Data Communication Network
DAY – 3

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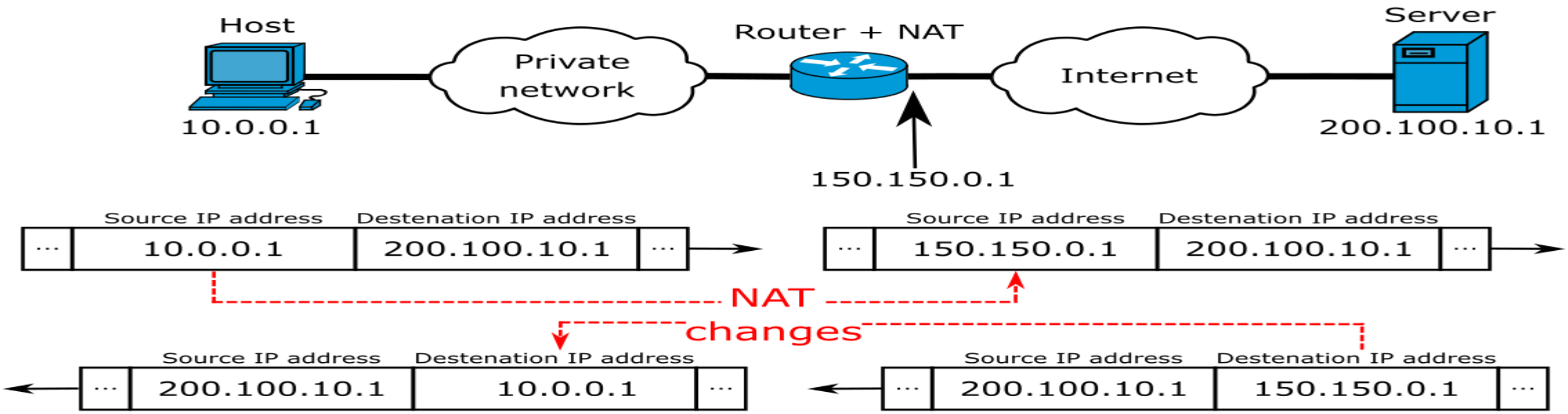
Network Address Translation (NAT)

Network Address Translation

- NAT is to allow multiple devices to access Internet through a single public address. To achieve this, translation of private IP address to a public IP address is required.
- **Network Address Translation (NAT)** is a process in which one or more local IP address is translated into one or more Global IP address and vice versa in order to provide Internet access to the local hosts.



Protocol

Protocol and Standards

- ***Protocols define the format and order of messages sent and received among network entities, and actions taken on message transmission and receipt.***
- A protocol defines what, how, when it communicated.
- **The key elements of a protocol :**
  - **syntax :** structure and format of the information data
  - **Semantics:** meaning of each section of bits. an route identify the route to be taken or the final destination of the message
  - **Timing:** when data should be sent and how fast it should be sent

