Design & Performance Analysis of Hybrid Protocols in MANET

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Abstract— The infrastructure-less network which is recognized as MANET is the major topic of discussion for the advancement in the field of technology and communication. MANETs are self-configuring which increases their utility. These auto-configuring networks change their topology automatically according to the requirement. The major problem or issue which is identified with the use of MANET can be its performance related to transfer of data packets. There are various researches which have been made over the time to identify the issues and address solutions to them. In this research, we have tried to make an effort in the improvement of MANET network with the development of the technology and approaches. The conventional methods which were used in MANET are recognized as DSR, TORA, and GRP, but still, the performance issues exist. Thus, we have tried work over the idea of combining two different approach models to develop a hybrid technique which can prevent the loss of data and information and increase transfer rate. We have developed a hybrid GRP-TORA combined approach which has shown the results in favor of improvement. The hybrid model has helped to reduce the energy consumption and ensure greater packet data transfer ratio.

Key words: MANET, routing protocol, packet delivery, QoS, DSR, GRP, TORA

I. INTRODUCTION

MANET, which is known as Mobile Ad Hoc Network or Ad-hoc wireless network, is an endless self-configuring, infrastructure less network of mobile devices which are connected wirelessly. The device which is embedded in MANET is open to moving individually in any direction, and it will also be able to change their links to other devices frequently. It is also usually well-defined as a network which has many free or autonomous nodes, and it can arrange themselves in various ways. It operates the function without strict top-down network so that they are able to perform all the functions according to the network proficiency. There are many different types of setups developed in MANET. [1]

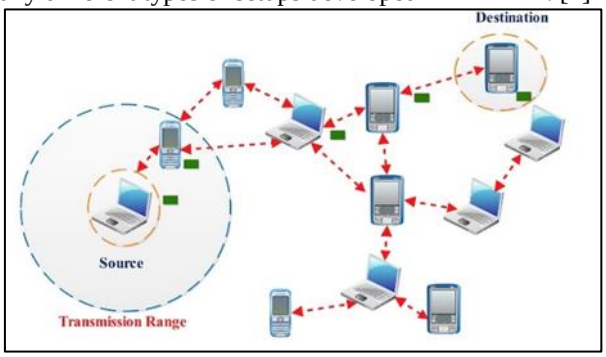

Fig. 1: Mobile Ad-Hoc Network

MANET is one of the significant topics of research at present. Because of widely available and inexpensive wireless devices, fast development has been seen in this area [12]. MANET is one of the emerging networks in the mobile technology. It is one of an essential technology that strongly supports the future computing scheme. These are the characteristics of the MANET that lead it to both the new opportunities and challenges.

A MANET is a collection of various devices such as a smartphone, laptops, sensors that can easily connect and communicate with each other through a wireless link. In this way, these devices behave as connected to the distributed network to deliver all the necessary functionality even in the absence of some fixed infrastructure [13]. In such network, when the mobile devices approach each other, they started detecting each other on the network to communicate through the wireless link. Bluetooth is an example of such network.

A. Challenges in Ad-hoc Network

There are various challenges that the ad hoc networks have to face. These include dynamic network topology, irregular connectivity, no fixed access point and the contrary environment. These networks instantly form and accommodate the limited and modification power. Along with this, there is no specific or fixed centralized administration. Because of the dynamic changing property, there are various issues and challenges that the network face which are listed below:

1) QoS (Quality of Service)

Providing high quality of service is a tough task in the ad hoc network because of its dynamically changing network. There is a high requirement of the quality of service because of the adaptation of real-time application and rapid development in the mobile technology [8]. Unfortunately, there are various factors that affect the quality of service. First is the radio interference. There is significant interference between the connected nodes that lead to poor quality of service. There are limited resources and bandwidth available or the link establishment. All these things lead to poor quality of service in an ad hoc network [3].

