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Routing Optimizing Decisions in MANET: The Enhanced Hybrid Routing Protocol (EHRP) with Adaptive Routing based on Network Situation

Advin Manhar[1], Dr. Deepak Dembla[2]
[1]Department of Computer Science & Engineering, JECRC University, Jaipur
adymanhar@gmail.com
[2]Department of Computer Application, JECRC University, Jaipur
dembla.deepak@gmail.com

Abstract— Mobile ad hoc networks (MANETs) are wireless networks that operate without a fixed infrastructure or base station. In MANETs, each node acts as a data source and a router, establishing connections with its neighboring nodes to facilitate communication. This research has introduced the Enhanced Hybrid Routing Protocol (EHRP), which combines the OLSR, AOMDV, and AODV routing protocols while considering the network situation for improved performance. The EHRP protocol begins by broadcasting a RREP (Route Reply) packet to discover a route. The selection of routing options is based on the current network situation. To determine the distance between the source and destination nodes, the proposed EHRP initiates a RREQ (Route Request) packet. In situations where network mobility exceeds the capabilities of the AODV protocol, the EHRP protocol can utilize the OLSR routing protocol for route selection and data transmission, provided that at least 70% of the network nodes remain stable. Additionally, the EHRP protocol effectively handles network load and congestion control through the utilization of the AOMDV routing protocol. Compared to the hybrid routing protocol, the enhanced hybrid routing protocol (EHRP) demonstrates superior performance. Its incorporation of the OLSR, AOMDV, and AODV protocols, along with its adaptive routing adaptation based on network conditions, allows for efficient network management and improved overall network performance.

The analysis of packet delivery ratio for EHRP and ZRP reveals that EHRP achieves a packet delivery ratio of 98.01%, while ZRP achieves a packet delivery ratio of 89.99%. These results indicate that the enhanced hybrid routing protocol (EHRP) outperforms the hybrid routing protocol (ZRP) in terms of packet delivery ratio. EHRP demonstrates a higher level of success in delivering packets to their intended destinations compared to ZRP.

The analysis of normal routing load for EHRP and ZRP reveals that EHRP exhibits a normal routing load of 0.13%, while ZRP exhibits a higher normal routing load of 0.50%. Based on these results, it can be concluded that the performance of the Enhanced Hybrid Routing Protocol (EHRP) is significantly better than that of the Hybrid Routing Protocol (ZRP) when considering the normal routing load. EHRP demonstrates a lower level of routing overhead and more efficient resource utilization compared to ZRP in scenarios with normal routing load.

When comparing the average end-to-end delay between the Enhanced Hybrid Routing Protocol (EHRP) and ZRP, the analysis reveals that EHRP achieves an average delay of 0.06, while ZRP exhibits a higher average delay of 0.23. These findings indicate that the Enhanced Hybrid Routing Protocol (EHRP) performs better than ZRP in terms of average end-to-end delay. EHRP exhibits lower delay, resulting in faster and more efficient transmission of data packets from source to destination compared to ZRP.

After considering the overall parameter matrix, which includes factors such as normal routing load, data send and receive throughput, packet delivery ratio, and average end-to-end delay, it becomes evident that the performance of the Enhanced Hybrid Routing Protocol (EHRP) surpasses that of the current hybrid routing protocol (ZRP). Across these metrics, EHRP consistently outperforms ZRP, demonstrating superior performance and efficiency. The Enhanced Hybrid Routing Protocol (EHRP) exhibits better results in terms of normal routing load, higher throughput for data transmission and reception, improved packet delivery ratio, and lower average end-to-end delay. Overall, EHRP offers enhanced performance and effectiveness compared to the existing hybrid routing protocol (ZRP).

Keywords- MANET, EHRP, AODV, ZRP, AOMDV, OLSR, NS-2.

