Comparison Study of Routing Protocol by Varying Mobility and Traffic (CBR, VBR and TCP) Using Random Walk & Random Way Point Models

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Abstract— **Mobile ad hoc networks (MANETs) are one of the fastest growing areas of research. They are an attractive technology for many applications, such as rescue and tactical operations, due to the flexibility provided by their dynamic infrastructure. In the current study we have compared the performance of three MANET protocols AODV as reactive, OLSR and TORA as proactive using random walk model and random way point models.These share some similar behavior, but the protocols internal mechanism leads to significant performance difference. We have analyzed the performance of protocols by varying network mobility and type of traffic (CBR, VBR and TCP). A detailed simulation has been carried out in OPNET. The metrics used for performance analysis are Throughput, Network load. Random Way Point mobility model for most of the MANET routing protocols give better performance than Random Walk Mobility Model.**

Keywords— **MANET, AODV, OLSR, TORA, CBR, VBR, Random Walk Mobility Model, Random Way Point Mobility Model Performance Metrics.**

I. INTRODUCTION

Mobile Ad-hoc Network (MANET) is formed by some wireless nodes communicating each other without having any central coordinator to control their function. Such a network is helpful in creating communication between nodes that may not be in line-of-sight and outside wireless transmission range of each other. Similar wireless networks have important applications in a wide range of areas covering from health, environmental control to military systems. In MANET, as the Some MANETs [1] are restricted to a local area of wireless devices (such as a group of laptop computers), while others may be connected to the Internet. For example, A VANET (Vehicular Ad Hoc Network), is a type of MANET that allows vehicles to communicate with roadside equipment. While the vehicles may not have a direct Internet connection, the wireless roadside equipment may be connected to the Internet, allowing data from the vehicles to be sent over the Internet. The vehicle data may be used to measure traffic conditions or keep track of trucking fleets. Because of the dynamic nature of MANETs, they are typically not very secure, so it is important to be cautious what data is sent over a MANET.

Fig. 1 MANET

II. MANET ROUTING PROTOCOLS

Routing protocols [2] between any pair of nodes within an ad hoc network can be difficult because the nodes can move randomly and can also join or leave the network. This means that an optimal route at a certain time may not work seconds later. Discussed below are three categories that existing ad-hoc network routing protocols fall into:

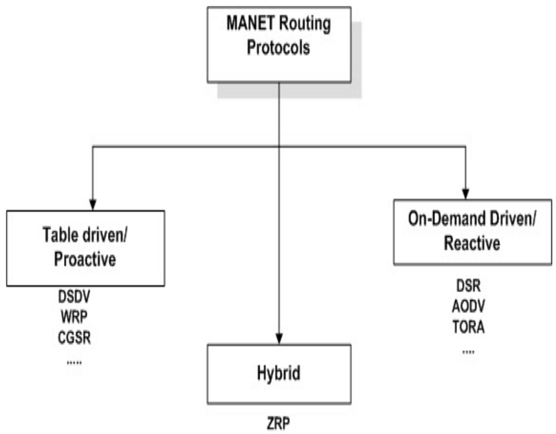

Fig. 2 Classification of MANET Routing Protocols

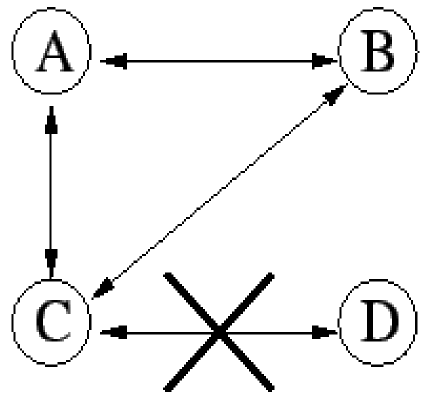

Fig. 3 AODV routing mechanism

A. Ad-Hoc on Demand Distance Vector(AODV)

Reactive protocols seek to set up routes on-demand. If a node wants to initiate communication with a node to which it has no route, the routing protocol will try to establish such a route. The philosophy in AODV[2], like all reactive protocols, is that topology information is only transmitted by nodes on-demand. When a node wishes to transmit traffic to a host to which it has no route, it will generate a route request(RREQ) message that will be flooded in a limited way to other nodes. This causes control traffic overhead to be dynamic and it will result in an initial delay when initiating such communication. A route is considered found when the RREQ message reaches either the destination itself, or an intermediate node with a valid route entry for the destination. For as long as a route exists between two endpoints, AODV remains passive. When the route becomes invalid or lost, AODV will again issue a request.

