Guest Editorial: Special Collection of Papers Arising From UComms14

From time to time, the IEEE JOURNAL OF OCEANIC ENGINEERING publishes Special Collections of papers to highlight specific areas of research. This issue showcases selected papers arising out of the Underwater Communications and Networking Conference held in Sestri Levante, Italy, September 3–5, 2014 (UComms14), second in a series of focused meetings intended to bring the best in the field together to present, discuss, and review the state of the art.

The first such meeting was held in 2012, and resulted in a Special Issue of the JOURNAL the following year (vol. 38, no. 4, Oct. 2013). This second collection continues the pattern, and we are pleased to offer a selection of eight diverse papers. Their topics span from physical-layer issues to higher layer considerations such as adaptive power strategies and scheduling to optimize channel throughput, clock synchronisation, and network simulation using physical-layer replay.

The first three papers address physical-layer issues. In "Performance analysis and optimal design of multichannel equalizer for underwater acoustic communications," Pajovic and Preisig discuss single-carrier broadband systems, offering an insight into the choice of equalizer filter length, as well as the number and separation of receiver elements. Equalization is further addressed in "Robust equalization of mobile underwater acoustic channels," where Pelekanakis and Chitre propose a sparse channel estimation procedure for equalization in the presence of non-Gaussian impulsive noise. Fundamental capacity issues, and their implications on a practical system design based on multicarrier modulation, are addressed by Aval *et al.* in "On the achievable rate of a class of acoustic channels and practical power allocation strategies for OFDM systems."

Issues related to the measurement, modeling, and simulation of acoustic channels are the subject of "Parametric replay-based simulation of underwater acoustic communication channels," by Socheleau *et al.*, in which they develop an acoustic channel simulator based on experimental measurements and their stochastic perturbations. Then, "Measurements and modeling of effects of out-of-plane reverberation on the power delay profile for underwater acoustic channels," by Jenserud and Ivansson considers some 3-D effects of acoustic propagation.

The last three papers deal with network-level issues. Otnes *et al.* explore a hybrid approach (lying between pure simulation and direct physical measurement) to network performance estimation in "Underwater acoustic network simulation with lookup tables from physical-layer replay." Vermeij and Munafò present a technique for synchronizing clocks in "A robust, opportunistic clock synchronization algorithm for *ad hoc* underwater acoustic networks," and some theoretical considerations for achieving high throughput in a grid network with long propagation delay are presented in "Throughput-maximizing transmission schedules for underwater acoustic multihop grid networks" by Lmai *et al.*

Underwater communications is currently entering a new phase of energetic exploration and application. With the rise in interest and maturity of autonomous vehicles, both underwater and on the sea surface, there has come the possibility of operating these vehicles in teams, rather than as stand-alone systems that are targeted by a detailed mission plan scripted at the outset of their deployment. Genuinely adaptive autonomous vehicles, acting in concert within a team of (possibly heterogeneous) partners, open up exciting and powerful opportunities including increased navigational accuracy, faster and better search and localization, wider sensing apertures, and increased resolution of environmental sensing, to name a few. However, all these collaborative benefits can only be achieved if team members can communicate with each other. Given the inherently low bandwidth and poor reliability of underwater communication links, underwater vehicles will need to be much more intelligent and autonomous than their aerial counterparts. They will adapt and maneuver in unplanned ways, so the communication networks that support them must be *ad hoc* and adaptable, rather than dependent on a top–down master plan.

The current challenge in underwater communications is therefore not only to design physical-layer coding schemes that are efficient and robust (though this still remains a substantial and important task), but to be able to construct *ad hoc* communication networks, with attendant medium access control (MAC) and higher level protocols that are both flexible and robust to the many severe challenges inherent in underwater communication.

This challenge will not be met by the existing paradigm of vertically stovepiped dedicated modems with proprietary operating systems from each of the handful of manufacturers in the marketplace. Collaborative *ad hoc* networks require modems from different suppliers to be able to talk to each other. Communication systems will require hybrid physical layers, switching from acoustic to optical to perhaps radio or magnetic means, as appropriate to the bandwidth, transmission distance, and other needs of the application. To achieve these goals, unification and consolidation of the technological marketplace is necessary. Just as for personal computing and the Internet, a standardization of communication protocols and a shift to software-defined systems will be necessary to harness the technological power at hand. Selecting and agreeing standards is a tough task that, if good choices are to be made, must be supported by the best performance characterization of candidate technologies. The papers in this special selection strive toward that goal. This is indeed an exciting point for this field, as we approach the dawning of the Internet of Underwater Things.

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Digital Object Identifier 10.1109/JOE.2015.2476595

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He worked for a while in Italy on acoustic propagation fluctuations, then sailed across the Atlantic to San Diego, CA, USA, to work at Scripps Institution of Oceanography on ambient noise imaging and marine mammal acoustics. In 1995, he sailed to Singapore where he founded the Acoustic Research Laboratory (ARL) as part of the Tropical Marine Science Institute (TMSI). He was Head of the ARL and Associate Director of the TMSI for 12 years, working on passive imaging, marine mammals, distributed autonomous intelligent sensing, underwater communications networking, and cooperative behavior. In 2004–2005, he sailed with his family around the Indian Ocean on a sponsored voyage of research, public outreach, and education to draw attention to the urgent need to become better custodians of our fragile planet. Returning to Italy in 2007, he led a team to develop underwater communications and networking, leading to an underwater internet for robots, and is now working on strategic development for the NATO Science & Technology Organization (STO) Centre for Maritime Research & Experimentation (CMRE), La Spezia, Italy.

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Mandar Chitre (M'03–SM'11) received the B.Eng. (honors) and M.Eng. degrees in electrical engineering from the National University of Singapore (NUS), Singapore, in 1997 and 2000, respectively, and the M.Sc. degree in bioinformatics and the Ph.D. degree from the Nanyang Technological University (NTU), Singapore, in 2004, and 2006, respectively.

From 1997 to 1998, he worked with the Acoustic Research Laboratory (ARL), NUS, as a Research Engineer. From 1998 to 2002, he headed the technology division of a regional telecommunications solutions company. In 2003, he rejoined ARL, initially as the Deputy Head (Research) and is now the Head of the laboratory. He also holds a joint appointment with the Department of Electrical & Computer Engineering at NUS as an Assistant Professor. His current research interests are underwater communications, autonomous underwater vehicles, and underwater signal processing.

Dr. Chitre has served on the technical program committees of the IEEE OCEANS, WUWNet, Defense Technology Asia (DTA), and Water Side Security (WSS) conferences and has served as reviewer for many international journals. He was the chairman of the student poster committee for the 2006 IEEE OCEANS Conference in Singapore. In the past years, he has served as the Vice Chairman, Secretary, and Treasurer for the IEEE Oceanic Engineering Society (Singapore chapter) and is currently the IEEE Technology Committee Co-Chair of Underwater Communication, Navigation & Positioning. He also serves as a Technical Co-Chair for the IEEE 2012 International Conference on Communication Systems (ICCS).