What is layering in Networked computing?

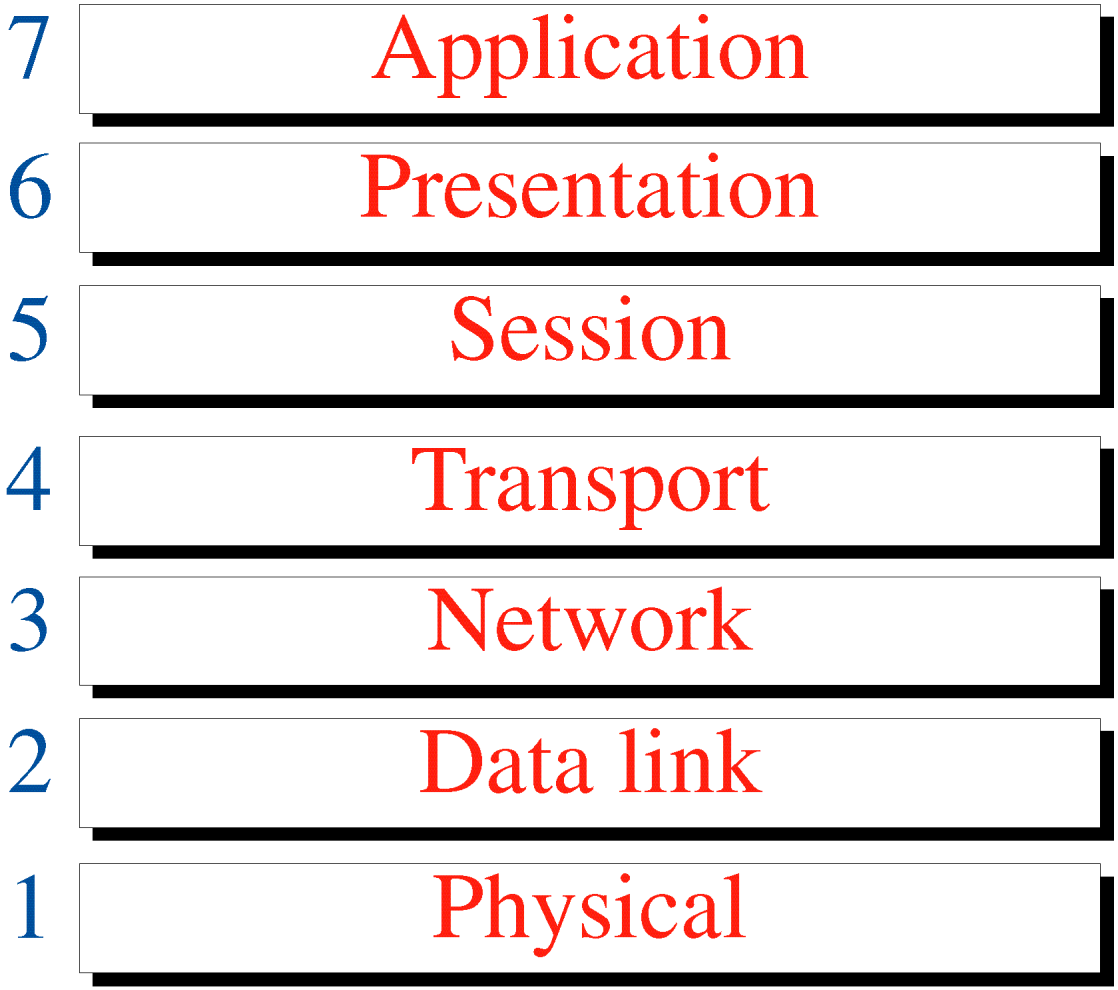
- Breaks down communication into smaller, simpler parts.

- Easier to teach communication process.
- Standardization across manufactures.
- Allows different hardware and software to work together.
- Reduces complexity

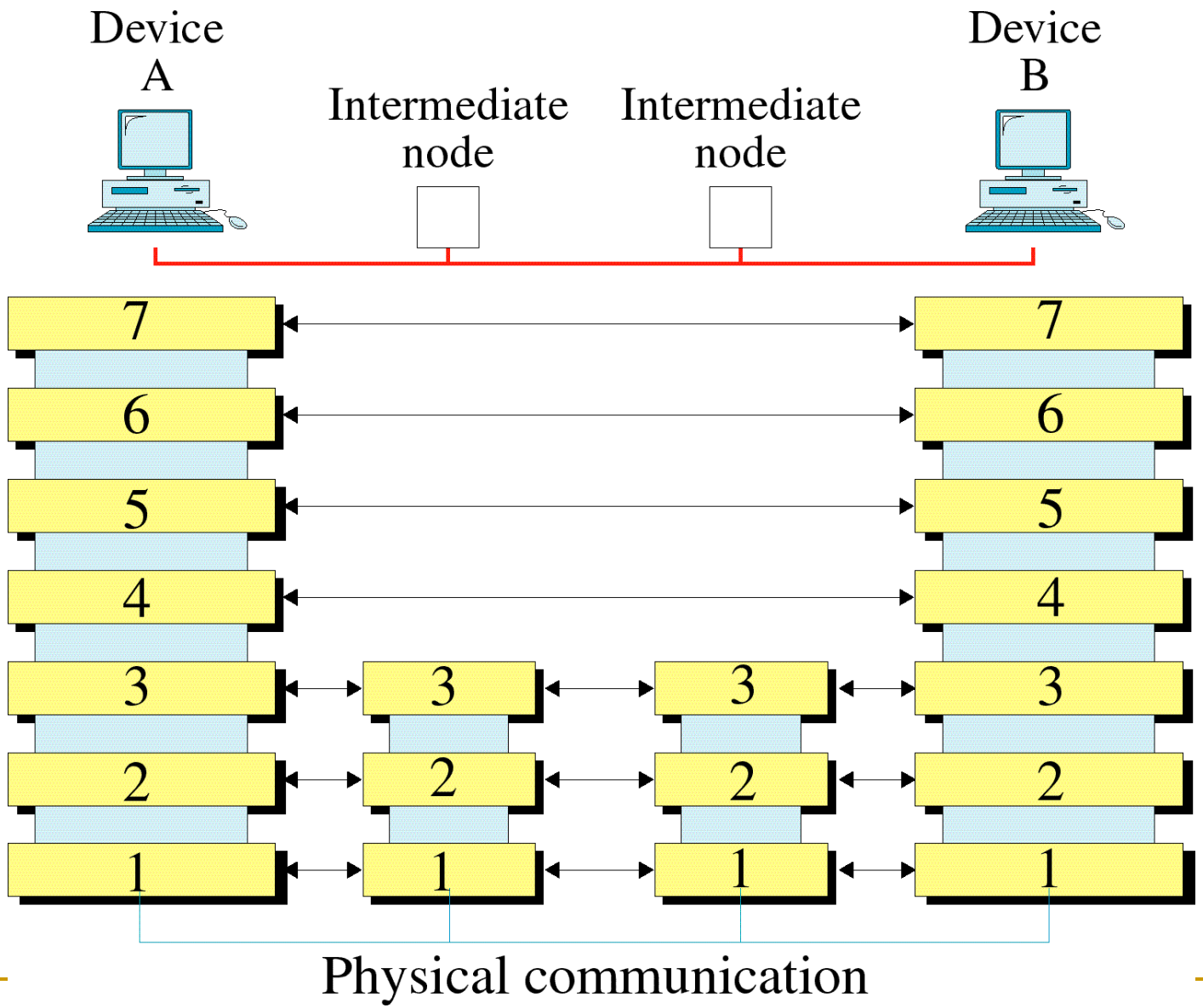
The OSI Model

- OSI “ Open Systems Interconnection".
- OSI model was first introduced in 1984 by the International Organization for Standardization (ISO).
  - Outlines **WHAT** needs to be done to send data from one computer to another.
  - Not **HOW** it should be done.
  - Protocols stacks handle how data is prepared for transmittal (to be transmitted)
- In the OSI model, The specification needed
  - are contained in 7 different layers that interact with each other.

