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1. Question 1 **Briefly describe the services provided by the data link layer**

Answer 1 **Data link layer** consists of frames; it receives the **data** and divides it into as manageable units from the network **layer**. Each frame consists of both physical addresses of the source and destination machines. It is responsible to provide the reliable **data** transfer across the **one** physical **link** within the network.

2. **2 Question Compare and Contrast**
    - **byte-oriented and bit-oriented protocols**
    - **byte-stuffing and bit-stuffing**
    - **flow control and error control**
    - **HDLC and PPP**
    - **Go-Back-N ARQ protocol and Selective-Repeat-ARQ protocol**
    - **circuit-switched network and a packet-switched network**
    - **space-division** and time-division switches

Answer 2(1): **1 byte-oriented and bit-oriented protocols**

Bit Oriented Protocol - In this any field can be an arbitrary number of bits long. So if the field only needs 64 possible values, it can be only 6 bits long. They are typically used in hardware where bandwidth is an important consideration. This will allow tighter packing of data.

Byte Oriented Protocol - In this field up to 8 bits is allocated 1 byte. Fields up to 8-16 bits is given double byte. There are typically used in software's as it is easy to process them. This will be loose packing of data compare to bit oriented protocol.

2 Byte-stuffing and bit-stuffing

2 Character-oriented protocols use byte-stuffing to be able to carry an 8-bit pattern that is the same as the flag. Byte-stuffing adds an extra character to the data section of the frame to escape the flag-like pattern. Bit-oriented protocols use bit-stuffing to be able to carry patterns similar to the flag. Bit-stuffing adds an extra bit to the data section of the frame whenever a sequence of bits is similar to the flag.

3 flow control and error control

Flow control refers to a set of procedures used to restrict the amount of data that the sender can send before waiting for acknowledgment. Error control refers to a set of procedures used to detect and correct errors

4. **HDLC and PPP** The major difference between **HDLC and PPP** is that **HDLC** is the bit oriented protocol, while **PPP** is the character-oriented protocol. The **HDLC and PPP** are the crucial data link layer protocols used in WAN (wide area network) where the **HDLC** can also be implemented with **PPP** for the efficient results.

5 Go-Back-N ARQ protocol and Selective-Repeat-ARQ protocol

The main difference between these two **protocols** is that after finding the suspect or damage in sent frames **go-back-n protocol** re-transmits all the frames whereas **selective repeat protocol** re-transmits only that frame which is damaged

6 circuit-switched network and a packet-switched network

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7 space-division and time-division switches

In a **space-division switch**, the path from one device to another is spatially separate from other paths. The inputs and the outputs are connected using a grid of electronic micro switches. In a **time-division switch**, the inputs are divided in **time** using TDM. A control unit sends the input to the correct output device."

Question 3 Explain the protocols for noiseless and noisy channels

Answer 2 Explanation:

Noiseless Channel

An ideal channel in which no frames are lost, duplicated or corrupted is regarded as Noiseless Channel.

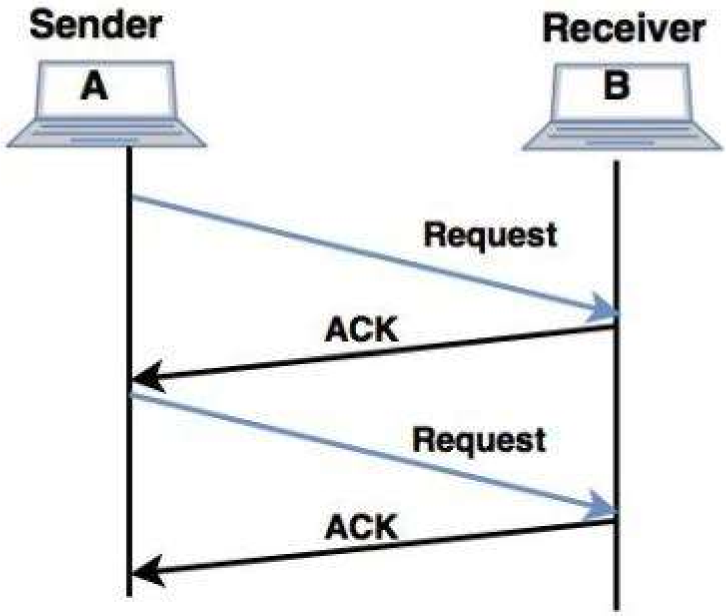
Simplest Protocol

- In simplest protocol, there is no flow control and error control mechanism. It is a unidirectional protocol in which data frames travel in only one direction (from sender to receiver).
- Also, the receiver can immediately handle any received frame with a processing time that is small enough to be negligible.
- The protocol consists of two distinct procedures :a sender and receiver. The sender runs in the data link layer of the source machine and the receiver runs in the data link layer of the destination machine. No sequence number or acknowledgements are used here.

