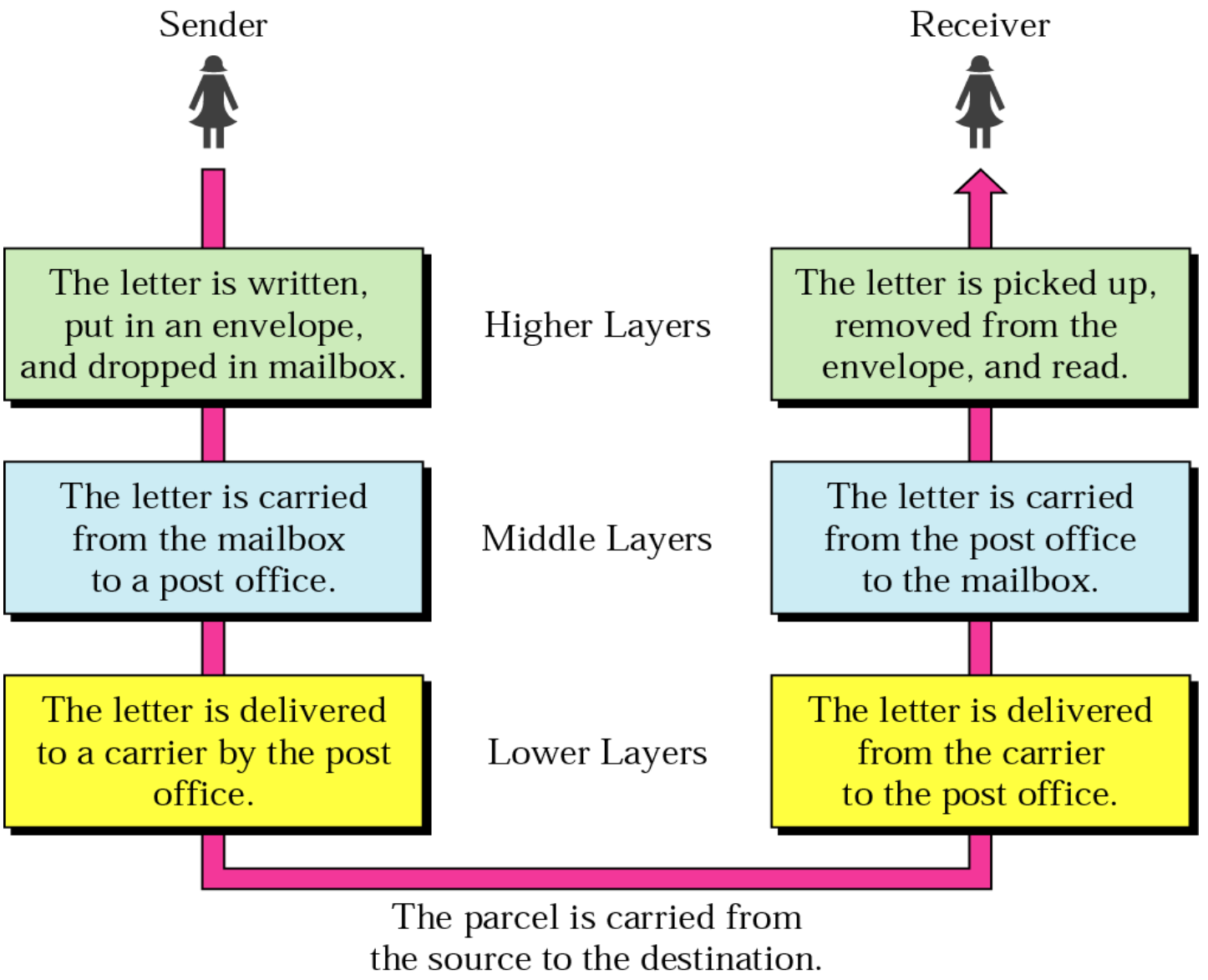
Computer Network

Chapter 2: Reference Models

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.

Protocol Analogy: Sending a Letter



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

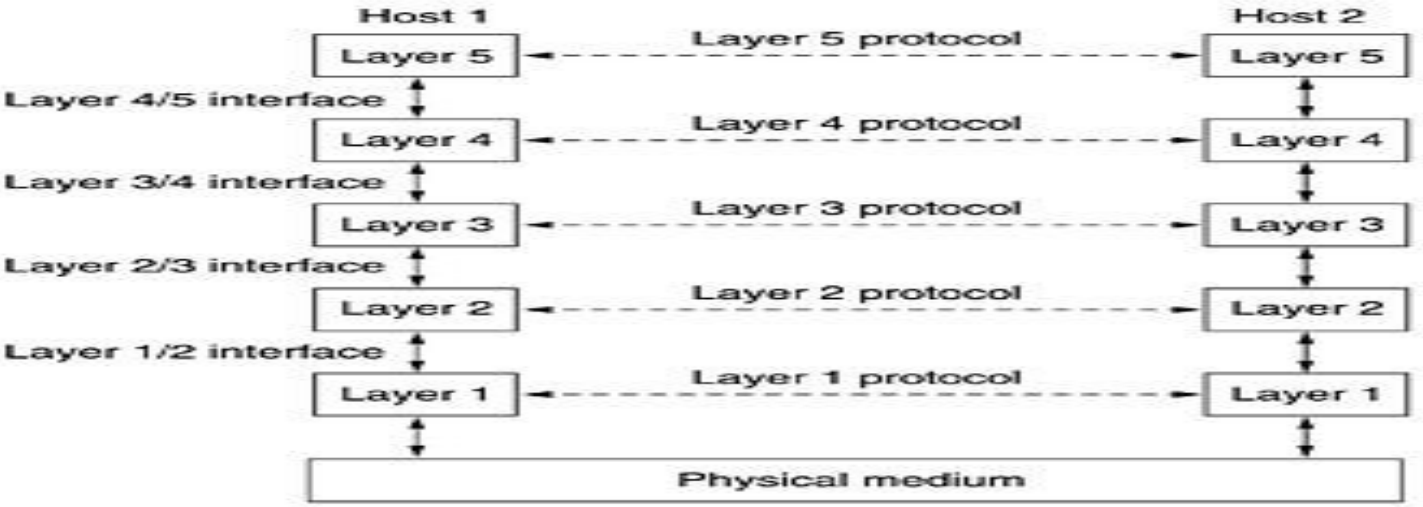
Airplane routing

Interfaces and Services

- There is an **interface** between each pair of adjacent layers.
- This interface defines what information and services a layer must provide for the layer above it.
- Interface will pass the Information between the Layers

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 De-multiplexing
- 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.

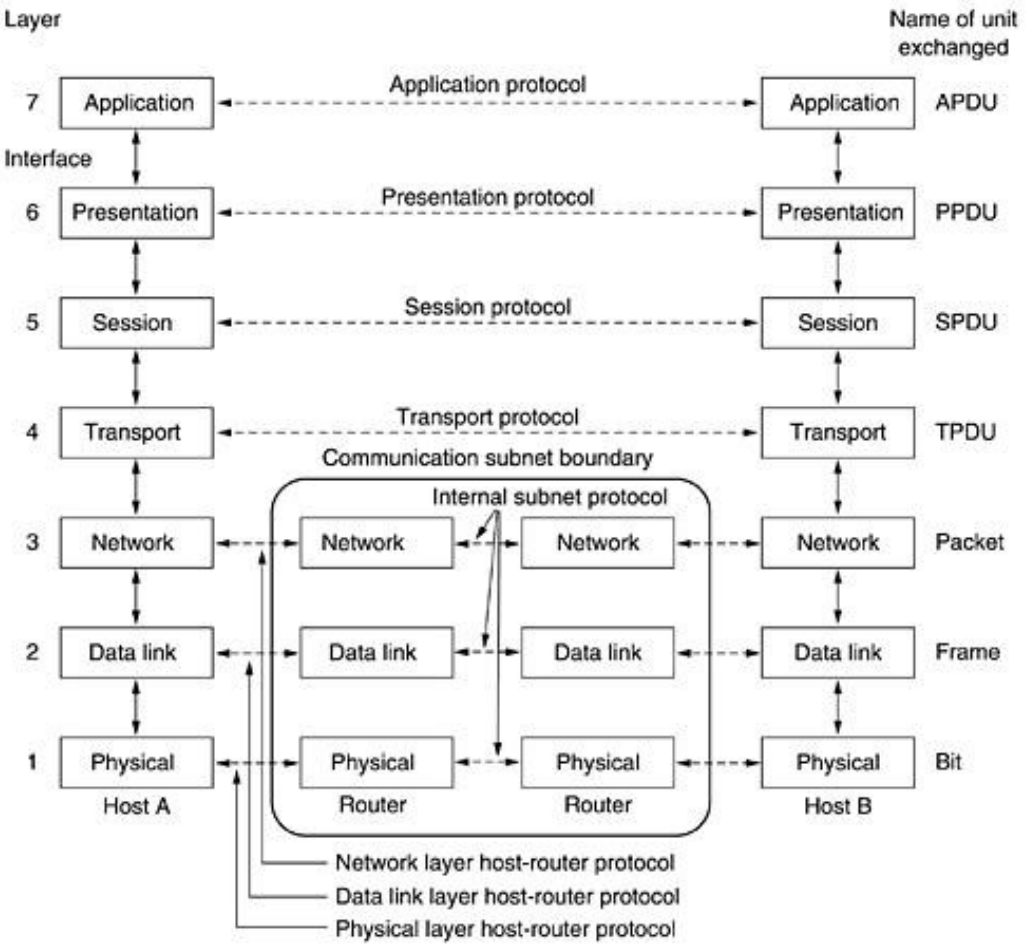
Why Layering ??

