MODULE-1: Networking principles and layered architecture

PROTOCOLS & STANDARDS

DATA COMMUNICATION AND NETWORKING

Protocols

Network Protocols

Set of rules that governs/used for communication. The key elements are given below.

1. **Syntax:** structure/format of the data. Meaning the order in which the data is present.

2. **Semantics:** The meaning of each section of bits.

3. **Timing:** Refers to two characteristics: - When data should be sent and how fast they can be sent.

How it works?

- Network protocols take large-scale processes and break them down into small, specific tasks or functions.
- Each layer is assigned a functions
- This occurs at every level of the network and each function must cooperate at each level to complete the larger task at hand.

List of Network protocols

- Communication
- Network management
- Security

Communication Protocol

- Communication Protocol is a system of rules that allow two or more entities of a communications system to transmit information via any kind of variation of a physical quantity.

Network Management Protocol: SNMP

- An Internet Standard protocol for
- collecting and organizing information about managed devices on IP networks
- modifying that information to change device behavior.
- Devices that typically support SNMP include cable modems, routers, switches, servers, workstations, printers, and more.

Network security protocols

- Ensures the security and integrity of data in transit over a network connection.
- Network security protocols define the processes and methodology to secure network data from any illegitimate attempt to review or extract the contents of data.

Popular Protocols

- **ISDN - Integrated Services Digital Network**. Communication protocol offered by phone companies which allows phone networks to carry voice, video, and data.
- **CDMA - Code Division Multiple Access**. **X.25 -** ITU's standard that defines how connections between terminal equipment and computers are maintained.
- TCP/IP (Transmission Control Protocol/Internet Protocol) suite
- ARP (Address Resolution Protocol)
- DNS (Domain Name System)
- FTP (File Transfer Protocol)
- HTTP (Hyper Text Transfer Protocol)
- HTTPS (Hypertext Transfer Protocol Secure)
- ICMP (Internet Control Message Protocol)
- IGMP (Internet Group Management Protocol)
- IMAP4 (Internet Message Access Protocol version 4)

Standards

- Standard provides a model for development that makes it possible for a product to work regardless of the individual manufacturer
- **Dejure** – haven't approved by organized body, but adopted as standards through wide spread use ASCII USB
- **Defacto** - Proprietary and Non proprietary
  - Proprietary – invented by commercial organizations; close off communications
  - Non proprietary-developed by groups or committees; open standards QWERTY

- International Standard Organization **(ISO)**
- International Telecommunications Union- Telecommunications Standard Sector **(ITU-T)**
- American National Standards Institute **(ANSI)**
- The Institute of Electricals and Electronic Engineering **(IEEE)**
- The Electronic Industries Association **(EIA)**

List of Standard Organizations

- **International Standard Organization (ISO)**. Responsible for a wide range of standards including networking standards.
- **CCITT - Consultative Committee for International Telegraph and Telephone**. Responsible for development of Communication standards.
- **International Telecommunications Union-Telecommunications Standards Sector (ITU-T)** - develops worldwide standards for telecommunication technologies.
- **American National Standard Institute (ANSI)**
- **Institute of International Electrical and Electronics Engineers (IEEE)**
- **Electronic Industries Association (EIA)**
- Telecommunications Industry Association **(TIA)** and other leading telecommunication companies worked cooperatively to create **ANSI/TIA/EIA-568-A** standard for commercial buildings.

OSI MODEL

DATA COMMUNICATION AND NETWORKING

The OSI Model

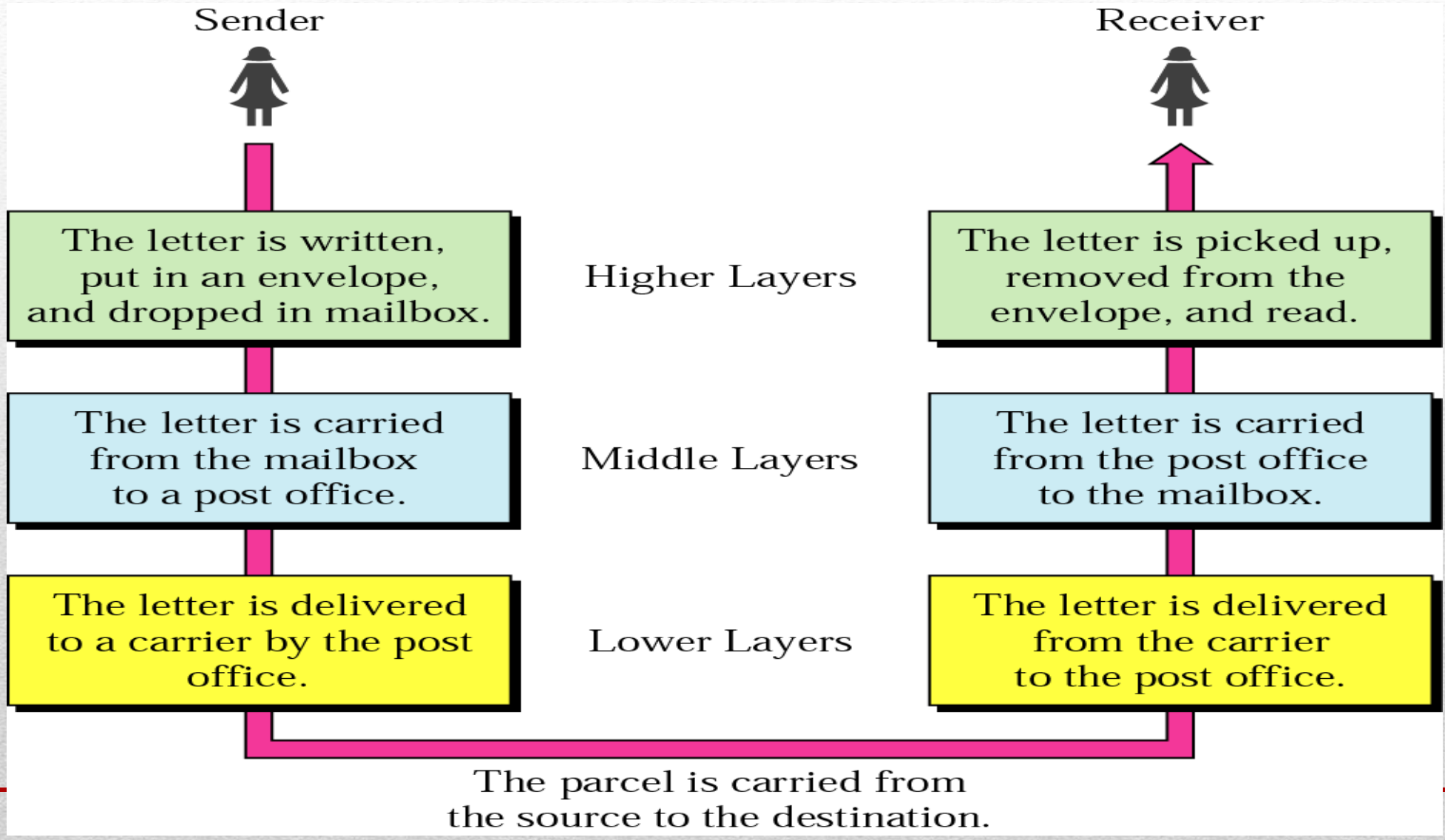
- **OSI - "Open Systems Interconnection".**
- Open communication between different systems without requiring changes to the underlying architecture.
- Introduced in 1984 by the **International Organization for Standardization (ISO).**
  - Outlines **WHAT** needs to be done to send data from one computer to another
- is a theoretical blueprint that helps us understand how data gets from one user's computer to another.
- helps develop standards so that all of our hardware and software talks nicely to each other.

Why a layered model ?

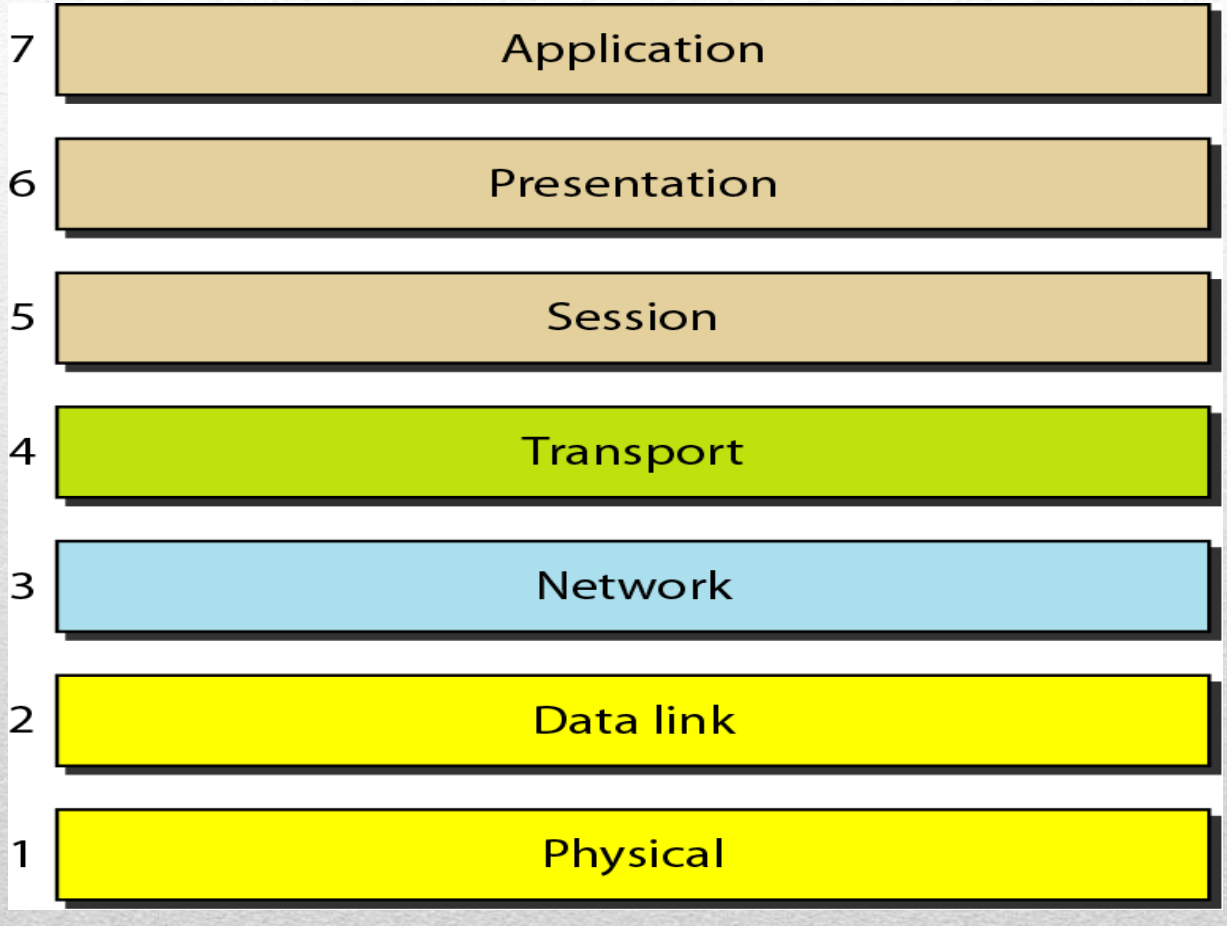
- Breaks down communication into smaller, simpler parts.
- Easier to teach communication process.
- Speeds development, changes in one layer does not affect how the other levels works.
- Standardization across manufactures.
- Allows different hardware and software to work together.
- Reduces complexity

- Each layer has its own function and provides support to other layers.
- Each layer uses services from layers below it & provides services for the layers above it.
- Each layer adds its own information to the message it receives and sends the package to the next.

