Analysis of Various Options for Multimode Fiber Links

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About this talk:

- Objective:
  - Show what outputs the analysis should provide
  - Show what is possible for various options
    - We can refine the parameters as we gather more information from various sources
- Not an objective:
  - to propose a solution for parameters or achievable distance

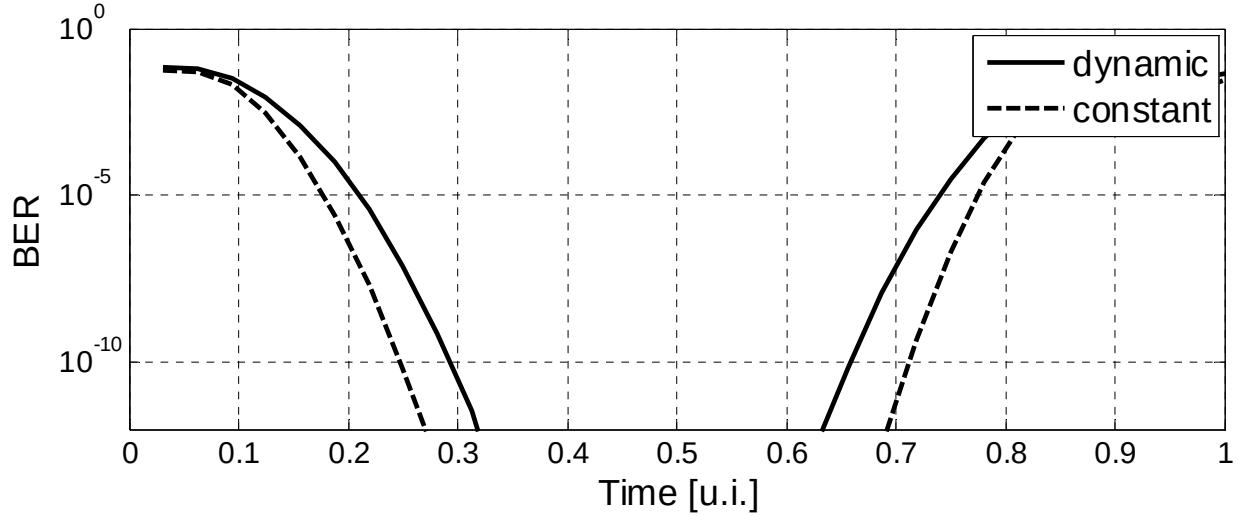
Approach to Link Analysis

- Higher bit rate requires careful treatment of noises in optical links
  - Mode Partition Noise (MPN) is just one of the major penalties for longer multimode links
- Used the same link model used for standardization of OM3 (and OM4) - same data sets for fiber DMD and launch conditions, statistics for connector offsets
- For a link with a given distance and power budget, compare bath-tub curves for both assumptions for MPN behavior (dynamic and constant MPN SD [3])
  - Calculate horizontal eye opening at 1e-12 (TP35)
  - Repeat for all 40000 links
  - Explore for various distances and power budgets
  - Explore impact of using CDR and/or FEC for various distances and power budgets

