LIFETIME MAXIMIZATION USING LMAC ALGORITHM IN UNDERWATER WIRELESS SENSOR NETWORK (UWSN)

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Abstract

Localization is a crucial task which requires multiple packet exchanges in Underwater Wireless Sensor Network (UWSN). Medium access control (MAC) is used to determine how sensor nodes share the channel for the packet transmission. To obtain the maximum network efficiency for accomplishing a specific task, the network has to take its parameters accordingly. In other words, different MAC protocols are required for different tasks. This paper concerns about designing a LMAC protocol for a UWSN which efficiently schedules the packets of the anchors. Knowing the relative positions of the anchors and their maximum transmission range, the scheduling protocol takes advantage of the long propagation delay in underwater communications to minimize the duration of the localization task. The collision-free packet transmission for localization is introduced, and it shows how the optimum network efficiency can be achieved. Furthermore, this paper proposes a low-complexity algorithm, and through comprehensive simulations the performances are compared with the optimal solution as well as with other existing methods. A numerical result shows that the

proposed algorithm performs better and provides optimal network efficiency than the existing solutions.

Keyword – UWSN, MAC, LMAC

1. INTRODUCTION

UWSN consists of sensor nodes equipped with acoustic modems and a sink node equipped with both acoustic and ratio modems. Underwater sensor networks enable various applications i.e. oil/gas spills monitoring, offshore exploration, disaster prevention, submarine detection etc. although, underwater networks resemble terrestrial ad hoc networks, the radio signals used in terrestrial networks are not suitable in underwater sensor networks. The radio signal propagates long distances at extra low frequencies which require large antennas and high transmission power. Generally, acoustic wave are used for underwater communication. However, the detrimental nature of acoustic channel leads to high bit error rate (BER), low bandwidth, high propagation delay, etc. These challenges lead to high energy consumption of network nodes, and low reliability of received data.

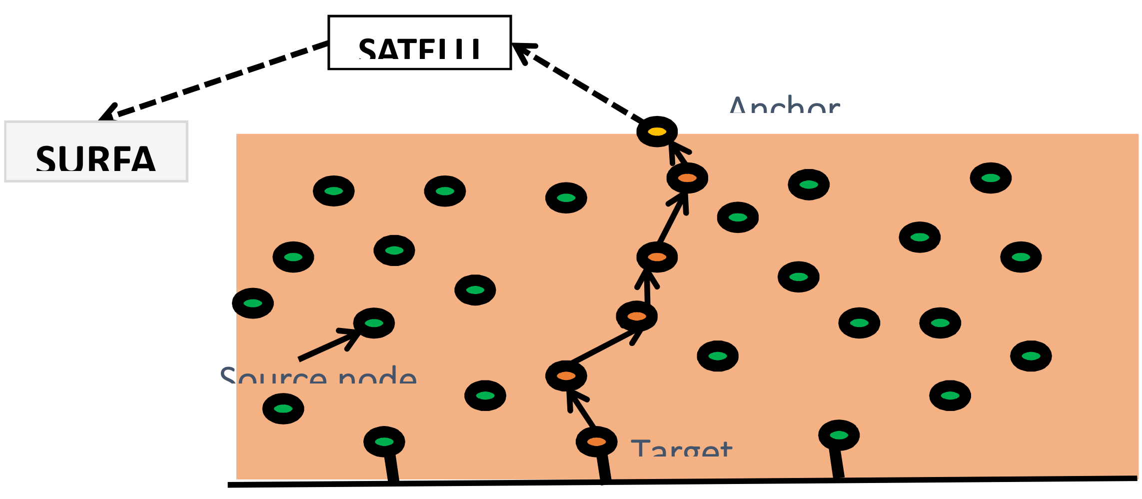

Fig.1 – Network Architecture

Random deployment of nodes allows for some part of the underwater network area to be less populated (low node density), while leaving other parts more populated (high node density).

2. PROPOSED ALGORITHM

Localization is known as location estimation of ordinary sensor nodes in a network. Most localization schemes need the location of some nodes to be known. These location aware nodes are known as anchor or beacon nodes. There are different methods to prepare location information for the anchors such as placed at fix location or using special hardware like Global Positioning System (GPS). Medium access control (MAC) determines how sensor nodes share the channel for packet exchanging.

