Chapter 2

# *Network Models*

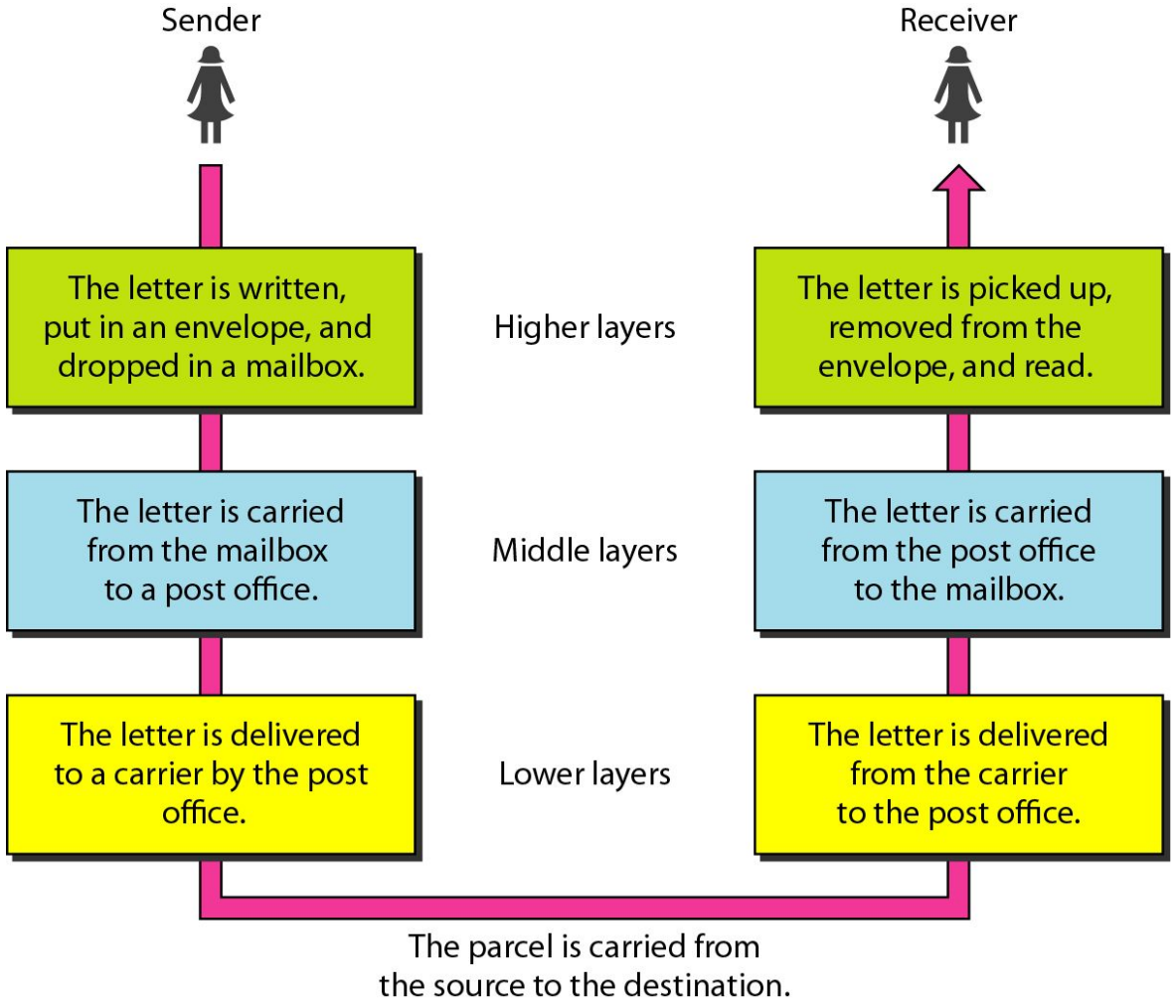
# 2-1 LAYERED TASKS

*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:*

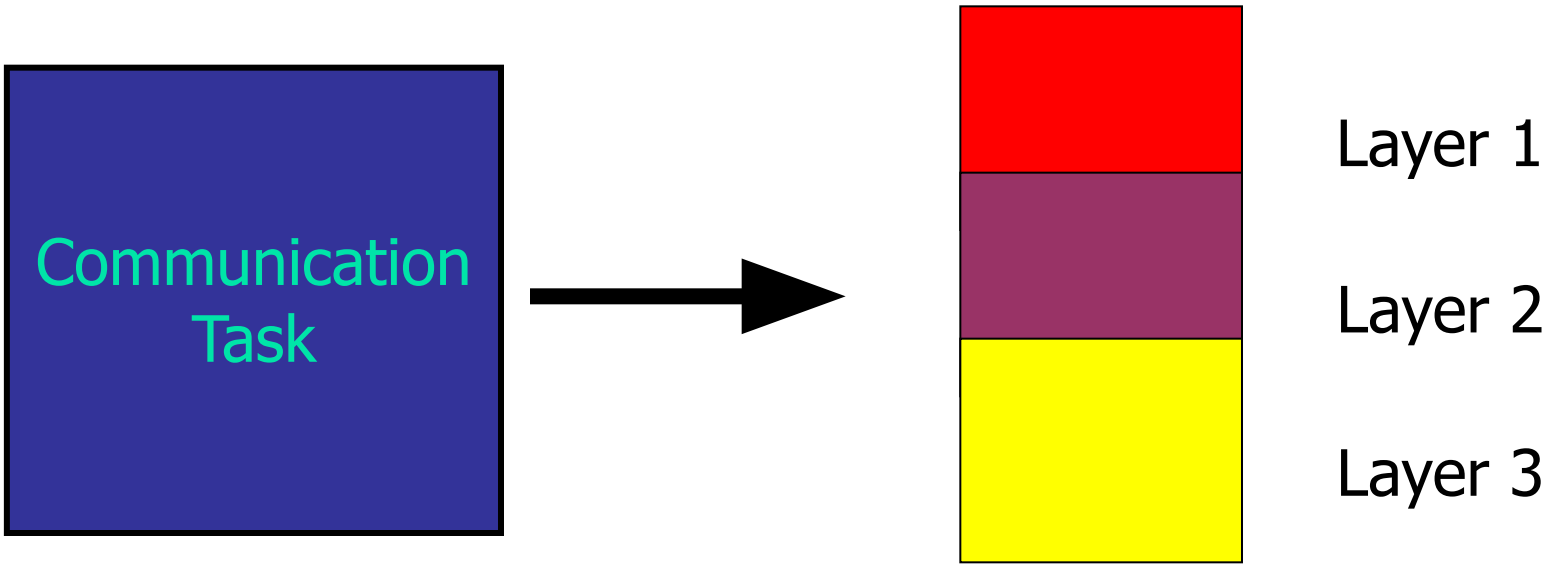
**Sender, Receiver, and Carrier**
**Hierarchy**

# Figure 2.1 Tasks involved in sending a letter



# Layering

- Task of communication broken up into layers



# Layers involving calling a friend

Where is the Café?

Content layer

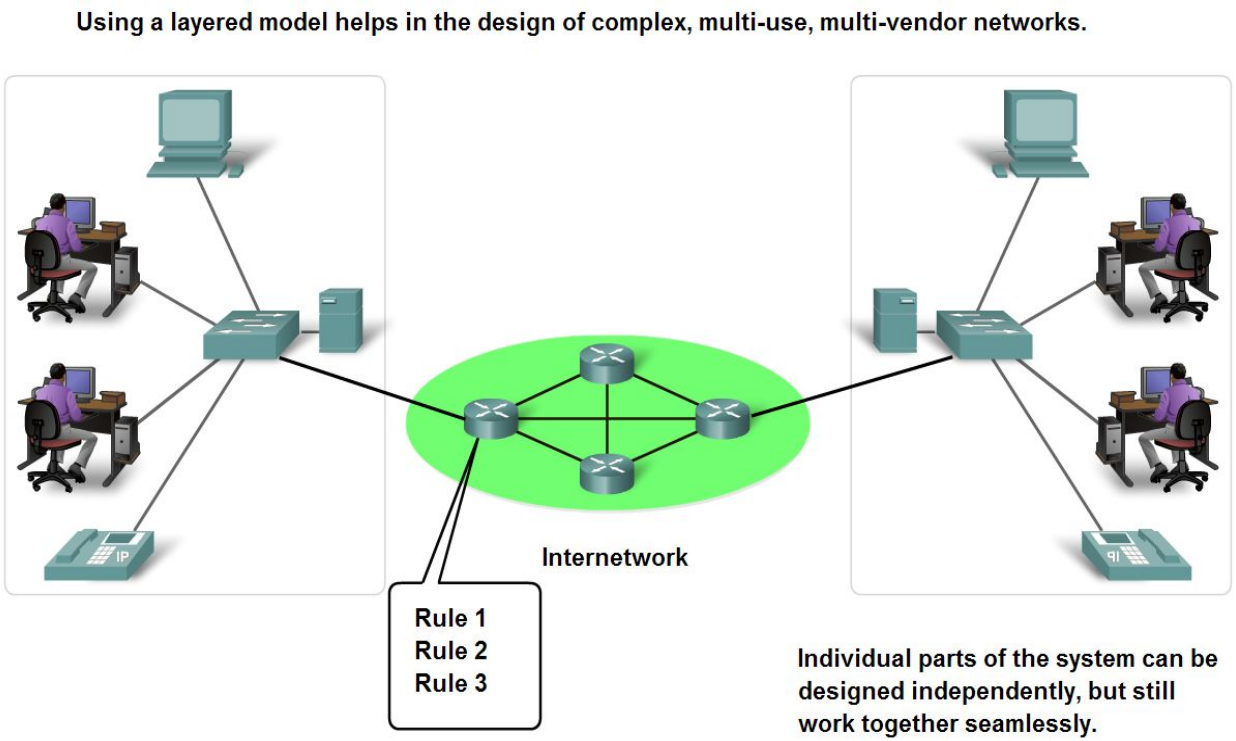
Conversation Protocol Suite
1. Use a Common Language
2. Wait Your Turn
3. Signal When Finished

Rules layer

Physical layer

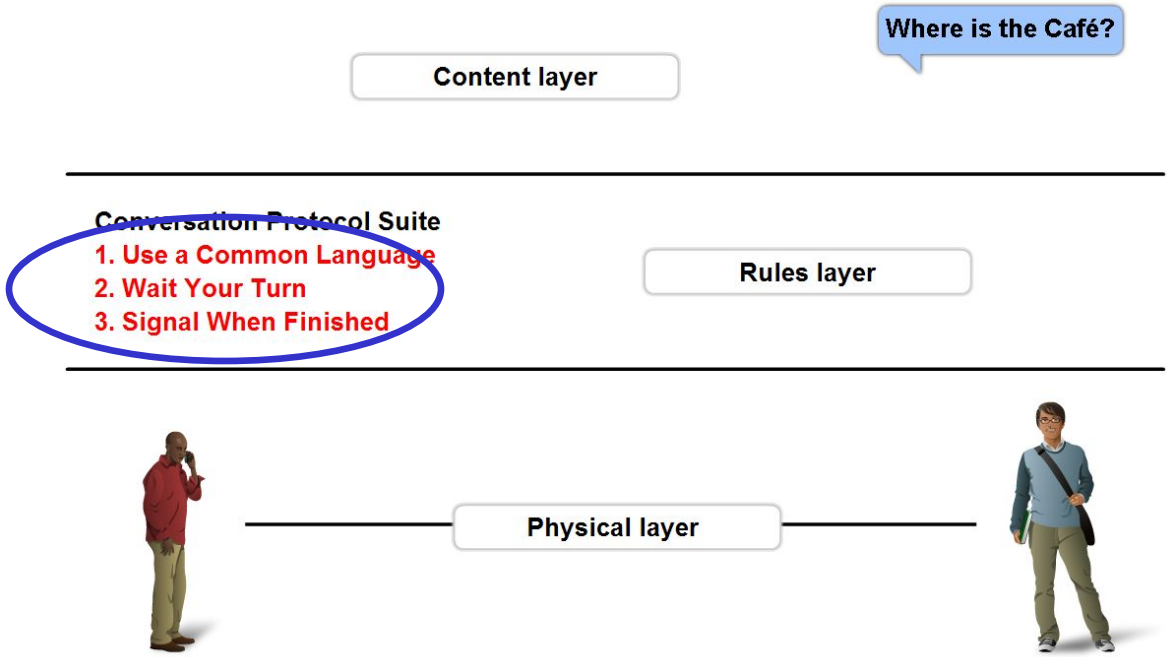
# Benefits of using a layered model

- To find out the fault easily.
- Changes in one layer do not affect other layers.
- Have defined information that they act upon.



# Rules that govern communications

- A protocol is a set of predetermined rules.
- Defines:
  - What is communicated??
  - How it is communicated??
  - When it is communicated??



# Protocols

- Describe processes such as:

The format or structure of the message. What?

The method by which networking devices share information about pathways with other network How?

How and when error and system messages are passed between devices. How/When?

The setup and termination of data transfer sessions. What/When/How?

# Protocols and Standards

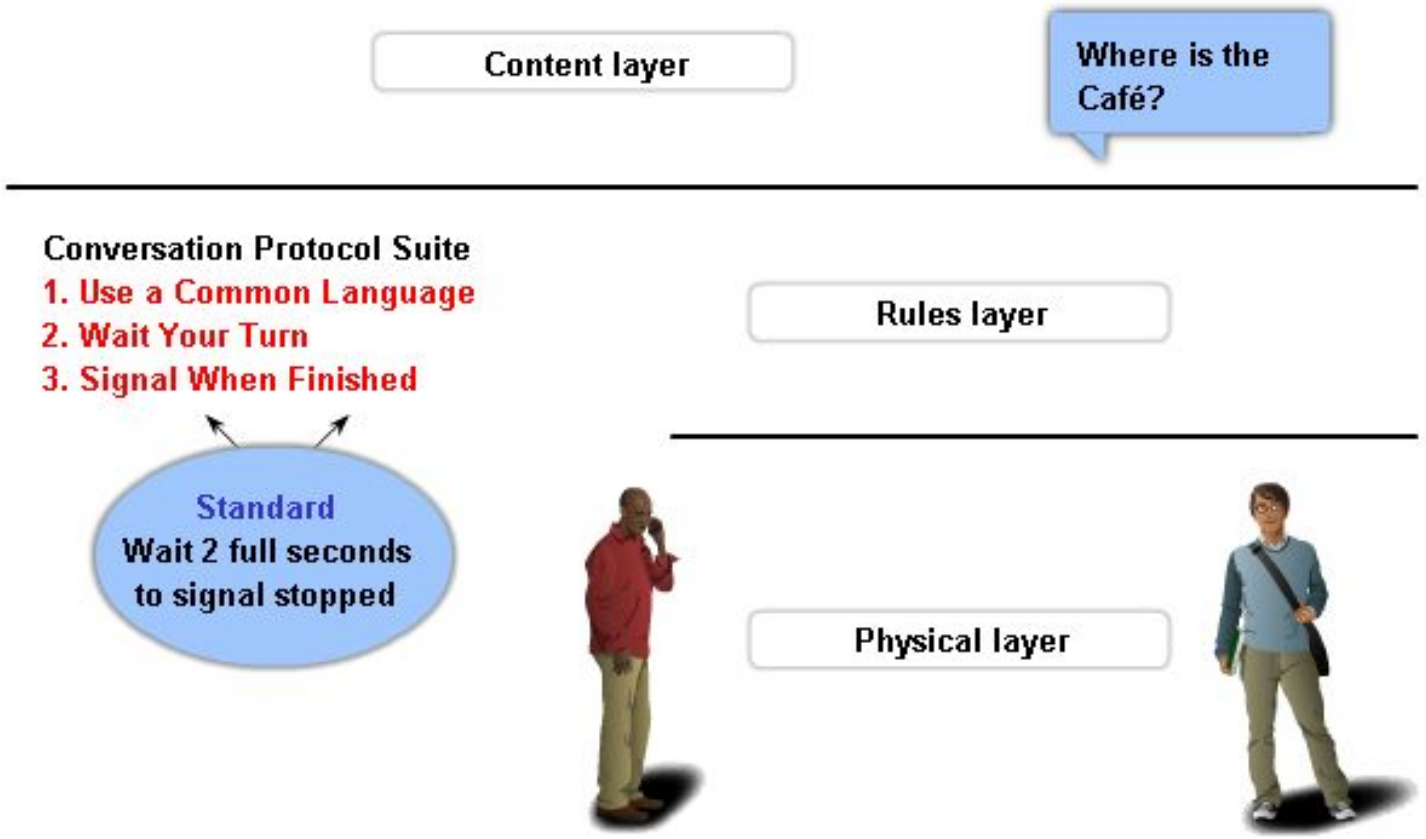
- **Protocols**
- **Standards**
- **Standards Organizations**
- **Internet Standards**

# 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

# Standards and Protocols

Standards are protocols and agreements that are widely used and accepted.



