
40GE SMF PMD Call for Interest

IEEE 802.3 Working Group
Atlanta, Ga
Nov 15-20, 2009

Objective for this Meeting

- To measure the interest in starting a study group for **40GE single-mode fiber PMD** optimized for client applications in the carrier environment
- We don't need to
 - Fully explore the problem
 - Debate strengths and weaknesses of solutions
 - Choose any one solution
 - Create PAR or five criteria
 - Create a standard or specification
- Anyone in the room may speak / vote
- **RESPECT**...give it, get it

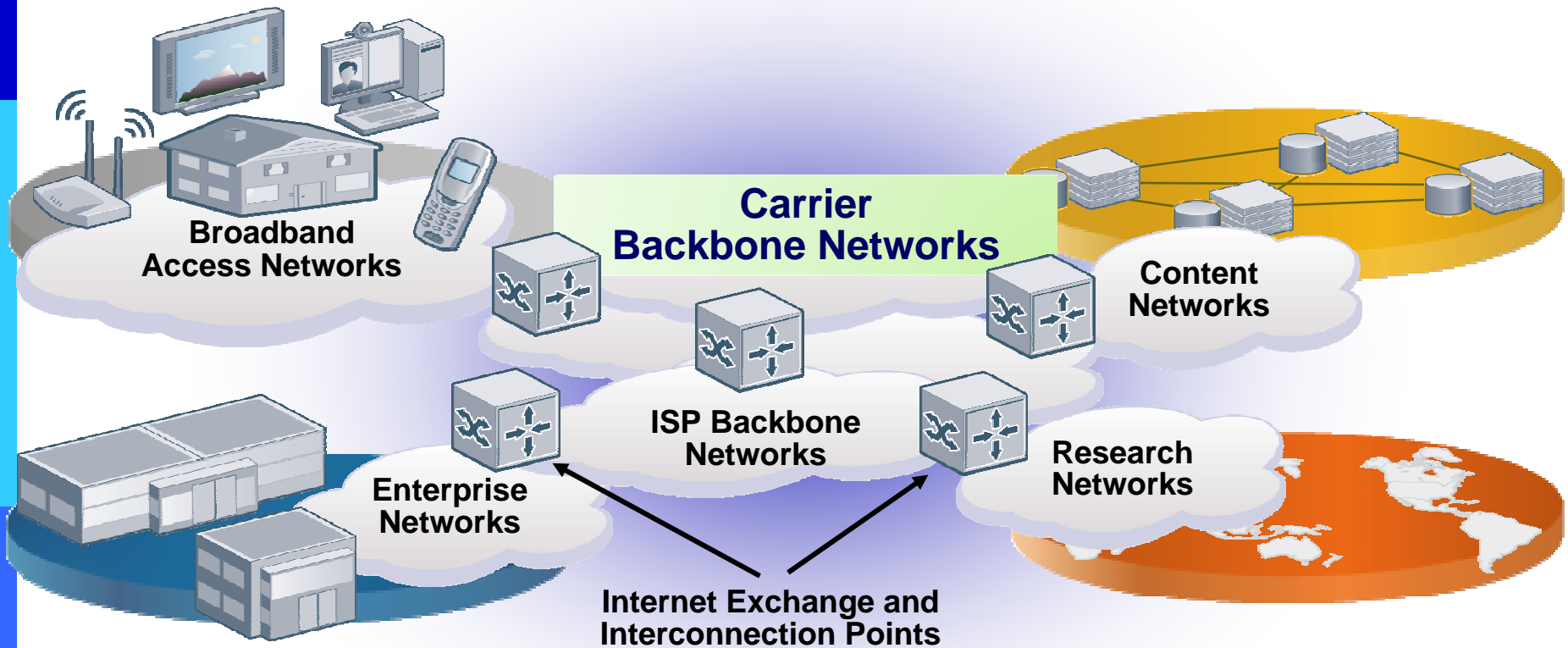
Agenda

- Presentations
 - “40GE SMF PMD Overview” Brad Booth
 - “The Need for 40GE SMF PMD” Martin Carroll & Sam Sambasivan
 - “The Technical Viability of 40GE SMF PMD” Matt Traverso
 - “40GE SMF PMD - Why Now?” Mark Nowell
- Discussion
- Call for Interest
- Future Work

