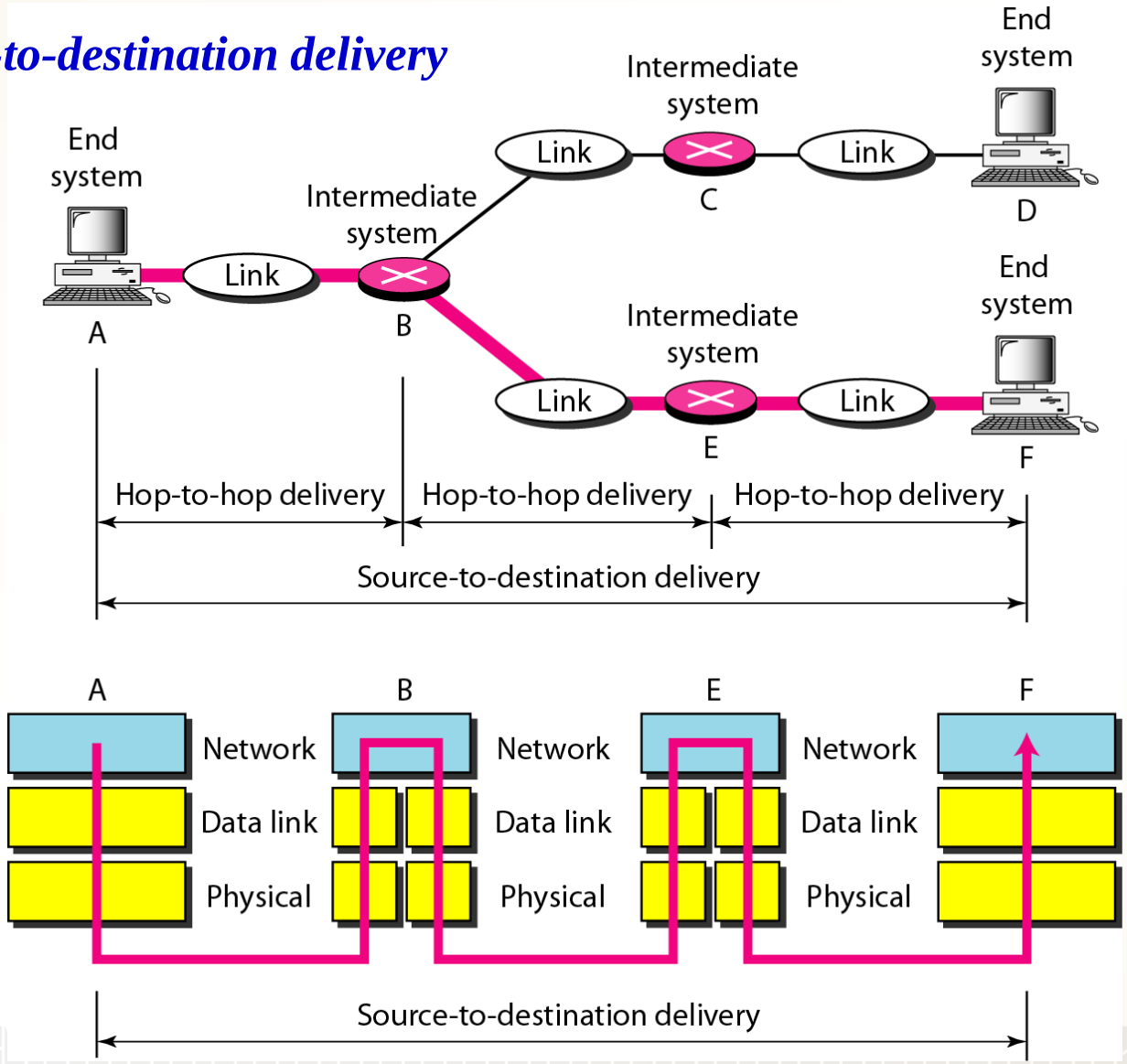
- Network Layer



3 Layers in The OSI Model

- Network Layer
  - Logical addressing
    - Addresses of the sender and receiver when the packet passes the network boundary
  - Routing
    - Routing or switching the packets to their final destination using connecting devices (routers or switches)

