
OFC'13 Summary

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Saigopal Thota

OFC/NFOEC'13 Technical Sessions - Access Networks

- **OTu3E • Convergence of Wireless and Optical Networking Symposium II: Future Technologies**
 - **OW3G • TDM-PON**
 - **OTh4A • Converged Access**
 - **NTu2J • FTTx Deployment Around the World**
 - **OTu2E • Convergence of Wireless and Optical Networking Symposium I: Future Architectures**
 - **NM2I • FTTx Network Operation**
 - **NTh3F • FTTx Network Design Consideration**
 - **NTh4F • NG-PON Technologies**
 - **OM3D • Converged Fiber-Wireless Networks**
 - **OW1A • WDM PON**
 - **OW1D • Performance Enhancements in Wireless Over Fiber Systems**
 - **OW4D • NG-PON2 and Beyond**
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Code	Title	Authors/Affiliation	Summary
OTu3E.1	4G/5G Mobile Technologies – Can They Be A Blueprint for Optical Networks?	Ali Khayrallah Ericsson Research USA	Spectrum crunch, Feedback from receiver to shape the transmitted signal to match the channel state, Frequency reuse, MIMO,
OTu3E.2	Emerging Disruptive Wireless Technologies – Prospects and Challenges for Integration with Optical Networks	Dalma Novak and Rod Waterhouse, Pharad	Smaller cells, Micro, Pico, Femto, Capacity and data rates beyond macro-cell, Network control to coordinate how users are optimally connected to wireless network infrastructure, PON, Active antenna system.

**OTu3E • Convergence of Wireless and Optical Networking Symposium II:
Future Technologies**

Code	Title	Authors/Affiliation	Summary
OTu3E.3	Radio-over-Fiber Technologies for Multi-Gb/s Wireless Applications	Anthony Ng'oma Science and Technology Division, Corning Incorporated, Corning, NY	Poor propagation of wireless signals inside buildings, RoF signal transmission techniques, for multi-Gb/s signal distribution at mm-wave frequencies, Demonstrated ultra-high capacity wireless system operating at >50Gb/s, Important consequence of high carrier frequency is significant path loss at 60GHz compared to 2.4 GHz, only in-room technology. Investigated efficacy of a variety of simple RoF signal transmission techniques

**OTu3E • Convergence of Wireless and Optical Networking Symposium II:
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Code	Title	Authors/Affiliation	Summary
OTu3E.4	SDN and OpenFlow for Converged Access/Aggregation Networks	Hagen Woesner, Daniel Fritzsche BISDN GmbH, Germany	Necessary steps to migration from today's residential network model to a converged access/aggregation platform based on SDN.

Network convergence to reduce number of devices such as PON for residential, business as well as mobile backhauling – Long reach fiber access will lead to network architectures where access and aggregation part eventually converges to single physical platform carrying Ethernet frames

Service provisioning requires additional information from the data path to attach correct management and control functions to traffic flows. SDN is seen as a potential solution for a unified control plane in converged access/aggregation and mobile networks allowing multiple control entities to reach a common understanding about a flow by defining a common and extensible syntax of header fields and their rules.

This paper discusses steps from today's network architecture to a converged access/aggregation domain based on SDN and OpenFlow with OpenFlow in OLT, OpenFlow in the home router and OpenFlow in the broadband network gateway.

OTu3E • Convergence of Wireless and Optical Networking Symposium II: Future Technologies

Code	Title	Authors/Affiliation	Summary
OW3G.1	Energy Efficient 10G-EPON system	Hiroaki Mukai , Fumihiko Tano , Junichi Nakagawa 1 Mitsubishi Electric Corporation, Information Technology R D Center, Japan 2 Mitsubishi Electric Corporation, Japan	60% total power consumed at ONU. ONU power saving by disabling the interface during period of no data traffic. No user data present, OLT allows ONU to power saving state, ONU moves to active state periodically to send upstream signal for link state confirmation, Either one of them terminates sleep mode if data is present. Relation between power consumption reduction and data transfer delay.
OW3G.2	Improving Hardware Protection Switching in 10Gb/s Symmetric Long Reach PONs	Seamas McGettrick, David B. Payne and Marco Ruffini CTVR, Trinity College Dublin, Republic of Ireland	Short Restoration times, 50 ms are typical of TDM-based SONET/SDH networks, PON reactivation time compared with a protocol implementation running on FPGA, PON with 512 users can be reactivated in less than 5ms. Physical layer ONU activation. Modification they propose is for 10G symmetric LR PON, increase the maximum random delay from 48-125 micro sec. less than 7ms leaving 43 ms for protection at higher layers.

