

Principles of Communications

EES 351

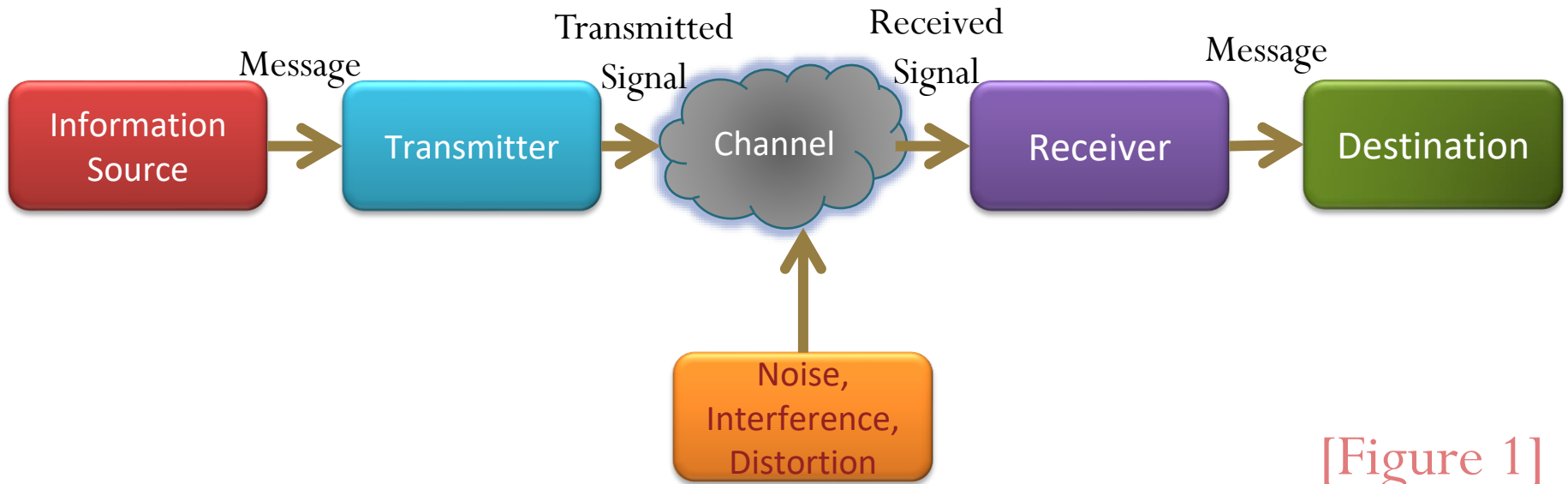
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Summary of Additional Topics

[Definition 1.2]

Basic elements of communication



[Figure 1]

CH 3-5

- Chapters 3-5



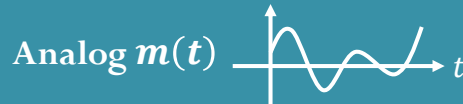
AM (4.3-4.5)

QAM (4.6)

FM, PM (CH5)

Sinusoidal Carrier: $A\cos(2\pi f_c t + \phi)$

Band-limited to B
Bounded by $\pm m_p$



$$\text{AM: } x_{\text{AM}}(t) = (A + m(t)) \cos(2\pi f_c t + \phi)$$

$$\text{PM: } x_{\text{PM}}(t) = A \cos\left(2\pi f_c t + \phi + k_p m(t)\right)$$

Useful for plotting $x_{\text{PM}}(t)$ over the time intervals where $m(t)$ is differentiable.

$$f(t) = f_c + \frac{k_p}{2\pi} \frac{d}{dt} m(t)$$

$$\text{FM: } x_{\text{FM}}(t) = A \cos\left(2\pi f_c t + \phi + 2\pi k_f \int_{-\infty}^t m(\tau) d\tau\right)$$

