Network Models & Protocol Architectures

Lecture 2 | CSE421 – Computer Networks

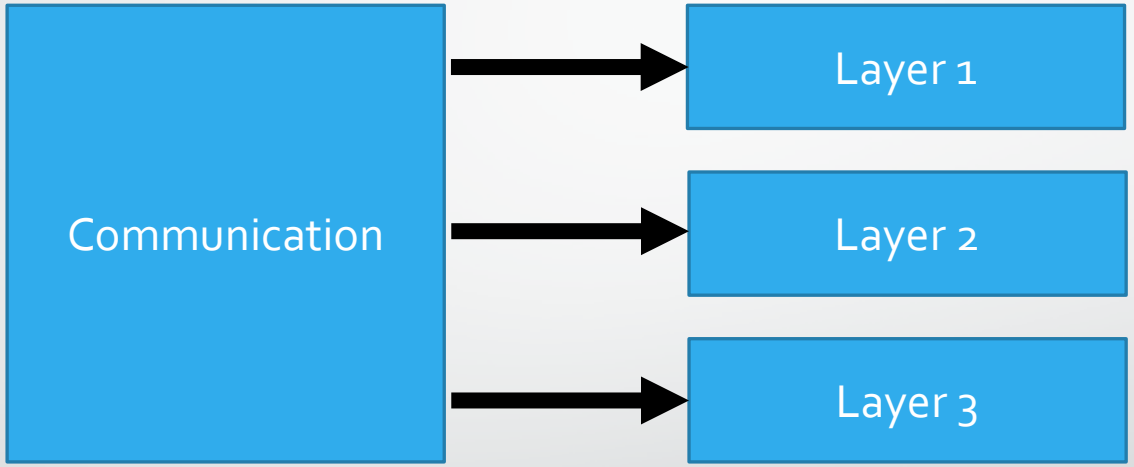
Department of Computer Science and Engineering
School of Data & Science

Objectives

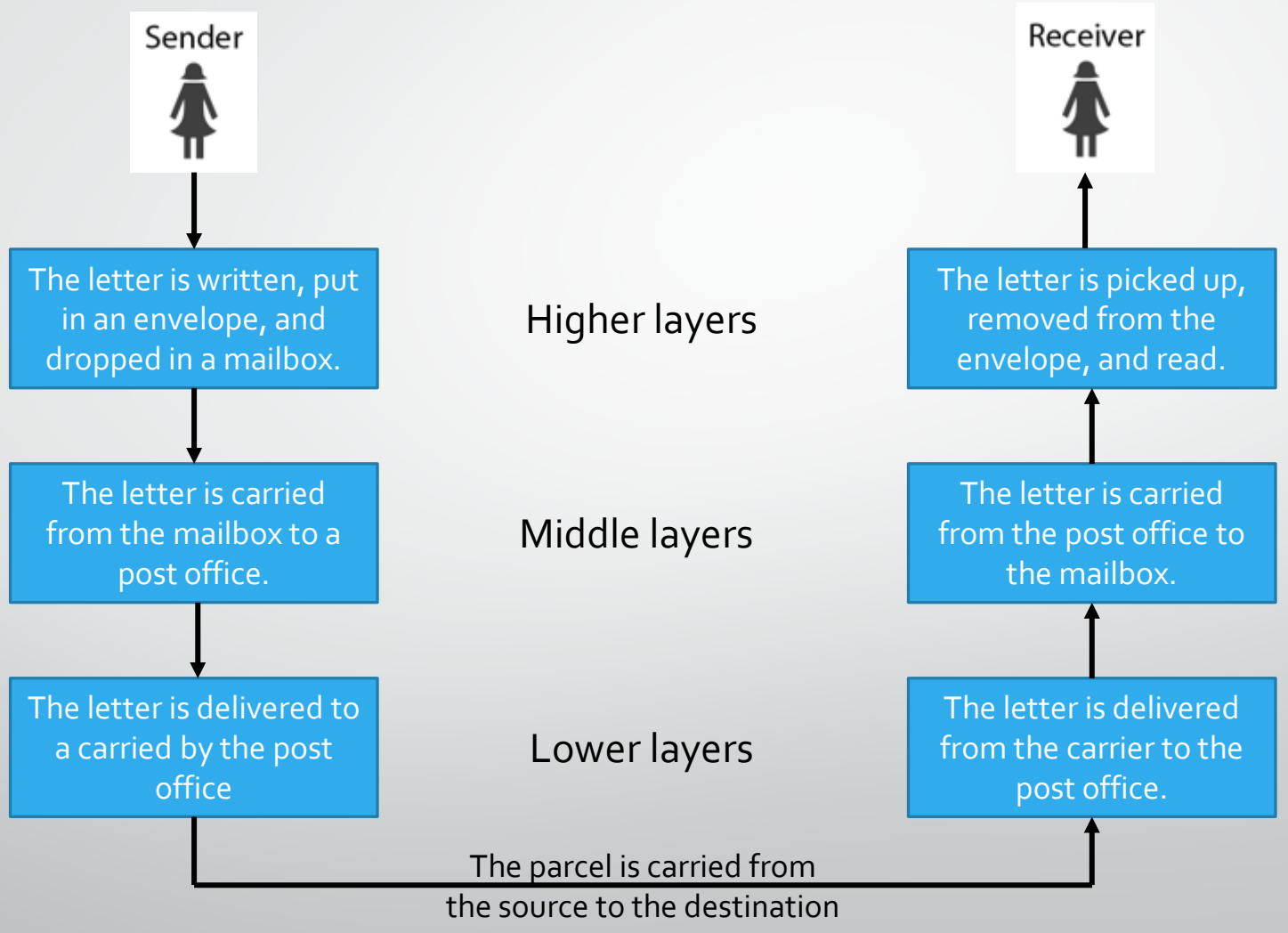
- Layering in communication
- Protocols
- Standards
- Protocol Suites
  - OSI Model
  - TCP/IP Model
- Addressing

Layering

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

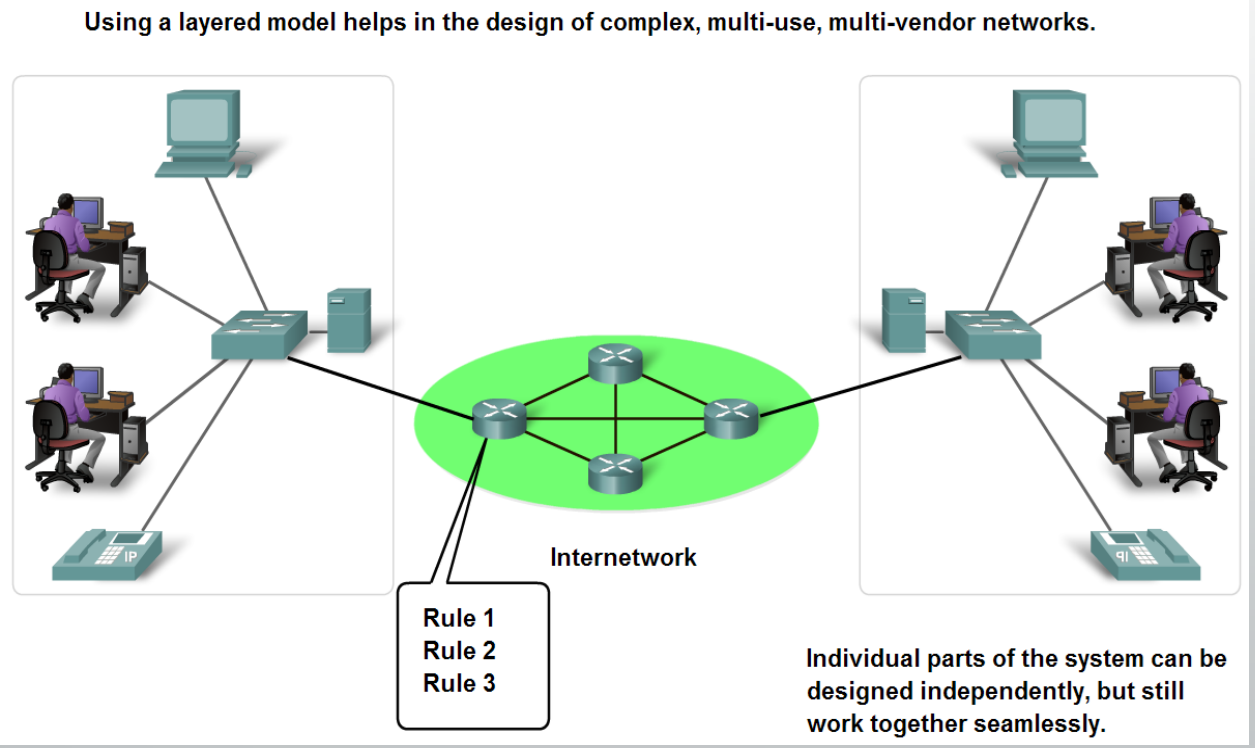


Layers: Sending a letter



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.



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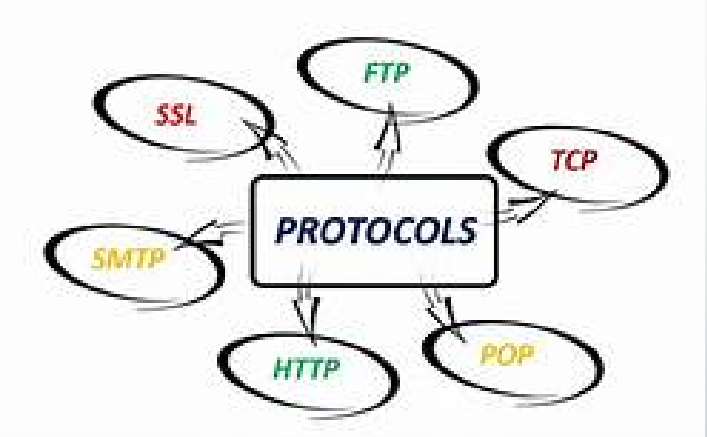
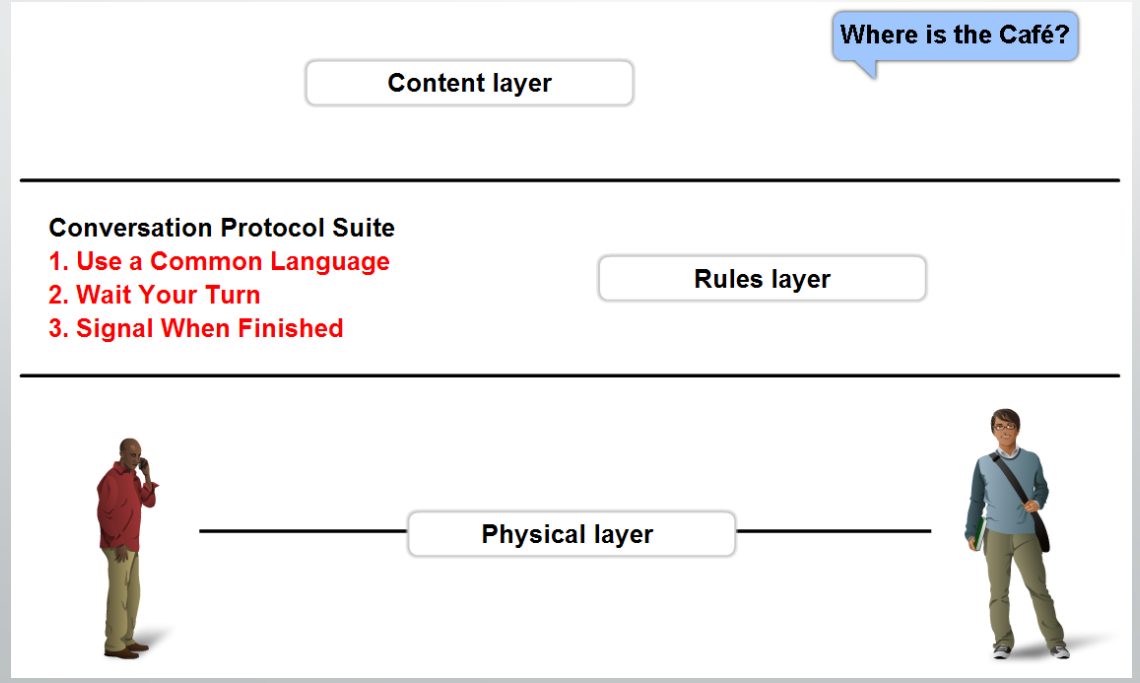
Protocols



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.

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Standards

Standards

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

Standards

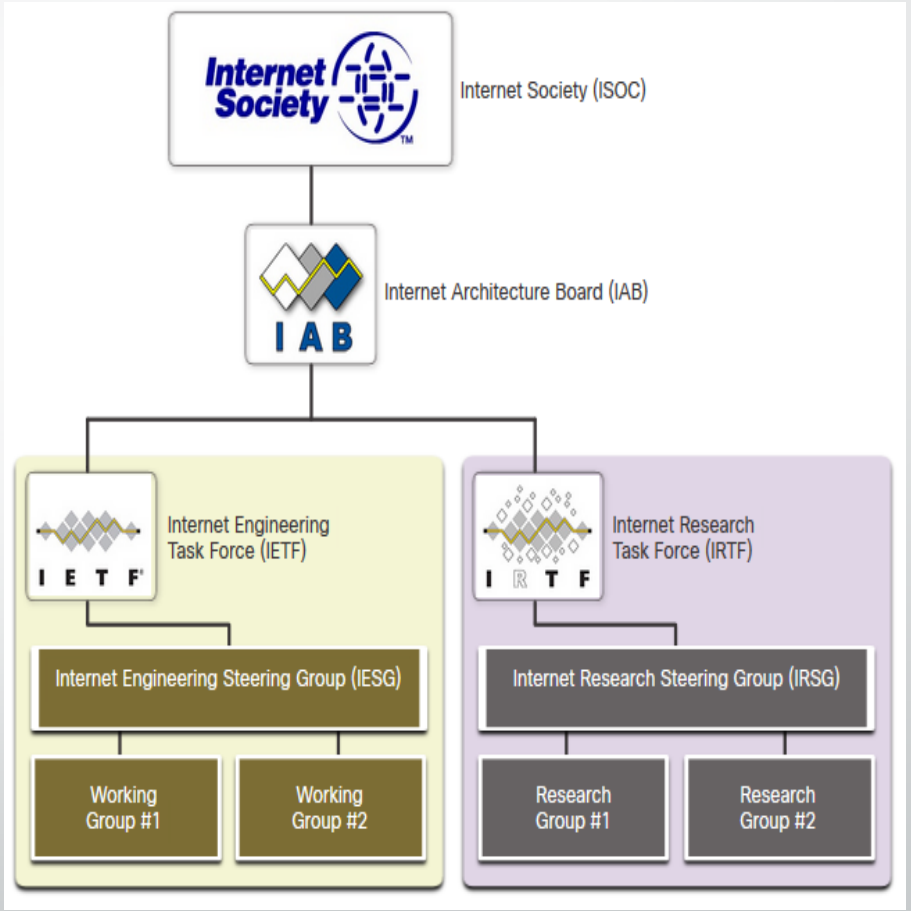
- Endorsed by the networking industry and approved by a standards organization.
- Benefits:
  - Create and maintain an open and competitive market.
  - Ensured greater compatibility and interoperability.
- Categories
  - **De facto – TCP/IP Protocol Model**
  - **De jure – OSI Reference Model**

