Communication Channels

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Overview

Communication Channels

Channel Type

1. Ideal channel
2. Attenuation channel
3. Distortion-less channel
4. Linear filter channel
5. Additive white Gaussian noise channel
6. Linear filter additive white Gaussian noise channel
7. Linear filter additive colored Gaussian noise channel
8. Nonlinear channel

Ideal channel

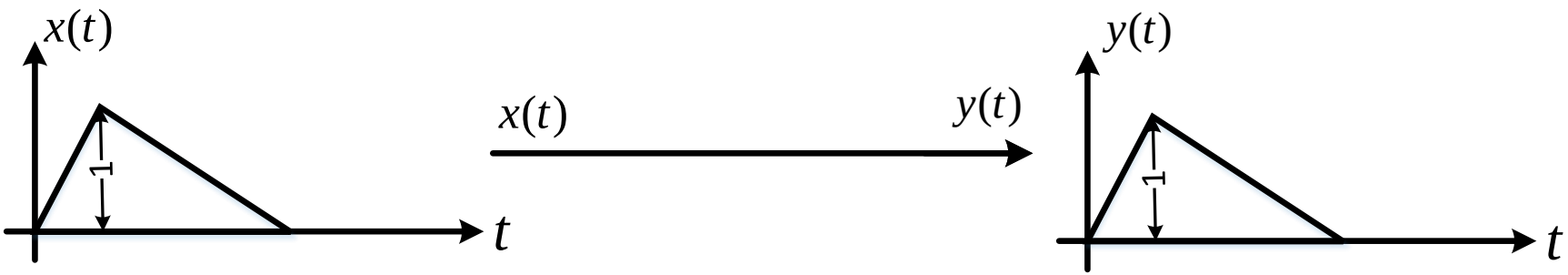

Figure: Ideal channel.

$$y(t) = x(t)$$

Attenuation channel

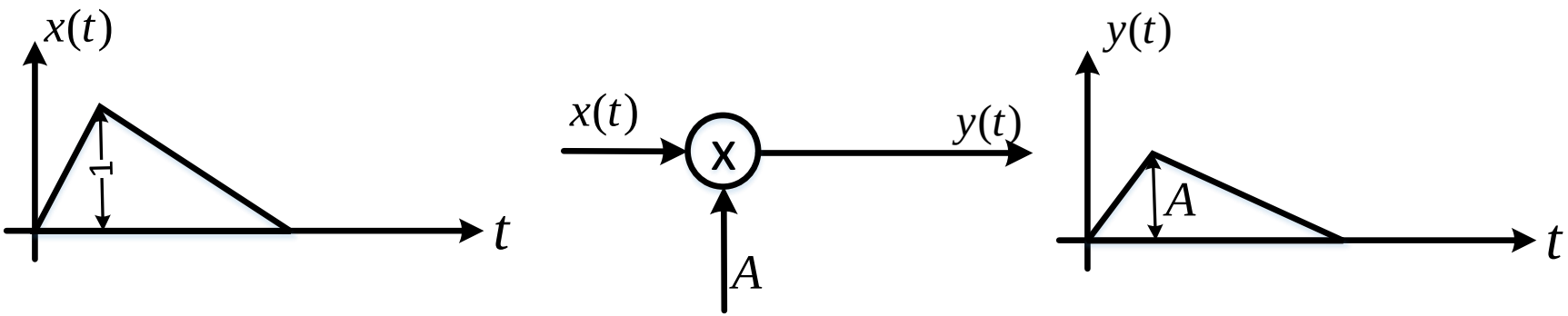

Figure: Attenuation channel.

