

Study and Analysis of Dynamic Routing Protocols for Different Parameters in Underwater Acoustic Sensor Networks

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Abstract— In this paper, effective shortest path dynamic routing scheme is proposed based on collectively time and distance between the sensor nodes. Many routing protocols have been proposed so far to optimize the route from source to destination but prominent among them are dynamic routing. Here we use On-Demand distance vector routing to explain the connectivity of 2D network. Study and analysis the routing scheme on the basis of different performance criterion such as throughput, routing overhead, error rate, packet delivery ratio and collision detection is the main objective of this paper.

Keywords— Acoustic communication, routing protocols, shortest path, underwater communication architecture, underwater networking, underwater wireless acoustic sensor networks (UWASNs).

I. INTRODUCTION

Underwater sensor network systems consist of different types of sensor nodes (surface sink, underwater sensor nodes etc), mobile wireless nodes (unmanned underwater vehicle submarines) and other devices that are acoustically interconnected to each other [1]. Recently, advances in wireless sensor networks (WSNs) leads to the development of underwater acoustic sensor networks (UASNs) that enable and enhances the application such as underwater monitoring, resource exploration, disaster prevention and pollution detection.

There are two types of classification in UWSNs: fixed and mobile. These classifications depend on two method of oceanic measurement: Eulerian and Lagrangian [2]. In Eulerian method only fixed nodes are used to retrieve time-varying data of its assigned area. In contrast, mobile nodes are used in Lagrangian method to acquire not only time-varying data but also location dependent.

Ocean networks basically consist of three components mainly include underwater server, gateway buoy and sensor nodes. Underwater server is located either on the ship or onshore which is controlled by the operator to supervise and examine the underwater deployment area.

The gateway buoy (GB) act as an intermediate which communicate with all the sensor nodes in underwater which in turn transmit the acoustic signal to the satellite [3][11]. The GB improves the lifetime of the network. But if GB is not present in ocean, then the satellite link acts as an alternative way of communication. GB can be fixed or mobile. If GB is fixed at a suitable position and anchored at the ocean floor, it has direct communication to the server. In contrast, if GB is mobile then the communication is done through satellite. Also, underwater sensor nodes can be fixed or mobile. Sensor nodes are anchored or moored at the seabed in case of fixed sensors whereas other sensors are moving in a vertical position at the different levels in the ocean. In underwater sensor networks we require high power due to farthest distance of the sensors whereas in terrestrial network the power required for the communication is low. Signals in underwater communication are mode distorted, faded and very complex. A very complex signal is processed at both ends.

II. APPLICATIONS

Underwater acoustic sensor networks enable a broad range of applications which explains the above described features [5].

1) *Seismic monitoring*: Sensor network that measure seismic activities for oil extraction process to access field performance. Moreover UWSNs would allow different approaches for reservoir management. This technique is one of the best techniques.

2) *Disaster prevention*: Sensor networks provide tsunami warning to the coastal areas and also locate the effect of seaquakes.

3) *Equipment monitoring*: Underwater sensor networks would enable monitoring of different equipments (sensors, routers, remote controls) instantly after the deployment. Moreover it is very helpful to encounter failures or some other problems in the initial phase.

B) 3D UWASN Architecture

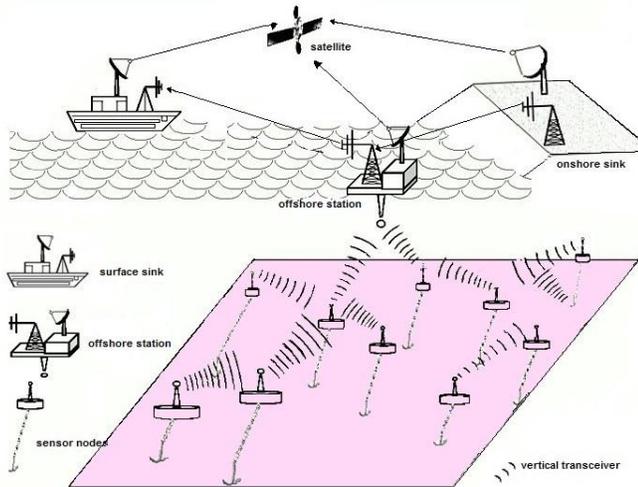


Figure 2: Architecture for 3D UWASN

3D underwater network are used to detect and observe phenomenon that can inadequately determined by the means of ocean bottom sensor nodes. 3D architecture mainly focuses on cooperative sampling of 3D ocean environment [4]. In this, sensor nodes float at different levels in order to observe 3D phenomenon. In Figure 2, each sensor is anchored to the ocean bottom and equipped with floating buoy that can be inflated by a pump. The surface buoy forces the sensors towards the ocean surface. The different depth of the sensors can be regulated by adjusting the length of the wire that connects the sensors to the anchor.

