



Network Models & Protocol Architectures

Lecture 2 | CSE421 – Computer Networks

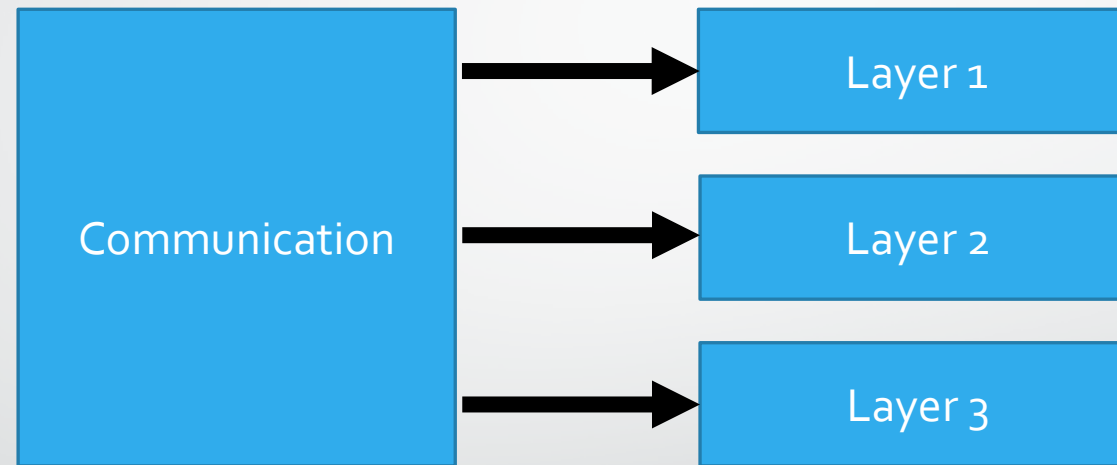
Department of Computer Science and Engineering
School of Data & Science

Objectives

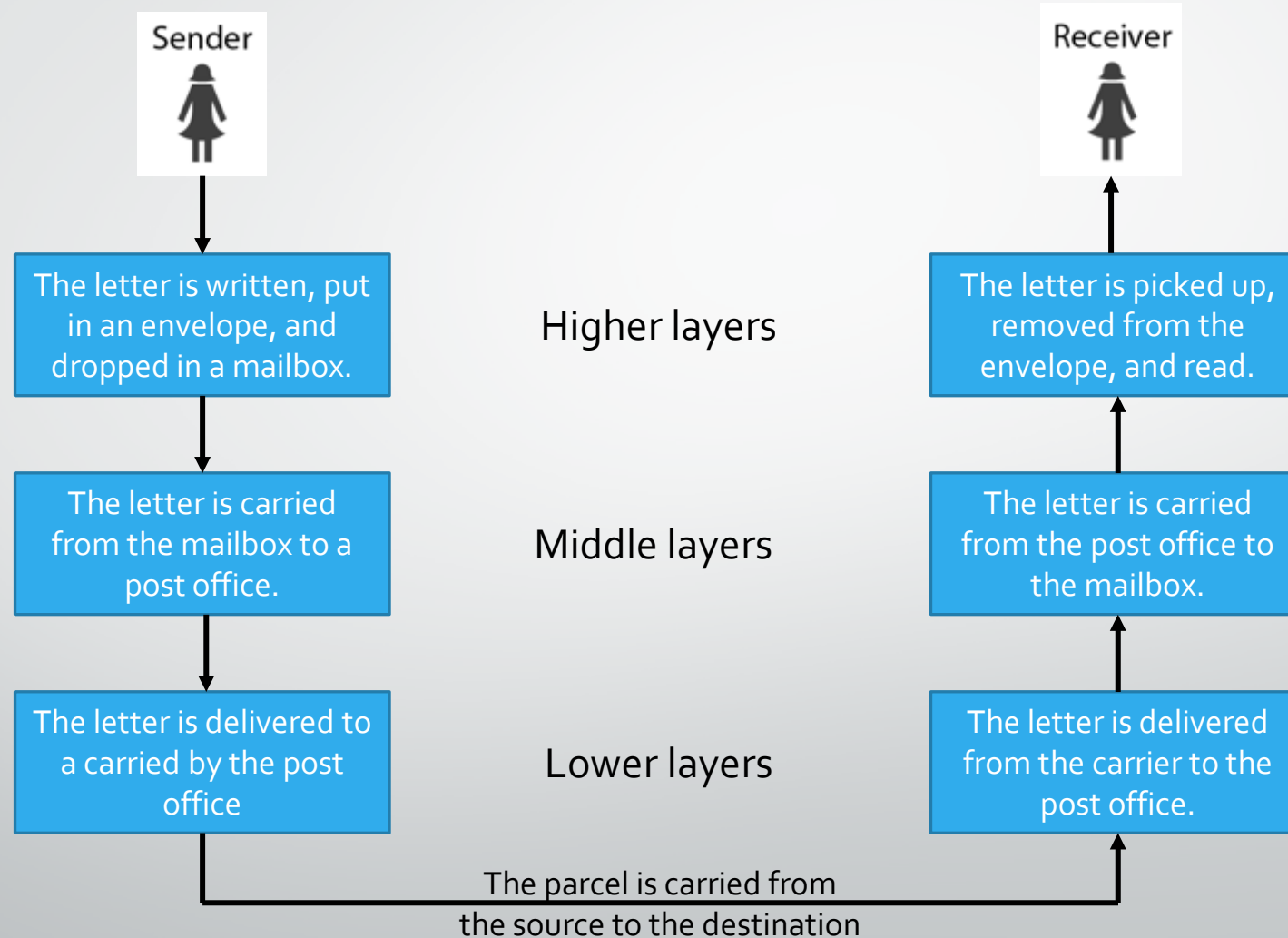
- Layering in communication
- Protocols
- Standards
- Protocol Suites
 - OSI Model
 - TCP/IP Model
- Addressing

Layering

Tasks of communication are broken up into **layers**

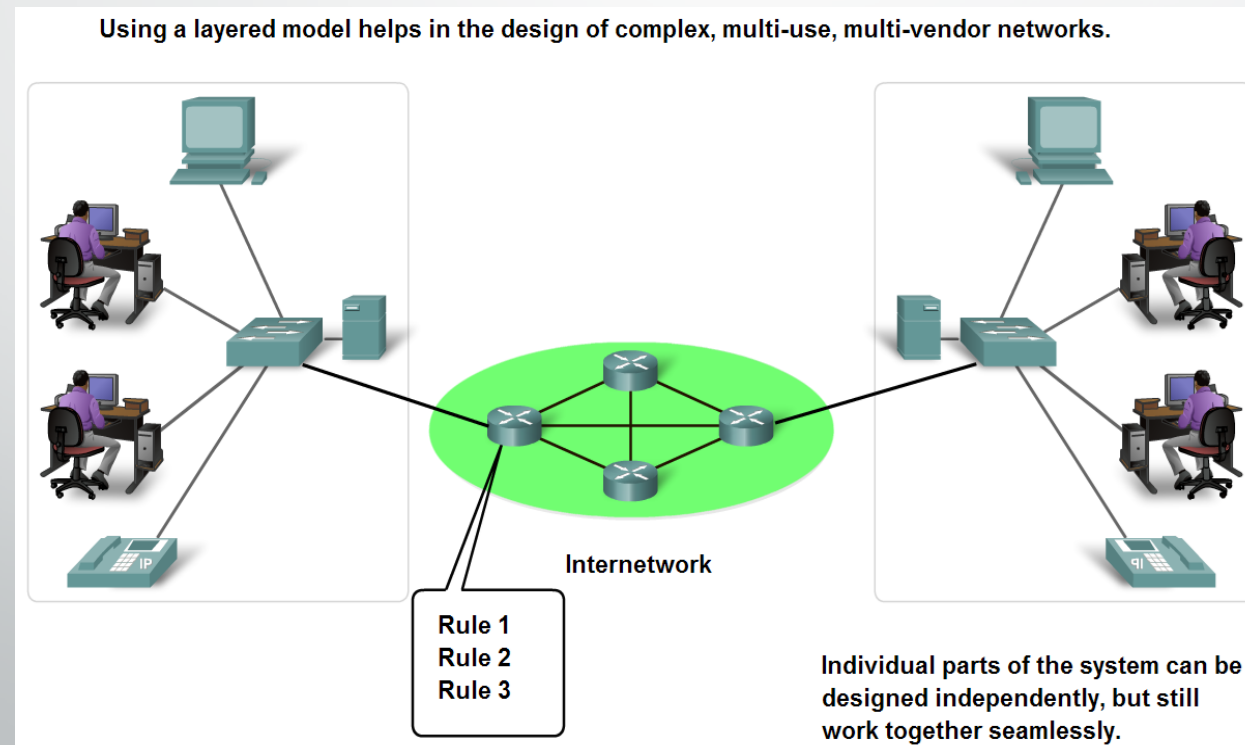


Layers: Sending a letter

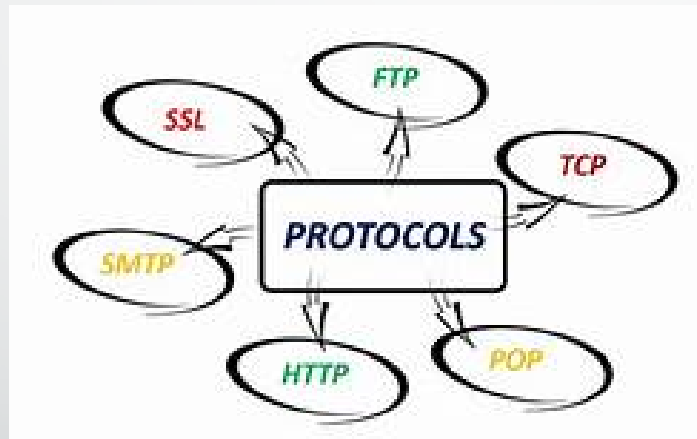


Benefits of using a layered model

- Fosters **competition**.
- **Technology changes** in one layer **do not affect** other layers.
- Each layer have **defined functions** that they act upon.

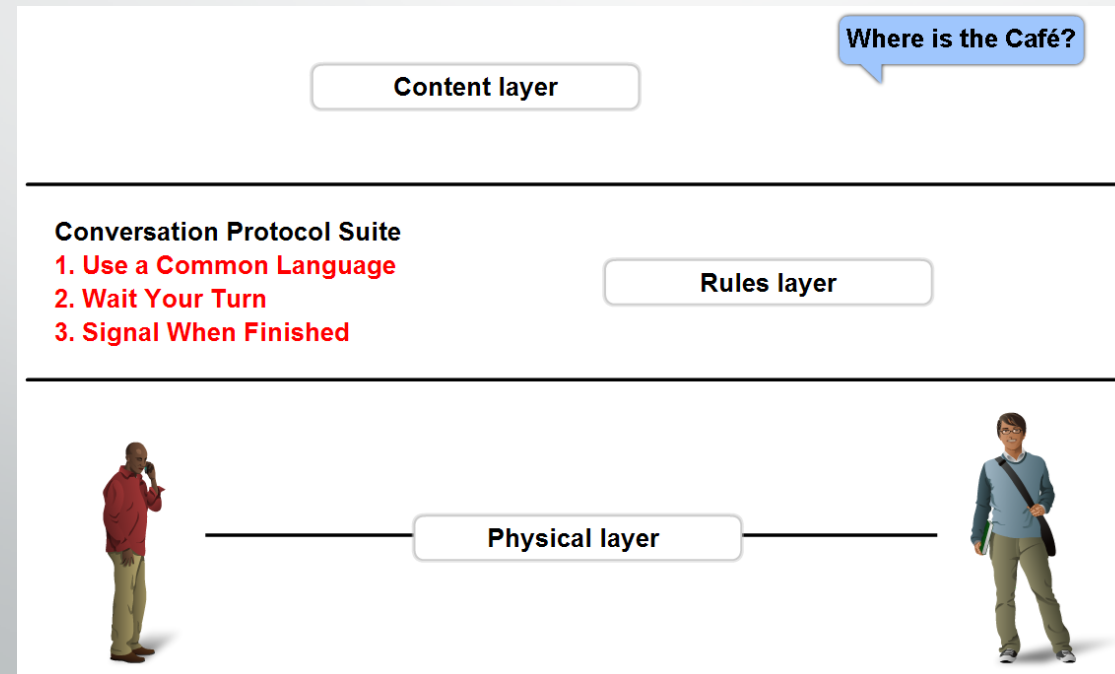


Protocols



Protocols

- All communications are **governed** by protocols
- Protocols are the rules that communications will follow.
- These **rules will vary** depending on the protocol.



Protocols

- Protocols must account for the following requirements:
 - An identified sender and receiver
 - Common language and grammar
 - Speed and timing of delivery
 - Confirmation or acknowledgment requirements
- Common computer protocols must agree in:
 - Message encoding
 - Message formatting and encapsulation
 - Message size, timing, delivery option.

Standards



Standards

- 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** – TCP/IP Protocol Model
 - **De jure** – OSI Reference Model

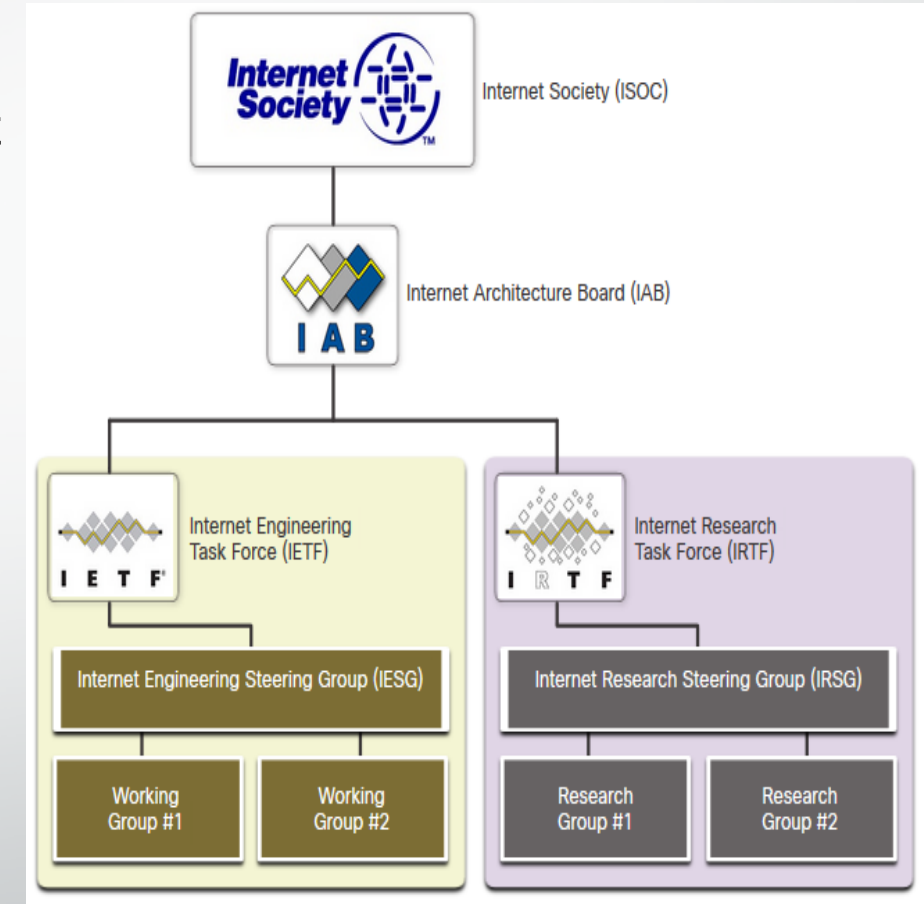
Open Standards

- Open standards encourage:
 - Interoperability
 - Competition
 - Innovation
- Standards organizations are:
 - vendor-neutral
 - non-profit organizations
 - established to develop and promote the concept of open standards.



