IJCSN International Journal of Computer Science and Network, Volume 6, Issue 2, April 2017
ISSN (Online) : 2277-5420
www.IJCSN.org
Impact Factor: 1.5

Evaluation of seven MANET Routing Protocols using Scalability Scenario

[1] K. Natarajan; [2] Dr.G. Mahadevan

[1] Research Scholar, Department of Computer Science, Rayalaseema University,
Kurnool, A.P State, India

[2] Principal, Annai College of Engineering & Technology,
Kumbakonam, T.N State ,India

Abstract - Wireless networks have gained momentum in the recent years due to the wide range of emerging applications. Among the available wireless networks, Mobile Ad Hoc Network (MANET) offers unique characteristics and application scenarios that create a great research attention recently. Designing an efficient and robust routing protocol is a challenging task and crucial to the core network operations owing to the dynamic properties of the MANET. The scalability is the major challenging scenario in protocol evaluation as the performance is affected on the escalation in the number of nodes and resources. The routing protocols must deliver the better scalability in varying number of mobile nodes in the network. The comparative performance analysis of seven MANET routing protocols such as AODV, DSR, LAR, DSDV, OLSR, FSR, and ZRP are evaluated using network simulation tool ns2. The network simulations using ns2 attempt to provide evidence for the effectiveness of a routing protocol under a wide range of network environments, and it plays a prime role in providing a virtual view of the real application scenario. Considering the significance of routing performance, this research work evaluates routing performance of proactive, reactive and hybrid routing protocols under various simulation scenarios to obtain the exact performance useful for different network conditions and application scenarios. This process analyze the scalability of routing protocols and demonstrate the suitability of routing protocols to different network environments. By considering the results under dynamic network topology, this work can determine the robust as well as most suitable protocols to the ad-hoc network environment. To accurately mimic the realistic context in simulation, the proposed work models the routing protocols in various simulation parameters

Keywords *– MANET,ns2,AODV, DSR, LAR, DSDV, OLSR, FSR, and ZRP*

1. Introduction

A collection of mobile nodes form a multi-hop autonomous mobile ad-hoc network without using any fixed infrastructure [2]. The data transmission is performed either in single or multi-hop manner, due to the limited radio propagation range. The frequent and unpredictable changes in node mobility degrade the stability of wireless links. The multiple intermediate nodes co-operate and assist the MANET in establishing the communication among far away nodes via multiple hops. The routing protocols must be distributed in nature to perform data forwarding between the source and the destination node. Routing [4] is the function of moving data from a source to a target, and it involves two activities named as optimal path determination and data transferring. In this process, the first activity becomes quite complex due to the arbitrary movement of the nodes in the network. The optimal path determination is suitable for a static network. However, this conception is not feasible in MANET environment. The factors such as variable link quality, topology changes, and high energy consumption are the relevant issues in MANET [3]. For instance, in a military environment, latency, reliability, security, and recovery from failure are of remarkable concerns. The lapse in the requirements of a node such as sufficient energy and adaptation to frequent changes hinders the probability of detection or interception in fast recovery needed fields such as the military. In a MANET, there are more advantages and challenges in achieving efficient routing protocol under various constraints such as dynamic mobility, limited energy resources, and infrastructure less networks [1]. The large scale networks face major problems due to dynamic nature, such as route discovery, neighbor list management, and security issues. The MANET provides the acceptable service level with the significant number of nodes in large-scale networks and has the capability to reduce the overhead in route discovery, and group membership management. The specific features of MANET pose some challenges in multi-hop routing [3]. The main challenges in MANET are mobility, limited bandwidth, infrastructure less networks, and energy efficiency. Simulation provides a quantitative evidence for the performance of a routing protocol under a wide range of environments. The simulation attempt to provide a virtual view of the real application scenario [7].Different simulation scenarios have been taken into the simulation for obtaining the exact performance as equal to the real scenario. The comparison of evaluation results is used to determine the efficiency and robustness of routing protocols [8]. The comparative analysis can demonstrate the suitability of routing protocols to the MANET applications [6]. Moreover, the performance comparison assists in understanding the distinct characteristics of a routing protocol clearly and estimating its relationship with others. To evaluate the routing protocols, it is essential to model a MANET environment using simulation tools. Thus, the design of the most realistic simulation environment takes into the account of knowledge the parameters that have an impact on the realistic scenario [10]. There are several extraordinary measures to disclose the performance of a routing protocol. The quantitative metrics are useful to observe the measures or highlight the internal capacity of the routing protocol under various simulation environments [11].

In a MANET, lots of routing protocols are proposed with different qualities [13]. The different characteristics of protocols are quite difficult to decide which are appropriate for an application or even for the simulation of a particular application. Several works compare the performance of various routing protocols to select an optimal one among them [14] [15].

