Chapter 6

Bandwidth Utilization: Multiplexing and Spreading

Note

Bandwidth utilization is the wise use of available bandwidth to achieve specific goals.

Efficiency can be achieved by multiplexing; i.e., sharing of the bandwidth between multiple users.

6-1 MULTIPLEXING

Whenever the bandwidth of a medium linking two devices is greater than the bandwidth needs of the devices, the link can be shared. Multiplexing is the set of techniques that allows the (simultaneous) transmission of multiple signals across a single data link. As data and telecommunications use increases, so does traffic.

Topics discussed in this section:

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

Difference between Modulation and Multiplexing

Modulation and multiplexing are two concepts used in communication in order to enable networking. Modulation is varying the properties of a career signal to send information.

Multiplexing is needed when we have to combine and send multiple signals that carrying information over a shared medium.

Both functionalities are essential for successful networking.

Figure 6.1 *Dividing a link into channels*

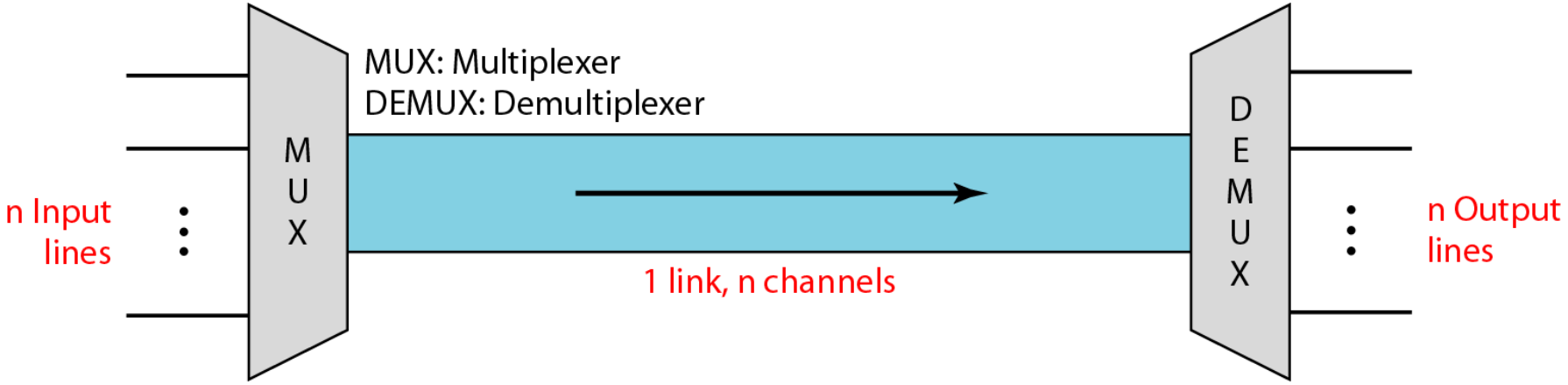


Figure 6.2 *Categories of multiplexing*

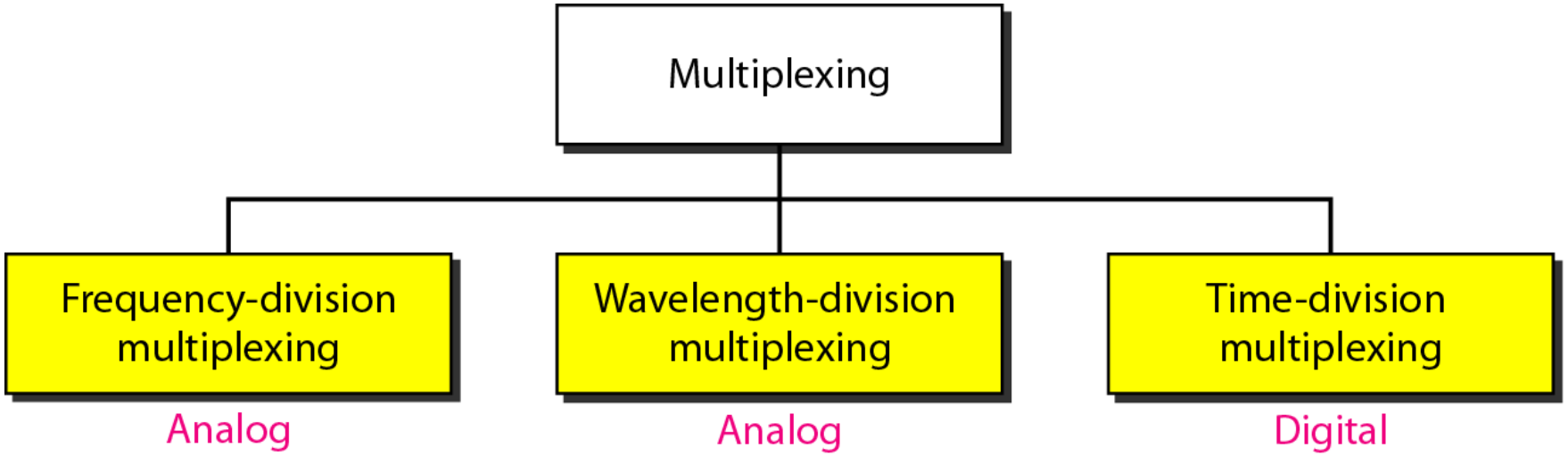
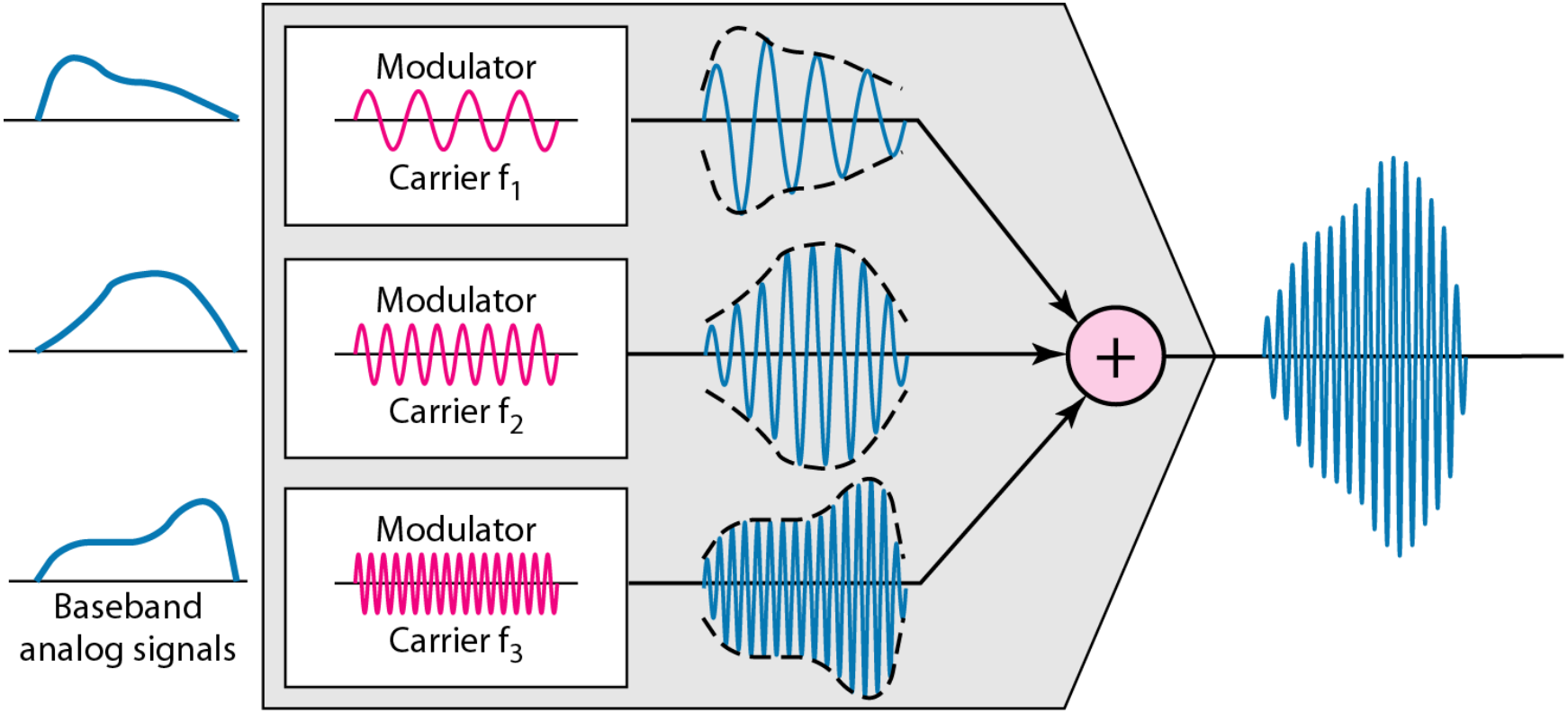


