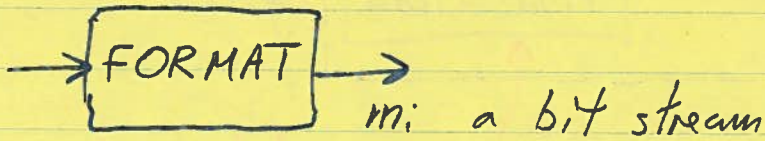


# L8 Baseband Demodulation / Detection Basics

1

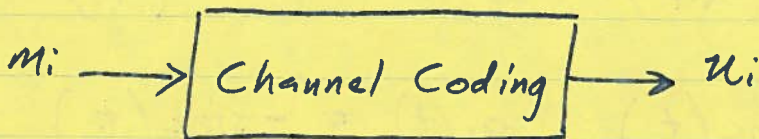
## 8.1 System Review

- Out of TX so far...



- bit stream may have some structural pattern already  
e.g. 3-bit chunks in an 8-level PCM  
7-bit chunks encoding an ASCII character of digital text

- Then you have...



- adding bits (redundancy) to stream

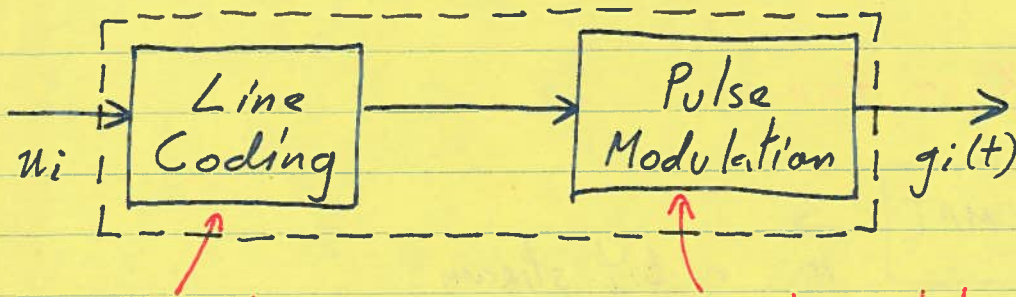
e.g. ASCII + even parity

1	2	3	4	5	6	7	8
1	0	0	1	0	1	0	1

- now if receive 00010101  $\Rightarrow$  ODD parity, detect an error
- practically like boosting signal power

- still from a low-level  $u_i$  is still just a stream of bits

• Then you run through the modulator



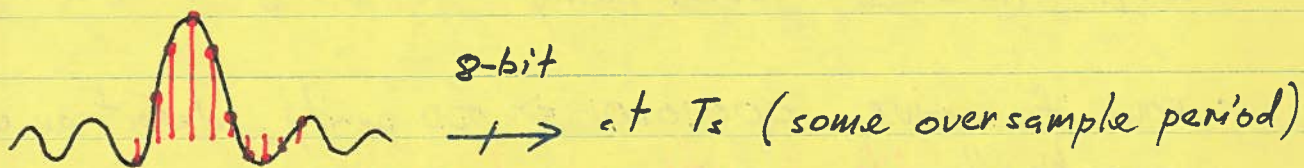
- manipulations of bit patterns
- bit representation (still discrete-time) (e.g. 4B5B)

- re-interpretation of bits or collections of bits into continuous waveform representations
- SYMBOLS

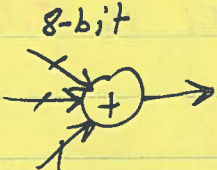
e.g.  $g_1(t) = \text{rect}\left(\frac{t}{T}\right)$       $g_2(t) = -\text{rect}\left(\frac{t}{T}\right)$

$g_1(t) = \text{sinc}\left(\frac{t}{T}\right)$       $g_2(t) = -\text{sinc}\left(\frac{t}{T}\right)$

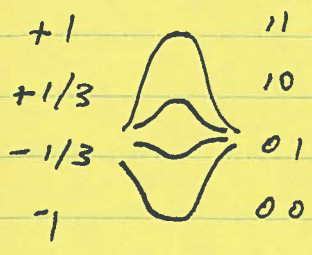
- in practice this may still be a **digital signal**



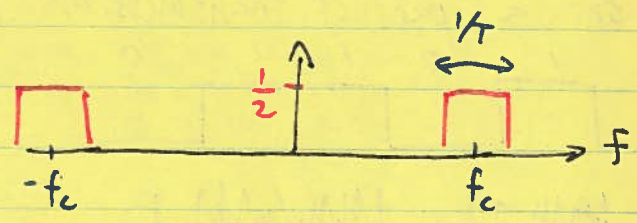
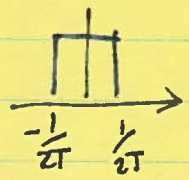
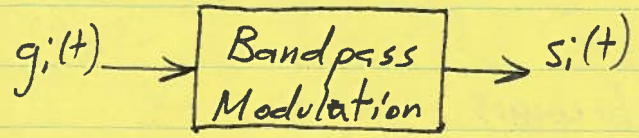
- digital allows us to carry out more complex functions

- e.g.  adding up many user waveforms to send from a base station

• you also have the option to encode in amplitude  
M-ary PAM



• you have more freedom... centre frequency **bandpass modulation**



$$\text{sinc}\left(\frac{t}{T}\right)$$

$$\text{sinc}\left(\frac{t}{T}\right) \times \cos(2\pi f_c t)$$

• how do we get our bits out of these waveforms ???

