Chapter 1

Introduction

Introduction

What is a communication system?

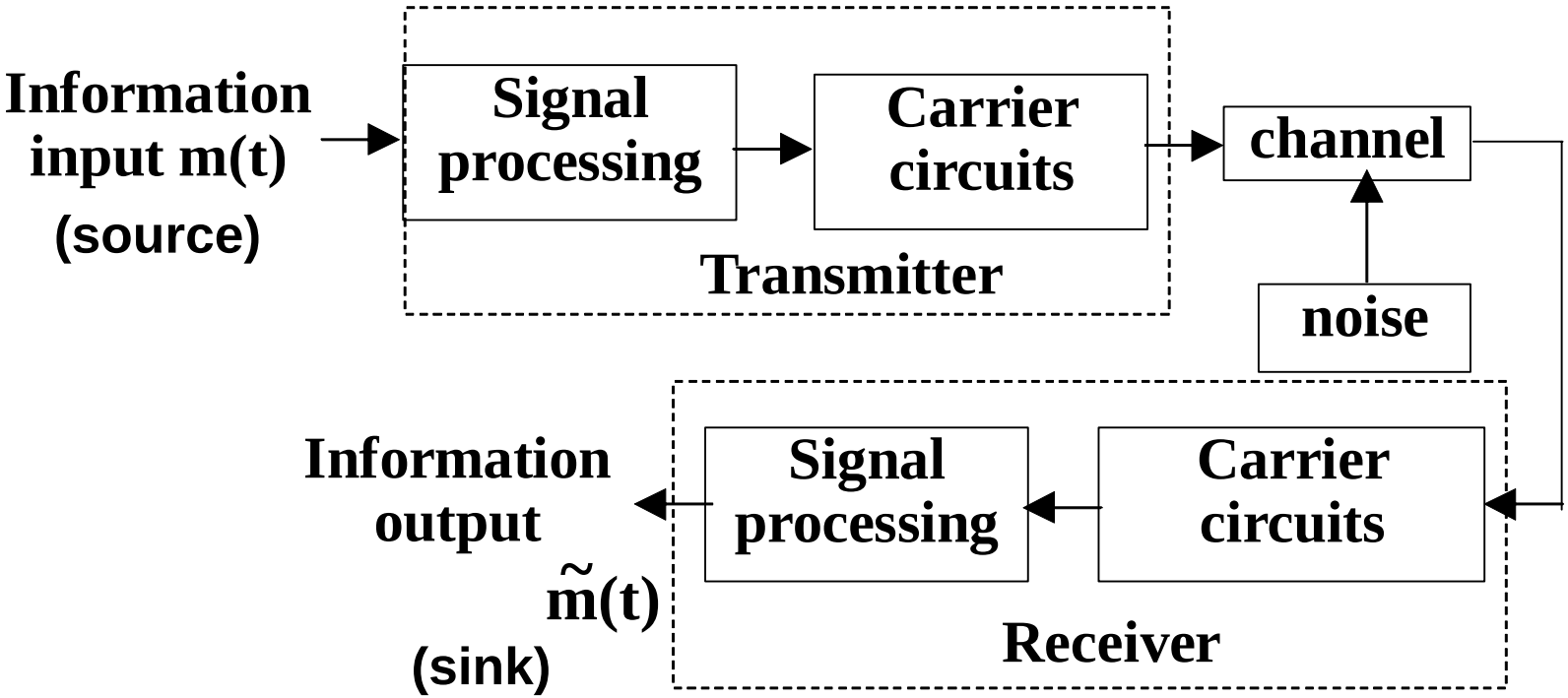
Example of communicaitons:

1. Telephone
2. Computer network
3. Broadcast & TV

Communication systems are systems designed to transmit information

Introduction

communication system



All communications systems involve three main sub-systems:

- *transmitter*
- *channel*
- *receiver*

Introduction

classification of communication system

according to information source :

Digital /Analog communication system

according to frequency (Spectra):

Baseband transmitting/ Bandpass transmitting system

according to transmitting medium (Channel) :

Wire /Wireless

according to service of transmission :

Telephone /Data /Image and so on

Introduction

Digital and Analog source and system

Digital information source

produces a finite set of possible messages. Such as typewriter and keyboard

Analog information source

produces messages that are defined on continuum.