3 Layers in The OSI Model



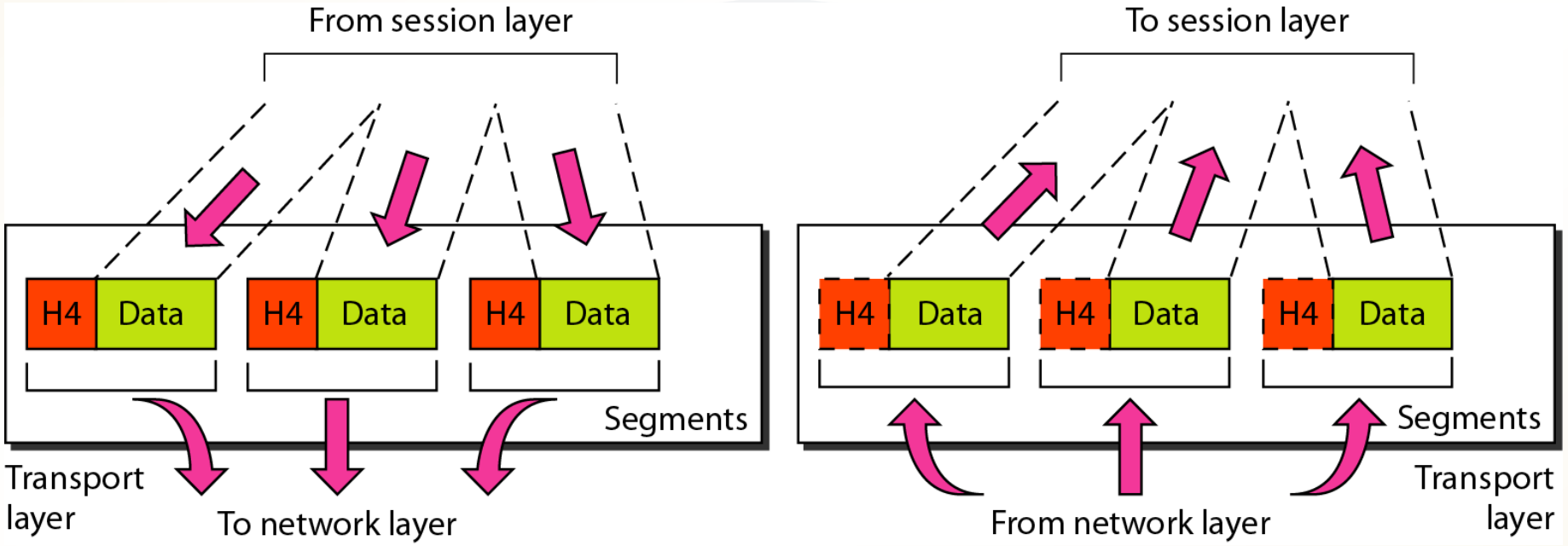
3 Layers in The OSI Model

- Transport Layer
  - Responsible for process-to-process delivery
  - A process is an application program on a host
  - Ensures that the whole message arrives intact and in order

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

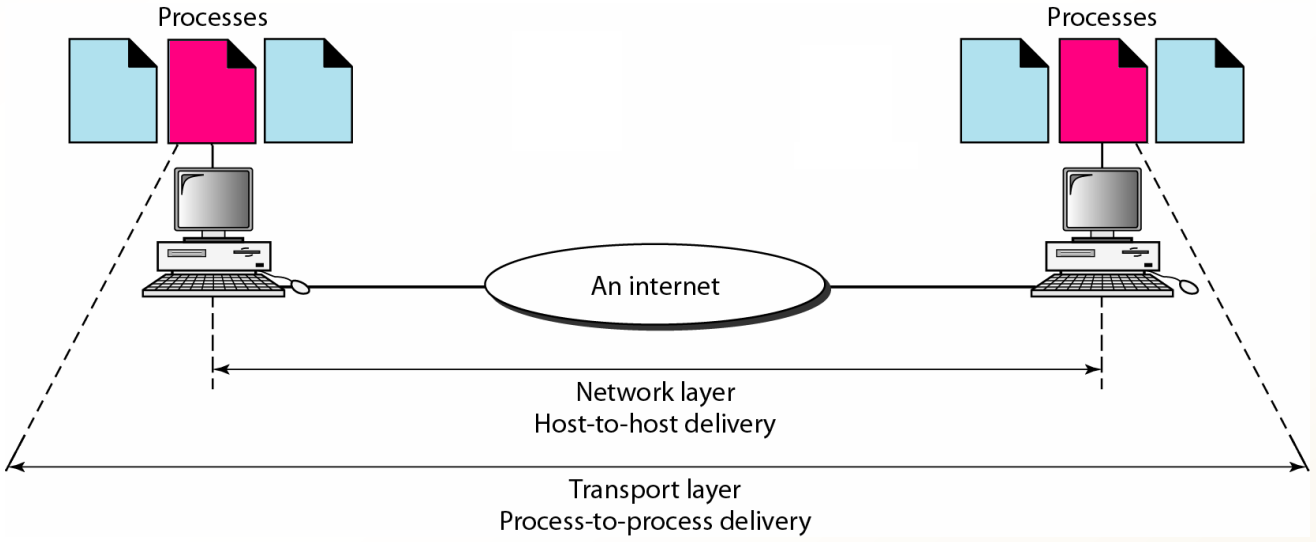
3 Layers in The OSI Model

- Transport Layer



3 Layers in The OSI Model

- Transport Layer
  - Service-point addressing
    - Delivery not only from one computer to the next but also from a specific process (running program) on one computer to a specific process on the other
    - Include service-point address (or port address)



3 Layers in The OSI Model

- Transport Layer
  - Segmentation and reassembly
    - Divide message into segments each contains a sequence #
    - Assemble the segments at the destination
  - Connection control
    - Connectionless: send packets to destinations
    - Connection-oriented: makes a connection before delivering the packets
  - Flow control
    - End to end rather than across a single link
  - Error control
    - Process to process rather than a single link

3 Layers in The OSI Model

- Session Layer
  - It is the network dialog controller
  - It establishes, maintains, and synchronizes the interaction among communicating systems

