Multiplexing

Multiplexing is the process of combining multiple signals into one signal, over a shared medium. A Multiplexing allows sharing a common line to transmit many terminal communications. Multiplexing is achieved by using a device called Multiplexer (MUX) which combines n input lines to generate a single output line. Demultiplexing is achieved by using device called Demultiplexer (DEMUX). DEMUX separates a signal into its component signals (one input to n outputs).

If analog signals are multiplexed, it is Analog Multiplexing and if digital signals are multiplexed, that process is Digital Multiplexing.

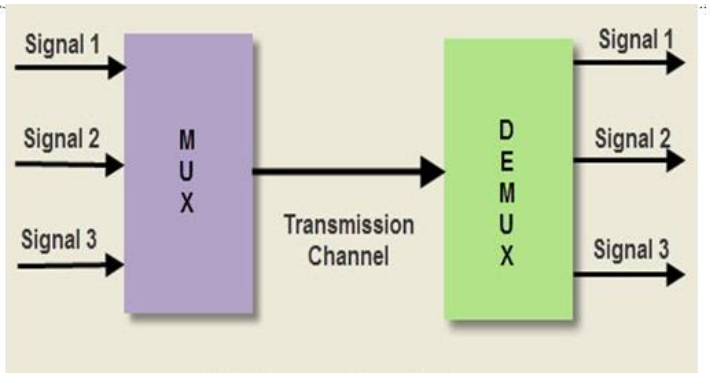
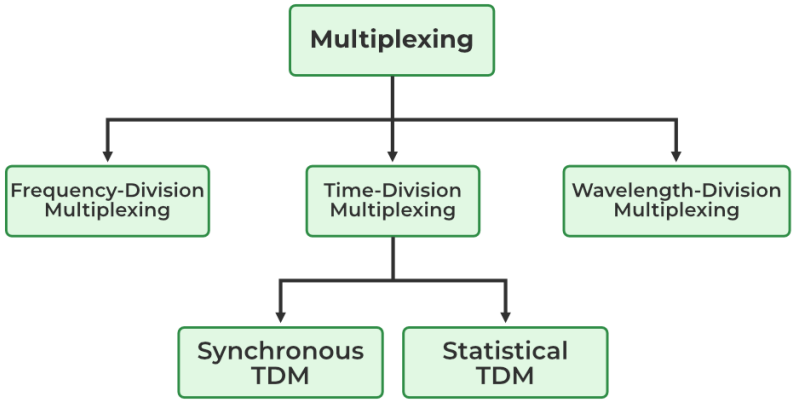


Fig: Multiplexing

Advantages of multiplexing

1. More than one signal can be sent over a single medium.
2. The bandwidth of medium can be utilized effectively.

Techniques of multiplexing



Frequency Division Multiplexing (FDM)

The assignment of non-overlapping frequency range to each user or signal on a medium, transmitting all signals at the same time each using different frequency is called FDM. The available bandwidth is divided into different frequency carriers in which different frequency are used by different users.

The concept of **'Guardband'** is used for the separation of channel and it ensures that the channel do not interface with each other.

Radio TV broadcasting are the example of FDM. Several individual stations broadcast their program in their own allocated frequency band sharing same unguided media. Some other examples are cable TV network, telephone system etc.

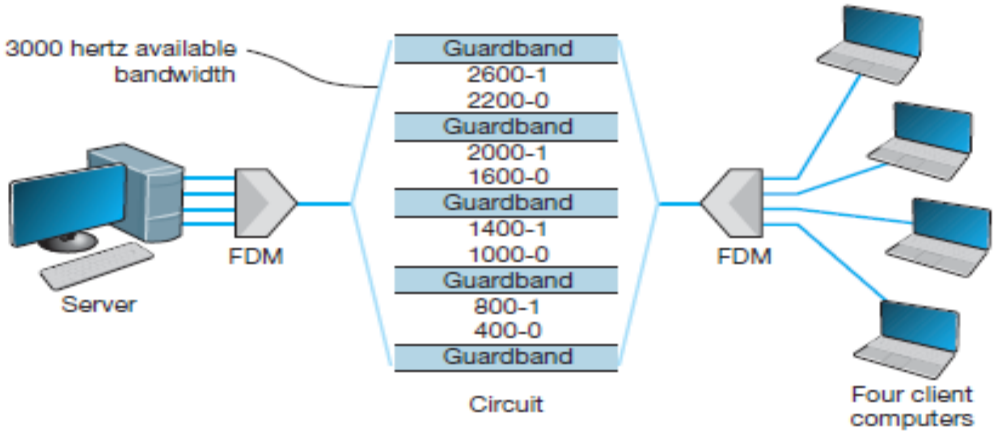


Fig: FDM Circuit

Figure above shows the use of FDM to divide one circuit into four channels. Each channel is a separate logical circuit, and the devices connected to them are unaware that their circuit is multiplexed. In the same way that radio stations must be assigned separate frequencies to prevent interference, so must the signals in a FDM circuit. The guardbands in Figure are the unused portions of the circuit that separate these frequencies from each other.

For example, suppose we had a physical circuit with a data rate of 64 Kbps that we wanted to divide into four circuits. We would simply divide the 64 Kbps among the four circuits and assign each circuit 16 Kbps. However, because FDM needs guardbands, we also have to allocate some of the capacity to the guardbands, so we might actually end up with four circuits, each providing 15 Kbps, with the remaining 4Kbps allocated to the guardbands.

Wavelength Division Multiplexing

WDM multiplexes multiple data stream into a single fiber optic line i.e. optical carrier signal of varying wavelength of laser light into a single optical fiber. Wavelength division multiplexing (WDM) is a technique of multiplexing multiple optical carrier signals through a single optical fiber channel by varying the wavelengths of laser lights. WDM allows communication in both the directions in the fiber cable.