Internet Standards

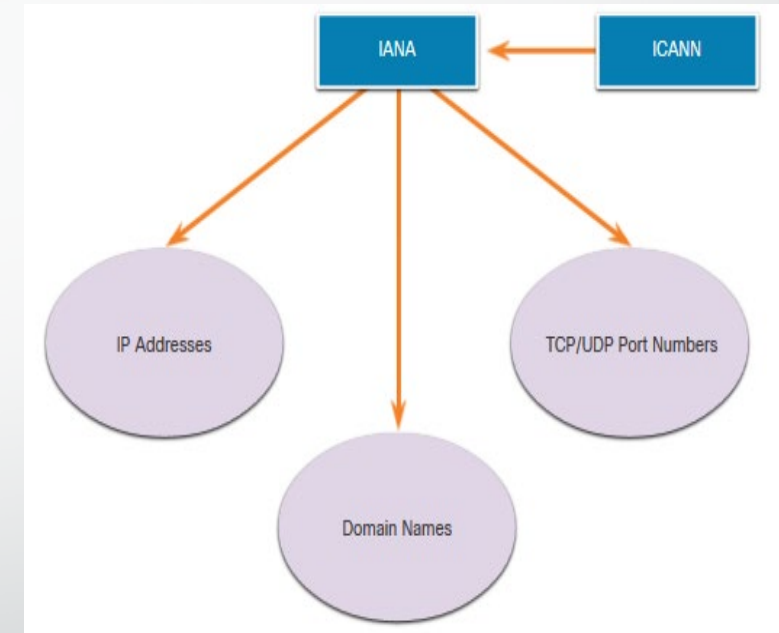
- **Internet Society (ISOC)** - Promotes the open development and evolution of internet
- **Internet Architecture Board (IAB)** - Responsible for management and development of internet standards
- **Internet Engineering Task Force (IETF)** - Develops, updates, and maintains internet and TCP/IP technologies
- **Internet Research Task Force (IRTF)** - Focused on long-term research related to internet and TCP/IP protocols



Internet Standards (Continued)


Standards organizations involved with the development and support of TCP/IP

- **Internet Corporation for Assigned Names and Numbers (ICANN)** - Coordinates IP address allocation, the management of domain names, and assignment of other information
- **Internet Assigned Numbers Authority (IANA)** - Oversees and manages IP address allocation, domain name management, and protocol identifiers for ICANN



Internet Standards (Continued)

- Formalized regulations and specifications for the Internet by IETF.
- Internet Draft
 - No official status
 - 6 month lifetime
- Request for comment (RFC)
 - Upon recommendation from Internet authorities
 - Different maturity levels
 - Example: Internet Protocol – RFC : 791



I E T F®
The Internet Engineering Task Force

INTERNET PROTOCOL
DARPA INTERNET PROGRAM
PROTOCOL SPECIFICATION
September 1981

★ 71st IETF - Philadelphia, PA, USA
(March 9-14, 2008)

[Overview of the IETF](#)
[The Internet Standards Process](#)
[IETF Working Groups](#)
[WG Chairs Web Page](#)
[Internet-Drafts](#)
[RFC Pages](#)
[Educational Materials](#)
[Mailing Lists](#)
[IETF Web Tools](#)

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[IETF Liaison Activities](#)
[IETF IPR Disclosure Page](#)
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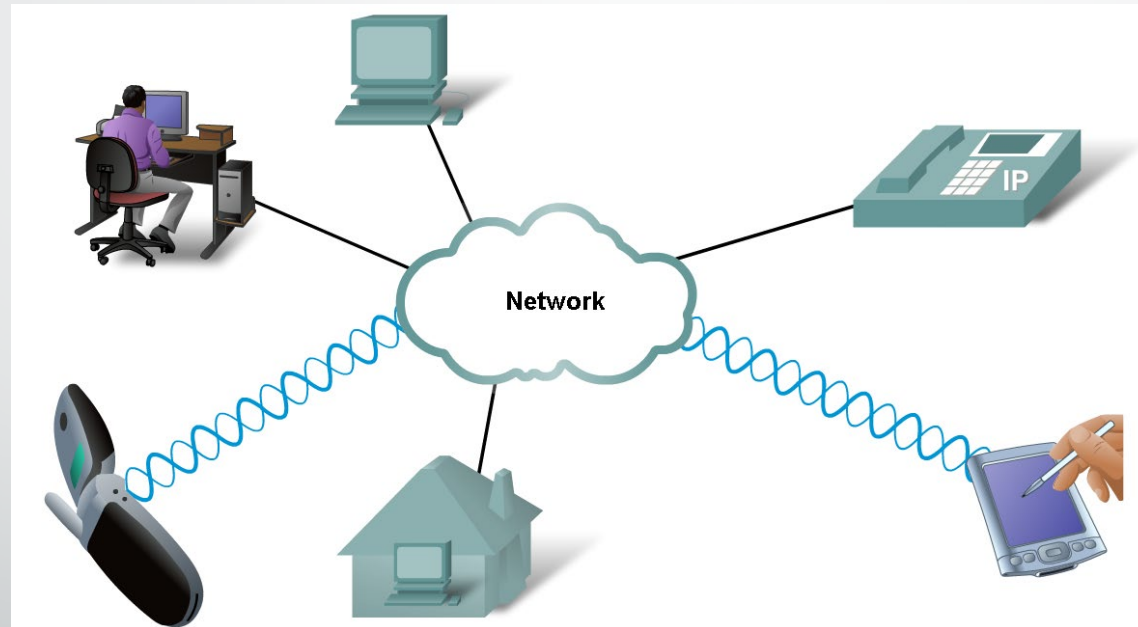
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Electronic and Communications Standards

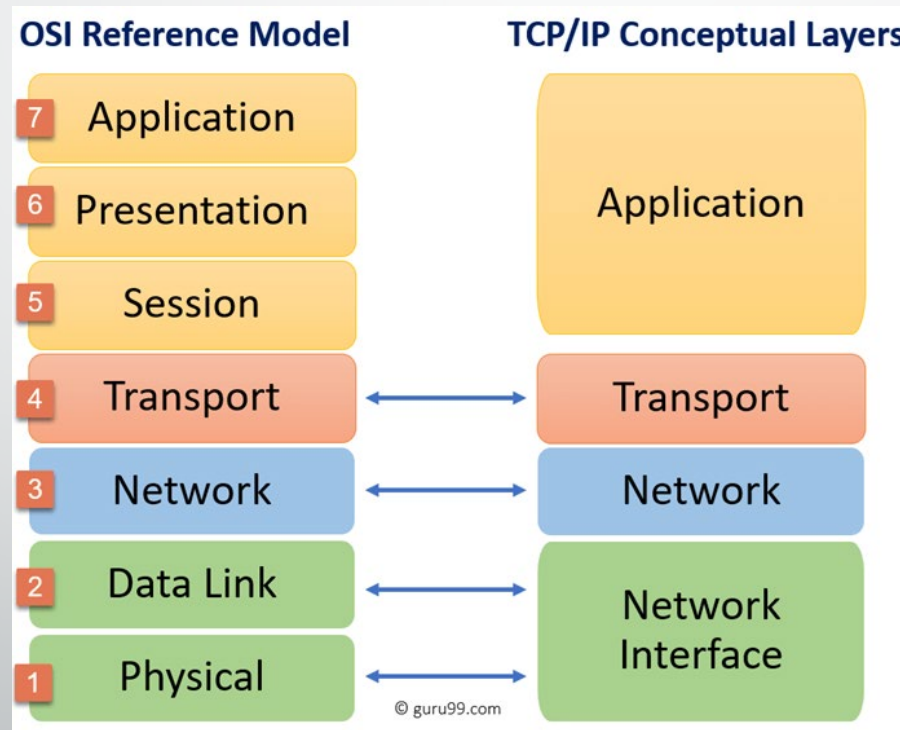
- **Institute of Electrical and Electronics Engineers (IEEE, pronounced "I-triple-E")** - dedicated to creating standards in power and energy, healthcare, telecommunications, and networking
- **Electronic Industries Alliance (EIA)** - develops standards relating to electrical wiring, connectors, and the 19-inch racks used to mount networking equipment
- **Telecommunications Industry Association (TIA)** - develops communication standards in radio equipment, cellular towers, Voice over IP (VoIP) devices, satellite communications, and more
- **International Telecommunications Union-Telecommunication Standardization Sector (ITU-T)** - defines standards for video compression, Internet Protocol Television (IPTV), and broadband communications, such as a digital subscriber line (DSL)

Technology Independent Protocols

- Protocols are **not dependent** upon any specific technology.
 - They describe **what** must be done to communicate but **not how** its is to be carried out.



Protocol Suites



Protocol Suites

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

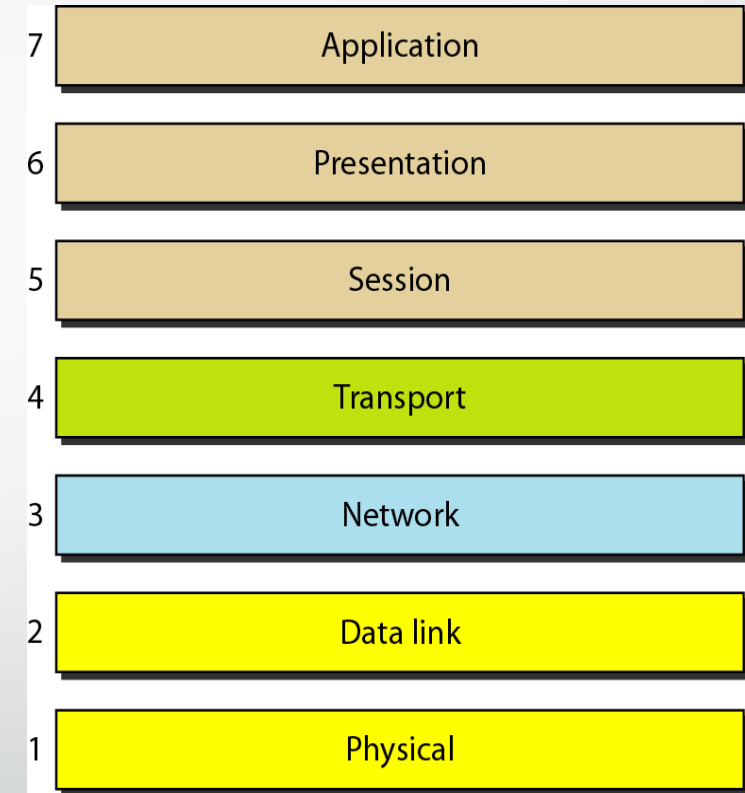
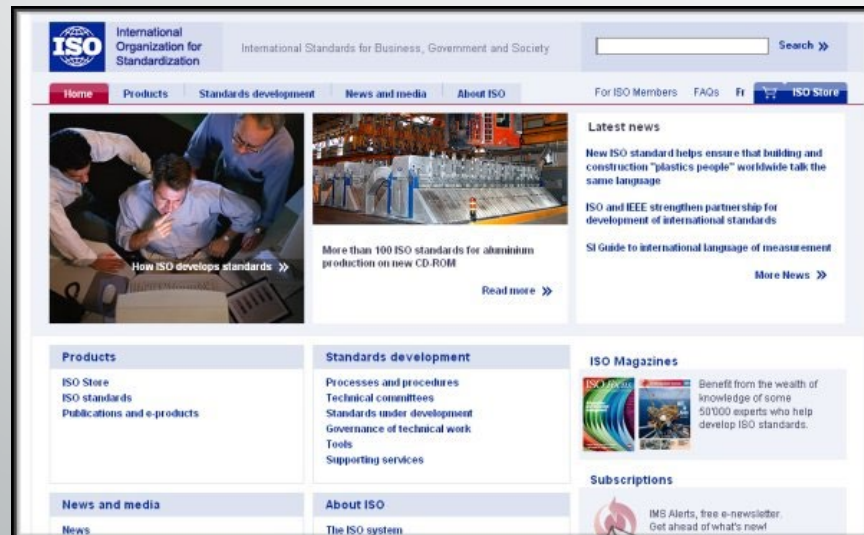
OSI Model

De Jure Standard

| Layers | |
|--------|--------------|
| 7 | Application |
| 6 | Presentation |
| 5 | Session |
| 4 | Transport |
| 3 | Network |
| 2 | Data Link |
| 1 | Physical |

OSI Model

- Open Systems Interconnection (OSI)
 - Seven layers
 - A theoretical system delivered too late!
 - TCP/IP is the de facto standard
- Developed by the International Organization for Standardization (ISO) in 1984.

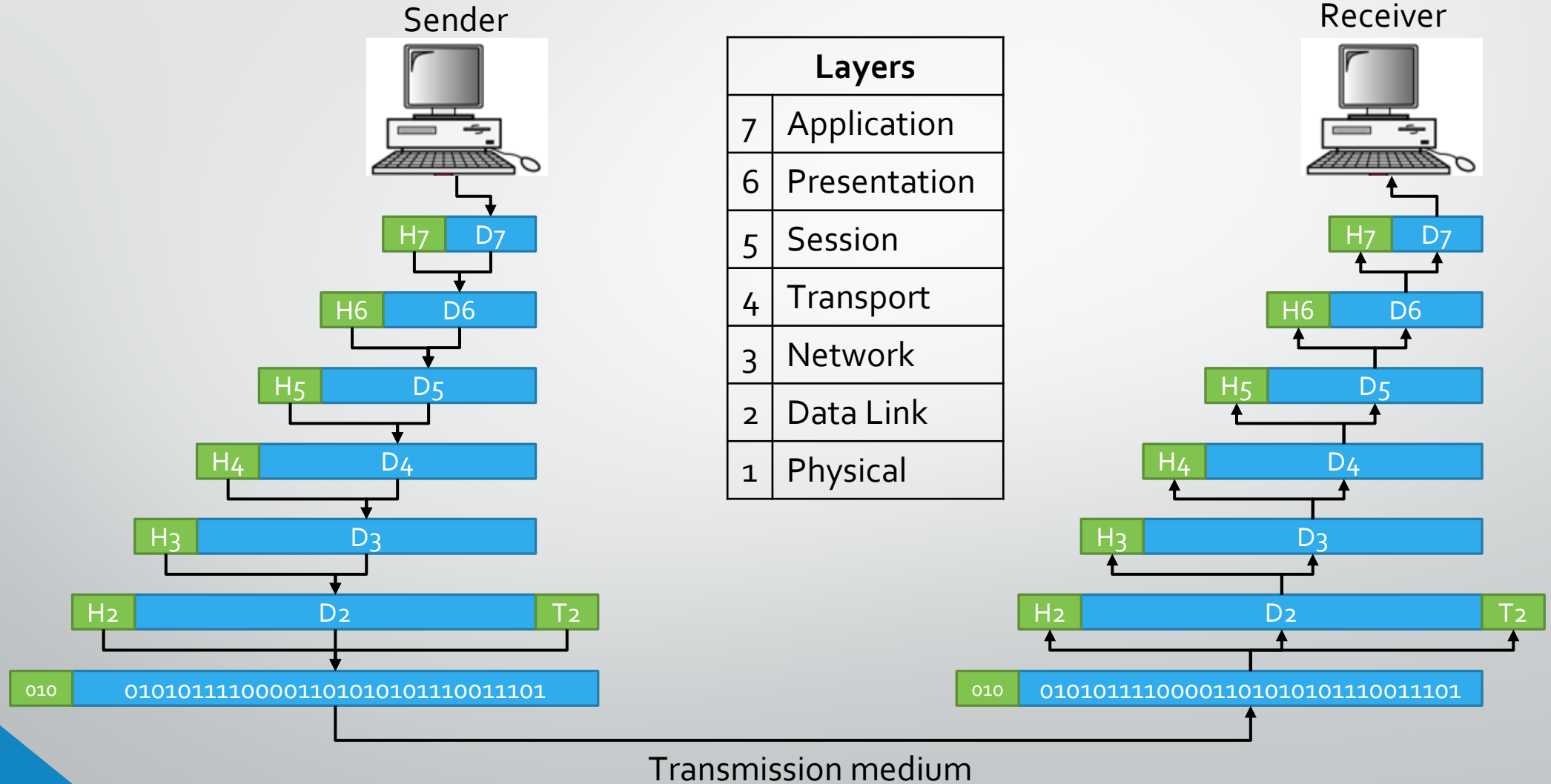


ISO is the **organization**.
OSI is the **model**.

