

# Why a layered model?

- Easier to teach communication process.
- Speeds development, changes in one layer does not affect how the other levels works.
- Standardization across manufactures.
- Allows different hardware and software to work together
- Reduces complexity

# The OSI Reference Model

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**OSI**

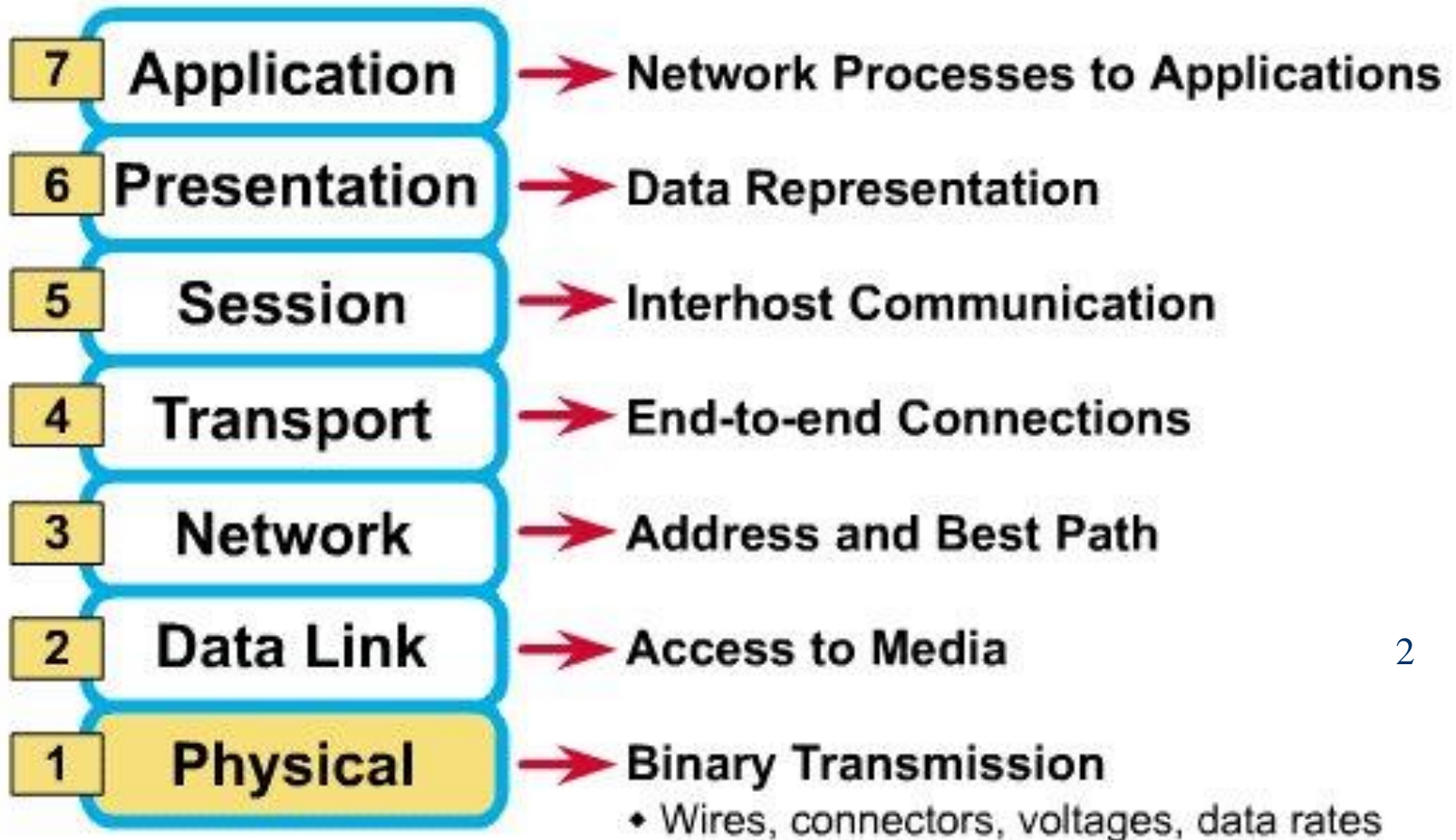
# The OSI Model

- 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.

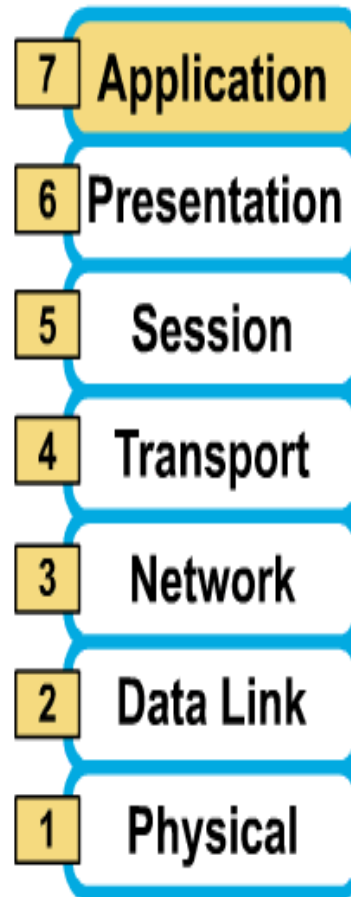
# What is “THE MODEL?”

- Commonly referred to as the OSI reference model.
- The OSI model
  - is a theoretical blueprint that helps us understand how data gets from one user’s computer to another.
  - It is also a model that helps develop standards so that all of our hardware and software talks nicely to each other.
  - It aids standardization of networking technologies by providing an organized structure for hardware and software developers to follow, to insure their products are compatible with current and future technologies.

# What Each Layer Does



# The 7 Layers of the OSI Model



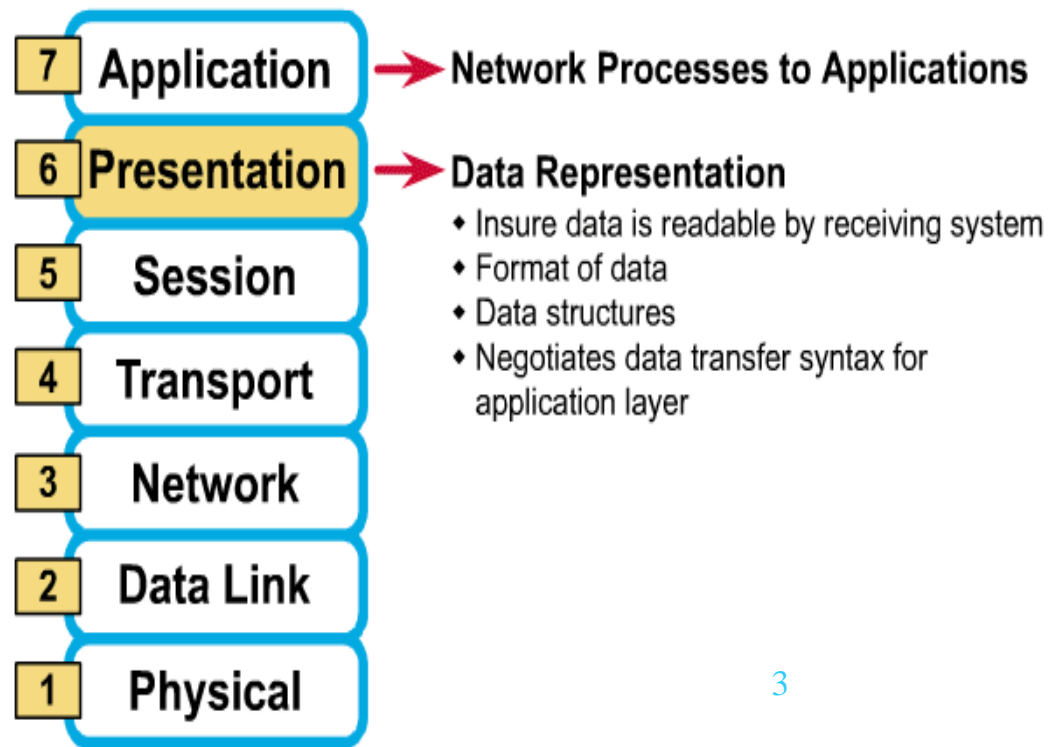
→ **Network Processes to Applications**

- ♦ Provides network services to application processes (such as electronic mail, file transfer, and terminal emulation)

