Data Comm Assignment 2

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COURSE : DATA COMMUNICATION
SECTION : H

CHAPTER - 05

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Answer

$\boxed{P5-1.}$

We know.

$$S = \frac{1}{r} \times N$$

(a) FSK

$\therefore r = \log_2 L = \log_2 2 = 1$ $\because L = 2$, $N = 2000$ bps Bit rate.

Baud rate, $S = \frac{1}{1} \times 2000$ bps $= 2000$ baud

(b) ASK

$L = 2$, $N =$ Bit rate $= 4000$ bps

$\therefore r = \log_2 L = \log_2 2 = 1$

Baud rate, $S = \frac{1}{1} \times 4000$ bps $= 4000$ baud

(c) QPSK

$L = 4$, $N =$ Bit rate $= 6000$ bps

$\therefore r = \log_2 L = \log_2 4 = 2$

Baud rate, $S = \frac{1}{2} \times 6000$ bps $= 3000$ baud

(d) 64-QAM

$L = 64$, $N =$ Bit rate $= 36{,}000$ bps

$\therefore r = \log_2 L = \log_2 64 = 6$

Baud rate, $S = \frac{1}{6} \times 36000$ bps $= 6000$ baud

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P5-2 We know,

Bit rate, $N = r \times S$

(a) FSK, Given,

$L = 2$, $S = 1000$ baud $\therefore r = \log_2 L = \log_2 2 = 1$

Bit rate, $N = 1 \times 1000 = 1000$ bps

(b) ASK

Given, $L = 2$, $S = 1000$ baud

$\therefore r = \log_2 L = \log_2 2 = 1$

Bit rate, $N = 1 \times 1000 = 1000$ bps

(c) BPSK

Given, $L = 2$, $S = 1000$ baud

$\therefore r = \log_2 L = \log_2 2 = 1$

Bit rate, $N = 1 \times 1000 = 1000$ bps

(d) 16-QAM

Given, $L = 16$, $S = 1000$ baud

$\therefore r = \log_2 L = \log_2 16 = 4$

Bit rate, $N = 4 \times 1000 = 4000$ bps

Constellation ...

P5-9

We know,

$r = \log_2 L$ to find out the number of bits per baud

(a) ASK → 4 different Amplitude

$\therefore r = \log_2 4 = 2$

(b) FSK → 8 different frequency

$\therefore r = \log_2 8 = 3$

(c) PSK → 4 different phase

$\therefore r = \log_2 4 = 2$

(d) QAM → constellation of 128 points

$\therefore r = \log_2 128 = 7$

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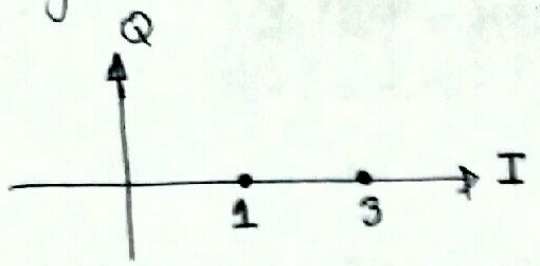
P5-4

Constellation Diagram

(a) ASK

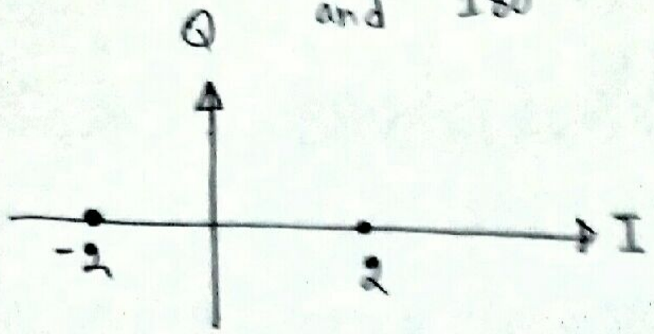
Two signal elements, signal peak amplitude 1 and 3. The phase of both signal elements are the same. Assume as 0 degree.



(b) BPSK

Given, Both signal elements are the same peak amplitude 2

Assuming Two Phase are 0° and 180°



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(c) QPSK

Given,

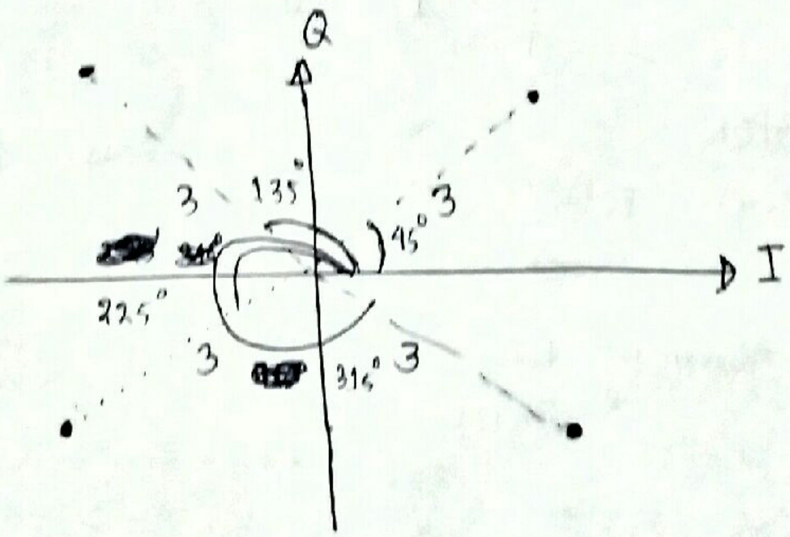
* Four signal elements
* Same peak Amplitude of 3
* Let for each signal elements there will be 90° degree phase difference

