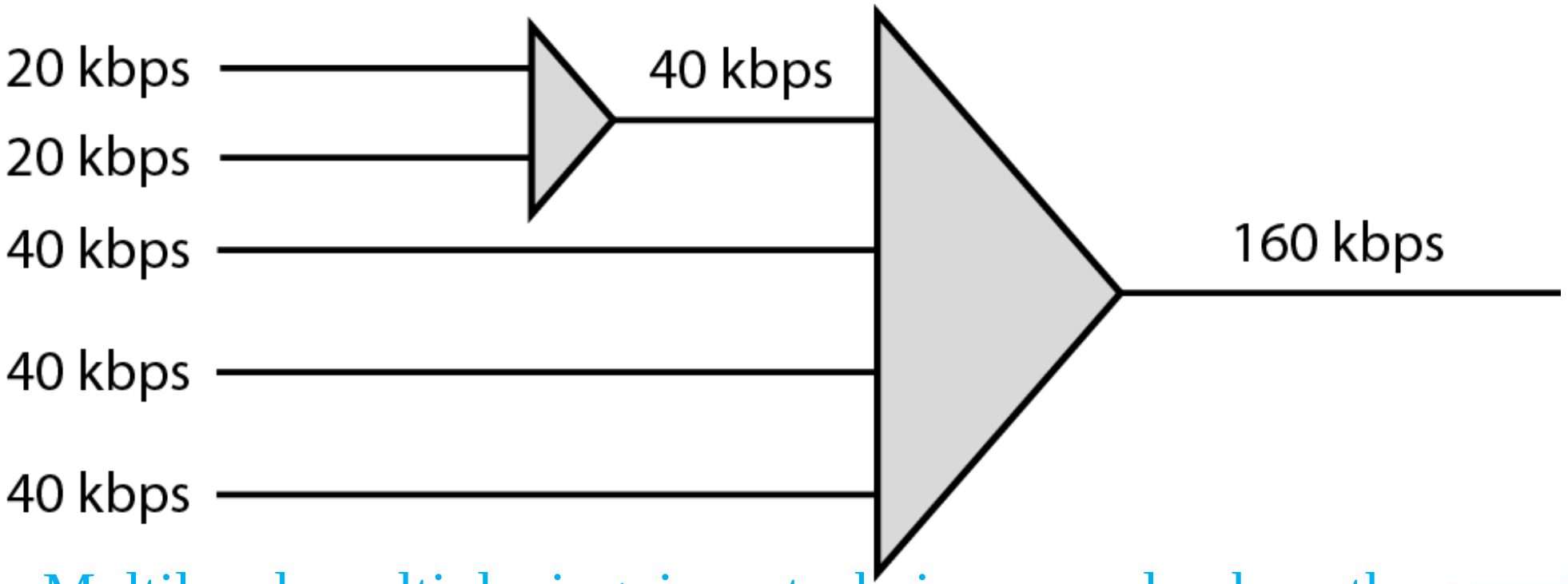
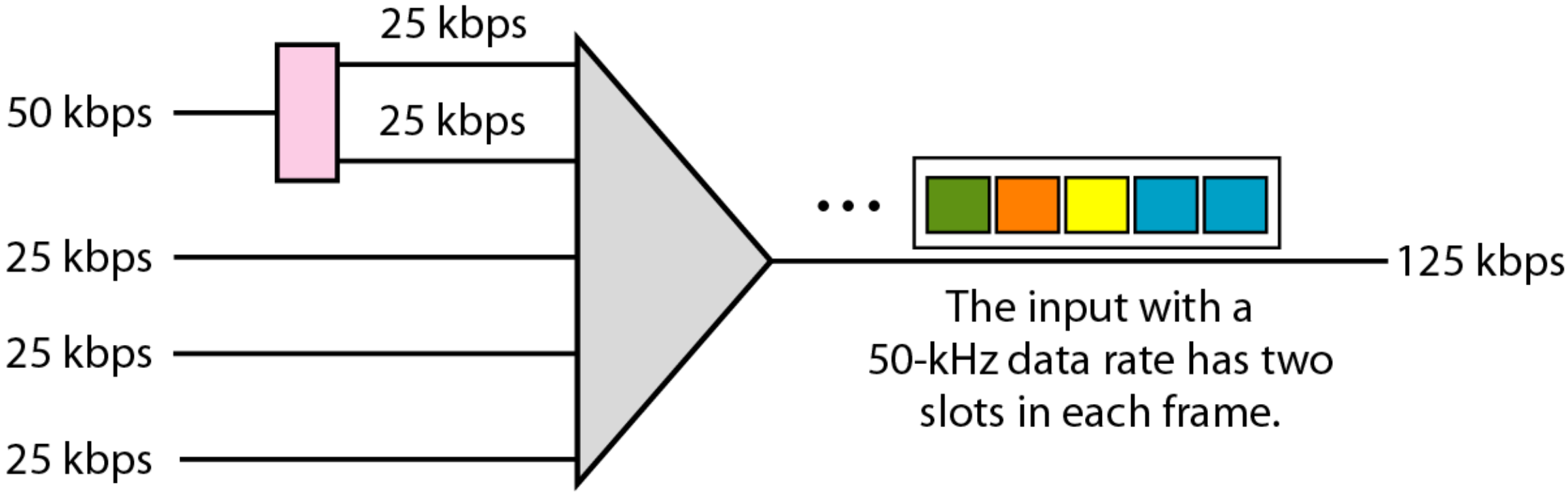
Multilevel Multiplexing



