Lecture 17: Time Division Multiplexing & Telephony

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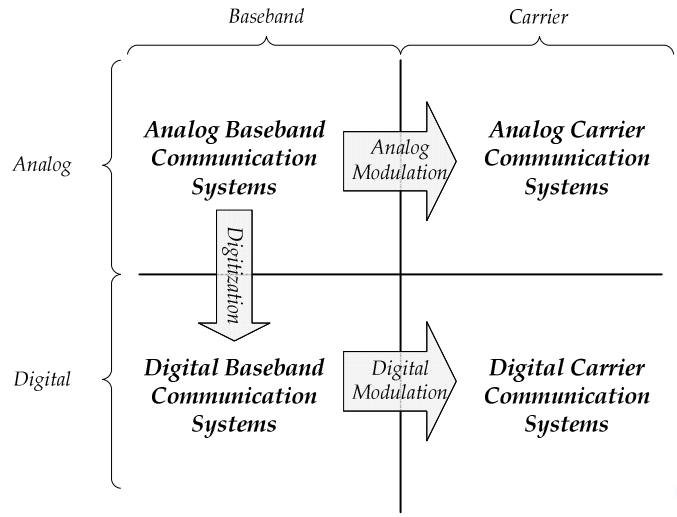
EE421: Communications I. For more information read Chapter 6 in your textbook or visit http://wikipedia.org/.

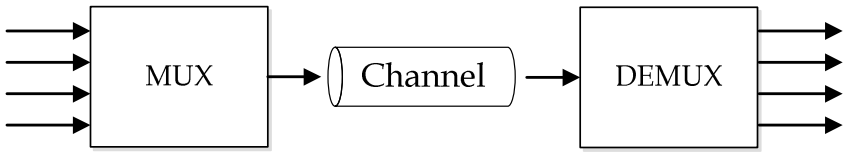
Modulation and Digitization



Multiplexing: TDM

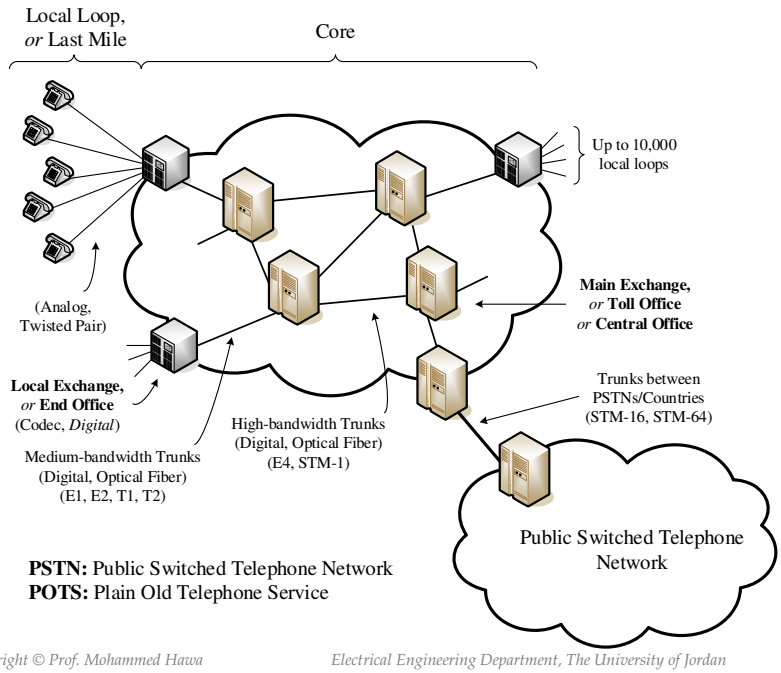
- Time Division Multiplexing (**TDM**) is a process that allows the transmission of several signals over the same baseband channel.
- Achieved by interleaving the bits of the different signals using different **time instants**.
- The receiver isolates one signal from the rest using a **time demultiplexer**.
- TDM is ***not*** limited to PCM or telephony.

