Performance Evaluation of MANET Routing Protocols with Scalability, Real time data and its effects on Qos

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Abstract: **MANET is group of mobile nodes which uses multi hop transmission for communication. Routing in MANET is challenging task, moreover presence of malicious nodes make the overall network very insecure furthermore dynamic nature of moving nodes adds to the complexity . Here, we focus on the case where the network nodes move according to the Random Walk mobility model and Random Way Point mobility model, and we derive both exact and approximate expressions of these probabilities. By obtained results, we study the problem of selecting an optimal route in terms of path availability. Finally, we propose an approach to improve the efficiency of Reactive Routing protocols. This paper focuses on performance comparison of Proactive routing protocol by focusing on Optimized Link State Routing (OLSR) and Reactive Routing Protocol by focusing on Ad Hoc On Demand Distance Vector (AODV) and Temporally Ordered Routing Algorithm (TORA). The performance of these routing protocols is analyzed by two metrics: Jitter and Mean Opinion Score (MOS). The paper presents a performance analysis of three Mobile Ad Hoc Network (MANET) routing protocols under the two mobility models i.e. Random Walk Mobility Model and Random Way Point.**

Keywords- MANET, AODV, OLSR, TORA, OPNET, Random Walk Mobility Model, Random Way Point Mobility Model.

I. INTRODUCTION

Mobile ad-hoc network (MANET) [1] is a type of ad hoc network that can change locations and configure itself on the fly. Because MANETS are mobile, they use wireless connections to connect to various networks. This can be a standard Wi-Fi connection, or another medium, such as a cellular or satellite transmission.
Some MANETs 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.

AD-HOC ROUTING PROTOCOLS

This section describes the main features of three protocols AODV (Ad hoc On-demand Distance Vector) [1] and OLSR (Optimized Link State Routing) [2],Temporally Ordered Routing Protocols Algorithm (TORA)deeply studied using OPNET 14.5.

A. AODV (Ad hoc On-demand Distance Vector)

AODV [1] provides a good compromise between proactive and reactive routing protocols. AODV uses a distributed approach which means that a source node is not required to maintain a complete sequence of intermediate nodes to reach the destination [10]. It is also an improvement from DSR by addressing the issue of high messaging overhead and large header packets in maintaining routing tables at nodes, so that packets do not have to store much routing information in the headers. AODV uses a routing table in each node and keeps one to two fresh routes. The incorporated features of AODV include features of DSDV, like the use of hop by hop routing, periodic beacon messaging and sequence numbering. A periodic beacon message is used to identify neighbouring nodes. The sequence numbering guarantees a loop free routing and fresh route to destination. AODV has the advantage of minimizing routing table size and broadcast process as routes are created on demand [9]. The two mechanisms route discovery and route maintenance of AODV are like those of DSR .AODV is an on-demand routing protocol. The AODV [9] algorithm gives an easy way to get change in the link situation. For example if a link fails notifications are sent only to the affected nodes in the network. This notification cancels all the routes through this affected node. It builds unicast routes from source to destination and that's why the network usage is least. Since the routes are build on demand so the network traffic is minimum. AODV uses Destination Sequence Numbers (DSN) to avoid counting to infinity that is why it is loop free. This is the characteristic of this algorithm.

B. OLSR (Optimized Link State Routing)

The OLSR [2][8] protocol is an optimised pure state link algorithm. It is designed to reduce retransmission duplicates and with a proactive nature the routes are always available when needed. It uses hop by hop mechanics when forwarding packets. It is a proactive routing protocol and is also called as table driven protocol because it permanently stores and updates its routing table. OLSR [6][7] keeps track of routing table in order to provide a route if needed. OLSR can be implemented in any ad hoc network. Due to its nature OLSR is called as proactive routing protocol. All the nodes in the network do not broadcast the route packets. Just Multipoint Relay (MPR) nodes broadcast route packets. These 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 neighbor nodes. These routes are built before any source node intends to send a message to a specified destination. Each and every node in the network keeps a routing table. This is the reason the routing overhead for OLSR [8] is minimum than other reactive routing protocols and it provide a shortest route to the destination in the network.

C. TORA (Temporally Ordered Routing Algorithm)

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 (oid), 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.