$$y(t) = Ax(t)$$

Distortion-less channel

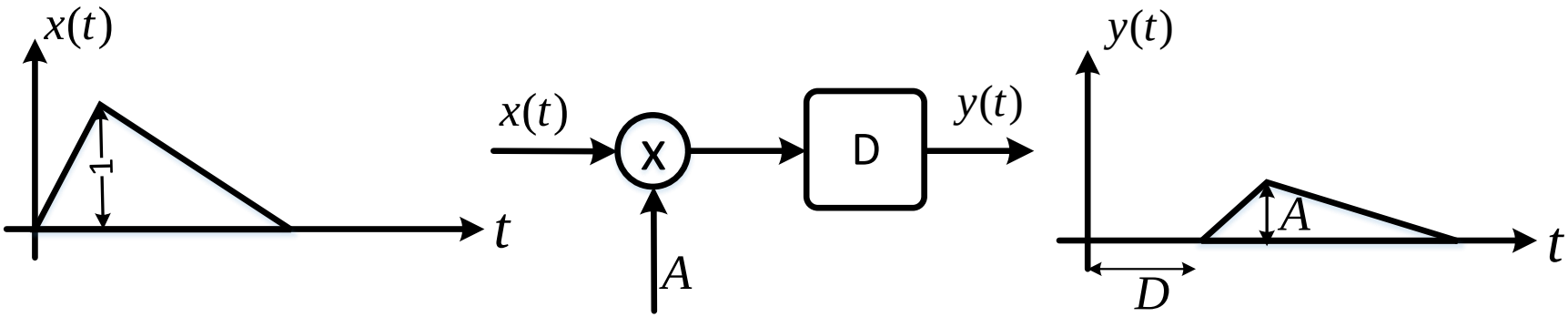

Figure: Distortion-less channel.

$$y(t) = Ax(t - D)$$

Linear filter channel

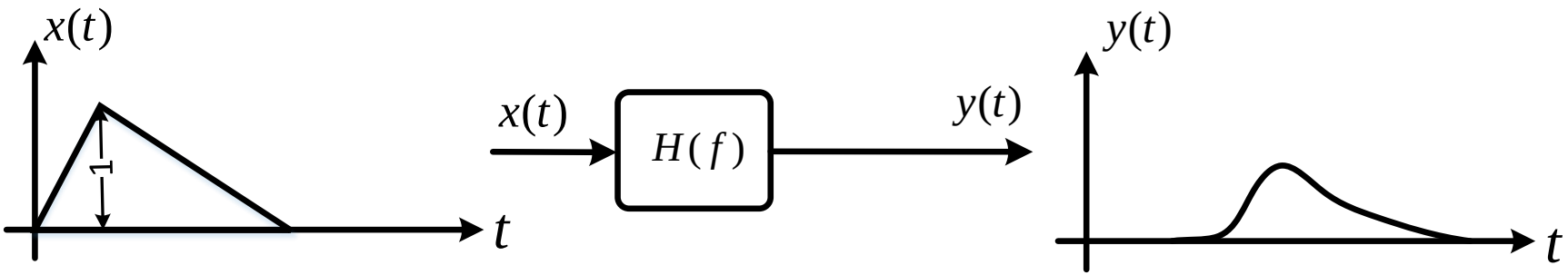

Figure: Linear filter channel.

$$y(t) = x(t) * h(t)$$

AWGN channel

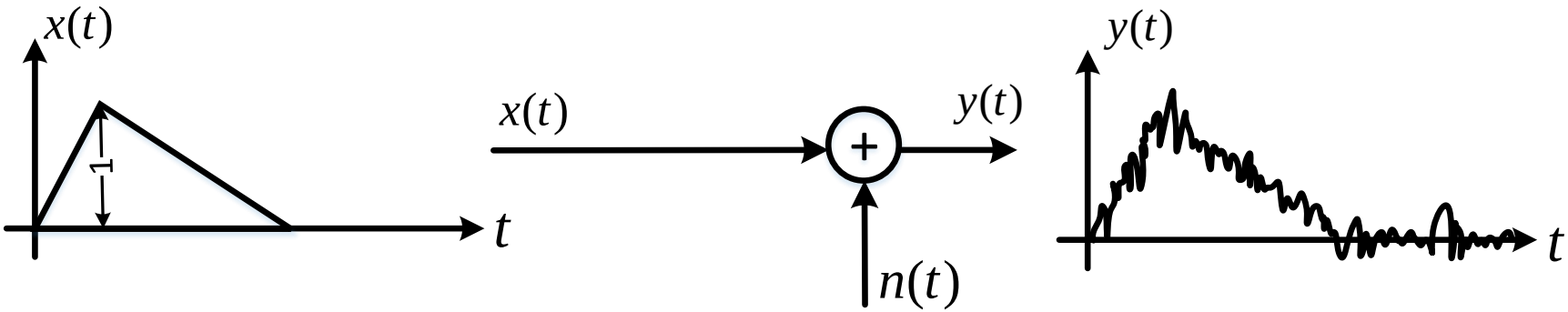

Figure: Additive white Gaussian noise channel.

