CHAPTER 8

Multiplexing

8.1 REVIEW QUESTIONS

1. FDM, WDM, and TDM.
3. A guard band keeps modulated signals from overlapping and interfering with one another.
5. WDM is conceptually the same as FDM. Both are combining different signals of different frequencies. In WDM the frequencies are very high and the energy source is light signals transmitted through fiber optic channels.
7. In TDM digital signals from n devices are interleaved with one another forming a frame of data.
9. In synchronous TDM the demultiplexer at the receiver decomposes each frame by discarding the framing bits and extracting each data unit in turn. As a data unit is removed from the frame it is passed to the appropriate receiving device. In asynchronous TDM the multiplexer at the receiver decomposes each frame by checking the local address of each data unit. The extracted data unit is removed from the frame and passed to the appropriate receiving device.
11. Analog switched service requires dialing, while analog leased service is a permanent dedicated link between two customers; no dialing is needed.
13. Switched/56, DDS, and DS.
15. DS-0: single digital channel (64 Kbps)

    DS-1: 24 DS-0 channels multiplexed = 1.544 Mbps

    DS-2: 4 DS-1 channels multiplexed = 6.312 Mbps

    DS-3: 7 DS-2 channels multiplexed = 44.376 Mbps

    DS-4: 6 DS-3 channels multiplexed = 274.176 Mbps
17. In order to use T lines for analog transmission the analog signal needs to be sampled first.
19. ADSL uses either carrierless amplitude phase (CAP) or the discrete multitone modulation technique (DMT).

21. Digital services are less sensitive to noise and have a wider bandwidth.
23. For synchronous TDM, the number of slots is the same as the number of input lines; for asynchronous TDM, the number of slots can be less than the number of input lines.

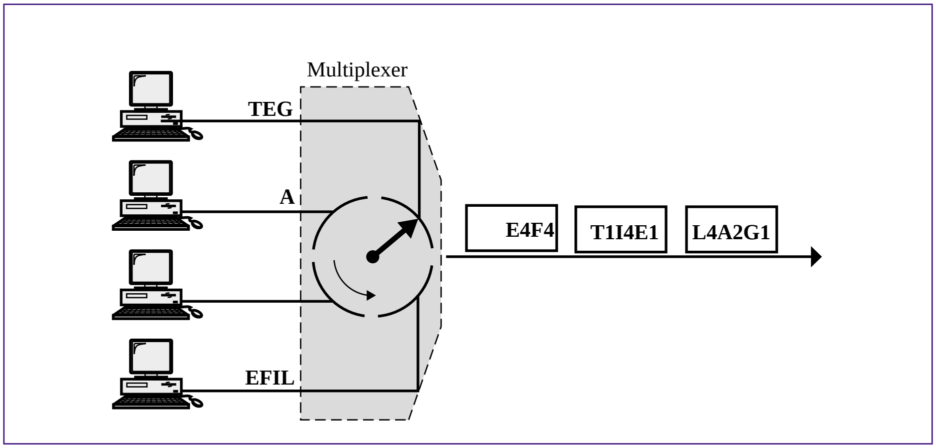
8.2 MULTIPLE CHOICE QUESTIONS

25. d	27. d	29. a	31. a	33. b	35. a	37. b	39. b	41. b	43. d
45. c	47. a	49. d	51. b	53. c	55. a	57. c			

8.3 EXERCISES

59. $(4000 \times 5) + (200 \times 4) = 20.8$ KHz
61. FDM: n is frequency of signal; TDM: n is time (s)
63. Number of slots is derived by statistical method (analysis) of the number of input lines that are likely to be transferring at any given time.
65. See Figure 8.1.

Figure 8.1 *Exercise 65*



67. 168 Kbps
69. The original telephone lines were designed for voice (0 to 4000 Hz).
71. Theoretically, 2,000,000, 000 / 64,000 or 31250 channels. However, we need framing bits for multiplexing. Therefore, the practical number of channels is a little bit less than 31250.
73. Bw = 20KHz – 4KHz = 16 KHz. See Figure 8.2
75. See Figure 8.3.

Figure 8.2 *Exercise 73*

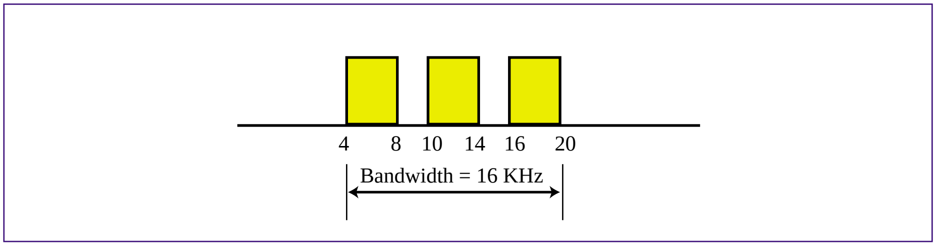
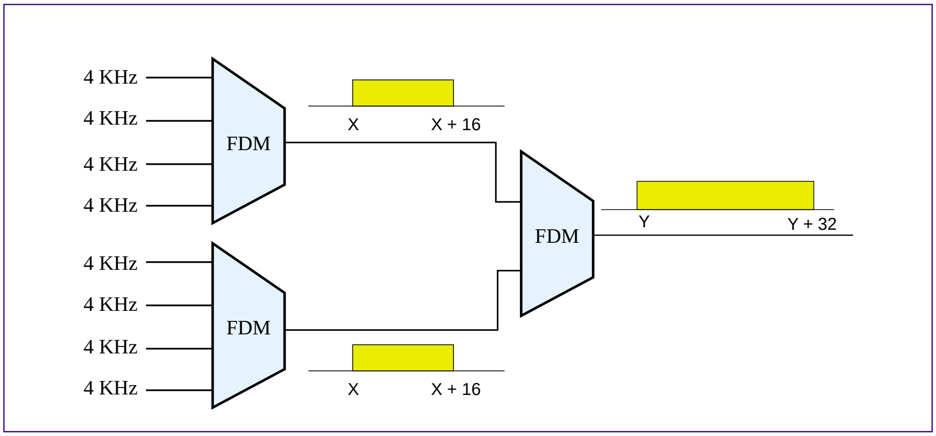
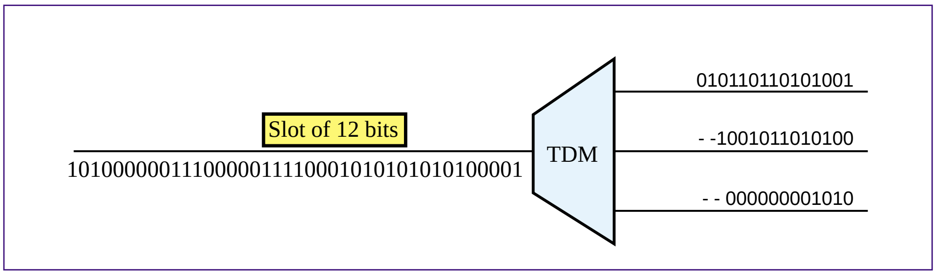


Figure 8.3 *Exercise 75*



77. 14.4 Kbps × 100 = 1.44 Mbps; assuming the overhead is not too big; a T1 line could handle the situation (1.544 Mbps)
79. 2 × 566 Kbps = 1.132 Mbps
81. See Figure 8.4

Figure 8.4 *Exercise 81*



83. Data rate of each line: 40 Kbps; number of stations sending at full capacity: 8
85. 8 Kbps