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A novel System Architecture for Underwater Sensor Network

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Abstract:
Underwater sensor networks find applications in oceanographic data collection, pollution monitoring, offshore exploration, disaster prevention, assisted navigation, tactical surveillance, and mine reconnaissance. The enabling technology for these applications is acoustic wireless networking. Underwater Acoustic Sensor Networks (UW-ASNs) consist of sensors and Autonomous Underwater Vehicles (AUVs) deployed to perform collaborative monitoring tasks. The objective of this research is to propose noval layered system architectures for UWSN.

Keyword: Underwater Sensor Network (UWSN), Underwater Acoustic Sensor Networks (UW-ASNs), Autonomous Underwater Vehicles (AUVs), Network Management System (NMS).

1. Introduction:

One major application of sensor networks is the investigation of complex and uninhabited under water surfaces; such sensor networks are called the Underwater Wireless Sensor Networks (UWSN).
Underwater Sensor Networks (UWSNs) are proposed as a means for oceanic observation, offering new capabilities such as real time monitoring, remote configuration and improved robustness. Underwater sensor networks are envisioned to enable applications for oceanographic data collection, pollution monitoring, and onshore exploration, disaster prevention. Self -organize an autonomous network this can adapt to the characteristics of the ocean environment [1] This paper is divided into four sections. In section1 given a basic introduction of UWSN, section 2 is related to the basics properties of underwater architecture. In section 3 describes the proposed novel system architecture for underwater sensor network and finally in section 4 given the conclusion and future work of the research.

2. Related work

Underwater Sensor Networks are attracting the attention of industry and academia as well [1], [2], [3]. At one side, it can enable a wide range of aquatic applications, and on the same time, adverse environmental conditions create a range of challenges for underwater communication and networking.
Underwater monitoring missions can be extremely expensive due to the high cost of underwater devices. Hence, it is important that the deployed network be highly reliable, so as to avoid failure of monitoring missions due to failure of single or multiple devices. For example, it is crucial to avoid designing the network topology with single points of failure that could compromise the overall functioning of the network.
AUVs can function without tethers, cables, or remote control, and therefore they have a multitude of applications in oceanography, environmental monitoring, and underwater resource study. Previous experimental work has shown the feasibility of relatively inexpensive AUV submarines equipped with multiple underwater sensors that can reach any depth in the ocean [4]. Hence, they can be used to enhance the capabilities of underwater sensor networks in many ways. The integration and enhancement of fixed

sensor networks with AUVs is an almost unexplored research area which requires new network coordination algorithms.

Network topology must be carefully designed and after deployment it must be optimized suitably and often whenever possible. Some of the architectures supporting underwater sensor networks are static two dimensional underwater acoustic sensor networks, static three dimensional underwater acoustic sensor networks and three dimensional networks of autonomous underwater vehicles as described in [1].

Static two dimensional UW-ASNs: these are constituted by sensor nodes that are anchored to the bottom of the ocean. Applications of this include environmental monitoring.

• Static three dimensional UW-ASNs: these include networks of sensors and may be used for surveillance applications or monitoring of ocean phenomenon like water streams, pollution.

• Three dimensional networks of AUVs: these networks include fixed portions composed of anchored sensors and mobile portions constituted by autonomous vehicles.

3. System Architecture

Here introduced new system architecture for underwater sensor network. Architecture is virtually divided into three horizontal layers and each layer has its own responsibility. Layer 1 known as network management layer is responsible for managing whole system with the help of Network Management System (NMS). A network management system is designed for set of management functions that integrate configuration, operation, administration, security and maintenance of all elements and services of a sensor network. We focus on applications that provide management schemes in terms of monitoring and controlling UWSNs.

