OFC/NFOEC'13 Summary

Virtualization, Cloud, Energy Efficiency

Shuqiang Zhang

OFC'13 Tracks

- **NW4I • High-performance Computers and Networking**

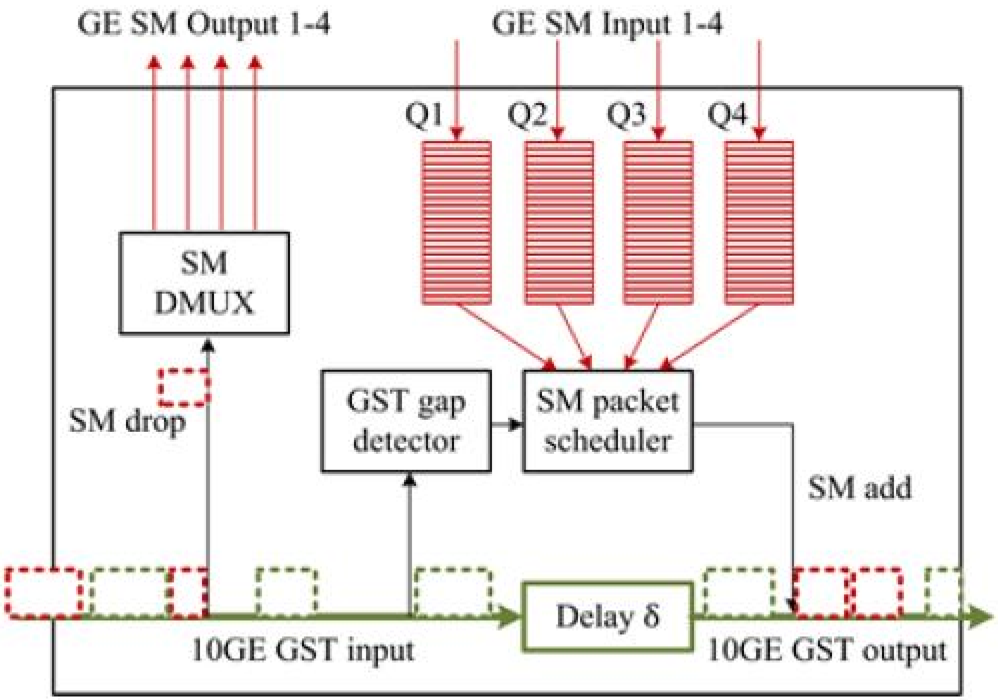
High-performance Computers and Networking

Code	Title	Author/Affiliate	Topic	Trends
NW4I.1	Optics for Supercomputers – One Engineers Perspective	Paul Coteus IBM T. J. Watson Research Center	The role of optics in Supercomputers is reviewed.	Cloud, Virtualization
NW4I.2	Multi-Tenant Data Center and Cloud Networking Evolution	Nabil Bitar Verizon, Inc.	Multi-tenant cloud networking is undergoing an evolution to address scalability, efficiency, and agility in allocating compute, storage and network resources to tenants. This paper provides an overview of existing and evolving cloud networking technologies.	
NW4I.3	Shared Mesh Restoration in ROADM Based Service Velocity Network	Inwoong Kim, Xi Wang, Mark D. Feuer, Sheryl L. Woodward Fujitsu and ATT Labs	Shared mesh restoration in a backbone network supporting rapid provisioning show up to 27% fewer regenerators than dedicated protection, plus ~40% increase in capacity.	

High-performance Computers and Networking

Code	Title	Author/Affiliate	Topic	Trends
NW4I.4	New Analytical Method to Compute Availability Non-Compliance Risks for Lambda Service	Darli A. A. Mello and Rafael B. Lourenc¸o University of Brasilia	a new analytical method to compute the SLA non-compliance risk for lambda services with availability guarantees, which applies to fiber links with arbitrary time-to-repair distributions	
NW4I.5	Integrated Packet/Circuit Hybrid Network Field-Trial	Raimena Veisllari, Steinar Bjornstad,Kuroh Bozorgebrahimi, Norwegian University of Science and Technology, TransPacket，UNINETT, Norway	the first field-trial of an integrated packet/circuit hybrid optical network.	

