CHAPTER 10

Data Link Control

10.1 REVIEW QUESTIONS

1. Transmission means to put a signal on a line. Communication is a meaningful and orderly relationship between devices that send and receive data.
2. Line discipline, error control, and flow control.
3. The purpose of line discipline is to determine which device should send data at a given time and to make sure the receiver is ready to receive the data. The line discipline functions of the data link layer oversee the establishment of links and the right of a particular device to transmit data at a given time.
4. The two methods for line discipline are ENQ/ACK and poll/select. The first method is used in peer-to-peer communication. The second method is used in primary-secondary communication.
5. The initiator of the transmission first transmits an ENQ frame asking the receiver if it is ready to receive data. The receiver then answers either with an ACK frame if it is ready or with a NAK frame otherwise.
6. If the primary device wants to receive data it asks the secondary devices if they have anything to send. This is called polling. If the primary wants to send data, it tells the target secondary to get ready to receive the data. This is called selecting.
7. In ENQ/ACK, no addressing is needed because it is a point-to-point connection, which means that any transmission put on the link by one device must be intended for only the other device it is connected to. In poll/select on the other hand, there are several secondary devices and in order to identify and communicate with a specific secondary device, addressing is needed.
8. Polling is used by the primary device to receive transmissions from secondary devices. Selecting is used by the primary device if it wants to send something to secondary devices.
9. Flow control prevents the receiving device from being overwhelmed with data.

10. Each receiving device has a block of memory (buffer) that is used for storing the incoming data until they are processed. If the buffer starts to fill up, the receiver must be able to notify the sender.
11. Stop-and-wait and sliding-window.
12. In stop-and-wait flow control the sender waits for an ACK from the receiver after each frame sent. A new frame is only sent out if the previous frame has been acknowledged.
13. In sliding-window flow control, the sender may transmit several frames before needing an acknowledgment. The receiver can send a single ACK frame to confirm multiple data frames.
14. Error control refers to methods of error detection and retransmission and is based on automatic repeat request (ARQ), which means retransmission of the data in the case of damaged frames, lost frames, or lost acknowledgments.
15. Stop-and wait ARQ and sliding window ARQ.
16. The sender retransmits a packet if the packet was damaged or lost or if the acknowledgment of that packet was lost.
17. The sender waits until it receives an acknowledgment for the last frame sent before sending another frame. The sending device keeps a copy of the frame sent until it receives an ACK. The ACK frames are numbered 0 and 1 alternately to identify the frame. If an error is detected at the receiver it will transmit a NAK frame to request the retransmission of the last frame sent. The sending device has a timer so when time runs out it assumes the frame got lost and resends the last frame.
18. The two types of sliding window ARQ are go-back-n and selective-reject. In the first method, if one frame is lost or damaged, all frames since the last acknowledgment are retransmitted. In selective-reject only the specific damaged or lost frames will be retransmitted.
19. Parameters to be considered are the speed at which the receiver can process data and the size of the buffer to store incoming data at the receiver.
20.
    a. If a frame is damaged, the receiver sends a negative acknowledgment (NAK) indicating the last frame sent was damaged and needs to be retransmitted.
    b. If a frame is lost, the timer goes off and the frame is resent.
21. If a NAK gets lost, the sender timer expires. The sender automatically retransmits the last frame sent. The NAK frames are not numbered because the sender waits for an acknowledgment after each frame is sent. If the sender receives a NAK frame it automatically knows that the last frame sent was damaged and retransmits that frame.
22. In practice, go-back-n ARQ is more popular due to its simplicity of implementation.
23. In the ARQ method frames are discarded when the receiver receives duplicates of already sent frames. This can happen in the case of lost acknowledgment frames, or in go-back-n when a damaged frame is received or a data frame gets lost. In this case all frames sent after that damaged or lost frame will be discarded until the receiver receives an undamaged copy of the damaged or lost frame.

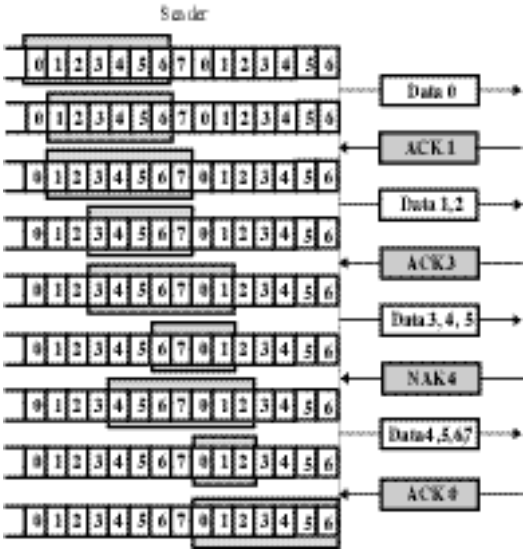
10.2 MULTIPLE CHOICE QUESTIONS

24. c 25. a 26. a 27. b 28. c 29. a 30. c 31. b 32. d 33. c
34. c 35. b 36. c 37. d 38. b 39. c 40. b 41. d 42. d 43. a
44. c 45. a

10.3 EXERCISES

46. See Figure 10.1.

Figur e 10.1 *Exercise 46*



47. See Figure 10.2

48.

