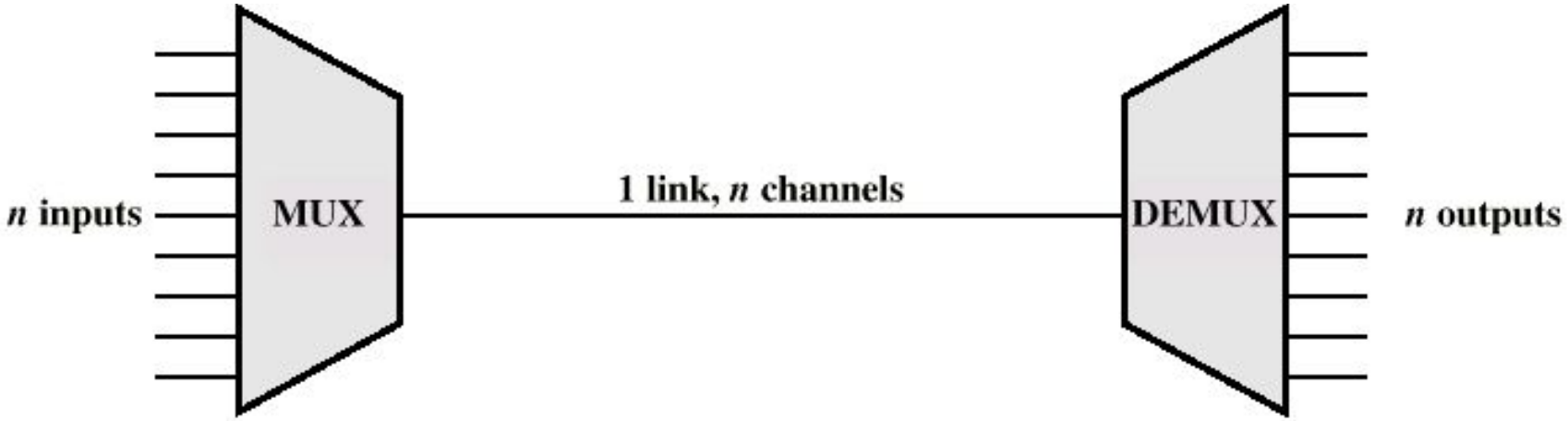
Multiplexing

Multiplexing



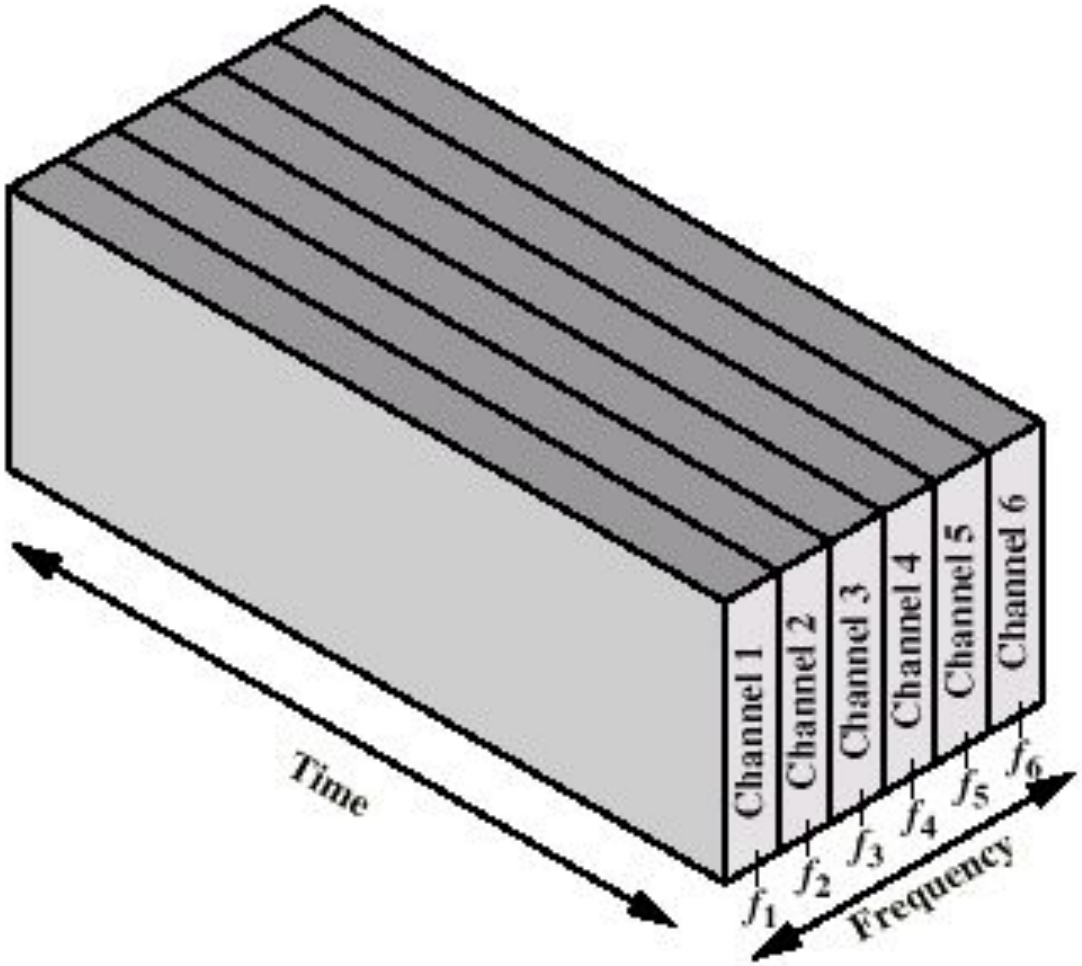
Frequency Division Multiplexing

- FDM is a scheme in which numerous signals are combined for transmission on a single communications line or channel.
- It is analog multiplexing technique.
- Each signal is assigned a different frequency (sub channel) within the main channel. It requires channel synchronization.
