

SMF PMD Decision Tree Status

400 Gb/s Ethernet Task Force
IEEE 802.3 Interim Meeting
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Ottawa, Canada
Peter Stassar, Huawei
Chris Cole, Finisar



Finisar[®]

Supporters

End Users

- Ralf-Peter Braun, Deutsche Telekom
- Martin Carroll, Verizon
- Derek Cassidy, British Telecom
- Lu Huang, China Mobile,
- Sam Sambasivan, ATT
- Shikui Shen, China Unicom
- Guangquan Wang, China Unicom
- Glenn Wellbrock, Verizon
- Haiyi Zhang, CATR
- Wenyu Zhao, CATR

System OEMs

- Ghani Abbas, Ericsson
- Pete Anslow, Ciena
- David Chalupsky, Intel
- Piers Dawe, Mellanox
- Mike Dudek, Qlogic
- Scott Kipp, Brocade
- Yonatan Malkiman, Mellanox
- Rich Mellitz, Intel
- Petar Pepeljugoski, IBM
- Steve Trowbridge, ALU
- Chengbin Wu, ZTE

Supporters, cont.

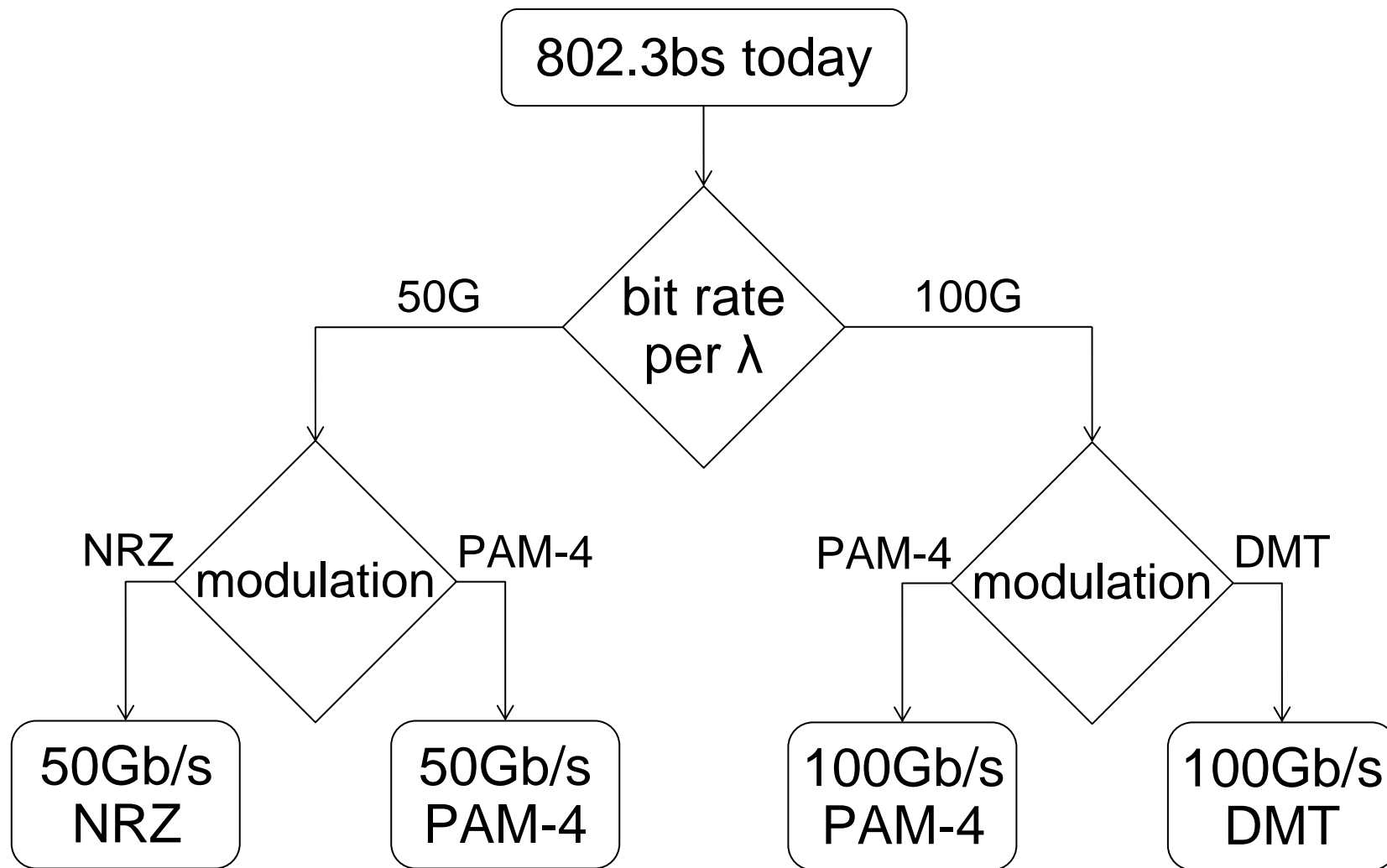
Suppliers

- John Abbott, Corning
- Bill Brennan, Credo
- Scott Irwin, MoSys
- Jonathan King, Finisar
- Keisuke Kojima, Mitsubishi
- Paul Kolesar, Commscope
- Robert Lingle, Jr., OFS
- Alan McCurdy, OFS
- Osa Mok, Innolight
- John Monson, MoSys
- Ichiro Ogura, PETRA
- John Petrilla, Avago,
- Rick Pimpinella, Panduit
- Haoli Qian, Credo
- Mizuki Shirao, Mitsubishi
- Steven Swanson, Corning

Outline

- SMF PMD Decision Tree
- Applications
- Feasibility
- Power
- >2020 Alternatives
- Conclusions
- Wisdom

SMF PMD Decision Tree



50G & 100G per lane Application Support

Primary Applications	50G NRZ or PAM-4	100G PAM-4 or DMT
400G 10km & High-Loss duplex SMF	Yes	No
400G 2km duplex SMF	Yes	Yes
400G 500m PSM4	Yes	Yes
