***COMPUTER NETWORKS ASSIGNMENT 1***

**STOP AND GO PROTOCOL**

Q1.)

A channel has a bit rate of 4 Kbps and one-way propagation delay of 20 msec. The channel uses stop and wait protocol. The transmission time of the acknowledgement frame is negligible. To get a channel efficiency of at least 50%, the minimum frame size should be-

1. 80 bytes
2. 80 bits
3. 160 bytes
4. 160 bits

Solution-

Given-

Bandwidth = 4 Kbps

Propagation delay (Tp) = 20 msec

Efficiency >= 50%

Let the required frame size = L bits.

Calculating Transmission Delay-

Transmission delay (Tt)

= Packet size / Bandwidth

= L bits / 4 Kbps

Calculating Value Of ‘a’-

a = Tp / Tt

a = 20 msec / (L bits / 4 Kbps)

a = (20 msec x 4 Kbps) / L bits

Condition for Efficiency to Be At least 50%-

For efficiency to be at least 50%, we must have-

1 / 1+2a >= 1/2

a <= 1/2

Substituting the value of ‘a’, we get-

(20 msec x 4 Kbps) / L bits <= 1/2

L bits >= (20 msec x 4 Kbps) x 2

L bits >= (20 x 10-3 sec x 4 x 103 bits per sec) x 2

L bits >= 20 x 4 bits x 2

L >= 160

Q.2)

If the packet size is 1 KB and propagation time is 15 msec, the channel capacity is 109 b/sec, then find the transmission time and utilization of sender in stop and wait protocol.

Solution-

Given-

Packet size = 1 KB

Propagation time (Tp) = 15 msec

Channel capacity = Bandwidth (here) = 109 b/sec

NOTE-

Generally, channel capacity is the total number of bits which a channel can hold. So, its unit is bits.

But here, channel capacity is actually given as bandwidth because its unit is b/sec.

Calculating Transmission Delay-

Transmission delay (Tt)

= Packet size / Bandwidth

= 1 KB / 109 bits per se

= 210 bits / 109 bits per sec

= 1.024 μsec

Calculating Value Of ‘a’-

a = Tp / Tt

a = 15 msec / 1.024 μsec

a = 15000 μsec / 1.024 μsec

a = 14648.46

Calculating Sender Utilization-

Sender Utilization or Efficiency (η)

= 1 / 1+2a

= 1 / (1 + 2 x 1468.46)

= 1 / 29297.92

= 0.0000341

= 0.00341 %

**SLIDING WINDOW PROTOCOL**

Q3.)

A sliding window protocol is designed for a 1 Mbps point to point link to the moon which has a one way latency (delay) of 1.25 sec. Assuming that each frame carries 1 KB of data, what is the minimum number of bits needed for the sequence number?

Solution-

Given-

Bandwidth = 1 Mbps

Propagation delay (Tp) = 1.25 sec

Packet size = 1 KB

Calculating Transmission Delay-

Transmission delay (Tt)

= Packet size / Bandwidth

= 1 KB / 1 Mbp

= (210 x 8 bits) / (106 bits per sec)

= 8.192 msec

Calculating Value of ‘a’-

a = Tp / Tt

a = 1.25 sec / 8.192 msec

a = 152.59

Calculating Bits Required in Sequence Number Field-\

Bits required in sequence number field

= ⌈log2(1+2a) ⌉

= ⌈log2(1 + 2 x 152.59) ⌉

= ⌈log2(306.176) ⌉

= ⌈8.25⌉

= 9 bits

Thus,

Minimum number of bits required in sequence number field = 9

With 9 bits, number of sequence numbers possible = 512.

We use only (1+2a) sequence numbers and rest remains unused.

**GO BACK N PROTOCOL**

Q.4)

A 1 Mbps satellite link connects two ground stations. The altitude of the satellite is 36504 km and speed of the signal is 3 x 108 m/sec. What should be the packet size for a channel utilization of 25% for a satellite link using go back 127 sliding window protocol?

A.120 bytes

B. 60 bytes

C. 240 bytes

D. 90 bytes

Solution-

Given-

Bandwidth = 1 Mbps

Distance = 2 x 36504 km = 73008 km

Propagation speed = 3 x 108 m/sec

Efficiency = 25% = 1/4

Go back N is used where N = 127

Let the packet size be L bits.