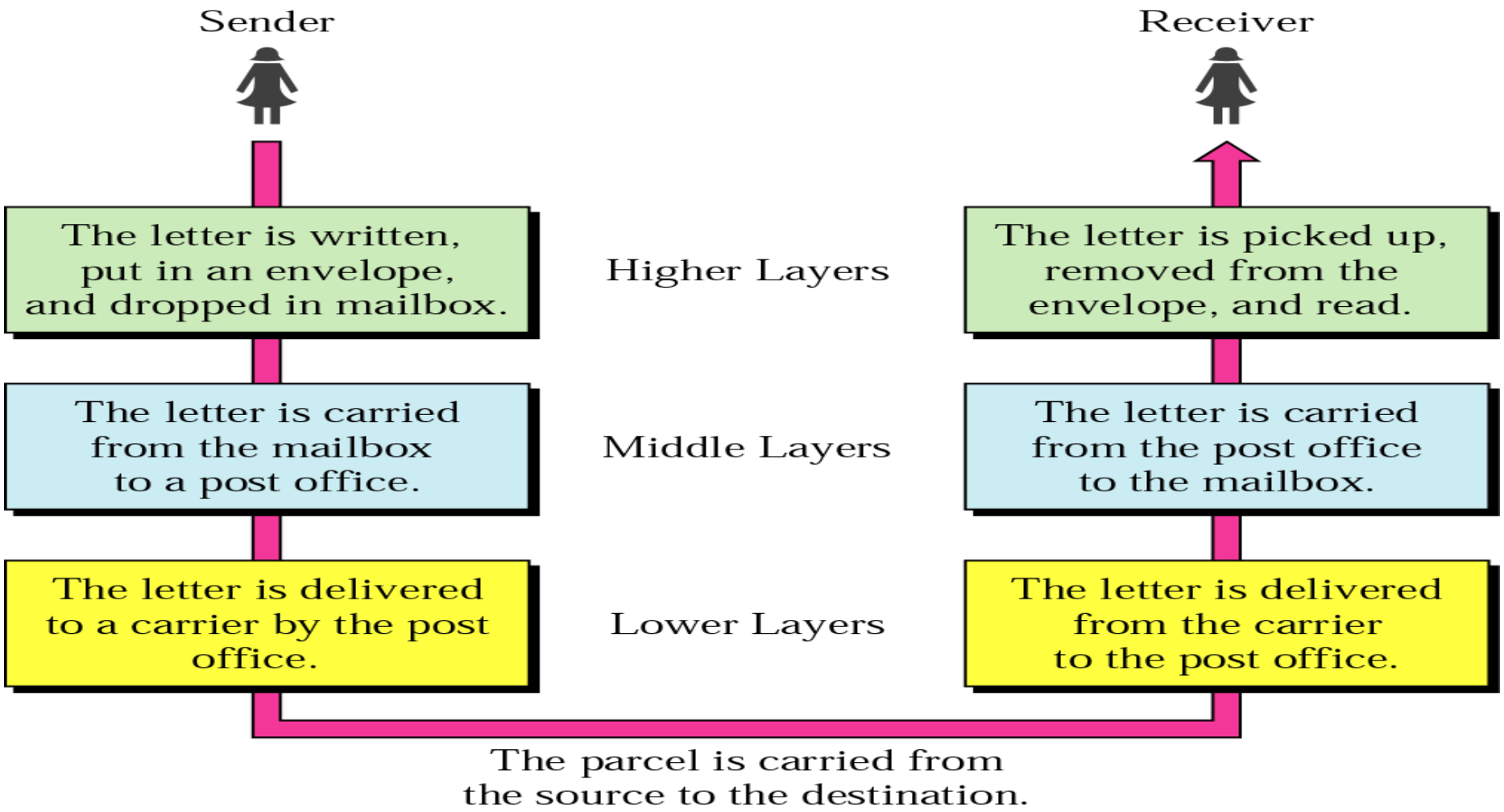
Standards

- Standards are developed by cooperation among standards creation committees, forums, and government regulatory agencies.
- Standards Creation Committees
  1. International Standards Organization (ISO)
  2. International Telecommunications Union (ITU)
  3. American National Standards Institute (ANSI)
  4. Institute of Electrical and Electronics Engineers (IEEE)

Network Models

- To make communications efficient, many components are involved, each with a specific function or service
- Tasks:
  - Hierarchy
    - The complex task is broken into smaller subtasks
  - Services
    - The higher layer uses the services of the lower layer

