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What Does Communication (or Telecommunication) Mean?

The term communication (or telecommunication) means the transfer of some form of information from one place (known as the source of information) to another place (known as the destination of information) using some system to do this function (known as a communication system).
*What is the difference between communication and communication**s**!*

Importance of Communications (by electrical signals)

Teleconferencing, teleshopping, telebanking, internet, computer networks, mobile,...etc

So What Will we Study in This Course?

In this course, we will study the basic methods that are used for communication in today's world and the different systems that implement these communication methods. Upon the successful completion of this course, you should be able to identify the different communication techniques, know the advantages and disadvantages of each technique, and show the basic construction of the systems that implement these communication techniques. *(Check the syllabus for course description, outcomes and objectives)*

Examples of Today's Communication Methods

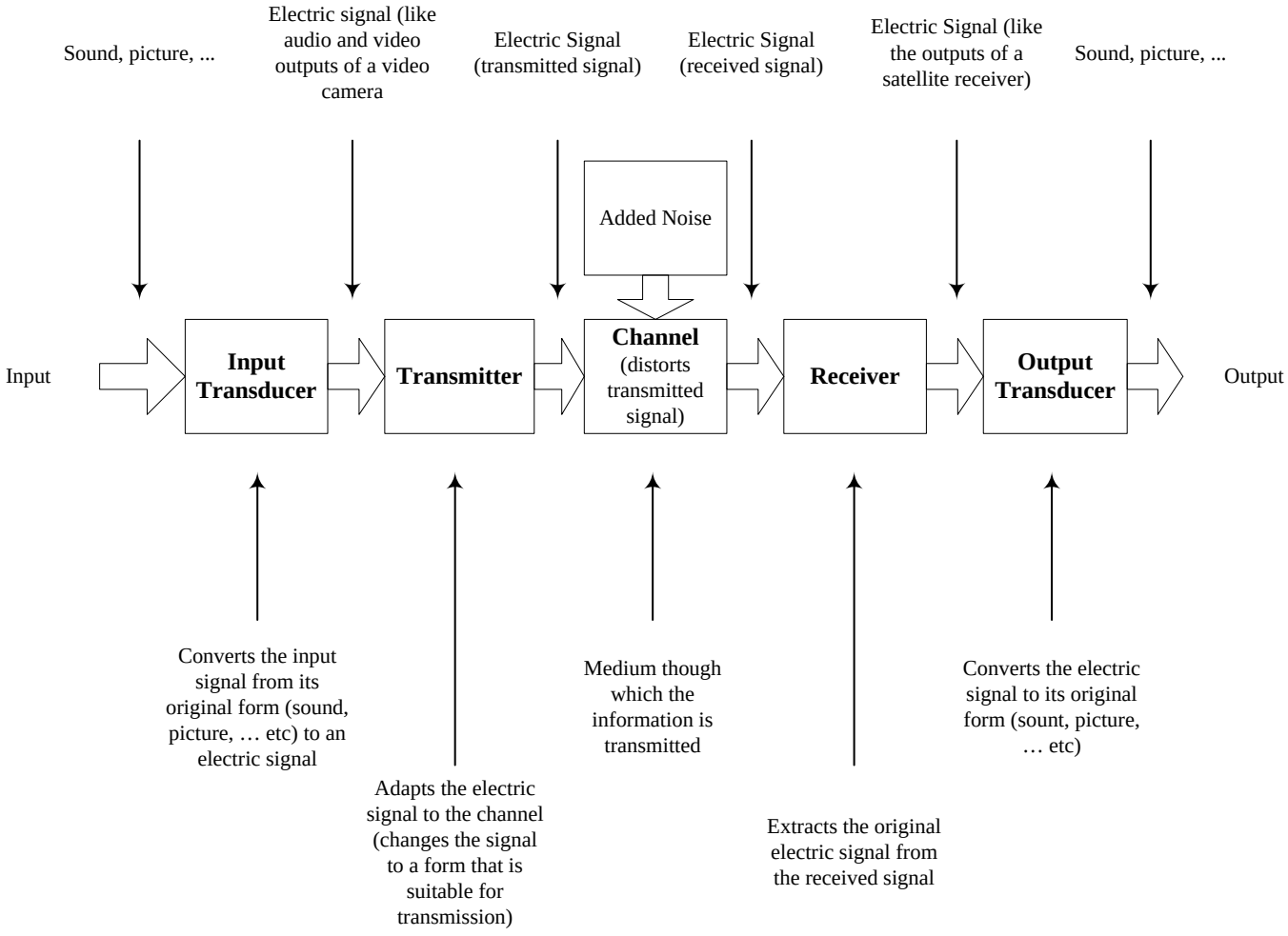
All of the following are electric (or electromagnetic) communication systems

- Satellite (Telephone, TV, Radio, Internet, …)
- Microwave (Telephone, TV, Data, …)
- Optical Fibers (TV, Internet, Telephone, …)
- Copper Cables (telephone lines, coaxial cables, twisted pairs, … etc)

Simplex vs. Duplex Communications

A communication system may transmit information in one direction such as TV and radio (simplex), two directions but at different times such as the CB (half-duplex), or two directions simultaneously such as the telephone (full-duplex).