AODV avoids the ``*counting to infinity*'' problem from the classical distance vector algorithm by using sequence numbers for every route. The counting to infinity problem is the situation where nodes update each other in a loop. Consider nodes A, B, C and D making up a MANET as illustrated in figure 3. A is not updated on the fact that its route to D via C is broken. This means that A has a registered route, with a metric of 2, to D. C has registered that the link to D is down, so once node B is updated on the link breakage between C and D, it will calculate the shortest path to D to be via A using a metric of 3. C receives information that B can reach D in 3 hops and updates its metric to 4 hops. A then registers an update in hop-count for its route to D via C and updates the metric to 5. And so they continue to increment the metric in a loop.

The way this is avoided in AODV, for the example described, is by B noticing that As route to D is old based on a sequence number. B will then discard the route and C will be the node with the most recent routing information by which B will update its routing table. AODV defines three types of control messages for route maintenance:

B. Optimized Link State Routing(OLSR)

OLSR [3] is a modular proactive hop by hop routing protocol. It provides the fresh path of destination bases of table driven approach. It is an optimization of pure link state algorithm in ad hoc network. The routes are always immediately available when needed due to its proactive nature. The key concept of the protocol is the use of "multipoint relays" (MPR). Each node selects a set of its neighbour nodes as MPR. Only nodes, selected as such MPRs are responsible for generating and forwarding topology information, intended for diffusion into the entire network. The MPR nodes can be selected in the neighbour of source node. Each node in the network keeps a list of MPR nodes.

This MPR selector is obtained from HELLO packets sending between in neighbour nodes. These routes are built before any source node intends to send a message to a specified destination In order to exchange the topological information the Topology Control (TC) message is broadcasted throughout the network. Nodes in the network send HELLO messages to their neighbours. These messages are sent at a predetermined interval in OLSR to determine the link status. Here we can understand by this Fig.5.

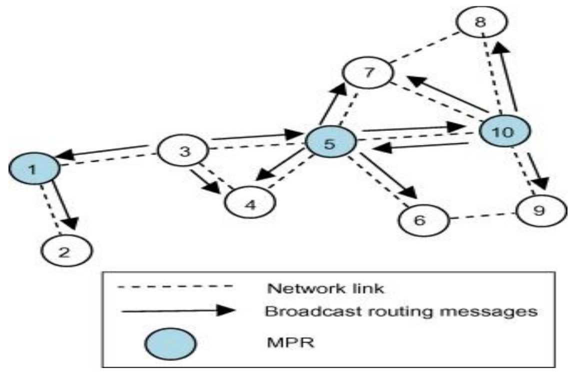

Fig.4 Multipoint Relays" (MPR) in OLSR

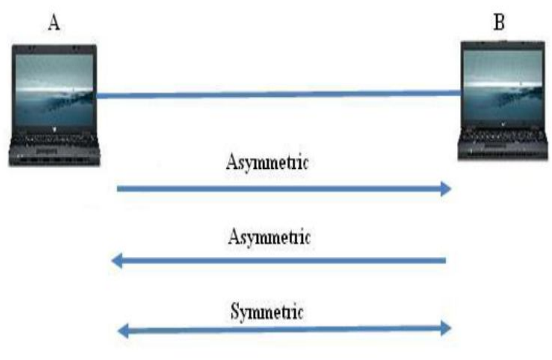

Fig. 5 HELLO Messages in MANET using OLSR

If node A and node B are neighbours, node A sends HELLO message to B node. If B node receives this message, we can say the link is asymmetric. If now B node sends the same HELLO message to A node. This is the same as first case, called asymmetric link. The HELLO messages contain all the neighbour information. This enables the mobile node to have a table in which it has information about all its multiple hop neighbours.