2) Scalability

Scalability is another issue that occurs in MANET because of its multi-hop nature. Scalability leads to equal node priority. All the nodes have the same priority and use the resources equally. It is necessary that the transmission capacity of the node is large enough that can avoid the interference from the neighbor node. Apart from this, the packets transmitted adopt the shortest possible path. It is possible to mitigate all the issues of scalability if the network area is divided according to the geographical information [10].

3) Security

The major concern in the MANET is the security. It is necessary that all the data transmission must be done in a secure way. But there are significant issues related to security in the ad hoc network that includes the small device size, dynamic topology, limited bandwidth and battery life. Thus it is very hard to maintain the secured transmission of data because of its dynamic nature [3].

B. Applications of MANET

MANET has various applications in the fields like:

1) Military Sector

MANET networks are utilized in the military sector for the purpose of maintaining information, sending and processing information among the soldiers, vehicles, and military information headquarters [9].

2) Local Level

MANET networks are used to link systems or computers using the notebook computer with the objective of exchanging the information among the participants that are using the system. For example, these networks help in conducting classes, conferences with people at remote locations.

3) Bluetooth

MANET networks are utilized in the Bluetooth to send the information between the mobile devices, laptops and Bluetooth enabled devices within small range.

4) Sensor Networks

MANET networks are also useful in the sensor networks which are used to identify the properties of an area in which system is established. These networks are used to determine things like temperature, pressure, and pollution, etc.

5) Collaborative work

These systems can be utilized in a cooperative sector like a business for the people that work on a single project and need to communicate with the other participants of the project beyond the office timings [6].

C. Routing Protocols

A protocol which explains how routers communicate with each other, distributing information is called routing protocol. Routing algorithms help to determine the specific choice of route. Each router is aware of only those networks to which it is attached directly. A routing protocol gains knowledge of the topology of the network by sharing the information. There are numerous types of routing protocols, but the widely used protocols are given below:

1) Interior gateway protocols

An IGP or interior gateway protocol is a kind of protocol used for transferring routing information among the gateways within an autonomous system. This routing information can be used to route network-layer protocols such as Internet Protocol (IP). The interior protocol is further divided into sub-protocols such as hybrid routing protocol, distance-vector routing protocol, and link state routing protocol.

2) Exterior gateway protocols

The protocol in routing protocol used to transfer routing information between autonomous systems is known as exterior gateway protocols. This exchange of information is important for communications over the Internet. Notable exterior gateway protocols contain Border Gateway Protocol (BGP), Exterior Gateway Protocol (EGP) and now obsolete. Exterior Gateway Protocol (EGP) is commonly used between hosts on the Internet to exchange routing table information. That table contains a list of known routers and their concerted activities.

D. Routing protocols in Ad-hoc networks

There are many routing protocols that have been recommended for ad-hoc networks. The main motive behind using the routing protocol is to establish a minimum hops or simply the optimal path between the source node and the destination node [7]. In ad hoc networks, nodes are not aware of their network topology. The ad hoc networks can also be used to mean an improvised established for a specific purpose. The list of ad hoc networks is given below:

On-demand routing: On-demand routing protocol is also known as reactive routing. On-demand routing protocol discovers a route on demand by flooding the network with route request packets. Power-aware DSR-based, ABR, dynamic source routing is some of the examples of reactive routing [2]. It is done through source routing or DVR (Distance Vector Routing). Thus, source routing does not require any routing tables. The next hop and destination address are used to route packets from source to destination.

Table-driven routing: Table-driven routing also known as proactive routing. This routing, routes to the destination are available on every node in the routing table. The routing tables are exchanged among the neighbors at regular interval of time [13]. DSDV (Destination-Sequenced Distance-Vector Routing) and OLSR (Optimized Link State Routing Protocol) are examples of proactive routing protocols.

