



# Marco Ruffini

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## OVERVIEW

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I am an academic in Optical Network architectures at the department of Computer Science and Statistics of the University of Dublin, Trinity College. Since 2018 I have been elected Fellow of Trinity College. I am associated with CONNECT, the centre for future networks and communication, where I lead the Optical Network Architectures laboratory (ONALab), of 9 researchers. My main research area is on converged access-metro and fixed-mobile network architecture, passive optical networks, and Software Defined Networks control planes for future 5G network deployments. While my work also addresses theoretical aspects of protocols and architectures, my optical networking group is experimentation oriented. I recently brought my virtual DBA concept into the Broadband Forum, which has included it in their TR-402 standard released in October 2018.

## APPOINTMENTS

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### Tenured Assistant Professor

2010-present

*The University of Dublin, Trinity College*

- Leading the Optical Network Architectures laboratory (ONALab): converged access-metro and fixed-mobile network architecture, passive optical networks, and Software Defined Networks control planes.
- Principal investigator for two SFI centres: IPIC (on photonics) and CONNECT (on telecommunications), where I also lead the converged network research area. I also hold an SFI Principal Investigator Award (O'SHARE) on access network sharing, an SFI/NSF award for optical intra and inter-DC communications and a H2020 project on federation of fixed/mobile converged testbeds.
- Coordinator, between 2012 and 2016, of the European FP7 DISCUS projects on next generation Long-Reach PON architectures

### Research fellow

2009-2010

*CTVR Research centre, University of Dublin, Trinity College*

- Research on passive optical networks architecture and protocol,
- Research on cost-effective resource sharing for PON dual-homed protection mechanisms

### Postdoctoral Fellow

2007-2009

*CTVR Research centre, University of Dublin, Trinity College*

- Research on optical flow switching network architectures.
- Signalling protocols and algorithms for optical IP switching.
- Testbed implementation of distributed Optical IP switching node architecture.

## Research scientist

2003-2005

*Philips research laboratories, Aachen, Germany*

- Research on inter-vehicle wireless communications technologies to enhance preventive safety on roads.

## EDUCATION

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### PhD Computer Science

2005-2007

*CTVR Research centre, University of Dublin, Trinity College*

Research on optical IP switching, signalling protocols and algorithms for optical switching, IP-optical testbed for dynamic bypass of IP routing layer

Thesis advisor: Prof. Donal O'Mahony

### Laurea Degree in Electronic Engineering (equivalent to B.Sc. in E.Eng, and M.Sc in Telecommunications),

1997-2002

*Marche Polytechnic University, Italy,*

Summa Cum Laude (110/10 and honours). Academic/Research advisors: Prof. Tullio Rozzi and Prof. Liam Barry,

Dissertation: Nonlinear optical properties of semiconductors in all-optical switches

## RESEARCH FUNDING

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My total funding today is in excess of €4M, of which €2.76M as Principal Investigator, €475K as Co-PI and €750K as funded researcher.

- 2015-2019: Science Foundation Ireland (SFI) **Principal Investigator award** O'SHARE project. Total funding of €1,020,000
- 2015-2018: **SFI/NSF collaborative project** on Agile cloud service delivery using integrated photonics networking. Funded researcher and PI for TCD for a total funding of €368,000.
- 2016-2019: **Co-PI and deputy coordinator** of the H2020 collaborative project FUTEBOL. TCD funding of €475,000.
- 2015: **PI of Enterprise Ireland commercialisation feasibility funding**. Total funding of €19,000.
- 2012-2015: **Technical coordinator** for the European FP7 project DISCUS. Project funding of €8.1M, of which managing €1,351,000M as PI in TCD.
- 2015-2021: **Funded Investigator** in the SFI-funded CONNECT SFI centre for €250,000
- 2010-2016: **Funded Investigator** in the SFI-funded CTVR research centre €500,000.