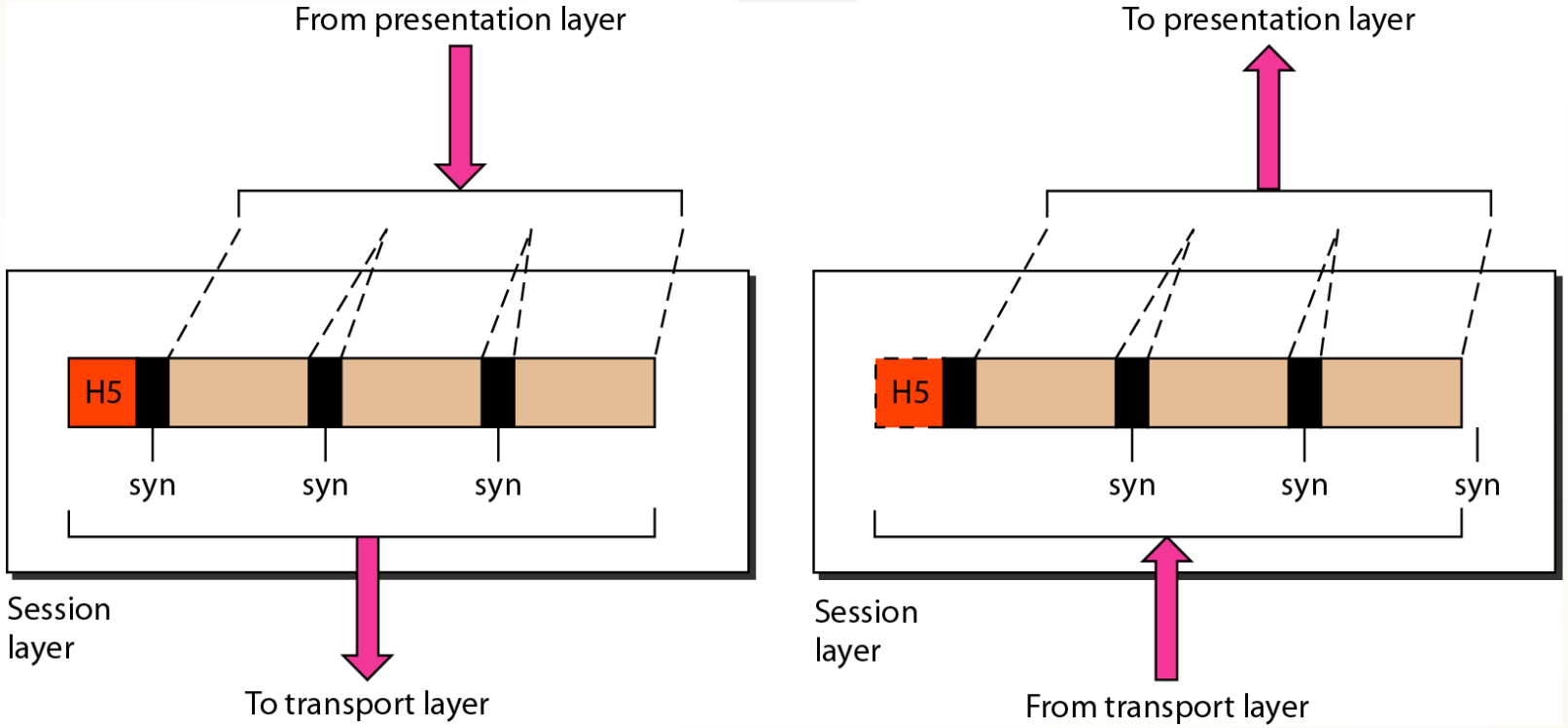
The session layer is responsible for dialog control and synchronization.

3 Layers in The OSI Model

- Session Layer
  - Dialog control
    - Allows two systems to enter into a dialog
    - Allows communication between two processes to take place in either half-duplex or full-duplex
  - Synchronization
    - Allows a process to add checkpoints, or synchronization points to a stream of data
    - Example: Sending a file of 2000 pages, insert checkpoints after every 100 pages. If a crash happens during transmission of page 523, the only pages that need to be resent after system recovery are pages 501 to 523

3 Layers in The OSI Model

- Session Layer



3 Layers in The OSI Model

- Presentation Layer
  - Concerned with the syntax and semantics of the information exchanged between two systems

