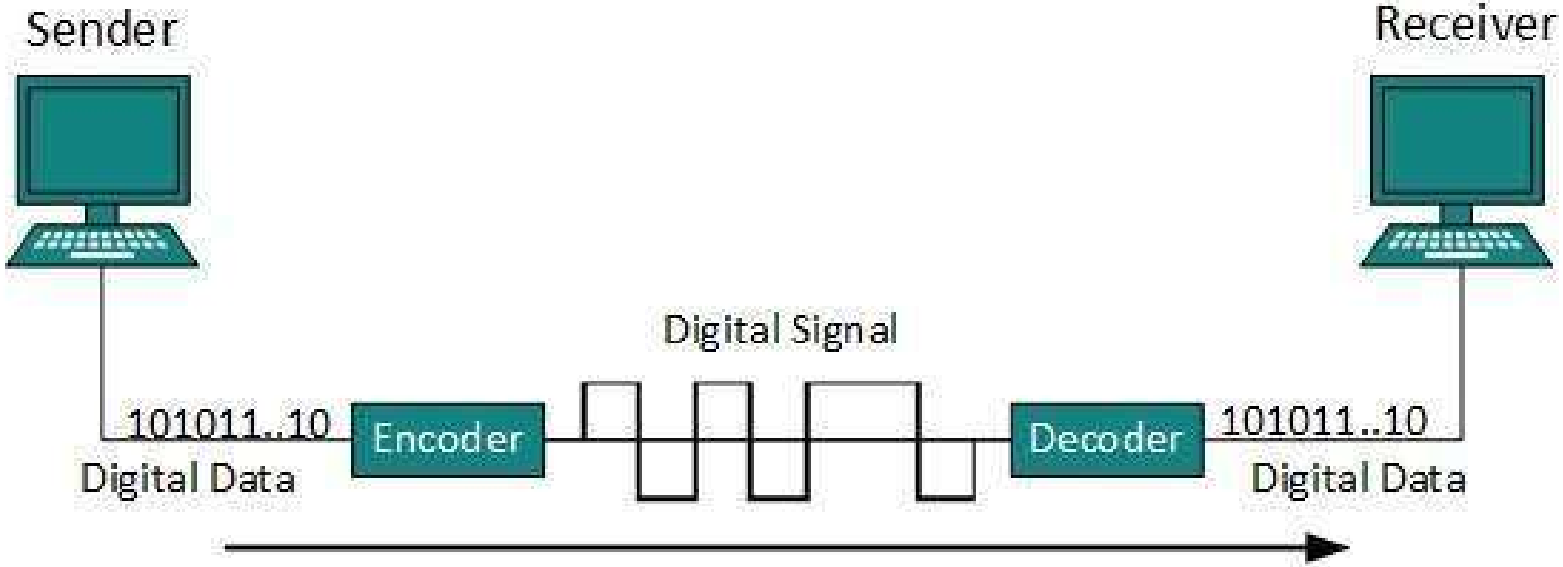
Chapter 4

Digital Transmission



Objective

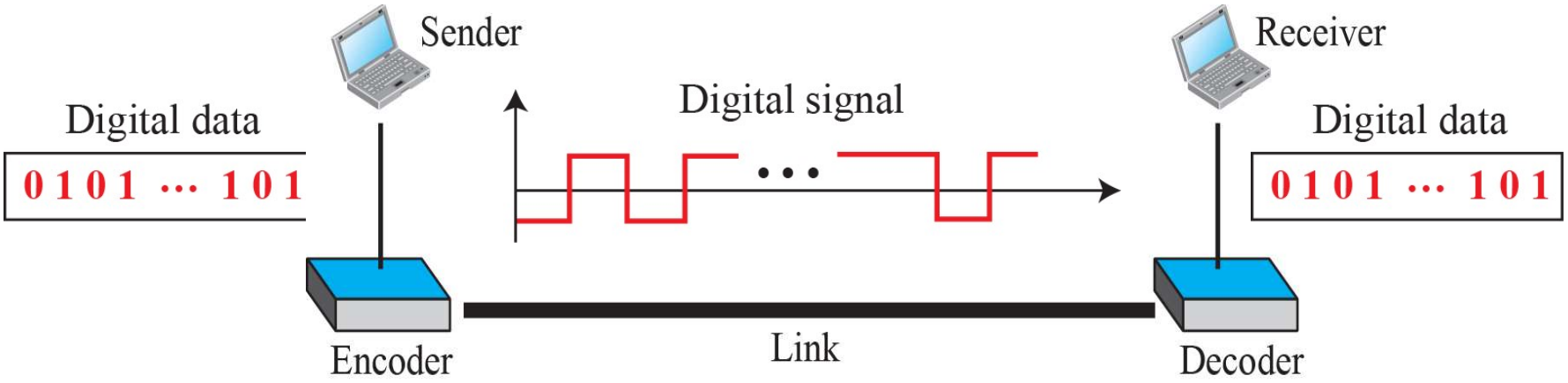
- digital-to-digital conversion.
  - Line coding, Redundancy, Scrambling.
- analog-to-digital conversion.
  - Pulse code modulation, Delta modulation.
- transmission modes.
  - parallel or serial transmission.

DIGITAL-TO-DIGITAL CONVERSION

- How we can represent digital data by using digital signals?
- The conversion involves three techniques: line coding, block coding, and scrambling.
- Line coding is always needed; block coding and scrambling may or may not be needed.

