

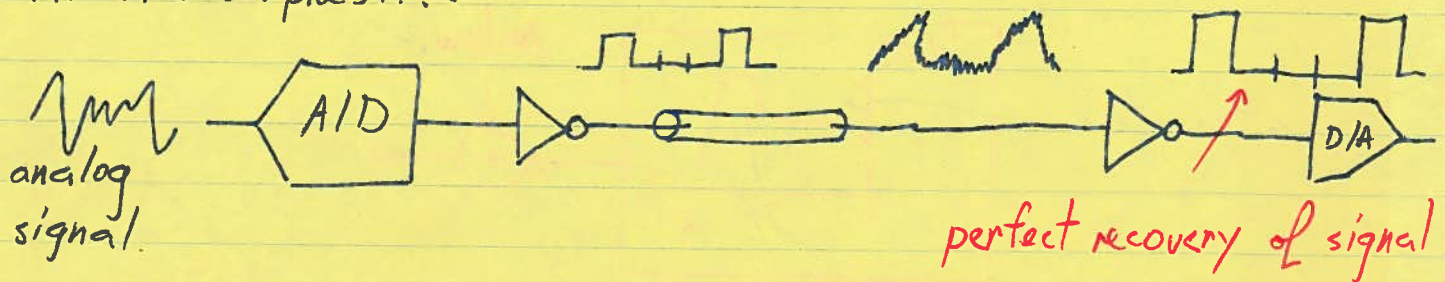
1/1 Introduction to Digital Communications

1

1.1 Basic Ideas

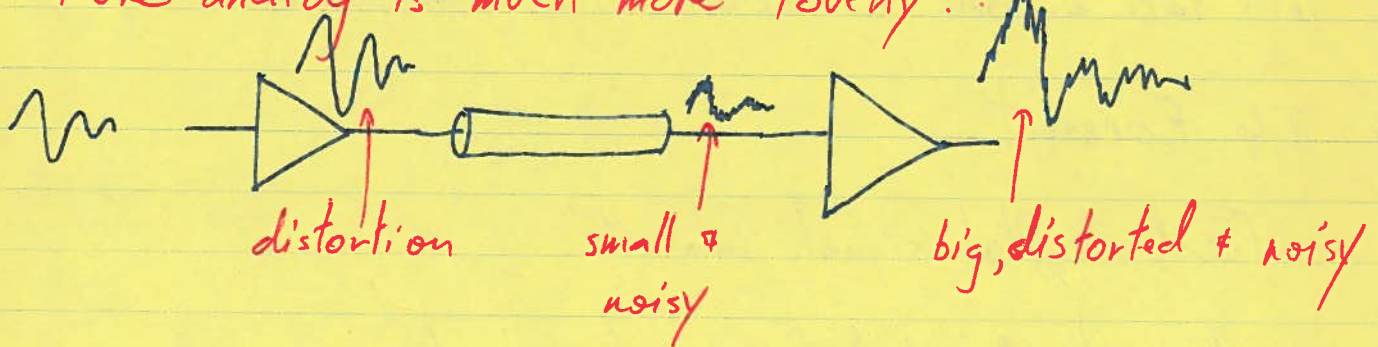
- What is digital comms? *Sending signals that have been converted to 0's & 1's*

- At it's simplest...



- The tremendous noise immunity of digital signals makes very robust digital comms. possible

