Demonstration of 40Gb/s 1310nm EA-DFB Laser feasibility for 40GbE 10km SMF application

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Kiyo Hiramoto, Opnext Japan Inc.
Masato Shishikura, Opnext Japan Inc.
Matt Traverso, Opnext Inc.

Supporters

Network Carrier
- Osamu Ishida, NTT
- Shoukei Kobayashi, NTT
- Hidenori Takahashi, KDDI Labs

System Supplier
- Youich Akasaka, Fujitsu labs
- Satoshi Obara, Fujitsu
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- Keiji Sato, Eudyna
- Hao Feng, Eudyna
- Song Shang, SMI
- Farzin Firoozmand, SMI
- Craig Hornbuckle, SMI
- Jen Fiedler, U2T

Motivation and contents of this presentation

Motivation

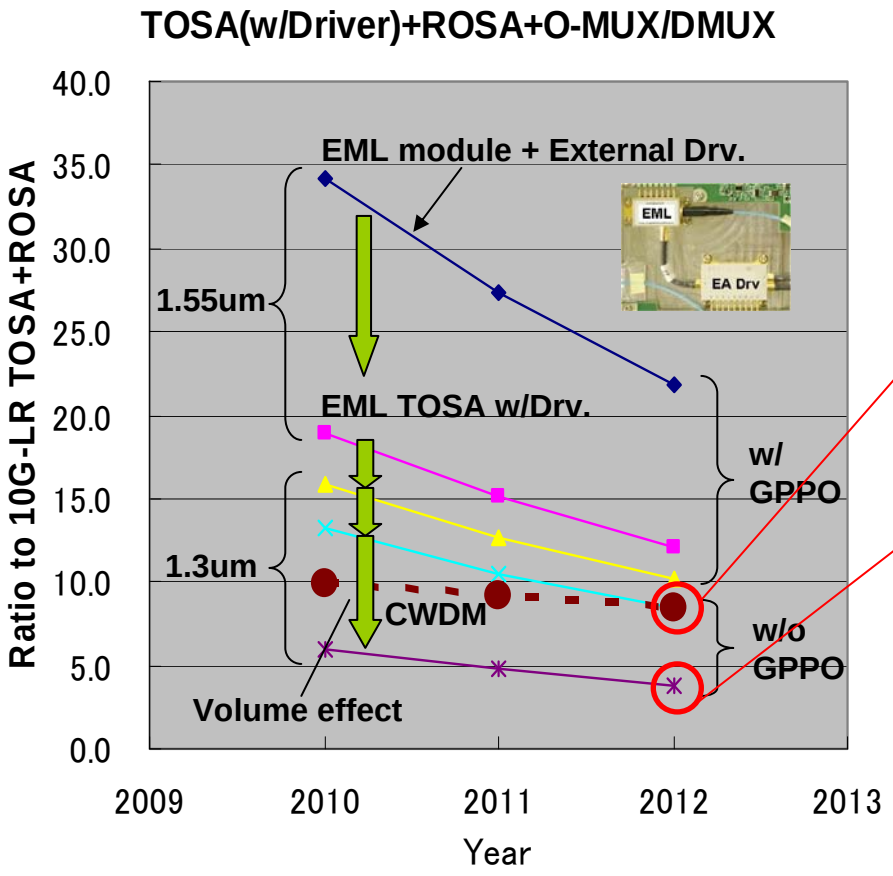
- Numerous discussions have been held in the IEEE802.3ba Task Force on the right solution for the 40GbE 10km SMF objective (serial vs. 4 x 10Gb/s CWDM) with regard to aspects below.
  - Cost comparison
  - Availability and technical feasibility
  - Power and Size comparison
- This presentation is to show technical feasibility of 40Gb/s EA-DFB Laser in near term (2010 through 2013) and also to address cost/power and size comparison between serial vs. 4 x 10Gb/s CWDM

Contents

- Cost analysis for 40Gb/s serial TOSA/ROSA vs. 4 x 10Gb/s CWDM TOSA/ROSA
- Technical feasibility of 1.3um 40Gb/s EA-DFB Laser
- Power consumption & size consideration
- Summary

Cost comparison between 40Gb/s TOSA/ROSA vs. 4 x 10Gb/sTOSA/ROSA + O-Mux/DeMux (1)

- Serial optics provide lower cost than CWDM optics from 2010.
- CWDM cost will be never lower than 4x of 10GbE cost in foreseeable future.