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

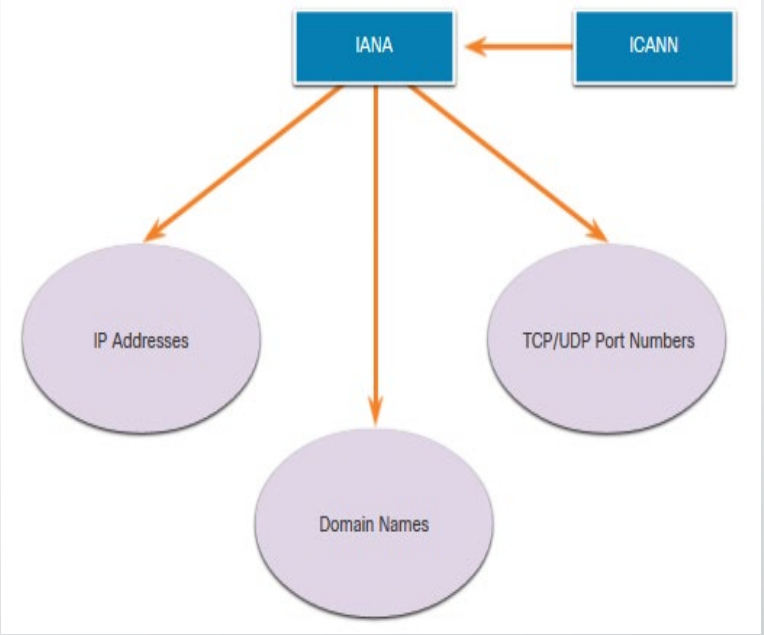
- **Internet Society (ISOC)** - Promotes the open development and evolution of internet
- **Internet Architecture Board (IAB)** - Responsible for management and development of internet standards
- **Internet Engineering Task Force (IETF)** - Develops, updates, and maintains internet and TCP/IP technologies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



Internet Standards (Continued)

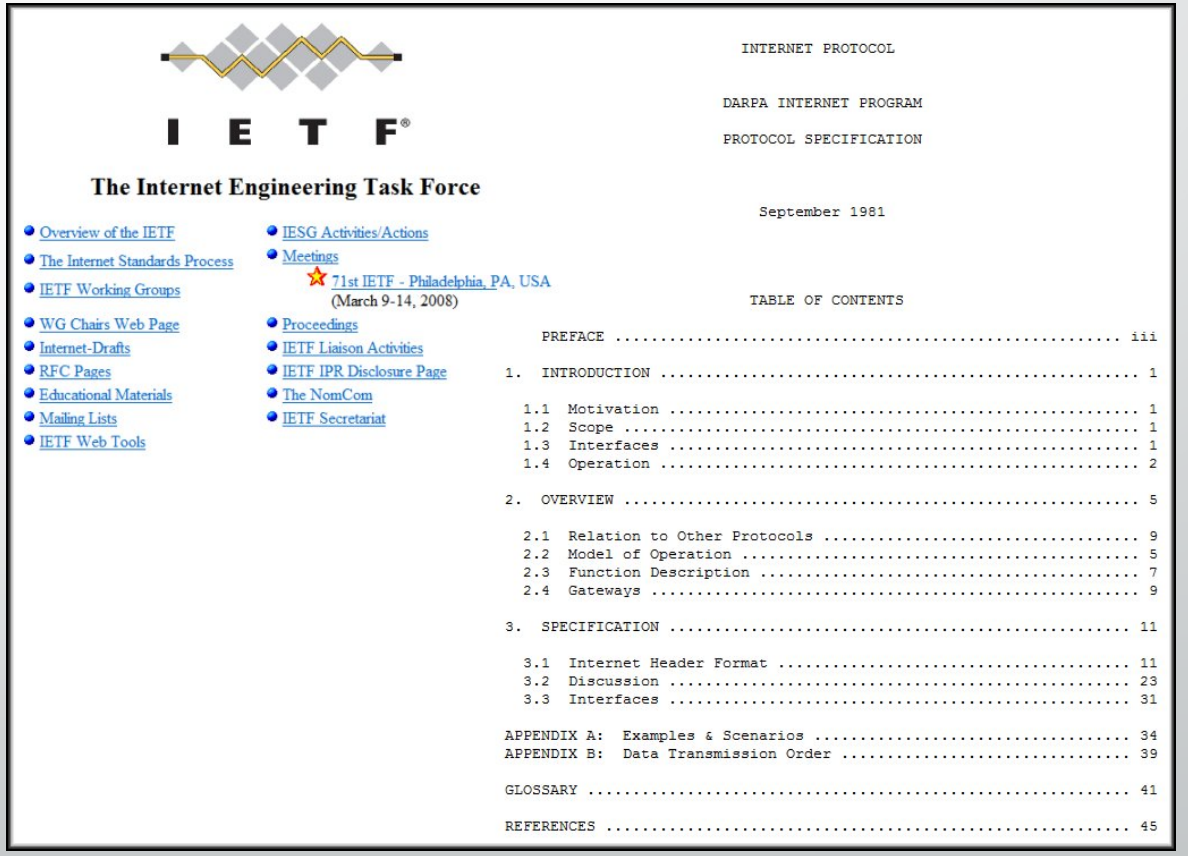
Standards organizations involved with the development and support of TCP/IP

- **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

- 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
- IESG Activities/Actions
- Meetings
- 71st IETF - Philadelphia, PA, USA (March 9-14, 2008)
- Proceedings
- IETF Liaison Activities
- IETF IPR Disclosure Page
- The NomCom
- IETF Secretariat

INTERNET PROTOCOL

DARPA INTERNET PROGRAM

PROTOCOL SPECIFICATION

September 1981

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Electronic and Communications Standards

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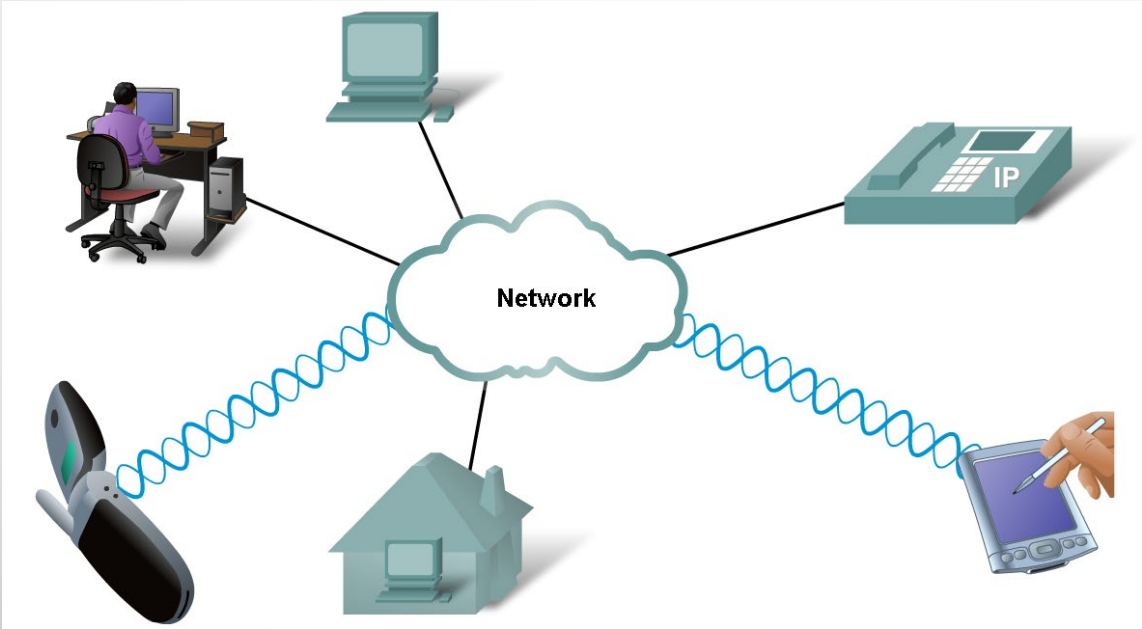
- **Institute of Electrical and Electronics Engineers** (**IEEE**, pronounced "I-triple-E") - dedicated to creating standards in power and energy, healthcare, telecommunications, and networking
- **Electronic Industries Alliance (EIA)** - develops standards relating to electrical wiring, connectors, 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.



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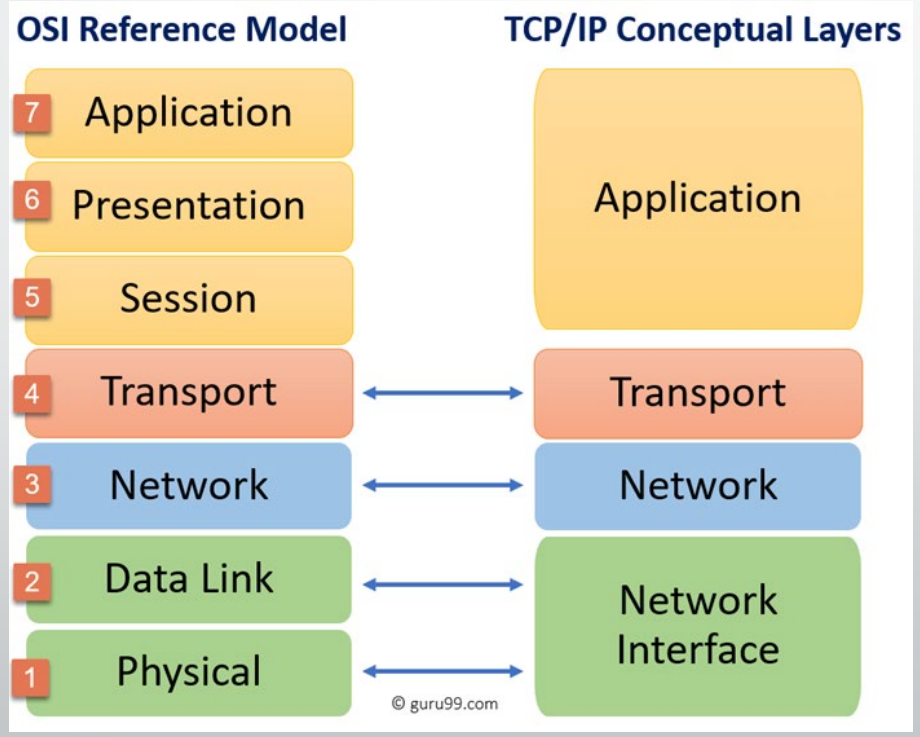
Protocol Suites



Protocol Suites

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

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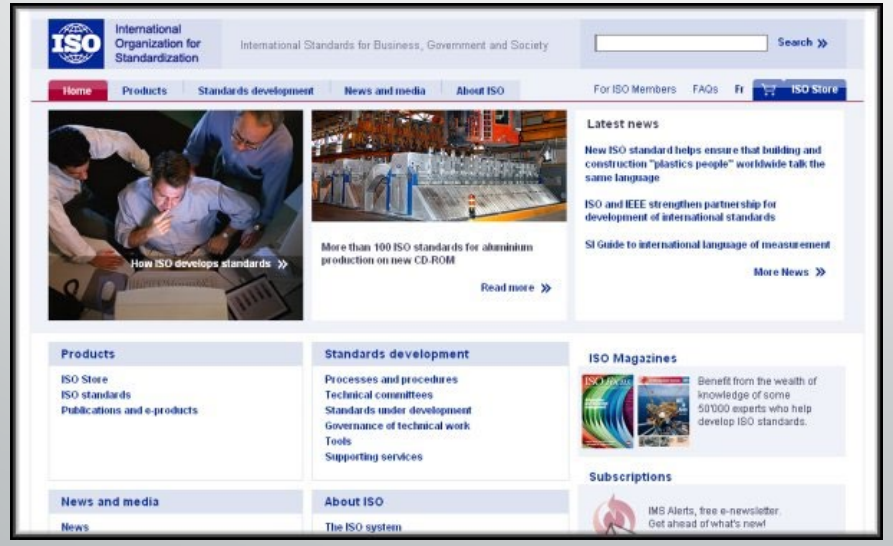
OSI Model

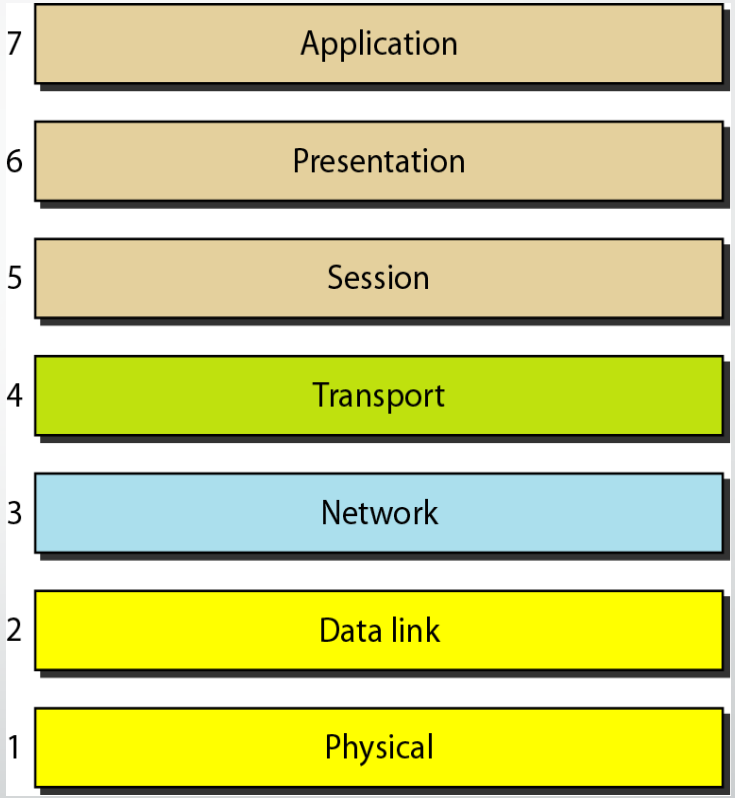
De Jure Standard

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.



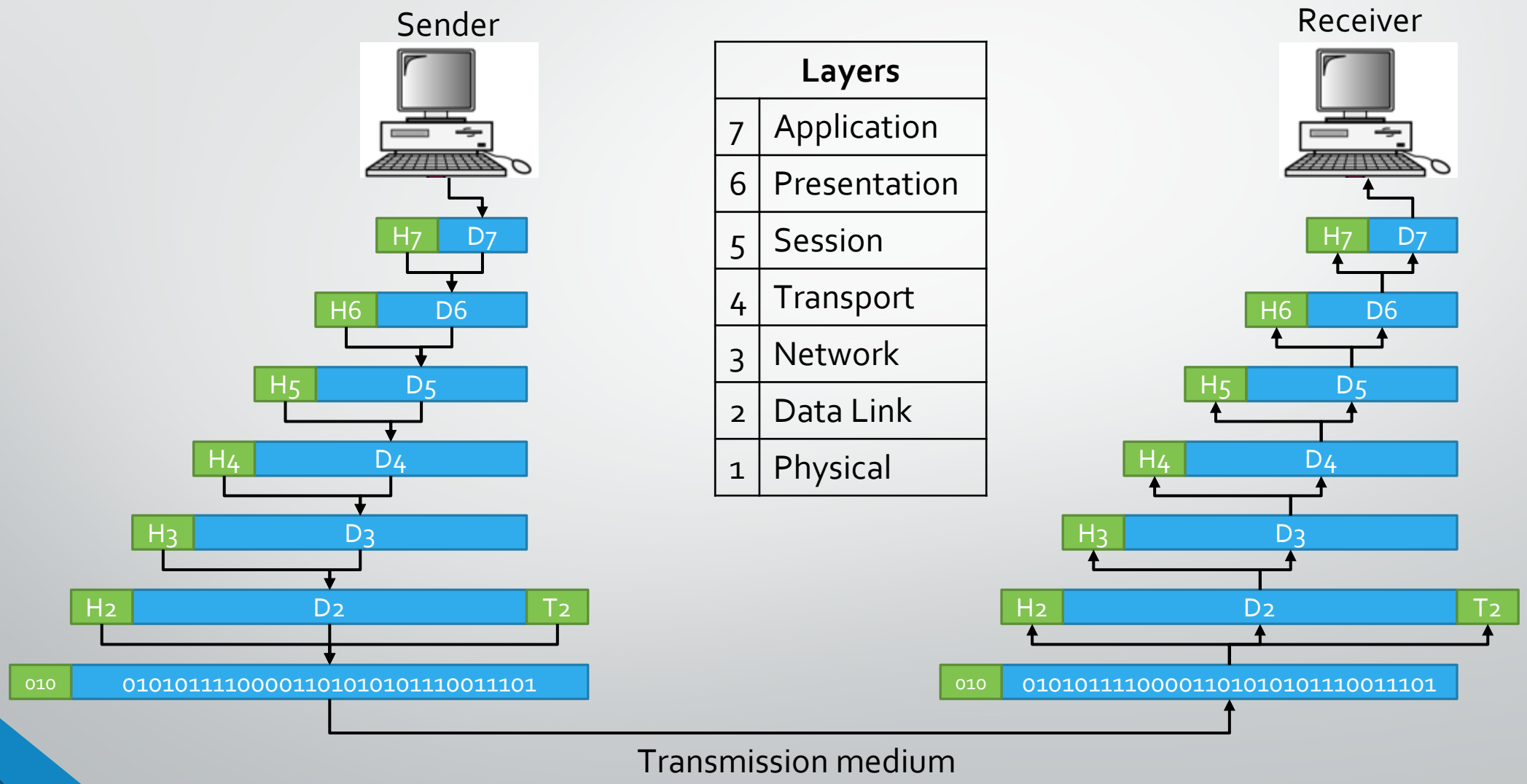


ISO is the **organization**.
OSI is the **model**.

