**Chapter: 4**

**Q6-1.**Describe the goals of multiplexing.

Ans: Multiplexing is a term used to refer to a process where multiple analog message signals or digital data streams are combined into one signal over a shared medium. The aim is to share an expensive resource. Multiplexing is provided by the Physical Layer of the OSI model while multiple access also involves a media access control protocol which is part of the Data Link Layer.

**Q6-2.**List three main multiplexing techniques mentioned in this chapter.

Ans: Frequency division multiplexing (FDM), Wavelength Division Multiplexing (WDM) and Time Division Multiplexing (TDM).

**Q6-3.**Distinguish between a link and a channel in multiplexing.

Ans: In multiplexed system n-lines (channels) share bandwidth of one link (physical path). Channel refers to the portion of the link that carries a transmission between a given pair of lines.

**Q6-4.**Which of the three multiplexing techniques is (are) used to combine analog   
signals? Which of the three multiplexing techniques is (are) used to combine digital signals?

Ans: The Wave division Multiplexing and the Frequency division multiplexing are used to combine analog signals. And the Time Division Multiplexing is used to combine digital signal.

**Q6-5.**Define the analog hierarchy used by telephone companies and list different levels of the hierarchy.

Ans: Telephone companies have multiplexing analog signal data from low bandwidth to high bandwidth line. The analog hierarchy uses voice channels (KHz), groups (48KHz), super-groups (240 KHz), master groups (2.4 MHz) and jumbo groups (15.12 MHz).

**Q6-6.**Define the digital hierarchy used by telephone companies and list different levels of the hierarchy.

Ans: Telephone companies have multiplexing digital signals from low rate data to high bandwidth line. The digital hierarchy uses DS-0 (64 Kbps), DS-1 (1.544 Mbps), DS-2 (6.312 Mbps), DS-3 (44.376 Mbps) and DS-4 (274.176 Mbps).

**Q6-7.**Which of the three multiplexing techniques is common for fiber-optic links? Explain the reason.

Ans: Wavelength division multiplexing (WDM) is common for fiber optic links because it allows the multiplexing of signals with a very high frequency. Optic fiber data rate is higher than metallic transmission cable.

**Q6-8.**Distinguish between multilevel TDM, multiple-slot TDM, and pulse-stuffed TDM.

Ans: **Multilevel TDM:** Multilevel TDM is used when the data rate of an input line is a multiple of others**.**

**Multiple Slot TDM:** Multi slot TMD is used when many slot in a frame produce 1 single line.

**Pulse stuffed TDM:** Pulse(stuffed TMD is used when bit rate sort are not multiple. So we add dummy to make it the same.

**Q6-9.**Distinguish between synchronous and statistical TDM.

Ans: Synchronous TDM: Data Flow of each input connection is divided into units and each input occupies one output time slot. Number of slots in each frame are equal to input lines. Synchronization bits are used at the beginning of each frame. Max Bandwidth utilization if all inputs have data to send. Buffering is not done, frame is sent after a particular interval of time whether someone has data to send or not.

Statistical TDM: Slots are allotted dynamically i.e input line is given slots in output frame iff it has data to send. Number of slots in each frame is less than the number of input lines. No synchronization bits are used. The capacity of link is normally less than the sum of the capacity of each channel. Buffering is done and only those inputs are given slots in output frame whose buffer contains data to send.

**Q6-10.**Define spread spectrum and its goal. List the two spread spectrum techniques discussed in this chapter.

Ans: Spread spectrum is when multiplexing combines signals from several source to achieve bandwidth efficiency. **Goal:** Spectrum are designed to use in wireless applications. **Two spectrum: Frequency hopping spread spectrum (**FHSS) **and Direct sequence spread spectrum (**DSSS).

**Q6-11.**Define FHSS and explain how it achieves bandwidth spreading.

Ans: The frequency hopping spread spectrum uses M different carrier frequencies that are modulated by the source signal. At one moment, the signal modulate one carrier frequency and the other moment, the signal modulates other carrier frequency.

**Q6-12.**Define DSSS and explain how it achieves bandwidth spreading.

Ans: The Direct Sequence Spread Signal expands the bandwidth of the original signal. It replaces each data bit within bits using a spreading code.

