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COLLISION TOLERANT PACKET SCHEDULING FOR UNDERWATER ACOUSTIC LOCALIZATION

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Abstract— **The aim is to minimize the time required to self locating of sensor node and proper scheduling of packets in underwater acoustic communication. These sensor nodes are randomly thrown in underwater working area. For this we considered two types of packet scheduling. They are namely Collision Free Packet Scheduling (CFPS) and Collision Tolerant Packet Scheduling (CTPS).The localization time is calculated for these packet scheduling methods. We used acoustic signals because they attenuate less in underwater compared to radio signals. When the sensor node senses the environmental parameters like Tsunami, cyclone and for detecting oil field in underwater, this sensor node sends packet to the gateway node. If the packet duration is small and the area in which the sensor node present is large then Collision Tolerant Packet Scheduling requires less time compared to Collision Free Packet Scheduling. CTPS consumes more energy because the packet transmits in all the paths. In this we use Gauss-Newton algorithm for self localization of sensor nodes. Additionally, in CTPS sensor nodes work independently of each other so the packets transmit without fail.**

Keywords— **CFPS, CTPS, Localization time**

I. INTRODUCTION

Autonomous underwater vehicles (AUVs) came into existence in the 70s, An emerging technology with the potential to enable and extend applications in aqueous environments is an Underwater Acoustic Network (UAN) [2],[3]. Underwater acoustic communication introduces many challenges that are not as apparent in terrestrial networks. The aforementioned issues make existing protocols developed for terrestrial networks inadequate for use in UANs. To take prevention against Tsunami and cyclone or for detecting the oil field and for close observation of shoreline etc. these parameters are measured by the nearby sensor node and message will be encoded into packets, these packets are sent along with its self locating area to the gateway center. Self location of the sensor node is found by the anchor nodes. If the packets are not having a self-location of the sensor node, then no use of these packets. So self localization of sensor node is very important.

Applications in aqueous environments are an Underwater Acoustic Network (UAN). UANs make use of sensors, vehicles and other devices to cover large areas of a water environment for monitoring and data acquiring tasks. Additionally, gateway nodes are placed on the water surface to act as a mediator between the control center and sensor nodes in underwater. They can also be used to collect or route data. An example deployment can be seen in Figure. Potential applications of UANs include submarine detection, tsunami monitoring and offshore structural health monitoring. The devices and sensors used in UANs are networked together using acoustic communication channels.

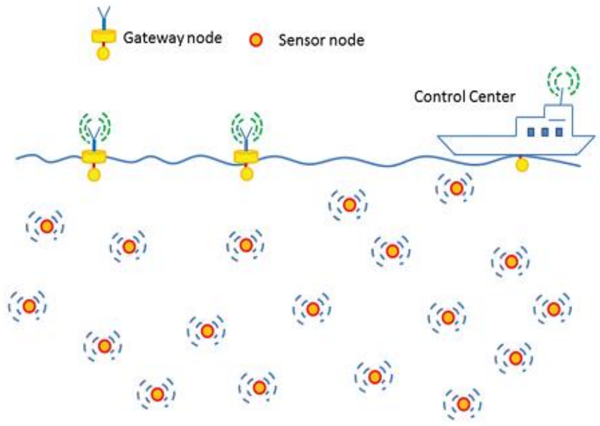

Fig. 1. UAN Deployment

Acoustic communication is the best communication method in underwater environments as radio waves suffer from high attenuation underwater and optical waves suffer from heavy scattering [4]. However, underwater acoustic communication introduces many challenges that are not as apparent in terrestrial networks. Acoustic signal in underwater attenuate less compared to the radio signals so they are able to travel more distances. Radio signals are harmful for underwater animals this is one more reason for using acoustic signals. In acoustic communication channel bandwidth is less. By observation, for 10 to 100km long distance, we get bandwidth in few kHz .For 1 to 10km medium distance, we get the bandwidth in the range of 10kHz. For <100m short distance, we get bandwidth is around a few hundred kHz. GPS signals cannot be used in underwater because it has High-frequency. They will not propagate properly [5][6].

For the sensor node to find its own location for sending its location packet, it can measure the time of departure (ToD) to several anchors. These anchors are with known positions to the gateway node. Calculate the distance between sensor node and nearby anchor nodes. We can also use other methods for finding self-location of sensor node such as finger-printing [7] or angle of arrival calculation of packets [8]. Nevertheless, packet transmissions from anchors are required for these methods.

For the localization [9] in underwater the sensor node begins the process by sending a “hi” message to the anchor nodes which are present in its working area. Those anchor nodes which receive a correct “hi” message, they will transmit back by medium access control (MAC) protocol is used for packet exchanging [10].

II. SYSTEM MODEL

Assume underwater contains P sensor nodes and Q anchor nodes as shown in Figure. 2.Every anchors in the underwater is encapsulates with identification number, self- location of the anchor, time at which the packet transmission started and the sequence for time of departure calculation from anchor node to sensor node.

