



WUWNET 2017

The 12th ACM International Conference on Underwater
Networks & Systems



November 6 – 8, 2017
Halifax, Canada
<http://www.wuwnet.org>

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About WUWNet

The oceans cover 71% of the Earth's surface and represent one of the least explored frontiers; yet, the oceans are integral to climate regulation, nutrient production, oil retrieval, and transportation. Also, water systems in general are of vital importance to life on Earth and commerce. For these reasons, there is significant interest in monitoring aquatic environments for scientific, environmental, commercial, safety, and military purposes.

WUWNet is the premier venue for research and development bringing real-time, in-situ sensing and actuation to this aquatic world. The goal of this conference is to bring together researchers and practitioners in areas relevant to **underwater networks and systems**. Thus, many aspects of the networking protocol stack - from the physical layer to the application layer and the various system issues - will be represented at this conference. The objective is to serve as a forum for presenting state-of-the-art research and development, for exchanging ideas and experiences, and for facilitating interactions and collaborations.

The conference will span *three days*, including presentations of keynote speeches, plenary talks, technical papers, and posters/demos. The scope of the WUWNet conference covers a broad range of research directions relevant to *underwater networks and network-related signal processing, communications, systems, and applications*. **Specific topics of interest include, but are not limited to:**

- Underwater network and system architectures
- Efficient underwater communications (including acoustic, optical, RF, and wired, etc.), with techniques from the physical layer to the application layer
- Underwater acoustic modeling and signal processing
- Cooperative underwater communications, including, PHY, MAC, routing, and data transfer, etc.
- Networked underwater robotics and systems, such as localization, navigation, security, communication & coordination, or human operator interaction.
- Coordinated energy harvesting systems and power systems for underwater networks and systems
- Energy-efficient algorithms, and protocol design for underwater networks, as well as signal/image processing and communication systems
- Operating system and middleware support for underwater networks and systems
- Applications that broadly address underwater networks and systems, including coordinated underwater vehicles
- Modeling, simulation, and testbeds for underwater systems and platforms
- Experimental results from underwater networking, signal/image processing and communications field trials
- Application requirements for underwater networks, signal/image processing and communication systems presented by end users

Welcome to the 12th ACM International Conference on Underwater Networks and Systems (WUWNet) in Halifax, Canada.

This year marks the second time WUWNet is being held in Canada, the previous one being held in Montreal in 2007. Halifax is a major marine technology hub, and Nova Scotia has an international reputation in ocean observation. We have the highest concentration of ocean technology companies involved in acoustics, sensors and instrumentation. We are home to more than 300 ocean-related companies and 60 innovative high-tech ocean companies. The organizing committee is very excited to welcome internationally renowned scientists in the field and to also introduce our local experts in the field as well as potential employers for students. We want to thank the WUWNet steering committee and advisory board for selecting Halifax as the venue for the 12th edition. The committee has provided invaluable guidance and support towards the success of this conference.

The Technical Program Committee has selected a diverse and strong set of papers for presentation, which includes 7 full papers, 9 short papers, 7 extended abstracts as well as 5 invited contributions. To facilitate discussion, in addition to the 20-minute talks for the full and short papers, each of the extended abstracts will be given 12 minutes for oral presentation. The accepted papers cover topics ranging from underwater communication, networking, localization, synchronization, vehicles, and controls to simulators, testbeds, and application studies. Many of the papers deal with theoretical advances in underwater networks and systems, but there is a strong trend towards applied research, both in terms of testing these theories in deployed networks, and developing novel underwater systems and using them in real-life applications.

The program is divided into five different technical sessions, covering network modelling, applications and experimentation, cross-layer design, physical layer and propagation. A best student paper award will be given in memory of Giovanni Toso. Finally, we have four keynotes by world renowned scholars in the field, as well as demo sessions.

