Computer Networks: Reference Model

By,

Mr. Kumar Pudashine, (MEng, AIT)
CCNP (Security), CEH, ITIL Expert, ISO 27001, CISA, AcitivIdentity Certified
Information Technology Division,
Agricultural Development Bank,
Ramshahpath, Kathmandu
Nepal

August 2016

Protocols : What It is ?

- A Protocol is a set of rules that governs Data Communications.

- For Communication to occur, the entities must agree on a Protocol.

- The Key Elements of a Protocol are
    - Syntax => Refers to Structure or Format of Data.
    - Semantics => Refers to Meaning of Each Data.
    - Timing => When Data Should be Sent and How Fast ?

"French Scientist Cannot Communicate With Japanese Scientist Without Any Protocol"

Standards : What It is ?

- Creates Open and Competitive Market for Manufacturers.

- Provides guidelines to Manufactures for Interoperability.

- Data Communication Standards Fall into Two Categories
  - *De facto*
  - *De jure*

- *De facto* Standards have not been approved by an Organization.

- Standards through Wide Spread Use are *De facto* Standards.

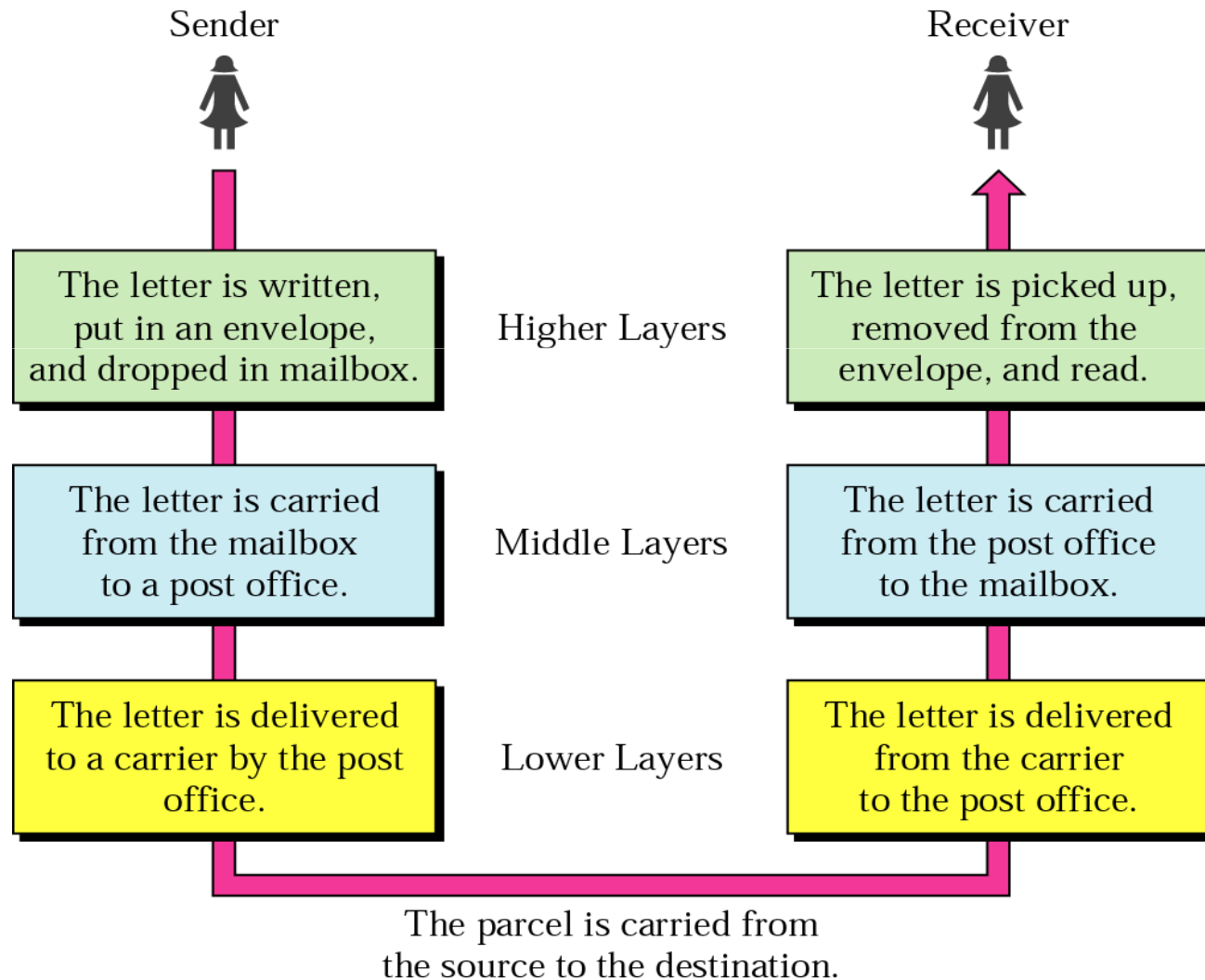- *De jure* Standards have been legalized by an Organization.

Standard Organization

- International Organization for Standardization (ISO)

- International Telecommunication Union (ITU)

- American National Standards Institute (ANSI)

- Institute of Electrical and Electronics Engineers (IEEE)

- Electronic Industries Association (EIA)

Protocol Analogy: Sending a Letter

Sender

Receiver

	Higher Layers	
The letter is written, put in an envelope, and dropped in mailbox.		The letter is picked up, removed from the envelope, and read.

	Middle Layers	
The letter is carried from the mailbox to a post office.		The letter is carried from the post office to the mailbox.

