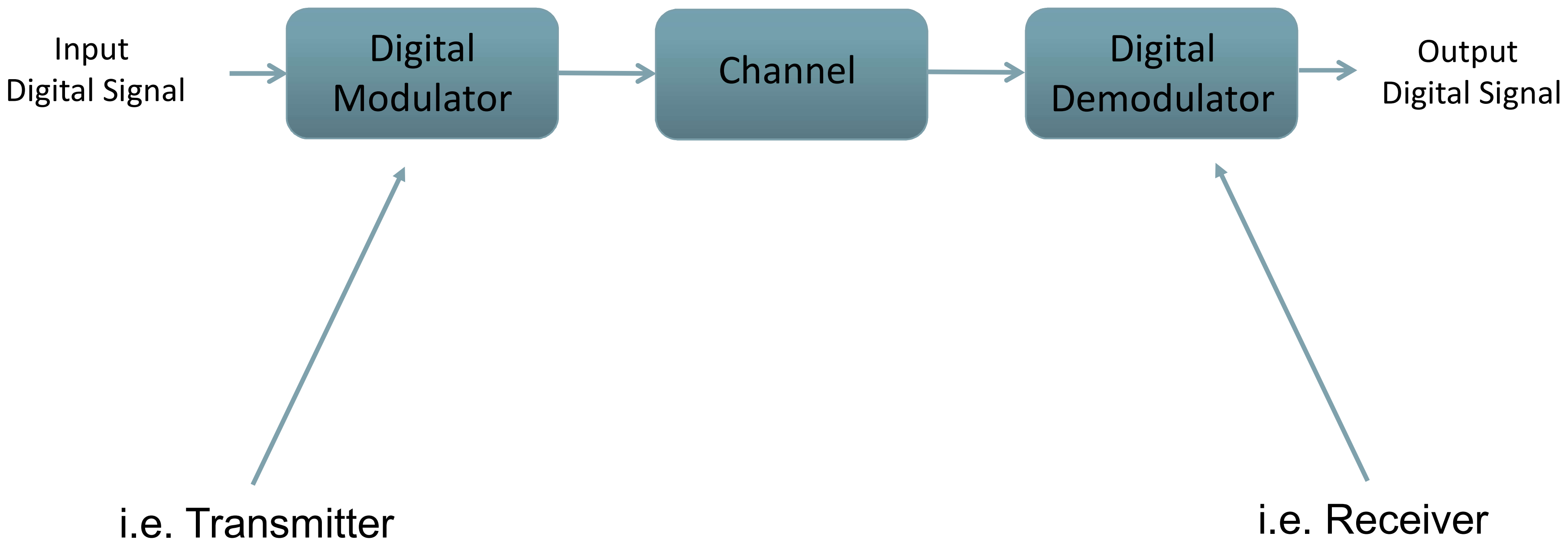
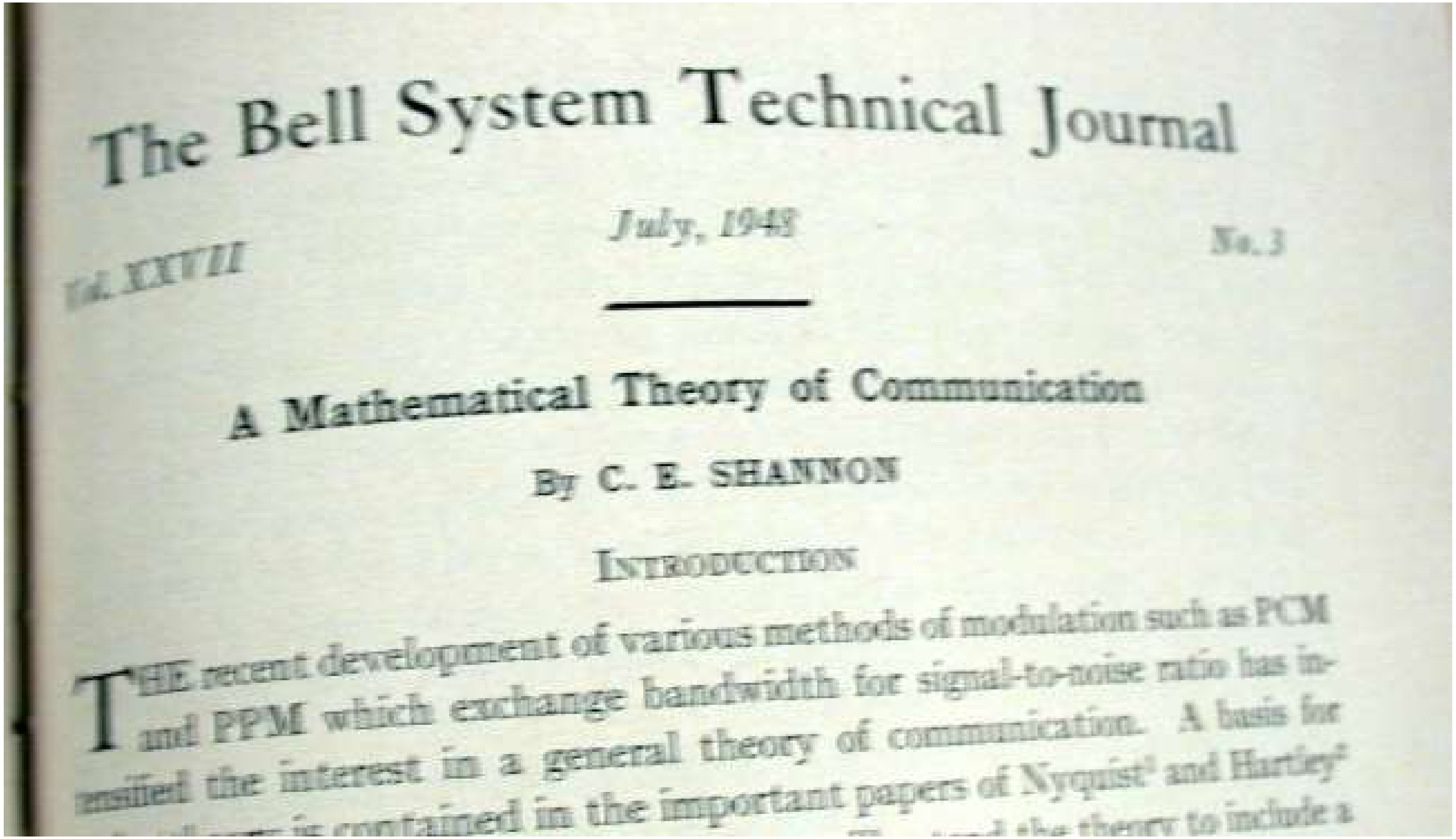
Wireless Communications Principles