Line Coding

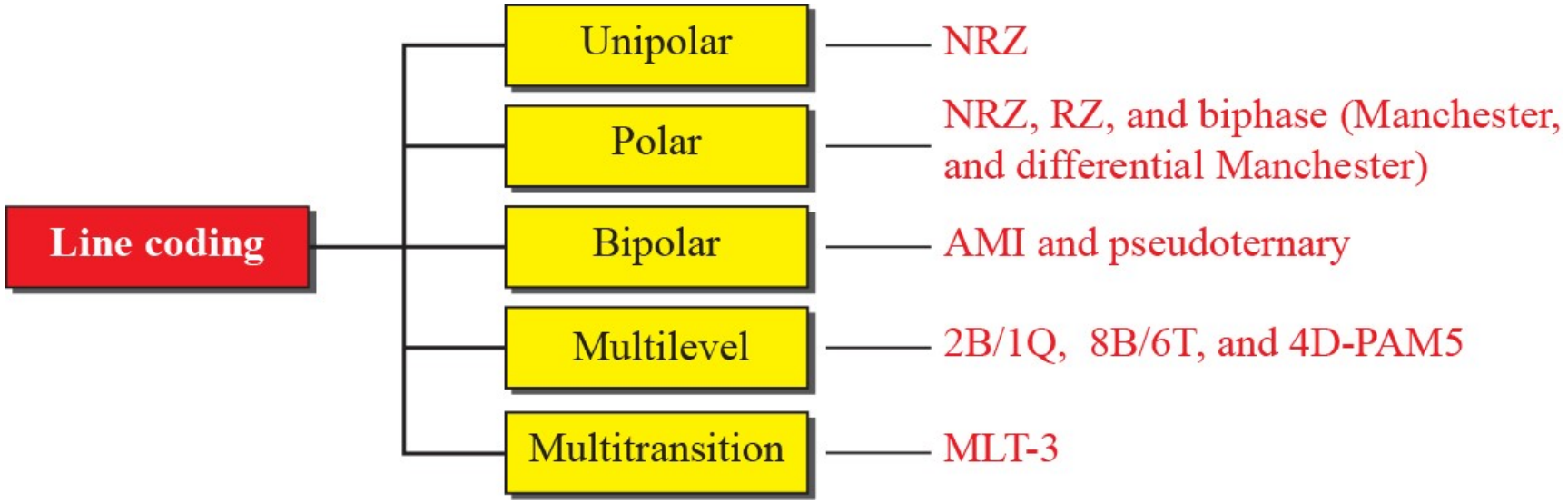
- Line coding is the process of converting **digital data to digital signals**.
- We assume that data, in the form of text, numbers, graphical images, audio, or video, are stored in computer memory as sequences of bits.
- Line coding converts a sequence of bits to a digital signal. At the sender, digital data are encoded into a digital signal; at the receiver, digital data are recreated by decoding the digital signal.



Line coding and decoding

Line Coding Schemes

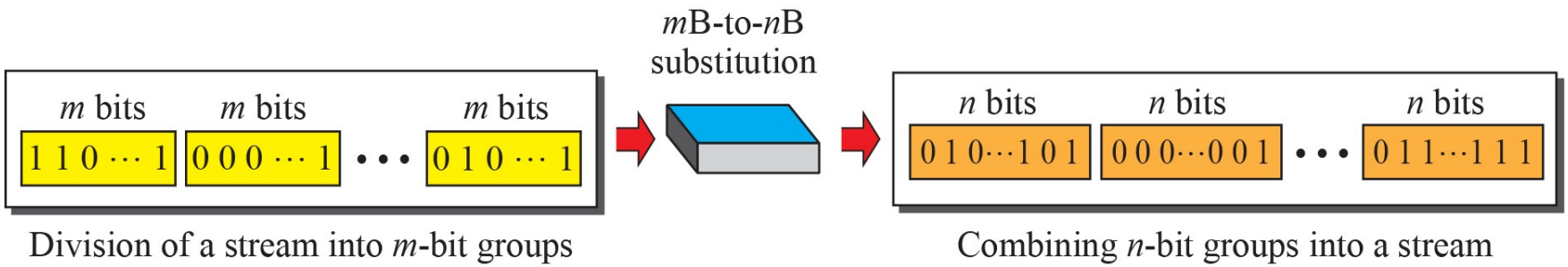
- We can roughly divide line coding schemes into five broad categories. There are several schemes in each category.



Line coding scheme

Block Coding

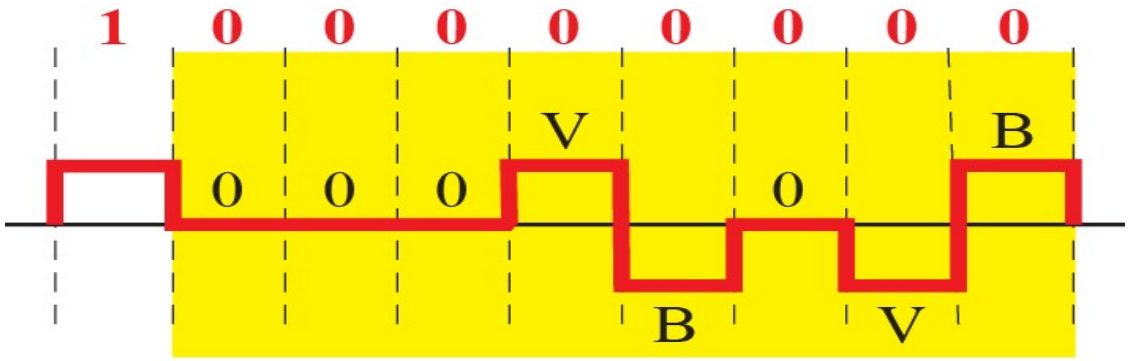
- We need redundancy to ensure synchronization and to provide some kind of inherent error detecting.
- Block coding can give us this redundancy and improve the performance of line coding.
- In general, block coding changes a block of m bits into a block of n bits, where n > m. Block coding is referred to as an mB/nB encoding technique.



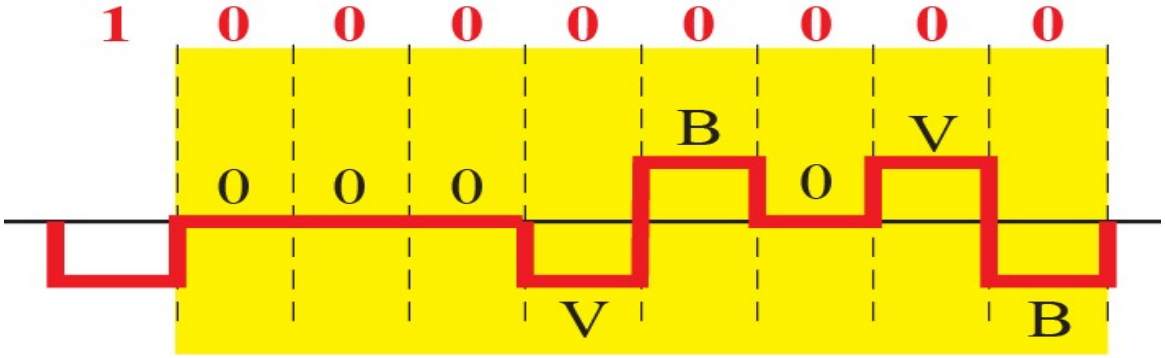
Block coding concept

Scrambling

- We modify line and block coding to include scrambling
- Note that scrambling, as opposed to block coding, is done at the same time as encoding.
- The system needs to insert the required pulses based on the defined scrambling rules.
- Two common scrambling techniques are B8ZS and HDB3.

