Higher Order Modulation for Optical PMDs

40Gb/s and 100Gb/s Fiber Optic Task Force

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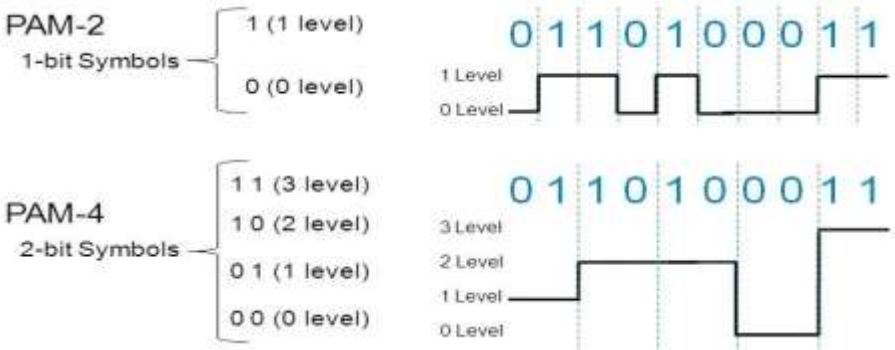
Outline

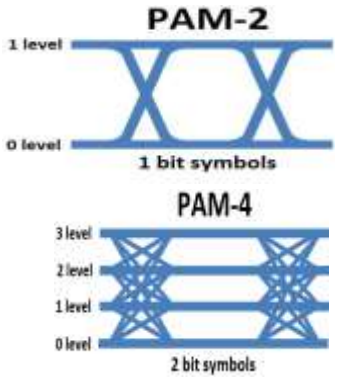
- Higher Order Modulation Rationale
- Higher Order Modulation in 802.3bm
- PAM-4
- PAM-8
- DMT
- Discussion

Higher Order Modulation Rationale

- Four basic parameters determine the optical link rate:
  1. Symbol (Baud) rate
  2. Number of fibers
  3. Number of wavelengths
  4. Number of bits/symbol (modulation order)
- Higher order modulation vs. NRZ (PAM-2) enables reduction of other parameters for the same link rate

  Ex. PAM-2 to PAM-4 allows ½ the wavelengths or fibers

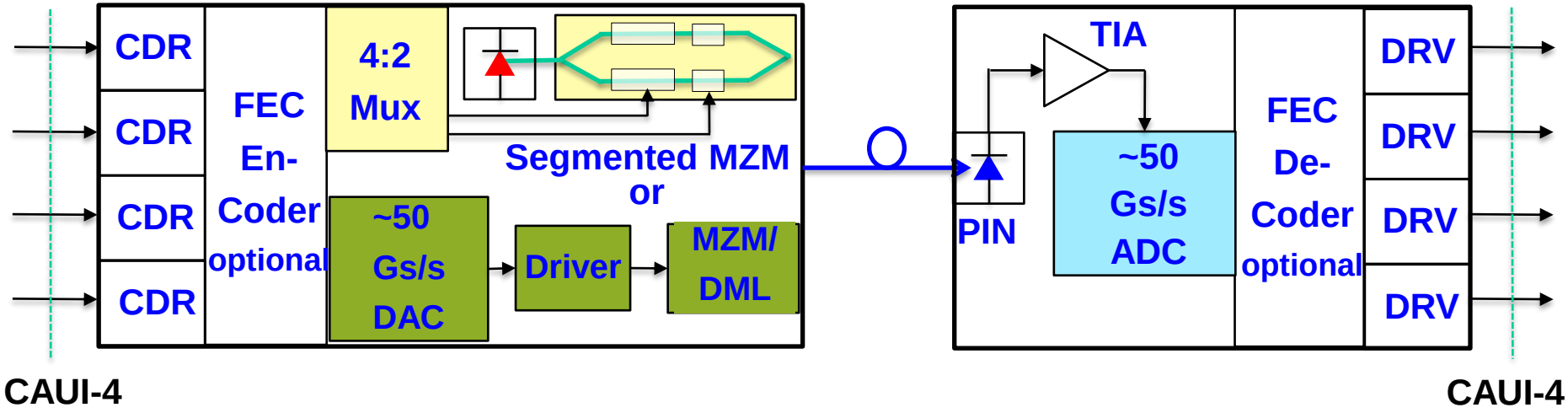




Higher Order Modulation in 802.3bm

- Introduced in bhoja_01_0112
- Since then ~50 presentation have been made in 8 meeting cycles
- Presented modulation formats are:
  - PAM-4
  - PAM-8
  - PAM-6/DSQ-32
  - DMT
  - QAM-16/CAP-16
- Consensus has not been reached on best approach
- This is no different than “modulation format wars” in past copper tracks including 802.3bj

