Lecture Notes for Data Communications for CCA

Unit 1-Introduction to Data Communication

Introduction to Data Communication

- When we communicate, we are sharing information. This sharing can be local or remote.
- Data communication is a technology which is used to transfer data from a sender machine to receiver machine.
- The message can have text, images, audio, video etc.
- These data are encoded in to the electromagnetic signals for transmission over a physical medium.
- The effectiveness of a data communications system depends on following four fundamental characteristics:

  - **Delivery:** The system must deliver data to the correct destination. Data must be received by the intended device or user and only by that device or user.
  - **Accuracy:** The system must deliver the data accurately. Data that have been altered in transmission and left uncorrected are unusable.
  - **Timeliness:** The system must deliver data in a timely manner. Data delivered late are useless. In the case of video and audio, timely delivery means delivering data as they are produced, in the same order that they are produced, and without significant delay. This kind of delivery is called real-time transmission.
  - **Jitter:** Jitter refers to the variation in the packet arrival time. It is the uneven delay in the delivery of audio or video packets.

Components of Data Communication System (DCS)

- The purpose of a DCS is to transmit intelligence signal from a source to a destination.
- Following Figure is a block diagram of a communication system. This system consists three basic components: transmitter, channel, and receiver.

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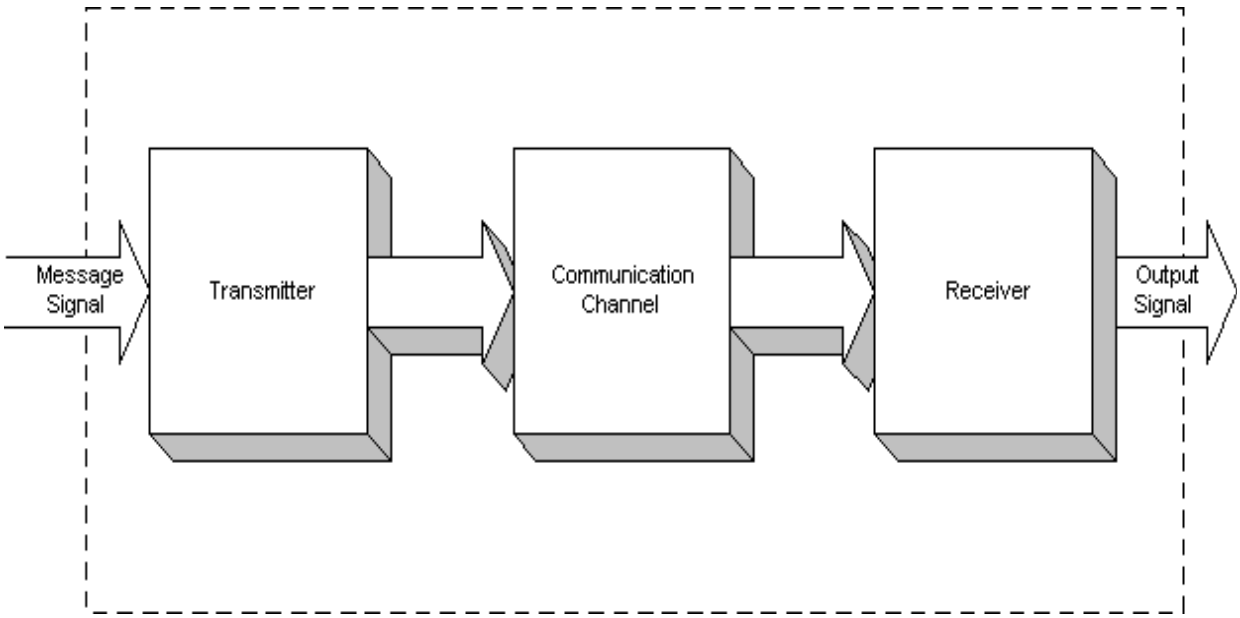
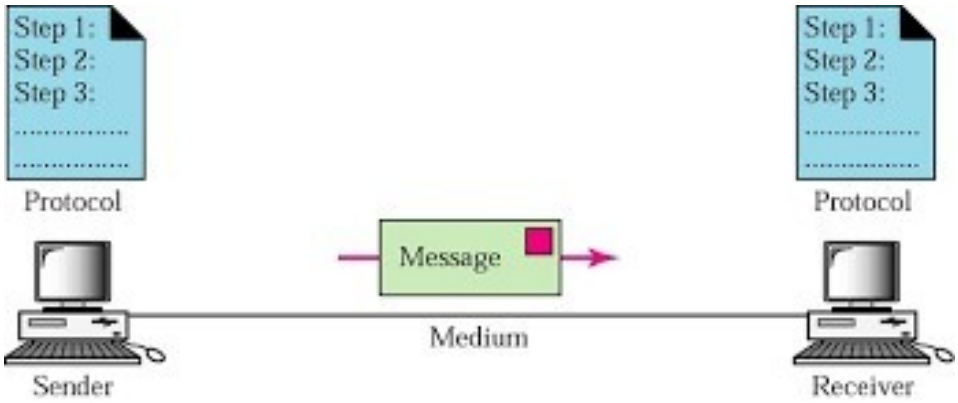