Figure 6.3 *Frequency-division multiplexing (FDM)*

Note

FDM is an analog multiplexing technique that combines analog signals.
It uses the concept of modulation.

Figure 6.4 *FDM process*



FM

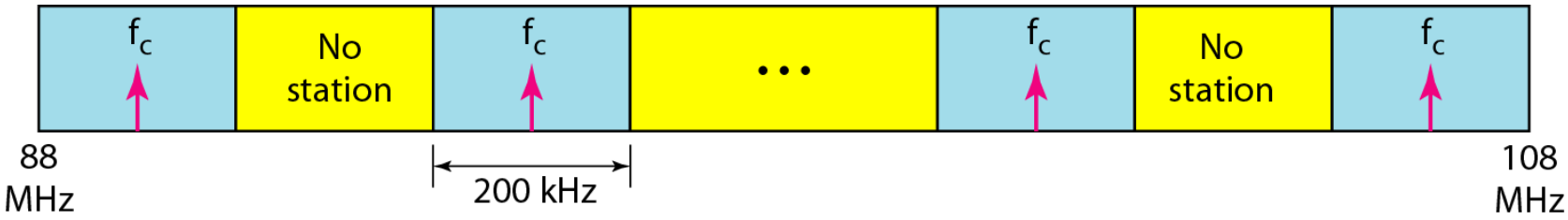
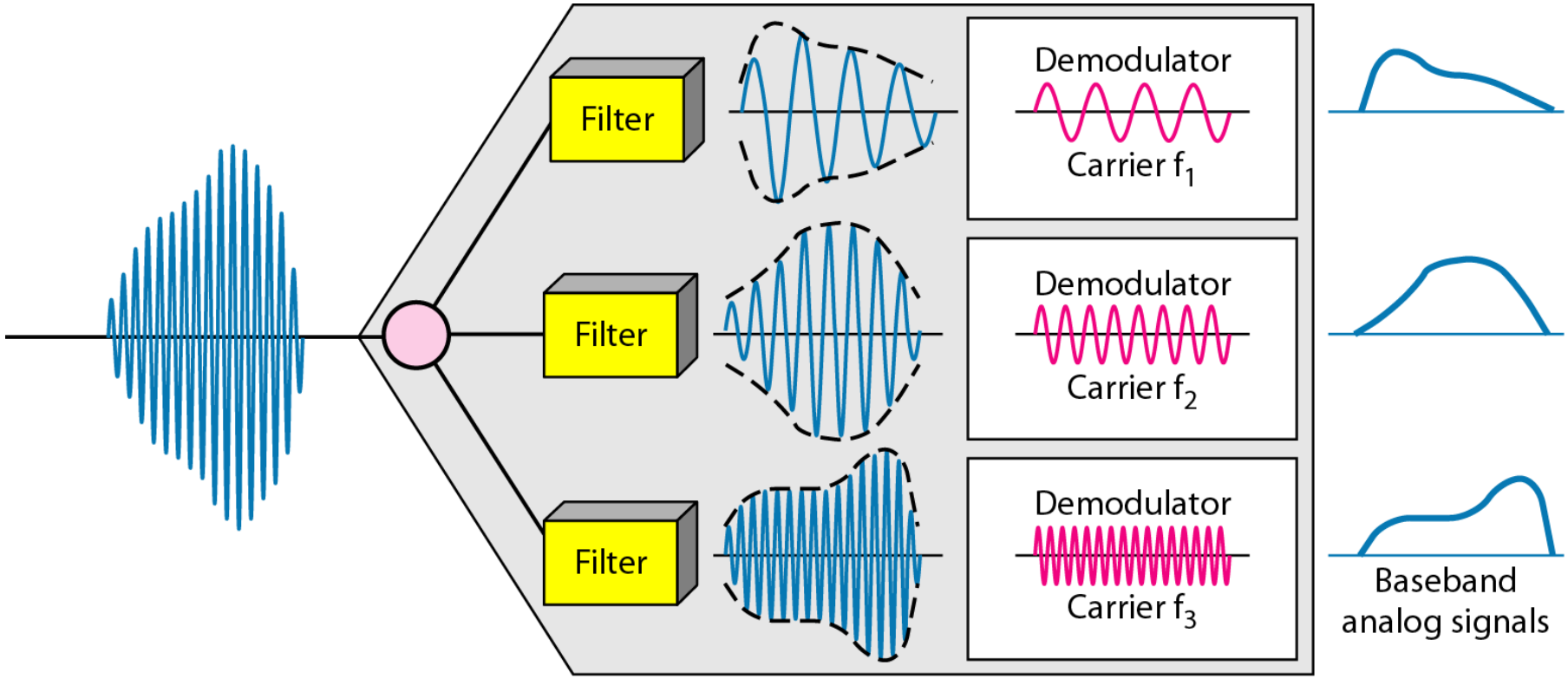


