AV312 - Lecture 1

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Review

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  "The fundamental problem of communication is that of reproducing at one point either exactly or approximately a message selected at another point"
- What are the channel characteristics that makes the communication problem challenging?
  - Distortion
  - Noise
  - Interference
  - Regulation

Today's plan

- Elements of a communication system
- Modelling channel distortion - using LTI systems
- The modulation process
- Example: Amplitude modulation - AM
- Scribes are Aathira and Abhinav
- Review of signals and systems

Elements of a communication system

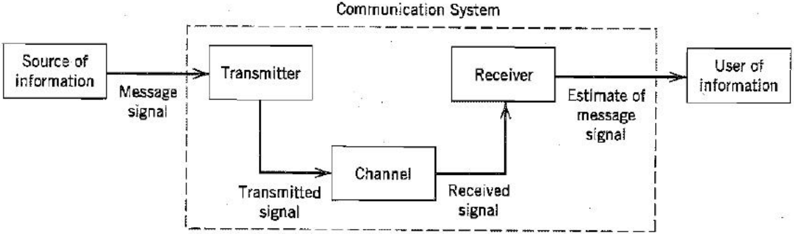

FIGURE 1 Elements of a communication system.

Resources in a communication system

- Primary resources in a communication system
  - Power
  - Bandwidth

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- Primary resources in a communication system
  - Power
  - Bandwidth
- A resource might be considered more important than the other in a particular system
  - Power limited
  - Band limited channels

Sources of information

- Non-graded assignment: Read Section "Sources of information" in Haykin.

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- Analog sources of information
  - Functions of continuous time
  - Characterized using the time domain function, frequency domain spectrum, power/energy spectrum
  - Bandwidth is an important way of getting a collective description of these signals
  - Example: 4 kHz for speech, 15 kHz for music

Remember the paragraph

A Mathematical Theory of Communication

By C. E. SHANNON

INTRODUCTION

THE recent development of various methods of modulation such as PCM and PPM which exchange bandwidth for signal-to-noise ratio has intensified the interest in a general theory of communication. A basis for such a theory is contained in the important papers of Nyquist[1] and Hartley[2] on this subject. In the present paper we will extend the theory to include a number of new factors, in particular the effect of noise in the channel, and the savings possible due to the statistical structure of the original message and due to the nature of the final destination of the information.

The fundamental problem of communication is that of reproducing at one point either exactly or approximately a message selected at another point. Frequently the messages have *meaning*; that is they refer to or are correlated according to some system with certain physical or conceptual entities. These semantic aspects of communication are irrelevant to the engineering problem. The significant aspect is that the actual message is one *selected from a set* of possible messages. The system must be designed to operate for each possible selection, not just the one which will actually be chosen since this is unknown at the time of design.

If the number of messages in the set is finite then this number or any monotonic function of this number can be regarded as a measure of the information produced when one message is chosen from the set, all choices

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- Digital sources of information
  - Abstractly represented as a sequence of bits
  - Could be converted into a function of continuous time - analog signal

Communication channels

- Examples: Telephone, Coaxial cable, Optical Fibres, Wireless, Satellite

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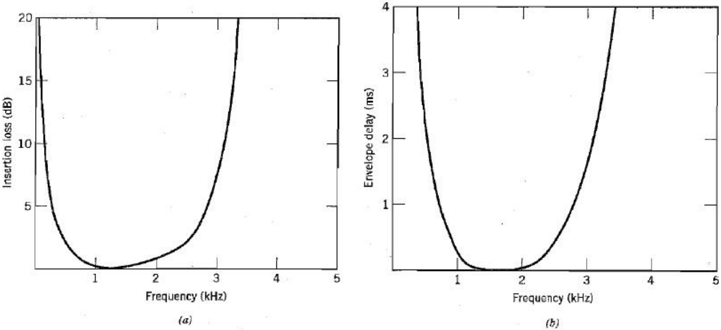

FIGURE 8 Characteristics of typical telephone connection: (*a*) Insertion loss. (*b*) Envelope delay. (Adapted from Bellamy, 1991.)

Modelling communication channels

- General input output model

Modelling communication channels

- General input output model
- Linear system models

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- Linear time invariant system models

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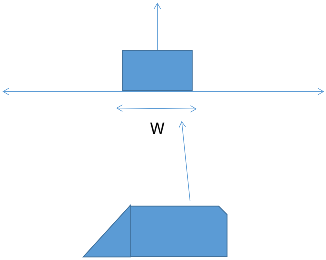
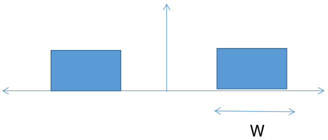
Modelling communication channels

- General input output model
- Linear system models
- Linear time invariant system models
- Ideal linear time invariant system models (ideal filters)
  - Ideal lowpass response - bandwidth
  - Ideal bandpass response - bandwidth





Analog modulation

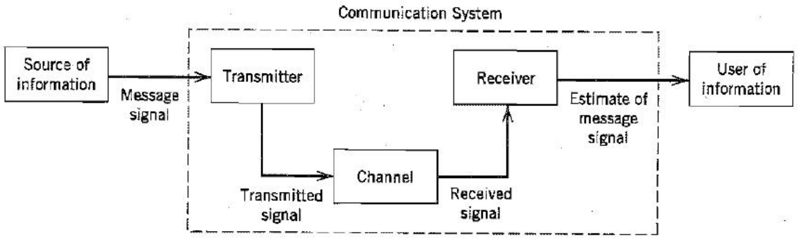


FIGURE 1 Elements of a communication system.