Hybrid routing: The hybrid routing protocol combines the advantages of table-driven (proactive) and on-demand (reactive) routing. The routing is primarily established with few of proactively prospected routes. The primary disadvantage of this routing process is less the number of activates, less the advantage offered and the traffic volume. Zone-based Hierarchical Link State Routing Protocol and Zone Routing Protocol are the examples of hybrid routing.

Hierarchical routing protocols: With hierarchical routing protocols, the choice of table-driven (proactive) and on-demand (reactive) routing depends on the hierarchical level in which a node be located in. The disadvantages of this routing protocols are as same as hybrid routing protocols. The examples of this algorithms are Zone-based Hierarchical Link State Routing Protocol, Cluster-Based Routing Protocol, Fisheye State Routing protocol, and order one network protocol.

II. LITERATURE REVIEW

Mandharea & Thool (2016) presented the distributed system using RERR of route cache update algorithm by which the performance of DSR protocol is improved up to 30%. This paper explains the method to handle routing protocol when the topology is changed. This study presents an approach known as cache updating which use distributed cache route update algorithm. The experiments in this research are done using network simulation of monarch group improves the performance 30-40% by QoS parameters such as an end to end delay, energy consumption, and packet delivery ratio (PDR) [1].

Kaur & Bhatia (2016) presented the LB-AODV algorithm which is used to control the routing overhead of lower end to end delay, higher packet delivery fraction in comparison with AODV and DSR routing algorithm. The research explained the functionality of dynamic source routing, AODV, and a new algorithm LB-AODV. From the

review carried out by this research, it is studied that LB-AODV algorithm has significantly controlled the routing overhead has higher packet delivery portion, a lower end to end delay as related to the DSR and AODV routing algorithms. [2]

Joshi et.al. (2016) analyzed the performance of the network after inclusion of black hole attack and gray hole attack in the network. The research presented three dimensional-distributed energy efficient distance vector (TD-DEEDV) that helps in to check the security on the basis of parameters which increases the performance of the network by implementing EMAODV in packet delivery ratio, throughput, and a number of nodes alive by 58%, 8%, and 5%. The attacks are more in a wireless communication network which is more difficult to handle them so; research focused on a combination of the black and gray hole [3].

Kodole & Agarkar (2015) described the reactive routing protocols of MANET which are based on the approach of load balancing and Neighbour knowledge method. Load balancing method approach is used in the central network to distribute the load and neighbor knowledge method approach of the broadcasting technique is used in the network to decrease collision, contention, and retransmission of the network. The broadcasting technique was used to search a route between source and destination, but it creates many problems such as collision, contentions and redundant retransmission [4].

Raja & Baboo (2014) described the mobile computing which is used for the mobile communication in mobile devices such as self- organizing, self-administering, self-creating wireless networks which are called MANET which are useful in security threat in networks. This study presents the potential applications, different attacks and the technologies of MANET which is a collection of the mobile devices such as laptops, sensors or smartphones used to communicate with each other over wireless links and in the distributed network which provides the important functionality of the network without any infrastructure [7].

Rani & Kadyan (2014) suggested a research to show that due to the increase of nodes in a network, routing traffic increases in the network which decreases the time of route discovery and also increases the average end-to-end delay in the network. To analyze the performance of a network in DSR, different aspects are used such as average route discovery time, route expiry time, Cache size, and traffic overhead [8].

Patel et.al. (2014) analyzed the TCP behavior in mobile ad hoc network over DSR, LAR1, WRP, and AODV regarding an average end to end delay, packet drop ratio, routing overhead, packet delivery ratio, and throughput which helps to evaluate the performance of the network metrics. This research shows the simulations with same networks, but they are running on the different protocols on the node of mobile which divided into two parts [9].

III. METHODOLOGY

After researching the previous papers, it was found that the protocols GRP and TORA didn't show efficient performance for the MANETs. So, it is required to further research on these two protocols and setup the network in such a way that performance of the network can be improved using these protocols. Other than this, the traffic type considered in the past researches is limited. In the current research, we will consider the traffic of Database, FTP, HTTP, Voice, Email, Video Streaming on the Mobile Ad-hoc network.

