2/11/19

# Analog Carrier System

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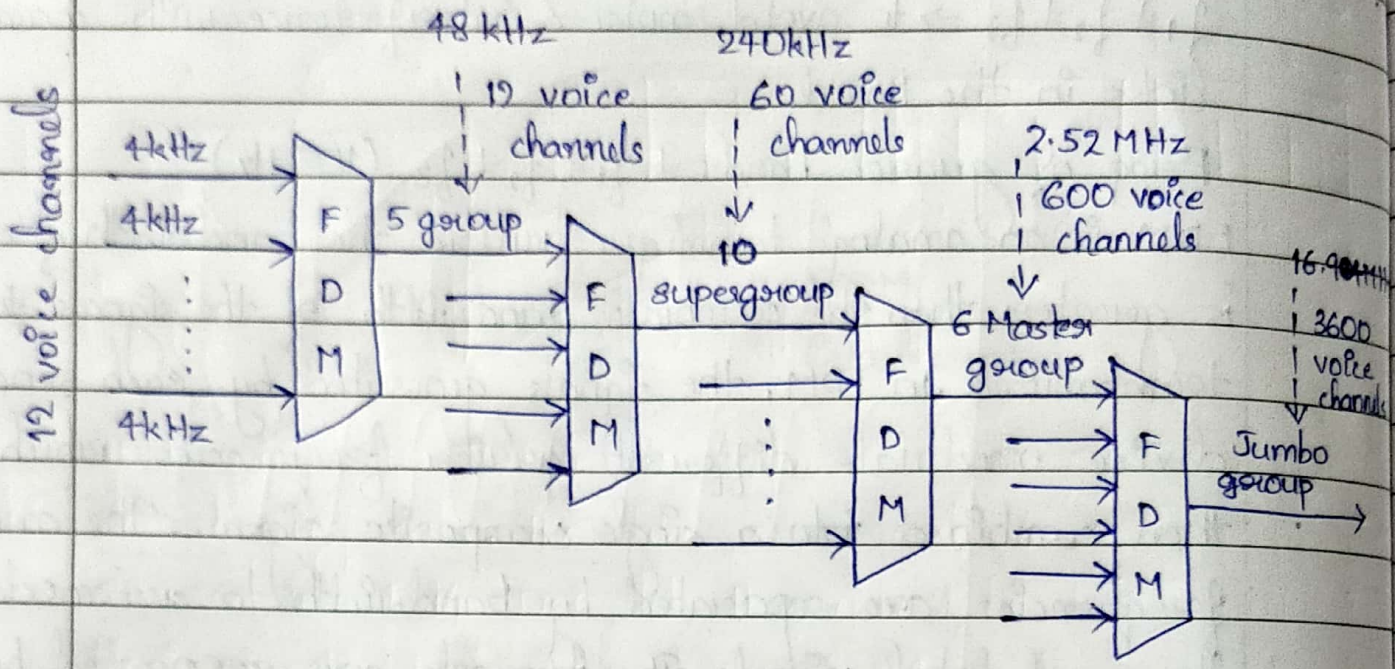
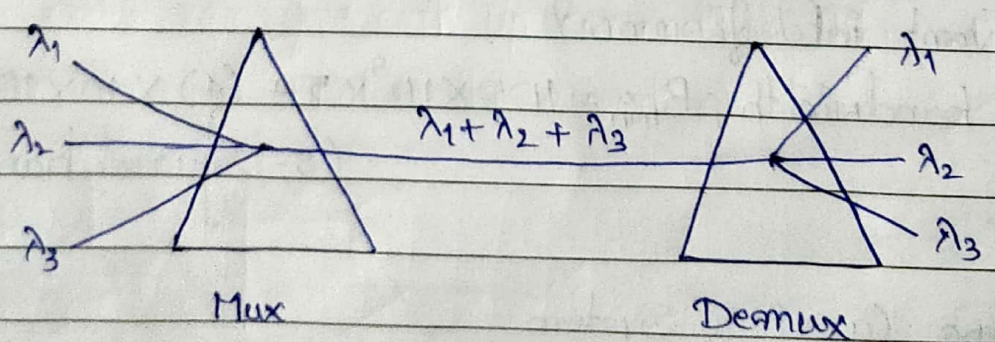



Analog carrier system is implemented in traditional telephone companies to mux signals from lower b/w lines to higher b/w lines.