Digital communication system

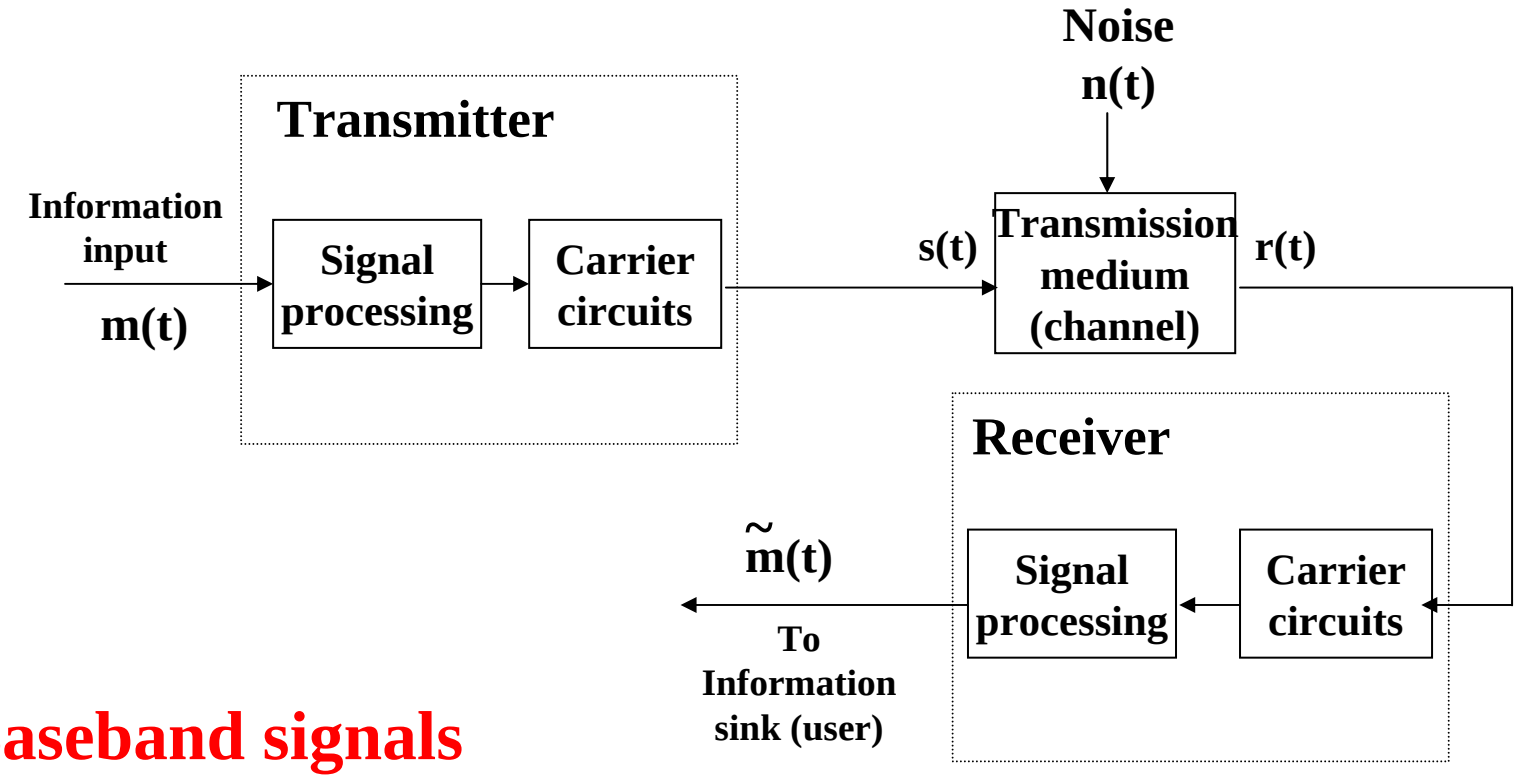
transfers information from a digital source to the intended receiver(sink)

Analog communication system

transfers information from a analog source to the intended receiver(sink)

Introduction

Baseband and Bandpass transmitting system



Baseband signals

The spectra of m(t) and $\tilde{m}(t)$ are concentrated about $f = 0$

Bandpass signal

The spectra of m(t) and $\tilde{m}(t)$ are concentrated about $f = \pm f_c$

Introduction

Communication system

Goal -- to design communication systems that transmit information to the receiver with as little deterioration as possible while satisfying design constraints, of allowable transmitted energy,allowable signal bandwidth,and cost.

Performance measure

- In digital system

  probability of bit error (P_e), also called the bit error rate (BER)

- In analog system

  signal-to-noise ratio (SNR) at the receiver output

Introduction

What must be considered when designing a communication system?

1. Selection of the information-bearing **waveform**
2. **Bandwidth and power** of the waveform
3. **Effect of system noise** on the received information
4. **Cost**

Information measure

The information sent form a digital source when the *j*th message is transmitted is given by

$$I_j = \log_2\left(\frac{1}{p_j}\right) \quad bits$$

where p_j is the probability of transmitting the *j*th message

The unit of information

- **Bit**
- **Nat**
- **Hartley**

Introduction

Information measure

The **average information** measure of a digital source is

$$H = \sum_{j=1}^{m} P_j I_j = \sum_{j=1}^{m} P_j \log_2\left(\frac{1}{P_j}\right) \quad bits$$

The average information is called **entropy.**

The **source rate** is given by

$$R = \frac{H}{T} \quad bits/s$$

Where H is the average information, T is the time required to send a message.

Introduction

Information measure

- **(For the case of signal plus white Gaussian noise) If the rate of information R (bit/s) is less than the channel capacity C, the probability of error would approach zero.**

- **The channel capacity C is**

$$C = B\log_2\left(1+\frac{S}{N}\right)$$

Where B： the channel bandwidth in hertz (Hz)；

S/N： the signal-to-noise power ratio at the input to the digital receiver.

Information measure

Example: **A1-2**

A telephone touch-tone keypad has the digits 0 to 9 with probability of sending being 0.099 each, plus "*" and "#" with probability of sending being 0.005 each. If the keys are pressed at a rate of 2keys/s. compute the data rate for this source.