WUWNet'17 would not have been possible without the help of an exceptionally strong and engaged organizing committee, all members of which played critical roles in various stages of the conference – thank you all! We also would like to gracefully acknowledge Amirix, COVE, Geospectrum Technologies, Turbulent Research, Ultra Electronics Maritime Systems, the Faculty of Engineering at Dalhousie and particularly Springboard for financial support. We also wish to give special thanks to ACM and the ACM Special Interest Group on Mobility of Systems, Users, Data, and Computing (SIGMOBILE) for their continued support and ASC (Acoustical Society of China), for the strong promotion of our conference in the acoustic community.

We hope that you find the research presented at WUWNet 2017 inspiring and thought provoking. WUWNet has always been the premier venue for underwater networking and systems research, and we have little doubt that this will continue this year and going forward.

WUWNet'17 General Chairs



Jean-François Bousquet



Jingdong Cheng



Paul Hines (Honorary Chair)

WUWNet'17 Technical Program Committee Chairs



Stefano Basagni



Jun Liu



Fei Ji

WUWNet' 17 Program

Sunday, November 5, 2017 (DAY 0)

16:30pm – 18:30pm **Registration**

Monday, November 6, 2017 (DAY 1)

08:00am – 08:15am **Registration**

08:15am – 08:30am **Opening Remarks (15 min) (J-F Bousquet and Stefano Basagni)**

08:30am – 9:30am **Keynote Speech I (1 hour) (Session chair: Greg McKinnon, Amirix)**

“Underwater Communications: Past, Present and Future”

Speaker: Prof. Milica Stojanovic (Northeastern University)

09:30am – 09:45am **Break (Poster and Demo setup)**

09:45am – 11:50pm **Technical Session I: Network Architectures and Models**
1 invited paper [20 min], 2 full paper [40min], 1 short paper [20min], 2 Abstracts [25 min] Total: 125 min

- **CUMAC-CAM: Addressing Triple Hidden Terminal Problems for Multi-Channel Transmission in Underwater Sensor Networks [Full Paper]**
Purobi Rahman (Bangladesh University of Engineering and Technology, Bangladesh); Mohammad S Alam (Bangladesh University of Engineering and Technology, Bangladesh); Shamim Ara Shawkat (University of Tennessee, USA); Mohammad Asadul Hoque (East Tennessee State University, USA)
- **Learning to Communicate Underwater an Exploration of Limited Mobility Agents in Underwater Acoustic Sensor Networks [Short Paper]**
Steven Porretta, Evangelos Kranakis and Michel Barbeau (Carleton University, Canada); Joaquin Garcia-Alfaro (Institut Mines-Telecom, France)
- **Aqua-Sim Next Generation: An NS-3 Based Underwater Sensor Network Simulator [Full Paper]**
Robert Martin and Sanguthevar Rajasekaran (University of Connecticut, USA); Zheng Peng (City College of New York, USA)

- **Multimodal Underwater Networks: Recent Advances and a Look Ahead [Invited paper]**
Filippo Campagnaro and Roberto Francescon (University of Padova, Italy); Paolo Casari (IMDEA Networks Institute, Spain); Roei Diamant (University of Haifa, Israel); Michele Zorzi (University of Padova, Italy)
- **Performance of the Combined Free/Demand Assignment Multiple Access Protocol for Underwater Networks [Extended Abstract]**
Wael Gorma and Paul D Mitchell (University of York, United Kingdom (Great Britain))
- **Reliable Acoustic Link using Non-coherent Turbo-coded Frequency Shift Keying [Extended Abstract]**
Andrew A Dobbin and Jean-Francois Bousquet (Dalhousie University, Canada)
- **Object Tracking Using Modified Lossy Extended Kalman Filter [Invited Paper]**
Mohammadreza Alimadadi, Milica Stojanovic and Pau Closas (Northeastern University, USA)

11:50pm – 01:00pm **Lunch**

01:00pm – 02:40pm **Technical Session II: Network deployments and applications**
2 invited paper [40 min], 1 full paper [20 min],
2 short paper [40 min], Total: 100 min

