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ENHANCED ROUTING PROTOCOL IN MOBILE AD HOC NETWORK FOR IMPROVING THE PERFORMANCE

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ABSTRACT

Packet routing among the route path is a tedious task in Wireless Network and Creating an efficient route management system in wireless devices is a difficult task, particularly in Mobile Ad hoc Networks. Many studies are focused on offering efficient route management through the use of new algorithms and approaches. This article focuses on developing an upgraded routing protocol with route head support known as the Route Head based Routing Protocol (RHRP), which consists of three stages: route head forming, route prediction and packet forwarding. In the stage of route head , one node chosen and which takes the responsibility of packet forwarding , in route prediction stage the node decide the route path from the source node to the destination , and in the stage of packet forwarding flow the path to travel the packet to reach to the destination. The proposed RHRP was implemented in a network simulator and compared to existing routing protocols such as FLCH-AODV in terms of power analysis, end to end delay, energy consumption and connectivity analysis, the results shows that the proposed RHRP protocol is better. This proposed protocol also supports hidden and exposed node issues, buffer overflow, and energy optimization.

Keywords: *MANET, Network Layer, Route Head, Routing Protocol, Route Head Routing Protocol*

1. INTRODUCTION

Mobile Ad-hoc Networks (MANETs) [1] offer unique routing issues due to their dynamic and decentralized character. Traditional routing protocols built for wired networks are sometimes ineffective for MANETs due to variables such as node mobility, low bandwidth, and unpredictable communications links. As a result, specialized routing protocols [2] have been created to solve these issues and improve communication between mobile nodes. In the MANET protocol stack, the network layer's main job is to create routes between source and destination nodes [3]. Routing techniques become difficult to handle when there is a divergence in packet delivery, such as misrouting or excessive floating, which can cause a network collapse. Furthermore, ineffective packet transfer degrades wireless communication performance in addition to wasting energy.

Including internal battery consumption is essential to ensuring consistent communication. When Mobile Ad-hoc Networks (MANETs) are used in disaster management scenarios, a dead battery can make communication impossible. In order to reduce this risk and increase battery longevity, efficient power management strategies are essential. Several routing protocols have been put forth to

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address the various difficulties that MANETs present, such as regular topological changes, collisions brought on by exposed and hidden terminal problems, and packet forwarding failures caused by buffering limitations or internal threats, all of which have a major negative influence on MANET quality of service [4]. The objective of this essay is to address the problems that arise in MANETs directly [5].

To address battery power management issues, a number of MANET technologies [6] [7], including innovative routing protocols [8] [9], have been proposed. Interestingly, improving the AODV protocol's performance has received a lot of attention lately. Promising protocols to increase battery life have been identified, including AOMDV [11], SQR-AODV [12], AODV-BR [13], AODV-RD [14], AODV-BR [15, ATOMDV [16], and AMORLM [17]. Furthermore, one of the most important tactics for lowering battery power consumption is acknowledged to be MANET setup optimization. In order to enable more efficient power management, this entails lowering MANET overhead, and a number of optimization strategies have been developed in this regard [18].

It has been demonstrated that using the LEACH technique for cluster node selection results in a more effective energy distribution, extending the life of MANETs [19]. The goal of integrating a fitness function in the context of FFAOMDV is to minimize power consumption and maximize energy utilization [20]. Furthermore, using artificial intelligence neural networks in MANETs presents a viable way to optimize energy usage, improving network performance and efficiency overall [21]. Prolonged MANET utilization has been established by utilizing GPS and long-range technologies in conjunction with signal strength indicator-based (RSSI) measurements [22]. Moreover, the EMBOA strategy shows promise for enhancing multipath routing while preserving energy [23]. It does this by fusing butterfly optimization approaches with machine learning methodology. Finally, to relieve power limitations among MANET nodes, the PEO-AODV algorithm estimates hop count parameters and incorporate geographic position monitoring [24].

