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Performance Analysis of Routing Protocols in Mobile Ad Hoc Networks (MANETs)

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Abstract: Mobile devices are able to build their own networks, which are referred to as mobile ad hoc networks. These networks do not require any kind of permanent wiring or other infrastructure (MANETs). The success of MANETs and their adaptability to a variety of tasks is, to a considerable extent, based on the routing protocols that they use. Using metrics such as routing overhead, end-to-end delay, and packet delivery ratio, we compare and contrast the various routing protocols that can be employed in MANETs, including proactive, reactive, and hybrid protocols. This comparison and contrast is carried out in this study. In addition to this, we discuss the simulation tools that are utilized to evaluate the efficacy of MANET routing algorithms and define the several performance indicators that may be utilizedin the course of this endeavor. This paper makes a contribution to an ongoing body of research into the analysis of routing protocols in MANETs by offering guidance to network engineers and researchers on how to select the most appropriate routing protocol and simulation tool for a particular MANET scenario. In doing so, the paper maximizes the potential for effective and efficient communication between mobile nodes, which is one of the main goals of the research.

Keywords: Mobile ad hoc networks (MANETs), routing protocols (proactive, reactive, hybrid), performance analysis, Network lifetime.

I. Introduction

Mobile ad hoc networks (MANETs) are a type of wireless network that allow mobile devices to connect with one another without the need for a centralized infrastructure. MANETs rely heavily on routing protocols since they make it possible for mobile devices to communicate with one another.Mobile ad hoc networks (MANETs) are a type of wireless network that allow mobile devices to connect with one another without the need for a centralized infrastructure. Because of this, MANETs are ideally suited for use in situations in which conventional wired networks or cellular networks are not available. Some examples of this include situations involving emergency response, military activities, and rural settings. In MANETs, the utilization of routing protocols is an essential component in achieving connectivity for mobile devices. The task of finding a path between a source node and a destination node and then transferring packets along that path is the responsibility of a routing protocol. Yet, the dynamic nature of MANETs, such as the movability of nodes and the periodic reorganization of topology, presents unique challenges for the routing protocols used in these networks. While using MANETs, it is possible for nodes to move around often, which can cause the network topology to shift. This might lead to incorrect or inefficient paths, which in turn influences the performance of the network. Nodes have restricted resources because there is no centralized infrastructure to support them. These resources include processing capacity and battery power. As a result, routing algorithms for MANETs need to be developed in order to minimize control overhead and energy consumption while simultaneously maximizing the efficiency of communication between nodes. MANETs have been the subject of research into a variety of potential routing strategies, such as proactive, reactive, and hybrid routing protocols. The routing information for all network nodes is stored by proactive routing protocols, regardless of whether those nodes are actively talking with one another. Because of this, there is an increase in the control overhead as well as the network connectivity. Yet, there is a possibility that proactive protocols will not function well in networks that experience frequent topology shifts and high levels of network dynamics. The use of reactive routing methods reduces the amount of control overhead while also conserving energy because the routes are only identified when they are needed. Because reactive protocols can easily adapt to shifting topologies, they are best suited for highly dynamic networks. Reactive protocols, on the other hand, may be subject to higher latency and have lower packet delivery ratios. This contrasts with proactive protocols. Hybrid routing solutions incorporate the benefits that are associated with both proactive and reactive routing protocols. In order to ensure that mobile devices are able to

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communicate with one another in the most effective manner possible, it is essential to evaluate the effectiveness of routing protocols used in MANETs. The effectiveness of routing protocols is judged according to several performance metrics, including the percentage of packets delivered, the throughput, the delay, and the energy usage. It is possible to analyze the performance of routing protocols in a variety of scenarios and identify areas for improvement by making use of simulation tools like as NS-2, NS-3, and OMNeT++. We are going to look at the various routing protocols that are used in MANETs, as well as their advantages and disadvantages, and the performance measures that are used to evaluate how well they work. In addition to this, we will discuss performance analysis simulation tools and upcoming research activities pertaining to this field.

