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Diminishing Propagation Delay within Underwater Sensor Networks Using JSL and ACO algorithm

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***Abstract*—**Long Propagation Delay is the major drawback in underwater sensor networks. In this paper, we use JSL algorithm, which synchronizes time and localization of sensor nodes, and ACO algorithm to find optimal path to forward packets from anchor node to base station using object node. Furthermore, by combining both the algorithms, we can reduce the propagation delays. Some QoS Parameters are analyzed. Simulation results shows low propagation delay and QoS parameters are improved using this method.

Index Terms*—UWSN s, Joint Time Synchronization and localization(JSL), Ant Colony Optimization(ACO), Quality of Service(QoS).*

I. INTRODUCTION

Wireless Sensor Networks consisting of nodes with limited power are deployed to gather useful information from the field. In WSNs, it is very difficult to collect the information in an efficient manner. Underwater localization is a key element in most underwater communication applications. GPS signals in water will highly attenuate, accurate ranging based techniques for localization need to be developed. In this paper, Joint time-synchronization and localization algorithm is used in the underwater acoustic channel for finding the time and locations of sensor nodes. We consider a realistic instance, where nodes are not time-synchronized and the sound speed in water is unknown, and describe the localization problem as a sequence of two linear estimation problems. Simulation results shows that our algorithm compensates for time synchronization and signal propagation speed uncertainties, and gets good localization accuracy using anchor nodes. We consider the problem of UWAL in a practical setting where the sound speed is unknown, and nodes are not time-synchronized and move permanently. Relying on the assumption that nodes are equipped with self-navigation systems and that these systems are accurate for use in short periods of time, we offer a heuristic solution for this problem, which we refer to as the joint sequential time-synchronization and localization (JSL) algorithm. For Path selection, We use Ant-Colony Optimization(ACO) Algorithm for selecting optimal path for data Transmission and collision avoidance. Finally, We Analyze QoS Parameters such as Throughput, propagation delay, Node Mobility, power consumption, bandwidth usage, data rate, and packet delivery ratio.

II. OVERALL ARCHITECTURE

Our proposed architecture provides a solution for reducing the propagation delays in Under Water Sensor Networks. The main goal of the architecture is to provide: Reduced propagation delay in the UWSN, Time and Location synchronization of sensor nodes, Route maintenance for packet delivery. The proposed architecture is shown in Figure 1 and its main modules are described below:

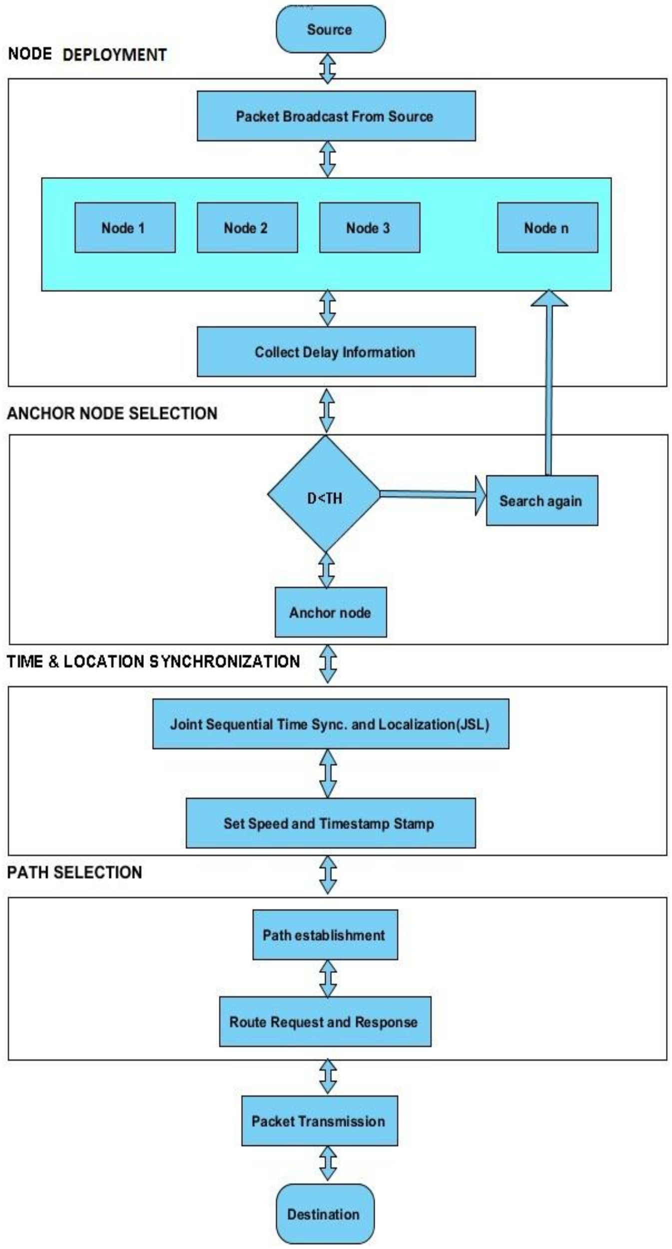

Figure 1: Architecture for Reducing Propagation Delays in Underwater Sensor Networks.

1) Node deployment:

Initially, we are forming a network. We are deploying the sensors in the Acoustic channel. The network many have static surface buoys and static base station nodes. The remaining deployed sensors will be moving i.e, non-static. The network will have non-static Object node, which will get information from anchor node and sends to base station.

2) Anchor node selection:

Choosing anchor points is a crucial step of the data gathering process since it determines the efficiency of energy transferring and the latency of data gathering. A trivial scheme is to simply visit all the sensor nodes, gather data and stores it. Anchor nodes are selected based on the bandwidth limits. Anchor nodes are used for gathering data easily from the neighboring sensor and sending the data to base station using object node.

3) Time and Location Synchronization:

Time and Location Synchronization is used to find out the nodes exact position at a particular time . We use JSL (Joint time synchronization and localization) Algorithm for synchronizing the time and location of each sensor nodes. It is a sequential approach. It involves Message exchange, Synchronization, Localization and Iteration. Synchronization helps in identifying the exact position of nodes at each time and it is used for optimal path selection.

4) Path Selection:

Path selection is done by Ant-Colony Optimization algorithm (ACO), which is a probabilistic technique for solving computational problems which can be reduced to finding optimal paths through graphs. In ACO algorithm, it will first find all possible routes from source to destination. Finally, it will select the shortest optimal path.

III. PROPOSED SYSTEM

In this proposed system, we implement Joint time-synchronization and localization algorithm on the UANT platform that is composed of a software defined radio and a mix of custom and commercially available hardware for the acoustic transmitter and receiver.JSL Algorithm relies on the existence of a navigation system that self-estimates the motion vector of nodes ,in short the algorithm utilizes the constant movements of nodes in the channel and relies on packet exchange to acquire multiple Time of Arrival measurements at different locations. We use Ant-Colony Optimization (ACO) algorithm for selecting the optimal path for data transmission and for collision avoidance. Hence, Reducing the Propagation delay, Power consumption, Improving node mobility and throughput.

METHODOLOGY AND ALGORITHM

We use two algorithms in this paper to reduce propagation delay. JSL algorithm, which synchronizes time and localization of sensor nodes, and ACO algorithm to find optimal path to forward packets from anchor node to base station using object node.

A. JSL Algorithm

JSL consists of four major phases, Message Exchange, Synchronization of sensor nodes, Localization of sensor nodes and Iteration. In Phase I, the ordinary sensor node acquires reference time and location information from neighboring reference sensor nodes. In Phase II, synchronization process is performed by ordinary nodes based on the information obtained in Phase I. Phase II consists of four steps. First, a node’s rough position is estimated by Time of Arrival. After that, the propagation delay is calculated. Next, JSL performs linear regression to synchronize the ordinary sensor node, which is followed by the update of the corresponding propagation delays. During Phase III, JSL carries out localization process based on the estimated propagation delays from Phase II.

Phase IV is a iteration process, the position estimated in Phase III acts as input to Phase II to replace the rough position. Then, both Phase II and Phase III are repeated until location's become stable. [2]

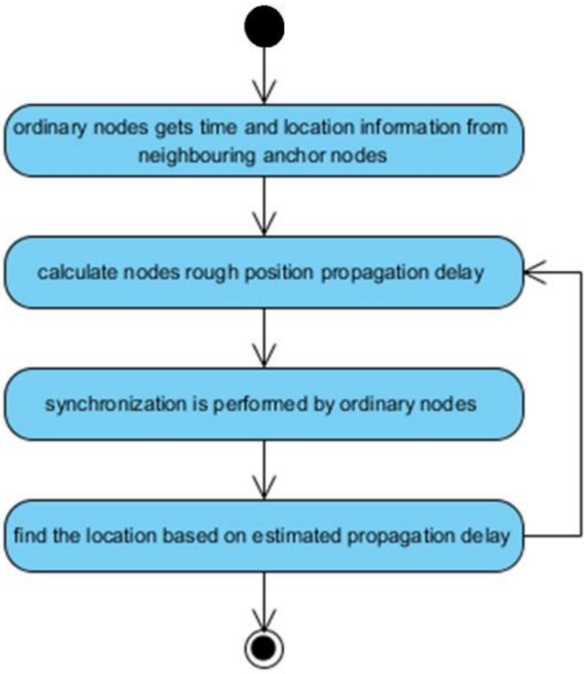

Figure 2: Activity diagram of JSL algorithm.

