Module 1

Introduction to Computer Networks

Dr. Sunandita Debnath, IIIT Vadodara

Evaluation Policy

Evaluation Breakdown

1. **Mid-Term Assessment - 30%**

a. Online Mid-Sem Examination (**15%**)

b. Remote Mid-Sem Examination (**15%**)

2. **End-Term Assessment – 45%**

a. Online End-Sem Examination (**25%**)

b. Remote End-Sem Examination (**20%**)

3. Other components (Assignments, Quizzes and Viva) - 25%

Course Content of Computer Networks

MODULE 1

Overview of an internet, internet as a service, internet architecture, circuit switching, packet switching, network performance metrics (delay, packet loss, and throughput), layered approach (TCP/IP and OSI models)

Course Instructor

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Google classroom Code: ucrmyhx

Reference Books

1. Computer Networking: A Top-Down Approach (Fifth Ed. by J. F. Kurose and K. W. Ross, publisher: Pearson

2. Data Communications and Networking (Fourth Ed. by B. A. Forouzan, publisher: McGraw Hill Education

3. Computer Networks (Fifth Ed. by A. S. Tanenbaum and D. J. Wetherall, publisher: Pearson

What is Internet?

*The internet is a computer network that interconnects **zillions** of computing devices throughout the world.*

"Internet is a network of networks"

Computer networks

- *A computer network is a set of nodes or specifically end systems connected by communication links .*

- **Three important terms in computer networking is:**
- *Nodes*
- *Communication links*
- *Packet switches*

- *Networking is everywhere*
- *Network supports the way we learn*
- *Network supports the way we work*
- *Network supports the way we play.*

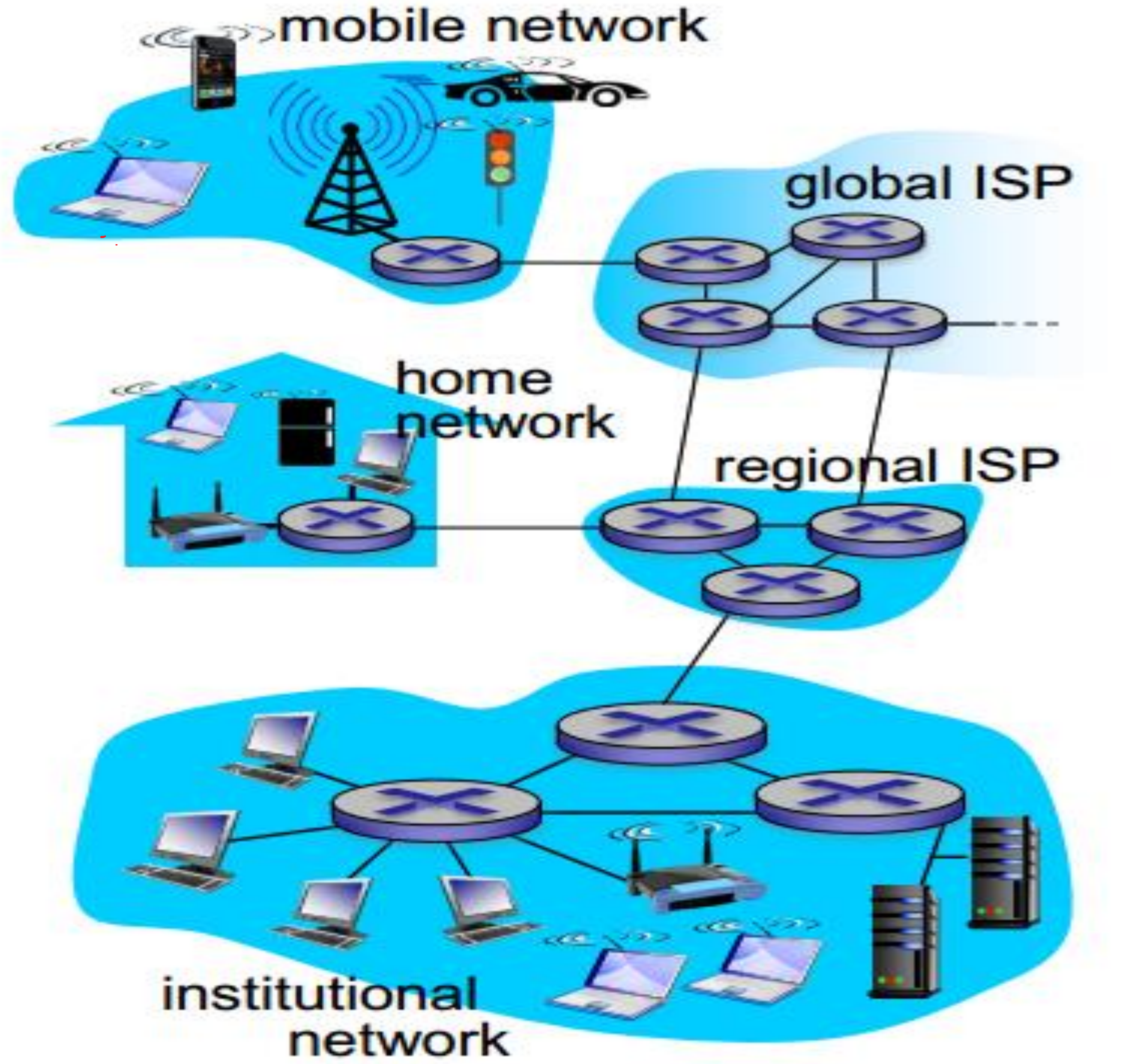
“Internet is everywhere”

Application includes:

- *Electronics mail*
- *Web surfing*
- *Social networks*
- *Instant Messaging*
- *Voice over IP (VoIP)*
- *Distributed games*
- *Peer-to-peer*
- *File sharing*
- *Television over internet*
- *Remote login*

A Computer network or simply any network is composed of:

- Nodes
  - End Nodes
  - Intermediatory Nodes
- Links
  - Wired Links
  - Wireless links



Nodes

End Nodes/Host

A end node can be a computer, printer, mobile phones, PDAs (Personal Digital Assistants) or any other devices capable of sending/ receiving data generated by the other nodes in the network.

Intermediary nodes:

A intermediary node can be a hub, cell phone tower, repeaters, routers, switches etc.

Desired characteristics of computer Network

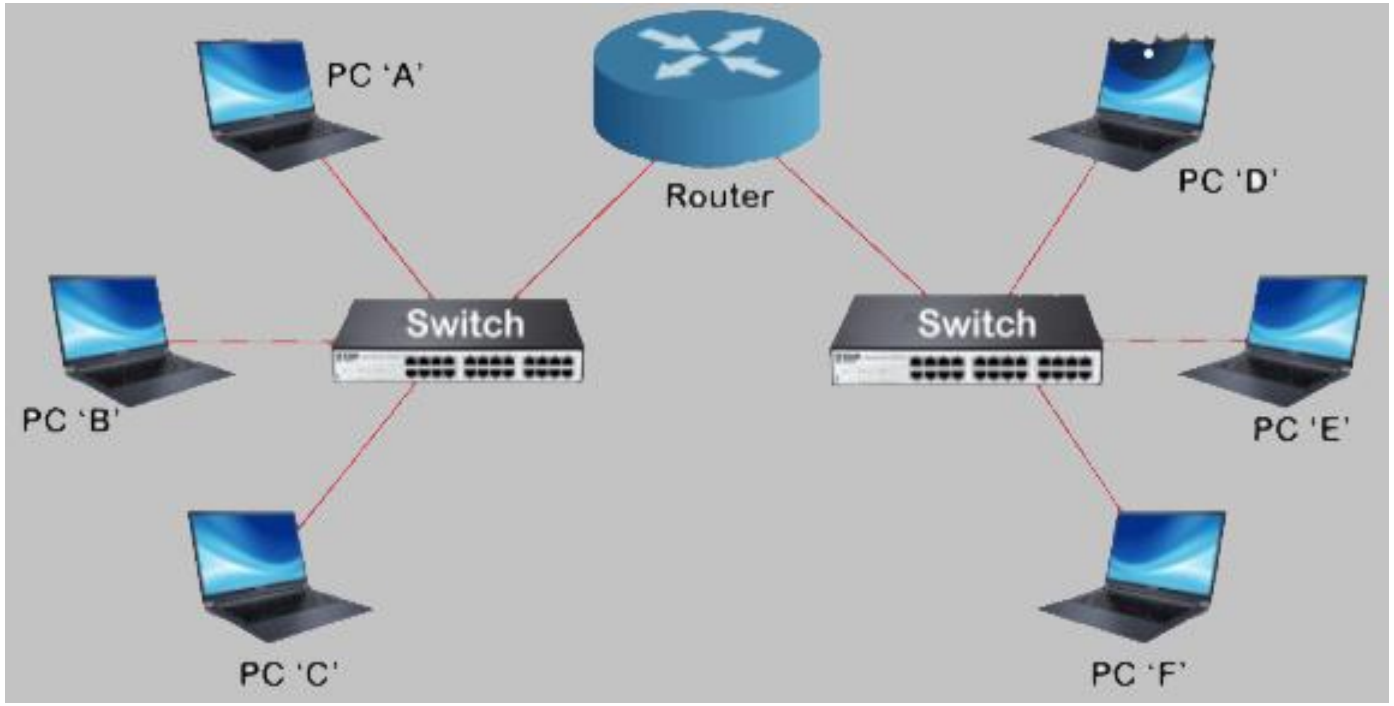
- ***Fault tolerant***

- ***Scalability***

- ***Quality of Service***

- ***Security***

- **Important terms in computer networking is:**
- *Hosts/End users*
- *Communication links (Wired or Wireless)*
- *Routers*
- *Switches*
- *Hub*
- *Servers*
- *Client*



- **Intermediary Devices**
- *Routers*
- *Switches*
- *Hub*

Network	**Routers**
Data Link	**Switches**
Physical	**Hubs**

Communication links

A commination link can be ***wired*** *or* ***wireless*** *links. This link or channel carries information.*

- **Co-axial cables, Optical Fiber, and RF spectrum (air)**

Wired Media

- Ethernet straight (for different type of devices)
- Ethernet cross (for same type of devices)
- Co-axial cables
- Optical Fibers
- USB cables

Wireless Media

- Infrared (for short rang e.g. TV/AC remote controls)
- Radio (e.g. Bluetooth, WiFi)
- Microwave links (e.g. Cell phone tower)
- Satellite links (for GPS)

Data communication

Data communication is the exchange of data between two nodes via some from of links such as cable.

Data flow in this data communication can be of three types

- **Simplex (E.g. Keyboard, Printers etc. one way communication)**
- **Half-Duplex (E.g. Walkie-Talkies. Two way communication but both not simultaneously)**
- **Duplex (E.g. Telecommunication. Two way communication at the same time)**

Protocols

Protocol is set of rules which governs all types of communication, like

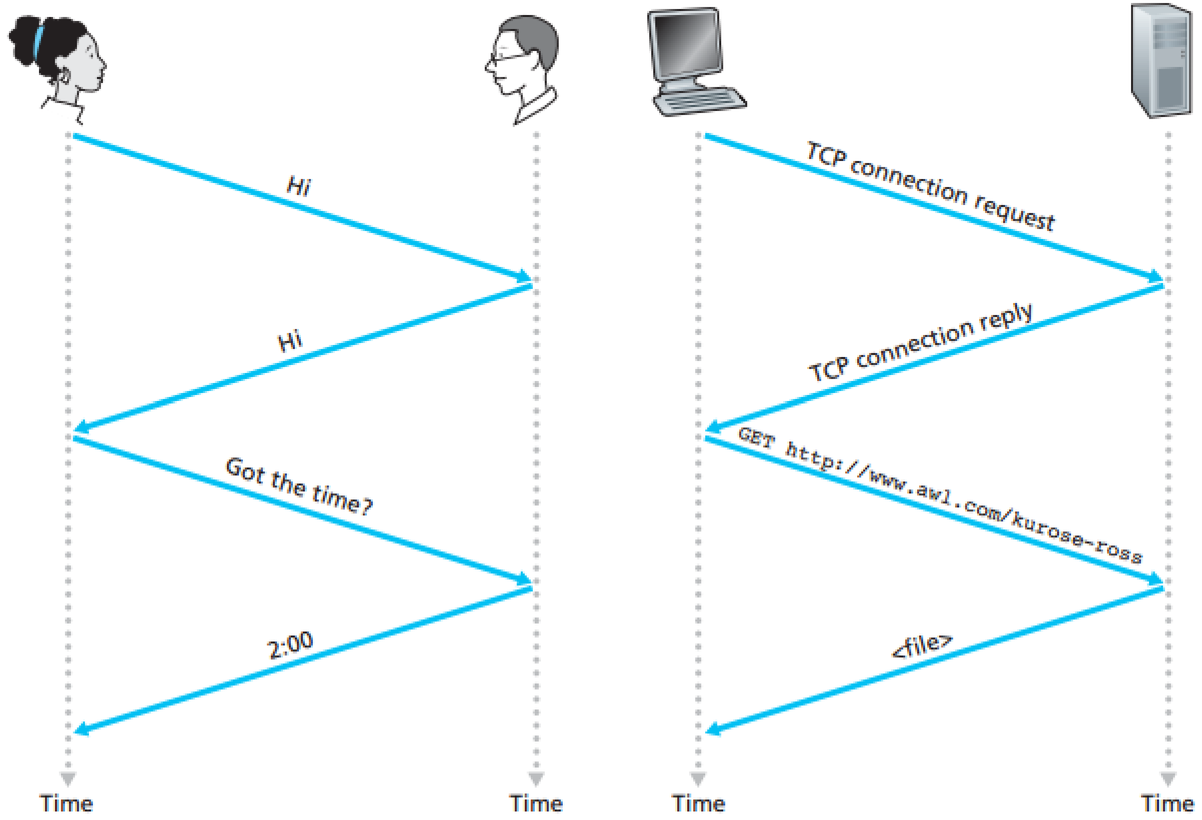
What is communicated?

How it is communicated?

When it is communicated?

Protocol

- *This is comparison of a human protocol and computer network protocol*

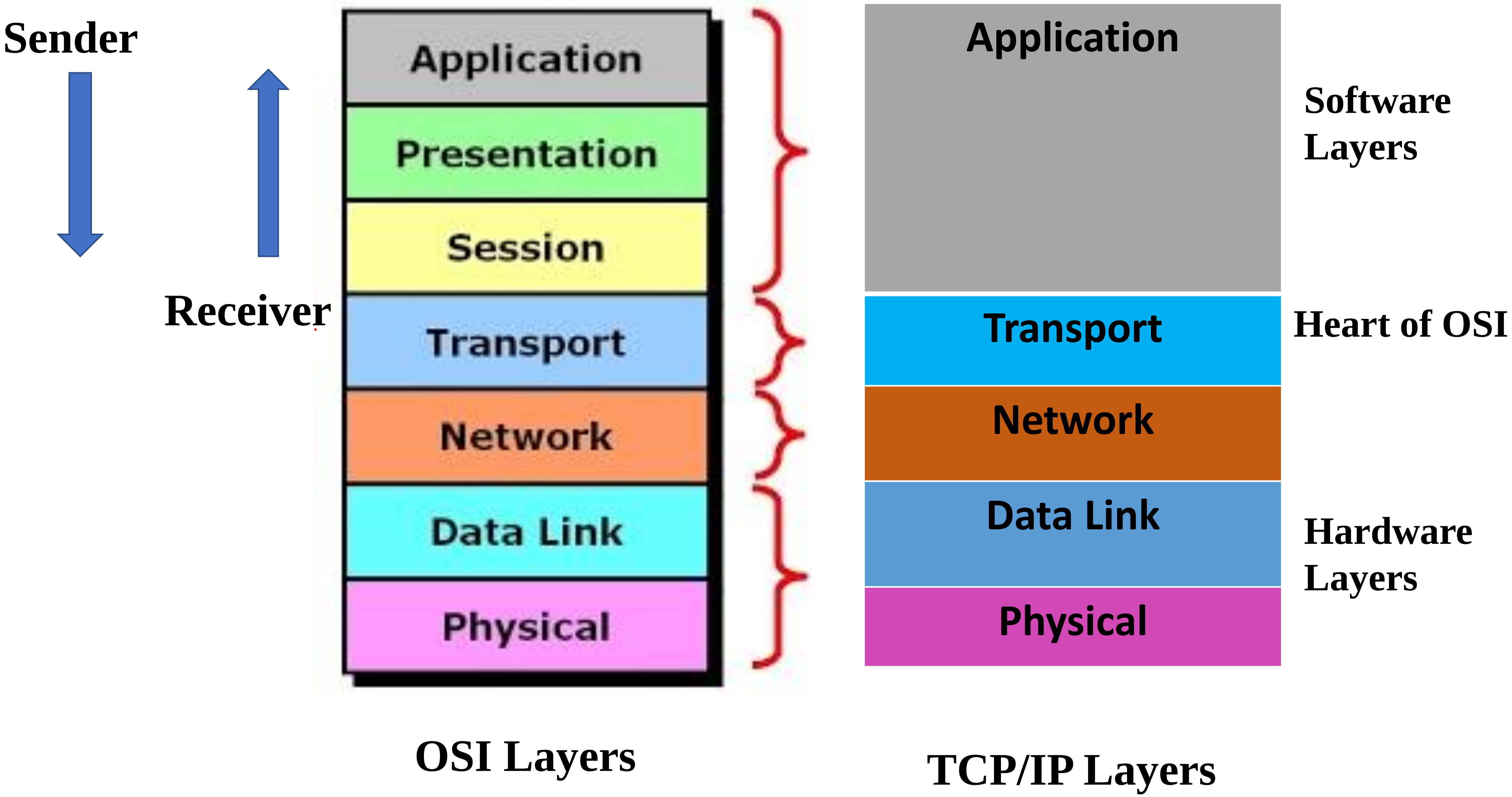


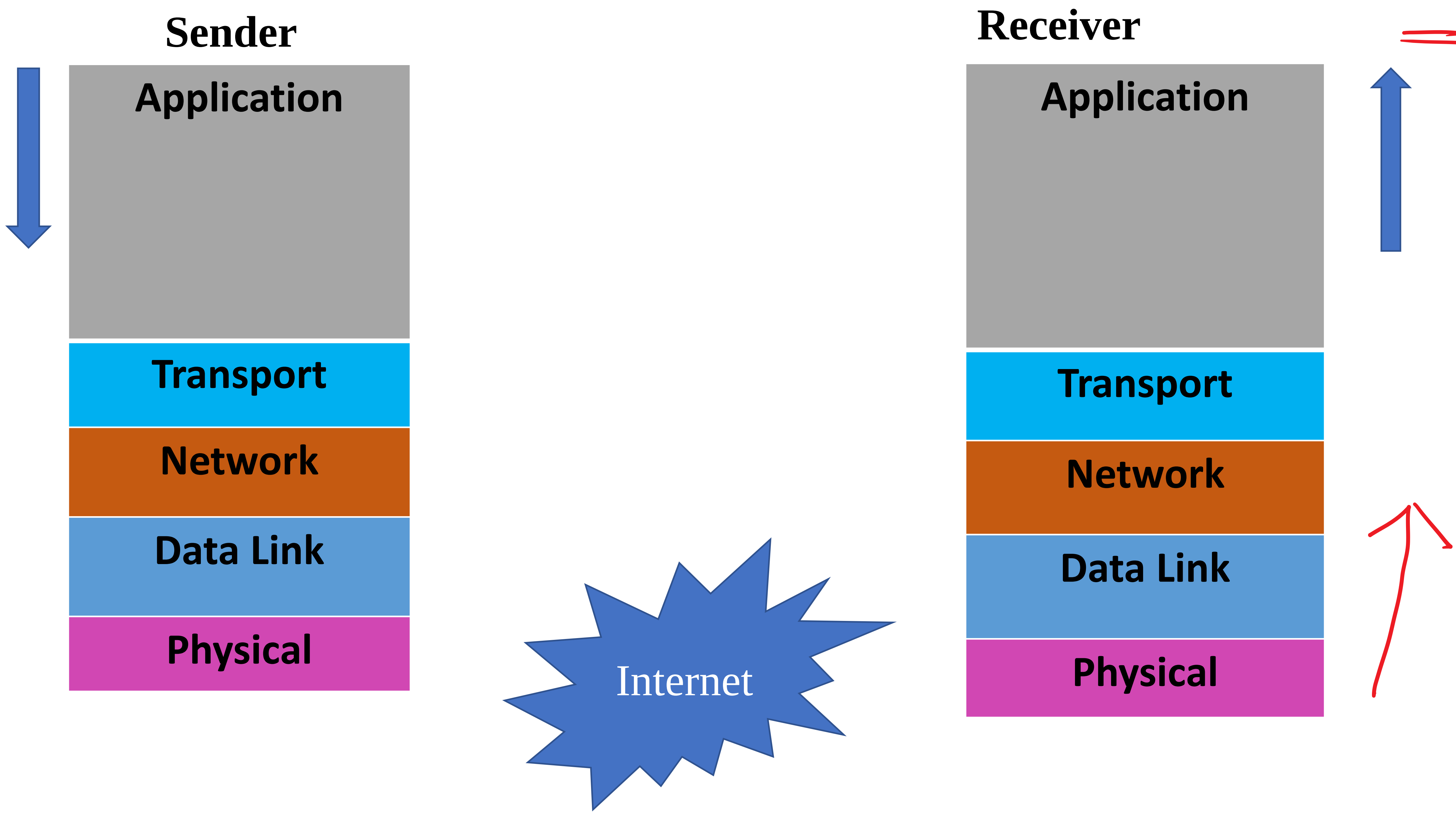
Important points:

- *If the system runs two different protocols then the protocols do not inter operate and no useful work can be accomplished.*
- *The two system should run the same protocol in order to accomplish the task.*

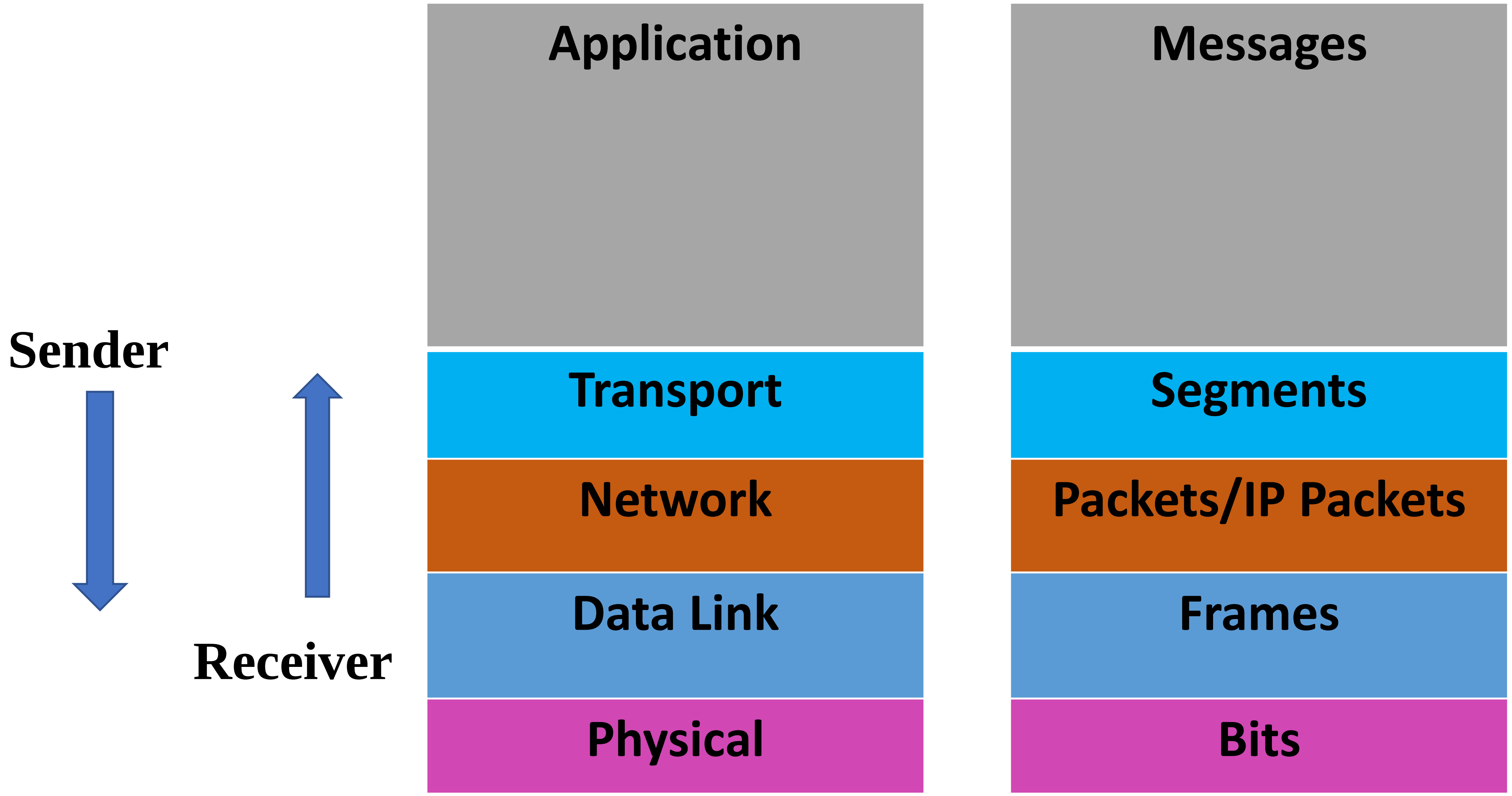
- ***A protocol defines the format and the order of message exchanged between two or more communicating entities, as well as the action taken on the transmission or reception of a message or other event.***

- ***Elements of Protocols:***
  - ***Message encoding***
  - ***Message formatting and encapsulation***
  - ***Message timing***
  - ***Message size***
  - ***Message delivery option***
    - ***Unicast***
    - ***Multicast***
    - ***Broadcast***


Sender
Receiver
Application
Presentation
Session
Transport
Network
Data Link
Physical
OSI Layers
Application
Transport
Network
Data Link
Physical
TCP/IP Layers
Software Layers
Heart of OSI
Hardware Layers


Sender
Application
Transport
Network
Data Link
Physical
Internet
Receiver
Application
Transport
Network
Data Link
Physical

Packet data Units (PDUs)



TCP/IP Layers

- **Intermediary Devices**

Network	**Routers: Data-Packets, Devices: between Intelligent devices, Full duplex, Addressing Type: IP address, Between two different networks, Routing Devices**
Data Link	**Switches: frames, Devices: between Intelligent devices, Half/Full duplex, Addressing Type: MAC address, Between devices on same network, Multicasting Device**
Physical	**Hubs: Data-Electrical signals/bits, Devices: between Non-intelligent devices, Half duplex, Addressing Type: MAC address, Between devices on same network, Broadcasting device**

Peer to Peer Network	Client server network
❑ No centralized administration ❑ All peers are equal ❑ Not scalable ❑ Simple sharing applications	❑ Centralized administration (one will be master and others will be slave) ❑ Request response model ❑ Scalable ❑ Server may be overloaded

Functions of each layer

Application Layer: *It enables the users to access the network resources. This layer also serves as a window for the application services to access the network and for displaying the received information to the user. It is also called as desktop layer.*

- *Mail services*
- *Directory services*
- *File transfer and Access management*

Protocols: *HTTP, SMTP, FTP, TFTP, DNS, DHCP*

Presentation Layer

It is concerned with the syntax and semantics of the information exchanges between the two systems. It is also called the as translation layer.

- *Translation (converting data into common format)*
- *Encryption (security purpose)*
- *Compression (compressing long duration videos and high resolution images and videos)*

Functions of each layer

Session Layer: *It establishes the connection and maintains the session between the communicating devices. It is also responsible for authentication and security.*

- *Dialog control*
- *Synchronization*
- *Session establishment, maintenance and termination*

Transport Layer: *It is responsible for process-to-process or end-to-end delivery of entire message/data. It provides services to the application layer and takes services from the network layer. This layer is responsible for acknowledgement of successful data transmission and re-transmit the data if error is found. Transport layer adds source and destination port numbers to the segmented data.*

- *Port addressing*
- *Segmentation and reassembly*
- *Connection control*
- *End to end flow control*
- *Error control*

Protocols: *TCP (connection oriented, used for reliable data transmission), UDP (connection less, used to real time traffic)*

Functions of each layer

Network Layer: *It is responsible for delivery of data from original source to destination with the help of IP addresses. It also takes cares of packet routing i.e. selection of the shortest route/path to transmit the packet, from the number of routes available*

- *Logical addressing*
- *Routing*

Data link Layer: *It is responsible for the node-to-node delivery of frames. The main function of this layer is to make sure that the data transfer is error-free from one node to other, over the physical layer. This layer is divided into LLC(Logical Link Control) and MAC (Media Access Control).*

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

Functions of each layer

Physical Layer: *It is responsible for the actual physical connection between the devices, the information are in form of bits. It also provides electrical and mechanical specifications.*

- *Physical characteristics of the medium (either wired or wireless)*
- *Synchronization of bits*
- *Bit rate control*
- *Physical topologies (star, bus or mesh connection)*
- *Transmission mode (duplex, half duplex, full duplex)*

Packet switches

Packet switches receives a packet arriving on one of its incoming communication links and forwards that packet on one of its outgoing communication links.

- **Routers** *(Core Networks)*
- **Link layer switches** (*Access Networks*)

End systems access the internet through ISPs (Internet service providers). ISPs can be different type:

- **Residential ISPs (e.g. Local cables or Telephone companies)**
- **Corporate ISPs (e.g. Offices)**
- **University and Colleges ISPSs (IIIT Vadodara)**
- **ISPs that provides WiFi access in airports, coffee shops and railway stations and other public places**

- *Each ISP*
- *itself a network of packet switches and communication links.*

IP Address	MAC Address
❑ Every node in the computer network is identified with the help of IP address or logical address. ❑ Can change based on the location of the device ❑ Assigned manually or dynamically. ❑ Represented in decimal and it has 4 octets (x.x.x.x). ❑ 0.0.0.0 to 255.255.255.255. (each octet is represented by 8 bit representation) total 32 bits long. ❑ Routers need IP address to forward data	❑ Every node in LAN is identified with the help of MAC address. ❑ Physical address or hardware address imprinted in the NIC (*Network Interface Controller*)card of the device. ❑ Cannot be changed it is a unique number, assigned by the manufacturer of the device. ❑ Represented in Hexadecimal. ❑ E.g. 70-20-84-00-ED-FC (48bits) ❑ Separated by, hyphen (-), dot(.), colon (:). ❑ Switches need MAC address to forward data.

Classification of computer networks:

- *LAN (Local Area Network)*
- *MAN (Metropolitan Area Network)*
- *WAN (Wide Area Network)*

LAN	MAN	WAN
❑ LAN (Local Area Network) is a computer network covering a small geographic area, like a home, office, school, or group of buildings, University campus. ❑ High speed (1000 Mbps) ❑ High bandwidth as lesser number of devices are connected. ❑ Range can be almost km using repeaters.	❑ A metropolitan area network (MAN) is a network with a size bigger than a LAN but smaller than a WAN. It normally covers the area inside a town or a city. ❑ moderate speed(44 to 155 Mbps) ❑ Less bandwidth than LAN as more devices are connected. ❑ 100 to 1000 of kms.	❑ WAN (Wide Area Network) is a computer network that covers a broad area e.g. country or continent. ❑ Less speed (150 Mbps) ❑ Low bandwidth as many MAN are connected. ❑ Satellite is used to manage WAN.

Access Network	Core Network
❑ The access network is the network or part of communication systems which provide the user access to the internet services. ❑ Typically connecting devices like phones and laptops to a access point in a café or home network.	❑ The core network is the part of a network that connects different access networks. ❑ Typically cover wide ranges like network connecting two different cities.

Network structure

Network Edge

- ***Access Networks***
- ***Physical Media***

Network core

- ***Packet switching***
- ***Circuit Switching***

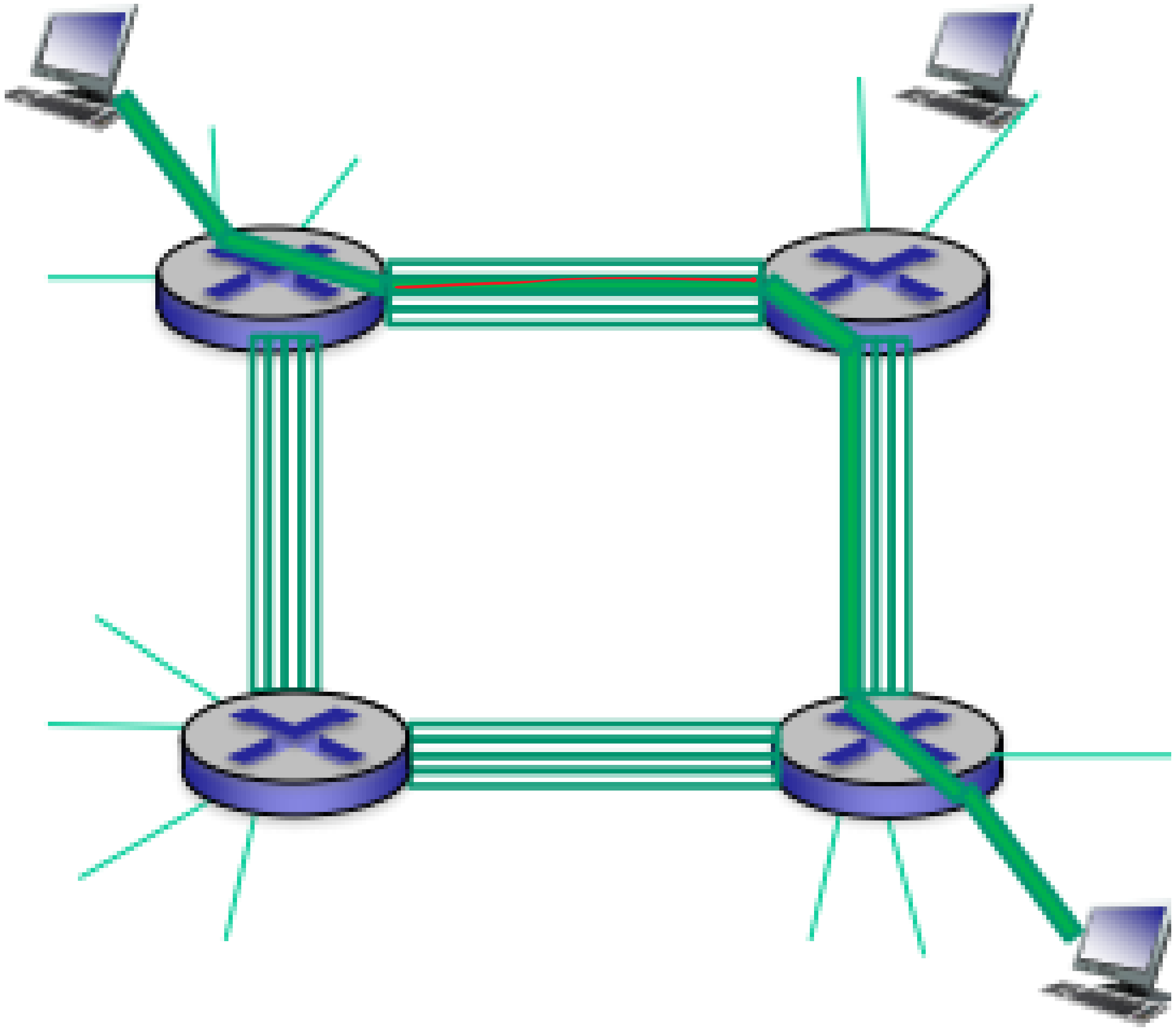
Physical Medium

Guided Medium	Unguided Medium
❑Twisted copper wire (Telephone lines) ❑Coaxial cable (television cable wire) ❑Fiber optic	❑Terrestrial radio networks • Very short distance over two or three meters (keyboard , mouse, headset) • Local area networks for ten meters to a few hundred meters (wires LANs) • Wide area network for tens of kms (cellular access technology e.g. cell phone tower) ❑Satellite radio channels

Circuit Switching	**Packet Switching**

❑ A dedicated path is established between the sender and receiver.
❑ Before data transfer connection will be established first.
❑ The three phases of circuit switching are:
    ❑ connection establishment
    ❑ Data transfer
    ❑ Connection termination
	❑ In packet switching, hosts breaks the messages into smaller packets.
	❑ Forward packets from one router to the next, across links on the path from source to destination.
	❑ Each packet is transmitted with full link capacity.
	❑ Packet switching works with the principal of **Store-and –Forward.**
	❑ **For sensing a packet of L bits over a link with transmission rate R bits/s, then the time required to transmit L bits is L/R secs.**

Circuit Switching



- A link consists of four circuits to support for connections.
- If each link between switches has a transmission rate of 1 Mbps, then each end-to-end circuit connection gets $\frac{1\ Mbps}{4}$ = 250 Kbps of dedicated transmission rate.

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Network structure

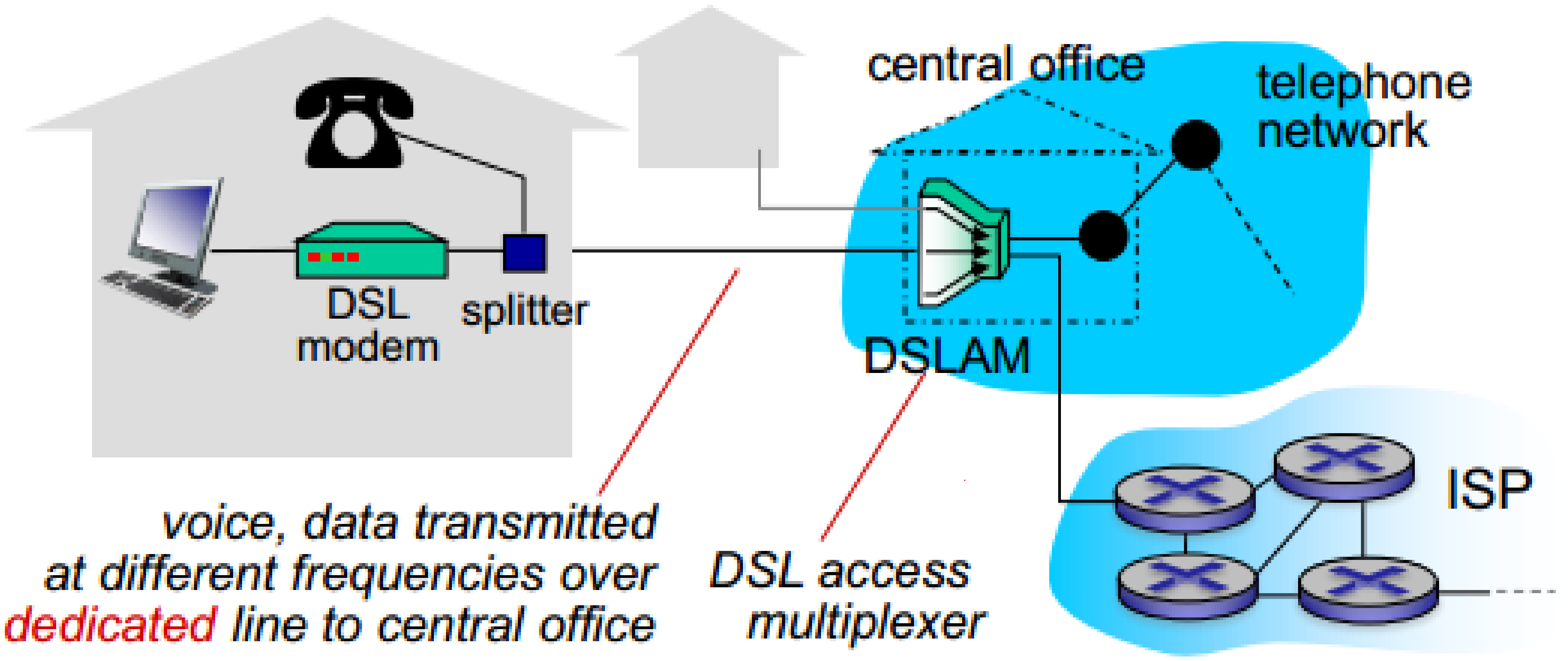
Access Networks-*The network that physically connects an end system to the first router (also known as edge router) on a path from the end system to any other distant end system.*

There are three types of access networks

- ***Home access***
- ***Enterprise access***
- ***Wide area mobile wireless***

Home Access structure

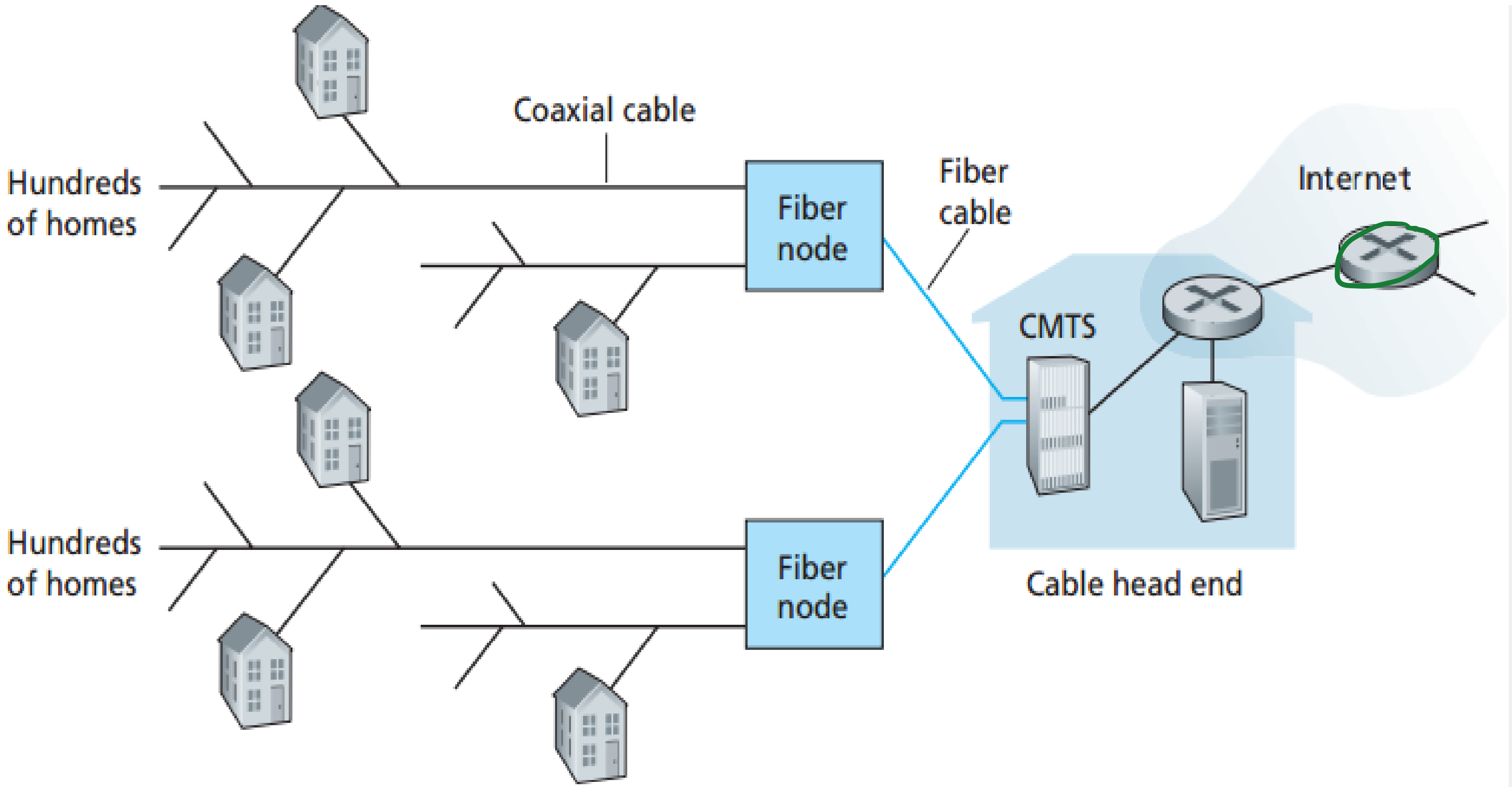
- *DSL (Digital subscriber line), Cable, FTTH (Fiber to the Home), Dial-Up*
- *Each customer's DSL modem uses the existing telephone line (twisted wire) to exchange data with a DSLAM located in the telecom Central Office (CO).*
- *The home's DSL modem takes digital data and translated it to high frequency tones for transmission over telephone wires to CO.*



- *The analog signal from many such houses are translated back into digital format at the DSLAM.*

A Hybrid Fiber co-axial access network

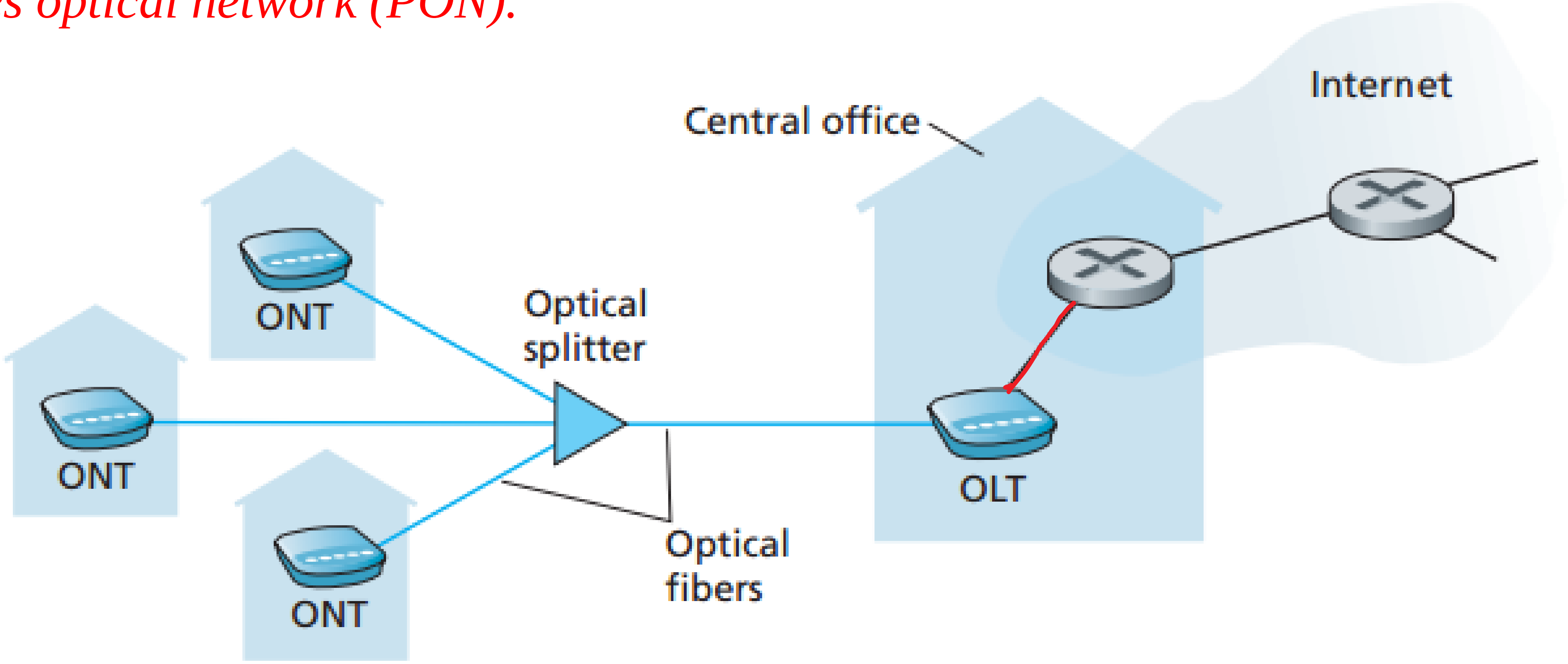
- *The fiber optics connect the cable head end to the neighbourhood level junctions, from which the traditional co-axial cable is then used to reach individual homes and apartments. Each neighbourhood junction typically supports 500 to 5000 homes.*
- *As both fiber optics and co-axial cables are involved it is often referred to as Hybrid Fiber Coax.*



- *At the cable head end, the CMT (Cable Modem Terminator Systems) serves a similar function as DSLM in the DSL networks-such as turning the analog signal sent from from several cable modems in many downstream home back into digital format.*

Fiber to The Home (FTTH)

- *It provides an dedicated optical fiber path from the central office (CO) directly to home.*
- *There are two types of Optical distribution network: Active optical network (AON) and Passives optical network (PON).*



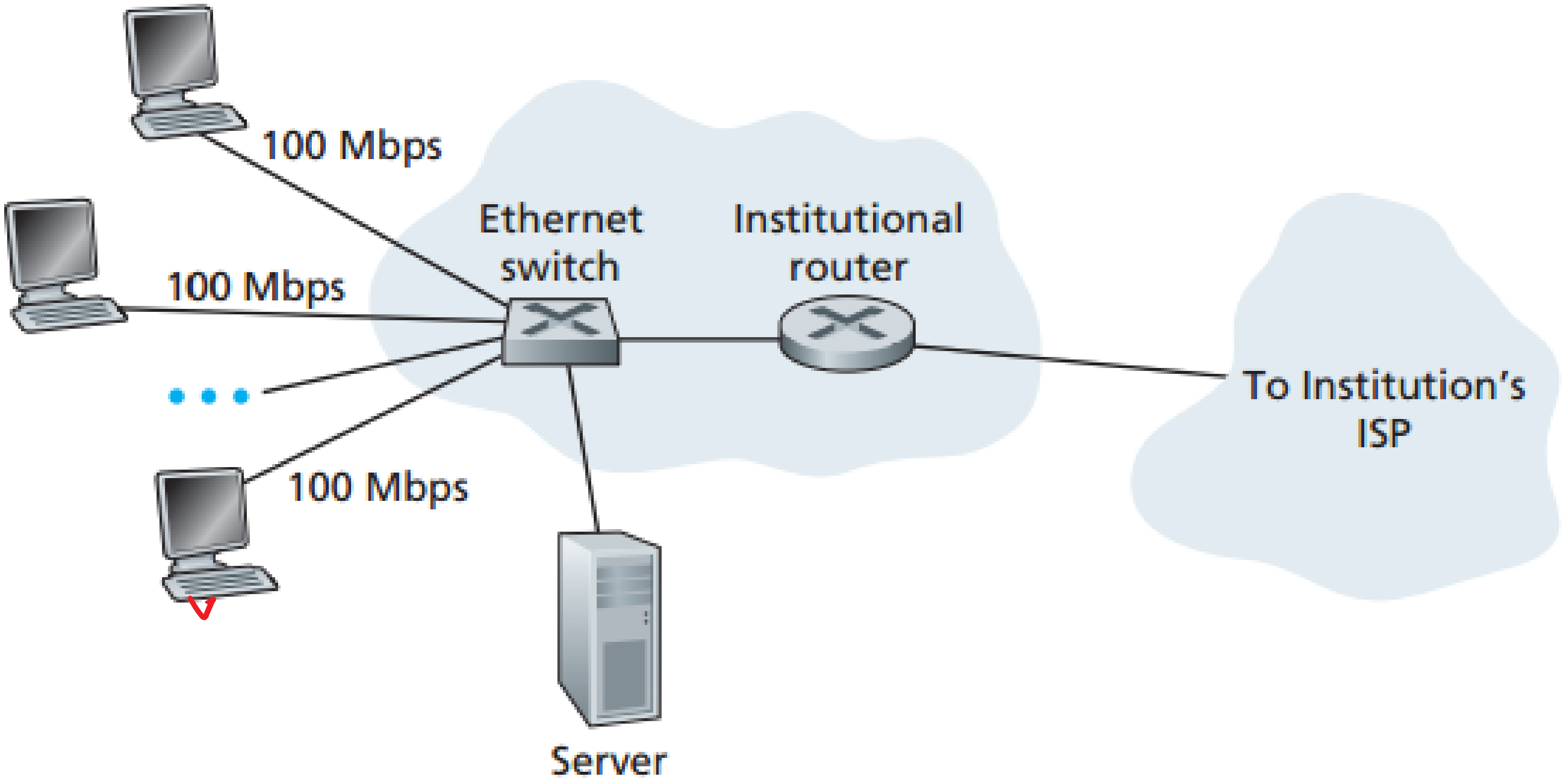
- *The analog signal from many such houses are translated back into digital format at the DSLAM.*

Fiber to The Home (FTTH)

- *Each home has an ONT (optical network terminator , which is connected to a optical splitter via a dedicated optical fiber link.*
- *The splitter combine a number of home (typically less then 100). The OLT (optical line terminator) provides the conversion between optical and electrical signals, connects to the internet via telco router*
- *FTTH can provide internet access rates in the Gbps range.*

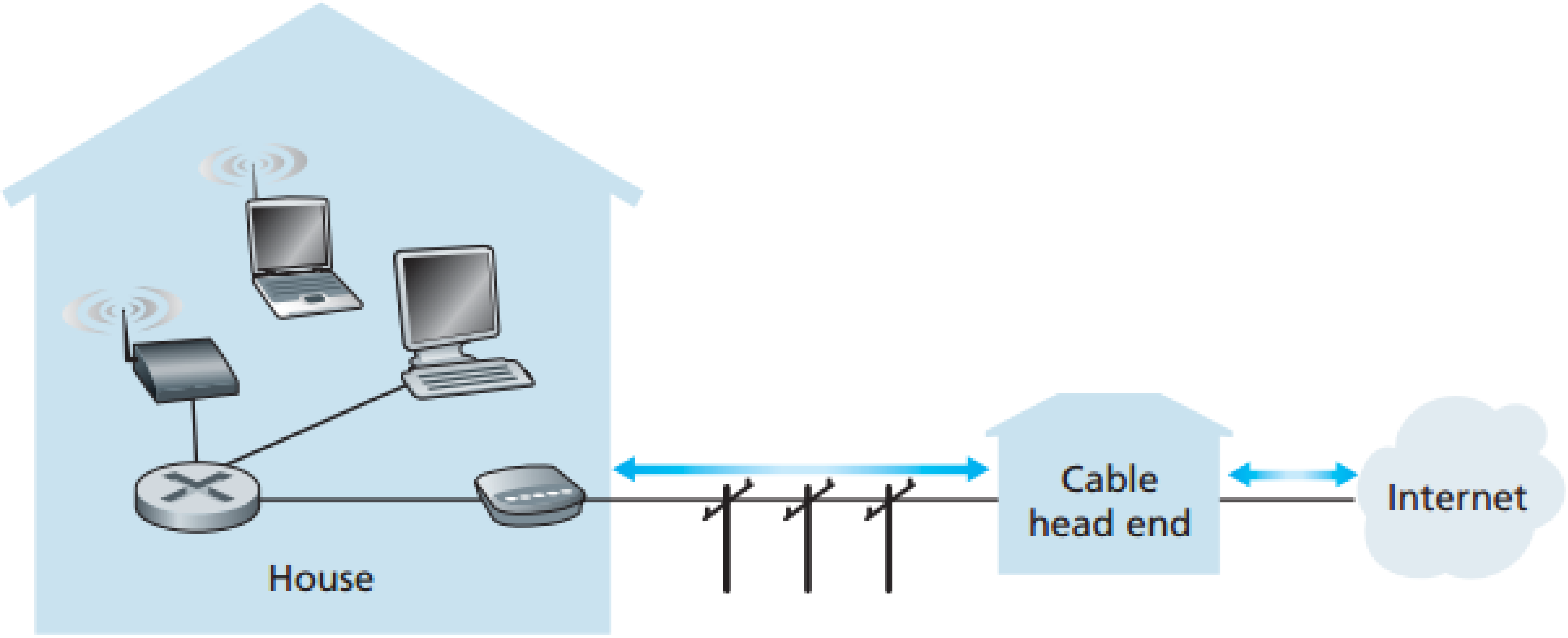
Access in Enterprise (and home): Ethernet and WiFi

- *It is typically use in university campus, companies and home settings where many devices and IOT related applications are connected.*
- *Ethernet users use twisted pair copper wire to connect to an Ethernet switch.*



Access in Enterprise (and home): Ethernet and WiFi

- *The Ethernet switch, or network of such interconnected Ethernet switches are then in turn connected to the larger internet.*
- *With Ethernet switch the user have 100 Mbps of data rate whereas the servers have 1 Gbps to 10 Gbps of data rate.*
- *The LAN (local area network) users must be in the range of 10 meters from the access point.*
- *Wireless LAN access based on IEEE 802.11 are mostly know as WIFi.*



A typical Home network

Wide- Area Wireless Access : 3G and LTE

- *Here the wireless devices (e.g. mobile phones) need to be within few kms from the base station to avail the 3G services and a data rate of typically 100 Mbps.*
- *Here the range is in kms whereas in WiFi the user need to be in tens of meter range from the access point ..*

Functions of each layer

Network Layer: *It is responsible for delivery of data from original source to destination with the help of IP addresses. It also takes cares of packet routing i.e. selection of the shortest route/path to transmit the packet, from the number of routes available*

- *Logical addressing*
- *Routing*

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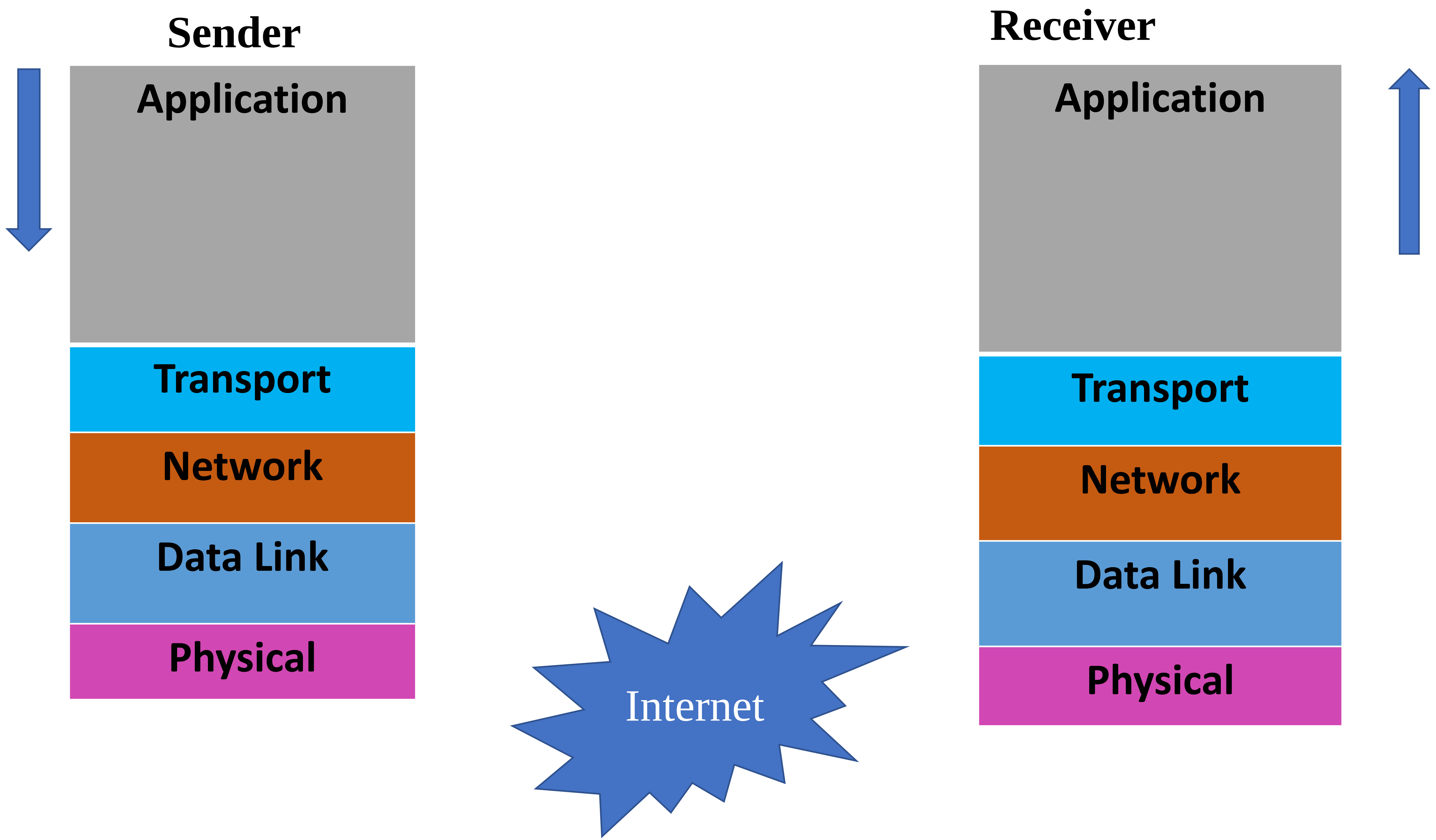
- *Framing*
- *Physical addressing*
- *Flow control*
- *Error control*
- *Access control*


Sender
Application
Transport
Network
Data Link
Physical
Internet
Receiver
Application
Transport
Network
Data Link
Physical

Data Link Layer

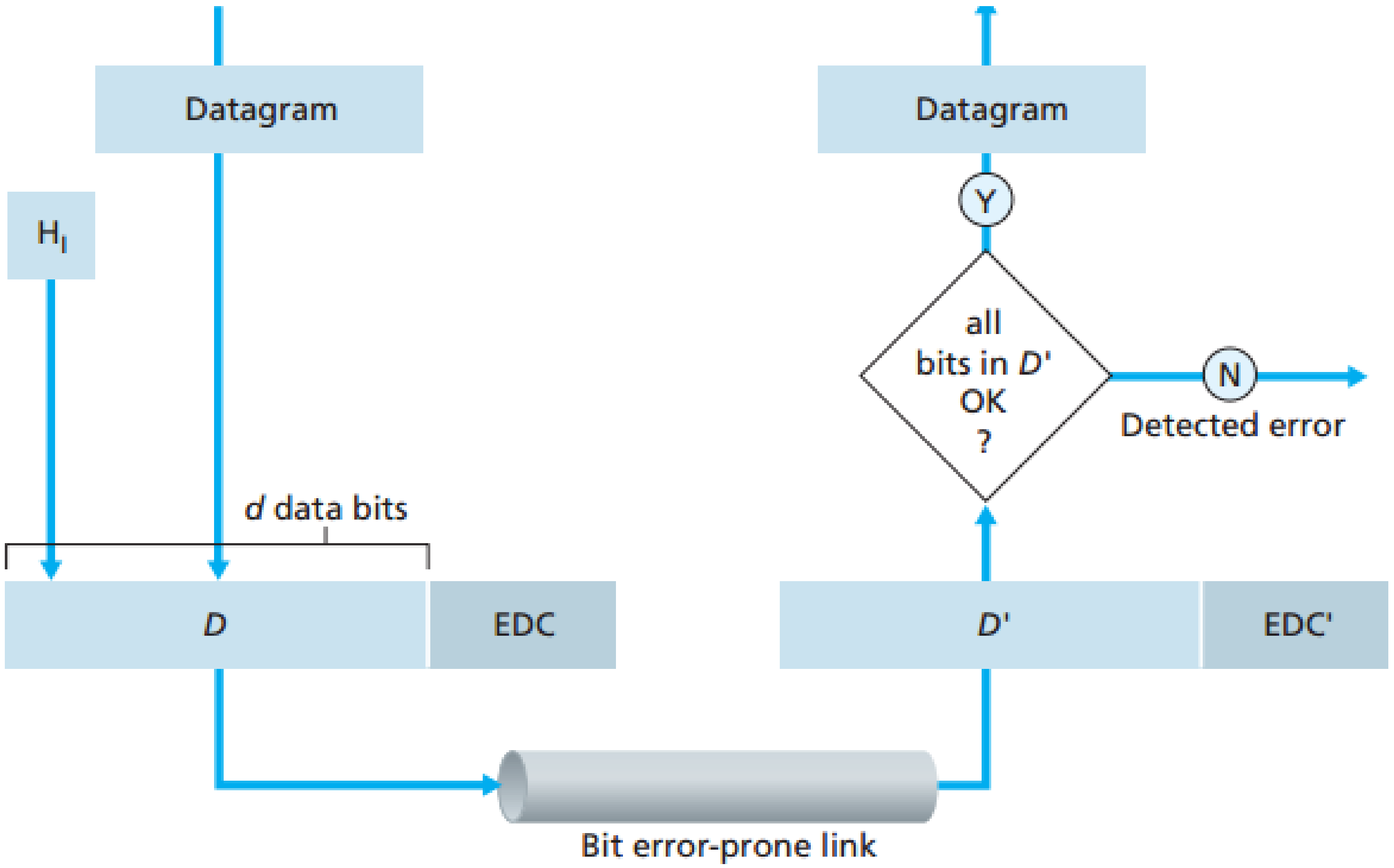
- **Data link layer is also known as Layer 2. Data link resides between the network layer and physical layer.**
- **Datalink layer are responsible for transferring datagram from one node to physically adjacent node over a link.**
- **Switch is a layer 2 device.**