Tasks involved in sending letter



Seven layers of the OSI model



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Organization of the Layers

1. Physical Layer
2. Data Link Layer
3. Network Layer

Network support Layers

(Deals with physical aspects of moving data)

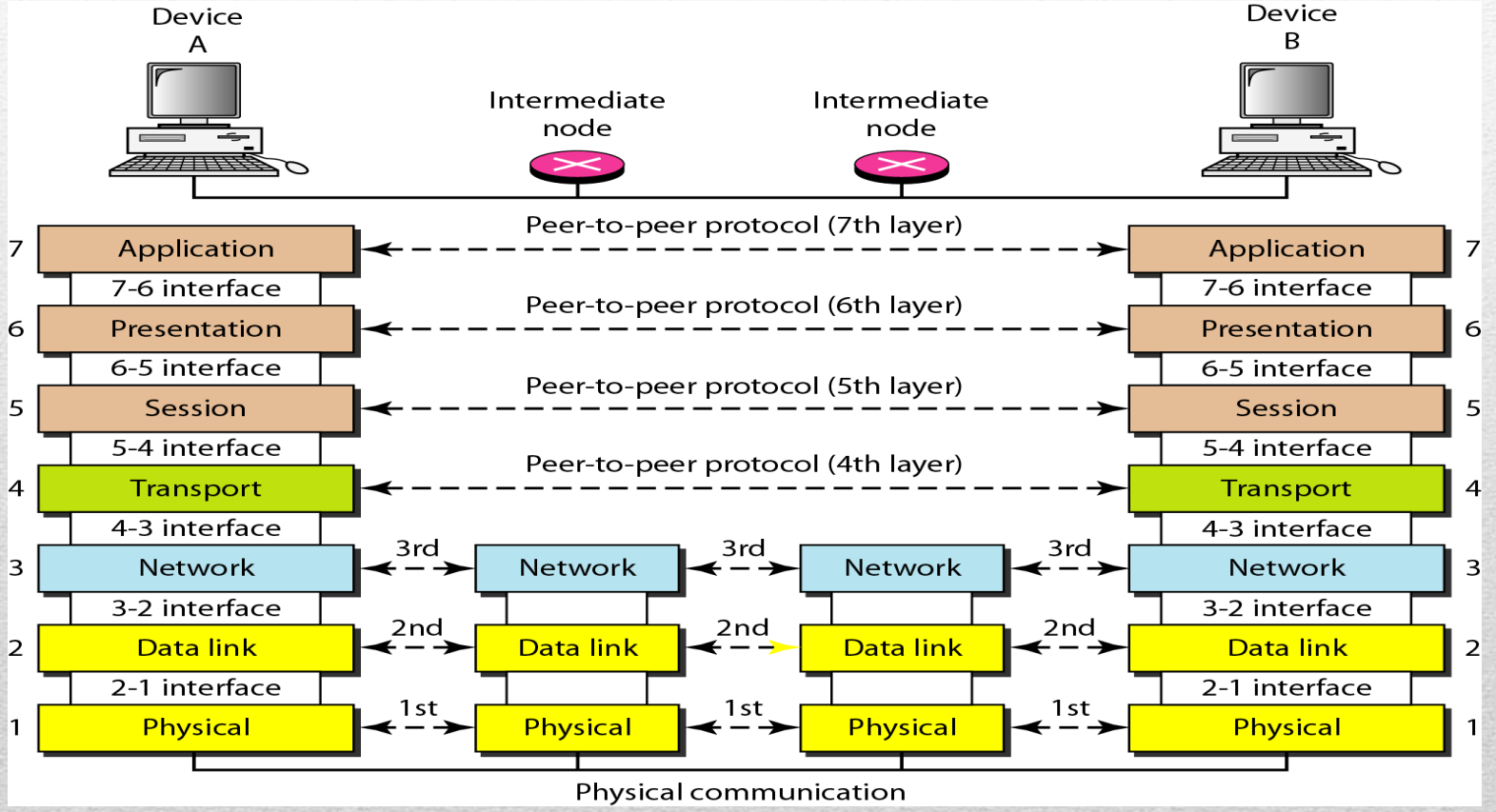
5. Session Layer
6. Presentation Layer
7. Application Layer

User support Layers

(Provides Interoperability among unrelated s/w)

4. Transport Layer - Ensures ***End-to-End*** reliable data transmission

The interaction between layers in the OSI model



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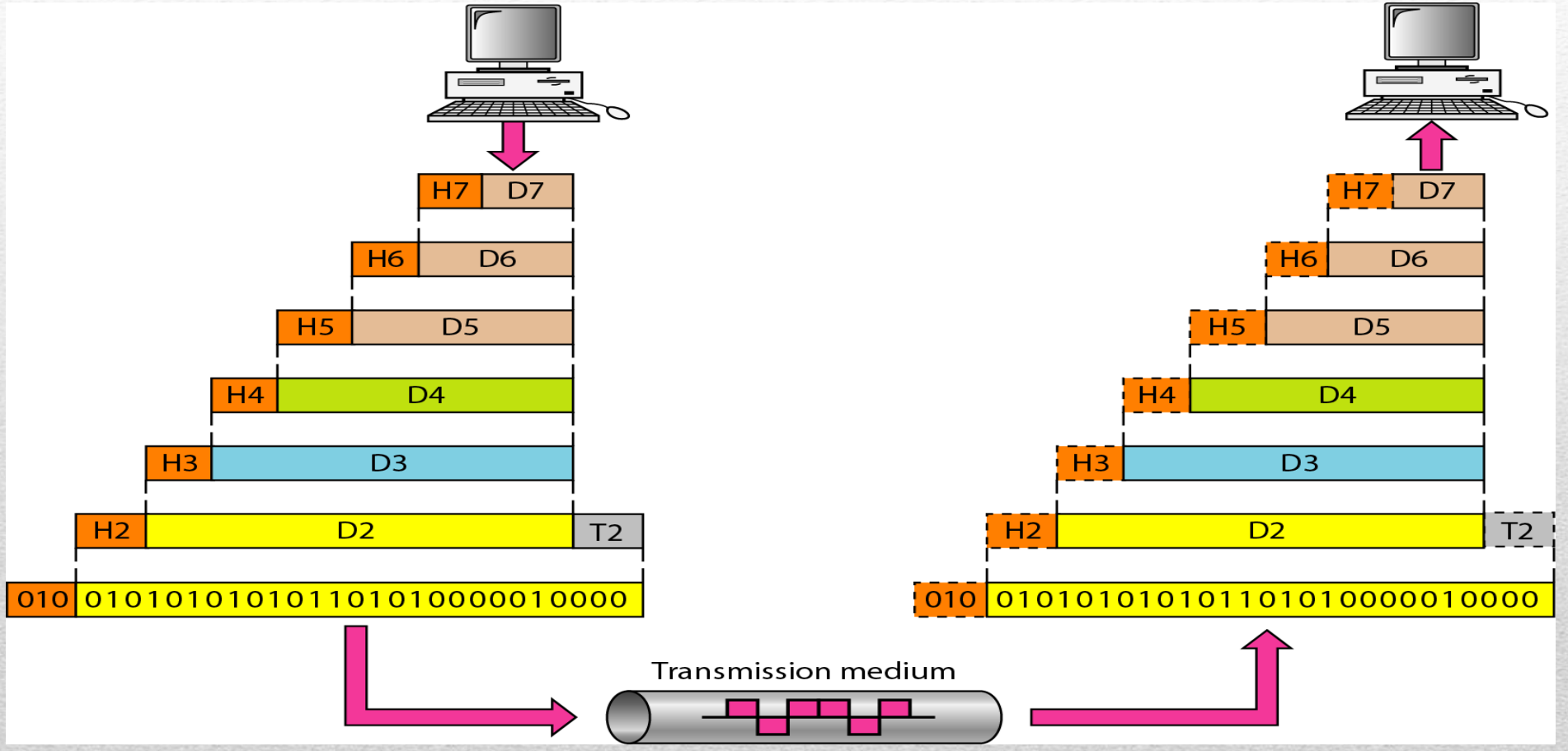
An exchange using the OSI model



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Physical Layer

- bottom layer of the OSI model
- unit of communication is a BIT
- converts bits into electronic signals for outgoing messages
- converts electronic signals into bits for incoming messages
- manages interface between the computer and the network medium

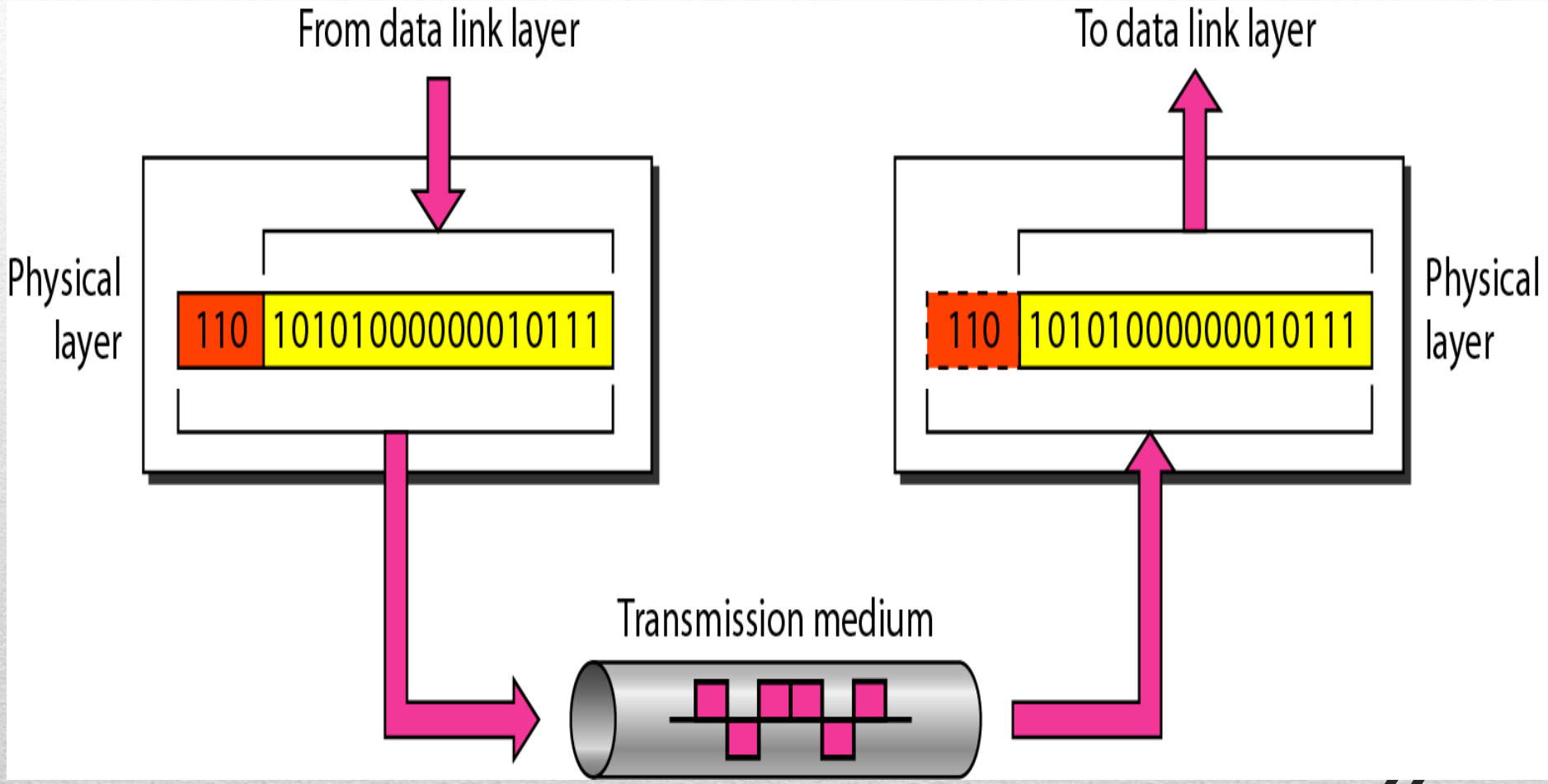
Concerns about

- ***Synchronization & Data Rate of bits***
- ***Line configuration***
- ***Physical topology***
- ***Transmission mode***

Ex: Network Interface Card

Physical layer

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



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Data link layer

The data link layer is responsible for transmitting frames from one node to the next.