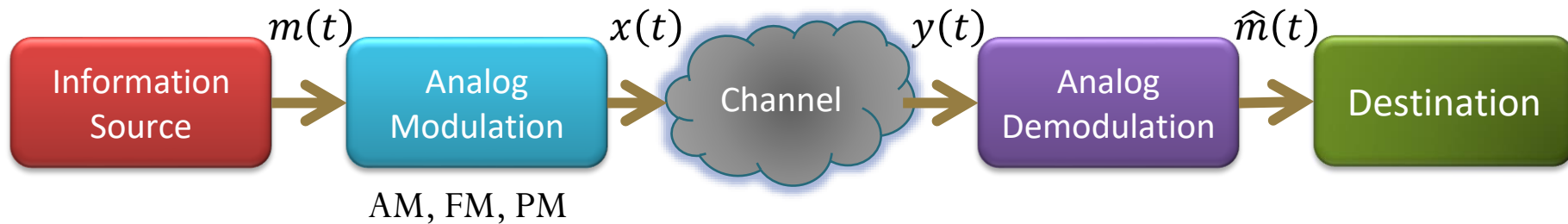
$$f(t) = f_c + k_f m(t)$$

$$\begin{aligned} x_{\text{QAM}}(t) &= m_1(t)\sqrt{2} \cos(2\pi f_c t) + m_2(t)\sqrt{2} \sin(2\pi f_c t) \\ &= \sqrt{2}E(t) \cos(2\pi f_c t + \phi(t)) \\ &= \sqrt{2}\{(m_1(t) - jm_2(t))e^{j2\pi f_c t}\} \end{aligned}$$

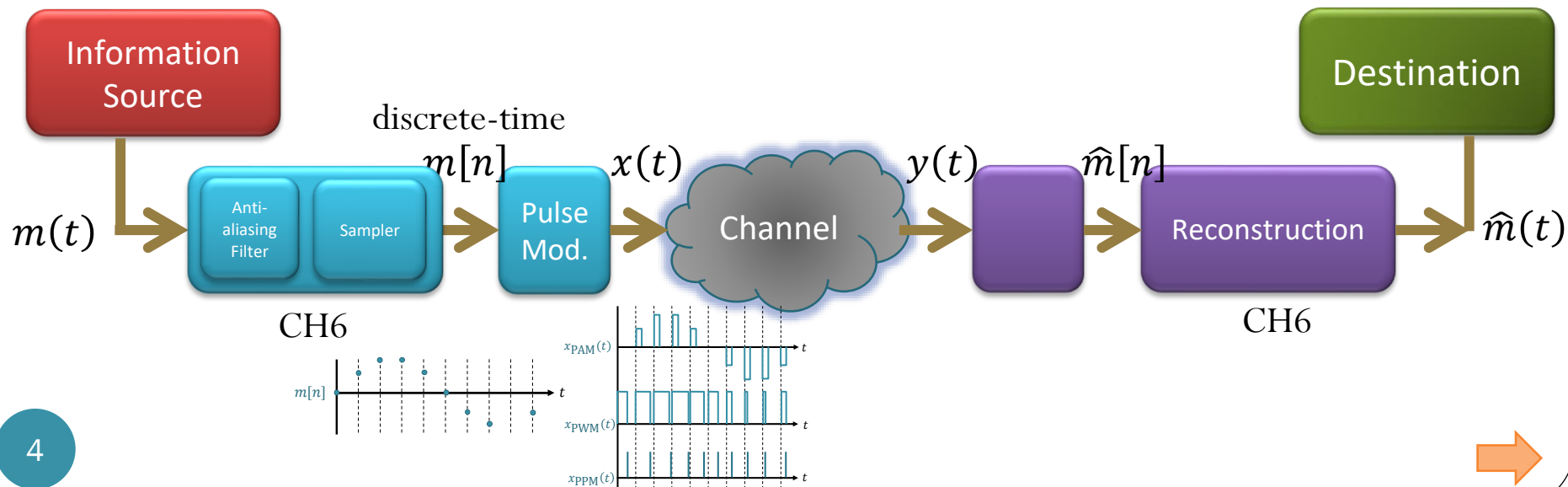


CH 3-5 vs. “CH 6 and beyond”

