EE 240B – Spring 2018

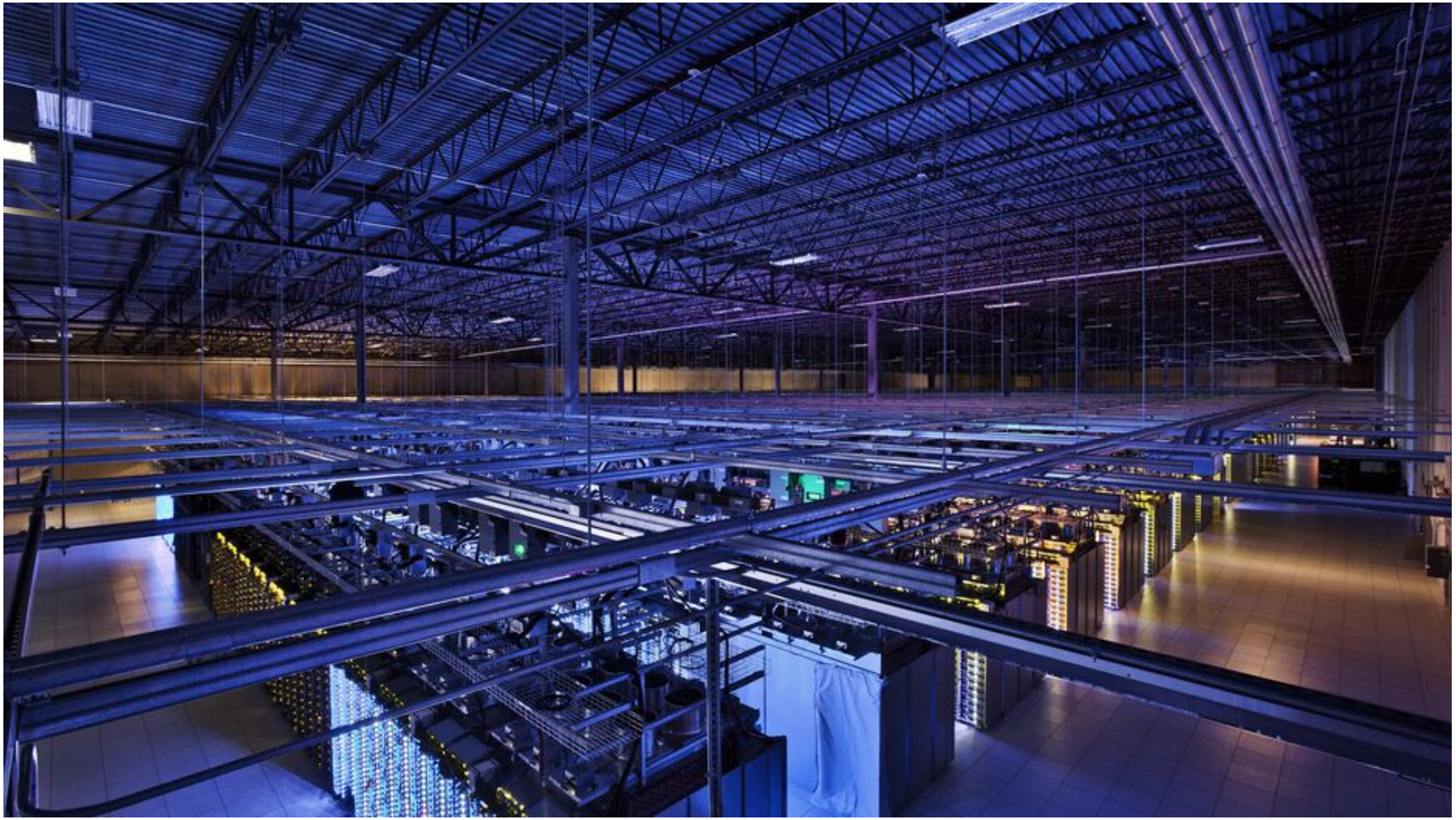
Advanced Analog Integrated Circuits

Lecture 14: Photonic Link Overview

Elad Alon

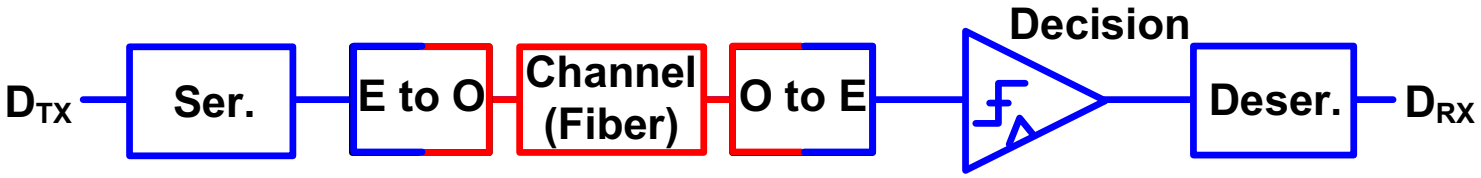
Dept. of EECS

Why Photonic Links?