Calculating Transmission Delay-

Transmission delay (Tt)

= Packet size / Bandwidth

= L bits / 1 Mbps

= L μsec

Calculating Propagation Delay-

Propagation delay (Tp)

= Distance / Speed

= (73008 x 103 m) / (3 x 108 m/sec)

= 24336 x 10-5 sec

= 243360 μsec

Calculating Value of ‘a’-

a = Tp / Tt

a = 243360 μsec / L μsec

a = 243360 / L

Calculating Packet Size-

Efficiency (η) = N / (1+2a)

Substituting the values, we get-

1/4 = 127 / (1 + 2 x 243360 / L)

1/4 = 127 x L / (L + 486720)

L + 486720 = 508 x L

507 x L = 486720

L = 960

From here, packet size = 960 bits or 120 bytes.

Thus, Correct Option is (A).

**SELECTIVE REPEAT PROTOCOL**

Q.5) In SR protocol, suppose frames through 0 to 4 have been transmitted. Now, imagine that 0 times out, 5 (a new frame) is transmitted, 1 time out, 2 times out and 6 (another new frame) is transmitted.

At this point, what will be the outstanding packets in sender’s window?

1. 341526
2. 3405126
3. 0123456
4. 654321

Solution-

In SR Protocol, only the required frame is retransmitted and not the entire window.

Step-01:

Frames through 0 to 4 have been transmitted

4, 3, 2, 1, 0

Step-02:

0 times out. So, sender retransmits it

0, 4, 3, 2, 1

Step-03:

5 (a new frame) is transmitted-

5, 0, 4, 3, 2, 1

Step-04:

1 time out. So, sender retransmits it-

1 , 5 , 0 , 4 , 3 , 2

Step-05:

2 times out. So, sender retransmits it-

2 , 1 , 5 , 0 , 4 , 3

Step-06:

6 (another new frame) is transmitted-

6 , 2 , 1 , 5 , 0 , 4 , 3

Thus, Option (B) is correct.

**FLOW CONTROL PROTOCOL**

Q.6) On a wireless link, the probability of packet error is 0.2. A stop and wait protocol is used to transfer data across the link. The channel condition is assumed to be independent from transmission to transmission. What is the average number of transmission attempts required to transfer 100 packets?

1. 100
2. 125
3. 150
4. 200

Solution-

Given-

Probability of packet error = 0.2

We have to transfer 100 packets

Now,

When we transfer 100 packets, number of packets in which error will occur = 0.2 x 100 = 20.

Then, these 20 packets will have to be retransmitted.

When we retransmit 20 packets, number of packets in which error will occur = 0.2 x 20 = 4.

Then, these 4 packets will have to be retransmitted.

When we retransmit 4 packets, number of packets in which error will occur = 0.2 x 4 = 0.8 ≅ 1.

Then, this 1 packet will have to be retransmitted.

From here, average number of transmission attempts required = 100 + 20 + 4 + 1 = 125.

Thus, Option (2) is correct.

Q.7) Compute the fraction of the bandwidth that is wasted on overhead (headers and retransmissions) for a protocol on a heavily loaded 50 Kbps satellite channel with data frames consisting of 40 bits header and 3960 data bits. Assume that the signal propagation time from the earth to the satellite is 270 msec. ACK frames never occur. NAK frames are 40 bits. The error rate for data frames is 1% and the error rate for NAK frames is negligible.

1. 1.21 %
2. 2.12 %
3. 1.99 %
4. 1.71 %

Solution-

Consider 100 frames are being sent. Then, we have-

Useful Data Sent-

Since each frame contains 3960 data bits, so while sending 100 frames,

Useful data sent

= 100 x 3960 bits

= 396000 bits

Useless Data Sent / Overhead-

In general, overhead is due to headers, retransmissions and negative acknowledgements.

Now,

The error rate for data frames is 1%, therefore out of 100 sent frames, error occurs in one frame.

This causes the negative acknowledgement to follow which causes the retransmission.

So, we have-

Overhead due to headers = 100 x 40 bits = 400 bits.

Overhead due to negative acknowledgement = 40 bits.

Overhead due to retransmission = 40 bits header + 3960 data bits = 4000 bits.

From here,

Total overhead

= 400 bits + 40 bits + 4000 bits

= 8040 bits

Calculating Efficiency-

Efficiency (η) = Useful data sent / Total data sent

Here,

Useful data sent = 396000 bits

Total data sent = Useful data sent + Overhead = 396000 bits + 8040 bits = 404040 bits

Substituting the values, we get

Efficiency (η)

= 396000 bits / 404040 bits

= 0.9801

Calculating Bandwidth Utilization-

Bandwidth Utilization

= Efficiency x Bandwidth

= 0.9801 x 50 Kbps

= 49.005 Kbps

Calculating Bandwidth Wasted-

Bandwidth wasted

= Bandwidth – Bandwidth Utilization

= 50 Kbps – 49.005 Kbps

= 0.995 Kbps

Calculating Fraction of Bandwidth Wasted-

Fraction of bandwidth wasted

= Wasted Bandwidth / Total Available Bandwidth

= 0.995 Kbps / 50 Kbps

= 0.0199

= 1.99 %

Thus, Option (3) is correct.

