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Channel Aware Multi-Layered Routing Protocol for Under Water Wireless Sensor Networks

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ABSTRACT: The definition and performance evaluation of a new multi-layered routing protocol for underwater wireless sensor networks is discovered in the paper. The solution, Channel aware multi-layered routing protocol (CAM-RP), reveals the goodness factor in the super nodes which represent an estimate of the quality of channel and the best reachable neighbor in a route to sink. CAM-RP also reduces transmission delay and packet error rate. The relay selection of the node depends on the high goodness ratio which helps the super node to determine the nodes which have energy efficiency and link reliability in the channel. CAM-RP works in two phases namely layering phase and Data forwarding phase. During layering phase, different layers are formed around the super nodes. In data forwarding phase, data packets are forwarded based on these layers. The performances of the CAM-RP is compared with the existing Channel aware routing protocol (CARP) under the metrics of Packet delivery ratio, End to End packet latency, energy consumption, throughput and jitter. The implementation is done using the MATLAB simulation tool and the results are plotted. The experimental results shows that the newly proposed CAM-RP yields better results comparing with the CARP algorithm incase of all parameters.
Keywords: Under water wireless sensor network, Routing, energy efficiency

I. INTRODUCTION

A. Under Water Sensor Networks

Two-thirds of the surface of the earth is covered by the water, and most of which are unexplored. As a promising solution to aquatic environmental monitoring and exploration, the idea of applying sensor networks in underwater environments, is called underwater wireless sensor networks (UWSNs). Similar to WSN, underwater wireless sensor networks (UWSNs) consist of a large number of low-cost sensor nodes which are deployed in the monitoring areas under the water .Since radio communications are not suitable for deep water, so it is replace by the acoustic communications in Under Water Sensor Networks (UWSNs) .

Under water sensor networks are used for various applications like for oceanographic data collection, offshore exploration, pollution monitoring, disaster prevention, assisted navigation and tactical surveillance applications. These applications are classified into two groups based on the time duration required, which are,

1. Long term Aquatic Monitoring (e.g. marine biology, oil/gas field monitoring, deep sea archaeology, seismic prediction etc.) and
2. Short term aquatic exploration (e.g. natural resource discovery, anti submarine mission, lost treasure discovery etc.)

B. Routing in Under Water Sensor Networks

There are some issues of Routing in under Water Sensor Networks which are followings

1. High propagation delays

In under Water Sensor Networks acoustic communications is use because radio signals do not work efficiently under water and acoustic channels. The main problems with the acoustic channel, however, are low bandwidths band long propagation delays.

2. Node mobility

Due to flow of water, nodes can fluctuate or move if they are not fixed with the bottom of the sea. This situation results in a dynamic network topology, this is a big issue of Routing in Under Water Sensor Networks.

3. *Harsh deployment environment*

The environment of water sensor networks is very harsh for deployment of sensor nodes, because the sensor nodes are deployed very deep in ocean.

4 Transmission loss

Transmission loss is combination of geometric spreading and attenuation. It has independent of frequency. [1, 2, 4, 5, 6, 10]

C. existing routing protocols in under water sensor networks

There are some Routing protocols in under Water Sensor Networks which are following:

1. Vector-Based Forwarding Protocol (VBF)

It is a location-based routing protocol designed for underwater sensor networks. A "routing pipe" is established between source and the destination nodes and packet delivery is accruing along this pipe. Each data packet has information of position of the sender, the target, and the forwarder and also a RANGE field which is used for mobility concept.

2. Depth-Based Routing for Underwater Sensor Networks (DBR)

It is a greedy algorithm in which each sensor Node makes the decision on whether to forward a packet or not, based on its depth and the depth of the previous sender.

3. Hop to Hop Dynamic Addressing based Routing protocol

Hop by hop dynamic addressing based Routing protocol is a novel routing protocol. It is for critical underwater monitoring missions. It applies on multi sink architecture and also energy efficient, scalable and robust. This protocol is also helpful for monitoring underwater missions.

4. Pressure Routing Protocol

Pressure Routing Protocol is hydraulic pressure depend on whatever cast routing protocol that applies the pressure levels other way we can say that Pressure Routing Protocol use depth information to search paths for forwarding packets from source to the surface buoys.