2.1 NETWORK MODEL

The underwater sensor network build with N surface located anchor nodes (they can be located anywhere if their positions are known) with a maximum communication range of R meters. The following assumptions are made in this work.

- The anchors are equipped with GPS devices, as well as radio (or satellite) and half-duplex acoustic modems. It is further assumed that the anchors are synchronized with each other.
- The information about the positions of the anchors can be collected by a fusion center through their radio modems.
- There is no information about the position of the underwater sensor nodes, and they can be located anywhere in the operating area. In addition, they are not necessarily synchronized with the anchors.

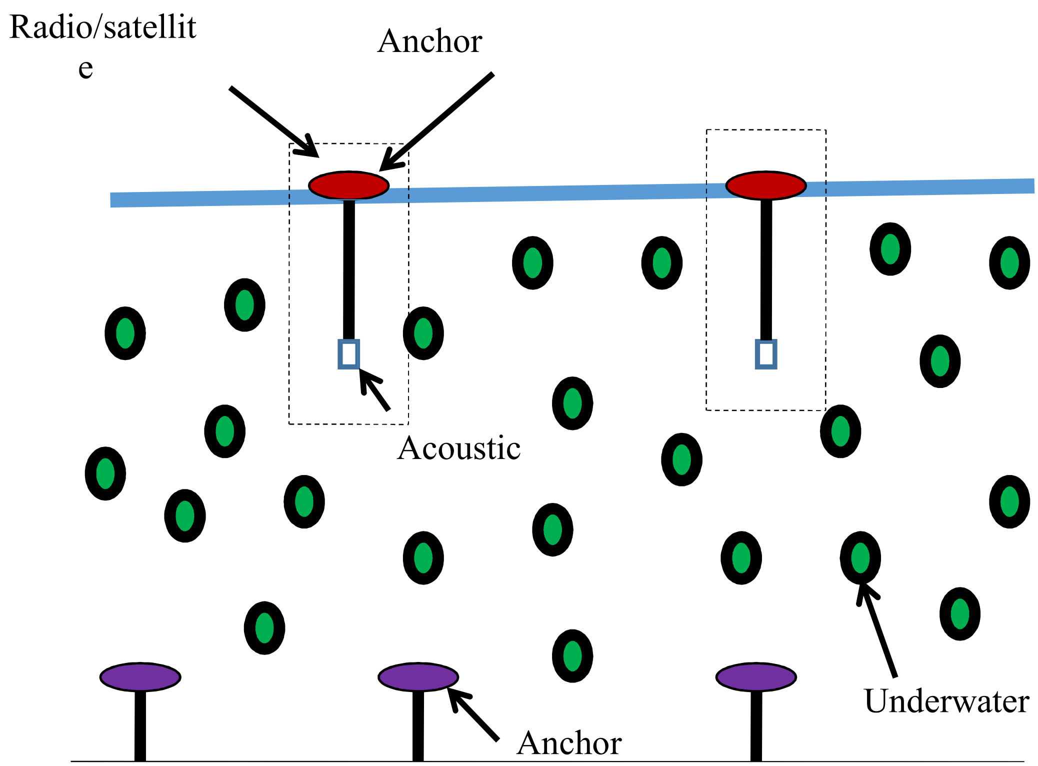

Fig. 2 - Network topology

Generally, localization packets only have a few bits of information, mainly about the anchor's position and the time when the packet is transmitted. As shown in Fig. The localization packet may also include other information such as a preamble, the anchor's ID, the guard time, and channel coding.

Anchor ID	Time of transmission	Position	CRC

Fig. 3 - Structure of packet

Fig. 4.3: Structure of packet

2.2 LMAC Algorithm

Step 1 Begin

Step 2 Initialize the sensor nodes

Step 3 Find neighbours of source node

Step 4 Select the neighbour node and compare the distance between two nodes

Step 5 Either condition satisfied efficient data transmission

Step 6 Otherwise data transmission with delay

Step 8 Halt

3. PERFORMANCE METRICS

In this section, the proposed LMAC algorithm and compare it with the existing routing protocol named AVN-AHH-VBF and Co-AVN-AHH-VBF in terms of following performance metrics

