University of Diyala

Telecom Switching Systems

Lecture 4

4th Stage

Communication department / Engineering collage

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Elements of a telecommunications network.

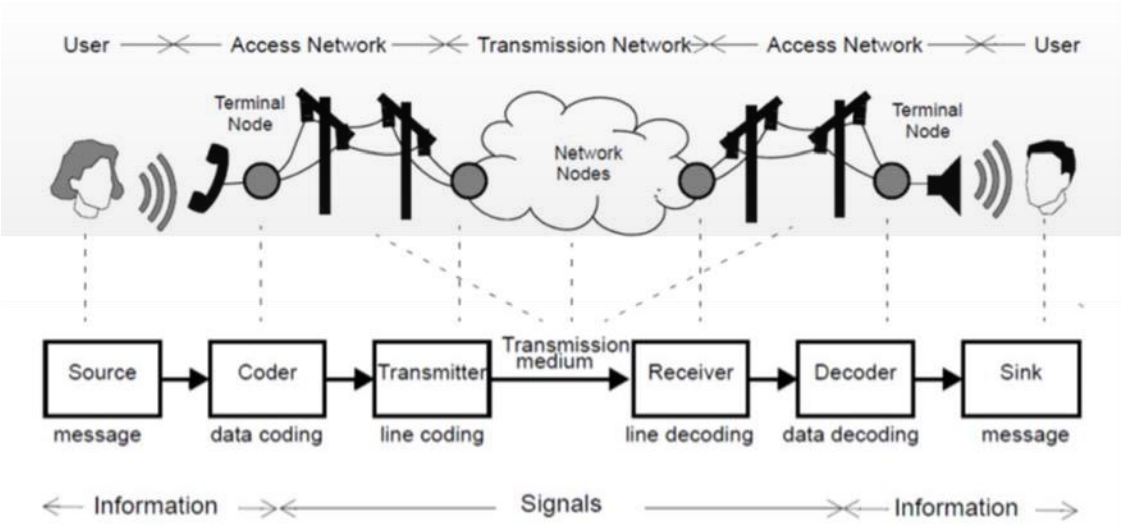

Figure 1.1 Elements of a telecommunications network.

Digital Transmission:

There are two basic modes of digital transmission:

- Asynchronous transmission
- Synchronous transmission.

Transmission Impairments:

1. Echos and Singing
2. Noise
3. Cross talk
4. Signal Attenuation
5. Distortion

Multiplexing:

Multiplexing is defined as the process by which several signals from different channels share a channel with greater capacity. Basically, a number of channels share a common transmission medium with the aim of reducing costs and complexity in the network.

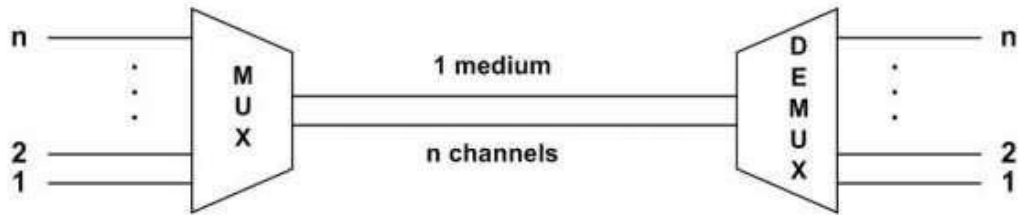

Fig. Basic concepts of Multiplexing

In above Figure, the multiplexer is connected to the de-multiplexer by a single data link. The multiplexer combines (multiplexes) data from these 'n' input lines and transmits them through the high capacity data link, which is being de-multiplexed at the other end and is delivered to the appropriate output lines.

Multiplexing techniques can be categorized into the following types:

1. Frequency-division multiplexing (FDM)
2. Time-division Multiplexing (TDM)

1. Frequency-division multiplexing (FDM)

FDM systems divide the available bandwidth of the transmission medium into a number of narrow band or sub channels. The channels are sent over a common path by modulating each channel to different carrier frequency.

