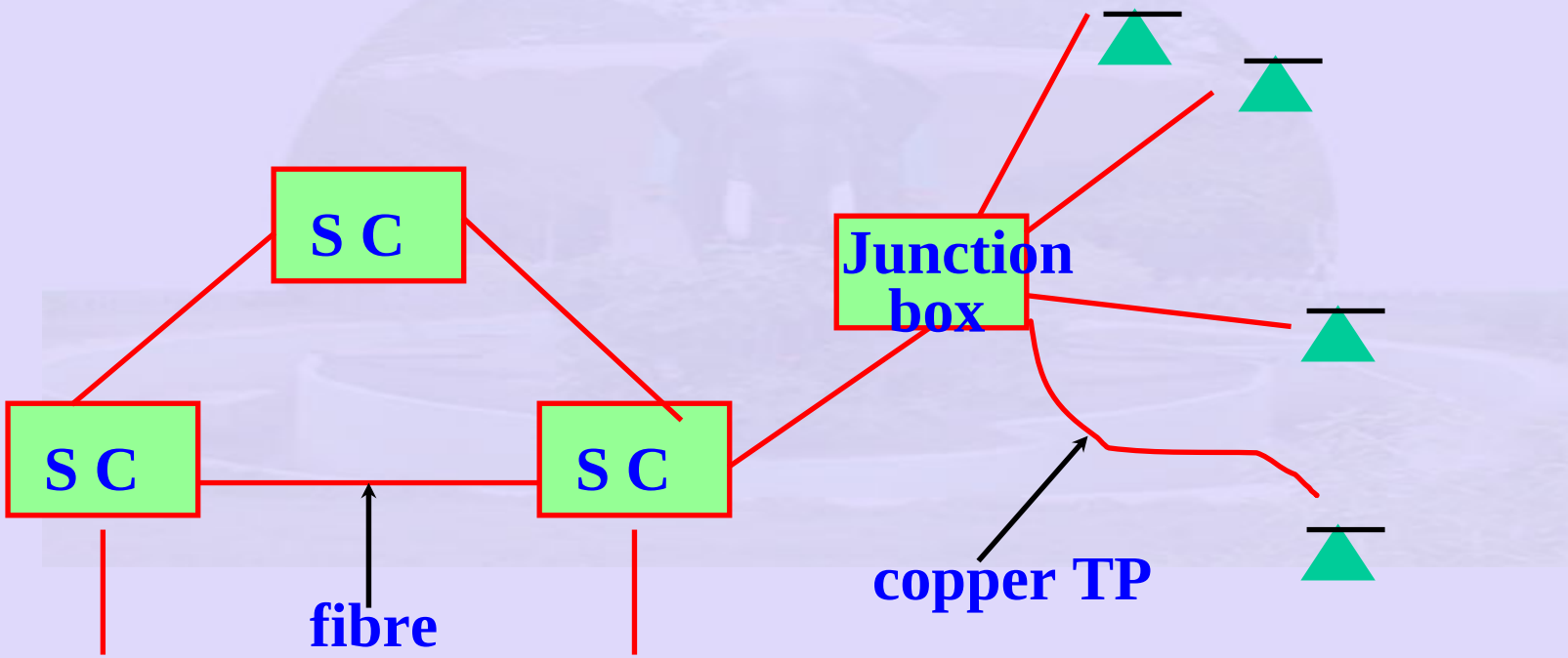
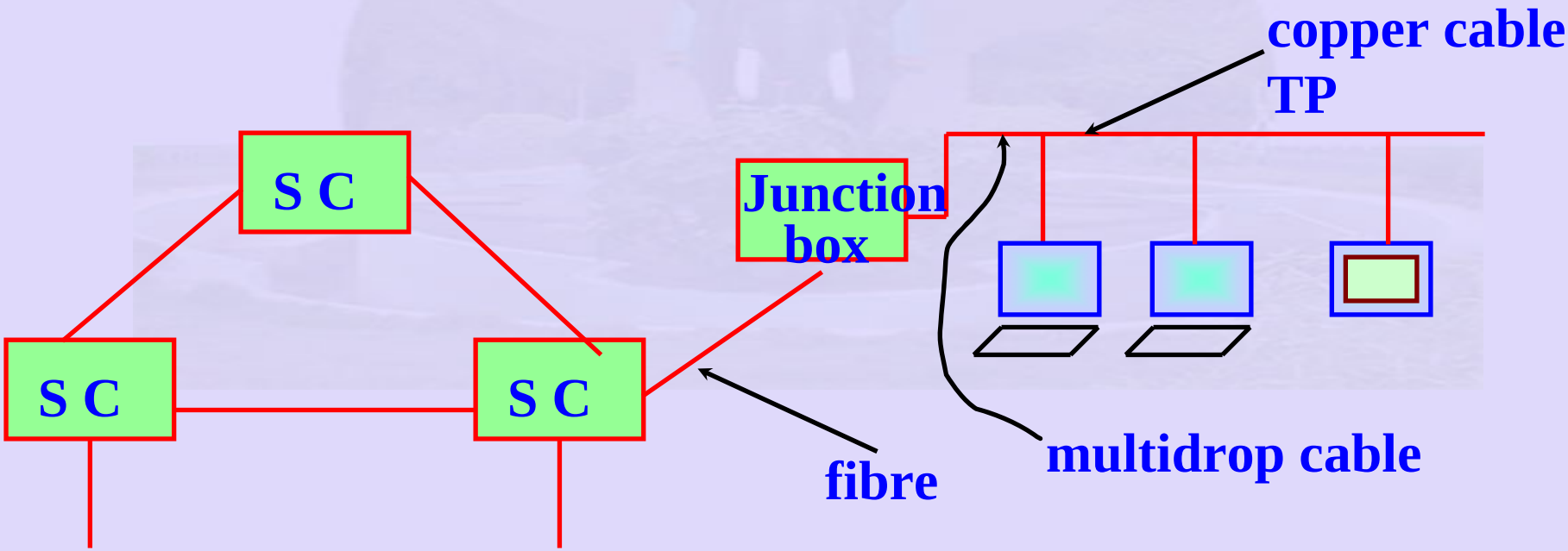
# Access to the Shared Medium

