PART B: Claude Shannon's Model

✓ Claude Shannon's Principals

Claude Shannon is an American mathematical engineer, whose work on technical and engineering problems within the communications industry, laying the groundwork for both the computer industry and telecommunications. Shannon put the basic concepts of information theory and in particular those are relating to finding efficient communication systems. He defined exactly what does information means, he put mathematical equations by which to determine the amount of information that can be transmitted over communication channels. Shannon also, noticed the similarity between Boolean algebra and the telephone switching circuits, he worked on the problem of most efficiently transmitting information. The fundamental unit of information is a yes-no situation. Either something is or is not. This can be easily expressed in Boolean two-value binary algebra by 1 and 0, so that 1 means "on" when the switch is closed and the power is on, and 0 means "off" when the switch is open and power is off. Under these circumstances, 1 and 0 are binary digits, a phrase that can be shortened to "bits." Thus the unit of information is the bit. Understanding Shannon's mathematical equations represents the basic principles of information theory. These concepts are:

1. Words are symbols used to carry information between humans
2. All telecommunication require three steps are:
    a) The message encoding Source.
    b) Message transfer through the channel of communication.
    c) Decoding the message encoded at the target.
3. There is a difference between the symbols rate of the communication channel specified in the design and the real capacity of the information.

The communication system described by Claude Shannon is:

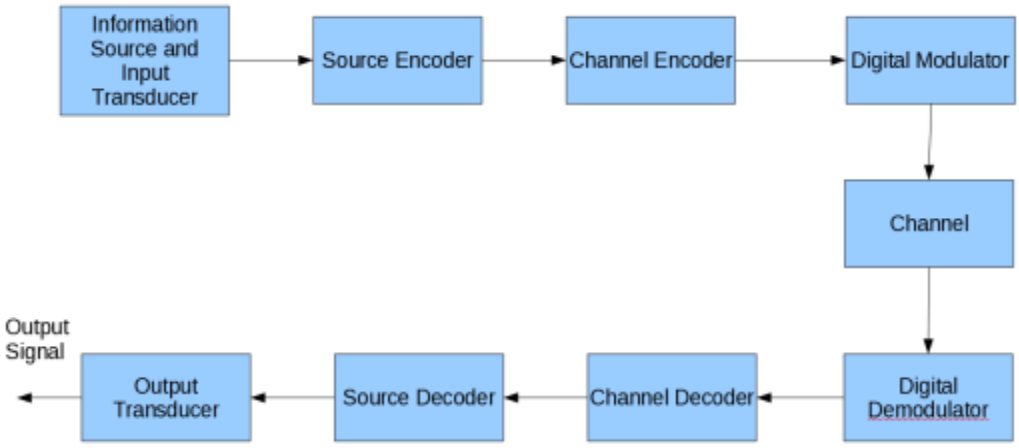
Source – Encoder – Channel – Decoder – Destination

✓ The Digital Communications Model

The digital communication system consists of main elements as in the figure below, where it gives a basic understanding of communication system. We will discuss these basic elements.

1. **Information Source and Input Transducer:**
   The source of information can be analog or digital, e.g. analog: audio or video signal, digital: like teletype signal. In digital communication the signal produced by this source is converted into digital signal consists of 1's and 0's. For this we need source encoder.

2. **Source Encoder**
   In digital communication we convert the signal from source into digital signal as mentioned above. The point to remember is we should like to use as few binary digits as possible to represent the signal. In such a way this efficient representation of the source output results in little or no redundancy. This sequence of binary digits is called **information sequence.** Source Encoding or Data Compression: *the process of efficiently converting the output of wither analog or digital source into a sequence of binary digits is known as source encoding*.
3. **Channel Encoder:**
   The information sequence is passed through the channel encoder. The purpose of the channel encoder *is to introduced,* in controlled manner, *some redundancy in the binary information sequence that can be used at the receiver to overcome the effects of noise and interference encountered in the transmission on the signal through the channel.* e.g. take k bits of the information sequence and map that k bits to unique n bit sequence called code word. The amount of redundancy introduced is measured by the ratio k/n and the reversal of this ratio (k/n) is known as rate of code or code rate.
4. **Digital Modulator:**
   The binary sequence is passed to digital modulator which in turns convert the sequence into electric signals so that we can transmit them on channel (we will see channel later). The digital modulator maps the binary sequences into signal wave forms, for example if we represent 1 by sin x and 0 by cos x then we will transmit sin x for 1 and cos x for 0.
5. **Channel:**
   The communication channel *is the physical medium that is used for transmitting signals from transmitter to receiver*. In wireless system, this channel consists of atmosphere, for traditional telephony, this channel is wired. There are optical channels, under water acoustic channels (connected with the sound) etc.
6. **Digital Demodulator:**
   The digital demodulator *processes the channel corrupted transmitted waveform and reduces the waveform to the sequence of numbers that represents estimates of the transmitted data symbols.*
7. **Channel Decoder:**
   This sequence of numbers then passed through the channel decoder which attempts to reconstruct the original information sequence from the knowledge of the code used by the channel encoder and the redundancy contained in the received data. The average probability of a bit error at the output of the decoder is a measure of the performance of the demodulator – decoder combination. THIS IS THE MOST IMPORTANT POINT.
8. **Source Decoder**
   At the end, if an analog signal is desired then source decoder tries to decode the sequence from the knowledge of the encoding algorithm. And which results in the approximate replica of the input at the transmitter end
9. **Output Transducer:**
   Finally we get the desired signal in desired format analog or digital.



Basic elements of Digital Communication System

The points worth noting are:

- The source coding algorithm plays important role in higher code rate
- The channel encoder introduced redundancy in data
- The modulation scheme plays important role in deciding the data rate and immunity of signal towards the errors introduced by the channel
- Channel introduced many types of errors like multipath errors due to thermal noise etc.
- The demodulator and decoder should provide high BER (Bit Error Rate).

The aim of any communication system is to make the system capable of sending and receiving the message without errors but as we know it is impossible because there is probability of a bit error or any noise can occur through the transmission. The types of noise affect the performance of communication systems, so all communication systems have a permissible level of errors.