II. SIMULATION SETUP

Project simulation is done with OPNET Modeler. We have analyzed and observed the performance of MANET network under two scenarios with varying number of nodes and some evaluation parameters. Table 1.1 gives the parametric representation of both scenarios.

Table 1.1: Simulation parameters

Parameter	Value
Simulator	Opnet 14.5
Area	3.5×3.5 Km
Wireless MAC	802.11
Number Of Nodes	50, 100
Mobility Model	Random Walk, Random Waypoint Mobility

Data Rate	11 Mbps
Routing Protocols	AODV,OLSR and TORA
Simulation Time	5 minutes
Traffic	CBR, VBR, TCP

III. RELATED WORK

S. R. Biradaret.al in their paper "Performance Comparison of Reactive Routing Protocols of MANETs using Group Mobility Model" (2009) [2] they compare the performance of two on-demand routing protocols for mobile ad hoc networks Dynamic Source Routing (DSR) and Ad Hoc On-Demand Distance Vector Routing (AODV). They demonstrate that even though DSR and AODV both are on-demand protocol, the differences in the protocol mechanics can lead to significant performance differentials. The performance differentials are analyzed using varying mobility.Liu Tie-yuanet.al in their study " Analyzing the Impact of Entity Mobility Models on the Performance of Routing Protocols in the MANET "(2009) [1] Present A comparative study on entity mobility models. Firstly, both the advantages and disadvantages of four typical entity mobility models are summarized; these models include the Random Walk model (RW), the Random Way Point model (RWP), the Random Direction model (RD)and the Markov Random Path model (MRP). Secondly, focus on primary parameters of these models, effects of both the speed and the pause time on the performance metric of MANET routing protocols are analyzed. Finally, with the help of the NS-2 simulator, the effect of different entity mobility models on the performance of MANET routing protocols is analyzed.

IV. RESULTS AND DISCUSSION

Jitter: Voice must be understandable at the Receiver end. Because of that, consecutive voice packets must arrive in the receiver at regular interval [1]. Jitter describes the degree of variability in packet arrivals, which can be caused by network congestion (bursts of data traffic), timing drift or because of route changes. Jitter is the delay variance from point-to-point or Tx to Rx . It is measured in milliseconds. Voice packets can tolerate about 75 milliseconds (40 ms preferred) of jitter delay.

Figures 1.1, 1.2, 1.3, 1.4 give the comparative analysis for jitter for three different protocols viz. AODV, OLSR, TORA with two mobility models i.e. Random Way Point and Random Walk Mobility Model.

It is observed that:

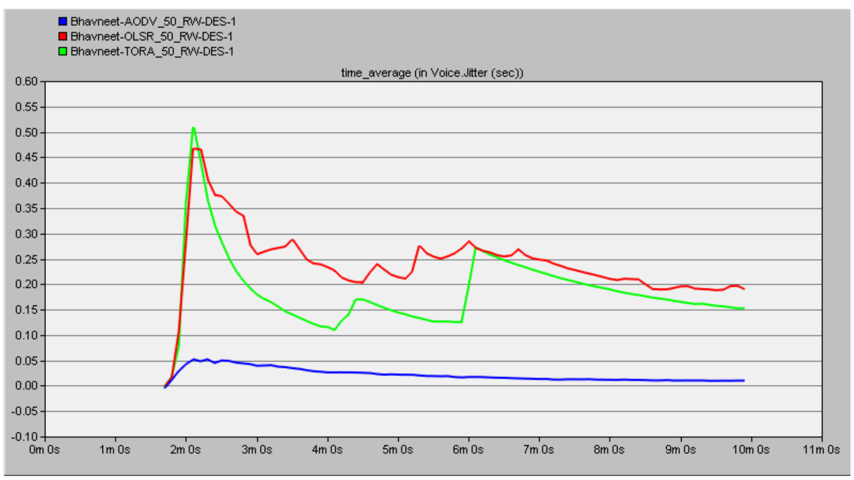

Fig. 1.1: Jitter (50 Nodes Random Walk)

