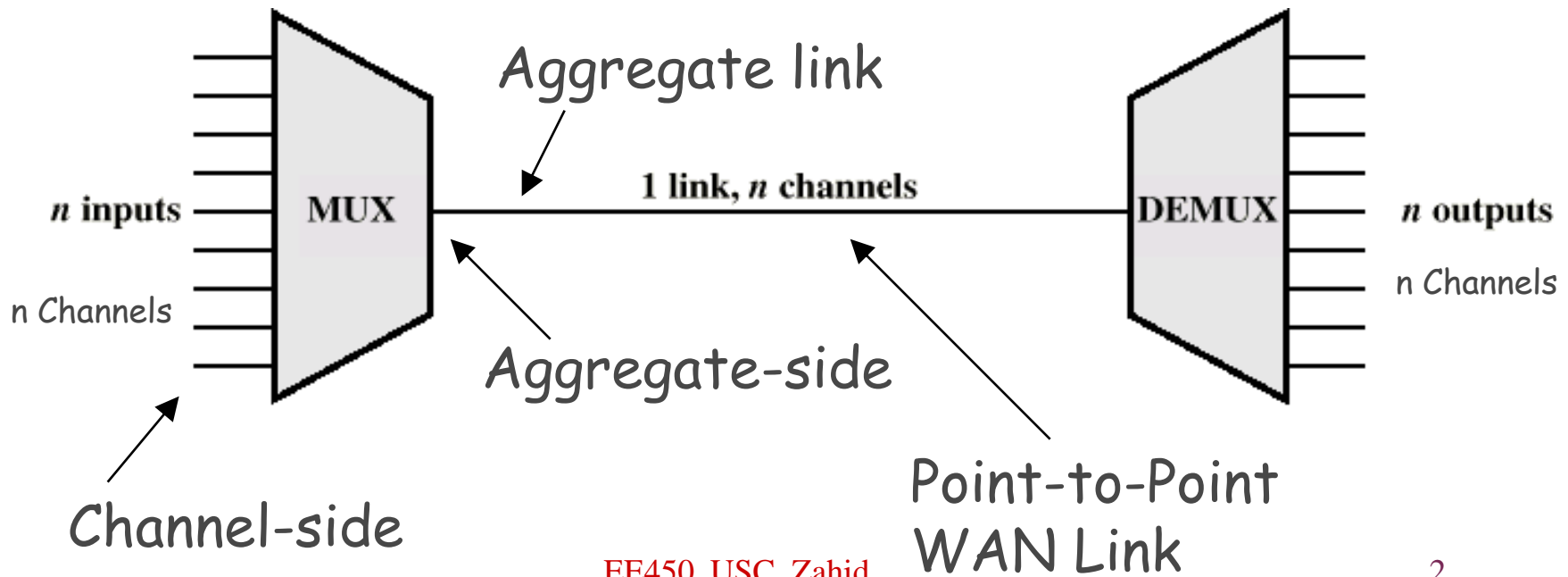

Multiplexing: “Resource Sharing”