Q.8) Which of the following characteristic is most basic to LAN?

1. Bit rate
2. Delay x Bandwidth Product
3. Geographical distance
4. Cost

Solution-

Geographical distance is the basic criteria on which networks are classified.

On the basis of geographical distance, networks are classified as LAN, MAN, WAN.

Thus,Option (3) is correct.

Q.9) On an Ethernet LAN when a collision is detected, the sending station-

1. continues to send the transmission
2. temporarily quits the transmission
3. notifies the destination of an error
4. permanently quits the transmission

Solution-

Ethernet uses CSMA / CD as access control method.

On detecting a collision, the sending station temporarily quits the transmission.

Transmitting station waits for Back Off time and then tries again.

Thus, Option (2) is correct.

*CSMA/CD PROBLEMS*

Q.10) In a CSMA / CD network running at 1 Gbps over 1 km cable with no repeaters, the signal speed in the cable is 200000 km/sec. What is minimum frame size?

Solution-

Given-

Bandwidth = 1 Gbps

Distance = 1 km

Speed = 200000 km/sec

Calculating Propagation Delay-

Propagation delay (Tp)

= Distance / Propagation speed

= 1 km / (200000 km/sec)

= 0.5 x 10-5 sec

= 5 x 10-6 sec

Calculating Minimum Frame Size-

Minimum frame size

= 2 x Propagation delay x Bandwidth

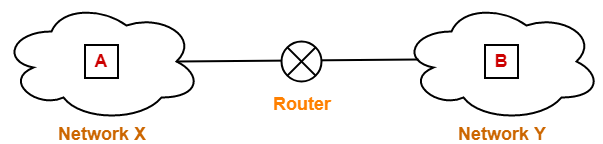
= 2 x 5 x 10-6 sec x 109 bits per sec

= 10000 bit

***COMPUTER NETWORKS ASSIGNMENT 2***

Q.18] Consider-

* There is a host A present in network X having MTU = 520 bytes.
* There is a host B present in network Y having MTU = 200 bytes.
* Host A wants to send a message to host B.



GIVEN :

Consider router receives a datagram from host A having-

Header length = 20 bytes

Payload length = 500 bytes

Total length = 520 bytes

DF bit set to 0

|  |  |
| --- | --- |
| *STEP 1*  Router examines the datagram and finds-  Size of the datagram = 520 bytes  Destination is network Y having MTU = 200 bytes  DF bit is set to 0    Router concludes-   * Size of the datagram is greater than MTU. * Hence divide the datagram into fragments. * DF bit is set to 0. * Hence allowed to create fragments of datagram. | *STEP 2*  Router decides the amount of data that it should transmit in each fragment  Router knows-   * MTU of the destination network = 200 bytes. * Max total length of any fragment = 200 bytes. * Out of 200, 20 bytes will be taken by the header. * Hence Max amount of data sent = 180 bytes. |
| ***RULE*** The amount of data sent in one fragment is chosen such that   * It is as large as possible but less than or equal to MTU. * It is a multiple of 8 so that pure decimal value can be obtained for the fragment offset field.   Following the above rule,   * Router decides to send maximum 176 bytes of data in one fragment. * This is because it is the greatest value that is a multiple of 8 and less than MTU. | |

## **Step-03:**https://www.gatevidyalay.com/wp-content/uploads/2018/09/IP-Fragmentation-Example-01-Fragments.png

 Router creates three fragments of the original datagram where-

* First fragment contains the data = 176 bytes
* Second fragment contains the data = 176 byes
* Third fragment contains the data = 148 bytes

The information contained in the IP header of each fragment is-

|  |  |
| --- | --- |
| **Header Information Of 1st Fragment-**    * Header length field value = 20 / 4 = 5 * Total length field value = 176 + 20 = 196 * MF bit = 1 * Fragment offset field value = 0 * Header checksum is recalculated. * ID number is same as that of original datagram. | **Header Information Of 2nd Fragment-**    * Header length field value = 20 / 4 = 5 * Total length field value = 176 + 20 = 196 * MF bit = 1 * Fragment offset field value = 176 / 8 = 22 * Header checksum is recalculated. * ID number is same as that of original datagram. |
| **Header Information Of 3rd Fragment-**    * Header length field value = 20 / 4 = 5 * Total length field value = 148 + 20 = 168 * MF bit = 0 * Fragment offset field value = (176 + 176) / 8 = 44 * Header checksum is recalculated. * ID number is same as that of original datagram. |  |

## **Step-04:**

At destination side,

* Receiver receives 3 fragments of the datagram.
* Reassembly algorithm is applied to combine all the fragments to obtain the original datagram.

