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1. (a) Define Data link layer? Write down the sub-layers of data link model.

(b) How does data link layer work? Explain briefly.

(c) Write down the functionalities of data link layer?

(d) Define flow control? Explain, the mechanism of flow control.

Answer to the Question no-1

(a)

Data link layer:

Data link layer is the second layer of OSI layered model. This layer is one of the most complicated layers and has complex functionalities and liabilites.

Data link layer has two sub-layers.

(i) Logic link control.

(ii) Media access control.

Answer to the Question no-1

(b)

Data link layer works between two hosts which are directly connected in some sense. This direct connection could be point to point or broadcast. Systems on broadcast network are said to be on same link. The work of data link layer tends to get more complex when it is dealing with multiple hosts on single collision domain.

Data link layer is responsible for converting data stream to singnals bit by bit and to send that over the underlying hardware.

At the receiving end, Data link layer picks up data from hardware which are in the form of electrical signals, assembles them in a recognizable frame format, and hands over to upper layer.

Answer to the Question no-1

(a)

Data link layer does many tasks on behalf of upper layer. These are-

(i) Framing: Data link layer takes packet from Network layer and encapsulates them into frames.

(ii) Addressing: Data link layer provides layer-2 hardware addressing mechanism. Hardware address is assumed to be unique on the link.

(iii) Synchronization: When data frames are sent on the link both machines must be synchronized in order to transfer to take place.

(iv) Error control: Stations on same link may have different speed or capacity. Data link layer ensures flow control that enables both machine to exchange data on same speed.

Two types of mechanism can be deployed to control the flow:

(i) Stop and wait: This flow control mechanism forces the sender after transmitting a data frame to stop and wait until the acknowledgement of the data frame sent is received.

(ii) Sliding window: In this flow control mechanism, both sender and receiver agree on the number of data frames after which the acknowledgement should be sent, as we learnt, stop and wait control mechanism wastes resources, this protocol tries to make use of underlying resources as much as possible.

(iii) Multi-access: When host on the shared link tries to transfer the data, it has a high probability of collision. Data link layer provides mechanism such as CSMA/CD to equip capability of accessing a shared media among multiple systems.

Answer to the Question no-1

ⓓ

Flow control:

When a data frame (Layer-2 data) is sent from one host to another over a single medium, it is required that the sender and receiver should work at the same speed. That is, sender sends at a speed on which the receiver can process and accept the data.

2. ⓐ Define flow control? Write down the two types of mechanisms of flow control?

ⓑ Define error control? Write down the requirements of error control mechanism.

ⓒ Explain, Data link layer may deploy to control the errors by Automatic Repeat Requests (ARQ).

ⓓ Briefly describe about the error detection and correction?

Answer to the Question no-2

ⓐ

Flow control: When a data frame (Layer-2 data) is sent from one host to another host over a single medium, it is required that the sender and receiver should work at the same speed.

Two types of mechanism of flow control:

(i) Stop and wait.
(ii) Sliding window.

Answer to the Question no-2

ⓑ

Error control: When data-frame is transmitted, there is a probability that data-frame may be lost in the transit or it is received corrupted.

Requirements of error control mechanism:

(i) Error detection: The sender and receiver either both or any, must ascertain that there is some

error in the transit.

(ii) Positive ACK: When the receiver receives a correct frame, it should acknowledge it.

(iii) Negative ACK: When the receiver receives a damaged frame or a duplicate frame, it sends a NACK back to the sender and the sender must retransmit the correct frame.

(iv) Retransmission: The sender maintains a clock and sets a timeout period. If it is an acknowledgement of a data frame previously transmitted does not arrive before the timeout the sender retransmits the frame, thinking that the frame or its acknowledgement is lost in transmit.

Answer to the Question no-2

(a)

There are three types of techniques available which data link layer may deploy to control the errors by ARQ.

(i) <u>Stop and wait ARQ</u>: The following transition may occur in stop and wait ARQ:

- The sender maintains a timeout counter.
- When a frame is sent, the sender starts the timeout counter.
- If the acknowledgement of frame comes in time, the sender transmits the next frame in queue.
- If acknowledgement does not come in time, the sender assumes that either the frame or its acknowledgement is lost in transmit.
- If a negative acknowledgement is received, the sender retransmits the frame.

(ii) <u>Go-back-NARQ</u>: Stop and wait ARQ mechanism does not utilise the resources at their best. When the acknowledgement is received, the sender sits idle and does nothing. In Go-Back-NARQ method, both sender and receiver maintain a window.

