Sample Solution for Exercise Communication Networks I

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General Remarks

Welcome to the exercise for Communication Networks I. Please adhere to the following general remarks regarding the organization of the exercise during this summer term.

- One week before the tutorial, a new exercise will be published at the Exercise area of the KN1 Moodle (`https://moodle.tu-darmstadt.de/course/view.php?id=5268`)
- The exercise serves as your hands-on experience in addition to the lecture and as a preparation for the exam
- The questions in the exercise can be discussed at the tutorial date
- The sample solution for the exercise is available at the Exercise area of KN1 Moodle in addition to the corresponding tutorial. Nevertheless, we encourage students to try to solve the exercise themselves before the tutorial date without looking into the solution as a good practice to understand the subject of the lecture

Problem 1 - Multiple Choice

a) What is the purpose of a checksum, such as CRC (Cyclic Redundancy Code)?

A) Add redundancy to a frame for error detection.
B) Flow control protocol.
C) Extension of HDLC (High-Level Data Link Control).
D) Find redundant code in cyclic routers.
E) Determine the routes in cyclic networks with redundant codepoints.

Solution: Answer A

b) In which layer is CRC used for error detection?

A) Physical Layer
B) Correction Layer
C) Data Link Layer
D) Network Layer
E) Transport Layer

Solution: Answer C

c) Which is an extension to the original sliding window algorithm?

A) Driving
B) Sequence number
C) Acknowledgment
D) Window size
E) Negative Acknowledgment

Solution: Answer E

Problem 2 - Sliding Window

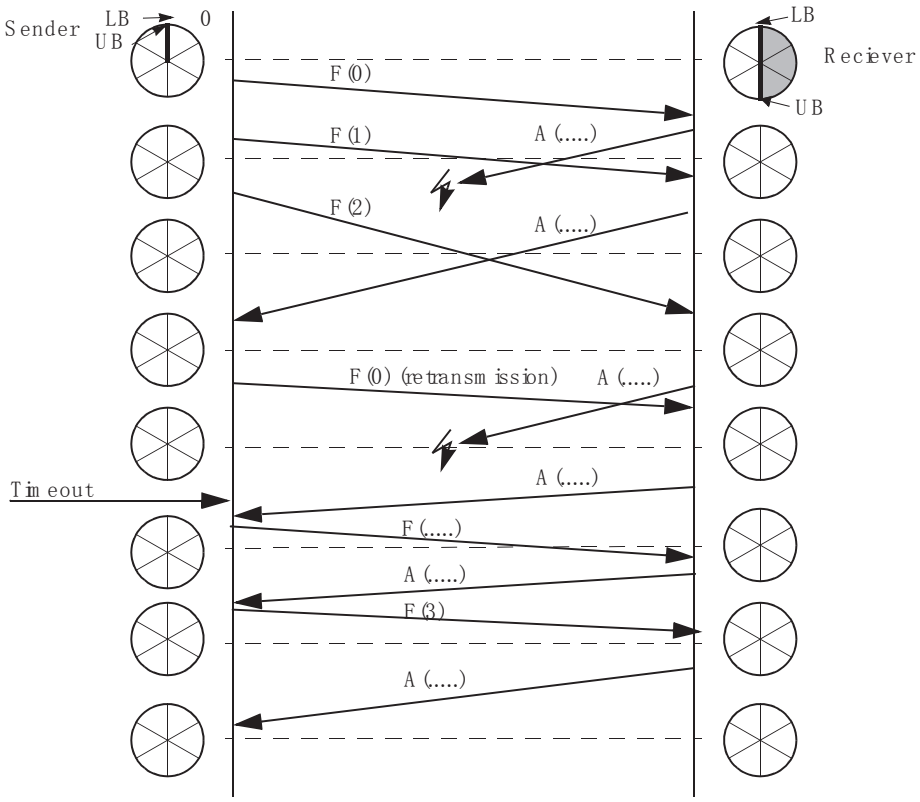
The Sliding-Window Protocol with window size 3, sequence numbers $0-5$, **including Acknowledgement**, (Ack1 = Acknowledgement of Frame 1 and all previous not yet acknowledged Frames) and for error treatment Selective-repeat is used.

a) Complete the entries for the Sender and Receiver Windows in the following table (B = free Buffer space, L/U = Lower/Upper Bound) and the sequence numbers used for the transmitted Frames and Acknowledgements. Hint: The column Action shows the last action the Sender/Receiver has done. For example the Sender has sent the Frame 0 (F0) at Time 1 and the Receiver has received Frame 0 at Time 2. Thus the values of the Upper/Lower bound and the Window must match with the Action column. At Time 3 the Sender/Receiver sends a Frame/ACK at the same time. What happens if ACK 2 is lost (Time 8)?