## INVITED TALKS

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- **Invited tutorial at the IEEE/OSA ECOC**. 'Moving the network to the cloud: multi-tenant and multi-service cloud central office'. September 2018.
- Invited talk at the The Global Experimentation for Future Internet (GEFI) meeting in Tokyo, Oct. 2018. Title of the talk: 'CONNECT's view on virtualisation: Testbeds, experimentation and future plans?.'

- Invited tutorial at the Asian Conference on Photonic Communications (ACP), Oct. 2018. Title of the talk: 'Virtualising the central office from the network functions down to the optical layer?', paper S4E.1.
- Invited talk at the IEEE Photonics Society Summer Topicals conference, July 2018. Title of the talk: 'From central office cloudification to optical network disaggregation'
- Keynote speaker at the workshop on Mathematical Techniques in Optical Networks, Eindhoven, Netherlands, April 16-18. Title of the talk: The virtualisation of telecommunications networks and its effect on optical networking.
- Keynote speaker at the CPqD workshop on Optical-Wireless Convergent Networks and 5G, Campinas, SP, Brazil, 10th November 2017. Title of the talk: Network convergence in future 5G networks.
- Keynote speaker at the Workshop on Optical-Wireless Convergent Networks Joining Brazilian and European Researchers and Network Operators, Ministry of Communications, Brasilia, DF, Brazil, 1st June 2017. Title of the talk: Network convergence for high performance and sustainable 5G networks.
- Invited as **team leader for IEEE/OSA OFC Workshop OFCity Challenge**, March 2017 .
- Invited talk at CommNet2, Future Networks Workshop, Middlesex University London, 16th January 2017 on [Optical Networks in the 5G era](#).
- **Invited tutorial at IEEE/OSA OFC**, March 2016 on [Converged Metro-Access](#).
- Invited as **team leader for IEEE/OSA OFC Workshop OFCity Challenge**, March 2016 .
- **Keynote speaker** for the IEEE Consumer Communications and Networking Conference, Jan 2016, Las Vegas. [Access-metro convergence in next generation broadband networks](#)
- Invited talk at the OSA Photonic networks and devices congress. Boston, June 29th, 2015. Design for Sustainable, Multi-service Optical Network Architectures.
- **Invited talk at the London Royal Society** meeting on communications networks beyond the capacity crunch. May 11th-14th, 2015. Tackling the capacity crunch: an attempt to rationalisation and mitigation.
- Invited talk at the 19th European conference on network and optical communications, NOC 2014: workshop on New Telecom Network Architectures for the Cloud Era, June 3rd 2014. DISCUS approach to end-to-end network modeling: an update on access and core architecture and technology.
- Invited talk at the Post-OFC workshop, UC Davis, March 14th 2014. The DISCUS FP7 project: ideas, issues and solutions for designing next-generation cost-effective and future-proof optical broadband network.
- Invited talk at the Future Internet Assembly, Dublin, May 10th 2013. A radical change to telecoms network architecture to provide unlimited broadband to all users: the DISCUS project.
- Invited talk at the Marche Polytechnic University, Ancona, Italy, April 12th 2013. Il progetto DISCUS: un cambio radicale nelle reti di telecomunicazioni per fornire banda larga senza limiti a tutti gli utenti.
- Invited talk at the ISTAO Business School, Ancona, Italy, April 12th 2013. Il progetto DISCUS: un cambio radicale nelle reti di telecomunicazioni per fornire banda larga senza limiti a tutti gli utenti.

- Invited talk at the HEAnet national conference, Kilkenny, Ireland, November 2011. Next-Generation Fibre to the Home Deployment: A HEAnet Case Study. .
- Invited talk at the HEAnet national conference, Kilkenny, Ireland, November 2010. FEDERICA virtual e-infrastructure for researchers.
- Invited talk at the UCLP Workshop, Edinburgh, UK, August 2006. Optical IP Switching and UCLP.