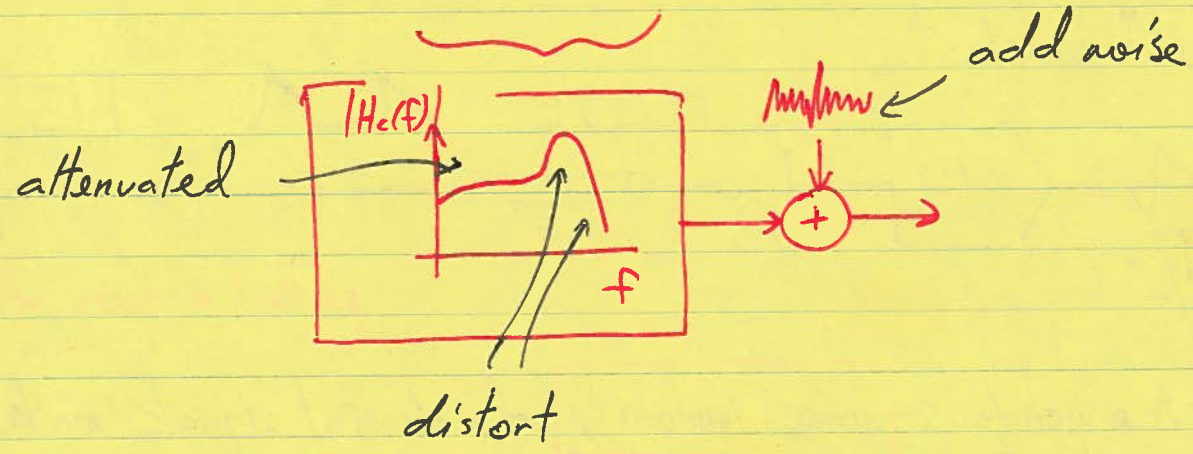
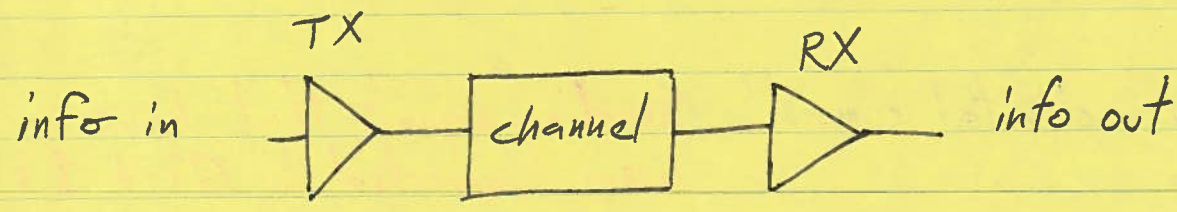
- *Pure analog is much more touchy!!*



- **BUT**... practical digital comms. requires a sophisticated array of components

- we will explore these requirements in this class

1.2 A Digital Comms. System

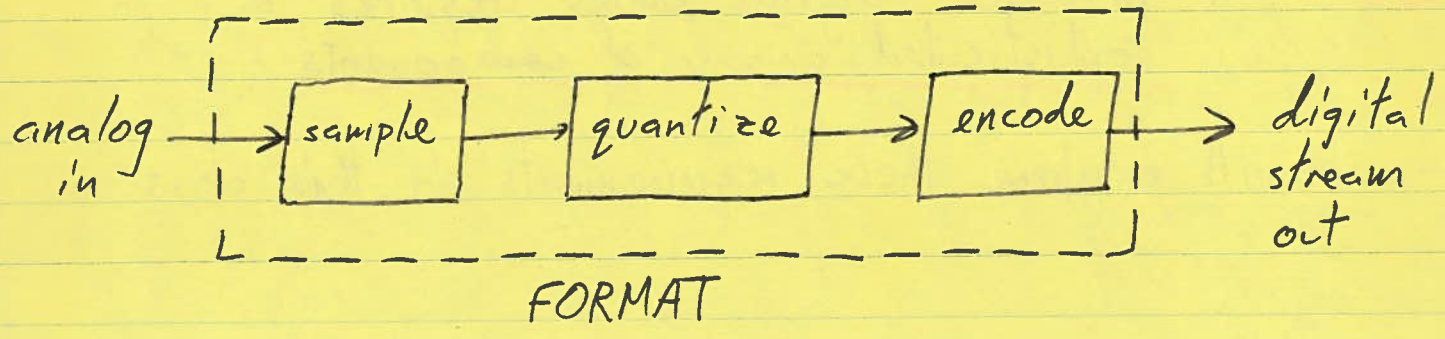


your tx & rx have to deal with all these problems

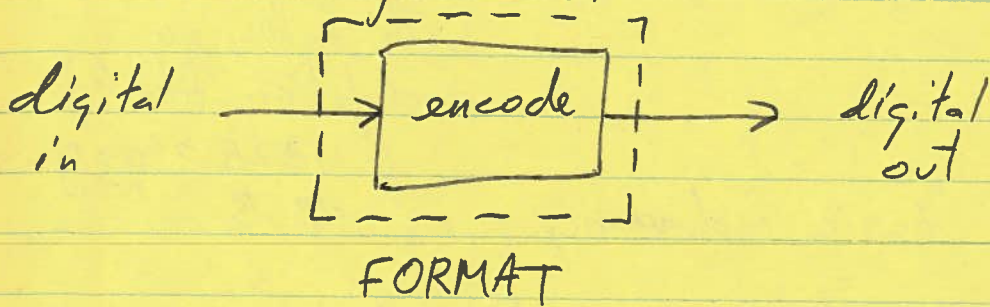
- let's take a look at some TX components