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

3 Layers in The OSI Model

- Presentation Layer
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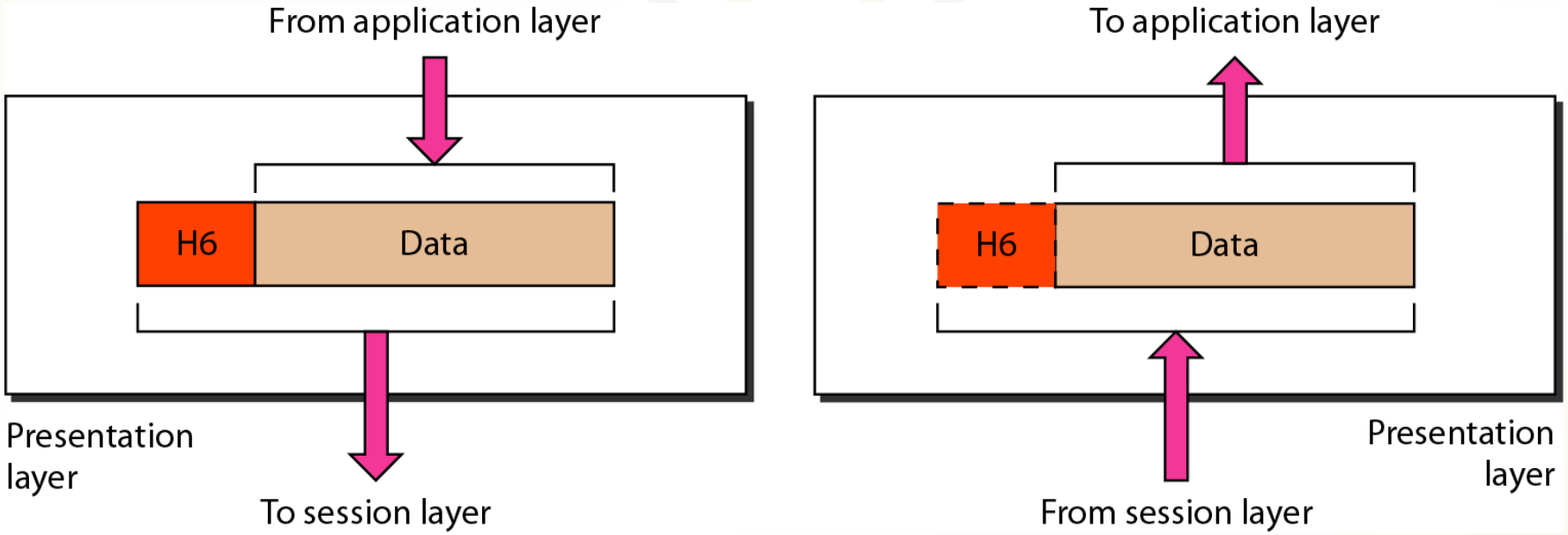


3 Layers in The OSI Model

- Presentation Layer
  - Translation
    - Interoperability between different coding systems
  - Encryption
  - Compression

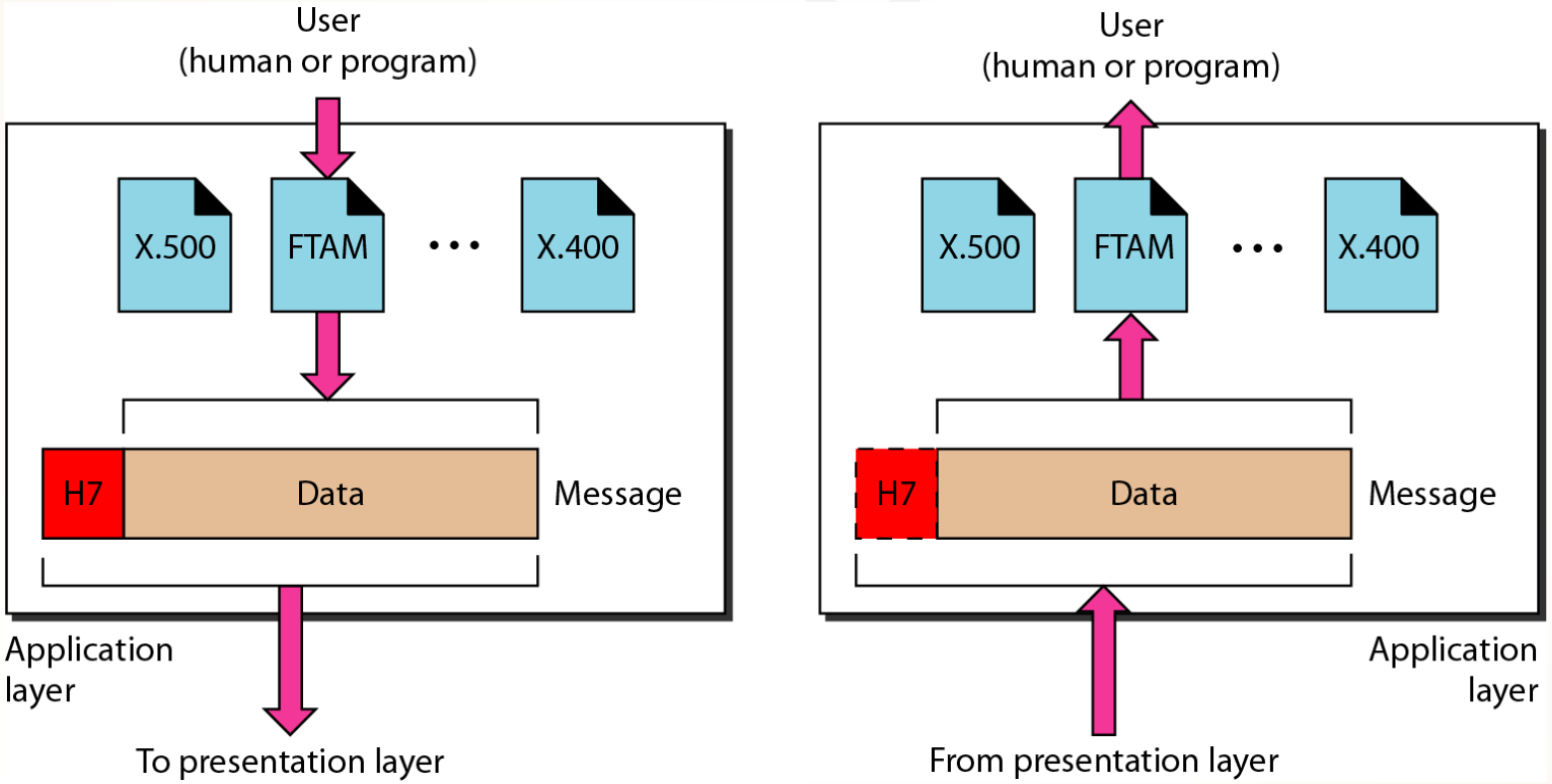
3 Layers in The OSI Model

- Application Layer
  - Enables the user to access the network
  - Provides user interfaces