- Multilevel multiplexing is a technique used when the data rate of an input line is multiple of others.

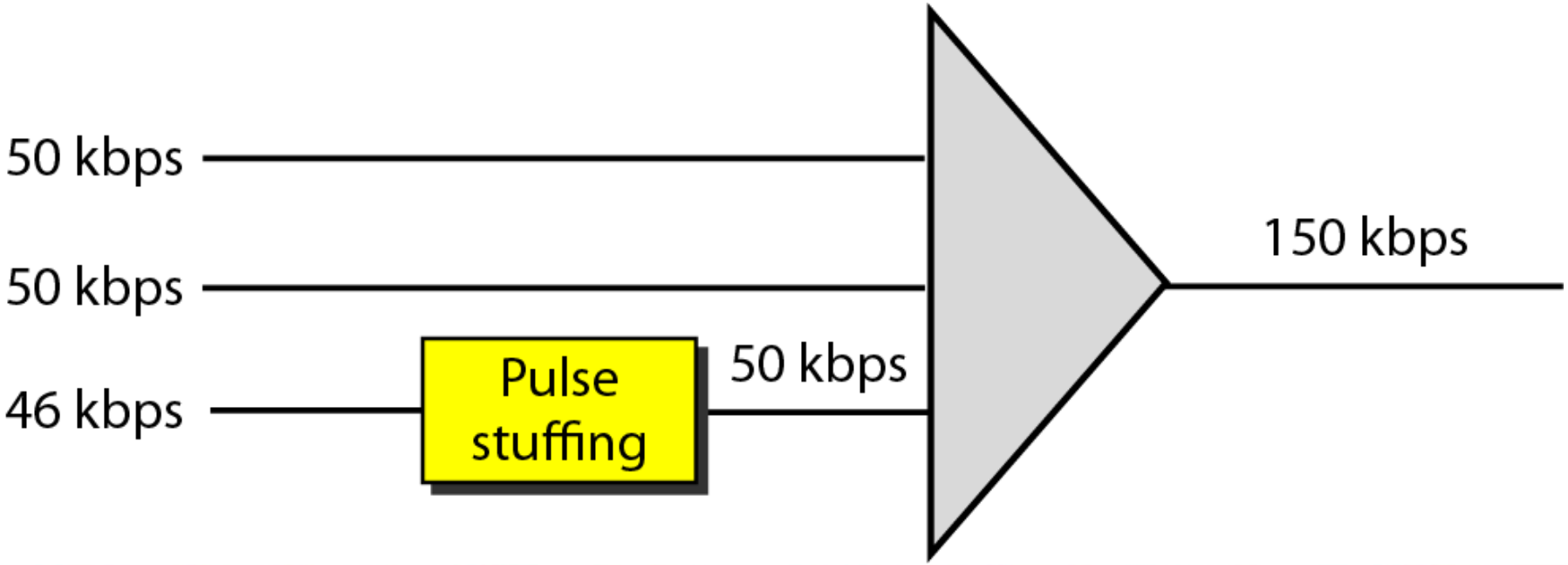
Multiple Slot Multiplexing



- Multiple slot multiplexing involves allocating more than one slot in a frame to a single input line.

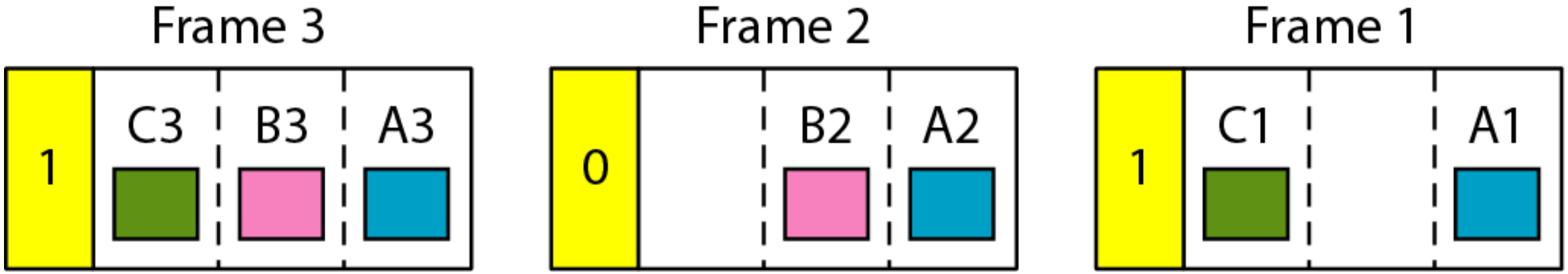
Pulse Stuffing

- Sometimes the bit rates of sources are not multiple integers of each other. Hence multilevel or multiple-slot multiplexing can not be applied.
- Solution is to make highest data rate dominant data rate and then add dummy bits to the input lines with lower data rates.
- This technique is called pulse stuffing, bit padding or bit stuffing.



