Enhanced Routing Protocol for Underwater Sensor Networks

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Abstract-- Opportunistic void avoidance routing (OVAR) protocol has been proposed for UWSNs. It is an anycast, geographic and opportunistic routing protocol. Increasing attention has recently been devoted to underwater sensor networks (UWSNs) because of their capabilities in the ocean monitoring and resource discovery. UWSNs are faced with different challenges, the most notable of which is perhaps how to efficiently deliver packets taking into account all of the constraints of the available acoustic communication channel. In this paper, we propose an enhanced routing protocol, called opportunistic void avoidance routing (OVAR). This address the void problem and the energy-reliability trade-off in the selection of forwarding set. OVAR takes advantage of distributed beaconing, constructs the adjacency graph at each hop and selects a forwarding set that holds the best trade-off between reliability and energy efficiency. The unique features of OVAR in selecting the candidate nodes in the vicinity of each other leads to the resolution of the hidden node problem.

Keywords-- *Underwater sensors, opportunistic routing.*

I. INTRODUCTION

Wireless Sensor Network (WSN) is a collection of spatially deployed wireless sensors by which to monitor various changes of environmental conditions (e.g., forest fire, air pollutant concentration, and object moving) in a collaborative manner without relying on any underlying infrastructure support. Recently, a number of research efforts have been made to develop sensor hardware and network architectures in order to effectively deploy WSNs for a variety of applications. Due to a wide diversity of WSN application requirements, however, a general-purpose WSN design cannot fulfil the needs of all applications. Many network parameters such as sensing range, transmission range, and node density have to be carefully considered at the network design stage, according to specific applications. To achieve this, it is critical to capture the impacts of network parameters on network performance with respect to application specifications.

Underwater sensor networks consist of number of underwater sensor nodes or just called sensor nodes which are equipped with acoustic transceivers that enable them to communicate with each other to perform collaborative sensing tasks over a given area from shallow water and seabed. USNs have many potential applications in ocean monitoring, such as current flow, oil pollution, seismic and tsunamis monitoring, to supply the high spatiotemporal resolution capability [1]-[3]. Nowadays, resource discovery in the underwater environment has become one of the important goals to reduce dependency on land resources.

However, it is a difficult and costly task to monitor and discover the underwater environment. Underwater sensor networks (UWSNs) have recently attracted much attention due to their significantly ability in ocean monitoring and resource discovery. Due to restrictions on the use of radio waves, acoustic transmission is most commonly used in the underwater environment. Required data are collected by the underwater sensors and directed towards the sink on the surface. Afterwards, the sink can transmit collected information to the monitoring centre via satellite for further analysis, . Some unique features of UWSNs make data forwarding in this environment a challenging task. This includes node movement, low available bandwidth, slow propagation speed, high deployment cost and a lossy environment. It also should be mentioned that the Global Positioning System (GPS) cannot be used in an underwater environment as a localization system because of the quick attenuation of its waves in water. Furthermore, nodes cannot be aware of their positions by pre-configuration, because they are not stationary due to the water current. Nevertheless, the depth of each node in the water can be estimated through an embedded pressure gauge.

The communication channel quality varies at different ocean depths under varying pressure, temperature and salinity. The limited bandwidth of acoustic transmission also reduces the efficiency of communication between underwater nodes. Generally, nodes are considered connected to each other if the transferred signal between them can be decoded without any error. In terms of energy consumption, there are also some restrictions due to the difficulties of replacing or recharging batteries, which are the main energy supply for the nodes, in the adverse and often deep underwater environment. In addition, underwater sensors consume more energy than terrestrial sensors because they use acoustic communication. Thus, employing an efficient routing protocol is quite essential to prolong the whole network lifetime. Opportunistic routing is a promising scheme in sensor networks because of its remarkable ability to increase transmission reliability and network throughput. In this way, packet forwarding is enhanced by taking advantage of simultaneous packet reception of neighboring nodes of a forwarding node and their collaboration to forward the packet. However, applying a terrestrial opportunistic routing protocol in UWSNs without considering its specific features is not possible in most cases. In the underwater environment, forwarding set selection without a hidden terminal and prioritizing them are affected by features like a high error bit rate, energy consumption, node movement and slow propagation speed. Furthermore, some terrestrial opportunistic protocols are GPS-based, which make them inappropriate for the GPS-denied underwater environment. The redundant packet transmission issue is one of the influential factors on the opportunistic routing performance.