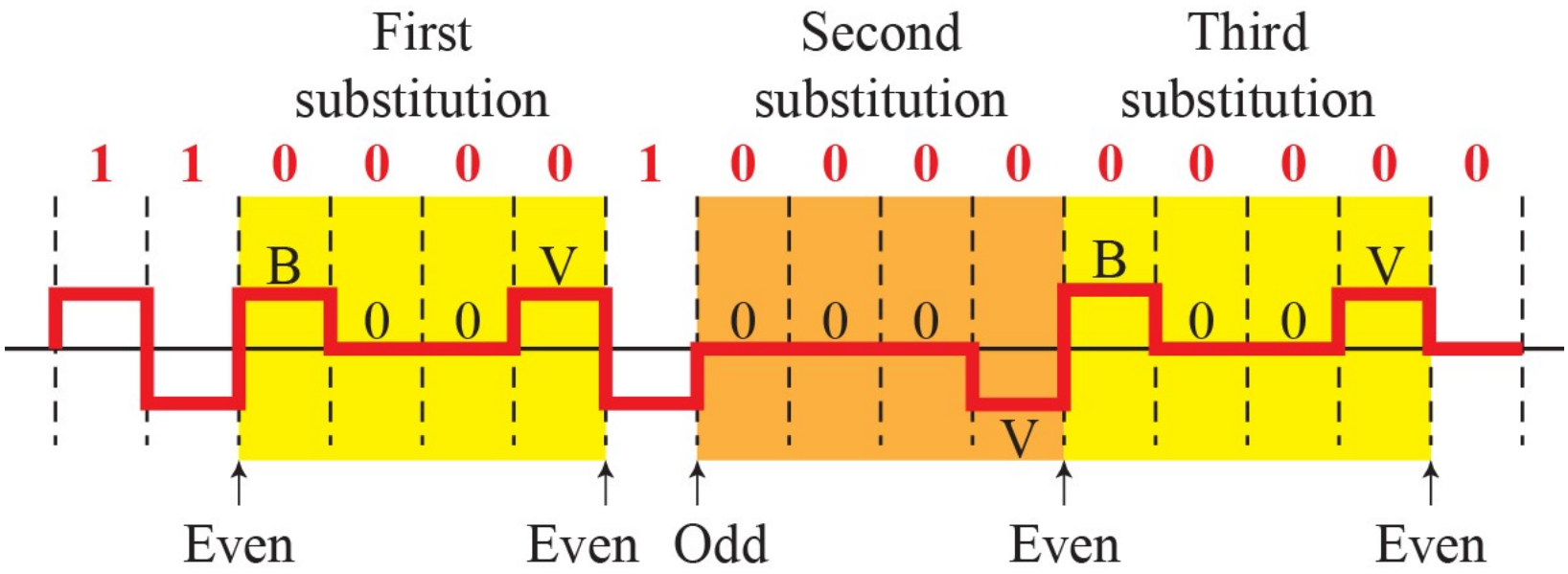


a. Previous level is positive.



b. Previous level is negative.

