Data Communication Network
DAY -3

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DCN DAY-3 Contents

- NAT
- Protocol
- OSI Layers
- OSI and TCP/IP Model

Network Address Translation (NAT)

Network Address Translation

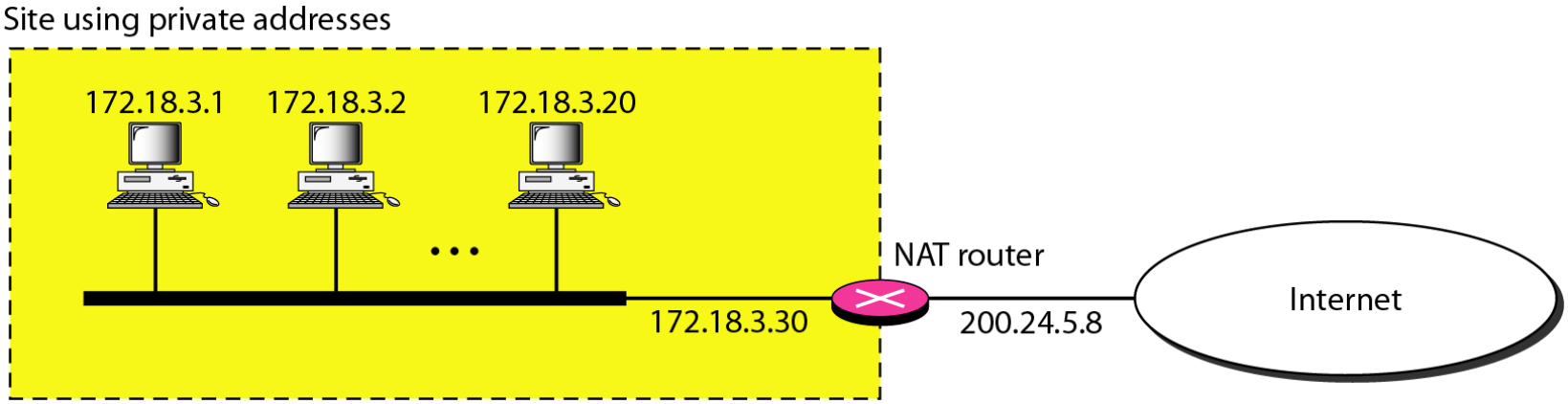
- NAT is to allow multiple devices to access Internet through a single public address. To achieve this, translation of private IP address to a public IP address is required.
- **Network Address Translation (NAT)** is a process in which one or more local IP address is translated into one or more Global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

Network Address Translation (NAT)

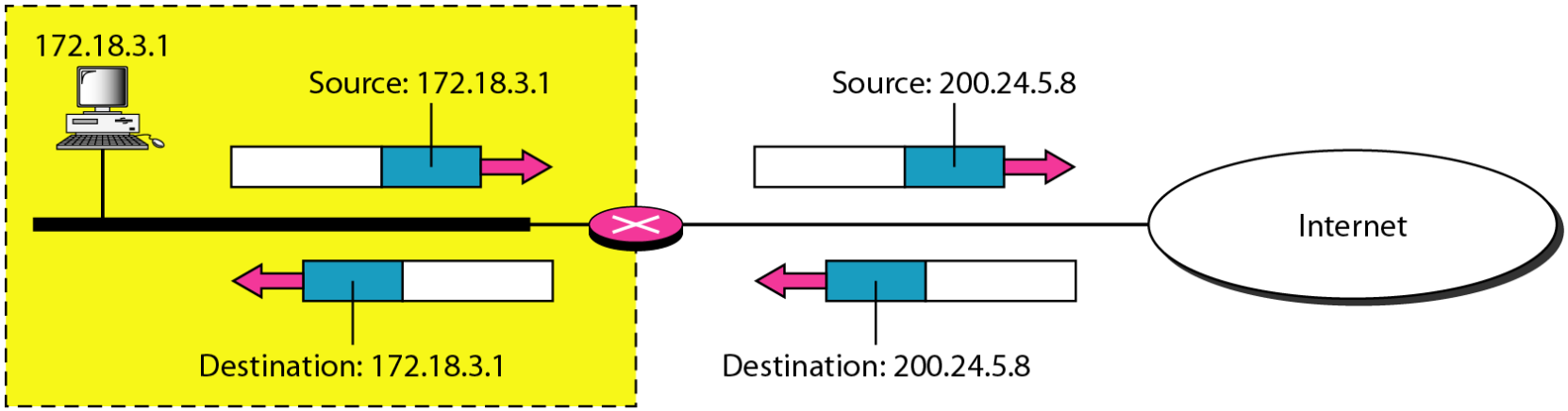
- Benefits
  - Use of a single IP address among many devices in a network
  - Use of a dynamic IP address for home user for sharing
- Private Addresses

Range			*Total*
10.0.0.0	to	10.255.255.255	2^{24}
172.16.0.0	to	172.31.255.255	2^{20}
192.168.0.0	to	192.168.255.255	2^{16}