2. Review on Routing Protocols in MANET

The routing [4] is a tough task in a MANET environment due to the high dynamic and decentralized nature. A set of rules is needed to control the nodes in that dynamic environment. Therefore, the routing protocol is exploited whenever data is to be forwarded to a target node via the number of mobile nodes and numerous routing protocols are being suggested for ad hoc networks. The routing protocols assist in discovering the route for data delivery as well as delivering the data to the exact destination. The studies on various features of MANET routing protocols have been an active area of analysis for many years. The numerous protocols have been proposed to keep applications and the type of network in their view [19]. Essentially, routing protocols are widely categorized into two types named as (i) Proactive or Table Driven Protocols and (ii) Reactive or On-Demand Protocols. Both the protocol properties are combined to produce a third one named as hybrid protocols [6]. The MANET [2] needs some distributed algorithms to organize the network topology with multiple intermediate routers in term of routing. The routing procedure assists the source node to find a routing path for forwarding the packets appropriately to the target destination [5]. Due to some difficulties in MANET, there is a necessity for using different routing strategies to establish the wireless communication among distant mobile nodes.. The major challenge in ad hoc network is the efficient design of robust routing protocols as the random nature creates a severe impact on the protocol design [3].

Table 1.:Properties of Protocols in Various Scenarios

Routing Property	**Proactive**	**Reactive**	**Hybrid**
Scalabilit y Level to Perform Efficient Routing	Usually up to 120 nodes	Source routing protocols up to few 100 nodes, Point-to-point is likely to scale higher	Designed for up to 1000 alternativ ely, more nodes
Mobility Handling Effects	Commonly updates occur based on mobility at fixed intervals	Local route discovery	Usually, more than one path may be available
Traffic Control Volume	Usually high	Low	Mostly lower than proactive and reactive protocols

The protocols are designed to discover the correct and reliable routing paths between the source and the destination pairs. Several routing protocols have been suggested in recent years with the greater ability [19]. Many researchers have been working to evaluate the performance of routing protocols in various simulation scenarios such as scalability, the mobility of nodes, and traffic. The scenarios are analyzed based on the different performance metrics such as a packet delivery ratio, throughput, delay, and overhead. The routing protocols provide their support depending on the routing properties as illustrated in Table 1.

3. Evaluation of MANET routing protocols based on Scalability

Scalability is a capability of a routing protocol to handle a huge number of nodes in the network. Comparatively, the number of nodes causes the severe impact on the simulation performance, since the mobile node density decides the network connectivity. The number of nodes is directly proportional to the path availability, resulting in less end-to-end delay. The node density supports the reactive type protocols to scale to large size networks, as they discover the route in an on-demand fashion. However, the high dense scenario leads to the network congestion in proactive protocols during the continuous updation of routing table entry. In contrast, the proactive protocols can retain the routing table updation with less congestion among a minimum number of nodes. Moreover, the hybrid routing protocols reduce the control traffic generated by the flooding and extend the usage of routing protocols to large size networks. To quantify the exact scalability of routing protocols, they are simulated and compared to varying number of nodes [27]. The scalability is the major challenging scenario in protocol evaluation as the performance is affected on the escalation in the number of nodes and resources. The routing protocols must deliver the better scalability in varying number of mobile nodes in the network. The mostly preferred routing protocols such as DSDV, DSR, OLSR, TORA are analyzed in [20] [21].

In this analysis, the proactive protocols such as DSDV obtain routes to all nodes in advance, since the routing table in DSDV is continuously updated in the fixed time interval which is independent of topology changes. This updating feature increases the control overhead over the network. Consequently, the throughput becomes low in DSDV. However, the DSR and AODV gets high throughput and packet delivery for any node density due to their source routing mechanism. The DSDV can attain large packet delivery in the number of node scenarios [22]. However, it is not important to consider this variation as the DSDV is not supporting to update the routing table in the rapidly changing topology. When taking the routing load into consideration, the DSDV and DSR achieve inferior results than AODV protocol. Thus, the normalized routing load is estimated as the ratio of all generated control packets sent to the total number of received data packets. In the case of packet loss, the escalation in the number of nodes severely impacts the DSDV performance due to its high control overhead whereas source routing protocols AODV and DSR cause insignificant packet loss. By the simulation result, it is observed that the DSR protocol has minimum routing packets among AODV and DSDV [23]. Therefore, the DSR attains better results in routing packets. In the performance analysis of routing protocols, the delay is the considerable metric to measure the scalability. As the measuring result, the AODV achieves high end-to-end delay due to its hop-by-hop routing methodology. Even though the DSR also follows the on-demand routing technique as similar to AODV, further it is capable of achieving the path based on its cache storage. Hence, the DSR or DSDV exposes comparatively less delay in a maximum number of nodes [20]. Comparing AODV, DSDV, and hybrid protocol ZRP in varying number of nodes, AODV attains less end to end delay compared to ZRP however, it reveals higher delay with the increment of nodes.