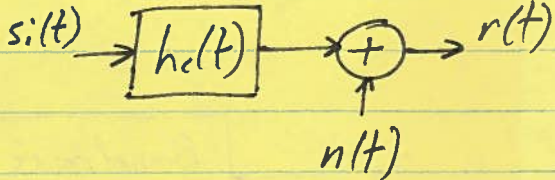
### 8.2 The Received Signal

... don't forget the signal we get is changed by the **channel**

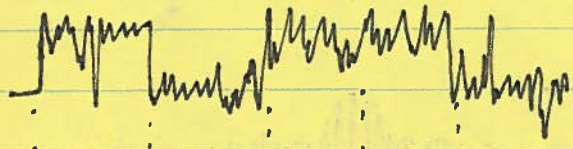
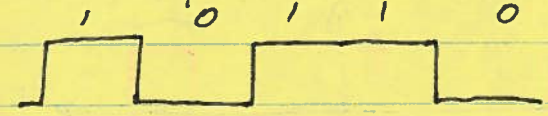
• transmitted digital waveforms (symbols) are

$$s_i(t) = \begin{cases} s_1(t) & 0 \leq t \leq T \text{ for binary 1} \\ s_2(t) & 0 \leq t \leq T \text{ for binary 0} \end{cases}$$

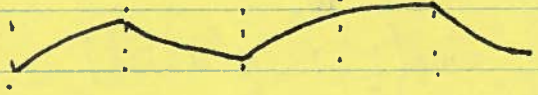
• after channel we get

$$r(t) = s_i(t) * h_c(t) + n(t)$$


• so a perfect transmission becomes



← noisy version in a **broadband** channel

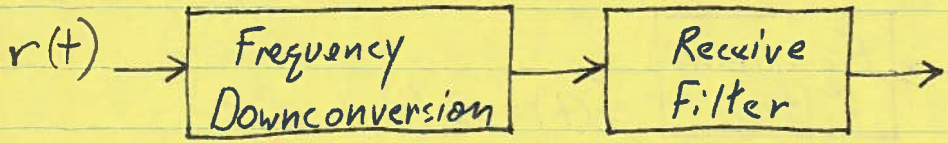


← distorted (and noisy) in a **narrowband** channel

• the effect of a symbol leaking out of its designated time period T to interfere with other symbols is **ISI**