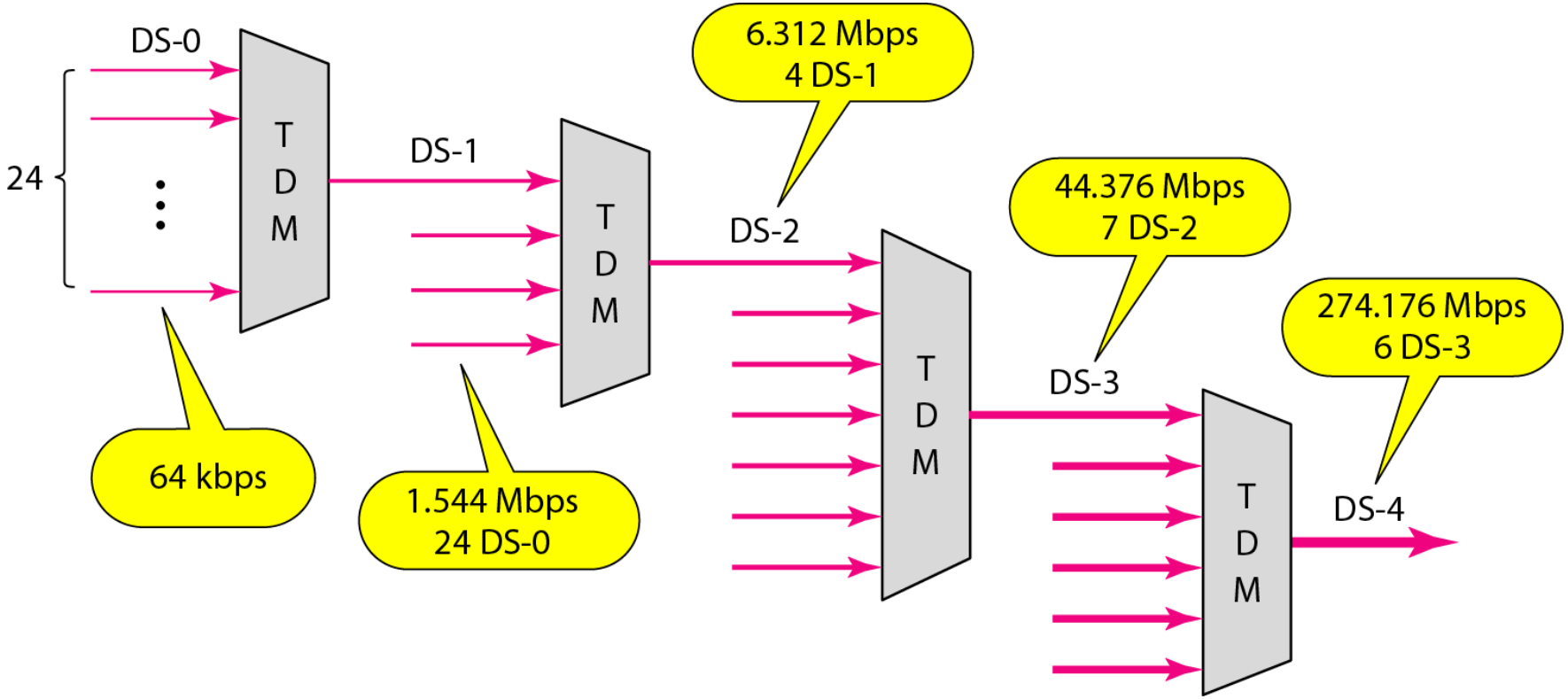
Framing Synchronization

Synchronization pattern



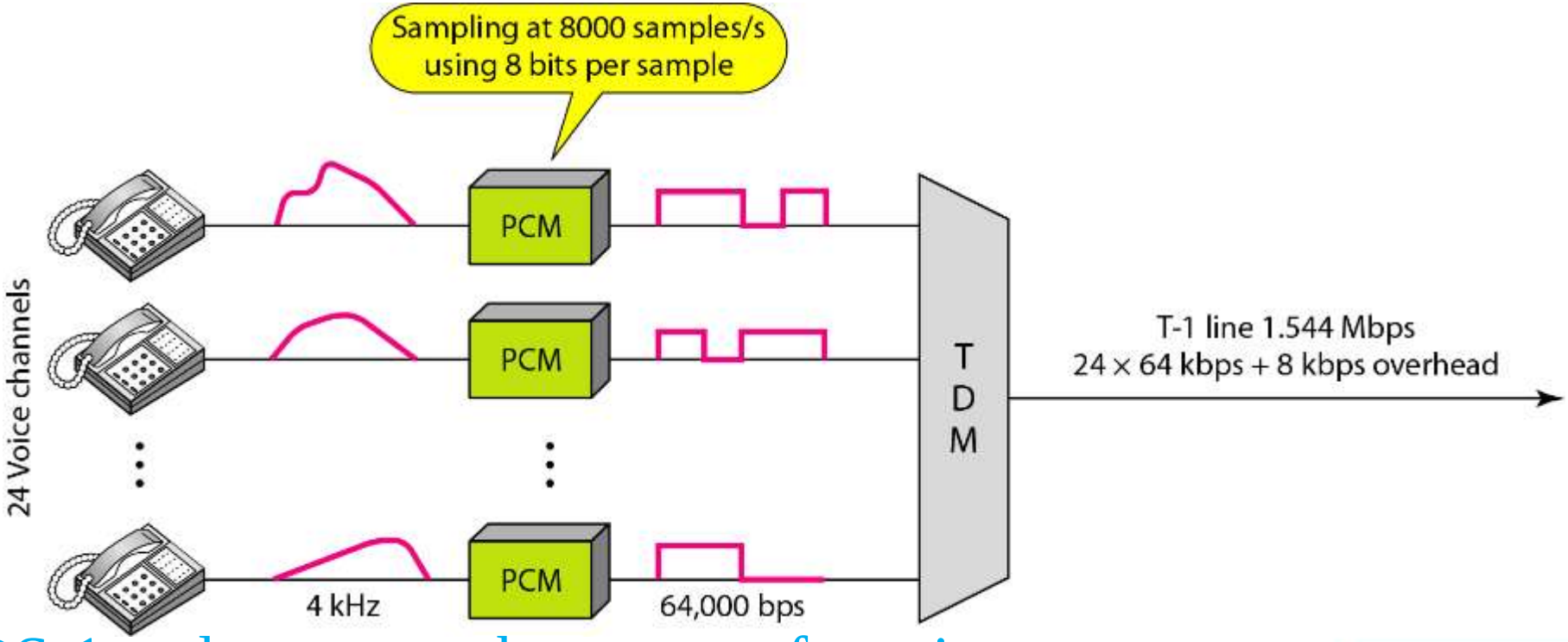
- Multiplexer and De-multiplexer when using TDM need synchronization.
- One or more bits synchronizing bits are usually added to the beginning of each frame.
- These bits, called framing bits, follow a pattern, frame to frame that allows de-multiplexer to synchronize with incoming stream so that it can separate the time slots accurately.

Digital Signal Service-Digital hierarchy



- Telephone companies implement TDM through a hierarchy of digital signals, called **digital signal (DS) service** or **digital hierarchy**.
- Figure shows the data rates supported by each level.

T-1 line for multiplexing telephone lines



- DS-0,DS-1 and so on are the names of services.
- To implement those services, the telephone companies use T lines (T-1, to T4).
- These are the lines with capacities precisely matched to the data rates of the DS-1 to DS-4 services.

