Performance Analysis of MANET Routing Protocols

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ABSTRACT
Mobile Ad-hoc Network (MANET) is one of the temporary network with mobile nodes. Find the optimal path between source and destination is very difficult in this temporary network. Because nodes in this temporary network is not stable one, all are moving. Routing protocol should be efficient then only it have capable to find optimal route between source and destination. This work analyse four different protocols from different category and suggest optimal protocol using OmNetpp.

Keywords
MANET, Optimal path, routing

1. INTRODUCTION
A private organization utilizes wireless connections to establish a data communication network for exchanging information among devices [1] [2]. This approach eliminates the need for costly infrastructure installation to connect devices in different locations. An example of such a network is cell networks, commonly referred to as "ad hoc networks." In this type of network, stations are capable of creating and sharing data within a multi-hop network. However, due to the dynamic nature of mobile ad hoc networks, the network topology undergoes frequent and unexpected changes, posing challenges and complexities to routing among mobile nodes. Routing protocols play a crucial role in establishing communication among mobile nodes and are considered the most dynamic research area within the mobile ad hoc networks domain [3].

Mobile ad hoc networks can operate independently or as part of a larger network. A highly dynamic independent topology may involve multiple transceivers between nodes. One of the major challenges in MANETs is equipping each device with the knowledge to correctly route traffic. For instance, environmental sensors can be used for road safety purposes.

In a mobile peer-to-peer network, data can be exchanged between different portable devices without relying on a central machine. This capability is facilitated by the spontaneous cellular network, through which mobile nodes communicate. MANET, being devoid of a fixed or centralized infrastructure, presents a unique alternative node that distinguishes it from other network types.

Measurement of mobile ad hoc networks involves tracking the movement of nodes, as they can join or leave the network at any time and from anywhere. MANET offers various advantages, including topology flexibility, reliability, rapid configuration, inherent quality of service support, geographic adaptability, self-healing capabilities, and the absence of a central coordination framework. These features have inspired numerous functional-based visions [4][5].

2. MOBILE AD-HOC NETWORK (MANET) ROUTING PROTOCOLS
The figure provided illustrates various types of routing protocols for Mobile ad-hoc networks, which can be broadly categorized into three main types.

2.1 Flat Routing Protocols
The spatial rules of hybrid management are based on the organization's present geographic location and are powerful concepts from mobile ad hoc networks. Geographic-based control protocols have weak enforcement capabilities when compared to geographic location-based control protocols (location-based control protocols). These protocols leverage additional information to generate geographic-based routing plans when interaction is necessary. Active (table) protocols, operational (on-demand) control protocols, and hybrid control protocols can all be used to determine the hub address on the hub geographical control [6][7].

2.1.1. Proactive Routing Protocols
The current convention is also known as table-based addressing. To save existing address knowledge, the current process uses at least one address table. Each centre has the ability to produce data on geographic changes. All legal processes are supported by this convention. Moving the package is now necessary. All other centres' courses are always accessible when they are appropriate thanks to the address table's update. The address table is updated using a special method. DSDV (Distance Sequencing Distance-Vector), OLSR (Optimised Link State Routing Protocol), and FSR (Fisheye State Routing) are a few examples of this convention.

