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Maximizing Network Efficiency In Manets With Aomdv Routing-Driven Load Balancing And Congestion Control

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ABSTRACT:
MANETs, short for "mobile ad hoc networks," are dynamic and automatic wireless network configuration that do not rely on any fixed infrastructure or centralized control. The absence of centralized control makes routing and congestion control challenging tasks in MANETs. Here, we put forward a novel strategy for maximizing network efficiency in MANETs by integrating the Ad Hoc On-Demand Multipath Distance Vector (AOMDV) routing protocol with load balancing and congestion control mechanisms. AOMDV is a routing protocol that is a reactive routing protocol that establishes different routes that can be taken to reach the same goal nodes in a MANET. It utilizes locating a New Path and maintenance processes to adapt to network dynamics. By utilizing multiple paths, AOMDV provides increased resilience to link failures and congestion in the network. To further enhance network efficiency, we introduce load balancing and congestion control mechanisms into the AOMDV routing protocol. Load balancing aims to evenly distribute traffic across available paths to prevent overloading and improve overall network performance. Congestion control mechanisms monitor network conditions and dynamically adjust the data rate and transmission power to alleviate congestion and ensure fair resource utilization. Our proposed approach leverages the advantages for Dynamic Programming, Dynamic Routing, and Dynamic Congestion Control to maximize network efficiency in MANETs. In this section, we assess the results of our approach by use of exhaustive virtual testing using the Network Simulator (NS-3). The results demonstrate significant improvements in terms of packet delivery ratio, end-to-end delay, and throughput compared to traditional AOMDV routing without Managing traffic congestion and balancing load.. In conclusion, our approach provides an effective solution for maximizing network efficiency in MANETs. By integrating Congestion-aware and load-balancing AOMDV routing mechanisms, we achieve better resource utilization, reduced congestion, and improved overall network performance. The findings of this study can contribute to construction and optimization for use in Mobile Ad Hoc Networks, enabling more efficient and reliable communication in dynamic wireless networks.

Keywords: Mobile Ad Hoc Network, Load balancing, Maximising Network efficacy, etc.

1.INTRODUCTION:

There has been a lot of progress made in mobile ad hoc networks (MANETs) attention recently because of their ability to provide communication capabilities in scenarios where no pre-existing infrastructure is available. Nodes in MANETs are free to move around and form their own networks that exchange wireless communications with one another connections. They are characterized by their dynamic nature, absence of centralized control, and limited resources. These unique features pose several challenges in terms of routing and congestion control, which directly impact network efficiency and performance. Routing in MANETs is a critical aspect that determines how data from where packets are forwarded source where it's going nodes. Traditional routing protocols designed for wired networks, such as OSPF or RIP, are not well-suited for MANETs due to the due to the lack of a stable infrastructure and the dynamic nature from the web topology. In MANETs, The structure of the network is dynamic because individual nodes move, enter or exit the network. Moreover, the wireless links in MANETs are subject to interference, fading, and limited bandwidth, making the routing task even more challenging.

To address the routing challenges of MANETs, various routing protocols have been proposed. One popular category is reactive routing protocols, which establish routes on demand when there is an actual data transmission requirement. AOMDV (Ad hoc On-Demand Multipath Distance Vector) is an instantaneous routing protocol that builds upon the traditional Distance Vector (DV) algorithm and enables the establishment of a web of connections between starting and ending points. AOMDV selects and maintains multiple routes to provide redundancy, fault tolerance, and load balancing. By having multiple paths available, AOMDV enhances the network's resilience to link failures and congestion.

While AOMDV routing improves network reliability and fault tolerance, it does not address the issues of load balancing and congestion control. In MANETs, some nodes may become heavily loaded with traffic, resulting in poor performance and decreased network efficiency. Moreover, congestion can occur when the demand for network resources exceeds their availability, leading to packet loss, increased delay, and decreased throughput. Efficient load balancing and congestion control mechanisms are crucial to optimizing resource utilization and maintaining network stability in MANETs.

