NHSEMH - 2023
2nd National Conference on New Horizons in Science, Engineering, Management and Humanities
International Journal of Scientific Research in Science and Technology
Print ISSN: 2395-6011 | Online ISSN: 2395-602X (www.ijsrst.com)

Comparative Study of Routing Protocols for Underwater Wireless Sensor Network

Suresh Wati, Nitin Rakesh, Parmanand Astya
PhD Scholar, Department of Computer Science & Engineering School of Engineering, Sharda University and IIMT College of Engineering, Greater Noida, Uttar Pradesh, India

ABSTRACT

Bandwidth restrictions, mobility of nodes, limitations on battery power, interference and a louder noise, area of shadow, detector or sensor node movements with a strong current of water, a high fault rate, debilitation, imersion, fauling and erosion, as well as a long and variable propagation delay are all factors that make the undersea environment is incredibly demanding and unpredictably unpredictable.This research examines a number of protocols for resolving node mobility difficulties, as well as determining which is the most efficient among them. Node mobility is a major issue that has arisen as a result of the mobile nature of nodes. During communication, the source and Environmental variables cause destination nodes to relocate from their initial places, resulting in a communication breakdown.

KEYWORDS- COMMUNICATION ISSUES, COMMUNICATION NETWORK, COMMUNICATION CARRIERS, UWSN, ROUTING PROTOCOLS

I. INTRODUCTION

Wireless sensor networks come in a variety of shapes and sizes. A subclass of wireless sensor networks is the UWSN. It enables communication via wireless between nodes of sensors and self-driving underwater vehicles (AUVs) positioned underwater to execute collaborative activities via an audio link across a defined area. The world's first wireless underwater sensor network was built in the United States at the end of WWII as a communication method for submarines. In the 8-11 kHz frequency, Analogue modulation was utilised in this communication system. Vehicle-to-vehicle communication is utilized for security and acquiring information about the maritime environment. In underwater circumstances, communication performance is solely dependent on an efficient and reliable routing mechanism. Routing protocols are the most important need for data routing in a network. Underwater wireless sensor nodes are used to store data gathering of the underwater world, locating an oil fields as well as underwater items, sampling of the ocean, environmental monitoring, and sensor nodes provide information when a disaster occurs. They are also used to avoid disasters. It is used to detect pollution in rivers and the sea. It's used to keep track of the weather and compile ocean statistics. Communication problems in the underwater acoustic network: Underwater, bandwidth is constrained, Bit error rates are high, and battery power is restricted. Because of consumption, energy efficiency is a concern and dependability, as well as node mobility and the probability of sensor node failure is extremely high. With a variety of suggested geographical routes algorithms utilised in UWSN, solve the difficulties mobility of node, a long propagation time and a high error rate.

II. RELATED WORK

2010 (Dario and colleagues) For UWSNs, they've proposed a multimedia pass protocol. New submerged applications like as photograph and video acquisition, tactical and coast observation and classification, and catastrophe avoidance will be possible. For Location aid for underwater sensors, they propose a " Algorithm for Anchor-Free Localization " (Liute and al., 2012). UWSN's fixed and mobile nodes were utilised in this strategy. It creates an algorithm structure using data from neighbouring nodes. The wireless sensor nodes have a limited data transfer capacity (bandwidth) as well as a propagation delay. Sensor nodes require a lot of energy to keep all sorts of communications running due to their limited power of battery. (Dini and colleagues, 2011). They've got to cope with the issue of undersea vessel coordination in a secure manner. They created a secure communication suit that includes vehicle validation and privacy. All conversations are likewise protected by the suit's integrity and security. Walter et al. (2018) presented "Arc Moment" as a way to increase node mobility utilising a 2 - D based method in previous work. The Euclidian 2 to D distance formula was employed in this procedure. Using this Euclidian 2 D distance formula, we were able to keep communication running smoothly. Walter and colleagues (Walter and colleagues, 2018) "KRUSH-D," a three-dimensional approach, has been proposed. It increases network connectivity while also addressing node mobility difficulties. It selects pathways using the well-known Krushkal method and the Euclidian 3 D distance calculation. The UWSN KRUSHKAL algorithm provides a way to keep communication stable. Mangla et al. (2016) presented "Cluster Based Energy-Efficient Sensor Nodes," which are based on each sensor node's dependability, energy efficiency and throughput. It uses a two-stage method. First, it uses the Euclidian distance formula to compute the distance between the head node (or undersea sink). Second, it is used to identify the node inside a cluster that is known as the head node. The head node can sometimes deliver stable communication. The head node sends all data to the surface station and ensures that communication with other nodes is reliable. UWSN routing techniques have been proposed by Mangla et al. (2018). It is determined by a number of factors, including packet delivery rate, energy efficiency and end-to-end delay. All of below protocols can be combined to create different network scenarios. These criteria can be used to assess the effectiveness of routing protocols and aid in the selection of the optimum protocol.

