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Under Water Acoustic Sensor Network: Challenges and Appli-actions

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Abstract— under water acoustic sensor network is highly challenged due to various obstacles i.e power souces, loacation, current flow, tidal flow etc. In this paper I have dicused the application and the challenges for under water sensor networks. Sensor nodes can be used for data collection, pollution monitoring, tactical surveillance applications. Moreover, an Autonomous Underwater Vehicles (UUVs, AUVs), fitted with sensors, will find application in natural undersea resources and gathering of required information. Underwater acoustic networking is the enabling technology for these applications.

1 INTRODUCTION

Ocean bottom sensor nodes are deemed to enable applications for oceanographic data collection, pollution monitoring, offshore exploration, disaster prevention, assisted navigation and tactical surveillance applications. Multiple Unmanned or Autonomous Underwater Vehicles (UUVs, AUVs), equipped with underwater sensors, will also find application in exploration of natural undersea resources and gathering of scientific data in collaborative monitoring missions. To make these applications viable, there is a need to enable underwater communications among underwater devices. Underwater sensor nodes and vehicles must possess self-configuration capabilities, i.e., they must be able to coordinate their operation by exchanging configuration, location and movement information, and to relay monitored data to an onshorestation. Wireless underwater acoustic networking is the enabling technology for these applications. UnderWater Acoustic Sensor Networks (UW-ASN) consist of a variable number of sensors and vehicles that are deployed to perform collaborative monitoring tasks over a given area. To achieve this objective, sensors and vehicles self-organize in an autonomous network which can adapt to the characteristics of the ocean environment.

2.1 Disadvantage of traditional Approaches:

- **Real time monitoring is not possible**. This is critical especially in surveillance or in environmental monitoring applications such as seismic monitoring. The recorded data cannot be accessed until the instruments are recovered, which may happen several months after the beginning of the monitoring mission.
- **No interaction is possible between onshore control systems and the monitoring instruments.** This impedes any adaptive tuning of the instruments, nor is it possible to reconfigure the system after particular events occur.
- **If *failures* or *misconfigurations* occur, it may not be possible to detect them** before the instruments are recovered. This can easily lead to the complete failure of a monitoring mission.
- **The amount of data that can be recorded during the monitoring mission by every sensor is limited** by the capacity of the onboard storage devices (memories, hard disks, etc.).

2.2 Challenges in design of Under water acoustic network:

- Battery power is limited and usually batteries can not be recharged, also because solar energy cannot be exploited;
- The available bandwidth is severely limited;
- Channel characteristics, including long and variable propagation delays, multi-path and fading problems;
- High bit error rates;
- Underwater sensors are prone to failures because of fouling, corrosion, etc.

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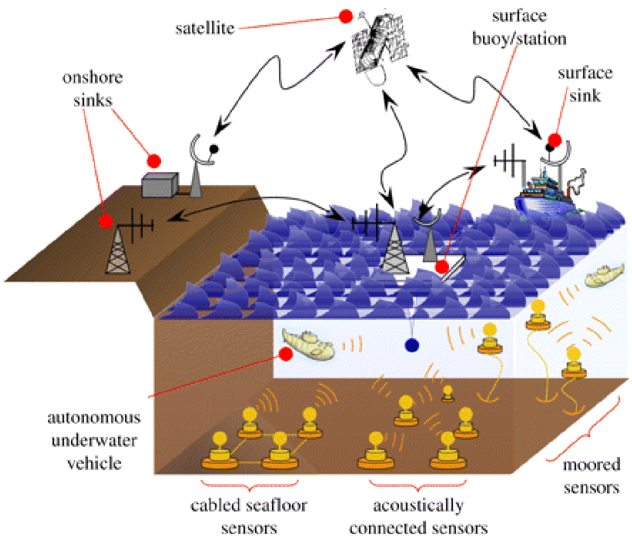
2. Underwater sensing applications:

(a)

Deployments



- **Figure 1.**
- Deployments can be cabled, fixed and moored wireless, mobile (on AUVs), and can have different links to shorefig. 1). (Online version in colour.)