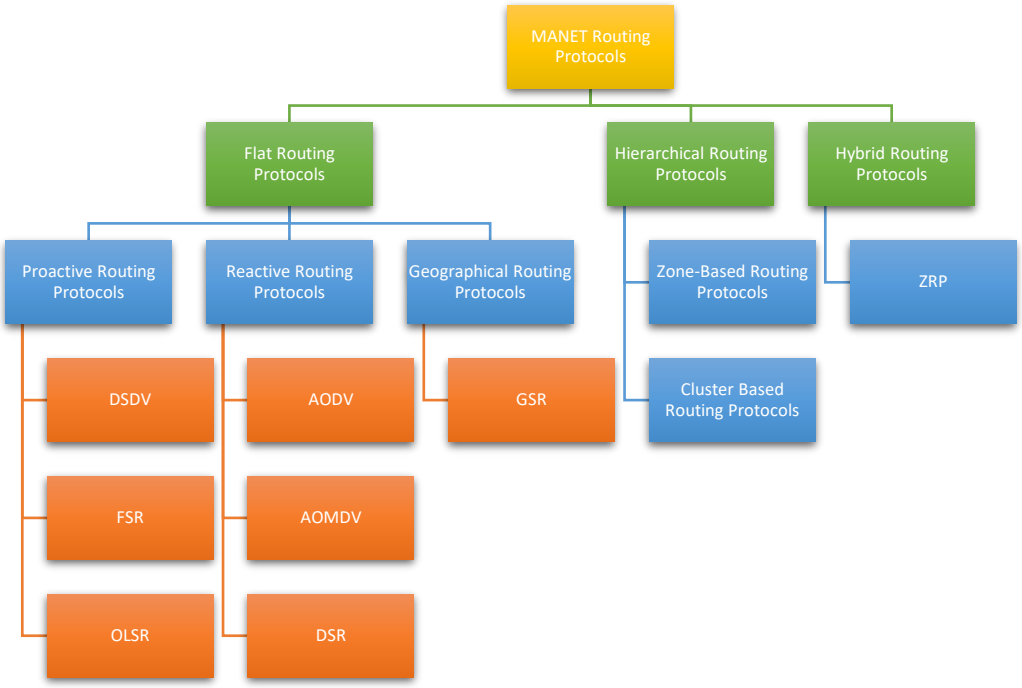

Figure 1: Different types of MANET routing protocols

2.1.1.1. DSDV

With a few new additions, such as the general aviation course on display, the agreement expands upon the "Bellman-Ford Act" and provides a sensible and reliable way to get the most recent information. The first is known as a "full dump" and contains all the information necessary to update the table, whereas the second is a "fixed pack- age" that simply contains the most current updates to the information in the last complete dump. As a result, dumping everything at once takes longer than an incremental bulk transfer [8].

2.1.1.2. FSR

A table-based technique called FSR (Fisheye State Routing) is based on "calculating link state." It lessens the organization's overall mobility and controls data related to topographic adjustment. A certain hub has modified data for keeping tables in FSR. For organising huge areas, it is also incredibly adaptable, however versatility will compromise accuracy. The frequent sending of interface updates, which can overwhelm organisations and air traffic, is the fundamental issue with this approach [9].

2.1.1.3. OLSR

The optimised link state routing protocol is proactive. The foundation of this protocol is the contact status protocol, which notifies the other network centres of any geographic changes. By minimising duplicate message retransmission when messages are relayed, a multipoint repeater reduces the administrative burden of using a multipoint repeater. In an MPR (multi-point repeater), various junctions designate neighbouring hubs that will receive information. By using any extra MPR-compatible hub to decrypt, measure, and deliver data packets but not retransmit them, the quantity of retransmissions can be decreased [10].

2.1.2. Reactive Routing Protocols

The request address protocol is another name for the current custom. The best approach to find courses is through adaptive conventions. The agreement's main goal is to lighten the organization's movement. The console cannot remain aligned with this arrangement. If the user has to submit information to the centre, he can do so in accordance with the geo-graphic location. Send a message beforehand so that people can understand the goal of this course. The target centre will be the path that was discovered up to processing. The booking rate is also mentioned in the agreement. When compared to the previous routing protocol, it will lessen the company's traffic. DSR, AODV, and AOMDV are the most used on-demand control protocols [11] [12].

2.1.2.1. AODV

Any distance vector that is available on demand combines dynamic source routing with a distance vector for distance sequencing, which can offer acyclic routes. The main difference between dynamic source routing and ad hoc on-demand distance vector is that in dynamic source routing, a single hub takes complete network addressing instructions. In an ad hoc on-demand distance vector, the hub has just one target location. It has been progressing, so naturally it will respond. When geo-graphy changes during the broadcast, ad hoc on-demand distance vectors also included the direction of objective consistency to clarify this concept.