- 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.

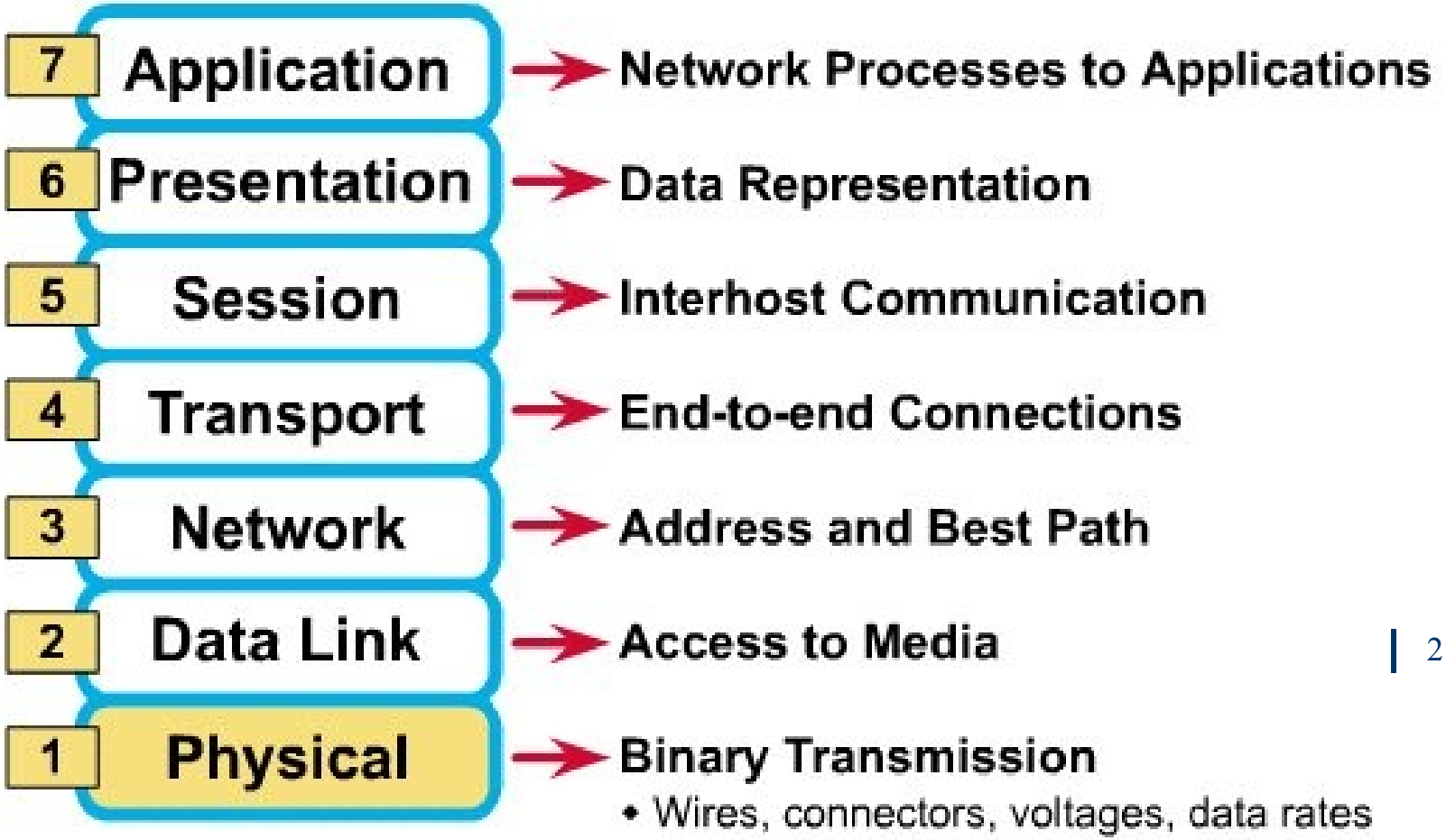
OSI Model

- 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



What Each Layer Does



OSI Layers

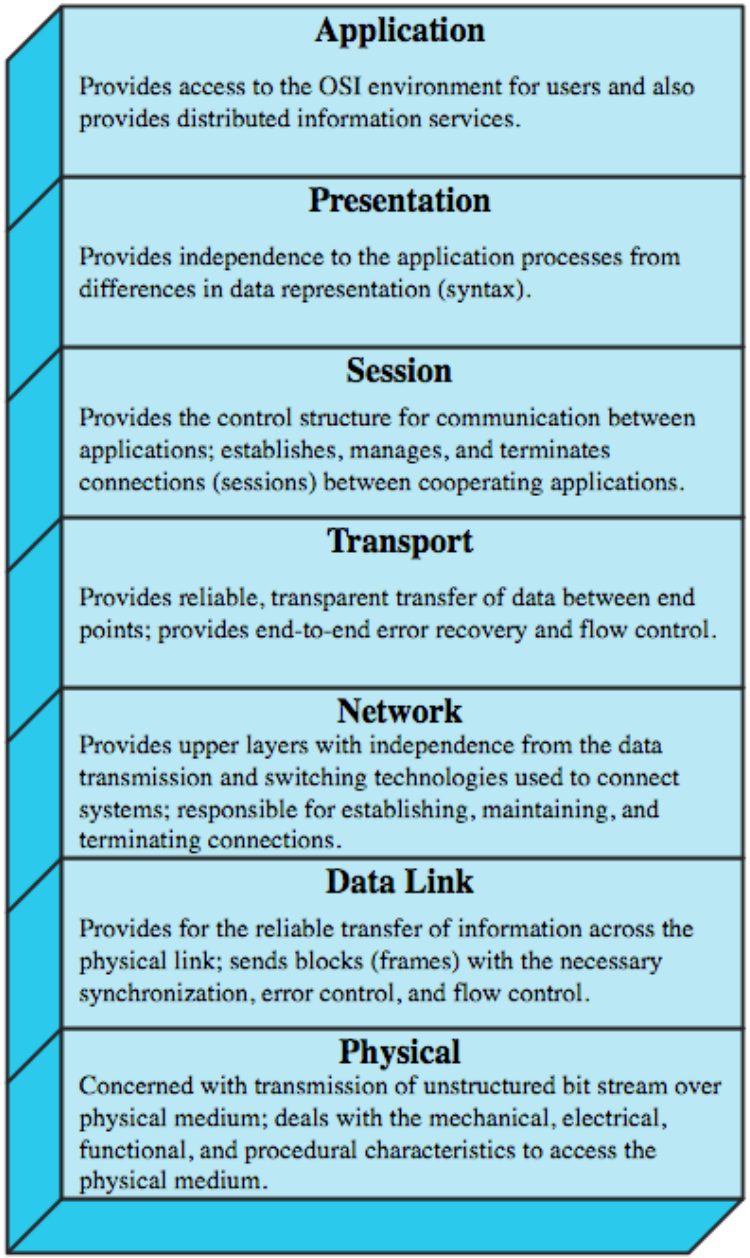
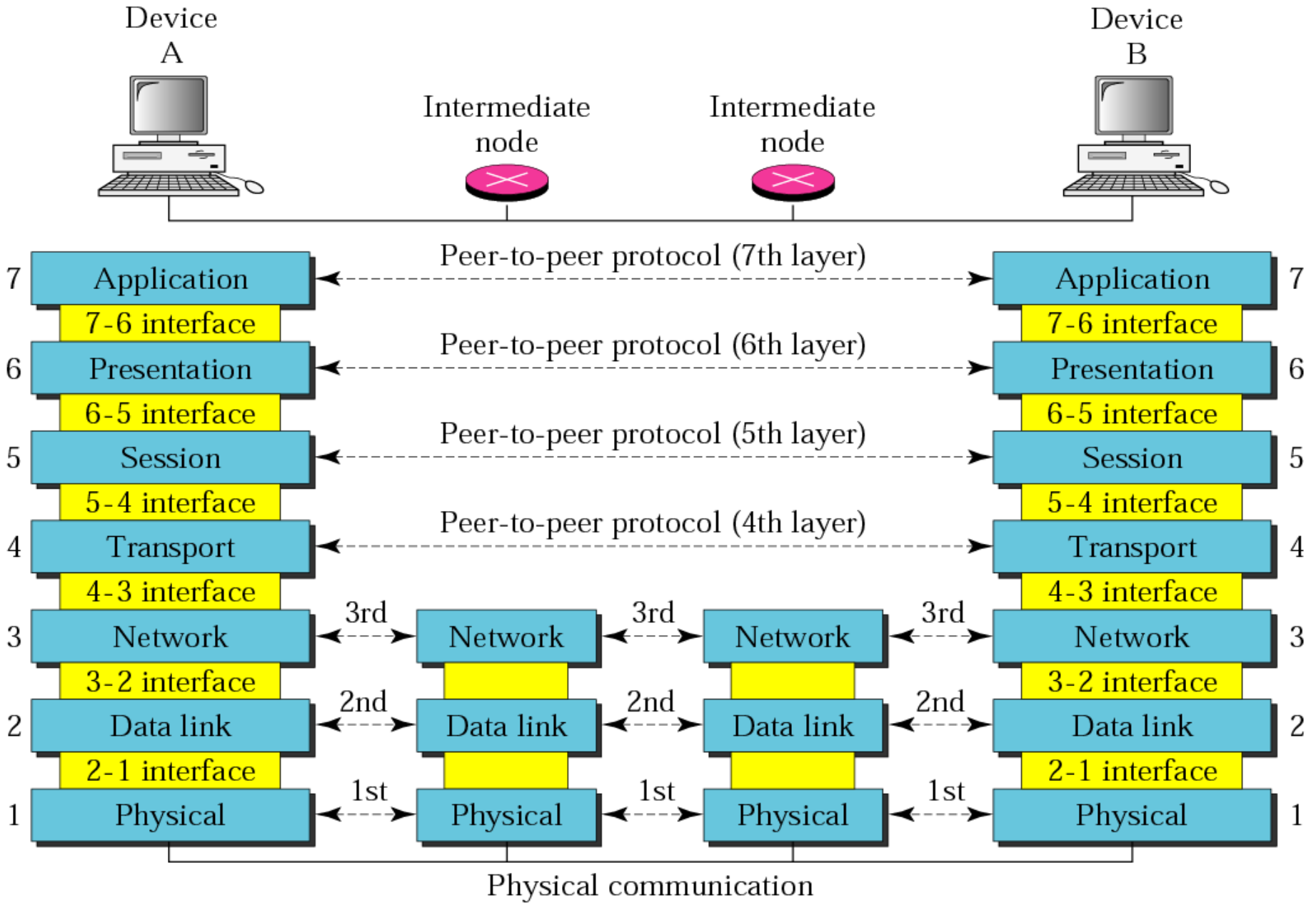


Figure 2.6 The OSI Layers

OSI layers


Device A
Device B
Intermediate node
Intermediate node
Peer-to-peer protocol (7th layer)
Peer-to-peer protocol (6th layer)
Peer-to-peer protocol (5th layer)
Peer-to-peer protocol (4th layer)
7 Application
7-6 interface
6 Presentation
6-5 interface
5 Session
5-4 interface
4 Transport
4-3 interface
3 Network
3-2 interface
2 Data link
2-1 interface
1 Physical
3rd
2nd
1st
Physical communication