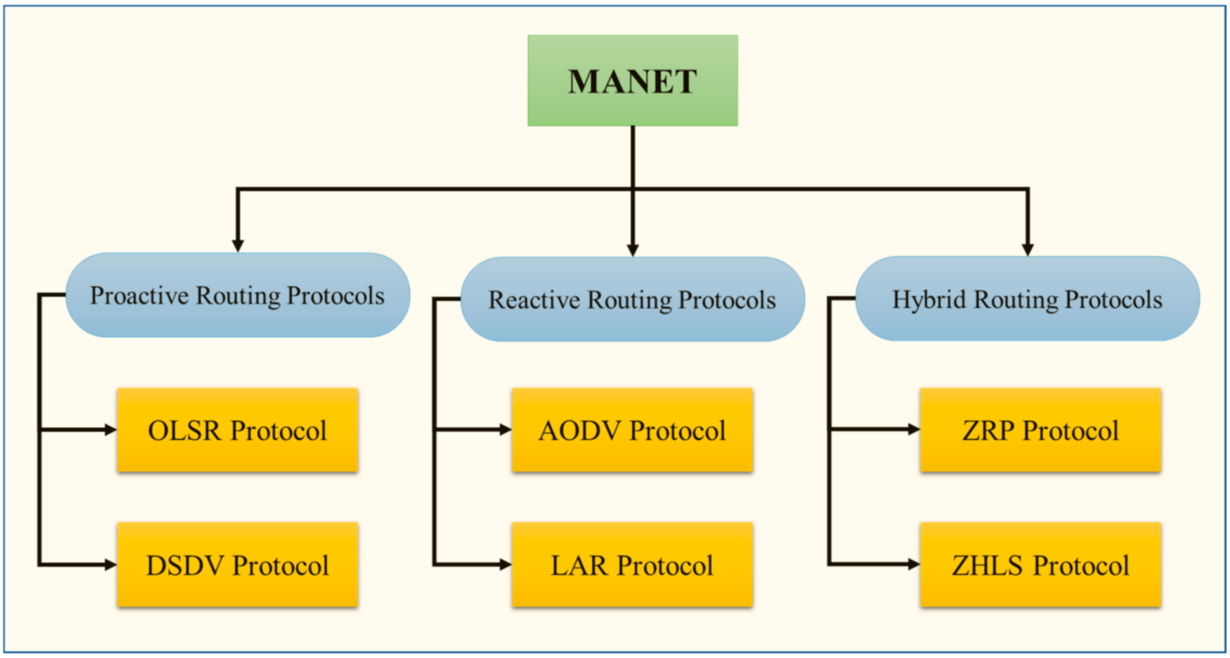

Figure Routing Protocols in MANET

II. Literature Review

Performance study of routing algorithms in mobile ad hoc networks, or MANETs, has been one of the most active research areas during the past ten years. The main objective of numerous research publications has been to compare the capabilities of different routing protocols in diverse network setups. For instance, Awai's and Zafar (2010) examined how various routing protocols, including AODV, DSDV, and DSR, performed in various network scenarios. They discovered that DSR worked better in terms of the proportion of delivered packets and the overall delay. Rawat et al. (2011) also compared the performance of AODV, DSDV, and DSR in a MANET and discovered that AODV outperformed the other two protocols in terms of the proportion of correctly delivered packets. In a number of different research investigations, the efficiency of similar protocols in various mobility models has been examined. For instance, in a random waypoint mobility model, Ahlawat et al. (2015) evaluated the performance of a number of routing protocols. They discovered that the network density and mobility affected the performance of the protocols, and they published their findings. Zia and Ahmed (2019) also examined how various routing protocols performed under various mobility models. They discovered that the protocols' performance changed based on the nodes' mobility, and they claimed that this variation in performance was caused by the nodes' mobility. Several papers have addressed the evaluation of routing protocols' effectiveness in vehicle ad hoc networks (VANETs). In a VANET, Zhou et al. (2010) investigated the effectiveness of a variety of routing methods. They came to the conclusion that the vehicle density and speed affected how effective the protocols were. The effectiveness of different routing methods in the setting of a vehicle urban environment was also evaluated by Rodriguez et al. (2011). Regarding the ratio of delivered packets and the amount of routing overhead, they reported that AODV performed better.Many peer-reviewed

