TOPIC: Digital Transmission

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CONTENT

INTRODUCTION

A computer network is designed to send information from one point to another. This information needs to be converted to either a digital signal or an analog signal for transmission

There are two schemes -

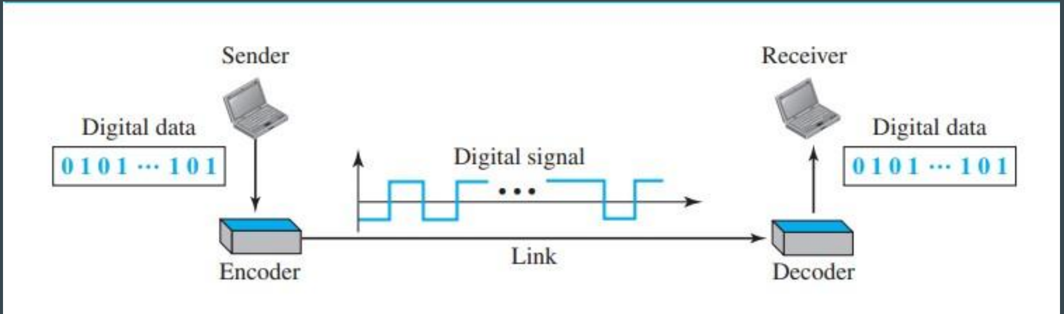
- *Digital-to-Digital conversion techniques* : methods which convert digital data to digital signals.
- *Analog-to-digital conversion techniques* : methods which change an analog signal to a digital signal

DIGITAL TO DIGITAL CONVERSION

- Data can be either digital or analog.
- Signals that represent data can also be digital or analog.
- 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

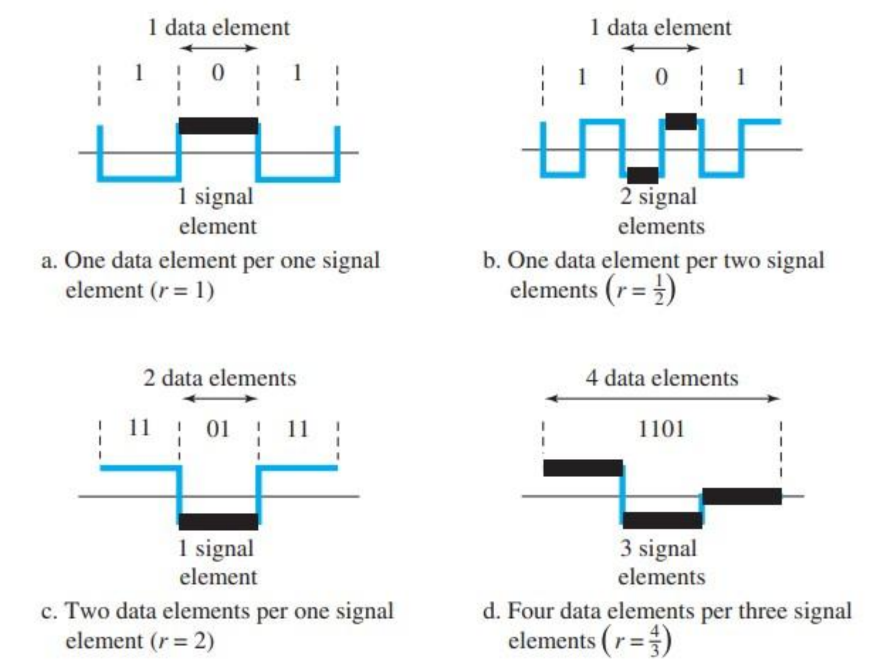
Line coding converts a sequence of bits to a digital signal. At the sender, digital data are encoded into a digital signal; at the receiver, the digital data are recreated by decoding the digital signal.



A data element is the smallest entity that can represent a piece of information: this is the bit.

A signal element is the shortest unit (timewise) of a digital signal.

LINE CODING (CONTINUED)



$$S_{ave} = c * N * (1/r) \text{ baud}$$

c is the case factor

Data Rate Versus Signal Rate

The ***data rate (N)*** defines the number of data elements (bits) sent in 1s. The unit is bits per second (bps). The data rate is sometimes called the bit rate.

