100GbE

SMF 1310nm PMD Link Comments

opnext
Powered by HITACHI

WE light IT UP

HSSG Meeting
November 2007 Plenary

Kiyo Hiramoto
Masato Shishikura
Atsushi Takai
Matt Traverso

Supporters: High Speed Laser Manufacturers

- ***Haruo Yonetani (Eudyna Devices Inc.[1])***
- ***Hiroshi Nakano (NEC electronics, Ltd. [1])***
- ***Junichi Shimizu (NEC electronics, Ltd. [1])***
- ***Yasunari Mizuguchi (Oki Electric Industry Co., Ltd. [1])***
- ***Atsushi Takai (Opnext, Inc. [1])***
- ***Kiyo Hiramoto (Opnext, Inc. [1])***
- ***Yasunori Murakami (Sumitomo Electric Industries, Ltd[1])***

Note 1: ***XLMD MSA member. XLMD MSA was formed to establish compatible sources of optical transmitter and receiver devices for use in 40Gbit/s optical transceiver modules.***

Outline

- ***Objectives and Discussion Point***
- ***Device Technology and Availability***
- ***Optical Link Distance Considerations***
  - ***Link budget***
  - ***Module cost***
- ***Wavelength grid***
- ***Other considerations***
- ***Summary***

Objective and Discussion Points

- *Objective*
  - *To achieve low cost optical link solution for 100GbE <10km SMF PMD(*1)*
- *Discussion Points*
  - *The distance and wavelength grids that minimize the cost.*
  - *Enable the first generation and future low-cost link*

(*1) Note that there is some discussion to select a reduced distance objective between 2 to 5km

Device Technology and Availability

- Technical Issues on development
  - The major technical issue is to achieve 25Gbit/s transmission
  - Wavelength grid is secondary
- Optical Device to be consider
  - Cooled EA-DFB: Expensive but easier to achieve 25Gbit/s transmission because 40Gbit/s device is commercially available.
    - Cooled technology allows both DWDM and CWDM wavelengths.
  - Cooled DFB: Relatively low cost.
  - Uncooled DFB: The cheapest. Future solution but only with CWDM wavelengths