I. INTRODUCTION

A mobile ad hoc network (MANET) is a type of wireless network that can be formed without any fixed infrastructure or centralized authority. Instead, the nodes in a MANET are mobile and autonomous, and they communicate with one another in a peer-to-peer fashion. The communication between the nodes is wireless, and it can be established and maintained dynamically, which means that the topology of the network can change rapidly and unpredictably. MANETs are particularly useful in situations where infrastructure-based networks are not

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available or reliable, such as in disaster-stricken areas, battlefields, and remote locations. In these scenarios, the nodes can form a self-configured network and provide communication services to each other without relying on any external infrastructure. However, MANETs also face several challenges, such as limited bandwidth, node mobility, network congestion, and security threats. These challenges require the development of new routing protocols, medium access control techniques, and security mechanisms that are specifically designed for MANETs. In this context, the study of MANETs is an active research area, and it has attracted the attention of researchers from various fields, such as computer science, electrical engineering, and communication networks [19]. The goal of this research is to develop new technologies and protocols that can enable efficient, reliable, and secure communication in MANETs.

II. HYBRID ROUTING PROTOCOL

A hybrid routing protocol is a routing protocol that combines proactive and reactive routing techniques to leverage their respective advantages. Proactive routing protocols, such as the Optimized Link State Routing (OLSR) protocol, maintain a comprehensive network topology and pre-calculate the shortest paths between nodes. These protocols work well in stable networks with low mobility but may suffer from inefficiency in highly mobile networks with numerous nodes. In contrast, reactive routing protocols like the Ad Hoc On-Demand Distance Vector (AODV) protocol establish routes on-demand as the need arises. Reactive protocols can be more efficient in highly mobile networks as they reduce control overhead and conserve network resources. However, they may introduce delays in route discovery and increase latency. Hybrid routing protocols aim to strike a balance by combining proactive and reactive approaches. Within a hybrid routing protocol, nodes in close proximity utilize proactive routing protocols to maintain pre-established routes, while nodes that are farther apart employ reactive routing protocols to establish routes only when necessary. This approach proves beneficial in networks with varying node mobility, offering an optimal trade-off between control overhead and latency. An example of a hybrid routing protocol is the Zone Routing Protocol (ZRP), which operates based on the concept of dividing the network into zones to efficiently manage route discovery and maintenance. By integrating proactive and reactive routing techniques, hybrid routing protocols enhance the routing efficiency and adaptability of ad hoc networks, making them suitable for diverse scenarios with different levels of node mobility and network dynamics.

A. Zone Routing Protocol (ZRP)

The Zone Routing Protocol refers to the hybrid routing-based protocol that collaborates the advantages of proactive and reactive routing protocols. It divides the network into zones, with each zone having a predefined radius. Within each zone, a proactive routing protocol is used to maintain routing information for nodes within the zone. When the particular node needs to communicate with a node outside of its zone, a reactive routing protocol is used to find a route to the destination. One of the main advantages of the ZRP is that it reduces the amount of control overhead in the network, as only nodes that are close to each other need to exchange routing information []18]. This can help conserve network resources and reduce network congestion. Research in ZRP has focused on improving its performance in various aspects, such as reducing the size of the routing table and improving the scalability of the protocol.

III. RELATED WORK

Kang et al. [1] proposed an enhanced hybrid routing protocol (EHRP) combining MANET and DTN. The performance was compared with aspects of delivery ratio, overhead ratio, and delivery latency. The proposed protocol, with carefully chosen delivery predictability threshold values, demonstrated a higher delivery ratio compared to the HSBR (Hybrid Stable-Based Routing) protocol. However, this improvement in delivery ratio came at the expense of increased overhead ratio. Furthermore, the proposed protocol exhibited comparable delivery latency to the HSBR protocol when considering the specified parameters. These findings have practical implications in disaster or military scenarios, where a combination of Mobile Ad hoc Networks (MANETs) and Delay-Tolerant Networks (DTNs) can be employed in a hybrid manner. In such environments, traditional infrastructure may be unreliable due to unstable connections between neighboring nodes. In situations where a clear routing path to the destination node exists, MANET can be utilized. However, when the routing path is unavailable, DTN can be deployed, allowing messages to be delivered using a store-carry-forward approach. This study's results provide valuable insights for designing communication systems in disaster or military settings, highlighting the benefits of integrating MANET and DTN technologies. By leveraging the strengths of both approaches, a hybrid solution can effectively overcome the challenges posed by unreliable infrastructure and ensure reliable message delivery.