The ***signal rate (S)*** is the number of signal elements sent in 1s. The unit is the baud.; the signal rate is sometimes called the pulse rate, the modulation rate, or the baud rate.

$$\boxed{S = N / r}$$

r is the number of data elements carried by each signal element

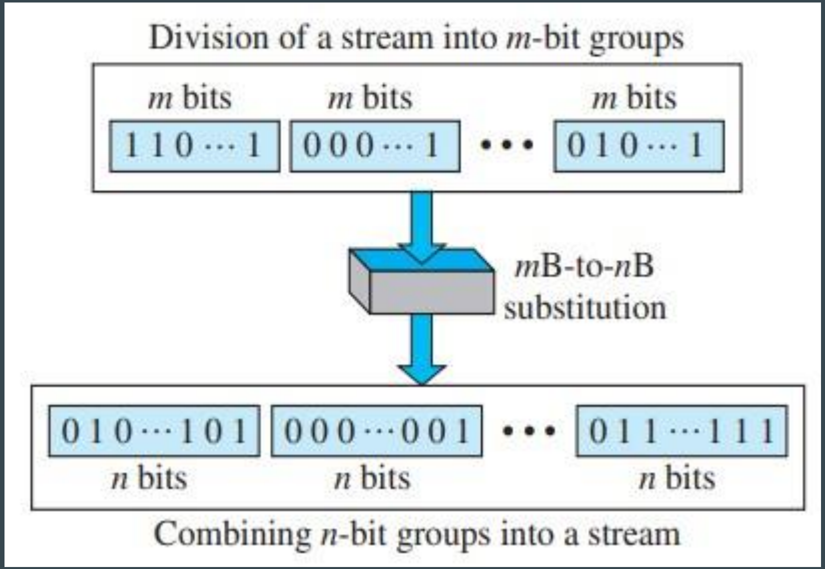
LINE CODING (CONTINUED)

Line Coding Schemes

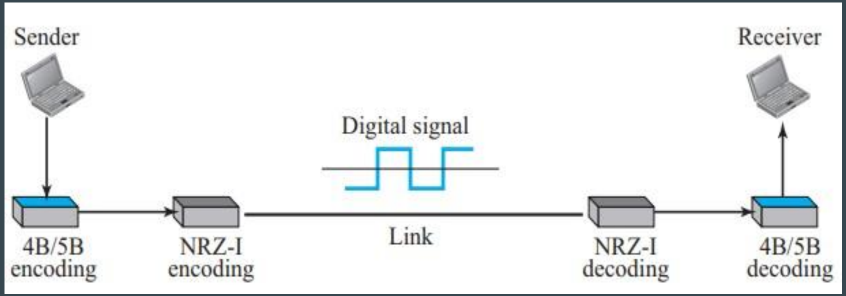
Category	*Scheme*	*Bandwidth (average)*	*Characteristics*
Unipolar	NRZ	$B = N/2$	Costly, no self-synchronization if long 0s or 1s, DC
Polar	NRZ-L	$B = N/2$	No self-synchronization if long 0s or 1s, DC
	NRZ-I	$B = N/2$	No self-synchronization for long 0s, DC
	Biphase	$B = N$	Self-synchronization, no DC, high bandwidth
Bipolar	AMI	$B = N/2$	No self-synchronization for long 0s, DC
Multilevel	2B1Q	$B = N/4$	No self-synchronization for long same double bits
	8B6T	$B = 3N/4$	Self-synchronization, no DC
	4D-PAM5	$B = N/8$	Self-synchronization, no DC
Multitransition	MLT-3	$B = N/3$	No self-synchronization for long 0s

BLOCK CODING

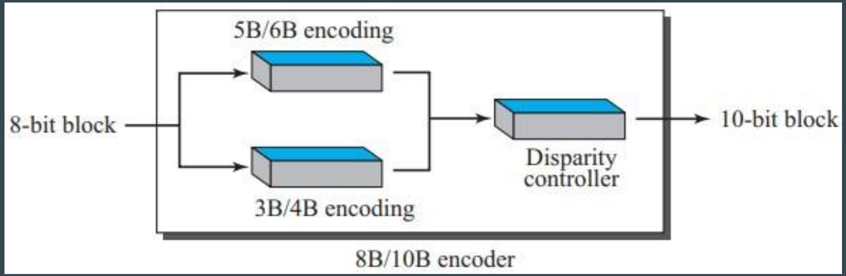
Block coding changes a block of m bits into a block of n bits, where n is larger than m. Block coding is referred to as an mB/nB encoding technique



