Effects of Node mobility on Energy Efficiency for Delay Sensitive routing algorithm in Underwater Sensor network

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***Abstract*—Underwater wireless sensor networks (UW-WSN) is the important field in the broad area computer networks, it consist of sensor nodes and its properties. It is different from the ground-based wireless sensor networks in terms of the communication methods and the mobility of the nodes. In this research we studied many geographical routing protocols on the basis of node mobility in sparse and dense underwater network. We also provide node mobility characteristics and different mobility models which are used to perform impact of node mobility on the system performance in terms of energy efficiency. We use distributed delay sensitive routing algorithm to perform node mobility concept to present the performance on energy efficiency.**

Keywords—Under Water Wireless Sensor Network; Node Mobility; Mobility Models; Geographical Routing Protocol.

I. INTRODUCTION

In the recent scenario, A flourishing interest in the Underwater wireless sensor networks(UW-WSN) has been seen by many researches which are developing for routing algorithms at the network layer. UW-WSN are foresee to perform collective efforts or cooperative functions for ocean sampling, disaster prevention, oceanographic data collection, pollution and environmental monitoring, assisted navigation and mine reconnaissance. Acoustic Communications is the technology in underwater sensor networks with the exclusive properties, such as high propagation delays, limited bandwidth capacity and limited power.

Energy efficiency is the most important factor which comes in UW-WSN. Delay sensitive applications such as real-time data delivery applications are required for end-to-end delays and energy saving problems in underwater communications. To work for these problems of delay sensitive applications autonomous underwater vehicles (AUVs) required to be mobile and may have two types of movements which are: Voluntary (nodes moves in given area with given velocity and direction) or involuntary movements (nodes moves in a limited area with low velocity).

In the last decade, many routing protocols are introduced for Ad hoc wireless sensor networks. Acoustic communication has unique characteristics for propagation of acoustic waves in underwater environment, so that work on acoustic channels routing protocols are subdivided into three protocols: Proactive, Reactive, Geographical routing Protocols. In our research we work on the energy efficient distributed geographical routing algorithm for the delay-sensitive applications for underwater sensor network.

This Geographical routing protocol mainly works on objectives such as: increasing the efficiency of the acoustic channel and limiting the packet error rate on each link. Scalability features and limited signaling messages are the properties of geographical routing protocols, these protocols provided the path from source to destination by holding the information of localization in which each node jointly selects its next hop according to the position of its neighbors and the destination node.

In this research we work on delay sensitive routing protocol to represent the impact of mobility on the system performance. we work on challenges :

1. we should specify mobility measured on the basis of velocity of nodes as well as their distribution in the network that it present in sparse or dense network.
2. Analyze the performance of the UW-WSN routing protocol in both sparse and dense network.
3. Analyze the impact of mobility of AUVs movements : voluntary and involuntary on routing protocol.
4. Represent the performance of the network with respect to the energy consumption, end-to-end delay and packet delivery ratio.

The remainder of this paper is organized as follows. In section II, we discussed the existing routing protocols for underwater sensor network. In section III, we presented our studied work about the mobility measures. In section IV we also showed mobility models for node mobility that is used for our research. In section V we will present the conclusion.

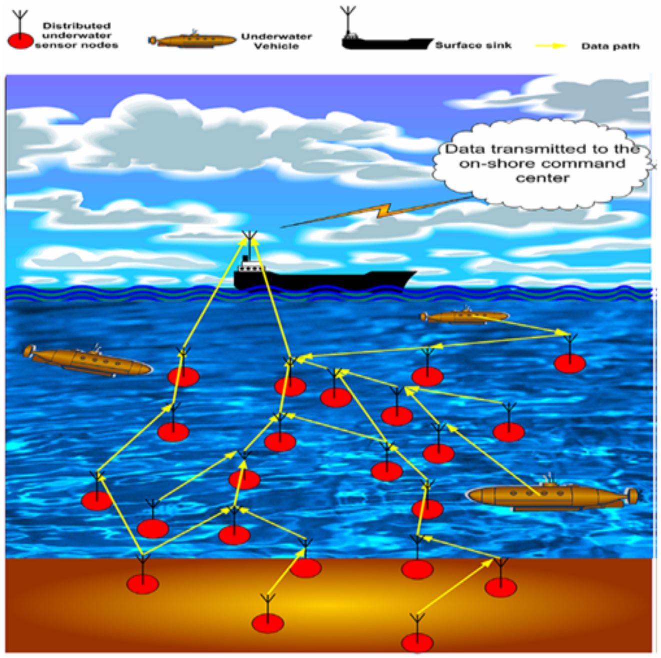

Fig. 1. Under water sensor network

II. Related Work

Underwater sensor networks have the major significant addition from many routing protocols which are designed on the basis of goals and requirements of the underwater applications. In this scenario every routing techniques contain strengths and limitations over the underwater network and environmental conditions. A large number of routing protocols are implemented in the field of UW-WSN but routing protocols mainly classified in three categories: proactive, reactive and geographical routing protocols.