The communication channel

Reminder: What is this course about?



Fundamental!



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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 in-
ensified the interest in a general theory of communication. A basis for
is contained in the important papers of Nyquist[1] and Hartley[2]

Claude Shannon

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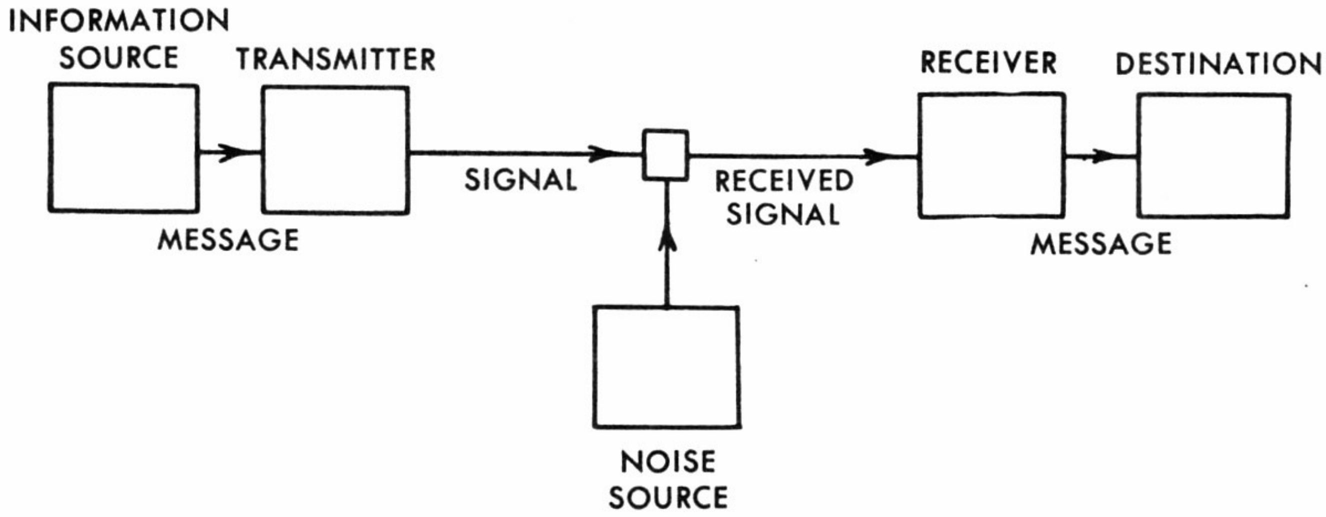
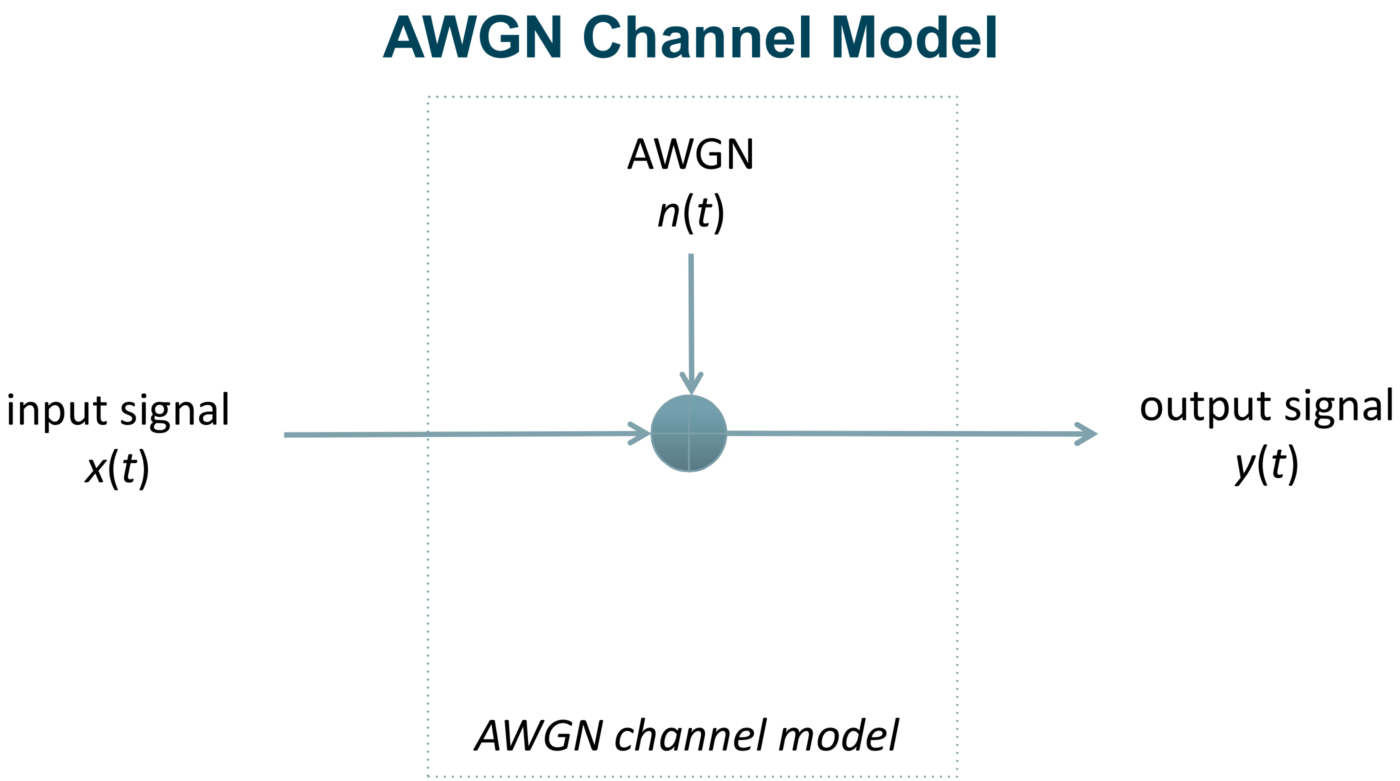


Fig. 1. — Schematic diagram of a general communication system.

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

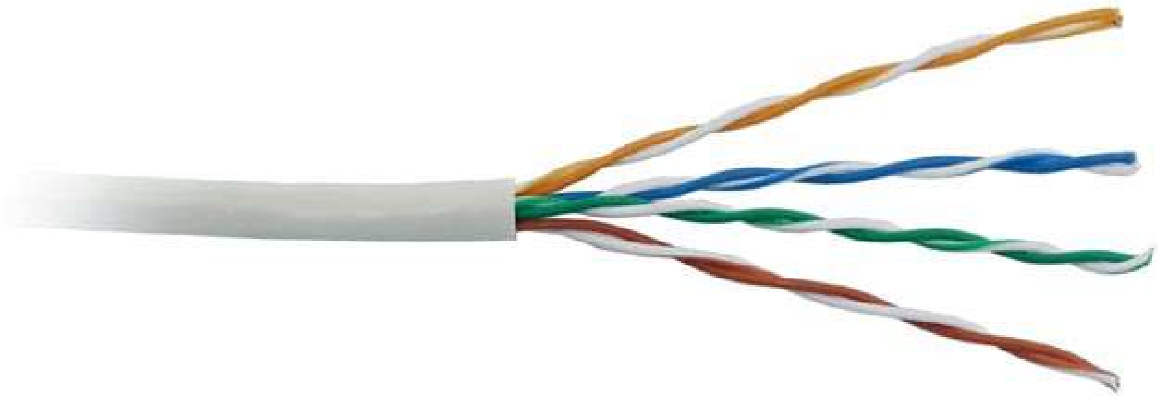
The AWGN Channel Model



We will recap on noise and consider its effect next week (when we look at signal reception)