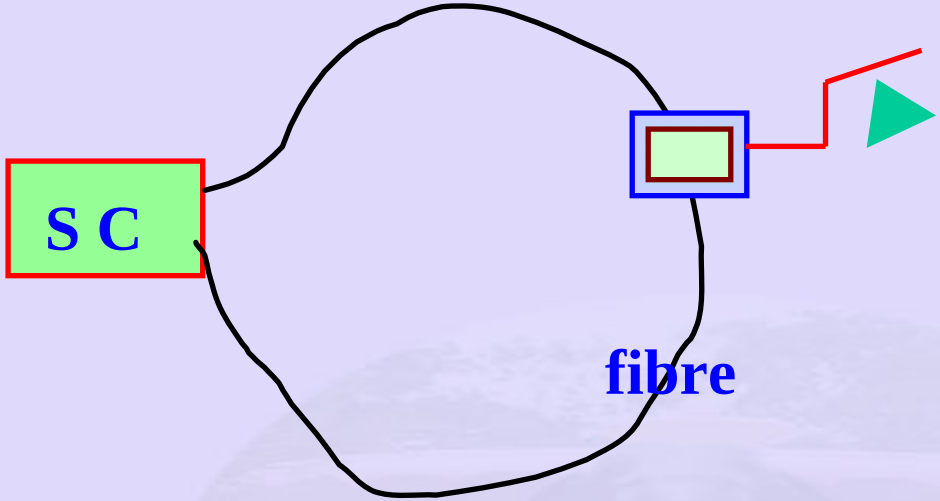
- Different topologies
- Different multiplexing schemes
  - Frequency Division Multiplexing
  - Time Division Multiplexing
  - Combination of both

