

# Thoughts on the practicality of Terabit Ethernet

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# Introduction

- **BWA Ad Hoc has presented continuing growth of bandwidth demands in core and transport layers beyond 100Gb/s**
- **Next rate beyond 100G: 400Gb/s or 1Tb/s?**
- **A 400G based CFI is being considered**
- **This presentation explores the options for 1Tb/s**

# 100GbE Optics Overview

- **Broad market for the existing 100GbE technology is still developing**
- **100GBASE-LR4 transceivers are not yet manufactured in high volume**
- **Alternative technologies for 100GBASE-nR4 are being investigated for addressing short reach:**
  - ✓ 4x25G Parallel
  - ✓ PAM-N

**but have not yet been proven to be sufficiently feasible to justify a new SMF PMD at 100G**

# How to create a 1Tb/s PMD on the basis of feasible technology and acceptable cost?

- **Cost target for 1Tb/s needs to be at or below 100G cost/bit\*sec and required R&D investments should be modest**
- **This would suggest to leverage current generation Ethernet technology for 100G**
- **100GbE technology based architecture would imply 40 lanes at 25G, which clearly would imply impractically big packages and large amount of interface signals**

# Alternative technologies for 1Tb/s PMD

- A 1Tb/s PMD would need a sufficient reduction in electrical and optical interfaces lanes to enable reasonably small packages
- A technical alternative would be the usage of advanced modulation formats, e.g. multi-level signaling, in order to:
  - ✓ Move complexity into the electronics to simplify the optics
  - ✓ Reduce the optical component count and associated packing complexity

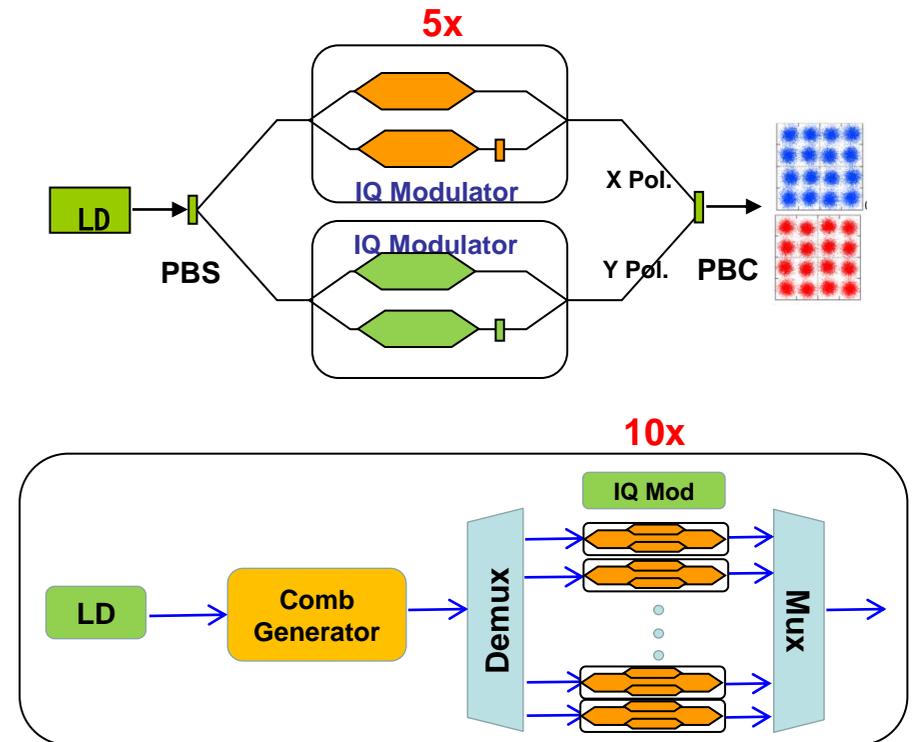
Type	#Fiber	Number of Physical Lanes	Bits/Symbol	Symbol Rate
100GBASE-LR4	1	40	1	25G
PAM-4	1	20	2	25G
PAM-16	1	10	4	25G

# Alternative Options for a 1Tb/s PMD

## ➤ More sophisticated modulation format (amplitude and phase)

- ✓ Re-use of line side technologies for 100G and 400G to minimize the number of lanes
- ✓ Need advanced CMOS IC and PIC technology

Alternative	Bits/Symbol	Rate, GBaud
5λx200G DP-16QAM	4	25G
10λx100G DP-QPSK	2	25G



# Feasibility of advanced modulation format technologies

- **Neither the multi-level nor the phase modulation format based technologies have been demonstrated to be sufficiently mature to justify usage in client PMDs towards 100Gb/s to 1Tb/s applications**
- **It probably will take many years to come before integrated optical technology has sufficiently matured to achieve satisfactory performance and permit low-cost manufacturing for the volumes expected for these new PMDs**

# Summary

- **The technology needed to implement advanced modulation formats is currently very far from technical and economic feasibility**
- **This would suggest that on the short term 1Tb/s would be a too high rate from an engineering perspective and it is unlikely to justify the major R&D cost needed to develop the required technology platform**
- **1Tb/s does seem a "bridge too far" at least for the coming 3 to 4 years**
- **400Gb/s appears to be the most sensible choice at this moment**



**THANK YOU**