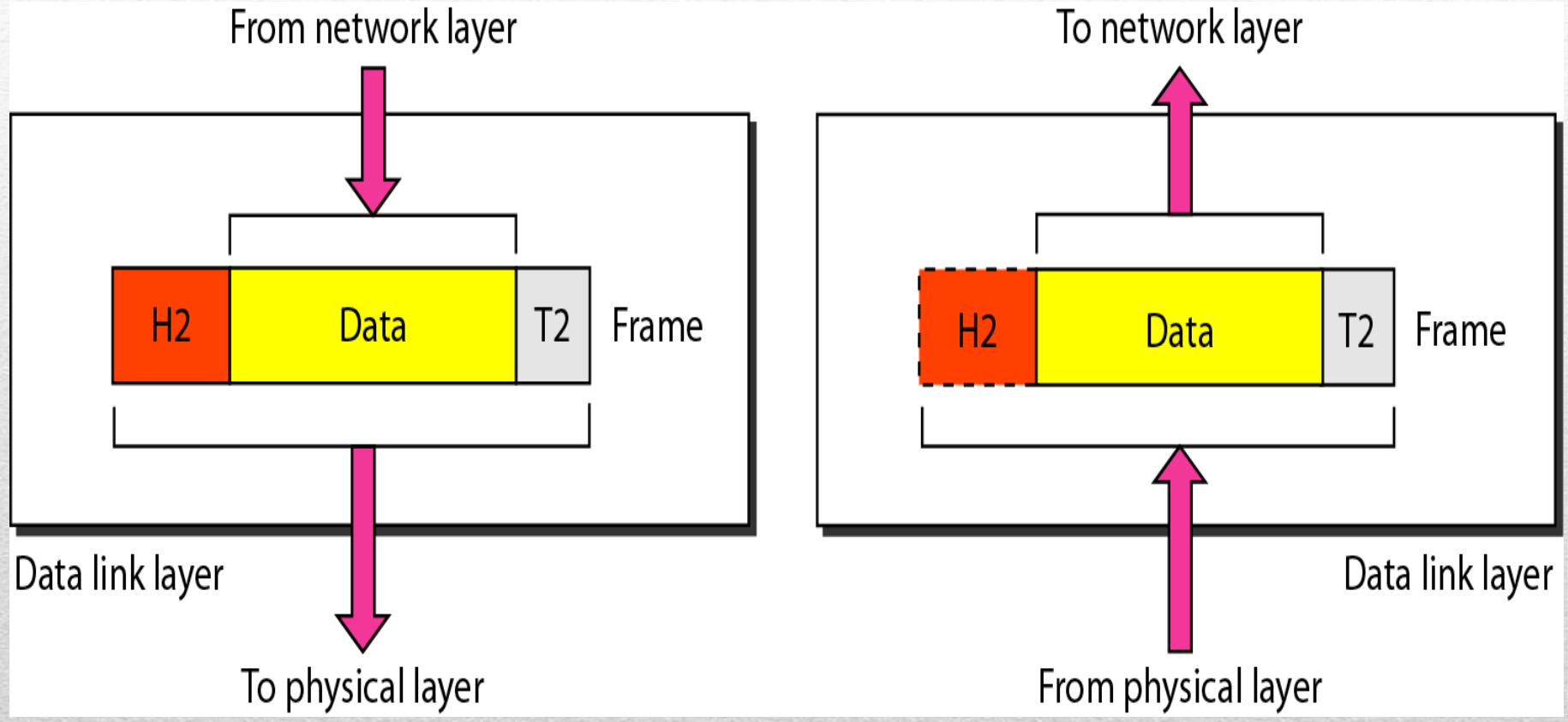
- unit of communication is a Frame
- Receiving end – packages raw data from the physical layer into data frames for delivery to the Network layer
- Sending end – converts data into raw formats that can be handled by the Physical Layer

Concerns about

- ***Physical Addressing***
- ***Sequence Numbering***
- ***Error Control***
- ***Flow Control***
- ***Access Control***

Data link layer (Cont....)

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



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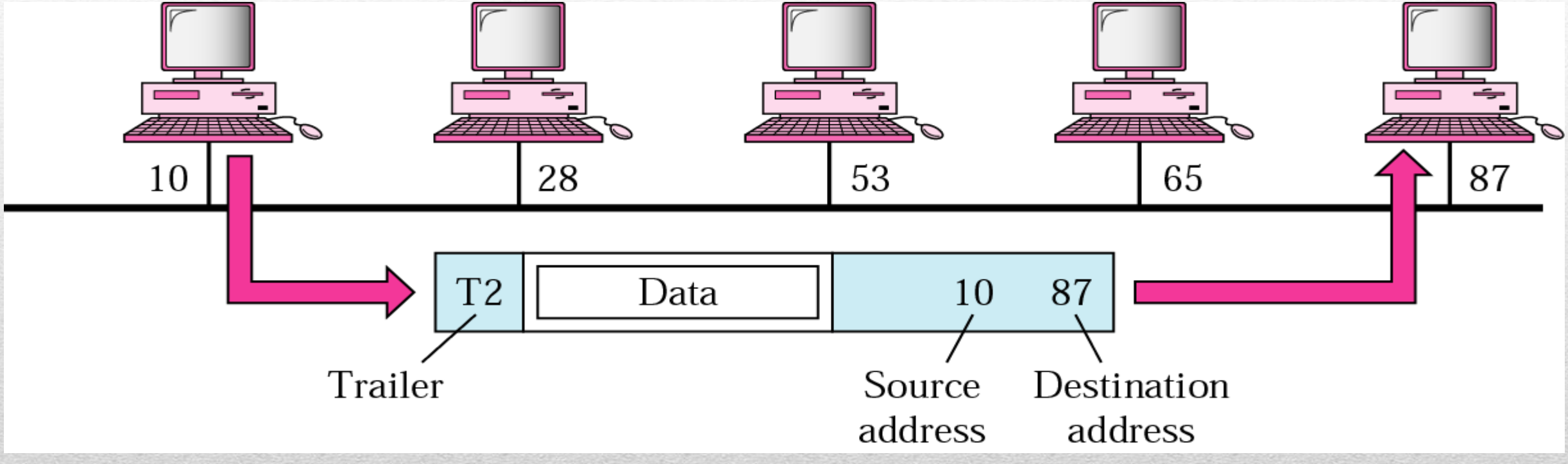
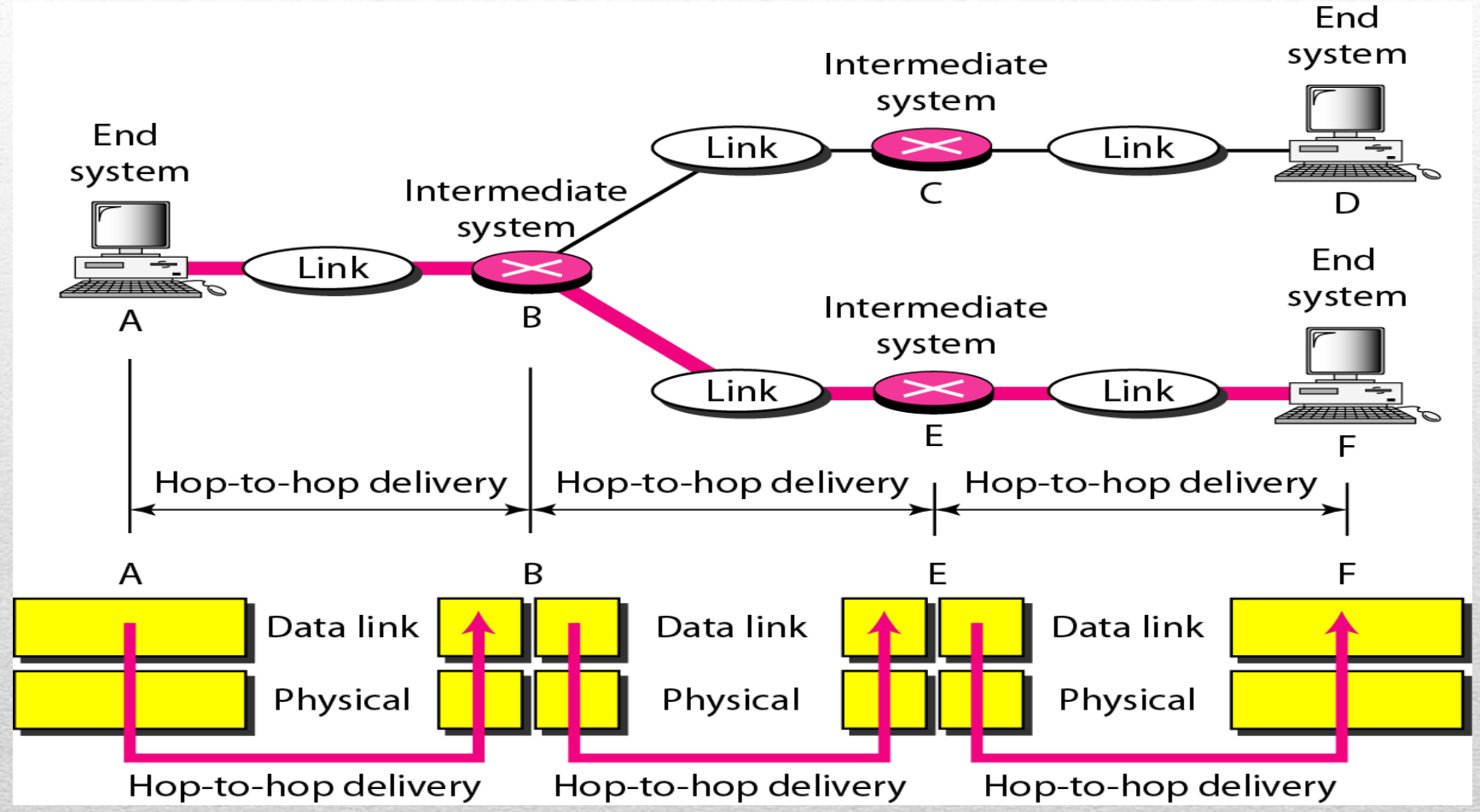
Data link layer (Cont....)