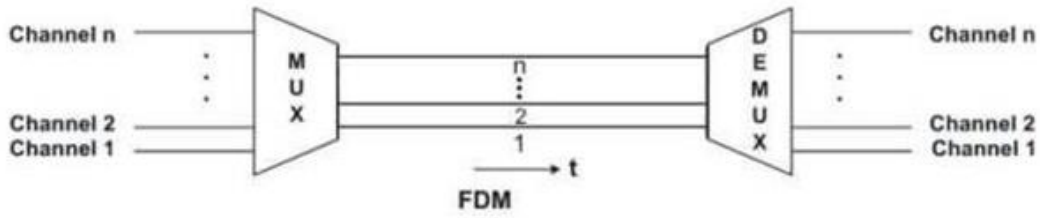

Fig. Basic Concepts of FDM

Using modulation, independent message signals are translated into different frequency bands. All the modulated signals are combined in a linear summing circuit to form a composite signal for transmission. The carriers used to modulate the individual message signals are called sub-carriers, shown as f_1, $f_2 \ldots f_n$ in Fig.

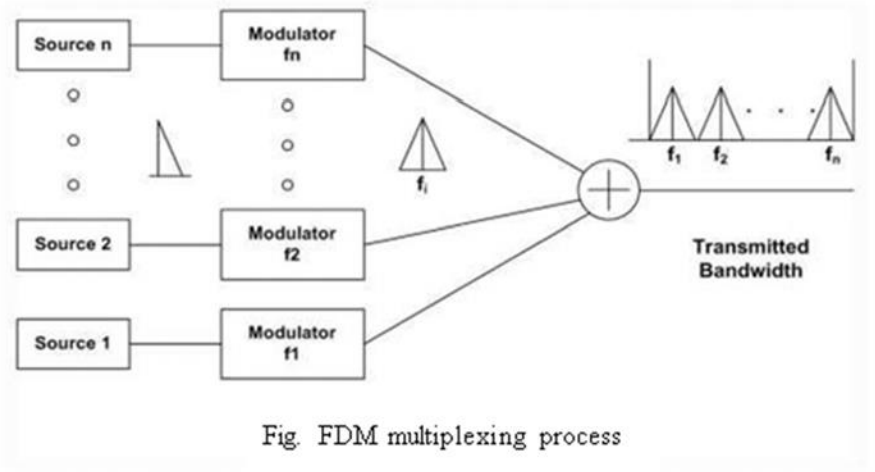

Fig. FDM multiplexing process

At the receiving end the signal is applied to a bank of band-pass filters, which separates individual frequency channels. The band pass filter outputs are then demodulated and distributed to different output channels as shown in Fig.

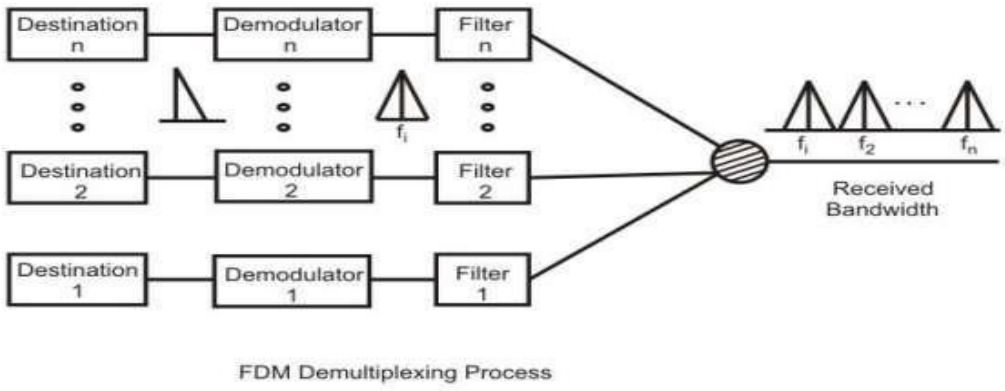

Fig. FDM De-multiplexing

If the channels are very close to one other, it leads to inter-channel cross talk. Channels must be separated by strips of unused bandwidth to prevent inter-channel cross talk. These unused channels between each successive channel are known as guard bands as shown in Fig below.