2.1.2.2. DSR

The message is sent using the source address via the dynamic source address. A sender can provide the general features of a hub from which data will be sent to the destination using dynamic source routing. Additionally, this hub links the data from this procedure to the data packet's header. Begin at one centre, then move on to the next. The two primary elements of this agreement are upkeep and exposure to the course. He will recognise the roadblocks in the outreach process that naturally lead to the goal by looking for paths leading there and by offering help at each geographic transition. The course will be sent again whenever it is stated that the original copy is missing. The key benefit of this approach is that the centre that discovers the course will eventually check it out. The transmitter can find it without searching when the rate and effective rate are stored, which is advantageous for organisations with limited flexibility.

2.1.2.3. Geographical Routing Protocols

Geological steering plans and advances the looking course towards the goal using information from the area [13] [14]. Additionally, there is a greater likelihood that the geography of large multi-jump remote organisations may vary frequently. The expansion of single-jump geographic data is required for topographical steering because it allows senders to select the perfect neighbour. It does away with affective need overloading and reduces the need to maintain the directing tables and control centre as a result of how it limits its technique [15]. The hub keeps sending informational packages inside the designated sending area. In order to avoid hubs that can speed a diversion for providing the information bundle, the source or Next, position-based directing, which is connected to geological steering, is mentioned. The area where a hub's neighbour is present must be felt. The fascinating tool that allows each centre to progress a group to an adjacent centre is the aspect of this instance that is relevant. Position-based control approaches get ready to reduce overhead and energy since floods for centre disclosure and state expansion limit inside a single leap. The key factors determining the effectiveness of the strategy are the organization's thickness, the hubs' exact confinement, and the sending rule [16]. moderating hubs can characterise this checked area.

2.1.2.4. Geography Source Routing (GSR)

In GSR, the source hub records the shortest path to the target using a calculation by Dijkstra that is based on distance measurements. It notes the distance between the information's source and the moderated hubs through which it is to be transmitted [17]. Data transfer capacity is wasted when the source hub queries the region and floods the parcel to the hubs.

Geographical Awareness in Routing To solve the problem of GPSR's operational methodology for recovery, it uses the GSR bundle-sending mechanism. Dijkstra's computation is used to determine which route is the most constrained. A source creates a GSR, which is a list of all the intermediate hubs the source has installed in the header of each information parcel. Each transmitting hub maps the circumstances of its neighbours into diagram hubs and selects the hub that is closest to the target [18].

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2.2 Hierarchical Routing Protocols

The concept behind direct control is to arrange incompatible or differing coverage zones for self-organizing network hosts [19]. When MANET's network size dramatically grows, a hierarchical network is used. Organisations are categorised by the direct control protocol into a cluster tree, where the tasks and hub components vary depending on the level of the direct system [20]. Area-based and cluster-based are the two subcategories of heterogeneous forwarding protocols. These agreements are organised by numerous Polish associations with management and leadership abilities.

2.1.3. Zone-Based Routing Protocols

Each hub has a local scope and different guiding procedures inside and outside the extension as correspondences move across the covering extensions. This versatility makes it feasible to execute general steering more skillfully. Additionally, by keeping track of the directional information for every hub in the organisation, mobile hubs in the same region are able to reach one another more cheaply. According to some zone-based directing conventions, explicit hubs serve as both gateway hubs and are the complete point of contact between zones. The organisation will be divided into many zones or allotments along these lines. A MANET zone-based progressive directing protocol is ZRP [21], for instance [22].

2.1.4. Cluster Based Routing Protocols

The most popular kind of sequence control is the group control protocol. An organization's segmentation into connected subprojects is referred to as a "cluster," and the foundation of that interconnection is referred to as a "cluster." In its region or group, the magnetic head functions as a non-permanent base station. He conversed with other team captains as well [23]. The explicit group calculations used in the group management agreement are for the political career of group leaders. New associations are required to use the mobile centre, and the association manager is in charge of finding administrative employees and leadership talent. The device can support a multi-level group structure, such as hierarchical state routing (HSR) [24], which is a worldwide voluntary agreement on organisational management.

