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REPUTATION BASED GEOGRAPHIC AND COOPERATIVE OPPORTUNISTIC ROUTING PROTOCOL FOR UNDERWATER SENSOR NETWORKS

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Abstract: Underwater Sensor Networks (UWSNs) are capable to explore the many unrevealed natural resources beneath the water, such as lakes, ponds, rivers, seas, and oceans. Futher there are so many challenges to be faced during the design of UWSN system due to the random nature of water waves. But, perhaps the most significant challenge in UWSNs is how to transfer the packets efficiently with minimum energy cost to the surface sink through the water waves. This can be achieved by employing geographic and opportunistic routing schemes to transfer the packets at the surface sink reliably in cooperation with relay nodes. In this paper, a new routing protocol called the Reputation based Geographic and Cooperative Opportunistic Routing Protocol (RGCORP) is developed using NS2, where data packets are routed from source node to the surface sink with the aid of relay nodes. In RGCORP protocol, initially, a relay forwarding set is being determined by the source node on basis of depth data, then weighting scheme is used to choose the best relay node from the relay forwarding set. The weight calculation is performed on normalized energy, packet delivery probability and normalized distance of the forwarding node to the known surface sink. The main purpose of developing the RGCORP protocol is to enhance packet delivery by using reputation values. Further the performance metrics of RGCORP are examined.

Keywords: Underwater Sensor Networks, Reputation based Geographic and Cooperative Opportunistic Routing Protocol, relay forwarding set, enhance packet delivery.

1. INTRODUCTION & RELATED WORK

Underwater Sensor Networks (UWSNs) are specialized networks composed of a collection of interconnected sensor nodes designed to operate in underwater environments. These networks enable the monitoring and gathering of data from various underwater phenomena, including oceanographic data, marine life, climate patterns, and natural resources exploration. UWSNs play a crucial role in fields such as marine research, environmental monitoring, underwater surveillance, and offshore exploration.

Depth Based Routing (DBR) [1], the depth of nodes are considered as neighbor node. Nodes with low-pressure sensors are chosen to be neighbour. When a void node enters the network, it is unable to optimize network performance. The network throughput suffers as a result of the node failing to elect a forwarder node. The next step is to use the depth and residual energy to determine the probable forwarder node using Energy-Efficient Depth Based Routing (EEDBR). High energy efficiency and throughput are attained by EEDBR [2]. However, in a sparse situation, it is unable to cope with a void node, leading to high Energy Consumption (EC) and End to End (E2E) delay. In the Void Aware Pressure Routing (VAPR) protocol [3], a beacon message that includes details about the void node is broadcasted so that other nodes are made aware of the issue. The neighbour node's forwarding orientation influences the choice of the forwarder node.

The protocol namely Avoiding Void Node with Adaptive Hop by Hop Vector-Based Forwarding (AVN-AHH-VBF)[4] is developed. To determine if the estimated distance falls inside the specified threshold or not, the forwarder node compares its location. It improves Packet Delivery Ratio (PDR) by reducing the amount of unnecessary DPs. The Resilient Pressure Routing (RPR) Protocol [5] makes use of an encryption and decryption mechanism to expand on the concept of DBR. The payload and packet header are also encrypted in RPR, which also achieves safe data transmission but uses a lot of energy. The Totally Opportunistic Routing Algorithm (TORA)[6] is used to get around the energy hole issue. It reduces the aforementioned issue by utilizing the multi-hop concept.

The protocol's dependability and complexity are not addressed. This tactic enhances PDR in the Void avoidance Forwarding (VAF) protocol [7], however the protocol experiences significant E2E delay. The E2E delay is high as a result of the recovery of void holes. The void node is recovered by using the depth recovery. It incurs significant overhead while building a recovery path but lowers the likelihood of void nodes.

The depth difference between 2-hops is taken into account by the Weighting Depth and Forwarding Area Division DBR routing protocol (WDFAD-DBR)[8], When a node with a high priority starts transmitting data, nodes with lower priorities halt their own transmission. This protocol achieves low EC, low EC latency, and high PDR in sparse networks. However, in network architecture, the protocol is unable to enhance network performance. In the Hydro Cast: Pressure routing for underwater sensor networks [9], select the subset of forwarders node that maximizes the greedy progress yet limits co-channel interference and an efficient underwater dead end recovery method is use. In Hop by Hop Dynamic Addressing based Routing Protocol for Pipeline Monitoring (H2-DARP-PM) [10], a dynamic addressing based routing protocol using linear sensor networks based on heterogeneous types of sensors and hop-by-hop addressing for underwater pipeline monitoring. H2-DARP-PM is flexible enough to be used for the long-term pipeline monitoring applications; it even has the capability to cover the long range pipelines using less number of nodes with no any limitation of the network size. In Localization Free Interference and Energy Holes Minimization (LF-IEHM)[11] routing overcomes interference during data packet forwarding by defining a unique packet holding time for every sensor node. The energy holes formation is mitigated by a variable transmission range of the sensor nodes and achieves high EC.