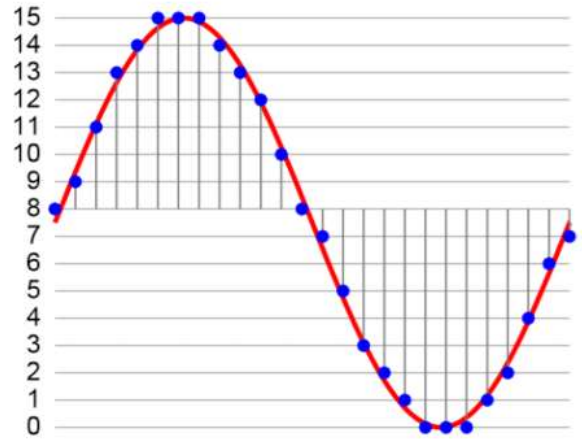
Two cases of B8ZS scrambling technique

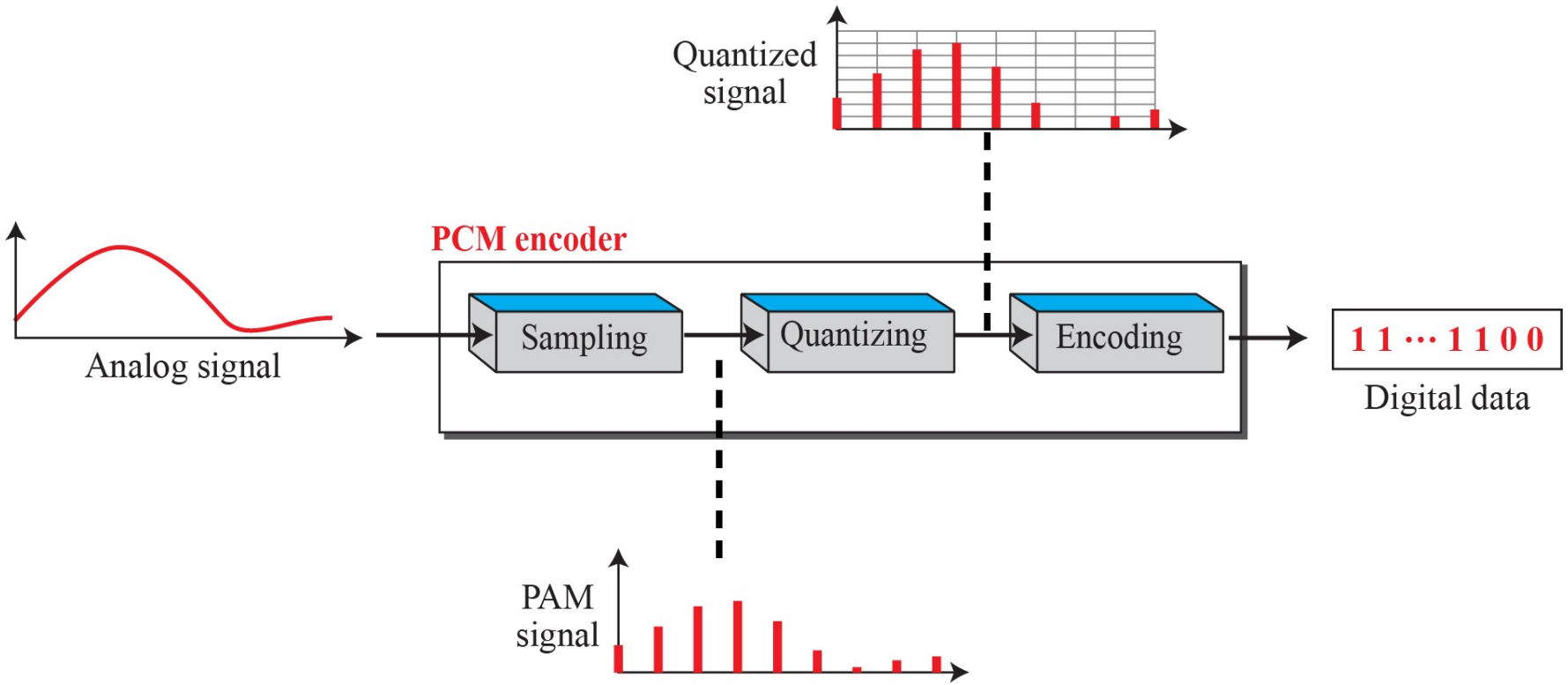


Different situations in HDB3 scrambling technique

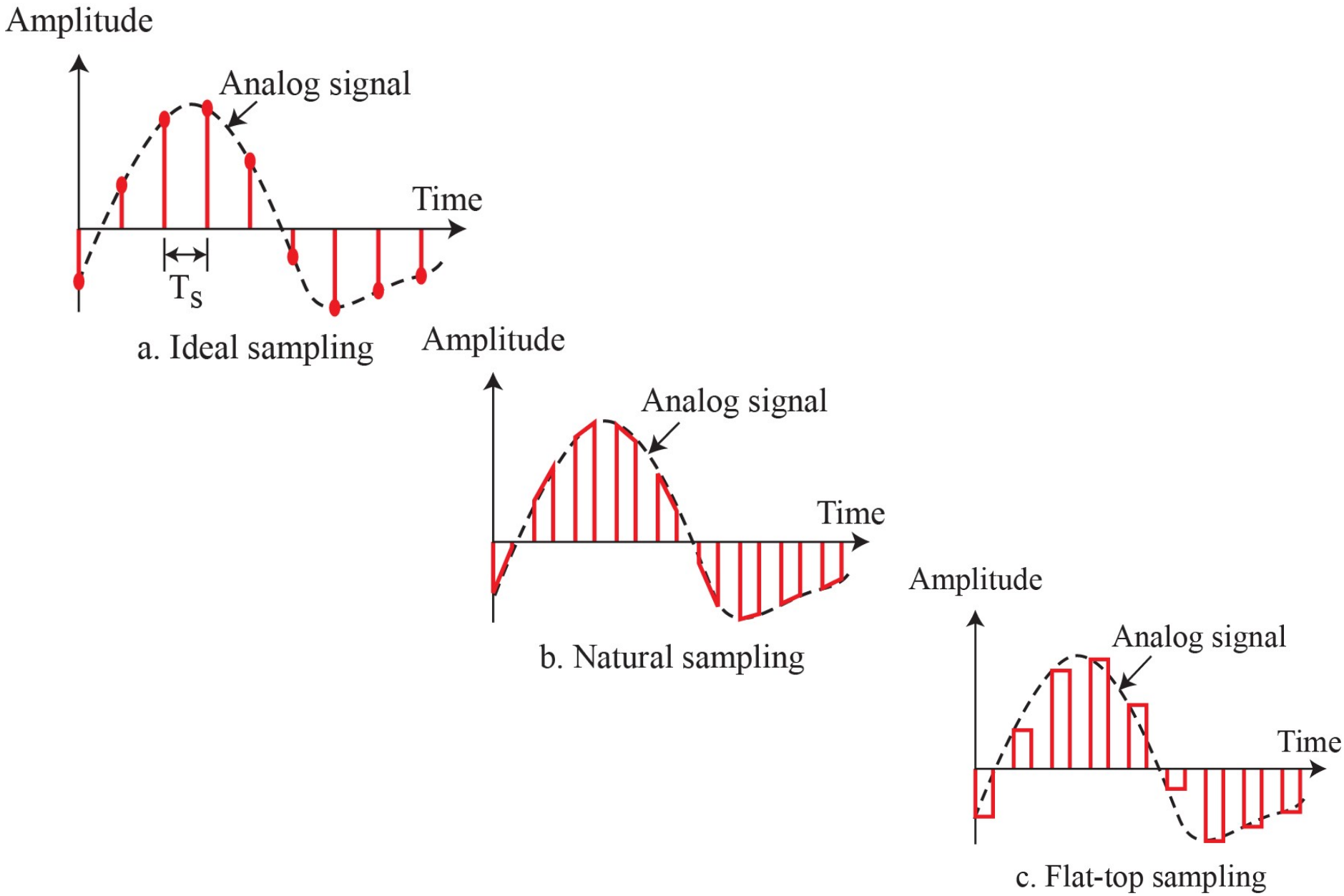
Pulse Code Modulation (PCM)

- The tendency today is to change an analog signal to digital data. Two techniques - pulse code modulation and delta modulation.
- The most common technique to change an analog signal to digital data (digitization) is called pulse code modulation (PCM).
- A PCM encoder has three processes