UNDERWATER ROUTING PROTOCOLS

Reactive Proactive and Geographical Routing protocols

Routing is a way to create and choose a route to send information from one source node to another. The network layer includes routing algorithms. Different routing algorithms can be used to create ad-hoc networks. These are the protocols used for routing VANETs Proactive Routing Protocols*:*

These protocols use a table. Every node manages a table to store and transfer information. Each node also connects to the other via linked nodes. These protocols are also known as table driven protocols and proactive routing protocols. Among the table-driven routing protocols are OLSR, FSR, and DSDV.

DSDV (Destination Sequence Displace Vector Routing)

DSDV is based upon the Bellman-Ford algorithm. DSDV protocol allows users to share data packets with other nodes. This packet stores information such as the IP address, sequence number, and hope count. Each node in the network changes its topology after a time, a fixed time, or immediately.

OLSR (Optimized link State Routing)

To collect information about the nearest node in OLSR, node used "hello" message.

Every node in a network sends "hello" signals to its neighbours as soon as an issue is detected. They also keep track of all nodes in a table. The classical link state algorithm is another name for this. This is a method of multipoint relay. This strategy lowers the cost of flooding to the sensor node, which is a time-consuming process.

Reactive Routing Protocols:

Reactive routing protocol allows you to create and choose a route to send information from one source node to another. This type of protocol is also known as on-demand routing protocols. Reactive routing protocol decreased network traffic. This protocol is used to discover routes and search for destinations in a network.

Types of reactive routing protocols:

1. AODV
2. DSR
3. TORA

We have used two UWSN reactive routing protocols in this paper. Nodes in UWSN have high mobility and move at high speeds. It is not suitable to use proactive based routing. Due to the large amount of table information and bandwidth consumed, proactive-based routing protocols could fail in UWSN TORA

AODV: This is a reactive routing protocol. It is used whenever a node wishes to send data to another node. The AODV extension of DSR (Dynamic source routing protocol) is the AODV. Many reasons AODV is called Reactive routing. It's a means of obtaining routes on demand, with routes being built on the fly. only when they are needed. This protocol is called on demand routing protocol. AODV is a broadcast routing discovery system that locates a route using RREQ (Route Request packet) broadcasting and establishes forward pathways using RREP (Route Reply Package). In AODV route tables entries establishment is dynamically, or nodes lies active path and maintain routing information.

If the routing table entry has expired, it is used to determine if it is still in use. To avoid routing loops, AODV employs a destination sequence number and avoid broken routes.

AODV manages ad-hoc networks and the results are very automated and efficient. Multi-hop routing is possible in this protocol, where nodes move through root. It allows nodes to quickly achieve their goal and does not require them to manage the path to destination.

DSR:

It is an efficient and routing protocol that is simple and was specifically developed for Wireless ad hoc networks with many hops. It allows the network's self-organization and configuration without any need for pre-established network infrastructure. Source routing is used to send packets between source nodes. Source routing requires that each source node knows the hop sequence to the destination.

III. PROTOCOL FOR GEOGRAPHICAL ROUTING

A. VBF

Vector Based Forwarding protocol is based on location. This protocol sends data packets from a source to a destination using a pipe. Each packet has complete information on the source, destination, and forwarder. If the receiving packet has arrived in the pipe, calculate its location. If not, toss the packet out.

