# Computer Networks

## Unit : Computer Network

- Introduction to Data Communication and Computer Network, Network Topologies, classification of computer network, Parallel & Serial Transmission, Transmission Models, Transmission Channel, Data Rate, Bandwidth Signal Encoding Schemes, Data Compression, Transmission Impairments, Layering and Design Issues, OSI Model and TCP/ IP model.

## Unit : Computer Network

- Data Link Layer: Need for Data Link Control, Frame Design Consideration, Flow Control & Error Control. MAC sublayer, contention based and polling based MAC protocols.

- Network Layer: Routing, Congestion control, Internetworking principles, Internet Protocols (IPv4, packet format, Hierarchal addressing sub netting, ARP, PPP), Bridges, Routers. Classless IP address.

## Unit : Computer Network

- Datalink Layer: Process to process communication. Socket meaning and socket address. Upward and downwards multiplexing. UDP and TPDU.

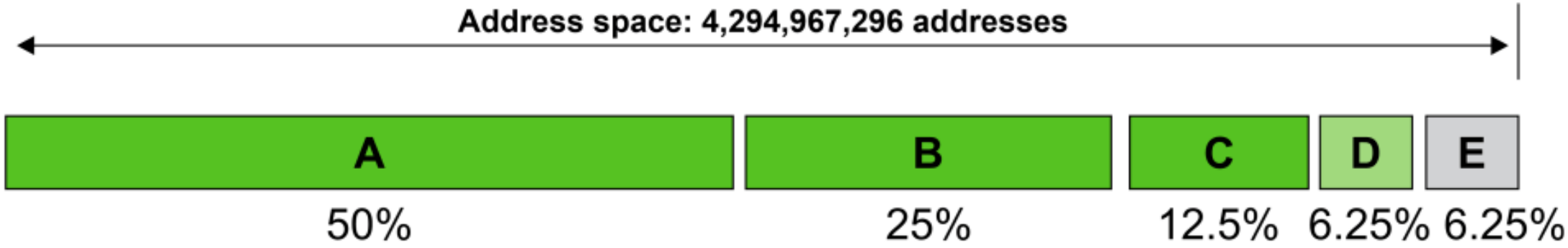
- Application Layer: HTTP, FTP, Telnet, SMTP, SNMP

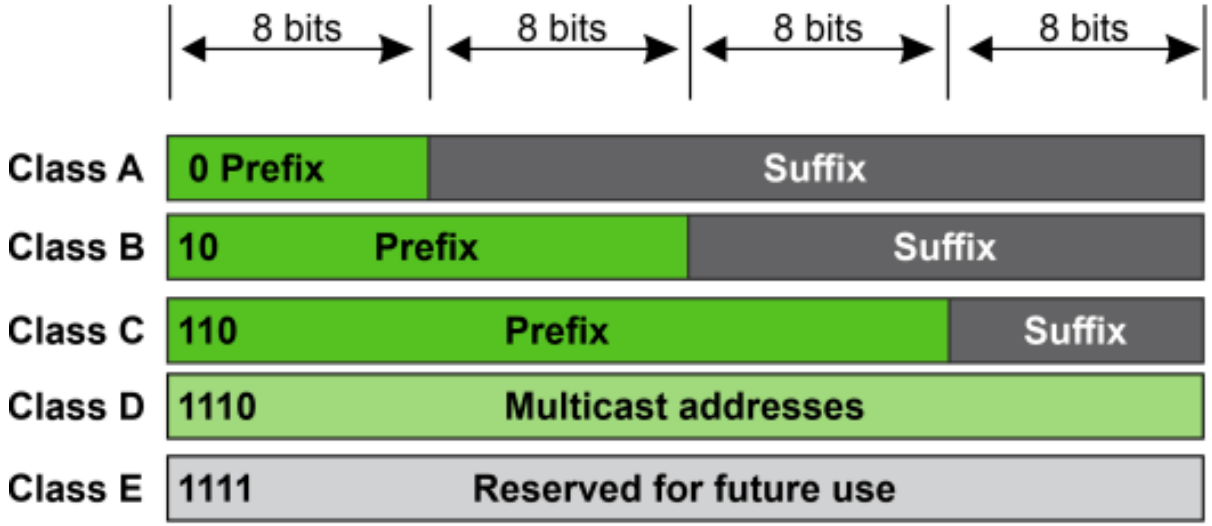
## Classful Addressing:

Introduced in 1981, with classful routing, IP v4 addresses were divided into 5 classes(A to E).

Classes A-C: unicast addresses
Class D: multicast addresses
Class E: reserved for future use

# Occupation of the address space in classful addressing




| Classes | Prefixes | First Byte |
|---|---|---|
| A | n = 8 bits | 0 to 127 |
| B | n = 16 bits | 128 to 191 |
| C | n = 24 bits | 192 to 223 |
| D | Not applicable | 224 to 239 |
| E | Not applicable | 240 to 255 |

| IPv6 | IPv4 |
| --- | --- |
| IPv6 has a 128-bit address length | IPv4 has a 32-bit address length |
| It supports Auto and renumbering address configuration | It Supports Manual and DHCP address configuration |
| The address space of IPv6 is quite large it can produce $3.4\times10^{38}$ address space | It can generate $4.29\times10^{9}$ address space |
| Address Representation of IPv6 is in hexadecimal | Address representation of IPv4 is in decimal |
| In IPv6 checksum field is not available | In IPv4 checksum field is available |
| IPv6 has a header of 40 bytes fixed | IPv4 has a header of 20-60 bytes. |

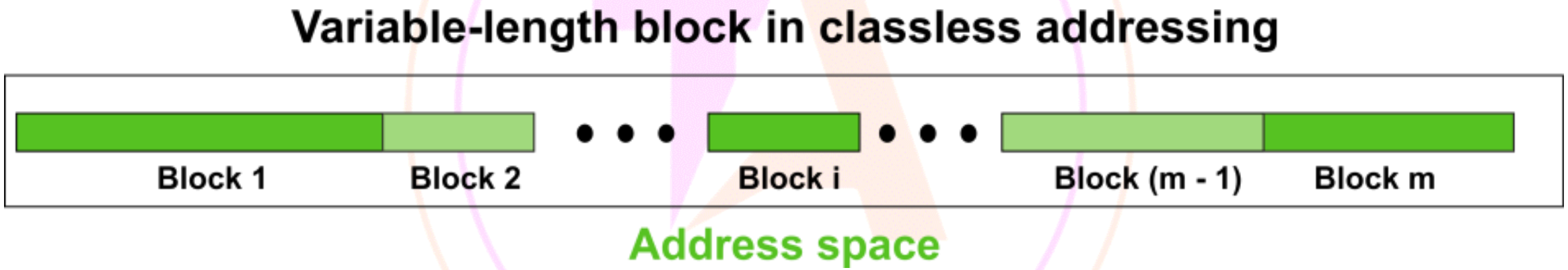
# CLASSLESS ADDRESSING

**The address depletion issue was not fully resolved by classful addressing's subnetting and supernetting techniques. As the Internet expanded, it became obvious that a bigger address space was required as a long-term fix. However, the expanded address space necessitates that IP addresses should be longer as well, necessitating a change in IP packet syntax. The short-term solution, which uses the same address space but modifies the distribution of addresses to deliver a fair amount to each business, was developed despite the fact that the long-term solution, known as IPv6, has already been developed. Classless addressing is the temporary fix, which nevertheless makes use of IPv4 addresses. In order to make up for address depletion, the class privilege was taken out of the distribution.**

