

Data communications

Chapter 2

Network Models

by NTR

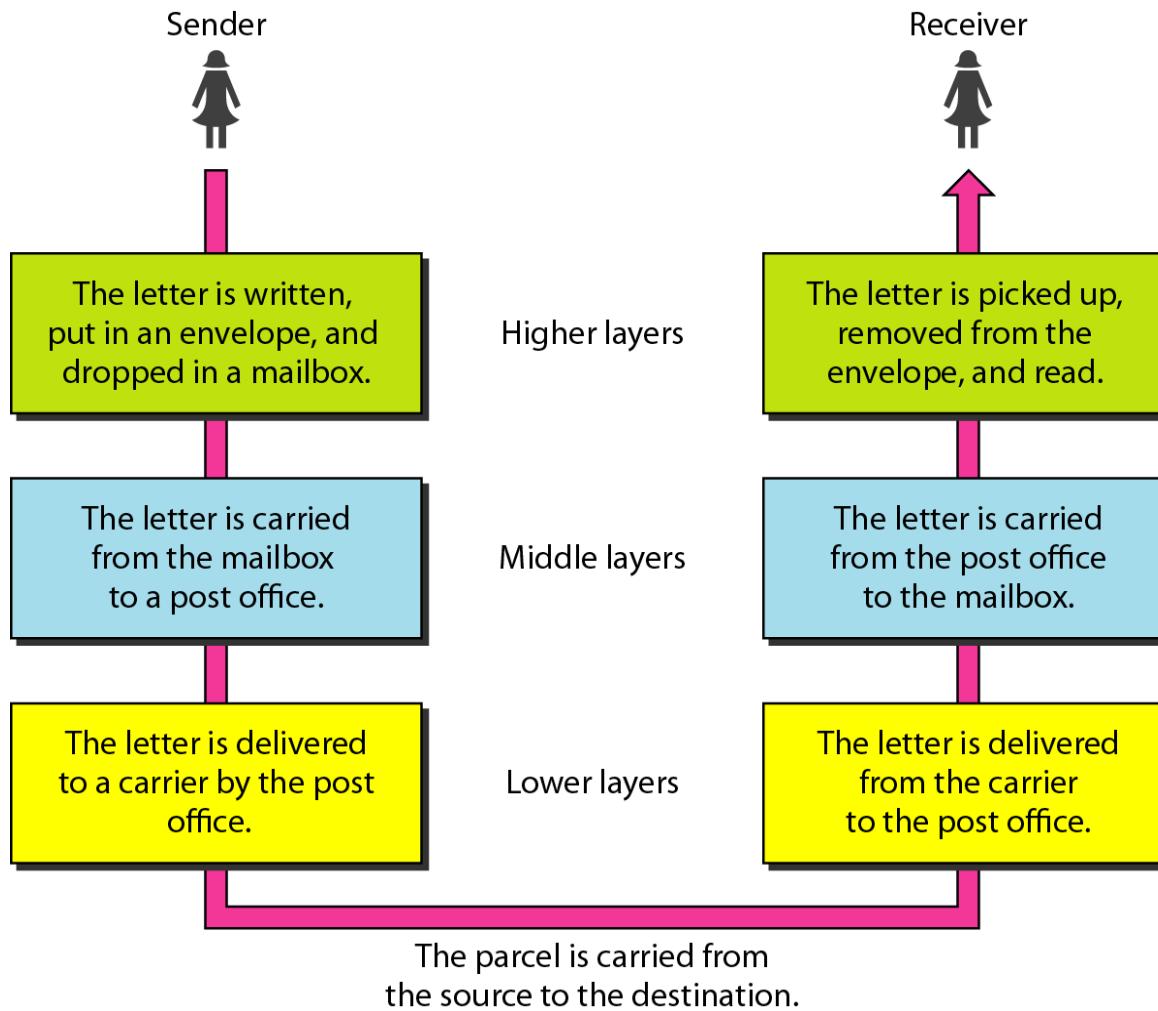
LAYERED TASKS

*We use the concept of **layers** in our daily life. As an example, let us consider two friends who communicate through postal mail. The process of sending a letter to a friend would be complex if there were no services available from the post office.*

Topics discussed in this section:

**Sender, Receiver, and Carrier
Hierarchy**

Tasks involved in sending a letter

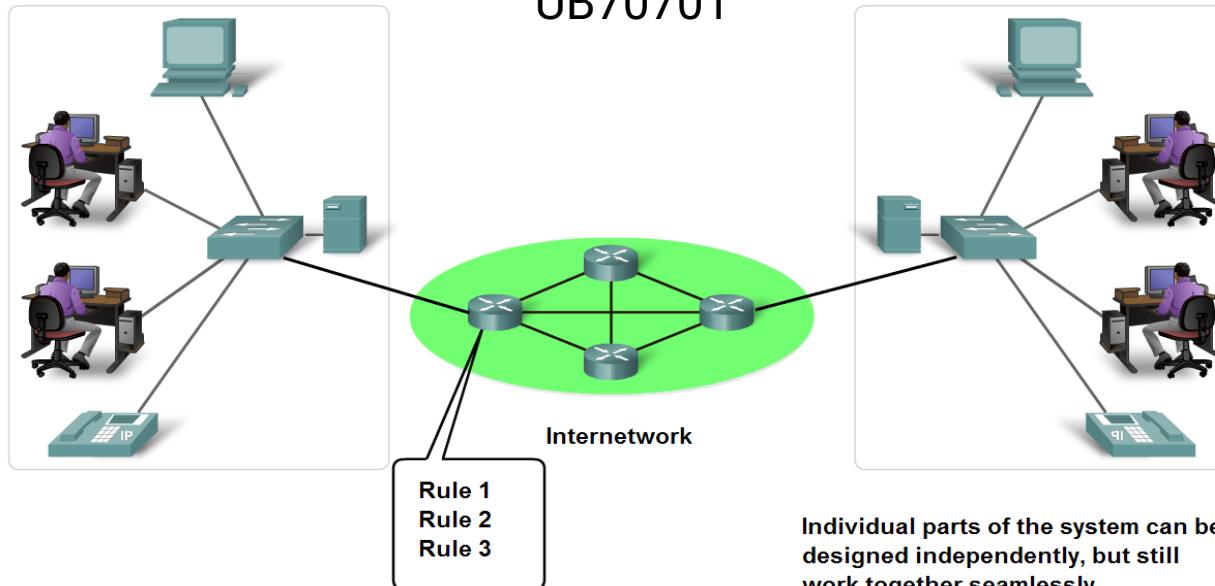


Benefits of using a layered model

- Layering means decomposing the problem into more manageable components(Layers).
 - To find out the **fault** easily.
 - **Changes** in one layer do not affect other layers.
 - It provides more modular design.

Using a layered model helps in the design of complex, multi-use, multi-vendor networks.

UB70701



Protocols

- It is a set of rules that governs data communication.
- The protocol in each layer governs the activities of the data communication.

Protocols and Standards

- **Protocols**
- **Standards**
- **Standards Organizations**
- **Internet Standards**

Standards

- Endorsed by the networking industry and approved by a standards organization.
- **Benefits:**
 - Create and maintain an open and competitive market.
 - Ensured greater compatibility and interoperability.
- Categories
- **De facto:** Standards that have not been approved by an organized body but have been adopted as standards through widespread use
- **De jure:** Those standards that have been legislated by an officially recognized body

Standard Organizations

- International Organization for Standardization (**ISO**)
- Institute of Electrical and Electronic Engineers (**IEEE**)
- American National Standards Institute (**ANSI**)
- Telecommunications Industry Association (**TIA**)
- The Internet Engineering Task Force (**IETF**)
- International Telecommunications Union –
Telecommunication Standards Sector (**ITU-T**)

Communication Process

Layered standards:

- **OSI Reference model**
 - De Jure Standard
- **TCP/IP Protocol suite**
 - Open De Facto Standard
 - Governed by IETF Working Groups

Layered Architectures

□ OSI Reference model

- The OSI model is not a protocol
- It is only a guideline and hence it is referred as OSI reference model.

□ TCP/IP Protocol suite

- TCP/IP is a hierarchical protocol made up of interactive modules, each of which provides a specific functionality.

THE OSI MODEL

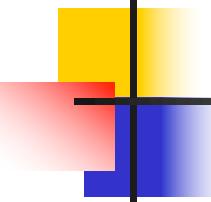
- *Established in 1947, the International Standards Organization (ISO) is a multinational body dedicated to worldwide agreement on international standards. An ISO standard that covers all aspects of network communications is the Open Systems Interconnection (OSI) model. It was first introduced in the late 1970s.*
- *An open system is a set of protocols that allows any two different systems to communicate regardless to their underlying architecture.*

Topics discussed in this section:

Layered Architecture

Peer-to-Peer Processes

Encapsulation



Note

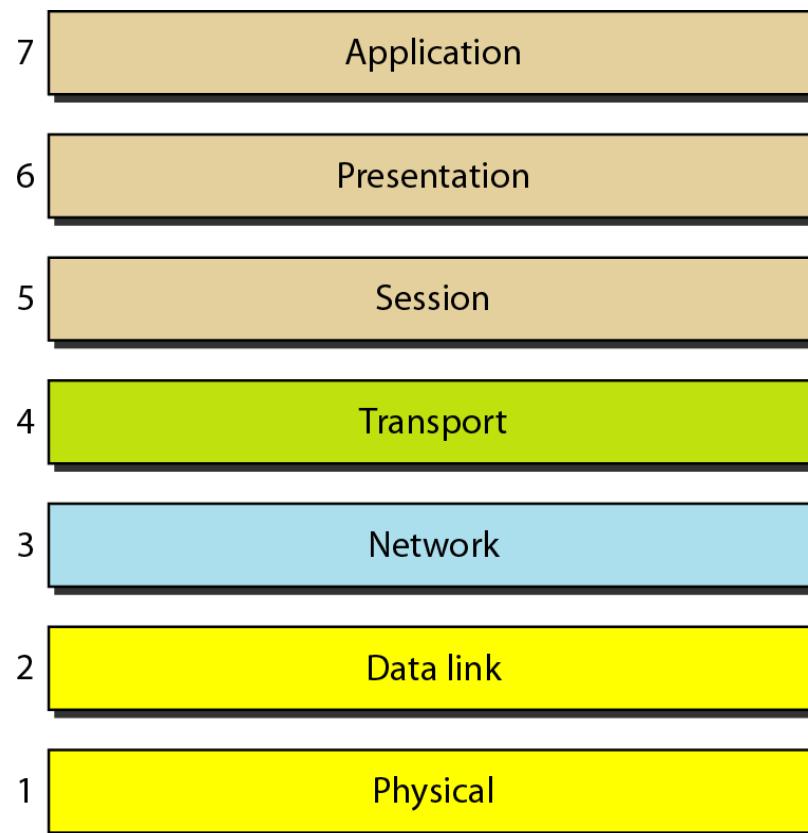
**ISO is the organization.
OSI is the model.**

THE OSI MODEL

- The OSI model is not a protocol, it is a model for understanding and designing a network architecture that is flexible, robust, and interoperable.

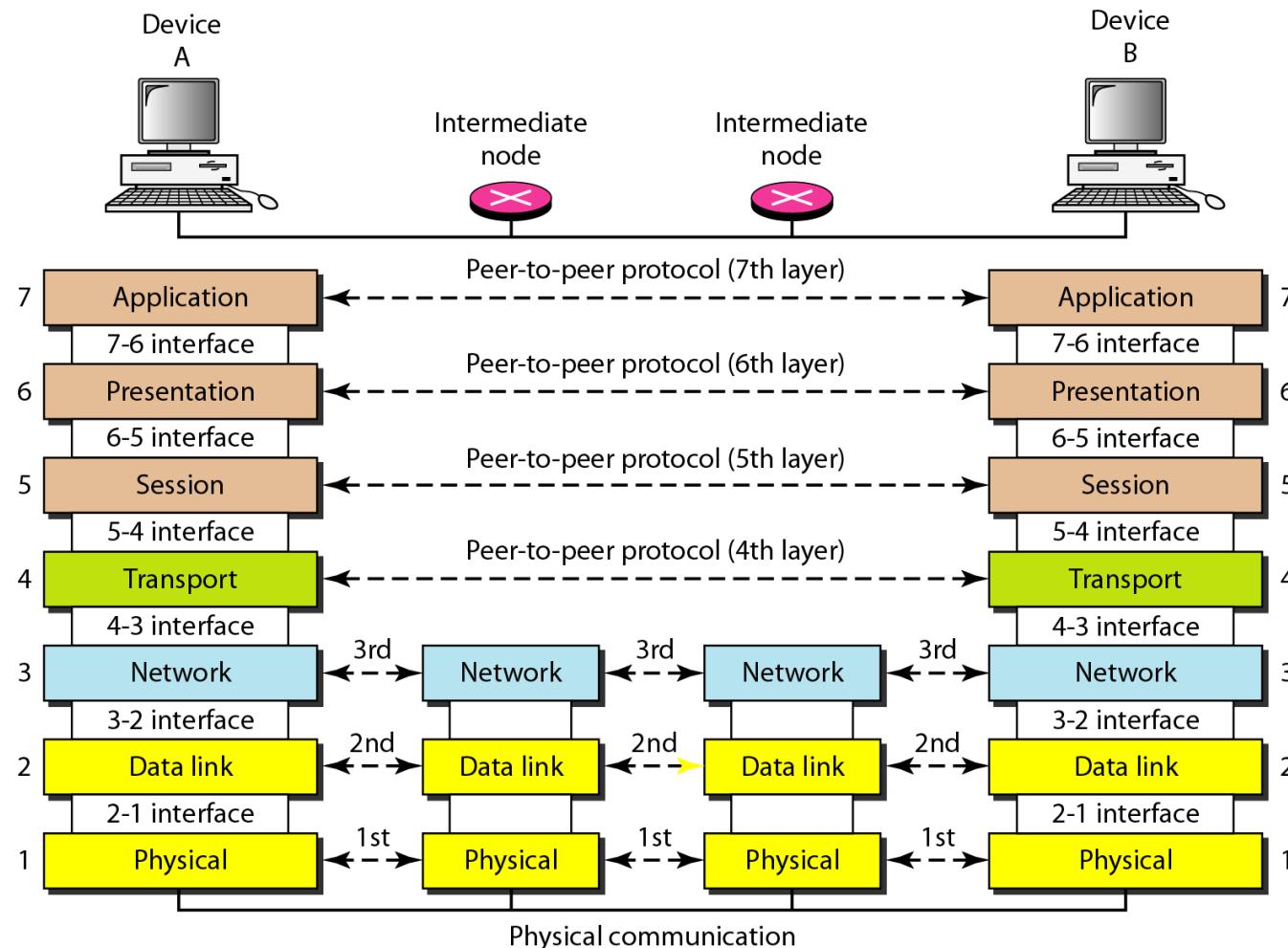
Layered Architecture: Seven layers of the OSI model

In layered Architecture, a particular layer uses the services provided by its lower layer and provides services for its upper layer



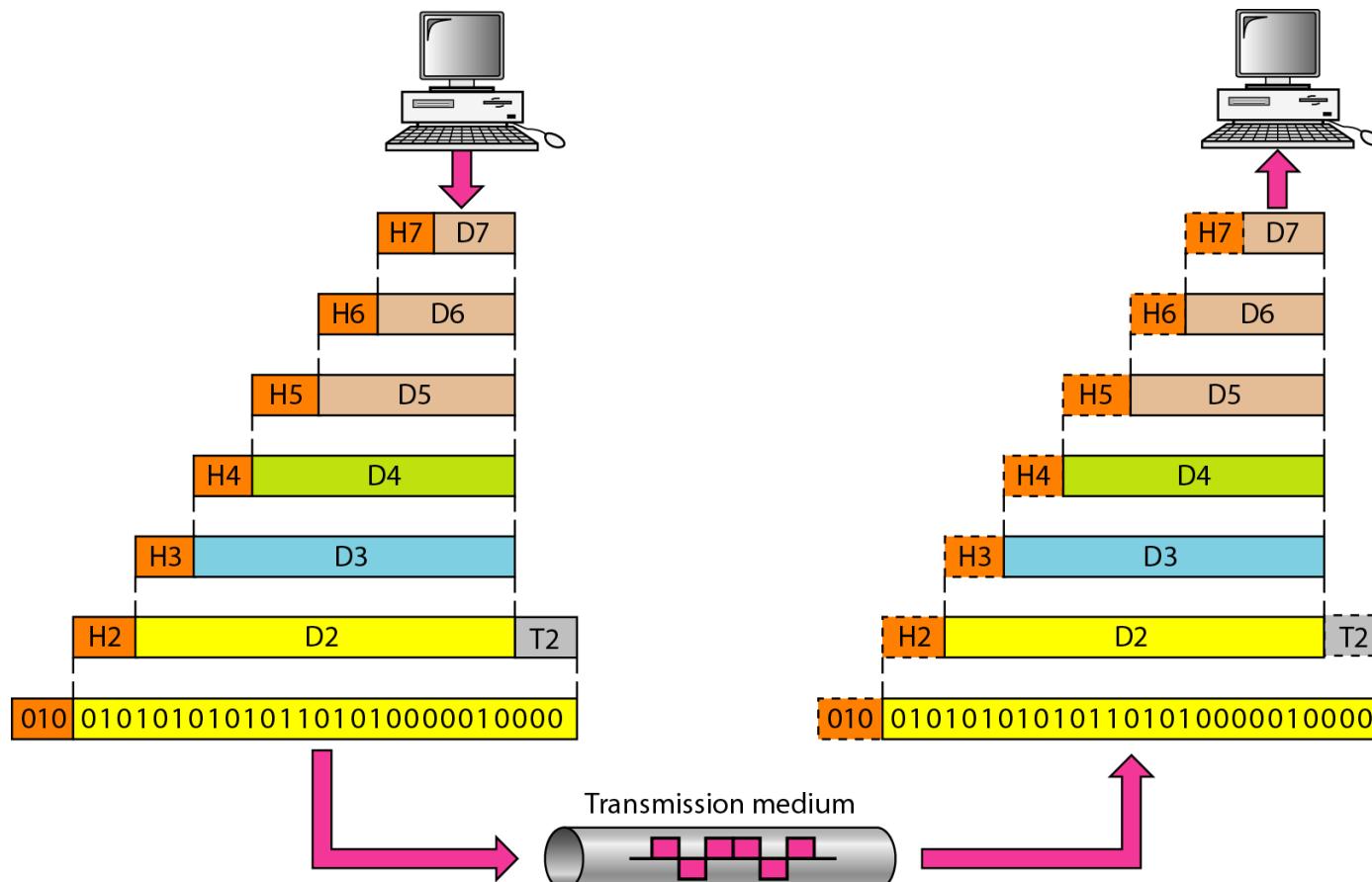
The interaction between layers in the OSI model

The processes on each machine that communicate at a given layer are called **peer-to-peer processes**.
Each layer communicates only with its peer layer on the receiving device.