40GE SMF PMD CFI Overview

**Presented by:
Brad Booth, AMCC**

Ethernet's Growing Deployment



Carrier networks overview

- Carrier networks represent a unique operational environment.
- Geographically diverse network with sparsely distributed equipment locations.
- Embarking on a path to support Ethernet services while supporting their investment in other protocols.
- Example:

AT&T Global network

- 38 Internet data centers on 4 continents
- >980k fiber route miles
- >4100 MPLS access nodes (143 countries)
- >1450 Ethernet access nodes (21 countries)

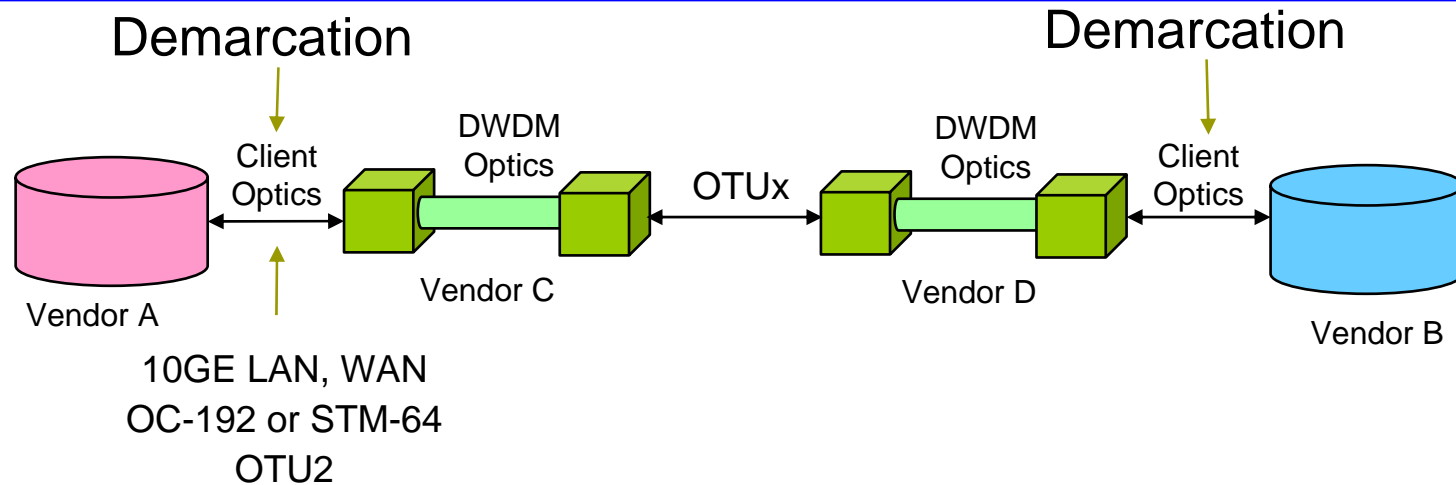
AT&T Domestic network

- 26 Core data centers in US
- US area is ~3.5M sq miles covered by 40 Gb/s core backbone with >22k fiber route miles
- >1800 additional non-core backbone links



Source: Young_01_1106 (updated 11/09)

Carrier Backbone Overview



- Demarcation point is still the most operationally challenging.
 - Multiple translations: SONET, SDH, OTN, Ethernet.
 - 10G WAN PHY was an attempt, but missed.
- Simplification at this point enables greater market potential for Ethernet.