Abhilash & Shivaprakasha [6] conducted a survey on MANET issues, but had problems gathering dynamic metrics due to network mobility. Tripathy et al. [25] proposed an adaptive routing system for MANET, but experienced issues collecting parameters due to the network's dynamic nature. Arappali and Rajendran [26] proposed an improved link state routing protocol (OLSR) with increased complexity while using BABEL for vector direction. Panda and Pattanayak [27] proposed an enhanced ant colony optimization algorithm (ACO) for secure routing, although their research was lacking in innovation. Quy et al. [28] examined routing protocols for MANET-IoT but presented restricted conclusions without a thorough study. Maruthupandi et al. [29]: Developed the DISNEY routing protocol with SDN to overcome congestion, but encountered delays in routing decisions owing to dynamic changes. Rajendra Prasad and Shivashankar [30] proposed an Enhanced Energy Efficient-Secure Routing protocol, but had trouble identifying thresholds and authentication-based nodes. Mohammad et al. [31] proposed TBSMR for MANET augmentation, but encountered practical issues due to the use of various factors for route prediction. Anubhuti Roda Mohindra and Charu Gandhi. [32]: SCCM routing mechanism was introduced, but the overhead of encryption/decryption caused delays. Hwanseok Yang [33] proposed a trust evaluation approach based on cluster structure, but encountered feasibility challenges when building the clustering structure in MANET. Uppalapati Srilakshmi et al. [34]: Developed a fuzzy clustering technique for trust-based protection, but encountered route selection delays due to fuzzy logic.

Achieving effective power-optimized routing is still a challenge, despite the variety of power management measures applied through routing protocols and current developments in machine learning, artificial intelligence, and clustering approaches. A possible solution is to use a cluster-head-based routing protocol to transfer packets from source nodes to destination nodes, thereby reducing the amount of packets that intermediate nodes send. In keeping with this, the study paper suggests a brand-new Routing Head based Routing Protocol (RHRP) that maximizes battery life. Routing Head nodes are formed at the start of the protocol, and each node is in charge of choosing a routing path and sending packets to their intended destination. After then, packets are forwarded to later head nodes using a forwarding technique, which essentially removes internal node forwarding and

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makes power optimization in MANETs possible. By doing this, buffer overflow, internal threats, hidden and exposed nodes, and other MANET issues are indirectly addressed by the RHRP.

The article's structure is delineated as follows: Section II provides a summary of the diverse existing routing-based power optimization methods implemented in MANET to date. Following this, Section III elucidates the operational principles of Routing Head in MANET. This is succeeded by an exposition on the simulation setup employed for conducting the research. Section IV encapsulates the Results and Discussion, while Section V culminates the discourse with the Conclusion.

2. RESEARCH WORK RELATED TO ROUTING PROTOCOLS

The Table I outlines several authors' contributions and methodologies for addressing challenges in Mobile Ad-hoc Networks (MANETs), focusing on routing protocols, security, and optimization. While Abhilash & Shivaprakasha [6] conducted a comprehensive survey, their reliance on dynamic parameters faced criticism for its feasibility in MANET's highly mobile environment. Tripathy et al [25] proposed an adaptive routing protocol, yet their struggle to gather parameters highlighted the practical challenges of adapting to MANET's dynamics. Arappali & Rajendran [26] introduced an optimized routing protocol, but the added complexity of using BABEL for Vector directing detracted from its practicality. Similarly, Panda & Pattanayak [27]'s enhancement of ant colony optimization lacked novelty, undermining its significance in the field. Quy et al [28] provided a broad analysis of MANET-IoT routing protocols but received criticism for their limited conclusion without detailed evaluation.

Maruthupandi et al [30] introduced the DISNEY routing protocol to overcome congestion but faced delays due to dynamic changes in routing decisions. Rajendra Prasad & Shivashankar [30]'s Enhanced Energy Efficient-Secure routing protocol faced challenges in determining threshold and authentication-based nodes, hindering network participation. Mohammad et al [31]'s TBSMR faced practical challenges in route prediction with multiple factors. Anubhuti Roda MOHINDRA and Charu GANDHI [32]'s SCCM protocol, though secure, suffered from overhead in encryption/decryption, causing packet computation delays. Hwanseok Yang [33]'s trust evaluation method faced feasibility issues in forming clustering structures in MANET, undermining its applicability. Uppalapati Srilakshmi et al [34]'s fuzzy clustering algorithm encountered route selection delays due to fuzzy logic, limiting its effectiveness. Overall, while these approaches contribute to the field, their practical limitations and drawbacks call for further research to address MANET's complex challenges effectively.