OSI Model - Layers

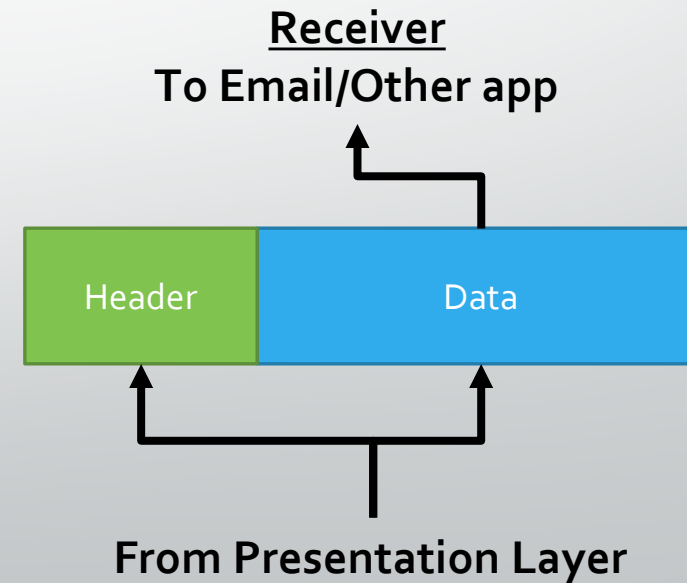
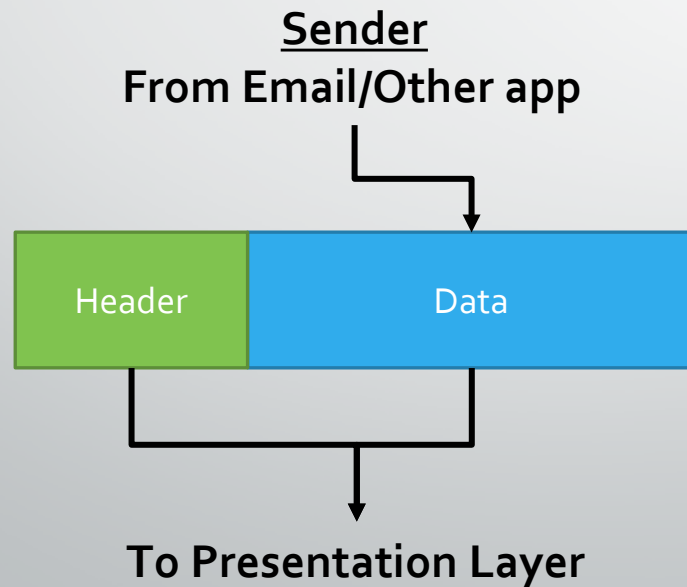
| Primary Concern | Layers | | Cisco |
|-------------------------------------|--------|--------------|-------------------|
| Communications between applications | 7 | Application | All |
| | 6 | Presentation | People |
| | 5 | Session | Seem |
| | 4 | Transport | To |
| | 3 | Network | Need |
| Moving raw data across the network | 2 | Data Link | Data |
| | 1 | Physical | Processing |

An exchange using the OSI Model



Application Layer

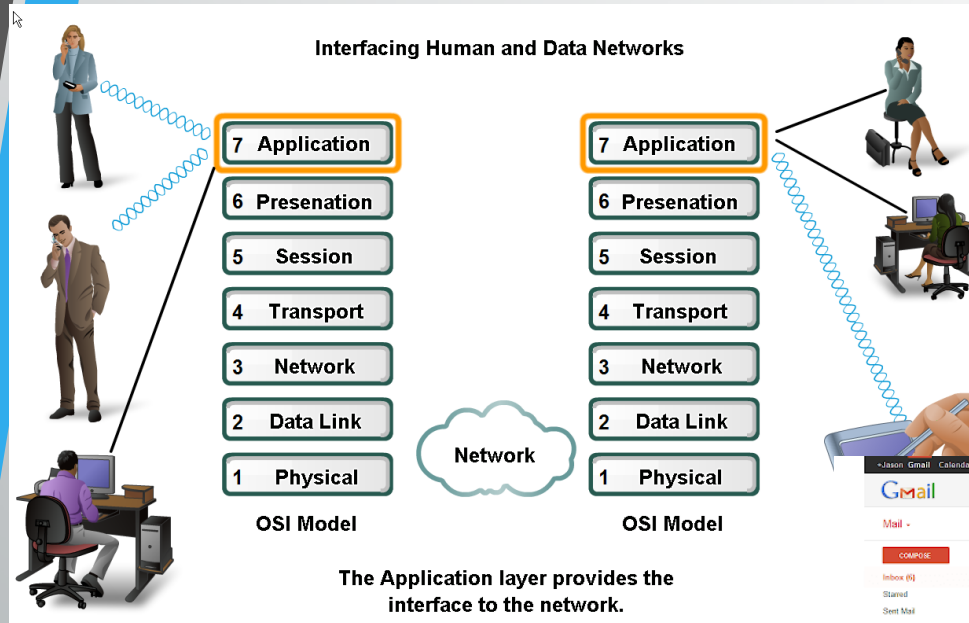
- The 7th Layer of OSI Model



Applications

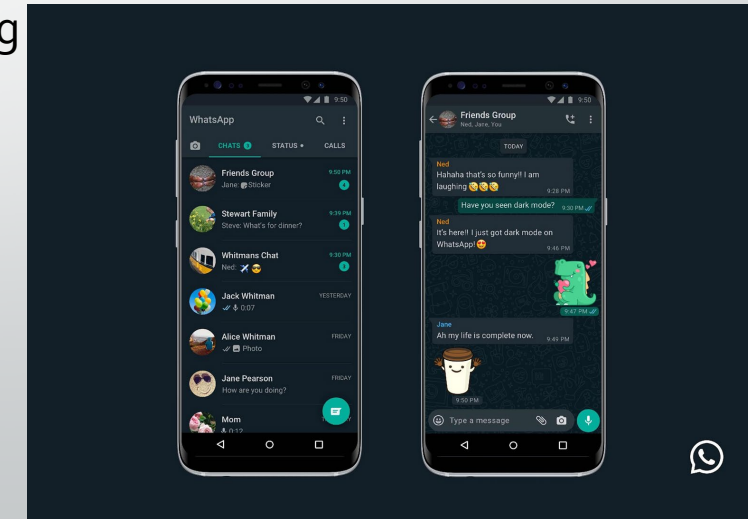
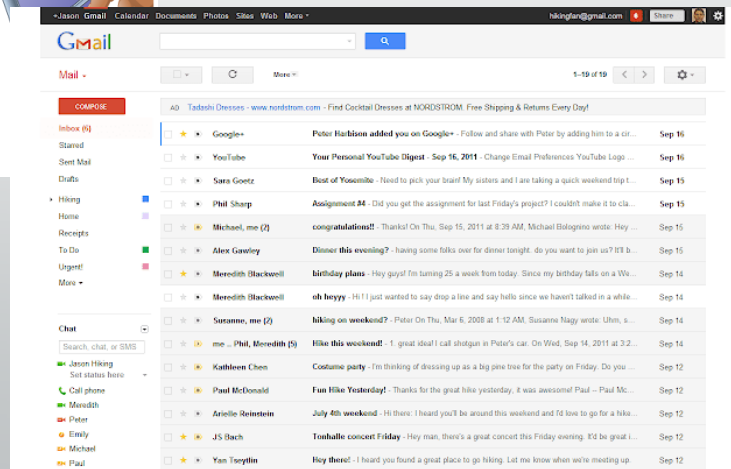
- The **Interface** Between Human and Data Networks
- Responsible for **providing services** to the user.

Browsers



Instant Messaging

Email

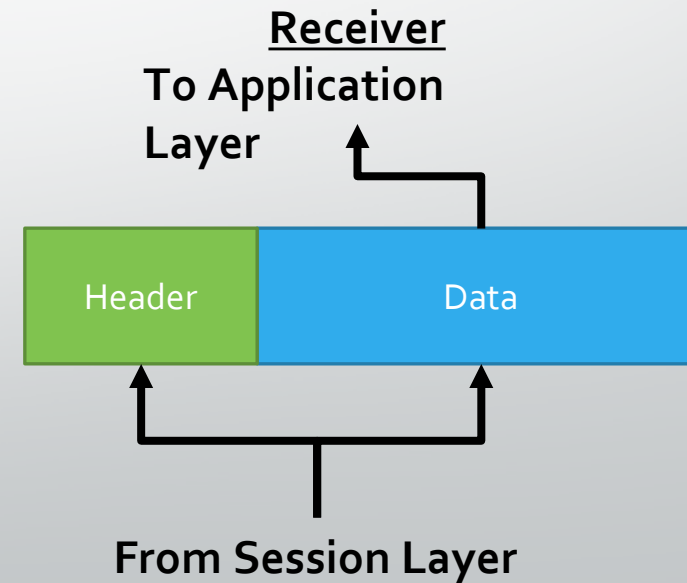
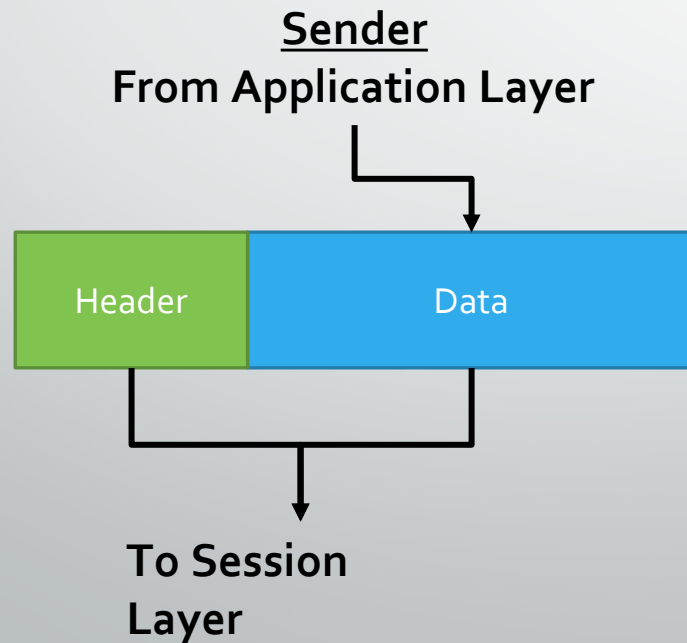


Examples: Application Layer Protocols

| Application Layer | Name System | Host Config | Email | File Transfer | Web |
|-------------------|-------------|-------------|-------|---------------|-------|
| | DNS | BOOTP | SMTP | FTP | HTTP |
| | | DHCP | POP | TFTP | HTTPS |
| | | | IMAP | | |

Presentation Layer

- The 6th Layer of OSI Model

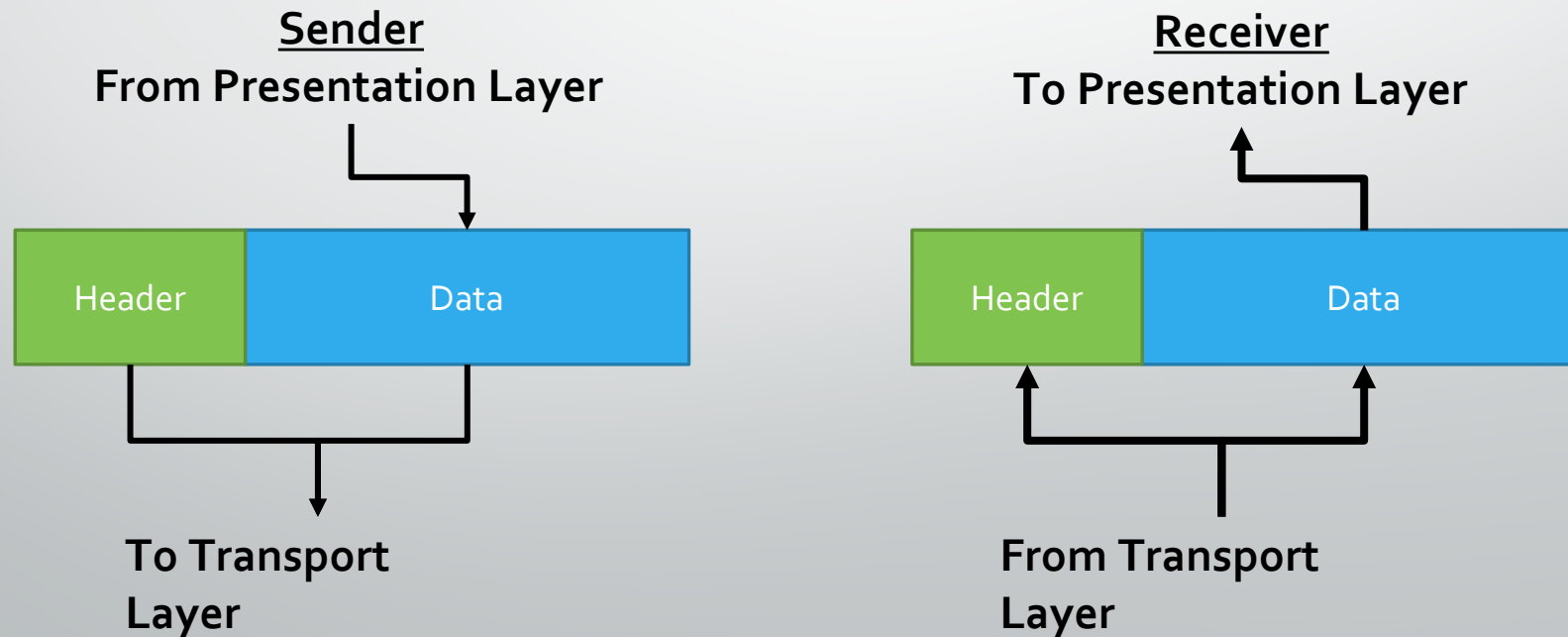


Presentation Layer

- The presentation layer is responsible for translation, compression, and encryption. i.e. the three primary functions
- Presentation layer implementations are not typically associated with a particular protocol stack.