1.3 The Format

- feed digital signals into tx
- obviously needed for analog signals



- some digital can also be encoded



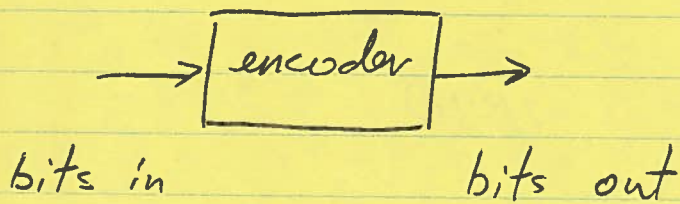
e.g. 7-bit ASCII + 1 parity
or truncated to
6-bit ASCII (e.g. BCD)

1.4 Source Encoder & Encryption

↓
take out redundancy

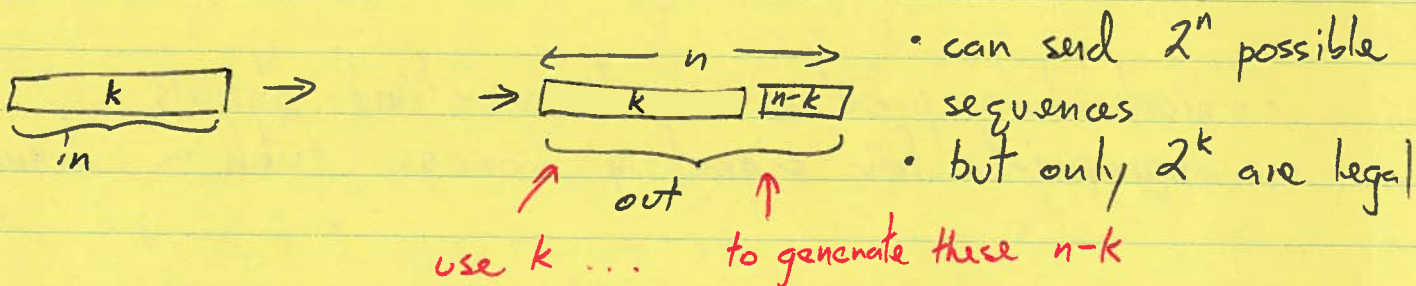
↓
add or scramble bits
to protect secrets

1.5 Channel Encoder

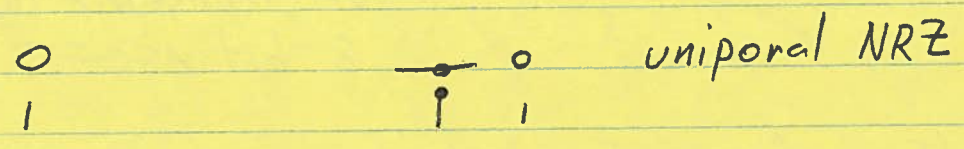


- throw in more bits to increase data redundancy
- channel coding

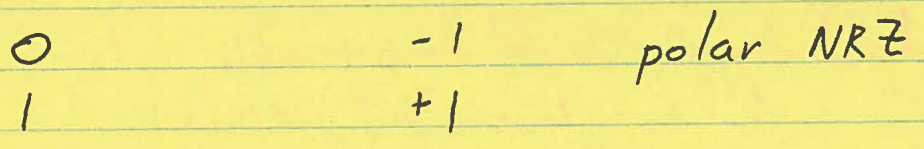
- redundancy makes it easier to detect or correct for errors when data is distorted & noise added



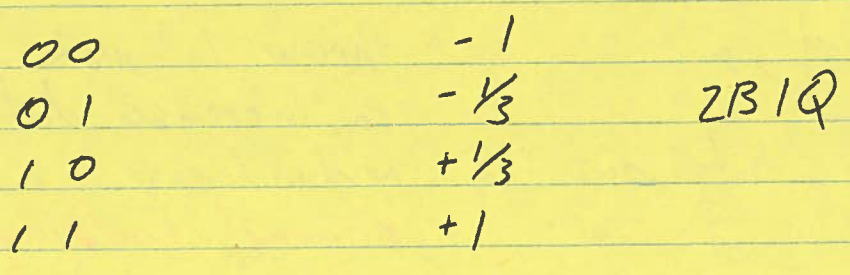
- a second tier is *line coding* (often associated with following modulation block)
- includes very basic redundancy e.g. 4B5B $\begin{matrix} 1B \rightarrow 2B \\ 0 \rightarrow 01 \\ 1 \rightarrow 10 \end{matrix}$
- and mapping of bits into symbol values