OSI Model - Layers

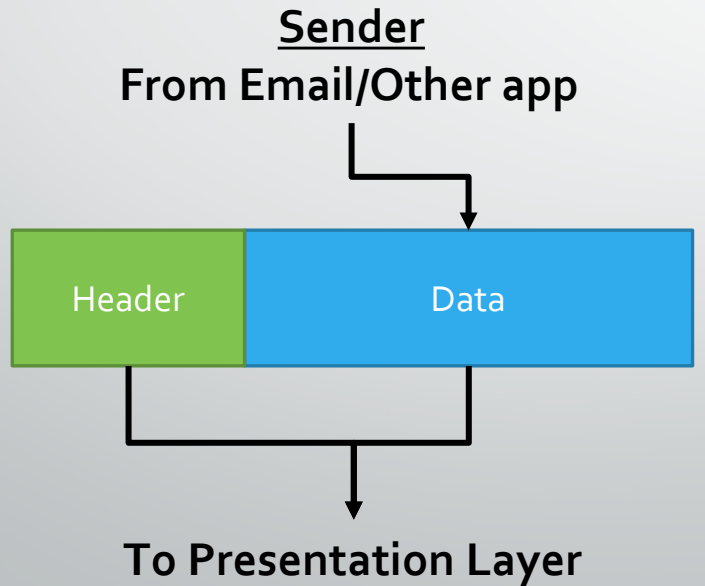
Primary Concern	Layers		Cisco
Communications between applications	7	Application	**A**ll
	6	Presentation	**P**eople
	5	Session	**S**eem
	4	Transport	**T**o
	3	Network	**N**eed
Moving raw data across the network	2	Data Link	**D**ata
	1	Physical	**P**rocessing

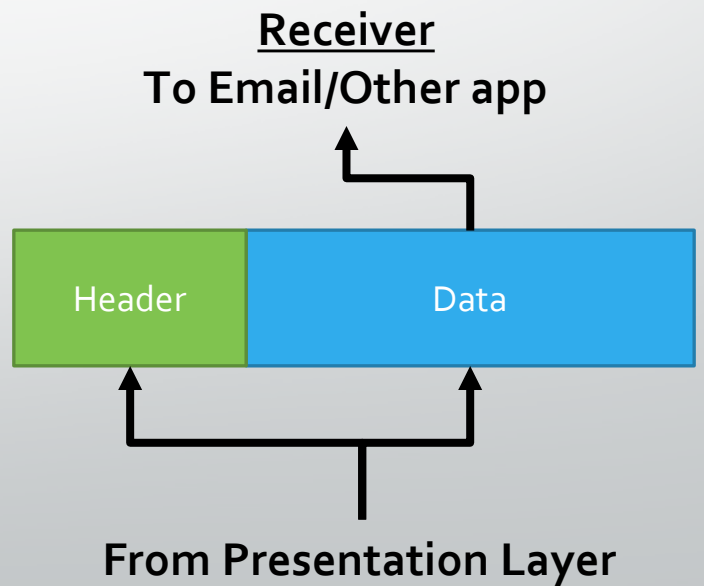
An exchange using the OSI Model



Application Layer

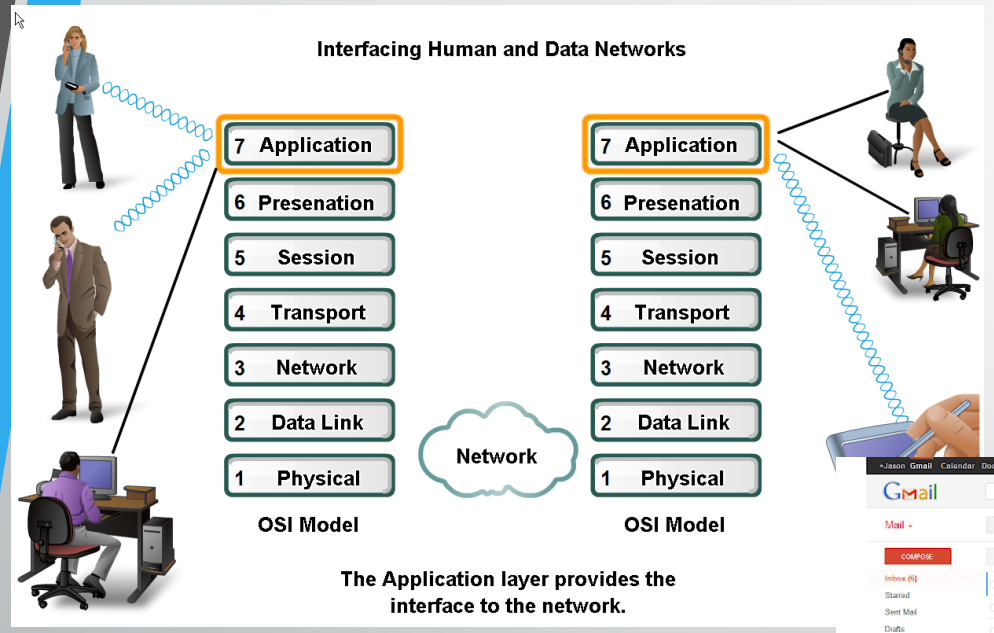
- The 7th Layer of OSI Model





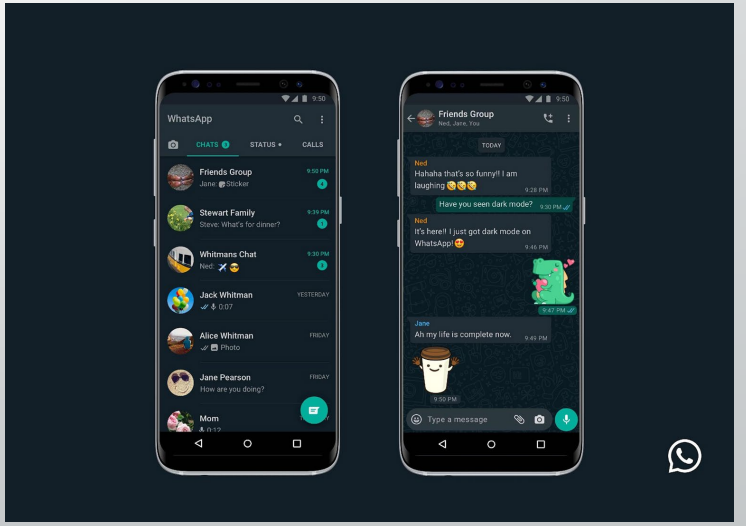
Applications

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

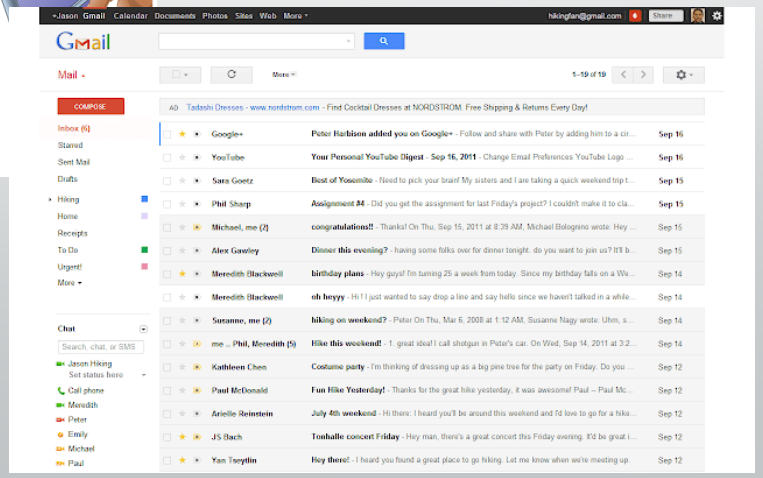


Browsers

Instant Messaging



Email



Examples: Application Layer Protocols

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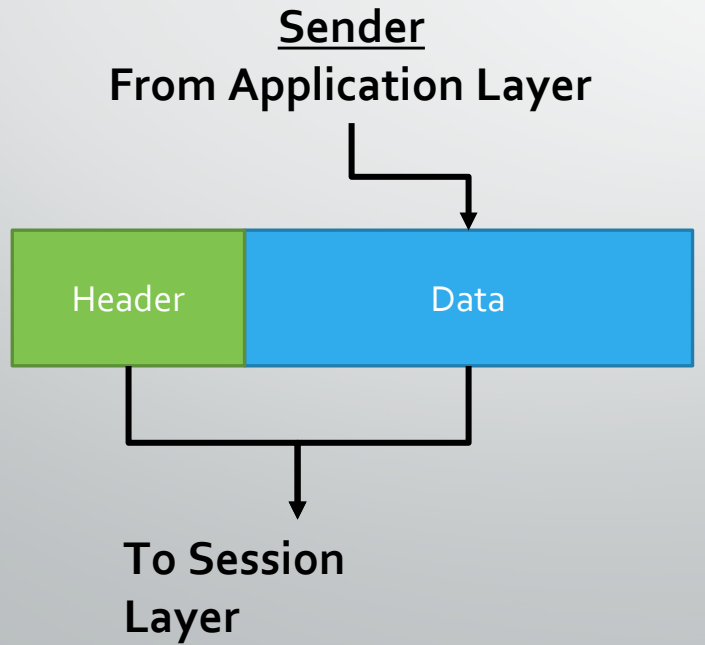
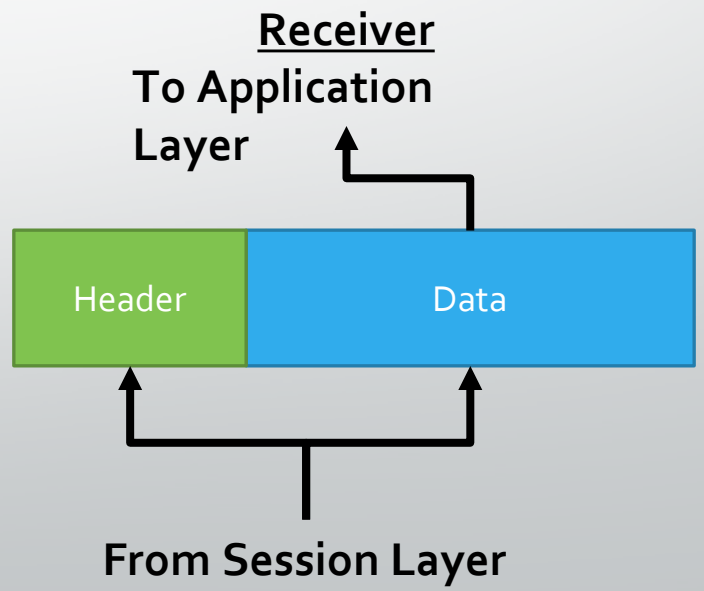
Application Layer	Name System	Host Config	Email	File Transfer	Web
	DNS	BOOTP	SMTP	FTP	HTTP
		DHCP	POP	TFTP	HTTPS
			IMAP		

