TOWARDS A PARAMETRIC ANALYSIS AND EVALUATION OF SEVEN MANET ROUTING PROTOCOLS

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Abstract
MANET is a wireless system that comprises group of mobile nodes which do not have pre-existing infrastructure in the form of communication network. Maintenance of these kinds of networks are not dependent on any special user. There are many problems in the creation of MANETs. such as routing in wireless media, power consumption, transportability and efficiency. Here we have concentrated mainly on the importance of efficiency related considerations. For example in the field of military, industrial, vehicular control and monitoring applications some crucial efficiency parameters should be considered which involves packet delivery, routing overhead and shortest available path. Simulation was carried out using network simulation tool ns-2 to evaluate the efficiency of the seven MANET routing protocols (DSR, AODV, DSDV, TORA, FSR, CBRP and CGSR). By these detailed simulation results and analysis an engineering methodology could be constructed depending on requirements, restrictions and availabilities.
Index Terms: **AODV, CBRP, CGSR, DSDV,,DSR, FSR, MANET, ns-2,TORA,**

I. INTRODUCTION

Mobile Ad Hoc Networks (MANETs) is a kind of distributed network systems where in mobile nodes in the network will act as clients and servers. The mobile nodes can vary dynamically and freely self-organize into temporary and arbitrary ad- hoc network topologies. In MANET, the nodes are mobile and have the freedom to join or leave the network at any time. Efficiency in MANETs is very important from both military and commercial views, here packet delivery and data communications are required [1]. It allows people and devices to share the resources seamlessly with no pre-existing communication base station [2]. A simulation was carried out to evaluate the efficiency of the seven MANET routing protocols (DSR, AODV, DSDV, TORA, FSR, CBRP and CGSR) using NS2 [3]. The following sections deals with an overview of MANET routing protocols, simulation environment, parameters considered in this work, comparison of various routing protocols in terms of efficiency and finally end with results & conclusion.

II. LITERATURE REVIEW AND RELATED WORK

In the performance evaluation of protocols for an ad hoc network, the protocols should be tested under realistic conditions. This paper is a research in which mobile ad hoc networks are described and some routing protocols are explained. During simulation, different results were given by changing the selected parameters. Firstly we have a technical look at these types of protocols and their specifications [5].

MANET routing protocols are classified into two types such as table- driven and on-demand

[6]. The table-driven, method is being used for alternate updating links and also it can use both the distance vectors and link statuses as used in the fixed networks. In the case of on- demand method other nodes do not update the route and the routes are determined at the origin of the request. The main advantage of using this method is that bandwidth is being used effectively. In this paper, the various types of MANET routing protocols are explained and then compared with different parameters [7].

A. On-demand protocols

In this type of protocols all updated routes are not maintained in each node, instead, routes are constructed only when it is necessary. When a source node wants to send something to a destination, it makes a request to the destination node for employing the route detection mechanisms. Hence, this type of protocol is known as a reactive protocol. This route remains valid until the destination node is accessible. The following section explains some of the on-demand routing protocols [8].

• AODV (Ad-Hoc On -demand Distance Vector Routing Protocol)

This protocol is being regarded as the improvement of DSDV algorithm. It maintain that it is a pure distributed on- demand routing algorithm that builds routes only when desired and minimizes routing table information. It uses a set of sequence numbers to ensure the novelty of routes. To find a path to a destination node. AODV broadcasts a route request packet. Route selection is maintained by a distributed grouping mechanism, which divides the mobile nodes logically into different groups to reduce and distribute routing traffic over the network [9].

• DSR (Dynamic Source Routing Protocol)

DSR is a simple and an efficient routing protocol designed specifically for use in multi-hop wireless ad hoc networks. This protocol allows the network to be completely self-configuring and self-organizing, without the need for any existing network infrastructure. DSR uses a concept called source routing method in which the source node identifies the complete sequence of nodes through which the data packets will be sent [10].

• TORA Protocol (Temporally-Ordered Routing Algorithm)

The main function of this protocol is the centralization of control messages in a very small set of near local nodes. To achieve this mechanism, nodes maintain routing information for the adjacent nodes for some interval. Generally TORA perform three operations such as route formation, route renovation and route cleaning [11].