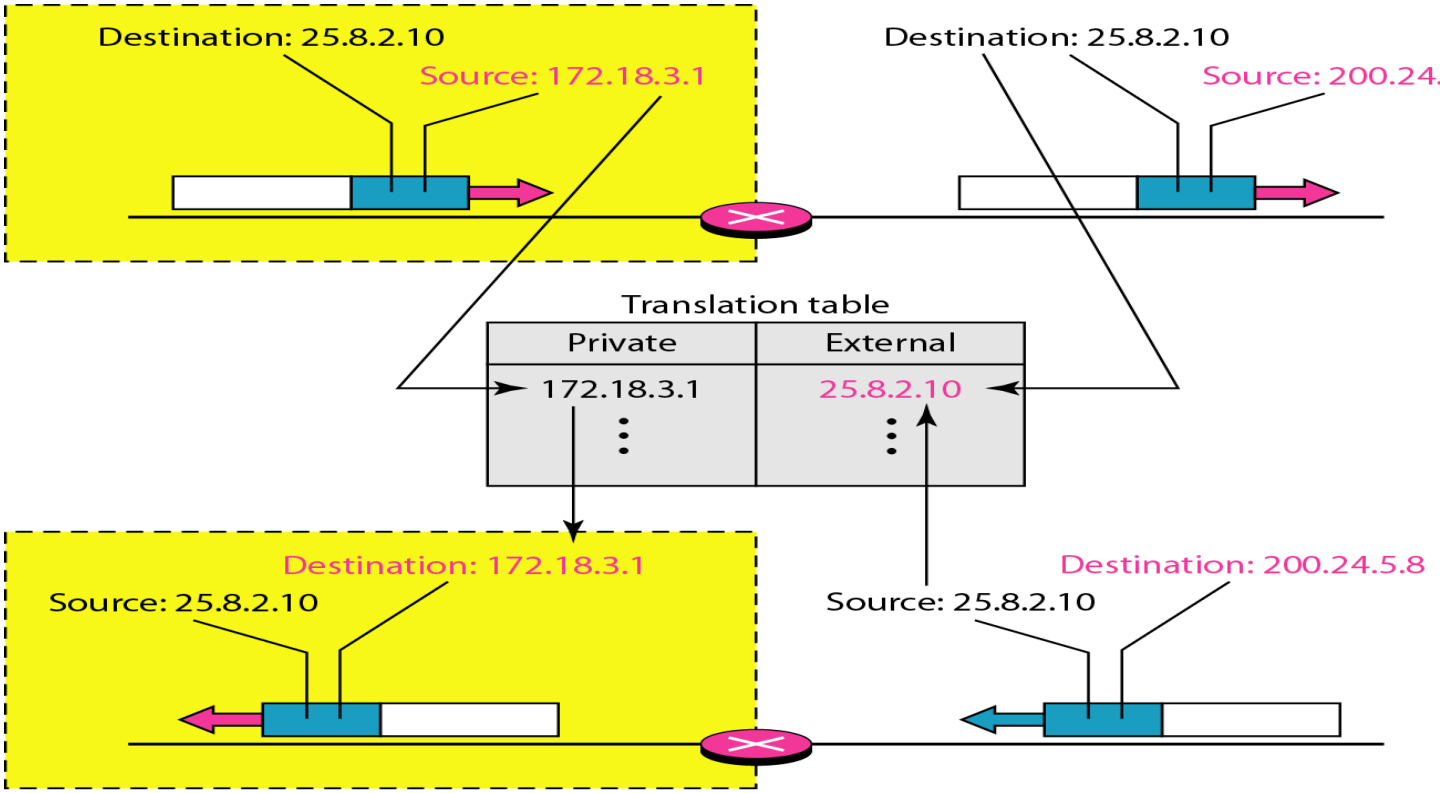
A NAT implementation



Addresses in a NAT



NAT address translation



Five-column translation table

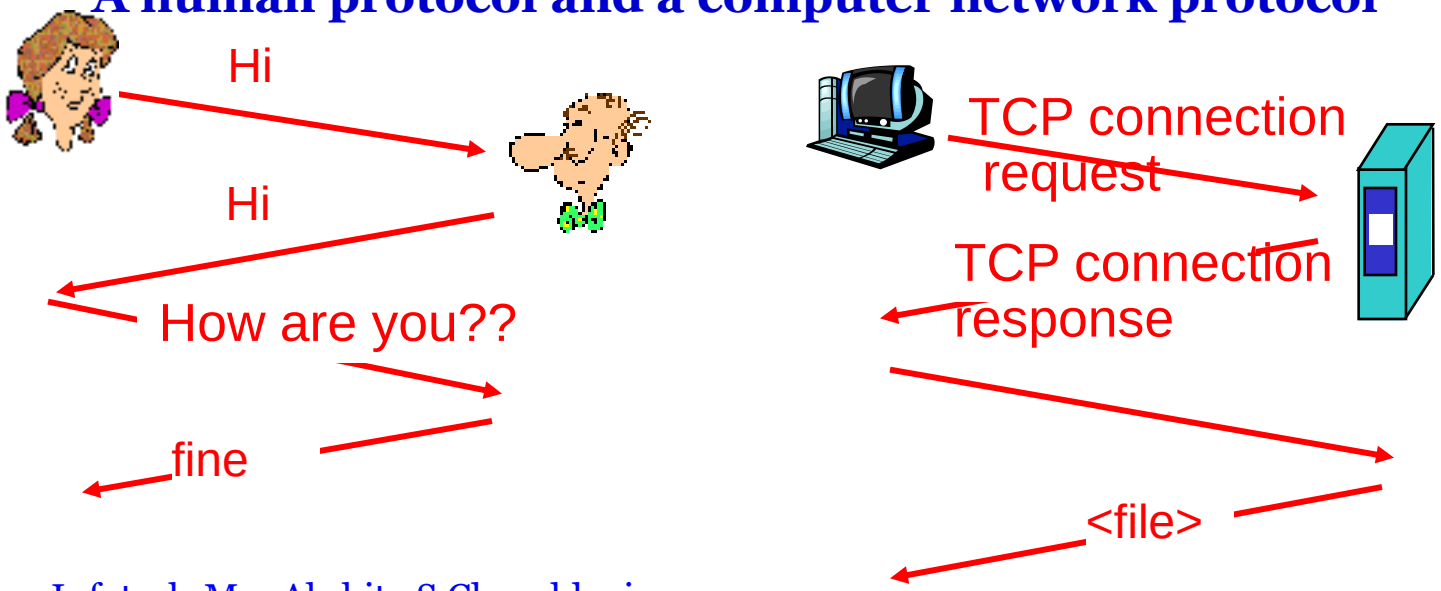
Private Address	*Private Port*	*External Address*	*External Port*	*Transport Protocol*
172.18.3.1	1400	25.8.3.2	80	TCP
172.18.3.2	1401	25.8.3.2	80	TCP
. . .	. . .	. . .	. . .	. . .