The Band-Limited Channel Model

Twisted-Pair Cable

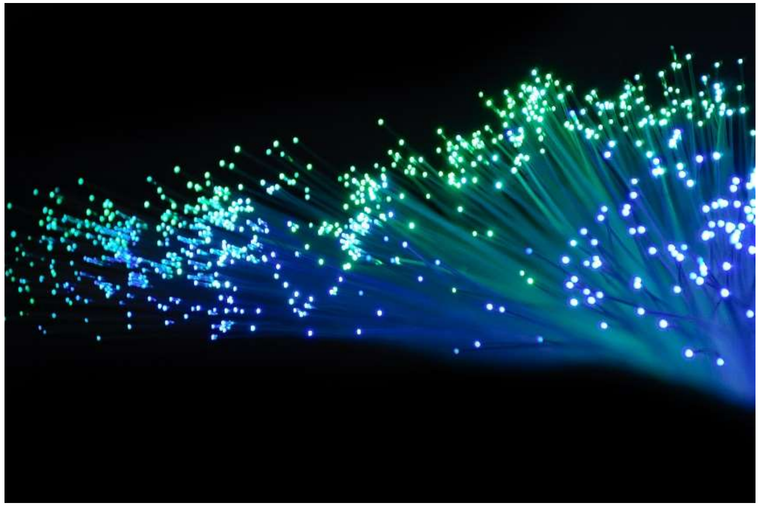


The Band-Limited Channel Model

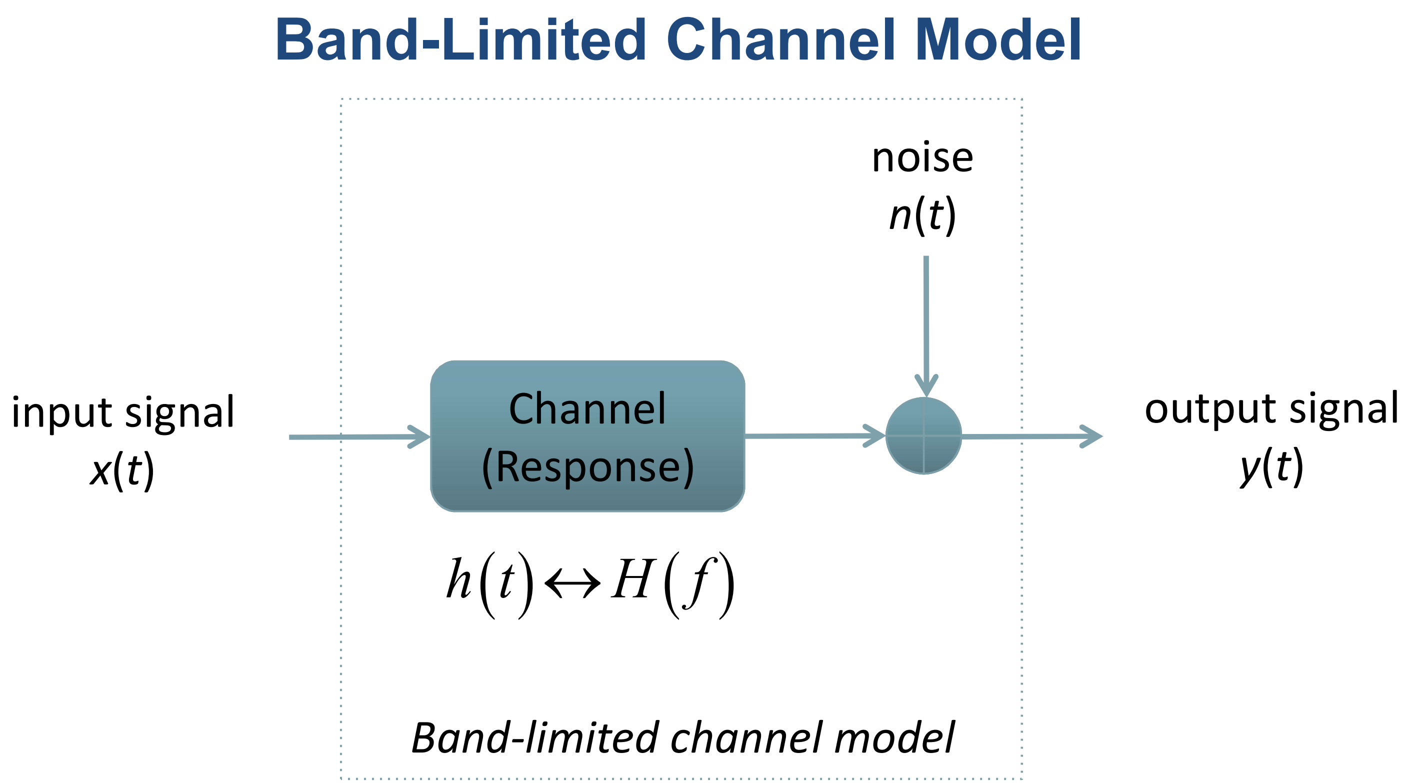
Coaxial Cable

The Band-Limited Channel Model

Optical Fibre



The Band-Limited Channel Model

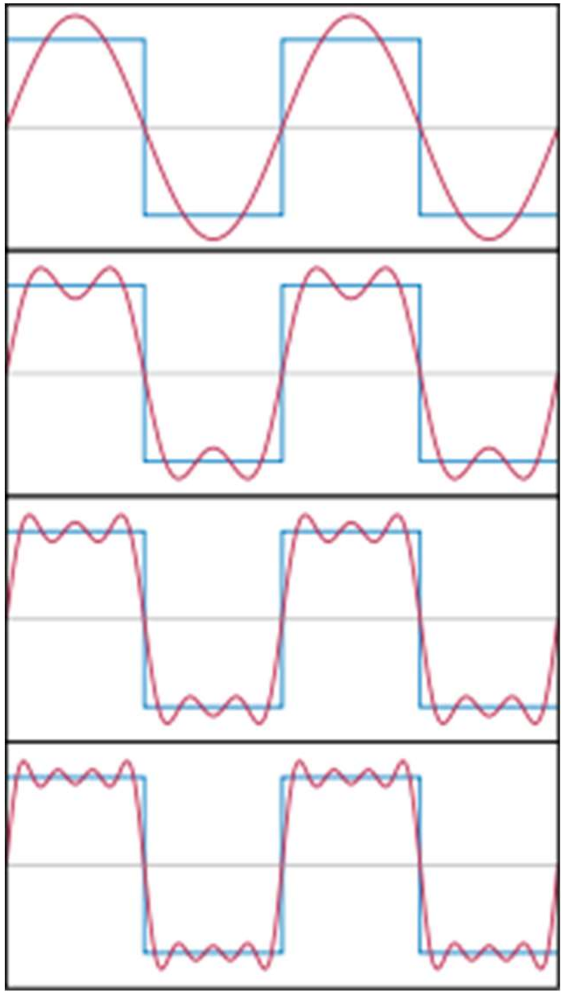