	Lower Layers	
The letter is delivered to a carrier by the post office.		The letter is delivered from the carrier to the post office.

The parcel is carried from the source to the destination.

Protocol Analogy: Organization of Air Travel

Ticket (purchase)   Ticket (complain)

Baggage (check)   Baggage (claim)

Gates (load)   Gates (unload)

Runway Takeoff   Runway Landing
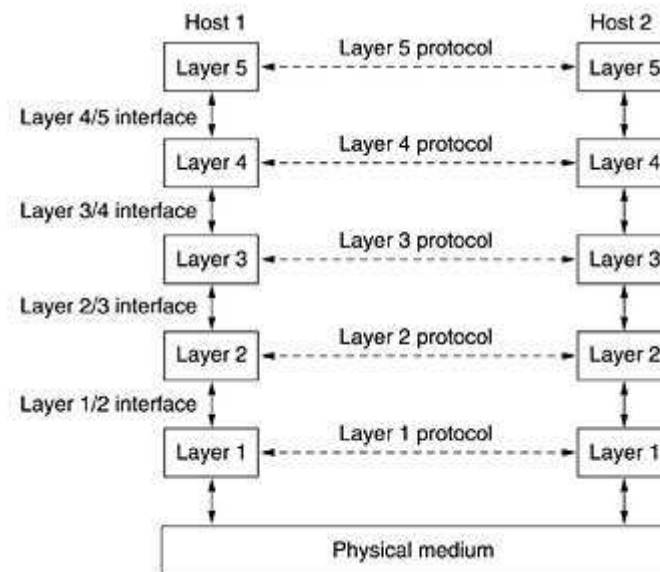
Airplane Routing   Airplane Routing

Airplane routing

Network Software : Protocol Hierarchies

- Stack of Layers => Protocol Stack OR Protocol Suite.
- Each Layer Provides Service to Layer Above It.

- No Direct Data Transfers from layer n on one Machine to Other.
- Through Physical Medium actual Communication Occurs.

Network Software : Design Issues of Layers

- Addressing
- Segmentation and Reassembly
- Encapsulation
- Connection Control
    - Connection Oriented Service
    - Connectionless Service

- Flow Control
- Error Control
- Multiplexing and Demultiplexing
- Routing

Network Software : Relationships of Services to Protocols

- Service is a set of Primitives (Operations) that a Layer Provides.

- *Layer K* Provides Service to *Layer K+1*.

- *Layer K* is the Service Provider.

- *Layer K+1* is the Service Taker.

- A Service is a Type of Abstract Data Type in OOP.

- ADT Defines Operations but Not How They are Implemented.

Why Layering ??

- To Separate Specific Functions in Each Layer.

- Each Layer Should Define a Unique Function.

- To make their Implementation Transparent to Other Components.

- Allows Independent Design and Testing of Each Components.

- Modularization Eases Maintenance and Updating of System.

OSI Model

- Open System Interconnection

- Developed by International Organization for Standardization.

- It Consists of Seven Layers.

- Considered as a Reference Model.

- A Theoretical System Delivered Too Late.