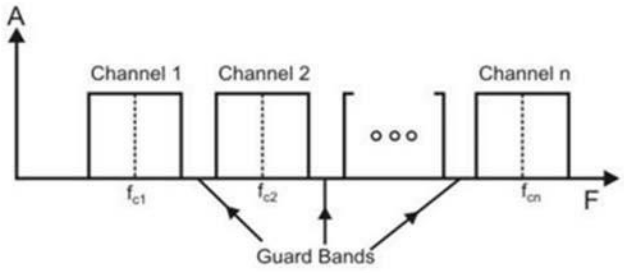

Fig. Use of Guard Bands

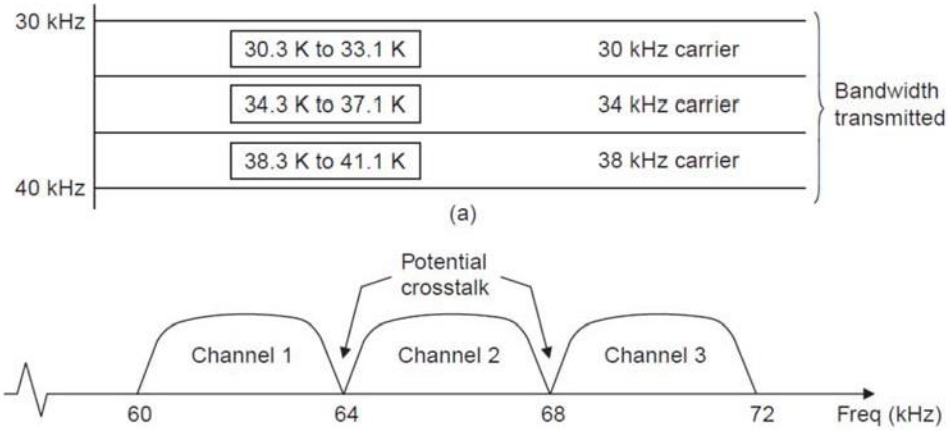

Fig. (a) Telephone multiplexing (b) FDM in telephone transmission.

2. Time-Division Multiplexing (TDM)

In frequency division multiplexing, all signals operate at the same time with different frequencies, but in Time - division multiplexing all signals operate with same frequency at different times. In TDM, the time available is divided into small slots, and each of them occupied by a piece of one of the signals to be sent. So it is travels through the media and is being de-multiplexed into appropriate independent message signals at the receiving end.

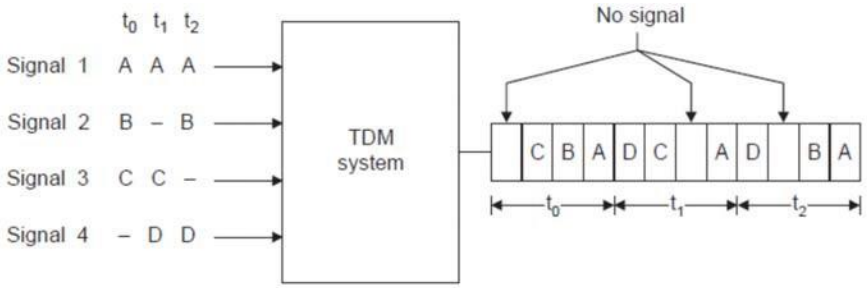

Fig. Principle of TDM.

As shown in Fig, the composite signal has some dead space (no signal) between the successive sampled pulses, which is essential to prevent inter-channel cross talks.

PCM multiplex group:

At the beginning of the 1960s, the proliferation of analog telephone lines, based on copper wires, together with the lack of space for new installations, led the transmission experts to look at the real application of PCM digitalization techniques and TDM multiplexing.

The **Pulse code modulation (PCM)** goal was that of converting an analogy voice telephone channel into a digital one based on the sampling theorem. Where the sampling theorem states that for digitalization without information loss, the sampling frequency (f_s) should be ***at least twice*** the maximum frequency component (f_{max}) of the analogy information: where The frequency $2\,f_{max}$ is called the Nyquist sampling rate

$$f_s > 2 \cdot f_{max}$$

A telephone channel admits frequencies of between 300 Hz and 3,400 Hz. Because margins must be established in the channel, the bandwidth is set at 4 kHz. Then the sampling frequency must be f_s ≥ 2 x 4000 = 8000 Hz equivalent to a sample period of $T = 1 \div 8000 = 125\mu s$