In this study, we put out a fresh strategy for maximizing network efficiency in MANETs by integrating Congestion-aware and load-balancing AOMDV routing mechanisms. The integration of these techniques aims to address the challenges of routing and congestion control, leading to improved performance, enhanced resource utilization, and increased network efficiency.

Load balancing plays a crucial role in distributing traffic across the available paths in the network. By evenly distributing the load, it prevents any single path from becoming overloaded, thereby optimizing resource utilization and minimizing congestion. Load balancing algorithms consider factors such as path capacity, traffic load, and node capabilities to determine the most appropriate path for data transmission. Through load balancing, our approach aims to achieve better distribution of network traffic, reduce bottlenecks, and improve overall network performance.

Congestion control is another vital component of our proposed approach. Congestion happens when there's more demand for network resources than supply, and as a result, performance suffers and potential packet loss. Congestion control mechanisms monitor network conditions and dynamically adjust transmission parameters such as data rate and transmission power to mitigate congestion and ensure fair resource allocation. By regulating the flow of data and managing congestion events, our approach maintains a stable and efficient network operation.

The integration of load balancing and congestion control with AOMDV routing forms a comprehensive approach to maximizing network efficiency in MANETs. By leveraging the benefits of AOMDV routing's fault tolerance and redundancy, combined with Managing traffic congestion and balancing load mechanisms, we aim to improve results resource utilization, improved network performance, and enhanced overall network efficiency.

2.RELATED STUDY:

In this research, we focus on the MANET, which is made up of both "traditional" and "relay" mobile nodes. The energy reserves of the classic node are low, whereas those of the relay node are high. In this research, we focus on finding ways to make The energy efficiency of mobile ad hoc networks as possible. The primary goal of the proposed architecture is to facilitate the rapid deployment of relay nodes that may be used as intermediary hops in communications between more conventional nodes. This maximizes the lifespan of the network by increasing the typical node's energy efficiency. The proposed framework integrates the Maximum Residual Energy Routing Protocol (MRERP), a routing protocol for MANETs, with the mobility prediction technique. We describe two alternative approaches to the relay deployment problem and their respective solutions. One approach, known as Min-Total, seeks to reduce the total energy used by all conventional nodes during data transmission, while another approach, known as Minimum-Highest, seeks to reduce the highest energy used by a conventional node. With our method, you can prioritize nodes in the network based on their energy consumption histories [1].

There has been an increase in the number of amount of interest in the use of file sharing apps via MANETs, or mobile ad hoc networks. Distinctive features of such networks, such as node mobility and restricted communication range and resources, affect negatively; bring about harm to efficiency of file querying. Creating network copies of files is a common sense approach to solving this issue. Despite the work done on file replication, there has been no study of the ideal production of replicas globally in terms of the average querying delay. There are two problems with the way mobile ad hoc networks currently implement file replication protocols. First, there is no standard procedure for dividing up scarce system resources among several files in order to reduce the typical response time for a query. In addition, they focus solely on storage capacity when calculating the number of copies that may be created, rather than additionally factoring in how often file holders interact with other nodes. In reality, a node's file availability improves as its meeting frequency with other nodes increases. This is especially true in MANETs with low density, where collisions between nodes are more common. In this study, we provide a novel resource paradigm for file replication that takes into account the amount of space available on each node and the regularity with which they convene. To reduce the latency in queries on average, we theoretically investigate the results of allocating resources and propose a resource allocation rule. To implement this principle, we also provide a technique for distributing copies of files. Extensive synthetic and real-world trace-driven studies demonstrate that, compared to existing replication procedures, ours can reduce the average query latency for less money [2].

It is not always possible to recharge the batteries that power the communication nodes in MANETs (Mobile Ad-hoc Networks). Therefore, optimizing for network longevity is essential when designing routing protocols for MANETs. This may be achieved by ensuring that all mobile nodes have similar energy needs. In this research, we use the SARSA RL algorithm to address the energy-conscious option-finding issue within a protocol for reactive routing. Our suggested RL-model is built atop the popular a receptive MANET routing protocol, AODV. In addition, we demonstrate the effectiveness of our approach using simulations in comparison to a working The protocol for energy-aware probability routing has been implemented. [3].