- **The Barrow Strait Real Time Observatory: Under-ice Monitoring in the Canadian High Arctic [Invited Paper]**
Clark Richards (Bedford Institute of Oceanography & Fisheries and Oceans Canada, Canada)
- **Full Reconfiguration of Underwater Acoustic Networks through Low-Level Physical Layer Access [Full Paper]**
Filippo Campagnaro and Roberto Francescon (University of Padova, Italy); Oleksiy Kebkal (EvoLogics GmbH, Germany); Paolo Casari (IMDEA Networks Institute, Spain); Konstantin Kebkal (Evolomics GmbH, Germany); Michele Zorzi (Università degli Studi di Padova, Italy)
- **ECO-Friendly Underwater Acoustic Communications: Channel Availability Prediction for Avoiding Interfering Marine Mammals [Short Paper]**
Wei Cheng (Virginia Commonwealth University, USA); Yu Luo (South Dakota School of Mines and Technology, USA); Zheng Peng (City College of New York, USA); Jun-Hong Cui (University of Connecticut & Jilin University, USA)
- **Detecting Abnormal Speed of Marine Robots Using Controlled Lagrangian Particle Tracking Methods [Short Paper]**
Sungjin Cho and Fumin Zhang (Georgia Institute of Technology, USA); Catherine Edwards (Skidaway Institute of Oceanography, USA)

- **Securing Underwater Communications: Key Agreement Based on Fully Hashed MQV [Invited Paper]**

Angelo T Capossole and Chiara Petrioli (University of Rome “La Sapienza”, Italy); Daniele Spaccini (Universita degli Studi di Roma “La Sapienza”, Italy); Gabriele Saturni (Sapienza University of Rome, Italy); Daniele Venturi (University of Rome “Sapienza”, Italy)

02:40pm – 03:00pm **Coffee Break, Poster and Demo Session (20 min)**

03:00pm – 05:00pm **Tour of COVE**

06:00pm – 08:00pm **Conference Welcome Cocktail Reception**

Tuesday, November 7, 2017 (DAY 2)

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|-------------------|---|
| 07:00am – 07:50am | Registration |
| 08:30am – 9:30am | Keynote Speech II (1 hour) (Session chair: TBD)
“Physical-Layer Modeling as a Design Aid for Underwater Acoustic Communications”
Speaker: Prof. Daniel Rouseff (University of Washington) |
| 09:30 – 09:45 | Coffee Break |
| 10:00am – 11:40am | Technical Session III: Cross-layer design and software defined modems
1 invited paper [20 min], 3 full paper [60 min],
1 short paper [20 min], Total 100 min |
| | <ul style="list-style-type: none"> • A Bidirectional Multi-flow MAC Protocol for Multihop Underwater Acoustic Sensor Networks [Full Paper]
 Jenifar Rahman (Bangladesh University of Engineering and Technology, Bangladesh); Mohammad S Alam (Bangladesh University of Engineering and Technology & IICT, Bangladesh); Shamim Ara Shawkat (University of Tennessee, USA); Mohammad Asadul Hoque (East Tennessee State University, USA) • Advanced Data Processing for Communication-constrained Underwater Domain [Full Paper]
 Ibrahim Olokodana (Prairie View A & M University, USA); Yonghui Wang and Lijun Qian (Prairie View A & M University, USA) • iSonar: Software-defined Underwater Acoustic Networking for Next-generation Amphibious Smartphones [Full Paper]
 Francesco Restuccia, Emrecan Demirors and Tommaso Melodia (Northeastern University, USA) • Simultaneous Design of Underwater Acoustic Sensor and Communication Networks [Short Paper]
 Stephane Blouin (DRDC, Canada) • “Sound sources for Communications” [Invited Oral Presentation/Sponsor]
 Armstrong (Geospectrum Technologies) |
| 12:00am – 01:00pm | Lunch |

01:00pm – 02:00pm **Keynote Speech III (1 hour) (Session chair: Bruce Armstrong, GTI)**

“Underwater Acoustic Communications in the Arctic”

Speaker: Prof. Lee Freitag (Woods Hole Oceanography Inst.)