# CLASSLESS ADDRESSING

**The entire address space is partitioned into blocks of varying lengths with classless addressing. An address's prefix designates the block (network); its suffix designates the node (device). We are capable of having a block of 20, 21, 22 ,..., 232 addresses, theoretically. One of the limitations is that a block of addresses must have a power of two addresses. One address block may be given to an organization. The given figure demonstrates the non-overlapping block segmentation of the entire address space**

# CLASSLESS ADDRESSING



| Sr. No. | Parameter | Classful Addressing | Classless Addressing |
|---|---|---|---|
| 1. | **Basics** | In Classful addressing IP addresses are allocated according to the classes- A to E. | Classless addressing came to replace the classful addressing and to handle the issue of rapid exhaustion of IP addresses. |
| 2. | **Practical** | It is less practical. | It is more practical. |
| 3. | **Network ID and Host ID** | The changes in the Network ID and Host ID depend on the class. | There is no such restriction of class in classless addressing. |
| 4. | **VLSM** | It does not support the Variable Length Subnet Mask (VLSM). | It supports the Variable Length Subnet Mask (VLSM). |
| 5. | **Bandwidth** | Classful addressing requires more bandwidth. As a result, it becomes slower and more expensive as compared to classless addressing. | It requires less bandwidth. Thus, fast and less expensive as compared to classful addressing. |

| | | | |
|---|---|---|---|
| 6. | **CIDR** | It does not support Classless Inter-Domain Routing (CIDR). | It supports Classless Inter-Domain Routing (CIDR). |
| 7. | **Updates** | Regular or periodic updates | Triggered Updates |
| 8. | **Troubleshooting and Problem detection** | Troubleshooting and problem detection are easy than classless addressing because of the division of network, host and subnet parts in the address. | It is not as easy compared to classful addressing. |
| 9. | **Division of Address** | • Network<br>• Host<br>• Subnet | • Host<br>• Subnet |

# Basic of Email

Electronic mail is a method of exchanging messages between people using electronic devices. Invented by Ray Tomlinson, email first entered limited use in the 1960s and by the mid-1970s had taken the form now recognized as email.

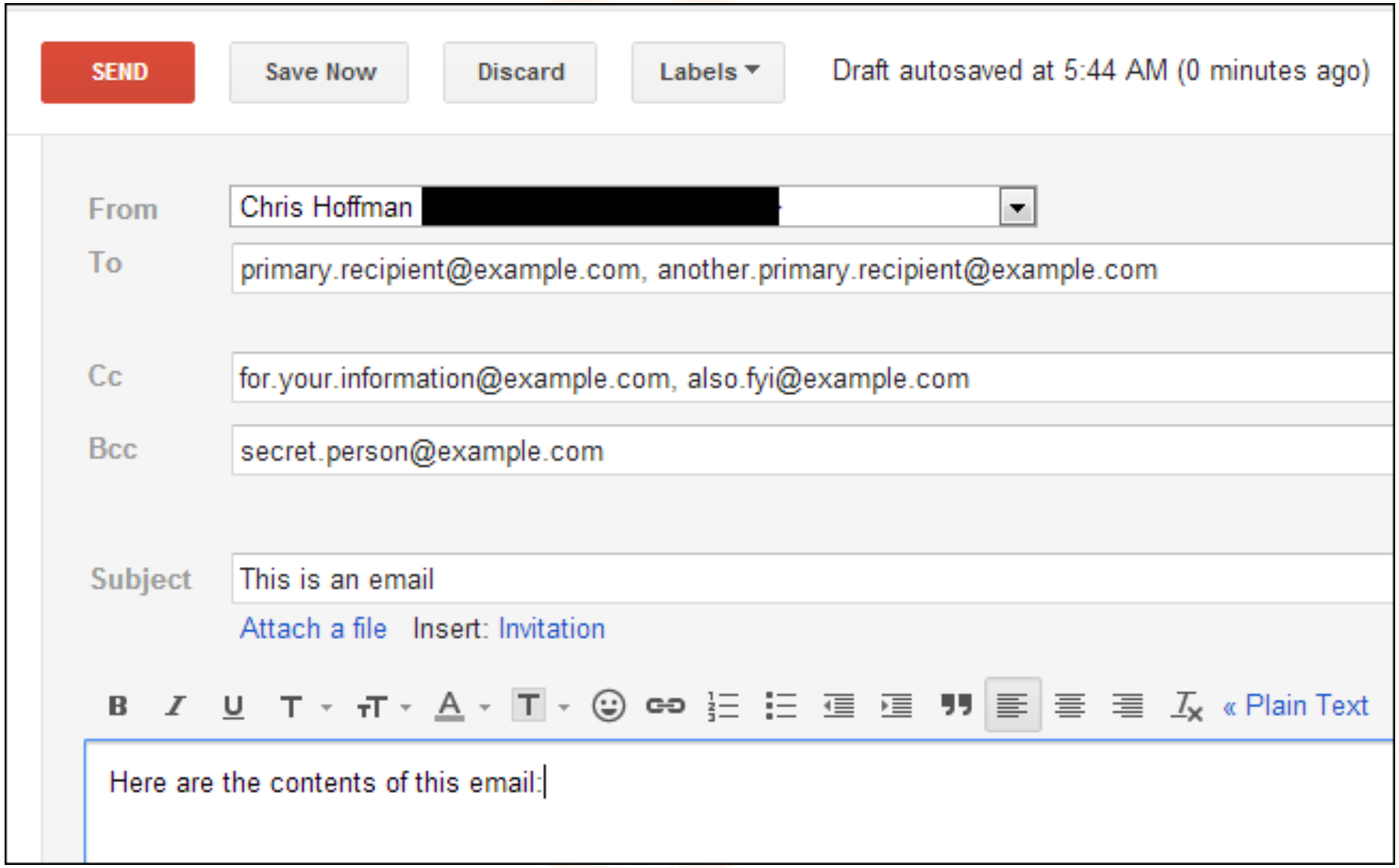
Email, short for Electronic Mail, consists of messages which are sent and received using the Internet. There are many different email services available that allow you to create an email account and send and receive email and attachments, many of which are free.