OSI Layers : Functions

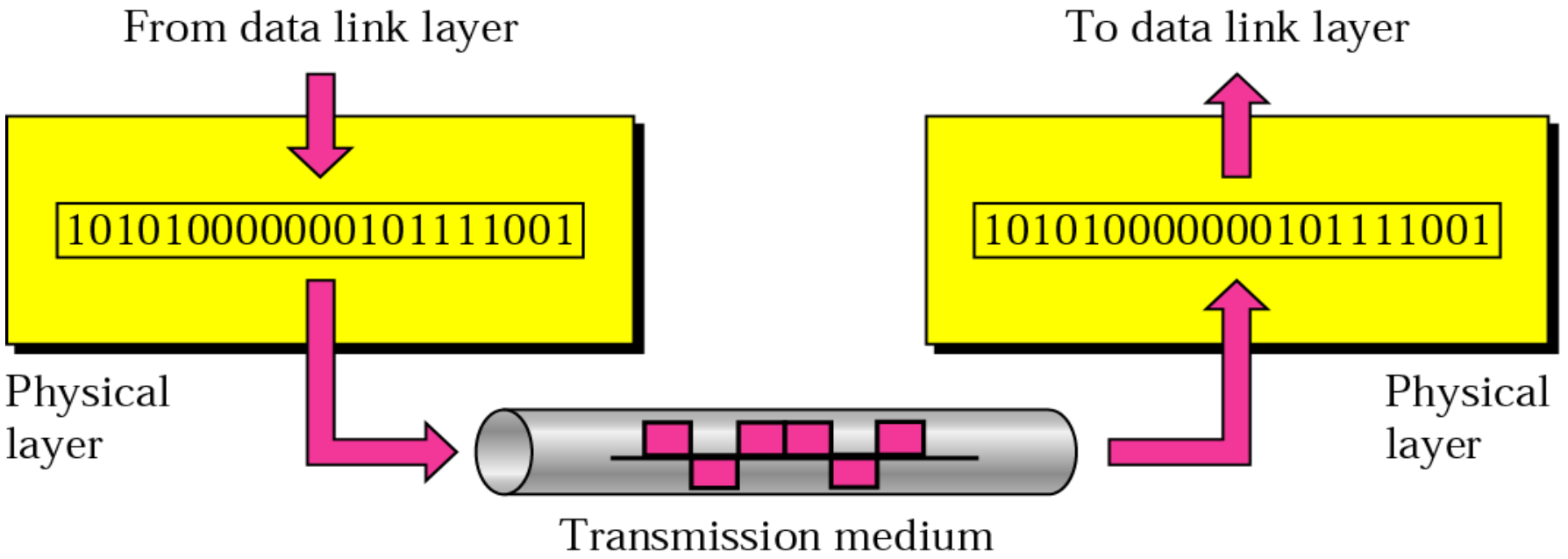
Physical Layer

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

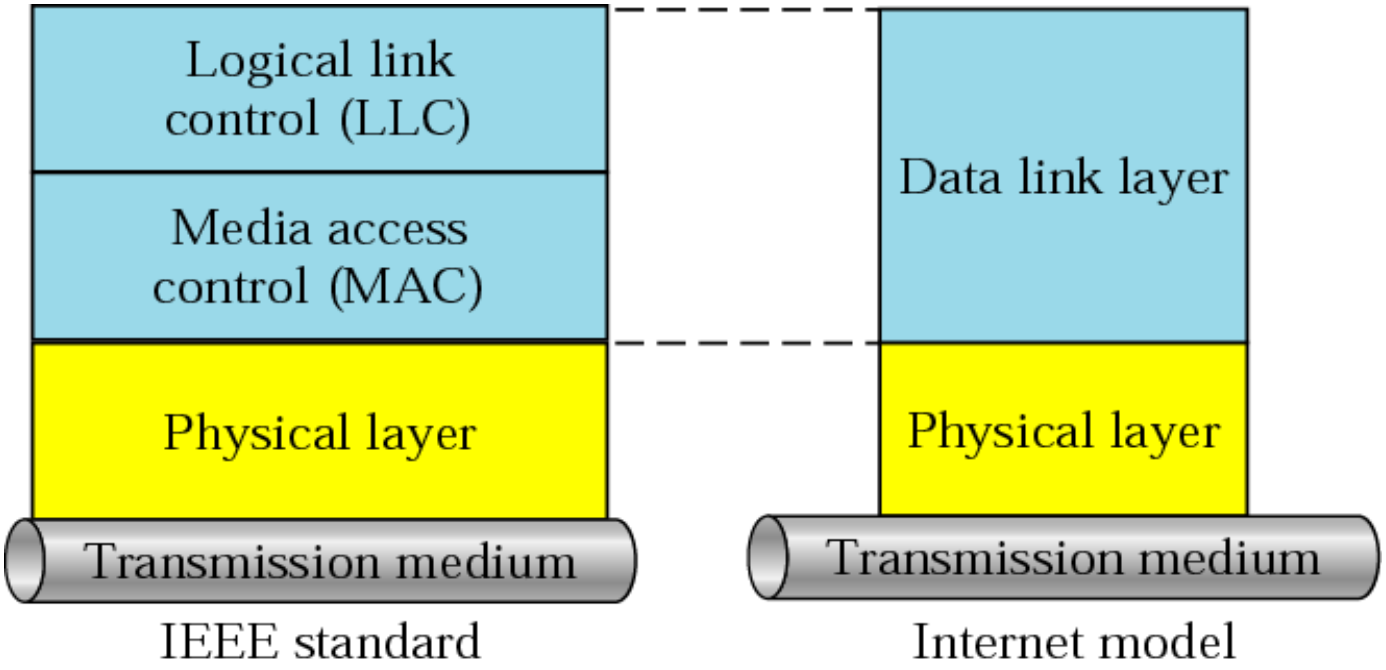
Data Link Layer

- 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]

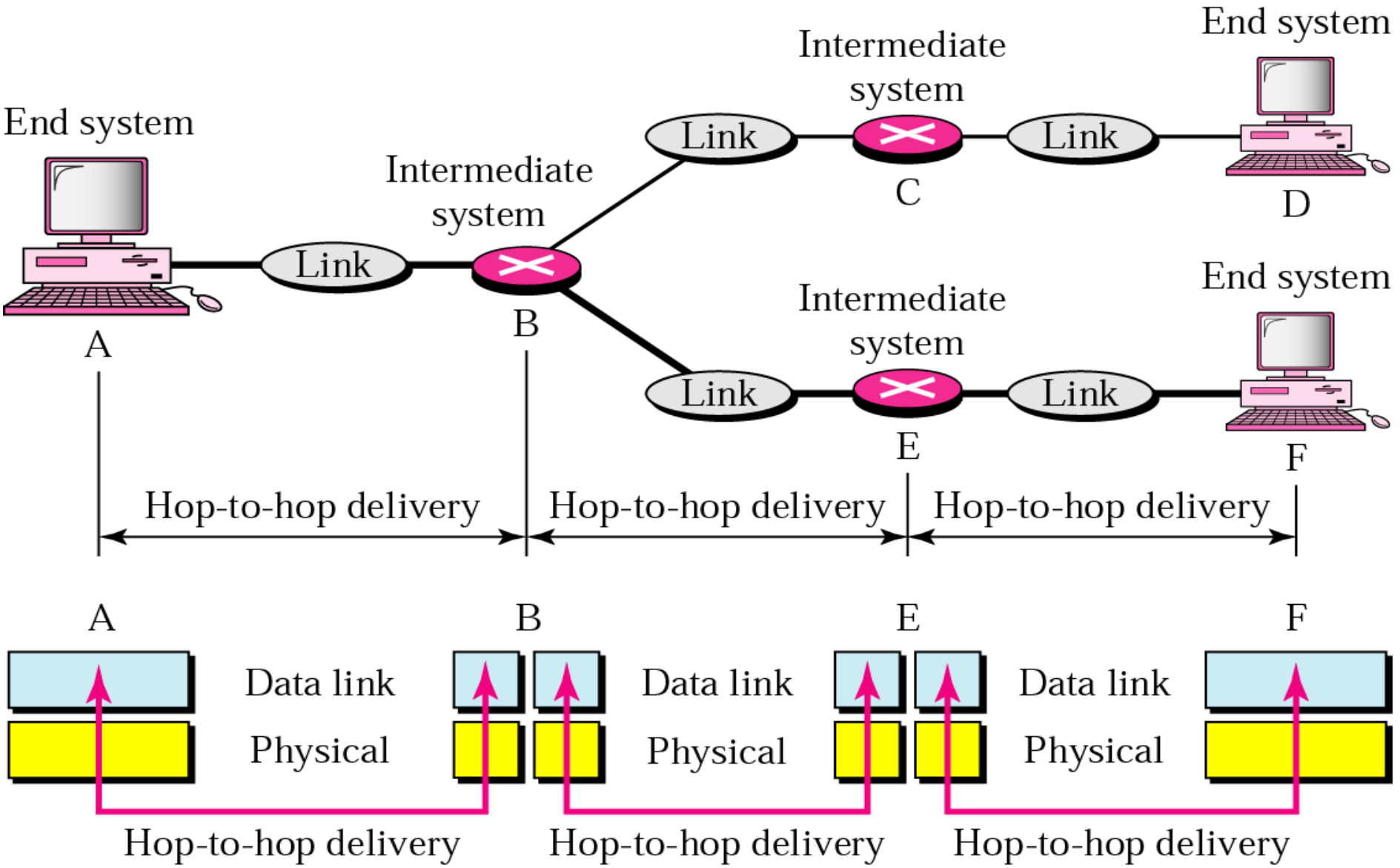
OSI Layers : Physical Layer



Data Link Sub Layers : LLC and MAC



Data Link Layer: Node to Node Delivery



Sub-layers of the Data Link Layer

- MAC (Media Access Control)
  - Gives data to the NIC
  - Controls access to the media through
  - CSMA/CD Carrier Sense Multiple Access/Collision Detection
  - Token passing

- LLC (Logical Link Layer)
  - Can detect some transmission errors using a Cyclic Redundancy Check (CRC). If the packet is bad the LLC will request the sender to resend that particular packet.
  - Multiplexing protocols transmitted over the MAC layer
  - IEEE 802.2 Protocol

