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Time synchronization scheme for mobile Underwater sensor networks

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ABSTRACT

The most important service provided by distributed networks is"Time Synchronization" for terrestrial Wireless Sensor networks (WSNs). Several time synchronization protocols have been proposed. Factors like long propagation delays which are used for acoustic communication and sensor node mobility were not considered in several proposed protocols. For UWSNs, "Time synchronization solution" is specifically designed. "Mobi-Sync" a time synchronization scheme is proposed for Mobile Under Water Sensor Networks. Mobi-Sync takes into consideration of spatial correlation among the mobility patterns of neighboring UWSNs. This enables Mobi-Sync to accurately estimate the long dynamic propagation delays.

Keywords: UWSNs, WSN, Nodes.

1. INTRODUCTION

UWSN applications depend on service termed as "time synchronization". For example, Data Mining uses global time information, TDMA requires Synchronization of nodes. Propagation Delay among sensors is negligible is assumed by most of the protocols. UWSNs sometimes suffer from the low propagation speeds of acoustic signals which are approximately around 1,500 m/s in water. Sensor Node mobility also contributes to variable and long propagation delay in UWSNs.Batteries of underwater sensor nodes are often impractical to replace due to their relative inaccessibility and difficult to recharge. Stringent requirements are imposed because of this lack of serviceability. Energy efficiency is needed for UWSNs. New challenges are introduced into the design of time synchronization schemes for UWSNs due to these distinguish characteristics.

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Already proposed Time Synchronization Algorithms for UWSNs are MU-Sync, D-Sync and TSHL. Long Propagation delays are addressed by these protocols. But, particular short comings are exhibited by all of them. For example, Static networks use TSHL which do not consider mobility of sensor node. Mobility issue is confronted by Mu-sync but it is not energy efficient. When estimating the Doppler shift, effect of the skew is overlooked by D-Sync. Mobi-Sync is proposed which overcome the limitations of existing approaches with a High Energy Efficient Time Synchronization Scheme specifically designed for mobile UWSNs.

The time synchronization procedure consists of three phases:

- Delay estimation
- Linear regression
- Calibration.

The advantagesof time synchronization schemeare Low communication bandwidth, Long propagation delays, higher error probability and Sensor node mobility

2. IMPLEMENTATION

Implementation has 3 modules to be considered. They are:

Module 1: Network Module

To obtain global time references and perform localization, Surface buoys are equipped with GPS. In underwater environment they serve as the “satellite” nodes.

Super nodes which work as reference clocks are powerful sensor nodes and they always maintain synchronization with surface buoys. Super nodes have the ability to perform moving speed estimation, obtain real time location and global time information as they can directly communicate with the surface buoys. Sensor nodes aiming to become synchronized are called Ordinary nodes. They are inexpensive, having low complexity, capable to communicate with their neighboring ordinary nodes or super nodes and are unable to make direct contact with surface buoys. The limited battery supply restricts the lifetime of Ordinary node.

Module 2: 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

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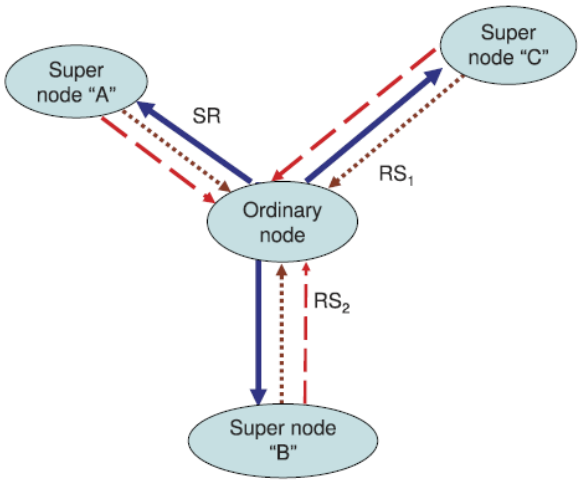
statistically independent and identically distributed, then multiple independent channels with identical characteristics can be created by pre coding and be used for either transmitting multiple data streams or increasing the reliability (in terms of bit error rate). In practice, the channels between different antennas are often correlated and therefore the potential multi antenna gains may not always be obtainable.

Module 3: 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.



3. CONCLUSION

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. In the future, the work will be extended in two directions:

- Explore other underwater mobility patterns, including one that involves vertical movement to examine the suitability of our design.
- Investigate the influence of errors on super node localization as well as velocity estimation, and also the influence on MAC layer activities such as packet loss and re-transmission

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