OW3G • TDM-PON

Code	Title	Authors/Affiliation	Summary
OW3G.3	High Performance, In-service Correlation OTDR	Leif Sandstrom, Dan Joffe, George Bekken, John Brooks, Kevin Schneider, Richard Goodson ADTRAN, Alabama	Optical Time Domain Reflectometer (OTDR) to detect faults in an ODN, developed an OTDR which uses continuous transmission and a correlative receiver to allow good OTDR performance with lower instantaneous transmit power.

Code	Title	Authors/Affiliation	Summary
OTh4A.1	3 Gbit/s LED-Based Step Index Plastic Optical Fiber Link Using Multilevel Pulse Amplitude Modulation	L. Geng, J. L. Wei, R. V. Penty, I. H. White Centre for Photonic Systems, EE Division University of Cambridge, D. G. Cunningham Avago Technologies, Framlingham Technology Centre, UK	Abstract: Multilevel PAM is investigated for a LED-based SI-POF link. Using PAM-8, transmission at a record 3 Gbit/s is demonstrated for a maximum length of 25 m step index POF with offline post-receiver processing.
OTh4A.2	Transmission of 25.5-Gb/s OFDM Signal over 200-m G62.5/125 MMF Using Mode Group Diversity Multiplexing	Jing Xu, Christian Ruprecht, Johannes von Hoyningen-Huene and Werner Rosenkranz Chair for Communications, University of Kiel,	Abstract: We experimentally demonstrate a transmission over 200-m OM1 mode group diversity multiplexing. power penalty induced by inter-channel crosstalk is only 0.5 dB.

Code	Title	Authors/Affiliation	Summary
OTh4A.3	Cascade of 4 SOAs with 448 Gbit/s (224 Gbit/s) Dual Channel Dual Polarization 16QAM (QPSK) for High-Capacity Business Paths in Converged Metro-Access Networks	S. Koenig¹, R. Bonk², R. Schmogrow¹, A. Josten¹, D. Karnick¹, H. Schmuck², W. Poehlmann², Th. Pfeiffer², C. Koos¹, W. Freude¹, J. Leuthold¹ Karlsruhe Institute of Technology (KIT), Germany 2: Alcatel-Lucent Deutschland AG, Germany	Abstract: We demonstrate 448 Gbit/s (224 Gbit/s) dual channel DP-16QAM (QPSK) transmission over four cascaded, linear SOAs using advanced modulation formats. As an application we envision dedicated high-capacity business paths in future converged metro-access networks.
OTh4A.4	A Novel In-Building Small-Cell Backhaul Architecture for Cost-Efficient Multi-Operator Multi-Service Coexistence	Cheng Liu^{1,2}, Neda Cvijetic², Karthikeyan Sundaresan², Meilong Jiang², Sampath Rangarajan², Ting Wang², Gee-Kung Chang¹ 1 School of ECE, Georgia Institute of Technology, Atlanta, 2 NEC Labs America, Princeton, USA	Increase coverage for mobile users in the form of Distributed antenna system as well as to enable spatial re-use of the spectrum and increase total system capacity. Exploit centralized optical switching to demonstrate multi-operator coexistence and infrastructure sharing for in-building small-cell backhaul, enabled by a novel optical receiver design that exploits low-cost coarse division multiplexing components confirmed 6-12 MBps throughputs with virtually no optical receiver side interference

