Lecture 5: Detection

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Block Diagram of a Typical Transmitter

| Information Source | → **b** → | Channel Code | → **c** → | Constellation Map | → $x[m]$ → | Modulation | → $x(t)$ → |

Information bits

Coded bits

Complex symbols

Passband signal

We will talk about this later.

Let's talk about this.

We've talked about this.
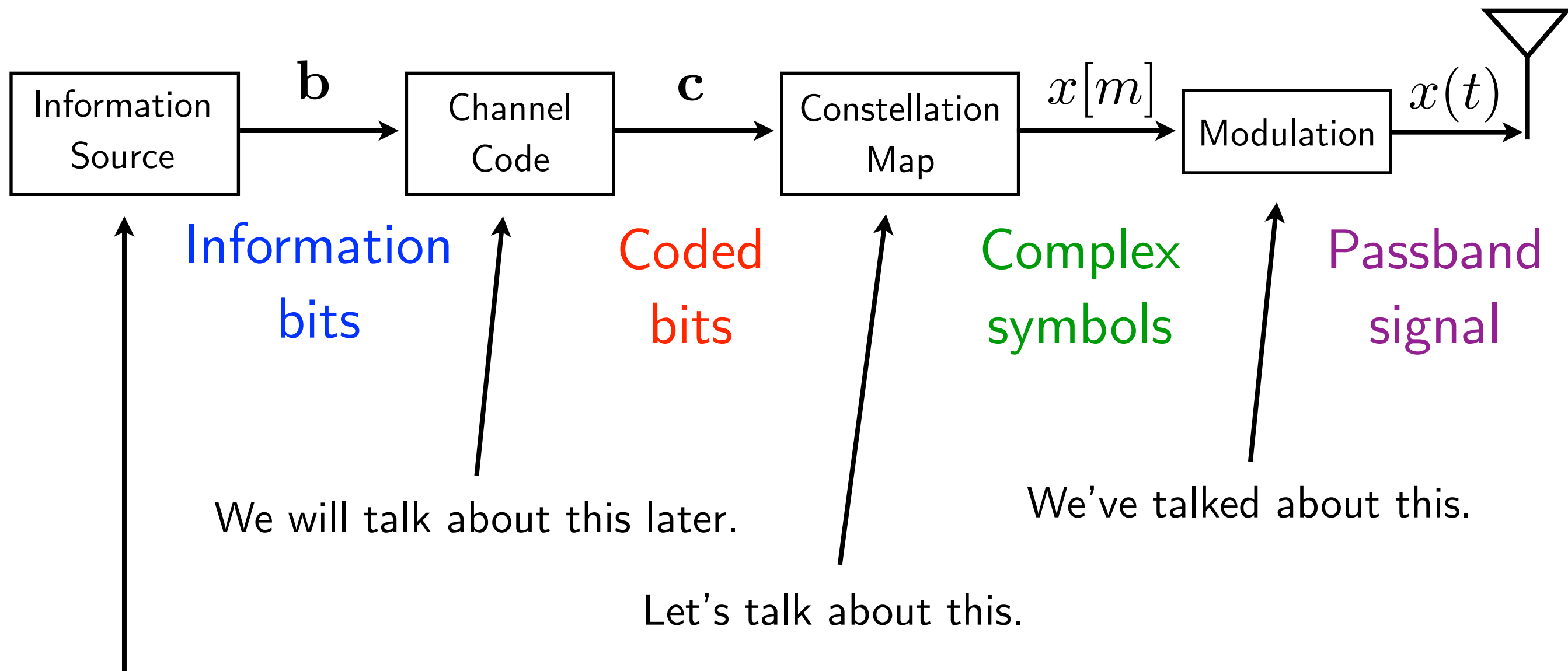
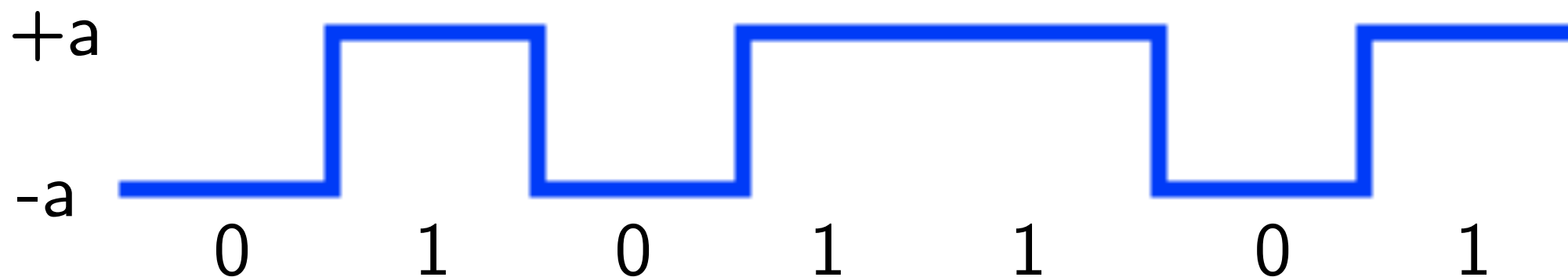● In this class, we will assume that the goal is to transmit bits.