- The transmitter's function is to process the message signal into a form suitable for transmission over the communication channel. This is called modulation.
- As for the communication channel, its function is to provide a pathway between the transmitter's output and the receiver's input.
- The job of the receiver is to process the received signal to recover the appropriate message signal.
- There are two methods in transmitting an intelligent message signal over the communication channel. The two methods are analog or digital.
- These methods have their advantages and disadvantages. For the digital method, is advantages include the following:
  - Increased immunity to noise in the channel and outside interference which are impossible to prevent in the communication channel.
  - Offer flexible operation of the system due to the technologies in digital system.
  - Different types of message signals as voice data, video data, or computer data can be implemented in the same format by the transmitter.
  - Message signals can be encrypted to provide security for sensitive data.

- The disadvantages of the digital method are that the communication system are very complex and can be costly for communication channel such as satellite channels and optical fibers.
- Analog has two very good benefits.
    - The first is that the communication system of analog method is very simple.
    - The second benefit of analog method is that it is not very expensive because the use of simple technology.
- Before we can send a message signal over the communication channel, we need to modify the message signal into a form that is suitable for transmission over a channel. We called this process of modifying message signal as modulation.
- This modulation process involves changing some parameters of a carrier wave in accordance with the message signal so the resultant wave will match the communication channel's bandwidth.
- In order to recover the message signal, the receiver of the communication system will have to go through the demodulation process, which is the inverse of the modulation process.
- One may wonder why a message signal must be modified for transmission. Following are the reasons for it:
    - First reason is to change the message signal to match the channel's bandwidth.
    - Second reason is that modulation permits multiplexing. Multiplexing means that different message signals can be transmitted in the same channel at the same time.
    - Third reason for modulation is to convert the message signal to be immune to noise and interference. This will allow a good transmission to take place without worrying much about noise.

- The modulation process involves encoding the message signal in a carrier wave. This carrier wave is just a sinusoidal wave.
- This carrier wave or sinusoidal wave has three independent parameters that can be varied with the message signal. These three parameters are amplitude, phase, and frequency.
- The variation of the amplitude is known as amplitude modulation (AM).
- Frequency modulation (FM) is to change the frequency accordingly with the message signal and the carrier wave.
- The last form of modulation is phase modulation. It is done by change the phase of the carrier wave according to the message signal.
- A data communications system has five components:



Message: The message is the information (data) to be communicated. Popular forms of information include text, numbers, pictures, audio, and video.

- **Sender:** The sender is the device that sends the data message. It can be a computer, workstation, telephone handset, video camera, and so on.
- **Receiver:** The receiver is the device that receives the message. It can be a computer, workstation, telephone handset, television, and so on.
- **Transmission medium:** The transmission medium is the physical path by which a message travels from sender to receiver. Some examples of transmission media include twisted-pair wire, coaxial cable, fiber-optic cable, and radio waves
- **Protocol:** A protocol is a set of rules that govern data communications.

It represents an agreement between the communicating devices. Without a protocol, two devices may be connected but not communicating, just as a person speaking French cannot be understood by a person who speaks only Japanese.

