


# Unit- Eight

## MULTIPLEXING AND SWITCHING

- ❖ Multiplexing types and Application
- ❖ Multiplexing Vs Non-Multiplexing
- ❖ The Telephone System: Analog services and its Hierarchy
- ❖ Digital services and Hierarchy Circuit Switching, Packet Switching, Message Switching, and Private Branch Exchange

# Multiplexing

It is the set of techniques that allows the simultaneous transmission of multiple signals across a single data link. In a multiplexed system several lines share the bandwidth of one link. The basic format of the multiplexed system is as shown below:



# Multiplexing

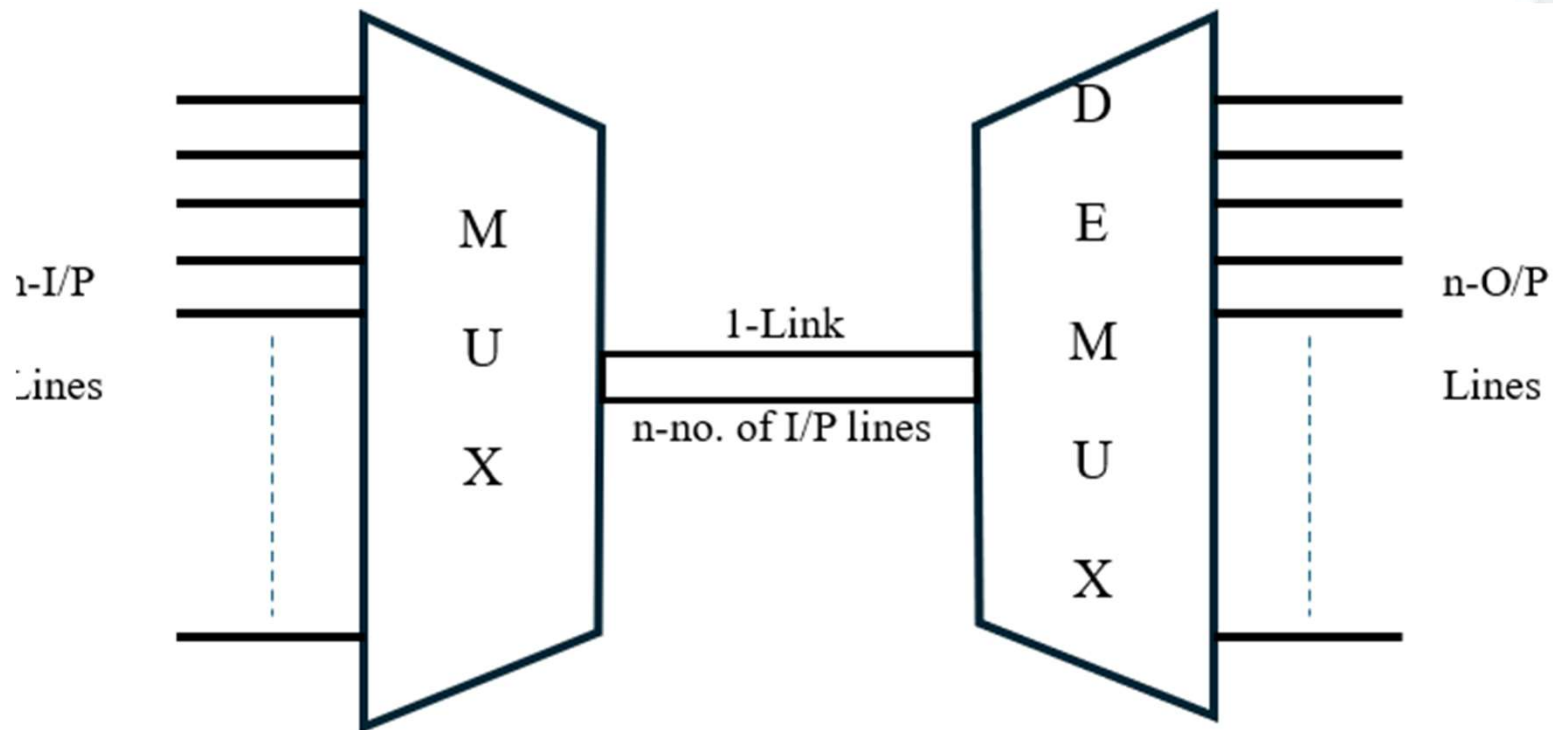


Fig: Multiplexing and Demultiplexing

# Multiplexing

In above figure, the n-no. of input lines or signals on the left side directs their transmission stream to a multiplexer [MUX] which combine them into a single stream. At the receiving ends input connected to a demultiplexer [DEMUX] which separates the input lines back into its components i.e. original signal for the further transmission DEMUX is also known as conversion of one signal into many signals.

# Multiplexing

## Types:

There are following three types of multiplexing techniques:

### **a. Frequency Division Multiplexing (FDM)**

In FDM, signals generated by each sending device modulates different carrier frequencies. These modulated signals are then combined into a single composite signal that can be transmitted by a link signal can be transmitted by the sufficient bandwidth to accommodate the modulated signal.

# Multiplexing

## a. Frequency Division Multiplexing (FDM)

Channels can be separated by stripes of unused bandwidth known as guard band to prevent the signals from overlapping and prevent interference between carrier frequencies and original data.