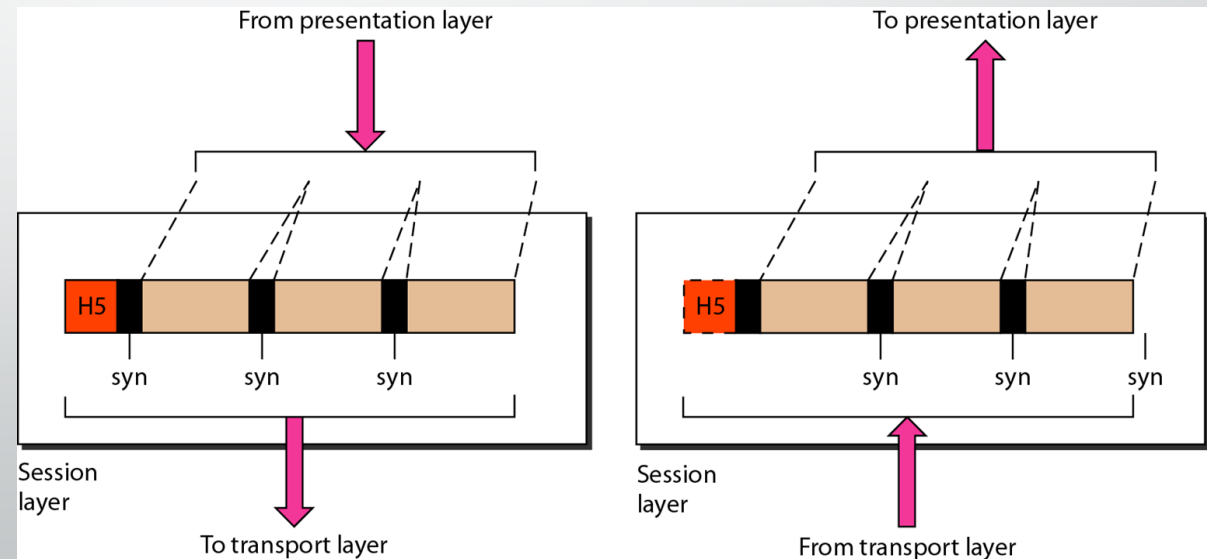
Session Layer

- The 5th Layer of OSI Model



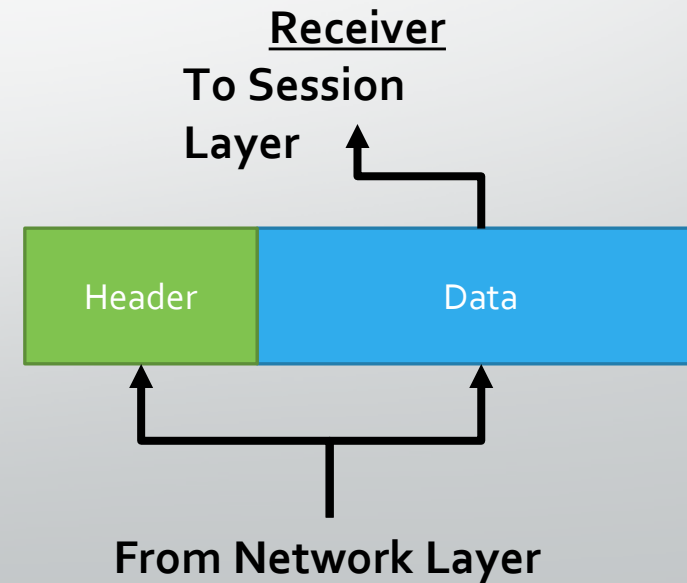
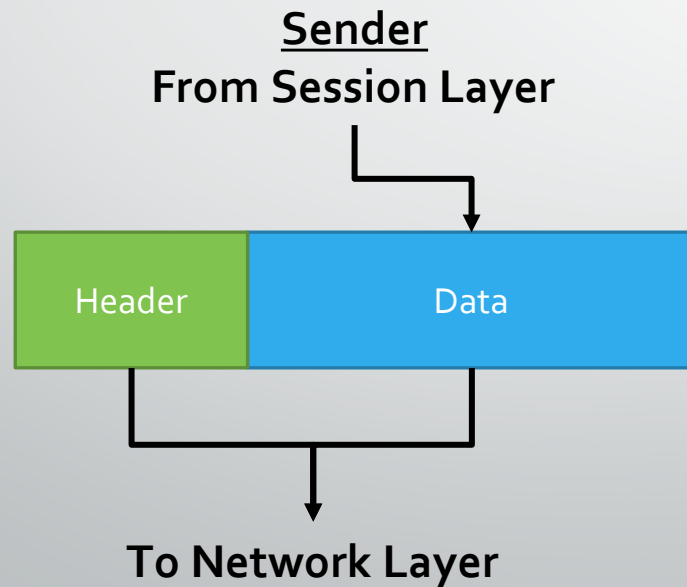
Session Layer

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



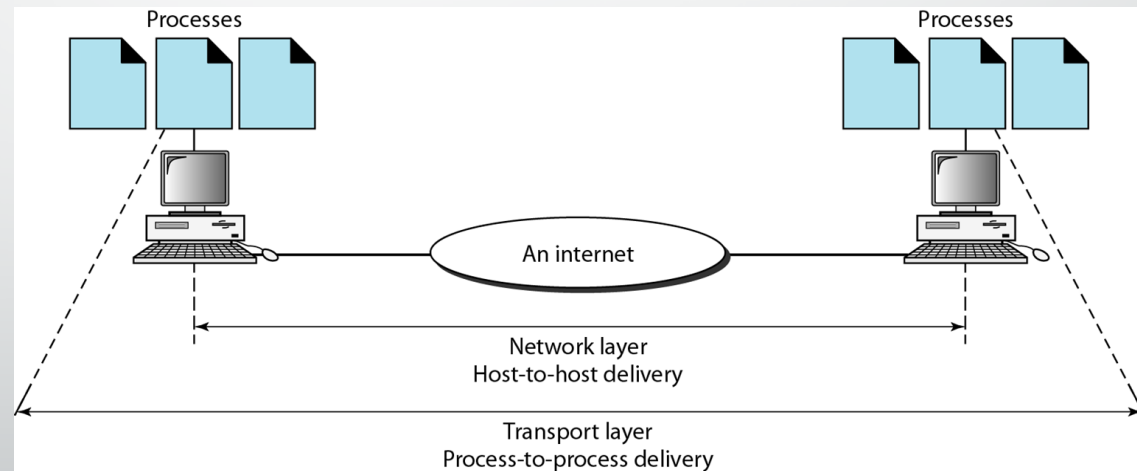
Transport Layer

- The 4th Layer of OSI Model



Transport Layer

- The transport layer is responsible for the **delivery** of a message from **one process** (sender) to another (receiver).
- **Transport Layer PDU** is called **Segments**
- Functions:
 - **Segmentation** and **Reassembly**
 - **Adds** Port Address and Sequence Number.
 - Connection Control
 - Flow and **Error** Control
 - **Multiplexing**

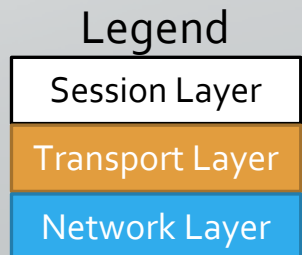
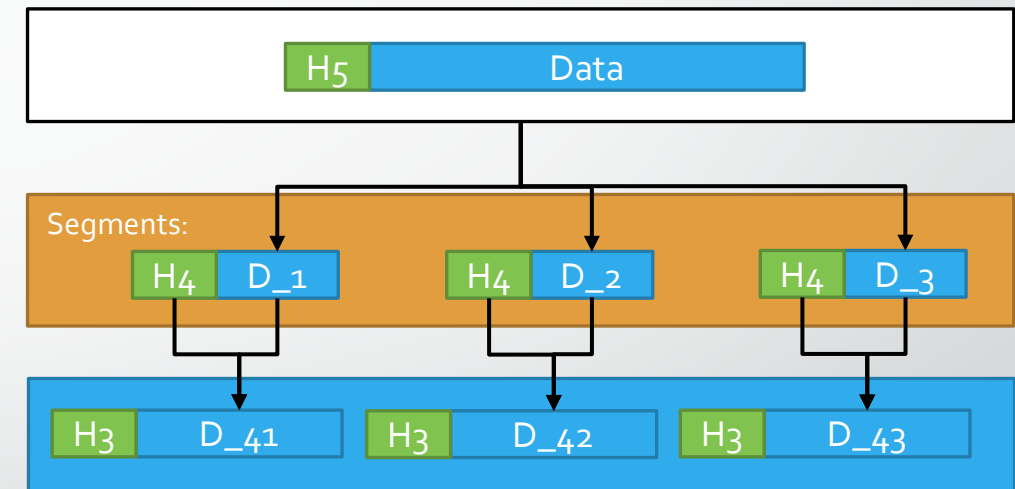


Notes

- A common protocol used in Transport Layer is **TCP**.
- *PDU – Packet Data Unit*

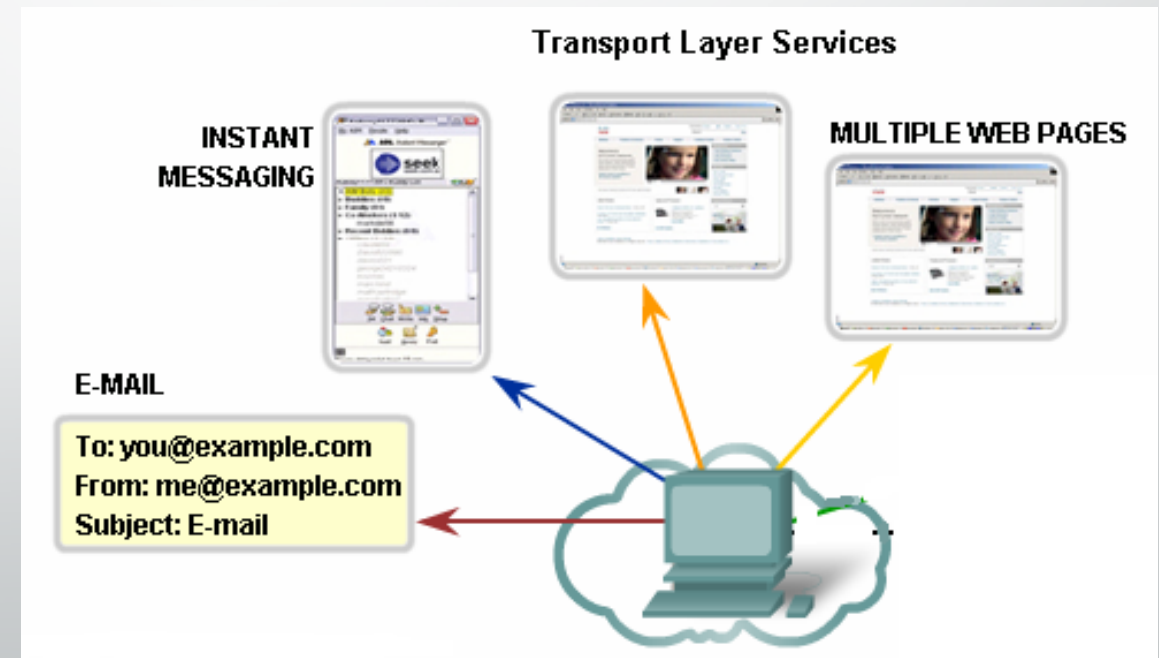
Functions – Segmentation/Reassembly

- Segments data received from application layer into small parts
- Steps (Sender):
 - Segments into small parts
 - Add a number to identify the application
 - Add a number sequence the segmented parts
- What do you think will happen at the Receiver end?
 - Uses the **sequence number** to **order** them **sequentially**, **merges** them and **sends** to the **upper layer**



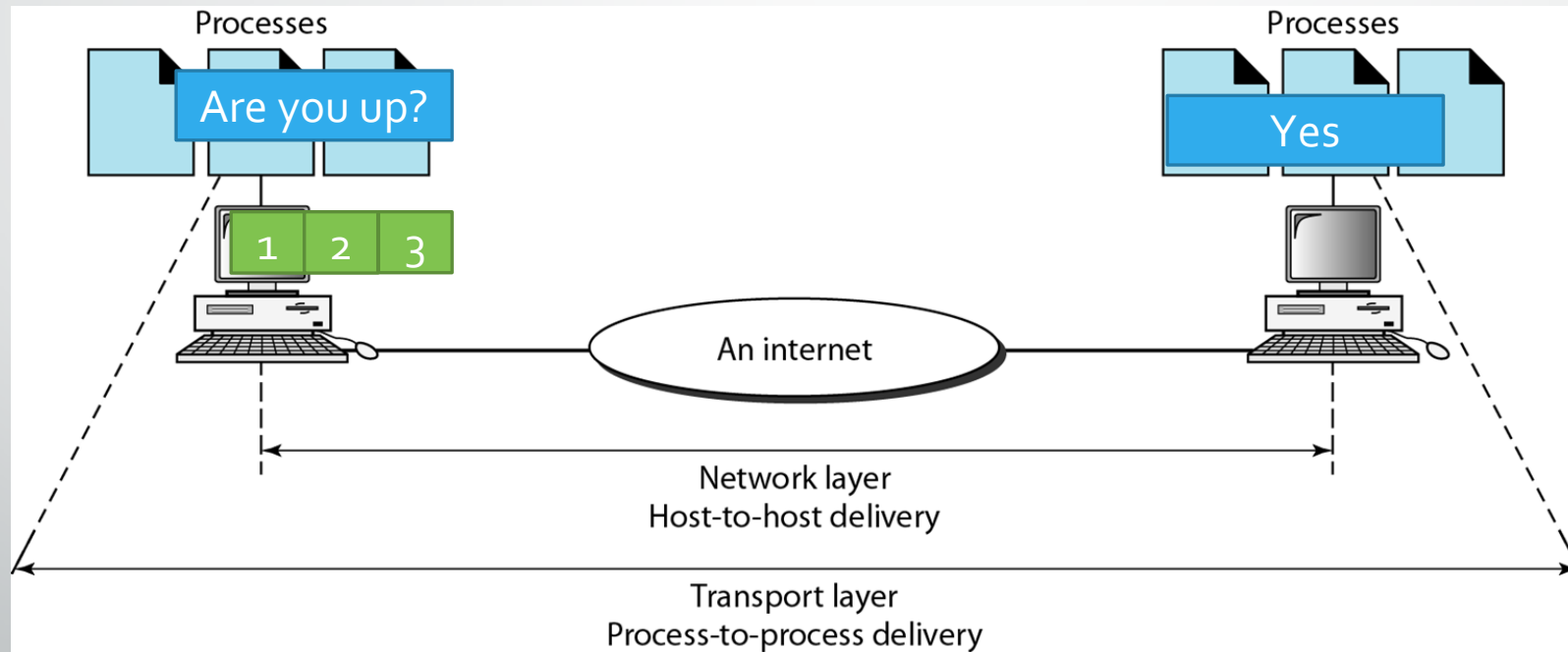
Function – Identification Using Port Address

- Port Numbers/Addresses are used to identify different applications/processes running in a computer
- 16-bit in length
 - Represented as one single decimal number
 - e.g. 80 – Web; 23 – TCP;



Function – Connection Control

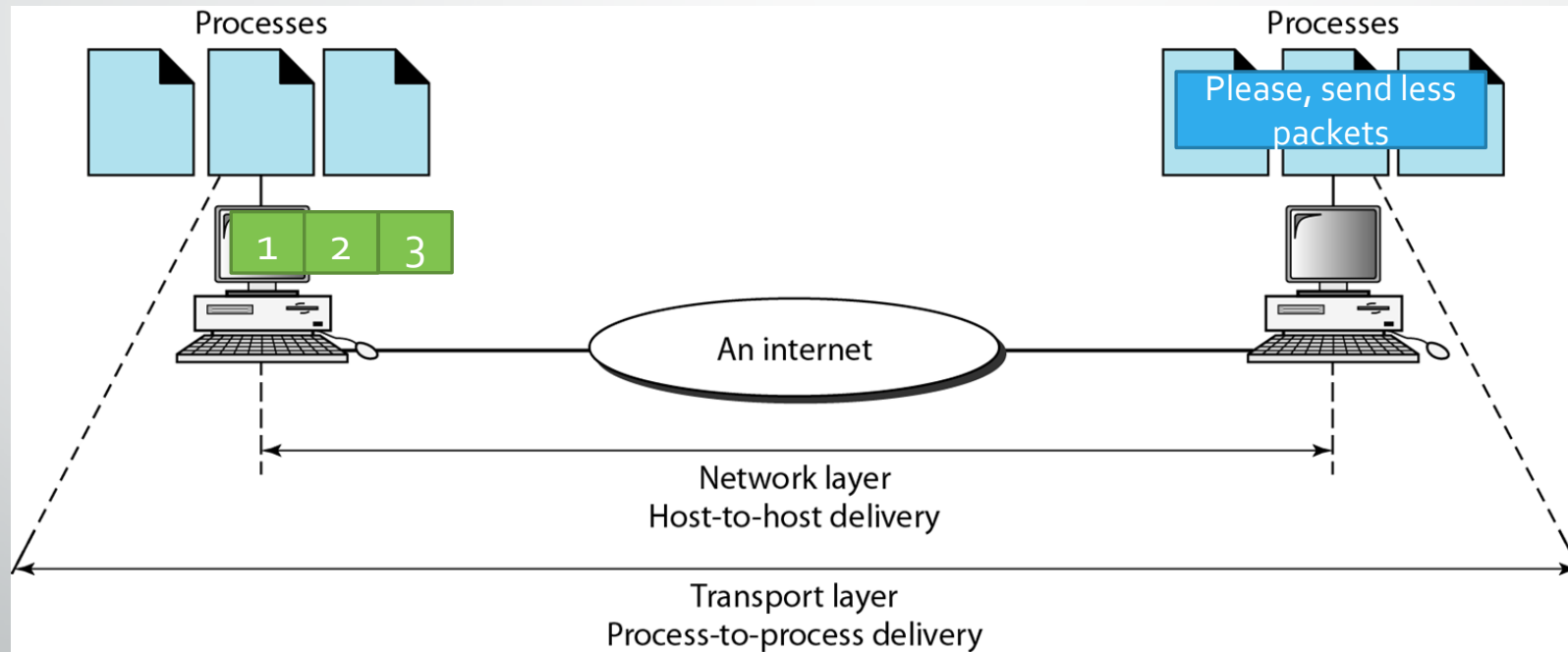
- Establishes secure connection (TCP – Three Way Handshake)