Q17] Suppose a router receives an IP packet containing 600 data bytes and has to forward the packet to a network with maximum transmission unit of 200 bytes. Assume that IP header is 20 bytes long. What are fragment offset values for divided packets?

1. 22, 44, 66, 88
2. 0, 22, 44
3. 0, 22, 44, 66
4. 22, 44, 66

Given-

MTU size of the destination network = 200 bytes

IP header length = 20

Now,

* Maximum amount of data that can be sent in one fragment = 200 – 20 = 180 bytes.
* Amount of data sent in a fragment must be a multiple of 8.
* So, maximum data sent that can be in one fragment = 176 bytes.

Thus, 4 fragments are created-

* 1st fragment contains 176 bytes of data.
* 2nd fragment contains 176 bytes of data.
* 3rd fragment contains 176 bytes of data.
* 4th fragment contains 72 bytes of data

So,

* Fragment offset value for 1st fragment = 0
* Fragment offset value for 2nd fragment = 176 / 8 = 22
* Fragment offset value for 3rd fragment = (176+176) / 8 = 44
* Fragment offset value for 4th fragment = (176 + 176 + 176) / 8 = 66

Thus, Option (C) is correct.

16] The checksum in IP must be recomputed at every router because of change in \_\_\_\_ fields.

1. TTL, Options, Identification Number, Offset
2. TTL, Options, Datagram Length, Offset
3. TTL, Options, Data, Offset
4. TTL, Header Length, Offset, ToS

Ans : Option (B) is correct.

--------------------------------------X--------------------------------------X------------------------------

15] What are fields required from IP header to allow destination to perform reassembly of fragments?

1. Identification, MF, Offset, Header length and Total length
2. MF, Offset and Destination IP
3. MF, Datagram length, Source IP
4. MF, Options and Offset

Ans : Option (A) is correct.

--------------------------------------X--------------------------------------X------------------------------

14] The subnet mask for a particular network is 255.255.31.0. Which of the following pairs of IP addresses could belong to this network?

(A) 172.57.88.62 and 172.56.87.233  
(B) 10.35.28.2 and 10.35.29.4  
(C) 191.203.31.87 and 191.234.31.88  
(D) 128.8.129.43 and 128.8.161.55

Ans : Option (D) is correct.

Explanation

Suppose we have a host A with IP Address IPA and Subnet mask of the subnet of which A is a part is Ms. Now when A wants to send packet to a host B with an IP address say IPB, then A will first AND the subnet-Mask Ms with IPA to find out the subnet-id IDN of the subnet in order to identify whether IPB belongs to the same network. Now if B also belongs to the same network, then IPB BITWISE-AND Ms must be equal to IDN which A has calculated.

If IPA and IPB belongs to same network, we must have

IPA BITWISE-AND Ms == IPBBITWISE-AND Ms

128.8.129.43 BITWISE-AND 255.255.31.0 = 128.8.1.0

128.8.161.55 BITWISE-AND 255.255.31.0 = 128.8.1.0

13] If default subnet mask for a network is 255.255.255.0 and if ‘m’ bits are borrowed from the NID, then what could be its supernet mask?

1. 255.255.(28-m – 1) x 2m.0
2. 255.255.(28-m) x 2m.0
3. 255.255.(28-m-1) x 2m-1.0
4. 255.255.(28-m) x 2m-1.0

GIVEN

Subnet mask = 255.255.255.0

m bits are chosen from the NID part.

Clearly, given subnet mask belongs to class C.

If m = 4, then the subnet mask = 255.255.11110000.0

|  |  |
| --- | --- |
| **Option-A:**  * Supernet mask = 255.255.(28-m – 1) x 2m.0 * Third octet = (28-m – 1) x 2m | On substituting m = 4, we get-  Third octet  = 15 x 24  = (1111)2 x 24  = 11110000 (Performing Left shift by 4 places) |

Thus, Option (A) is correct.

|  |  |
| --- | --- |
| **Option-B:**  * Supernet mask = 255.255.(28-m) x 2m.0 * Third octet = (28-m ) x 2m | On substituting m = 4, we get-  Third octet  = 16 x 24  = (10000)2 x 24  = 100000000 (Performing Left shift 4 places) |

Similarly, other options are also incorrect.