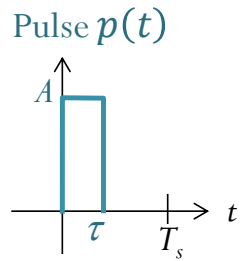
- Chapters 3-5



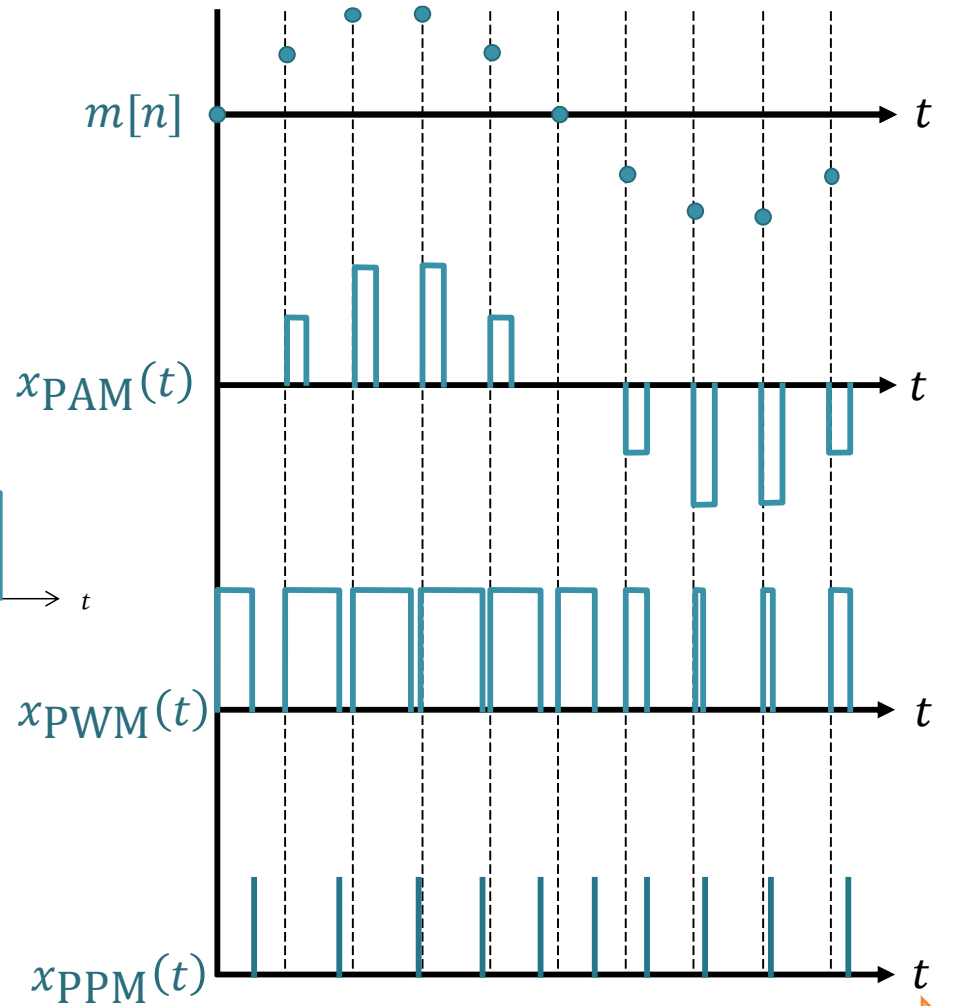
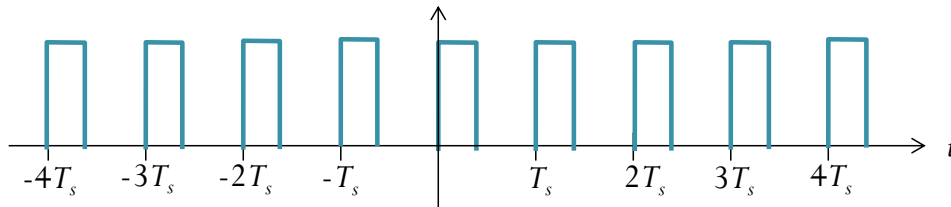
- Chapters 6 and beyond