= = = 01010011...

BPSK Signaling

- Let's assume that we only want to send a single bit (0 or 1).

- Binary Phase-Shift Keying (BPSK): Map 0 to -a and 1 to +a.

- Linear modulation: Baseband signal can be written as
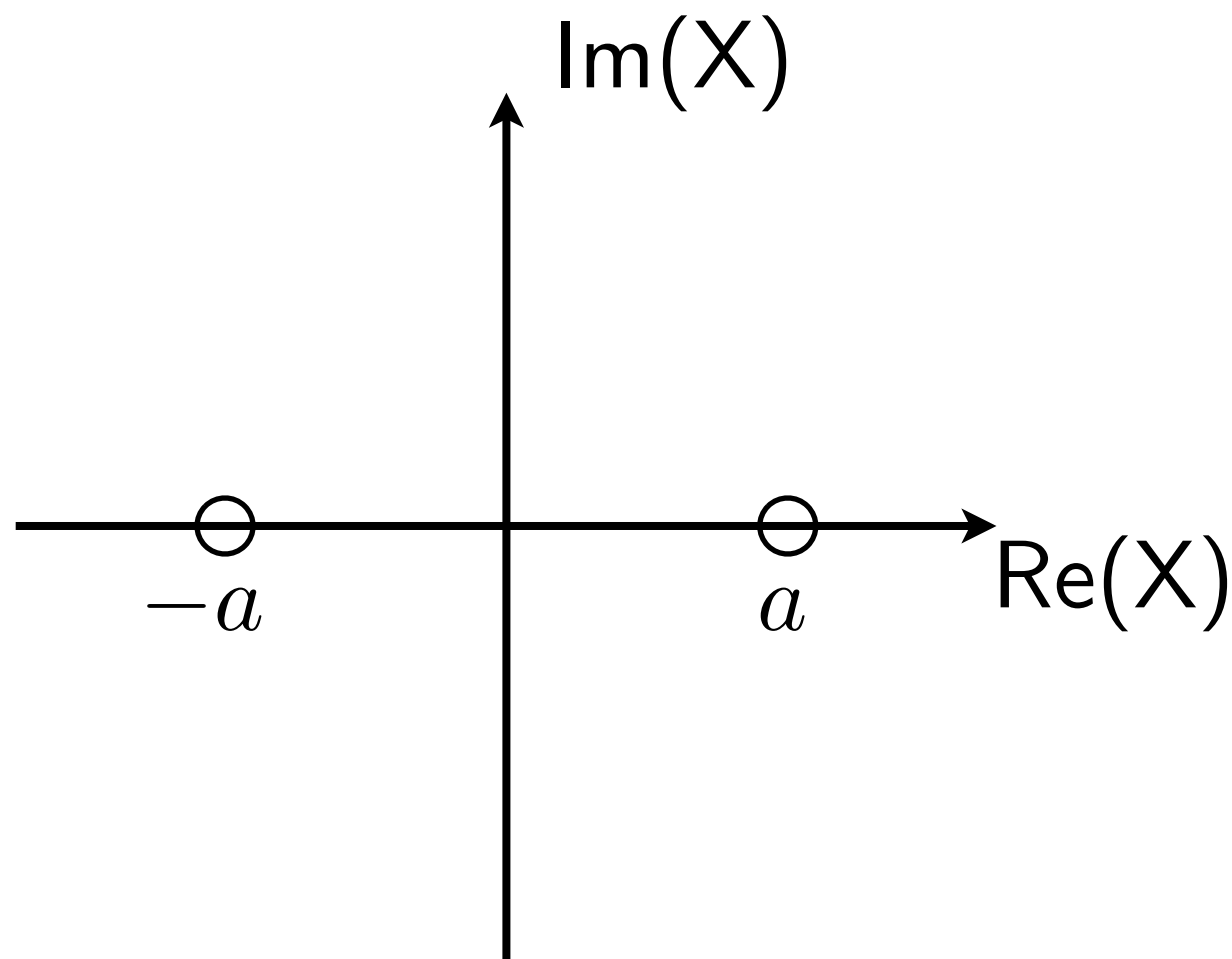
$$x_b(t) = \sum_m x[m]g\left(t - \frac{m}{W}\right)$$