(b) Application domains

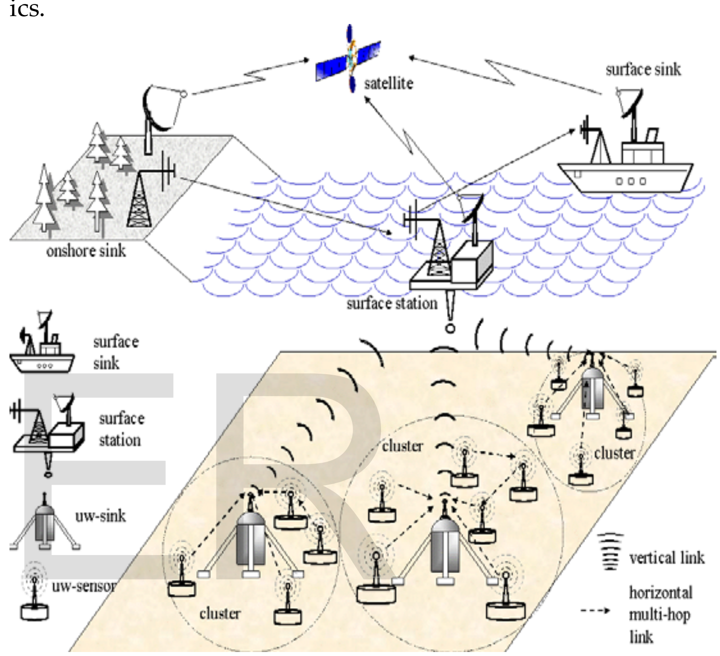
Applications of underwater networks fall into similar categories as for terrestrial sensor networks.*Scientific applications* observe the environment: from geological processes on the ocean floor, to water characteristics (temperature, salinity, oxygen levels, bacterial and other pollutant content, dissolved matter, etc.) to counting or imaging animal life (micro-organisms, fish or mammals).*Industrial applications* monitor and control commercial activities, such as underwater equipment related to oil or mineral extraction, underwater pipelines or commercial fisheries. Industrial applications often involve control and actuation components as well. *Military and homeland security applications* involve securing or monitoring port facilities or ships in foreign harbours, de-mining and communication with submarines and divers.

(c) Examples

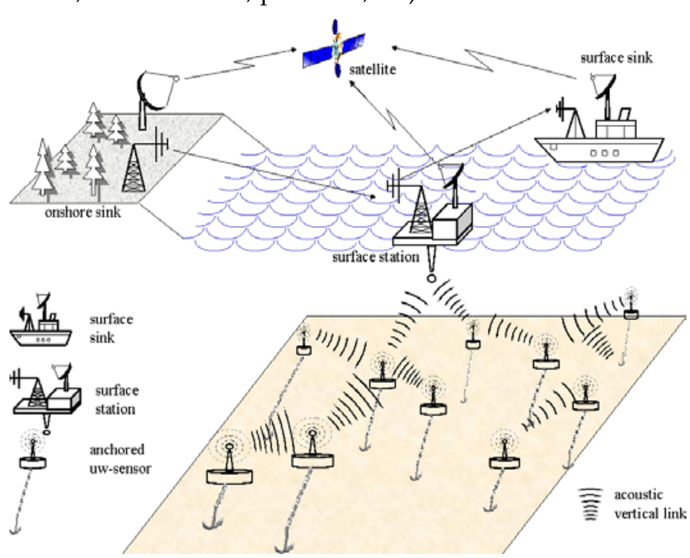
There are many short-term or experimental deployments of underwater sensing or networking; here we only describe a few representative examples. Seaweb [13] is an early example of a large deployable network for potential military applications. Its main goal was to investigate technology suitable for communication with and detection of submarines. Deployments were in coastal ocean areas for multi-day periods. Massachusetts Institute of Technology (MIT) and Australia's Commonwealth Scientific and Industrial Research Organisation explored scientific data collection with both fixed nodes and mobile autonomous robotic vehicles. Deployments have been relatively short (days),in very near shore areas of Australia and the South Pacific [3].

2.3 Network Architecture:

Two-dimensional UW-ASNs for ocean bottom monitoring. These are constituted by sensor nodes that are anchored to the bottom of the ocean. Typical applications may be environmental monitoring, or monitoring of underwater plates in tectonics.