- **Applications of TDM:** FM & AM radio broadcasting, television broadcasting, First generation cellular telephone.

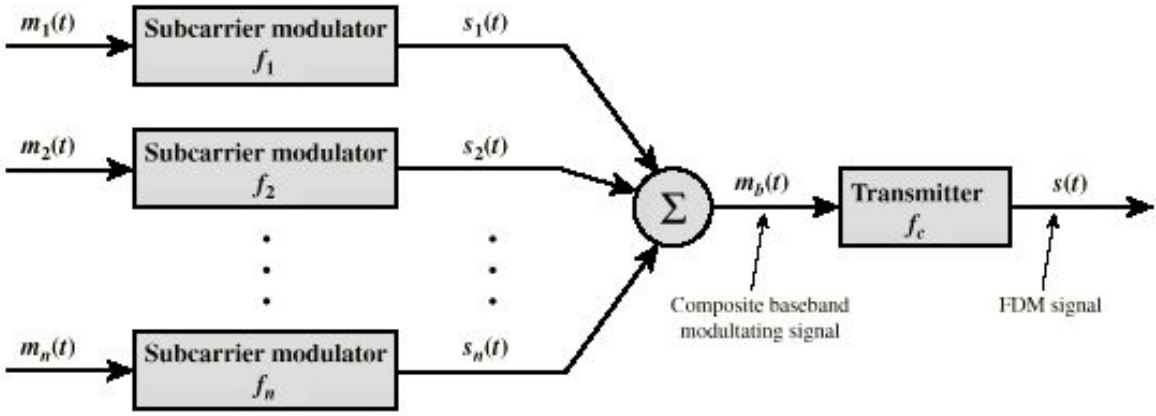
Frequency Division Multiplexing

- FDM
- Useful bandwidth of medium exceeds required bandwidth of channel
- Each signal is modulated to a different carrier frequency
- Carrier frequencies separated so signals do not overlap (guard bands)
- e.g. broadcast radio
- Channel allocated even if no data