# 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 Model**
  - Open De Facto Standard
  - Governed by IETF Working Groups

# 2-2 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.*

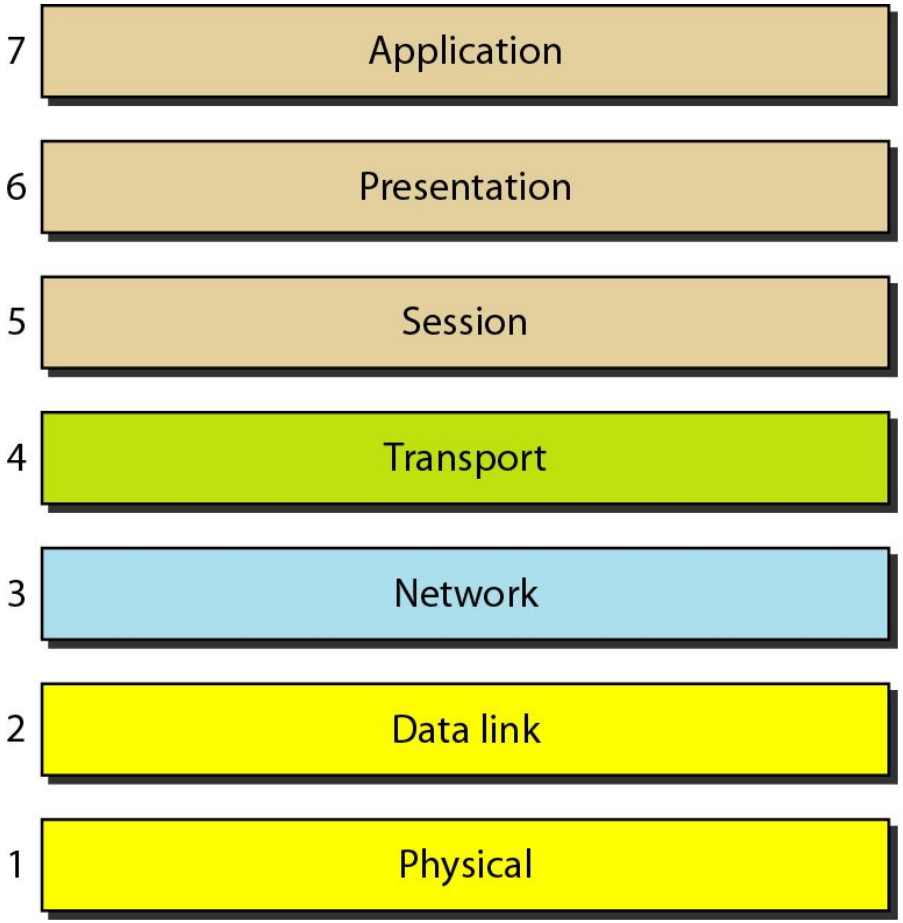
*Topics discussed in this section:*

**Layered Architecture**
**Peer-to-Peer Processes**
**Encapsulation**

*Note*

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

## Figure 2.2 *Seven layers of the OSI model*



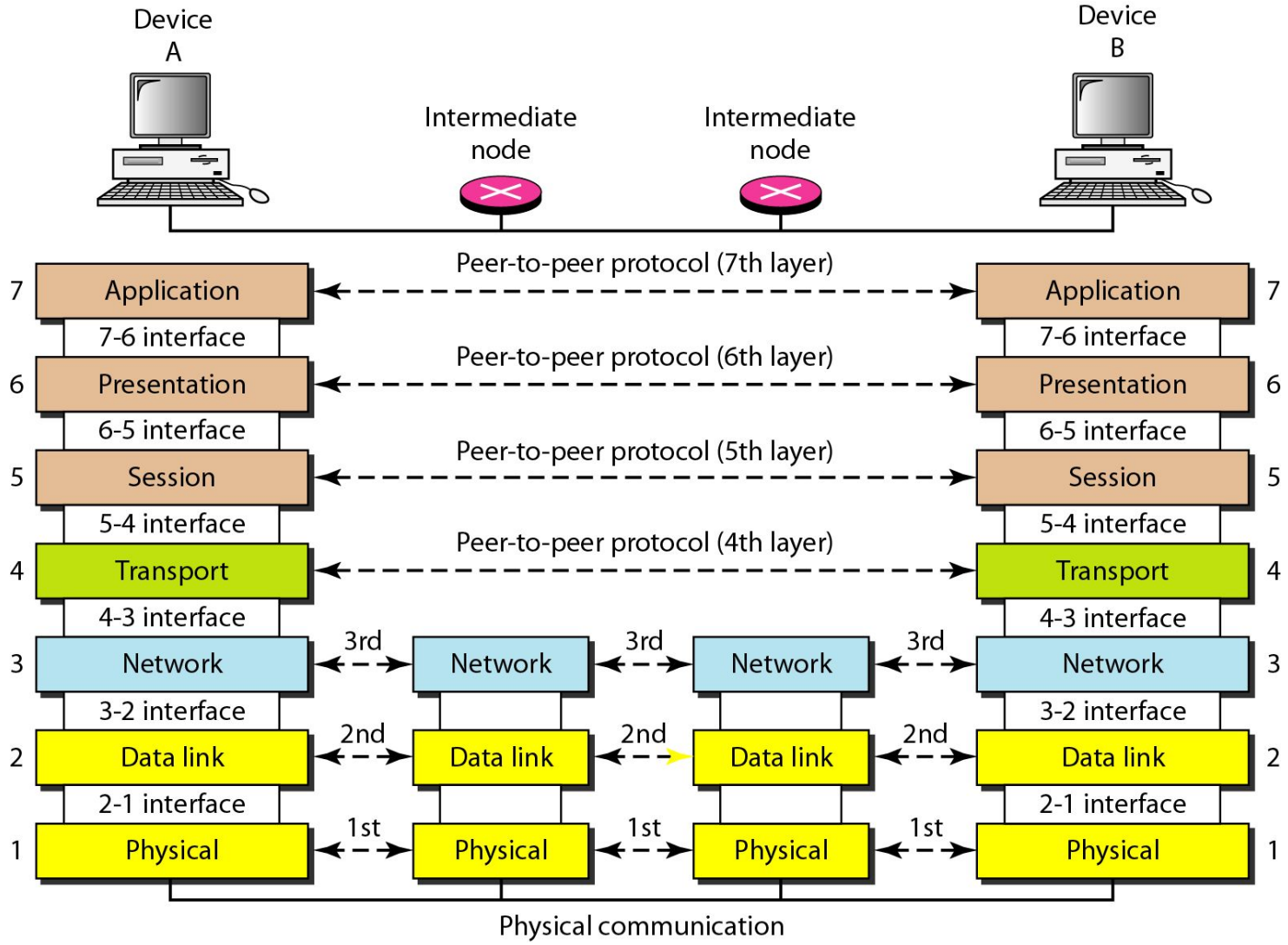
# OSI Model- 7 Layers

Primary concern: Communications between applications

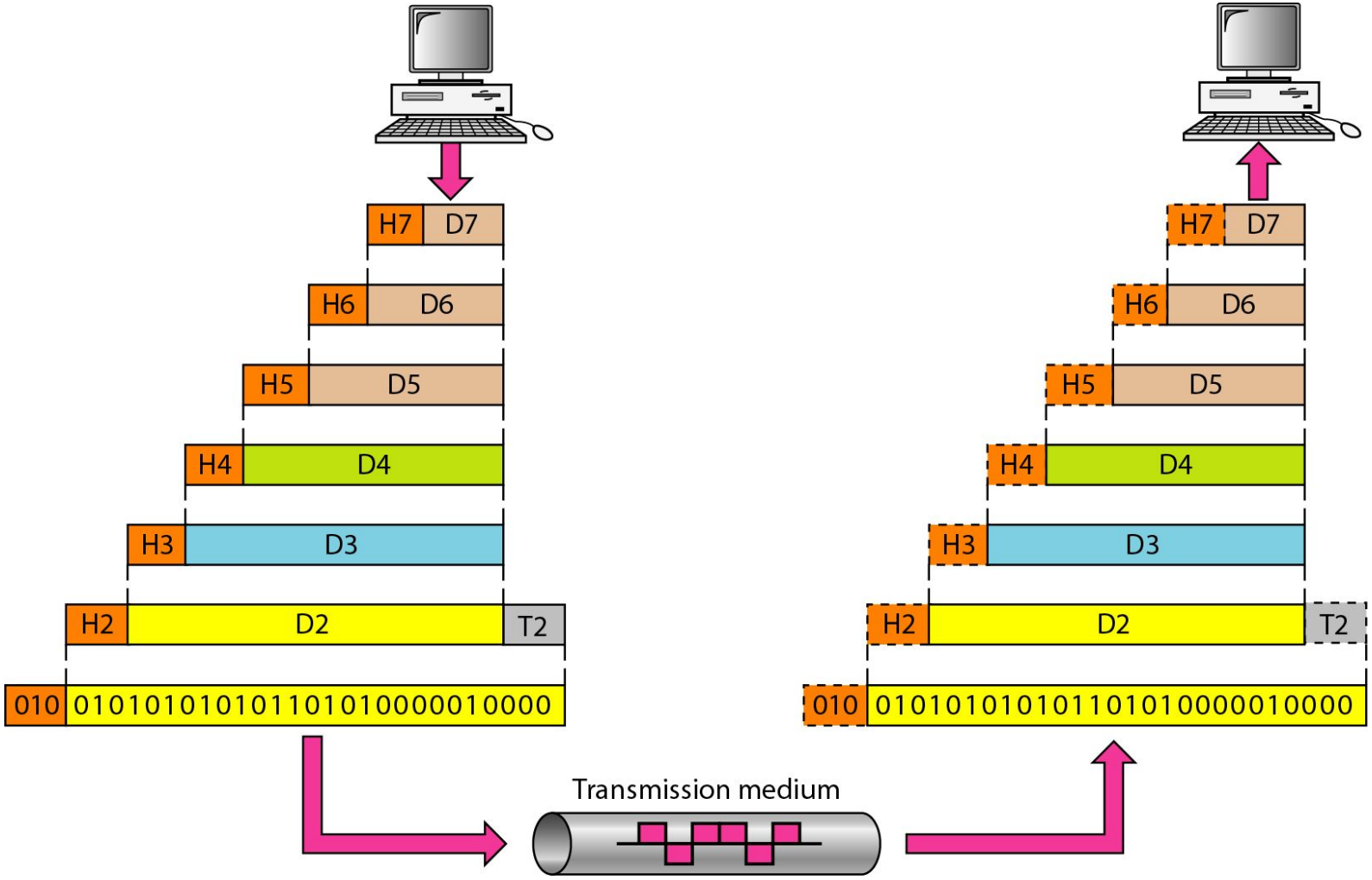
Primary concern: Moving raw data cross the network

| Layers | | CISCO |
|---|---|---|
| 7 | Application | All |
| 6 | Presentation | People |
| 5 | Session | Seem |
| 4 | Transport | To |
| 3 | Network | Need |
| 2 | Data Link | Data |
| 1 | Physical | Processing |

# Figure 2.3 *The interaction between layers in the OSI model*



# An exchange using the OSI model



# 2-3 LAYERS IN THE OSI MODEL

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

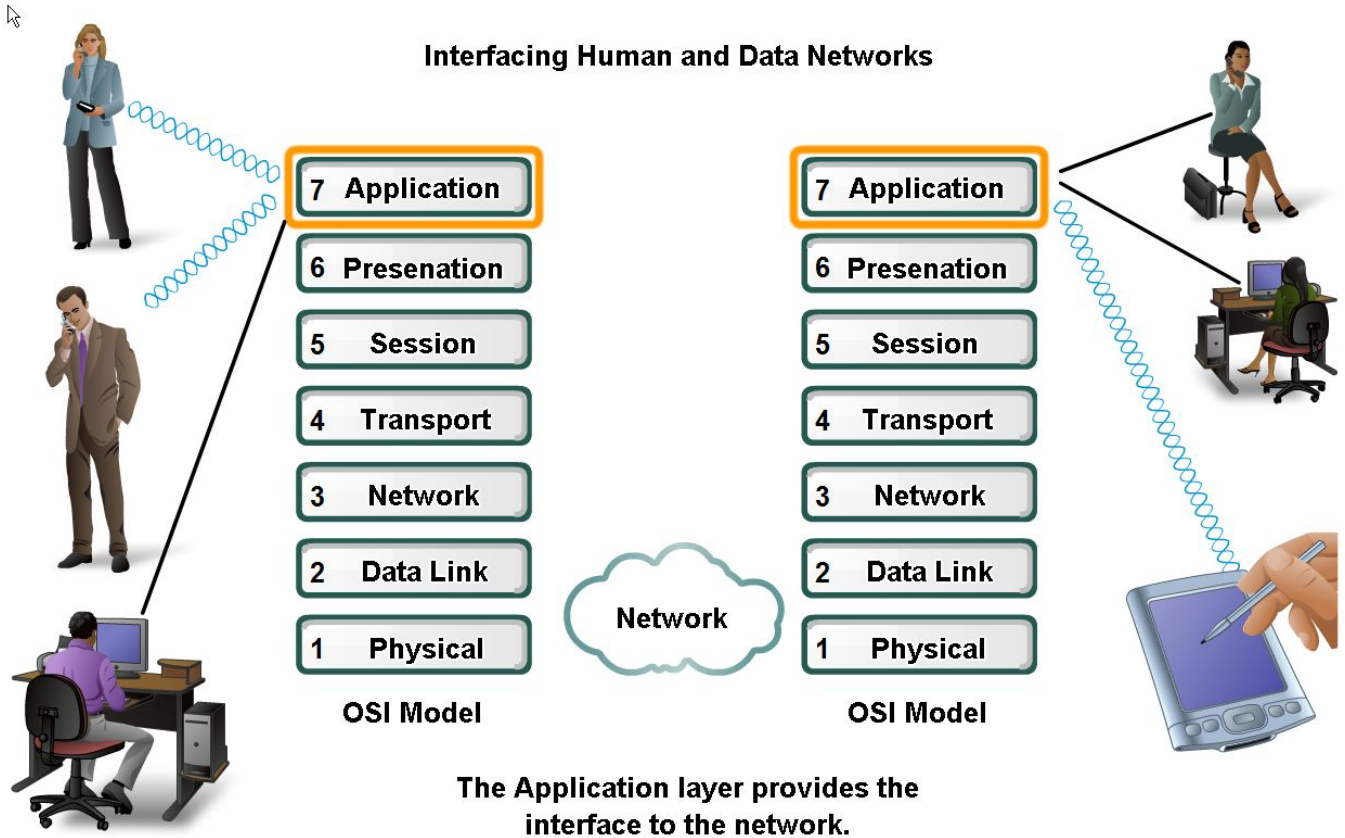
*Topics discussed in this section:*

**Physical Layer**
**Data Link Layer**
**Network Layer**
**Transport Layer**
**Session Layer**
**Presentation Layer**
**Application Layer**

