Augmenting Mobility Model Algorithms

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Abstract --- Many wireless networking problems have to be solved for the efficient design and deployment of these communications devices that operate in a Mobile Ad-hoc Network (MANET) environment. A Mobile Ad hoc Network (MANET) is an infrastructure less network of mobile devices which are equipped with a transmitter and receiver. If any node want to communicate with the other node then each node act as a router for the establishment of the route in the Mobile Ad hoc Network. Therefore, if two nodes (devices) in a Mobile Ad hoc network want to communicate with each other, then packets can be transmitted directly or through some intermediate nodes i.e. Mobile Ad hoc Network is a collection of self organized network of flexible wireless nodes without a centralized control or infrastructure. In this paper, we are comparing an optimized routing algorithm for Mobile Ad hoc Network using NS2.
Keywords: NS2, DSR, MANET, router, routing algorithm.

I. INTRODUCTION

A Mobile Ad hoc Network is a collection of an infrastructure less self organized network of flexible wireless nodes without a centralized control or infrastructure. These mobile nodes are capable to communicate with each other directly or with the help of intermediate nodes without a central controller using wireless links or multi-hop wireless links. These types of networks have dynamic topology i.e. topology of the network is not fixed and all the nodes work as access points without the need of any base stations. Battlefields, emergency services, moving vehicles, and conference rooms are some of the applications where Mobile Ad hoc Network is used.

Due to the rapidly and unpredictable topology of the network the control, management and security of Mobile Ad hoc Network is distributed among the participating nodes. The responsibility to forward packets to other nodes relies on each node in the networks.

The various ad hoc routing protocols have their unique characteristics. Hence, in order to find out the most adaptive and efficient routing protocol for the highly dynamic topology in ad hoc networks, the routing protocols behavior has to be analyzed using varying node mobility speed, Traffic and network size. Thus, the goal is to carry out a systematic performance comparison of ad hoc routing protocols under mobility models[4].
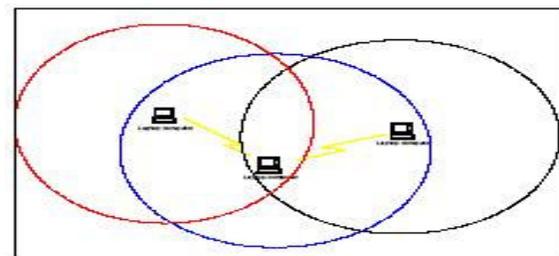
II. MANET ARCHITECTURE

Wireless networking appeared in the 1970s when these networks were called packet radio networks [2]. Since then, mobile wireless networks have developed into two main technologies:

1- Mobile IP networks, Figure1(a)
2- Mobile Ad- Hoc Networks (MANETs), Figure1(b))
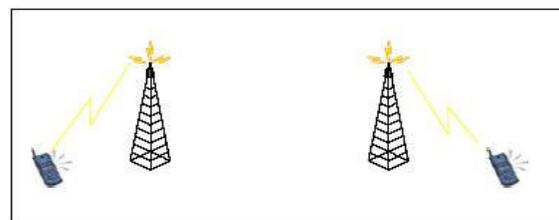
(a) Mobile IP (cellular)

(b) Mobile Ad-hoc Networks

Fig 1. Existing Mobile Communication Networks

MANETs have four distinct characteristics [3]: dynamic topologies, bandwidth constraints, energy-constraints and limited physical security. The first characteristic allows the nodes to move arbitrarily and unpredictably causing possible failures in links or routes. The second concerns the wireless links typically having a significantly lower capacity than their wired counterparts. Moreover due to contention from multiple users, fading, noise and interference, the capacity is highly time variable. Third, the nodes are usually battery-operated; therefore, management of the power is needed. Fig. 2 shows the Mobile Node Protocol Stack[4][13].
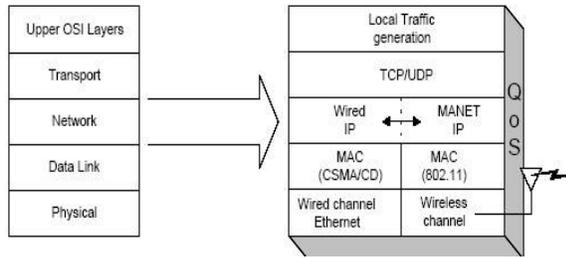
Fig. 2. Mobile Node Protocol Stack