Protocol

Protocol

- ***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

A human protocol and a computer network protocol



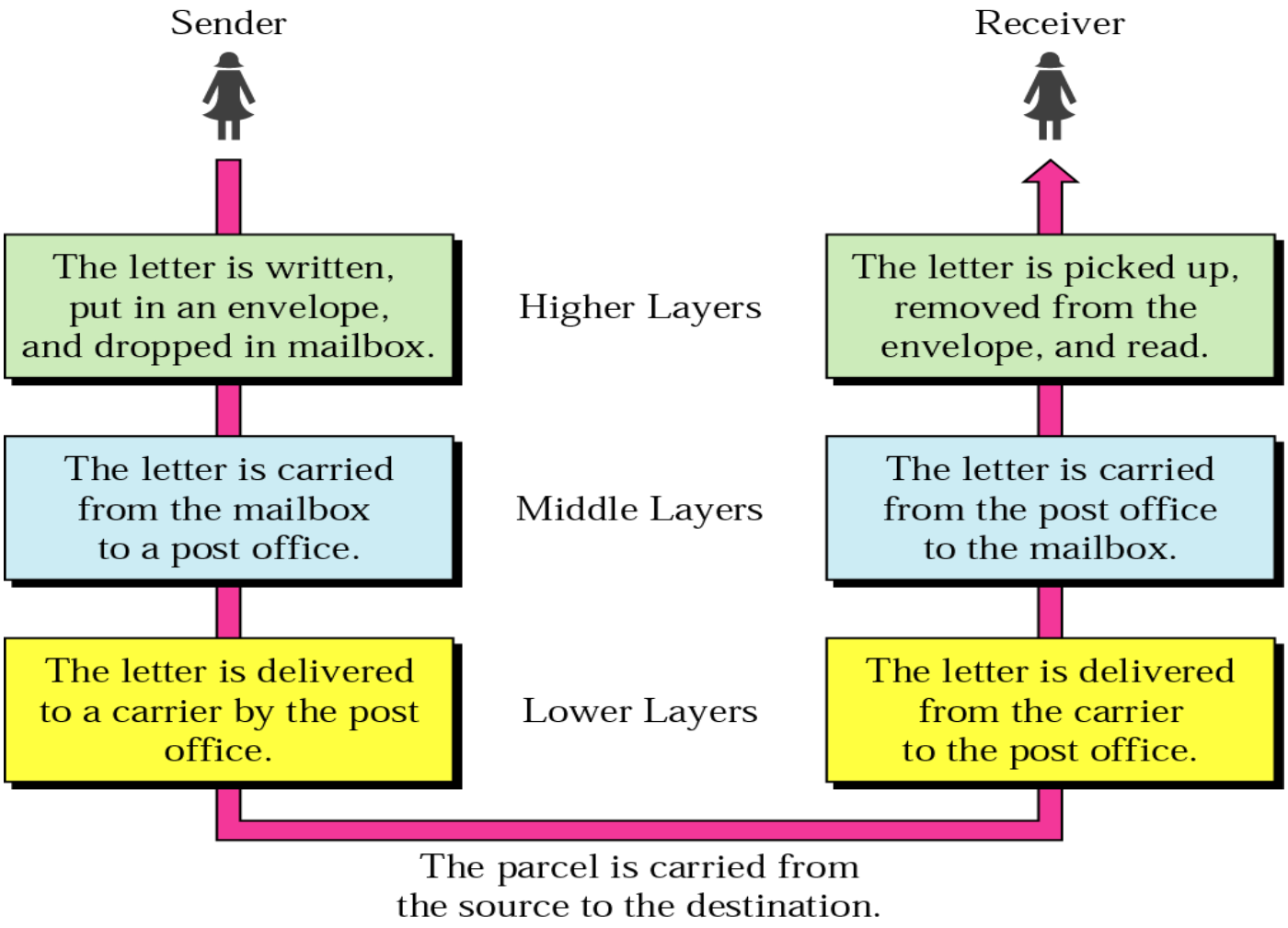
Standards

- 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

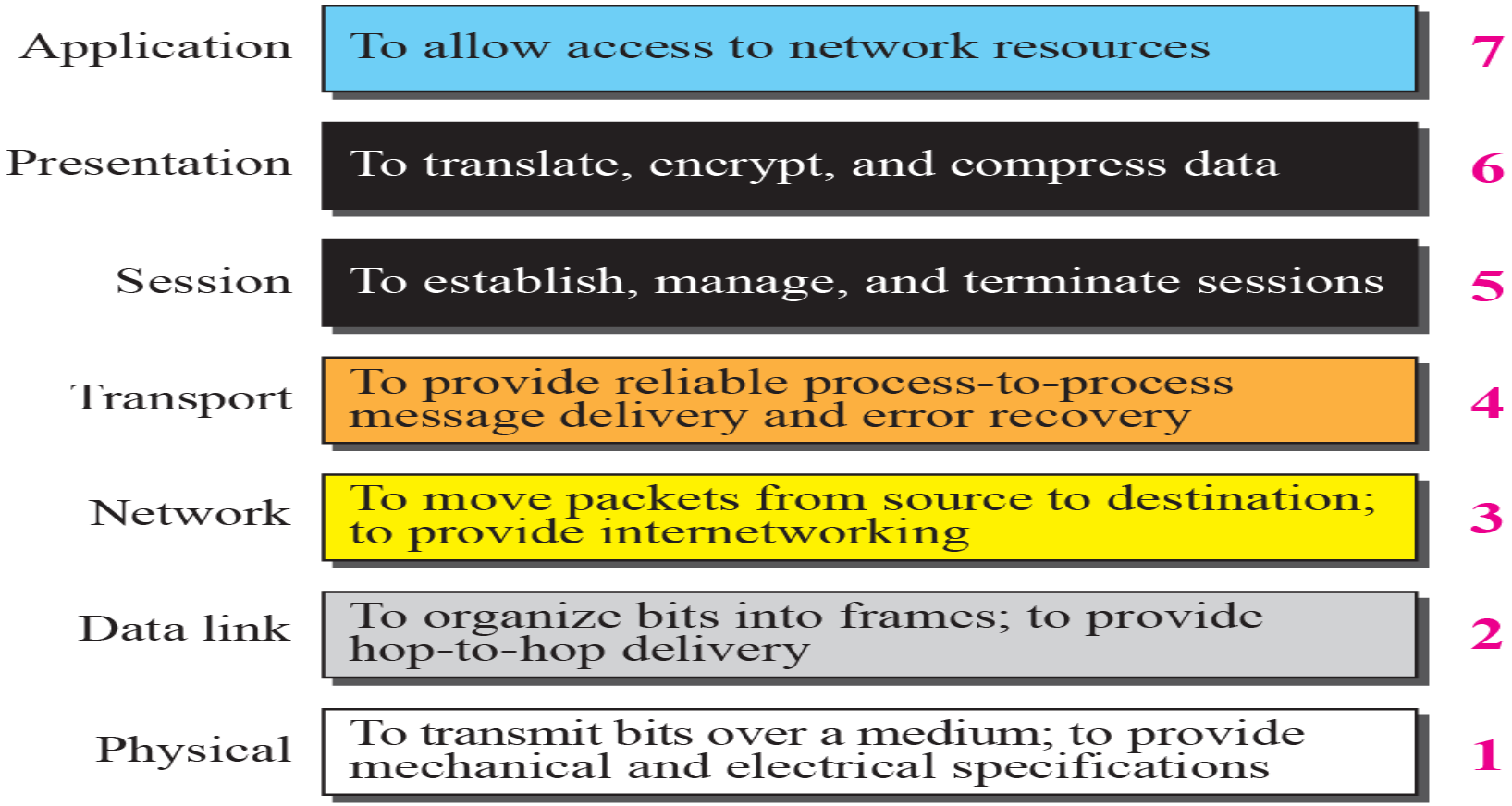
Example of Sending Letter



OSI Model & Layers

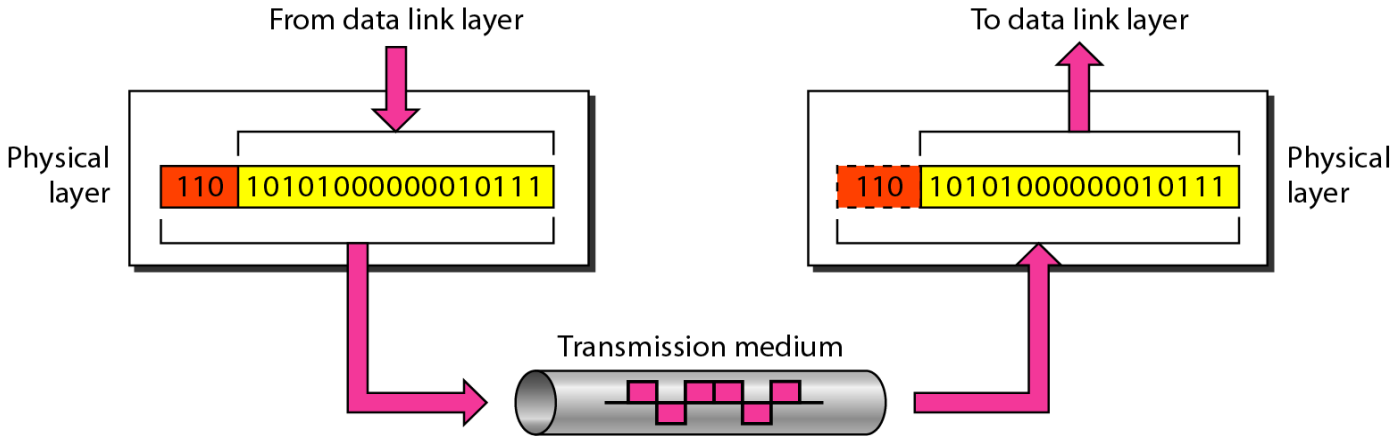
- Established in 1947, **the International Standards Organization (ISO)** is a multinational body dedicated to worldwide agreement on international standards.
- We can not see standard but we can represent them.
- An ISO standard that covers all aspects of network communications is the **Open Systems 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

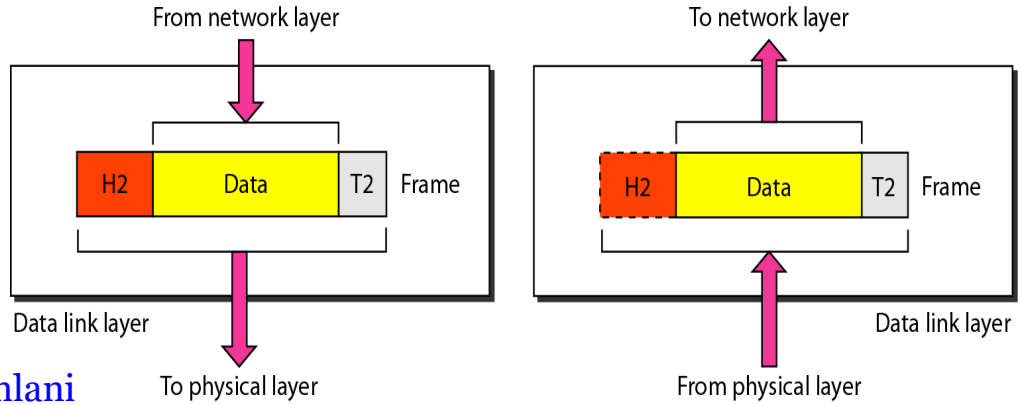
Physical Layer

- 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:**
  - Cables/hubs/repeaters/connectors



Data Link Layer

- Data link layer attempts to provide reliable communication over the physical layer interface.
- Handle errors by implementing an acknowledgement and retransmission scheme.
- physical addressing
  - uses MAC address to identify every NIC uniquely
- Framing
  - Breaks the outgoing data into frames and reassemble the received frames.
  - every frame contains
    - Source MAC address
    - Destination MAC address
- Protocols
  - ARP(Address Resolution Protocol)
    - getting physical address from logical address
  - RARP: Reverse Address Resolution Protocol



Responsibilities of Data Link Layer

- **Framing**
- **Physical addressing**
- **Flow control**
- **Error control**
- **Access control**

Network Layer

- The network layer is responsible for the source-to-destination delivery of a packet, possibly across multiple networks (links).

If two systems are connected to the same link, there is usually no need for a network layer. However, if the two systems are attached to different networks (links) with connecting devices between the networks (links), there is often a need for the network layer to accomplish source-to-destination delivery.