* phase would be 45°, 135°, 225°, 315°

45°] 90° phase difference 135°

135°] 90° phase difference 225°

225°] 90° phase difference 315°



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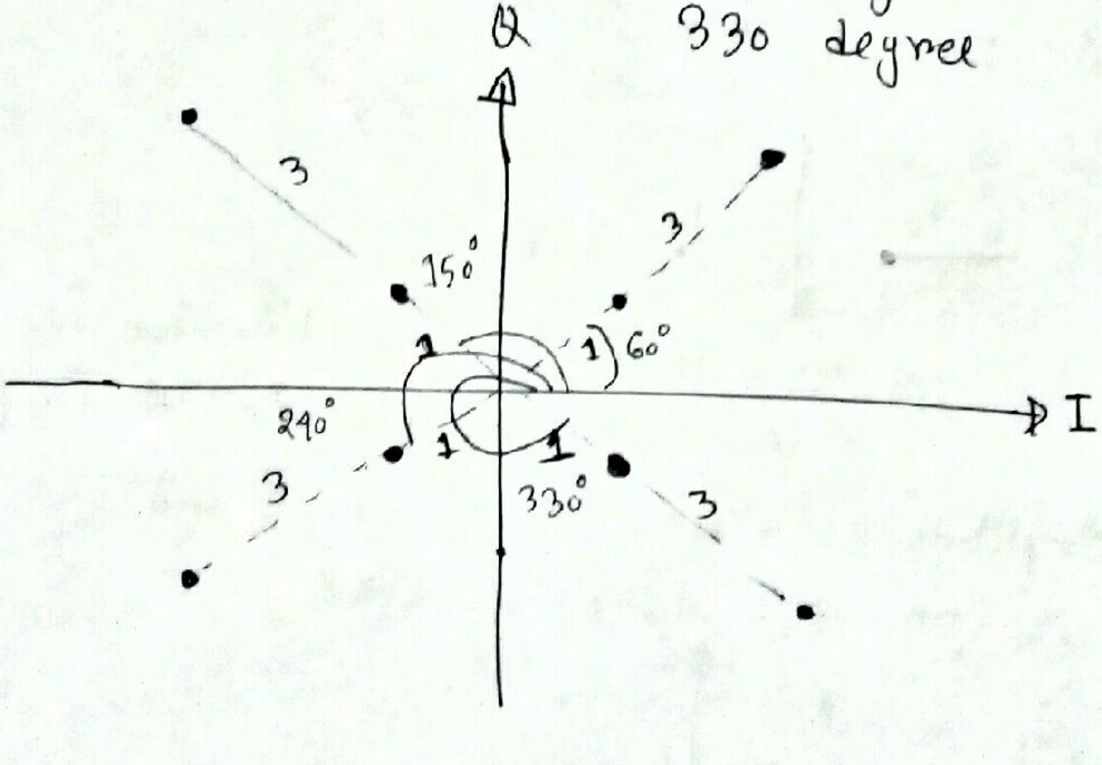
(d) 8-QAM

This diagram is dibberent from previous cause

Given, the Amplitude ~~is~~ can be 1 and 3.

Let phase are.

60 degree
150 degree.
240 degree
330 degree



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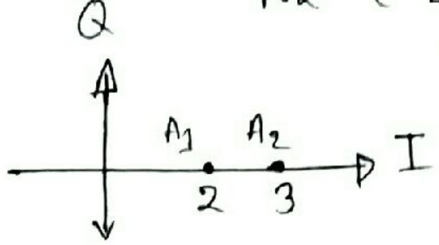
$\boxed{P5-5}$

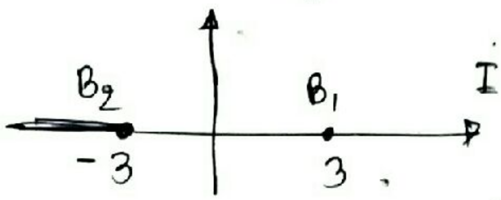
(a) ASK. * Two Peak Amplitude
* Same phase