2.3 Hybrid Routing Protocols

Combining proactive and reactive routing methods' benefits. One of the most used hybrid routing systems is zone routing protocol (ZRP). After dividing the community into several zones, tracking takes place, and the placement of the supply and destination mobile nodes takes place. When the source and destination mobile nodes are located in the same zone, proactive routing is used to send data packets between them. Additionally, if the source and destination mobile nodes are located in different zones, reactive routing is used to send the data packets between them.

2.1.5. ZRP

Table-driven and adaptive contract management components are included in ZRP, making it a hybrid. With this approach, each hub's boundaries are identified by a specified address area that was determined by an acceptable number of operational organisations. The roads of these centres, which are only used by process leaders whose receptive permission is the best source, have resolved except for jumps outside of these places, and they are situated in the downtown area. It decreases the corresponding channel when compared to the table convention. It also reduces the latency of package movement as compared to on-demand setups [25].

3. LITERATURE REVIEW

For various chain frameworks, many writers have previously worked on in-depth performance analyses of the standard models of AODV (Ad Hoc On-Demand Distance Vector) and DSDV routing protocols [26] [27]. Later, in order to realise performance progression, they carried out a number of experiments on the AODV and DSDV routing protocols by sterilising key aspects of the protocol parameters and comparing their performances with benchmark models [28].

The effectiveness of DSDV (Destination Sequenced Distance Vector) and the impact of adding network nodes to a particular cellular network were thoroughly simulated. The network employs a highly different quality CBR (constant bit rate) flow mode. In an effort to evaluate the display of the DSDV steering convention, it determines the scientific score and delay of the

generated data packets [29].

In order to compare performance, the joint node density, packet length, and quality in ad-hoc cellular networks are analysed. AODV, DSR (Dynamic Source Routing protocol), and other routing protocols are taken into consideration. They basically examined a few protocol parameters for the simulation based on the study. Basic routing techniques are significantly impacted by mobility [30].

Ad Hoc On-Demand Distance Vector, Destination Sequenced Distance Vector, Dynamic Source Routing protocol, and other direction conventions were examined and analysed using NS3 re-enactment in [31] [32]. For various organisation hub sets, the reproduction uses the conventional models of these steering conventions [33].

The multicast parameters, which are mostly based on the DSDV routing protocol, are introduced to boost energy savings in arbitrary networks, and an exhibition investigation of the all-inclusive DSDV (Destination Sequenced Distance Vector) convention for successful steering in arbitrary distant organisations [34].

Routing protocols for mobile ad hoc networks were investigated for a realistic simulation scenario. They offer a Gauss-Markov movement model with a constant rate in this case; that is, they transfer data packets at the same rate, alter the three different outlines, and assess how different Mobile Ad hoc Network routing protocols exhibit themselves [35].

The authors of [36] presented a comparison of passive and active routing protocols with various parameters (such as Packet Delivery Ratio and end-to-end delay), and they also discuss various routing protocol characteristics.

According to [37], proactive agents and geographic routing protocols are particularly well suited for sensor networks, where information aggregation effectively reduces redundancy by removing the redundancy between data packets from multiple sources during downstream transmission.

The modified MANET (Mobile Ad hoc Network) standard routing protocol attribute mod- el is examined in this article. It offers a comparison of throughput, packet delivery ratio, residual energy, and performance indicators for table-based routing, on-demand routing, and geographic routing protocols.

4. PROPOSED WORK

This work is divided into two sub-works. In the first work, comparisons are made with AODV, DSR, DSDV, and GSR. These protocol's comparison is made with Packet Delivery Ratio, End-to-End Time Delay, Average Throughput, and Residential Energy. In the second sub-work, we are going to evaluate the performance of the first work's best protocol.

5. SIMULATION

A discrete event simulation environment called OMNeT++ was created by Andr'as Varga at the Technical University of Budapest. The simulation of network communications is its main use. Since OMNeT++ is designed to be general, adaptable, and modular, its creators anticipate that it may also be used for the modelling of complex IT systems, queuing networks, or hardware designs. The simulation kernel and models can be simply integrated into an application because the design is modular. The modules in OMNeT++ were created using the computer language C++.

