The Islamic University of Gaza

Faculty of Engineering

Computer Engineering Department

Data Communications ECOM 4314

Solution

(Chapters 5-6-7-8)

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1. A cable company uses one of the cable TV channels (with a bandwidth of 6 MHz) to provide digital communication for each resident. What is the available data rate for each resident if the company uses a 64-QAM technique?

A digital circuit switched network has a path of 1Mbps. The exchange of 1000bits is required for the setup and teardown phases. The distance between two communicating nodes is 5000Km. If the propagation speed is 2108 m/s, what is the total delay if 100,000 bits of data are exchange during the data transfer phase?

Total Delay = setup delay + data transfer delay + tear down delay

(1) setup delay = $2T_p + 2T_r$

$= 2\left(\frac{5*10^6}{2*10^8}\right) + 2\left(\frac{1*10^3}{1*10^6}\right)$

$= 5*10^{-2} + 2*10^{-3} =$ 0.052 sec

(2) Data Transfer delay = $T_r + T_p$

$= \frac{100*10^3}{1*10^6} + \frac{5*10^6}{2*10^8}$

$= 0.1 + 0.025 =$ 0.125 sec

(3) Tear down delay = $T_p + T_r$

$= \frac{5*10^6}{2*10^8} + \frac{1*10^3}{1*10^6}$

$= 0.025 + 0.001 =$ 0.026 sec

Total delay = $3T_p + 3T_{r_{st}} + T_p + T_{r_{td}}$

$= 0.052 + 0.125 + 0.026 = 0.203$

= 203 m sec

3. We need to use synchronous TDM and combine 20 digital sources, each of 100 Kbps. Each output slot carries 1 bit from each digital sources, 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?
b. What is the output frame rate?
c. What is the duration of an output frame?
d. What is the output data rate?
e. What is the efficiency of the system (ratio of useful bits to the total bits).

a) frame size = 20 + 1 = **21 bit**

b) frame rate = $\frac{1}{\text{frame duration}} = \frac{1}{\text{input slot duration}}$

= **100,000 frame/sec**

c) frame duration = $\frac{1}{\text{frame rate}} = \frac{1}{100000} = 0.01 * 10^{-3}$

= 0.01 msec

= **10 Msec**

d) output data rate = frame rate * frame size

= $100 * 10^3 * 21$

= 2100 kbps = **2.1 Mbps**

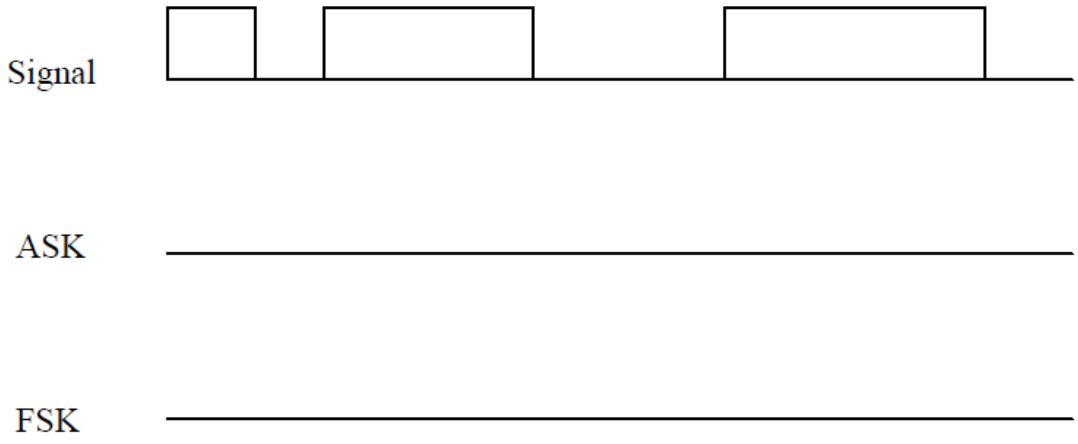
e) efficiency = $\frac{\text{useful bits}}{\text{total sent bits}} = \frac{20}{21}$ = **0.9523**

* 20 bit of each frame is useful
21 bit are actually sent per frame.

Percentage = 0.9523 * 100

= **95.23 %** of the sent data is useful !!

4. What are the modulated signals for the sample signal below. (You can choose the carrier frequencies, but make sure they are distinguishable).