Forwarder nodes are chosen in the Cluster-Based Energy Efficient Routing (CBE2R) [12] on the basis of the weights that have been allocated to them in terms of least energy dissipation and maximum PDR. In EECOR [13], Energy-Efficient Cooperative Opportunistic Routing, performance metrics are discovered and the fuzzy rule is applied based on the best relay rule and the optimal path for enhanced packet delivery. Data can be forwarded via a Power-Efficient Routing (PER) [14] routing protocol without transferring the entire packet. As a result, memory usage is reduced. The Geographic and Cooperative Opportunistic Routing Protocol (GCORP) [15] improves packet delivery ratio while extending network lifetime, using less energy, and reducing end-to-end delay. However, multi path issues prevent the improved performance from being realized. Here, in this article, an attempt has been made to develop underwater sensor network using RGCORP. In RGCORP, the best relay nodes is selected to transmit the packet from source to sink node without packet loss and it enhance the network metrics.

The rest of the article is followed in Section II describes the existing protocols. Section III clearly shows the methodology of proposed system, which include RGCORP protocol. Section IV describes the result and discussion of existing, proposed methods and also comparison between GCORP and RGCORP done in terms of performance metrics. Finally, Section V gives the conclusion of the proposed work and future direction.

2. EXISITNG WORK

This section elaborate about the USWN Architecture and the existing protocol i.e GCORP.

USWN ARCHITECTURE

The UWSN architecture is shown in Fig.No.1 which include nodes namely source node, neighbouring nodes and sink nodes.

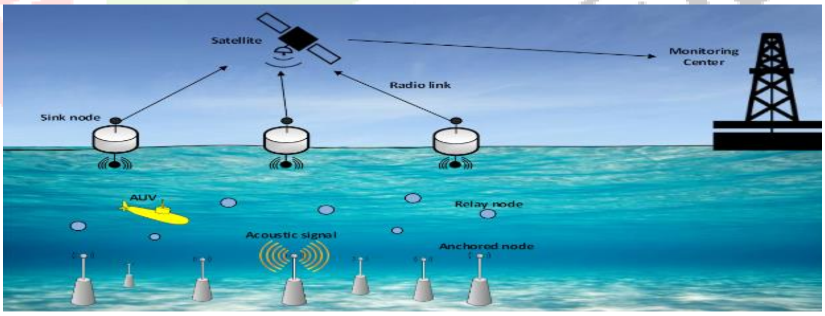


Fig.1 Underwater sensor network

SOURCE NODE

Source Node are placed randomly at the bottom-sea. It analyses the underwater behaviour and collect the data from the bottom level. It uses acoustic link from forwarding the data packet to the neighbouring node also called relay node.

NEIGHBOURING NODE

The neighbouring node collect the packet data from the source node via acoustic links in the denser underwater environment. The relay nodes is selected based on weight and the process is repeated until it reach the sink nodes.

SINK NODES

These nodes are placed in the upper side of the sea. In this, the packet from the best replay node is send to the nearest sink nodes via acoustic link and in order to communicate with environment RF link is used.

GCORP

In this GCORP, source node which is routed underwater can able to communicate with relay nodes via acoustic links and transmit packet to the sink nodes in co-ordination with neighbouring nodes Fig. No. 2 elaborate the working of GCORP.

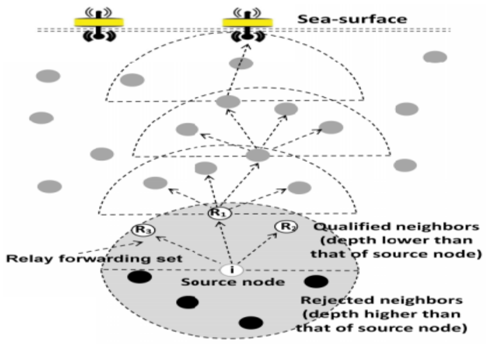


Fig. 2 Packet transferring from source to sink nodes

WORKING OF GCORP

i)Firstly, the source node transfers the data packets from the bottom sea environment to the sink nodes with the help of relay node.

ii)Secondly, the relay nodes is selected based the fitness value. By identifying the best relay nodes, packets is transferred.

iii)Finally, the packet is delivered to the sink nodes and then it transfers the packet to the terrestrial Fig. No. 2 elaborate the working of GCORP.

