

Curriculum Vitæ et Studiorum

Paolo Casari



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General information

Nationality:	Italian
Date of birth:	August 20 th , 1980
Place of birth:	Ferrara, Italy
Marital Status:	Not married
Current Position:	Senior Post-doctoral research fellow at the University of Padova, Italy Technical Manager for the NAUTILUS project Research Unit POC for the RACUN project

Biography

I received the Laurea (B.E.) in Electronics and Telecommunications Engineering in 2002 and the Laurea Specialistica (M.E.) in Telecommunications Engineering in 2004, both *summa cum laude*, from the University of Ferrara, Italy. I was with the same University through 2004 to work on the optimization of geographic routing protocols as a research fellow. In 2005, I joined the School of Information Engineering at the University of Padova as a PhD student, and graduated in March 2008.

During the PhD, my research has been focused on cross-layer design for two very different kinds of wireless networks, namely MIMO ad hoc networks and wireless sensor networks. With regard to the former topic, I considered the application of MIMO techniques to the design of PHY-aware MAC and routing protocols, with the objective to optimize the throughput and delivery ratio performance in the network, while at the same time limiting or at least managing the mutual interference originated by concurrent transmissions. Later, I also worked on the relationship between imperfect channel estimation and the performance of MAC protocols for MIMO ad hoc networks. With regard to wireless sensor networks, I considered cross-layer design in the form of a joint MAC and routing approach to geographic forwarding. I contributed the design of a novel MAC/routing protocol called ALBA-R and to a companion algorithm that enables easy routing around connectivity holes in sparse networks.

After the PhD, I joined the Department of Information Engineering of the University of Padova as a postdoctoral fellow, and collaborated several times with CFR, a research consortium located in Ferrara, Italy. The experience I accumulated during the PhD earned me the role of Technical Manager for a large National Italian project on WIRELESS SENSOR networks for city-Wide Ambient Intelligence (WISE-WAI), running from 2008 to 2011. Among the achievements of the project, we demonstrated environmental monitoring and localization via a full-fledged protocol suite running over a network of around 350 embedded wireless sensors. These sensors have been installed throughout the premises of the Department of Information Engineering of the University of Padova.

Presently, my main research topic is underwater acoustic communications and networks. I have been in touch with this topic for the first time when Prof. Milica Stojanovic came to Padova to give a course on Underwater Communications in 2006. In 2007, I spent six months as a visiting student with her at the Massachusetts Institute of Technology, which were very important as a starter in the underwater networking field. Until today, I progressively focused on underwater communications and networking, and I made several contributions in this field, centered on MAC and routing protocol design, on the analysis of fundamental tradeoffs between energy consumption, transmission

range and bit rate, on the simulation of network protocols using realistic channel models, as well as on the synthesis of simplified channel models to be used as an approximation in network simulations.

Since 2009, I have been leading all activities related to underwater communications within the networking group at the University of Padova. More specifically, I have been engaged in two major EU-funded projects, namely CLAM (FP7), where I have been WP leader, and RACUN (EDA), where I am the reference point-of-contact of my technical unit; one major Italian project, namely NAUTILUS (IIT-SEED), for which I am also Technical Manager; several funded collaborations with JHUAPL, as well as the US NSF and ONR. These projects span several topics, from channel characterization to protocol design, from simulation to sea trials and real-life experiments. I managed these activities and carried them out along with the group I led, which counted up to 11 people, including several PhD and Master students. Among the major achievements of the group, in May 2012 we released DESERT Underwater, a suite of software libraries that enables the simulation of underwater networks, and the easy experimentation thereof by reusing the same software used for simulation, in a hardware-in-the-loop fashion. The suite also contains all protocols we have been designing in the meantime.

I am active in the community as a TPC or organizing committee member and as a reviewer for several conferences, among which IEEE OCEANS and ACM WUWNet are very common venues for papers related to underwater communications. I have been recognized Excellent reviewer by the editorial board of the IEEE Wireless Communications Letters (for 2012) and by the editorial board of the IEEE Journal of Oceanic Engineering (for 2011 and 2012). I have been guest editor of a special issue of the Hindawi Journal of Electrical and Computer Engineering on "Underwater Communications and Networking". I have served as a project proposal reviewer for the Qatar National Research fund from 2009 through 2013. I participated to the definition of the NATO standard JANUS for first-contact and unsolicited broadcasting of information using acoustic signals under water.

I collaborated to the organization and writing of several project proposals, of which many got funded and turned into the project efforts on underwater communications mentioned above. I also secured funding in the form of fellowships for my PhD program and, more recently, by submitting my own 2-year program proposal for the "Senior" kind of postdoctoral fellowship at the University of Padova. I was also part of a team that secured enough funding to purchase several underwater acoustic modems plus control boards, power supplies, laptops etc, as required to set up a full-fledged underwater communications and networking laboratory.

As of 15/11/2012, I co-authored more than 70 papers appeared in international journals and conferences. In 2013, I was elevated to the grade of Senior Member of the IEEE. I am also a member of the ACM and of the Italian multi-university Consortium for Telecommunications (CNIT).

Education

PhD in Information Engineering

Institution: University of Padova, Italy, *Doctoral School of Information Engineering*

Title of thesis: "MAC and Routing in Wireless Ad Hoc and Sensor Networks: a Cross-Layer Approach"

Supervisor: Prof. Michele Zorzi

Professional Engineering examination (2006)

Passed on June 2006 at the University of Bologna, Italy.