Today, the top webmail providers are Yahoo!, Microsoft's Outlook.com (previously Hotmail), and Google's Gmail.

The first five lines of an E-mail message is called E-mail header.

The header part comprises of following fields:

- From
- Date
- To
- Subject
- CC
- BCC



- **Bcc Stands for "Blind Carbon Copy."** When you send an e-mail to only one person, you type the recipient's address in the "To:" field. When you send a message to more than one person, you have the option to enter addresses in the "Cc:" and "Bcc:" fields. "Cc" stands for "Carbon Copy," while "Bcc" stands for "Blind Carbon Copy."

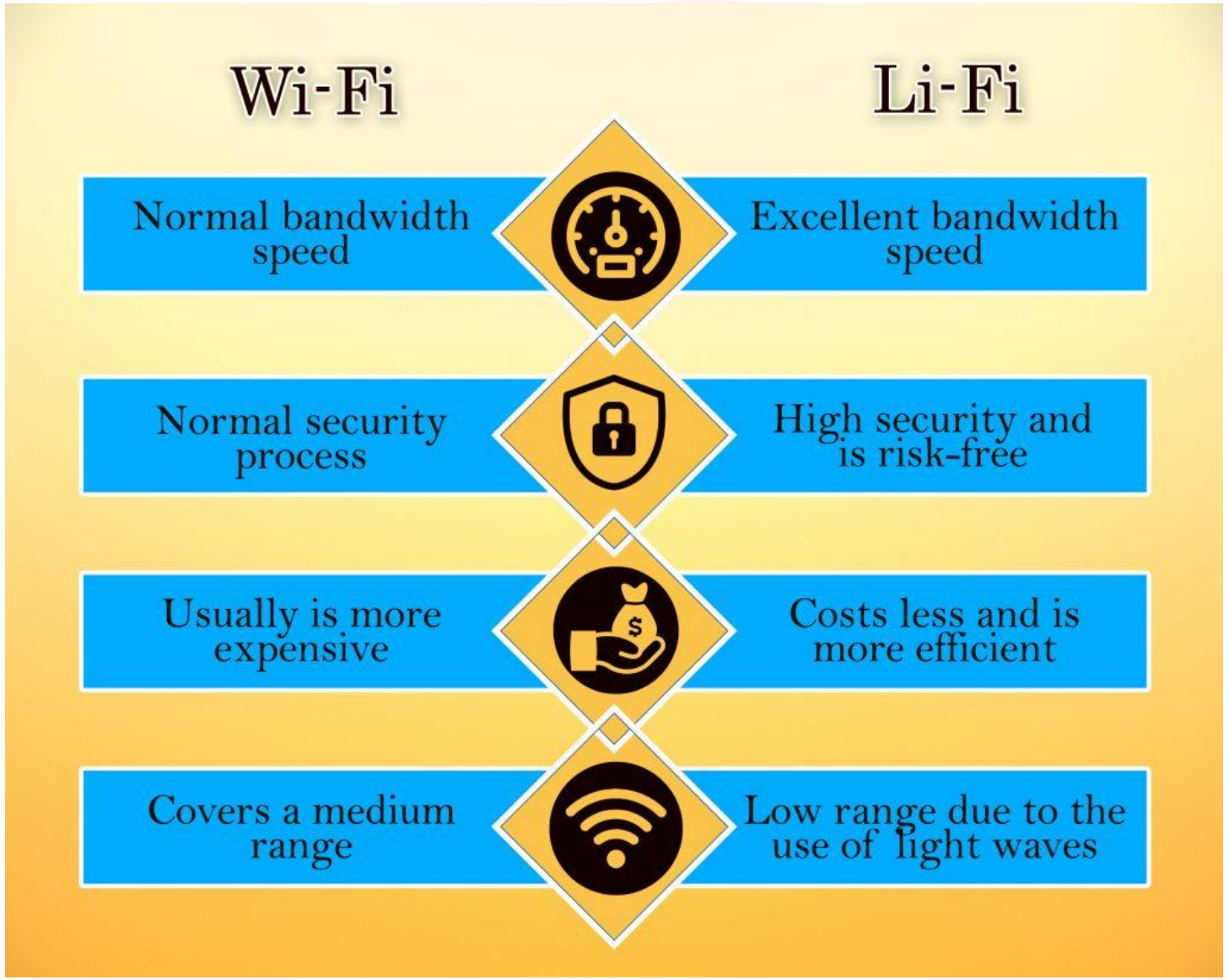
- **A Carbon Copy, or "Cc'd"** message is an e-mail that is copied to one or more recipients. Both the main recipient (whose address is in the "To:" field) and the Cc'd recipients can see all the addresses the message was sent to. When a message is blind carbon copied, neither the main recipient nor the Bcc'd recipients can see the addresses in the "Bcc:" field.

- **Blind carbon copying** is a useful way to let others see an e-mail you sent without the main recipient knowing. It is faster than sending the original message and then forwarding the sent message to the other recipients.

Q. Which of the following statement is correct about Wi-Fi and Li-Fi?

I. Wi-Fi uses light emitting diodes for data transmission.
II. Li- Fi works very well in dense environment.
III. In Li-Fi, data transfer speed is about 1 Gbps.

A. I
B. II
C. I and II
D. II and III



**Q. With reference to 'LiFi' recently in the news, which of the following statements is/are correct?**

**1. It uses light as the medium for high-speed data transmission.**
**2. It is a wireless technology and is several times faster than 'WiFi'.**