BLOCK CODING CONCEPT



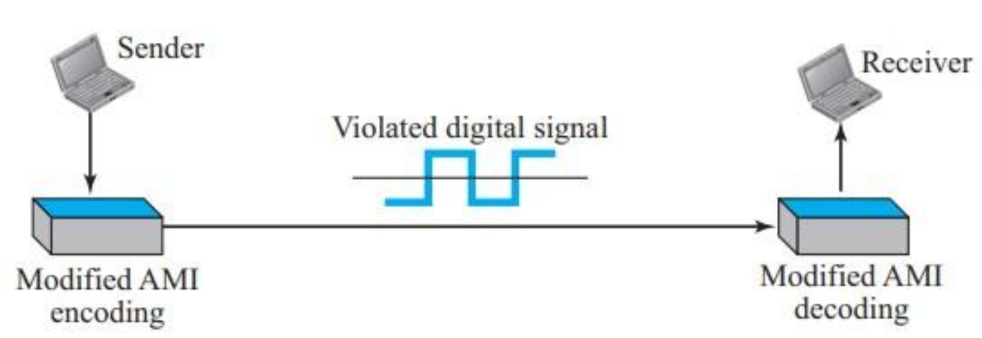
4B/5B CODING SCHEME



8B/10B CODING SCHEME

SCRAMBLING

- ➔ Biphase schemes are suitable for LANs but not for long-distance communication due to wide bandwidth requirements.
- ➔ Block coding combined with NRZ line coding is not suitable for long-distance encoding due to the DC component.
- ➔ Bipolar AMI encoding is narrow-bandwidth and lacks a DC component but faces synchronization issues with long 0 sequences.
- ➔ ***Scrambling*** is a technique to avoid long 0 sequences in bipolar AMI encoding for long-distance communication.
- ➔ B8ZS and HDB3 are common scrambling techniques used for this purpose.



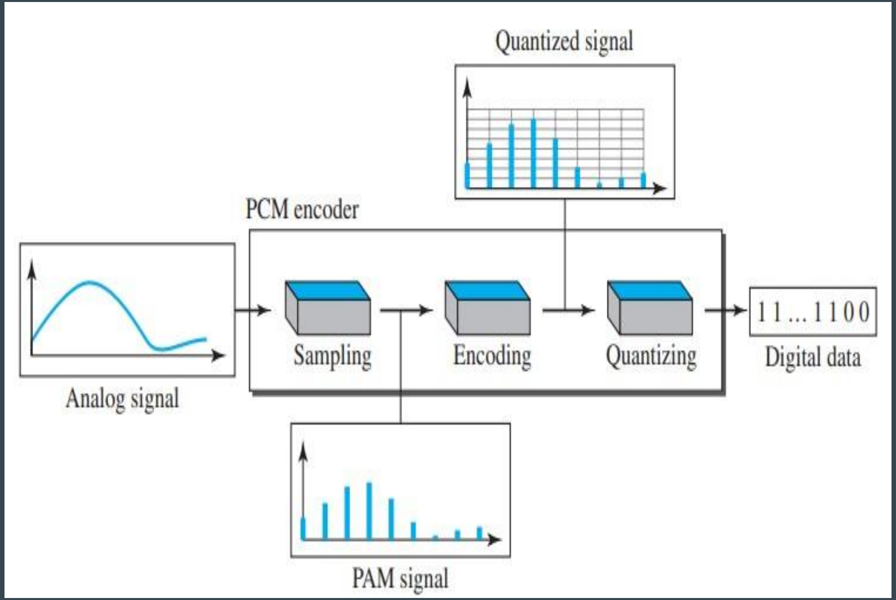
AMI used with scrambling

ANALOG TO DIGITAL TRANSMISSION

- Analog to digital transmission converts continuous analog signals into discrete digital data.
- It involves sampling, quantization, and encoding to represent analog information in digital form.
- This process is crucial for efficient and reliable communication in digital systems.
- The resulting digital signal can be easily processed, transmitted, and reconstructed at the receiving end.

