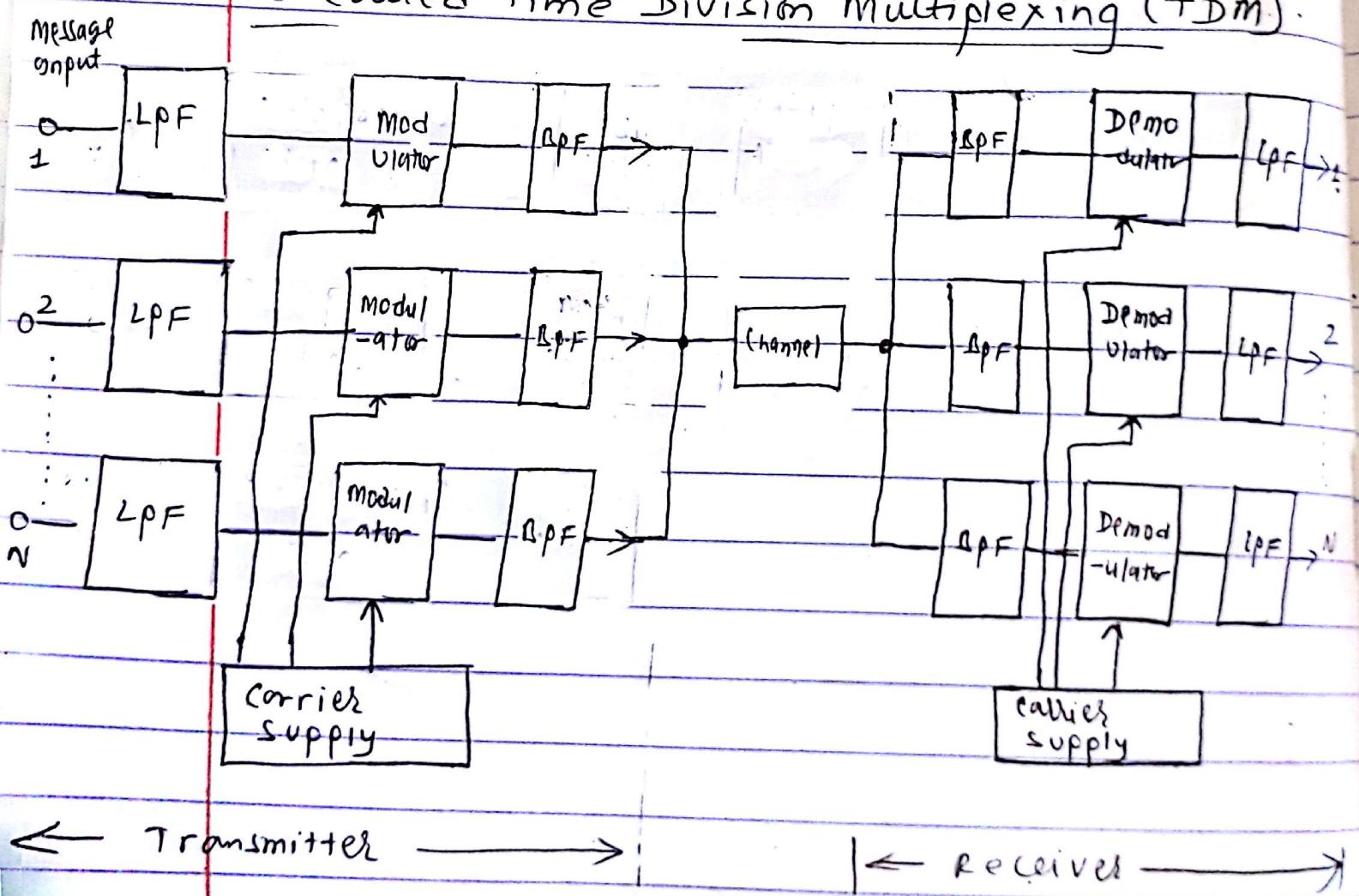


## \* Frequency Division Multiplexing (FDM) system

Multiplexing is a technique in which number of independent signals from same source or different are combined together to transmit over a same channel.

