

EE350: Communication Systems

Modulation (AM, FM, PAM),
Demodulation and Noise

Fairfield University:
School of Engineering

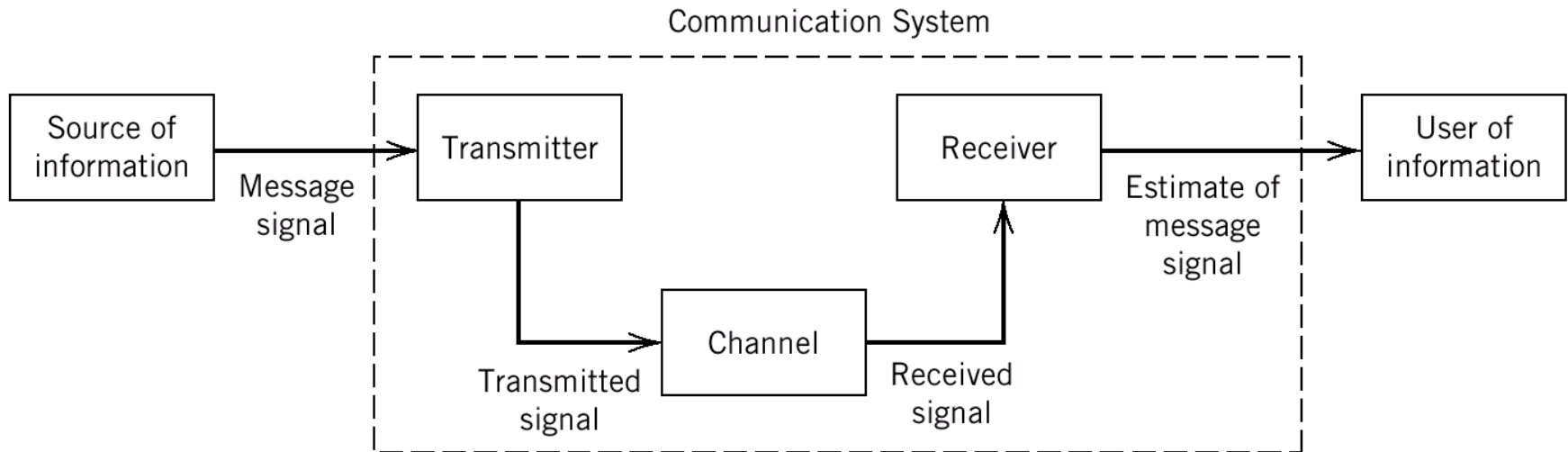
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<http://doctord.webhop.net>

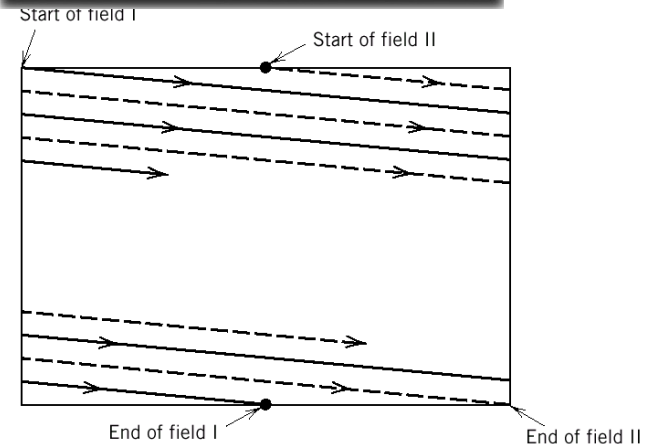
The Communication Problem

- Get information from here to there
- Channel challenges
 - Additive noise: “white”, Gaussian noise here
 - Non-linear distortion and time variation: only touched on here (but used and analyzed in xmitter/receiver implementations)
 - Frequency response: Gain & Phase “Distortion”



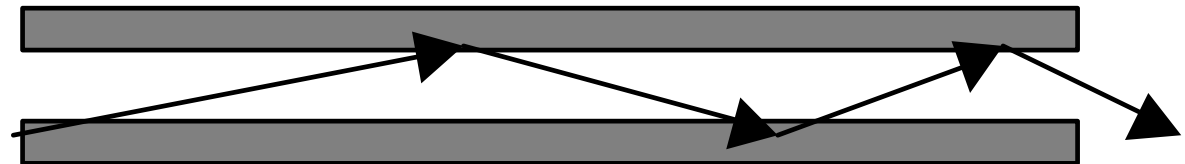
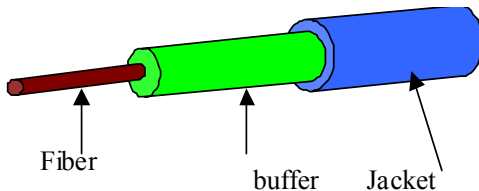
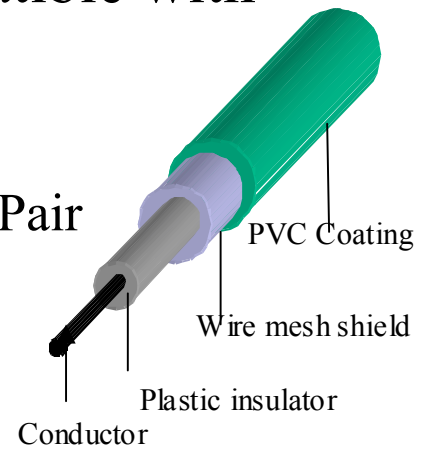
Some Terminology