The OSI Reference Model
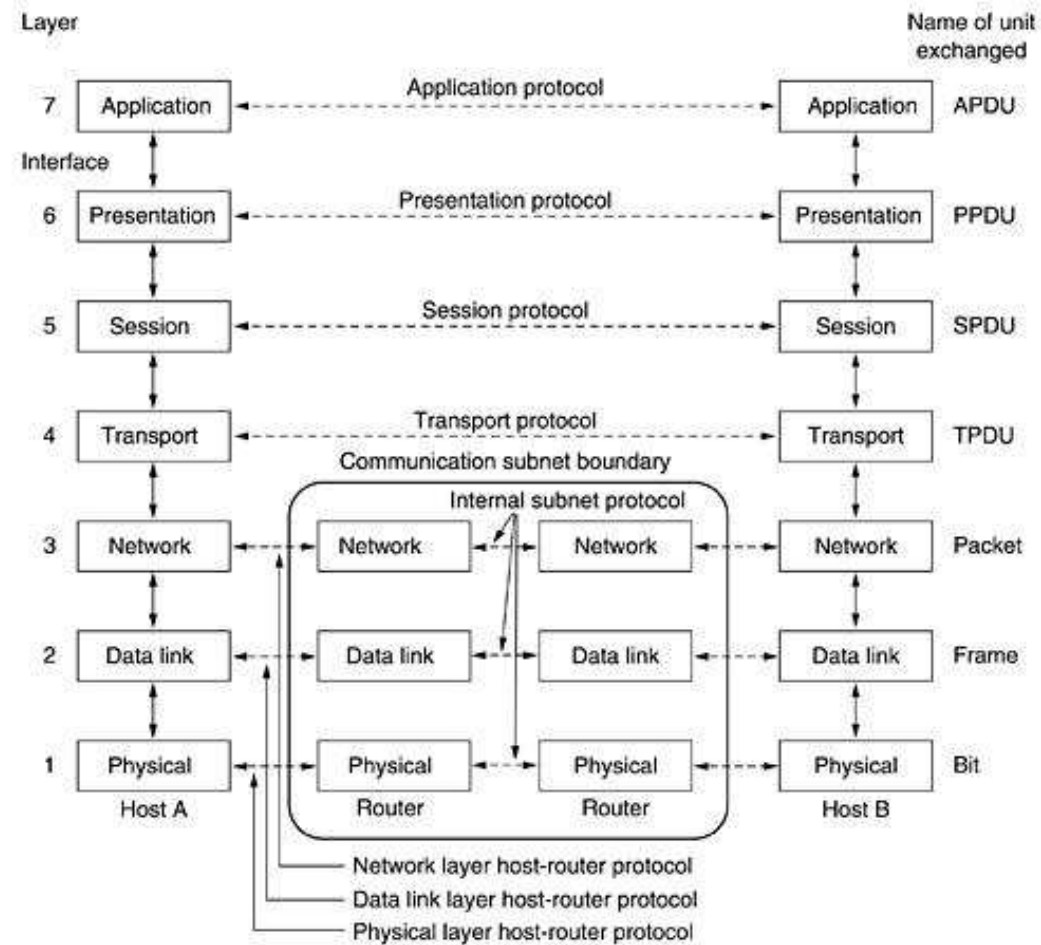
The OSI Environment
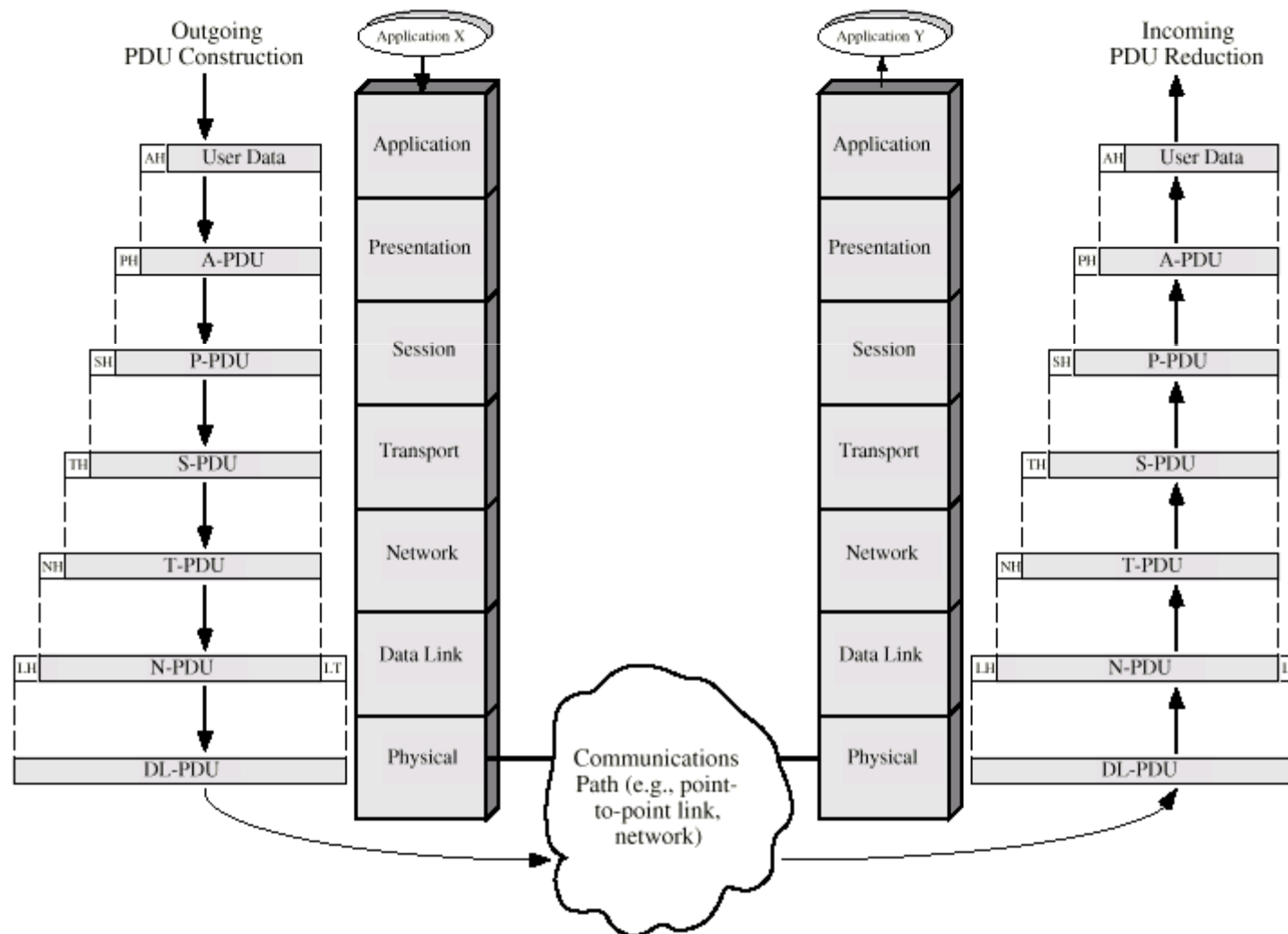
OSI Layers : Functions

Physical Layer

- Responsible for Transmitting Individual Bits.
- Deals with Physical Characteristics of Interfaces and Medias.
  [Electrical and Mechanical]