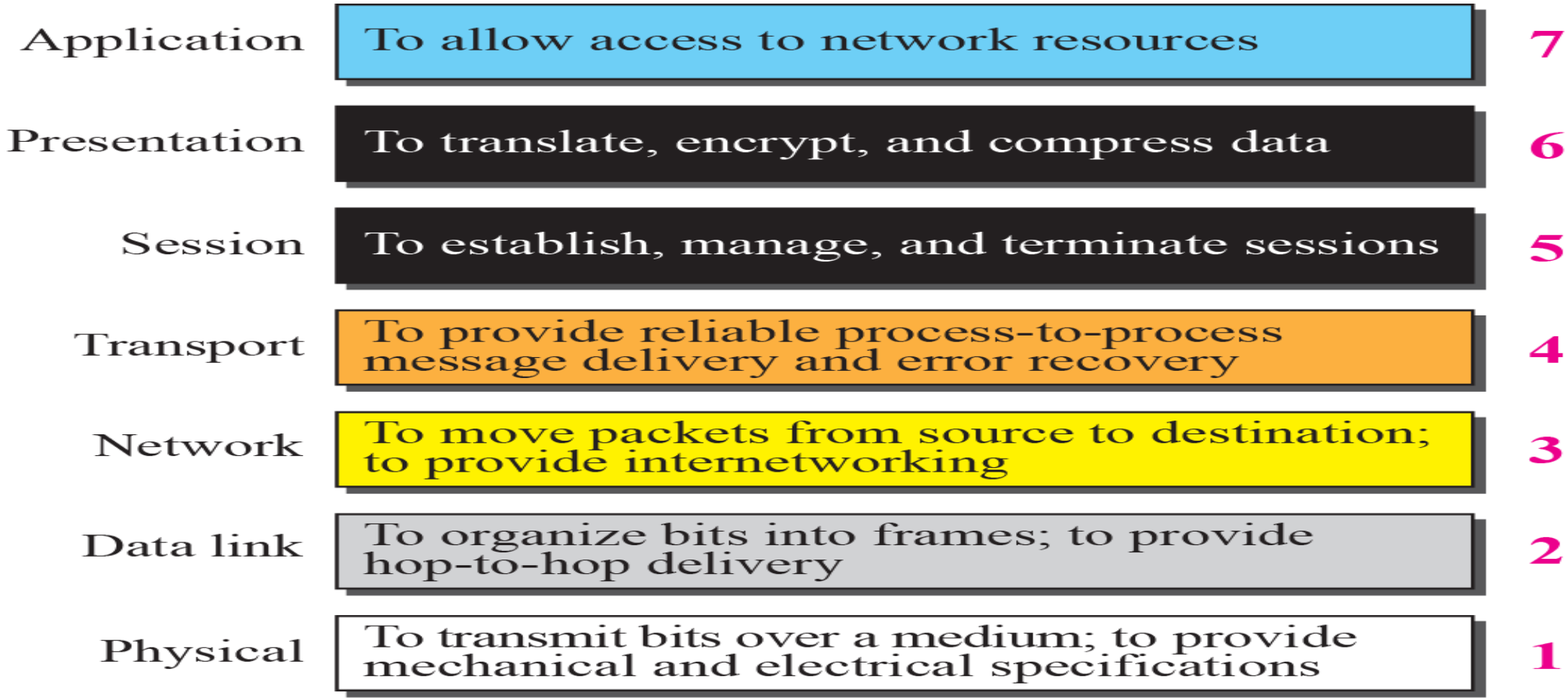
Example of Sending Letter



OSI Model & Layers

- Established in 1947, **the International Standards Organization (ISO)** is a multinational body dedicated to worldwide agreement on international standards.
- We can not see standard but we can represent them.
- An ISO standard that covers all aspects of network communications is the **Open Systems Interconnection (OSI)** model.
- OSI model is now considered the primary Architectural model for inter-computer communications.
- **Term "open" denotes the ability to connect any two systems which conform to the reference model and associated standards.**

OSI Layers


Application
To allow access to network resources
7
Presentation
To translate, encrypt, and compress data
6
Session
To establish, manage, and terminate sessions
5
Transport
To provide reliable process-to-process message delivery and error recovery
4
Network
To move packets from source to destination; to provide internetworking
3
Data link
To organize bits into frames; to provide hop-to-hop delivery
2
Physical
To transmit bits over a medium; to provide mechanical and electrical specifications
1

Application Layer

- Interacts with application programs and is the highest level of OSI model.
- contains management functions to support distributed applications.
- enables the user, whether human or software, to access the network
- Examples : browser , applications such as file transfer, electronic mail, remote login etc.
- Protocols
  - http [80]: hyper text transfer protocol
  - https [443]: secure hyper text transfer protocol
  - ftp [20/21]: file transfer protocol
  - Smtp (25) : simple mail transfer protocol
  - Pop3 (110) : post office protocol
  - telnet(23) : used to connect to the remote machine
  - ssh [22]: secure shell
  - dns (53) : domain name service (used to get the IP address from the domain name)