The ZRP has a higher delay than other two routing protocols. Also, it has the poorest throughput in a maximum number of nodes [24]. When the number of nodes is escalated, the control overhead of DSDV, AODV, and OLSR protocols increases, whereas the DSR quite a very low overhead [25]. The routing strategies are differentiated from each other depending on which type of information is being updated either topology or position. Different routing protocols have been introduced for wireless transmission [26]. The protocols such as AODV, DSR, LAR, DSDV, OLSR, FSR, and ZRP are taken into the comparative analysis of this work. To investigate how the protocols reveal their performance as similar to the realistic situation, the protocols are compared with different kinds of scenarios that certainly exhibit the originality of routing protocols [16].

4. Experimental design and implementation.

4.1. Evaluation platform

The software-based simulation method is a viable alternative and widely used solution for protocol implementation. The simulation allows the network to be handled as a whole, and easy to use and monitor [10]. Furthermore, the implementations are represented as scenario files, and they are reproducible. Several simulation tools are exploited to evaluate the MANET routing protocols in an efficient and realistic manner [18].

Simulation Parameters	Value
Simulator	NS-2
Routing Protocols	AODV,DSR,LAR,DSDV ,OLSR,FSR,ZRP
Network Area	1000x1000m
No. of nodes	100,125,150,175,200
Mobility Model	RWP
Speed	20m/s
Pause Time	10s
CBR Connections	5,10,15,20,25
Traffic Type	TCP, UDP
Traffic Generator	FTP,CBR
MAC Protocol	IEEE 802.11
Queuing Model	Drop Tail/Priority Queue
Priority Queue Size	50
Simulation Time	100s

Due to the complex nature of the MANET, the simulation becomes more challenging one. The simulation tools used in MANET depend on various techniques for enhancing their speed, accuracy, scalability, and performance metrics. The combination of various scenario parameters can provide the possibility to model the realistic application environment and obtain the originality of protocol results in terms of direction, speed, traffic, and density [12]. To assess the efficiency of different protocols, the NS2 simulator has been extensively utilized to model the different network simulation environments.

4.2 Performance Metrics

The performance metrics are essential aspects of the decision-making process that decide the performance of a protocol in the given scenario [17]. The performance metrics employed to evaluate the performance are delineated as follows.

Overhead: The overhead denotes the ratio of control packets involved in data transmission, and the total generated control packets.

Throughput: Throughput is defined as the rate of successful data delivery to the destination. The throughput ensures the reliability of packet delivery.

Table 2: Simulation Settings for Scalability Scenario

4.3 Scalability Scenario-Based Evaluation

The Table 2 exposes the settings of simulation parameters for scalability scenario. The number of nodes plays a major role in the traffic increment over the network area.

Table 3: Traffic based performance analysis

Traffic Investigations	
Type of Scenario	**Description**
Low Traffic	This low traffic scenario is configured for evaluating the impact of TCP and UDP traffic with varying number of communication flows from 5 to 10. The file size is 491.520kb. Therefore, (5*81.920kbps(single flow)= 409.6kbps and 10*81.920kbps=819.2kbps) in this scenario, the data traffic rate from 409.6kbps to 819.2kbps is forwarded, as the escalation in the number of flows has increased the traffic on the data rates. The TCP quickly adapts during the traffic increment due to its congestion control mechanism.

IJCSN International Journal of Computer Science and Network, Volume 6, Issue 2, April 2017
ISSN (Online) : 2277-5420
www.IJCSN.org
Impact Factor: 1.5

Medium Traffic	This scenario represents the medium traffic and uses same file size as in the low traffic scenario which is configured with 10 to 20 numbers of flows. The traffic rate has escalated from 819.2kbps to 1638.4kbps (20*81.920kbps). In network scenarios such as mobility, scalability, the traffic flows are fixed at 15 flows which mean 1228.8kbps (15*81.920kbps) of data traffic has generated.
High Traffic	Same as, low and medium traffic scenario, this scenario evaluates the protocol performance under TCP and UDP traffic types. However, high traffic scenario escalates the flows from 20 to 25. Therefore, 1638.4kbps to 2048kbps (25*81.920kbps) of the data traffic rate gets generated. The UDP forwards the data at a constant rate irrespective of bandwidth availability.