Code	Title	Authors/Affiliation	Summary
OTh4A.5	Flexible QoS Differentiation in Converged OFDMA-PON and LTE Networks	Wansu Lim¹, Konstantinos Kanonakis², Pandelis Kourtessis¹, Milos Milosavljevic¹, Ioannis Tomkos², John M. Senior¹ 1University of Hertfordshire, 2Athens Information Technology (AIT), Greece	OFDMA-PON is attractive for backhauling high-capacity wireless networks such as LTE. eNB is served by a dedicated ONU. Uplink, LTE packets are encapsulated within IP packets sent to the ONU and transferred. Note OLT handles the subcarrier assignment in both directions Focus is mapping between LTE bearer connections and OFDMA PON priorities and assign subcarriers according to both their aggregate load and exact traffic priority
OTh4A.6	Data Bandwidth Reduction based on Wireless Resource Allocation for Digitized Radio over TDM-PON System	Naotaka Shibata, Shigeru Kuwano, Jun Terada, Naoto Yoshimoto NTT Access Network Service Systems Laboratories, Japan	Centralized BBU than RRU, TDM-PON, a cost effective wired network solution. Digitized R over TDM-PON. Presents a new method to reduce the required data bandwidth for digitized radio over TDM-PON system. Can be applied to other types of TDM-based PONs such as large-capacity WDM?TDM PON for management of number of sectors and frequency bands in cellular systems.

OTh4A • Converged Access

Code	Title	Authors/Affiliation	Summary
NTu2J.1	France Telecom's PON deployment, learnt lessons and next steps	P. Chanclou, B. Capelle, B. Charbonnier, J.-L. Courant, Y. Denis, N. Genay, S. Gosselin, D. Kurz, B. Landousies, E. Le Bris, B. Le Guyader, A. Pizzinat, F. Saliou <i>Orange Labs, France</i>	FTTH, 2007, several major cities, 2 billion euros to cover 10million homes by 2015 and 15 mil. By 2020, End of June 2012, fiber coverage available with 1.75 million FTTH homes Evolution towards new PON generations and mobile back and front haul solutions
NTu2J.2	FTTH Deployments in Latin America	Nelson Hiroshi Saito Furukawa Industrial SA Produtos Elétricos, Rua Hasdruball Bellegard, Paraná, Brazil	

Code	Title	Authors/Affiliation	Summary
NTu2J.3	FTTdp: Complementing FTTH in Difficult Areas	Richard Goodson ADTRAN, AL	Fiber to the distribution point (FTTdp): Architecture to deliver fiber-like service rates over the existing copper drop wire infra. Telcos to utilize their existing copper assets providing high speed service at a lower cost compared to FTTH. SFU, MDU, Service unit is mounted near DP and connected to the drop wires. Fiber from DP to the service provider. Fiber could be PON or P2P, reverse powering to DP,
NTu2J.4	Cost Optimization in an FTTP Environment	Roger L. Tobin Verizon Technology	Longer reach, splitter ratio may need to be smaller requiring more PONS. Verizon investigated CO bypass in which several wire centers are served out of a single CO. Given a cluster of wire centers select the number and locations of COs for optimal host locations

NTu2J • FTTx Deployment Around the World

Code	Title	Authors/Affiliation	Summary
OTu2E.1	Operator Perspective on Next-Generation Optical Access for High-Speed Mobile Backhaul	Naoto Yoshimoto NTT Access Network Service Systems Laboratories, NTT Corporation Japan	Small cell, Photonic access network with high capacity and low delay
OTu2E.2	A Small Cell Augmentation to a Wireless Network Leveraging Fiber-to-the-Node Access Infrastructure for Backhaul and Power	P. P. Iannone¹, K. C. Reichmann¹, C. Ranaweera², M. G. C. Resende³ 1 AT&T Labs-Research, NJ, USA 2 Department of EEE, The University of Melbourne, Australia, 3 AT&T Labs-Research, Florham Park, NJ, USA	Cost-efficient maximum coverage and optical access network design: Given a set of locations where small cells can be deployed, a population of users, find p small cites such that the total covered population is maximized. PON configurations based on available fiber are compared to baseline method of deploying p2p gigabit Ethernet links, results indicate substantial cost savings.