## **EDITORIAL WORK AND COMMUNITY SERVICE**

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- **Editorial Board** of Springer Photonic Networks Communications Journal, since 2015.
- **Managing Guest Editor** for Elsevier Optical Fibre Technology Journal, special issue on Next Generations Optical Access Networks, Fall 2015
- **General chair** for IEEE Optical Network Design and Modeling 2018 (Dublin).
- **General chair** for IEEE online Greencom 2016.
- **TPC chair** for IEEE Optical Network Design and Modeling 2017, IEEE Conference on Standards for Communications and Networking (CSCN) 2017 track on 5G Carrier and Converged Networks, IEEE online Greencom 2015.
- **TPC member** for IEEE-ACM ITC 30 Conference - Teletraffic in a Smart World 2018, IEEE Consumer Communications & Networking Conference, 2018, ICC Green Communications Systems and Networks Symposium 2017, IEEE WCNC workshop on Green and Sustainable 5G Wireless Networks 2017, IEEE Consumer Communications and Networking Conference 2017, IEEE International Conference on Communications (ICC) 2017, IEEE International Symposium on Communication Systems, Networks and Digital Sign (CSNDSP) 2016, IEEE Optical Network Design and Modeling Conference (ONDM) 2016, International Conference on Networking and Network Applications (NaNA) 2016, IEEE Consumer Communications and Networking Conference 2016, IEEE Optical Network Design and Modeling Conference (ONDM) 2015, IEEE International Teletraffic Congress (ITC) 2015, Demonstration Session Chair for IEEE online Greencom 2014, European Conference on Networks and Communications (EuCNC) 2014, Future Networks and Mobile Summit (FuNeMS) 2013.
- **Workshop organiser** for:
  - OSA Workshop on Scalable Integrated Photonics for 5G and IoT, San Diego, March 2018.
  - OFCity challenge workshop at OFC 2018, San Diego, March 2018.
  - ECOC 2015 workshop titled 'Fibre access and core network evolution: what are the next steps towards an integrated end-to-end network?';
  - ECOC 2014 workshop titled 'Is NG-PON2 an ultimate access solution? Is there anything coming afterwards?';
  - ONDM 2014 workshop titled 'Network protection and resiliency in Next Generation access and core networks';
  - Dublin 2013 workshop on 'Ownership, Usage And Regulation In Next Generation Fibre Access Network: Can We Move Away From Competition At The Physical Layer?'
- **Active or past reviewer** of the following international journals: IEEE Journal on Selected Areas on Communication, IEEE Communications Magazine, IEEE/OSA Journal of Lightwave Technology, IEEE/OSA Journal of Optical Communications and Networking, OSA Optics Express, Elsevier Optical Fibre Technology, Springer Photonic Networks Communications.

- **Poposal reviewer** for the US Global Environment for Network Innovations (GENI) initiative and EPSRC (UK) Associate College member.
- **External Ph.D examiner** for:  
Alvaro Fernandez, Trondheim technical University, February 2017;  
Christophe Van Praet, IMEC, University of Ghent, December 2013.

## **AWARDS AND DISTINCTIONS**

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- **Fellow of The University of Dublin, Trinity College.**
- **Senior IEEE member**
- My research activity appeared in the **TCD Provost Annual Review 2012-2013.**
- **Ireland's Champions of EU Research 2012**, presented by Ireland's President Michael D. Higgins.
- Member of Italian Engineers Associations.
- Awarded best paper award at IEEE ONDM 2016.
- Awarded Distinguished Paper Award at IEEE Europar 2012.

