A Review of Void Node Detection Techniques for Underwater WSN

Sampada Kumbhalkar[1], Prof. Roshani Talmale[2]
[1]PG Student (M Tech IIIrd Sem) Department of Computer Science and Engineering, TGPCET, Nagpur India
[2]HOD, Department of Computer Science and Engineering, TGPCET, Nagpur India

Abstract- Underwater wireless sensor networks (UWSNs) have been showed as a promising technology to monitor and explore the ocean of traditional undersea wire-line instruments. Nevertheless, the data gathering of UWSNs is severely limited because of the acoustic channel communication characteristics. One way to improve the data collection in UWSNs is through the design of routing protocols considering the unique characteristics of the underwater acoustic communication and the highly dynamic network topology. In this paper, we propose the GEDAR routing protocol for UWSNs. GEDAR is an anycast, geographic and opportunistic routing protocol that routes data packets from sensor nodes to multiple sonobuoys (sinks) at the sea's surface. When the node is in a communication void region, GEDAR 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 GEDAR 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.

Keywords- Underwater sensor network, void node, geographic routing, routing protocol

I. INTRODUCTION

OCEANS represent more than 2/3 of the Earth's surface. These environments are extremely important for human life because their roles on the primary global production, carbon dioxide (CO_2) absorption and Earth's climate regulation, for instance.

In this context, underwater wireless sensor networks (UWSNs) have gained the attention of the scientific and industrial communities due their potential to monitor and explore aquatic environments. UWSNs have a wide range of possible applications such as to monitoring of marine life, pollutant content, geo-logical processes on the ocean floor, oilfields, climate, and tsunamis and seaquakes; to collect oceanographic data, ocean and offshore sampling, navigation assistance, and mine recognition, in addition to being utilized for tactic surveillance applications .Acoustic communication has been considered as the only feasible method for underwater communication in UWSNs. High frequency radio waves are strongly absorbed in water and optical waves suffer from heavy scattering and are restricted to short-range-line-of-sight applications. Nevertheless, the underwater acoustic channel introduces large and variable delay as compared with radio frequency (RF) communication, due to the speed of sound in water that is approximately $1.5*10^3$m/s (five orders of magnitude lower than the speed of light ($3*10^8$m/s)); temporary path loss and the high noise resulting in a high bit error rate; severely limited bandwidth due to the strong attenuation in the acoustic channel and multipath fading; shadow zones; and the high communication energy cost, which is of the order of tens of watts. In this context, geographic routing paradigm seems apromising methodology for the design of routing protocols for UWSNs . Geographic routing, also called of position-based routing, is simple and scalable. It does not require the establishment or maintenance of complete routes to the destinations. Moreover, there is no need to transmit routing messages to update routing path states. Instead, route decisions are made locally. At each hop, a locally optimal next-hop node which is the neighbour closest to the destination is selected to continue forwarding the packet. This process proceeds until the packet reaches its destination. Geographic routing can work together with opportunistic routing (OR) (geo-opportunistic routing) to improve data delivery and reduce the energy consumption relative to packet retransmissions. Using opportunistic routing paradigm, each packet is broadcast to a forwarding set composed of neighbours. In this set, the nodes are ordered according to some metric, defining their priorities. Thus, a next-hop node in the for-warding set that correctly received the packet, will forward it only whether the highest priority nodes in the set failed into do so. The next-hop forwarder node will cancel a scheduled transmission of a packet if it hears the transmission of that packet by a higher priority node. In our paradigm, the packet will be retransmitted only if none of the neighbours in the set receives it. The main disadvantage of geo-opportunistic routing is the communication void region problem. The communication void region problem occurs whenever the current forwarder node does not have a neighbour node closest to the destination than itself, i.e., the current forwarder node is the closest one to the destination. The node located in a communication void region is called void node. Whenever a packet gets stuck in a void node, the routing protocol should attempt to route the packet using some recovery method or it should be discarded.