OSI Layers : Functions

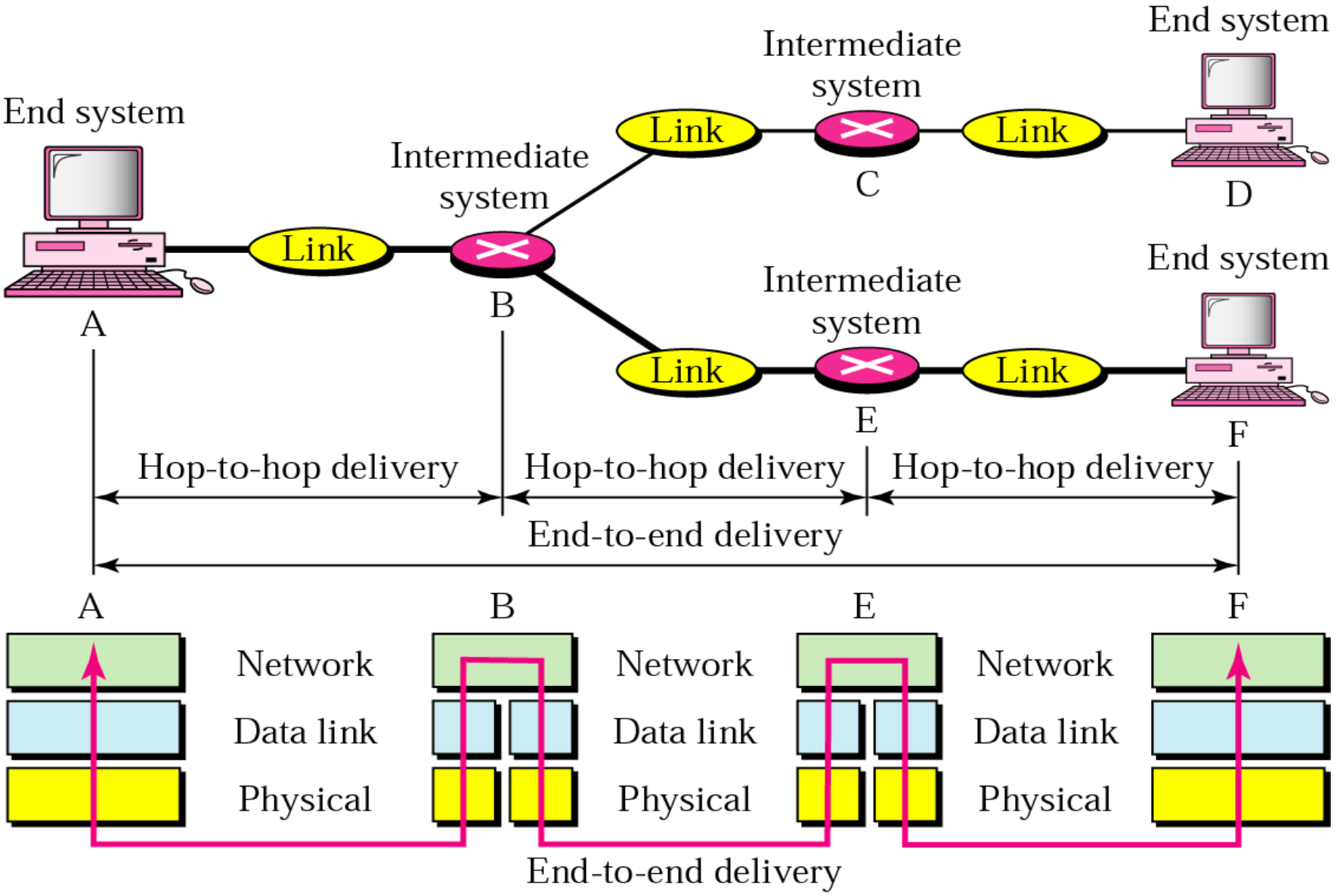
Network Layer

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

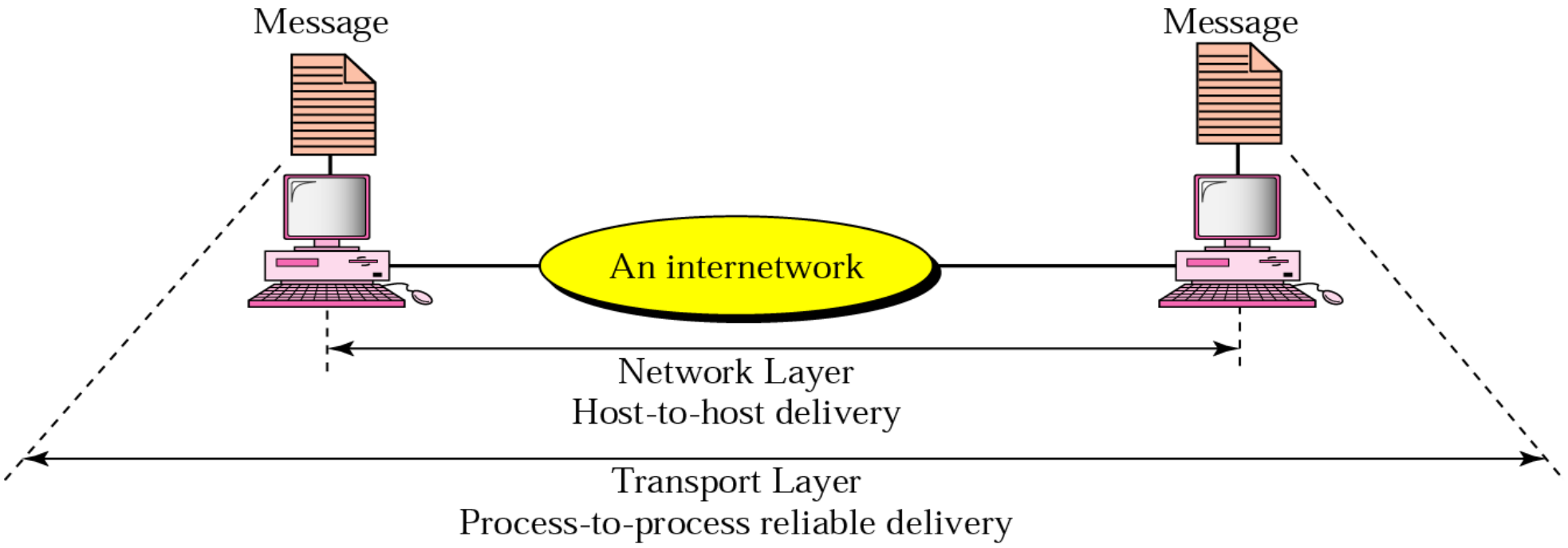
Transport Layer

- Enables Process to Process Communication.
- Port Addressing
  - Well Known Ports
  - Registered Ports (1024 – 49151)
  - Dynamic / Private Ports (49152 - 65535)
- Segmentation and Reassembly.
- Connection Control
- Flow Control
- Error Control

