Signal Transmission and Encoding

Swagat Ranjan Sahoo
Assistant Professor

Department of Computer Science and Engineering
GL Bajaj Institute of Technology and Management, Greater Noida-201306, India

Signal Transmission

What is analog data and digital data?

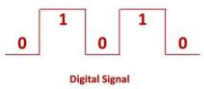
- Human understand data in various forms. This forms of data is known as analog data
- Unfortunately computer can not understand this analog data.
- Analog data need to be encoded into digital form

Example of analog data
- Voice/sound
- Temperature
- Time
- Light

Signal Transmission

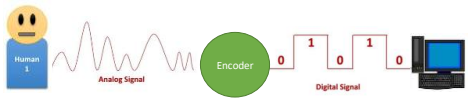
What is analog data and digital data?

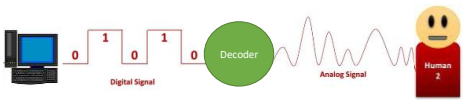
- Digital data is what computing system under stands. It is represented in the form of 0's and 1's
- Arrangement of 0's and 1's combined together can be used represents different digital media such as text, audio, video
- Human can not under that the data in in this forms



Example of what digital data represents
- Text and numeric symbol
- Pixel data of bitmap image
- Sample rate in an audio file

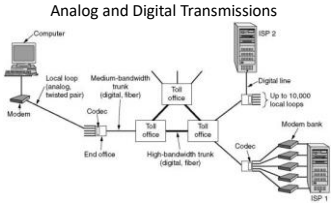
Signal Transmission





Signal Transmission

Analog and Digital Transmissions



- The use of both analog and digital transmissions for a computer-to-computer connection.
- Conversion is done by the modems and codecs.

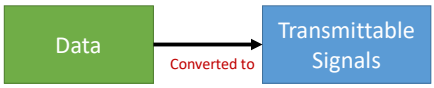
Signal Transmission

Data Encoding Techniques

- Digital Data, Analog Signals **[modem]**
- Digital Data, Digital Signals **[wired LAN]**
- Analog Data, Digital Signals **[codec]**
  - Frequency Division Multiplexing (FDM)
  - Wave Division Multiplexing (WDM) **[fiber]**
  - Time Division Multiplexing (TDM)
  - Pulse Code Modulation (PCM) **[T1]**
  - Delta Modulation

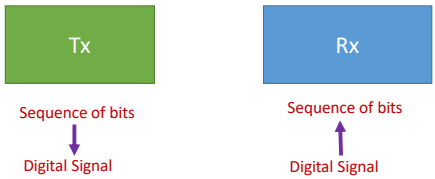
Signal Transmission

Line coding in digital communication



Signal Transmission

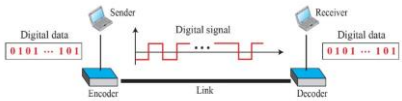
Line coding in digital communication



Signal Transmission

Line coding

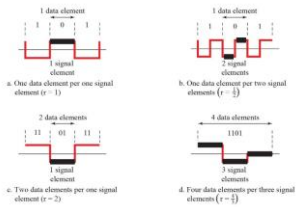
- The process for converting digital data into digital signal is said to be Line Coding.
- Digital data is found in binary format.
- It is represented (stored) internally as series of 1s and 0s.



Signal Transmission

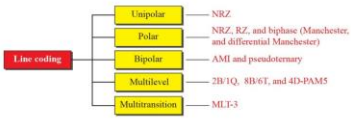
Line coding

Signal Element vs data element



Signal Transmission

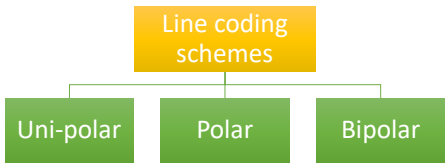
Line coding



What is Polarity?

Signal Transmission

Line coding



Signal Transmission

Line coding

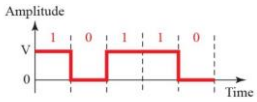
NRZ Signal does not return to zero within a bit period.

RZ Signal returns to zero within the bit period.

Line coding

1.Unipolar NRZ scheme

- All the signal levels are on one side of the time axis, either above or below.
- Positive voltage defines bit I and the zero voltage defines bit O.
- It is called NRZ because the signal does not return to zero at the middle of the bit



Line coding

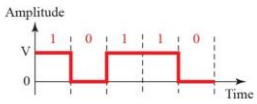
1.Unipolar NRZ scheme

Advantages

- It is simple.
- A lesser bandwidth is required.

