UNIT II

PHYSICAL LAYER AND DATA LINK LAYER

Unguided Media

Unguided media, also known as wireless or unbounded media, transport electromagnetic waves through the atmosphere or free space without a physical conductor. They offer mobility and flexibility but are more susceptible to interference and security risks.

- **RF (Radio Frequency) Waves**
  - **Description**: Electromagnetic waves in the frequency range of 3 kHz to 1 GHz. They are omnidirectional, meaning they propagate in all directions and can penetrate walls and other obstacles.
  - **Applications**: Used for AM/FM radio broadcasting, cordless phones, and wireless LANs (Wi-Fi).
- **Microwave**
  - **Description**: High-frequency electromagnetic waves (1 GHz to 300 GHz) that are unidirectional and require a line-of-sight path between the transmitting and receiving antennas. They do not penetrate solid objects effectively.
  - **Applications**: Used in terrestrial point-to-point communication links and cellular phone networks.
- **Satellite**
  - **Description**: A form of microwave transmission that uses satellites in orbit around the Earth as relay stations. Signals are sent from a ground station (uplink), amplified, and retransmitted to another ground station (downlink), enabling global coverage.
  - **Applications**: Facilitates global communication, television broadcasting, and GPS navigation.

Non-Return-to-Zero (NRZ), Return-to-Zero (RZ)

Non-return-to-zero (NRZ) and **return-to-zero (RZ)** are binary encoding schemes used in digital communications that handle clock synchronization differently.

Non-Return-to-Zero (NRZ)

NRZ encoding uses two distinct voltage levels (high and low) to represent binary ones and zeros, with no return to a neutral or zero voltage level between bits. The voltage level remains constant for the entire bit duration.

- **Advantages**: It is simple to implement, offers high bandwidth efficiency, and its pulses have more energy, making it suitable for high-speed, short-distance data transmission.
- **Disadvantages**: A major drawback is the **lack of self-clocking**. Long sequences of consecutive ones or zeros result in a constant signal level, which makes it difficult for the receiver to maintain synchronization with the transmitter's clock, a problem known as baseline wander.

Return-to-Zero (RZ)

RZ encoding, in contrast, ensures the signal drops to a neutral or zero voltage level (a rest condition) between every single pulse, even for consecutive bits of the same value.

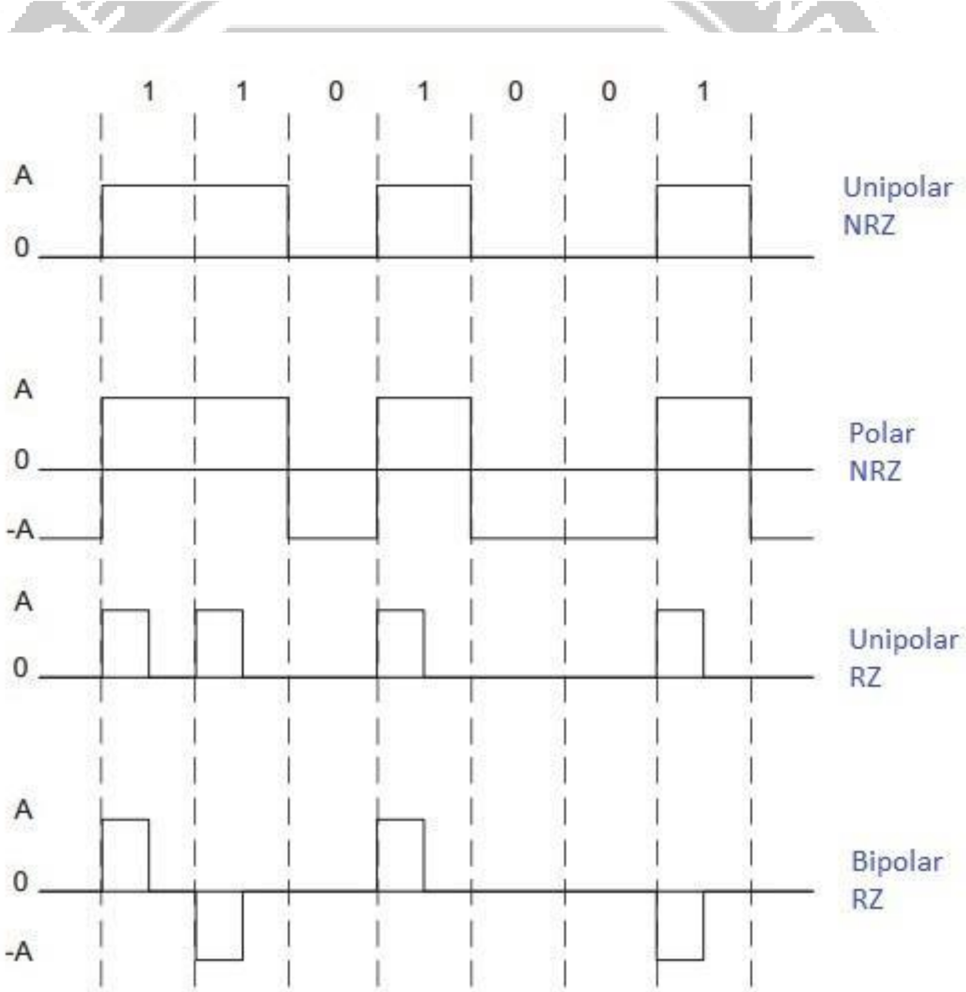
- **Advantages**: The signal transitions for every bit make it **self-clocking**, meaning synchronization information is embedded within the data stream. This provides better synchronization and easier clock recovery for the receiver.
- **Disadvantages**: The signal changes twice as fast as NRZ for the same data rate, requiring nearly double the bandwidth of NRZ to achieve the same bit rate. The lower data density makes it less bandwidth efficient than NRZ.

