UNDERWATER WIRELESS COMMUNICATIONS AND NETWORKS: THEORY AND APPLICATION: PART 1


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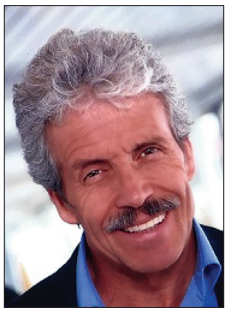
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The Earth is a water planet, two-thirds of which is covered by water. With the rapid developments in technology, underwater communications has become a fast growing field, with broad applications in commercial and military water based systems. The need for underwater wireless communications exists in applications such as remote control in the off-shore oil industry, pollution monitoring in environmental systems, collection of scientific data from ocean-bottom stations, disaster detection and early warning, national security and defense (intrusion detection and underwater surveillance), as well as new resource discovery. Thus, the research of new underwater wireless communication techniques has played the most important role in the exploration of oceans and other aquatic environments. In contrast with terrestrial wireless radio communications, the communication channels in underwater wireless networks can be seriously affected by the marine environment, by noise, and by limited bandwidth and power resources, and by the harsh underwater ambient conditions. Hence, the underwater communication channel often exhibits severe attenuation, multipath effect, frequency dispersion, and constrained bandwidth and power resources, etc., which turn the underwater communication channel into one of the most complex and harsh wireless channels in nature. When facing these unique conditions in diverse underwater applications, many new challenges, which were not encountered in terrestrial wireless communications, are emerging in underwater acoustic, optical, and RF communications for future underwater wireless networks. Of these challenges, acoustic and optical are the most compelling, and somewhat complementary, owing to the potential for longer range and high bandwidth networked communications in size- and power-constrained modems and unmanned systems.

Inspired by the attractive and unique features and potential benefits of advanced underwater communications, the topic of underwater wireless networks has attracted increasing attention from researchers not only in academia, but also in the military and industrial sectors. While a great deal of research efforts have been made in recent years to underwater wireless networks, the aforementioned challenges posed by underwater acoustic as well as optical wireless channel exploitation in future underwater wireless system developments still remain an open problem. As we are launching the first Feature Topic of *IEEE Communications Magazine* focusing on underwater wireless communications and networking, we aim at addressing the urgent needs in both theory and application aspects by industry, military, and the research community in order to better understand the recent progress, explore the future potential research directions, and define new research paradigms in underwater wireless communications and networks. The response to our Call for Papers on this Feature Topic was overwhelming, with a total of 52 articles submitted from all around the world. Going through the rigorous two-round review process, Part 1 of this Feature Topic contains eight excellent articles focusing on the key issues and emerging concepts of contemporaneous underwater wireless networks and techniques.

The first article, "Realizing Underwater Communication through Magnetic Induction," introduces the magnetic induction as a new alternative communication paradigm tackling the high propagation-delay, low data-rates, and highly environment-dependent underwater wireless communications and networks. The second article, "Undersea Laser Communication with Narrow Beams," demonstrates the two main advantages of narrow-beam optical communication: increased power throughput and decreased temporal spread using Monte Carlo analysis under the undersea scattering environment. The third article, "Security and Privacy in Localization for Underwater Sensor Networks," addresses the security and privacy issues in underwater localization by proposing their schemes

against the attacks and investigating the techniques for privacy preservation during the localization process. The fourth article, "Software-defined Underwater Acoustic Networks: Towards a High-rate Real-time Reconfigurable Modem," investigates adopting the software-defined radio principles in underwater acoustic networks and proposes and analyzes the software-defined acoustic modem prototype. The fifth article, "Routing Protocols for Underwater Wireless Sensor Networks," overviews the existing routing protocols in under-water-sensor-networks through classifying them into two categories based on a route decision maker, and investigates and compares their various performance issues. The sixth article, "Turbo Equalization for Single-Carrier Underwater Acoustic Communications," investigates the time- and frequency-domain Turbo equalization schemes with low-complexity for MIMO Single-Carrier Modulation systems in underwater acoustic communications infrastructure. The seventh article, "Structured Sparse Methods for Active Ocean Observation Systems with Communication Constraints," presents an ocean monitoring infrastructure with multiple mobile/static acoustic sensors for field reconstruction, target tracking, and exploration-exploitation. The eighth article, "Underwater Sensor Networks: A New Challenge for Opportunistic Routing Protocols," proposes the promising opportunistic-routing protocols for underwater wireless sensor networks by employing dynamic-relay schemes to overcome bandwidth, reliability, and propagation-delay constraints.

We would like to thank all the authors for their excellent contributions and all the reviewers for their valuable reviewing comments. We also appreciate strong supports from Dr. Sean Moore, the former Editor-in-Chief, and Dr. Osman Gebizlioglu, the current Editor-in-Chief of *IEEE Communications Magazine*, and the IEEE Publications team. Finally, we hope that the readers find this Feature Topic interesting and stay tuned for new developments in this research area and Part II of this feature topic in February 2016.

BIOGRAPHIES

XI ZHANG received his Ph.D. degree from The University of Michigan. He is a Full Professor at Texas A&M University, has published over 300 research papers, received U.S. NSF CAREER Award in 2004, is IEEE Distinguished Lecturer, and received four IEEE Best Paper Awards. He is author of an IEEE BEST READINGS journal paper. He has been Editors for numerous IEEE Transactions/Journals, TPC Chair for IEEE GLOBECOM 2011, and TPC Vice-Chair for IEEE INFOCOM 2010.

JUN-HONG CUI received her Ph.D. degree from UCLA in 2003. She is now a Full Professor at the University of Connecticut. Her recent research mainly focuses on underwater sensor networks, autonomous underwater vehicle networks, cyber-aquatic systems, smart ocean technology and ocean computing. Jun-Hong co-founded ACM WUWNet (International Conference on Underwater Networks and Systems), and is now serving as its steering committee chair. She was the recipient of NSF CAREER Award and ONR Young Investigator Award.

SANTANU DAS is the Program Manager of Communications and Networking program within the C4ISR Dept. of Office of Naval Research, where he has broad responsibility for planning, executing and providing leadership for integrated Science & technology projects to develop new capabilities for Naval communication networks. He received a Ph.D. in Electrical Engineering from University of Alberta, Edmonton, Canada and conducted research at AT&T Bell Labs, Whippany, NJ in areas of 3G-wireless and fiber-optic communications.

MARIO GERLA [F'92] received the Ph.D. degree from UCLA. He was part of the team that developed the early ARPANET protocols under the guidance of Prof. Leonard Kleinrock. He joined the UCLA Computer Science Dept. in 1976. He is leading several advanced wireless network projects under Industry and Government funding. His team is developing a Vehicular Testbed for safe navigation, content distribution, urban sensing and intelligent transport.

MANDAR CHITRE received holds a Ph.D. degree in electrical engineering via research in underwater acoustic communications. He currently holds a joint appointment with the Department of Electrical and Computer Engineering at the National University of Singapore as an Assistant Professor and with the Tropical Marine Science Institute as the Head of the Acoustic Research Laboratory. His current research interests include underwater communications, autonomous underwater vehicles, and acoustic signal processing.