- Continuous wave and pulse modulation schemes

Digital modulation

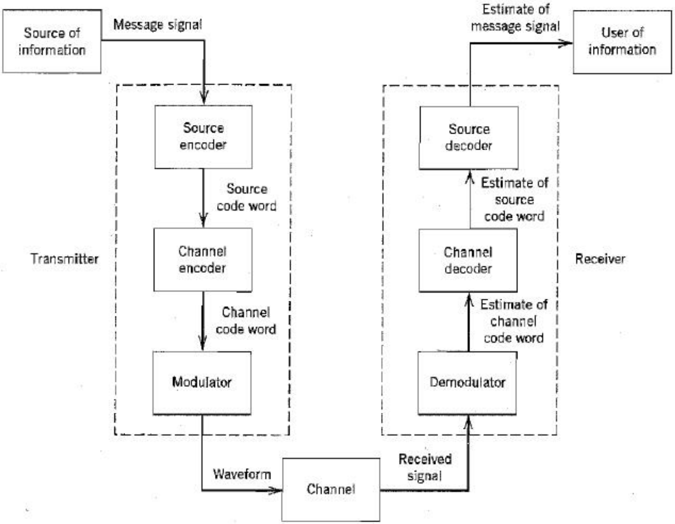


FIGURE 9 Block diagram of digital communication system.

Amplitude modulation (DSBSC)

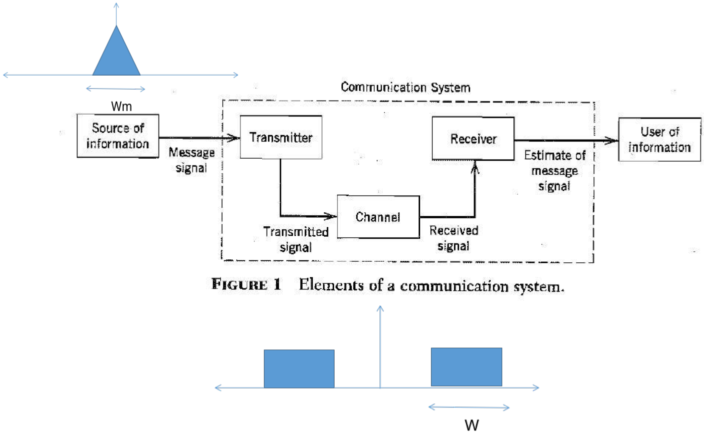
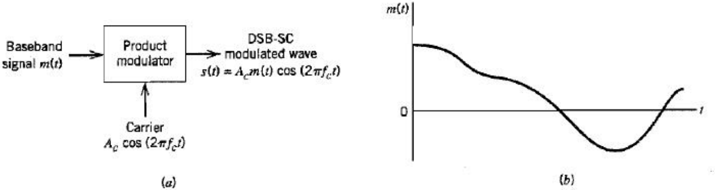


FIGURE 1 Elements of a communication system.

- Assume that $W_m < W$
- Design the transmitter and receiver so that we obtain a "good" reproduction of the source signal at the destination

Amplitude modulation (DSBSC)



- Obtain the FT of the signal $x(t)$

Amplitude demodulation (DSBSC)

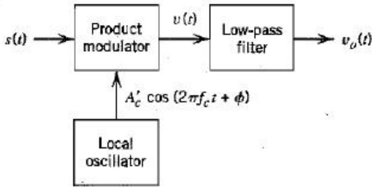
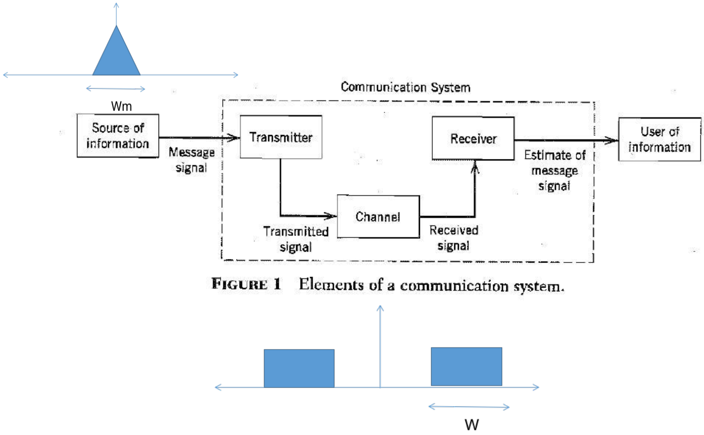


FIGURE 2.7 Coherent detector for demodulating DSB-SC modulated wave.

- Obtain the FTs of the signals $v(t)$ and $v_o(t)$

Amplitude modulation (DSBSC)



- Assume that $W_m > W$
- Design the transmitter and receiver so that we obtain a "good" reproduction of the source signal at the destination

Signals and Systems review

- Signals and their classification
- Energy and power of signals
- Fourier series, Parseval's theorem
- Fourier transform, Rayleigh's theorem
- Convolution
- LTI systems, IO relationship