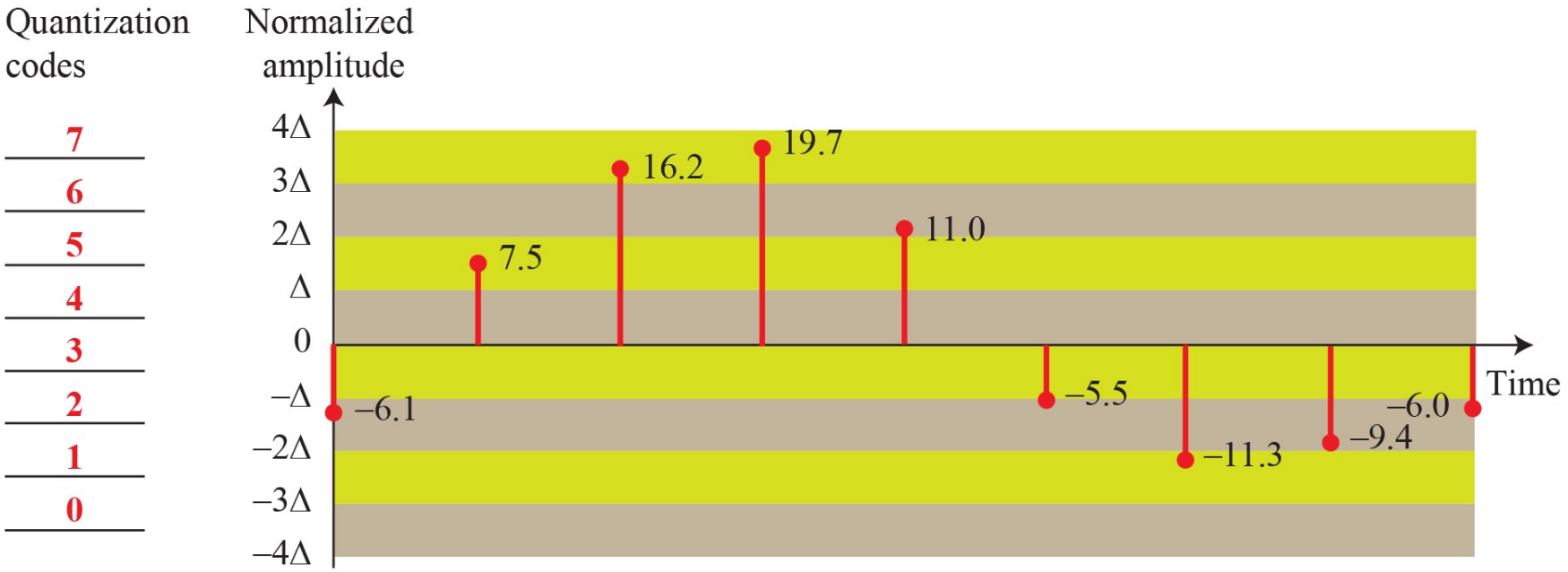




Components of PCM encoder



Three different sampling methods for PCM



Normalized PAM valucs	−1.22	1.50	3.24	3.94	2.20	−1.10	−2.26	−1.88	−1.20
Normalized quantized values	−1.50	1.50	3.50	3.50	2.50	−1.50	−2.50	−1.50	−1.50
Normalized error	−0.28	0	+0.26	−0.44	+0.30	−0.40	−0.24	+0.38	−0.30
Quantization code	2	5	7	7	6	2	1	2	2
Encoded words	010	101	111	111	110	010	001	010	010

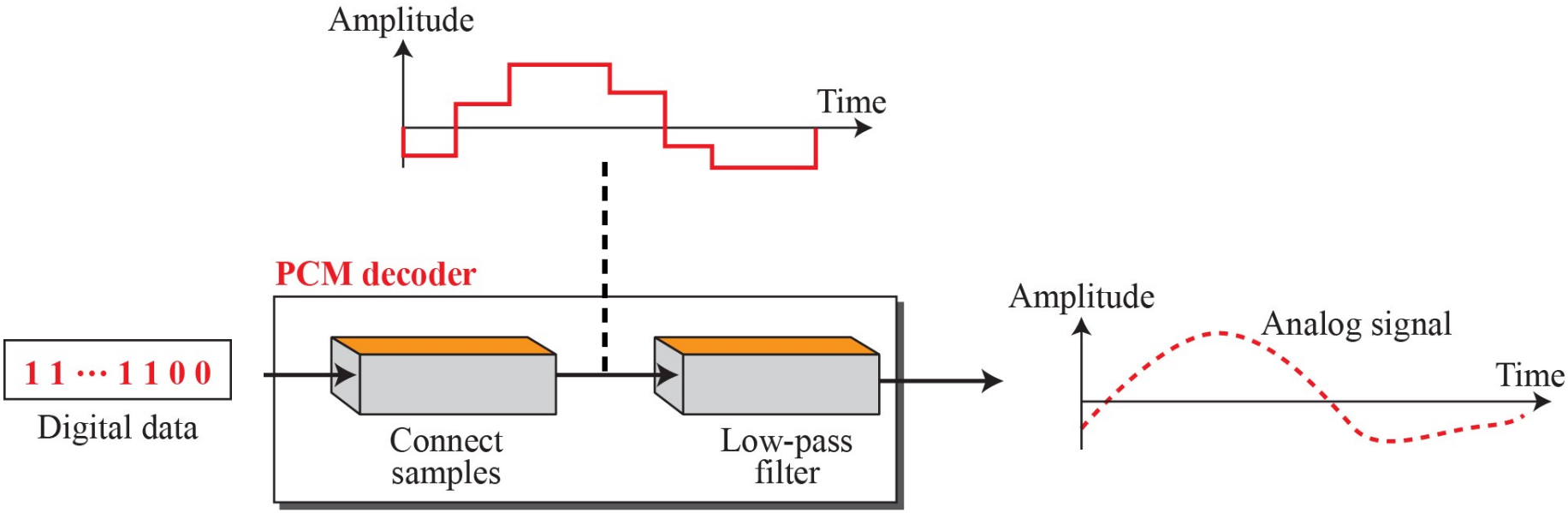
Quantization and encoding of a sampled signal

Encoding

- Encoding is the process of converting the data or a given sequence of characters, symbols, alphabets etc., into a specified format, for the secured transmission of data.

Encoding for each symbol				Encoding for "ABBA"
A	B	C	D	
00	01	10	11	00 01 01 00

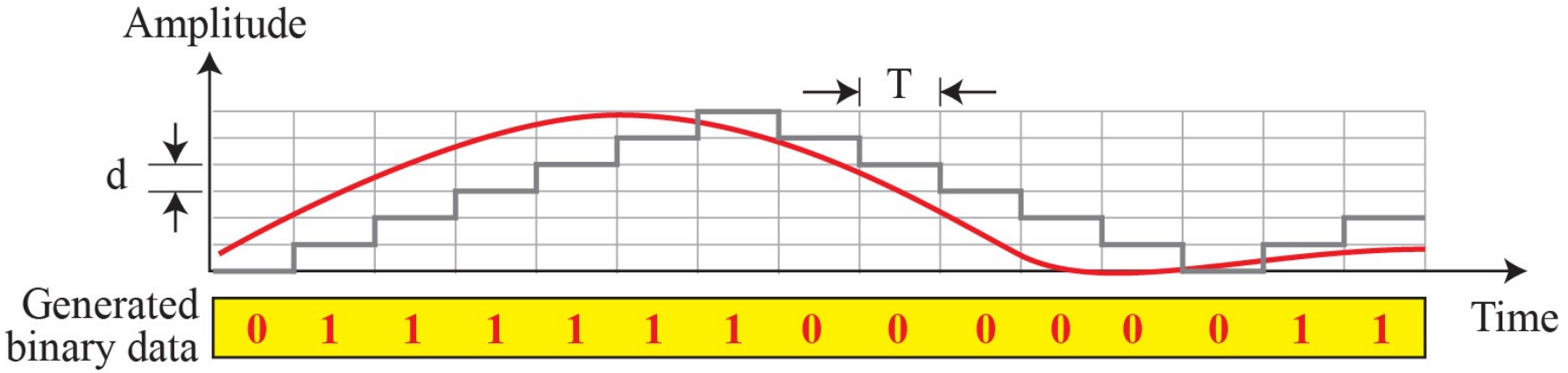
Decoding



Components of a PCM decoder

Delta Modulation (DM)