- Gives end-user applications access to network resources
- Where is it on my computer?
  - Workstation or Server Service in MS Windows

# Presentation Layer

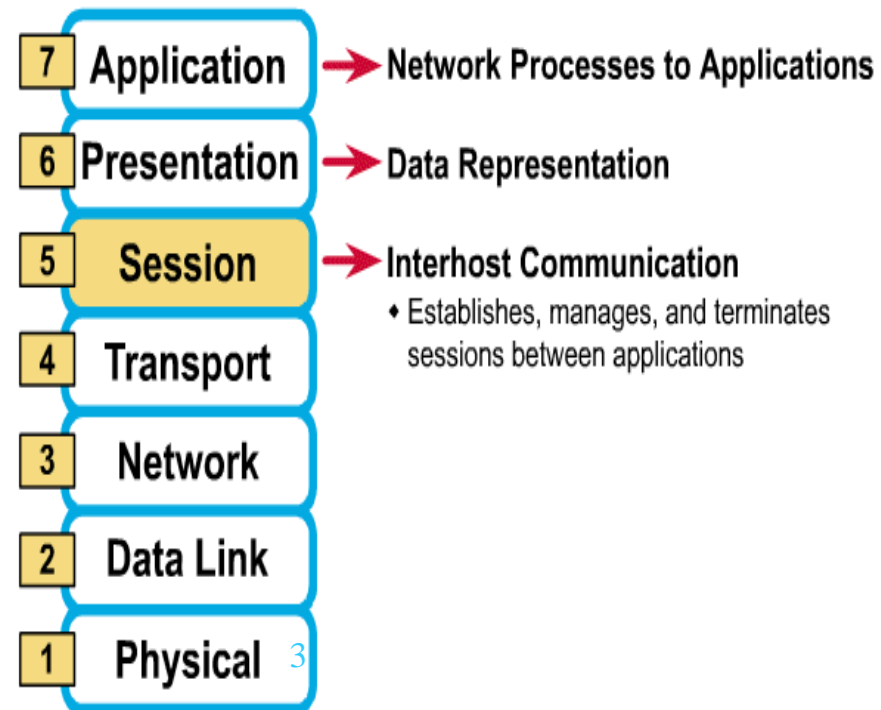
## The 7 Layers of the OSI Model



# Session Layer

- Allows applications to maintain an ongoing session
- Where is it on my computer?
  - Workstation and Server Service (MS)
  - Windows Client for NetWare (NetWare)

## The 7 Layers of the OSI Model

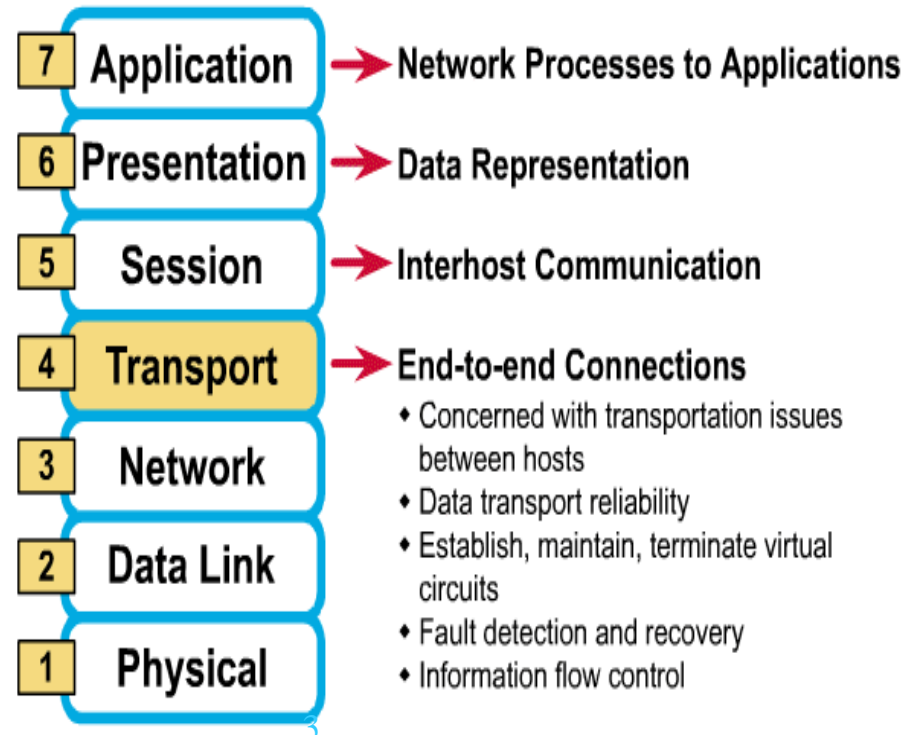




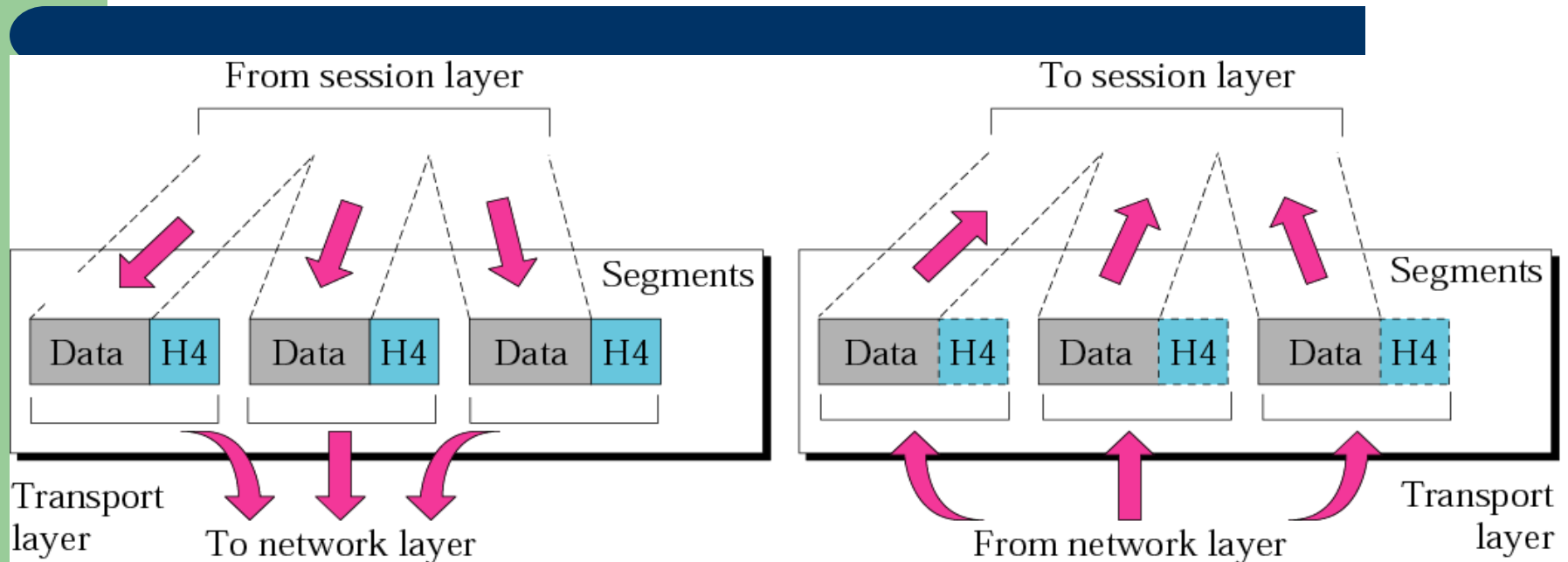
# Transport Layer

- Provides reliable data delivery
- It's the TCP in TCP/IP
- Receives info from upper layers and segments it into packets
- Can provide error detection and correction

