Efficient Data Transmission using Opportunistic Routing in Underwater Sensor Networks

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***Abstract*—An Underwater Sensor Network (UWSN) has many unique features that makes it different from terrestrial network. This includes lower bandwidth, longer propagation delay, dynamic topology, high error rate, and energy constraint. To overcome the limitations of such an environment, opportunistic routing has recently attracted much attention due to its ability to improve the performance of UWSNs in terms of life time ratio and energy saving. With the aid of opportunistic data routing, underwater sensors can collaboratively route a packet towards the destination which is a more adequate approach for sparse and lossy channels. In this paper we proposed a new method called Efficient Data Transmission using Opportunistic Routing with address to efficient packet transmission. This is an anycast, geographic and opportunistic routing protocol that routes data packets from sensor nodes to multiple sonobuoys (sinks) at the seas surface. When the node is in a communication void region, switches to the recovery mode procedure which is based on topology control through the depth adjustment of the void nodes, instead of the traditional approaches using control messages to discover and maintain routing paths along void regions. Simulation results show that proposed scheme significantly improves the network performance when compared with the baseline solutions, even in hard and difficult mobile scenarios of very sparse and very dense networks and for high network traffic loads**

***Index Terms*—Geographic routing,Opportunistic Routing, Communication void problem, Underwater Sensor Networks.**

I. Introduction

Research about oceans has become increasingly necessary in recent years. Oceans represent around 2/3 of the Earths surface and play an important role in sustaining human life. They are a substantial source of primary global production, absorb most of the carbon dioxide (CO_2) emitted into the atmosphere, and regulate the Earths climate. Despite the oceans importance, it is estimated that 95 percent of their volume remains unknown. Underwater sensor networks (UWSNs) have great potential to help change the aforementioned reality. UWSN has been proposed as an alternative solution for observing and exploring aquatic environments against the traditional wired and communicationless technologies. By providing nodes with underwater wireless communication capabilities, UWSNs enable real-time monitoring and actuation, online system reconfiguration, and failure detection [1]. This novel technology has enabled a new era in scientific and industrial underwater monitoring applications, such as ocean exploration, oceanographic data collection, ocean and offshore sampling, navigation assistance, and tactical surveillance applications.

Recently, opportunistic routing (OR) has been proposed for tackling channel fading, which diminishes the routing performance of traditional routing paradigms. Instead of a unique nexthop forwarder selected in traditional multihop routing, OR selects a set of next-hop forwarder candidates that can overhear the packet transmission and continue forwarding it in a prioritized way toward the destination. Packet retransmission occurs only if it is not received by any candidate. The importance of OR for underwater networks arises from the challenges imposed by underwater acoustic communication, which is characterized by strong attenuation and ambient noise, time-varying multipath propagation, and low-speed sound propagation (1500 m/s). These aspects result in a high delay and error rate, temporary loss of connectivity, limited bandwidth capacity, and high energy communication cost. Thus, OR can help mitigate underwater channel effects and enhance the poor underwater acoustic physical links by taking advantage of the broadcast nature of the wireless transmission medium.

A. OPPORTUNISTIC ROUTING

To improve the quality of routing in underwater, different approaches are proposed. Opportunistic routing (OR) is a technique which promises to deliver reliable communication in networks. Compared to cooperative routing, OR proves to be less energy hungry. OR comprises of a forwarding set selection and relay prioritization. If the intended destination fails to receive that packet transmitted by the sender, nodes residing in forwarding set, which have overheard the transmission act as a relay and transmit the data instead. Relay with the highest priority is selected first and so on fig1. The performance of OR based routing protocols depend on how efficiently forwarding set selection and relay prioritization is handled. The drawback of OR is the communication void region. It is a problem which occurs when a particular node cannot forward a packet because it does not have a neighbor in its vicinity through which packet can be delivered to the sink. In such a scenario, the node is deemed to be a void node.