Disadvantages

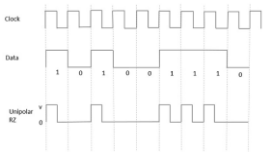
- No error correction done.
- Presence of low frequency components may cause the signal droop.
- No clock is present.
- Loss of synchronization is likely to occur (especially for long strings of **1s** and **0s**).



Line coding

Unipolar RZ scheme

- Half of the bit duration remains high but it immediately returns to zero.
- shows the absence of pulse during the remaining half of the bit duration.



Line coding

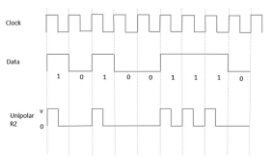
Unipolar RZ scheme

Advantages

- It is simple.
- The spectral line present at the symbol rate can be used as a clock

Disadvantages

- No error correction.
- Occupies twice the bandwidth as unipolar NRZ.
- The signal droop is caused at the places where signal is non-zero at 0 Hz.



Line coding

2. *Polar NRZ Schemes*

- voltages are on the both sides of the time axis.
- Ex. voltage level for 0 can be positive and the voltage level for I can be negative

Non Return to Zero Level (NRZ-L)

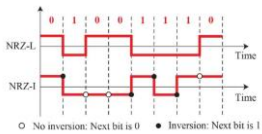
0=high level

1=low level

Non Return to Zero Inverted (NRZ-I)

0=No transition at the beginning of the interval (1 bit time)

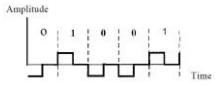
1=Transition at the beginning of the interval



Line coding

Polar RZ Schemes

- Problem with NRZ encoding occurs when the sender and receiver clocks are not synchronized.
- The receiver does not know when one bit has ended and the next bit is starting



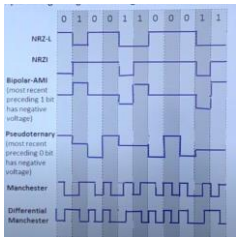
Line coding

Bipolar AMI

- 0=No line signal
- 1=Positive or negative voltage level alternative for successive ones

Pseudoternary

- 0=positive or negative voltage level alternative for successive zeros
- 1=No line signal



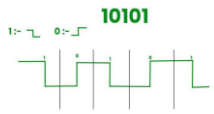
Line coding

Manchester Encoding

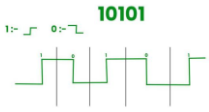
- The idea of RZ (transition at the middle of the bit) and the idea of NRZ-L are combined into the Manchester scheme.
- Duration of the bit is divided into two halves.
- The voltage remains at one level during the first half and moves to the other level in the second half.
- The transition at the middle of the bit provides synchronization.
- There are two types of conventions in Manchester encoding:
  - **Dr. Thomas:** In this manchester encoding 0 is represented as low-to-high and 1 is represented as high-to-low.
  - **IEEE802.3:** In this manchester encoding, 0 is represented as high-to-low and 1 is represented as low-to-high

Line coding

Manchester Encoding



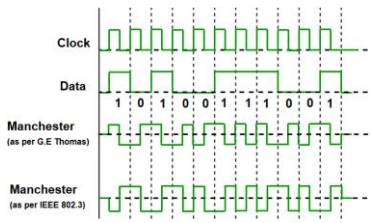
Dr. Thomas method



IEEE802.3 method

Line coding

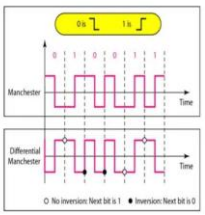
Manchester Encoding



Line coding

Differential Manchester Encoding

- Combines the ideas of RZ and NRZ-I.
- There is **always a transition in the midd of the bit,** but the bit values are determined at the beginning of the bit.
  - If the next bit is 0, there is a transition at th beginning;
  - If the next bit is 1, there is none.



Line coding

Multi level line coding

2BIQ: 2 Binary 1 Quaternary

- Data patterns of 2 bits are considered here and one signal has four levels

8B6T: 8 Binary 6 Ternary

- Data patterns of 8bits are considered
- 6 signal elements each with three level

4D-PAM5: Four Dimensional Five level Pulse Amplitude Modulation

- Data is sent over four wires (channels) simultaneously

Line coding

Multi-transition line coding

MLT-3: Multiline Transition using three levels

- If next bit is 0 →no transition
- Next bit is 1, current level is not 0→next level 0
- Next bit is 1, current level is 0 → next level is the opposite of last non zero level

Thank you!