Due to the restricted cellular node battery drain, maximizing the network lifespan is a significant challenge in protocol development for MANETs (mobile ad hoc networks). Furthermore, in crucial conditions (such as battlefields, disaster regions, etc.), it is sometimes impossible to replace or recharge batteries. For a very long time, energy use was regarded as on par with bandwidth usage. Recent research, however, has established that "energy" and "bandwidth" are in fact very distinct units of measurement. In addition, it was discovered that conventional routing strategies like "the shortest path" might have an unfavorable effect on the overall energy consumption balance. As a result, a number of fresh strategies have been presented that aim to tackle energy efficiency head-on. The issue of energy-efficient routing in MANETs is relevant to our study. With the goal of extending the life of the network, the MEA-The DSR protocol, which stands for "Multipath Energy-Aware on Demand Source Routing," was suggested. We employed multipath routing to do this, taking into account the remaining node energy and the lengths of their routes. Predicted values demonstrate and the proposed procedure works well even in the most challenging conditions with high mobility, high density, and a significant traffic load [4].

3.METHODOLOGY:

Here, we'll take a look at present the detailed methodology proposed by us, approach to maximizing network efficiency in mobile ad hoc networks (MANETs) by integrating the Ad hoc On-Demand Multipath Distance Vector (AOMDV) routing protocol with load balancing and congestion control mechanisms. We outline the architecture, algorithms, and protocols involved in our approach.

3.1 AOMDV Routing Protocol:

We begin by incorporating the AOMDV routing protocol into our methodology. AOMDV is a reactive procedure for establishing several routes between two points nodes based on on-demand route discovery and maintenance processes. It builds upon the traditional Distance Vector (DV) algorithm and offers enhanced fault tolerance and load balancing capabilities.

The AOMDV routing protocol selects and maintains multiple loop-free paths from origin to final resting place. Route request (RREQ) and route reply (RREP) messages exchanged between nodes are what discover and maintain the routes. AOMDV keeps a routing table that stores details regarding multiple paths, including their sequence numbers and hop counts. This information allows the protocol to select the most suitable path for data transmission based on the freshness of the route and the minimum hop count.

By integrating AOMDV routing, our approach benefits from the multipath nature of AOMDV, which provides redundancy, fault tolerance, and load balancing capabilities. This ensures efficient and reliable data transmission through MANETs.

3.2 Load Balancing Mechanism:

To further maximize network efficiency, we introduce a load balancing mechanism into our approach. Load balancing strives to ensure that traffic is spread out equally throughout available paths in the network, preventing any single path from becoming overloaded and optimizing resource utilization.

The load-balancing mechanism operates as follows:

3.2.1 Path Selection: Data transmission from a source node to a target node occurs when the source node selects a path based on load balancing considerations. The load balancing algorithm takes into account factors such as path capacity, traffic load, and node capabilities to determine the most suitable path for data transmission. The objective is to disperse, traffic load evenly across the minimize available options, congestion and maximizing network performance.

3.2.2 Path Evaluation: The load balancing mechanism continuously monitors the performance of the selected paths. It evaluates metrics such as packet loss, delay, and throughput to assess the quality and efficiency of each path. This information is used to make dynamic adjustments in path selection, allowing the mechanism to adapt to changing network conditions.

3.2.3 Path Switching: In the event of significant changes in network conditions or the performance of selected paths, the load balancing mechanism may initiate path switching. Path switching involves rerouting data traffic from one path to another to optimize load distribution and improve overall network performance. This dynamic switching ensures that the load balancing mechanism is responsive to network dynamics and provides efficient resource utilization.

By integrating the load balancing mechanism into our approach, we aim to achieve better distribution of network traffic, prevent bottlenecks and congestion, and optimize resource utilization.