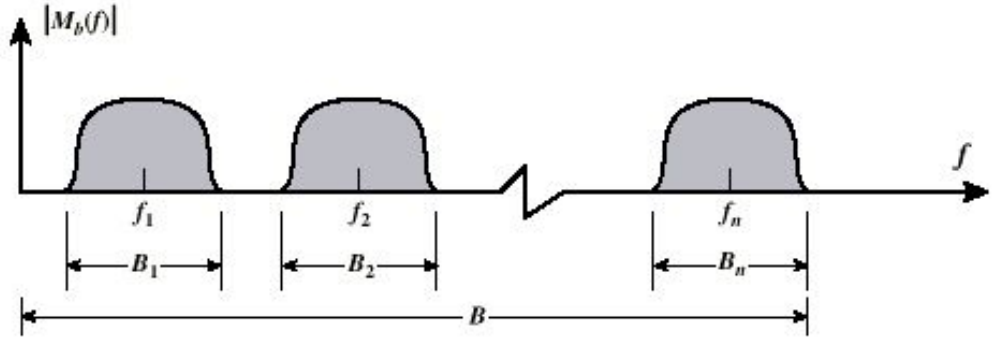
Frequency Division Multiplexing Diagram



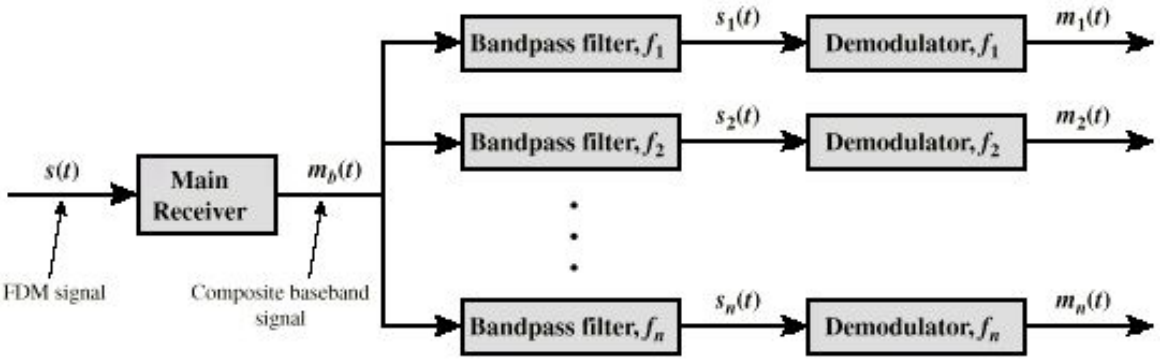
FDM System



(a) Transmitter



(b) Spectrum of composite baseband modulating signal



(c) Receiver

Time Division Multiplexing

- Time Division Multiplexing (TDM) is the time interleaving of samples from several sources so that the information from these sources can be transmitted serially over a single communication channel.
- **Applications of TDM:** Digital Telephony, Data communications, Satellite Access, Cellular radio

