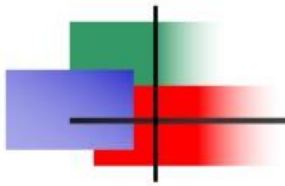


Chapter 5

Digital transmission through the AWGN channel

—— by Prof. XIAOFENG LI

SICE, UESTC

Contents 16 Hrs

- Introduction
- Geometric rep. of the sig waveforms
- Pulse amplitude modulation
- 2-d signal waveforms
- M-d signal waveforms
- Opt. reception for the sig. In AWGN
- Optimal receivers and probs of err

Introduction

In this chapter, we focus on how to transmit digital info signals with waveforms.

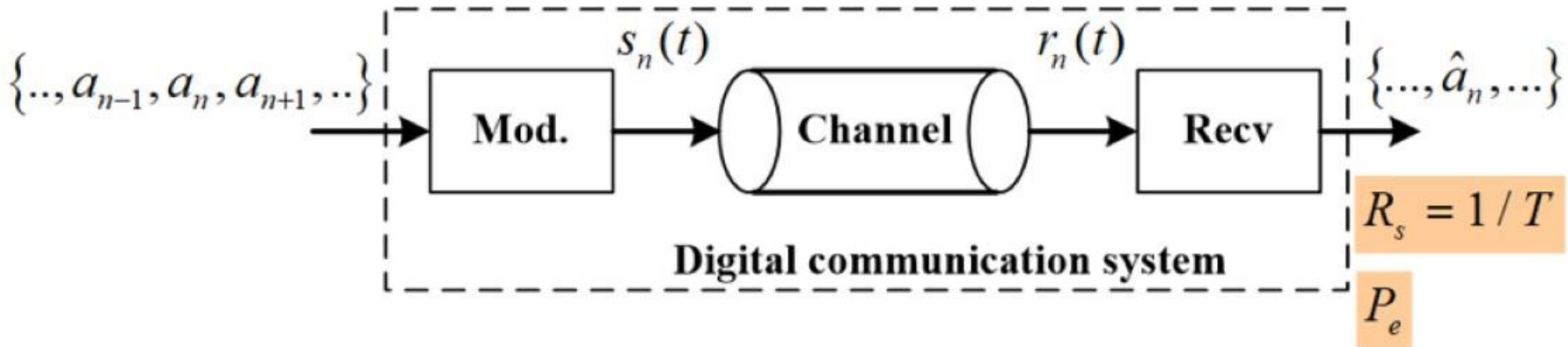
The topics include:

1. Geometric representation of sig waveforms;
2. Diff types of waveforms for digital transmissions;
3. Optimal reception;
4. Performance evaluation on the AWGN channel
5. Comparison of the methods.

5.6.10 Comparison of modulations

1) Efficiency, R_b
2) Reliability, P_b

Recall a general block diagram of digital communication



It is natural to evaluation the whole systems in 2 aspects:

1) Efficiency, how fast? R_s
2) Reliability, how many errors? P_e

More generally, we talk about the bit-rate R_b and bit-err P_b respectively.

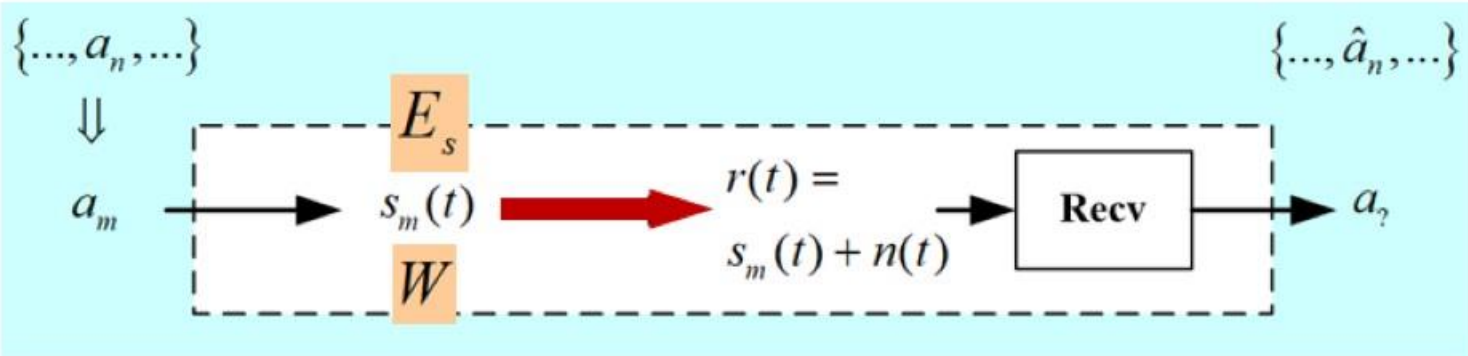
We see that,

1) $R_b = kR_s = (\log_2 M)R_s, \quad k = \log_2 M$
2) $P_b = ? P_e$. With Gray code, we have $P_b = P_e / k$.

5.6.10 Comparison of modulations

1) Efficiency, R_b
2) Reliability, P_b

In the physical channel, Electrical waveforms, such as pulses and carriers, are used to transmit info in the physic media.