Stop and Wait Protocol

- The simplest retransmission protocol is stop-and-wait.
- Transmitter (Station A) sends a frame over the communication line and then waits for a positive or negative acknowledgement from the receiver (station B).
- If no error occurs in the transmission, station B sends a positive acknowledgement (ACK) to station A.
- Now, the transmitter starts to send the next frame. If frame is received at station B with errors, then a negative acknowledgement(NAK) is sent to station A. In this case, station 'A' must retransmit the old packet in a new frame.
- There is also a possibility that the information frames or ACKs may get lost.
- Then, the sender is equipped with a timer. If no recognizable acknowledgement is received when the timer expires at the end of time out interval, the same frame is sent again.

- The sender which sends one frame and then waits for an acknowledgement before process is known as **stop and wait.**



Stop and Wait

Noisy Channels

Consider the normal situation of a communication channel that makes errors. Frames may be either damaged or lost completely.

1. Stop and Wait Automatic Repeat Request

- In a noisy communication channel, if a frame is damaged in transit, the receiver hardware will detect this when it computes the checksum.
- If a damaged frame is received, it will be discarded and transmitter will retransmit the same frame after receiving a proper acknowledgement.
- If the acknowledgement frame gets lost and data link layer on 'A' eventually times out. Not having received an ACK, it assumes that its data frame was lost or damaged and sends the frame containing packet 1 again. This duplicate frame also arrives at data link layer on 'B', thus part of file will be duplicated and protocol is said to be failed.

- A typical approach to solve this problem is the provision of a sequence number in the header of the message.
- The receiver can then check the sequence number determine if the message is a duplicate since only message is transmitted at any time.
- The sending and receiving station needs only 1-bit alternating sequence of '0' or '1' to maintain the relationship of the transmitted message and its ACK/ NAK.
- A modulo-2 numbering scheme is used where the frames are alternatively label with '0' or '1' and positive acknowledgements are of the form ACK 0 and ACK 1.

2. Sequence numbers

- The protocol specifies that frames need to be numbered. This is done by using sequence number. A field is added to the data frame to hold the sequence number of that frame.
- The sequence numbers are based on modulo-2 arithmetic.
- Stop-and-wait ARQ is the simplest mechanism for error and flow control.

Question 4 Explain Piggybacking in HDLC?

Answer 4:

The receiver waits until its network layer passes in the next data packet. The delayed acknowledgement is then attached to this outgoing data frame. This technique of temporarily delaying the acknowledgement so that it can be hooked with next outgoing data frame is known as **piggybacking**.

1. ## Question 5 Explain blocking in a switched network.

Answer 5: In multistage **switching**, **blocking** refers to times when one input cannot be connected to an output because there is no path available between them—all the possible intermediate **switches** are occupied. One solution to **blocking** is to increase the number of intermediate **switches** based on the Clos criteria.

Question 6 Two neighboring nodes (A and B) use a sliding-window protocol with a 3-bit sequence number. As the ARQ mechanism, go-back-N is used with a window size of 4. Assuming A is transmitting and B is receiving, show the window positions for the following succession of events:

- Before A sends any frames
- After A sends frames 0, 1, 2 and receives acknowledgment from B for 0 and 1
- After A sends frames 3, 4, and 5 and B acknowledges 4 and the ACK is received by A

Answer 6 :

a. Before A sends any frames

System A - Initial

0	1	2	3	4	5	6	7	0	1	2	3

System B - Initial

0	1	2	3	4	5	6	7	0	1	2	3

b.