Laurea Specialistica (M.E.) in Telecommunications Eng. (2004)

July 22nd, 2004, University of Ferrara, Italy

Final graduation mark: **110/110 cum laude**

Thesis topic: Simulation of a geographic routing protocol wireless sensor networks, aimed at the evaluation of energy-latency tradeoffs.

Other projects accomplished before the final dissertation: Analysis of numeric algorithms for computing emitted electric field and antenna currents; programming of a psychoacoustic-model-based audio compressor; programming of image watermarking algorithms; programming of a RSA cryptosystem; programming of main CPU functions on FPGA through VHDL.

Laurea (B.E.) in Electronics and Telecommunications Eng. (2002)

July 19th, 2002, University of Ferrara, Italy

Final graduation mark: 110/110 cum laude

Thesis topic: Simulation of a digital wireless communication system with multi-level quadrature digital modulation, carrier frequency and symbol timing recovery.

Diploma di Maturità scientifica (high school education) (1999)

July 18th, 1999, Liceo Scientifico "A. Roiti", Ferrara, Italy.

Final mark: 100/100

Awards

- 2013: Recognized **Excellent Reviewer** for 2012 by the Editorial Board of the IEEE Journal of Oceanic Engineering
- 2013: Recognized **Excellent Reviewer** by the Editorial Board of the IEEE Wireless Communications Letters
- 2012: Recognized **Excellent Reviewer** for 2011 by the Editorial Board of the IEEE Journal of Oceanic Engineering
- 2004: **Letter of Encomium from the Laurea Specialistica evaluation commission** for “the outstanding examination marks, proven scientific skills and excellent achievements”
- 1999: “**Francesco Viviani**” **Prize** (for students completing high school with full marks).

Academic Experience

Contracts and fellowships

- July 01, 2013 – Today: **senior postdoctoral fellowship** at the **University of Padova, Italy** (scheduled for completion on June 30, 2015).
- December 01, 2012 – June 30, 2013: **postdoctoral fellowship** at the **University of Padova, Italy**
- February 01, 2012 – November 30, 2012: **postdoctoral fellowship** at the **University of Padova, Italy**
- February 01, 2010 – January 31, 2012: **postdoctoral fellowship** at the **University of Padova, Italy**
- June – September 2009: **research fellowship from the NATO Undersea Research Centre (NURC)**, La Spezia, Italy
- January 01, 2008 – December 31, 2009: **postdoctoral fellowship** at the **University of Padova, Italy**
- February 01 – July 31, 2007: **visiting student fellowship** from the **Massachusetts Institute of Technology (MIT)**, Cambridge, MA
- January 01, 2005 – December 31, 2007: **3-year fellowship** from the **Italian Ministry of University and Research (MIUR)** to cover the duration of the PhD course of studies

Research projects

- June 01, 2010 – 31/08/2013: **Task Leader and WP leader** for the EU FP7 *CLAM* project
 - February 01, 2010 – October 30, 2013: **Technical manager** for the *NAUTILUS* project, funded by the Italian Institute of Technology (IIT)
 - July 15, 2010 – July 14, 2014: **Research unit reference person** for the *RACUN* project
 - July 01, 2007 – June 30, 2011: **Technical manager** for the *WISE-WAI* project
 - 2010 through 2012: **Research collaborator and coordinator** within other *US NSF-* and *US ONR-* funded research projects on underwater networking
- (see Section “Activity within national and international projects” for a description of these research efforts)

Collaborations

- April and October 2012: **Collaboration contract** at **Consorzio Ferrara Ricerche**, Ferrara, Italy, to be an exchange researcher in the context of the Marie Curie action *SWAP*
- September 06, 2010 – December 31, 2012: **Research collaboration contract** at **Consorzio Ferrara Ricerche**, Ferrara, Italy
- October 01, 2004 – December 31, 2004: **Research fellowship** at **University of Ferrara**, Italy

Teaching assistantships

- During 2011:
 - ✓ “Modelli per le Reti” (Network Modeling), University of Padova (lecturer: Prof. Michele Zorzi)
- During 2010:
 - ✓ “Modelli per le Reti” (Network Modeling), University of Padova (lecturer: Prof. Michele Zorzi)
- During 2009:
 - ✓ “Modelli per le Reti” (Network Modeling), University of Padova (lecturer: Prof. Michele Zorzi)
- During 2008:
 - ✓ “Modelli per le Reti” (Network Modeling), University of Padova (lecturer: Prof. Michele Zorzi)

- During 2006:
 - ✓ “Matematica per l’Elaborazione dei Segnali” (Calculus for Signal Processing), University of Ferrara (lecturers: Prof. Daniela Mari and Prof. Leonardo Badia)
 - ✓ “Modelli per l’Analisi delle Prestazioni nelle Reti” (Models for Network Performance Evaluation), University of Padova (lecturer: Prof. Michele Zorzi)
- During 2005:
 - ✓ “Elaborazione Numerica dei Segnali” (Digital Signal Processing), University of Ferrara (lecturer: Prof. Leonardo Badia)
 - ✓ “Modelli per l’Analisi delle Prestazioni nelle Reti” (Models for Network Performance Evaluation), University of Padova (lecturer: Prof. Michele Zorzi)
 - ✓ “Teoria dei Fenomeni Aleatori” (Stochastic Modeling), University of Ferrara (lecturer Prof. Michele Rossi)
- During 2004
 - ✓ “Sistemi di Telecomunicazione” (Telecommunication Systems), University of Ferrara, (lecturer: Prof. Michele Zorzi)