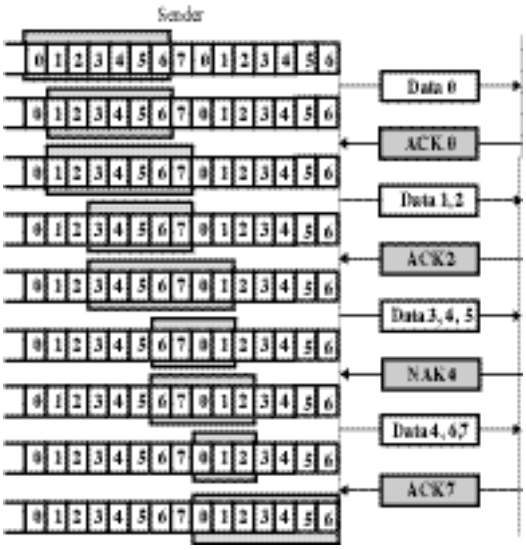
a. Data frame or NAK
b. ACK or NAK

49.

a. No number
b. The number refers to the damaged frame; all frames sent since that last frame acknowledged should be resent.
c. The number refers to the damaged frame; only that frame should be resent.

50.

Figur e 10.2 *Exercise 47*



a. The number refers to the receipt of an acceptable frame.
b. The number refers to the next expected frame.
c. The number refers to the next expected frame.

51.

a. Frames 7 and 0 received; next frame expected is frame 1
b. Frames 7, 0, 1, 2, and 3 received; next frame expected is frame 4
c. Frames 7, 0, 1, 2 received; the next frame expected is frame 3
d. Frames 7 and 0 received; frame 1 was damaged or lost. Frames 1, 2, and 3 should be resent.
e. Frames 7, 0, 1, and 2 received; frame 3 damaged or lost. Frame 3 should be resent.
f. Frame 7 damaged or lost. Frames 7, 0, 1, 2, and 3 should be resent.

52. Four bits.
53. 127.
54. 0, 1, 2, 3, 4, 5, 6, 7, 0, 1, 2, 3, 4, 5, 6, 7, 0, 1, 2, 3, 4, 5, 6, 7, 0, 1, 2
55. Window size is 15.
56. See Figure 10.3.
57. See Figure 10.4
58. See Figure 10.5.
59. See Figure 10.6
60. See Figure 10.7
61. See Figure 10.8.

Figure 10.3 *Exercise 56*

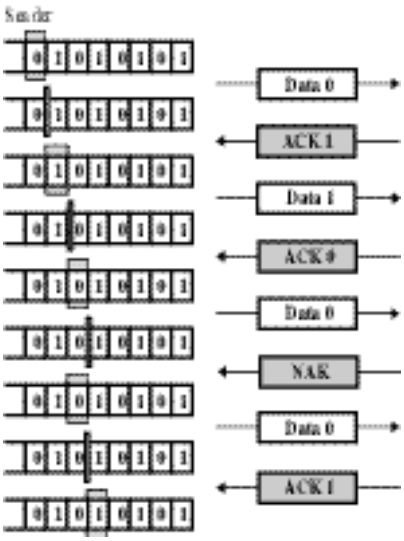
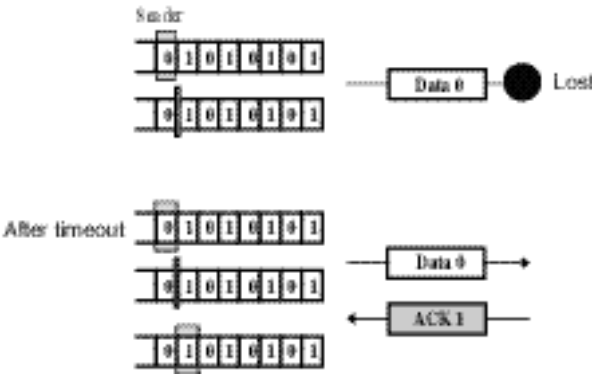


Figure 10.4 *Exercise 57*



62. 26 ms
63. 80 μs
64. 26 ms
65. less than 6 ms
66. See Figure 10.9.
67. See Figure 10.10.
68. See Figure 10.11.
69. See Figure 10.12.