When a group of candidate nodes are selected to collaboratively forward a packet while placed out range of each other, they cannot notice the transmission of any packet by other candidates. Thus, each forwarding node sets its forwarding timer and forwards the packet separately, resulting in more collisions and energy consumption. If the forwarding nodes are selected within the transmission range of each other (without any hidden node), this increases the chance of hearing the packet transmission by other higher priority candidate nodes, although there is no absolute guarantee, because of other factors, like shadow zone occurrence. Nevertheless, some underwater routing protocols (e.g., Adaptive Hop-by-Hop

Vector-Based Forwarding (AHH-VBF), HydroCast, Void-Aware Pressure Routing (VAPR)) take advantage of a group of forwarding nodes in the vicinity of each other with a timer-based coordination to eliminate the duplicated packet problem in the routing layer.

It should be noticed that the hidden terminal problem still may exist in the other layers of the network, which is out of the scope of this work. In this paper, we propose a new opportunistic void avoidance routing (OVAR) protocol in order to increase the throughput and reliability in the sparse and lossy underwater environment while imposing less overhead in comparison to those protocols using high cost localization to obtain their geographic coordinates in this environment. Furthermore, unlike the stateful protocols, which require global topology information, OVAR only depends on the information provided by one-hop neighboring nodes. Each forwarding node selects its forwarding set with the aid of information obtained from the distributed beaconing mechanism initiated from the sink node. OVAR is able to bypass void areas before being stuck in a void node and simultaneously selects a group of candidate nodes with the highest advancement towards the sink. The forwarding set is selected in such a way that its members can hear each other and suppress duplicate transmissions, which leads to a decrease in energy consumption and congestion. In order to prevent energy wasting in a high-density forwarding set, the number of receiving nodes can be appropriately adjusted.

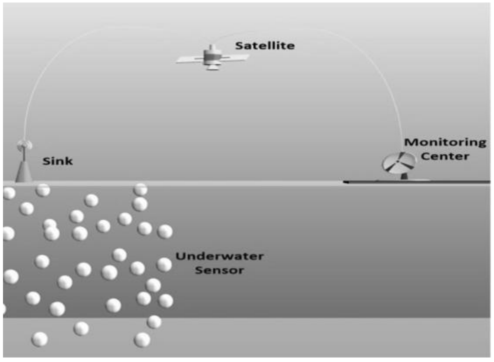

Figure 1: derwater Sensor Network

Underwater sensor networks are envisioned to enable applications for oceanographic data collection, pollution monitoring, offshore exploration, disaster prevention, assisted navigation and tactical surveillance applications. Multiple unmanned or autonomous underwater vehicles (UUVs, AUVs), equipped with underwater sensors, will also find application in exploration of natural undersea resources and gathering of scientific data in collaborative monitoring missions. To make these applications viable, there is a need to enable underwater communications among underwater devices. Underwater sensor nodes and vehicles must possess self-configuration capabilities, i.e., they must be able to coordinate their operation by exchanging configuration, location and movement information, and to relay monitored data to an onshore station. Wireless underwater acoustic networking is the enabling technology for these applications. Under Water Acoustic Sensor Networks (UW-ASNs) consist of a variable number of sensors and vehicles that are deployed to perform collaborative monitoring tasks over a given area. To achieve this objective, sensors and vehicles self-organize in an autonomous network which can adapt to the characteristics of the ocean environment

II. LITERATURE REVIEW

Underwater wireless sensor networks (UWSNs) have been showed as a promising technology to monitor and explore the oceans in lieu of traditional undersea wireline instruments [1]. Nevertheless, the data gathering of UWSNs is still 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, Rdolfo et al 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.

Recent advances in environmental energy harvesting technologies have provided great potentials for traditional battery-powered sensor networks to achieve perpetual operations. Due to dynamics from the temporal profiles of ambient energy sources, most of the studies so far have focused on designing and optimizing energy management schemes on single sensor node, but overlooked the impact of spatial variations of energy distribution when sensors work together at different locations [2]. To design a robust sensor network, it has beedn used mobility to circumvent communication bottlenecks caused by spatial energy variations. Wang et al employ a mobile collector, called SenCar to collect data from designated sensors and balance energy consumptions in the network. To show spatial-temporal energy variations, first they conduct a case study in a solar-powered network and analyze possible impact on network performance. Next, the system presents a two-step approach for mobile data collection. First, adaptively select a subset of sensor locations where the SenCar stops to collect data packets in a multi-hop fashion. Wang et al develop an adaptive algorithm to search for nodes based on their energy and guarantee data collection tour length is bounded. Second, focus is on designing distributed algorithms to achieve maximum network utility by adjusting data rates, link scheduling and flow routing that adapts to the spatial-temporal environmental energy fluctuations. Finally, numerical results indicate the distributed algorithms can converge to optimality very fast and validate its convergence in case of node failure.