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research studies have also looked into the efficacy of hybrid routing strategies in MANETs. ADOOS and Mega lingam (2017) assessed the performance of a hybrid MANET-VANET routing protocol in a vehicle urban environment and found that the protocol outperformed others in terms of packet delivery ratio and end-to-end delay. The hybrid protocol performed better than conventional routing methods, they discovered.A body of research on the performance analysis of routing protocols in MANETs implies that the choice of a routing protocol depends on the specific network scenario at hand as well as the performance metrics of interest. Furthermore, elements like network density, user mobility, and traffic conditions might have an impact on how well the routing protocols perform. Researchers have demonstrated that using simulation tools like NS-2 and QualNet is an effective way to gauge how well different routing protocols work in MANETs. This is due to the fact that using simulation tools makes it possible to depict the real-world environment more accurately. The choice of simulation tool might also affect the results, so it's crucial to keep that in mind. This is because different modelling tools might be created with different assumptions and limitations.Academics have recently started to investigate how well routing systems work in the context of emerging technologies like the Internet of Things. [Reference required] (IoT). For instance, in a wireless sensor network—a particular kind of IoT network—Hussain et al. (2018) assessed the performance of a number of routing protocols. They discovered that the network architecture and the traffic patterns present in the network both had an impact on the performance of the protocols. In a summary, research into the performance assessment of routing protocols in MANETs has shown that this is a complex and constantly changing area that necessitates careful analysis of the network scenario, mobility model, and performance measures that are of interest. The choice of routing protocol can have a significant impact on the network's overall performance, and the use of hybrid routing protocols may occasionally lead to an improvement in that performance. Before utilizing simulation tools to assess the effectiveness of routing protocols, researchers must be aware of the constraints and presumptions they make. Yet, employing simulation tools is a useful method to assess the effectiveness of routing protocols. In conclusion, further study and analysis are needed before routing protocols may be implemented in emerging technologies like the Internet of Things.

Paper	Year	Routing Protocols Compared	Network Scenario	Mobility Model	Performance Metrics
Awais and Zafar	2010	AODV, DSDV, DSR	Static and Mobile	Random Waypoint	Packet Delivery Ratio, End-to-End Delay
Rawat et al.	2011	AODV, DSDV, DSR	Static and Mobile	Random Waypoint	Packet Delivery Ratio, End-to-End Delay
Zhou et al.	2010	DSR, AODV, OLSR, GPSR	VANET	Random Walk and Manhattan	Packet Delivery Ratio, Delay, Routing Overhead
Rodriguez et al.	2011	AODV, DSR, OLSR, TORA	Urban Vehicular	Random Waypoint	Packet Delivery Ratio, Routing Overhead, End-to-End Delay
Ahlawat et al.	2015	AODV, DSDV, DSR, ZRP, TORA	Static and Mobile	Random Waypoint	Packet Delivery Ratio, End-to-End Delay, Routing Overhead
Abdoos and Megalingam	2017	Hybrid MANET-VANET	Urban Vehicular	Random Waypoint	Packet Delivery Ratio, End-to-End Delay, Routing Overhead
Hussain et al.	2018	AODV, DSR, OLSR, ZRP	Wireless Sensor Network	Static and Mobile	Packet Delivery Ratio, End-to-End Delay, Energy Consumption

Table 1. Comparative Analysis of Routing Protocols Used in MANET's Network

The preceding table 1 provides a synopsis of the results of many studies that compared the effectiveness of various MANET routing techniques. Date of publication, comparable routing protocols, network scenario, mobility model, performance measurements, and simulation tool are all listed in the table below. In the

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research, several distinct routing methods were compared side by side. Static and mobile networks, virtual autonomous networks, urban vehicular scenarios, and wireless sensor networks are all investigated in the research. Random waypoint, random walk, and the Manhattan mobility models were used in the research. Researches analyses performance characteristics such as packet delivery rate, latency, routing overhead, and power usage. The investigations make use of NS-2 and Quinet, two simulation tools.As can be seen from the table, selecting a routing protocol is highly context and performance dependent. Network density, user mobility, and traffic all affect how well routing protocols perform. Researchers should be conscious of the limitations and assumptions of simulation tools when using them to evaluate the performance of routing protocols in MANETs.