These different traffic types will help in identifying the performance of each protocol in different traffic scenarios. The parameters that will be measured/ calculated include the packet delivery ratio, throughput, overhead, packet drop rate, end-to-end delay, and energy consumption. These will help in evaluating the performance of the selected protocols as compared with the results of previous research carried by the Mandhare V.V. in 2016. [1] This research was carried in an NS-2 Software environment that includes the coding scripts of the TCL. The research proposed is carried out in OPNET simulator as it provides better performance in terms of end-to-end delay, throughput, and packet delivery ratio as compared with the NS-2 simulator

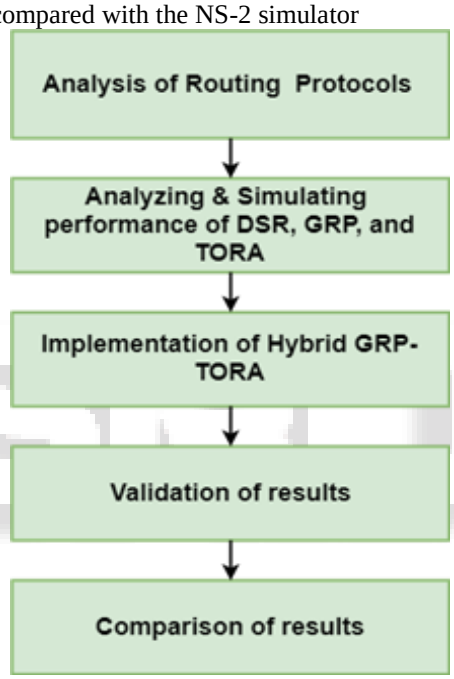

Fig. 2: Flowchart of research methodology

A. Protocols

For the current research work, we used GRP and TORA. Our main aim is to improve the performance of these protocols in the MANETs.

1) DSR (Dynamic Source Routing)

It is a reactive routing protocol operating by the on-demand scheme and allows the mobile nodes to find dynamic route among the network nodes. The parameter considered for the DSR in this research are:

- Max Route cache: At any time during simulation, this value given for holding a maximum number of routes.
- Route Expiry Time: Route cache expires after the specified time of installation in the route cache.
- Maximum Request Table Identifiers: Every target address must have a maximum number of identification values. These values will retain it in Route Request Table entry.

– Request Table Size: It defines the Maximum number of destinations to which the route request table can hold requests.
– Packet Salving: If identified that there is a breakage in the route. If an alternative route exists, it is advisable that the node should salvage the packet. It should not discard it.

Parameter	Value
Max. Cache routes	100
Route Expiry time (Seconds)	300
Send buffer's Max. size	50 packets
Send buffer's Expiry time	30 seconds
Request table size	64 nodes
Initial request period	0.5 seconds

2) GRP (Gathering based routing protocol)

It is a Hybrid protocol that divides the network into zones. It maintains hierarchical structure where each node has to store additional topological information requiring additional memory. Its main parameters used in the simulation are:

– Hello interval: It describes that each node broadcasts the hello message to all the neighbors.
– Neighbor expiry time: It is expected that node will receive the hello message from the neighbor node within the neighbor expiry time; if it is not so then the node is not considered to be a neighbor anymore.
– Backtrack option: It specifies whether this node can backtrack.
– Route Export: It means exports the route taken to the destination by every packet originating from this node to an output table (OT).
– A number of initial floods: They describe the Number of initial flooding attempts done by this node.

Parameter	Value
Hello Interval (seconds)	5.1
Neighbor Expire time (seconds)	15
Distance Moved (Meters)	1000
Position request timer (seconds)	10

3) TORA (Temporally-Ordered Routing Algorithm)

It is a distributed, loop-free algorithm based on the link reversal. This protocol performs four major functions that are creating, maintaining, erasing, and optimizing the routes. TORA has the main feature of propagation of control messages only around the point of failure when a link failure occurs.