• CBRP (Cluster based Routing Protocols)

In these protocols, clusters are formed by dividing the whole network into self-managed groups of nodes. To form these clusters, the following algorithm is used. When a node enters the network, it enters an indefinite state then adjusts a timer and distributes a Hello message for all other nodes. When a cluster head receives this message, it replies with the same message immediately. When the unknown node receives this message, it changes its state to member. If the indefinite node does not receive a reply after the defined time, it introduces itself as a cluster head in the case that it has a two-sided conductive linkage with a node or nodes that are its neighbors. Otherwise, it will remain in the indefinite state and repeats the same procedure [12].

B. Table-driven protocols

These protocols have their ability to maintain routing tables that store information regarding the routes from one node in the network to the rest of other nodes. Here, all nodes update their tables to preserve compatibility by exchanging routing information between the participating nodes. When the topology of the network changes, the nodes distribute update messages across the network [6]. This protocols may be easy to implement, but the major limitation is that, due to the inherently highly mobile and dynamic nature of ad-hoc networks, the maintenance of routing information in these tables is challenging. The following sections explain some of these routing protocols [8].

• DSDV (Destination-Sequenced Distance –Vector Routing Protocol)

DSDV is based on the Bellman-Ford classical routing mechanism [8]. Here each mobile node maintains a routing table that includes all accessible destinations, the number of hops necessary for reaching that destination and the sequence of the digits appropriate to that destination. Routing table entries are tagged with sequence of digits which are originated by the destination nodes [14]. This sequence of digits is used to distinguish new routes from old routes and also to determine the creation of a ring. Route updates are transmitted either periodically or immediately after a significant topology change is being detected. DSDV protocol generates a supplementary traffic that adds to the real data traffic[15].

- CGSR Protocol (Cluster head Gateway Switch Routing Protocol)

This protocol is based on the DSDV routing algorithm [16]. Mobile nodes are collected inside packets, and a cluster head is selected. A gateway node is a node in a communication interval between two or more cluster heads. CGSR protocol uses a distributed algorithm which is stable since the cluster heads will change only under two conditions: when two cluster heads come within the range of each other or when a node gets disconnected from any other cluster .In this state, the origin sends the packet to its cluster head; the cluster head sends this packet to the gateway node to which it and the node which is located in the route of destination are connected. The gateway sends the packet to another cluster head and the packet to another cluster head and this action continues until the cluster head receives the destination node of packet. Finally, the destination cluster head sends the packet to the destination node [8].

- FSR Protocol (Fisheye State Routing)

FSR protocol is based on the ‘‘fisheye’’ technique of graphic information compression where the technique was used to reduce the size of information required to represent graphical data [17]. In an FSR, an updating message does not include information about all of the nodes. Instead, it exchanges information with the adjacent nodes with a higher frequency more than it does with farther nodes, leading to a decrease in the size of the updating message. Thus, each node has accurate information about its neighbors, and the details and accuracy of the information decrease when the distance between two nodes increases.

III. SIMULATION MODEL AND METHODOLOGY

The simulation was performed using NS2 simulator with two values: a maximum speed of 20 m/s (average speed of 10 m/s) and 1 m/s. At first, seven protocols - DSR, AODV, DSDV, TORA, FSR, CBRP and CGSR – have been simulated with a maximum node speed of 20 m/s, followed by a simulation with a maximum node speed of 1 m/s. The basic model parameters that have been used in the simulation given details in this section are summarized in Table 1.

A. Mobility Model

In the simulation, nodes move on the basis of the Random Waypoint model [13], so that movement scenarios include a stop time specification. A node moves toward a randomly selected destination in area of 1500×300 sq meters with unsteady speed between zero and its maximum speed.

TABLE I. SIMULATION MODEL PARAMETERS AND ITS VALUE

SIMULATOR	Network Simulator 2
NUMBER OF NODES	50
AREA	1500m x 300m
COMMUNICATION RANGE	250m
INTERFACE TYPE	Phy/Wireless Phy
MAC TYPE	IEEE 802.11
QUEUE TYPE	Droptail /Priority Queue
QUEUE LENGTH	50 Packets
ANTENNA TYPE	Omni Antenna
PROPAGATION TYPE	Two Ray Ground
ROUTING PROTOCOL	DSR,AODV,DSDV,TORA,FSR, CBRP and CGSR
MOBILITY MODEL	Random Way Point
TRANSPORT AGENT	UDP
APPLICATION AGENT	CBR
PACKET SIZE	1024 bytes
NODE SPEED	20 & 1m/s
NUMBER OF	5