(I, Q) points For $A_1 = (2, \boxed{0})$ Phase '0'
$A_2 = (3, \boxed{0})$



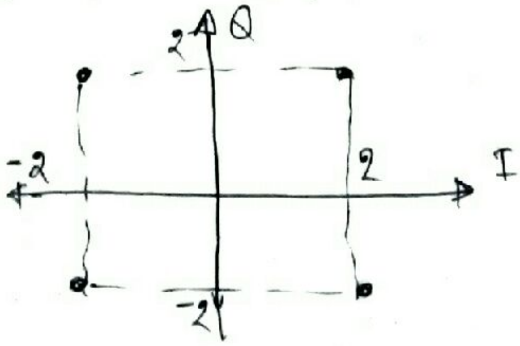
(b) BPSK. * Peak Amplitude 3
* phase Angle different

(I, Q) points for $B_1 = (3, 0)$
$B_2 = (-3, 0)$



(c) This can be either QPSK (1 Amplitude, four phase)
or 4-QAM (1 Amplitude, four phase)

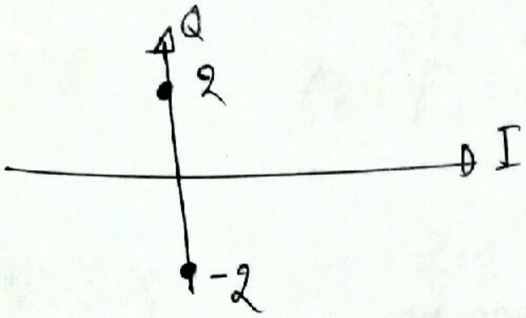
Amplitude is between any one point and origin is $= \sqrt{2^2+2^2} = 2.83$



(d) It's BPSK.

* Peak Amplitude 2
* phase are 90° and 270°.

Points
$(I, Q) = (0, 2)$
$(I, Q) = (0, -2)$



$\boxed{P5-6}$

Bits per baud can we send

The number of bits per baud is actually $= r$

We know, $r = \log_2 L$

'L' is Given for (a) (b) (c) (d)

(a) $L = 2$ $\therefore r = \log_2 L = \log_2 2 = 1$

(b) $L = 4$ $\therefore r = \log_2 L = \log_2 4 = 2$

(c) $L = 16$ $\therefore r = \log_2 L = \log_2 16 = 4$

(d) $L = 1024$ $\therefore r = \log_2 1024 = 10$

$\boxed{P5-7}$ Required Bandwidth

We know

Bandwidth Formula

$$B = (1+d) \times (1/r) \times N$$

Given,

$d = 1$

$N = 4000$ bps

ASK (a) $r = 1$, $B = (1+1) \times (1/1) \times 4000$ bps

$= 8000$ ~~baud~~ Hz

FSK (b) $r = 1$, $B = (1+1) \times (1/1) \times 4000$ bps

$= 8000$ Hz

QPSK (c) $r = 2$, $B = (1+1) \times \frac{1}{2} \times 4000$ bps

$= 4000$ Hz

16-QAM (d) $r = 4$, $B = (1+1) \times \frac{1}{4} \times 4000$ bps

$= 2000$ Hz

$\boxed{P5-8}$ Maximum Number of bits can we send through a telephone line

We know,

Bitrate Formula,

$$N = \left(\frac{1}{1+d}\right) \times r \times B$$

Given, $B = 4$ kHz

$d = 0$

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(a) $L = 2$, 'ASK'

$r = \log_2 L = \log_2 2 = 1$

$\therefore N = \frac{1}{1+0} \times 1 \times 4\,kHz$

$\therefore N = 4\,kbps$

(b) $L = 4$, $r = \log_2 L = \log_2 4 = 2$ 'QPSK'

$\therefore N = \frac{1}{1+0} \times 2 \times 4\,kHz = 8\,kbps$

'16-QAM' (c) $L = 16$, $r = \log_2 L = \log_2 16 = 4$

$\therefore N = \frac{1}{1+0} \times 4 \times 4\,kHz = 16\,kbps$

'64-QAM' (d) $L = 64$, $r = \log_2 64 = 6$

$\therefore N = \frac{1}{1+0} \times 6 \times 4\,kHz = 24\,kbps$

$\boxed{P5-9}$

Bandwidth for each channel? 'QAM technology'

$\therefore B = \frac{1\,MHz}{10} = 100\,kHz$

Bit per baud for each channel

$B = (1+d) \times \frac{1}{r} \times N$ $\quad \because d = 0$

$N = 1\,Mbps$

$B = 100\,kHz$

$r = N/B = \frac{1\,Mbps}{100\,kHz}$

$\therefore r = 10$

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Levels = ?

$\therefore L = 2^r = 2^{10} = 1024$

So, we need 1024-QAM technique to achieve this data rate.

$\boxed{P5-10}$ The avainable Data Rate

We know,

$$N = \frac{1}{1+d} \times r \times B$$

Given,
$d = 0$
$B = 6\,MHz$

64-QAM technique?