But still many problems arise with such an architecture, which needs to be solved in order to perform 3D sampling [8]. 3D sensors should regulate their depth in order to achieve full column coverage according to the sensing range. Network devices should coordinate their depth in such a way that at least one path always exist from every sensor to the offshore station.

V. PROBLEM STATEMENT

Assumption made:

1. *Sensor nodes:* All the sensor nodes are static and homogeneous in nature. This means all the sensor nodes are identical sensing ability, computational ability and ability to communicate [12].

2. *Battery power:* Initial battery powers of the different devices are full and identical at deployment. Also, assume battery power do not drain out completely during the whole process.

3. The communication range of mobile sensor nodes is assumed not to be change drastically during the entire runtime communication is assumed to be Omni-direction in nature.

4. *Coverage:* Assume all the sensor nodes provide uniform coverage to the deployment area.

5. *Random Deployment:* All the sensor nodes are deployed randomly over the surveillance environment.

VI. GOALS OF THE WORK

To design the shortest path routing scheme that locates the shortest distance from one random sensor node to another random sensor node based on time. After finding the shortest path, we can easily study and analyse different factors affecting the proposed environment.

VII. PROPOSED WORK AND SIMULATION

Due to uncertainty in underwater environment, sensor deployment is very difficult to implement in such an environment. The problem we target is to establish connectivity of a static underwater network under the time distance shortest path scheme. Here we use existing 2D architecture for further calculations. In this paper a time-based, distance-based shortest path is implemented [16]. Here we use Ad-Hoc On Demand vector routing (AODV) to study different parameters in underwater sensor networks. AODV [14][15] offers quick adaption to dynamic link condition, self starting, multihop routing between participating nodes wishing to establish and maintain our proposed network. This dynamic routing scheme randomly selects the source and destination and count minimum distance with time to select the shortest path. Figure 3 shows the number of nodes in the deployment area. During transmission of the packets to find out minimum path, we analyze number of challenges in underwater sensor network.

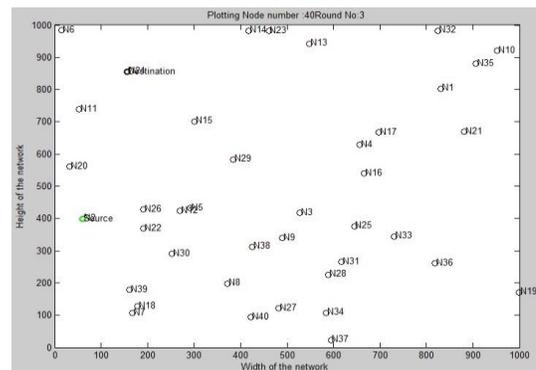


Figure 3: Nodes in the deployment area

Here the simulation of underwater network is done in MATLAB. To obtain all these challenges experiment is done by plotting 10 number of iterations, 50 number of nodes, 500mX500m of MATLAB environment to find out the performance by the shortest path. The proposed analysis of different parameters on the basis of given dynamic routing scheme is shown below:

a) Throughput

Throughput is a measure of how many unit of information a network can process in a given amount of time as shown in figure 4. Here throughput can be calculated as:

$$T = (P - ((dc+nc)*pd*dn)) / P$$

Where T is the throughput, P is the number of packets which has to be transferred, dc is the number of dead collisions, nc is the number of normal collisions, pd is packet drop and dn is the number of dead nodes in our proposed network. In underwater acoustic sensor networks, throughput is directly proportional to the transmission rate of the physical channel. In this higher the transmission rate, higher is the throughput. It is measured in bits per second or megabits per second or gigabits per second.

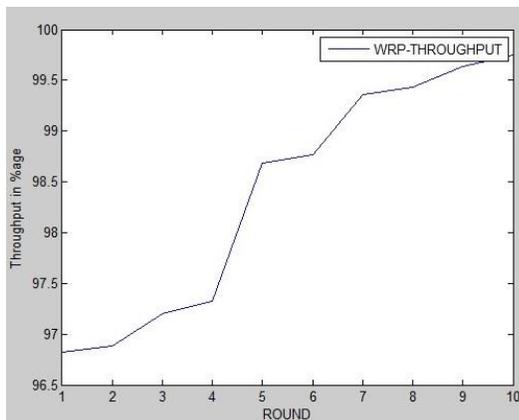


Figure 4: Throughput

b) Routing overhead

Routing overhead is flooding packet throughout the network as shown in figure 5. We have calculated routing overhead and various observations have been made.

$$O = ((dc+nc) * pd * dn)$$

Where O is a routing overhead.