Functions of Data Link Layer

- **Framing:** *encapsulate datagram into frame, i.e. adding header and trailer.*
- **Link access:** *Channel access if share media. A MAC protocol specifics the rules by which a frame is transmitted onto the link.*
  - *When there is a point-to-point connection between a sender ad receiver i.e. a single sender at one end of the link and a single receiver at another end of the link, then the MAC protocol is simple means whenever the link is idle the sender can send.*
  - *When multiple nodes share a single broadcast link-the multiple access problem occurs and the MAC protocol has to coordinate the frame transmissions of the many nodes.*
- **Reliable delivery: Reliable delivery services are offered by both transport layer and data link layer.**
  - *It is important for high error rate links such as wireless links, where the goal of correcting an error locally is more desirable than retransmission of the datagram.*
  - *Seldom used in low bit error links such as fiber and twisted pair wires.*

Functions of Data Link Layer Contd…

- **Error detection and Error correction:** *The transmitting node include error-detection bits in the frame, and having the receiving node perform an error check .*

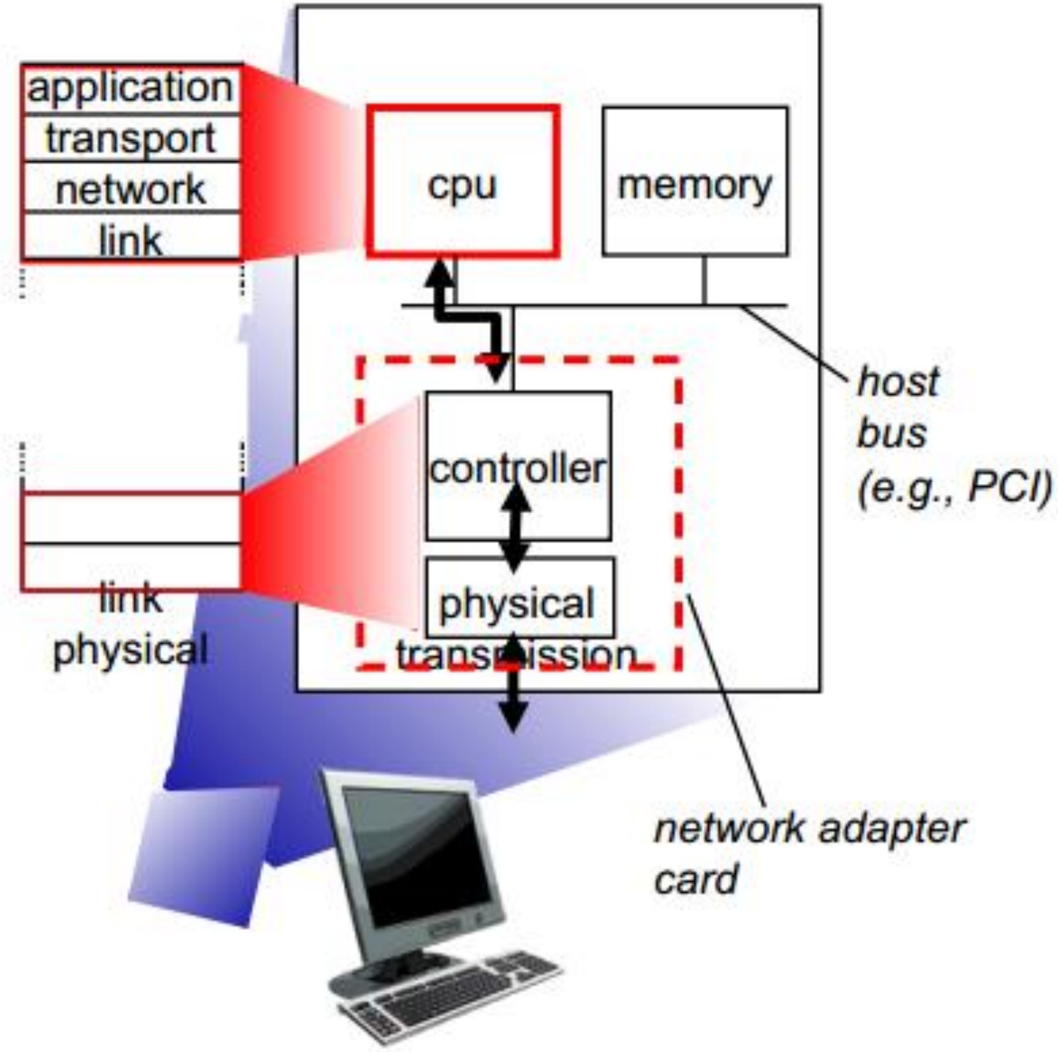


Where is this link layer implemented

- *Link layer is mostly implemented in the network adapter i.e. in the NIC (Network Interface Card) card*

- *At the heart of the network adapter is the link layer controller that implement many of the link layer services such as framing, link access, error detection and so on.*

- *Now a days network adapters are being integrated onto the hosts motherboard (LAN on motherboard configuration).*



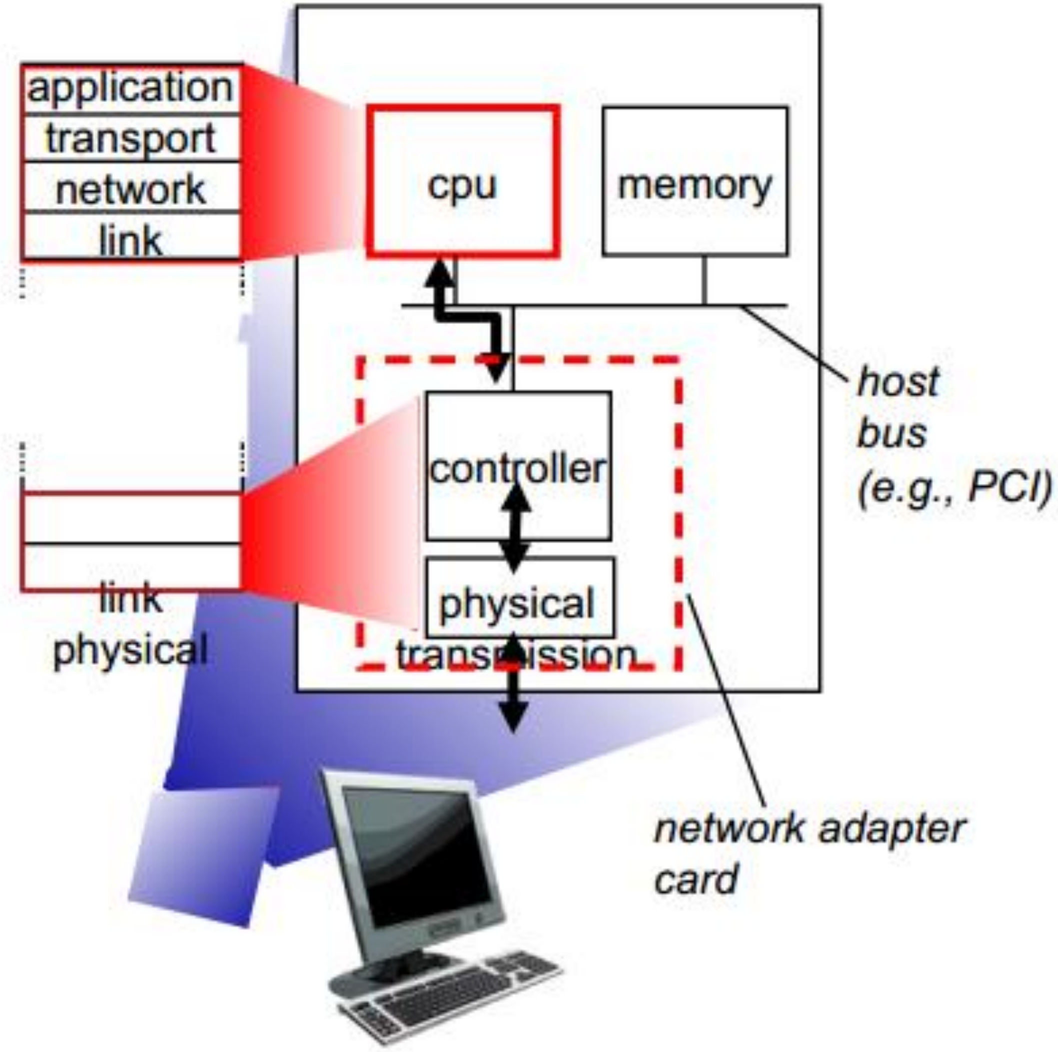
Where is this link layer implemented contd..

- On the sender side, the controller takes the datagram that has been created and stored in the host memory by the higher layers of protocol stack, encapsulate the datagram in a link layer frame and transmit the frame into the communication link, following the link access protocol.

- On the receiver side, a controller receives the entire frame and extracts the network layer datagram.

- If the link layer performs error detection, then the sending controller that sets the error-detection bits in the frame header and is the receiving controller that performs error detection.

- Link layer is a combination of hardware and software-the place where software meets hardware

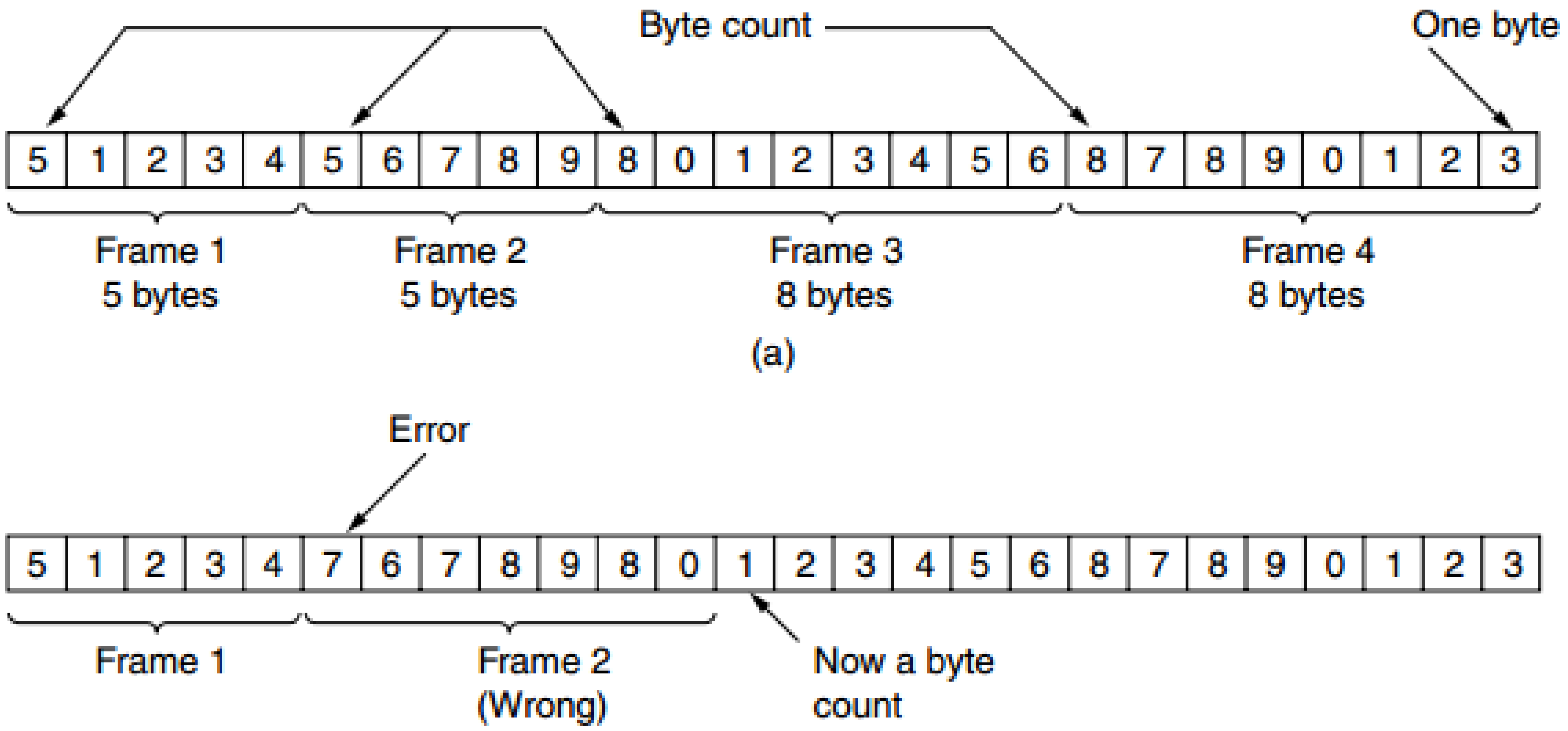


Framing

- Byte count
- Flag bytes with bytes stuffing
- Flag bits with bits stuffing
- Physical layer coding violation

Framing

- **Byte count**



Framing

➢ Flag Byte with Byte Stuffing

FLAG	Header	Payload field	Trailer	FLAG

- *Here the resynchronization problem in byte count is overcomed by inserted a special bytes at the starting and ending of a frame as delimiters, this special bytes are called Flag Byte*
- *Thus if the receiver ever loses synchronization then it will search for two consecutive Flag bytes to find the end of one frame and start of the next frame.*

Framing

- **Flag Byte with Byte Stuffing contd.**

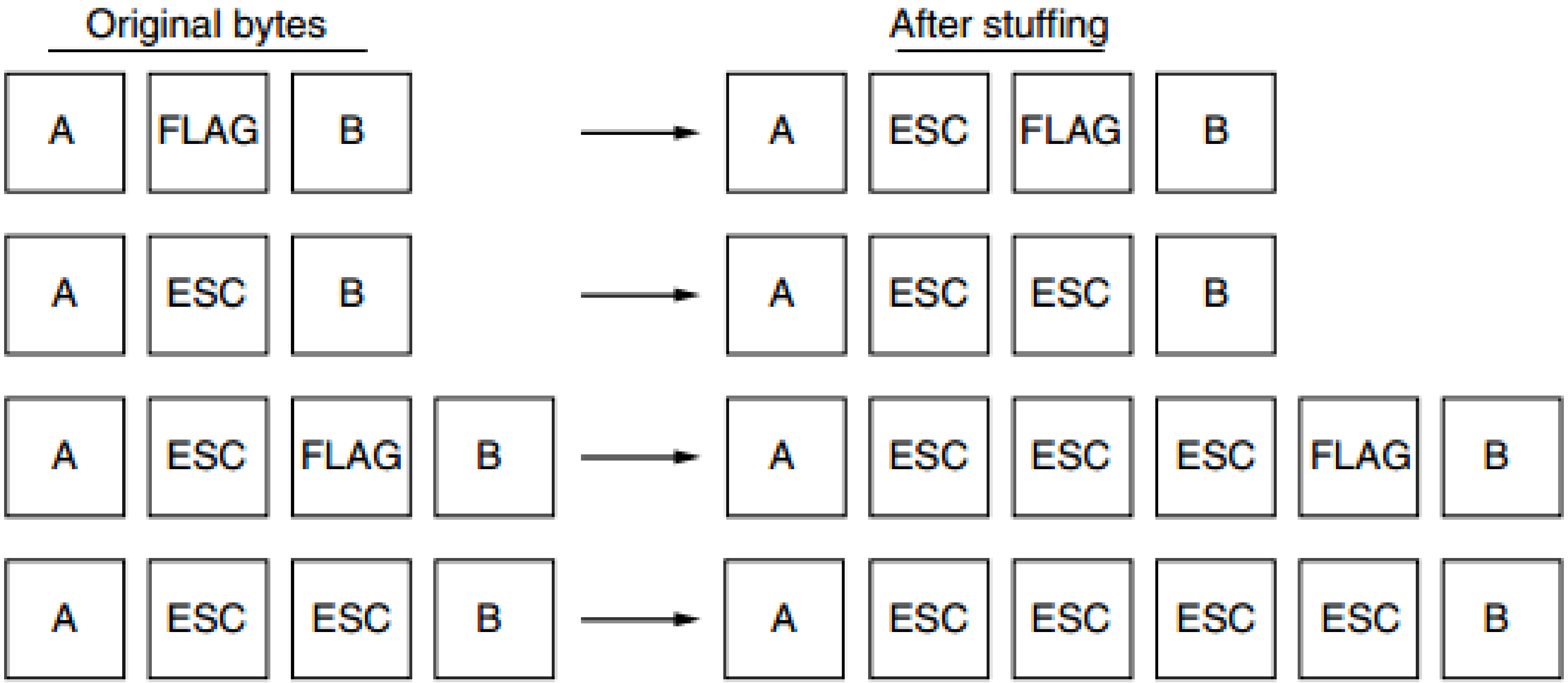
1100010011001100

- *If the same sequence of '0' and '1' which indicates the Flag bytes occurs in the middle of the data.*
- *To solve this problem is to have the sender's data link layer insert a special escape byte (ESC) just before each "accidental" flag byte in the data.*
- *Thus, a framing flag byte can be distinguished from one in the data by the absence or presence of an escape byte before it.*
- *The data link layer on the receiving end removes the escape bytes before giving the data to the network layer. This technique is called **byte stuffing**.*

Framing

Flag Byte with Byte Stuffing contd.

- *Now if the data itself consists of an ESC byte then what is the solution.*
- *It is again stuffed with an escape byte. At the receiver, the first escape byte is removed, leaving the data byte that follows it.*
- *the byte sequence delivered after **destuffing** is exactly the same as the original byte sequence.*



Framing

Flag Bit with Bit Stuffing

- *Byte stuffing has one disadvantage of that it is tied around to use of 8-bits byte.*
- *Frames can contain any arbitrary number of bits. It was for the protocol HDLC (High Level Data Link Control) protocol.*
- *Each of the frame begins and end with a special sequence of bits* **01111110** *or* **0x7E** *in Hex. This pattern is a Flag byte.*

01111110	**Data**	**01111110**

Framing

Flag Bit with Bit Stuffing contd…

- *If the sender data link layer finds the data consists of Flag byte then it automatically stuff one zero bit after five consecutive ‘1’s.*
- *The reviver finds five consecutive 1 bits, followed by a 0 bit, it automatically dyestuffs (i.e.) delete the 0 bit.*

Flag	Data	Flag
	0101011111101010	
01111110	01010111110101010	01111110

Framing

Physical layer coding Violations

- *In bit stuffing and byte stuffing the length the data increases unnecessarily.*
- *This takes helps of physical layer where there are some reserved signal which will be used to indicate the starting and ending of a frame.*

Error Detection and Correction Techniques

- *Parity Check*
- *Checksum*
- *Cyclic Redundancy Check (CRC)*

Error Detection and Correction Techniques

Checksum(at the Sender side)

- *Break the original message into 'k' number of blocks with 'n' bits in each block.*
- *Sum all the 'k' data blocks*
- *Add the carry to the sum if any.*
- *Do 1's complement of the sum and this will be the checksum bit which will be appended with the transmitted data.*

Checksum(at the Receiver side)

- *Sum all the 'k' data blocks with the checksum bits*
- *If the resultant sum is all '1's then the received data bit is correct and error free.*

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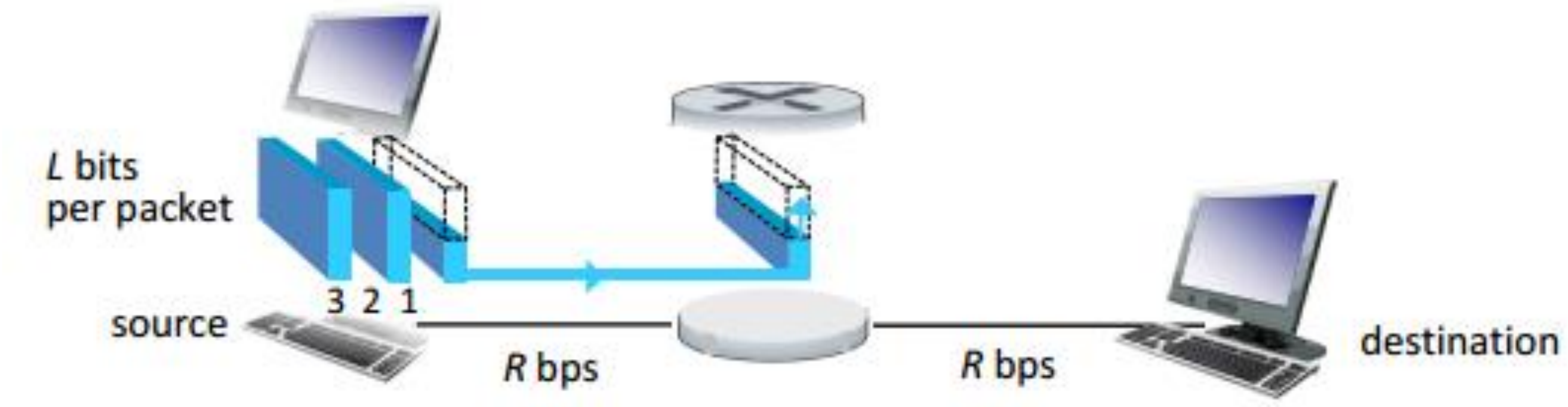
Store-and-Forward



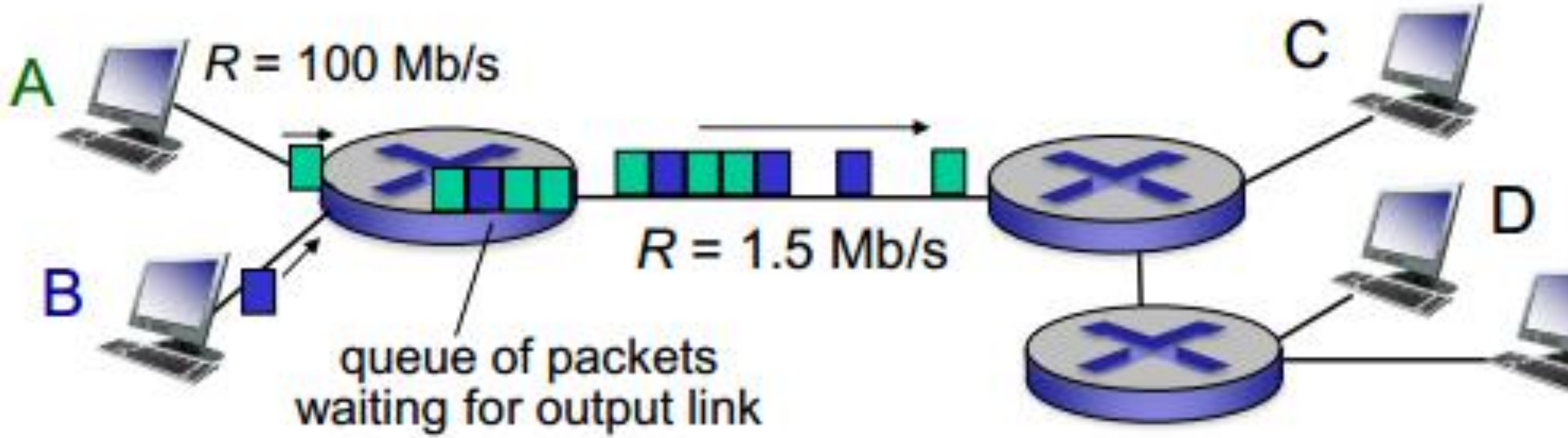
- The packet switch must receive the entire packet before it can *start* to transmit the first bit of the packet onto the outbound link. Instead it must *store* the packets' bits.
- Suppose the source is transmitting 3 packets of equal length of *L* bits and the link has a transmission rate of R bits/sec
- Until the entire bits of packet #1 will reaches at the router, the router will not begin transmission. So, the time required for the packet #1 to reach the destination is (L/R+L/R)secs i.e. 2L/R secs.

Store-and-Forward

- **Now for reaching all the *three* packets for reaching the destination is (3L/R+L/R) secs.**
- **Here we have considered that the router has only one incoming and out going link.**
- **Now for sending one packet from source to destination over a path consists of N links (means N-1 routers have to crossed) each of transmission rate of R bits/sec.**
- **Then the total end to end delay is**

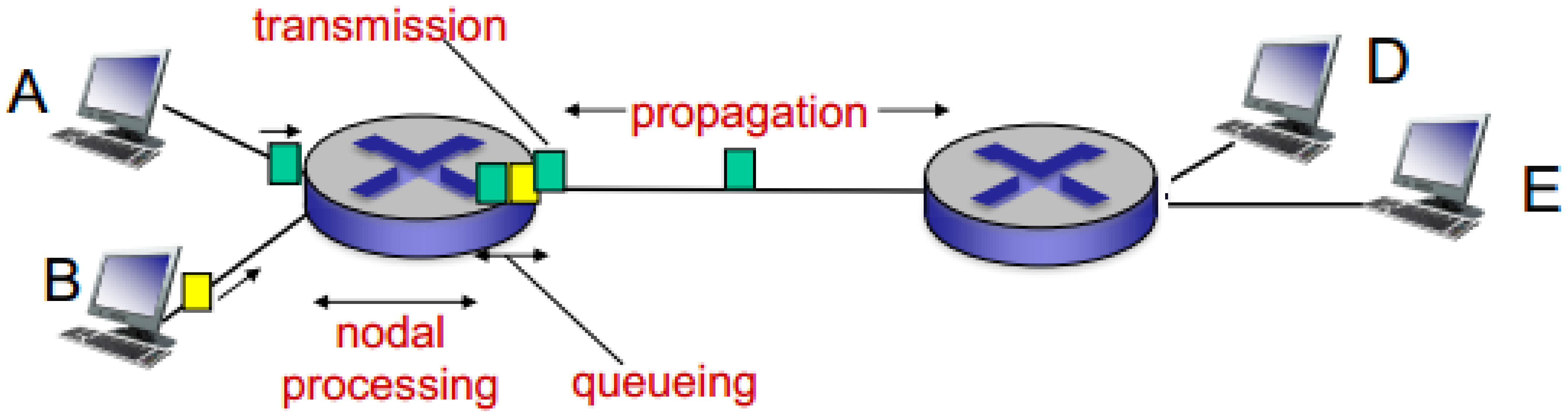
$$d_{end-to-end} = N\frac{L}{R}$$

Queuing delay and Packet loss



- For each attached link packet switch has an output buffer (also known as output queue) which stores packet which the router is about to send into that link.
- This queueing occurs when the arrival rate on the link exceeds the trasmmission rate of the link for a period of time.
- Two things happens in such situations:
- Packet will be queued, wait to be transmitted on the link
- Packets can be dropped (lost) if memory (buffer) fills

Four source of Packet delay



- A packet starts in a host (the source e.g. A or B), passes through a series of routers, ends its journey in another host (destination e.g. C or D). As packet travels from a node (host or router) to the subsequent node (host or router) along this path, suffers from several types of delay.

$$d_{nodal} = d_{proc} + d_{queue} + d_{trans} + d_{prop}$$

Processing Delay (d_{proc}) *Processing delay in high speed routers are typically on the order of microseconds or less.*

Queueing Delay (d_{queue}) *packets will be transmitted in a first-come-first-served manner. waiting Time at the output link for transmission depends on congestion level of routers.*

Transmission Delay (d_{trans}) *If the length f packet is L bits and the transmission rate of the link from router A to B is R bits/sec then the transmission delay is*

$$d_{trans} = \frac{L}{R}\ sec$$

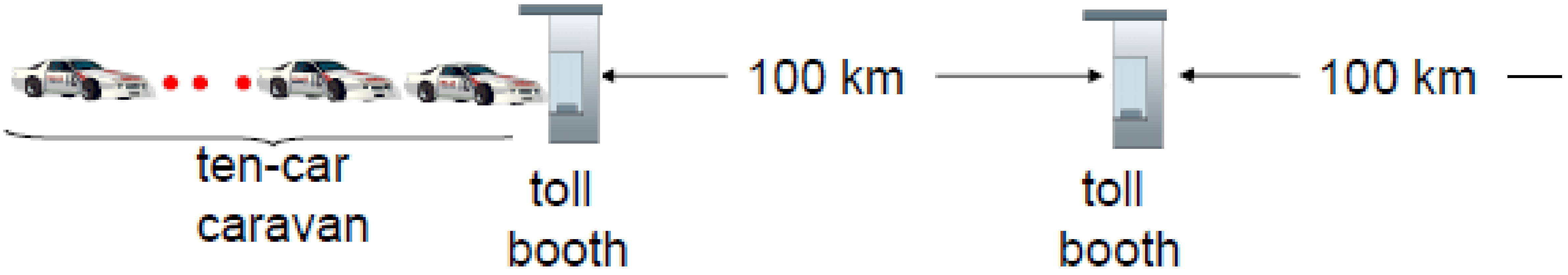
It is the amount of delay or time required to push all the bits of a packet into the link.
It is order of milisecs or microsecs.

Propagation Delay (d_{prop})

The propagation delay is given by

$$d_{prop} = \frac{Distance\ between\ the\ two\ router\ (phyisical\ Length)}{Propagation\ speed\ of\ the\ link} = \frac{d}{s}$$

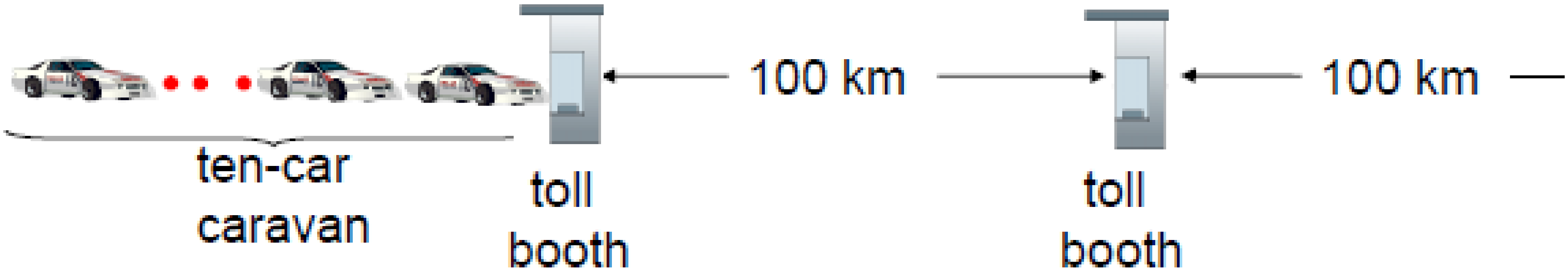
Caravan Analogy



- *In a highway each of the tollbooths are 100 kms away.*
- *Suppose there are 10 cars travelling together as caravan, follow each other in a fixed order.*
- *Assume that the car travels on the highway at a rate of 100kms/hours.*

$$d_{prop} = \frac{Distance\ between\ the\ two\ router\ (phyisical\ Length)}{Propagation\ speed\ of\ the\ link} = \frac{d}{s} = \frac{100\ Kms}{100kms/hour}$$
$$= 60\ mins$$

Caravan Analogy Contd…

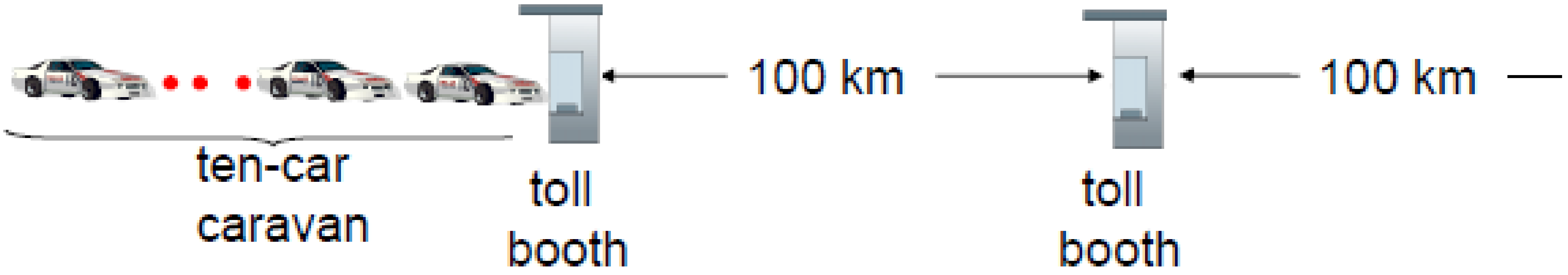


- *Let the tollbooth services the one car at 12 secs. On the other way in 60 secs it will be able to service all the 10 cars.*
- *So the transmission delay of the caravan*

$$d_{trans} = \frac{Length\ of\ packet}{Transmission\ rate\ of\ the\ link} = \frac{L}{R} = \frac{10\ cars}{5\ cars/min} = 2mins$$

- *Also assume that whenever the first car arrives at the tollbooth it waits at the entrance of the tollbooth until the other 9 cars arrives and lined up in sequence.*

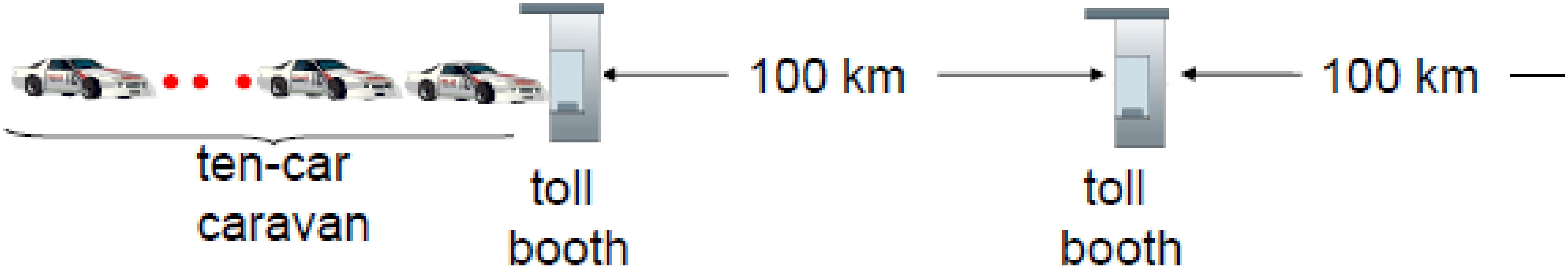
Caravan Analogy Contd…



- *So finally the time from when the caravan is stored infront of a tollbooth until the caravan is stored infront of the next tollbooth is the sum of the*

$d_{trans} + d_{prop} = 60 + 2 = 62 mins$

Caravan Analogy



- *In a highway each of the tollbooths are 100 kms away.*
- *Suppose there are 10 cars travelling together as caravan, follow each other in a fixed order.*
- *Assume that the car travels on the highway at a rate of 1000kms/hours.*

$$d_{prop} = \frac{Distance\ between\ the\ two\ router\ (phyisical\ Length)}{Propagation\ speed\ of\ the\ link} = \frac{d}{s} = \frac{100\ Kms}{1000kms/hour}$$

$$= 6\ mins$$

Caravan Analogy Case2 Contd…

- *Let the tollbooth services the one car at 1 mins secs.*
- *So the transmission delay of the caravan*

$$d_{trans} = \frac{Length\ of\ packet}{Transmission\ rate\ of\ the\ link} = \frac{L}{R} = \frac{10\ cars}{1\ cars/min} = 10\ mins$$

- *So the **transmission delay > propagation delay**. In this case the first car will reach the next tollbooth before the last care in the caravan leaves the first tollbooth.*

Computer Networks CS301

Module 1

Introduction to Computer Networks

Dr. Sunandita Debnath, IIIT Vadodara

Queuing Delay and Packet Loss

Queuing Delay:

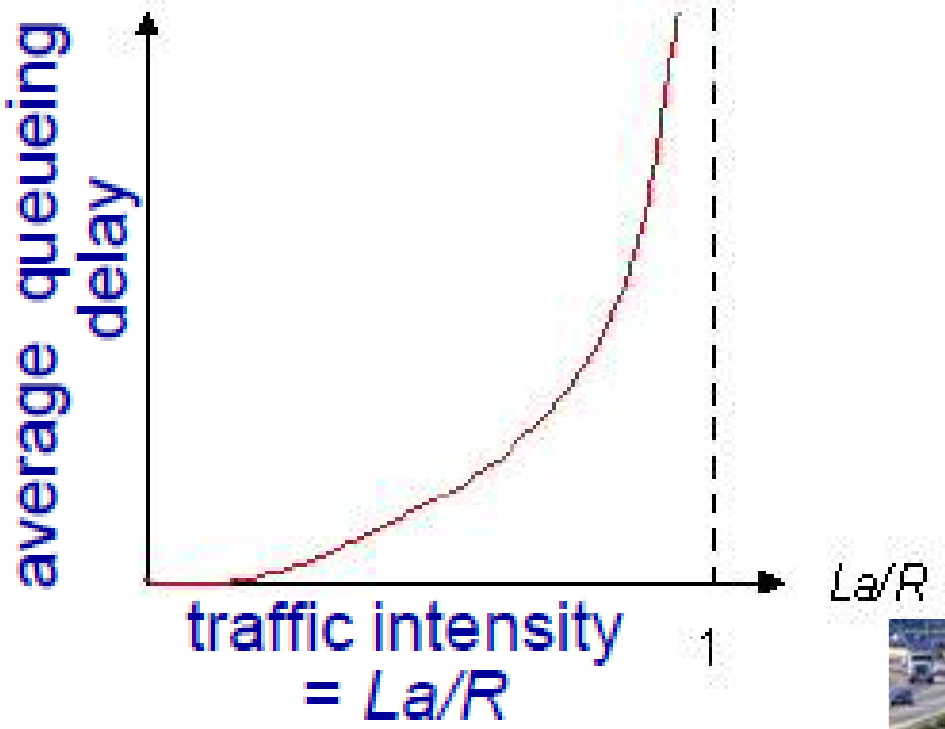
- *Let a = average rate at which packet arrives at the queue a packets/sec*
- *R = transmission rate (in bits/sec) at which the bits are pushed out of the queue and loaded to the outbound link of the router.*
- *Assume each of the packet is consists of L bits. So, the total size of traffic in bits La.*

$$Tarffic\ Intensity = \frac{La}{R}\ (the\ desired\ traffic\ intensity\ should\ not\ be\ greater\ than\ 1)$$

- $If\ \frac{La}{R} > 1,\ the\ arrival\ rate\ is\ greater\ than\ transmiison\ rate.$
- $If\ \frac{La}{R} < 1,\ the\ arrival\ rate\ is\ lesser\ than\ transmiison\ rate.$
- *If packets arrive in bursts but periodically, there can be a significant average queuing delay. For example, suppose N packets arrive simultaneously every (L/R)N seconds. Then the first packet transmitted has no queuing delay; the second packet transmitted has a queuing delay of L/R seconds; and more generally, the Nth packet transmitted has a queuing delay of (N-1)L/R seconds.*

Queuing Delay and Packet Loss

Queuing Delay



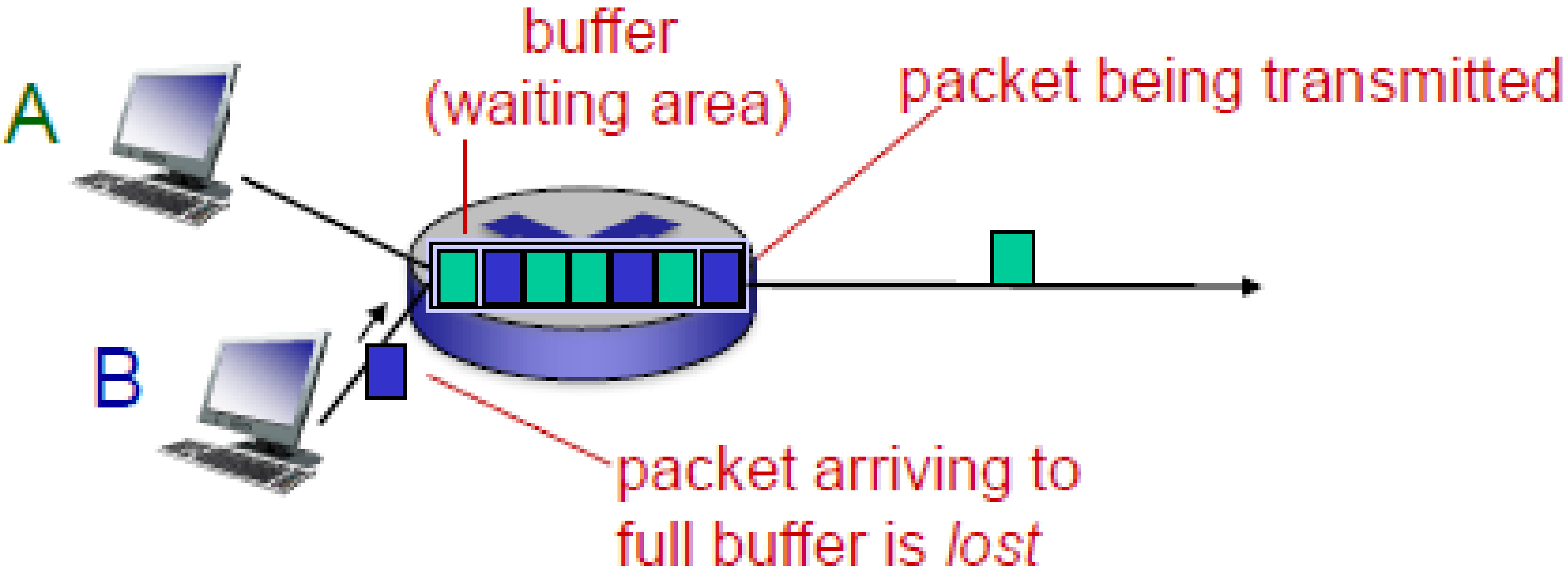
La/R~0

La/R> 1

Queuing Delay and Packet Loss

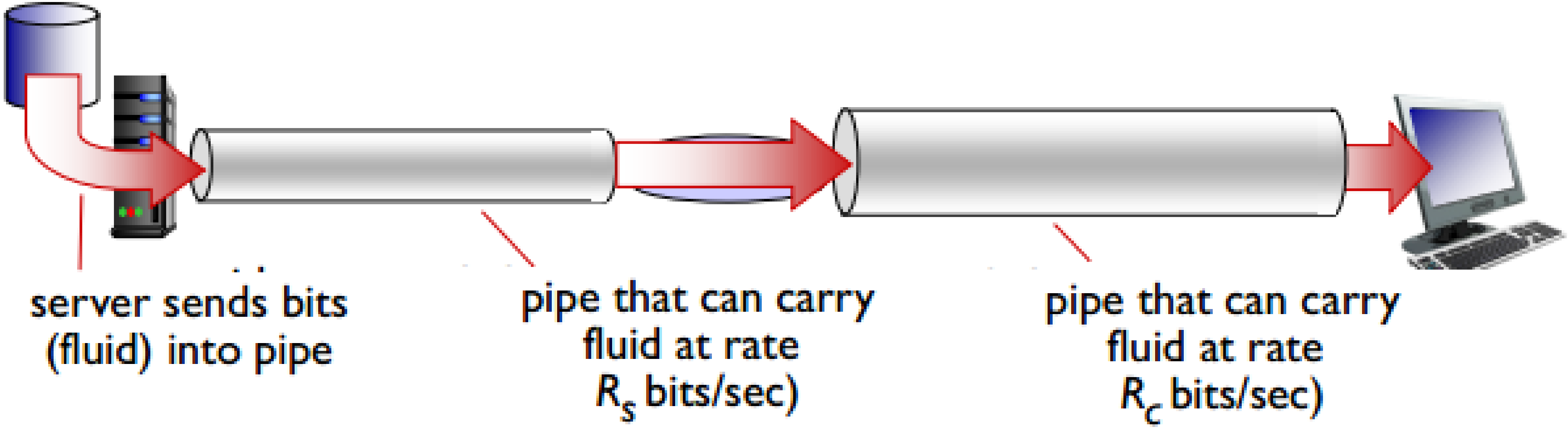
Packet Loss:

- *Queue (buffer) has finite capacity*
- *If the queue is full, then any new packet arriving at the router will be lost or dropped.*
- *Lost packet may be retransmitted*
- *The fraction of lost packet increasing as the traffic intensity increases.*



Throughput

- *The rate (bits/sec) at which bits transferred from sender to receiver.*
- *suppose the rate of the link between server and router is R_s $bits/sec$, and the rate of the link between the router and the client is R_c $bits/sec$.*
- *Two cases and occur $R_s < R_c$ and $R_s > R_c$*



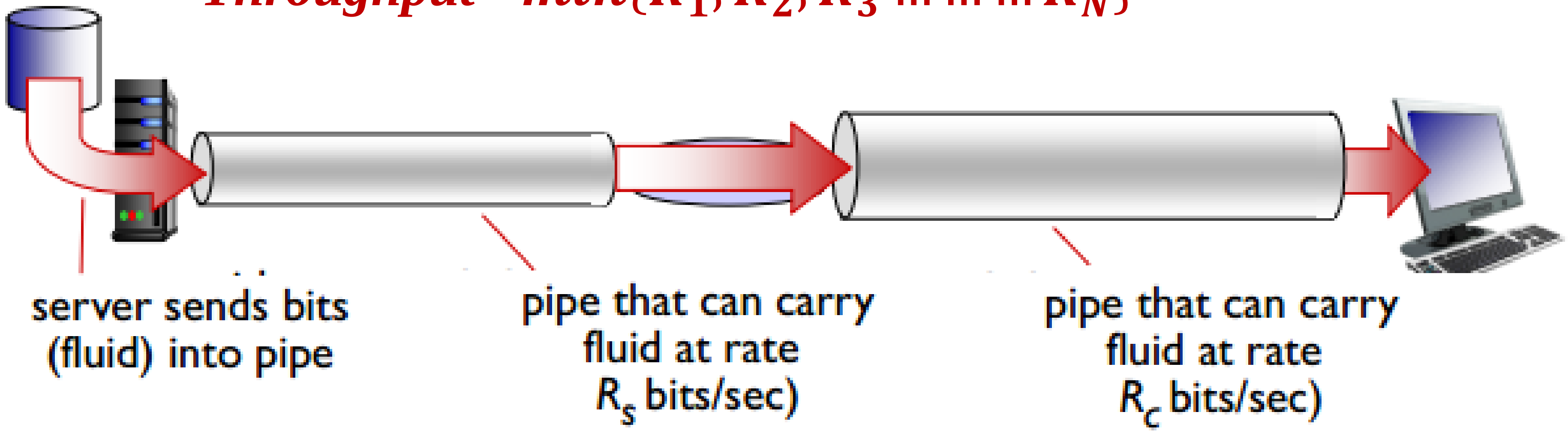
Throughput contd..

- $R_s < R_c$: *the bits pumped by the server will flow right through the router and arrive at the client at a rate of* R_s *bits/sec, giving a throughput of* R_s *bps.*
- $R_s > R_c$: *the router will not be able to forward bits as quickly as it receives them from the server. In this case bits will only leave the router at a rate of* R_c*bits/sec, giving a throughput of* R_c *bps.*
- *Because of this condition the backlog of bits at the router waiting for transmission to the client will grow and grow –which is a most undesirable condition*

$$\textbf{Throughput} = \boldsymbol{min\{R_s, R_c\}}$$

If there are N no. of links and transmission rates $\boldsymbol{of\ R_1, \ldots\ldots R_N}$***, then the throughput will be***

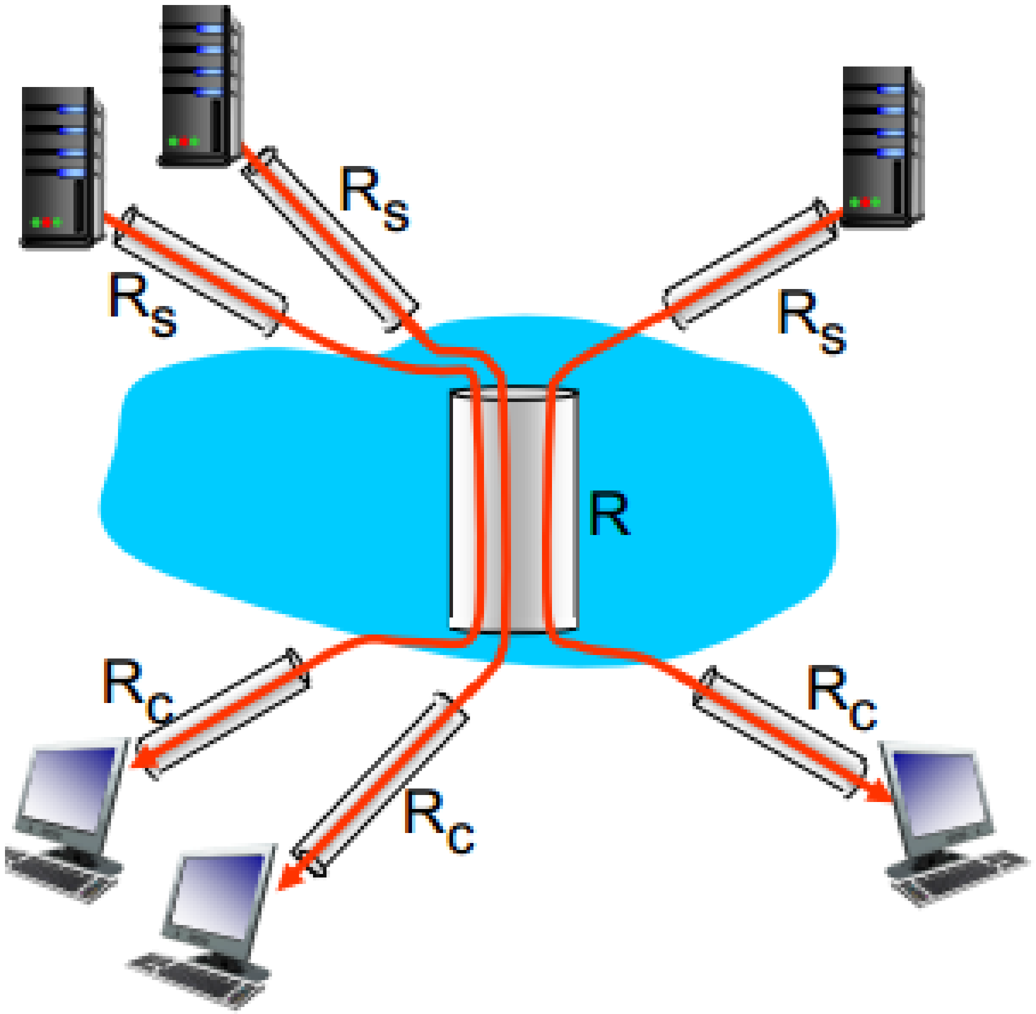
$$\textbf{Throughput} = \boldsymbol{min\{R_1, R_2, R_3 \ldots\ldots\ldots R_N\}}$$



Throughput contd..

- *Suppose there are 10 downloads from the server to client and these are the only traffic in the network.*
- *All server access link have a rate of R_s, and all client access links a have a rate of R_c bps.*
- *The common link has a transmission rate of R bps.*
- *Suppose **R_s** = 2 Mbps, **R_c** = 1 Mbps and **R** = 5 Mbps. The R will be equally shared among the 10 links **5Mbps/10 = 500 Kbps**.*

  ***Throughput= 500 Kbps**.*

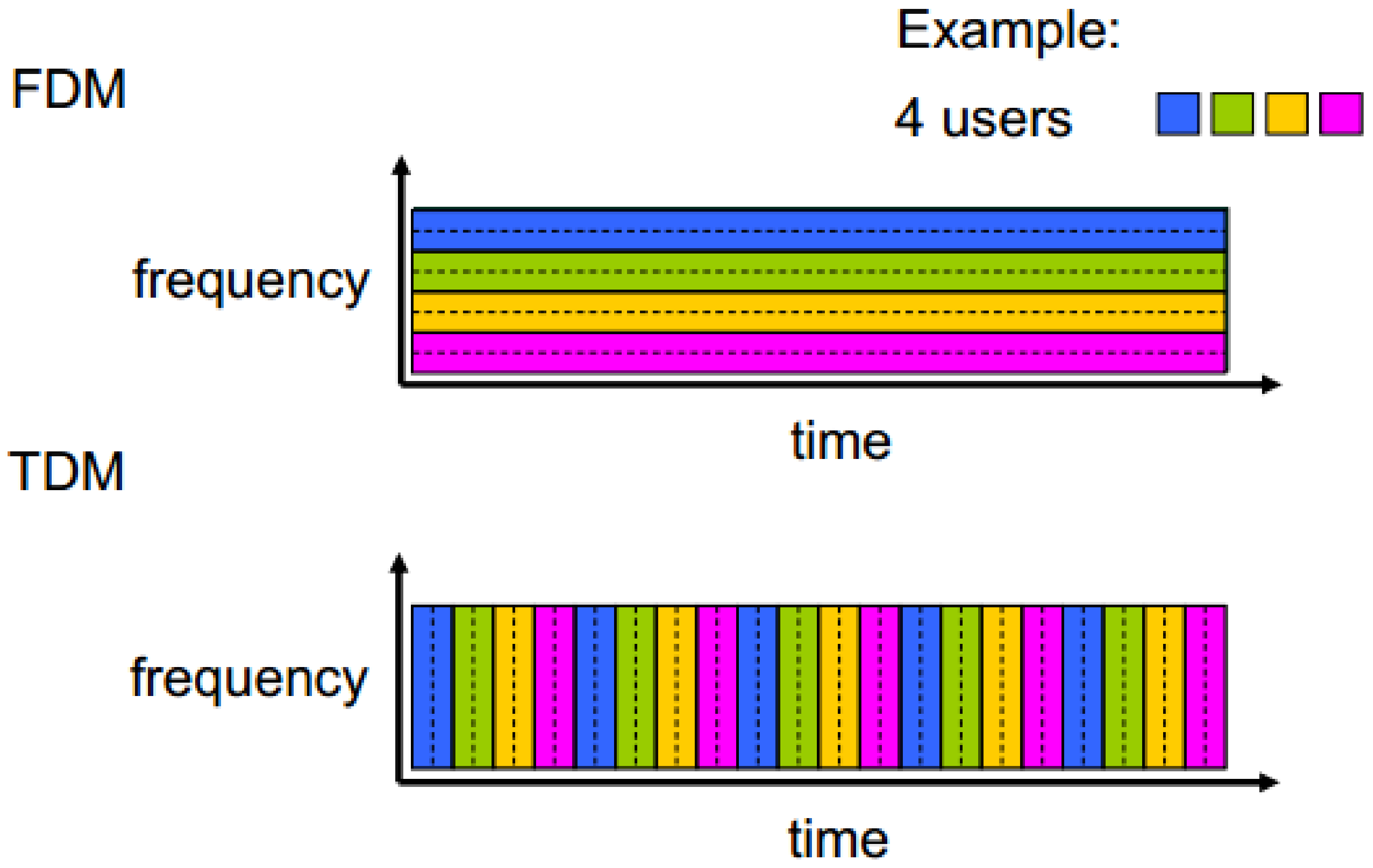


10 connections (fairly) share backbone bottleneck link *R* bits/sec

Note: Packet switches can be both routers and link layer switches.

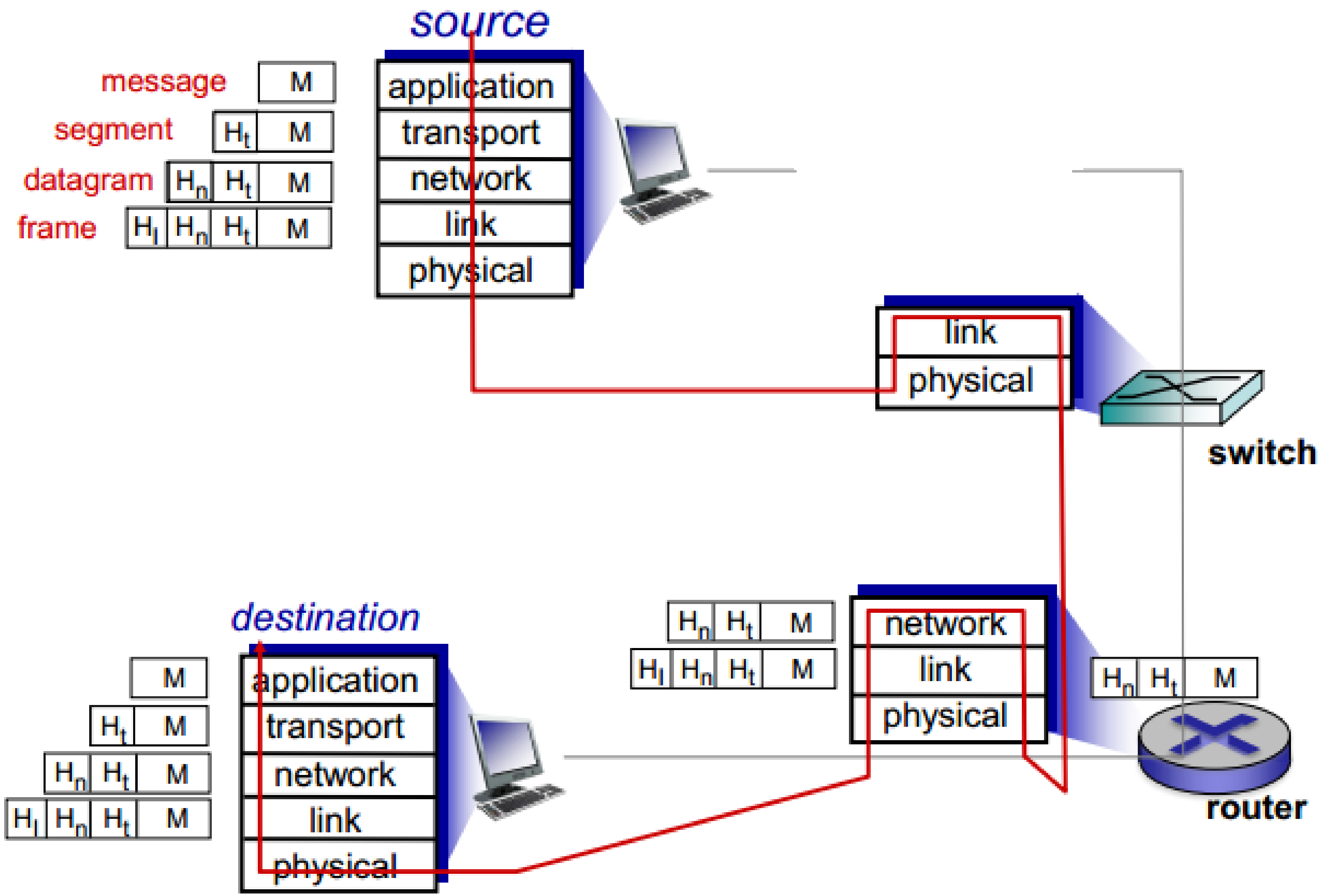
Circuit Switching

- TDM (Time Division Multiplexing)
- FDM (Frequency Division Multiplexing)



Encapsulation

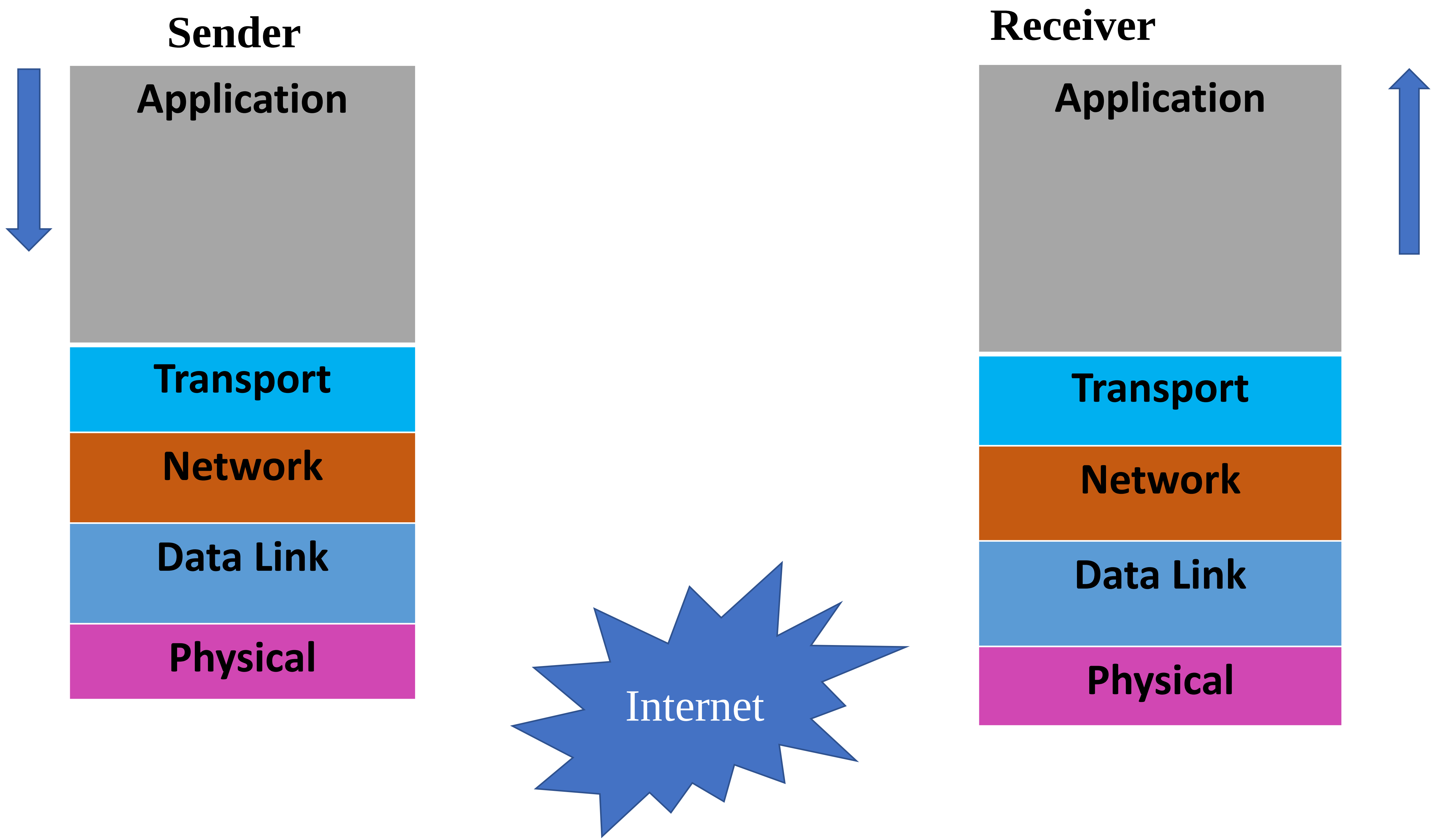
- At each layer the a packet has two fields one is header fields and one is payload field.
- Payload is the typically a packet received from the above layer.