For transmission of the composite signal, the signals are kept apart either in frequency or time. Therefore separating of signals to avoid interference with respect to frequency is called Frequency Division Multiplexing (FDM) and with respect to time is called Time Division Multiplexing (TDM).



As shown in above figure each input signal are passed through L.P.F to remove the high frequency component to avoid interference to other message signal sharing the common channel.

The output of L.P.F are passed to the modulators where the modulation takes place with the supplied carrier shown in figure.

Single side Band (SSB) modulation is preferred as it requires less transmission band width ' $f_m$ ' ( $f_m \Rightarrow$  B/W of message signal). The SSB modulated wave is passed through Band pass Filter (BPF) to restrict the frequency within the band of frequency of modulated wave. This restricted band limited signals are transmitted through the common channel.

At the receiving side the Band pass Filter (BPF) with their input connected in parallel are used to separate the modulated wave. These separated modulated signals are fed to demodulators and low pass filter to recover the original message signal.

## \* Frequency DIVISION Multiplexing (FDM) in Telephony

The long distance carrier systems in United States (U.S) and throughout the world is designed to transmit voice band signals over a high capacity transmission link. e.g (coaxial cable, microwave)

The earliest and still a very common technique for utilizing high capacity links is Frequency Division Multiplexing (FDM).

→ In (U.S) United States, AT&T (American Telephone and Telegraph) has designed a hierarchy of Frequency Division Multiplexing (FDM) schemes to accommodate transmission system of various capacities.

Similarly (ITU-T) International Telecommunication Union - Telecommunication has similar but not identical system to AT&T.

FDM in telephony provides a way of keeping a number of individual telephone signals separated while transmitting them over a same transmission medium. There are two types of FDM standard.

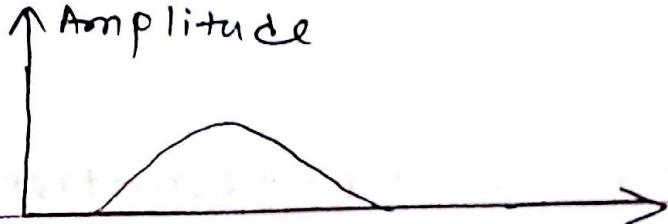


Table: North American and International FDM  
Carrier standard.

No of voice channels	Bandwidth	Spectrum	AT&T	ITU-T
12	48 kHz	60-108 kHz	Group	Group
60	240 kHz	312-552 kHz	Super Group	Super Group
300	1.232 MHz	812-2044 kHz	-	Master Group
600	2.52 MHz	564-3084 kHz	Master Group	-
900	3.872 MHz	8.516-12.388 MHz	-	Super Master Group
Nx600	Master Group Multiplier	Multiples of 12		
3600	16.984 MHz	0.564-17.598 MHz	Jumbo Group	
10800	57.492	3.924-60.516 MHz	Jumbo Group Multiplier	

At the first level

of AT&T hierarchy and ITU-T, 12 voice channels are combined together to produce **Group Signal** with a bandwidth of  $(12 \times 4 = 48 \text{ kHz})$  in the range of spectrum 60-108 kHz. The signals are produced in a fashion similar to subcarrier frequency from 64 to 108 kHz in the increment of 4 kHz as shown in figure below.