Figure 10.5 *Exercise 58*

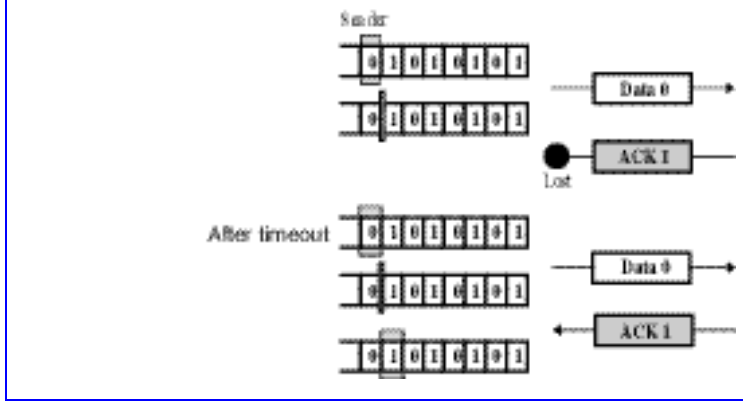


Figure 10.6 *Exercise 59*

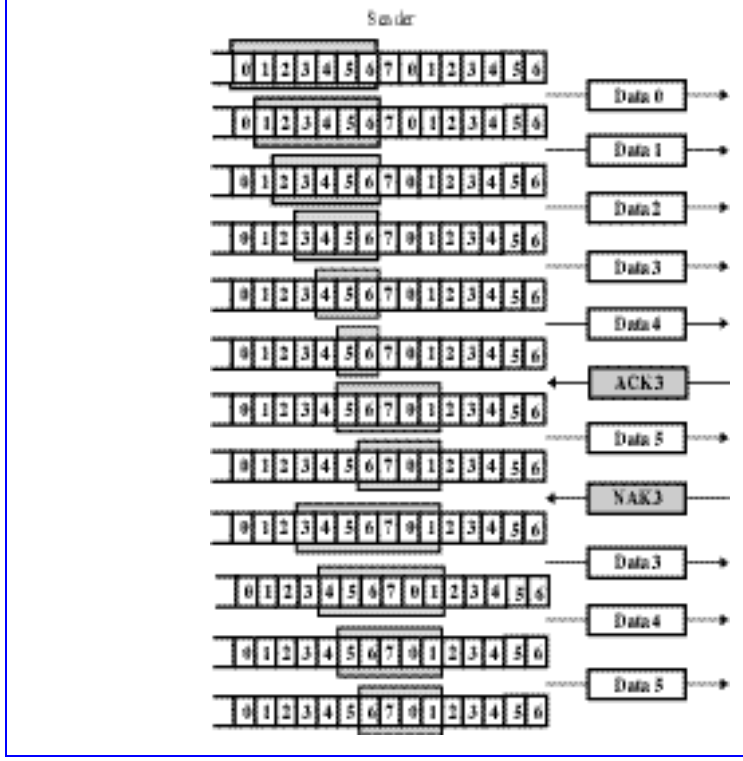


Figure 10.7 *Exercise 60*

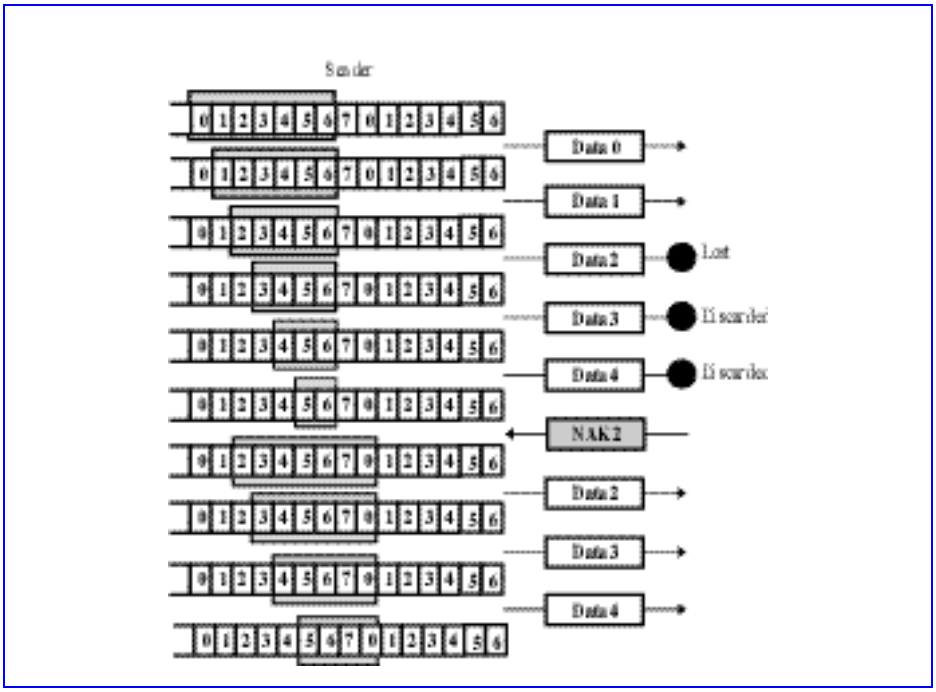


Figure 10.8 *Exercise 61*

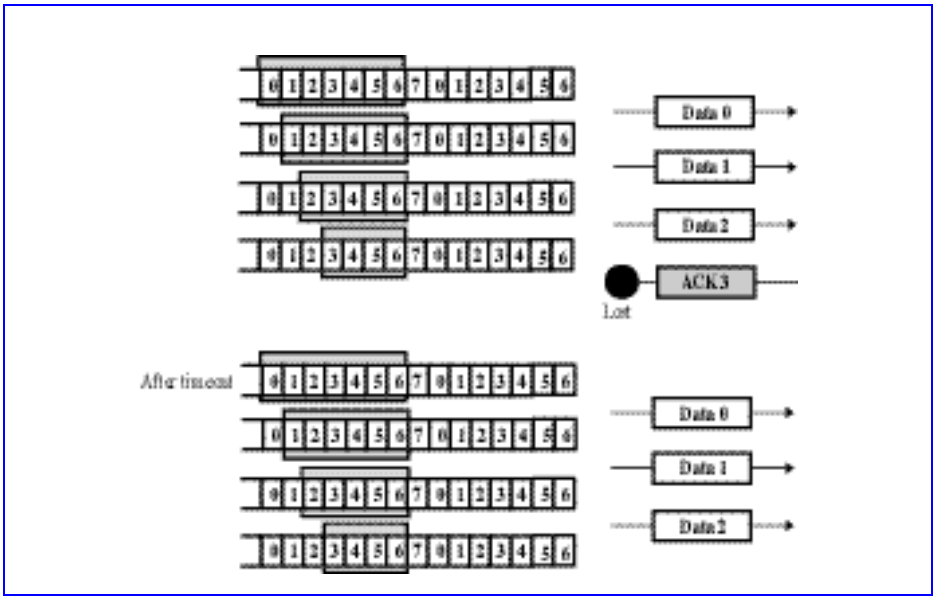