Module 1

Introduction to Computer Networks

Dr. Sunandita Debnath, IIIT Vadodara


Sender
Application
Transport
Network
Data Link
Physical
Internet
Receiver
Application
Transport
Network
Data Link
Physical

Data Link Layer

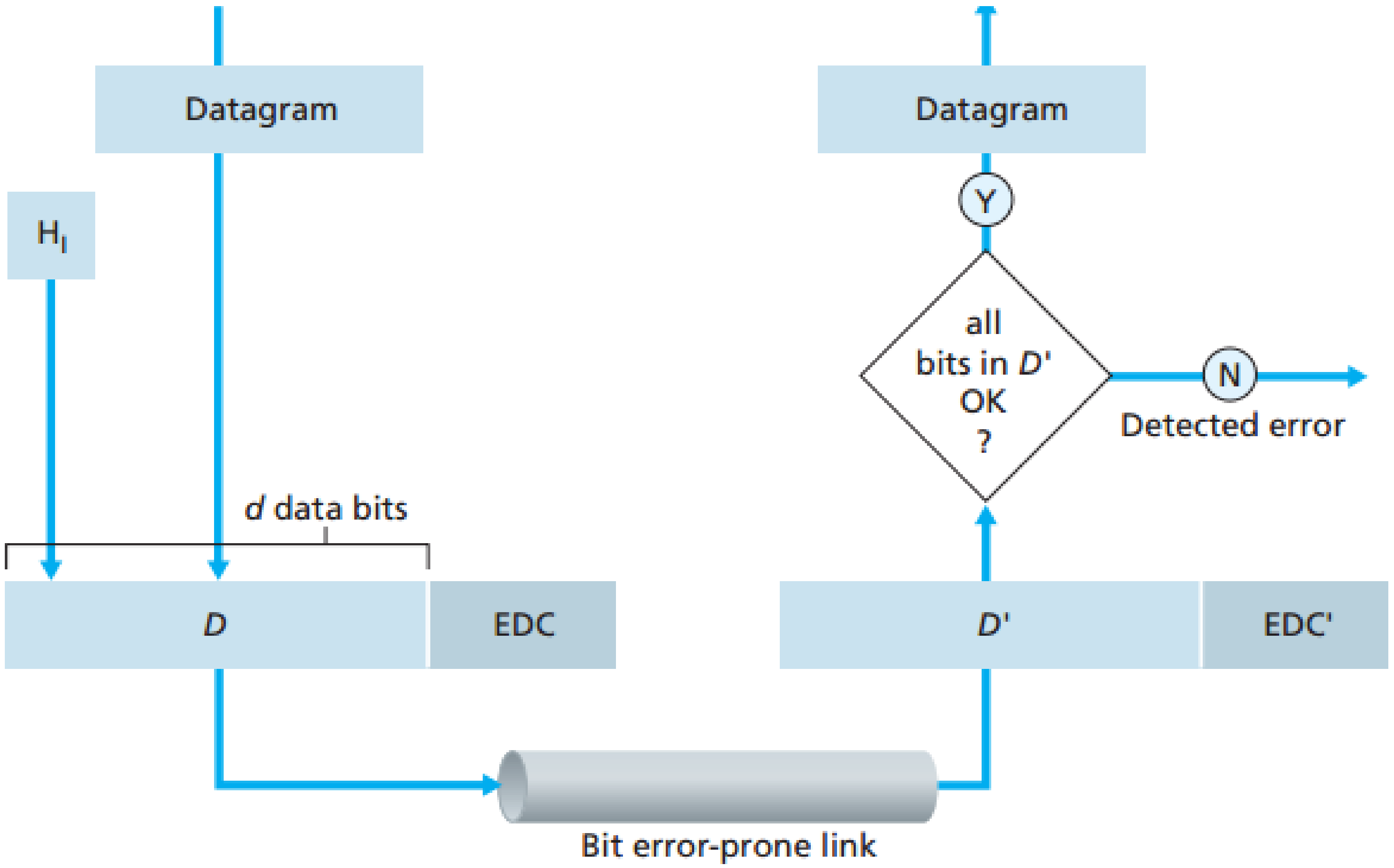
- **Data link layer is also known as Layer 2. Data link resides between the network layer and physical layer.**
- **Datalink layer are responsible for transferring datagram from one node to physically adjacent node over a link.**
- **Switch is a layer 2 device.**

Functions of Data Link Layer

- **Framing:** *encapsulate datagram into frame, i.e. adding header and trailer.*
- **Link access:** *Channel access if share media. A MAC protocol specifics the rules by which a frame is transmitted onto the link.*
  - *When there is a point-to-point connection between a sender ad receiver i.e. a single sender at one end of the link and a single receiver at another end of the link, then the MAC protocol is simple means whenever the link is idle the sender can send.*
  - *When multiple nodes share a single broadcast link-the multiple access problem occurs and the MAC protocol has to coordinate the frame transmissions of the many nodes.*
- **Reliable delivery: Reliable delivery services are offered by both transport layer and data link layer.**
  - *It is important for high error rate links such as wireless links, where the goal of correcting an error locally is more desirable than retransmission of the datagram.*
  - *Seldom used in low bit error links such as fiber and twisted pair wires.*

Functions of Data Link Layer Contd…

- **Error detection and Error correction:** *The transmitting node include error-detection bits in the frame, and having the receiving node perform an error check .*

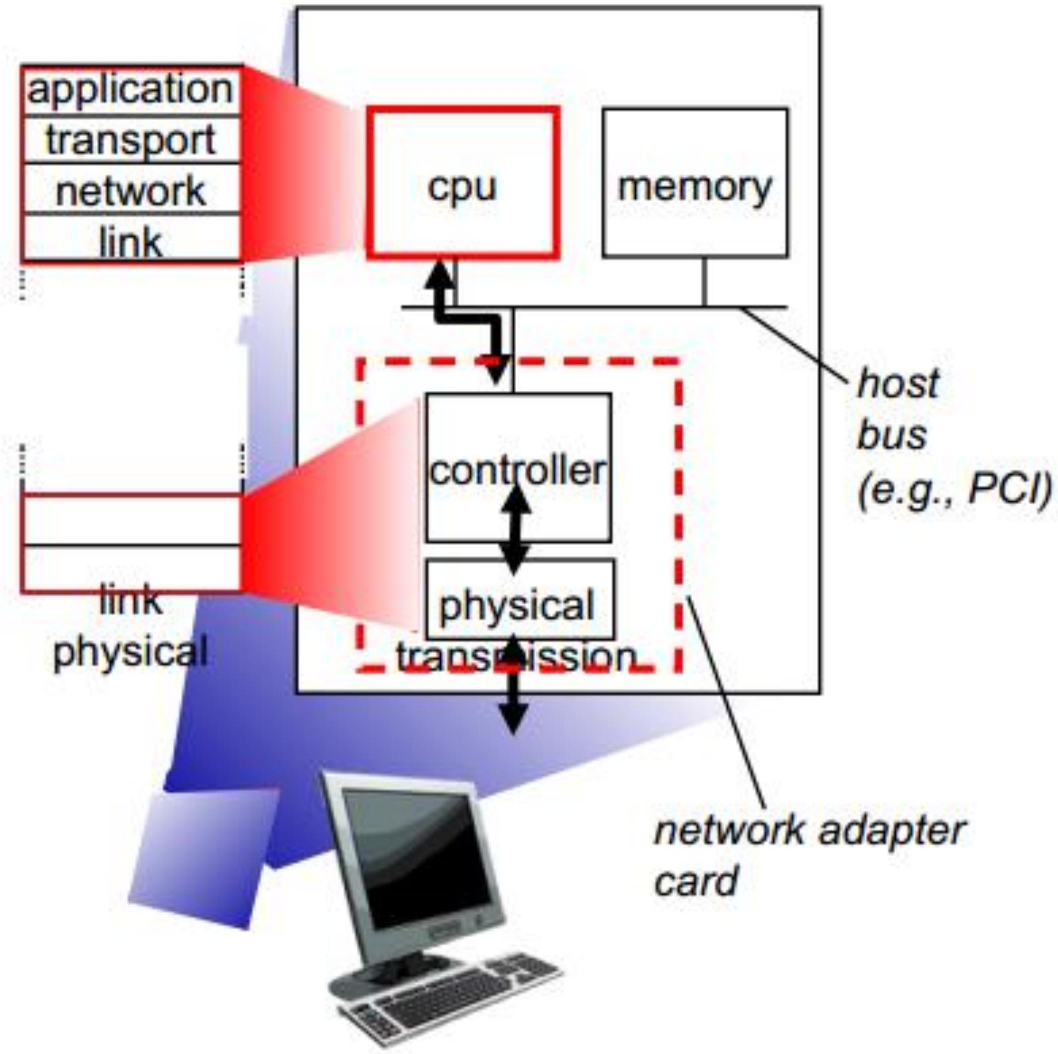


Where is this link layer implemented

- *Link layer is mostly implemented in the network adapter i.e. in the NIC (Network Interface Card) card*

- *At the heart of the network adapter is the link layer controller that implement many of the link layer services such as framing, link access, error detection and so on.*

- *Now a days network adapters are being integrated onto the hosts motherboard (LAN on motherboard configuration).*



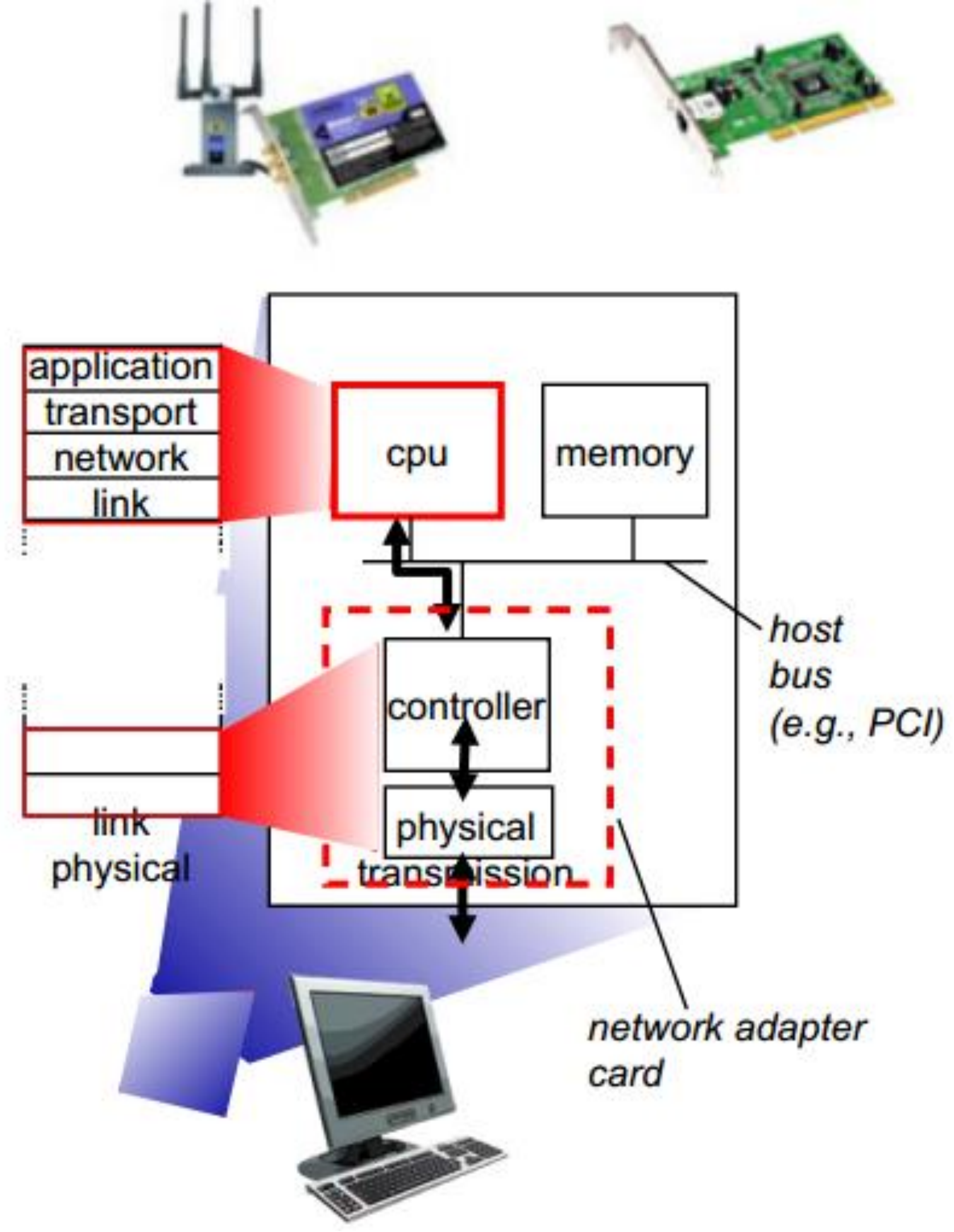
Where is this link layer implemented contd..

- *On the sender side, the controller takes the datagram that has been created and stored in the host memory by the higher layers of protocol stack, encapsulate the datagram in a link layer frame and transmit the frame into the communication link, following the link access protocol.*

- *On the receiver side, a controller receives the entire frame and extracts the network layer datagram.*

- *If the link layer performs error detection, then the sending controller that sets the error-detection bits in the frame header and is the receiving controller that performs error detection.*

- *Link layer is a combination of hardware and software-the place where software meets hardware*



Computer Networks CS301

Module 1

Introduction to Computer Networks

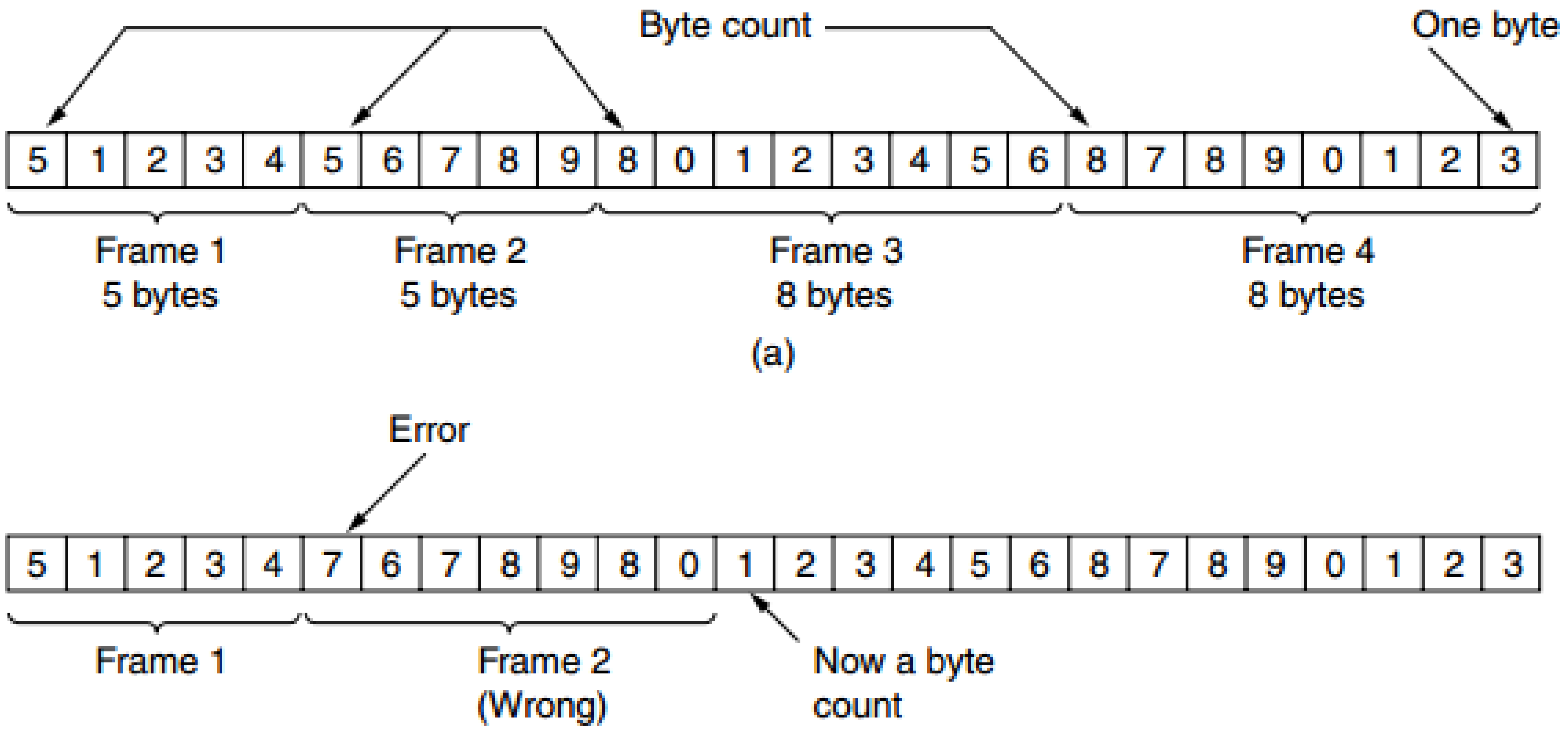
Dr. Sunandita Debnath, IIIT Vadodara

Framing

- **Byte count**
- **Flag bytes with bytes stuffing**
- **Flag bits with bits stuffing**
- **Physical layer coding violation**

Framing

➢ **Byte count**



Framing

➢ Flag Byte with Byte Stuffing

FLAG	Header	Payload field	Trailer	FLAG

- *Here the resynchronization problem in byte count is overcomed by inserted a special bytes at the starting and ending of a frame as delimiters, this special bytes are called Flag Byte*
- *Thus if the receiver ever loses synchronization then it will search for two consecutive Flag bytes to find the end of one frame and start of the next frame.*

Framing

- **Flag Byte with Byte Stuffing contd.**

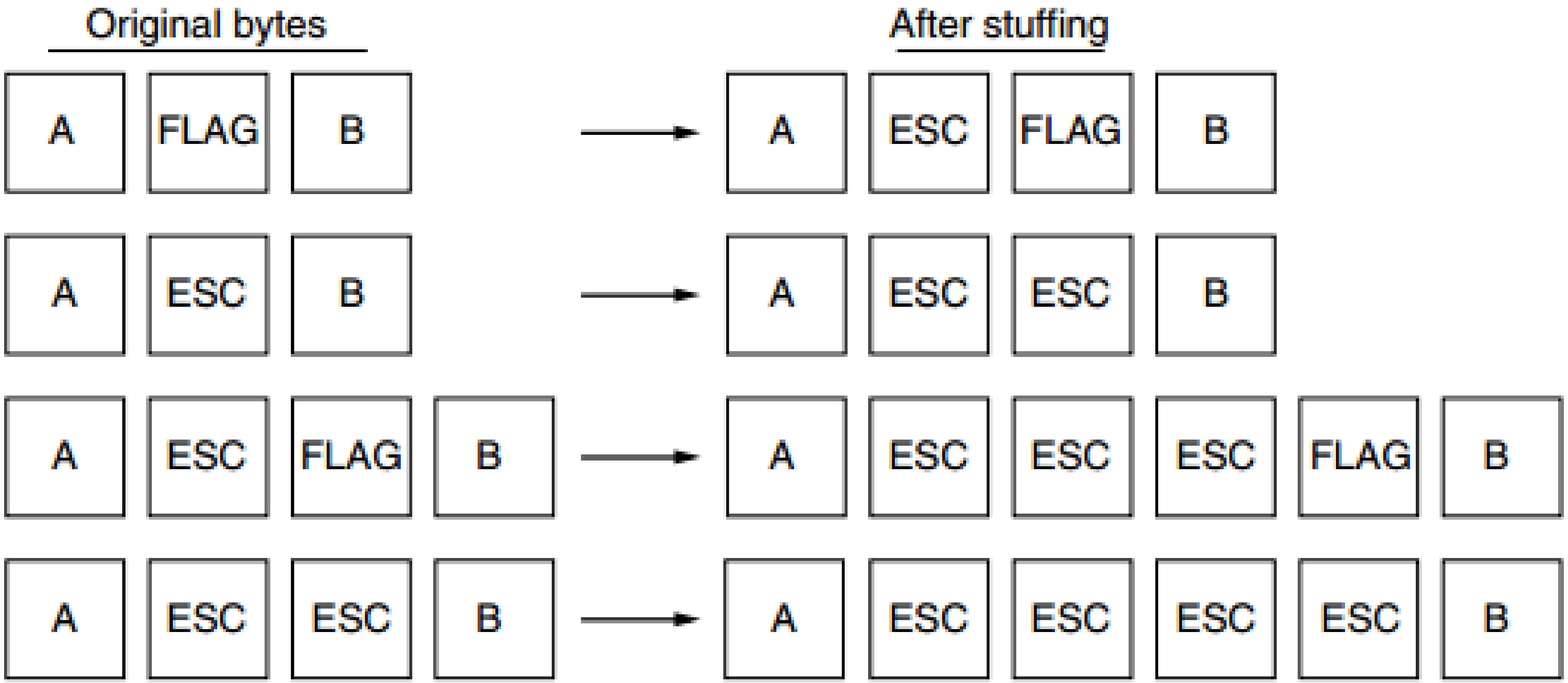
1100010011001100

- *If the same sequence of '0' and '1' which indicates the Flag bytes occurs in the middle of the data.*
- *To solve this problem is to have the sender's data link layer insert a special escape byte (ESC) just before each "accidental" flag byte in the data.*
- *Thus, a framing flag byte can be distinguished from one in the data by the absence or presence of an escape byte before it.*
- *The data link layer on the receiving end removes the escape bytes before giving the data to the network layer. This technique is called **byte stuffing**.*

Framing

Flag Byte with Byte Stuffing contd.

- *Now if the data itself consists of an ESC byte then what is the solution.*
- *It is again stuffed with an escape byte. At the receiver, the first escape byte is removed, leaving the data byte that follows it.*
- *the byte sequence delivered after **destuffing** is exactly the same as the original byte sequence.*



Framing

Flag Bit with Bit Stuffing

- *Byte stuffing has one disadvantage of that it is tied around to use of 8-bits byte.*
- *Frames can contain any arbitrary number of bits. It was for the protocol HDLC (High Level Data Link Control) protocol.*
- *Each of the frame begins and end with a special sequence of bits* **01111110** *or* **0x7E** *in Hex. This pattern is a Flag byte.*

01111110	**Data**	**01111110**

Framing

Flag Bit with Bit Stuffing contd…

- *If the sender data link layer finds the data consists of Flag byte then it automatically stuff one zero bit after five consecutive ‘1’s.*
- *The reviver finds five consecutive 1 bits, followed by a 0 bit, it automatically dyestuffs (i.e.) delete the 0 bit.*

Flag	Data	Flag
	0101011111101010	
01111110	01010111110101010	01111110

Framing

Physical layer coding Violations

- *In bit stuffing and byte stuffing the length the data increases unnecessarily.*
- *This takes helps of physical layer where there are some reserved signal which will be used to indicate the starting and ending of a frame.*

Module 2

Data Link Layer

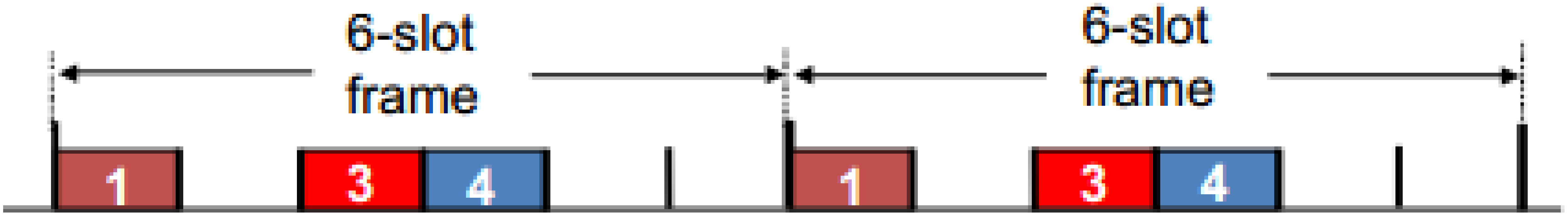
Dr. Sunandita Debnath, IIIT Vadodara

Channel partioning protocol

- *TDMA (Time Division Multiple Access)*
- *FDMA (Frequency Division Multiple Access)*
- *CDMA (Code Division Multiple access)*

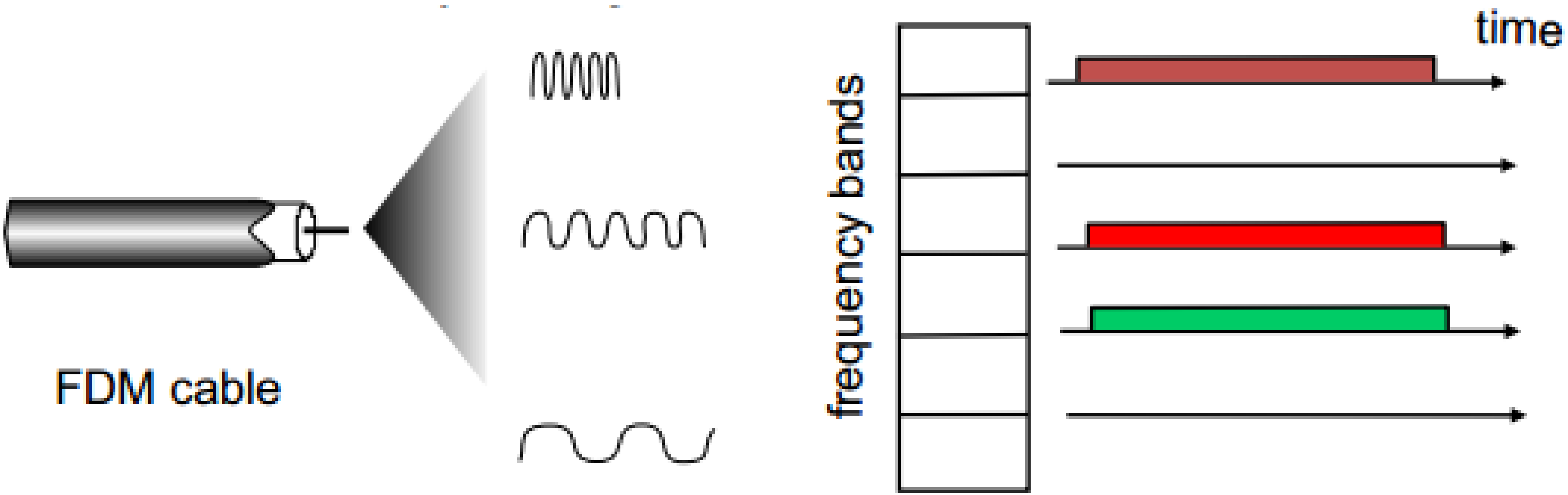
Channel portioning protocol

- *TDMA (Time Division Multiple Access)*



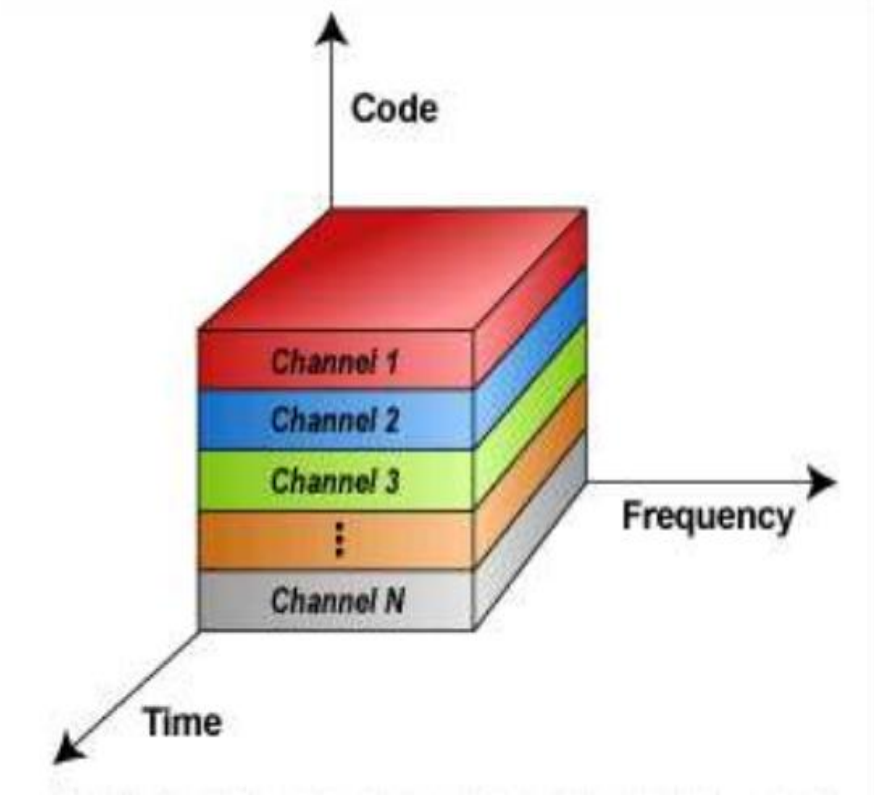
Channel portioning protocol

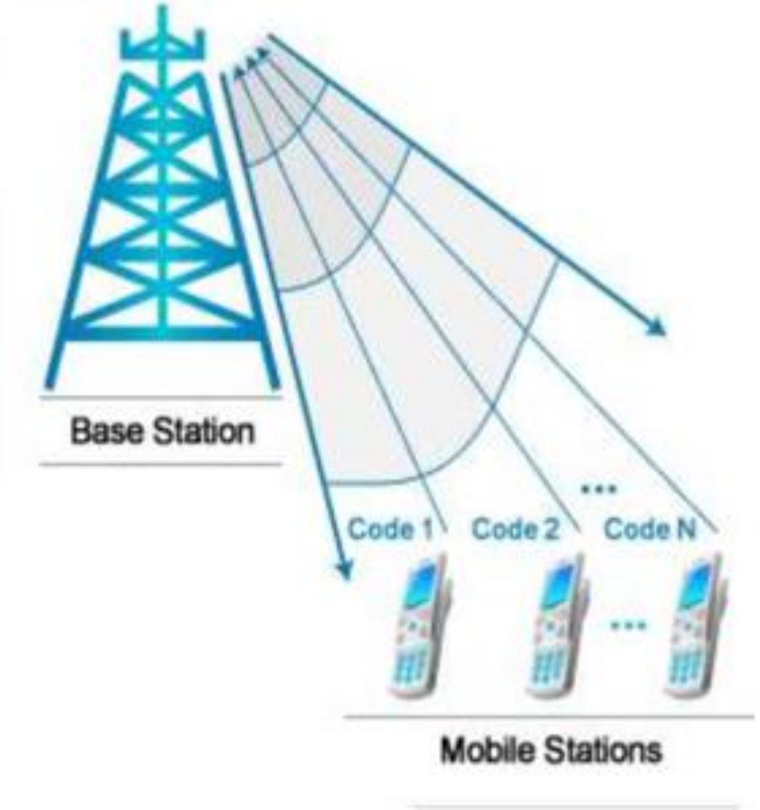
- ***FDM (Frequency Division Multiple Access)***



Channel portioning protocol

- *CDMA (Code Division Multiple Access)*





Random access Protocol

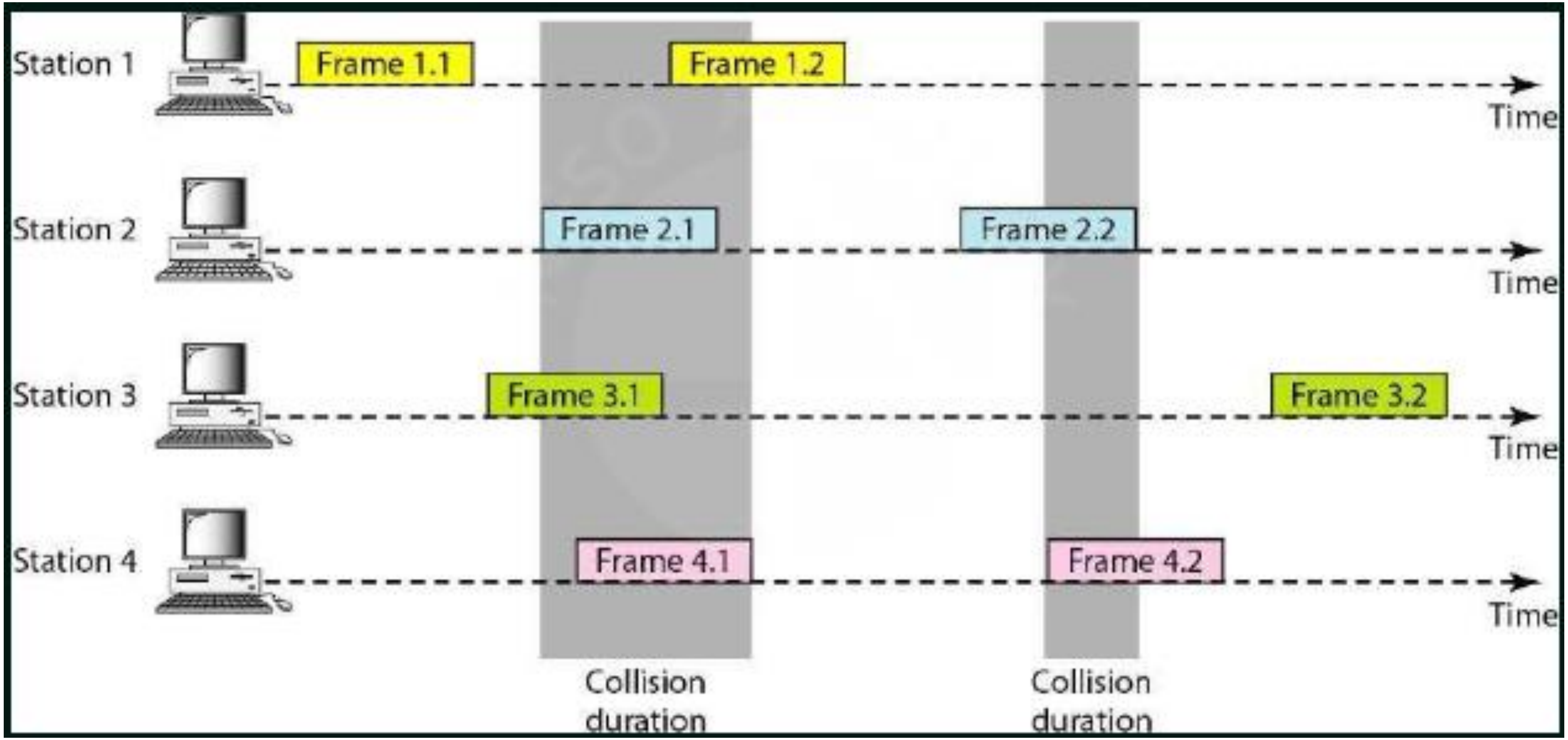
- ***ALOHA***
  - *Pure ALOHA*
  - *Slotted ALOHA*

- ***CSMA(Carrier Sense Multiple access)***
  - *1-persistent*
  - *non-persistent*
  - *P-persistent*
  - *O-persistent*

- ***CSMA/CA***
- ***CSMA/CD***

Random access Protocol

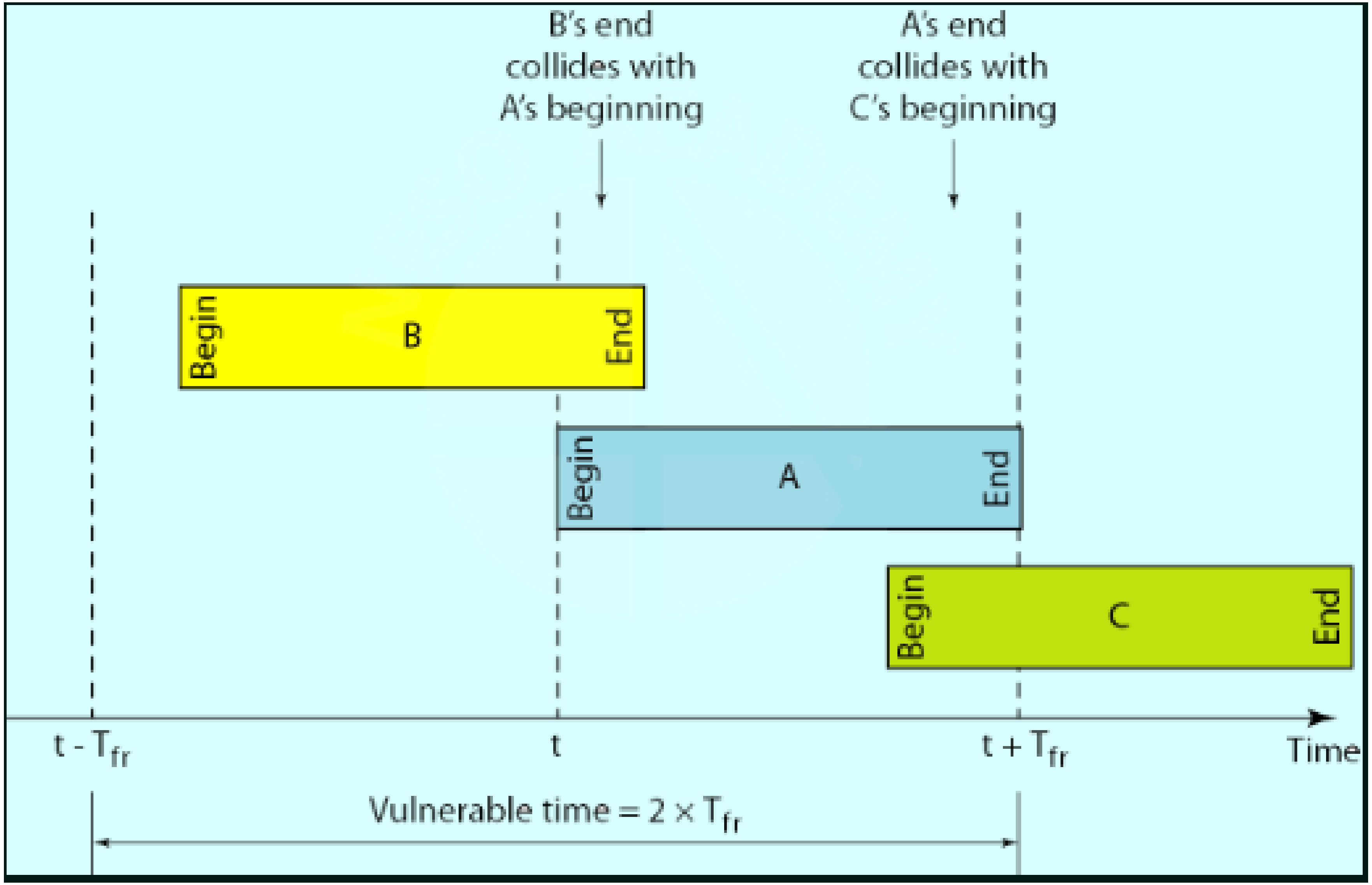
- ***ALOHA***
  - *Pure ALOHA*



Random access Protocol

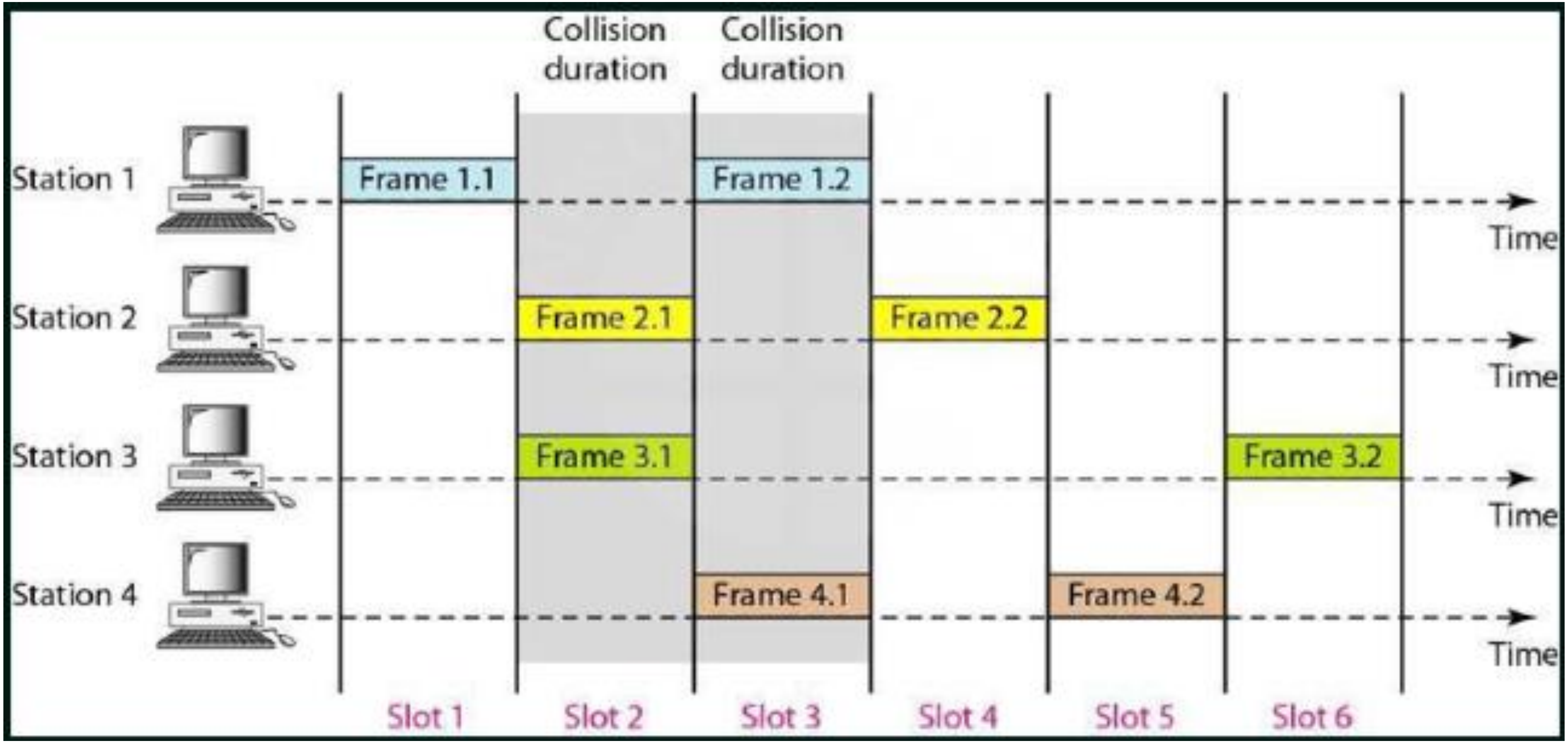
- *Pure ALOHA*

$Vulnerable\ time = 2 \times T_{fr}$



Random access Protocol

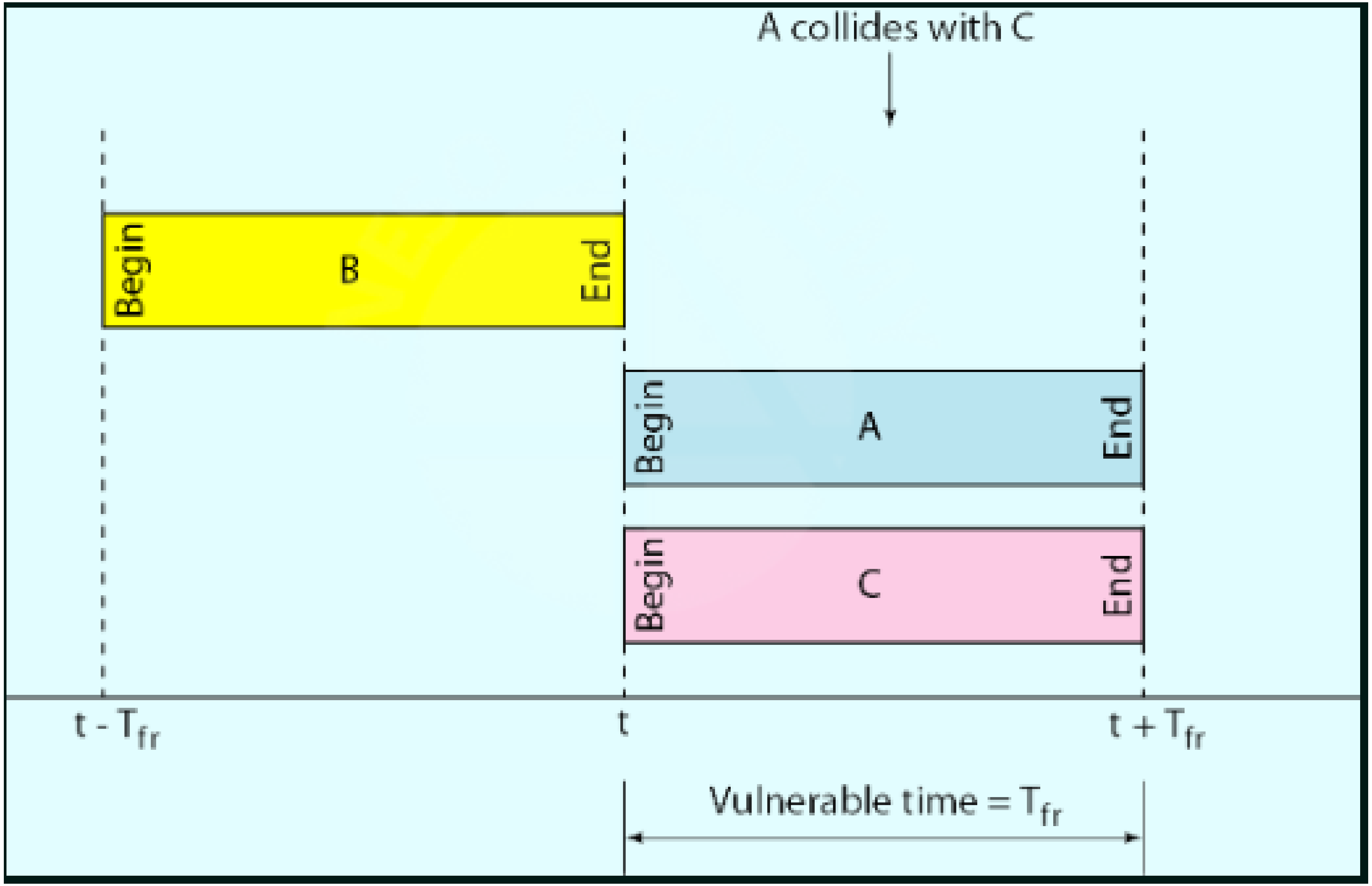
- *Slotted ALOHA*



Random access Protocol

❑ *Slotted ALOHA*

$$Vulnerable\ time = T_{fr}$$



Random access Protocol

Pure Aloha	Slotted Aloha
▪ Any station can transmit data at any time. ▪ The time is continuous and not globally synchronized. ▪ Vulnerable time in which Collison may occur = $2 \times T_{fr}$ ▪ Probability of successful transmission of data packet $= G \times e^{-2G}$ ▪ Maximum efficiency 18.4 % (G=1/2) ▪ Main advantage is simplicity in transmission.	▪ Any station can transmit the data at he beginning of any time slot. ▪ The time is discrete and globally synchronized. ▪ Vulnerable time in which Collison may occur = T_{fr} ▪ Probability of successful transmission of data packet $= G \times e^{-G}$ ▪ Maximum efficiency 36.8 % (G=1) ▪ Main advantage It reduces the number of collison to half and alost double the efficiency.

- ***Advantages of slotted Aloha over Channel partioning***
  - *In channel portioning (FDMA and TDMA) when only one active node to transmit , then also it will have access to apportion of the channel e.g. R/N bps not able to transmit at the full rate. In slotted Aloha if only one active user is there then it is able to transmit continuously at the full rate R bps.*

  - *But in slotted Aloha un-wasted slots are the only slot in which exactly one node transmits. The efficiency of slotted Aloha is when there are a large number of active users and each of them always having a large no. of frames to transmit.*

Module 2

Datalink Layer

Dr. Sunandita Debnath, IIIT Vadodara

- ***CSMA(Carrier Sense Multiple access)***

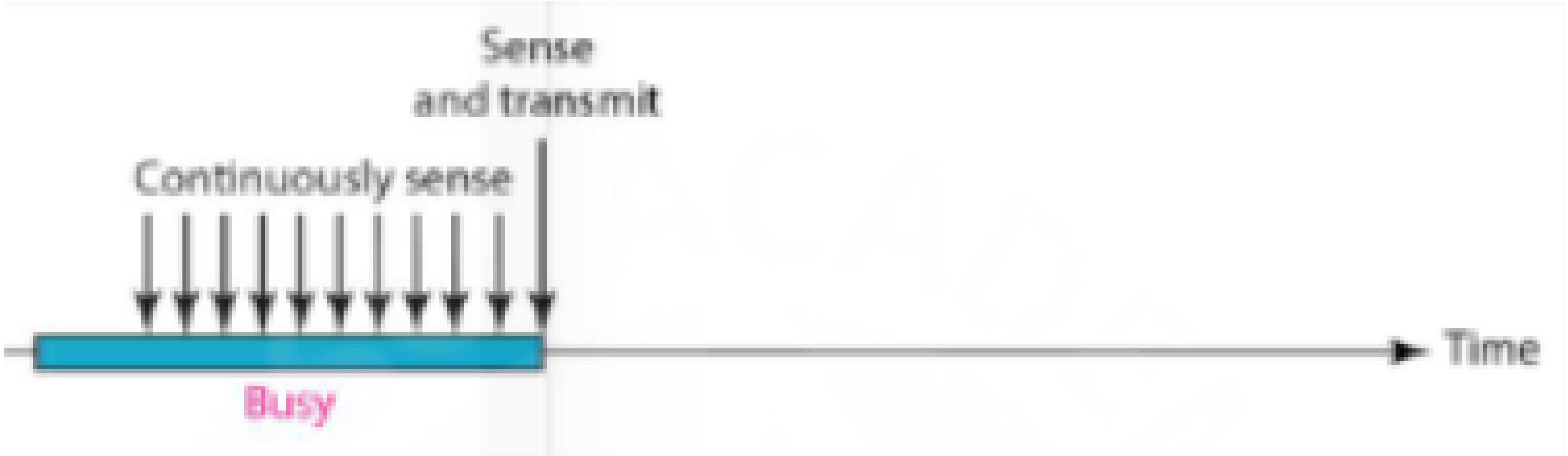
- *The disadvantages of pure and slotted Aloha has been overcomed in CSMA In Aloha the node's decision to transmit is made independently of the activity of the other nodes attached to the broadcast channel.*
- *CSMA is based on channel (carrier) sensing mechanism.*
  - *Listen before speaking-This is called carrier sensing, a node listens to the channel before transmitting. If a frame from another node is currently being transmitted into the channel, a node then waits until it detects no transmission for short amount of time and then begin transmission.*

  - *If someone else begins talking at the same time, stop talking- This is called collision detection. A transmitting node listens to the channel while it is transmitting. If it detects that another node is transmitting an interfering frame, it stops transmitting and waits for a random amount of time before repeating the sense-and –transmit-when-idle cycle*

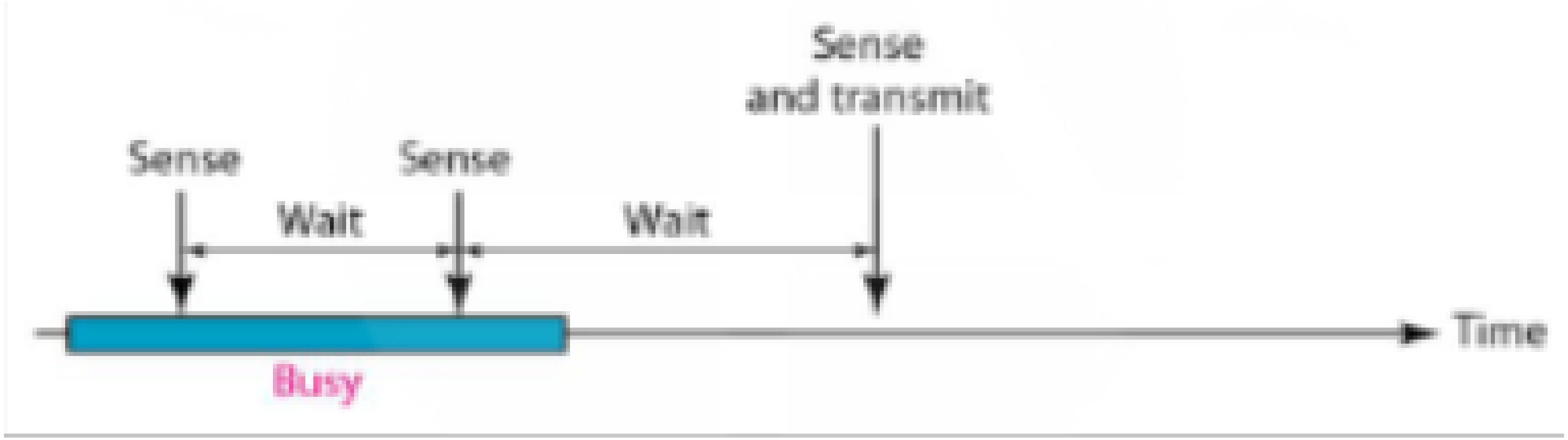
➢ *CSMA(Carrier Sense Multiple access)*

1-persistent	non-persistent	P-persistent
▪ Before sending the data, the station first listens to the channel to see if anyone else is transmitting at that moment. If the channel is sidle the station transmits a frame. ▪ If busy then it senses continuously until it becomes idle. ▪ Since the station transmits the frame with probability 1 when the channel is idle, the scheme is called 1-persistent CSMA.	▪ Before sending a frame, a station senses the channel . If no one else is sending the station begins sending. ▪ However, if a channel is busy, the station does not continuously sense it for the purpose of seizing immediately upon detecting the end of previous transmission. ▪ Instead it waits for a random amount of time and then repeats the algorithm. ▪ Consequently this algorithm leads to better channel utilization but longer delays than 1-persistent CSMA.	▪ It applies to a slotted channel. When a station becomes ready to send it senses the channel. ▪ If it is sidle it transmit with the probability P. and it defers with a probability $Q = (1 - P)$ until the next slot. ▪ If that slot is idle , it either transmits or defers again with probability P & Q. This process is repeated until either the frame is has been transmitted or any other station has begin transmission. ▪ In the later case the unlucky station acts like there had a collision and waits for random

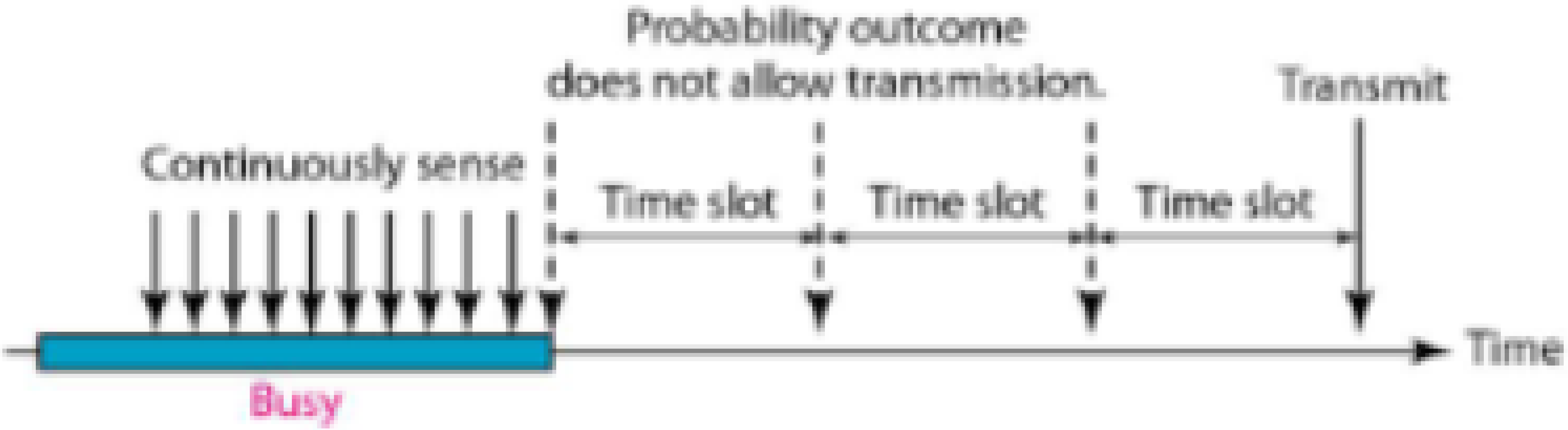
1-persistent



non-persistent



P-persistent

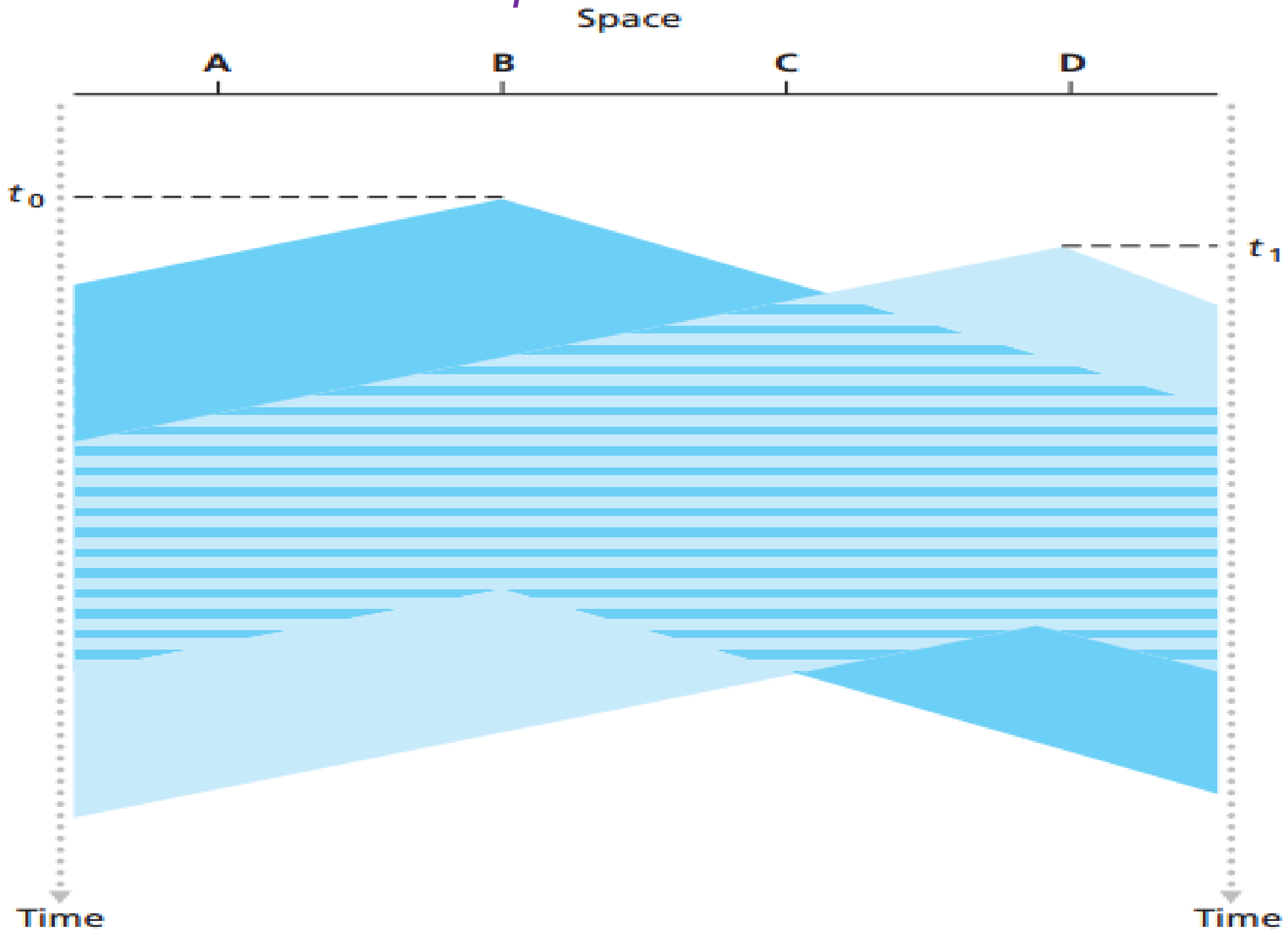


O-persistent

Each node is assigned a transmission order by a supervisory node

The effect of propagation delay in CSMA

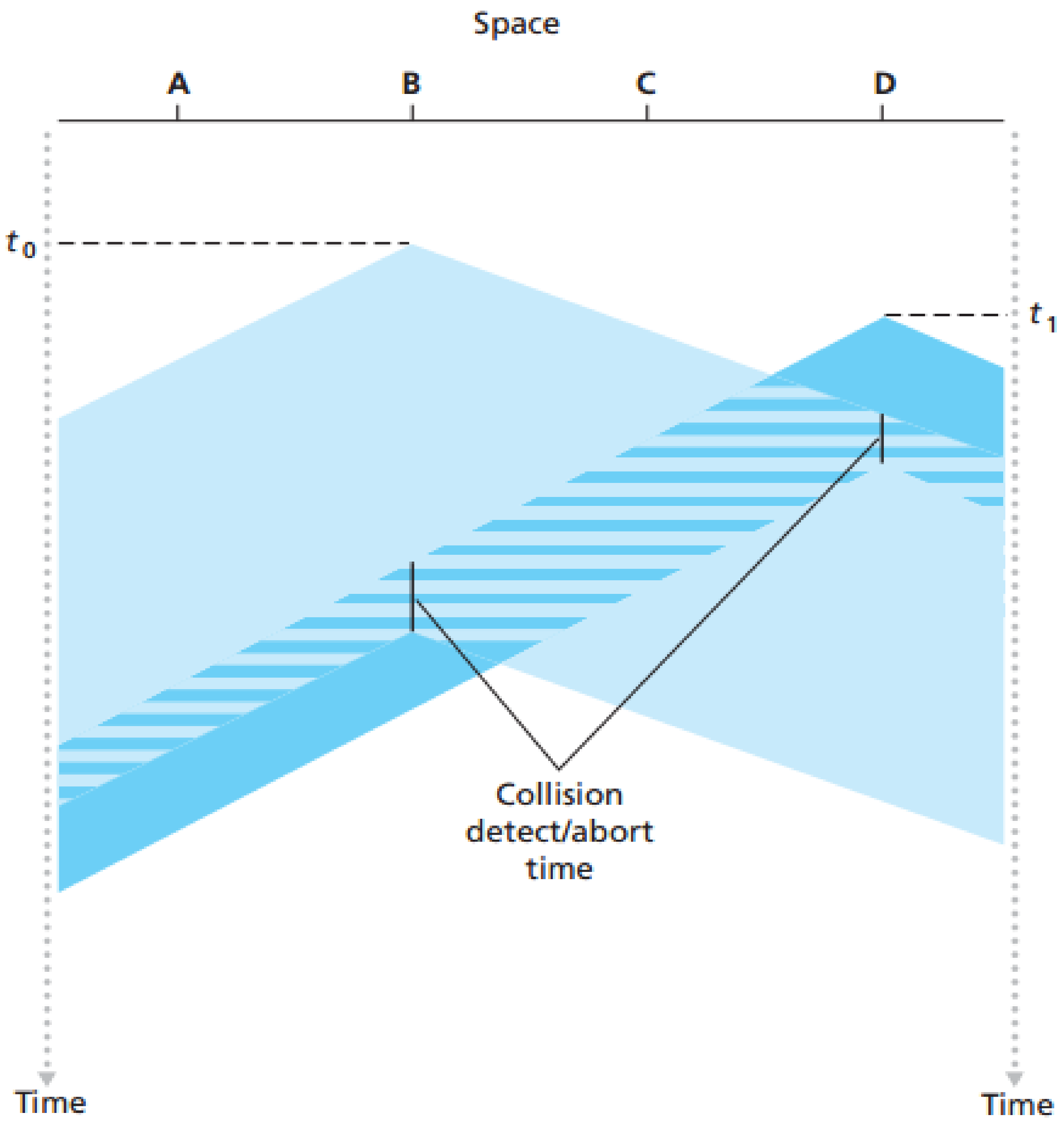
- Sender B started transmission at t_0 as it senses the medium is idle. As the propagation delay is nonzero at time t_1 ($t_1 > t_0$), node D senses the medium is idle and begin its transmission and after a short interval of time B's frame interfere with D's frame. So longer the end-to-end propagation delay more will be the chances of collision.