Other apps of FDM are AM & FM broadcasting. Another app is 1st gen. cellular telephones

(ii) Wavelength Division Multiplexing (WDM)



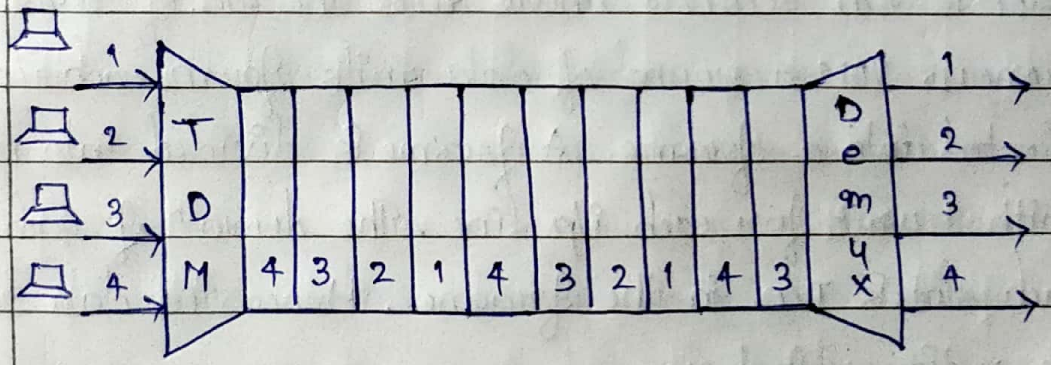

App of WDM → SONET (Synchronous Optical NETworks)

It is an analog mux technique. It uses high data rate based on the capacity of optical fibre cable. It combines the optical signals of different frequencies & the freq. range is very high. The basic idea of WDM is to combine multiple light sources into 1 single light at the mux & do the reverse at demux. The combining & splitting of light sources are handled by a prism based on the angle of incidence & freq.

Apps → SONET

A new method called Dense WDM (DWDM) can multiplex a very large no. of channels by spacing the channels very close to each other.

(iii) Time Division Multiplexing (TDM)

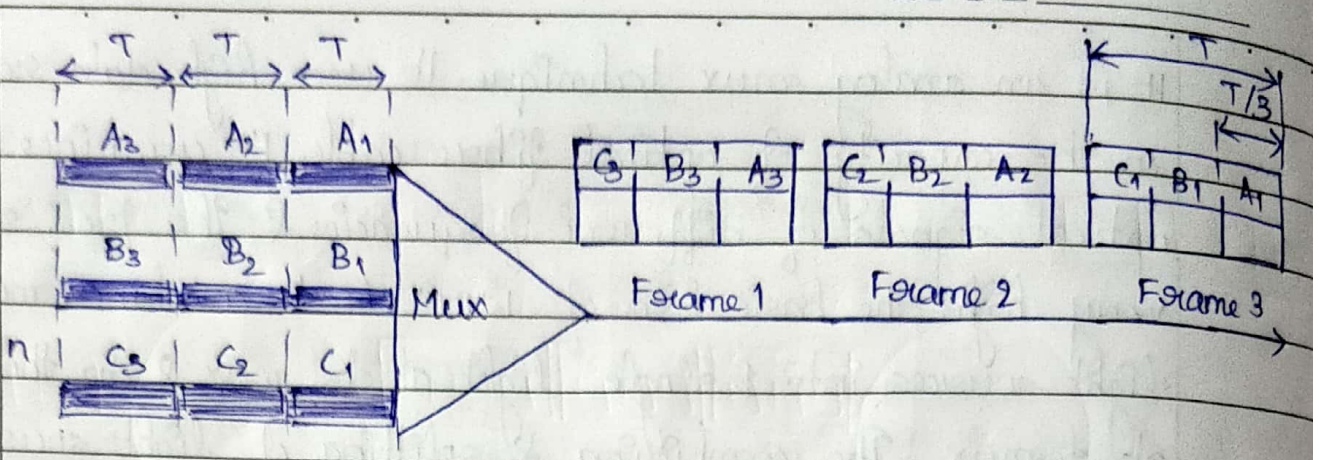



TDM is a digital process that allows several connections to share the high bandwidth of a link. It combines several low rate channels into high rate one. There are 2 types:

(a) Synchronous TDM

(b) Statistical TDM

Synchronous TDM




Synchronous TDM has an allotment in the o/p even if it is not sending data. The data flow of each i/p connectn is divided into 1 i/p time slot. It can be 1 bit, 1 character or 1 block of data. Each i/p unit occupies 1 o/p time slot. But the durat$^n$ of an o/p time slot is n times shorter than the durat$^n$ of i/p time slot i.e. if i/p time slot is T seconds then the o/p time slot is T/n seconds where n is the no. of connect$^n$s. In synchronous TDM a round of data units from each i/p connect is collected into a frame. A frame is divided into n time slots with 1 unit for each i/p line. The durat$^n$ of each frame T & each slot is T/n in the frame. Hence the data rate of t link is n times faster.