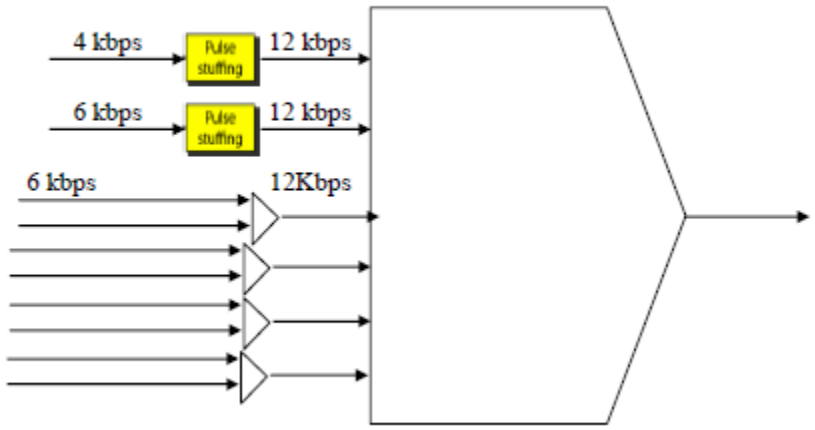


(Do it by yourself☺)

5. We need to use synchronous TDM and combine 10 digital sources; as follows: Source 1: 4 Kbps data rate. Sources 2-10: 6 Kbps data rate. 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:

1. Draw the TDM block so that the data rate should be 12Kbps for each multiplexer input?

Solution:



2. What is the size of an output frame in bits?

Solution: Each output frame carries 1 bit from each source plus one extra bit for synchronization. Frame size = 6 × 1 + 1 = **7 bits.**

3. What is the output frame rate?

Solution:
12,000 frames/s

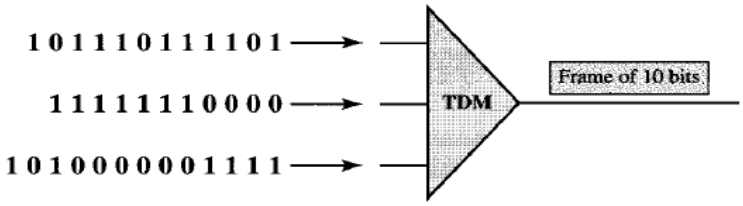
4. What is the duration of an output frame?

Solution:
Frame duration = 1 /(frame rate) = 1 /12,000 = **83.3 µs.**

5. What is the output data rate?

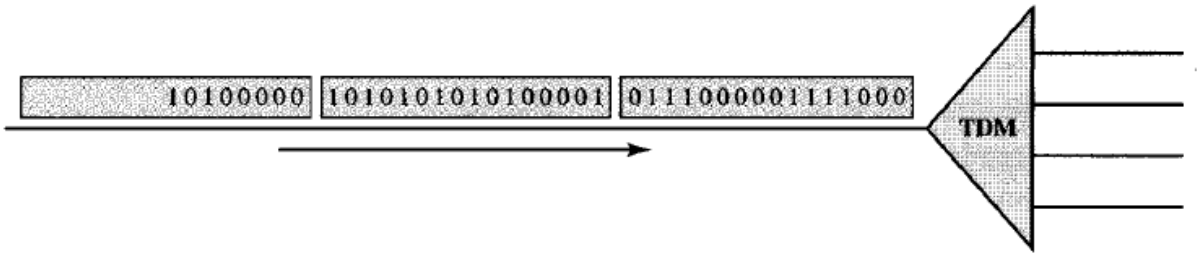
Solution:
Data rate = (12,000 frames/s) × (7 bits/frame) = **84 Kbps**

6. The figure below 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.

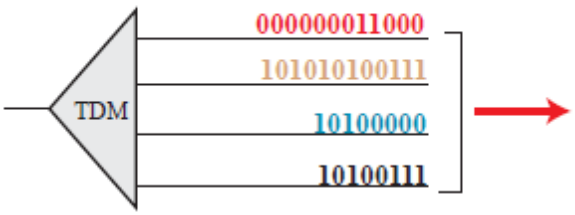


Sol:

7. The figure below shows a demultiplexer in a synchronous TDM. If the input slot is 16 bits long (no framing bits), what is the bit stream in each output? The bits arrive at the demultiplexer as shown by the arrows.