Analog Pulse Modulation



Unmodulated pulse train



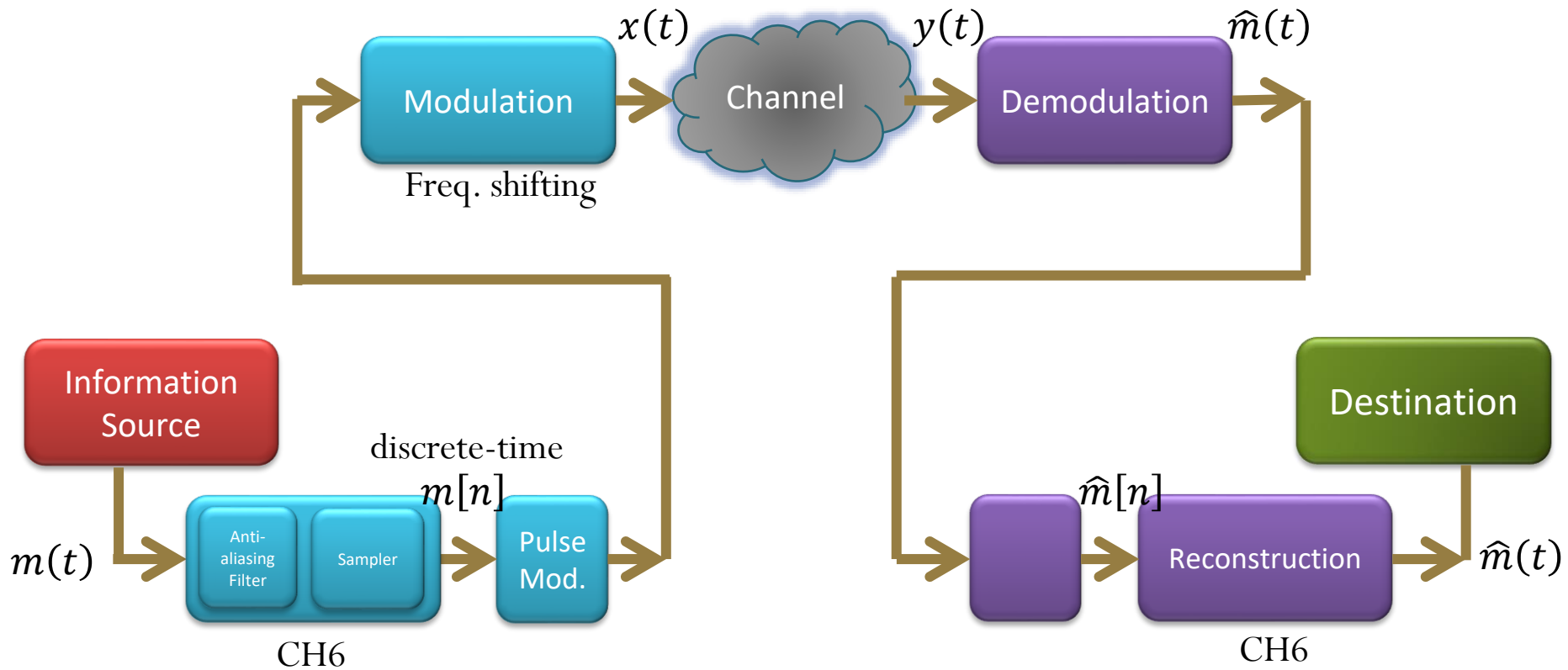
Pulse-Width Modulation



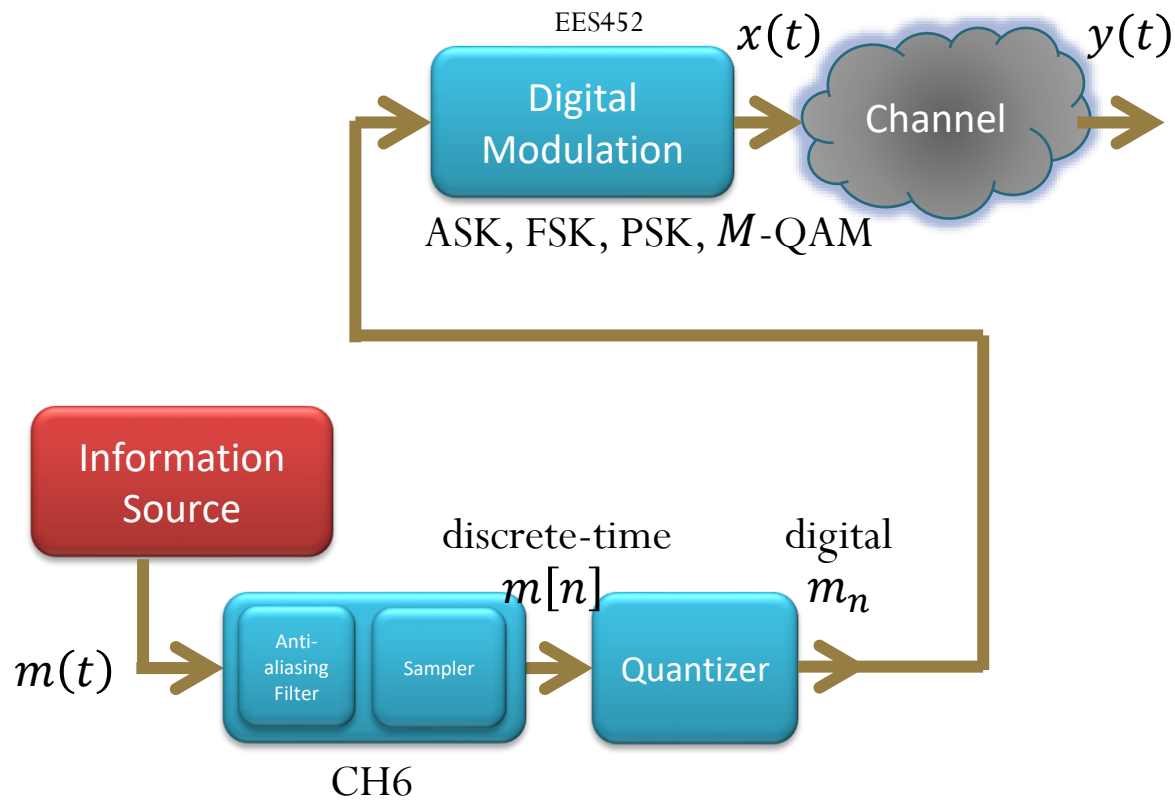
Pulse Position Modulation



CH 3-5 + “CH 6 and beyond”



CH 3-5 + “CH 6 and beyond”