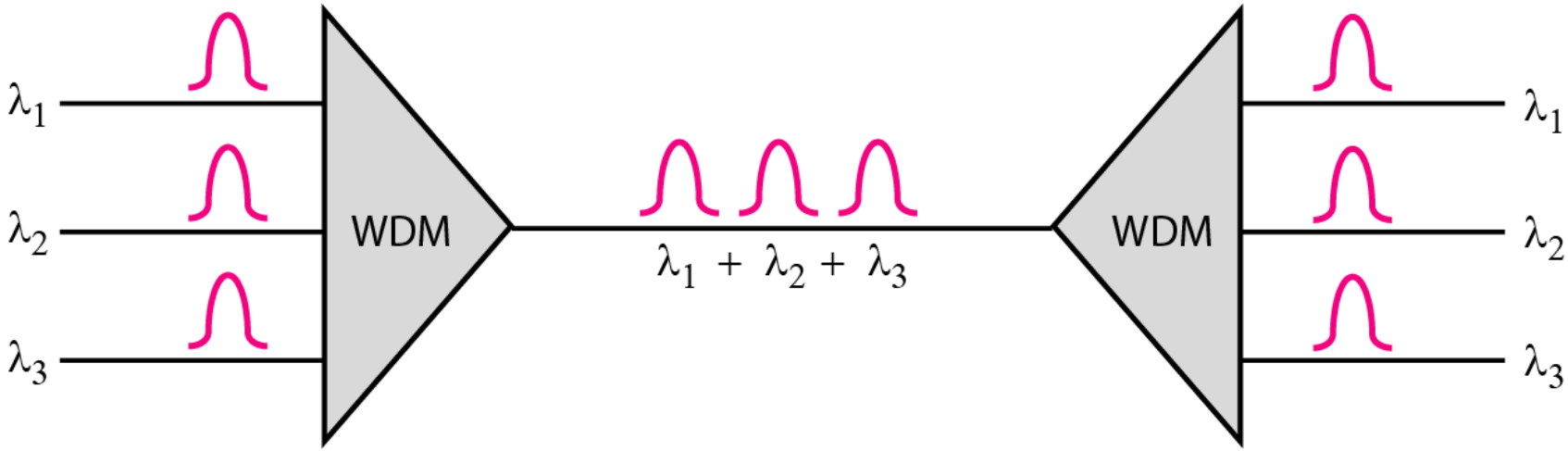
Figure 6.5 *FDM demultiplexing example*



Note

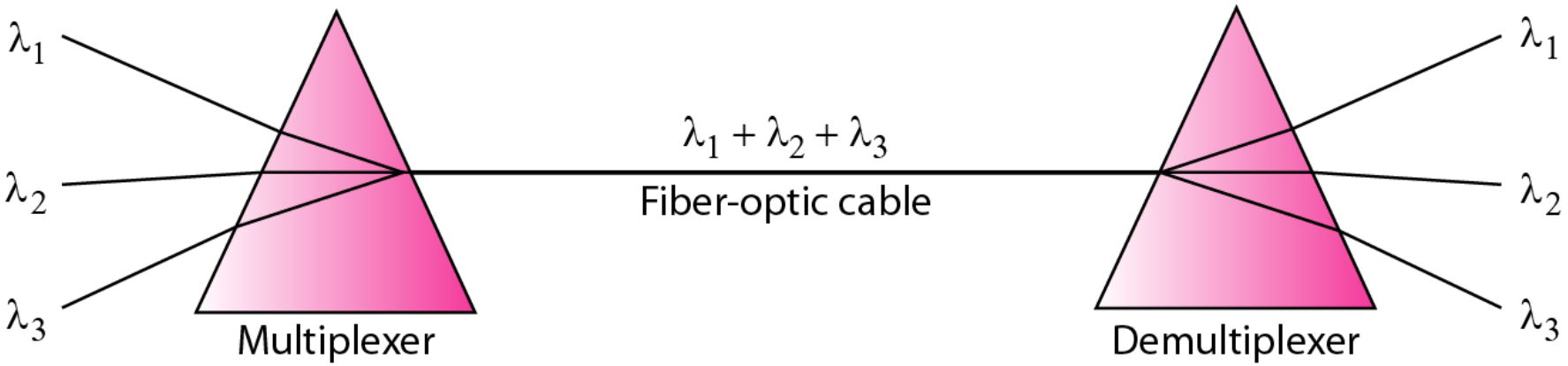
WDM is an analog multiplexing technique to combine optical signals.

Wavelength-division multiplexing (WDM)



Wavelength-division multiplexing (WDM) is a method of combining multiple signals on laser beams at various infrared (IR) wavelengths for transmission along fiber optic media. Each laser is modulated by an independent set of signals. Wavelength-sensitive filters, the IR analog of visible-light color filters, are used at the receiving end.

Figure 6.11 ***Prisms in wavelength-division multiplexing and demultiplexing***



Time Division Multiplexing

Time division multiplexing (TDM) is a communications process that transmits two or more streaming digital signals over a common channel. In TDM, incoming signals are divided into equal fixed-length time slots. After multiplexing, these signals are transmitted over a shared medium and reassembled into their original format after de-multiplexing. Time slot selection is directly proportional to overall system efficiency.

Figure 6.12 Time Division Multiplexing (*TDM*)