Three-dimensional UW-ASNs for ocean column monitoring. These include networks of sensors whose depth can be controlled, and may be used forsurveillance applications or monitoring of ocean phenomena (ocean bio-geo-chemical processes, water streams, pollution, etc).



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Three-dimensional networks of Autonomous Underwater Vehicles (AUVs). These networks include fixed portions composed of anchored sensors and mobile portions constituted by autonomous vehicles.

TABLE I
AVAILABLE BANDWIDTH FOR DIFFERENT RANGES IN UW-A CHANNELS

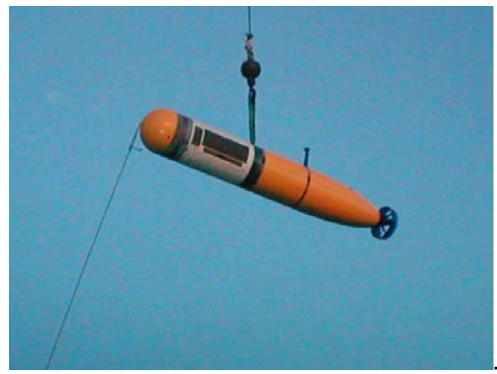
	Range [km]	Bandwidth [kHz]
Very Long	1000	< 1
Long	$10 - 100$	$2 - 5$
Medium	$1 - 10$	≈ 10
Short	$0.1 - 1$	$20 - 50$
Very Short	< 0.1	> 100

2.4 Sensor Networks with Autonomous Underwater Vehicles:

AUVs can function without tethers, cables, or remote control, and thus have a multitude of applications in oceanography, environmental monitoring, and underwater resource study. The integration and enhancement of fixed sensor networks with AUVs is an almost unexplored research area which requires new network coodination algorithms, such as:

Adaptive sampling. This includes control strategies to command the mobilevehicles to places where their data will be most useful. This approach is also known as adaptive sampling and has been proposed in pioneering monitoring missions. For example, the density of sensor nodes can be adaptivelyincreased in a given area when a higher sampling rate is needed for a given monitored phenomenon.

Self-Configuration. This includes control procedures to automatically detectconnectivity holes due to node failures and requests the intervention of an AUV. AUVs can either be used to deploy new sensors or as relay nodes to restore connectivity Below, we show some pictures of existing AUVs.



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3 CONCLUSION AND FUTURE CHALLENGES

4 Applications drive the development of underwater sensing and networking. Inexpensive computing, sensing and communications have enabled terrestrial sensor networking in the past couple of decades; we expect that cheap computing, combined with lower cost advanced acoustic technology, communication and sensing, will enable underwater sensing applications as well.

5 While research on underwater sensor networks has significantly advanced in recent years, it is clear that a number of challenges still remain to be solved. With the flurry of new approaches to communication, medium access, networking and applications, effective analysis, integration and testing of these ideas is paramount—the field must develop fundamental insights, as well as understand what

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stands up in practice. For these reasons, we believe that the development of new theoretical models (both analytical and computational) is very much needed, and that greater use of testbeds and field experiments is essential; such work will support more accurate performance analysis and system characterization, which will feed into the next generation of underwater communications and sensing. In addition, integration and testing of current ideas will stress the seams that are often hidden in more focused laboratory research, such as total system cost, energy requirements and overall robustness in different conditions.

As demonstrated in this document, the numbering for sections upper case Arabic numerals, then upper case Arabic numerals, separated by periods. Initial paragraphs after the section title are not indented. Only the initial, introductory paragraph has a drop cap.

(1)

Be sure that the symbols in your equation have been defined before the equation appears or immediately following. Italicize symbols (*T* might refer to temperature, but T is the unit tesla). Per IJSER, please refer to "(1)," not "Eq. (1)" or "equation (1)," except at the beginning of a sentence: "Equation (1) shows ... ." Also see *The Handbook of Writing for the Mathematical Sciences*, 1993. Published by the Society for Industrial and Applied Mathematics, this handbook provides some helpful information about math typography and other stylistic matters. For further information about typesetting mathematical equations, please visit the IJSER styel guide: http://www.ijser.org.

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