Attributes	Values
Router ID	Auto Assigned
Mode of Operation	On-Demand
OPT Transmit Interval(seconds)	300
IP Packet Discard Timeout(seconds)	10

B. Parameters to evaluate

In this research following parameters are being calculated and evaluated for the MANETs:

Packet Delivery Ratio – It is the number of packets that are successfully received by the receiver. It can be calculated using the below formula:

PDR = (Number of packets received)/(Number of packets sent)

Throughput- it is calculated by the data that s successfully routed to the destination in a particular time period.

Packet Drop rate – It is measured as the number of packets that are sent but not received by the destination.

Dp = Number of sent packets – Number of received packets

Overhead- Extra traffic sent on the network along with data traffic is considered as overhead.

End-to-end delay- Total delay of receiving the packet after it is forwarded from the destination.

Energy consumption – It is related to the control messages flooded between the nodes during the transmission.

IV. RESULTS

A. New Hybrid protocols

For the current research, we selected the two-hybrid protocols namely TORA and GRP. These

Configuration of the network

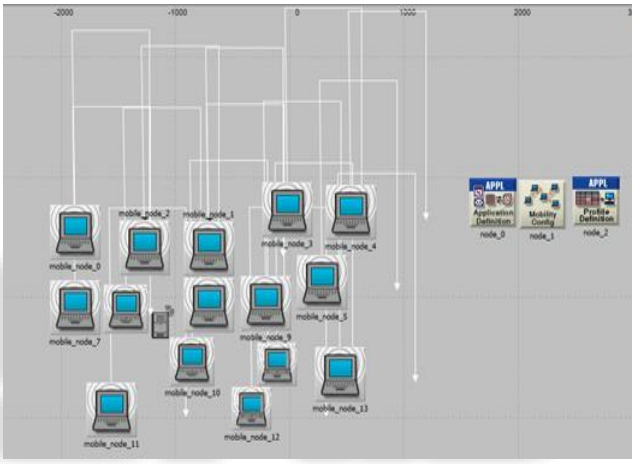

Fig. 3: Network Simulation Parameters

Parameter	Value
Area Size	3000 * 3000m
Nodes	15
MAC Protocol	IEEE 802.11
Traffic Type	Database, FTP, HTTP, Voice, Email, Video Streaming
Pause Time	3,6,9,12,15,18,21
Topology	Random Way Point
Simulation Time	10 minutes
Node movement	Random

B. Hybrid - GRP, and TORA

The Hybrid protocols GRP and TORA showed efficient and improved performance in MANET networks as compared to the DSR protocol. So, this research further presents the result of combining both these protocols in a single network. For this, we simulated a network in OPNET with two types of mobile nodes. One type of mobile nodes that use GRP protocol to communicate and other used TORA for same. The performance of the network is measured in terms of various parameters including delay, throughput, energy consumption, overhead, etc.

V. RESULTS

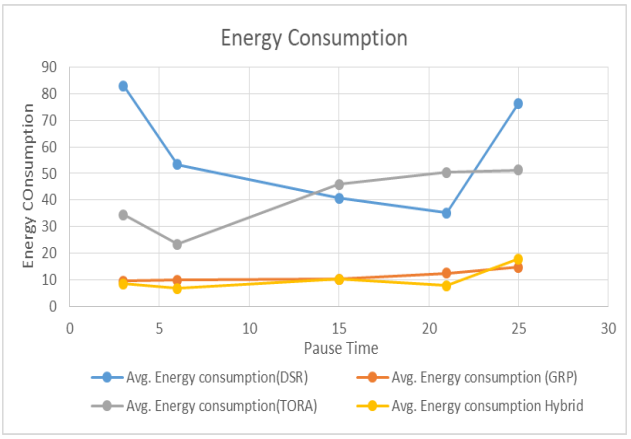

Fig. 3: Average energy consumption of each routing protocols

The hybrid model has shown minimum values of the energy consumption when plotted over pause time vs. energy consumption graph as compared to the use of DSR, TORA and GRP alone.

