Efficient Hierachical Route Allocation for Underwater Sensor Network

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Abstract: ***Time synchronization is an important requirement for many services provided by distributed networks. A lot of time synchronization protocols have been proposed for terrestrial Wireless Sensor Networks (WSNs). However, none of them can be directly applied to Underwater Sensor Networks (UWSNs). A synchronization algorithm for UWSNs must consider additional factors such as long propagation delays from the use of acoustic communication and sensor node mobility. These unique challenges make the accuracy of synchronization procedures for UWSNs even more critical. Time synchronization solutions specifically designed for UWSNs are needed to satisfy these new requirements.***

This paper proposes Mobi-Sync, a novel time synchronization scheme for mobile underwater sensor networks. Mobi-Sync distinguishes itself from previous approaches for terrestrial WSN by considering spatial correlation among the mobility patterns of neighboring UWSNs nodes. This enables Mobi-Sync to accurately estimate the long dynamic propagation delays. Simulation results show that Mobi-Sync outperforms existing schemes in both accuracy and energy efficiency.

I. UNDERWATER ACOUSTIC SENSOR NETWORKS: RESEARCH CHALLENGES

Underwater sensor nodes will find applications in oceanographic data collection, pollution monitoring, off shore exploration, disaster prevention, assisted navigation and tactical surveillance applications. Moreover, unmanned or autonomous underwater vehicles (UUVs, AUVs), equipped with sensors, will enable the exploration of natural undersea resources and gathering of sciatic data in collaborative monitoring missions. Underwater acoustic networking is the enabling technology for these applications. Underwater networks consist of a variable number of sensors and vehicles that are deployed to perform collaborative monitoring tasks over a given area. In this paper, several fundamental key aspects of underwater acoustic communications are investigated. Deferent architectures for two-dimensional and three-dimensional underwater sensor networks are discussed, and the characteristics of the underwater channel are detailed. The main challenges for the development of efficient networking solutions posed by the underwater environment are detailed and a cross-layer approach to the integration of all communication functionalities is suggested. Furthermore, open research issues are discussed and possible solution approaches are outlined.

II. CHALLENGES: BUILDING SCALABLE MOBILE UNDERWATER WIRELESS SENSOR NETWORKS FOR AQUATIC APPLICATIONS

Large-scale mobile Underwater Wireless Sensor Network(UWSN) is a novel networking paradigm to explore aqueous environments. However, the characteristics of mobile UWSNs, such as low communication bandwidth, large propagation delay, floating node mobility, and high error probability, are significantly different from ground-based wireless sensor networks. The novel networking paradigm posesinter-disciplinary challenges that will require new technological solutions. In particular, in this article we adopt atop-down approach to explore the research challenges in mobile UWSN design. Along the layered protocol stack, we roughly go down from the top application layer to the bottom physical layer. At each layer, a set of new design intricacies are studied. The conclusion is that building scalable mobile UWSNs is a challenge that must be answered binder-disciplinary efforts of acoustic communications, signal processing and mobile acoustic network protocol design.

III. PROBLEM DEFINITION

This paper addresses the time synchronization problem, a critical service in any sensor network. Nearly all UWSN applications depend on time synchronization service. For example, data mining requires global time information, TDMA, one of the most commonly used Medium Access Control (MAC) protocols, often requires nodes to be synchronized. Furthermore, most of the localization algorithms for underwater and terrestrial sensor networks assume the availability of time synchronization service. Numerous times synchronization protocols for terrestrial Wireless Sensor Networks (WSNs) have been proposed in the literature synchronization accuracy and energy efficiency for land-based applications is cogent.

However, most of these approaches assume that the propagation delay among sensors is negligible. This is not the case in UWSNs, which suffer from the low propagation speeds of acoustic signals (roughly 1,500 m/s in water). Sensor node mobility also contributes to long and variable propagation delay in UWSNs. These additional complicating factors render previous approaches less suitable for adaptation to UWSNs. Furthermore, the batteries of underwater sensor nodes are difficult to recharge and it is often impractical to replace due to their relative inaccessibility. This lack of serviceability imposes even more stringent requirements. The UWSN will need to be energy efficient. This set of distinguishing characteristics introduces new challenges into the design of time synchronization schemes for UWSNs

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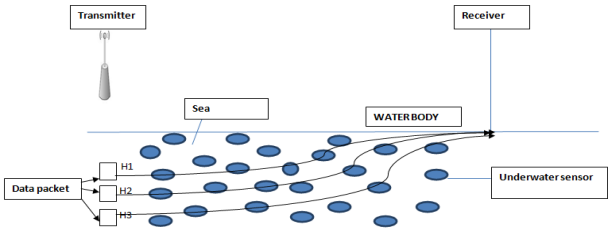
Proposed System



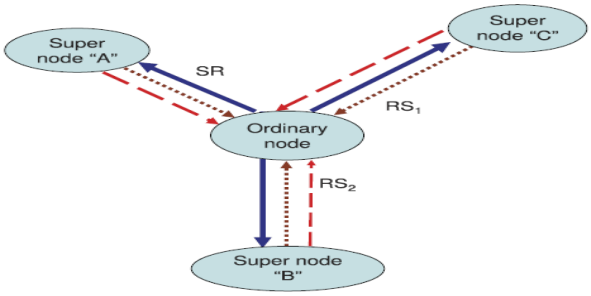
IV. SPATIAL CORRELATION

In this module, the performance of wireless communication systems can be improved by having multiple antennas at the transmitter and the receiver. The idea is that if the propagation channels between each pair of transmit and receive antennas are statistically independent and identically distributed, then multiple independent channels with identical characteristics can be created by pre coding and be used for either transmitting multiple data streams or increasing the reliability (in terms of bit error rate). In practice, the channels between different antennas are often correlated and therefore the potential multi antenna gains may not always be obtainable

V. MESSAGE EXCHANGE

In this Module, message exchanges among sensor nodes for the case where there are three super nodes available to assist the ordinary node perform time synchronization. A single run of the message exchanged between the ordinary node and each super node.

The synchronization procedure starts when an ordinary node initializes the synchronization process by broadcasting the synchronization request message SR to its neighboring super nodes. SR contains the sending time-stamp T1 obtained at the MAC layer, immediately before it departs from the ordinary node. Upon receiving SR, super nodes mark their local time.



VI. CONCLUSION

This paper presents Mobi-Sync, a time synchronization scheme for mobile UWSNs. Mobi-Sync is the first time synchronization algorithm to utilize the spatial correlation characteristics of underwater objects, improving the synchronization accuracy as well as the energy efficiency. The simulation results show that this new approach achieves higher accuracy with a lower message overhead.

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