- **Dropped Packet (DP)**

The dropped packet defined as the average of packets dropped at during transmissions and it increases energy consumption in the network.

$$DP = T_{ps} - R_{ps}$$

- **End to End Delay (E2ED)**

The end to end delay means that the time required to forwarding the data packet from the source node to the sink node.

$$E2ED = D_{prop} + D_{tran} + H_{time}$$

- **Packet Delivery Ratio (PDR)**

It is the ratio of packets received at the sink to packet sent by the source node.

$$PDR = \frac{Total \quad packets \quad received \quad at \quad Sink}{Total \quad packets \quad sent \quad by \quad all \quad source \quad nodes}$$

- **Energy consumption**

The average energy consumed by a node in the network on a packet which has been successfully transmitted by source to sink node.

Energy consumption = Initial energy – Remaining energy

3.1 SIMULATION PARAMETER

The localization task is required repeatedly in the network, and is carried out when decided by a fusion center or upon requests from underwater nodes.

The fusion center is responsible for scheduling the localization packet transmission of the nodes where each packet has duration. Beside the localization data, other information can be encapsulated in the localization packets.We randomly deployed 100 to 600 nodes which is a sparsely distributed underwater wireless sensor network. The simulation parameters are shown in table.

Table 1 - Simulation parameter

PARAMETER	SPECIFICATION
Number of Nodes	600
Topology Area	1800 m x 1800 m
Mobility Model	Random
Packet Size	512 bits
Simulation Time	210 sec
Type of Antenna	Omni directional

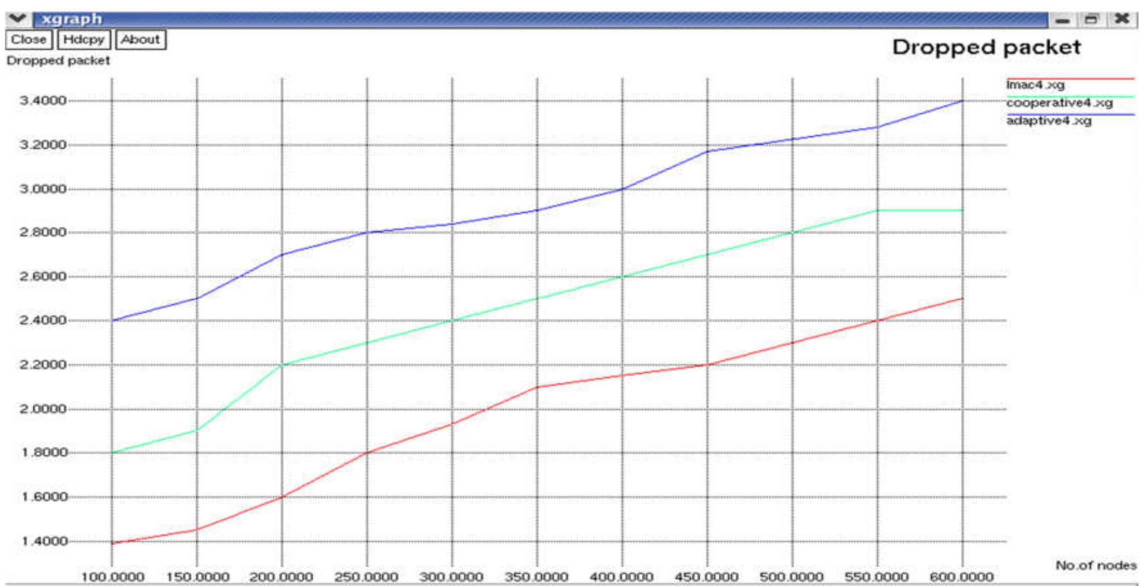

Fig. 4 - No. of nodes Vs Dropped packet

It can be seen from Fig. 4 that DP is low when the no. of nodes is low. With the increase of the no. of nodes, the average DP increases gradually. In generally, the average DP is less than existing protocols.