**Problem**

**P6-1.**Assume that a voice channel occupies a bandwidth of 4 kHz. We need to multiplex 10 voice channels with guard bands of 500 Hz using FDM. Calculate the required bandwidth.

Solution: Given, Channel Bandwidth 4 KHz

Number of Channel = 10

Guard Bands = 500 Hz or 0.5 KHz

To multiplex 10 nice channels, we need 9 guard bands.

B = 4 \* 10 + 0.5\* 9 = 44.5 KHz.

**P6-2.**We need to transmit 100 digitized voice channels using a passband channel of 20 KHz. What should be the ratio of bits/Hz if we use no guard band?

Solution: The bandwidth allocated to each channel B= 20 KHz/100 = 200 KHz

Data rate of each digitized voice channel = 64 Kbps.

Modulation technique uses the ratio is 64Kbps/200 = 64000/200 = 320 bits/Hz.

**P6-4.**We need to use synchronous TDM and combine 20 digital sources, each of   
100 Kbps. Each output slot carries 1 bit from each digital source, but one extra bit is added to each frame for synchronization. Answer the following questions:   
**a.** What is the size of an output frame in bits? 21 bits.

**b.** What is the output frame rate? 100000 frames/s  
**c.** What is the duration of an output frame? 1/FrameRate = 1/100000.

**d.** What is the output data rate? 100000 \* 21 = 2.1 Mbps.  
**e.** What is the efficiency of the system (ratio of useful bits to the total bits)? In each frame 20 bits out of 21 are useful, Efficiency = (20/21) \* 100 = 95%.

**P6-6.**We have 14 sources, each creating 500 8-bit characters per second. Since only some of these sources are active at any moment, we use statistical TDM to combine these sources using character interleaving. Each frame carries 6 slots at a time, but we need to add 4-bit addresses to each slot. Answer the follow- ing questions:   
**a.** What is the size of an output frame in bits? 6 \* (8+4) = 72 bits.

**b.** What is the output frame rate? Number of slots i.e 6 input lines (Each bit carry 8 bits. Frame rate = 500/1 = 500 frames/s  
**c.** What is the duration of an output frame? 1/500 = 2ms.

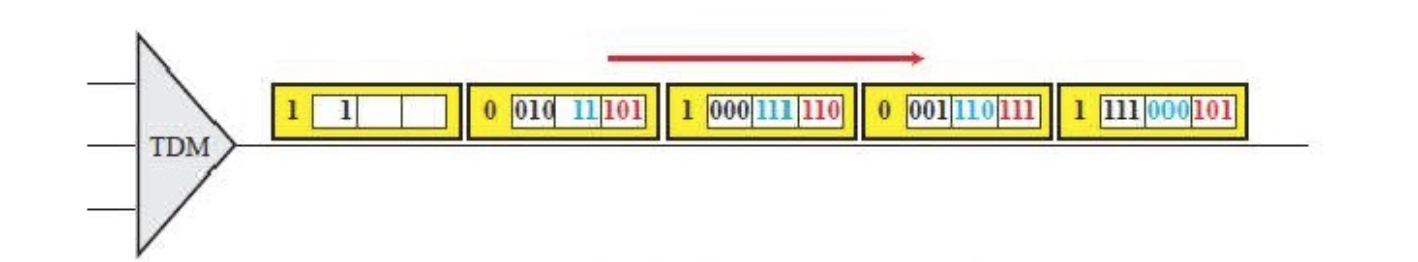
**d.** What is the output data rate? Frame Rate \* Frame size = 500 \* 72 = 36kbps.

**P6-9.**Two channels, one with a bit rate of 190 kbps and another with a bit rate of 180 kbps, are to be multiplexed using pulse-stuffing TDM with no synchronization bits. Answer the following questions:

**a.** What is the size of a frame in bits? 1 + 1 = 2 bits.  
**b.** What is the frame rate? Each frame carries 1 bit from each 190 kbps source = Frame rate = 190000 frames/s  
**c.** What is the duration of a frame? 1/ Frame Rate = 1/190000 = 5.3 us.

**d.** What is the data rate?

Frame Rate \* Frame size = 190000\* 2 = 380 kbps.