II. RELATED WORK

In this section, we discuss some routing protocols which address void node detection and recovery, energy efficiency and lifetime maximization in UWSNs. The classification on routing protocols is shown in Figure 1

A. Light Weight Depth Based Routing Protocol : Safia Gul, Sana Hoor Jakhio and Imran Ali Jokhio in[1] discussed a light weight depth based routing (LDBR) based on depth information of sensor nodes which efficiently forwards the packet to the water surface and reduces the energy consumption. The decision to forward a packet in LDBR is based on the measurement of two parameters those are the depth of the sender sensor node and the relay sensor node.A light-weight and robust depth based routing (LDBR) is developed as an extension to the actual DBR protocol.

B. Depth Based Routing Protocol : Hai Yan, Zhijie Shi, and Jun-Hong Cui proposed a depth based routing (DBR) in [2]. DBR uses a greedy approach to deliver packets to the sinks at the water surface. DBR well utilizes the general underwater sensor network architecture: data sinks are usually situated at the water surface. Thus based on the depth information of each sensor, DBR forwards data packets greedily towards the water surface (i.e., the plane of data sinks). In DBR, a data packet has a field that records the depth information of its recent forwarder and is updated at every hop. The basic idea of DBR is as follows. When a node receives a packet, it forwards the packet if its depth is smaller than that embedded in the packet. Otherwise, it discards the packet

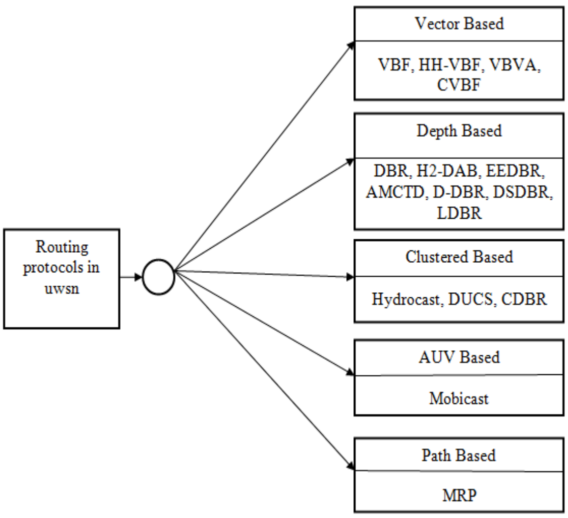

Fig.1: Classification of Routing Protocols for UWSN

C. Vector Based Forwarding Protocol : Peng Xie1, Jun-Hong Cui1, and Li Lao2 proposed a vector based forwarding in [3]. Vector-Based Forwarding (VBF) protocol addresses the node mobility issue in a scalable and energy-efficient way. In VBF, each packet carries the positions of the sender, the target and the forwarder (i.e., the node which forwards this packet). The forwarding path is specified by the routing vector from the sender to the target. VBF is essentially a geographic routing protocol. To our best knowledge, VBF is the first effort to apply the geo-routing approach in underwater sensor networks

D. Clustering Depth based Routing Protocol : In [4] Clustering Depth Based Routing is based on existing Depth Based Routing (DBR) protocol. In DBR, routing is based on the depth of the sensor nodes: the nodes having less depth are used as forward nodes and consumes more energy as compared to the rest of nodes. As a result, nodes nearer to sink dies first because of more load. In cDBR, cluster based approach is used. In order to minimize the energy consumption, load among all the nodes are distributed equally. The energy consumption of each node is equally utilized as each node has equal probability to be selected as a Cluster Head (CH). This improves the stability period of network from DBR. In cDBR Cluster Heads (CHs) are used for forwarding packets that maximizes throughput of the network.

