Towards Terabit Capacity

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What is the OIF?

• Since 1998 OIF has brought together industry groups from the data and optical worlds

• Mission: To foster the development and deployment of interoperable products and services for data switching and routing using optical networking technologies

• Our 100+ member companies represent the entire industry ecosystem:
  • Carriers and network users
  • Component and systems vendors
  • Testing and software companies
Where We Fit
Need for Speed

1T

400G

100G
Need for Speed

1T

400G

100G

OIF OPTICAL INTERNETWORKING FORUM
A closely coupled set of projects which enables an ecosystem to provide products which meet the carriers' needs for 100G LH DWDM transport.
Dual Polarization

Filter Width
200 GHz
~ 2 Tb/s per system

1 X 100 G

100G Modulation Format Assumption

100G Trade speed for parallelism, then tackle parallel complexity with photonic integration

Quadrature Phase Shift Keying

Filter Width
100 GHz
~ 4 Tb/s per system

2 X 50 G

Filter Width
50 GHz
~ 8 Tb/s per system

4 X 25 G
OIF 100G

- 100G integrated photonics IAs
- MSA module IA
- FEC white paper
- CEI 25G/28G
OIF Physical and Link Layer (PLL) is currently working on 4 areas

- Maintenance activities on existing IAs
- 2nd generation coherent receiver
- ITxA
- 2nd generation MSA 100G LH Electro-Mechanical
• 1\textsuperscript{st} Gen 100G MSA
  • 5” x 7” x 1.29”
  • 80W

• 2\textsuperscript{nd} Gen 100G MSA targets
  • 4” x 5” x 0.75”
  • 45W

*Ref: http://www.cfp-msa.org/
Market Trend/Needs

• Next generation architectures capable of supporting industry growth rates
• To enable economical adoption of 4x25 Gb/s, definition of interfaces was required for board-to-board, chip-to-chip and chip-to-module
• Broad deployment through interoperable chips, connectors, and optical modules

Interconnect Challenges

• Ensure robust electrical interfaces able to meet system Bit Error Rate (BER) targets
• Multi-vendor Interoperability
• Defined parameters meeting industry objectives
PLL Demo includes three individual Interoperability Demos with thirteen participating OIF member companies.

This was the first time the demonstration included both CFP2 and QSFP28 modules.

Two demos focused on chip-to-module 4x25G CFP2 applications as defined in CEI-28G-VSR Implementation Agreement.

One demo focused on Very Short Reach 4x25G QSFP28 application.

Hot-plugs completed in February 2013.
CEI-28G-VSR targeted to chip-to-module channels of up to 10 dB loss

CEI-28G-VSR channel loss budget
OIF NG-100G
Demo 1: 100 GbE CFP2 Application

100Gbase-LR4 Link

Altera FPGA CFP2 Host Board

Finisar CFP2

Semtech CDR

Yamaichi CFP2 Connector

Oclaro CFP2

Semtech CDR

Yamaichi CFP2 Connector

Inphi Gearbox CFP2 Host Board

Altera

Finisar

Oclaro

Inphi

Yamaha Electronics

OIF

Optical Internetworking Forum
OIF NG-100G
Demo 2: 100 GbE CFP2 Application
OIF NG-100G
Demo 3: CEI-28G-VSR QSFP28 Application
OIF NG-100G
Benefits of PLL Interoperability Demo

- Demonstration of viability of NG 25 - 28 Gbit/s electrical system interfaces for switches, routers, transport and data center equipment
- Validation of interface architectures and constraints as defined in the Implementation Agreement
- Demonstration that an Ecosystem is now in place to deliver the next generation of data rates to System OEM vendors and manufacturers
Need for Speed

1T

400G

100G
OIF Physical and Link Layer (PLL) is currently working on 2 areas

- Electrical interfaces for client side
- 400G line side
OIF towards 400G
100G Client Side Today

- 12x10G electrical lanes (CAUI for 10x10G)
- 10x10G or 8x25G electrical lanes (CPPI for 10x10G
  CEI-28G-VSR for 4x25G)
- 4x25G electrical lanes (CEI-28G-VSR for 4x25G)
**OIF towards 400G**

**400G Client Side -Speculation-**

CDFP MSA:
- 16x25/28G electrical lanes

CDFP2/CFP2 4x4:
- 8x50/56 or 10x40/45G electrical lanes

CDFP4/CFP4 4x4:
- 4x100G electrical lanes

CEI-28G-VSR

CEI-56G-VSR

* Ref: http://www.cfp-msa.org/

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**OIF**

**OPTICAL INTERNETWORKING FORUM**
OIF towards 400G
400G Client Side

Assumption

- **First Generation 400G Client Modules will use 16x 25G/28G**
  - CEI 25G/28G

- **Second Generation 400G Modules will use 10x 40G or 8x 56G to improve the economics and power**
  - New CEI 56G
OIF towards 400G
CEI56G Project

- The IA shall define electrical I/O lane(s) that support data rates from 39 to 56Gb/s for chip-to-module interfaces
- The IA will define the channel model based on the chip-to-module applications
- The IA shall define a compliance test methodology for chip-to-module interface including a single connector
- Reach 0 to ~100mm (exact max reach TBD)
- Definition of compliance test methodology including test boards
OIF towards 400G
400G Line Side

OSNR Penalty, QPSK as reference [dB]

No. of QAM constellation points
OIF towards 400G

400G Line Side

Filter Width
800 GHz
~ 2 Tb/s per system

1 X 400 Gbit/s

Filter Width
800 GHz
~ 2 Tb/s per system

2 X 200 Gbit/s

Filter Width
400 GHz
~ 4 Tb/s per system

4 X 100 Gbit/s

Filter Width
100 GHz
~ 16 Tb/s per system

8 X 25 GBaud

Dual Polarization

16 QAM
OIF towards 400G
400G MSA
Towards 400G/1T

OIF Physical and Link Layer (PLL) is currently working on

- Next Generation Interconnect Framework Document
  - 15mm up to 2km
  - Electrical & Optical
# OIF towards 400G/1T NG Interconnect - Challenges

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<th>CHALLENGES</th>
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<td>Increase Level of Integration of Electronics &amp; Optics</td>
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OIF towards 400G/1T
Next Generation Interconnect Framework

- NG data rates will require new technologies
- There is benefit to industry if interoperability points are agreed on a number of application spaces (chip to chip, ...)
- Thus both vendors as well as users will benefit from interoperable agreements
- Establish a common language across the OIF and other standards bodies for NG developments
- New interconnection technologies which need to be developed across the eco system require significant investments

* Planed to be published after 2Q2013 meeting
OIF towards 400G/1T
NG Interconnect – App. Spaces & Interop. Points

- Chip-to-Chip
- Chip-to-OE
- Chip-to-Module
- Chassis-to-Chassis
OIF towards 400G/1T
NG Interconnect - App. Spaces

Rack to rack in the same row

Rack to rack in the same data warehouse
Summary

- Re-using experiences and lessons learnt of 100G
  - Consolidation of the supply chain
- NG-100G key components
  - Increase efficiency, reduce size and cost
- Towards 400G
  - CEI 56G
  - 400G MSA
- Towards 1T
  - Evaluation of new technologies
  - Electrical and optical interconnects
Thank you for your kind attention!