TABLE I - Survey

S.NO	Authors	Methods	Limitations
1	Abhilash & Shivaprakasha [6]	Survey on MANET challenges: routing protocol, scheduling strategy, energy optimization, security factors	Difficulty in collecting dynamic parameters (security, trust values, etc.) in MANET's dynamic mobility nature.
2	Tripathy et al [25]	Proposed adaptive routing protocol for MANET. Used parameters and features for dynamic route function configuration	Difficulties in collecting parameters (security, trust, geographical values) due to MANET's dynamic nature.
3	Arappali & Rajendran [26]	Proposed optimized link state routing protocol (OLSR) with Raspberry Pi.	Additional task of using BABEL for Vector directing.
4	Panda & Pattanayak [27]	Enhanced ant colony optimization algorithm (ACO) for secured routing in MANET.	Fundamental for ACO-based security routing research, but may lack novelty.
5	Quy et al [28]	Analyzed routing protocols for MANET-IoT across performance, energy, QoS,	Limited conclusion recommending proactive

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		security.	protocols as good without detailed evaluation.
6	Maruthupandi et al [29]	Invented DISNEY routing protocol using SDN for MANET to overcome congestion.	Dynamic changes in efficient route manipulated table may cause delays in routing decisions.
7	Rajendra Prasad & Shivashankar [30]	Proposed Enhanced Energy Efficient-Secure Routing protocol.	Difficulty in determining threshold and authentication-based nodes, impacting network participation.
8	Mohammad et al [31]	Proposed trust-based multipath routing protocol (TBSMR) for MANET enhancement.	Multiple factor usage for route prediction may not be practical with large node numbers.
9	Anubhuti Roda MOHINDRA and Charu GANDHI [32]	Proposed Secure Cryptography based Clustering Mechanism (SCCM) routing protocol.	Encryption/decryption and ECC processes overhead, causing delays in packet computation.
10	Hwanseok Yang [33]	Proposed trust evaluation method of nodes using cluster structure and key exchange.	Forming clustering structure may not be feasible in MANET.
11	Uppalapati Srilakshmi et al [34]	Proposed fuzzy clustering algorithm for trust-based protection with energy optimization.	Route selection delay due to fuzzy logic in forming cluster heads.

The research work done by specializing in a particular area of the MANET, such as routing, mobility, clustering, and hybrid approaches transmission range, also proved successful, but other techniques produced unfavorable outcomes, according to the analysis of related work regarding the routing protocol. To implement routing for power optimization in MANETs, more investigation is needed. This study suggested an improved routing protocol that would do away with the need for intermediary nodes to forward packets in order to find the route and reach the target node.

3. RESEARCH METHODOLOGY

The purpose of this research article is to build the Route Head node, which aids in MANET routing schemes to improve the battery life of individual nodes while also overcoming buffer overflow, congestion, and packet collision difficulties between hidden and exposed nodes. The research approach is divided into four sections: first, the establishment of the route head node; second, the computation of route pathways from the route head to another route head; third, determining the route direction from source to destination; and finally, packet forwarding.

3.1 Route Head Node

For selecting of the route node uses the minimum spanning tree computation of the all the edges weight a minimal spanning tree (MST) is a subset of edges in a connected, edge-weighted, undirected graph. It connects all of the vertices without producing any cycles, while minimizing the total weight of the edges involved.

The Equation (1) commonly used to describe a minimum spanning tree problem is

$$(u,v) \; \varepsilon \; T^{\; w(u,v)} \qquad (1)$$

Where T represents the least spanning tree, (u, and v) are the tree's edges, and w (u, v) is the edge's weight.
Kristal's technique is one of the most well-known methods for calculating the least spanning tree. Here's an overview of Kristal's algorithm:

1. Sort the edges in non-decreasing order of weight.
2. Create an empty graph T to represent the smallest spanning tree.
3. Iterate through sorted edges: If adding the current edge to T does not result in a cycle, add it to T.
4. Repeat step 3 until T has n-1 edges, where n is the number of vertices in the graph.