$$y(t) = x(t) + n(t)$$

Linear filter additive white Gaussian noise channel

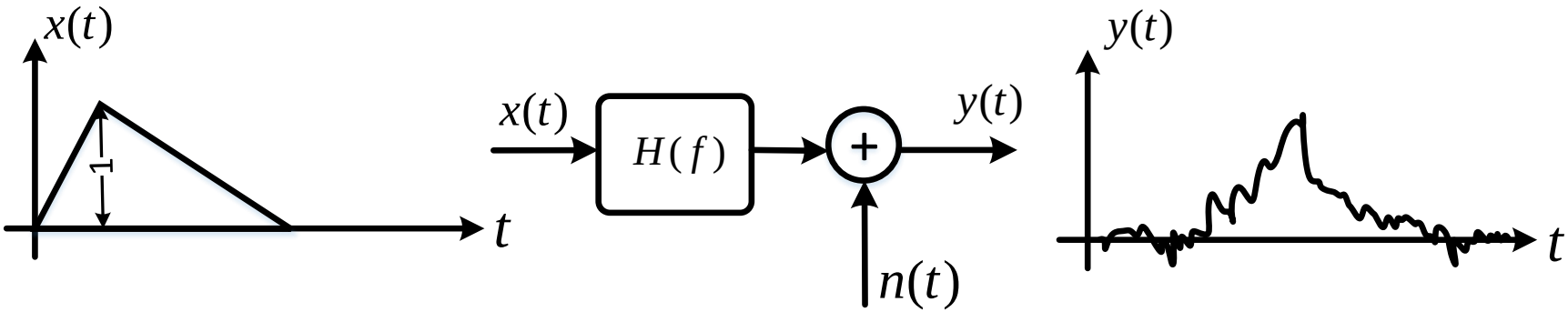

Figure: Linear filter additive white Gaussian noise channel.

$$y(t) = x(t) * h(t) + n(t)$$

Linear filter additive colored Gaussian noise channel

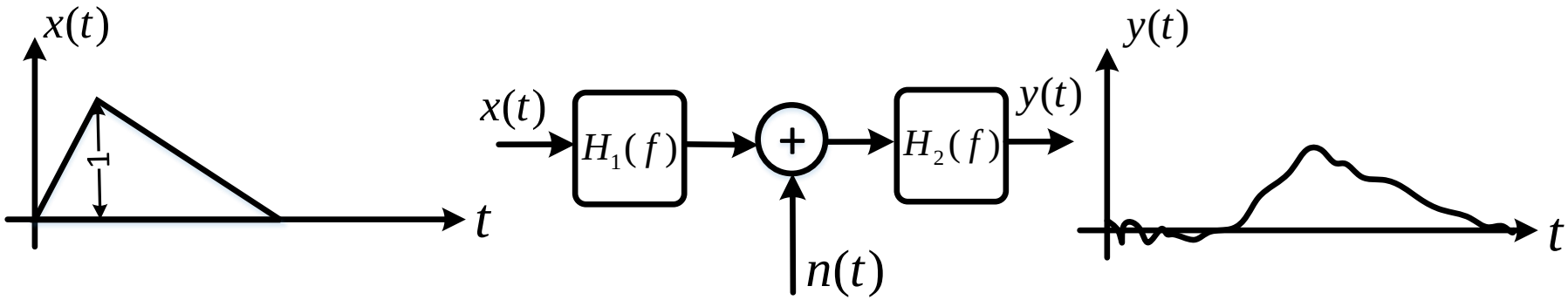

Figure: Linear filter additive colored Gaussian noise channel.

$$y(t) = \left[x(t) * h_1(t) + n(t)\right] * h_2(t) = x(t) * h_1(t) * h_2(t) + n(t) * h_2(t)$$

Nonlinear noisy channel

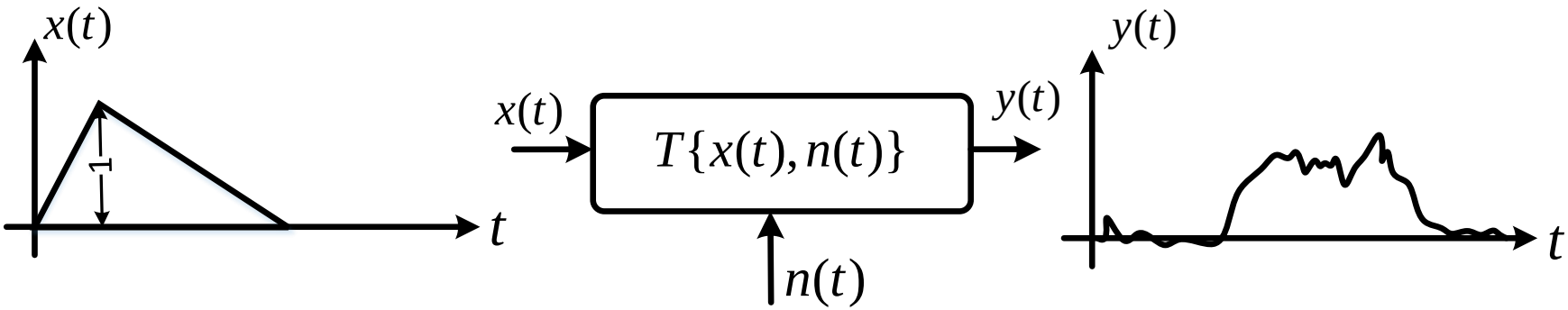

Figure: Nonlinear noisy channel.

