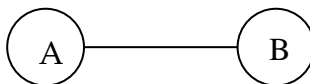


Part #4: Error & Flow Control

You are given the following parameters of a Point-to-Point Data Link

- Transmission Time of a Data Frame = 1 sec
- One way Propagation Delay = 1 sec
- Transmission Time of ACK frames = 0sec
- Processing Delay at either side is = 0sec
- Timeout = 3 sec. The Timer, for any frame, starts immediately after the sender finishes transmitting that frame.
- # of bits for frame sequencing $m = 2$. Start the sequencing with F_0 . Acknowledgements are sequenced as follows: ACK_n means receiver is acknowledging frame F_n (i.e., not accumulative acknowledgements). Frames received out of order are acknowledged. When receiver receives a frame in error, it drops it and does nothing. Frames are 1000 bits long. The sender has only 5 frames to send F_0 through F_4 .
- Frame Length = 1000 bits
- No accumulative Acknowledgements

A Selective Repeat ARQ is used with $SWS = RWS = \text{Maximum allowable}$. You are asked to show a detailed timing diagram until F_4 is acknowledged. You are also asked to calculate the Throughput and the Link Utilization for this following scenario: Frame F_1 is received in error and frame F_3 is lost in the channel.



Solutions

Throughput = $5000/15 = 333.3$ bps

Link Utilization = $5/15 = 33.3\%$

Time	Action @ Transmitter	Action @ Receiver	Time
0	F ₀ is transmitted		0
1	F ₁ is transmitted		1
2	Sender window is closed	F ₀ is received (No errors), ACK ₀ is returned	2
3	ACK ₀ is received. Window slides by 1 and F ₂ is transmitted	F ₁ is received and detected to be in error, Frame F ₁ is dropped	3
4	Sender window is closed		4
5	F ₁ is timed out and is retransmitted.	F ₂ is received and ACK ₂ is returned	5
6	ACK ₂ is received. Window does NOT slide		6
7	Sender window is still closed	F ₁ is received and ACK ₁ is returned	7
8	ACK ₁ is received. Sender window slides by two units. F ₃ is transmitted. This frame is lost in channel		8
9	F ₄ = F ₀ (the new one) is transmitted		9
10	Sender window is closed		10
11	Sender is idle	F ₄ is received and ACK ₄ is returned	11
12	F ₃ is timed out and is retransmitted. ACK ₄ is received		12
13	Sender is idle		13
14	Sender is idle	F ₃ is received and ACK ₃ is returned	14
15	ACK ₃ is received. Sender is done		15

Start from $t = 0$ and assume every division is 1 sec

[illegible]