Supervised students and collaborators

As a senior Postdoctoral researcher, I collaborate to several research projects at the University of Padova, and supervise of the research activities of several students and collaborators. As far as underwater network activities are concerned, I am currently co-supervising the following 7 people:

- Giovanni Toso (PhD student)
- Federico Favaro (Research engineer)
- Ivano Calabrese (Master student)
- Federico Guerra (External collaborator)
- Loris Brolo (Research engineer)
- Saiful Azad Muhammad (External collaborator)

During the period 2008-2013 the group grew to include up to 11 people under my supervision.

Furthermore, I supervised several bachelor and master thesis students in several topics as follows.

1. Ad Hoc Networks with MIMO Systems (2): Marco Levorato (2005), Daniele Mazzi (2006)
2. Wireless Sensor Networks (13): Paola Violin (2005), Dino Zuliani (2005), Matteo Cappellin (2005), Federico Bertoldi (2006), Francesco Zorzi (2006), Davide Zennaro (2008), Nicola Bressan (2009), Matteo Salmistraro (2010), Renato Spiandorello (2010), Mattia Gheda (2010), Matteo Canale (2010), Leonardo Bazzaco (2010), Walter Berardi (2011)
3. Underwater Acoustic Sensor Networks (14): Stefano Marella (2006), Fabio Emilio Lapicciarella (2007), Paolo Casciaro (2008), Beatrice Tomasi (2008), Federico Guerra (2008), Nicola dalla Pozza (2009), Giuseppe Loccisano (2010), Giovanni Toso (2011), Federico Favaro (2011), Matteo Lazzarin (2012), Marco Zanforlin (2012), Matteo Petrani (2012), Ivano Calabrese (2012), Loris Brolo (2013)

Funding

- **2004:** Secured a **fellowship** from the Italian Ministry of Education, University and Research to cover the PhD course of studies (2005-2007). **Amount:** ~32.000 Euro
- **2012:** Secured a 2-year **Senior Postdoc Grant** from the University of Padova, Italy, for the period from July 2013 to June 2015. **Amount:** ~42.500 Euro
- **2013:** I was part of a team that was able to secure an **infrastructure fund**. **Amount:** ~54.000 Euro

In addition to the above, I was able to secure postdoctoral fellowships of ~19000 Euro per year for the period from 2008 to 2012.

Experimentation activities

I personally participated to several sea/lake/river trials so far, as part of my research on underwater acoustic networks. For these trials I did one or more of the following:

- Organization of the trial logistics
- Definition and preparation of the experiments to be carried out
- Hands-on experimentation and collection of results
- Coordination of a team of collaborators for the pursuit of the trial objectives

The trials I took part in are:

1. **(2013) NAUTILUS ST3**, carried out in collaboration with the NATO CMRE during the CommsNet'13 campaign, in the gulf of La Spezia, Italy. We experimented three networking protocols in similar topologies and in heterogeneous networks, under a variety of channel conditions. The trial was managed from on board the research vessel Alliance, with the participation of Leonardo for some tests.
2. **(2013) Preparation trial for the ST3 of the NAUTILUS project**, carried out in collaboration with EvoLogics, Berlin, Germany. We experimented several network protocols based on routing and/or controlled access, as well as a new version of the remote modem control framework.
3. **(2013) CLAM ST3**, Trondheim fjord, Norway. During 2 weeks, we experimented two different networking protocols and collaborated to define the topology and timeline of the experiments, which were carried out at the pier of a camping site during the first week, and in the open waters of the fjord during the second week, thanks to the availability of NTNU's Gunnerus research vessel.
4. **(2013) RACUN ST2**, Den Helder, The Netherlands. During 3 weeks, we experimented networking protocols for the RACUN project, employing both a monolithic software implementation and a modular workflow running from simulations to sea trials thanks to the DESERT Underwater libraries. The experiment was organized by the Royal NL Navy on board a diver support vessel; the German partners of the project also participated on a second research ship.
5. **(2013)** I collaborated to the definition of the activities for the **RACUN Pre-HAT**, Kiel, Germany.
6. **(2012)** I collaborated to the definition of a channel probing experiment carried out in collaboration with the Scripps Institution of Oceanography, San Diego, CA.
7. **(2012)** I collaborated with the definition of the proof-of-concept experiments to be carried out at the **CLAM ST2**, at Kongsberg Maritime premises, Horten, Norway.
8. **(2012)** I collaborated with the definition of the University of Padova's experimental module for the **CommsNet 2012** trials, organized by the NATO CMRE (formerly NURC).
9. **(2012) SUN protocol and remote modem control framework trials** in Berlin, Germany, in collaboration with EvoLogics.
10. **(2011/2012) Several basin, river and lake trials** to experiment the DESERT Underwater libraries. The trials were mainly located in Padova, Italy. I also collaborated to the organization of two more advanced trials held i) in collaboration with **EvoLogics**, Berlin, Germany in March 2012 and ii) at the pier of the **Woods Hole Oceanographic Institution**, Woods Hole, MA, earlier, at the end of 2011. An advanced version of the proof-of-concept experiments for DESERT Underwater was repeated in collaboration with WASS, Livorno, in La Spezia waters, in April 2012, during the **RACUN ST1**.
11. **(2010) ACommsNet'10**, Pianosa, Italy. Trials organized by the NATO NURC, La Spezia, Italy. Main topic of my research: providing support to Medium Access Control protocol tests and relating environmental measurement to ray traces, in order to infer the causes of channel variability.
12. **(2009) Subnet'09**, Pianosa, Italy. Trials organized by the NATO NURC, La Spezia, Italy. We tested the JANUS transmission format (preamble detection, Doppler compensation, computation of the probability of error for transmissions between static nodes as well as static/mobile nodes).