ORIGIN	
STOP TIME	0,30,60
BANDWIDTH	2 Mbps
SIMULATION TIME	50 seconds

Once the node reaches the destination, it stops for a portion of its stop time (per second) and then selects another destination. This behavior persists throughout the simulation. Each simulation is implemented for 60 s, and the stop times considered in this simulation were 0, 30, and 60 seconds; a 0 second stop time represents a continuous movement while a 60 second stop time represents a static network. Because the efficiency of protocols is dependent upon the nodes' movement model, 42 different movement models have been considered for nodes so that for each stop time, 10 different implementations are performed, and two different values have been considered for the maximum node speed. In the following sections, the simulation results with maximum speeds of 20 m/s and along with results obtained from simulations with a maximum speed of 1 m/s, are shown.

B. Communication Model

For implementing the simulations, the following parameters have been considered: traffic origins with a constant bit rate (CBR); the sending rate equal to 1, 4 and 8 packets per second; the number of origins equal to 10, 20 or 30; and packet sizes of 64 and 1024 bytes. Changing the number of CBR origins is similar to changing the sending rate, and therefore, in these simulations, a constant sending rate of four packets per second has been considered, and three different models have been created with a change in the number of CBR origins. The number of origins considered here is 5.

C. Work Methodology

The final aim of this simulation is to measure how the efficiency of routing protocols is affected by topological changes of the network as long as the packets are successfully sent to their destinations. To measure this ability, a basic simulation has been considered that is compared to results obtained from other simulations. In the basic simulation, 50 moving nodes have been placed in a simulation environment of 1500×300 sq meters over 60 seconds of implementation.

D. Movement Model Specification

To show the difference between how the models performed on routing protocols, the length of the route of each protocol has been measured for the delivery of packets and the total number of topological changes in each scenario. When each packet is produced, an intermediate mechanism calculates the shortest path between the packet sender and the receiver and places it inside the packet. This value is compared with the number of real hops that the packet has made in reaching the destination.

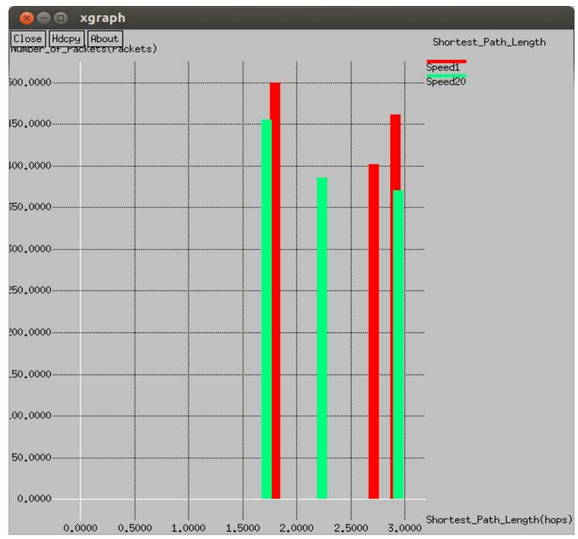

Fig 1. Shortest path length

Fig.1. shows the distribution of the shortest paths for all 42 scenarios for node speeds of 1 and 20 m/s. The height of each rod shows the number of packets for each destination, each of which has a definite distance at the time of packet production. With the increase of speed from 1m/s to 20 m/s the simulation shows the number of delivered packets are reduced.

E. Measurement Criteria

In comparing the routing protocols, three parameters and the following criteria are assessed:

- Rate of packet delivery: ratio of the number of packets produced by origin nodes in the application layer to the number of packets received by the final destination.
- Routing overhead: total number of routing packets sent throughout the simulation
- Route optimum: difference between the

numbers of hops made to reach the destination and length of the estimated shortest path at the time of packet production.

IV. PARAMETRIC ANALYSIS & COMPARISONS

To perform a better comparison of the seven protocols examined in the second section - DSR, AODV, DSDV, TORA, FSR, CBRP and CGSR - the following sections compare them in terms of rate of packet delivery, routing overhead, path optimality and movement speed of nodes.