Table 4: Network Size Based Scenario Analysis

Node Investigations	
Type of Scenario	**Description**
Scenario-1 : Small Size Network	Scenario 1 is designed with different entities and configured for a network size of 100 to 125 nodes, the file size of 491.520kb, the MAC standard of IEEE 802.11, the speed of 20 m/s with a pause time of 10 Sec. Also, the scalability scenario considers the number of communication flows which has escalated on the increment of nodes, since there is a possibility to establish the number of connections among increasing nodes. This small size scenario is configured with 5 to 10 flows.
Scenario-2 : Medium Size Network	Scenario 2 indicates the medium size network, which is designed with 125 to 175 nodes and 10 to 20 communication flows. However, with another scenario setting such as node speed, file size, the MAC protocol is not changed and fixed as in scenario 1. The main intention to observe the performance of routing protocols via varying number of nodes and flows is to create any have the impact as equal to the realistic scenario.
Scenario-3 : Large Size Network	Scenario 3 is similar to that of scenario 1 and scenario 2 except the size of the network and communication flows vary from 175 to 200 nodes and 20 to 25 respectively. This flow assists in observing the impact on MANET environment.

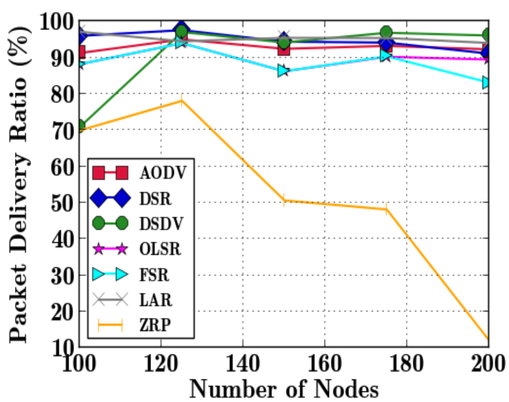
Based on the types of traffic either TCP or UDP, the protocols reveal their performances in the scalability scenario. The traffic scenario settings are clearly described with three levels as shown in Table 3. Table .4 describes scalability scenario in term of different network size.

5. Results & Discussion

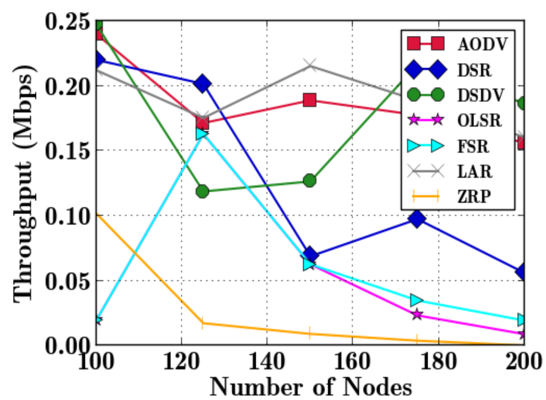
5.1 Results of Simulation Scenario with TCP

The comparative performance analysis of AODV, DSR, LAR, DSDV, OLSR, FSR, and ZRP routing protocols in TCP traffic with varying number of nodes from 100 to 200 is shown in Figure 1. The scenario settings are followed as fixed in Table.2. Overall, in TCP traffic, the ZRP protocol performs worst on the increment of nodes due to the difficulties in maintaining the intra-zone and inter-zone structure. As shown in Figure.1(a), the protocols except ZRP retain the appreciable performance between 71% to 96%, and they successfully deliver the packets even attaining some delay. However, the increasing number of nodes (as scenario 3 in Table 3) within the stable network area (1000mx1000m) escalates the traffic load in both the inter and intra zones which leads to packet drop. Therefore, the ZRP does not maintain the PDR compared with other protocols.