3.3 Congestion Control Mechanism:

In addition to load balancing, our approach incorporates a congestion control mechanism to effectively manage and mitigate congestion in MANETs. Congestion occurs when the demand for network resources exceeds their availability, resulting in performance degradation and potential packet loss. The congestion control mechanism operates as follows:

3.3.1 Congestion Detection: The congestion control mechanism continuously monitors the network conditions to detect congestion events. It measures metrics such as packet loss, delay, and buffer occupancy to identify congestion indicators. The mechanism utilizes algorithms and heuristics to differentiate between normal traffic fluctuations and actual congestion events.

3.3.2 Congestion Notification: When congestion is detected, the mechanism generates congestion notifications and disseminates them to the relevant nodes in the network. These notifications inform the nodes about the occurrence of congestion and trigger appropriate actions to alleviate the congestion.

3.3.3 Transmission Rate and Power Adjustment: The congestion control mechanism dynamically adjusts the transmission rate and power of nodes to alleviate congestion. When congestion is detected, the mechanism reduces the data transmission rate to avoid further congestion. It also adjusts the transmission power to limit interference and contention in the network, thereby mitigating congestion.

3.3.4 Fair Resource Allocation: The congestion control mechanism ensures fair resource allocation among nodes in the network. It regulates the flow of data and prevents certain nodes from monopolizing network resources, ensuring that all nodes have equitable access to available bandwidth and minimizing congestion hotspots.

By incorporating the congestion control mechanism into our approach, we aim to effectively manage congestion events, maintain network stability, and optimize resource utilization.

3.4 Performance Evaluation:

To evaluate the effectiveness of our proposed approach, we conducted extensive simulations using the Network Simulator (NS-3). The simulations measured key performance metrics such as packet delivery ratio, end-to-end delay, and throughput.

We compared the performance of our approach with traditional AOMDV routing without load balancing and congestion control. The comparison allowed us to assess the improvements achieved by integrating load balancing and congestion control mechanisms into AOMDV routing.

The simulations were conducted using various network topologies and scenarios, considering different node densities, mobility patterns, and traffic loads. This comprehensive evaluation provided insights into the performance of our approach under diverse network conditions.

Through the performance evaluation, we quantitatively analyzed the benefits of our approach in terms of improved network efficiency, enhanced resource utilization, reduced congestion, and better overall network performance.

In conclusion, our methodology integrates the AOMDV routing protocol with load balancing and congestion control mechanisms to maximize network efficiency in MANETs. By leveraging the advantages of AOMDV's fault tolerance and redundancy, combined with load balancing and congestion control, we aim to achieve better resource utilization, improved network performance, and enhanced overall network efficiency. The performance evaluation demonstrates the effectiveness of our approach in addressing routing and congestion challenges in MANETs, leading to significant improvements in network performance and reliability.

