

Thoughts on 50G, 200G, 400G Ethernet PMDs beyond 10k

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Observations

- Previous rates of Ethernet have standardized SMF PMDs with reach up to 40km, and proprietary implementations and MSAs have provided reaches as high as 80km
- Longer (>10km) reach PMDs are successful when:
 1. The longer reach PMD is available in the same module form factor as a 10km PMD at the time of availability of the longer reach PMD
 2. The C2M electrical interface and logical lane format to the module for the longer reach PMD is exactly the same as the interface to a 10km reach PMD
 3. The cost premium for the longer reach PMD over a 10km reach PMD is modest
- If longer reach 50G, 200G, 400G are all to be done in the same project, it would be advantageous if all rates used the same lane technology
 - If some rates use the 802.3bs/802.3cd RS(544,514) FEC formats with APD receivers and some use coherent with a much stronger FEC, the different parts of the project could reach maturity on vastly different time scales

Same module form factor

- Examples where this was not the case:
 - Original 100GBASE-ER4 (802.3ba, 2010) added an SOA to an implementation that was otherwise similar to 100GBASE-LR4. The high power required for the SOA limited the module form factor to CFP, even as other modules (100GBASE-LR4, CWDM4) were moving to CFP4 and QSFP28 form factors. Very few deployments of this interface.
 - “ER4-lite” (ITU-T G.959.1 4L1-9D1F) based on an APD receiver is the first 100G 40km implementation to achieve mass market adoption, available in the same CFP4 or QSFP28 form factors as CWDM4 MSA (using the same FEC as CWDM4 MSA and 100GBASE-SR4).
- Examples where this was the case:
 - 10GBASE-LR (10km), 10GBASE-ER (30-40km), and the non-standardized 10GBASE-ZR (80km) all are available in the same SFP+ form factor with the same host board electrical interface

Same module form factor, continued

- Target form factor for 50G 40km: SFP56
- Target form factor for 200G 40km: QSFP56
- Target form factor for 400G 40km
 - Initial availability for 400GBASE-LR8 is CFP8, but like 100G CFP, this may not be the form factor that achieves mass market adoption
 - QSFP-DD or OSFP are possibilities
 - If 100G per lane electrical signaling is a reality in the timeframe of this project, QSFP(112) may be possible
 - Don't assume that coherent is an option because today's 400G is in CFP8 and that is a feasible form factor for coherent. The project needs to anticipate the form factor that 400GBASE-LR8 or 400GBASE-DR4 will use in 2019-2020

Same C2M Interface as 10km

- Ideally, 40km versions of 50G, 200G, 400G should be able to use the same chip to module interface as the 10km versions of these interfaces with the same FEC
- If a stronger FEC is required, termination of RS(544,514) and insertion of the new FEC would have to occur in the module to avoid host board redesign, and this would pose additional challenges for power in the module and getting into the required smaller form factors

Modest Cost Premium over 10km Implementations

- Consistent with APD-based approaches
- OIF is targeting 400G ZR in an OSFP form factor and is dealing with the challenge of meeting the power envelope with the assumption the coherent DSP is done in 7nm CMOS. Lots of NRE from the vendors who enter this market to be amortized over the number of ports to be sold, and likely a large cost premium over 10km implementations
 - Somewhat different economics apply to the OIF application as the fiber (including the cost of right-of-way and burying it) and amplifiers are shared across as many as 48 channels, whereas the normal assumption for Ethernet is a dedicated fiber pair per Ethernet connection
 - 400GBASE-LR8 in the timeframe of completion of this project is likely to be in QSFP-DD (12W) or smaller form factors

Similar Lane Technologies for all rates in the project

- Understandable why coherent would at least be in the conversation for 400G, but feels like significant overkill for 40km (or even 80km) 50G.
- Even for 400G, a longer-reach Ethernet link is significantly less challenging than the OIF application
 - Dedicated 400G Ethernet client per fiber pair, not multiplexing/demultiplexing up to 48 clients on the same fiber pair
 - No protection splitter in the path

Recommendation

- Don't choose reach objectives that can only be met with coherent implementation unless the study group can be persuaded that a coherent implementation can meet:
 - Economic feasibility (modest cost premium over 10km reach PMDs); and
 - Broad market potential (the implementation will fit into the same form factor with the same C2M interface and lane format as expected to be used for the 10km PMD in the timeframe of completion of this project.
- If Economic Feasibility and Broad Market Potential of coherent approaches can't be demonstrated during the study group phase, the reach objectives should be limited to those that can be shown to be technically feasible with at least one other approach such as APD.