This algorithm ensures that the selected edges form a tree with the lowest possible overall weight.

In the MANET nodes Route Head node selection is based on the location of the others nodes. Nodes which are in the same region and one node are selected as a Route node using the spanning tree as shown in the Fig 1.

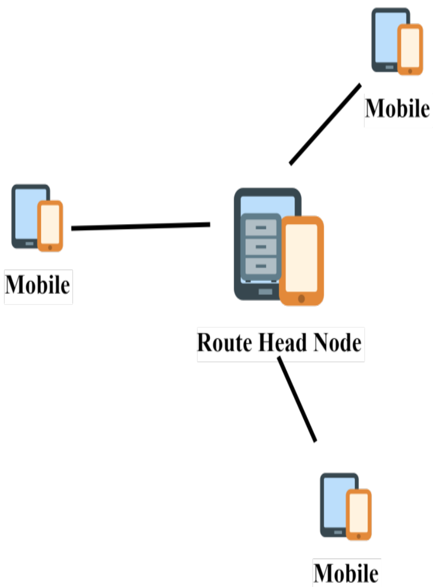

Fig 1 Route Head Node Forming

Let the MANET has formed N number of nodes from 1 to n where each node could able to form the node head based on the minimum spanning tree as shown in the Figure 2. A node which is selected based on the maximum connection to other nodes.

The system model is initially created for the creation of internal Routing node, after each routing node created the route path creation, then forming the route table between all the source nodes to the destination nodes as shown in the Figure 3. Finally the packet transmission could be taken place through the route heads rather the intermediate nodes. This proposed model supports to reduce the buffer overflow, congestion, Hidden and exposed nodes issues.