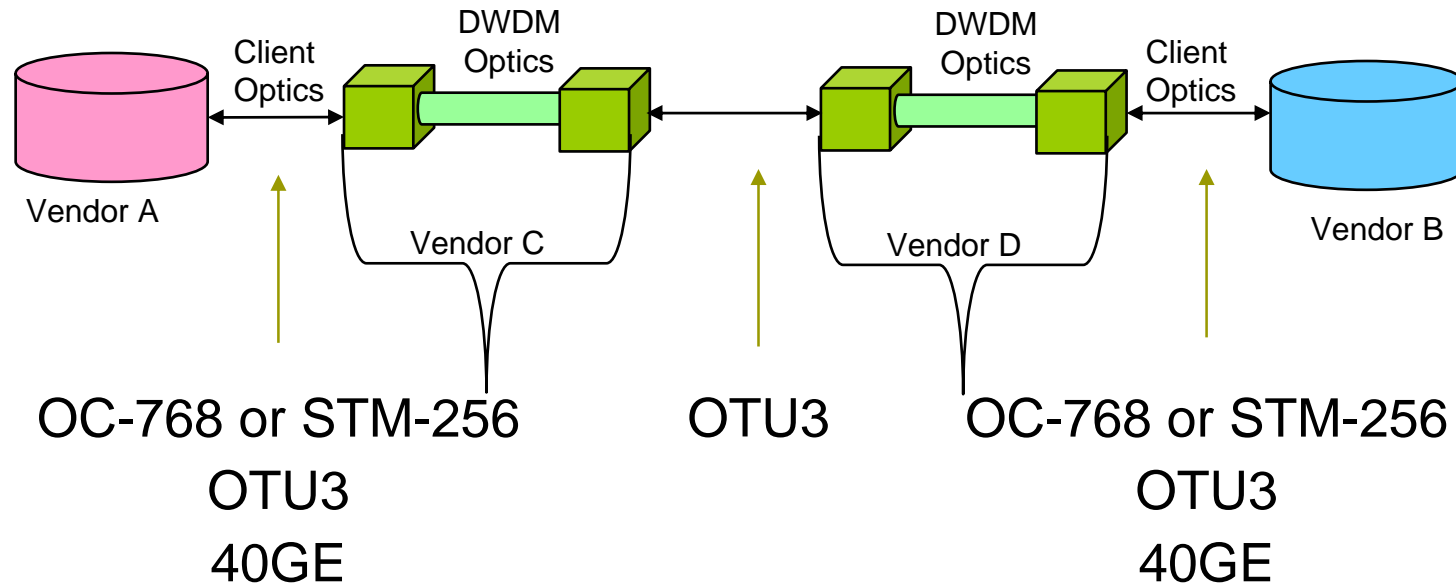
Support for Carrier environment

- Purpose of P802.3ba OTN support objective:
 - Transport 40GbE and 100GbE across an OTN infrastructure
- 40GBASE-LR4:
 - Wavelength division multiplexing optics.
 - 802.3ba decision driven by near-term data center needs.
 - Optically incompatible with the installed base of carrier 40G.
- Adding a 40GE SMF PMD to the family:
 - Strengthens the support of Ethernet for carriers.
 - Enables Ethernet services transition.

The need for 40GE Serial PMD optimized for client applications in the carrier environment

**Presented by:
Sam Sambivisan, AT&T
Martin Carroll, Verizon**

Carrier 40G Network Architecture



- As currently defined in 802.3ba, 40GBASE-LR4 is optically incompatible with installed base preventing development of a single multi-protocol 40G module (ex. CFP) that supports 40GE and the installed base of OC-768 or STM-256, and OTU3 services.
- This has significant cost implications for carrier networks.
- A single multi-protocol 40G module optimized for central office reach* benefits carriers immensely and enables efficient increase in the global Ethernet footprint and penetration.

* Common reach for client interfaces in carrier networks is 2km

Contributors to cost of optical networks for carriers – client optics

There are two major contributors for carriers with respect to client optics:

- CapEx (Capital Expense) is the acquisition cost of optics.
 - Similar for both carriers and data center operators.
 - Focus of 802.3ba debate in 2008 about 40GE standards alternatives.
- OpEx (Operating Expense) is the operational cost of optics.
 - It is significantly higher for carriers than data center operators.
 - Multiple services need to be supported in equipment centers distributed across large geographic areas that have lower equipment densities compared to data centers.

Deserves separate consideration by 802.3 to address this higher cost of optics for carriers.

Carrier OpEx considerations due to client optical interfaces

- Higher carrier OpEx contributors due to client optics (vs. data center operator OpEx):
 - Shipping, Installation, Bring-up, Configuration, Sparing, Training, Life-cycle length.
 - Multi-protocol support.
- Carrier OpEx is proportional to the number of module types that have to be supported.
- A single module type minimizes OpEx by allowing configuration of same module for different services.
- Today, the OpEx of providing 10G client services (Ethernet, SONET or SDH, and OTN) is minimized through use of a single multi-protocol 10G SMF module (ex. XFP) that complies with 10GE, OC-192 or STM-64, and OTU2 standards.