OSI Model


7
Application
6
Presentation
5
Session
4
Transport
3
Network
2
Data link
1
Physical

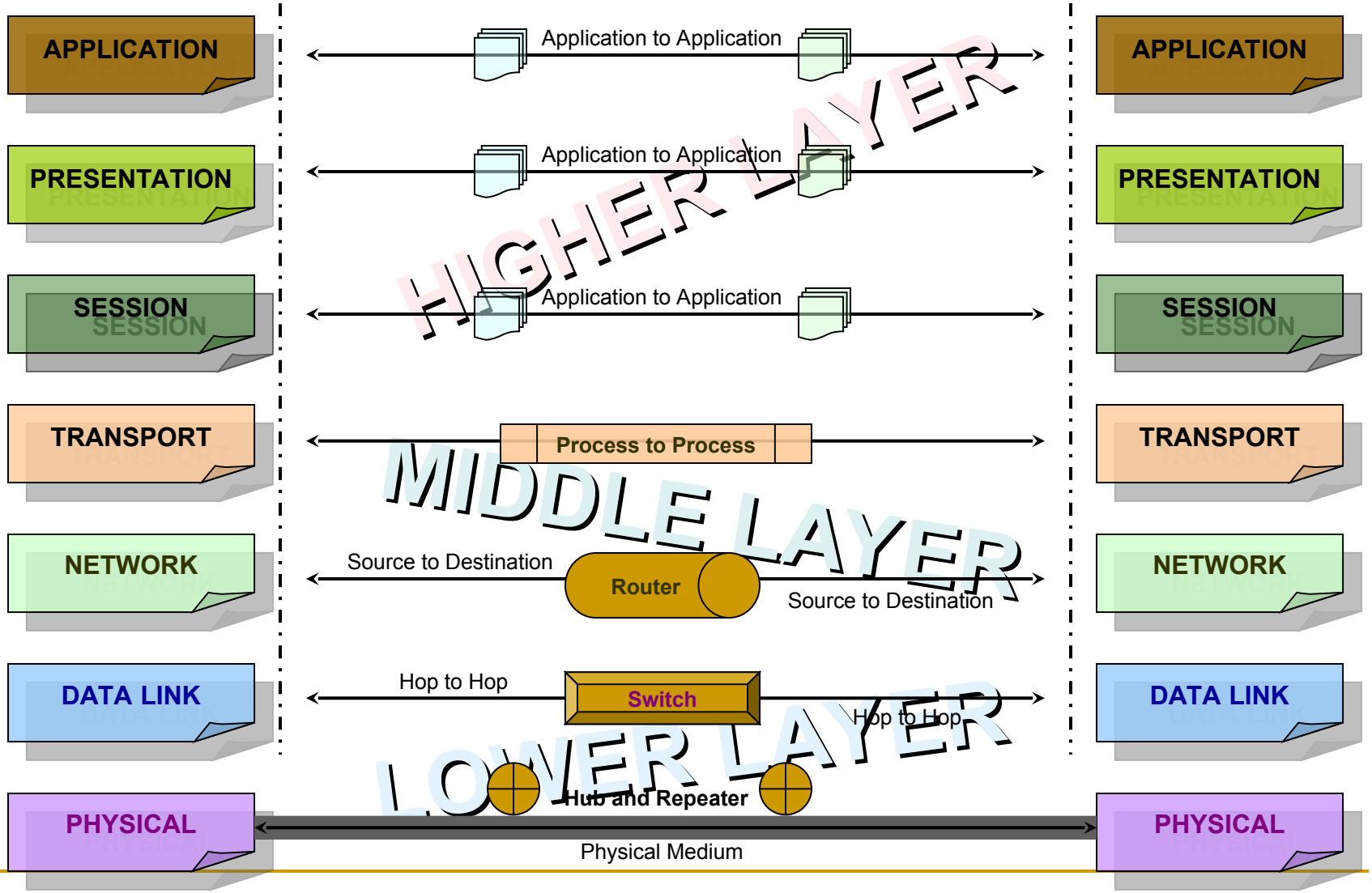
OSI Layers


Device A
Intermediate node
Intermediate node
Device B
7
6
5
4
3
2
1
Physical communication

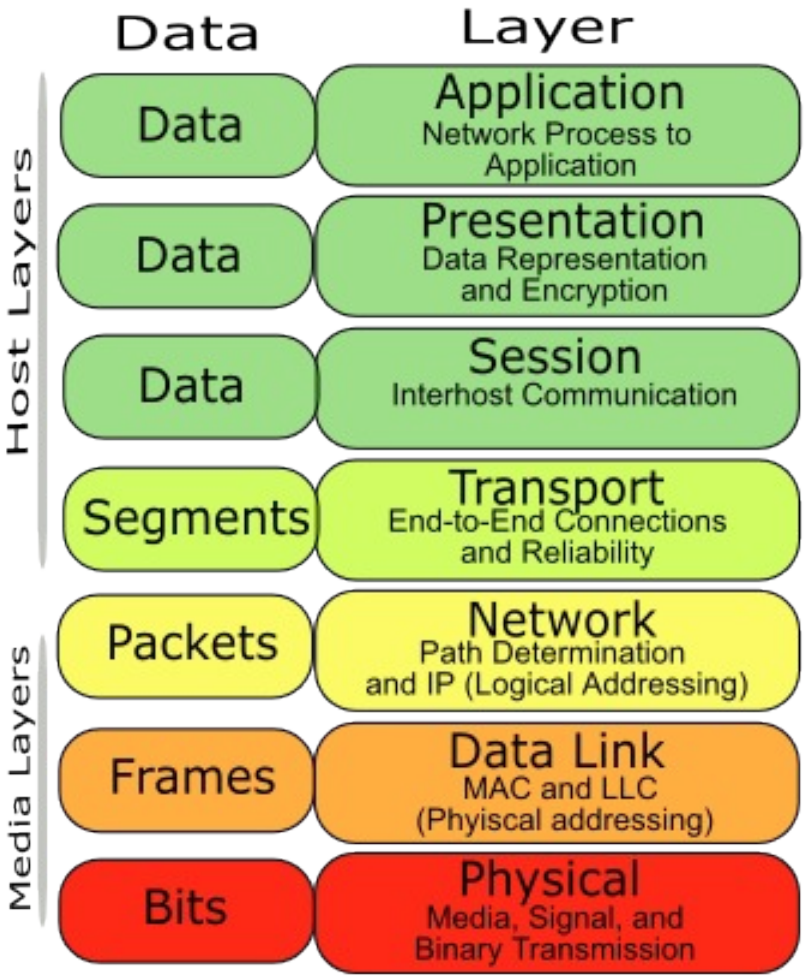
Introduction

- Open Systems Interconnection Basic Reference Model (OSI Reference Model or **OSI Model**) is an abstract description for layered communications and computer network protocol design.
- It was developed as part of the **Open Systems Interconnection** (**OSI**) initiative. In its most basic form, it divides network architecture into seven layers which, from top to bottom, are the Application, Presentation, Session, Transport, Network, Data-Link, and Physical Layers.
- It is therefore often referred to as the **OSI Seven Layer Model**.

OSI Model's 7 Layers



Host and Media Layer



These terms are used to refer at which OSI layer we are referring to, the data remain same but the headers and trailers are getting added or removed.

In Phy layer i.e. physical layer the actual data is in "bits" i.e. 0 and 1.

When it reaches to data link layer or Layer 2 it becomes **"frame"** with source and destination mac address getting added.