System A sends 3 frames F0, F1, F2

No acknowledgments received

System A

0	1	2	3	4	5	6	7	0	1	2	3

System B receives 3 frames F0, F1, F2

No acknowledgments sent

System B

0	1	2	3	4	5	6	7	0	1	2	3

c.

System A receives RR3 from B

System A

0	1	2	3	4	5	6	7	0	1	2	3

System B sends RR3

System B

0	1	2	3	4	5	6	7	0	1	2	3

Question 7 List three techniques of digital-to-digital conversion

Answer 7:

The conversion involves three techniques of digital-to-digital conversion:
o Line coding,
o Block coding
o Scrambling.
Line coding is always needed; block coding and scrambling may or may not be needed.

Question: 8 Distinguish between a signal element and a data element.

Answer: 8 "A **data element** is **the** smallest entity that can represent a piece of information (a bit). A **signal element** is **the** shortest unit of a digital **signal**. **Data elements** are what we need to send; **signal elements** are what we can send. **Data elements** are being carried; **signal elements** are **the** carriers

Question: 9 Distinguish between data rate and signal rate.

Answer: 9

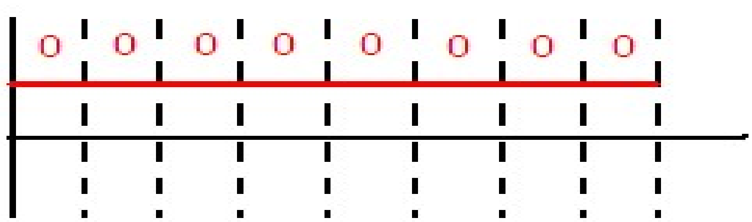
Data rate and Signal rate:

Data rate – Number **of data** elements transmitted per second. **Signal rate** – Number **of signal** elements transmitted per second.

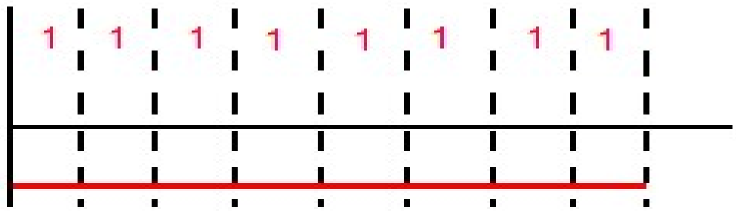
3. **Question: 10** Draw the graph of the NRZ-L scheme using each of the following data streams, assuming that the last signa11evel has been positive. From the graphs, guess the bandwidth for this scheme using the average number of changes in the signal level. Compare your guess with the corresponding entry in Table 4.1.
   a. 00000000
   b. 11111111
   c. 01010101
   d. 00110011

Answer 10

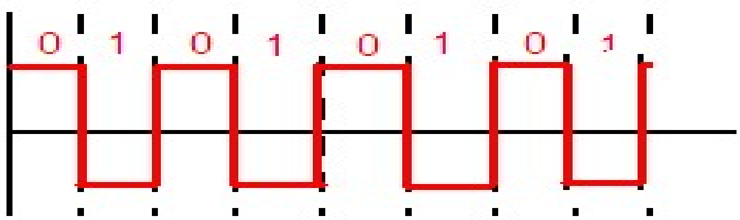
a) 00000000



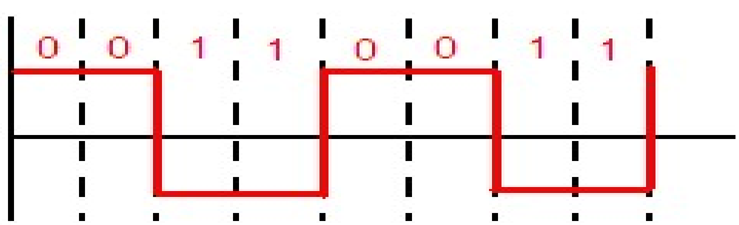
b) 1111111



c) 01010101



00110011



4. **Question 11 What is the number of bits in an IPv4 address? What is the number of bits in an IPv6 address?**

   Answer 11

Pv4 uses a 32-bit address for its Internet addresses. ... **IPv6** utilizes 128-bit Internet addresses. Therefore, it can support 2^128 Internet addresses—340,282,366,920,938,463,463,374,607,431,768,211,456 of them to be exact. The number of **IPv6** addresses is 1028 times larger than the number of **IPv4** addresses.