$\therefore r = \log_2 64 = 6$

$\therefore r = 6$

$\therefore N = 1 \times 6 \times 6\,MHz = 36\,Mbps$

$\boxed{P5-11}$ Find the bandwidth

Given
$B = 5\,kHz$

(a) AM $B_{AM} = 2 \times B = 2 \times 5$

$\therefore B_{AM} = 10\,kHz$

(b) FM $B_{FM} = 2 \times (1+\beta) \times B$

$= 2 \times (1+5) \times 5\,kHz$

$\therefore B_{FM} = 60\,kHz$

Given,
$\beta = 5$
$B = 5\,kHz$

(c) PM $B_{PM} = 2 \times (1+\beta) \times B$

$= 2 \times (1+1) \times 5\,kHz$

$\therefore B_{PM} = 20\,kHz$

Given,
$\beta = 1$

P

P5-12

Total number of channels

Not the coexistings stations.

(a) AM

(

Highest ~~frequency~~ Amplitude range = 1700 kHz

Lowest ~~frequency~~ Amplitude range = 530 kHz

One channel capacity = 10 kHz

Number of channel = $\frac{1700-530}{10}$ = 117 channel

b (b) FM

Highest frequency range = 108 MHz

Lowest frequency range = 88 MHz

One channel capacity = 200 kHz

) Number of channel = $\frac{108-88}{200} = \frac{20 \text{ MHz}}{200 \text{ kHz}}$

) = 100

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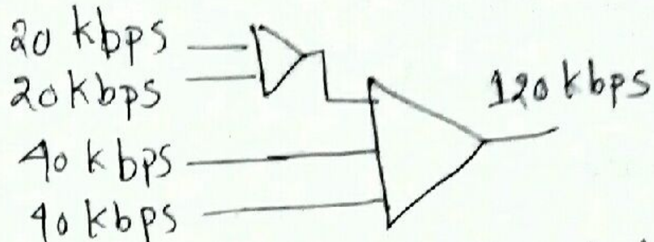
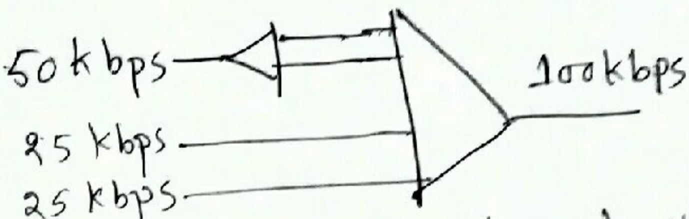
chapter : 06

Q6-8

Multilevel TDM : Some lower Data-rate lines are combined to make a new line with the same data rate of the other lines.



Multiple-slot TDM: Higher Data rate lines to make them compatible with the lower data-rate lines.



Pulse Stuffing TDM : It's used when the data rates of some lines are not an integral multiple of other lines.

Q6-9 Synchronous and Statistical TDM

In Synchronous TDM, each input has a reserved slot in the output frame. This can be inefficient if some input lines have no data to send.

In statistical TDM, slots are dynamically allocated to improve bandwidth efficiency. Only when an input line has a slot's worth of data to send is it given a slot in the output frame.

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Q6-10 Spread Spectrum

In spread spectrum, we spread the bandwidth of a signal into a larger bandwidth. Spread spectrum techniques add redundancy, they spread the original spectrum needed for each station. The expanded bandwidth allows the source to ~~warp~~ wrap its message in a protective envelope for a more secure transmission. Two spread spectrum techniques

* Frequency hopping spread spectrum (FHSS)
* Direct Sequence spread spectrum (DSSS)

Q6-11 FHSS technique:

It uses 'M' different carrier frequencies that are modulated by the source signal. At one moment, the signal modulates one carrier frequency, at the next moment, the signal modulates another carrier frequency.

Q6-12 DSSS technique:

It expands the bandwidth of the original signal. It replaces each data bit with n bits using a spreading code.

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$\boxed{PG-1}$ Band width = ?

Multiplex 10 voice channels

$\boxed{PG-2}$ Ratio of bits/Hz = ?