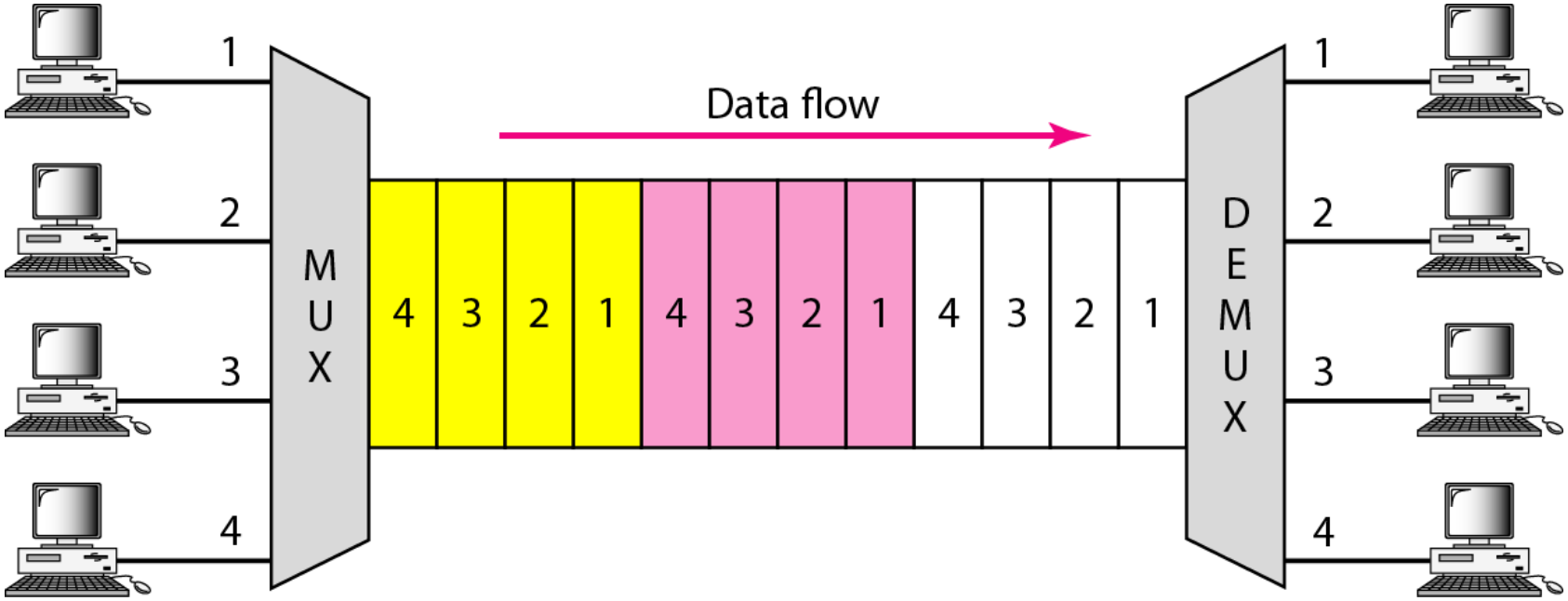


Figure 6.13 *Synchronous time-division multiplexing*

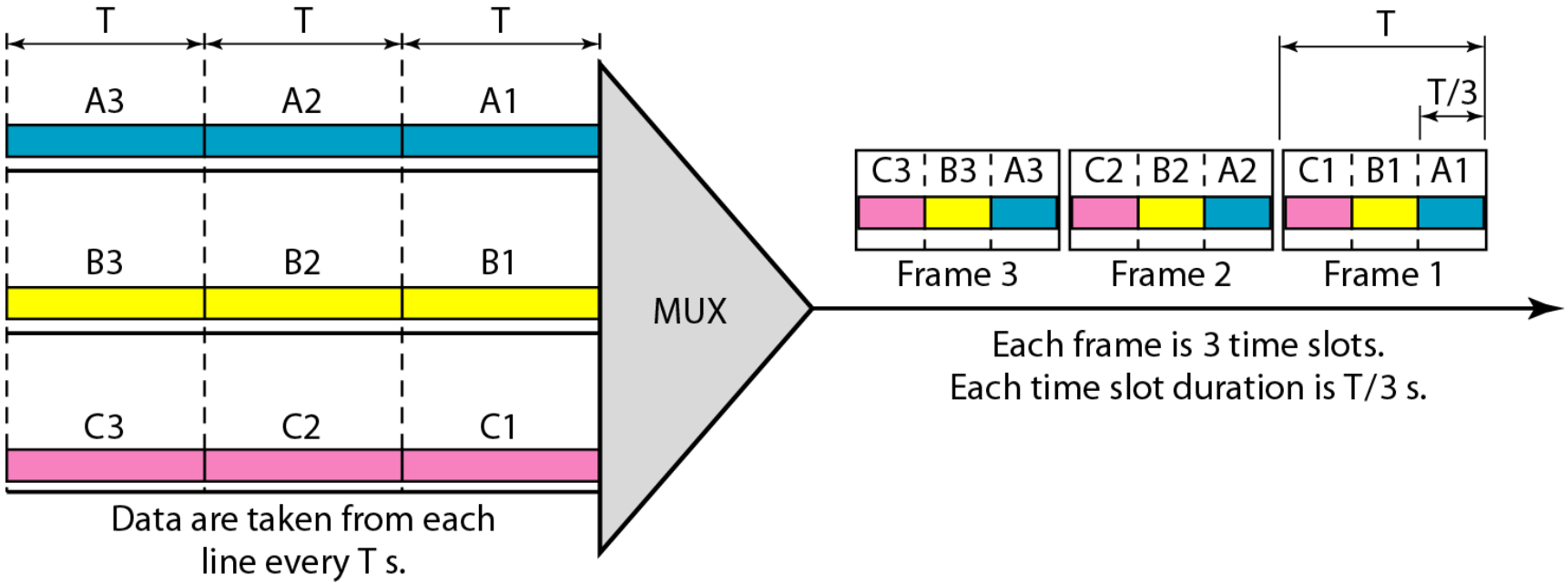
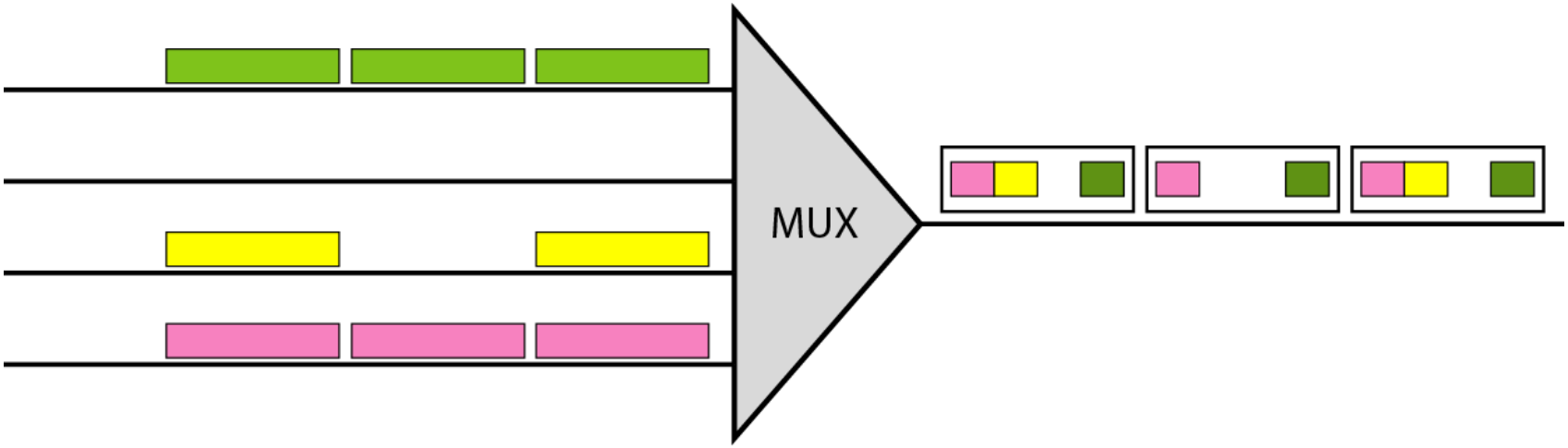


Figure 6.18 *Empty slots*



Statistical TDM

STDM, or statistical time division multiplexing, is one method for transmitting several types of data simultaneously across a single transmission cable or line (such as a T1 or T3 line). STDM is often used for managing data being transmitted via a local area network (LAN) or a wide area network (WAN). In these situations, the data is often simultaneously transmitted from any number of input devices attached to the network, including computers, printers, or fax machines.