In wireless sensor networks, sensor nodes are usually self-organized, delivering data to a central sink in a multi-hop manner. Reconstructing the per-packet routing path enables fine-grained diagnostic analysis and performance optimizations of the network. The performances of existing path reconstruction approaches, however, degrade rapidly in large scale networks with lossy links. Gao et al presents Pathfinder, a robust path reconstruction method against packet losses as well as routing dynamics. At the node side, Pathfinder exploits temporal correlation between a set of packet paths and efficiently compresses the path information using path difference. At the sink side, Pathfinder infers packet paths from the compressed information and employs intelligent path speculation to reconstruct the packet paths with high reconstruction ratio. Gao propose a novel analytical model to analyze the performance of Pathfinder and further evaluate

Pathfinder compared with two most related approaches using traces from a large scale deployment and extensive simulations.

Marchang et al reduce the duration of active time of the IDSs without compromising on their effectiveness. To validate the proposed approach, model the interactions between IDSs as a multi-player cooperative game in which the players have partially cooperative and partially conflicting goals.

III. PROPOSED SYSTEM

The proposed routing protocol employs the greedy forwarding strategy by means of the position information of the current forwarder node, its neighbours, and the known sonobuoys, to determine the qualified neighbours to continue forwarding the packet towards some sonobuoys.

OVAR Routing protocol is an any cast, that tries to deliver a packet from a source node to some sonobuoys(sink).The proposed routing protocol employs the greedy forwarding strategy by means of the position information of the current forwarder node, its neighbours, and the known sonobuoys, to determine the qualified neighbours to continue forwarding the packet towards some sonobuoys. For that we need to find a next-hop forwarder selection to forward the data packet. In traditional multi hop routing; only one neighbour is selected to act as a next-hop forwarder.

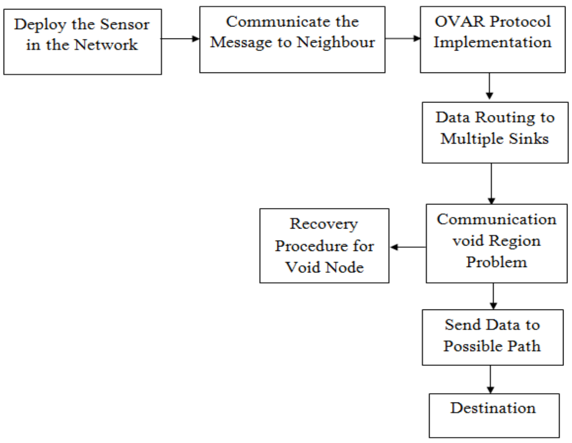

Figure 2: OVAR Model

In opportunistic routing, takes shared transmission medium, each packet is broadcast to a forwarding set composed of several neighbours. The packet will be retransmitted only if none of the neighbours in the set receive it. During the transmissions, each node locally determines if it is in a communication void region by examining its neighbourhood. If the node is in a communication void region, that is, if it does not have any neighbour leading to a positive progress towards some surface sonobuoy, it announces its condition to the neighbourhood and waits the location information of two hop nodes in order to decide which new depth it should move into and the greedy forwarding strategy can then be resumed. After, the void node determines a new depth based on 2-hop connectivity such that it can resume the greedy forwarding.

A. Network Creation

The network is framed with multiple sinks on the surface of sea level. Each Sonoboys (sinks) is equipped with a GPS and uses periodic beaconing to disseminate its location information to the underwater sensor nodes. The monitoring center keep tracks the periodic information's from sonoboys.

B. Routing

Packet forwarding is more likely to be successful if packets are relayed over multiple short distances instead of traversing over long distances. The GEDAR (geographic and opportunistic routing) protocol is used for communication recovery over void region. The problem occurs whenever the current forwarder node does not have a neighbour nodes closet to the sonoboys. To avoid unnecessary transmissions, low priority nodes suppress their transmissions whenever they detect that the same packet was sent by a high priority node.