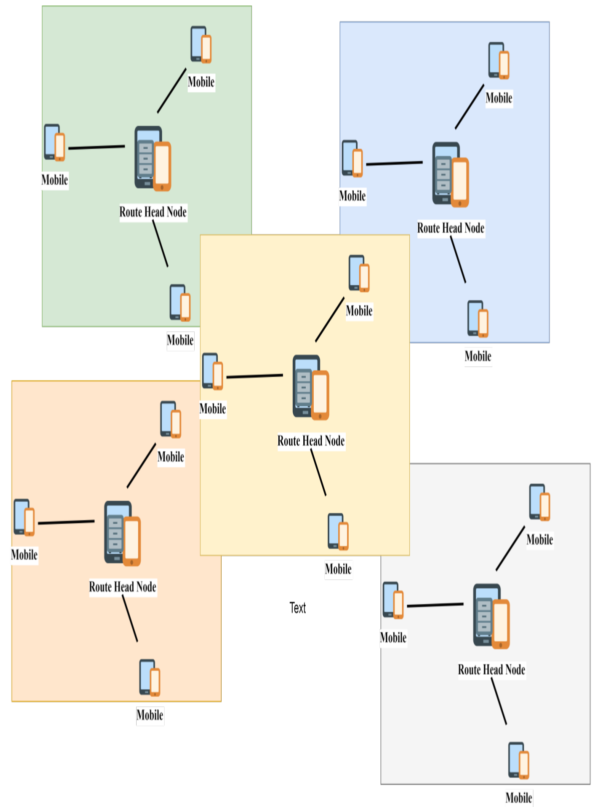

Figure 2 Route Head Forming In MANET Nodes

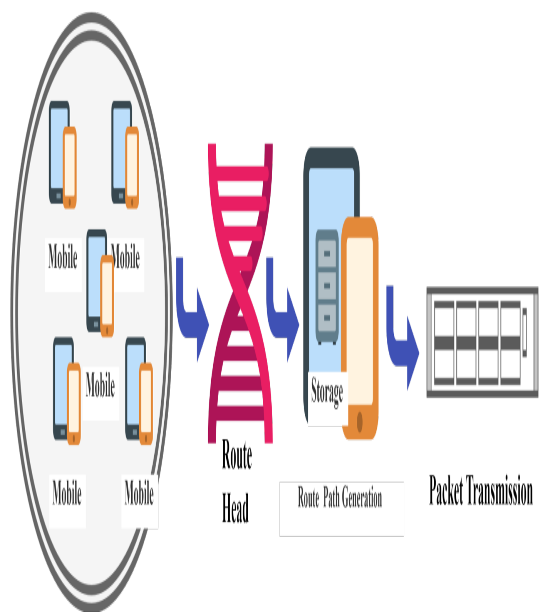

Figure 3 System Model

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3.2 Route path selection and forwarding packets

Once the primary node for routing was determined among the MANET nodes, the subsequent step involved selecting the route path for transmission. To ensure reliability from the source node to the destination node, the source node initiates a message request to the corresponding route head node, which then broadcasts a route request to all other route head nodes. In this research, intermediate nodes are excluded from message forwarding, as depicted in Figure 4. For instance, when the source node sends a request message to RHN1, RHN1 forwards the request to RHN2 and RHN3; with RHN3 further relaying it to RHN4. As the destination node falls under RHN4, RHN4 responds via RREP to RHN3, which then relays it back to RHN1, establishing the final path from S to D as RHN1 → RHN3 → RHN4 → D. Once the reliable path is established, the source nodes begin packet transmission to RHN1, which subsequently forwards it to the next RHN until reaching the destination. This approach ensures optimized power consumption for intermediate nodes and minimizes collisions, as other intermediate nodes are excluded from the transmission and forwarding processes.

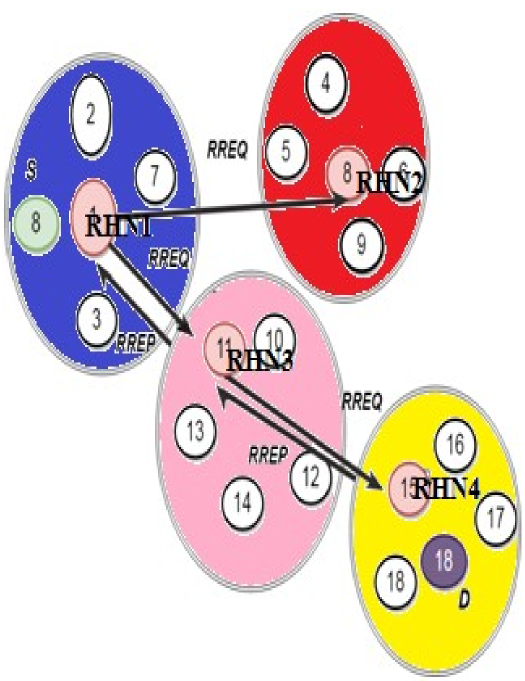

Figure 4. Route Path Selection

4. RESULT ANALYSIS

The proposed route head based routing protocol was implemented using the Network simulator with the simulation parameters for the MANET network interface are as follows: The network interface is wireless, utilizing a physical interface with an Omni Antenna. The simulated area has dimensions of 1000 * 1000 square meters. The number of nodes in the network varies, with options for 50, 100, 150, or 200 nodes. The link count ranges from 20 to 50. Source transmission is set to Constant Bit Rate Transmission, with each packet size being 512 bytes and a buffer size of 40 packets. The MAC layer used is 802.11b. The simulation model is defined as random, with a 2 Way Ground propagation model. Nodes have a maximum speed of 25 meters per second and a pause time of 15 seconds. During each interval, two packets are sent. The simulation time can be set for 50 or 100 seconds. Initial node energy is 240 Joules, with each node's transmission power set to 0.9 Joules and receiving power to 0.4 Joules. Sleep power is 0.002 Joules, and the changeover time is 0.009 seconds. To compare performance evaluation, FLCH-AODV [34] was simulated alongside the proposed RHRP-AODV protocol. The parameters evaluated for the performance analysis include connectivity analysis, power analysis, end-to-end latency, and energy consumption. Each and every performance parameter is done simulation by varying the total number of nodes from 50nos, 100nos, 150nos and 200 nos.