EE450: Introduction to Computer Networks

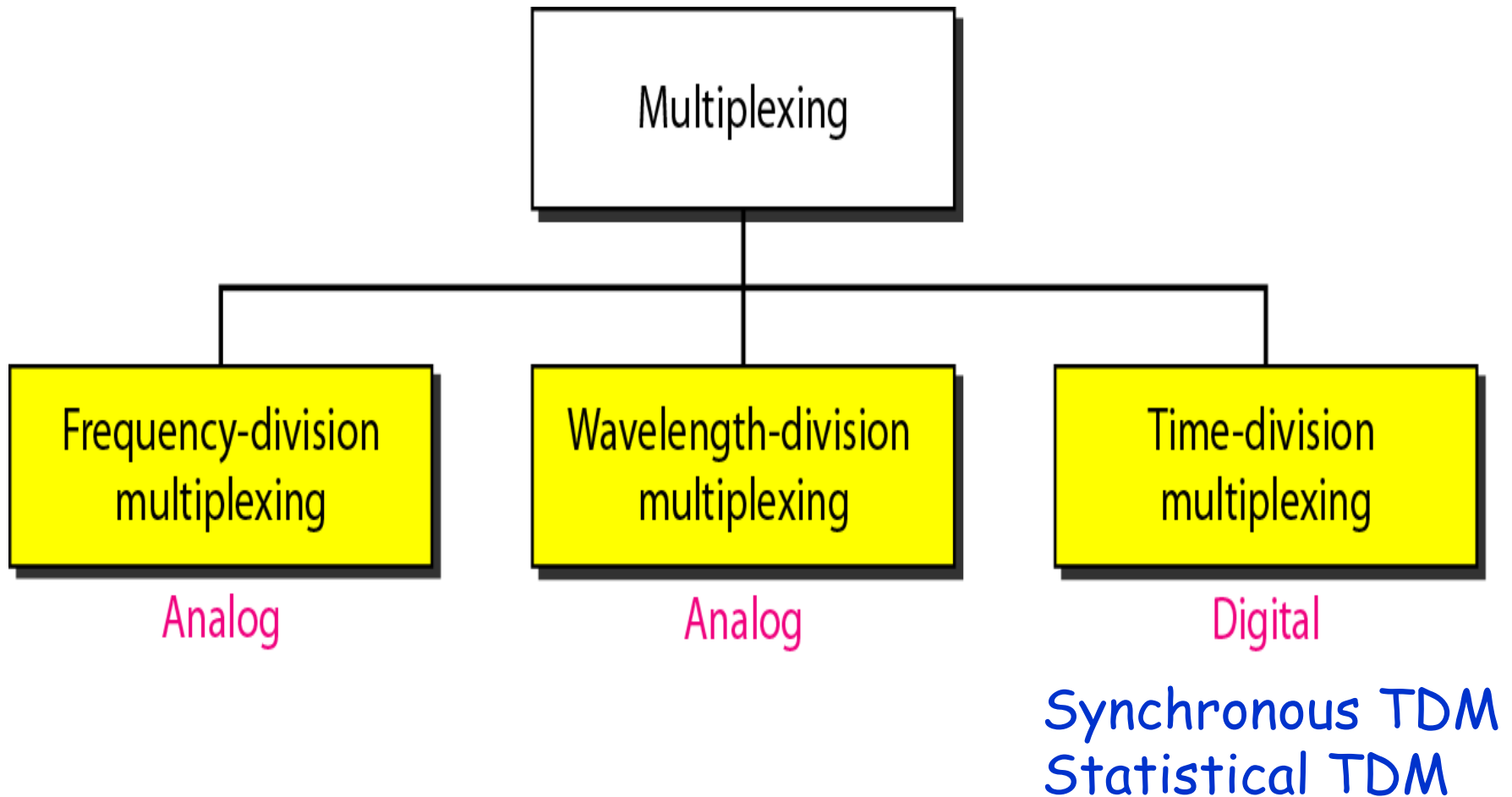
Professor A. Zahid

Multiplexing

- Multiplexing is a resource sharing process allowing information from several information sources to be aggregated onto a single, high-speed link



Categories of Multiplexing

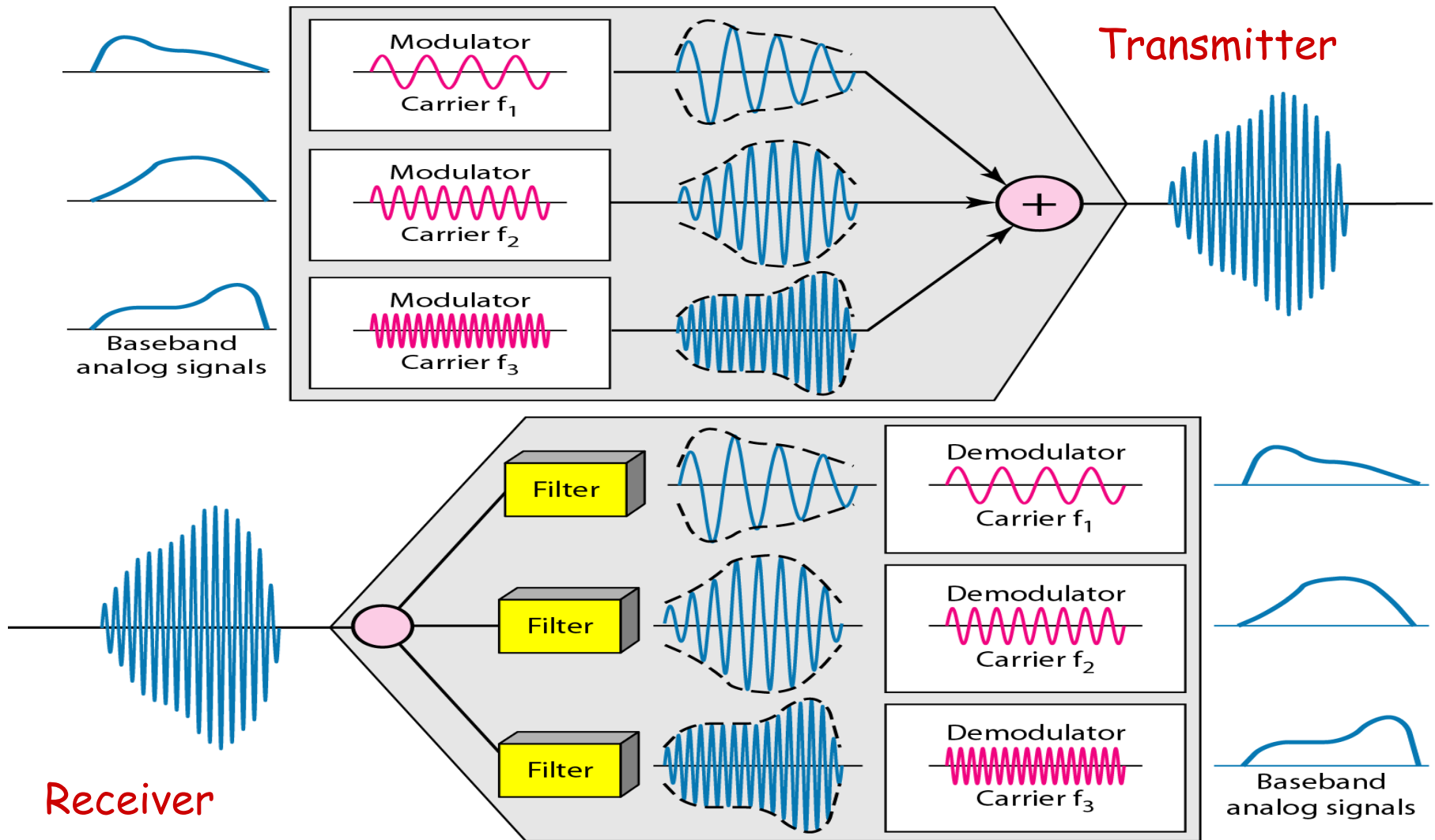


Frequency Division Multiplexing

- Useful bandwidth of medium exceeds required bandwidth of channel
- In FDM, each signal is modulated to a different carrier frequency
- Carrier frequencies separated so signals do not overlap (guard bands), example: Broadcast Radio