# A Telephone Network



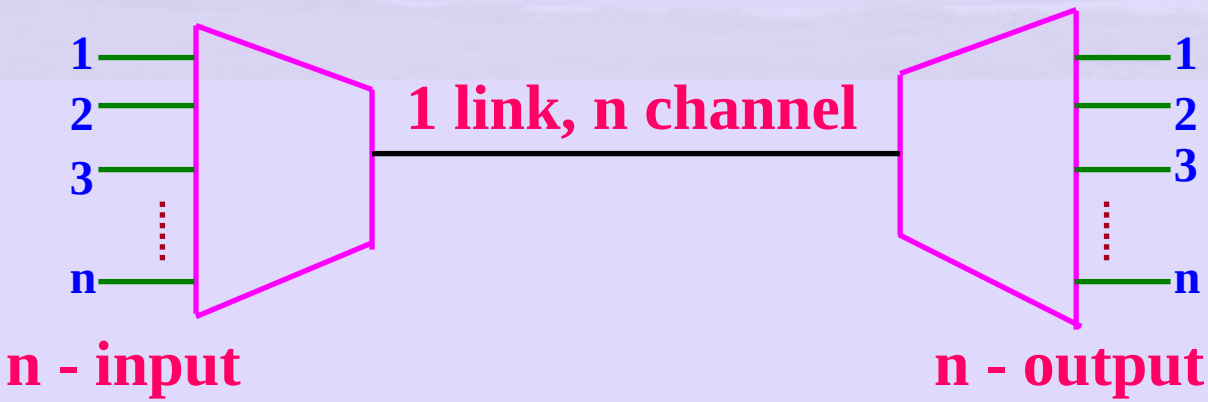
# A Data Network






In urban areas – perhaps best solution is fibre

**Trunks and multiplexing:**



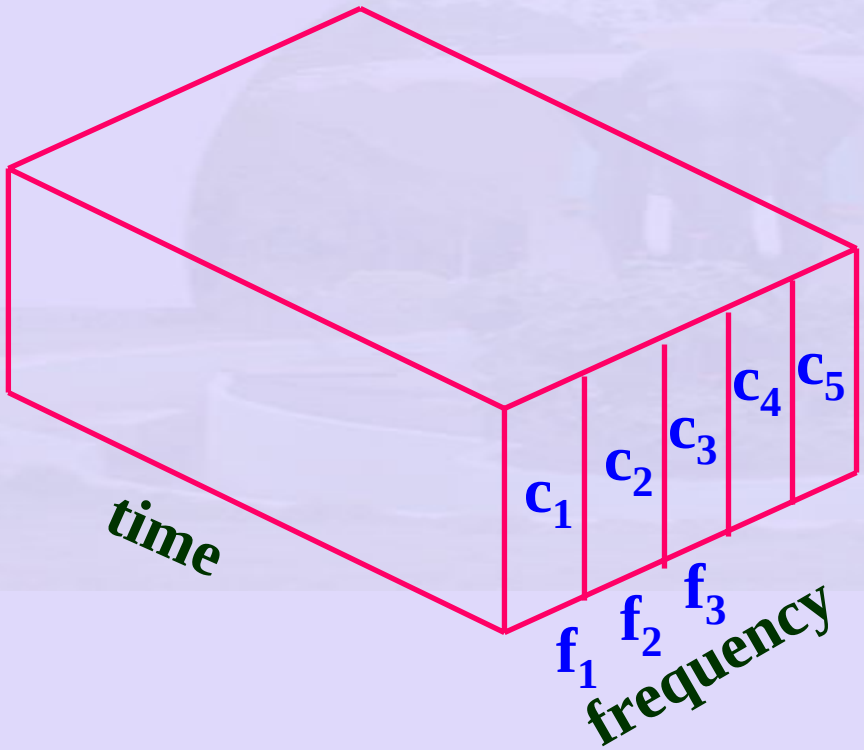
# Multiplexing

- Frequency Division Multiplexing (FDM) and Time Division Multiplexing (TDM)
  - Multiple conversation on the same link
- Frequency Division Multiplexing:
  - Frequency spectrum divided among logical channels
  - each user has exclusive access to a logical channel