T-1 frame structure

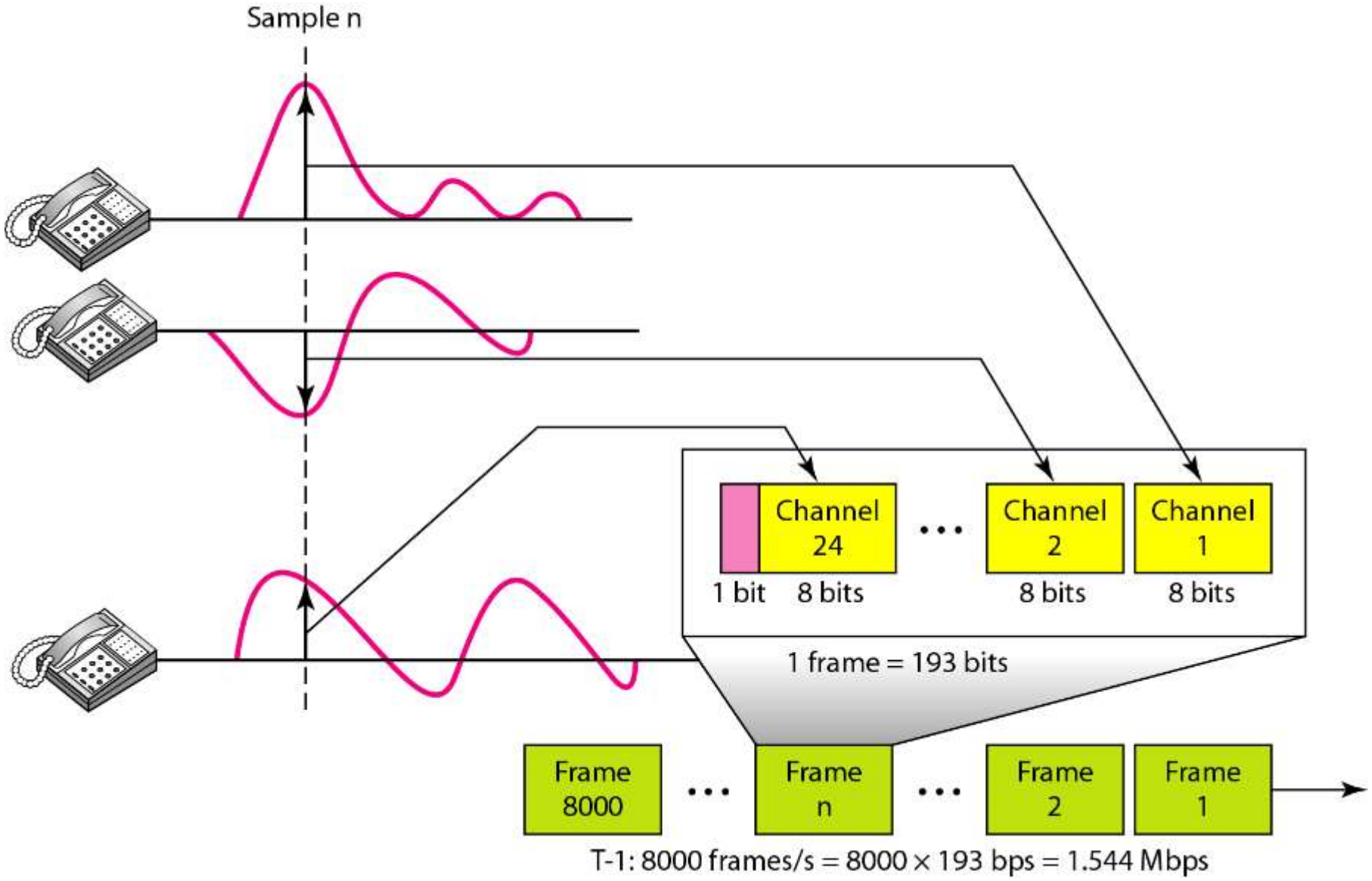


Table E line rates

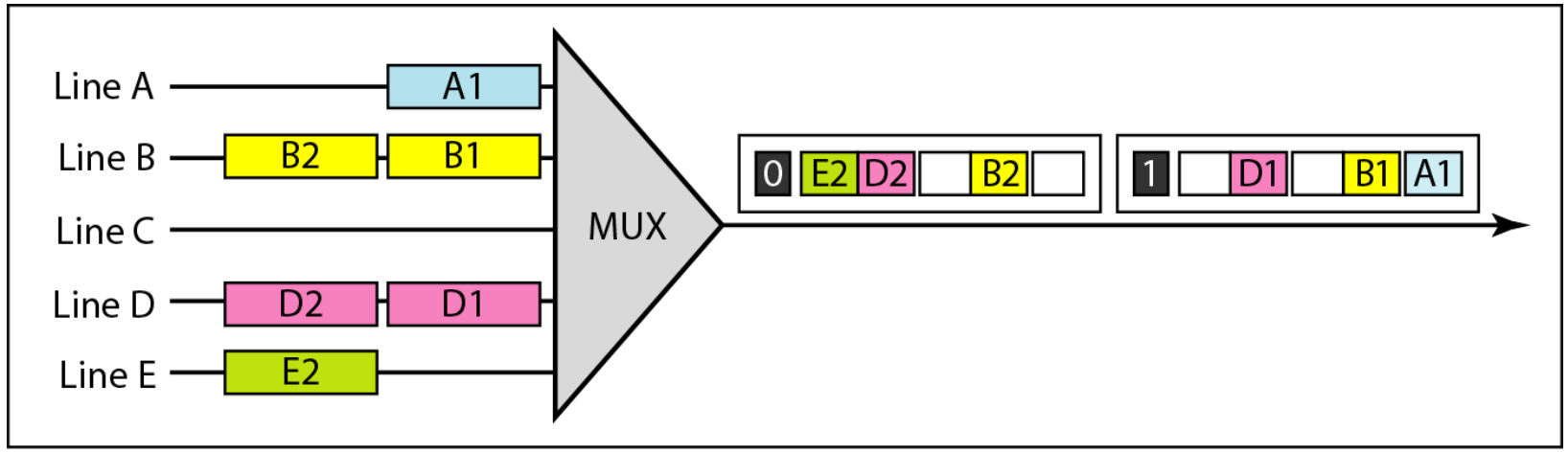
Line	*Rate (Mbps)*	*Voice Channels*
E-1	2.048	30
E-2	8.448	120
E-3	34.368	480
E-4	139.264	1920