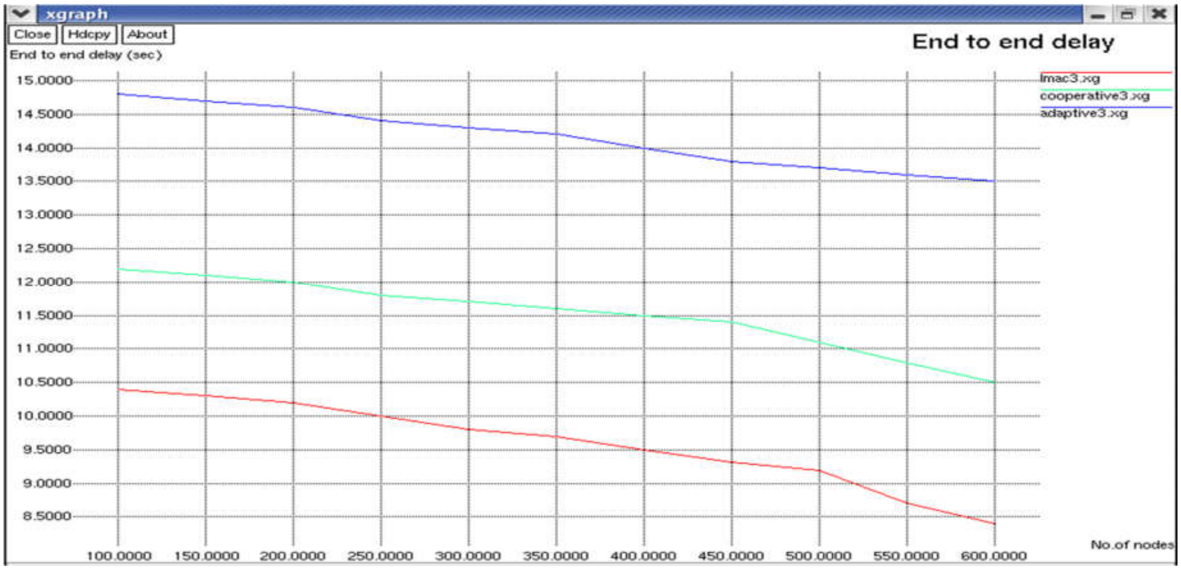

Fig. 6 - No. of nodes Vs End to end delay

Fig. 6 shows that, when the number of nodes varies from 100 to 600, the average E2E delay of LMAC and existing protocols (AVN-AHH-VBF & Co-AVN-AHH-VBF) are both decreased. It is because the more nodes are deployed the less routing voids appear which can lead to packet loss.

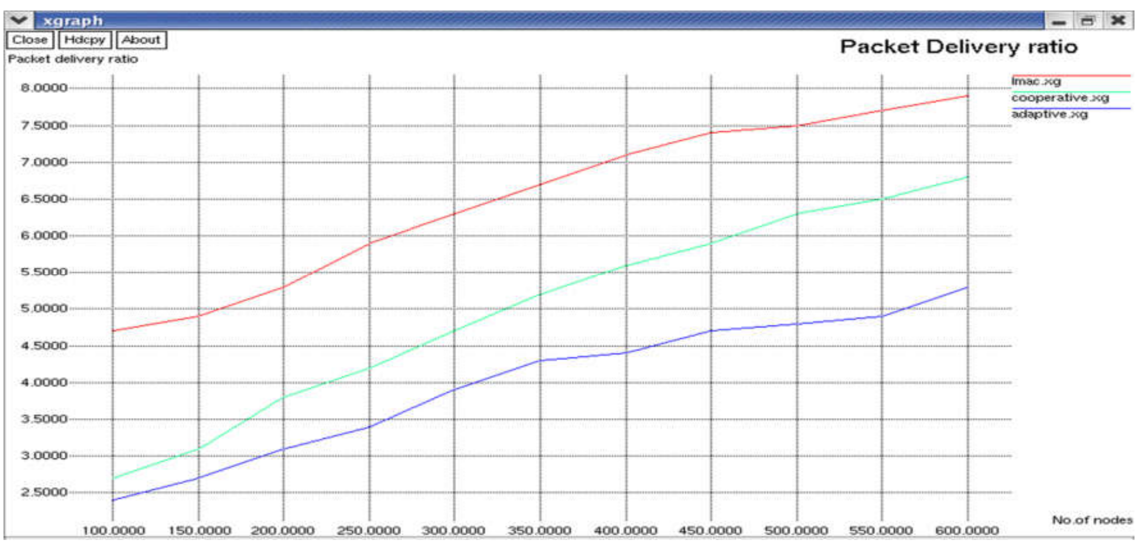

Fig. 7 - No. of nodes Vs Transmission on received packet

Fig. 7 shows how the packet delivery ratio (PDR) changes with different number of nodes. All the simulation results show a similar trend where the PDR grows with the increased number of the deployed nodes. The reason for this trend is that the more nodes are deployed, the less routing voids appear which can lead to packet loss.