Question: 12 What are the differences between classful addressing and classless addressing in IPv4?

Answer

The **main difference** between classful and classless addressing is that **classless addressing allows allocating IP addresses more efficiently than classful addressing**.

Every device in a network has an IP address. The address helps to identify each device in the network and allows communicating with other devices in the network. An IP address consists of 32 bits. Every 8 bits is an octet, and they are separated by a dot. The address consists of two sections as network ID and host ID. The network ID represents the network while the host ID represents the host. There are two IP addressing types as classful and classless addressing.

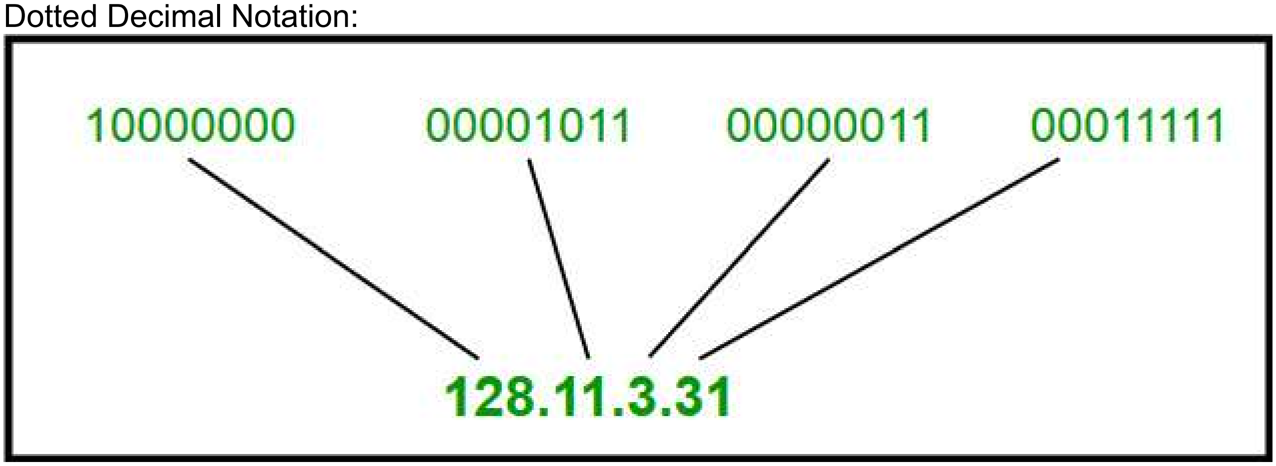
1. **Question 13 List the classes in classful addressing and define the application of each class (unicast, multicast, broadcast, or reserve).**