Data Link Layer

- Enables Node to Node Communication.
- Responsible for Transmitting Frames From One Node to Next.
- Framing
- Physical Addressing
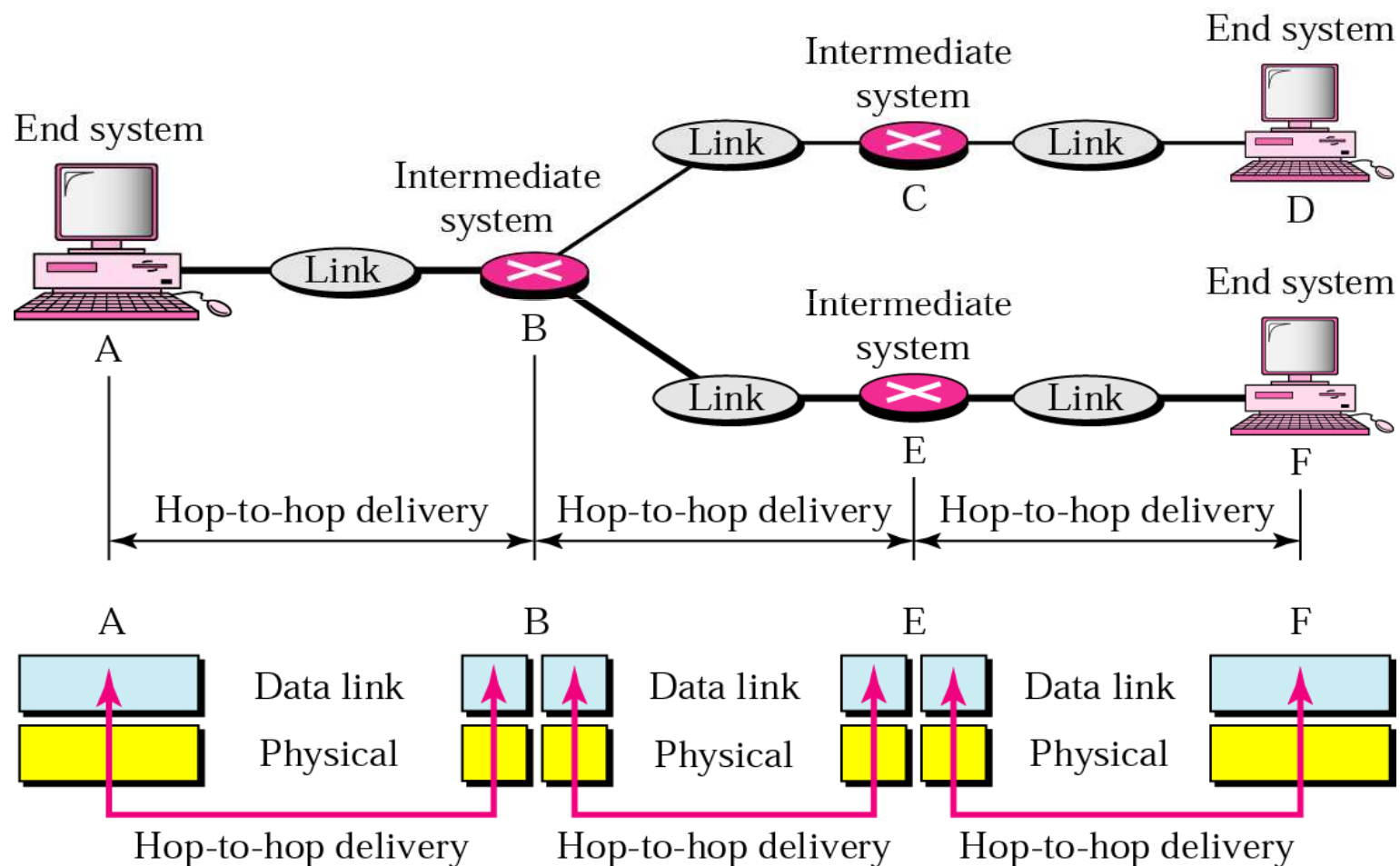- Error Control
- Access Control [E.g CSMA/CD]