Function – Flow Control

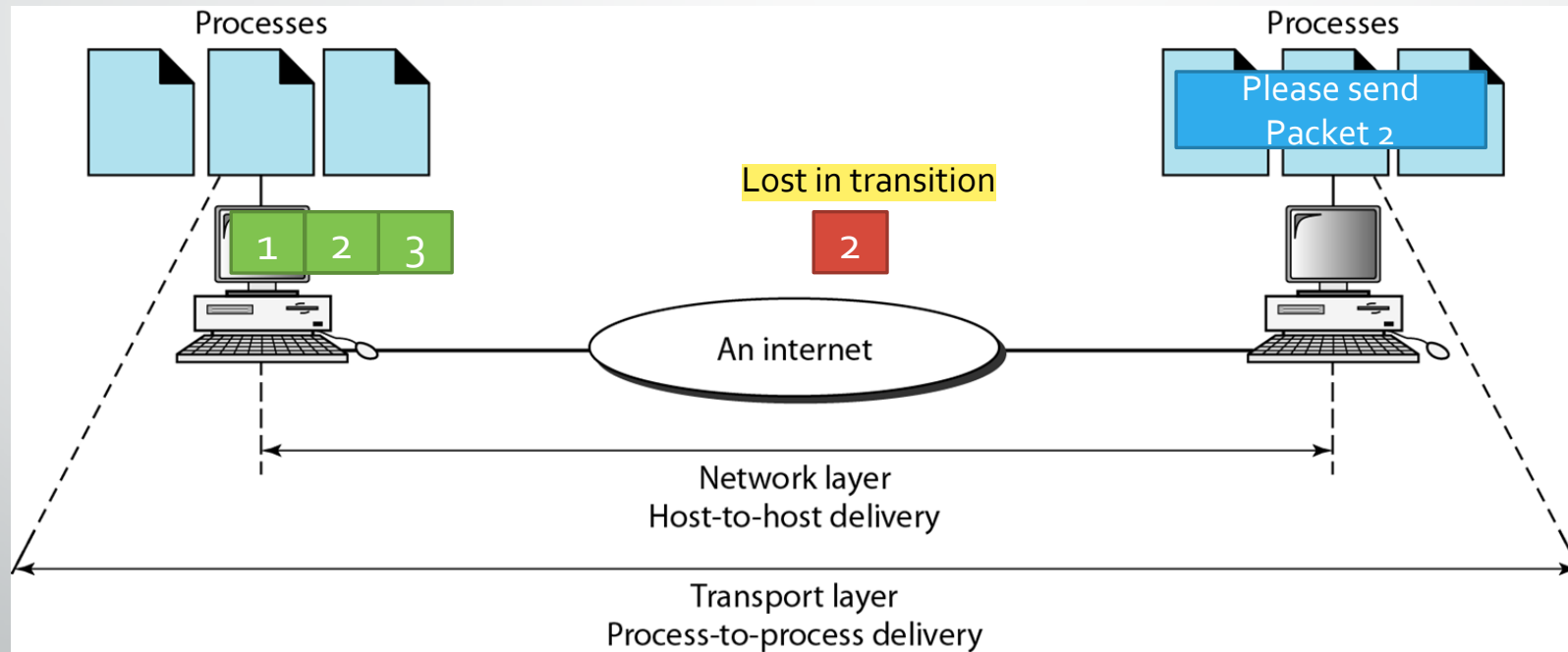
- Establishes secure connection (TCP – Three Way Handshake)

At this point, this host has too many packets to process. Hence, the **buffer** to store incoming packets overflows.

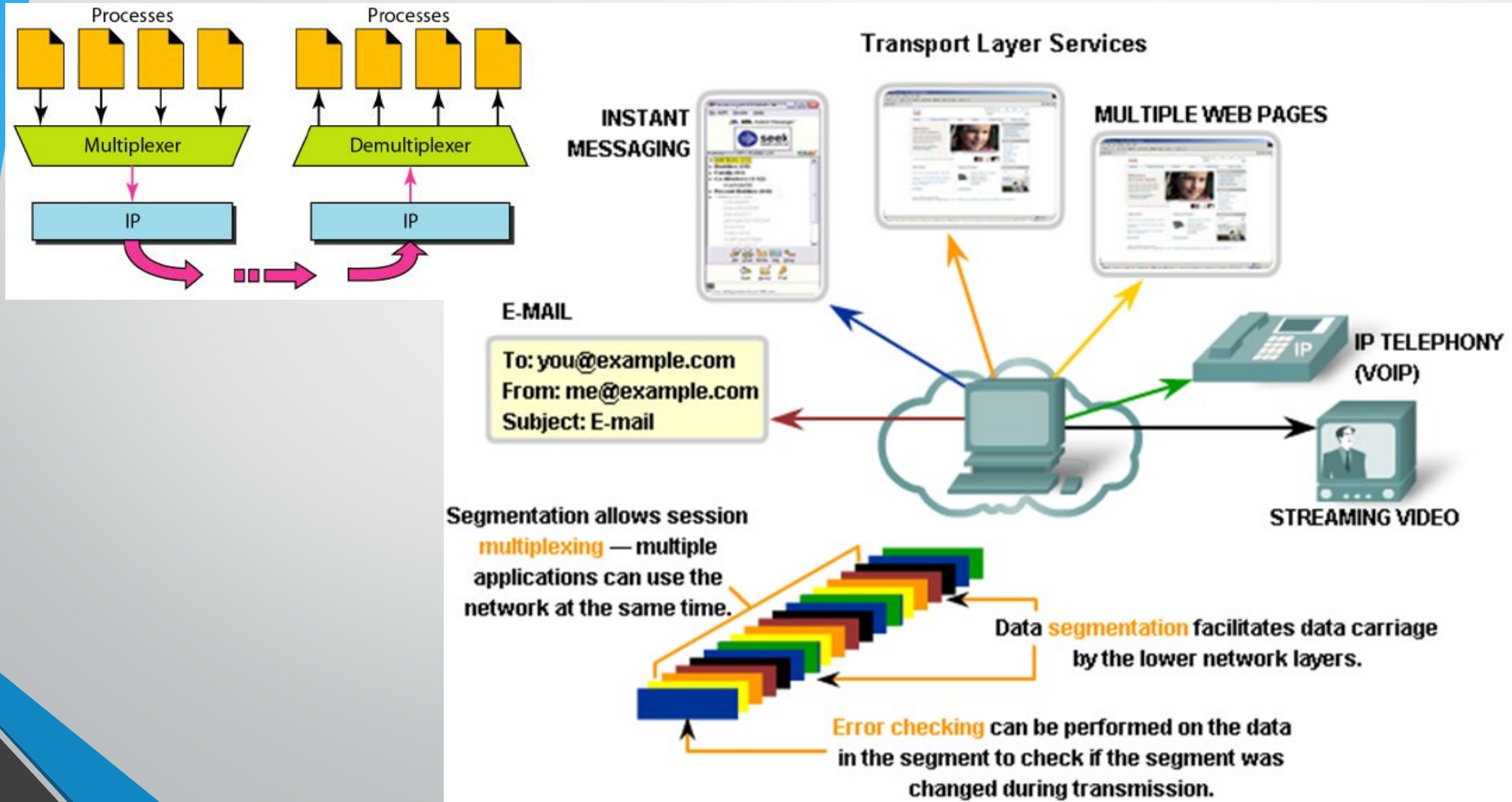


Function – Error Control

- Establishes secure connection (TCP – Three Way Handshake)

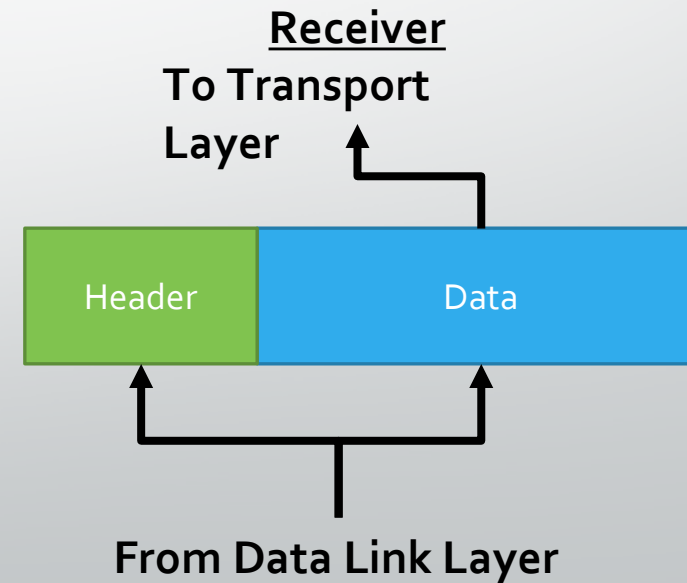
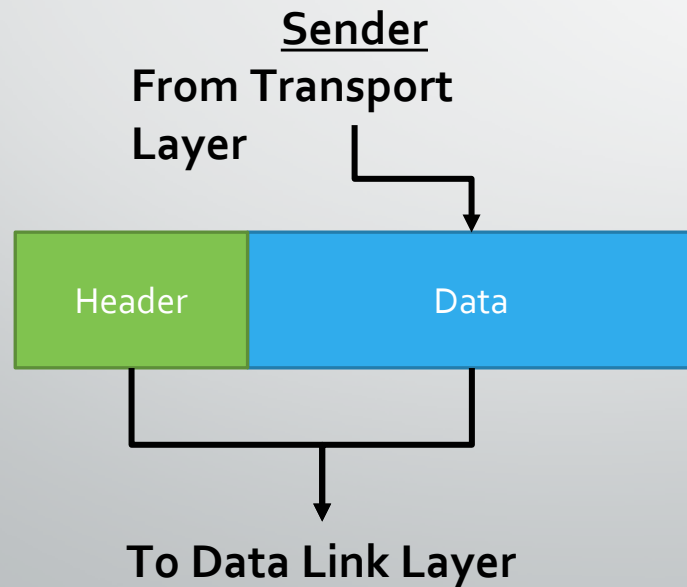


Function – Multiplexing



Network Layer

- The 3rd Layer of OSI Model



Network Layer

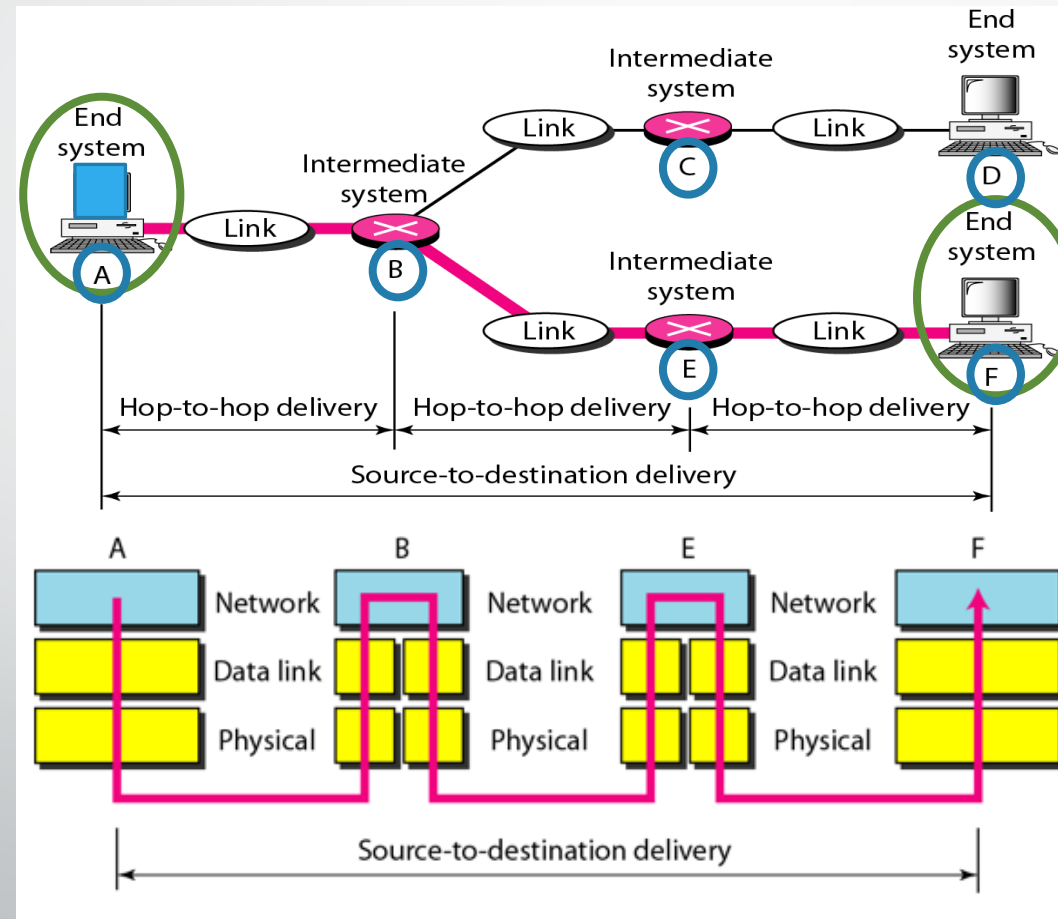
- Network Layer PDU is called **Packet**.
- The network layer is responsible for the delivery of individual packets from the **source host** to the **destination host**.
- Common Network Layer Protocol is called **Internet Protocol (IP)**
- Functions :
 - Adds an address (Logical Address) to identify sender and receiver hosts.
 - Decides which path to take (Routing).