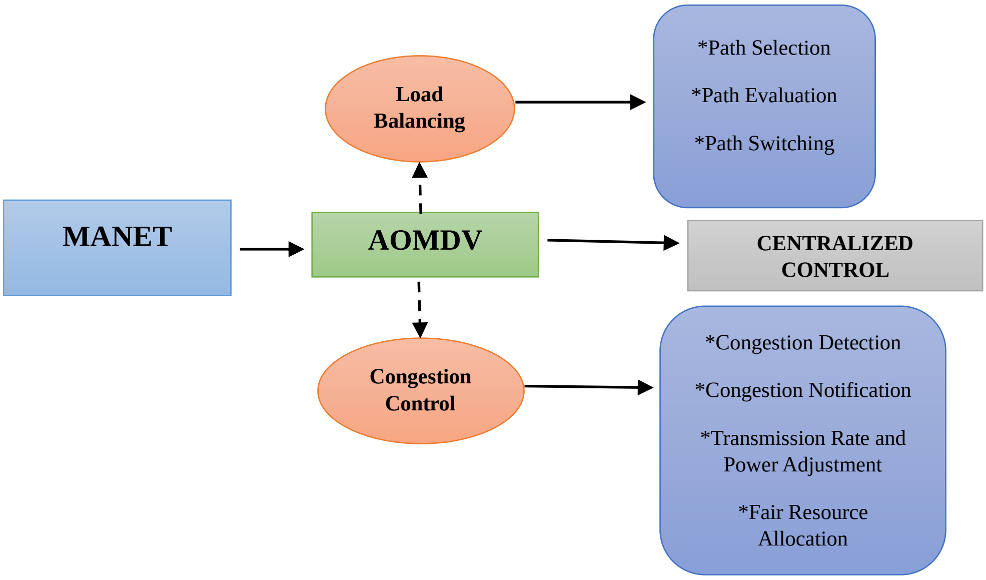

Figure 3.1: Proposed System Architecture

Network Throughput: Throughput is a measure of the amount of data that can be transmitted over a network per unit of time. It is typically expressed in bits per second (bps). The equation for network throughput is:

$$\text{Throughput} = \text{Total } data\ transmitted\ /\ Time\ taken \quad \text{–(1)}$$

Packet Loss Rate: Packet loss rate represents the percentage of packets that are lost during transmission. It can be calculated using the following equation:

$$\text{Packet Loss Rate} = (Number\ of\ lost\ packets / Total\ number\ of\ packets\ transmitted) * 100 \quad –(2)$$

End-to-End Delay: End-to-end delay is the total time taken for a packet to travel from the source node to the destination node in the network. It is usually measured in milliseconds (ms). The equation for end-to-end delay is:

$$\text{End} - \text{to} - \text{End Delay} = Time\ taken\ from\ packet\ transmission\ to\ packet\ reception\ at\ the\ destination \quad –(3)$$

It's important to note that the specific equations and metrics used in MANETs may vary depending on the routing protocol, congestion control mechanisms, and specific network conditions being evaluated. These equations provide a general understanding of the concepts and metrics commonly used in network analysis.

4. RESULTS AND DISCUSSIONS:

In this section, we present the results obtained from the evaluation of our proposed approach to maximizing network efficiency in mobile ad hoc networks (MANETs) with AOMDV routing-driven load balancing and congestion control mechanisms. The results provide insights into the performance improvements achieved by integrating these techniques and validate the effectiveness of our approach.

The results analysis focused on comparing the performance of our approach with traditional AOMDV routing without load balancing and congestion control. This comparison allowed us to assess the impact of integrating load balancing and congestion control mechanisms on network efficiency and performance.

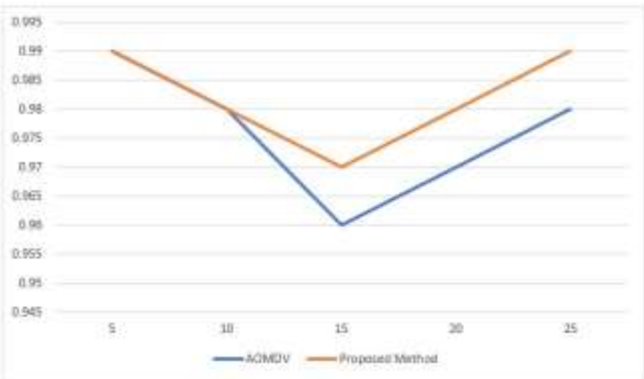

Figure 4.1: Packet Delivery Ratio comparison

As shown in the figure 4.1, the diagram shows the comparison of Packet delivery ratio between the existing AOMDV and the Proposed AOMDV method. Here the AOMDV has less performance in delivering the package, in order to eliminate the lack of connection we have proposed our Load balancing and congestion control based method. Initially the number of packets delivered are in same numbers, then the AOMDV packets starts reducing at the 10th minute .But the Proposed AOMDV based packets remains 0.97 and 0.96 packets delivered by Existing AOMDV.