-OR-

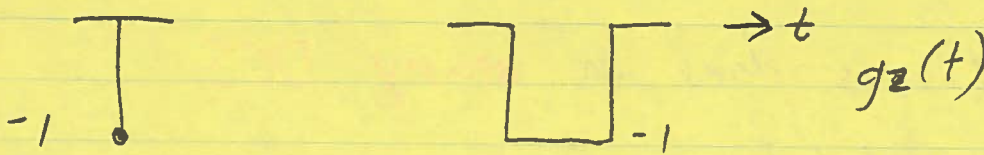
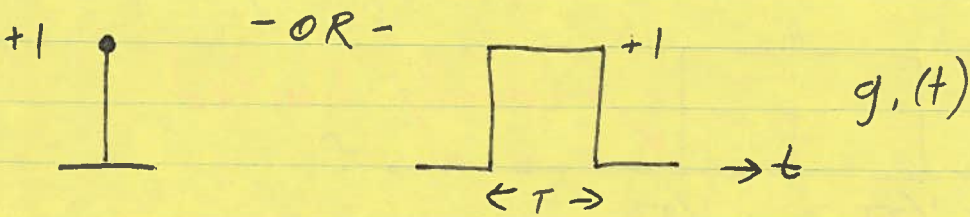
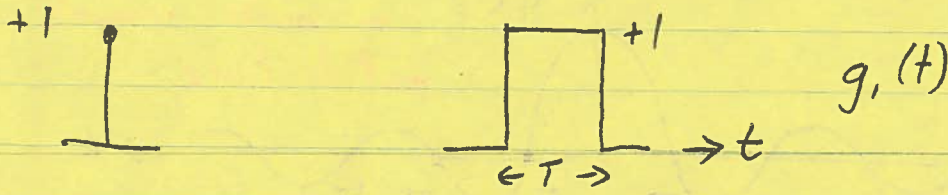
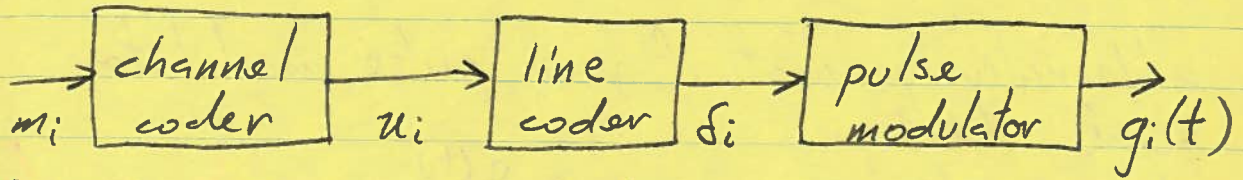


-OR-

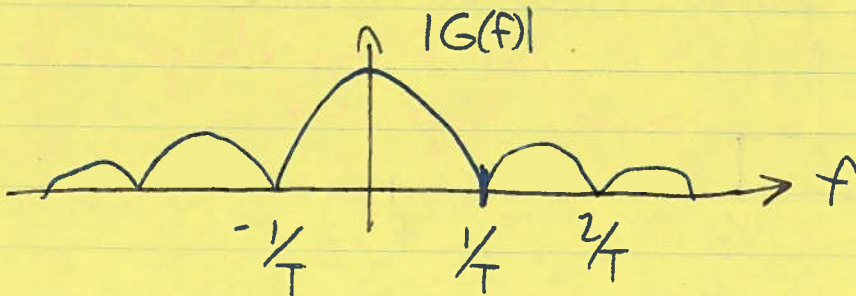


1.6 Pulse Modulation

- channels are real continuous (in time) entities
- modulators produce continuous-time signals appropriate for signalling across such a channel