B. ***ACO Algorithm***

• Initially, the ant wanders randomly until it finds the food source (F), then it returns to the nest (N), laying a pheromone trail.
• Other ants follow one of the paths at random, also laying pheromone trails. Since the ants on the shortest path lay pheromone trails faster, this path gets reinforced with more pheromone, making it more appealing to future ants.
• The ants become increasingly likely to follow the shortest path since it is constantly reinforced with a larger amount of pheromones. The pheromone trails of the longer paths evaporate.[3]

ACO algorithm in UWSN:

1) Object node will collect information from anchor nodes and forwards it to Surface buoys and base station.

2) Initially, object node will collect information and forwards packets through a random path.

3) By using ACO algorithm, we can find shortest and best path. So, object node will send packets to base station faster and thus reducing propagation delay.

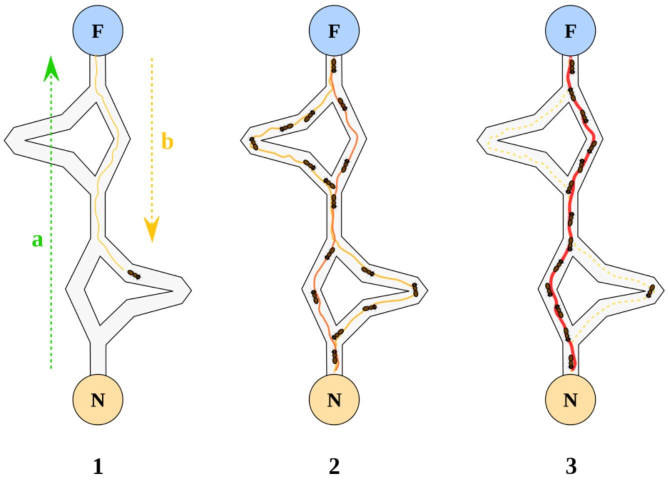

Figure 3: Diagram of ACO algorithm

IV. RESULTS

The Simulation result of nam window is show below in Figure, where the nodes are been deployed and static surface buoys and base station is fixed and the anchor nodes are been selected. The object node will be getting information as packets from anchor nodes and forwards it to base station through the shortest optimal distance. The simulation results are given below:

NAM Window output:

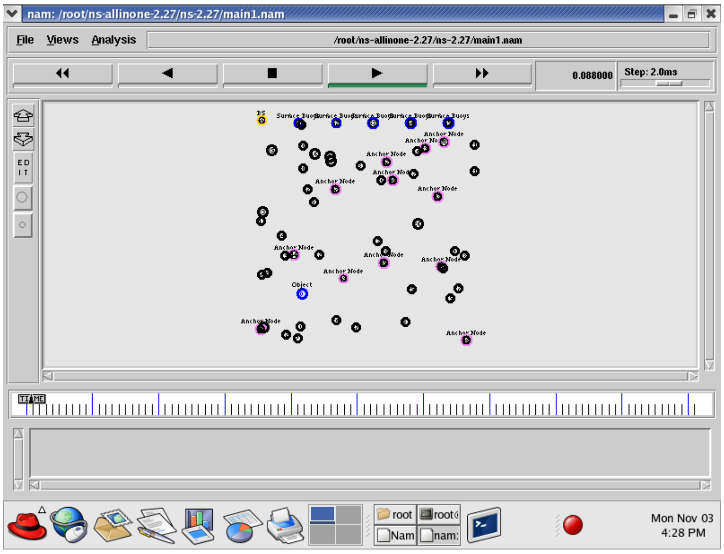

Figure 4: Node Deployment and Anchor node Selection

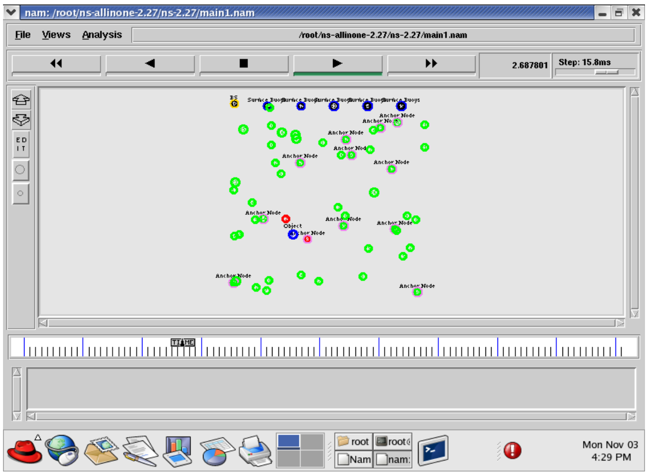

Figure 5: Object node gets information from Anchor nodes

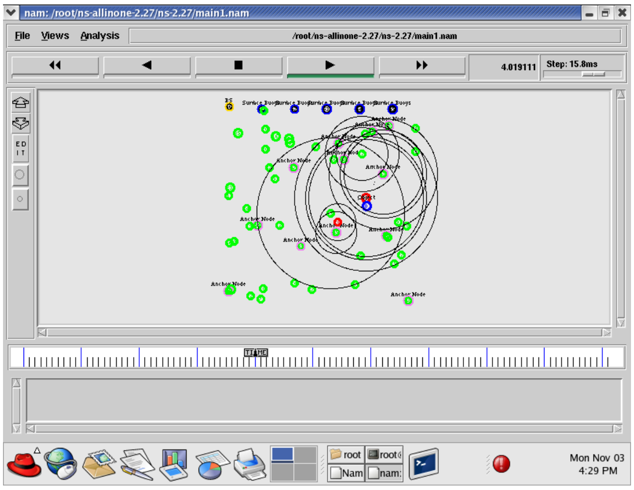

Figure 6: Object node sends the packets to surface buoys

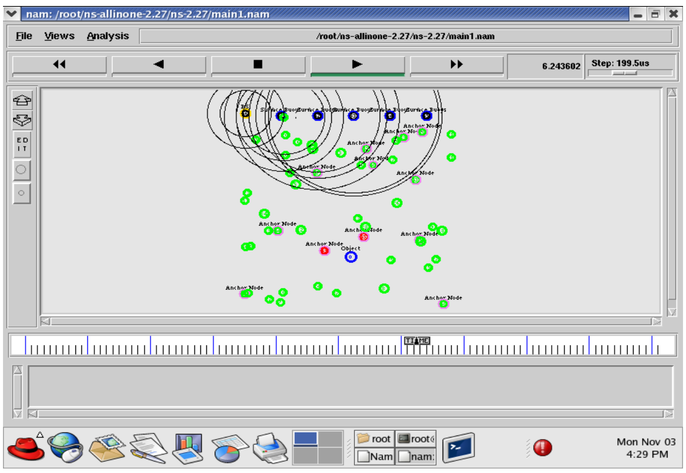

Figure 7: Surface buoys sends the packets to base station

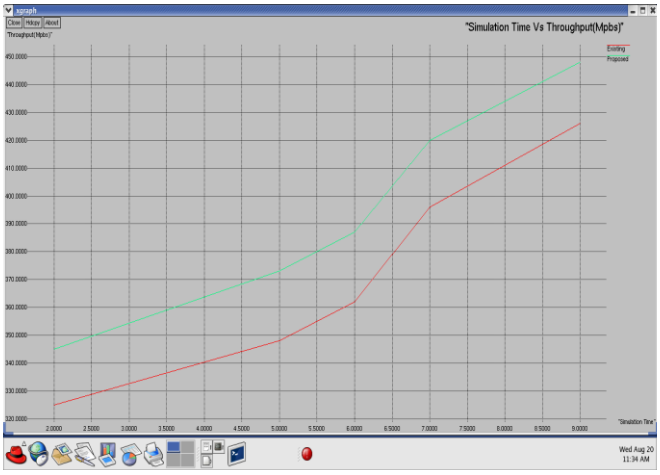

Figure 8: Graph showing increase in throughput

V. CONCLUSIONS

In this paper, we proposed a technique to reduce the propagation delay by combining JSL and ACO algorithm. Furthermore, Time-Synchronization and localization, optimal path selection is also achieved. Our simulation results show low propagation delay and improved QoS parameters.

Acknowledgment

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