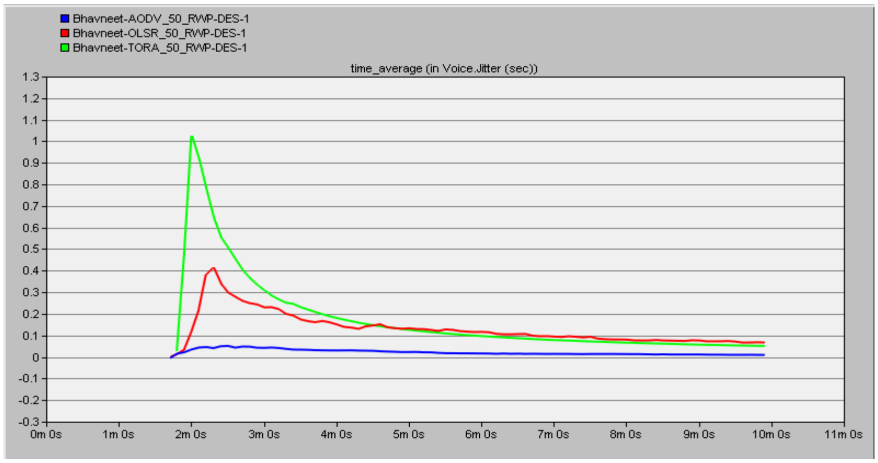

Fig. 1.2: Jitter (50 Nodes Random Way Point)

a. AODV under both Random Way Point and Random Walk Mobility Model shows better jitter in 50 node setup than the other two protocols.
b. OLSR jitter performance is quite unpredictable. Even with such a good throughput jitter is very high and it increases as the numbers of nodes are increased.
c. TORA on the other hand performs excellently with higher node density.

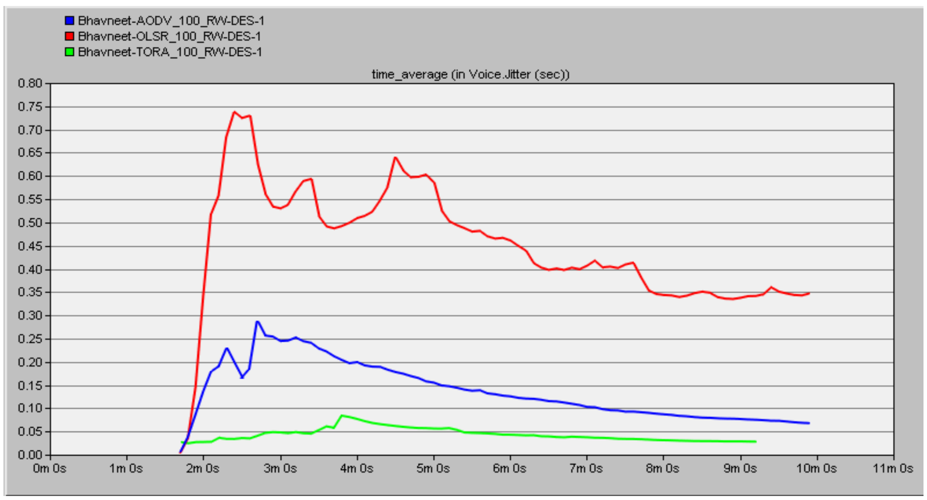

Fig. 1.3: Jitter (100 Nodes Random Walk)

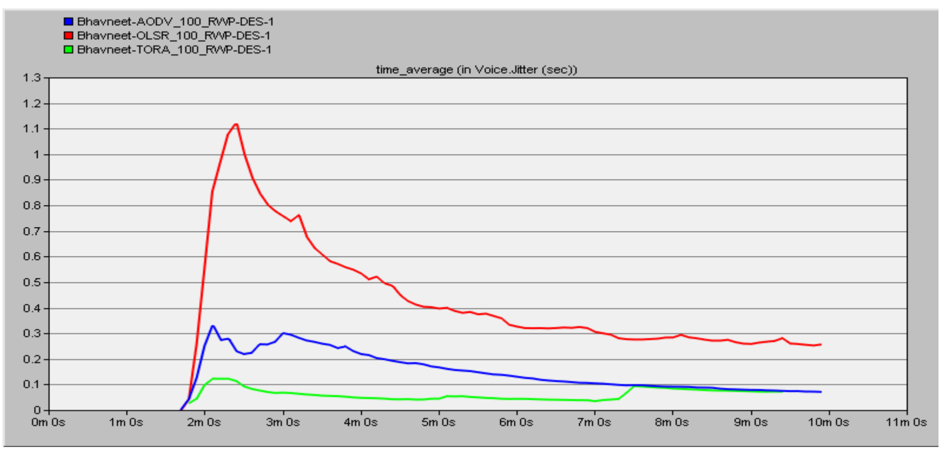

Fig. 1.4: Jitter (100 Nodes Random Way Point)