note frequency char. of such a pulse

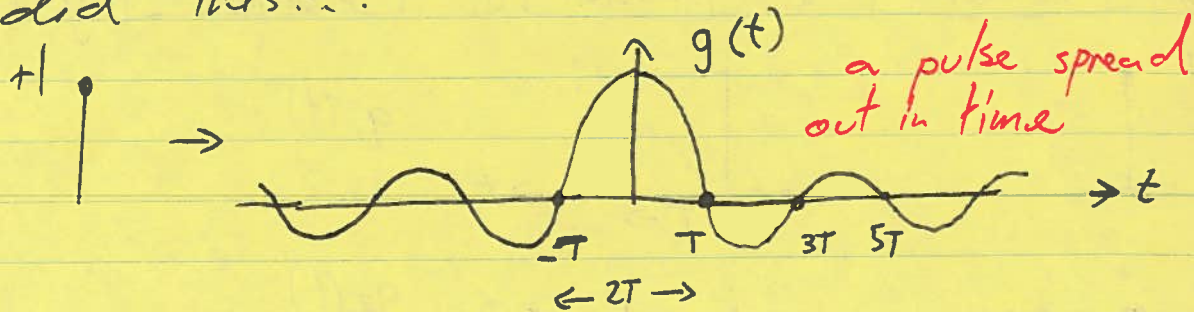


if $T = 1 \mu s$
 $R = \frac{1}{T} = 1 \text{ Mbps}$

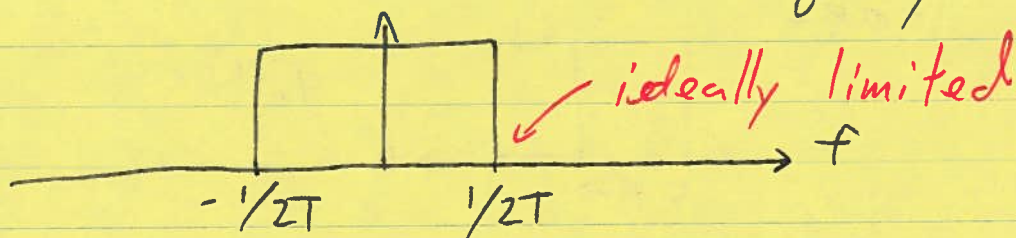
1 MHz 2 MHz ... BW (W) extends to higher freqs.

- note lots of "signal" at L.F. (progressively less as you move up)
- roughly the idea behind **BASEBAND TX.**

- alternatively what if your pulse modulator did this...



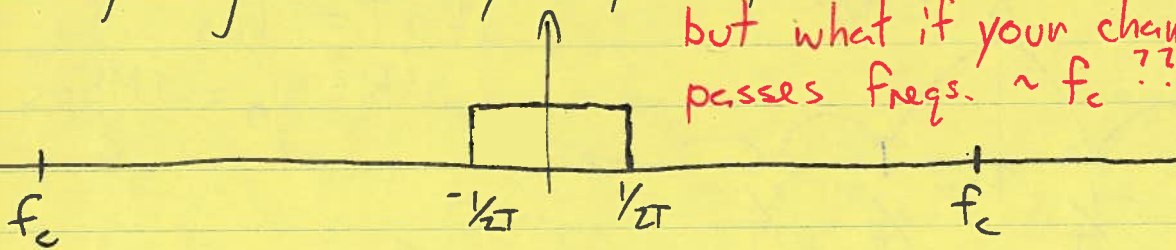
... BUT ... a nice confined frequency response