C. Temporally Ordered Routing Algorithm (TORA)

TORA is a routing algorithm. It is mainly used in MANETs to enhance scalability. TORA is an adaptive routing protocol. It is therefore used in multi-hop networks. A destination node and a source node are set. TORA establishes scaled routes between the source and the destination using the Directed Acyclic Graph (DAG) built in the destination node. This algorithm does not use 'shortest path' theory, it is considered secondary. TORA builds optimized routes using four messages. Its starts with a Query message followed by an Update message then clear message and finally Optimizations message. This operation is performed by each node to send various parameters between the source and destination node. The parameters include time to break the link (t), the originator id (o_{id}), Reflection indication bit (r), frequency sequence (d) and the nodes id (i). The first three parameters are called the reference level and last two are offset for the respective reference level. Links built in TORA are referred to as 'heights', and the flow is from high to low. At the beginning, the height of all the nodes is set to NULL i.e. (-,-,-,-,i) and that of the destination is set to (0,0,0,0,dest). The heights are adjusted whenever there is a change in the topology. A node that needs a route to a destination sends a query message with its route required flag. A query packet has a node id of the intended destination. When a query packet reaches a node with information about the destination node, a response known as an Update is sent on the reverse path. The update message sets the height value of the neighbouring nodes to the node sending the update. It also contains a destination field that shows the intended destination.

III. MANET MOBILITY MODELS

In MANETs, mobile nodes roam around the network area. It is hard to model the actual node mobility in a way that captures real life user mobility patterns. Mobility models are designed to evaluate the performance of ad-hoc networks and characterize the movements of real mobile node in which variation in speed and direction must occur during regular time interval. Therefore, many researchers attempted to design approximate mobility models to resemble real node movements in MANETs but we are using random walk mobility model as follows:

A. Random walk mobility model

In this mobility model mobile host moves from current location to new location by choosing randomly direction and speed from the predefined ranges between min speed and max speed. Since many entities move in unpredictable ways, the Random Walk Mobility Model was developed to mimic this erratic movement [1]. In this kind of mobility model, a mobile node randomly chooses a direction and speed to move from its current location to a new location. The speed and direction are chosen from pre-defined ranges, [minimum speed, maximum speed] and [0, 2] respectively. If a mobile node reaches a simulation boundary, it bounces off the simulation border with an angle determined by the incoming direction. The node then continues along this new path. Several varieties of the model have been developed such as the 1-D, 2-D, 3-D, and n-D walks. Because the Earth's surface is usually modelled using a 2-D representation, the 2-D Random Walk Mobility Model is of special interest. The Random Walk Mobility Model is widely used [1], and it is a memory less mobility pattern because it does not have any knowledge concerning its past locations and speed values. The current direction and speed of the node are independent of its past direction and speed [5]. This model may generate unrealistic movements such as sudden stops and sharp turns.

B. Random way point mobility model

In this model, the position of each MN is randomly chosen within a fixed area and then moves to the selected position in linear form with random speed. This movement has to stop with a certain period called pause time before starting the next movement. The pause time is determined by model initialization and its speed is uniformly distributed between [*Min Speed, Max Speed*]. The Random Waypoint Mobility Model is the most widely used mobility model. Many researchers use it to compare the performance of various mobile ad hoc network routing protocols. This model includes pause times between changes in direction and/or speed. Using the waypoint mobility model, each node starts the simulation by remaining stationary for pause-time seconds. Then, it randomly chooses a destination in the simulation area and moves towards that destination at a speed uniformly chosen between zero and maximum speed. When the node reaches the selected destination, it halts again for pause-time, selects another destination and starts to move towards the new destination. This process is repeated for the duration of the simulation. In [6], it has been shown that the average speed of a mobile node decays with time. This is because of the fact that low speed nodes spend more time to reach their destinations than high speed nodes. It is also shown that increasing the speed of nodes results in increased network connectivity.