**Select the correct answer using the code given below**

**A. 1 only**
**B. 2 only**
**C. Both 1 and 2**
**D. Neither 1 nor 2**

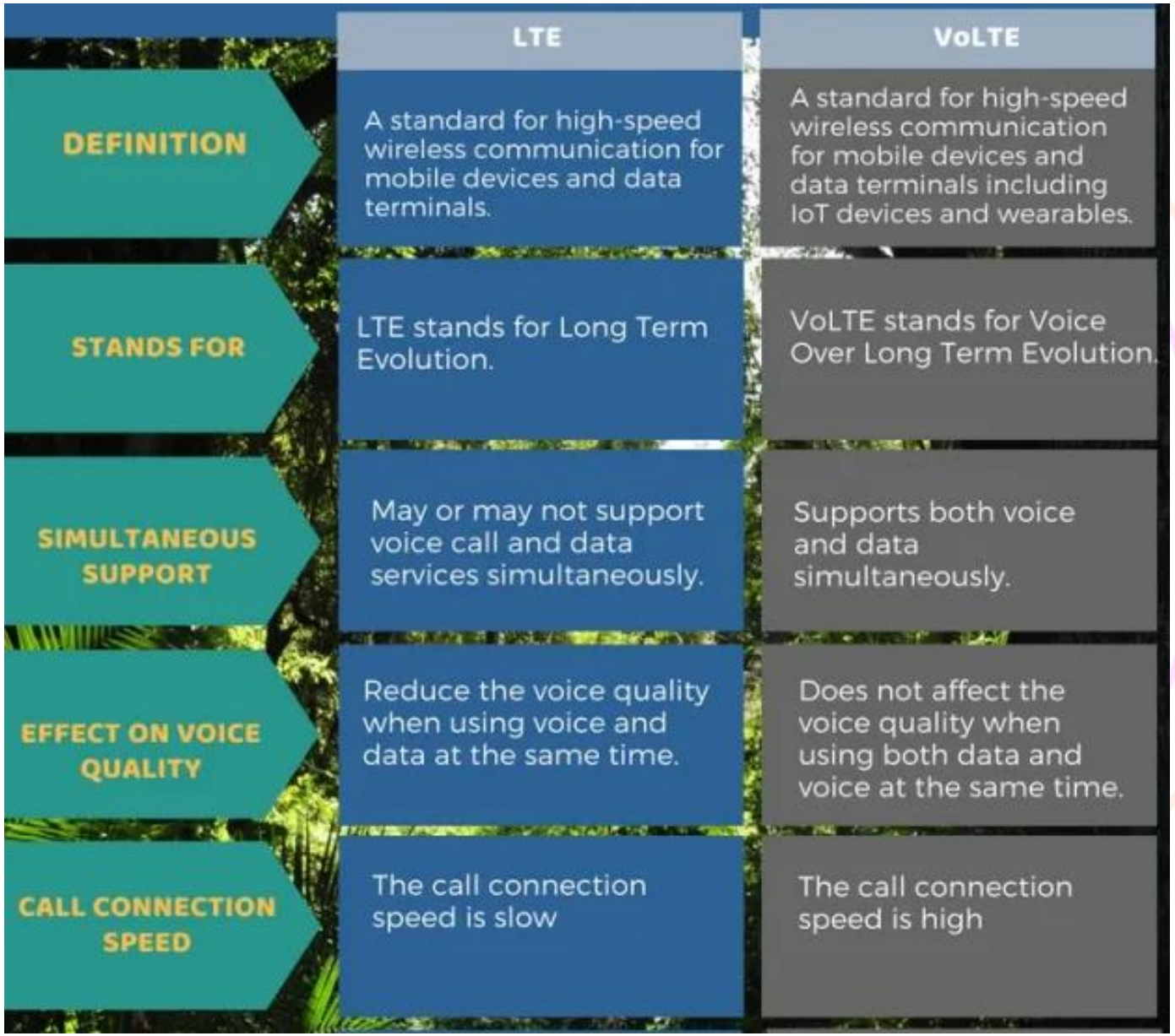
| SrNo. | Comparison Basis | LIFI | WIFI |
|---|---|---|---|
| 1. | Full Form | Light fidelity | Wireless fidelity |
| 2. | Operation | Transmits data using bits with help of light from LED bulbs. | Transmits data with help of radio waves with help of WIFI router |
| 3. | Security | Secured (cannot be hacked) as light is blocked by walls. | Not secured (can be hacked) as for RF signal dry walls are transparent |
| 4. | Interference | Do not have any interference issue similar to radio waves. | Has interference issue from nearby access points (routers) |
| 5. | Spectrum | The Spectrum range is 10000times than Wi-Fi | It has radio spectrum range. |
| 6. | Frequency | The frequency band is 100 times of Tera HZ | The frequency band is 2.4GHz,4.9GHzand 5GHz |
| 7. | Speed | Fast speed internet (greater than 1- 3.5Gbps) | Comparatively slow speed (54-250 Mbps) |
| 8. | Where To Use | Anywhere, where light source is present. | Inside a building. typically Within a array of WLAN communications , habitually inside a structure. |
| 9. | Cost | Cheap as LED lamps are used. | Quiet expensive. |
| 10. | Data transmission rate | Very high rate of data transmission due to visible light spectrum. | Transmission rate is slow as compared to Li-Fi as RF is used to communicate. |
| 11. | System components | Lamp drivers, LED bulbs and light detectors will form complete Li-Fi system. | Routers have to be to be installed, devices like laptops, PDAs, desktops are called as stations. |

**Q. Which of the following statements are correct regarding VoLTE?**

**(A) VoLTE stands for 'Voice over Long Term Evalution'.**
**(B) It is a digital packet voice service delivery over IP via an LTE access network.**
**(C) Provides more efficient use of spectrum than traditional voice.**
**(D) Eliminates the need to have voice on one network and data on another network.**

**Choose the correct answer from the options given below:**

1. **A, B, C and D Only**
2. **B, C and D Only**
3. **A, B and C Only**
4. **A, C and D Only**



- **Light-Fidelity (Li-Fi) is a wireless optical networking technology that uses light-emitting diodes (LEDs) for data transmission.**

- **Wireless-Fidelity (Wi-Fi) is a wireless optical networking technology that uses routers, modems and access point for data transmission.**

- **Wi-Fi work in less dense environment due to interference related issues while Li-Fi is unrestricted by radio interference.**

- **In Li-Fi, data transfer speed is about 1 Gbps while data transfer speed in Wi-Fi ranges from 150Mbps to maximum of 2 Gbps.**

Q. For which type of connection WPA security used?

A. Ethernet
B. Bluetooth
C. Wi-Fi
D. Infrared

- ✓ For Wi-Fi connection WPA security used.
- ✓ WPA stands for Wi-Fi Protected Access.
- ✓ Wi-Fi Protected Access (WPA) is a security standard for users of computing devices equipped with wireless internet connections.
- ✓ WPA2 stands for Wi-Fi Protected Access II.
- ✓ The Wi-Fi Alliance announced WPA3 as a replacement to WPA2 in 2018.
- ✓ Bluetooth is a wireless technology used for exchanging data between fixed and mobile devices over short distances.
- ✓ The IEEE standardized Bluetooth as IEEE 802.15.1

Q. Which among the following network topologies has the highest transmission speed?

A) LAN
B) WAN
C) MAN
D) Both LAN and WAN have equal transmission speeds.

Q. Which of the following internet service is appropriate to access the computer of your office from home?

A. WWW
B. IRC
C. FTP
D. Telnet

- ✓ Any application that empowers users to remotely access another computer(no matter how far away) is called remote access.
- ✓ Telnet is an application protocol that uses a virtual terminal connection to offer bidirectional interactive text-oriented communication over the Internet.
- ✓ Telnet facilitates remote login on a computer.
- ✓ It also facilitates terminal emulation purposes.
- ✓ Telnet was developed in 1969.
- ✓ Telnet allows users to execute various application programmes on a distant site and then transport the results back to their local computer.