C. Topology Control Algorithm

The aim of the topology control algorithm is to move void nodes to new depths to resume the Geographic routing whenever it is possible. The depth adjustment is based on the neighbour nodes closet to the sonoboys location in order to organize the network topology and improve the routing task. The current forwarder node forward the packet to neighbour node closet to the sink based upon the energy based routing.

a. Advantages TCA

1. Energy consumption is less.
2. Packet delivery ratio is increased.
3. Throughput response is increased.

It is compatibles in hard and difficult mobile scenarios of very sparse and very dense networks and for high network traffic loads. Improves the network performance when compared with existing underwater routing protocols Improve the data routing in underwater sensor networks.

IV. EXPERIMETNAL RESULTS

Network Simulator (NS2) is a discrete event driven simulator developed at UC Berkeley. It is part of the VINT project. The goal of NS2 is to support networking research and education. It is suitable for designing new protocols, comparing different protocols and traffic evaluations. NS2 is developed as a collaborative environment. It is distributed freely and open source. A large amount of institutes and people in development and research use, maintain and develop NS2. This increases the confidence in it. Versions are available for FreeBSD, Linux, Solaris, Windows and Mac OS X.

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation.

CONCLUSION AND FUTURE ENHANCEMENTS

In this work, we proposed and evaluated the OVAR routing protocol to improve the data routing in underwater sensor networks. OVAR is a simple and scalable geographic routing protocol that uses the position information of the nodes and takes advantage of the broadcast communication medium to greedily and opportunistically forward data packets towards the sea surface sonobuoys.

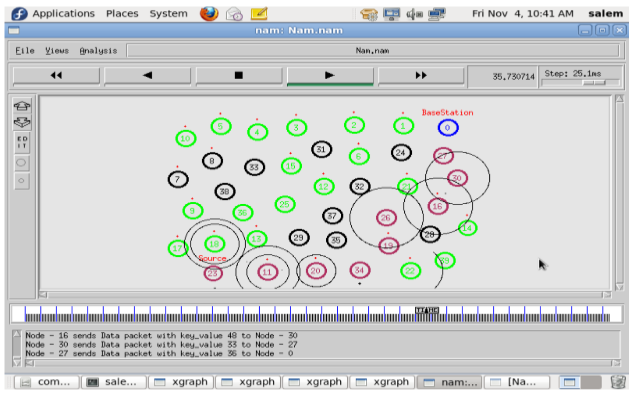

Figure 2: Packed Data

Furthermore, OVAR provides a novel depth adjustment based topology control mechanism used to move void nodes to new depths to overcome the communication void regions.

As future work to investigate the relationship between the opportunistic data forwarding and network energy balance based on the residual energy distribution in the entire network.

References

[1] P. Xie, Z. Zhou, Z. Peng, J.-H. Cui, and Z. Shi, “Void avoidance in three-dimensional mobile underwater sensor networks,” in Wireless Algorithms, Systems, and Applications, pp. 305–314, Springer, 2009.

[2] H. Yu, N. Yao, and J. Liu, “An adaptive routing protocol in underwater sparse acoustic sensor networks,” Ad Hoc Networks, 2014.

[3] R. W. Coutinho, A. Boukerche, L. F. Vieira, and A. A. Loureiro, “A novel void node recovery paradigm for long-term underwater sensor networks,” Ad Hoc Networks, 2015.

[4] Rodolfo W.L. Coutinho, Azzedine Boukerche, Luiz F.M. Vieira, and Antonio A.F. Loureiro “Geographic and Opportunistic Routing for Underwater Sensor Networks” IEEE Transactions on Computers, Vol. 65, no. 2, Feb 2016.

[5] Cong Wang, Songtao Guo, and Yuanyuan Yang “An Optimization Framework for Mobile Data Collection in Energy-Harvesting Wireless Sensor Networks” DOI 10.1109/TMC.2016.2533390, IEEE.

[6] Yi Gao, Student Member, IEEE, Wei Dong, Member, IEEE, Chun Chen, Member, IEEE, Jiajun Bu, Member, IEEE, and Xue Liu, Member, IEEE, “Towards Reconstructing Routing Paths in Large Scale Sensor Networks” DOI 10.1109/TC.2015.2417564, IEEE.

[7] Ningrinla Marchang, Member, IEEE, Raja Datta, Senior Member, IEEE, and Sajal K. Das, Fellow, IEEE “A Novel Approach for Efficient Usage of Intrusion Detection System in Mobile Ad Hoc Networks” IEEE Transactions on Vehicular Technology.