Half –duplex communication between sensor and anchor nodes. i.e., only anyone can transmit message at a particular time. All sensor nodes are randomly distributed in the underwater and has limited operating area. For determining the distance between anchor and sensor node is done by an iterative Gauss-Newton self-localization algorithm using probability density function.

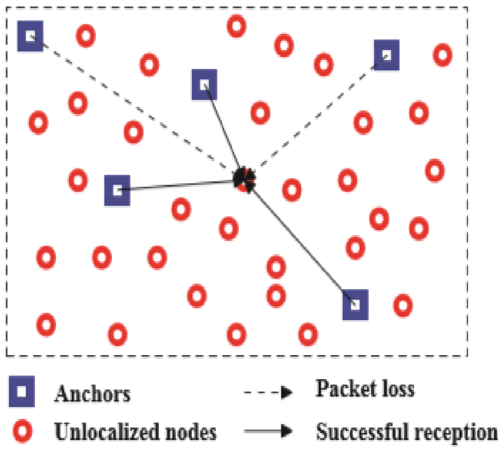

Fig. 2. Anchor nodes and sensor nodes distributed in squere area and sensor node determining its location

III. PACKET SCHEDULING

A. Collision-free packet scheduling

Collision Free Packet Scheduling is an completely-connected (single-hop) network, based on the known position of the anchors location.
First the sensor node send request packet to Anchor node. This wakes up the anchors from their sleep mode puts them in the Active mode. Then Anchor node listening and Reply's to Sensor Node. The requested packet is used for a accurate estimation and calculating the location of the Sensor node. After the sensor node estimates its location by using an iterative Gauss-Newton self-localization algorithm, and senses the warning message and send to anchor node. In this paper, we assume that all the anchors have its ID, and All Anchor node been correctly send the warning messages to Gateway node.
Gateway node already knows the Position of all anchors. Anchors simply transmit their IP address and Port number. This shown in following figure.3. Each anchor has to transmit packet without delay after receiving the previous anchor’s packet. Each anchor is fully depends on its previous anchor node. Finally send the message to gateway.
So transmission time more because anchor node waits until it receives the localization packet from previous anchor if the

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packet loss occurs in the previous node the present anchor does not know about the packet loss.

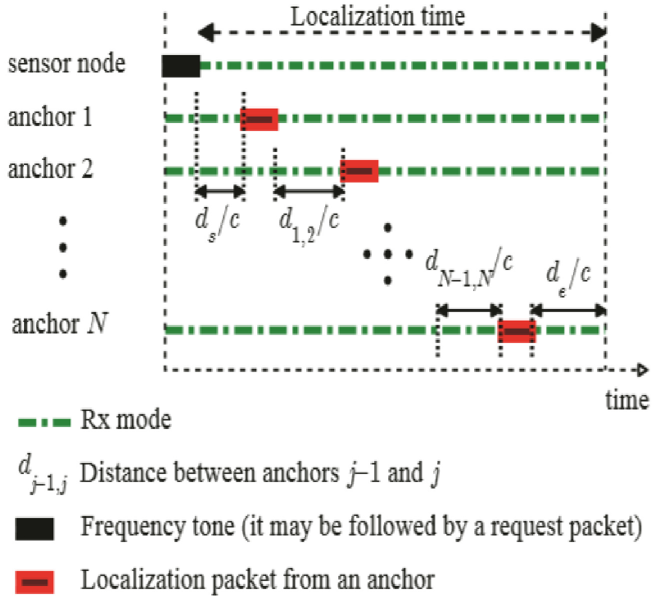

Fig. 3. packet transmission from one anchor node to another anchor node by sequence of anchors with their ID.

B. Collision Tolerant Packet Scheduling

The Collision Tolerant Packet Scheduling is better than the Collision Free Packet Scheduling because in this all anchor nodes transmit packets independently to other anchor nodes. So the packet transmission time is reduced. When the packets transmitted from different anchor nodes to the sensor node if collision occurs at that time packet will not be received by sensor node. Sensor node sends packet to the gateway [11] where sensor node knows its location.

The CTPS consumes more energy for packet transmission due to packet transmission in different paths so collision is reduced. From this we get best accurate location of sensor node. The collision tolerant packet scheduling helps to control the probability of collision by the packet transmission rate therefore each sensor node can receive enough error free packets.

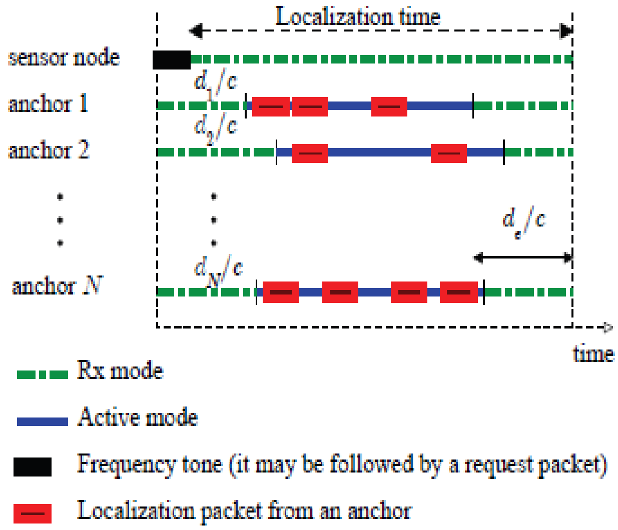

Fig. 4. anchors are independent to transmit their packets.