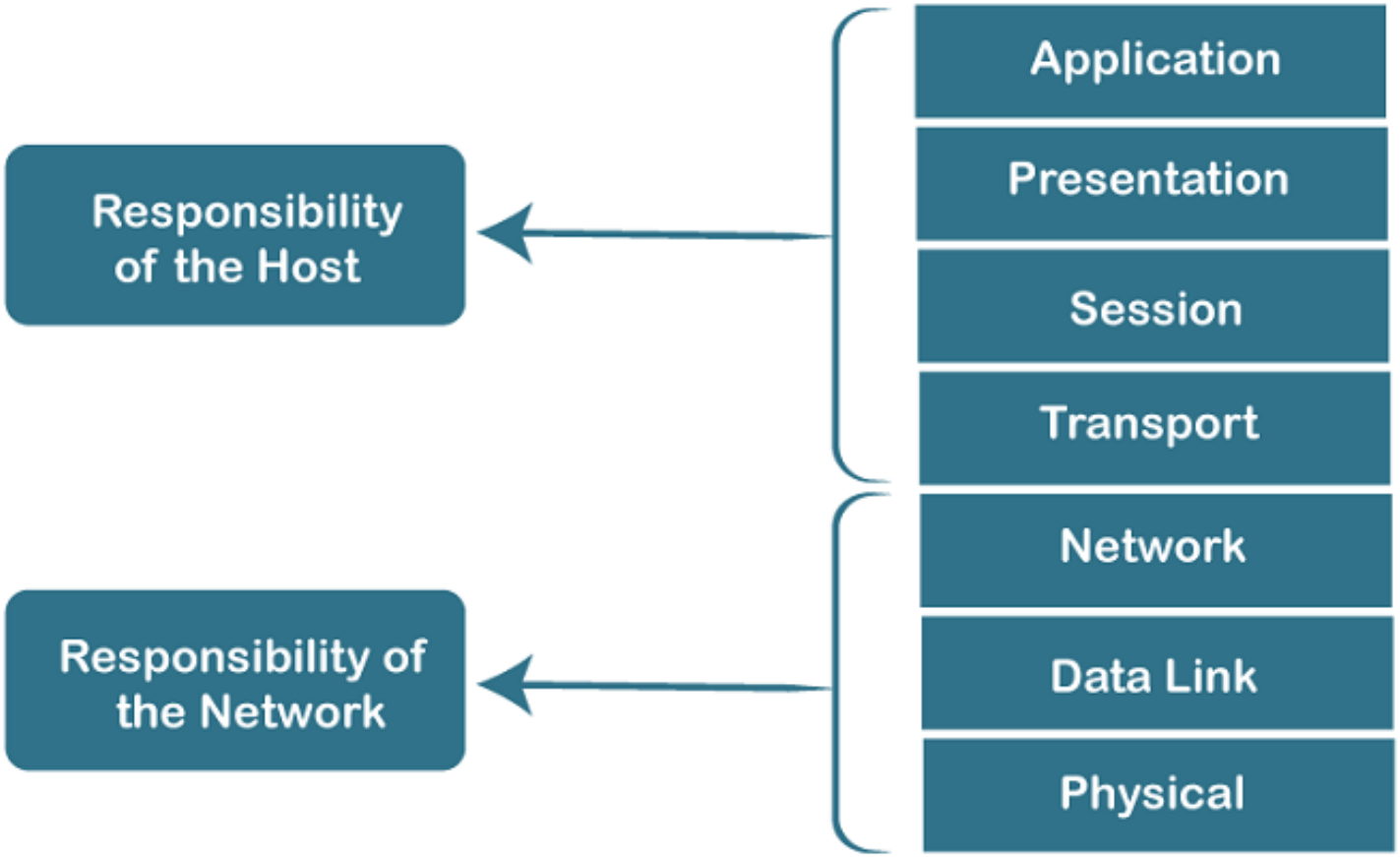
- ✓ **Real-Time Protocol (RTP)** is a protocol designed to handle real-time traffic (like audio and video) of the Internet.

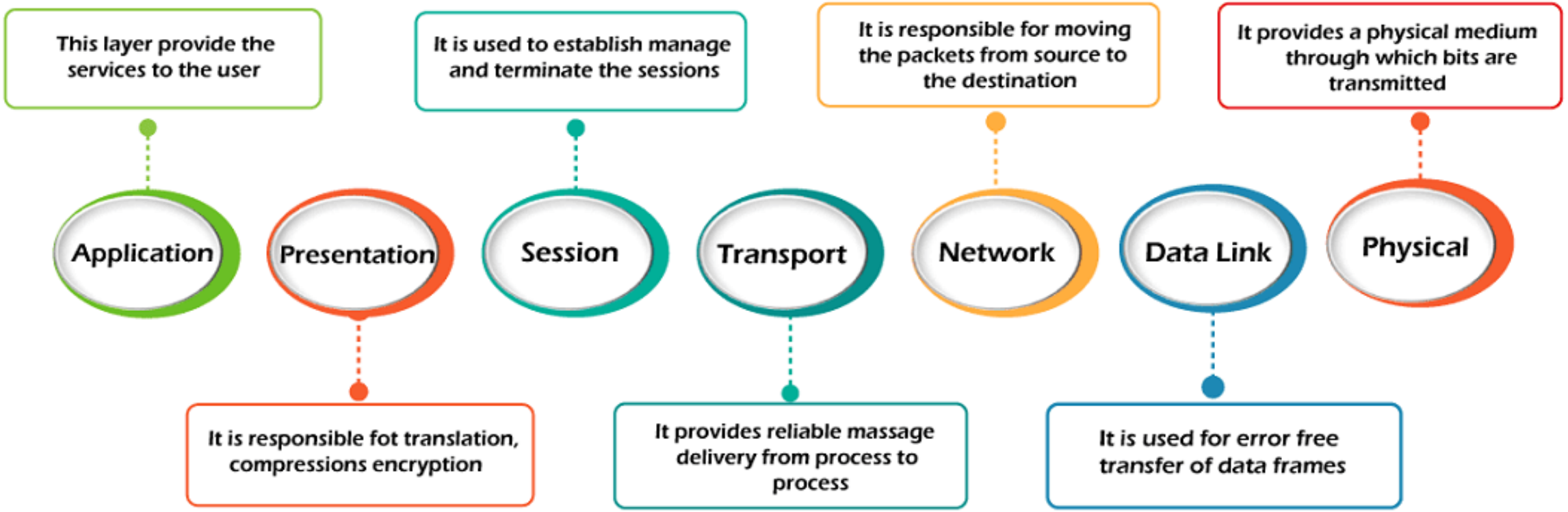
- ✓ **File Transfer Protocol** is a set of rules that govern how computers transfer files from one system to another over the internet

Q. The design issue of Datalink Layer in OSI Reference Model is

A. Framing
B. Representation of bits
C. Synchronization of bits
D. Connection control

# Characteristics of OSI Model





## Functions of a Physical layer:

- ✓ **Line Configuration:** It defines the way how two or more devices can be connected physically.
- ✓ **Data Transmission:** It defines the transmission mode whether it is simplex, half-duplex or full-duplex mode between the two devices on the network.
- ✓ **Topology:** It defines the way how network devices are arranged.
- ✓ **Signals:** It determines the type of the signal used for transmitting the information.