Difference Between Synchronous and Statistical TDM

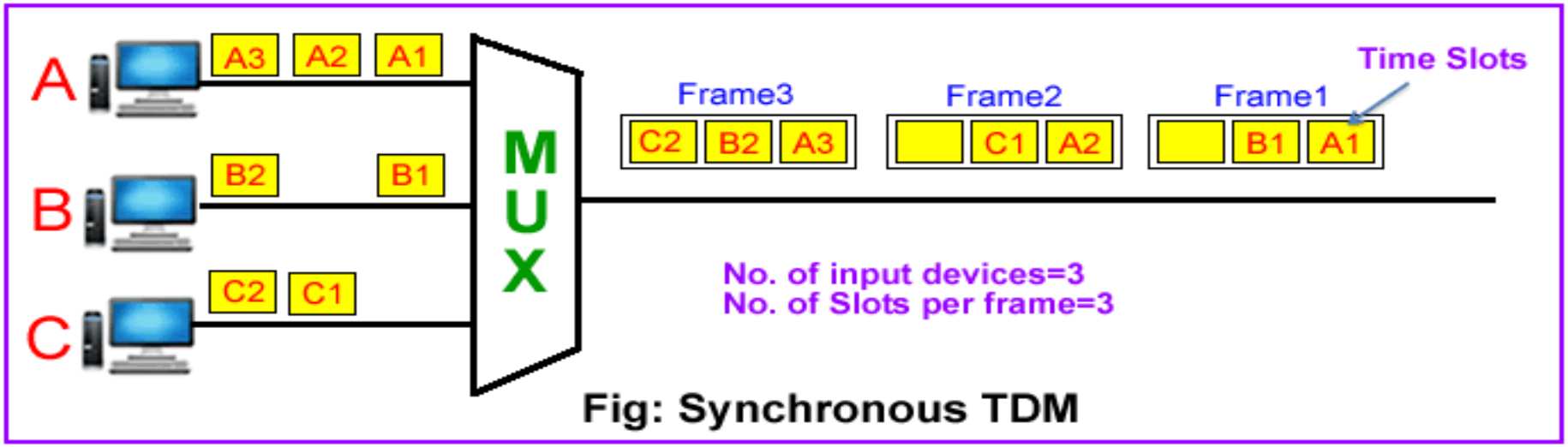


Fig: Synchronous TDM

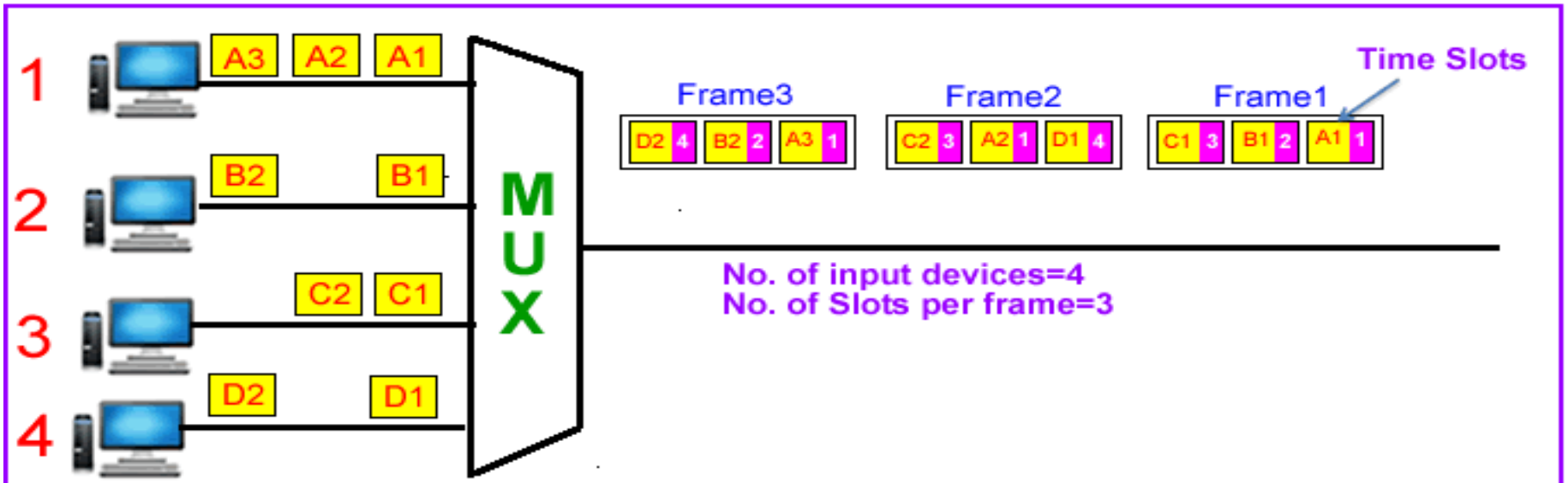


Fig: Statistical TDM