Integrated Packet/Circuit Hybrid Network Field-Trial



OFC'13 Tracks

- **OM3E • Enabling the Cloud Symposium II: Network Virtualization**

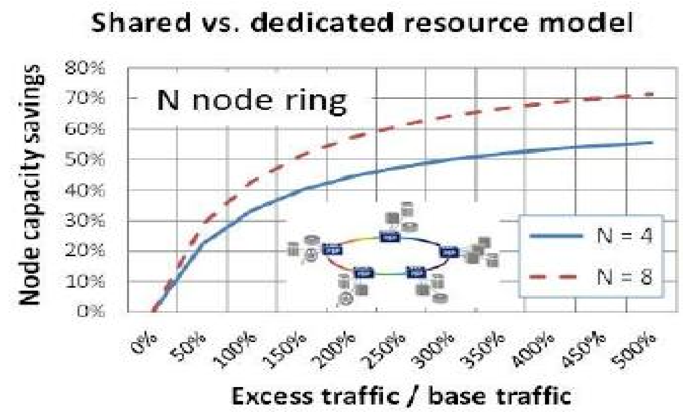
Network Virtualization

Code	Title	Author/Affiliate	Topic	Trends
OM3E.1	Role of Optical Network Infrastructure Virtualization in Data Center Connectivity and Cloud Computing	R. Nejabati, S. Peng, D. Simeonidou University of Bristol, UK	A Datacenter as a Service architecture utilizing coordinated virtualization of distributed datacenters and operator's optical network is proposed.	Network and IT resources orchestrate d through a common framework (such as OpenStack, CloudStack)
OM3E.2	WAN Virtualization: Looking beyond point-to-point circuits	Inder Monga, Eric Pouyoul, Chin Guok, ESnet, Lawrence Berkeley National Lab	This talk describes a flexible switching-service abstraction that enables distributed science collaborations as well as enterprise cloud computing.	
OM3E.3	Extending Network Virtualization into the Optical Domain	Jörg-Peter Elbers, Achim Autenrieth ADVA Optical Networking SE	This paper discusses prospects, challenges and solutions for extending network virtualization into the optical domain.	

Extending Network Virtualization into the Optical Domain

Jörg-Peter Elbers, Achim Autenrieth
ADVA Optical Networking SE, Fraunhoferstr. 9a, 82152 Martinsried, Germany

Enable dynamic resource sharing



Complexity of optical networks: e.g., wavelength continuity, ROADM Blocking, physical impairments, etc

An approach is desired which hides the optical layer complexity, but allows an abstract representation and sharing of the optical network resources.

A compromise between hiding optical-layer complexity and exposing topology is desirable.