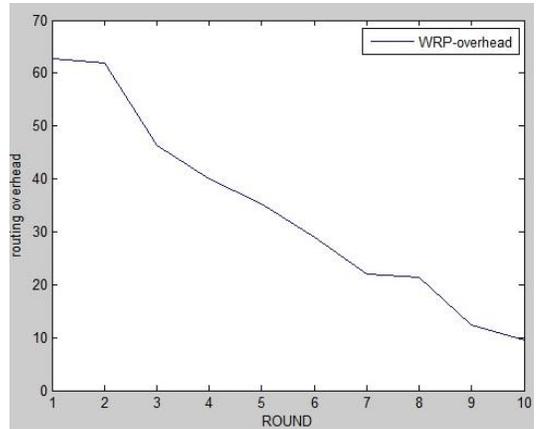


Figure 5: Routing overhead

c) Packet delivery ratio

In figure 6, experiment result is shown for packet delivery per 500 packet transfer in the underwater sensor network. It is calculated as follows.

$$PDR = (P - (pd*2)) / P$$

Where PDR is the packet delivery ratio.

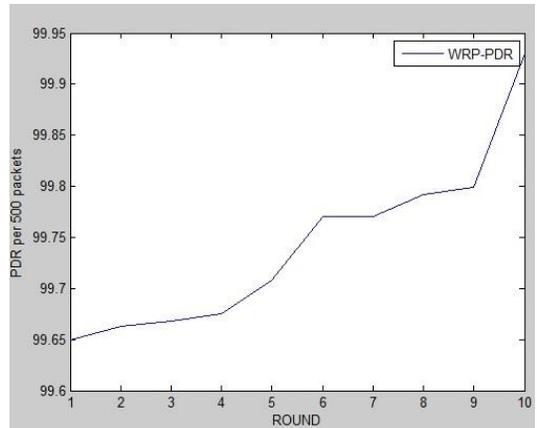


Figure 6: Packet delivery ratio per 500 packets

d) Error rate

The degree of the error encountered during data transmission over the communication or network connection. Figure 7 shows error rate between total number of nodes and error encountered in network.

$$E = (\text{mean}(E) + (dn*pd+\text{erroroccurrence})) / n$$

Here, E is the error rate which is been calculated.

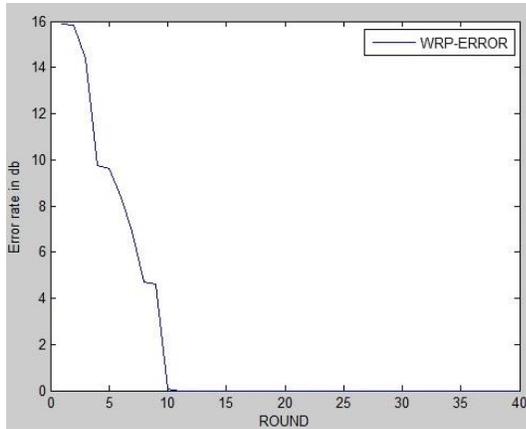


Figure 7: Error rate

e) Collision detection

In this paper we calculate the number of collision per second. Collision is the result of two sensor nodes attempts to transmit information at exactly the same time. In figure 8 we plot the collisions for number of iterations.

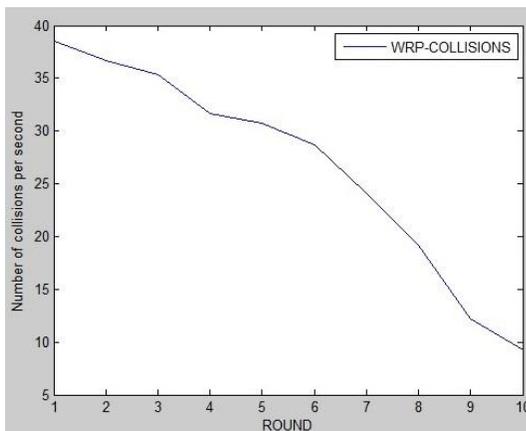


Figure 8: Number of Collisions per second

VIII. CONCLUSION

We discuss the main challenges for efficient communication in underwater acoustic sensor networks. The ultimate objective of this paper is to encourage research efforts to lay down fundamental basis for efficient communication. In this paper, we implement different research problems through the technique of time-based shortest path scheme in 2D architecture. A future study is to optimize the topology design and investigate other research parameters in underwater networks.

In underwater, networking is very difficult to implement in real time but still many researchers are needed to advance this field.

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