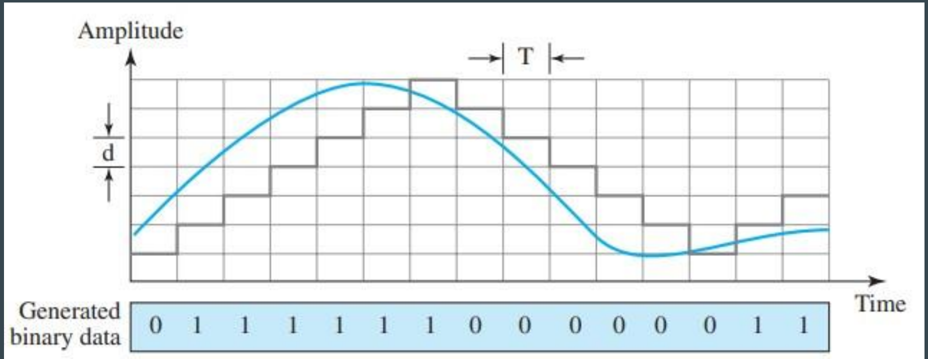
PULSE CODE MODULATION

- Pulse Code Modulation (PCM) is a method for digitally encoding analog signals.
- It involves three main steps: sampling, quantization, and encoding.
- In sampling, the analog signal is measured at regular intervals.
- Quantization assigns discrete amplitude values to the sampled points.
- Encoding then represents these quantized values as digital code.
- PCM is widely used in telecommunications and audio processing for high-quality signal representation.



DELTA MODULATION

- ➔ Delta Modulation (DM) is a simple form of analog-to-digital signal encoding.
- ➔ It quantized the difference (delta) between the current sample and the previous one.
- ➔ DM simplifies encoding by transmitting only the sign and size of the change in signal amplitude.
- ➔ It is a type of differential pulse code modulation, providing a basic method for analog signal digitization.
- ➔ While simple, DM may exhibit slope overload and granular noise issues in certain applications.



TRANSMISSION MODES

Parallel Mode:

- Multiple bits transmitted simultaneously.
- Faster data transfer.
- Commonly used in short-distance communication.

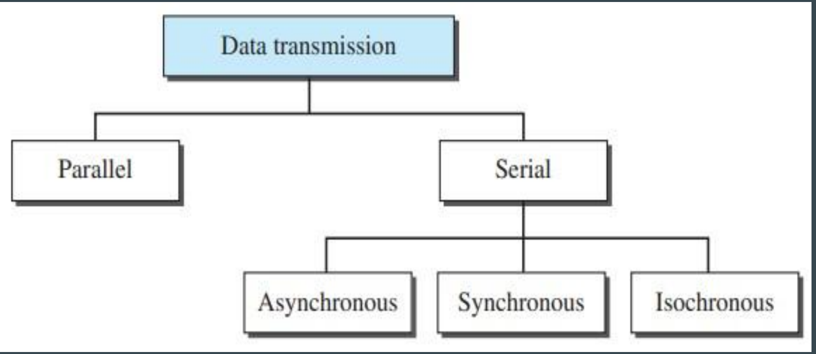
Serial Mode:

- Bits transmitted sequentially.
- Efficient for long-distance communication.
- Examples: Asynchronous, Synchronous, Isochronous.

Serial Transmission:

Asynchronous:

- Variable time intervals between characters.
- Start and stop bits used for synchronization.
- Common in low-speed applications.



Synchronous:

- Continuous stream of data without start-stop bits.
- Requires a clock signal for synchronization.
- Efficient for high-speed data transfer.

Isochronous:

- Constant, fixed-rate data transmission.
- Commonly used in real-time applications.
- Guarantees timely delivery of data.

CONCLUSION

Efficiency Boost:

- Digital transmission enhances reliability and efficiency in computer networks.

Adaptive Modes:

- Simplex, Half-Duplex, and Full-Duplex cater to diverse network communication needs.

Strategic Balance:

- Choosing between parallel and serial transmission optimizes speed and simplicity for network performance.

REFERENCE

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THANK YOU