Table 1: Simulation Parameters

Parameters	Value
Network Size	600 m X 600 M
Number of Nodes	0-50
Min and Max Speed	0m/s, 3m/s, 6m/s, and 10m/s
Pause Time	1-100s
Traffic Model	CBR
Routing Protocols	AODV, DSR, DSDV, and GSR
Simulation Time	600s

6. METHODOLOGY

6.1 Packet Delivery Ration (PDR)

This ratio can be calculated by dividing the total number of packets directed by the origin by the total number of packets arriving at the target, which is the packet transmission rate. In order to assess the success of guiding arrangements in an organisation, the delivery rate of packages is crucial.

The size of the site, the number of centres, the spread range, and the organisational structure are the key limitations [46]. The transit portion of the package is determined by the overall amount of information. The information sources sent by the source are divided up into the data packet mentioned in the objection [47]. In this way, the ratio of parcels received at the destination to bundles supplied by an origin is known as the bundle transmission rate. When the bundle trans- portation speed is high, the presentation impact is greater.

$$p = \left(\frac{P_r}{P_g}\right) X\ 100$$

6.2 End-to-End Time Delay (EERD)

The average time from when a packet is generated at the source to when it reaches the destination nodes is calculated using this metric. The measurement is performed by determining:

$$D = \frac{\sum_{i=1}^{N} d_t^i + d_p^i + d_{pc}^i + d_q^i}{N}$$

This metric is calculated by considering various factors. N represents the total number of transmission links, symbolizes the transmission delay of a specific link, denotes the propagation delay of the link, represents the processing delay of the link, and signifies the transmission delay of the link.

6.3 Average Throughput (AT)

This represents a realistic portion of the actual package delivery when compared to the fictitious package delivery. The client is informed of the target's packet count by the predicted message bandwidth. The performance will display how much data has been taken at any given moment from the source. How much data can be transferred from source to goal in a given amount of time is a factor in organisational efficiency. The quantity of packages would successfully display throughout the protest. The data rate per second is measured in data units, much as how the power restrictions are estimated in bits per second.

$$T = \left(\frac{R}{T^2 - T^1}\right) X \left(\frac{8}{1000}\right)$$

Where is the simulation start time, is the simulation stop time, and R is the total number of received packets at all destination nodes.

6.4 Residential Energy (RE)

The energy consumption of the sensor concentrator can be determined by summing up the energy used in each state. The remaining energy in the concentrator is calculated based on this sum. The hub experiences energy loss with every data packet it sends or receives. Hence, the initial energy value resides in the concentrator. Once address packets are sent or received, the energy value in the concentrator remains constant. The energy model pertains to the energy level of the organization's hub and primarily signifies the energy it possesses at the start of the stationary phase, known as the "initial energy." During operation, the variable "energy" represents the energy level at a specific point in time. The transmitters transmit the initial energy value as payload, while the hub loses a certain amount of energy for each data packet transmission and reception. Consequently, the initial energy value decreases over time. Upon receiving or sending address data packets, the current energy cost of the hub exceeds the initial energy. Information transmission between hubs is established using CBR traffic and UDP experts. The energy search method involves estimating the center's energy multiple times by retrieving the variable "energy."

7. RESULT AND DISCUSSION

7.1 Packet Delivery Ration (PDR)

Table 2. Comparison of Packet Delivery Ration (%)

Number of Nodes	AODV	DSR	DSDV	GSR
10	72	41	49	74
20	68	70	47	37
30	71	50	46	52
40	80	46	44	37
50	63	39	44	53

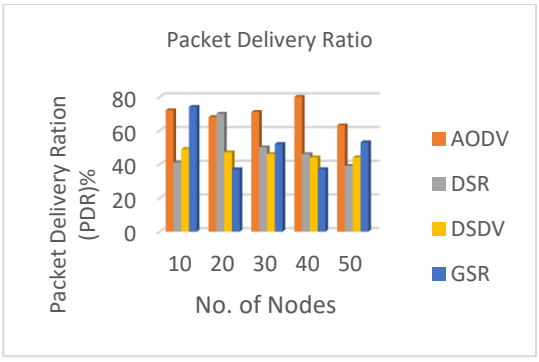

Figure 1. Comparison of Packet Delivery Ration (%)