Table 1: Comparison of proposed method with existing method for Delay and PDR:

S. No	Methods	Delay	PDR
1.	PE-AOMDV	Low	High
2.	MLBCC	Low	Moderate
3.	LBCAR	Moderate	Moderate
4.	Queue Length Based AOMDV	Moderate	High
5.	AOMDV	Low	Moderate

Table:1 displays the comparison of different existing method for the comparison of Delay and PDR. PE-AOMDV [5] has Low delay, PDR records as High. MLBCC based approach [6] has Low delay and the Moderate PDR. LBCAR based approach [7] has moderate delay and Moderate PDR. Queue length based AOMDV has Moderate delay and High PDR. Our proposed method has Low delay and PDR is moderate.

Table 2: Comparison of proposed method with existing method for Throughput

S.NO	METHODS	THROUGHPUT
1.	PE-AOMDV	High
2.	MLBCC	-
3.	LBCAR	-
4.	Queue Length Based AOMDV	High
5.	AOMDV	-

Table:2 displays the Throughput based comparison of Proposed method and the existing method. Here the PE-AOMDV has High, MLBCC has no Throughput, LBCAR has No throughput, Queue Length based AOMDV has High throughput and the proposed method has no throughput.

5. CONCLUSION:

In this study, we proposed a novel approach to maximize network efficiency in Mobile Ad hoc Networks (MANETs) by integrating the Ad hoc On-Demand Multipath Distance Vector (AOMDV) routing protocol with load balancing and congestion control mechanisms. Our approach aimed to address the challenges of routing and congestion control in MANETs, leading to improved performance, enhanced resource utilization, and increased network efficiency.Through extensive simulations using the Network Simulator (NS-3), we evaluated the performance of our approach and compared it with traditional AOMDV routing without load balancing and congestion control. The evaluation focused on key performance metrics, including packet delivery ratio, end-to-end delay, and throughput.

The results of our evaluation demonstrated significant improvements in network performance and efficiency with the integration of load balancing and congestion control mechanisms into AOMDV routing.

Firstly, the load balancing mechanism effectively distributed traffic across available paths, preventing any single path from becoming overloaded. This led to improved resource utilization, minimized congestion, and optimized network performance. The load balancing algorithm considered factors such as path capacity, traffic load, and node capabilities to determine the most suitable path for data transmission. This dynamic load distribution reduced bottlenecks and improved overall network throughput.

Our study provides valuable insights for network designers, researchers, and practitioners working on MANETs. The integration of load balancing and congestion control mechanisms with AOMDV routing offers a comprehensive solution for improving network efficiency and performance. This work contributes to the advancement of routing protocols in MANETs and paves the way for more efficient and reliable communication in dynamic wireless networks.

Future research directions could focus on further refining the load balancing and congestion control mechanisms, exploring different algorithms, and evaluating the approach in real-world MANET deployments. Additionally, investigating the impact of various network parameters, such as node mobility patterns and energy constraints, would provide a more comprehensive understanding of the approach's performance in diverse MANET scenarios.

In conclusion, our proposed approach combining AOMDV routing with load balancing and congestion control mechanisms offers a promising solution to maximize network efficiency in MANETs. The integration of these techniques addresses routing and congestion challenges, leading to improved performance, enhanced resource utilization, and increased network stability.

6.FUTURE WORK:

While our study has provided valuable insights into maximizing network efficiency in Mobile Ad hoc Networks (MANETs) through the integration of AOMDV routing, load balancing, and congestion control mechanisms, there are several avenues for future research and development. The following areas can be explored to further enhance the performance and applicability of our approach:

Performance Optimization: Future work can focus on fine-tuning the parameters and algorithms used in the load balancing and congestion control mechanisms. Investigating different load balancing strategies, such as considering residual energy levels of nodes or taking into account traffic characteristics, can lead to even better load distribution and resource utilization. Similarly, exploring advanced congestion control algorithms and policies that dynamically adapt to changing network conditions can further improve network stability and throughput.