PROBLEM STATEMENT

In GCORP, the source node routes the packet to the destination node with help of neighbouring node. However, the routing path also becomes a very difficult task because the packet have to be routed in the reliable path. If the packet is lost, it has to regenerate another packet while doing this it consumes more energy to be transfer. So, in the current work, protocol namely Reputation based GCROP is being implement this packet loss roblem. If the packet loss is minimized, the PDR will increases likewise EC decreases. The brief notes for the protocol is discussed in the below section.

3. PROPOSED WORK

This section discusses about the RGCORP and its simulation results.

A. REPUTATION BASED GCORP ROUTING PROTOCOL

In this RGCORP, the source node determines geographic location to the forward packet to destination node. But, it is not possible for all the condition, some packet may be lost in between the routing path. So, RGCORP helps to recover the lost packet and make efficient routing path.

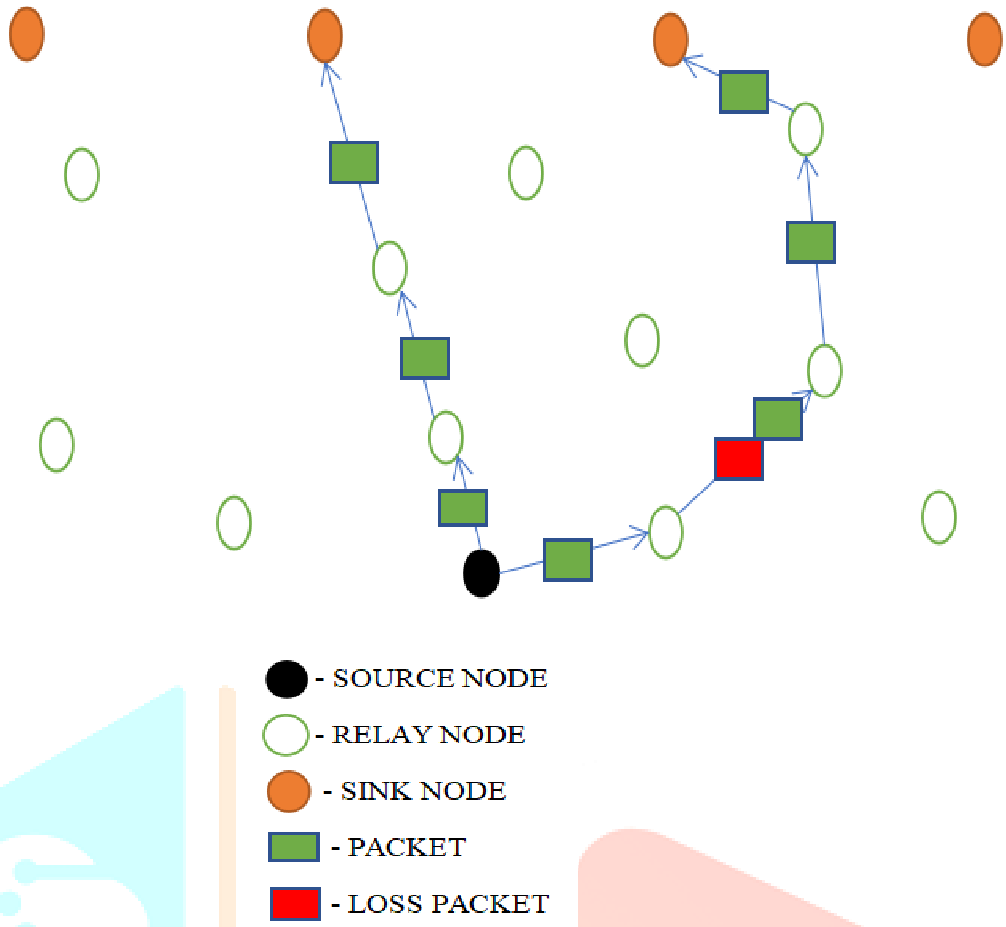


Fig. 4 packet recovering diagram

In this **Fig. 5**, source node transmits the packet from source node to sink node. In this multiple sink netowrk architecture, source node takes the fitness value based on the normalized energy, PDP, location. The node is selected which is above the source node, the node which is lower than the source node is neglected. The red colour denotes the loss packet where as the green colour denotes the recover packet and then the packet moves to the sink node with the help of reliable routing path. It enhances PDR, EC decreases, E2E decreases. The routing path which result in the clear discussion of RGCORP is mentioned in the following **Fig. 5**.