Presentation Layer

- The 6th Layer of OSI Model



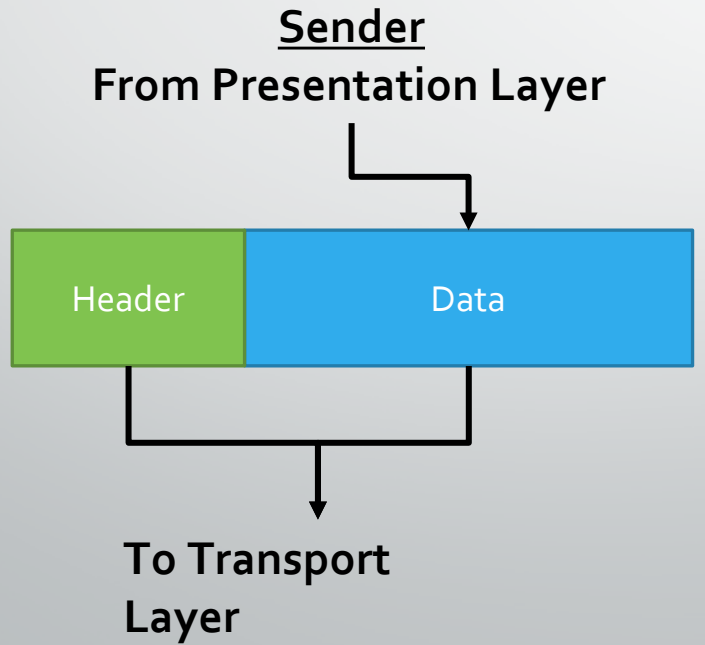


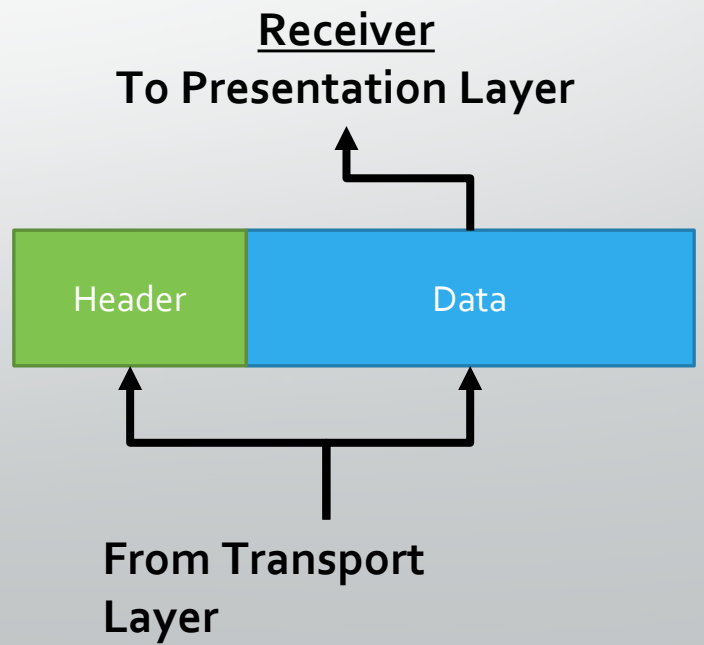
Presentation Layer

- 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

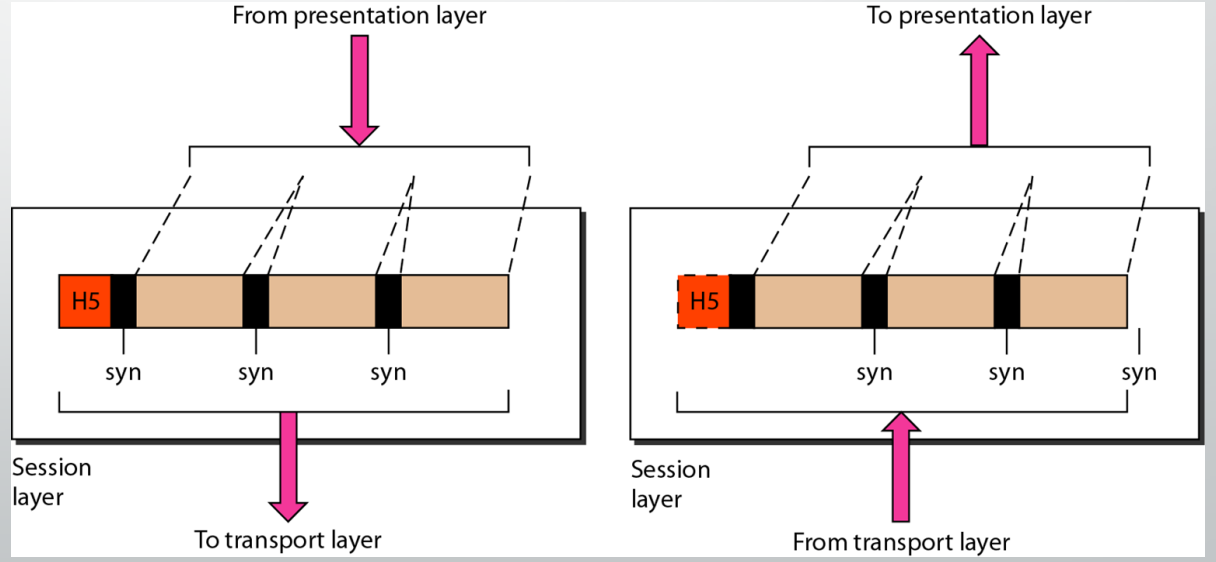




Session Layer

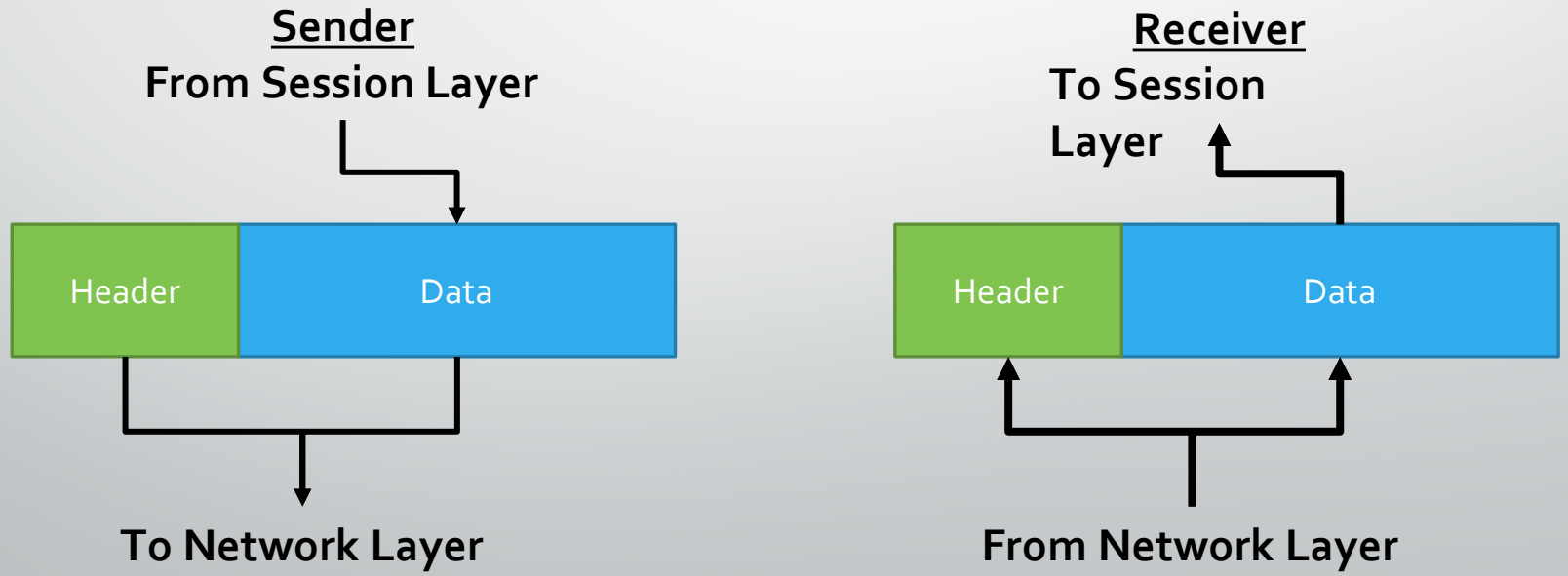
- The session layer is responsible for dialog control and synchronization.
- It handles the exchange of information
  - to initiate dialogs
  - keep them active, and
  - to restart sessions that are disrupted or idle for a long period of time

- Most applications, like web browsers or e-mail clients, incorporate functionality of the OSI layers 5, 6 and 7.



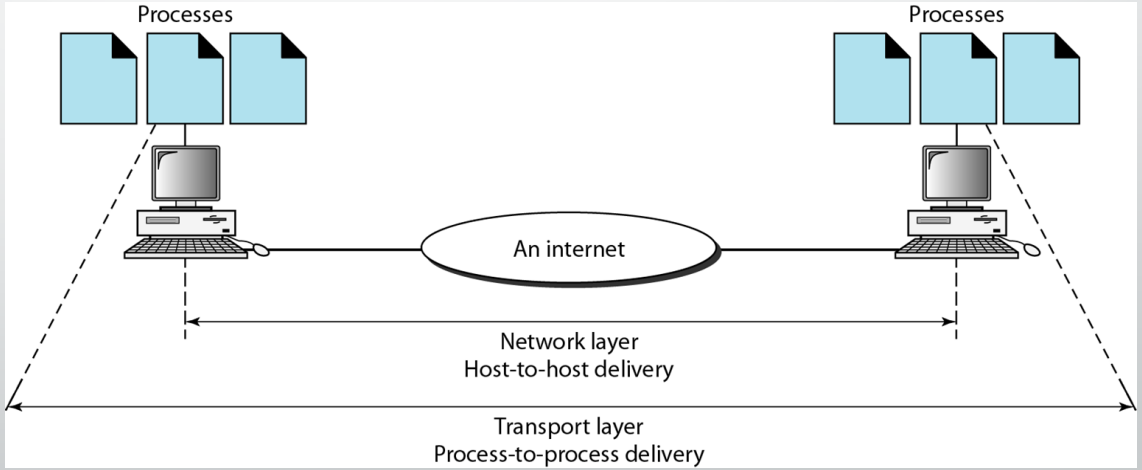
Transport Layer

- 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



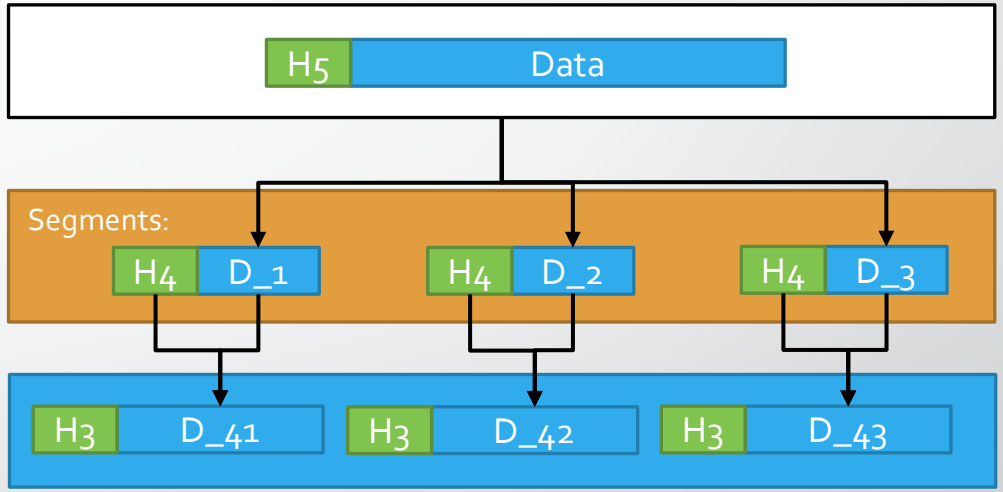
Notes

- 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



Legend

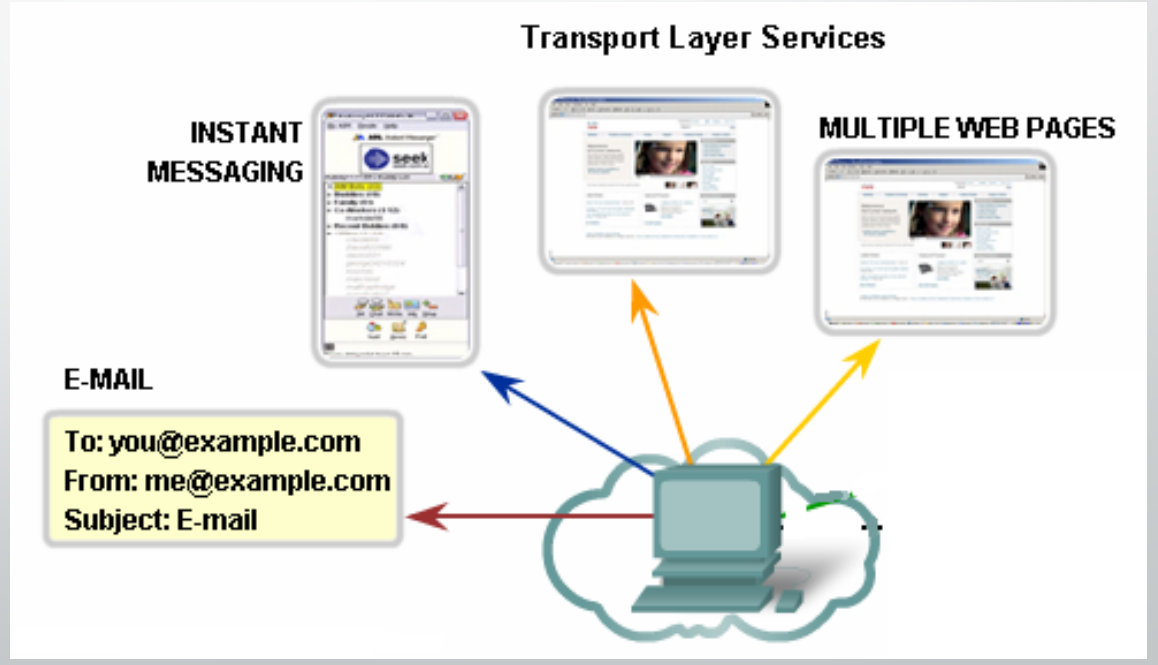
Session Layer

Transport Layer

Network Layer

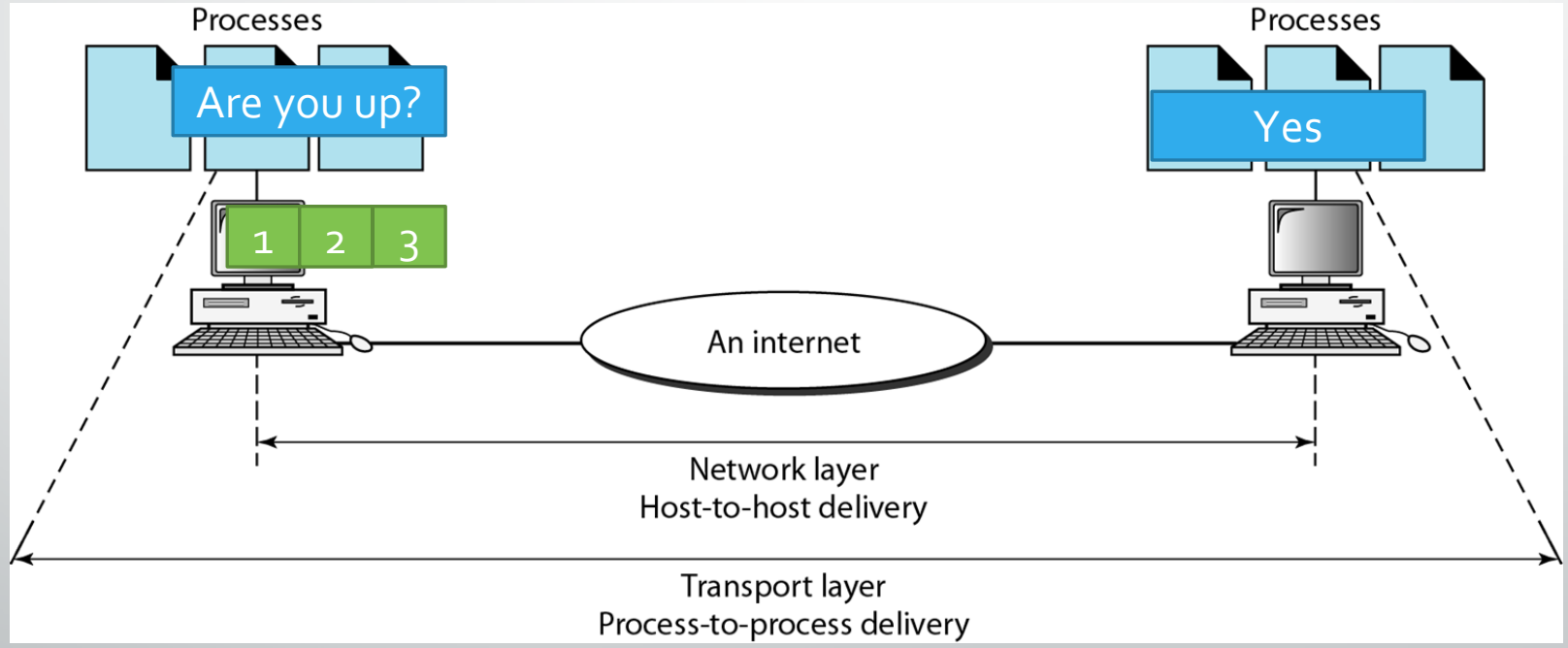
Function – Identification Using Port Address

- 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

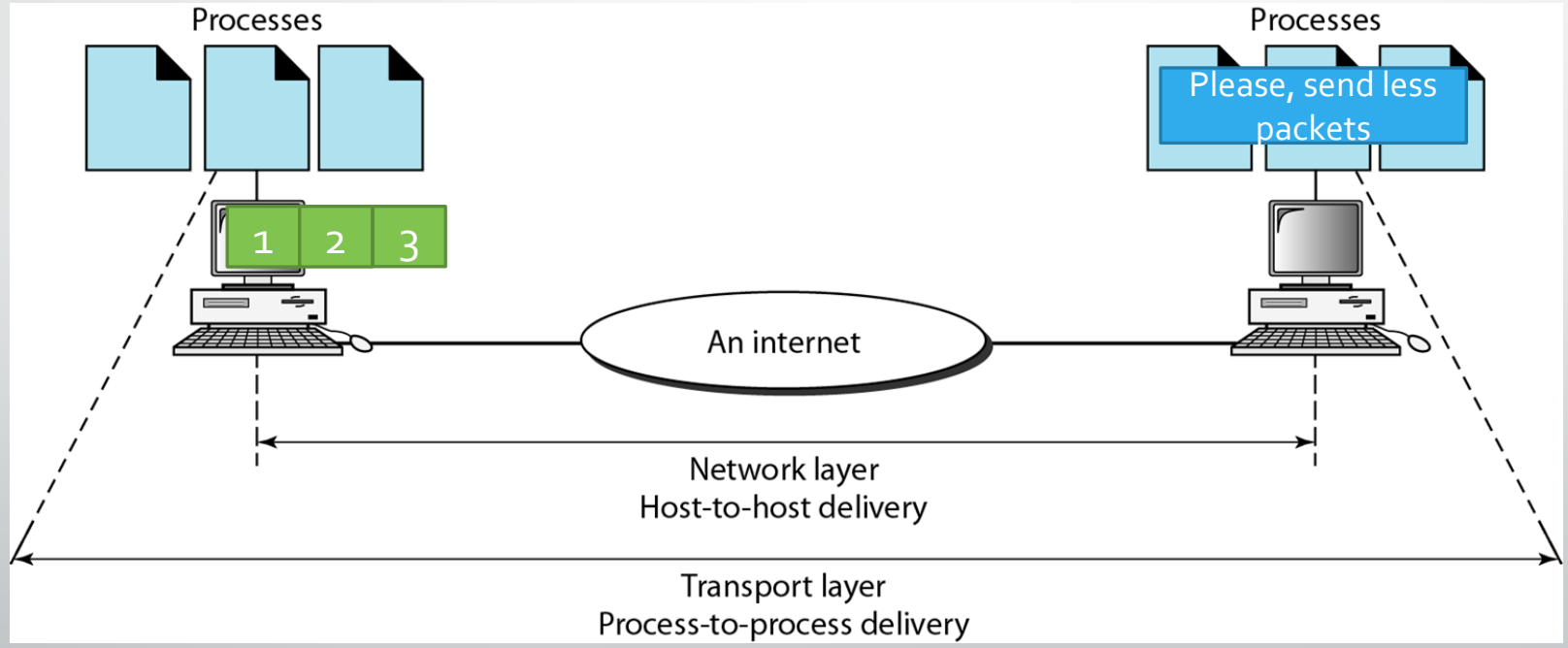
- Establishes secure connection (TCP – Three Way Handshake)