10km, 3/4km link budget consideration

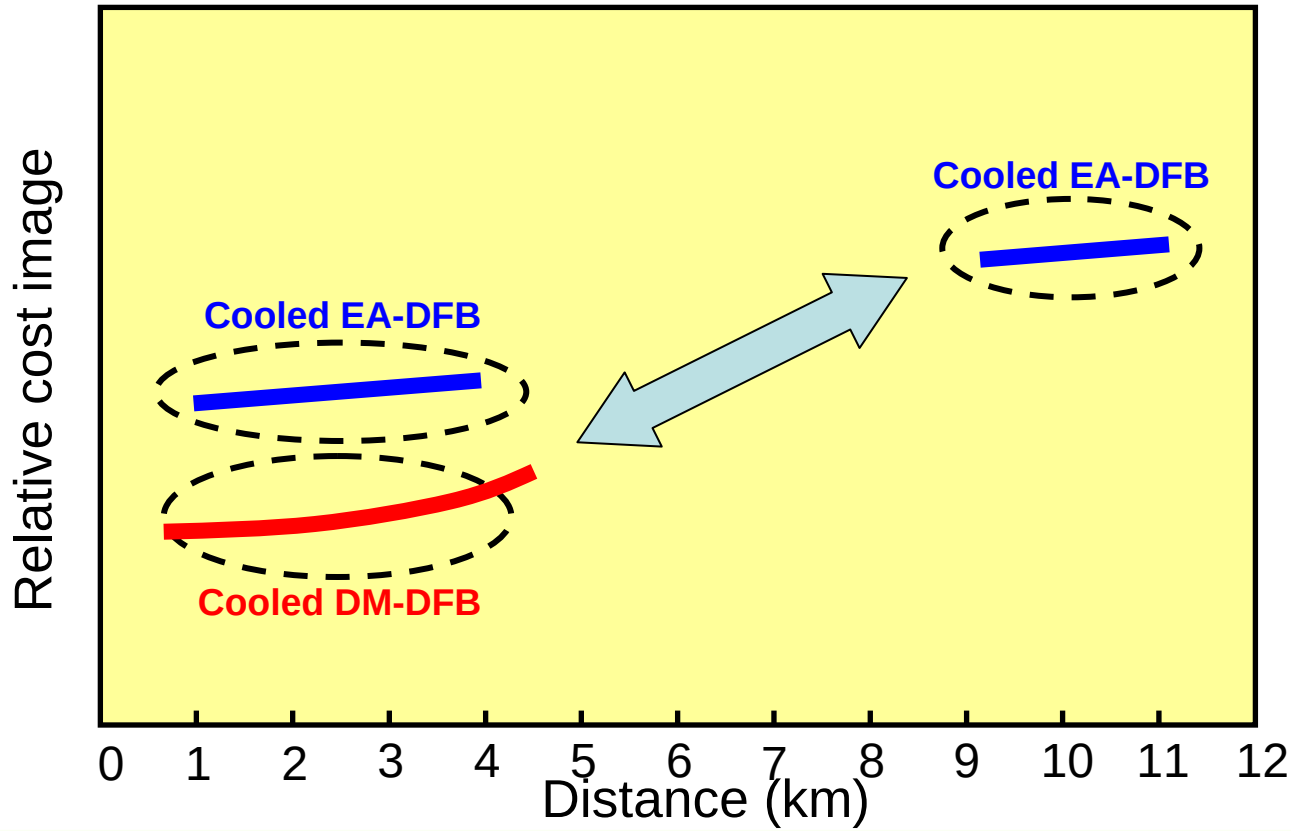
- Below is one of the optimized power budgets for 10 and 3/4km.
- Considering tracking error and aging degradation of 1dB, 10km reach needs additional wavelength and power control circuitry (like DWDM systems)

Parameter	0km (for Rx overload)	3km	4km	10km
TOSA max. Ave (dBm)	4.0	4.0	4.0	4.0
TOSA min. OMA (dBm)	-	0.4	0.9	4.3
Opt-Mux loss (dB)	0.5	2.5	2.5	2.5
Tx max. Ave (dBm)	3.5	3.5	3.5	3.5
Tx min. OMA (dBm)	-	-2.1	-1.6	1.8
Link Budget	0	5.5	6.0	9.4
Rx min. OMA (dBm)	-	-7.6	-7.6	-7.6
Rx overload Ave (dBm)	3.5	3.5	3.5	3.5
Opt-Demux loss (dB)	0.5	2.5	2.5	2.5
ROSA min. OMA (dBm)	-	-10.1	-10.1	-10.1
ROSA overload Ave (dBm) (*2)	3.0	3.0	3.0	3.0
TOSA output power tuning margin @ ER=3.5dB	-	2.4	1.9	-
TOSA output power tuning margin @ ER=6dB	-	4.4	3.9	0.5

(*1) TOSA: Transmitter optical sub-assembly, ROSA: Receiver optical sub-assembly
Tx: Transimtter output at TP2, Rx: Receiver input at TP3
(*2) To achieve 3dB ROSA overload is challenging and needs further study.