CSMA(Carrier Sense Multiple access)

CSMA/CD

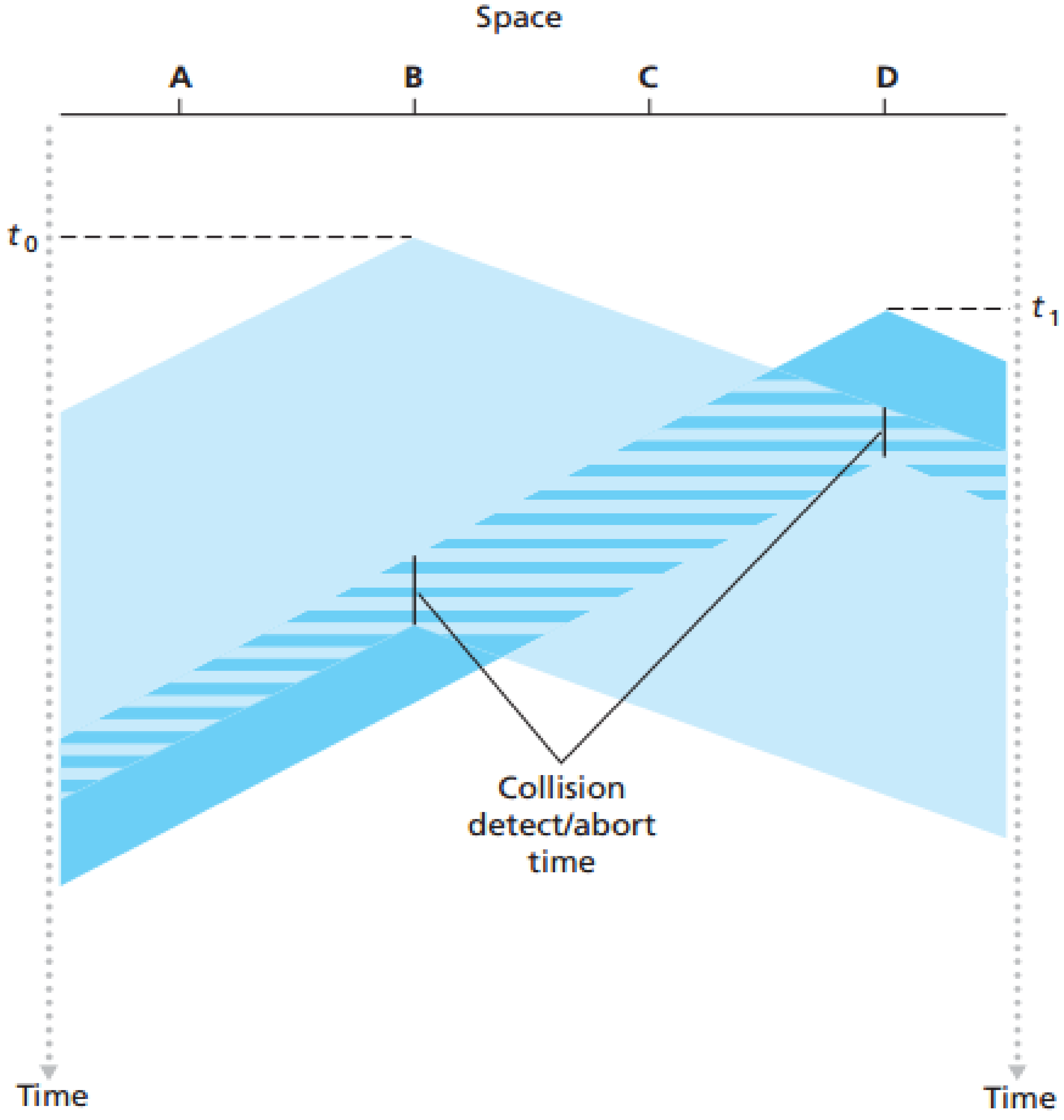
- If two stations senses the channel is idle and begin transmitting simultaneously, then both will detect collision almost immediately.
- As soon as it detects a collision both the sender ceases transmission. Quickly terminating damaged and corrupted frames from transmitting saves time and bandwidth.
- CSMA/CD is used in LANs and Ethernet



CSMA(Carrier Sense Multiple access)

CSMA/CD

- *After aborting the transmission. Both the senders wait for a random amount of time.*
- *If both the stations waits for the same amount of time then again they will collide and continue colliding forever.*
- *Two cases to be considered:*
  - *If the interval is large and number of colliding node are small, nodes are likely to wait a large amount of time before repeating the transmission again.*
  - *If the interval time is small and large number of colliding nodes are there then the randomly chosen time to be nearly close and the nodes will collide again.*



CSMA(Carrier Sense Multiple access)

Binary Back-off Algorithm for CSMA/CD

- *It is used in Ethernet.*
- *Suppose a frame has already experienced n collisions, then this sender will chooses the vale K at random K belongs to* $(0,1,2 \ldots\ldots 2^n - 1)$.
- *Thus the more numbers of collision the larger the interval from which the K value will be chosen.*
- *Suppose a sender attempts to frame for the first time and detects a collision then,* $n = 1$, *so* $2^1 - 1 = 1$. *Therefore the range of* $k \in (0,1)$. *So it chooses K =0 with probability ½ and chooses 1 with probability ½.*
- *Thus, the size of the sets from which K is chosen grows exponentially with the number of collisions; for this reason this algorithm is referred to as binary exponential backoff.*
- *The efficiency of CDMA/CD is given by*

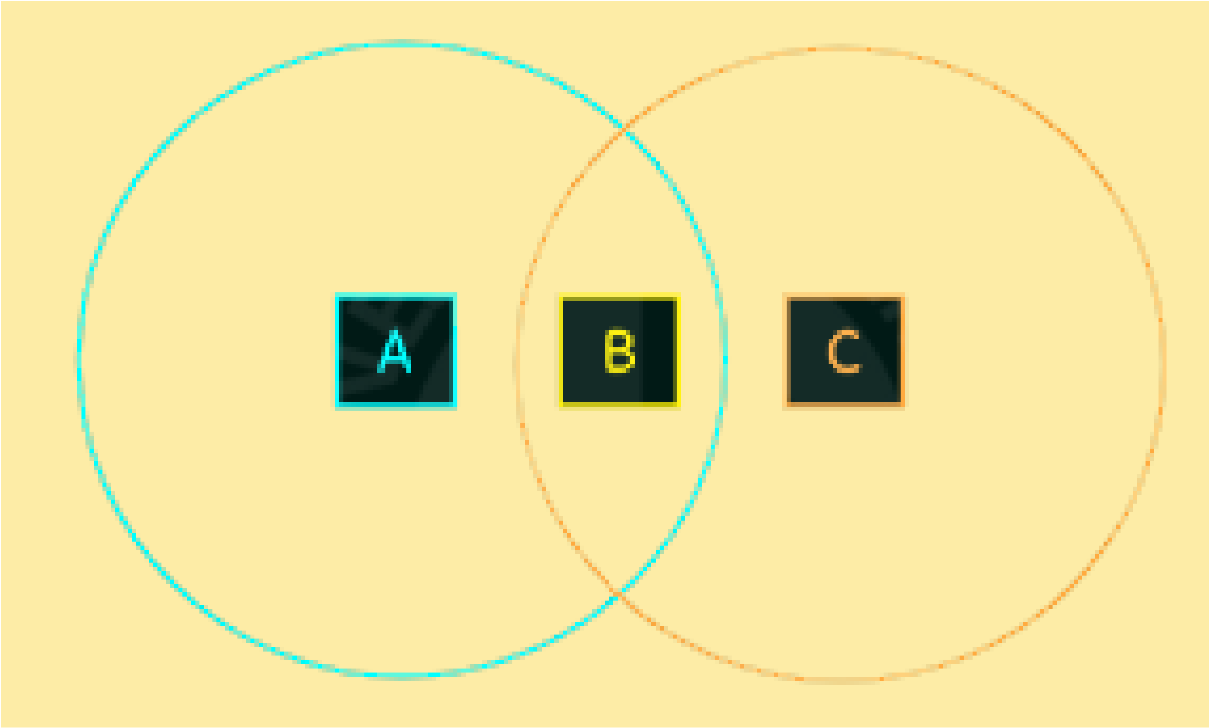
$$\boldsymbol{Efficency = \frac{1}{1 + 5d_{prop}/d_{trans}}}$$

CSMA(Carrier Sense Multiple access)

CSMA/CA (Collision Avoidance)

- *It is used for wireless communication.*
- *CSMA/CA is a network multiple access method in which carrier sensing is used, but nodes attempt to avoid collisions by beginning transmission only after channel is sensed to be idle.*
- *I is particularly important for wireless networks. Where the collision detection of the alternative CSMA/CD is not possible due to wireless transmitters desensing their receivers during packet transmission.*
- *CSMA/CA is unreliable because of hidden node problem and exposed terminal problem.*
- *Solution is RTS (request to send)/CTS (clear to send)*
- *The access method used in IEEE 802.11 (WiFi) is CSMA/CA.*

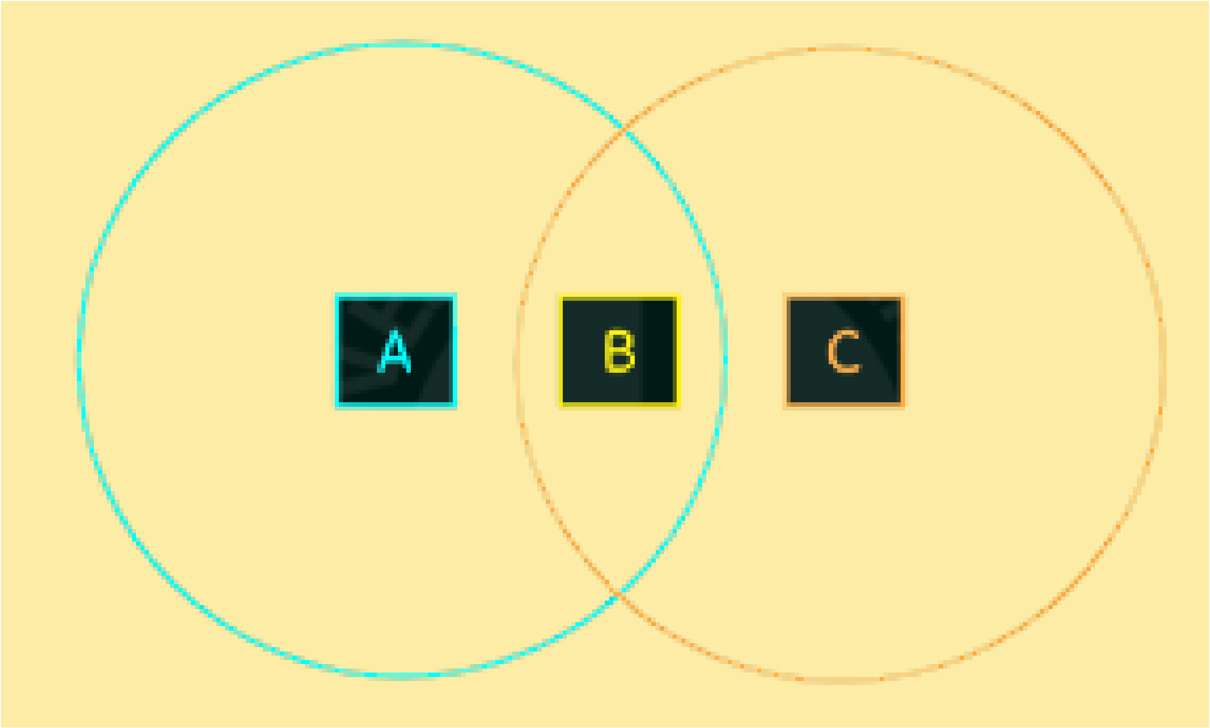
Hidden Terminal Problem



Suppose both A and C want to communicate with B and so they each can send it a frame

- *A and C are unware of each other since their signals do not reach that far in other words they are not in the sensing range of each other.*
- *These two frames collide with each other at B (but unlike Ethernet neither A or C is aware of this collision).*
- *A and C are hidden nodes with respect to each other.*

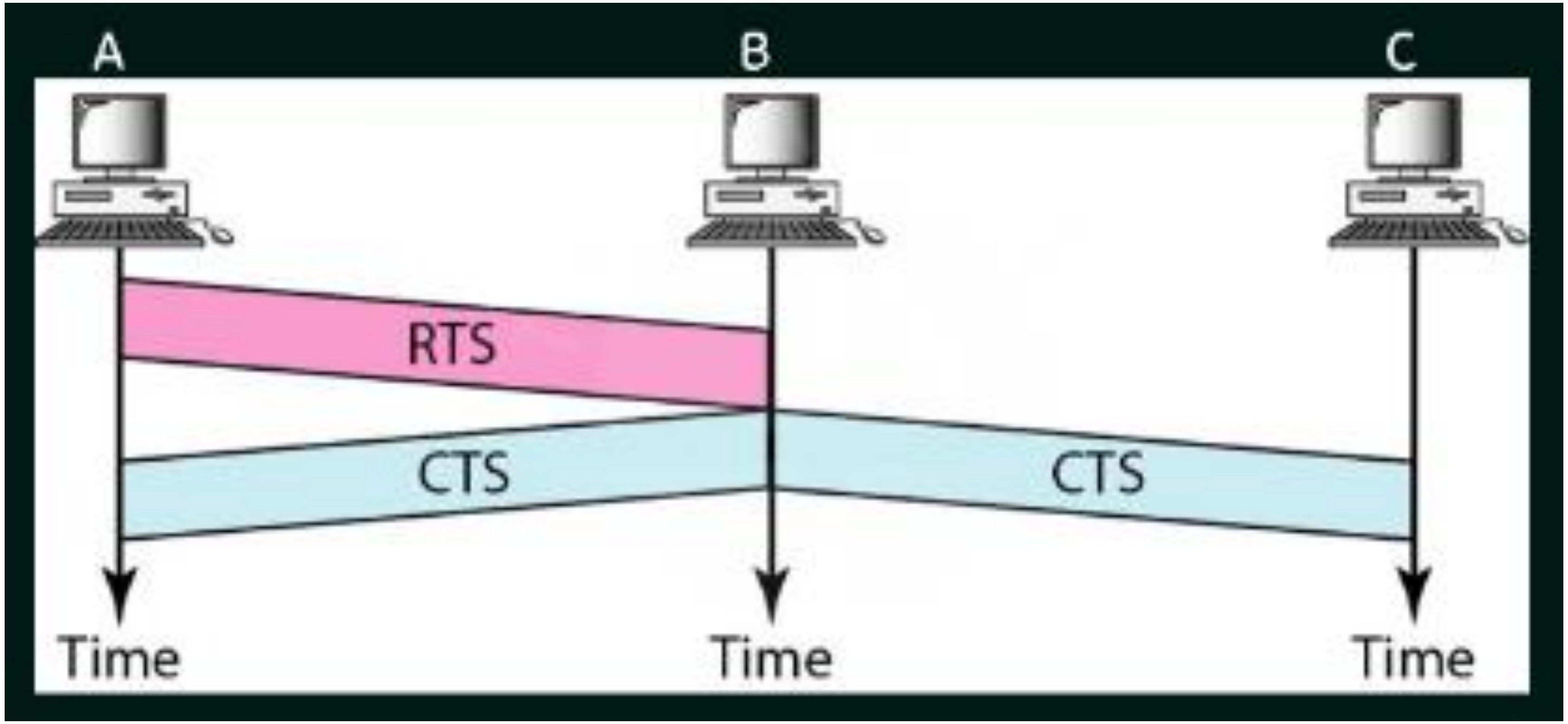
MACA Protocol



This hidden node problem is solved using MACA protocol. Suppose both A and C want to communicate with B and so they each can send it a frame

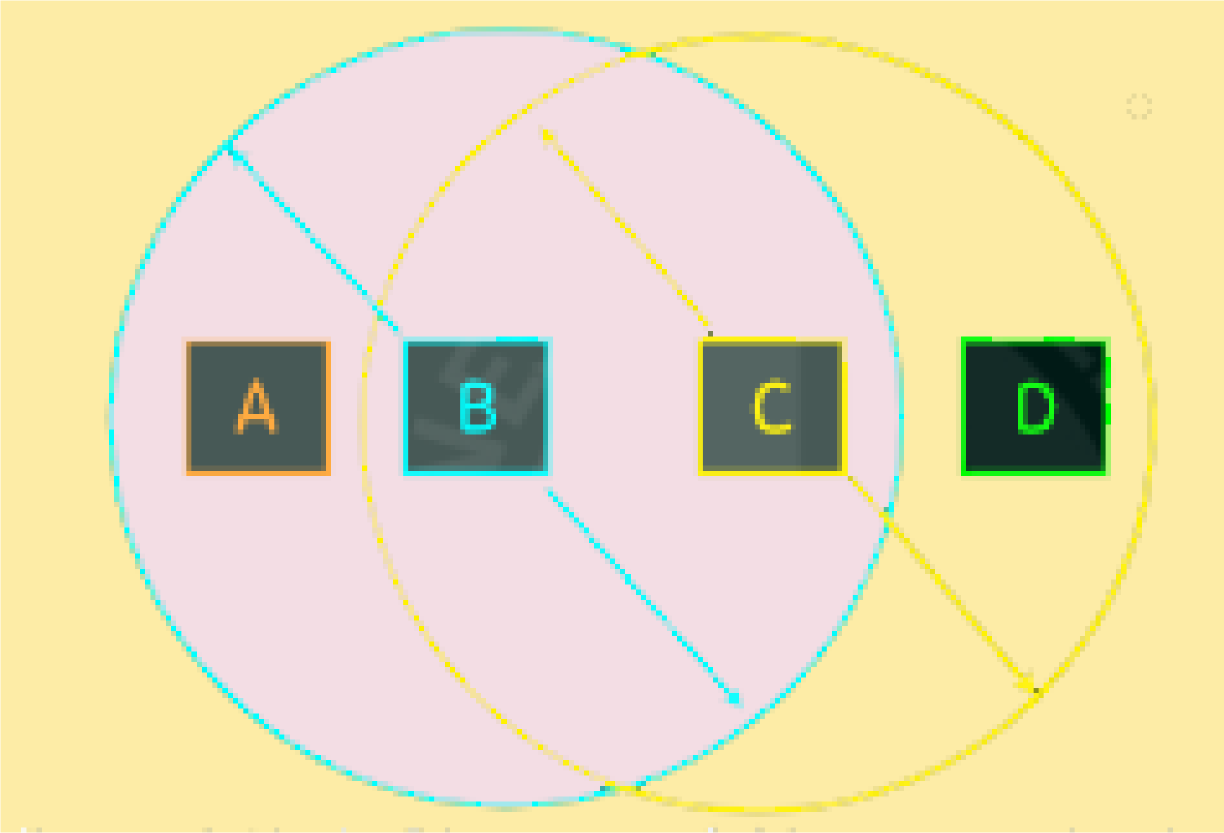
- *A and C are unware of each other since their signals do not reach that far in other words they are not in the sensing range of each other.*
- *These two frames collide with each other at B (but unlike Ethernet neither A or C is aware of this collision).*

MACA Protocol



Station C doesn't hear RTS from A, but it does hear CTS from B, so it know something is up.

Exposed Terminal Problem



Suppose B is sensing to A. Node C is aware of this communication because B is in range of C i.e. it can hear B's transmission.

- *It would be mistake to C to conclude that it cannot transmit to D or anyone just because it can hear B's transmission.*
- *IF C wants to transmit to D , this is not a problem since C's tranmissison to D will not interfere with A's ability to transmit or receive from B.*

CSMA/CA –Two algorithms are addressed in IEEE 802.11 with:

- ***MACA (Multiple Access with Collision Avoidance)***
- ***MACAW (MACA for Wireless LANs)***

MACA

- *In MACA sender and receiver exchange control frames with each other before the sender actually transmits any data.*
- *This exchange informs all nearby nodes that a transmission is about to begin*
- *Sender transmits a RTS (Request to Send) frame to the receiver*
  - *RTS frame includes a field that indicate how long the sender wants to hold the medium/ channel i.e. the length of the data frame be to transmitted.*
- *Receiver replies with a CTS (Clear to Send) frame*
  - *This CTS frame is broadcast by the receiver and also includes the length of the frame which is informed by the sender while asking for request to send.*
- *Any node which hears the CTS frame knows that it is close to the receiver, therefrom refrained from transmitting (i.e. cannot transmit) for the period of time it takes to send a frame of the specified length.*

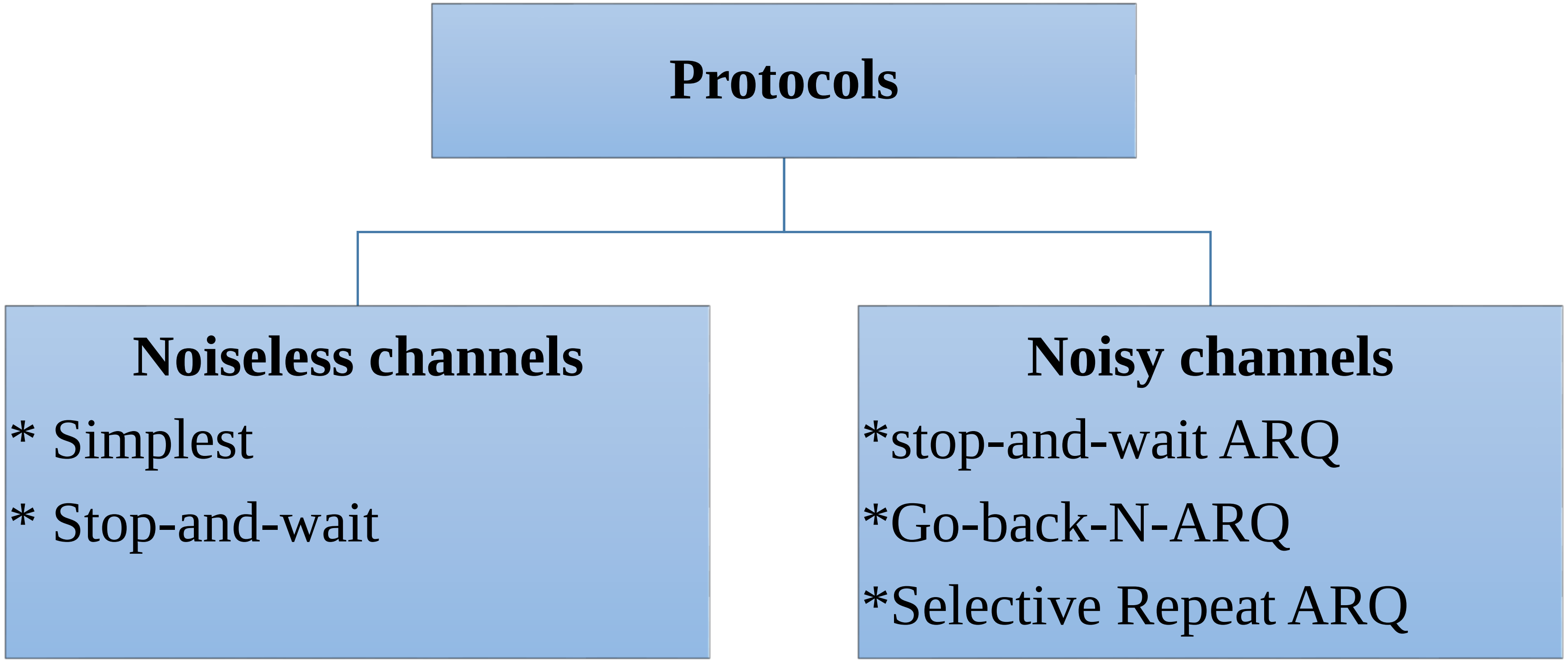
MACA

- *Any node that hears the RTS frame but not the CTS frame it get to know that it is not close enough to the receiver to interfere with it and so free to transmit to any other node.*

MACAW

- *The idea of using CK (acknowledgement)A in MACA is proposed in MACAW: MACA foe Wireless LANs.*
- *Receiver sends a ACK to the sender after successfully receiving a frame.*
- *As this ACK is also a broadcast message, all nodes must wait till this ACK before trying to begin a new transmission.*
- *If two or more nodes detects an idle link and try to transmit an RTS at the same time*
  - *This RTS frame will collide with each other*
  - *802.11 does not support collision detection*
  - *So the sender realize the collision has happened when they are not receiving an CTS after a period of time from the receiver node.*
  - *In this case they both wait a random period of time before trying again*
  - *The amount of time a given node must wait is defined by same the exponential backoff algorithm used on the Ethernet.*

Flow control



Stop and wait protocol

- *Stop-and-wait protocol is data link layer protocol for transmission of frames over noiseless channels.*
- *It provides unidirectional data transmission with flow control facilities but without error control facilities.*
- *After transmitting one frame, the sender waits for an acknowledgement before transmitting the next frame.*

- ***Sender side :***

Rule 1: send one data frame at a time

Rule 2: Send the next frame only after receiving ACK for the previous one.

- ***Receiver side:***

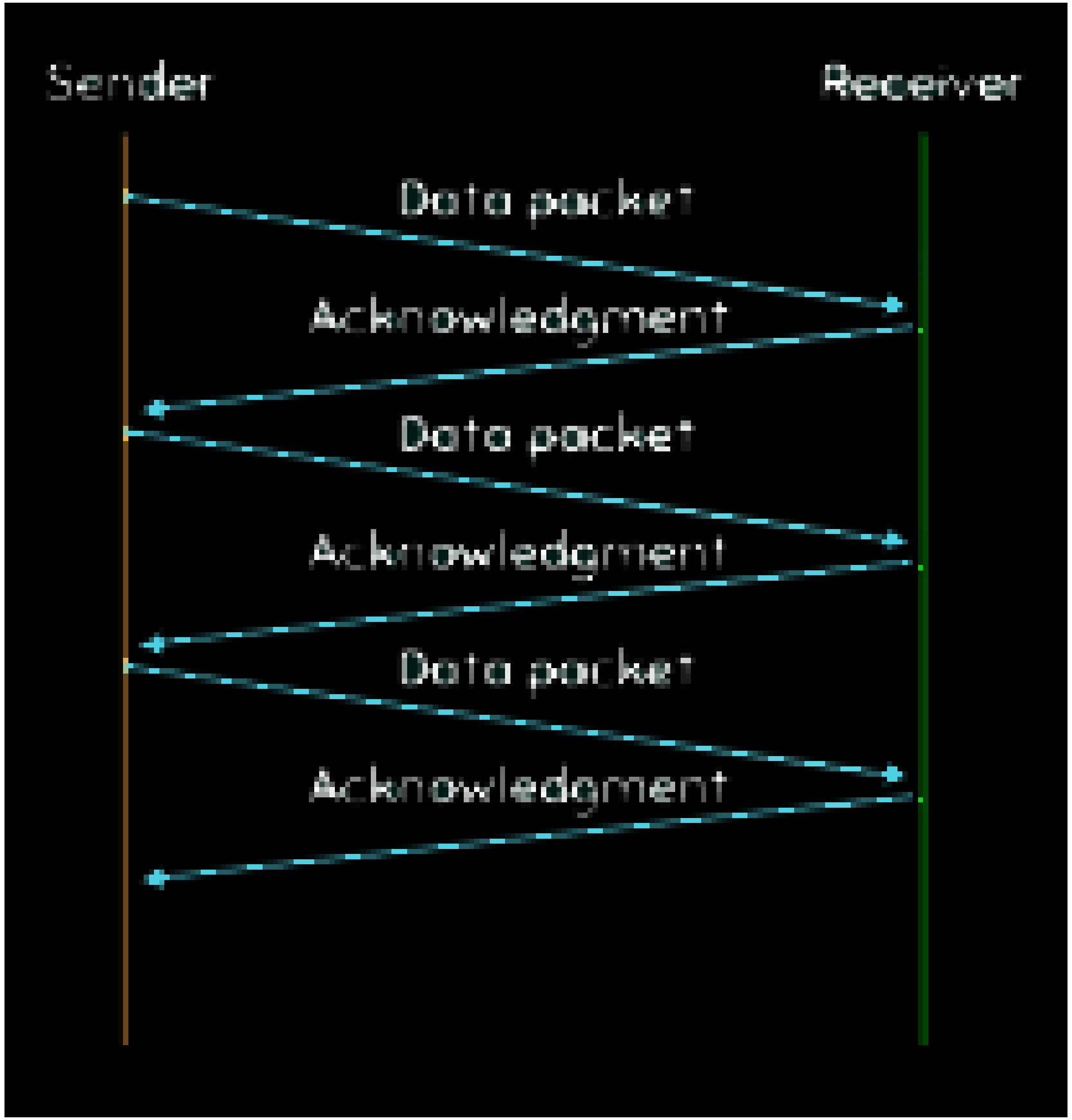
Rule 1: Receive and consume frame send one data frame at a time

Rule 2: After consuming frame ACK need to be sent (Flow control)

Stop and wait protocol

The disadvantage of this protocol is if the sender has a large number of frames say 1000 frames then it has to send only one frame at a time and waits for the ACK each time.

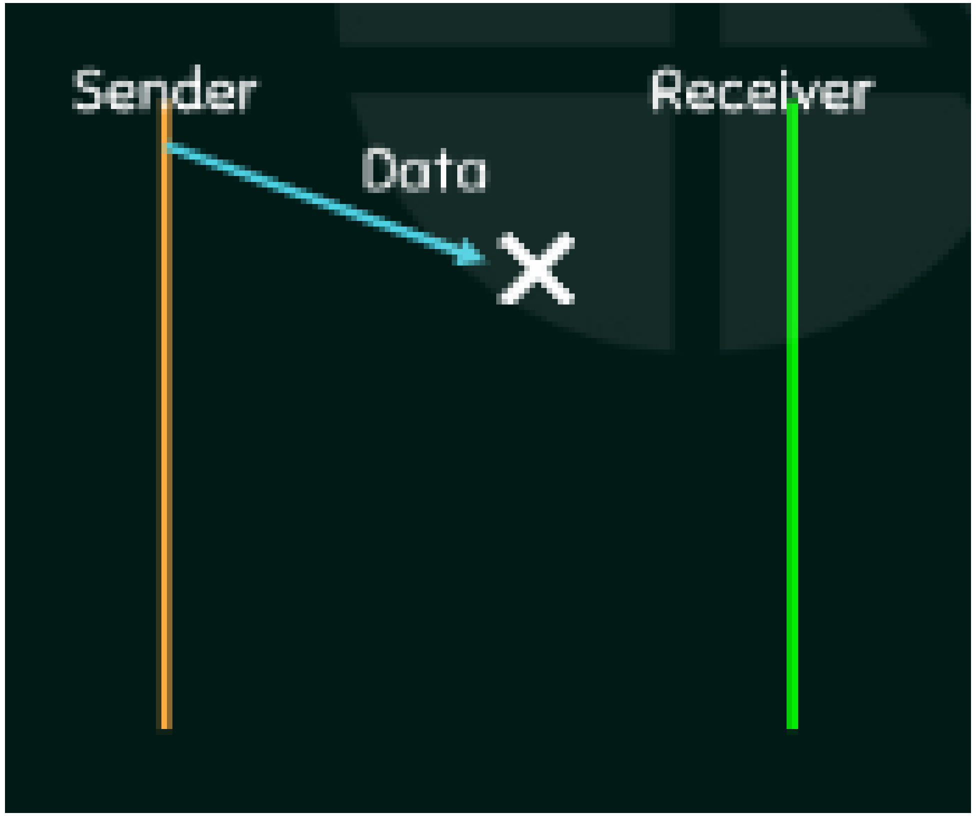
- *Problem due to lost frame*
- *Problem due to lost ACK*
- *Problem due to delayed frame/ACK*



Stop and wait protocol

Problem due to lost frame

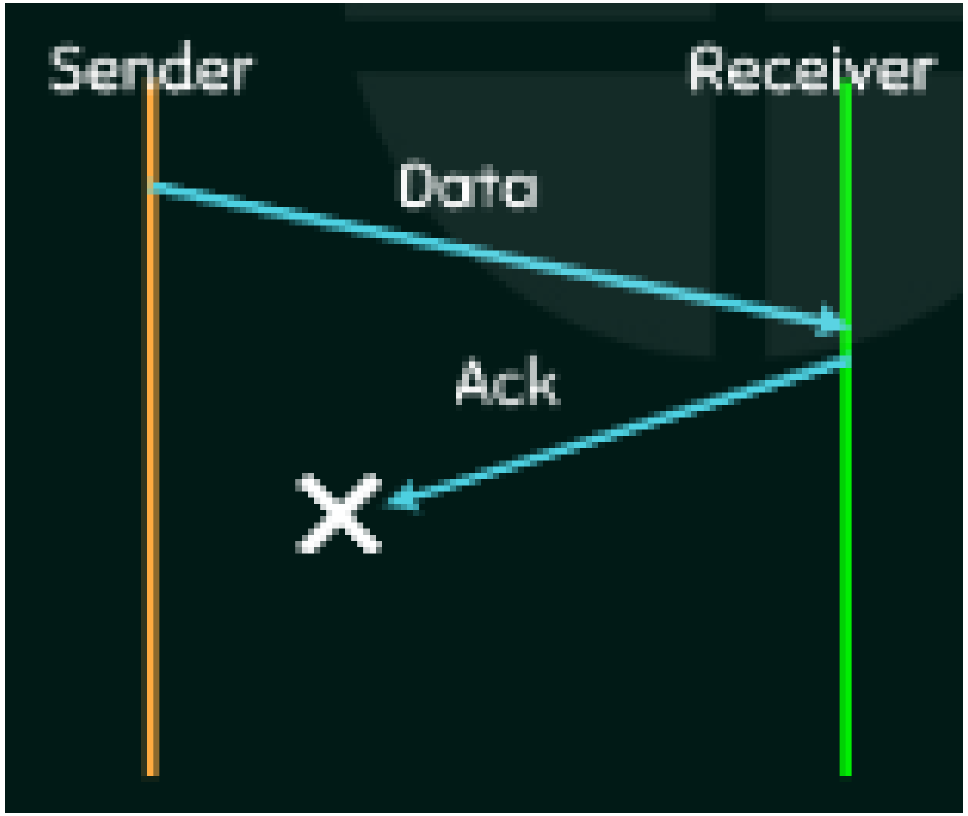
- *Sender waits for ACK for an infinite amount of time*
- *Receiver waits for data for an infinite amount of time*



Stop and wait protocol

Problem due to lost ACK

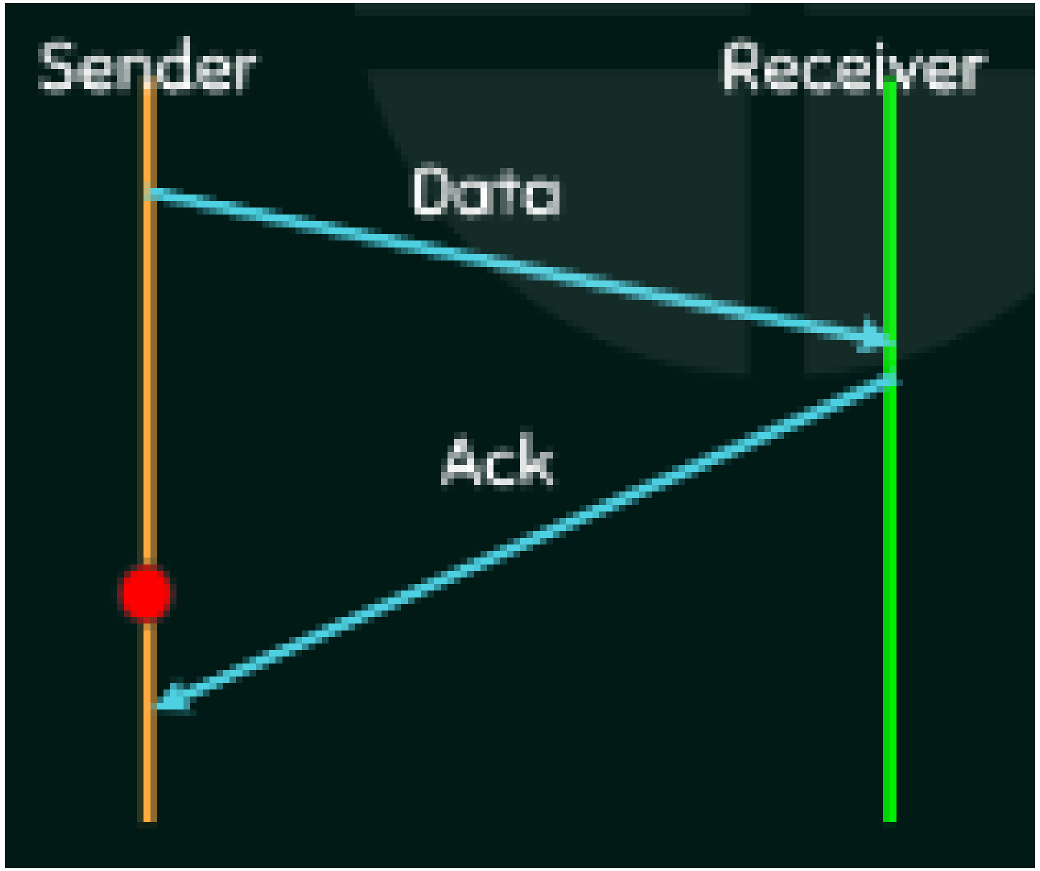
- *Sender waits for an infinite amount of time for ACK. So there is an infinite delay for the next frame in the queue to be transmitted.*



Stop and wait protocol

Problem due to delayed frame/ACK

- *After timeout at sender side, a delayed ACK might be wrongly considered as ACK of some other data frames.*



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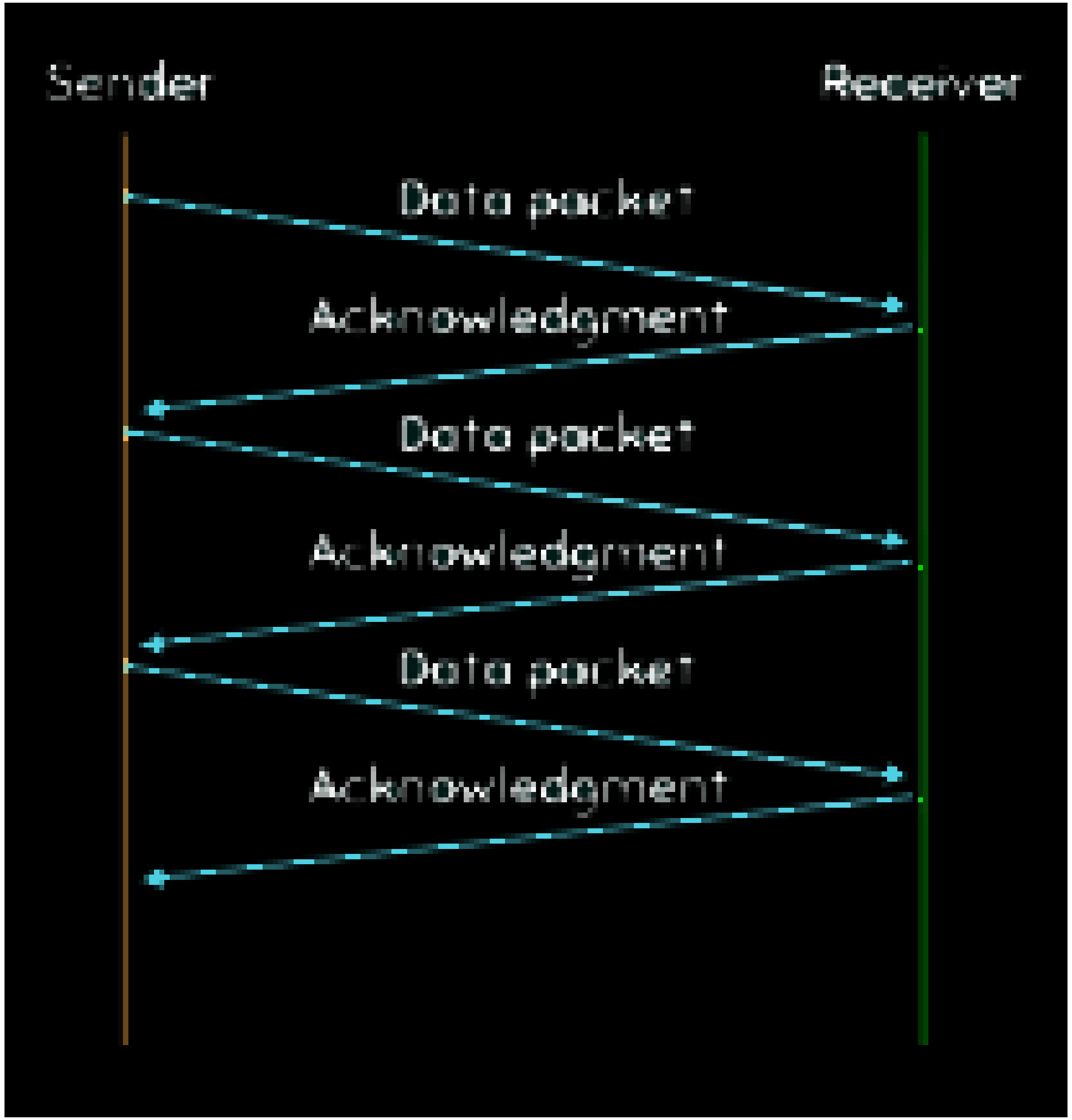
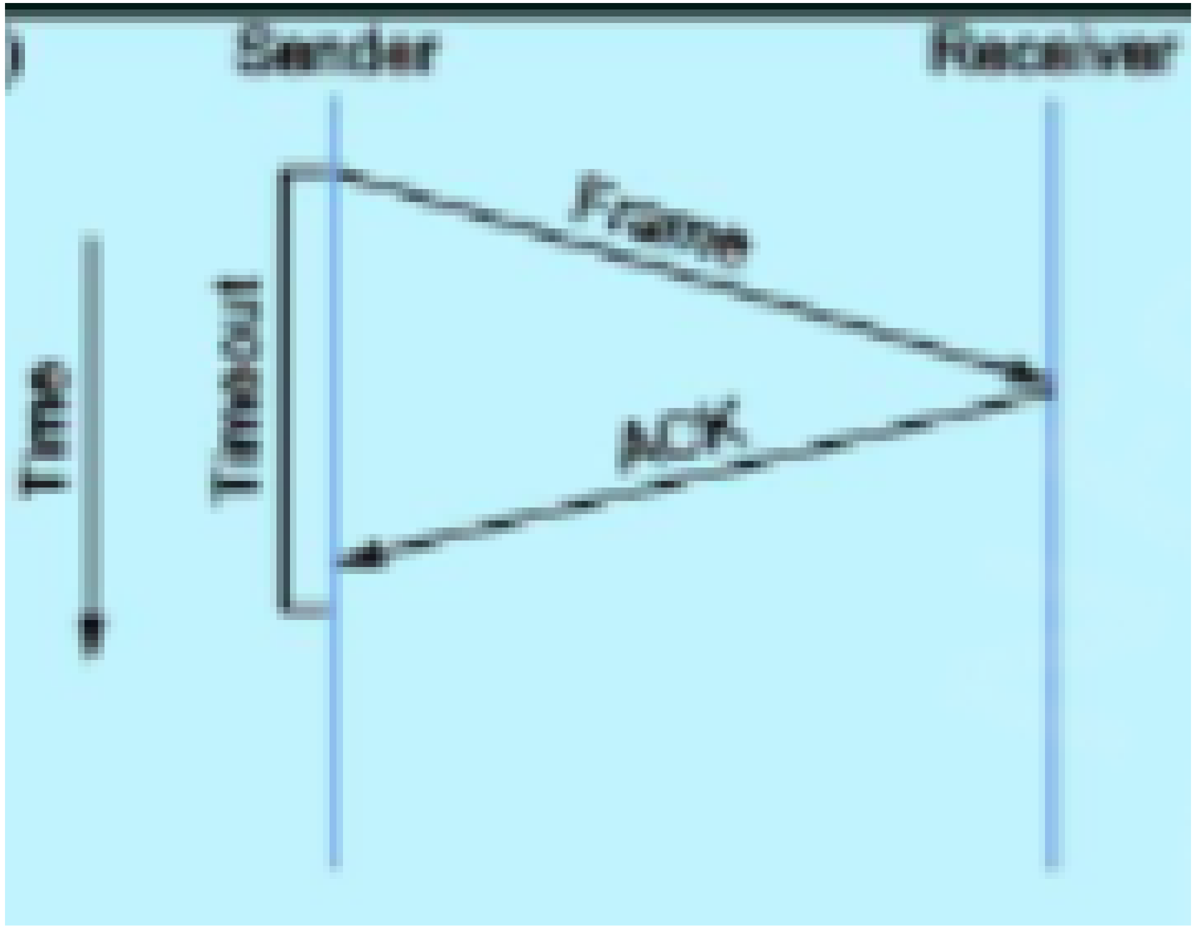


Stop and wait ARQ protocol

- *After transmitting one frame, the sender waits for an acknowledgement before transmitting the next frame.*
- *If the acknowledgement does not arrive after a certain period of time the sender times out and retransmits the original frame.*
- **Stop and wait ARQ = Stop and wait + Timeout Timer +Sequence number**

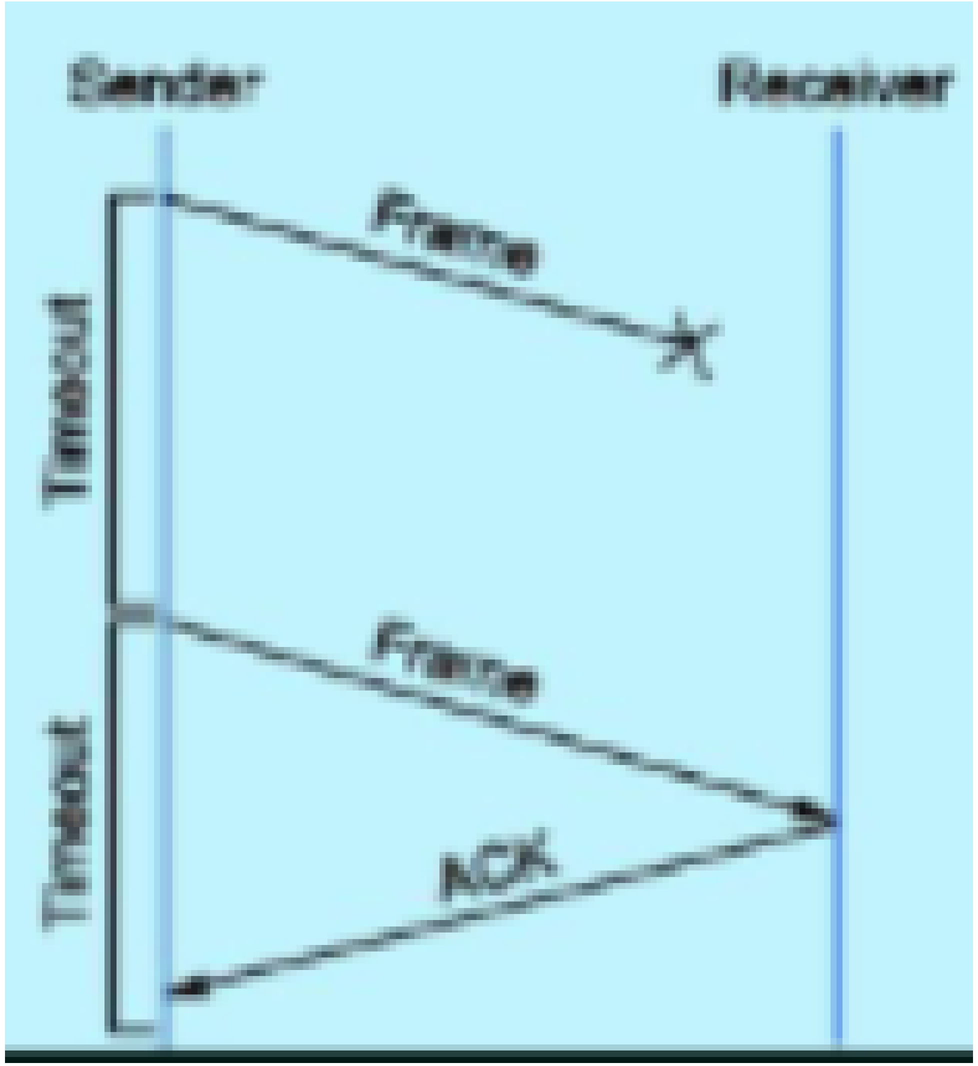
Stop and wait ARQ protocol

ACK is received before the timer expires



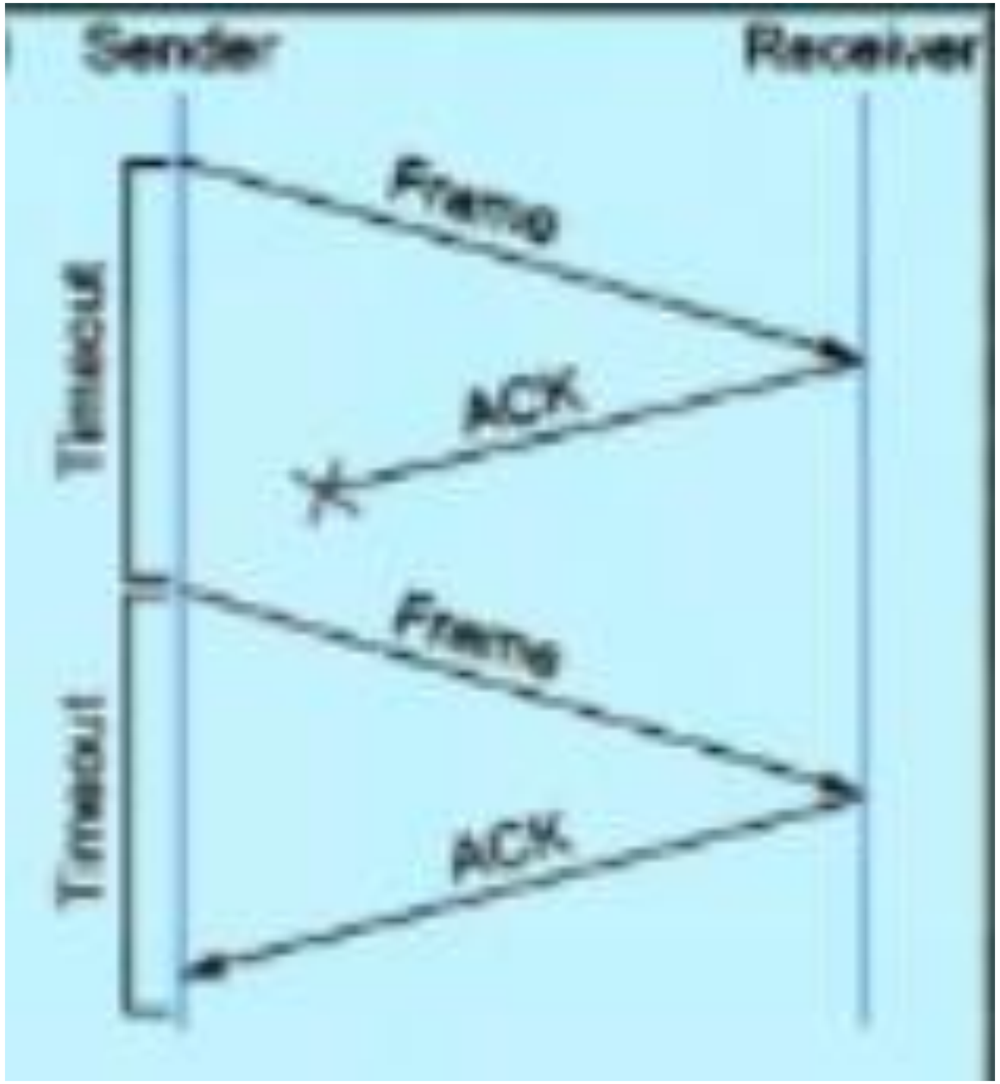
Stop and wait protocol

The original frame is lost



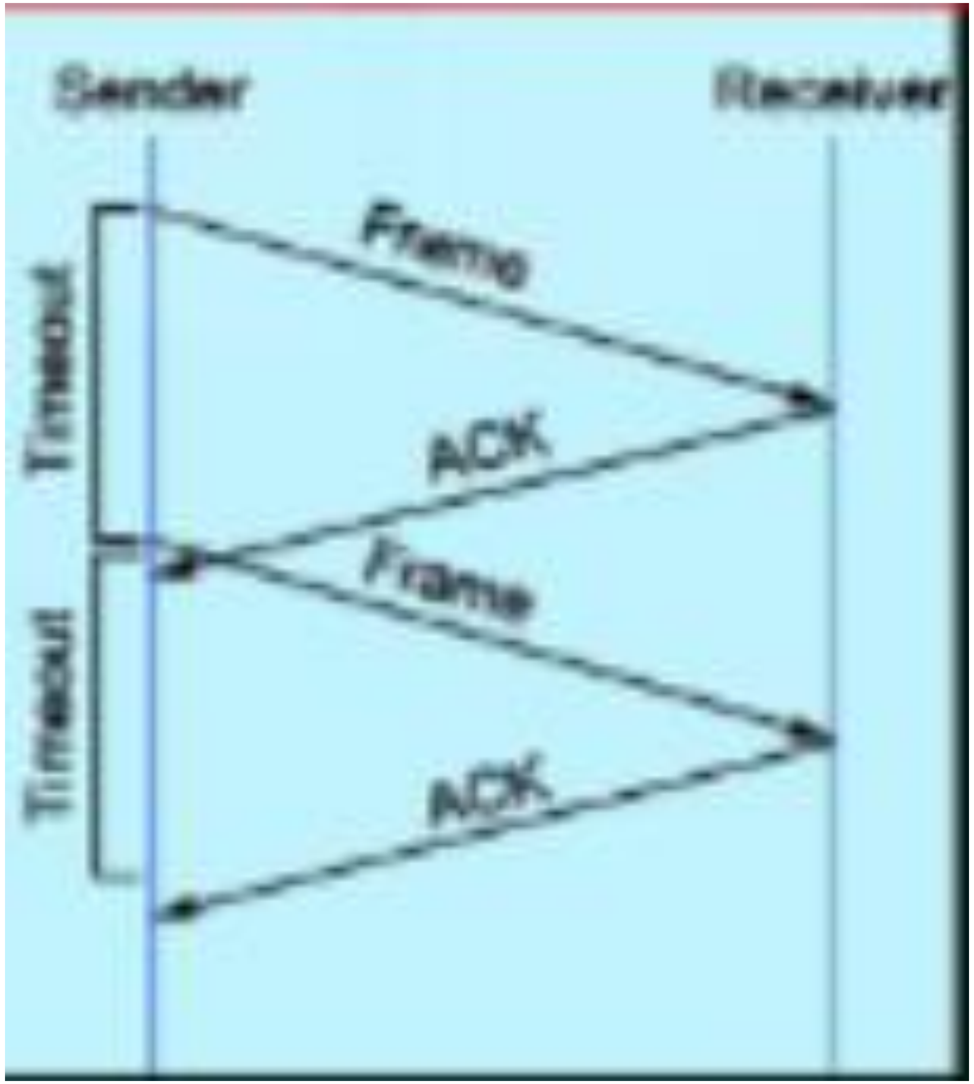
Stop and wait ARQ protocol

ACK is lost



Stop and wait protocol

The timer fires too soon



Sliding window Protocol

- *Go-back-N ARQ*
- *Selective Repeat Request*

The disadvantages of stop-and –wait ARQ protocol is

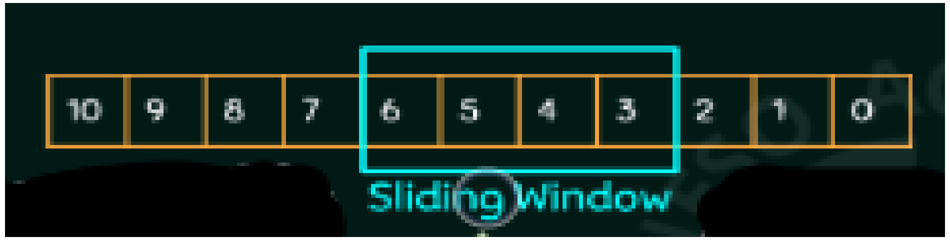
- *One frame at a time*
- *Poor utilization of bandwidth*
- *Poor performance*

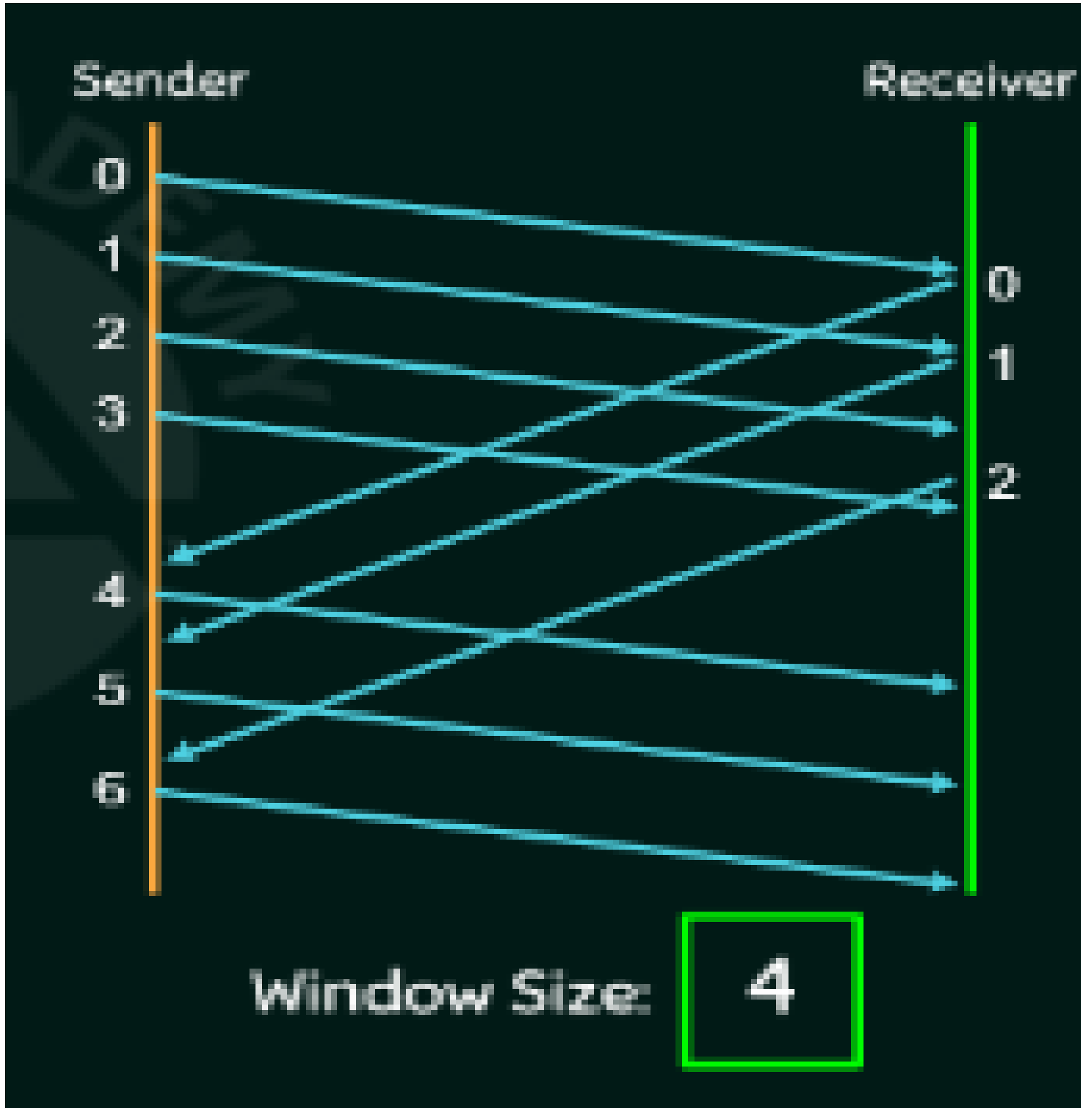
The advantages of sliding window protocol is

- *Send multiples frames at a time*
- *Number of frames to be send is based on the window size*
- *Each frame is numbers i.e. each frame is associated with a sequence number.*

Working of sliding window protocol

- *Supposes sender has 11 no. of frames to transmit.*
- *Here 0 to 10 depicts the sequence nos. of the frames.*
- *Window size of the sender N = 4.*
- ***Step 1:*** *Sender will send first four frames at ones.*
- ***Step 2:*** *After getting the ACK from the 0th frame, the window will slide by one position on the left side. And the sender now transmits the 4^{th} frame. Similarly after getting the acknowledgment from the 2^{nd} frame the window slides on the left by one position*
- *So, there are three categories of frames in the buffer, 0 to 2^{nd} are frames which are **sent and got acknowledged**, 3 to 6^{th} frame are **sent and waiting for acknowledgement**, and 7 to 10^{th} frame are **not yet sent and in the queue**.*





Go-Back-N ARQ protocol

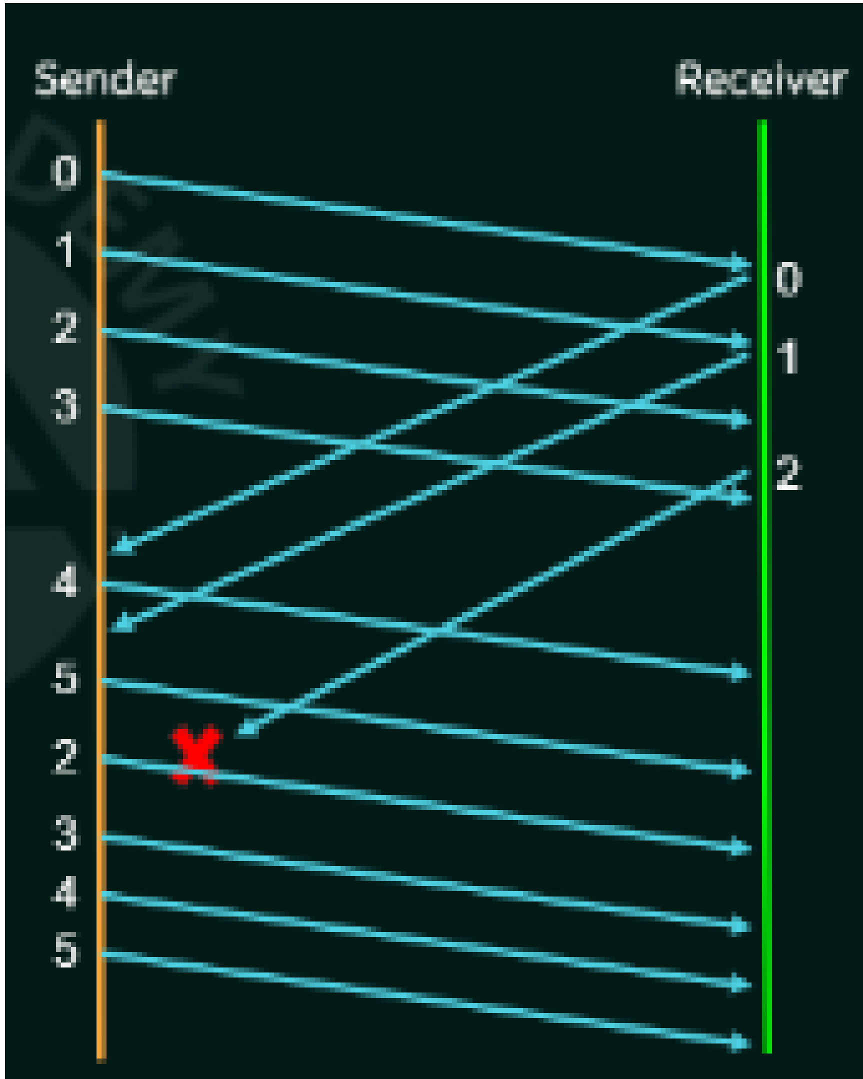
- *Here N represents the window size, suppose N =4.*
- *Supposes sender has 11 no. of frames to transmit.*
- *Here sequence nos. of the frames depends on the window size*

$$N = 4 = 2^2$$

Then the sequence nos. will be 0,1,2,3. (This power represents the number of binary bits required to represents the sequence nos. in its decimal equivalent). The max sequence no. can go up to $\{0,1,2 \ldots\ldots 2^n - 1\}$.