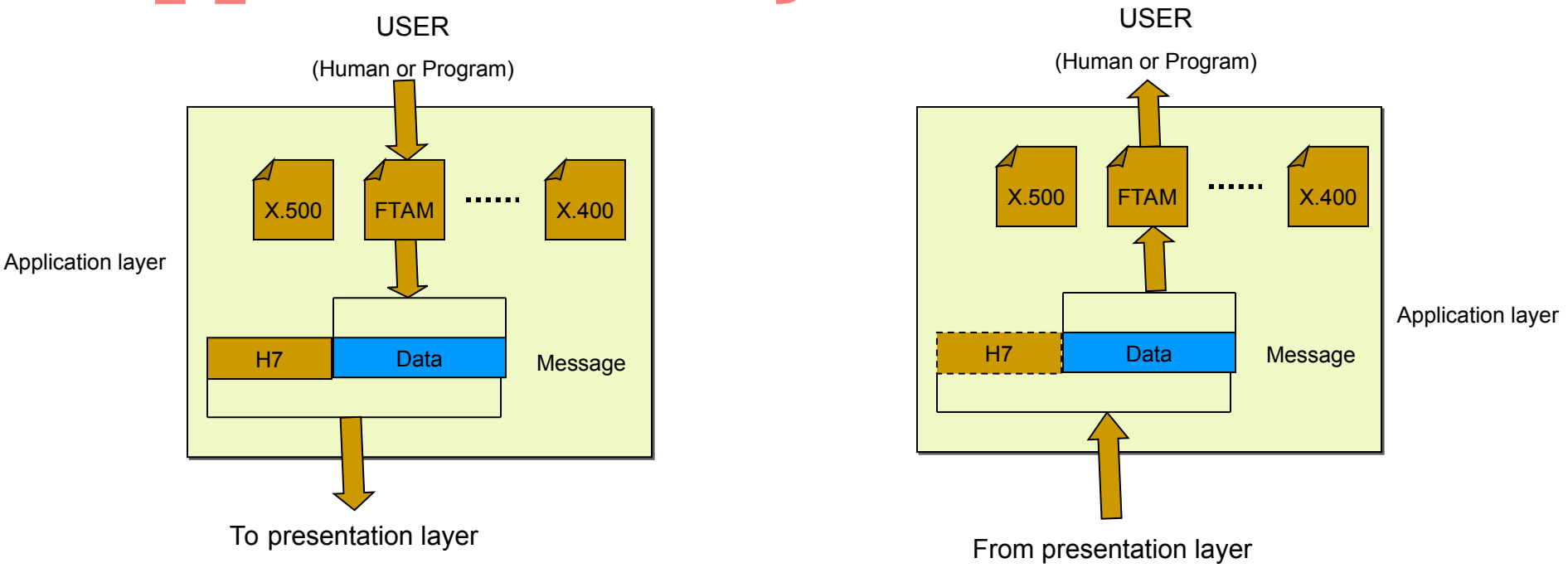
When it reaches the third layer or the networking layer it becomes a **"packet"** with source and destination IP address attached to it.

Finally it become **"segment"** at Layer 4 or TCP/IP layer. Basically **"segment"** term is used for TCP(Transmission Control Protocol) connections and **"datagrams"** for UDP(User Datagram Protocol).

So what about other layers like : session, presentation and application ? In these layers the data is termed as **"PDU" or "protocol data unit**".

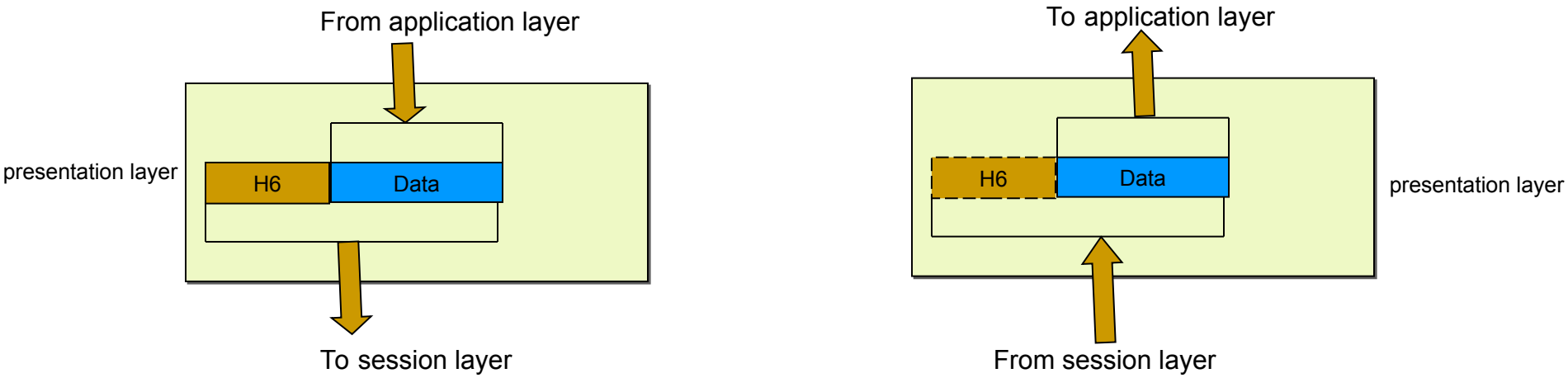
So when someone says, that a **"frame"** is being received by a networking device, then you know that the device is switch.

Application Layer (user level service)



- The application layer is responsible for providing services to the user.
- Concerned:
  - Network virtual terminal (Software)
  - File transfer, access and management
  - Mail services
  - Directory services (access to distributed database sources for global information about various objects and services)

Presentation Layer (dependency)

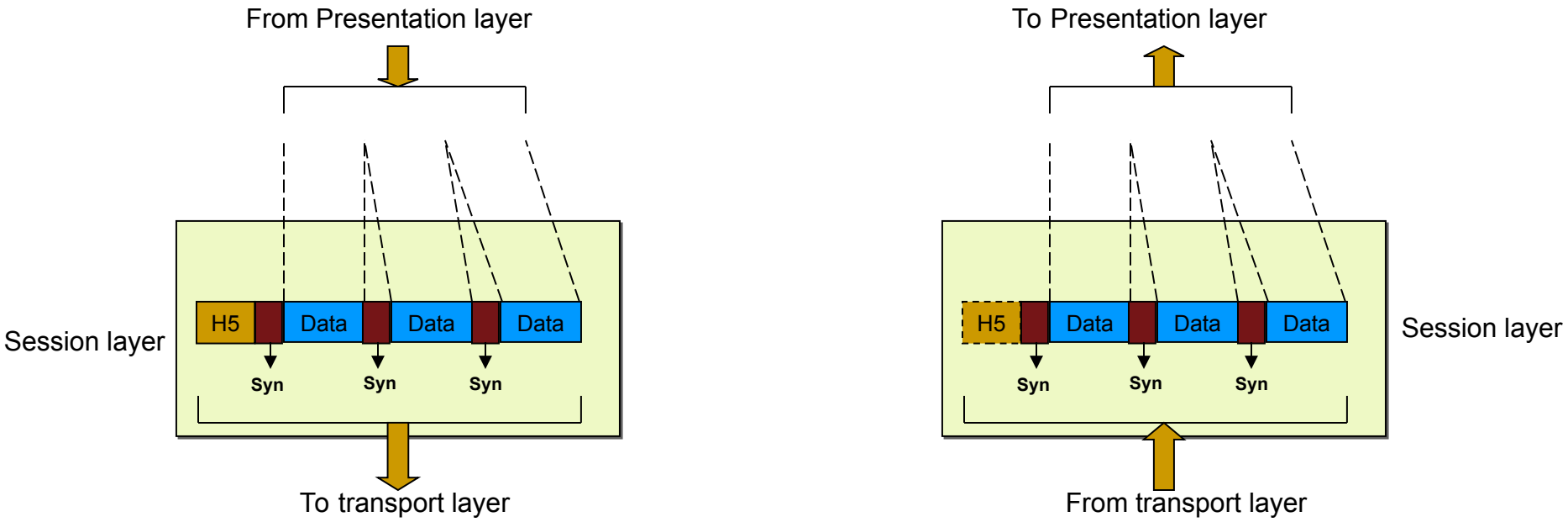


- The presentation layer is responsible for translation, compression and encryption(syntax or format, semantics

- Concerned:
  - Translation (interoperability between different encoding system)
  - Encryption (Privacy schemes)
  - Compression (data compression)

