Considerations on Baud Rate and Lane Number for 400 Gigabit Ethernet Optical Interfaces

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Introduction

- This presentation focuses on the 400 Gigabit Ethernet SMF reach objectives
  - At least 500m over SMF
  - At least 2km over SMF
  - At least 10km over SMF
- Cost, power, port density are priorities
  - All are influenced by baud rate and number of optical lanes of an interface
- Time to market
  - Consideration of short-term, medium-term, long-term solutions

Background

- 400Gb/s technology options include
  - 16 x 25Gb/s NRZ (25Gbaud)
  - 8 x 50Gb/s NRZ (50Gbaud)
  - 8 x 50Gb/s PAM4 (25Gbaud)
  - 4 x 100Gb/s PAM4 (50Gbaud)
  - 4 x 100Gb/s DMT (25Gbaud)
- Higher-order modulation formats minimize the number of optical lanes and therefore the optical component count and cost.
- Study Group presentations indicate that technology choices might differ between reach objectives
  - 10km is longest reach objective of this task force
  - Longer reach objective might arrive in future generation
- Number of optical lanes vs. bandwidth of components

Lowering baud rate and optical lane count

8 x 50Gb/s NRZ

- 8 optical lanes changes wavelength plan (with respect to 100G BASE-LR4)
- increases component count
- more challenging for yield?
- need higher bandwidth optical/electrical components
- 50Gbaud components

8 x 50Gb/s PAM4

- 8 optical lanes changes wavelength plan (with respect to 100G BASE-LR4)
- increases component count
- more challenging for yield?
- 25Gbaud components available to market

4 x 100Gb/s PAM4

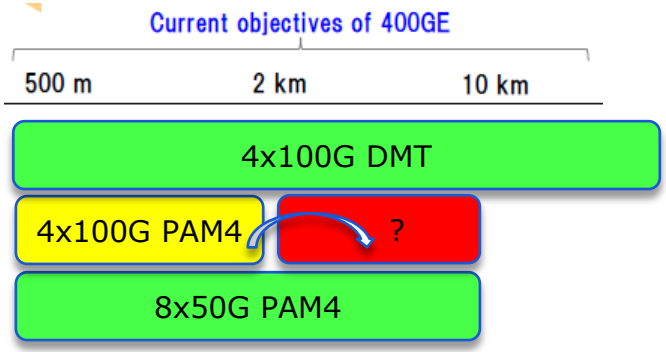
- 4 optical lanes same LAN-WDM wavelength plan as 100G BASE-LR4
- smaller size
- reduced component count
- need higher bandwidth optical/electrical components
- 50Gbaud components

4 x 100Gb/s DMT

- 4 optical lanes same LAN-WDM wavelength plan as 100G BASE-LR4
- smaller size
- reduced component count
- 25Gbaud components available to market

Technical feasibility demonstrated to-date

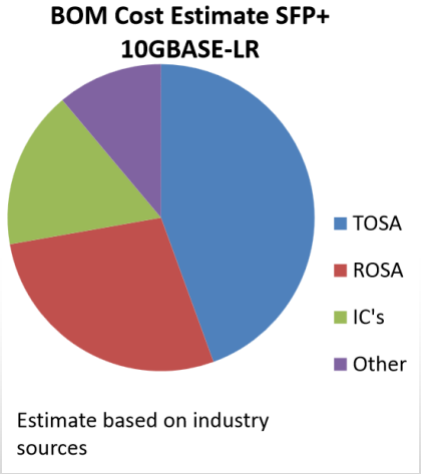
- 4x100G DMT demonstrated with hardware for up to approximately 40km SMF
  - takahara_400_01_0114.pdf
- 4x100G PAM4 not demonstrated with hardware; simulations to-date do not indicate it will achieve at least 10km SMF
  - nicholl_01b_0312_NG100GOPTX.pdf
  - dove_400_01a_0114.pdf
- Total Dispersion Penalty (TDP)
  - DMT – no equalization required
  - PAM4 – equalization for given reaches
- Additional considerations
  - FEC implementation
  - latency



Economic feasibility demonstrated to-date

- Somewhat similar cost estimates between DMT and PAM4, given the presumed accuracy of the current level of modelling
  - dove_400_01a_0114.pdf
  - isono_3bs_02_0514.pdf

- Improve cost estimate
  - ADC/DAC
  - Equalizers



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Summary

- Higher number of optical lanes (16) to reuse 100 Gigabit Ethernet at 25Gbaud NRZ results in undesirably high power consumption and size.
- A solution based on 4 optical lanes can increase volume and reduce cost if applied over the multiple reach objectives both near-term and longer-term.
- A solution based on 8 optical lanes ultimately doesn’t lead to the same cost and power reduction and might be short-lived.