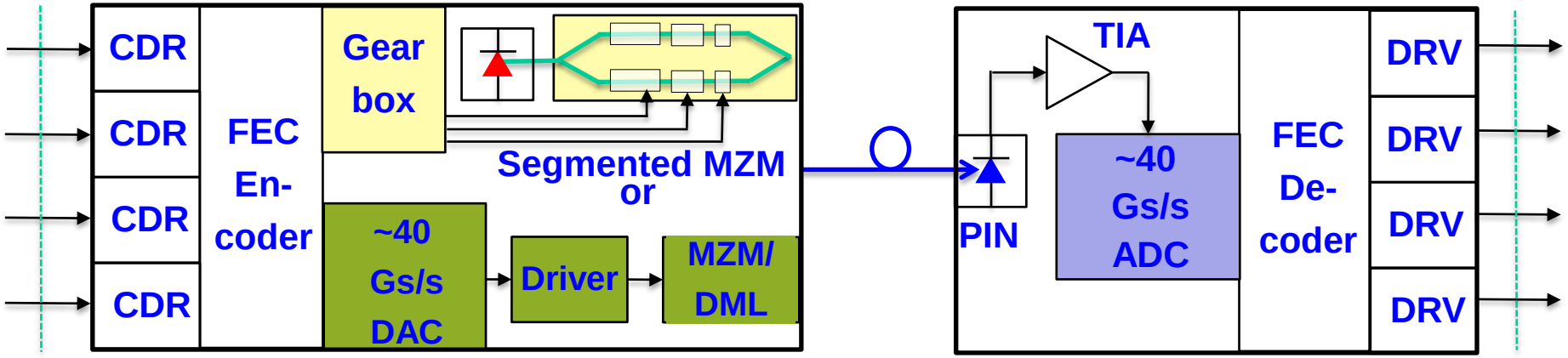
PAM-4



- 2 bits/symbol
- 802.3bj host FEC maybe sufficient (no FEC in module)
- Low RIN CW laser (for low SNR)
- Low RL connector (to suppress MPI)
- Select presentations:

  nicholl_01b_0312, ghiasi_01a_0912, lyubomirsky_01a_1112

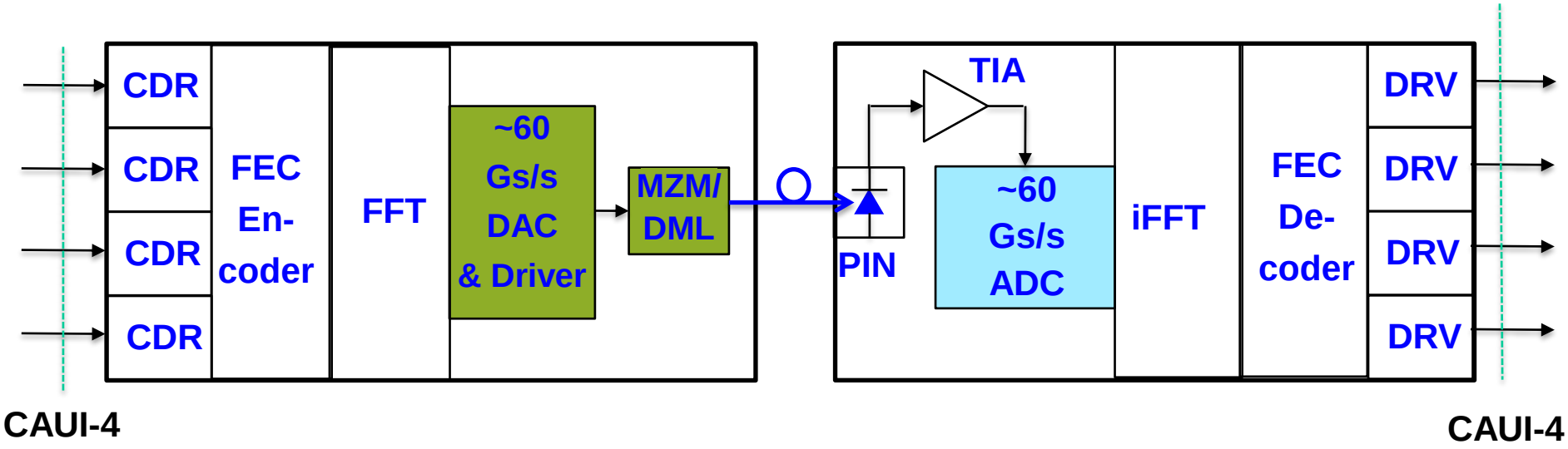
PAM-8



- 2.5 bits/symbol
- FEC in module required
- Low RIN CW laser (for low SNR)
- Low RL connector (to suppress MPI)
- Select presentations:

  bhatt_01_0113, ghiasi_01a_0912, lyubomirsky_01a_1112

DMT



- 128 to 256 multi-tones
- FEC in module required
- Low RIN CW laser (for low SNR)
- Low RL connector (to suppress MPI)
- Select presentations:

  tanaka_01a_1112, tanaka_01_0113, lyubomirsky_01_0113

Discussion

- Higher Order Modulation (HOM) is an important technology for datacenter interfaces because it enables reduction in the number of wavelengths and/or fibers compared to NRZ
- Several modulation formats have been introduced including PAM-N and DMT
- More stringent technical requirements, including higher SNR, laser RIN, and connector MPI have been identified
- Agreement has not been reached on modulation format best suited for datacenter optical interfaces
- If HOM based PMD is not adopted in 802.3bm, it will be an important alternative for future 100Gb/s and higher rate PMDs.