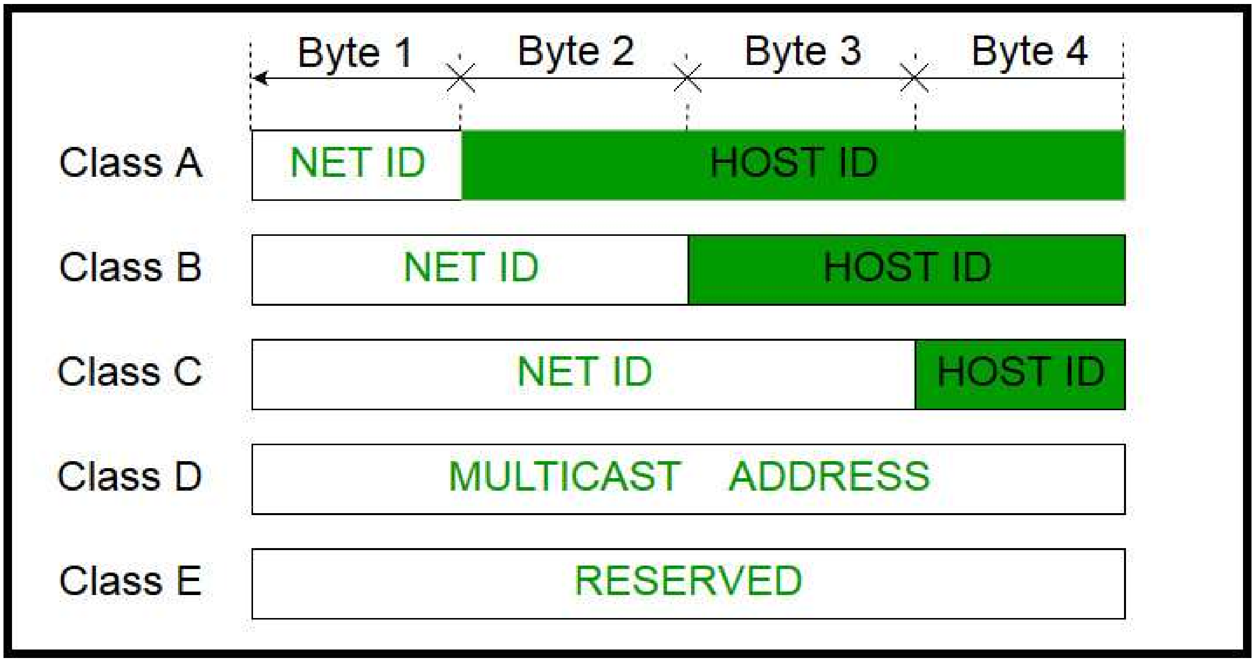
   Answer

IP address is an address having information about how to reach a specific host, especially outside the LAN. An IP address is a 32 bit unique address having an address space of 2^{32}.

Generally, there are two notations in which IP address is written, dotted decimal notation and hexadecimal notation.

Dotted Decimal Notation:





Question 14 What is a mask in IPv4 addressing? What is a default mask in IPv4 addressing?

Every single computer that is connected to a subnet shares an identical portion of the IP address. This shared information is known as a routing prefix, and in IPV4 (Internet Protocol Version 4), the routing prefix is called a **subnet mask**. The **subnet mask** is a "quad-dotted decimal representation".

The **default** subnet **mask** for Class A IP address is 255.0. 0.0 Which implies that Class A **addressing** can have 126 networks (2^7-2) and 16777214 hosts (2^{24}-2).

Question 15 What is the network address in a block of addresses? How can we find the network address if one of the addresses in a block is given?

Answer:

A mask is a 32-bit binary number that gives the first **address** in the **block** (the **network address**) **when** bitwise ANDed with an **address** in the **block**. The **network address** is the beginning **address** of each **block**. It **can** be **found** by applying the default mask **to any of the addresses** in the **block** (including itself).

Question 16 What is NAT? How can NAT help in address depletion

Answer

NAT (Network **Address** Translation) is a mechanism in TCP / IP networks that allows **to** replace your local **address** with a white (public) **address**. ... **NAT** allows the router **to** determine which services are behind the router and must be accessible from the Internet so that users **can** use these services from there.

A **NAT** (Network **Address** Translation or Network **Address** Translator) is the virtualization of Internet Protocol (IP) **addresses**. **NAT helps** improve security and decrease the number of IP **addresses** an organization needs. **NAT** gateways sit between two networks, the inside network and the outside network.

Question 17 What is the address space in 16-bit addresses

Answer

One **address addresses** one byte. Using **16 bits**, you can write 65536 **addresses** (from 0 to 65535, that's 65536 different **addresses**), and **address** 65536 bytes. 65536 bytes is 64kB.

Question 18 An address space has a total of 1024 addresses. How many bits are needed to represent an address?

Answer

Addressing within a **1024**-word page requires 10 **bits** because **1024** = 2^{10}. Since the logical **address space** consists of 8 = 2^3 pages, the logical **addresses** must be 10+3 = 13 **bits**. Similarly, since there are 32 = 2^5 physical pages, phyiscal **addresses** are 5 + 10 = 15 **bits**.

Question 19 Change the following IP addresses from dotted-decimal notation to binary notation.

a. **129.14.6.8**
b. **208.34.54.12**

5. **Question:20** Change the following IP addresses from binary notation to dotted-decimal notation.
   a. 01111111 11110000 01100111 01111101
   b. 10101111 11000000 11111000 00011101

Answer

a **129.14.6.8 10.Find the class of the following IP addresses: a.11110111 11110011 10000111**

b **208.34.54.12 b.238.34.2.1 c.242.34.2.8 11110111 11110011 10000111**

**********************THE END********************************