02:00pm – 03:40pm **Technical Session IV: Physical layer algorithms and devices**

1 invited paper [20 min], 1 full paper [20 min], 2 short paper [40 min], 1 extended abstract [12 min] Total 95 min

- **Effective Communications Over Doubly-Selective Acoustic Channels using Iterative Signal Cancellation [Invited paper]**
Christian Schlegel, Dmitri Truhachev, Zahra Alavizadeh and Amir Vaezi (Dalhousie University, Canada)
- **Wireless Underwater Communication via Analog OFDM Modulated Light [Extended Abstract]**
Gunther Ardelt, Martin Mackenberg, Horst Hellbrack (Luebeck University of applied Sciences, Germany);
- **A Compact Magneto-Inductive Coil Antenna Design for Underwater Communications [Short Paper]**
Ningcheng Gaoding and Jean-Francois Bousquet (Dalhousie University, Canada)
- **Entropy Minimization Based Synchronization Algorithm for Underwater Acoustic Receivers [Short Paper]**
Xiao Liu and Jean-Francois Bousquet (Dalhousie University, Canada)
- **Exploring Simulation of Software-Defined Underwater Wireless Networks [Full Paper]**
Li Wei (MTU, USA); Yuxin Tang (Shanghai Jiao Tong University, P.R. China); Yuching Cao (University of California, Los Angeles, USA); Zhaohui Wang (Michigan Technological University, USA); Mario Gerla (University of California at Los Angeles, USA)

03:40pm – 04:00pm **Break (20 min)**

04:00pm – 05:00pm **Judging of Posters and Demos**

06:00pm – 08:00pm **Conference Banquet (Presenting Best Student Paper Award)**

Wednesday, November 8, 2017 (DAY 3)

07:00am – 07:50am	Registration
08:00am – 9:00am	Keynote Speech IV (1 hour) (Session chair: Jean Quirion, UEMS) “Underwater Communications between Mobile Marine Nodes” Speaker: Prof. Mae Seto (Dalhousie University)
9:00 – 09:15am	Coffee Break, Poster and Demo Session
09:15am – 10:45am	Technical Session V: Acoustic Propagation and Noise 2 short papers [40 min], 3 abstracts [36 min], 1 invited paper [20 min] Total 95 min
	<ul style="list-style-type: none"> • Matched-field Source Localization Using Sparsely-coded Neural Network and Data-Model Mixed Training [Short Paper] Shougui Cai and Wen Xu (Zhejiang University, P.R. China) • Estimation of the Under-Ice Acoustic Field in AUV Communication Networks [Short Paper] Wensheng Sun, Chaofeng Wang, Zhaohui Wang and Min Song (Michigan Technological University, USA) • Three-dimensional ambient noise modeling [Invited Oral Presentation] Barclay (Dalhousie University)
10:15am – 10:35am	Coffee Break
	<ul style="list-style-type: none"> • Path Gain Characterization of Shallow Water Acoustic Channel: A Geometry Based Approach [Poster Paper] Farheen Fauziya, Brejesh Lall, Monika Aggarwal, Ayushi Garg and Krutika Jaiswal (Indian Institute of Technology Delhi, India) • Matched Field Source Localization as A Multiple Hypothesis Tracking Problem [Poster Paper] Qiuyun Wu and Wen Xu (Zhejiang University, P.R. China) • Measurement of a Space-Time Noise Mitigation Technique Light [Poster Paper] Afolarin Egbewande and Jean-Francois Bousquet (Dalhousie University, Canada)
11:30am – 11:40am	Closing Remarks and Adjourn
11:40am – 01:00pm	Lunch

Work-In-Progress Posters

- **Acoustic Networks for Tsunami Early Warning System [Poster Paper]**
Sandipa Singh and Lee Freitag (Woods Hole Oceanographic Institution, USA)
- **Noise Identification and Measurement Using Varying Acoustic Signal [Work In Progress Paper]**
Sadia Ahmed (University of South Florida, USA)
- **A Conflict-free Topology Discovery Protocol Based on Node ID for Underwater Acoustic Networks [Work In Progress Poster]**
Yuan Liu, Ruiqin Zhao, (Northwestern Polytechnical University, Xian, China)