E. Hop-by-Hop Vector Based Forwarding (HH-VBF) Protocol : Nicolas Nicolaou , Andrew See , Peng Xie , Jun-Hong Cui†, Dario Maggiorini in [5] discussed a hop-by-hop vector-based forwarding protocol. It uses the same concept of routing vector as VBF. However, instead of using a single virtual pipe from the source to the sink, HH-VBF defines a different virtual pipe around the per-hop vector from each forwarder to the sink. In this way, each node can adaptively make packet forwarding decisions based on its current location. it can significantly improve the robustness of packet delivery in sparse networks.

F. Mobicast Routing Protocol : In [6] the energy efficient Mobicast routing protocol is used in underwater sensor network.. The mobicast is power-saving 3D routing protocol. In mobicast the apple peel scheme is proposed to resolve the problem of unpredictable 3D holes. It is an AUV based routing protocol.

G. Multi-Layered Routing Protocol: It is an path based routing protocol. In [7]Multi-layer Routing Protocol (MRP) is proposed for underwater wireless sensor network. MRP routing protocol is used to resolve the problem of localization and enhances the battery life of ordinary sensor node.

H. Optimized Depth-Based Routing Protocol : Tanveer Ahmed, Maham Chaudhary, M. Kaleem and Sajid Nazir in [8] discussed a Optimized Depth-Based Routing Protocol. An Optimized Depth Based Routing (ODBR) scheme which ensures uniform energy consumption amongst sensor nodes and hence maximizes network lifetime. It allocate more initial energy to nodes that have higher traffic load compared to the ones with less traffic load. The results show that this strategy helps to balance energy utilization amongst sensor nodes and improves lifetime of the network.

I. Directional Flooding-Based Routing Protocol : Daeyoup Hwang, Dongkyun Kim [9] proposed a DFR protocol. DFR relies on a packet flooding technique to increase the reliability. However, the number of nodes which flood a packet is controlled in order to prevent a packet from flooding over the whole network and the nodes to forward the packet are decided according to the link quality. In addition, DFR also addresses a well-known void problem by allowing at least one node to participate in forwarding a packet. Their simulation study using ns-2 proves that DFR is more suitable for UWSNs especially when links are prone to packet loss.

III. CHALLENGES IN UWSN

There are various challenges in underwater wireless sensor network as mentioned below.

A. The impact of nodes movement on the void area have not been investigated thoroughly in the literature. The void area is continuously reshaped or move with the water current [30]. The void-handling techniques also suffer from lack of a realistic model for node mobility. Most of the existing protocols assume that nodes are mobile at a low rate or they are stationary. Therefore, investigating the impact of node movement on the void-handling techniques seems to be a challenging issue

B. Existing void-handling techniques have only focused on the network layer. There is an cross layer design issue in UWSN.

C. Dealing with a void area within a geocast region is still a challenging issue. The existing model involves many relay nodes to cover the geocast region with a larger area.

D. In underwater communication more power require because for exchanging data inside in water need more electricity require.

E. Reliability is one of the major design issues for reliable delivery of sensed data to the surface sink is a challenging task compare to forwarding the collected data to the control center.

F. Battery power is the major issues which mainly comes underwater sensor network because many underwater devices working throw the battery suppose if a underwater sensor device is not working so underwater charging is not possible or it may not be charged.

G. In underwater sensor another problem is issue is related to bandwidth because bandwidth size is limited.

H. Node mobility is also another concern which comes under routing protocol for underwater sensor network because if they are not anchored at the bottom of the sea. This situation conclusion in a dynamic topology.

I. High propagation delays are the major factor of routing protocol for underwater sensor network.

IV. EXISTING WORK

- Depth-based routing (DBR) routing protocol is the first underwater sensor network routing protocol that uses node depth information to route data packets.
- The basic idea of DBR is to forward data packets greedily towards the water surface. Thus, packets can reach multiple data sinks deployed at the water surface. During the forwarding, the current sender broadcasts the packet. After receiving it, if the receiver is closer to the water surface, it becomes qualified as a candidate to forward the packet. Otherwise, it will discard the packet.
- Node priority is given by means of the holding time. The farther the candidate node is on the current forwarder, the lower is its holding time. After the holding time, the packet is broadcast if the node has not received the same data from a neighbor.
- The impacts of nodes movement on the void area have not been investigated thoroughly.
- The existing model involves many relay nodes to cover the geocast region with a larger area.
- In depth based routing, the void node is determined based on the depth adjustment of the neighboring nodes towards the water surface.
- Cluster depth based routing is used to minimize the energy consumption.
- Hop to Hop Dynamic Addressing based Routing protocol is use to maximize the delivery ratio, optimize energy consumption.
- Existing void-handling techniques have only focused on the network layer.