## Functions of the Data-link layer

- ✓ **Framing:** The data link layer translates the physical's raw bit stream into packets known as Frames. The Data link layer adds the header and trailer to the frame. The header which is added to the frame contains the hardware destination and source address.

- ✓ **Physical Addressing:** The Data link layer adds a header to the frame that contains a destination address. The frame is transmitted to the destination address mentioned in the header.

# Functions of the Data-link layer

- ✓ **Flow Control:** Flow control is the main functionality of the Data-link layer. It is the technique through which the constant data rate is maintained on both the sides so that no data get corrupted. It ensures that the transmitting station such as a server with higher processing speed does not exceed the receiving station, with lower processing speed.
- ✓ **Error Control:** Error control is achieved by adding a calculated value CRC (Cyclic Redundancy Check) that is placed to the Data link layer's trailer which is added to the message frame before it is sent to the physical layer. If any error seems to occurr, then the receiver sends the acknowledgment for the retransmission of the corrupted frames.

| S.NO. | Flow control | Error control |
|---|---|---|
| 1. | Flow control is meant only for the transmission of data from sender to receiver. | Error control is meant for the transmission of error free data from sender to receiver. |
| 2. | For Flow control there are two approaches : Feedback-based Flow Control and Rate-based Flow Control. | To detect error in data, the approaches are : Checksum, Cyclic Redundancy Check and Parity Checking. To correct error in data, the approaches are : Hamming code, Binary Convolution codes, Reed-Solomon code, Low-Density Parity Check codes. |
| 3. | It prevents the loss of data and avoid over running of receive buffers. | It is used to detect and correct the error occurred in the code. |
| 4. | Example of Flow Control techniques are : Stop & Wait Protocol and Sliding Window Protocol. | Example of Error Control techniques are : Stop & Wait ARQ and Sliding Window ARQ (Go-back-N ARQ, Selected Repeat ARQ). |

# Functions of the Data-link layer

- ✓ **Access Control:** When two or more devices are connected to the same communication channel, then the data link layer protocols are used to determine which device has control over the link at a given time.

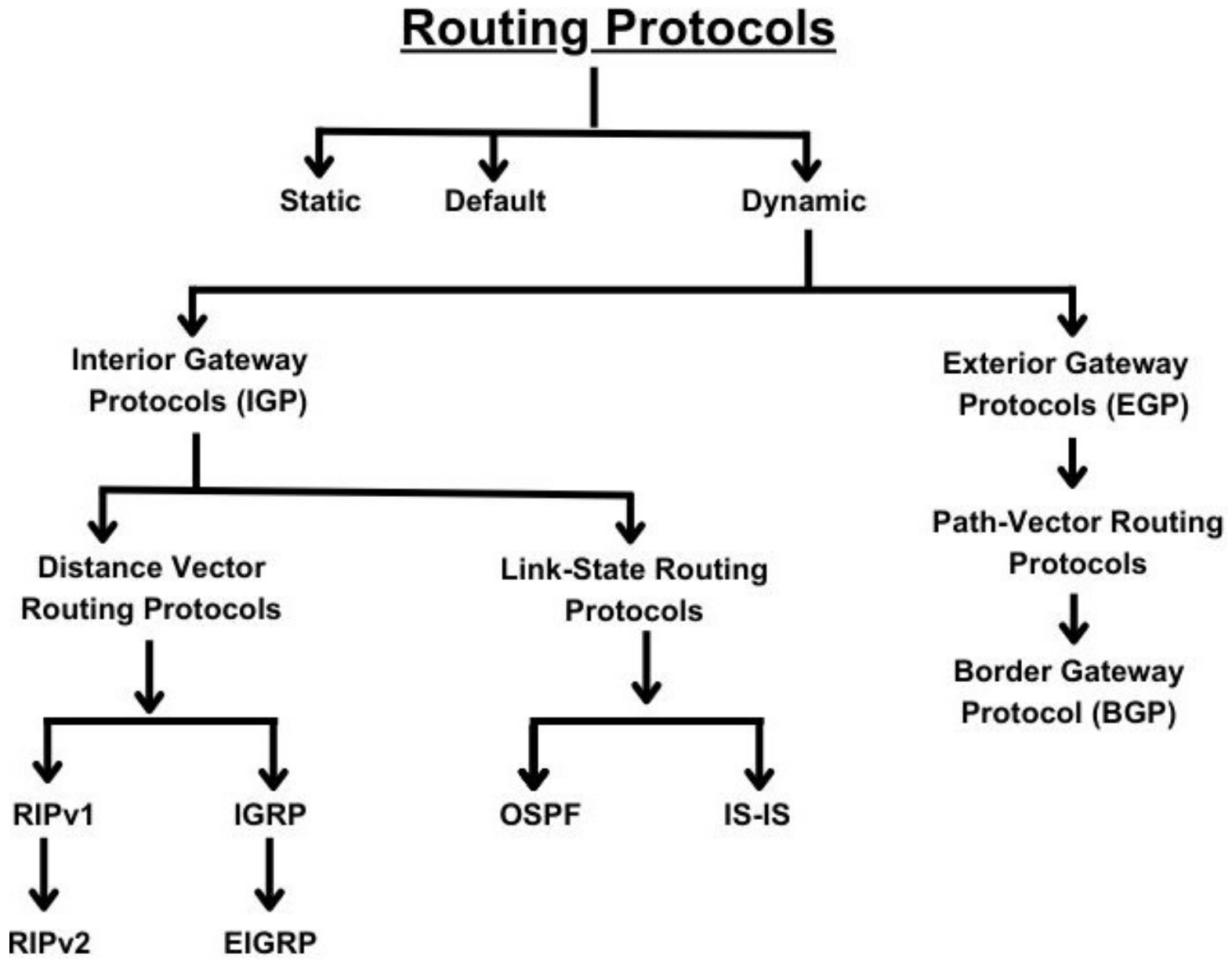
# Functions of Network Layer:

**Internetworking:** An internetworking is the main responsibility of the network layer. It provides a logical connection between different devices.

**Addressing:** A Network layer adds the source and destination address to the header of the frame. Addressing is used to identify the device on the internet.

**Routing:** Routing is the major component of the network layer, and it determines the best optimal path out of the multiple paths from source to the destination.