## The 7 Layers of the OSI Model



**Figure 2.9** *Transport layer*

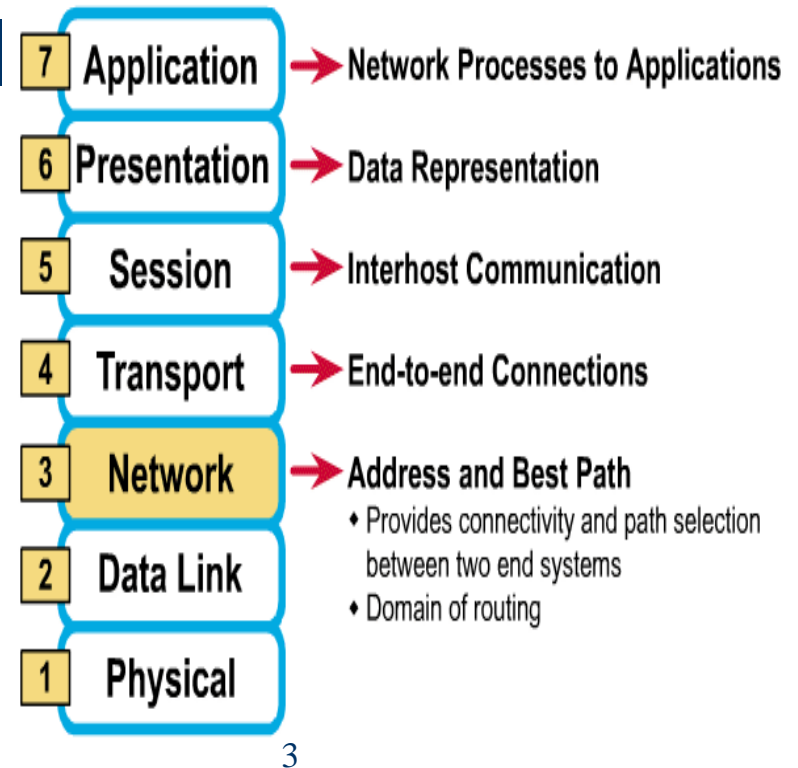


*The transport layer is responsible for the delivery of a message from one process to another.*

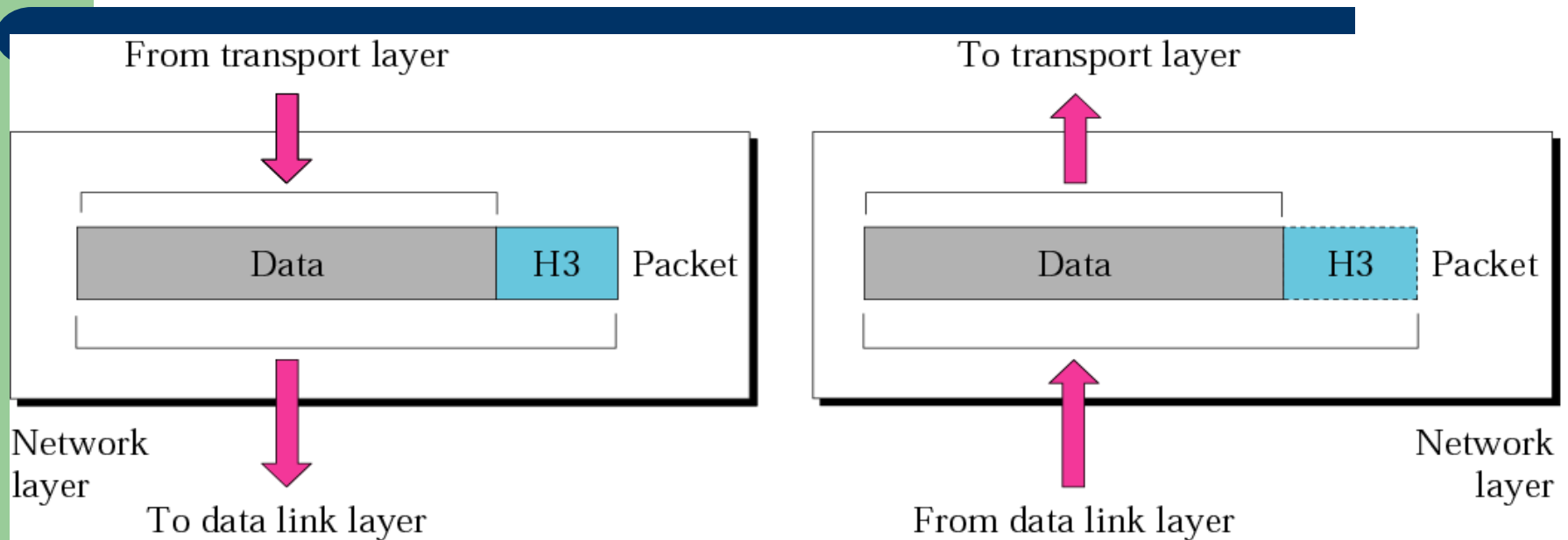
# Network Layer

- Provides network-wide addressing and a mechanism to move packets between networks (routing)
- Responsibilities:
  - Network addressing
  - Routing
- Example:
  - IP from TCP/IP

## The 7 Layers of the OSI Model



## *Network layer*



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

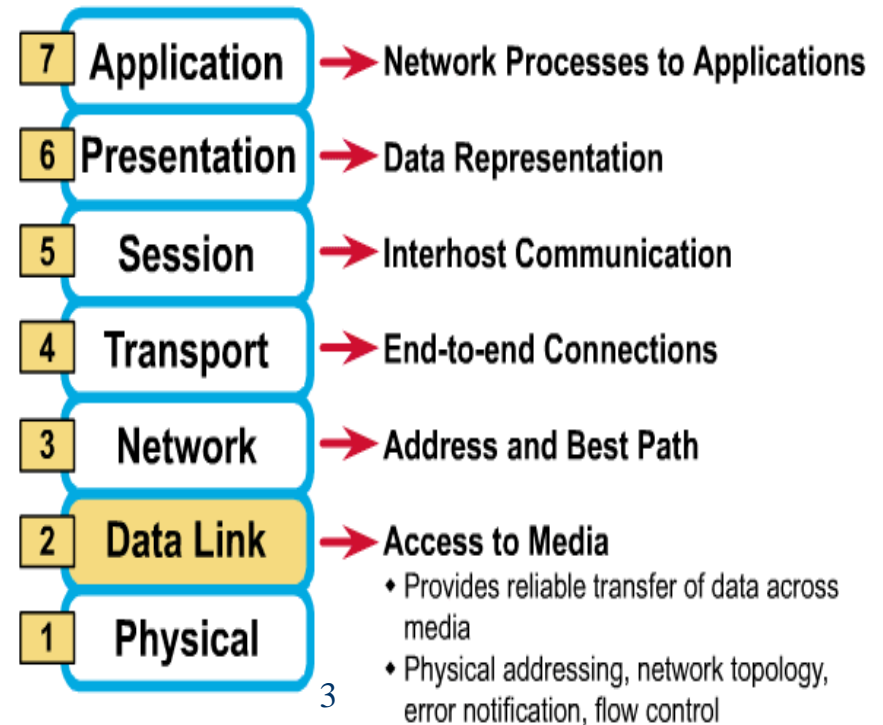
# Network Addresses

- Network-wide addresses
- Used to transfer data across subnets
- Used by routers for packet forwarding
- Example:
  - IP Address
- Where is it on my computer?
  - TCP/IP Software