- *In Go-Back-N ARQ protocol the sender can send multiple frames before receiving acknowledgement from the first frame.*
- *The nos. of frames can be sent depends on the window size.*
- *If the ACK frames is not received within an agreed period of time, all frames in the current window is retransmitted.*

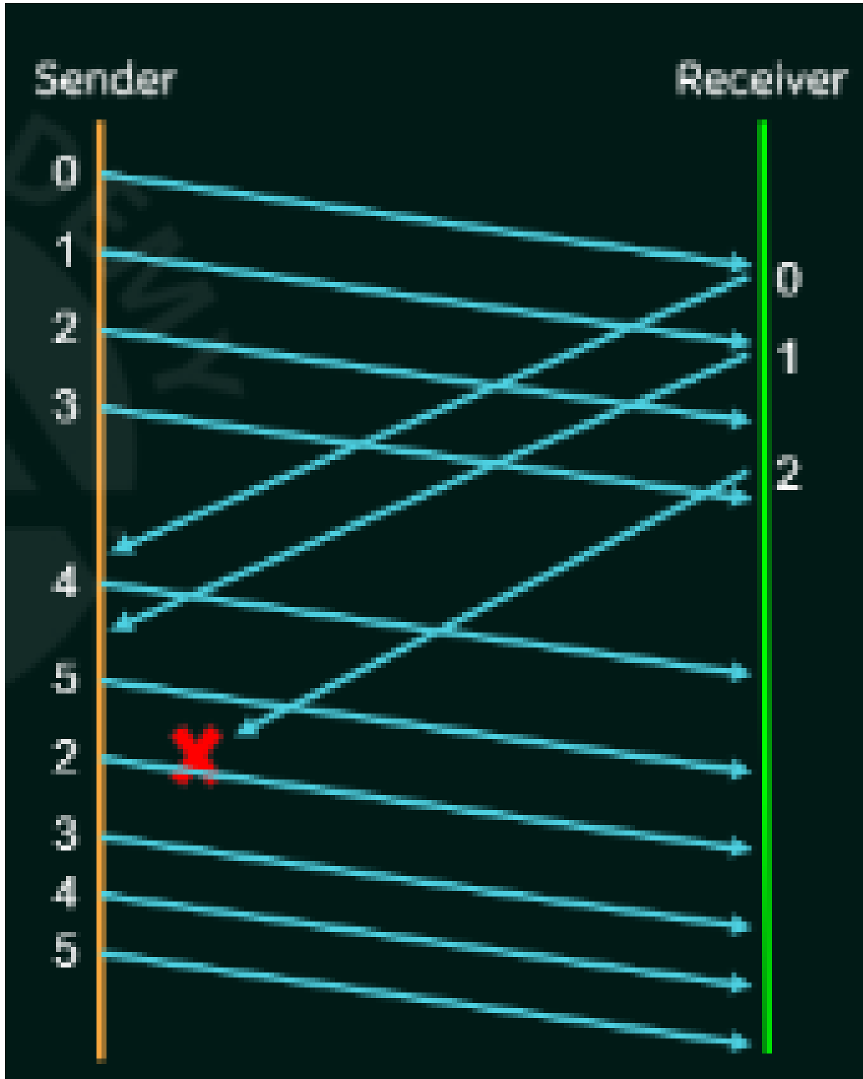
Go back to 2



Go-Back-N ARQ protocol

- *Supposes sender has sent 4 frames at ones 0,1,2, 3 and also got acknowledgment for the 0th frame.*
- *Now the window is holding 1, 2,3 and 4th frames. And the sender also got acknowledgment for the frame with sequence no. 1. Now the window of size 4 is containing frames 2, 3, 4 and 5.*
- *If the acknowledgement from the frame with sequence no.2 is not received then within a finite period of time. Then the sender times out again will transmit all the frames in the window starting from the frame with sequence no. 2. (i.e. 2,3,4,5) again.*
- *That's why it is called Go-Back ARQ protocol, because if one frame in the window is not acknowledged then the all the frame in the window will be retransmitted again.*

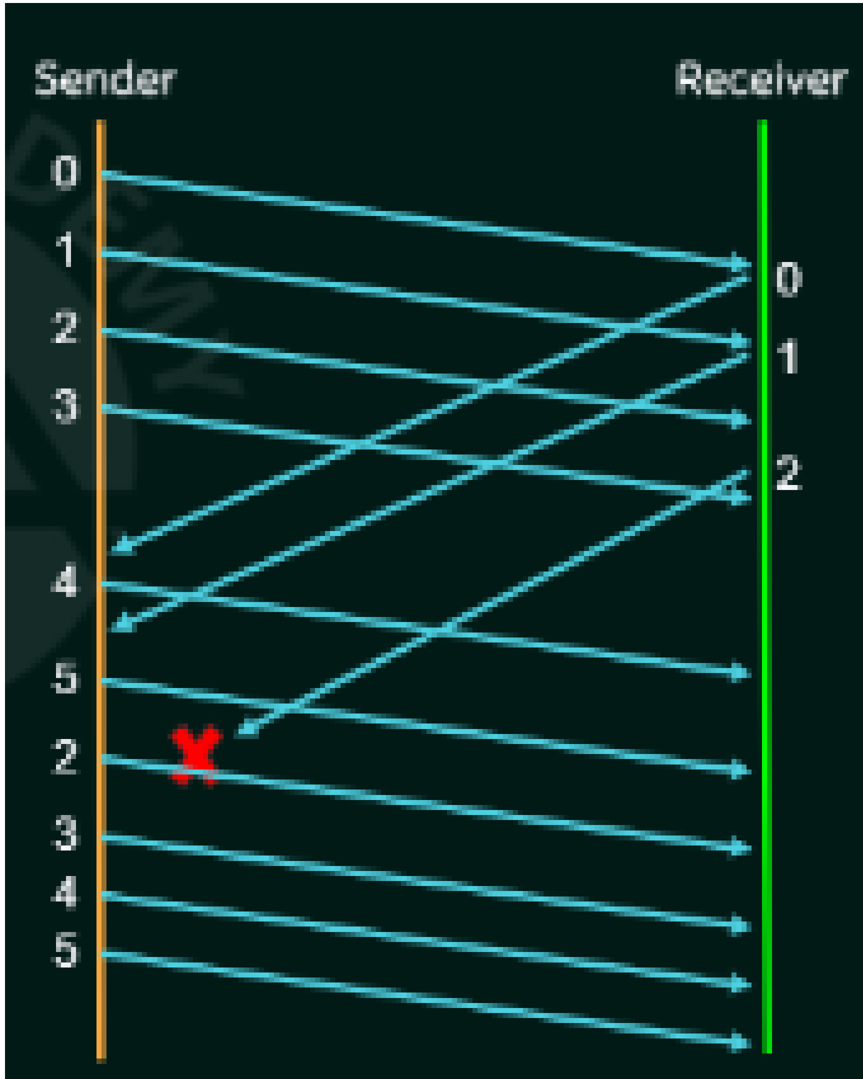
Go back to 2



Go-Back-N ARQ protocol

- *Sender window size = N= (1+2a) for*
- *Receiver window size =1*
- *Efficiency* = $\frac{N\ (window\ size\ of\ sender)}{1+2a}$
- *Where a* $= \frac{Propagation\ delay\ T_p}{Transmission\ delay\ T_t}$
- *Maximum data rate possible/Throughput = Efficiency × Bandwidth*
- *Round Trip Time (RTT) = 2 ×* T_p
- *Optimal Sender window size = N= (1+2a) for 100% efficency*

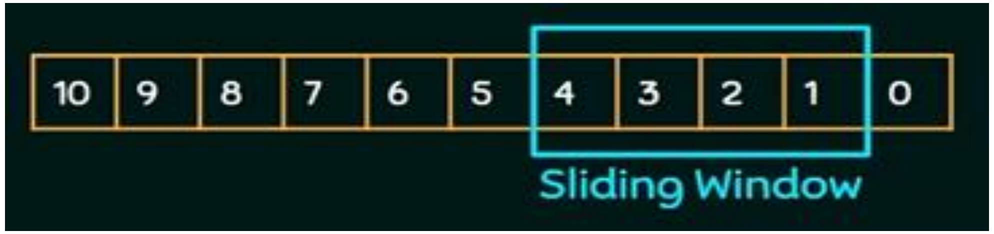
Go back to 2

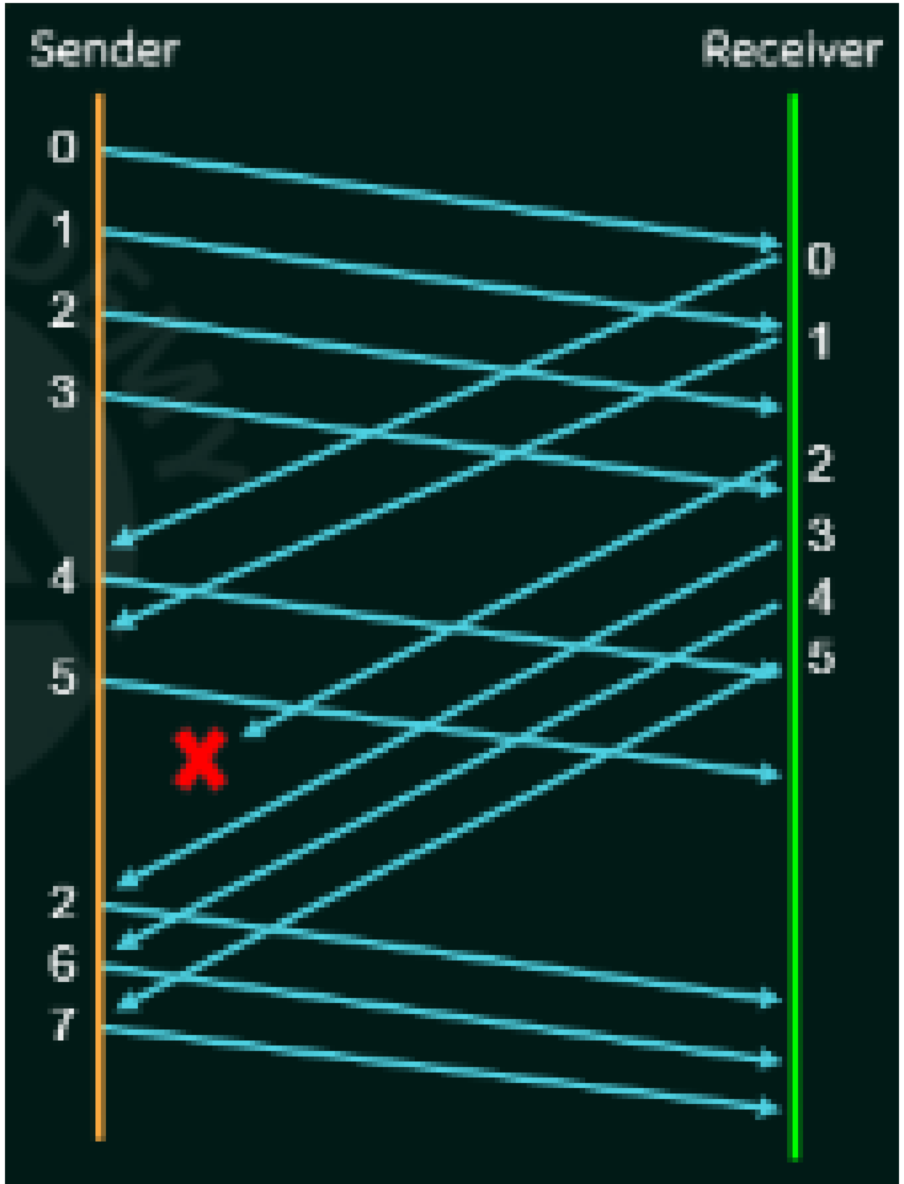


Selective Repeat Request ARQ Protocol

- *In selective repeat ARQ, only the erroneous or lost frames are retransmitted, while correct frames are received and buffered at the receiver side.*
- *The receiver while keeping track of sequence numbers, buffers the frames in memory and sends NACK (Not Acknowledged) for only frame which is missing or damaged.*
- *The sender will send/retransmits the frame for which NACK is received.*
- *In this protocol only the required frame is retransmitted and not the entire window.*

  - *Sender window size = N*
  - *Receiver window size =N*





Window Size = 4

Selective Repeat Request ARQ Protocol

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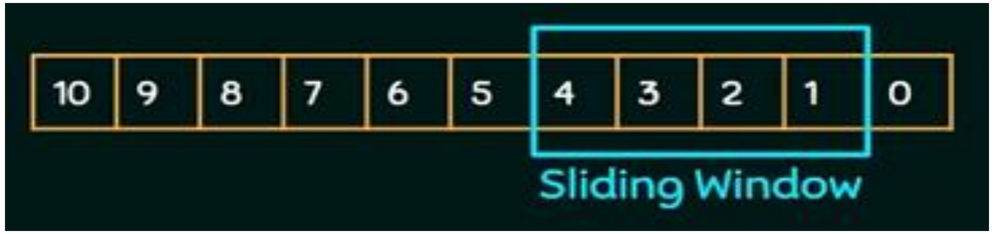
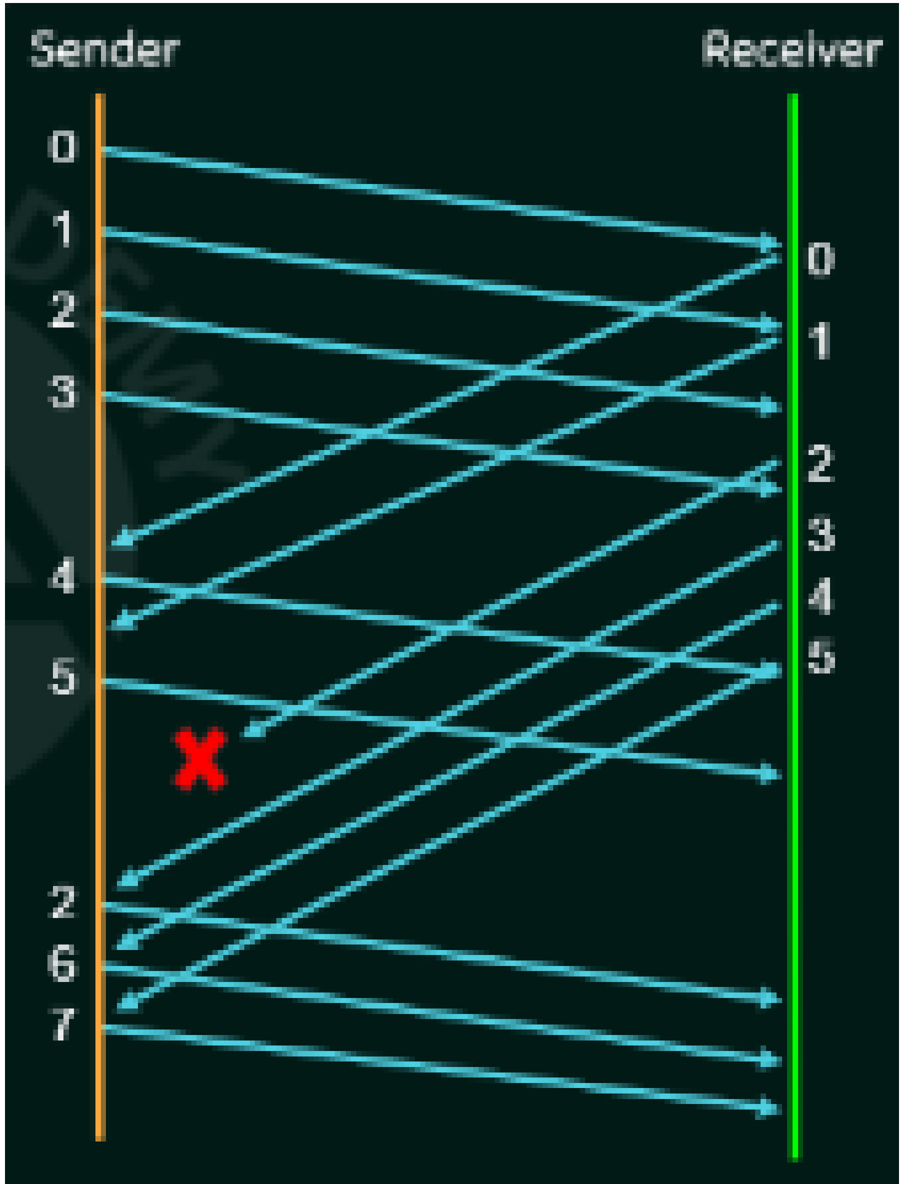




Window Size = 4

Ethernet

- *Ethernet is the most widely used wired LAN technologies.*

- *Ethernet protocol operates in data link layer and physical layer.*

- *Ethernet is in the family of networking technologies that are IEEE 802.2 and 802.3.*

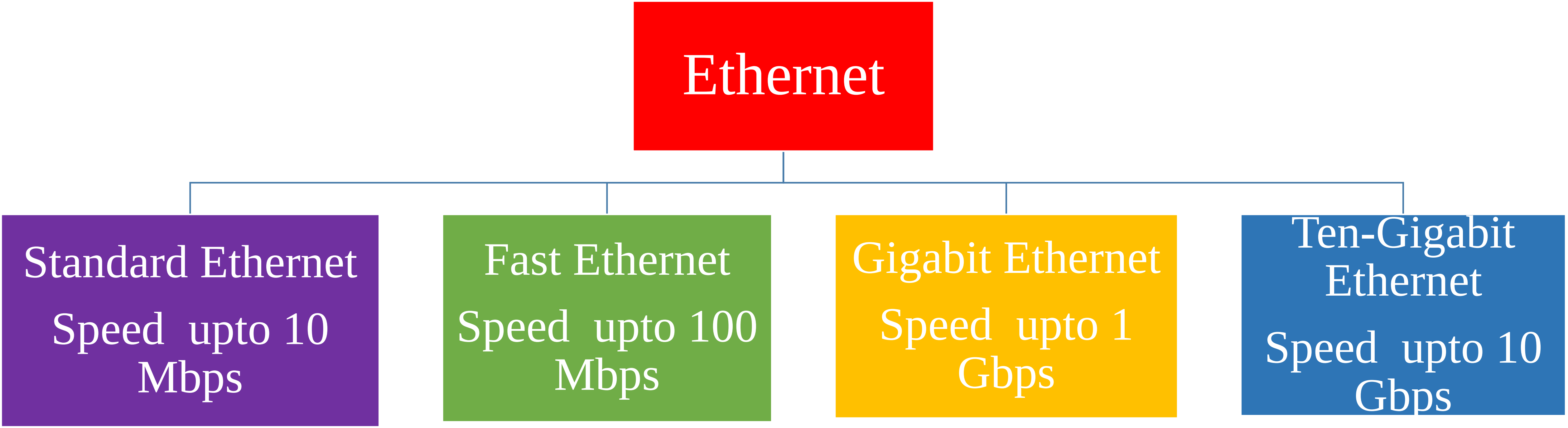
- *Supports data bandwidth of 10 Mbps, 100 Mbps, 1000 Mbps, 40, 000 Mbps and 1 Gbps.*

- *In this protocol only the required frame is retransmitted and not the entire window.*

- *Ethernet standards define Layer 2 protocol and Layer 1 technologies.*

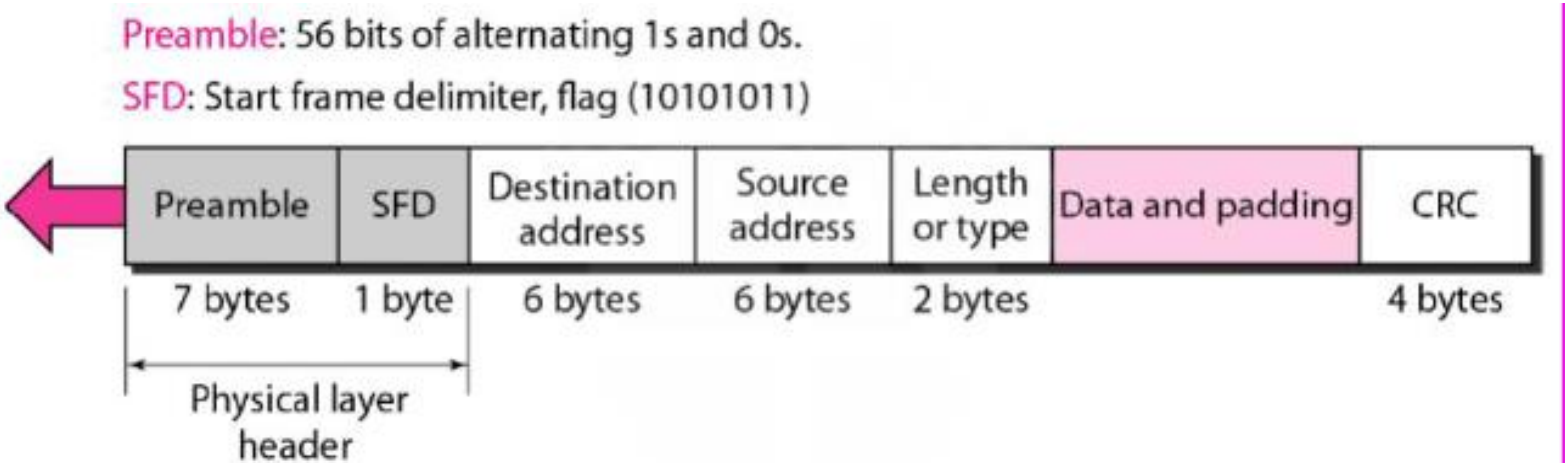
- *Ethernet operates in two separate sublayer of data link layer   logical link layer and MAC sublayer.*

Evolution of Ethernet



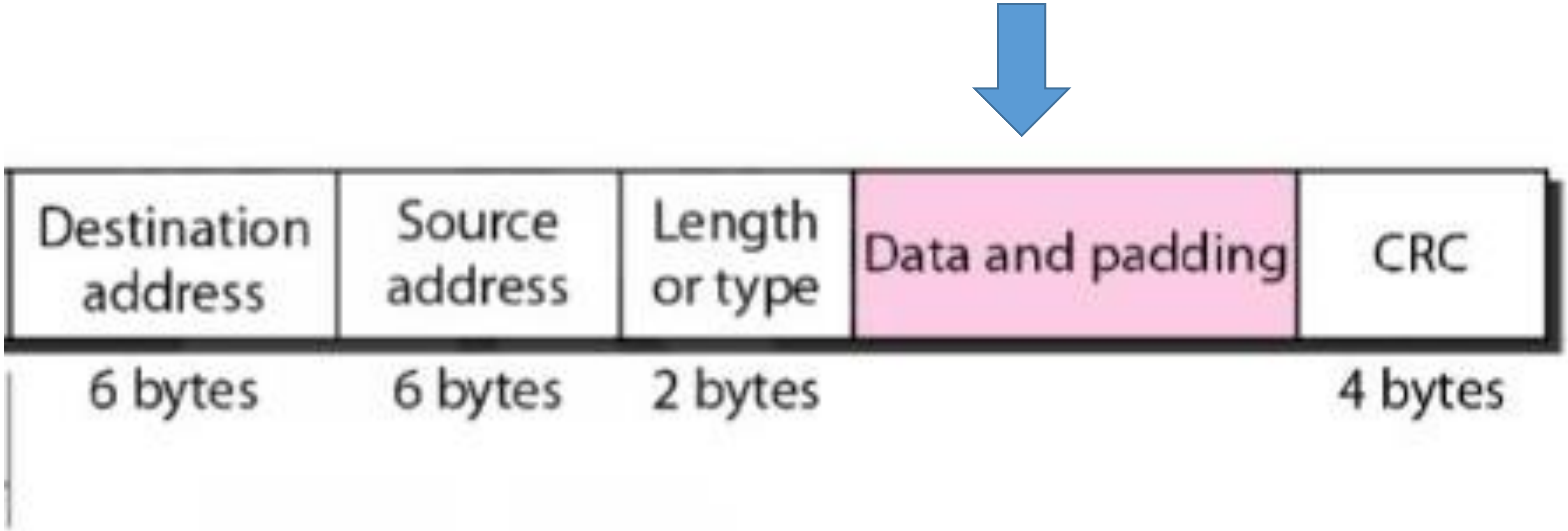
Ethernet Frame Format

- *Preamble: 56 bits of alternating ‘1’s and ‘0’s. It is needed for synchronization purpose.*
- *SDF (Start Frame Delimiter): Flag 10101011. This also needed for synchronization purpose. The last two bits of the Flag indicates the next field of the Ethernet frame is the destination address.*
- *Padding is required to make the received data from the upper layer (i.e network layer) a fixed size length.*



Minimum and Maximum Length of the Ethernet Frame

Payload from the network layer
Min payload = 46 bytes
Max. payload =1500 bytes



Min size of the Ethernet frame = 64bytes
Max. size of the Ethernet frame =1518bytes

Ethernet Address

Example: **06:01:02:01:2C:4B**

- *The least significant bit of the first byte defines the type of the address*
- *Last bit 0 defines Unicast, otherwise multicast*
- *If all bits in the frame is '1' then this is Broadcast.*

Started on	Thursday, 19 August 2021, 10:21 AM
State	Finished
Completed on	Thursday, 19 August 2021, 10:59 AM
Time taken	38 mins 19 secs
Grade	**21.00** out of 30.00 (**70**%)

Question **1**
Complete
Mark 0.00 out of 1.00

Which is true for circuit switching?

- a. The bandwidth used is not constant.
- b. While switching, time is wasted in waiting.
- c. All of these
- d. The rate at which the data is transmitted is constant.

The correct answer is:
The rate at which the data is transmitted is constant.

Question **2**
Complete
Mark 1.00 out of 1.00

Ethernet frame consists of

- a. Default mask
- b. None of these
- c. IP address
- d. MAC address

The correct answer is:
MAC address

Question **3**

Complete

Mark 1.00 out of 1.00

Which of the following is a set of rules that governs the data communication in a computer network

- a. Protocols
- b. None of these
- c. RFCs
- d. Activity standards

The correct answer is:
Protocols

Question **4**

Complete

Mark 2.00 out of 2.00

What will be the propagation time when the distance between two nodes is 2400km? Assuming the communication media between the nodes is fiber cable and the light travels with a speed to be $2x10^8$m/s in the cable.

- a. 2 ms
- b. None of these
- c. 12 ms
- d. 5 ms

The correct answer is:
12 ms

Question **5**

Complete

Mark 0.00 out of 2.00

A shared broadcast medium of transmission rate 5 Mbps is being shared by 10 users (U1, U2, ...U10). Calculate the maximum transmission rate of each of the users if the channel access scheme used is FDMA. If instead of FDMA the scheme being used is CDMA then what will be the maximum transmission rate of each of the users?

- a. 50 Mbps, 5 Mbps
- b. None of these
- c. 500 Kbps, 5000 Kbps
- d. 5000 Kbps, 5000 Kbps

The correct answer is:
500 Kbps, 5000 Kbps

Question **6**

Complete

Mark 1.00 out of 1.00

A landline telephone network is an example of.............. network.

- a. Circuit switched
- b. Line switched
- c. Packet switched
- d. Both packet switched and circuit switched

The correct answer is:
Circuit switched

Question **7**
Complete
Mark 1.00 out of 1.00

Which sub-layer of the data link layer performs data link functions that depend upon the type of medium?

- a. Logical link control sub-layer
- b. error control sub-layer
- c. Media access control sub-layer
- d. network interface control sub-layer

The correct answer is:
Media access control sub-layer

Question **8**
Complete
Mark 1.00 out of 1.00

Which address identifies a process on a host?

- a. port address
- b. physical address
- c. logical address
- d. specific address

The correct answer is:
port address

Question **9**

Complete

Mark 0.00 out of 1.00

What kind of transmission medium is most appropriate to carry data in a computer network that is exposed to electrical interference?

- a. Coaxial cable
- b. Optical fiber
- c. Microwave link
- d. Un-shielded twisted pair

The correct answer is:
Optical fiber

Question **10**

Complete

Mark 1.00 out of 1.00

The sharing of medium and its links by two or more devices is called

- a. Duplexing
- b. Multiplexing
- c. Fully duplexing
- d. Microplexing

The correct answer is:
Multiplexing

Question **11**

Complete

Mark 1.00 out of 1.00

Transmission delay not depends upon

- a. Distance between routers
- b. Bandwidth of the medium
- c. Packet length
- d. Transmission rate

The correct answer is:
Distance between routers

Question **12**

Complete

Mark 1.00 out of 1.00

In computer networks nodes are....

- a. the computer that originates/generates the data
- b. the computer that routes the data
- c. All of these
- d. the computer that terminates the data

The correct answer is:
All of these

Question **13**
Complete
Mark 1.00 out of 1.00

Communication between a computer and a speaker involves

a. Simplex

b. Full-duplex

c. Automatic

d. Half-duplex

The correct answer is:
Simplex

Question **14**
Complete
Mark 1.00 out of 1.00

The function of Digital Subscriber Line Access Multiplexer is to ________

a. Amplify digital signals

b. Convert digital signals into analog signals

c. De-amplify digital signals

d. Convert analog signals into digital signals

The correct answer is:
Convert analog signals into digital signals

Question **15**

Complete

Mark 1.00 out of 1.00

Which of the following task is not done by data link layer?

a. Flow control

b. Encoding

c. Framing

d. Error control

The correct answer is:
Encoding

Question **16**

Complete

Mark 0.00 out of 1.00

Which is of the following statement is incorrect,

A shared broadcast media of transmission bandwidth 20 Mbps is shared by 100 users then,

a. Using TDMA scheme, each of the users have an access to 200 Kbps of bandwidth

b. Using CDMA scheme, each of the users have an access to 20 Mbps of bandwidth

c. Using CDMA scheme, each of the users have an access to 200 Kbps of bandwidth

d. Using FDMA scheme, each of the users have an access to 200 Kbps of bandwidth

The correct answer is:
Using CDMA scheme, each of the users have an access to 200 Kbps of bandwidth

Question **17**

Complete

Mark 0.00 out of 1.00

Optical Network Terminator is connected to splitter using ________

- a. Optical cable
- b. Twisted pair cable
- c. microwave link
- d. hybrid fiber co-axial cable

The correct answer is:
Optical cable

Question **18**

Complete

Mark 1.00 out of 1.00

In link layer, parity bits are used for

- a. to detect errors
- b. to identify the user
- c. encryption of data
- d. to transmit data faster

The correct answer is:
to detect errors

Question **19**

Complete

Mark 1.00 out of 1.00

The number of bits in IPV4 address, IPV6 address, MAC address and Port address are

- a. 32, 128, 64, 16
- b. 128, 32, 48, 16
- c. 32, 128, 48, 32
- d. 32, 128, 48, 16

The correct answer is:
32, 128, 48, 16

Question **20**

Complete

Mark 1.00 out of 1.00

Which physical media provides the highest transmission speed in a network?

- a. co-axial cable
- b. optical fiber
- c. electrical cable
- d. twisted pair cable

The correct answer is:
optical fiber

Question **21**

Complete

Mark 0.00 out of 3.00

What are the propagation time and the transmission time for a 5Mbyte message (an image) if the transmission rate of the network is 1Mbps? Assume that the distance between the sender and the receiver is 8000 km and that light travels at 4×10^9 m/s.

- a. 50msecs, 40msecs
- b. 2msecs, 40msecs
- c. 2msecs, 40secs
- d. 50msecs, 40secs

The correct answer is:
2msecs, 40secs

Question **22**

Complete

Mark 3.00 out of 3.00

The message 11001001 is to be transmitted using CRC polynomial x^3+1 to protect it from errors. The message that should be transmitted after appending the CRC code with the original data is

- a. 1100001010
- b. None of these
- c. 1100001011
- d. 1100001110

The correct answer is:

None of these

Question **23**

Complete

Mark 1.00 out of 1.00

Which is not true for Packet switching?

- a. Installation costs of packet switching are expensive.
- b. Multiple users can use the same channel while transferring their packets.
- c. A dedicated path is followed throughout the session.
- d. The delivery of these packets becomes easy when complicated protocols are used.

The correct answer is:
A dedicated path is followed throughout the session.

Question **24**

Complete

Mark 1.00 out of 1.00

Header of a frame generally contains

- a. All of these
- b. MAC addresses
- c. Synchronization bytes
- d. Frame identifier

The correct answer is:
All of these

◄ Mid-Semester Exam_CS301 (Section 1 + Section 2)_13-09-2021_9.00 AM to 9.40 AM

Jump to...

Continuous LAB Assessment_24.08.2021_4.15pm to 4.30pm ►

Started on	Friday, 12 November 2021, 1:20 PM
State	Finished
Completed on	Friday, 12 November 2021, 1:28 PM
Time taken	8 mins 30 secs
Grade	**7.00** out of 10.00 (**70**%)

Question **1**

Complete

Mark 1.00 out of 1.00

The well-known port addresses are assigned to the

- a. None of these
- b. Destination
- c. Source
- d. Routers

Question **2**

Complete

Mark 1.00 out of 1.00

Which fields helps to check rearrangement of the fragments in IPV4?

- a. Protocol field value
- b. Checksum
- c. Fragment Offset
- d. Flags

Question **3**

Complete

Mark 1.00 out of 1.00

A email service uses which one of the following transport layer protocol?

- a. UDP
- b. Both TCP and UDP
- c. HTTP
- d. TCP

Question **4**

Complete

Mark 1.00 out of 1.00

The traffic field of IPV6 is similar to which field in the IPV4 header?

- a. Fragmentation field
- b. Type of service
- c. Option field
- d. Fast switching

Question **5**

Complete

Mark 1.00 out of 1.00

Fragmentation is done in .... layer.

- a. Transport Layer
- b. Data link Layer
- c. Physical layer
- d. Network Layer

Question **6**

Complete

Mark 1.00 out of 1.00

Which of these is not a type of error-reporting message?

- a. Destination unreachable
- b. Router error
- c. Source quench
- d. Time exceeded

Question **7**

Complete

Mark 0.00 out of 1.00

Which of the following is incorrect about Network Address Translation?

- a. Router will do NAT translation without configuration.
- b. NAT is a process in which one or more local IP address is translated into one or more Global IP address and vice versa.
- c. Certain application will not function while NAT is enabled.
- d. NAT results in switching path delays.

Question **8**

Complete

Mark 0.00 out of 1.00

Routing inside a single administrative domain is called as................ routing.

- a. Path Vector
- b. Intra-domain
- c. Inter-domain
- d. None of these

Question **9**

Complete

Mark 0.00 out of 1.00

In an IPV4 packet, the value of HLEN is 1010 in binary. How many bytes of options are being carried by this packet?

- a. 20 bytes
- b. 12 bytes
- c. 10 bytes
- d. 32 bytes

Question **10**

Complete

Mark 1.00 out of 1.00

Which of the following is true for Address Resolution Protocol (ARP)?

- a. ARP request is broadcast and ARP reply is also broadcast.
- b. ARP request is broadcast and ARP reply is unicast.
- c. ARP request is unicast and ARP reply is also unicast.
- d. ARP request is unicast and ARP reply is broadcast.

Jump to...

Continuous LAB Assessment_28.10.2021_4.15pm to 4.30pm ►

Started on	Tuesday, 24 August 2021, 4:19 PM
State	Finished
Completed on	Tuesday, 24 August 2021, 4:25 PM
Time taken	6 mins
Grade	**8.00** out of 10.00 (**80**%)

Question **1**
Complete
Mark 1.00 out of 1.00

What will be the propagation time when the distance between two points is 2400km?Assuming the propagation speed to be $4x10^8$m/s in cable

- a. 2ms
- b. 5ms
- c. 1ms
- d. 6ms

The correct answer is:
6ms

Question **2**
Complete
Mark 1.00 out of 1.00

The _____ layer links network/user support layers by segmenting and rearranging the data.

- a. application layer
- b. transport layer
- c. session Layer
- d. network layer

The correct answer is:
transport layer

Question **3**
Complete
Mark 0.00 out of 1.00

The OSI model was developed ____ TCP/IP model.

- a. None of these
- b. after
- c. simultaneous to
- d. prior to

The correct answer is:
after

Question **4**
Complete
Mark 1.00 out of 1.00

Which multiple access techniques is used by IEEE 802.11 standards for wireless LANs?

- a. CSMA
- b. CSMA/CA
- c. ALOHA
- d. CSMA/CD

The correct answer is:
CSMA/CA

Question **5**
Complete
Mark 1.00 out of 1.00

In reference to OSI model, TCP/IP model does not have _____

- a. application layer
- b. transport layer
- c. session layer
- d. application layer

The correct answer is:
session layer

Question **6**
Complete
Mark 1.00 out of 1.00

Which of the following option is correct?

In wireless distribution system

- a. only one access point exits
- b. access points are not required
- c. multiple access points are inter-connected with each other
- d. there is no access point

The correct answer is:
multiple access points are inter-connected with each other

Question **7**
Complete
Mark 1.00 out of 1.00

Which layer is responsible for the process to process delivery in a general network model?

- a. transport layer
- b. network layer
- c. session layer
- d. data link layer

The correct answer is:
transport layer

Question **8**

Complete

Mark 1.00 out of 1.00

Transmission data rate is decided by __________

- a. network layer
- b. data link layer
- c. physical layer
- d. transport layer

The correct answer is:
physical layer

Question **9**

Complete

Mark 1.00 out of 1.00

There are ***n*** stations in a slotted LAN. Each station attempts to transmit with a probability ***p*** in each time slot. What is the probability that only one station transmits in a given time slot?

- a. $1-(1-p)^{(n-1)}$
- b. $(1-p)^{(n-1)}$
- c. $p(1-p)^{(n-1)}$
- d. $np(1-p)^{(n-1)}$

The correct answer is:
$np(1-p)^{(n-1)}$

Question **10**

Complete

Mark 0.00 out of 1.00

Which multiple access techniques is used by Ethernet standards for wireless LANs

- a. CSMA
- b. CSMA/CD
- c. ALOHA
- d. CSMA/CA

The correct answer is:
CSMA/CD

◄ Pre-Mid-Semester Exam_CS301 (Section 1 + Section 2)_19-08-2021_10.15 ti 11.15 AM

Jump to...

[Dashboard](#) / [Courses](#) / [Autumn 2021-22](#) / [BTech Sem-5](#) / [CS301 CSE & IT](#) / [General](#)
/ [Continuous LAB Assessment 28.10.2021 4.15pm to 4.30pm](#)

Started on	Thursday, 28 October 2021, 4:21 PM
State	Finished
Completed on	Thursday, 28 October 2021, 4:28 PM
Time taken	7 mins 19 secs
Grade	**8.00** out of 10.00 (**80**%)

Question **1**
Complete
Mark 1.00 out of 1.00

Which one of the following is not a function of network layer?

- a. **routing**
- b. **congestion control**
- c. **error control**
- d. **inter-networking**

Question **2**
Complete
Mark 0.00 out of 1.00

For a given subnet mask 255.128.0.0, what is the number of subnets?

- a. 8
- b. 2
- c. 4
- d. 6

Question **3**
Complete
Mark 1.00 out of 1.00

In a given subnet mask 255.0.0.0, what is the number of Host ID bits?

- a. 21
- b. 24
- c. 12
- d. 221

Question **4**
Complete
Mark 1.00 out of 1.00

In class C classful IPv4 addressing format, the number of networks allowed under Class C addresses is

- a. **2^24**
- b. **2^7**
- c. **2^14**
- d. **2^21**

Question **5**
Complete
Mark 1.00 out of 1.00

Error control is responsibility of which OSI layers

- a. **Network and Transport layer**
- b. **Physical and Data link layer**
- c. **All of these**
- d. **Data link and Transport layer**

Question **6**

Complete

Mark 1.00 out of 1.00

Which one of the following protocol is NOT used to resolve one form of address to another one?

- a. **DNS**
- b. **ARP**
- c. **RARP**
- d. **DHCP**

Question **7**

Complete

Mark 1.00 out of 1.00

While configuring the router, the IP address assigned to one port is 201.14.2.1/23. LAN1 is attached to this port of the router. Which of the following IP addresses are valid on this LAN1 interface,

I1: 201.14.1.100

I2: 201.14.1.3

I3: 201.14.2.2

I4: 201.14.3.0

- a. Only I2 and I3
- b. Only I1 and I2
- c. Only I3 and I4
- d. Only I1 and I3

Question **8**

Complete

Mark 0.00 out of 1.00

Find out the invalid subnet mask from the following

- a. **223.0.0.0**
- b. **None of these**
- c. **255.255.255.252**
- d. **255.240.0.0**

Question **9**

Complete

Mark 1.00 out of 1.00

In the even parity, find the parity bit of data 1001001001.

- a. **1**
- b. **X**
- c. **0**
- d. **None of these**

Question **10**

Complete

Mark 1.00 out of 1.00

In the IPV4 addressing format, the number of hosts allowed under Class A addresses

- a. **2^32-2**
- b. **2^24-2**
- c. **2^16-2**
- d. **2^8-2**

◄ Continuous Assessment_12.11.2021_1.15pm to 1.30pm

Jump to...

Announcements ►

Q1. Station A uses 45 byte packets to transmit messages to Station B using a sliding window protocol. The round trip time delay between A and B is 60ms and the bottleneck bandwidth on the path A and B is 120kbps. What is the optimal window size that A should use? **(4 Marks)**

Ans: Frame size = 45 byte

Round trip time (RTT) delay between A and B is = 60ms= 2*30 ms

T_p= 30 ms

$$T_t = \frac{45 * 8}{120} = 3\ ms$$

$$N = (1 + 2a) = \left(1 + 2 * \frac{T_p}{T_t}\right) = (1 + 2 * \frac{30}{3}) = 21$$

Q2.(a) If each frame carries 1000 bits of data, how long does it take to send 2 million (2,000,000) bits of data using (a) Stop-and-Wait ARQ, (b) Go-Back-N ARQ and (iii) Selective Repeat ARQ. Assume that all three ARQs are using 4 bits for representing sequence numbers. The distance between sender and receiver is 5000 Km and the propagation speed is 2 x10^8 s/ m. Ignore transmission, waiting and processing delays. Assume no data or control frame is lost or damaged. **(4 Marks)**

Ans: a. RTT = 25+25 ms=50ms

window size = 2^4 = 16

Number of frames = 2,000,000/1000= 2000

Stop-and-Wait ARQ= 50ms ×Number of frames= 50×2000 =10^5 ms = 100 s

Go-Back-N ARQ = (Number of frames/window size) × 50 ms = 6250 ms = 6·25 s

Selective Repeat request = 6·25 s

Q2.(b) For the above problem, to achieve minimum delay for transmission of 2 million bits using (a) Go-back-N protocol and (b) Selective repeat ARQ, what will be the optimal size of windows at the sender and receiver side? Also find out the optimal number of required bits to incorporate sequence numbers for both the protocols. Ignore transmission, waiting and processing delays. **(4 Marks)**

Ans: b. As there are no transmission delays. So, the window size N = (1+2a) where $a = T_p/T_t$, as there is no transmission delay so a = ∞, so N = ∞, i.e. the window is of size infinity. So at ones 2000 frame scan be transmitted from the sender to have optimal delay. So in case of Go-back-N protocol sender window size N = 2000 and receiver window size =1. And in case of Selective repeat ARQ sender window size and receiver window size both are equal i.e. N =2000.

Q3. Suppose a sender A needs to send a message consisting of 11 frames to receiver B using a sliding window (window size 4) and Go-Back-N ARQ flow control strategy. All packets are ready and immediately available for transmission. If the 5th frame in the queue that A transmits gets lost at the first attempt (but no ACKs from B ever get lost), then what is the total number of frames that A will transmit for sending the entire message to B? **(4 Marks)**

Ans: Total no. of frames to be sent = 11

Window size = 4

If the 5th frame in the queue is lost

11	10	9	8	7	6	5	4	3	2	1

Only 5th frame is lost. Not every 5th Frame

#step 1- Since the sender window size is 4. So the sender will sends 4 packets 1,2,3,4
So, total no. of frames sent till now from the sender side is = 4

#step 2- After getting the ACK for the frame with sequence no. 1, the content of the window will be 2,3,4,5 and the 5th frame will be sent
So, total no. of frames sent till now from the sender side is = (4+1) = 5

#step 3- After getting the ACK for the frame with sequence no. 2, the content of the window will be 3,4,5, 6 and the 6th frame will be sent
So, total no. of frames sent till now from the sender side is = (5+1) = 6

#step 4- After getting the ACK for the frame with sequence no. 3, the content of the window will be 4,5,6, 7 and the 7th frame will be sent
So, total no. of frames sent till now from the sender side is = (6+1) = 7

#step 5- After getting the ACK for the frame with sequence no. 4, the content of the window will be 5,6,7,8 and the 8th frame will be sent
So, total no. of frames sent till now from the sender side is = (7+1) = 8

#step 5- As the 5th frame is lost so no ACK for this frame will receive from the receiver B, the content of the window will be 5,6,7,8
As the 5th frame is in error so again all the frame in the window have to be retransmitted

So, total no. of frames sent till now from the sender side is = (8+4) = 12

#step 6- After getting the ACK for the frame with sequence no. 8, the content of the window will be 9,10,11 and the 11th frame will be sent
So, total no. of frames sent till now from the sender side is = (12+1) = 13

#step 7- After getting the ACK for the frame with sequence no. 9, the content of the window will be 10,11 and as all frames are already sent and only waiting for acknowledgment

So, total no. of frames sent till now from the sender side is = (12+1) = 13

Q4. (a) A group of k stations share 200 kbps slotted Aloha channel. Each station outputs a 400 bits frame on an average of 1000 ms even if the previous one has not been sent. What is the required value of k? **(4 Marks)**

Ans: Throughput of each stations = Number of bits sent per sec = $\frac{400\ bits}{1000\ ms}$ = 400 bits/sec

Throughput for slotted Aloha = Efficiency * Bandwidth = 0.368*200 Kbps

Total no. of stations = = $\frac{0.368*200\ \text{Kbps}}{400\ bits} = 184\ stations$

Q4. (b) Discuss how the efficiency of slotted Aloha is more than pure Aloha? **(2 Marks)**

Q5. A 50 Kbps satellite link has a propagation delay of 500 ms. The transmitter employs the "Go Back 16 ARQ" scheme. Assuming that each frame is 200 bytes long, what is the maximum data rate possible? **(4 Marks)**

Ans: $T_p = 500$ ms

$T_t = 32$ ms

a = 15.625

Efficiency $\times$ BW

Efficiency = 0.496

0.496 $\times$ 50 Kbps .

maximum data rate possible = 24.8 Kbps=25 Kbps

Q6. Station A uses 45 byte packets to transmit messages to Station B using a sliding window protocol. The round trip time delay between A and B is 60ms and the bottleneck bandwidth on the path A and B is 120kbps. What is the optimal window size that A should use?

Ans: 21

Q7. Explain the difference between: **(6 Marks)**
a. 1-persistent, p-persistent and non-persistent CSMA
b. Hub, Switch, and Bridges

Q8. Suppose we want to transmit the message 11001001 and protect it from errors using CRC polynomial $x^3 + 1$. Use polynomial long division to determine the message that should be transmitted. Corrupt the left-most third bit of the transmitted message and show that the error is detected by the receiver using CRC technique. **(5 Marks)**

Data : 11001001.

Divisor : x^3+1

$x^3+0.x^2+0.x+x^0$

1001.

$L-1 = (4-1) = 3$.

```
          11010011
1001 ) 11001001000
       1001
        1011
        1001
         0100
         0000
          1000
          1001
           0011
           0000
            0110
            0000
             1100
             1001
              1010
              1001
               011
```

remainder

⇓

CRC

Data transmitted to be

11001001011

Transmitted msg = 11001001011

↑ error

11010011 = 11001001111

```
1001 ) 11001001111
       1001
        1011
        1001
         0100
         0000
          1000
          1001
           0011
           0000
            0111
            0000
```

```
1001 ) 1111
       1001
        1101
        1001
         100
```

remainder

non-zero

so error is there

Started on	Tuesday, 24 August 2021, 4:15 PM
State	Finished
Completed on	Tuesday, 24 August 2021, 4:23 PM
Time taken	7 mins 57 secs
Grade	**9.00** out of 10.00 (**90%**)

Question **1**
Complete
Mark 1.00 out of 1.00

There are n stations in a slotted LAN. Each station attempts to transmit with a probability p in each time slot. What is the probability that only one station transmits in a given time slot?

- a. $np(1\text{-}p)^{(n\text{-}1)}$
- b. $(1\text{-}p)^{(n\text{-}1)}$
- c. $p(1\text{-}p)^{(n\text{-}1)}$
- d. $1\text{-}(1\text{-}p)^{(n\text{-}1)}$

The correct answer is:
$np(1\text{-}p)^{(n\text{-}1)}$

Question **2**

Complete

Mark 1.00 out of 1.00

What will be the propagation time when the distance between two points is 2400km?Assuming the propagation speed to be $4x10^8$m/s in cable

- a. 5ms
- b. 2ms
- c. 6ms
- d. 1ms

The correct answer is:
6ms

Question **3**

Complete

Mark 1.00 out of 1.00

Which layer is responsible for the process to process delivery in a general network model?

- a. session layer
- b. data link layer
- c. network layer
- d. transport layer

The correct answer is:
transport layer

Question **4**

Complete

Mark 1.00 out of 1.00

Which of the following option is correct?

In wireless distribution system

- a. only one access point exits
- b. access points are not required
- c. there is no access point
- d. multiple access points are inter-connected with each other

The correct answer is:
multiple access points are inter-connected with each other

Question **5**

Complete

Mark 1.00 out of 1.00

The ______ layer links network/user support layers by segmenting and rearranging the data.

- a. network layer
- b. session Layer
- c. transport layer
- d. application layer

The correct answer is:
transport layer

Question **6**

Complete

Mark 1.00 out of 1.00

Transmission data rate is decided by __________

a. transport layer

b. data link layer

c. network layer

d. physical layer

The correct answer is:
physical layer

Question **7**

Complete

Mark 1.00 out of 1.00

In reference to OSI model, TCP/IP model does not have _____

a. application layer

b. application layer

c. session layer

d. transport layer

The correct answer is:
session layer

Question **8**

Complete

Mark 1.00 out of 1.00

Which multiple access techniques is used by IEEE 802.11 standards for wireless LANs?

- a. CSMA/CA
- b. CSMA
- c. CSMA/CD
- d. ALOHA

The correct answer is:
CSMA/CA

Question **9**

Complete

Mark 0.00 out of 1.00

The OSI model was developed _____ TCP/IP model.

- a. None of these
- b. prior to
- c. after
- d. simultaneous to

The correct answer is:
after

Question **10**

Complete

Mark 1.00 out of 1.00

Which multiple access techniques is used by Ethernet standards for wireless LANs

- a. CSMA/CA
- b. CSMA
- c. CSMA/CD
- d. ALOHA

The correct answer is:
CSMA/CD

◄ Pre-Mid-Semester Exam_CS301 (Section 1 + Section 2)_19-08-2021_10.15 ti 11.15 AM

Jump to...

Started on	Thursday, 28 October 2021, 4:16 PM
State	Finished
Completed on	Thursday, 28 October 2021, 4:25 PM
Time taken	9 mins 44 secs
Grade	**8.00** out of 10.00 (**80%**)

Question **1**
Complete
Mark 1.00 out of 1.00

Which one of the following protocol is NOT used to resolve one form of address to another one?

a. **DNS**

b. **RARP**

c. **DHCP**

d. **ARP**

Question **2**
Complete
Mark 0.00 out of 1.00

Error control is responsibility of which OSI layers

a. **Data link and Transport layer**

b. **Physical and Data link layer**

c. **All of these**

d. **Network and Transport layer**

Question **3**

Complete

Mark 1.00 out of 1.00

Find out the invalid subnet mask from the following

- a. **223.0.0.0**
- b. **255.255.255.252**
- c. **None of these**
- d. **255.240.0.0**

Question **4**

Complete

Mark 1.00 out of 1.00

Which one of the following is not a function of network layer?

- a. **inter-networking**
- b. **error control**
- c. **routing**
- d. **congestion control**

Question **5**

Complete

Mark 0.00 out of 1.00

In class C classful IPv4 addressing format, the number of networks allowed under Class C addresses is

- a. **2^21**
- b. **2^24**
- c. **2^14**
- d. **2^7**

Question **6**

Complete

Mark 1.00 out of 1.00

While configuring the router, the IP address assigned to one port is 201.14.2.1/23. LAN1 is attached to this port of the router. Which of the following IP addresses are valid on this LAN1 interface,

I1: 201.14.1.100

I2: 201.14.1.3

I3: 201.14.2.2

I4: 201.14.3.0

- a. Only I2 and I3
- b. Only I1 and I2
- c. Only I3 and I4
- d. Only I1 and I3

Question **7**

Complete

Mark 1.00 out of 1.00

In a given subnet mask 255.0.0.0, what is the number of Host ID bits?

- a. 24
- b. 21
- c. 12
- d. 221

Question **8**

Complete

Mark 1.00 out of 1.00

In the IPV4 addressing format, the number of hosts allowed under Class A addresses

- a. **2^24-2**
- b. **2^16-2**
- c. **2^8-2**
- d. **2^32-2**

Question **9**
Complete
Mark 1.00 out of 1.00

In the even parity, find the parity bit of data 1001001001.

- a. **X**
- b. **None of these**
- c. **0**
- d. **1**

Question **10**
Complete
Mark 1.00 out of 1.00

For a given subnet mask 255.128.0.0, what is the number of subnets?

- a. 6
- b. 4
- c. 2
- d. 8

◄ Continuous Assessment_12.11.2021_1.15pm to 1.30pm

Jump to...

Announcements ►

Started on	Friday, 12 November 2021, 1:16 PM
State	Finished
Completed on	Friday, 12 November 2021, 1:26 PM
Time taken	9 mins 52 secs
Grade	**6.00** out of 10.00 (**60%**)

Question **1**
Complete
Mark 1.00 out of 1.00

The traffic field of IPV6 is similar to which field in the IPV4 header?

- a. Fast switching
- b. Fragmentation field
- c. Option field
- d. Type of service

Question **2**
Complete
Mark 1.00 out of 1.00

Which of these is not a type of error-reporting message?

- a. Destination unreachable
- b. Router error
- c. Source quench
- d. Time exceeded

Question **3**
Complete
Mark 1.00 out of 1.00

Routing inside a single administrative domain is called as................ routing.

- a. Inter-domain
- b. Intra-domain
- c. None of these
- d. Path Vector

Question **4**
Complete
Mark 0.00 out of 1.00

In an IPV4 packet, the value of HLEN is 1010 in binary. How many bytes of options are being carried by this packet?

- a. 32 bytes
- b. 12 bytes
- c. 10 bytes
- d. 20 bytes

Question **5**
Complete
Mark 0.00 out of 1.00

Which of the following is incorrect about Network Address Translation?

- a. NAT results in switching path delays.
- b. NAT is a process in which one or more local IP address is translated into one or more Global IP address and vice versa.
- c. Router will do NAT translation without configuration.
- d. Certain application will not function while NAT is enabled.

Question **6**

Complete

Mark 1.00 out of 1.00

A email service uses which one of the following transport layer protocol?

- a. HTTP
- b. Both TCP and UDP
- c. UDP
- d. TCP

Question **7**

Complete

Mark 1.00 out of 1.00

Which of the following is true for Address Resolution Protocol (ARP)?

- a. ARP request is broadcast and ARP reply is also broadcast.
- b. ARP request is unicast and ARP reply is also unicast.
- c. ARP request is unicast and ARP reply is broadcast.
- d. ARP request is broadcast and ARP reply is unicast.

Question **8**

Complete

Mark 1.00 out of 1.00

Fragmentation is done in .... layer.

- a. Network Layer
- b. Physical layer
- c. Transport Layer
- d. Data link Layer

Question **9**

Complete

Mark 0.00 out of 1.00

Which fields helps to check rearrangement of the fragments in IPV4?

- a. Checksum
- b. Protocol field value
- c. Fragment Offset
- d. Flags

Question **10**

Complete

Mark 0.00 out of 1.00

The well-known port addresses are assigned to the

- a. Routers
- b. None of these
- c. Source
- d. Destination

Jump to...

Continuous LAB Assessment_28.10.2021_4.15pm to 4.30pm ►

Started on	Thursday, 19 August 2021, 10:15 AM
State	Finished
Completed on	Thursday, 19 August 2021, 10:55 AM
Time taken	40 mins
Grade	**23.00** out of 30.00 (**77%**)

Question **1**

Complete

Mark 1.00 out of 1.00

The function of Digital Subscriber Line Access Multiplexer is to ________

a. De-amplify digital signals

b. Convert analog signals into digital signals

c. Amplify digital signals

d. Convert digital signals into analog signals

The correct answer is:
Convert analog signals into digital signals

Question **2**

Complete

Mark 0.00 out of 1.00

A landline telephone network is an example of.............. network.

a. Circuit switched

b. Line switched

c. Both packet switched and circuit switched

d. Packet switched

The correct answer is:
Circuit switched

Question **3**

Complete

Mark 1.00 out of 1.00

Optical Network Terminator is connected to splitter using ________

- a. microwave link
- b. hybrid fiber co-axial cable
- c. Twisted pair cable
- d. Optical cable

The correct answer is:
Optical cable

Question **4**

Complete

Mark 0.00 out of 1.00

Which is not true for Packet switching?

- a. Multiple users can use the same channel while transferring their packets.
- b. The delivery of these packets becomes easy when complicated protocols are used.
- c. Installation costs of packet switching are expensive.
- d. A dedicated path is followed throughout the session.

The correct answer is:
A dedicated path is followed throughout the session.

Question **5**

Complete

Mark 1.00 out of 1.00

Which physical media provides the highest transmission speed in a network?

a. co-axial cable

b. electrical cable

c. optical fiber

d. twisted pair cable

The correct answer is:
optical fiber

Question **6**

Complete

Mark 1.00 out of 1.00

Bluetooth is a wireless technology for

a. WAN (Wide Area Network)

b. LAN (Local Area Network)

c. PAN (Personal Area Network)

d. MAN (Metropolitan Area Network)

The correct answer is:
PAN (Personal Area Network)

Question 7

Complete

Mark 1.00 out of 1.00

The number of bits in IPV4 address, IPV6 address, MAC address and Port address are

- a. 32, 128, 48, 16
- b. 32, 128, 48, 32
- c. 32, 128, 64, 16
- d. 128, 32, 48, 16

The correct answer is:
32, 128, 48, 16

Question 8

Complete

Mark 0.00 out of 3.00

What are the propagation time and the transmission time for a 5Mbyte message (an image) if the transmission rate of the network is 1Mbps? Assume that the distance between the sender and the receiver is 8000 km and that light travels at 4×10^9 m/s.

- a. 2msecs, 40msecs
- b. 50msecs, 40msecs
- c. 50msecs, 40secs
- d. 2msecs, 40secs

The correct answer is:
2msecs, 40secs

Question **9**

Complete

Mark 1.00 out of 1.00

Header of a frame generally contains

a. MAC addresses

b. Synchronization bytes

c. All of these

d. Frame identifier

The correct answer is:
All of these

Question **10**

Complete

Mark 1.00 out of 1.00

Which of the following is a set of rules that governs the data communication in a computer network

a. Activity standards

b. None of these

c. Protocols

d. RFCs

The correct answer is:
Protocols

Question **11**

Complete

Mark 3.00 out of 3.00

The message 11001001 is to be transmitted using CRC polynomial x^3+1 to protect it from errors. The message that should be transmitted after appending the CRC code with the original data is

- a. None of these
- b. 1100001110
- c. 1100001011
- d. 1100001010

The correct answer is:

None of these

Question **12**

Complete

Mark 1.00 out of 1.00

In link layer, parity bits are used for

- a. encryption of data
- b. to detect errors
- c. to identify the user
- d. to transmit data faster

The correct answer is:
to detect errors

Question **13**

Complete

Mark 0.00 out of 1.00

Which of the following delay is faced by the packet in travelling from one end system to another?

a. Propagation delay

b. Transmission delay

c. Queuing delay

d. All of these

The correct answer is:
All of these

Question **14**

Complete

Mark 2.00 out of 2.00

Suppose five clients are connected to five servers (making five pairs of client-server networks) through a common transmission channel of transmission rate 10 Mbps. All the server access links have a transmission rate of 8 Mbps and all the client access links have a transmission rate of 5 Mbps, the throughput of this network will be

a. 10 Mbps

b. 2 Mbps

c. None of these

d. 5 Mbps

The correct answer is:
2 Mbps

Question **15**

Complete

Mark 1.00 out of 1.00

Which sub-layer of the data link layer performs data link functions that depend upon the type of medium?

a. network interface control sub-layer

b. Media access control sub-layer

c. Logical link control sub-layer

d. error control sub-layer

The correct answer is:
Media access control sub-layer

Question **16**

Complete

Mark 1.00 out of 1.00

What kind of transmission medium is most appropriate to carry data in a computer network that is exposed to electrical interference?

a. Microwave link

b. Optical fiber

c. Un-shielded twisted pair

d. Coaxial cable

The correct answer is:
Optical fiber

Question **17**

Complete

Mark 1.00 out of 1.00

Which of the following is link layer protocol

a. HDLC (High Level Data Link control)

b. PPP (point-to-point protocol)

c. All of these

d. Ethernet

The correct answer is:
All of these

Question **18**

Complete

Mark 1.00 out of 1.00

In computer networks nodes are....

a. the computer that originates/generates the data

b. All of these

c. the computer that routes the data

d. the computer that terminates the data

The correct answer is:
All of these

Question **19**

Complete

Mark 0.00 out of 1.00

Which is true for circuit switching?