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

3 Layers in The OSI Model

- Application Layer

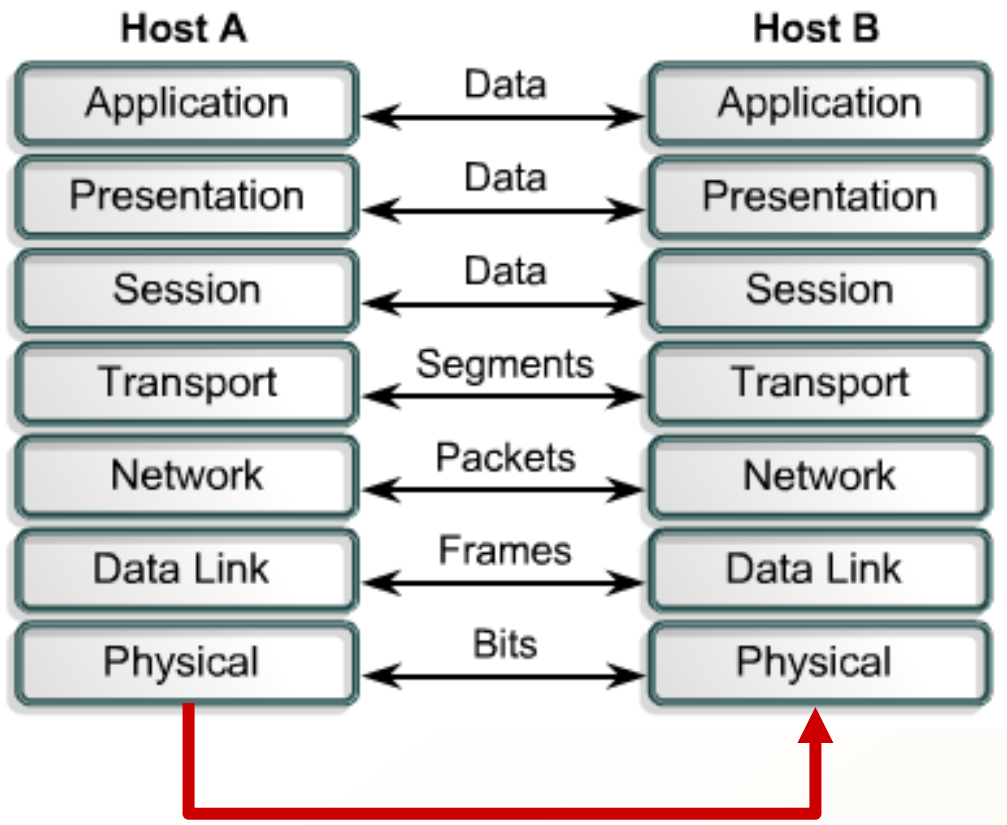


3 Layers in The OSI Model

- Application Layer
  - Enables network virtual terminal (a software version of a physical terminal) it allows a user to log on to a remote host
  - File transfer access, and management
  - Mail services
  - Directory services

