Analog Communications

— Lecture 01 —
Introduction

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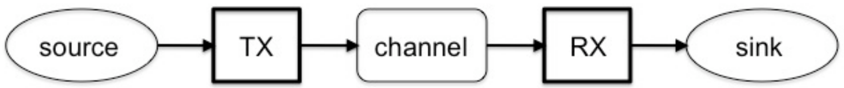
Outline of the Course

- Baseband Representation of Signals
- Linear Modulation
- Performance of Linear Modulation over AWGN Channel
- Angle Modulation
- Performance of Angle Modulation over AWGN Channel
- Comparison of Analog-Modulation Schemes
- Modulators and Demodulators

Communication System

Block diagram of a point-to-point communication system, also denoted Single-Input Single-Output (SISO) communication system



- Source: source of the information signal
- Sink: destination of the information signal
- Channel: physical medium linking the source to the sink
- TX & RX: make reliable communications possible (to be designed)

Each block is a "virtual" system including different functionalities depending on the focus of the designer

Notation (1/2)

- $t \in \mathbb{R}$ independent temporal variable
- $x(t) \in \mathbb{R}$ is the signal to be transmitted
- $z(t) \in \mathbb{R}$ is the transmitted signal
- $r(t) \in \mathbb{R}$ is the received signal
- $y(t) \in \mathbb{R}$ is the delivered signal

Notation (2/2)

- $\mu_x(t) = \mathbb{E}\{x(t)\}$
  mean of a stochastic process
- $R_x(t,s) = \mathbb{E}\{x(t)x^*(s)\}$
  Auto-Correlation Function (ACF) of a stochastic process
- $P_x(f) = \mathcal{F}\left\{\lim_{T\to\infty} \frac{1}{T}\int_{-T/2}^{+T/2} R_x(t,t-\tau)dt\right\}(\tau \to f)$
  Power Spectral Density (PSD) of a stochastic process

Physical Channels

Common channels

- Wireline Channels
- Fiber Optic Channels
- Wireless Electromagnetic Channels
- Underwater Acoustic Channels

Common impairments

- Attenuation
- Linear (amplitude and phase) distortion
- Nonlinear distortion
- Additive noise
- Interference

Channel Models

- Additive-Noise Channel

$$r(t) = z(t) + w(t)$$

- Linear-Filter Channel

$$r(t) = h(t) \star z(t) + w(t) = \int_{\mathbb{R}} h(\tau)z(t-\tau)d\tau + w(t)$$

- Linear Time-Variant Filter Channel

$$r(t) = h(t,\tau) \star z(t) + w(t) = \int_{\mathbb{R}} h(t,\tau)z(t-\tau)d\tau + w(t)$$