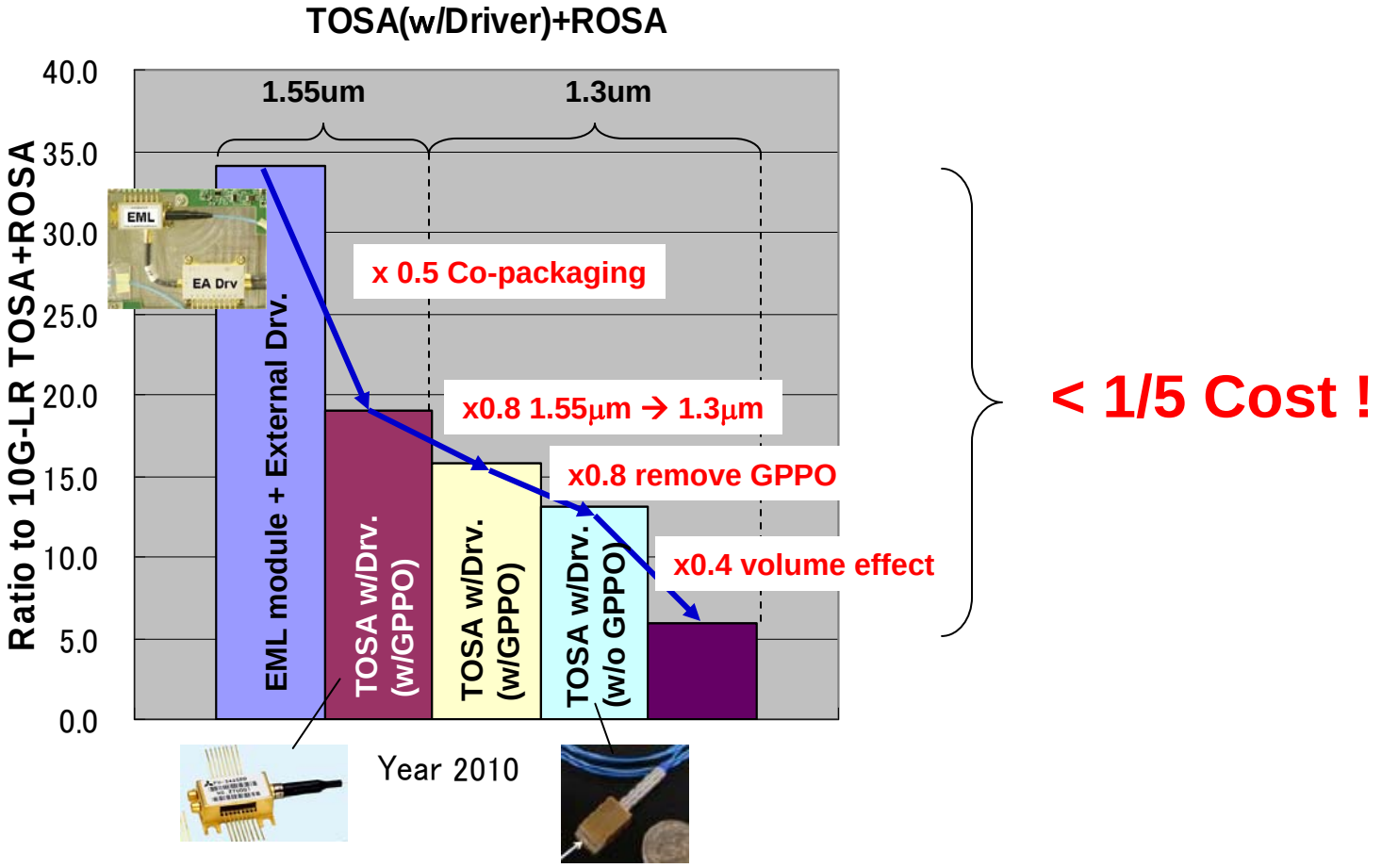
x6.8
More than x4 10G-LR

x3.4
Less than x4 10G-LR

- CWDM can not achieve the cost less than x4 10G-LR in 2012
- Serial can achieve the cost less than x4 10G-LR in 2012