* Transmit 100 digitalize voice channel
* Passband 20KHz

voice channel bandwidth for each $= \frac{20\ KHz}{100} = 200Hz$

We know,

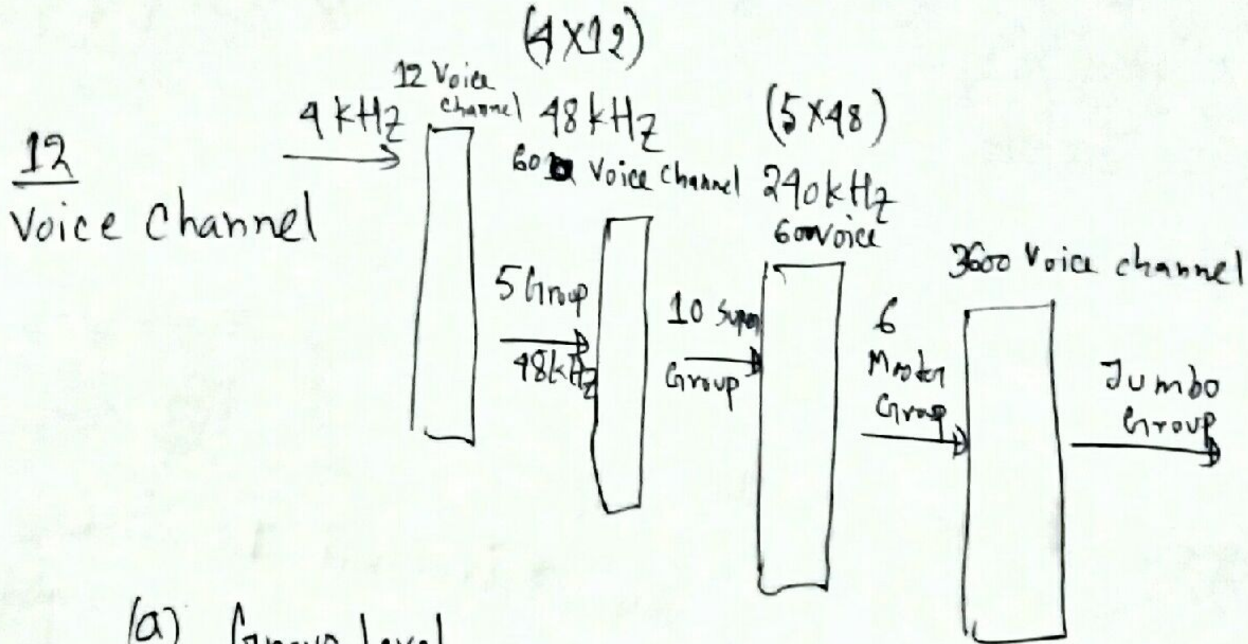
Digitalized voice channel Data rate $= \left(8000\ sample \times \frac{8\ bit}{Sample}\right)$

$= 64\ kbps$

Our modulation technique uses $= \frac{64000}{200} = 320\ bits/Hz.$

P6-3

Overhead - Analog hierarchy



(a) Group level

overhead = 48 kHz - (12 × 4 kHz) = 0 Hz

(b) SuperGroup level

overhead = 240 kHz - (5 × 48 kHz) = 0 Hz

(c) Mastergroup level

overhead = 2520 kHz - (10 × 240 kHz) = 120 kHz

(d) Jumbogroup

overhead = 16,984 MHz - (6 × 2.52 MHz)

= 1.864 MHz

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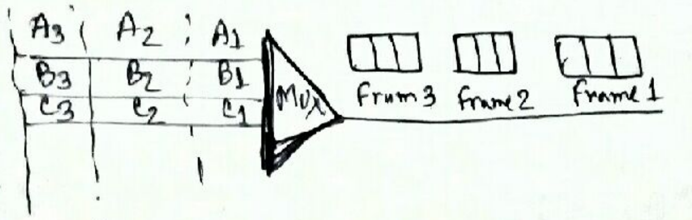
P6-4

* Synchronous TDM
* Combine 20 digital sources
* output slot carries 1 bit from each digital source
* One extra bit added to each frame.

We know, TDM,



We know, Source = 20

(a) Frame size = ?

output frame carries = 1 bit

Synchronous bit = 1 bit

Frame size = source × output frame carries + synchronous bit

∴ Frame size = 20 × 1 + 1

∴ Frame size = 21 bits

(b) Frame rate = ?

Each frame carries 1 bit from each source

frame rate = 100kbps = 100000 frames/s

(c) duration of output frame = ?

$$\text{Frame duration} = \frac{1}{\text{frame rate}} = \frac{1}{100000} = 10\mu s$$

(d) Output Data rate = ?

∴ Output data rate = frame ~~duration~~ Rate × Frame size

= (100000) × (21 bit/frame)

= 2.1 Mbps

(e) In each frame 20 bits out of 21 are useful.

$\therefore$ Efficiency $= 20/21 = 95\%$

$\boxed{P6-5}$

Output slot carries 2 bits from each source

(a) Frame size $= 20 \times 2 + 1$
$= 41$ bits

(b) Each ~~Output~~ frame carries 2 bits from Each source.

$$\text{Frame rate} = \frac{100\,000}{2} = 50,000 \text{ frames/s}$$

(c) $$\text{Frame duration} = \frac{1}{\text{Frame rate}} = \frac{1}{50,000} = 20\,\mu s$$

(d) Data rate = frame rate $\times$ frame Size
$= (50,000 \text{ frame/s}) \times (41 \text{ bits/frame})$
$= 2.05$ Mbps

Output Data rate here is slightly less than the previous

(e) In each frame 40 bits out of 41 are useful. Efficiency $= 40/41 = 97.5\%$

Here Efficiency is Better than previous.

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PG-6

* 14 Sources
* Statistical TDM used for character interleaving
* Each frame carries 6 slots at a time
* Add 4 bit addresses to each slot

(a) Frame size = $6 \times (8+4) = 72$ bits

(b) Assume that we have 6 input lines. Each frame needs to carry one character from ~~ea~~ each of these lines.