(iii) Selective-Repeat-ARQ: In Go-Back-NARQ, it is assumed that the receiver does not have any buffer space for its window size and has to process each frame as it comes. The sender in this case, sends only packet for which NACK is received.

Answer to the Question no-2

(d)

There are many reasons such as noise, cross-talk etc which may help data to get corrupted during transmission. The upper layers work on same generalized view of network architecture and are not aware of actual hardware data processing. Hence, the upper layers expect error-free transmission between the systems. Applications such as voice and video may not be that affected and with some errors they may still function well.

Data link layer uses some error control-mechanism to ensure that frames (data bit streams) are transmitted with certain level of accuracy. But to understand how errors is controlled, it is essential to know what types of errors may occur.

3. ⓐ Define error detection. Write down the type of errors.

ⓑ Define error connection? Write down the two ways of error control mechanism.

ⓒ Define CRC ? Describe the importance of cyclick redundancy check (CRC) in error detection.

ⓓ Explain $2^r >= m+r+1$

Answer to the Question no-3

ⓐ

Error detection: Errors in the received frames are detected by means of parity check and cyclic redundancy Check (CRC). In both cases, few extra bits are sent along with actual data to confirm that bits received at other end are same as they were sent.

There are three types of errors-

(i) Single bit error.
(ii) Multiple bit error
(iii) Burst bit error

Answer to the Question no-3

ⓑ

Error correction: To correct the error in data frame, the receiver must know exactly which bit in the frame is corrupted. Backward error correction is simple and can only be

efficiently used where retransmitting is a expensive.

Error control mechanism may involve two po ways -

(i) Error detection

(ii) Error correction.

Answer to the Question no-3

(c)

CRC: CRC is a different approach to detect i the received frame contains valid data. This technique involves binary division of the data bits being sent. The divisor is generated using polynomials. The sender performs a division operation on the bits being sent and calculate the remainder. Before sending the actual bits the sender adds the remainder at the end of the actual bits. Actual data bits plus the remainder is called a codeword. The sender transmits data bits as codewords.

```
        11
101 | 11001
      101
      ---
       110
       101
       ---
        111
        101
        ---
         10
```

CRC

```
        111
101 | 1100110
      101
      ---
       110
       101
       ---
        111
        101
        ---
         101
         101
         ---
         000
```

No error

Answer to the Question no-3

ⓓ

In this digital word, error correction can be done in two ways:

ⓘ Backward error correction: when the receiver detects an error in the data received, it requests back the sender to retransmit the data unit.

ⓘⓘ Forward error correction: When the receiver detects some error in the data received, it executes error-correcting code, which helps it to auto-recover and to correct some kinds of errors. For m data bits, r redundent bits

are used, r bits can provide 2^r combinations of information.

In m+r bit codeword, there is possibility that the r bits themselves may get corrupted. So, the number of r bits used must inform about m+r bit locations plus no-error information.

i.e. $m+r+1$

$2^r >= m+r+1$.

4. (a) Define Network layer. How does it works?
(b) Write down the functionalities of Layer-3.
(c) Explain, Internet protocol is widely respected and deployed Network layer protocol.
(d) Which network address we use in ~~m~~ nowadays, Explain?

Answer to the Question no-4

ⓐ

Network Layer: Layer-3 in the OSI model is called network layer. Network layer manages options pertaining to host and network addressing, managing sub-networks and internet working.

Network layer takes the responsibility for routine packets from source to destination within or outside subnet. Two different subnet may have different addressing schemes or non-compatible addressing types. Network layer has the responsibility to route the packets from source to destination, mapping different addressing schemes and protocols.

Answer to the Question-4

ⓑ

Devices which work on network layer mainly focus on routine. Routing may include various tasks aimed to achieve a single goal. These

can be:

(i) Addressing devices and networks.
(ii) Populating routing tables or static routes.
(iii) Queuing incoming and outgoing data and then forwarding them according to quality of service constraints set for those packets.
(iv) Internetworking between two different subnets.
(v) Delivering packets to destination with best efforts.
(vi) Provides connection oriented and connection less mechanism.

Answer to the Question no-4

(c)

With its standard functionalities, Layer-3 can provide various features as:

(i) Quality of service management.
(ii) Load balancing and link management.
(iii) Security.

(iv) Interrelation of different protocols and subnets with different schema.

(v) Different logical network design over the physical network design.

(vi) L3 VPN and tunnels can be used to provide end to end dedicated connectivity.