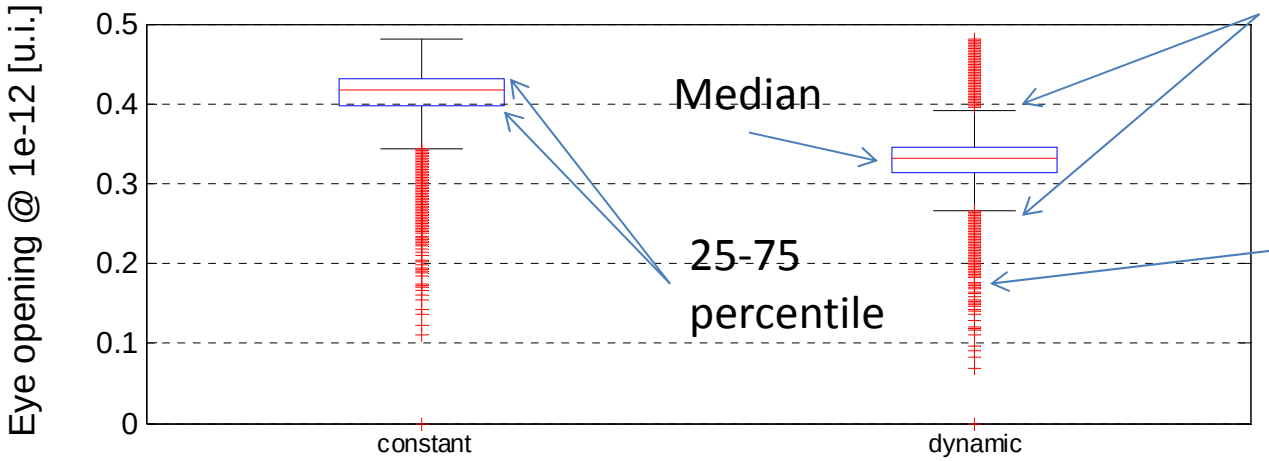
Dynamic vs. constant MPN assumption

- Bath tub curves for both assumptions (ref [3]) compared, 6dB power budget, 100m, no CDR
- Extract eye width at given BER