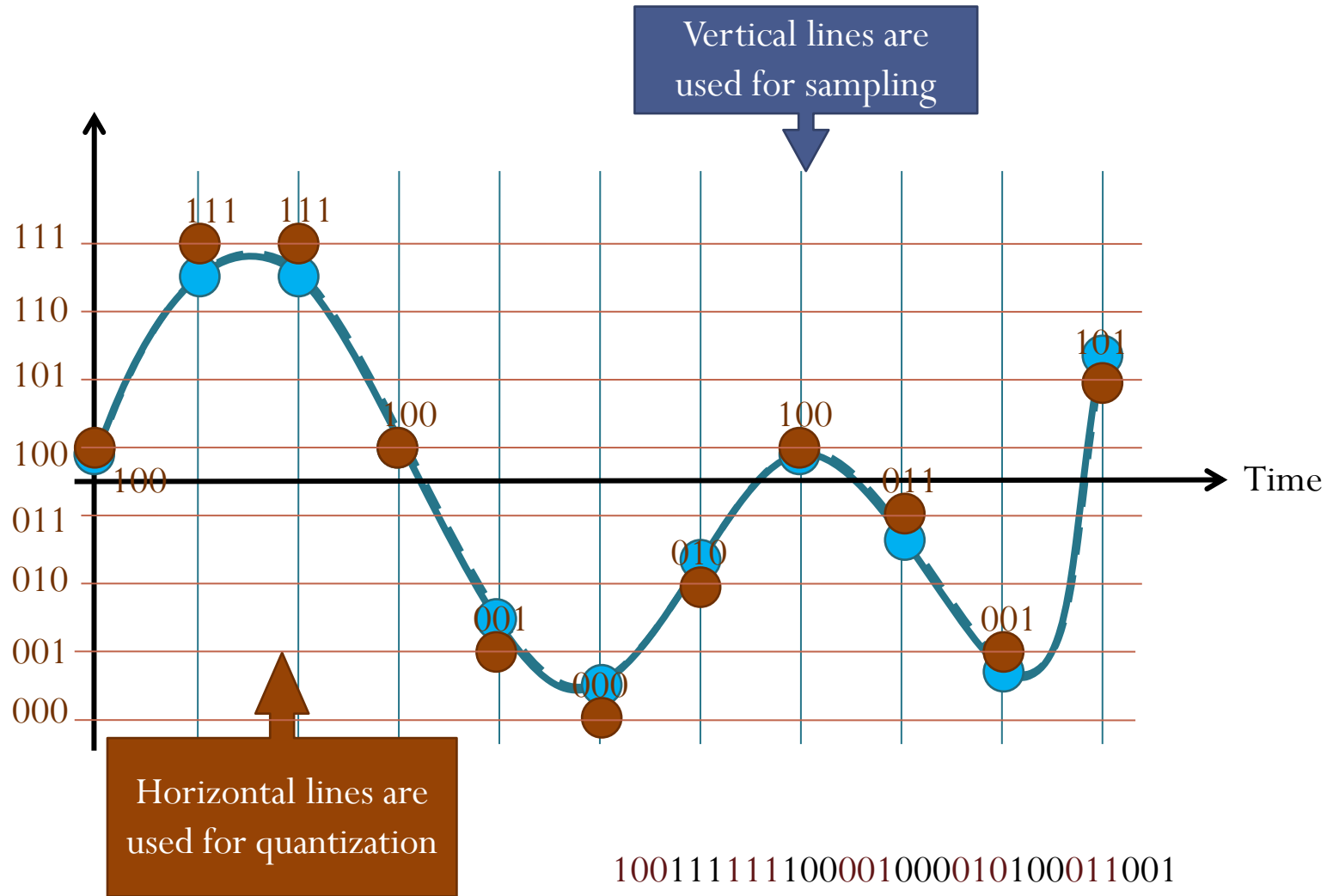
Digital Modulation: Waveform Modulation



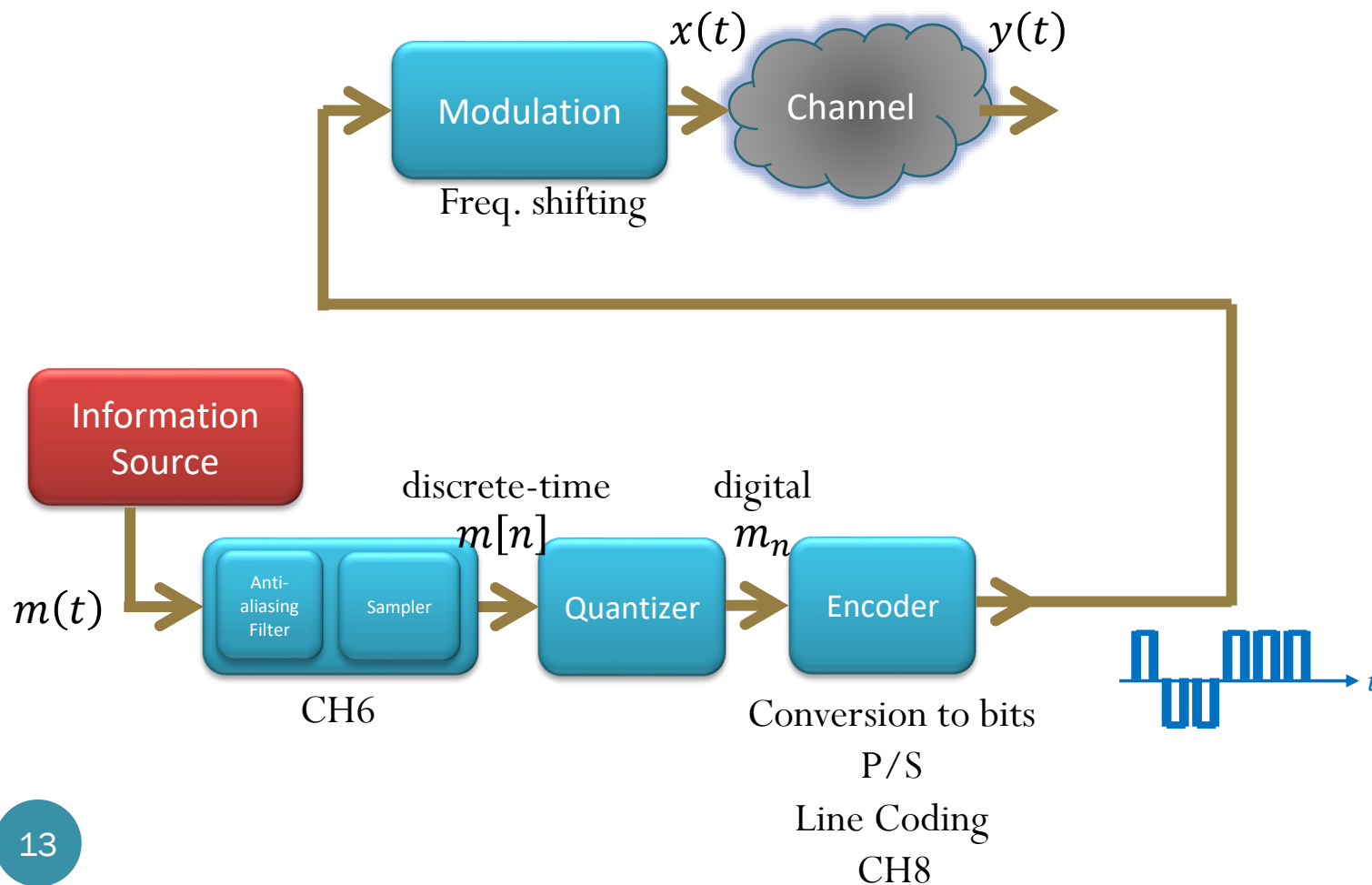
Digital Modulation: Waveform Modulation