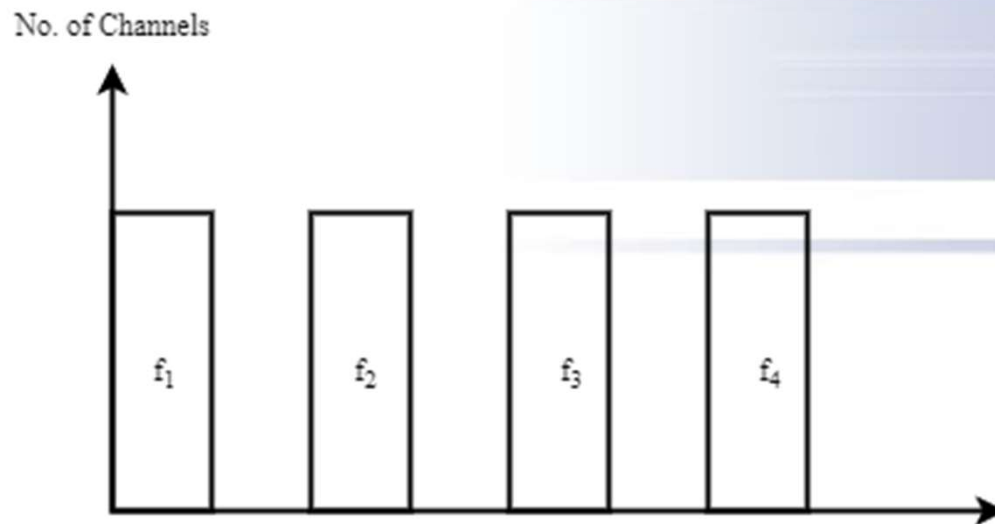


Fig: Frequency Division Multiplexing

# Multiplexing

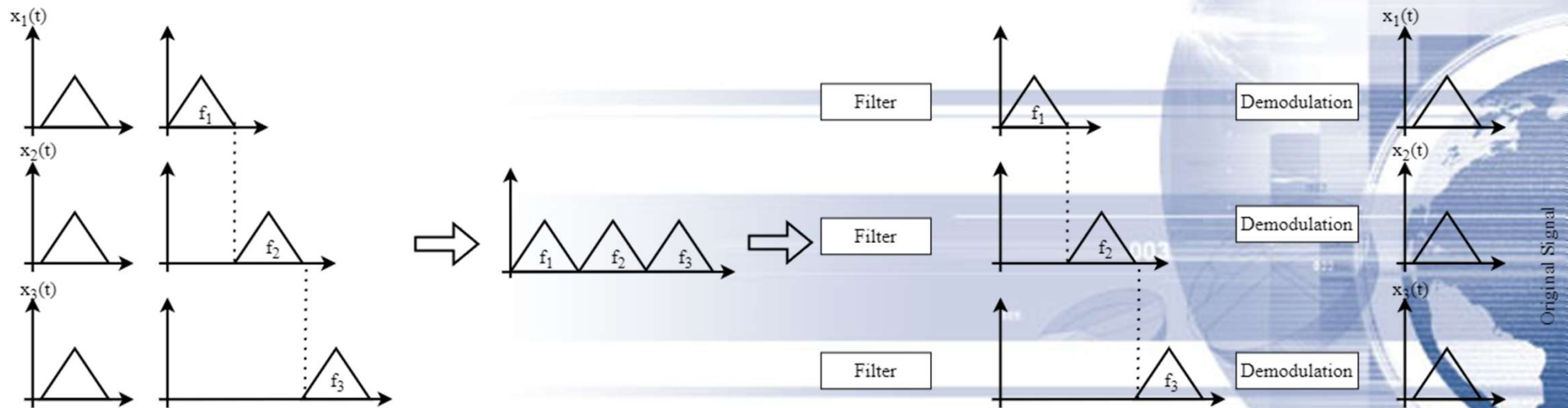


Fig: Multiplexing and Demultiplexing in Frequency Domain

# Multiplexing

## a. Frequency Division Multiplexing (FDM)

### Features of FDM:

- Combination multiple channels in frequency domain.
- Initially used in analog system for frequency multiplexing.
- It is an old and mature technology, its circuit design is simple, less use of components like adder, filter etc.

No need to take care of timing while transmitting signals..

# Multiplexing

## a. Frequency Division Multiplexing (FDM)

### Disadvantages:

- Interference may occur between two signals or channels.
- Frequency resource is repeated for multiplexing large no. of signals.
- It is unsecure than other multiplexing techniques.
- Spectrum management is so difficult.

# Multiplexing

## Types:

### b. Time Division Multiplexing (TDM)

TDM is possible when the achievable data rate of medium is greater than the rate of digital signals to be transmitted. Multiple digital signals can be carried on a single transmission path while interleaving the portion of each signal in time. The interleaving can be at the bit level or into the different blocks of bytes or larger quantities.