Network Layer – Logical Address

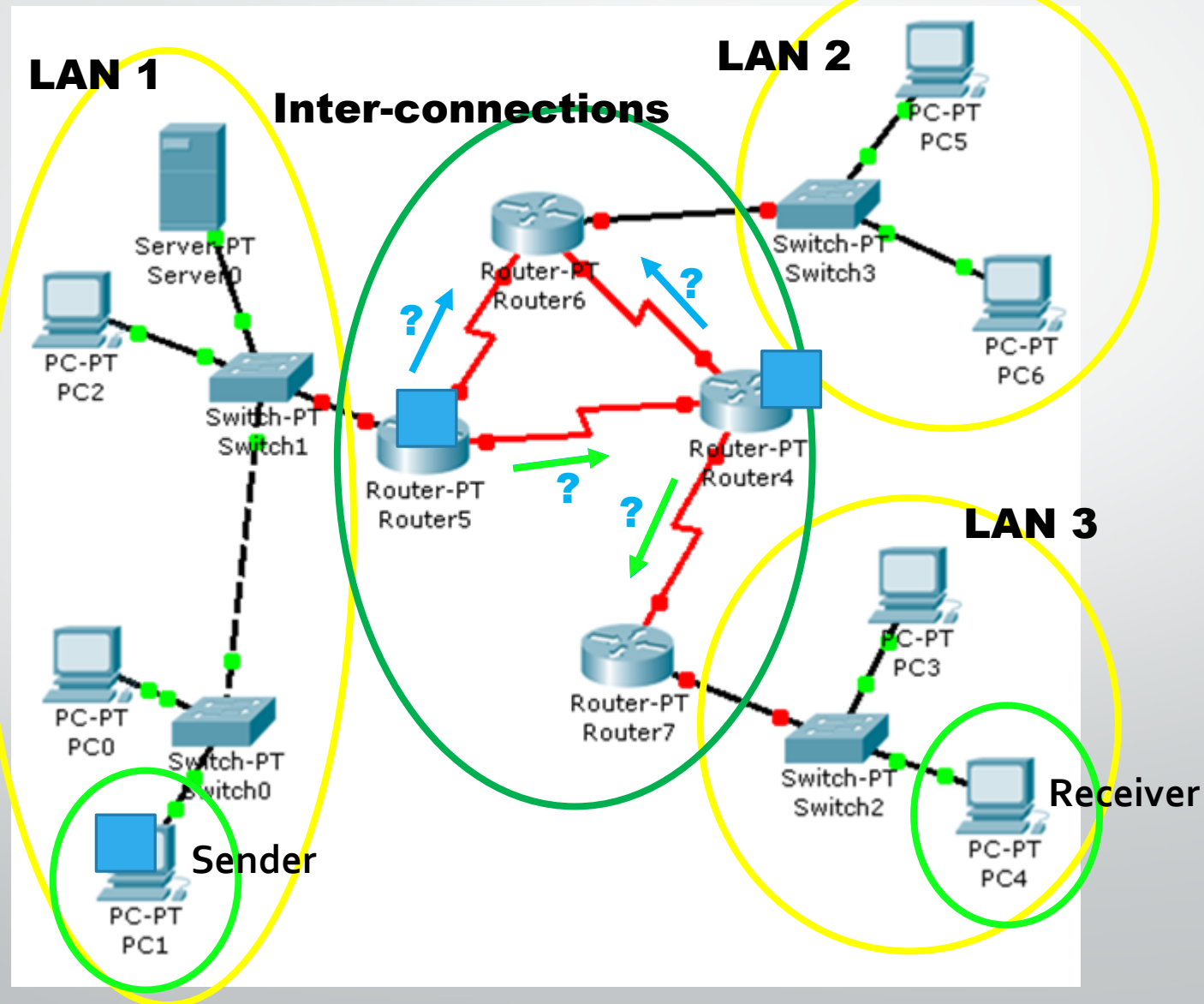
- Universal address, each host uniquely defined.
- 32-bit address also known as IP Address.
 - The bits are written in dotted decimal notation. Each decimal represented by 8 bits.
 - Example: 192.168.10.1
- Independent of underlying physical networks.

Network Layer - Example

- A,B,C,D,E and F are Logical addresses
- Packet to be delivered from A to F

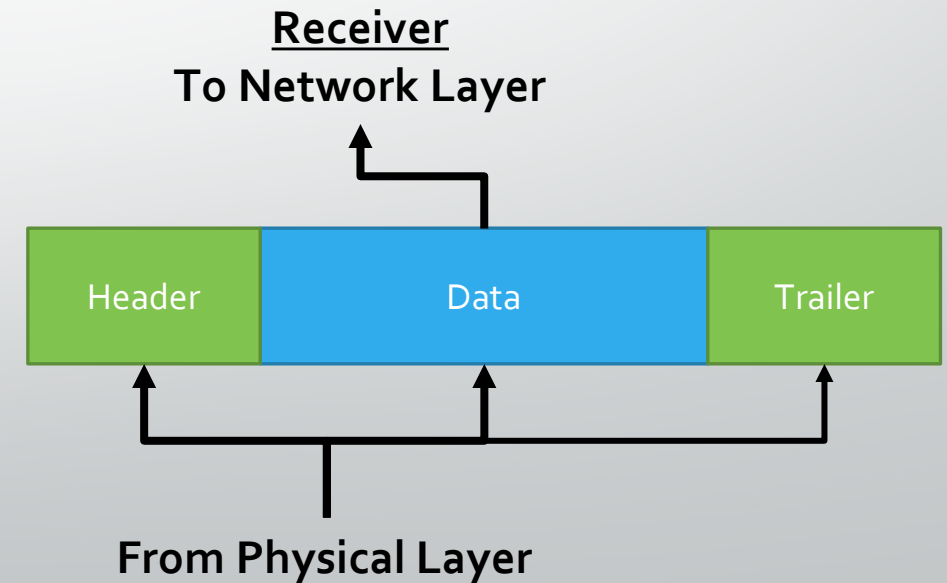
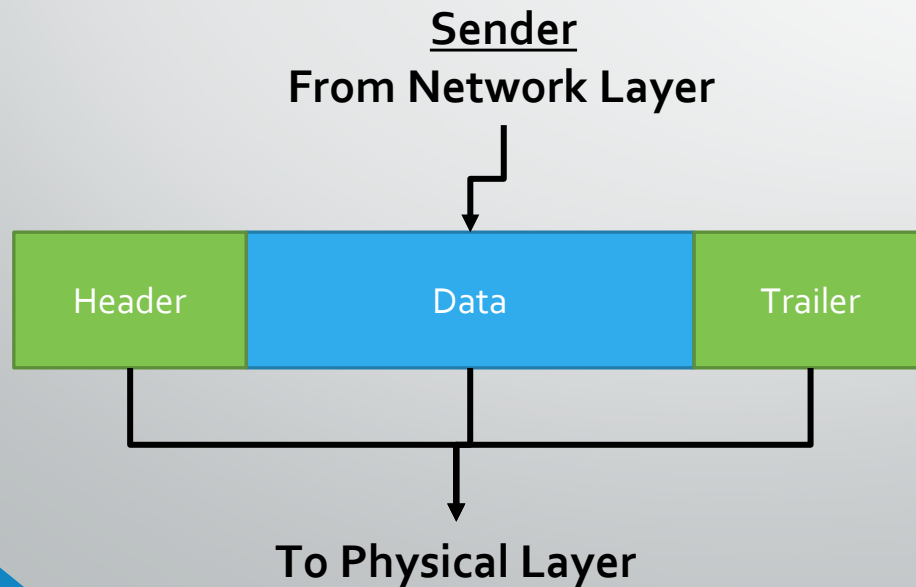


Network Layer – Another Example



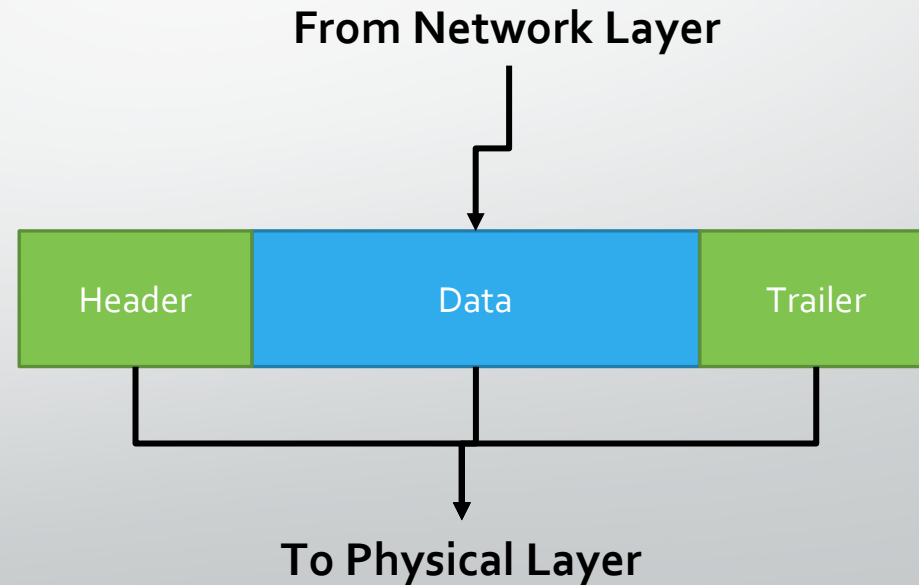
Data Link Layer

- The 2nd Layer of OSI Model

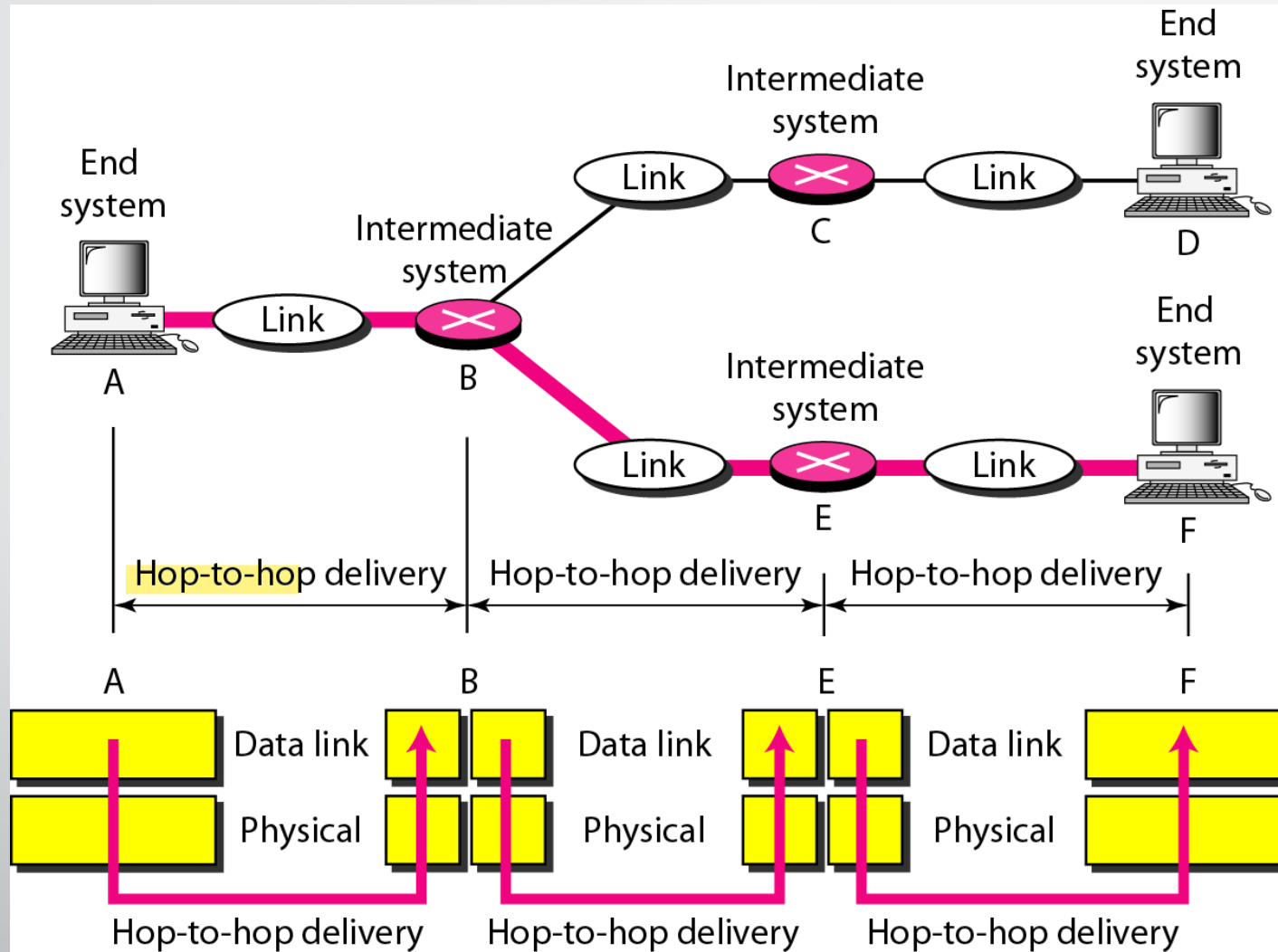


Data Link Layer

- Data Link Layer PDU is called **Frame**.
- The data link layer is responsible for moving frames from one hop (node) to the next.
- Protocols on this layer varies.
- Functions :
 - Framing
 - Physical Addressing
 - Flow Control
 - Error Control
 - Access Control



Hop-to-Hop Delivery

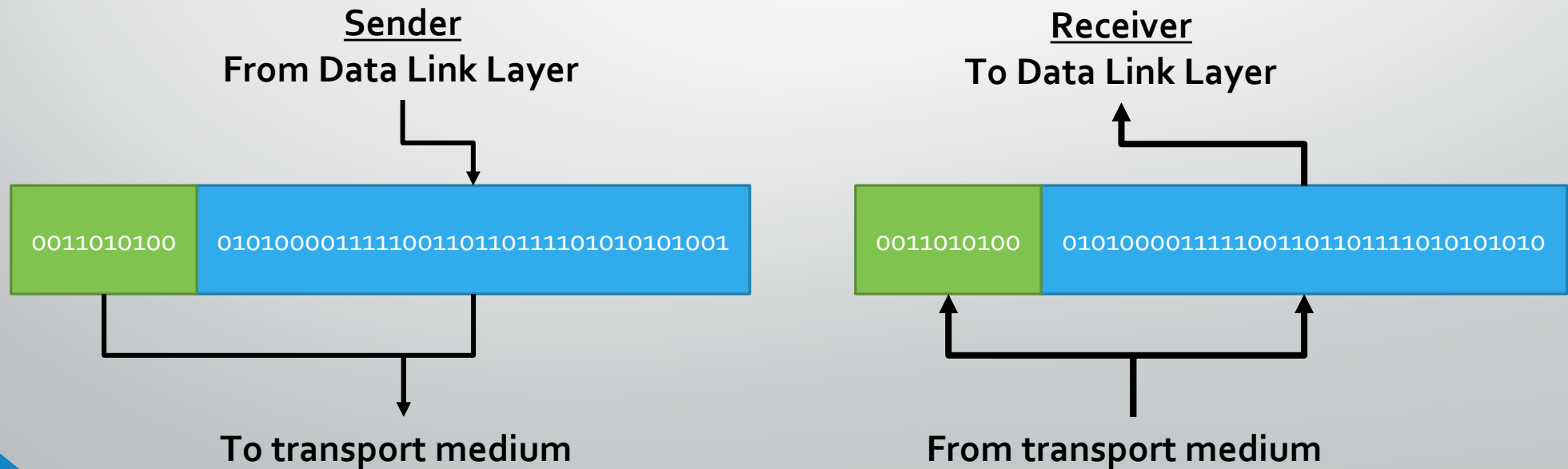


Data Link Layer – Physical Address

- Also known as **MAC (Media Access Control)** Address
- Every interface/port/device has an **unique identifying** number.
 - Given **by manufacturer**.
- **48 bits long**, represented by **12 hexadecimal** digits grouped in pairs and separated by '-' or ':'.
 - Example: 07:01:02:01:2C:4B

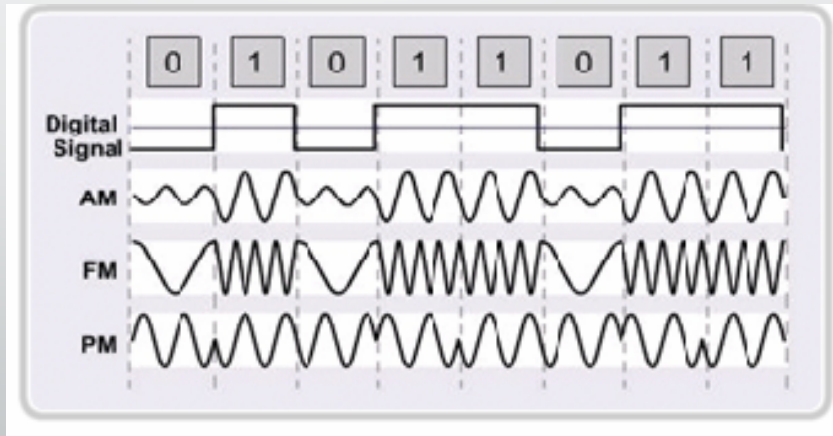
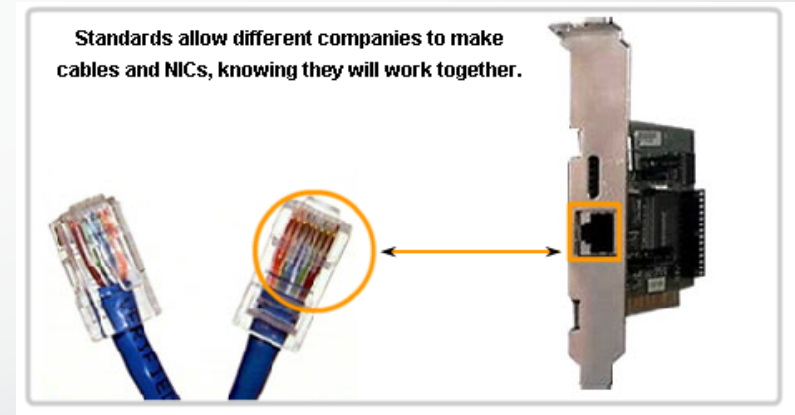
Physical Layer