Encapsulation: An exchange using the OSI model

The data portion of a packet at level n-1 carries the whole packet (data and header and maybe trailer) from level n. The concept is called encapsulation.



LAYERS IN THE OSI MODEL

In this section we briefly describe the functions of each layer in the OSI model.

Topics discussed in this section:

Physical Layer

Data Link Layer

Network Layer

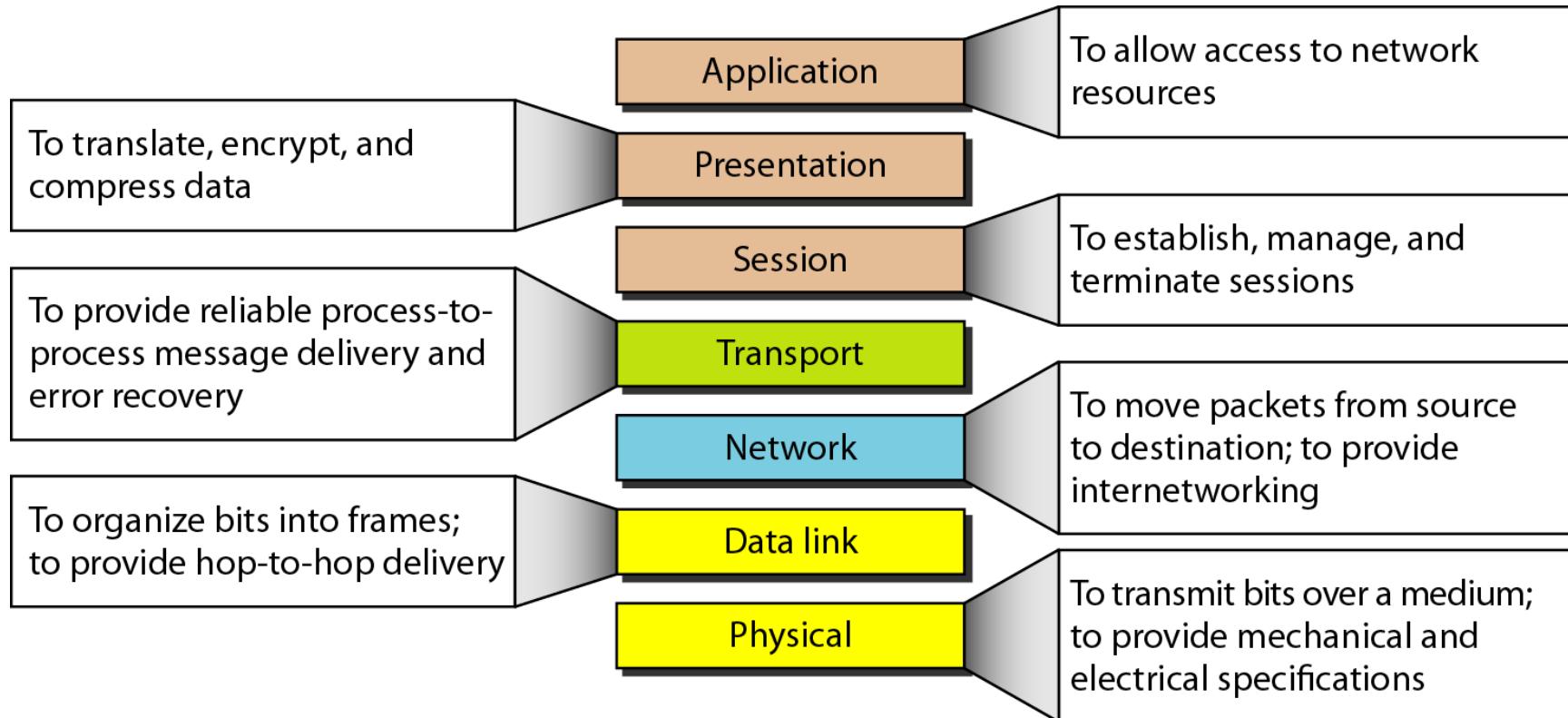
Transport Layer

Session Layer

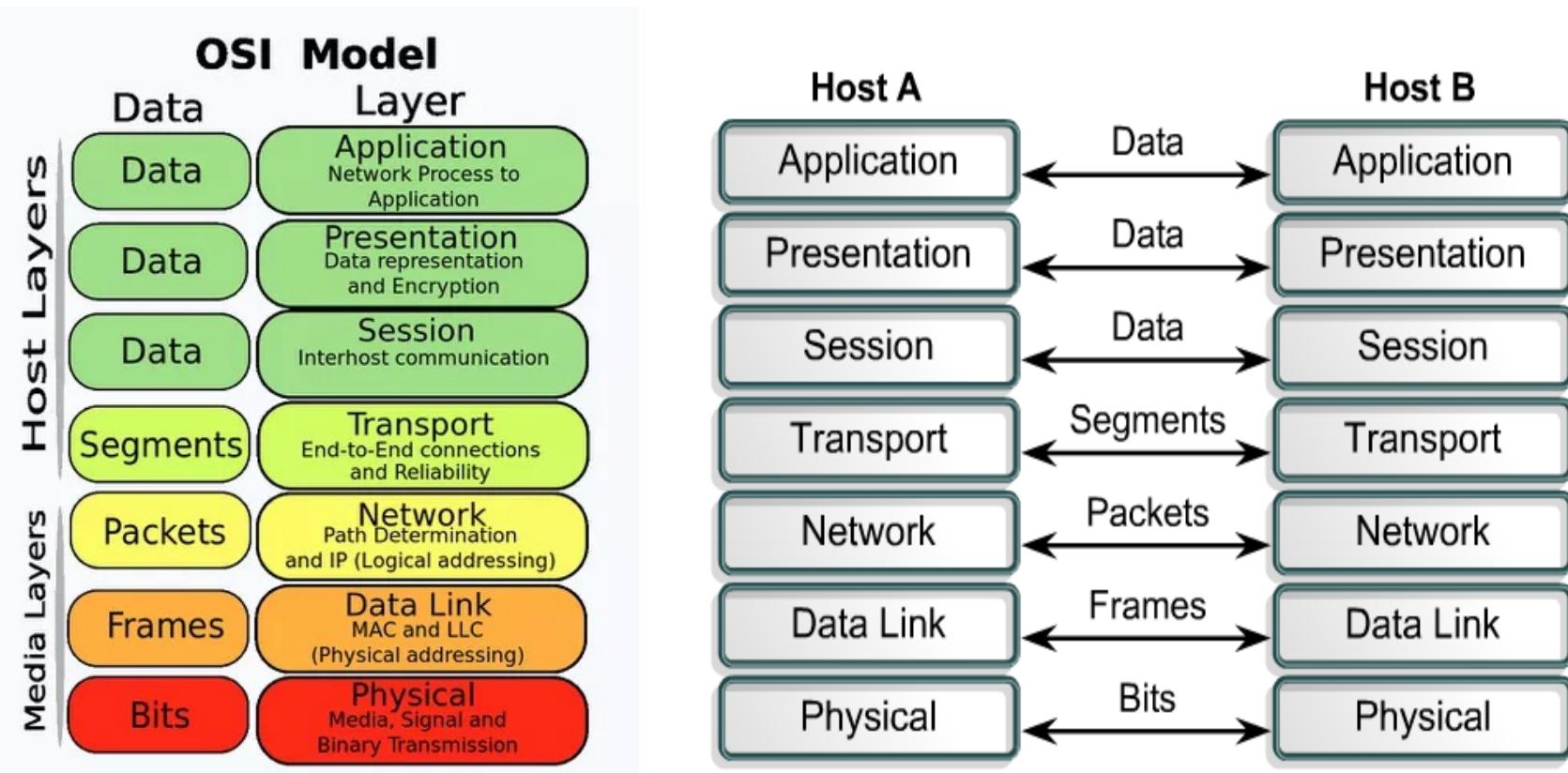
Presentation Layer

Application Layer

Summary of layers

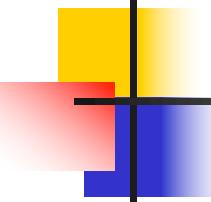


LAYERS IN THE OSI MODEL



OSI Model- 7 Layers

Layers		<u>CISCO</u>
7	Application	All
6	Presentation	People
5	Session	Seem
4	Transport	To
3	Network	Need
2	Data Link	Data
1	Physical	Processing

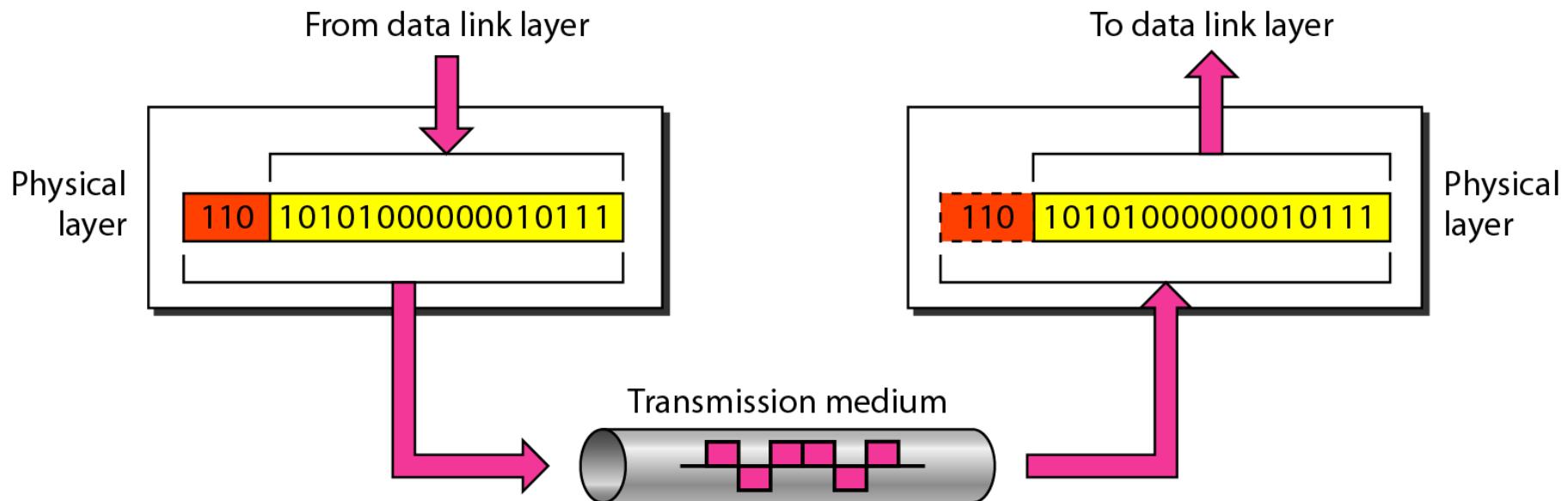


Physical Layer

Note

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

Physical layer



Physical layer

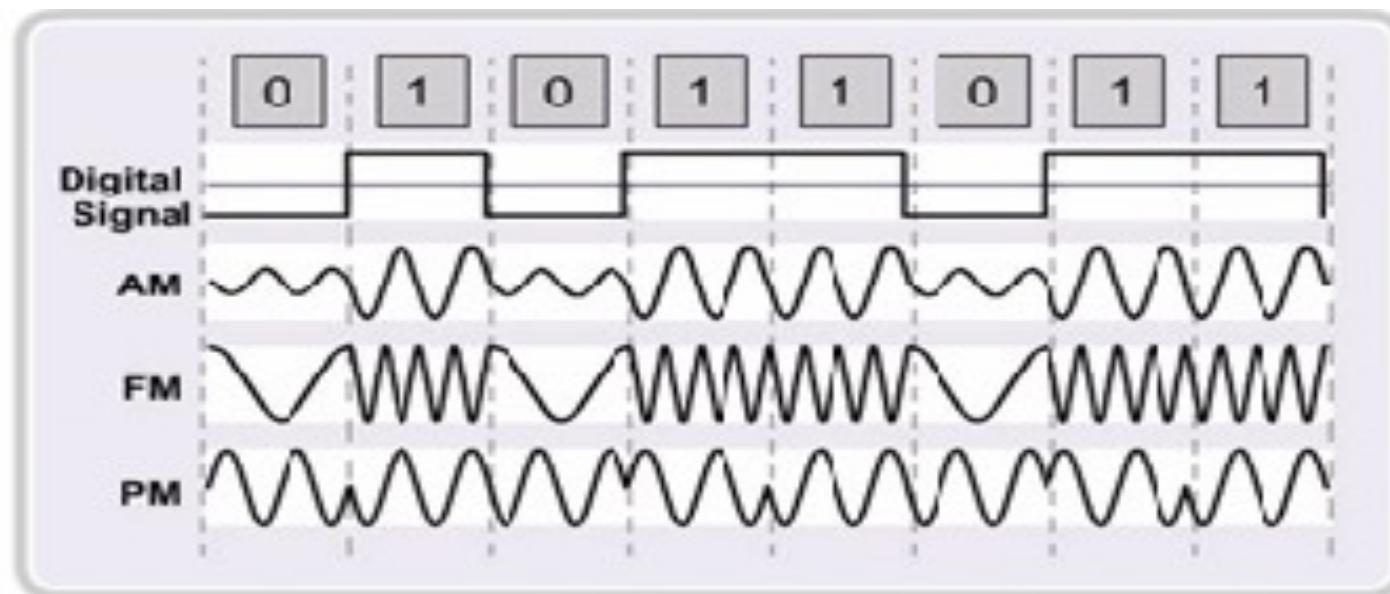
- Coordinates the functions required to carry a bit stream over a physical medium.
- It deals with the mechanical and electrical specifications of the interface and transmission medium.
- It also defines the procedures and functions that physical devices and interfaces have to perform for transmission.

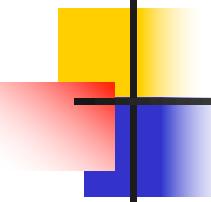
Physical layer- Responsibilities:

- Physical characteristics of Interfaces and medium
- Representation of bits (Encoded into signals- electrical or optical)
- Data transfer rate (bits per second and duration)
- Synchronization of bits (clock sync of Sender and receiver)
- Line Configuration (point to point multipoint)
- Physical topology (Bus, Ring, Star, Mesh)
- Transmission Mode (simplex, Half and full duplex))

Physical layer- Representation of bits

- Amplitude modulation (AM)
- Frequency modulation (FM)
- Phase modulation (PM)



