

## CURRICULUM VITAE

### WALTER CERRONI

Assistant Professor of Communication Networks (Tenured)  
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#### EDUCATION

- **July 2003:** Ph.D. in Electrical and Computer Engineering from the University of Bologna, Italy. Title of dissertation: *DWDM photonic packet-switched networks*.
- **July 1999:** 5-year *Laurea* degree in Telecommunication Engineering from the University of Bologna, Italy. Title of dissertation: *Architectures for optical IP routers with wavelength multiplexing*.

#### CURRENT POSITION

**April 2005 to present:** Assistant Professor of Communication Networks (tenured since 2008) at the Department of Electrical, Electronic and Information Engineering “G. Marconi” (DEI) of the University of Bologna, School of Engineering and Architecture, Cesena Campus, Italy.

#### PREVIOUS AND TEMPORARY POSITIONS

- **January to August 2008:** Visiting Assistant Professor at the School of Information Sciences, University of Pittsburgh, USA.
- **May 2003 to April 2005:** Research Associate at the National Inter-University Consortium for Telecommunications (CNIT), Italy.
- **May 2000 to March 2003:** Grantee of research studentships at the Department of Electronics, Computer Science and Systems, University of Bologna, Italy.
- **November 1998 to December 1999:** Intern at the Alcatel Corporate Research Center, Dallas, TX, USA, partly with a grant as Visitor Researcher from the University of Texas at Dallas.

## TEACHING EXPERIENCE

Walter Cerroni's teaching experience is related to different aspects of communication networks. In Italy, he has been involved in teaching at different educational levels, including undergraduate and graduate courses at the University of Bologna, a graduate course at the University of Modena and Reggio Emilia and a few vocational training courses at other local Institutions. Internationally, Walter Cerroni was responsible for a graduate course at the School of Information Sciences, University of Pittsburgh, USA, where he was also in charge of redesigning the local Computer Networking Laboratory and the related course content.

General topics of Cerroni's teaching activity include: communication and computer networks, TCP/IP protocol stack, routing protocols, QoS in the Internet, Software Defined Networking, queuing theory, and network security. Most of the classes he teaches are integrated with laboratory sessions on real network equipment, to provide the students with a clear view of the many practical issues behind the operations of a communication network. Walter Cerroni served as student advisor at the University of Bologna both for final theses and internships at local companies working in the field of communication networks.

List of courses for which Walter Cerroni is/was responsible:

- Undergraduate course on *Laboratory of Communication Networks*, School of Engineering and Architecture, Bologna Campus, University of Bologna, Italy, academic years 2013/14 to 2016/17.
- Graduate course on *Advanced Laboratory of Communication Networks*, School of Engineering and Architecture, Cesena Campus, University of Bologna, Italy, academic years 2010/11 to 2016/17.
- Undergraduate course on *Laboratory of Communication Networks*, School of Engineering and Architecture, Cesena Campus, University of Bologna, Italy, academic years 2002/03 to 2016/17.
- Graduate course on *Wide Area Networks*, School of Information Sciences, University of Pittsburgh, USA, academic year 2007/08.
- Graduate course on *Laboratory of Local and Wide Area Networks*, School of Engineering, University of Modena and Reggio Emilia, Italy, academic years 2006/07 to 2009/10.
- Graduate course on *Communication Networks Design*, School of Engineering, Cesena Campus, University of Bologna, Italy, academic years 2005/06 to 2012/13.
- Undergraduate course on *Advanced Communication Networks*, School of Engineering, Cesena Campus, University of Bologna, Italy, academic years 2003/04 to 2005/06.
- Short training course on *Communication Networks* at Techne, Cesena, Italy, December 2009, December 2010, December 2011.
- Short training course on *Wi-Fi Security* for system administrators at the University of Rome "La Sapienza," Italy, May 2006, October 2006, March 2007 (in cooperation with Marco Ramilli, formerly PhD student at the University of Bologna).

- Short training course on *W-Fi Security* for Postal, Communication and Computer Crime Police personnel, Cesena, Italy, March/April 2007 (in cooperation with other professors from the University of Bologna).
- Short training course on *System and Network Administration* at ECAP, Imola, Italy, December 2002 (in cooperation with Prof. Franco Callegati).
- Short training course on *Network Traffic Engineering* at ATS, Modena, Italy, October 2002, January 2003, May 2003 (in cooperation with other professors from the University of Bologna).