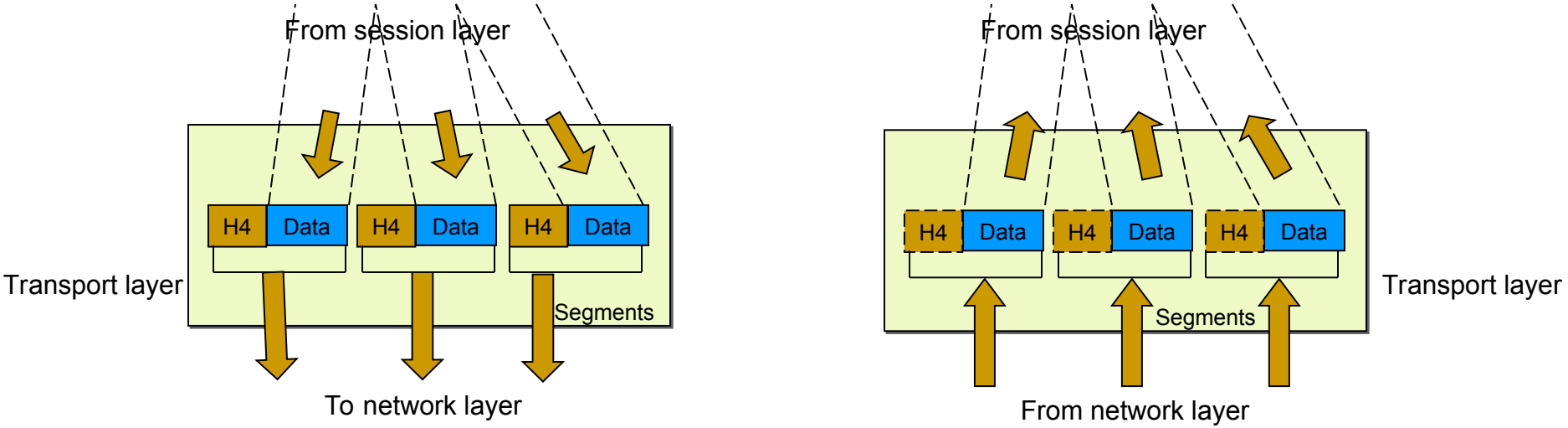
- Encryption and decryption of a message for security
- Compression and expansion of a message so that it travels efficiently
- Graphics formatting
- Content translation
- System-specific translation

Session Layer (Dialog initiation)



- The session layer is responsible for dialog control and synchronization
- Concerned:
  - Dialog Control (Half Duplex/Full duplex)
  - Synchronization (Synchronization points, process inline within same page)

Transport Layer (Process to Process)

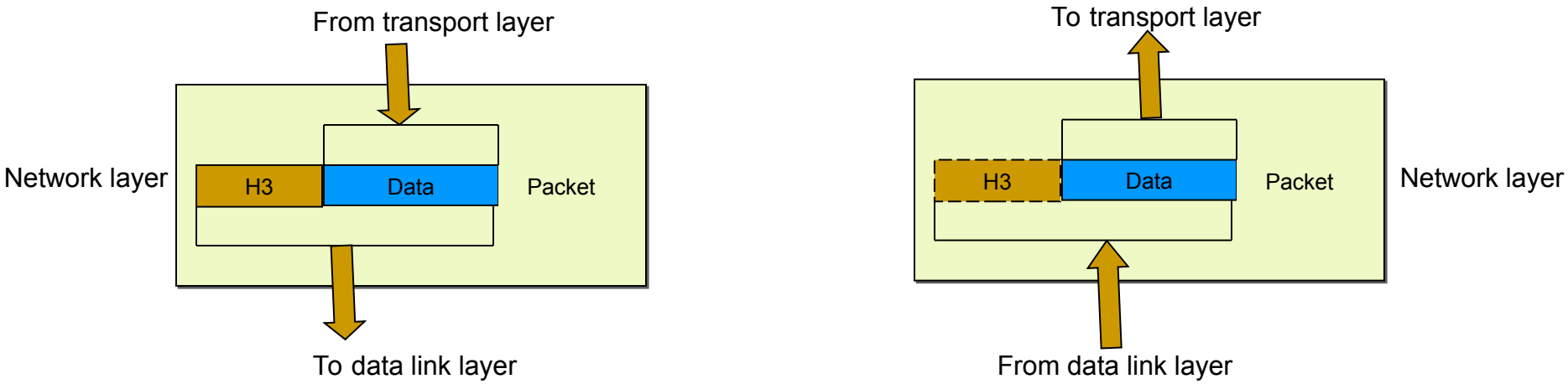


- The transport layer is responsible for the delivery of a message from one process to another

- Concerned:
  - Service-point addressing (Port address)
  - Segmentation and reassembly (Sequence number)
  - Connection control (Connectionless or connection oriented)
  - Flow control (end to end)
  - Error Control (Process to Process)

- • Application identification
- • Client-side entity identification
- • Confirmation that the entire message arrived intact
- • Segmentation of data for network transport
- • Control of data flow to prevent memory overruns
- • Establishment and maintenance of both ends of virtual circuits
- • Transmission-error detection
- • Realignment of segmented data in the correct order on the receiving side
- • Multiplexing or sharing of multiple sessions over a single physical link

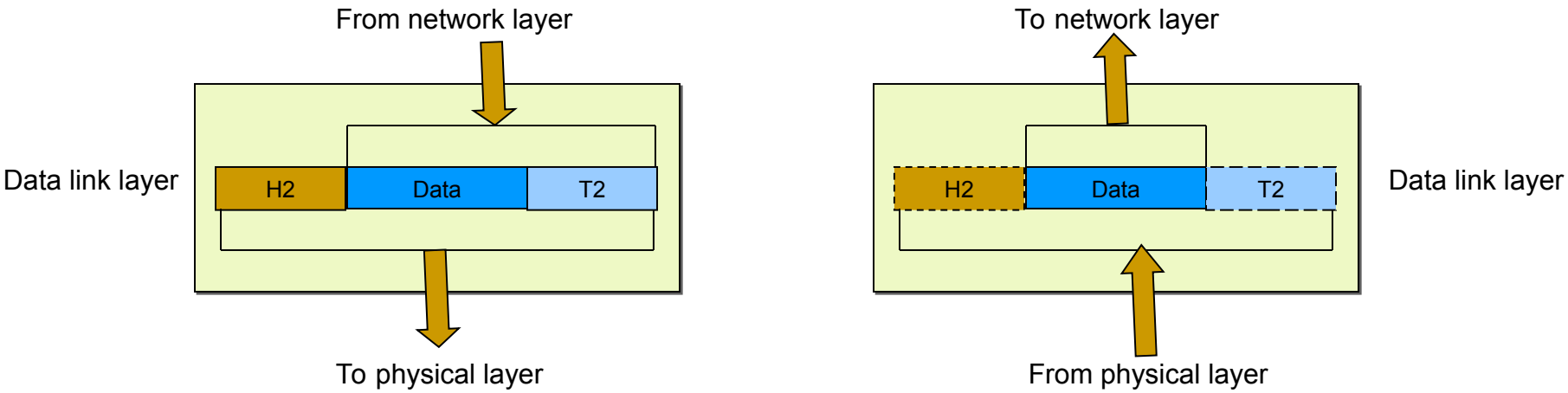
Network Layer (Source to Destination)



- The network layer is responsible for the delivery of individual packets from the source host to the destination host.
- Concerned:
  - Logical addressing (IP Address)
  - Routing (Source to destination transmission between networks)

- Virtual connection between application entities
- Synchronization of data flow
- Creation of dialog units
- Connection parameter negotiations
- Partitioning of services into functional groups
- Acknowledgements of data received during a session
- Retransmission of data if it is not received by a device

Data Link Layer (Host to Host)



- Data link layer is responsible for moving frames from one hop (Node) to the next.