A. Protocols comparison based on packets delivery ratio

In this comparison of protocols based on the rate of packet delivery, it is been observed that the amount of deliverable packets each protocol had, based on movement (stop time function) and network load (amount of origin nodes) . For CGSR, CBRP, FSR, AODV, and DSR, the rate of packet delivery is independent of traffic load and is between 95% and 100% for all modes. As mentioned in previous sections, DSDV holds just one path for each destination, therefore, when the route is destroyed, packets are not deliverable and so they are eliminated [18].

B. Protocols comparison based on routing overhead

This comparison is evaluated by the number of packets sent by each routing protocol to obtain the rate of delivery. It is expected that when increasing the number of origins, the number of packages in the routing protocols needs to increase because many paths must be kept. DSR, AODV and CBRP use only on-demand packets and are very similar to basic mechanisms; therefore, the curve is shaped very similarly to the curve of the basic mechanisms. However, the overhead of AODV is approximately 5 times that of DSR. This increase in overhead of AODV is due to broadcasting of packets to all nodes in a special network by each path discovery [3].The overhead of FSR is less than DSR and more than AODV, so it indicates the similarity of these two protocols which belong to different groups. The overhead of TORA is the sum of two overheads: independent to mobility (stable) and dependent on mobility (variable).

The stable overhead arises from the IMEP neighbor discovery mechanism for which it is required that each node sends at least one hello message in the range of conducting waves. By simulating this in 900 second with 50 nodes, this matter adds at least 45000 packets to the overhead. The variable section of the overhead includes TORA routing packets used in path discovery and maintenance produced by multiplying the number of resends and acknowledge packets together.

Apart from mobility or traffic rate, DSDV in this simulation has an almost constant overhead [19]. This constant behavior is due to broadcasting update packets every 15 seconds along with new sequence number by each destination node like as D. Therefore, in this simulation, at least one node among these 50 uncoordinated nodes commits this. Thus, according to the manner of performing this work which has been explained in previous section, the overhead of this protocol in a 900 second simulation using 50 nodes is about 45000 packets.

C. Protocols comparison based on path optimality

As described in the previous sections, a middle mechanism in the simulation calculated the shortest path between nodes and placed the information in all produced packets. Fig.2 shows the difference between the shortest path length and actual journey taken by the packet. A difference of zero means that the packet took the shortest path, whereas a difference greater than zero indicates the number of additional hops taken in the real path.

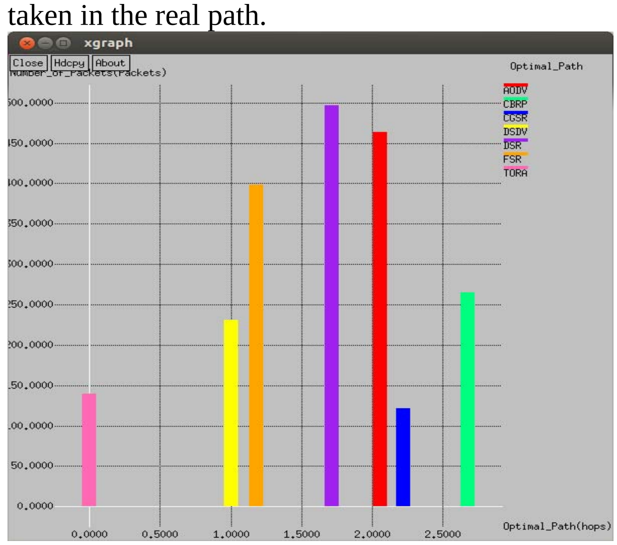

Fig.2. .Difference between actual path length and the shortest path

DSDV, DSR and CBRP use a path close to the optimum path. TORA, AODV, FSR and CGSR use a path for some packets which is longer than the optimum path by around four HOPs or more, although TORA has not been designed based on finding the shortest path [20]. For more clarity, Fig. 2 indicates data congestion in all stop times using one graph.

D. *Protocols comparison based on movement speed of nodes*

To determine how much the rate of topological change has an effect on efficiency of the protocols, the speed of nodes was decreased from 20 m/s to 1 m/s, and the scenarios are evaluated for the seven protocols. Figures 3 and 4 show the results of this simulation using 20 origin nodes.