Internet protocol is widely respected and deployed Network layer protocol which helps to communicate end to end devices over the internet. It comes in two flavours. IPV6 is created to replace IPV4 and hopefully mitigates limitations of IPV4 too.

Answer to the Question no-4

(d)

The IP network address as it is the only one we use in practice these days. IP addressing provides mechanism to differentiate between hosts and network. Because IP addresses are assigned in hierarchical manner, a host always

resides under a specific network. The host which needs to communicate outside its subnet, needs to know destination network address, where the packet/data is to be sent. Routers take help of routing tables, which has the following information:

Method to reach the network. The next router on the path follows the same thing and eventually the data packet reaches its destination. Network address can be one of following:

(i) Unicast (destined to one host)
(ii) Multicast (destined to group)
(iii) Broadcast (destined to all)
(iv) Anycast (destined to nearest one)

5. (a) Define Network addressing? Write down the categories of Network addressing.

(b) Define unicast routing. Write down the protocols of unicast routing?

(c) Define broadcast routing? Explain, the two ways of Broadcast routing that it can be done.

(d) Define anycast routing. How much is it important in Network routing?

Answer to the Question no-5

(a)

Network addressing: Layer-3 Network addressing is one of the major tasks of Network layer. Network addresses are always logical i.e. these are software based addresses which can be changed by appropriate configurations.

There are different kinds of network addresses.

(i) IP
(ii) IPX
(iii) AppleTalk

Answer to the Question no-5

(b)

Unicast routing: Most of the traffic on the internet and internets known as unicast data or unicast traffic is sent with specified destination. Routing unicast data over the internet is called unicast routing.

There are two kinds of routing protocols available to route unicast packets.

(i) Distance vector routing protocol: Distance vector is simple routing protocol which takes routing decision on the number of hops between source and destination. A route with less number of hops is considered as the best route.

(ii) Link state routing protocol: Link state protocol is slightly complicated protocol than Distance Vector. It takes into account the states of links of all the routers in a network.

Answer to the Question no-5

(c)

Broadcast routing: By default, the broadcast packets are not routed and forwarded by the routers on any network. Routers create broadcast domains.

Broadcast routing can be done in two ways (algorithm):

(i) A router creates a data packet and then sends it to each host one by one. In this case, the router creates multiple copies of single data packets with different destination addresses.

(ii) Secondly, when router receives a packet that is to be broadcasted, it simply floods those packets out of all interfaces. All routers are configured in the same way. This technique is used to detect and discard duplicates.

Answer to the Question no-5

(d)

Anycast routing packet forwarding is a mechanism where multiple hosts can have same logical address. When a packet destined to this logical address is received, it is sent to the host which is nearest in routing topology.

Anycast routing is done with the help of DNS server. Whenever an anycast packet is received it is enquired with DNS to where to send it. DNS provides the IP address which is the nearest IP configured on it.

6. (a) Define Network layer routing? Write down the multiple path of network layer routing?
(b) Define multicast routing? How much is it important in network layer routing?
(c) Write down the protocols of multicast routing?
(d) Explain, the algorithms of network layer routing.

Answer to the Question no-6

(a)

Network layer routing: When a device has multiple paths to reach a destination, it always selects one path by preferring it over others. This selection process is termed as routing.

The multiple path of network layer routing-

(i) Hop count
(ii) Bandwidth
(iii) Metric
(iv) Prefix-length
(v) Delay.

Answer to the Question no-6

(b)

Multicast routing: It is special case of broadcast routing with significance difference and challenges. In broadcast routing, packets are sent to all nodes even if they don't want it. But in multicast routing, the data is sent to only nodes which ~~need~~ wants to receive the packets.

The router must know that there are nodes, which wish to receive multicast packets they only it should forward. Multicaston routing also uses reverse path forwarding technique, to detect and discard duplicates and loops.

Answer to the Question no-6

(c)

Unicast routing protocols use graphs while multicast routing protocols use trees, i.e. spanning tree to avoid loops. The optical tree is called shortest path spanning tree.

(i) DVMRP: Distance vector multicast routing protocol.

(ii) MOSPF: Multicast open shortest path first.

(iii) CBT: Core Based Tree.

(iv) PIM: Protocol independent multicast.

Protocol independent multicast is commonly used now. It has two flavors:

(i) PIM Dense Mood: This mode uses source-based trees. It is used in dense environment such as LAN.

(ii) PIM sparse Mood: This mode uses shared trees. It is used in space environment such as WAN.