Function – Flow Control

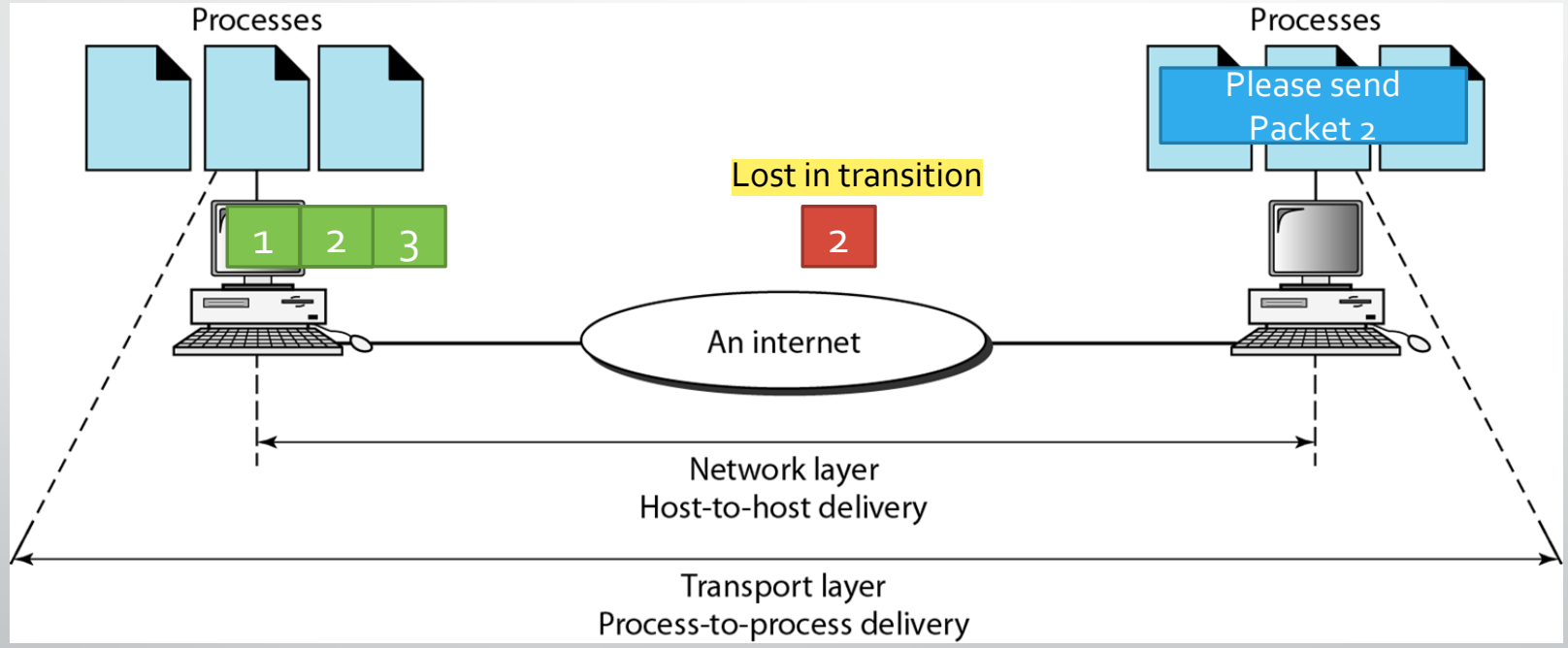
- Establishes secure connection (TCP – Three Way Handshake)

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

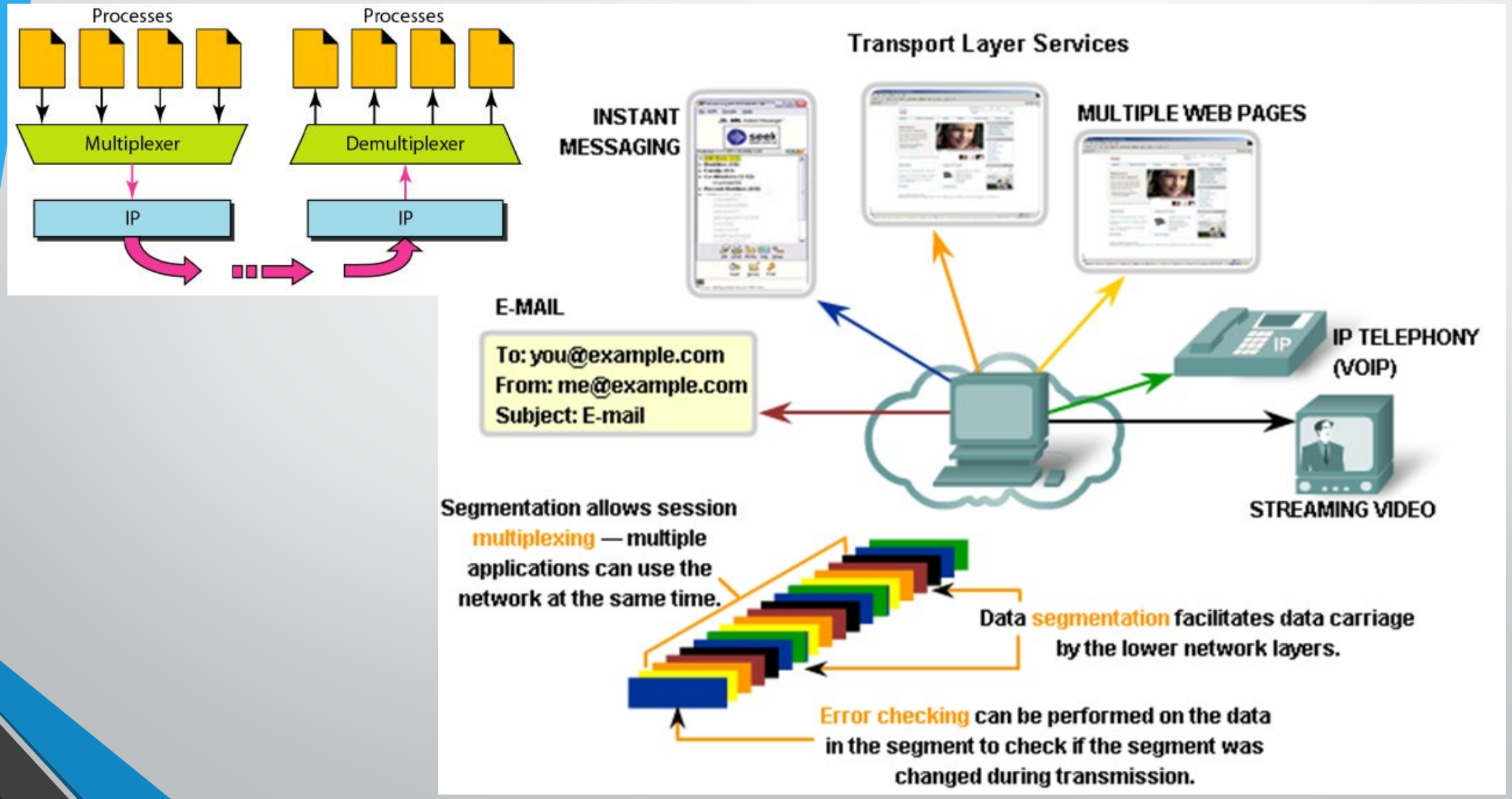


Function – Error Control

- Establishes secure connection (TCP – Three Way Handshake)

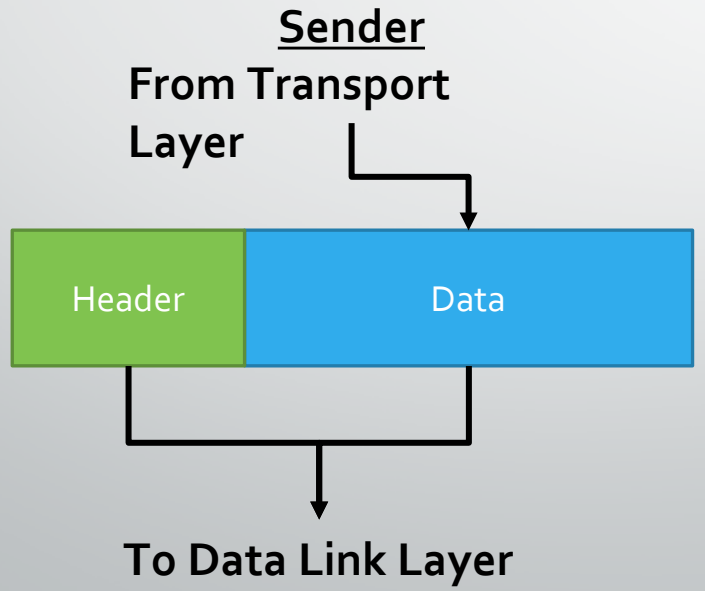


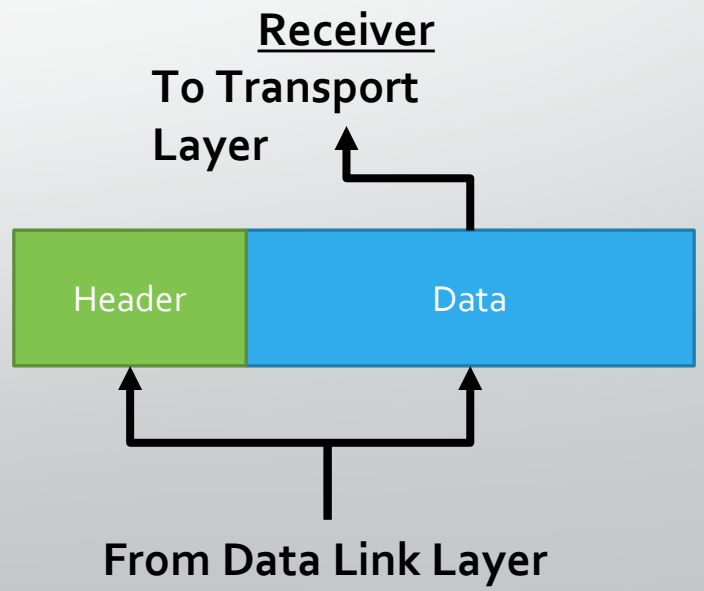
Function – Multiplexing



Network Layer

- The 3rd Layer of OSI Model





Network Layer

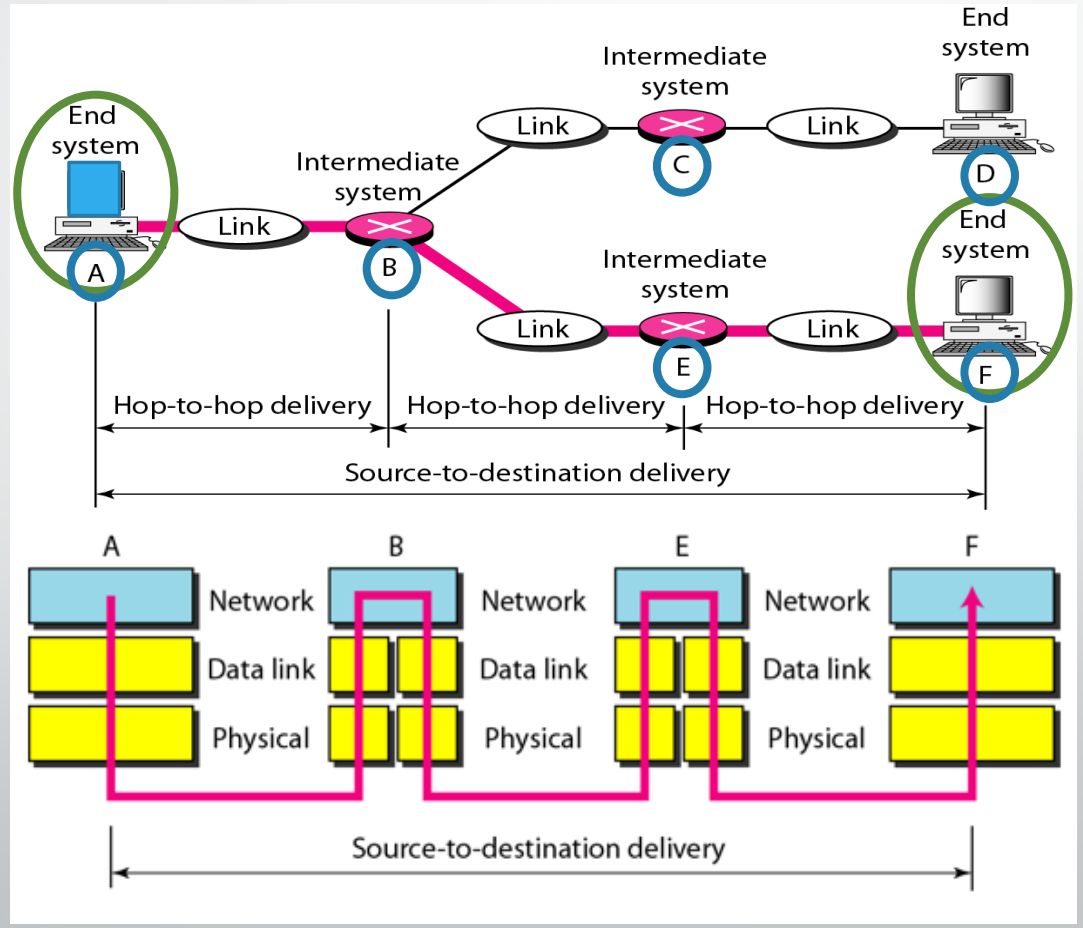
- Network Layer PDU is called **Packet**.
- The network layer is responsible for the delivery of individual packets from the **source host** to the **destination host**.
- Common Network Layer Protocol is called **Internet Protocol (IP)**
- Functions :
  - Adds an address (Logical Address) to identify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

Network Layer – Logical Address

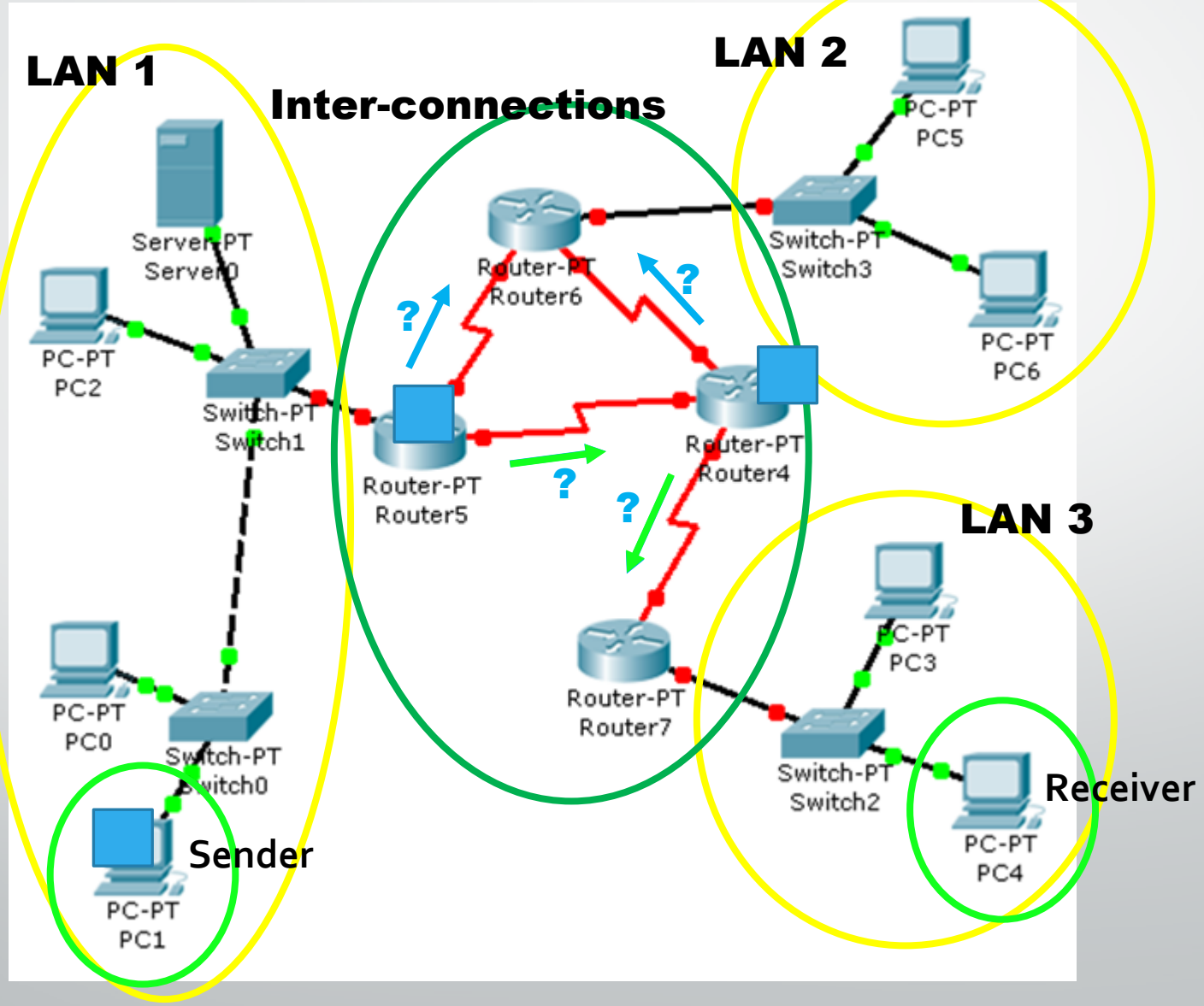
- Universal address, each host uniquely defined.
- 32-bit address also known as IP Address.
  - The bits are written in dotted decimal notation. Each decimal represented by 8 bits.
  - Example: 192.168.10.1
- Independent of underlying physical networks.