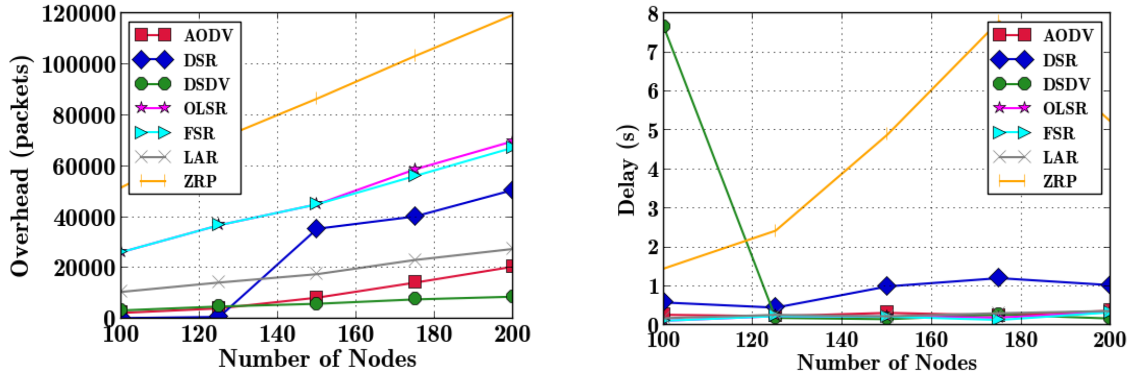
The ZRP attains only 12.11% of PDR in 200 nodes. The AODV has high throughput in the presence of 100 nodes which is depicted in Figure 1(b). This is because the AODV finds the path widely over the network which leads to obtaining the maximum connectivity among less number of nodes. When comparing the AODV to LAR, the LAR attains a high throughput value after 125 nodes as the restricted flooding area of LAR automatically reduce the overhead and collision caused by a maximum number of nodes. Furthermore, comparing FSR and ZRP protocols, the FSR maintains a routing table for routing. Instead, the ZRP has inter-zone and intra-zone tables. By this reason, during the presence of minimum nodes (100), the ZRP efficiently retains the throughput without the heavy overhead. With 125 nodes, the FSR has sufficient connectivity than ZRP afterward, both are decreased on the escalation in nodes. Also, the FSR does not need hello messages which lead to obtain less congestion and higher connectivity up to 200 nodes than ZRP. It achieves more throughput by 99.6% than ZRP in 200 nodes. The OLSR provides the similar result to FSR due to the MPR mechanism. However, the maximum nodes degrade the throughput than FSR. The OLSR maintains two-hop neighbors that escalate additional overhead.



(a)



(b)



(c) (d)

Fig 1: Performance Comparison with Varying Number of Nodes Under TCP Traffic

The DSDV has increased throughput after 125 nodes due to the high possibility of selecting the required routes. When considering the DSR, it DSR attains poor throughput than AODV, DSDV, and LAR in the presence of 200 nodes due to the cache staleness and collision. As shown in Figure 1(c), all protocols have to escalate overhead value with increasing nodes due to the high density which leads to network traffic and collision.

The LAR exhibits relatively higher overhead than AODV and DSDV since the LAR concentrates the restricted flooding area to reach the appropriate destination which has the possibility of high control traffic. Conversely, the AODV widely performs flooding over the determined network area. The DSR has higher overhead by 59.4% and 82.6% than AODV and DSDV in the presence of 200 nodes respectively. The reason is that the cache route storage in DSR leads to high control overhead when the data traffic rates are escalated. Moreover, the FSR has relatively less overhead by 3.7% than OLSR in 200 nodes due to its multi-point scope mechanism. The MPR technique in OLSR causes the control traffic over the network instead of multi-point scope in FSR.

As exhibits in Figure 1(d), the DSDV has a high delay than others in 100 nodes as, the routing table updation among the 100 nodes leads to packet dropping which causes the delay performance. After 120 nodes, all protocols except ZRP show acceptable delay with increasing nodes. The inter and intra-zone nodes in ZRP are escalated up to 200 within a static network area which leads to packet drop and delay.

5.2 Results of Simulation Scenario with UDP

The comparative performance analysis of AODV, DSR, LAR, DSDV, OLSR, FSR, and ZRP routing protocols in UDP traffic with varying number of nodes from 100 to 200 is shown in Figure 2.