One link

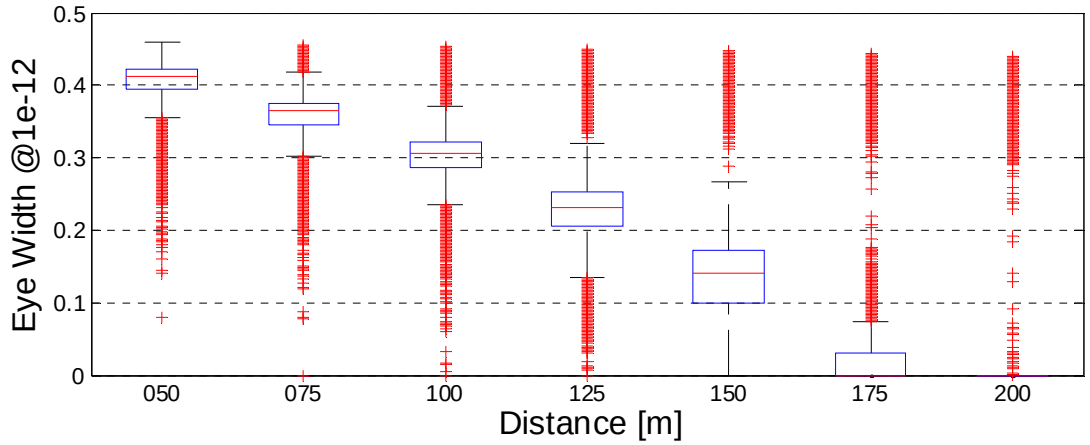


All 40k links

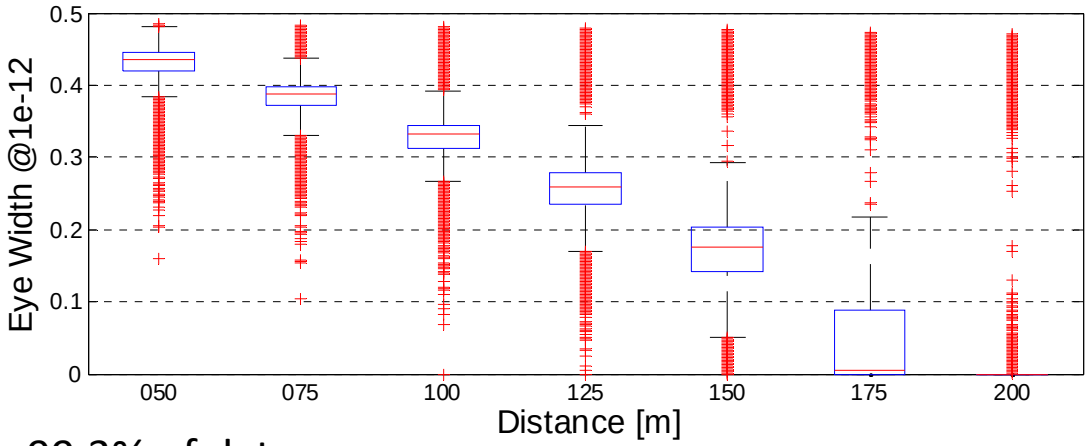


Exploring Distance

- Calculations repeated for various distances and power budgets (5 and 6 dB results shown)