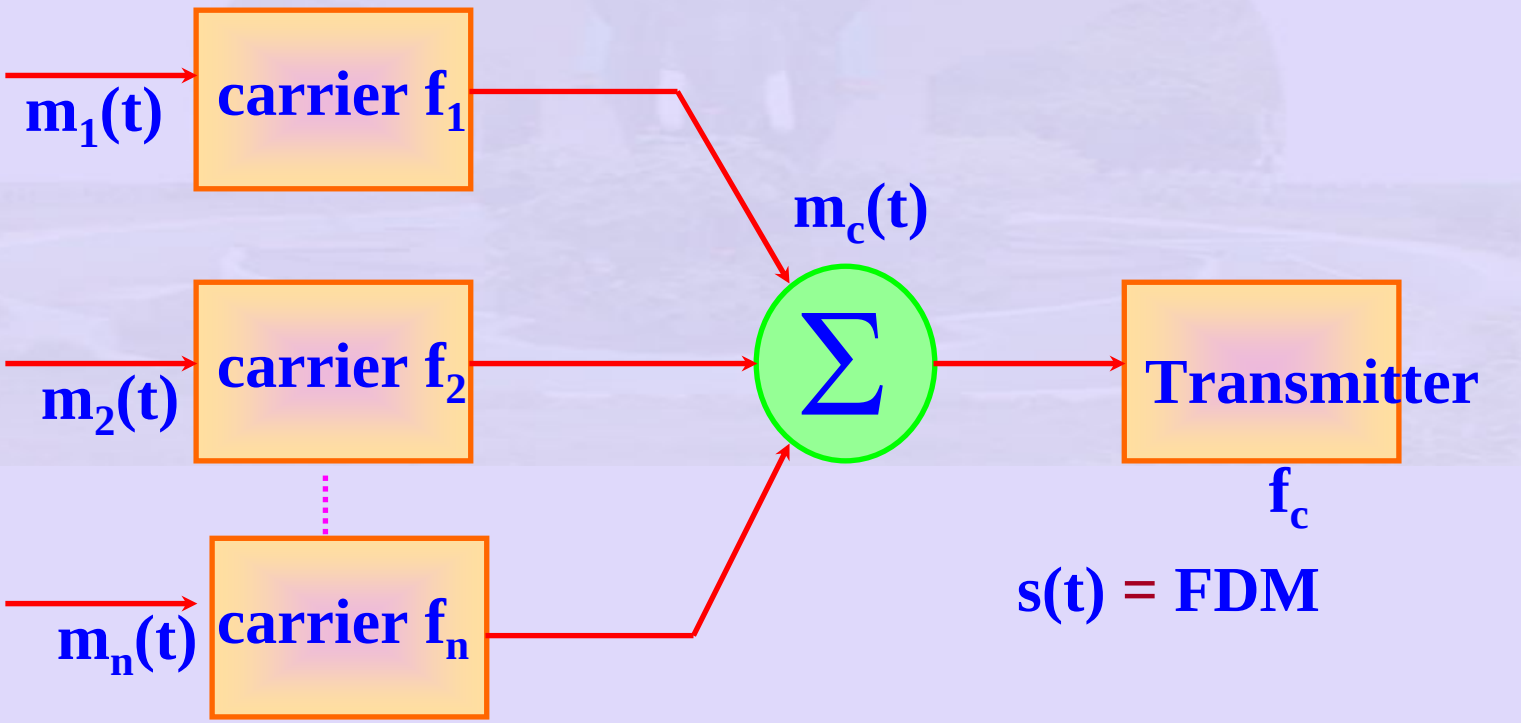
# Multiplexing

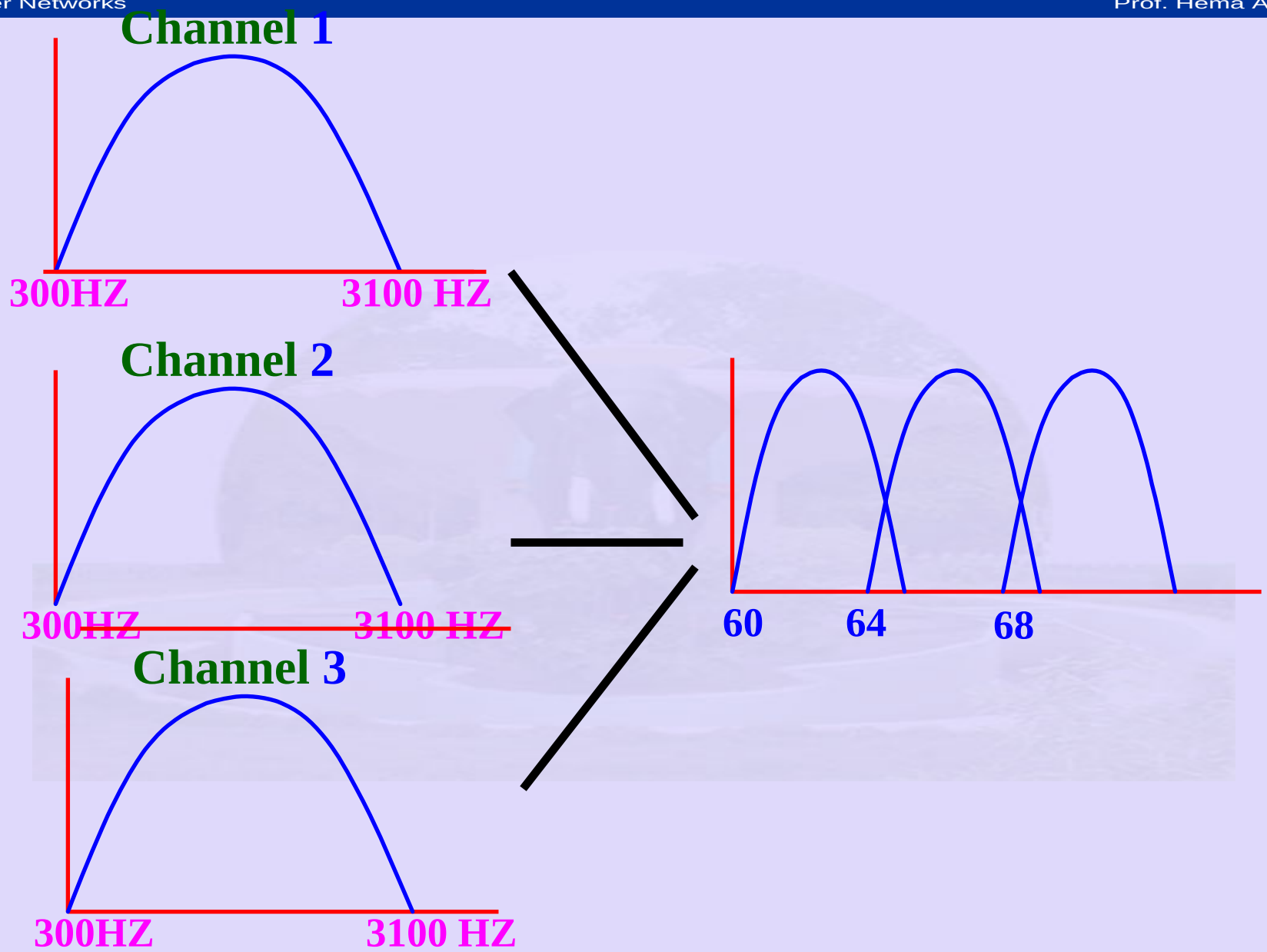
- Time division multiplexing:
  - User take turns in a round robin fashion
  - each user periodically gets the entire bandwidth for a little burst of time

