Ministry of Higher Education and Scientific Research

Al-Mustaqbal University

College Of Engineering & Technology

Computer Techniques Engineering Department

Computer Networks Fundamentals

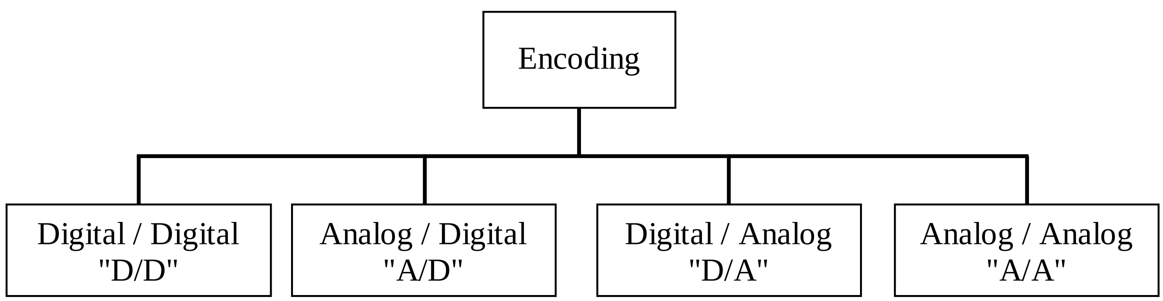
Lecture 10:

Encoding

10.1- <u>Encoding</u>

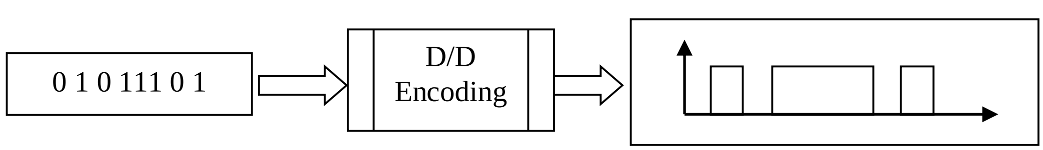
Information must be ***encoded*** into *signals* before it can be transported across communication media. Information is encoded depends on its original format and on the format used by the communication hardware.

A simple signal by itself dose not carry information any more than a straight line conveys words. The signal must be manipulated so that it contains identifiable changes that are recognizable to the sender and receiver as representing the information intended. Information can be of two types, digital or analog, and signals can be of two types, also digital or analog. Therefore, *four* types of encoding are possible as shown in the figure below.

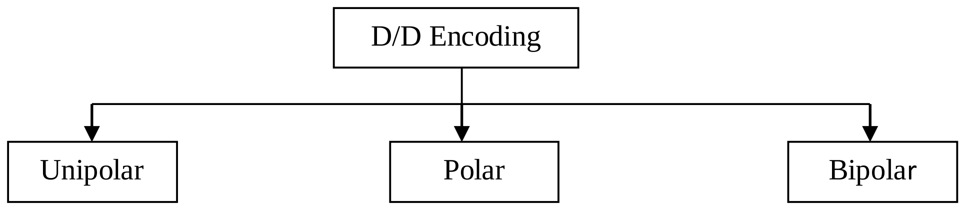


10.1.1- <u>Digital-to-Digital Encoding</u>

Digital-to-digital encoding is the representation of digital information by a digital signal. For example, in transmitting data from the computer to the printer, both the original data and the transmitted data are digital. The binary 1's and 0's generated by a computer are translated into a sequence of voltage pulses that can propagate over a wire as shown in following figure;

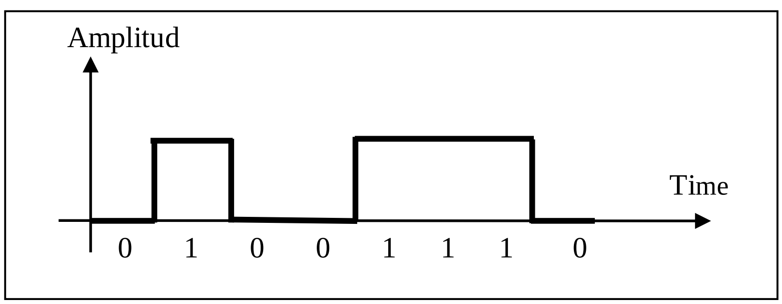


D/D encoding can be categorized into three main types as shown below:



(a)- <u>Unipolar</u>

Is a very simple and primitive. One voltage level stands for binary 0, and another level stands for binary 1. The polarity of a pulse refers to whether it is positive or negative. Only one of the two states is encoded, usually the 1. The other state (the 0) is represented by zero voltage or an idle line.