Srilakshmi et al. [2] suggested an approach of a novel hybrid optimization methodology for MANETs achieving a minimum energy of 0.10 joules, a trivial amount of time in milliseconds, throughout clock cycles of 0.85 bits per second, a detection rate of 91%, and a packet delivery ratio of 89%. The suggested approach was compared against the current methods

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and techniques in the presence and absence of the selective packet dropping assault. They split up the network into main fold dynamic of clusters by utilizing the Dual Constraint Clustering (DCC) approach that works upon the Mobility Metric (MoM) and Hop Count (HC) by selecting the Cluster Head (CH) with the Type-II fuzzy approach. The routing was performed by the Hybrid Cellular Automata and African Buffalo Optimization (HCA2BO) algorithm. The study concluded that the use of extensive analysis in the NS-3 simulation tool appeared intensified performance in network lifetime, energy consumption, and delay.

Baskar et al. [3] proposed a novel hybrid optimization methodology for MANETs. To begin with, the network was divided into dynamic clusters using the Dual Constraint Clustering (DCC) approach, which takes into account Mobility Metric (MoM) and Hop Count (HC). This partitioning technique ensured efficient cluster formation within the network. Within each cluster, a cluster head (CH) was selected using the Type-II fuzzy approach, which utilizes fuzzy logic principles to make informed decisions. Once the clusters and cluster heads were established, routing was carried out using the Hybrid Cellular Automata and African Buffalo Optimization (HCA2BO) algorithm. This novel optimization algorithm considers multiple metrics to determine the optimal route for data transmission. By leveraging both cellular automata and the African Buffalo Optimization technique, the algorithm achieved efficient and effective routing decisions. Extensive analysis was conducted using the NS-3 simulation tool to evaluate the performance of the proposed approach. The results demonstrated significant improvements in network lifetime, energy consumption, and delay compared to existing methods. The proposed approach showcased enhanced efficiency and effectiveness in terms of network operation, resource utilization, and communication delays, thereby validating its superiority.

Sharma et al. [4] proposed the hybrid AODV (HAODV) technique incorporating the MFR (Most Forward within Radius) technique to detect the shortest path routing algorithm for selecting the neighbour node and the shortest path. The Firefly algorithm was enhanced and applied in the hybrid AODV to determine the shortest path. The proposed HAODV algorithm demonstrated improvements in packet delivery ratio, end-to-end delay, routing overhead, and throughput.

Pate et al. [5] proposed a comprehensive analysis between AODV, DSR, and ZRP protocols by varying the velocity of mobile nodes. The performance of routing protocols varied in different network environments, yielding diverse results. Simulation analysis considered average jitter, TTL-based average hop count, and average end-to-end delay as performance metrics. AODV outperformed DSR and ZRP in terms of average jitter and average end-to-end delay. However, the performance of ZRP deteriorated with increasing velocity. DSR took the minimum number of hops to transmit the packets, while ZRP took the maximum.

Soomro et al. [6] compared the hybrid approach to the conventional AODV routing protocol with respect to the speed of nodes, representing normal in a disaster situation. The simulation results depicted a significant performance advantage of the hybrid approach over AODV. A clear contrast emerged, with the hybrid approach outperforming the existing AODV protocol by a notable margin, resulting in an improvement of 9% to 12%.

Wane et al. [7] evaluated various routing protocols, such as proactive, reactive, hybrid, hierarchical, multipath, location-based, and geographical routing protocols. The survey encompassed the routing phenomenon, network scenario, mobility model, performance metrics, and algorithm complexity on scalability, reliability, loops, control overheads, and bandwidth.