① The data rate for each i/p connectn is 1kbps: If 1 bit at a ti is multiplexed, what is the durat$^n$ of

(a) Each i/p slot

(b) Each o/p slot

(c) Each frame

ans Data rate = 1kbps = 1000 bps

Bit durat$^n$ = 1/Data rate

For each i/p slot = $\frac{1}{1000}$ = 1ms

For each o/p slot = $\frac{1}{3000}$ = 0.33ms

For each frame = $\frac{1}{1000}$ = 1ms

② 4 1kbps connectⁿs are multiplexed together. A unit is 1 bit Find:

(a) Duratⁿ of 1 bit before multiplexing

(b) The txm rate of the link

(c) The duratⁿ of a time slot

(d) The duratⁿ of a frame.

ans n = 4

Data rate = 1kbps = 1000bps

(a) Duratⁿ of 1 bit before multiplexing = $\frac{1}{1000}$ = 1ms

(b) txm rate of link = 4 × 1kbps = 4kbps

(c) Duratⁿ of time slot = $\frac{1}{4000}$ = ~~1ms~~ 0.25 ms

(d) Duratⁿ of frame = $\frac{1}{1000}$ = 1ms

Interleaving

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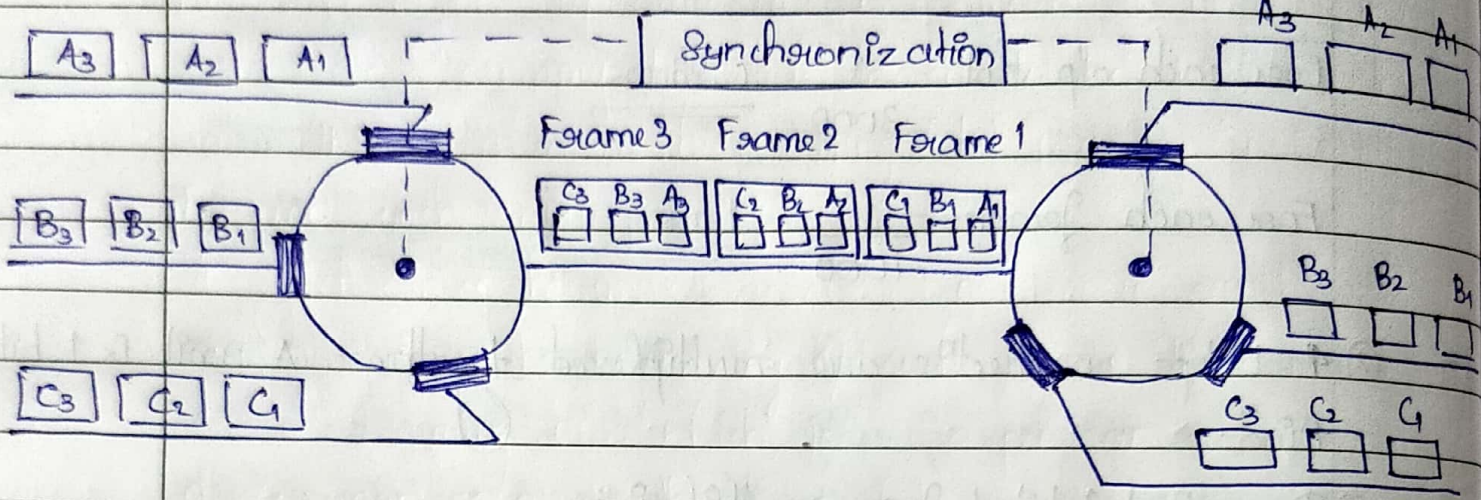
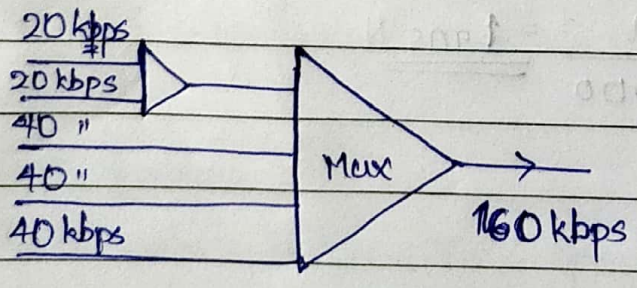



TDM has 2 fast-rotating switches on the multiplexing & demultiplexing side, which are synchronized & rotated at same speed, but in opp. direct$^n$. On the multiplexing side, the switch opens to a connect$^n$ that sends a unit onto the path. This process is called interleaving. On the demultiplexing side, the connect$^n$ receives a unit from the path.