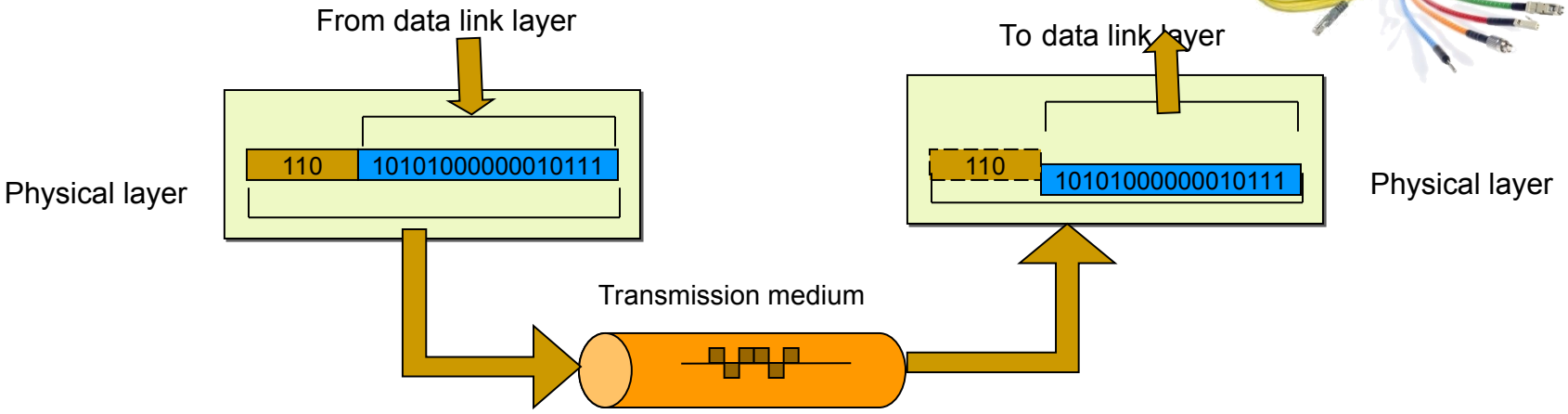
- Concerned:
  - Framing (stream of bits into manageable data units)
  - Physical addressing (MAC Address)
  - Flow Control (mechanism for overwhelming the receiver)
  - Error Control (trailer, retransmission)
  - Access Control (defining master device in the same link)

- Layer 2 of the OSI model provides the following functions:

- Allows a device to access the network to send and receive messages
- Offers a physical address so a device's data can be sent on the network
- Works with a device's networking software when sending and receiving messages
- Provides error-detection capability

- Common networking components that function at layer 2 include:
- • Network interface cards
- • Ethernet and Token Ring switches
- • Bridges

Physical Layer

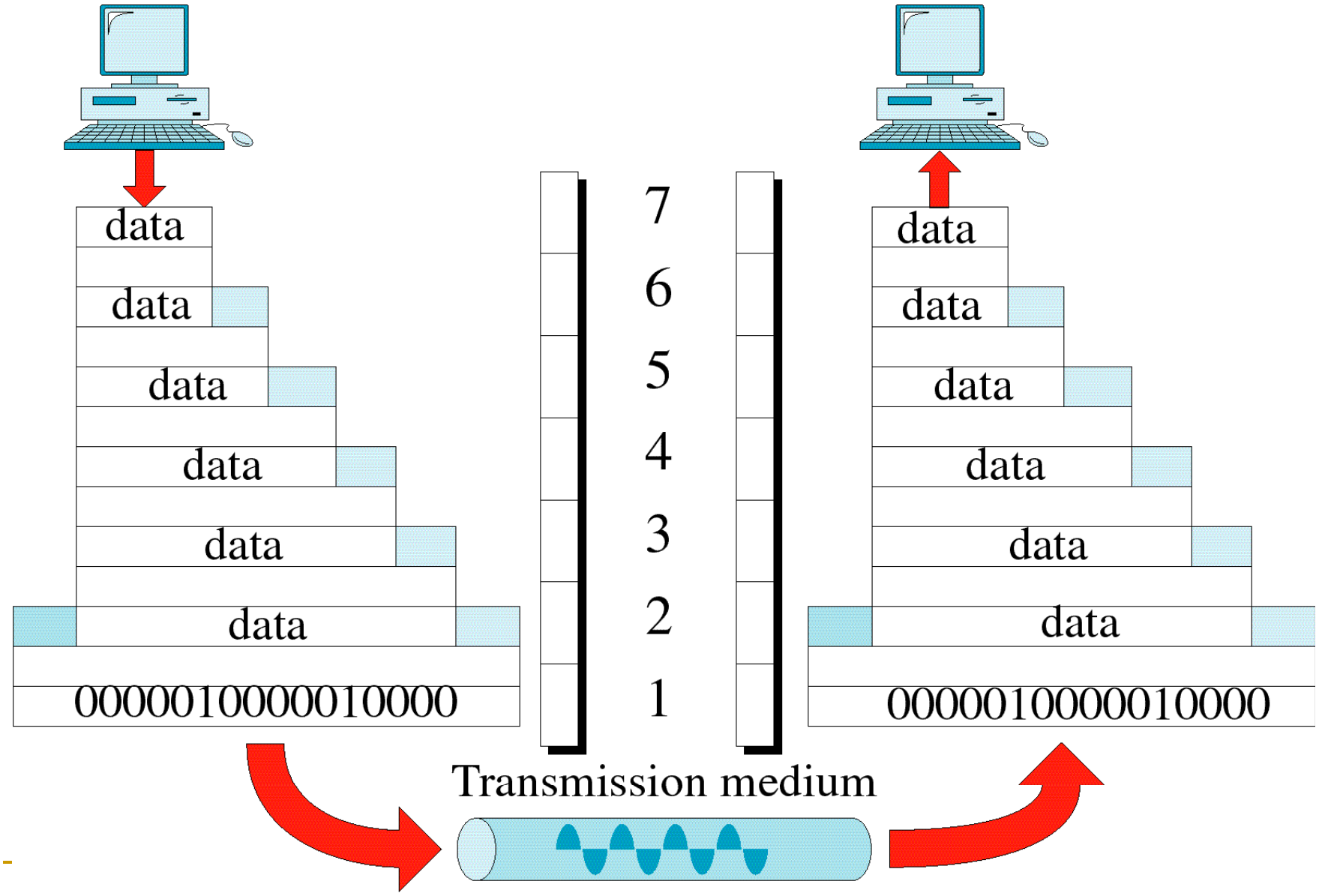


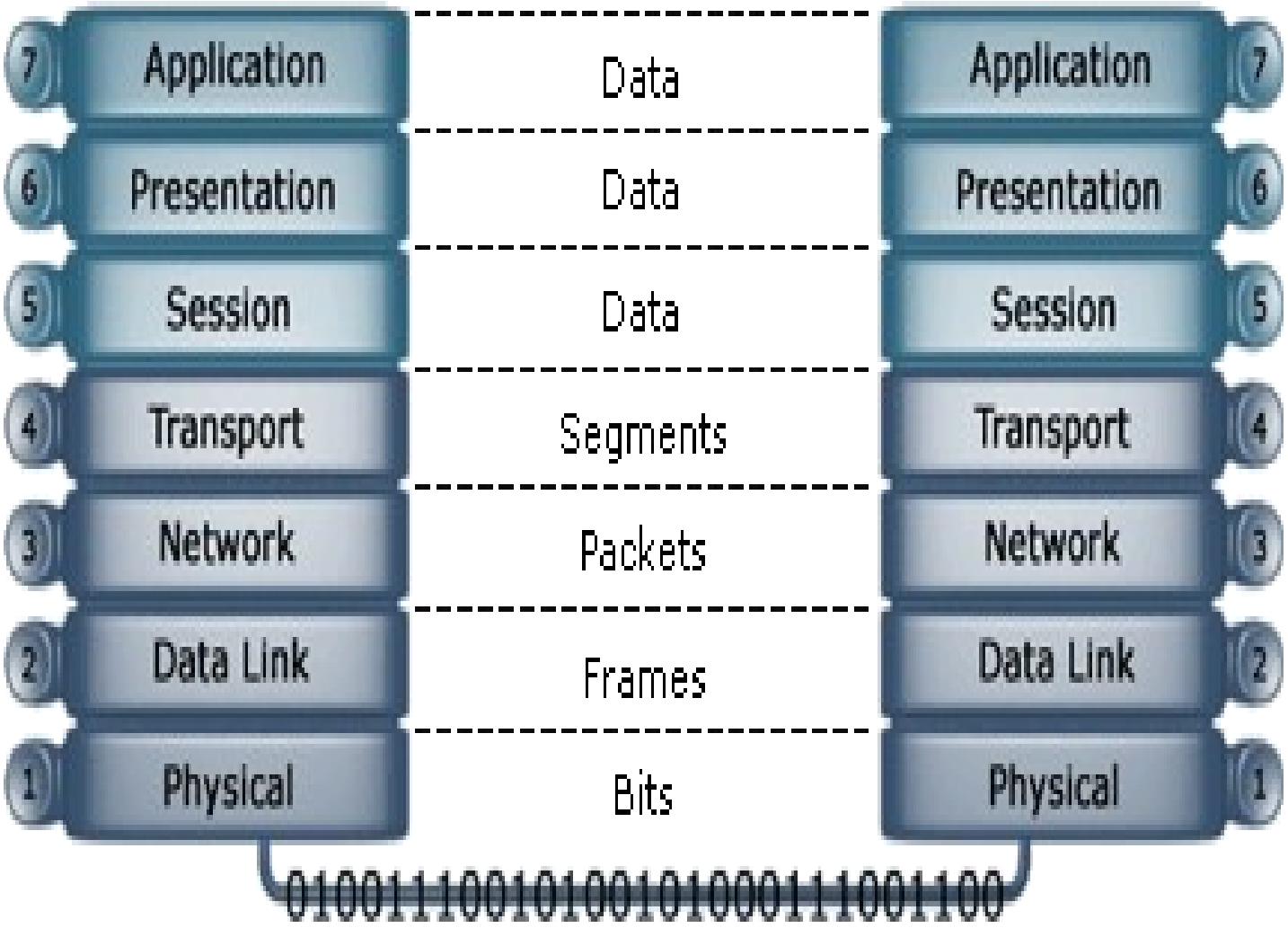
- One of the major function of the physical layer is to move data in the form of electromagnetic signals across a transmission medium.
- Its responsible for movements of individual bits from one hop (Node) to next.
- Both data and the signals can be either *analog* or *digital*.
- Transmission media work by conducting energy along a physical path which can be wired or wireless