## **TEACHING ACTIVITIES**

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### **Courses**

- University: The University of Dublin, Trinity College (Ireland)  
Course name: Future Networks (CS4031) - fourth and fifth year, 90 students  
Academic Years: 2016/2017, 2018/2019
- University: The University of Dublin, Trinity College (Ireland)  
Course name: Mobile Networks (CS4031) - fourth year, 40 students  
Academic Years: 2011/2012, 2012/2013, 2013/2014, 2014/2015, 2015/2016
- University: The University of Dublin, Trinity College (Ireland)  
Course name: Telecommunications I (CS1031) - first year, 100 students  
Academic Years: 2012/2013, 2013/2014, 2014/2015, 2015/2016, 2016/2017, 2018/2019
- University: The University of Dublin, Trinity College (Ireland)  
Course name: Data communications (CS7002) - fifth year, 50 students  
Academic Years: 2011/2012, 2012/2013
- **Online lectures:** Some of my optical lectures have been uploaded in [youtube](#) and received over 2000 views.

## RESEARCH ACTIVITIES

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My main research area is on converged access-metro and fixed-mobile network architecture, passive optical networks, and Software Defined Networks control planes. While my work also addresses theoretical aspects of protocols and architectures, my optical networking group is experimentation oriented.

**I am and have been involved in the following research projects:**

- **O'SHARE is an open-access SDN-driven architecture enabling multi-operator and multi-service convergence in shared optical access networks** This is a 4-year project of which I am the personal grant holder, aiming at designing and demonstrating an SDN-based dynamic control and management platform for broadband access networks to enable efficient sharing of physical resources among multiple Network Operators and Service Providers. This is achieved through two main innovations: open-access oriented interfaces, which will simplify network access by multiple network operators and service providers; and algorithms and techniques to virtualise Passive Optical Networks, leading to a more efficient exploitation of system resources. The theoretical work carried out in O'SHARE will be first tested through simulations and then implemented into a hardware testbed, which will lead up to an international demonstrator showcasing industry-led networking scenarios. O'SHARE will create the basis for an information-led society without digital divide.
- **Agile Cloud** is a joint project between three large research centres in Ireland (CONNECT), US (CIAN), and Northern Ireland (University of Ulster). The project aims at developing architectures and technology for next generation intra and inter data centre communications. We Trinity College Dublin cooperate in this project with The University of Arizona, Columbia University, Dublin City University and University of Ulster. We aim to develop next generation optical data centre networks and their interconnection to converged access/metro networks to enable a seamless integration with the future 5G ecosystem. Features include fast optical switching (microsecond level) at metro nodes to enable transparent interconnection between data centres (from micro to macro DCs) and from DC to 5G devices, such as mobile base stations and remote radio heads. The 5G vision includes virtualisation of network functions at different levels, see for example the AT&T and ON.lab CORD project on central office virtualisation. Moving virtualised network function into the data centre will require an agile metro node capable of fast switching of wavelengths, which remain transparent from the access end point all the way to the data centre, where the virtual function resides (see figure below as an example).
- **FUTEBOL** is a project aiming at federating research infrastructure, developing a supporting control framework, and conducting experimentation-based research in order to advance the state of telecommunications through the investigation of the optical/wireless boundary of networks.
- **Converged networks** is the research area I lead in the CONNECT research centre. The project aims at fully integrating the Cloud Radio Access Network within the converged access/metro architecture through various technology, backhaul, fronthaul and midhaul (or split PHY processing). We are currently carrying out the first integration tests of wireless links with our next generation multi-wavelength Long-Reach PON prototype developed in our lab.
- **DISCUS FP7 project**. The DIStributed Core for unlimited bandwidth supply for all Users and Services (FP7 Grant Agreement 318137) was coordinated by TCD and aimed at demonstrating technology and concepts needed to define and develop a new radical architectural concept that can enable an integrated wireless and FTTP future network which addresses the economic, energy consumption,

capacity scaling, evolutionary, regulatory and service demand challenges arising from an FTTP enabled future.