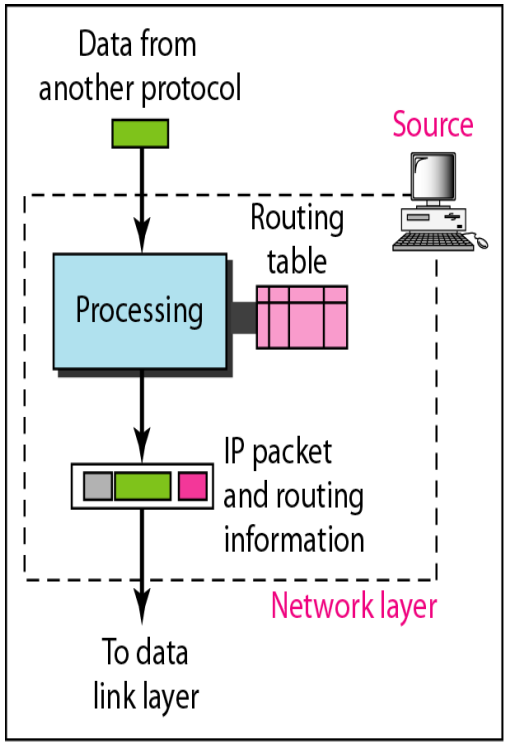
Various Protocols Used by Network Layer are :

- IP: Internet Protocol
- OSPF: Open Shortest Path First
- BGP: Border Gateway Protocol
- PPP: point to point

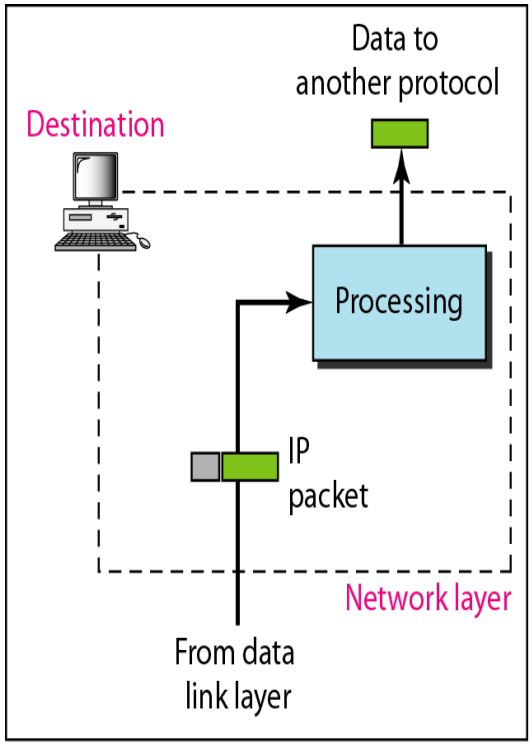
Network Layer Responsibilities:

1. Logical Addressing
2. Routing
3. Internetworking

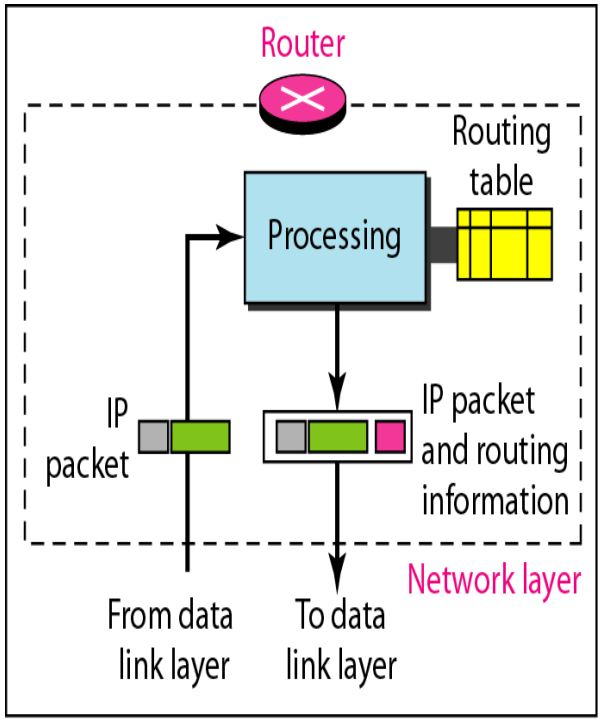
Network layer at the source, router, and destination