Example: Bandwidth Effects

- The periodic pulse signal can be reproduced by adding multiple sinusoidal signals together.

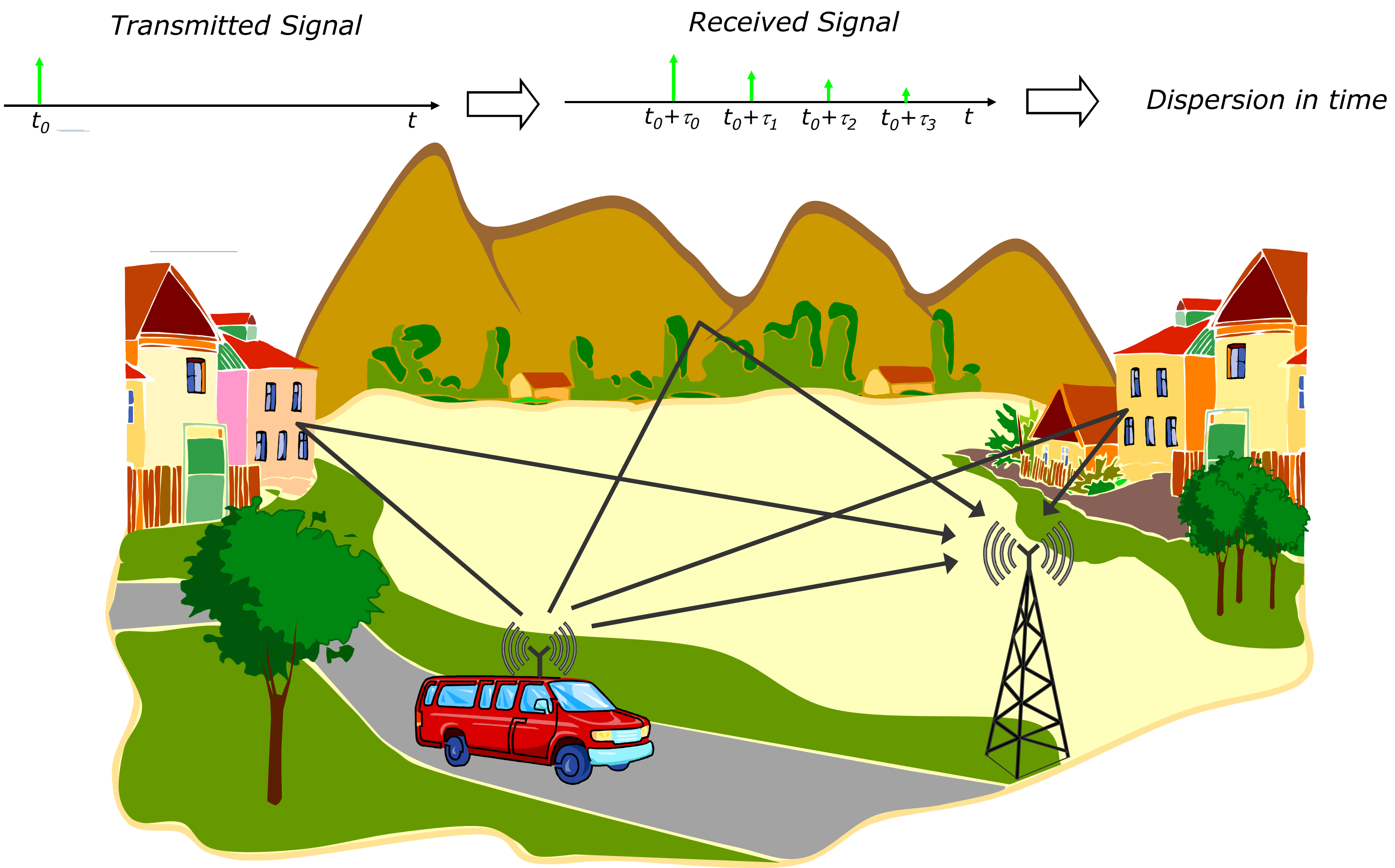
- A periodic square waveform can be approximated by adding numbers of waveforms with different harmonic frequency components.