Hop-to-hop delivery



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Network layer

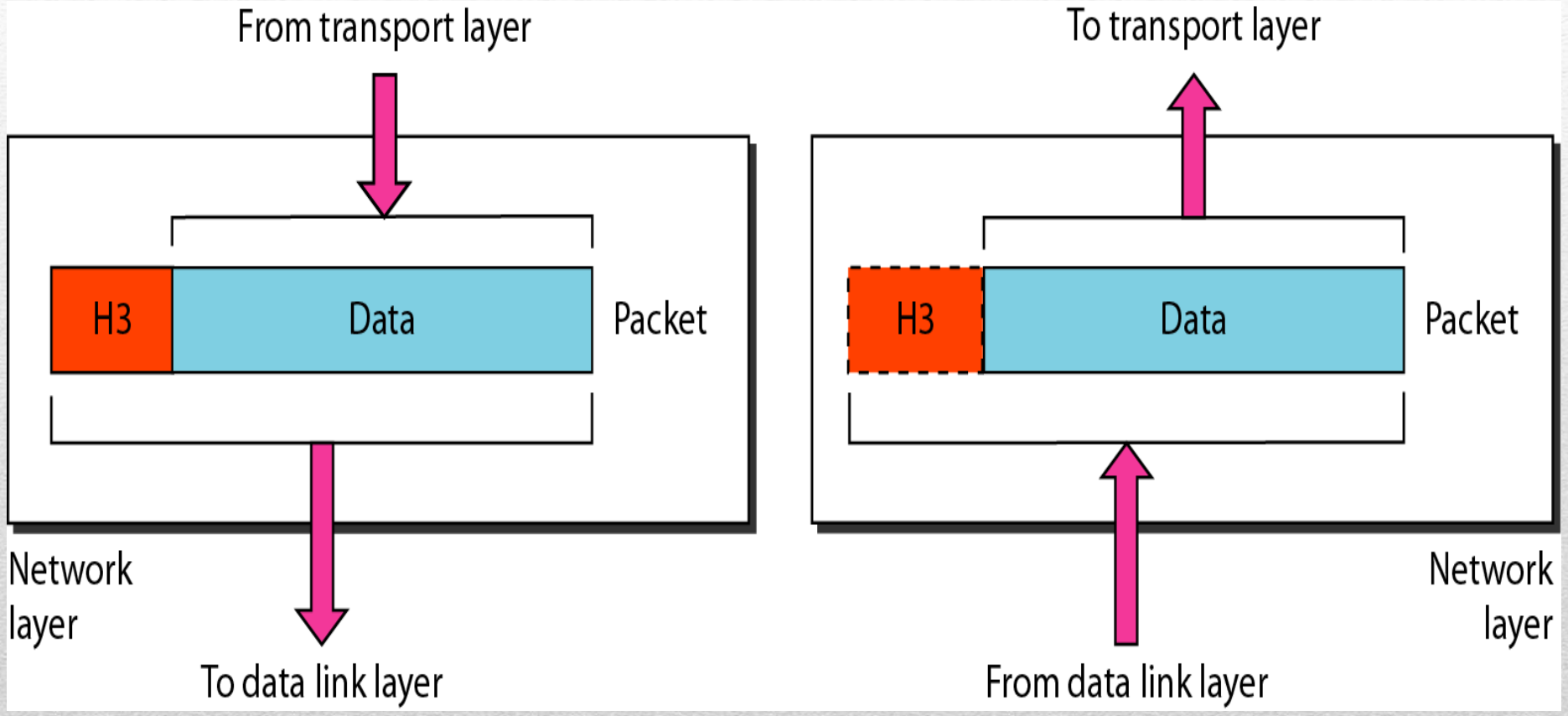
The network layer is responsible for the delivery of individual packets from the source to the final destination.

(end-to-end delivery)

- unit of communication is a Packet
- Responsible for Source-to-Destination delivery of packets
- Provides a mechanism to move packets between networks
- Also handles packet switching and network ***congestion control***
- Responsibilities:
  - ***Network addressing (Logical Addressing)***
  - ***Routing***

Network layer

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



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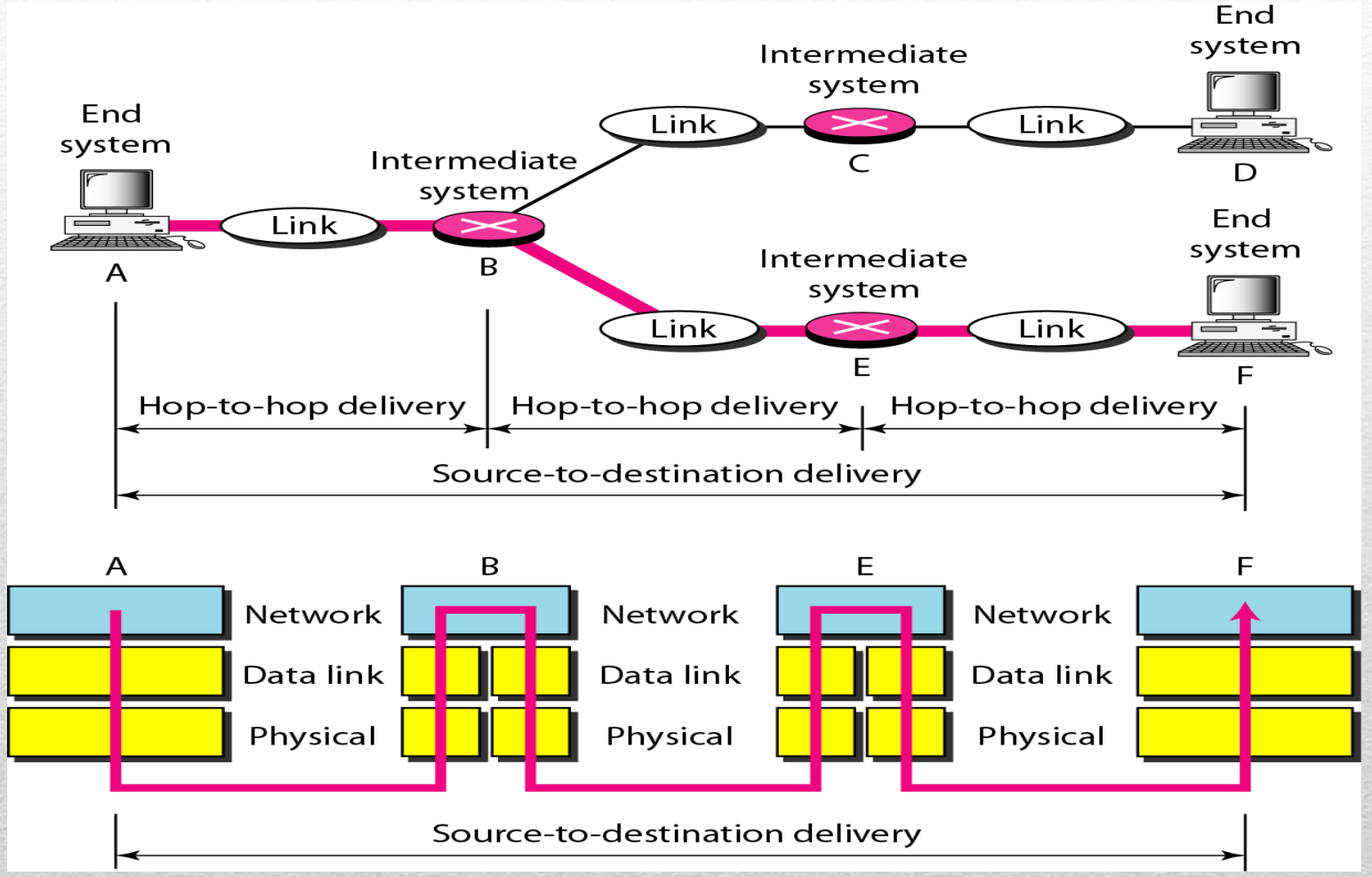
Source to destination delivery



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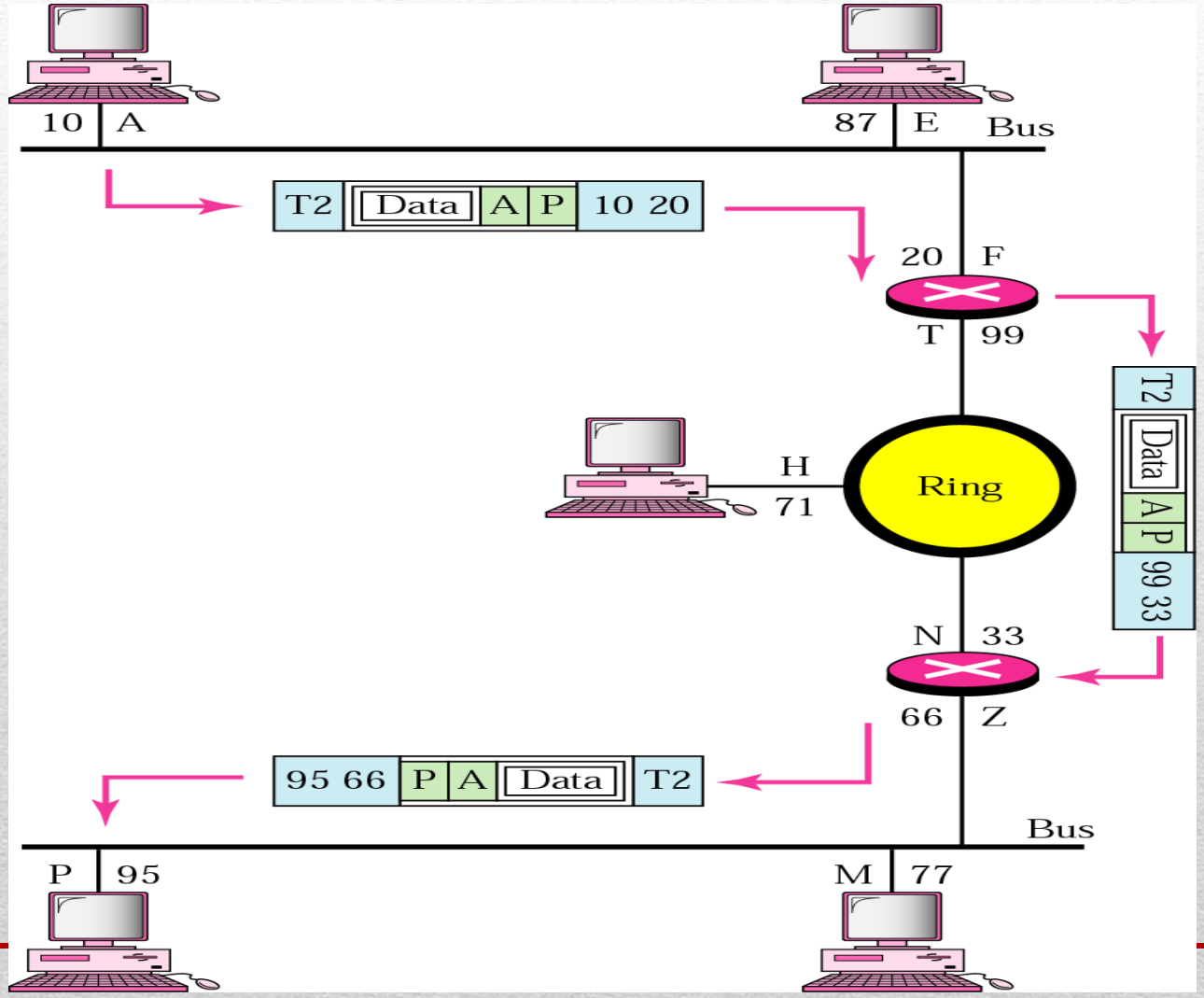
Network layer



Network Address

A , P

Physical Address

10, 95

Transport layer

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

unit of communication is a Segment

provides reliable data delivery

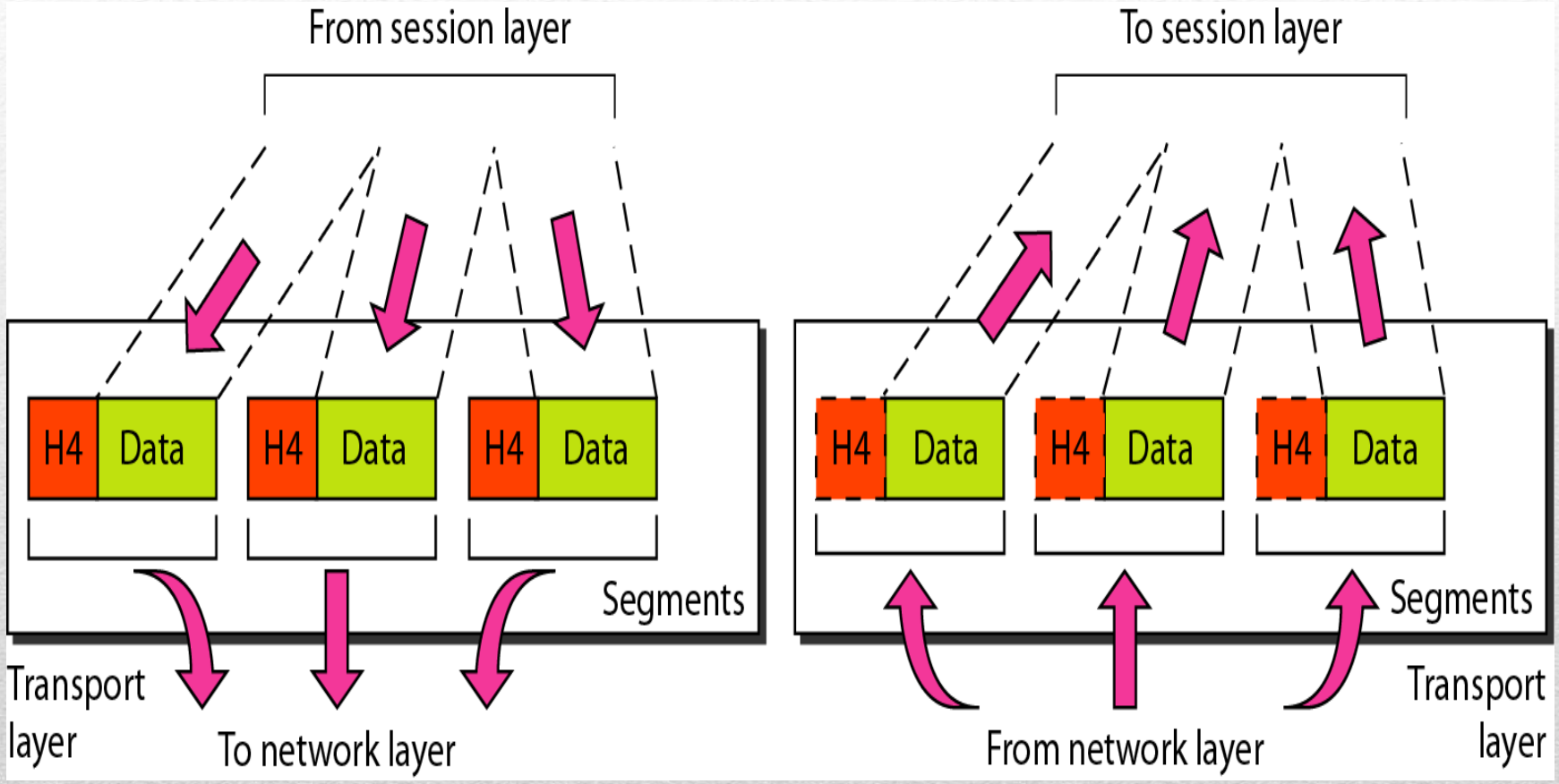
receives information from upper layers and segments it into packets