OFC'13 Tracks

- **OTh3E • Virtualization in Networks**

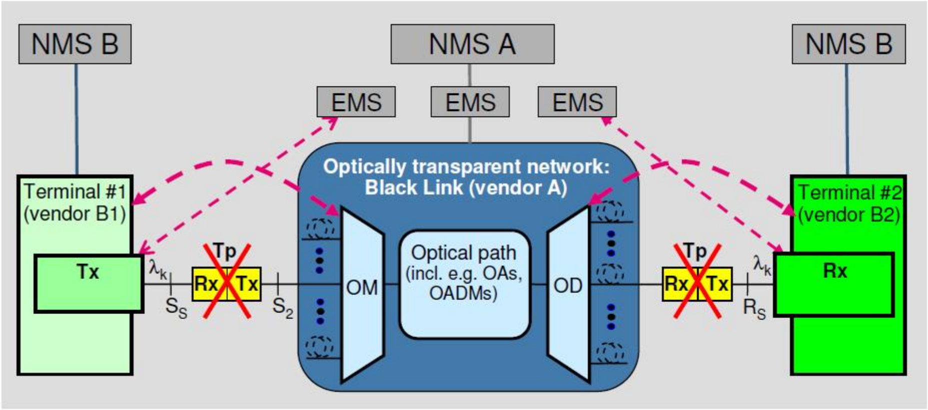
Virtualization in Networks

Code	Title	Author/Affiliate	Topic	Trends
OTh3E. 2	Failure Coverage in Optimal Virtual Networks	Arsany Basta, Dominic A. Schupke, etc. Nokia Siemens Networks, Technical University of Munich	Optimal virtual network design models with protection against various physical and virtual failures.	Virtualization
OTh3E. 3	Dynamic Adaptive Virtual Optical Networks [invited]	Anna Tzanakaki, Markos Anastasopoulos , Konstantinos Georgakilas Athens Information Technology	Adaptive virtual optical networks are proposed to support the Future Internet	
OTh3E. 4	Fault-Tolerant Virtual Network Mapping to Provide Content Connectivity in Optical Networks	M. Farhan Habib, Massimo Tornatore, Biswanath Mukherjee UC Davis, Politecnico di Milano	A scheme is proposed for virtual network mapping and content placement to ensure content connectivity after failures.	

Virtualization in Networks

Code	Title	Author/Affiliate	Topic	Trends
OTh3E.5	DT's Standardization Activities to achieve interoperability on 100G for Metro Applications [invited]	Ruediger Kunze, Deutsche Telekom AG, Group Technology	Report about simplification of network infrastructure by reducing the number of interconnected layers, integration of IP and Optics and the related standardization activities	Virtualization

The existing GMPLS overlay model (RFC 4208) is not sufficient to support a multi layer network architecture composed of IP and DWDM infrastructure



NTh4J.2 Evaluating Efficiency of Multi-Layer Switching in Future

Soumya Roy, Anuj Malik, Abhijeet Deore, Satyajeet Ahuja, Onur Turkcu, Steve Hand, Serge Melle
Infinera Corporation 140 Caspian Court Sunnyvale CA 94089

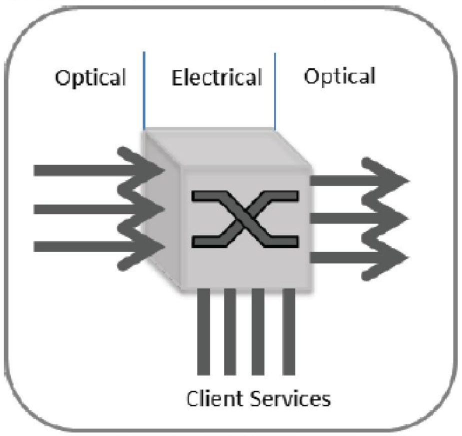


Fig. 1(a) Digital Switching Architecture

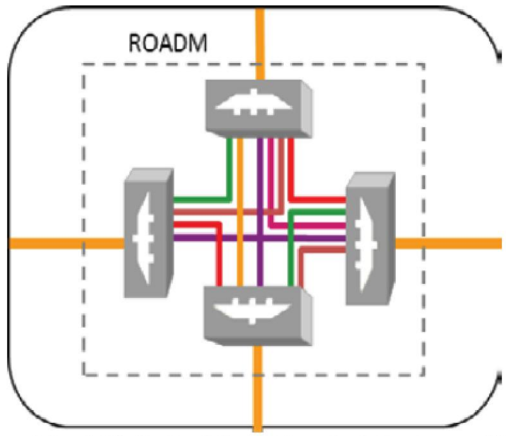


Fig. 1(b) Optical Switching Architecture

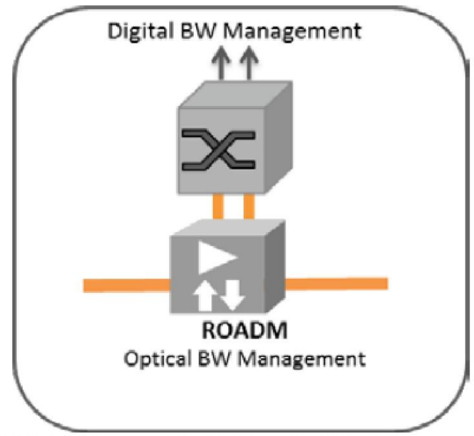
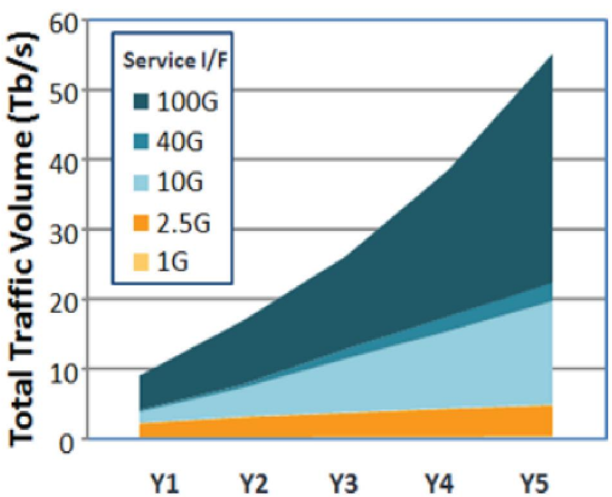