- a. While switching, time is wasted in waiting.
- b. The rate at which the data is transmitted is constant.
- c. All of these
- d. The bandwidth used is not constant.

The correct answer is:
The rate at which the data is transmitted is constant.

Question **20**

Complete

Mark 1.00 out of 1.00

Transmission delay not depends upon

- a. Packet length
- b. Distance between routers
- c. Bandwidth of the medium
- d. Transmission rate

The correct answer is:
Distance between routers

Question **21**

Complete

Mark 1.00 out of 1.00

Propagation delay depends on

- a. Distance between routers
- b. Packet length
- c. Speed of CPU
- d. Transmission rate

The correct answer is:
Distance between routers

Question **22**

Complete

Mark 1.00 out of 1.00

Ethernet frame consists of

- a. Default mask
- b. None of these
- c. MAC address
- d. IP address

The correct answer is:
MAC address

Question **23**

Complete

Mark 1.00 out of 1.00

Which address identifies a process on a host?

a. specific address

b. port address

c. logical address

d. physical address

The correct answer is:
port address

Question **24**

Complete

Mark 2.00 out of 2.00

A shared broadcast medium of transmission rate 5 Mbps is being shared by 10 users (U1, U2, ...U10). Calculate the maximum transmission rate of each of the users if the channel access scheme used is FDMA. If instead of FDMA the scheme being used is CDMA then what will be the maximum transmission rate of each of the users?

a. 500 Kbps, 5000 Kbps

b. 5000 Kbps, 5000 Kbps

c. None of these

d. 50 Mbps, 5 Mbps

The correct answer is:
500 Kbps, 5000 Kbps

◄ Mid-Semester Exam_CS301 (Section 1 + Section 2)_13-09-2021_9.00 AM to 9.40 AM

Jump to...

Continuous LAB Assessment_24.08.2021_4.15pm to 4.30pm ►

Module 3

Network Layer

Dr. Sunandita Debnath, IIIT Vadodara

IPV4 Address

- *IPV4 addresses are 32 bits long that uniquely and universally defines the connection of a device on the internet.*
- *IPV6 addresses are 128 bits long.*
- *Two devices on the internet can never have the same addresses at the same time.*
- *The addresses range of IPV4 addresses are* 2^{32} *i.e. more than 4 billions*
- *But we have more devices, the NAT (network address translation) technology will resolve this.*

IPV4 Address

- *IPV4 addresses have two notations*
    - *Binary notations.*
    - *Dotted Decimal notations.*

Binary notations: 01110101 10010101 00011101 00000010

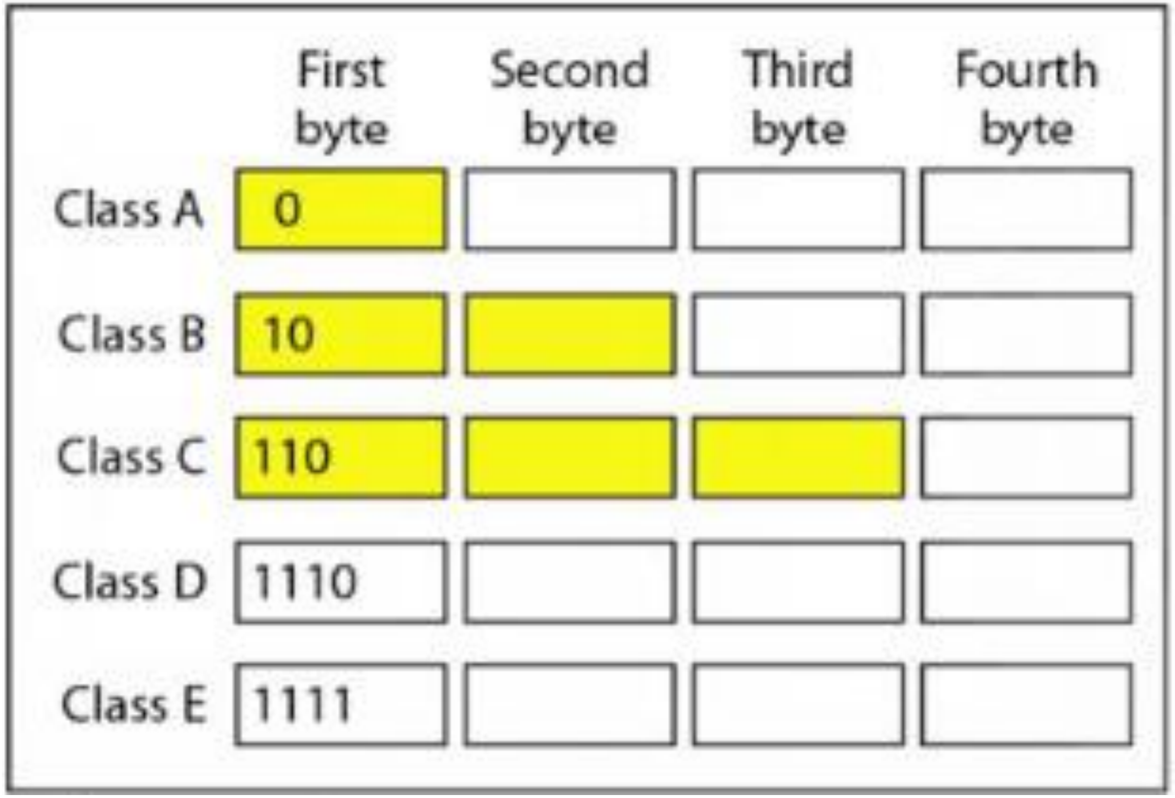
Dotted Decimal notations: 117.149.29.2

- *IPV4 addresses consist of four octets each octet consists of 8 binary bits.*
- *Each octet ranges from 0 to* $2^8 - 1 = 255$

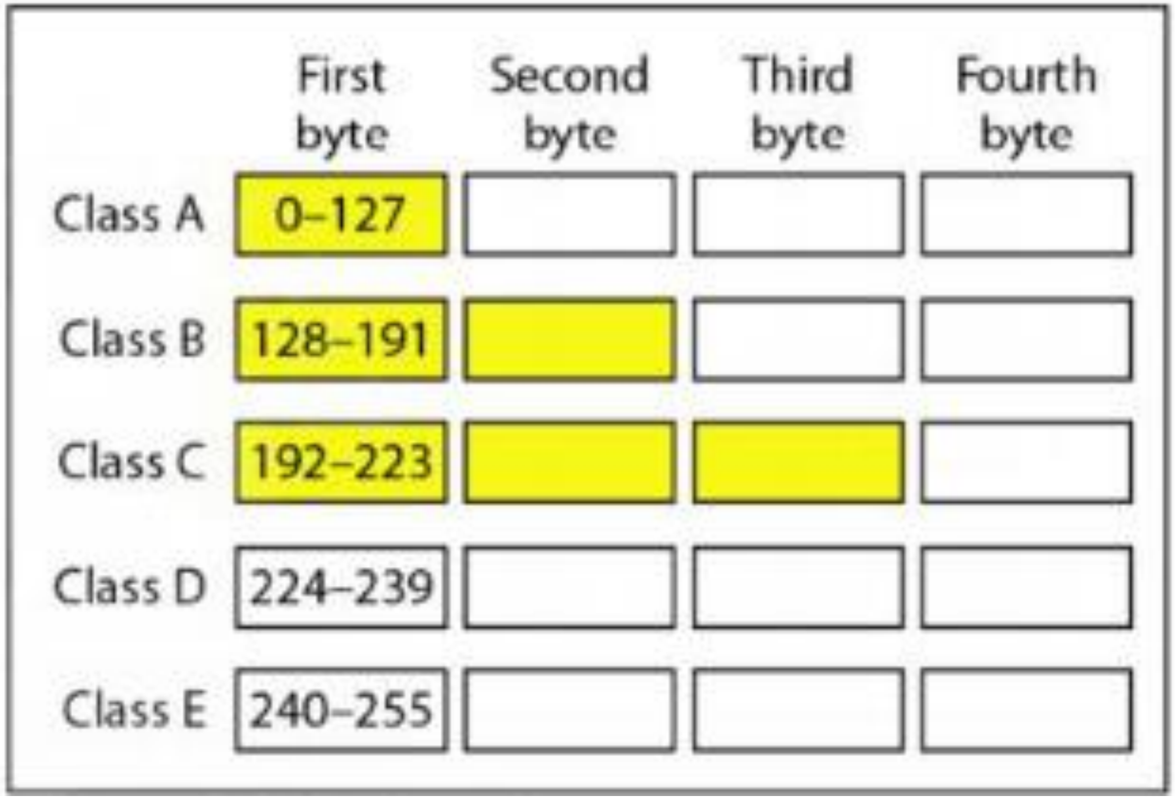
IPV4 Address Conversion

- Binary to Dotted Decimal conversion
- Dotted Decimal to Binary Conversion

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
128	64	32	16	8	4	2	1



Binary Notation



Decimal Notation

Address Class	1st Octet range in decimal	1st Octet bits (Blue Dots do not change)	Network (N) and Host (H) Portion [redacted]	Default mask (Decimal) [redacted]	Number of possible networks and hosts per network
A	0-127	00000000 - 01111111	N.H.H.H [redacted]	255.0.0.0 [redacted]	128 Nets (2^7) 16,777,214 hosts ($2^{24}-2$)
B	128-191	10000000 - 10111111	N.N.H.H [redacted]	255.255.0.0 [redacted]	16,384 Nets (2^{14}) 65,534 hosts ($2^{16}-2$)
C	192-223	11000000 - 11011111	N.N.N.H [redacted]	255.255.255.0 [redacted]	2,09,150 Nets (2^{21}) 254 hosts (2^8-2)
D	224-239	11100000 - 11101111	NA (Multicast)	-	-
E	240-255	11110000 - 11111111	NA (Experimental)	-	-

Subnet Mask (Slash Notation)

Class	Subnet Mask (in Dotted Decimal)	Subnet Mask (in Binary)	Slash Notation
A	255.0.0.0	11111111.0000000.00000000.0000000	/8
B	255.255.0.0	11111111.11111111.00000000.0000000	/16
C	255.255.255.0	11111111.11111111.111111111.0000000	/24

IP address	Network portion of IP address Host portion of IP address **192.168.10.2**
Subnet Mask	255.255.255.0

Module 3

Network Layer

➢ **Subnetting**

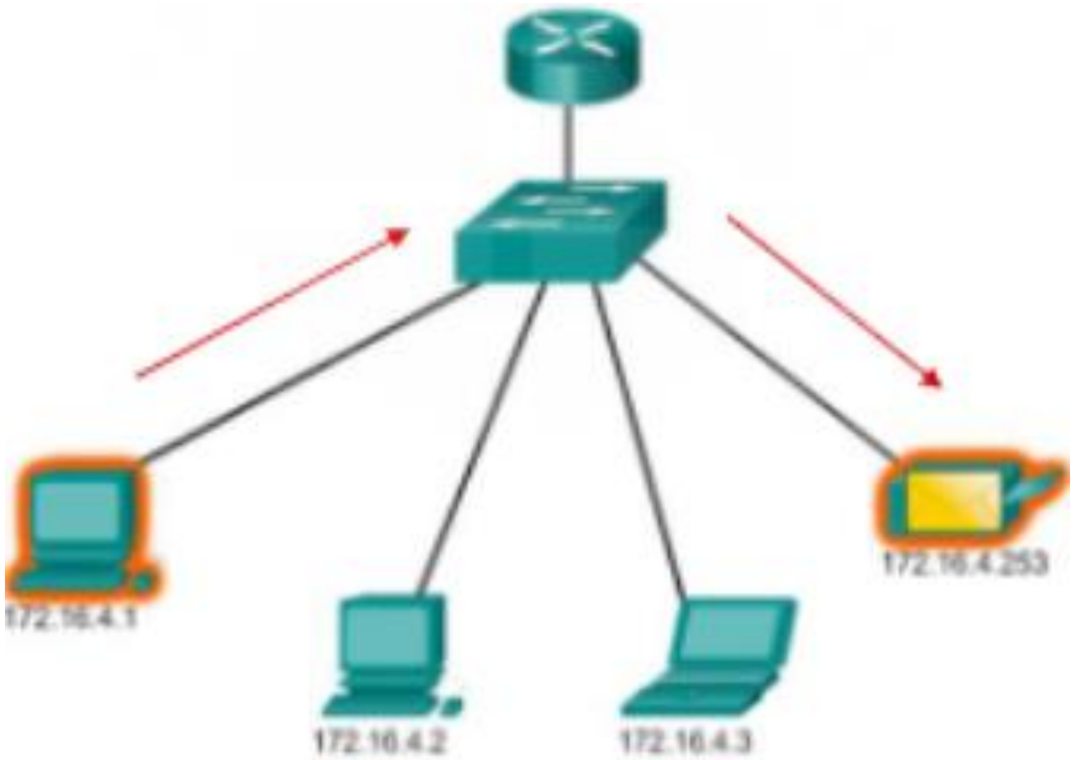
Dr. Sunandita Debnath, IIIT Vadodara

Different ways of Transmission in IPV4

- *In a IPV4 network, the hosts communicate one of three different ways*
  - *Unicast*
  - *Broadcast*
  - *Multicast*

Unicast Transmission: *The process of sending a packet from one individual host to another host.*

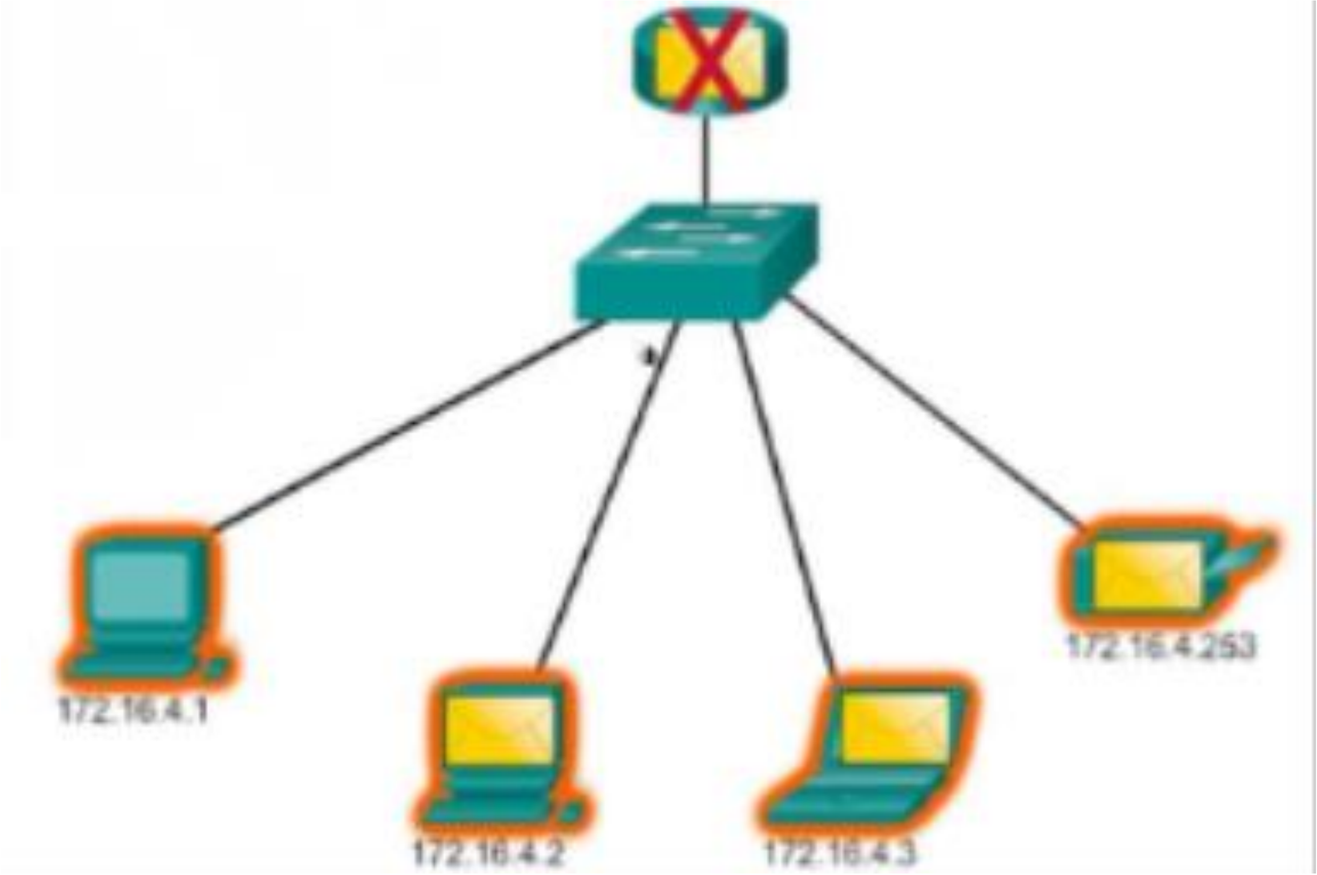
Source: 172.16.4.1
Destination: 172.16.4.253



Different ways of Transmission in IPV4

Broadcast Transmission: *The process of sending a packet from one host to all hosts in the network.*

- ❑ *Limited Broadcast*
- ❑ *Directed Broadcast*



Limited Broadcast

Source: 172.16.4.1

Destination: 255.255.255.255

Router will not forward a limited broadcast.

Directed Broadcast

Destination: 172.16.4.255

Host within the 172.16.4/24 network

Different ways of Transmission in IPV4

Multicast Transmission: *The process of sending a packet from one host to a selected group of hosts, possibly in different networks.*

- *Multicast transmission reduces traffic*
- *The multicast address range 224.0.0.0 to 239.255.255.255.*
- *Link Local-224.0.0.0 to 224.0.0.255 (E.g. routing information exchanged by routing protocols)*
- *Globally scoped address-224.0.1.0 to 238.255.255.255 (E.g. 224.0.1.1 has been reserved for Network Time Protocol)*

Public and Private IPV4 Addresses

Private IP addresses:

- *IPV4 address ranges from 0.0.0.0 to 255.255.255.255, where 0.0.0.0 is the network address and 25.255.255.255 is the broadcast address.*
- *According to early network design, IP addresses should be unique, but its is not true with the introduction of private and public IP addresses.*
- *Two computers can use the same private address using NAT (Network Address Translation).*
- *Hosts that do not require access to the internet can also use private addresses. E.g. many computers in a company do not need internet connectivity but can communicate internally among each other using private IP addresses.*

Private IPV4 Addresses

- *Ranges of Private IP address*
    - **10.0.0.0 to 10.255.255.255 (10/8) Class A**
    - **172.16.0.0. to 172.31.255.255 (172.16.0.0/12) Class B**
    - **192.168.0.0 to 192.168.255.255 (192.168.0.0/16) Class C**

- *The aforementioned are the three non overlapping ranges of IPV4 addresses for private networks are reserved.*

- *Public IP address is used to communicate outside the network. Public IP addresses are basically assigned by the Internet Service Provider (ISP)*

Special use IPV4 Addresses

- **Network and Broadcast addresses**

Within each network the last and first address can not be assigned to hosts.

- **Loopback addresses 127.0.0.1 (127.0.0.0 to 127.255.255.255 are reserved)**

127.0.0.1 *is a special address which host s use to direct traffic to themselves*

Link-Local addresses 169.254.0.0 to 169.254.255.255 (169.254.0.0/16)

Can automatically assigned to the local hosts.

Test-Net addresses 192.0.2.0 to 192.0.255.255 (192.0.2.0/24)

Set aside for teaching and learning purposes, used in documentation and network example.

- **Experimental addresses 240.0.0.0 to 255.255.255.254**

Are listed as reserved for experimental purpose.

Drawbacks of Classful Addressing

Address Class	1st Octet range in decimal	1st Octet bits (Blue Dots do not change)	Network (N) and Host (H) Portion	Default mask (Decimal)	Number of possible networks and hosts per network
A	0-127	00000000 [redacted] 01111111	N.H.H.H [redacted]	255.0.0.0 [redacted]	128 Nets (2^7) 16,777,214 hosts ($2^{24}-2$)
B	128-191	10000000 - 10111111	N.N.H.H [redacted]	255.255.0.0 [redacted]	16,384 Nets (2^{14}) 65,534 hosts ($2^{16}-2$)
C	192-223	11000000 - 11011111	N.N.N.H [redacted]	255.255.255.0 [redacted]	2,09,150 Nets (2^{21}) 254 hosts (2^8-2)
D	224-239	11100000 - 11101111	NA (Multicast)	-	-
E	240-255	11110000 - 11111111	NA (Experimental)	-	-

Drawbacks of Classful Addressing

- *Lack of Internal Address Flexibility*
- *Inefficient use of address space*
- *Proliferation of Router Table entries*

Classless Addressing

- *Formal name is Classless Inter-Domain Routing (CIDR).*

- *Created a new set of standards that allowed service providers to allocate IPV4 addresses on nay address bit boundary (prefix length) instead of only Class A, B, and C addresses.*

- *Classless addressing is possible with the help of subnetting.*

Valid Subnet Masks

Subnet Value	Bit Value 128	64	32	16	8	4	2	1
255	1	1	1	1	1	1	1	1
254	1	1	1	1	1	1	1	0
252	1	1	1	1	1	1	0	0
248	1	1	1	1	1	0	0	0
240	1	1	1	1	0	0	0	0
224	1	1	1	0	0	0	0	0
192	1	1	0	0	0	0	0	0
128	1	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

Valid Subnet Masks

/n	Mask	/n	Mask	/n	Mask	/n	Mask
/1	128.0.0.0	/9	255.128.0.0	/17	255.255.128.0	/25	255.255.255.128
/2	192.0.0.0	/10	255.192.0.0	/18	255.255.192.0	/26	255.255.255.192
/3	224.0.0.0	/11	255.224.0.0	/19	255.255.224.0	/27	255.255.255.224
/4	240.0.0.0	/12	255.240.0.0	/20	255.255.240.0	/28	255.255.255.240
/5	248.0.0.0	/13	255.248.0.0	/21	255.255.248.0	/29	255.255.255.248
/6	252.0.0.0	/14	255.252.0.0	/22	255.255.252.0	/30	255.255.255.252
/7	254.0.0.0	/15	255.254.0.0	/23	255.255.254.0	/31	255.255.255.254
/8	255.0.0.0	/16	255.255.0.0	/24	255.255.255.0	/32	255.255.255.255

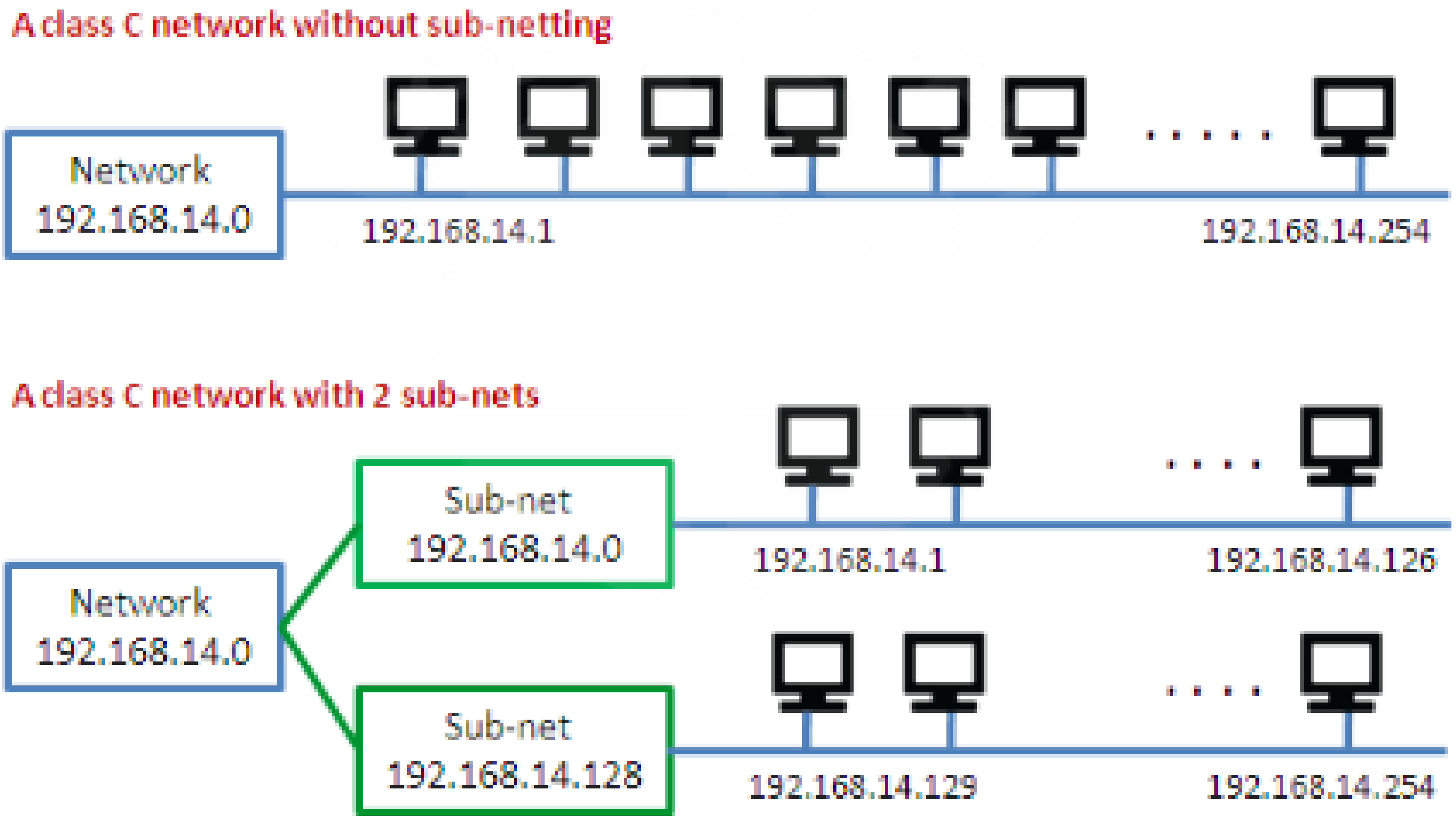
Subnetting

- *A subnetwork or subnet is a logical subdivision of an IP addresses.*

- *The practice of dividing a network into two or more networks is called subnetting.*

- *Computers that belongs to a subnet are addressed with an identical most significant bit-group in their IP addresses.*

IP Subnetting Example



- *The first address and the last address is reserved for network and broadcast respectively. The default subnet mask for Class C which is 255.255.255.0 cannot be used for subnetworks. But the total number of host supported by Class C ie.e* $2^8 - 2 = 254$ *should be maintained.*

Subnetting

Subnetting can be done both according to Host requirement and network requirement.

The steps for subnet the given network according to host requirements:

- ❑ *Identify the Class of the IP address and note the default subnet mask.*
- ❑ *Convert the default subnet mask into binary format.*
- ❑ *Note the number of hosts required per subnet and find the binary equivalent of it.*
- ❑ *Find the subnet generator (SG) and octet position.*
- ❑ *Generate the new subnet mask.*
- ❑ *Use the SG and generate the network ranges in the appropriate Octet positions.*

Q. Subnet the IP address 216.21.5.0 into 30 hosts in each subnet.

Q. Subnet the IP address 196.10.20.0 into 52 hosts in each subnet.

Q. Subnet the IP address 150.15.0.0 into 500 hosts in each subnet.

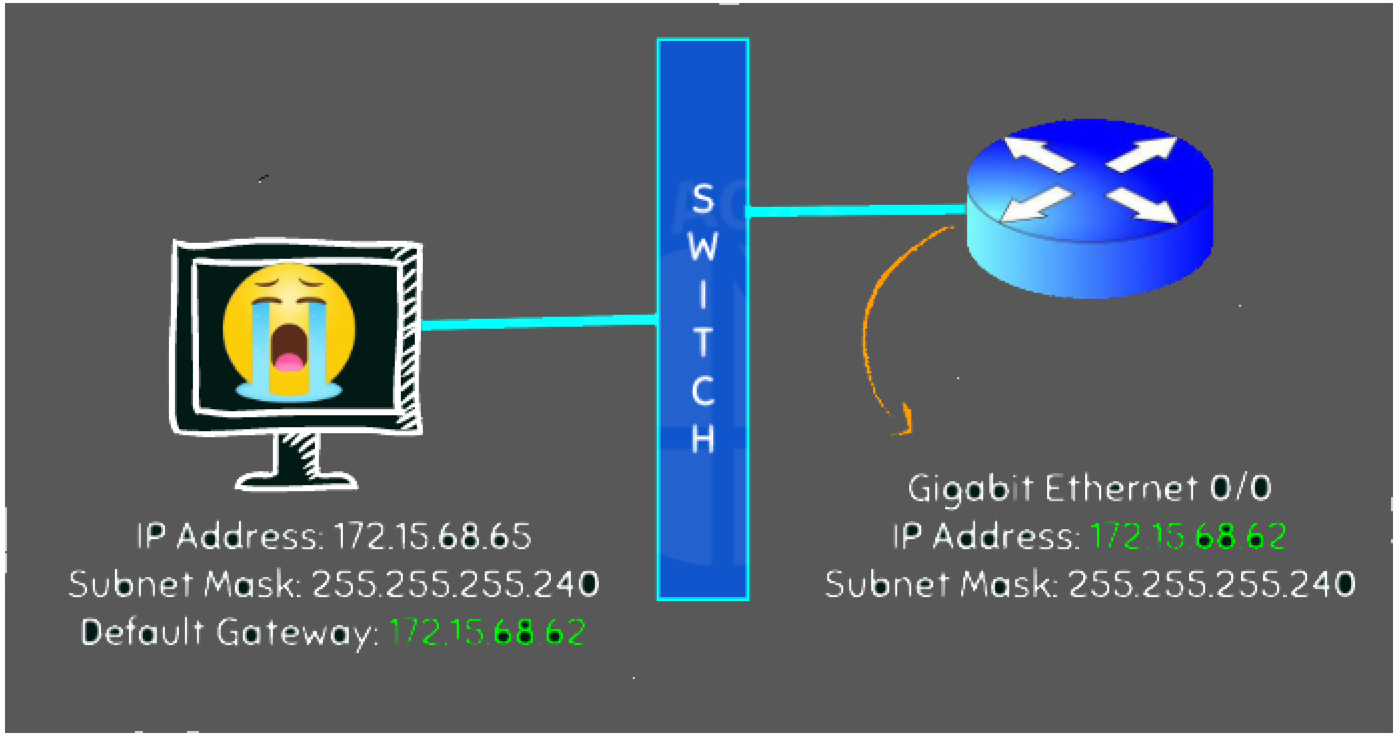
Q. Subnet the IP address 10.0.0.0 into 100 hosts in each subnet.

Trouble shooting in Subnetting

A computer is assigned with an IP address 192.168.1.127 and subnet mask 255.255.255.224. But the computer is not able to communicate with the PCs in the network, why?

Trouble shooting in Subnetting

A computer is assigned with an IP address 172.15.68.65 and subnet mask 255.255.255.240 and the default gateway for connecting to the internet or other computer in different is 172.15.68.62. But the computer is not able to communicate with the PCs in the other network, why?



Module 3

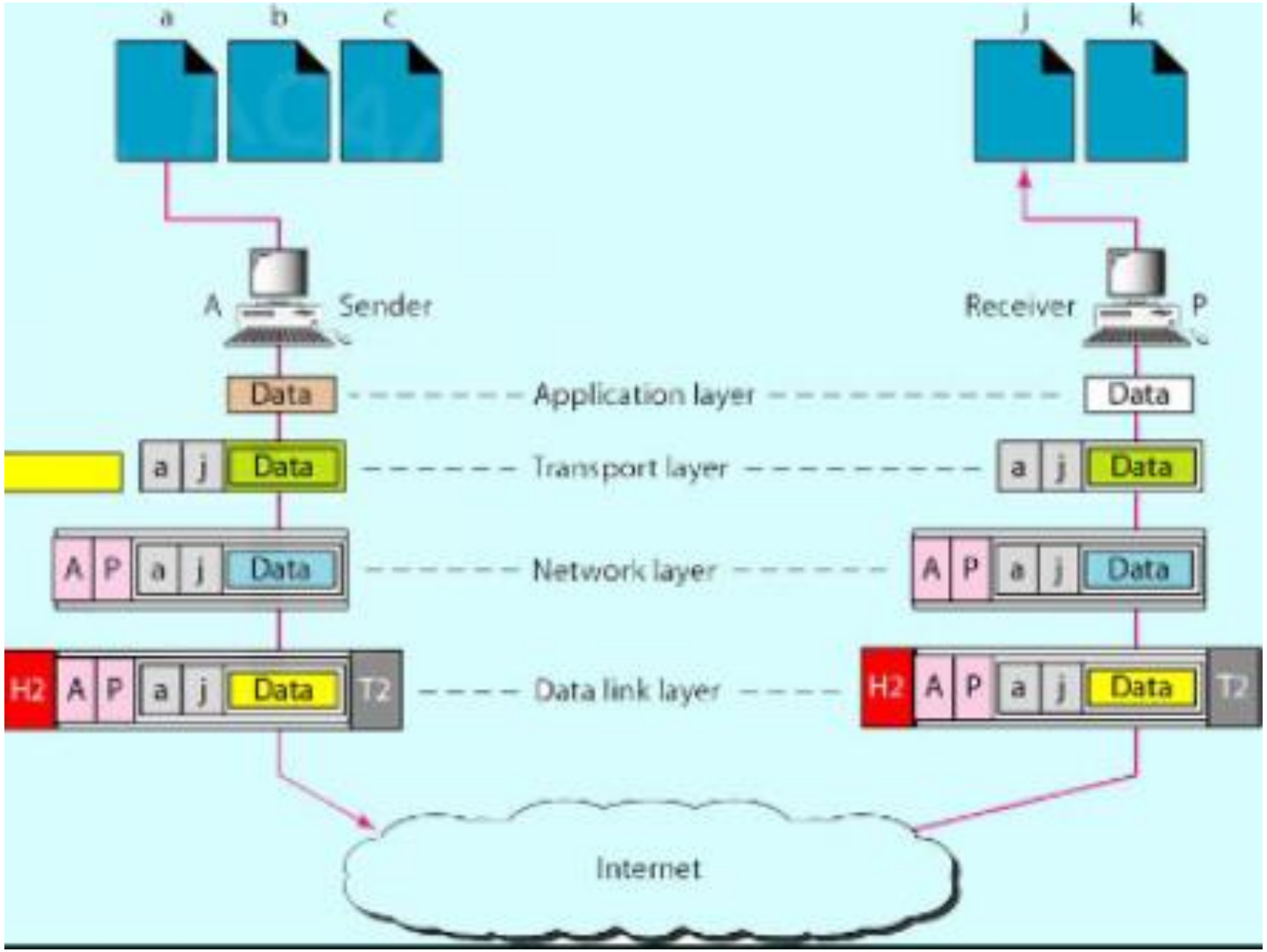
Network Layer protocols

Dr. Sunandita Debnath, IIIT Vadodara

Different ways for Communication

➢ *Transport layer deals with port addressing, Port no is of 16 bits (0 to 65535)*

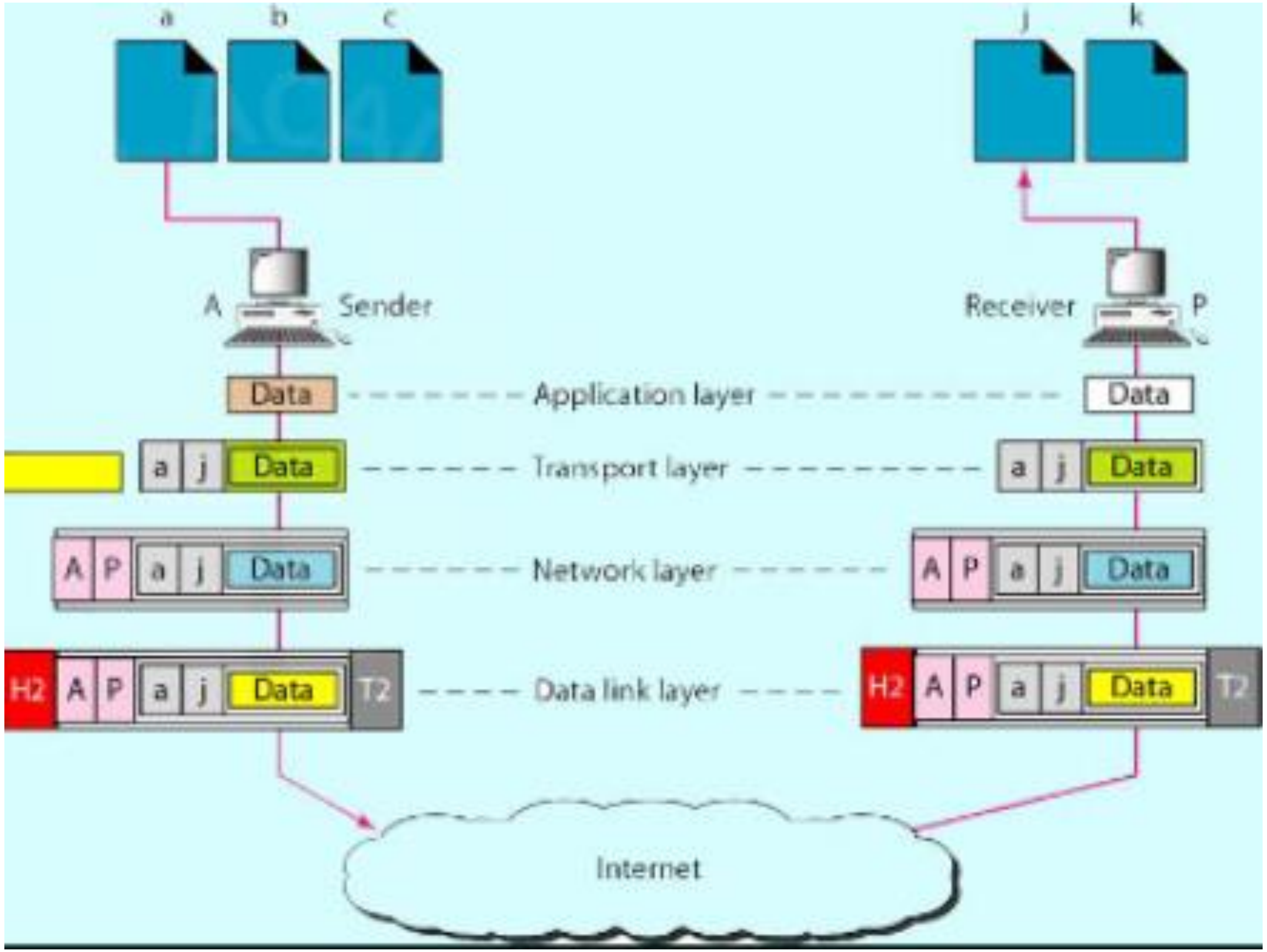
- *Well known ports (0 to 1023)*
- *Registered ports (1024 to 49151)*
- *Dynamic or private ports (49152 to 65535)*



Different ways for Communication

- *Network layer or Internet layer deals with IP addresses IPV4 addresses are 32 bits and IPV6 addresses are 128 bits long (Hexadecimal).*

- *Either user provides the IP addresses or DNS resolves the names into IP addresses.*

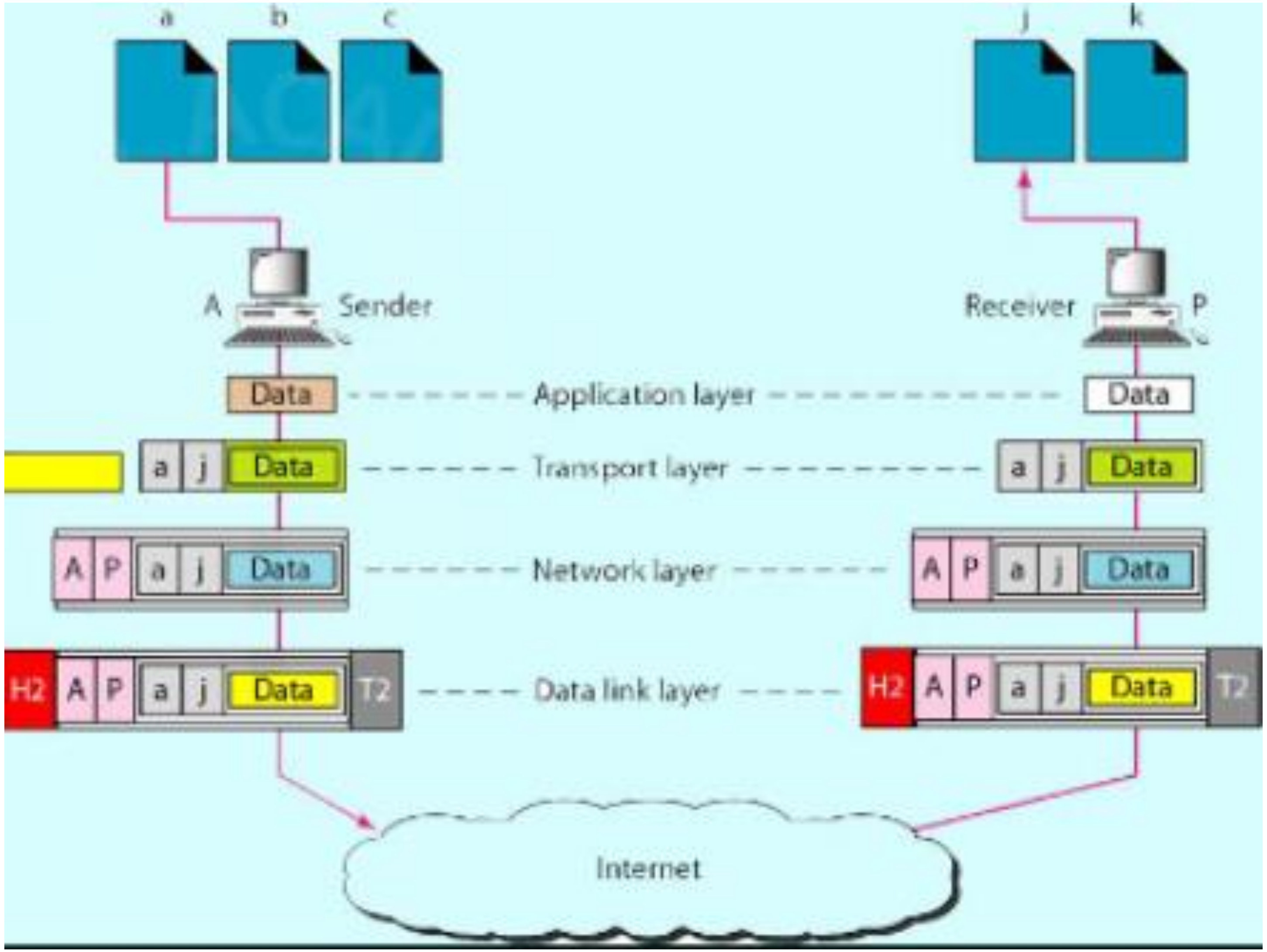


Different ways for Communication

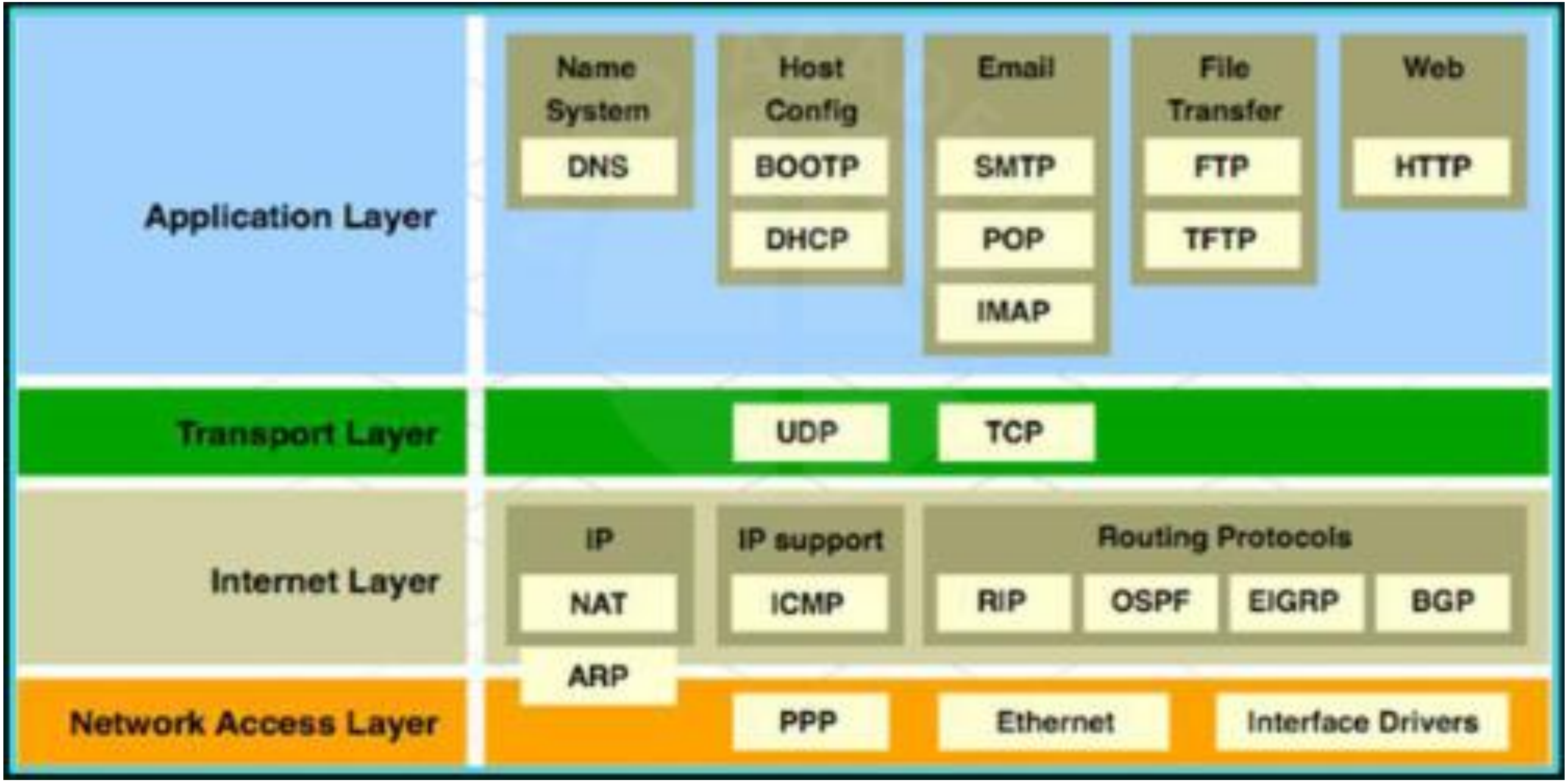
- *Data link deals with MAC addresses or hardware addresses. MAC addresses are 48 bits long (Hexadecimal).*

- *Assigned by manufacturer and usually wont be changed.*

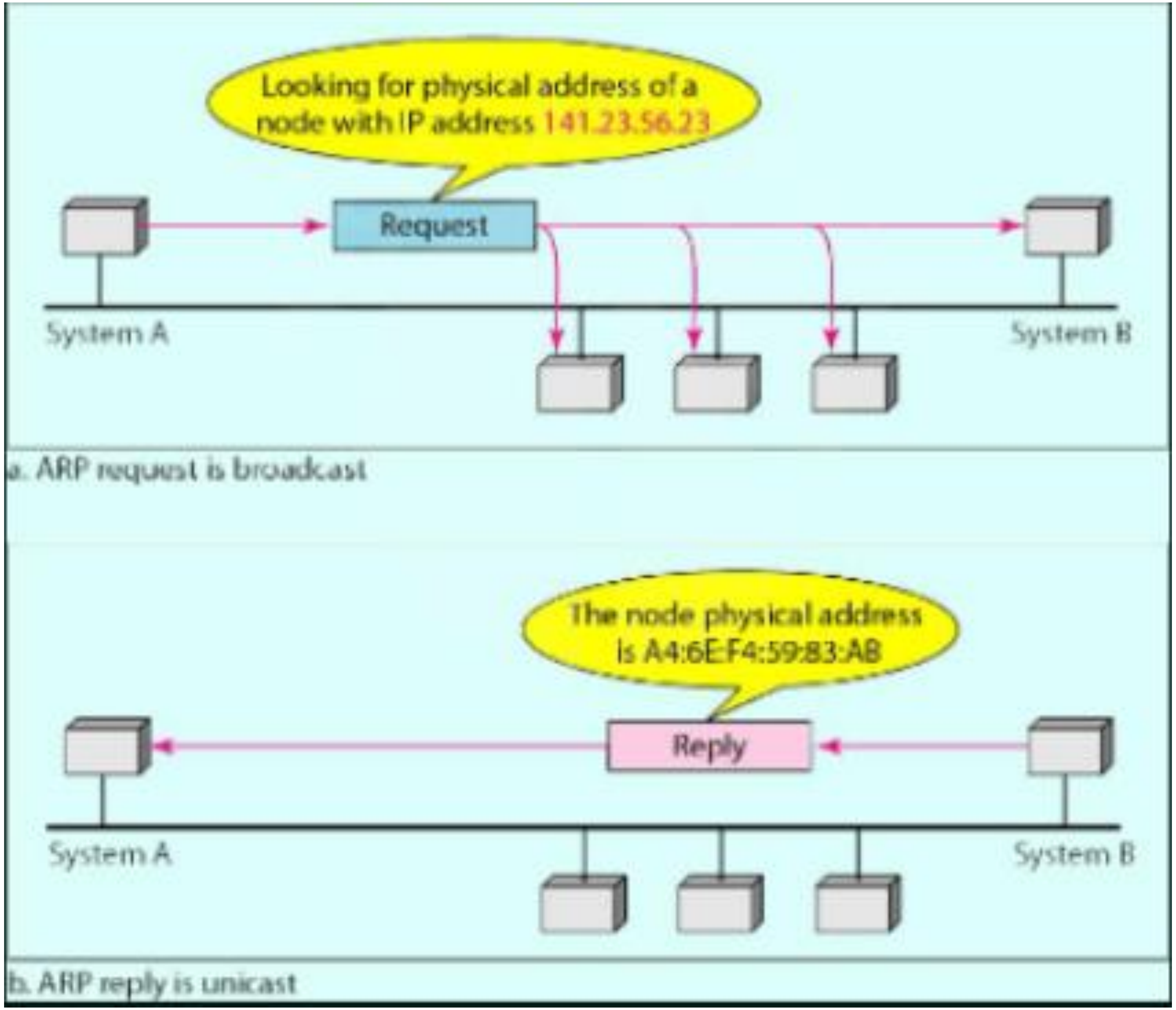
- ***The mapping between the IP address and the MAC address is done by the ARP (Address Resolution Protocol).***



TCP/IP suite


Application Layer
Name System
DNS
Host Config
BOOTP
DHCP
Email
SMTP
POP
IMAP
File Transfer
FTP
TFTP
Web
HTTP
Transport Layer
UDP
TCP
Internet Layer
IP
NAT
ARP
IP support
ICMP
Routing Protocols
RIP
OSPF
EIGRP
BGP
Network Access Layer
PPP
Ethernet
Interface Drivers

Address Resolution Protocol (ARP)



ARP Protocol

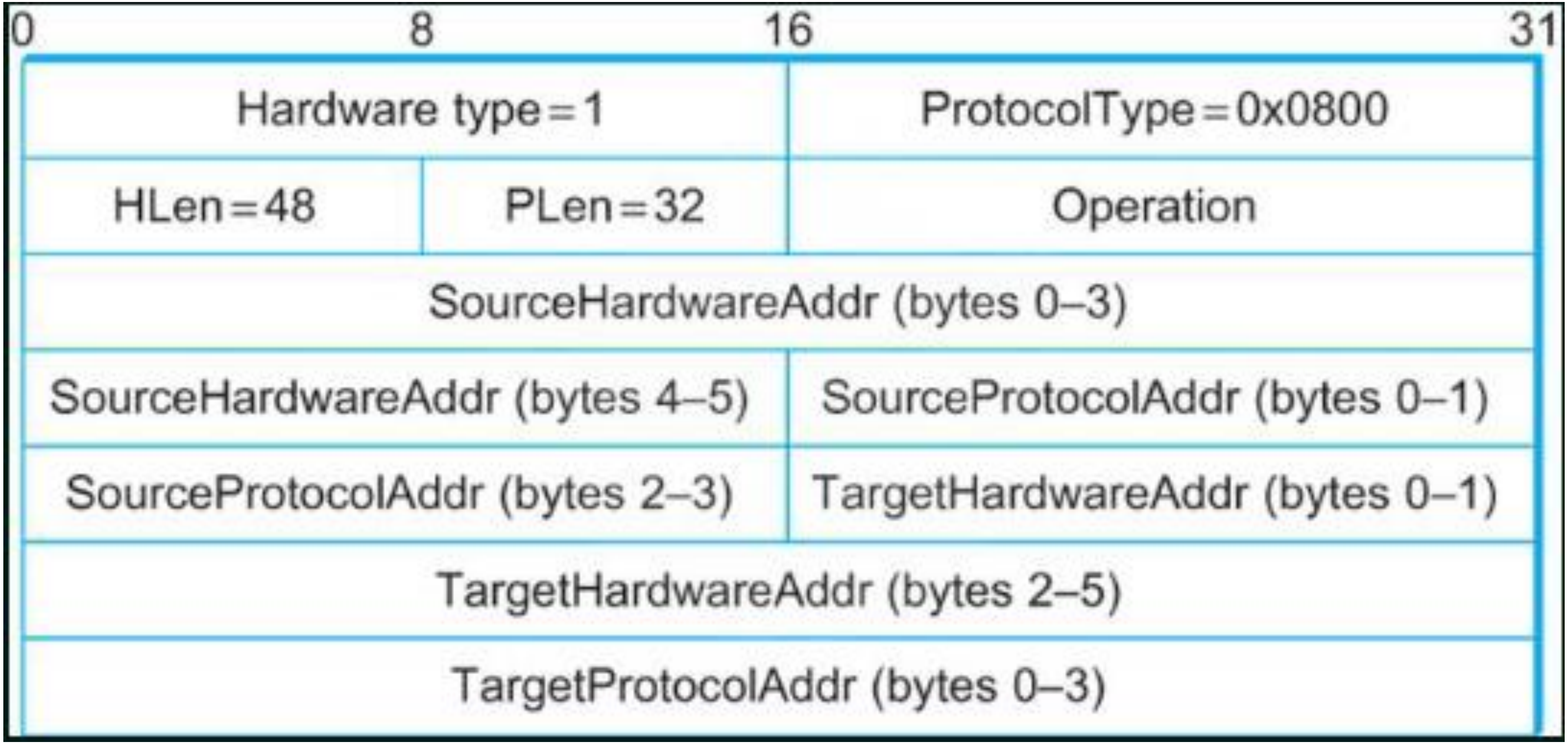
The ARP protocol provides two basic functions:

- *Resolving IPV4 address to MAC address.*
- *Maintaining a table of mapping.*

ARP Protocol

- *ARP maintains a cache of IP addresses and MAC addresses.*
- *ARP request is sent with an broadcast MAC address FFFF.FFFF.FFFF if the IP address ins not in the table.*
- *Target machine responds (unicast) with its physical address.*
- *Table entries are discarded if not refreshed.*

Header of ARP Packet



Header of ARP Packet

- ***Hardware Type:*** *Type of Physical network (i.e. Ethernet)*
- ***Protocol Type:*** *Type of upper layer protocol (e.g. IP)*
- ***HLEN and PLEN:*** *Length of physical address and Protocol address*
- ***Operation:*** *ARP Request or a ARP Reply*
- *Source Physical address /Protocol address & Target Physical address /Protocol addresses*

RARP Protocol

The ARP protocol provides two basic functions:

- *Reverse ARP (RARP) is an obsolete computer networking protocol used by a cleuicent computer to request its internet protocol address from a computer network, when all it has available is its link layer or hardware address, such as MAC address.*

- *The protocol can use the known MAC address to retrieve its IP addrwss. Functionality wise, RARP is the complete opposite of ARP. The RAP uses the known IP address to determine the MAC address of the computer.*

- *It has been rendered obsolete by the Bootstrap protocol (BOOTP) and the modern dynamic host configuration protocol (DHCP), which both support a much greater feature set than ARP.*

- *The RARP cannot handle subnetting because no subnet masks are sent. If multiple subnets are deployed, an RARP server must be available in each subnet.*

DHCP

- *Dynamic Host Configuration Protocol .*

- *The MAC addresses are configured into network by manufacturer and they are expected to be unique.*

- *IP addresses must be unique in a inter-network. Most operating system provide away to manually configure the IP information for the host.*

- *Drawback of manual configuration:*

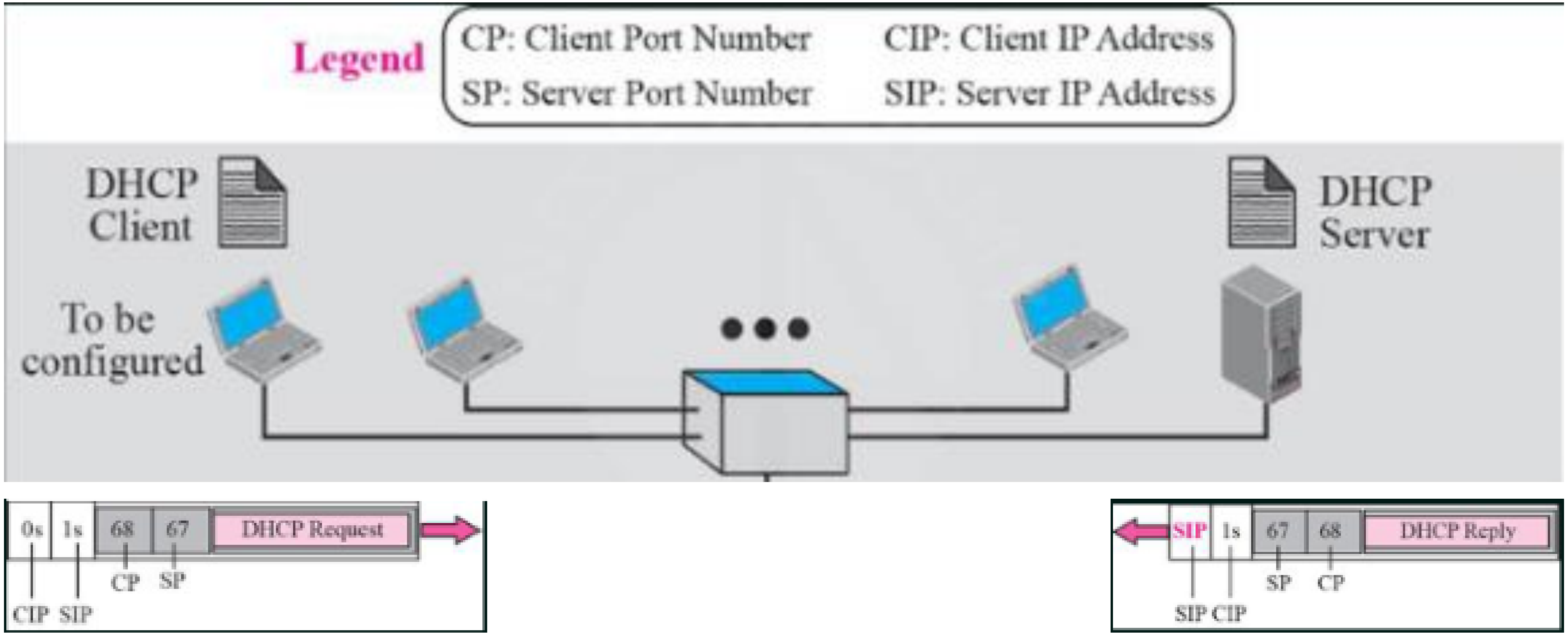
A lot of work to configure all the hosts in a large network.

Configuration process in error prone.