PCM: Pulse Code Modulation

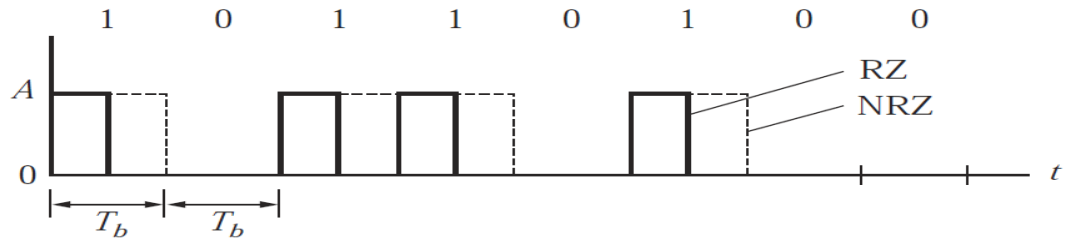


CH 3-5 + “CH 6 and beyond”

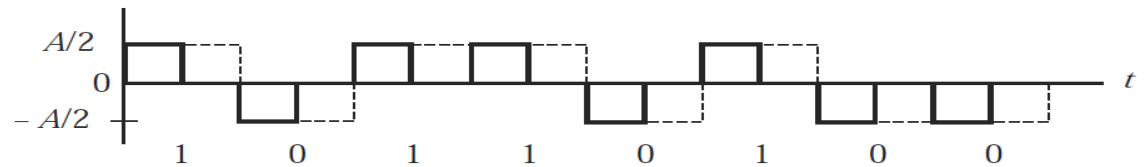