- The 1st Layer of OSI Model



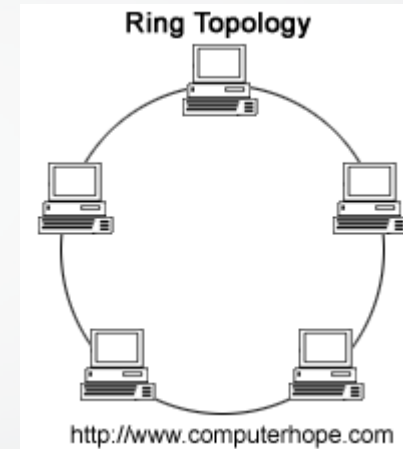
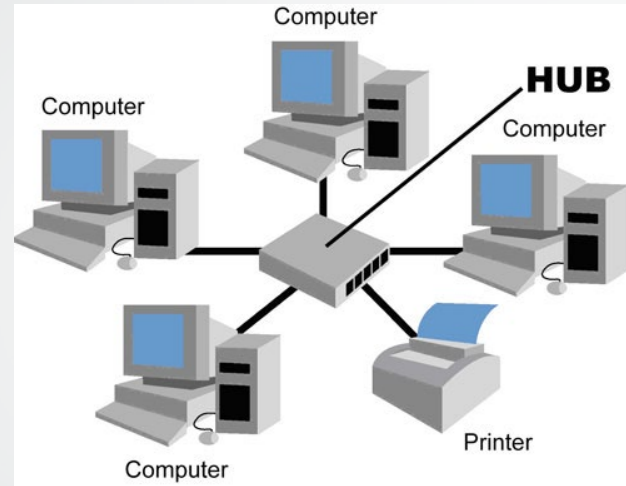
Physical Layer

- The physical layer is responsible for movements of individual bits from one hop (node) to the next.
- Functions
 - Physical Characteristics of interfaces and medium.
 - Representation of bits
 - Data Rate
 - Synchronization of bits

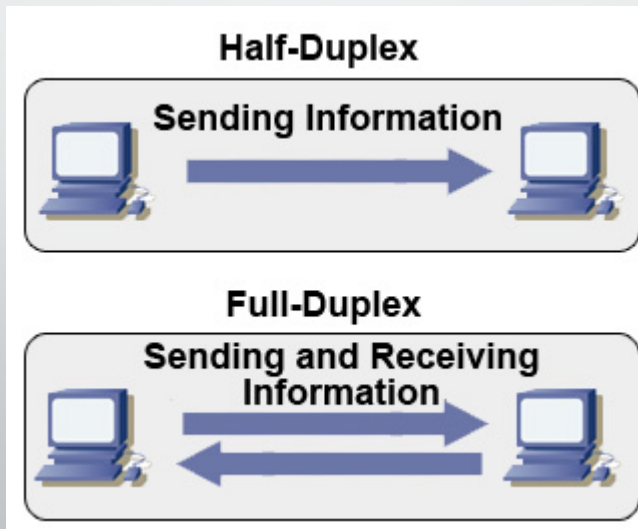


Physical Layer

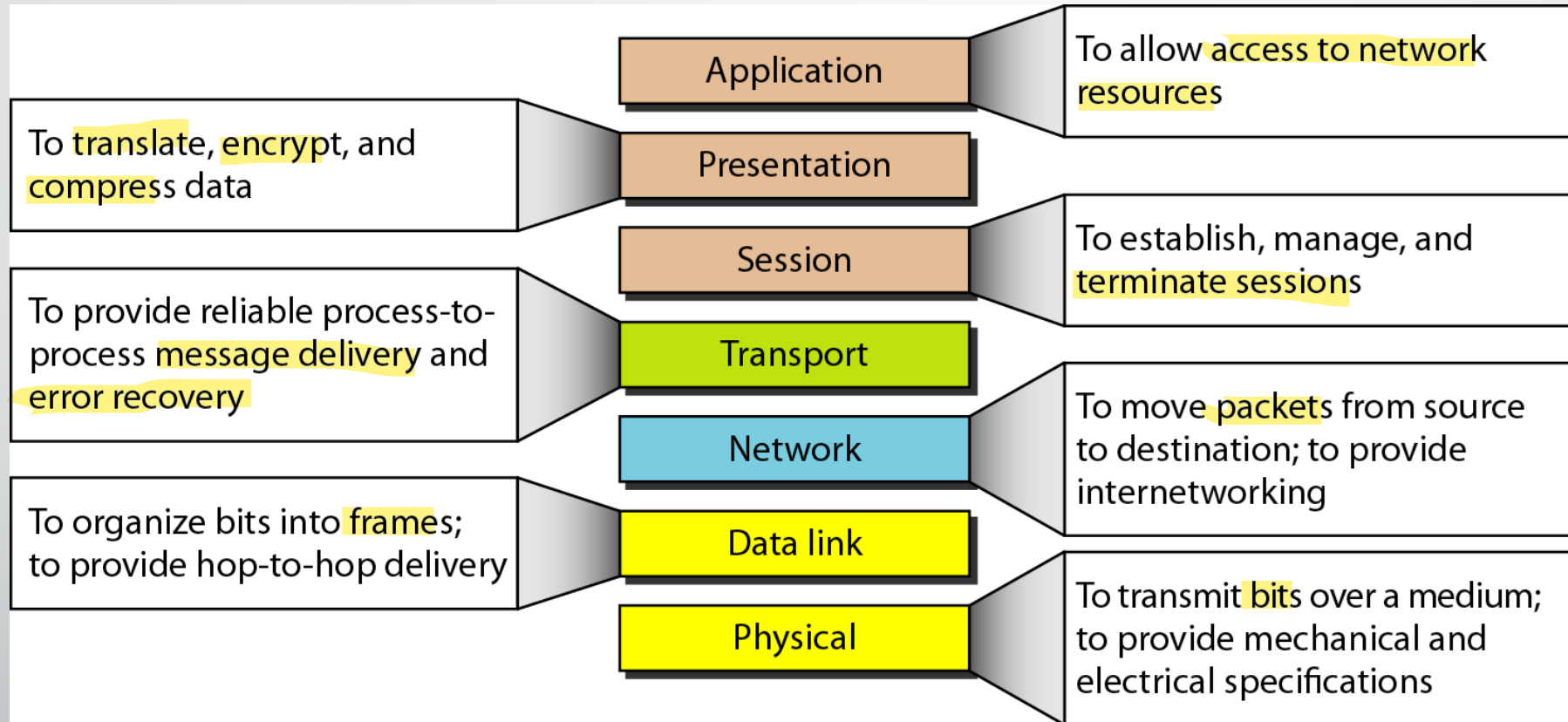
- Physical Topology
 - Example: Bus, ring, etc.



- Transmission Modes
 - Simplex
 - Half Duplex
 - Full Duplex



Summary of OSI Layers



TCP/IP Model

De Facto Standard

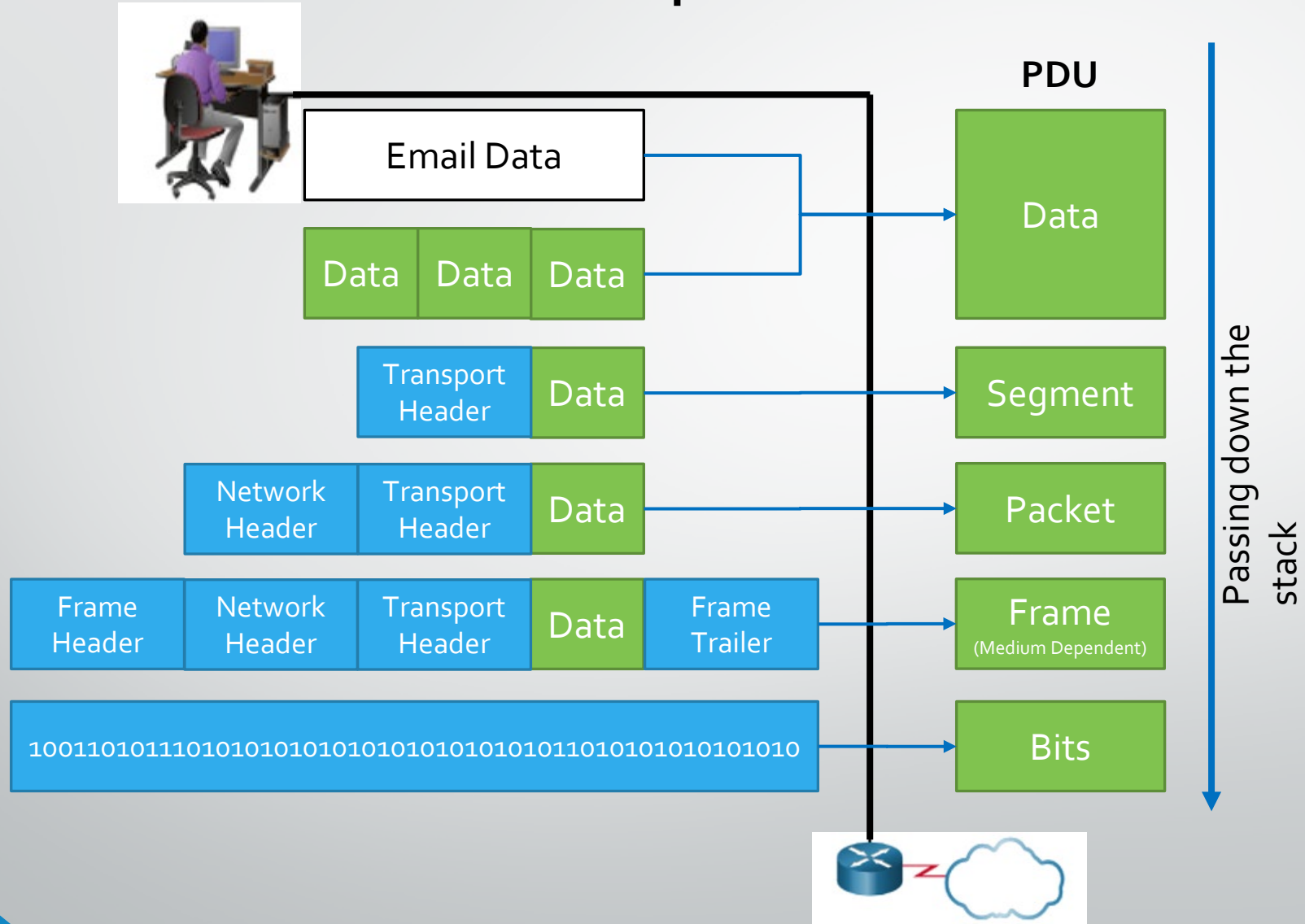
| OSI Model | | TCP/IP Model |
|-----------|--------------|----------------|
| 7 | Application | Application |
| 6 | Presentation | |
| 5 | Session | |
| 4 | Transport | Transport |
| 3 | Network | Internet |
| 2 | Data Link | Network Access |
| 1 | Physical | |

TCP/IP Model

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

| OSI Model | | TCP/IP Model |
|-----------|--------------|----------------|
| 7 | Application | Application |
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| 3 | Network | Internet |
| 2 | Data Link | Network Access |
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TCP/IP Encapsulation and PDU



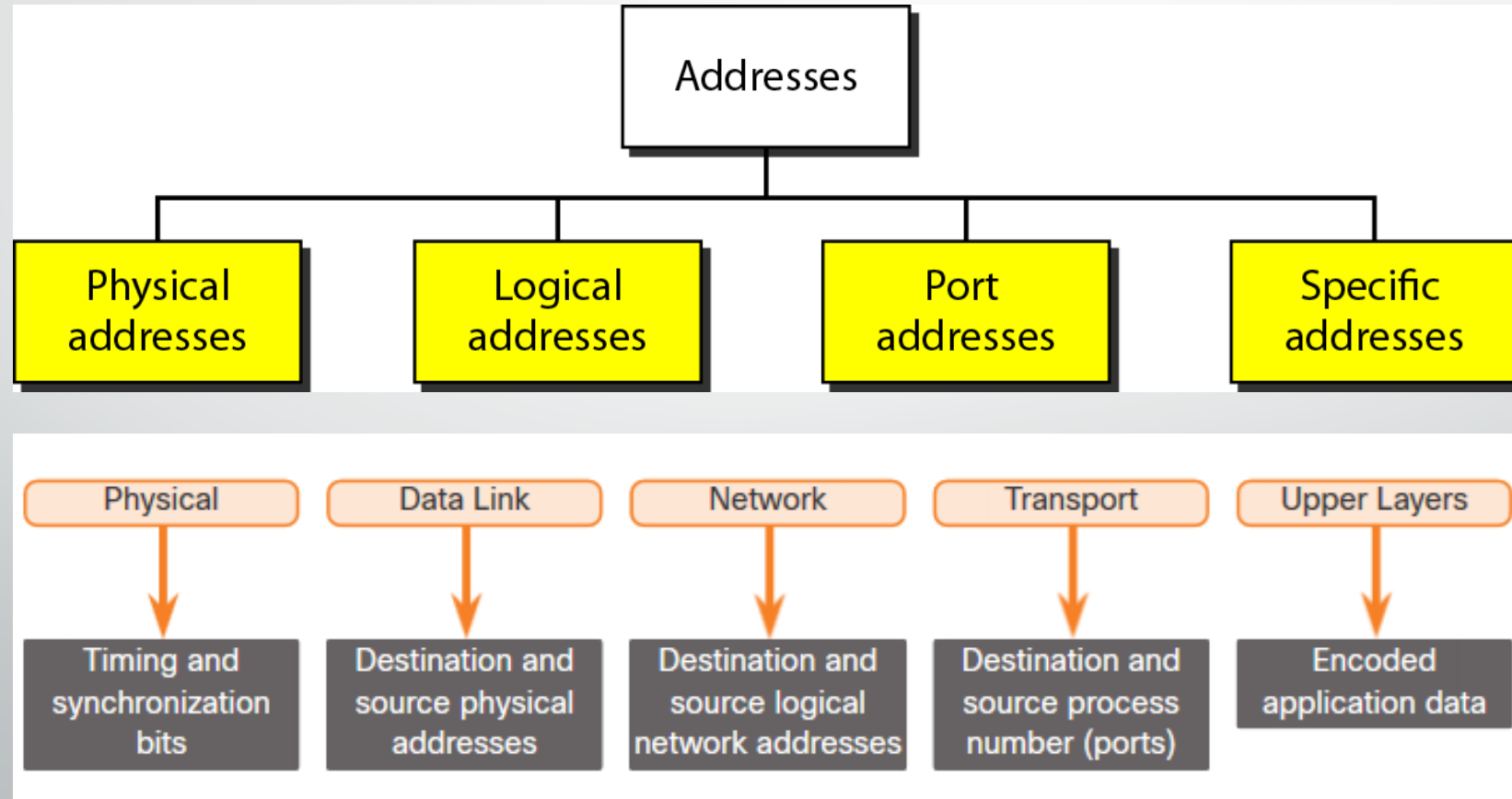
TCP/IP and Other Models

| Layer Name | TCP/IP | ISO | AppleTalk | Novell Netware |
|----------------|---|------------------------------|---------------------|-------------------|
| Application | HTTP DNS DHCP FTP | ACSE ROSE TRSE SESE | AFP | NDS |
| Transport | TCP UDP | TP0 TP1 TP2 TP3 TP4 | ATP AEP NBP RTMP | SPX |
| Internet | IPv4 IPv6 ICMPv4 ICMPv6 | CONP/CMNS CLNP/CLNS | AARP | IPX |
| Network Access | Ethernet PPP Frame Relay ATM WLAN | | | |