Network layer Communication



Transport Layer: Process to Process Delivery



OSI Layers : Functions

Session Layer

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

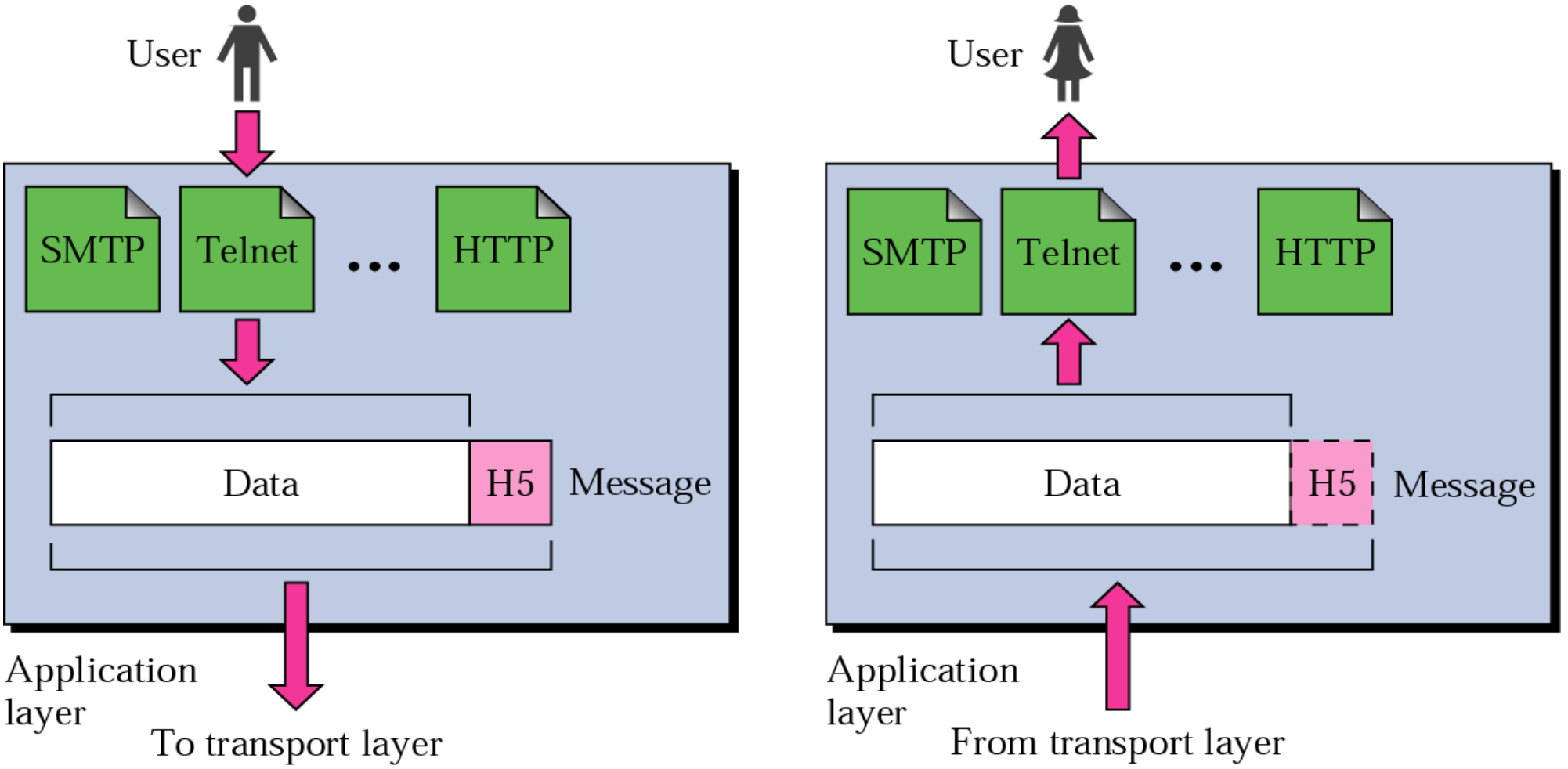
Presentation Layer

- Data Formats and Coding.
- Data Compression
- Encryption

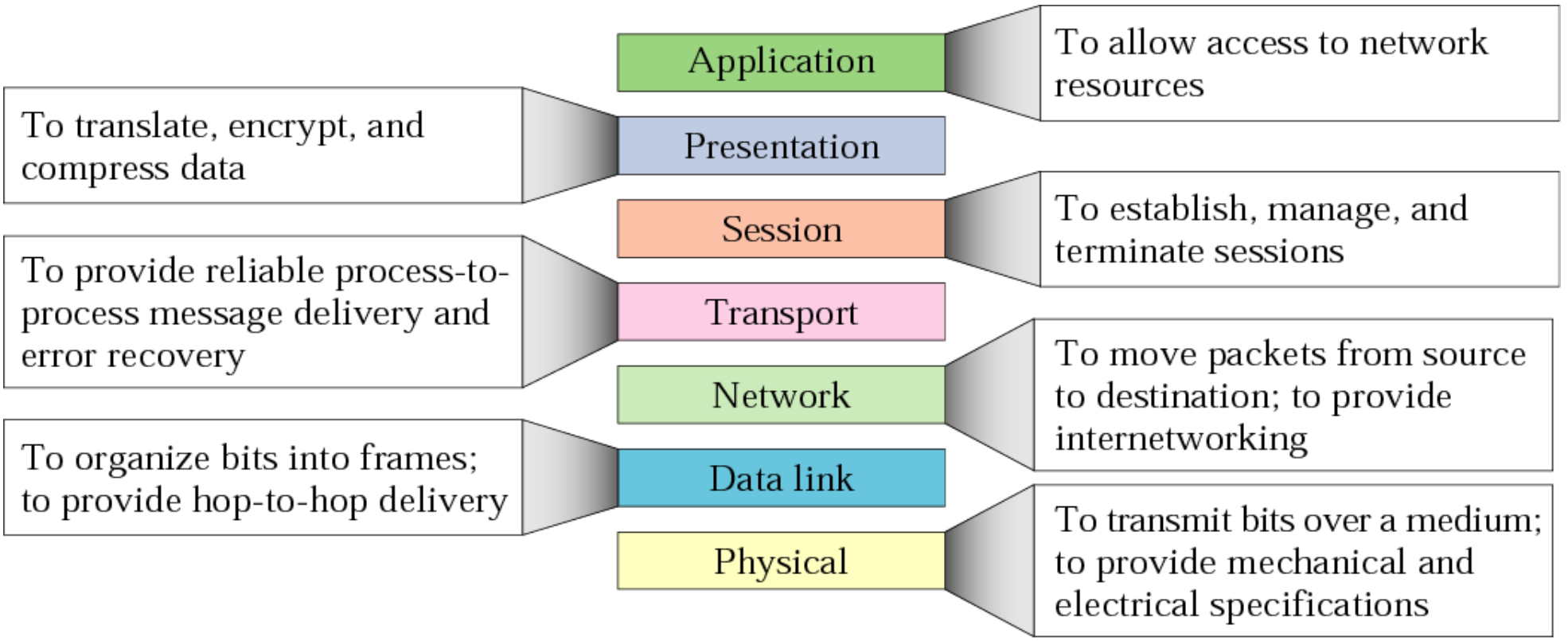
Application Layer

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

Application Layer



Summary of layers



TCP/IP model development

In late-60s The Defense Advance Research Projects Agency (DARPA) originally developed