# APPLICATION LAYER

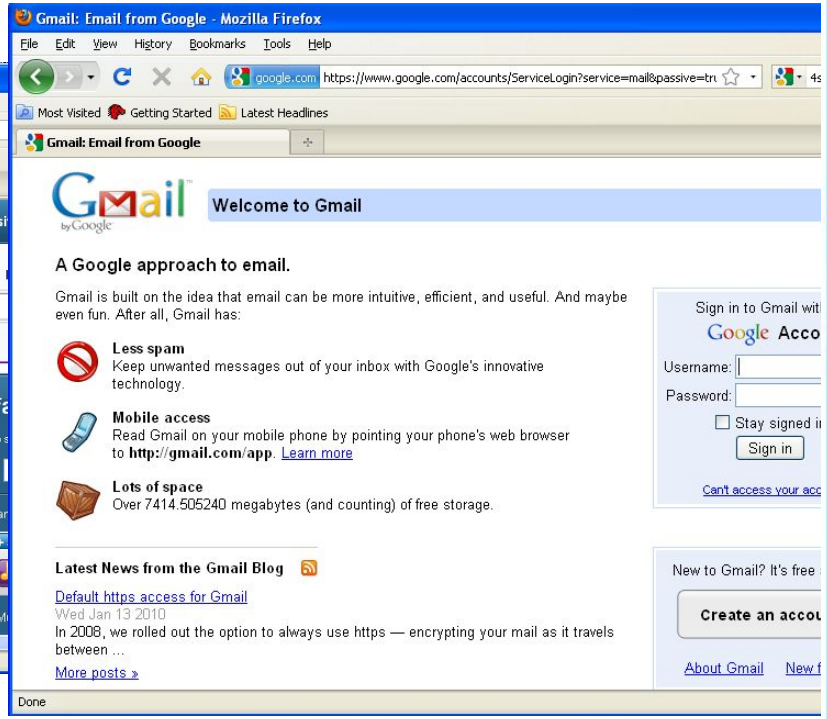
# Applications

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

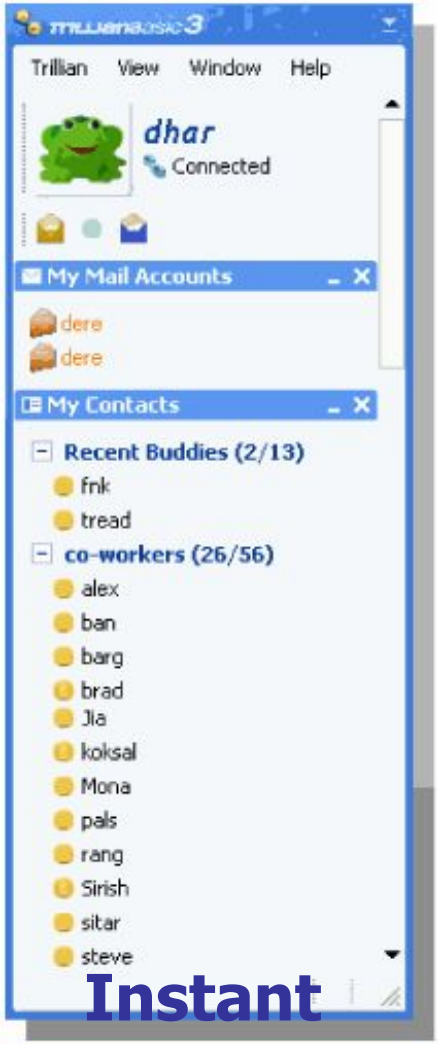


# Applications in Application layer


**Web Page**

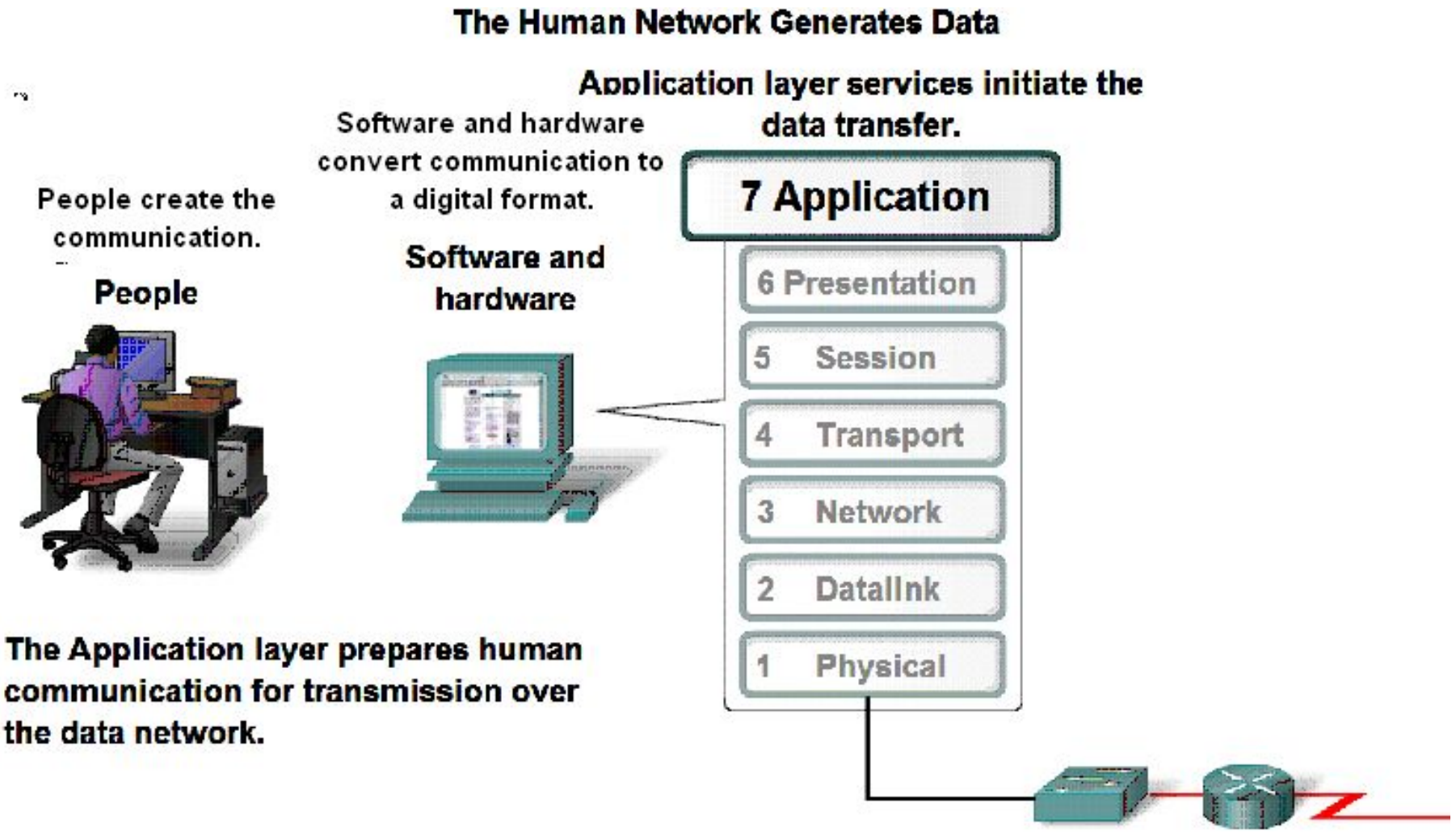



**Email**

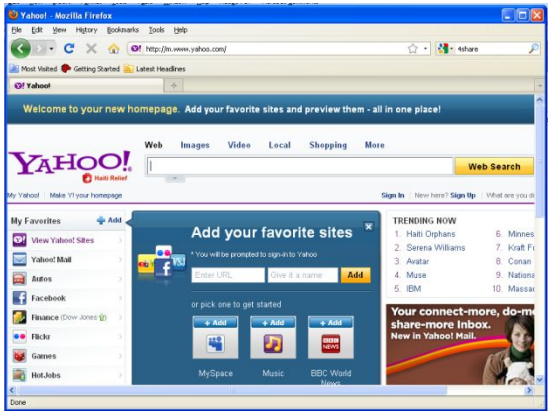



**Instant messaging**

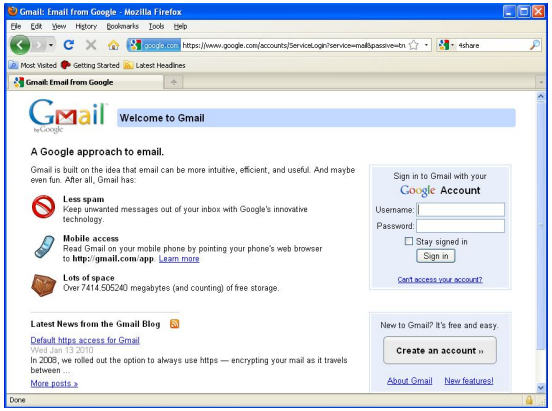
# Application Layer



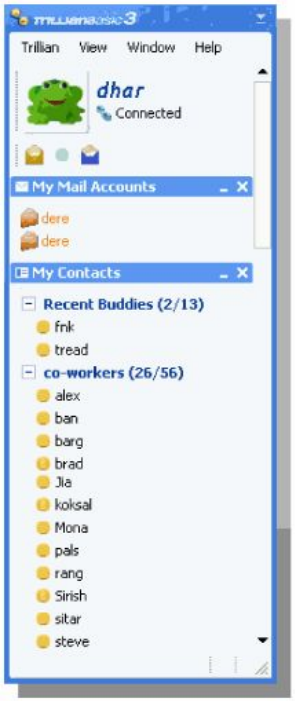
# Applications in Application layer



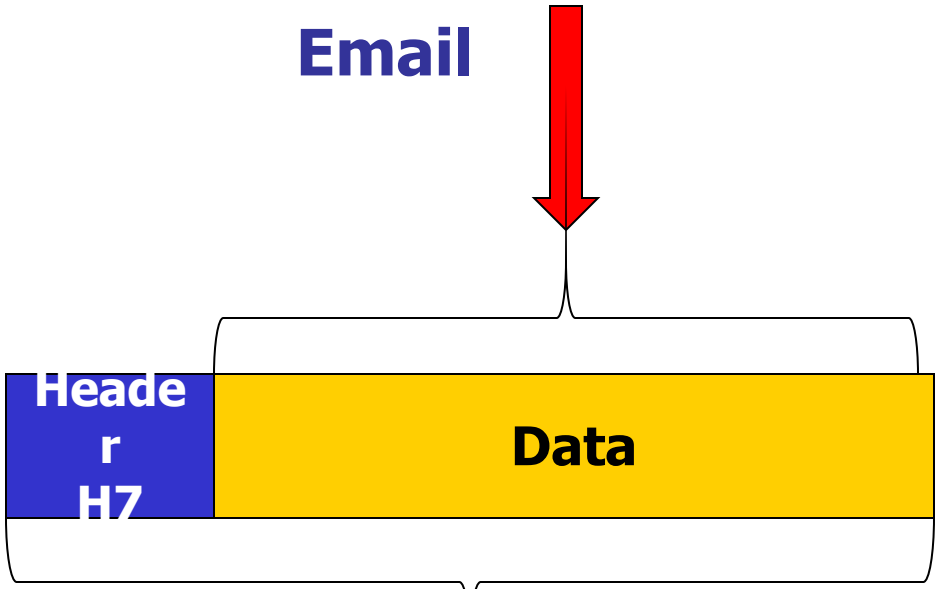

**Web Page**




**Email**

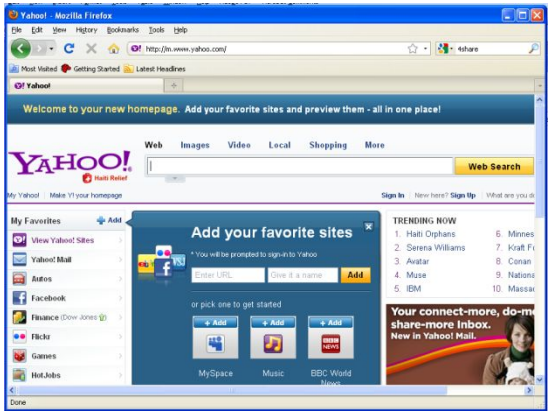



**Instant messaging**

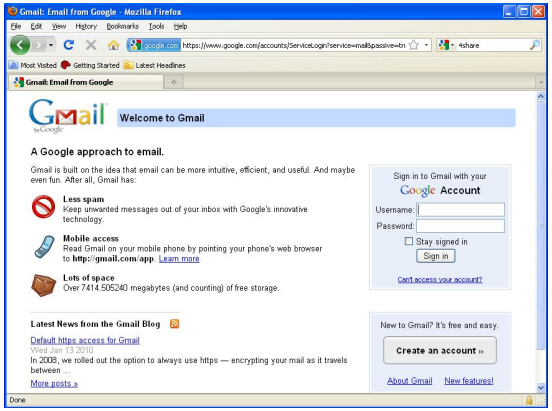



**To Presentation Layer**

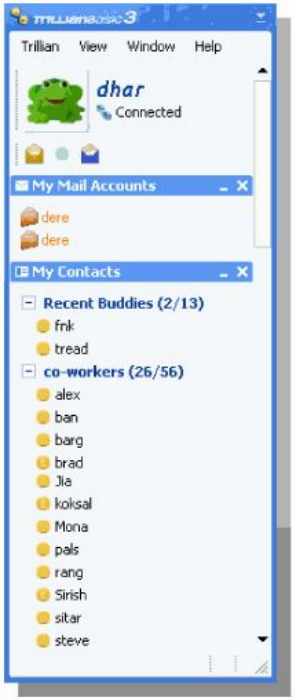
# Application layer



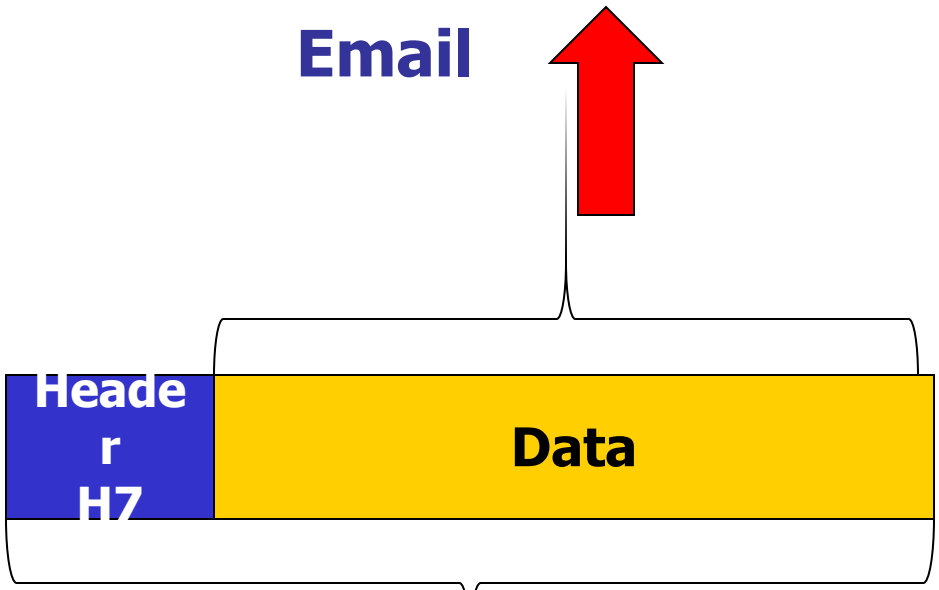

Web Page




Email

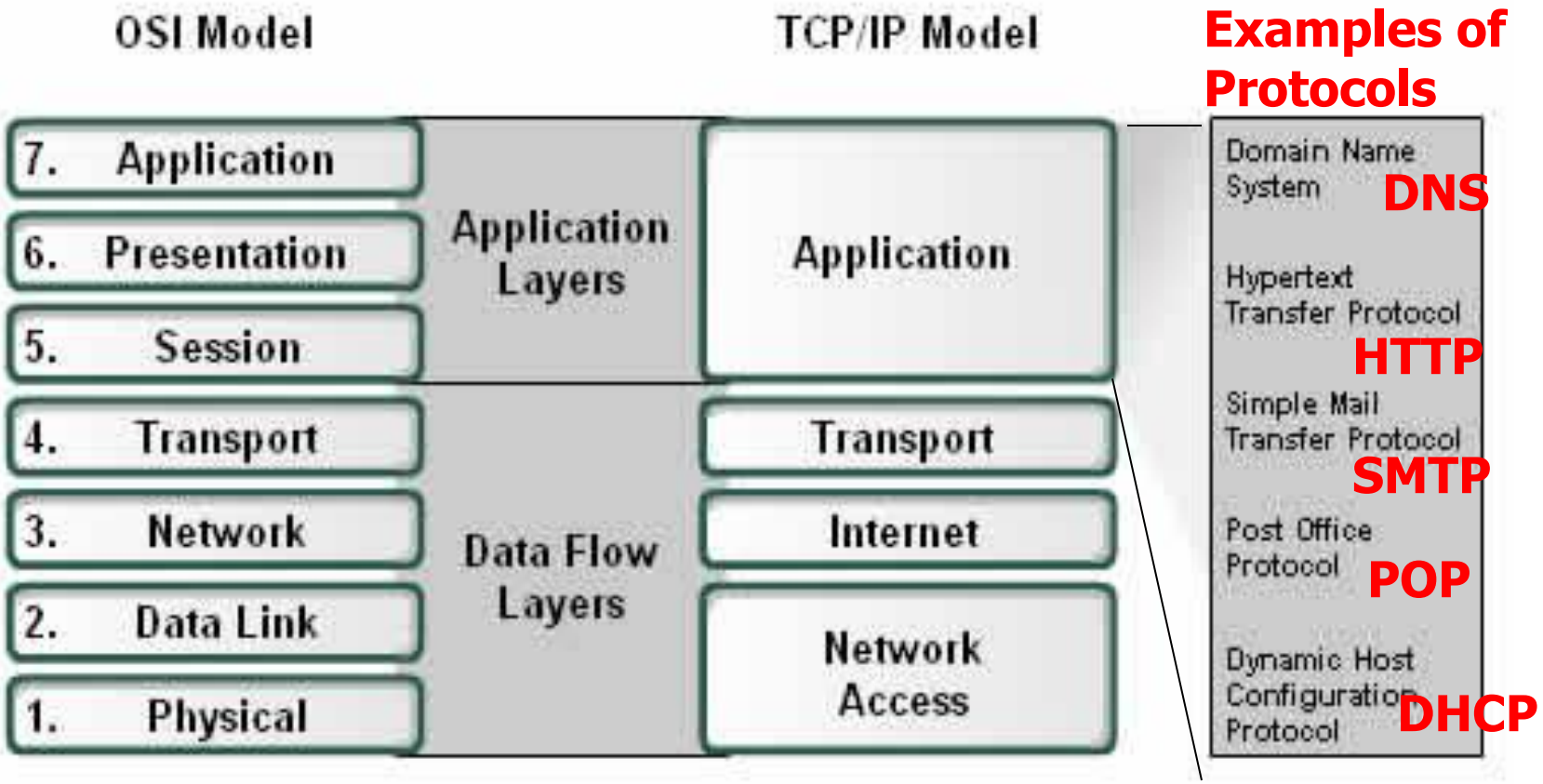



Instant messaging



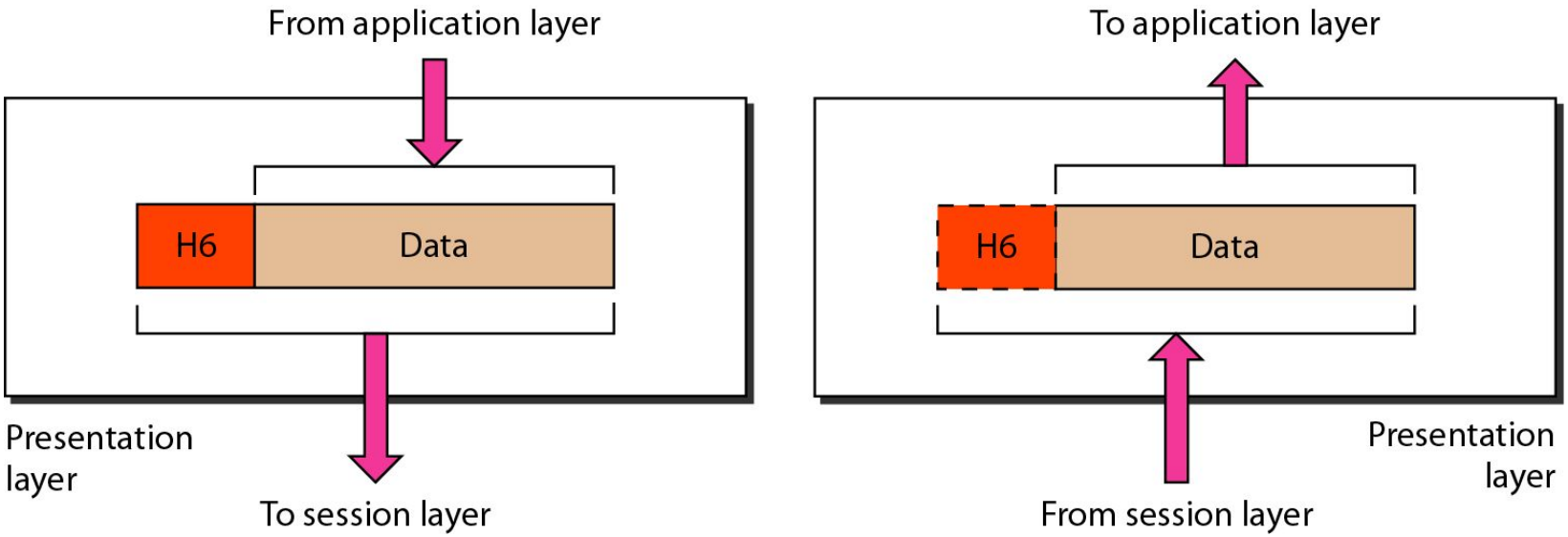

From Presentation Layer

# Application Layer



# PRESENTATION LAYER

# Presentation layer




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

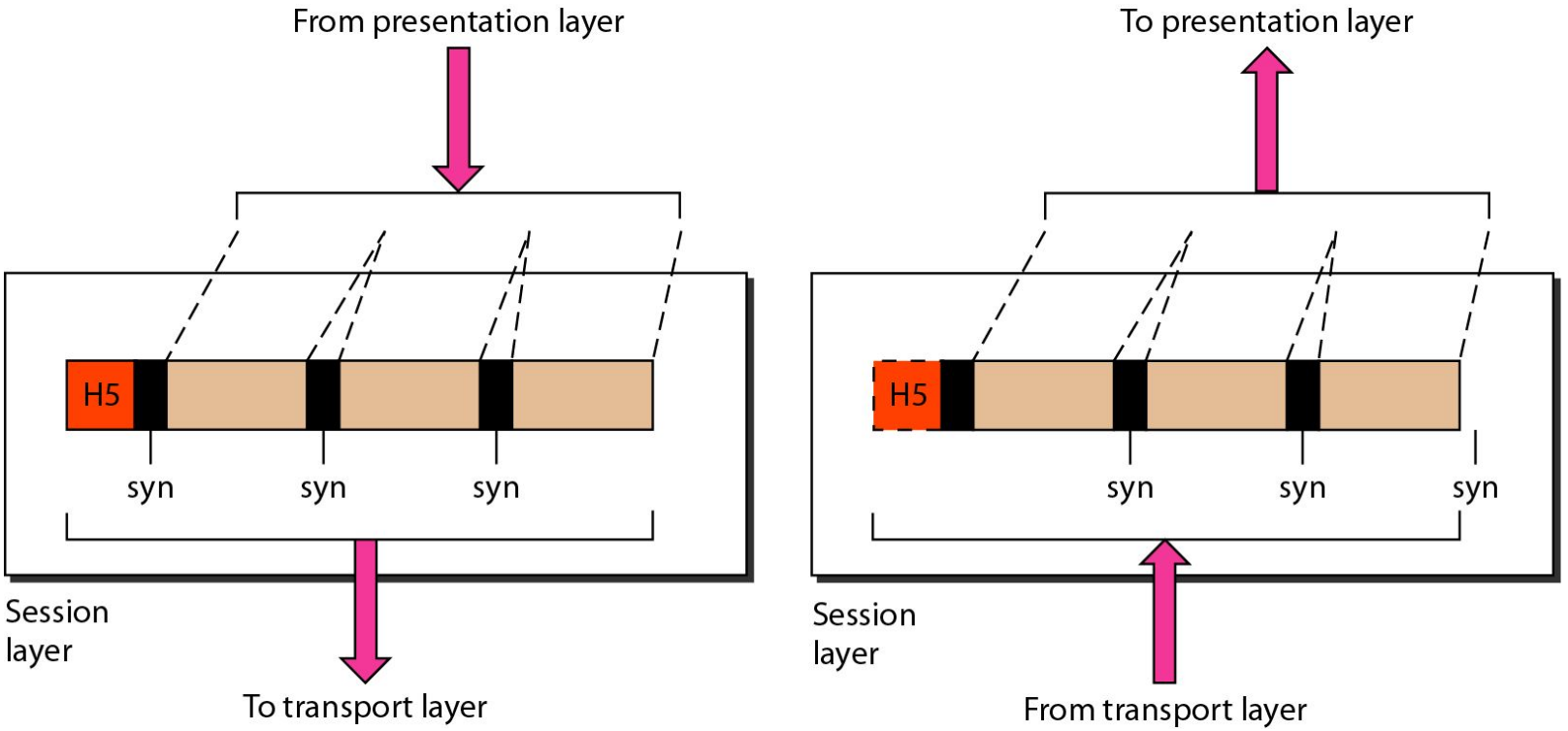
# Presentation Layer

- 3 primary functions:
  - Coding and conversion
  - Compression of the data
  - Encryption of the data

- Presentation layer implementations are not typically associated with a particular protocol stack.