Clock Synchronization

Clock synchronization is the process of aligning the receiver's timing with the transmitter's timing to correctly sample and decode the incoming data stream.

- **In NRZ systems**, because the signal lacks inherent timing information during long strings of identical bits, a separate clock signal must be provided, or alternative encoding schemes with embedded synchronization features (like Manchester encoding or 4B/5B encoding) must be used.

- **In RZ systems**, the transition to zero in every bit period inherently provides timing references, making it a self-clocking signal and simplifying the synchronization process at the receiving end.



Encoding Techniques – Manchester, Framing & Error Detection

Manchester encoding, framing, and error detection are digital communication concepts. Manchester encoding uses a mid-bit transition to represent data and for self-clocking, making it inherently self-clocking and simple to implement, but it requires more bandwidth. Framing is the process of structuring data into discrete packets or "frames" for transmission. Error detection involves methods like parity or checksums to identify corrupted data during transmission, with Manchester encoding providing an inherent method for basic error detection.

Encoding Techniques: Manchester Encoding

- **What it is:** A line coding technique where the signal transitions in the middle of each bit period.
- **How it works:** It combines clock and data signals. A transition in the middle of the bit is used for synchronization, while the presence or absence of a transition at the start of the bit period defines the data bit (1 or 0).
- **Key features:**
  - **Self-clocking:** The mid-bit transition helps the receiver synchronize its clock with the transmitter, eliminating the need for a separate clock signal.
  - **No DC component:** It removes the DC component from the signal, reducing errors from external sources.
  - **Error detection:** A voltage level change in a time interval can indicate a bit error, making it a simple error detection mechanism.
- **Drawbacks:**
  - Requires a higher bandwidth than other methods because each bit requires a transition.
  - Has a lower data rate compared to other encoding methods like Non-Return-to-Zero (NRZ).

Framing

- **What it is:** The process of dividing a stream of bits into a series of discrete packets called frames.
- **Why it's used:** It allows for the efficient and organized transmission of data. Each frame is treated as a separate unit, and can be addressed, routed, and checked for errors independently.
- **Framing methods:**
  - A preamble is often added to the beginning of a frame to help the receiver locate the start of the frame.
  - Framing can be used to reset the higher-level interpretation logic in the receiver when a bit stuffing violation occurs.

Error Detection

- **What it is:** The process of detecting errors that may have occurred during data transmission, such as bit corruption.
- **How it works:** The sender adds extra bits to the data, such as parity bits or a checksum, that allow the receiver to verify the integrity of the received data.
- **Error detection and Manchester encoding:**
  - Manchester encoding provides a simple way to detect errors because any unexpected voltage change within a bit period can indicate a problem.
  - More sophisticated error detection methods, like parity or checksums, can be used in conjunction with Manchester encoding for more robust error handling.