III. RELATED WORK IN MANET PROTOCOLS

Fig. 3 shows the main problem with ad-hoc networking is how to send a message from one node to another with no direct link. The nodes in the network are moving around unpredictably, and it is very challenging which nodes that are directly linked together. The topology of an ad-hoc network is constantly changing and it is very difficult for routing process. There are two main approaches for routing process in ad hoc networks. The first approach is a proactive approach which is table driven and uses periodic protocols.
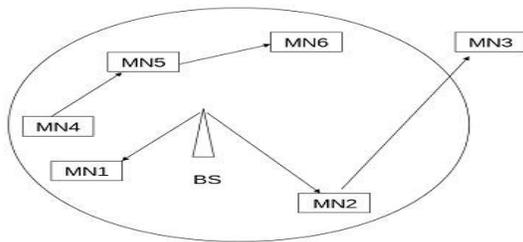

Fig. 3. Mobile Node Topology

The AODV, TORA and DSR are source-initiated or on-demand routing protocols and DSDV is a table driven protocol. The ad hoc routing protocols considered in this study are explained below.

a) Destination - Sequenced Distance Vector – DSDV

DSDV [2] belongs to the class of pro-active routing protocols. This protocol is based on the classical Bellman-Ford routing algorithm [2] to apply to mobile ad hoc networks. DSDV also has the feature of the distance-vector protocol [3] in that each node holds a routing table including the next-hop information for each possible destination. Each entry has a sequence number.

Routing information is transmitted by broadcast. Updates have to be transmitted periodically or immediately when any significant topology change is available. Sequence numbers are assigned by destination, means the destination gives a sort of default even sequence number, and the emitter has to send out the next update with this number[22].

Packets are transmitted between the stations of the network by using routing tables which are stored at each station of the network. Each routing table, at each of the stations, lists all available destinations, and the number of hops to each. Each route table entry is tagged with a sequence number which is originated by the destination station.

b) Ad-Hoc On Demand Distance Vector Routing – AODV

The Ad-hoc On-demand Distance Vector routing protocol [7][1] enables multi-hop routing between the participating mobile nodes wishing to establish and maintain an ad-hoc network. AODV is a reactive protocol based upon the distance vector algorithm.

The algorithm uses different messages to discover and maintain links. Whenever a node wants to try and find a route to another node it broadcasts a Route Request (RREQ) to all it's neighbors. The RREQ propagates through the network until it reaches the destination or the node with a fresh enough route to the destination. Then the route is made available by uncasing a RREP back to the source.

The algorithm uses hello messages (a special RREP) that are broadcasted periodically to the immediate neighbors. These hello messages are local advertisements for the continued presence of the node, and neighbors using routes through the broadcasting node will continue to mark the routes as valid. If hello messages stop coming from a particular node, the neighbor can assume that the node has moved away and mark that link to the node as broken and notify the affected set of nodes by sending a link failure notification (a special RREP) to that set of nodes.

c) Temporally - Ordered Routing Algorithm – TORA

TORA protocol [10] belongs to the class of reactive protocols. The protocol is highly adaptive, efficient and it is used to establish the "temporal order" of topological change events which is used to structure the reaction to topological changes. The protocol is designed to minimize reaction to topological changes. The protocol is distributed in that nodes need only maintain information about adjacent nodes. The protocol is "source initiated" and quickly creates a set of routes to a given destination only when desired.

The protocol accomplishes three functions through the use of three distinct control packets [8] such as query (QRY), update (UPD) and clear (CLR). QRY packets are used for both creating and maintaining routes, and CLR packets are used for erasing routes.

d) Dynamic Source Routing-DSR

Dynamic Source Routing (DSR) [5], belongs to the class of reactive protocols and allows to dynamically discover a route across multiple network hops to any destination. Source routing means that each packet in its header carries the complete ordered list of nodes through which the packet must pass[21]. DSR uses no periodic routing of messages, thereby reducing network bandwidth

overhead, conserving battery power and avoiding large routing updates throughout the ad-hoc network. Instead DSR relies on support from the MAC layer.

In general, systems are designed for the worst-case propagation conditions; however, because of the unpredictability of radio channels, a system can also be designed to adapt to the link quality at both the link layer and the network layer level.

IV. PERFORMANCE DEGRADATION IN MANET

In Ad hoc networks, due to the interactions with the MAC layer, the performance in terms of throughput and end-to-end delay often degrades significantly, which can be attributed to hidden node, exposed node and control packet overhead. These problems cause throughput instability, unfairness, and dependence on the number of nodes, size of the area, and the length of the packets. These in turn affect the quality of service at the application layer level[19].