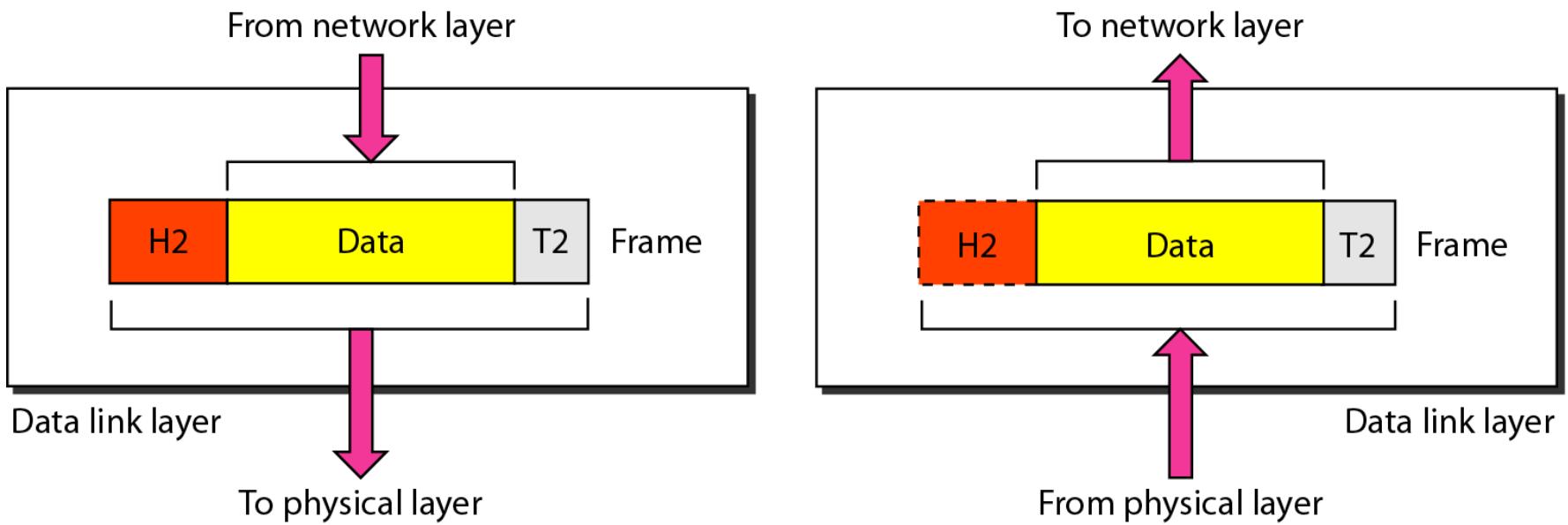


Data link Layer

Note

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

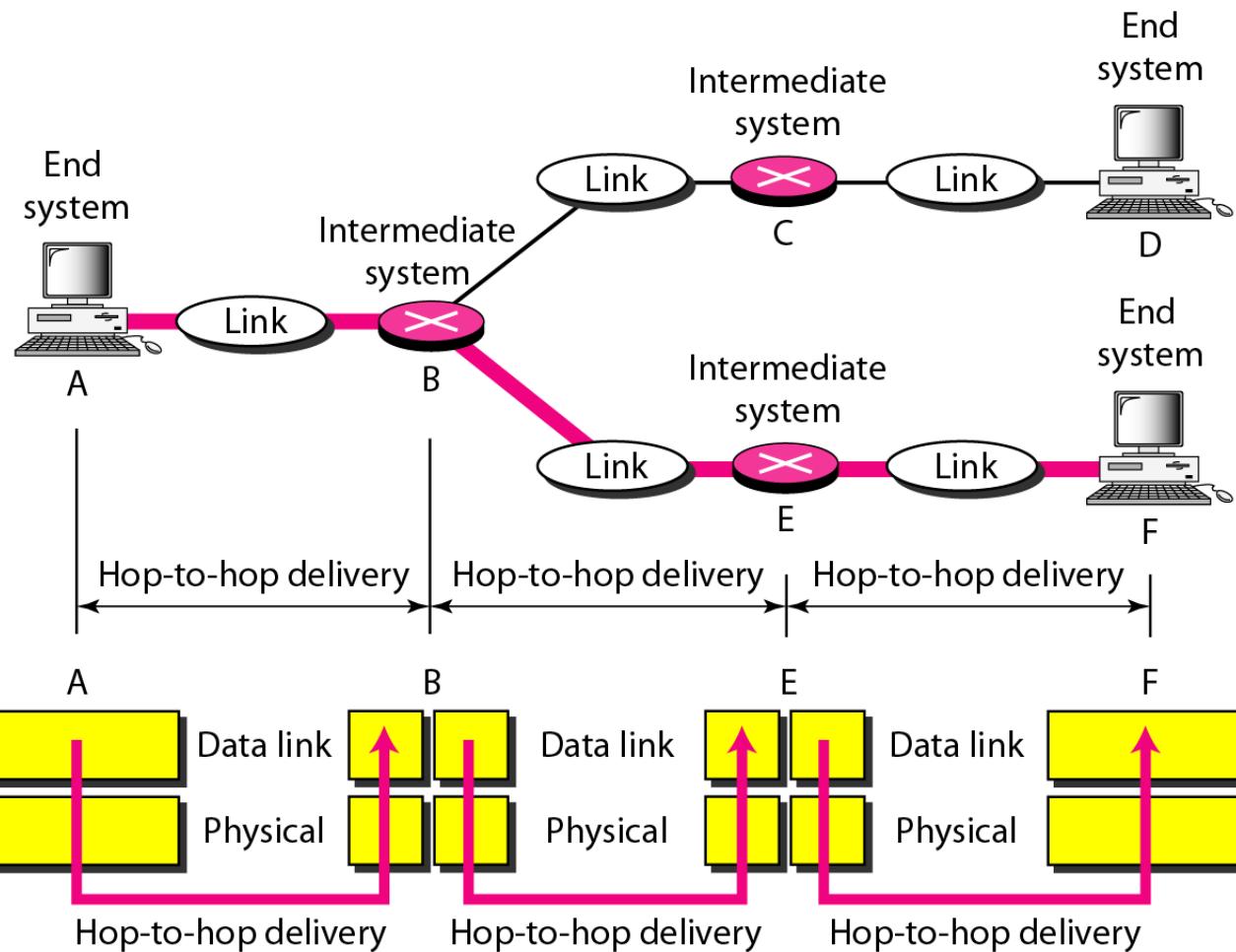
Data link layer



Data Link layer

- It makes the physical layer appear error free to upper layer (Network layer)
- The data link layer oversees the delivery of the frames between two systems on the same network
- Responsibilities:
 - Framing
 - Physical Addressing
 - Flow Control (maintain data transfer rate)
 - Error Control (detect and re-transmit the lost frame)
 - Access Control (who will get access in a given time)

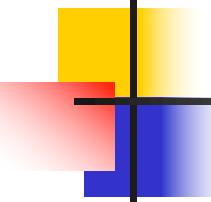
Hop-to-hop delivery



Physical Address : MAC Address

- MAC (Media Access Control) address for a device or port of a router is an unique identification number given by manufacturer.
- 48 bits long, represented by 12 hexadecimal digits.

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



Network Layer

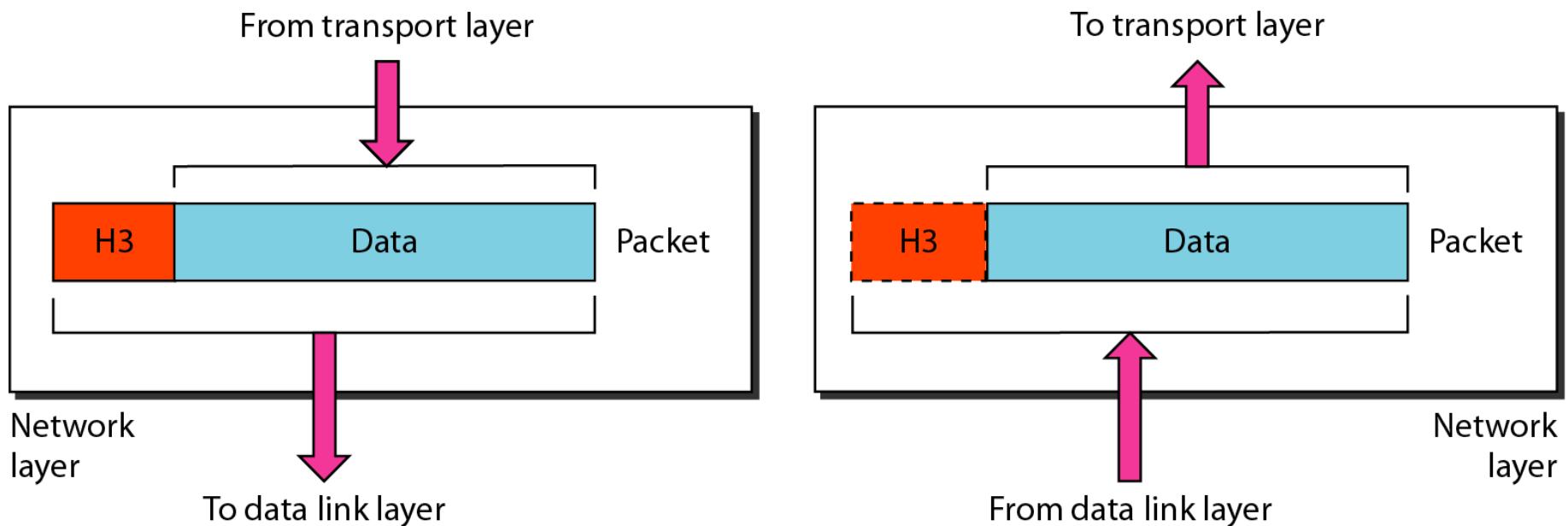
Note

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

Network layer

- It does not recognize any relationship between packets. It treats each packet independently as though each piece belonged to a separate message.
- Responsibilities:
 - Logical Addressing(unique for a device)
 - Routing(which path to take)

Network layer



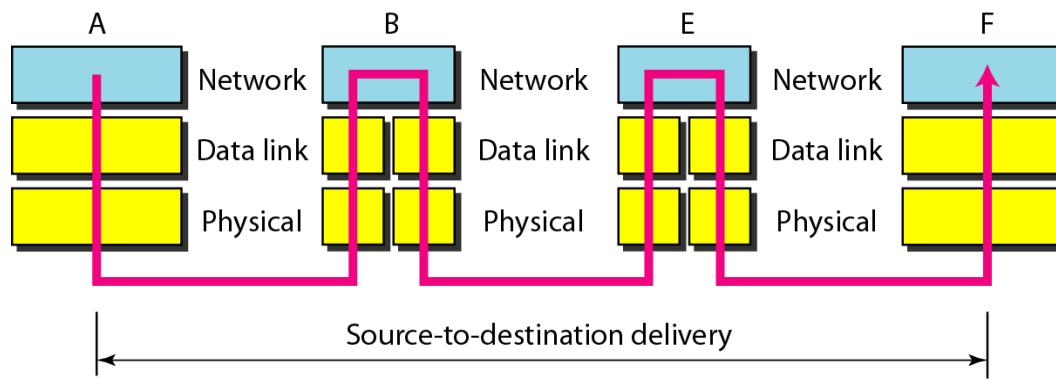
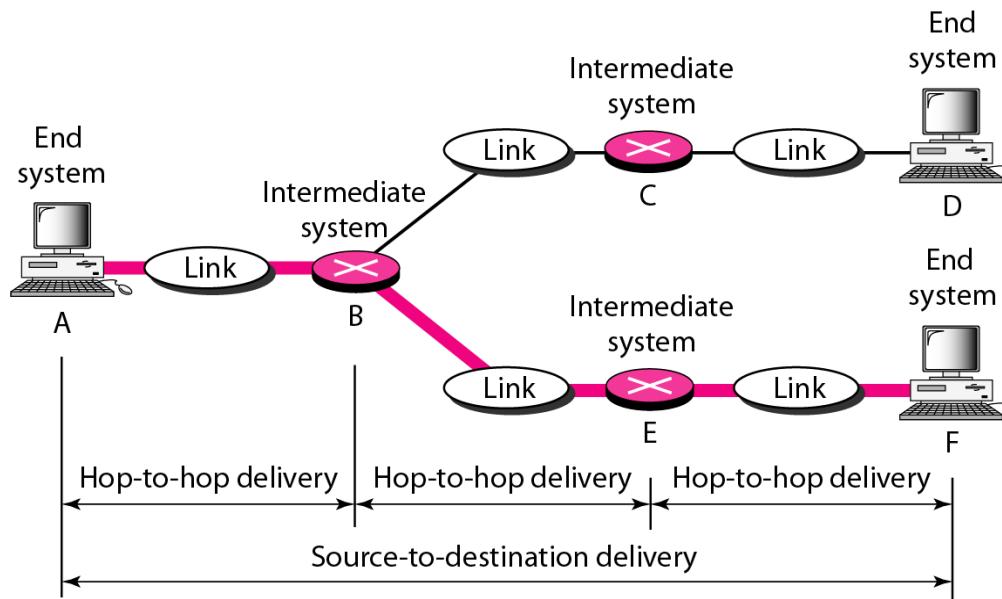
Logical Addresses :: IP Address

- Universal address, each host uniquely defined.
- 32-bit address also known as **IP Address**.
- Independent of underlying physical networks.
- Common Network layer Protocol is called **Internet Protocol (IP)**
- Network Layer PDU is called **Packets**.

192.168.10.1

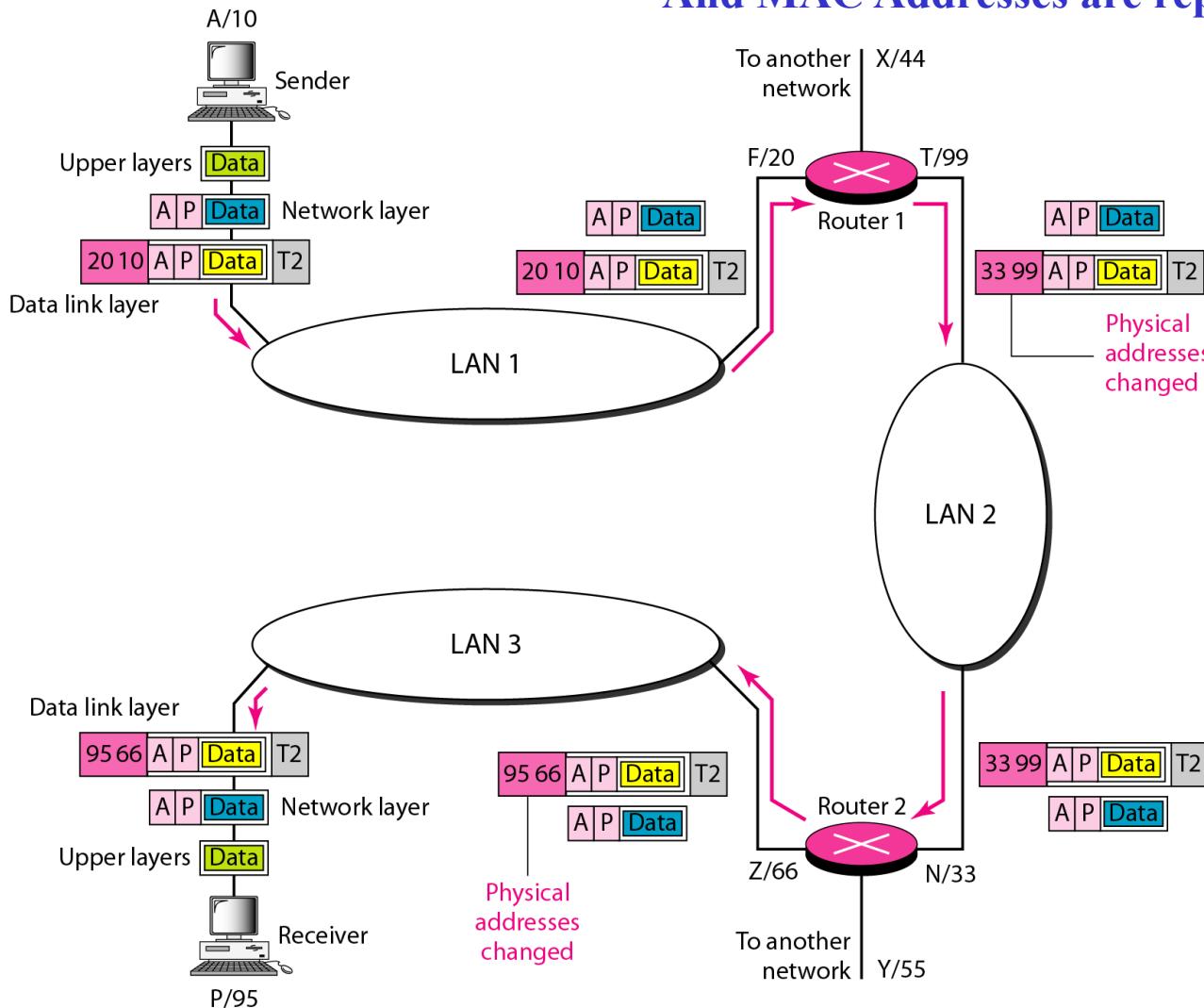
32 bits written in dotted decimal notation. Each decimal represented by 8 bits.

Source-to-destination delivery

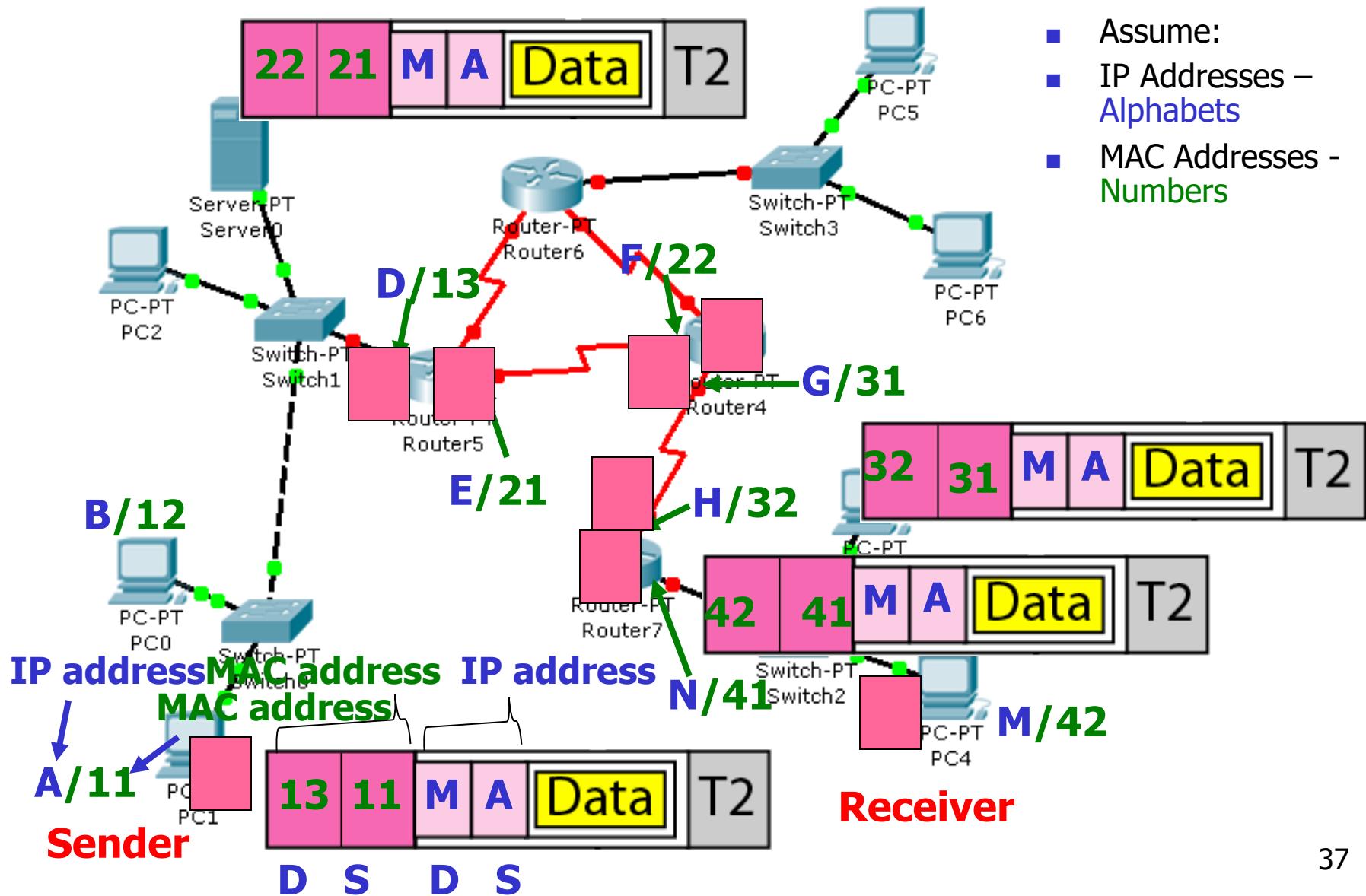


Physical and Logical Addressing

Suppose A is source and P is destination IP address
And MAC Addresses are represented by Numbers