V. PROPOSED WORK

- GEDAR is an anycast, geographic and opportunistic protocol that tries to deliver a packet from a source node to some sonobuoys. During the course, GEDAR uses the greedy forwarding strategy to advance the packet, at each hop,towards the surface sonobuoys.
- A recovery mode procedure based on the depth adjustment of the void node is used to route data packet when it get stuck at a void node. The proposed routing protocol employs the greedy for-warding strategy by means of the position information of the current forwarder node, its neighbors, and the known sonobuoys, to determine the qualified neighbors to continue forwarding the packet towards some sonobuoys.
- Despite greedy forwarding strategy being a well known and used next-hop forwarder selection strategy, GEDAR considers the anycast nature of underwater routing when multiple surface sonobuoys are used as sink nodes.
- GEDAR overcomes the problem of the void region by depth adjustment technology.
- The impacts of nodes movement on the void area have not been investigated thoroughly. The void area is continuously reshaped or move with the water current[12]. We will work for investigating the impact of node movement.
- With a cross-layer design, the number of collisions can be managed more efficiently over the MAC layer, while the results of some tasks, such as beaconing, can be shared between layers.
- Dealing with a void area within a geocast region is an challenging issue. The existing model involves many relay nodes to cover the geocast region with a larger area. Hence, we design the new void-handling techniques to further decrease the number of involving nodes

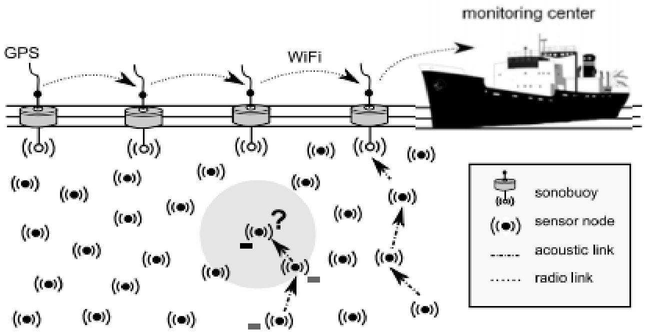

Fig.2: Architecture of UWSN with a void region problem

As shown in Fig. 2 we have a large number of mobile underwater sensor nodes at the ocean bottom and sonobuoys, also named sinks nodes, at the ocean surface. They move as a group with the water current [16]. It will transfer the data from sonobuoy to monitoring center.

VI. CONCLUSION

Routing for UWSNs has been one of the most important issues in underwater applications. Over the past few years, many routing protocols have been proposed for UWSNs based on the unique characteristics of UWSNs. In this article we present a detailed survey of underwater routing protocols. Each routing protocol is carefully analyzed, and its advantages, disadvantages, and performance issues are highlighted. We shows how the void nodes are detected and recover by using GEDAR routing protocol.

VII. REFERENCES

[1]. Safia Gul, Sana Hoor Jokhio, Imran Ali Jokhio (2018), "Light-weight depth-based routing for underwater wireless sensor network", International Conference on Advancements in Computational Sciences (ICACS) .

[2]. Yan, H., Z.J. Shi, and J.-H. Cui, "DBR: depth-based routing for underwater sensor networks", in NETWORKING 2008 Ad Hoc and Sensor Networks, Wireless Networks, Next Generation Internet. 2008, Springer. p. 72-86.