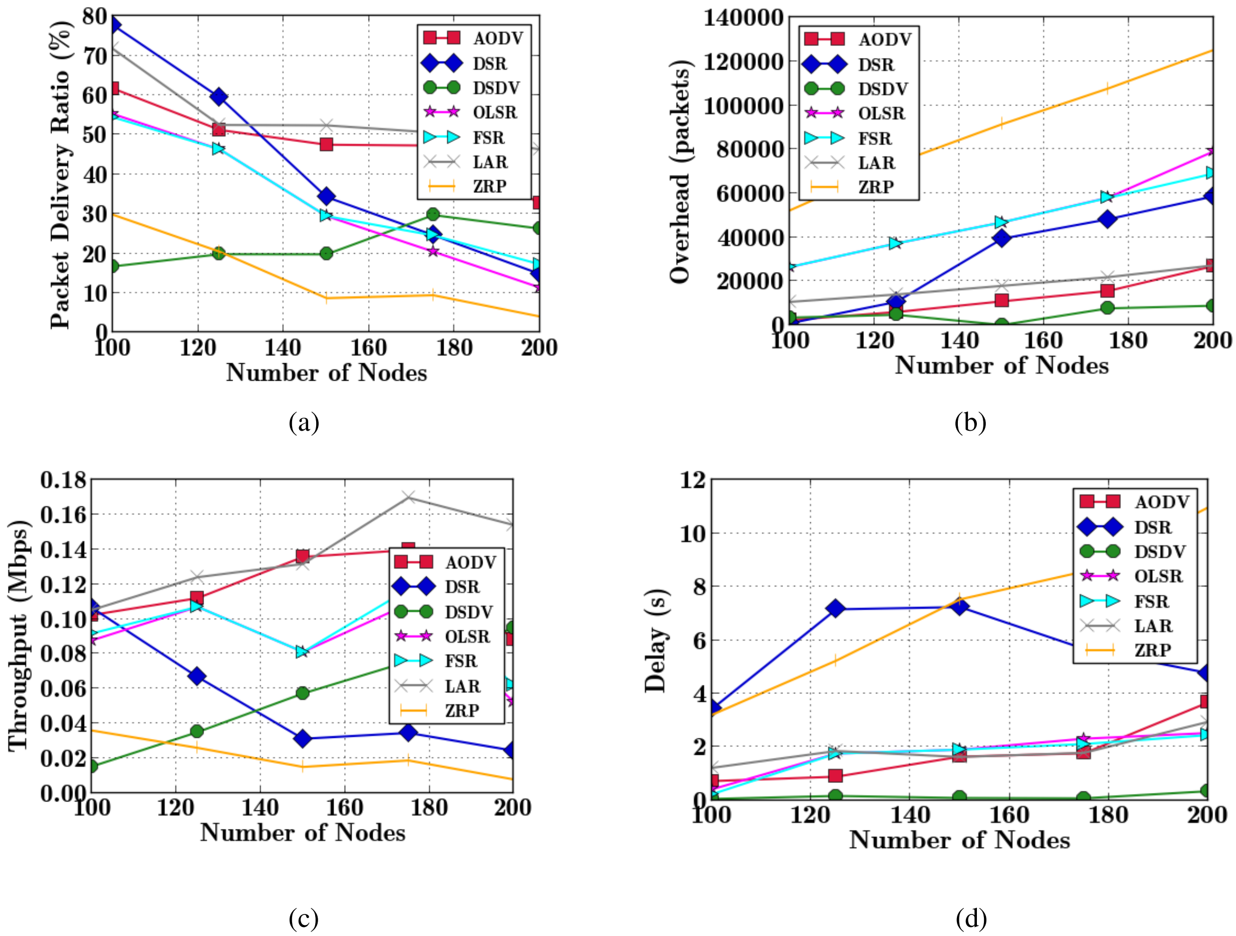


Fig 2: Performance Comparison with Varying Number of Nodes Under UDP Traffic

Overall, for UDP traffic the AODV exposes improved result, as well as the LAR, shows a fair result to AODV. As illustrated in Figure 2(a), when the DSR, AODV, and LAR are taken into the comparison, initially the DSR has a relatively high PDR due to the sufficient cache route availability. Afterward, the maximum routes in cache caused by a huge number of nodes create the collision which triggers DSR to perform poorly. Moreover, the OLSR and FSR achieve reduced PDR due to the high traffic and collision caused by retransmission in UDP nature with a lack of acknowledgments reception. In this, the two-hop neighbor maintenance of OLSR escalates the overhead which leads to packet drop. The ZRP attains poor performance regarding PDR and also throughput as exposed in Figure 2(b). The overlapping zones in ZRP develop complexities during routing. Also, the long distance between the source and the destination leads to maximum intermediate zones which result in the collision in intra and inter-zone escalates on the augmentation in nodes. The LAR has escalated throughout after 150 nodes than AODV as the LAR retains its connectivity with a considerable amount of collision in higher nodes.

Another prime factor is overhead in the network. Initially, all the protocols have obtained less and closer overhead as shown in Figure 2(c). With an increasing number of nodes, the overhead of all protocols has raised. This is because the maximum number of nodes escalates the probability of broadcasting. Comparing all, the ZRP has high overhead by 44.8% and 36.8% than FSR and OLSR others. Also, the collision and packet dropping due to higher load lead to retransmission, which increases the end to end delay as depicted in Figure 2(d). The reason for poor performance in DSR is that it has delayed while paving the route from its cache by staleness. After crossing 150 nodes, the ZRP passes the DSR due to its zone maintenance complexity. It reaches higher delay (viz., 10.96 seconds) at the presence of 200 nodes. This is because the maximum nodes in the static area certainly raise the traffic and packet loss. This makes ZRP perform with high delay. The FSR, LAR, AODV, and OLSR reveal almost comparable delay depending on the number of nodes except DSDV. The DSDV performs better even in 200 nodes, and it retains the minimum delay between 0.057 seconds and 0.34 seconds as it has the route to all possible destinations at all the time.