Frame rate is 500 frame/s

(c) Frame duration $= \frac{1}{\text{frame rate}} = \frac{1}{500} = 2\text{ms}$

(d) Data rate = (500 frame/s) × (72 bits/frame)
= 36 kbps

PG-7

Sources = 10
6 Bit rate = 200 kbps
4 Bit rate = 400 kbps
* used Multilevel TDM
* No synchronous bit

We combine six 200 kbps into three 400 kbps

Now we have $(3+4) = 7$ 400 kbps channel

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Multiple-slot TDM

(a) Each output frame carries 1 bit from each of the seven 400-kbps line.

$\therefore$ Frame size $= 7 \times 1 = 7$ bits

(b) Each frame carries 1 bit from each 400-kbps source.

Frame rate $= 400\,000$ frame/s

(c) Frame duration $= \frac{1}{\text{frame rate}} = \frac{1}{400\,000} = 2.5\,\mu s$

(d) Output Data rate $=$ (400 000 frame/s) $\times$ (7 bits/frame)

$= 2.8$ Mbps

we also can calculate the output data rate as ~~input~~ the sum of input data rate because there is no synchronous bits.

Output data rate $= (6 \times 200 + 4 \times 400)$

$= 2.8$ Mbps

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P6-8

4 channels

* 2 bit rate = 200 kbps
* 2 bit rate = 150 kbps
* Multiple-slot TDM
* No synchronous bits

(a) Frame carries 4 bits from each of the first two sources and 3 bits from each of the second two sources

Frame size $= 4 \times 2 + 3 \times 2$
$= 14$ bits

(b) Frame rate $= \frac{200\,000}{4} = \frac{150000}{3}$
$= 50,000$ frames/s $= 50,000$ frames/s

(c) Frame duration $= \frac{1}{\text{frame rate}} = \frac{1}{50000} = 20\mu s$

(d) Output data rate $=$ (50,000 frame/s) $\times$ (14 bits/frame)
$= 700$ kbps

2nd Approach,

No synchronous bit, the sum of input data rate

Output data rate $= 2 \times 200 + 2 \times 150$
$= 700$ kbps

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P6-9 Two channels

1 bit rate = 190 kbps

1 bit rate = 180 kbps

* Multiple - slot TDM
* No synchronous bits

(a) Frame size = 1+1 = 2 bits

(b) Each frame carries 1 bit from each 190-kbps source.

Frame rate = 190000 frame/s

(c) Frame duration $= \frac{1}{190000} = 5.3\ \mu s$

(d) Output data rate = (190 000 frames/s) × (2 bits/frame)

= 380 kbps

Here the output bit rate is greater than the sum of the input rates (370 kbps) because of extra bits added to the second source.

