IT 4505
Section 1.2

Data Transmission Concepts

Section 1.2

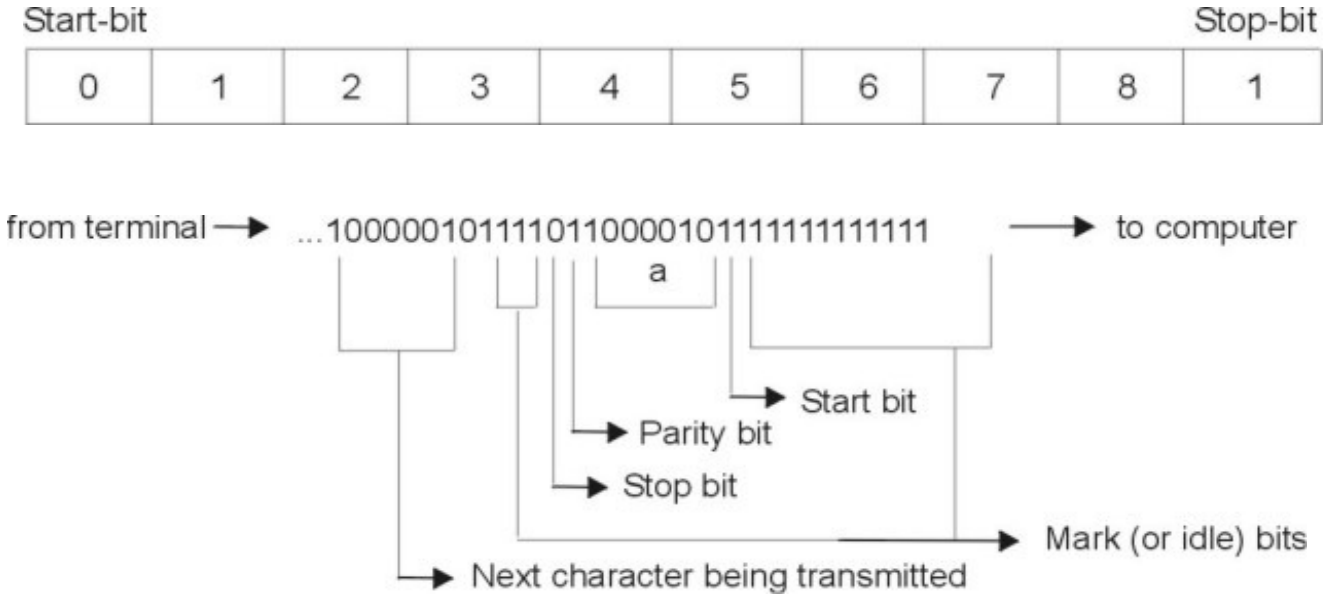
Synchronization and Baseband encoding

Synchronization

- Synchronization is the process of timing the serial transmission to properly identify the data being sent (receiver to interpret the incoming data correctly).
- Synchronization could be achieved in three levels: bit or clock level, byte or character level, block or frame level.
- Two commonly used protocols in achieving the synchronization are:
  - Asynchronous
  - Synchronous
- Some of the parameters used during serial communication are:
  - Bits-per-Character
  - Bits-per-Second
  - Baud Rate
  - Parity
  - Start, Stop, and Marked Bits

1.2.1 Asynchronous Serial Transmission

- In asynchronous serial transmission transmitted data is first grouped together into a sequence of bits (5~8 bits) and then each of these groups are encoded with start and end bits, specifying the beginning and end of each data group. When no bits are transmitted (idle), the line is maintained at high state (or negative).



Asynchronous Serial Transmission

- Asynchronous transmission is primarily used when the data to be transmitted are generated at random intervals.
- The COM ports operate in this mode (UART – Universal Async Receiver Transmitter).
- Asynchronous transmission is used for low bit rate (character based) communication.