IV. Traffics in MANET

In MANETs, several factors influences the performance of the routing protocols that are selected to use across the MANETs, and these factors include security level employed across the network, maintenance of the route, configuration of router, various types of applications supported by MANETs and different kinds of traffic that are sent throughout the network.

MANETs supports different types of traffics and the most important and frequently used traffics are TCP, VBR and CBR traffics here VBR means Variable bit rate and CBR means Constant bit rate. The traffic type selected across the routing procedure will influence the routing protocol performance. The performance of the routing protocol is also based on the nodes selected in the MANETs generally two types of nodes can be used in MANETs and they are mobile nodes and fixed nodes.

MANETs are basically dynamic in nature and so it supports a large variety of applications and the most important and most commonly used applications of MANETs are FTP, video conferencing, VOIP, Email, voice and web applications. The characteristic of the traffic sent across the MANET is decided by the selected type of application. The application selected is also used to influence the performance of the routing protocol similarly the selected traffic type also influence the performance of routing protocol that may be reactive or proactive that is used throughout the MANET. The issues related to these MANETs are discussed in many existing studies and researches which also includes the comparison of performance of routing protocols in various aspects which are done mostly among the selected routing protocols when compared to the selected kind if traffic.

V. Simulation Setup and Result Analysis

A. Simulation Setup

To simulate our Network, we used OPNET 14.5. The simulation parameters and their values are given in Table 1.

TABLE.1
NETWORK PARAMETERS

Parameter	Value
Simulator	Opnet 14.5
Area	3.5×3.5 Km
Wireless MAC	802.11
No. of Nodes	50,100
Mobility Model	Random Walk
Data Rate	11 Mbps
Routing Protocols	AODV,OLSR and TORA
Simulation Time	5 minutes
Traffics	CBR, VBR, TCP

- *Performance Metrics*: The following metrics are used in varying scenarios to evaluate the different protocols:

1) *Throughput*— Throughput or network throughput is the average rate of successful message delivery over a communication channel.
2) *End-End Delay*— the packet end-to-end delay is the time of generation of a packet by the source up to the destination reception. So this is the time that a packet takes to go across the network.

B. Result Analysis

Figures 6,7,8,9,10,11,12,13 give the comparative analysis for throughput for three different protocols viz. AODV, OLSR, TORA with two mobility models i.e. Random Way Point and Random Walk Model.

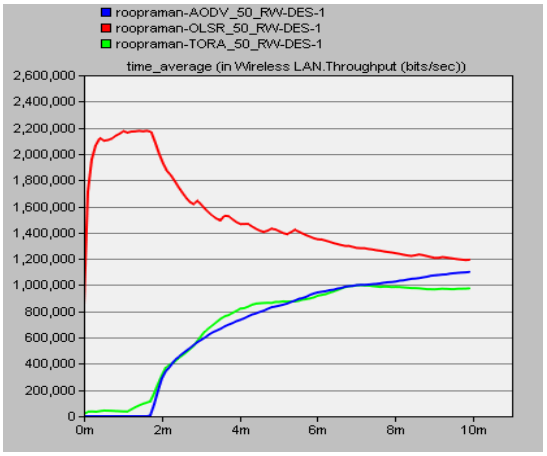

Fig.6 Throughput (50 Nodes Random Walk)

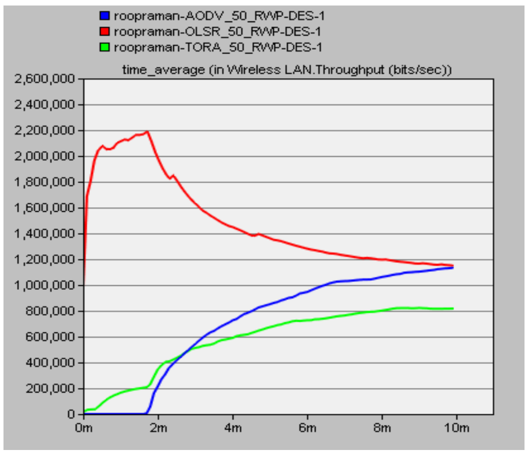

Fig.7 Throughput (50 Nodes Random Way point)