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P-6:10 T-1 Line

(a) T-1 line sends 8000 frames,

Frame duration $= \frac{1}{8000} = 125\mu s$

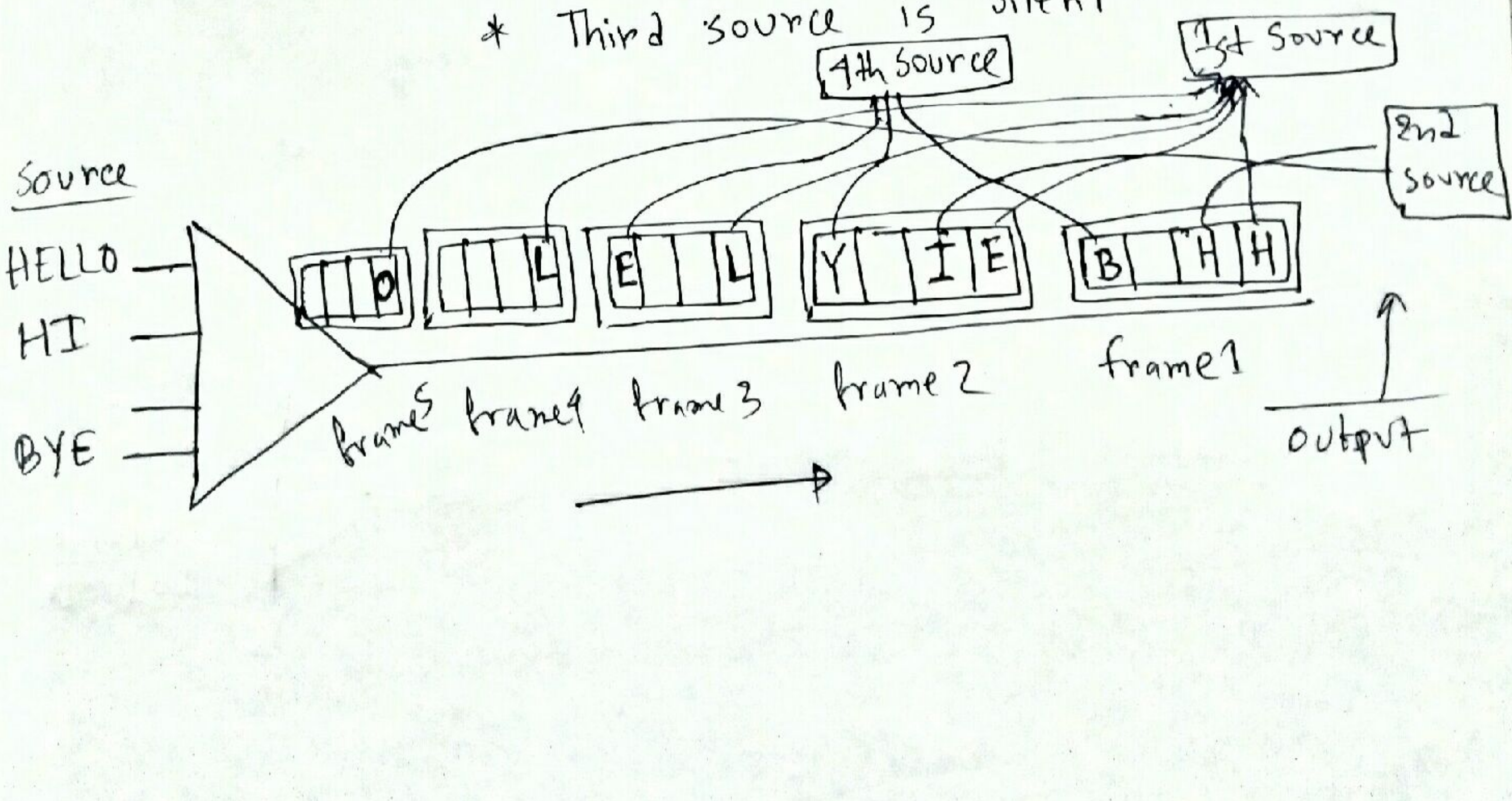
(b) Each frame carries one Extra Bit

Overhead $= 8000 \times 1$

$= 8$ kbps

P6-11 Output Frames = 5

* Synchronous TDM
* Multiplexer combines 4 sources
* Order should ~~be~~ same
* Third source is silent.



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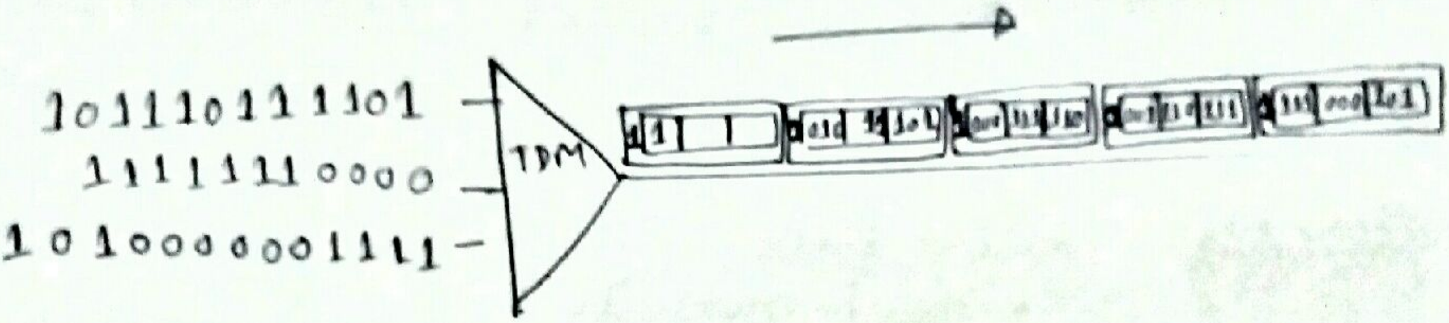
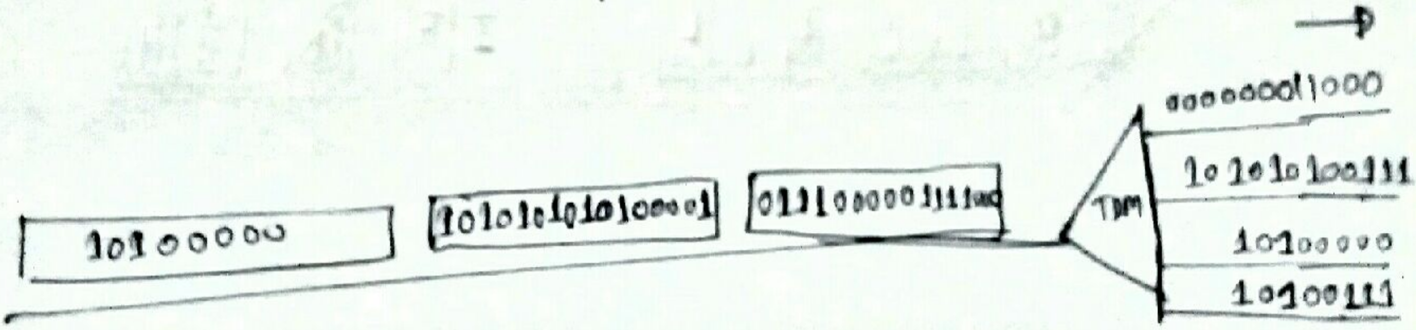
P6-12

* Multiplexer Synchronous TDM
* Output slots 10 bits long
* 3 bits from each input plus 1 framming bit
* output stream?