100G Next Gen SMF (after 4x25G)	Yes	Yes
400G Next Gen MMF (after 16x25G)	Yes	No
100G Next Gen MMF (after 4x25G)	Yes	No
Synergy w/ 50G per lane Electrical I/O	TBD	No
Later Applications	50G	100G
50G Serial SMF & MMF	Yes	No
40G Serial SMF & MMF	Yes	No
64x Fibre Channel	Yes	No

“10km” Applications

- “10km” PMDs are used for 10km and high-loss applications
 - 10km PMD should not simply be dismissed by arguing that there is no need for 10km reach inside data-center
 - 2km to 10km reach Telecom & Datacom
 - Inter central-office
 - Described in several 802.3 projects by multiple carriers
 - Inter data-center
 - <2km reach high-loss Datacom
 - Intra mega data-center
 - Intra Internet-exchange
 - Supports many connectors and passive loss elements
- “High-loss applications are important for large scale data-centers.”

Hong Liu, Google

100G/400G SMF PMD Feasibility

- 100G λ 2km optical specs are difficult to meet (for PAM-4 very difficult), which negates $\frac{1}{2}$ λ s cost advantage
- 100G λ 10km optical specs are too difficult to meet
- 50G λ NRZ 2 & 10km optical specs. are easier to meet based on analysis, but need experimental confirmation
- 50G λ PAM-4 2km optical specs. are feasible based on analysis and testing
- 50G λ PAM-4 10km optical specs. are harder to meet than NRZ but appear feasible based on analysis and testing
- 50G λ optics support multiple applications which creates volume that is the most important factor in reducing cost
- 50G λ NRZ and PAM-4 alternatives are under investigation to decide the modulation format