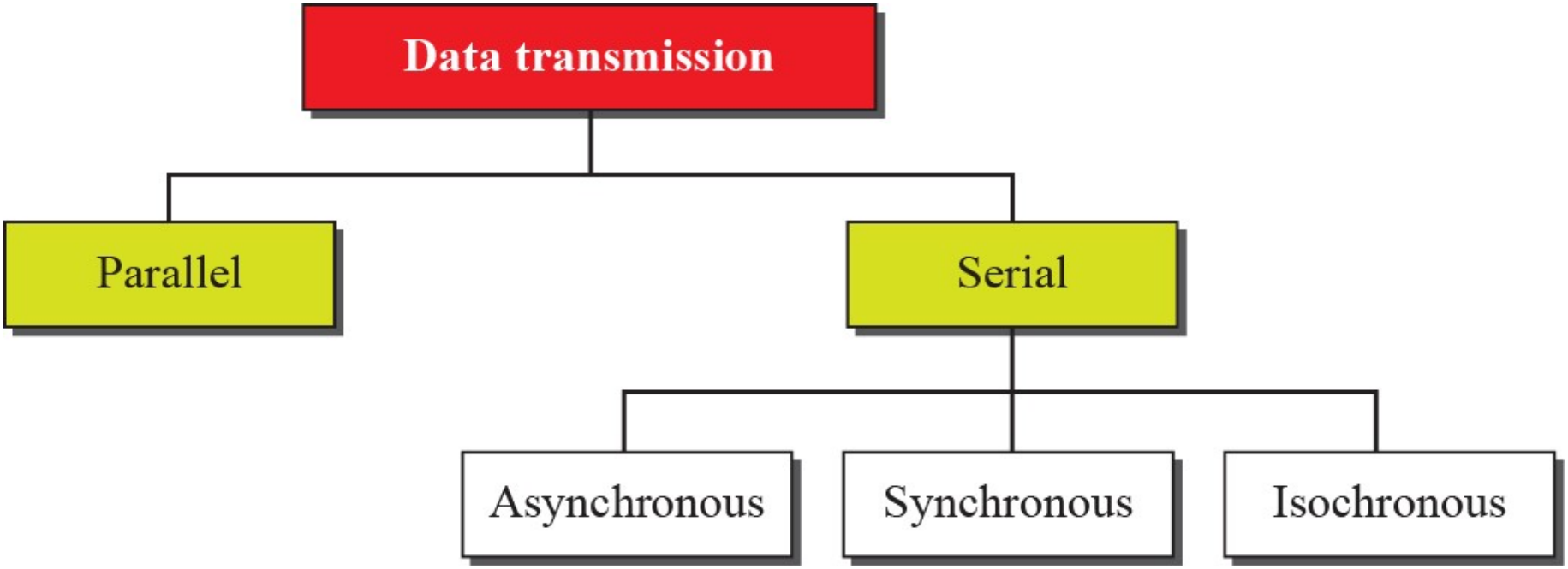
- PCM is a very complex technique. Other techniques have been developed to reduce the complexity of PCM.
- The simplest is delta modulation. PCM finds the value of the signal amplitude for each sample; DM finds the change from the previous sample.
- Note that there are no code words here; bits are sent one after another.



The process of delta modulation

TRANSMISSION MODES

- Of primary concern when we are considering the transmission of data from one device to another is the wiring, and of primary concern when we are considering the wiring is the data stream.
- Do we send 1 bit at a time; or do we group bits into larger groups and, if so, how?
- The transmission of binary data across a link can be accomplished in either parallel or serial mode *(sync, async and isochronous)*.