P6-13

* De Multiplexer Synchronous TDM
* Input slot 16 bits long
* No framing bits
* output bit stream?



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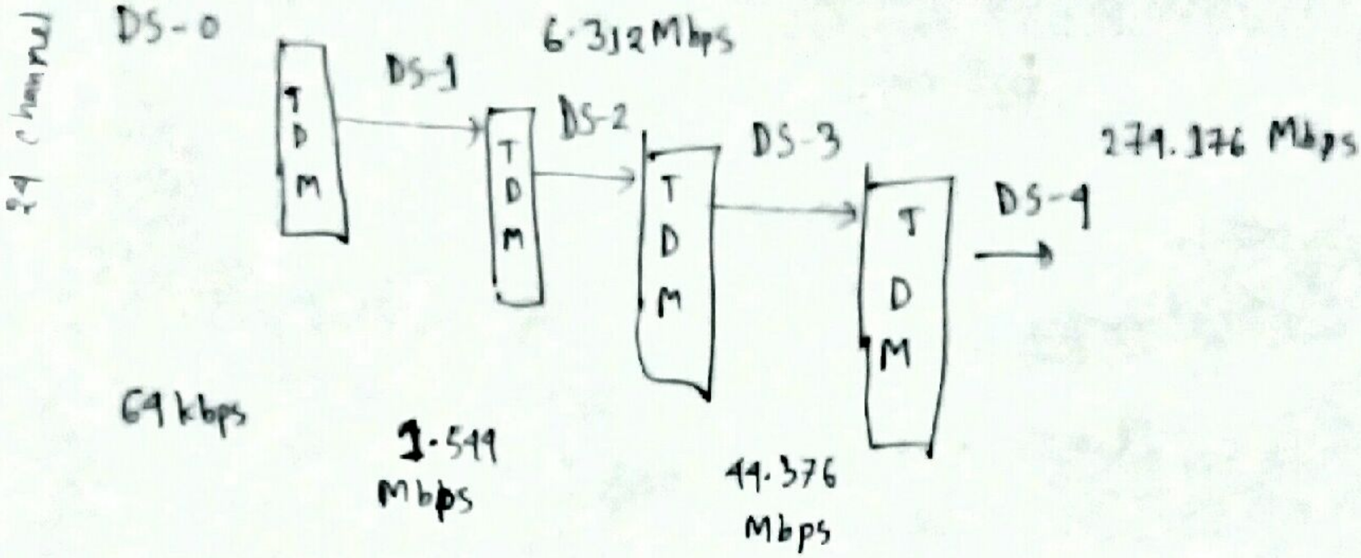
P6-14 Digital Hierarchy



(a) DS-1 overhead = 1.544 Mbps − (24 × 64 kbps)

= 8 kbps

(b) DS-2 overhead = 6.312 Mbps − (4 × 1.544 Mbps)

= 136 kbps

(c) DS-3 overhead = 44.376 Mbps − (7 × 6.312 Mbps)

= 192 kbps

(d) DS-4 overhead = 274.176 Mbps − (6 × 44.376 Mbps)

= 7.92 Mbps

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Create ... and ...

P6-15 PN sequence

Minimum Number of Bits ?

Bit rate 64 bits per seconds

(a) Given, $B = 4kHz$

$B_{SS} = 100\ kHz$

$\therefore$ Hops $= 100kHz / 4kHz = 25$

$\Rightarrow \log_2(\text{hops}) = \log_2 25 = 4.65 \approx 5$ bits

P6-16 Given, 4 bit PN-sequence, $n = 4$, $N = 64$ bps

(a) channel possible $= 2^n = 2^4 = 16$

(b) complete cycle of PN $= \frac{64\text{ bps}}{4\text{ bits}} = 16$ cycles

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$\boxed{P6-17}$ Create a Random Series

Given,

$$N_{i+1} = (5 + 7N_i) \bmod 17 - 1$$

Lets say

Radom Number are,

9, 8, 3, 12, 6, 10, 13, 11

$N_1 = 9$

$N_2 = (5 * 7 \times 9) \bmod 17-1 = 8$

$N_3 = (5 * 7 \times 8) \bmod 17-1 = 3$

$N_4 = (5+7 \times 3) \bmod 17-1 = 12$

$N_5 = (5+7 \times 12) \bmod 17-1 = 6$

$N_6 = (5+7 \times 6) \bmod 17-1 = 10$

$N_7 = (5+7 \times 10) \bmod 17-1 = 13$

$N_8 = (5+7 \times 13) \bmod 17-1 = 11$

$\boxed{P6-18}$ Given, $N = 10$ Mbps

DSSS Barker Sequence ?

Barker chip is 11 bits. Increase bit rate 11 times.

64kbps voice channel needs = 64 Kbps × 11
= 704 kbps

∴ Bandpass can carry = $\frac{10 \text{ Mbps}}{704 \text{ kbps}}$ = 14 channels (approximate)

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