An Efficient Approach to Minimize the Delay in Underwater Sensor Networks

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Abstract- *An Underwater Wireless Sensor Network (UWSN) is one of the most innovative technologies nowadays to observe and monitor the acoustic networks. Delay is a major issue while transmission and reception in an acoustic communication. Depends on the distance of each node either the time of transmission and reception, the delay rate can vary. It may cause due to any of the following delay like the sensing delay, the transmission delay or the propagation delay. Even, the delay varies with respect to the energy of that particular node, because of the node with lower energy senses slowly. In this work, the E-GEDAR protocol is designed to estimate the delay variation as well as the data communication rates between the underwater nodes. Simulation results display the significant improvement with respect to these parameters when compared with the GEDAR protocol.*

Keywords- Delay, Data transmission, Routing, Underwater.

I. INTRODUCTION

Only 30% is covered by land and remaining 70% is occupied by the water but still, the underwater environment is unexplored [12]. UWSN monitors and develops the self-organized network to implement the data collection, processing, and storage [2]. This kind of sensor technology is to be utilized in the various aquatic environment [1]. It forms a multi-hop network and the topology is three dimensional [2] in underwater. In real-time, it helps us to monitor the borderlines and pipelines between various countries [7].

Due to the absorption of the water, the radio frequency does not work in the underwater situation [2]. Usually, Sound waves are used in UWSNs but it produces the high error rate probability and the propagation delay. Since the water current is dynamic in nature, nodes are dynamically deployed [2]. When compare to the signal frequency, the local delays are more sensitive to the signal duration [5]. The optical transmission requires the clear water along with the line-of-sight propagation rather than the turbidity, marine fouling, backscatter, etc., whereas the electromagnetic (EM) have higher bandwidth, lower propagation delays, faster data rates and robustness to the channel disturbances by human activities or the water currents [8]. The QoS requirement may vary for the data delivery for various kinds of networks in underwater [10].To improve the data delivery, the geographic and the opportunities routing has to work together in the network to attain the maximum efficiency [11]. As the frequency increases, the Signal to Noise (SNR) decreases. But in deep water and shallow water is more with respect to lower frequency [12]. End-to-end delay is one of the major problems in UWSNs [2].The data forwarding node controls the traffic of the data since it is independent for each node. To avoid the traffic, the dead-end nodes had to detect and mark them as forbidden regions [4]. For longer distance communication, the electromagnetic signals are not working due to its attenuation. An acoustic waveform is the one and only way to propagate longer distance information in underwater. It causes the multipath spread and propagation delay in the underwater communication [16].

The rest of the paper is presented as follows, section 2 explains the principal issues with respect to the delay. The protocol is defined in section 3. Simulation results for performance evaluation are discussed in section 4 followed by the conclusion and future work in section 5.

II. PRINCIPAL ISSUES

A real-time condition or sensitive data is measured as the end-to-end delay [2].

A. Delay:

The main characteristics are as follows: (1) Propagation delay is greater than the transmission time of the data packets in the acoustic signals. (2) Swarm mobility causes the high dynamic topology of the networks. (3) The Spare network is due to the vast ocean. UWSNs are high-dynamic, large-scale sparse networks and high-latency [3]. The topologies are the single hop and multi-hop topology. It determines the transmission range of the node and its distance between the nodes. For every data packet, it needs at least two hops to transfer the data [3].

Delivery Failure Observation: A link is set for each forwarding nodes and stands for the link quality. If the packet is not received, it leads to packet loss [4]. Delay Reduction: In a communication route, the unnecessary transmission or reception must be reduced. Interferences are one of the issues which lead to long delay. To adapt this, the hop count of the data packets had to tailor [4]. The forwarding schemes are as follows: (1) SINR means a transmission or reception is the success between the two nodes and if exceeds the pre-defined threshold. (2) Local Delay is defined the average time between the transmitter and the receiver until the signal receives successfully. Some of the factors which affect the delay performance are node density, frequency, signal duration and transmit probability which sheds the design and plan of underwater [4].

Propagation Delay: The salinity of the water is fixed [7]. It is the ratio of the total distance travels by a signal to the propagation. The throughput is high and it detects fast for the lower propagation delay [8]. It is a time taken to transfer the packets between two nodes and speed of sound in the underwater networks [12]. Energy-Delay Tradeoffs: It reduces when the number of hops increases in the network. By it linearly increases the end-to-end delay [7]. Delay Analysis: As per the data rate and speed of the acoustic signals, the delay increases. The transmission, processing and propagation delay are the sum of total delays [9].