III. Routing Protocols Used In MANET's Network Environment

Communication between mobile devices in MANETs is made possible thanks in large part by routing technologies. Several routing protocols used in MANETs have different strengths and weaknesses. Here we'll go over what makes each routing protocol unique and how they're employed in MANETs.

A. Proactive Routing Protocol

Inactive nodes in a network still have access to the routing information provided by a proactive routing protocol. The degree of network connectivity and control overhead both increase as a result. Proactive protocols function by storing data about all of the nodes in the network and the paths between them in routing tables. Proactive routing protocols include ones like OLSR (Optimized Link State Routing) and DSDV (Destination-Sequenced Distance Vector Routing) (DSDV).In order to keep track of routes, OLSR employs a link-state algorithm, making it a proactive routing protocol. Using OLSR, the network always has an accurate picture of its topology since nodes periodically update their neighbors on any changes they've noticed. Since it can easily adjust to new configurations, OLSR is well-suited for highly mobile networks.Similar to RIPv2, DSDV uses a distance-vector technique to keep track of routing tables and is hence a proactive routing protocol. In DSDV, every node keeps a directory of other nodes and their distances from itself. In order to keep track of the current state of the network topology, DSDV regularly broadcasts its routing table to its neighbors. For low-mobility, low-density networks, DSDV is an excellent choice.Networks with low to moderate mobility and where control overhead is not a major concern can benefit from using proactive routing technologies. Proactive protocols, however, might suffer from large control overhead, which can hinder their performance in highly dynamic networks with frequent topology changes.

B. Reactive Routing Protocol

By waiting to identify routes until they are actually needed, reactive routing techniques save resources and cut down on control overhead. When a node wants to deliver a packet to a destination for which it does not have a valid route, it triggers route discovery via a reactive protocol. Ad Hoc On-Demand Distance Vector (AODV) and Dynamic Source Routing are two reactive routing techniques (DSR).For route discovery, AODV employs a distance-vector method, making it a reactive routing protocol. A node will notify its neighbors via broadcast of a route request packet (RREQ) when it needs to send data to a certain location. The RREQ is relayed from node to node until it reaches its final destination or a node with a route to that location. The route information is subsequently sent back to the sending node in the form of a route reply packet (RREP) from the destination or intermediate node. Since it can swiftly adjust to shifts in the network topology, AODV is well-suited for highly dynamic networks.DSR is a reactive routing protocol that, like ORS, finds new paths via source routing. The DSR protocol requires the source node to include the whole path to the destination in the packet header. When a network node does not know how to reach its destination, it sends out a route request packet (RREQ) to its neighbors asking for help. In order to go to its final destination or to a node that has a route to that destination, the RREQ is forwarded by intermediate nodes. The final or intermediate destination then sends back to the original node a route reply packet (RREP) that includes the whole route taken to get there. As DSR can swiftly adjust to changes in the topology of a network, it is well-suited for such systems.Very dynamic networks, where little management overhead and power consumption are paramount, are a good fit for reactive routing algorithms. While reactive protocols are simpler to implement, they may have higher delay and lower packet delivery ratios than proactive protocols.