Network Layer - Example

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

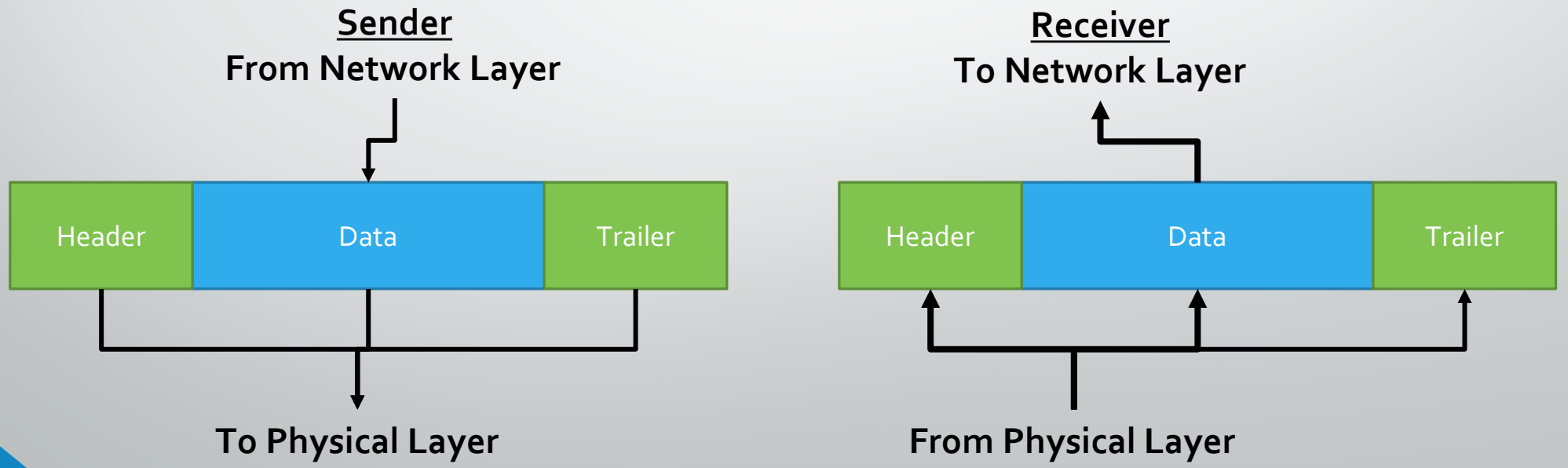


Network Layer – Another Example



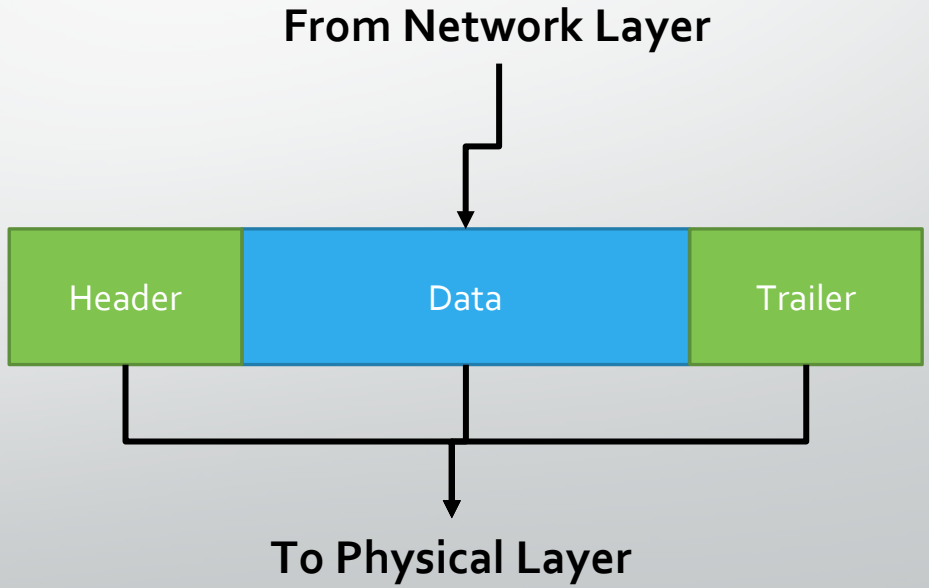
Data Link Layer

- The 2nd Layer of OSI Model

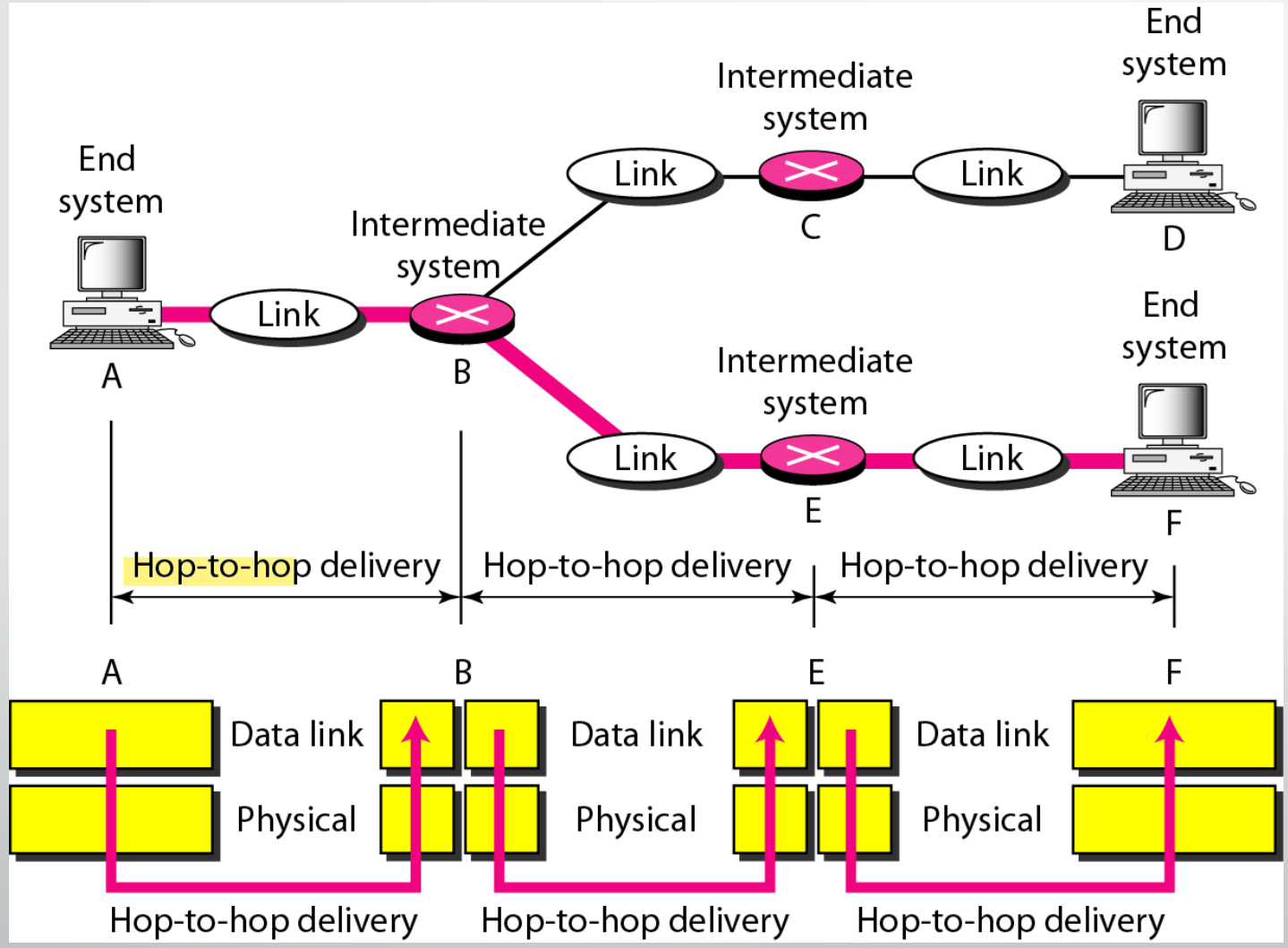


Data Link Layer Layer

- 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

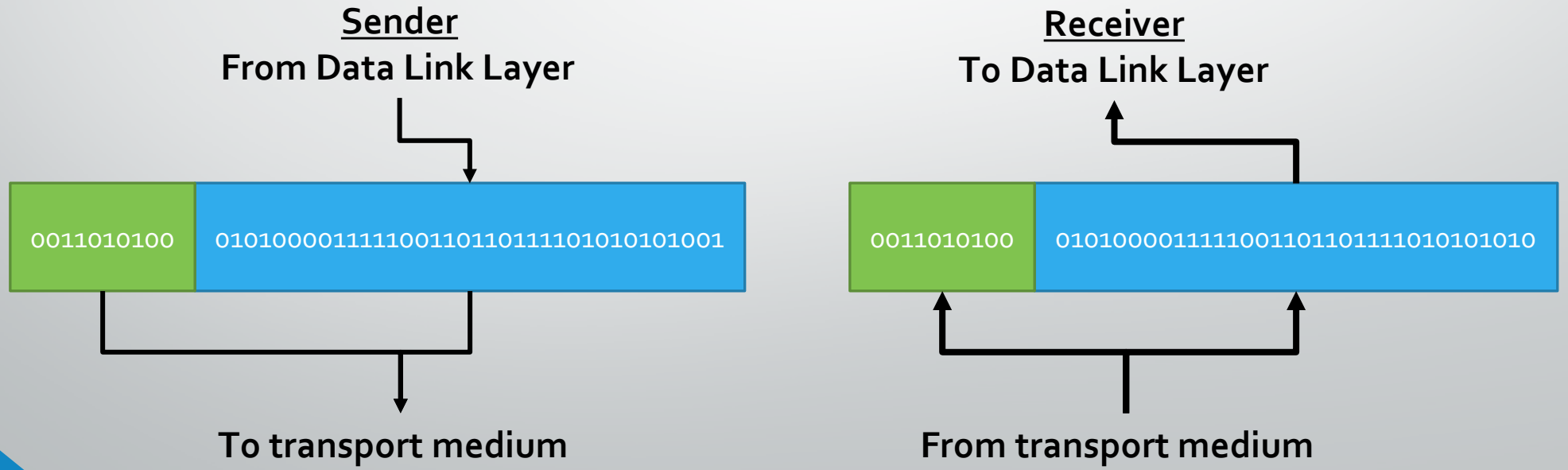


Data Link Layer – Physical Address

- 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

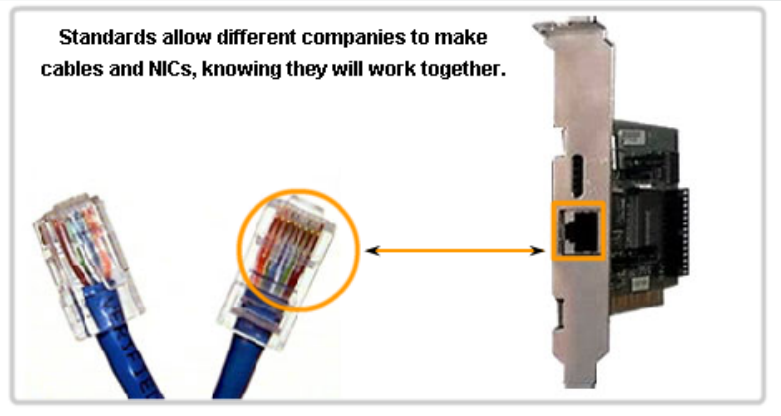
Physical Layer

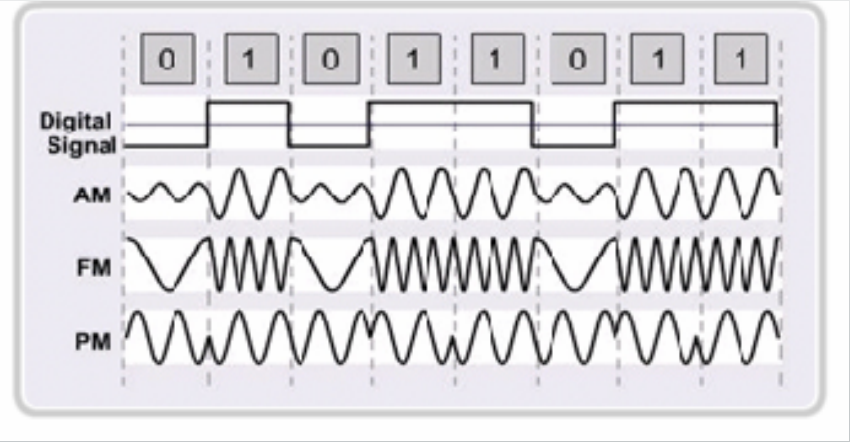
- The 1st Layer of OSI Model



Physical Layer

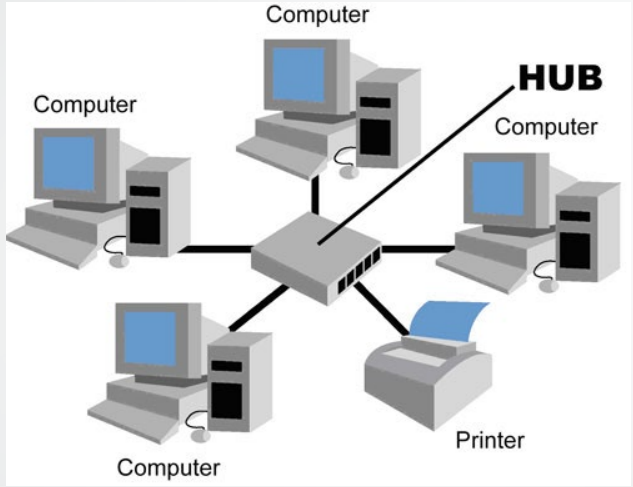
- The physical layer is responsible for movements of individual bits from one hop (node) to the next.
- Functions
  - Physical Characteristics of interfaces and medium.
  - Representation of bits
  - Data Rate
  - Synchronization of bits