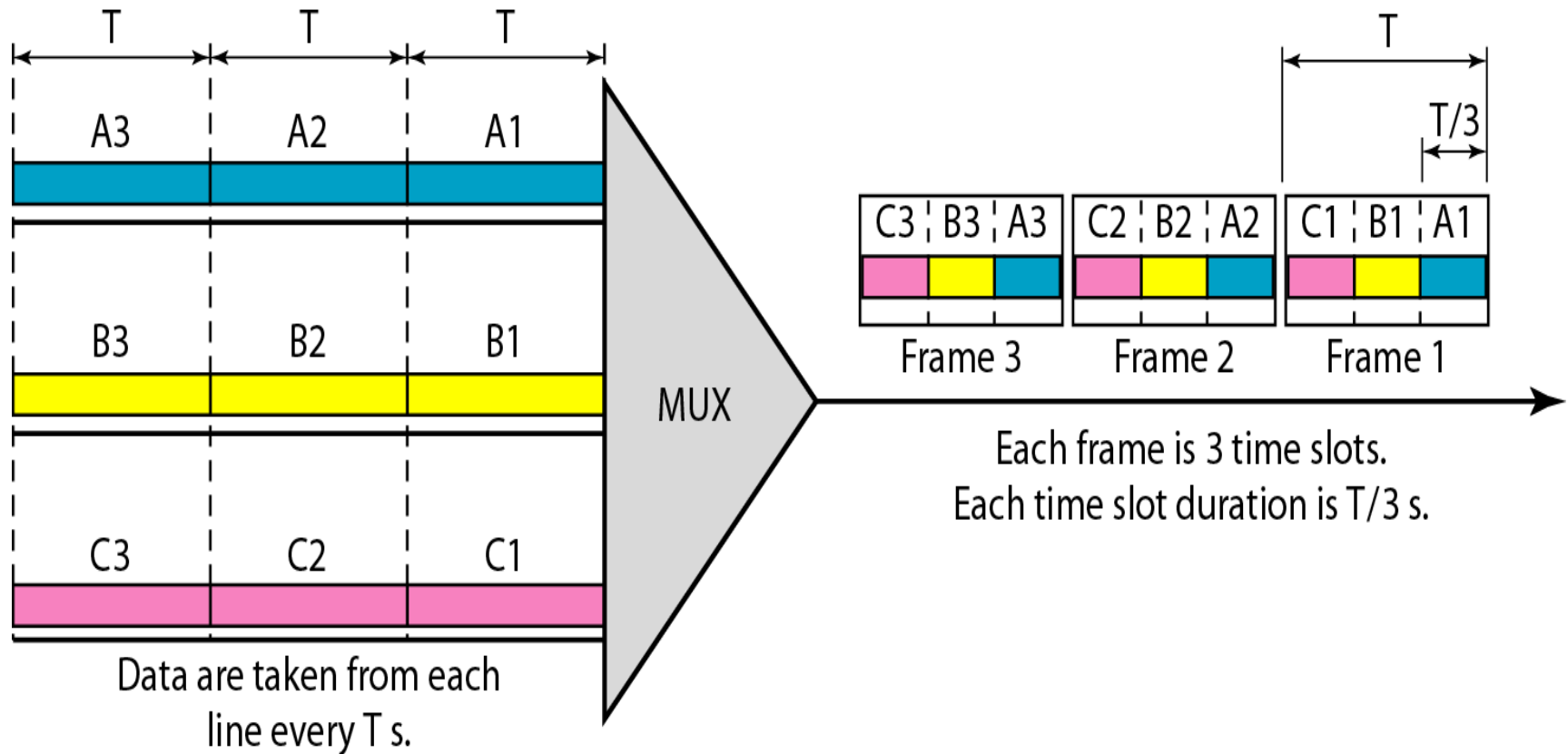
FDM Process



Synchronous TDM

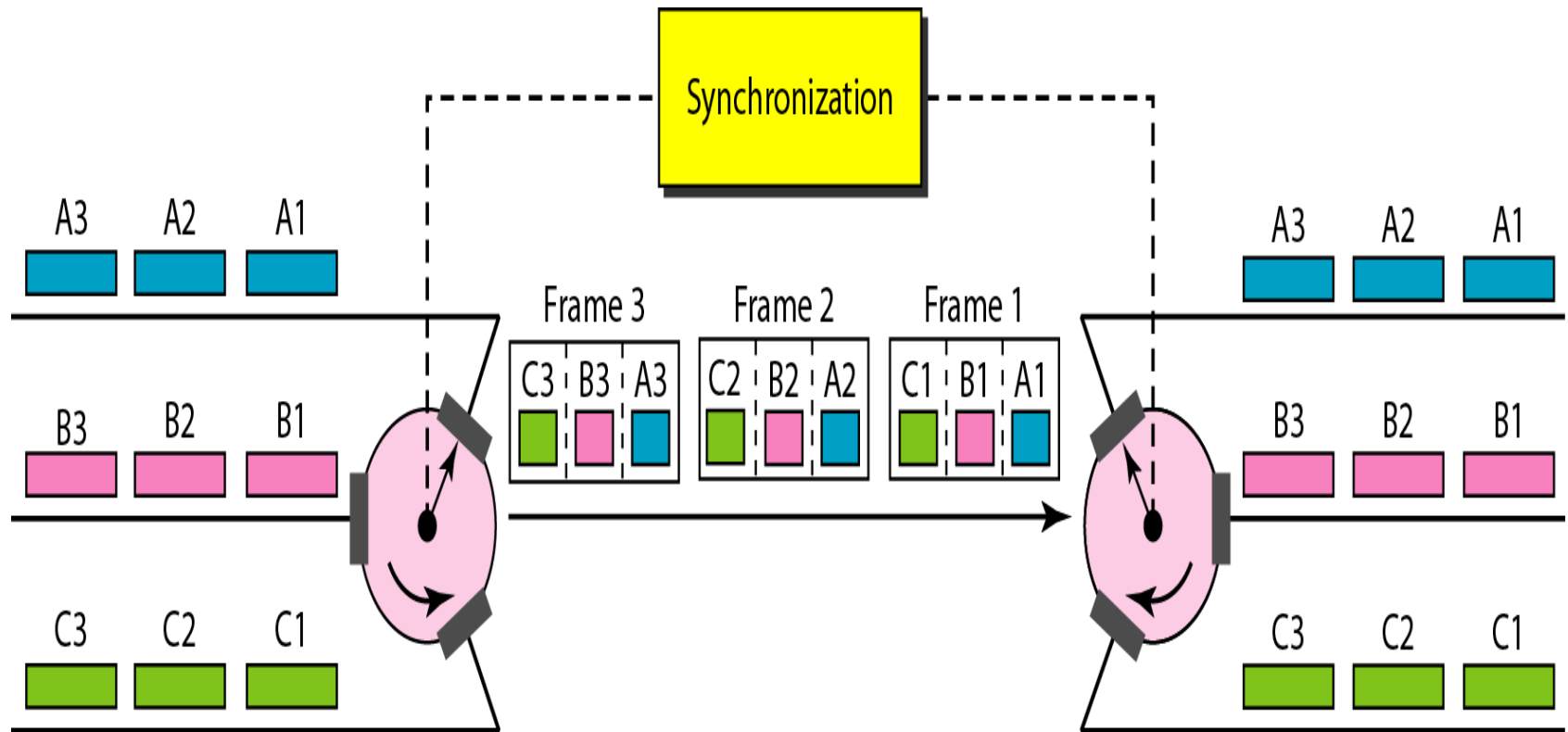
- Data rate of medium exceeds data rate of digital signal to be transmitted
- Multiple digital signals interleaved in time
- May be at bit level or block of bits
- Time slots pre-assigned to sources and fixed