a. Network layer at source



b. Network layer at destination

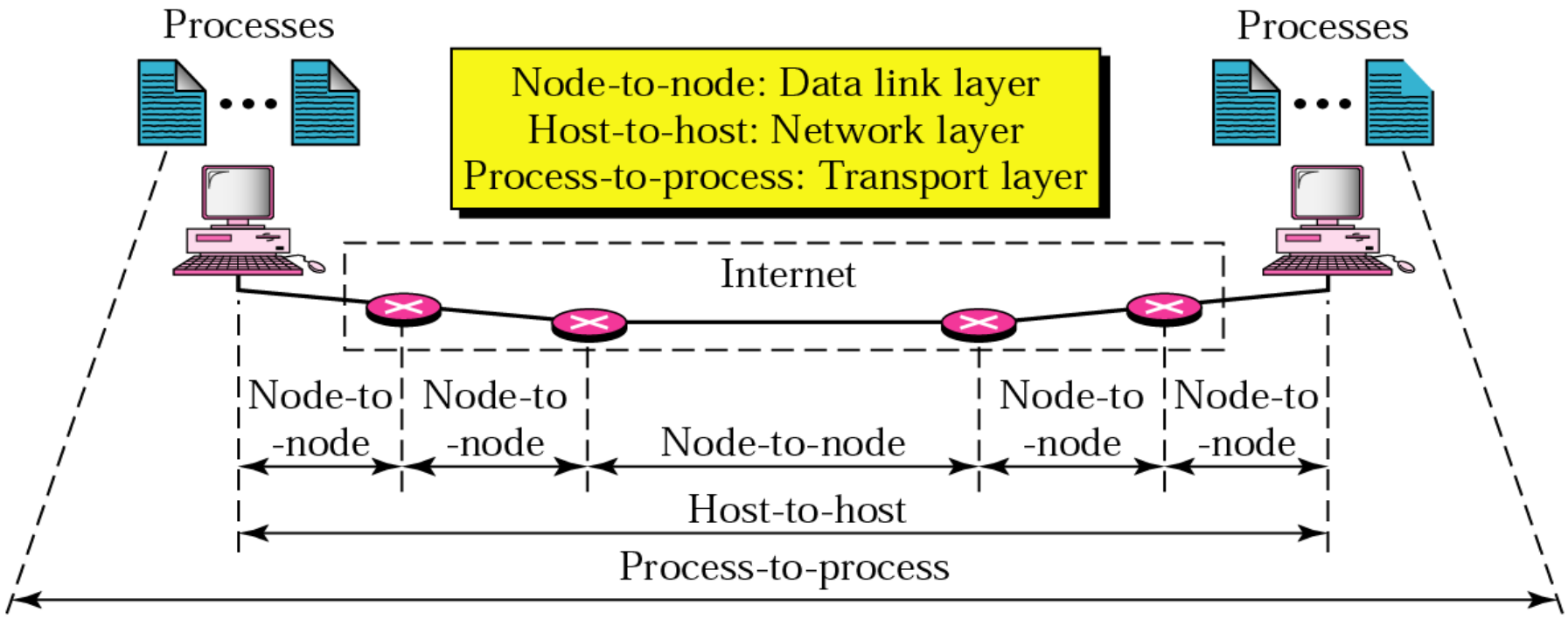


c. Network layer at a router

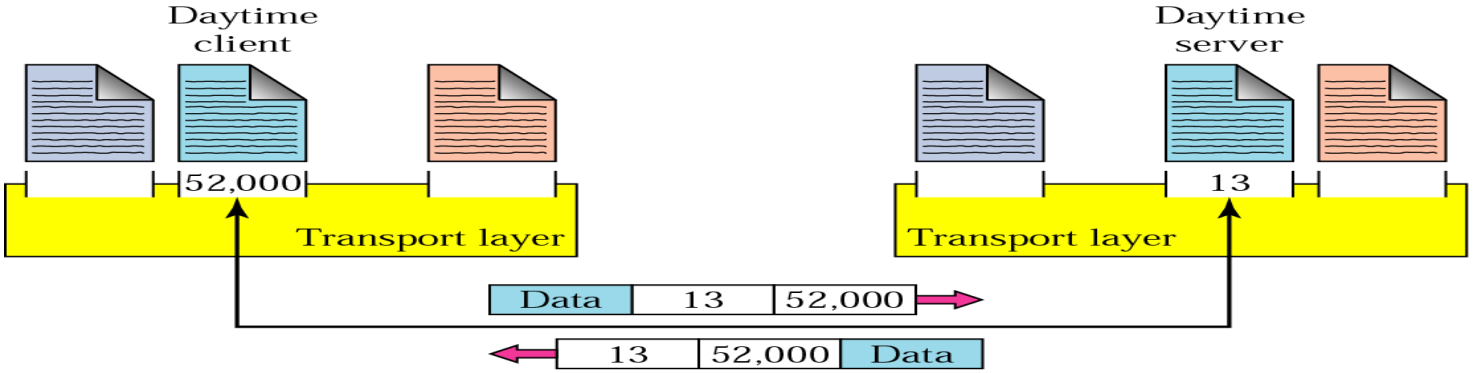
Transport Layer

- Responsible **for process-to-process delivery** of the entire message.
- Provide a reliable mechanism for the **exchange of data between two processes** in different computers.
- converts the session PDU into segment
- Segment
  - smaller part of session PDU
  - every segment contains sequence number
  - every segment contains checksum for error checking