## RESEARCH ACTIVITIES

Walter Cerroni's recent research interests are related to several aspects of next generation network design, control, management, resource optimization, performance evaluation, and experimentation. The most relevant topics include:

- design and implementation of stateful and service-aware control plane solutions for Software Defined Networking (SDN) and Network Function Virtualization (NFV);
- experimental assessment of NFV and SDN solutions in production-level software platforms for Cloud Computing, such as OpenStack;
- design and implementation of intent-based northbound interfaces for virtualized infrastructure management in the ETSI NFV Management and Orchestration (MANO) framework;
- design, implementation, and performance evaluation of virtualized network functions in Cloud Computing environments;
- modeling and performance evaluation of NFV solutions running on general purpose hardware and adopting virtual machine migration techniques;
- modeling and design of inter- and intra-data center interconnection networks for Cloud Computing infrastructures;
- design of programmable, software-defined, hybrid optical network architectures, with different switching techniques (e.g., based on circuit and packet paradigms);
- deployment of session-layer protocols for efficient and integrated network and application resource management in data center interconnections;
- performance evaluation of dynamic spectrum allocation techniques in flexible-grid optical networks;
- assessment of the key parameters for the design and optimization of contention resolution mechanisms in the time, wavelength and space domains in optical networks;
- optimization of header processing and internal device configuration functions within optical switching nodes;
- development of dynamic routing techniques taking into account resource availability at each node in optical networks.

The research activities mentioned above represent the contribution to several national and international projects, including:

- PRIN “*GAUCHO - A Green Adaptive Fog Computing and Networking Architecture*,” funded by the Italian Ministry of Research (MIUR) from 2017 to 2020;
- POR FESR “*SACHER - Smart Architecture for Cultural Heritage in Emilia Romagna*,” funded by the Emilia Romagna region from 2016 to 2018;
- Activity 16406 “*Certification Centre for Business Acceleration of SDN and NFV*,” Action Line on “Future Networking Solutions,” funded by EIT Digital in 2016;
- Activity 15270 “*SDN at the Edges*,” Action Line on “Future Networking Solutions,” funded by EIT Digital in 2015;
- Activity 13132 “*Smart Networks at the Edge*,” Action Line on “Future Networking Solutions,” funded by EIT ICT Labs in 2013;
- Network of Excellence “*EINS – The Network of Excellence in Internet Science*,” funded by the European Union in the VII Framework Program from 2012 to 2015;
- PRIN “*SFINGI - Software router to Improve Next-Generation Internet*,” funded by the Italian Ministry of Research (MIUR) from 2011 to 2013;

- Network of Excellence “*BONE – Building the Future Optical Network in Europe,*” funded by the European Union in the VII Framework Program from 2008 to 2010;
- PRIN “*OSATE – Optics in Switching Architectures: Theory and Experimentation,*” funded by the Italian Ministry of Research (MIUR) from 2006 to 2007;
- Network of Excellence “*e-Photon/ONe – Optical Networks: Towards Bandwidth Manageability and Cost Efficiency,*” funded by the European Union in the VI Framework Program from 2004 to 2007.

From January to August 2008, as a Visiting Assistant Professor at the School of Information Sciences, University of Pittsburgh, USA, Walter Cerroni worked in collaboration with local faculty and graduate students on quality of service scheduling techniques in hybrid optical circuit and burst switching networks.

From May 2003 to April 2005, as a Research Associate at CNIT, Walter Cerroni worked in the framework of the national project “*GRID.IT – Enabling platforms for high-performance computational grids oriented to scalable virtual organization,*” funded by the Italian Ministry of University and Research within the FIRB 2002-06 program and including participants from leading Italian research organizations. During this period his research was focused on the study of network infrastructures, based on optical packet switching, enabled to the transport of traffic generated by grid computing applications.

From May 2000 to July 2003, as a PhD student in Electrical and Computer Engineering at the University of Bologna, his main research topics were related to node architectures and performance evaluation of DWDM photonic packet-switched networks. He was involved in the IST project “*DAVID – Data and voice integration over DWDM,*” funded by the EU in the V Framework Program from June 2000 to October 2003. He also participated to the activities of national projects “*IPPO – IP Optical Packet Networks,*” and “*INTREPIDO – End-to-end Traffic Engineering and Protection in IP over DWDM Networks,*” funded by the Italian Ministry of University and Research within the PRIN 2001-02 and 2003-04 programs, respectively.

