Lec-21, DC, 24-25, Sec A

Time division multiplexing :- (TDM)

Due to sampling theorem, tx. of information engages the comm. channel for only a fraction of the sampling interval on a periodic basis.

time interval b/w adjacent samples is cleared for use by other independent message sources on a time shared basis.

TDM :- utilization of a common communication channel by multiple independent message sources without interference.

1. N - message inputs.

2. Restrict in B.W. by a LP anti-aliasing filter (W – cutoff freq.)

3. Apply to a commutator – implemented using electronic switching circuit.

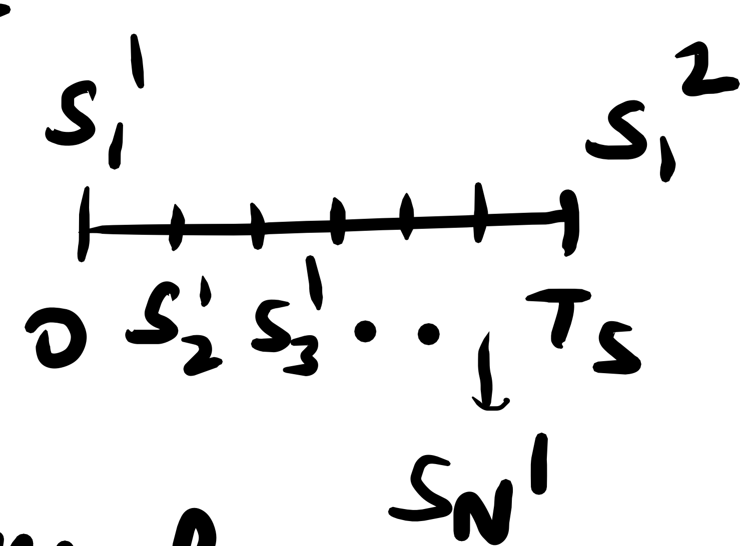
4. Sequentially interleave these N samples inside the sampling interval T_s.

5. Pulse modulate & transmit.

$S_1 \rightarrow S_1^1 \; S_1^2$

$0 \quad T_s$

→ TDM introduces a B.W. expansion factor N, because the scheme must squeeze N samples derived from N independent sources into a time slot equal to one sampling interval.



$S_1 \rightarrow n_1$ bits to encode.

$S_2 \rightarrow n_2$ "

$\vdots$

$S_N \rightarrow n_N$ " "

See fig. 3.19 from Haykin's TB. (pg. 211)

If you Tx only S_1, then in a time interval T_s you need to Tx. n_1 bits.

But with TDM, in T_s interval, you need to Tx $\sum_{i=1}^{N} n_i$ bits.

$$\geq \left(\sum_{i=1}^{N} n_i\right) B$$

<u>T1 system</u>:- Bell labs - North America & several other countries.

24 voice channels over a pair of twisted wires - regenerative repeaters spaced at approx. 2 km intervals.

1. Voice signal limited to a band 300Hz – 3100Hz.

2. Pass it through a LPF with a cutoff freq. of about 3.1 KHz. – Nyquist rate of 6.2 KHz sampling – usually 8 KHz is the Standard
" rate in telephone system.

3. Each frame of multiplexed signal occupies

$1/(8\times10^3) = 125\ \mu s$

↳ It consists of 24, 8-bit words plus a single bit that is added at the end of the frame for the purpose of synchronization.

Q. Find each bit's duration → $24\times8+1 = 193$ bits in a frame.

each bit duration :- $\frac{125 us}{193} = 0.647$ usec

Resulting in a Tx. rate of $\frac{1}{0.647}$ Mbps =

1.544 Mbps.

→ We have not discussed implementation of companders.- as done via piecewise manner in T1

→ synchronization (which is done with single bit over here)