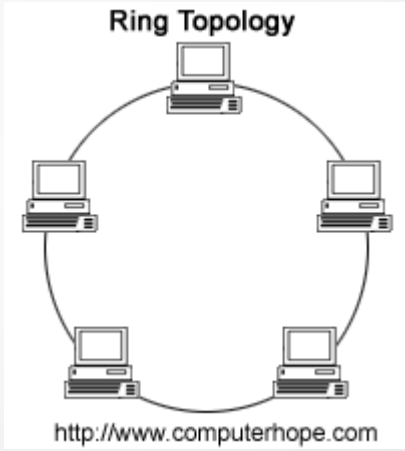




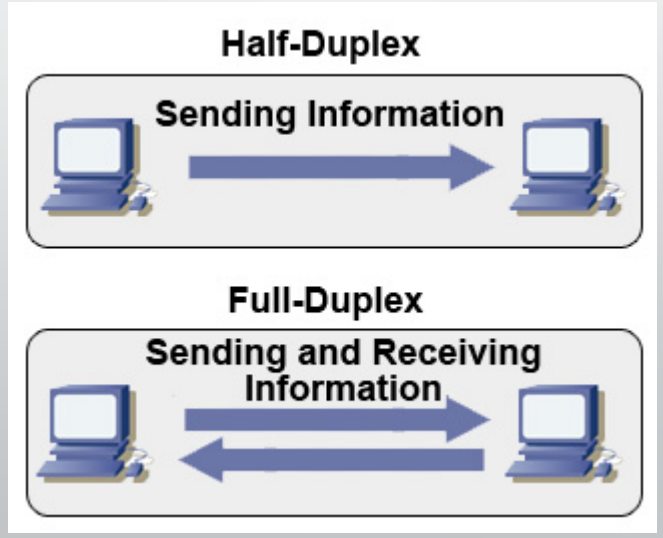
Physical Layer

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

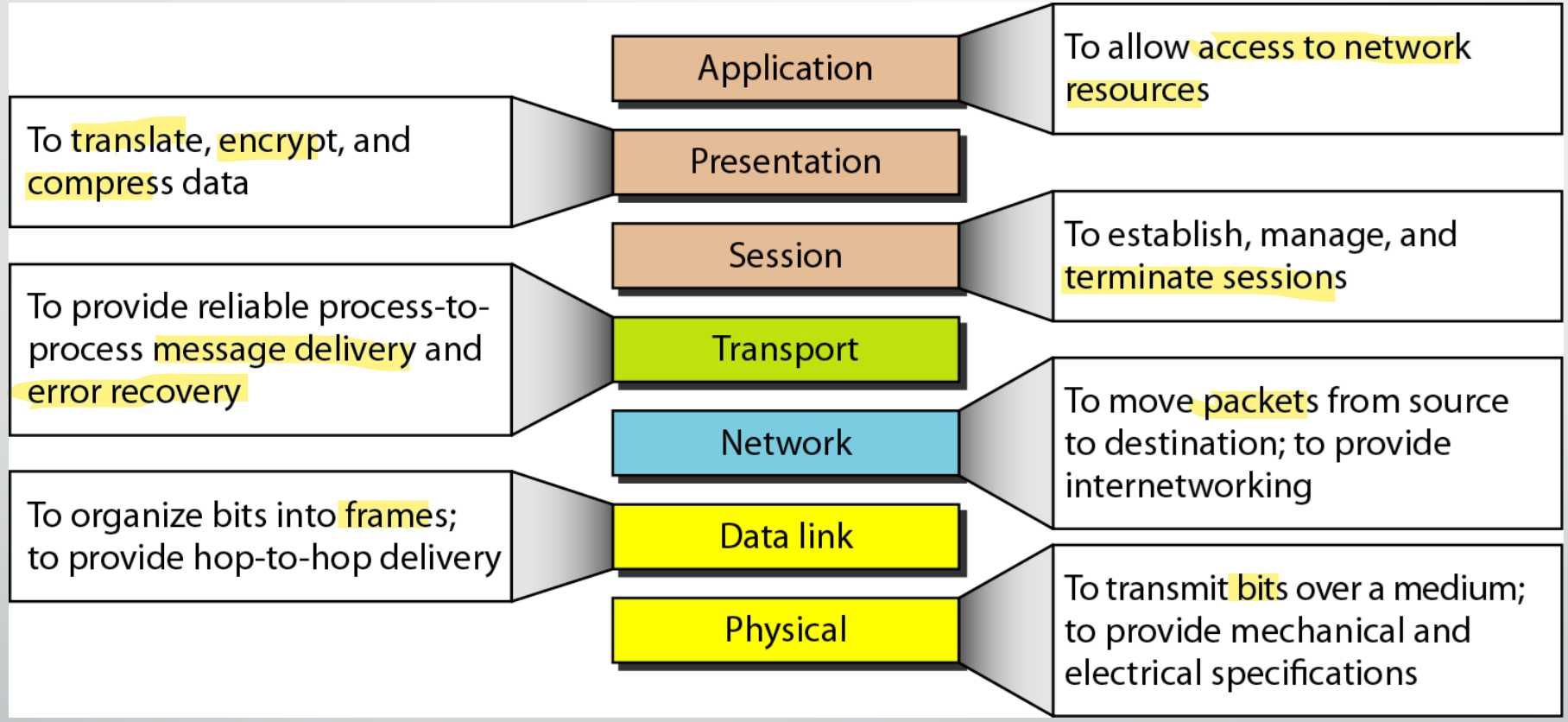




- Transmission Modes
  - Simplex
  - Half Duplex
  - Full Duplex



Summary of OSI Layers



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TCP/IP Model

De Facto Standard

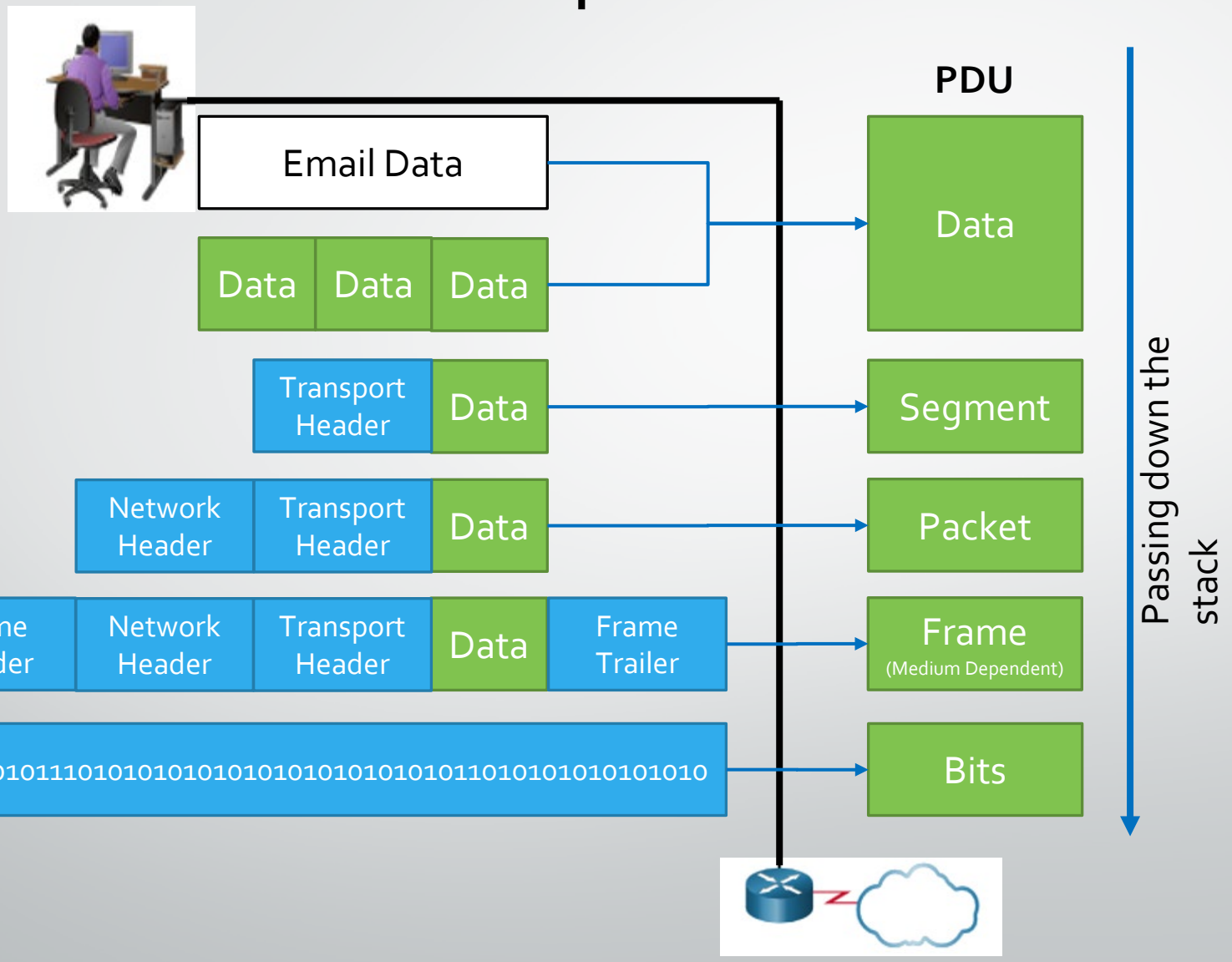
OSI Model		TCP/IP Model
7	Application	Application
6	Presentation	
5	Session	
4	Transport	Transport
3	Network	Internet
2	Data Link	Network Access
1	Physical	

TCP/IP Model

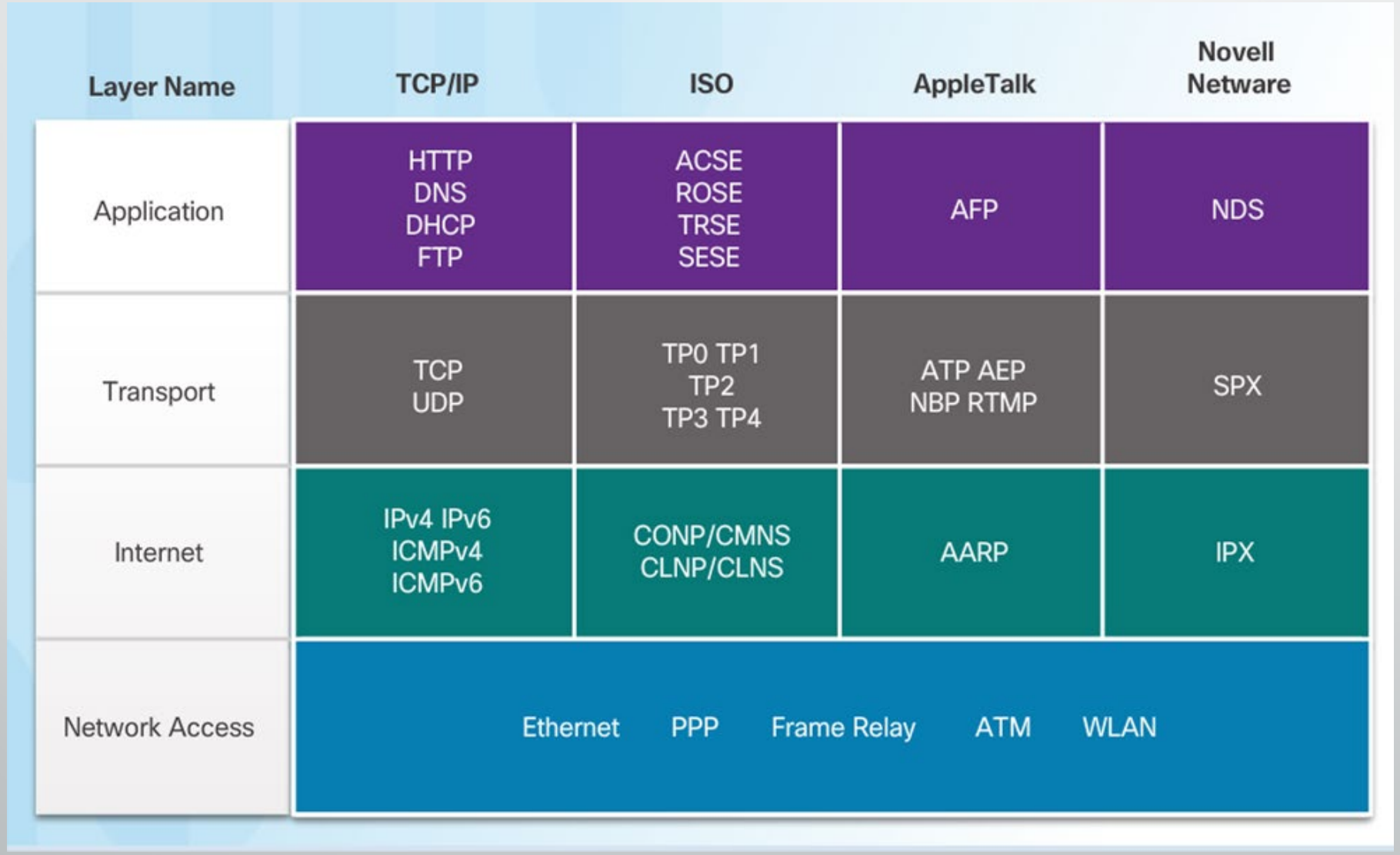
- Developed by the US Defense Advanced Research Project Agency (DARPA) for its packet switched network (ARPANET)
- Used by the global Internet.
- Also known as **De Facto Standard.**

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

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			

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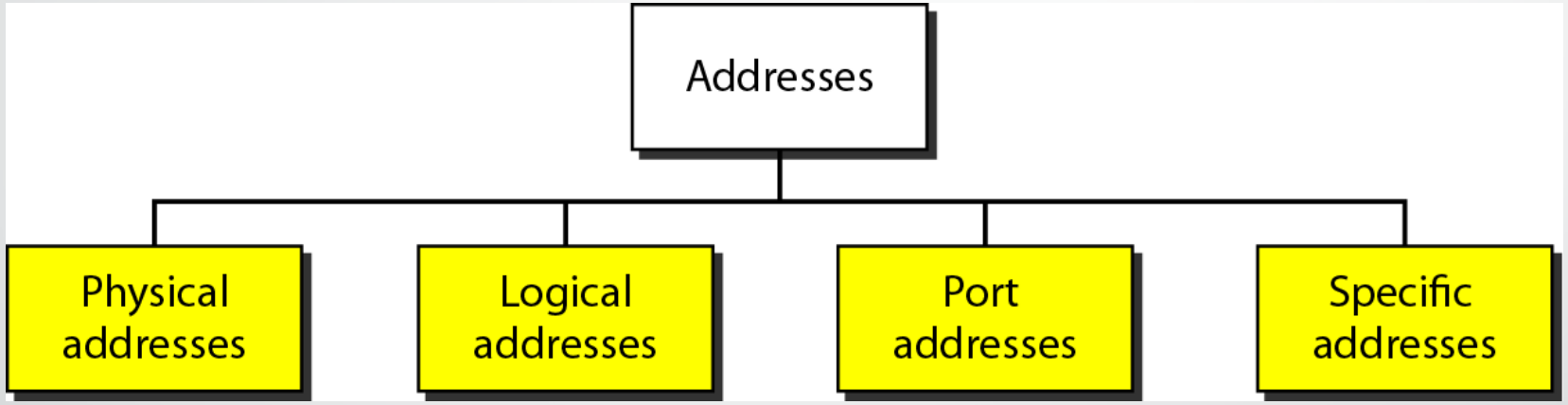
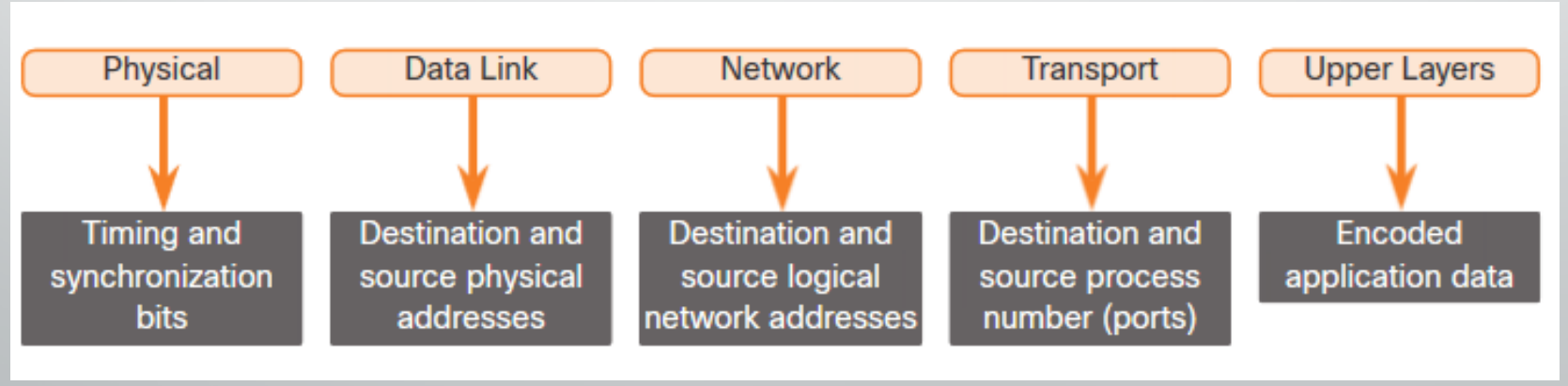
Addressing in Networking