Internships and Exchange Programs

- **Exchange researcher** for Consorzio Ferrara Ricerche within the secondment program of the Marie-Curie action SWAP
- **September 2010: Research Assistant at the NATO Undersea Research Centre (NURC), La Spezia, Italy**, during the ACommsNet 2010 sea trial campaign.
- **June-September 2009: Visiting Research Consultant, NATO Undersea Research Centre (NURC), La Spezia, Italy**
 - ✓ **Advisor:** Kim McCoy
 - ✓ **Research topic:** Design and implementation of an energy detector and signal parameter estimator for the JANUS signal waveform
- **February-August 2007: Visiting student, Massachusetts Institute of Technology, Cambridge, MA**
 - ✓ **Advisor:** Milica Stojanovic
 - ✓ **Research Topic:** Design and characterization of physical-layer aware protocols for Underwater Acoustic Sensor Networks

Talks, Conferences and Schools

- **Speaker** of a talk on “Modeling random access in underwater acoustic networks,” **NTNU**, Trondheim, Norway, June 2013.
- **Italian Networking Workshop 2013**, Bormio, Italy. **Speaker** of a talk on “The throughput of underwater networks: Analysis and Validation using a ray tracing simulator.”
- **Speaker** of a talk on “Modeling random access in underwater acoustic networks,” **University of California at San Diego**, November 2012.
- **Asilomar conference on Signals, Systems and Computer 2012**, Pacific Grove, CA. **Presentation** of the invited paper: “A study on channel dynamics representation and its effects on the performance of routing in underwater networks.”
- **Centre de Telecomunicacions Tecnico de Catalunya (CTTC)**, Barcelona, Spain: **invited speaker** of a talk on “Recent results on underwater acoustic communications”.
- **ECUA 2012**, Edinburgh, Scotland. **Presenter** of the paper “Endowing Underwater Networks with Channel Awareness: a discussion on computational complexity and information size issues”.
- **Underwater Acoustic Measurements (UAM) 2011**, Kos, Greece. **Presenter** of the paper “Performance Evaluation of SNR Prediction Schemes in Acoustic Communication Systems using Variable-Rate Modulation” and of a second paper on behalf of a colleague.
- **IEEE/OES OCEANS 2011**, Santander, Spain. **Presenter** of the papers “On the Performance of Delay-Tolerant Routing Protocols in Underwater Networks” , “On ARQ Strategies over Random Access Protocols in Underwater Acoustic Networks” and “On the Impact of the Environment on MAC and Routing in Shallow Water Scenarios”.
- **Speaker** in a series of talks on the topic “Re-engineering Network Protocols to meet new challenges: the case of underwater communications”. The talk has been offered at major research groups working in the field of underwater communications, including **UCLA** (Los Angeles, CA), **ASU** (Tempe, AZ), **Harvard University** (Cambridge, MA), **University of Florida** (Gainesville, FL), **VirginiaTech** (Blacksburg, VA), **University of Connecticut** (Storrs, CT), **University of Stuttgart** (Germany) and **TU Delft** (The Netherlands).
- **ACM WUWNet 2010**, Woods Hole, MA, USA. **Publicity Chair** and **Session Chair**: “Networking I”. **Presenter** of a paper on behalf of Prof. Mandar Chitre, National University of Singapore.
- **MTS/IEEE Oceans 2010**, Seattle, WA, USA. **Session Chair**: “Underwater communication networks”. **Presenter of the papers** “A Study of Incremental Redundancy Hybrid ARQ over Markov Channel Models Derived from Experimental Data” **and** “Performance Evaluation of Random and Handshake-Based Channel Access in Collaborative Mobile Underwater Networks”