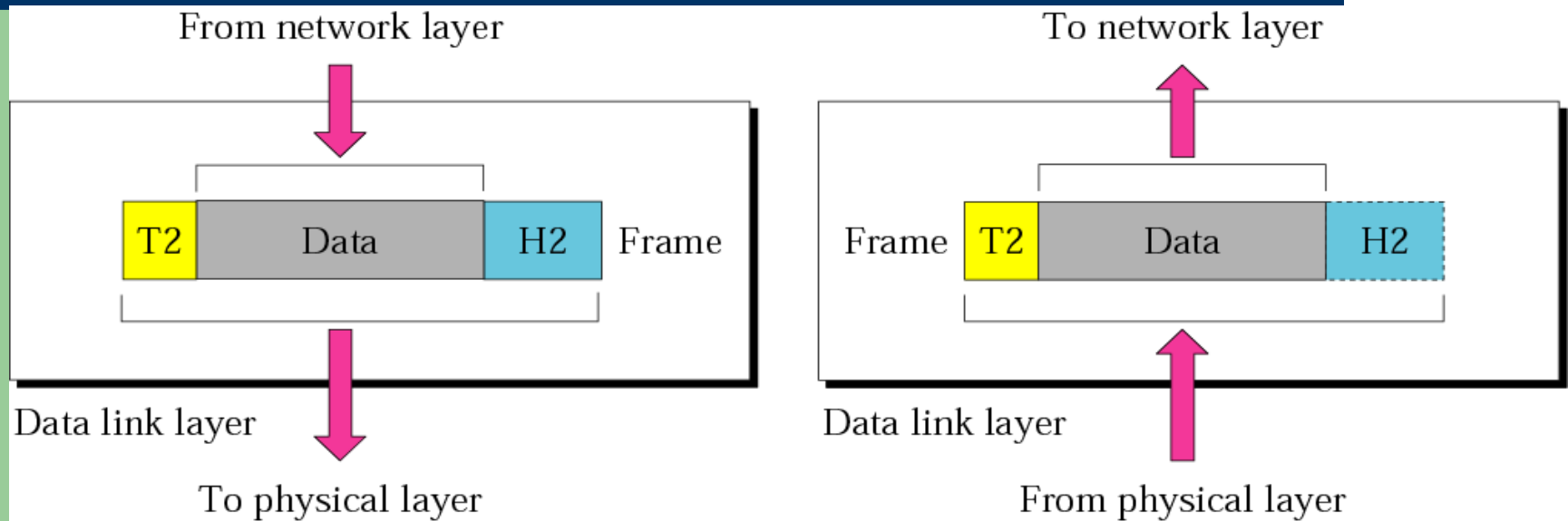
# Data Link Layer

- Places data and retrieves it from the physical layer and provides error detection capabilities

## The 7 Layers of the OSI Model



## *Data link layer*

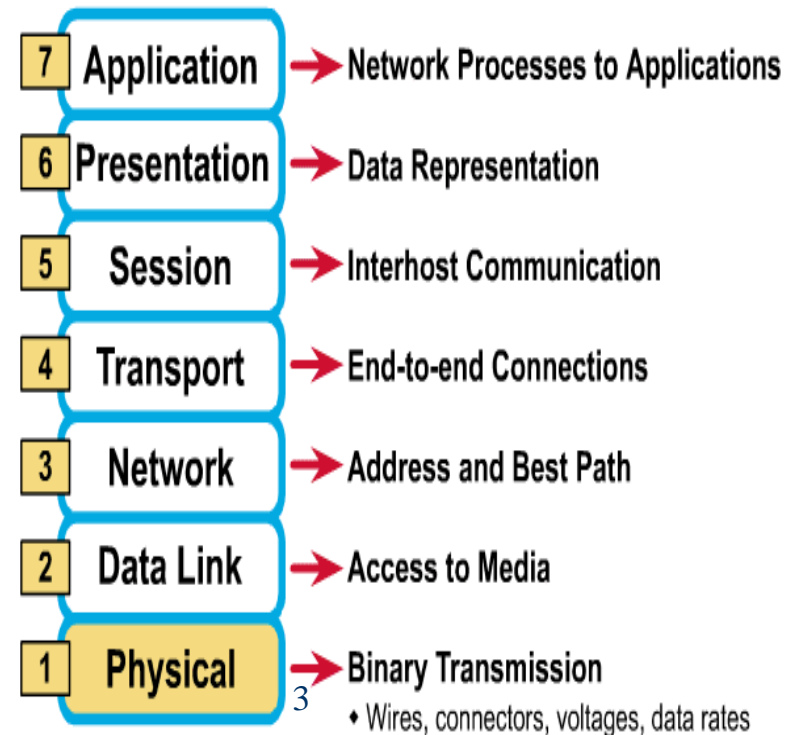


*The data link layer is responsible for moving frames from one hop (node) to the next.*

# Physical Layer

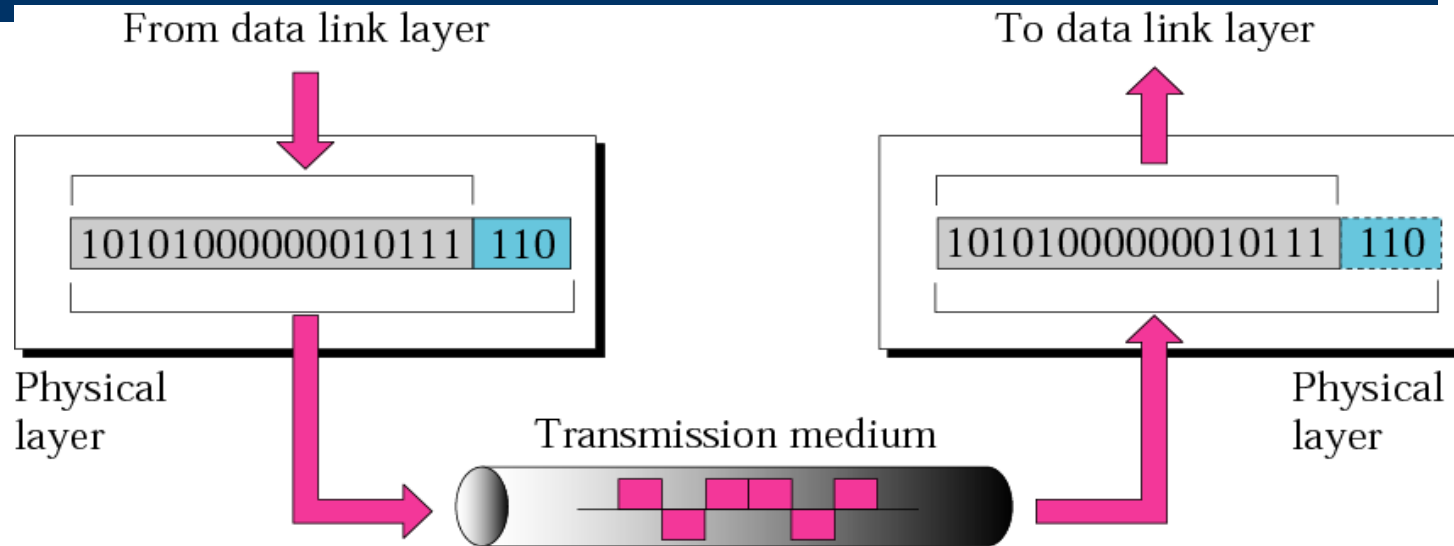
- Determines the specs for all physical components
  - Cabling
  - Interconnect methods (topology / devices)
  - Data encoding (bits to waves)
  - Electrical properties
- Examples:
  - Ethernet (IEEE 802.3)
  - Token Ring (IEEE 802.5)
  - Wireless (IEEE 802.11b)