Presentation Layer

Translation

- **On sender side : translates from ASCII to EBDIC (Extended Binary Coded Decimal Interchange Code)**
- **On receiver side: translates from EBDIC to ASCII**

Encryption/Decryption

- **Plain Text to Cipher Text**
- **Algorithms : RSA, SHA**

Compression / Decompression

- **Sender Side : Compression**
- **Receiver Side : Decompression**

Data Representation [Content-type] (Used to Decide Common File Formats)

- For text (plain: text/plain , html: text/html , json: application/json , xml: text/xml)
- For image (bmp: image/bmp , png: image/png, jpg: image/jpg , jpeg: image/jpeg)
- For audio & Video (wave: audio/wav, mp3: audio/mp3, mp4: video/mp4, fllv: video/flv

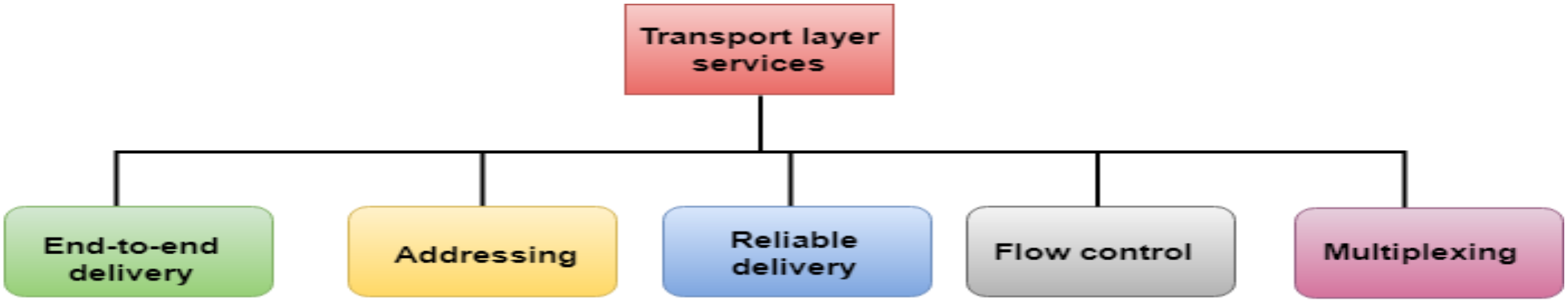
Session Layer

- **To start/manage/terminate the session.**
  - how to start, control and end conversations (called sessions) between applications.
  - log-on or password validation is also handled by this layer.
- **The session layer is the network *dialog controller.***
  - mechanism for controlling the dialogue between the two end systems and synchronization.
  - Allows the communication between two processes to take place in either half duplex (one way at a time) or full-duplex (two ways at a time) mode.
- **Synchronization**
  - Session layer can also provide check-pointing mechanism such that if a failure of some sort occurs between checkpoints, all data can be retransmitted from the last checkpoint.
  - It establishes, maintains, and synchronizes the interaction among communicating systems.
- **Protocols**
  - SIP: session initiation protocol
  - NetBIOS : Network Basic Input Output Service
  - RPC: Remote Procedure Call

Transport Layer

- Most Important Layer of OSI
- Responsible **for process-to-process/ End to End delivery** of the entire message.
- Provide a reliable mechanism for the **exchange of data between two processes** in different computers.
- Segment
  - smaller part of session PDU
  - every segment contains sequence number
  - every segment contains checksum for error checking
  - Segment contains:
    - **data** (from the session layer PDU)
    - **sequence number** : used for re-assembling the segments on the receiver machine
    - **checksum :** used to check if the data is not damaged

Responsibilities of Transport Layer



End –to-End delivery

- The transport layer transmits the entire message to the destination

Addressing

- The transport layer provides the user address which is specified as a station or port.

Reliable delivery

- provides reliability services by retransmitting the lost and damaged packets
- Error control, sequence control, loss control, duplicate control.

Error Control

- performs the checking for the errors end-to-end to ensure that the packet has arrived correctly.