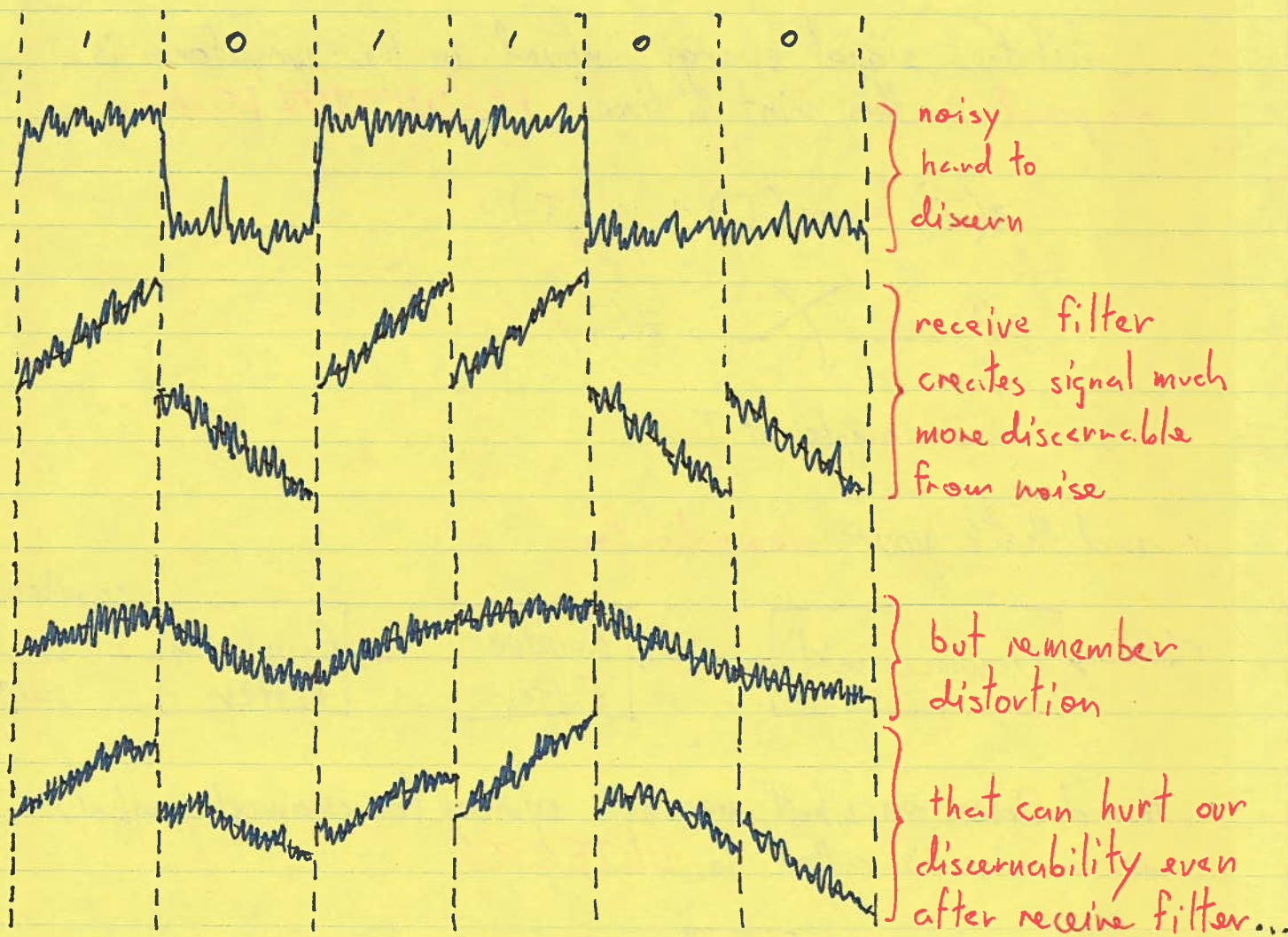
### 8.3 Demodulation & Detection

• How does a digital comms. RX deal with a signal filtered by the channel?

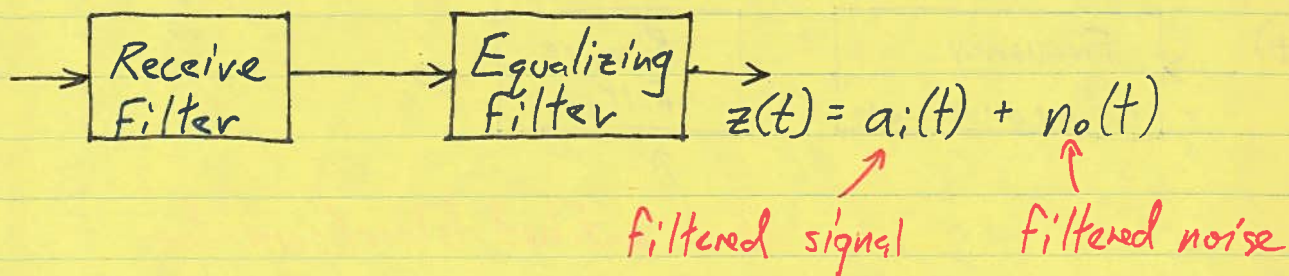


aka matched filter/correlator

- tries to extract as much signal energy as possible while eliminating as much noise as possible



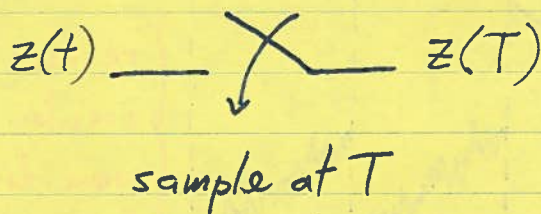
- ... so use an "un-distorter" (equalizer)



... now sample it at the optimal time,  $T$  (typically the end of the allotted symbol time)

... all the signal energy impud in the waveform is mapped to this point in time: **PREDICTION POINT**

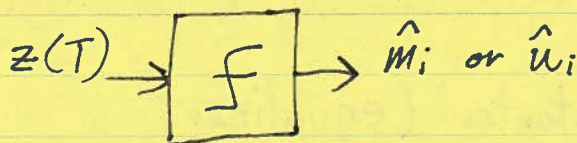
$$z(T) = a_i(T) + n_o(T)$$



• and that's your **demodulator**



• the decider on what message symbol (or channel symbol) we receive is called the **DETECTOR**



- the detector carries out a **statistical hypothesis test**
- an "explanation" for an observation that contains probabilistic influences
- obviously the explanation/hypothesis is ... we received this signal because a "0" arrived -OR- we received this signal because a "1" arrived

$H_1$ : Based on  $z(T)$  received I hypothesize that a '1' was sent

$H_2$ : " " " " " " " " '0' " "

- These hypotheses are based on a **THRESHOLD MEASUREMENT**

$$z(T) \underset{H_2}{\overset{H_1}{\geq}} \gamma$$

choose  $H_1$  if  $z(T) > \gamma$

choose  $H_2$  if  $z(T) < \gamma$

(2)

1. The first part of the book is devoted to a study of the

history of the subject, and the author shows how the

subject has developed over the years, and how the

author's own work has contributed to the progress of

the subject. The author also discusses the

importance of the subject, and the need for further

research. The author concludes that the subject is

of great importance, and that it is essential for

the progress of the subject that it should be

studied in a systematic and scientific manner.

The author's work has been of great value to the

subject, and it is hoped that it will be of

use to other workers in the field.

The author's work is a valuable contribution to the

subject, and it is hoped that it will be of