Kumar et al. [8] proposed a congestion control load balancing adaptive routing protocol (CCLBARP) algorithm to reduce delay, system routing overhead, and congestion and enhance the life of the network in MANET. The proposed CCLBARP technique was evaluated against existing MANET routing protocols, namely DYMO and DSR, across various performance metrics. CCLBARP demonstrated superior performance in terms of throughput, end-to-end delay, packet drop jitter, packet delivery ratio, and normalized routing overhead, surpassing DSR and DYMO.

Bhavin and Dhaval [9] evaluated the normal routing strategy and proposed LEACH-based routing. By repeatedly performing simulation comparisons of the proposed strategy with the existing strategy, they concluded that the proposed strategy gave efficient output for mobile communication. The simulation results of the proposed scheme were validated with theoretical analysis. The performance of the proposed protocol gave excellent results for the given simulation parameters.

Rupérez et al. [10] presented HACOR, a hybrid ACO-based routing protocol with novel characteristics and enhanced techniques compared to its predecessors. The experimentation results showed that HACOR performed better than AODV. Overall, a significant improvement with regard to overhead in the number of packets was found.

Bohra et al. [11] proposed an efficient routing protocol by analyzing the proactive, reactive, and hybrid routing protocols. The study concluded that selecting a routing protocol should consider factors like traffic type, packet size, node mobility, and QoS requirements. While DSDV performed better in average

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end-to-end delay, DSR, AODV, and ZRP were found to be suitable for all parameters. AODV exhibited a higher constant PDF value as the number of nodes increased, while DSR scaled well with node density. DSDV maintained a consistent behavior with varying node density, and ZRP demonstrated good scalability in low-density mode based on PDF.

Soomro et al. [12] introduced an improved hybrid routing protocol approach that combines two reactive and one proactive routing protocols to provide efficient route discovery and maintenance mechanisms. The proposed approach was evaluated in a simulation environment, demonstrating superior performance in data packet delivery, routing load, throughput, and end-to-end delay compared to AODV and ZRP. The results highlighted a significant performance advantage of the IHRP, leading to a performance increase of 9% to 12% compared to existing protocols.

Sirmollo et al. [13] proposed a routing algorithm based on node speed, direction, and residual energy to select more stable routes among the intermediate nodes located in the path of the source and destination nodes. The proposed algorithm underwent simulation-based testing and evaluation, considering varying node density, node speeds, and different mobility models.

Zhao et al. [14] proposed NHRP, and the protocol reliability relationship between ZRP and NHRP was demonstrated by a comparative analysis of route reliability between ZRP and NHRP. The theoretical analysis shows that NHRP has higher reliability than ZRP.

Alsaeedi et al. [15] proposed a hybrid extended particle swarm optimization (EPSO) model to improve the performance of MANET routing protocols. The proposed model identified the optimal mobility, number of hubs, and nodes to achieve an optimal version of MANET. By setting appropriate routing protocol parameters, the model achieved high performance with minimal packet discards and low delays. In the proposed model, 167 packets were sent, with less than 1% discarded.

Hassan et al. [16] proposed a QoS-routing algorithm applicable to MANETs that satisfied energy and delay constraints. Using CA with GAABO techniques, this study sought to enhance the network lifetime as well as the E2E delay.

Hassan et al. [17] presented a summary of the challenges facing routing protocols for QoS in MANETs on DSR and AODV. They also briefly explained and compared different reactive routing protocols for QoS.

[20] Deepak and Yogesh proposed a novel AODV-Efficient and dynamic probabilistic broadcasting approach that is both efficient and dynamic, and resolves the broadcast storm problem in AODV. The simulation is done on Global Mobile Simulator (GloMoSim).

IV. PROPOSED METHODOLOGY OR PLAN

Implementing routing protocols in Mobile Ad hoc Networks (MANETs) faces challenges related to node mobility and changing network topology. This research proposes the Enhanced Hybrid Routing Protocol (EHRP), which combines AODV, AOMDV, and OLSR routing protocols to adapt to network situations. EHRP ensures superior network performance in any scenario by effectively managing network behavior. It incorporates reactive and proactive elements, making it suitable for frequent or infrequent node movement. EHRP outperforms the existing hybrid routing protocol in terms of minimizing data re-transmissions, delay, and routing load, while maximizing packet delivery ratio, throughput, and data transmission rate. Simulation results confirm EHRP's superior performance compared to ZRP, validating its effectiveness.

