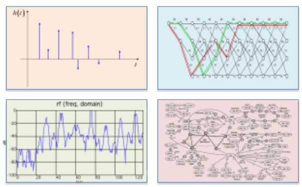


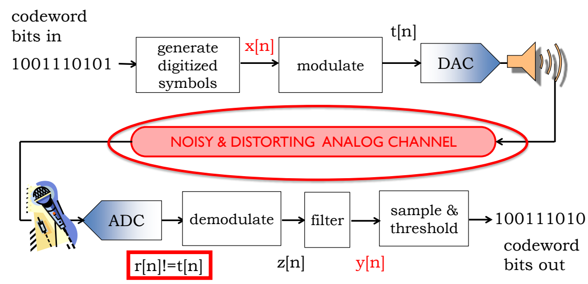
INTRODUCTION TO EECS II

DIGITAL COMMUNICATION SYSTEMS

6.02 Spring 2012
Lecture #11

- Acoustic channel
- Intersymbol Interference
- Convolution

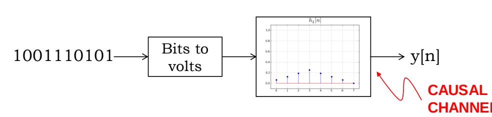
From Bits to Modulated Signal, and Back

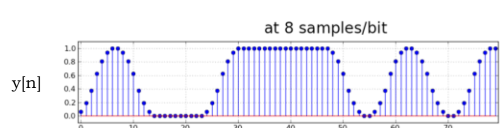


Let's explore acoustic transmission in this room

Many thanks to **Keith Winstein** for his extensive work on the acoustic channel platform for 6.02 and for today's demo!

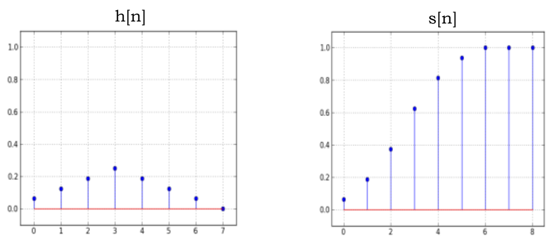
Transmission Over LTI Channel



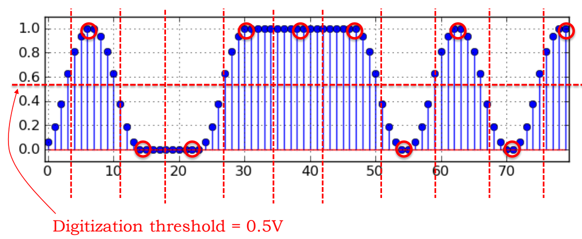


Response of LTI Channel

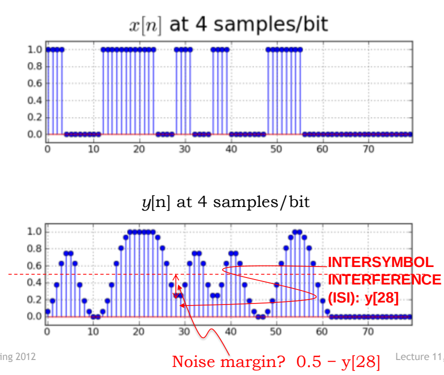
Example of unit sample response h[n] and corresponding unit step response s[n] for a causal channel model:



Receiving the Response

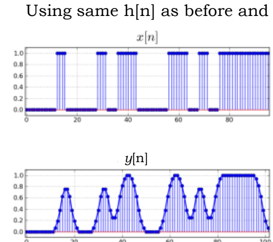


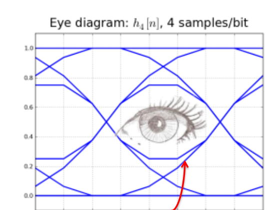
Faster Transmission



Eye Diagrams

Using same h[n] as before and 4 samples per bit

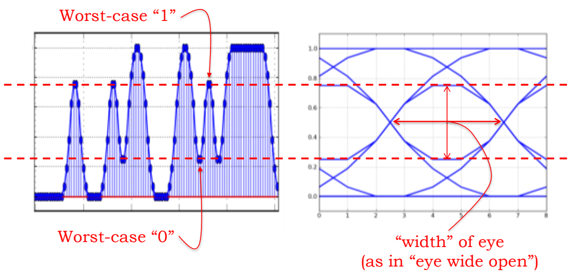




Eye diagrams make it easy to find the worst-case signaling conditions at the receiving end.

These are overlaid two-bit-slot segments of step responses, plotted without the 'stems' of the stem plot on the left

"Width" of Eye

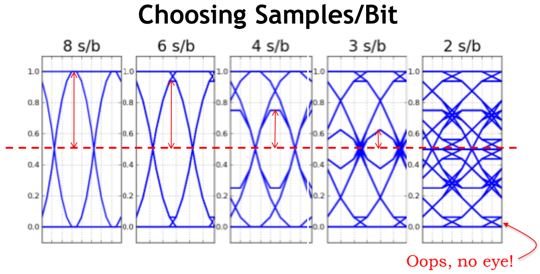


To maximize noise margins:
Pick the best sample point → eye most open
Pick the best digitization threshold → half-way across width

Constructing the Eye Diagram

1. Compute B, the number bits "covered" by h[n]. Let N = samples/bit
$$B = \left\lfloor \frac{\text{length of active portion of h[n]}}{\text{N}} \right\rfloor + 2$$
2. Generate a test pattern that contains all possible combinations of B bits – want all possible combinations of neighboring cells. If B is big, randomly choose a large number of combinations.
3. Transmit the test pattern over the channel ($2^B BN$ samples)
4. Instead of one long plot of y[n], plot the response as an *eye diagram:*
   a. break the plot up into short segments, each containing KN samples, starting at sample 0, KN, 2KN, 3KN, … (e.g., K=2 or 3)
   b. plot all the short segments on top of each other

Choosing Samples/Bit



Given h[n], you can use the eye diagram to pick the number of samples transmitted for each bit (N):

Reduce N until you reach the noise margin you feel is the minimum acceptable value.

Example: "ringing" channel