Sol:



8. Calculate the baud rate for the given bit rate and type of modulation.

a. 2000 bps, FSK

b. 36,000 bps, 64-QAM

9. Find the bandwidth for the following situations if we need to modulate a 5-KHz voice.

a. AM

$B_{AM} = 2 \times B = 2 \times 5 = 10$ KHz

b. PM (set $\beta = 5$)

$B_{PM} = 2 \times (1 + \beta) \times B = 2 \times (1 + 1) \times 5 = 20$ KHz

10. What is the required bandwidth for the following cases if we need to send 4000 bps? Let d = 1.

a. ASK

r → B= (1 + 1) × (1/1) × (4000 bps) = 8000 Hz

b. FSK with $2\Delta f$ = 4 KHz

r = 1 → B = (1 + 1) × (1/1) × (4000 bps) + 4 KHz = 8000 Hz

c. QPSK

r = 2 → B = (1 + 1) × (1/2) × (4000 bps) = 2000 Hz

11. 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.

12. Choose the correct answer

1. How many carrier frequencies are used in QPSK?

a) 2
b) 1
c) 0
d) none of the above

2. Which of the following is not an analog-to-analog conversion?

a) AM
b) PM
c) FM
d) QAM

3. In _____ transmission, the carrier signal is modulated so that its amplitude varies with the changing amplitudes of the modulating signal.

a) AM
b) PM
c) FM
d) none of the above

4. Given an AM radio signal with a bandwidth of 10 KHz and the highest-frequency component at 705 KHz, what is the frequency of the carrier signal?

a) 700 KHz
b) 705 KHz
c) 710 KHz
d) Cannot be determined from given information

5. If the baud rate for a 64-QAM signal is 2000, what is the bit rate?

a) 300
b) 400
c) 1000
d) 12000

6. In QAM, both _____ of a carrier frequency are varied.

a) frequency and amplitude
b) phase and frequency
c) amplitude and phase
d) none of the above

7. In synchronous TDM, for n signal sources of the same data rate, each frame contains _____ slots.

a. n
b. n + 1
c. n - 1
d. 0 to n

8. In TDM, the transmission rate of the multiplexed path is usually _____ the sum of the transmission rates of the signal sources.

a. greater than
b. less than
c. equal to
d. not related to

9. _____ utilization is the use of available bandwidth to achieve specific goals.

a. Frequency
b. Bandwidth
c. Amplitude
d. None of the above

10. FSM is an _____technique.

a. analog
b. digital
c. either (a) or (b)
d. none of the above

11. In _____ TDM, slots are dynamically allocated to improve bandwidth efficiency.

a. synchronous
b. statistical
c. isochronous
d. none of the above

12. Transmission media lie below the _____ layer.

a) physical
b) network
c) transport
d) application

13. _____ cable consists of an inner copper core and a second conducting outer sheath.
a) Twisted-pair
b) Coaxial
c) Fiber-optic
a) Shielded twisted-pair

14. Which of the following primarily uses guided media?
a) cellular telephone system
b) local telephone system
c) satellite communications
d) radio broadcasting

15. What is the major factor that makes coaxial cable less susceptible to noise than twisted-pair cable?
a) inner conductor
b) diameter of cable
c) outer conductor
d) insulating material

16. A(n) _____ medium provides a physical conduit from one device to another.
a) guided
b) unguided
c) either (a) or (b)
d) none of the above

17. _____ cable can carry signals of higher frequency ranges than _____ cable.
a) Twisted-pair; fiber-optic
b) Coaxial; fiber-optic
c) Coaxial; twisted-pair
d) none of the above

18. Circuit switching takes place at the _____ layer.
a) data line
b) physical
c) network
d) transport

19. In _____, there is no resource allocation for a packet.
    a) datagram switching
    b) circuit switching
    c) frame switching
    d) none of the above

20. A _____ network is a cross between a circuit-switched network and a datagram network. It has some characteristics of both.
a) virtual-circuit
b) packet-switched
c) frame-switched
d) none of the above

21. A _____ network is made of a set of switches connected by physical links, in which each link is divided into n channels.
a) line-switched
b) frame-switched
c) circuit-switched
d) none of the above