Figure 10.9 *Exercise 66*

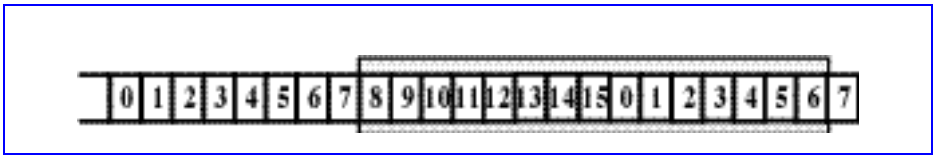


Figure 10.10 *Exercise 67*

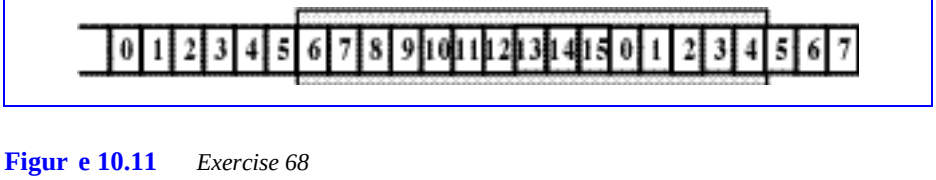


Figure 10.11 *Exercise 68*

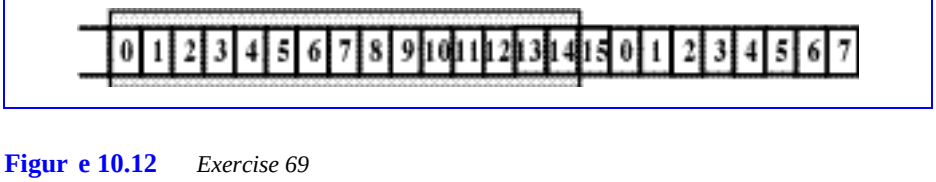


Figure 10.12 *Exercise 69*