IV. Experiment and Result

To illustrate these two results, we considered a two-dimensional working area with length Dx and width Dy where sensor nodes are co-relevantly distributed. Anchor nodes are distributed with known position. The length of the localization packet plays a very important role in the collision-tolerant algorithm.

In figure.5 minimum time required for locating packets from one anchor to another anchor versus the probability of packet loss by the anchors. This is due to fading, shadowing and noise in the network.

Collision-Tolerant Packet Scheduling has higher growth compared with Collision Free Packet Scheduling is shown in figure 6.

CFPS has more influence on the performance on size of working area than CTPS this shown in Figure.7.

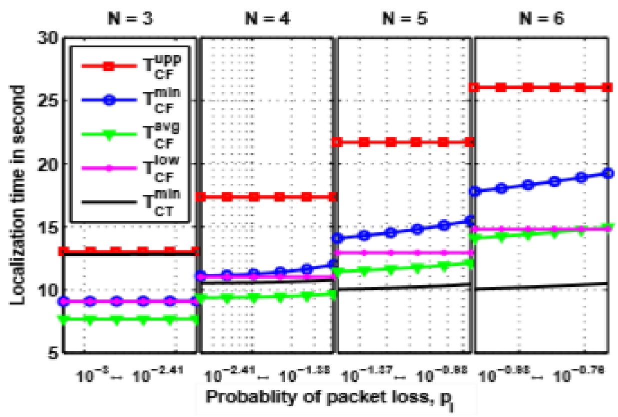

Fig. 5. Time required for localization versus probability of packet loss

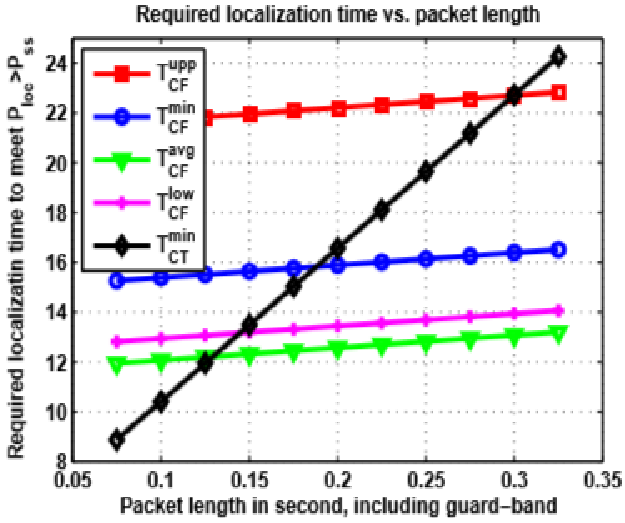

Fig. 6. Length of the packet on the minimum localization time

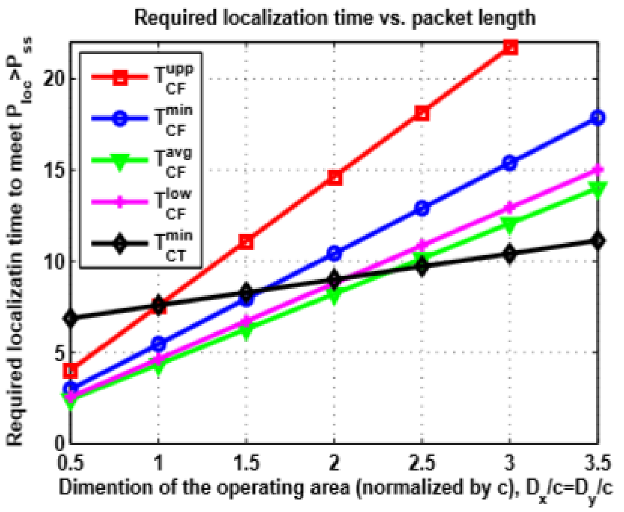

Fig. 7. Effect on the size of working area to the localization time.

V. CONCLUSION

In this paper we have considered two types of self localization for packet scheduling scheme in underwater acoustic localization. They are Collision Free Packet Scheduling (CFPS) and Collision Tolerant Packet Scheduling (CTPS). CFPS works as there is no collision between sensor nodes because of packet transmission by one anchor to other anchor is dependent. Collision Tolerant algorithm design there may collision occurs but controlling the probability of collision for localization. We also used Gauss-Newton based localization algorithm for these schemes to have probability density of sensor nodes in particular area. In this article we are comparing these two algorithms in terms of the time required for localization.

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