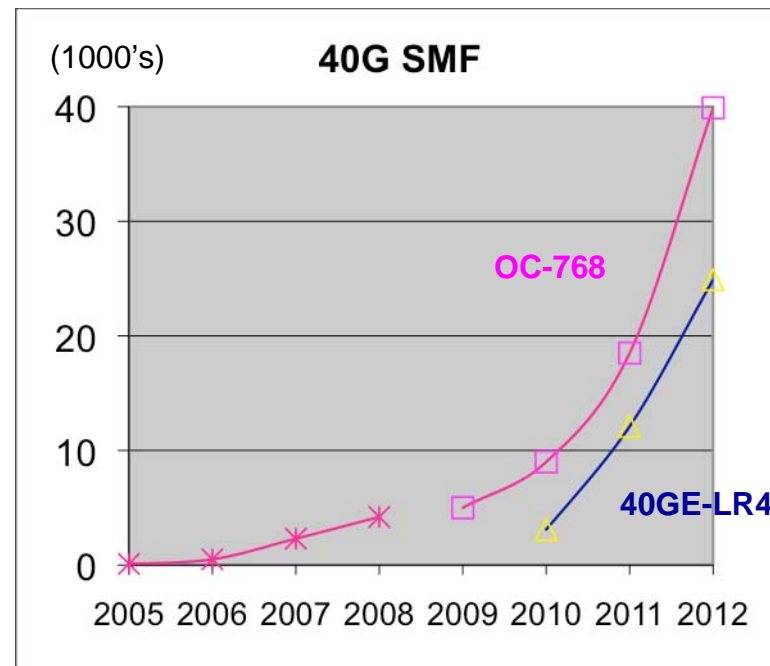
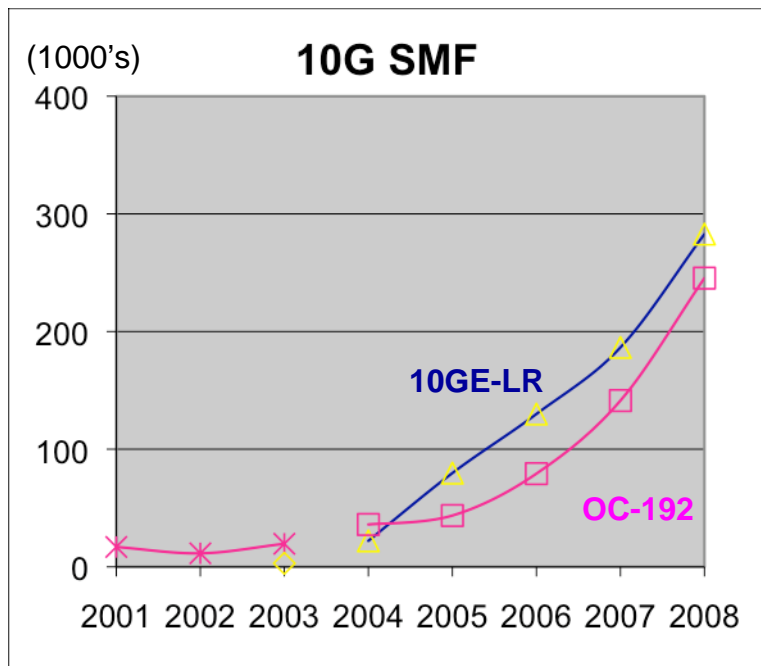
Carrier 40G Deployment to date

- Carrier deployment of 40G technology started in 2004.
- Initial deployed technologies were OC-768 or STM-256 standards (40G NRZ).
- Deployment of OTU3 technology started to support OTN service.
- Dual protocol OTU3/OC-768 modules were deployed in order to minimize costs. Both based on 40G NRZ optical technology.
- Today there is a significant installed base of these interfaces.
- Future 40G clients will additionally be based on a 40GE standard to support Ethernet services.

40G SMF client market scoping

While market forecast is not a factor in a CFI discussion, it is highly relevant to a Study group discussion.

In development of this CFI material, some preliminary market analysis was done:



Sources:
Lightcounting
RHK-Ovum

Preliminary inference: Carrier needs (assumed to be represented by OC-x data) is comparable to Ethernet LR forecasts.