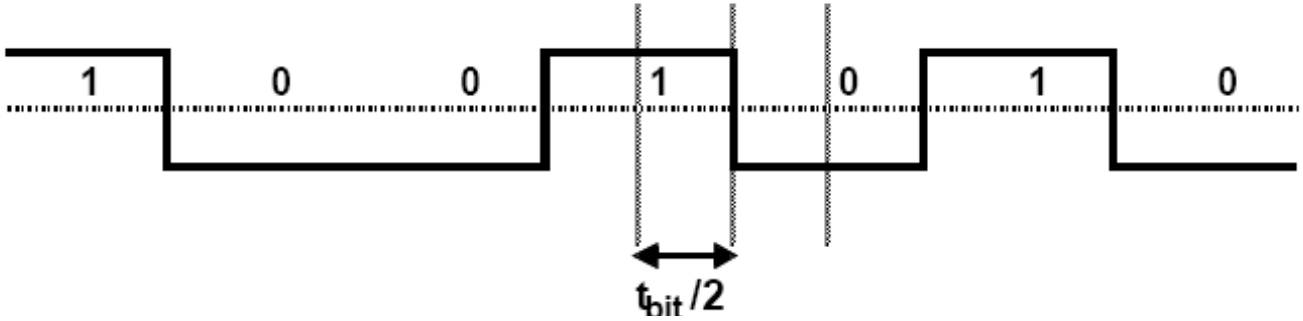


Basic Link Issues

- **Signaling: getting bits from the TX to the RX**



- **Timing: determining which bit is which**



TX: E to O (1)

TX: E to O (2)