Finally, Option (A) is the only correct option.

--------------------------------------X--------------------------------------X------------------------------

12] Consider default subnet mask for a network is 255.255.255.0. How many number of subnets and hosts per subnet are possible if ‘m’ bits are borrowed from HID.

1. 2m , 2(HID-m) – 2
2. 2m , 2(HID-m)
3. 2m – 1, 2(HID-m) – 2
4. 2m , (HID-m) – 2

Ans : Option (A) is correct.

Explanation

* Subnet mask = 255.255.255.0
* Number of bits borrowed from Host ID part = m
* So, number of subnets possible = 2m
* Number of bits available for Hosts = HID – m
* So, number of hosts that can be configured = 2(HID – m) – 2

--------------------------------------X--------------------------------------X------------------------------

|  |  |  |
| --- | --- | --- |
| Destinatin | Mask | Interface |
| 144.16.0.0 | 255.255.0.0 | eth0 |
| 144.16.64.0 | 255.255.224.0 | eth1 |
| 144.16.68.0 | 255.255.255.0 | eth2 |
| 144.16.68.64 | 255.255.255.224 | eth3 |

10 + 9] A packet bearing a destination address 144.16.68.117 arrives at the router. On which interface will it be forwarded?

(A) eth0  
(B) eth1  
(C) eth2  
(D) eth3

Ans : Option (C) is correct.

* For sure A and B can not be answer
* For C: subnet address of interface = 144. 16 . 68 .0
* Subnet address of incoming IP = 144. 16. 68. 117 AND 255.255.255.0 = 144. 16. 68.0
* Both sub-network addresses are same, so can be forwarded to this interface eth2

For D:

* Subnet address of incoming IP = 144. 16. 68. 117 AND 255.255.255.224 = 144. 16. 68.96
* Hence both subnet addresses are different, so cannot be forwarded to this eth3 interface.

--------------------------------------X--------------------------------------X-----------------------------

8] A packet addressed to 128.48.64.0 came to a router having routing table as follows.

Which interface will it be forwarded to ?

(A) A  
(B) B  
(C) C  
(D) D  
  
Ans : Option (B) is correct.

Logical AND operation between subnet mask and IP address gives the subnet ID.

a)128.48.64.0 & 255.255.255.0 = 128.48.64.0 which is not equal to the destination so the packet will not be forwarded to the interface A.

b) 128.48.64.0 & 255.255.128.0 = 128.48.0.0 so packet can be forwarded to B.  
c) 128.48.64.0 & 255.255.0.0 = 128.48.0.0 so packet can be forwarded to C.  
If two IP addresses match then the packet should be forwarded to the subnet with more number of 1’s in the subnet mask.

Hence, router will forward the packet to interface B.

7] Match the following-

|  |  |
| --- | --- |
| **Column-I:**200.10.192.1007.10.230.1128.1.1.254255.255.255.255100.255.255.255 | **Column-II:**Class ALimited Broadcast AddressDirect Broadcast AddressClass CClass B |

*(I, D), (II, A), (III, E), (IV, B), (V, C)*

--------------------------------------X--------------------------------------X------------------------------

6] Suppose that instead of using 16 bits for network part of a class B Address, 20 bits have been used. How many class B networks would have been possible?

Solution-

1. Total 20 bits are used for Network ID of class B.
2. The first two bits are always set to 10.
3. Then, with 18 bits, number of networks possible = 218

--------------------------------------X--------------------------------------X------------------------------

5] For the following IP Addresses

1. 1.2.3.4
2. 10.15.20.60
3. 130.1.2.3
4. 150.0.150.150
5. 200.1.10.100
6. 220.15.1.10
7. 250.0.1.2
8. 300.1.2.3

Identify the Class, Network IP Address, Direct broadcast address and Limited broadcast address of each IP Address.