**OTu2E • Convergence of Wireless and Optical Networking
Symposium I: Future Architectures**

Code	Title	Authors/Affiliation	Summary
OTu2E.3	Unified Access and Aggregation Network Allowing Fixed and Mobile Networks to Converge	D. Breuer¹, E. Weis¹, S. Gosselin², T. Mamouni², J. Torrijos³ 1 Deutsche Telekom AG, Innovation Laboratories, Germany 2 Orange Labs Networks, France 3 Telefónica Investigación y Desarrollo, Madrid, Spain	Structural convergence cloud RAN, etc.

More sessions next week...

NM2I • FTTx Network Operation

NTh3F • FTTx Network Design Consideration

NTh4F • NG-PON Technologies

OM3D • Converged Fiber-Wireless Networks

OW1A • WDM PON

**OW1D • Performance Enhancements in Wireless
Over Fiber Systems**

OW4D • NG-PON2 and Beyond

Code	Title	Authors/Affiliation	Summary
NTh3F.2	Cost Optimization of Fiber Deployment for Small Cell Backhaul	C.S. Ranaweera¹, P.P. Iannone², K.N. Oikonomou², K.C. Reichmann² and R.K. Sinha² <i>¹The University of Melbourne, Australia,</i> <i>²AT&T-Research, USA</i>	Deployment of large number of smaller cells to supplement the existing macro infra. P2P is not advised. PON based backhaul minimizing total cost of PON deployment for small cell backhauling. Relative cost analysis compared to P2P
NTh3F.3	Fiber To The distribution point (FTTdp) architecture for single user based on hybrid fiber and copper scheme	M. Leroux, N. Genay, H. Mariotte, F. Neddham, D. Kurz, Y. Denis, P. Chanclou, B. Capelle, B. Le Guyader, J. Guy, Orange Labs, France	Fiber to the distribution point, addressing upto 8 customers. An alternative: A hybrid fiber/copper ONTdp dedicated to a unique customer and providing a bitrate upto 100 Mbps. Reverse powering scheme..power over Ethernet. VDSL2 for customers looking for utilizing their twisted copper pair.

Code	Title	Authors/Affiliation	Summary
NTh3F.4	Cost and Performance Evaluation of WDM-based Access Networks	Ralf Huelsermann¹, Klaus Grobe², Dirk Breuer¹ ¹ Deutsche Telekom AG Laboratories, Germany ² ADVA Optical Networking SE, Germany	Active equipment in fewer larger sites. Requires increased reach and higher client count per feeder fiber. WR-WDM, UD-WDM, hybrid WDM/TDMA PON against GPON and XGPON.

Code	Title	Authors/Affiliation	Summary
OM3D.5	How to Design an Energy Efficient Fiber-Wireless Network	Leonid G. Kazovsky¹, Tolga Ayhan¹, Apurva Gowda¹, Kadir M. Albeyoglu¹, Hejie Yang², Anthony Ng'Oma² ¹ Stanford University, ² Corning Inc., NY	In-Building networks. New network implementation approaches employing fiber-wireless technologies could lead to significant energy savings. Fiber optics instead of copper, RoF, Energy-efficiency protocols. Optimal small cell size, depending on the EC per bit.

Code	Title	Authors/Affiliation	Summary
NTh4F.5	NG-PON2 Technologies	Hirota Nakamura NTT Access Network Service Systems Laboratories, NTT Corporation	Tutorial

Code	Title	Authors/Affiliation	Summary
NM21.5	Energy Consumption Analysis of Converged Networks: Node Consolidation vs Metro Simplification	Björn Skubic, Ioanna Pappa Ericsson AB, Sweden	Reduce power consumption – Reduce the number of active sites. Node consolidation by using long-reach, DWDM-centric transport solution in metro-access segment to eliminate aggregation sites. Optimal placement of active aggregation sites. Densification of radio access sites contradicts with node-consolidation. Centralization of baseband processing.
NM21.6	Protection Schemes Beyond Currently Defined in FTTx	Takeshi Sakamoto NTT Access Network Service Systems Laboratories, Japan	Business, backhaul – Requires high availability, Effect of a single PON failure, Different redundant PON topologies, PON Outage due to planned maintenance, component failure, Accident/disaster, Failure rates provided, OLT protection, N:1 OLT protection with a N+1 optical switch, Flexible and scalable OLT protection using N:M

FTTx Network Operation