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Modelling and Performance Evaluation of Dynamic Routing over MANET using NS-2.35

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***Abstract* — The goal of this paper is to investigate the suitable model among the various models on the basis of Quality of Services (QoS) parameters. This paper describes the identification of potential problem areas within these routing protocols. Route acquisition, expiration and maintenance methods used by the routing protocol are all factors that contribute to the overall performance. In this paper the problem of mobility have been investigated. The three main types of models designed in this paper. First, The multimedia model shows how well the routing protocol can handle real-world traffic like streaming video and audio, and the need to try and guarantee QoS, for this type of data. Second, The circular model attempts to address the potential problems with ad-hoc routing where there is only one destination node, mirroring a real life hotspot scenario, where receivers on buildings. Sincely, the dynamic model attempts to address problems with an extremely dynamic topology where nodes leave and join the network continually, putting extreme strain on the routing protocol, and network overheads.**

***Keywords* - Circular model, Dynamic model, Multimedia model, Quality of Services.**

I. INTRODUCTION

The aim of this paper is to investigate models for the creation of routing over adhoc networks. This can incorporate any number of network key factor such as: the number of nodes connected at any one point; the number of source and destination nodes sending and receiving traffic within ad-hoc wireless networks; routing factors such as throughput, delay, packet loss; the performance of the routing algorithm as a whole; and the determination of the best path from one node to another. The three models circular model, dynamic model and multimedia model proposed by [1] on adhoc network. The main focus of this paper is to investigate the realistic models for adhoc routing scenarios [2]. Comparative investigation of the models is based on various performance metrics has been done [3], and to optimization of models and their suitability for various situations has been expected. Algorithm of dynamic routing for ad hoc network Addressing is describing in [4].

The problem of QoS directly at routing level is one approach that [5] addresses. [6] has given the recent detail Classification of Routing Protocols for Mobile Ad Hoc Networks. The Impact of Mobility of node on MANET Routing Protocols Models has given in [7].

An ad-hoc network is a self-configuring network of wireless links connecting mobile nodes. These nodes may be routers and/or hosts. The mobile nodes communicate directly with each other and without the aid of access points, and therefore have no fixed infrastructure. An important factor in routing is that there must be security built-into the system. [8] Also proposes a robust method of routing where an intermediate node requests a node on the next hop to send a confirmation message to the source.

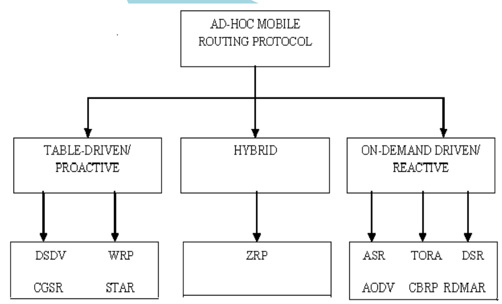

Fig.1 Ad-hoc Mobile Routing Protocols

Table Driven Routing Protocols, also known as Proactive Protocols; work out routes in the background independent of traffic demands. In a network with little data traffic. It will use limited resources such as power and link bandwidth therefore they might not be considered an effective routing solution for Ad-hoc Networks. On Demand Routing Protocols, also known as Reactive Protocols, establish routes between nodes only when they are required to route data packets. On Demand Protocols more suited to large networks with light traffic and low mobility. An example of an On Demand Protocol is DSR [9] and AODV [10, 11] etc. Hybrid Routing Protocols combines Table Based Routing Protocols with On Demand Routing Protocols. They use distance-vectors for more precise metrics to establish the best paths to destination networks, and report routing information only when there is a change in the topology of the network. Each node in the network has its own routing zone, the size of which is defined by a zone radius, which is defined by a metric.

The prediction model prescribed in Predictive Caching Strategy for On-Demand Routing Protocols in Wireless Ad Hoc Network [12, 13, 14] described about On-demand Multipath Distance Vector Routing in Ad Hoc Networks.

II.MODEL DESCRIPTION

All simulations are done in Network Simulator 2(NS-2.35)[15], which is discrete event simulator for networking research. It work at packet level and provide substantial support to simulate bunch of protocols like TCP, UDP, FTP,

HTTP and DSR. NS-2 is used to simulate wired and wireless network. These protocols are based on distance vector routing protocol [16]. For describing the various problems there are following models simulated

a)Multimedia model

It is designed to cover one major performance-related metric addressed by [1]. It specifies the potential for guaranteed QoS for multimedia-based systems over 4G like streaming video and dropping packets of critical data.