The hidden node and exposed node problems are not completely isolated in the IEEE 802.11 standard. In spite of using RTS, CTS, and random back off mechanism, collisions still happen. The result is degradation in throughput is referred to as throughput instability and unfairness [5][6].

V. NETWORK LAYER ISSUES

Routing, a function associated with Layer 3 (OSI model), is a technique used by the network to determine a path for packets from a source to a destination. In each node, a router examines the packet's destination address, estimates the best path and forwards the packet along this route. The routing information is related to the topology and conditions of the network. In a MANET in which the topology changes frequently, the routing information needs to be updated more frequently than in the fixed networks[4].

VI. QUALITY OF SERVICE (QOS) ISSUES

Mobile ad hoc networks, as mentioned in the previous chapter, are generally the worst-case scenarios for providing QoS guarantees[23]. Not only is the performance of these networks unpredictable due to network dynamics, but they also operate with a limited-bandwidth, in a high- error-rate environment. Additionally, if a MANET supports real-time traffic, there is a need for effective traffic management by implementing an efficient QoS scheme[4][9].

### VII. PERFORMANCE EVALUATION RESULTS

The mobile node then travels toward the newly chosen destination at the selected speed. Upon arrival, the mobile node pauses for a specified period of time starting the process again. The random waypoint model is a commonly used mobility model in the simulation of ad hoc networks[24].

This fact impairs the accuracy of the current simulation methodology of ad hoc networks and makes it impossible to relate simulation-based performance results to corresponding analytical results. To overcome these problems, it is presented a detailed analytical study of the spatial node distribution generated by random waypoint mobility. The movement trace of a mobile node using the Random Waypoint model is shown in figure 4.

This section discusses the various predominance metrics used and the Performance differentials analyzed. The performance metrics analyzed are the fraction of packets delivered at the destination and the packet delivery ratio for various speeds of mobility, Traffic and Network Size[20].

Fig. 4. Shows the Packet Delivery Fraction for varying speeds. The simulation is done with different nodes in wireless sensor networks with respect to the random-based mobility model: Random Waypoint, Random Walk and Random direction models. The protocols considered for analysis are AODV, DSDV, TORA and DSR. Fig. 4(a), 4(b), 4(c).
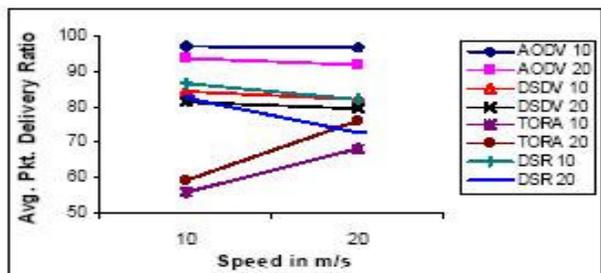
a) Speed vs Packet Delivery Fraction
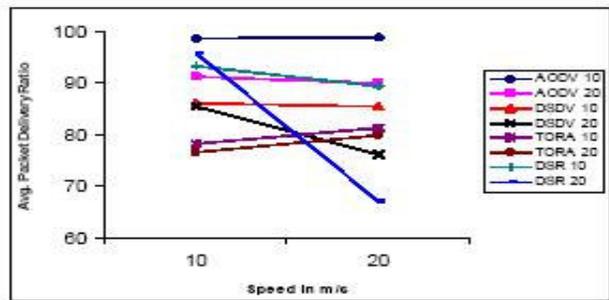
a) Random way point
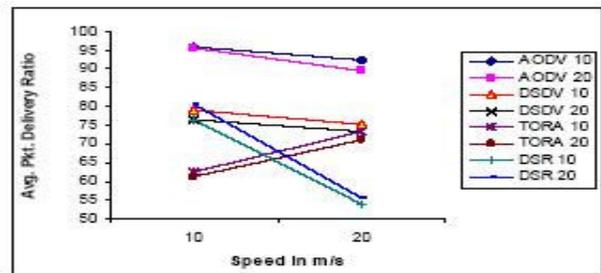
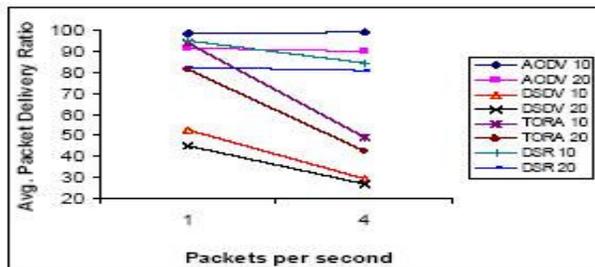b) Random Walk

c) Random Direction

Fig. 4. Packet Delivery Fraction for varying speeds

A mobile node chooses a random direction in which to travel similar to the Random Walk Mobility Model. The node then travels to the border of the simulation area in that direction. Once the simulation boundary is reached, the node pauses for a specified time, chooses another angular direction (between 0 and 180 degrees) and continues the process.