- Time slots allocated even if source is idle
- Time slots do not have to be evenly distributed amongst sources

Synchronous TDM (Cont.)

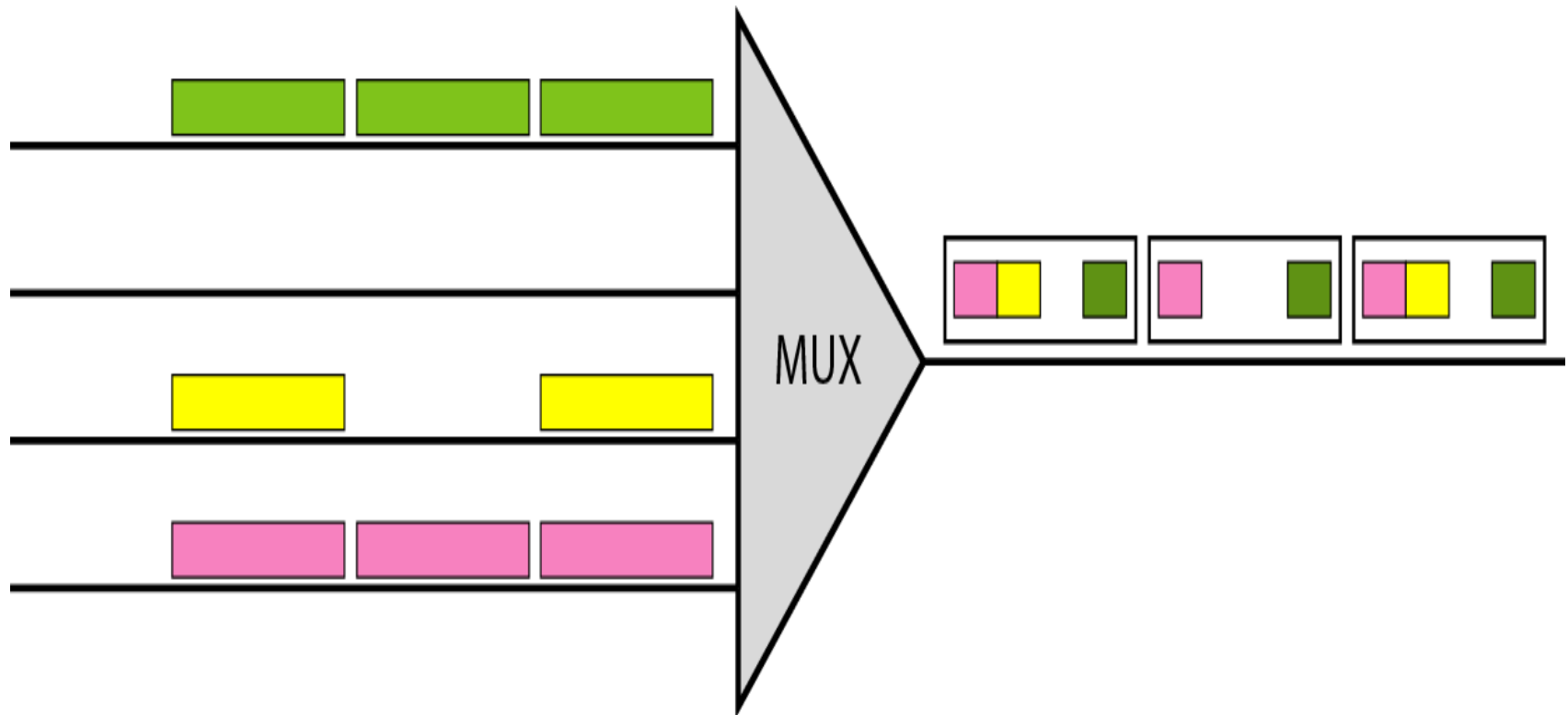


In synchronous TDM, the data rate of the link is n times faster, and the unit duration is n times shorter.