Transmission Control Protocol/Internet Protocol (TCP/IP) to interconnect various defense department computer networks.

The Internet, an International Wide Area Network, uses TCP/IP to connect networks across the world.

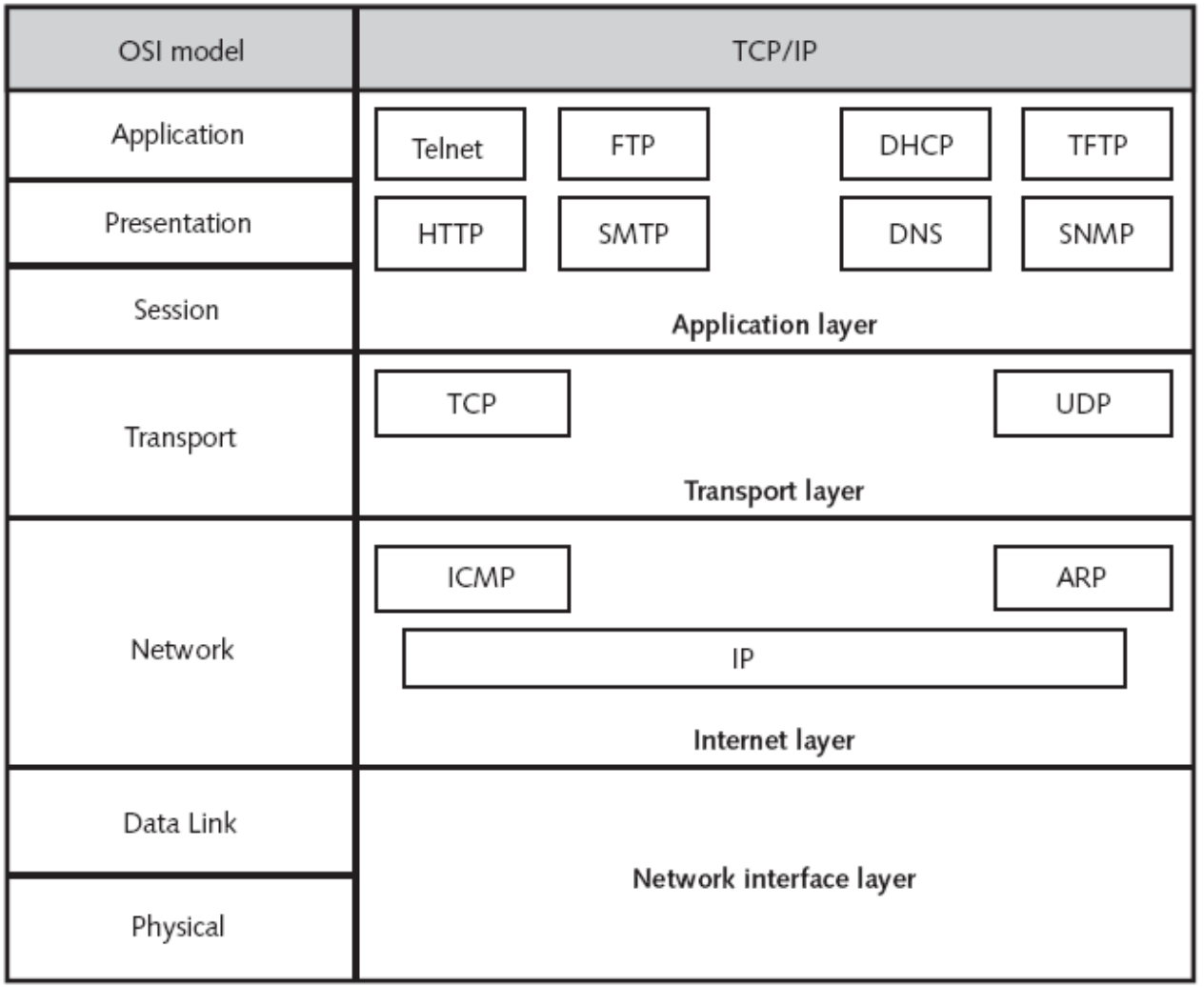
4 layers of the TCP/IP model

Layer 4: Application
Layer 3: Transport
Layer 2: Internet
Layer 1: Network access

It is important to note that some of the layers in the TCP/IP model have the same name as layers in the OSI model.