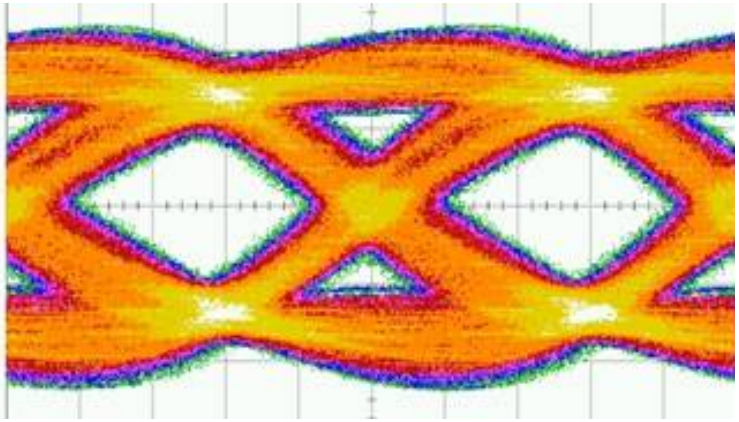
RX: O to E

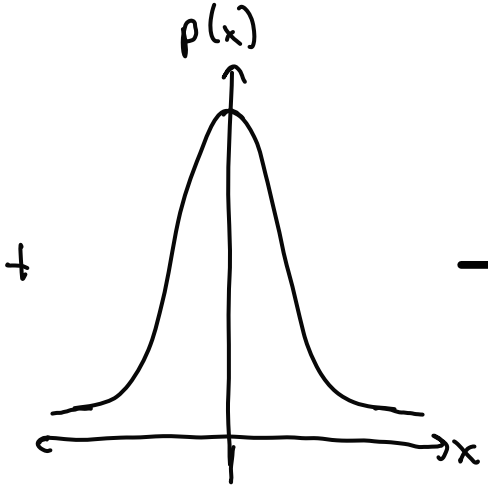
RX: O to E Model

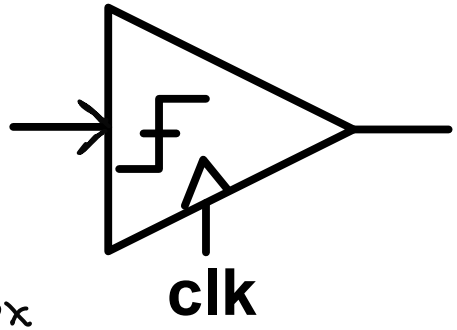
Photonic RX: Attempt #1

Photonic RX: Attempt #2

Noise → BER

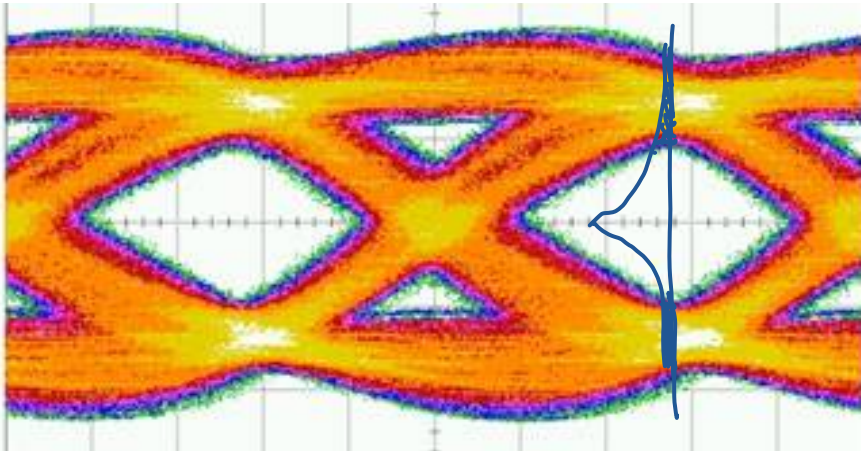


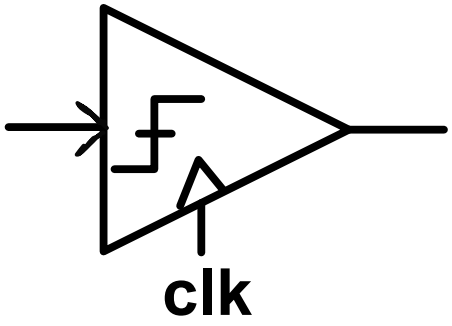




- **RX circuits always have noise**
  - If noise is ever larger than the input signal (at sampling point), RX will decode the bit incorrectly
- **BER = Bit Error Rate**
  - I.e., average # of incorrectly received bits / total transmitted bits

Min. Signal Amplitude





- **Min. signal set by noise σ and residual offset:**

$$BER = \tfrac{1}{2}\, erfc\left(\frac{V_{in,ampl} - V_{off}}{\sqrt{2}\sigma_{noise}}\right)$$

- **BER = 10^{-12}: ($V_{in,ampl} - V_{off}$) = $7\sigma_n$**
- **BER = 10^{-20}: ($V_{in,ampl} - V_{off}$) = $9.25\sigma_n$**

So What?

- **Why not just hit the RX with a larger signal?**
  - (Not a stupid question – this is often what people do)

- **Simple (hand wavy) answers:**
  - Generating optical power can be (very) expensive
    - Wall-plug efficiency usually ~1-10%
  - Larger swing doesn't help with ISI…

Intersymbol Interference (ISI)

ISI continued

Receiver Design Revisited

TIA-Based Front-End

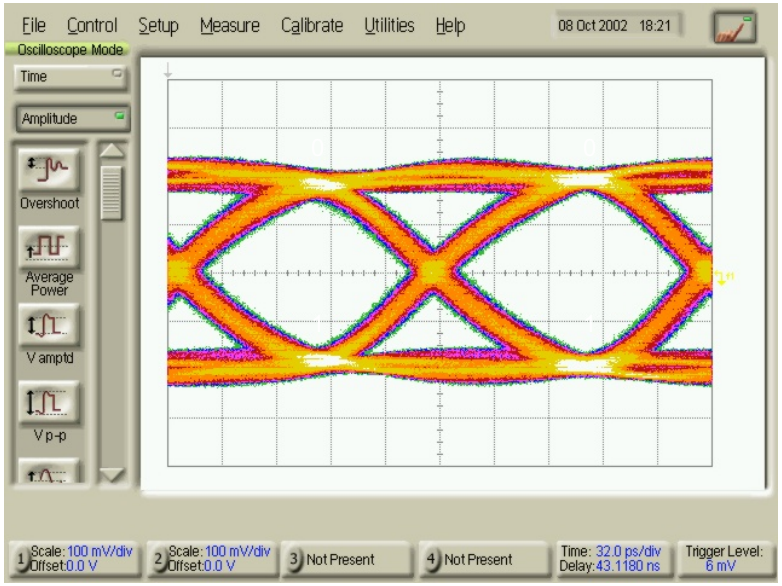
TIA-Based Receiver

Front-end Bandwidth

Performance Limits

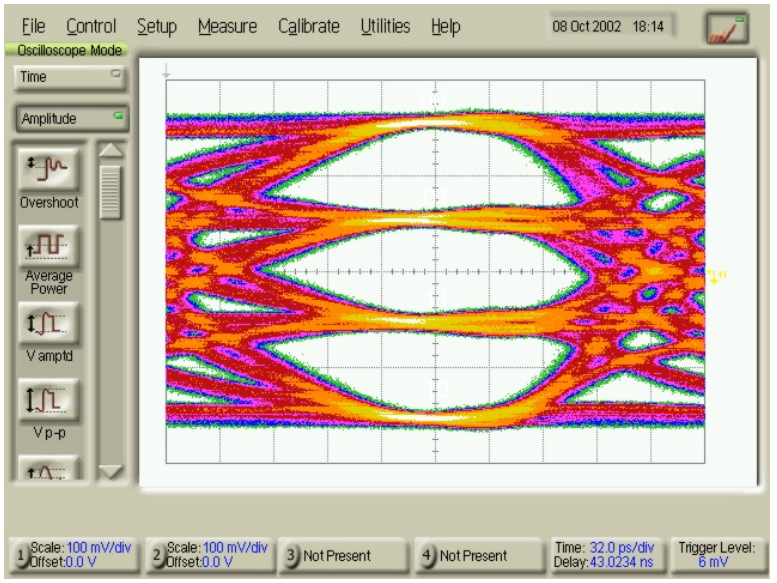
Overcoming PD Bandwidth Limit: Multi-Level Signaling

2PAM:



1bit/symbol

4PAM:



2 bits/symbol

4PAM RX