# Frequency Division Multiplexing

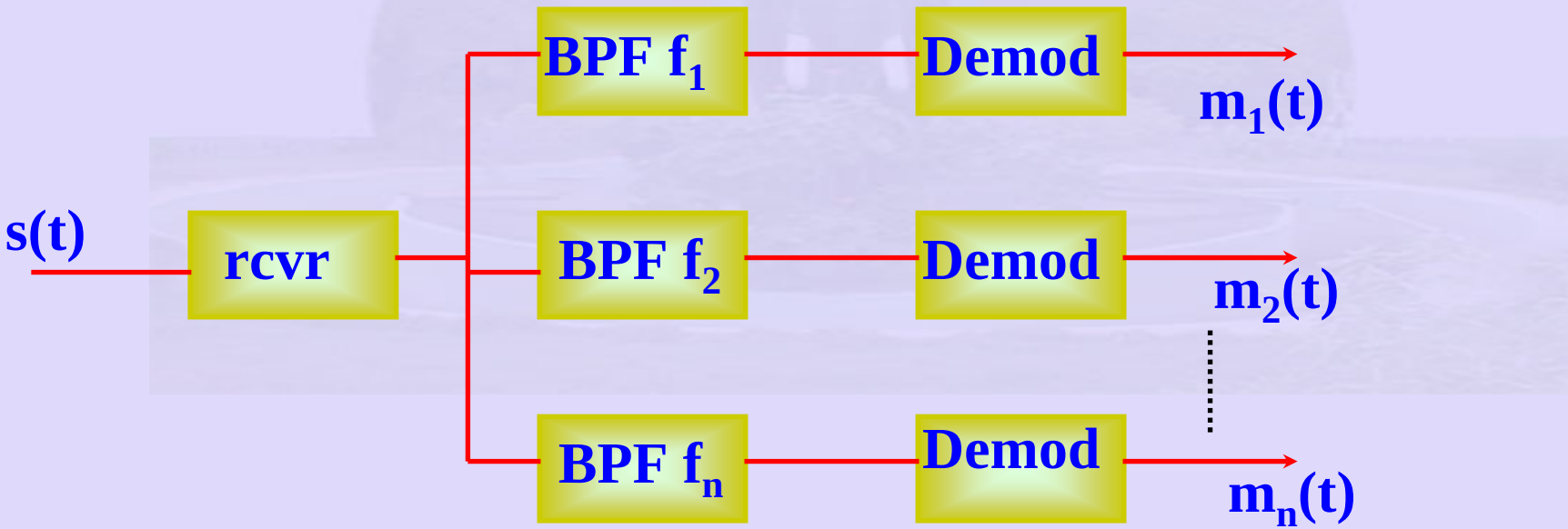


# FDM (Transmitter)

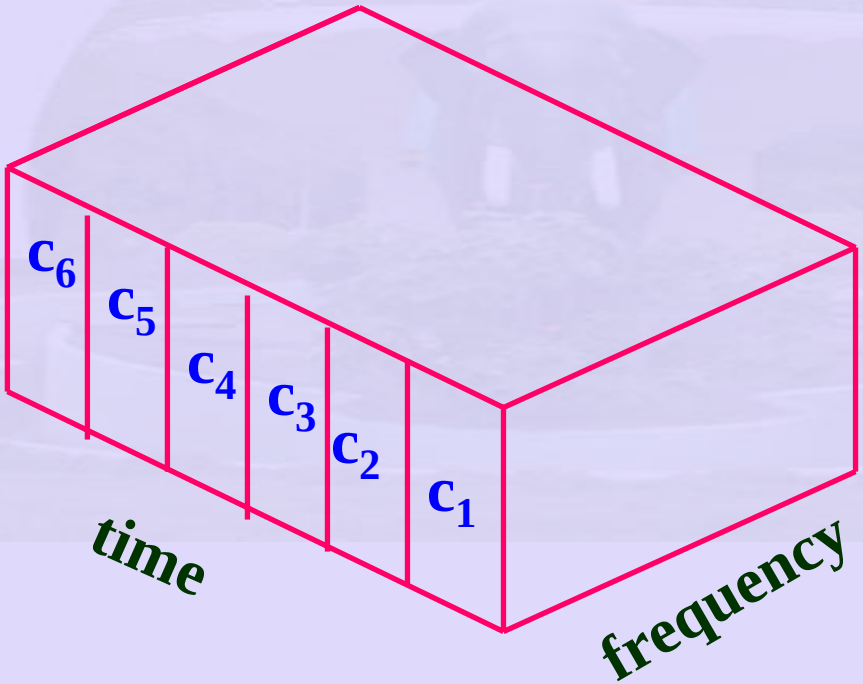



Channel 1
300HZ
3100 HZ
Channel 2
300HZ
3100 HZ
Channel 3
300HZ
3100 HZ
60
64
68

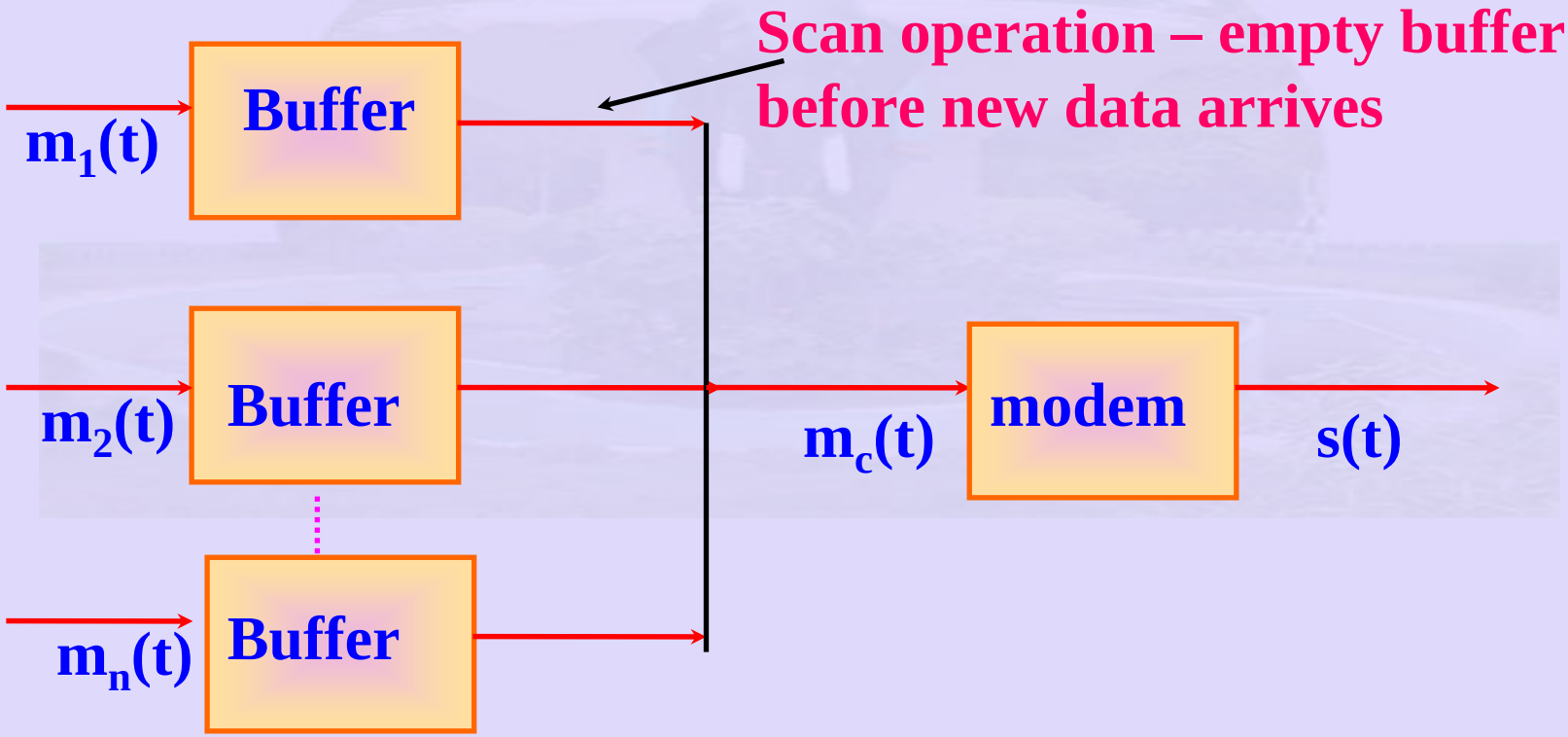
# FDM (Receiver)



# Time Division Multiplexing



# TDM (Transmitter)



# Time Division Multiplexing

- Generally digital data:
  - interleave data from different channels
  - interleave portion of each signal
- Example: Each channel capacity 9.6kbps
  - To Multiplex 6 channels
    - Channel capacity – 57.6kbps + overhead bits for control