Relative cost image (2-4km vs. 10km)

- For 10km link, only EA-DFB will be a choice due to much dispersion.
- DM-DFB will be cheaper but can achieve only shorter distance



Cost minimum distance

- There will be more choices to achieve low cost if we can reduce distance down to 3/4km while cooled EA-DFB will be only choice in case of 10km link
  - Above 3/4km, transmission capability with sophisticated device and control schemes is required
- Considering current solution of cooled EA-DFB and future solution of DM-DFB, 3/4km is a cost inflection point
- In DM-DFB, the critical distance for transmission is between 3 and 4km
- Thus, we recommend 3km

CWDM or LAN WDM Specification

- Wavelength Specifications
  - Key merit of LAN WDM proposal is to share common wavelength scheme with 40km transmission proposal
  - 40km transmission proposal needs more detailed feasibility study
    - May be merit to share more commonality with DWDM interfaces being considered for OTN applications

	CWDM	LAN WDM	Note
Grid	**1271, 1291, 1311, 1331 (*1)**	**1312 center**	
Spacing	**20 nm**	**2 – 4 nm (*2)**	
Tolerance	**+/- 6 nm**	**+/- 0.36 – 0.8 nm**	

(*1) Longer set of wavelength (1290nm to 1351nm) was discussed in traverso_01_0907.pdf.
(*2) In case of 400 to 800GHz spacing, wavelength spacing must be 2.29 to 4.59 nm

Device Availability

- For first generation SMF PMD Availability
  - Cooled EA-DFB is most likely device for both CWDM and LAN WDM in 2008/2009.
- Technical Issues on development
  - Wavelength grid is not an issue if it is defined
    - The MQW composition of DFB portion is very well understood and has been in mass production for both LX4 and CWDM
    - The MQW composition of EA must be adjusted to wavelength Thus 4 kinds of chip development is necessary for both WDM
  - From device development experience, availability of CWDM and LAN WDM is almost the same

Manufacturing and Cost

- To focus on the cooled EA-DFB manufacturing
  - Four (4) wafer fabrications required -- each optimized per wavelength, for either WDM proposal
  - Wavelength yield will determine the cost difference
  - 1310nm EA-DFB is more specific for 100GbE and other application is very limited.

- Wavelength Yield and Cost
  - CWDM: Wavelength yield will be 100% without individual wavelength test
  - LAN WDM: Narrower wavelength tolerance will hit wavelength yield
    - Wavelength distribution is 2-5 nm in the wafer and wafer-wafer variation
    - Adding wavelength test for each chip is required
  - Thus LAN WDM chips may have issue on cost and delivery

Others

- Wavelength for 40km application
  - Transmission of 40km using WDM is still challenging
    - Four wavelength mixing and optical budget to be confirmed
  - It is too early to define the wavelength set for 40km application
  - Laser chip may be different from 10 (2/3/4) km chip even for the same wavelength

- Future
  - CWDM allows uncooled devices that reduce power dissipation significantly in future. Compact module can be achieved
  - Uncooled DFB is challenging but theoretically feasible with CWDM

CWDM or LAN WDM Summary

- Laser / TOSA Manufacturers would like to recommend CWDM rather than LAN WDM from the view point of manufacturing and cost.

Item		CWDM	LAN WDM	Note
Specification	Grid	1271 - 1331	1312 center	
	Pitch	20 nm	2 – 4 nm	
	Tolerance	+/- 6 nm	+/- 0.36 – 0.8 nm	
Laser for 1st generation		Cooled EA-DFB		
Device development	Technical Issue	25G 1310nm EA-DFB 25G Operation is the major challenge Wavelength grid is very minor challenge		
Manufacturing	Wafer fabrication	4 kinds wafer		
	Wavelength yield	100%	Lower yield	
	Wavelength test	No	Required	
Availability		Same		
40km		NA	Need investigation	
40GbE		Available	NA (expensive)	
Future		Cooled DFB, Uncooled EA-DFB, Uncooled DFB	Cooled DFB	

Summary

- Optical link budget for 3km, 4km and 10km were estimated, Shorter distance (2 to 4km) is preferred for lowering cost
- CWDM is lower cost solution than LANWDM because of wider wavelength tolerance
- Within 2km to 4km distance range, shorter distance (2 to 3km) is preferred in terms of cost for CWDM solution
- We recommend CWDM rather than LAN WDM from the view point of manufacturing and cost