The main task of UWSN monitoring is to collect information about the following parameters: node states (e.g., energy level and communication power), network topology, wireless bandwidth, link state, and the coverage and exposure bounds of UWSNs. A sensor network management system can perform a variety of management control tasks based on the collected network states such as controlling sampling frequency, switching node on/off (power management), controlling wireless bandwidth usage (traffic management), and performing network reconfiguration in order to recover from node and communication faults (fault management).NMS will be installed in surveillance ship and responsible for whole network from ground based network to sensor nodes.

Layer 2 works as deployment layer is responsible for deployment of sensor nodes and inject new sensor at required places with the help of Autonomous Underwater Vehicle (AUV).

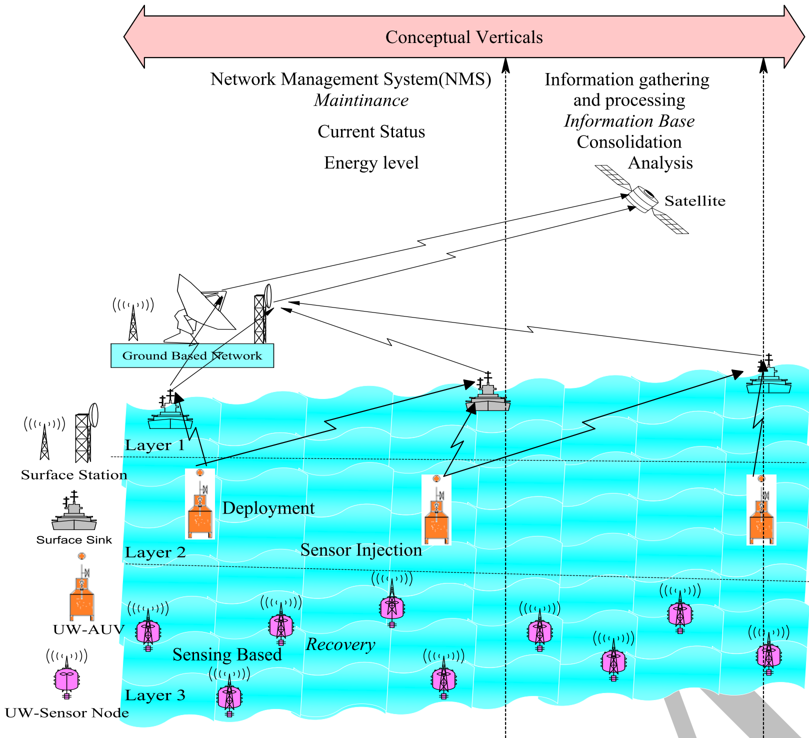

Figure: *Layered Three Dimensional Architecture with Mobile AUV*

An autonomous underwater vehicle (AUV) is a robot which travels underwater without requiring input from an operator. AUVs constitute part of a larger group of undersea systems known as unmanned underwater vehicles, a classification that includes non-autonomous remotely operated underwater vehicles (ROVs) controlled and powered from the surface by an operator/pilot via an umbilical or using remote control. In military applications AUVs more often referred to simply as unmanned undersea vehicles (UUVs).

Layers 3 works as sensor layer are responsible for routing issues in between the nodes, sensing capacity of nodes and handle the recovery of dead nodes. Main work of sensor layer is collecting the information, decide the route from the sensor node to ground based network and provide the sensor information to the network management system (like energy level of sensor node ,hop distance, location of nodes).

Here the node broadcast data in upper hemisphere. The communication range of a node is assumed to be uniform in all directions, which means it covers a sphere where the node is the center with a range radius proportional to its transmission power.

The important assumption is the symmetrical property of the channel i.e. if a node A is able to hear node B, then node B can hear also node A. Nodes are fixed in a location using anchors or buoys which means no movement is assumed, since the adopted architecture for UWSNs is the Static Three-Dimensional one. The architecture, as mentioned earlier, is widely used in long term applications such as ocean sampling and environmental monitoring. However, some relative movement is expected but it is unlikely to affect the constructed routes or the operation of the routing algorithm.