Conclusion: further analysis needed by study group

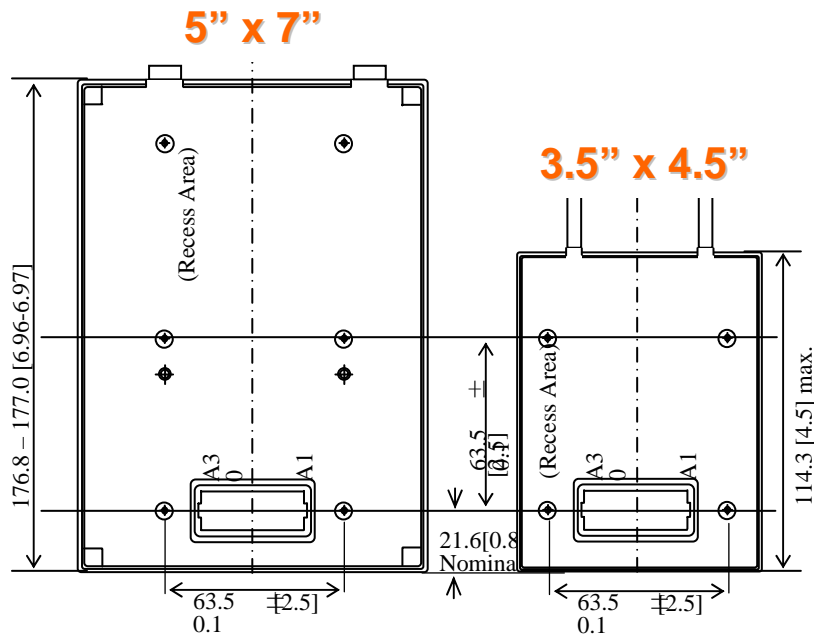
The need for 40GE serial PMD

- Preferred carrier approach would be to deploy multi-protocol 40GE/OC-768/STM-256/OTU3 modules to:
 - minimize OpEx costs due to simplified deployment.
 - leverage combined volumes to achieve lower CapEx .
 - provide backwards compatibility with deployed technology.
- Current 40GBASE-LR4 is optically incompatible with 40G serial based OC-768/OTU3. CWDM vs. serial.
- **Requires development of a new 40GE PMD to enable compatibility for multi-protocol implementation.**
- The alternative is a multi-protocol 40G CWDM module (ex. CFP) based on G.695 and 40GE-LR4 standards. However, this breaks backwards compatibility with the installed and growing 40G carrier deployments.

Technical viability of a 40GE SMF PMD optimized for client applications in the carrier environment

**Presented by:
Matt Traverso, Opnext**

40Gbps Supply Chain Established: Module

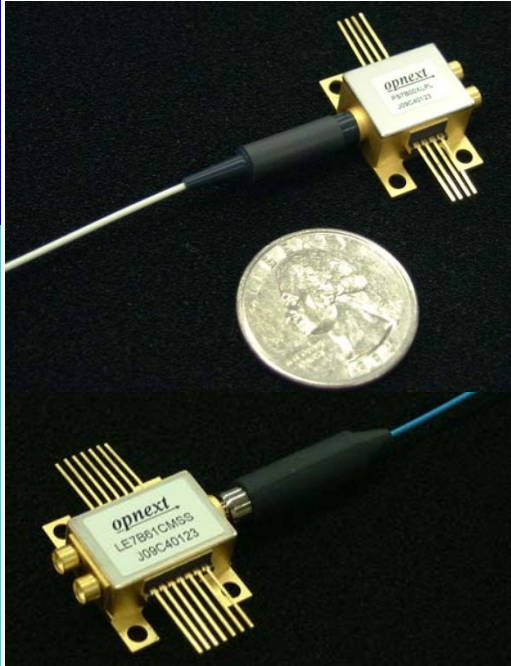


Finisar



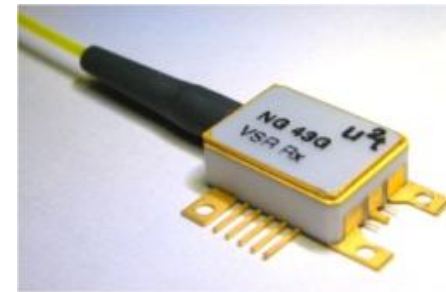
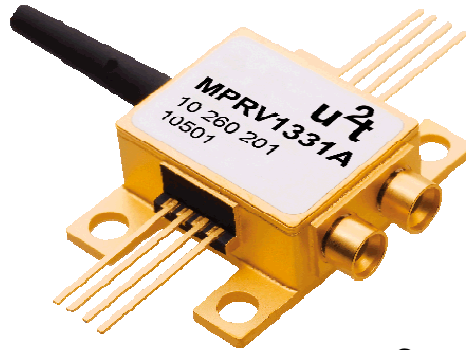
- 40Gbps optical modules commercially available from multiple suppliers.
- Modules based upon 300pin MSA:
 - 1st Generation larger size (5"x7") shipping since 2004.
 - 2nd Generation smaller size & more robust controls & features.
- Multiple rates/protocols supported: OC-768/STM-256 and OTU3.