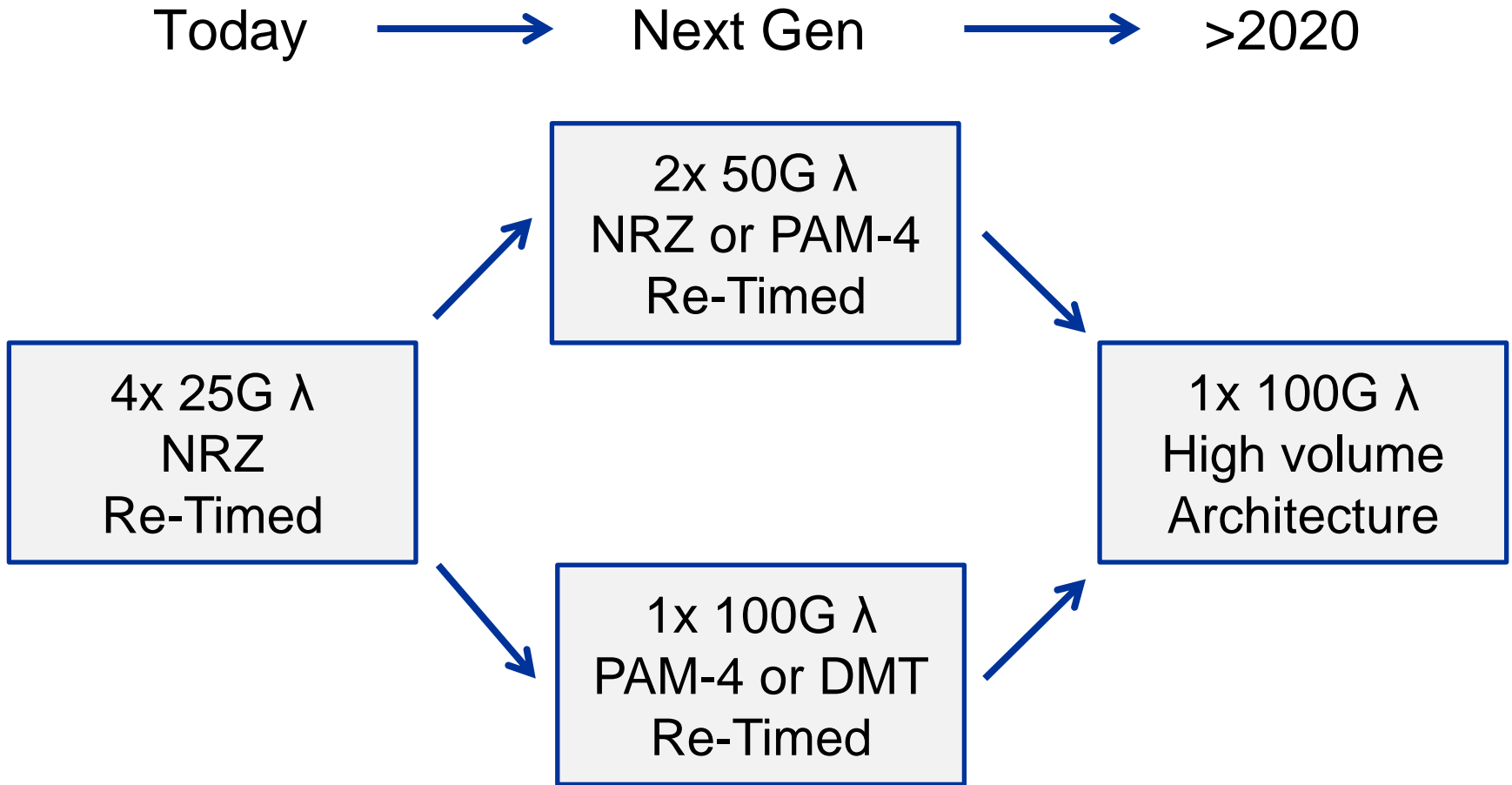
100G SMF PMD Module Power

- CFP LR4 discrete EML: **16 - 20W**
- CFP2 LR4 DML & Mod: **6 - 9W**
- CFP4 LR4 DML: **4 - 5W**
- QSFP28 LR4 DML: **3.5 - 4W**
- QSFP28 CWDM4 DML: **3 - 3.5W**
- Next Gen 100G objective: **2W**
 - Feasible with 2x50G λ proposals
 - Not feasible with 100G λ proposals (<20nm ASIC is 2W)
- >2020 100G compelling objective (ex. 100G SFP): **1W**
 - Not feasible with any 50G λ or 100G λ 802.3bs proposal
 - Requires different 100G λ architecture

100G λ Optics >2020 Alternatives

- 100G λ examples with higher optical loss budget architecture than 802.3bs proposals:
 - 100G NRZ
 - 100G Coherent
- 100G λ examples with lower power architecture than 802.3bs proposals:
 - 100G NRZ
 - 100G w/ linear interface
- 100G λ high volume architecture will be optimized with 100G electrical I/O, to which there is no visibility today

100G Optics Roadmap



None of today's Next Gen proposals will be compelling >2020

Conclusions

- 100G λ is not ready for standardization
 - Today only supports 2km SMF applications
 - Module power not compelling
 - Appropriate for >2020 standardization
 - Requires substantially more development to have compelling proposals in future 802.3 projects
- 50G λ should be standardized in 802.3bs
 - Supports all SMF applications including 10km reach and high-loss, and will support all future MMF applications
 - Multi-application volume will drive down cost
 - Potential synergy with 50G per lane electrical I/O
 - Requires further analysis and testing to decide between NRZ & PAM-4

Final Thought



To go beyond is as wrong as to fall short.
(Confucius)

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SMF PMD Decision Tree Status

Thank you



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