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TUTORIAL 8 & 9

Problem-01:

The maximum window size for data transmission using the selective repeat protocol with n bit frame sequence numbers is-

A. 2^n
B. 2^{n-1}
C. 2^{n-1}
D. 2^{n-2}

We know-

- With n bits, total number of sequence numbers possible = 2^n.
- In SR Protocol, sender window size = receiver window size = W (say)

For any sliding window protocol to work without any problems,

Min Available Sequence Numbers = Sender window size + Receiver window size

So, we have-

$$2^n = W + W$$

$$2^n = 2W$$

$$W = 2^{n-1}$$

Therefore, maximum window size possible of sender and receiver = 2^{n-1}

Thus, Option (B) is correct.

Problem-02:

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 times out, 2 times out and 6 (another new frame) is transmitted. At this point, what will be the outstanding packets in sender's window?

A. 341526
B. 3405126
C. 0123456
D. 654321

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 times 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.

Problem-03:

The selective repeat protocol is similar to Go back N except in the following way- (select one or more options as given below)

A. **Frame Formats are similar in both the protocols**
B. **The sender has a window defining maximum number of outstanding frames in both the protocols**
C. **Both uses piggybacked acknowledgements where possible and does not acknowledge every frame explicitly.**
D. **Both uses piggyback approach that acknowledges the most recently received frame.**

Option (A)

- Both the protocols use the same frame formats because both are sliding window protocols.
- The variation occurs only in the coding and implementation.

Option (B)

- In both the protocols, sender has a window which defines the maximum number of outstanding frames.

Option (C

- Both the protocols use piggybacked acknowledgements wherever possible.
- Sending acknowledgements along with the data are called as **piggybacked acknowledgements**.
- But Go back N protocol uses cumulative acknowledgements and does not acknowledge every frame explicitly.
- On the other hand, Selective repeat protocol acknowledges each frame independently.

Option (D)

- Both the protocols use piggyback approach.
- Go back N acknowledges the most recently received frame by sending a cumulative acknowledgement which includes the acknowledgement for previous packets too if any.
- On the other hand, Selective Repeat protocol acknowledges all the frames independently and not only the recently received frame.

Thus, Options (C) and (D) are correct.

Problem-04:

Consider a 128 x 10^3 bits/sec satellite communication link with one way propagation delay of 150 msec. Selective Retransmission (repeat) protocol is used on this link to send data with a frame size of 1 KB. Neglect the transmission time of acknowledgement. The minimum number of bits required for the sequence number field to achieve 100% utilization is

Given-

- Bandwidth = 128 x 10^3 bits/sec
- Propagation delay (T_p) = 150 msec
- Frame size = 1 KB

Now,

- To achieve 100% utilization, efficiency must be 100%.
- Efficiency is 100% when sender window size is optimal i.e., 1+2a

Transmission delay (T_t) = Frame size / Bandwidth
= 1 KB / (128 x 10^3 bits per sec) = (1 x 2^{10} x 8 bits) / (128 x 10^3 bits per sec)
= 64 msec

a = T_p / T_t = 150 msec / 64 msec = 2.34

Optimal sender window size = 1 + 2a = 1 + 2 x 2.34 = $\lceil 5.68 \rceil$ = 6

sender window size = receiver window size = 6

For any sliding window protocol, **minimum number of sequence numbers required**
= Sender window size + Receiver window size = 6 + 6 = 12

Minimum number of bits required in sequence number field = $\lceil \log_2(12) \rceil$ = 4

Thus,

- Minimum number of bits required in sequence number field = 4
- With 4 bits, number of sequence numbers possible = 16
- We use only 12 sequence numbers and rest 4 remains unused.

Problem-05

A group of N stations share 100 Kbps slotted ALOHA channel. Each station output a 500 bits frame on an average of 5000 ms even if previous one has not been sent. What is the required value of N?

Throughput of each station = Number of bits sent per second
= 500 bits / 5000 ms = 500 bits / (5000 x 10^{-3} sec) = 100 bits/sec

Throughput of slotted aloha = Efficiency x Bandwidth = 0.368 x 100 Kbps = 36.8 Kbps

Throughput of slotted aloha = **Total number of stations** x Throughput of each station
36.8 Kbps = N x 100 bits/sec
∴ N = 368
Thus, required value of N = 368.

Problem-06

Difference Between Pure Aloha And Slotted Aloha

Pure Aloha	**Slotted Aloha**
Any station can transmit the data at any time.	Any station can transmit the data at the beginning of any time slot.
The time is continuous and not globally synchronized.	The time is discrete and globally synchronized.
Vulnerable time in which collision may occur $= 2 \times T_t$	Vulnerable time in which collision may occur $= T_t$
Probability of successful transmission of data packet $= G \times e^{-2G}$	Probability of successful transmission of data packet $= G \times e^{-G}$
Maximum efficiency = 18.4% (Occurs at G = 1/2)	Maximum efficiency = 36.8% (Occurs at G = 1)
The main advantage of pure aloha is its simplicity in implementation.	The main advantage of slotted aloha is that it reduces the number of collisions to half and doubles the efficiency of pure aloha.

Problem-07

In what protocols is it possible for the sender to receive an acknowledgement for a packet that falls outside its current window?

A. Stop and Wait
B. Selective Repeat
C. Go back N
D. All of the above

- Delayed Acknowledgements fall outside the current window.
- They may occur in any of the flow control protocols and received by the sender.

Thus, correct option is (D).

Problem-08

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?

A. 100
B. 125
C. 150
D. 200

If there are n packets to be transmitted and p is the probability of packet error, then-

Number of transmission attempts required

$= n + np + np^2 + np^3 + \ldots\ldots + \infty$

$= n / (1-p)$

Substituting the given values, we get-
Average number of transmission attempts required = 100 / (1-0.2) = 125.

Thus, Option (B) is correct.

Problem-10
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.

A. 1.21 %
B. 2.12 %
C. 1.99 %
D. 1.71 %

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

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

Useful data sent = 100 x 3960 bits = 396000 bits

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.

Total overhead = 400 bits + 40 bits + 4000 bits = 8040 bits

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

Efficiency (η) = 396000 bits / 404040 bits = 0.9801

Bandwidth Utilization = Efficiency x Bandwidth = 0.9801 x 50 Kbps = 49.005 Kbps

Bandwidth wasted = Bandwidth – Bandwidth Utilization = 50 Kbps –49.005 Kbps = 0.995kbps

Fraction of bandwidth wasted = Wasted Bandwidth / Total Available Bandwidth

= 0.995 Kbps / 50 Kbps = 0.0199 = 1.99 %

Thus, Option (C) is correct.