## Lecture one 1 :-

1. **Introduction of digital communication.**

   ❖ **Main diagram of digital communication system**

   ❖ **Types of communication systems**

   ❖ **Advantages of digital communication**

   ❖ **Disadvantages of digital communication**

   ❖ **Main types of communication systems**

2. **Multiplexing techniques:**

   A. **Frequency Division Multiplexing (FDM)**

   B. **Time Division Multiplexing (TDM)**

# 1. Introduction to digital communications:

The term digital communication covers a broad area of communications techniques, including digital transmission and digital radio.

Digital transmission, is the transmitted of digital pulses between two or more points in a communication system. Digital radio, is the transmitted of digital modulated analog carriers between two or more points in a communication system.

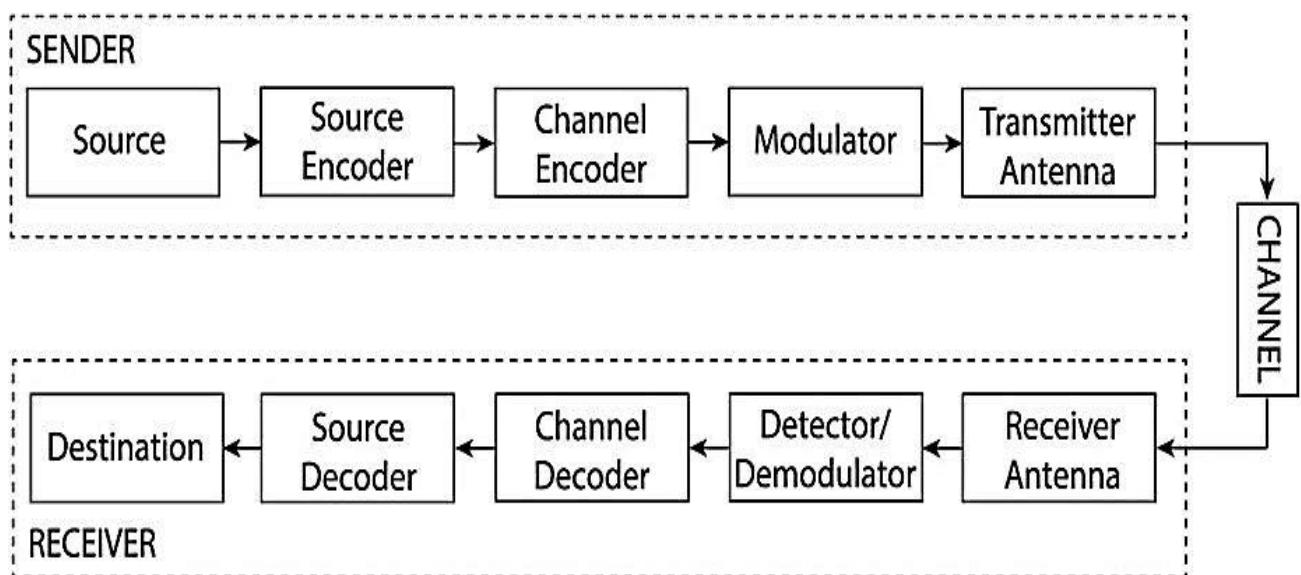❖ The main diagram of digital communication system is shown below:



Figure (1): Main diagram of digital communication system

Where:

**Source:** analog or digital

**Channel:** cable, optical fibre, free space, etc.

**Destination:** person, loud, speaker, computer, etc.

**Types of information:** Voice, data, video, music, email, etc.

❖ **Advantages of digital communications:**

There are many reasons for choosing digital communications as the best transmission systems to be used in the recent communication applications.

   **A.** The primary advantage is the ease with which digital signals, compared to analog signal, are regenerative.

   The shape of the waveform is affected by two mechanisms:

(1) As all the transmission lines and circuits have some nonideal transfer function, there is a distorting effect on the ideal pulse.

(2) Unwanted electrical noise or other interference further distorts the pulse waveform.

Both of these mechanisms cause the pulse shape to degrade as a function of distance. During the time that the transmitted pulse can still be reliably identified, the pulse is thus regenerated. The circuits that perform this function at regular intervals along a transmission system are called regenerative repeaters.

   **B.** Digital circuits are less subject to distortion and interference than analog circuits.

   **C.** Digital circuits are more reliable and can be produced at lower cost than analog circuits. Also, digital hardware lends itself to more flexible implementation than analog hardware.