# SESSION LAYER

# Session layer



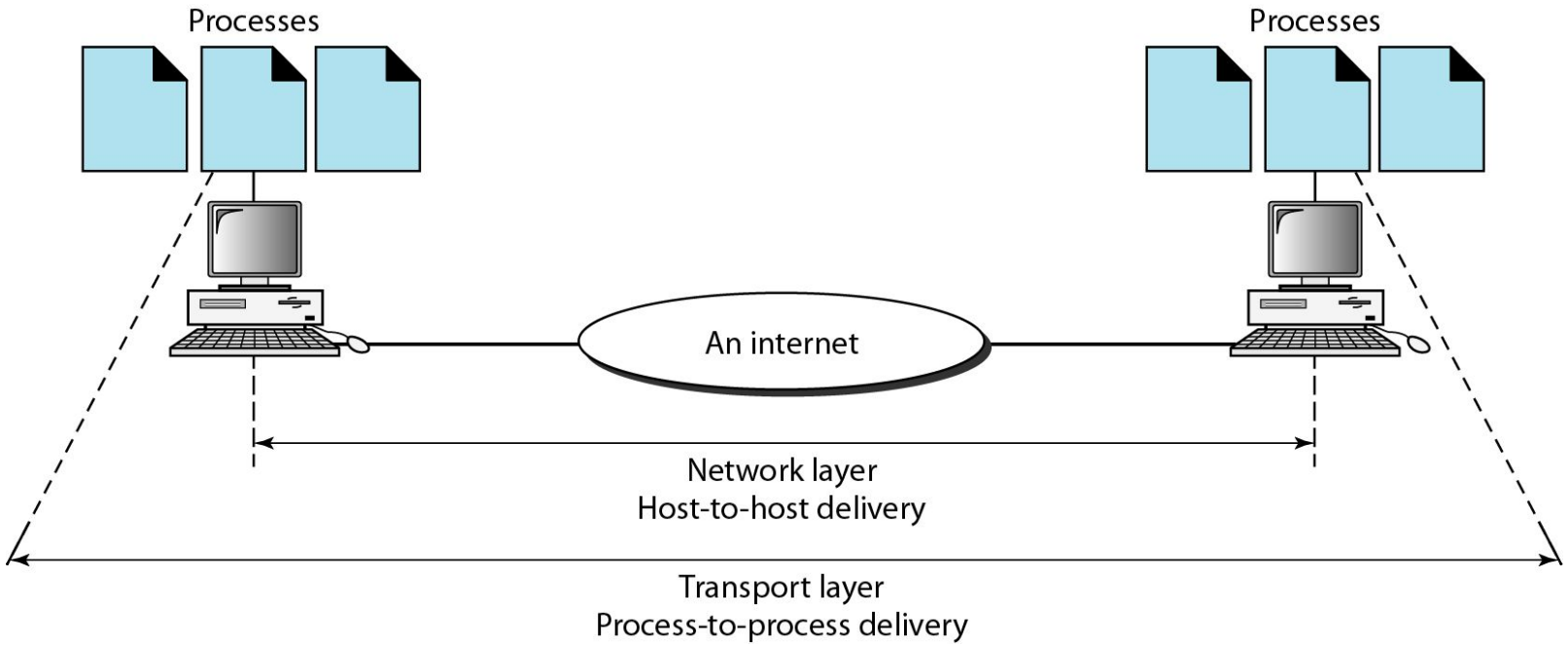

**The session layer is responsible for dialog control and synchronization.**

# Session Layer

- It handles the exchange of information
  - to initiate dialogs,
  - keep them active, and
  - to restart sessions that are disrupted or idle for a long period of time
- Most applications, like web browsers or e-mail clients, incorporate functionality of the OSI layers 5, 6 and 7.

# TRANSPORT LAYER

# Transport layer




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

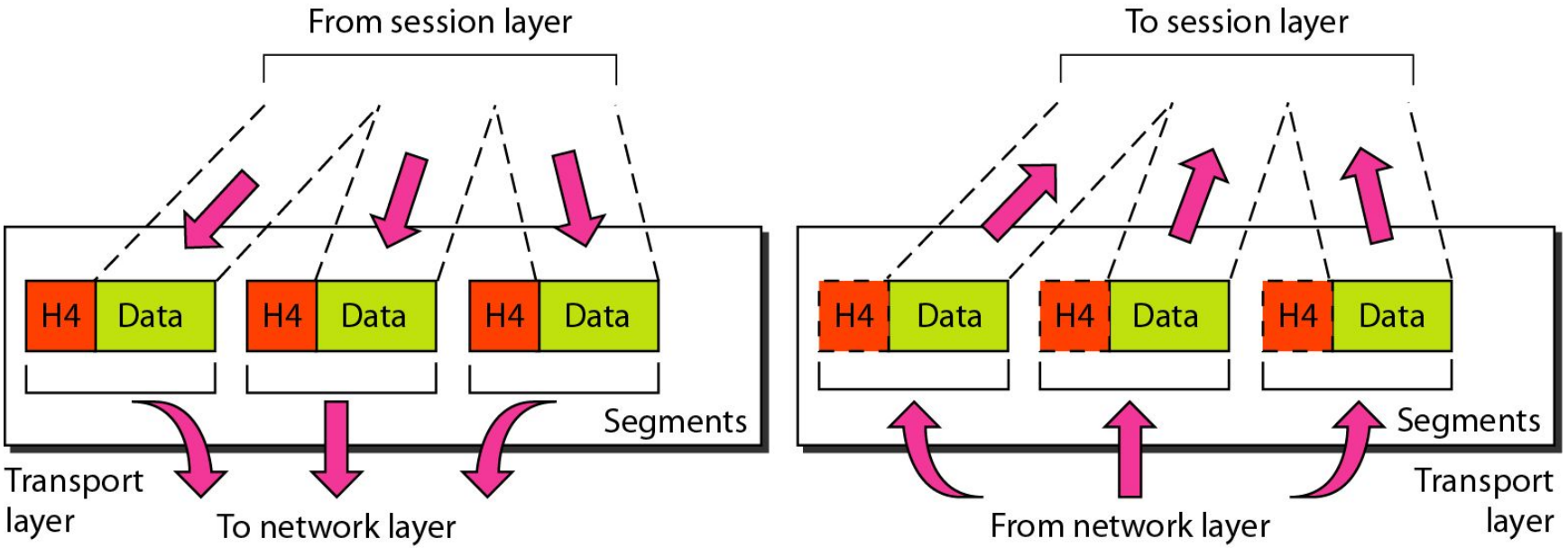
# Functions– Transport Layer

- Segmentation and Reassembly
- Adds Port Address and Sequence Number.
- Connection Control
- Flow and Error Control
- Multiplexing

Transport Layer PDU is called **Segments**.

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

# Transport layer



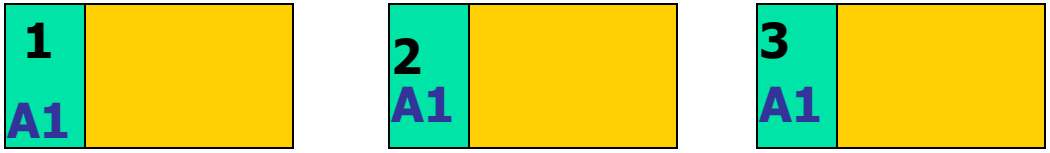

- Segments data received from application layer into small parts.
- Transport Layer Protocol Data Unit is called **Segments**.

# Function: Segmentation



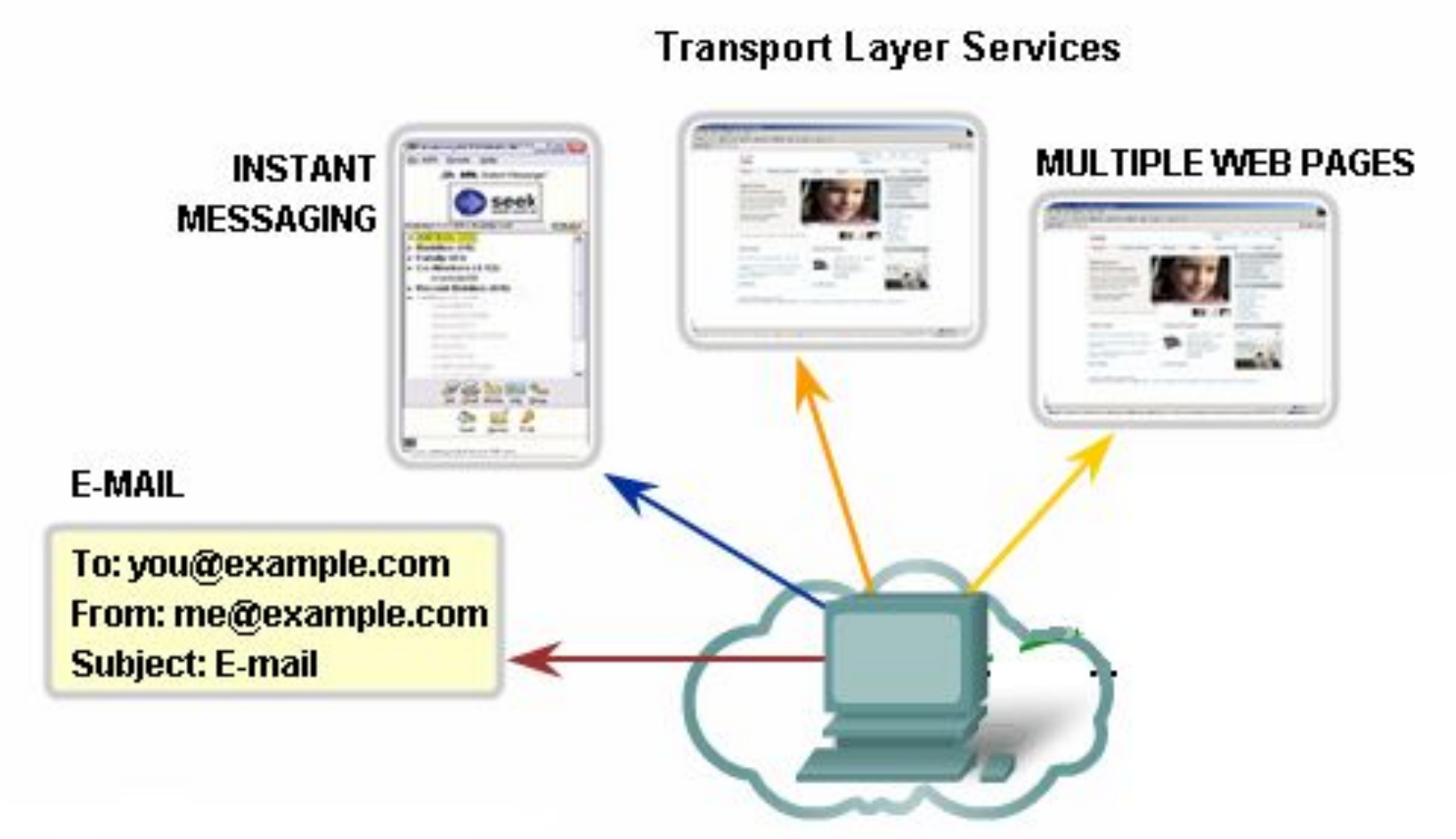
**Data from Application layer**

**Received by Transport Layer**




1. **Segments into small parts**
2. **Add a number to identify the application.**
3. **Add a number sequence the segmented parts.**

# Identifying Different Applications




- Port Numbers

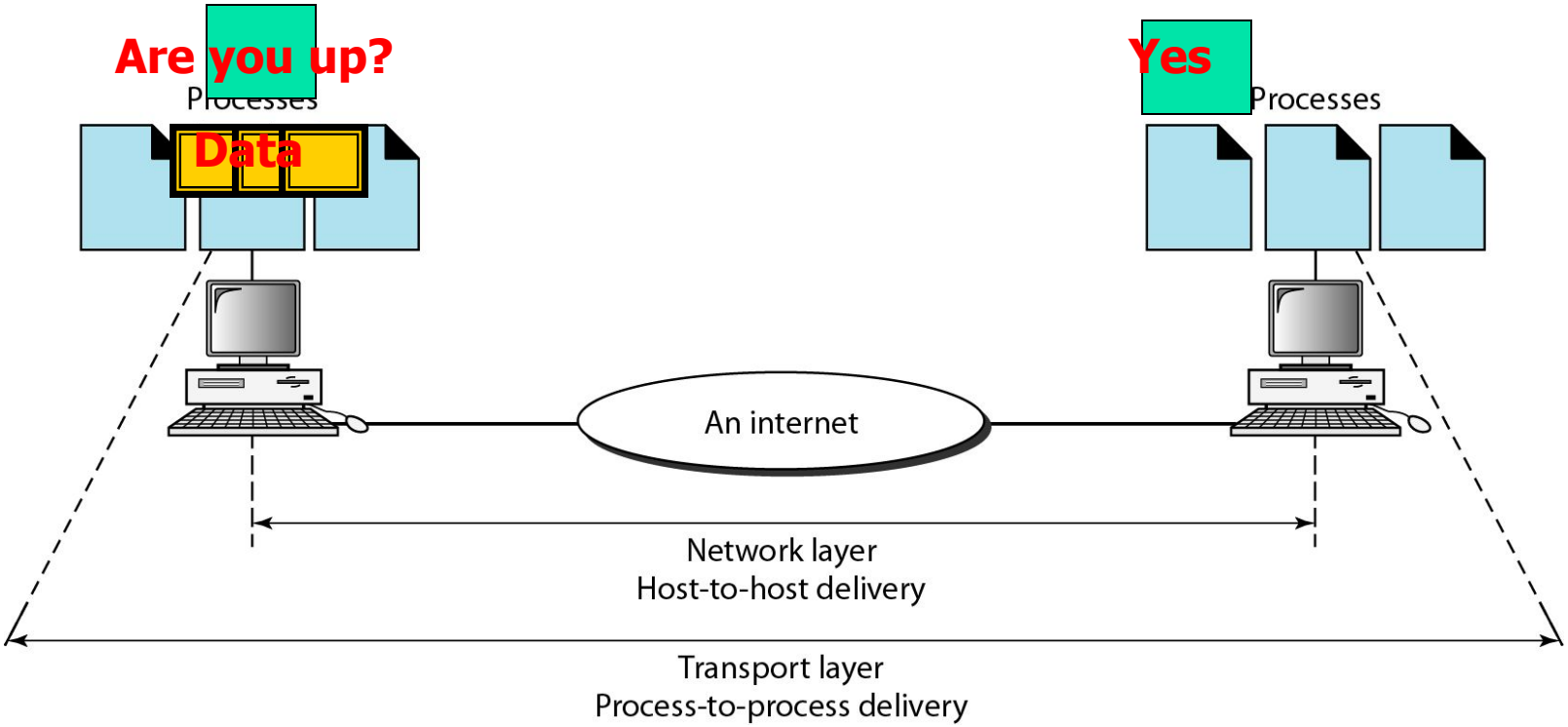
# Port Address

- To define multiple processes running in a computer.
- 16-bit in length

**80**

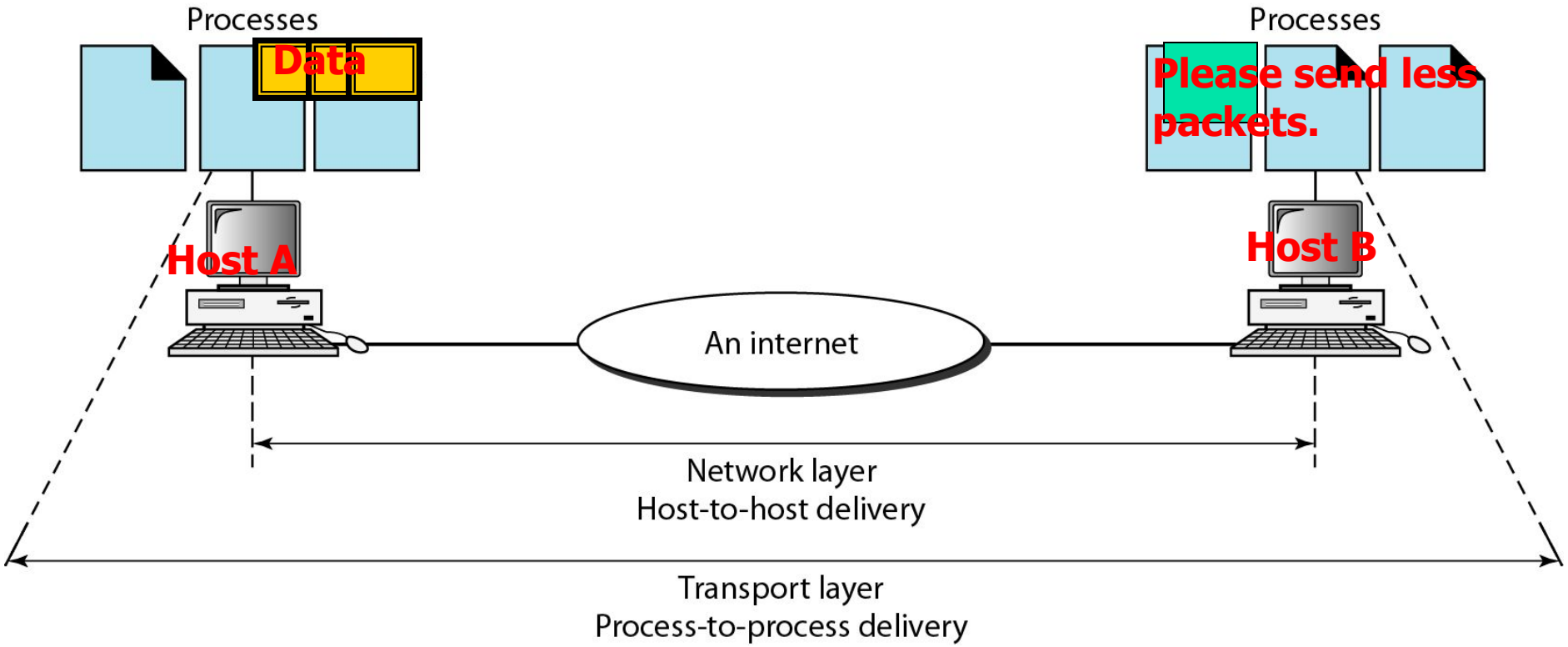
**A 16-bit port address represented as one single number.**