7.2 Residential Energy (RE)

Table 2. Comparison of Residential Energy (J)

Number of Nodes	AODV	DSR	DSDV	GSR
10	500	595	505	498
20	500	600	507	502
30	510	488	508	499
40	500	485	505	502
50	499	600	510	499

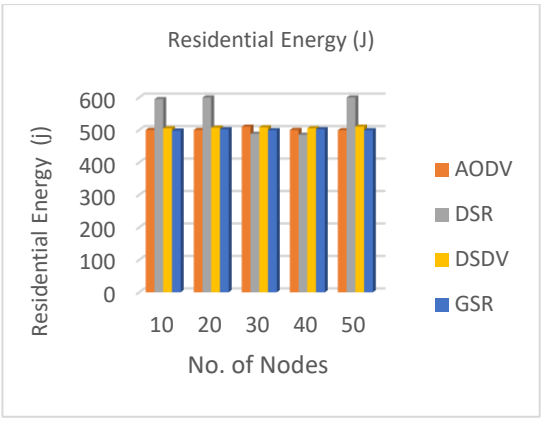

Figure 2. Comparison of Residential Energy (J)

7.3 End-to-End Time Delay (EETD)

Table 4. Comparison of End to End Delay (ms)

Number of Nodes	AODV	DSR	DSDV	GSR
10	252	262	450	620
20	198	213	400	580
30	171	196	370	570
40	190	205	394	580
50	1150	1090	1000	1472

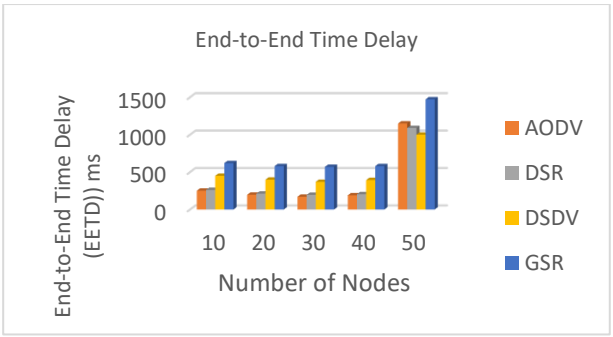

Figure 3. Comparison of End to End Delay (ms)

7.4 Average Throughput (AT)

Table 5. Comparison of Average Throughput (KB)

Number of Nodes	AODV	DSR	DSDV	GSR
10	1.56	1.125	2.2	1.55
20	1.01	1.55	2.2	0.95
30	1.75	1.2	2.09	0.98
40	1	1.19	2.1	0.97
50	1.25	1.1	1.3	1.35

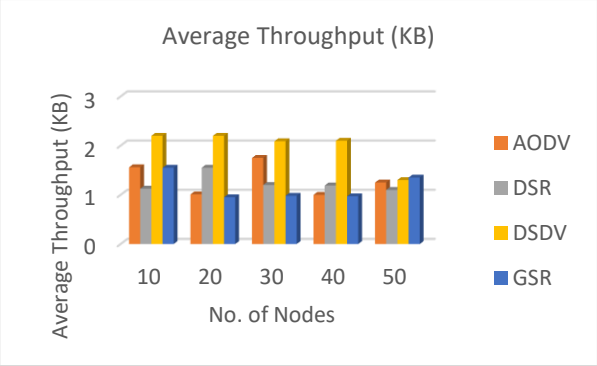

Figure 4. Comparison of Average Throughput (KB)

From this result compare to all other protocol AODV gives good packet delivery ratio. DSR have good residential energy. AODV and GSR give less end to end time delay. Finally DSDV provides goo through put.

8. CONCLUSION

Four protocols from different types of MANET routing protocols are examined in this investigation. Each protocol has a unique set of benefits and drawbacks. According to the results, AODV performs about averagely compared to the other protocols. This study comes to the conclusion that the AODV protocol is appropriate for the author's research. The author intends to incorporate AODV in their upcoming research. In addition to this project, the author plans to analyse the time complexity and security aspects of AODV. Subsequently, the author will explore potential solutions to address the time and security complexities associated with the use of AODV.

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