- **<u>Disadvantages of Unipolar</u>**

1- DC Component (Direct Current)

The average amplitude of the unipolar signal is non-zero that is it is a component with zero frequency. This makes it unable to travel through microwaves or transformers.

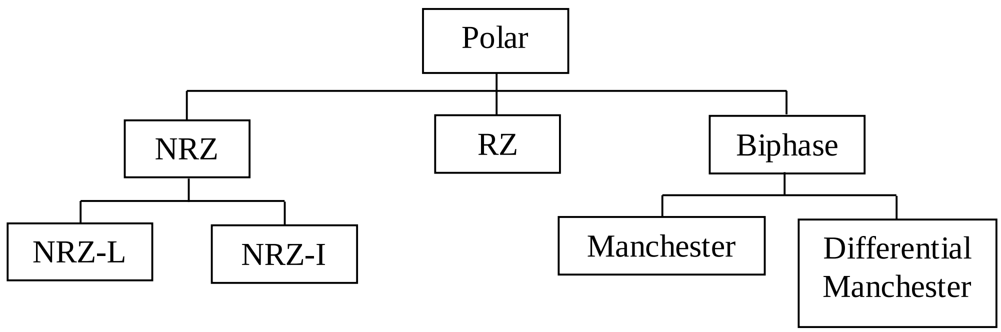
2- Synchronization

When the signal is unvarying, the receiver cannot determine the beginning and ending of each bit. Therefore, a Synchronization problem can occur wherever the data stream includes a long uninterrupted series of 1's or 0's.

وعندما تكون الإشارة غير متجانسة، لا يستطيع المستقبل تحديد بداية ونهاية كل بت. لذلك يمكن أن تحدث مشكلة التزامن حيثما يتضمن تدفق البيانات سلسلة طويلة دون انقطاع من 1 أو 0.

(b)- Polar

Uses two voltage levels, one positive and one negative of amplitudes this reduces the average level on the line and eliminates the DC component problem of unipolar. The most popular polar encoding types are shown in figure below:



- **Types of Polar**

I- Non-Return to Zero (NRZ)

In NRZ, the level of the signal is always either positive or negative. If the line is idle it means no transmission is occurring at all. The two most popular methods of NRZ are:

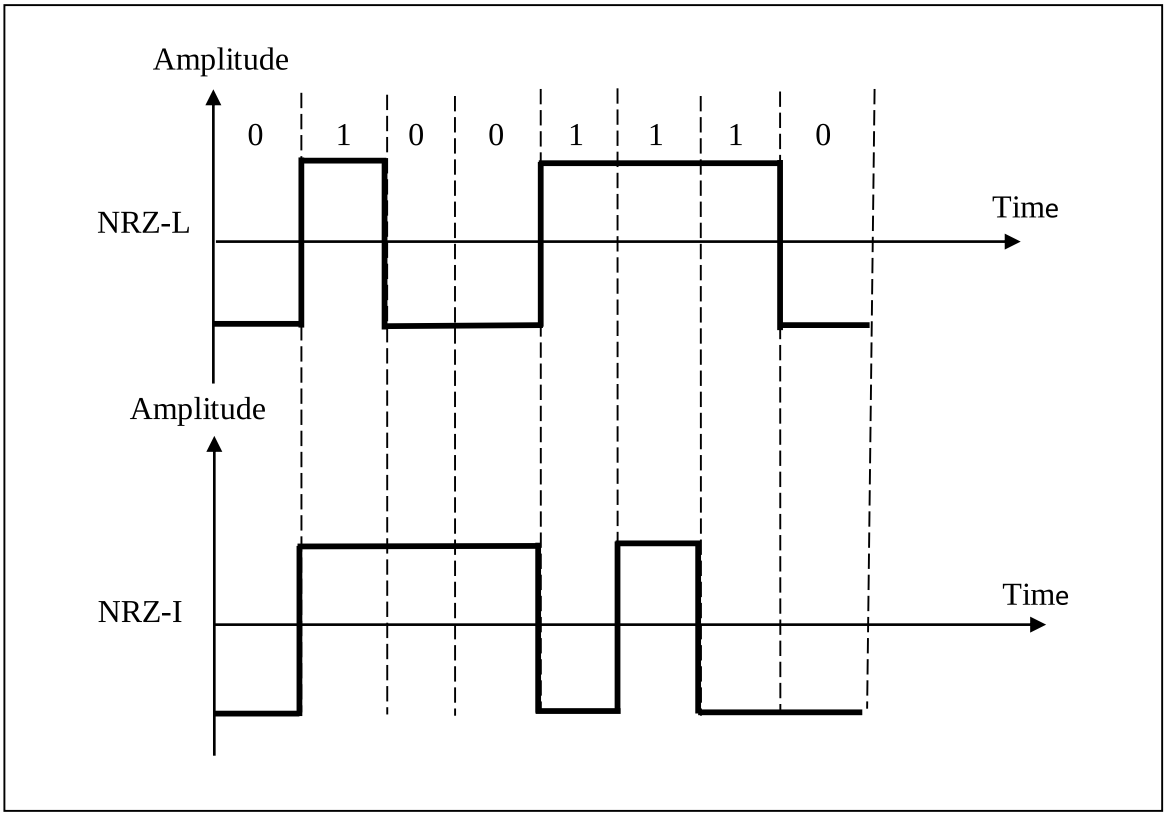
- **NRZ-L**

  The level of the signal is dependent upon the state of the bit (0 negative, 1 positive).

- **NRZ-I**

  The signal is inverted if a 1 is encountered (0 no change, 1 invert).

The *advantage* of NRZ-I over NRZ-L is that because the signal changes every time a 1 bit is encountered; it provides some synchronization. A string of 0's can still cause a problem of synchronization.



II- Return to Zero (RZ)

The RZ encoding uses three values: positive, negative, and zero to assure synchronization for both 0's and 1's. In RZ, the signal change not between bits but during each bit.

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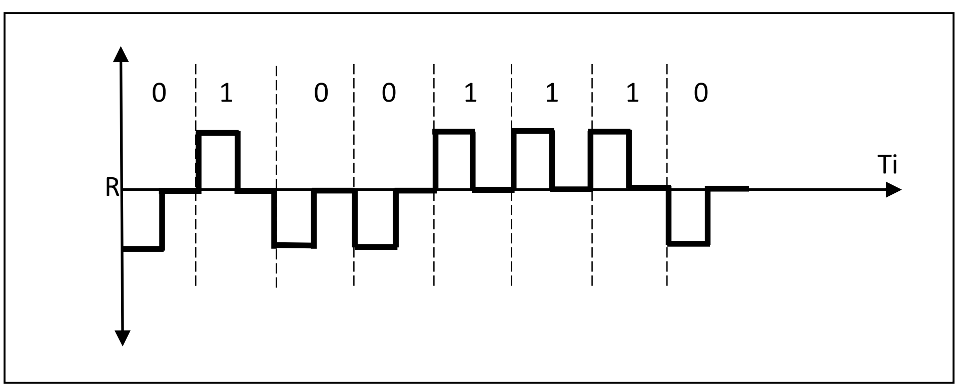