Fig. 1(c) Multi-Level Switching Architecture



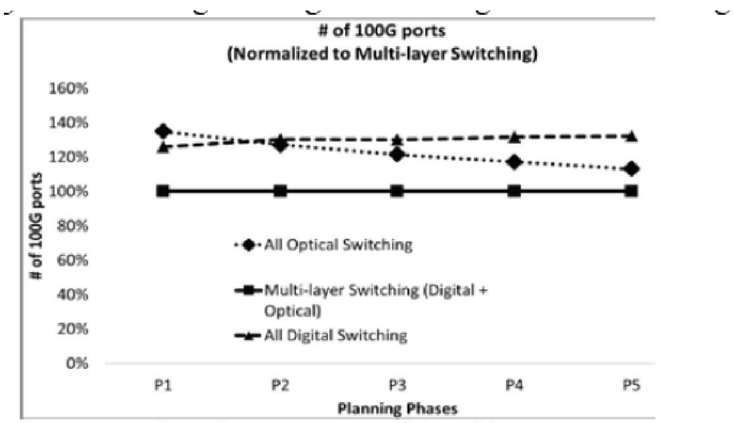


Figure 3 Number of 100G Ports provisioned in Pan European Network

OFC'13 Tracks

- **OTh1A • Optical Networks for Data Centers**

Optical Networks for Data Centers

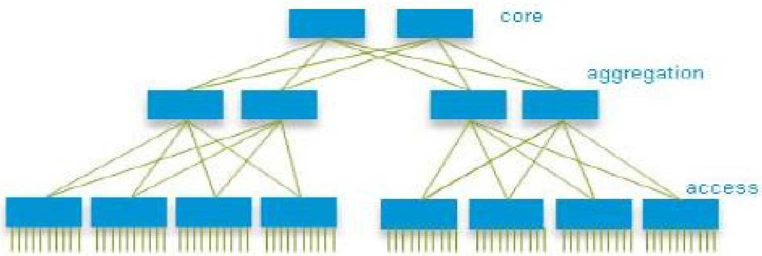
Code	Title	Author/Affiliate	Topic	Trends
OTh1A.2	Full System Simulation of Optically Interconnected Chip Multiprocessors Using gem5	Anouk Van Laery, Timothy Jonesx, Philip M. Watts. University College London, University of Cambridge	Demonstrated chip multiprocessor performance improvements of up to 18% using a wavelength striped optical crossbar interconnect	Optical interconnections in data centers
OTh1A.3	A 270 x 270 Optical Cross-connect Switch Utilizing Wavelength Routing with Cascaded AWGs	Tomonobu Niwa, Hiroshi Hasegawa, and Ken-ichi Sato Nagoya University	a 270 x 270 optical cross-connect that utilizes cascaded arrayed waveguide-grating (AWG) configuration	
OTh1A.4	The role of optical interconnections in data-center architecture evolution	Errol Roberts*, Loukas Paraschis Cisco	DC architectures require more optical interconnections, in systems with higher port density, and networks with more flexibility, in order to unlock stranded capacity, and thus lower overall cost.	