For streaming video, the delay and the dropping of packets on the delivery of the critical data would have a very visual effect on the performance making the viewing of such data impossible and sporadic. To help overcome this serious performance degradation, the use of a *prediction* enhancement to the routing protocol, as described by [2], could enhance overall network performance, and almost guarantee QoS. An abstract design of three different networks communicating together is shown in Figure 2.

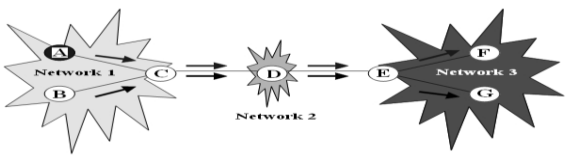

Fig. 2 Model design of Multimedia Model

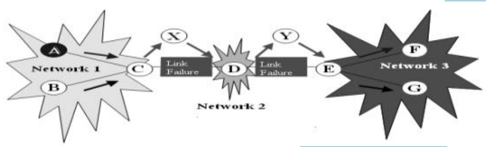

Fig. 3 Model design of Multimedia Model with prediction

With the addition of nodes X and Y, it is guaranteed another valid route for data communication if the links between networks 1 and 2, and specifically nodes C D break, simulating a lack of coverage between the nodes or signaling that one node is out-of-range of the other. This method of *prediction* is a very simplistic form suggested by Su [2], and can be used in all node link connections shown in figure 3. For instance, any of the links between the nodes: A-C; B-C; C-D; D-E; E-F or E-G could go down at any time, and the prediction should allow for another route to be available almost straight away. The prediction, in this case, does not actually use GPS information, or mobility information, to determine when nodes will move out of coverage areas of each other. It simply simulates this type of scenarios.

b)Circular Model

In this model, there is, once again, a need to address potential problems with route maintenance and link failure. It is basically the wireless equivalent to the well-known ring topology used in standard Ethernet networks. The ring topology is used to help show that the route discovery is similar to that of the AODV protocol described in [17]. Although, not covered here in its entirety, this wireless ring topology will show that traffic is routed along a route with the shortest number of hops from a source to a destination - a familiar trait of the AODV protocol. A major factor of this topology is that, although there are a number of source nodes, there is just one destination node. This topology will simulate a number of nodes connected to a wireless hotspot, and, if a node link breaks, an alternative route through the remaining nodes must be established. The main factors to consider here are:

- That there is *one* destination node imitating a real-life hotspot/access point.
- There are a number of source nodes, all sending packets to the destination node.
- In a slight variation to what Perkins[18] measured, the effect that different packet size may have on the performance will be investigated.
- That the route with the smallest number of hops should be taken.
- The effect that varying mobility has.

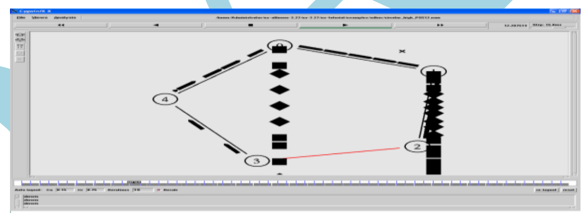

Fig. 4 Simulation Environment of Circular model design

c) Dynamic Model

This model is designed to show the effects that a very dynamic topology has on the overall performance of the routing protocol. The model contains between 10 to 15 nodes, with all nodes having more than one route to it. This helps to provide the routing protocol with alternative routes when the mobility factor is high.

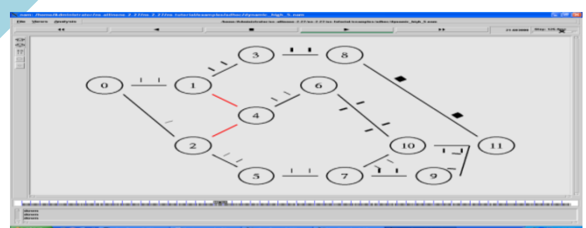

Fig. 5 Simulation Environment of Dynamic Model design

Full model details are:

1) In this scenario there are no mobility and very high mobility.
2) As with other models, the optimum route will be taken at any point dependant on the mobility factor.

Dynamic model uses the mobility factor to simulate the effect of nodes moving in and out of the coverage area, thus resulting in link failures, dropped packets, lost packets and dynamic route acquisition. Figure 5 illustrates the dynamic model topology.

In this model, there are two routes to every node allowing the protocol to simulate amending routing table entries and quickly provide an alternative route to a destination. The traffic should also be evenly spread-out, regardless of the number of sources, and it should provide interesting performance information on varied load and varied mobility.

d)Performance Metrics

The following performance metrics have chosen to compare the performance of models.