- **Information source:** supplies an analog signal in the form of a time-varying voltage or current that directly corresponds to the information. (baseband signal)
 - Audio
 - Telephone: 300Hz to 3.3kHz
 - AM broadcast: 100Hz to 5kHz
 - FM Broadcast: 50Hz to 15kHz
 - CD Audio: 20Hz to 20kHz
 - Scanned Video (Philo Farnsworth, electron beam, 1921)
 - NTSC: 6MHz



Terminology (2)

- **Transmitter:** Puts the signal into a form that can traverse the **channel**.
 - **Carrier:** a simple waveform that is compatible with the **channel**.
 - Usually a sine wave
 - **Transmission line:** Coaxial cable, Twisted Pair
 - **Free space:** Electromagnetic Wave
 - Can be a light beam (or ultrasound)
 - Free Space: Laser
 - **Fiber Optics:** What keeps the light inside the fiber?

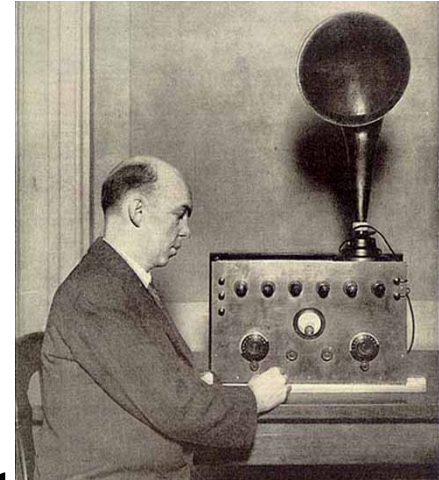


Terminology (3)

– **Modulation:** vary a parameter of the **carrier** in proportion to the baseband information signal.

- AM: amplitude modulation
- FM: frequency modulation
(Colonel Edwin Armstrong)
(closely related to phase modulation)

Armstrong with an
early superhetrodyne
receiver



• **Receiver:** recovers an estimate of the original information baseband signal from the corrupted (by the **channel**) transmitted signal.

– **Demodulation:** the inverse of the modulation process, sometimes called **detection**.

Terminology (4)

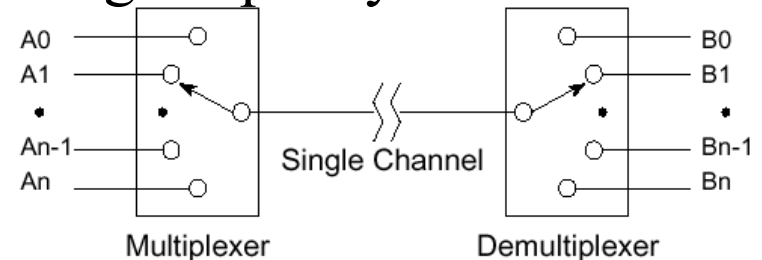
- **Channel:** The medium through which the signal travels.
 - **Additive noise:** Interferes with the desired signal
 - “**White noise**”: **Random** (unpredictable) signal with equal energy at all frequencies
 - **Gaussian noise:** values distributed according to the “bell” curve
 - **Non-linear distortion:** Usually ignored in schoolwork, not here
 - **Time variation:** Variations in transmission delay and gain, not dealt with here
 - **Frequency response:** sometimes due to “reflections” or echoes
 - **Gain** variation with frequency
 - **Phase** variation with frequency:
 - **Linear phase:** just a fixed delay
 - **Phase distortion:** different propagation delay at different frequencies

Terminology (5)

- **Multiplexing:** The sharing of a high capacity channel

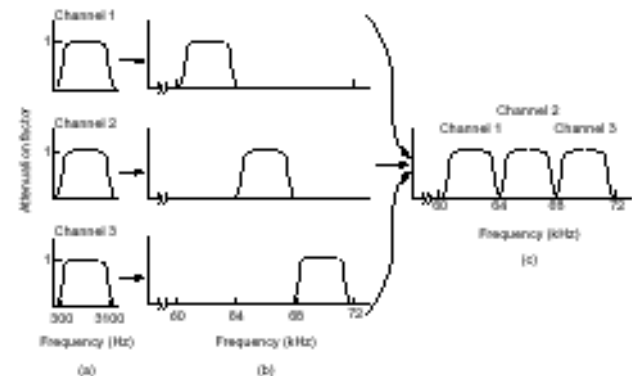
- Time-Division Multiplexing

- Fast channel; Slow signals
- **Sampling:** Represent a continuous signal as a sequence of narrow pulses (**PAM**)



- Frequency-Division Multiplexing

- Wide **bandwidth** channel; Narrow bandwidth signals
- **Modulation:** move each signal to a different frequency range
- **Demodulation:** recover a particular baseband signal



Course Description

- DoctorD's Web Site: <http://doctord.webhop.net>
- Syllabus
 - Schedule (updated often)
 - Texts: cover both EE350 and EE352: Digital Communications
 - Haykin, “Communication Systems”, Wiley, 2001
 - Hsu, “Analog and Digital Communications”, Schaums Outlines, 2003
 - References: Web
- Class Contact List
- Learnlinc: <http://learnlinc2.ffldusoe.edu/learnlinc/>