5. Error prone acoustic underwater channels

The bandwidth capacity of acoustic channels is very low, that's why they suffer from high bit error rates. *Limited energy* Since the sensor nodes are battery powered and deployed in very deep in ocean so it is impossible to change the battery. So nodes have limited source of energy.

6. A Low Propagation Delay Multi-Path Routing (MPR)

A Low Propagation Delay Multi-Path Routing (MPR) forms a path from source to the destination consisting of a several multi-sub paths during the routing path construction. Multi-sub paths are defined as sub-paths from the sender to its two-hop neighbors via a relay node in the neighborhood of both sender and receiver nodes. This approach is used to prevent data collision at receivers since they receive packets from different relay nodes.

7. ***Adaptive Routing***

Adaptive Routing is a routing protocol, in this routing is performed by adaptively based on the type of the messages and application requirements. The protocol exploits message redundancy and resource allocation to fulfill different performance requirements. The main goal of the protocol is to achieve a good trade-off between delivery ratio, average delay, and energy consumption and it also provide different services for data packets having different priority

II. LITERATURE REVIEW

Chenn-Jung Huang et al [1] have proposed a direction-sensitive routing protocol (DSR) for UWSNs. The design of the routing protocol focus on enhancing performance metrics in volatile underwater environments, especially the need for
ease of deployment and the severe energy constraints of the nodes are thoroughly considered. A fuzzy logic inference system is utilized to select the suitable sensor(s) for forwarding packets, and a simple algorithm is developed to prevent the growing of the packet broadcast tree so as to effectively reduce the energy consumption of the sensor nodes. The simulation results show that the proposed routing protocol can achieve excellent performance in terms of the metrics, the packet delivery ratio, energy consumption, and average end-to-end delay. The drawback of this paper is that the performance of metric packet delivery ratio, end to end delay and energy efficiency is limited to third level of tree. They have not considered the metric bandwidth in the proposed protocol.

Yuh-Shyan Chen et al [11] have proposed a new efficient routing protocol, called multi-path routing (MPR) protocol, for UWSNs to improve the transmission delay. Multi-path is utilized during the path construction from the source node to the destination node, which is composed of a series of multi-sub paths. Each multi-sub path is a sub-path from a layers are formed by te super nodes using different transmission powers.ach of ordinary sensor nodes is assigned a unique ID called Layer ID.sending node to its two-hop neighboring node, called receiving node, by one more relay nodes, where these relay nodes simultaneously are neighboring nodes of sending and receiving nodes.

Due to the different propagation delay of UWSN, the packet arrival time along the different sub-path is different; thus it may avoid the data collision in the receiving node when receiving different packets from different relay nodes. It surely sends the different packet along different sub-path to significantly improve delay time and packet delivery ratio. Finally, simulation results illustrate the performance achievements of the MPR protocol in improving delay time, packet delivery ratio, throughput and reducing overhead ratio. The drawback of this paper is that in the proposed protocol they have not considered the metric energy efficiency.

Zheng Guo et al [12] have proposed an adaptive routing protocol for underwater delay/disruption tolerant sensor networks. This protocol considers the characteristics of both packets and the network, defines several routing states with different redundancy, and treats different types of packets adaptively by mapping the packet priority to various routing states. Through extensive simulations, they have demonstrated that our protocol can provide delivery diversity to applications with different requirements and achieve a good trade-off among delivery ratio, delay and energy consumption. The drawback of this paper is that they have not considered the metrics like routing overhead and throughput**.**

Abdul Wahid et al [13] have proposed a Multi-layered Routing Protocol (MRP) for UWSNs. MRP is non-localization based routing protocol which does not require any localization technique of sensor nodes. MRP employed two types of sensor nodes for routing i.e. super nodes and ordinary sensor nodes. The super nodes are the nodes having high transmission power and high energy, while the ordinary sensor nodes have typical transmission power and energy. MRP has two phases: layering and forwarding phases. During the layering phase, multiple

During the forwarding phase, data packets are forwarded from the ordinary sensor nodes towards the super nodes based on the assigned Layer IDs. Through simulations, MRP was compared with a well known non-localization based protocol called DBR. Through simulation results, it was proved that MRP has improved performance over DBR. The drawback of this paper is that in the proposed protocol they have not considered the efficient utilization of bandwidth, energy efficiency and bit error rate.