B. FLOW CHART

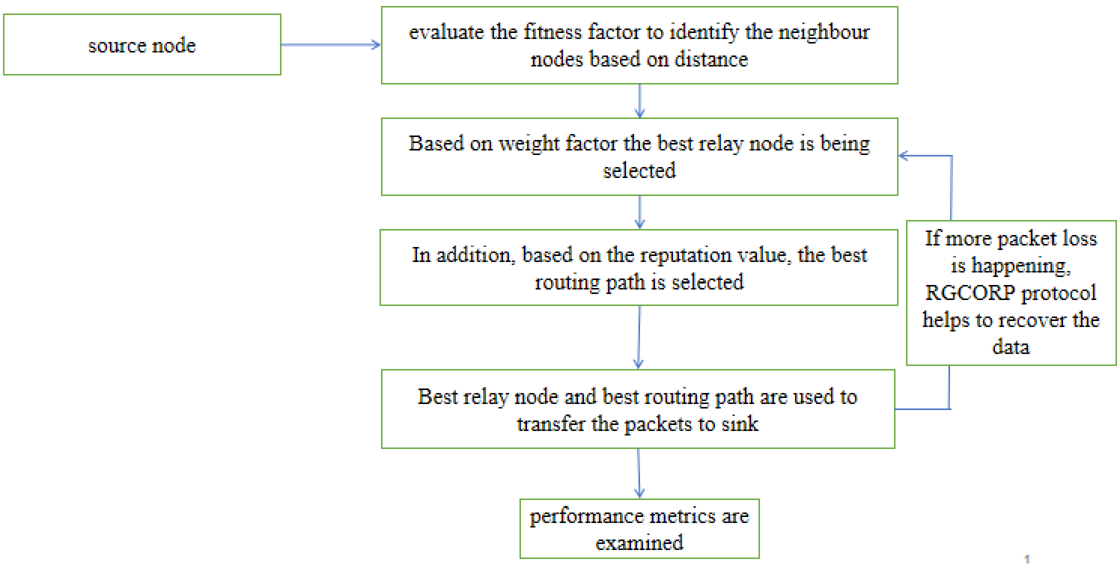


Fig. 5 Flow chart of proposed work

4. RESULTS AND DISCUSSION

A. SIMULATION PARAMETERS

In order to implement and analysis the performance of the RGCORP protocol in Network Simulator (NS2), multiple sinks architecture are being used. The relay nodes can have 2D random walk directions. The parameters considered for simulation are listed in **Fig. 6.**

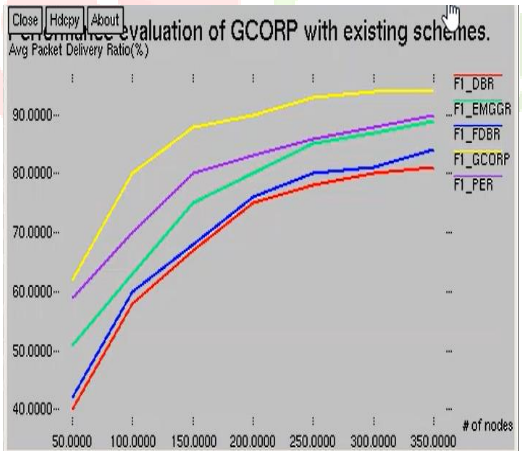
PARAMETER TYPE	PARAMETER
STIMULATION TOOL	NS2 SCRIPT
TOPOLOGY OF THE NODE	RANDOM
MOBILITY MODEL	2D random walk
NUMBER OF NODES	50 to 400
TOPOLOGY SIZE	500x500m^2
ACOUSTIC SPEED	1500 m/s
DATA PACKET SIZE	100 bytes
SIMULATION RUN TIME	1000 Sec
NUMBER OF STIMULATION RUNS	50 times