|  |  |
| --- | --- |
| 1.2.3.4   * IP Address belongs to class A * Network IP Address = 1.0.0.0 * Direct Broadcast Address = 1.255.255.255 * Limited Broadcast Add = 255.255.255.255 | 10.15.20.60   * IP Address belongs to class A * Network IP Address = 10.0.0.0 * Direct Broadcast Address = 10.255.255.255 * Limited Broadcast Add = 255.255.255.255 |
| 130.1.2.3   * IP Address belongs to class B * Network IP Address = 130.1.0.0 * Direct Broadcast Address = 130.1.255.255 * Limited Broadcast Add = 255.255.255.255 | 150.0.150.150   * IP Address belongs to class B * Network IP Address = 150.0.0.0 * Direct Broadcast Address = 150.0.255.255 * Limited Broadcast Add = 255.255.255.255 |
| 200.1.10.100   * IP Address belongs to class C * Network IP Address = 200.1.10.0 * Direct Broadcast Address = 200.1.10.255 * Limited Broadcast Add= 255.255.255.255 | 220.15.1.10   * IP Address belongs to class C * Network IP Address = 220.15.1.0 * Direct Broadcast Address = 220.15.1.255 * Limited Broadcast Add = 255.255.255.255 |
| 250.0.1.2   * IP Address belongs to class E * Network IP Address = Not available * Direct Broadcast Address = Not available * Limited Broadcast Add = Not available | 300.1.2.3   * This is not a valid IP Address. * This is because for any given IP Address, the range of its first octet is always [1, 254]. * First and Last IP Addresses are reserved. |

*PROBLEMS ON TCP*

19] If WAN link is 2 Mbps and RTT between source and destination is 300 msec, what would be the optimal TCP window size needed to fully utilize the line?

1. 60,000 bits
2. 75,000 bytes
3. 75,000 bits
4. 60,000 bytes

Given-

Bandwidth = 2 Mbps

RTT = 300 msec

### **Optimal TCP Window Size-**

  = Maximum amount of data that can be sent in 1 RTT

= 2 Mbps x 300 msec

= 600 x 103 bits

= 60,0000 bits

= 75,000 bytes

*Thus, Option (B) is correct.*

--------------------------------------X--------------------------------------X------------------------------

20] A TCP machine is sending windows of 65535 B over a 1 Gbps channel that has a 10 msec one-way delay.

1. What is the maximum throughput achievable?
2. What is the line efficiency?

Given-

Window size = 65535 bytes

Bandwidth = 1 Gbps

One-way delay = 10 msec

 Maximum amount of data that can be sent in 1 RTT

= 1 Gbps x (2 x 10 msec)

= (109 bits per sec) x 20 x 10-3 sec

= 20 x 106 bits

= 25 x 105 bytes

 Amount of data that is actually being sent in 1 RTT = 65535 byte

 Thus,Line Efficiency(η)

= Amount of data being sent in 1 RTT / Maximum amount of data that can be sent in 1 RTT

= 65535 bytes / 25 x 105 bytes

= 0.026214

= 2.62%

 Now,Maximum Achievable Throughput

= Efficiency x Bandwidth

= 0.0262 x 1 Gbps

= 26.214 Mbps

21] Given the bandwidth of a network is 1 MB / sec. Calculate the wrap around time.

Note

* Wrap around time = Time taken to use all the 232 sequence numbers.
* TCP assigns 1 sequence number to each byte of data.
* To calculate wrap around time, calculate how much time taken to send 232 bytes data.

Now,

* Given bandwidth = 1 MB / sec = 106 bytes / sec.
* It means 106 bytes of data is sent in time = 1 sec.
* So, 232 bytes of data will be sent in time = ( 1 / 106 ) x 232 sec.
* On solving, we get 1.19 hours.

 Thus,

* It will take 1.19 hours to consume all the 232 sequence numbers if bandwidth = 1 MB / sec.
* Wrap Around Time = 1.19 hours.

--------------------------------------X--------------------------------------X------------------------------

22] If bandwidth of the network is 1 GBps, how many extra bits will have to be appended in the Options field so that wrap around time becomes equal to the lifetime of segment?

Note

* Wrap around time to become equal to the life time of TCP segment,Number of sequence numbers required = Number of bytes sent in life time of TCP segment
* Lifetime of TCP segment = 180 sec.
* Bandwidth of the network = 1 GBps (Given)

 Now,

* Number of bytes transferred in 1 sec = 1 GB
* So, number of bytes transferred in 180 sec = 180 GB = 180 x 230 bytes
* So, number of sequence numbers required = 180 x 230

Let No.of bits in the sequence number field are required to represent the value 180 x 230 be y

 So, we have-

2y = 180 x 230

ylog2 = log(180 x 230)

y = log2(180 x 230)

y = log2180 + log2230

y = 7.49 + 30

y ≅ 38

From here,

* Total number of bits required for sequence numbers = 38 bits.
* In TCP header, sequence number field is a 32-bit field.
* So, extra bits required to be appended in the Options field = 38 – 32 = 6 bits

--------------------------------------X--------------------------------------X------------------------------

23] In a network that has a maximum TPDU size of 128 bytes, a maximum TPDU lifetime of 30 sec and 8 bit sequence number, what is the maximum data rate per connection?