- Europeans use a version of T lines called E Lines.
- The two systems are conceptually identical, but their capabilities differ.

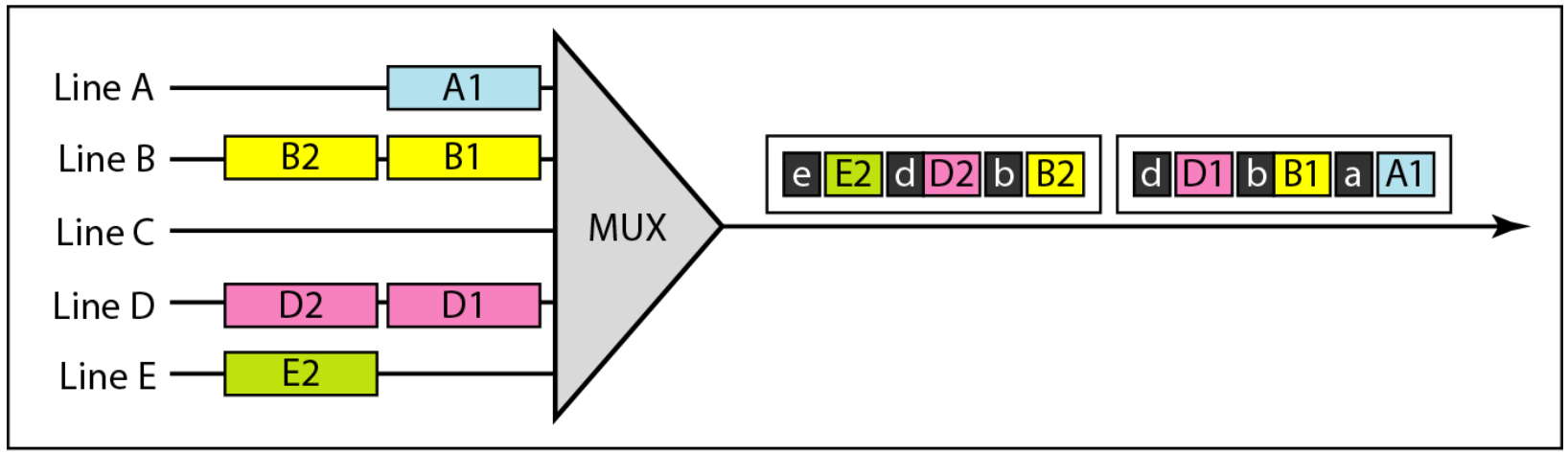
Statistical Time-division Multiplexing

- In **synchronous TDM**, each input has reserved slot in the output frame.
- This can be inefficient if some input lines have no data to send.
- In statistical time-division multiplexing, slots are dynamically allocated to improve band-width efficiency.
- Only when an input line has a slot's worth of data to send is it given a slot in the output frame.
- In statistical multiplexing, the number of slots in each frame is less than the number of input lines.