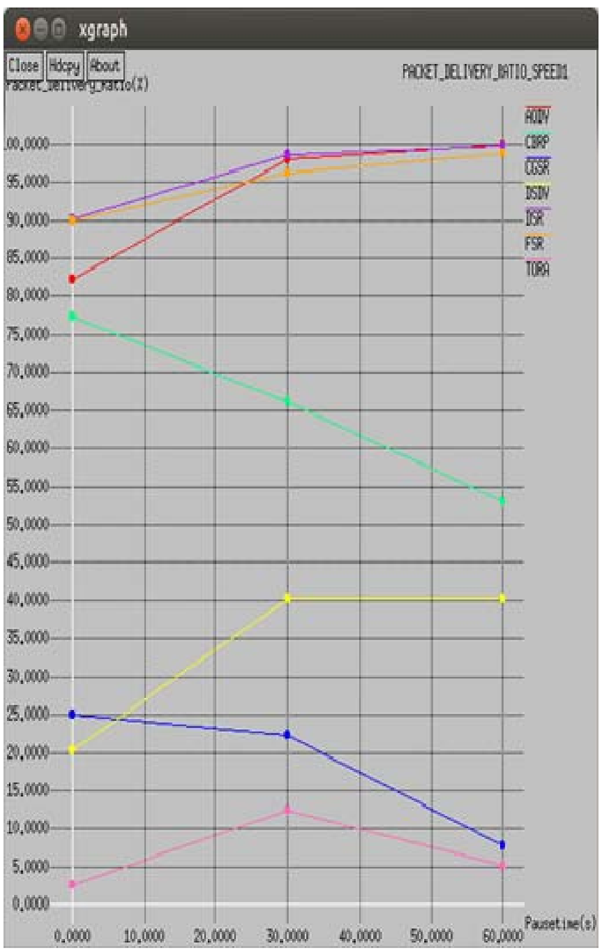

Fig.3. Packet Delivery Ratio for speed 1(m/s)

All protocols deliver more than 95.5% of packets in this case. In contrast to the scenario with a speed of 20 m/s, in which DSR could not approach such values, the efficiency of DSR in this simulation is high. Moreover, at a low rate of movement, each of the protocols shows a considerable difference for the routing parasite .Neither DSR nor AODV has shown a significant difference in these scenarios, and an increase in the routing parasite depends only on a decrease in the stop time

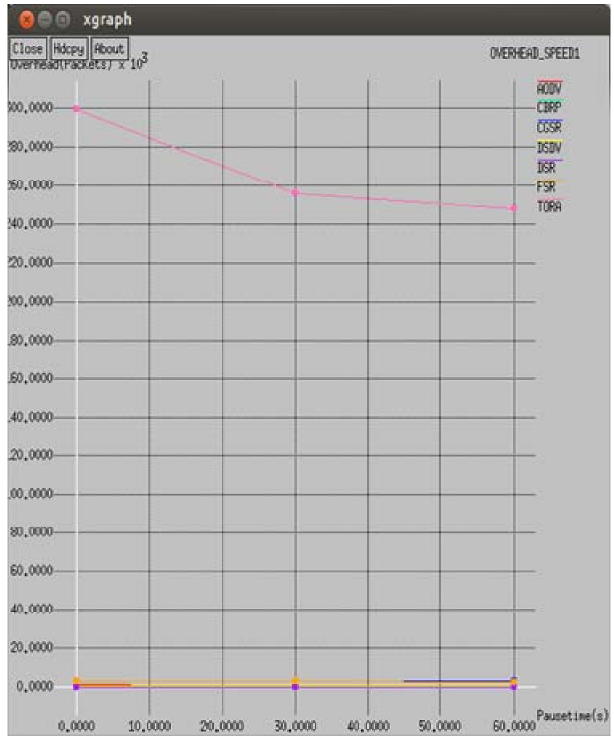

Fig 4. Overhead for speed 1(m/s)