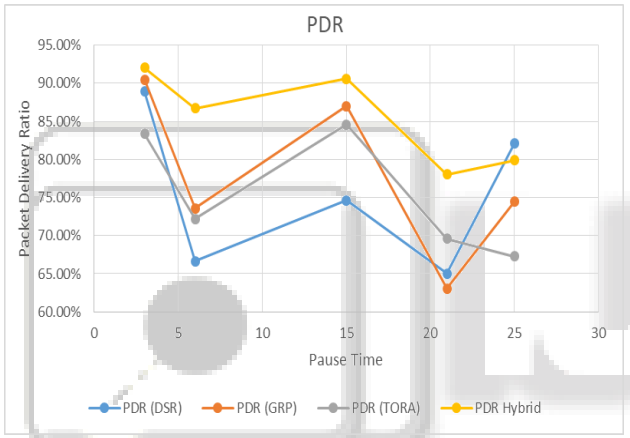

Fig. 4: Packet delivery ratio of each routing protocols

The packet delivery ratio for the Hybrid approach is higher than GRP followed by DSR and TORA.

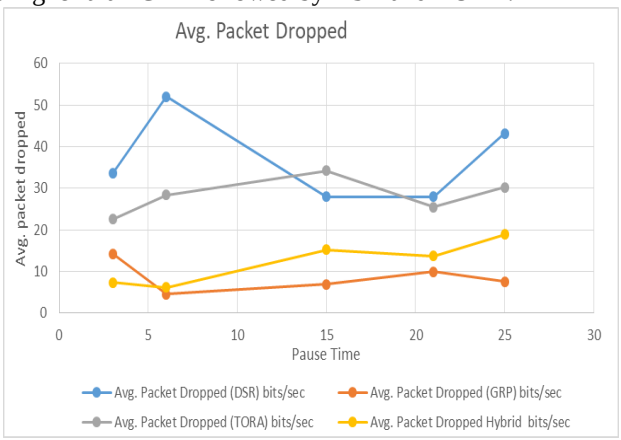

Fig. 5: Average packet dropped of each routing protocols

The value of average packet dropped was maximum for DSR while the minimum for GRP. The hybrid approach stands a little above the GRP after the initial pause time of value 6.

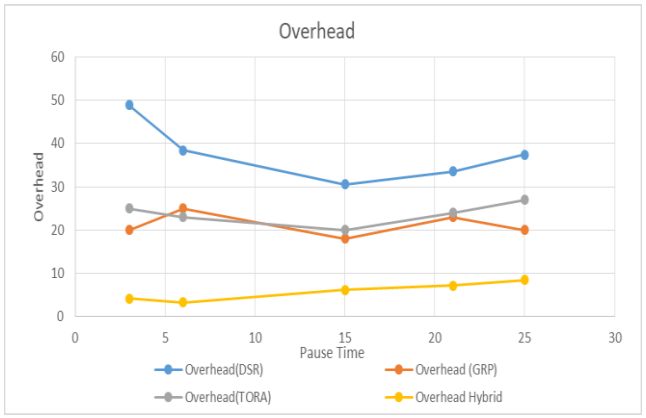

Fig. 6: Overhead value of each routing protocols

Overhead value for the pause time vs. overhead graph was observed to be minimum for a hybrid approach.