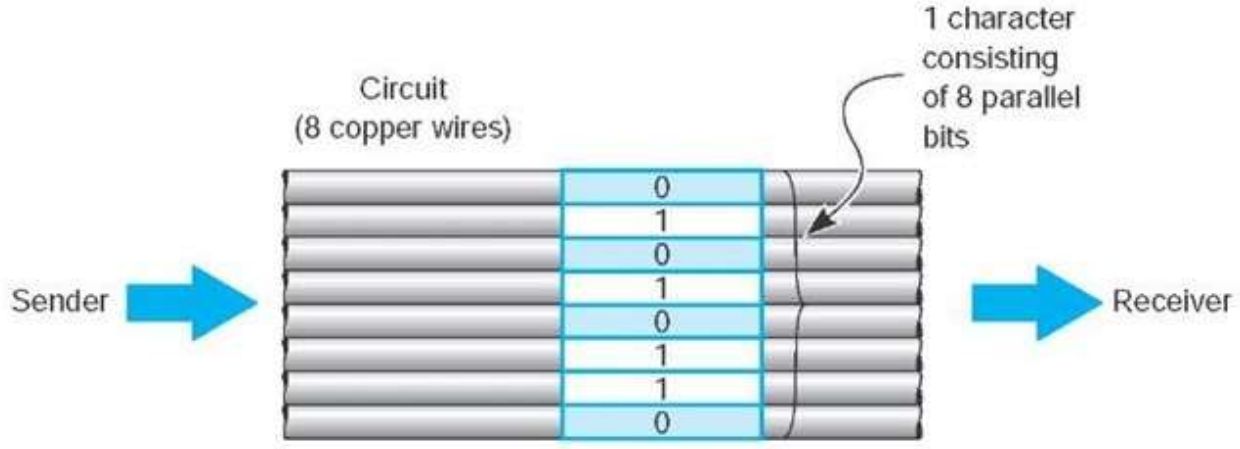


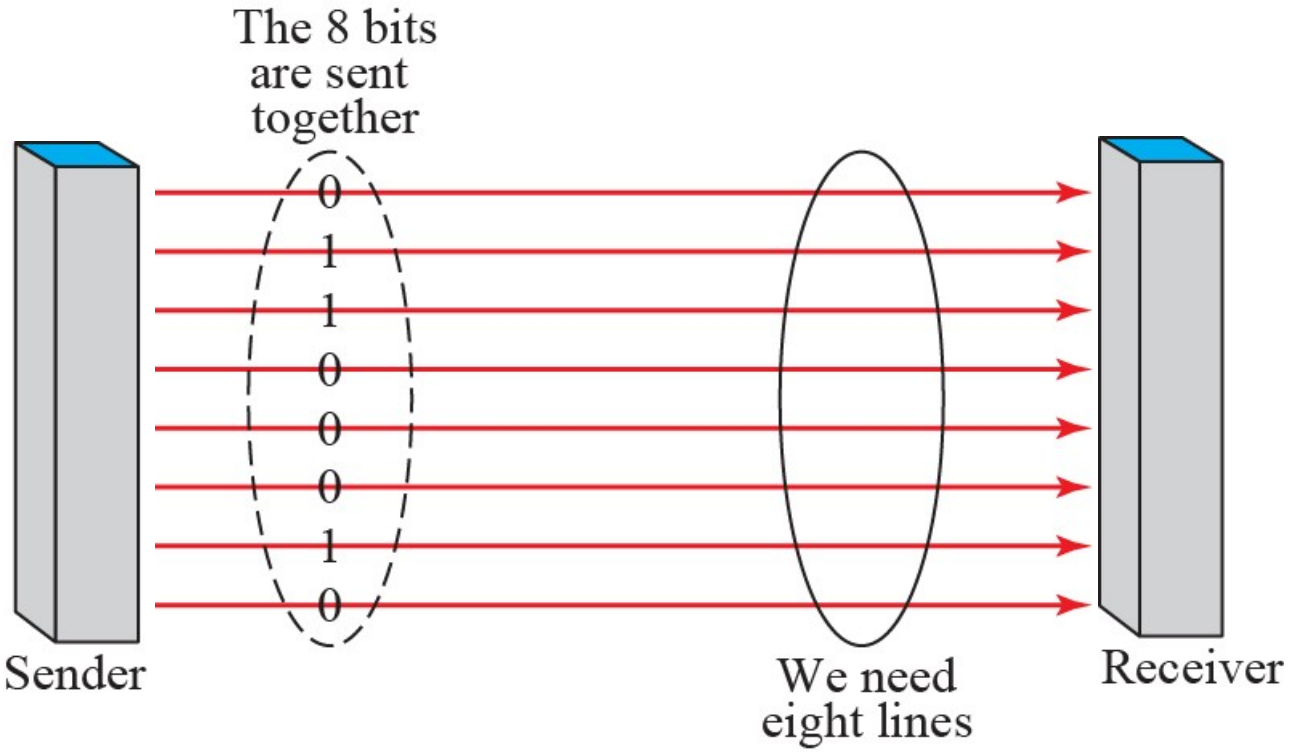
Data transmission modes

Parallel Transmission

- In Parallel Transmission, many bits are flow together simultaneously from one computer to another computer.

- Parallel Transmission is faster than serial transmission to transmit the bits. Parallel transmission is used for short distance.