$$y(t) = T\{x(t), n(t)\}$$

Channel Modeling

Example (Linear filter channel)

A point-to-point microwave radio channel can be modeled as a linear filter channel with the impulse response $h(t) = A_1\delta(t - D_1) + A_2\delta(t - D_2)$

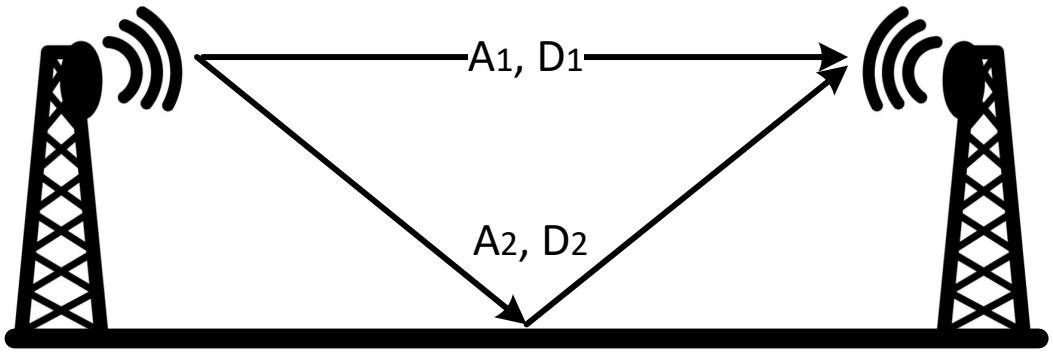

Figure: Point-to-point microwave radio channel.

$$y(t) = A_1x(t - D_1) + A_2x(t - D_2)$$

$$y(t) = x(t) * \left[A_1\delta(t - D_1) + A_2\delta(t - D_2)\right] = x(t) * h(t)$$

Channel Modeling

Example (Linear filter AWGN channel)

A noisy point-to-point microwave radio channel can be modeled as a linear filter additive white Gaussian noise channel with the impulse response $h(t) = A_1\delta(t - D_1) + A_2\delta(t - D_2)$ and additive white Gaussian noise process $n(t)$.

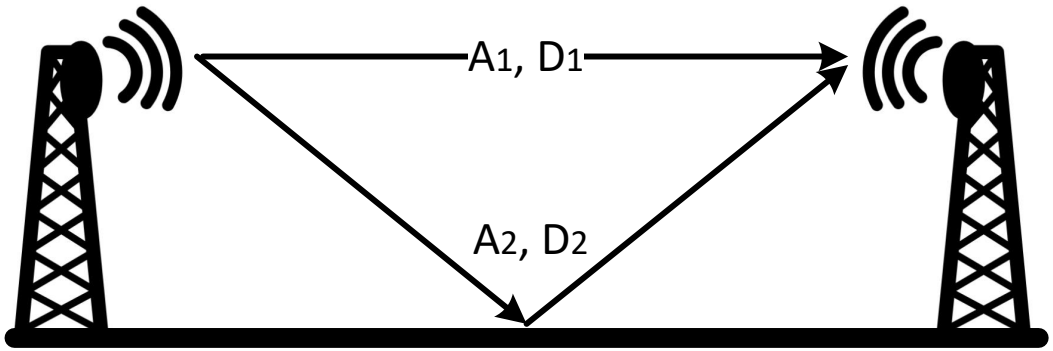

Figure: Noisy point-to-point microwave radio channel.

$$y(t) = A_1x(t - D_1) + A_2x(t - D_2) + n(t)$$

$$y(t) = x(t) * \left[A_1\delta(t - D_1) + A_2\delta(t - D_2)\right] + n(t) = x(t) * h(t) + n(t)$$

Example (Nonlinear channel)

Square-law photo-detector can be modeled as a nonlinear channel with the transformation $i(t) = \eta |E(t)|^2$.

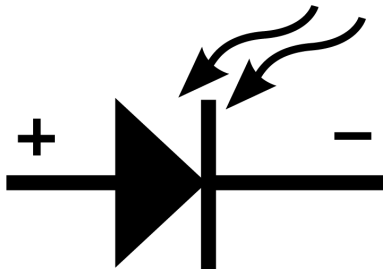

Figure: Photodetector.

$$i(t) = \eta |E(t)|^2$$

$$y(t) = \eta |x(t)|^2$$

The End