DEPARTMENT OF ELECTRICAL ENGINEERING

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# Unit 2

# Electrical Communication Systems

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## 1 ELEMENTS OF AN ELECTRICAL COMMUNICATION SYSTEM

Electrical communication systems are designed to send messages or information from a source that generates the messages to one or more destinations.

An essential feature of any source that generates information is that its output is described in probabilistic terms, i.e., the output of a source is not deterministic. Otherwise, there would be no need to transmit the message.

A transducer is usually required to convert the output of a source into an electrical signal that is suitable for transmission. For example, a microphone serves as the transducer that

converts an acoustic speech signal into an electrical signal, and a video camera converts an image into an electrical signal.

At the destination, a similar transducer is required to convert the electrical signals that are received into a form that is suitable for the user, e.g., acoustic signals, images, etc.

The heart of the communication system consists of three basic parts, namely, the transmitter, the channel, and the receiver. The functions performed by these three elements are described next.

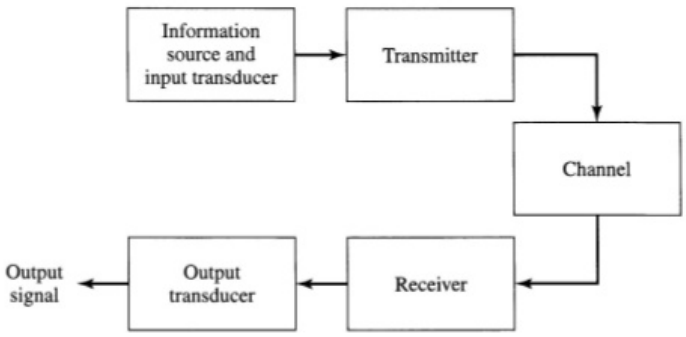


Figure 1.1: Functional diagram of a communication system

## 1.1 The Transmitter

The transmitter converts the electrical signal into a form that is suitable for transmission through the physical channel or transmission medium. For example, in radio and TV broadcast, the Federal Communications Commission (FCC) specifies the frequency range for each transmitting station.

The transmitter must translate the outgoing information signal into the appropriate frequency range that matches the frequency allocation assigned to the transmitter. Thus, signals transmitted by multiple radio stations do not interfere with one another.

In general, the transmitter matches the message signal to the channel via a process called modulation. Usually, modulation involves the use of the information signal to systematically vary either the amplitude or the frequency or the phase of a sinusoidal carrier.

In addition to modulation, other functions that are usually performed at the transmitter are filtering of the information-bearing signal, amplification of the modulated signal and, in the case of wireless transmission, radiation of the signal by means of a transmitting antenna.

## 1.2 The Channel

The communications channel is the physical medium that is used to send the signal from the transmitter to the receiver.

In wireless transmission, the channel is usually the atmosphere (free space). On the other hand, telephone channels usually employ a variety of physical media, including wirelines, fiber optic cables, and wireless (microwave radio).

Whatever the physical medium for signal transmission, the essential feature is that the transmitted signal is corrupted in a random manner by a variety of possible mechanisms. The most common form of signal degradation comes in the form of additive noise, which is generated at the front end of the receiver, where signal amplification is performed. This noise is often called thermal noise.

Interference from other users of the channel is another form of additive noise that often arises in both wireless and wireline communication systems.

Both additive and non-additive signal distortions are usually characterized as random phenomena and described in statistical terms. The effect of these signal distortions must be considered in the design of the communication system.

In the design of a communication system, the system designer works with mathematical models that statistically characterize the signal distortion encountered on physical channels.

On the other hand, in some communication system designs, the statistical characteristics of the channel may vary significantly with time. In such cases, the system designer may design a communication system that is robust to the variety of signal distortions.

## 1.3 The Receiver

The function of the receiver is to recover the message signal contained in the received signal.

If the message signal is transmitted by carrier modulation, the receiver performs carrier demodulation to extract the message from the sinusoidal carrier.

Since the signal demodulation is performed in the presence of additive noise and possibly other signal distortions, the demodulated message signal is generally degraded to some extent by the presence of these distortions in the received signal.

Besides performing the primary function of signal demodulation, the receiver also performs a number of peripheral functions, including signal filtering and noise suppression.