**Packetizing:** A Network Layer receives the packets from the upper layer and converts them into packets. This process is known as Packetizing. It is achieved by internet protocol (IP).



# ICMP Protocol

The ICMP stands for Internet Control Message Protocol. It is a network layer protocol. It is used for error handling in the network layer, and it is primarily used on network devices such as routers. As different types of errors can exist in the network layer, so ICMP can be used to report these errors and to debug those errors.

For example, some sender wants to send the message to some destination, but the router couldn't send the message to the destination. In this case, the router sends the message to the sender that I could not send the message to that destination.

## Functions of Transport Layer:

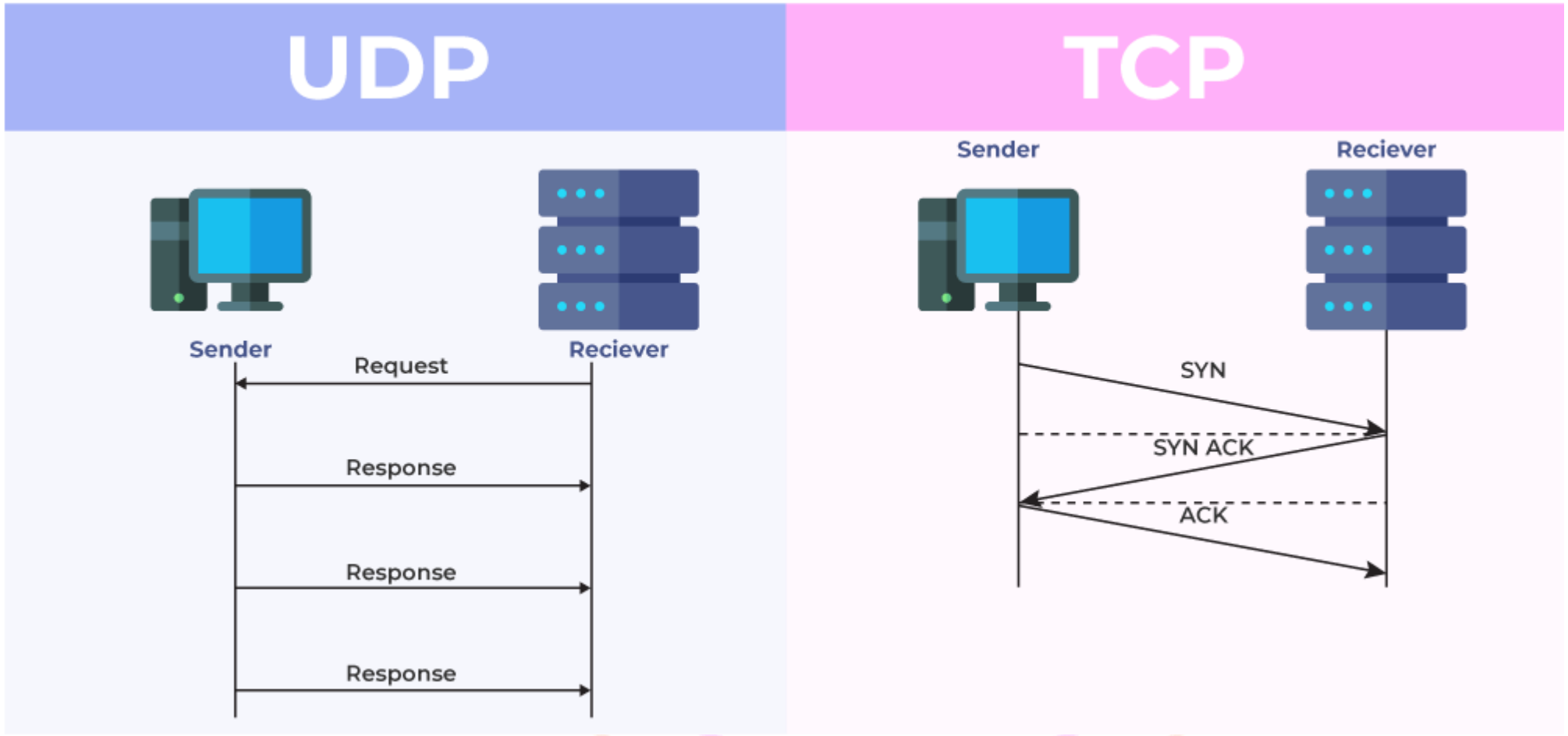
- ✓ **Service-point addressing:** Computers run several programs simultaneously due to this reason, the transmission of data from source to the destination not only from one computer to another computer but also from one process to another process. The transport layer adds the header that contains the address known as a service-point address or port address. The responsibility of the network layer is to transmit the data from one computer to another computer and the responsibility of the transport layer is to transmit the message to the correct process.

# Functions of Transport Layer:

- ✓ **Segmentation and reassembly:** When the transport layer receives the message from the upper layer, it divides the message into multiple segments, and each segment is assigned with a sequence number that uniquely identifies each segment. When the message has arrived at the destination, then the transport layer reassembles the message based on their sequence numbers.

## Functions of Transport Layer:

- ✓ **Connection control:** Transport layer provides two services Connection-oriented service and connectionless service. A connectionless service treats each segment as an individual packet, and they all travel in different routes to reach the destination. A connection-oriented service makes a connection with the transport layer at the destination machine before delivering the packets. In connection-oriented service, all the packets travel in the single route.



| Protocol | TCP | UDP |
|---|---|---|
| Connection | connection-oriented | connectionless |
| Usage | high reliability, critical-less transmission time | fast, efficient transmission, small queries, huge numbers of clients |
| Ordering of data packets | rearranges packets in order | no inherent order |
| Reliability | yes | no |
| Streaming of data | read as a byte stream | sent and read individually |
| Error checking | error checking and recovery | simply error checking, no error recovery |
| Acknowledgement | acknowledgement segments | no acknowledgment |

# Functions of Transport Layer:

- ✓ **Flow control:** The transport layer also responsible for flow control but it is performed end-to-end rather than across a single link.

- ✓ **Error control:** The transport layer is also responsible for Error control. Error control is performed end-to-end rather than across the single link. The sender transport layer ensures that message reach at the destination without any error.

## Functions of Session layer:

- ✓ **Dialog control:** Session layer acts as a dialog controller that creates a dialog between two processes or we can say that it allows the communication between two processes which can be either half-duplex or full-duplex.

- ✓ **Synchronization**: Session layer adds some checkpoints when transmitting the data in a sequence. If some error occurs in the middle of the transmission of data, then the transmission will take place again from the checkpoint. This process is known as Synchronization and recovery.

## Functions of Presentation layer:

- ✓ **Translation:** The processes in two systems exchange the information in the form of character strings, numbers and so on. Different computers use different encoding methods, the presentation layer handles the interoperability between the different encoding methods. It converts the data from sender-dependent format into a common format and changes the common format into receiver-dependent format at the receiving end.