Throughput: It is the rate at which a network sends receives data. It is a good channel capacity of net connections and rated in terms bits per second (bit/s).

Packet Lost: It is where network traffic fails to reach its destination in a timely manner. Most commonly packets get dropped before the destination can be reached.

End to End Delay: It refers to the time taken for a packet to be transmitted across a network from source to destination.

Jitter: Jitter is the fluctuation of end-to-end delay from one packet to the next packet of connection flow.

III.COMPARSIONS AND RESULTS

Each of the models addresses different wireless problems and help push towards conclusions and recommendations based on these tests. The tests have covered issues addressed by [17] such as:

Mobility issues**:** The effect a dynamic topology has on performance.

Varied Load**:** The effect the number of sources and destination nodes within a network has on overall performance.

Prediction**:** Addresses the proposals put forward by[14] about prediction and the effect they have on performance.

Topology layout**:** The effect that size and layout of the topology has on the performance based on realistic scenarios.

A. Multimedia Model

There are total five simulation model designed

1) Low mobility Model
2) Medium mobility, with no prediction Model
3) Medium mobility, with prediction Model
4) High mobility, with no prediction Model
5) High mobility, with prediction Model

The purpose of the testing and analysis of the multimedia models is designed to prove the problems associated with QoS within multimedia traffic environments.

a. **Multimedia, no prediction models**

Table 1
Packet information from non-prediction multimedia models

Model Name	No of generated packets	No of dropped packets	No. of lost packets
Low mobility	23700	0	0
Medium mobility	33970	27	1452
High Mobility	32089	73	5460

Table 1 shows, as anticipated, with low mobility, or, in this case, no mobility, the routing protocol manages to deliver 100% of the total packets generated. There are no packets either dropped, or lost in the network. However, when the mobility is increased with the medium mobility model, where there are six links down during the simulation time, the number of dropped packets increases to 27, which is only 0.1% of the total number generated. Also, the total number of packets lost in this scenario jumps from zero to 1452, which is around 4.3% of the total number of packets generated. This is a combined total of 4.4% of the total number of packets being generated within the network failing to reach their destination.

If we increase the mobility factor to high, which simulates 17 Links breaking during the simulation time, it can be seen, from Table 1 that the number of packets dropped and lost increase again. In this case the number of packets dropped jumps to 0.22% (73) of the total number generated, and the total number of packets dropped jumps to a huge 5460, which is 17% of the total number of packets generated. From this, we can investigate with the mobility increasing throughout the models, the overall number of packets reaching the intended destination drops. The difference between the links simulated being dropped in the medium mobility model to the high mobility model is a factor of, approximately 3. This figure is directly proportional of the total number of packets that reach there intended destination. Overall, from Table 1, we can investigate that the overall performance of the routing protocol is severely impeded by the mobility metric that is increased during simulation, and that this metric has a detrimental effect on the performance.

b. **Multimedia Prediction models**

Simulating adding a prediction method to the routing protocol was intended to show what proposed, that it could enhance the overall performance compared with routing protocols that did not use prediction. In these set of tests, both medium and high mobility models from the previous section are used, with an added alternative route for the data to take, simulating this prediction. Table 2 presents medium mobility and the added simulated mechanism for prediction, that the total number of packets dropped stays the same, at 0.1% of the total number of packets generated. However, the total number of packets lost drops from 1452 to 27, a decrease of approximately 98.14%. The overall number of packets not reaching the intended destination in this model is now 0.34% of the overall number of packets generated. With the high mobility model with prediction, the total number of packets dropped stays at 0.22%, the total number of packets lost falls to around 92.1% of what was recorded in the model with no mobility.

Table 2
Packet information from with prediction multimedia models

Model Name	No of generated packets	No of dropped packets	No. of lost packets
Low mobility	23700	0	0
Medium mobility with prediction	35472	27	96
High Mobility with prediction	41625	74	432

We observe that the cumulative generation of packets of High mobility model with prediction and no prediction. In the High mobility model with prediction generate more packets (41625) as compare to no prediction (32089). Table 1 and 2 also provides the exact comparison between both models of high mobility. In the medium mobility model also the model with prediction gives much batter result i.e. packet lost reduced very much.

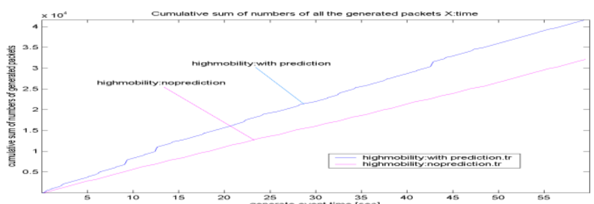

Fig. 6 : Comparison of delivered packets during High mobility

B. Circular Model

The aim of the design of the Circular model is to incorporate the behavior of nodes and the routing protocol in a real-life hotspot situation. The main focuses are: That there is one destination node showing a real life hotspot/access point.