B. Hop-by-hop vector-based forwarding (HH-VBF)

A location-based Protocol was also used in the development of VBF. A pipe was utilized to send a packet from source to destination in this protocol. This is because per hop forwarding pathways define forwarder nodes. For networks with a small number of nodes, VBF and HH provide better forwarding methods.

C. Depth - Based Routing (DBR)

It's a dynamic and dense network with excellent efficiency. It enables scalable and efficient routing without the need for localization. DBR only employed a depth sensor. DBR makes use of a depth sensor. The data is sent through a sink in the water's surface.

D. Topology - Control Vector Based Forwarding (TCVBF)

It makes optimum the use of energy resources, and also provides reliable data transmission to wireless sensor networks. It can be divided into network connectivity and network coverage. The first is network coverage. This is determined by how the objective land is verified by the sensor node. It works to consume less power and provide reliable sensing areas. System affinity refers to a proficient sensor relationship topology that uses UWSN architecture to regulate and operate power.

IV. THE ARCHITECTURE OF THE UWSN

A. UWSN architecture in one-dimension

Sensor nodes are positioned underwater in a one-dimensional layout. Each sensor node forms its own network. Collecting data and transmitting it to remote stations is a time-consuming process. A camera, CPU, battery, and storage device are all included in sensor nodes. A node can be an autonomous underwater vehicle (AUV) using this design. It is an autonomous underwater vehicle (AUV) that moves in the water without the need for direction from an administrator. A sensor node communicates to one another using a combination of radio frequency, optical, and acoustic communication careers.

B. UWSN architecture in two-dimension

Two-dimensional architecture, in which sensors nodes are placed underwater. A cluster is made up of several nodes. Each cluster builds its own network. The head node of a cluster is known as anchor node. They are located at the bottom of the ocean. Other sensors nodes gather information from the undersea and transmit it to the head node. The information was collected by the head node and sent to AUV. AUV connects directly to the surface sink via wired connection. Horizontal communication links every cluster communication node with the head node. The AUV surface sink receives data and is directly connected to it. For communication, the head node and the other nodes use wireless connections. Two-dimensional sensor nodes communicate with each other using the three communication careers acoustic (optical) and radio frequency communication career, depending on the nature of the underwater environment.

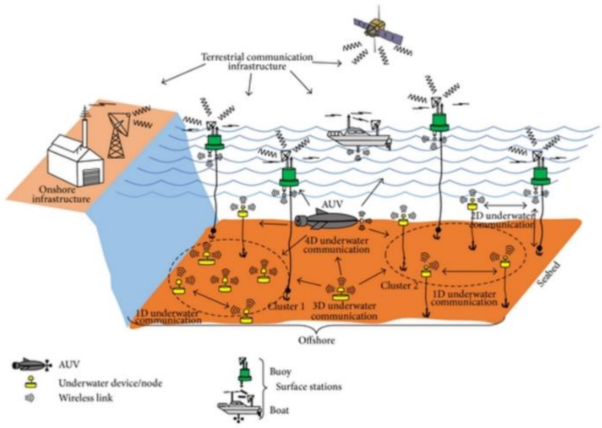

Fig.1 Architecture of UWSN

C. UWSN architecture in three-dimension

In 3D architecture, sensor nodes form a cluster and connect at the bottom underwater. This architecture will support three communication scenarios:

Inter cluster

Intra cluster

Communication via an anchor-floatable node. Communication scenarios will use optical, acoustic and radio frequency links.

D. UWSN architecture in four-dimension

The D UWSN is a combination three-dimensional underwater sensor network and mobile UWSNs. Remotely operated underwater vehicles (ROVs) will contain the mobile UWSN. ROVs gather data from the head nodes, and transmit the data to the remote station. ROVs may be autonomous underwater vehicles, robotics, ships, or underwater vehicles. The sensors can all be autonomous underwater vehicles that will send the data directly to ROVs. This data is used to calculate the distance between a node and a ROV. The distance between the ROVs and underwater sensor nodes will determine which communication scenario is used. Acoustic or radio can also be used. Also, there may be a relationship of data between ROVs to sensor nodes. For transmitting data, the sensor node will use radio links. UWSNs research focuses mainly on communication, self-organization and processing capabilities.