The following Table: 5 shows the performance of protocols which reveals the good performance under different network sizes and parameters.

Table 5: Performance of Protocols in Scalability Scenario

Traffic Type	Network Size	Suitability			Description
		Reliability	**Energy Sensitive**	**Delay Sensitive**	
TCP	Small	DSR, AODV	DSR	DSR, AODV	In TCP traffic, the ZRP hybrid protocol performs poor in all metrics. The DSDV shows almost better performance even in high-density scenario due to the updating ability of recent paths.
	Medium	DSDV, LAR, AODV	DSDV	LAR	
	Large	DSDV	DSDV	DSDV	
UDP	Small	LAR, AODV, DSR	DSDV, AODV	LAR, AODV	In UDP, the LAR and AODV expose their best almost in all network sizes. The restricted area allocation ability makes the LAR provide better results.
	Medium	LAR, AODV	DSDV	DSDV	
	Large	LAR, AODV	DSDV	DSDV, LAR	

Table 6 : Comparison of Simulation Results of the Scalability scenario

Network Scenario	Metrics	Traffic Type	AODV	DSR	LAR	DSDV	OLSR	FSR	ZRP
Scalability	PDR	TCP	High	High	High	Medium	High	High	Low
	Throughput		High	Medium	High	High	Medium	Medium	Low
	Overhead		Low	Medium	Low	Low	Medium	Medium	High
	Delay		Low	Medium	Low	Medium	Low	Low	High
	PDR	UDP	High	Medium	High	Low	Medium	Medium	Low
	Throughput		High	Medium	High	Medium	Medium	Medium	Low
	Overhead		Low	Medium	Low	Low	Medium	Medium	High
	Delay		Medium	High	Medium	Low	Medium	Medium	High

6. Conclusions

This research work has explained the evaluations of routing protocols and discusses the impact of different network scenarios on the protocol evaluation for obtaining the exact performance as similar to the realistic context. It also defines the performance metrics to analyze the results. The different scenarios such as scalability and mobility are considered in protocol evaluation. It significantly assists the network professionals to decide a suitable routing protocol for a specific application requirement by evaluating the key performance metrics of the routing protocol. The TCP and UDP traffic create the significant impact on evaluation, and so the protocols are simulated with both the TCP and UDP traffic. Thus, the different network scenario consideration provides the efficient and accurate performance evaluation for each protocol. To assess the efficiency of different protocols, the NS2 simulator has been extensively utilized to model the different network simulation environments. The major contributions of the research work are concluded as follows. The TCP and UDP traffic type based protocol analysis efficiently assist the comparison in obtaining the routing protocols which behave well over much important scenarios of MANET such as mobility and scalability.

Eventually, the simulation results estimate the exact performance of routing protocols as equal to the realistic environment. The following Table 6 illustrates the performance comparison of protocols in different metrics.

References

[1] Chen, Chang Wen, R. L. Lagenduk, A. Reibman, and Wenwu Zhu, "Introduction to the special issue on wireless communication", IEEE Transactions on Circuits and Systems for Video Technology, Vol. 12 No. 6, 2002. .

[2] de Morais Cordeiro, Carlos, and Dharma P. Agrawal, "Mobile ad hoc networking", Center for Distributed and Mobile Computing, ECECS, University of Cincinnati, pp. 1-63, 2002..

[3] Chlamtac, Imrich, Marco Conti, and Jennifer J-N. Liu, "Mobile ad hoc networking: imperatives and challenges", ELSEVIER, Ad hoc networks, Vol. 1, No. 1, pp. 3-64, 2003.

[4] Pathan, Al-Sakib Khan, and Choong Seon Hong, "Routing in mobile ad hoc networks", Springer, Guide to Wireless Ad Hoc Networks, pp. 59-96, 2009.

[5] Marina, Mahesh K., and Samir R. Das, "Routing in mobile ad hoc networks", Springer, Ad Hoc Networks, pp. 63-90. 2005.

[6] Wang, Lan, and Stephan Olariu, "Hybrid Routing Protocols for Mobile Ad-hoc Networks", Springer, Resource Management in Wireless Networking, pp. 472-506, 2005.

[7] Andel, Todd R., and Alec Yasinsac, "On the credibility of manet simulations", IEEE, Computer, Vol. 39, No. 7, pp. 48-54, 2006.

[8] Trung, Ha Duyen, Watit Benjapolakul, and Phan Minh Duc, "Performance evaluation and comparison of different ad hoc routing protocols", ACM, Computer Communications, Vol. 30, No. 11, pp. 2478-2496, 2007.