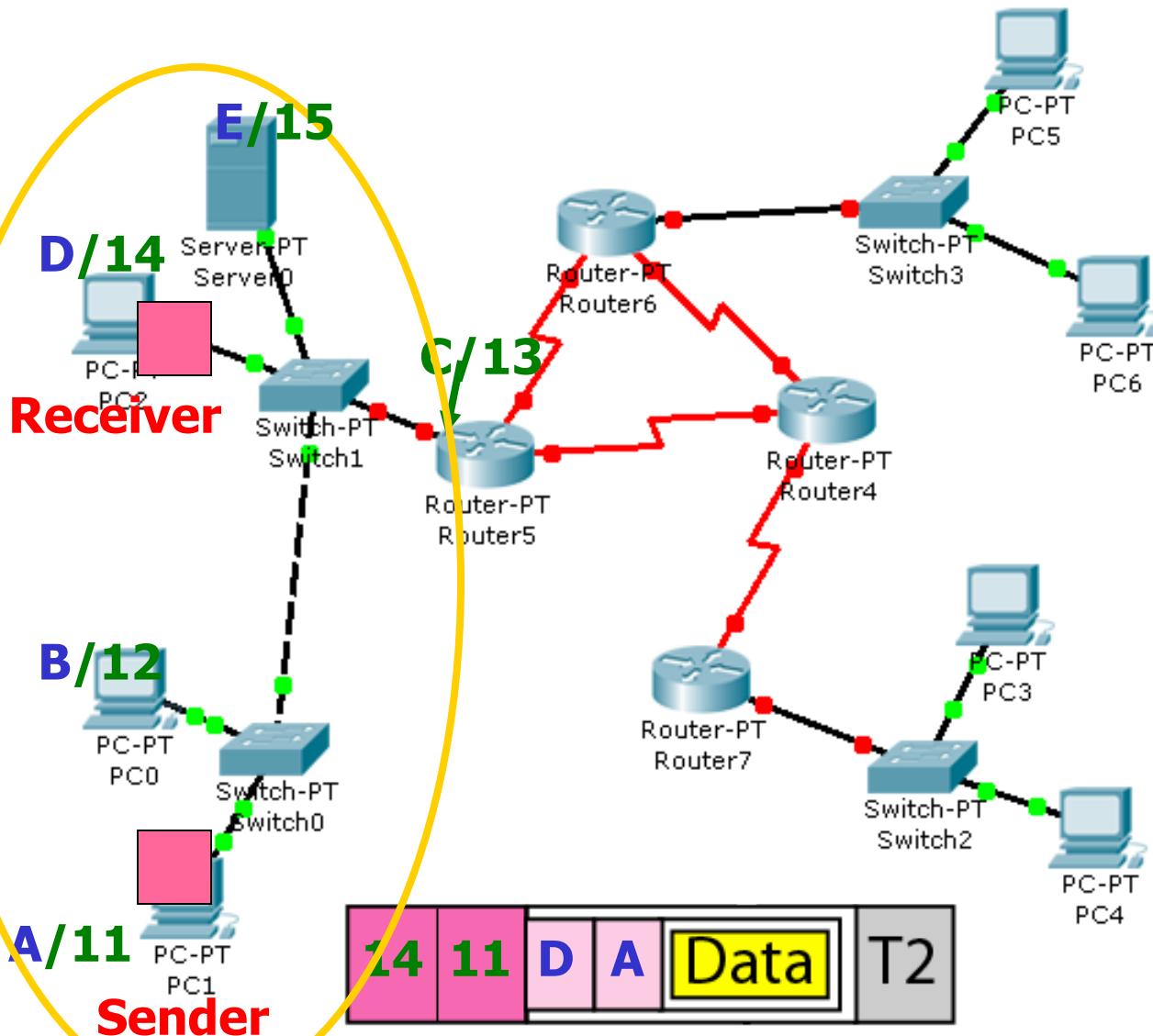


Physical and Logical Addressing (in different network)

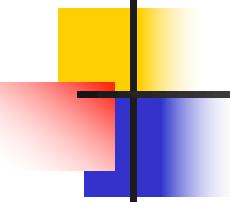


- Assume:
 - IP Addresses – Alphabets
 - MAC Addresses - Numbers

Physical and Logical Addressing (in same network)



- Assume:
- IP Addresses – Alphabets
- MAC Addresses - Numbers



Transport Layer

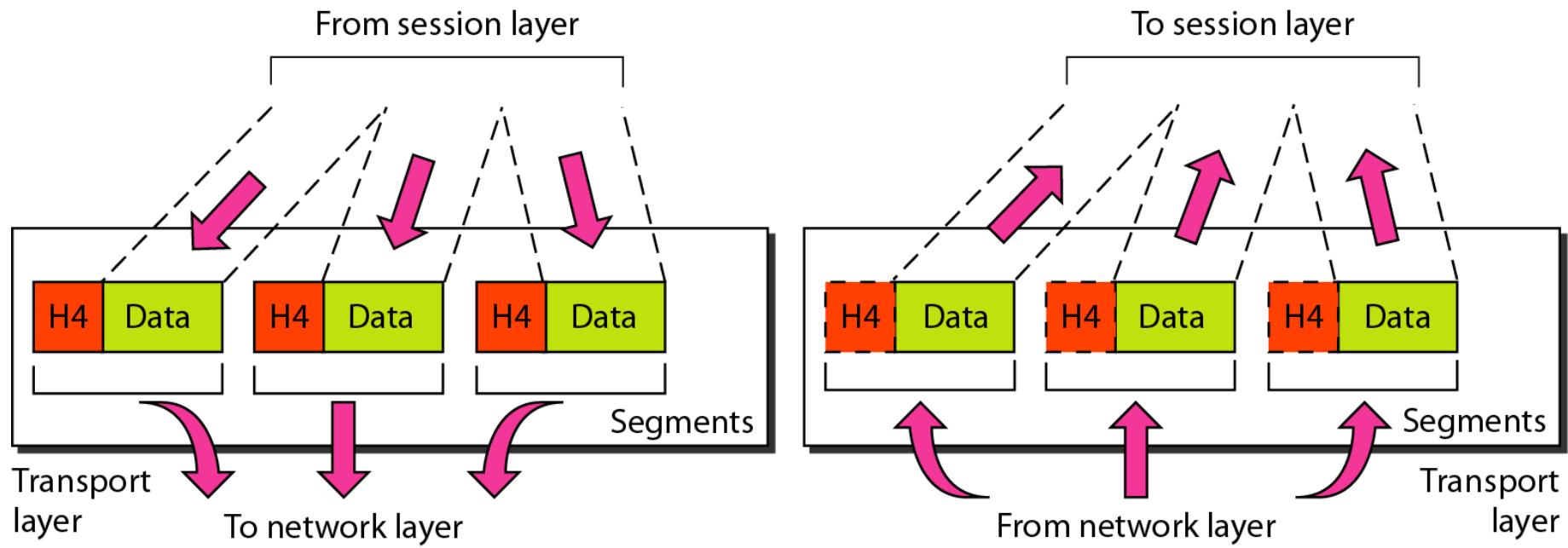
Note

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

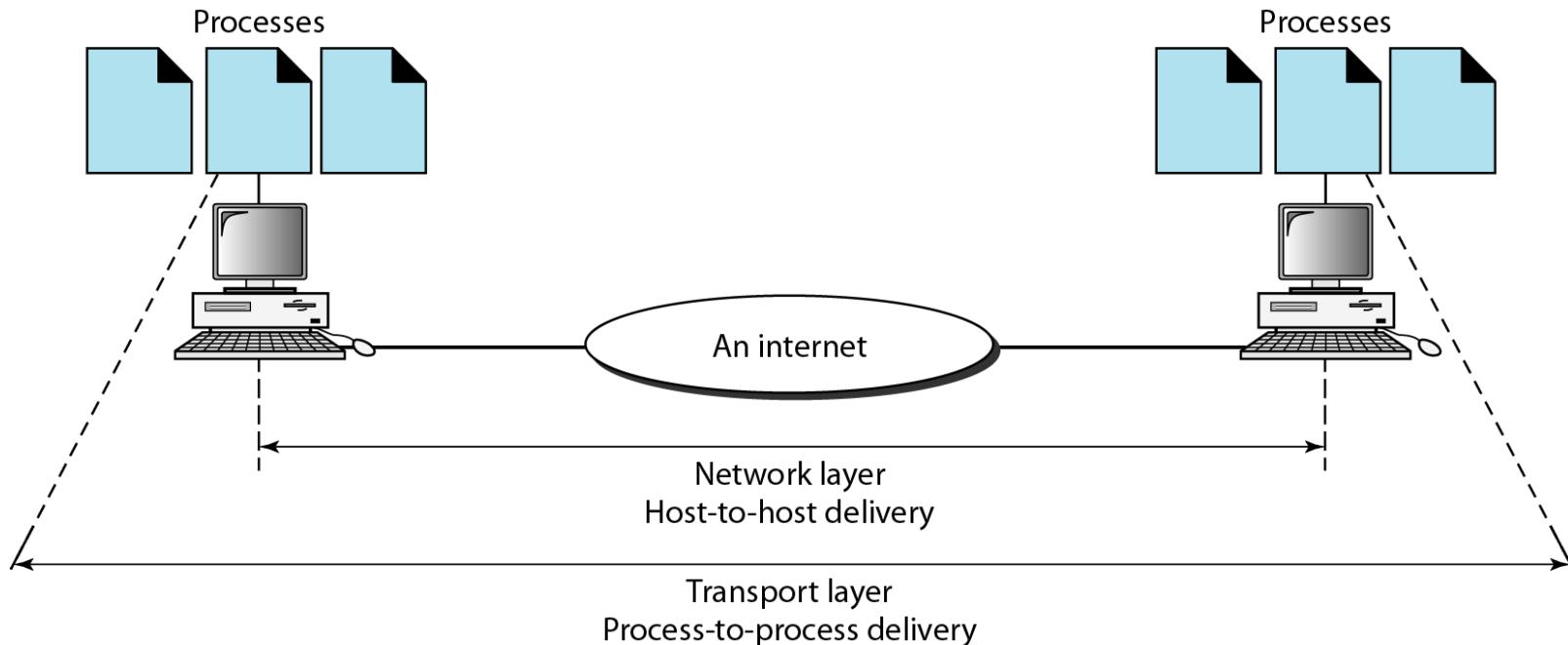
Transport layer

- The transport layer is responsible for process to process delivery of the entire message
- The transport layer ensures that the whole message arrives intact and in order
- Responsibilities:
 - Service point addressing
 - Segmentation and reassembly
 - Connection control
 - Flow control
 - Error control

Transport layer



Reliable process-to-process delivery of a message

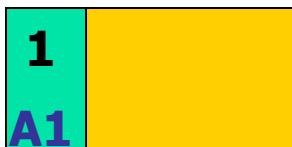


Segmentation



Data from Application
layer

Received by Transport
Layer



1

2

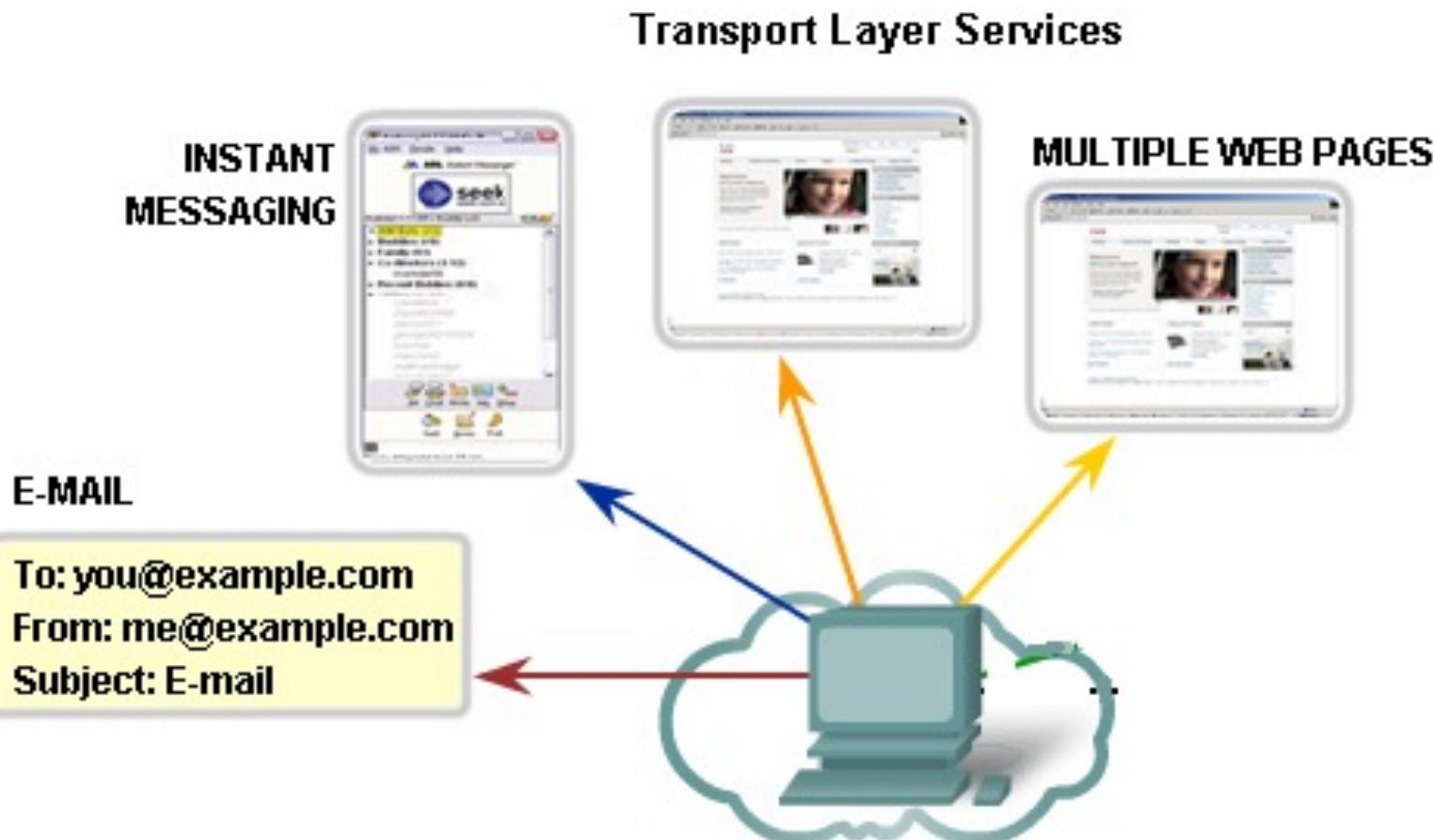
3

Segments into small parts

Add a number to identify
the application.

Add a number sequence
the segmented parts.

Identifying Different Applications



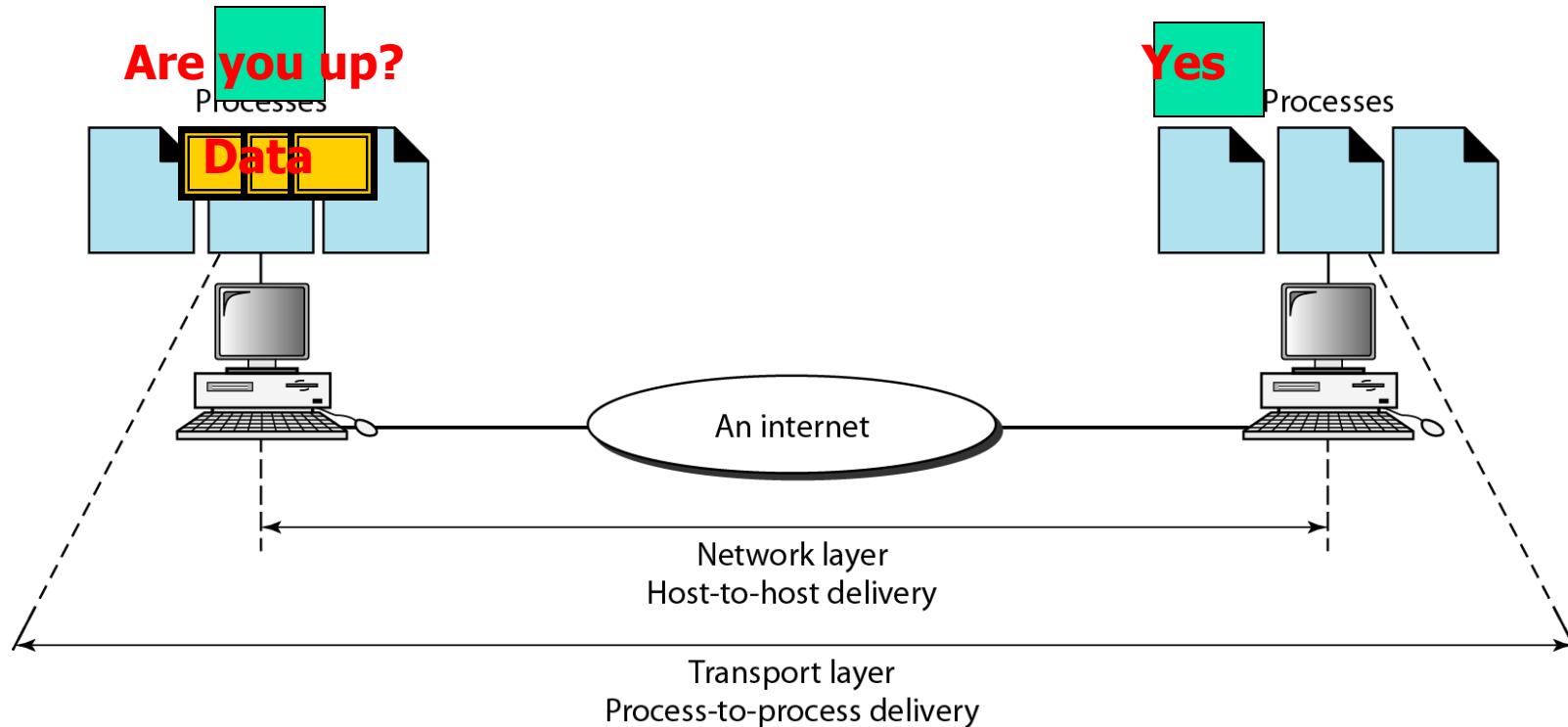
■ Port Numbers

Port Address

- To define multiple processes running in a computer.
- 16-bit in length
- A 16-bit port address represented as one single number.