E. Architecture of 3-D communication

3-D communication architecture, which can be observed in underwater monitoring. It will form clusters. It will form clusters. There will be one common gateway that connects two clusters and one selected cluster head. This architecture is used for underwater observation. This architecture uses communication between the cluster head and horizontal sensor nosdes (HN), vertical sensors nodes (VN), and surface station (SS), as well as between the cluster head (CH), gateway (GW), and between different types nodes.

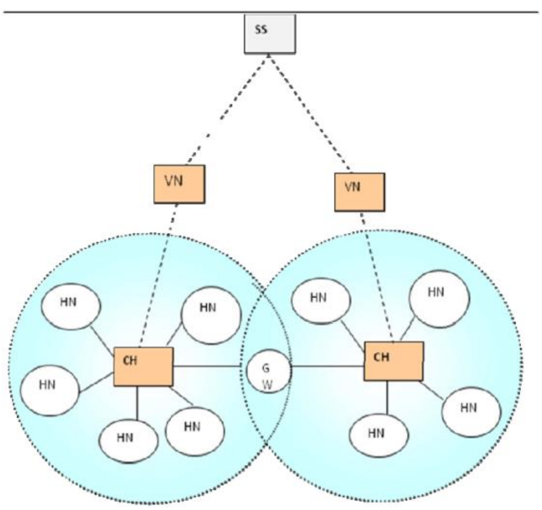

Fig2. Communication in 3D Architecture

Table1. Communication in 3D Architecture

Type	HN to CH	CH to Gateway	VN to SS
Communication	Acoustic Horizontal link	Acoustic Vertical Link	Acoustic Vertical Link

F. COMMUNICATION TYPE

UWSN offers two type of communication :

Underwater communication is intra-cluster between sensor nodes, cluster head, surface stations and horizontal sensors nodes.

The cluster head, gateway, surface station, cluster head, and horizontal sensor nodes communicate underwater. a cluster head, a surface station, a gateway, a neighbour cluster head, a neighbour cluster head, a neighbour cluster head, a neighbour cluster head, a neighbour cluster head.

G. DATA COMMUNICATION ISSUES IN UNDERWATER

Many factors that effects in UWSNs communications are given here:

a. Transmission Loss

Underwater medium is susceptible to attenuation transmission losses and geometric spreading loss. Spreading of the acoustic signal. Conversation of the energy of an acoustic wave can cure attenuation. Attenuation can be found in underwater communications due to loss spreading and loss absorption. This reduces the power of desired signals, but it is still very effective. It is crucial to delete the required data from the received signal at destination.

b. Bandwidth

Underwater wireless sensor networks have a very restricted bandwidth. At a low data rate, its range is close to 102 KHz. This isn't the case in terrestrial

networks, which have significantly more capacity than underwater wireless sensor networks. Information can only be moved at a limited frequency range underwater due to the incontinence of the environment. Acoustic systems are limited in their design and operation due to the limited bandwidth of the acoustic spectrum. To establish routes and send data packets to their destinations, routing protocols must take into account the limited frequency range.
The bandwidth of an underwater application's bandwidth is directly proportional to the convergence (transmission range).