The main test to this topology is to evaluate the effect of differing packet size would have on the routing performance. Also, there is a need to see what effect mobility has in a ring topology where there is a longer, alternative route to a destination when a node link goes down and the effect this has, overall.

The following models are implemented:

1.1 Circular no 64
1.2. Circular no 512.
2.1. Circular med 64
2.2. Circular med 512
3.1. Circular high 64
3.2. Circular high 512

a. Circular 64 and 512 Byte Packet models

Initially it is observe that smaller packet sized models that contain 64 byte packets, and the effect they have on the routing protocol. From table 3, it is investigate that with no mobility factor; the network performs like expected with no packet loss and very minimal delay. As increase the mobility through the models, there is a minimal increase in both delay and packet loss.

Table 3 is showing that the packet loss is not coming from the destination node, but from all the others in the topology. Therefore, the ways that routes are procured by the routing protocol appear to have a slight detrimental effect on the performance as a whole.

Table 3
Test information from 64 Byte circular models with varying mobility

Model Name	No of dropped packets	No. of lost packets	Average end 2 end delay(sec)
Cir no 64	0	0	0.01534
Cir med 64	28	28	0.01640
Cir high 64	60	63	0.01758

Table 4
Test information from 512 Byte circular models with varying mobility

Model Name	No of dropped packets	No. of lost packets	Average end 2 end delay(sec)
Cir no 512	0	0	0.01801
Cir med 512	1743	694	0.03049
Cir high 512	3652	1488	0.04547

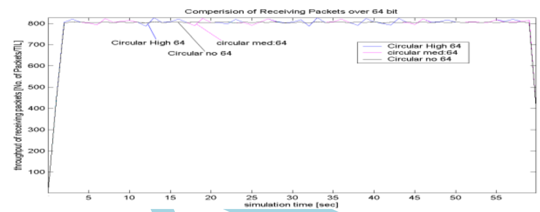

Fig. 7: Delivered Throughput analyses from 64 byte circular models with varying mobility

The figure 7 shows the variation of throughput experienced at the destination node(s) due to varying other attributes. From the three levels of throughput, it can be seen that the throughput experiences the same level of diversity than that of the delay and packet loss figures in Table 3 that there is little variation.

However, observing at the results from the 512 byte circular models shows that the increase in byte size over the same testing environments has a major effect on the throughput available. This is illustrated in Figure 8 where the throughput fluctuates much greater at higher mobility, than at lower mobility.

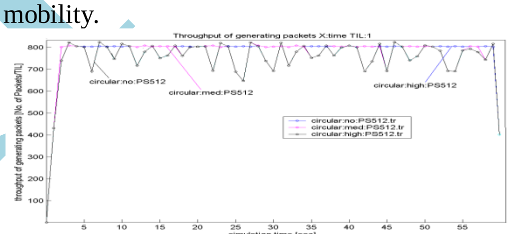

Fig. 8: Delivered Throughput analyses from 512 Byte circular models with varying mobility

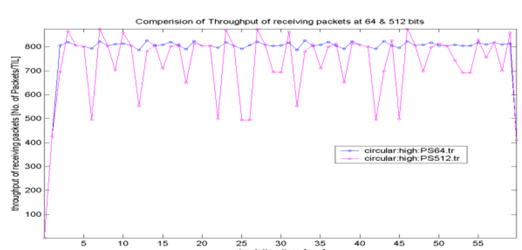

Fig. 9 Analysis of Throughput at node 2 with 64 versus 512 byte data pack

This throughput is most probably affected by the loss in traffic with increased dropped and lost packets at higher mobility. The methods the routing protocol uses for route discovery and route maintenance probably affects the throughput due to the way data is routed, with increased route length during high mobility due to link failures. A summary throughput at the destination node 2 of the two data packet sizes is shown in Figure 9.

B. Dynamic model

The design of the dynamic model prepare with the need to test a very dynamic topology of wireless nodes. Although the previous two main models, the circular and the multimedia models, included mobility factors in them, this is a standard metric to test in a mobile environment as the nodes within the topology moving at some point. This dynamic model was designed in such a way that it would cover any other major points put forward in section 2.

The main focus are :That the route with the smallest number of hops should be taken, There are a number of varying sources in the different models, Simulate high mobility, Experiments shows that when nodes are moving quickly, and, therefore potentially, moving in and out-of-range of other wireless nodes. Here, the dynamic code this time will break all links to and from a specified node rather than just individual links.

