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RESEARCH ARTICLE

Quality of Service Assessment of AOMDV for Random Waypoint and Random Walk Mobility Models

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Abstract— Routing Protocol performance is strongly affected by user or node mobility in Mobile Ad hoc Network. Performance of any routing protocol for Mobile Ad Hoc Network is investigated and assessed using simulator. Network Simulator - 2 uses various mobility models to mimic mobility patterns. Simulating a precise real life user/node mobility pattern is difficult. The ns-2 mobility models attempt through its mechanism to emulate real time traffic.

This paper is an attempt to study one MANET routing protocol with two mobility models of ns-2.34. The investigation focuses three qualities of services to examine the protocol performance, Throughput, Average Delay and Drop Packet Ratio. Through this evaluation we are able to show that Random Waypoint Mobility model is superior in performance over Random Walk Mobility Model. But the simulation of real time mobility patter is more factual with Random Walk Mobility model than Random Waypoint Mobility Model.

Keywords— Mobile Ad Hoc Network; MANET Routing; Mobility Models; Quality of Services

I. INTRODUCTION

Routing is fundamental in any network. Hence the role of routing protocol is major in communication. Mobile Ad Hoc Network is a self configuring network of mobile devices. Because of the dynamic nature of MANET Achieving desired Quality of Services (QoS) in Mobile Ad-hoc networks (MANET) is the key challenge. Dynamic topologies in MANET not only make routing difficult but also become prime hindrance in achieving desired QoS. Communication routes in MANETs are discovered either periodically or on-demand. Due to the additional overheads added in periodic discovery, On-demand route discovery is more efficient. MANET nodes are mobile and hence route failure probability is more, that means the route discovery process has to start whenever route fails. Each route discovery flood is associated with significant latency and overhead.

On-Demand multi-path routing protocols discover multiple paths between a source-destination pair, in a single route discovery. So a new discovery is needed only when all these paths fail. In contrast, a single path routing protocol has to invoke a new route discovery whenever the only path from source to destination fails. [1] Ad-Hoc on-demand multi-path distance vector (AOMDV) routing protocol is a multi-path extension of Ad-Hoc on-demand distance vector (AODV) routing protocol. AOMDV has three novel aspects compared to other on-demand multi-path routing protocols. First, it does not have inter-nodal coordination overheads like some other protocols. Second, it ensures disjointness of alternate routes via distributed computation without the use of source routing. Finally, AOMDV computes alternate paths with minimal additional overhead over AODV. It does this by exploiting already available alternate path routing information as much as possible [1].

User Mobility plays a key role in routing protocol performance. Different mobility models mimic the application's user mobility pattern. In this paper we analyze the performance of AOMDV routing protocol for mobility, offered load and size of network for two mobility models. Rest of this paper is organized as follows. Idea of AOMDV routing protocol is provided followed by the two mobility models. The performance evaluation is provided next to it.

II. AOMDV SCHEME

The basic idea behind multi-path routing is of finding multiple paths between source and destination. As on-demand routing protocols for MANET discovers a route when a source needs to communicate with destination. The multi-path routing protocol discovers multiple paths during single route discovery process. These multiple paths can be used for load spreading or as backup routes when the primary route fails [2]. In AOMDV multiple routes are discovered in single route discovery. AOMDV is primarily designed for highly dynamic ad hoc network where link failures and route breaks occur frequently.

AOMDV is multi-path extension of AODV. When a node wants to communicate, it initiates a route discovery. The node (source) broadcast a route request (RREQ) with a unique sequence number so that duplicate requests can be discarded. If an intermediate node receives the RREQ it first checks if it has a fresh enough route entry available in its routing table if yes then sends a reply (RREP) back to the source else rebroadcast the RREQ. The nodes on reverse route towards source update their routing information. Duplicate RREP on reverse route is only forwarded if it contains either a larger destination sequence number or a shorter route found. In AOMDV each RREQ (respective RREP) arriving at node potentially defines an alternate path. Accepting such duplicate RREQs may lead to formation of routing loops [1,2,3,4,5]. AOMDV route update rules, applied locally at each node, play a key role in maintaining loop freedom and disjointness properties [1]. There are two types of disjoint paths: node-disjoint and link-disjoint. Node disjoint paths do not have any nodes in common except the source and the destination. Whereas in link-disjoint paths do not have any common link. Note that link-disjoint paths may have common nodes [3] (See Fig.1).