From November 1998 to December 1999, as an intern at the Alcatel Corporate Research Center, Dallas, TX, USA, Walter Cerroni’s research focused on multicast-enabled architectures for optical IP routers and algorithms for the computation of minimum-cost multicast trees in optical networks.

## EDITORIAL ACTIVITIES AND OTHER SERVICES

Walter Cerroni is a Senior Member of the Institute of Electrical and Electronics Engineers (IEEE) since 2016 (Member since 2001). He is actively involved in the following IEEE Communications Society (ComSoc) Technical Committees:

- Transmission, Access, and Optical Systems (TAOS);
- Optical Networks (ONTC);
- Communication Switching and Routing (CSR).

He served as TAOS representative **member of the Selection Committee** for the IEEE ComSoc Student Competition in 2016, 2015, and 2014.

Walter Cerroni is currently serving or has served as:

- **Guest Editor** for a Special Issue of the IEEE/OSA Journal of Optical Communications and Networking (JOCN) on the best papers presented at the Optical Networks and Systems (ONS) Symposium and the Optical Wireless Communications (OWC) Workshop in the IEEE 2016 International Conference on Communications (ICC 2016);
- **Co-Chair** for the Symposium on Next Generation Networking and Internet (NGNI) in the IEEE 2017 Global Communications Conference (GLOBECOM 2017), to be held in Singapore, December 2017;
- **Co-Chair** for the Second International Workshop on Orchestration for Software Defined Infrastructures (O4SDI), held in conjunction with IEEE NFV-SDN 2016 in Palo Alto, CA, USA, November 7, 2016;
- **Co-Chair** for the First International Workshop on Orchestration for Software Defined Infrastructures (O4SDI), held in conjunction with IEEE ICC 2016 in Kuala Lumpur, Malaysia, May 27, 2016;
- **Co-Chair** for the Symposium on Optical Networks and Systems (ONS) in the IEEE 2016 International Conference on Communications (ICC 2016), held in Kuala Lumpur, Malaysia, May 23-27, 2016.

He is/was also involved in the organization of the following events:

- as **Publication Co-Chair** for the 2017 IEEE Conference on Network Function Virtualization and Software Defined Networks (IEEE NFV-SDN 2017), to be held in Berlin, Germany, November 2017;
- as **Publication Co-Chair** for the 3rd IEEE Conference on Network Softwarization (IEEE NetSoft 2017), to be held in Bologna, Italy, July 3-7, 2017;
- as **Publicity Co-Chair** for the 4th Workshop on CrossCloud Infrastructures & Platforms, to be held in conjunction with EuroSys 2017 in Belgrade, Serbia, April 23-26, 2017;
- as **Publication Co-Chair** for the 1st IEEE Workshop on Software Defined Networks for Future Networks and Services (SDN4FNS 2013), held in Trento, Italy, November 11-13, 2013, technically co-sponsored by IEEE Communications and Computer Societies;
- as **Publication Chair** for the 15th International Conference on Optical Network Design and Modeling (ONDM 2011), held in Bologna, Italy, February 8-10, 2011, technically co-sponsored by IEEE Communications Society.

Walter Cerroni served as a **Technical Program Committee member** for several international conferences, including:

- IEEE Globecom 2016, 2015, 2014, 2013, 2012
- IEEE ICC 2017, 2016, 2015, 2014, 2013, 2011
- IEEE HPSR 2017, 2016, 2015, 2014, 2013, 2012, 2011
- IEEE SDN4FNS 2013
- IEEE NetSoft 2017, 2016, 2015
- IEEE NFV-SDN 2016
- IEEE LANMAN 2017, 2016
- IEEE Mobile Cloud 2017
- IEEE FIE 2014, 2013, 2012
- SDNMO Workshop @ IEEE/IFIP NOMS 2014
- CCSNA Workshop @ IEEE Globecom 2016, 2015
- EN4PPDR Workshop @ IEEE WiMob 2016, 2015, 2014
- SWFAN Workshop @ IEEE INFOCOM 2016
- CNSM 2016 (co-sponsored by IEEE Computer Society)
- ICNC 2017, 2016, 2015, 2014, 2013, 2012 (co-sponsored by IEEE Communications Society)
- ICCVE 2014, 2013 (co-sponsored by IEEE Computer Society)
- ONDM 2017, 2016, 2015, 2014, 2013, 2012, 2011 (co-sponsored by IEEE Communications Society)
- MASONS Workshop @ ICCCN 2015 (co-sponsored by IEEE Communications Society)
- CrossCloud Workshop @ EuroSys 2017, 2016
- NETWORKS 2016, 2014, 2012, 2010, 2008 (co-sponsored by IEEE)
- EuCNC 2016, 2015, 2014 (co-sponsored by IEEE Communications Society)
- OPTICS 2012, 2011, 2010 (co-sponsored by IEEE)
- ICSAI 2012 (co-sponsored by IEEE)
- ISWCS 2014 (co-sponsored by IEEE Communications Society)
- Broadnets 2009, 2008, 2007, 2006, 2005, 2004 (co-sponsored by IEEE Communications Society)

Walter Cerroni served as a **reviewer** for many international conferences and for the following journals and magazines:

- IEEE Communications Magazine
- IEEE Network Magazine
- IEEE Communications Letters
- IEEE Journal on Selected Areas in Communications
- IEEE/OSA Journal of Lightwave Technology
- IEEE/OSA Journal of Optical Communications and Networking
- IEEE Photonics Technology Letters
- IEEE Transactions on Information Forensics and Security
- IEEE Transactions on Communications
- IEEE Transactions on Computers
- IEEE Transactions on Wireless Communications

- IET Communications
- Elsevier Computer Communications
- Elsevier Computer Networks
- Elsevier Optical Switching and Networking
- Elsevier Journal of Network and Computer Applications
- European Transactions on Telecommunications
- Journal of High Speed Networks
- Springer Photonic Network Communications Journal

Bologna, 05/01/2017

Walter Cerroni

## LIST OF PUBLICATIONS

Walter Cerroni has co-authored more than 100 articles published in the most renowned international journals, magazines and conference proceedings related to communication networks. His Google Scholar H-index is 15.

### BOOKS AND BOOK CHAPTERS

1. R. Cafini, W. Cerroni, C. Raffaelli, M. Savi, "Security Issues in Programmable Routers for Future Internet," in *Trustworthy Internet*, N. Blefari-Melazzi, G. Bianchi, L. Salgarelli editors, Springer, Italy, 2011, pp. 17-30, ISBN: 978-88-470-1817-4.
2. M. L. Merani, M. Casoni, W. Cerroni, *Hands-On Networking. From Theory to Practice*, Cambridge University Press, UK, 2009, ISBN-13: 9780521869850.
3. C. Raffaelli, S. Aleksic, F. Callegati, W. Cerroni, G. Maier, A. Pattavina, M. Savi, "Optical Packet Switching," in *Enabling Optical Internet with Advanced Network Technologies*, J. Aracil, F. Callegati editors, Springer, UK, 2009, pp. 31-85, ISBN: 978-1-84882-277-1.
4. C. M. Gauger, S. Bjornstad, M. Nord, E. Baert, F. Callegati, D. Careglio, W. Cerroni, J. Cheyns, D. Colle, P. Demeester, C. Develder, D. R. Hjelm, G. Junyent, M. Klinkowski, M. Kowalewski, M. Lackovic, M. Marciniak, M. Pickavet, C. Raffaelli, J. Solé-Pareta, N. Stol, E. Van Breusegem, P. Zaffoni, "Optical Burst Switching and Optical Packet Switching," in *Advanced Infrastructure for Photonic Networks - Extended Final Report of COST Action 266*, R. Inkret, A. Kuchar, B. Mikac editors, University of Zagreb, Croatia, 2003, pp. 115-154.