**My optical network architecture research group has developed the following tools:**

- a Passive Optical Network module for the Network Simulator 3 (NS3), one of the most popular open source simulator for research in networking. (open source)
- a simulator for peer-to-peer networks used for content distribution. (open source).
- a tool for generating traffic matrices. This was used to predict traffic matrix and feed the architectural studies for the European DISCUS project. (open source)
- an FPGA hardware platform for prototyping Optical Line Terminal and Optical Network Units for Passive Optical Networks. (proprietary)
- a Software Defined Network system for access-metro networks. (proprietary)

**My number of citations is currently 988 according to Google Scholar, with i10-index of 34 and h-index of 19.**

## **GRADUATED PH.D STUDENTS**

- Pedro Alvarez (Co-supervisor), Dynamic Bandwidth Allocation for Open Access and Long-Reach Passive Optical Networks, January 2017.
- Frank Slyne , Software Defined Telecommunication Networks, October 2016.
- Emanuele Di Pascale, Optimizing Multimedia Content Delivery over Next-Generation Optical Networks, July 2015.

## PEER-REVIEWED JOURNAL PAPERS

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1. F. Musumeci, C. Rottondi, A. Nag, I. Macaluso, D. Zibar, M. Ruffini and M. Tornatore. An Overview on Application of Machine Learning Techniques in Optical Networks. To appear in IEEE Surveys and Tutorials.
2. N. Afraz and M. Ruffini. A Sharing Platform for Multi-Tenant PONs. IEEE/OSA Journal of Lightwave technology, Vol. 36 , No. 3, Oct. 2018.
3. Domanic Lavery, Marco Ruffini, Luca Valcarenghi, Naoto Yoshimoto, Thomas Pfeiffer, Dave Hood, Junwen Zhang, Daniel King, Hal Roberts, Rajesh Yadav, Nicola Sambo, Marco Tacca, Silvia Fichera, Franco Tecchia, Marcello Carrozzino, Elaine Wong, Ning Cheng, Yuki Yoshida, Denis Khotimsky, and Jun Shan Wey. Networks for Future Services in a Smart City: Lessons Learned from the Connected OFCity Challenge 2017. Accepted for publication at the IEEE Communications Magazine.
4. V. Lopez, J. M. Gran Josa, V. Uceda, F. Slyne, M. Ruffini, R. Vilalta, A. Mayoral, R. Munoz, R. Casellas, R. Martinez. End-to-end Service Orchestration From Access to Backbone [invited]. IEEE/OSA Journal of Communications and Networking, Vol. 9, No. 6, June 2017.
5. M. Ruffini, M. Achouche, A. Arbelaez, R. Bonk, A. Di Giglio, N. J. Doran, M. Furdek, R. Jensen, J. Montalvo, N. Parsons, T. Pfeiffer, L. Quesada, C. Raack, H. Rohde, M. Schiano, G. Talli, P. Townsend, R. Wessaly, L. Wosinska, X. Yin and D.B. Payne. Access and metro network convergence for flexible end to end network design [invited]. IEEE/OSA Journal of Communications and Networking, Vol. 9, No. 6, June 2017.
6. M. Ruffini, Multi-Dimensional Convergence in Future 5G Networks. IEEE/OSA Journal of Lightwave technology, March 2017.
7. F. Slyne and M. Ruffini, FLATLAND: A Novel SDN-based Flat Layer-2 Architecture Enabling NFV and Metro-Access Convergence. IEEE/OSA Journal of Communications and Networking, Vol. 9, No 3, March 2017.
8. G. Talli, F. Slyne, S. Porto, D. Carey, N. Brandonisio, A. Naughton, P. Ossieur, S. McGettrick, C. Blumm, M. Ruffini, D. Payne, R. Bonk, T. Pfeiffer, N. Parsons, P. Townsend. SDN Enabled Dynamically Reconfigurable High Capacity Optical Access Architecture for Converged Services.IEEE/OSA Journal of Lightwave technology, Vol. 35, No.3, March 2017.
9. Rod Tucker, Marco Ruffini, Luca Valcarenghi, Divanilson R. Campelo, Dimitra Simeonidou, Liang Du, Maria-Cristina Marinescu, Catherine Middleton, Shuang Yin, Tim Forde, Kevin Bourg, Eugene Dai, Ed Harstead, Philippe Chanclou, Hal Roberts, Volker Jungnickel, Sergi Figuerola, Tomoo Takahara, Rajesh Yadav, Peter Vetter, Denis A. Khotimsky, and Jun Shan Wey. Connected OFCity: Technology Innovations for a Smart City Project. IEEE/OSA Journal of Communications and Networking, Vol. 9, No 2, Feb 2017.
10. A. Arokkiam, P. Alvarez, X. Wu, K.N. Brown, C.J. Sreenan, M. Ruffini, N. Marchetti, L. Doyle, D. Payne. Design, Implementation, and Evaluation of an XG-PON Module for ns-3. Transactions of The Society for Modeling and Simulation International, January 2017.
11. A. Nag, M. Furdek, P. Monti, L. Wosinska and M. Ruffini. Exploiting Dual Homing in Access Networks to Improve Resiliency in Core Networks. IEEE/OSA Journal of Optical Communications and Networking, vol. 8, No. 11, October 2016.