(TPDU is Transport layer protocol data unit which is the segment.)

 Given-

* Maximum segment size (MSS) = 128 bytes
* Segment lifetime = 30 sec
* Bits in sequence number = 8

Now,

* Maximum number of possible sequence numbers using 8 bits = 28 = 256.
* So, maximum number of bytes that can be uniquely identified = 256 bytes.
* Lifetime of a segment = 30 seconds.
* So, maximum amount of data that can be sent in 30 seconds = 256 bytes.

Thus,

Maximum data rate per connection

= 256 bytes / 30 seconds

≈ 68 bits/sec

--------------------------------------X--------------------------------------X------------------------------

28]Suppose that the advertised window 1 MB long. If a sequence number is selected at random from the entire sequence number space, what is the probability that the sequence number falls inside the advertised window?

 We know,

* Number of bits in sequence number field = 32 bits.
* So, Maximum number of sequence numbers possible = 232.
* 232 bytes of data can be labeled uniquely with these sequence numbers.
* Advertised window size = 1 MB = 220 bytes which uses 220 sequence numbers.

 Therefore,

Required probability

= 220 / 232

= 1 / 212

*PROBLEMS ON TCP CONGESTION*

24] Consider the effect of using slow start on a line with a 10 msec RTT and no congestion. The receiver window is 24 KB and the maximum segment size is 2 KB. How long does it take before the first full window can be sent?

Given-

* Receiver window size = 24 KB
* Maximum Segment Size = 2 KB
* RTT = 10 msec

### **Receiver Window Size-**

 Receiver window size in terms of MSS

= Receiver window size / Size of 1 MSS

= 24 KB / 2 KB

= 12 MSS

 Slow Start Threshold-

 Slow start Threshold

= Receiver window size / 2

= 12 MSS / 2

= 6 MSS

 Slow Start Phase-

 Window size at the start of 1st transmission = 1 MSS

* Window size at the start of 2nd transmission = 2 MSS
* Window size at the start of 3rd transmission = 4 MSS
* Window size at the start of 4th transmission = 6 MSS

 Since the threshold is reached, so it marks the end of slow start phase.

Now, congestion avoidance phase begins.

### **Congestion Avoidance Phase-**

* Window size at the start of 5th transmission = 7 MSS
* Window size at the start of 6th transmission = 8 MSS
* Window size at the start of 7th transmission = 9 MSS
* Window size at the start of 8th transmission = 10 MSS
* Window size at the start of 9th transmission = 11 MSS
* Window size at the start of 10th transmission = 12 MSS

From here,

* Window size at the end of 9th transmission or at the start of 10th transmission is 12 MSS.
* Thus, 9 RTT’s will be taken before the first full window can be sent.

 So,Time taken before the first full window is sent

= 9 RTT’s

= 9 x 10 msec

= 90 msec

25] Consider an instance of TCP’s Additive Increase Multiplicative Decrease (AIMD) algorithm where the window size at the start of slow start phase is 2 MSS and the threshold at the start of first transmission is 8 MSS. Assume that a time out occurs during the fifth transmission. Find the congestion window size at the end of tenth transmission.

1. 8 MSS
2. 14 MSS
3. 7 MSS
4. 12 MSS

Given-

* Window size at the start of slow start phase = 2 MSS
* Threshold at the start of first transmission = 8 MSS
* Time out occurs during 5th transmission

|  |  |
| --- | --- |
| **Slow Start Phase 1-** Window size at start of 1st transmission = 2 MSS  Window size at start of 2nd transmission = 4 MSS  Window size at start of 3rd transmission = 8 MSS    Since the threshold is reached, so it marks the end of slow start phase. Now, congestion avoidance phase begins. | **Congestion Avoidance Phase 2 -** Window size at start of 4th transmission = 9 MSS  Window size at start of 5th transmission = 10 MSS    It is given that time out occurs during 5th transmission.  So now,  Slow start threshold = 10 MSS / 2 = 5 MSS  Congestion window size = 2 MSS |
| **Slow Start Phase 2 -** Window size at start of 6th transmission = 2 MSS  Window size at start of 7th transmission = 4 MSS  Window size at start of 8th transmission = 5 MSS    Since the threshold is reached, so it marks the end of slow start phase.  Now, congestion avoidance phase begins. | **Congestion Avoidance Phase 2-** Window size at start of 9th transmission = 6 MSS  Window size at start of 10th transmission = 7 MSS  Window size at start of 11th transmission = 8 MSS    From here,  Window size at the end of 10th transmission  = Window size at the start of 11th transmission  = 8 MSS |

*Thus, Option (A) is correct.*

26] Suppose that the TCP congestion window is set to 18 KB and a time out occurs. How big will the window be if the next four transmission bursts are all successful? Assume that the MSS is 1 KB.