II. RELATED WORKS

S.Zaras.et.al[3] proposed a new clustering technique which works closely in accordance with OR to ensure less number of redundant packets in the network and improved throughput. The nodes are randomly arranged in the network. All nodes get their neighbours location and ID through periodic beaconing. After identifying all neighbours they are categorized into two : lower depth set (LDS) of nodes and higher depth set (HDS) of nodes. A transmitting node finds a node in HDS nodes then it is used for transmission else a cluster beam message

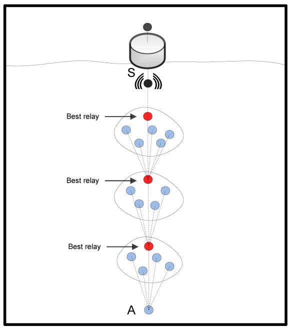

Fig. 1. Opportunistic Routing

is send. If it receives any acknowledgment a suitable node is available in LDS. Selected node In LDS form a cluster with all other nodes that have path to the sink. Then data transmission occurs through the cluster head. If the transmiting node does not find any forwarder node in either HDS or LDS , then the void recovery algorithm is used.

Hsu,et.al [4] proposed an opportunistic routing protocol that maximizing data goodput with end-to end latency. In this protocol retransmission mechanism is not used to decrease end to end latency. Also channel reliability is ensured by opportunistic routing. The UWOR protocol first determines the relay priorities for the forwarding sets. Once the relay priorities are determined the they are formed into cluster based on their priorities. From these clusters one node with highest priority is chosen as the forwarding node. Mainly this protocol maintains one hop reliability to prevent duplications. A time deadline is given for the packet , if any packet cannot reach its deadline then it is dropped.

Void-aware pressure routing (VAPR) [5] uses the depth information of the nodes to forward data packets towards the sea surface. VAPR is a geographic and opportunistic routing protocol where a next-hop forwarder set to continue the packet forwarding is determined from the greedy pressure strategy. In VAPR, each node is aware of the void nodes from the sonobuoys reachability information disseminated in the network via periodic beaconing. Each node uses that information to build a directional (upwards or downwards) path towards some surface sonobuoy. The next-hop forwarding set is selected according to the neighbor forwarding direction, that is, those directions in which there is a match of the forwarding direction with the current forwarder (upward or downward).

The authors in [6] propose a cooperative and opportunistic routing protocol. The surface sink and all the nodes communicate with one another through the regular exchange of beacon signals. A beacon signals contains the ID, depth, hop count and neighbors information of the broadcasting node. This process is done by every node so as no node in the network is left without any neighbor. This controls the data loss due to absence of the neighbor nodes. The set of forwarding nodes for opportunistic routing is selected on the bases of the packet delivery probability and packet advancement that the nodes also share with one another. A trade-off is established between energy consumption and the participant forwarding nodes by using packet holding time. Energy consumption, throughput and latency are improved by the protocol. However, its performance is compromised in sparse condition where the beacon signals do not work efficiently and effectively.

The authors propose an energy efficient cooperative opportunistic routing (EECOR) protocol[7]. A set of forwarding nodes is first selected by the source node and then a single relay node is selected from the set based on fuzzy logic to forward packets to the destination. The protocol is efficient in reducing energy consumption, packets delivery and end-toend delay. However, it has poor performance in sparse conditions when nodes are far apart and selection of a set of relay nodes becomes cumbersome. In addition, the forwarding set of nodes has to be constantly monitored that introduces extra delay in packets forwarding. It is due to the reason that selection of a forwarder set requires communications among the sensor nodes. This becomes challenging with extra delay when the sensor nodes change their positions with water drift. Nodes have not only to know the recent position of one another but have to identify the changes in their positions as well.

III. Proposed system

An efficient data transmission using opportunistic routing protocol for underwater sensor network is proposed.The proposed protocol is combined with geographic routing which utilizes the location information of the neighbors and reachable sonobouys.The main advantage of opportunistic routing is that it allows retransmission if none of the nodes in forwarding set receives the data from the source,Also, in order to avoid unnecessary transmission the low priority nodes suppress their transmission when they know that a high priority node is active in transmission.Most of the existing routing protocols doesnot bother about the presence of a communication void problem. The proposed protocol proposes a recovery method. When any node reaches a communication void region, then that node is no more able forward the node to reach destination.So geographic routing performs a recovery method.

IV. SYSTEM DESIGN

Design of the system consist of four modules

A. *Beaconing*

Periodic beaconing is used to obtain the location information all neighbors and all nearby sonobouys(sink node). The sink node broadcasts a hello message to the underwater containing its sequence number and location ID The nodes that receive the hello message sent acknowledgment to sink node adding its sequence number and ID. The nodes also broadcasts messages ti its neighbors also. Hence every sensor node know its neighbours location and its reachable sonobouys.