Representation of Message in DCS

Message can be consisting the text, numbers, images, audio and video.

Text Representation:

- Text is represented as a bit pattern, a sequence of bits 0's & 1's.
- Different sets of bit patterns have been designed to represent text symbols.
- Each set is called a code, and the process of representing symbols is called coding.
- Today, the prevalent coding system is called Unicode, which uses 32 bits to represent a symbol or character used in any language in the world.
- The American Standard Code for Information Interchange (ASCII), now constitutes the first 127 characters in Unicode and is also referred to as Basic Latin.

Number Representation:

- Numbers are also represented by bit patterns.
- ASCII is not used to represent numbers.
- The number is directly converted to a binary number to simplify mathematical operations.

Representation of Images:

- Images are also represented by bit patterns.
- In its simplest form, an image is composed of a matrix of pixels (picture elements), where each pixel is a small dot.
- The size of the pixel depends on the resolution.
- In the second case, there is a better representation of the image (better resolution), but more memory is needed to store such image.
- After an image is divided into pixels, each pixel is assigned a bit pattern.

- The size and the value of the pattern depend on the image.
- For an image made of only black-and-white dots, a I-bit pattern is enough to represent a pixel.
- If an image is not made of pure white and pure black pixels, you can increase the size of the bit pattern to include gray scale. For example, to show four levels of gray scale, you can use 2-bit patterns. A black pixel can be represented by 00, a dark gray pixel by 01, a light gray pixel by 10, and a white pixel by 11.
  - There are several methods to represent color images. One method is called RGB, so called because each color is made of a combination of three primary colors: red, green, and blue.
- The intensity of each color is measured, and a bit pattern is assigned to it.
- Another method is called YCM, in which a color is made of a combination of three other primary colors: yellow, cyan, and magenta.

Audio Representation:

- Audio refers to the recording or broadcasting of sound or music.
- Audio is different from text, numbers, or images.
- It is continuous, not discrete. Even when we use a microphone to change voice or music to an electric signal, we create a continuous signal.

Video Representation:

- Video refers to the recording or broadcasting of a picture or movie.
- Video can either be produced as a continuous entity (e.g., by a TV camera), or it can be a combination of images, each a discrete entity, arranged to convey the idea of motion.

Modes of data communication used in DCS

Communication between two devices can be simplex, half-duplex, or full-duplex as shown in following figure

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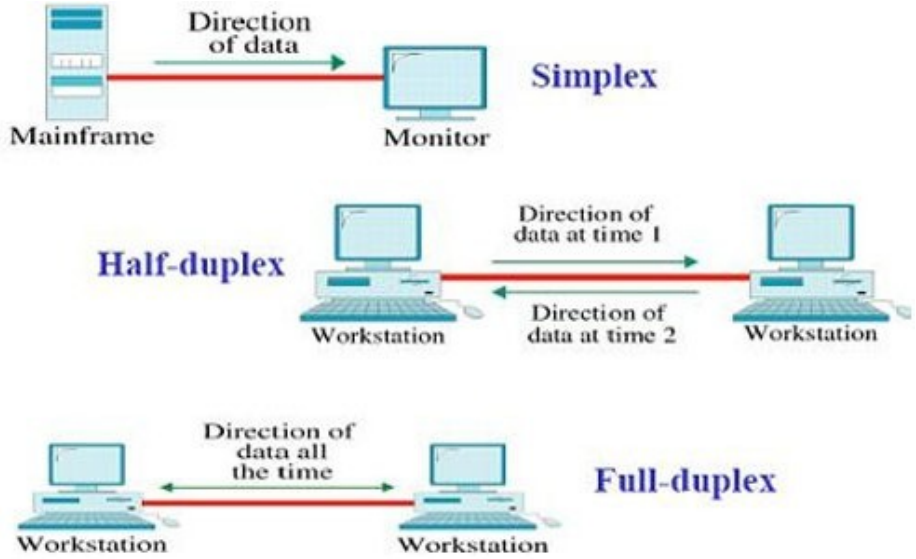

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2. http://www-ee.eng.hawaii.edu/~sasaki/Undergrad/WaveCalc/ZeLi/elements.html