Transmission Loss: It depends on the attenuation and transmission range of the network. It also decreases the sound intensity through the path [9]. Spreading Loss: It occurs when the sound travels from the source to the destination because of the weakness in the signals [9]. Absorption Loss: It represents the energy loss due to the viscous friction which occurs in the sound wave [9].Signal to Noise Ratio (SNR): It defines the signal strength to the background noise. It expressed in terms of directivity index and ambient noise [9]. Each node sends the data to the central control node and it varies depend on its location [13]. The two reuse mechanism are as follows: (1) Temporal Reuse is to utilize the long propagation latencies. (2) Spatial Reuse improves the concurrent transmission by the property of the channel utilization [14].The two major conditions for the collision-free transmission are RTS wait time and CTS wait time. Transmission Scheduling: It decides whether to transmit without the interfering of the neighbor or not. The conditions hold in this are Neighboring non-interference and Prospective non-interference. Schedule Recovery: It is used to minimize the damages during a collision or lost frames or deadlocks in the communication [14].

It includes the cluster formation and the normal operation. It schedules the sleep mode to save the energy [15]. The major issue for this delay occurrence is the hidden terminal problem. The impacts for this are the number of channels, data packet length, input traffic and sequence length [16].

B. Data Communication Rate

It is a major issue in shallow water because of the multipath, noise, high variance, transmission loss, doppler spread and high delay. It varies their range depends on the distance between the source and the destination. Also, the bandwidth is directly proportional to the distance factor [6].

III. ROUTING PROTOCOL

In various aspects of data communication rate and delay variation rate, the routing protocol is described. To reduce this issue, the depth adjustment technique on the void nodes [13] with the layering approach had introduced with other routing protocols. The E-GEDAR is one of the approaches to monitor the depth of the underwater regions. The delay variant is designed for each and every layer in the network to determine the depth adjustment approach. It analyses the nearby layer to identify the group of candidate nodes to minimize the delay during transmission or reception. The retransmission of the data packets also deals with sensing and propagation delay. It happens only if none of the neighbors receive it. It overcomes the problem of the void region and minimizes the delay, the proposed approach will be more efficient.

IV. PERFORMANCE EVALUATION

We evaluate the difference of the GEDAR protocol with the E-GEDAR protocol. The E-GEDAR had employed to deal with the void regions in underwater sensor nodes. The main objective is to analyze the performance of delay rate and data communication rate with respect to E-GEDAR. The simulation results are explained below.

As in the Fig. 1, With respect to lower density, the average displacement per node is high. The delay also increases as the increases in the number of nodes.

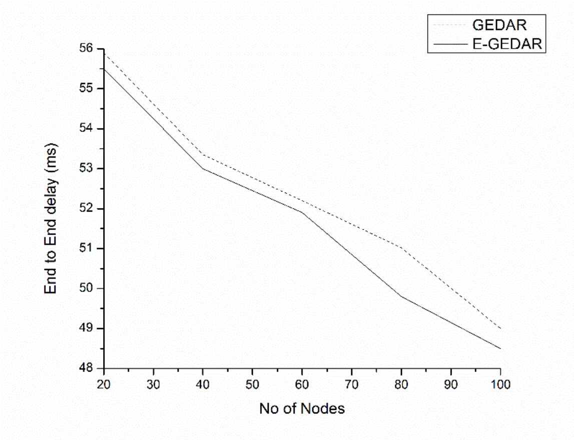

Figure 1. Time Vs Delay rate

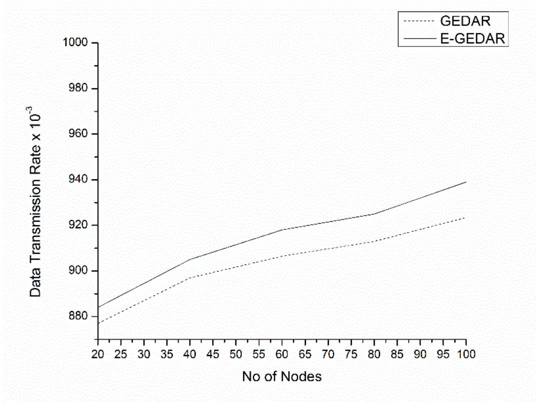

Figure 2. Time Vs Data Communication Rate

The Data Communication Rate (DCR) is presented in Fig. 2. As the delay rate of a node is low, the data communication rate is high. DCR decreases the delay of a node which dies quickly due to unbalanced energy in low depths.

V. CONCLUSION AND FUTURE WORK

In this paper, the delay rate and data communication rate had improved by the E-GEDAR protocol in UWSNs. The delay varied for each and every layer of underwater sensor nodes. Our simulation results had improved the efficiency of E-GEDAR approach for both the delay rate and the data communication rate. Each node as the same load to transfer the information. But, if some node had unbalanced data load then the delay rate varies. The delay had reduced the network lifetime with less energy and made the nodes unstable. This issue can be overcome with the E-GEDAR algorithm. Consequently, the delay varies for different scenarios depends on the traffic load and network density. It also used to identify the alive nodes for transmission. In future, other parameters like latency, jitter, etc., have to consider for the dynamically deployed nodes in UWSN.

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