spectrum of voice frequency signal

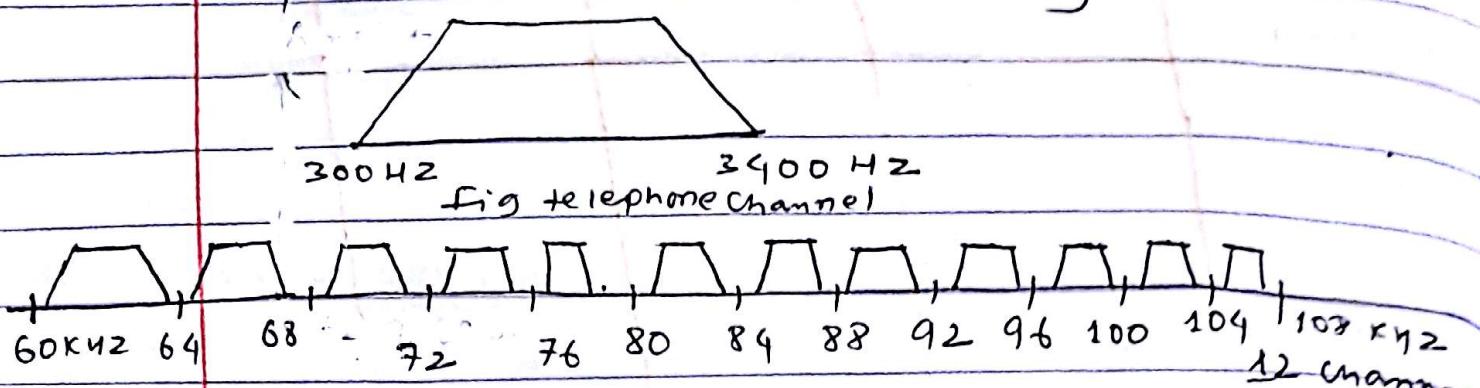


fig: → Spectrum of Composite signal in Group

The combination of voice

1) Super Group: → 60 channel . . .

together are called super group

In other words 5 Group channel makes a Super Group which has bandwidth of  $\frac{240}{12}$  kHz and range of spectrum is 312 - 552 kHz.

From above we can see that the carrier spacing is 4 kHz thus 12 channel occupies the band from 60 kHz to 108 kHz and Each channel has a baseband or message signal from 300 Hz to 3.4 kHz. As from the figure to avoid overlap between two channel, the channels are spaced apart with the frequency of base band signal ' $f_m$ ' which may be known as guard band.

2) master group :  $\Rightarrow$

In AT&T Standard  
the combination of 600 voice channel,  
group of 10 supergroup of bandwidth  
2.52 MHz is called Master Group.

In ITU-T Standard the  
combination of 300 voice channel, group of 5  
Supergroup of bandwidth 1.232 MHz is  
called Master Group.

3) Super Master Group :  $\Rightarrow$  In ITU-T Standard  
the combination of 900 voice channel of 3.872  
MHz bandwidth is called Super Master Group.

4) Jumbo Group :  $\Rightarrow$  In AT&T Standard  
the combination of 3600 voice channel of  
16.984 MHz bandwidth is called Jumbo Group.

5) Jumbo Group Multiplier :  $\Rightarrow$

In AT&T Standard  
the combination of 10800 voice channel  
of 57.442 MHz bandwidth is called  
Jumbo Group Multiplier.

## \* Fundamentals of communication Access Technology

Access methods are multiplexing techniques that provide communication services to multiple user in single bandwidth wired or wireless medium.

Access method allows many user to share these limited channel.

There are three types of Access or multiplexing method.

