Ministry of Higher Education and Scientific Research

Al-Mustaqbal University

College Of Engineering & Technology

Computer Techniques Engineering Department

Computer Networks Fundamentals

Lecture 9:

Signals & Encoding Transmission Media

Signals & Encoding

Transmission Media

((PHYSICAL LAYER))

9.1- <u>Signals</u>

Information can be in the form of data, voice, and picture, and so on. Generally, the information usable to a person or application is not in a form that can be transmitted over a network. For example, you cannot roll up a photograph, insert it into a wire, and transmit it across town. You can transmit however, an encoded description of the photograph. Instead of sending the actual photograph, you can use an ***encoder*** to create a stream of 1's and 0's that tells the receiving device how to reconstruct the image of the photograph. But even 1's and 0's cannot be sent as such across network links. They must be further converted into a form that transmission media can accept. Transmission media work by conducting energy along a physical path.

A major concern of the physical layer is moving information in the form of electromagnetic *signals* across a transmission medium by turning the data stream of 1's and 0's into energy in the form of electromagnetic signals.

9.2- <u>Analogue and Digital</u>

Both *data* and the *signals* that represent them can take either *analogue or digital* form. Analogue refers to something that is *continuous*, while digital refers to something that is *discrete*.

Both analogue and digital signals can be of two forms: *periodic and a periodic* (non periodic).

9.2.1- Analogue Signals

The sine wave is the most fundamental form of a periodic analogue signal as Visualized as simple oscillating curve, its change over the course of a cycle is smooth and consistent, Sine waves can be fully described by three characteristics: *amplitude, period or frequency, and phase.*

Amplitude refers to the height of the signal.

Period is the amount of time it takes a signal to complete one cycle; *frequency is the* number of cycles per second. Frequency and period are inverses of each other: $f = 1/T$ and $T = I / f$.

Phase describes the position of the waveform relative to time zero.

9.2.2- Digital Signals

In addition to being represented by an analog signal, data can also be represented by digital signal. For example, a 1 can be encoded as a positive voltage and a 0 as a zero voltage. The three characteristics of periodic analog signals (amplitude, period, and phase) can be redefined for a periodic digital signal.

A digital signal can have more than two levels. In this case, we can send more than 1 bit for each level.

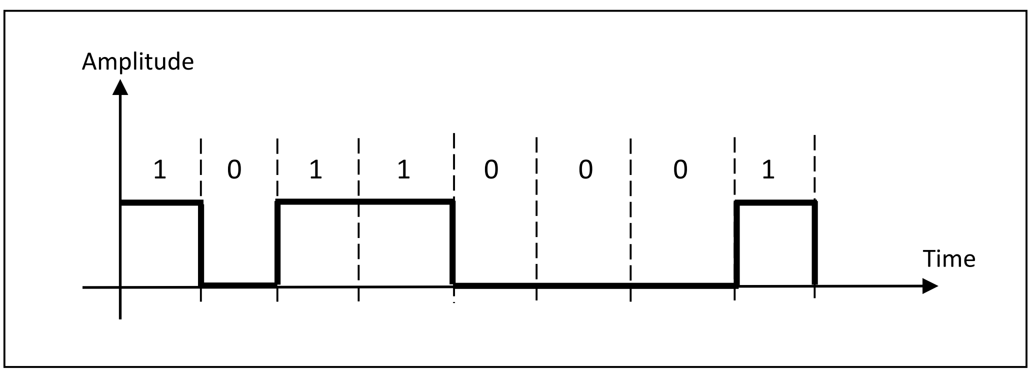


Figure (3.1): An example on digital signal

Example 1

A digital signal has eight levels. How many bits are needed per level?

We calculate the number of bits from the formul

a

Number of bits per level =log2 8 =3

Each signal level is represented by 3 bits.

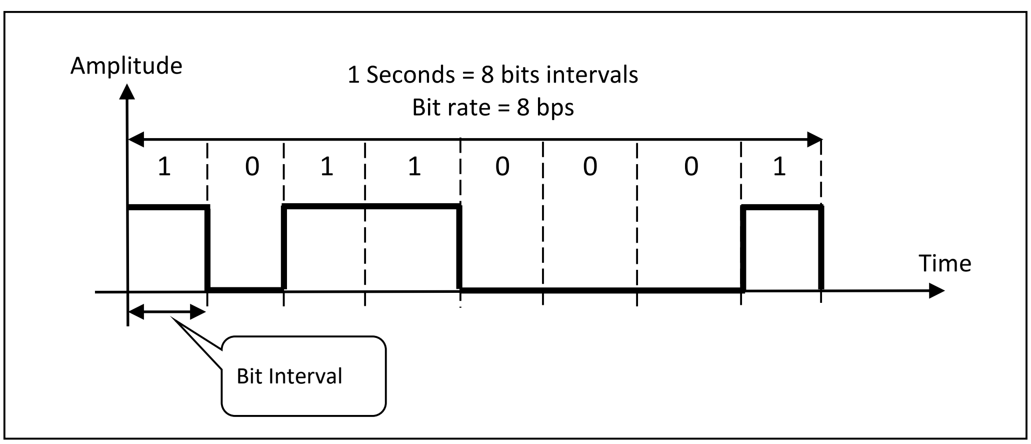
Example 2

A digital signal has nine levels. How many bits are needed per level?

We calculate the number of bits by using the formula. Each signal level is represented by 3.17 bits. However, this answer is not realistic. The number of bits sent per level needs to be an integer as well as a power of 2. For this example, 4 bits can represent each level.

3.3 Bit-Interval and Bit-Rate

Most digital signals are aperiodic and thus period or frequency is not appropriate. Two new terms, ***bit intervals*** (instead of period) and ***bit rate*** (instead of frequency) are used to describe digital signals. The bit interval is the time required to send one single bit. The bit rate is the number of bit intervals per second. This means that the bit rate is the number of bits sent in one second, usually expressed in bps (bits per second).



Example 3

Assume we need to download text documents at the rate of 100 pages per minute. What is the required bit rate of the channel? assume each page has 24 lines each line 80 byte.

Solution

If we assume that one character requires 8 bits

The bit rate is

100 x 24 x 80 x 8 =1,536,000 bps =1.536 Mbps