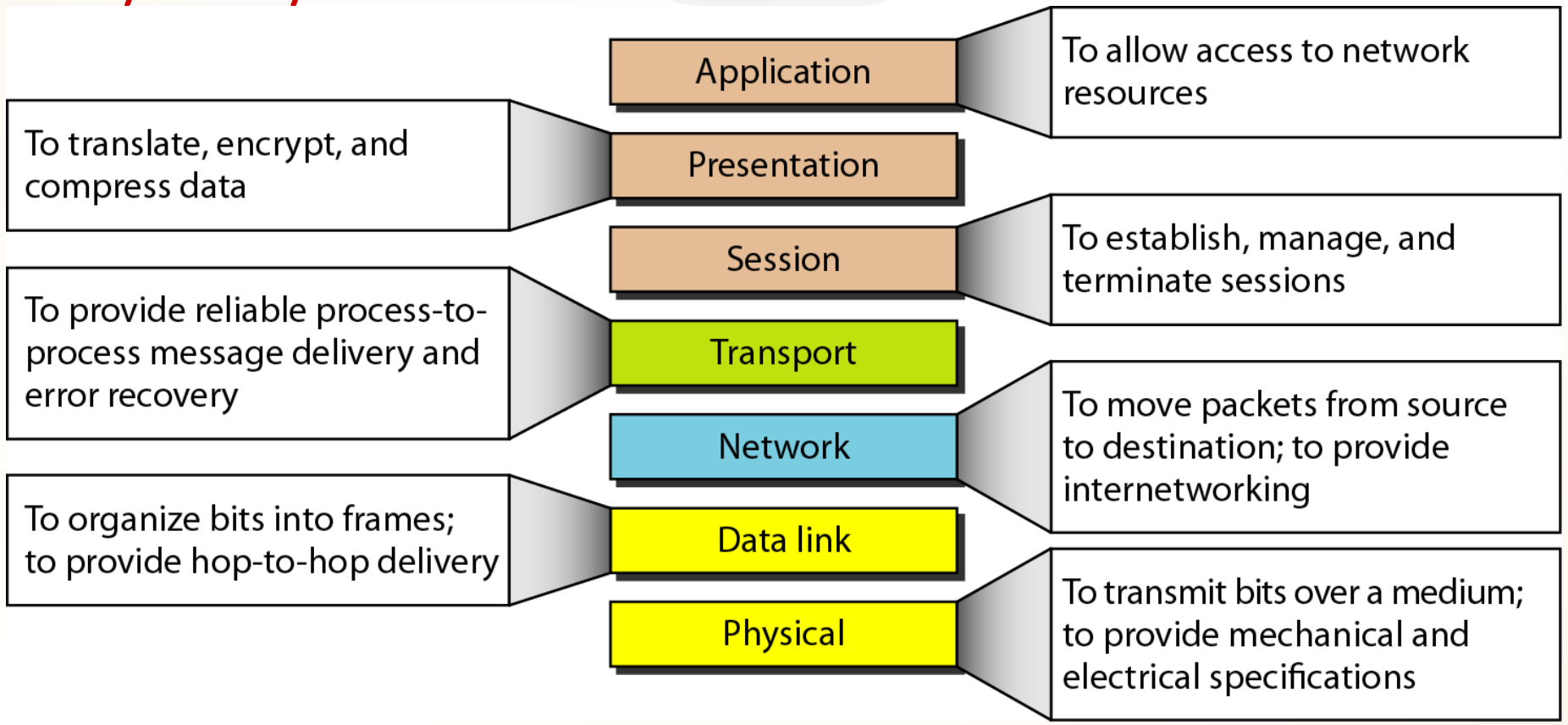
3 Layers in The OSI Model

- Summary of Layers



3 Layers in The OSI Model

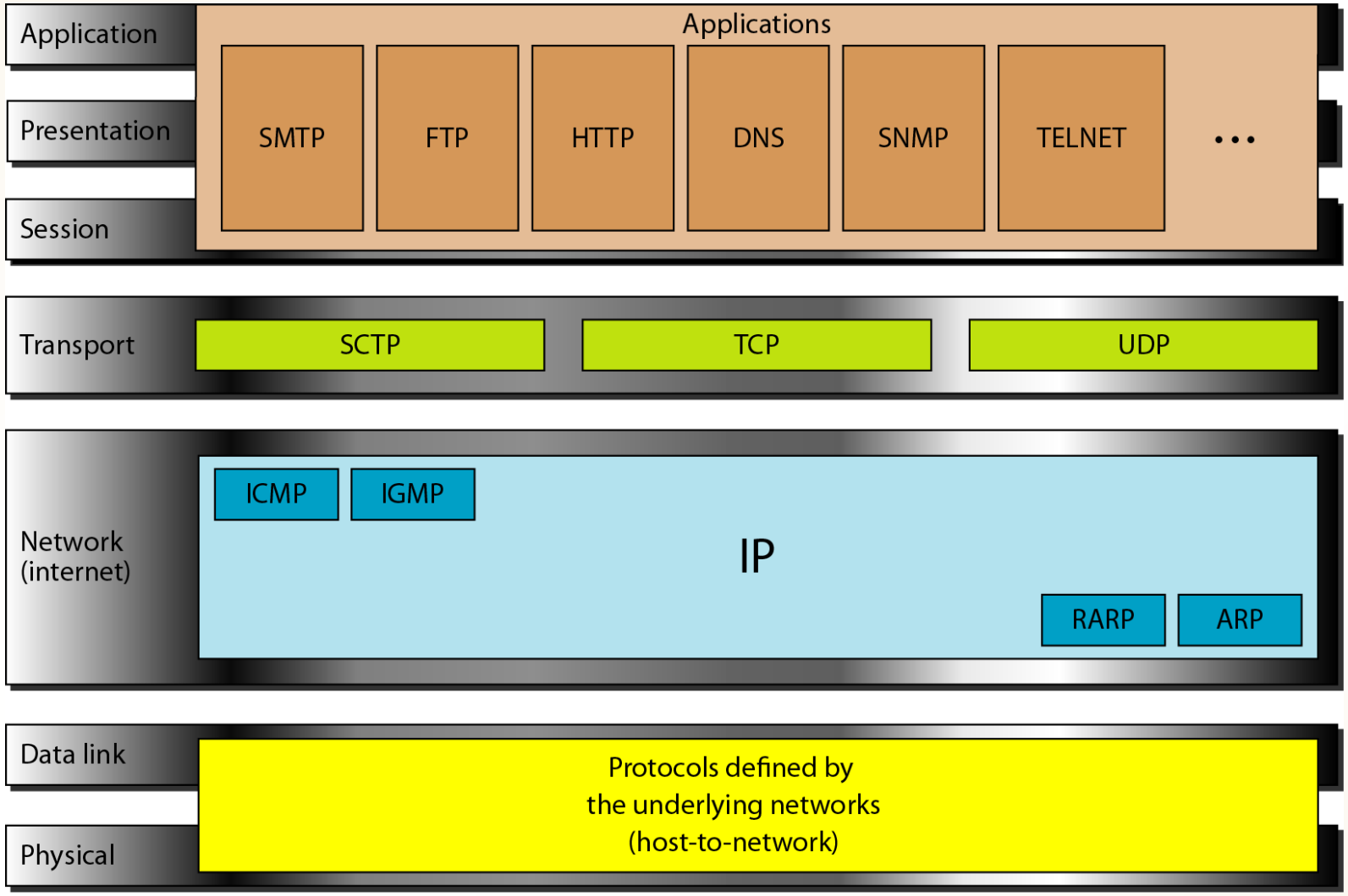
- Summary of Layers



2.4 TCP/IP Protocol Suite

- TCP/IP protocol was defined as having 4 layers: host-to-network, internet, transport, and application
- The layers in the TCP/IP protocol suite do not exactly match those in the OSI model
- When TCP/IP is compared to OSI, it can be said that the TCP/IP protocol is made of 5 layers: physical, data link, network, transport, and application

4 TCP/IP Protocol Suite



4 TCP/IP Protocol Suite

- Physical and Data Link Layers
- Network Layer
- Transport Layer
- Application Layer

4 TCP/IP Protocol Suite

- Physical and Data Link Layers
  - TCP/IP does not define any specific protocol
  - It supports all the standard and proprietary protocols

4 TCP/IP Protocol Suite

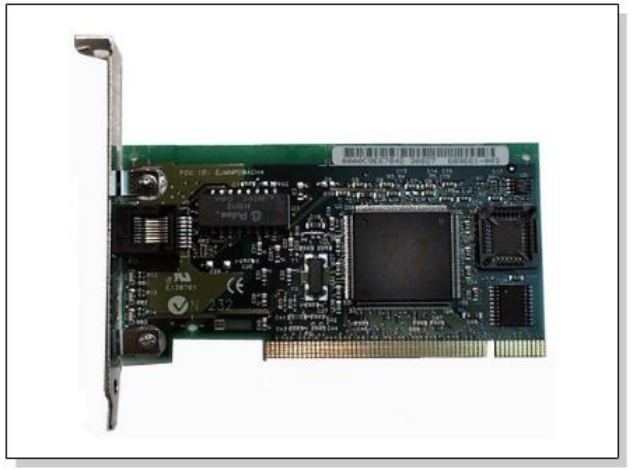
- Network Layer:
  - TCP/IP supports the Internetworking protocol (IP)
  - It uses 4 supporting protocol
    - ARP
    - RARP
    - ICMP
    - IGMP

4 TCP/IP Protocol Suite

- Network Layer
  - Internetworking Protocol (IP)
    - The transmission mechanism used by the TCP/IP protocols
    - Unreliable and connectionless protocol – *best short delivery service* (means no error checking or tracking)
    - Data packets are called *datagrams* which are transmitted separately. Datagrams can travel along different routes and can arrive out of sequence or be duplicated.
    - IP does not keep track of the routes and has no facility for reordering datagrams once they arrive at their destination
    - IP provides bare-bones transmission functions that free the user to add only those facilities necessary for a given application and thereby allow for maximum efficiency

4 TCP/IP Protocol Suite

- Network Layer