[9] Alsaqour, Ola, Raed Alsaqour, Tariq Alahdal, Rashid Saeed, and Mohammed Al-Hubaishi, "A comparative study of simulation based performance evaluation of routing protocol for ad-hoc networks", Springer, Innovations and Advances in Computing, Informatics, Systems Sciences, Networking and Engineering, pp. 215-221, 2015.

[10] Hogie, Luc, Pascal Bouvry, and Frédéric Guinand, "An overview of manets simulation", Electronic notes in theoretical computer science, Vol. 150, No. 1, pp. 81-101, 2006.

[11] Buruhanudeen, Shafinaz, Mohamed Othman, and Borhanuddin M. Ali, "Existing MANET routing protocols and metrics used towards the efficiency and reliability-an overview", In Telecommunications and Malaysia International Conference on Communications ICT-MICC IEEE International Conference, pp. 231-236, 2007.

[12] Das, Samir R., Robert Castañeda, and Jiangtao Yan, "Simulation-based performance evaluation of routing protocols for mobile ad hoc networks", Springer, Mobile networks and applications, Vol. 5, No. 3, pp. 179-189, 2000.

[13] Abolhasan, Mehran, Tadeusz Wysocki, and Eryk Dutkiewicz, "A review of routing protocols for mobile ad hoc networks", Ad hoc networks, Vol. 2, No. 1, pp. 1-22, 2004.

[14] Misra, Rajiv, and C. R. Mandal, "Performance comparison of AODV/DSR on-demand routing protocols for ad hoc networks in constrained situation", IEEE International Conference on Personal Wireless Communications, pp. 86-89, 2005.

[15] Boukerche and Azzedine, "Performance evaluation of routing protocols for ad hoc wireless networks", Mobile Networks and Applications, Vol. 9, No. 4, pp. 333-342, 2004.

[16] Johansson, Per, Tony Larsson, Nicklas Hedman, Bartosz Mielczarek, and Mikael Degermark, "Scenario-based performance analysis of routing protocols for mobile ad-hoc networks", ACM/IEEE, Mobile computing and networking, pp. 195-206, 1999.

[17] Ya'acob, Norsuzila, Nurhazwani Rosli, Azita LailyYusof, and Mohd Tarmizi Ali, "Investigate the performance metrics of mobile ad hoc networks (MANET)", IEEE Symposium on Wireless Technology and Applications (ISWTA), pp. 28-33, 2013.

[18] Malhotra and Jyoteesh, "A survey on MANET simulation tools", IEEE Computational Intelligence on Power, Energy and Controls with their impact on Humanity (CIPECH), pp. 495-498, 2014.

[19] Al-Omari, Saleh Ali K., and Putra Sumari, "An overview of mobile ad hoc networks for the existing protocols and applications", Networking and Internet Architecture, pp. 1003.3565, 2010.

[20] Geetha, N., and A. Sankar, "Performance analysis of certain topology based routing protocols of mobile ad hoc network", ACM Research in Applied Computation Symposium, pp. 215-220, 2012.

[21] Sandhu, Davinder Singh, and Sukesha Sharma, "Performance Evaluation of DSDV, DSR, OLSR, TORA Routing Protocols–A Review", Springer, Mobile Communication and Power Engineering, pp. 502-507, 2013.

[22] Jisha, G., and Philip Samuel, "Impact of node density on node connectivity in manet routing protocols." Springer International Conference on Advances in Computing and Communications, pp. 1-8, 2011.

[23] Tuteja, Asma, Rajneesh Gujral, and Sunil Thalia, "Comparative performance analysis of DSDV, AODV and DSR routing protocols in MANET using NS2", IEEE International Conference on Advances in Computer Engineering (ACE), pp. 330-333, 2010.

[24] Gandhi, Savita, Nirbhay Chaubey, Naren Tada, and Srushti Trivedi, "Scenario-based performance comparison of reactive, proactive & Hybrid protocols in MANET", IEEE International Conference on Computer Communication and Informatics (ICCCI), pp. 1-5, 2012.

[25] Mohapatra, S., and P. Kanungo, "Performance analysis of AODV, DSR, OLSR and DSDV routing protocols using NS2 Simulator", ELSEVIER, Procedia Engineering, Vol. 30, pp. 69-76, 2012.

[26] Royer, Elizabeth M., and Chai-Keong Toh. "A review of current routing protocols for ad hoc mobile wireless networks." IEEE personal communications, Vol. 6, No. 2, pp. 46-55, 1999.

[27] Seung-Chul, M.W. and S. Suresh, "Scalable routing protocol for ad hoc networks", Wireless Networks, Vol. 7, No. 5, p.p. 513-529, 2001.