- **MTS/IEEE Oceans 2009**, Biloxi, MS. **Session chair**, “Acoustic Telemetry and Communications: Modeling/Simulation 2”. **Presenter** of the paper “A Performance Comparison of MAC Protocols for Underwater Networks using a Realistic Channel Simulator”
- **Underwater Acoustic Measurements (UAM) 2009**, Nafplion, Greece. **Presenter** of the paper “MAC Protocols for monitoring and event detection in underwater networks employing a FH-BFSK physical layer”.
- **IEEE IWCMC 2009**, Leipzig, Germany. **Presenter** of the paper “TinyNET: A Tiny Network Framework for TinyOS”
- **Centre de Telecomuncacions Tecnico de Catalunya (CTTC)**, Barcelona, Spain: **invited speaker** of a talk on Cross-layer design in MIMO ad hoc networks and Wireless Sensor Networks (2009).
- **Italian Networking Workshop**, Cortina d’Ampezzo, Italy. **Speaker** of a talk on “Energy-efficient routing protocols for underwater acoustic networks”
- **MTS/IEEE Oceans 2008**, Québec City, Canada. **Session chair**, “Acoustic Communications and Networking 3”. **Presenter** of the papers “A Comparison Between the Tone-Lohi and Slotted FAMA MAC Protocols for Underwater Networks” and “Effective Heuristics for Flexible Spectrum Access in Underwater Acoustic Networks”
- **IEEE IWCMC 2008**, Crete Island, Greece. **Presenter** of the paper: “On the Design of Routing Protocols in MIMO Ad Hoc Networks under Uniform and Correlated Traffic”
- **DEI Colloquia (talks of the Department of Information Engineering, University of Padova)**, 18/01/2007, talk on the topic “PHY-aware MAC protocol design for MIMO ad hoc networks”
- **IEE Mobility Conference 2006**, Bangkok, Thailand. **Presenter** of the paper: “Testbed Implementation and Refinement of a Range-Based Localization Algorithm for Wireless Sensor Networks”
- **ACM MOBIHOC 2006**, Florence Italy
- **MILCOM 2005**, Atlantic City, NJ. **Presenter** of the paper: “A Detailed Simulation Study of Geographic Random Forwarding (GeRaF) in Wireless Sensor Networks”
- **Summer School on Wireless Sensor Networks**, Schloss Dagstuhl, Germany, September 2005

Scientific Activity

Present – Underwater Acoustic Networks

When sensor networks are used for underwater data sensing and delivery, further research challenges unveil. Presently, the technology of choice when it comes to transmitting signals underwater involves the use of sound. Radio signals attenuate too fast, and optical signals can be profitably employed only at very small distances due to scattering losses that increase very rapidly with distance. Acoustic transmissions, instead, feature a typically much longer reach (on the order of hundreds of meters to some kilometers, which are the distances of interest in many scenarios), but achieve such ranges at the price of a much lower bit rate than in terrestrial radio systems.

Acoustic channels exhibit different propagation characteristics, with respect to terrestrial radio links: the noise (thermal or acoustic, e.g., generated by surface wind and shipping activities) is not white, the attenuation depends on frequency and, as a combined effect, the optimal communication frequency decreases and the available communication bandwidth shrinks with increasing distance. In addition, there is a substantial difference between a horizontal and a vertical propagation channel. Horizontal shallow water channels are characterized by harsher fading phenomena and faster channel variations than deep water vertical channels. Not least, acoustic waves propagate at a speed of 1.500 m/s, which is mildly variable with increasing depth. This translates into larger times for any message to reach its recipient.

Standard packet radio access methods do not perform well underwater, because of both the large propagation times and the harsher channel conditions. The design of new protocols that account for (and possibly exploit) the features of underwater channels, as well as a performance comparison of currently available approaches is part of my current research aims. I am also collaborating in the definition of synthetic channel models for the underwater acoustic channel, with the aim of including such models into simulation software, which is usually required to perform long simulation runs, and thus requires an accurate yet simple physical layer model. This activity includes comparing the performance of underwater networks using synthetic or empirical channel models with the performance obtained using precise models (e.g., based on acoustic ray tracing), in order to understand which model is most accurate, and for which values of the most important environmental parameters. Finally, I am supervising several activities in the field of simulation and experimentation, with the aim to obtain two fundamental objects for underwater networking research: a simulation tool that accounts for the environment in a sufficiently realistic way, and a testbed framework that reuses the simulation code and runs it on actual underwater modems.

Part of my research activity in underwater networks included a 6 months stay at the Massachusetts Institute of Technology, Cambridge, MA, under the supervision of Milica Stojanovic, an esteemed expert in the field of underwater communications, working on the assessment of the tradeoff between network metrics when using different communication strategies. I also spent some months at the NATO Undersea Research Centre (NURC), La Spezia, Italy, under the supervision of Kim McCoy, whose experience in the organization of at-sea trials allowed me to gain expertise in the topic. At NURC, I worked on an energy detection and feature extractor algorithm for a specific waveform (called JANUS), which has been proposed as an open standard for unsolicited broadcasting and beaconing.

Finally, the close cooperation with the partners of the several research projects I am involved in helped create a network of contacts and provided the natural source of many shorter-time collaborations.

Past – Ad hoc networks with multiple antennas

Ad hoc networks are unattended, non-administered networks of wireless terminals. This requires them to independently set up communications, organize themselves independently and autonomously cope with connectivity issues that may arise. Due to limited coverage, packets may also need cooperation among nodes, e.g., in the form of multi-hop packet relaying.

Besides designing more efficient protocols, a recent research thrust is moving toward the creation of specific solutions for terminals with multiple antennas. Such a technological difference may have a strong impact, as

it would allow to exploit beamforming techniques in order to focus radiated energy, null signals coming from a given direction, or resort to the more complex signal processing techniques at the base of MIMO systems.

In particular, with MIMO systems, spatial multiplexing/demultiplexing algorithms could allow to dramatically improve the reuse factor of the network, offering greater instantaneous throughput, provided a good means is available to understand which signals carry wanted data and which do not. Exploring the tradeoff among the additional complexity required by additional MIMO processing and further achievable advantages, and devising smart protocols for handling MIMO communications in ad hoc networks was part of my research interests. I was also dealing with the characterization of the interaction between such typical physical layer parameters as the training sequence length (which affects channel estimation accuracy) and Medium Access Control (MAC)-level as well as upper-level network performance.