Multiplexer/Demultiplexer

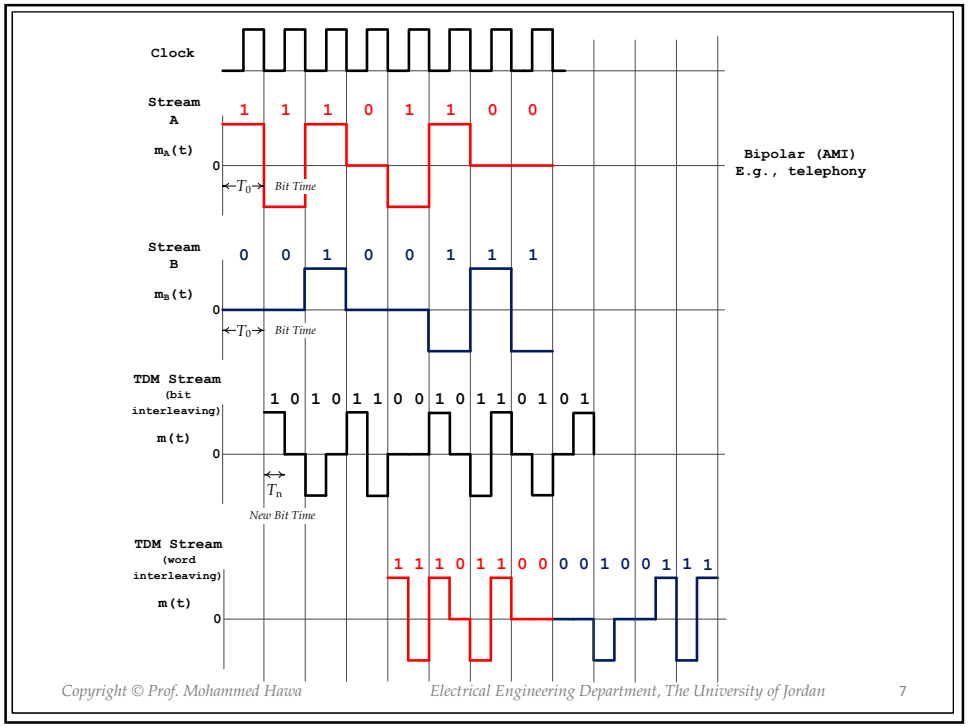


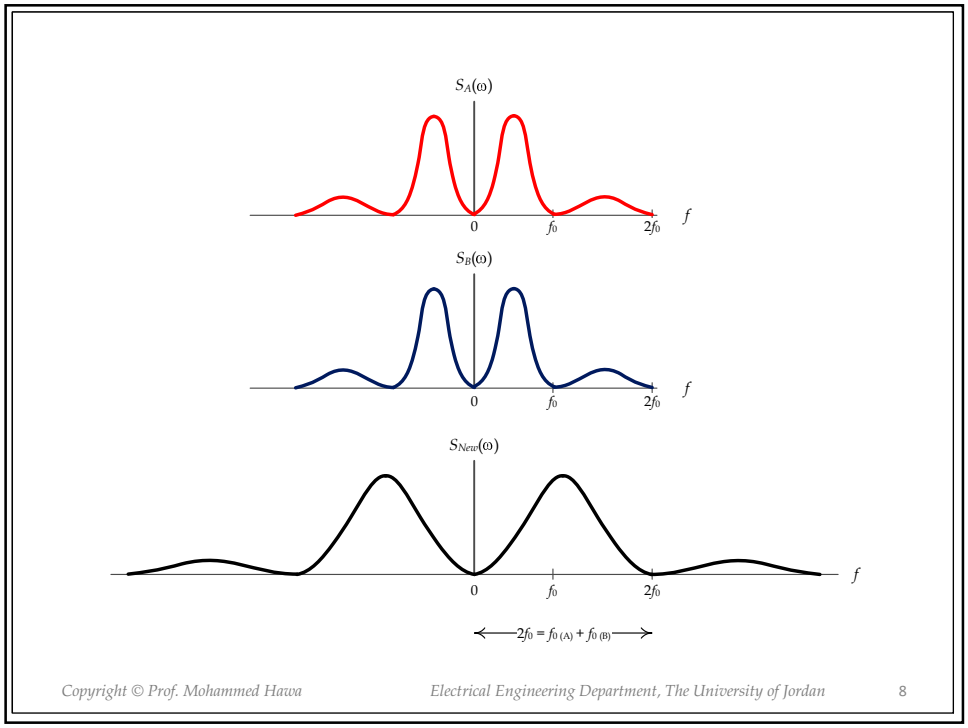
TDM *Multiplexer*

TDM *Demultiplexer*

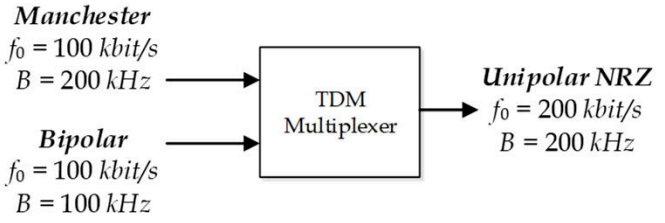


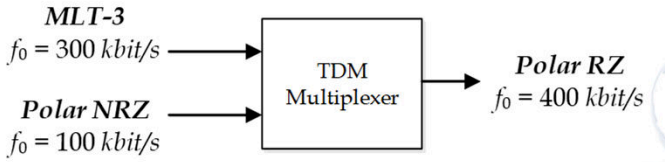
TDM Multiplexer


Clock
Stream A
1 1 1 0 1 1 0 0
$m_A(t)$
0
T_0
Bit Time
Bipolar (AMI)
E.g., telephony
Stream B
0 0 1 0 0 1 1 1
$m_B(t)$
0
T_0
Bit Time
TDM Stream (bit interleaving)
1 0 1 0 1 1 0 0 1 0 1 1 0 1 0 1