OSI Layers : Physical Layer

From data link layer

To data link layer

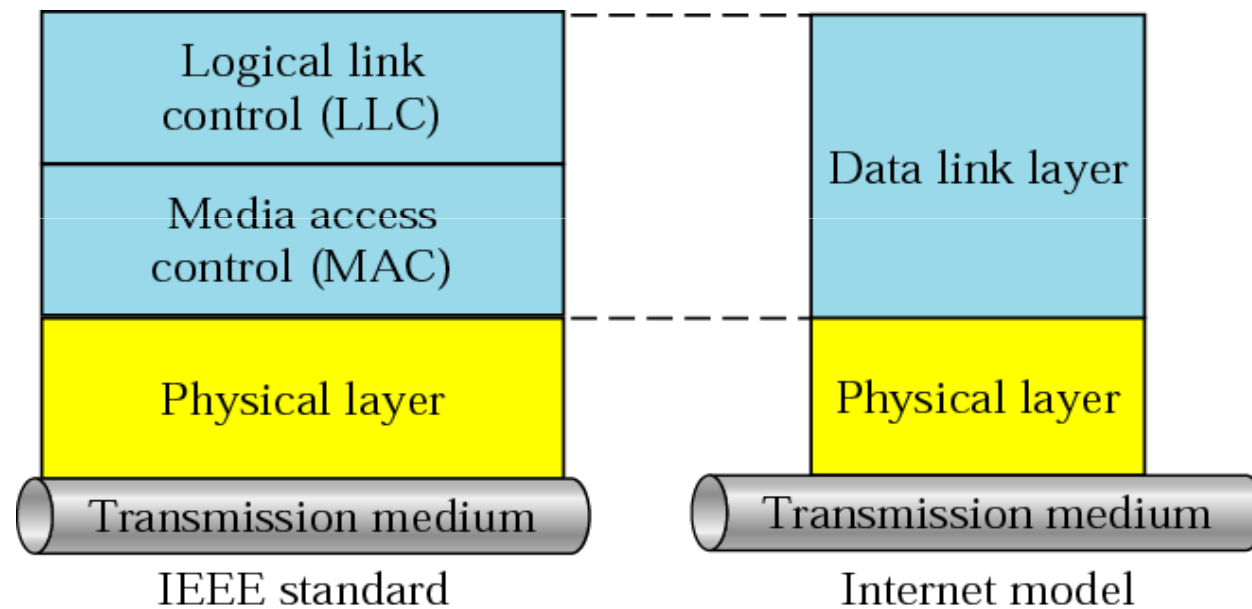1010100000010111001

1010100000010111001

Physical
layer

Physical
layer

Transmission medium
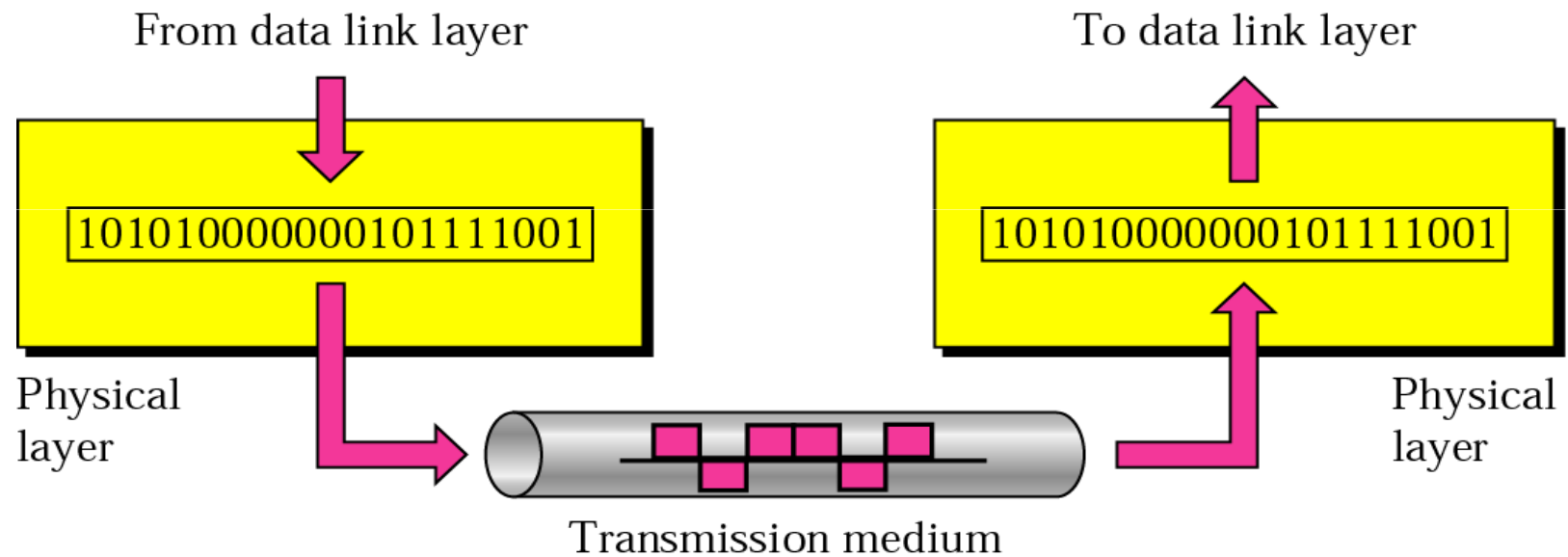
Data Link Layer : Node to Node Delivery

Data Link Sub Layers : LLC and MAC

Logical link control (LLC)

Media access control (MAC)

Physical layer

Transmission medium

IEEE standard

Data link layer

Physical layer

Transmission medium

Internet model

OSI Layers : Functions

Network Layer

- Enables Host to Host Communication
- Responsible for Delivery of Packets
- Logical Addressing
- Routing

Transport Layer

- Enables Process to Process Communication.
- Port Addressing
- Segmentation and Reassembly.
- Connection Control
- Flow Control
- Error Control