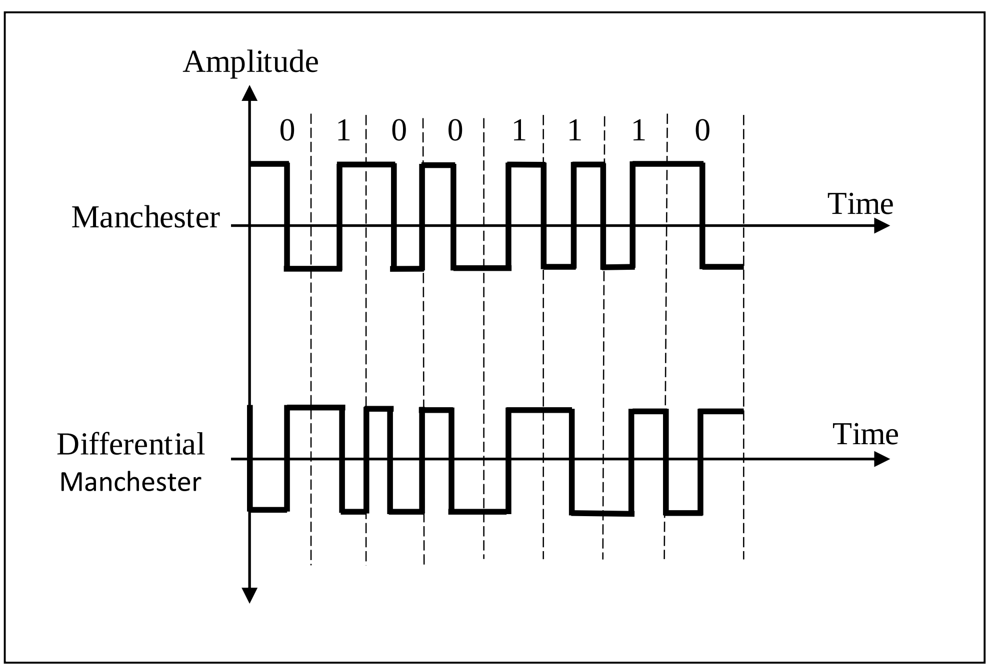
The main *disadvantage* of RZ encoding is that it requires two signal changes to encode one bit and therefore requires more bandwidth.

III- Biphase

Biphase is the best existing solution for the synchronization problem. The signal changes at the middle of the bit interval but dose not return to zero. Instead, it continues to the opposite pole. As in RZ these mid interval transitions allow for synchronization. There are two main types of biphase encoding, these are:

- **Manchester Biphase**
  Uses the inversion at the middle of each bit interval for both synchronization and bit representation. A *negative to positive* transition represents binary **1** and *positive to negative* transition represent binary **0**. By using a single transition for a dual purpose, Manchester achieves the same level of synchronization as RZ but with only two levels of amplitude.

- **Differential Manchester Biphase**
  The inversion at the middle of the bit interval is used for synchronization, but the present or absence of an additional transition at the beginning of the interval is used to identify the bit. A *transition* means binary **0** and *no transition* means binary **1**. Differential Manchester requires two signal changes to represent binary 0 and only one to represent binary 1.

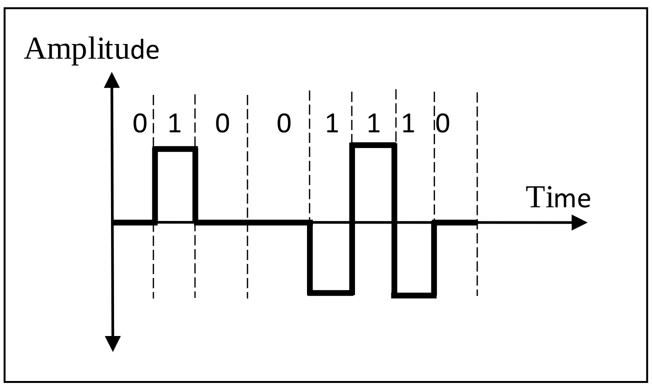


(c)- <u>Bipolar</u>

Bipolar encoding uses three voltage level (positive, negative, and zero). The zero level is to represent binary 0. Positive and negative voltages represent alternating 1's. If the first 1 bit is represented by the positive amplitude, the second will be represented by the negative amplitude, the third by positive, and so on. This alternation occurs even when the 1 bit are not consecutive.

Three types of bipolar encoding are in popular use: AMI, B8ZS, and H0B3.

The AMI is the simplest type of bipolar. In AMI, zero voltage represents binary 0. Binary 1's are represented by alternative positive and negative voltages as shown below.



The other bipolar types have been developed to solve the problem of synchronizing sequential 0's.