Synchronous TDM (Cont.)

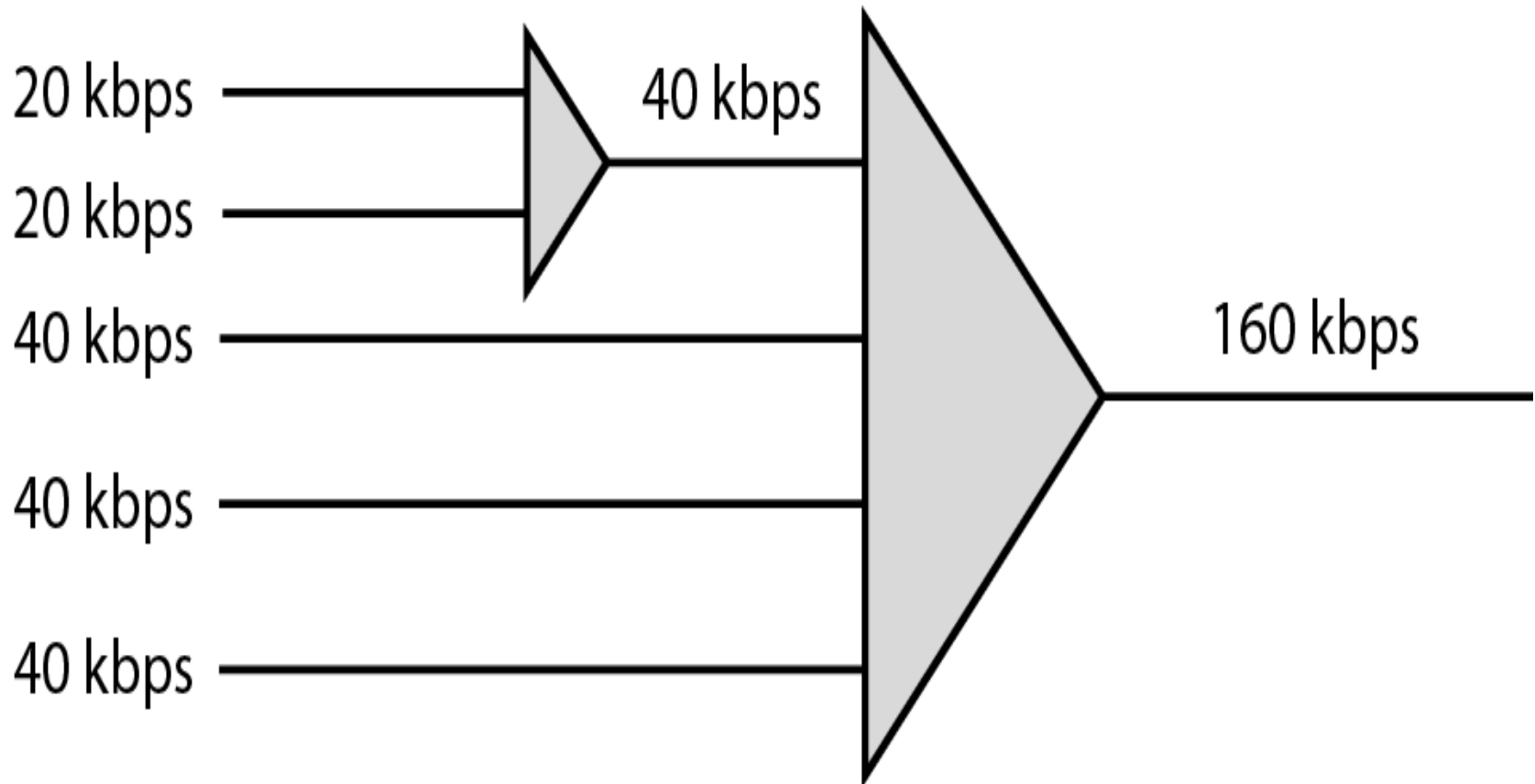


Empty Time Slots

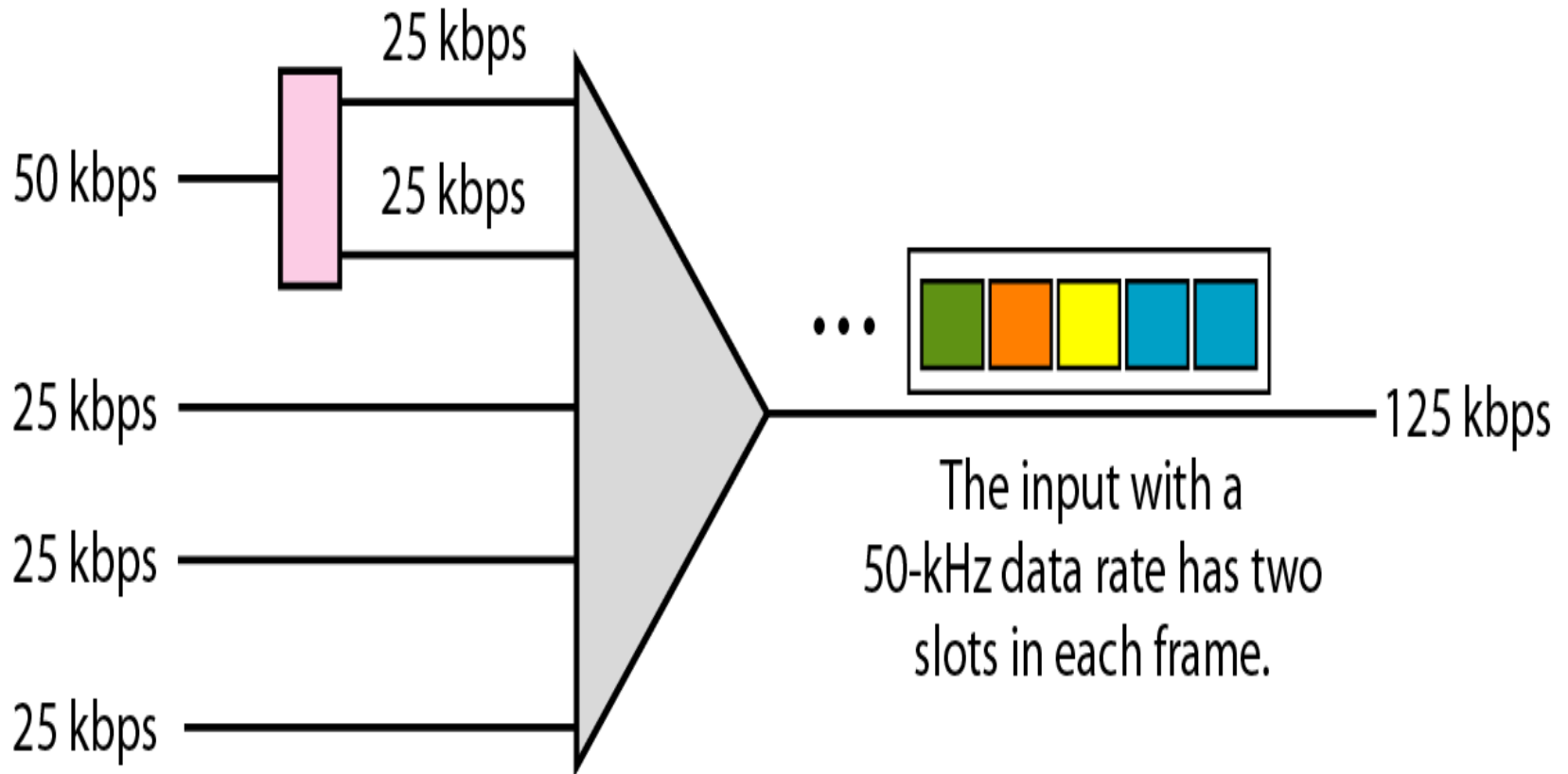


Empty TS can't be used by other
Sources \Rightarrow Waste of Bandwidth

Multilevel Multiplexing



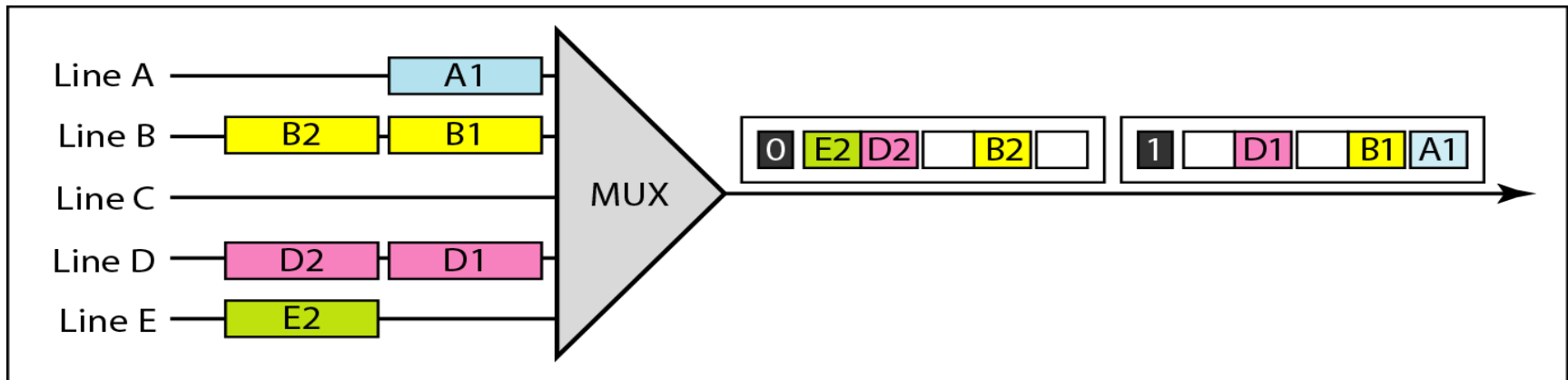
Multiple-Slot Multiplexing



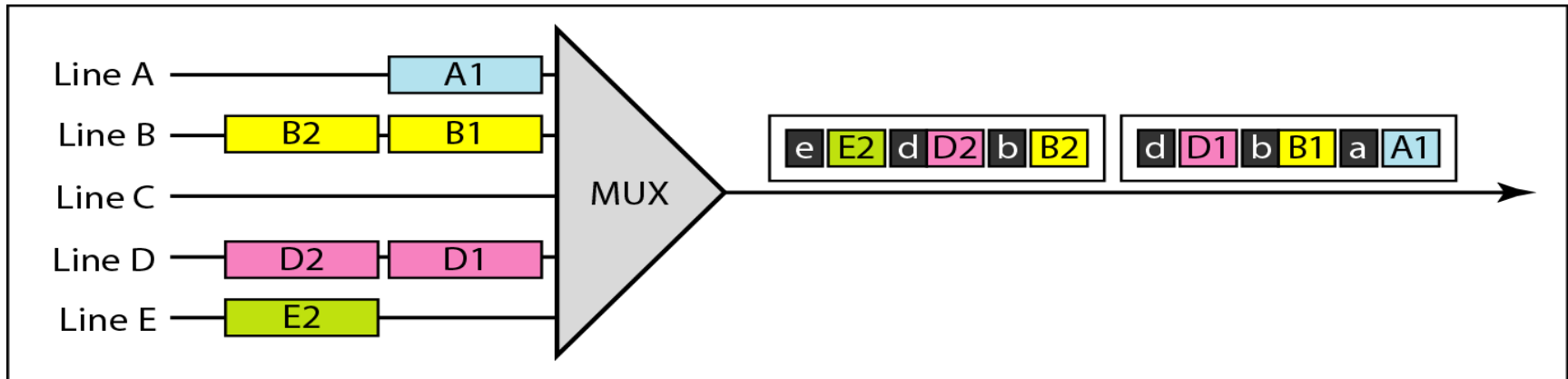
Statistical (Asynchronous) TDM

- In Synchronous TDM many slots are wasted