Responsibilities:

- ***Process-to-process communication*** ***[Header – Service point address]***
- ***Segmentation and reassembly***
- ***Connection Control***

Transport layer

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



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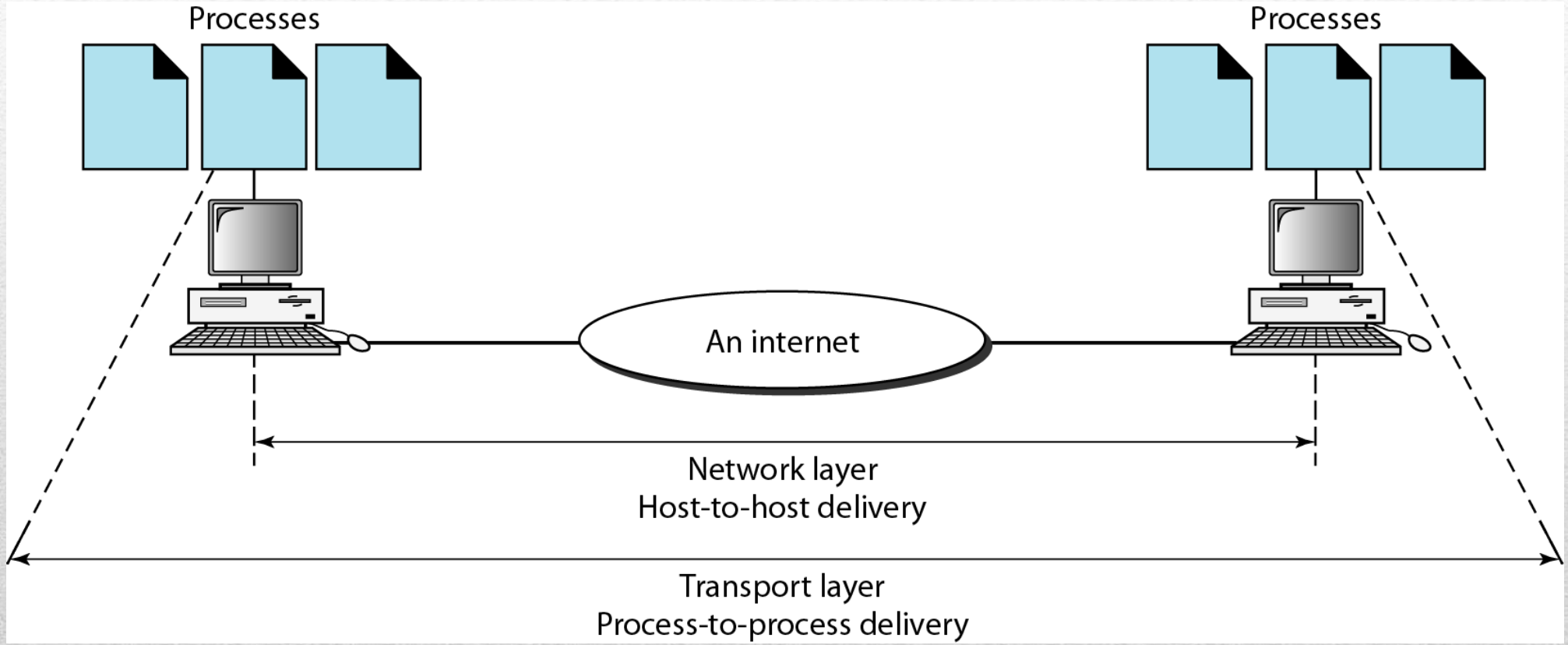
Reliable process-to-process delivery of a message



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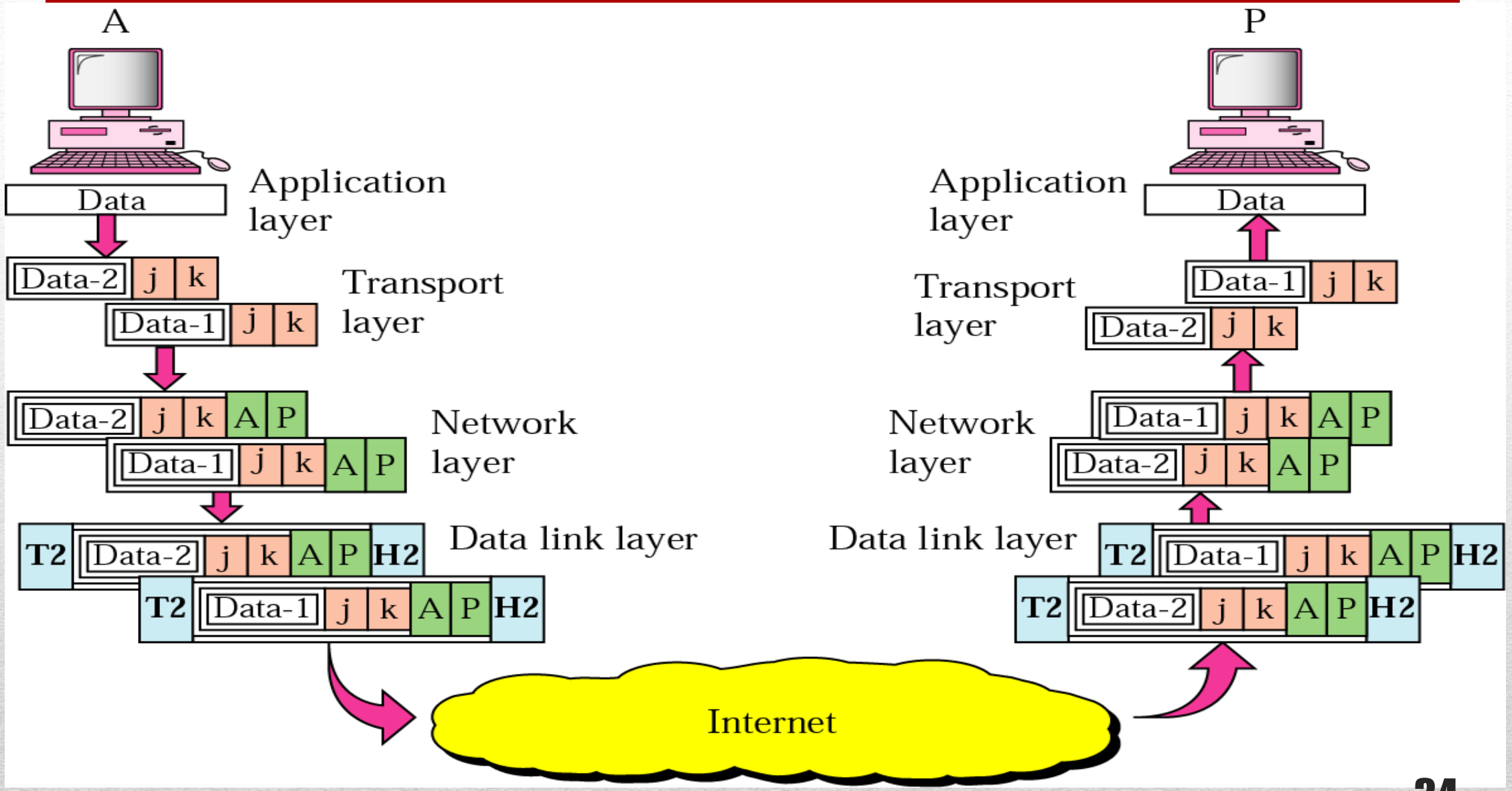
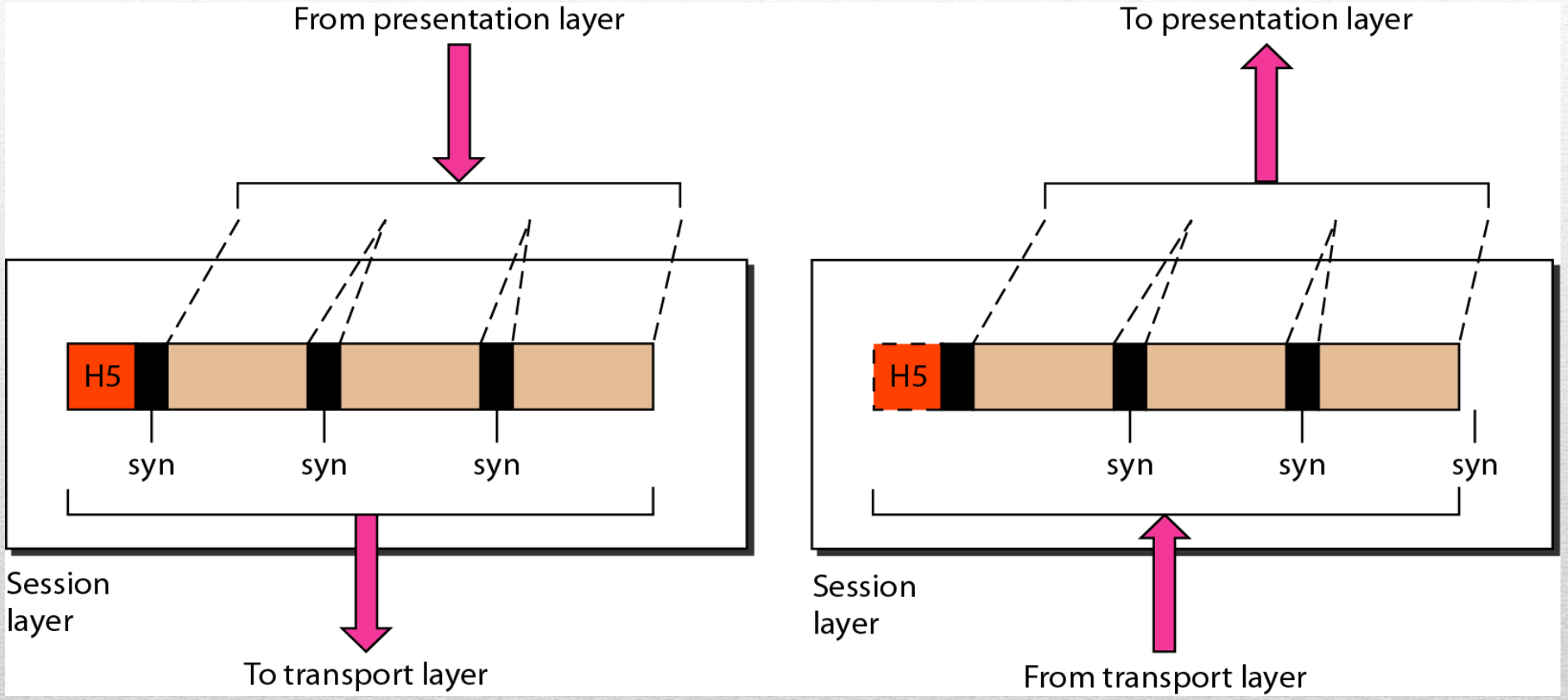


j – Address of sending application k - Address of receiving application

Session layer

The session layer is responsible for dialog control and synchronization.