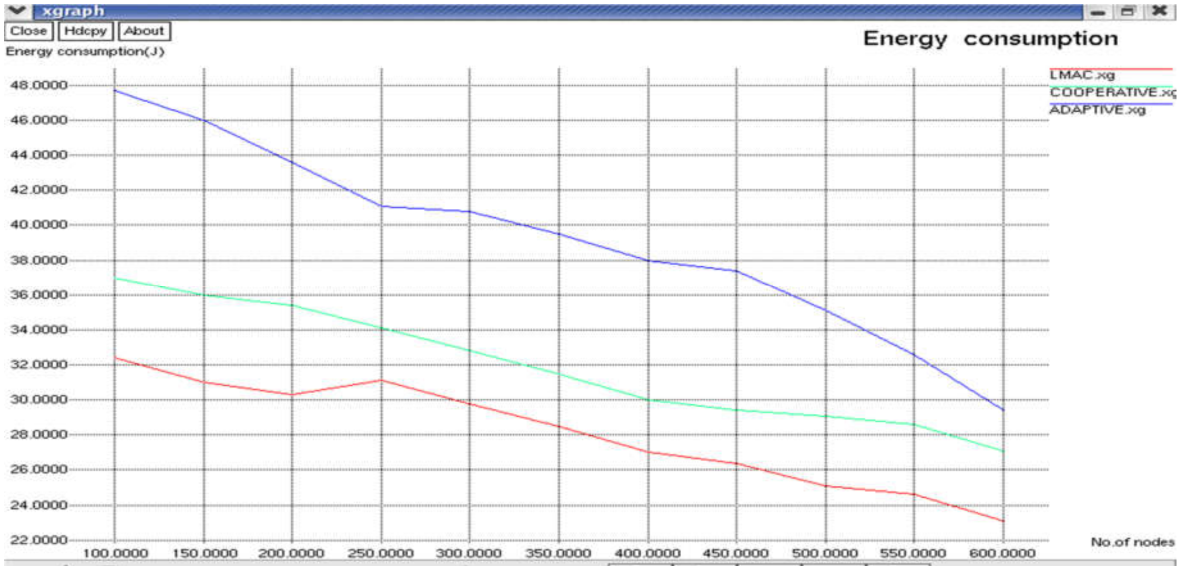

Fig. 8 - No. of nodes Vs Energy consumption

In Fig. 8 the comparison of both proposed LMAC and existing protocols (AVN-AHH-VBF and Co-AVN-AHH-VBF) for energy tax per received packet. When the no. of nodes increases to reduced the energy tax per received packet. It is because the more nodes are deployed the less routing voids appear which can lead to packet loss. The ETR of LMAC is 65% with 600 nodes, which is about 12% less than the existing protocols.

4. CONCLUSION

Localization in underwater wireless sensor networks has become an active research area for the past few years. The information about the sensor node's position is an essential requirement for many applications, ranging from military to mobile. The proposed low complexity LMAC algorithm is used to minimize the duration of the localization task. The results also demonstrate that energy is utilized efficiently as there is no flooding of message in the network. Furthermore, it has been revealed that the localization task duration depends on the number of sub channels, localization packet length, the anchor's maximum transmission range and the number of collision-risk neighbors. Through comprehensive simulation performance shows better than other alternative solutions in the underwater wireless sensor network.

5. FUTURE SCOPE

Analysis of the same protocol by adding more security is considered necessary to the future enhancement of the proposed scheme. Since the underwater nodes are not under the coverage of the anchors here the localization method has to be introduced with additional security measures as they will add more value to the suggested protocol. The optimal scheduling Protocol for such networks can be considered as an extension of the work carried out in this paper.

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