### JOURNALS AND MAGAZINES

1. W. Cerroni, F. Esposito, "Optimizing Live Migration of Multiple Virtual Machines," *IEEE Transactions on Cloud Computing* (to appear).
2. F. Callegati, W. Cerroni, C. Contoli, R. Cardone, M. Nocentini, A. Manzalini, "SDN for Dynamic NFV Deployment," *IEEE Communications Magazine*, Vol. 54, No. 10, pp. 89-95, October 2016.
3. F. Callegati, W. Cerroni, C. Contoli, "Virtual Networking Performance in OpenStack Platform for Network Function Virtualization," *Journal of Electrical and Computer Engineering*, Hindawi, Vol. 2016, Art. 5249421, pp. 1-15, April 2016.
4. P. Bellavista, F. Callegati, W. Cerroni, C. Contoli, A. Corradi, L. Foschini, A. Pernaflini, G. Santandrea, "Virtual Network Function Embedding in Real Cloud Environments," *Computer Networks*, Elsevier, Vol. 93, Part 3, pp. 506-517, 24 December 2015.
5. W. Cerroni, M. Gharbaoui, B. Martini, A. Campi, P. Castoldi, F. Callegati, "Cross-layer resource orchestration for cloud service delivery: A seamless SDN approach," *Computer Networks*, Elsevier, Vol. 87, pp. 16-32, 20 July 2015.

6. W. Cerroni, G. Moro, R. Pasolini, M. Ramilli, "Decentralized detection of network attacks through P2P data clustering of SNMP data," *Computers & Security*, Elsevier, Vol. 52, pp. 1-16, July 2015.
7. W. Cerroni, "Network performance of multiple virtual machine live migration in cloud federations," *Journal of Internet Services and Applications*, Springer, Vol. 6, No. 1, Art. 6, pp. 1-20, 20 March 2015.
8. F. Lezama, G. Castanon, A. M. Sarmiento, F. Callegati, W. Cerroni, "Survivable virtual topology mapping in IP-over-WDM networks using differential evolution optimization," *Photonic Network Communications*, Springer, Vol. 28, No. 3, pp. 306-319, December 2014.
9. W. Cerroni, C. Raffaelli, "Analytical model of quality of service scheduling for optical aggregation in data centers," *Photonic Network Communications*, Springer, Vol. 28, No. 3, pp. 264-275, December 2014.
10. M. Casoni, W. Cerroni, M. Fiorani, "TCP performance in multi-EPON access networks under different optical core switching paradigms," *Optical Switching and Networking*, Elsevier, Vol. 13, pp. 17-33, July 2014.
11. F. Callegati, L. H. Bonani, F. Lezama, W. Cerroni, A. Campi, G. Castanon, "Trunk Reservation for Fair Utilization in Flexible Optical Networks," *IEEE Communications Letters*, Vol. 18, No. 5, pp. 889-892, May 2014.
12. A. Manzalini, R. Minerva, F. Callegati, W. Cerroni, A. Campi, "Clouds of Virtual Machines in Edge Networks," *IEEE Communications Magazine*, Vol. 51, No. 7, pp. 63-70, July 2013.
13. I. Aldaya, R. Cafini, W. Cerroni, C. Raffaelli, M. Savi, "Optical switch emulation in programmable software router testbed," *Photonic Network Communications*, Springer, Vol. 25, No. 1, pp. 10-23, February 2013.
14. F. Callegati, A. Campi, W. Cerroni, "Application Scenarios for Cognitive Transport Service in Next-Generation Networks," *IEEE Communications Magazine*, Vol. 50, No. 3, pp. 62-69, March 2012.
15. F. Callegati, A. Campi, W. Cerroni, "Automated transport service management in the future Internet: concepts and operations," *Journal of Internet Services and Applications*, Springer, Vol. 2, No. 2, pp. 69-79, September 2011.
16. R. Cafini, W. Cerroni, C. Raffaelli, M. Savi, "Standard-Based Approach to Programmable Hybrid Networks," *IEEE Communications Magazine*, Vol. 49, No. 5, pp. 148-155, May 2011.
17. P. Pavon-Marino, M. Bueno-Delgado, W. Cerroni, A. Campi, F. Callegati, "A parallel iterative scheduler for asynchronous Optical Packet Switching networks," *Optical Switching and Networking*, Elsevier, Vol. 8, No. 2, pp. 103-115, April 2011.
18. F. Callegati, A. Campi, W. Cerroni, "Fast and versatile scheduler design for optical packet/burst switching," *Optical Switching and Networking*, Elsevier, Vol. 8, No. 2, pp. 93-102, April 2011.