- Concerned:
  - Physical characteristics of interface and medium (Transmission medium)
  - Representation of bits (stream of bits (0s or 1s) with no interpretation and encoded into signals)
  - Data rate (duration of a bit, which is how long it last)
  - Synchronization of bits (sender and receivers clock must be synchronized)
  - Line configuration (Point-to-Point, Point-to-Multipoint)
  - Physical topology
  - Transmission mode (Simplex, half duplex, full duplex)

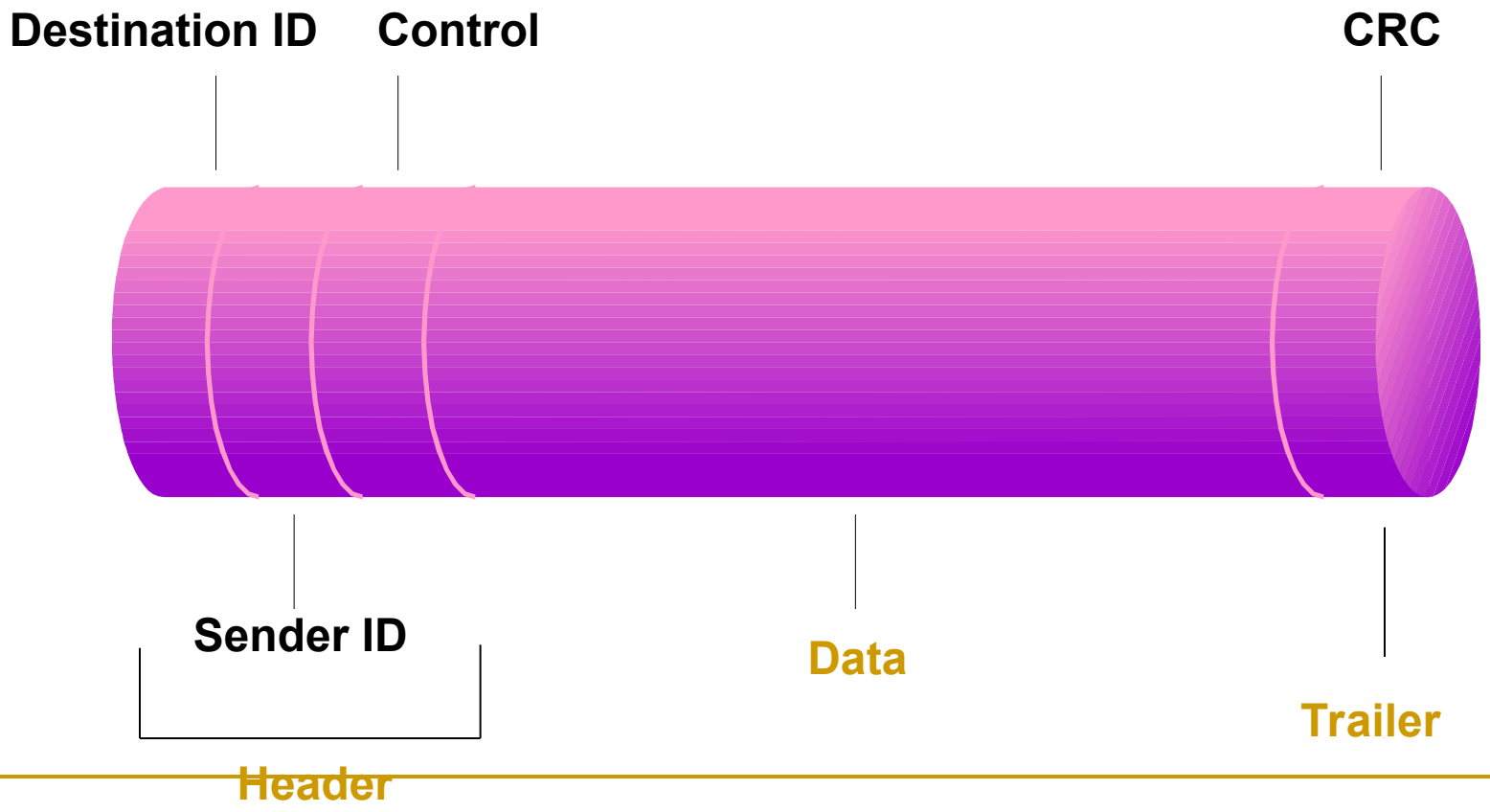
- Components of the physical layer include:
- • Cabling system components
- • Adapters that connect media to physical interfaces
- • Connector design and pin assignments
- • Hub, repeater, and patch panel specifications
- • Wireless system components
- • Parallel SCSI (Small Computer System Interface)
- • Network Interface Card (NIC)