Cost comparison between 40Gb/s TOSA/ROSA vs. 4 x 10Gb/sTOSA/ROSA + O-Mux/DeMux (2)

- Serial optics provide lower cost than CWDM optics from 2010.
- CWDM cost will be never lower than 4x of 10GbE cost in foreseeable future.



Merits of 1.3μm EML

- 1.3μm EML has advantage for higher output power.
  - higher photon energy
  - less absorption at EA modulator
- Chromatic dispersion at the wavelength of 1.3μm is almost negligible compared with 1.5μm.
  - less trade off between chirp and Bandwidth
  - less absorption at EA modulator = higher output power (same as above)
- Share the 40G serial components (1.3μm EML etc.) for newly added 1.3μm 40G 10km/20km/40km application in ITU G959.1

	1.3μm EML (IEEE802.3ba)	1.5μm EML (ITU-T G.693)
Output power	2~3dB advantage	
Chromatic dispersion	-22.8~18.2 ps/nm	40 ps/nm
Chip cost	x 1	x 2
TOSA cost (w/ Driver)	x 1	x 1.4

43-Gbps EA/DFB Laser structure

- Low RC (*) EA modulator structure for High speed modulation over 43-Gbps
- InGaAlAs QW band structure with larger ΔE_c and smaller Δe_v
- Better extinction ratio at high temp. due to strong electron confinement.
- High-speed, high power operation due to suppression of hole pile-up.

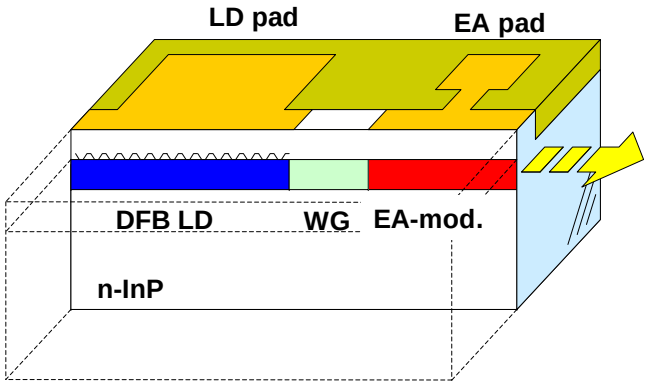
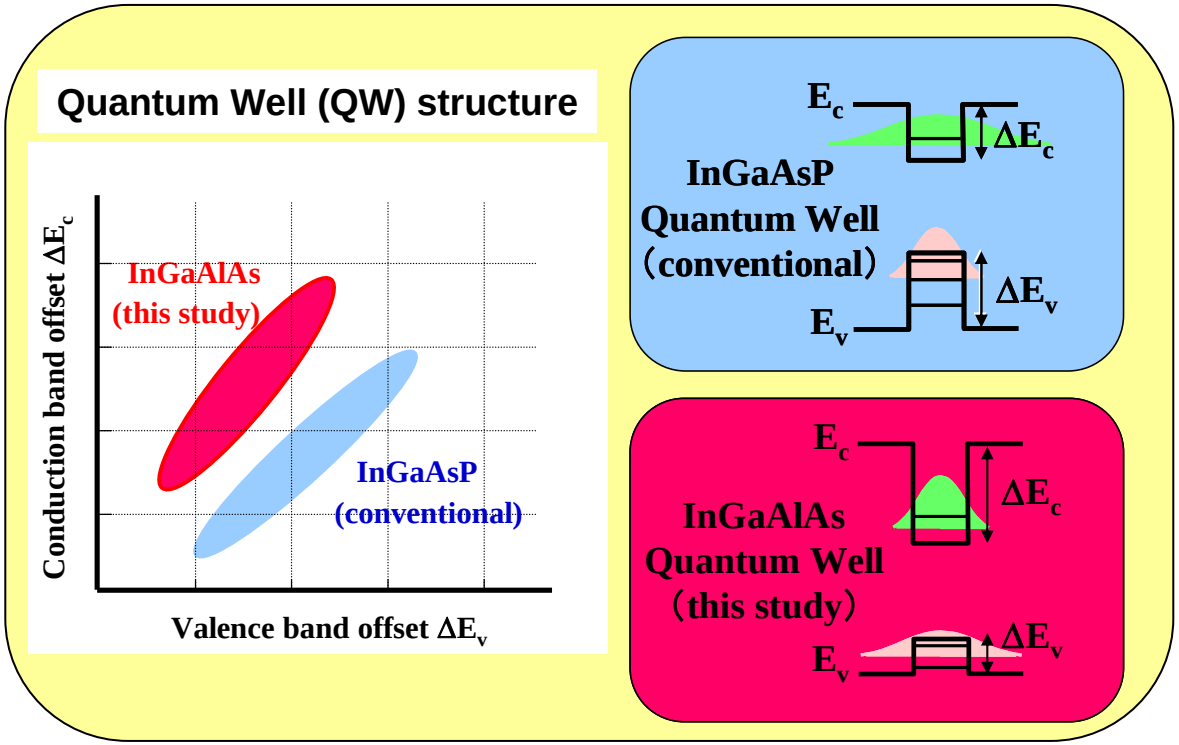