19. M. Prandini, M. Ramilli, W. Cerroni, F. Callegati, "Splitting the HTTPS Stream to Attack Secure Web Connections," *IEEE Security and Privacy*, Vol. 8, No. 6, pp. 80-84, November/December 2010.
20. F. Callegati, W. Cerroni, M. Ramilli, "Man-in-the-Middle Attack to the HTTPS Protocol," *IEEE Security and Privacy*, Vol. 7, No. 1, pp. 78-81, January/February 2009.
21. G. Zervas, Y. Qin, R. Nejabati, D. Simeonidou, F. Callegati, A. Campi, W. Cerroni, "SIP-enabled Optical Burst Switching architectures and protocols for application-aware optical networks," *Computer Networks*, Elsevier, Vol. 2, No. 10, pp. 2065-2076, July 16, 2008.
22. N. Ciulli, G. Carrozzo, G. Giorgi, G. Zervas, E. Escalona, Y. Qin, R. Nejabati, D. Simeonidou, F. Callegati, A. Campi, W. Cerroni, B. Belter, A. Binczewski, M. Stroinski, A. Tzanakaki, G. Markidis, "Architectural approaches for the integration of the service plane and control plane in optical networks," *Optical Switching and Networking*, Elsevier, Vol. 5, No. 2-3, pp. 94-106, June 2008.
23. F. Callegati, W. Cerroni, C. Raffaelli, M. Savi, "QoS differentiation in Optical Packet-Switched Networks," *Computer Communications*, Elsevier, Vol. 29, No. 7, pp. 855-864, April 24, 2006.
24. F. Callegati, D. Careglio, W. Cerroni, G. Muretto, C. Raffaelli, J. Solé-Pareta, P. Zaffoni, "Keeping the Packet Sequence in Optical Packet-Switched Networks," *Optical Switching And Networking*, Elsevier, Vol. 2, No. 3, pp. 137-147, November 2005.
25. F. Callegati, C. Develder, W. Cerroni, M. Pickavet, G. Corazza, P. Demeester, "Scheduling algorithms for a slotted packet switch with either fixed or variable length packets," *Photonic Network Communications*, Kluwer Academic Publishers, Vol. 8, No. 2, pp. 163-176, September 2004.
26. F. Callegati, W. Cerroni, C. Raffaelli, P. Zaffoni, "Wavelength and time domain exploitation for QoS management in optical packet switches," *Computer Networks*, Elsevier, Vol. 44, No. 4, pp. 569-582, March 15, 2004.
27. F. Callegati, W. Cerroni, C. Raffaelli, P. Zaffoni, "Dynamic Wavelength Assignment in MPLS Optical Packet Switches," *Optical Networks Magazine*, SPIE/Kluwer Academic Publishers, Vol. 4, No. 5, pp. 41-51, September 2003.
28. L. Dittmann (editor), C. Develder, D. Chiaroni, F. Neri, F. Callegati, W. Koerber, A. Stavdas, M. Renaud, A. Rafel, J. Solé-Pareta, W. Cerroni, N. Leligou, Lars Dembeck, B. Mortensen, M. Pickavet, N. Le Sauze, M. Mahony, B. Berde, G. Eilenberger, "The European IST project DAVID: A viable approach towards optical packet switching," *Journal on Selected Areas in Communications*, IEEE, Vol. 21, No. 7, pp. 1026-1040, September 2003.
29. F. Callegati, W. Cerroni, G. Corazza, "Optimization of Wavelength Allocation in WDM Optical Buffers," *Optical Networks Magazine*, SPIE/Kluwer Academic Publishers, Vol. 2, No. 6, pp.66-72, November 2001.