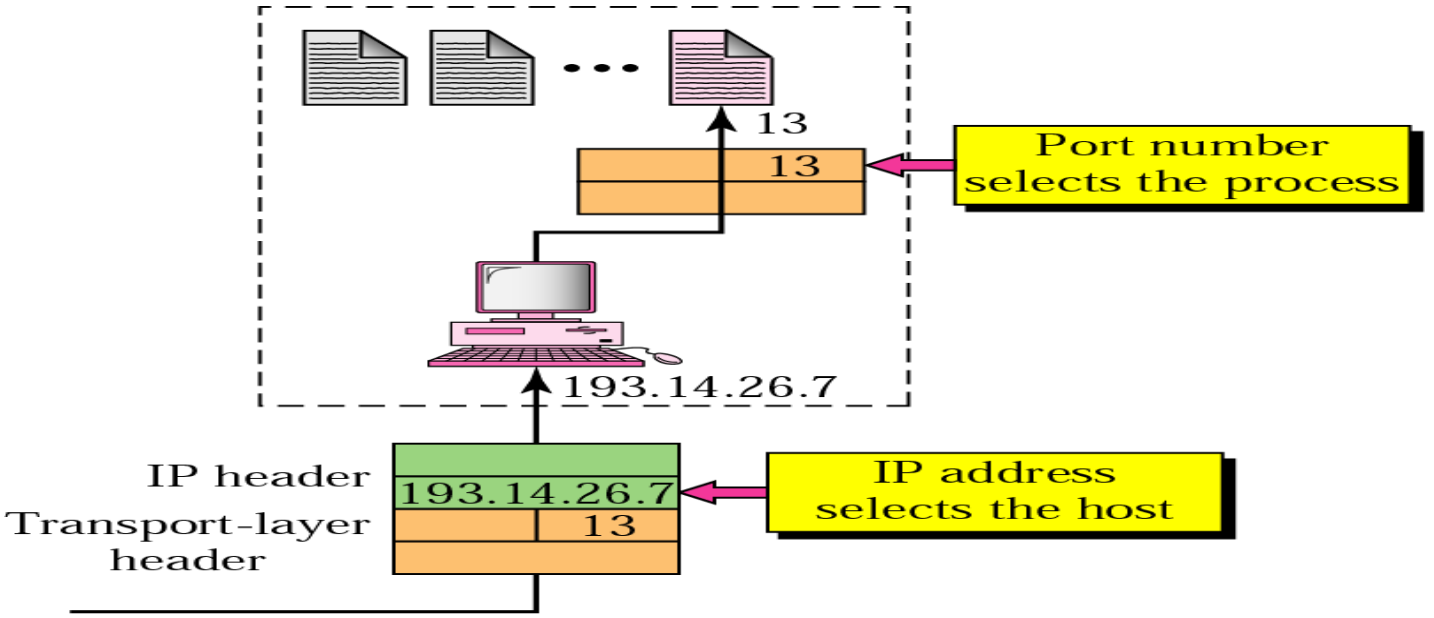
Types of data deliveries



Port Numbers

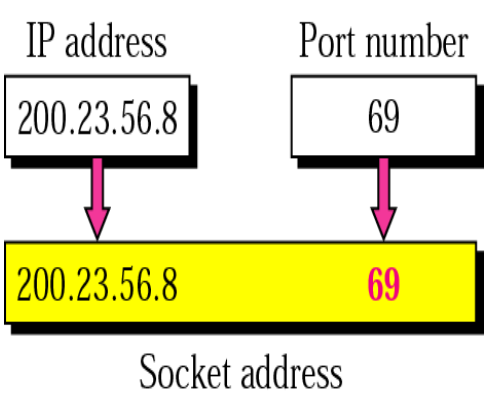


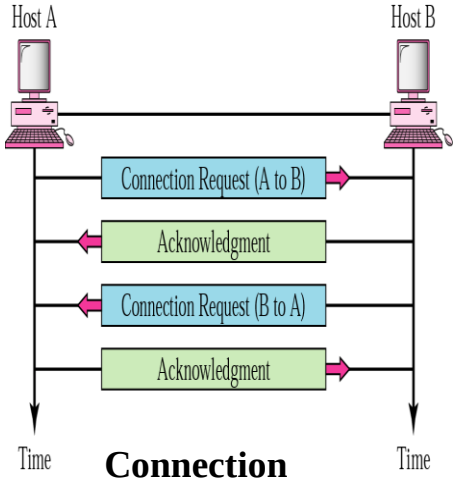
IP Address VS Port Numbers



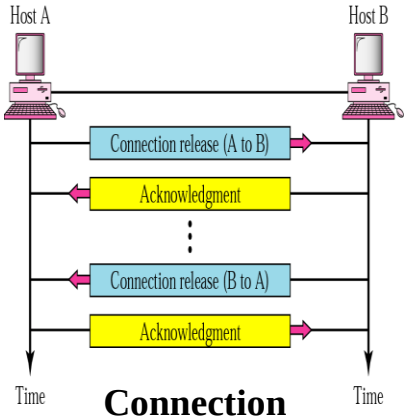
Responsibilities of Transport Layer

- **Sequencing**
- **Error Checking & Error Control**
- **Segmentation and reassembly**
- **Connection control**
- **Flow control**

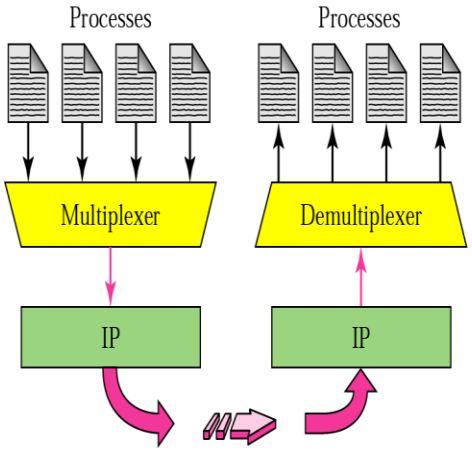




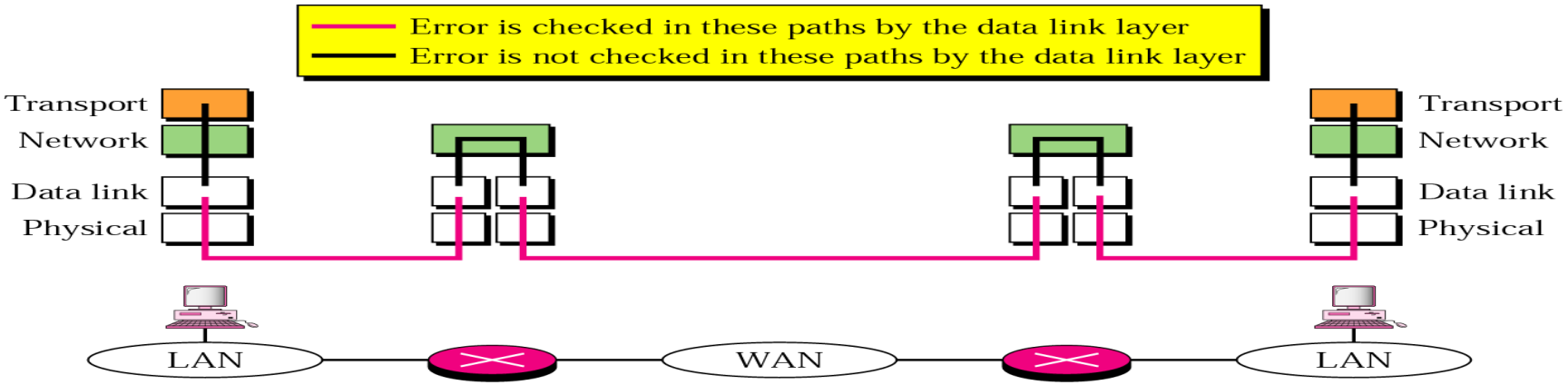
Connection establishment



Connection termination



Multiplexing and demultiplexing



Error control

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

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

Presentation Layer

- Used to decide common file formats
- e.g. [content-type]
  - 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)