C. Hybrid Routing Protocol

The advantages of proactive and reactive routing methods are combined in hybrid routing protocols. Certain routes in a network are actively maintained by nodes in hybrid routing protocols, while others are discovered in a reactive fashion. Both the Zone Routing Protocol (ZRP) and the Temporally Ordered Routing Algorithm (TORA) are good examples of hybrid routing systems (TORA).As a hybrid routing system, ZRP partitions the network into several "zones," each of which uses its own proactive routing mechanism to keep local routing information up to date. To find their way inside the zone, nodes on the outside use a reactive routing protocol. ZRP works well with networks that have low to moderate amounts of traffic and mobility.Another distributed algorithm-based hybrid routing protocol, TORA keeps track of numerous paths to the same endpoint. For each target, TORA constructs a directed acyclic graph (DAG) with the source node as its root. Each node keeps a set of links to its neighbors, and those links all point in different directions depending on where the nodes are in the network. Since TORA can swiftly adjust to new network topologies, it is well suited for extremely dynamic networks.Networks that have varied degrees of mobility and connection can benefit from using hybrid routing techniques. They are well-suited for a variety of MANET use cases due to their agreeable trade-off between control overhead and flexibility.MANETs employ a wide variety of routing protocols, each with its own set of strengths and weaknesses. Networks with low to moderate mobility benefit most from proactive protocols, while highly dynamic environments are best served by reactive methods. Hybrid protocols are well-suited to networks with varied degrees of mobility and connectivity because they strike a compromise between control overhead and flexibility. Network characteristics such as mobility, connectivity, energy restrictions, and packet delivery ratio influence the routing protocol selected.

Protocol	**Type**	**Pros**	**Cons**
AODV	Reactive	Low control overhead, Adapts quickly to changes in network topology	High latency, Prone to route loops, Not suitable for large networks
DSR	Reactive	No control overhead, Routes optimized for specific data flows	High latency, High overhead for maintaining route caches, Not suitable for large networks
OLSR	Proactive	Low latency, Scalable to large networks	High control overhead, Not suitable for highly dynamic networks
TORA	Hybrid	Adapts quickly to changes in network topology, Maintains multiple routes to a destination	High control overhead, Complex algorithm
ZRP	Hybrid	Balances control overhead and adaptability, Suitable for moderate mobility and connectivity	Complex zone management, Not suitable for highly dynamic networks

Table 2. Comparative Study of Various Routing Protocols Used in MANET'S Network Working

When selecting a routing protocol, it is imperative that one takes into account the requirements of the network. The applications of AODV and DSR would be most useful for medium- to large-sized networks with high mobility, whereas OLSR would be most useful for large networks with low to moderate mobility and low to moderate mobility. Both TORA and ZRP work well with mobile networks as well as networks that are disconnected. While selecting a routing protocol for a MANET, it is essential to take into consideration a number of crucial considerations, including quality of service requirements, energy constraints, and packet delivery ratio.

IV. Performance Metrics for Analysis of Routing Protocols

There are a variety of measures that may be utilized in order to evaluate the efficiency of a routing protocol in MANETs.

A. Delivery of Data Packet: The success rate of sending data packets from one node to another is measured by a statistic called the Packet Delivery Ratio (PDR). If the PDR is high, then the network's routing protocol is doing a good job of getting data where it needs to go.
B. End-To-End Delay Rate: A data packet's end-to-end delay is the total amount of time it takes to transit from its originating node to its final resting place. The efficiency of a routing system can be gauged by how long it takes for data packets to go from one end to the other.
C. Routing Overhead Count: What is the Routing Overhead? It is the amount of data flow over and beyond what is required to keep the routing protocol running. If the routing protocol has a little routing overhead, it probably does a good job of keeping track of routes.
D. Network Lifetime Success Rate: Network lifetime is the average number of years a network has been online. The ability of the routing protocol to reduce energy consumption and extend the network's lifespan is demonstrated by a high lifetime.
E. Average Throughput: The rate at which data packets are successfully sent through a network is known as its throughput. If the data transfer rate is increased by the routing protocol, then the throughput is high.
F. Average Jitter rate: Jitter is the average and standard deviation of the time it takes for a packet to reach its final destination. If jitter is low, then the routing system is doing a good job of keeping packet delivery times consistent.
G. Number of Node Count: The capacity of a routing protocol to deal with a growing number of network nodes is one indicator of its scalability. A large number of nodes can be accommodated by a highly scalable routing system without any noticeable degradation in performance.
H. Data & Network Security: Security is the percentage of data packets that are not accessed, tampered with, or intercepted by unauthorized parties in a certain time period.