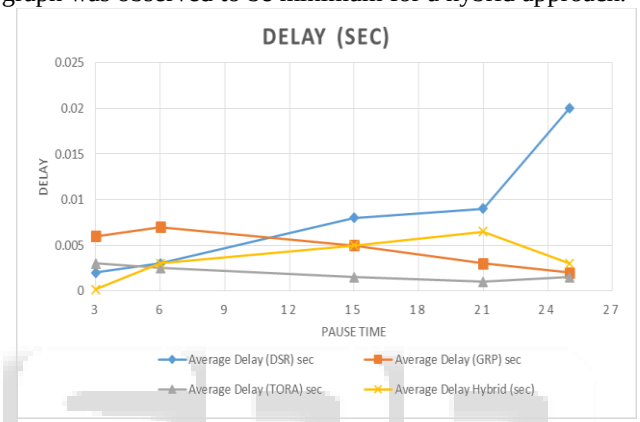

Fig. 7: Delay value of each routing protocols

The value of average delay in the hybrid model is the minimum for the pause time under 6 while it increases till 21 and drops again. It is not lowest but still satisfactory as compared to GRP, TORA, and DSR.

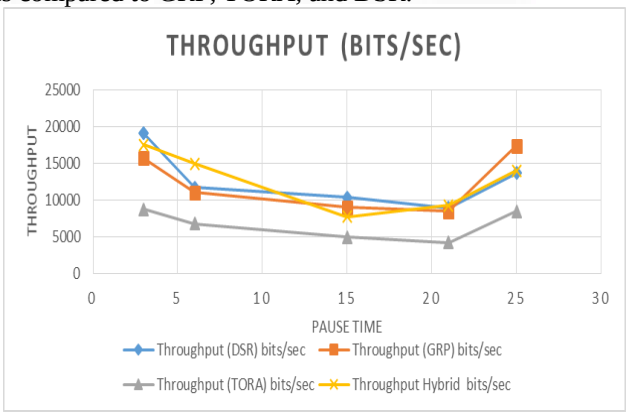

Fig. 8: Throughput of each routing protocols

The throughput for the hybrid model is discovered to be higher than that of TORA and GRP while it was lesser than that of DSR in certain areas of initial, middle and final stages.

The results show that the combination of TORA and GRP results in improved performance of the overall network. The new hybrid protocol results in the increased performance in all aspects including increased packet delivery ratio and decreased delay, energy consumption, packet dropped, and overhead.

VI. CONCLUSION

We reviewed the MANET and various routing protocols. Many methods have been proposed till now to improve the packet delivery rate and transmission delay. The research was done by the use of two major protocols GRP and TORA which were identified to be reducing the performance of the DSR and the overall performance of the network. The hybrid model has shown 0 seconds value in delay during initial stages while at the end the value was found to be 0.003 seconds which is much lower than the current techniques. Also, the value of throughput at the final stage was found to be 14061 (bits/sec) at 25 seconds for a hybrid model, while TORA showed 8475 (bits/sec) and GRP had 17390 (bits/sec). The energy consumption of hybrid protocol achieved is 17.87% whereas it was about 76.35% using DSR. The overhead achieved is too less in the new hybrid protocol (8.5 bits/sec) as compared with other protocols (37.452 for DSR, 20 for GRP, and 27 for TORA). The PDR ratio achieved by the new hybrid protocol is 79.88% that is higher than individual GRP (74.44%) and TORA (67.31%) but less than PDR achieved by DSR protocol (82.06%).

The average packet dropped ratio in the new proposed model is 18.87% that is highly improved as compared to DSR which has packet drop ratio of 43.147%. The model proposed may lack in final throughput and PDR but overall the performance was much better than DSR, GRP or TORA individually. It is apparent from the positive results attained from these techniques. The loss of information can be avoided, and the performance of the system is improved by working with the parameters which have a significant role in the enhancement of QoS or quality of service of the MANET.