Specifically,

- Baseband (BB) : pulses of diff amps (PAM), or orthogonal pulses (PPM);
- Passband (PB) : Carriers with amp/phs/freq mod. (ASK/PSK/FSK), QAM

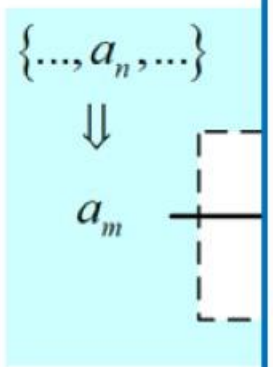
The essential physical features of the waveform is the

1) The BW: denoted by W;
2) The energy: denoted by E_s (if unequal, E_{av}) , or $E_b=E_s/k$;

5.6.10 Comparison of modulations

1) Efficiency, R_b~W, or η
2) Reliability, P_b~E_b/N_0

In the physical cha
are used to transm



Specifically,

- Baseband (BB) :
- Passband (PB) :

Refer to the **BW** of a waveform, we simply conclude that,

BB pulse: $W = R_s/2$ PB signals: $W = R_s$

For M-D signals,

BB pulse: $W = MR_s/2$ PB signals: $W = MR_s$

We define the normalized data rate (alse called spectral efficiency) as

$$\eta = \frac{R_b}{W} = \frac{kR_s}{W} \text{ (bps/Hz)} \qquad k = \log_2 M$$

The essential physical features of the waveform is the

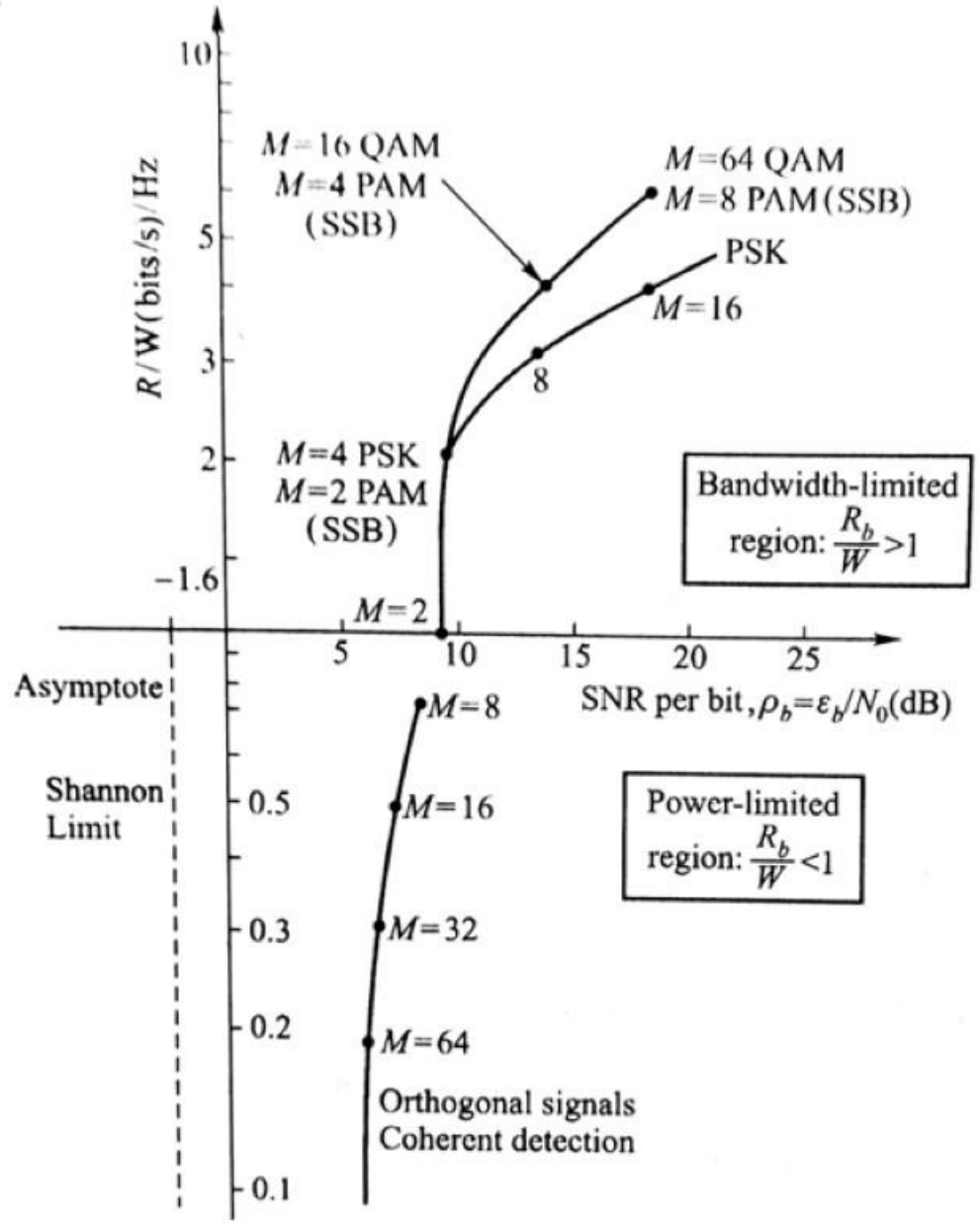
1) The BW: denoted by W;
2) The energy: denoted by E_s (if unequal, E_{av}) , or $E_b=E_s/k$;

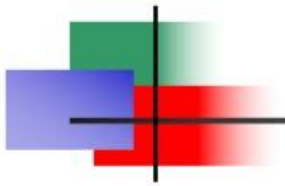
5.6.10 Comparison of modulations

Note that there are two **typical applications**:

1) Band-limited which demands high special efficiency, QAM is the best, for its required E_b/N_0 is relatively small.
2) Power-limited which demands low energy, FSK is an option, for its required E_b/N_0 can be very small.

Fig 5.66 on p341.





End of this chapter

Thank you