Proactive protocols are which have need a large signaling overhead to organized the routs for the start time and each time the network topology is changed. It happens because of node mobility, node failures or changes in network topology has to be produced to all network devices. In this type of routing protocols scalability feature is more crucial issue so that proactive protocols not suitable for underwater sensor networks.

Reactive protocols are suitable for dynamic environment and it require high latency. To establish the paths it require source initiated a route discovery process to control packets. These protocols are not suitable for underwater sensor network because it generate high latency in the establishment of paths, which is processed by the slow propagation of acoustic signals in underwater.

Geographical routing protocols are suitable for underwater sensor network because of their scalability feature and require limited signaling. These protocols are more appropriate for localization features. By these localization perform in both 2D and 3D underwater sensor networks.

2.1 Depth Based Routing Protocol (DBR): In [2], Depth based routing protocol depends on the depth information of the nodes in underwater sensor network. It is a distributed routing protocol having local information of nodes along with depth information, balanced energy level and approximated distance to neighboring nodes. These parameters are also helps to take routing decisions. DBR can support multiple sink configuration underwater sensor network architecture. DBR performs better in dense network as compared to sparse network. High packet delivery ratio with energy consumption for sparse network allowed by DBR in multiple sink networks.

2.2 Vector Based Forwarding protocol (VBF): In [3], Vector based forwarding protocol provided in underwater sensor network with important characteristics such as robustness, scalability and energy efficiency. In VBF routing base term "vector" is introduced for routing in the UW-WSN. In which nodes which are close to vector forward the message from source to destination. In this routing small number of nodes processed in routing so that it saves the energy of the network. To account more energy efficient and take enhance performance in VBF authors developed a localized and distribution self-adaption algorithm by which energy consumption reduced by discarding low benefit packets. Node mobility provided by VBF in very efficient manner, in dense network low end-to-end delay shows by VBF. In sparse network VBF presents some limitations to show the energy performances.

2.3 Hop by Hop Vector based forwarding protocol (HH-VBF): In [4], To increase the robustness of the VBF this protocol introduced in position based routing. In HH-VBF same virtual routing pipe concept used as VBF but here per Hop virtual pipe presents for each forwarder. In sparse network HH-VBF produces better simulation results compared to VBF. In [5], Authors provided the simulation results for HH-VBF protocol, they conclude that HH-VBF shows the better performances when the mobility is taken into sparse networks with multiple source traffic. In this more paths are present from source to destination which helps to present better node mobility in sparse networks.

2.4 Focused Beams Routing protocol (FBR): In [6], FBR routing protocol is presented for routing technique which is based on location information for multi-hop communications in underwater sensor networks. The technique of this routing protocol for location information is suppose that every node has its own location information, and every source node in network knows about the final destination location. The FBR protocol uses cone for transmitting RTS(request to send) packets, through which it builds virtual path from source to destination.

In [7], the author propose the two distributed geographical routing algorithms for Delay Sensitive and Delay insensitive applications. The objective is that minimizing the energy consumption, increasing the efficiency of the acoustic channel, limiting the packet error rate on each link taking the varying conditions of the underwater channel. For achieving high channel efficiency requires longer packets and maintaining low packet error rate requires smaller packets. In this authors provide solutions for delay insensitive and delay sensitive static underwater sensor networks applications but these routing algorithms distributed nature helps in case of mobility.

In brief, there are many geographical routing protocols are present for underwater sensor networks. All acquire some strengths and limitations also. there are many routing protocols are present for dynamic networks and provide energy efficient and scalable results for underwater sensor networks. There are certain routing issues are comes according to node management such as sparse or dense networks, which affects the energy consumption, end-to-end delay, packet delivery ratio in each routing protocol. In sparse network DBR, VBF and HH-VBF shows the low energy consumption and packet data rate but end-to-end delay becomes higher. In sparse network FBR shows higher the energy consumption and lower end-to-end delay.

III. NODE MOBILITY

Underwater sensor network is the collection of sensor nodes which are communicate to each other in underwater without infrastructure. We already discussed about many geographical routing protocols for underwater sensor networks. These all routing protocols important to simulate for determining the performance of the protocol in underwater. Protocol simulation has several key parameters such as mobility model, traffic comes between communication, localization etc. The mobility model is require to determine the protocol performance. It is use to define the movement of the sensor nodes according to their velocity, location and acceleration over time. Time oriented or real time applications needed movement of the sensor node on time for that some underlying mobility model must be there for applications of underwater.

Node mobility is the concept in which mobility models characteristics applies to the sensor nodes of the underwater sensor network. Mobility models work on to the routing protocols, network topology of the communication in underwater sensor network. Protocol performance depends on to duration of interconnections between nodes, average connected paths and impact of the node density. Based on the node distribution in the network such as sparse and dense network routing protocols react differently. In geographical routing algorithms protocol performance depends on some metrics:

3.1 Packet Delivery Ratio : It is the ratio of the number of packets received successfully at the surface sink to the total number of packets produced at the source node. If a packet reaches the surface sink multiple times then these repeated packets are considered as only one time.