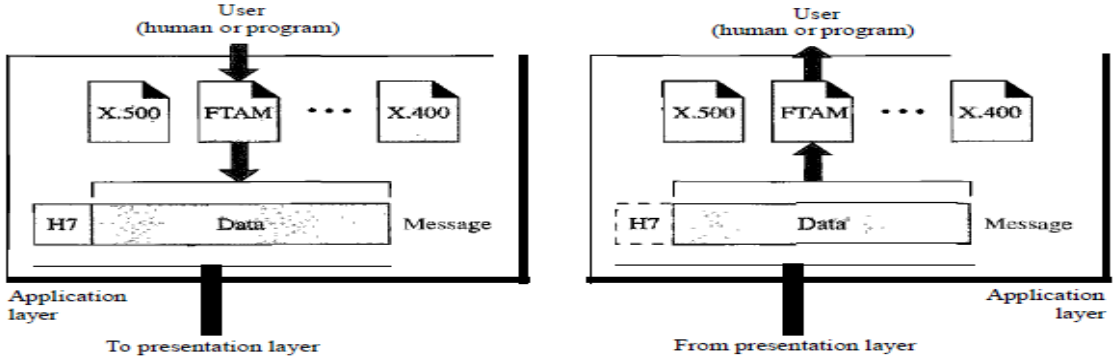
Translation

Encryption/Decryption

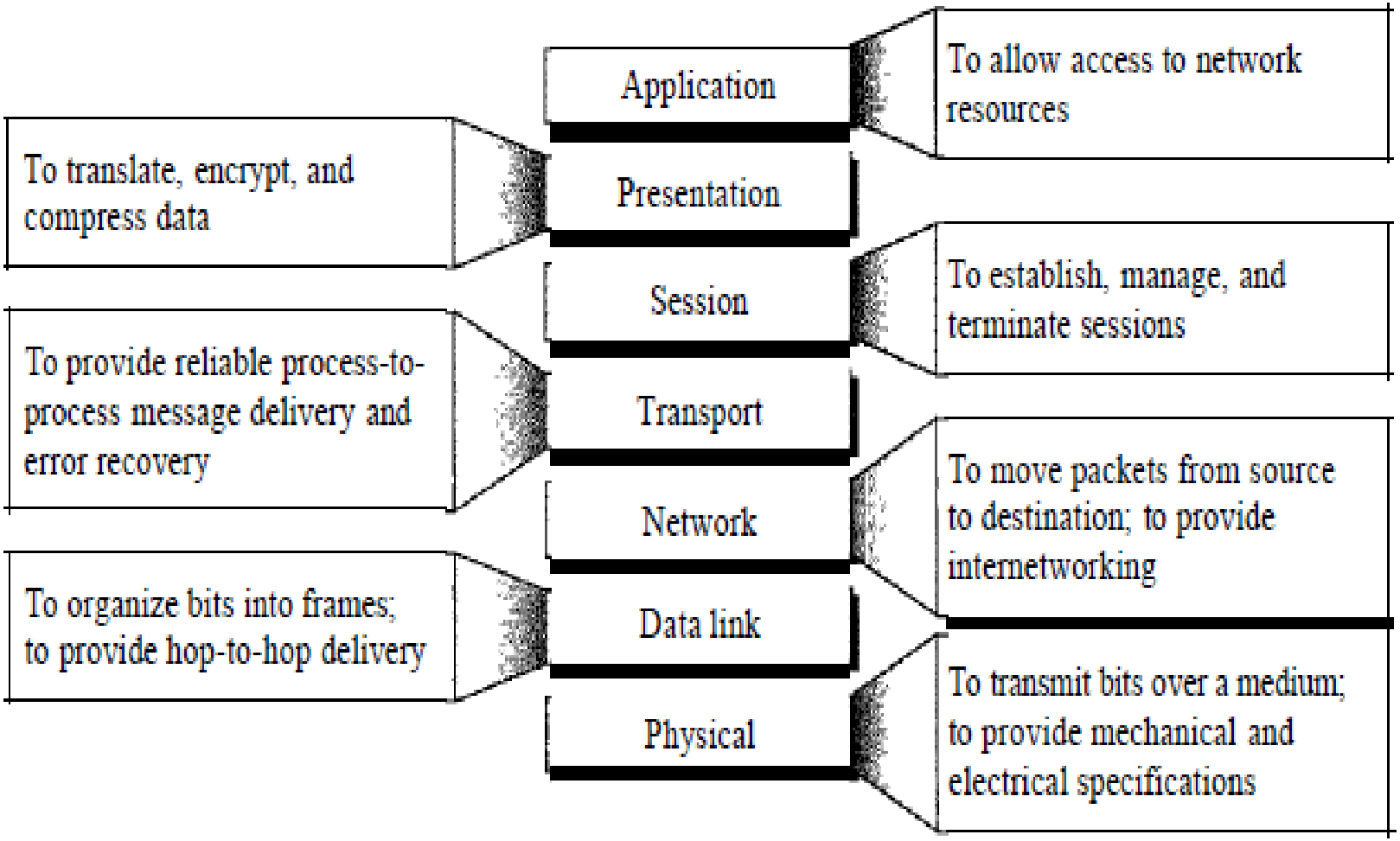
Compression / Decompression

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 : 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: simple mail transfer protocol
  - pop3: post office protocol
  - telnet: used to connect to the remote machine
  - ssh [22]: secure shell



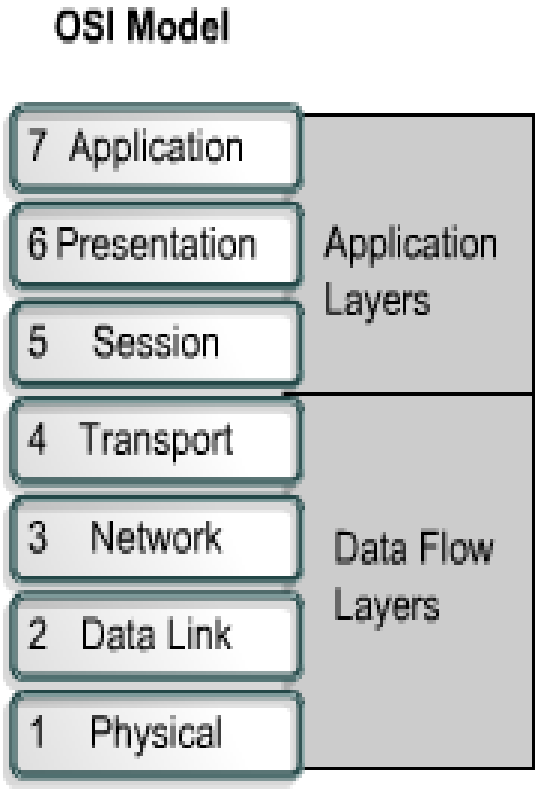
Summary of layers

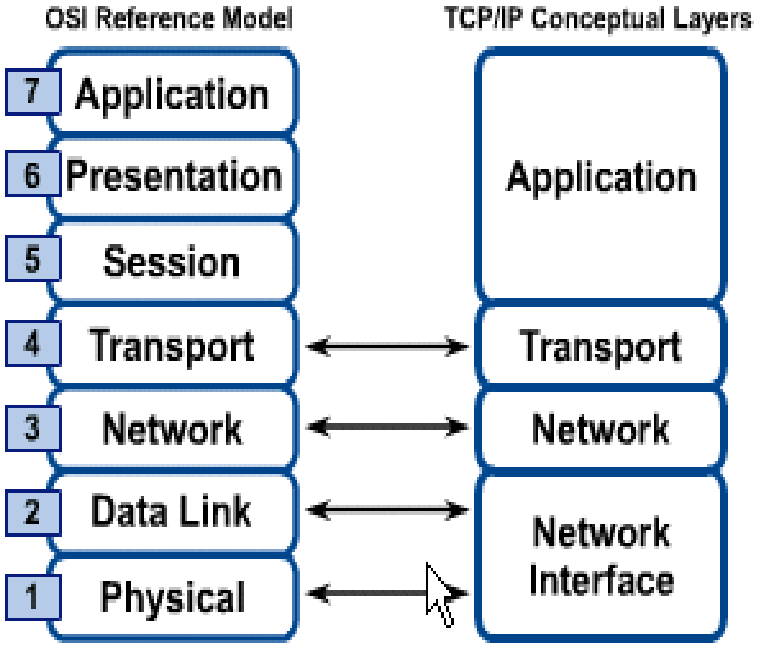


7 Layers of OSI Model

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





Thank You