# Function: Connection Control

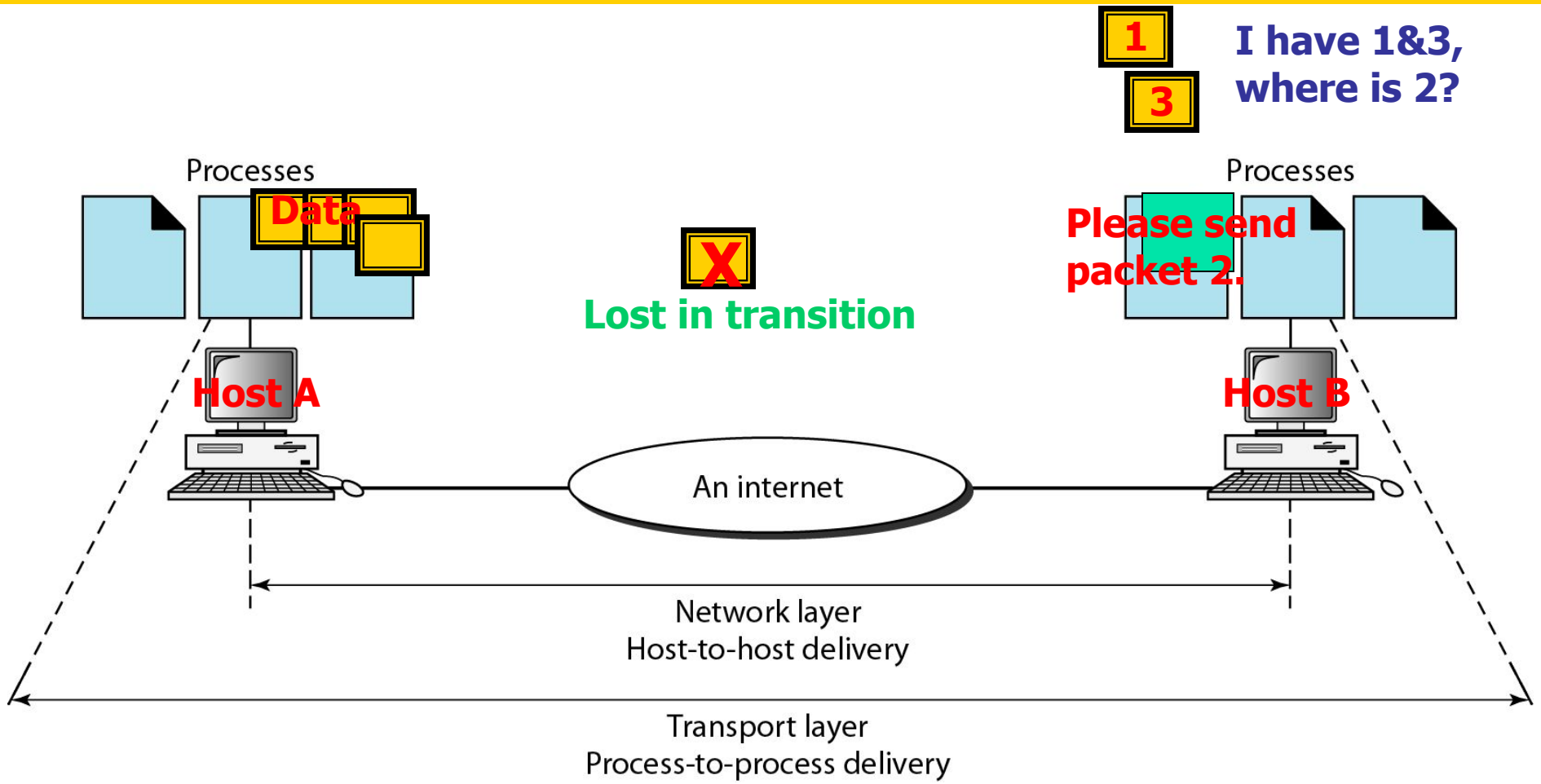


# Function: Flow Control

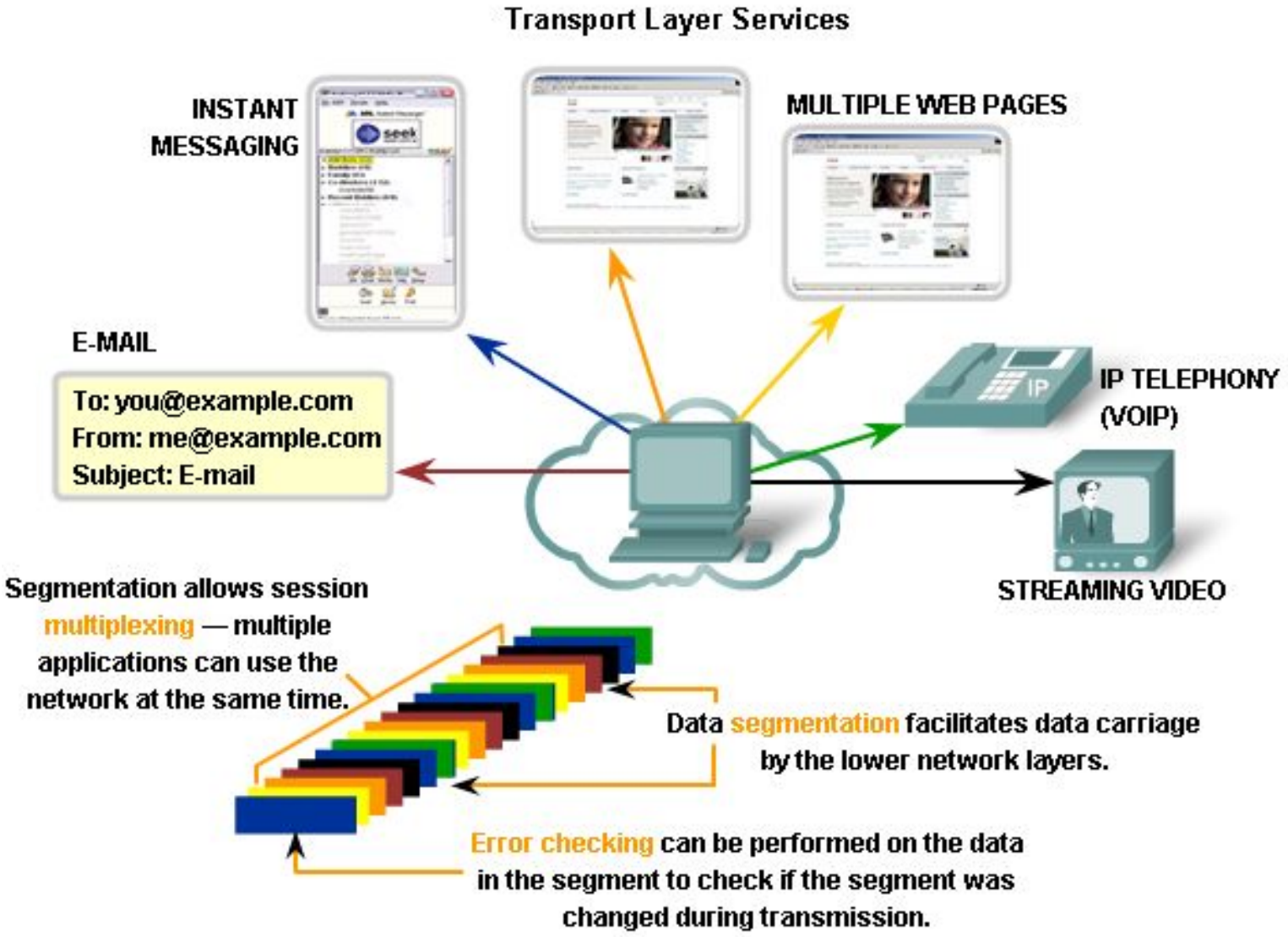
- Host B has too many packets to process.
- Buffer to store incoming packets overflows



# Function: Error Control

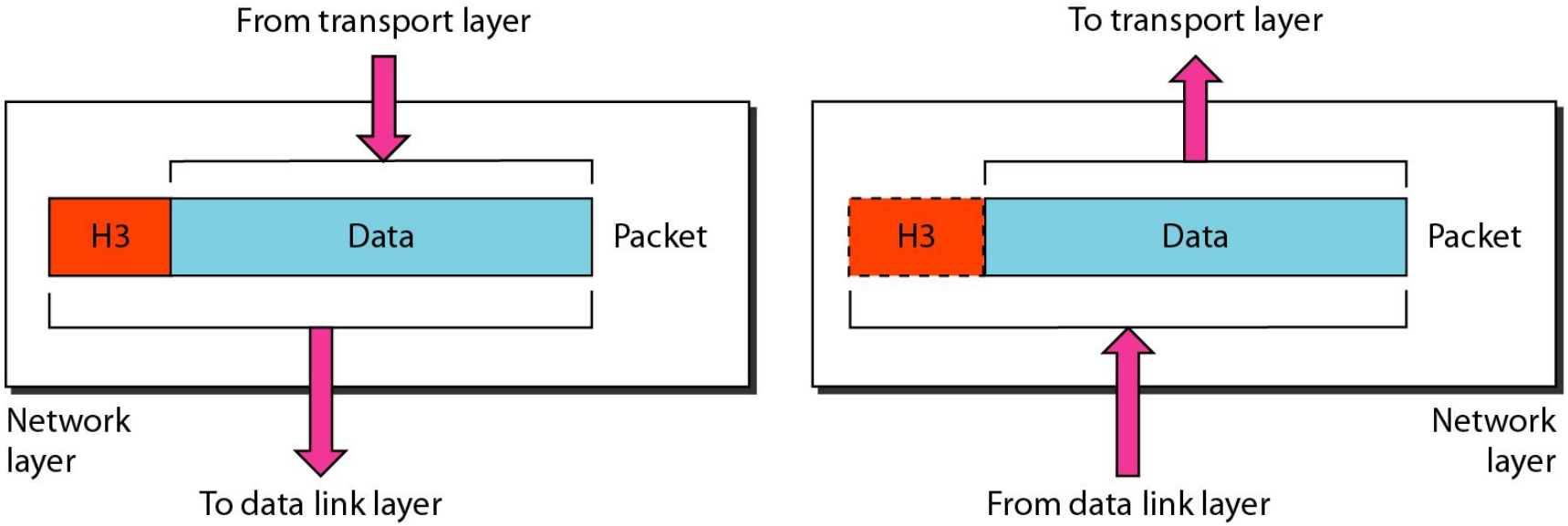


# Functions– Multiplexing



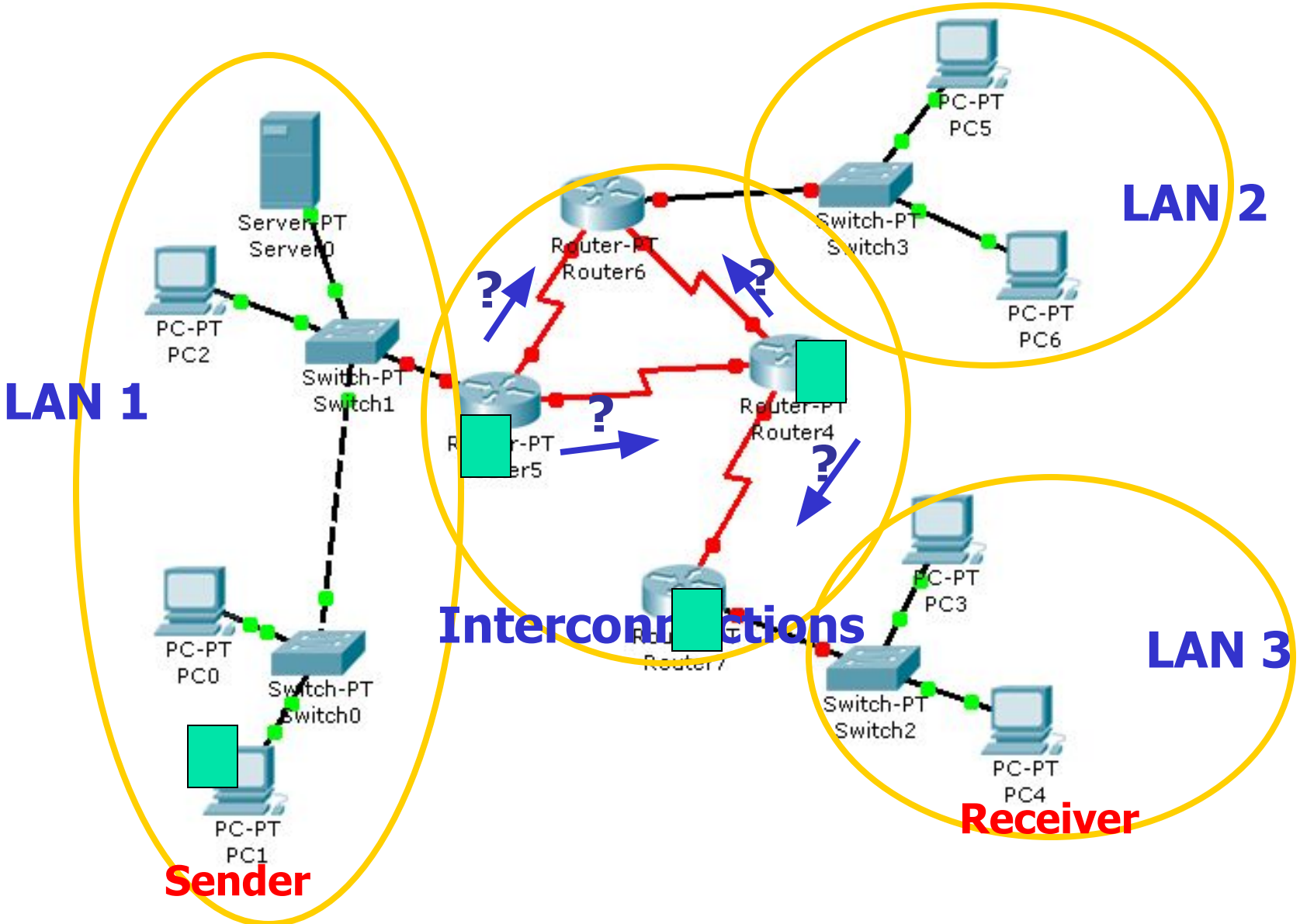
# NETWORK LAYER

# Network layer



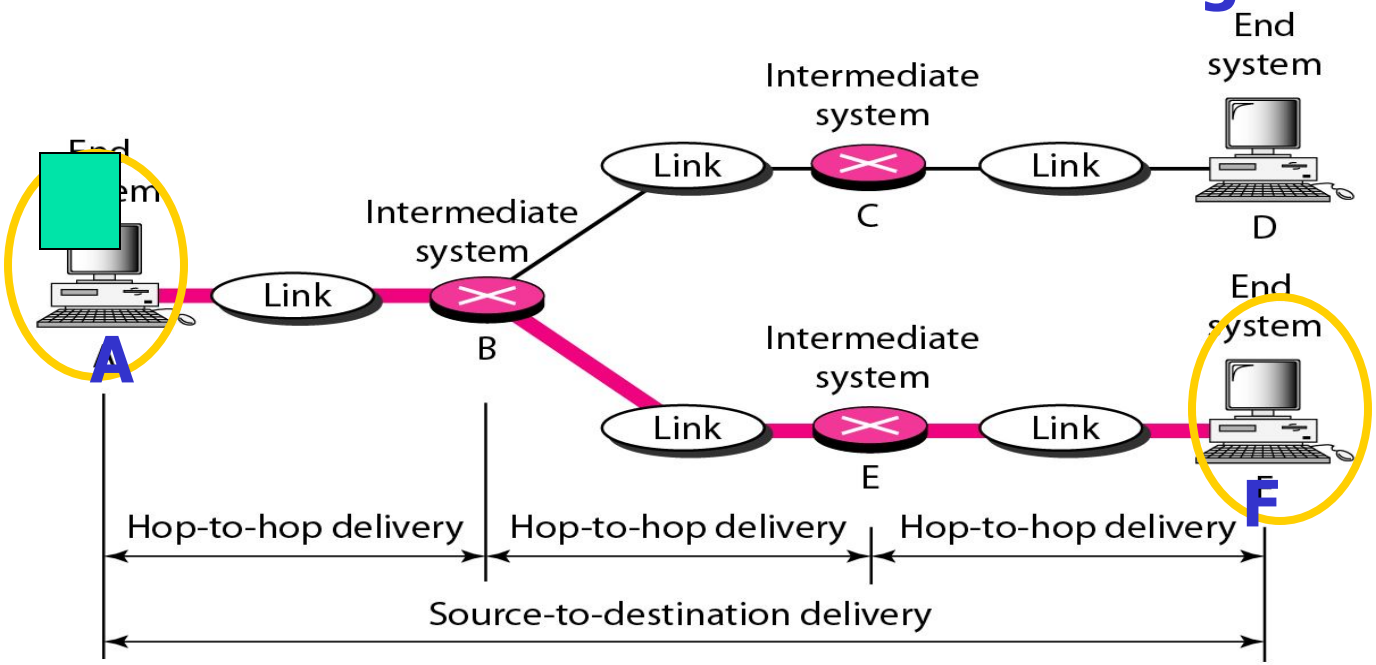

**The network layer is responsible for the delivery of individual packets from the source host to the destination host.**

# Example

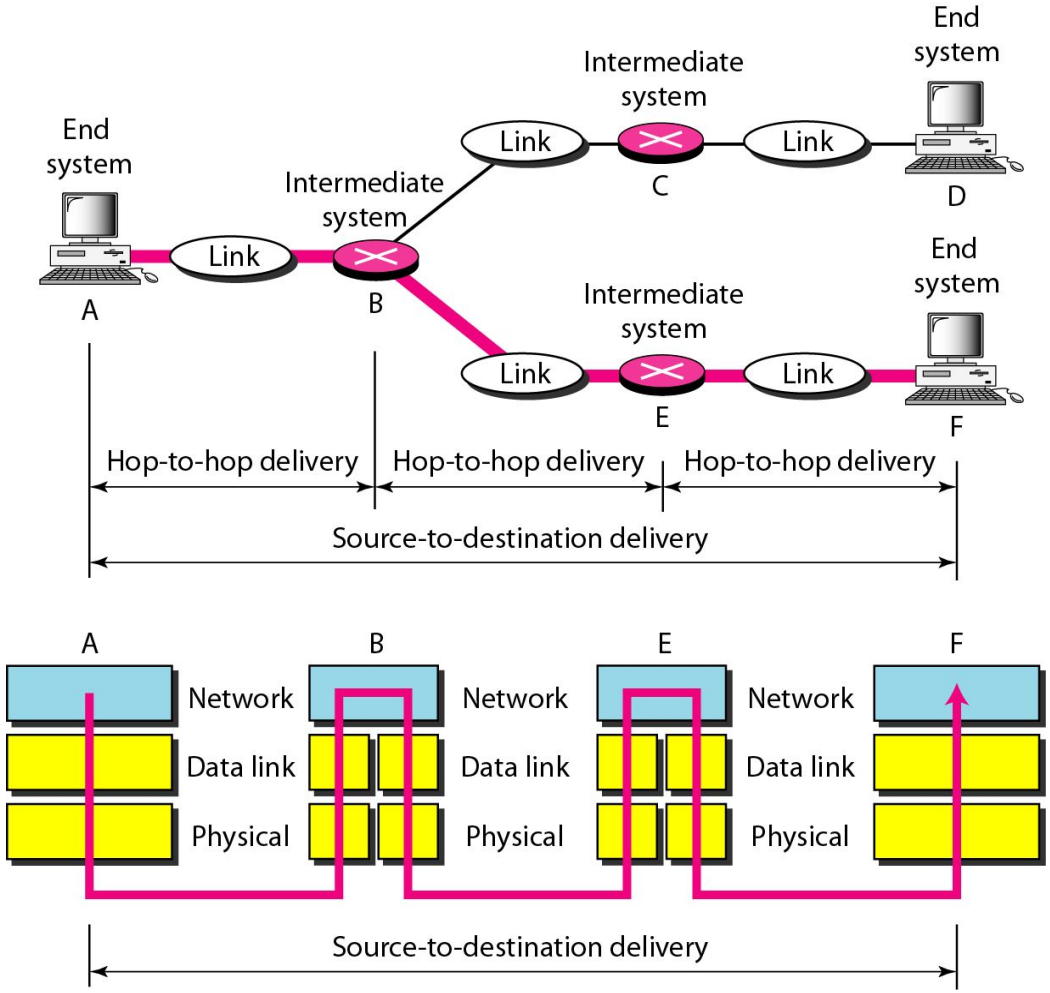

LAN 1
LAN 2
LAN 3
Interconnections
Sender
Receiver
PC-PT PC0
PC-PT PC1
PC-PT PC2
PC-PT PC3
PC-PT PC4
PC-PT PC5
PC-PT PC6
Switch-PT Switch0
Switch-PT Switch1
Switch-PT Switch2
Switch-PT Switch3
Router-PT Router4
Router-PT Router6
?
?
?
?