Fig. Device Structure

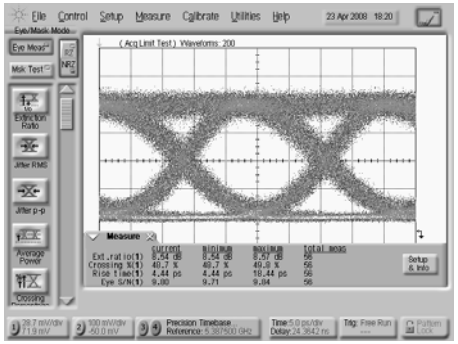
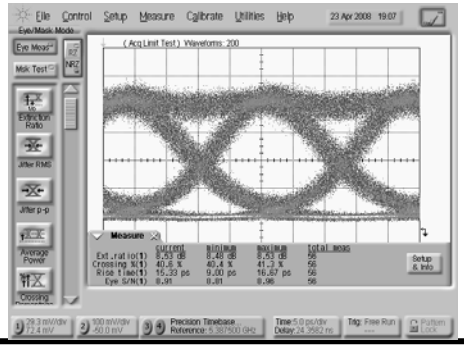


(*) RC: Resistance and Capacitance

[1] S. Makino, et al, Hitachi CRL.

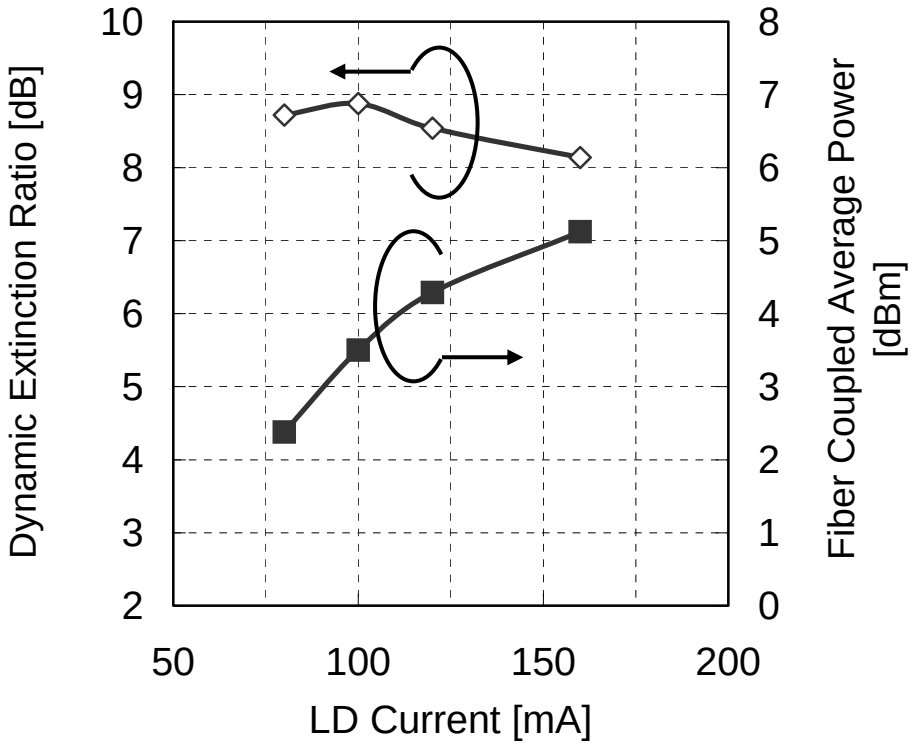
43-Gbps 10-km Transmission Performance (Semi-cooled)