## The 7 Layers of the OSI Model



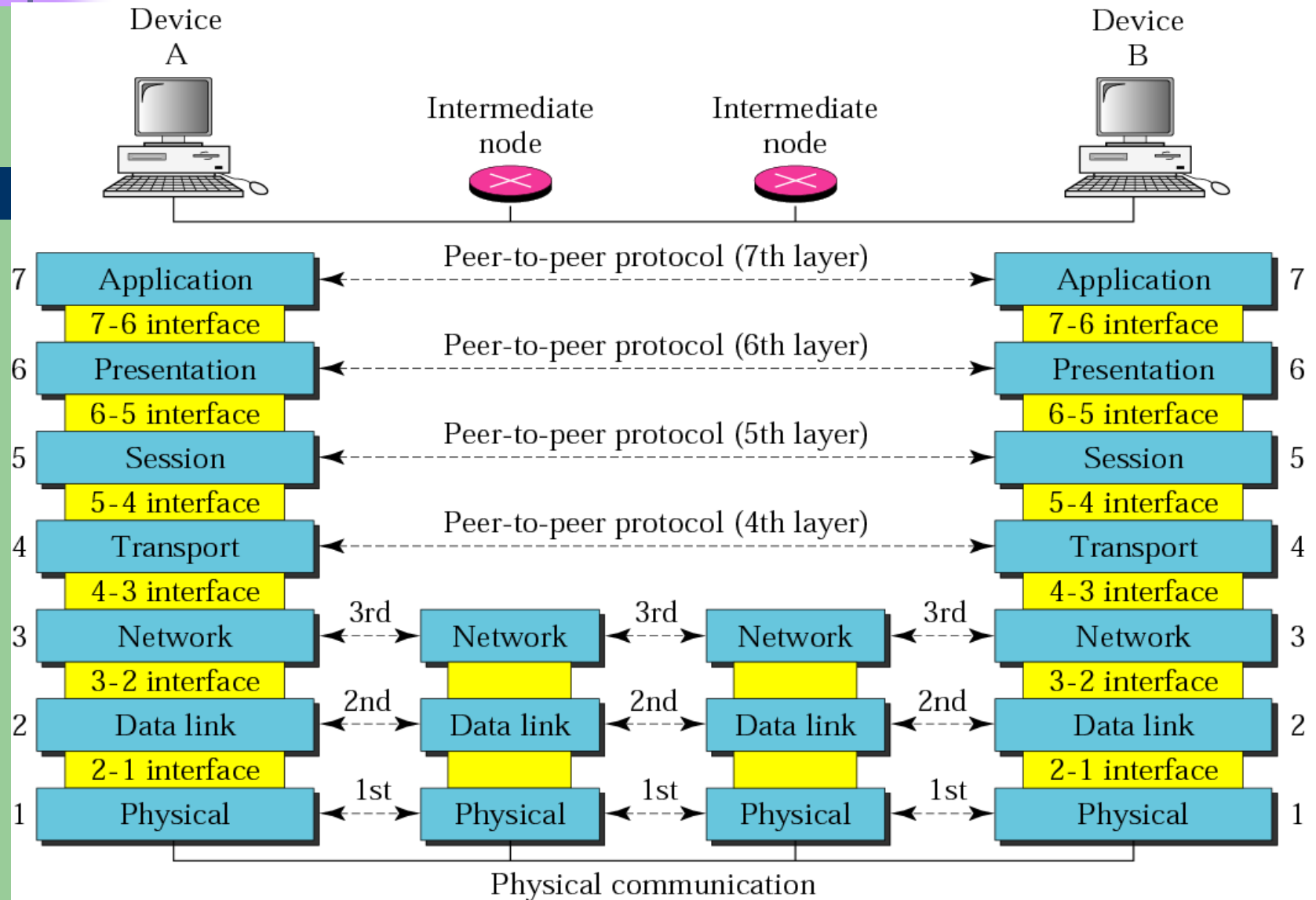


## *Physical layer*



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

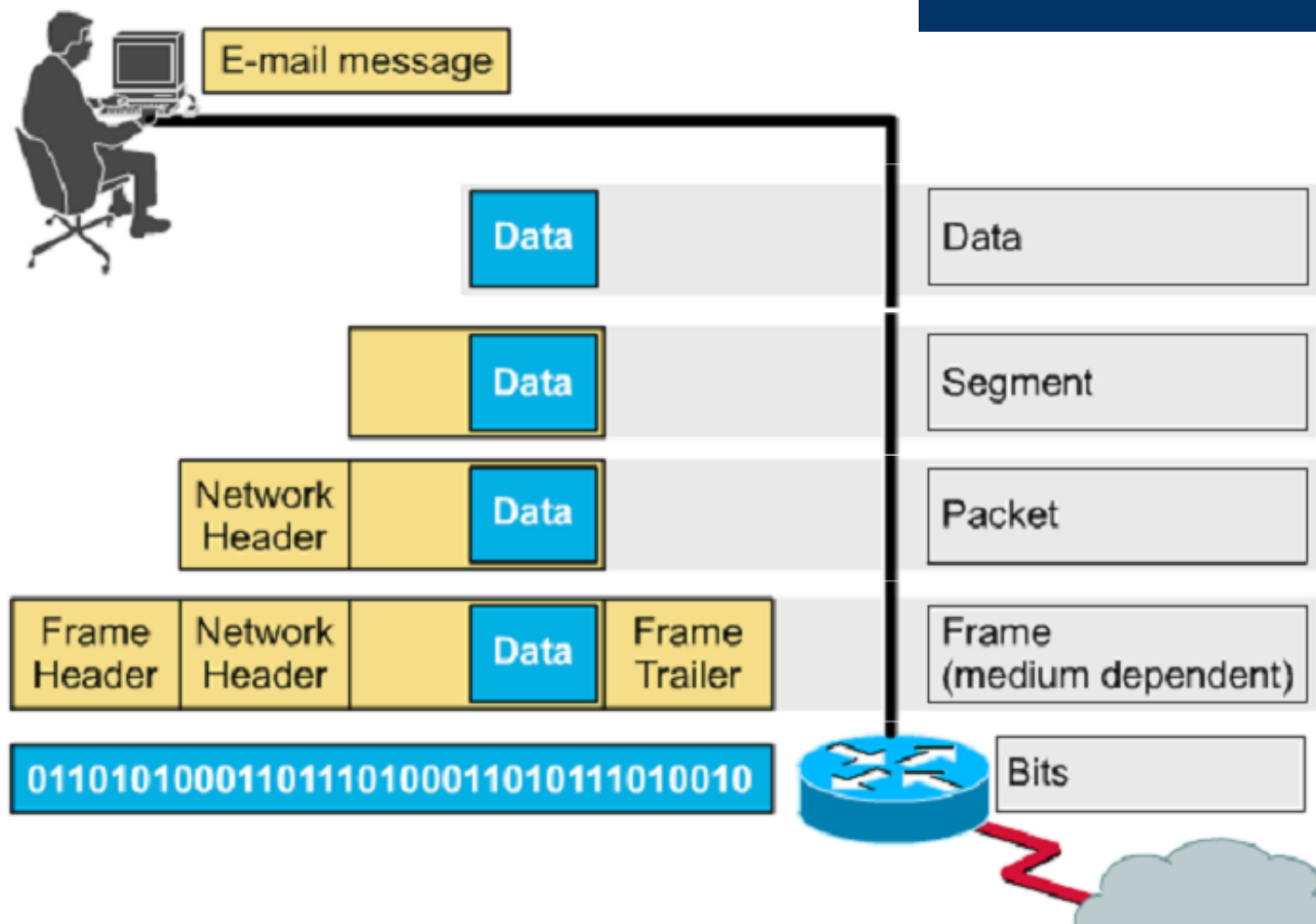
**Figure 2.2** *OSI layers*



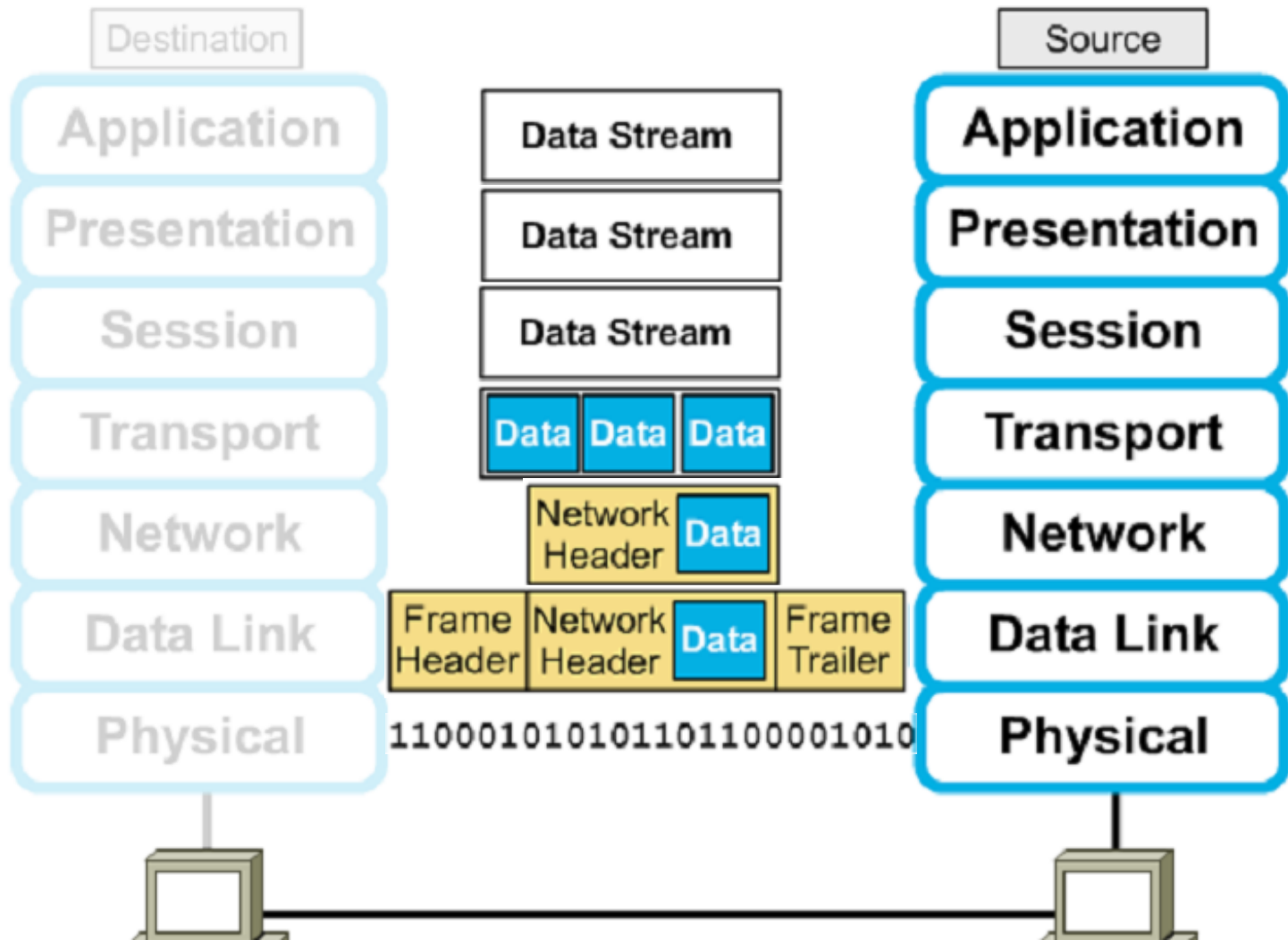
# Data Encapsulation In TCP/IP

- At each layer in the TCP/IP protocol stack
  - Outgoing data is packaged and identified for delivery to the layer underneath
- PDU – Packet Data Unit – the “envelop” information attached to a packet at a particular TCP/IP protocol
  - e.g. header and trailer
- Header
  - PDU’s own particular opening component
  - Identifies the protocol in use, the sender and intended recipient