Do not confuse the layers of the two models.

OSI Model Compared to TCP/IP



The network access layer

- Concerned with all of the issues that an IP packet requires to actually make the physical link.
- All the details in the OSI physical and data link layers.
- Electrical, mechanical, procedural and functional specifications
- Data rate, Distances, Physical connector.
- Frames, physical addressing.
- Synchronization, flow control, error control.

The Internet Layer

- Concerned with Packet Addressing
- Send source packets from any network on the internetwork and have them arrive at the destination independent of the path and networks they took to get there.
- Functions Includes
  - Packets, Logical addressing.
  - Internet Protocol (IP).
  - Route , routing table, routing protocol.

The transport layer

- The transport layer deals with the quality-of-service issues of reliability, flow control, and error correction.
- Segments, data stream, datagram.
- Connection oriented and connectionless.
- Transmission control protocol (TCP).
- User datagram protocol (UDP).
- End-to-end flow control.
- Error detection and recovery.

Transport Layer (cont)

- Allows end-to-end communication
- Connection establishment, error control, flow control
- Two main protocols at this level

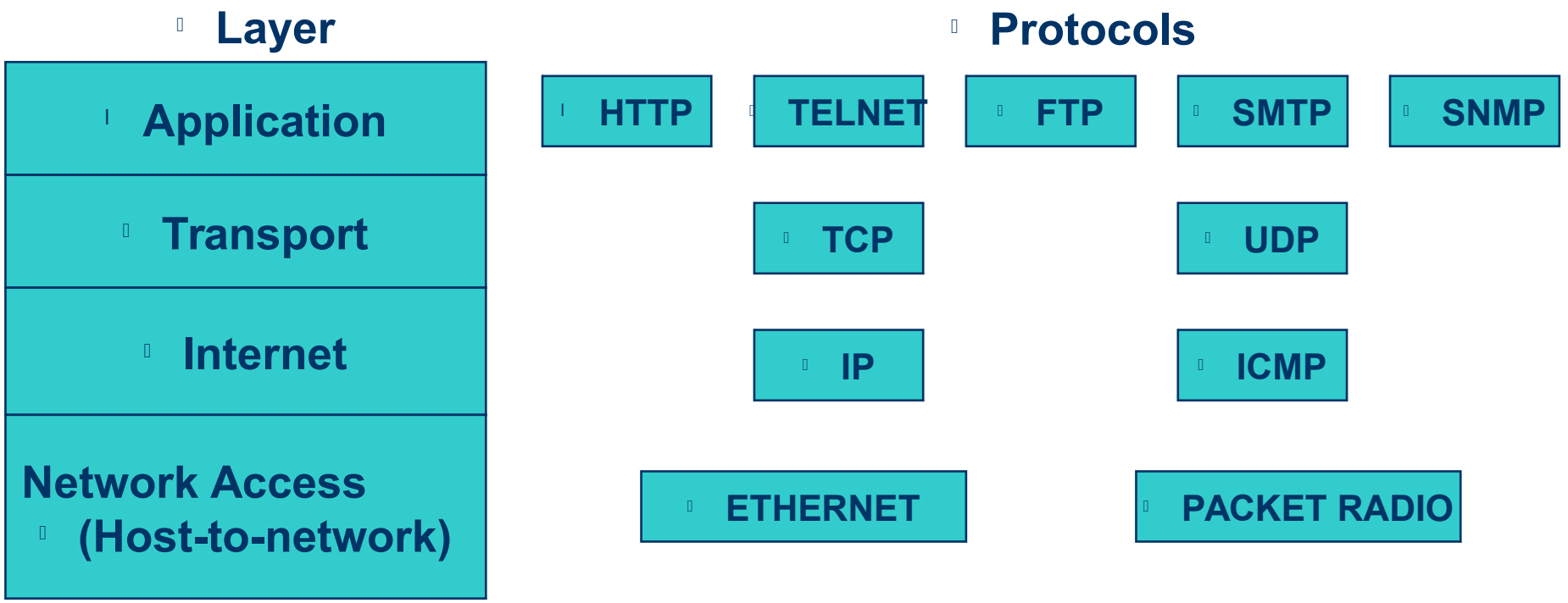
- Transmission control protocol (TCP)
  - Connection oriented
  - Connection established before sending data
  - Reliable

- User datagram protocol (UDP)
  - Connectionless
  - Sending data without establishing connection
  - Fast but unreliable

The application layer

- Handles high-level protocols, issues of representation, encoding, and dialog control.
- The TCP/IP combines all application-related issues into one layer, and assures this data is properly packaged for the next layer.
- Applications(Software) that works at Application Layer
  - FTP, HTTP, SMNP, DNS ...
  - Format of data, data structure, encode …
  - Dialog control, session management …

TCP/IP Reference Model



Protocols at the application layer

- HTTP:
  - Browser and web server Communication
- FTP :
  - file transfer protocol
- TELNET:
  - remote login protocol
- POP3: Retrieve email
  - POP3 is designed to delete mail on the server as soon as the user has downloaded it
- IMAP (Internet Message Access Protocol)
  - Retrieve emails,
  - retaining e-mail on the server and for organizing it in folders on the serve

Protocols at the transport layer

- Transmission control protocol (TCP)
  - Connection oriented
  - Connection established before sending data
  - Reliable
- user datagram protocol (UDP)
  - Connectionless
  - Sending data without establishing connection
  - Fast but unreliable