## CONFERENCES

1. F. Esposito, W. Cerroni, "GeoMig: Online Multiple VM Live Migration," Proc. of *3rd IEEE International Symposium on Software Defined Systems (SDS 2016)*, Berlin, Germany, April 2016.
2. F. Esposito, W. Cerroni, "Integrating Piece and Peer Selection in Content Distribution Networks," Proc. of *2015 IEEE Global Communications Conference (Globecom 2015)*, San Diego, CA, December 2015.
3. F. Callegati, W. Cerroni, C. Contoli, G. Santandrea, "SDN Controller Design for Dynamic Chaining of Virtual Network Functions," Proc. of *4th European Workshop on Software Defined Networks (EWSN 2015)*, Bilbao, Spain, October 2015.
4. F. Callegati, W. Cerroni, C. Contoli, G. Santandrea, "Implementing Dynamic Chaining of Virtual Network Functions in OpenStack Platform," Proc. of *17th International Conference on Transparent Optical Networks (ICTON 2015)*, Budapest, Hungary, July 2015.
5. W. Cerroni, C. Raffaelli, N. Slimani, "Channel Sharing Techniques in Hybrid Optical Networks for Data Centers," Proc. of *17th International Conference on Transparent Optical Networks (ICTON 2015)*, Budapest, Hungary, July 2015.
6. F. Callegati, W. Cerroni, C. Contoli, G. Santandrea, "Dynamic Chaining of Virtual Network Functions in Cloud-Based Edge Networks," Proc. of *1st IEEE Conference on Network Softwarization (NetSoft 2015)*, London, UK, April 2015.
7. F. Callegati, W. Cerroni, C. Contoli, G. Santandrea, "Performance of Multi-tenant Virtual Networks in OpenStack-based Cloud Infrastructures," Proc. of *2nd IEEE Workshop on Cloud Computing Systems, Networks, and Applications (CCSNA 2014)*, in conjunction with IEEE Globecom 2014, Austin, TX, December 2014.
8. D. C. Mocanu, G. Santandrea, W. Cerroni, F. Callegati, A. Liotta, "Network Performance Assessment with Quality of Experience Benchmarks," Proc. of *10th International Conference on Network and Service Management (CNSM 2014)*, Rio de Janeiro, Brazil, November 2014.
9. F. Callegati, W. Cerroni, C. Contoli, G. Santandrea, "Performance of Network Virtualization in Cloud Computing Infrastructures: The OpenStack Case," Proc. of *3rd IEEE International Conference on Cloud Networking (CloudNet 2014)*, Luxemburg, October 2014.
10. W. Cerroni, "Performance of Network and Computing Resource Sharing in Federated Cloud Systems," Proc. of *ACM SIGCOMM Workshop on Distributed Cloud Computing (DCC 2014)*, in conjunction with ACM SIGCOMM 2014, Chicago, IL, August 2014.
11. C. Contoli, W. Cerroni, F. Callegati, G. Pau, "Performance of Named Data Networking in Urban Vehicular Communications," Proc. of *16th International Conference on Transparent Optical Networks (ICTON 2014)*, Graz, Austria, July 2014.
12. L. H. Bonani, A. dos Santos Tozetti, F. Callegati, W. Cerroni, "Routing Issues on Spectrum Sharing and Partitioning for Flexible Optical Networks," Proc. of *16th International Conference on Transparent Optical Networks (ICTON 2014)*, Graz, Austria, July 2014.