Table 1.2: Comparison Table

Jitter	AODV		OLSR		TORA	
	Random Walk	**Random way Point**	**Random Walk**	**Random Way Point**	**Random Walk**	**Random Way Point**
50 Nodes	0.05	0.02	0.47	0.41	0.51	1.01
100 Nodes	0.27	0.32	0.74	1.14	0.07	0.1

MOS: In voice and video communication, quality usually dictates whether the experience is a good or bad one. Besides the qualitative description we hear, like 'quite good' or 'very bad', there is a numerical method of expressing voice and video quality. It is called Mean Opinion Score (MOS). MOS gives a numerical indication of the perceived quality of the media received after being transmitted and eventually compressed using codec's. MOS is expressed in one number, from 1 to 5, 1 being the worst and 5 the best. MOS is quite subjective, as it is based on figures that result from what is perceived by people during tests. MOS can simply be used to compare between VoIP services and providers. But more importantly, they are used to assess the work of codec's, which compress audio and video to save on bandwidth utilization but with a certain amount of drop in quality. MOS tests are then made for codec's in a certain environment.

Figures 1.5, 1.6, 1.7, 1.8 give the comparative analysis for MOS for three different protocols viz. AODV, OLSR, TORA with two mobility models i.e. Random Way Point and Random Walk Mobility Model.
It is observed that:

a. AODV under both Random Way Point and Random Walk Mobility Model ranks high on Mean Opinion Score.MOS rank for TORA falls with extended node density.

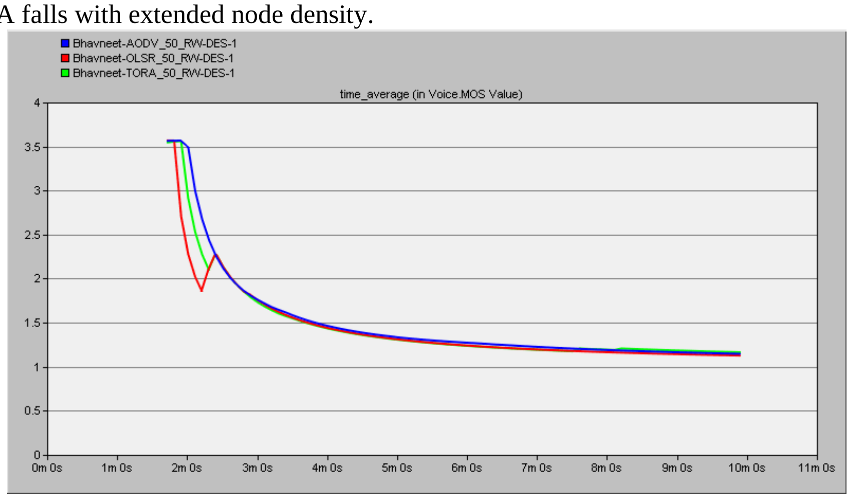

Fig. 1.5: MOS (50 Nodes Random Walk)

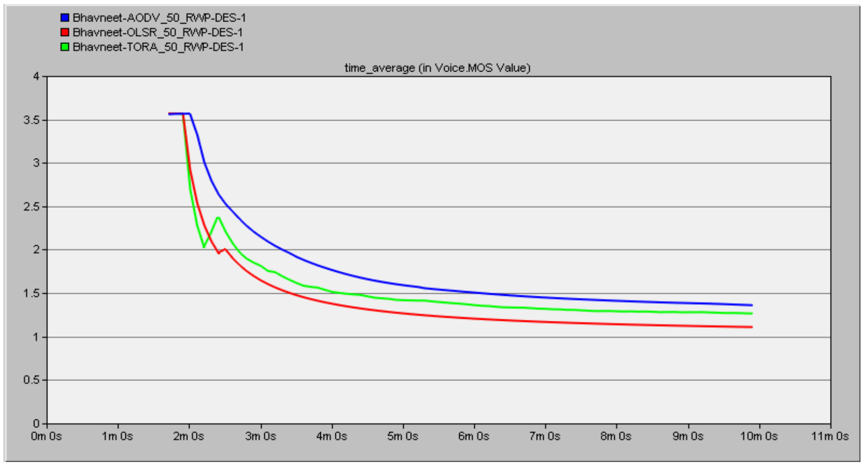

Fig. 1.6: MOS (50 Nodes Random Way Point)