T_LD=50°C, Chip in Package, NRZ, 2^{31}-1 PRBS

I_LD	**120 mA**
DER	**8.6 dB (Ave.)/6.0dBm(OMA)**
Pfmod	**+4.2 dBm**
BTB	
10-km SMF	

200-Waveforms

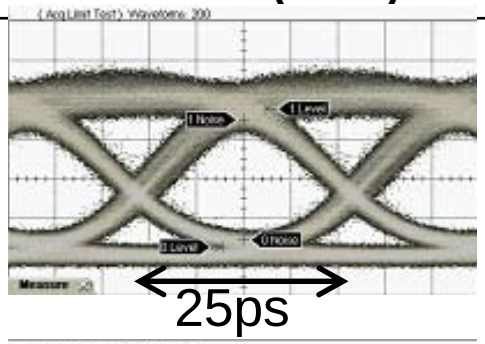
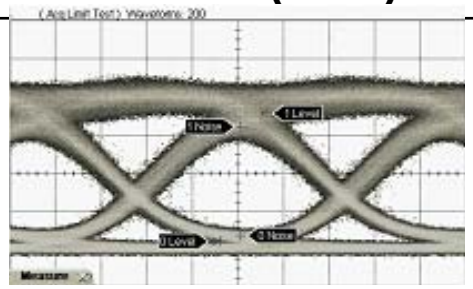
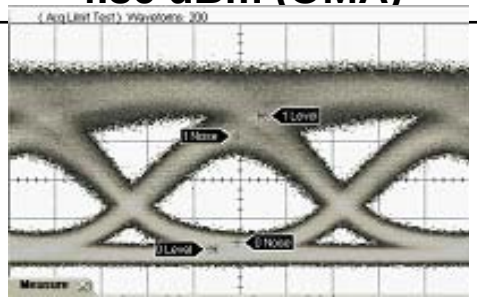
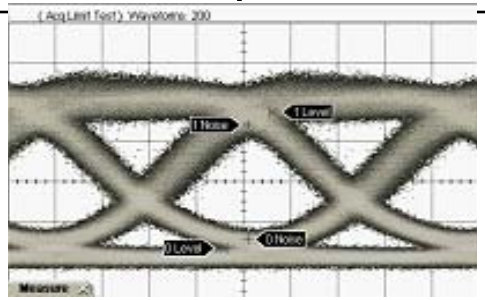
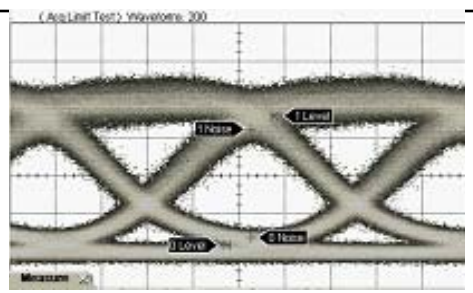
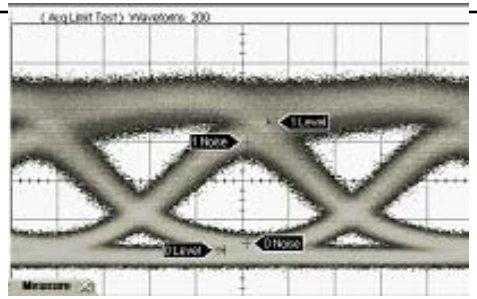
Output power: >+4dBm (OMA)
ER: >8dB



[1] S. Makino, et al, Hitachi CRL.

