

400GBASE-LR4

Module and Market Considerations for CWDM4 based solutions

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Module: Economics

- Using a CWDM4 Grid has two key benefits for 400GBASE-LR4
 - Eliminates the need for tight wavelength control on each laser
 - Allows for considerable (or complete) re-use of 400GBASE-FR4 designs
- Eliminating tight wavelength control expected to decrease the cost floor for 400GBASE-LR4 solutions
 - Controlling the wavelengths to +/- 1 nm generally requires TECs, and may require several TEC's depending on laser integration method.
 - Controlling the wavelength to +/- 6.5 nm generally does not require TECs, although does allow them if necessary to improve dispersion performance
- Enabling a common BOM with 400GBASE-FR4 has two key advantages
 - May allow for a single development initiative to service both markets, reducing effective development costs for a 10km solution
 - May allow for 400GBASE-LR4 to be built as a subset (BIN) of 400GBASE-FR4, decreasing cost and improving time to market.

Module: Performance

- Various contributions (with both EML and SiP technologies) have been shown with acceptable dispersion penalties while using the CWDM4 grid:
 - *lewis_cu_adhoc_041719.pdf*
 - *schube_3cu_01_0519.pdf*
 - *johnson_optx_01_0319.pdf*
 - *mazzini_3cu_adhoc_070319.pdf*
- Methods to optimize for dispersion include:
 - Wavelength control of 1270nm and 1330nm bands
 - Chirp control
 - PAM4 level optimization
 - Rise/Fall (bandwidth) optimization and pre-emphasis
- Using a CWDM4 grid likely to enable a lower power consumption transceiver
 - Obviates the need for TECs (for at least some technologies & wavelengths)
 - Next gen 2x400G transceivers will need to fit in a 15-20W thermal envelope.
 - Perhaps at elevated operating temperatures ~ 75+ C
 - TEC could consume non-trivial power in these applications (~1W)

Market: Interoperability

- At 100G, interop cases between 2km and 10km do exist at some end users
 - 100G-CWDM4 connected to 100G-4WDM10, with a 2km reach
 - Some end users doing so to better manage inventory
 - ie, ratio of 2km and 10km links can vary, being able to repurpose a 10km for 2km applications makes supply management easier
- Comparable support for interop between 400GBASE-LR4 and 400GBASE-FR4 may accelerate 400GE deployment
- The proposal in lewis_3cu_0719 would allow one to build a 400GBase-LR4 modules that also meets the 400GBase-FR4 specification.

Summary

- 400GBASE-LR4 on a CWDM4 grid has been shown to be feasible with two different technology types: EML and SiP
 - This doesn't mean that all EML and SiP technologies are viable, but at least two demonstrations of each (four different technology providers) have been shown
- Using a CWDM4 grid is expected to yield lower cost modules, and reduce development costs
- A CWDM4 based solution is more likely to enable 2x400G modules
- Certain end customers favor interoperability between 2km and 10km solutions, which may accelerate 400G adoption

Thank You