Past – Wireless Sensor Networks

The field of seamless data gathering through autonomous networks of wireless sensors is currently reporting a great amount of interest. Wireless Sensor Networks are a specific kind of ad hoc networks, in that sensors are smaller, if not tiny objects, much more constrained in terms of available energy, processing capabilities, radio communication speed and coverage. The design of protocols that allow for efficient communication, reliable data delivery, energy savings and bounded end-to-end delays are one of the greatest challenges.

My main focus in this topic has been on geographic forwarding. He considered the Geographic Random Forwarding (GeRaF) algorithm via Markov modeling and renewal analysis, collaborated to simulations of this protocol, and extended to improve the effectiveness of relay choices. He also collaborated to the design of efficient methods to route around connectivity holes without building a planar network graph, and designing fast ways to handle contentions among multiple relays are my main research focus in this area. These activities led to the definition of a new protocol, called ALBA-R (Adaptive Load-Balancing Algorithm – Rainbow) that effectively distributes traffic in the network while guaranteeing geographic advancement and, when required, routing around connectivity holes in a seamless and efficient way.

As part of the research efforts toward the integration of (even tiny) networkable objects into the “Internet of Things”, I worked within projects aiming at defining network structures, protocols, applications, interfaces and software that will help realize the vision of anywhere-anytime-anything internetworking. One of these projects, WISE-WAI (see section “Activity within national and international projects”), specifically aimed at setting up a large-scale network and at demonstrating that advanced applications and interactions are in fact feasible and realizable in a practical fashion. The project, for which I was appointed Technical Project Manager, was successfully completed at the beginning of 2011, and output a number of theoretical and practical results, from new protocols to a complete communications stack for wireless networks of constrained objects. In addition, an installation of 350 nodes spanning several areas of the Department was completed, along with all the tools necessary to program, maintain, log and retrieve data from the network.

Publications

Journal Papers (from most recent)

1. P. Casari, C. Tapparello, F. Guerra, F. Favaro, I. Calabrese, G. Toso, S. Azad, R. Masiero, M. Zorzi, "Open-source Suites for the Underwater Networking Community: WOSS and DESERT Underwater," submitted to the *IEEE Network magazine Special Issue on Open Source for Networking: Development and Experimentation [2013]*.
2. S. Azad, P. Casari, M. Zorzi, "L-CROP: Multi-path Routing with Limited Cross-Path Interference in Underwater Networks," submitted to the *IEEE Wireless Communications Letters [2013]*.
3. B. Tomasi, P. Casari, L. Badia, M. Zorzi, "A Study of Incremental Redundancy Hybrid ARQ over Markov Models for Underwater Acoustic Communications," submitted to the *IEEE Transactions on Wireless Communications [2013]*.
4. C. Petrioli, M. Nati, P. Casari, S. Basagni, M. Zorzi, "ALBA-R: Load-Balancing Geographic Routing Around Connectivity Holes in Wireless Sensor Networks," *IEEE Transactions on Parallel and Distributed Systems*, vol. 24, no. 3, Mar. 2014, pp. 529-539 [in press]. Online-first version, DOI: 10.1109/TPDS.2013.60.
5. B. Tomasi, G. Toso, P. Casari, M. Zorzi, "On the Impact of Time-varying Underwater Acoustic Channels on the Performance of Routing Protocols," *IEEE Journal of Oceanic Engineering, S.I. "Underwater Communications – Part I*," vol.38, no. 4, Oct. 2013, pp. 771-783.
6. S. Azad, P. Casari, M. Zorzi, "The Underwater Selective Repeat Error Control Protocol for Multiuser Acoustic Networks: Design and Parameter Optimization," *IEEE Transactions on Wireless Communications*, vol. 12, no. 10, Oct. 2013, pp. 4966-4877.
7. K. Stamatiou, P. Casari, M. Zorzi, "The Throughput of Underwater Networks: Analysis and Validation using a Ray Tracing Simulator," *IEEE Transactions on Wireless Communications*, vol. 12, no. 3, Mar. 2013, pp. 1108-1117.
8. N. Bui, A. Castellani, P. Casari, M. Zorzi, "The Internet of Energy: A Web-enabled Smart Grid system," *IEEE Network*, vol. 26, no. 4, pp. 39-45, July 2012.
9. P. Casari, M. Zorzi, "Protocol Design Issues in Underwater Acoustic Networks," *Elsevier Computer Communications Journal*, vol. 34, no. 17, Nov. 2011, pp. 2013-2025.
10. P. Casari, M. Nati, C. Petrioli, M. Zorzi, "A Detailed Analytical and Simulation Study of Geographic Random Forwarding," *Wiley Wireless Communications and Mobile Computing*, vol. 13, no. 10, pp. 916-934, 2013.
11. D. Chiarotto, P. Casari and M. Zorzi, "On the Impact of Channel Estimation Errors on MAC Protocols for MIMO Ad Hoc Networks," *IEEE Transactions on Wireless Communications*, vol. 9, no. 10, pp. 3290-3300, Oct. 2010.
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1. C. C. Tsimenidis, Y. Zakharov, C. Laot, K. Pelekanakis, P. Casari, and A. K. Morozov, "Underwater Communications and Networking," Editorial paper for a special issue of the *Hindawi Journal of Electrical and Computer Engineering*. [doi:10.1155/2012/214012].