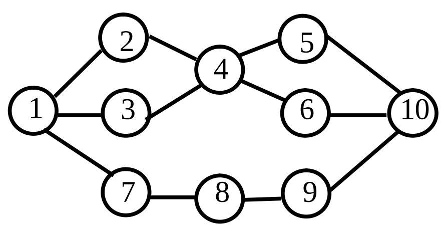


Fig.1. Source node1 and Destination10.
Path 1-2-4-5-10 and 1-3-4-6-10 are link disjoint paths and not node disjoint as node 4 is common. Path 1-2-4-5-10 / 1-3-4-6-10 and 1-7-8-9-10 are link disjoint.

To avoid any possibility of loop the "advertised hop count" is introduced. The advertised hop count of a node I for a destination D represent the maximum hop count of the multiple paths for D available at I. Alternate routes with hop count lower than the advertised hop count is accepted. Advertised hop count mechanism establishes link-disjoint paths. To get node-disjoint paths following mechanism is used. When a node S floods RREQ packet in the network, each RREQ arriving at node I via a different neighbor of S or S itself, defines a node-disjoint path from I to S. In AOMDV this is used at intermediate nodes. Duplicate copies of RREQ are not immediately discarded. Each packet is examined to see if it provides node -disjoint path to source. For node-disjoint paths all RREQs need to arrive via different neighbours of the source. At the destination slightly different approach is used, the paths determined there are link-disjoint, and not nod-disjoint. In order to do this, the destination replies up to k copies of the RREQ, regardless of the first hops. The RREQ only need to arrive via unique neighbors [1,3,4,5].

III. MOBILITY MODELS

The mobility model gives mobile users movement pattern, their location, speed and changes in due course. The mobility is significant parameter among other simulation parameters to determining the protocol performance in MANET. Therefore it should emulate desirable movement pattern of real life application. Mobile nodes in random based mobility model move randomly and freely with no restrictions. The destination, speed and direction for node are chosen randomly and independently of other nodes [6]. Following subsection describes two random based mobility models.

A. Random Waypoint Mobility Model

Most simulation study uses Random Waypoint Mobility Model to simulate mobile nodes movements. At the start each mobile node randomly selects one location in the simulation area as a destination and chooses a speed that is uniformly distributed between *[min-speed, max-speed].* When the node reaches the chosen location, it stops for duration defined by pause time. After the pause time the node again chooses a random destination and repeats the whole process until the end of simulation [6,7].

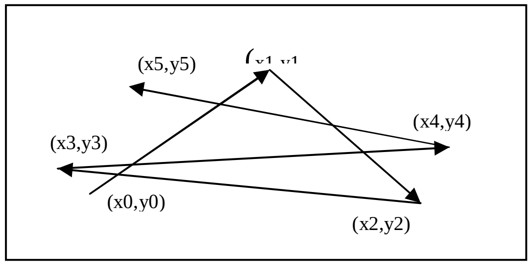


Fig2. Random Waypoint Mobility model example node movement

B. *Random Walk Mobility Model*

Random Walk mobility model imitate unexpected movements of mobile nodes. It is similar to Random Waypoint mobility Model as node movements are random in both models. The pause time for mobile nodes is =0 in Random Walk mobility model where as the pause time is <= 0 in Random Waypoint Mobility Model. At each time interval the nodes of Random Walk model changes their speed and direction. In this model the previous status of speed and direction is not used for the future decision. Hence it is a memory less mobility process. Every time node chooses speed and direction from pre defined ranges respectively *[min-speed, max-speed]* and *[0, 2*pi].* Each movement in the Random Walk Mobility Model occurs in either a constant time interval *t* or a constant travelled *d* distance, at the end of which a new direction and speed are calculated [6,7].