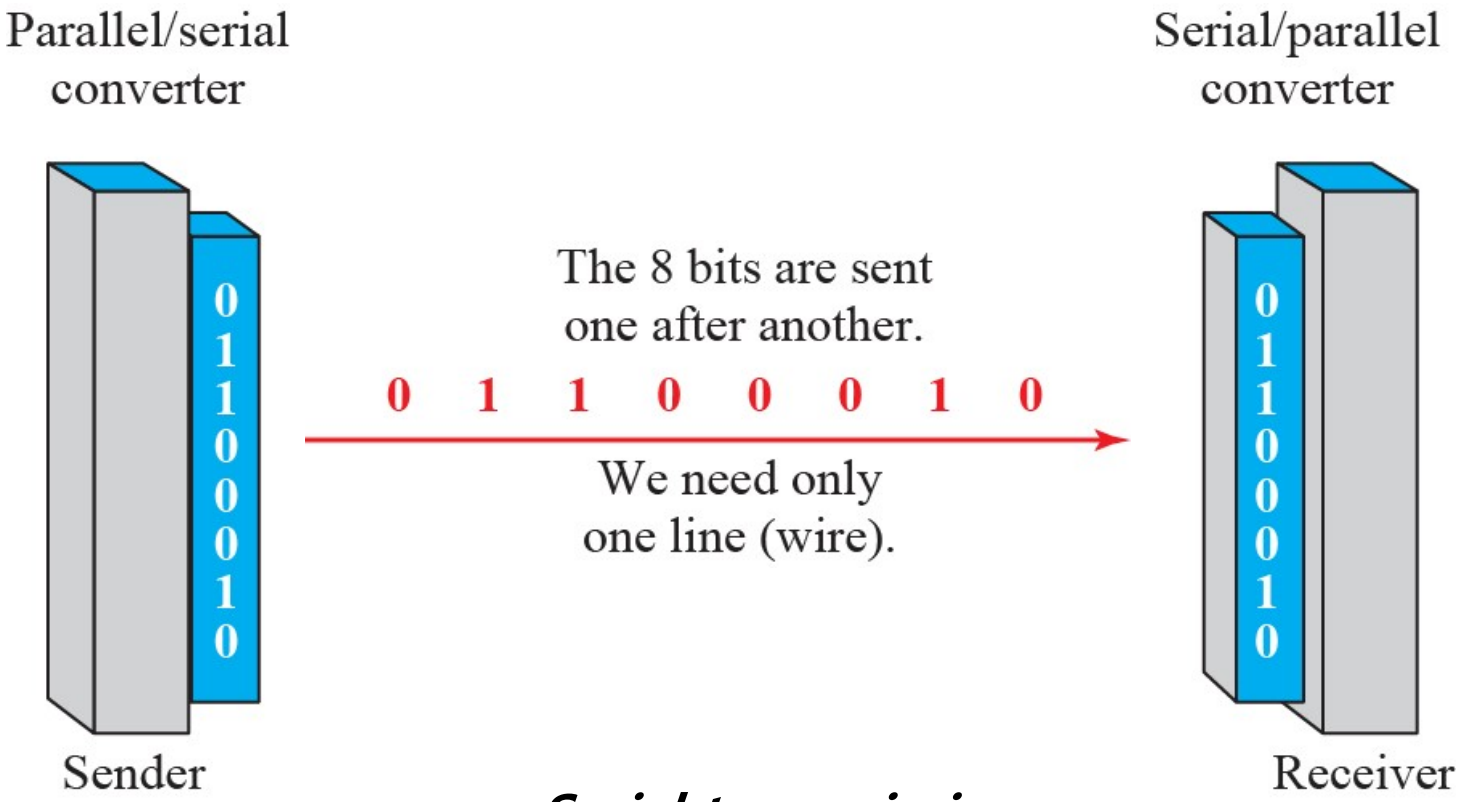




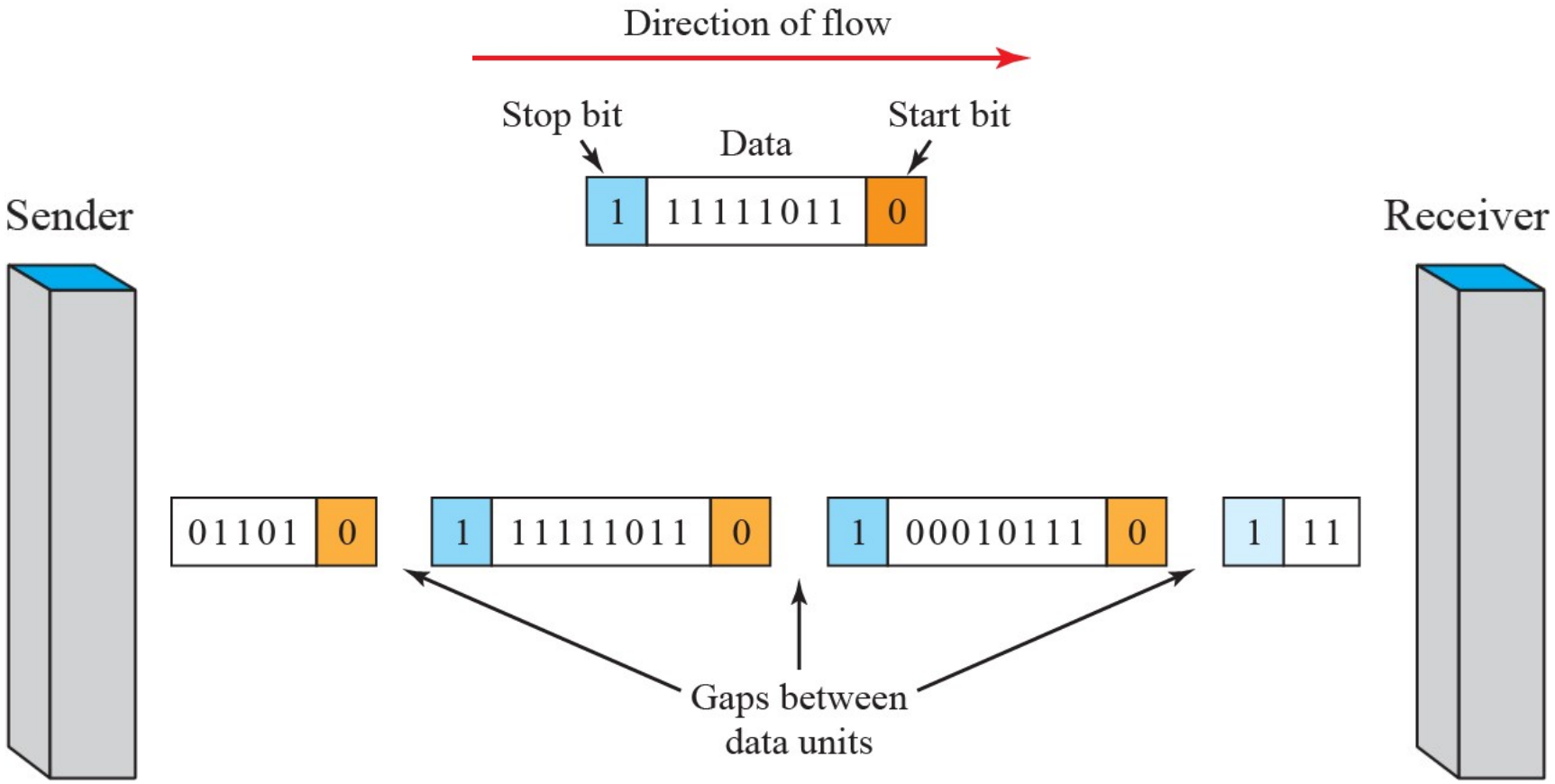
Parallel transmission

Serial Transmission

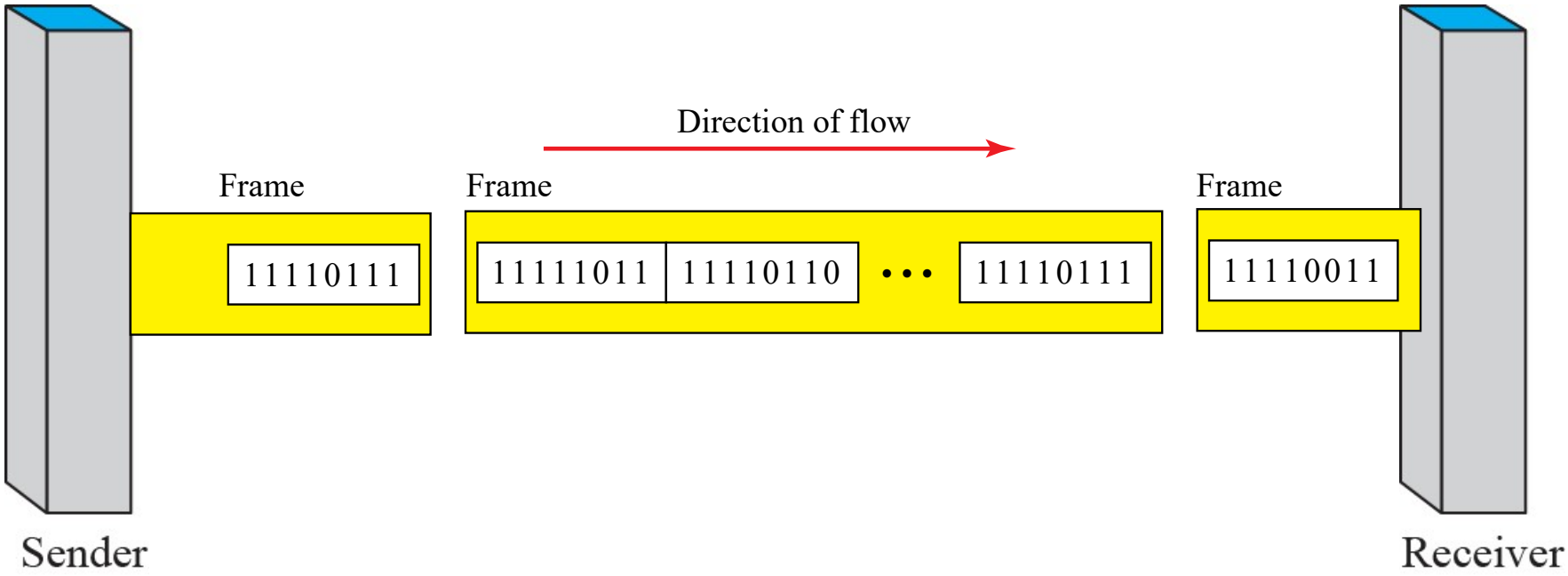
- We need only one communication channel rather than n to transmit data between two communicating devices.



Serial transmission



Asynchronous transmission



Synchronous transmission

Isochronous mode

- In information technology, isochronous pertains to processes that require timing coordination to be successful, such as voice and digital video transmission.

- It needs to arrive at close to the same rate of data flow as the source. Isochronous data transfer ensures that data flows continously and at a steady rate in close timing with the ability of the display mechanism to receive and display the image data.