# Source-to-destination delivery

- Functions :
  - Adds an address to identify sender and receiver hosts. **Adds Logical Addressing**
  - Decides which path to take. **Routing**



# Source-to-destination delivery




- Network Layer PDU is called **Packets**.
- Common Network layer Protocol is called **Internet Protocol (IP)**

# Logical Addresses :: IP Address

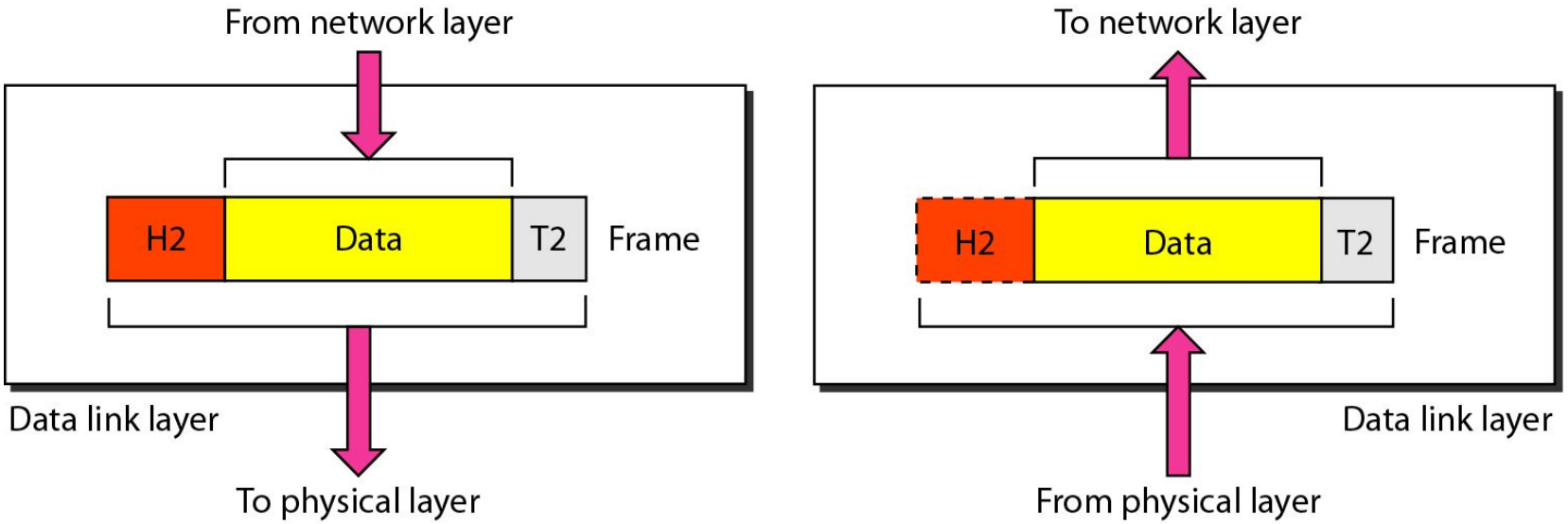
- Universal address, each host uniquely defined.
- 32-bit address also known as **IP Address**.
- Independent of underlying physical networks.

**192.168.10.1**

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

# DATALINK LAYER

# Data link layer




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

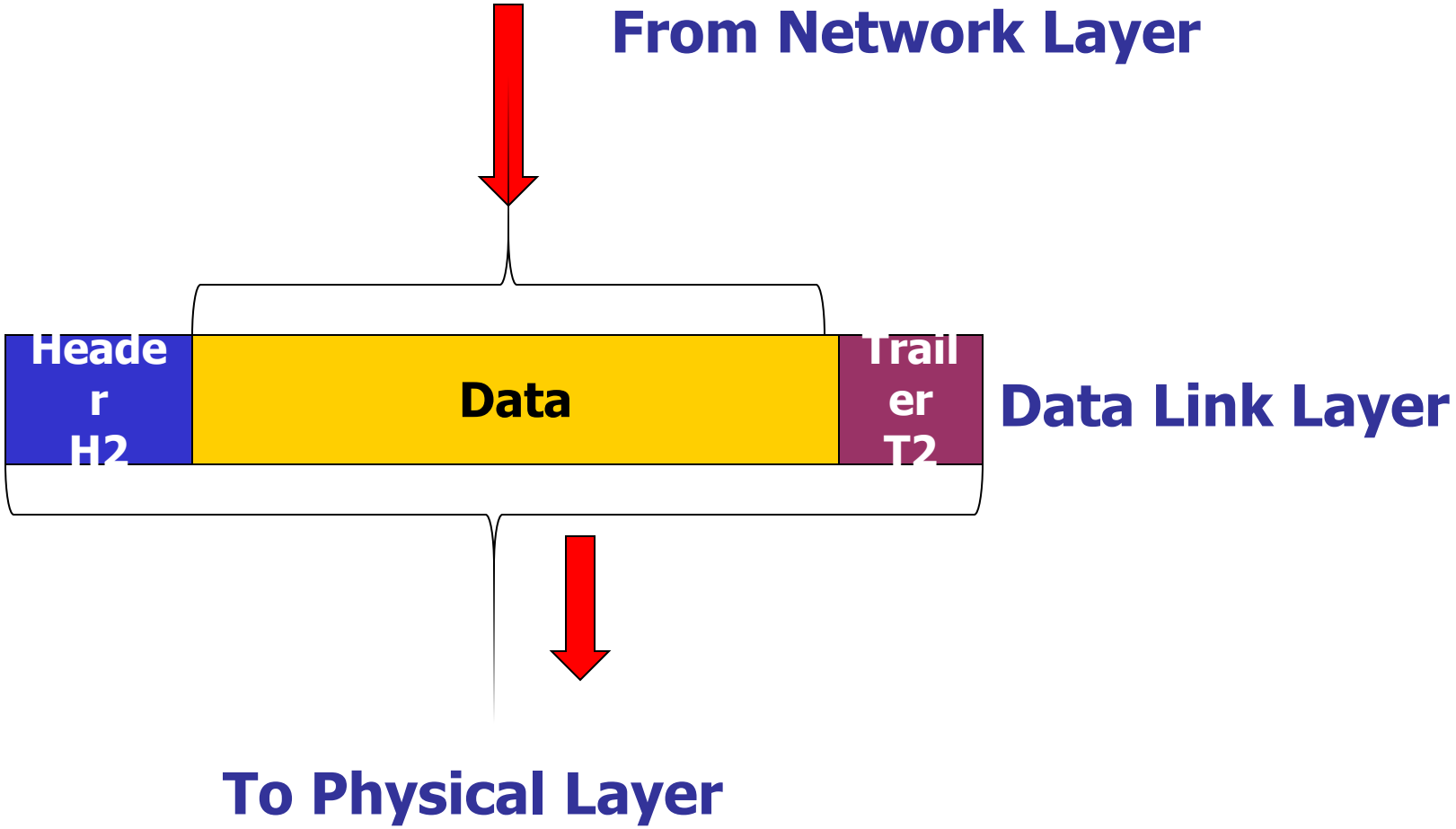
# Functions-Data Link Layer

- Framing.
- Physical Addressing
- Flow Control
- Error Control
- Access Control

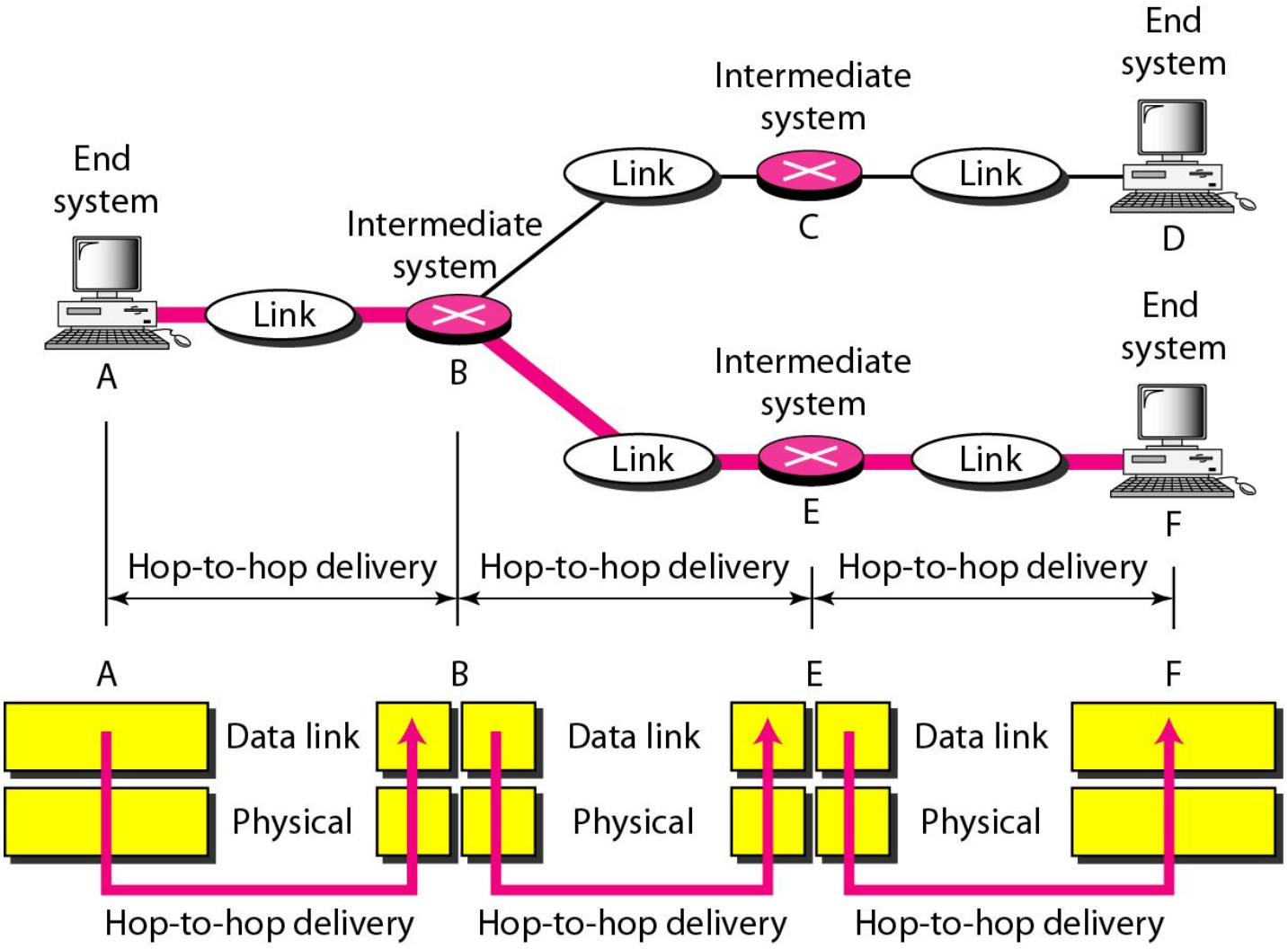
Data Link Layer PDU is called **Frames.**

Data Link Layer Protocol varies.

# Functions : Framing



# Hop-to-hop delivery



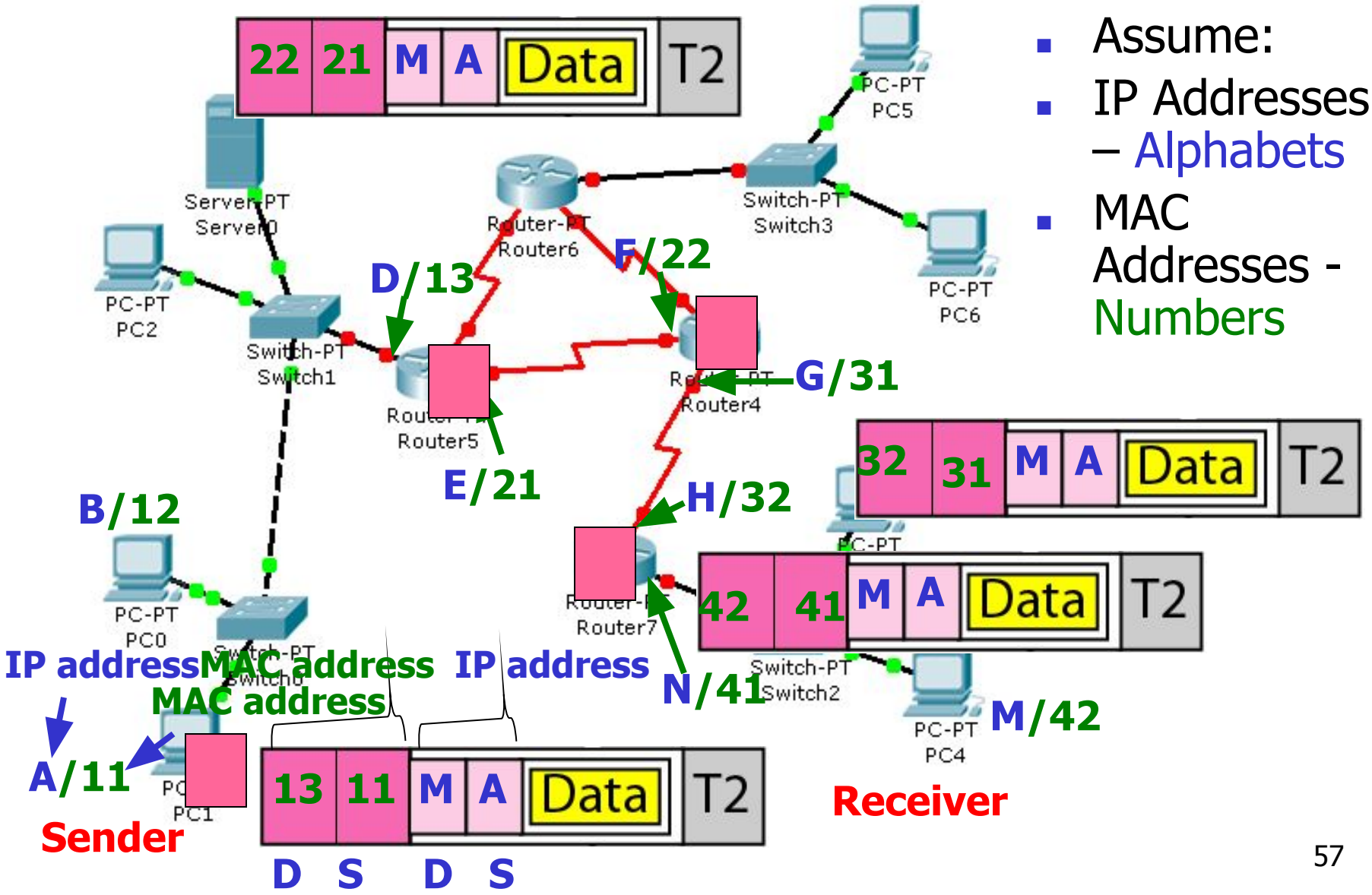
# Physical Address : MAC Address

- Every interface/port has an unique identifying number.
- Given by manufacturer.
- 48 bits long, represented by 12 hexadecimal digits.

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

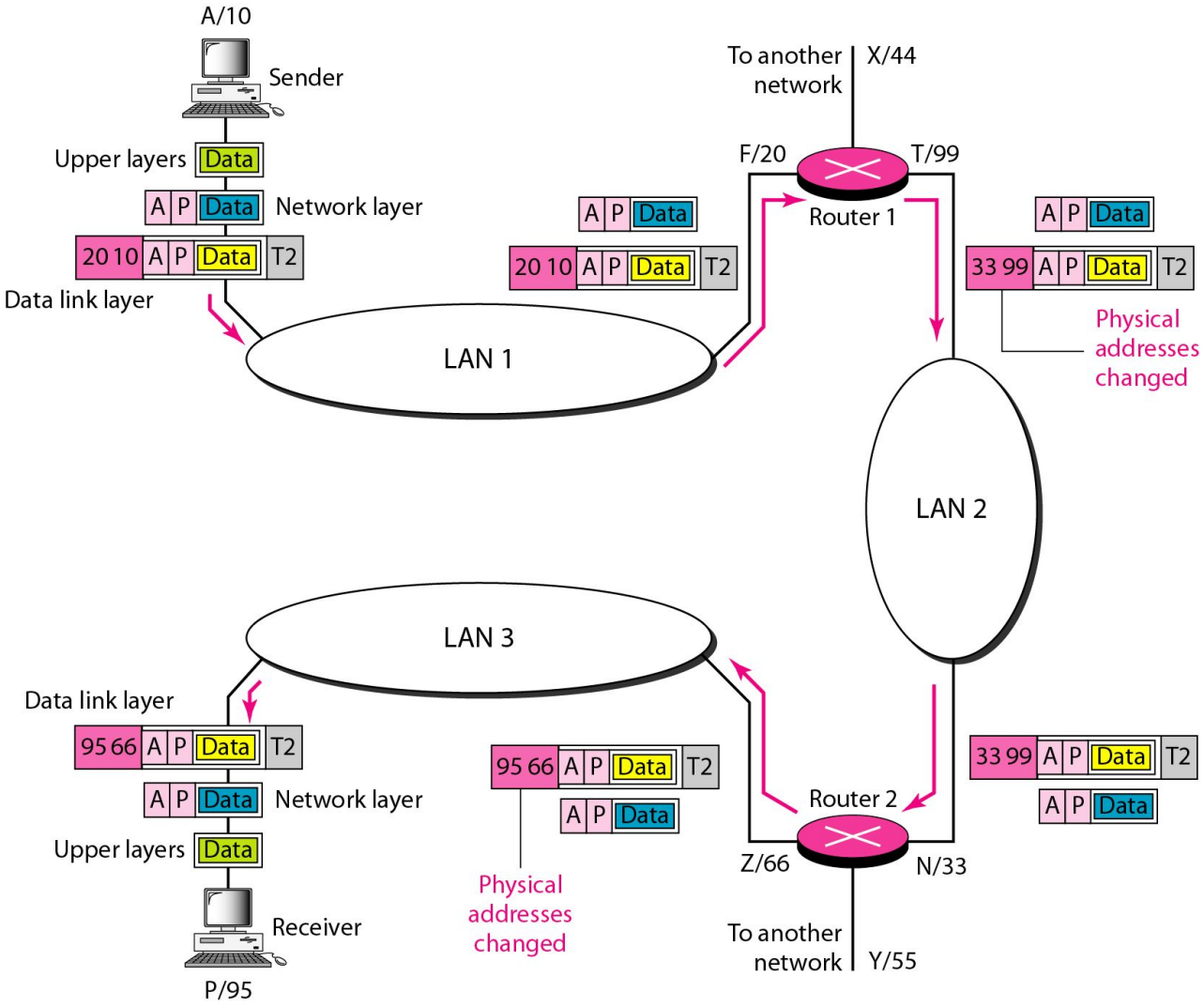
**Also known as MAC (Media Access Control) Address.**