Port Number(s)	Protocol	Port Type
21	FTP	TCP, UDP
22	SSH	TCP, UDP
23	Telnet	TCP, UDP
25	SMTP	TCP, UDP
53	DNS	TCP, UDP
67/68	DHCP	UDP
80	HTTP	TCP, UDP
110	POP3	TCP, UDP
137-139	NetBIOS/NetBT	TCP, UDP
143	IMAP	TCP
161/162	SNMP	TCP, UDP
389	LDAP	TCP, UDP
427*	SLP	TCP, UDP
443	HTTPS	TCP, UDP
445	SMB/CIFS	TCP
548	AFP	TCP
3389	RDP	TCP, UDP

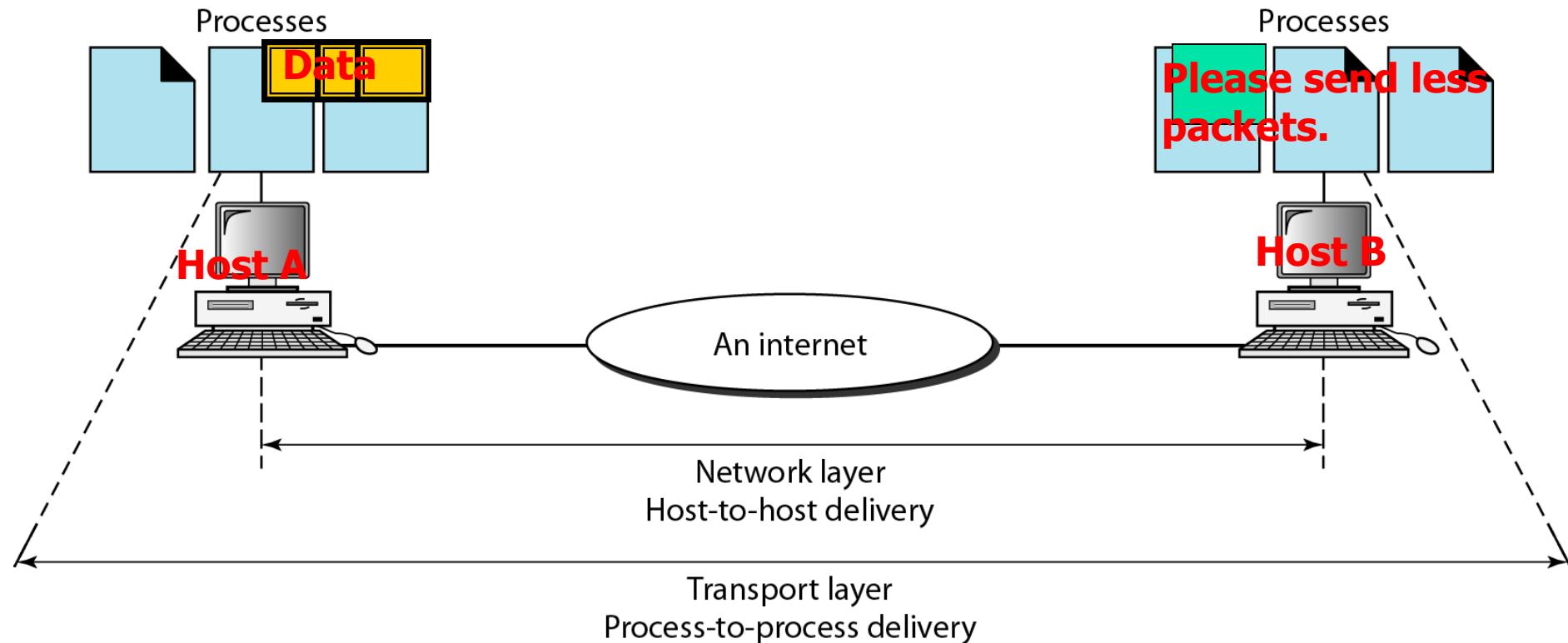
Connection Control



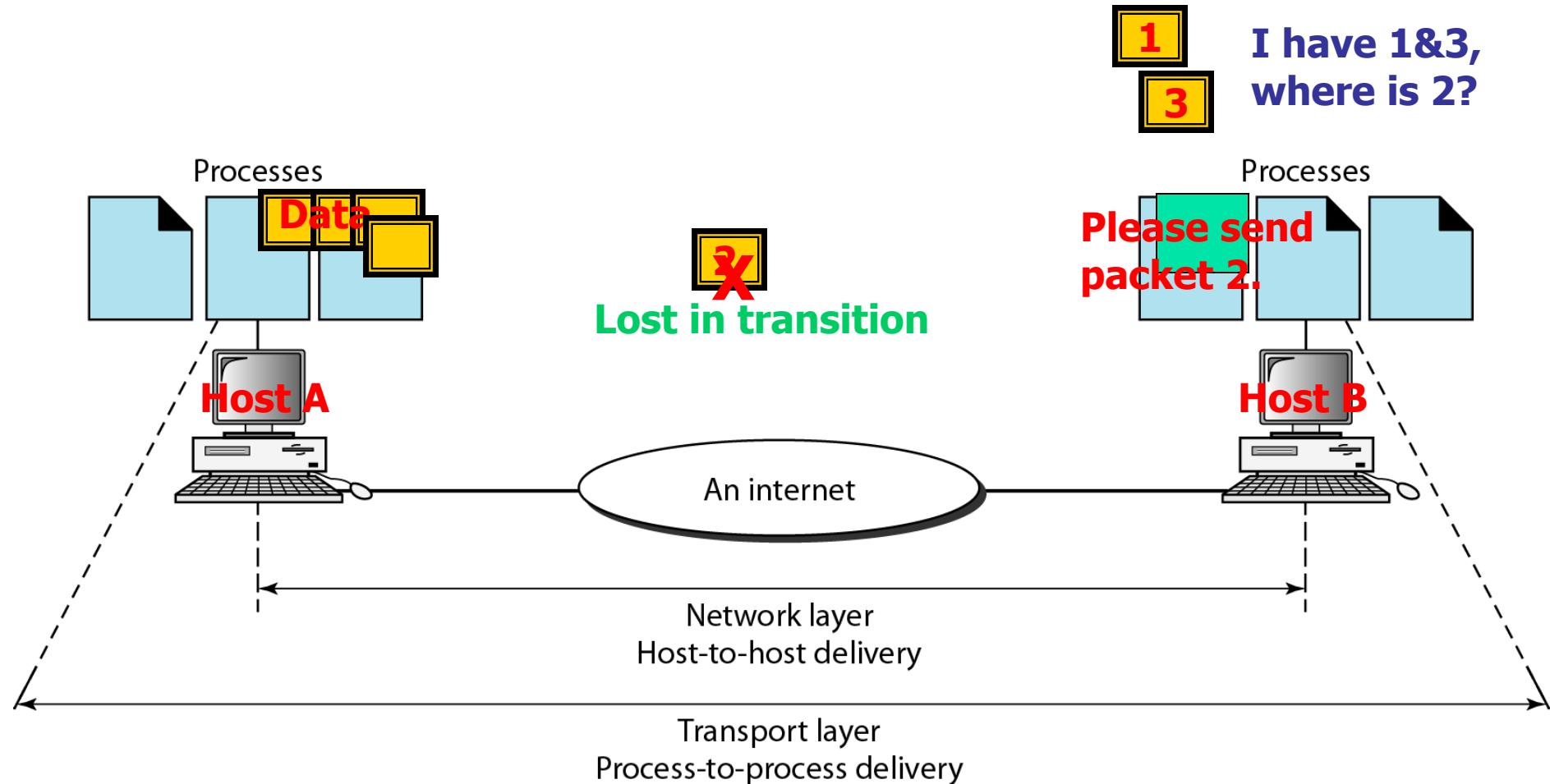
Flow Control

- Host B has too many packets to process.

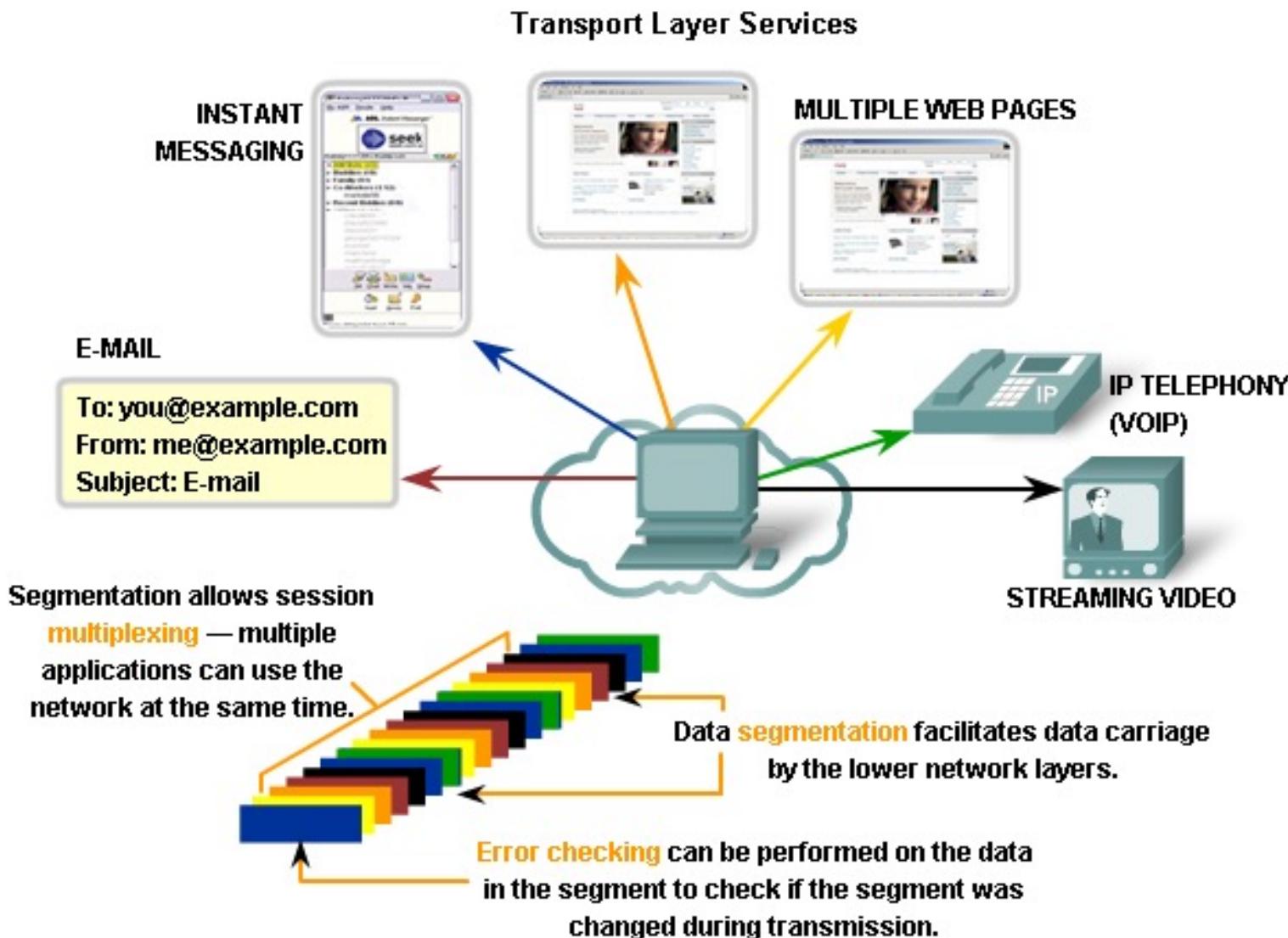
- Buffer to store incoming packets overflows



Error Control

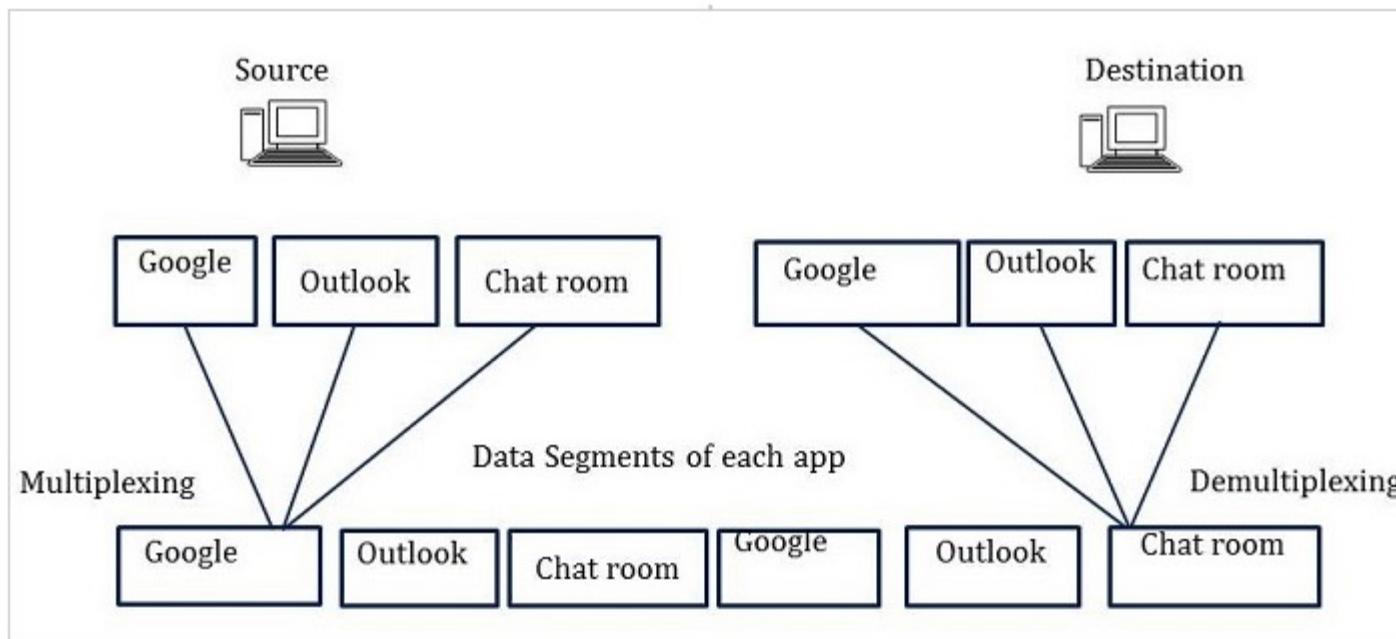


Multiplexing

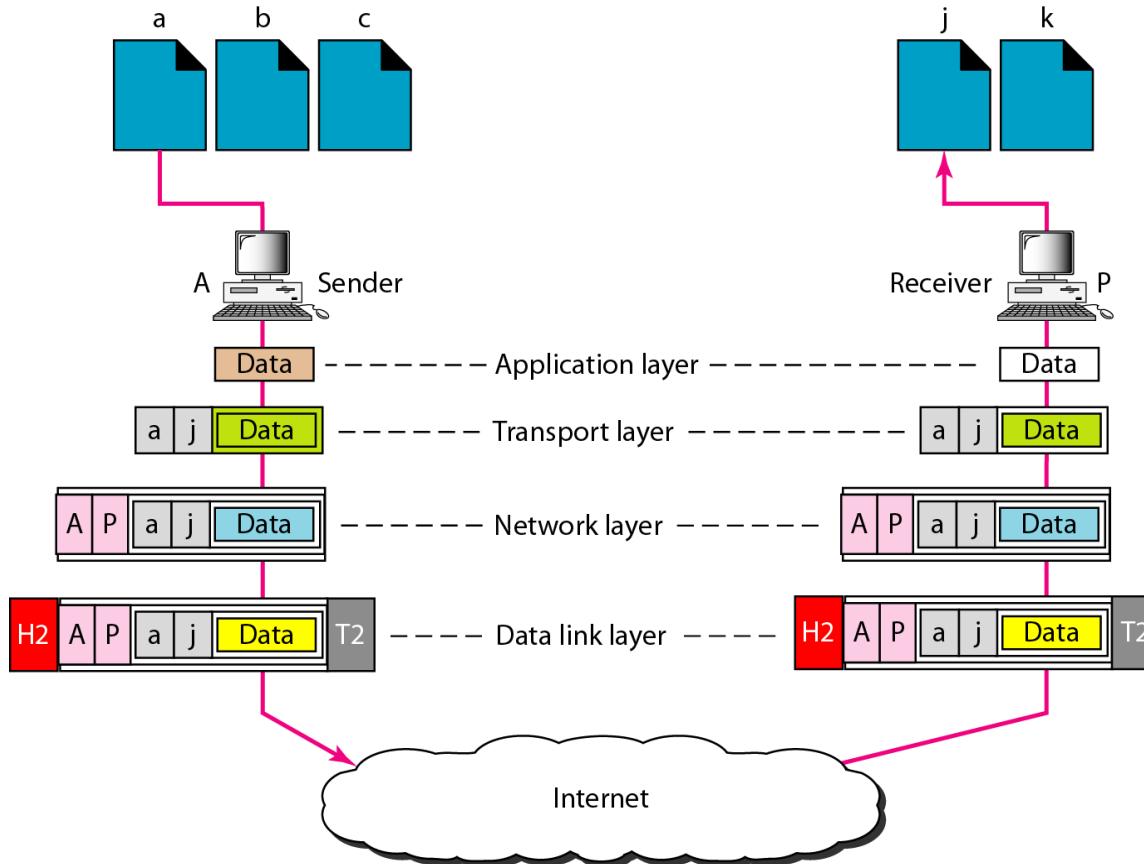


Multiplexing- Demultiplexing

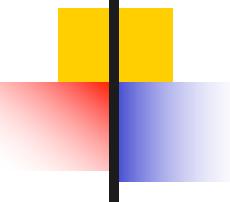
Multiplexing and de-multiplexing are just concepts that describe the process of the transmission of data generated by different applications simultaneously. When the data arrives at the Transport layer, each data segment is independently processed and sent to its appropriate application in the destination machine.