B. Candidate Set Selection

The greedy forwarding technique is used to determine the set of neighbors able to continue the forwarding towards respective sonobouys.The basic idea of the greedy forwarding strategy is to forward the packet towards sonobouys through each hop.

C. Forwarder Set Selection

Opportunistic routing is used in this step. The main advantage of opportunistic routing is that it reduces the number of retransmission. Also taking the advantage of shared transmission , each packet is broadcast to a forwarding set composed of several neighbors. Forwarding set is formed based on the distance between the nodes and sonobouys, after finding the forwarding set, the current forwarder node contains the address of next forwarder node in the packet. When packet reached next forwarding set, each node checks the address attached with packet with their own address. If they are not the next forwarder they will suppress their transmission. Low priority node will transmit only if the high priority node fails .

D. Recovery Mode

When the nodes are not possible to forward data by greedy technique, then void node recovery procedure is used. A node which receives a data and cannot be forwarded to the next hop to reach its destination is known as void node ,and the region is known as communication void region. During transmission each node periodically determines the location of its neighbors. If any node that cannot receive any information from two hop nodes,then it came to know that it is in void region and is not able for further transmission. So it announces its void condition to its neighbors and stops beaconing. Then any high priority node in the forwarding set initiates recovery method to find an alternative path in new location.Finally the packet is transmitted through this route to reach the destination.

V. SIMULATION RESULTS

In simulation, we constructed a network with 37 sensor nodes ,4 sonobouys and one monitoring center with a transmission range of 100m. fig.2

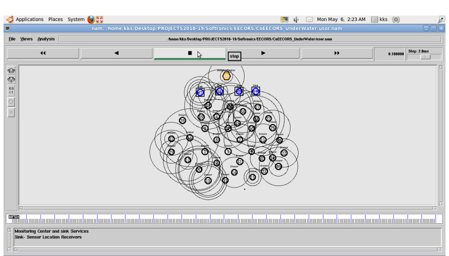

Fig. 2. Network of nodes

We evaluate the performance of the proposed system against simple geographic routing.Opportunistic routing, which considers the distance and location of the nodes is a solution for non delay Routing Fig.3 shows the results of Time Vs End to end delay. The blue line shows the result of existing algorithm and red is the proposed one. From the results we can see that proposed one has slightly lower delay.

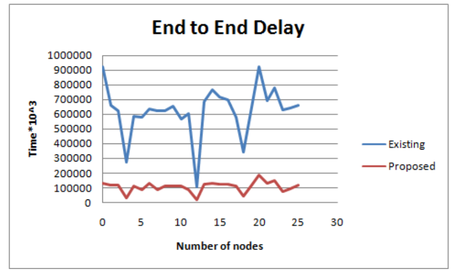

Fig. 3. End to End Delay

A. Life Time Ratio

We can see in fig4 that the life time of nodes in more in proposed

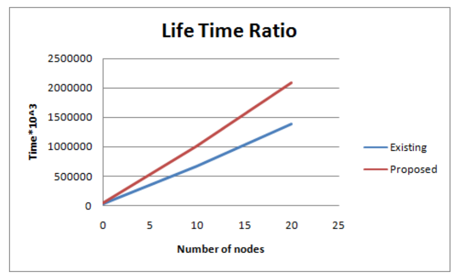

Fig. 4. Life Time Ratio

B. Energy Consumption

Fig.5 clearly shows that the proposed scheme consumes less energy during transmission.

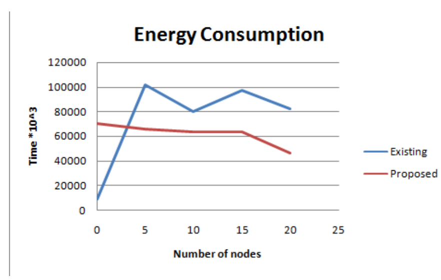

Fig. 5. Energy Consumption

VI. CONCLUSION

In this paper,we proposed an Efficient data transmission using opportunistic routing.The Opportunistic routing combines with geographic routing which utilizes its location identification property for efficient data transmission. The broadcasting nature of opportunistic routing reduces the number of retransmission, hence the total energy consumption is also reduced.Communication void problem is solved by recovery method by assigning another route in different location.Moreover, the opportunistic routing improves the life time of the networks and reduces End to End delay.

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