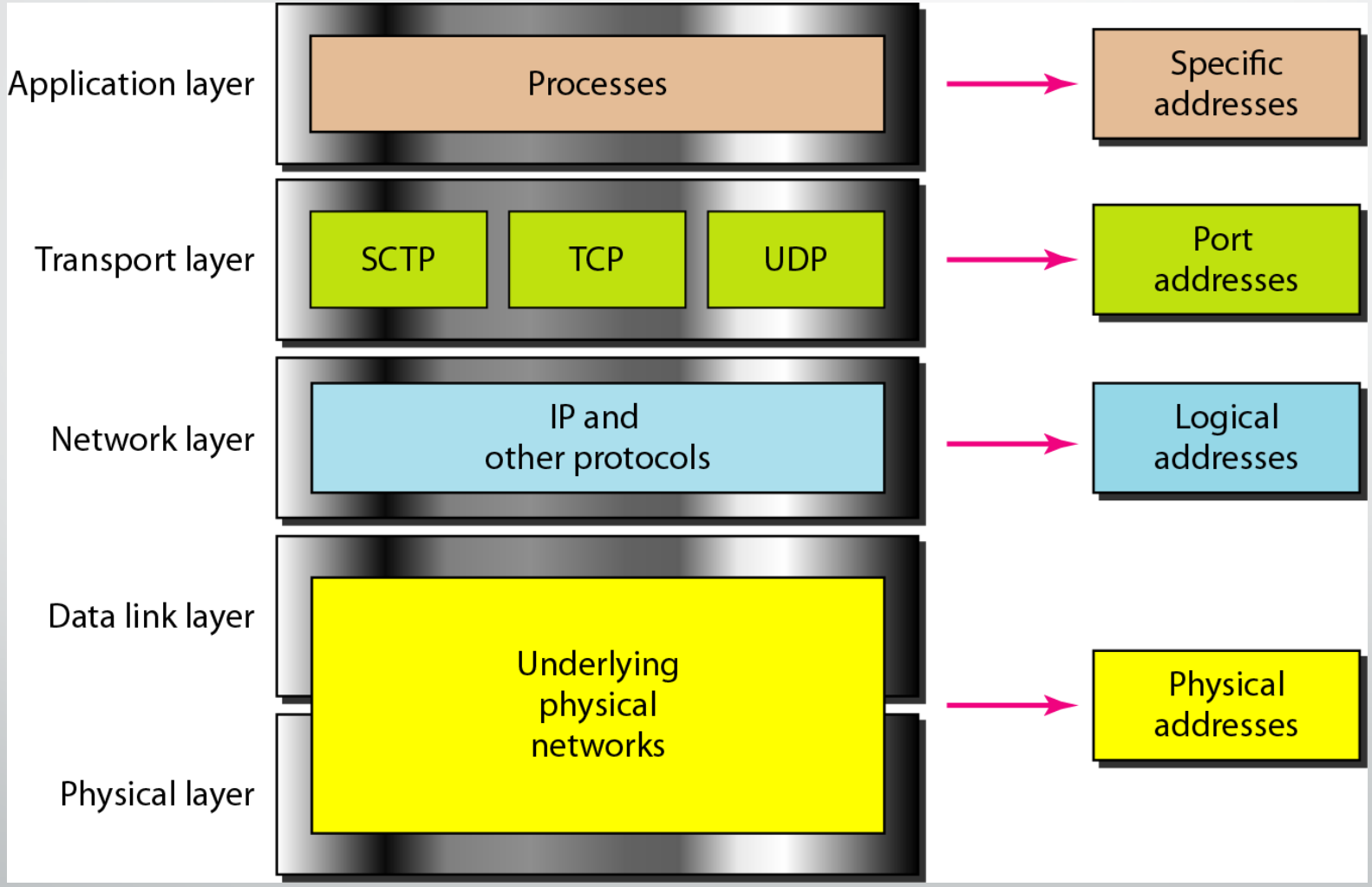
Addressing - Summary

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





Relationship of layers and address in TCP/IP

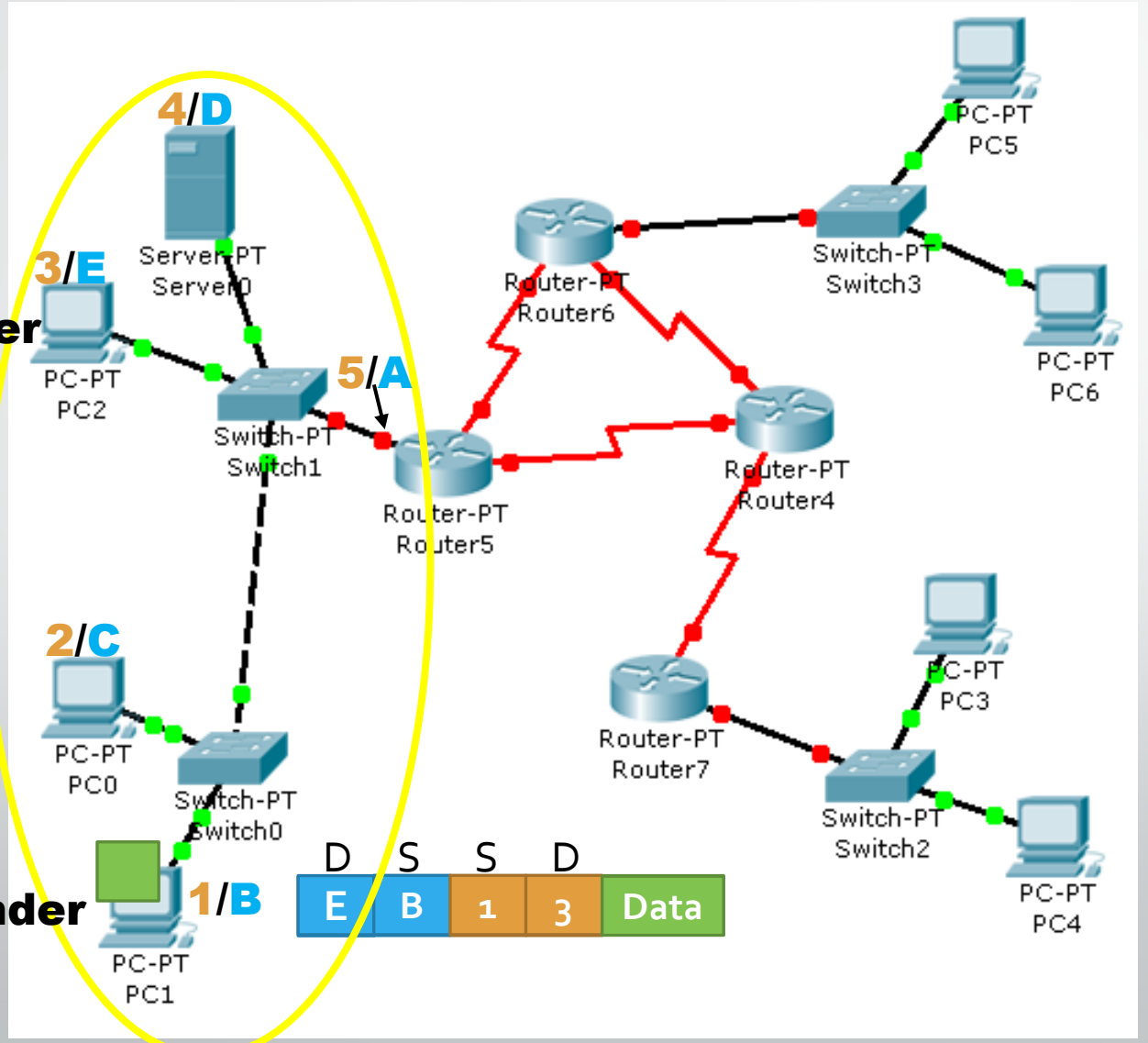


Addresses

- Specific Address
  - Applications having user friendly addresses.
  - Email addresses or URLs.
    - john@gmail.com or www.bracu.ac.bd
  - Theses 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**)*

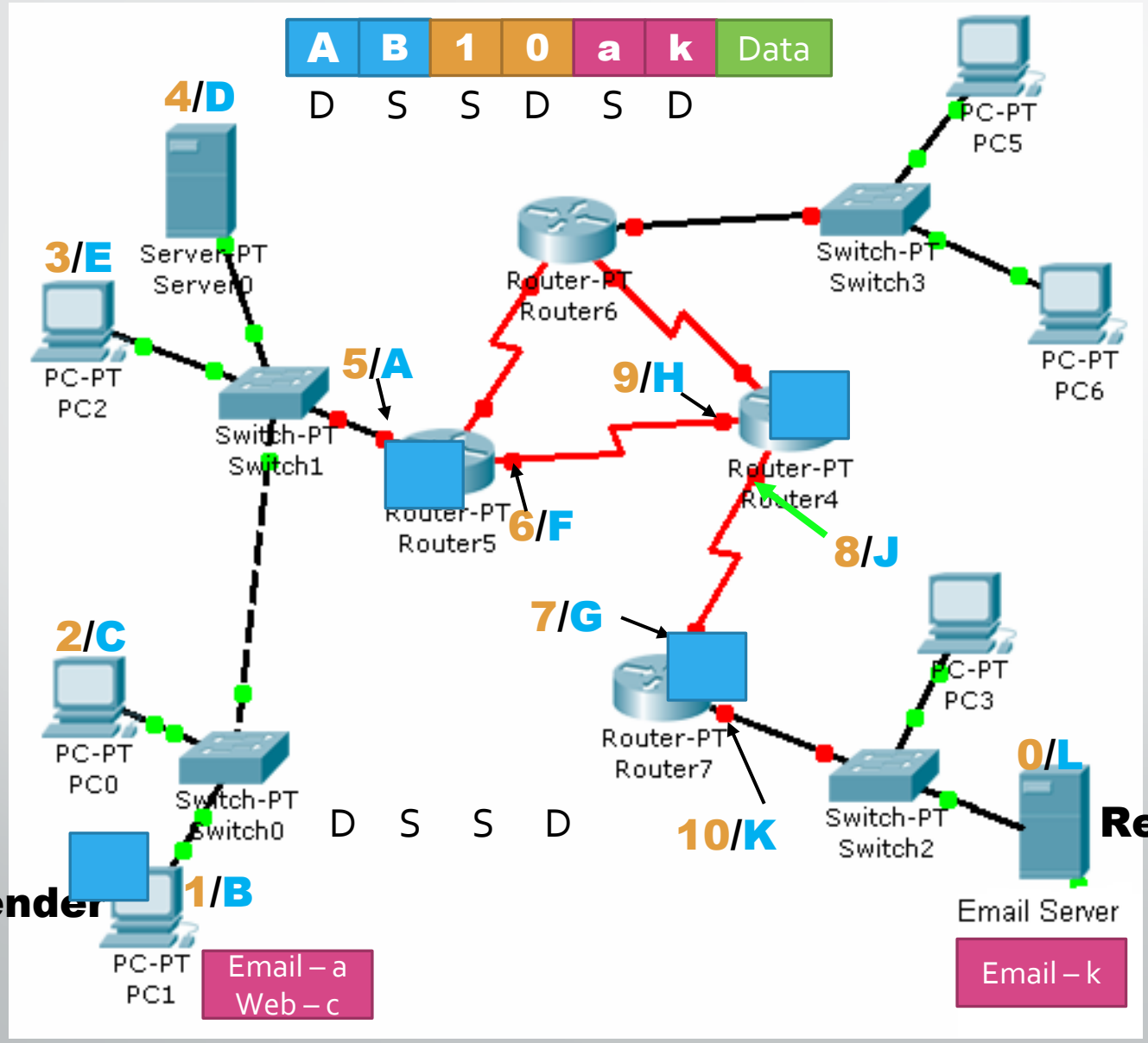
Logical and Physical Address – Same Network



Legend:

- IP Addresses – **Numbers**
- MAC Address – **Alphabets**

Port, Logical & Physical Address – Different Network

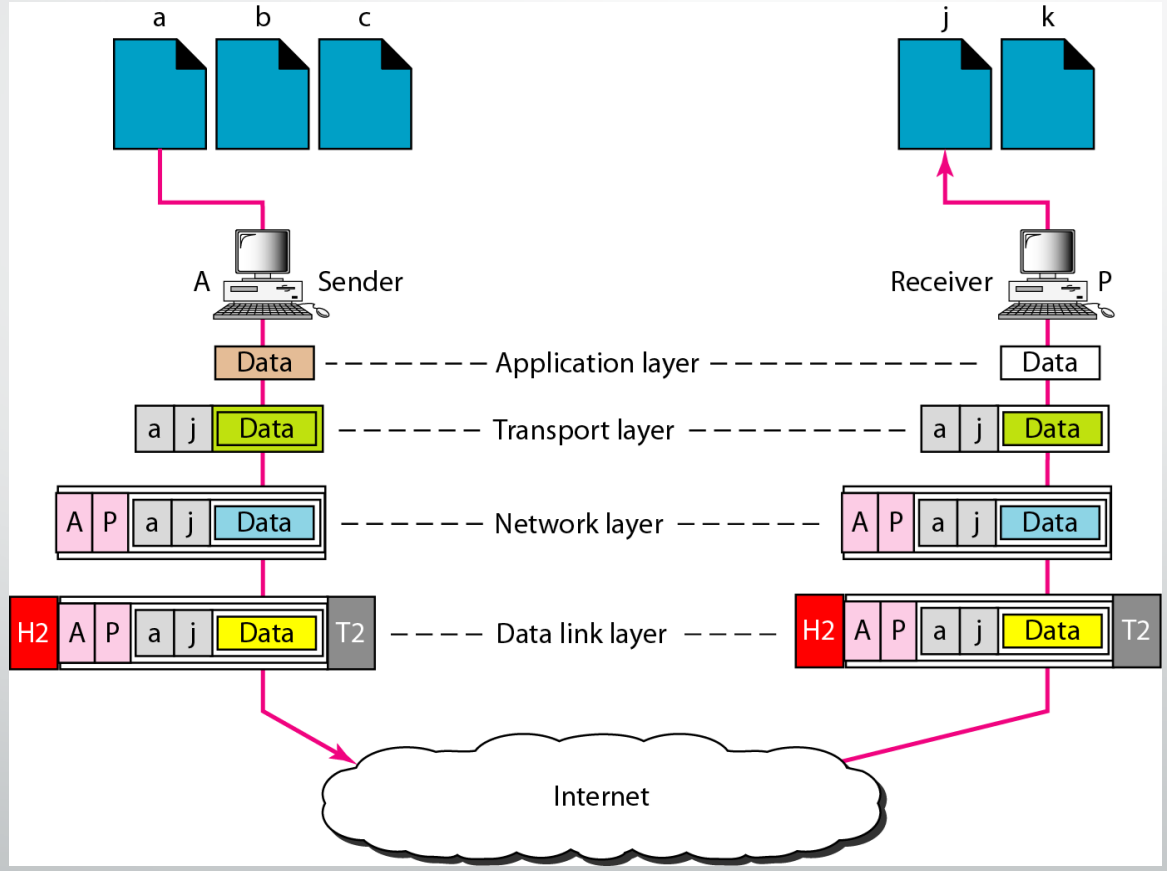


Legend:

- IP Addresses – **Numbers**
- MAC Address – **Capital Alphabets**
- Port Address – **Small Alphabets**

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.