Difference Between TDM and FDM

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TDM (Time Division Multiplexing) and **FDM (Frequency Division Multiplexing)** are the two techniques of multiplexing. The common difference between TDM and FDM is that TDM share the timescale for the different signals; Whereas FDM shares the frequency scale for the different signals.

Before understanding both terms in deep let's understand the term multiplexing. **Multiplexing** is a technique through which multiple signals are simultaneously transmitted over a single data link. Multiplexed system involves n number of devices which share the capacity of one link that's how a link (path) can have multiple channels.

Multiple devices fed their transmission streams to a Multiplexer (MUX) which combines them into a single stream. At the receiving end, the single stream is directed to the Demultiplexer (DEMUX), then the stream is converted back into its component transmission and sent to their intended receivers.

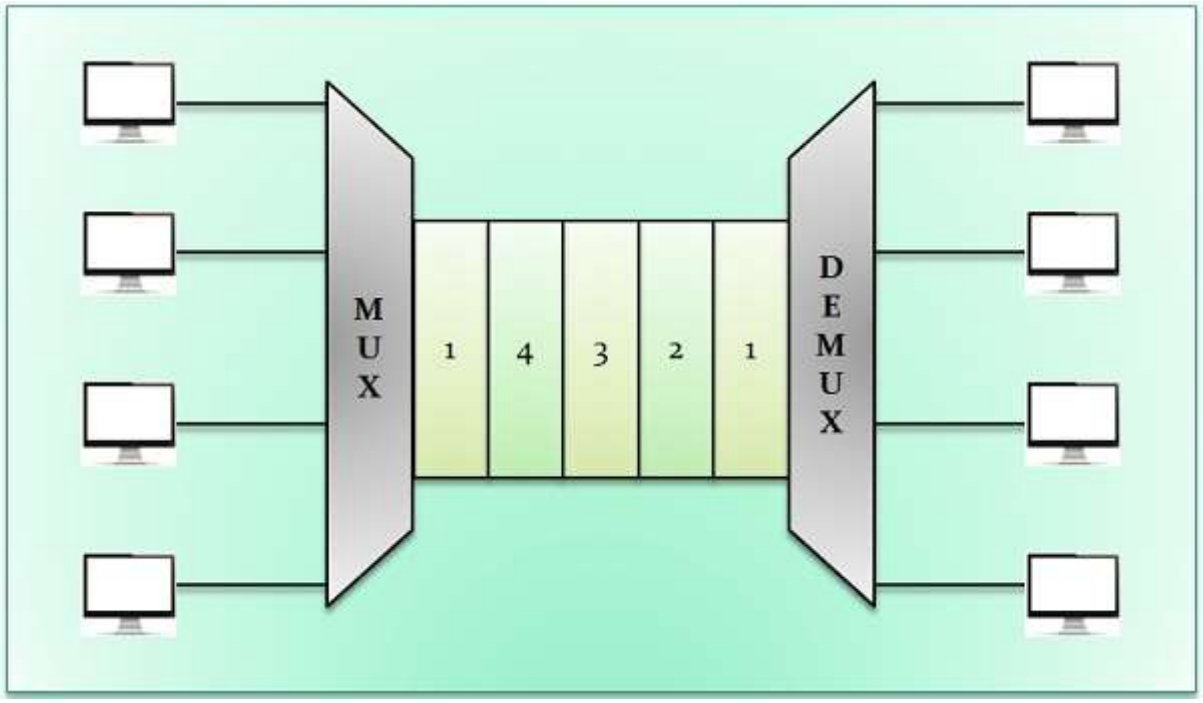
Content: TDM Vs FDM

Comparison Chart

BASIS FOR COMPARISON	TDM	FDM
Basic	Times scale is shared.	Frequency is shared.
Used with	Digital signals and analog signals	Analog signals
Necessary requirement	Sync Pulse	Guard Band
Interference	Low or negligible	High
Circuitry	Simpler	Complex
Utilization	Efficiently used	Ineffective

Definition of TDM

Time-division multiplexing (TDM) is considered to be a digital process which can be applied when the transmission medium data rate capacity is higher than the data rate requirement of the transmitting and receiving devices. In TDM, respective frames carry data to be transmitted from the various sources. Each frame consists of a set of time slots, and portions of each source is assigned a time slot per frame.