Disadvantage → The synchronous data is not that efficient because if the source does not have data in the i/p slot, the corresponding slot in the o/p frame is empty.

Data Rate Management

(i) Multilevel Mux



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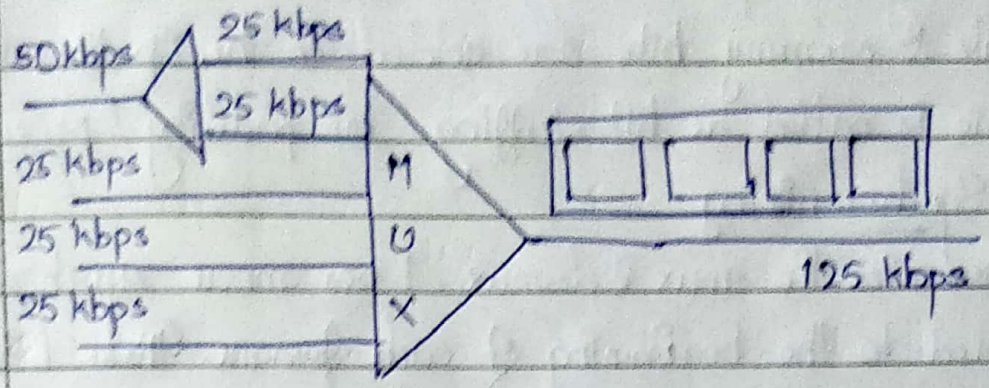
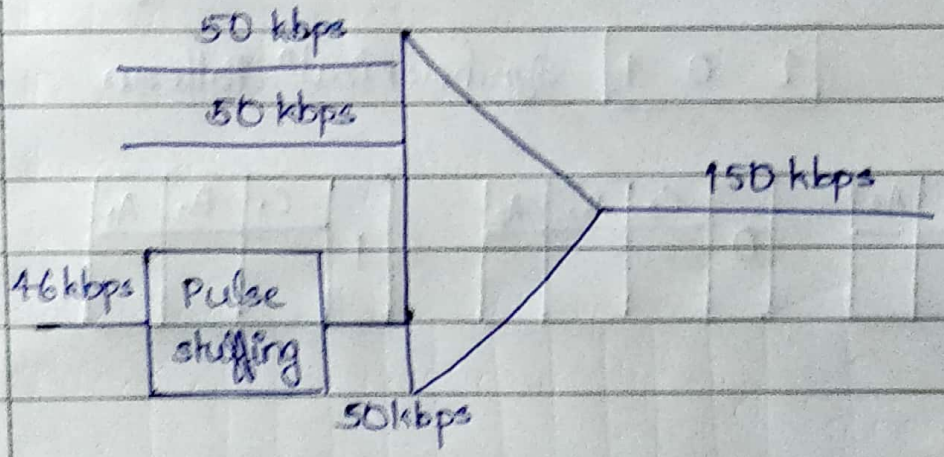
(iii) Multiple Slot Mux




(iv) Pulse Stuffing




~~Data~~ To handle disparity in the i/p data rate, 3 strategies are used:

a) Multilevel Multiplexing

It is used when the data rate of an i/p line is a multiple of others. Any 2 i/p lines can be multiplexed together to provide a data rate equal to others.

b) Multiple Slot Allocat°

Here, more than 1 slot is assigned in a frame for a single i/p line. A demux is used in the line to make 2 i/ps out of 1.

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(iii) Pulse Stuffing

Here, the highest i/p data rate is selected as the dominant data rate & dummy bits are added to the i/p lines with lower rates. This is called as bit stuffing / bit padding / pulse stuffing

Frame Synchronizing

To synchronize the mux & demux, 1 or more synchronizat$^n$ bits are added to the beginning of each frame. These bits are called framing bits, which follow a pattern so that the demux can separate the time slots accurately

| 1 | 0 | 1 |
|---|---|---|

Synchronizat$^n$ Pattern

| 1 | $C_3$ | $B_3$ | $A_3$ |
|---|---|---|---|
| | | | |

| 0 | $C_2$ | $B_2$ | $A_2$ |
|---|---|---|---|
| | | | |

| 1 | $C_1$ | $B_1$ | $A_1$ |
|---|---|---|---|
| | | | |