12. S. McGettrick, F. Slyne, N. Kitsuwon, D.B. Payne, and M. Ruffini. Experimental End-to-End Demonstration of Shared N:M Dual Homed Protection in SDN-controlled Long Reach PON and Pan-European Core. *IEEE/OSA Journal of Lightwave technology*, vol. 34, No. 18, September 2016.
13. P. Alvarez, N. Marchetti, and Marco Ruffini. Evaluating Dynamic Bandwidth Allocation of Virtualized Passive Optical Networks Over Mobile Traffic Traces. *IEEE/OSA Journal of Optical Communications and Networking*, vol. 8, No. 3, March 2016.
14. A. Nag, D. B. Payne, and Marco Ruffini. N?1 Protection Design for Minimizing OLTs in Resilient Dual-Homed Long-Reach Passive Optical Network. *IEEE/OSA Journal of Optical Communications and Networking*, vol. 8, No. 2, February 2016.
15. M. Ruffini, G. Cincotti, A. Pizzinat, P. Vetter. Editorial: Next Generation Access Networks. *Elsevier Optical Fibre Technology*, Vol. 26, part A, December 2015.
16. M. Ruffini, F. Slyne, C. Bluemm, N. Kitsuwon, S. McGettrick. Software Defined Networking for next generation converged metro-access networks. *Elsevier Optical Fibre Technology special issue on Next Generation Access*, Vol. 26, part A, December 2015.
17. K. Christodouloupoloulos, D. Lugones, K. Katrinis, M. Ruffini, D. O'Mahony. Performance evaluation of a hybrid Optical/Electrical interconnect. *IEEE/OSA Journal of Optical Communications and Networking*, vol. 7, No. 3, March 2015.
18. N. Kitsuwon, S. McGettrick, F. Slyne, D. B. Payne and M. Ruffini. An Independent Transient Plane Design for Protection in OpenFlow-based Networks. *IEEE/OSA Journal of Optical Communications and Networking*, vol. 7, No. 4, April 2015.
19. N. Kitsuwon, F. Slyne, S. McGettrick, D. B. Payne and M. Ruffini. A Europe-Wide Demonstration of Fast Network Restoration with OpenFlow. *IEICE Communications Express*, Vol. 3, No. 9, September 2014.
20. E. Di Pascale, D. B. Payne, L. Wosinska and M. Ruffini. Locality-Aware P2P Multimedia Delivery over Next-Generation Optical Networks. *JOCN*, vol. 6, no. 9, September 2014.
21. M. Ruffini, L. Wosinska, M. Achouche, J. Chen, N. J. Doran, F. Farjady, J. Montalvo, P. Ossieur, B. O'Sullivan, N. Parsons, T. Pfeiffer, X.-Z. Qiu, C. Raack, H. Rohde, M. Schiano, P. Townsend, R. Wessaly, X. Yin, D. B. Payne, DISCUS: An end-to-end solution for ubiquitous broadband optical access. *IEEE Com. Mag.*, vol. 52, no. 2, February 2014.
22. P. Loskot, M.A.M. Hassani, F. Farjady, M. Ruffini and D. Payne, Long-term drivers of broadband traffic in next-generation networks. *Springer annals of Telecommunications*, February 2014.
23. K. Christodouloupoloulos, K. Katrinis, M. Ruffini, D. O'Mahony. Tailoring the network to the problem: topology configuration in hybrid electronic packet switched/optical circuit switched interconnects. *Concurrency and Computation: Practice and Experience*, Wiley Online Library, 2013.
24. M. Ruffini, D. Mehta, B. O'Sullivan, L. Quesada, L. Doyle, D. B. Payne. Deployment Strategies for Protected Long-Reach PON. *IEEE/OSA Journal of Optical Communications and Networking*, vol. 4, Issue 2, p118 ? 129, Jan 2012.
25. P. Szegedi, J.F. Riera, J.A. Garcia-Espin, M. Hidell, P. Sjodin, P. Soderman, M. Ruffini, D. O'Mahony, A. Bianco, L. Giraud, M. Ponce de Leon, G. Power, C. Cervello-Pastor, V. Lopez, S. Naegele-Jackson.