### **Congestion Window Size-**

 Congestion window size in terms of MSS

= 18 KB / Size of 1 MSS

= 18 KB / 1 KB

= 18 MSS

### **Reaction Of TCP On Time Out-**

TCP reacts by-

* Setting the slow start threshold to half of the current congestion window size.
* Decreasing the congestion window size to 1 MSS.
* Resuming the slow start phase.

So now,

* Slow start threshold = 18 MSS / 2 = 9 MSS
* Congestion window size = 1 MSS

 Slow Start Phase-

 Window size at the start of 1st transmission = 1 MSS

* Window size at the start of 2nd transmission = 2 MSS
* Window size at the start of 3rd transmission = 4 MSS
* Window size at the start of 4th transmission = 8 MSS
* Window size at the start of 5th transmission = 9 MSS

 Thus, after 4 successful transmissions, window size will be 9 MSS or 9 KB.

27] On a TCP connection, current congestion window size is 4 KB. The window advertised by the receiver is 6 KB. The last byte sent by the sender is 10240 and the last byte acknowledged by the receiver is 8192.

|  |  |
| --- | --- |
| **Part-01:** The current window size at the sender is \_\_\_\_.   1. 2048 B 2. 4096 B 3. 6144 B 4. 8192 B | **Part-02:** Amount of free space in sender window is \_\_.   1. 2048 B 2. 4096 B 3. 6144 B 4. 8192 B |

### **Part-01:**

 Sender window size

= min (Congestion window size, Receiver window size)

= min(4KB , 6KB)

= 4 KB

= 4096 B

Thus, Option (B) is correct.

 Part-02:

 Given-

=Last byte acknowledged by the receiver = 8192

=Last byte sent by the sender = 10240

 From here,

* It means bytes from 8193 to 10240 are still present in the sender’s window.
* These bytes are waiting for their acknowledgement.
* Total bytes present in sender’s window = 10240 – 8193 + 1 = 2048 bytes.

 From here,

Amount of free space in sender’s window currently

= 4096 bytes – 2048 bytes

= 2048 bytes

 This indicates that half of the sender’s window is currently empty.

Thus, Option (A) is correct.

11) What is the maximum number of hosts in a Class C network?

Answer: The default subnet mask for Class C is 255.255.255.x. Class C gives 2097152 (221) Network addresses and 254 (28-2) Host addresses.

12) What is the subnet address of the destination IP address is 144.16.34.124 and subnet mask is 255.255.240.0?

Answer: 144.16.32.0

Explanation: By look that 144 ... we can conclude that it is class b network. so we need to convert that destination ip address (144.16.34.124) into binary. The natural mask of class b network is 255.255.0.0 ...convert this natural mask into binary form .and apply (AND operation).by that we get network address.

to get subnet address ....

convert that 34 in destination ip address (144.16.34.124) into binary form.

and also convert that (240) subnet mask address (255.255.240.0) into binary

and apply (AND operator). we will get the subnet.

13)What do the following IP addres signify? 144.16.255.255

Answer: The given address signifies that it belongs to Class B.

Explanation: The class names are labelled from A to E according to the values given below:

Numbers from 1 till 26 belongs to Class A

Numbers from 128 till 191 belongs to Class B

Numbers from 192 till 223 belongs to Class C

Numbers from 224 till 239 belongs to Class D

Numbers from 240 till 254 belongs to Class E

So the given address 144.16.255.255 falls under the range of Class B.

14) In an IP packet, the value of HLEN is 5, and the value of the TOTAL LENGTH field is 1000 (in decimal). The number of data bytes in the packet will be \_\_\_\_\_\_\_\_

Answer:980

Explanation:Number of bytes in the header = 5\*4 = 20 bytes

Number of bytes of data = Total length - header bytes

                                         = 1000 - 20

                                         = 980 bytes.

15) An IP packet arrives at a router with the first eight bit as 01001000. How many bytes are there in the options field?”

The first 4 bits (nybble) with a value 4 define the packet is an IPv4 packet.

The next nybble with value 8 says that there are eight 32-bit words or 32 bytes in the header. There are 20 bytes in the basic header, leaving 12 bytes of option data.