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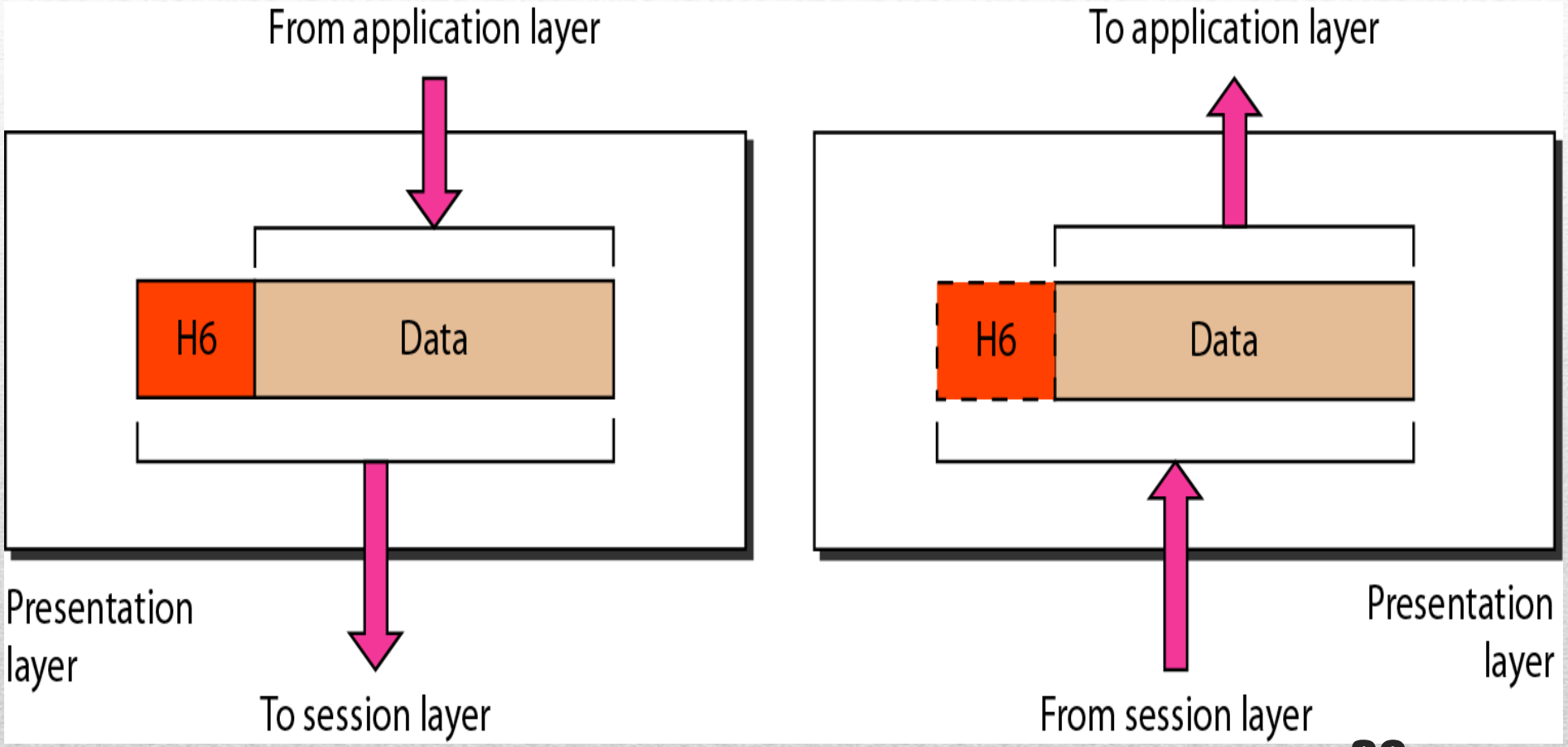
Presentation layer

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



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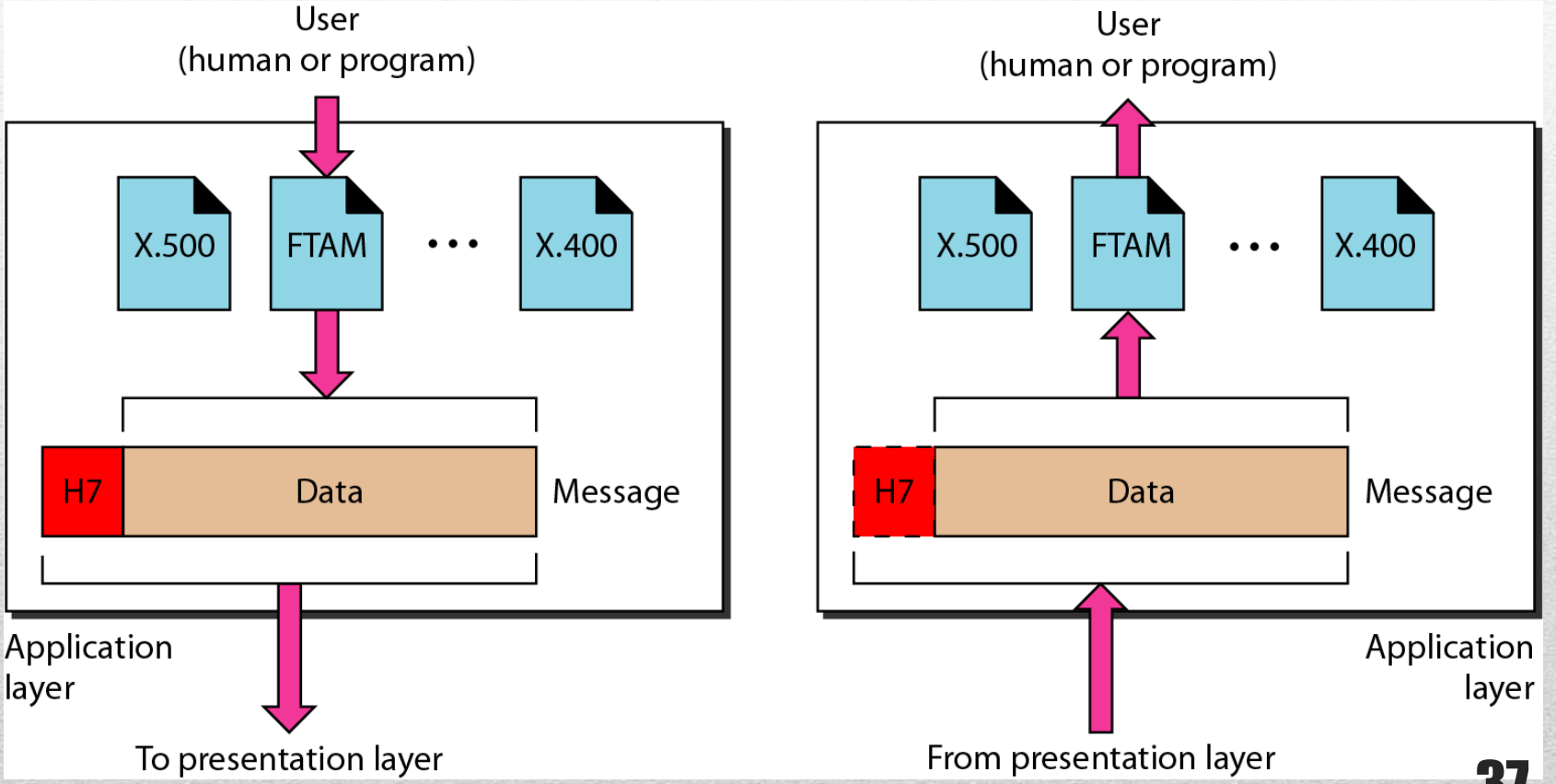
Application layer

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



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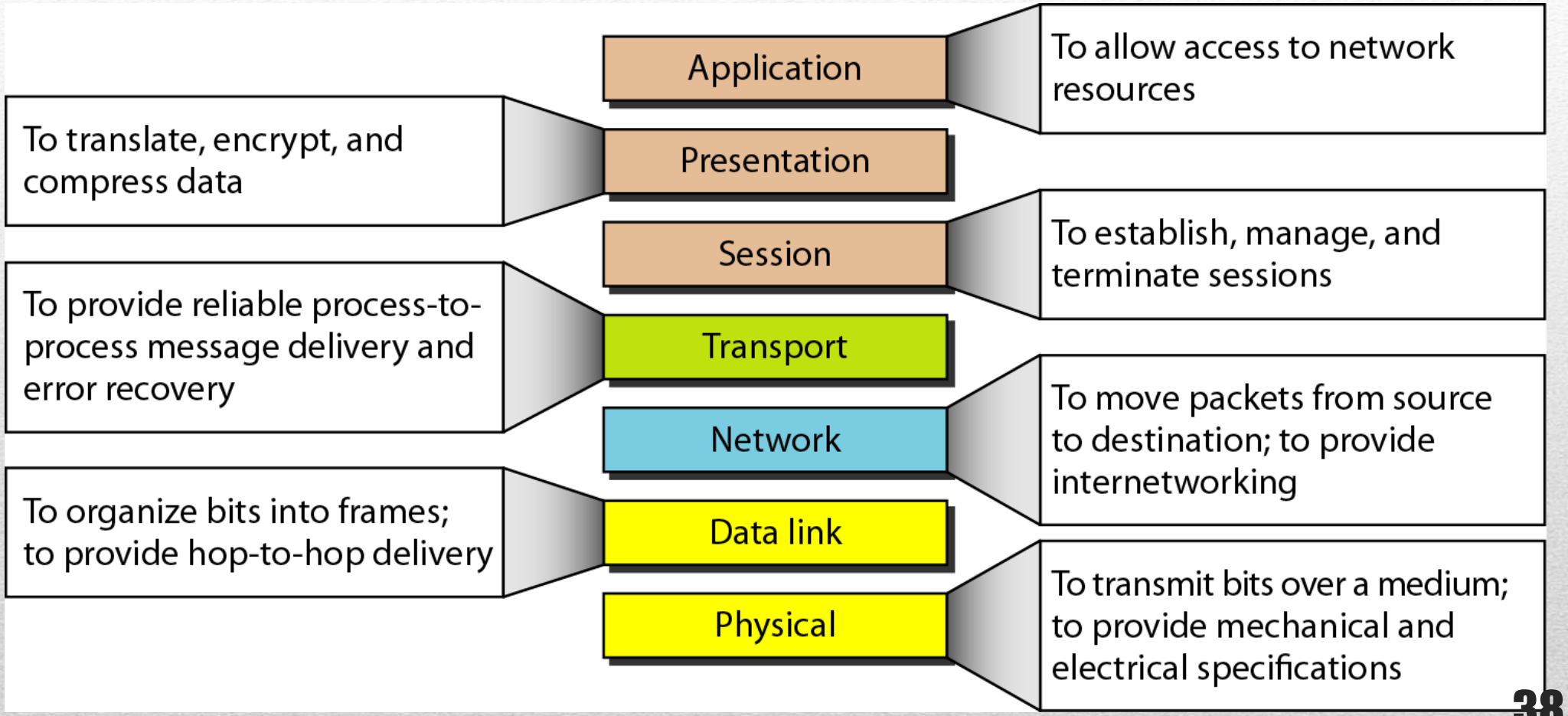
Summary of layers