1.2.2 Synchronous Serial Transmission

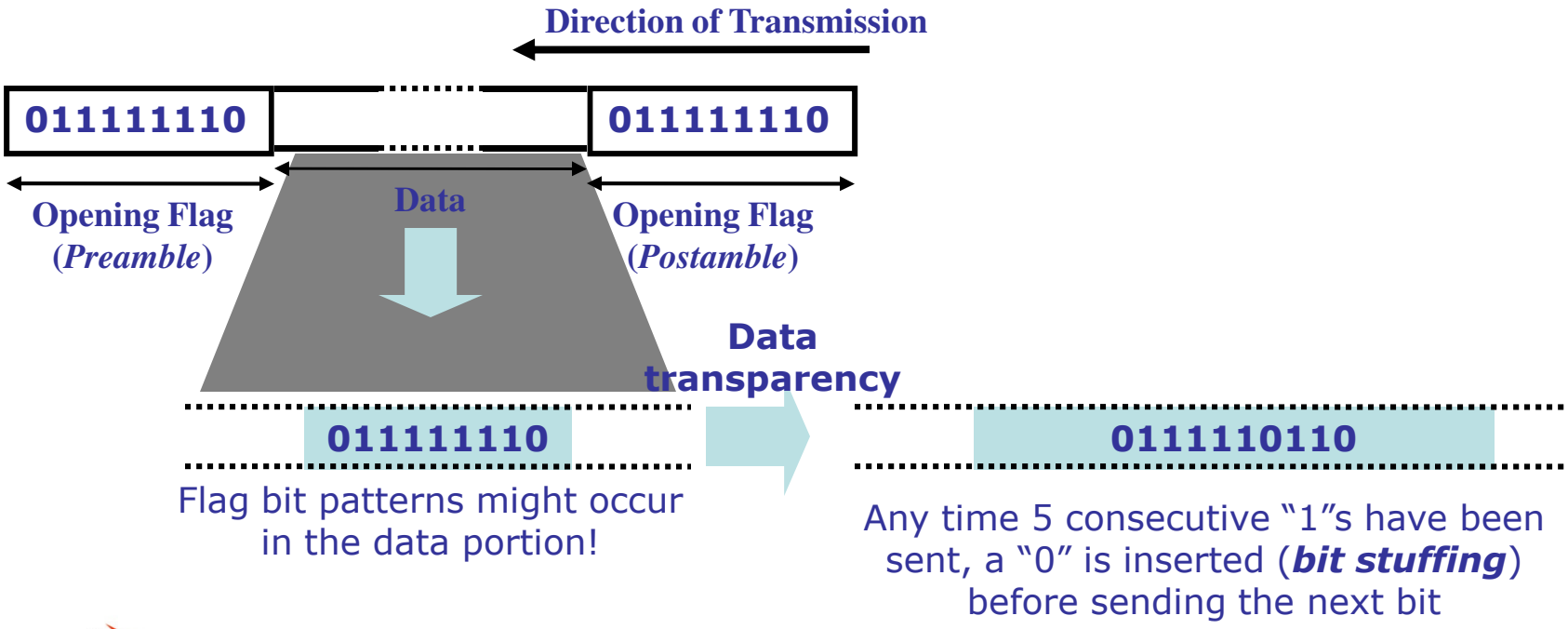
- In synchronous serial transmission, the line idle state is transformed in to a known character sequence (SYN), which is used to synchronize the receiver to the sender. No start or stop bits are used, instead a data packet is prefixed with a header, and suffixed with a trailer.
- Synchronous serial transmissions are used when large amounts of data must be transferred quickly from one location to other.
- The following are characterized to synchronous serial communication:
  - There are no gaps between data being transmitted.
  - Timing is supplied by the devices at each end of the connection
  - Synchronous idle character sequences (SYN) precede the data being transmitted and they provide the timing for synchronization.

Synchronous Serial Transmission Cont.

- Two categories of synchronous transmission:
  - Byte-oriented Synchronous Transmission
    - These protocols use ASCII characters, such as, SYN, SOH and ETX to control the transmission of data blocks.
  - Bit-oriented Synchronous Transmission
    - Data is transmitted as a steady stream of bits.
    - A special flag 01111110 is used to delimit each frame.