- Statistical TDM allocates time slots dynamically, i.e. based on demand
- Every Slot has to start with a header identifying the device (address)
- Multiplexer scans input lines and collects data until frame full
- Data rate on line lower than aggregate rates of input lines

Synchronous vs. Statistical



a. Synchronous TDM



b. Statistical TDM

Performance of Statistical TDM

of Inputs = 10

Rate of each input (active) = 1000 bps

% of time a source is active = 50%

Case 1: Multiplexer capacity = 5000 bps

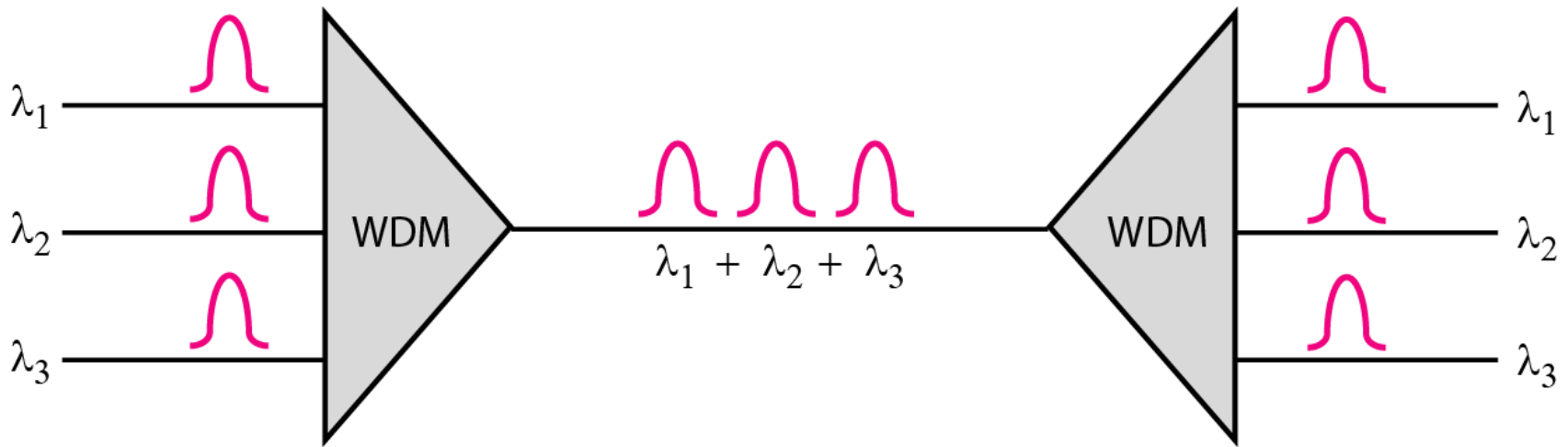
Case 2: Multiplexer capacity = 7000 bps

	Capacity = 5000 bps		Capacity = 7000 bps	
Input	Output	Backlog	Output	Backlog
6	5	1	6	0
9	5	5	7	2
3	5	3	5	0
7	5	5	7	0
2	5	2	2	0
2	4	0	2	0
2	2	0	2	0
3	3	0	3	0
4	4	0	4	0
6	5	1	6	0
1	2	0	1	0
10	5	5	7	3
7	5	7	7	3
5	5	7	7	1
8	5	10	7	2
3	5	8	5	0