Enabling future internet research: the FEDERICA case. IEEE Communications Magazine, vol. 49, no. 7, pp 54-61, July 2011.

26. M. Ruffini, D. O'Mahony, L. Doyle. Optical IP Switching: a flow-based approach to distributed cross-layer provisioning. IEEE/OSA Journal of Optical Communications and Networking, Vol. 2, Issue 8, pp. 609-624, August 2010.
27. M. Ruffini, D. O'Mahony, L. Doyle. Automatic Configuration in Future Semi-Transparent Optical Network Nodes. Springer Photonic Network Communications Journal, vol. 14, no. 3, pp 241-251, 2007.
28. H-J. Reumerman, M. Roggero, M. Ruffini. Application-Based Clustering Concept and Requirements for Intervehicle Networks. IEEE Communications Magazine, vol. 43, no. 4. May 2005.

## **CONTRIBUTION TO STANDARDS**

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Prof. Ruffini contributed the virtual Dynamic Bandwidth Allocation (vDBA) concept, for which he also holds a patent, to the BroadBand Forum (BBF) working task WT-402. This standard is being published in September 2018 as technical report (TR-402) "PON Abstraction Interface for Time-critical Applications". He also followed and provided input to TR-384 "Cloud Central Office Reference Architectural Framework".

## **PEER-REVIEWED INTERNATIONAL CONFERENCES**

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1. . Afraz and M. Ruffini, A Marketplace for Real-time Virtual PON Sharing. Asia Communications and Photonics Conference (ACP) 2018.
2. . Ruffini, Moving the Network to the Cloud: Multi-Tenant and Multi-Service Cloud Central Office (Invited Tutorial). Proc. of ECOC 2018.
3. . Slyne, J. Singh, R. Giller M. Ruffini, Demonstration of Real Time VNF Implementation of OLT with Virtual DBA for Sliceable Multi-Tenant PONs. Proc. of ECOC 2018.
4. . Browning, M. Ruffini, B. Cardiff and L.P. Barry, Single Lane 168 Gb/s PAM-8 Short Reach Transmission Using an EAM with Receiver Skew Compensation. Proc. of ECOC 2018.
5. . Frascolla, C. Colman-Meixner, R. Nejabati, D. Simeonidou, F. Slyne, Y. Zhang, L. A. DaSilva, M. Ruffini, M. Martinello, R. S. Guimaraes, M. R. Nunes Ribeiro. When optical networks meet wireless systems: experiments at the boundary. Proc. of Photonics in Switching, Sept. 2018
6. . Ruffini and D. Kilper, From central office cloudification to optical network disaggregation. Proc. of IEEE Photonics Society Summer Topicals, July 2018.
7. aulo Marquez et al., Optical and wireless network convergence in 5G systems ? an experimental approach. To appear in proc. of CAMAD 2018.
8. . Zhang, F. Barusso, D. Collins, M. Ruffini and L. A. DaSilva. Dynamic Allocation of Processing Resources in Cloud-RAN for a Virtualised 5G Mobile Network. Accepted for publication at the 26th European Signal Processing Conference (EUSIPCO), Sept. 2018.
9. Alan A. Diaz-Montiel, Jiakai Yu, Weiyang Mo, Yao Li, Daniel C. Kilper and Marco Ruffini. Performance Analysis of QoT Estimator in SDN-Controlled ROADMs Networks. Accepted for publication at ONDM 2018.