40Gbps Supply Chain Established: Optics



Courtesy: Opnext

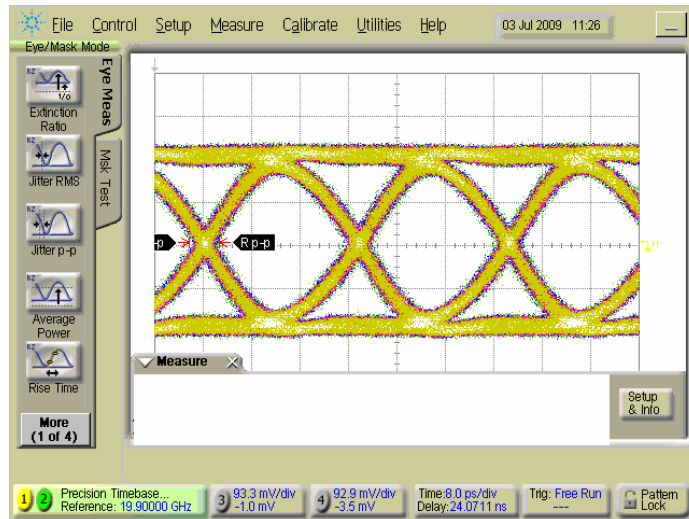
u²t photonics



Courtesy: u²t Photonics

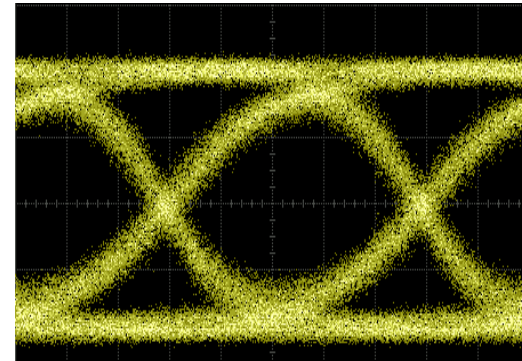
- XLMD MSA established for 40Gbps transmitter and receive optical subassemblies.
- Multiple optical subassemblies available from multiple suppliers.
- Component suppliers developing compact packaging with advanced cost reduced interconnect technologies.

40Gbps Supply Chain Established: Analog & Digital ICs



Courtesy: Sierra Monolithics

40G TIA



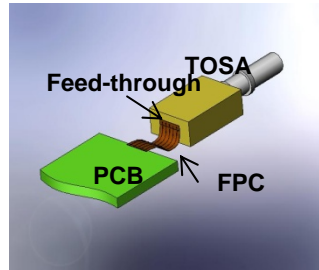
Courtesy: Inphi

- 40Gbps SerDes commercially available.
 - 3rd Generation ICs offering superior performance with reduced power .
- 40Gbps analog ICs for interfacing to the optics commercially available.
 - Driver ICs & Transimpedance amplifiers with efficient gain & high bandwidth available.
- Multiple rates/protocols supported: OC-768/STM-256 and OTU3.

New Technology on the Horizon

- Advanced Optics

- Uncooled transmitter technology demonstrated.



$\lambda=1290$ nm, Chip on Carrier, 43 Gbps, NRZ, 2⁷-1 PRBS

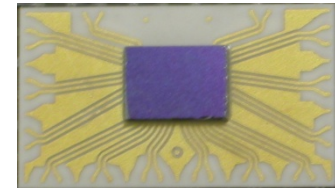
T _{LD}	25°C	55°C	85°C
DER	7.47 dB	8.68 dB	9.09 dB
P _{mod}	8.42 dBm	7.69 dBm	2.93 dBm
VOH	-1.8 V	-1.1 V	-0.3 V
BTB			
10-km SMF			

NRZ: Non Return to Zero, PRBS: Pseudo Random Bit Stream 200-Waveforms

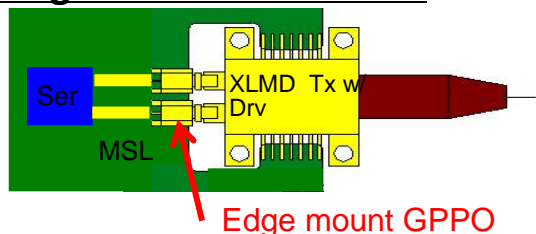
Courtesy: Opnext

- Advances in Electronics

- New lower power structures for Bi-CMOS.
- High responsivity transimpedance amplifiers emerging.
- Low cost yet high performance packaging.