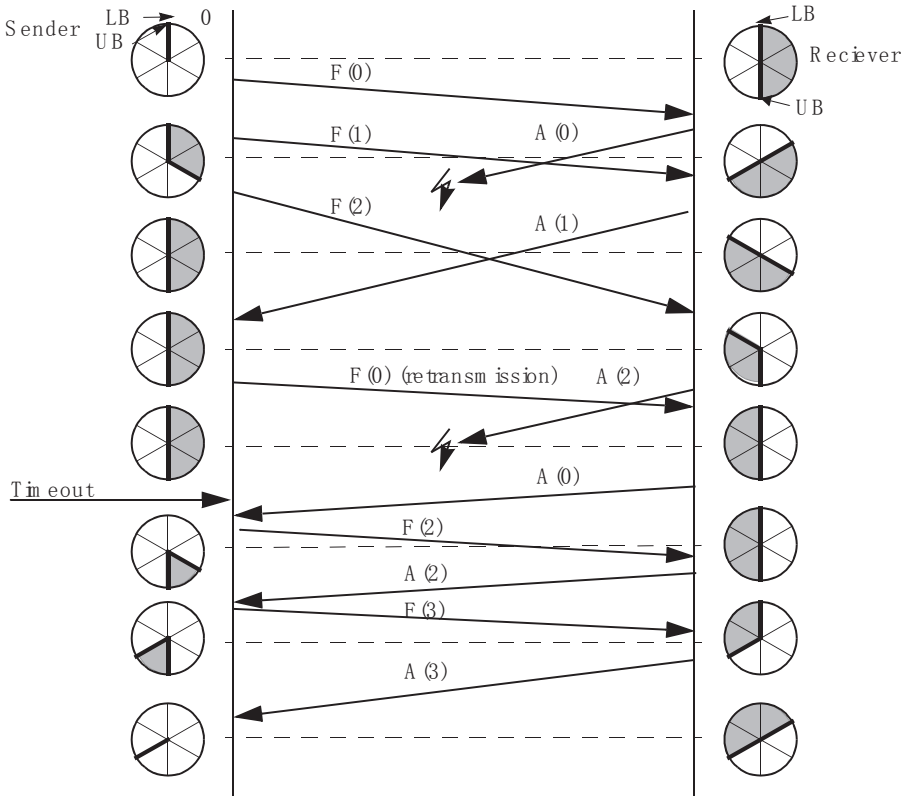
Time	Sender Window			Action		Receiver Window		
	B	L	U	Sender	Receiver	L	U	B
0	3	0	0			0	2	3
1	2	0	1	F 0		0	2	3
2	2	0	1		F 0	1	2	2
3	1	0	2	F 1	ACK 0	1	3	3
4	1	0	2		F 1	2	3	2
5	2	1	2	ACK 0		2	3	2
6	1	1	3	F 2		2	3	2
7	1	1	3		F 2	3	3	1
8	1	1	3		ACK 2 (lost)	3	5	3
9	0	1	4	F 3		3	5	3
10	0	1	4	timeout	F 3	4	5	2
11	0	1	4	F 1 (retransmit)		4	5	2
12	0	1	4		F 1	4	5	2
13	0	1	4		ACK 3	4	0	3
14	3	4	4	ACK 3		4	0	3
15	2	4	5	F 4		4	0	3
16	2	4	5		F 4	5	0	2
17	2	4	5		ACK 4	5	1	3
18	3	5	5	ACK 4		5	1	3

Problem 3 - Sliding Window

a) The Sliding-Window Protocol with window size 3, sequence numbers 0 – 5, **separate Acknowledgement** and error treatment Selective-Repeat is used. The clock like circles are used to indicate the Sender and Receiver Windows (LB = Lower Bound and UB = Upper Bound). Complete the following diagram.



Solution:



Comment to A(0) after the retransmission: The receiver discards the frame (because it has it already), but sends an acknowlegdement back. It is not possible that this is the F(0) of the next batch.

b) Compare the error treatment methods "Go-Back-N" and "Selective-Repeat"? What does the decision, which one is to be used, depend upon?

Solution: "Go-Back-N" is much simpler to implement, since "Selective-Repeat" needs more complex algorithms (e.g. for buffer management). In most networks the ratio of "probability of a correct transmission" to "Number of bits on the line" respectively to the "end-to-end-delay" is large enough so the smaller protocol overhead of "Go-Back-N" is utilized. If this ratio decreases, the needed buffer and and/or the delay rises, so that "Selective-Repeat" becomes interesting.

c) What does the start_ack_timer do?

Solution: It ensures that an acknowledgement is sent timely when no data is to be sent that could piggyback the acknowledgement.