1: Communication

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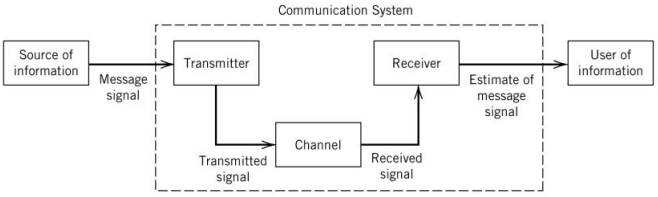
I. Communication

- Transmission of information from one point to another
- Basic elements:
  - Information source
  - Transmitter
  - Channel
  - Receiver



A. Communication channels

- **Propagation loss**: Signal strength decay with distance
- **Bandwidth**: Frequency range used for communication
- **Time variation**: Channel characteristic variation in time
- **Nonlinearity**: Introduced by some elements e.g. repeaters
- **Multi-path interference**: Deteriorates signal contents

B. Noise

- Unwanted signals in communication system
- Two types:
  - **External noise**: Natural noise, man-made noise
  - **Internal noise**: Thermal noise due to channel
- Signal-to-noise ratio (SNR):

$$\text{SNR} = \frac{\text{Signal power}}{\text{Noise power}}$$

II. Transmitter and Receiver

- **Transmitter**: Convert source into transmissible format
  - **Modulation**: Carrier-wave parameter based on signal
  - **Up-conversion**: Modulated $f(x)$ convert to final RF
- **Receiver**: Reconstruct original signal from modulated
  - **Down-conversion**: Convert to original RF
  - **Demodulation**: Convert to original signal
- Some degradation depending on channel and modulation

III. Objectives of system design

- Primary resources in communication design:
  - Transmitted power
  - Channel bandwidth
- Deliver message efficiently and reliably within constraints
  - Efficiency: Number of transmitted bits in unit power
  - Reliability: SNR or Error Probability

A. Shannon capacity formula

- Maximum rate of reliable transmission:

$$C = W \log(1 + \text{SNR})$$

  where W (Hz) is the bandwidth of a channel
- Almost 0 error probability if signal rate less than C