## Functions of Presentation layer:

- ✓ **Encryption:** Encryption is needed to maintain privacy. Encryption is a process of converting the sender-transmitted information into another form and sends the resulting message over the network.

- ✓ **Compression:** Data compression is a process of compressing the data, i.e., it reduces the number of bits to be transmitted. Data compression is very important in multimedia such as text, audio, video.

## Functions of Application layer:

- ✓ **File transfer, access, and management (FTAM):** An application layer allows a user to access the files in a remote computer, to retrieve the files from a computer and to manage the files in a remote computer.

- ✓ **Mail services:** An application layer provides the facility for email forwarding and storage.

- SNMP stands for Simple Network Management Protocol.
- SNMP is a framework used for managing devices on the internet.
- It provides a set of operations for monitoring and managing the internet.

Q. Coaxial cables are categorized by Radio Government rating are adapted for specialized functions. Category RG-59 with impedance 75Ω used for

a. Cable TV
b. Ethernet
c. Thin Ethernet
d. Thick Ethernet

**Q. Match the following :**

| List – I | List – II |
|---|---|
| a. Application layer | 1. TCP |
| b. Transport layer | 2. HDLC |
| c. Network layer | 3. HTTP |
| d. Data link layer | 4. BGP |

Codes : a b c d

a. 2 1 4 3

b. 3 4 1 2

c. 3 1 4 2

d. 2 4 1 3

Q. Which layer of OSI reference model is responsible for decomposition of messages and generation of sequence numbers to 'ensure correct re-composition from end to end of the network?‘

a. Physical
b. Data-link
c. Transport
d. Application

Q. The period of a signal is 10 ms. What is its frequency in Hertz?

a. 10
b. 100
c. 1000
d. 10000

Q. Which address is used to identify a process on a host by the transport layer?

a) physical address
b) logical address
c) port address
d) specific address

Q. Header of a frame generally contains _____

a) synchronization bytes

b) addresses

c) frame identifier

d) all of the mentioned

Q. Transmission control protocol _____

(a) is a connection-oriented protocol
(b) uses a three way handshake to establish a connection
(c) receives data from application as a single stream
(d) all of the mentioned

Q. Transport layer protocols deals with _____

(a) application to application communication
(b) process to process communication
(c) node to node communication
(d) man to man communication

Q. Physical or logical arrangement of network is _____

(a) Topology
(b) Routing
(c) Networking
(d) Control

Q. The sharing of a medium and its link by two or more devices is called _____

(a) Fully duplexing
(b) Multiplexing
(c) Microplexing
(d) Duplexing

Q. With respect to physical media, STP cables stands for _____

a) Shielded Twisted Pair Cable
b) Spanning Tree Protocol Cable
c) Static Transport Protocol Cable
d) Shielded Two Power Cable

Q. What is the max data transfer rate for optical fiber cable?

a) 10 Mbps
b) 100 Mbps
c) 1000 Mbps
d) 10000 Mbps

Q. The attacker using a network of compromised devices is known as _____

a) Internet
b) Botnet
c) Telnet
d) D-net

Q. Which of this is not a guided media?

a) Fiber optical cable
b) Coaxial cable
c) Wireless LAN
d) Copper wire

Q. To deliver a message to the correct application program running on a host, the _____ address must be consulted.

a) IP
b) MAC
c) Port
d) None of the mentioned

Q. Electronic mail uses which Application layer protocol?

a) SMTP
b) HTTP
c) FTP
d) SIP

Q. The _____ translates internet domain and host names to IP address.

a) domain name system
b) routing information protocol
c) network time protocol
d) internet relay chat

Q. Which one of the following is not correct?

a) IP is an application layer protocol
b) HTTP is a session layer protocol
c) TCP is an application layer protocol
d) All of the mentioned

Q. In FTP protocol, client contacts server using ____ as the transport protocol.

a) transmission control protocol
b) user datagram protocol
c) datagram congestion control protocol
d) stream control transmission protocol

Q. SMTP uses which of the following TCP port?

a) 22
b) 23
c) 21
d) 25

Q. Which of the following is false with respect to UDP?

a) Connection-oriented
b) Unreliable
c) Transport layer protocol
d) Low overhead

Q. Network layer firewall works as a _____

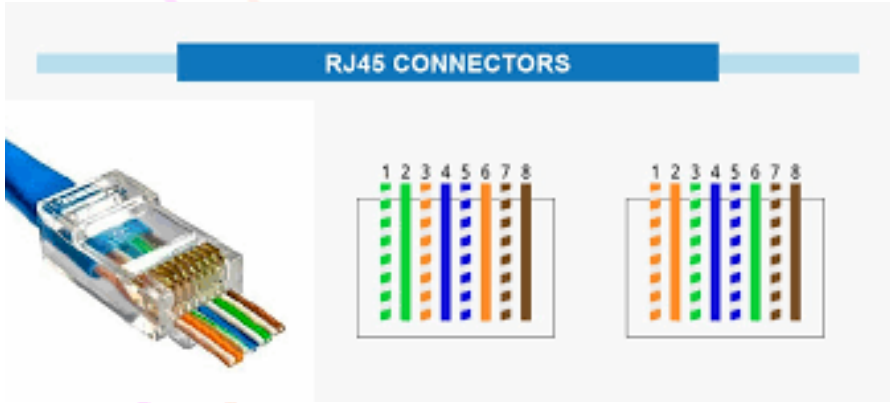
a) Frame filter
b) Packet filter
c) Content filter
d) Virus filter

Q. MAC address is of _____

a) 24 bits
b) 36 bits
c) 42 bits
d) 48 bits

Q. Which connector does the STP cable use?

a) BNC
b) RJ-11
c) RJ-45
d) RJ-69



Q. The packet of information at the application layer is called _____

a) Packet
b) Message
c) Segment
d) Frame

| Layer No | Layer Name | Responsibility | Information Form(Data Unit) | Device |
|---|---|---|---|---|
| 7 | Application Layer | Helps in identifying the client and synchronizing communication. | Message | – |
| 6 | Presentation Layer | Data from the application layer is extracted and manipulated in the required format for transmission. | Message | – |
| 5 | Session Layer | Establishes Connection, Maintenance, EnsuresAuthentication, and Ensures security. | Message | Gateway |
| 4 | Transport Layer | Take Service from Network Layer and provide it to the Application Layer. | Segment | Firewall |
| 3 | Network Layer | Transmission of data from one host to another, located in different networks. | Packet | Router |
| 2 | Data Link Layer | Node to Node Delivery of Message. | Frame | Switch, Bridge |
| 1 | Physical Layer | Establishing Physical Connections between Devices. | Bits | Hub, Repeater, Modem, Cables |