   **D.** Digital techniques lend themselves naturally to signal processing functions that protect against interference and jamming.

**E.** Much data communication is computer to computer, or digital instrument or terminal to computer. Such digital terminations are naturally best served by digital link.

❖ **Disadvantaged of digital communications:**

**A.** Requires reliable synchronization.

**B.** Requires A/D conversion at high rate.

**C.** In general, requires larger bandwidth than analog systems.

❖ **Main types of communication systems:**
  ✓ Public Switched Telephone Network (voice, fax, modem)
  ✓ Satellite systems
  ✓ Radio, TV broadcasting, and Cellular phones
  ✓ Computer networks (LANs, WANs, WLANs)

## 2. Multiplexing techniques:

Multiplexing is the transmission of information (either voice or data) from more than one source to more than one destination on the same transmission medium. The most two common methods used are frequency division multiplexing (FDM) and time division multiplexing (TDM).

## A. Frequency Division Multiplexer (FDM)

In FDM multiple sources that originally occupied the same frequency spectrum are each converted to a different frequency band and transmitted simultaneously over a single transmission medium. FDM is an analog multiplexing scheme. Figure below shows the frequency-time plane.
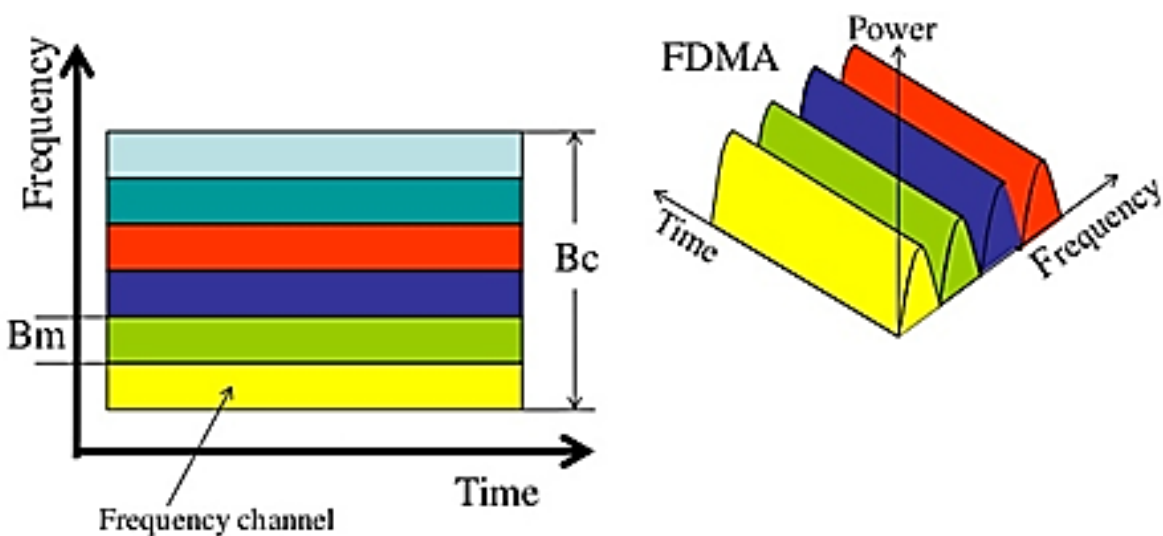


Figure (2): Frequency Division Multiplexing (FDM)

If two input signals to a mixer are sinusoids with frequencies fA and fB, the mixing or multiplication will yield new sum and difference frequencies at fA+B and fA-B. Equation below describes the effect of the mixer.