  - Address Resolution Protocol (ARP)
    - Used to associate a logical address with a physical address
    - Each device on a on a link is identified by a physical or station address usually imprinted on the network interface card (NIC)



4 TCP/IP Protocol Suite

- Network Layer
  - Reverse Address Resolution Protocol (RARP)
    - Allows a host to discover its Internet address when it knows only its physical address
    - It is used when the computer is connected to a network for the first time

4 TCP/IP Protocol Suite

- Network Layer
  - Internet Control Message Protocol (ICMP)
    - A mechanism used by hosts and gateways to send notification of datagram problems back to the sender
  - Internet Group Message Protocol (IGMP)
    - Used to facilitate the simultaneous transmission of a message to a group of recipients

4 TCP/IP Protocol Suite

- Transport Layer
  - Protocols TCP, UDP, and SCTP
  - IP is host-to host
  - UDP and TCP are process-to-process

4 TCP/IP Protocol Suite

- Transport Layer
  - User Datagram Protocol (UDP)
    - Process-to-process protocol
    - Adds:
      - Port addresses
      - Checksum error control
      - Length information to the data from the upper layer

4 TCP/IP Protocol Suite

- Transport Layer
  - Transmission Control Protocol (TCP)
    - Provides full transport-layer services to applications
    - A reliable stream (connection-oriented) transport protocol
    - At the sending end of each transmission, TCP divides a stream of data into smaller units called *segments*
    - Each segment includes a sequence number for reordering after receipt together with an acknowledgment number for the segments received
    - Segments are carried across internet inside of IP datagrams
    - At the receiving end TCP collects each datagram as it comes in and reorders the transmission based on sequence numbers