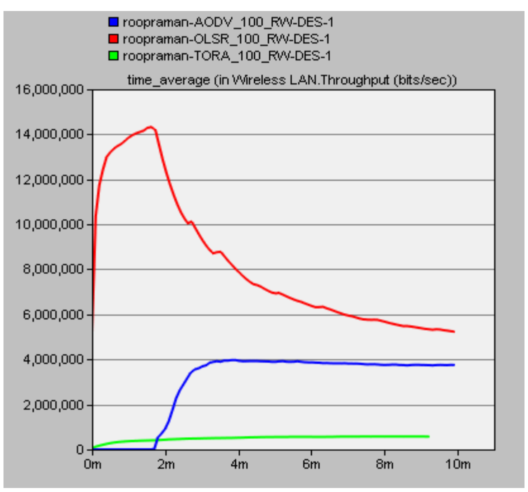

Fig.8 Throughput (100 Nodes Random Walk)

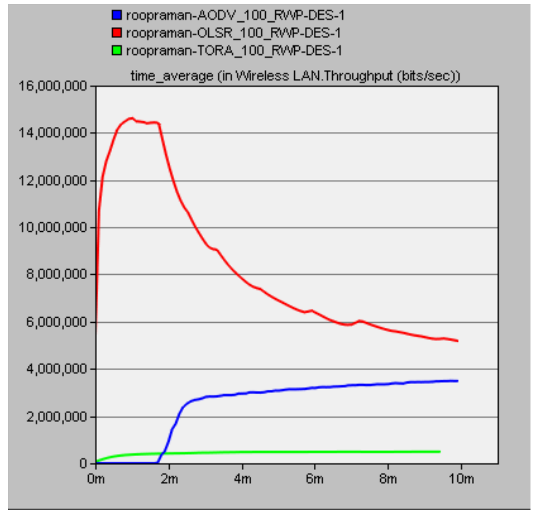

Fig.9 Throughput (100 Nodes Random Way point)

Through-put	AODV		OLSR		TORA	
	Random Walk	**Random Way Point**	**Random Walk**	**Random Way Point**	**Rando m Walk**	**Rando m Way Point**
50 Nodes	1,100,020	1,152,120	2,199,231	2,200,000	1,100,0 00	810,00 0
100 Nodes	4,000,000	4,000,050	14,223,65 2	14,754,32 6	810,23 1	721,32 6

TABLE.2
COMPARISON TABLE

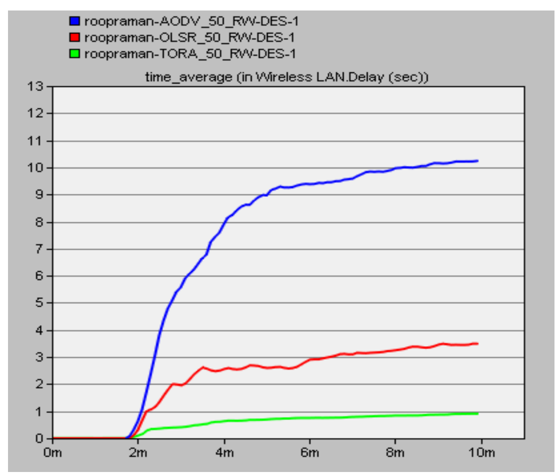

Fig.10 Delay (50 Nodes Random Walk)