Day 1: November 6, 2017

Underwater Communications: Past, Present and Future

Milica Stojanovic

Professor of electrical and computer engineering

Northeastern University

ABSTRACT:

In this presentation, we take a tour of underwater communications, scrolling through the past, present and future of key technologies, signal processing and networks. We begin by briefly summarizing the achievements of the past—those that have resulted in mature technology that is now routinely deployed in various scientific and commercial systems. We follow with observations on the more recent research efforts, touching upon the issues of channel estimation and equalization for single- and multi-carrier communication systems, acoustics and optics, system integration and networking. At present, there is no dominant application (market) that drives technology development, and the challenge to the scientific community is to continue to provide fundamental building blocks that will push the application limits. The underlying issues are closely intertwined with our major question: What is the future of underwater communications, or more importantly, what are the underwater communications of the future? We invite the audience to participate in answering this question, so if you are reading these lines, think about an item or two that you would put on a “to do” list for both the near and not-so-near future.



Milica Stojanovic graduated from the University of Belgrade, Serbia, in 1988, and received the M.S. and Ph.D. degrees in electrical engineering from Northeastern University in Boston, in 1991 and 1993. She was a Principal Scientist at the Massachusetts Institute of Technology, and in 2008 joined Northeastern University, where she is currently a Professor of electrical and computer engineering. She is also a Guest Investigator at the Woods Hole Oceanographic Institution. Her research interests include digital communications theory, statistical signal processing and wireless networks, and their applications to underwater acoustic systems. Milica is a Fellow of the IEEE, and the recipient of its Oceanic Engineering Society’s Distinguished Technical Achievement Award. She serves as an Associate Editor for the IEEE Journal of Oceanic Engineering (and in the past for Transactions on Signal Processing and Transactions on Vehicular Technology). She also serves on the Advisory Board of the IEEE Communication Letters, and chairs the IEEE Ocean Engineering Society’s Technical Committee for Underwater Communication, Navigation and Positioning.

Day 2 (AM): November 7, 2017

Physical-Layer Modeling as a Design Aid for Underwater Acoustic Communications

Daniel Rouseff

Professor and Affiliate Scientist at Applied Physics Laboratory

University of Washington

ABSTRACT:

Reliable underwater communications could be a key enabler for several important military applications: network-centric warfare with submarines as a node in the network, coordination between autonomous underwater vehicles (AUVs), data sharing between sensors involved in tracking and detection, voice communication with special forces, forwarding information to the outside world via unmanned surface vehicles (USVs), and so on. Progress towards this vision of underwater networks requires research and development on several fronts. With respect to communication using AUVs, the trend is towards acoustic modem designs featuring compact, multi-element receiving arrays.

In the present talk, it is argued that physical-layer models need not always be complicated. Relatively simple models can sometimes capture the essential physics and distill the results into a form useful for adjusting the parameters of an equalizer. Predictions for communications performance as a function of adjustable equalizer parameters are shown to match favorably with experimental results for a fixed-source, fixed-receiver scenario.



Professor **Daniel Rouseff** received a Ph.D. degree in electrical engineering from the University of Washington in 1989. Upon graduation, he joined the Senior Professional Staff at the Milton S. Eisenhower Research Center, Applied Physics Laboratory, Johns Hopkins University. In 1992, he returned to the University of Washington, where he is currently an Affiliate Scientist at that university's Applied Physics Laboratory. Since 2006, he has also been an Adjunct Research Associate Professor at Portland State University in the Department of Electrical and Computer Engineering. He has held industrial positions at Boeing, Honeywell, and ABB. He has held visiting academic positions at the Naval Research Laboratory, Washington DC,

and the Department of Applied Mathematics and Theoretical Physics, Cambridge University, Cambridge, U.K. Rouseff was Chief Scientist on the 2009 Cooperative Array Performance Experiment (CAPEx09), a joint China-USA underwater acoustics experiment. His primary technical interests are in how oceanographic variability affects underwater acoustic signal processing.