Fig. 6 simulation parameters

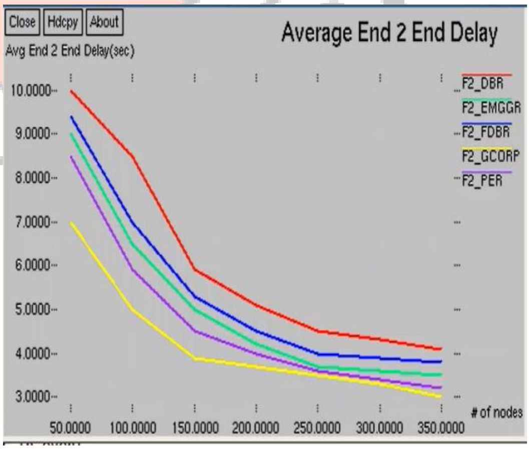
B. RESULT ANALYSIS FOR EXISITNG WORK

In this section, the performance of the GCORP routing protocol is analysed.

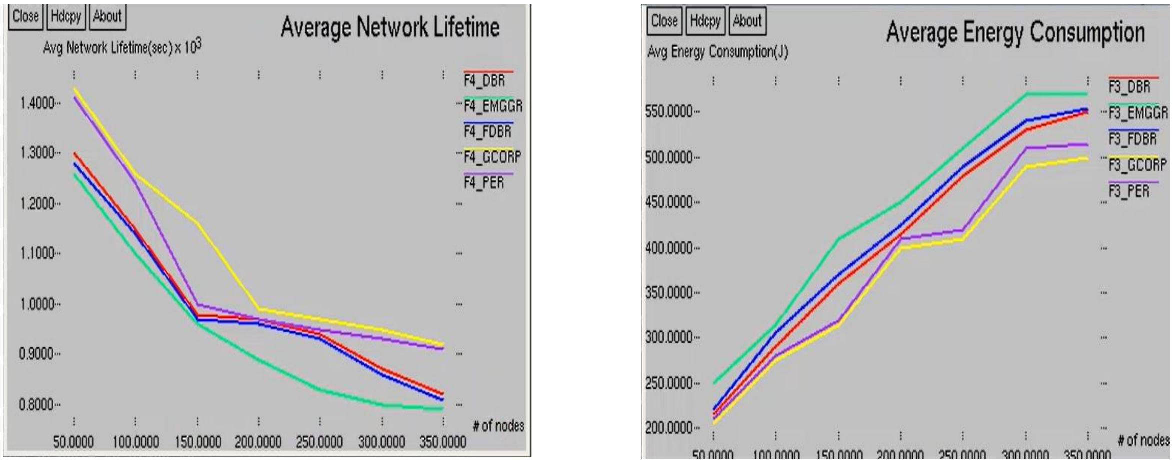
PERFORMANCE ANALYSIS OF GCORP



(a)Average Packet Delivery Ratio



(b) Average End-2-End delay



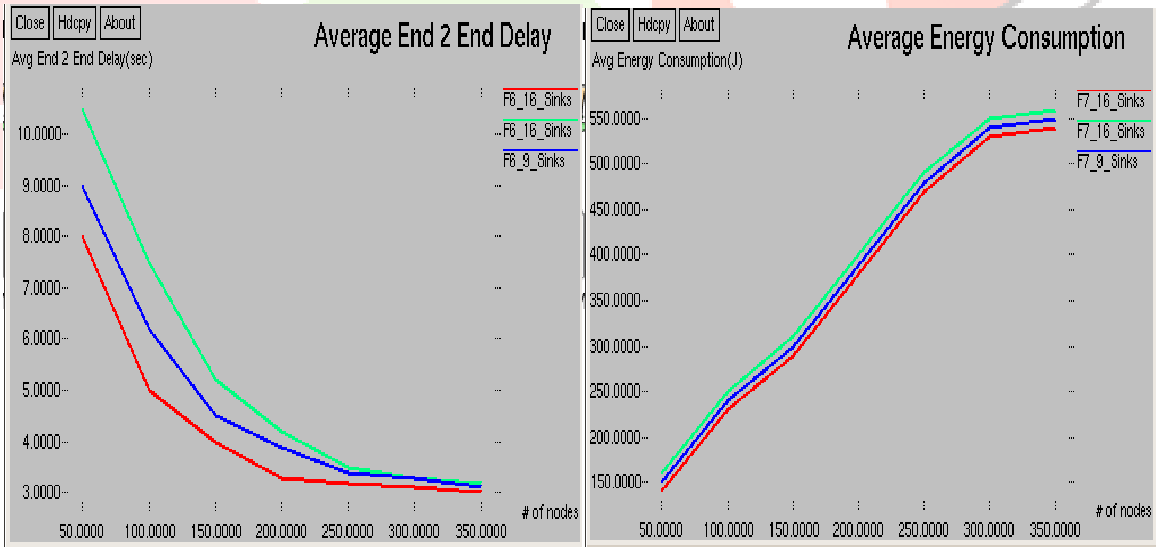
(c)Average Energy Consumption (d) Average Network Lifetime