- Trailer (or packet trailer)
  - Provides data integrity checks for the payload

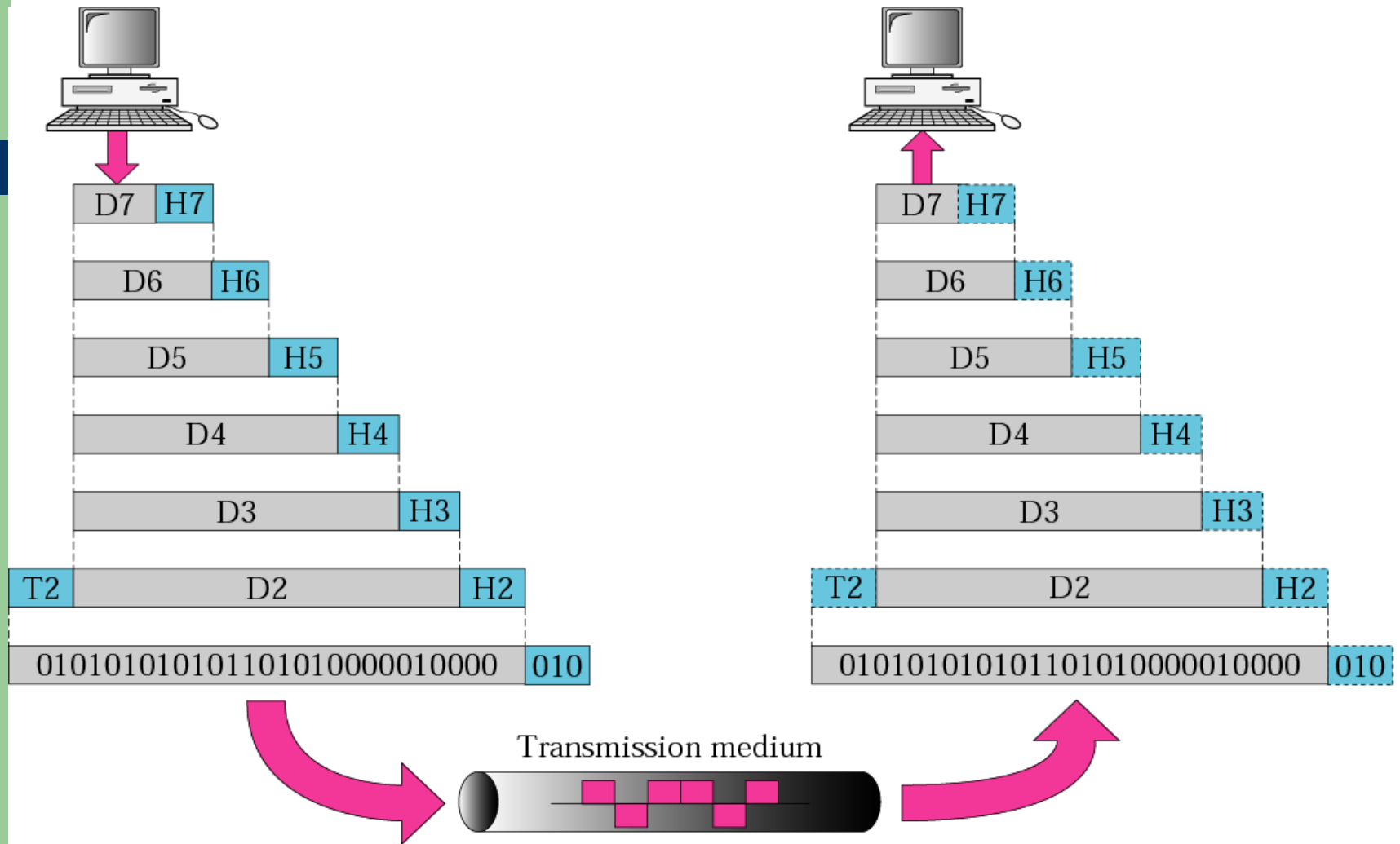
# Encapsulation example: E-mail



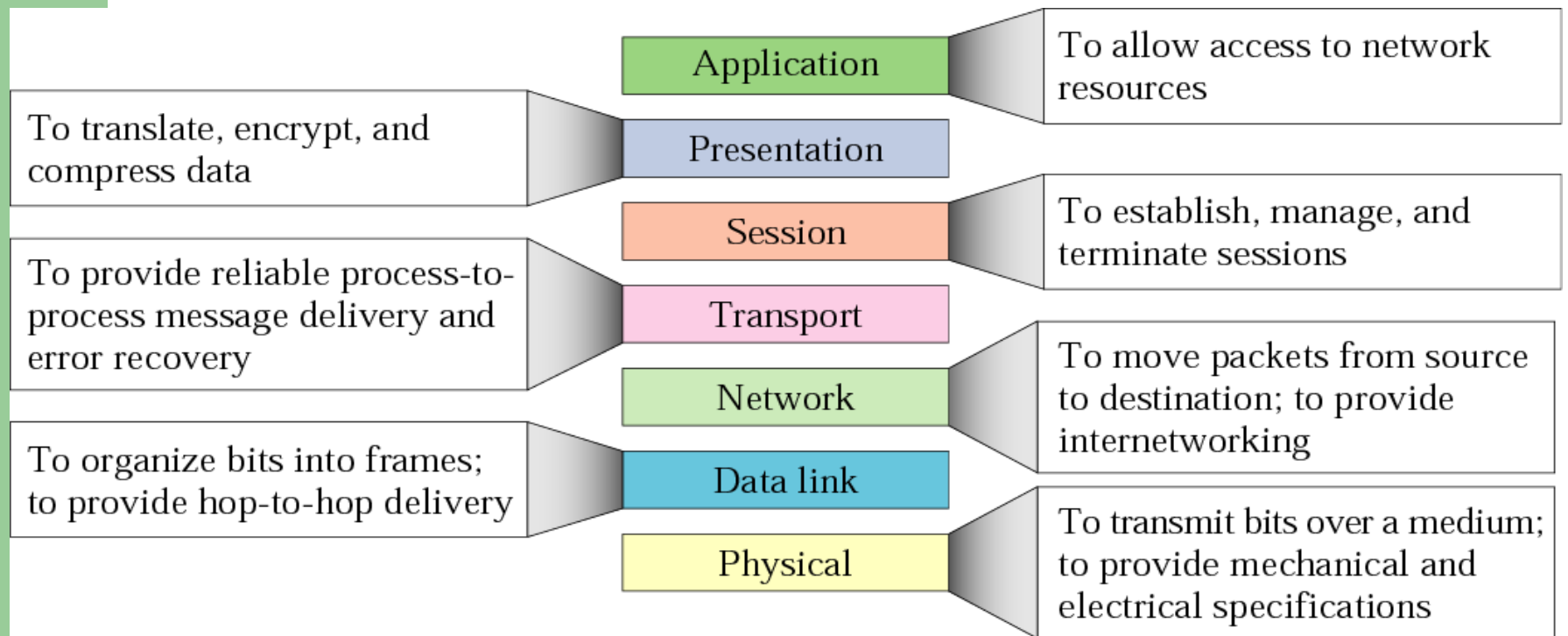
# Encapsulation



**Figure 2.3** *An exchange using the OSI model*



**Figure 2.14** *Summary of layers*



# TCP/IP model development

- The 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

Application

Transport

Internet

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.***

# 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

- 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.
  - 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.