Flow Control

- Flow control is used to prevent the sender from overwhelming the receiver.
- If the receiver is overloaded with too much data, then the receiver discards the packets & ask for retransmission of packets.

Multiplexing

- uses the multiplexing to improve transmission efficiency.

Transport Layer Protocol

TCP

- Transmission Control Protocol (Reliable)
- connection oriented protocol
  - connection will kept alive till the data transfer in progress
- flow control, error checking and sequencing
- slower than UDP
- E.g. Email (no data loss)

UDP

- User Datagram Protocol (Unreliable)
- Connection Less Protocol
- does not provide error checking/ flow control
- Faster than TCP because no ACK only sending of data packets
- E.g: Online Games, Streaming

Network Layer

- The network layer is responsible for the source-to-destination delivery of a packet, possibly across multiple networks (links).
- It determines the route from the source to the destination and also manages the traffic problems such as switching, routing and controls the congestion of data packets.
- Segment Contains :
  - data
  - source IP address
  - destination IP address
- **Network Layer Responsibilities:**
  - Logical Addressing : The network layer translates the logical addresses into physical addresses
  - Routing : sending the data across the network
  - Internetworking : provides the logical connection between different types of networks
  - Fragmentation : breaking the packets into the smallest individual data units that travel through different networks.
- **Protocols :**
  - IP : internet protocol
  - IPx : internetwork packet exchange
  - ICMP : Internet Control Messaging Protocol
  - NAT : Network Address Translation
  - ARP : Address Resolution Protocol
  - PPP: Point to Point Protocol
- **Device** : Router

Data Link Layer

- Data link layer attempts to provide reliable communication over the physical layer interface.
- **DATA LINK Layer Responsibilities :**
  - **Framing:**
    - Breaks the outgoing data into frames and reassemble the received frames.
    - every frame contains (Source MAC address and Destination MAC address)
  - **Physical Addressing:**
    - uses MAC address to identify every NIC uniquely
  - **Flow Control:**
    - A flow control mechanism to avoid a fast transmitter from running a slow receiver by buffering the extra bit is provided by flow control. This prevents traffic jam at the receiver side.
  - **Error Control:**
    - Error control is achieved by adding a trailer at the end of the frame. Duplication of frames are also prevented by using this mechanism. Data Link Layers adds mechanism to prevent duplication of frames.
  - **Access Control:**
    - Protocols of this layer determine which of the devices has control over the link at any given time, when two or more devices are connected to the same link.
- **Protocols**
  - ARP(Address Resolution Protocol) : getting physical address from logical address
  - RARP: Reverse Address Resolution Protocol
- **Device :** Switch

Physical Layer

- Provides physical interface for transmission of information.
- Covers all - mechanical, electrical, functional and procedural - aspects for physical communication. Characteristics like voltage levels, timing of voltage changes, physical data rates, etc.
- send data in the form of 1's and 0's.
- senders and receivers clock must be synchronized.
- **Transmission mode:**
  - Defines direction of transmission simplex, half duplex and full duplex
- **Devices:**
  - NIC , Cables , hubs , repeaters , connectors