Bit-Oriented Synchronous Transmission

- Bit-oriented protocols:
  - SDLC – Synchronous Data Link Protocol (IBM)
  - HDLC – High-level Data Link Protocol (OSI)
  - PPP



1.2.3 Encoding

- Both analog and digital information can be encoded as either analog or digital signals. The particular encoding that is chosen depends on the specific requirements to be met and the media and communications facilities available.

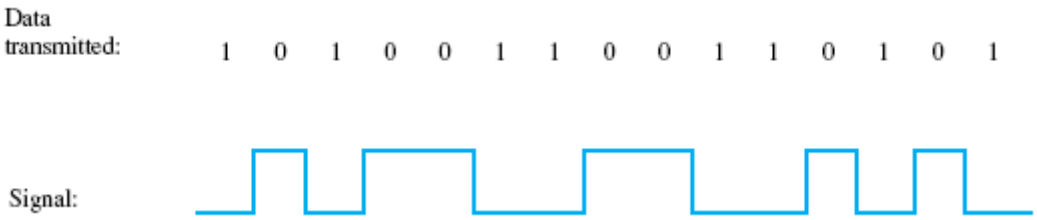
- the four possible combinations are

  - ✓ **Digital data, digital signal**
  - ✓ **Analog data, digital signal**
  - ✓ **Digital data, analog signal**
  - ✓ **Analog data, analog signal**

Encoding cont.

Digital data, digital signal

The simplest form of digital encoding of digital data is to assign one voltage level to binary one and another to binary zero. More complex encoding schemes are used to improve performance, by altering the spectrum of the signal and providing synchronization capability.



Encoding cont.

Digital data, analog signal

A modem converts digital data to an analog signal so that it can be transmitted over an analog line. The basic techniques are amplitude shift keying (ASK), frequency shift keying (FSK), and phase shift keying (PSK). All involve altering one or more characteristics of a carrier frequency to represent binary data.

Analog data, digital signals

Analog data (voice, video), are often digitized to be able to use digital transmission facilities. The simplest technique is **pulse code modulation** (PCM), which involves sampling the analog data periodically and quantizing the samples.

Encoding cont.

Analog data, analog signals:

Analog data are modulated by a carrier frequency to produce an analog signal in a different frequency band, which can be utilized on an analog transmission system. The basic techniques are amplitude modulation (AM), frequency modulation (FM), and phase modulation (PM).

Encoding cont.

Definition of Digital Signal Encoding Formats

Nonreturn to Zero-Level (NRZ-L)

0 = high level

1 = low level

Nonreturn to Zero Inverted (NRZI)

0 = no transition at beginning of interval (one bit time)