Answer to the Question no-6

(d)

The routing algorithms are follows -

(i) Flooding: Flooding is simplest method packet forwarding. When a packet is received, the routers send it to all the interfaces expect the one on which it was received. This

creates too much burden on the network and lots of duplicate packets wandering in the network.

(ii) <u>Shortest path:</u> Routing decision in networks, are mostly taken on the basis of cost between source and destination. Hop count plays major role here. Common shorted path algorithms are-

(i) Dijkstra's algorithm
(ii) Bellman Ford algorithm
(iii) Floyd Warshall algorithm

7. (a) Define internetworking? How does it work?
(b) Define Tunneling? Write a short note about the packet fragmentation?
(c) Define ARP? Briefly describe about ICMP?
(d) Define Internet protocol version 6? Write down the difference between IPV4 and IPV6.

Answer to the Question no-7

ⓐ

Internetworking: Networks under same administration are generally scattered geographically. There may exist requirement of connecting two different networks of same kind as well as different kinds. Router between two networks is called internetworking.

Networks can be considered different based on various parameters such as, protocol, topology, Layer-2 Network and addressing scheme.

Answer to the Question no-7

ⓑ

Tunneling: Tunnelling is a mechanism by which two or more same networks communicate with each other, by passing intermediate networking complexities.

Packet fragmentation: Most Ethernet segments have their maximum transmission unit (MTU). fixed to 1500 bytes. It is a packet with DF (don't fragment) bit set to 1 comes to a router which can not handle the packet because of its length. The packet is dropped.

When a packet is received by a router has its MF (more fragments) bit set to 1, the router then knows that it is a fragmented packet and parts of the original packet is on the way.

Answer to the Question no-7

(c)

Address Resolution protocol (ARP): while communicating, a host needs Layer-2 (MAC) address of the destination machine which belongs to the same broadcast domain or network.

ICMP is network diagnostic and error reporting protocol. ICMP belongs to IP protocol suite and

uses IP carrier protocol. After constructing ICMP packet, it is encapsulated in IP packet. Because IP itself is a best-effort non-reliable protocol, so is ICMP. ICMP echo and ICMP-echo-reply are the most commonly used ICMP messages to check the reachability of end to end hosts. When a host receives an ICMP-echo request, it is bound to send back and ICMP-echo-reply. If there is any problem in the transit network, the ICMP will report the problem.

Answer to the Question no-7

(d)

IPV6: Exhaustion of IPV4 addresses gave birth to a next generation IPV6. IPV6 addresses its nodes with 128 bit wide address providing plenty of address space for future to be used to entire planet or beyond.

Difference between IPV4 and IPV6 :

IPV4: IPV4 is 32-bit addressing scheme used as TCP/IP host addressing mechanism. IP addressing enables every host on the TCP/IP network to be uniquely ~~int~~ identifiable. IP addresses are divided into many categories-

(i) Class A - it uses first octet for network addresses and last three octets for host addressing.

(ii) Class B - first two octets for network address.

(iii) Class C - first three octets for network address.

(iv) Class D - it provide flat IP addressing scheme.

(v) Class E - It is used as experimental.

IPV6: IPV6 is still in transition phase and is expected to replace IPV4 complementary in coming years. At present there are few networks

which are running on IPV6. There are some transition mechanisms available for IPV6.

(i) Dual stack implementation

(ii) Tunnelling

(iii) NAT-PT

8. (a) Define Data link layer? Write down the two sublayers of data link layer.

(b) Describe the transition of stop-and-wait ARQ in error control.

(c) Write down the features of network layer.

(d) Explain about the protocols of multicast routing.

Answer to the Question no-8.

(a)

Data link layer: Data link layer is a second layer of OSI layered model. This layer is one of the most complicated layers and has complex functionalities.

Data link layer has two sub-layers-

(i) Logical link control
(ii) Media access control

Answer to the Question no-8

(b)

The following transition may occur in stop-and-wait ARQ:

(i) The sender maintains a timeout counter.
(ii) When a frame is sent, the sender starts the timeout counter.
(iii) If acknowledgement of frame comes in time, the sender transmits the next frame in queue.
(iv) If acknowledgement does not come in time, the sender assumes that either the frame or its acknowledgement is lost transmit.

(v) If a negative acknowledgement is received, the sender retransmits the frame.

Answer to the Question no-8

(c)

With its standard functionalities, Layer-3 can provide various features as-

(i) Quality of service management.
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