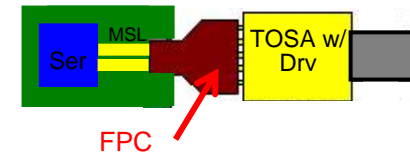


GPPO edge mount connectors



Edge mount GPPO

FPC interconnection



FPC

40Gbps SMF Optical Budgets Exist

	VSR2000-3R2 (1550nm)*	VSR2000-3R1 (1310nm)	P111-3D1 (1310nm)
Wavelength	1530-1565	1290 - 1330	1307 - 1317
Pout	+3 to 0	+3 to 0	+4 to 0
ER	8.2	8.2	8.2
Psens	-6	-5	-7
Distance	2km	2km	10km
Attenuation	4	4	6
Penalty	2	1	1
Document	G.693	G.693	G.959.1

* VSR200-3R2 is the only interface known to be deployed

- Opportunity for IEEE to leverage past work and select optimized solution for marketplace.
- Unified module for maximum interfaces.

Summary

- Multiple companies have developed commercial 40Gbps technology.
- Significant innovation underway to drive technology improvement in 40Gbps solutions.
- Opportunity for IEEE to leverage 40Gbps investments in telecom applications to deliver most effective solution for 40GbE for Carrier Ethernet market & beyond.

A new 40GE SMF PMD - Why Now?

**Presented By:
Mark Nowell, Cisco**

Summary

- Ethernet's deployment is very broad and inclusive of many areas including carrier networks.
- Carrier networks have operational constraints which are unique:
 - Operational efficiency is required to enable 40GE penetration into an existing infrastructure.
 - Carrier demand justifies market acceptance.
- Feasible technology options are available to enable a cost effective solution.
- Why now?
 - 40GE penetration at it's infancy
 - SMF optimized client is necessary to enable accelerated penetration of 40GE into carrier networks
 - Accelerated adoption into carrier networks strengthens the whole Ethernet ecosystem

Supporters

- Andrew Ambrose Alcatel-Lucent
- Martin Birk AT&T
- George Young AT&T
- Sam Sambasivan ATT Labs
- Kathleen Tse ATT Labs
- Scott Kipp Brocade
- Gary Nicholl Cisco
- Mark Nowell Cisco
- Chris Cole Finisar
- John D'Ambrosia Force10
- Hiroshi Hamano Fujitsu
- Hideki Isono Fujitsu
- Ryan Latchman Gennum
- Bikash Koley Google
- Atul Gupta Inphi
- Francis Ho Inphi
- Thananya Baldwin Ixia
- Larry Green Ixia
- Jerry Pepper Ixia
- David Lewis JDSU
- Jeff Maki Juniper
- David Oflet Juniper
- Hidenori Takahashi KDDI Labs
- Farzin Firoozmand Monolithics
- Song Shang Monolithics
- John McDonough NEC-America
- Peter Anslow Nortel
- Osama Ishida NTT Labs
- Christophe Betoule Orange-FT
- Yann Loussouarn Orange-FT
- Erwan Pincemin Orange-FT
- Mike Dudek Qlogic
- Hirotake Iwadate SEDU
- Feng Tian SEDU
- Hirotake Oomori SEI Transmission Devices R&D Laboratories
- Eddie Tsumura SEI Transmission Devices R&D Laboratories
- Frank Chang Vitesse

Straw Polls:

Call for Interest:

- Should a Study Group be formed to study “40GE SMF PMD optimized for client applications in the carrier environment”?

Y: N: A:

Participation

- **I would participate in the “40GE SMF PMD” Study Group in IEEE 802.3.**

Tally:

- **My company would support participation in the “40GE SMF PMD” Study Group in IEEE 802.3**

Tally:

Future Work

- Ask 802.3 to form 40GE SMF PMD SG on Thursday
- If approved:
 - 802 EC informed of Higher Speed SG on Friday .
 - First 40GE SMF PMD SG meeting, week of 25 January 2010 IEEE 802.3 Interim.