$$x[m] = \text{ stream of constellation symbols}$$

$$g(t) = \text{modulation waveform (pulse or sinc)}$$

Constellation Diagram

- Remember that we only want to work in discrete-time.

- Constellation Diagram: Visualization of possible constellation symbols.
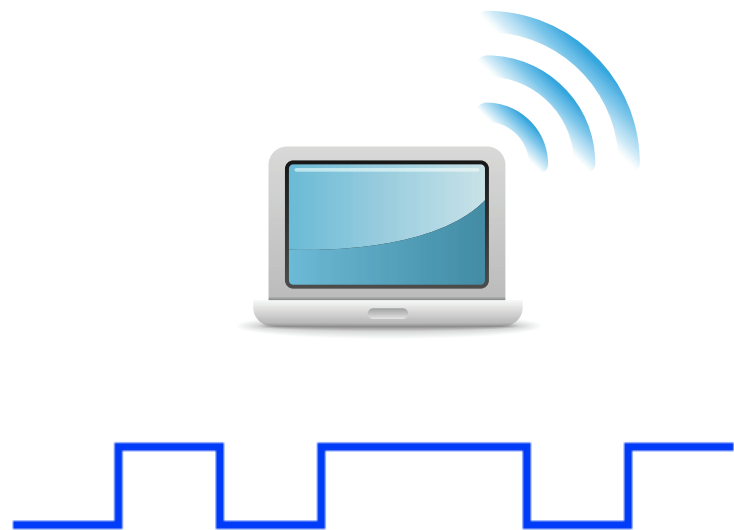
- For BPSK: $x[m] \in \{ +a, -a \}$

- From here, we can see that we are not using half of the possible signal dimensions by limiting ourselves to real-valued constellations (in complex baseband).

