Silicon Photonics enables next-generation cloud computing, data center and HPC connectivity

Arlon Martin

PIC International Conference, March 2016
The Ever Growing Demand for Higher Performance

Performance Development

- **Terascale**
  - 2000
  - "Roadrunner"

- **Petascale**
  - 2005
  - 1st
  - "Summit" System

- **Exascale**
  - 2010
  - "Sierra" System
  - "Lawrence Livermore National Laboratory"

The Interconnect is the Enabling Technology

- **SMP to Clusters**
- **Single-Core to Many-Core**
- **Co-Design**

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High-Performance Designed 100Gb/s Interconnect Solutions

Adapters

- **ConnectX-4**
  - 100Gb/s Adapter, 0.7us latency
  - 150 million messages per second
  - (10 / 25 / 40 / 50 / 56 / 100Gb/s)

Switch

- **SwitchIB-2**
  - 36 EDR (100Gb/s) Ports, <90ns Latency
  - Throughput of 7.2Tb/s
  - 7.02 Billion msg/sec (195M msg/sec/port)

Switch

- **Spectrum**
  - 32 100GbE Ports, 64 25/50GbE Ports
  - (10 / 25 / 40 / 50 / 100GbE)
  - Throughput of 6.4Tb/s

Interconnect

- **LinkX**
  - Transceivers
  - Active Optical and Copper Cables
  - (10 / 25 / 40 / 50 / 56 / 100Gb/s)
  - VCSELs, Silicon Photonics and Copper
Three Major 2015 OCP Summit Contributions

**ConnectX-4 Multi-Host Technology**

**Open Optics MSA**

**SAI Switch Abstraction Interface**

Frank Frankovsky
Chair & President, Open Compute Project Foundation

New OCP contributions

Ghiasi Quantum

Microsoft

The Generation of OPEN ETHERNET

The Open Compute Project

Switch Abstraction Interface
Facebook Yosemite: First Ever Disaggregated Multi-Host Server

Facebook Yosemite Quad Core Multi-Host Platform

- 100Gb/s Copper Cable
- 100Gb/E QSFP
- Multi-Host PCI-Express Host Connections
- ConnectX-4 OCP2.0 100Gb/s Multi-Core Adapter
- Yosemite Sled With Quad CPU Cards
Mellanox View of Data Center Fabrics

Data Center Fabrics

- DACs
- VCSELs
- Silicon Photonics

Optical Link Length (m)

Data Rate per Lane (Gb/s)

1 2 3 5 10 20 30 50 75 100 150 300 500 1000 2000 5000 10000

Copper
Multi-mode fiber
OM3
OM4
Single mode fiber

- Direct Attach Copper
  - Zero power
  - Demo’d 8m at 100G
  - Best fit 3m

- Active Optical Cables
  - VCSELs or SiP
  - Reaches to 200m
  - Best fit for 5-20m

- VCSEL Transceivers
  - Reaches to 100m
  - Best fit for MMF

- SiP Transceivers
  - Reaches to 2km
  - Best fit for SMF
  - Parallel or WDM
Where Silicon Photonics Fits in Data Center Fabrics Today

DAC
Server/ToR-to-ToR

AOC
ToR-Leaf/Spine

SR4
For structured cabling
Short Reaches

PSM4
For Structured Cabling
Long Reaches

WDM4

"DAC In the Rack"
3m

25G SFP
Dual 50G Breakout
Quad 25G SFP breakout

"DAC In the Rack"
3m

Multi-Mode Optics
3m-100m

25G SFP
dual 50G Breakout
Quad 25G SFP breakout

8-Fiber MPO

2-Fiber LC

Optical Patch Panel

3m

Single-Mode Optics
Up to 2Km

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LinkX™ Silicon Photonics: Designed for Data Center Economics

Mellanox silicon photonics chips, drivers and TIAs, QSFP modules, Integrated WDM

No WDM specific lasers, No laser sub-assembly, No hermetic packages
No active laser alignment, No detector sub assembly

Mellanox Delivers!

- Innovation
- Integration
- Low power

Making 100Gb/s Deployments as Easy as 10Gb/s
Mellanox and Ixia Confirm 100Gb/s Ethernet Interoperability

Silicon Photonics & VCSELs

2km SMF

100G PSM4 & SR4 Transceivers
Silicon Photonics Solutions at Mellanox: 100 Gb/s Transceivers

- QSFP28
- Low power
- Integration
Franz-Keldysh modulator is >>10x smaller than MZI
- Only 40 um long
- Provides 5dB ER
- Integrates well w/WDM section

Density: Tiny FK Modulator Scales to >50 GHz
Density: 25 GHz Germanium Detectors Also Scale to >50 Gb/s
Density & Scalability: Echelle Gratings as Mux/Demux

- Echelle gratings scale from 4 to 40+ channels
- 10x smaller than AWGs
- Provide excellent wavelength registration
- Very low cross talk

Spectra on a 12 channel multiplexer
Density & Scalability: Mellanox has Demonstrated > 1Tb/s Devices

Connecting one fiber is a little easier and cheaper than connecting 40!
Echelle Gratings Allows Us to Squeeze 4x25G WDM 100G into a QSFP

- QSFP package provides great density
- WDM link uses standard SMF duplex fiber (same as 10G today)
- 2 km reach
Silicon Photonics is the Fastest Path to EDR & 200GbE

- Operating at 1550nm with ~40nm bandwidth
- Over 60GHz bandwidth measured
The Future for Silicon Photonics in Data Center Fabrics
Thank You