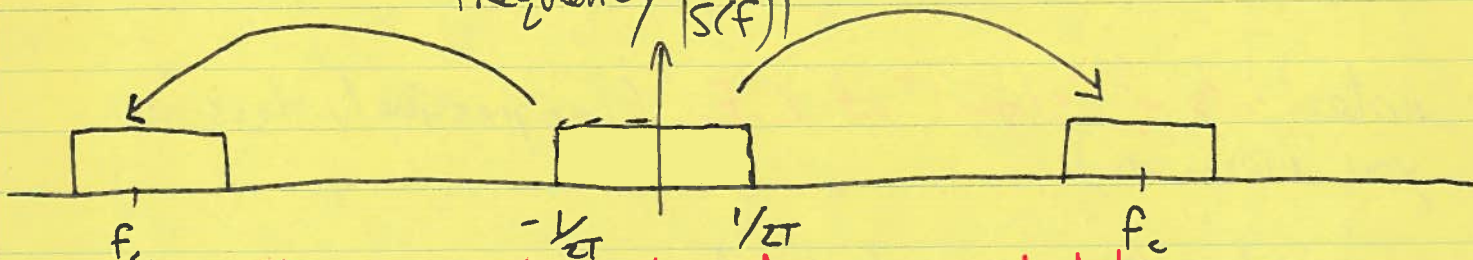
- turns out this is done in many DCS

1.7 Bandpass Modulation

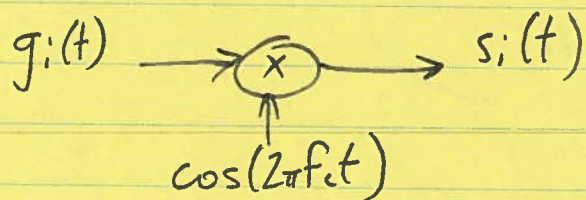
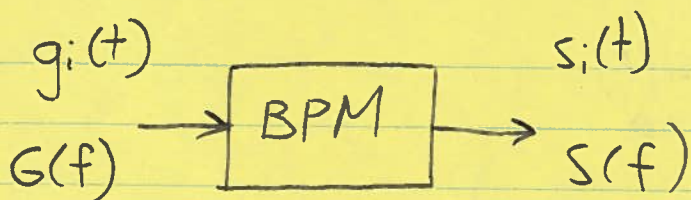
- getting a nicely shaped spectrum is nice but what if your channel only passes freqs. $\sim f_c$???



→ translate your $G(f)$ to the appropriate frequency $|S(f)|$

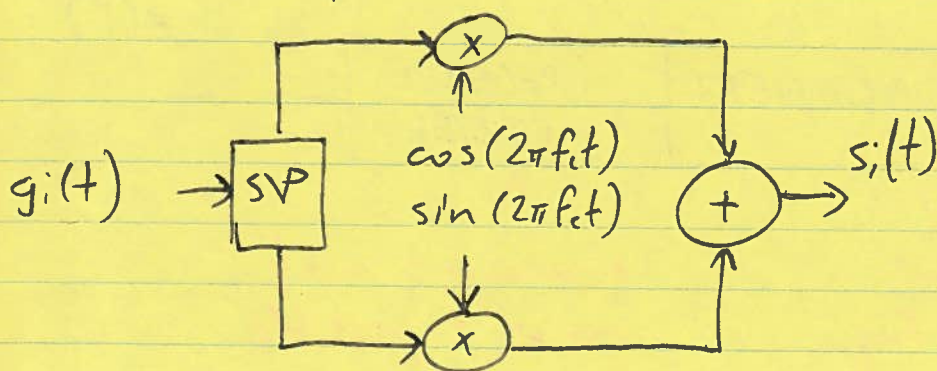


→ this is called bandpass modulation



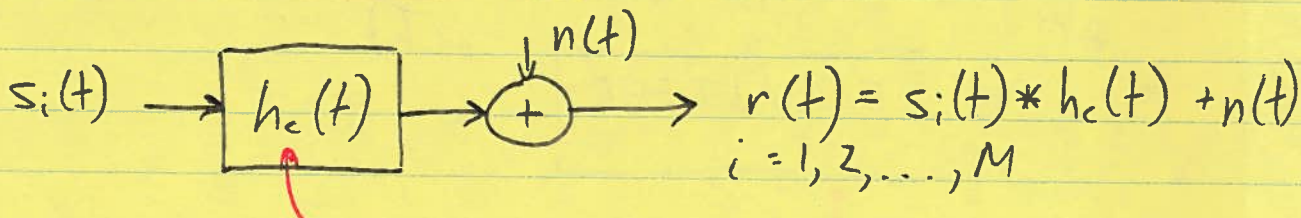
more complicated

QAM



1.8 The Channel

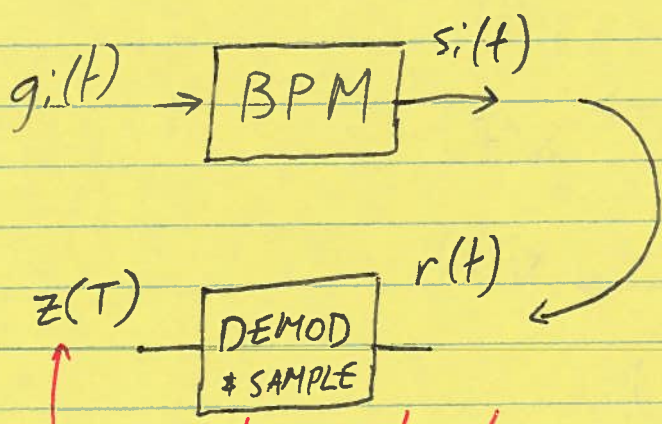
→ treat like a filter with additive noise