Network Layer : End to End Delivery
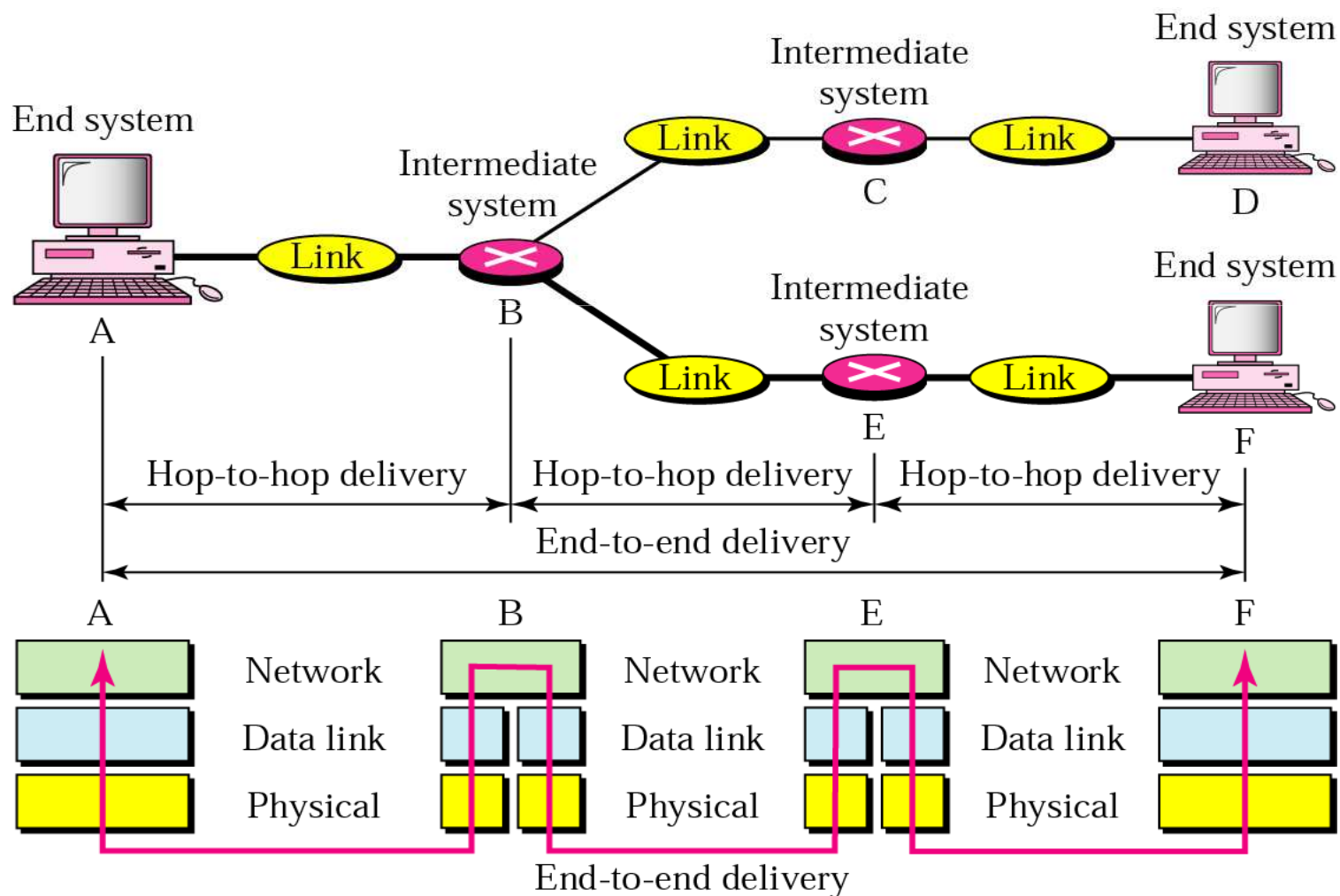
Transport Layer : Process to Process Delivery

Message

Message

An internetwork

Network Layer
Host-to-host delivery

Transport Layer
Process-to-process reliable delivery
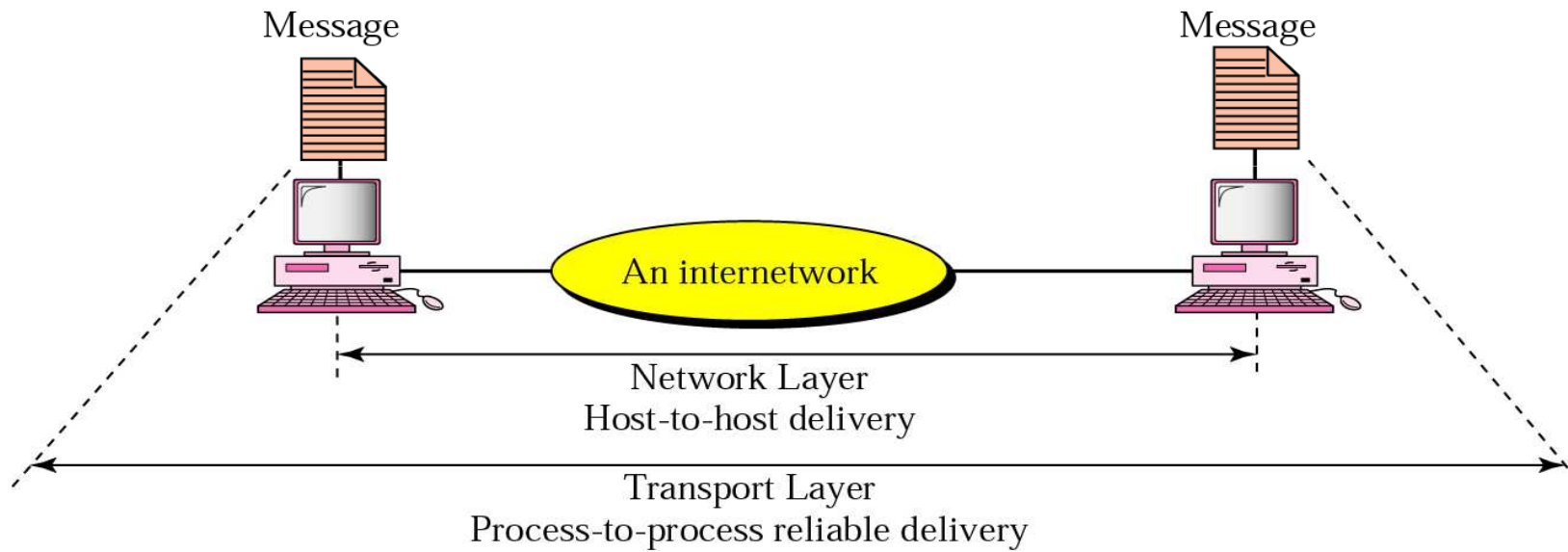
OSI Layers : Functions

Session Layer

- Control of Dialogues Between Applications.
- Whose Turn is To Transmit ??
- Dialogue Discipline => Half Duplex/ Full Duplex

Presentation Layer

- Data Formats and Coding.
- Data Compression
- Encryption

Application Layer

- Responsible for Providing Service to End Users.
- Mail Transfer Service.
- File Transfer Service.