m(t)
0
T_n
New Bit Time
TDM Stream (word interleaving)
1 1 1 0 1 1 0 0 0 0 1 0 0 1 1 1
m(t)
0

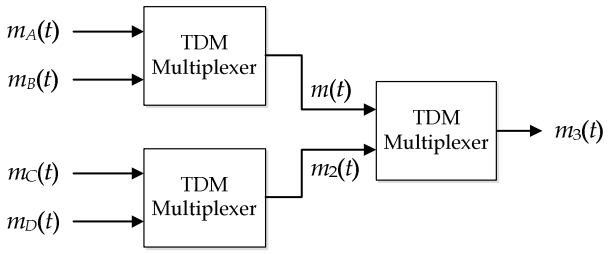

$S_A(\omega)$
0
f_0
$2f_0$
f
$S_B(\omega)$
0
f_0
$2f_0$
f
$S_{New}(\omega)$
0
f_0
$2f_0$
f
$2f_0 = f_{0\,(A)} + f_{0\,(B)}$

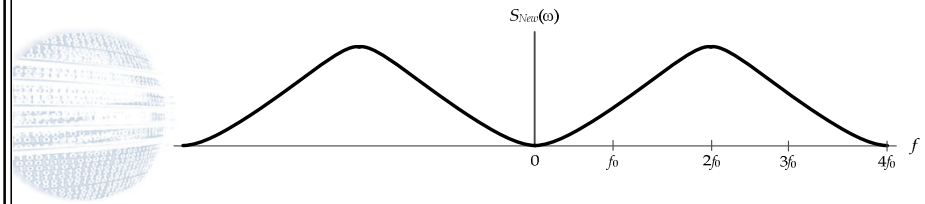
TDM works on bits *NOT* voltages!



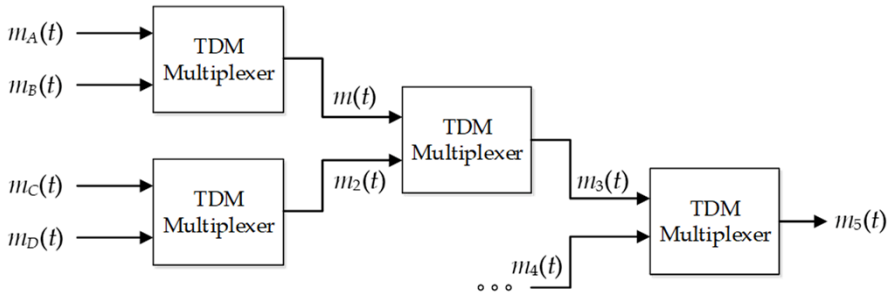


Hierarchical TDM Multiplexing





Any number of steps!