An Exchange Using the OSI Model

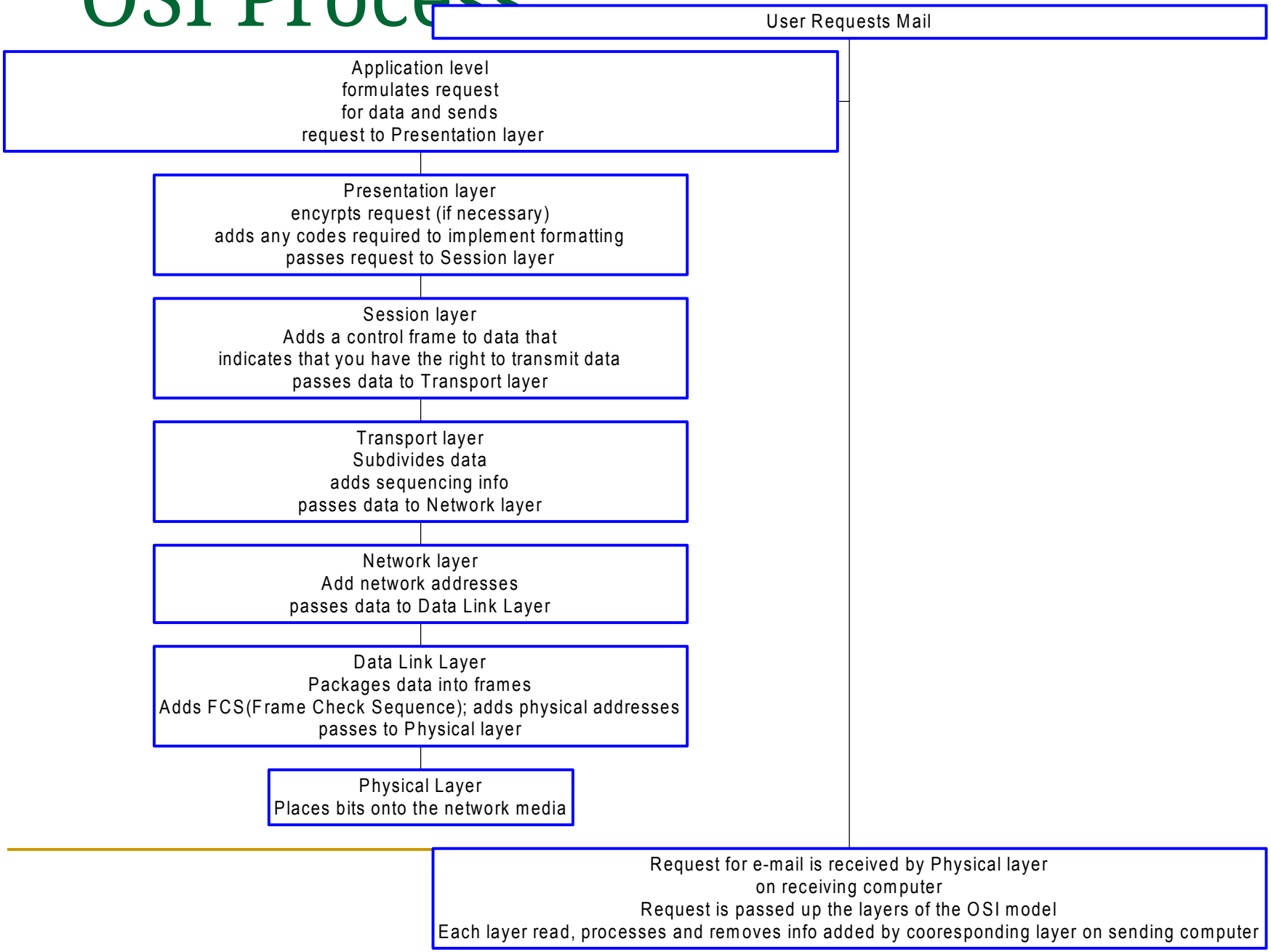



7
Application
Data
Application
7
6
Presentation
Data
Presentation
6
5
Session
Data
Session
5
4
Transport
Segments
Transport
4
3
Network
Packets
Network
3
2
Data Link
Frames
Data Link
2
1
Physical
Bits
Physical
1
0100111001010010100011001100

A simple data packet



OSI Process


User Requests Mail
Application level
formulates request
for data and sends
request to Presentation layer
Presentation layer
encyrpts request (if necessary)
adds any codes required to implement formatting
passes request to Session layer
Session layer
Adds a control frame to data that
indicates that you have the right to transmit data
passes data to Transport layer
Transport layer
Subdivides data
adds sequencing info
passes data to Network layer
Network layer
Add network addresses
passes data to Data Link Layer
Data Link Layer
Packages data into frames
Adds FCS(Frame Check Sequence); adds physical addresses
passes to Physical layer
Physical Layer
Places bits onto the network media
Request for e-mail is received by Physical layer
on receiving computer
Request is passed up the layers of the OSI model
Each layer read, processes and removes info added by cooresponding layer on sending computer

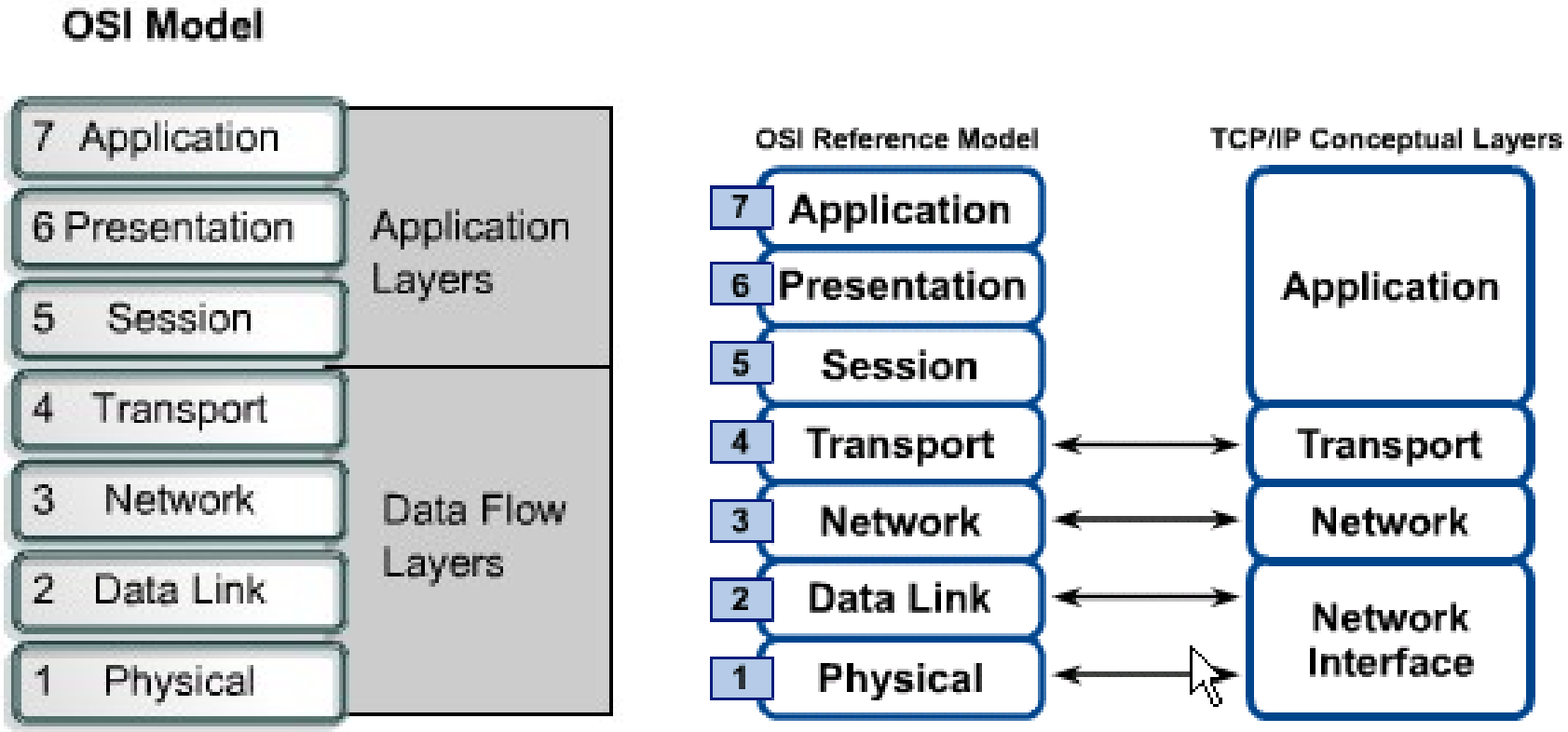
2.3 TCP/IP Protocol Suite

*The **TCP/IP protocol suite** is made of five layers: physical, data link, network, transport, and application. The first four layers provide physical standards, network interface, internetworking, and transport functions that correspond to the first four layers of the OSI model. The three topmost layers in the OSI model, however, are represented in TCP/IP by a single layer called the application layer.*

The topics discussed in this section include:

Physical and Data Link Layers
Network Layer
Transport Layer
Application Layer

OSI & TCP/IP Models



The TCP/IP model

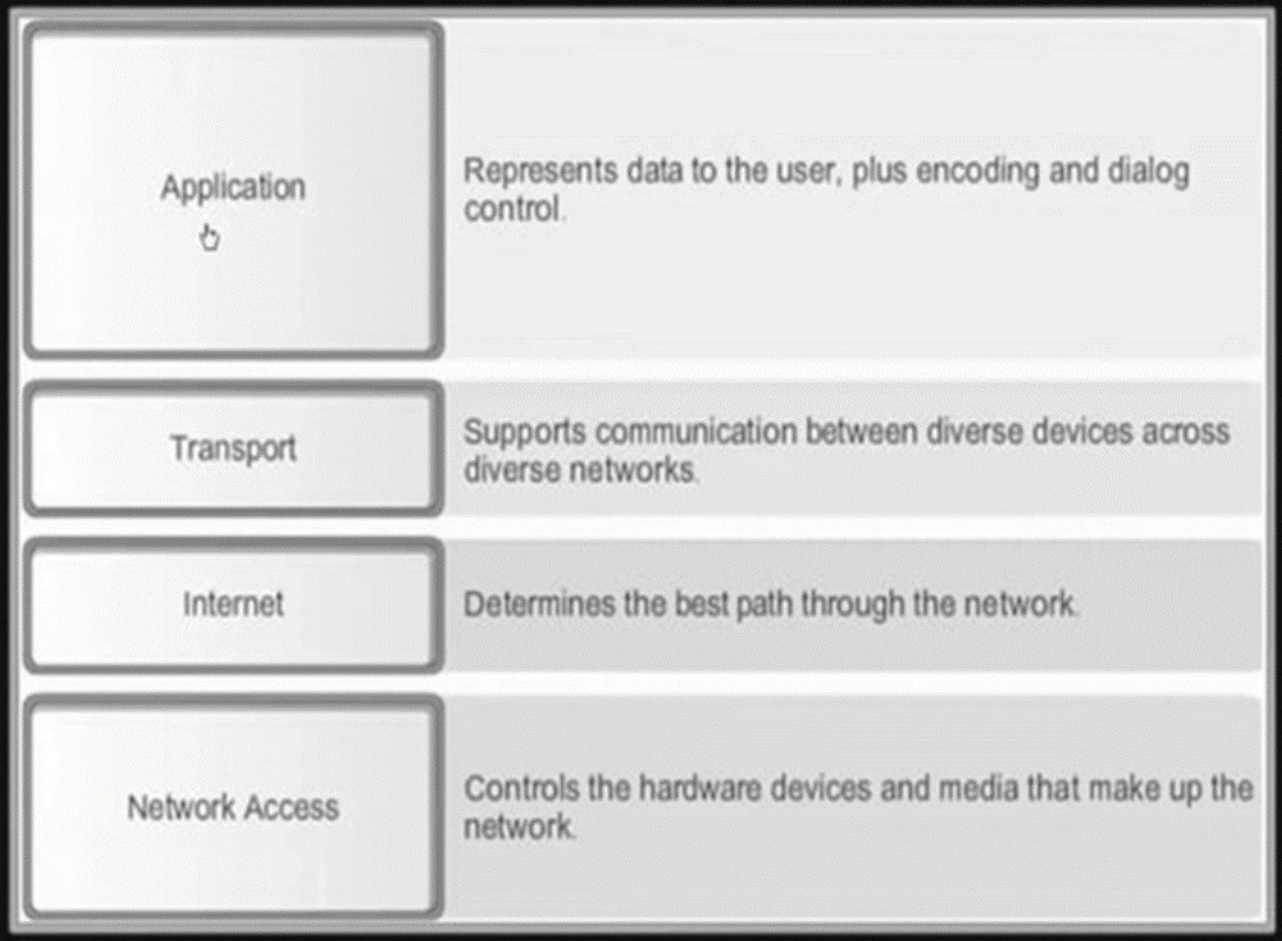
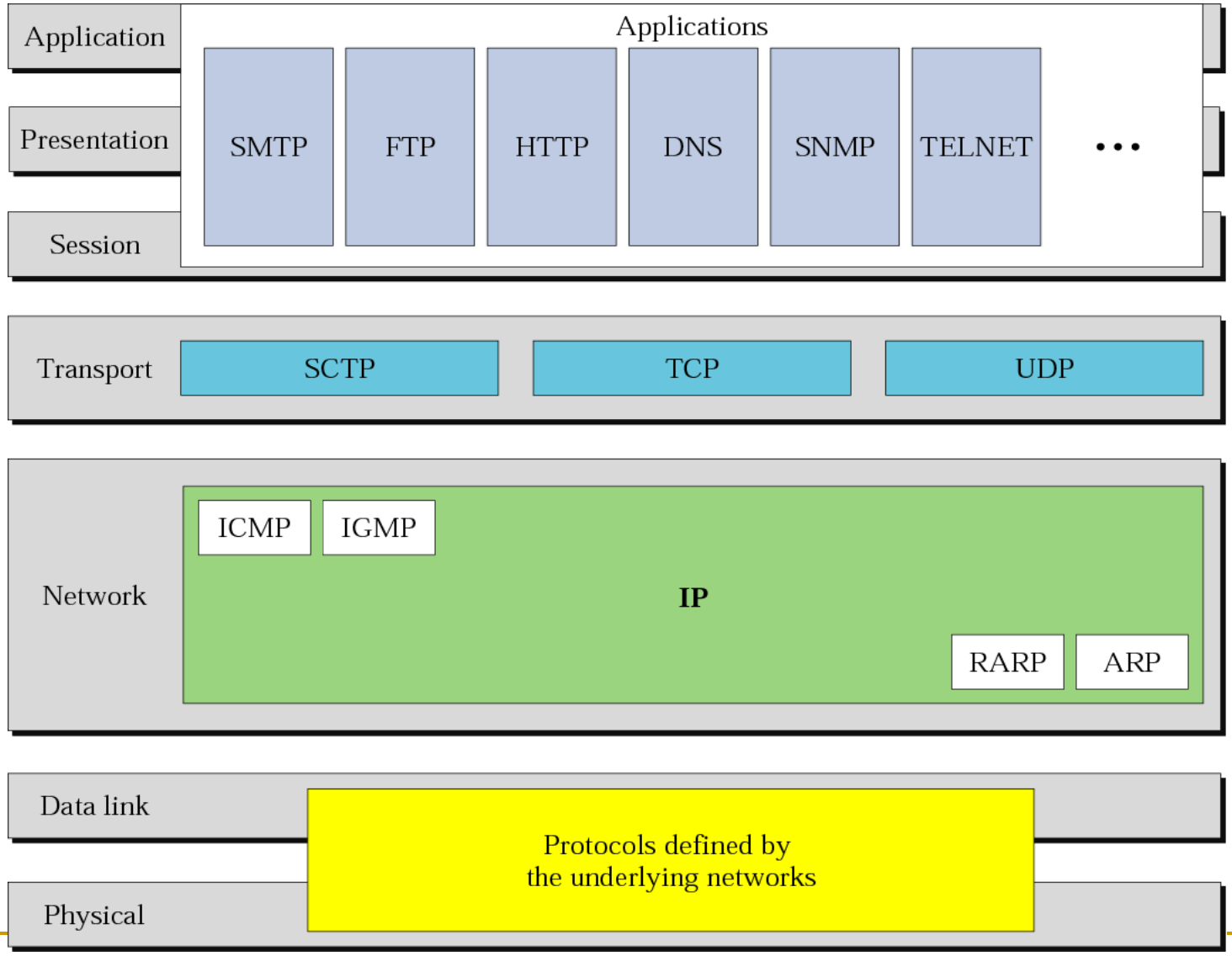


Figure 2.15 *TCP/IP and OSI model*



TCP/IP	OSI
Implementation of OSI model	Reference model
Model around which Internet is developed	This is a theoretical model
Has only 4 layers	Has 7 layers
Considered more reliable	Considered a reference tool
Protocols are not strictly defined	Stricter boundaries for the protocols
Horizontal approach	Vertical approach
Combines the session and presentation layer in the application layer	Has separate session and presentation layer
Protocols were developed first and then the model was developed	Model was developed before the development of protocols
Supports only connectionless communication in the network layer	Supports connectionless and connection-oriented communication in the network layer
Protocol dependent standard	Protocol independent standard

Figure 3-14

Summary of Layer Functions