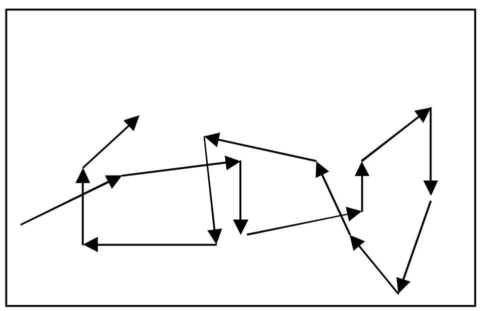


Fig3. Random Walk Mobility model example node movement

IV. SIMULATION EXPERIMENT

For comprehensive study of a MANET routing protocol it is important to simulate the protocol and evaluate its performance. Mobility model is one of the key protocol simulation parameter. This investigation focuses on analysis of AOMDV with two mobility models. Also the impact of mobility model on protocol performance is targeted.

Estimation of AOMDV performance for various qualities of services with Random Waypoint and Random Walk mobility models is done using network simulator -2 (ns-2) versions 2.34 [8]. Network Simulator is a discrete event simulator that provides substantial support for simulating wireless ad hoc networks. The IEEE802.11 is used as the medium access control (MAC) layer protocol in the simulation. The size of topology was set in a 1000 X 1000 grid. Multiple sources and destinations used. Constant bit rate (CBR) traffic is analyzed with Random Waypoint and Random Walk mobility model. CBR traffic most effectively stresses a network as there are no control mechanisms to consider when flows are delayed or packet lost. TCP can be unsuitable for most real time applications because the protocol needs extra time to verify packets and request retransmission [9]. We have analyzed the performance of AOMDV with CBR traffic types for varying mobility, offered load and network size. Also different numbers of sources and destinations are used. We have used 100 nodes. The simulation run time was set to 200s. Data packet size was set to 512 bytes [10, 11]. The simulation parameters used are given in table1.

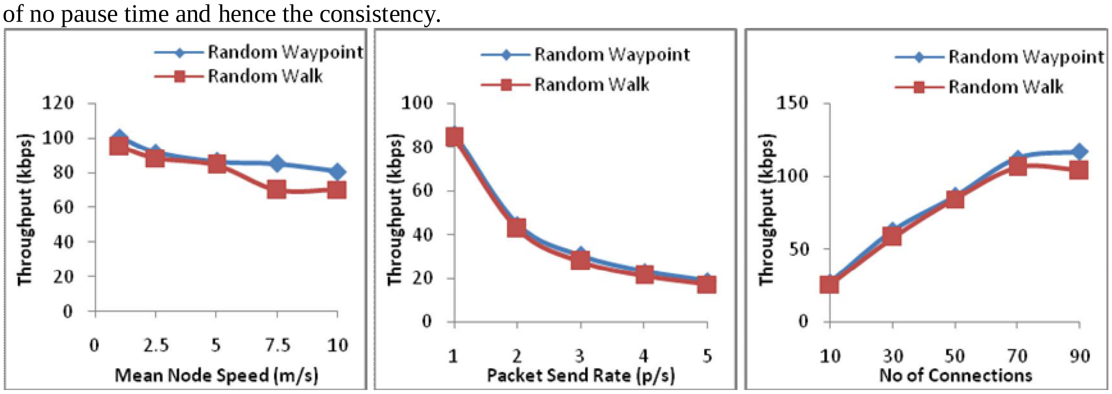
TABLE I
SIMULATION PARAMETERS

Parameters	Values
Topology size	1000 X 1000
No of Nodes	100
No of Sources	Multiple
No of Destinations	Multiple
Packet size	512 bytes
MAC protocol	IEEE 802.11
Simulation time	200s
Traffic Types	Cbr
Simulation run	200s for each packet rate
Mobility Model	RandomWaypoint/Random Walk