# Addressing

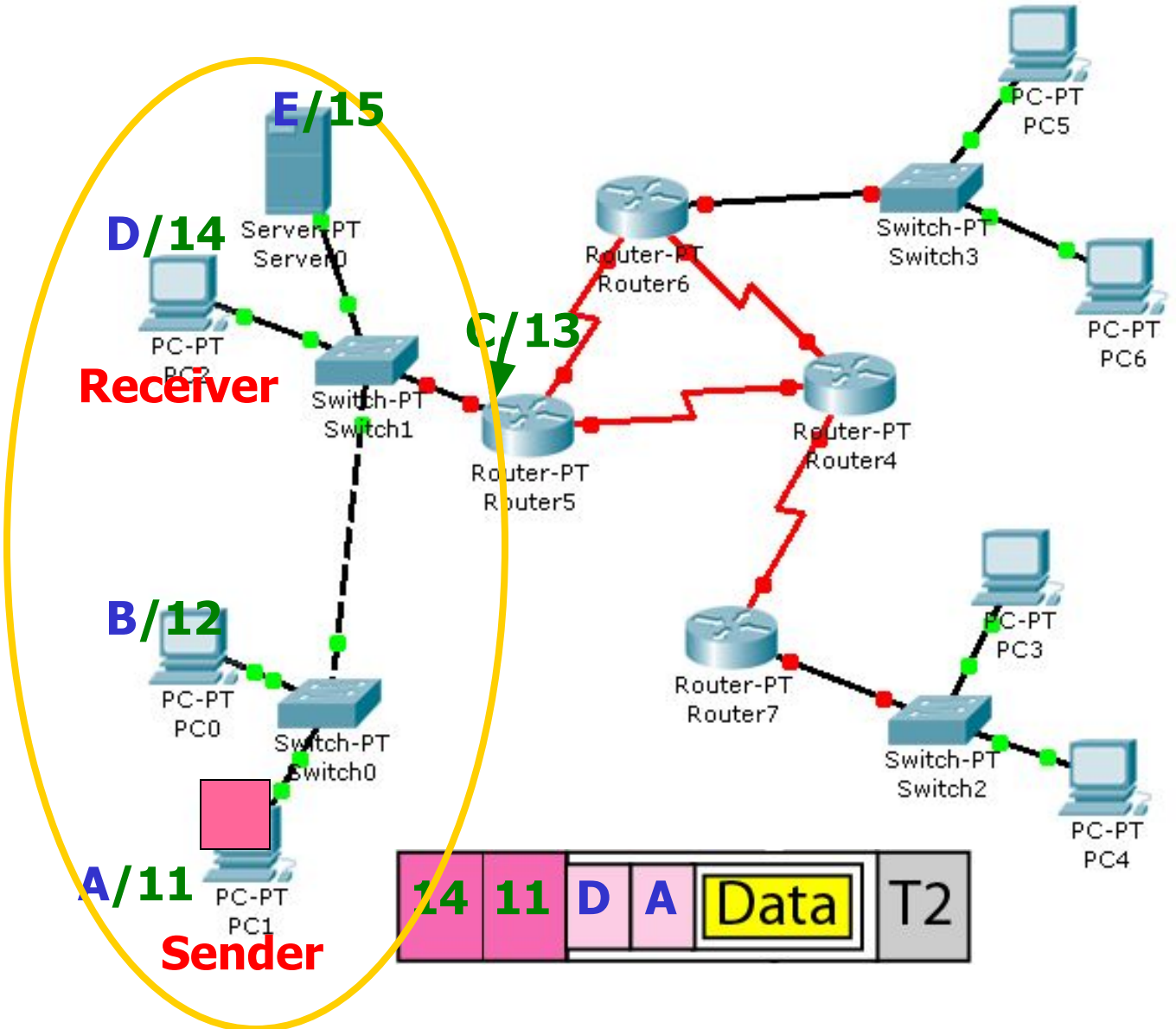



- Assume:
- IP Addresses – Alphabets
- MAC Addresses - Numbers

# Addressing


A/10
Sender
Upper layers
Data
A P Data
Network layer
20 10 A P Data T2
Data link layer
LAN 1
To another network
X/44
F/20
T/99
Router 1
A P Data
20 10 A P Data T2
33 99 A P Data T2
Physical addresses changed
LAN 2
LAN 3
Data link layer
95 66 A P Data T2
A P Data
Network layer
Upper layers
Data
Receiver
P/95
95 66 A P Data T2
A P Data
Physical addresses changed
Router 2
Z/66
N/33
33 99 A P Data T2
A P Data
To another network
Y/55

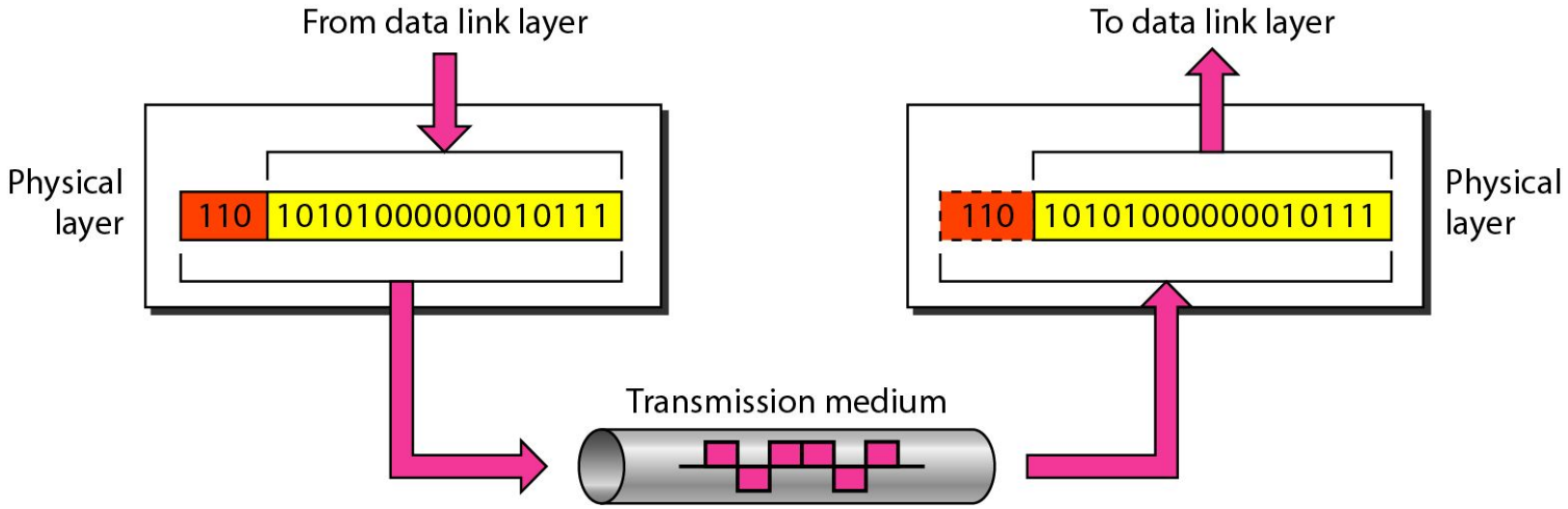
# Addressing-Within the same network




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

# PHYSICAL LAYER

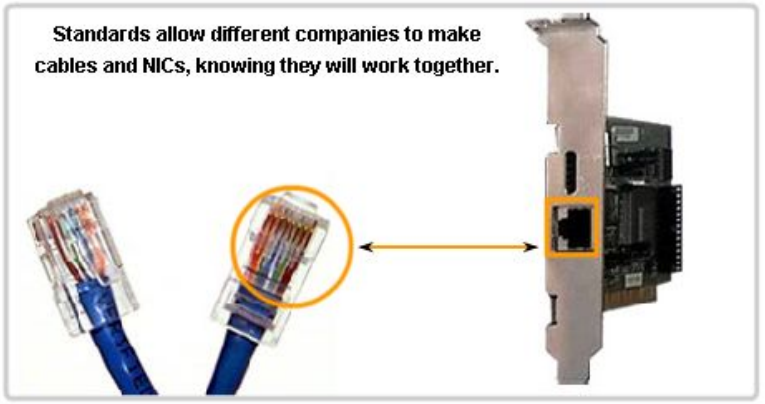
# Physical layer

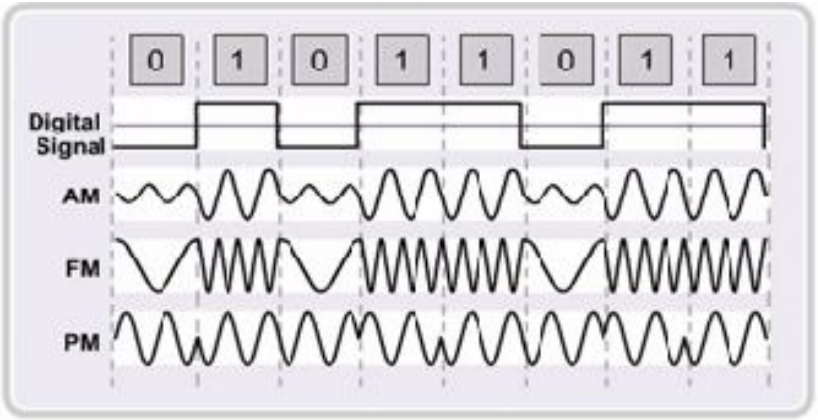



**The physical layer is responsible for movements of individual bits from one hop (node) to the next.**

# Functions-Physical Layer

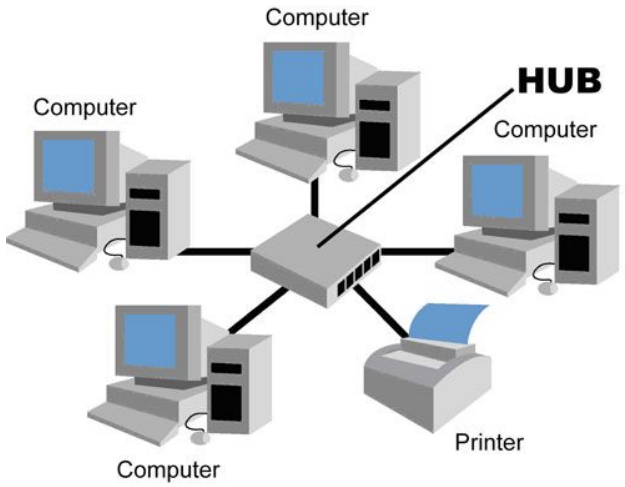
- Physical Characteristics of interfaces and medium.
- Representation of bits
- Data Rate
- Synchronization of bits