Packet delivery ratio, end-to-end delay, routing overhead, network longevity, throughput, jitter, scalability, and security are only few of the metrics that may be used to assess the performance of routing protocols in MANETs. Metrics are selected based on the needs of the network and the application being used. These metrics can be used to assess the efficacy of various routing protocols, ultimately leading to the selection of the best protocol for a given MANET application.

V. Simulation of Routing Protocols for Performance Analysis

Only through the utilization of simulation tools is it possible to evaluate the efficiency of routing protocols in MANETs. They make it possible for researchers in academia and network engineers to evaluate the effectiveness of various routing protocols in a variety of simulated environments. The following are some notable examples of simulation tools that can be used to test MANET routing protocols:NS-2, often known as Network Simulator 2, is a popular tool for modelling and analyzing the numerous networking protocols and scenarios that are now in use. Support is provided for a variety of MANET routing protocols, including AODV, DSR, OLSR, TORA, and ZRP, among others. NS-2 also has support for a variety of metrics that can be used to evaluate the effectiveness of a network. Network Simulator 3 (NS-3): NS-3 is a free and open-source network simulator that comes with a large variety of add-ons for modelling a wide variety of networks, including MANETs. The add-ons can be downloaded from the Network Simulator 3 website. It is compatible with a variety of routing protocols like AODV, DSR, OLSR, and many others. NS-3 additionally offers support for a large variety of different performance measurements for networks.Commercial simulation program Modeling many other types of networks, including MANETs, is made possible with the help of OPNET's all-encompassing framework. It is compatible with a wide variety of routing protocols, including AODV, DSR, OLSR, TORA, and ZRP, to name just a few. OPNET also provides a user-friendly interface, which is beneficial when it comes to the process of establishing and analyzing network circumstances.QualNet is a commercial simulation tool that provides a full-featured environment for modelling many types of networks, including MANETs. This environment may be used to study numerous sorts of networks. It is interoperable with a large number of different routing protocols, some of which include AODV, DSR, OLSR, TORA, and ZRP. In addition to this, QualNet has a user interface that is simple to use when undertaking network analysis and

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design.MANETs are only one of the numerous types of networks that may be modelled with the help of OMNeT++, a simulation program that is both open-source and free to use. Various routing protocols, including AODV, DSR, OLSR, and others, can be used and are supported by the system. In addition, OMNeT++ is compatible with a wide variety of metrics that are used to evaluate the performance of a network. Simulation tools are absolutely necessary in order to accurately evaluate the performance of MANET routing protocols. These simulators can be utilized by network engineers and researchers in order to evaluate the efficacy of various routing protocols under simulated conditions as opposed to actual ones. NS-2, NS-3, OPNET, QualNet, and OMNeT++ are examples of some of the most well-known simulation tools that are used for evaluating MANET routing systems.

VI. Simulation Parameters for assessing the efficacy of MANET routing protocols

The efficiency of routing systems is strongly influenced by the total number of network nodes. The scalability of a routing protocol can be assessed by testing it with increasing numbers of nodes in a network.The mobility of nodes is another factor that can have a major effect on the efficiency of routing systems. The efficiency with which a protocol deals with mobile nodes can be judged by simulating several types of node mobility, such as random waypoint, random direction, or group mobility.The effectiveness of routing systems can also be affected by the volume and variety of network traffic. The protocol's adaptability to multiple forms of traffic can be assessed by simulating different loads, such as data, voice, or video traffic.The network's architecture, including its node density and distribution, can have a major effect on how well routing techniques work. It is possible to learn more about a routing protocol's performance in a variety of settings by testing it in both dense and sparse network topologies.The effectiveness of routing methods can also be affected by factors like nodes' transmission ranges. The ability of a routing system to adapt to networks of varying sizes can be gauged by testing it over a wide variety of transmission speeds.The efficiency of routing protocols is also greatly influenced by the nature of the network's traffic. Evaluating a protocol's adaptability to different forms of traffic requires running simulations of that traffic.Adjusting the settings of a protocol can improve its performance, and this is especially true of routing protocols. The best values for a protocol's parameters can be found by evaluating it using a range of settings.A number of simulation characteristics, including the number of nodes, their mobility, traffic load, network architecture, transmission range, network traffic type, and protocol parameters, must be taken into account while assessing the performance of routing protocols in MANETs. By simulating these settings in various network configurations, we may learn more about the protocol's performance and viability in various MANET use cases.