**P6-12.**Figure 6.34 shows a multiplexer in a synchronous TDM system. Each output slot is only 10 bits long (3 bits taken from each input plus 1 framing bit). What is the output stream? The bits arrive at the multiplexer as shown by the arrows.

**Chapter: 7**

**Q7-1.**What is the position of the transmission media in the OSI or the Internet   
model?

Ans: The transmission media is located beneath the Physical Layer.

**Q7-2.**Name the two major categories of transmission media.

Ans: Guided Media and UnGuided Media

**Q7-3.**How do guided media differ from unguided media?

Ans: Guided Media has physical boundaries whereas Unguided media is unbounded.

**Q7-4.**What are the three major classes of guided media?

Ans: Twisted Cables, Coaxial Cables and Fiber Optic Cables.

**Q7-5.**What is the function of the twisting in twisted-pair cable?

Ans: The significance is cancelling out any electro magnetic interference (EMI) that may be given out by external resources. These external sources could include crosstalk from other nearby pairs of cables.

**Q7-6.**What is refraction? What is reflection?

Ans: **Reflection**: This happens when a wave traveling in one medium strikes the surface of a different medium and changes direction so that it turns back into the medium that it was originally traveling in.

**Refraction:** The speed at which a wave travels is dependent upon the medium in which it travels alone or through. The speed of a wave changes when a wave moves from one medium to another. This change in speed is accompanied by the change in wavelength and change in direction.

**Q7-7.**What is the purpose of cladding in an optical fiber?

Ans: Optical fiber transmits optical signals using refraction of that signal. For refraction to happen the densities at the refracting media should be different. This is why cladding is used.

**Q7-8.**Name the advantages of optical fiber over twisted-pair and coaxial cable.

Ans: Higher Bandwidth, Less signal attenuation and other losses, Electromagnetic Isolation, Less weight and Smaller in size but great capacity.

**Q7-9.**How does sky propagation differ from line-of-sight propagation?

Ans: Sky propagation is not limited to send signals to receivers line of sight is dependent on direction range and objects which may occur between sender and receiver. Sky propagation is not limited in sense of distance of source and destination and not restricted by being in range or in direction with antennas. In this case signals are sent towards space and then signals have vast range to reach receivers back to the earth. Sky is the beyond the troposphere and ionosphere. When signals gone beyond these spheres so when satellite will reflect those signals back they will have much vast access to receivers. On other hand line of sight propagation is limited because of earth curvature. If antennas (source and target) are not directional not facing each other or something preventing to establish the connection so communication won’t be made.

**Q7-10.**What is the difference between omnidirectional waves and unidirectional waves?

**Ans:** Omni direction meant that different direction whereas unidirectional means waves having single direction. Omni direction devices receive and broadcast their signals from all directions whereas Unidirectional focuses on picking up or transmitting their signals from one direction.

**Problem:**

P:1 Tabulate the attenuation

Solution:

|  |  |  |  |
| --- | --- | --- | --- |
| **Distance** | **dB at 1 KHz** | **dB at 10 KHz** | **dB at 100 KHz** |
| **1 km** | **-3** | **-5** | **-7** |
| **10 km** | **-30** | **-50** | **-70** |
| **15 km** | **-45** | **-75** | **-105** |
| **20 km** | **-60** | **-100** | **-140** |

**P:3 Tabulate the Attenuation**

**Solution:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Distance** | **dB at 1 KHz** | **dB at 10 KHz** | **dB at 100 KHz** |
| **1 km** | **-3** | **-7** | **-200** |
| **10 km** | **-30** | **-70** | **-200** |
| **15 km** | **-45** | **-105** | **-300** |
| **20 km** | **-60** | **-40** | **-400** |

**P: 7 In Book:**

Solution: a) B = [(2 \* 108) 1000 \* 10 – 9] – [(2 \* 108) 1200 \* 10 – 9] = 33 THz

b) B = [(2 \* 108) 1000 \* 10 – 9] – [(2 \* 108) 1400 \* 10 – 9] = 57 THz

P: 10 In Book

Solution: The Delay = distance / propagation speed.

1. Delay = 10/2\*108 = 0.05 ms
2. Delay = 100/2\*108 = 0.5 ms
3. Delay = 1000/2\*108 = 5 ms