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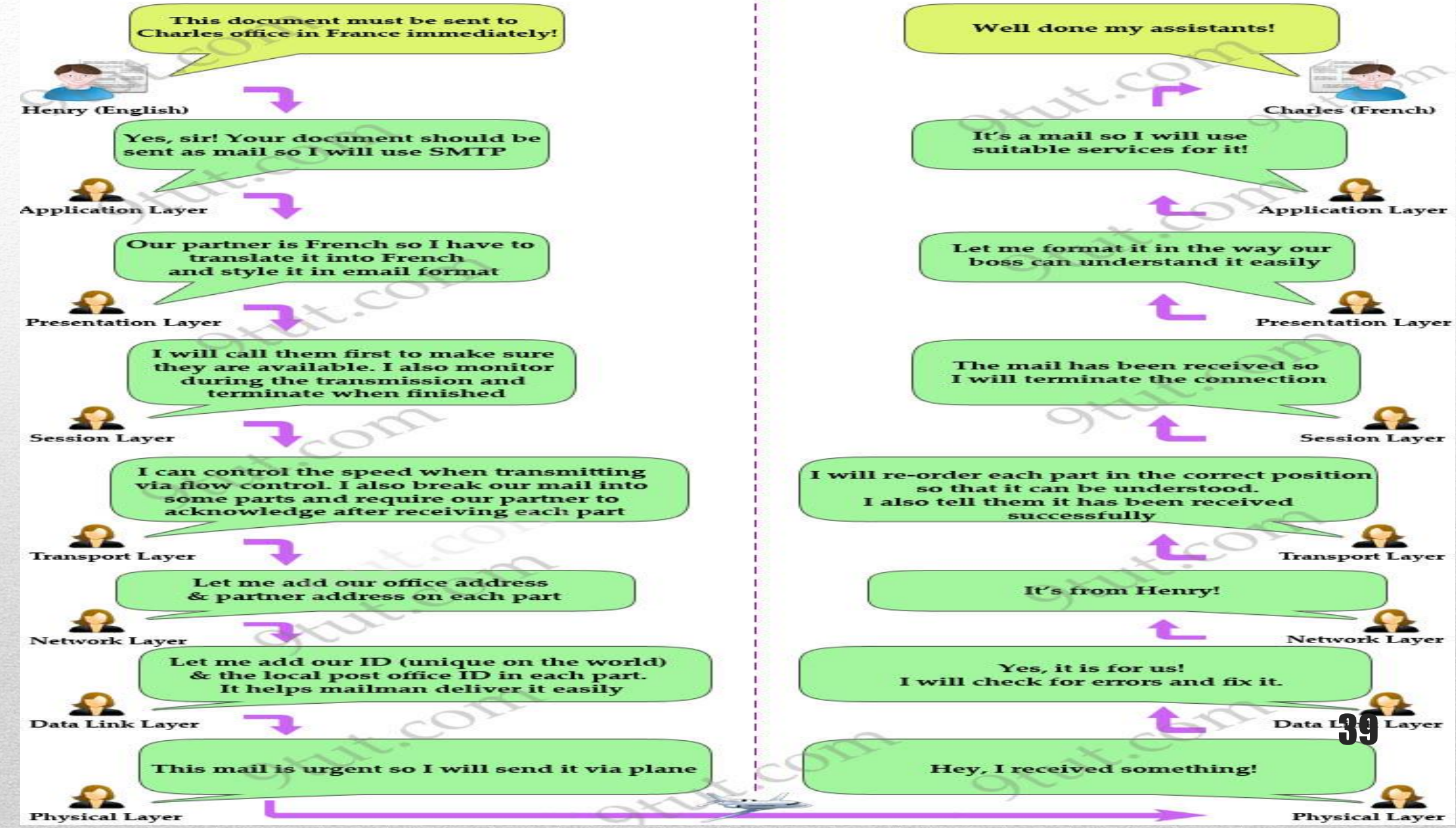

This document must be sent to Charles office in France immediately!
Henry (English)
Yes, sir! Your document should be sent as mail so I will use SMTP
Application Layer
Our partner is French so I have to translate it into French and style it in email format
Presentation Layer
I will call them first to make sure they are available. I also monitor during the transmission and terminate when finished
Session Layer
I can control the speed when transmitting via flow control. I also break our mail into some parts and require our partner to acknowledge after receiving each part
Transport Layer
Let me add our office address & partner address on each part
Network Layer
Let me add our ID (unique on the world) & the local post office ID in each part. It helps mailman deliver it easily
Data Link Layer
This mail is urgent so I will send it via plane
Physical Layer
Well done my assistants!
Charles (French)
It's a mail so I will use suitable services for it!
Application Layer
Let me format it in the way our boss can understand it easily
Presentation Layer
The mail has been received so I will terminate the connection
Session Layer
I will re-order each part in the correct position so that it can be understood. I also tell them it has been received successfully
Transport Layer
It's from Henry!
Network Layer
Yes, it is for us! I will check for errors and fix it.
Data Link Layer
Hey, I received something!
Physical Layer

TCP/IP PROTOCOL

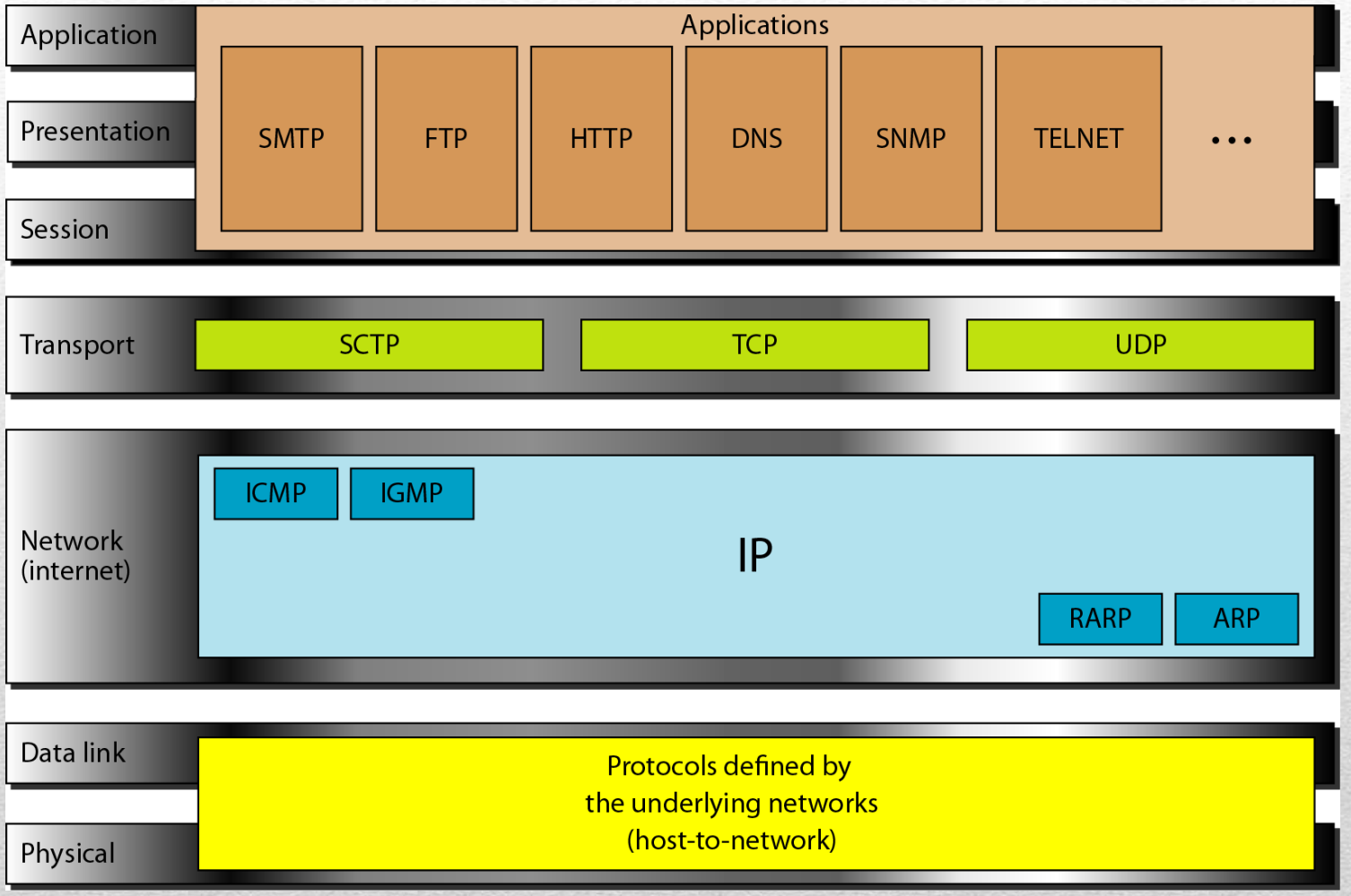
DATA COMMUNICATION AND NETWORKING

TCP/IP PROTOCOL SUITE

- The TCP/IP is compared to OSI, we can say that the TCP/IP protocol suite is made of five layers: physical, data link, network, transport, and application.

- **Topics discussed in this section:**
- Physical Layer
- Data Link Layer
- Network Layer
- Transport Layer
- Application Layer