Feasibility study of uncooled operation

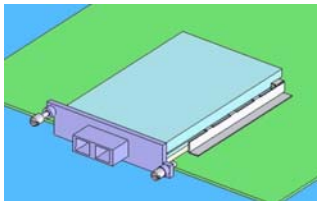
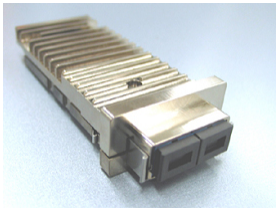
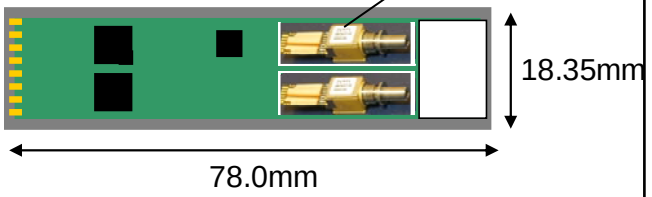
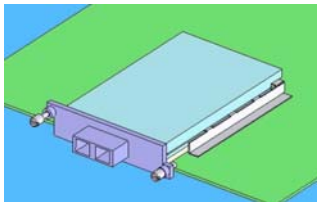
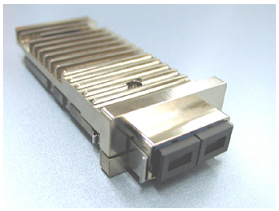
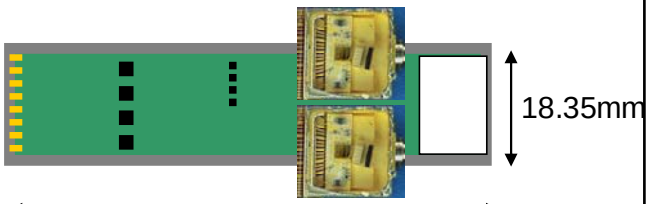
Chip on Carrier, 43 Gbps, NRZ, 2^7-1 PRBS

T_{LD}	25ºC	55ºC	85ºC
DER	7.47 dB	8.68 dB	9.09 dB
Pmod	8.42 dBm (Ave.) 9.86dBm (OMA)	7.69 dBm (Ave.) 9.52 dBm (OMA)	2.93 dBm (Ave.) 4.86 dBm (OMA)
BTB			
10-km SMF			

200-Waveforms

[1] H. Hayashi, S. Makino, et al, Hitachi CRL, Will be presented at ECOC2008.

Size and power consumption trend

		Now	Tomorrow	Future
Serial	Pc	4.8W (*1)	4.8W (*1)	3.5W (*1) / 3W (uncool)
	Size	Double XENPAK 	X2 	XFP XMD  Possible!
CWDM	Pc	5.0 W (*1)	5.0 W (*1)	3.6W (*1)
	Size	Double XENPAK 	X2 	QSFP??  Possible??

(*1) traverso_02_0708

Summary

- Optical component cost (TOSA+ROSA+O-Mux/DeMux) for 40GbE serial is lower than CWDM in 2010 based on *currently* available devices/technologies.
- TOSA+ROSA cost for 40GbE will get lower than 4x 10GbE LR cost in future whereas that for CWDM will never be lower than 4x 10GbE LR in foreseeable future
- 43 Gb/s operation of 1310nm EA-DFB was demonstrated. Also, technology potential for uncooled operation was demonstrated which will results in lower power consumption. Thus, serial enables high density 40GbE multi-port systems in the future
- Because of its lower cost in 2010 and roadmap to smaller module size in future, we strongly recommend serial 40GbE for 10km SMF application.