# TCP/IP Reference Model (cont)

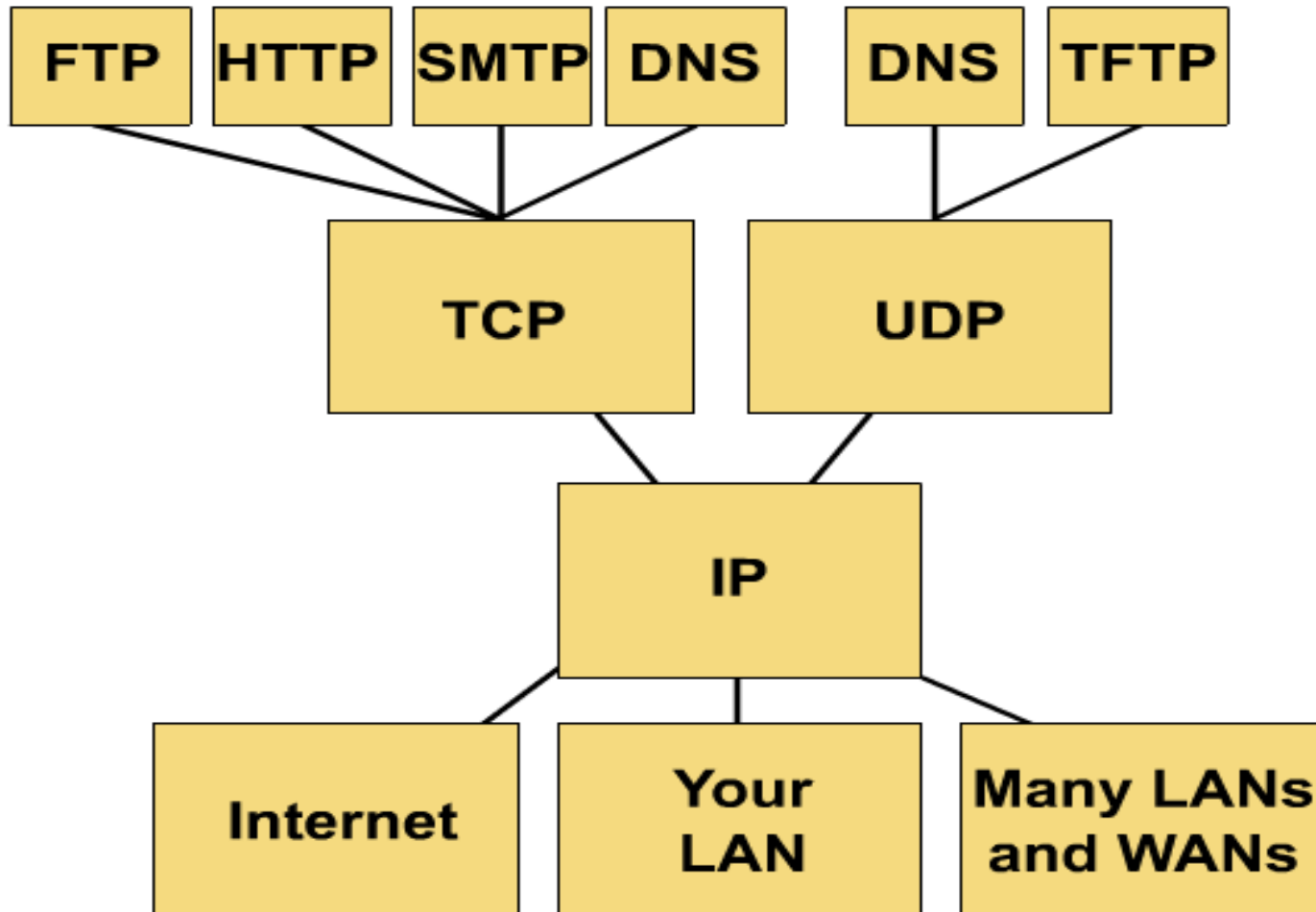
- 3. Transport layer (layer 3)
  - Allows end-to-end communication
  - Connection establishment, error control, flow control
  - Two main protocols at this level
    - Transmission control protocol (TCP),
      - Connection oriented
        - Connection established before sending data
        - Reliable
    - user datagram protocol (UDP)
      - Connectionless
        - Sending data without establishing connection
        - Fast but unreliable



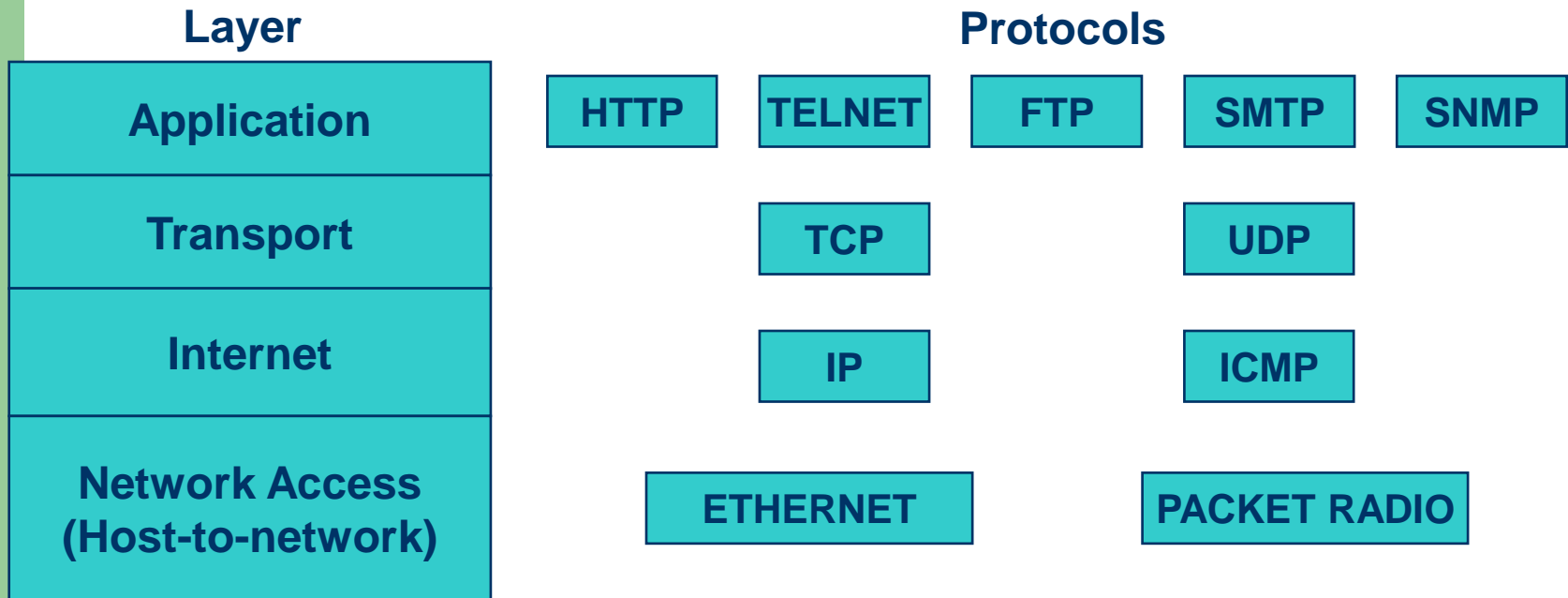
# The application layer

- 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.
  - FTP, HTTP, SMNP, DNS ...
  - Format of data, data structure, encode ...
  - Dialog control, session management ...