Line Codes

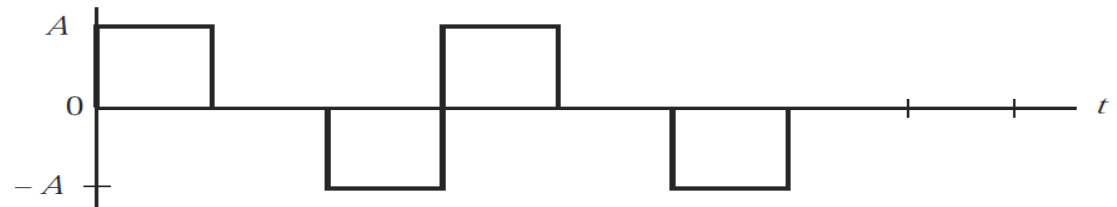
Unipolar



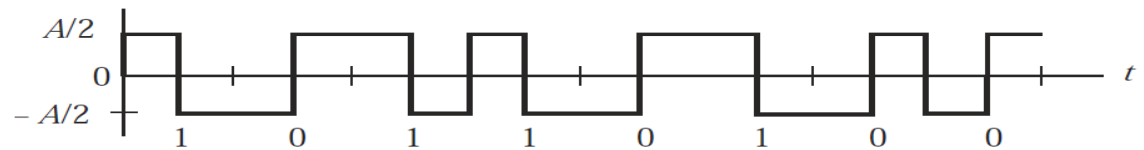
Polar



Bipolar



Manchester



4-PAM