- So, a band-limited channel has the reverse effect – removing the high frequency content, for example

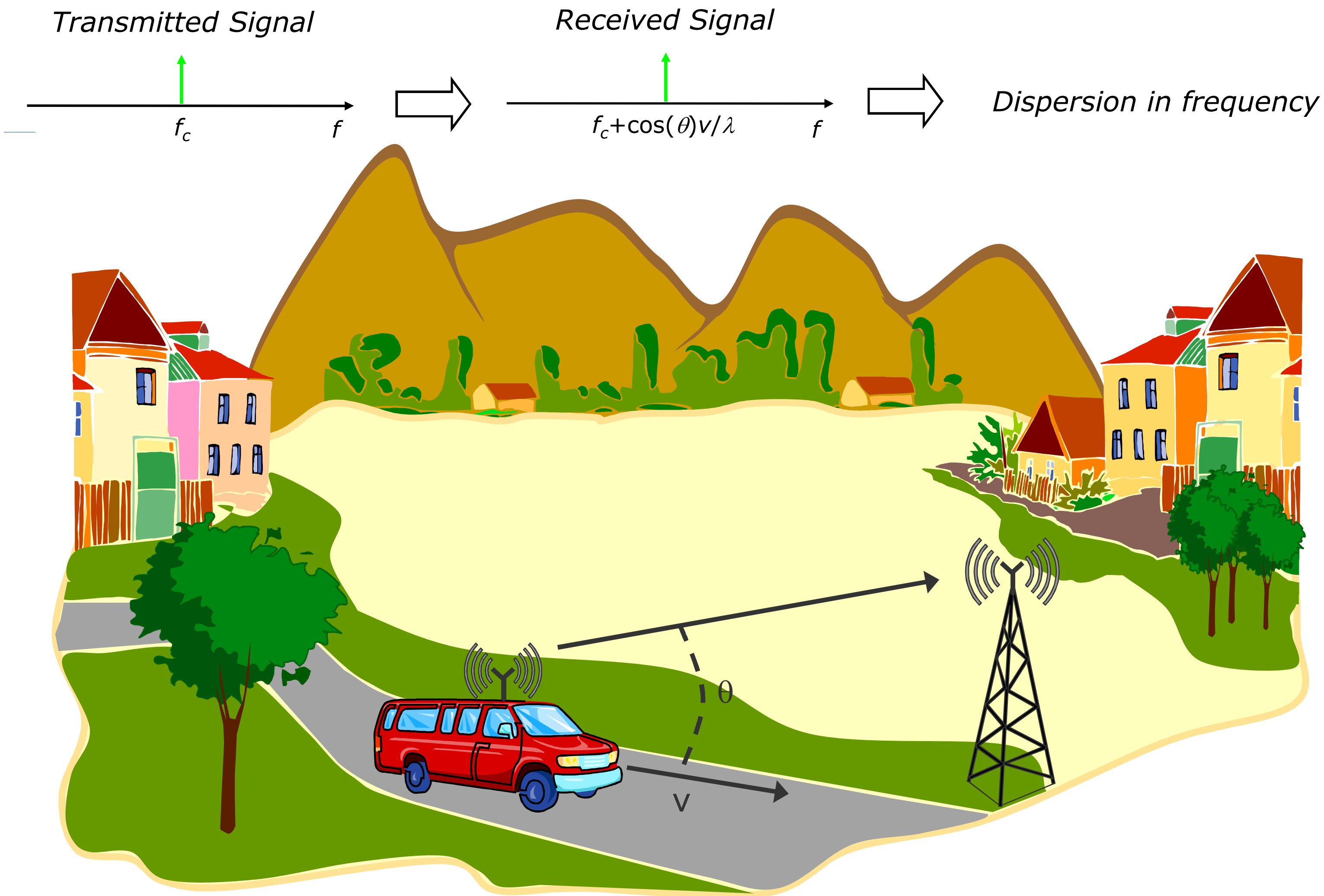


The Wireless Channel

The Wireless Channel

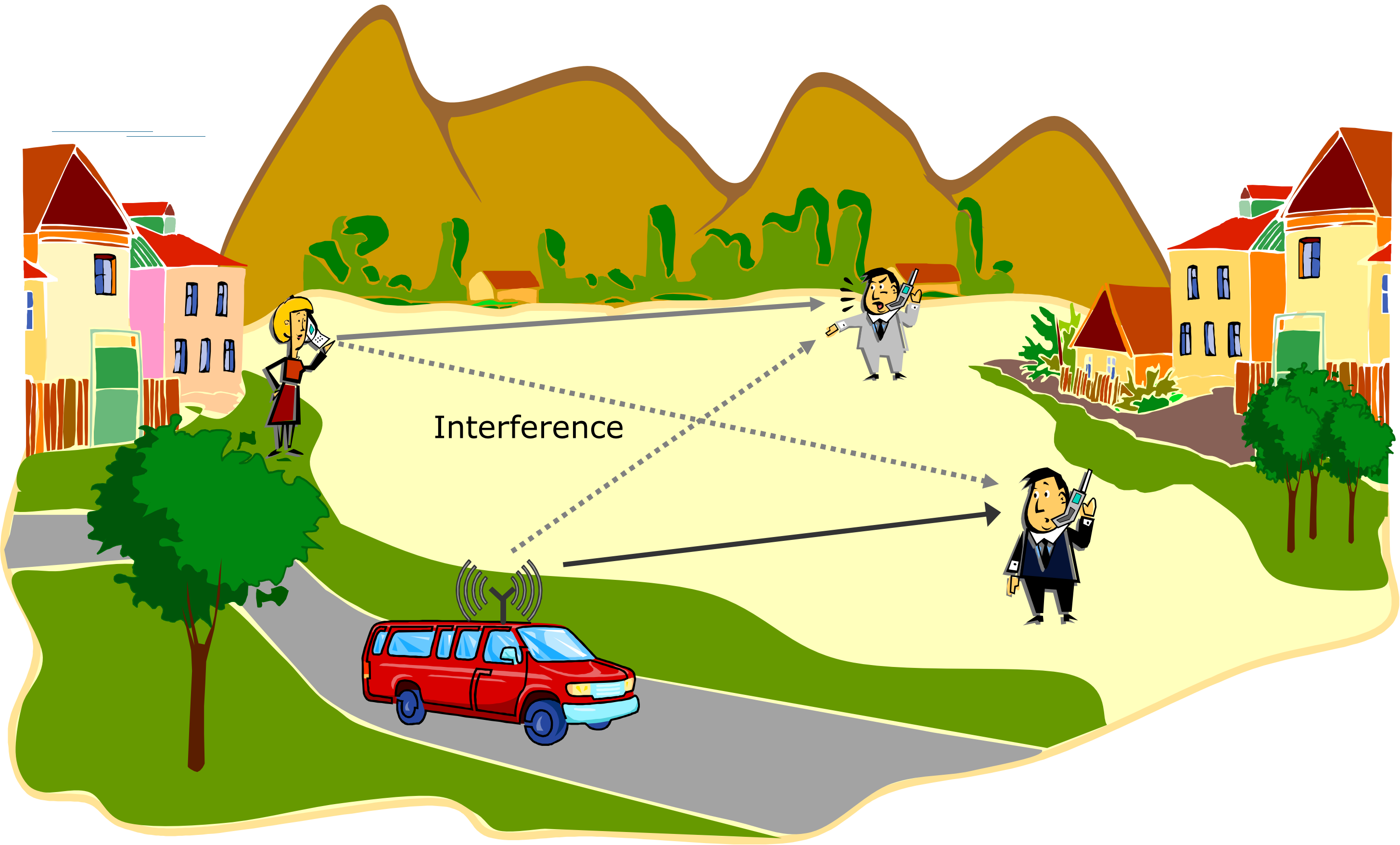


The Wireless Channel

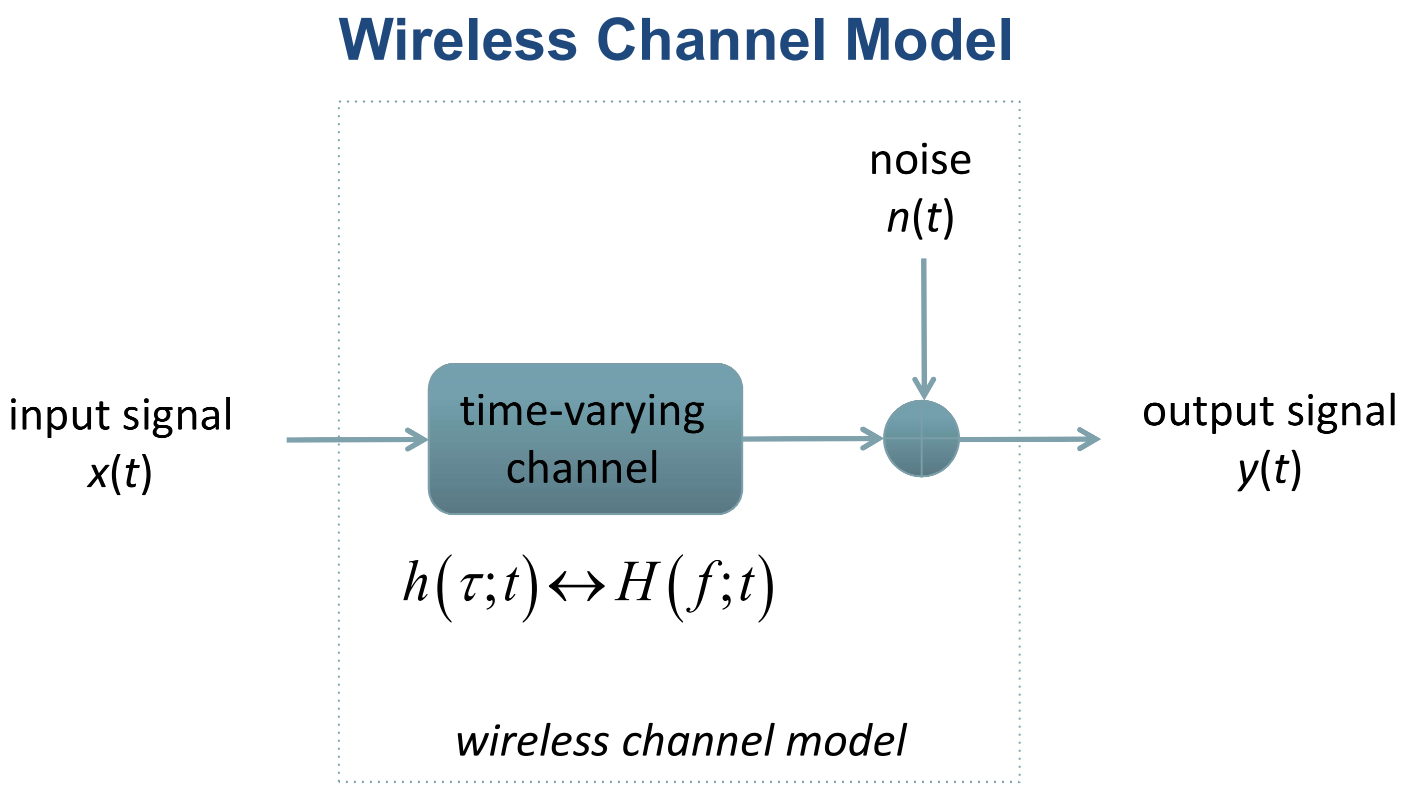


The Wireless Channel

The wireless channel introduces interference



The Wireless Channel Model



Modulation and encoding

- **How we encode and modulate the signal for transmission over the channel is important**
- Why consider power spectral density?
  - How much bandwidth the signal occupies
- Why consider energy and power in a signal?
  - Power/energy efficiency

- **Will examine a number of metrics for defining performance**
  - Bit rate
  - Spectral efficiency
  - Energy efficiency
  - Bit error rate (after detection)
  - Complexity (cost)

Self-assessment Example

A sinc-shaped pulse $x(t) = \mathrm{sinc}(t)$ is passed through a channel with an impulse response given by $h(t) = \mathrm{sinc}^2(t)$.

Find the Fourier spectrum of the output signal $y(t) = x(t) * h(t)$.

Sketch your result and comment on it.

(Hint: if you don't already know it, you need to think about how to obtain the Fourier transform of $\mathrm{sinc}(t) \times \mathrm{sinc}(t)$ first.)