In total, there are nine experiments on this topology, and are as follows:

1) Dynamic 1Model
2) Dynamic 1 med Model
3) Dynamic 1 high Model
4) Dynamic 5 Model
5) Dynamic 5 med Model
6) Dynamic 5 high Model
7) Dynamic 10 Model
8) Dynamic 10 med Model
9) Dynamic 10 high Model

Table 5
Test information from Dynamic models with varying mobility

Model Name	No of generated packets	No of dropped packets	No. of lost packets
Dyn 1	12960	0	0
Dyn 5	60260	0	0
Dyn 10	119120	0	0
Dyn med 1	13588	10	81
Dyn med 5	60951	740	3251
Dyn med 10	118146	777	4032
Dyn high 1	20062	852	2251
Dyn high 5	66839	1608	6662
Dyn high 10	118501	231	8348

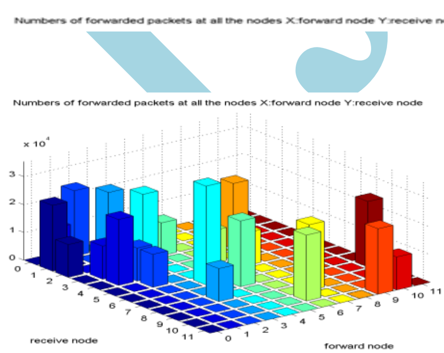

Fig. 10: Representation of forwarded packets in model Dynamic 10 Model

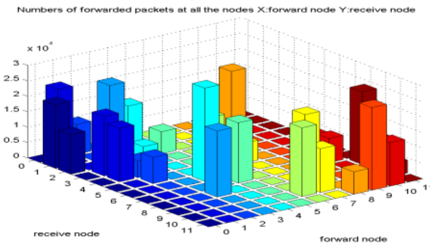

Fig.11: Representation of forwarded packets in model Dynamic 10 med Model

The three models with no mobility factors, the aim is to show how a larger topology with a limited bandwidth of 2Mbps handles under no mobility. As Table 5 shows, the number of dropped and lost packets with relation to number of sources and mobility is inconclusive. The scripts that generated the results have been checked for bugs within the scripts and nothing was found. Therefore, it appears even with high mobility the models with the same amount of source nodes can just as easily re-route data through another route to the destination.

Thus, the pattern of forwarding data packets is investigated. With varying mobility, it is only the models with high sources and destinations of data that produced very slight varying results. Consider the representation of the forwarded

As compares the graphs, it can immediately see from Figure 11 & 12 that forwarding node 3 and receiving node 8, the link between nodes 3-8, is now used more often than in Figure 10. This is due to the mobility metric simulation used in the code. Other links that have either increased or decreased noticeably in the Figures shown are:

- *Increased traffic over:* Links 1 - 3, 3 - 8, 6 - 10 and 7 - 10.
- *Decreased traffic over:* Links 0 - 2, 5 – 7

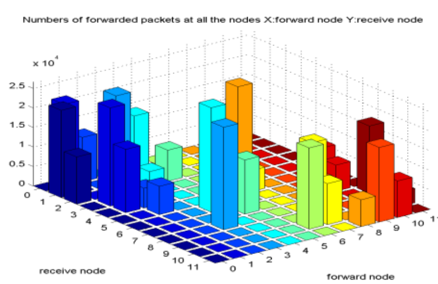

Fig.12: Representation of forwarded packets in model Dynamic 10 high Model

As the links 1-3 and 3-8 are based on the same route. Therefore if nodes link traffic consumption is increased during simulation, then the other must increase also, unless that is of course it is the destination node. This is down to the fact that during mobility, where nodes and links move in and out-of-range, and with it breaking connection and a traffic route to a destination, the routing protocol must find the next available route.

IV. CONCLUSION

We implemented the various types of model prescribed and investigated the models on the basis of various QoS matrices. The Multimedia model, and the problems guaranteeing QoS was addressed and a prediction mechanism is put forward and tested with varying mobility. The circular model put forward concerns with route discovery and route maintenance in a real-world scenario with the hotspot problem. The last set of tests, related to dynamic topology, proved to be relatively inconclusive. The differing sets of experiments helped come to the main conclusions that the models show that with the varying mobility increasing, the number of packets lost and dropped increased and with the use of simulated prediction, the routing protocols performance improved dramatically. The Distance Vector routing protocol used in the simulations could work well with prediction enhancement to help try and guarantee Quality of Service.

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