4 TCP/IP Protocol Suite

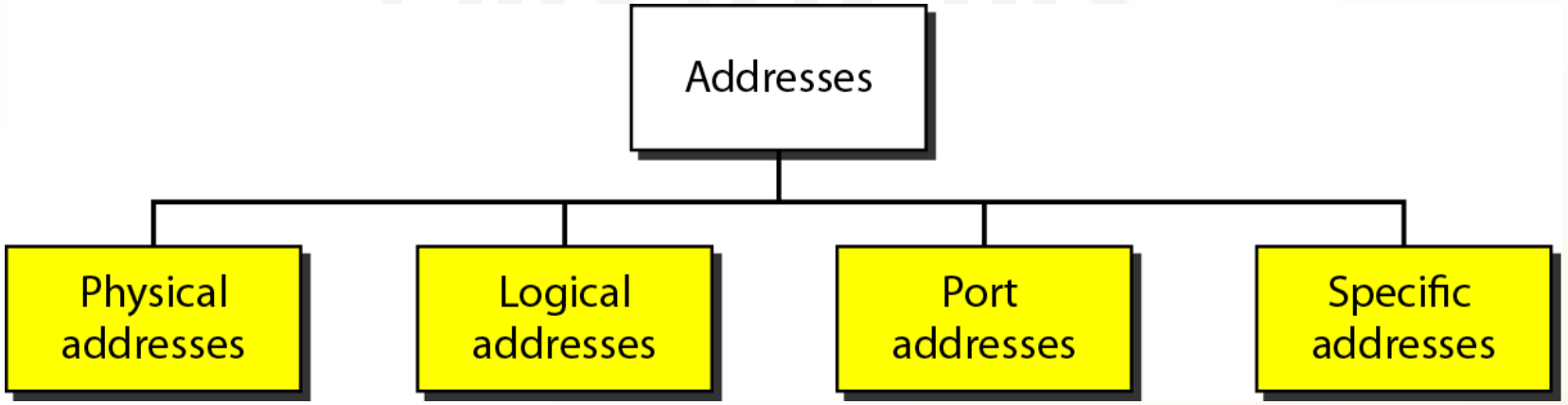
- Transport Layer
  - Stream Control Transmission Protocol (SCTP)
    - Provides support for newer applications such as voice over the Internet

4 TCP/IP Protocol Suite

- Application Layer

4 TCP/IP Protocol Suite

- In an internet employing the TCP/IP protocols 4 levels of addresses are used
  - Physical (link) addresses
  - Logical (IP) addresses
  - Port addresses
  - Specific addresses



In OSI model, OSI stands for?

A. Open Source Interconnection
B. Open System Interconnection
C. O-System Interconnection
D. O-Source Interconnection

Ans : B
Explanation: The International Standard Organization has a well-defined model for Communication Systems known as Open System Interconnection, or the OSI Model

2. Which of the following is Layer-7?

A. Presentation Layer
B. Session Layer
C. Application Layer
D. Transport Layer

Ans : C
Explanation: Application Layer (Layer-7) : This is where the user application sits that needs to transfer data between or among hosts.

3. Which layer helps to understand data representation in one form on a host to other host in their native representation?

A. Application Layer
B. Presentation Layer
C. Session Layer
D. Transport Layer

Ans : B
Explanation: Presentation Layer (Layer-6) : This layer helps to understand data representation in one form on a host to other host in their native representation.

4. HTTP is an example of?

A. Session Layer
B. Presentation Layer
C. Data Link Layer
D. Application Layer

Ans : D
Explanation: For example : HTTP, file transfer application (FTP) and electronic mail etc.

5. Which layer helps to uniquely identify hosts beyond the subnets and defines the path which the packets will follow or be routed to reach the destination?

A. Physical Layer
B. Data Link Layer
C. Network Layer
D. Transport Layer

Ans : C
Explanation: Network Layer (Layer-3) – This layer helps to uniquely identify hosts beyond the subnets and defines the path which the packets will follow or be routed to reach the destination.

6. Physical Layer is Layer-1.

A. Yes
B. No
C. Can be yes or no
D. Can not say
View Answer

Ans : A
Explanation: Yes, Physical Layer is Layer-1.

7. How many layers does OSI Reference Model has?

A. 6
B. 7
C. 8
D. 9

Ans : B
Explanation: The OSI Model has the following seven layers.

8. The physical layer concerns with

A. bit-by-bit delivery
B. process to process delivery
C. application to application delivery
D. None of the above
View Answer

Ans : B
Explanation: The physical layer concerns with process to process delivery.

9. Bits can be send over guided and unguided media as analog signal by

A. digital modulation
B. amplitude modulation
C. frequency modulation
D. phase modulation

Ans : A
Explanation: Bits can be send over guided and unguided media as analog signal by digital modulation.

10. The network layer is responsible for carrying data from one host to another.

A. TRUE
B. FALSE
C. Can be true or false
D. Can not say
View Answer

Ans : A
Explanation: True, The network layer is responsible for carrying data from one host to another.

11. TCP/IP model does not have _____ layer but OSI model have this layer.
a) session layer
b) transport layer
c) application layer
d) network layer
View Answer

Answer: a
Explanation: In OSI reference model, there are two layers which are not present in TCP/IP model. They are Presentation and Session layer. The functions of Presentation and Session layer in the OSI model are handled by the transport layer itself in TCP/IP.

12.Which layer is used to link the network support layers and user support layers?
a) session layer
b) data link layer
c) transport layer
d) network layer
View Answer
Answer: c
Explanation: Physical, data link and network layers are network support layers and session, presentation and application layers are user support layers. The transport layer links these layers by segmenting and rearranging the data. It uses protocols like TCP and UDP.