5dB

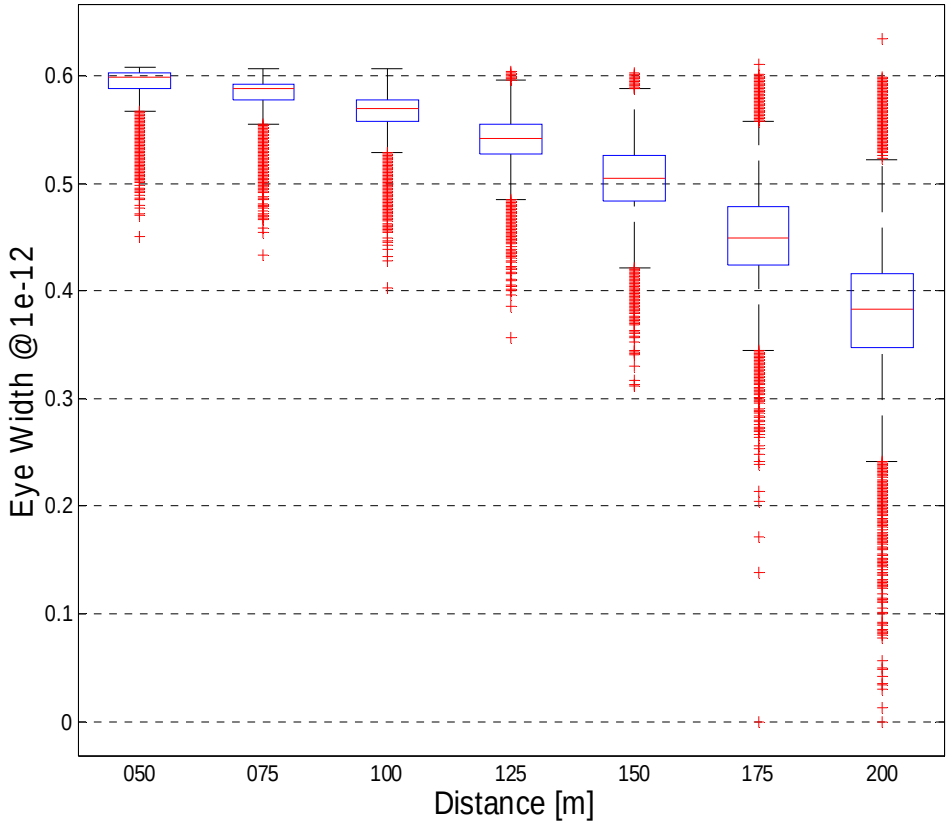


6dB

Whiskers signify 99.3% of data range

Distances using FEC

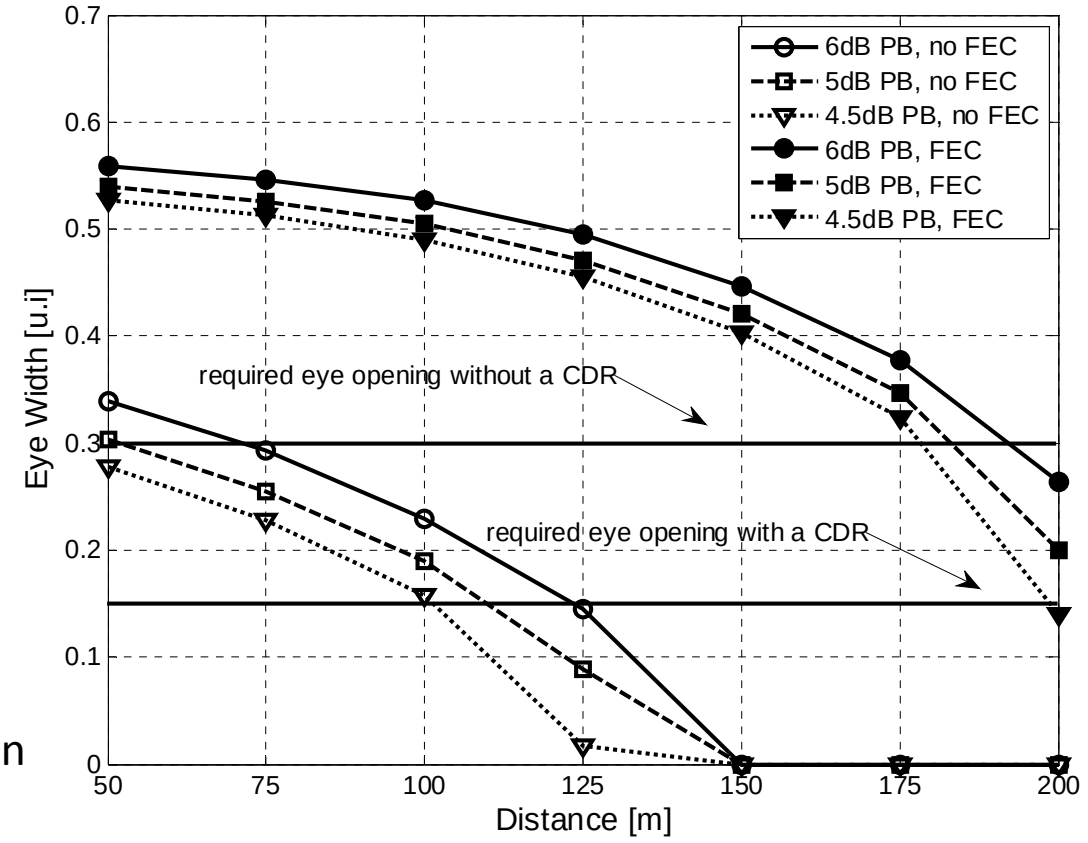
- Repeated results considering the use of FEC
  - Still need to have minimum eye opening, but at higher BER (4.68e-6)



5dB PB

Summary of all options

- Three values for power budget (4.5, 5 and 6 dB), with and without FEC (1e-12 or 4.68e-6)
- Assume minimum required eye opening for a CDR is 0.15UI



99 percentile shown

Instead of Conclusion

- Explored impact of power budget size, use of CDR and or FEC on link distances
  - FEC provides great boost to achievable distance
- Need to refine parameters, make choices
  - Cost impact of power budget size should be discussed
    - What is the cost ratio between the 20m and 100m?

References

[1]. Agrawal, Antony and Shen: "Dispersion Penalty for 1.3 um Lightwave Systems with Multimode Semiconductor Lasers", IEEE Journal of Lightwave Technology, Vol. 6 No.5, 1988, pages 620-625

[2] Ogawa: "Analysis of Mode Partition Noise in Laser Transmission Systems", IEEE Journal of Quantum Electronics, Vol. QE-18, No. 5, May 1982, pages 849-855

[3] Pepeljugoski, P.: “Dynamic Behavior of Mode Partition Noise in Multimode Fiber Links”, IEEE Journal of Lightwave Technology, Vol. 30, No.15, August 2012, pp. 2514-2519.

Backup Slides

Signal Eye diagrams

- ISI at laser output is ~1.52 dB
- ISI at the fiber output is ~1.9 dB