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1. G. Toso, R. Masiero, P. Casari, O. Kebkal, M. Komar, M. Zorzi, "A Master/Slave Approach to Command Acoustic Modems during Underwater Networking Sea Trials," **demo presented at ACM WUWNet**, Los Angeles, CA, Nov. 2012.
2. F. Favaro, S. Azad, P. Casari, M. Zorzi, "On the Performance of Unsynchronized Distributed MAC Protocols in Deep Water Acoustic Networks," *WUWNet 2011*, Seattle, WA. **Extended poster abstract** pubblicato nei proceedings della conferenza.
3. P. Casari, M. Nati, C. Petrioli, and M. Zorzi, "Geographic Forwarding and Adaptive Load Balancing in Wireless Sensor Networks," *MOBICOM 2006*, Los Angeles, CA. **Extended poster abstract** pubblicato in *ACM Mobile Computing and Communications Review*, vol. 11, no. 2, pp. 53-54.

Community involvement

- **2012: Guest editor** of a special issue of the Hindawi Journal of Electrical and Computer Engineering on “Underwater Communications and Networking”.
- **Participant** in the definition of the NATO Standard JANUS for open, unsolicited broadcast communication and beaconing
- **Technical Program Committee Member**
 - ✓ ACM WUWNet 2013
 - ✓ IEEE IWCLD 2013
 - ✓ ACM WUWNet 2012
 - ✓ IEEE MASS 2012
 - ✓ IEEE IWCLD 2011
 - ✓ European Wireless 2009
 - ✓ IEEE IWCLD 2009
 - ✓ IEEE GlobeCom 2007
- **Publicity co-chair**
 - ✓ ACM WUWNet 2010
- **Session chair:** OCEANS 2008, OCEANS 2009, OCEANS 2010, WUWNet 2010, OCEANS 2011
- **Project proposal reviewer** for the Qatar National Research Fund’s National Priorities Research Program (2009 through 2013)
- **Reviewer for International Conferences and Symposia:**
 - ✓ IEEE WCNC, IEEE ICC, IEEE PIMRC, IEEE/VTS VTC, IEEE GlobeCom, IEEE ISWCS, IEEE MilCom, IEEE WONS, IEEE IWCMC, EWSN, ACM IWCNC, IEEE IWCLD, European Wireless, ACM MobiCom, ACM MobiHoc, IEEE InfoCom, IEEE OCEANS, ACM WUWNet.
- **Reviewer for International Journals:**
 - ✓ IEEE Transactions on Communications, IEEE Transactions on Wireless Communications, IEEE Transactions on Mobile Computing, IEEE Transactions on Vehicular Technology, IEEE Transactions on Networking, IEEE Journal on Selected Areas in Communications (various issues on different topics), IEEE Journal of Oceanic Engineering, IEEE Communications Magazine, IEEE Communication Letters, IEEE Wireless Communications Letters, IEEE Wireless Communications Magazine, ACM Mobile Networks and Applications, ACM Wireless Networks, ACM Mobile Computing and Communications Review, Elsevier Ad Hoc Networks, Wiley Journal of Wireless Communications and Mobile Computing

Languages

- **Italian:** native speaker
- **English:** fluent speaking and writing
- **French:** basic knowledge (both spoken and written)
- **Spanish:** basic knowledge (both spoken and written)

Activity within national and international projects

This section details the main national and international research efforts where I collaborated to carry out one or more of the following:

- Autonomous and/or coordinated research activity
- Project proposal writing and organization
- Deliverable and report writing
- Technical Management
- Administration

The projects and activities listed below span a period from 2005 to date, in chronological order.

Space-Time Processing for Tactical Mobile Ad Hoc Networks

This project was funded by a MURI grant, and aimed at considering the application of space-time digital signal processing to next generation ad hoc networks. Such techniques, can boost the communication capabilities of ad hoc terminals, achieving higher throughput, which directly translates into better situational awareness for all applications that require real time field data.

The project brought together a blend of different skills, focused on different levels of the network stack, such that the interaction and exchange of ideas could boost the research on ad hoc networking towards next generation wireless networks. Within this framework, my main activity has been focused on the design of networking protocols for MIMO ad hoc networks, with a particular emphasis on MAC and routing protocols.

WiSeNts

The **Wireless Sensor Networks and Embedded Cooperating Objects (WiSeNts)** project was a European Commission-funded Cooperation Action, aimed at investigating communication paradigms and solution for future embedded networks of smart objects.

Part of the efforts on Wireless Sensor Networks (WSNs) were directed toward the creation of small objects, integrating sensing, processing, and wireless communication capabilities. Since the literature on WSNs was rapidly growing, the WiSeNts project aimed at constructing a taxonomy and classification of current approaches for radio channel access and data forwarding. This first step was then used as a starting point for a further objective: devising strategies, protocols and solutions for larger networks, made of smaller elements, like sensors, actuators, communication hubs, etc., which have to coordinate, communicate, and ultimately join forces to accomplish a more complex task. I contributed to all these activities with my research on geographic forwarding strategies.

Acoustic Communication Networks for Distributed Autonomous Platforms

This project was funded through NOAA's Sea Grant College Program, and aimed at defining techniques for realizing wireless acoustic networking in underwater environments. Part of the project was aimed at designing and building a novel Autonomous Underwater Vehicle (AUV) that was sufficiently easy to handle and deploy and allows to build a network of underwater mobile nodes with lower investments than currently required by off-the-shelf AUVs.

