1. In TDM medium access control bus LAN, each station is assigned a one-time slot per cycle for transmission. Assume that the length of each time slot is time to transmit 100 bits plus end-to-end propagation delay. Let propagation speed be 2 * 10^8 m/sec. The length of LAN is 1 km with a bandwidth of 10 Mbps. The maximum number of stations that can be allowed in a LAN so that the throughput of each station can be 2/3 Mbps is

(A) 3	(B) 5
(C) 10	(D) 20

Solution: Option (c)

EXPLANATION:

Propagation delay $= \frac{1km}{2\times10^8 m/sec}$ =5μsec

⇨ T_x=L/B =1000bits/(10×10^6bits/sec)=10^{-5}sec=10μsec

Let there are N stations

Length of cycle = N*(10+5) = 15Nμsec

In whole cycle, each user transmits only for 10μsec

∴ Efficiency = $\frac{10}{15N}$

⇨ Throughput = Efficiency * Bandwidth

⇨ $\frac{2}{3}$Mbps=$\frac{10}{15N}$*10Mbps

⇨ N = 10

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

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

Solution: Option (a)
Explanation:

A station can transmit only when all other stations (n-1 stations) are idle.
Each station attempts with probability = p
The probability of a station not attempting to transmit is =1-p
Probability when the n-1 stations are not transmitting= $(1-p)^{n-1}$
Probability when all other n-1 stations are not transmitting, and one particular station is transmitting= $p(1-p)^{n-1}$
This probability is for all n stations.
The probability that ONLY one station (any station could be the lucky one) transmits in a given time slot is $np(1-p)^{n-1}$

3. Let A and B be the stations using the backoff algorithm to transmit the data. During the first collision, B wins the race and transmitted the packet. Again, the collision happened,

and B wins the race while A sends 1st packet and B sends its 2nd packet. What is the probability of A winning the next time transmission (A's 1st packet, B's 3rd packet.)?

A. 5/8 B. 13/16 C. 1/8 **D. 1/16**

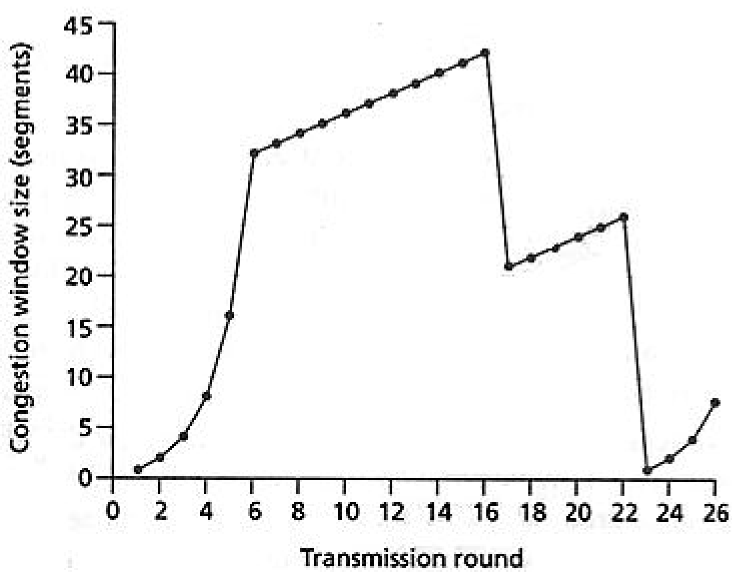
Answer: Option D

Explanation:

In first collision:

	A *winning probability*	B *winning probability*
	$2^1(0,1)$ 1/2	$2^1(0,1)$ 1/2
Next collision (A's 1st packet, 2nd collision; B's 2nd packet 1st collision)	$2^2(0,1,2,3)$ 1/8	$2^1(0,1)$ 5/8
Next collision (A's 1st packet, 3rd collision; B's 3rd packet, 1st collision)	$2^3(0,1,..7)$ 1/16	$2^1(0,1)$ 13/16

4. The diagram below shows the size of a TCP sender's congestion window over a period of time. Answer the following questions based on this diagram.