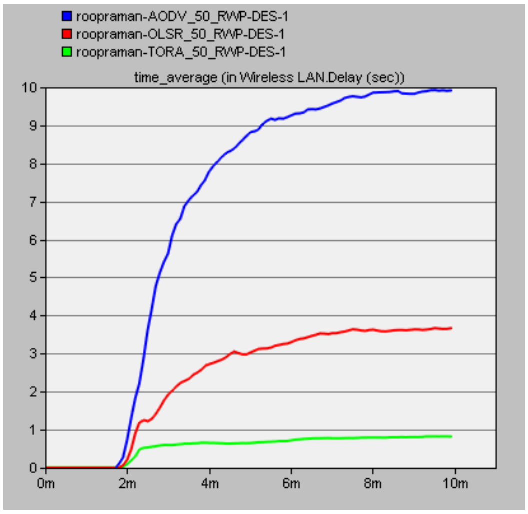

Fig.11 Delay (50 Nodes Random Way Point)

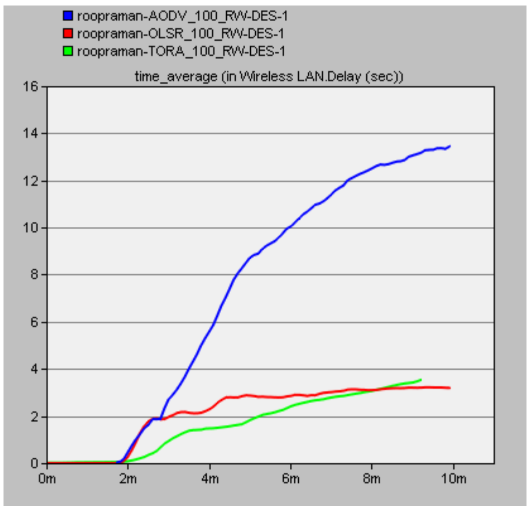

Fig.12 Delay (100 Nodes Random Walk)

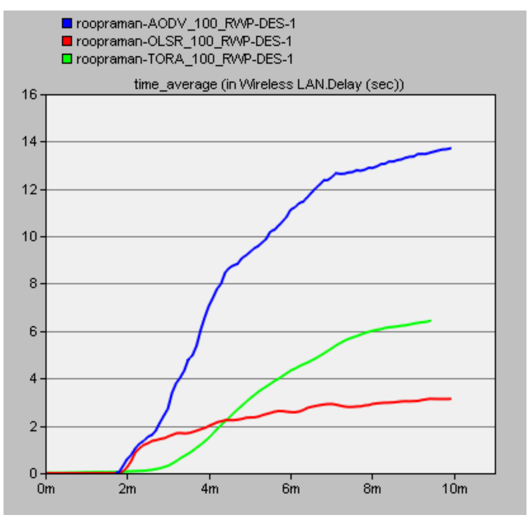

Fig.13 Delay (100 Nodes Random Way Point)

TABLE.3
COMPARISON TABLE

Delay	AODV		OLSR		TORA	
	Random Walk	**Random Way Point**	**Random Walk**	**Random Way Point**	**Random Walk**	**Random Way Point**
50 Nodes	10.2	10.01	3.57	3.79	1	0.89
100 Nodes	13.36	13.65	3.12	3.32	3.37	6.45

VI. Conclusion and Future Scope

Our research paper is mainly consists of two Mobility Models Comparison, one is Random Walk and other is Random Way Point. We compare these two models by varying mobility and Traffics using routing protocols. There are three categories of routing protocols used in mobile ad hoc networks that are reactive routing protocols, proactive routing protocols and hybrid routing protocols, all categories have their own usage, so the selection of these categories in ad-hoc networks is very important.

We have evaluated the two performance matrics i.e. End-to-end delay and Throughput with different mobility models (Random Walk model and Random Waypoint Mobility model) and TCP, CBR and VBR as traffic type while taking 50 and 100 as the node density. From the extensive simulation results, it is found that OLSR shows the best performance in terms of throughput, load. Moreover, Random Way Point Model outperforms Random Walk Model for all three routing protocols i.e. AODV, OLSR and TORA in terms of throughput, load, and delay. However, the variations in delay are higher for OLSR than rest two. Random Way Point mobility model for most of the MANET routing protocols give better performance than Random Walk Mobility Model.

In future, we will work on three other performance metrics i.e. Network load, jitter, MOS. Doing so would bring out the contrast between the two mobility models and thus help in making reaching accurate conclusions.

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