Another part of the project is devoted to the design and implementation of signal processing techniques and protocols for allowing reliable, high-data rate acoustic communications. The performance characterization of underwater environment-specific communication techniques and the preliminary study of channel access protocol that employ such techniques were the subject of my exchange program at the Massachusetts Institute of Technology (MIT), where I was on leave from February to August 2007.

WISE-WAI

(Wireless Sensor networks for city-Wide Ambient Intelligence)

This project was funded by Fondazione Cassa di Risparmio di Padova e Rovigo, an Italian foundation. The project aimed at advancing technology in the field of wireless sensor networks (WSNs), by providing a campus-wide network as the first step toward city-wide testbeds supporting advanced ambient intelligence applications. One of the first objectives of the project is to demonstrate the feasibility of large WSNs, by providing object localization and tracking services, aided navigation, and environmental control through periodic monitoring. As such, the project had a key role in demonstrating the practicality and feasibility of such concepts as the Internet of Things.

The network that has been deployed within the project is among the few in the world to cover such a large area and to provide similar advanced services. I have been appointed Technical Project Manager for the WISE-WAI project and, among other activities, I participated to the design and development of the protocol stack for the network, as well as to the deployment of the network itself.

Networking infrastructure for collaborating autonomous underwater vehicles (AUVs)

This project has stemmed from the collaboration between the University of Padova and the NATO Undersea Research Centre (NURC), La Spezia, Italy. The main thrust behind the project was an increasing interest in allowing complex systems of autonomous, heterogeneous nodes to collaborate towards a common task in the marine environment. The project aims at demonstrating that such nodes can satisfy application requirements (e.g., in terms of the accuracy in sensing a specific phenomenon/event) while collaborating and exchanging information with other mobile and fixed nodes (such as bottom-mounted sensors) as well as gateway nodes (such as buoys bridging acoustic communications underwater with radio communications in the air).

The concept and solutions developed within this project will find their main application in maritime/coastal surveillance tasks, as well as in the protection of surface vessels against such threats as sea piracy. I collaborated through the definition of metrics for protocol evaluation, through the design and evaluation of channel access schemes, and through specific activities related to the use of the JANUS protocol and to the design and test of a receiver for JANUS signals.

CoLIaborative eMbedded networks for submarine surveillance (CLAM)

The CLAM project was completed at the end of October 2013. CLAM aimed at developing a collaborative embedded monitoring and control platform for submarine surveillance by combining acoustic sensor technology and 1D, 2D, 3D sensor arrays, underwater wireless sensor networks protocol design, advanced techniques for acoustic communication, new solutions for collaborative situation-aware reasoning and distributed data and signal processing and control for horizontal and vertical sensor arrays. The main operational target of the project is wireless underwater pipeline monitoring. My specific tasks within the project concern PHY-aware, cross-layer MAC/routing protocol design for underwater networks. The final CLAM experiment took place in the Trondheim fjord, in Norway, in May 2013, and successfully demonstrated a working network including both mobile and static devices, capable of transferring environmental and equipment monitoring data over multiple hops.

NAUTILUS

The “Network Architecture and protocols for Underwater Telerobotics via acoustic Links in Ubiquitous Sensing, monitoring and explorations” (NAUTILUS) project also stems from the great interest in monitoring the oceans, and focuses in particular on creating a flexible and dependable networking infrastructure for teleoperation of Autonomous Underwater Vehicles (AUVs), with the objective of ensuring a predictable behavior over the course of time in spite of the unpredictable nature of the underwater environment, adapting system response as events unfold. Key outcomes of NAUTILUS include detailed studies of protocol design and optimizations for underwater networks, novel simulation tools that capture the specific features of acoustic propagation, as well as experimental activities for demonstrating and testing the proposed solutions.

Other than conducting independent and team research, I was the technical manager of NAUTILUS. In the project, several small and large sea trials were organized, both independently and in conjunction with other projects, partners and institutions. The final trial, in particular, was organized in the scope of the CommsNet'13 trial, jointly performed by the NATO CMRE (formerly NURC) in conjunction with the University of Padova and several other international partners.

RACUN

RACUN (short for Robust Acoustic Communications in wireless Underwater Networks) is a research effort funded by the European Defense Agency (EDA). The project gathers several European companies and research institutions, and has the objective to demonstrate that fast, possibly secure underwater acoustic communications are a viable options for coastal surveillance, mine countermeasures and submarine movement detection and tracking. The specific task of the research group at the University of Padova is to study the impact of the channel on communications, and to design communication protocols for single- and multi-hop communications in static, mobile and hybrid networks. This is performed both via simulations and with the implementation of proof-of-concept demonstrators.

References

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Mainly for a personal disposition, but also for the wide scope of the activities in my research group, I have been able to supervise and collaborate with several people during my academic experience so far. This included teaching, problem solving, collaborative research, work sharing and teamwork in general.

I believe that the capability to build and profitably supervise a research group is a prominent trait of a full-rounded researcher. If an opinion about my proficiency in doing so is sought, Prof. Michele Zorzi has made himself available to provide specific details about this aspect.

Further references are available upon request.

I give my consent that the information contained in this CV be used for selection procedures, in compliance with the current national and international laws.

Faithfully,



Padova, Italy – February 05, 2014