Day 2 (PM): November 7 2017

Underwater Acoustic Communications in the Arctic

Lee Freitag

*Applied Ocean Physics and Engineering Department at the Woods Hole
Oceanographic Institution*

ABSTRACT:

The effects of climate change are accelerating the loss of ice in the Arctic and as a result there is a need to understand the processes that drive the changes in ice cover and thickness, and to do so at range scales of meters to hundreds of kilometers. Further, the reduction in the amount and extent of ice has encouraged expanded tourism and industrial activities that may result in the need for under-ice exploration and survey by autonomous vehicles. Unfortunately, unlike in temperate climates, ice-cover precludes easy access to the surface for both GPS navigation and Iridium communications, thus there is a need for a replacement that will allow command and control, plus geo-referenced data collection by unmanned underwater vehicles (UUVs).

The talk will review the missions that UUVs have done and will soon do in the Arctic, present the acoustic conditions in the different environments, and show results from multiple experiments. In addition, some of the practical issues associated with traveling and working in the Arctic in Alaska, Greenland and Norway will be illustrated in photos and video.



Lee Freitag holds BS and MS degrees in Electrical Engineering from the University of Alaska, Fairbanks. He has spent his entire professional career in the Applied Ocean Physics and Engineering Department at the Woods Hole Oceanographic Institution (WHOI) where he has worked for the past 25 years. Throughout this time, he has worked on primarily on underwater acoustic communication and navigation to support ocean science, unmanned undersea vehicles and Navy submarine systems. One of his first tasks is now the Teledyne class of

acoustic modems. Subsequently he worked on acoustic tomography systems for several years, which provided exposure to long-range ocean acoustic propagation and oceanography. In the late 1990s he worked on the development of long-range acoustic communications for Navy submarine systems, and the methods developed for that project are still in use today. He manages a team of six full time engineers in the Applied Ocean Physics and Engineering Department at WHOI who focus nearly exclusively on acoustic communications and related system integration. He has participated in more than 50 scientific cruises around the world, including the Arctic Ocean north of Alaska and Svalbard.

Day 3: November 8 2017

Underwater Communications between Mobile Marine Nodes

Mae Seto

Professor of Department of Mechanical Engineering, Dalhousie University

ABSTRACT:

Communications between mobile marine nodes like unmanned underwater vehicles and unmanned surface vehicles makes it possible for them to collaborate. This means: underwater vehicles can perform submerged missions without periodic surfacing for position calibrations; UUVs can relay timely data or information (e.g. images) above-water for further prosecution; submerged nodes that are distributed far apart can communicate, the robots can cue one another to make measurements in missions that benefit from both their capabilities (e.g. surveys in progressively shallow waters, iceberg profiling). Beyond the immutable physics of underwater acoustic propagation, communications between such mobile marine nodes have challenges like Doppler shifting, proximity of the free surface, highly variable environment, simultaneously dealing with deep and shallow water communications issues, and increased ambient. This presentation discusses the impact of these challenges on marine robot collaborations that span from deeper water to the surface, discusses solutions and suggestions for future work.



Mae Seto received her Ph.D. in Mechanical Engineering from the University of British Columbia in 1996. Upon graduation she tenured her NSERC Industrial Post-Doctoral Fellowship at ISE Research Ltd. She joined Defence R&D Canada as a Defence Scientist in 2000. Her areas of expertise are in the autonomy and control of marine robots (above, on, and under water), underwater acoustics, and robotic navigation. In 2013 Dr. Seto was at MIT as a Research Scientist collaborating with the Marine Robotics Group. Dr. Seto recently became a Professor with the Dalhousie University Mechanical Engineering Dept. and is also cross-appointed to Electrical and Computer Engineering. To perform in-water validation of her research, Dr. Seto has been Chief / Principal Scientist on scientific trials all over the world including one to the Canadian Arctic and most recently, Unmanned Warrior 2016 in Scotland. She is a member of the Observation Module within the Ocean Frontiers Institute. Dr. Seto is a Past Chair of the IEEE Canadian Atlantic Section, Guest Editor for the IEEE Journal of Oceanic Engineering in Marine Vehicle Autonomy, and Chapter Chair of the IEEE Ocean Engineering Society. Her work in underwater acoustics focuses on robotic collaboration between multiple mobile and fixed underwater nodes. Specifically, devising communications solutions that are adaptive to the dynamic environment.