13. W. Cerroni, F. Callegati, "Live Migration of Virtual Network Functions in Cloud-Based Edge Networks," Proc. of *2014 IEEE International Conference on Communications (ICC 2014)*, Sydney, Australia, June 2014.
14. W. Cerroni, "Multiple Virtual Machine Live Migration in Federated Cloud Systems," Proc. of *IEEE Workshop on Cross-cloud Systems (CrossCloud '14)*, in conjunction with IEEE INFOCOM 2014, Toronto, Canada, April 2014.
15. F. Callegati, W. Cerroni, "Live Migration of Virtualized Edge Networks: Analytical Modeling and Performance Evaluation," Proc. of *IEEE Workshop on SDN for Future Networks and Services (SDN4FNS 2013)*, Trento, Italy, November 2013.
16. F. Callegati, A. Campi, W. Cerroni, M. Marano, C. Rossi, G. Pau, "All Electrical Vehicles Connected to the Internet: Implementation and Experiments," Proc. of *3rd IFIP Conference on Sustainable Internet and ICT for Sustainability (SustainIT 2013)*, Palermo, Italy, October 2013.
17. A. Manzalini, R. Minerva, E. Dekel, Y. Tock, E. Kaempfer, W. Tavernier, K. Casier, S. Verbrugge, D. Colle, F. Callegati, A. Campi, W. Cerroni, R. Vilalta, R. Munoz, R. Casellas, R. Martinez, N. Crespi, N. Mazzocca, E. Maini, "Manifesto of Edge ICT Fabric," Proc. of *17th International Conference on Intelligence in Next Generation Networks (ICIN 2013)*, Venice, Italy, October 2013.
18. F. Lezama Cruzvillasante, F. Callegati, W. Cerroni, L.H. Bonani, "Trunk reservation for elastic optical networks," Proc. of *15th International Conference on Transparent Optical Networks (ICTON 2013)*, Cartagena, Spain, June 2013.
19. W. Cerroni, F. Callegati, B. Martini, P. Castoldi, "Design trade-offs for anycast service provisioning in optical data center interconnections," Proc. of *15th International Conference on Transparent Optical Networks (ICTON 2013)*, Cartagena, Spain, June 2013.
20. W. Cerroni, G. Leli, C. Raffaelli, "Design and Test of a Software Defined Hybrid Network Architecture," Proc. of *1st Workshop on High Performance and Programmable Networking (HPPN 2013)*, co-located with ACM HPDC 2013, New York, NY, June 2013.
21. F. Callegati, L. H. Bonani, W. Cerroni, "Service Fairness in Flexible Optical Networks," Proc. of *2013 Optical Fiber Communication Conference and Exposition (OFC/NFOEC 2013)*, Anaheim, CA, March 2013.
22. W. Cerroni, G. Moro, T. Pirini, M. Ramilli, "Peer-to-Peer Data Mining Classifiers for Decentralized Detection of Network Attacks," Proc. of *24th Australasian Database Conference (ADC 2013)*, Adelaide, Australia, January 2013.
23. G. Corazza, W. Cerroni, G. Leli, C. Raffaelli, M. Savi, N. Stol, "Analytical Model of 3-level QoS Scheduling in Hybrid Optical Networks," Proc. of *2nd International Conference on Computing, Networking and Communications (ICNC 2013)*, San Diego, CA, January 2013.
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# ANNEX I

COMMUNICATION NETWORKS LAB  
UNDERGRADUATE COURSE  
UNIVERSITY OF BOLOGNA

LOCAL AND GEOGRAPHIC NETWORKS LAB  
GRADUATE COURSE  
UNIVERSITY OF MODENA AND REGGIO EMILIA

## COURSE OBJECTIVE

To gain knowledge on network services and equipment through lab experiments, focusing in particular on network service configuration on open source platforms.

## COURSE CONTENT

- Recap about TCP/IP protocols
- Introduction to Linux networking
- Basic Linux networking commands
- Network protocol analyzer
- Network interface configuration, DHCP service
- Packet forwarding alternatives, proxy-ARP setup
- Firewall and NAT service configuration
- Open-source routing software configuration
- The “Click” modular router implementation
- VPN set-up with IPsec
- Network services management

## ANNEX II

### COMMUNICATION NETWORKS DESIGN GRADUATE COURSE UNIVERSITY OF BOLOGNA

#### COURSE OBJECTIVE

Ability to solve engineering problems related to dimensioning and performance evaluation of telecommunication networks, with particular emphasis on queuing theory.

#### COURSE CONTENT

The course is split in two modules, the first taught by Prof. Callegati, the second by Dr. Walter Cerroni.

##### First module

- Basic teletraffic concepts
- Arrival and service process statistics, Little's law
- Markov chain models for queuing system
- Circuit-switched network design, Erlang's B formula
- Call-center and circuit-switching fabric dimensioning

##### Second module

- M/G/1 queuing systems
- Priority queuing
- Non-FIFO scheduling: shortest job next, round-robin, processor sharing
- Queuing networks
- Multi-service networks
- Simulation of queuing systems

## ANNEX III

### ADVANCED COMMUNICATION NETWORKS UNDERGRADUATE COURSE UNIVERSITY OF BOLOGNA

#### COURSE OBJECTIVE

Follow-up of a basic networking course. To extend basic TCP/IP networking knowledge, with particular emphasis on network planning, routing and quality/security-related issues.

#### COURSE CONTENT

- Recap about Internet and TCP/IP protocols
- IP network planning: subnetting and CIDR
- Simple network monitoring: ICMP protocol
- IP packet forwarding alternatives, routing tables
- Internet routing algorithms and protocols: BGP and OSPF
- IP router architectures
- A look to the application layer: HTTP, DNS
- Network security: cryptography, authentication, firewall, VPNs
- Quality of service: IntServ, DiffServ