10. Jiakai Yu, Yao Li, Mariya Bhopalwala, Sandip Das, Marco Ruffini, Daniel C. Kilper. Midhaul Transmission Using Edge Data Centers with Split PHY Processing and Wavelength Reassignment for 5G Wireless Networks. Accepted for publication at ONDM 2018.
11. C. Browning, M. Ruffini, Y. Lin, R. B. Timens, D. H. Geuzebroek, C. G. H. Roeloffzen, D. Geskus, R. M. Oldenbeuving, R. G. Heideman, Y. Fan<sup>3</sup>, K. J. Boller and L. P. Barry. Optically switched 56 GBd PAM-4 using a hybrid InP-TriPLeX integrated tunable laser based on silicon nitride micro-ring resonators. Accepted at CLEO 2018.
12. Nima Afraz, Amr Elrasad, Marco Ruffini, DBA Capacity Auctions to Enhance Resource Sharing across Virtual Network Operators in Multi-Tenant PONs. Proc. of Optical Fibre Communications conference (OFC), 2018.
13. Pedro Alvarez, Frank Slyne, Christian Bluemm, Johann M. Marquez-Barja, Luiz A. DaSilva, Marco Ruffini, Experimental Demonstration of SDN-controlled Variable-rate Fronthaul for Converged LTE-over-PON. Proc. of Optical Fibre Communications conference (OFC), 2018.
14. Frank Slyne, Amr Elrasad, Christian Blumm and Marco Ruffini, Demonstration of Real Time VNF Implementation of OLT with Virtual DBA for Sliceable Multi-Tenant PONs. Proc. of Optical Fibre Communications conference (OFC), 2018. SDN/NFV demo session.
15. Yao Li, Mariya Bhopalwala, Sandip Das, Jiakai Yu, Weiyang Mo, Marco Ruffini, Daniel C. Kilper, Joint Optimization of BBU Pool Allocation and Selection for C-RAN Networks. Proc. of Optical Fibre Communications conference (OFC), 2018.
16. Nima Afraz, Amr Elrasad, Hamed Ahmadi and Marco Ruffini, Inter-Operator Dynamic Capacity Sharing for Multi-Tenant Virtualized PON. 28th International Symposium on Personal, Indoor and Mobile Radio Communication, PIMRC, Oct. 2017.
17. Giuseppe Talli, Stefano Porto, Daniel Carey, Nicola Brandonisio, Peter Ossieur, Frank Slyne, Seamas McGettrick, Christian Blumm, Marco Ruffini, Alan Hill, David Payne, Paul Townsend, Metro-Scale Optical Access Supporting Service Convergence and SDN Controlled Reconfigurability. Proc. of IEEE Photonic Conference, Oct. 2017.
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19. Paulo Marques, Carlos Silva, Valerio Frascolla, Edmundo Madeira, Cristiano Both, Moises Ribeiro, Pekka Aho, F. Macedo, Ali Hammad, Pedro Alvarez, Marco Ruffini, Johann M. Marquez-Barja and Luiz DaSilva, Experiments Overview of the EU-Brazil FUTEBOL Project. Proc. of European Conference on Networks and Communications (EuCNC), July 2017.
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