- *Hence automated IP configuration is required.*

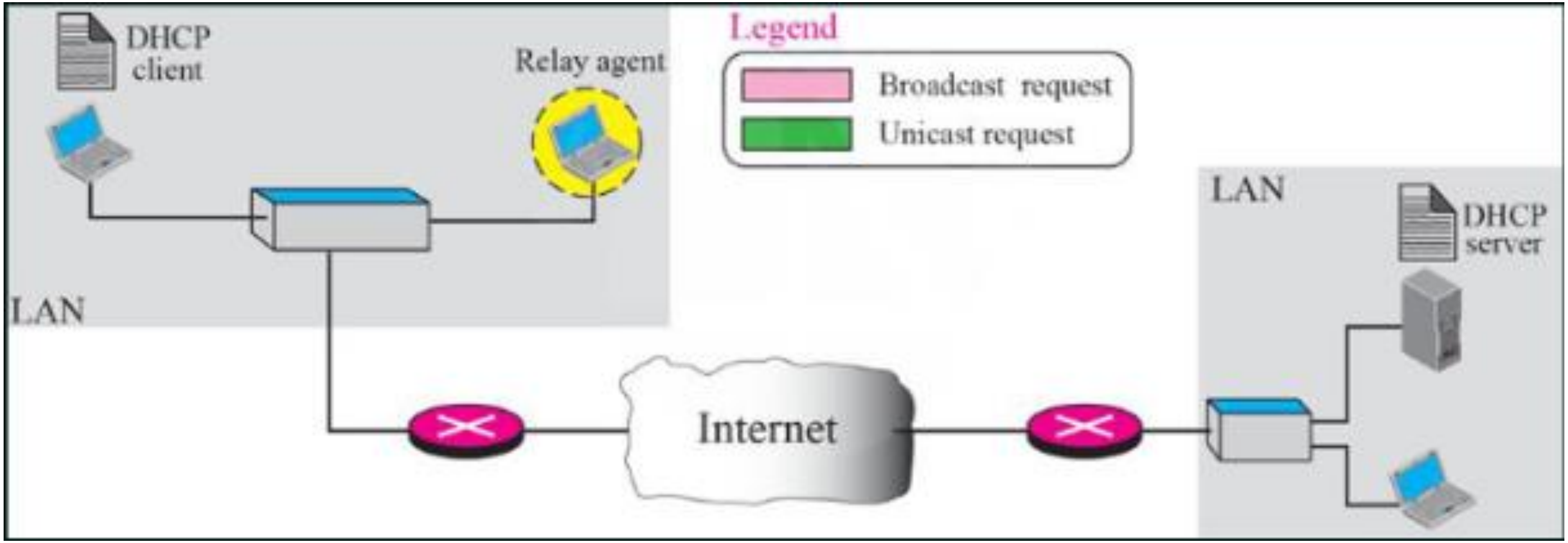
DHCP

❑ *DHCP server and Host in same network*



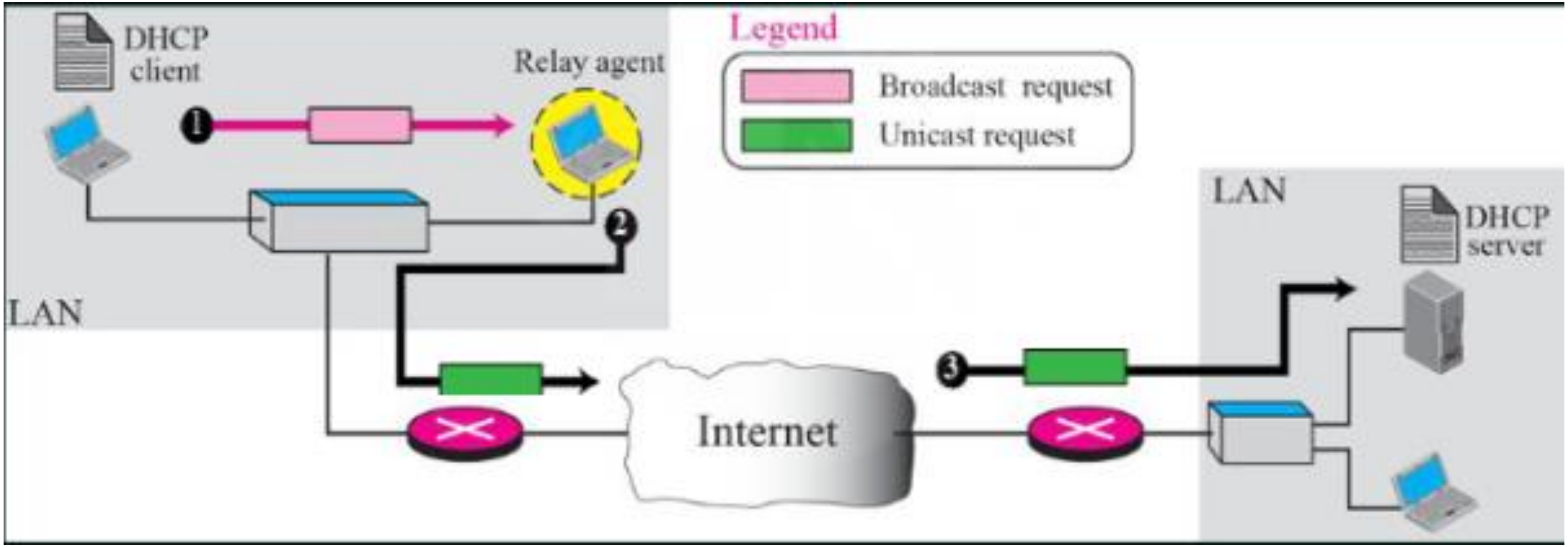
DHCP

❑*DHCP server and Host in Different network*



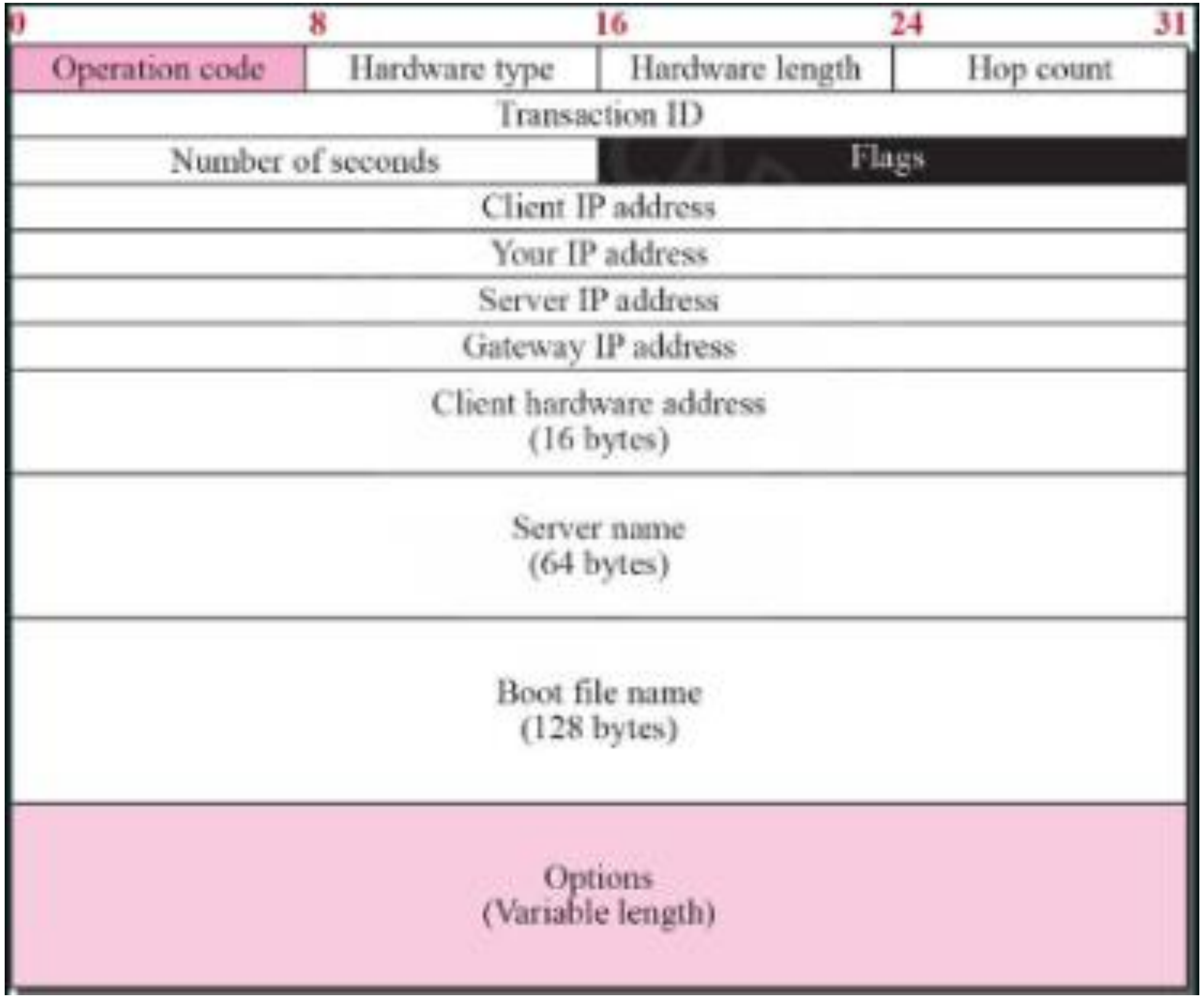
DHCP

- *Dynamic Host Configuration Protocol .*



DHCP

❑*DHCP Packet Format*

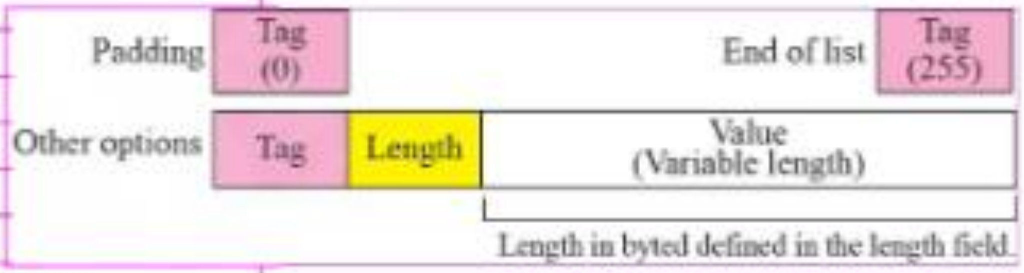


DHCP

❑DHCP Packet Format

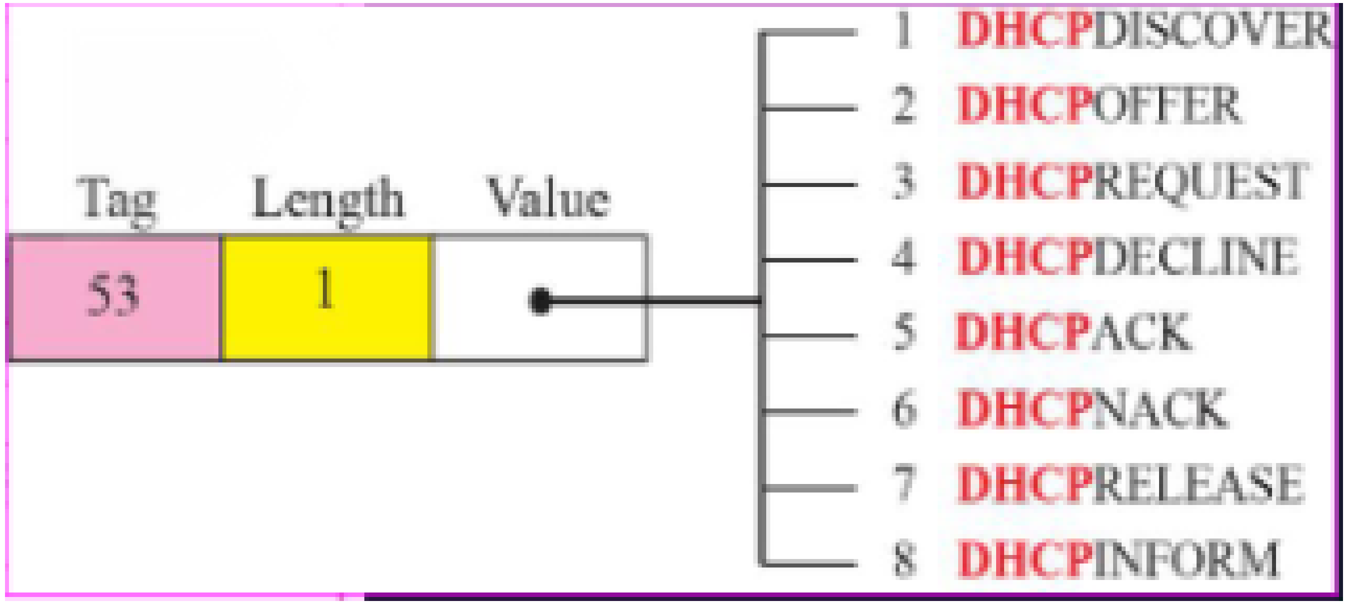
Options for DHCP

Tag	*Length*	*Value*	*Description*
0			Padding
1	4	Subnet mask	Subnet mask
2	4	Time of the day	Time offset
3	Variable	IP addresses	Default router
4	Variable	IP addresses	Time server
5	Variable	IP addresses	IEN 16 server
6	Variable	IP addresses	DNS server
7	Variable	IP addresses	Log server
8	Variable	IP addresses	Quote server
9	Variable	IP addresses	Print server
10	Variable	IP addresses	Impress
11	Variable	IP addresses	RLP server
12	Variable	DNS name	Host name
13	2	Integer	Boot file size
53	1	Discussed later	Used for dynamic configuration
128–254	Variable	Specific information	Vendor specific
255			End of list



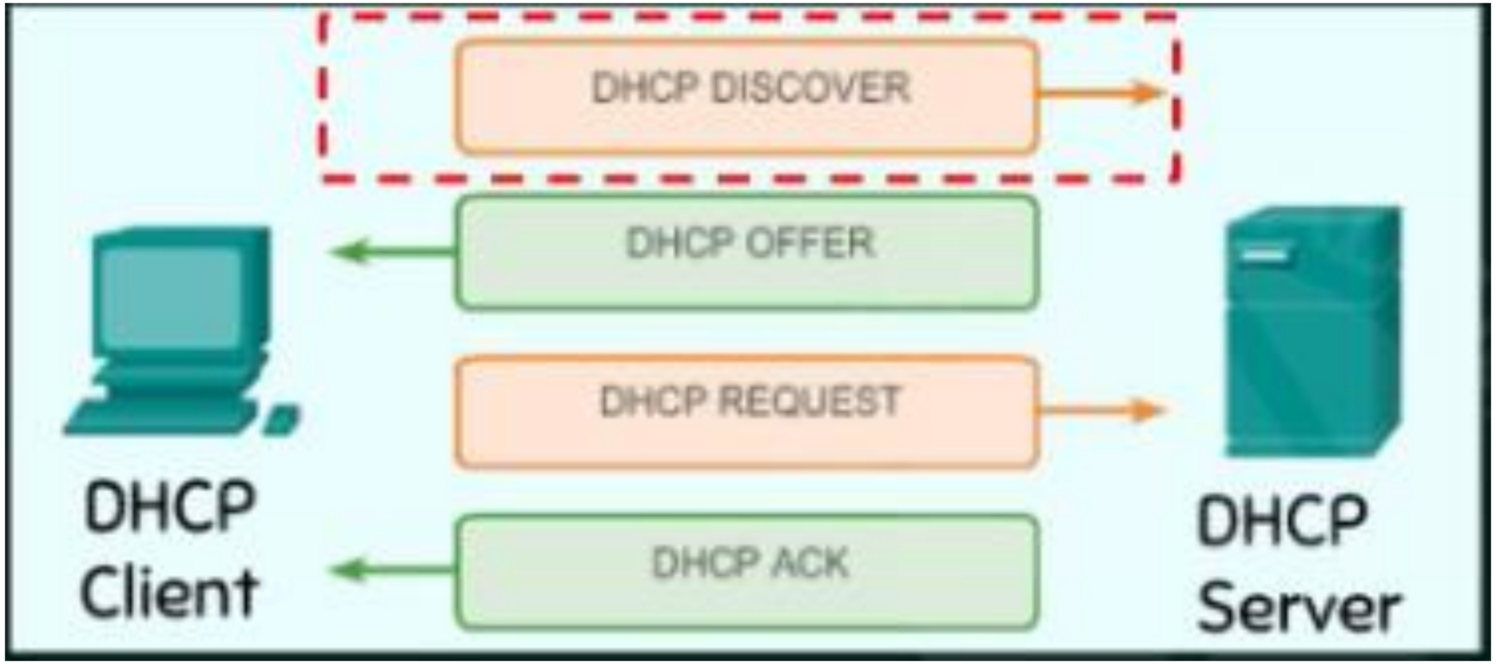
DHCP

❑DHCP Packet Format



DHCP

❑DHCP Operation



ICMP

- *Internet Control Message Protocol.*

- *ICMP is a supporting protocol in the internet protocol suite. It is used by network devices, including routers, to send error messages and operational information indicating success or failure when communicating with another IP address.*

- *Example :*

➢ *Destination host unreachable due to link/node failure*

➢ *Reassembly process failed*

➢ *TTL (Time To Live) had reached 0 (So datagram don't cycle forever)*

➢ *IP header Checksum failed.*

- *ICMP messages are typically used for diagnostic or control purpose or generated in response to errors in IP operation.*

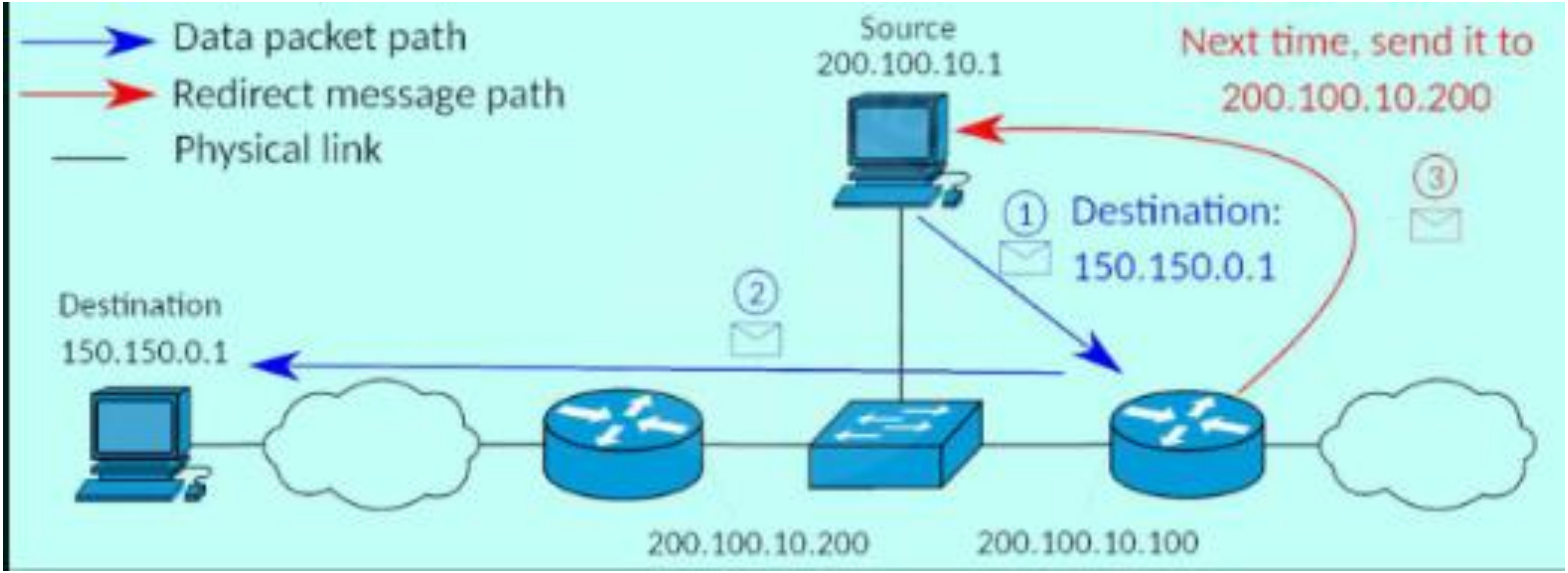
ICMP

- *ICMP errors are directed to the source IP address of the originating packet*

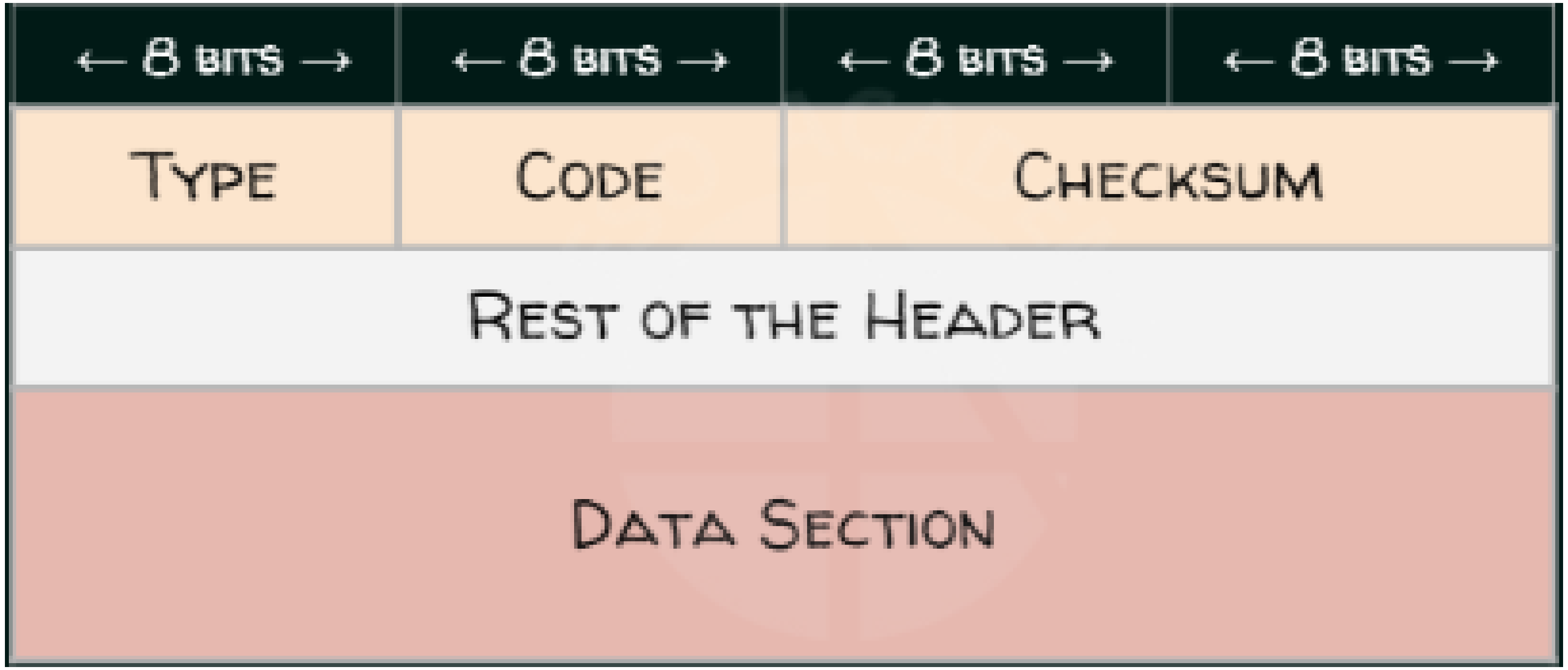
- *This protocol defines a collection of error messages that are sent back to the source host whenever a router or host is unable to process an IP packet successfully.*

- *ICMP redirect*
  - *From router to the source host*
  - *With a better route information*

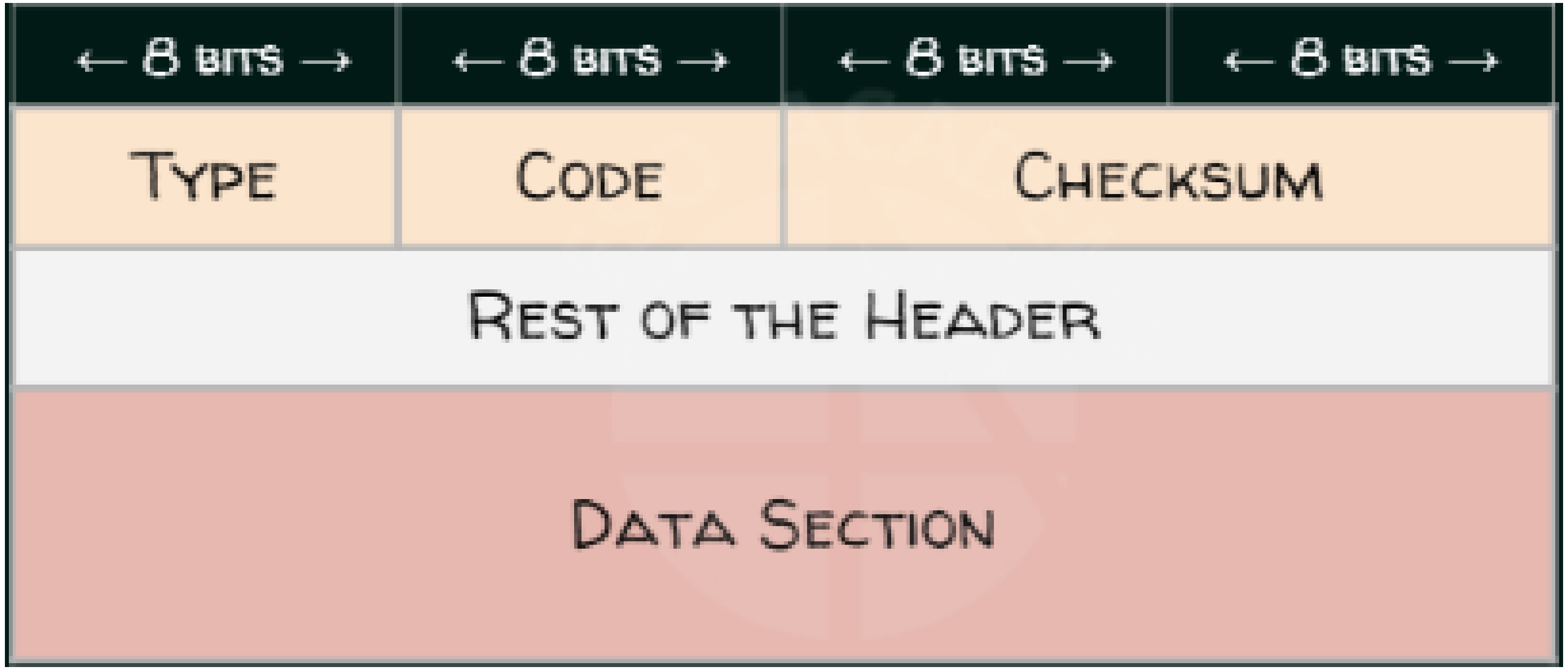
ICMP Redirect



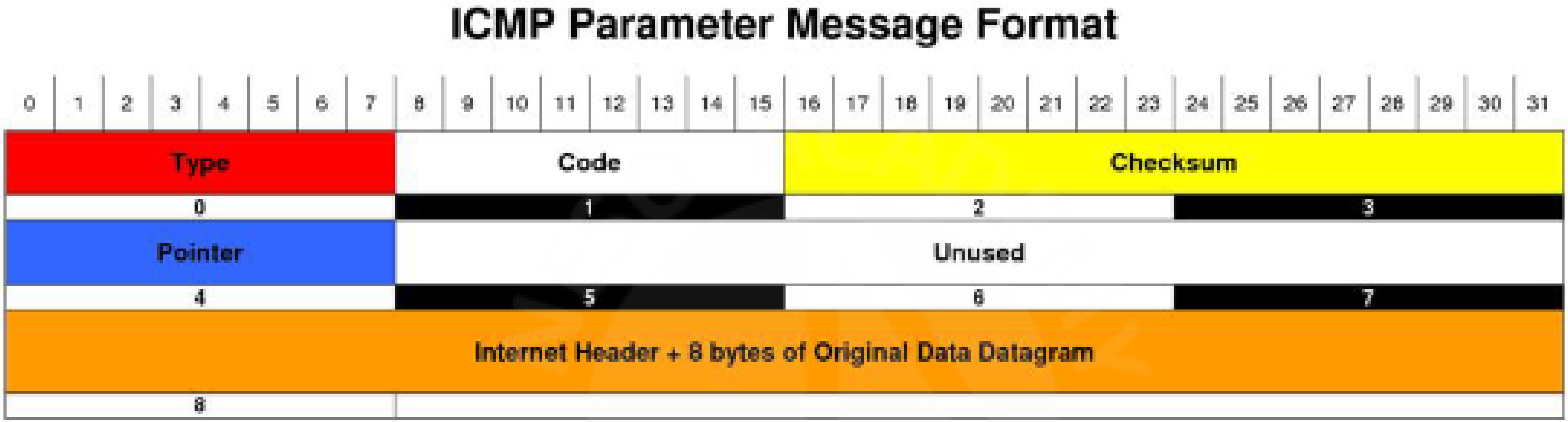
ICMP Packet Format



ICMPv4 Packet Format



ICMPv4 Packet Format



ICMPv4 Packet Format

Type	Code	Meaning
0	0	Echo Reply
3	0	Net Unreachable
	1	Host Unreachable
	2	Protocol Unreachable
	3	Port
	4	Frag needed and DF set
	5	Source route failed
	6	Destination network unknown
	7	Destination Host unknown
	8	Source host isolated
	9	
	.	
	13	Communication admin prohibited

ICMPv4 Packet Format

Type	Code	Meaning
4	0	Source Quench
5	0	Redirect data gram from the network
	1	
	2	
	3	
8	0	Echo
9	0	Router advertisement
10	0	Router selection
11	0	TTL exceeded in transit

ICMP

- *Calculate the checksum for the following ICMPv4 packet*

<table>
<tr><td>8</td><td>0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">1</td><td colspan="2">9</td></tr>
<tr><td colspan="4">TEST</td></tr>
</table>

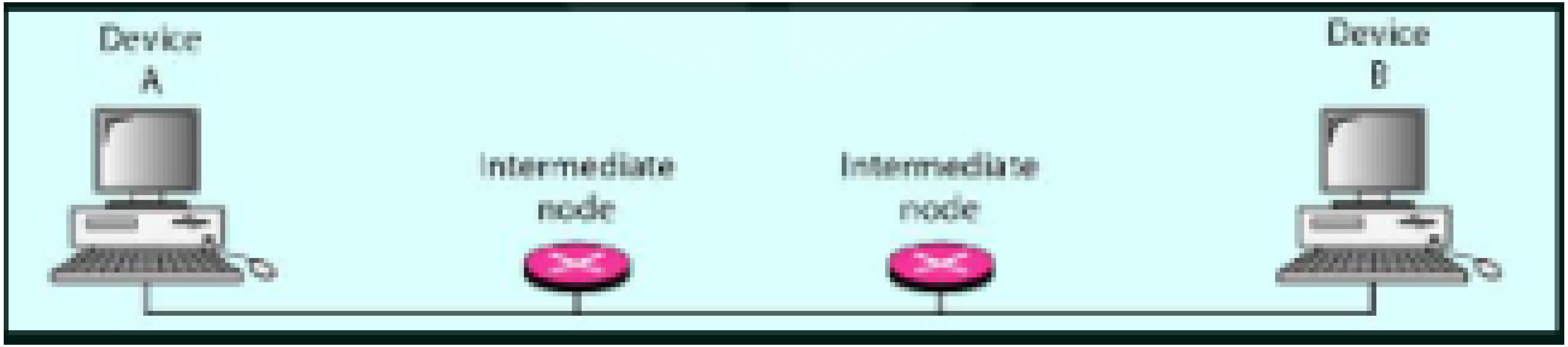
ICMP

IP protocol (Internet Protocol)

- *The responsibility of network later or Layer 3 is delivery of data from the original source to the destination network.*

- *Service provided by the network layer*

- *Logical addressing*
- *Routing*



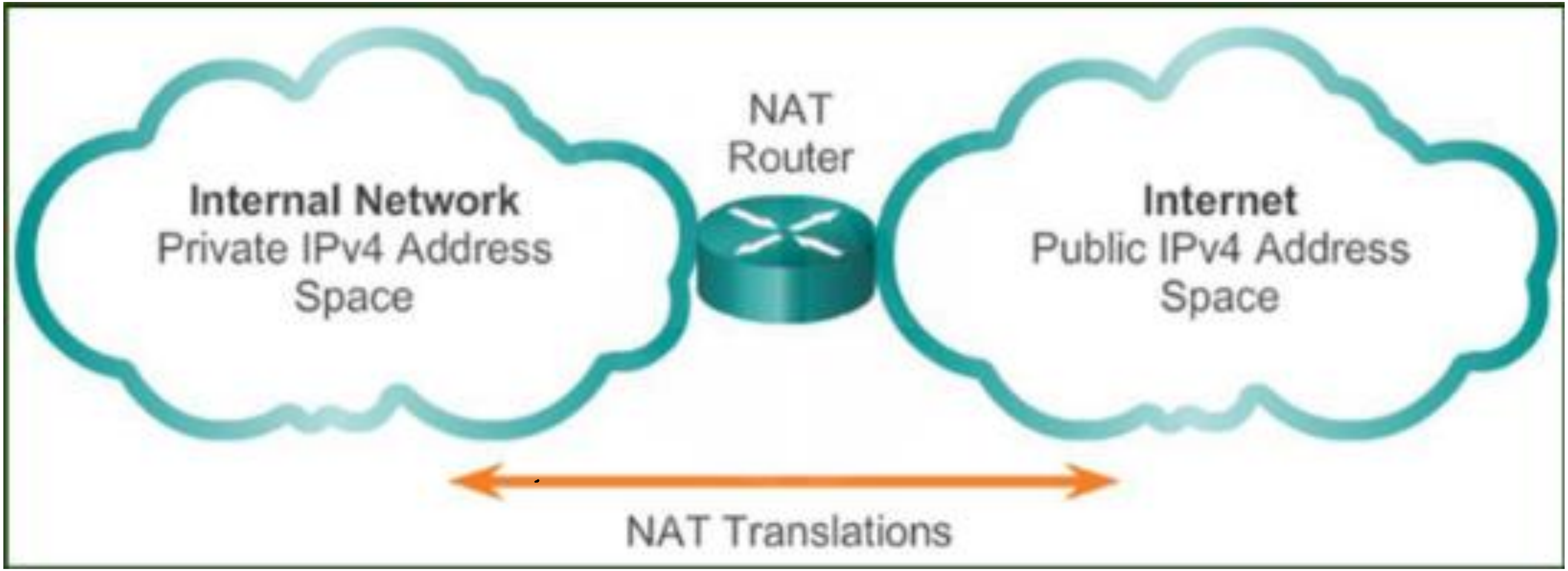
Module 3

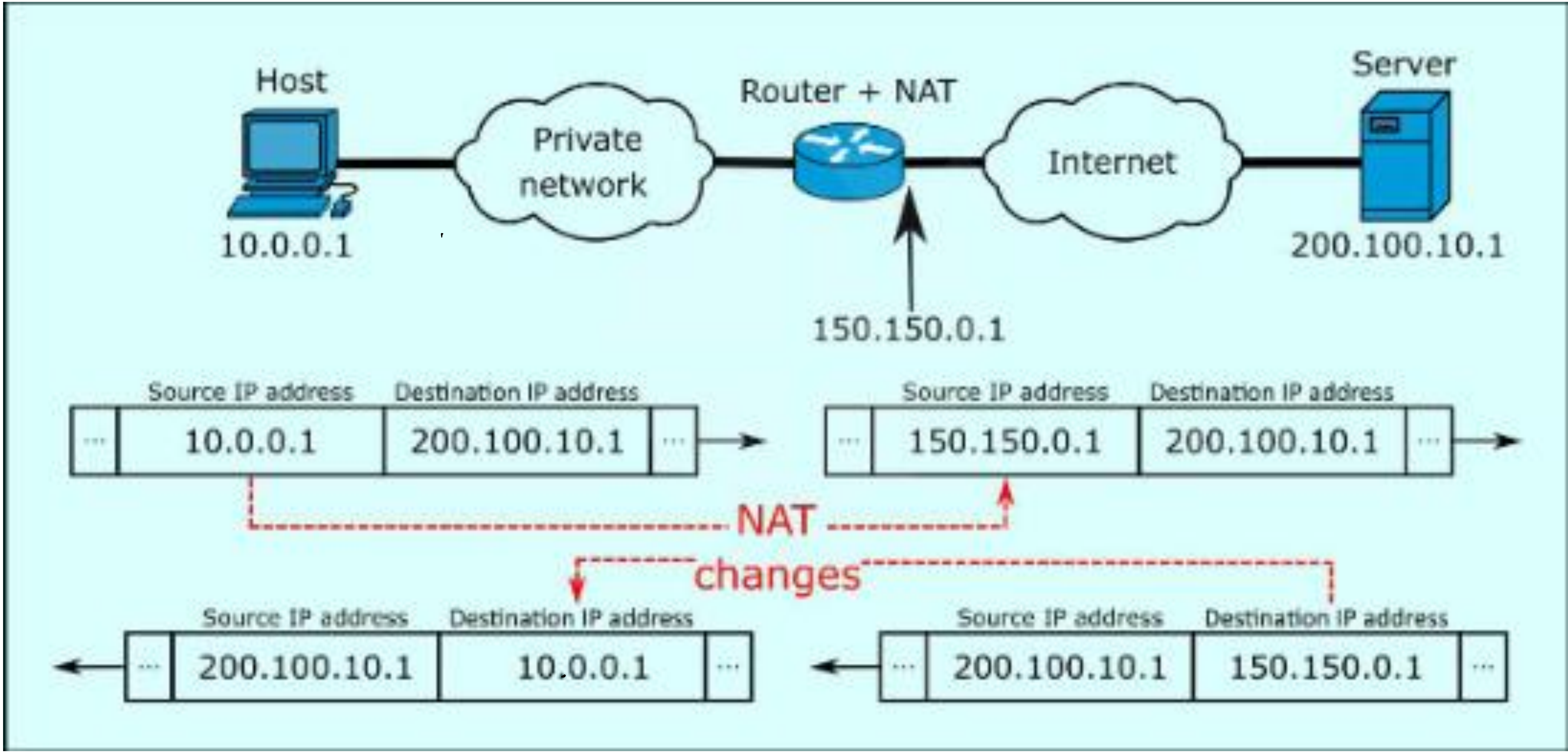
IPV6

Dr. Sunandita Debnath, IIIT Vadodara

NAT

- *NAT (Network Address Translation) maps Private IP addresses to Public IP addresses.*
- *Router does not forward private IP addresses. For translation of IP addresses from private to public the router should be NAT enable.*




Host
10.0.0.1
Private network
Router + NAT
150.150.0.1
Internet
Server
200.100.10.1
Source IP address
Destination IP address
... 10.0.0.1 200.100.10.1 ...
... 150.150.0.1 200.100.10.1 ...
NAT
changes
... 200.100.10.1 10.0.0.1 ...
... 200.100.10.1 150.150.0.1 ...

NAT

- *IPV4 address space is not big enough to uniquely address devices that must be connected to the internet.*
- *Network private addresses are described in RFC 1918 and designed to be used within an organization or site only.*
- *Private addresses are not routed by internet routers while public addresses are routed by the internet routers.*
- *Private addresses can be alleviate IPV4 scarcity, but because they aren't routed by internet devices e.g. routers , they first need to be translated.*
- *NAT is process used to perform such translation.*
- *NAT's (Network Address Translation) primary use is to conserve public addresses.*

NAT

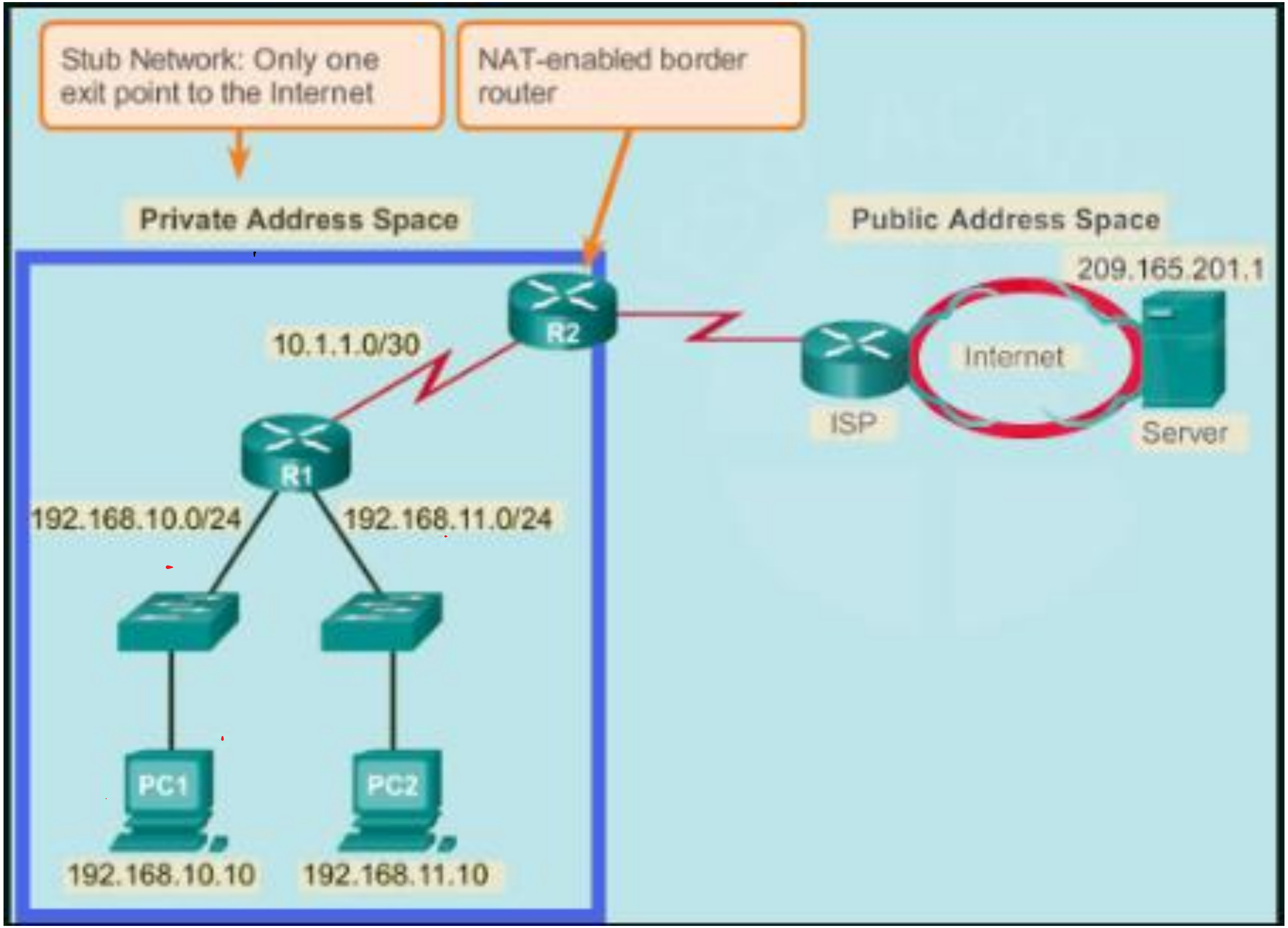
- *NAT is usually implemented at border network devices, such as firewall and routers.*

- *NAT allows the network to use private addresses internally, only translating to public addresses when needed.*

- *Devices within the organization can be assigned private addresses and operate with locally unique addressees.*

- *When traffic must be sent or received to or from other organizations or the internet, the border router translates the addresses to a public and globally unique address*

NAT- The savior of the internet



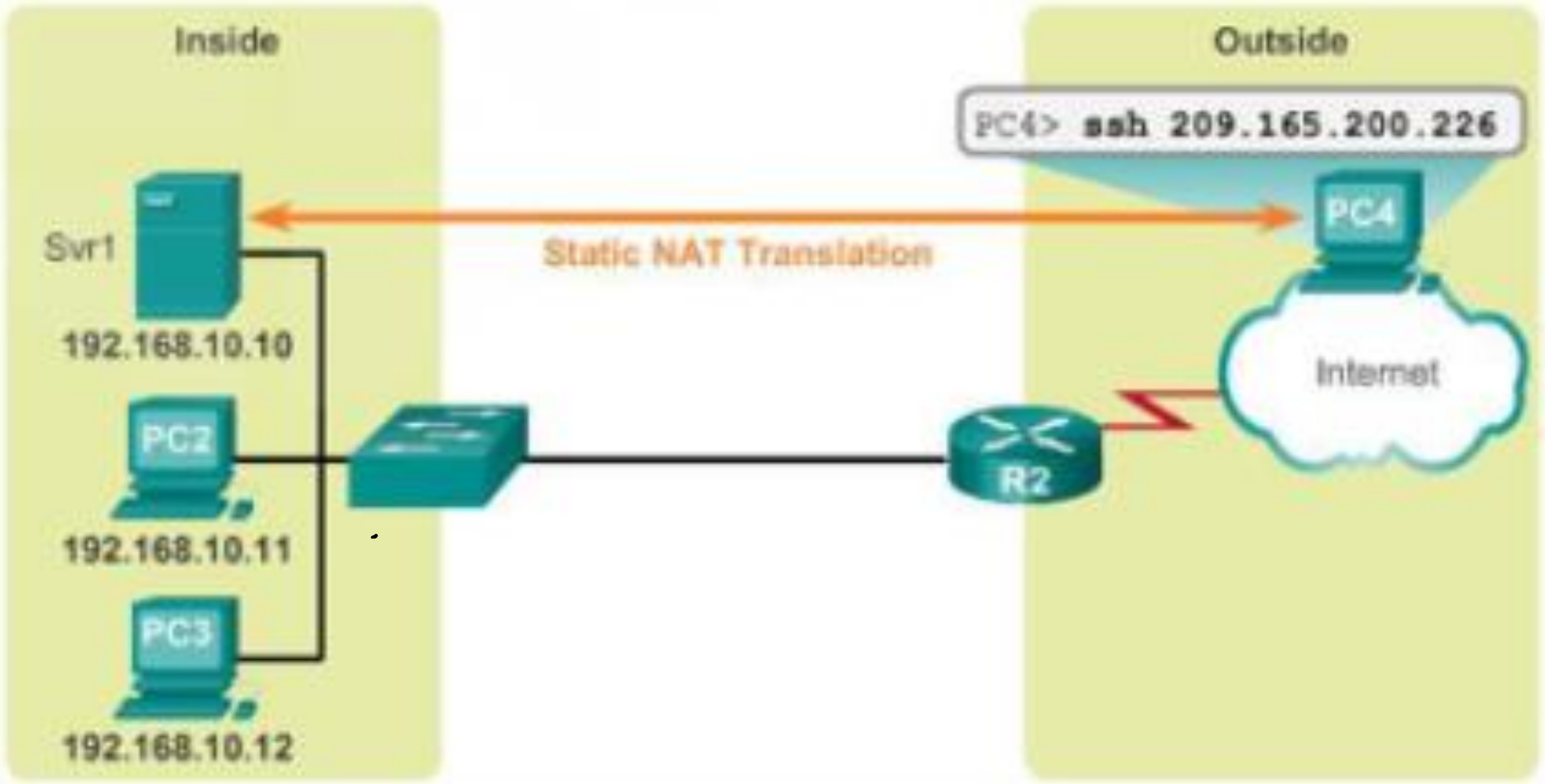
Types of NAT- The savior of the internet

- *Static NAT*
- *Dynamic NAT*
- *PAT (Port Address Translation)*

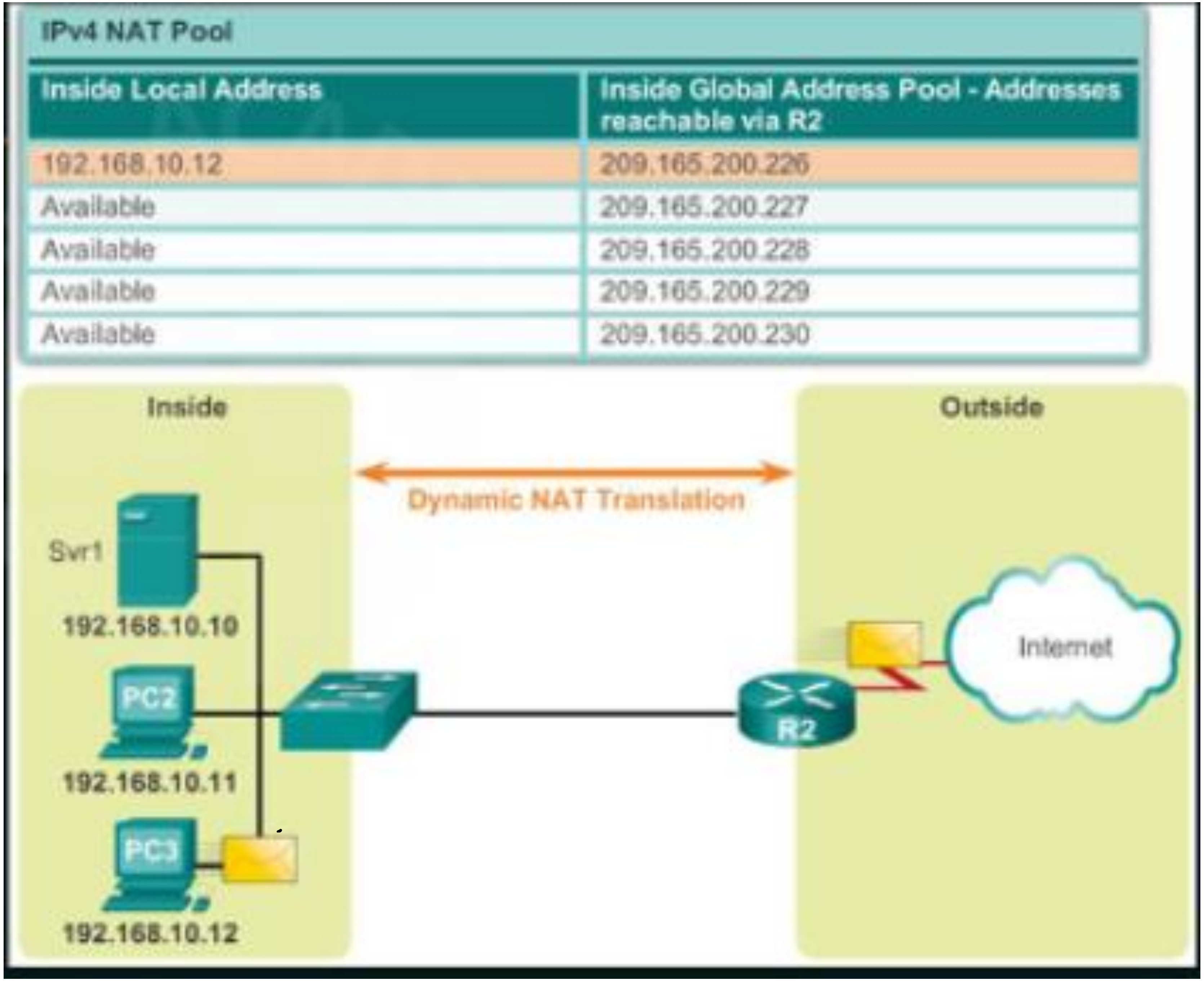
Static NAT

Static NAT Table

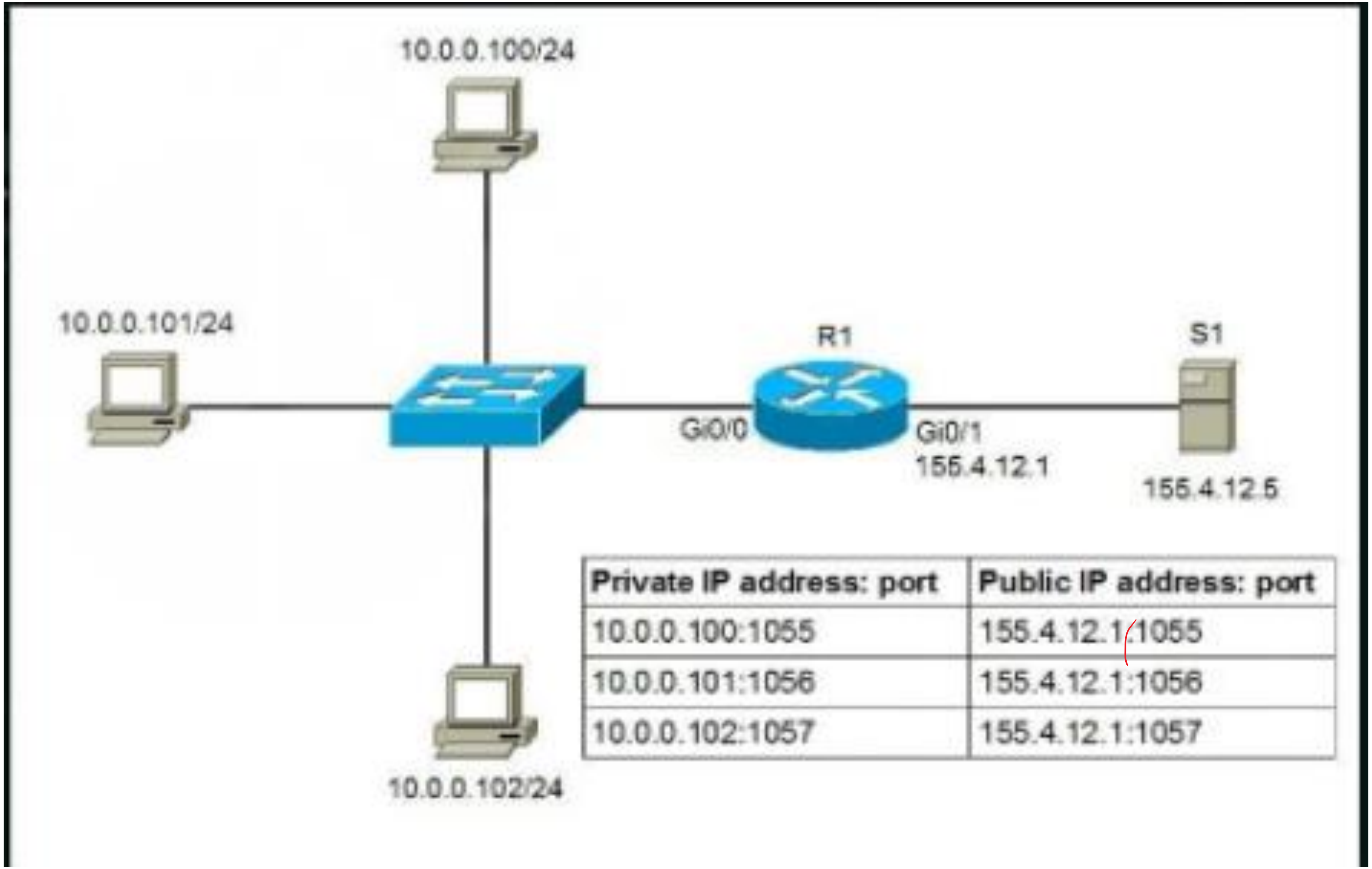
Inside Local Address	Inside Global Address - Addresses reachable via R2
192.168.10.10	209.165.200.226
192.168.10.11	209.165.200.227
192.168.10.12	209.165.200.228



Dynamic NAT


IPv4 NAT Pool
Inside Local Address
Inside Global Address Pool - Addresses reachable via R2
192.168.10.12
209.165.200.226
Available
209.165.200.227
Available
209.165.200.228
Available
209.165.200.229
Available
209.165.200.230
Inside
Outside
Dynamic NAT Translation
Svr1
192.168.10.10
PC2
192.168.10.11
PC3
192.168.10.12
R2
Internet

PAT



Private IP address: port	Public IP address: port
10.0.0.100:1055	155.4.12.1:1055
10.0.0.101:1056	155.4.12.1:1056
10.0.0.102:1057	155.4.12.1:1057

Pros and Cons of IPV4

Pros	Cons
➢ Conserve the legally registered addressing scheme. ➢ Increasing the flexibility of connection to the public network. ➢ Provide consistency for internet network addressing scheme. ➢ Provides network security.	➢ Performance is degraded (due to additional responsibility on routers.) ➢ End-to-end functionality is degraded. (as the source IP address is removed by the NAT enabled router). ➢ Tunneling is more complicated. ➢ Initiating TCP connection can be disrupted.

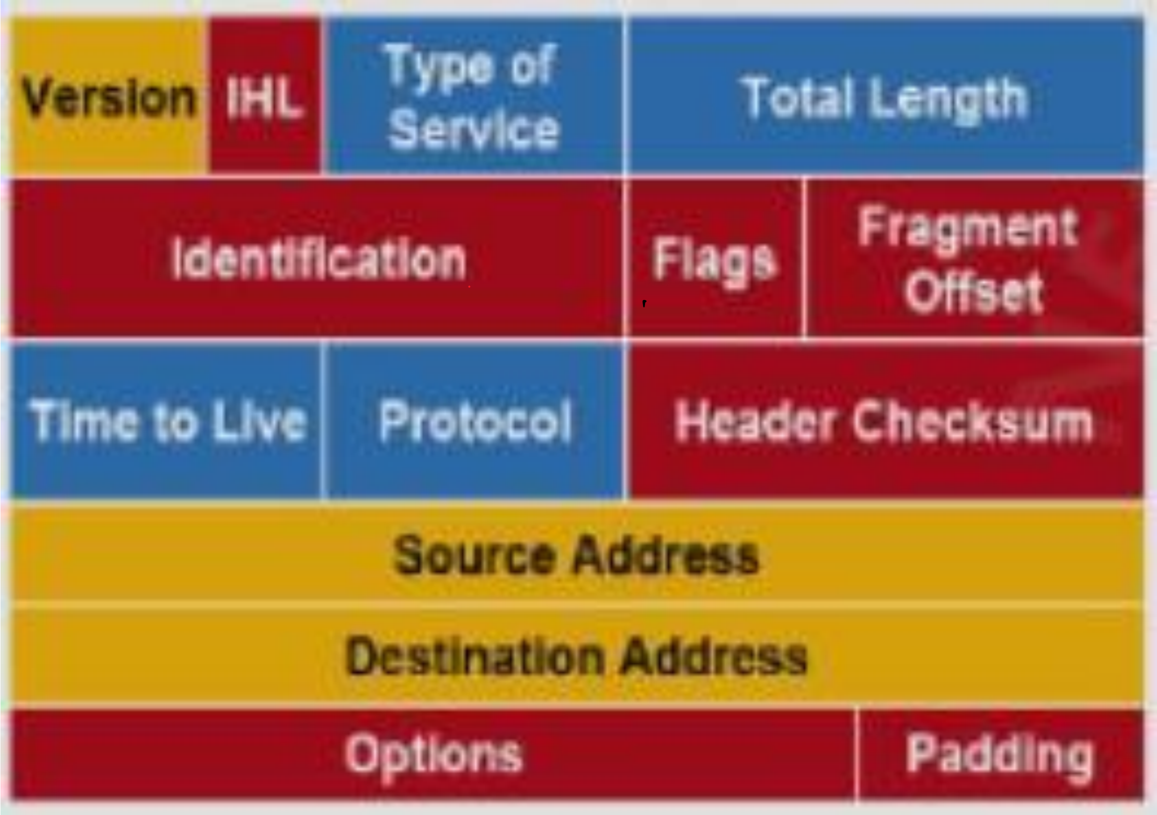
Limitation of IPV4

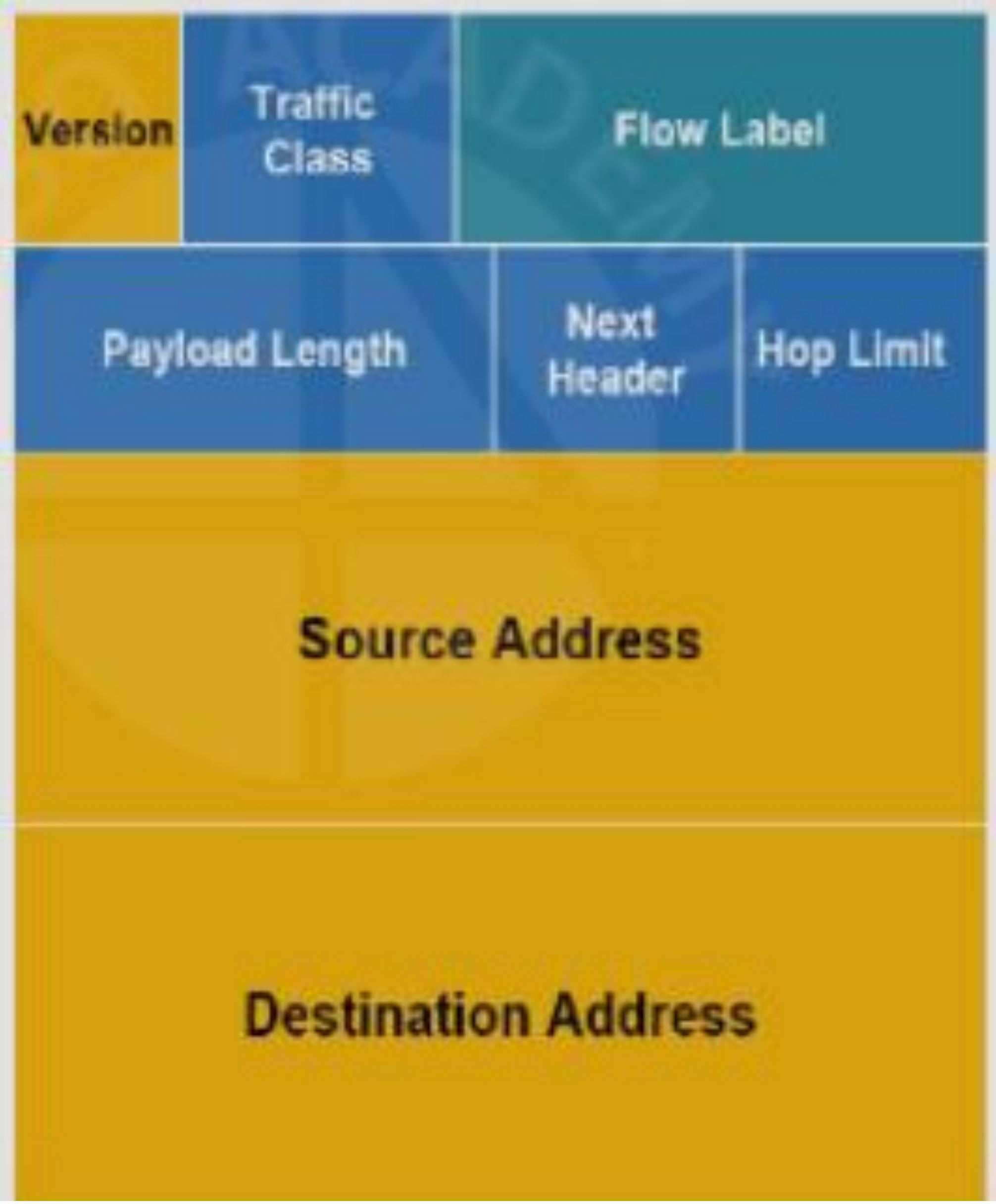
- *IP address depletion : 4 billion IPV4 addresses*
- *Internet routing table expansion.*
- *Lack of end-to-end connectivity.*

Features of IPV6

- *Increased address space 2^{128} IP addresses.*
- *Improved packet handling (the packet format of IPV6 is much simpler than IPV4).*
- *Eliminate the need for NAT.*
- *Integrated security*
- *Auto configuration*
- *End-to-End fragmentation..*
- *Enhanced routing functionality, including support for mobile hosts*

IPV4 verses IPV6 packet format





IPV6

- *Notation of IPV6 X.X.X.X..X.X.X.X (X= 16-bit hex number)*

- *128 bit in length and written as a string of hexadecimal values.*

- *In IPV6, 4 bits represents a single hexadecimal digit, 32 hexadecimal value =IPV6 address.*

- *Hextet used to refer a segment of 16 bits or four hexadecimals*

- *IPV6 addresses can be written in upper case or lower case.*

IPV6 Unicast Addresses

IPV6 Unicast Addresses

- Global Unicast
- Link -Local
- Loopback ::1/128
- Unspecified Address ::/128
- Unique-Local FC00::/7 to FDFF::/7
- Embedded IPV4

IPV6 Unicast Addresses

- **Global Unicast:**

Similar to public IPV4 address.
Globally unique
Internet routable addresses
Can be configured statically or assigned dynamically.

- **Link Local:**

Used to communicate with other devices on the same link.
Confined to a single link; not routable beyond the link. 128 bit in length and written as a string of hexadecimal values.

- **Loop Back:**

Used by a host to send a packet to itself and cannot be assigned to a physical interface.
Ping an IPV6 loopback address to the test the configuration of TCP/IP on the local host.
All 0's except the last bit, represented as ::1/128 or just ::1.

IPV6 Unicast Addresses

- **Unspecified Address**

All 0's address represented as ::/128 or just ::.
Cannot be assigned to an interface and is any used as a source address.
An unspecified address is used as a source address when the device does not have a permanent IPV6 address or when the source of the packet is irrelevant to the destination.