The Performance of the routing protocols in terms of packet delivery ratio is examined with respect to the mobility of nodes. Two different network traffic density scenarios are considered one with 10 connections and another with 20 connections. The simulation results are shown in the figure 4.
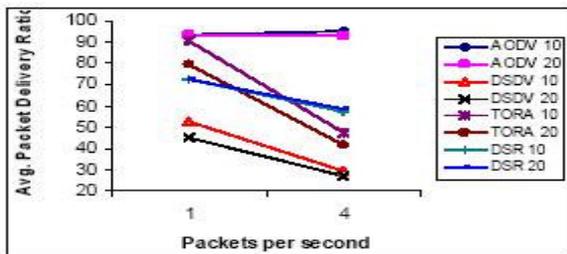
b) Traffic vs Packet delivery fraction

The performance of the routing protocols in terms of packet delivery ratio is examined with respect to traffic load. Two different network traffic density scenarios are considered one with 10 connections and another with 20 connections. The simulation results are shown in the figure 5. The packet delivery ratios obtained from the simulation show sharp decrease when the number of packets is increased from 1 to 4 and number of connections is increased from 10 to 20[17][21]. Fig. 5.shows the Packet Delivery Fraction for varying number of sources-
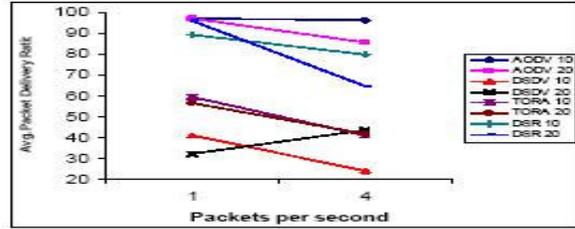

a) Random way point

In Random way point model, packet delivery ratios produced by all the protocols are very close when the speed is low.
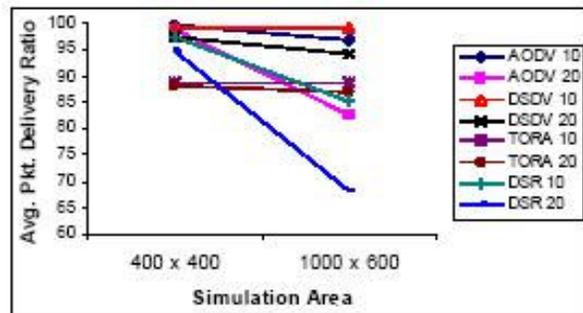

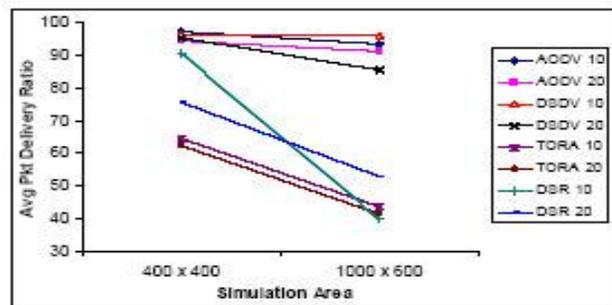b) Random Walk

c) Random Direction

Fig. 5. Packet Delivery Fraction for varying number of sources

The slight difference in the ratio is produced for with 10 connections and 20 connections. When the speed is increased to 20 m/s. the packet delivery ratio s produced by the protocols differs sharply and this difference becomes more with 20 connections. In the case of Random walk and Random Direction mobility models, the packet delivery ratio differs heavily for lower mobility and higher mobility[18].
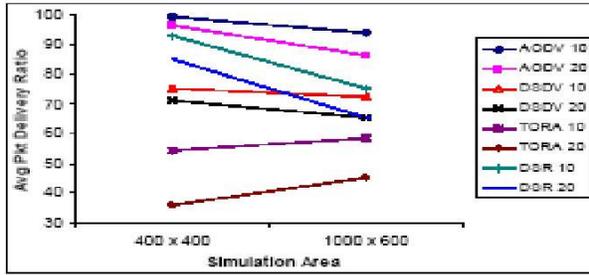
**c) Node density Vs Packet Delivery Fraction**

a) Random way point

b) Random Walk

c)   Random Direction

Fig. 6. Packet Delivery Fraction for Varying Network Size

The performance of the Routing protocols in terms of packet delivery ratio is examined with respect to the area in which the nodes are likely to move. Packet delivery ratios are considered for 10 connections and 20 connections traffic density. The simulation results are shown in the figure 6.