A. EHRP Working

EHRP, the Enhanced Hybrid Routing Protocol, leverages the strengths of reactive and proactive routing protocols to improve network efficiency. By combining AODV, AOMDV, and OLSR, we address the limitations of flooding, reducing unpredictability and data packet dropping. Our design focuses on expedited route discovery, crucial for mitigating flooding issues. EHRP considers dynamic environments, where AODV excels, and emphasizes energy consumption. The AOMDV routing protocol aids in network load balancing and congestion control, while OLSR excels in stable networks with link stability-based routing. By incorporating these protocols into EHRP, we achieve superior network performance in any scenario.

The EHRP follows a process where a route request packet is initially broadcasted to find the path from the source to the destination node. The selection of routing protocols depends on the network situation. In the proposed EHRP, if the network node movement exceeds Ten M/sec, the AODV protocol is employed to handle the situation. It broadcasts the route request packet to determine the shortest path among communicating nodes. Conversely, if the network node movement is below Ten M/sec, the OLSR protocol is utilized for route selection and data transfer. The EHRP also incorporates the AOMDV protocol to handle network load and manage congestion effectively.

The Enhanced Hybrid Routing Protocol (EHRP) proposes a novel approach to address the challenges of high network load and varying node movement frequencies in Mobile Ad hoc Networks (MANETs). When a communication link is identified as experiencing a heavy network load, EHRP employs a load-balancing mechanism by establishing multiple paths. This

dynamic load distribution strategy aims to optimize network performance and enhance overall efficiency. EHRP harnesses

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the benefits of both reactive and proactive routing protocols, integrating them seamlessly to adapt to different scenarios. This hybrid approach enables EHRP to effectively handle diverse node movement frequencies and ensure continuous connectivity in MANETs. One of the key advantages of EHRP is its ability to minimize data re-transmissions, which is crucial for reducing network overhead and conserving valuable resources. By intelligently distributing the network load across multiple paths, EHRP avoids bottlenecks and congestion points, resulting in improved data transmission rates and reduced normalised routing load (NRL). Furthermore, EHRP significantly reduces end-to-end delay, enhancing real-time communication and ensuring timely delivery of data packets. This is accomplished through efficient path selection and optimization, considering factors such as link stability, node mobility, and network topology. By adapting to the dynamic nature of MANETs, EHRP provides low-latency routing, enabling time-sensitive applications to operate smoothly.

B. Our Implementation Environment is Based on:

Packet delivery ratio (PDR): measures the effectiveness of packet transmission by calculating the ratio between the number of successfully received packets at the destination node and the total number of packets sent from the source node.

End-to-End Delay (E-to-E delay): quantifies the overall delay experienced by data packets during transmission. It is calculated by comparing the time at which a packet is sent from the source node to the time it is received at the destination node.

Routing load: refers to the burden imposed on the network due to the transmission of control packets necessary for routing operations. It is evaluated by determining the number of control packets delivered at the destination node for every data packet transmitted.

Throughput: measures the rate of successful packet delivery per unit of time. It is determined by calculating the number of packets successfully sent to the target node within a given time frame, thereby assessing the efficiency of data transmission in the network.