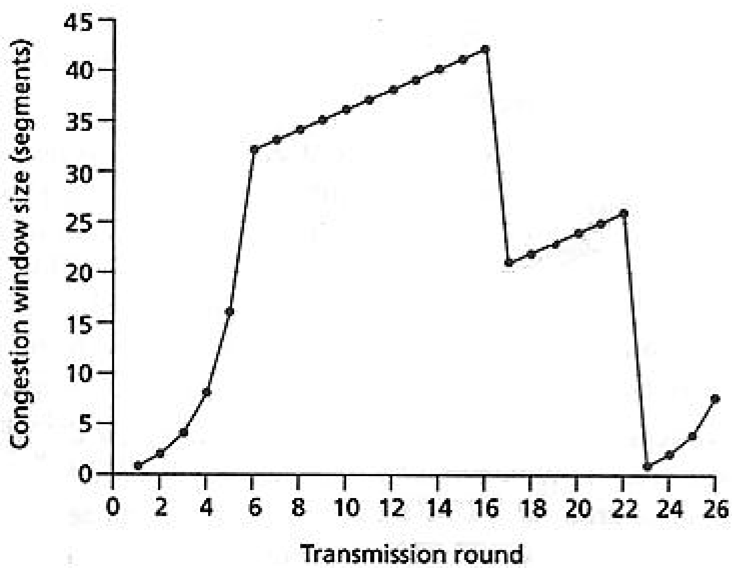
At what transmission round will the 128th segment be sent?

A. 9 B. 7 **C. 8** D. 6

Answer: Option C

Explanation:
During the 1st transmission round, packet 1 is sent; packet 2-3 are sent in the 2nd transmission round; packets 4-7 are sent in the 3rd transmission round; packets 8-15 are sent in the 4th transmission round; packets 16-31 are sent in the 5th transmission round; packets 32-63 are sent in the 6th transmission round; packets 64 – 96 are sent in the 7th transmission round;packets 97-131 are sent in 8th transmission round. Thus, packet 128 is sent in the 8th transmission round.

5. The diagram below shows the size of a TCP sender's congestion window over a period of time. Answer the following questions based on this diagram.



In the diagram it clearly shows that after the 22nd transmission round, there is a packet/segment loss. This packet/segment is lost due to ________________________.

A. Duplicate ack's B. None **C. Timeout** D. Can not say

Answer: Option C

Explanation:

After the 22nd transmission round, segment loss is detected due to timeout, and hence, the congestion window size is set to 1.

6. Consider a LAN with the sender and receiver 30 km apart, and the link works at the speed of light in the fibre. Suppose a packet of size 2KB needs to be transferred; at what data rate does the round-trip delay equal the transmission delay of the packet?

A. 70 Mbps **B. 80 Mbps** C. 40 Mbps D.60 Mbps

Answer: Option B

Explanation:

The speed of light in fibre is about $3 * 10^8$ m/sec.
For a 30-km line, the propagation delay is 10^{-4} sec.

RTT = $2*10^{-4}$ sec.

Packet size L = 2KB = 16384 bits.

⇒ Given, Ttrans = RTT

⇒ L/B = $2 * 10^{-4}$ sec

⇒ B = 16384 / $(2 * 10^{-4})$

= $8192*10^4$ bps
= 80Mbps

7. Consider a scenario where a channel is used in the communication between the Earth and a geostationary satellite. Suppose the bandwidth is 50 Mbps and each packet is 1500 bytes; what are the channel capacity (bandwidth-delay) and the maximum window size (in packets), respectively?

Note: Generally, the delay in the geostationary link will be 0.27 sec

A. 27Mb, 2249
B. 27Mb, 2252
C. 14Mb, 2211
D. 14Mb, 2222

Answer: Option B

Explanation:

The propagation delay = 0.27 sec = 270 msec
The round-trip delay = 540 msec

The Transmission delay = L/B

$$= \frac{1500 \times 8\text{bits}}{50 \times 10^6} = 24 \times 10^{-5}\text{sec}$$

$$\begin{aligned}\text{Channel capacity or bandwidth delay} &= \text{Bandwidth} \times \text{RTT} \\ &= 50 \times 10^6 \times 540 \times 10^{-3}\text{bits} \\ &= 27 \times 10^6\text{bits}\end{aligned}$$

So, with a 50-Mbps channel, the bandwidth-product delay is 27 Megabits or 3,375,000 bytes. Each packet size is 1500 bytes; with packets of 1500 bytes, it takes 2250 packets to fill the pipe.
So the window should be at least 2250 packets.
In options, we do not have this 2250. Then we go for greater than 2250 because the window should be at least 2250 packets.