Optical Networks for Data Centers

Code	Title	Author/Affiliate	Topic	Trends
OTh1A.5	An Optical Multi-ring Burst Network for a Data Center	Ning Deng[1], Qingsong Xue[1], Mo Li[1], Guowei Gong[1], Chunming Qiao[2] 1. Huawei Technologies, 2. SUNY Buffalo	An efficient scheme to all-optically inter-networking the pods of a data center. With the proposed multi-ring burst network, many transceivers, fibers and core switches are eliminated and ultrahigh-capacity switching is achieved	Optical interconnections in data centers

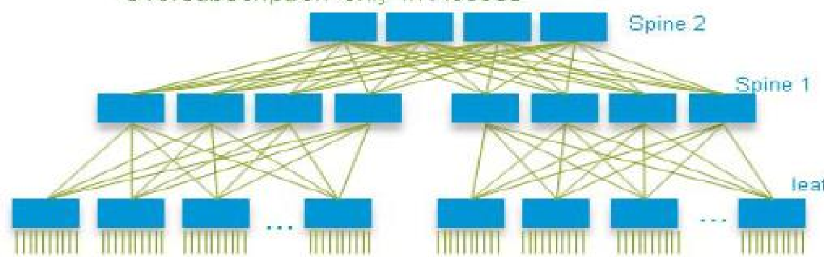
The role of optical interconnections in data-center architecture evolution

3 Tier Architecture
Oversubscription between Access Aggregation and Core



Tree-based architecture optimized for N-S traffic
Over-subscription in access, aggregation and core
Lower ports counts in Agg-Core

3 Tier spine
Low/Non-blocking Data Center Fabric
Oversubscription only in Access



Meshed architecture better suited for N-S and E-W traffic
Over-subscription only in access, low /1:1 to spine
Higher ports counts in Agg/spine-Corel
Each leaf connect each spine in cluster

Intra-data center Challenges: High speed
Transmission reach
Port density, power density

Inter-data center Challenges: Latency, flexibility

OFC'13 Tracks

- **OW3H • Re-Configurable Data Center Networks**
- **OTu3H • Computer and Data Center Architecture Evolution**

OFC’13 Tracks

- **OM3A • Techno-Economics and Energy in Networks**

Techno-Economics and Energy in Networks

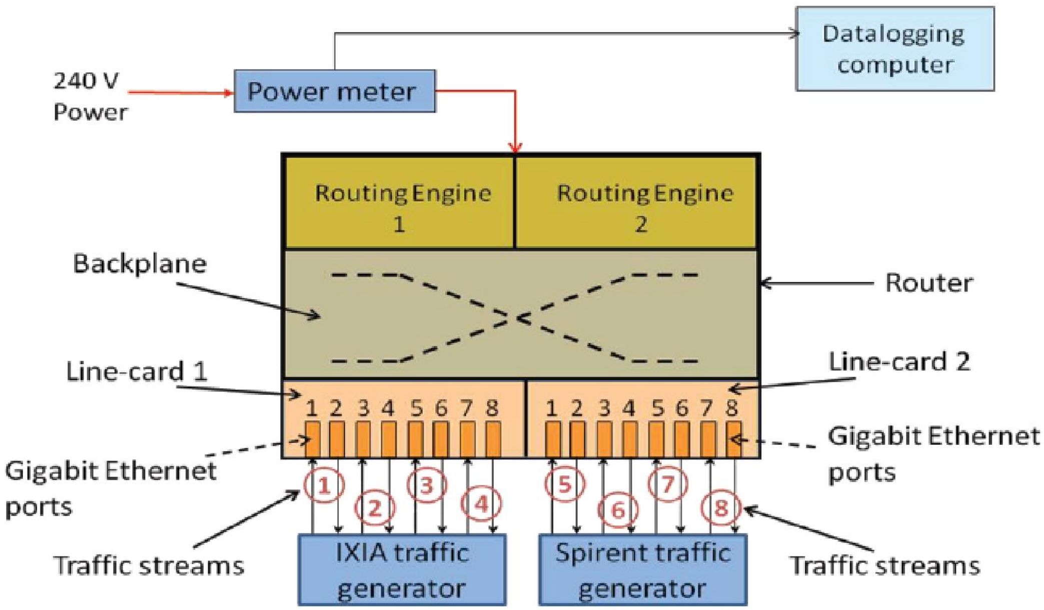
Code	Title	Author/Affiliate	Topic	Trends
OM3A.1	Differentiated Quality of Protection to Improve Energy Efficiency of Survivable Optical Transport Networks	J. López, etc Huawei Technologies, Munich, Germany, Politecnico di Milano, Technische Universitaet Dortmund	A differentiated quality of protection scheme is evaluated in terms of energy efficiency for fixed-grid WDM and flexible-grid OFDM-based networks.	Energy efficiency
OM3A.2	Impact of Wavelength/Waveband Convertors and the Cost Bound in Hierarchical Optical Path Networks	Z. Shen, H. Hasegawa, and K. Sato Nagoya University	This paper investigates the impact of wavelength /waveband convertors in hierarchical optical path networks. Hierarchical optical path networks can be cost effective over a wide traffic demand area.	
OM3A.3	Green and Agile Petabit Optical Sub-wavelength Switching Prototype for the Future OTN Multi-Chassis Switch Cluster	Bo Wu, etc, Huawei, Chengdu, China	A proof-of-concept prototype of optical sub-wavelength switching fabric is demonstrated with low power consumption.	