V. PROPOSED FLOW CHART FOR EHRP

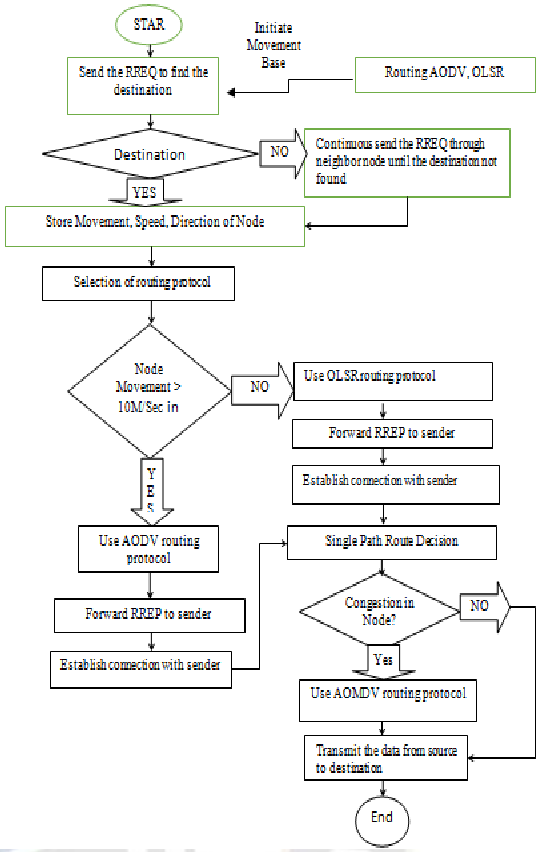

Figure 1. Representing the proposed flow chart of EHRP

VI. PSEUDO CODE FOR EHRP

```
START
   Send the RREP to find the target
If (Destination found) Then
Calculate node movement and speed
Establish the connection
If (Node Mobility > 70%) Then
Use AODV routing protocol
If (Congestion in Node) Then
  Use AOMDV routing protocol
Spread the information Origin to target
End If
                Else
Spread the information Origin to destination
End If

    If (Node Mobility <= 70%) Then
 Use OLSR routing protocol
If (Congestion in Node) Then
  Use AOMDV routing protocol
Transmit the data from source to destination
End If
                Else
                  Spread the information Origin to destination
              End If

Else

            Continuous send the RREQ through neighbour node until the destination not found

End If
```

VII. EXPERIMENTAL SETUP

The simulation was conducted using Network Simulator (NS) 2.31, an open-source software widely used in research and

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educational settings. NS2 is specifically designed for traffic evaluations, protocol comparisons, and the development of new protocols. It is a versatile tool employed by researchers and numerous institutions, available for various operating systems including Windows, Linux, Mac OS X, and Solaris.

A. Parameters in simulation

The obtained results have been generated according to the given parameters.

TABLE I
Simulation Parameters

Parameters	**Configuration Value**
Routing Protocol	EHRP, ZRP
Simulation Area	800*800
Network Type	MANET
Nodes/Devices	29
Physical Medium	Wireless
Node Movement	Random
Simulation Iteration	100
Queue Length	10
MAC Layer	MAC 802.11
Traffic Type	CBR, FTP
Propagation radio model	Two ray ground
Rate	Random

B. Results

The results obtained from EHRP and ZRP routine protocol has been presented here:

1. Analysis of Packet Delivery Ratio:

In Figure 2, the analysis of packet delivery ratio (PDR) for EHRP and ZRP is depicted. The results indicate that EHRP achieves a PDR of 98.1%, while ZRP achieves a PDR of 89.99%. Based on these findings, it is evident that the Enhanced Hybrid Routing Protocol (EHRP) outperforms ZRP significantly in terms of packet delivery ratio.

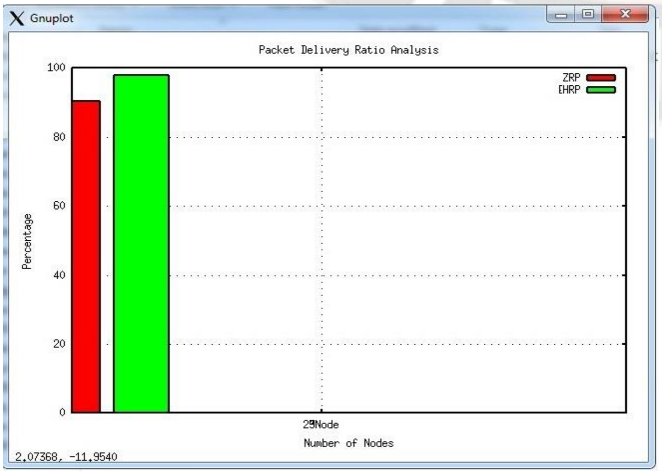

Figure 2. Showing "Packet Delivery Ratio" Analysis for EHRP and ZRP.