3.2 Average End-to-end delay : It describe the average time taken by a packet to travel from the source to the any surface sink.

3.3 Energy Consumption: It represents the total energy consumed in packet delivery, along with transmitting, receiving and idling energy consumption of all sensor nodes in the underwater sensor network.

Routing Algorithm Name	Pkt. Delay Ratio	End-End Delay	Energy Consumption
DBR	High	Significant	High
VBF	Low	Low	High
HH-VBF	High	-	-
FBR	High	Low	High

Table 1 : Routing algorithms performance in sparse network

Routing Algorithm Name	Pkt. Delay Ratio	End-End Delay	Energy Consumption
DBR	Higher then sparse	Significant	Significant
VBF	High	Low	Significant
HH-VBF	-	-	-
FBR	-	-	-

Table 2 : Routing algorithms performance in dense network

IV. MOBILITY MODELS

The mobility model plays the important role to determine the routing protocol performance. To evaluated the movement pattern of real time applications of underwater sensor network. If mobility model not used than observation may be misguide. Proper underlying mobility model need to be select for perform node mobility .We discuss the two models of mobility to perform node mobility in underwater sensor networks. These are shows the mobility effects on the node of the sensor network on the protocol performance in the basis of energy efficiency.

RANDOM-BASED MOBILITY MODELS

In this type of mobility models, the nodes are move randomly without restrictions. Here nodes direction, speed all are select randomly. There are two random based mobility models are present :

4.1 Random Waypoint Model: Random Waypoint model is mostly used as the mobility model, because of its simplicity and wide availability. In this mobility model node pauses for some time after every change in direction and speed. In a pause time node stays in a one location after that node chooses a destination in simulation area with a speed between its min and max value. Random way point model is similar to random walk model if pause time is equal to zero.

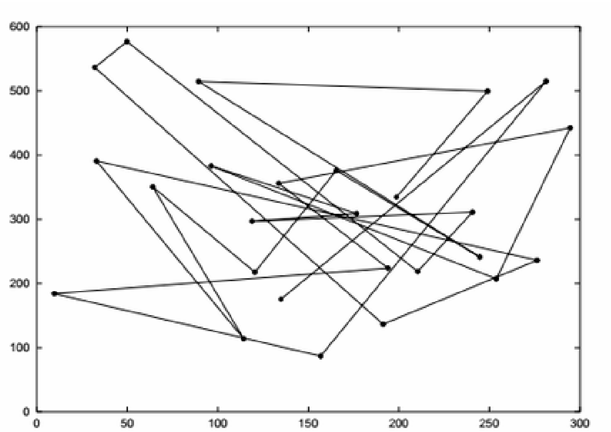

Fig.2: Time based movement of a node in Random way mobility model

4.2 Random Walk model: This model is called memory less mobility model because it does not contain any information about its previous location and speed value. In this mobility model, an MN moves from its current location to a new location by randomly choosing a direction and speed in which to travel. The new speed is chosen from pre-defined ranges between its minimum and maximum speed. The new direction is chosen from pre-defined ranges between 0 to 2π. In random walk mobility model each movement happens in a fix time or in a fix distance and after completing that node moves in a new position.

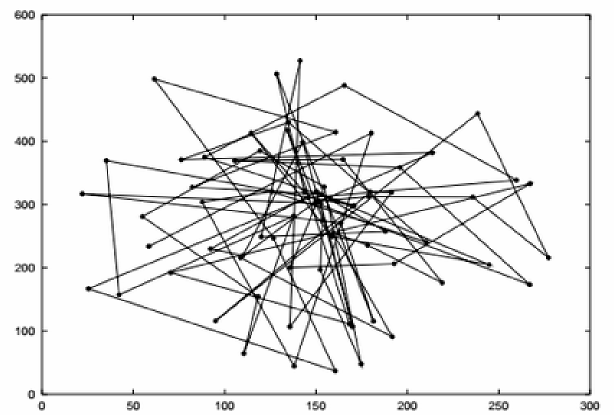

Fig.3: Time based movement of a node in Random walk mobility model

In our research we will use random waypoint mobility model to present the protocol performance in the underwater sensor networks. In this we work on the routing algorithm for delay sensitive applications of underwater sensor networks. We present the node mobility effects in the sparse and dense network. Node mobility perform on the energy efficiency parameter of underwater.

V. CONCLUSION

In this research we have discussed different-2 geographical routing algorithms and their performances in sparse and dense under water sensor network. Also we have discussed node mobility concept and their effects on energy efficiency of routing algorithms. Further we shows different random mobility models for underwater sensor networks. These take plays important role to present node mobility in UW-WSN. By using all these concepts we will perform node mobility effects on the delay sensitive routing algorithm in our research.

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