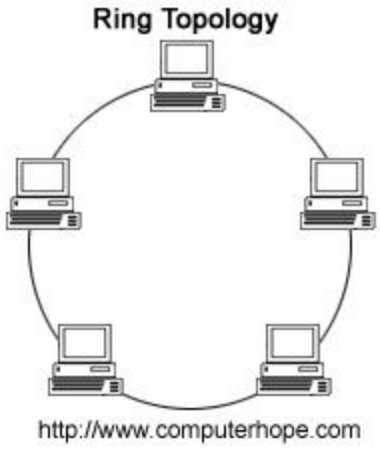


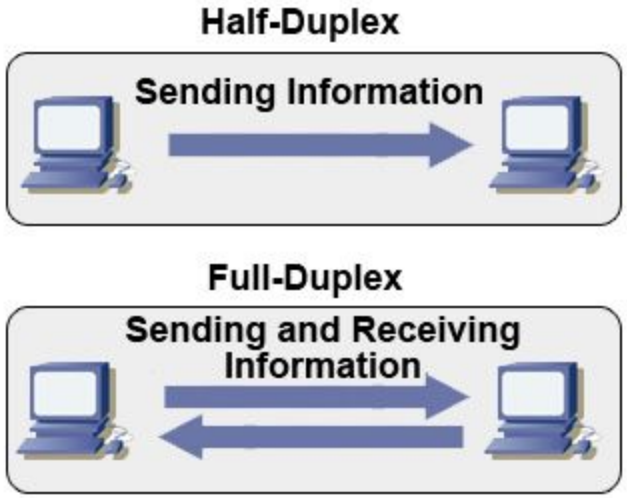
# Functions-Physical Layer

- Physical Topology
  - Bus
  - Ring etc

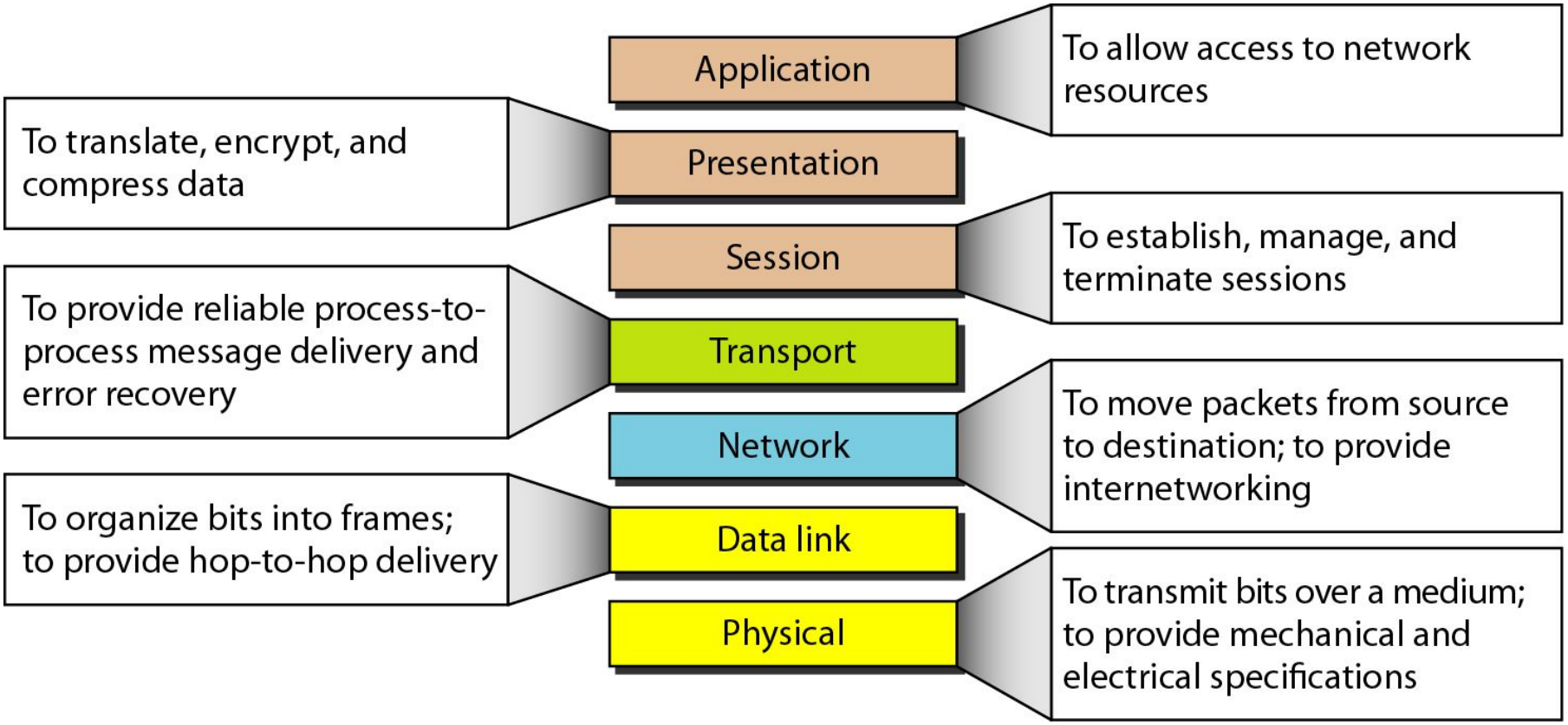


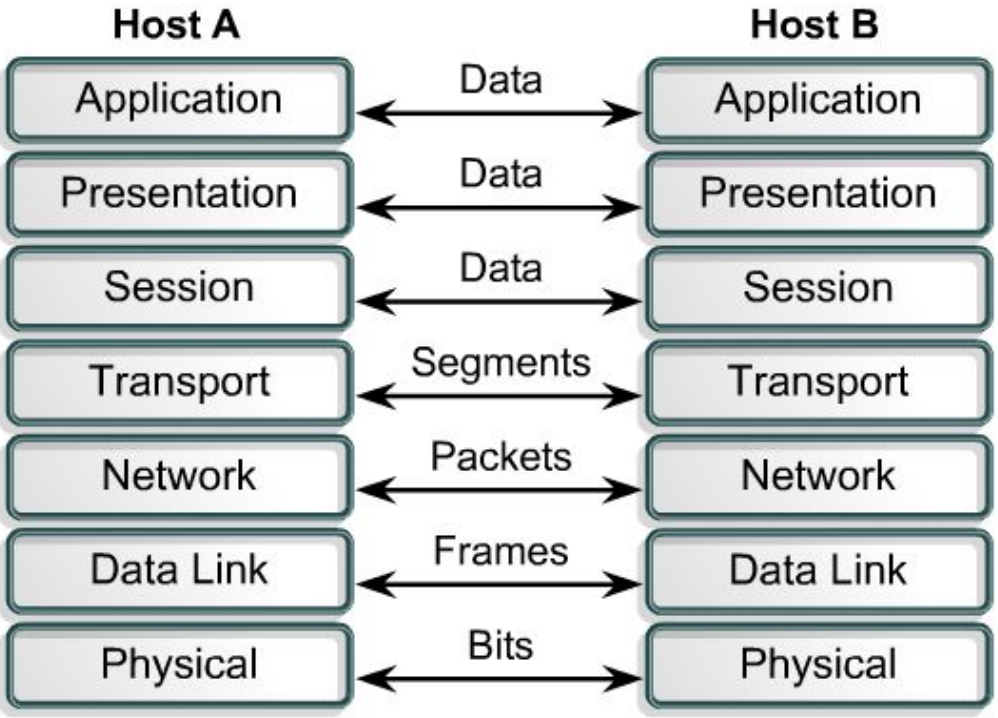

- Transmission Modes
  - Simplex
  - Half Duplex
  - Full Duplex



# Summary of OSI Layers



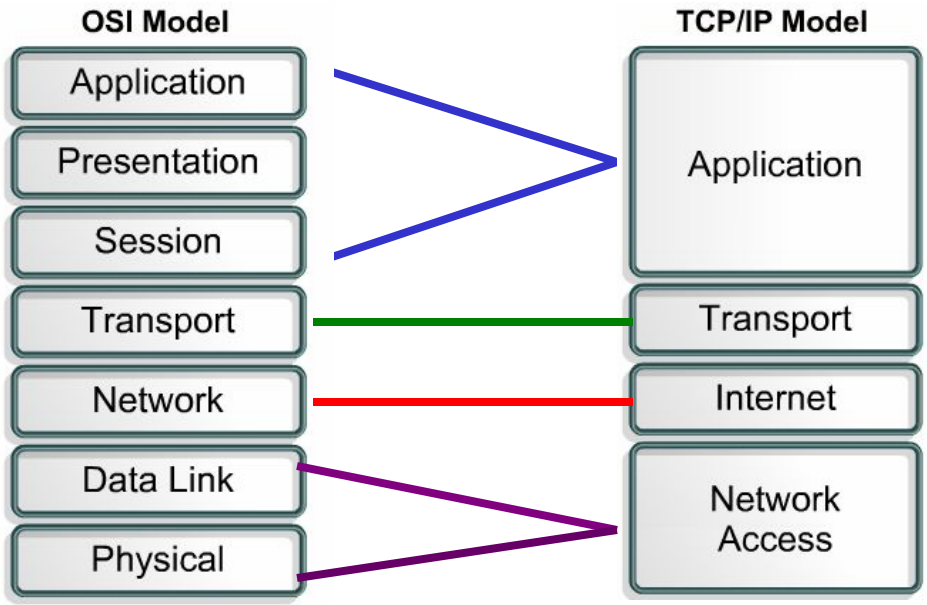
# Summary



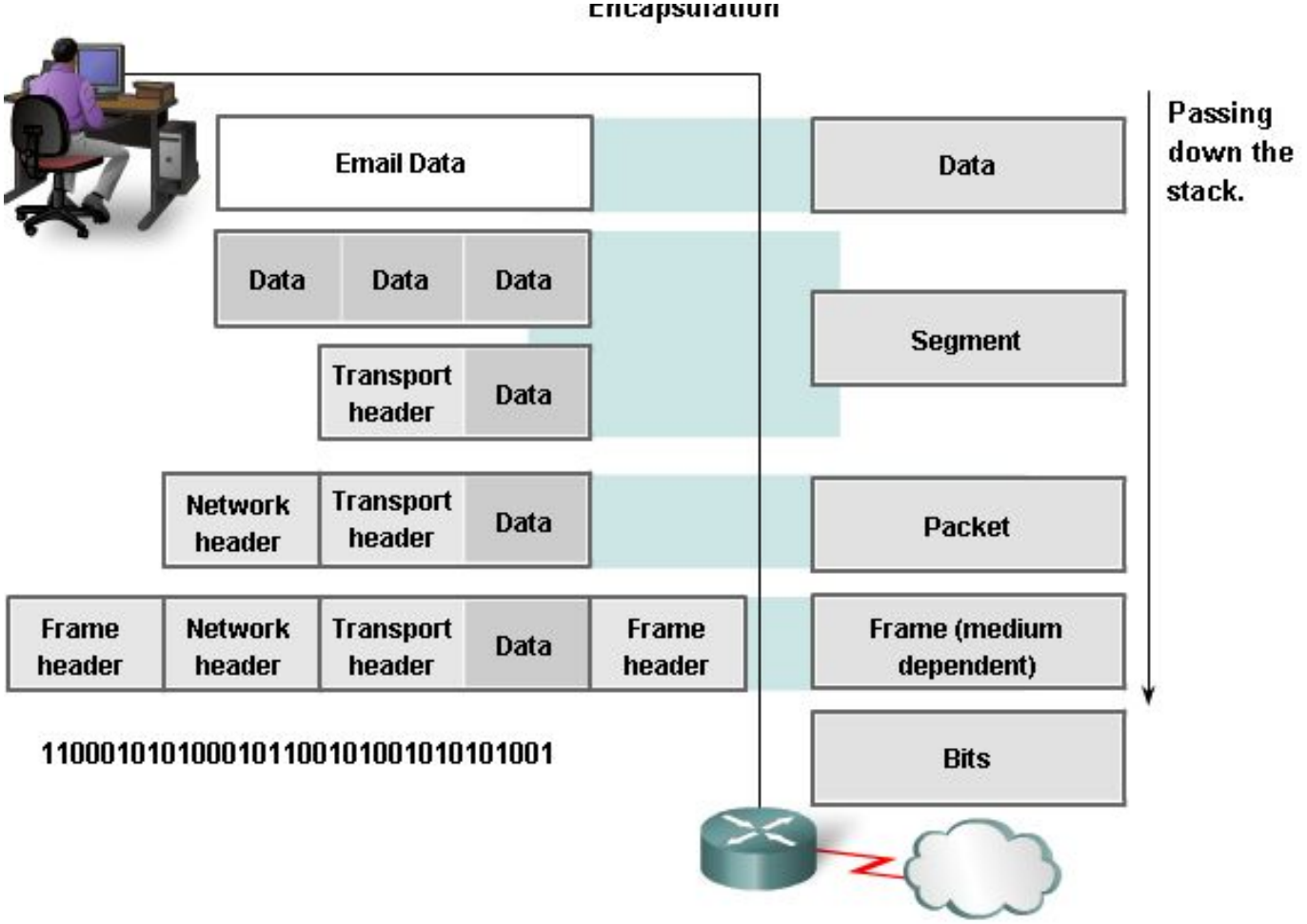

- PDUs
- Encapsulation
- Headers and trailers

# TCP/IP

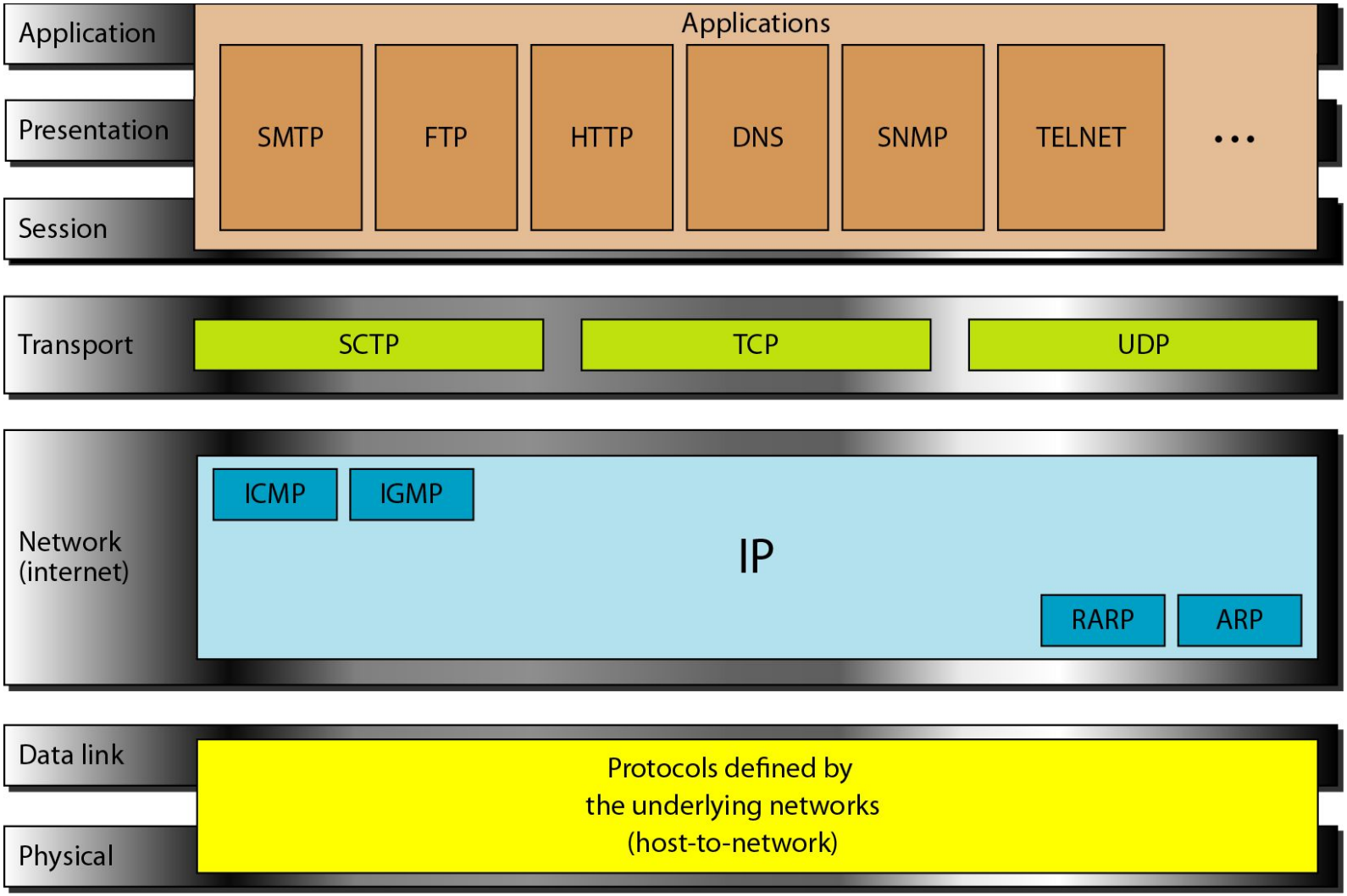
- Developed by the US Defense Advanced Research Project Agency (DARPA) for its packet switched network (ARPANET)
- Used by the global Internet.
- De Facto Standard



# TCP/IP Encapsulation

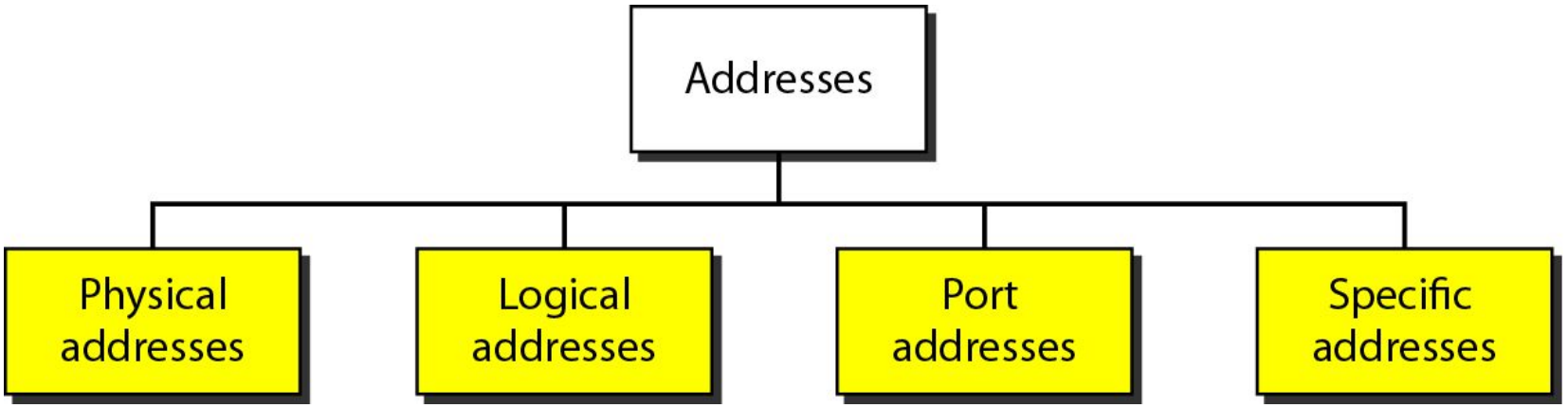


# TCP/IP and OSI model

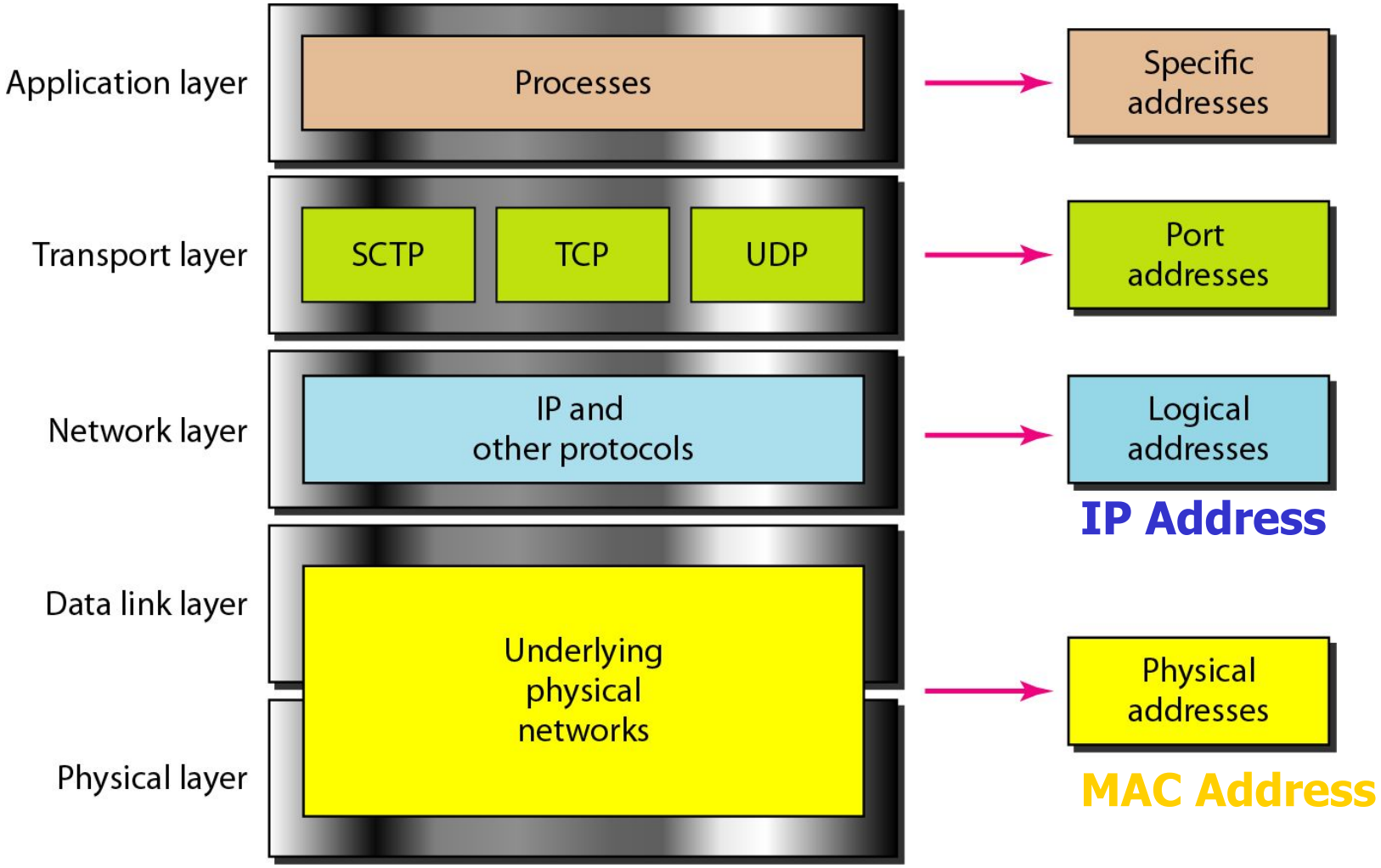


# Addressing Summary

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



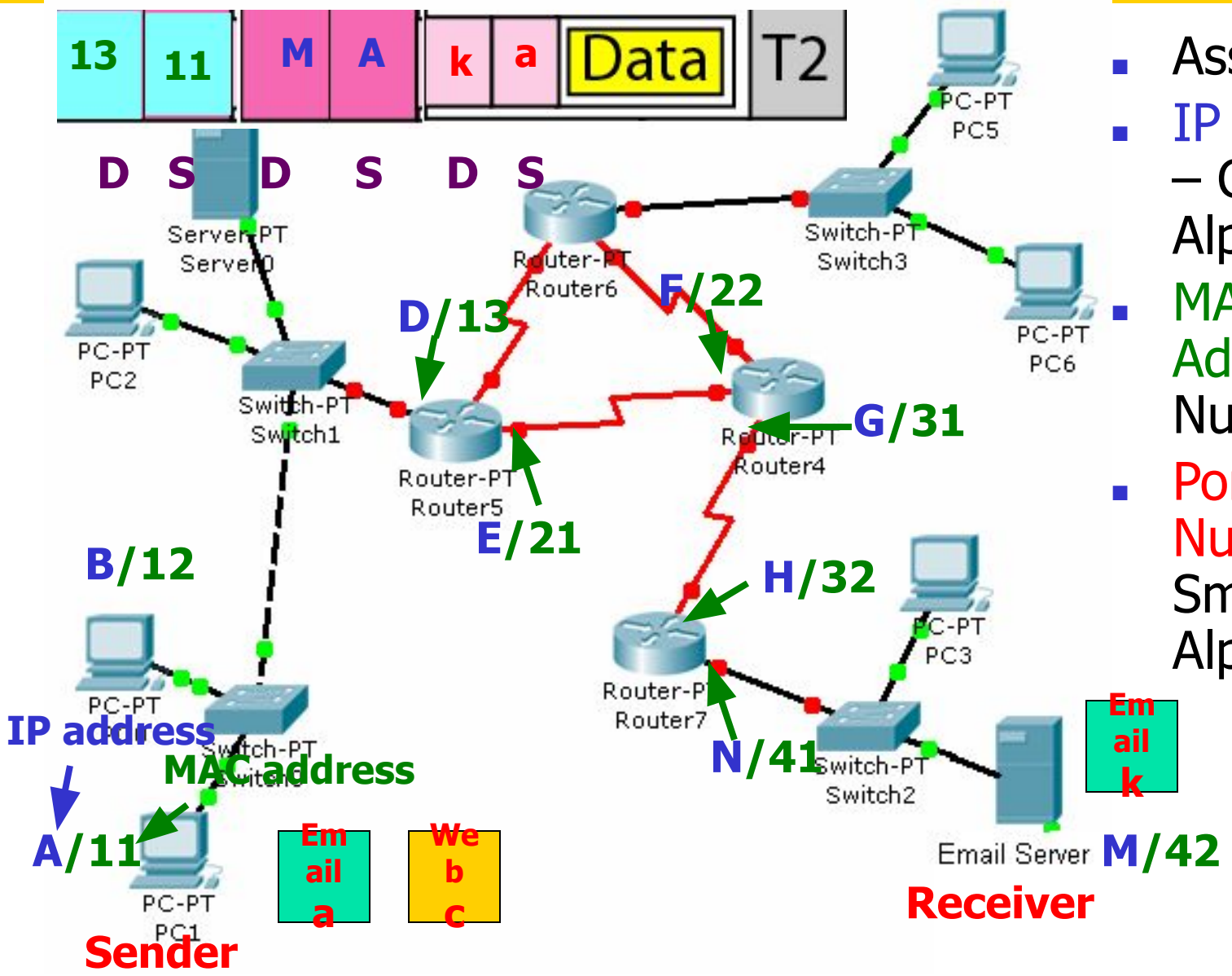
# Relationship of layers and addresses in TCP/IP



# Specific Addresses

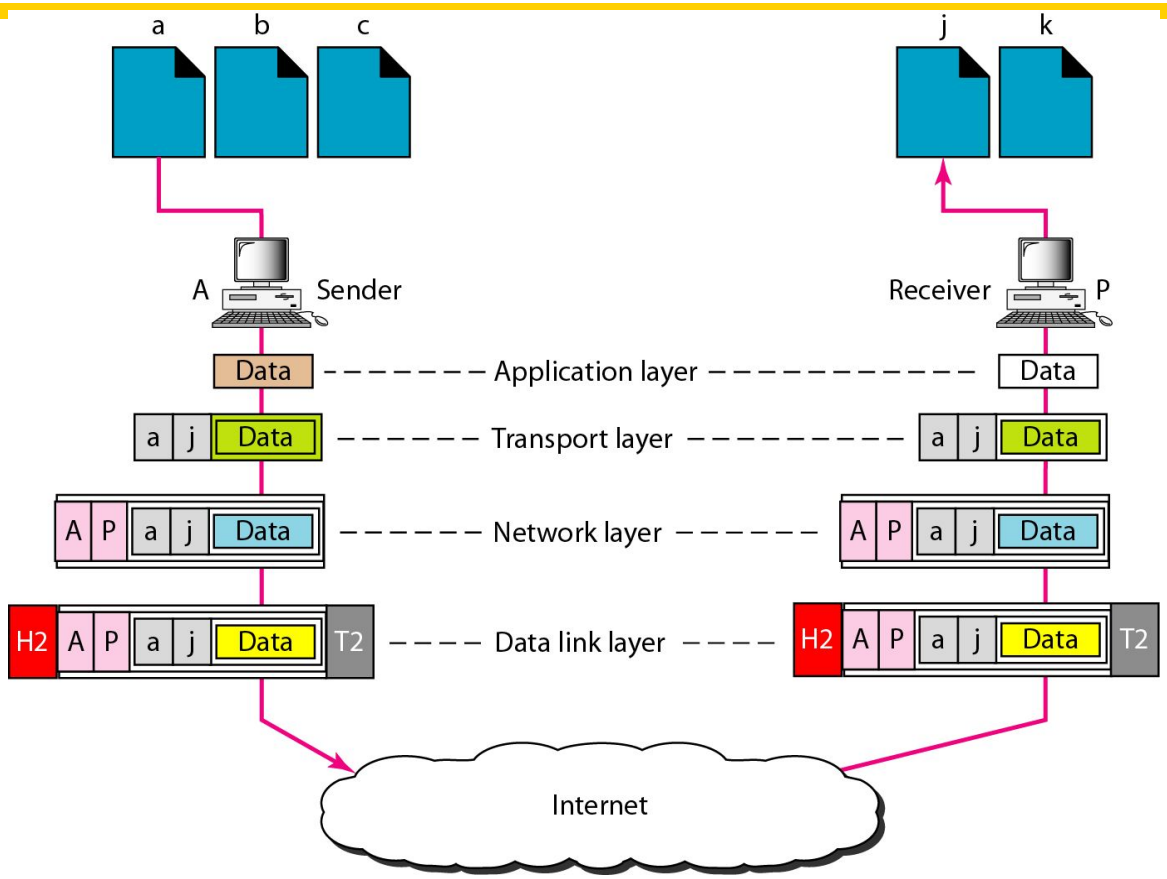
- Applications having user friendly addresses.
- Email addresses or URLs.
  - john@gmail.comjohn@gmail.com or www.bracu.ac.bd
- These are converted into corresponding port and logical addresses by the sending computer.

# Addressing Review




- Assume:
- IP Addresses – Capital Alphabets
- MAC Addresses – Numbers
- Port Numbers- Small Alphabets

# Addressing Review




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

# END