4. Conclusion:

In this paper, we proposed the novel conceptual system architecture in layered form for underwater sensor network. In this architecture we explained the working of each layer and mention the networks management system. It is assumed that network is installed in harsh and difficult environments, where human accessibility is difficult and the replacement of the batteries is very costly.

The focus was on the problem of designing reliable UWSN that are capable of transferring data from a variety of sensors to on-shore facilities. Major impediments to the design of such networks were considered, which are:

1. severe power limitations imposed by battery power
2. Severe bandwidth limitations
3. Channel characteristics including long propagation times, multipath, and signal fading. Various multiple-access methods, network protocols, and routing algorithms were also considered.

Future scope:

The ultimate objective of this paper is to encourage research efforts to lay down fundamental basis for the development of new advanced communication techniques for efficient underwater communication and networking for enhanced ocean monitoring and exploration applications. We strongly advocated the use of network management system approach to manage optimize the main networking functionalities in order to design communication suites that are adaptable to the variability of the characteristics of the underwater channel and optimally exploit the extremely scarce resources.

As future work, we would like to pursue the following directions:

(1) We plan to add the concept of load balancing in this proposed system architecture.

(2) We will extend this architecture with different network structures, and mobility models.

(3) We will design routing protocol with load balancing for this architecture.

Reference:

1. Jun-Hong Cui, Jiejun Kong, Mario Gerla and Shengli Zhou, " Challenges: Building Scalable Mobile Underwater Wireless Sensor Networks for Aquatic Applications", IEEE Network, Special Issue on Wireless Sensor Networking, Vol. 20, No. 3, pp.12-18, May/June 2006.
2. Heidemann, J. "Wei YeWills, J.Syed, A.Yuan LiResearch challenges and applications for underwater sensor networking", Inst. of Inf. Sci., Southern California Univ., CA; April 2006.
3. E. M. Sozer, M. Stojanovic, and J. G. Proakis, "Underwater Acoustic Networks," IEEE Journal of Oceanic Engineering, vol. 25, pp. 72-83, Jan 2000.
4. AUV Laboratory at MIT Sea Grant, Available from <http://auvlab.mit.edu/>.
5. K. Ovaliadis*, N. Savage and V. Kanakaris" Energy Efficiency in Underwater Sensor Networks: a Research Review", Journal of Engineering Science and Technology Review 3 (1) (2010) 151-156, Received 11 March 2010; Revised 30 April 2010; Accepted 20 June 2010
6. Manjula B, Sunilkumar S Manvi "Issues in Underwater Acoustic Sensor Networks", Vol 3, February 2011, 101-110.
7. Dongkyun Kim, Dongseung Shin and Hongseok Yoo, "Porviding Service-Connectivity in Delay Tolerant Networks", International Conference on Advanced Language Processing and Web Information Technology, 2008.
8. Josep Miquel Jornet, Milica Stojanovic and Michele Zorzi, "Focused Beam Routing Protocol for Underwater Acoustic Networks", WUWNet' 08, September 15, 2008, California, USA.

9. Zheng Guo, Gioele Colombi, Bing Wang, Jun-Hong Cui, Dario Maggiorini, Gian Paolo Rossi, "Adaptive Routing in Underwater Delay/Disruption Tolerant Sensor Networks", Wireless on Demand Network Systems and Services, 2008. Fifth Annual Conference on, Jan 2008.
10. Muhammad Ayaz, Azween Abdullah, "Hop-by-Hop Dynamic Addressing Based (H2-DAB) for Underwater Wireless Sensor Networks" International Conference on Mobile Wireless and Optical Communications (MWOC' 09), Korea, December 16-18, 2009.
11. A. Syed and J. Heidemann. Time synchronization for high latencyacoustic networks. In Proc. IEEE Infocom, 2006.
12. B. Zhang, G.S. Sukhatme, A.A. Requicha, Adaptive sampling for marine microorganism monitoring, in: IEEE/RSJ International Conference on Intelligent Robots and Systems, 2004.