Table2. Bandwidth relationships in UWSN

Convergence	Range in (km)	Bandwidth in (kHz)
Very long	More than 100	Less than 1
Long	More than 10–100	Almost 2–5
Medium	Almost 1–10	Almost 10
Short	Almost 0.1–1	20–50
Very short	Less than or equal to 0.11	Greater than 100

c. Noise

There are two types of underwater noise: man-made and natural. Natural noise will be caused by biological, seismic and hydrodynamic activities. Man-made noise will come from machinery and shipping noises. The ability to connect underwater noise to the data will improve the quality of communications. The best route must be chosen, as it is less affected by noise. This can improve underwater communication. There are four components to underwater noise: shipping noise, turbulence, wave and thermal. The The total of all four noise types equals the power spectral density (N) of ambient noise in decibels. N =Nsh + nwv + ntb+Nth is the formula for calculating it (1)
The power spectrum densities for shipping, wave, and turbulence are Nsh, Nwv, and Ntb, respectively.

d. Multipath

Multipath effect occurs in the underwater environment due to wave reflections from surfaces and bottom.

e. High Delay

UWSNs have a much higher propagation delay than terrestrial wireless sensor networks. This reduces the throughput in an underwater environment. The underwater environment is four times more time-consuming than terrestrial wireless sensor networks.

f. Doppler Spread

Doppler shift, receiver movement, and channel boundaries are all caused by receivers. Doppler spread is affected by all these parameters.

g. Short Network Lifetime

The network's life expectancy is greatly affected by the absence of solar energy. The underwater environment can only store a limited number of sensor nodes. It is possible to replace the battery after a while. Due to a limited supply of battery power, the sensor nodes begin to lose battery power. This creates energy holes. This is a problem with the battery and it means that the network fails, which can delay data delivery to the surface sink. The problem with battery power. This problem will be solved by making efficient and effective use of the electrical power available to sensor nodes in the underwater environment. The routing protocol underwater must select the best path that is suitable for the network. This will reduce the network's energy consumption. These nodes are called energy holes if they lose battery power in the early stages of network operation. They then become dead. Energy holes allow safe packet delivery to the destination. Underwater communications vary the speed of an acoustic waves according to salt, temperature, and depth.

The speed of acoustic waves within water is:
C=1449 + 5.304 x 10-2-2 T +2.1744 x 10-4-5 T3 + 1.34 (S – 35) + +1.63x10-2D + 1.675x10-7 T+1.025x10-2T(S – 35) 7.139x10-3 T3 (2)

The sea depth in meters, water salinity factors per thousand, temperature and degree Celsius are the respective temperatures. C, S, D, T, and T refer to the speed of acoustic wave in meters per second

H. UNDERWATER COMMUNICATION CARRIER

There are many communication mediums that can be used underwater for data transmission. These include radio communication technique and optical communication technique. For data transfer, all acoustic communication carriers can be used underwater. Acoustic sound waves are medium for data transmission. The 'Table' table shows a comparison of communication techniques in an underwater environment.

Table3. Underwater Communication Carrier

Communication technique	Acoustic communication	Radio communication	Optical communication
Communication carrier	Sound waves	Radio frequency	Light waves
Propagation speed in (m/s)	1. 5 *10^3	3 * 10^8	2.1 to 3 * 10^8
Bandwidth	KHZ	MHZ	10-150MHZ
Frequency band	KHZ	MHZ	10^14-10^15HZ
Data rate	Up to 100kbps	Up to 10mbps	1gbps
Transmission range	50-5km	1m-100m	1m-100m

a. Radio communication

The electromagnetic wave is also known by radio communication carrier. Radio communication carrier has a limited communication range due to high frequency absorption and channel attenuation. It is also less than 1 meter in fresh water. Radio frequency waves propagate through conductive salty underwater over long distances at low frequencies (30-30 Hz), which is why it's so expensive to have a large antenna and high transmission power. For underwater communication, radio communication modems cannot be used.

b. Optical communication

Because optical communication carriers are only suitable for clean and fresh water, they are not suitable to be used in an underwater environment. This type of communication is intended for point-to-point underwater communication. Because of its limited range, this type of communication is not appropriate for the underwater environment. This type is only for short distances. Optic communication is not recommended for long distance and dirty communications.

c. Acoustic Communication

It is ideal for use in the underwater environment. It can be used for long distances. It can also be used in deep dirty water. The transmission range of acoustic can be set up in an underwater environment within this range. It propagates at a slower rate than other communication carriers. The frequency and bandwidth are in KHZ for acoustic communication careers.