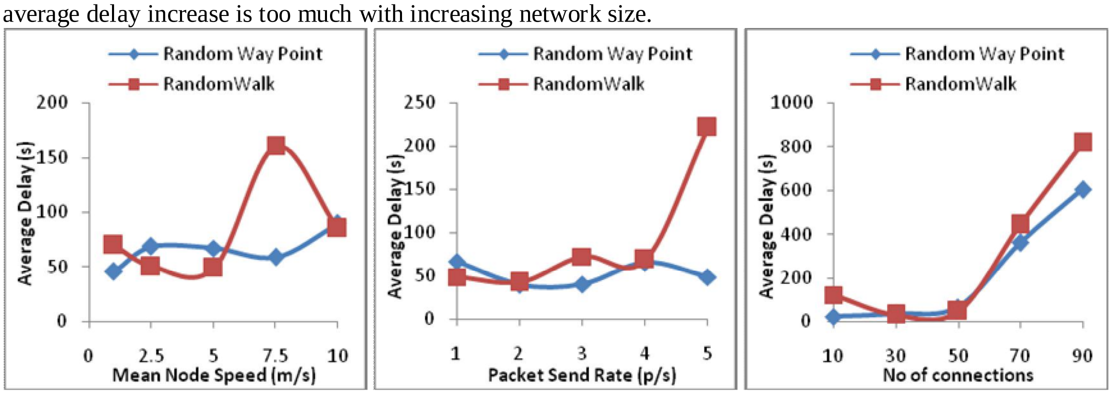
V. SIMULATION RESULTS

The main objective of the investigation was to analyze AOMDV performance with respect to varying mobility (mean node speed), network size (number of connections) and offered load (Packet Send Rate). Key metrics such as throughput, Drop packet ratio (DPR) , average delay (Avg Delay) are evaluated for Random Waypoint Mobility model and Random Walk Mobility Model.

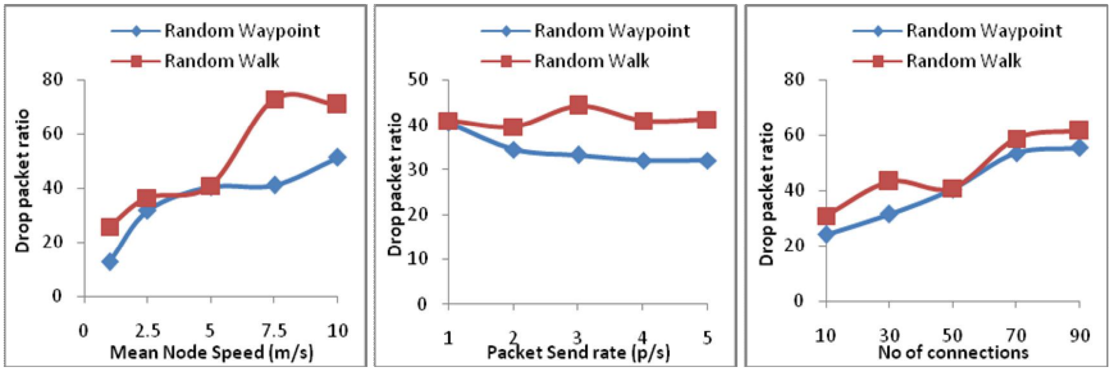
Throughput degrades with increasing mobility and load whereas it improves with increasing network size. AOMDV performance with respect to both mobility models is almost consistent. With Random Waypoint Model the throughput is superior compared to Random Walk Mobility Model. Because of pause time the node gets a bit of steadiness which improves its throughput. As pause time ranges from 0 to max there may be cases of no pause time and hence the consistency.



In Random Walk Mobility Model the pause time also affects the average delay. With increasing mobility i.e. when mean node sped increases the average delay increases means the routing protocol performance degrades. Similar is the case for increased load. For both Offered load and mobility average delay is constant for Random Waypoint mobility model. Case with increasing network size is different for both the mobility models. The average delay increase is too much with increasing network size.



With increasing offered load the drop packet ratio for both the mobility models is consitent. Increasing mobility affects drop packet ratio strongly in Random Walk Mobility model. Overall it looks that Random Wayoint Mobility model performance is better than that of Random Walk Mobility Model.



VI. CONCLUSIONS

This paper is an attempt to investigate the multi-path MANET routing protocol AOMDV for two mobility models. The extensive analysis is done to evaluate the performance of varies quality of service parameters. Also we have evaluated the effect of mobility model on routing protocol performance. Initially the two Mobility Models are discussed in brief. The Random Waypoint Mobility Model is commonly used mobility model to simulate real life mobility. But this model does not imitate the real life condition as there may or may not be pause time in real life circumstances. It seems that Random Walk Mobility model mimic the real life situations in better sense.

Through this work we institute that Routing protocol performance is better with Random Way Point Mobility Model than that of Random Walk Mobility Model. It means that the simulation studies need to be more on Random Walk Mobility Models as it mimics real time mobility more precisely than Random Waypoint Mobility Model.

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