$$\cos A \cos B = \frac{1}{2}[\cos(A + B) + \cos(A - B)]$$

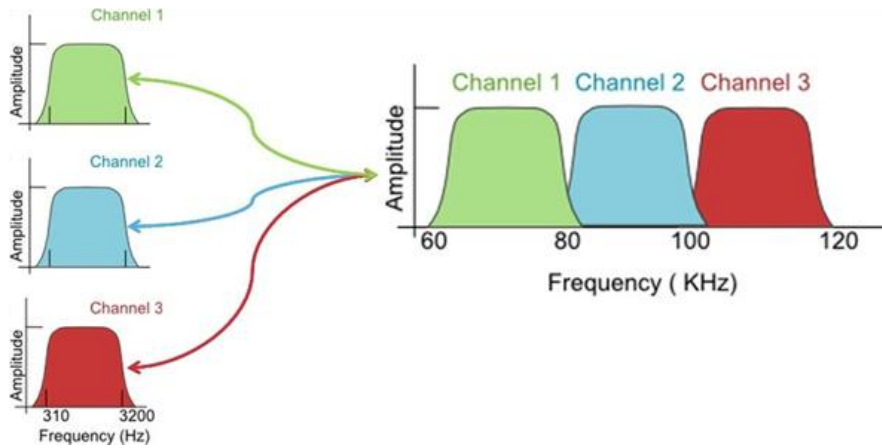A simple FDM example with three translated voice channels is shown in figure below.

Figure (3): Multiplexing of three channels using (FDM)

## B. Time Division Multiplexing (TDM)

With TDM system, transmission from multiple sources occurs on the same transmission medium but not at the same time. Transmission from various sources is interleaved in time domain.

Figure below shows the time-frequency plan in TDM system, the same communication resources is shared by assigning each of N symbols or users the full spectral occupancy of the system for a short duration of time called *time slot*. The unused time regions between slot assignments, called *guard times*, act as buffer zone to reduce interference.
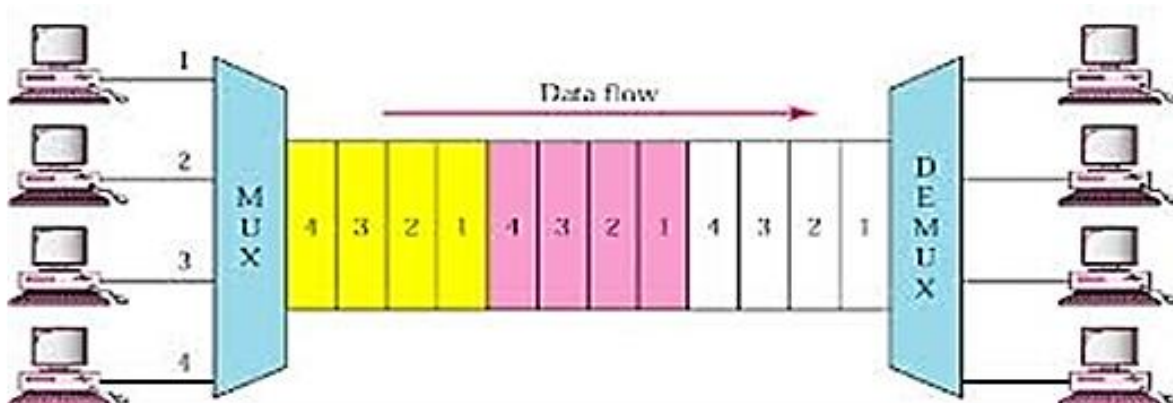


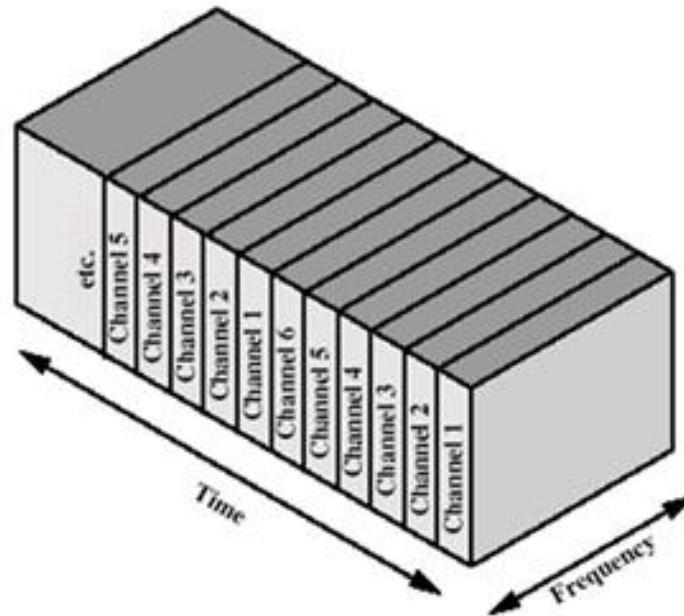Figure (4): The time-frequency paln in TDM system

Figure (5): Typical TDM system

The multiplexing operation consists of providing each source with an opportunity to occupy one or more slots. The demultiplexing operation consists of desloting the information and delivering the data to the intended sink.