1 = transition at beginning of interval

Bipolar-AMI

0 = no line signal

1 = positive or negative level, alternating for successive ones

Pseudoternary

0 = positive or negative level, alternating for successive zeros

1 = no line signal

Manchester

0 = transition from high to low in middle of interval

1 = transition from low to high in middle of interval

Differential Manchester

Always a transition in middle of interval

0 = transition at beginning of interval

1 = no transition at beginning of interval

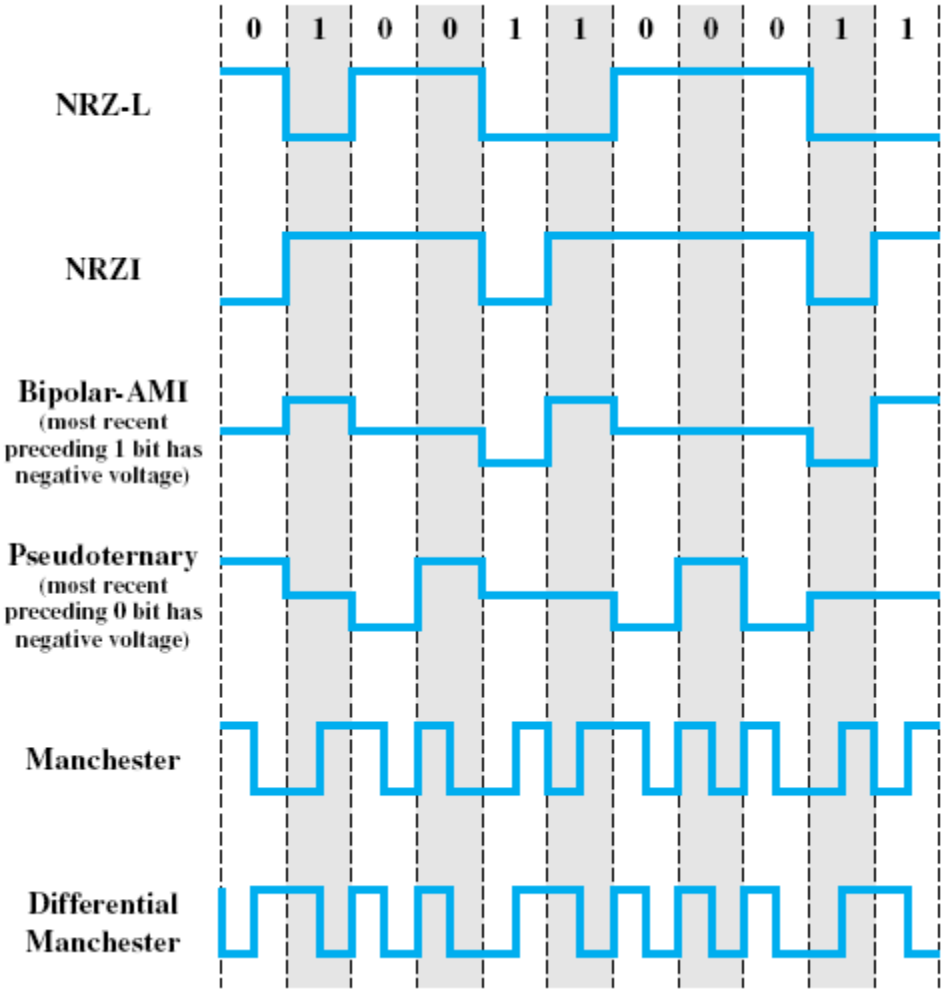
B8ZS

Same as bipolar AMI, except that any string of eight zeros is replaced by a string with two code violations

HDB3

Same as bipolar AMI, except that any string of four zeros is replaced by a string with one code violation

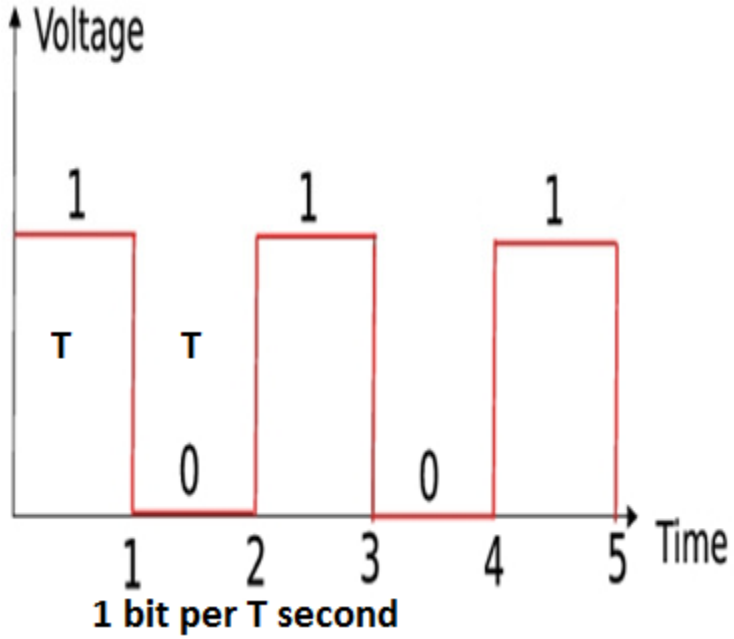
Encoding cont.