# TCP/IP protocol stack



# TCP/IP Reference Model





# Protocols at the application layer

- HTTP:
  - browser and web server communicatin
- 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

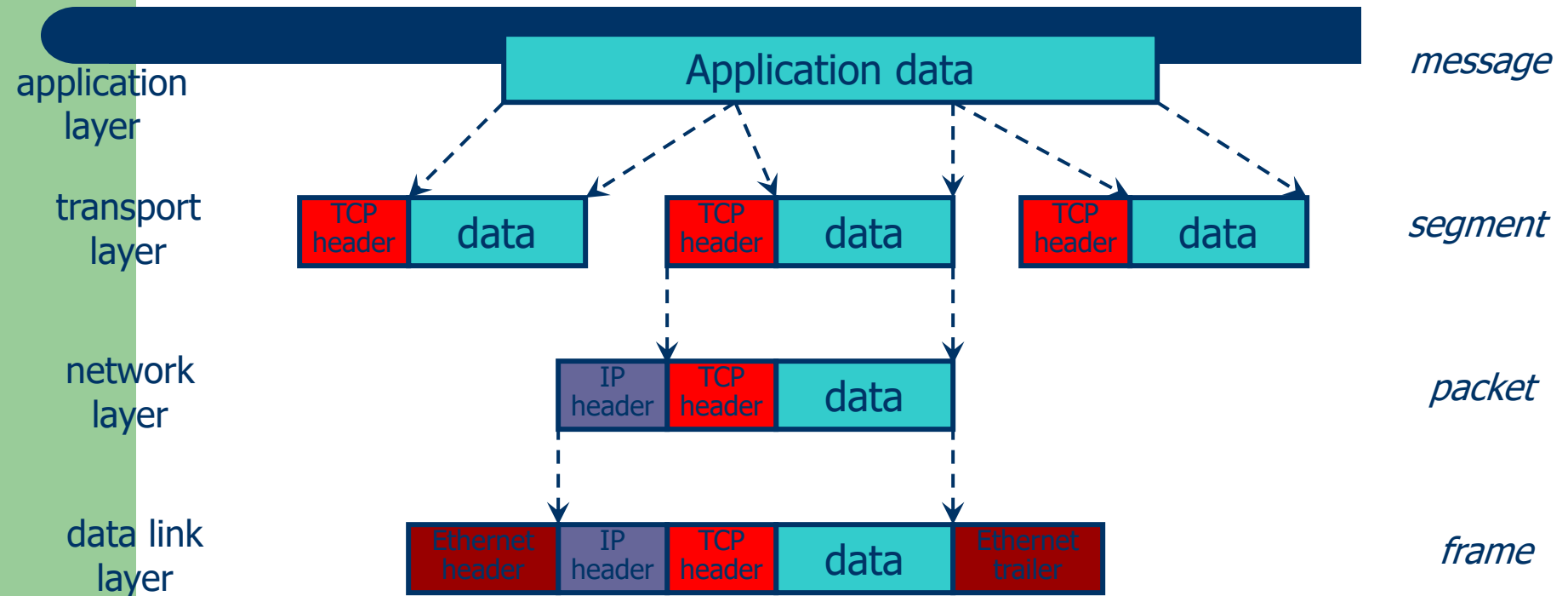
- IP
  - Path selection ,
  - routing and addressing
- ICMP (Internet Control Message Protocol )
  - sends error messages relying on IP
    - a requested service is not available
    - a host or router could not be reached

# Protocols at the link layer

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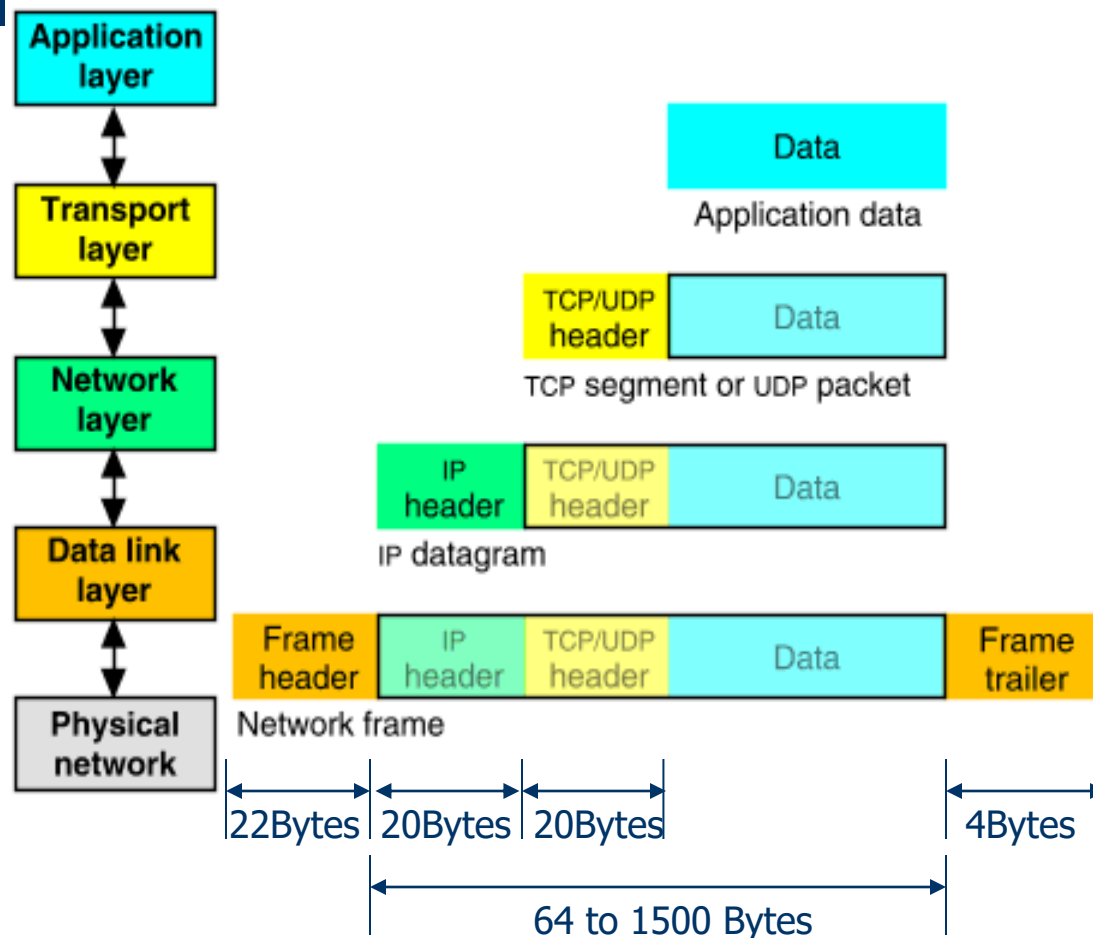
- Ethernet
  - Uses CSMA/CD
- Token Ring

# Data Formats



# Packet Encapsulation (TCP/IP)

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



# Comparing TCP/IP with OSI

OSI Model	TCP/IP Hierarchy	Protocols				
7 <sup>th</sup> Application Layer	Application Layer	HTTP	SMTP	POP3	FTP	...
6 <sup>th</sup> Presentation Layer						
5 <sup>th</sup> Session Layer						
4 <sup>th</sup> Transport Layer	Transport Layer	TCP		UDP		
3 <sup>rd</sup> Network Layer	Network Layer	IP				ICMP
2 <sup>nd</sup> Link Layer	Link Layer	ARP RARP Ethernet		PPP		...
1 <sup>st</sup> Physical Layer						

Link Layer : includes device driver and network interface card

Network Layer : handles the movement of packets, i.e. Routing

Transport Layer : provides a reliable flow of data between two hosts

Application Layer : handles the details of the particular application

# Internet applications

- TCP/IP takes care of the hard problems
  - Location of the destination host
  - Making sure the data is received in the correct order and error free
- Coding Internet applications
  - Turns out to be straightforward.
- The key concept of Internet programming is
  - The client-server model



# Client-Server model

- Client and server processes operate on machines which are able to communicate through a network:
  - The Server waits for requests from client
  - When a request is received
  - The server lookup for the requested data
  - And send a response the client
- Sockets and ports
  - A socket is and end-point of way communication link between two programs
  - A port number bound to a socket specifies the protocol need the be used at the receiving end
- Example of servers
  - File servers
  - Web servers
- Example of client applications
  - Browsers
  - Email clients