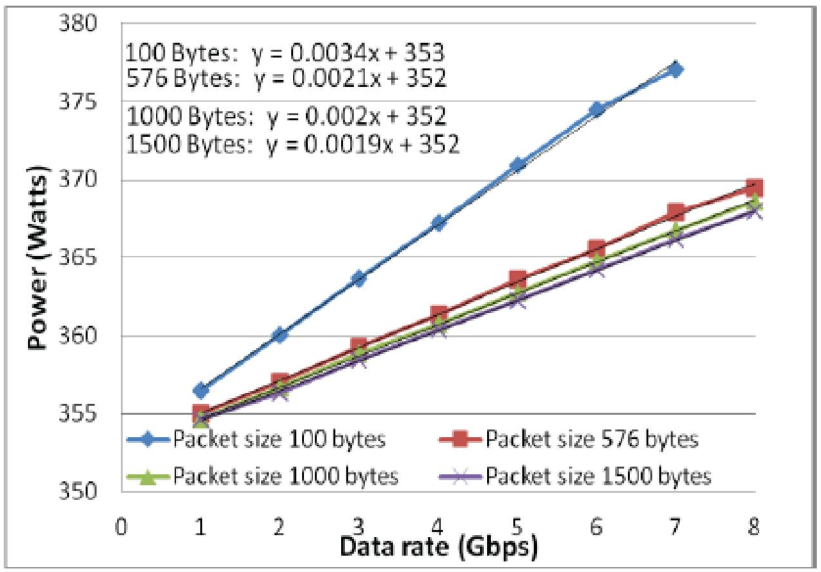
Techno-Economics and Energy in Networks

Code	Title	Author/Affiliate	Topic	Trends
OM3A.4	On the Energy and Cost Trade-Off of Different Energy-Aware Network Design Strategies	A. Morea, G. Rizzelli, M. Tornatore Alcatel-Lucent, France, Politecnico di Milano, Italy	Energy efficiency does not always mean cost efficiency. Without extra devices, up to 26% energy savings can be achieved with respect to a 100Gb/s static network	Energy efficiency Network Cost
OM3A.5	Dynamic Grouped Routing Optical Networks for Cost Effective and Agile Wavelength Services	Yuki Taniguchi, Hiroshi Hasegawa, Ken-ichi Sato Nagoya University	a dynamic control algorithm for coarse granular optical routing networks that provide wavelength services. Significant switch scale reduction at nodes while keeping fiber increment to marginal level	
OM3A.6	Estimating the Energy Consumption for Packet Processing, Storage and Switching in Optical-IP Routers	Arun Vishwanath, Rodney S. Tucker University of Melbourne, Australia	a methodology to empirically quantify the energy consumption associated with packet processing, storage and switching in high-capacity routers	

Estimating the Energy Consumption for Packet Processing, Storage and Switching in Optical-IP Routers

Arun Vishwanath, Jiazhen Zhu, Kerry Hinton, Robert Ayre, Rodney S. Tucker
Centre for Energy-Efficient Telecommunications, Dept. of Electrical and Electronic Engineering, University of Melbourne, Australia





$$P = P_{idle} + E_p R/L + E_{st} R$$

Per packet processing energy	1375 nJ
Per byte storage energy	14 nJ
Per packet switching energy	129 nJ

Trends

- Virtualization.
- Vertical convergence: multi-layer convergence (optics integration in routers, unified control (SDN), etc).
- Horizontal convergence: IT (computing, storage) and networking convergence (e.g., OpenStack).
- Optics in data centers.
- Energy and cost reduction.

Thank you!