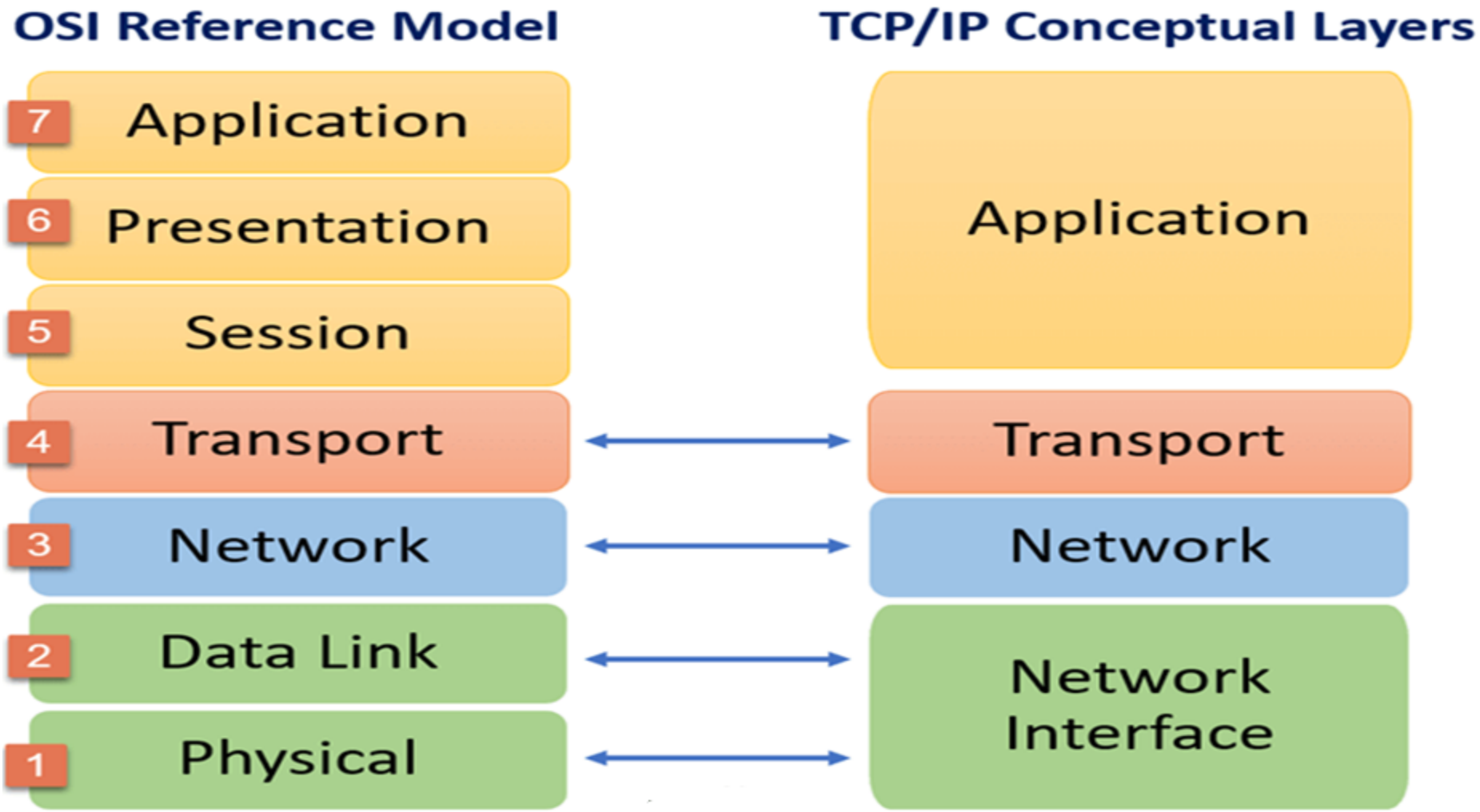
7 Layers of OSI Model

Application (PDU : Data)	• End user Layer • HTTP, FTP, IRC, SSH, DNS
Presentation (PDU : Data)	• Syntax Layer • SSL, SSH, IMAP, FTP, MPEG, JPEG
Session (PDU : Data)	• Synch and Send to port • API's, Sockets
Transport (PDU : Segment)	• End to end Connections • TCP , UDP
Network (PDU : Packet)	• Packets • IP, ICMP, IPSec, IGMP
Data Link (PDU : Frame)	• Frames • Ethernet, PPP. Switch, Bridge
Physical (PDU : Bits)	• Physical Structure • Coax, Fiber, Wireless, Hubs, Repeaters

OSI and TCP/IP Model

- OSI model is a generic model that is based upon functionalities of each layer. TCP/IP model is a protocol-oriented standard.
- OSI model distinguishes the three concepts, namely, services, interfaces, and protocols. TCP/IP does not have a clear distinction between these three.
- OSI model gives guidelines on how communication needs to be done, while TCP/IP protocols layout standards on which the Internet was developed. So, TCP/IP is a more practical model.
- In OSI, the model was developed first and then the protocols in each layer were developed. In the TCP/IP suite, the protocols were developed first and then the model was developed.
- The OSI has seven layers while the TCP/IP has four layers.

OSI and TCP/IP Model



Thank You