TDM slot comparison

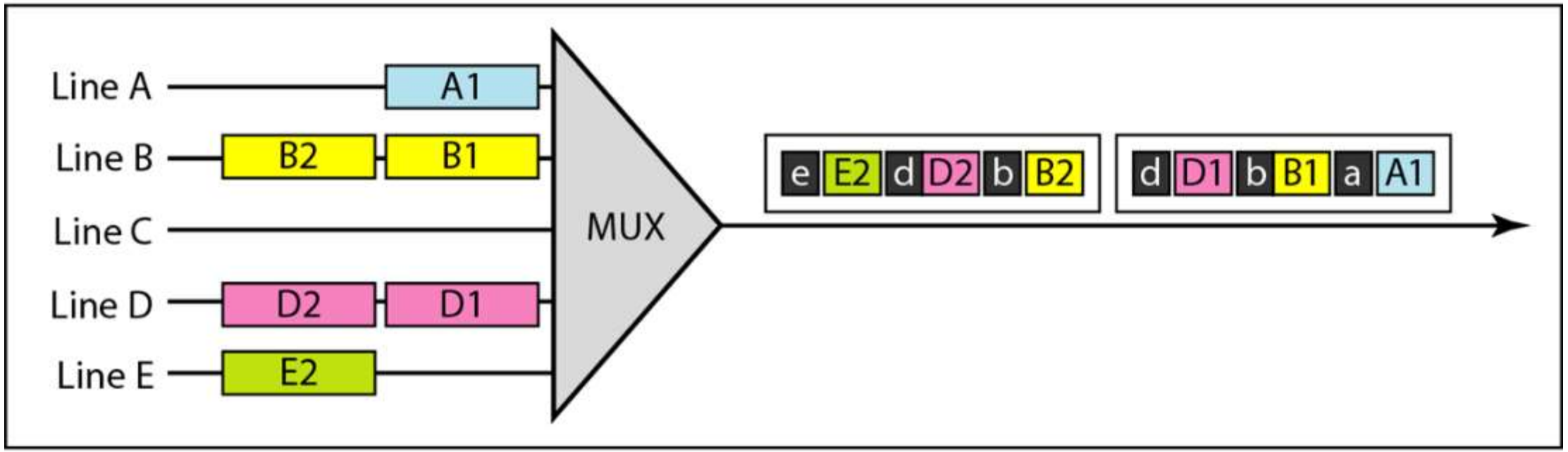


a. Synchronous TDM



b. Statistical TDM

Statistical Time-division Multiplexing



- The multiplexer checks each input line in round-robin fashion.
- It allocates a slot for an input line if the line has data to send; otherwise, it skips the line and checks the next line.

Lecture Summary - Multiplexing

- Frequency-Division Multiplexing
- Wavelength-Division Multiplexing
- **Synchronous Time-Division Multiplexing**
- **Statistical Time-Division Multiplexing**

Next Lecture – Spread Spectrum

- Frequency Hopping Spread Spectrum (SHSS)
- Direct Sequence Spread Spectrum (DHSS)

Assignment 5

Question 3

There are four sources, each creating 250 characters per second. If the interleaved unit is a character and 1 synchronizing bit is added to each frame, find (a) the data rate of each source, (b) the duration of each character in each source, (c) the frame rate, (d) the duration of each frame, (e) the number of bits in each frame, and (f) the data rate of the link.

Ask Questions & Share Responses

You can ask your questions and share your responses at:

- Email: barbindanandit@Sanjivani.org.in and/or
- WhatsApp Group: SE IT 2022 batch, SE IT COA/FCCN 2019-2020

Lecture Presentation and Literature

To refer presentation of this lecture and literature visit:

- https://github.com/aabarbind/IT2020