Binary Encoding – NRZ

NRZ - non-return to zero

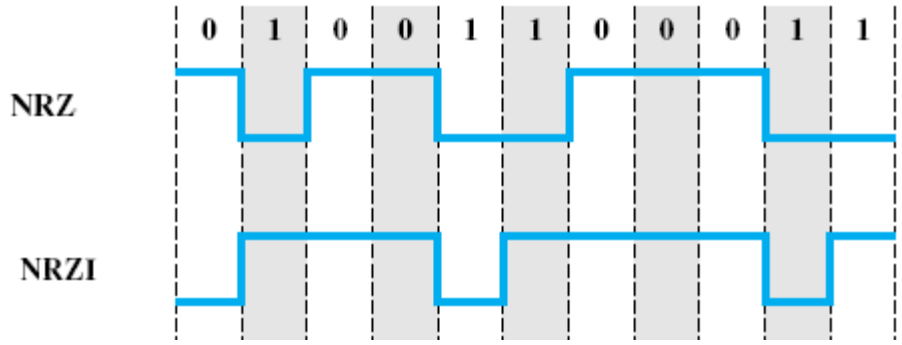
- The most common and easiest way to transmit digital signals is to use two different voltage levels for the two binary digits.
- Voltage level is constant during bit interval
  - There is no transition – non-return to zero



Binary Encoding – NRZI

NRZI – Non-Return-to-Zero Inverted

- A variation of NRZ is known as **NRZI (Non return to Zero, invert on ones).**As with NRZ, NRZI maintains a constant voltage pulse for the duration of a bit time. The data themselves are encoded as the presence or absence of a signal transition at the beginning of the bit time. A transition (low to high or high to low) at the beginning of a bit time denotes a binary 1 for that bit time; no transition indicates a binary 0.
- The popular **USB (Universal Serial Bus) standard for connecting** computer peripherals uses NRZI



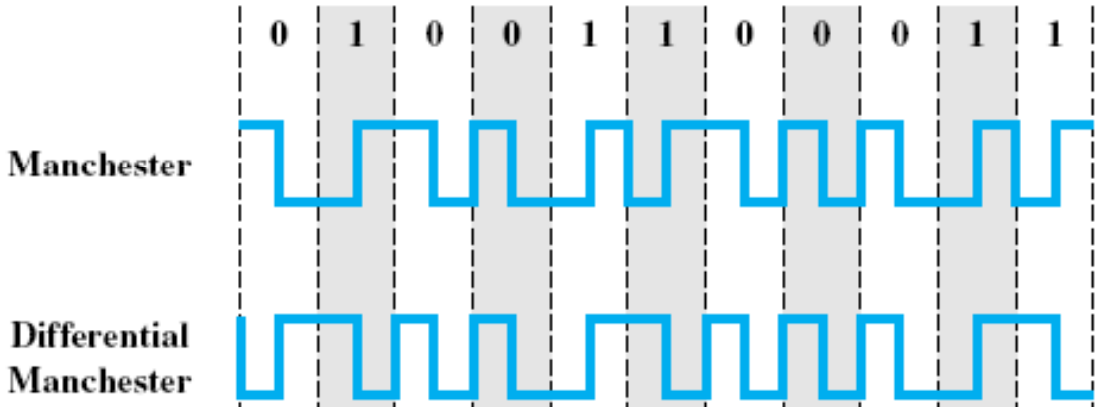
Manchester Encoding

Manchester and differential Manchester

- In the Manchester code, there is a transition at the middle of each bit period. The midbit transition serves as a clocking mechanism and also as data.
- a low-to-high transition represents a 1, and a high-to-low transition represents a 0.
- In differential Manchester, the midbit transition is used only to provide clocking. The encoding of a 0 is represented by the presence of a transition at the beginning of a bit period, and a 1 is represented by the absence of a transition at the beginning of a bit period. Differential Manchester has the added advantage of employing differential encoding.
- Used in Ethernet/802.3 networks.

Manchester Encoding

Manchester and differential Manchester



Data Encoding

Differential Manchester Encoding and Non-Return-To-Zero (NRZ)

- 0s & 1s are indicated by presence and absence of transition at the start of the interval
- Much better than Manchester encoding
- Used in Fast Ethernet (100Mbps) and Gigabit Ethernet (1000Mbps)