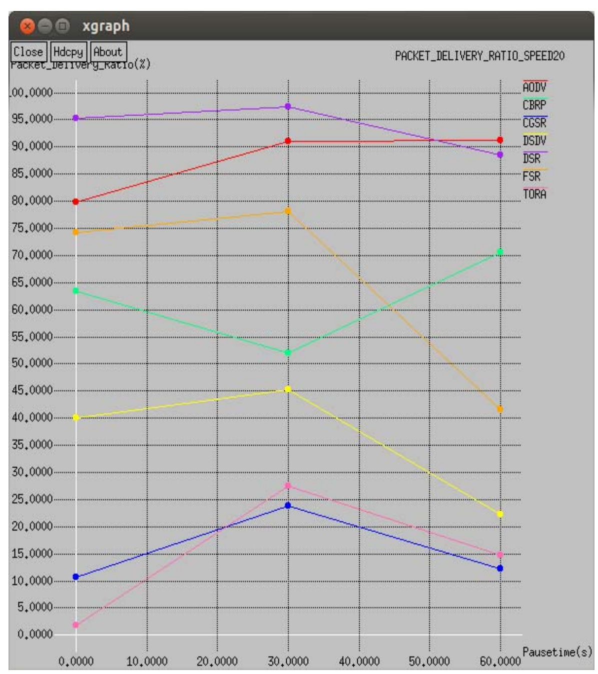

Fig.5. Packet Delivery Ratio for speed 20(m/s)

Figure 5 and 6 show the efficiency of the seven routing protocols with a maximum speed of 20 m/s. All protocols deliver a high percentage of packets produced when the movement of nodes is low (for example with a high stop time) and the value reaches 100% when the movement of nodes reaches zero.

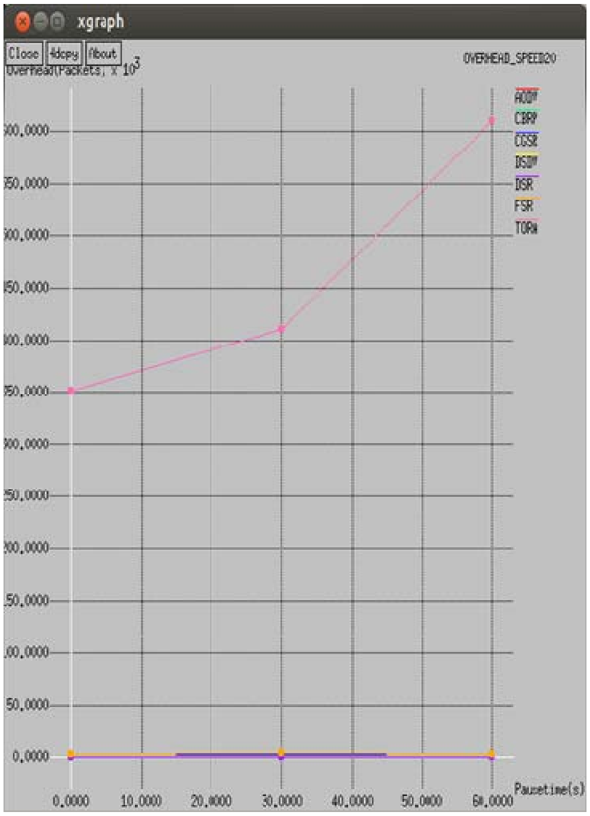

Fig.6. Overhead for speed 20(m/s)

V. RESULTS ANALYSIS AND DISCUSSION

From our experimental results we can summarize our final conclusion as follows: A comparison has been made between the protocols on the basis of their efficiency, and these comparisons have been performed in different states. In order to show a general result, a simulation has been performed with a traffic load of 5 origins and a maximum speed of 20 m/s. All protocols delivered a high percentage of the produced packets when the movement of nodes was low, for example, with the increase of speed from 1m/s to 20 m/s the number of delivered packets are reduced. But its value reaches 100% when the movement of nodes reaches zero. The DSR, AODV, FSR, CBRP and CGSR protocols deliver more than 95% of the packets for each rate of movement.

The seven routing protocols have different values for the routing parasite. Generally, one can say that DSR has the lowest parasite while TORA has the highest parasite. TORA, DSR, CBRP and AODV are on-demand protocols, and their parasite changes with changes in the movement rate. However, the table-driven protocols, DSDV, FSR and CGSR, are not highly dependent on the rate of movement and show constant behavior. With variation of pause time the overhead is increased in the TORA routing protocol when compared to other routing protocols.

VI. CONCLUSION

In this research work we have studied about MANETs, and discussed some of the most important routing protocols. After having performed these extensive simulations using ns-2, a few conclusion can be drawn from the evaluation of these seven routing protocols. Different results were given by changing the selected parameters. Based on these results, the DSR and AODV protocols have shown better performance than any other protocols. And also it is found that TORA has had the worst result and DSDV has fixed behavior in all scenarios due to its table driven specification. From the detailed simulation results and analysis, a suitable routing protocols can be chosen for a specified network and goal.

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