Sponsors



ACM brings together computing educators, researchers, and professionals to inspire dialogue, share resources, and address the field's challenges. As the world's largest computing society, ACM strengthens the profession's collective voice through strong leadership, promotion of the highest standards, and recognition of technical excellence. ACM supports the professional growth of its members by providing opportunities for life - long learning, career development, and professional networking.



AMIRIX Systems Inc. enables in-water technology collaboratively and effectively. Divisions include VEMCO, world leaders in acoustic telemetry fish tracking and monitoring equipment in fresh and saltwater environments; HTI-Vemco USA, manufacturers of hydro-acoustic fisheries research equipment; and Realtime Aquaculture, providers of sensors with a centralized hub system that enable real time continuous monitoring of open water fish farm conditions.



COVE – Centre for Ocean Ventures & Entrepreneurship is a collaborative facility for applied innovation in the ocean sector.



We love science, engineering, and design. We help our customers get the best quality sensor data possible, reliably, easily, and affordably. We are experts in underwater acoustics, real time processing, and low power embedded circuit design for long term and autonomous instrument deployments.



GeoSpectrum Technologies Inc. specializes in underwater acoustic transducers and systems. For over two decades, we have been meeting the needs of our customers as designers and manufacturers of hydrophones and sound projectors as well as consultants on the integration and testing of acoustic systems. Whether it is from our existing product line or a custom design, our experience can help you define your needs and find a transducer that best meets them.



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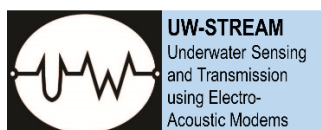


The Ocean Frontier Institute (OFI) was established in September 2016 through a partnership led by Dalhousie University, Memorial University of Newfoundland and the University of Prince Edward Island. An international hub for ocean science, OFI brings together scientists and other experts from both sides of the Northwest Atlantic to harness the vast potential of the ocean by delivering transformative research. farm conditions.

Supporters



Built on a solid 100-year foundation, the Faculty of Engineering goes beyond traditional classroom education. Our professors provide students with real-world experience through participation in faculty research projects. Such collaboration gives students the vast set of skills necessary to become leaders. We have an extensive history of educating some of the best engineers in Canada, and we intend to keep doing that for a very long time.



The UW-STREAM is an academic laboratory with research focus on design and experimentation of next generation electronics for subsea monitoring, sensing and communications.

Venue

WUWNet'17 will take place at **Prince George Hotel**, located at: **1725 Market St, Halifax, NS, Canada, B3J 3N9**. The hotel is in the downtown of Halifax, near the waterfront of the city, as shown in the map below. It is approximately 40 km from the Halifax International Airport. The rooms have been negotiated by the WUWNet committee at a preferential rate. The reduced rate is guaranteed for the conference, Phone the hotel directly at **1-800-565-1567** and ask for the "International Conference on Underwater Networks".

The major international airport in Halifax is **Halifax Stanfield International Airport**. From the airport, shuttles, and taxis are available to take you to different locations in the city.

Accommodation

As a center for finance, marine technology, history and culture in the Atlantic area of Canada, Halifax has a lot to offer. Below are some helpful resources for general tourist information:

- <http://www.novascotia.com>
- <http://www.tripadvisor.com>

Attractions

As a major seaport in Canada, Halifax has a lot to offer. Below are some helpful resources for general tourist information:

- Halifax Transportation
- Destination Halifax is the official source for visitors to Halifax NS Canada.

Famous and popular local attractions include but are not limited to:

- Peggy's Cove
- Day Trip historic tours
- Lunenburg a UNESCO World Heritage Site, National Historic District
- Winery Tours