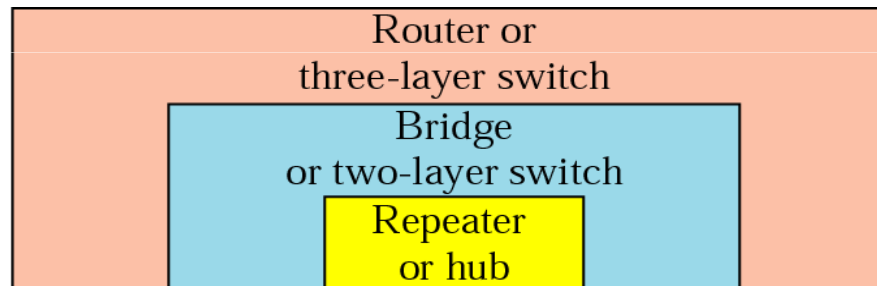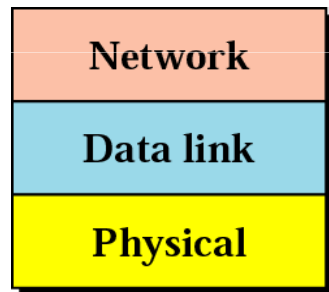# OSI Model Compared to TCP/IP

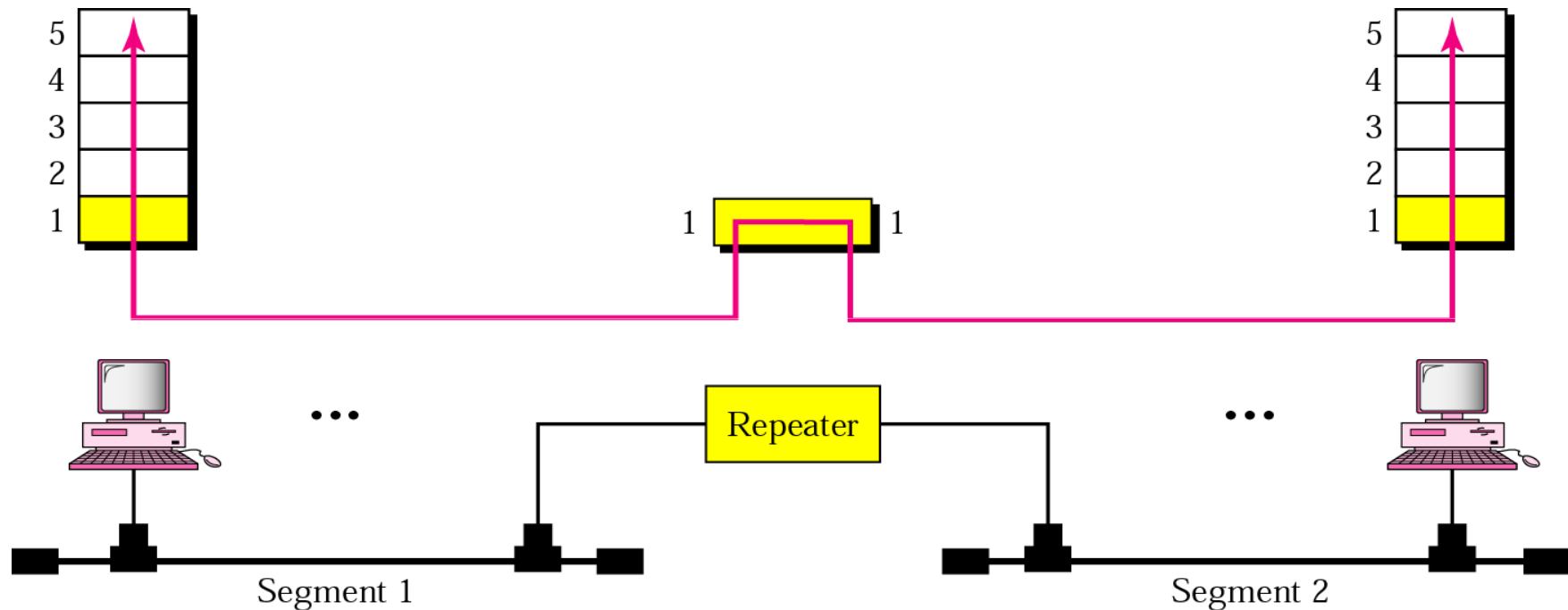| OSI model	TCP/IP
Application	Telnet FTP DHCP TFTP
Presentation	HTTP SMTP DNS SNMP
Session	Application layer
Transport	TCP UDP Transport layer
Network	ICMP ARP IP Internet layer
Data Link	Network interface layer
Physical	