The communication switches (S1...SM) have synchronized so that the massage corresponding to signal (1), for example, appears on the channel (1) output, and so on. Time is segmented in to intervals called *frames*. Each frame is further partitioned in to assignable user time slots.

The simplest TDM scheme called *fixed-assignment TDM*. In fixed assignment TDM scheme, the entire slot has no data to send during a particular frame, that slot is wasted.

Another more efficient scheme is the *dynamic assignment TDM* of the slots rather than fixed assignment.

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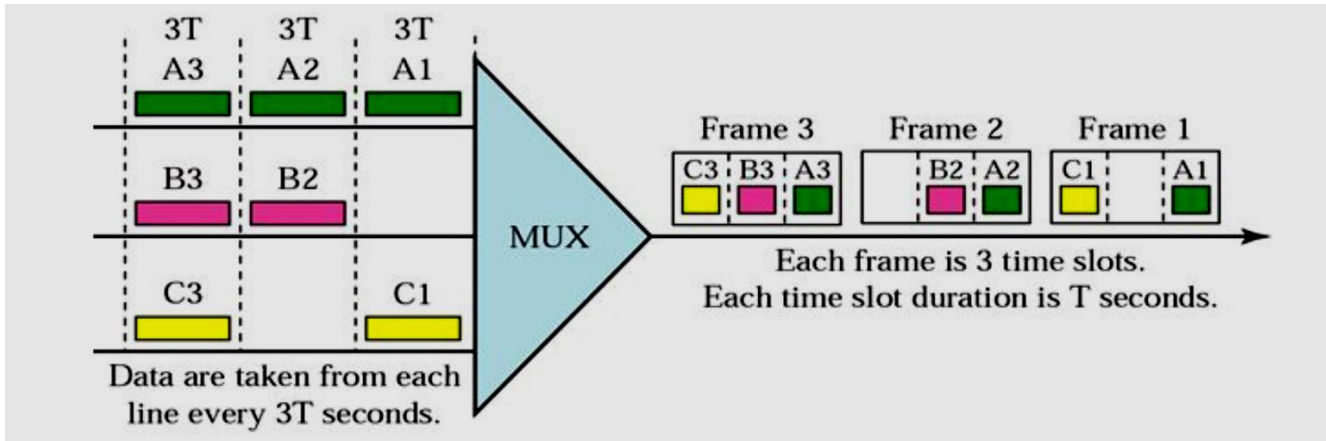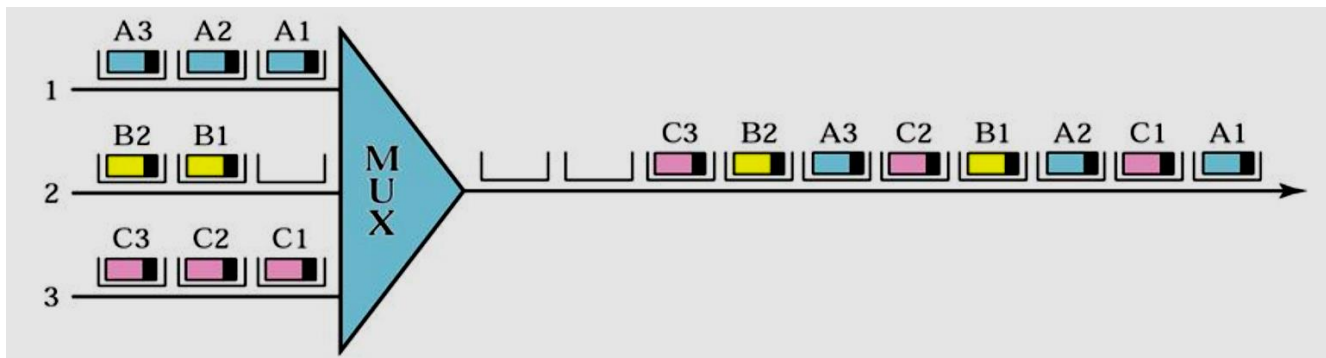Figures below show the fixed and dynamic assignment TDM system.



Figure (6): Example of Fixed TDM



Figure (7): Example of Dynamic TDM