Stefano Basagni et al [14] have proposed a new* distributed cross-layer Channel-aware Routing Protocol (CARP) for UWSNs. It follows the cross layer design paradigm in that i**U** efficiently exploits short control messages to perform joint channel access and relay selection. The well known approach is enriched by CARP with the introduction of link quality information in the cross layer relay selection. Robustness of the selected link is also achieved by computing the transmission power so to obtain similar PER for short control packets and longer data packets, thus allowing to exploit the short control packet exchange to identify links, which result in reliable data transmissions. A comparative simulation-based performance evaluation of CARP, FBR and DBR reveals that including link quality explicitly into relay selection is key to obtain superior throughput efficiency, end to- end latency and energy consumption. The drawback of this paper is that the proposed protocol cannot perform well for the idling condition at lower traffic in terms of energy consumption.

Tiansi Hu et al [15] have proposed a novel multi-layer. Q-learning based routing protocol, MURAO, for acoustic-optical hybrid underwater sensor networks. MURAO takes advantage of both long-range acoustic communication and fast optical communication. The upper-layer nodes are responsible for coordinating the lower-layer optical communications so that the cluster members perform routing in a more globally efficient way. MURAO has been examined by simulations with different network configurations. The results show that MURAO is more responsive to changes of network topology. As a result, it achieves much higher and steady delivery rates, shorter delays and higher energy efficiency compared to the flat Q-learning based protocol in highly dynamic networks. From this paper, future work can be extended for the efficient utilization of bandwidth in the network resources.

III PROBLEM AND SOLUTION

Direction-Sensitive Routing Protocol is proposed for the UWSNs in which fuzzy logic inference system is employed to determine the appropriate sensors to forward the packets to the destination.

The main aim of the proposed protocol is to satisfy the requirements of different application and to improve the performance metrics such as delivery ratio, average end to end delay and energy consumption.

The basic idea is to construct the routing paths for the packet based on the direction vector from source node to destination node. When a node receives a packet, it forwards or discards the packet according to its vertical distance between the node and direction vector.

Drawbacks:

High energy consumption to satisfy the packet delivery ratio and end to end delay. DSR cannot perform well to find the sensor node at the depth and hence restricted to the third level of the tree in searching node which is caused by the duplication of packet in the depth of broadcast tree.

A non localization based routing protocol called Multilayered Routing protocol for UWSNs is proposed. In this protocol, two different types of underwater sensor that is sensor nodes and ordinary sensor nodes are used.

The super nodes are sensor nodes with high capacity such as extensive energy and high power. The ordinary sensor nodes have typical energy and transmission power. Super nodes forms different layer and a cost (i.e. layer number) is assigned to each ordinary node based on its existence in the corresponding layer.

Drawbacks:

In MRP, the proposed super nodes require high energy to act as relay under the depth of water and hence it is not energy efficient.

They require large network resources to transmit the data in the network. They have not considered the metrics routing overhead and throughput efficiency.

In this proposal, we propose to develop a channel-aware multi layered routing protocol for UWSNs. In our proposed solution, the goodness factor [14] is implemented in the super nodes which represent an estimate of the quality of channel and the best reachable neighbor in a route to sink. The link quality is computed based on the success of past transmission to its neighbor. This keeps the importance of time varying nature of channel, giving importance to the recently happened situation.

CARP [14] is utilized to take advantage of modem which allows the selection of any transmission power, to obtain the same desirable PER for both control and data packet which helps the super node to efficiently utilize the transmission power and controls PER.

The relay selection of the node depends on the high goodness ratio which helps the super node to determine the nodes which have energy efficiency and link reliability in the channel.

Advantages:

- Efficient utilization of resources in the network.
- Increase in the reliability of link and hence it increases throughput.
- Increase in energy efficiency.
- Decrease in end to end delay.

IV. PROTOCOL DESCRIPTION

In physical layer network packets are forwarded in bit stream, tends to errors and packet lost. So a multi layer network, within which data link layer and network layer are incorporated with physical layer network.