# Issues in TDM

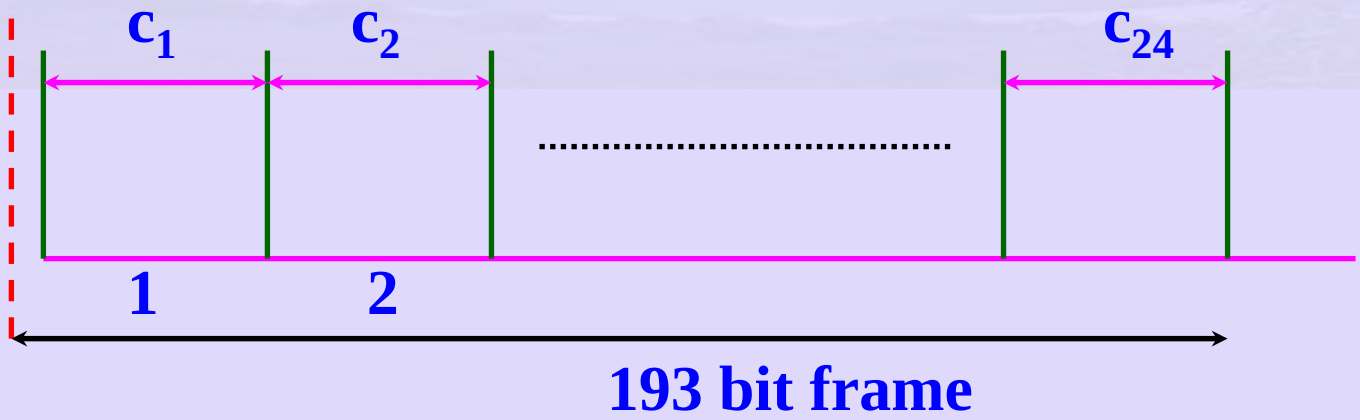
- Transmission must be synchronous
- Data organised in frame
- frame ➔ a cycle of time slots
- a slot dedicated to each data source
- slot length – transmission buffer length

# Issues in TDM

- synchronous TDM – slots preassignd to sources
  - time slots for each slot transmitted whether data is present or absent
- Handle data source with different rates
  - assign more slots/ channels and fast sources
- Data is digital
  - Analog to digital conversion
    - PCM, DPCM, ADPCM, DM

# Telephone Channel (T1 (DS1))

- Conversion of analog signal to digital
  - PCM – 8 KHZ * 8 bit/ s
- 125 s / frame = 64 Kbps
- 24 voice channels multiplexed together



# T1 Frame Format

- 101010 …… pattern in odd frames – signalling for every frames
- channel associated signalling:
  - each channel has private signalling mechanism
  - 8 bits in every 6th frame – used for signalling
  - frames in each channel is eight bits wide
  - Frames in 6th frame 7 bits wide

# E1 Frame Format

- E1 - 2.048 Mbps
  - 32 channels
  - 32 - 8 bit data samples packetised into the basic 125 μ sec frame
- 30 channels for information
- 2 channels for signaling