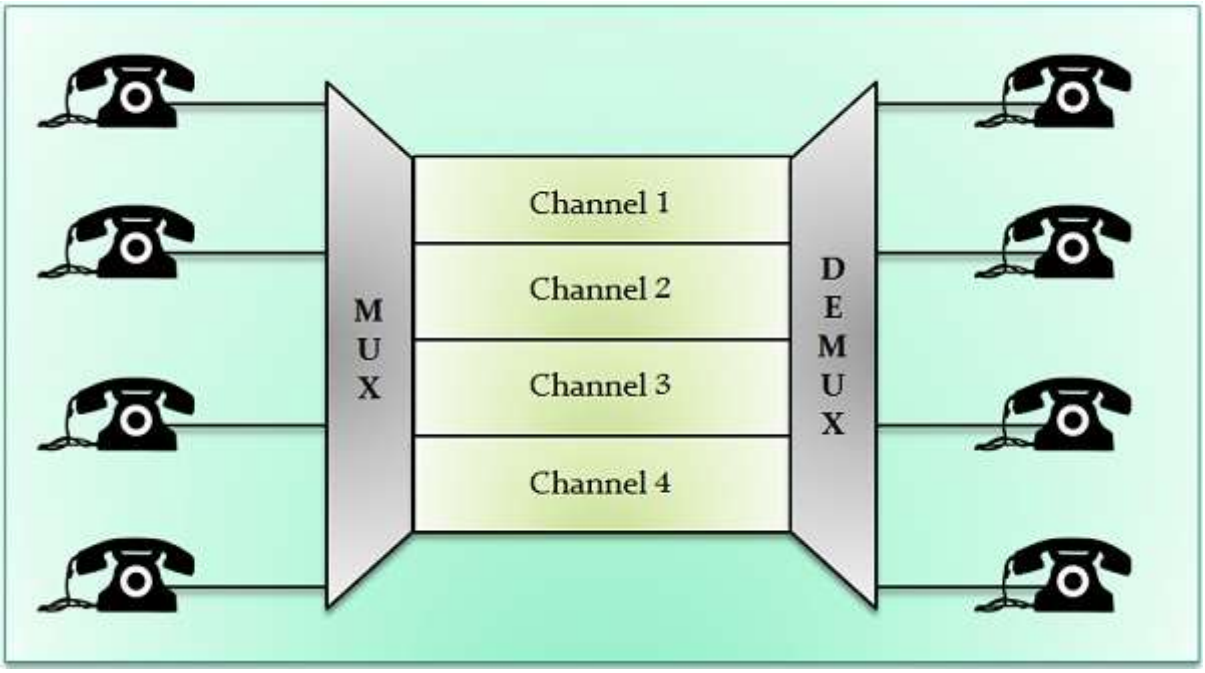
Types of TDM :

- **Synchronous Time-Division Multiplexing** – In this type the synchronous term signifies that the multiplexer is going to allocate exactly the same slot to each device at all times whether a device has anything to transmit or not. If it doesn't have something, the time slot would be empty.
  TDM uses **frames** to group time slots which covers a complete cycle of time slots. Synchronous TDM uses a concept, i.e., **interleaving** for building a frame in which a multiplexer can take one data unit at a time from each device, then another data unit from each device and so on. The order of the receipt notifies the demultiplexer where to direct the each time slot, which eliminates the need of addressing.
  To recover from timing inconsistencies **Framing bits** are used which are usually appended to the beginning of each frame. **Bit stuffing** is used to force speed relationships to equalize the speed among various devices into an integer multiple of each other. In bit stuffing, the multiplexer adds extra bits to device's source stream.
- **Asynchronous Time-Division Multiplexing** – Synchronous TDM waste the unused space in the link hence it does not guarantee the efficient use of the full capacity of the link. This gave rise to Asynchronous TDM. Here Asynchronous means flexible not fixed. In Asynchronous TDM multiple lower speed input lines are multiplexed to a single higher speed line.
  In Asynchronous TDM, the number slots in a frame is less than the number of data lines. On the contrary, In Synchronous TDM the number of slots must be equal to the number of data lines. That's why it, avoids the wastage

of the link capacity.

Definition of FDM

Frequency-division multiplexing (FDM) is an analog technique which is applied only when the bandwidth of the link is greater than the combined bandwidth of the signals to be transmitted. Each sending device generates signals which modulate at different carrier frequencies. To hold the modulated signal, the carrier frequencies are separated by sufficient bandwidth.



These modulated signals are then combined into one composite signal that can be transported by the link. The signals travel through the bandwidth ranges referred as channels.

Signals overlapping can be prevented through using unused bandwidth strips for separating the channels, these are known as **guard bands**. Also, carrier frequencies should not interfere with the original data frequencies. Failure to adhere to either condition can result in unrecoverability of the original signals.

Key Differences Between TDM and FDM

1. The time-division multiplexing (TDM) includes sharing of the time through utilizing time slots for the signals. On the other hand, frequency-division multiplexing (FDM) involves the distribution of the frequencies, where the channel is divided into various bandwidth ranges (channels).

2. Analog signal or Digital signal any could be utilized for the TDM while FDM works with Analog signals only.
3. **Framing bits** (Sync Pulses) are used in TDM at the start of a frame in order to enable synchronization. As against, FDM uses **Guard bands** to separate the signals and prevent its overlapping.
4. FDM system generates different carriers for the different channels, and also each occupies a different frequency band. In addition, different bandpass filters are required. On the other hand, the TDM system requires identical circuits. As a result, the circuitry needed in FDM is more complex than needed in TDM.
5. The **non–linear** character of the various amplifier in the FDM system produces **harmonic distortion**, and this introduces the **interference**. In contrast, in TDM system time slots are allotted to various signals; as the multiple signals are not inserted simultaneously in a link. Although, the non-linear requirements of both the systems are same, but TDM is immune to interference (crosstalk).
6. The utilization of physical link in case of TDM is more efficient than in FDM. The reason behind this is that the FDM system divides the link in multiple channels which does not make use of full channel capacity.

Conclusion

TDM and FDM, both are the techniques used for multiplexing. FDM uses analog signals, and TDM uses Analog and digital both types of signals. However, TDM is much more efficient technique than FDM.

Related Differences:

1. **Difference Between Go-Back-N and Selective Repeat Protocol**
2. **Difference between Synchronous and Asynchronous Transmission**
3. **Difference Between Baseband and Broadband Transmission**
4. **Difference Between Analog and Digital Signal**
5. **Difference Between Bandwidth and Frequency**