The network layer is responsible for packet forwarding including routing through intermediate routers whereas the data link layer provides the functional and procedural means to transfer data between network entities and might provide the means to detect and possibly correct errors that may occur in the physical layer. At network setup, packets are flooded from the sink through the network as frames with predefined frame length. Each packet carries information on its source node and the hop count h(x) information. Each node receives a packet and checks whether its h(x) is greater than the hop count carried by the packet plus

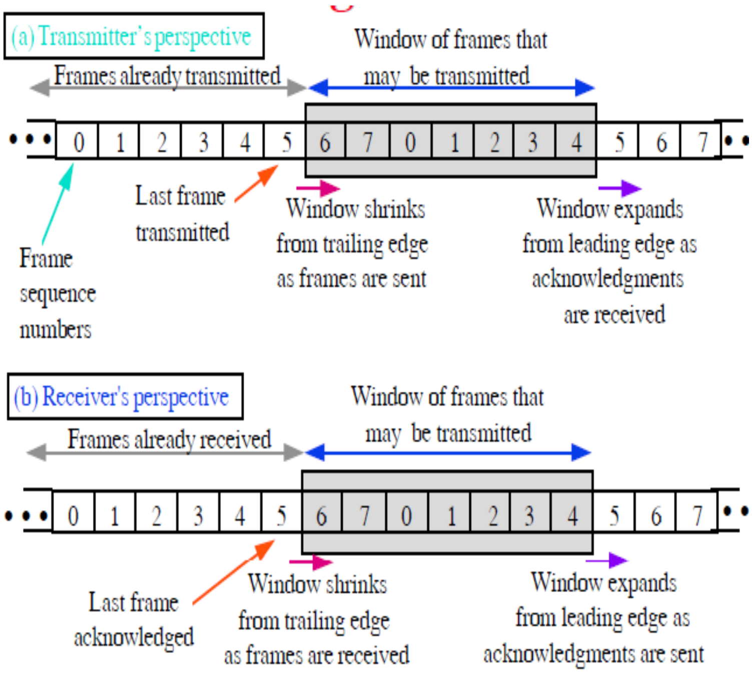

Fig 1 Data-link layer functioning

1. If this is the case, x updates its hop count to the value in the packet plus 1, and re-transmits the packet increasing its hop count field by 1. Otherwise, the packet is dropped. A node y that receives the packet immediately replies with the acknowledgement
Upon receiving an acknowledgment from y, node x updates its hop count to h(y) + 1.. When node y has received one or more data packets, it checks whether it has received them previously, so to re-transmit only those that it has not forwarded already. Error control is the mechanism of the data link layer, which deliver frames without error in the proper order to network layer. For a receiver to detect transmission error, the sender must add redundant information (in the form of bits) to the frame sent as an error detection code (parity bit).

If the expected rate is not received, the retransmission is using ARQ (Automatic Repeat Request) and error correction using FEC (Forward error correction). To detect and correct d errors, distance d+1 code and distance 2d+1 code is required respectively. Let 'd' is the minimum hamming distance between any two code words written in the code.

Flow Control mechanism is a technique for speed-matching of transmitter and receiver. Flow control ensures that a transmitting station does not overflow a receiving station with data. The commonly used technique called Sliding Window Flow Control is used here. It allows transmission of multiple frames and assigns each frame a k-bit sequence number. The range of sequence number is 0…..2^{k-1} i.e., frames are counted modulo 2^k. The sliding window flow control protocol is shown in the fig.

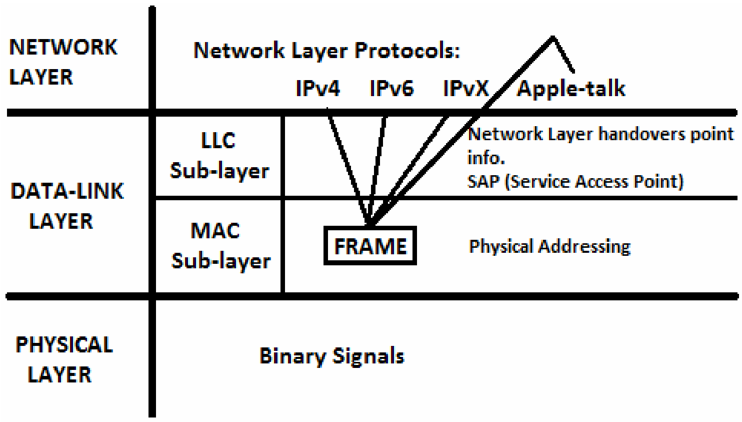

Fig 2 Sliding window Flow control

The network layer establishes connection between two end nodes and provides path selection. The protocol type of network layer is shown in the fig.