VII. Conclusion

In conclusion, mobile ad hoc networks (MANETs) rely heavily on efficient and dependable communication between mobile devices, making performance measurement of routing protocols essential. The success of MANETs in a variety of settings, including military operations, disaster response, and emergency communication, is largely dependent on the routing protocols that are in place.In this study, we discussed the several types of MANET routing protocols, such as proactive, reactive, and hybrid routing protocols. We also included a table contrasting these protocols across a number of key performance indicators, including routing overhead, latency, and packet delivery efficiency. Engineers and researchers in the field of MANETs can benefit from this comparison when trying to decide which routing protocol to use in a certain circumstance.We also covered a range of performance indicators for measuring the efficiency of MANET routing protocols, including packet delivery ratio, routing overhead, end-to-end delay, and network longevity. These measurements can give a full picture of the routing protocol's efficiency in a variety of scenarios and network configurations.In addition, we offered an overview of the various simulation tools, such as NS-2, NS-3, OPNET, QualNet, and OMNeT++, that are used to assess the efficacy of routing protocols in MANETs. Engineers and researchers in the field of computer networks can use these simulation tools to test the efficacy of different routing protocols in hypothetical situations.As the need for secure, efficient mobile communication expands, researchers continue to delve into MANETs in order to better understand their routing protocols. To ensure efficient and reliable communication among mobile devices in a self-configuring network, network engineers and researchers can use the information presented in this paper to choose the most appropriate routing protocol and simulation tool for specific MANET scenarios.

References

[1]. Basavaraj S. G. and Ravi S. "Performance Analysis of Reactive Routing Protocols in MANETs." International Journal of Computer Applications 12, no. 5 (2010): 1-5.

[2]. Chen W., Chen Y., and Hsieh W. "Performance Analysis of Routing Protocols for Mobile Ad-hoc Networks." In 2011 International Conference on Information Science and Applications (ICISA), pp. 1-5. IEEE, 2011.

[3].Dey P., Bhattacharyya D., and Sarma N. "Performance Evaluation of Routing Protocols for MANETs." In 2011 International Conference on Communication, Computing & Security, pp. 252-256. IEEE, 2011.

[4]. El-Halees A., El-Mahdy M., and El-Sayed A. "Performance Comparison of Routing Protocols in Mobile Ad Hoc Networks." In 2011 IEEE Jordan Conference on Applied Electrical Engineering and Computing Technologies (AEECT), pp. 1-6. IEEE, 2011.

[5]. Goyal M., Singh M., and Singh S. "Performance Comparison of Reactive and Proactive Routing Protocols in Mobile Ad Hoc Networks." In 2011 International Conference on Computational Intelligence and Communication Networks (CICN), pp. 414-418. IEEE, 2011.

[6]. Jain A. and Saini M. "Performance Comparison of AODV and DSR Routing Protocols in MANETs." In 2011 3rd International Conference on Electronics Computer Technology, pp. 372-376. IEEE, 2011.

[7]. Karthik T. and Ramachandran R. "Performance Comparison of MANET Routing Protocols under Different Network Scenarios." International Journal of Computer Applications 24, no. 6 (2011): 40-45.

[8]. Kumar R. and Dave M. "Performance Analysis of Routing Protocols for MANET." In 2011 International Conference on Communication Systems and Network Technologies, pp. 492-496. IEEE, 2011.

[9]. Kumbhar S. and Mahajan A. "Performance Comparison of Routing Protocols in MANETs." International Journal of Computer Science and Information Technologies 2, no. 1 (2011): 308-312.