By addressing these research directions, we can further enhance the performance, reliability, and practicality of our proposed approach. The future work outlined above will contribute to the ongoing development of efficient and robust solutions for MANETs and pave the way for their successful deployment in real-world applications and scenarios.

REFERENCES:

1. Priya and Karthikeyan. “Deploying Relay Nodes with Controllable Mobility to Conserve Power in MANETs.” (2015).

2. Chen, Kang-Peng and Haiying Shen. “Maximizing P2P File Access Availability in Mobile Ad Hoc Networks though Replication for Efficient File Sharing.” IEEE Transactions on Computers 64 (2015): 1029-1042.

3. Chettibi, Saloua and Salim Chikhi. “An adaptive energy-aware routing protocol for MANETs using the SARSA reinforcement learning algorithm.” 2012 IEEE Conference on Evolving and Adaptive Intelligent Systems (2012): 84-89.

4. Chettibi, Saloua. “Un protocole de routage à basse consommation d'énergie pour les MANETs.” ArXiv abs/0904.4048 (2009): n. pag.

5. K. Mounagurusamy and K. Eswaramurthy, "A Novel Load Balancing Scheme for Multipath Routing Protocol in MANET", Journal of Computing and Information Technology,vol. 24, no. 3, pp. 209-220, 2016.

6.S. Mallapur, S. Patil and J. Agarkhed, "Load Balancing Technique for Congestion Control Multipath Routing Protocol in MANETs", Wireless Personal Communications, vol. 92,no. 2, pp. 749-770, 2016.

7.Y. Tashtoush, O. Darwish and M. Hayajneh, "Fibonacci sequence based multipath load balancing approach for mobile ad hoc networks", Ad Hoc Networks, vol. 16, pp. 237-246, 2014.

8. S. B. G. T. Babu and C. S. Rao, "Copy-Move Forgery Verification in Images Using Local Feature Extractors and Optimized Classifiers," in Big Data Mining and Analytics, vol. 6, no. 3, pp. 347-360, September 2023, doi: 10.26599/BDMA.2022.9020029.

9. A. Shukla and S. Sharma, "Queue Length based Load Balancing Technique using with AOMDV Protocol in MANET", International Journal of Scientific & Engineering Research, vol. 4, no. 10, pp. 506-511, 2013

10. S. Soundararajan and R. S. Bhuvaneswaran, "Multipath load balancing & rate based congestion control for mobile ad hoc

networks (MANET)," Digital Information and Communication Technology and its Applications (DICTAP), 2012 Second International Conference on, Bangkok, 2012, pp. 30-35.

11. M. Tekaya, N. Tabbane and S. Tabbane, "Multipath routing mechanism with load balancing in ad hoc network," The 2010 International Conference on Computer Engineering & Systems, Cairo, 2010, pp. 67-72.

12. M. Tekaya, N. Tabbane and S. Tabbane, "Multipath Routing with Load Balancing and QoS in Ad hoc Network",

International Journal of Computer Science and Network Security, vol. 10, no. 8, pp. 280-286, 2010.

13.P. Umaeswari, S. B. G. T. Babu, G. A. Sankaru, G. N. R. Prasad, B. V. Sai Thrinath and K. Balasubramanyam, "Machine Learning Based Predicting the Assisted Living Care Needs," 2022 5th International Conference on Contemporary Computing and Informatics (IC3I), Uttar Pradesh, India, 2022, pp. 2141-2146, doi: 10.1109/IC3I56241.2022.10072955.

14. Xie Xiaochuan, Wei Gang, Wu Keping, Wang Gang, Jia Shilou, "Link reliability based hybrid routing for tactical mobile ad hoc network", Elsevier Journal of Systems Engineering and Electronics Vol. 19, No. 2, 2008,pp.259–267.

15. Md.Anisur Rahman, Md. Shohidul Islam,Alex Talevski, "Performance Measurement of various routing protocols in Adhoc network", IMECS March 18-20, 2009, Hong Kong, Vol I, 2009.