In this a higher packet delivery ratio for higher density of nodes and decreases when the when the node density becomes sparse. In Random waypoint mobility model AODV produces higher packet delivery ratio and DSDV, TORA, and DSR produces lower packet delivery ratio.

a) Random way point

b) Random Walk
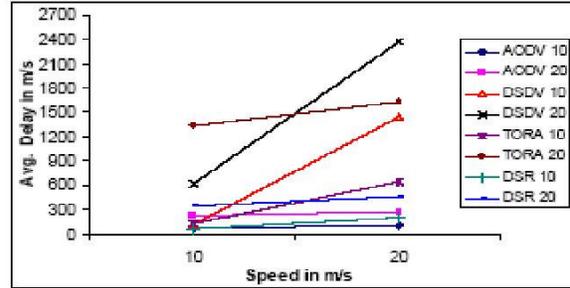
d)   Random Direction

Fig. 7. End-to-end delay for varying speeds

The performance of the routing protocols in terms of End-to-End Delay is examined with respect to mobility of the nodes. End-to-end delays are considered for 10 connections and 20 connections traffic density. The results are shown in the figure 7.

VIII.   FUTURE DISCUSSION

In Random Waypoint model, most of the times the nodes choose destination closer to the centre of the simulation area and thus producing a dense wave near the centre and stays back there for the specified pause time, also having more neighbors to the nodes in the centre. This will give minimal hop distance between the source-destination pairs.

The Random Walk model creates a high mobility scenario with larger travel time the nodes will travel almost to all the areas. The simulation results show that the AODV performs better than DSR, TORA and DSDV. One of the reason here is the average hop distance between the source-destination becomes high, and this will increase packet overhead[15][16].

The Random Direction Model is an unrealistic model because it is unlikely that people would spread themselves evenly throughout an area. The nodes choose pause times only at the boundaries and no change of speed and direction before reaching the boundary. AODV protocol produces better results than DSDV, TORA and DSR. When the network size is large, DSDV produces better results than TORA and DSR[11][14].

IX.   CONCLUSION

In Random way point model the simulation results shows that when the network becomes sparse or the traffic load becomes high the performance produced by DSR and TORA decreases sharply. DSDV protocol's performance is closer to AODV under network size metric. TORA protocol's performance was not so good under this mobility model. Hence, AODV protocol can be chosen as the routing protocol in this type of mobility conditions.

In random walk model, AODV performs better than DSR, TORA and DSDV because the average hop distance between the source-destination becomes high in AODV and this will increase packet overhead. So AODV protocols perform better under low and high mobility conditions.
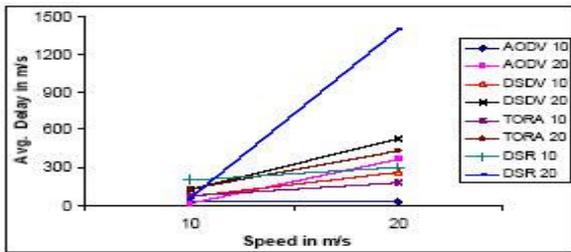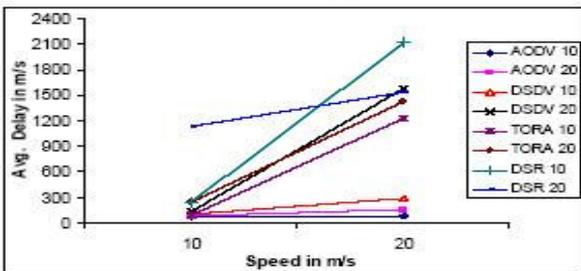
The Random Direction Model produces better results than DSDV, TORA and DSR. When the network size is large, DSDV produces better results than TORA and DSR. This shows that AODV is the suitable choice under this mobility model.

In this paper, only four ad-hoc routing protocols were considered and their performance were analyzed only under the Random based mobility models. In future, this paper can be enhanced by analyzing the other ad-hoc routing protocols under real-world scenarios such as Group-mobility models.

X.   REFERENCES

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