Fig. 7 Performance evaluation of GCORP with existing schemes

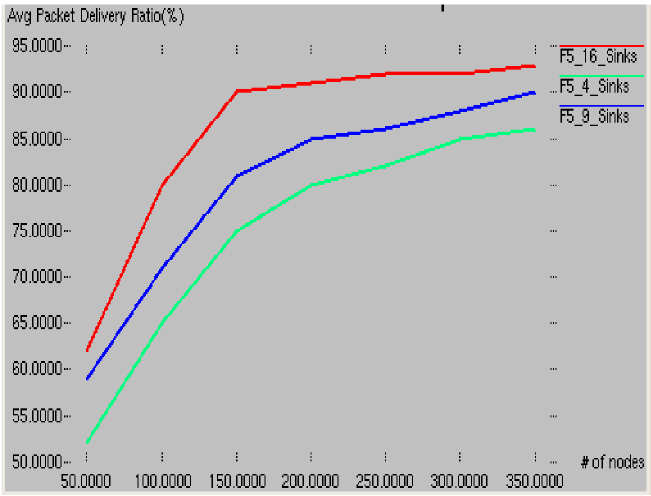
Packet Delivery Ratio vs number of nodes is illustrated through the **Fig. 7**(a). It is obtained through that figure that PDR increased for increased on number of nodes. Further, GCORP achieves better PDR than that of other existing routing protocols. Average End-2-End delay vs number of nodes is illustrated through **Fig.7**(b). It is observe through the figure that Average E2E delay decreased for increased on number of nodes. Further, GCORP achieves better E2E delay than that of other existing routing protocols. Average Energy Consumption vs number of nodes is illustrated through **Fig. 7**(c). It is noted through the figure that Average EC delay decreased for increased on number of nodes. Further, GCORP achieves better EC delay than that of other existing routing protocols. Average Network Lifetime vs number of nodes is illustrated through **Fig. 7**(d). It is obtained through the figure that Average NT delay increased for increased on number of nodes. Further, GCORP achieves better NT delay than that of other existing routing protocols.

PERFORMANCE ANALYSIS OF RGCORP

This section investigate the performance of multiple sink numbers 4, 9, 16 and simulation result will be discussed.



(a) Average End to End Delay (b) Average Energy Consumption



(c)Average Packet Delivery Ratio

Fig. 8 performance analysis of proposed work

Average End 2 End delay vs number of nodes is illustrated through **Fig. 8(a)**. It is obtained through the figure that Average End 2 End delay increased for increased on number of nodes. Further, RGCORP achieves better Network Lifetime than that of GCORP. Average Energy Consumption vs number of nodes is shown in **Fig. 8**(b). It is obtained through the figure that Average Energy Consumption increased for increased on number of nodes. Further, RGCORP achieves better Energy Consumption delay than that of GCORP. Average Packet Delivery Ratio vs number of nodes is illustrated through **Fig. 8**(c). It is obtained through the figure that Average Packet Delivery Ratio increased for increased on number of nodes. Further, RGCORP achieves better Packet Delivery Ratio delay than that GCORP.

C. COMPARSION TABLE

The comparison table prove that the RGCORP is better than GCORP. This comparison table is done to analyse the performance metrics of GCORP and RGCORP by considering 50-100 nodes.

PROTOCOL	AVERAGE PACKET DELIVERY RATIO	AVERAGE END TO END DELAY	AVERAGE ENERGY CONSUMPTION
GCORP	55-70%	~7-8sec	200-250 joules
RGCORP	60-85%	~5-6.5sec	150-250joules

Fig. 9 Performance comparison between GCORP (Existing protocol) and RGCORP (Proposed protocol)

5. CONCLUSION

In this work, RGCORP is developed and then the corresponding performance are analyzed. The source node select the best relay node based on fitness factor. The simulation result shows that the RGCORP protocol achieves better performance compared to that of GCORP in terms of network metrics such as PDR, EC, E2E efficiently by varying the sink numbers. For future recommendations it is intended to resolve the issue of void nodes by developing the void node recovery algorithm. Besides this, machine learning based algorithms will also be designed for improving the network metrics even more than this scheme (i.e) RGCORP.

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