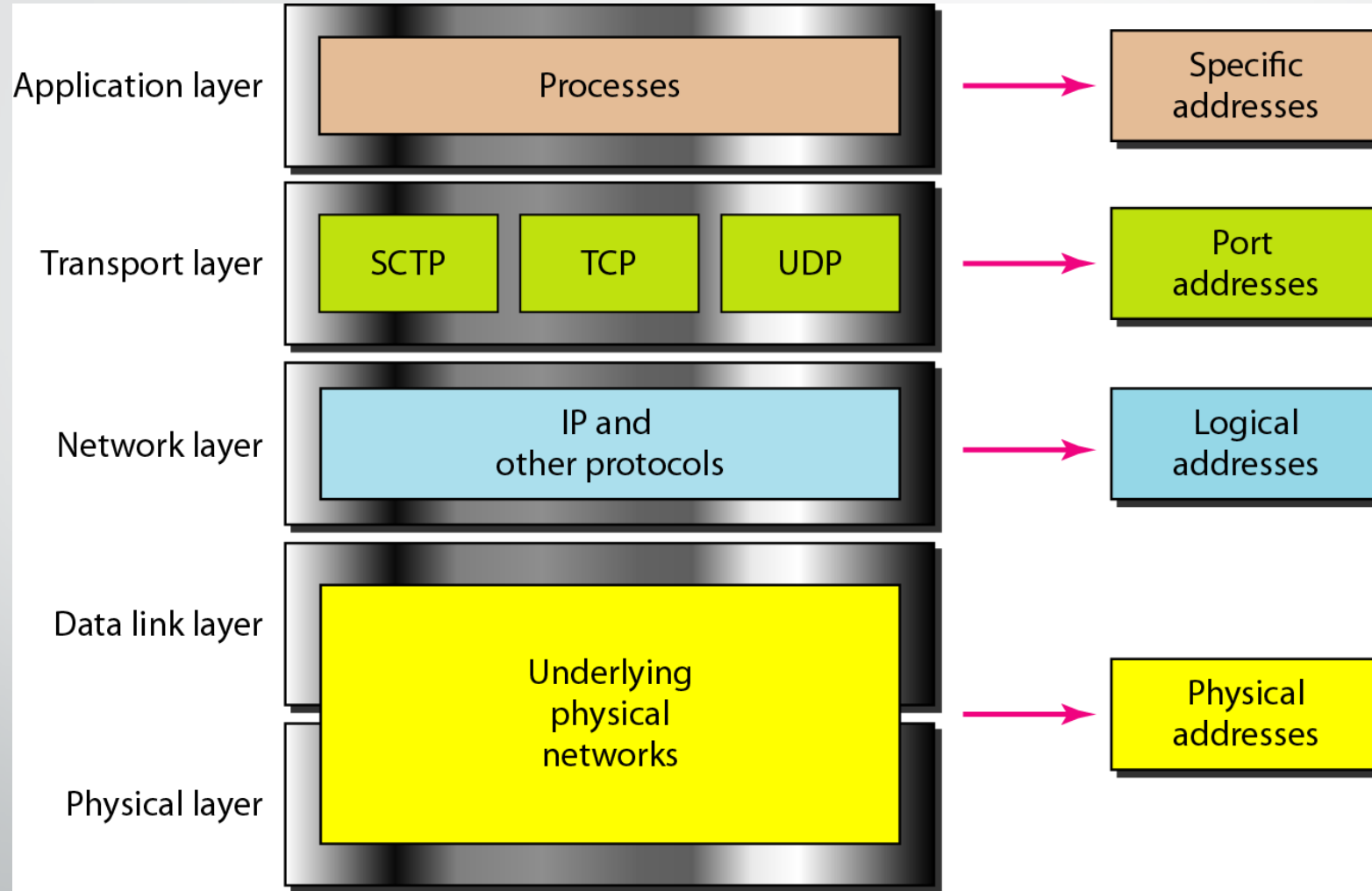
Addressing in Networking

Addressing - Summary

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



Relationship of layers and address in TCP/IP

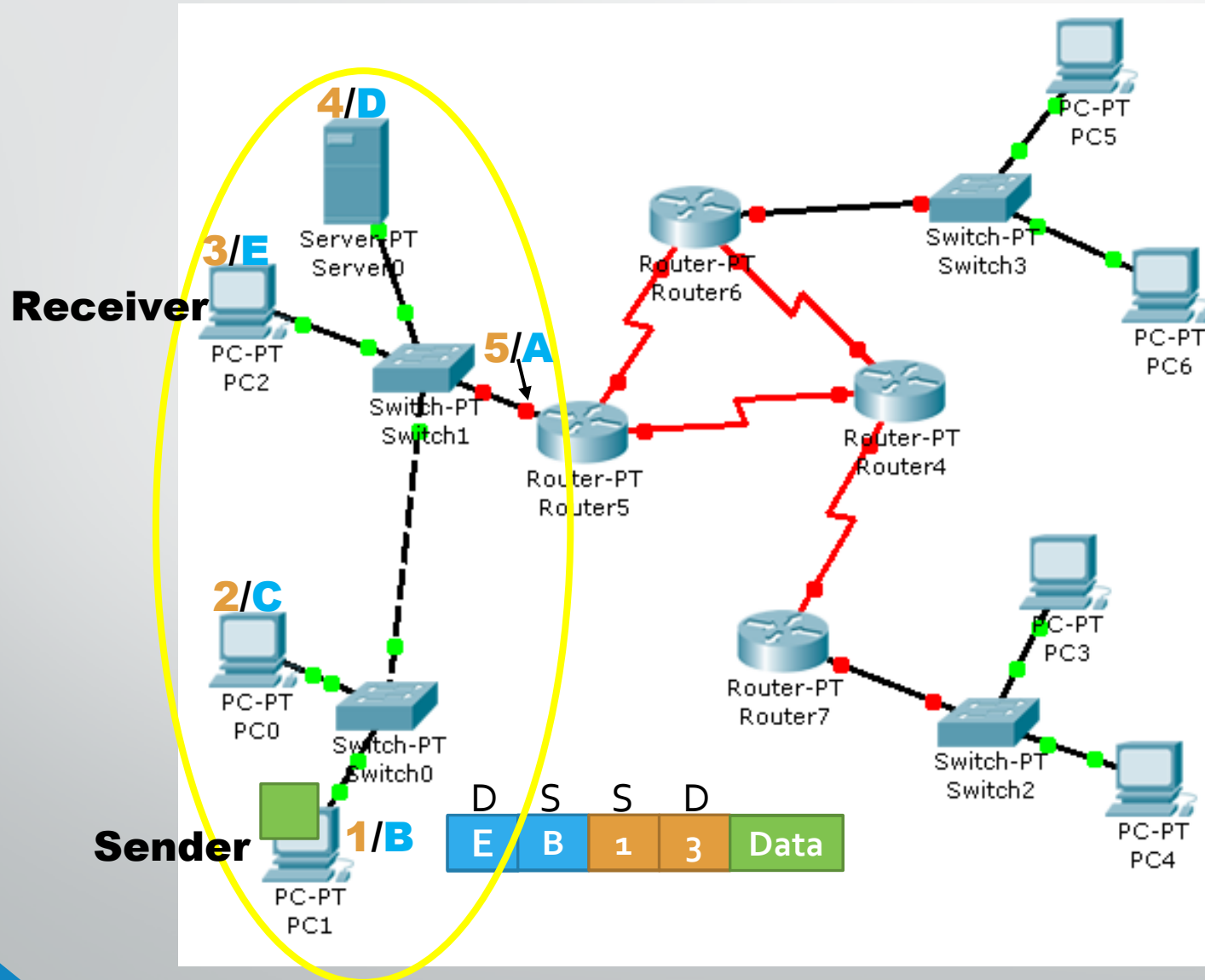


Addresses

- Specific Address
 - Applications having user friendly addresses.
 - Email addresses or URLs.
 - john@gmail.com or www.bracu.ac.bd
 - These are converted into corresponding port and logical addresses by the sending computer.
- The other addresses are already discussed in the earlier slides! Can you identify them?

***Port address (Slide 35), Logical Address (Slide 42), Physical Address (Slide 48)*

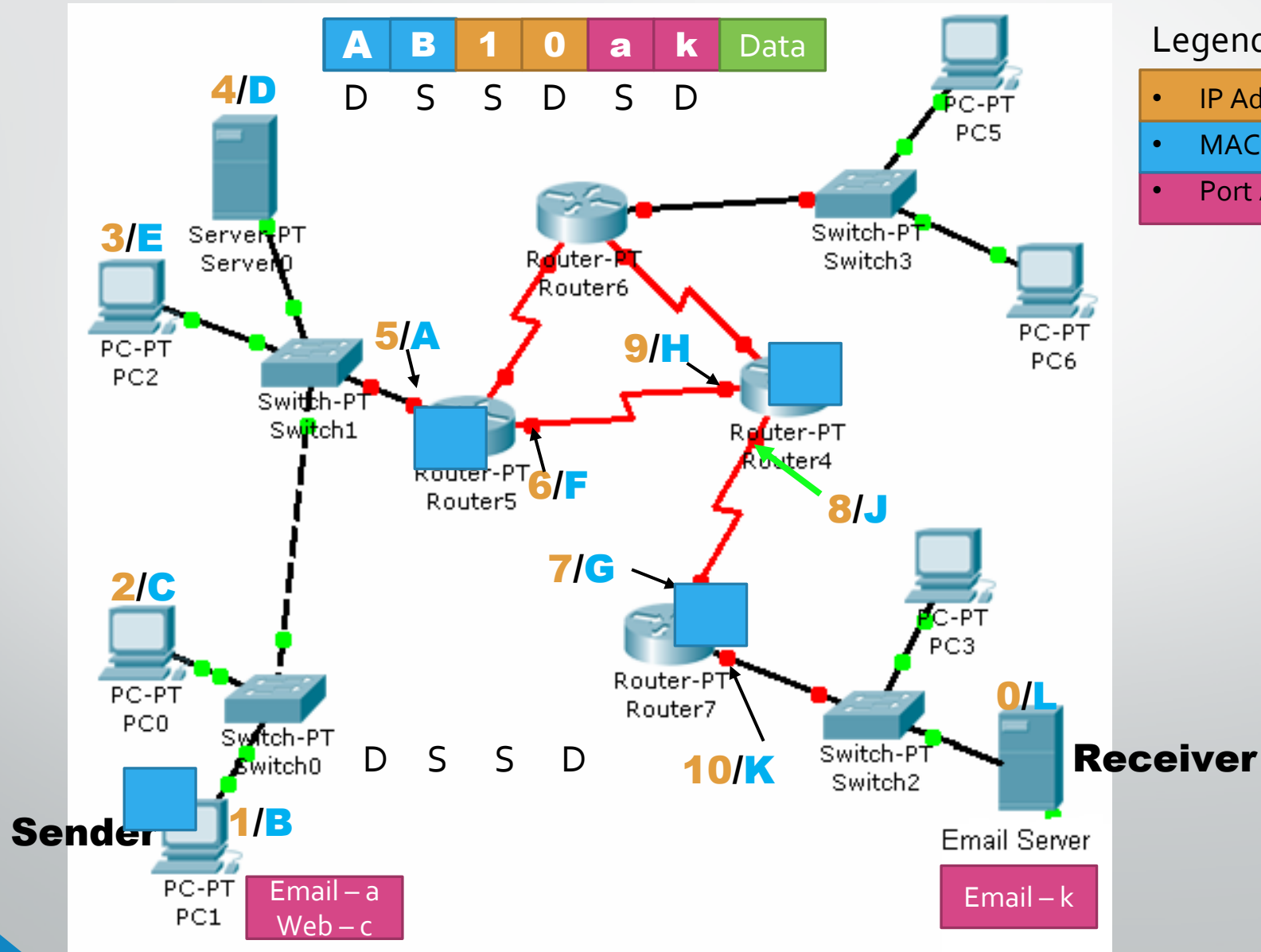
Logical and Physical Address – Same Network



Legend:

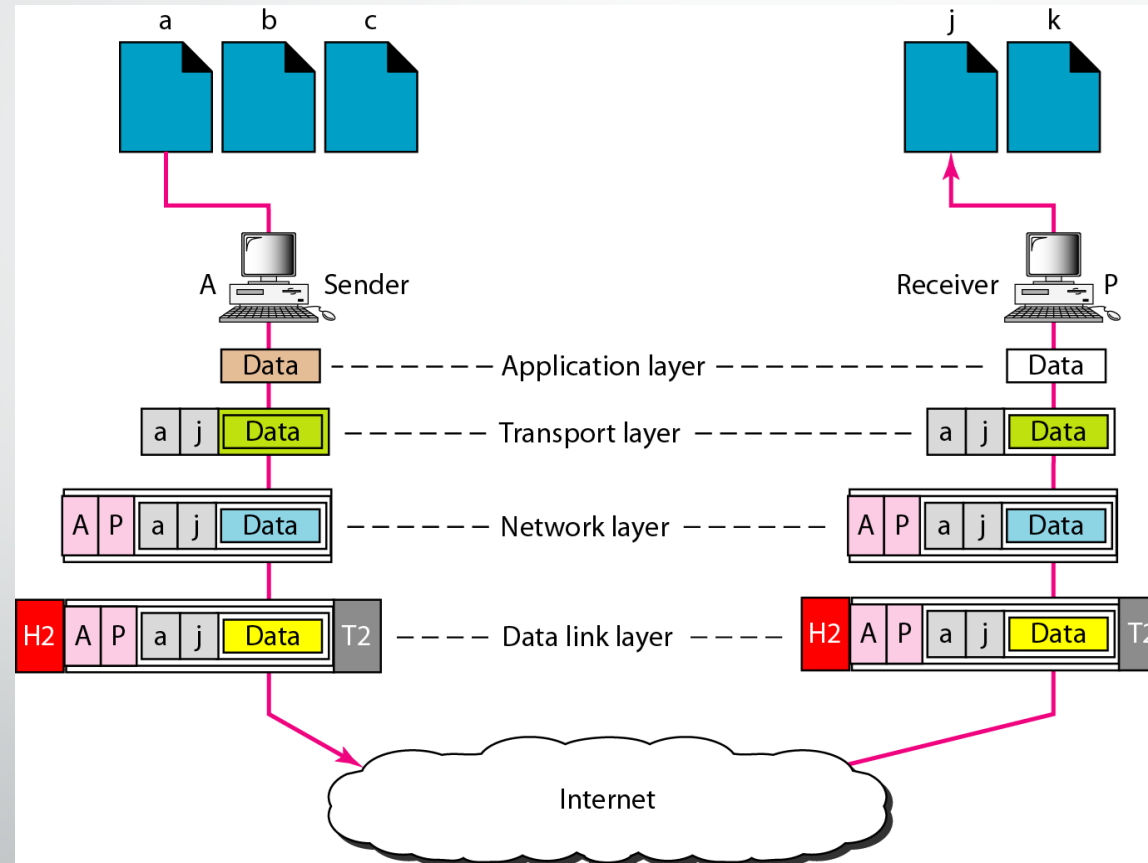
- IP Addresses – Numbers
- MAC Address – Alphabets

Port, Logical & Physical Address – Different Network



Addressing – Review

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



The End

- **References**

- [1] Chapter 2, The McGraw-Hill Companies, Inc.
- [2] Chapter 3, The McGraw-Hill Companies, Inc.
- [3] CCNA 1, CISCO.