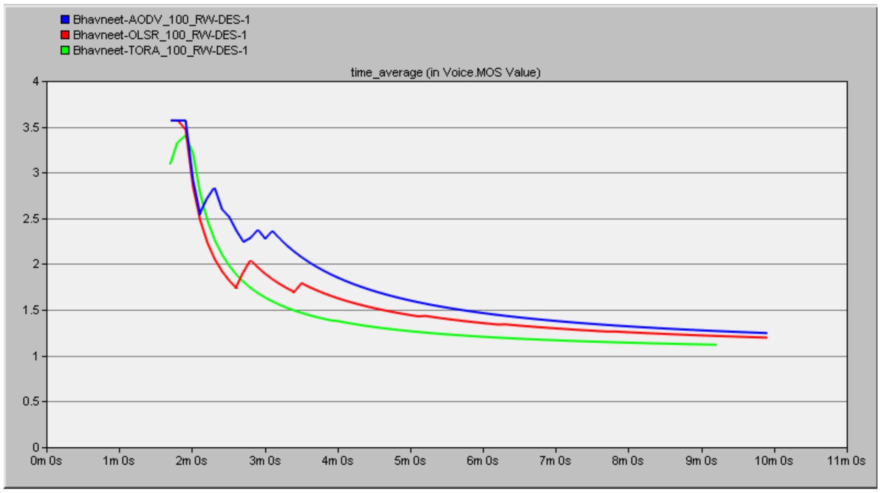

Fig. 1.7: MOS (100 Nodes Random Walk)

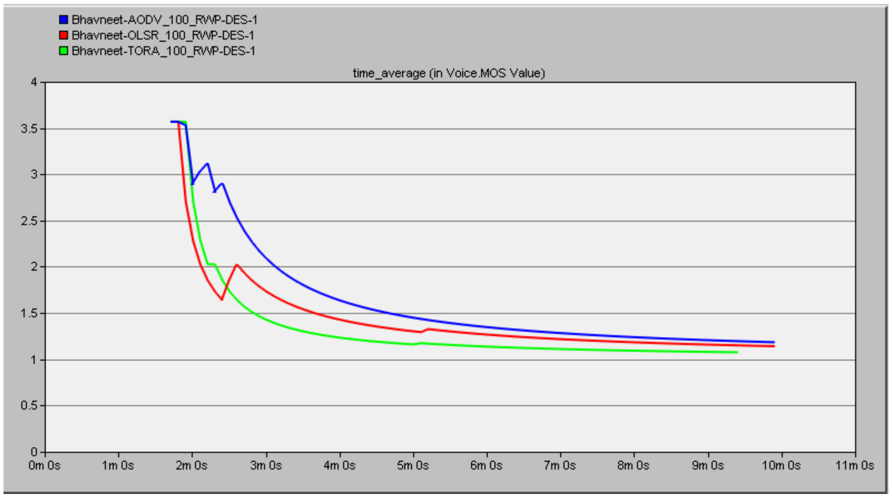

Fig. 1.8: MOS (100 Nodes Random Way Point)

Table 1.3: Comparison Table

MOS	AODV		OLSR		TORA	
	Random Walk	**Random way Point**	**Random Walk**	**Random Way Point**	**Random Walk**	**Random Way Point**
50 Nodes	1.1	1.4	1.1	1.1	1.1	1.3
100 Nodes	1.25	1.19	1.24	1.24	1.2	1.11

V. CONCLUSION

We have evaluated the mainly two performance measures i.e. jitter and MOS 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 and jitter. Moreover, Random Way Point Model outperforms Random Walk Model for all three routing protocols i.e. AODV, OLSR and TORA in terms of throughput, delay and MOS. However, Jitter that indicates the variations in delay is higher for OLSR than rest of two. In future, the node density can be varied to study its impact on the performance of the routing protocols and thus check their efficiency as the nodes increase. Doing so would bring out the contrast between the two mobility models and thus help in making reaching accurate conclusions.

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