(or)

Window size = 1 + 2*a, where a = Tp/Tt

$$1 + 2 \times \frac{0.27}{0.24 \times 10^{-3}} = 2251$$

In options, we do not have this 2251. Then we go for greater than 2251 because the window should be at least 2251 packets.

8. **Let us consider a statistical time division multiplexing of packets. The number of sources is 10. In a time unit/slot, a source transmits a packet of 1000 bits. The number of sources sending data for the first 20 time units is 6, 9, 3, 7, 2, 3, 2, 5, 4, 6, 1, 10, 7, 5, 8, 3, 6, 2, 9, 5 respectively. The output capacity of the multiplexer is 5000 bits per time unit. Then, the average number of backlogged packets per time unit during the given period is**

A. 4.52 B. 3 **C. 4.45** D. 5.16

Answer: Option C
Explanation:

Each station can send 1000 bits for a packet.
Multiplexer output = 5000 bits.

i.e. 5 packets can be sent in a time unit.
This means for each time unit, All the data is successfully transmitted if 5 stations (sources) or less than 5 stations want to transmit the data(each 1000 bits or 1 packet). If more than 5 stations want to transmit the data, the remaining station's packets are all backlogged packets(because only 5 packets can be sent in a time unit).
For each time unit data packets has to send is = ((No. of stations want send * 1 packet) + (backlogged packets from previous unit))
Given no. of stations for each time unit 6, 9, 3, 7, 2, 3, 2, 5, 4, 6, 1, 10, 7, 5, 8, 3, 6, 2, 9, 5
No. of backlogged packets in each station :
6(want to send) - 5(able to send) = 1,
9(want to send)+1(backlogged) - 5 = 5,
3(want to send)+5(backlogged) - 5 = 3,
7(want to send)+3(backlogged) - 5 = 5,
2(want to send)+5(backlogged) - 5 = 2,
3(want to send)+2(backlogged) - 5 = 0,
2(want to send)+0(backlogged) - 5 = 0,
5(want to send)+0(backlogged) - 5 = 0,
4(want to send)+0(backlogged) - 5 = 0,
6(want to send)+0(backlogged) - 5 = 1,
1(want to send)+1(backlogged) - 5 = 0,
10(want to send)+0(backlogged) - 5 = 5,
7(want to send)+5(backlogged) - 5 = 7
5(want to send)+7(backlogged) - 5 = 7
8(want to send)+7(backlogged) - 5 = 10
3(want to send)+10(backlogged) - 5 = 8
6(want to send)+8(backlogged) - 5 = 9
2(want to send)+9(backlogged) - 5 = 6
9(want to send)+6(backlogged) - 5 = 10
5(want to send)+10(backlogged) - 5 = 10
Avg. no. of packets backlogged
= (1 + 5 + 3 + 5 +2 + 1 + 5 + 7 + 7 + 10 + 8 + 9 + 6 + 10 + 10) / 20
= 4.45

9. Suppose a channel has a bandwidth of 72 Kbps and uses pure ALOHA as a flow control mechanism. Assume there are N stations are trying to share this channel. Each station sends a frame of size 2048-bit for every 120 sec, even though the previous frame has yet to be sent. Find the value of N?

A. 779 B. 777 **C. 776** D. 775

Answer: C

Explanation:
Given Bandwidth (B) = 72 Kbps = $72*10^3$
Bitrate for each host (b) = 2048/120 = 17.06 b/s

In pure ALOHA,

Number of stations N = (0.184 * Bandwidth) / Bitrate of each station.
= (0.184 * 72*10^3) / 17.06
= 776.5 stations

10. Find the true statement among the following, given that an exponential back-off algorithm is used in some MAC protocols.

A. It ensures that two nodes that are involved in a collision in a time slot will never collide with each other when they retry that packet.
B. It ensures that two or more nodes involved in a collision in a time slot will experience a lower probability of collision during the next retry.
C. It can be used with slotted Aloha but not with CSMA.
D. Over a short time, it improves the fairness of throughput achieved by different nodes compared to not using the algorithm.

Answer: Option B