TCP/IP and OSI model



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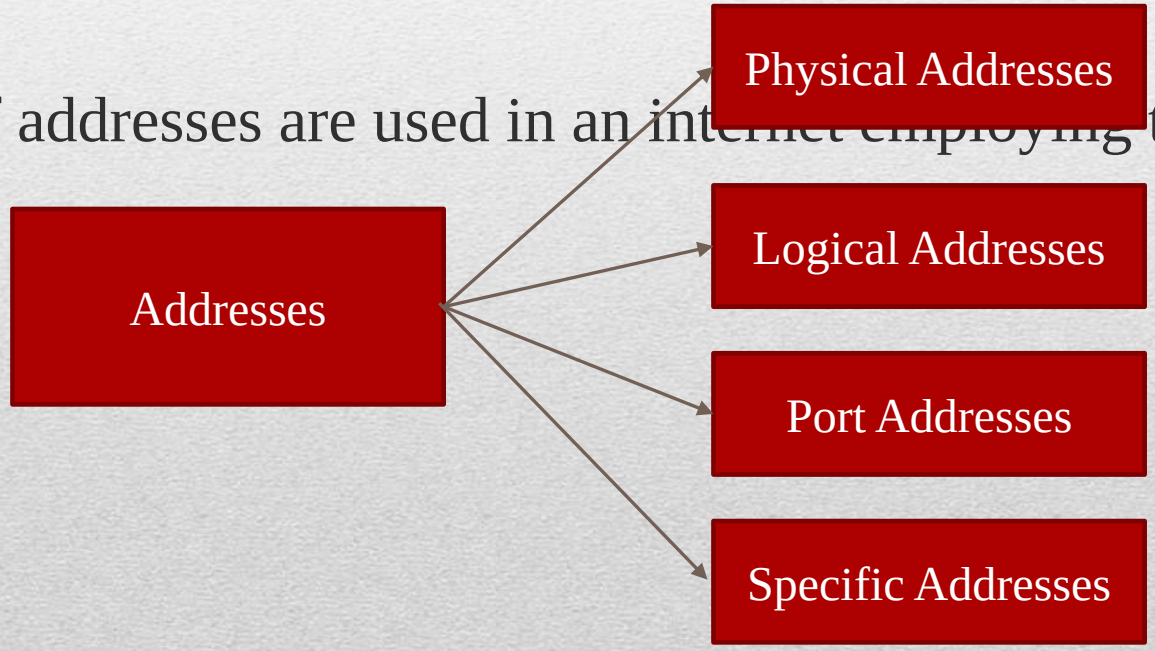
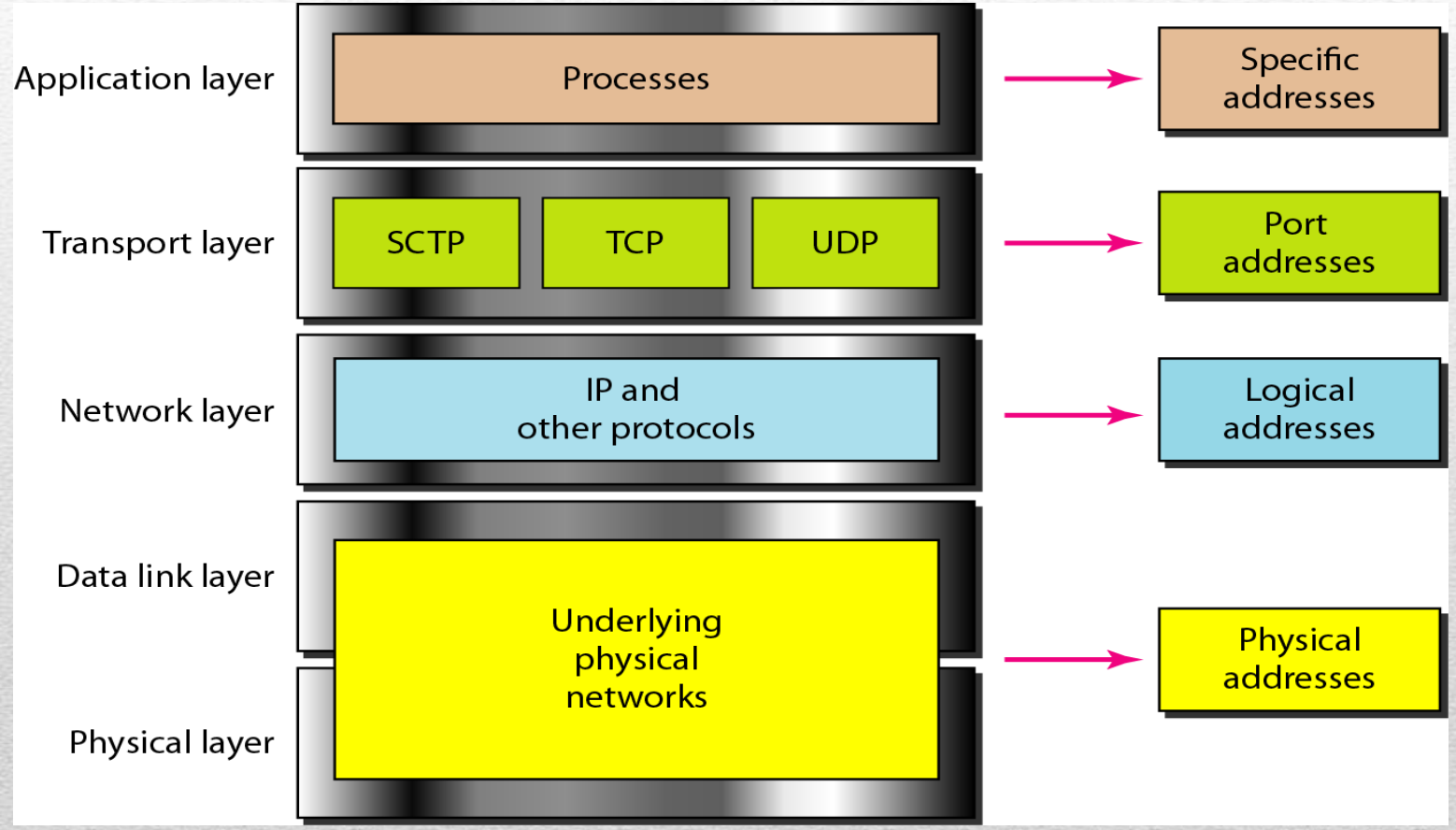
Addressing

Four levels of addresses are used in an internet employing the TCP/IP protocols



Relationship of layers and address TCP/IP



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MAC address or Physical address

Most local-area networks use a 48-bit (6-byte) **physical address** written as 12 hexadecimal digits; every byte (2 hexadecimal digits) is separated by a colon, as shown below:

07:01:02:01:2C:4B

A 6-byte (12 hexadecimal digits) physical address

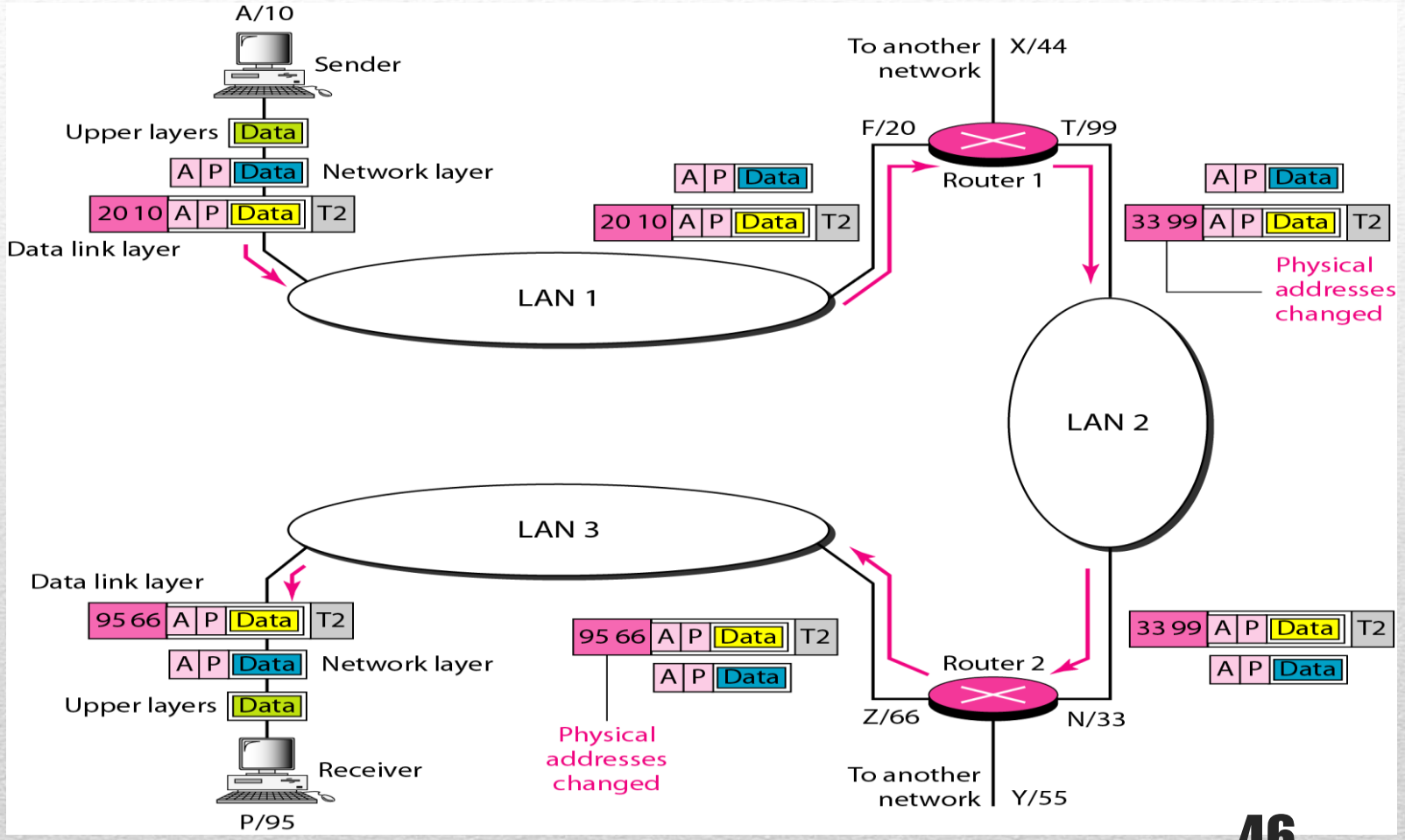
Source: Data Communications and Networking – Behrouz A. Forouzan

IP Address

The physical addresses will change from hop to hop, but the logical addresses usually remain the same.

A logical address is a 32-bit(IPv4) or 128-bit(IPv6).

Examples
IPv4: 192.168.2.33
IPv6:
2dbe:ab67:237f:50cd:83fd:ab34:92bd:66ca



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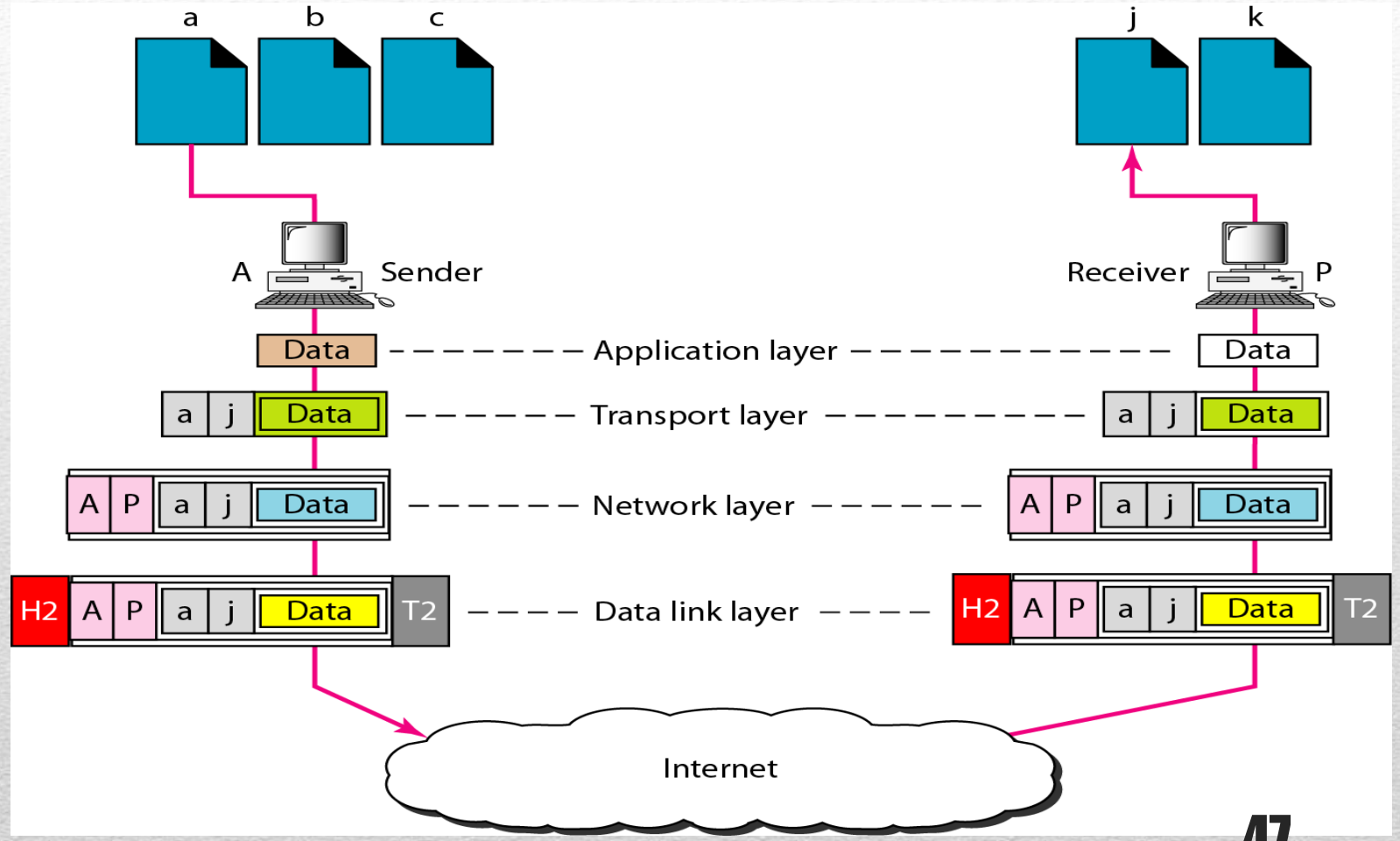
Port address

A port address is a 16-bit address represented by one decimal number. Ex.753
A 16-bit port address represented as single number.



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Thank You