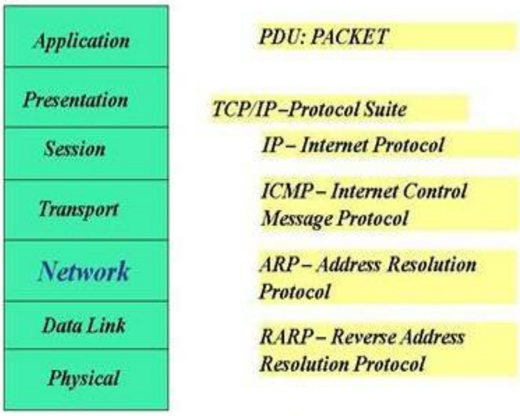

Fig 3. Protocols of Network Layer

Channel aware multi-layered routing protocol (CAM-RP) is designed using the incorporation of data-link layer and Network layer. The physical layer is used for data transmission and reception. Here data-link layer is used for the conversion of bits into frames, error detection and flow control. Within the semantics of the OSI network architecture, the data-link-layer protocols respond to service requests from the network layer and they perform their function by issuing service requests to the physical layer. The flow chart of the CAMRP protocol is shown in the fig.

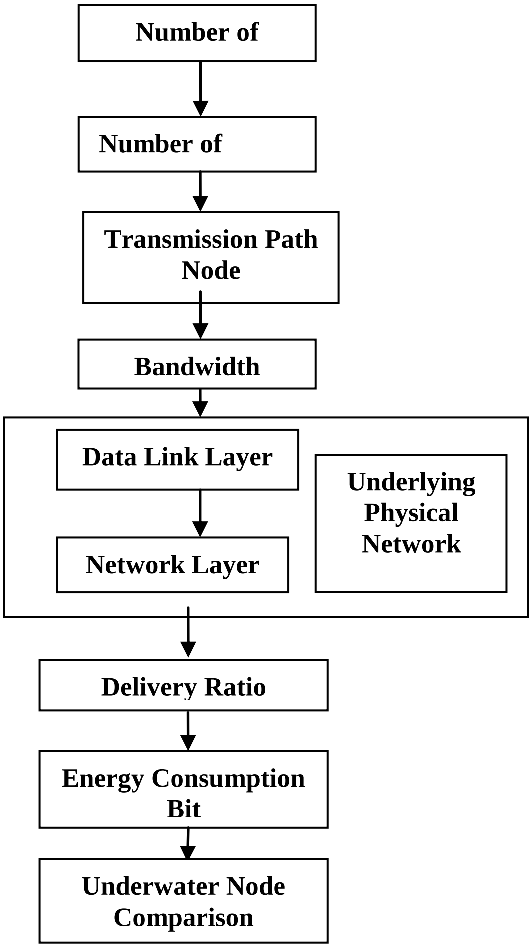

Fig 4 : Flow Chart - CAMRP Protocol

IV. PERFORMANCE EVALUATION

This section describes the comparative performance evaluation of CAMRP and the previously proposed CARP. The CAMRP and CARP is implemented using the simulation tool MATLAB. MATLAB is a high-performance language for technological computing. It integrates computation, visualization, and programming in an easy-to-use environment, where problems and solutions are expressed in familiar mathematical notation. Typical uses include math and computation algorithm development data acquisition modeling etc.

Here the simulation is done routing through MANET under different parameters such as throughput, jitter, energy consumption, route length and delivery ratio.