4.1 Connectivity analysis

Examining the results reported in Figure 5 reveals that both RHRP-AODV and FLCH-AODV have differing performance outcomes across different unit values. RHRP-AODV values increase consistently as units move from 50 to 200, recording 8, 16, 24, and 32, respectively. In contrast, FLCH-AODV shows a more dramatic growth trend, with values of 12, 26, 40, and 50 across the same unit range. These data imply that each protocol has unique operational characteristics, revealing possible strengths and weaknesses in various network settings. Further research and experimentation may be required to fully understand the suggested RHRP-AODV protocols' applicability for various applications and network settings.

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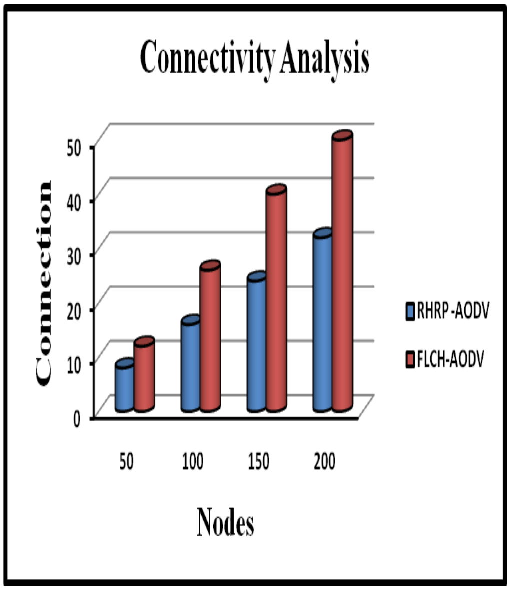

Figure 5 Connectivity Analysis

4.2 Power analysis

The Figure 6 presents the power analysis comparison between two routing protocols, RHRP-AODV and FLCH-AODV, across varying network sizes. For a network with 50 nodes, RHRP-AODV demonstrates an average power of 19.02 J, while FLCH-AODV exhibits a slightly higher power of 21.03 J. As the network size increases to 100 nodes, both protocols experience a marginal increase in power, with RHRP-AODV at 19.01 J and FLCH-AODV at 22.05 j. Similarly, for networks with 150 and 200 nodes, both protocols show a further increase in power consumed. RHRP-AODV records power of 19.06 J and 19.08 J for networks with 150 and 200 nodes, respectively, while FLCH-AODV demonstrates power consumed 25.03 J and 26.07 J for the same network sizes. Overall, the comparison reveals variations in average power between the two protocols across different network sizes, with FLCH-AODV generally exhibiting slightly higher power values compared to RHRP-AODV.