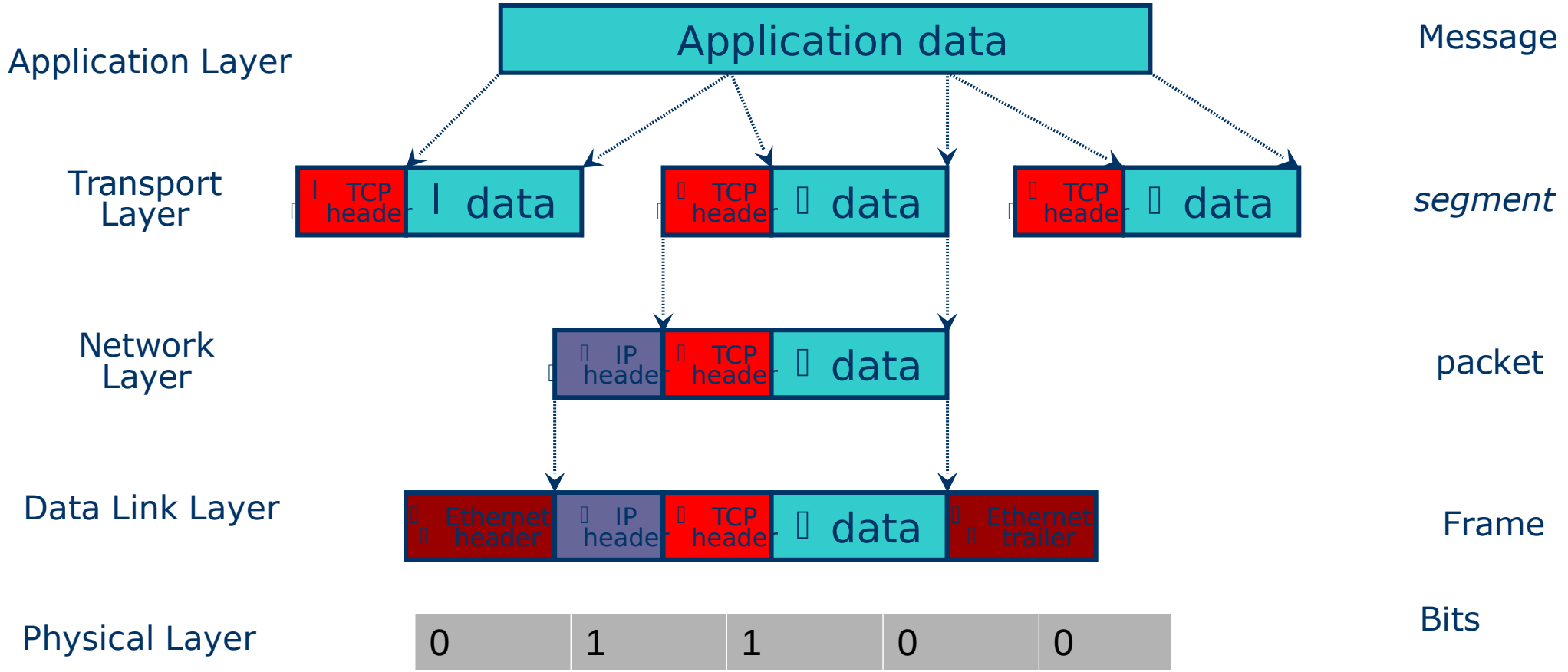
Protocol at the network layer

- IP (Internet Protocol)
  - Path selection
  - routing and addressing
- ICMP (Internet Control Message Protocol)
  - sends error messages relying on IP
  - IF requested service is not available
  - IF host or router could not be reached
- ARP (Address Resolution Protocol)
  - Map IP to Mac Address

Protocols at the link layer

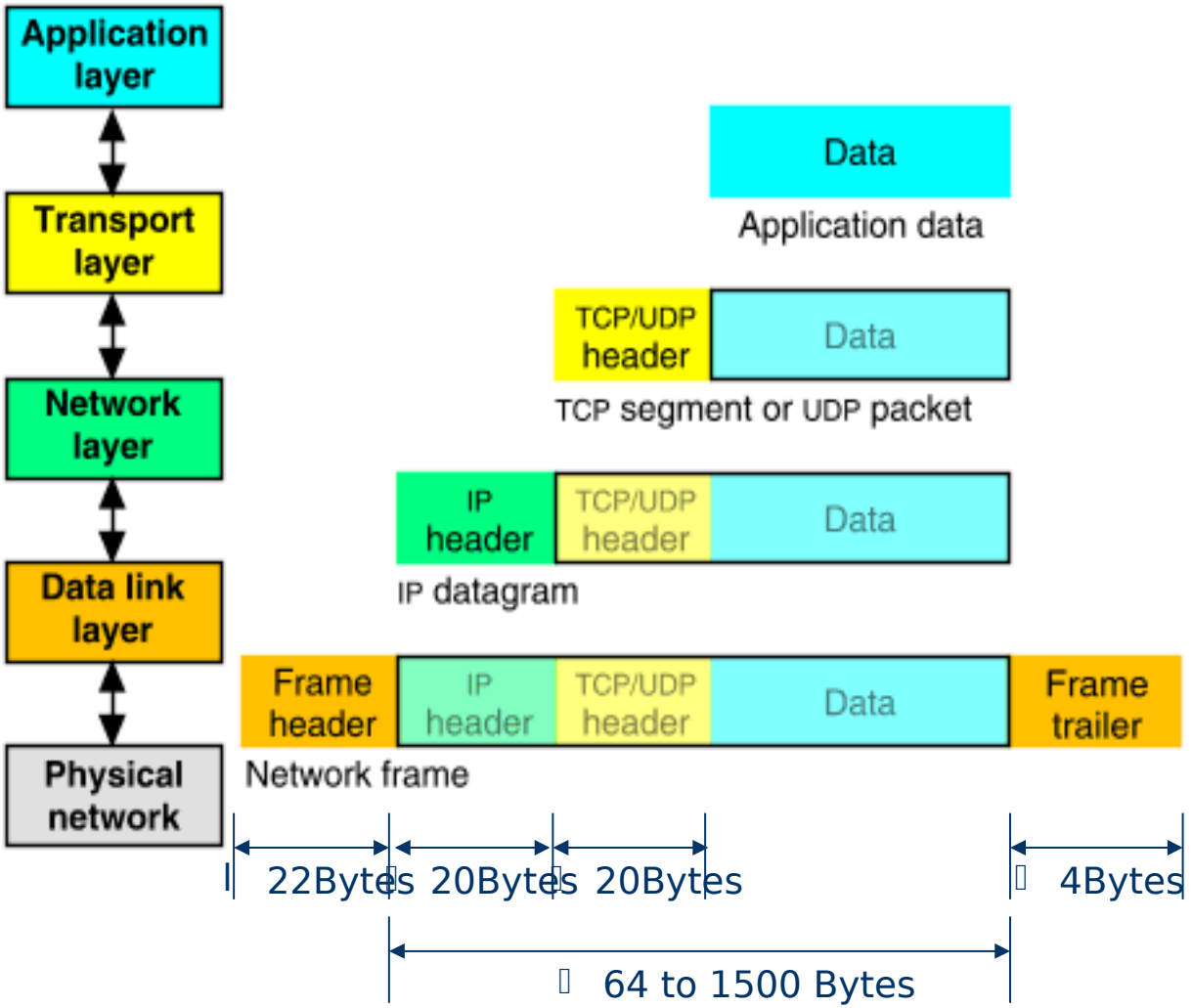
- Ethernet
  - Uses CSMA/CD
- Token Ring

PDU (Protocol Data Encapsulation) Method



Packet Encapsulation (TCP/IP)

- The data is sent down the protocol stack
- Each layer adds to the data by prepending headers



Networking Hardware

- NIC
- HUB
- Repeater
- Switches
- Bridge
- Router

NIC

- Network Interface Controller
  - Also called Network Interface Card
- Computer Hardware
  - Connect Computer to Computer Network
- WNIC for wireless Communication

HUB

- Also called An Ethernet hub, active hub, network hub, repeater hub, multiport repeater or hub
- Device which Connect multiple Ethernet devices together
  - making them act as a single network segment.
- Has multiple input/output (I/O) ports
- Also called Multi-port Repeater
- In which a signal introduced at the input of any port appears at the output of every port except the original incoming.
- A HUB works at the physical layer (layer 1) of the OSI model
- Hubs are now largely obsolete, having been replaced by network switches except in very old installations or specialized applications.

All PCS are Communicating with HUB in Half DUPLEX MODE

parar

Repeater

- Electronic Device, that receives signal and Retransmit it at a higher level or higher power
  - So, signal can Cover the Large distance
- A broadcast relay station performs an analogous role in broadcast radio and television.

- Repeater Can be defined as:
  - Analog device that amplifies an input signal regardless of its nature (analog or digital).

- A digital device that amplifies, reshapes, retimes, or performs a combination of any of these functions on a digital input signal for retransmission.
- A repeater that includes the retiming (synchronization) function is also known as a regenerator
- Works at Layer 1 of OSI model

Switches

- switch will only forward a message to one or multiple devices that need to receive
- Doesn't broadcast message to all ports
- Network switch is a multi-port network bridge
- Works data link layer (layer 2) of the OSI model
- Filter and Process Frames

Router

- Layer 3 Devices
- Network Layer in OSI and Internet layer in TCP/IP protocol stack
- Main Function
  - Routing of Packets (Based on Routing Table)
  - Path Selection(Best Path) to forward the packets
  - Internetwork Communications

Bridge

- Bridge is the Layer 2 Devices
- Process frames
- Switch can often called as multi port Bridge
- Bridge process Frames using software
  - Switches used ASIC chips to process the frames
  - ASIC: Application Specific Integrated Chips

Bridge operate slower than Switch

Thank You