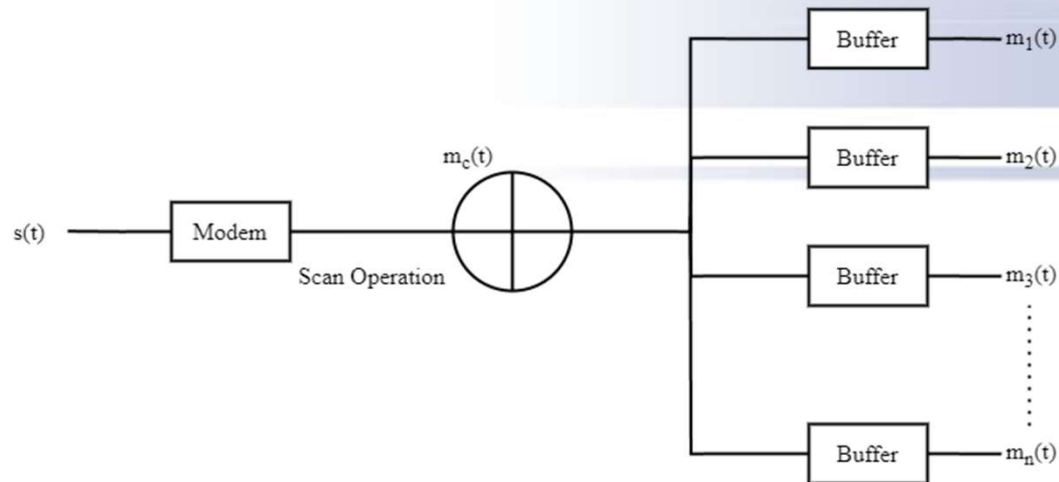
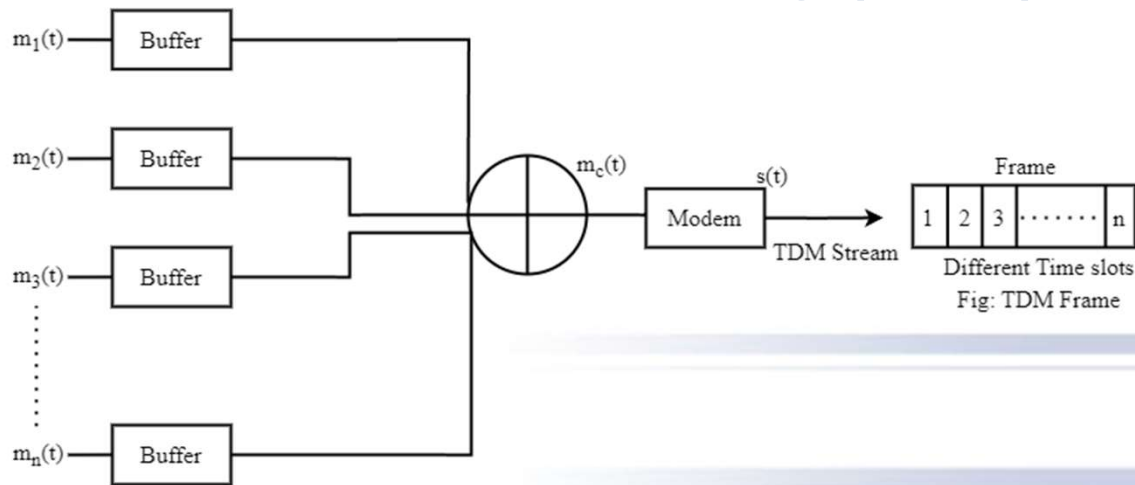
# Multiplexing

## b. Time Division Multiplexing (TDM)

The incoming data from each source are briefly buffered each buffer is typically one bit or one character in length. The buffers are scans sequentially to form a composite digital data stream  $[m_c(t)]$  may be transmitted directly or pass through a modem. So, that an analog signal may be transmitted.

# Multiplexing

## b. Time Division Multiplexing (TDM)



# Multiplexing

## b. Time Division Multiplexing (TDM)

### Advantages of TDM:

- Digital technology, easy to implement.
- Secure than FDM.
- Encryption is possible.
- Data transfer rate is high.
- Multiple signals can be transmitted through the single channel while using buffer.

# Multiplexing

## b. Time Division Multiplexing (TDM)

### Disadvantages of TDM:

- Circuit design is complex compared with FDM.
- Timing accuracy is most important factor.
- Synchronization of multiple input signal is required.

# Multiplexing

## Types:

### c. Wavelength Division Multiplexing (WDM)

The WDM is conceptually same as the FDM technique, except that multiplexing and demultiplexing involves light signals transmitted through fiber optic channels. In case of optical fiber transmission when multiple beams of light having different wavelength are transmitted on the same optical fiber, wavelength division multiplexing is used.

In WDM system, LASER beam at different wavelength which are generated by no. of input sources, which are sent to multiplexer for the transmission over a single optical fiber cable.

# Multiplexing

## c. Wavelength Division Multiplexing (WDM)

After transmission signal over long distance, the composite signal arrives at the demultiplexer and the input signals are separated and sent to the receiver for the destination point. Most wavelength division system operates in the range of 1550 nm. In early systems, the frequency range of 200 MHz was allocated to each channel but recently WDM system used 50 GHz or higher spacing.

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