Throughput is the average rate of successful message delivery over a communication channel. Throughput can be measured in bits per second (bit/s or bps), data packets per second or data packets per time slot. This data may be delivered over a physical or logical link, or pass through a certain network node. The greater value of throughput means the better performance of the protocol.

$$throughput = \frac{Tot.no\,of\ data\ packets}{Time\,taken} \quad \textbf{(1)}$$

Packet delivery ratio is defined as the ratio of the number of delivered data packet to the destination. This illustrates the level of delivered data to the destination. The greater value of packet delivery ratio means the better performance of the protocol.

$$packet\,delivery\,ratio = \frac{\sum No.of\ \ packets\,received}{\sum No.of\ \ packets\,send} \quad \textbf{(2)}$$

Jitter is defined as the mean deviation of the difference in packet spacing at the receiver compared to the sender, for a pair of packets. If S_i is the time in which packet i was sent by the sender and R_i is the time it was received by the receiver, Jitter sample J_i is given by

$$J_i = |(R_{i+1} - R_i) - (S_{i+1} - S_i)| \quad \textbf{(3)}$$

Energy per bit is the energy consumed by the network to correctly deliver a bit of data to the sink.

In this , simulation results are discussed here. The fig 5 shows the throughput efficiency of the two considered protocols for increasing traffic Ω. For every packet per time, throughput efficiency of CAMRP is better than CARP. Thus CAMRP outperforms the CARP. The energy spent for delivering one bit to the sink correctly.

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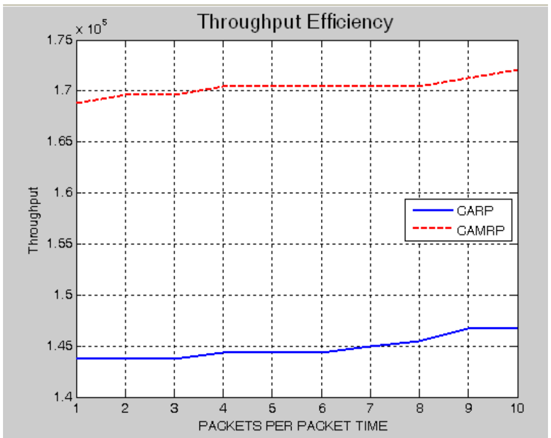

Fig 5: Throughput Efficiency

Figure 6 shows the energy consumed for each data bit successfully delivered to the sink

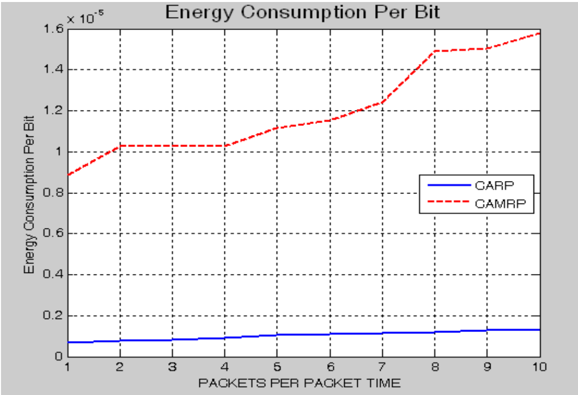

Fig 6: Energy consumption per bit

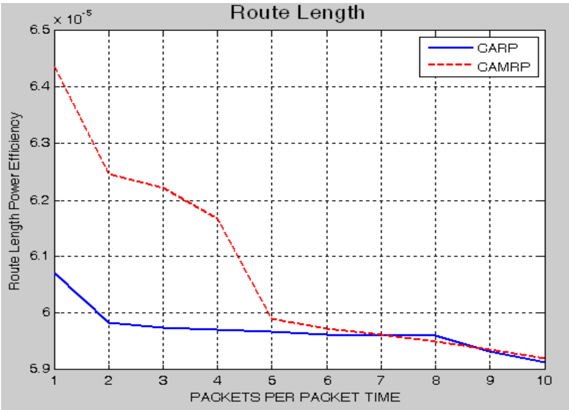

Fig 7 Route length

From the fig 7 it is clear that the jitter value of CAMRP is better than CARP. Being lightweight and able to correctly deliver packets to the sink CAMRP significantly outperforms CARP protocol, resulting in energy per bit

V.CONCLUSION

In this paper we presented CAMRP as an efficient new protocol for UWSNs. CAMRP follows the cross layer design paradigm in that it efficiently exploits short control messages with error correction and flow control. The new approach is designed by incorporating data-link layer and network layer with underlying physical layer.