Time Division Multiplexing

At the Transmitter

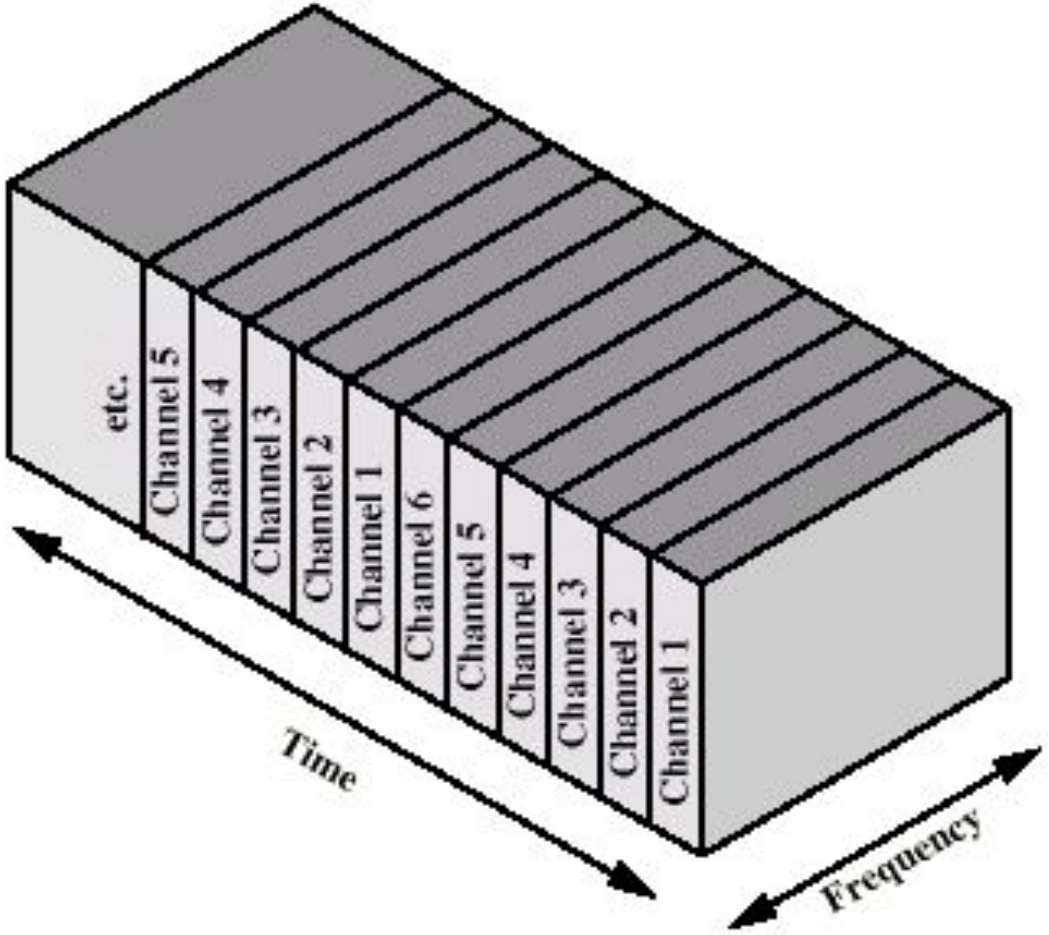
- Simultaneous transmission of several signals on a time-sharing basis.
- Each signal occupies its own distinct time slot, using all frequencies, for the duration of the transmission.
- Slots may be permanently assigned on demand.

Time Division Multiplexing

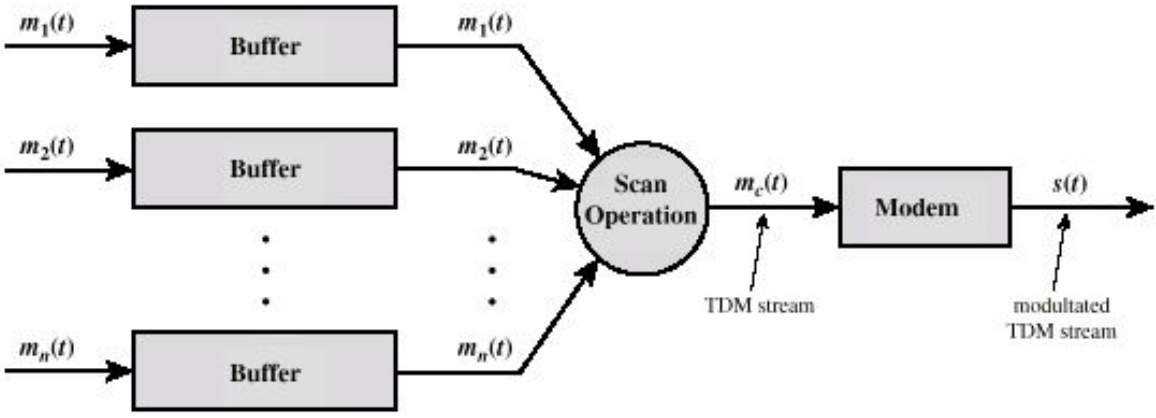
At the Receiver

- Decommutator (sampler) has to be synchronized with the incoming waveform ☐ *Frame Synchronization*
- Inter Symbol Interference – poor channel filtering
- Feed through of one channel's signal into another channel -- *Crosstalk*