REFERENCES

[1] Mandhare and R. C. Thool, "Improving QoS of Mobile Ad-hoc Network using Cache Update Scheme in Dynamic Source Routing Protocol, 7th International Conference on Communication, Computing and Virtualization, Vol.2, pp. 692-699, 2016.
[2] G. Kaur and V. Bhatia, "A Review of Reactive Algorithms Deployed for Mobile Ad-Hoc Wireless Network," International Journal of RIEECE, IETF Internet Draft, Vol.3, ISSN: 1694-2310, pp.275-279, 2016.
[3] Joshi, A. Agrawal, and A. K. Jaiswal and R. Paulus, "TD-DEEDV: A Technique to prevent collaborative e-attacks using Clustering and Digital Signature in Multi-Hop Hybrid Ad-hoc Networks," International Journal of Advanced Research in Computer Engineering & Technology (IJARCET), Vol.5, ISSN: 2278-1323, pp.2306-2311, 2016.
[4] Kodole and P. M. Agarkar, "A Survey of Routing Protocols in Mobile Ad Hoc Networks Multidisciplinary." Journal of Research in Engineering and Technology, vol.2, ISSN: 2348-6953, pp. 336-341, 2015.
[5] Jayalakshmi and T. Razak, "A Study on Issues and Challenges in Mobile Ad Hoc Networks," International Journal of Innovative Research in Computer and Communication Engineering, vol. 3, no. 9, pp. 7939-7944, 2015.
[6] K. Natarajan and G. Mahadevan, "A Comparative Analysis and Performance Evaluation Of TCP Over Manet Routing Protocols," Journal of Wireless Network and Microsystems, Vol.4, ISSN: 2321-9637, pp. 9-20, 2015.
[7] L. Raja and S.S. Baboo, "Applications, Attacks, and Challenges," International Journal of Computer Science and Mobile Computing," Vol.3, ISSN: 2320–088X, pp. 408-417, 2014.
[8] K. Rani and P.S. Kadyan, "Caching the Performance of Dynamic Source Routing Protocol for Mobile Ad Hoc Network," International Journal of Advanced Research in Computer Science and Software Engineering, Vol.4, ISSN: 2277 128X, pp.768-770, 2014.
[9] S. K. Patel Deptt., R. K. Gupta, A. P. Singh. "A Comparative Analysis and Performance Evaluation of TCP over various MANET Routing Protocols." International Journal of Innovations & Advancement in Computer Science, Volume 3, Issue 9 November 2014.
[10] Mandhare and R. C. Thool. "Improving Performance in Mobile Ad-hoc Network Using Data Caching Schemes." Int. J. Computer Technology & Applications, Volume 5, Issue 5, 2014.
[11] Prabha, S. Kumar, and R. Khanna, "Wireless Multi-hop Ad-hoc Networks: A Review," IOSR Journal of Computer Engineering, vol. 16, no. 2, pp. 54-62, 2014.
[12] J. Singh and N. Dhiman, "A Review Paper on Introduction to Mobile Ad Hoc Networks," International Journal of Latest Trends in Engineering and Technology, Vol.2, ISSN: 2278-621X, pp. 143-149, 2013.
[13] G. Taral and P. R. Deshmukh, "Overcoming Cache Staleness Issue Using Dynamic Source Routing Protocol," International Journal Of Engineering And Computer Science, Vol.2, ISSN:2348-6953, pp. 3548-3555, 2013.
[14] A.A.A. Radwan, T.M. Mahmoud, E.H. Houssein. "Evaluation comparison of some ad hoc networks routing protocols." Egyptian Informatics Journal, Volume 12, 20 January 2011.
[15] S. Omari and P. Sumari, "An Overview of Mobile Ad Hoc Networks for the Existing Protocols and Applications," International Journal on Applications of Graph Theory in Wireless Ad Hoc Networks And Sensor Networks, vol. 2, no. 1, pp. 87-110, 2010.
[16] P. Ghosekar, G. Katkar, and P. Ghorpade, "Mobile Ad Hoc Networking: Imperatives and Challenges," IJCA Special Issue on "Mobile Ad-hoc Networks," pp. 153-158, 2010.