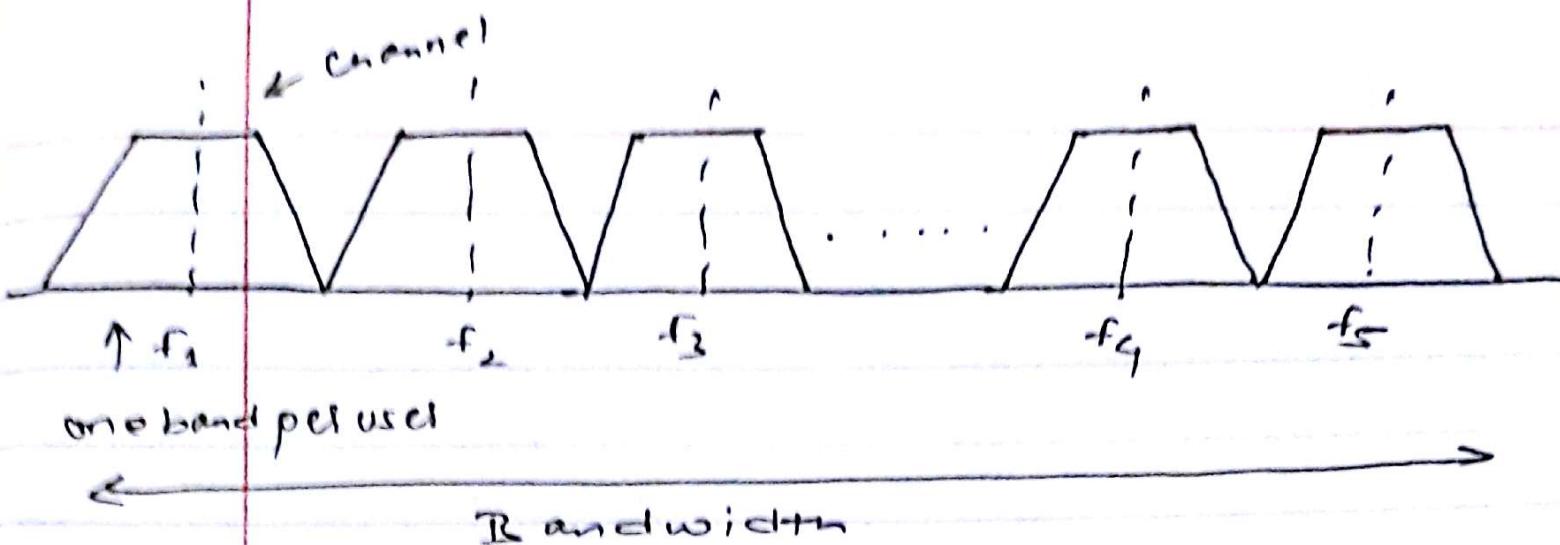
They are

1. Frequency Division Multiple Access
2. Time Division Multiple Access .
3. Code Division Multiple Access .

### 1. Frequency Division Multiple Access →

Frequency

Division Multiple Access (FDMA) is the process of dividing bandwidth into multiple individual bands . Each bands is allocated to the single user . Therefore FDMA divides shared medium bandwidth into individual channel . Therefore a number of user can transmit information Simultaneously . Guard band are placed



eg: → cable television, optical fiber, Analog telephone

in adjacent frequency band to avoid interference.

Single channel per carrier (SCPC) refers to use a single signal at a given frequency and bandwidth. It is generally used on broadcast satellite in which one carrier is allocated for the duration of the transmission. SCPC is simple and reliable technology with datarate 64 Kbps to 50 Mbps.

Demand Assigned Multiple Access (DAMA) increases satellite utilization factor where channel are assigned when needed. In this system

when the earth station 'A' desires to establish connection for communication to earth station 'B' sends request signal to satellite. The satellite will then assign any of the free channel presently unoccupied to establish link between A and B.

### Single channel per

carrier pulse Code Modulated Multiple Access Demand Assignment Equipment (SPADE) carries traffic using Demand Assignment for satellite communication. It uses or requires common signaling channel (CS) where all earth station are permanently connected. It consists of 800 channel where the earth station selects the free channel randomly through the signaling link.

## \* Filter and oscillator requirements in FDM

Filter and oscillator are required in FDM system because

1. It is used to track the phase and frequency of the carrier component of an incoming signal.
2. Oscillators are used to tune the frequency that means providing synchronism to the modulated wave. It is then possible to extract the message signal.
3. Filters are used to block the noise which are considered as high frequency component.
4. Filters are used to separate the frequency of the individual signals that are to be multiplexed and transmit over same channel.
5. At the receiving side, the process is reversed which tracks the modulated wave from different source and all demodulated separately and reached to the destination.