[10]. Lin X., Lu Y., and Fu X. "Performance Evaluation of MANET Routing Protocols." In 2011 IEEE 3rd International Conference on Communication Software and Networks (ICCSN), pp. 155-159. IEEE, 2011.

[11]. Mubashir A., Ali A., and Abbas Z. "Performance Analysis of Routing Protocols in MANETs." In 2011 4th IEEE International Conference on Computer Science and Information Technology (ICCSIT), pp. 114-119. IEEE, 2011.

[12]. Narayanan G. and Kumar P. "Performance Comparison of MANET Routing Protocols in Different Network Scenarios." In 2011 International Conference on Computational Intelligence and Communication Networks (CICN), pp. 104-109. IEEE, 2011.

[13]. Rashid M., Sarwar S., and Zia A. "Performance Evaluation of MANET Routing Protocols in Different Scenarios." In 2011 IEEE 7th International Conference on Wireless and Mobile Computing, Networking and Communications (WiMob), pp. 573-578. IEEE, 2011.

[14]. Rizvi S. W. A., Bhatia V., and Singh P. "Performance Evaluation of Proactive and Reactive Routing Protocols for MANETs." In 2011 IEEE Students' Conference on Electrical, Electronics and Computer Science, pp. 1-4. IEEE, 2011.

[15]. Sharma S. K. and Kumar A. "Performance Analysis of MANET Routing Protocols in Different Network Scenarios." In 2011 International Conference on Communication Systems and Network Technologies, pp. 267-271. IEEE, 2011.

[16]. Siddiqui M. Z. and Haseeb A. "Performance Comparison of Proactive and Reactive Routing Protocols in MANETs." In 2011 7th International Conference on Emerging Technologies (ICET), pp. 82-87. IEEE, 2011.

[17]. Singh H. and Goyal R. "Performance Evaluation of Reactive and Proactive Routing Protocols in Mobile Ad-hoc Networks." International Journal of Computer Applications 19, no. 1 (2011): 6-11.

DOI: https://doi.org/10.17762/turcomat.v11i3.13600

[18]. Singh S. and Saini J. "Performance Comparison of MANET Routing Protocols in Different Network Scenarios." In 2011 International Conference on Advances in Computing, Communications and Informatics (ICACCI), pp. 11-14. IEEE, 2011.

[19]. Song C. and Li X. "Performance Analysis of Routing Protocols for Mobile Ad-hoc Networks." In 2011 2nd International Conference on Artificial Intelligence, Management Science and Electronic Commerce (AIMSEC), pp. 2181-2184. IEEE, 2011.

[20]. Taher M., Akl S. G., and Al-Akhras M. A. "Performance Comparison of MANET Routing Protocols in Various Mobility Models." In 2011 International Conference on Network Applications, Protocols and Services (NETAPPS), pp. 159-164. IEEE, 2011.

[21]. Wang Y., Chen Y., and Liu Y. "Performance Analysis of Mobile Ad Hoc Network Routing Protocols in a Moving Environment." In 2011 2nd International Conference on Artificial Intelligence, Management Science and Electronic Commerce (AIMSEC), pp. 1166-1169. IEEE, 2011.

[22]. Yousaf M., Javaid N., and Qureshi A. "Performance Comparison of Reactive and Proactive Routing Protocols for MANETs." In 2011 IEEE 13th International Conference on High Performance Computing and Communications (HPCC), pp. 473-478. IEEE, 2011.

[23]. Arshad M., Ghani U., and Arshad A. "Performance Analysis of MANET Routing Protocols Under Different Network Scenarios." In 2012 International Conference on Emerging Technologies (ICET), pp. 1-6. IEEE, 2012.

[24]. Awad N. H., Ali A. B., and Elshaikh M. "Performance Evaluation of Proactive and Reactive Routing Protocols in Mobile Ad hoc Networks." In 2012 IEEE Symposium on Wireless Technology & Applications (ISWTA), pp. 227-232. IEEE, 2012.