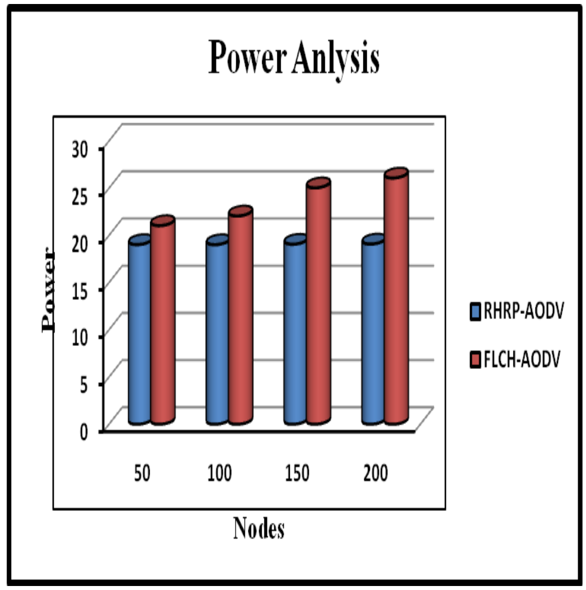

Figure 6 Power Analysis

4.3 Energy consumed

The Figure 7 displays the energy consumption comparison between two routing protocols, RHRP-AODV and FLCH-AODV, across different network sizes. For a network with 50 nodes, RHRP-AODV achieves energy 4 J while FLCH-AODV records a slightly higher of 5 J. As the network size increases to 100 nodes, both protocols experience a rise in routing energy with RHRP-AODV at 8J and FLCH-AODV at 9J . Similarly, for networks with 150 and 200 nodes, RHRP-AODV exhibits routing energy of 14 J and 22 J, respectively, whereas FLCH-AODV demonstrates energy of 15 J and 20 J. Overall, the comparison indicates variations in routing energy consumed between the two protocols across different network sizes, with FLCH-AODV generally exhibiting slightly higher energy consumed compared to RHRP-AODV.

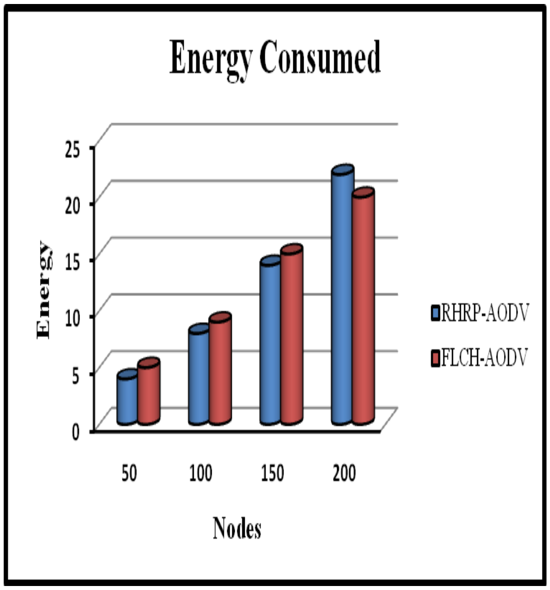

Figure 7 Energy Consumed

4.4 End to End Delay computation

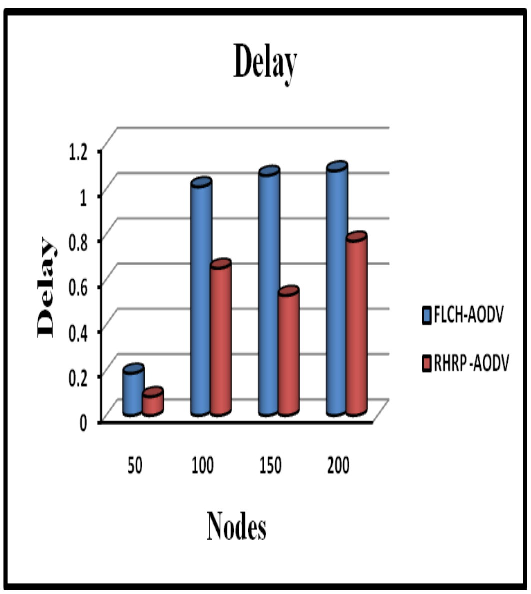

Figure 8 End to End Delay

When analyzing the delay shown in Figure 8, it is clear that FLCH-AODV and RHRP-AODV have distinct End to End performance metrics at different unit values. FLCH-AODV values gradually increase from 50 to 200, with recorded values of 0.186, 1.01, 1.06, and 1.08, delay respectively. RHRP-AODV, on the other hand, shows changing tendencies, with values ranging from 0.083 to 0.77 across the same unit range. These findings show the differences in behaviour between the two protocols under discussion, emphasizing the significance of RHRP-AODV selecting a less delay in routing protocol.

5. CONCLUSION

This article proposed the enhanced routing protocol for improving the Mobile Adhoc network performance for supporting the buffer overflow, congestion, hidden and exposed nodes. This was achieved by the Routing head node selection and maintaining the route path between the route head nodes and finally the packet transmission was achieved by the support of the route head node. The suggested routing protocol was entitled Routing Head based routing protocol, and it was compared against the FLCH-AODV protocol for performance metrics such as power analysis, end-to-end delay, energy consumption, and connectivity analysis. The results show that the proposed RHRP protocol is superior.

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