[3]. Xie, P., J.H. Cui, and L. Lao, "VBF: Vector-based forwarding protocol for underwater sensor networks" Networking 2006: Networking Technologies, Services, and Protocols; Performance of Computer and Communication Networks; Mobile and Wireless Communications Systems, 2006. 3976: p. 1216-1221

[4]. Tanveer Khan, Israr Ahmad, Waqas Aman, Irfan Azam, Zahoor Ali Khan, Umar Qasim, Sanam Avais, Naddem Javaid (2016), "Clustering depth based routing for underwater wireless sensor networks", IEEE 30th International Conference on Advanced Information Networking and Applications (AINA).

[5]. Nicolaou, N., et al., "Improving the robustness of location-based routing for underwater sensor networks". Oceans 2007 - Europe, Vols 1-3, 2007: p. 1485-1490.

[6]. Chen, Y.-S. and Y.-W. Lin, "Mobicast routing protocol for underwater sensor networks". Sensors Journal, IEEE, 2013. 13(2): p. 737-749.

[7]. Wahid, A., et al., "MRP: A Localization-Free Multi-Layered Routing Protocol for Underwater Wireless Sensor Networks". Wireless Personal Communications, 2014. 77(4): p. 2997-3012.

[8]. Tanveer Ahmed ,Maham Chaudhary, M. Kaleem, Sajid Nazir (Dec. 2016), "Optimized Depth-Based Routing Protocol for Underwater Wireless Sensor Networks", IEEE International Conference on Open Source Systems & Technologies (ICOSST).

[9]. Daeyoup Hwang, Dongkyun Kim, "DFR: Directional Flooding-Based Routing Protocol for Underwater Sensor Networks". Oceans 2008 .

[10]. Seyed Mohammad Ghoreyshi, Alireza Shahrabi, and Tuleen Boutaleb (2016), "An Underwater Routing Protocol with Void Detection and Bypassing Capability", IEEE 31st International Conference on Advanced Information Networking and Applications (AINA).

[11]. Rodolfo W. L. Coutinhoa, Azzedine Boukercheb, Luiz F. M. Vieiraa, Antonio A. F. Loureiro "A Novel Void Node Recovery Paradigm for Long-Term Underwater Sensor Networks", Ad Hoc Networks Volume 34, November 2015, Pages 144-156.

[12]. Seyed Mohammad Ghoreysh, Alireza Shahrabi , Tuleen Boutaleb(2017), "Void-Handling Techniques for Routing Protocols in Underwater Sensor Networks: Survey and Challenges", IEEE Communications Surveys & Tutorials Volume: 19 , Issue: 2, Secondquarter 2017.

[13]. Peng Xie, Zhong Zhou, Zheng Peng, Jun-Hong Cui, and Zhijie Shi(2009), "Void Avoidance in Three-Dimensional Mobile Underwater Sensor Networks", WASA 2009: Wireless Algorithms, Systems, and Applications pp 305-314.

[14]. Youngtae Noh, Uichin Lee, Paul Wang, Brian Sung Chul Choi, and Mario Gerla (2013), "VAPR: Void-Aware Pressure Routing for Underwater Sensor Networks", IEEE Transactions on Mobile Computing Volume: 12 , Issue: 5 , May 2013

[15]. Hao Qin, Zhiyong Zhang, Rui Wang, Xiaojun Cai, and Zhiping Jia (2017), "Energy-Balanced and Depth-Controlled Routing Protocol for Underwater Wireless Sensor Networks", International Conference on Algorithms and Architectures for Parallel ProcessingICA3PP 2017: Algorithms and Architectures for Parallel Processing pp 115-131.

[16]. Rodolfo W. L. Coutinho ; Azzedine Boukerche ,Luiz F. M. Vieira , Antonio A. F. Lour(2015), "Geographic and Opportunistic Routing for Underwater Sensor Network", IEEE Transactions on Computers, Volume: 65 Issue: 2 pp 548 - 561