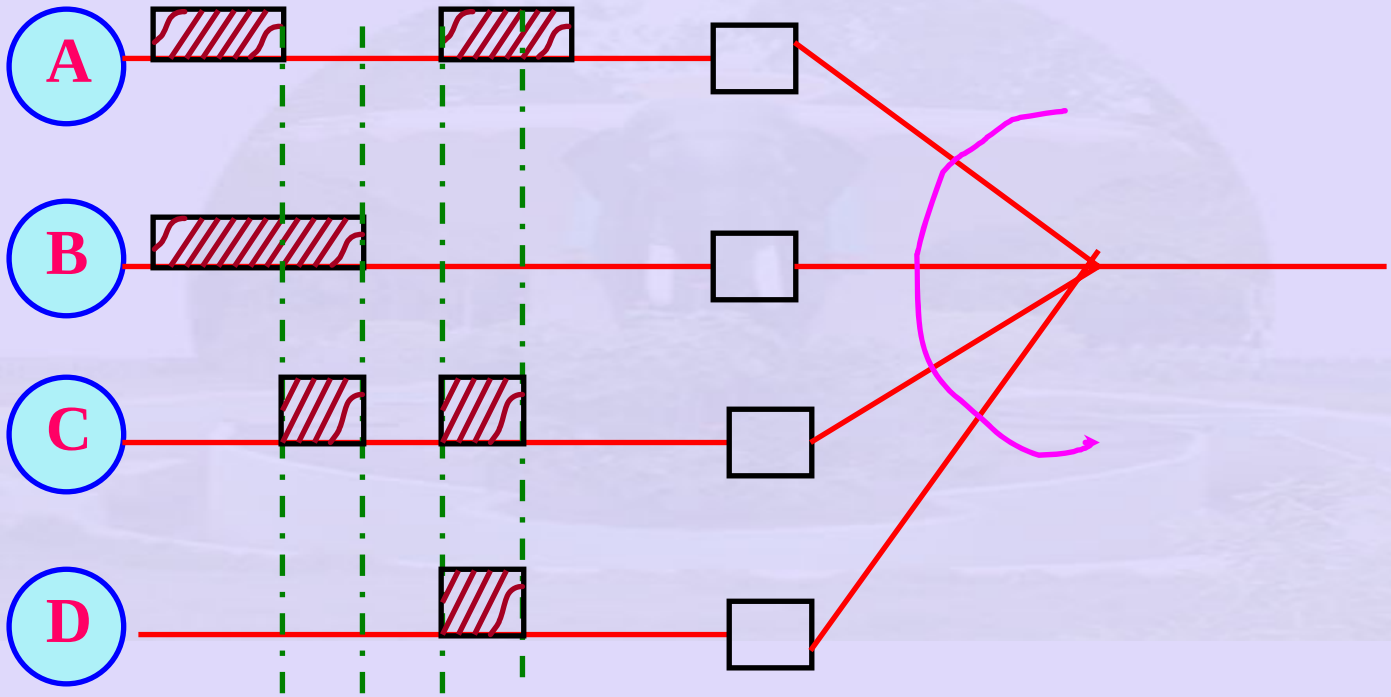
# Standards

- **Leased lines:**
- **DS1 1.544 Mbps (24 channels) (T1)**
- **DS3 44.736 Mbps (30 DS1 links)**
- **STS-1 - Synchronous Transport Signal**
- **STS-1 – base link speed**
- **STS-N - also called OC-N (electrical signal)**
- **OC - optical carrier (optical signal)**
- **STS-48 - 2.488320 Gbps**
- **STS-3 - 155.250 Mbps**
- **STS-12 - 622.080 Mbps**
- **STS-24 - 1.244160 Gbps**
- **Telephone Network: primarily for voice and is circuit switched.**

# Standards

- Last Mile Links:
- POTS 28.8 – 56 Kbps
- ISDN 64 – 128 Kbps
- (Integrated Services Digital Network)
- xDSL 16 Kbps – 55.2 Mbps
- CATV 20 – 70 Mbps
- ADSL (asymmetric DSL)
- ADSL:
- - Different speeds from home to CO & CO to home.
- - Downstream (CO to subs) - 8.448 Mbps (9000 ft)
- 1.544 Mbps (depends on distance from CO to home)
- 16 Kbps - 640 Kbps
- (1800 ft) (9000 ft)
- VDSL – very high data rate (12.96 Mbps – 55.2 Mbps)
- (1000 – 4000 ft)

# Asynchronous TDM



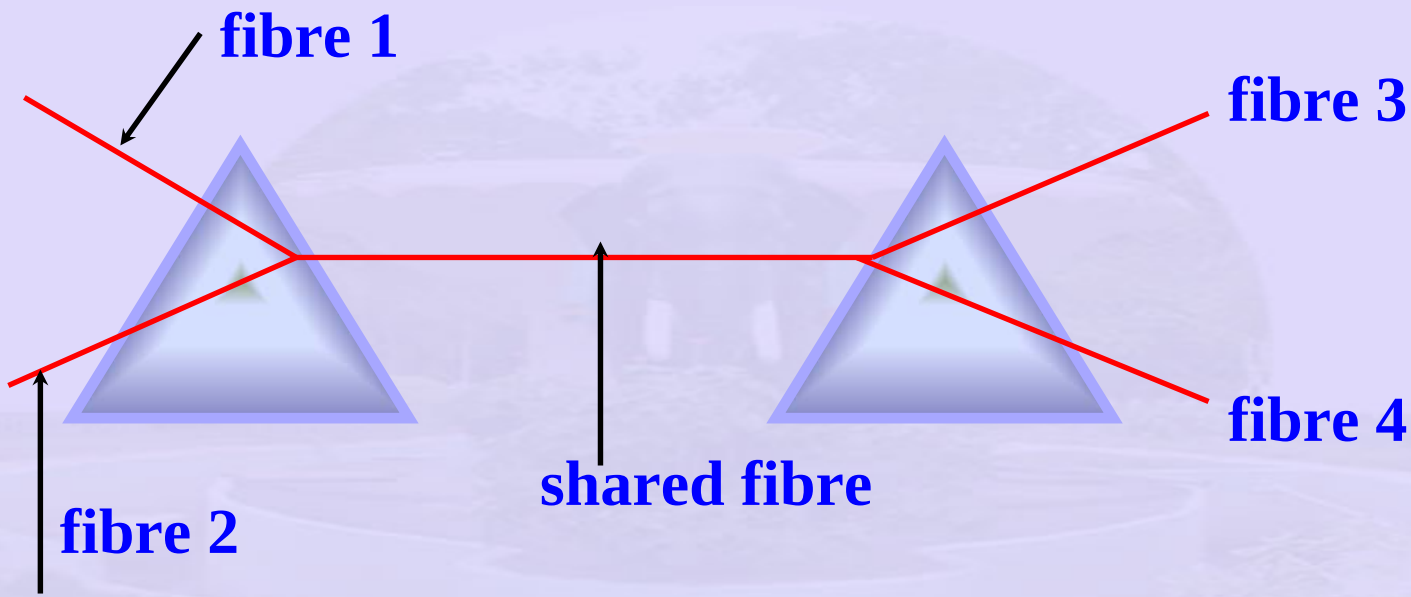

**Asynchronous TDM:** Intelligent **TDM** – allocate time slots on demand

- uses lower rate than required to multiplex **n** channels.

# TDM and FDM

- Divide Frequency channel into a number frequency bands using FDM
- In each channel
  - Multiplex a number of channels using TDM
- Advent of Fibre
  - Wavelength division multiplexing
  - In each wavelength – multiplex number of channels using TDM

# Wavelength Division Multiplexing




WDM Switch