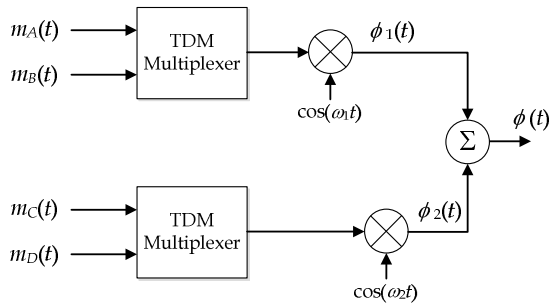


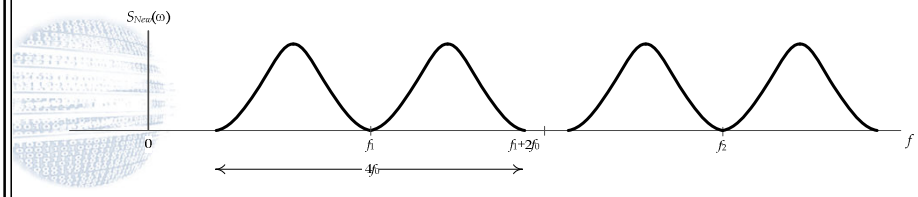
- *Homework*: Show the hardware blocks at the receiver side (Aqaba).

TDM Hierarchy Standard (Tel.)

	U.S. Standard	*European Standard*
Low bit-rate PDH: Plesiochronous Digital Hierarchy	***T1***	***E1***
High bit-rate SDH: Synchronous Digital Hierarchy	***SONET*** (Synchronous Optical Network)	***SDH*** (Synchronous Digital Hierarchy)

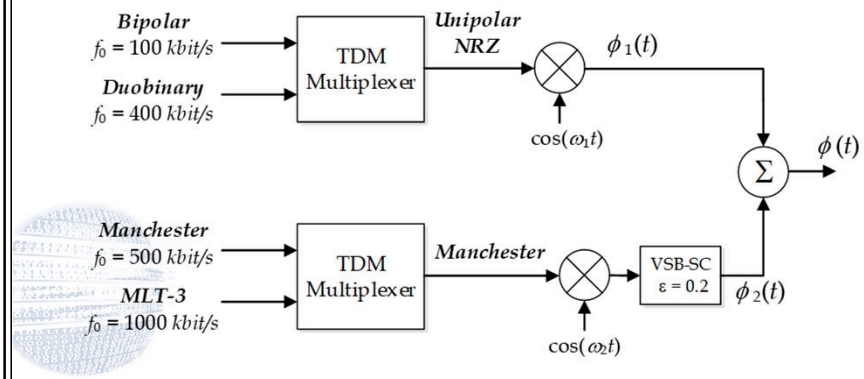
TDM combined with FDM





Homework

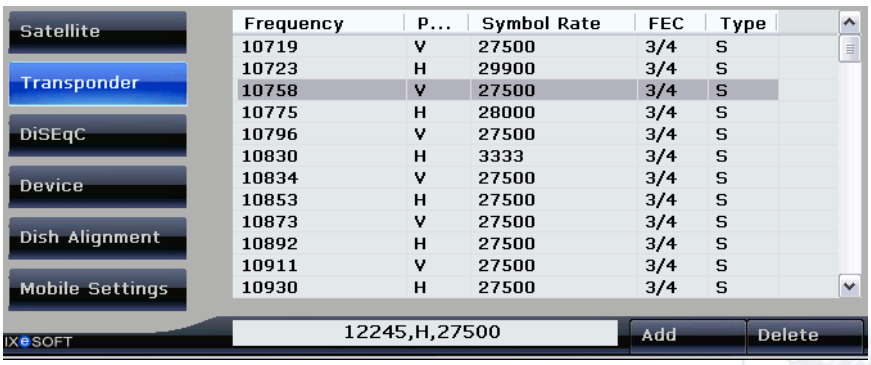
- Sketch the PSD for the output signal $\phi(t)$ below.
- Show the block diagram of the receiver.



Examples on TDM with FDM

- ATSC and DVB digital TV broadcasting systems.
  - Anywhere between 3 and 12 TV stations are multiplexed in one 6 MHz or 8 MHz channel using TDM.
- GSM cellular communications system.
  - Every 8 phone calls are combined using TDMA into one 200 kHz channel.
  - The 200 kHz channels are multiplexed using FDMA.

Homework: Satellite Receiver



GSM uses TDMA/FDMA/FDD