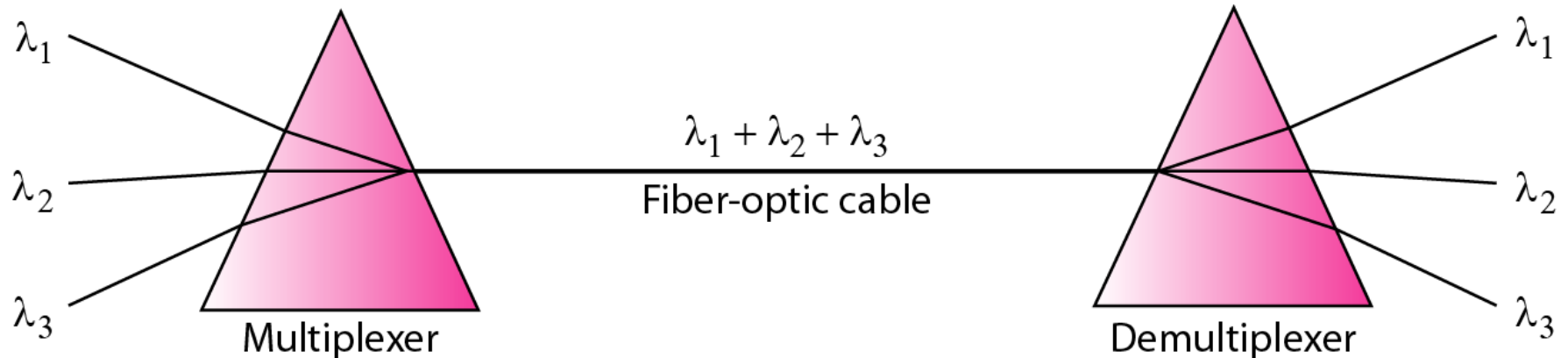
Conclusions

- TDM - Guarantees the User a bandwidth but on the contrary wastes valuable carrier capacity. Suitable for streamy type traffic like voice (digitized)
- STDM - Utilizes unused time slots. Suitable for Bursty-type traffic such as data
 - More efficient use of capacity
 - When times are busy, user suffers delay

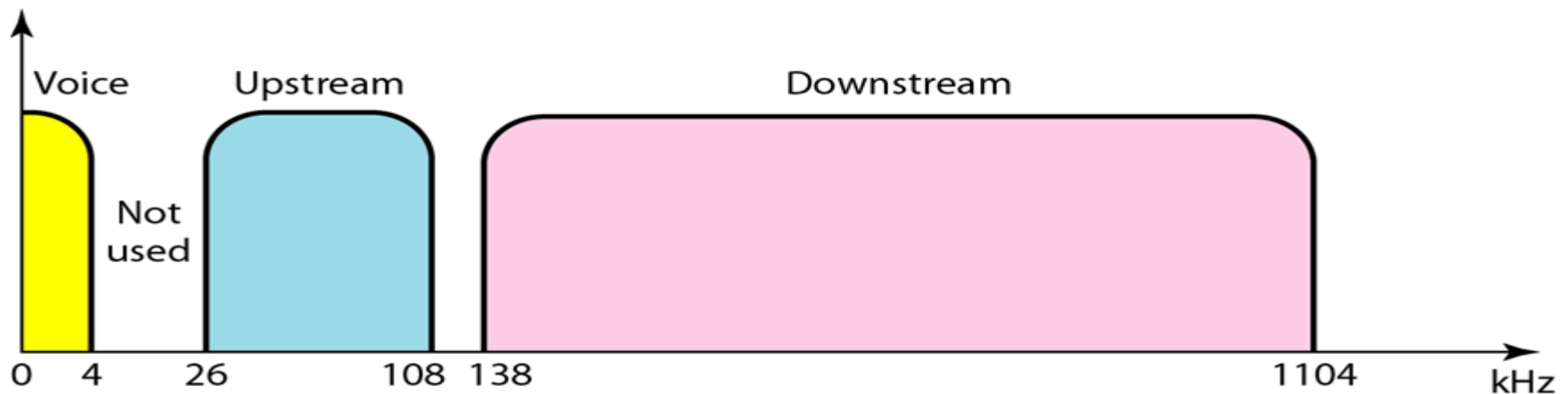
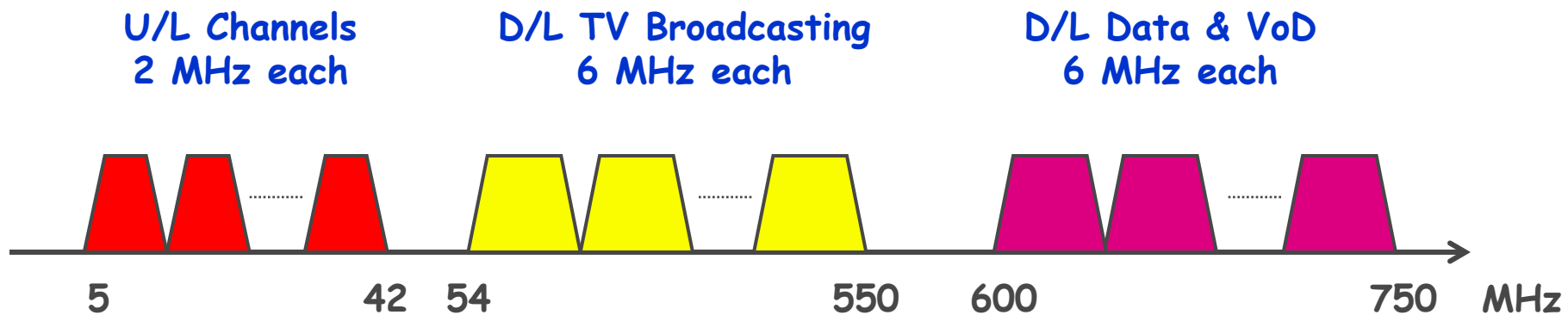
Wave-Length Division Multiplexing



Prisms in wavelength-division multiplexing and de-multiplexing



Cable vs. ADSL Bandwidth Allocations



Two-Way Cable Access