Different wavelengths lasers called **lambdas** transmit the multiple signals. Each signals carried on the fiber can be transmitted at different rate.

In WDM, the optical signals from different sources or (transponders) are combined by a multiplexer, which is essentially an optical combiner. They are combined so that their wavelengths are different. **Dense wavelength MUX** combines many lambdas onto one fiber (30-50 or more). **Coarse wavelength** combines only few lambdas.

The combined signal is transmitted via a single optical fiber strand. At the receiving end, a demux splits the incoming beam into its components and each of the beams is send to the corresponding receivers.

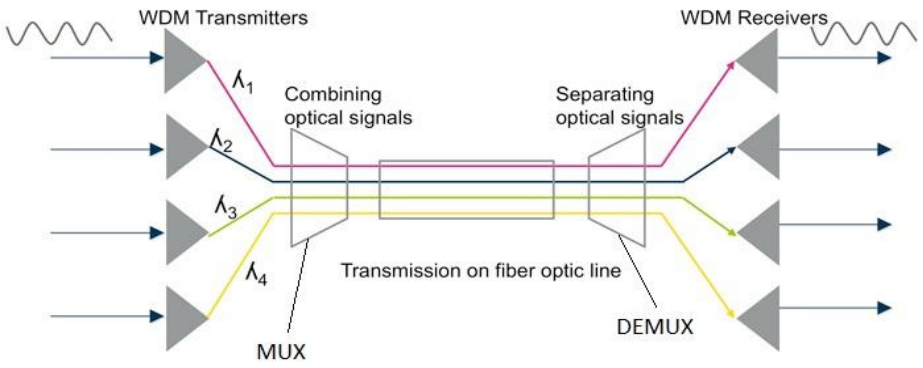


Fig: Wavelength Division Multiplexing

Time Division Multiplexing (TDM)

In this technique of multiplexing the total available transmission time is divided on a medium among users. The specific predefined amount of time is given to each user. Time is divided into slots and these slots are given to the all input channels and all inputs share a same communication medium.

Digital signaling is used.

The main reason to use TDM is to take advantage of existing transmission lines.

Types of TDM:

a. **Synchronous TDM**
b. **Statistical TDM**

Synchronous TDM

It is an original type of TDM in which multiplexer accepts input from devices in a round robin fashion and translates the data in a never ending pattern. Every line is given T seconds and every cycle is completed in 3T.

Example ISDN telephone lines.

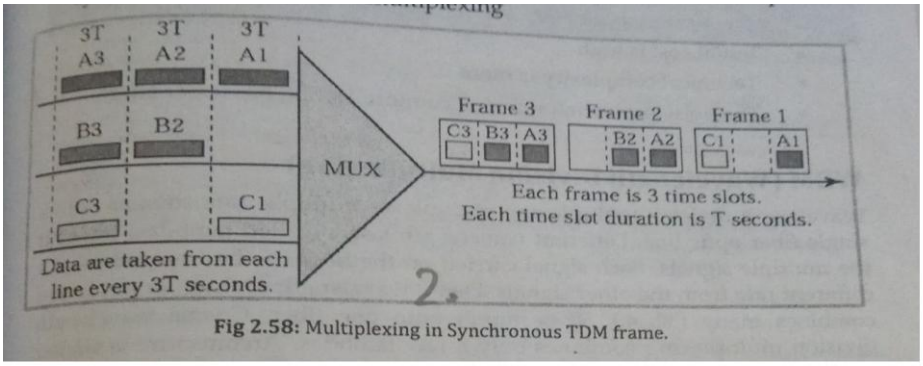


Fig 2.58: Multiplexing in Synchronous TDM frame.

Statistical TDM

Statistical TDM transmits the data only from active workstation. If a workstation is not active no space is wasted in the multiplexed stream. A statistical multiplexer accepts the incoming data stream and creates a frame containing the data to be transmitted.

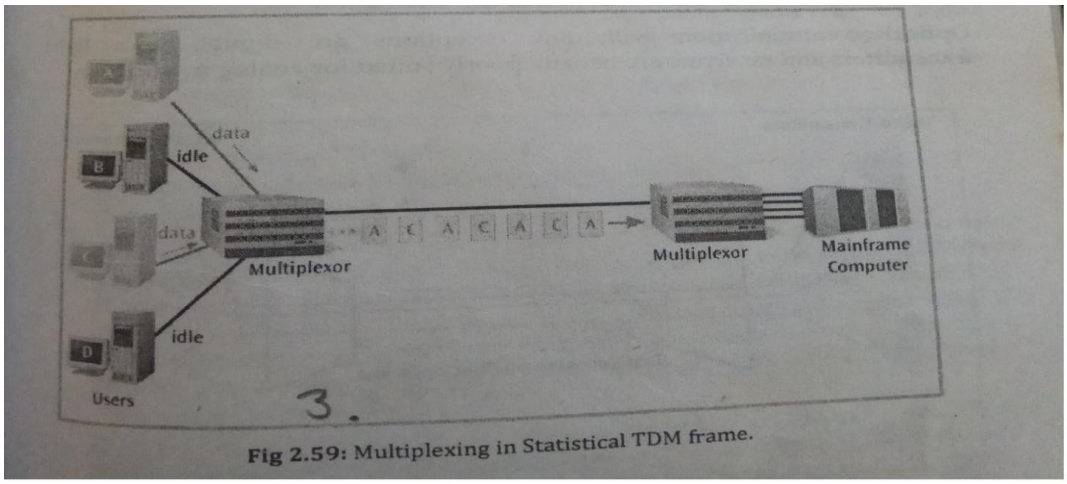


Fig 2.59: Multiplexing in Statistical TDM frame.