d. Sonar Communication

Sonar communication is a subclass in acoustic communications. Like acoustic, it uses sound waves to transmit signals. It can be divided into active and passive modes. Both modes use hydrophones to receive or emit sonar waves. The transmission range of sonar communication and acoustic communications is very similar. Communication frequency ranges are also very similar. Sonar communication carrier and radio communication carrier are physically and electrically different. Sonar communication is not used to trans-border condition in air water.

e. Magneto-Inductive Communication

The magneto inductive communication carrier can be used as an alternative communication method to radio communication and acoustic communication. It is free from any impairments. Magneto inductive communication carriers include dynamic channels, high propagation delays, multiple paths fading, and multiples paths. This communication uses induction coils. These magneto-inductive communication instruments can be deployed underwater. It can be equipped with elastic antenna structures that are low-cost and allow for the formation of underwater networks of magnet waves whipping path losses.

V. CONCLUSION

This paper discusses routing protocols and solution for improving communication issues in an underwater wireless sensor network environment. It includes transmission loss, propagation delay, noise, multipath, Doppler spread, and transmission loss. UWSNs will benefit from a comprehensive overview of 3-D-based communication architecture. This study focuses on the choice of a communication carrier. For underwater wireless sensor networks, acoustic communication is the most suitable communication medium. We have demonstrated that the propagation delay caused by acoustic signals is lower than radio frequency. Future work will be to develop efficient communication protocols for underwater sensor network considering performance metrics such as throughput, energy efficiency and delay. We also want to improve reliability of the network.

VI. REFERENCES

[1]. Agarwal.Kanika, Rakesh.Nitin, “Node mobility issues in UWSN,” International Conference on Smart System, Inovation and Computing(ICSSIC), pp. 1-8, 2016.

[2]. Bansal.Rubal, Maheshwari.Saurabh, and Awwal.Payal, ” Challenges and Issues in Implementation of UWSN,” Springer Nature Singapore Pte Ltd, pp. 507-514, January 2018.

[3]. Felemban.Emad, S.K.Faisal, Q.M.Umair, A.S.Adil, and Q.B.Saad,”UWSN Applications,” International Journal of Distributed Sensor Networks, pp. 1-14, 2015.

[4]. H.Min, Y.Cho, J.Heo, “Enhancing the Reliability of Head Nodes in UWSN”, MDPI Sensor, pp. 1194-1210, 2012.

[5]. K. Anwar, A.Ihsan, G. Abdullah, K.Nawsher, A.Mohammed, R.U. Atiq, and M.Hasan, “Routing Protocols for UWSN,” MDPI Sensor, pp. 1-30. 2018.

[6]. Lloret.Jaime, “Underwater Sensor Nodes and Network,” MDPI Sensor, pp. 11782-11796, 2013

[7]. Mangla.Jyoti, Rakesh.Nitin, “Cluster-Based Energy-Efficient Communication in UWSN,” International Confrence on Smart System, Inovation and Computing (ICSSIC), pp. 1-8, 2018.

[8]. Pompili Dario, Akyildiz A., (2010) A Multimedia Cross Layer Protocol for Underwater Acoustic Sensor Network. IEEE Trans. on wireless communication, 9(9), pp. 2924-2933.

[9]. Pompili Dario,. Akyldiz Ian F., (2009) Overview of Networking Protocols for Underwater Wireless Communications. IEEE Transaction on wireless communication, 9(2), pp. 16345-16363.

[10]. R.Alak, and S.Nityanand, “Selection of Communication Carrier for UWSN,” International Symposium on Advanced Computing and Communication (ISACC), pp. 1-7, 2015.

[11]. Walter.Nishit, Rakesh.Nitin, “KRUSH-D approach for the solution to node mobility issue in UWSN,” Networking Communication and Data Knowledge Engineering (NCDKE), pp.89-98, 2018.

[12]. Walter.Nishit, Rakesh.Nitin, “SEE THROUGH Approach for the solution to Node Mobility in UWSN,,” International Confrence on Smart System, Inovation and Computing(ICSSIC), pp. 19-29, 2018.