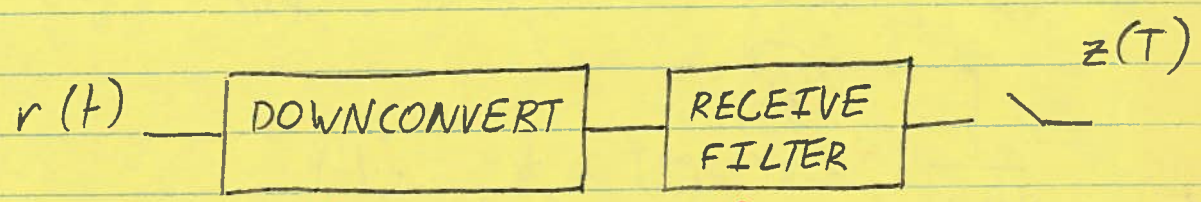
channel impulse response

1.9 The RX

- RX does everything in reverse & is generally harder to design (deals with small signal & random noise)

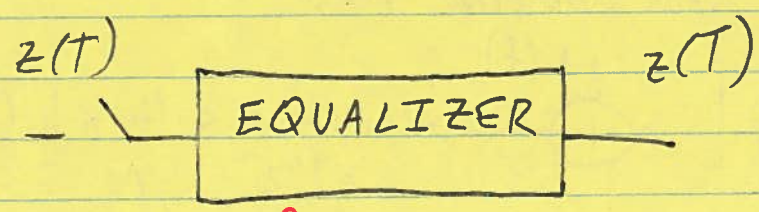


map your input signal into a single level every T



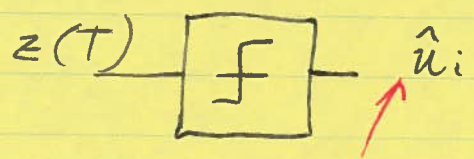
bring signal down in freq.

remove as much noise as possible in Mapping (Matched Filter/ Correlator)



remove distortion introduced by channel

1.10 Detector



estimate of u_i

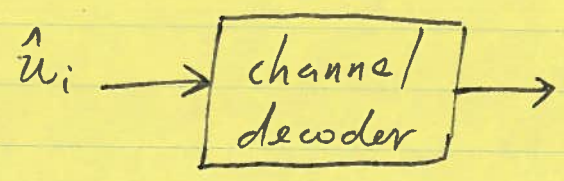
make the best possible decision on the symbol represented by $z(T)$

shooting for minimal BER or P_e

$$P_e = \frac{\text{\# of errors}}{\text{total \# of symbols sent}}$$

for wireless comms after detector $\sim 10^{-3} - 10^{-4}$
 " wired $\sim 10^{-7} - 10^{-8}$

1.11 Channel Decoder



$P_e / \text{wireless} \sim 10^{-6} - 10^{-7}$

$P_e / \text{wired} \sim 10^{-12} - 10^{-20}$

10/10/10

1. The first part of the book is a history of the world from the beginning of time to the present day. It covers the major events and people that have shaped the world as we know it.

Introduction

The world is a vast and complex place, and it is difficult to understand it without a knowledge of its history. This book is intended to provide a comprehensive overview of the world's history, from the beginning of time to the present day.

The book is divided into three main parts: the first part covers the prehistoric period, the second part covers the ancient world, and the third part covers the modern world.

The prehistoric period is the longest and most mysterious of the three. It is a time when the world was first populated by man, and when the first tools and weapons were invented.

The ancient world is a time of great achievement and discovery. It is a time when the first civilizations were born, and when the first great works of art and literature were created.

The modern world is a time of rapid change and progress. It is a time when the world has become a global village, and when the human race has achieved more in the last few centuries than in all the centuries before.

The book is written in a clear and concise style, and it is intended to be accessible to a wide range of readers. It is a book that should be read by everyone who is interested in the world and its history.

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