- **Unique Local:**

Similar to private addresses for IPV4.
Used for local addressing within a site or between a limited number of sites.
In the range FC00::/7 to FDFF:::/7.

- **Embedded IPV4:**

Used to help transition from IPV4 to IPV6.

IPV6 Addresses

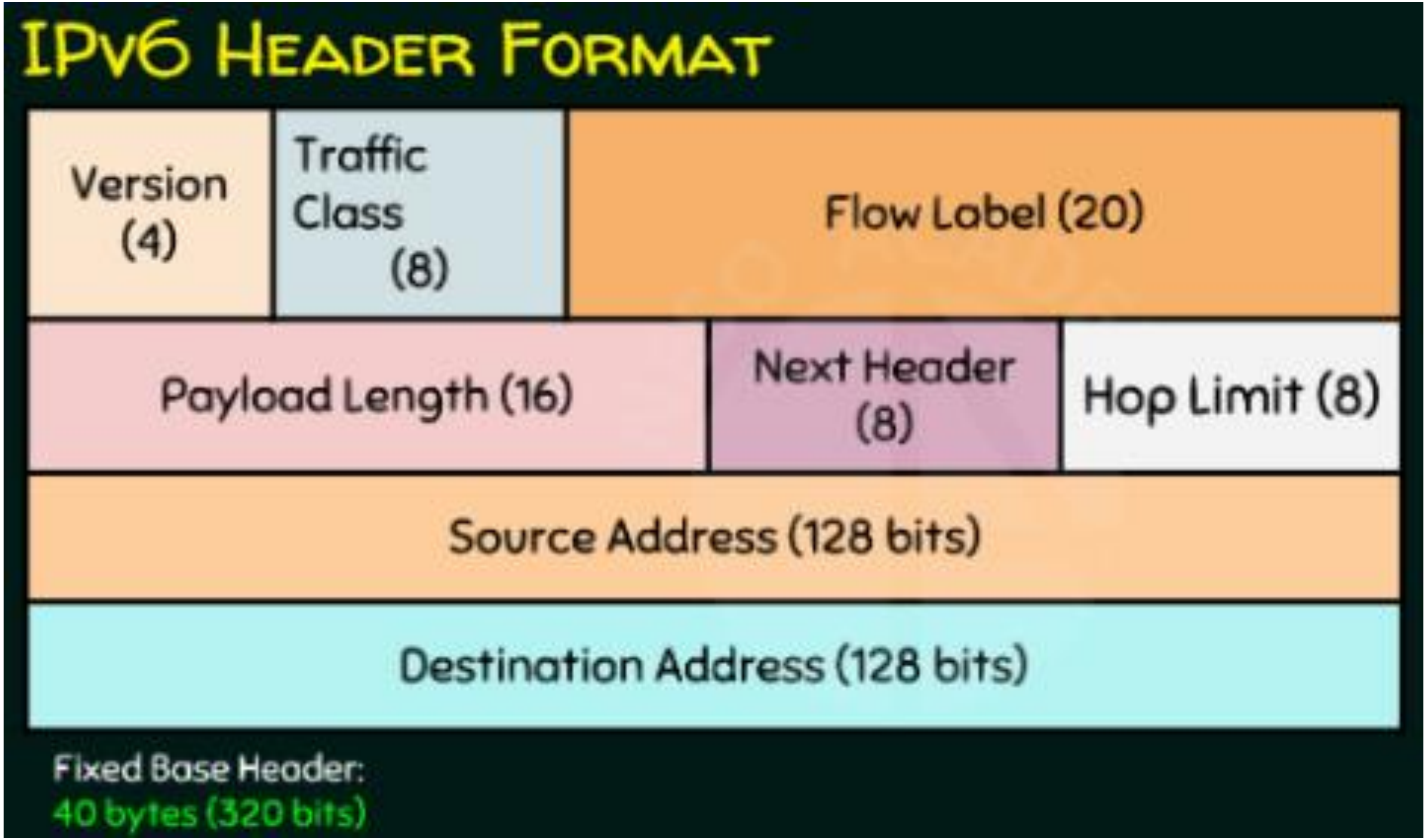
- **Unicast** ✓
- **Multicast** ✓
- **Anycast** (to more than interface)

IPV6 donot have broadcast addresses.

IPV4

unicast
Multicast
broadcast
limi
dire

IPV6 Header format



IPV6 Header Format

- **Version**
- *Indicates version of Internet protocol which contains bit sequence 0110.*

- **Traffic Class:**
- *The bits of this field hold two values. The six most significant bits held the differentiated service field (DS field), which is used to classify packets.*
- *The remaining two bits field are used for Explicit Configuration Notification (ECN).*

- **Flow label:**
- *A high entropy identifier of a flow of packets between asource and destination.*
- *A flow is a group of packets e.g. a TCP session or a media session.*
- *The special flow label 0 means the packet does not belong to any flow (using this scheme). It has further being suggested that the flow label be used to help detect spoofed packets.*

IPV6 Header Format

➢ **Payload Length**

- *The size of the payload in octets, including any extension header.*
- *The length is se t to zero when a hop-by-hop extension header carriers a Jumbo payload option.*

➢ **Next Header:**

- *Specifies the type of the next header.*
- *This field usually specifies the transport layer protocol used by a packet payload.*
- *When extension headers are present in the packet this field indicates which extension header follows.*

➢ **Hop Limit:**

- *Replace the TTL field din IPV4.*
- *This value is decremented by one at each forwarding node and the packet is discarded if it becomes 0.*
- *However, the destination node should process the packet normally even if received with a hop limit 0.*

IPV6 Header Format

- **Source Address**
- *The unicast IPV6 address of the sending node.*

- ***Destination Address:***
- *The IPV6 unicast or multicast address of the destination nodes.*

Extension of IPV6 Header Format

- **Routing Header**
- **Hop-by-Hop option**
- **Fragment Header**
- **Authentication Header**
- **Destination Option**
- **Encapsulation Security payload Source Address**

IPV6 Addressing

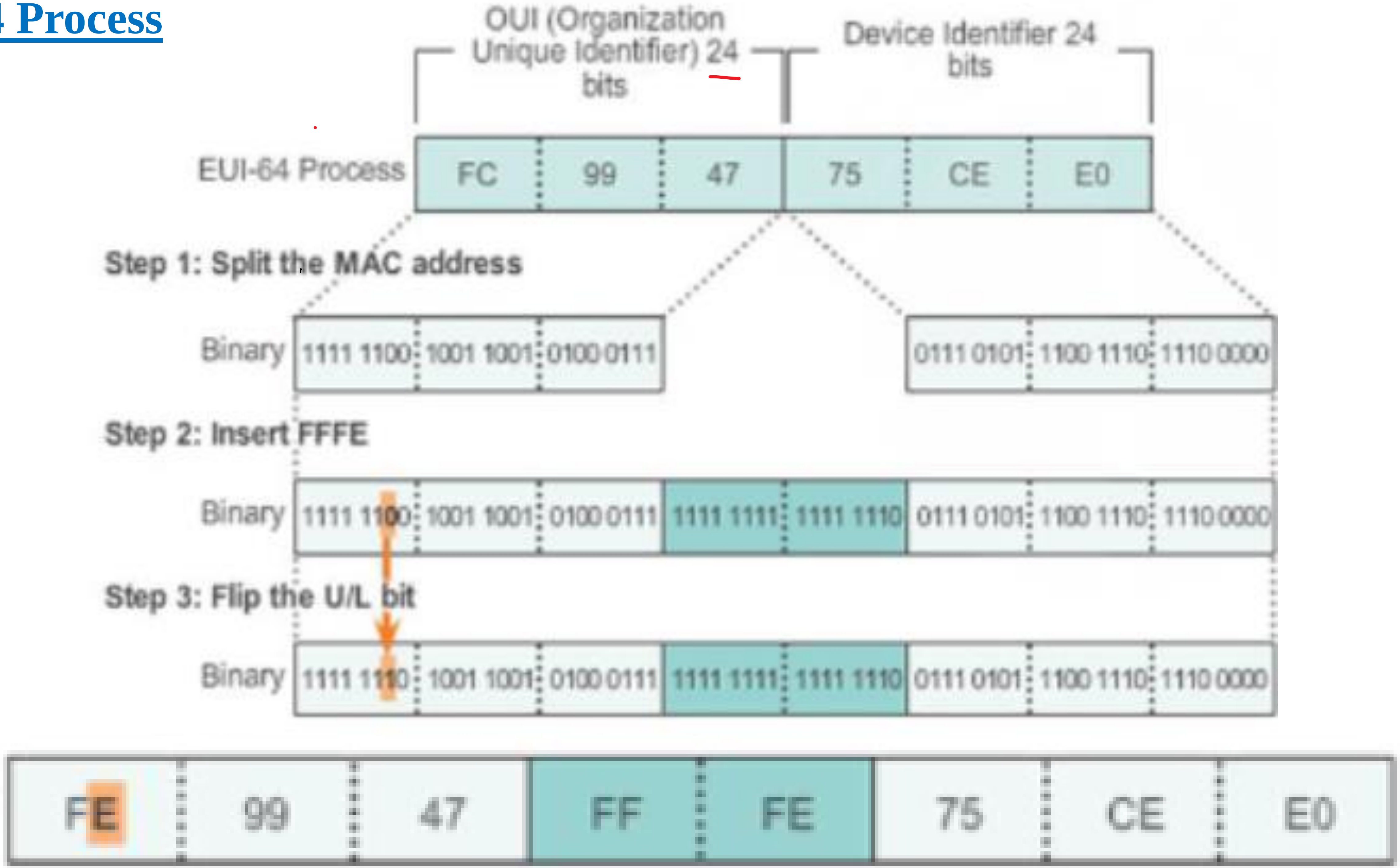
- **Static addressing**
- ***Static* addressing with DHCPv6 (Stateless)**
- ***Dynamic* addressing with DHCPv6 (State full)**
- **SLAAC alone , or SLAAC with DHCPv6 (Stateless)**

Structure of IPV6 Global Unicast Address

EUI 64 Process

- **Step 1: Split the 48 bits MAC address.**
- **Step 2: Insert FFFE.**
- **Step 3: Flip the seventh bit and generate the IPV6 address.**

EUI 64 Process



EUI (Extended Unique Identifier) 64 Process

Q. The MAC address of host is 0200:1234:5678 and initial prefix learned by the router's message is 2000:1234:5678::/64. What is the resulting IPV6 host address?

Q. The MAC address of host is 0200:1234:5678 and initial prefix learned by the router's message is 2000:1234:5678::/64. What is the resulting IPV6 host address?

0200:1234:5678

24 bits

24 bits

insert

Flip the

000000100000000000010010 | 001101000101011001111

0

00000010 0000000 0000000 10010 1111 1111 1111 1110 001

0101 0110 0111 10

0 0 0 0 1 2 F F F E 3 4 5 6 7 8 → Hexadecimal (

2000:1234:5678::0000:12FF:FE34:5678

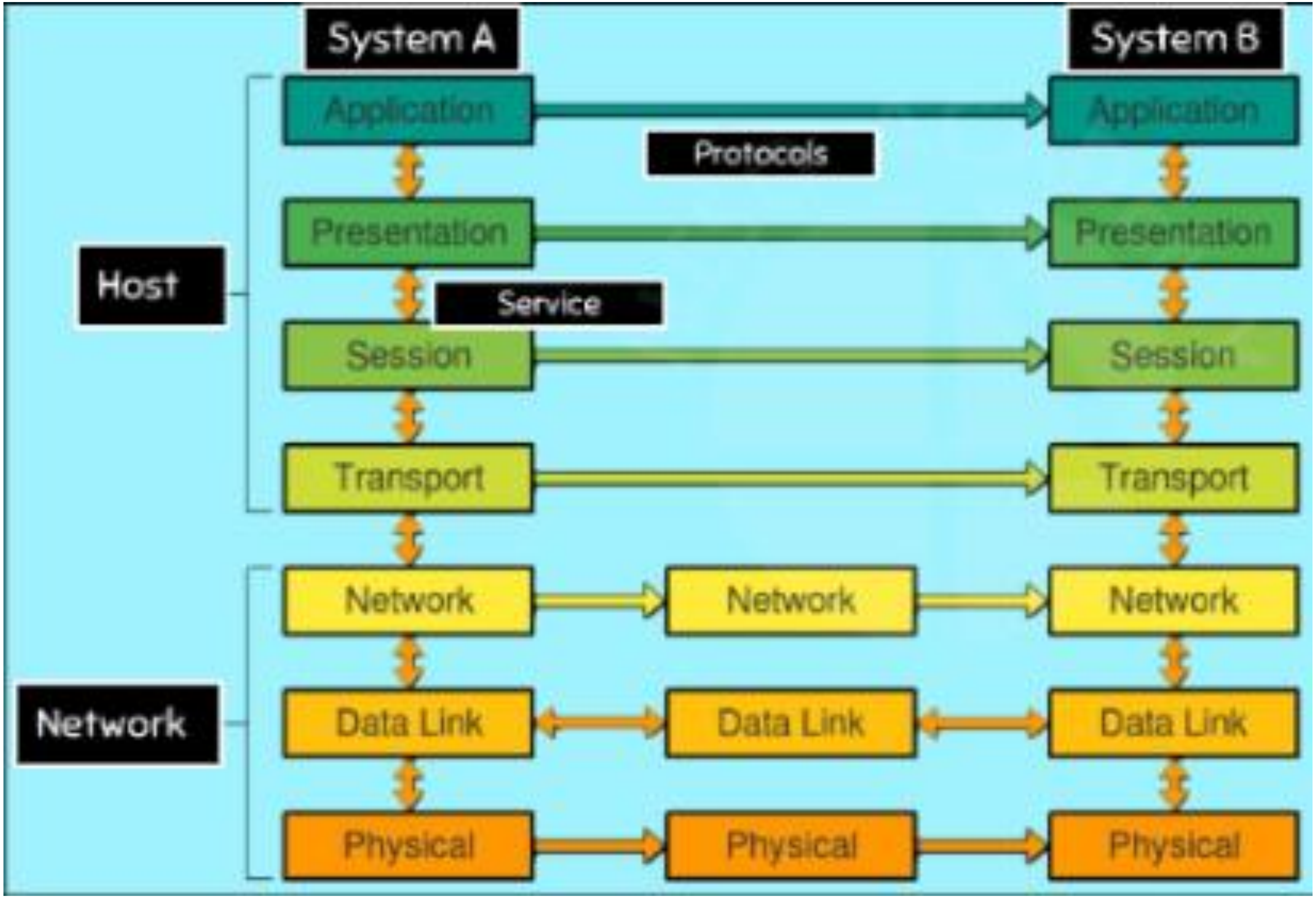
2000:1234:5678::12FF:FE34:5678 → MAC of IPV

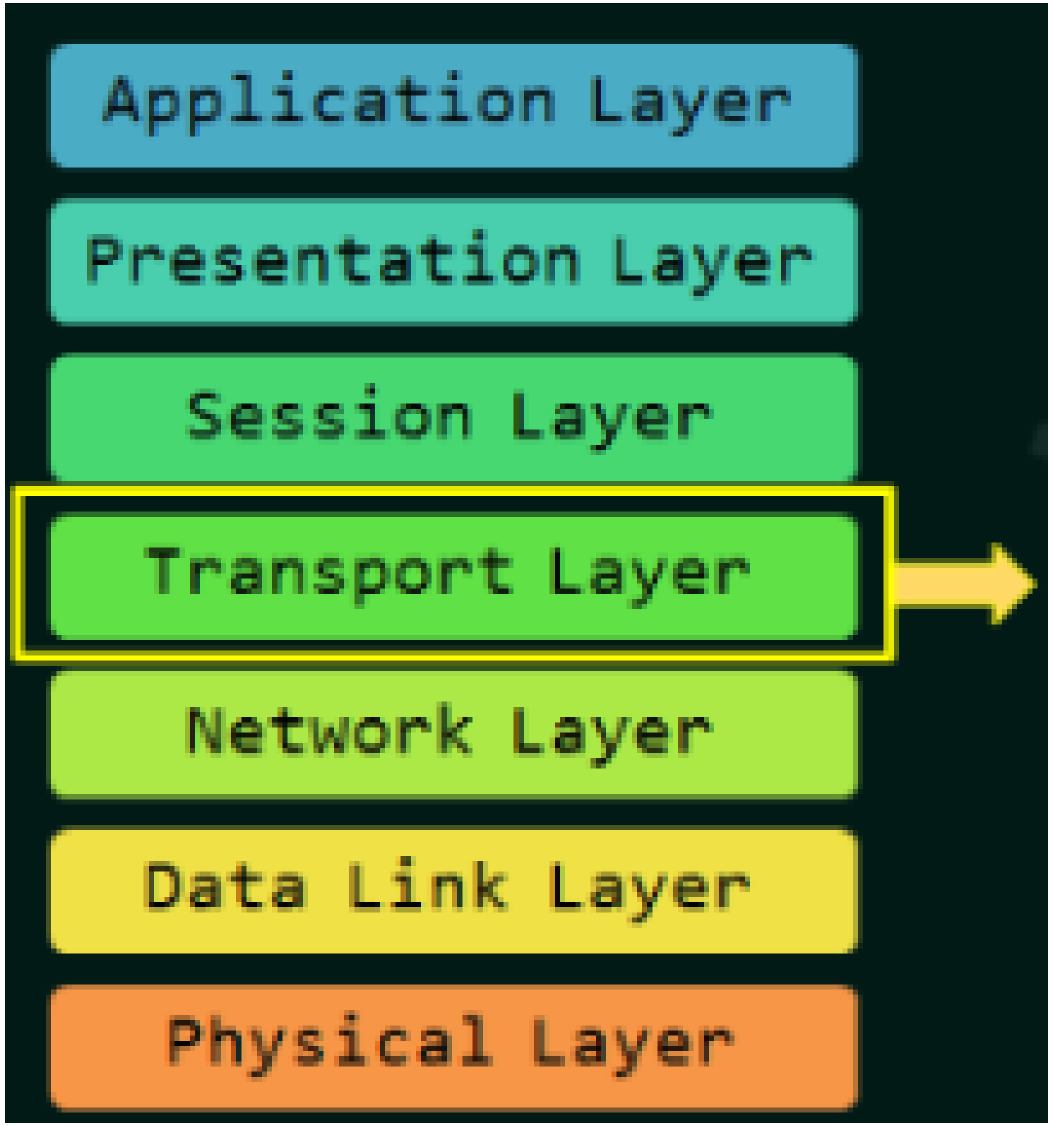
Computer Networks CS301

Module 4

Transport Layer

Dr. Sunandita Debnath, IIIT Vadodara

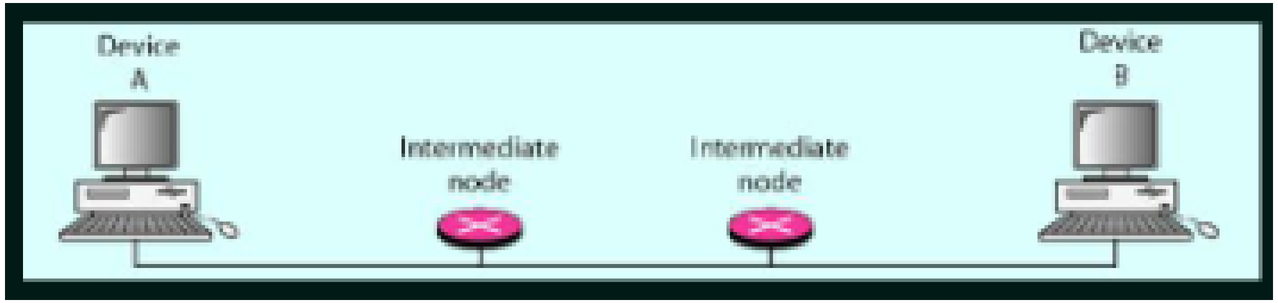

System A
System B
Application
Application
Protocols
Presentation
Presentation
Host
Service
Session
Session
Transport
Transport
Network
Network
Network
Network
Data Link
Data Link
Data Link
Physical
Physical
Physical

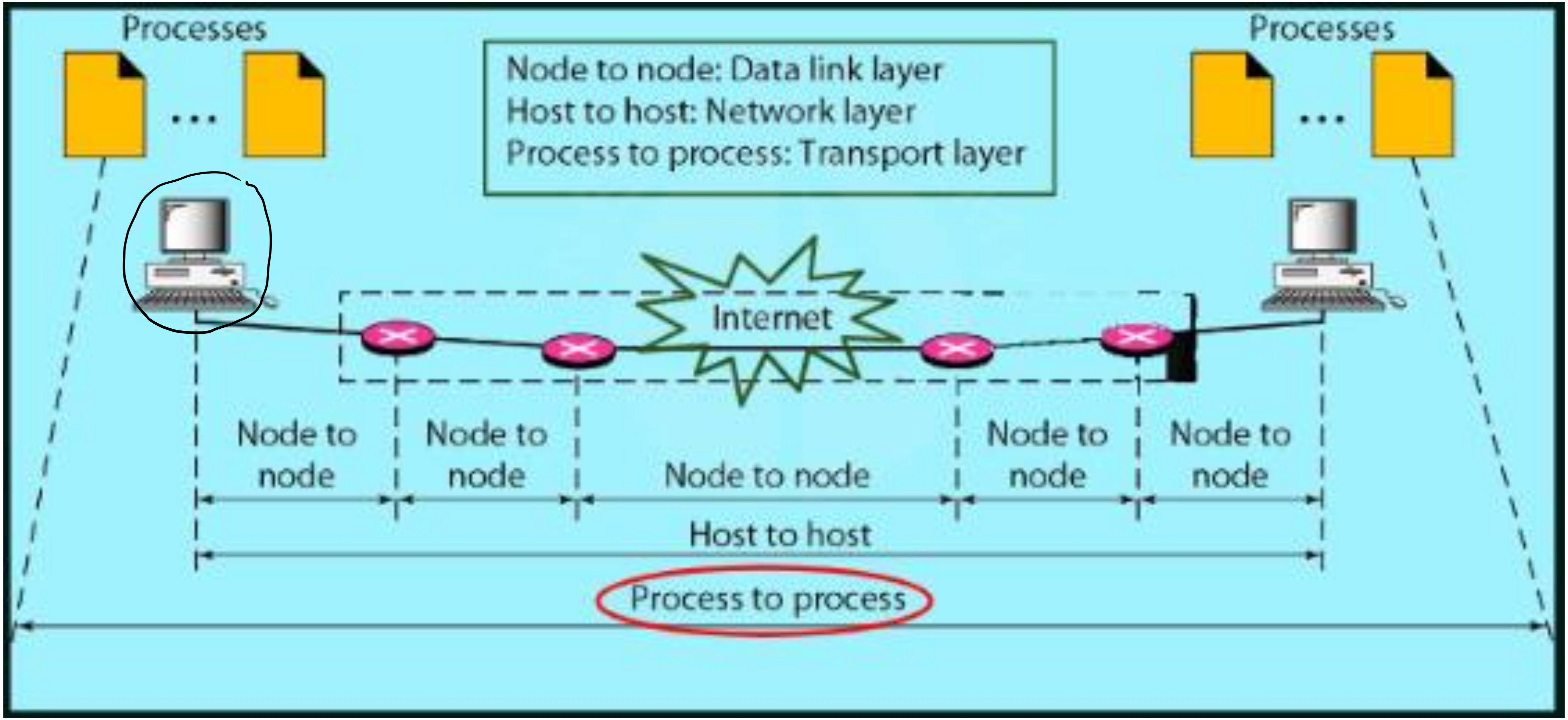


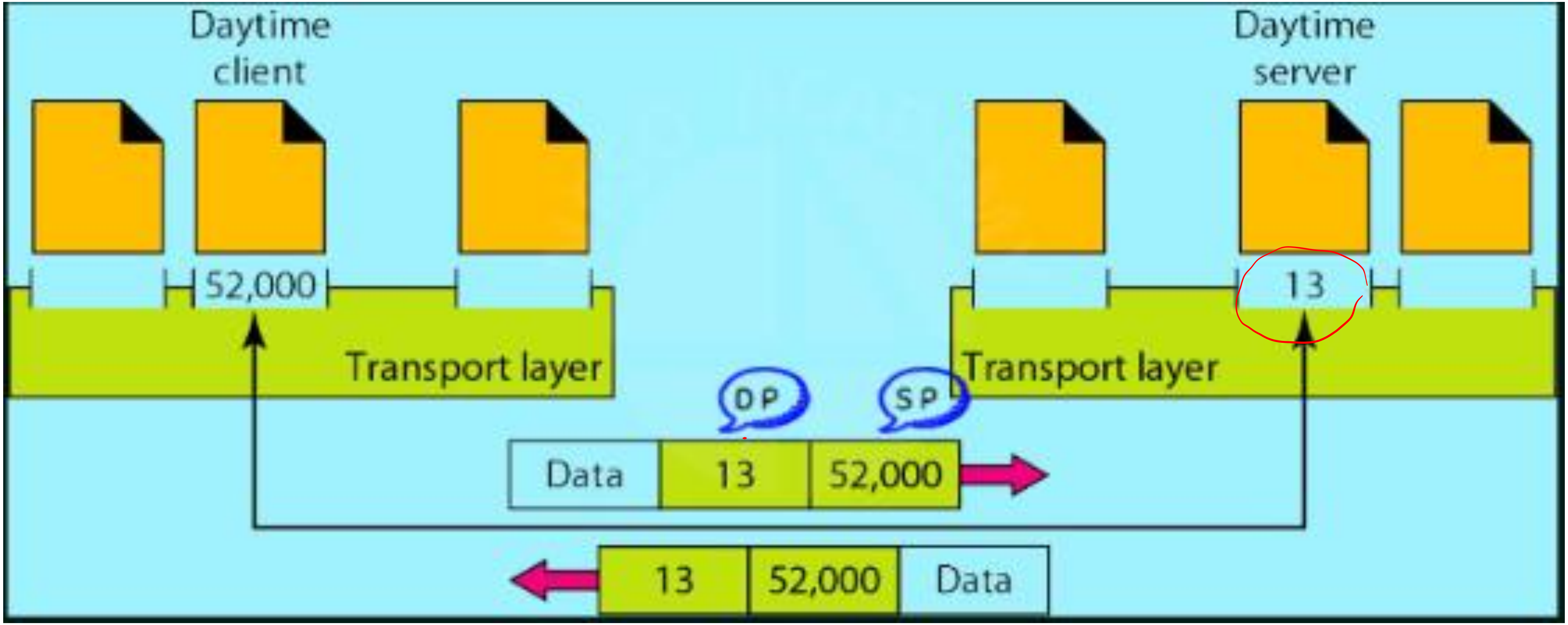
It is responsible for process to process delivery of the entire message.

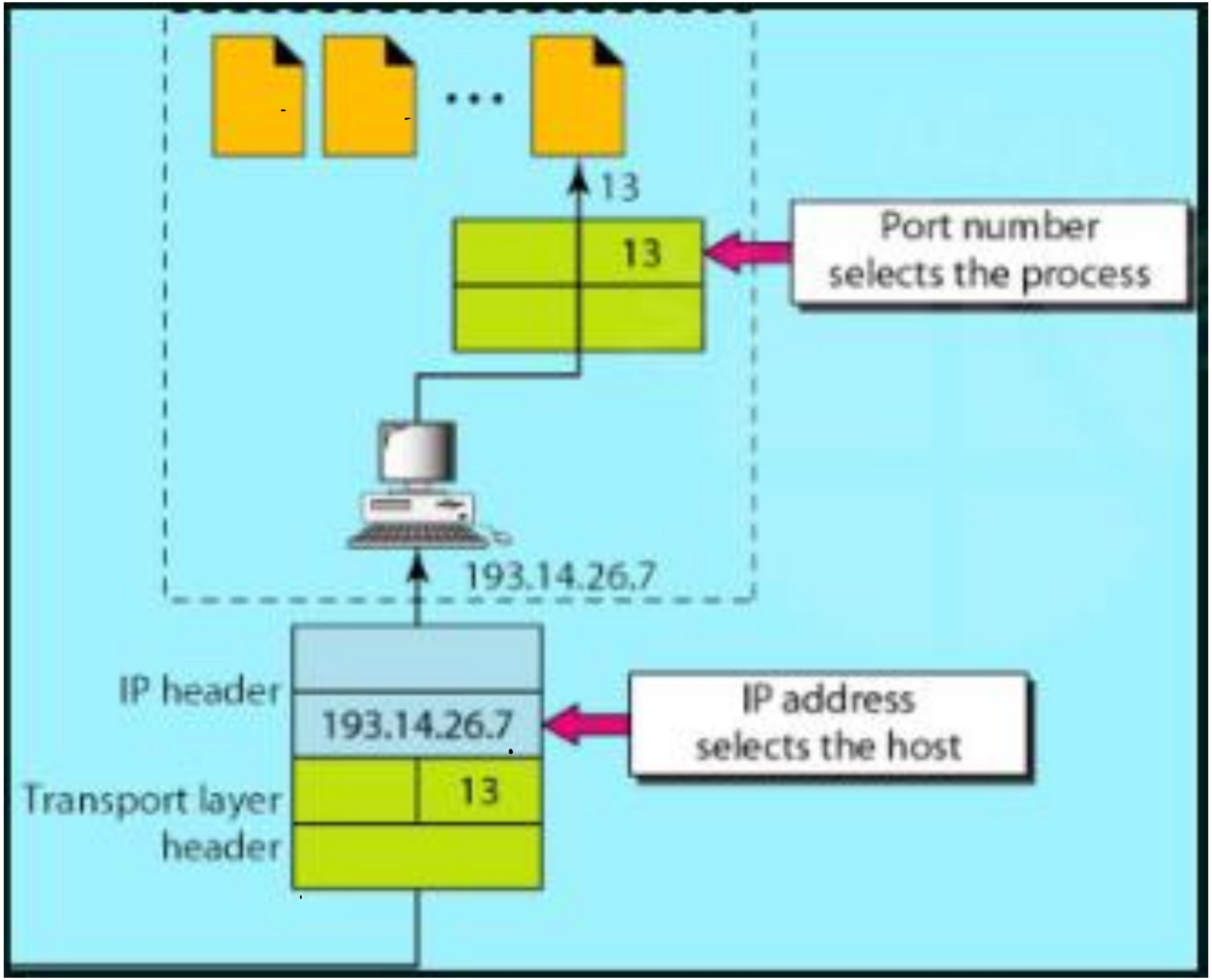
Service provided by Transport Layer

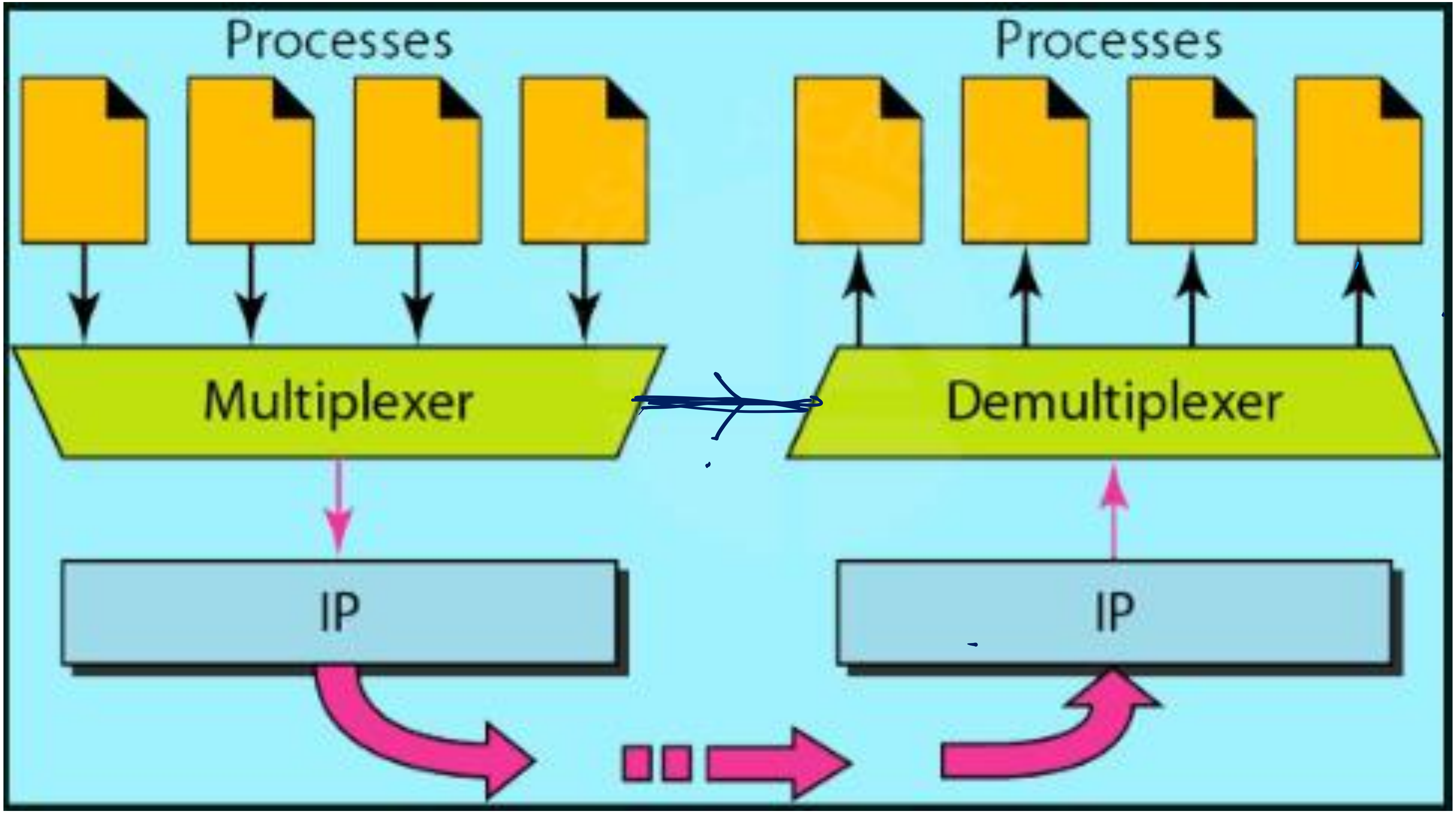
- ❑ Port addressing
- ❑ Segmentation and Reassembly
- ❑ Connection Control
- ❑ Flow control
- ❑ Error control

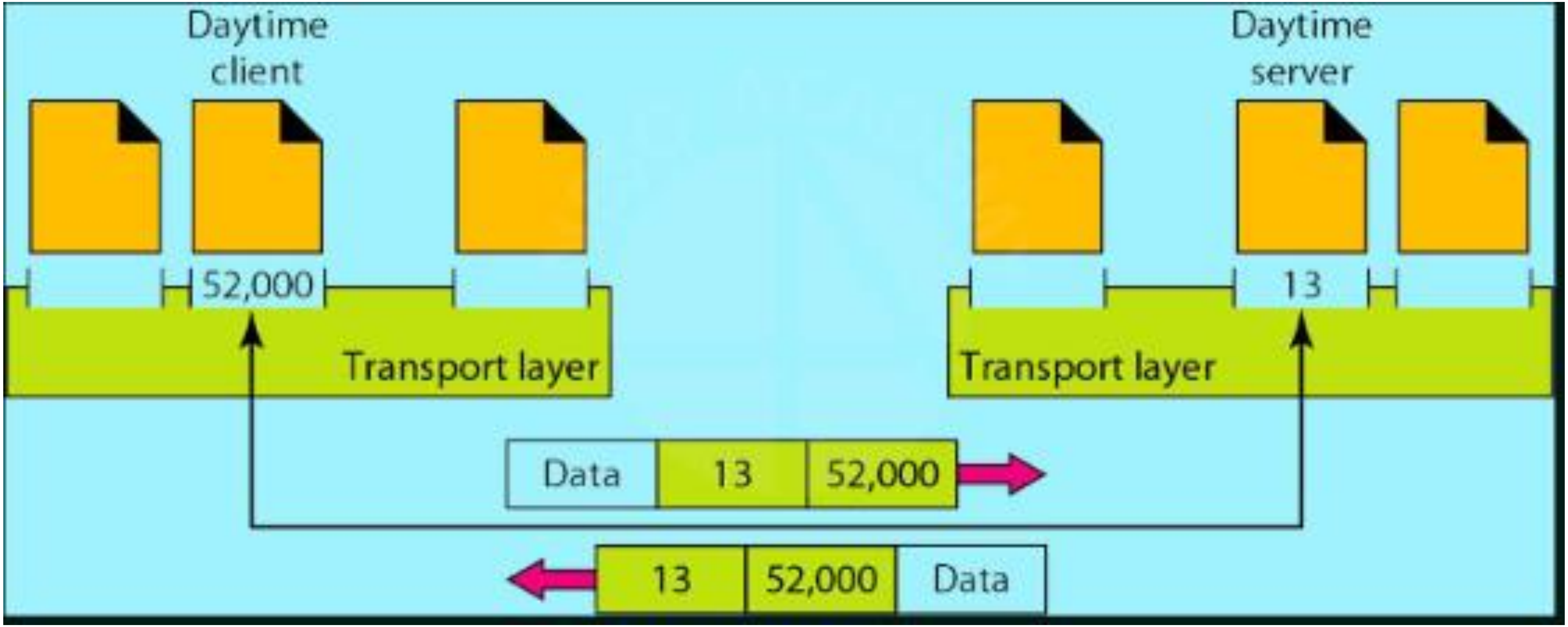



Processes
Processes
Node to node: Data link layer
Host to host: Network layer
Process to process: Transport layer
Internet
Node to node
Node to node
Node to node
Node to node
Node to node
Host to host
Process to process

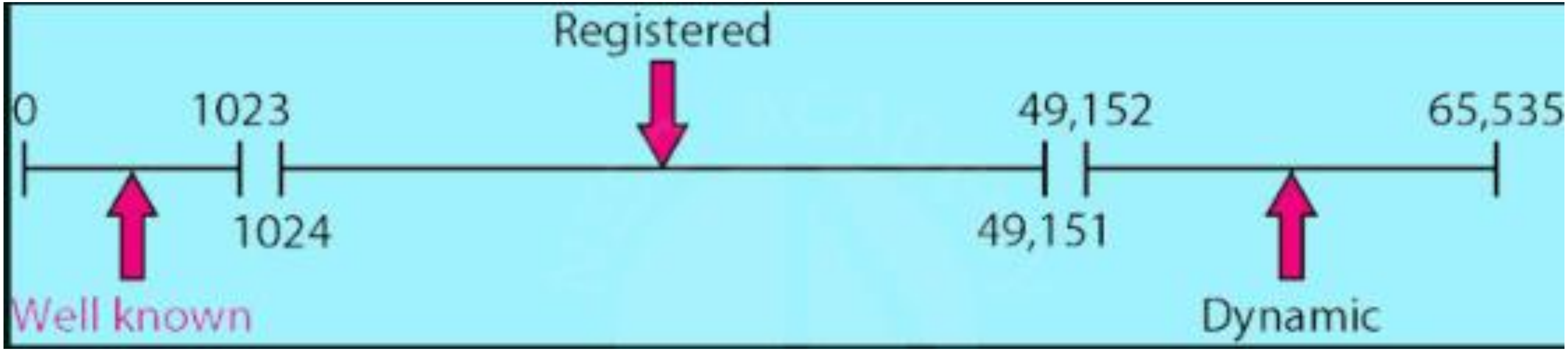

Daytime
client
Daytime
server
52,000
13
Transport layer
Transport layer
DP
SP
Data
13
52,000
13
52,000
Data


13
13
Port number
selects the process
193.14.26.7
IP header
193.14.26.7
IP address
selects the host
13
Transport layer
header


Processes
Processes
Multiplexer
Demultiplexer
IP
IP


Daytime
client
52,000
Transport layer
Daytime
server
13
Transport layer
Data
13
52,000
13
52,000
Data

Port Numbers



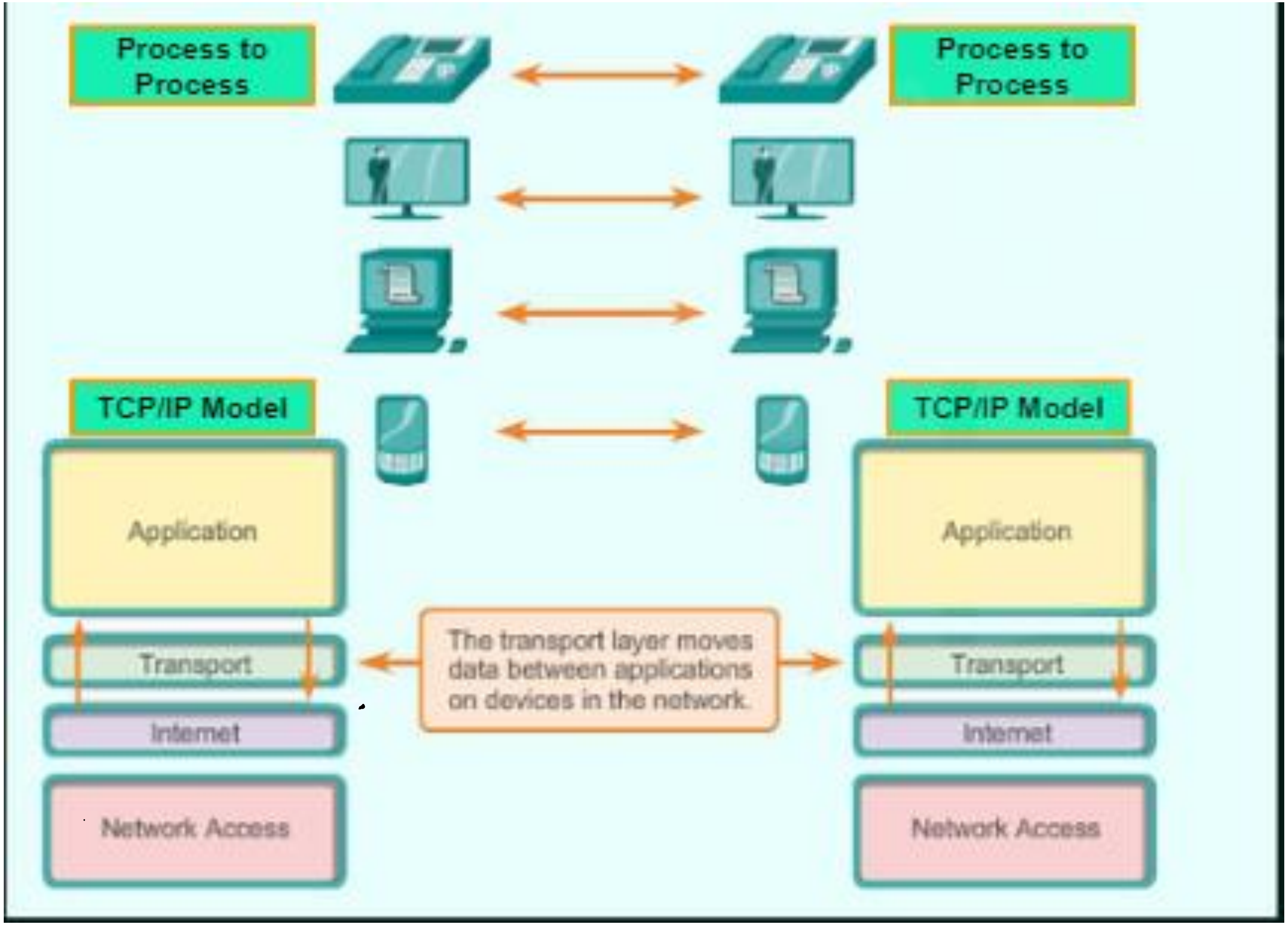
- This includes the registration of commonly used port numbers for well-known Internet services.

- The port numbers are divided into three categories

- Well-known ports
- Registration ports
- Dynamic or private ports

Well Known Ports

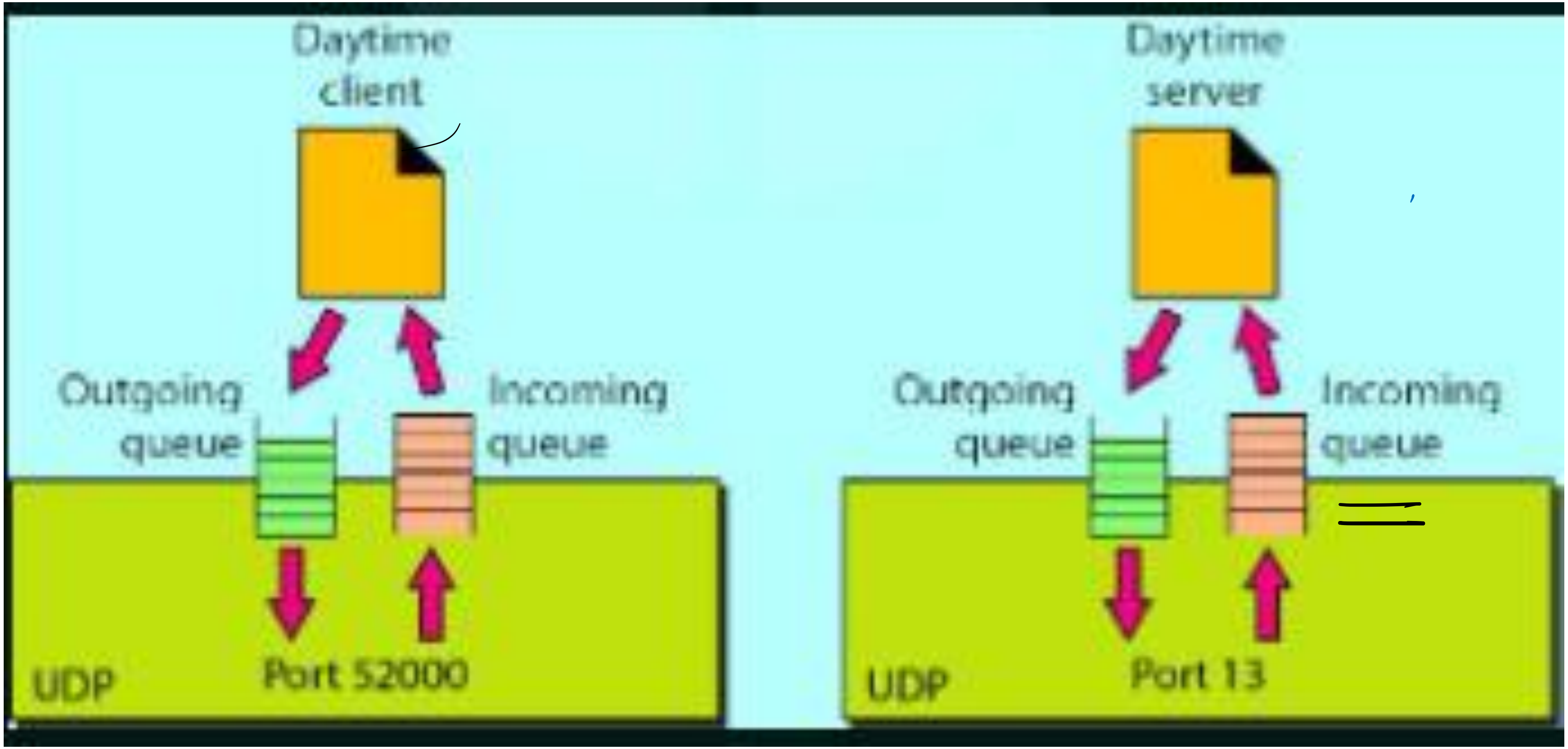
Ports Numbers	Assignments
20	File Transfer Protocol (FTP) Data Transfer
21	File Transfer Protocol (FTP) Command Control
22	Secure Shell (SSH) Secure Login
23	Telnet remote login service, unencrypted text messages
25	Simple Mail Transfer Protocol (SMTP) E-mail routing
53	Domain Name System (DNS) Service
67,68	Dynamic Host Configuration Protocol
80	Hypertext Transfer Protocol (HTTP) used in world wide web
110	Post Office Protocol (POP3)
123	Network Time Protocol (NTP)
143	Internet Message Access protocol (IMAP) Management of Digital mail
161	Simple Network Management Protocol (SNMP)
443	HTTP over SSL/ TLS (or) HTTP Secure


Process to Process
Process to Process
TCP/IP Model
Application
Transport
Internet
Network Access
TCP/IP Model
Application
Transport
Internet
Network Access
The transport layer moves data between applications on devices in the network.

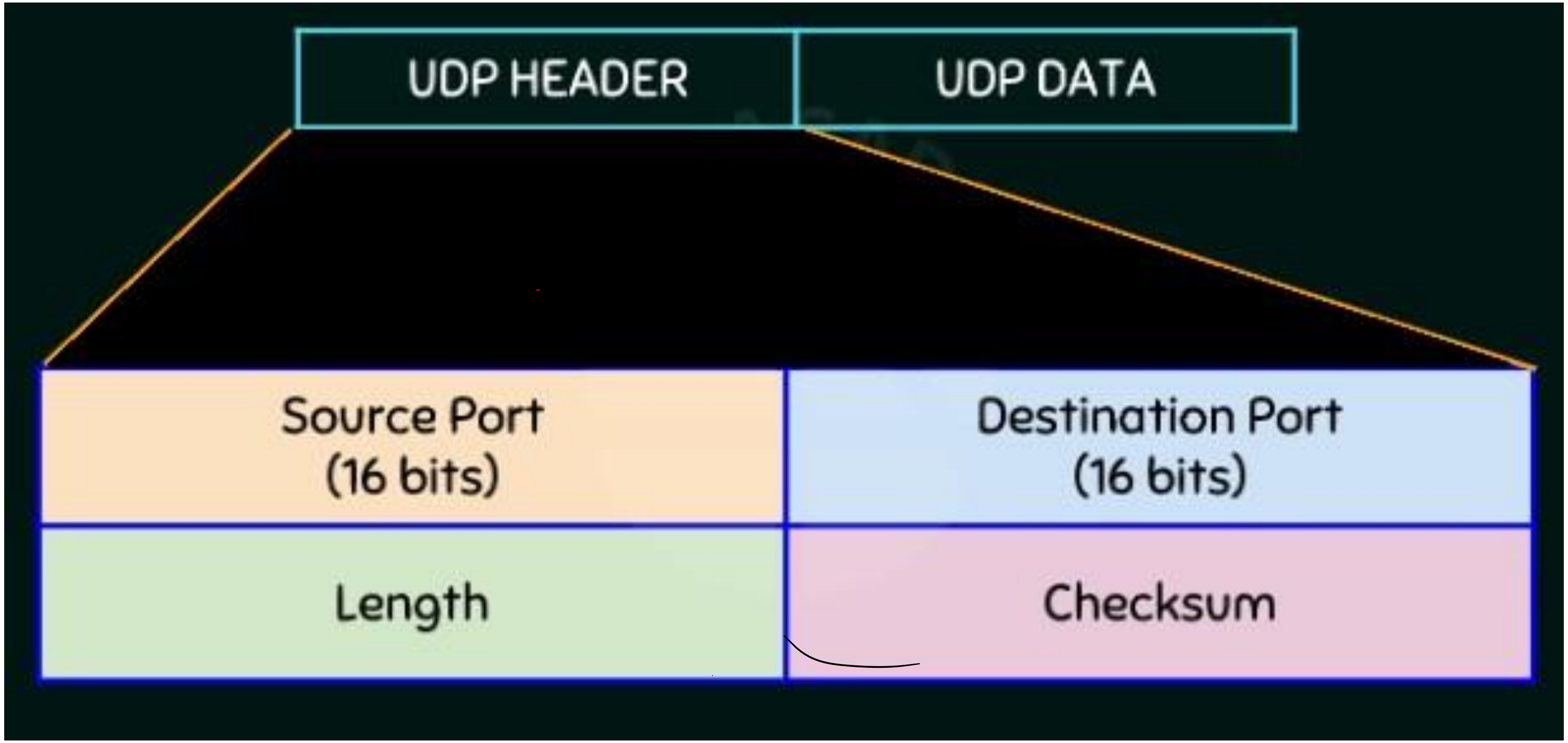
TCP (Transmission Control Protocol) vs UDP (User Datagram protocol))

TCP	UDP
➢ No loss but delay is allowed ➢ Retransmission is possible. ➢ Application uses TCP as transport layer protocol ❑ FTP ❑ SMTP ❑ HTTP ❑ Telnet	➢ No delay but low loss is allowed ➢ Retransmission is not possible ➢ Application uses UDP as transport layer protocol ❑ DNS ❑ DHCP ❑ SNMP ❑ TFTP ❑ VoIP

UDP


Daytime
client
Daytime
server
Outgoing
queue
Incoming
queue
Outgoing
queue
Incoming
queue
UDP
Port 52000
UDP
Port 13

UDP (User Datagram protocol) Header Format



The following is a dump of a UDP header in hexadecimal format
0632000D001CE217

a. **What is the source port number?**
b. **What is the destination port number?**
c. **What is the length of the data?**
d. **What is the total length of the datagram?**
e. **Is the packet directed from a client to a server or vice versa?**

Started on	Tuesday, 6 September 2022, 2:01 PM
State	Finished
Completed on	Tuesday, 6 September 2022, 2:40 PM
Time taken	39 mins 22 secs
Grade	**34.00** out of 37.00 (**92**%)

Question **1**

Complete

Mark 1.00 out of 1.00

Which is not true for Packet switching?

a. Multiple users can use the same channel while transferring their packets.

b. The delivery of these packets becomes easy when complicated protocols are used.

c. Installation costs of packet switching are expensive.

d. Multiple users can use the same channel while transferring their packets.

The correct answer is:
Multiple users can use the same channel while transferring their packets.

Question **2**

Complete

Mark 1.00 out of 1.00

In reference to OSI model, TCP/IP model does not have ______

- a. transport layer
- b. network layer
- c. application layer
- d. session layer

The correct answer is:
session layer

Question **3**

Complete

Mark 1.00 out of 1.00

The time required to examine the packet's header and determine where to direct the packet is part of _________

- a. Propagation delay
- b. Queuing delay
- c. Transmission delay
- d. Processing delay

The correct answer is:
Processing delay

Question **4**

Complete

Mark 0.00 out of 1.00

In the transfer of files between four pairs of client-servers through a common transmission channel of transmission rate 1 Mbps. All the server access links have a transmission rate of 2 Mbps and all the client access links have a transmission rate of 2.5 Mbps, the throughput of this network will be

- a. 2.5 Mbps
- b. 0.25 Mbps
- c. None of these
- d. 2 Mbps

The correct answer is:
0.25 Mbps

Question **5**

Complete

Mark 1.00 out of 1.00

The functions of _______ layer in the OSI model are handled by the transport layer itself in TCP/IP.

- a. network layer and presentation
- b. presentation and session
- c. transport layer and session
- d. application layer and session

The correct answer is:
presentation and session

Question **6**

Complete

Mark 1.00 out of 1.00

What will be the propagation time when the distance between two points is 2400km? Assuming the propagation speed to be $4x10^8$m/s in cable.

- a. 5ms
- b. 1 ms
- c. 2 ms
- d. 6ms

The correct answer is:

6ms

Question **7**

Complete

Mark 0.00 out of 1.00

Which of the following statements is not applicable for cable internet access?

- a. It includes Hybrid Fiber Co-axials
- b. Analog signal is converted to digital signal in DSLAM
- c. Cable modem connects home PC to Ethernet port
- d. It is a shared broadcast medium

The correct answer is:
Analog signal is converted to digital signal in DSLAM

Question **8**

Complete

Mark 1.00 out of 1.00

The OSI model was developed _____ TCP/IP model.

a. after

b. prior to

c. with no link to TCP/IP

d. simultaneous to

The correct answer is:
after

Question **9**

Complete

Mark 1.00 out of 1.00

Which of the following statement is correct for Slotted Aloha

a. divide time into discrete time intervals

b. None of these

c. divide time into discrete time intervals and also requires global time synchronization

d. require global time synchronization

The correct answer is:
divide time into discrete time intervals and also requires global time synchronization

Question **10**

Complete

Mark 1.00 out of 1.00

Layer that translates between physical (MAC) and logical addresses is ....

- a. Datalink
- b. Transport
- c. Network
- d. Physical

The correct answer is:
Network

Question **11**

Complete

Mark 1.00 out of 1.00

Which multiple access techniques is used by IEEE 802.11 standards for wireless LANs?

- a. CSMA
- b. CSMA/CA
- c. ALOHA
- d. CSMA/CD

The correct answer is:
CSMA/CA

Question **12**

Complete

Mark 1.00 out of 1.00

A sender-receiver employs even parity for error correction scheme, what will be the parity bit for 1001011?

- a. 1
- b. None of these
- c. 2
- d. 0

The correct answer is:
0

Question **13**

Complete

Mark 1.00 out of 1.00

What is the role of logical link control sublayer in layer 2?

- a. Sequencing
- b. Acknowledgment
- c. Connection Establishment
- d. Error detection

The correct answer is:
Error detection

Question **14**

Complete

Mark 2.00 out of 2.00

Consider the Go-back-N protocol with a sender's window size of '8'. Suppose at time 't' the next frame in the buffer (i.e. the next inorder frame) the receiver is expecting has a sequence No. 5. Assume that the medium does not reorder the messages. What is the possible set of sequence number inside the sender's window at time '*t*'. Assume the sender has already received acknowledgment for all the previously transmitted frames.

- a. [4, 12]
- b. None of these
- c. [5, 13]
- d. [5, 12]

The correct answer is:
[5, 12]

Question **15**

Complete

Mark 1.00 out of 1.00

What is the total vulnerable time value of pure Aloha?

- a. $2 \times T_{fr}$
- b. None of these
- c. T_{fr}
- d. ½ T_{fr}

The correct answer is:
$2 \times T_{fr}$

Question **16**

Complete

Mark 1.00 out of 1.00

Which of the following protocols is the bit-oriented protocol?

- a. SSL
- b. All of these
- c. HDLC
- d. HTTP

The correct answer is:
HDLC

Question **17**

Complete

Mark 1.00 out of 1.00

In Carrier Sense Multiple Access which node senses the channel, if idle it sends the data, otherwise it checks the medium after a random amount of time (not continuously) and transmits when found idle.

- a. P-persistent
- b. Non-persistent
- c. O-persistent
- d. 1-persistent

The correct answer is:
Non-persistent

Question **18**

Complete

Mark 0.00 out of 1.00

Which is true for Circuit Switching?

a. All true

b. The bandwidth used is not fixed.

c. The bandwidth used is not fixed.

d. The bandwidth used is not fixed.

The correct answer is:
The bandwidth used is not fixed.

Question **19**

Complete

Mark 1.00 out of 1.00

To avoid collisions on wireless networks, _______was invented.

a. None of these

b. Ethernet

c. CSMA/CA

d. CSMA/CD

The correct answer is:
CSMA/CA

Question **20**

Complete

Mark 1.00 out of 1.00

A three-layer switch can be called as...........

- a. Bridge
- b. None of these
- c. Repeater
- d. Router

The correct answer is:
Router

Question **21**

Complete

Mark 1.00 out of 1.00

What is the primary purpose of a virtual local area networks?

- a. Demonstrating the proper layout for network
- b. Segmenting a network inside a switch or device
- c. Simulating a network
- d. To create a virtual private network

The correct answer is:
Segmenting a network inside a switch or device

Question **22**

Complete

Mark 1.00 out of 1.00

What are not the responsibilities of the Data link Layer?

a. IP addressing

b. MAC addressing

c. Framing

d. Error detection

The correct answer is:
IP addressing

Question **23**

Complete

Mark 1.00 out of 1.00

The technique of temporarily delaying acknowledgements so that they can be hooked onto the next outgoing data frame is called

a. Piggybacking

b. Parity check

c. None of these

d. Cyclic redundancy check

The correct answer is:
Piggybacking

Question **24**

Complete

Mark 1.00 out of 1.00

What are not the responsibilities of the Data link Layer?

- a. MAC addressing
- b. Framing
- c. Error detection
- d. IP addressing

The correct answer is:
IP addressing

Question **25**

Complete

Mark 1.00 out of 1.00

In Carrier Sense Multiple Access, which CSMA scheme senses the channel, if idle it sends the data, otherwise it continuously keeps on checking the medium for being idle and transmits unconditionally as soon as the channel gets idle.

- a. Non-persistent
- b. 1-persistent
- c. P-persistent
- d. O-persistent

The correct answer is:
1-persistent

Question **26**

Complete

Mark 1.00 out of 1.00

Error detection and correction are offered by both

- a. Data link layer and Network Layer
- b. Physical Layer and Data link Layer
- c. Network Layer and Transport Layer
- d. Data link layer and Transport Layer

The correct answer is:
Data link layer and Transport Layer

Question **27**

Complete

Mark 1.00 out of 1.00

The length of the ....of a specific packet will depend on the number of earlier-arriving packets that are queued and waiting for transmission onto the link.

- a. Propagation delay
- b. Queuing delay
- c. None of these
- d. Transmission delay

The correct answer is:
Queuing delay

Question **28**

Complete

Mark 1.00 out of 1.00

What are not the responsibilities of the Network Layer?

a. IP addressing

b. Routing

c. Path determination

d. Framing

The correct answer is:
Framing

Question **29**

Complete

Mark 1.00 out of 1.00

The ______ layer links network/user support layers by segmenting and rearranging the data.

a. Transport Layer

b. Session Layer

c. Application Layer

d. Network Layer

The correct answer is:
Transport Layer

Question **30**

Complete

Mark 2.00 out of 2.00

The sender employs the "Go Back 10 ARQ" scheme. A 50 Kbps link has a propagation speed of 2×10^8 m/s. The transmitter and receiver is at 2000 km distance from each other. Each frame is 100 bytes long, assuming no transmission delay what will be the minimum round trip time delay for transmission of 1 million bits?

- a. 10 ms
- b. 50 ms
- c. None of these
- d. 20 ms

The correct answer is:
20 ms

Question **31**

Complete

Mark 1.00 out of 1.00

Transmission data rate is decided by ___________.

- a. data link layer
- b. physical layer
- c. transport layer
- d. network layer

The correct answer is:
physical layer

Question **32**

Complete

Mark 1.00 out of 1.00

Which are end system devices

- a. web servers
- b. smartphones
- c. mail servers
- d. All of these

The correct answer is:
All of these

Question **33**

Complete

Mark 1.00 out of 1.00

In _________, each station is forced to send only at the beginning of the time slot.

- a. Pure Aloha
- b. CSMA/CA
- c. CSMA/CD
- d. Slotted Aloha

The correct answer is:
Slotted Aloha

Question **34**

Complete

Mark 1.00 out of 1.00

Which is of the following statement is incorrect, if the transmission bandwidth of a shared broadcast media of 50 Mbps is shared by 500 users then,

- a. Using FDMA scheme, each of the users have an access to 100 Kbps of bandwidth
- b. Using CDMA scheme, each of the users have an access to 50 Mbps of bandwidth
- c. Using TDMA scheme, each of the users have an access to 100 Kbps of bandwidth
- d. Using CDMA scheme, each of the users have an access to 100 Kbps of bandwidth

The correct answer is:
Using CDMA scheme, each of the users have an access to 100 Kbps of bandwidth

Question **35**

Complete

Mark 1.00 out of 1.00

In slotted ALOHA, the vulnerable time is _____ the frame transmission time.

- a. same as the a frame transmission time
- b. None of these
- c. half of a frame transmission time
- d. twice of a frame transmission time

The correct answer is:
same as the a frame transmission time

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