Examples of Constellations

QPSK (4–PSK or 4–QAM)

8–PSK

16–QAM
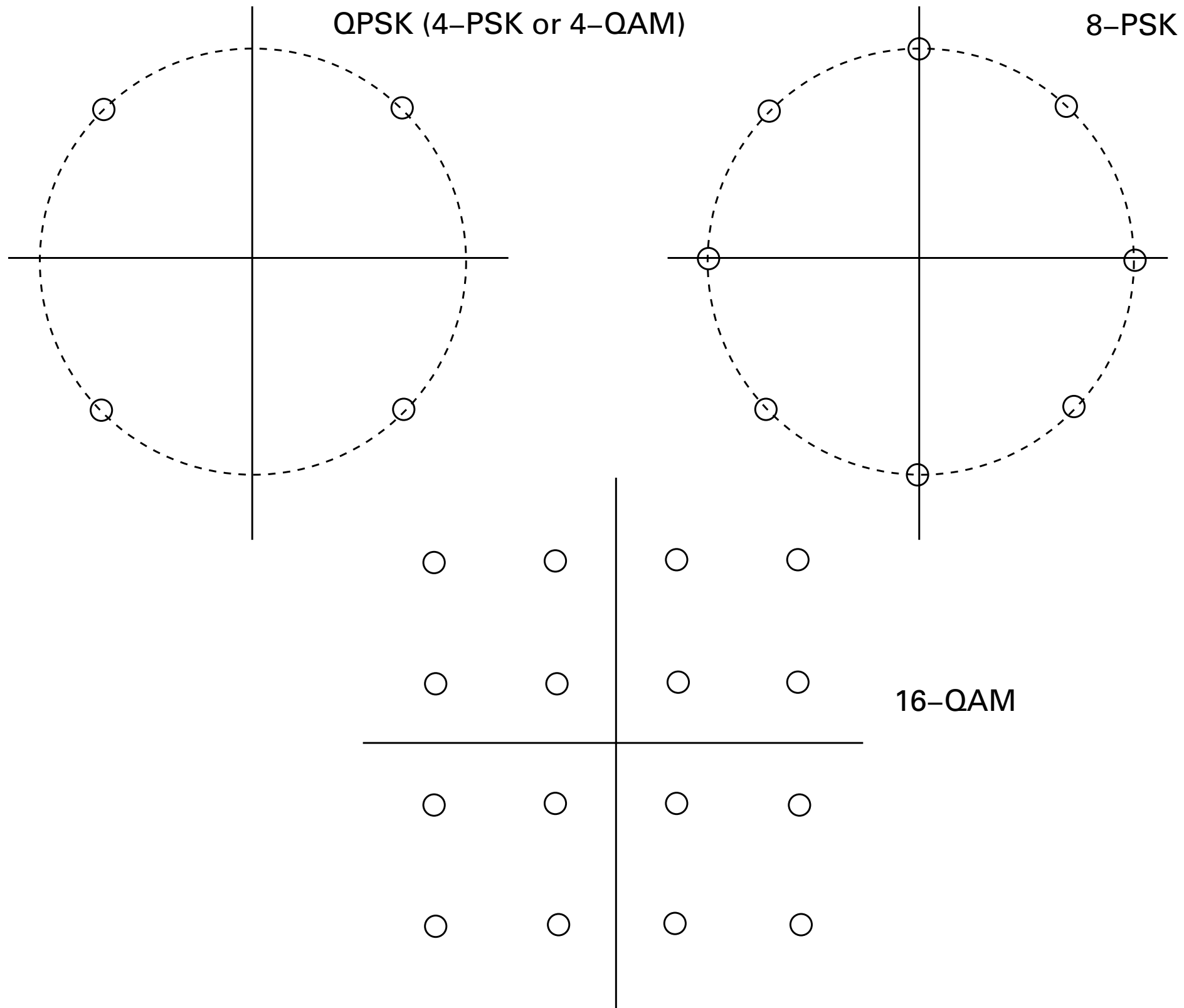
How should the receiver decode?

- Due to noise, the receiver will not see exactly what is sent by the transmitter (even if there is no fading).

$$x_b(t)$$

$$y_b(t) = x_b(t) + w_b(t)$$

- We will focus on understanding the optimal decoder after sampling. To see why this is an optimal approach, look up signal space representation. (Chapter 3 from Madhow which is now on blackboard.)