2. Throughput Analysis:

In Figure 3, the analysis of throughput for EHRP and ZRP is illustrated. The results indicate that EHRP achieves a throughput of 3.53, while ZRP achieves a throughput of 2.48. These findings clearly demonstrate that the Enhanced Hybrid Routing Protocol (EHRP) exhibits superior performance in terms of throughput compared to ZRP.

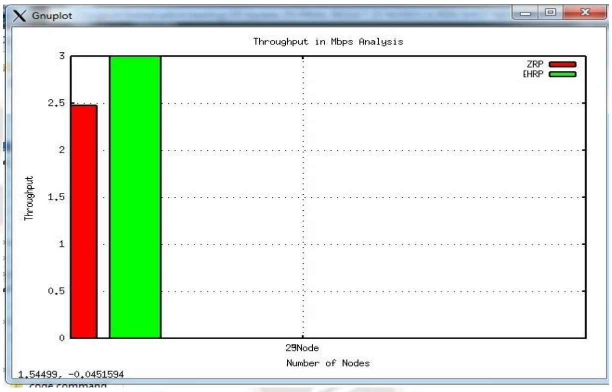

Figure 3. Showing "Throughput" Analysis for EHRP and ZRP.

3. Normal load Routine:

Figure 4 illustrates the analysis of normal routing load for EHRP and ZRP. The results reveal that EHRP exhibits a normal routing load of 0.13%, whereas ZRP demonstrates a normal routing load of 0.50%. These findings unequivocally demonstrate that the performance of the Enhanced Hybrid Routing Protocol (EHRP) surpasses that of the Hybrid Routing Protocol (ZRP) in terms of normal routing load.

Figure 4. Showing "Normal Routine Load" Analysis of EHRP and ZRP.

4. Average End to End Delay (ms) Analysis:

Figure 5 depicts the analysis of average end-to-end (E-to-E) delay for EHRP and ZRP. The results indicate that EHRP exhibits an average E-to-E delay of 0.06, whereas ZRP demonstrates an average E-to-E delay of 0.23. This clearly demonstrates that the performance of the Enhanced Hybrid Routing Protocol (EHRP) in terms of average E-to-E delay is significantly lower than that of the Hybrid Routing Protocol (ZRP).

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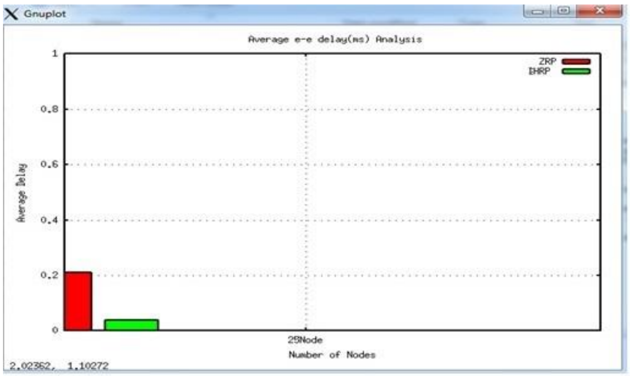

Figure 5. "Average end to end Delay" Analysis for EHRP and ZRP.

5. Data Send:

Figure 6 represents the packet send analysis for the Enhanced Hybrid Routing Protocol and ZRP. Here we clearly show that the packet send is 8677 by the Enhanced Hybrid Routing Protocol and 8224 by the ZRP, Therefore, we can conclude that the execution of the Enhanced Hybrid Routing Protocol in the case of the packet send is far higher than the ZRP.