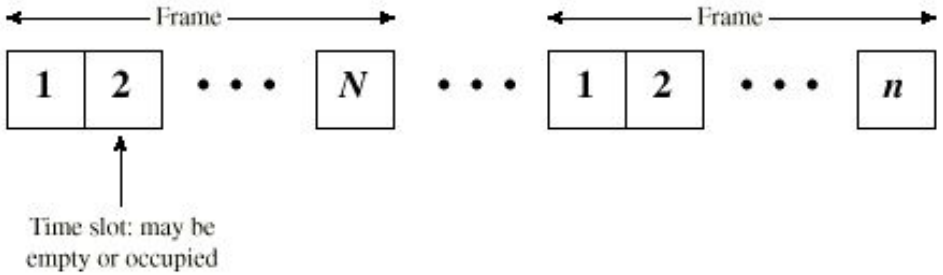
Time Division Multiplexing



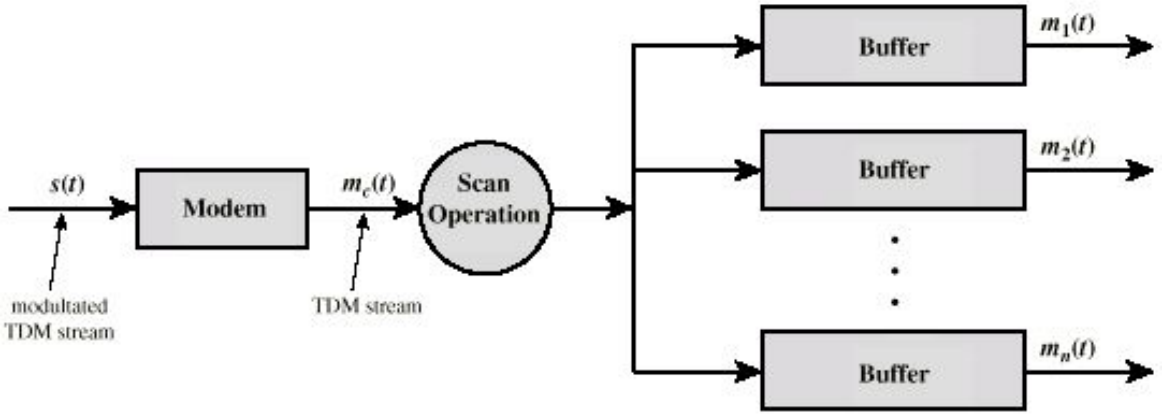
TDM System



(a) Transmitter



(b) TDM Frames



(c) Receiver

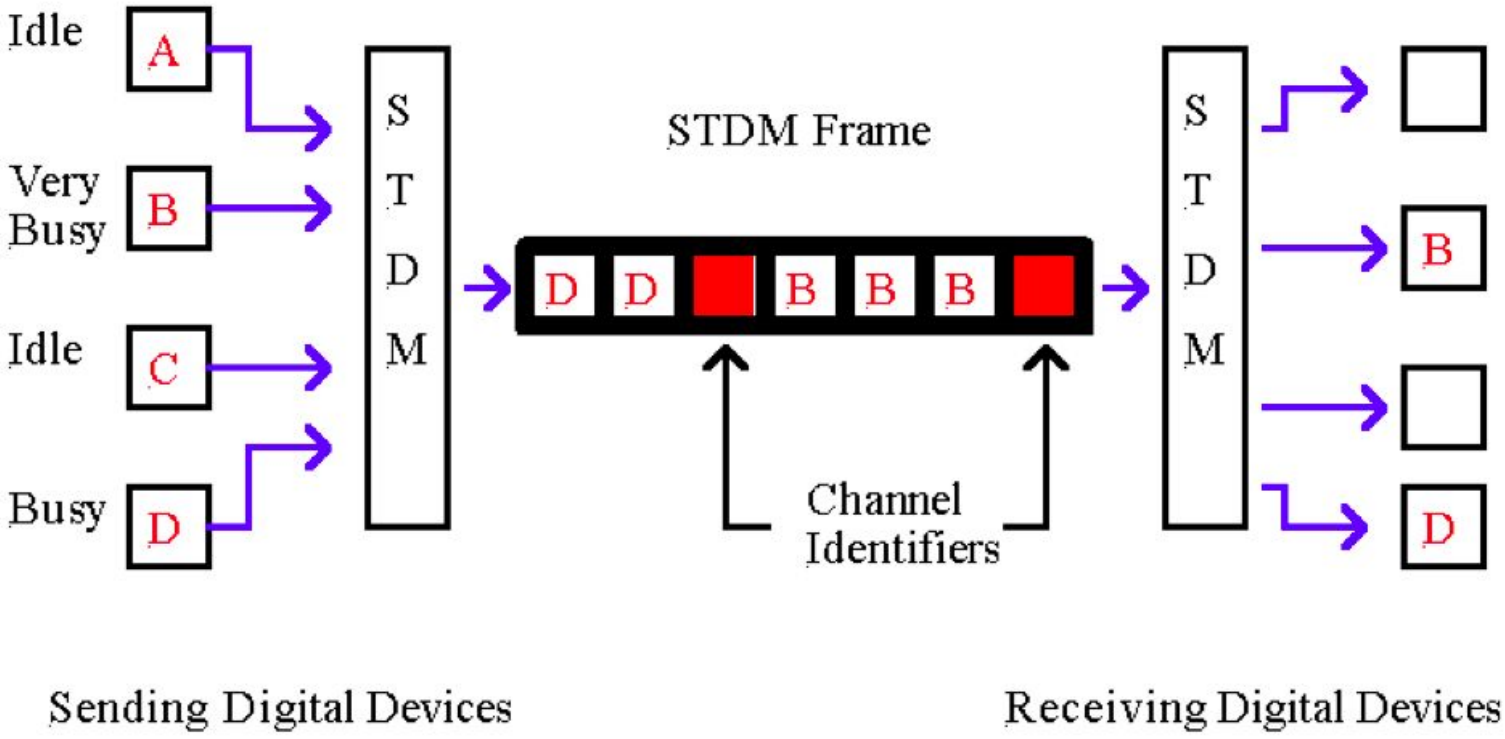
FDM v/s TDM

Sr no.	FDM	TDM
1.	The signals which are to be multiplexed are added in the time domain . But they occupy different slots in the frequency domain .	The signals which are to be multiplexed can occupy the entire bandwidth in the time domain .
2.	FDM is usually preferred for the analog signals .	TDM is preferred for the digital signals .
3.	Synchronization is not required .	Synchronization is required .
4.	The FDM requires a complex circuitry at Tx and Rx .	TDM circuitry is not very complex .
5.	FDM suffers from the problem of crosstalk due to imperfect BPF .	In TDM the problem of crosstalk is not severe .
6.	Due to bandwidth fading in the Tx medium , all the FDM channels are affected .	Due to fading only a few TDM channels will be affected .

Statistical TDM

- In TDM many slots are wasted
- Statistical TDM allocates time slots dynamically based on demand
- Multiplexer scans input lines and collects data until frame full
- Data rate on line lower than aggregate rates of input lines

Statistical TDM



Comparison

Advantages

- **FDM**
  - Simple
  - Cheap
  - Popular
- **TDM**
  - Digital signals
  - Multiplexing hierarchy
    - different data rates
- **STDM**
  - More efficient bandwidth use
  - Frame can contain control information
  - Packet can be of varying sizes

Disadvantages

- **FDM**
  - Susceptible to noise
  - Wasted bandwidth
  - Limited frequency range
- **TDM**
  - Wasted bandwidth
- **STDM**
  - More complex and expensive