The data-link-layer protocols respond to service requests from the network layer and they perform their function by issuing service requests to the physical layer. Robustness of the selected link is achieved by the node path and the network parameters evaluation.

From the above figures 5,6 and 7 it is concluded that the new multi-layered routing protocol (CAM-RP) for underwater wireless sensor networks reveals the goodness factor in the super nodes which represent an estimate of the quality of channel and the best reachable neighbor in a route to sink.

A MATLAB simulation-based performance evaluation reveals that CAM-RP obtained superior throughput, delivery ratio, route length and jitter to CARP.

IV. REFERENCES

[1] Huang, Chenn-Jung, et al. "A direction-sensitive routing protocol for underwater wireless sensor networks." Next-Generation Applied Intelligence. Springer Berlin Heidelberg, 2009. 419-428.

[2] Su, Chang, Xiaoming Liu, and Fengju Shang. "Vector-based low-delay forwarding protocol for underwater wireless sensor networks." Multimedia Information Networking and Security (MINES), 2010 International Conference on. IEEE, 2010.

[3] Ayaz, Muhammad, and Azween Abdullah. "Hop-by-hop dynamic addressing based (H2-DAB) routing protocol for underwater wireless sensor networks." Information and Multimedia Technology, 2009. ICIMT09. International Conference on. IEEE, 2009.

[4] Huang, Chenn-Jung, et al. "A direction-sensitive routing protocol for underwater wireless sensor networks." Next-Generation Applied Intelligence. Springer Berlin Heidelberg, 2009. 419-428.

[5] Su, Chang, Xiaoming Liu, and Fengju Shang. "Vector-based low-delay forwarding protocol for underwater wireless sensor networks." Multimedia Information Networking and Security (MINES), 2010

International Conference on. IEEE, 2010.

[6] Ayaz, Muhammad, and Azween Abdullah. "Hop-by-hop dynamic addressing based (H2-DAB) routing protocol for underwater wireless sensor networks." Information and Multimedia Technology, 2009. ICIMT09. International Conference on. IEEE, 2009.

[7] Huang, Chenn-Jung, et al. "A direction-sensitive routing protocol for underwater wireless sensor networks." Next-Generation Applied Intelligence. Springer Berlin Heidelberg, 2009. 419-428.

[8] Su, Chang, Xiaoming Liu, and Fengju Shang. "Vector-based low-delay forwarding protocol for underwater wireless sensor networks." Multimedia Information Networking and Security (MINES), 2010 International Conference on. IEEE, 2010.

[9] Ayaz, Muhammad, and Azween Abdullah. "Hop-by-hop dynamic addressing based (H2-DAB) routing protocol for underwater wireless sensor networks." Information and Multimedia Technology, 2009. ICIMT09. International Conference on. IEEE, 2009.

[10] Huang, Chenn-Jung, et al. "A direction-sensitive routing protocol for underwater wireless sensor networks." Next-Generation Applied Intelligence. Springer Berlin Heidelberg, 2009. 419-428.

[11] Su, Chang, Xiaoming Liu, and Fengju Shang. "Vector-based low-delay forwarding protocol for underwater wireless sensor networks." Multimedia Information Networking and Security (MINES), 2010 International Conference on. IEEE, 2010.

[12] Ayaz, Muhammad, and Azween Abdullah. "Hop-by-hop dynamic addressing based (H2-DAB) routing protocol for underwater wireless sensor networks." Information and Multimedia Technology, 2009. ICIMT09. International Conference on. IEEE, 2009.

[13] Akyildiz, Ian F., Dario Pompili, and Tommaso Melodia. "Underwater acoustic sensor networks: research challenges." Ad hoc networks 3.3 (2005): 257-279.

[14] Jha, Vivekanand, Preeti Gupta, and Urvashi Ahuja. "QoS Issues In Underwater Sensor Networks." (2012).

[15] Bayrakdar, Yonca, Nirvana Meratnia, and Aylin Kantarci. "A comparative view of routing protocols for underwater wireless sensor networks." OCEANS, 2011 IEEE-Spain. IEEE, 2011.