Basic Construction of Electrical Communication System



What does the channel do?

- **Distortion** (Linear vs. nonlinear, distortion vs. distortionless channels) corrected by equalizers.
- **Noise** (unwanted, unpredictable): is an undesired signal that gets added to (or sometimes multiplied with) a desired transmitted signal at the receiver. The source of noise may be external to the communication system or internal to the communication system.
    - **External:** noise resulting from electric machines, other communication systems, noise from outer space ,lightning, automobile ignition➔ can be reduced or eliminated.
    - **Internal:** caused by thermal motion of electrons in the conductors➔ can be reduced but not eliminated.

Basic Terminology Used in Communications Systems

A Signal: is a function that specifies how a specific variable changes versus an independent variable such as time, location, height (examples: the age of people versus their coordinates on Earth, the amount of money in your bank account versus time).

A System: operates on an input signal in a predefined way to generate an output signal.

Analog Signals: are signals with amplitudes that may take any real value out of an infinite number of values in a specific range (examples: the height of mercury in a 10cm–long thermometer over a period of time is a function of time that may take any value between 0 and 10cm, the weight of people setting in a class room is a function of space (x and y coordinates) that may take any real value between 30 kg to 200 kg (typically)).

Digital Signals: are signals with amplitudes that may take only a specific number of values (number of possible values is less than infinite) (examples: the number of days in a year versus the year is a function that takes one of two values of 365 or 366 days, number of people sitting on a one-person chair at any instant of time is either 0 or 1, the number of students registered in different classes at KFUPM is an integer number between 1 and 100).

Signal to Noise Ratio (SNR): is the ratio of the power of the desired signal to the power of the noise signal. (amplifier does not help!)

Signal Bandwidth (BW): is the width of the frequency range that the signal occupies. For example the bandwidth of a radio channel in the AM is around 10 kHz and the bandwidth of a radio channel in the FM band is 150 kHz.

Rate of Communication: is the speed at which DIGITAL information is transmitted. The maximum rate at which most of today's modems receive digital information is around 56 k bits/second and transmit digital information is around 33 k bits/second. A Local Area Network (LAN) can theoretically receive/transmit information at a rate of 100 M bits/s. Gigabit networks would be able to receive/transmit information at least 10 times that rate.

Signal Power **related to quality, distance, rate….**

Security!

Analog and Digital Communications

Since the introduction of digital communication few decades ago, it has been gaining a steady increase in use. Today, you can find a digital form of almost all types of analog

communication systems. For example, TV channels are now broadcasted in digital form (most if not all Ku–band satellite TV transmission is digital). Also, radio now is being broadcasted in digital form (see sirus.com and xm.com). Home phone systems are starting to go digital (a digital phone system is available at KFUPM). Almost all cellular phones are now digital, and so on. So, what makes digital communication more attractive compared to analog communication?

Advantages of Digital Communication over Analog Communication

- Immunity to Noise (possibility of regenerating the original digital signal if signal power to noise power ratio (SNR) is relatively high by using of devices called repeaters along the path of transmission).
- Efficient use of communication bandwidth (through use of techniques like compression).
- Digital communication provides higher security (data encryption).
- The ability to detect errors and correct them if necessary.
- Design and manufacturing of electronics for digital communication systems is much easier and much cheaper than the design and manufacturing of electronics for analog communication systems.

Modulation

Modulation is changing one or more of the characteristics of a signal (known as the carrier signal) based on the value of another signal (known as the information or modulat***ing*** signal) to produce a modulat***ed*** signal.

A **carrier** is a sinusoidal of high frequency with one of its parameters (amplitude, phase, or frequency) is varied in proportion to the message $m(t)$

Famous Types

- Amplitude Modulation (AM): varying the amplitude of the carrier based on the information signal as done for radio channels that are transmitted in the AM radio band.
- Phase Modulation (PM): varying the phase of the carrier based on the information signal.
- Frequency Modulation (FM): varying the frequency of the carrier based on the information signal as done for channels transmitted in the FM radio band.

Why to modulate?

- Antenna size is inversely proportional to the frequency. Antenna size has to be comparable to the wave length. $c=\lambda f$
- To receive transmitted signals from multiple sources without interference between them, they must be transmitted at different frequencies (frequency division multiplexing, FDM) by modulating carriers that have different frequencies with the different information signals. (like painting with colors).
- To improve the propagation. Low frequency penetrates walls better than high frequency signals.