Addressing Review



Although **physical addresses** change from hop to hop, **logical and port** addresses remain the same from the source to destination.



Session Layer

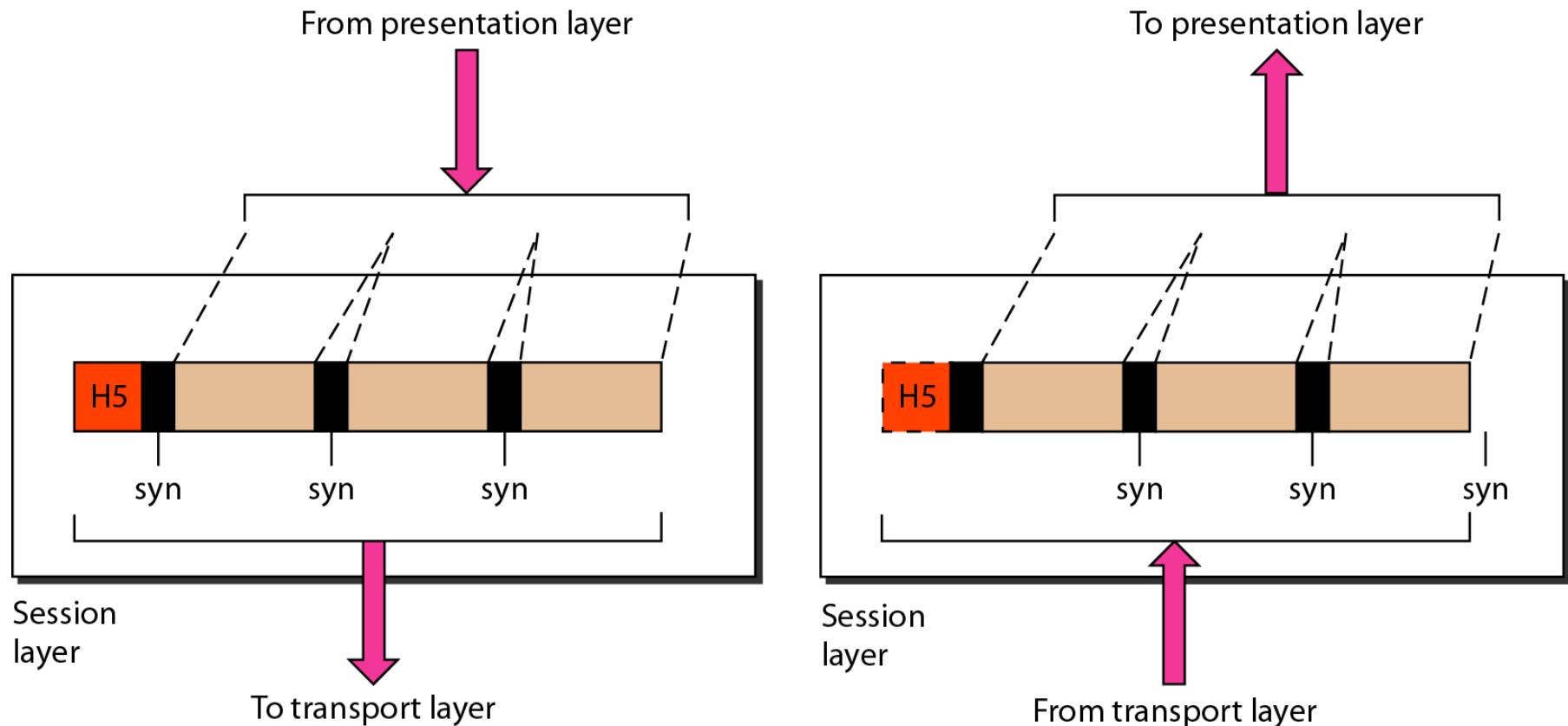
Note

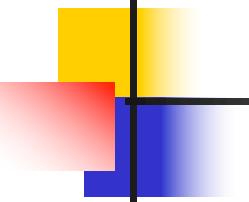
The session layer is responsible for dialog control and synchronization.

Session layer

- It establishes, maintains and synchronizes the interaction among communicating systems
- Responsibilities:
 - Dialog control(half duplex/ full-duplex)
 - Synchronization(check points/ synchronization point)

Session layer





Presentation Layer

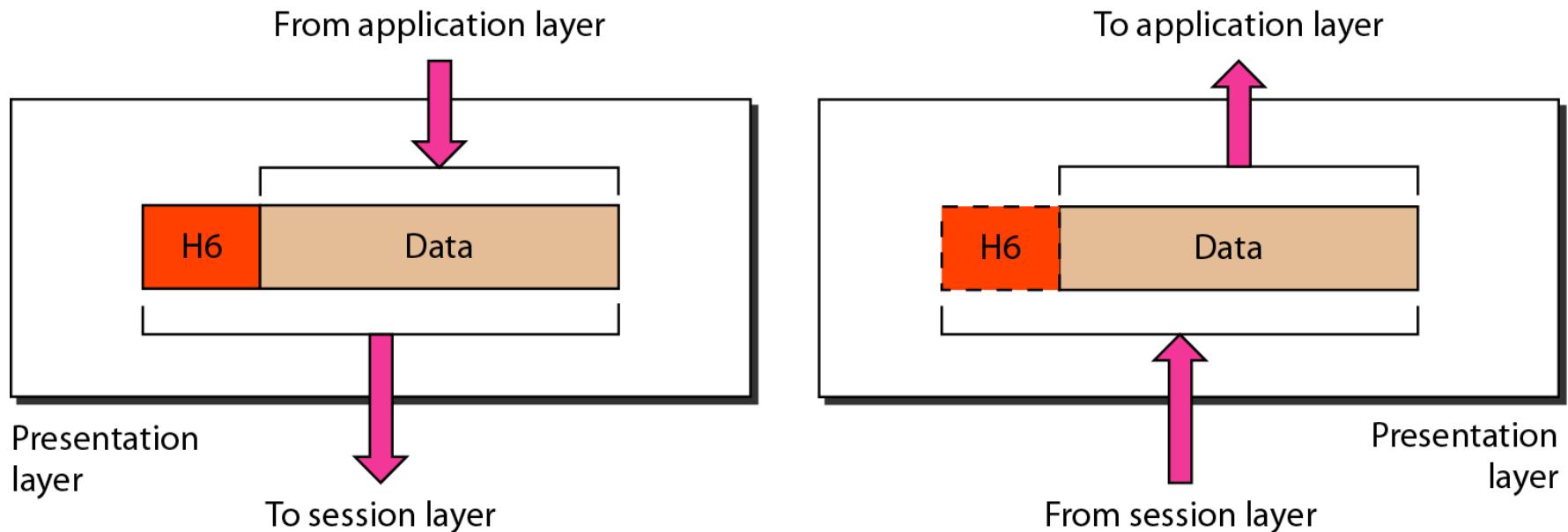
Note

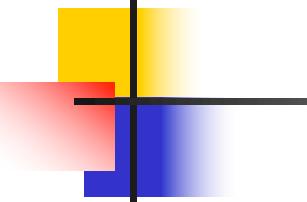
The presentation layer is responsible for translation, compression, and encryption.

Presentation layer

- It is concern with the syntax and semantics of that information exchange between two systems
- Responsibilities:
 - Translation_(sender format-common format/ common format-receiver format)
 - Compression_(reduce the number of bits)
 - Encryption_(for ensuring privacy)

Presentation layer





Application Layer

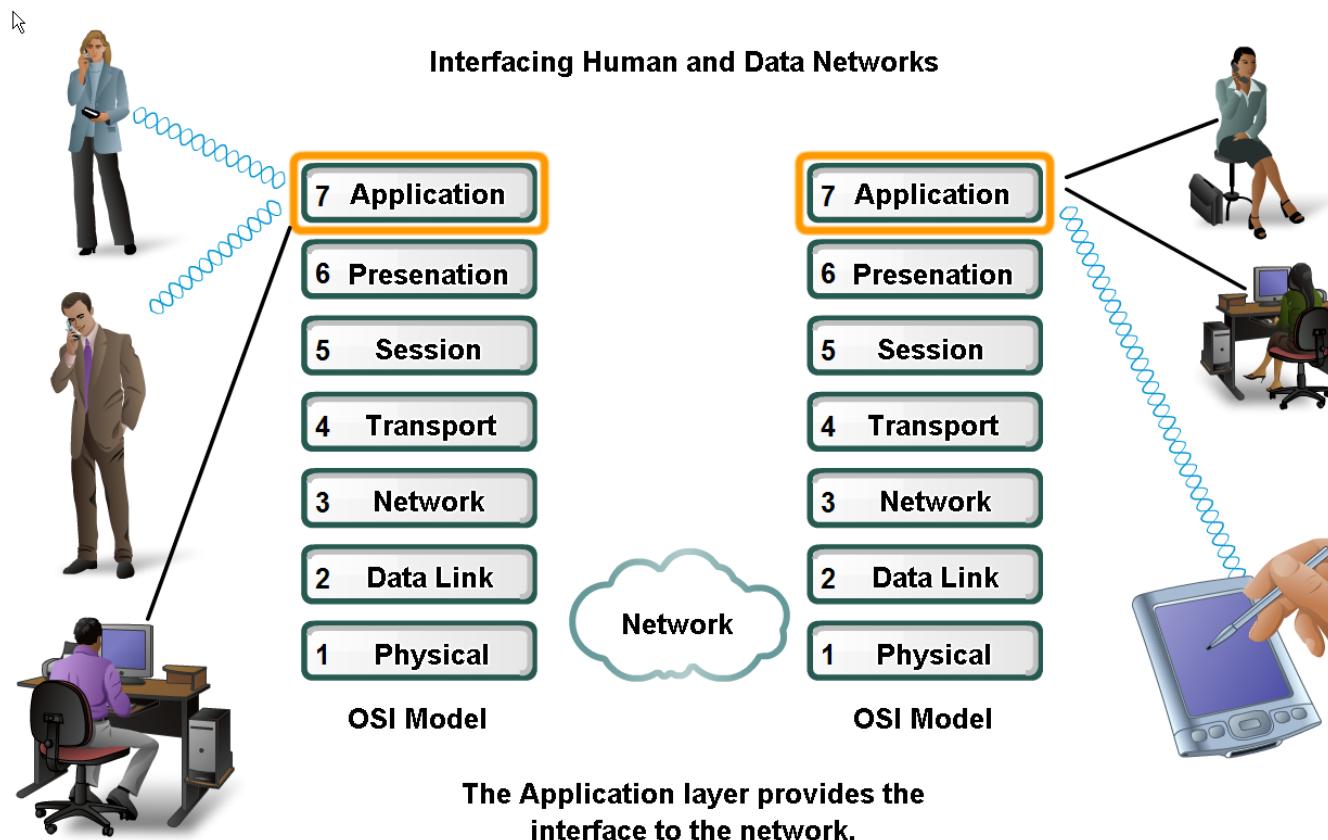
Note

The application layer is responsible for providing user interfaces and services to the user, such as electronic mail, remote file access and transfer, shared database management and other types of distributed information services.

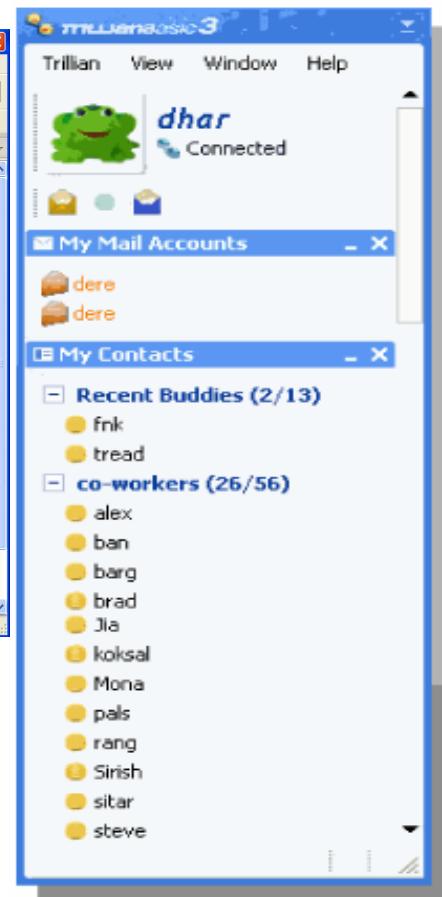
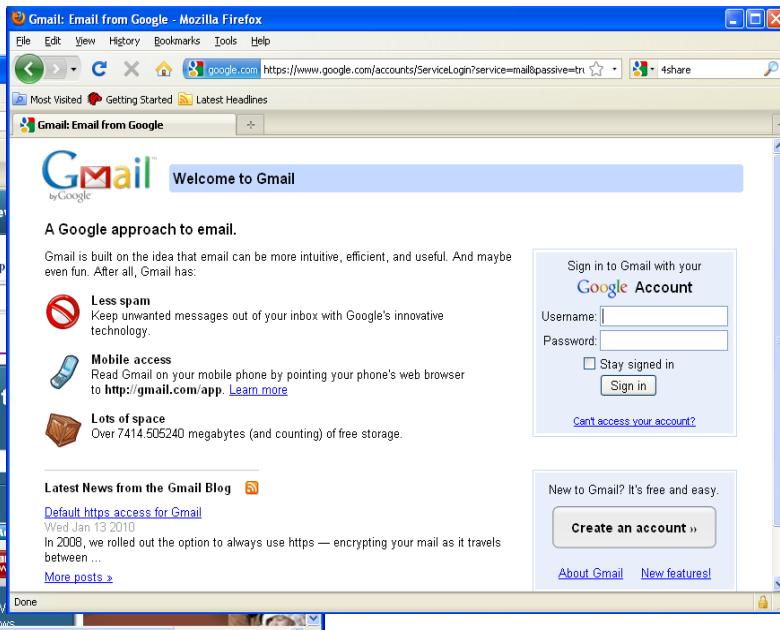
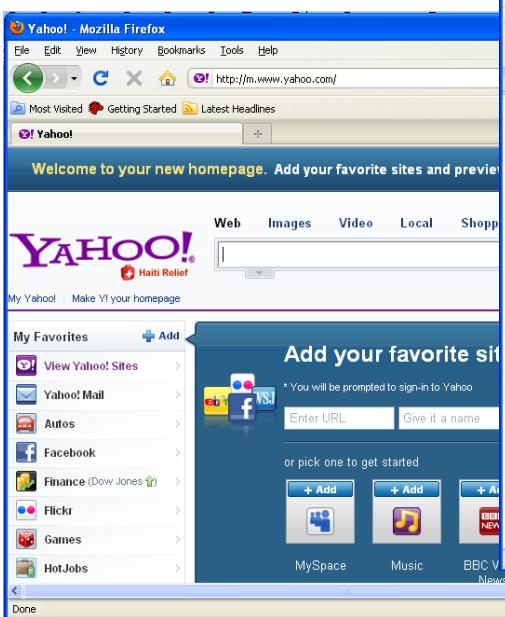


Applications

- The Interface Between Human and Data Networks
- Responsible for providing services to the user.



Applications and responsibilities in Application layer



Web Page

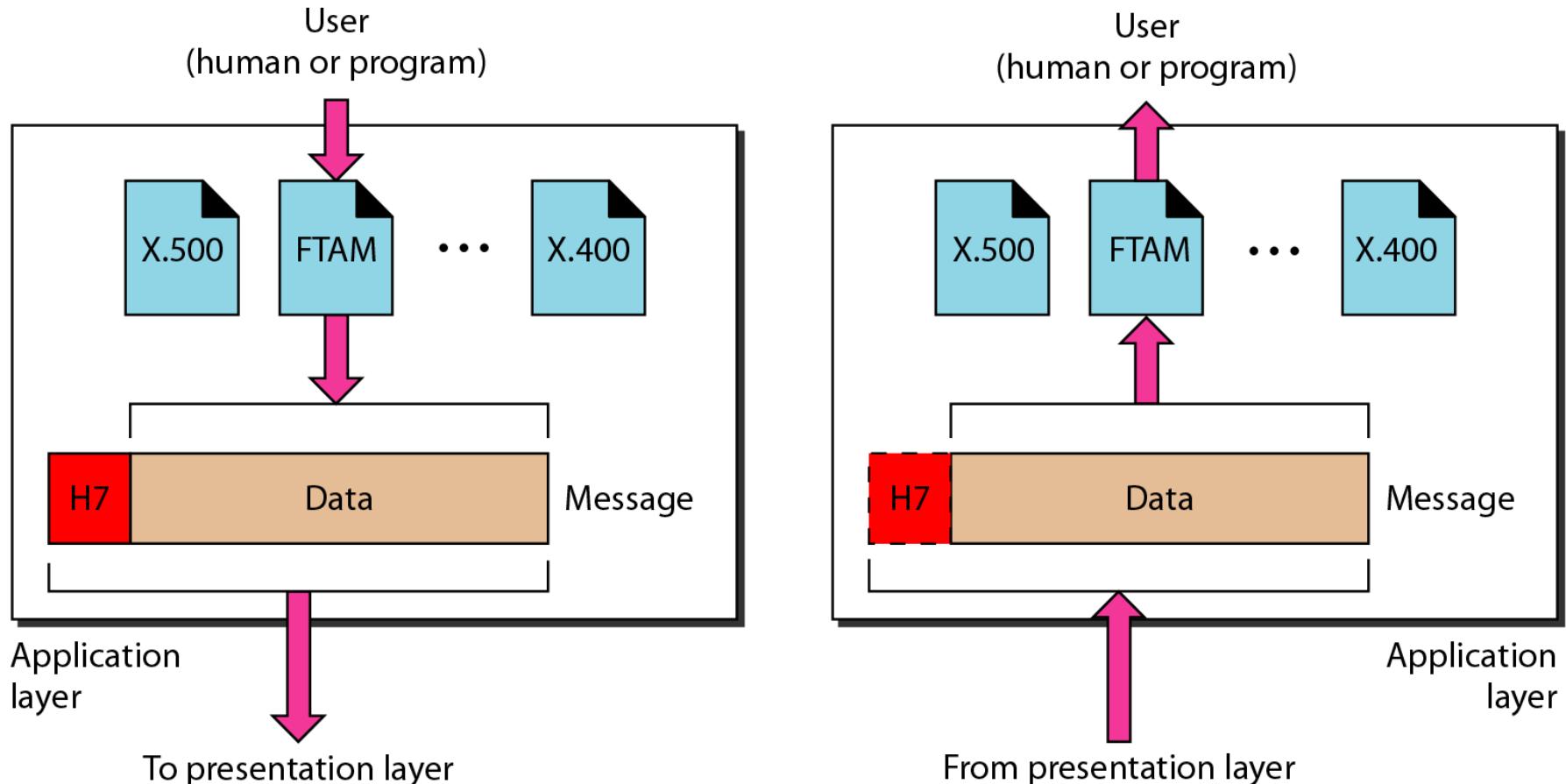
Email

Responsibilities:

- Network virtual terminal
- File transfer, access and management
- Mail service
- Directory service

Instant messaging

Application layer



TCP/IP PROTOCOL SUITE

The layers in the TCP/IP protocol suite do not exactly match those in the OSI model. The original TCP/IP protocol suite was defined as having four layers: host-to-network, internet, transport, and application. However, when 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 and Data Link Layers

Network Layer

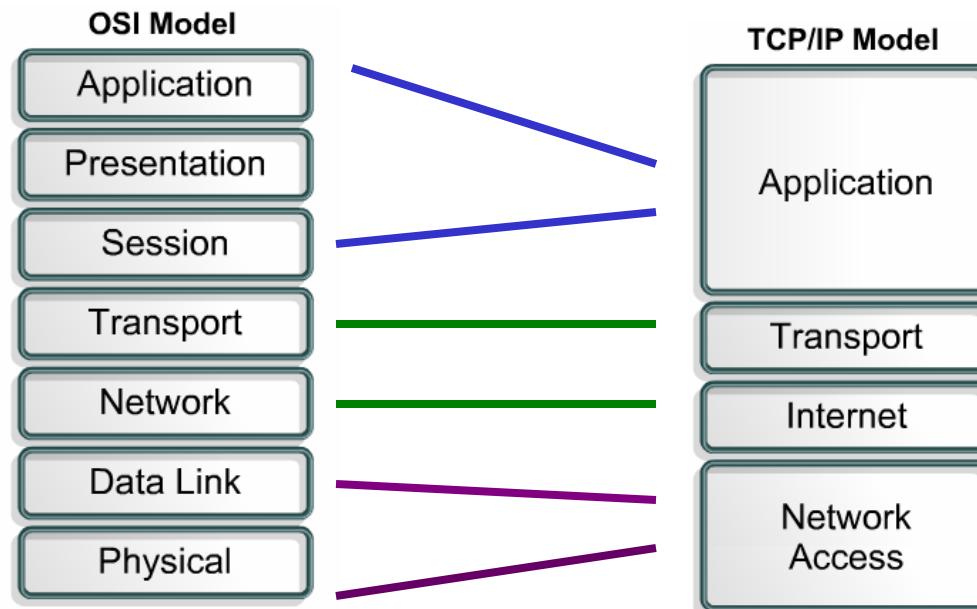
Transport Layer

Application Layer

TCP/IP PROTOCOL SUITE

- TCP/IP stands for Transmission Control Protocol/Internet Protocol and is a suite of communication protocols used to interconnect network devices on the internet.
- It describes a set of general design guidelines and implementations of specific networking protocols to enable computers to communicate over a network. It provides end to end connectivity specifying how data should be formatted, addresser, transmitted, routed and received at the destination.
- Developed by the US Defense Advanced Research Project Agency (DARPA) for its packet switched network (ARPANET)
- Used by the global Internet.

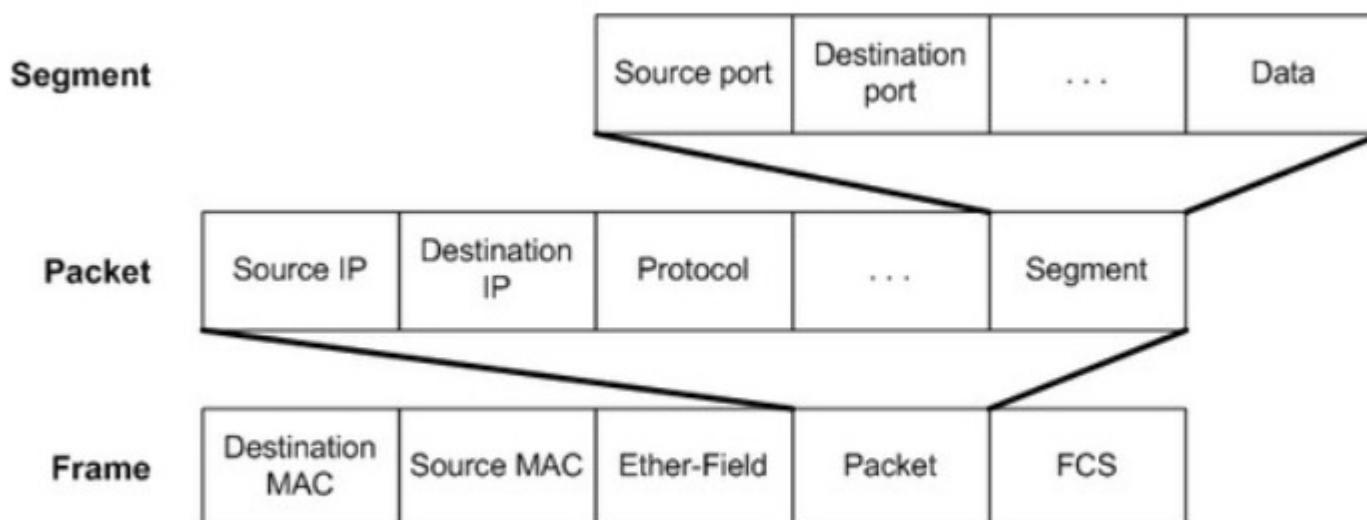
TCP/IP and OSI model



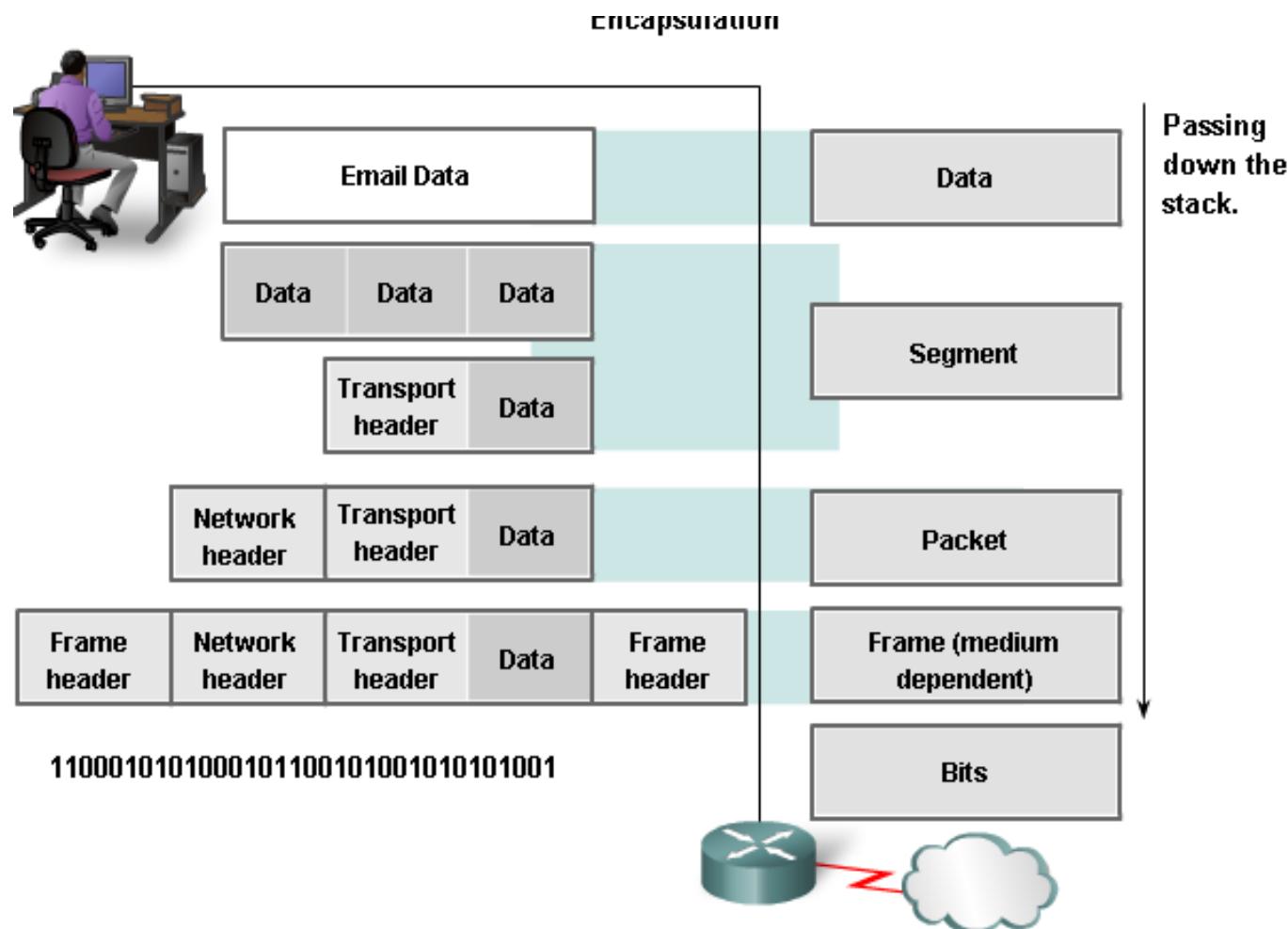
Protocol data units(PDU) and layer addressing

PDU is a significant term related to the initial four layers of the OSI model. In Layer 1, PDU is a bit, in Layer 2 it is a frame, in Layer 3 it is a packet and in Layer 4 it is a segment. In Layer 5 and above, PDU is referred to as data.

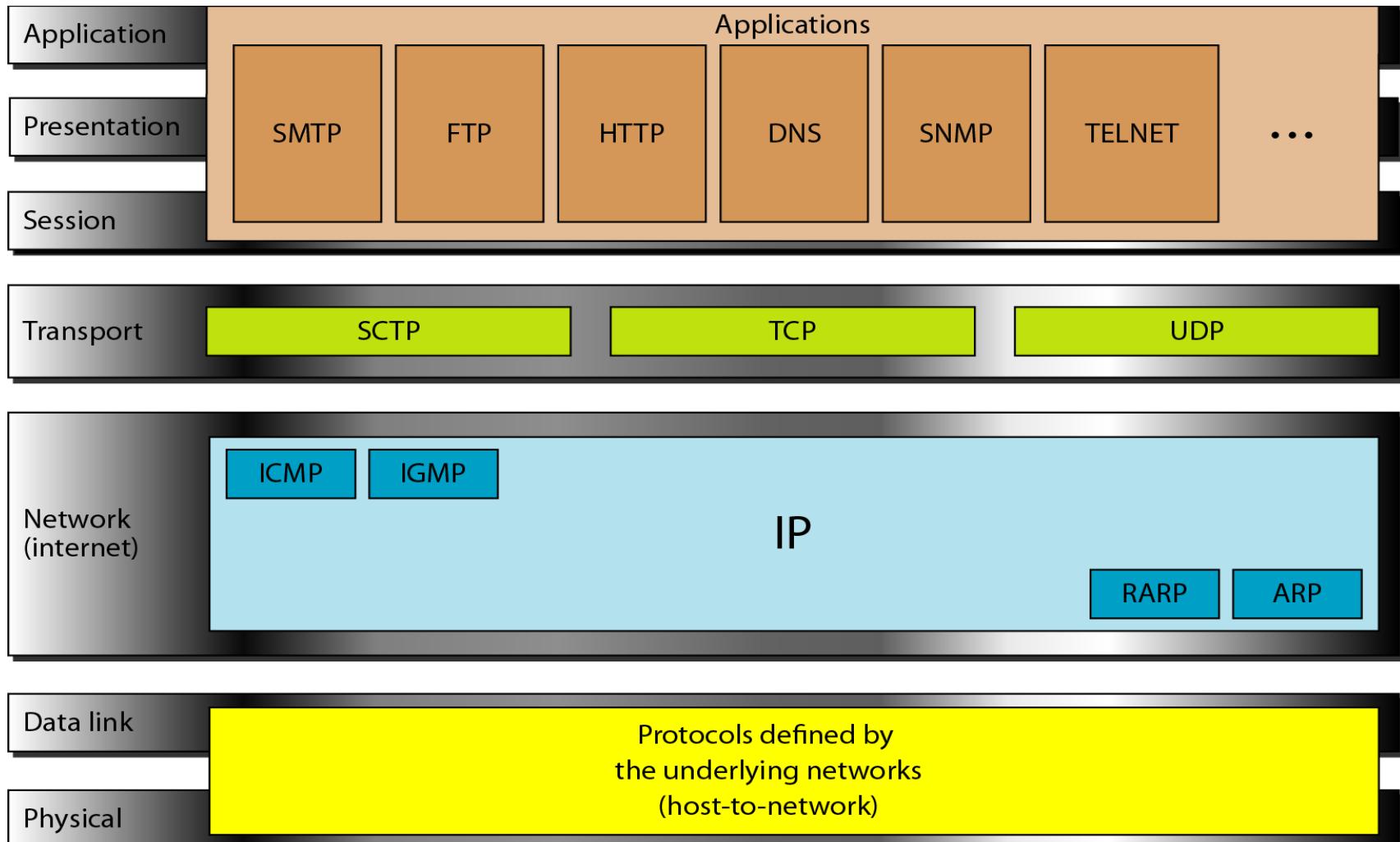
Common Protocol used in Transport Layer is **TCP**



TCP/IP Encapsulation



TCP/IP PROTOCOL SUITE



Some of the protocols included in the TCP/IP suite are:

- **ARP (Address Resolution Protocol)** – used to associate an IP address with a MAC address. Used to find the PA. of the node when its Internet address is known.
- **IP (Internet Protocol)** – used to deliver packets from the source host to the destination host based on the IP addresses.
- **ICMP (Internet Control Message Protocol)** – used to detect and reports network error conditions. Used in ping.
- **TCP (Transmission Control Protocol)** – a connection-oriented protocol that enables reliable data transfer between two computers.
- **UDP (User Datagram Protocol)** – a connectionless protocol for data transfer. Since a session is not created before the data transfer, there is no guarantee of data delivery.
- **FTP (File Transfer Protocol)** – used for file transfers from one host to another.
- **Telnet (Telecommunications Network)** – used to connect and issue commands on a remote computer.
- **DNS (Domain Name System)** – used for host names to the IP address resolution.
- **HTTP (Hypertext Transfer Protocol)** – used to transfer files (text, graphic images, sound, video, and other multimedia files) on the World Wide Web.

ADDRESSING

*Four levels of addresses are used in an internet employing the TCP/IP protocols: **physical, logical, port, and specific.***

Topics discussed in this section:

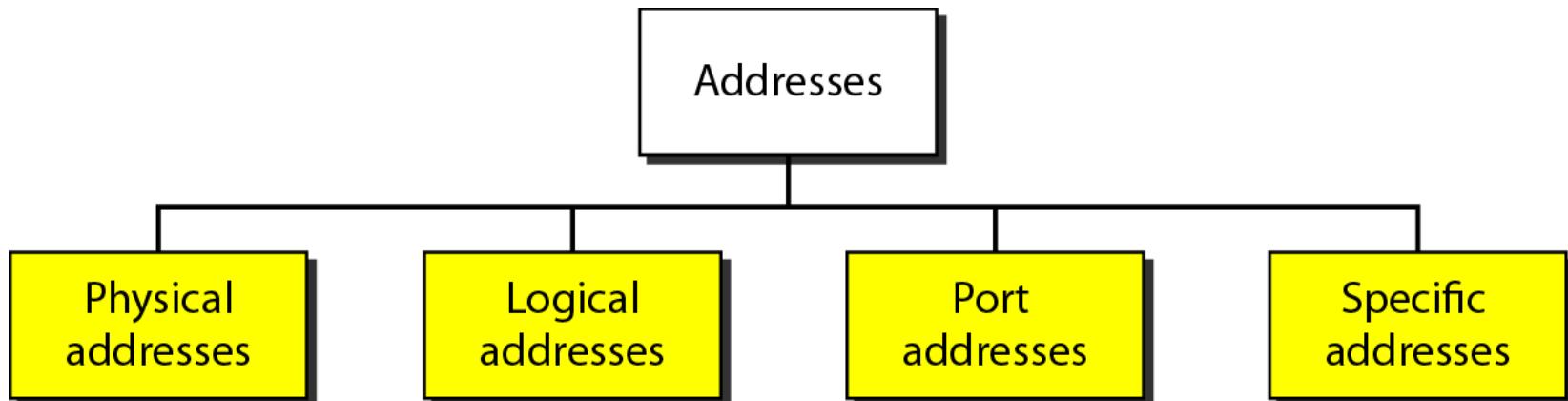
Physical Addresses

Logical Addresses

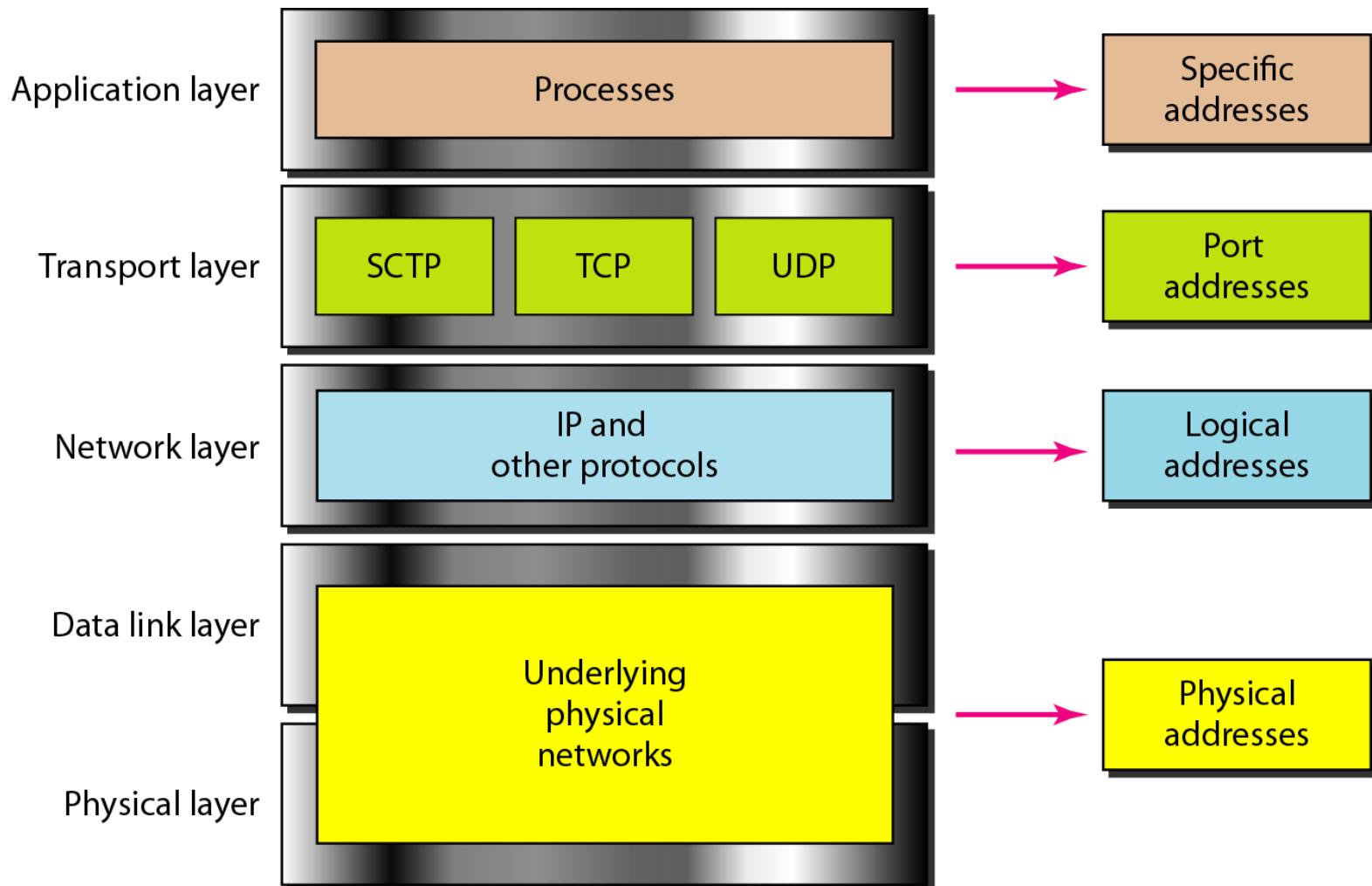
Port Addresses

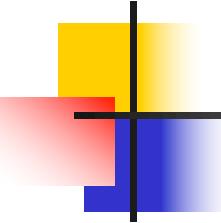
Specific Addresses

Addresses in TCP/IP



Relationship of layers and addresses in TCP/IP

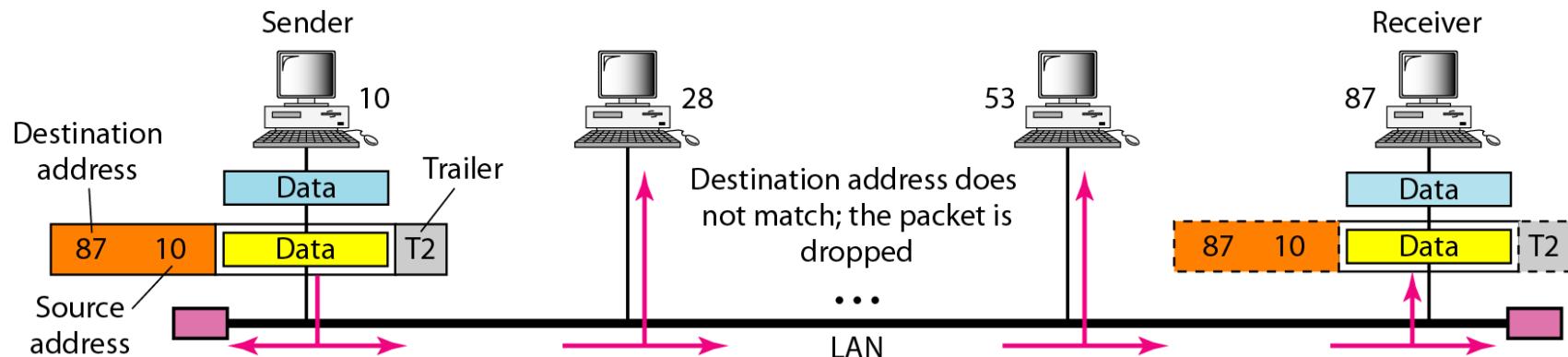


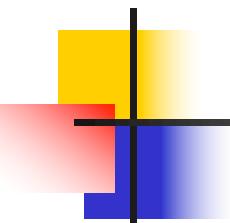


Example 2.1

In Figure of next slide a node with physical address 10 sends a frame to a node with physical address 87. The two nodes are connected by a link (bus topology LAN). As the figure shows, the computer with physical address 10 is the sender, and the computer with physical address 87 is the receiver.

Physical addresses



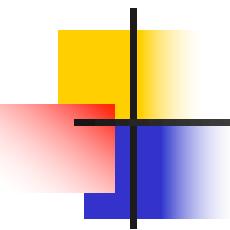


Example 2.2

*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

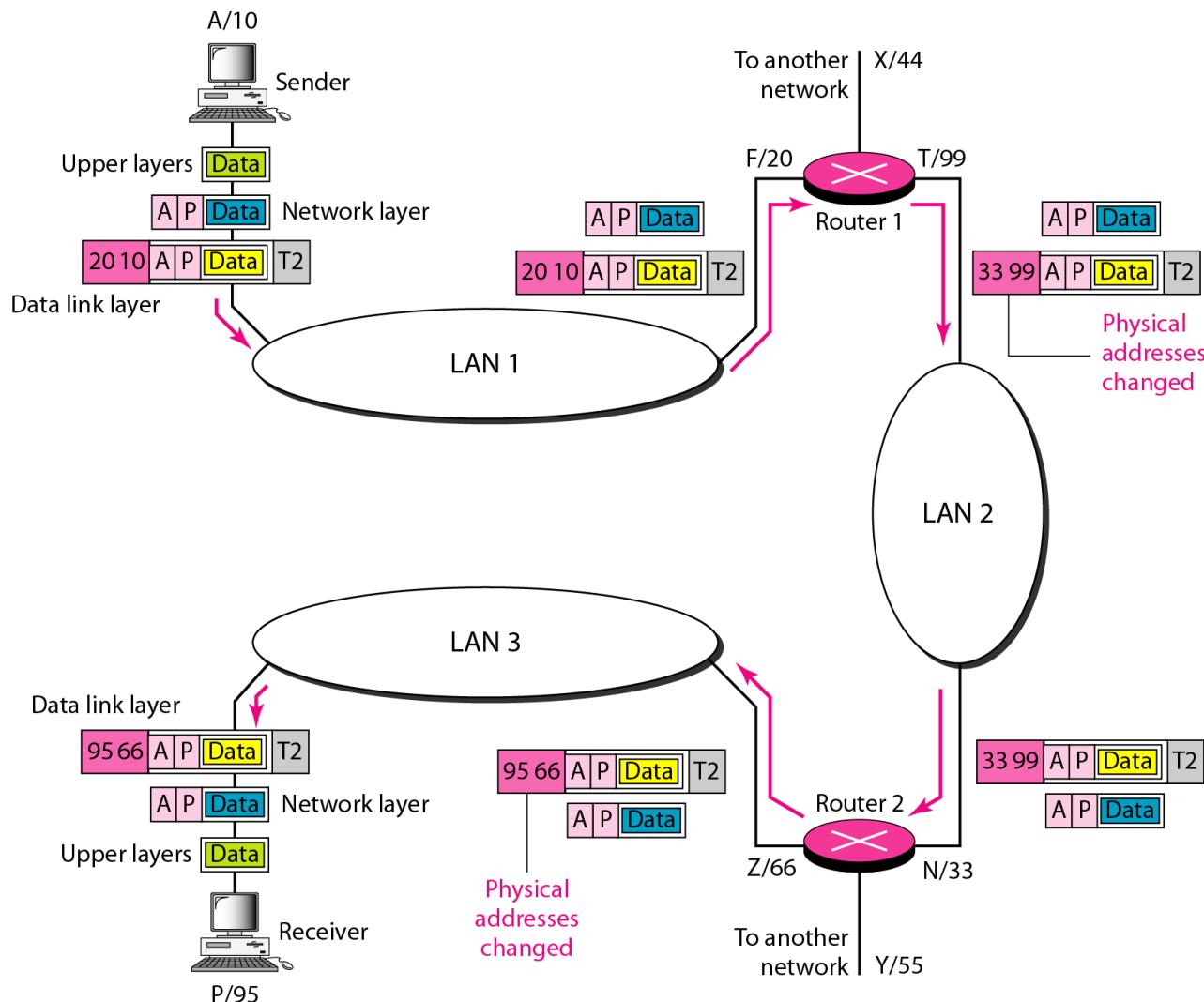
A 6-byte (12 hexadecimal digits) physical address.

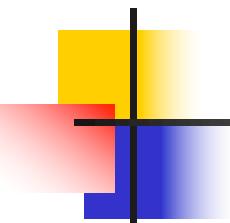


Example 2.3

Figure of next slide shows a part of an internet with two routers connecting three LANs. Each device (computer or router) has a pair of addresses (logical and physical) for each connection. In this case, each computer is connected to only one link and therefore has only one pair of addresses. Each router, however, is connected to three networks (only two are shown in the figure). So each router has three pairs of addresses, one for each connection.

IP addresses

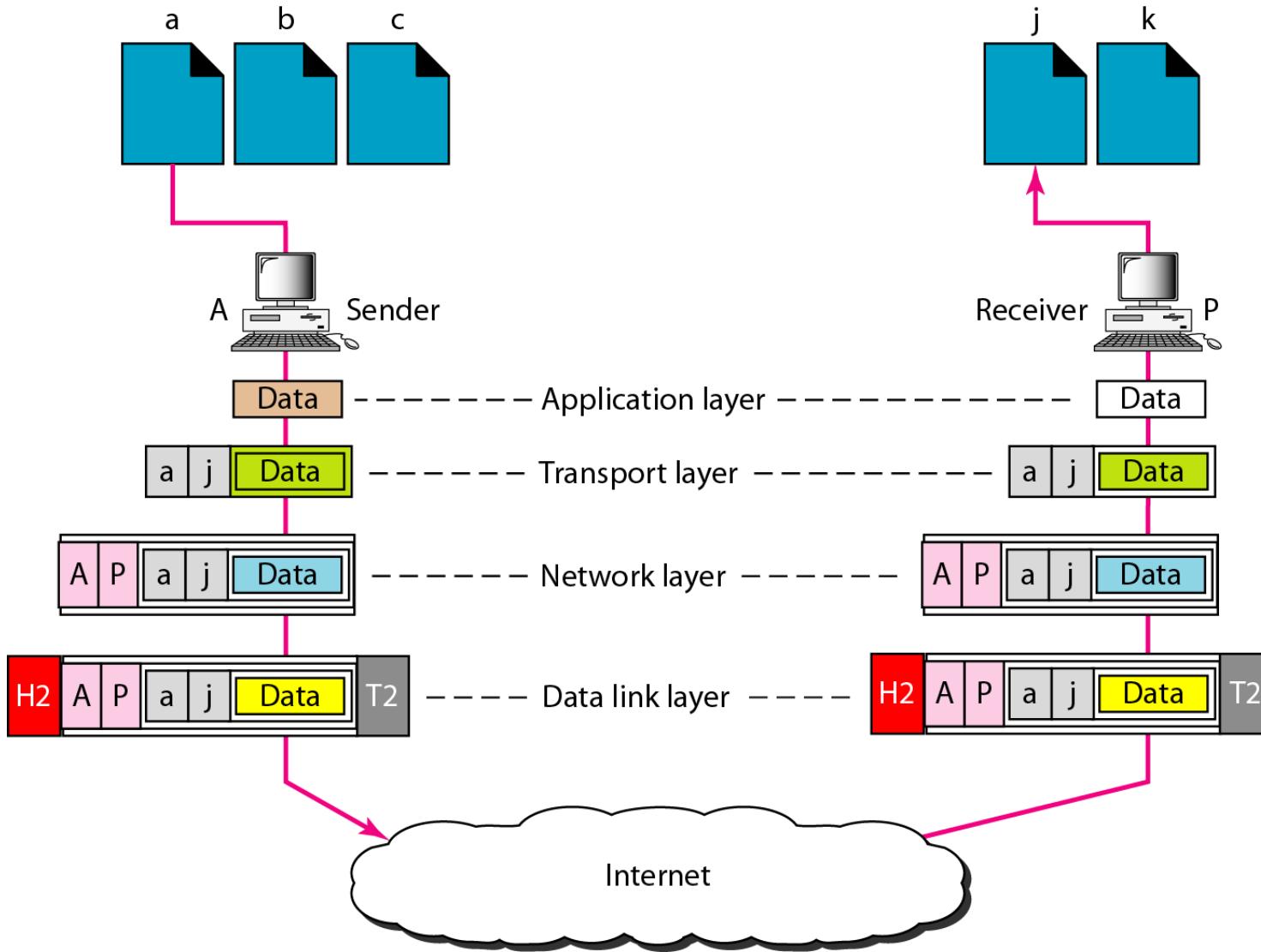




Example 2.4

Figure of next slideshows two computers communicating via the Internet. The sending computer is running three processes at this time with port addresses a, b, and c. The receiving computer is running two processes at this time with port addresses j and k. Process a in the sending computer needs to communicate with process j in the receiving computer. Note that although physical addresses change from hop to hop, logical and port addresses remain the same from the source to destination.

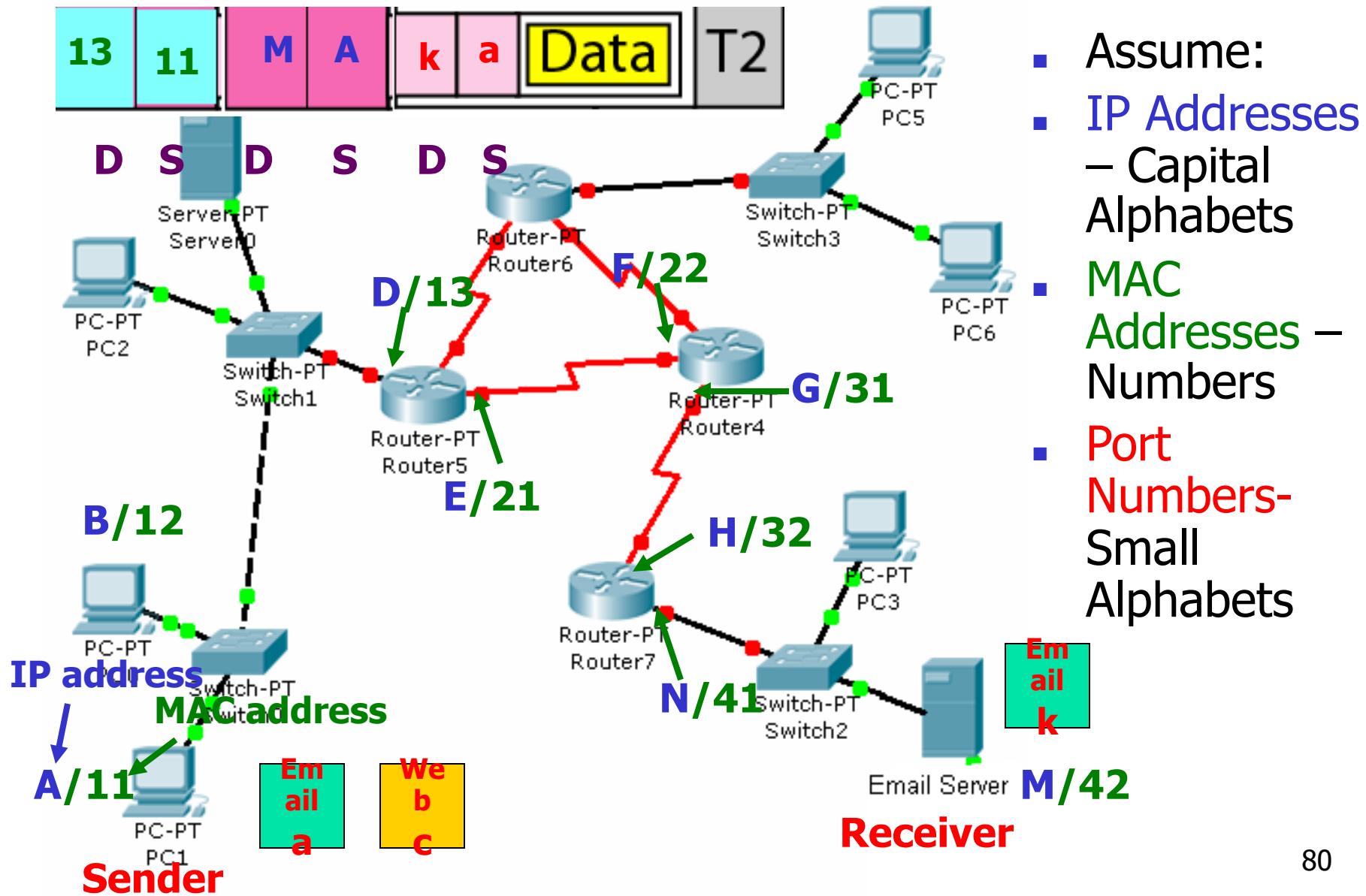
Port addresses



Specific Address

- Designed by users for access web resources through different application on network.
- Two types of specific address: URL, E-mail address
- URL(Uniform Resource Locator)
 - Address of resources on Internet, web sites, wed document
 - <https://www.prothomalo.com/sports/football/98rpu81sf0>
- E-mail(electronic mail):
 - It is message contains text, file, images, videos etc.
 - heroalom@gmail.com
- These are converted into corresponding port and logical addresses by the sending computer.

Addressing Review



END