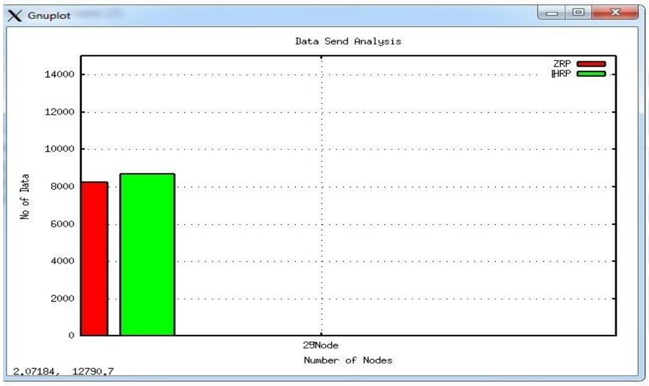

Figure 6. Showing "Data Analysis" Analysis for EHRP and ZRP.

6. Data Received:

Figure 7 represents the packet received analysis for the Enhanced Hybrid Routing Protocol and ZRP. Here we clearly show that the packet received is 8137 by Enhanced Hybrid Routing Protocol and 7438 by ZRP, therefore, we can conclude, that the performance of Enhanced Hybrid Routing Protocol in terms of throughput is more notable than ZRP.

Figure 7. Showing "Packet Received" Analysis of EHRP and ZRP.

C. Summary of Performance matrix:

The overall execution of EHRP and ZRP protocols has been established by the given protocol.

Table II of Performances Matrices

Parameters	**EHRP**	**ZRP**
PDR	**98.01**	**89.99**
THROUGHPUT	**3.53**	**2.48**
NRL	**0.13**	**0.50**
E-E- DELAY	0.06	**0.23**
Packet Sent	**8677**	**8224**
Packet Received	**8137**	**7438**

The performance metrics analysis reveals that the Enhanced Hybrid Routing Protocol (EHRP) outperforms the Hybrid Routing Protocol (ZRP) in various aspects.

The packet delivery ratio (PDR) for EHRP is 98.90%, whereas ZRP achieves 89.99%. This indicates that EHRP significantly surpasses ZRP in terms of PDR.

In terms of normal routing load, EHRP exhibits a load of 0.13%, while ZRP demonstrates a load of 0.50%. Hence, EHRP performs much better in handling normal routing load compared to ZRP.

The number of packets sent by EHRP is 8677, whereas ZRP sends 8224 packets. Thus, EHRP demonstrates superior performance in terms of packet transmission.

EHRP achieves a throughput of 3.55, whereas ZRP achieves a throughput of 2.50. This clearly indicates that EHRP outperforms ZRP in terms of throughput.

The average end-to-end delay for EHRP is 0.06, while ZRP exhibits a delay of 0.23. This result emphasizes that EHRP performs better in minimizing end-to-end delay compared to ZRP.

Regarding packet reception, EHRP receives 8137 packets, whereas ZRP receives 7438 packets. Hence, EHRP exhibits superior performance in terms of packet reception.

Overall, the performance evaluation of the Enhanced Hybrid Routing Protocol (EHRP) demonstrates its superiority over the existing Hybrid Routing Protocol (ZRP) across various performance parameters.

VIII CONCLUSION AND FUTURE PROSPECTS

Mobile ad-hoc networks (MANET) refer to wireless networks that operate in a self-organized manner without relying on a fixed infrastructure or base station. In MANETs, each node plays the role of a data source and a communication router. It identifies its neighboring nodes and utilizes them to establish communication with other nodes within its transmission range. To evaluate the performance of different routing protocols, specifically EHRP and ZRP, simulations were conducted using the NS 2.31 network simulator. Our proposed solution, the Enhanced Hybrid Routing Protocol (EHRP), combines reactive and proactive routing protocols, similar to the existing ZRP. EHRP incorporates the proactive routing protocol OLSR and the reactive protocols AOMDV and AODV. By leveraging the capabilities of these three protocols, namely AOMDV, AODV, and OLSR, we developed the enhanced hybrid routing protocol, EHRP.

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