

## Answers to Exercise 2: Multiplexing and ARQ

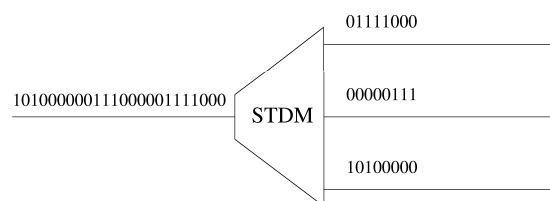
Data Communications

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HT 2009

1.
  - a) 21 bits
  - b) 100 000 frames/s
  - c)  $10 \mu s$
  - d) 2.1 Mbps
  - e) 95%
2.
  - a) 41 bits
  - b) 50 000 frames/s
  - c)  $20 \mu s$
  - d) 2.05 Mbps
  - e) 97.5%
3.
  - a) 72 bits
  - b) 500 frames/s
  - c) 2 ms
  - d) 36 kbps
4.
  - a) 101111101 1 000111110 0 001100111 1 111000101 0  $\rightarrow$
  - b) 1 Mbps
  - c)  $1 \mu s$
  - d)  $10 \mu s$

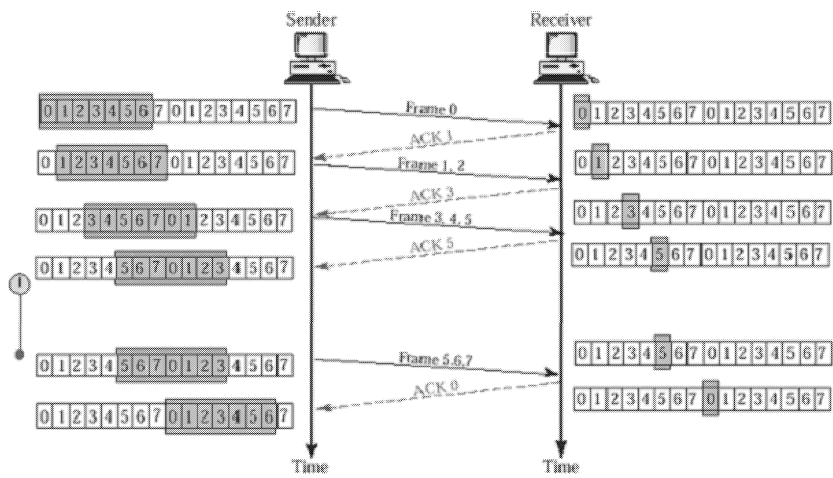
5. a)



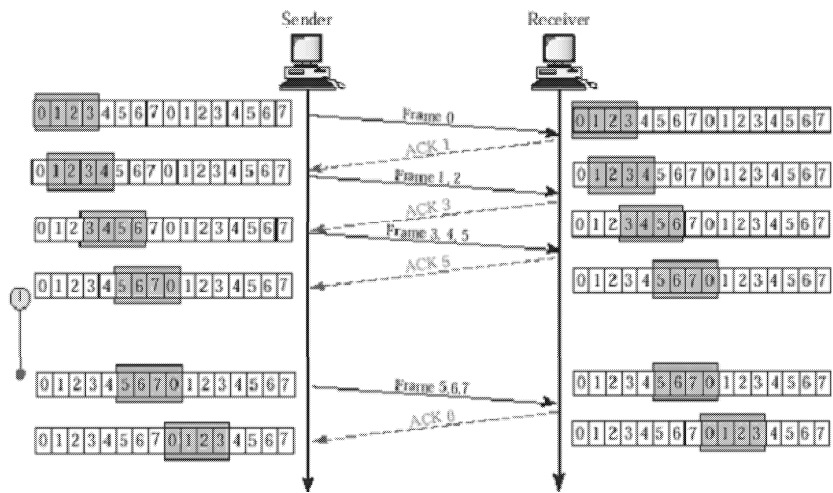
- b) 3 Mbps

6. 2500 Hz
7.  $\geq 4$
8.  $\leq 64$
9.
  - a) 0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7 0 1 2 3
  - b) 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 0 1 2 3

10. See Figure 1 a)
11. See Figure 1 b)
12. If, for example, we choose  $m=2$ , and a window size of 4, the following can happen. Assume that all acknowledgements are lost, and the frame 0 timeout expires. Then, the sender retransmits frame 0. But the receiver, which has received frames 0,1,2, and 3, is now expecting a new frame 0. So when the retransmitted frame 0 arrives, it is incorrectly assumed to be a new frame.



a)



b)

Figure 1: a) Exercise 10, b) Exercise 11.