Networking Hardware : Hub and Repeaters

Network
Data link
Physical

Router or three-layer switch		
	Bridge or two-layer switch	
	Repeater or hub	

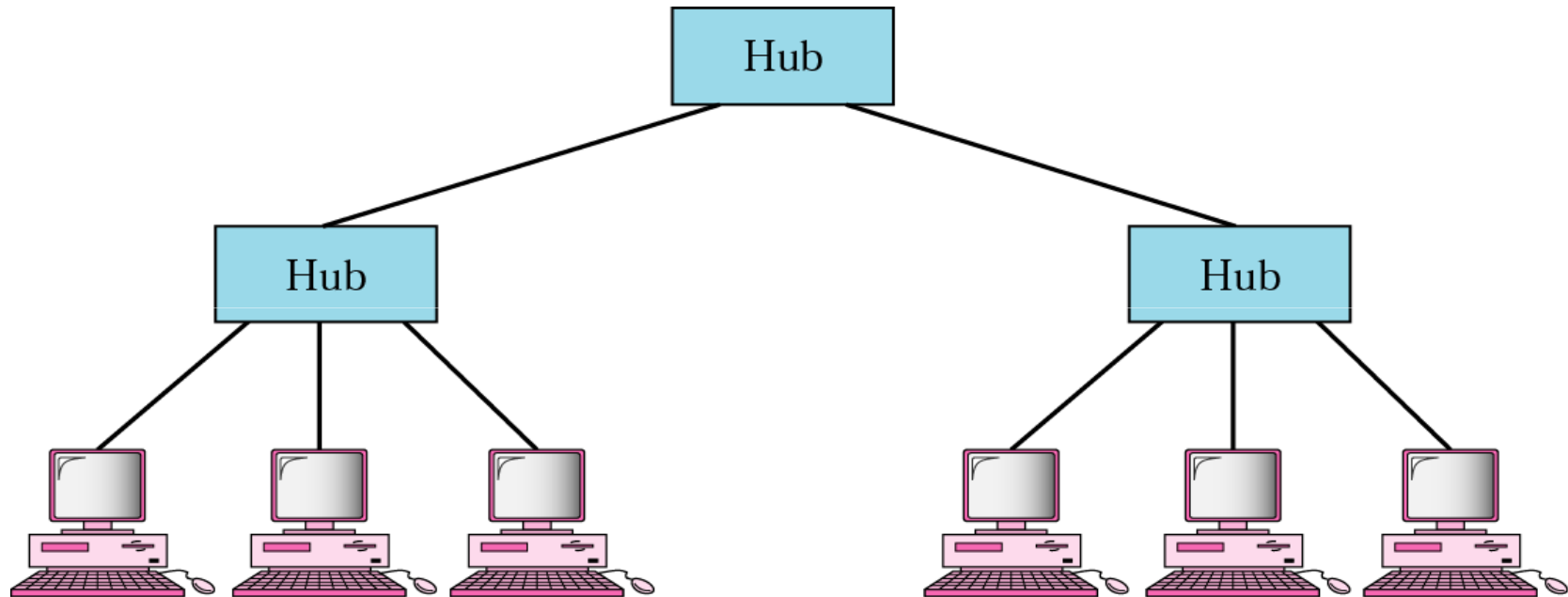| Network |
|---|
| Data link |
| Physical |
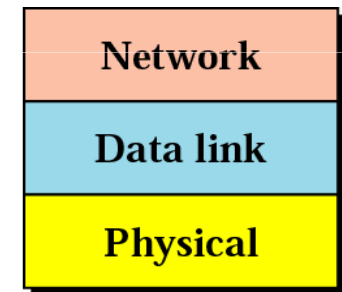
Physical Layer Devices : Repeaters

❑ Repeater Forwards Each Frame.

❑ It has No Filtering Capability

❑ Repeater is a Regenerator NOT an Amplifier.

Physical Layer Devices : Hubs

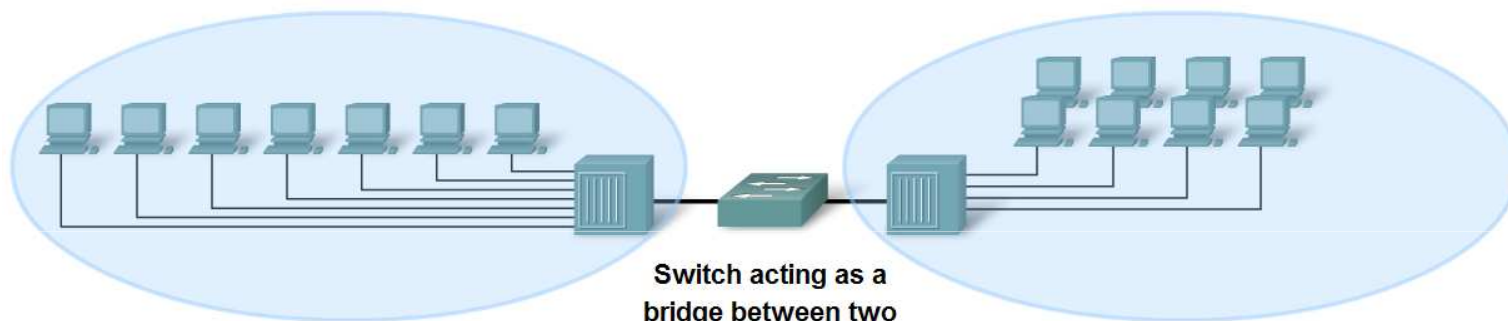❑ Physical Topology => Star

❑ Logical Topology => Bus

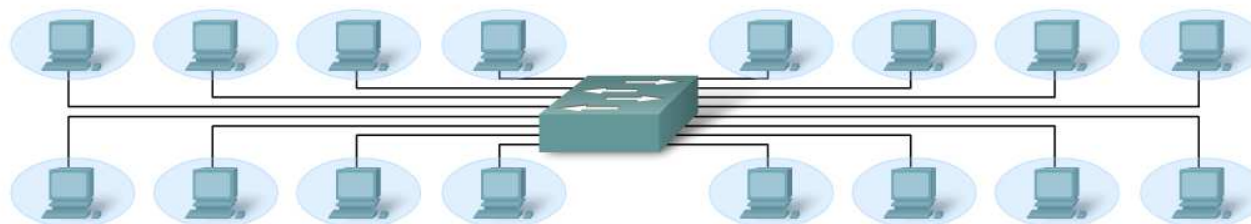❑ Extends Collision Domain.

Link Layer Devices : Switch

Switch Uses

Switch acting as a
bridge between two
shared-media hubs

Two collision domains—one for
each shared media LAN.

Switch at the
center of a LAN

Each computer has its own
collision domain.

Thank You