Challenging Ad-Hoc Networks under Reliable & Unreliable Transport with Variable Node Density

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ABSTRACT

The main motivation of the research paper is to analyze different performance parameters of three well known Ad-hoc network routing protocols (AODV, DSDV, DSR) with varying node density and velocity. As in real world the movements of nodes are almost always random, therefore we selected the random way point mobility model. Ad hoc network is an active research area now-a-days. Plenty of literature is available in this field. The researcher has developed many Routing Algorithms for effective routing in MANETs. Similarly researchers also have analyzed these protocols in different scenarios. The Research area which needs more work & is still demanding the researcher attention is to work out efficiency of such networks in reliable (suitable for delay tolerant and error sensitive data) & unreliable (for delay sensitive and error tolerant information such voice and video streaming) transport layer protocols. In this study we evaluate the behavior of different Ad –hoc network routing protocols (AODV, DSDV, DSR) under reliable TCP and unreliable UDP transport layer protocols with variable node density and velocity. From simulation results we observed that each protocol perform in a different way with different node density and velocity.

Keywords: *Mobile Ad-hoc Network (MANET), Routing Protocols AODV (Ad-hoc on demand distance vector), DSDV (Destination Sequenced distance vector), DSR (Dynamic Source Routing)*

1. INTRODUCTION

With the advancement in radio technologies like Bluetooth, IEEE 802.11 or Hiperlan, a new concept of networking has emerged. This is known as ad hoc networking where potential mobile users arrive within the common perimeter of radio link and participate in setting up the network topology for communication. Nodes within ad hoc are mobile and they communicate with each other within radio range through direct wireless links or multihop routing [4].

Mobile Ad-hoc networks (MANETs) are networks where the nodes are mobile, communicating via wireless links, operating without fixed infrastructure. MANET is also known as infrastructure-less network as it doesn't require any pre-established infrastructure like access points in case of WLAN and BTSs in cellular wireless networks.

We classify the Ad-hoc Network routing protocols as follow:

Proactive Routing Protocols are routing protocols which try to maintain always up-to-date entries in routing table for every possible source and destination. The advantage of these protocols is that when data packets are generated, they are transmitted according to routing tables' entries. That is, transmission occurs without delay, due to maintainability of up-to-date routing table entries. These protocols are suitable for wired networks and ad hoc networks where mobility is low. Its examples are DSDV, and OLSR. Destination Sequenced Distance Vector (DSDV)

Destination sequence distance vector (DSDV) [31] is one of proactive routing protocol proposed for mobile ad hoc networks. Each node in DSDV maintains routing table, having all available destination with number of hopes to each. Each node in DSDV routing protocol advertise its routing information to neighbor nodes periodically or incrementally, according to topology condition. DSDV uses destination sequence number to avoid routing loop and count-to-infinity problem [14] [5] [21].

In this way it reduces control traffic. Therefore it is best suited for network with high mobility. However its data transmission rate is more than that of proactive routing protocol due to route discovery for data packet on-demand. Some of reactive routing protocols are AODV and DSR. Ad hoc on-demand distance vector (AODV) routing protocol is also reactive routing protocol that is routes are determined in on-demand fashion. AODV also uses broad cast route discovery mechanism as used in DSR. AODV routing protocol does not use source routing mechanism but instead of that it relies on dynamically establishing routing tables at intermediate nodes. It uses destination sequence number, to maintain most recent routing information between nodes. However the maintenance of this sequence number is different from DSDV. In AODV each node maintain monotonically increasing sequence number counter. To maintain local connectivity a node may locally broadcasts periodic Hello messages. It is also possible that a node listen to the retransmission of data packet to insure that next node is within range [14] [16].

Dynamic Source Routing (DSR) is reactive routing protocol. Therefore route is determined in on-demand fashion that is there are no periodic route advertisements. It has two important phases, route discovery and route maintenance. When a node wants to send a packet and does not know the route to the destination, it initiates route discovery process. In this phase the node broadcast the route request, having the initiator, target destination, list of intermediate node through which it has been forwarded. DSR is source routing that is the route, complete sequence of hops through which the packet should be forwarded, to the destination is specified in the packet by source. Due to source routing in DSR, the routing loop, either short-lived or long-lived, cannot be formed as they can be detected and removed immediately [14] [15] [18]**.**

There are numerous mobility models, but since we have taken one mobility model for our research that is Random way point Mobility Model. In Random Way Point Mobility model each node selects uniformly at random a destination point, called waypoint, in the simulation area. The node move toward this Reactive Routing Protocol In these routing protocols, routes are determined on-demand. That is when a node wants to transmit the data packets; it initiates the route discovery process to the destination, destination with velocity selected uniformly at random [Speedmin, Speedmax]. When node reaches its destination, it pauses for some predefined time, called pause time. After pause time, the same process is repeated by the node. If pause time in Random Waypoint mobility model is equal to 0 then this model behave similar to random walk mobility model [16].

2. RELATED WORK

There are many research papers with the performance evaluation of Adhoc network protocols but they use different metrics to evaluate there results instead of nodes mobility and nodes velocity some of them. In this section an overview of some papers is covered. In the paper [4], the authors investigate the performance of TCP of various (single-hop and multi-hop) routing protocols for mobile ad hoc networks. Using *ns*-2, here the Authors evaluate the TCP window size, throughput and packet delay over a single TCP connection. And there results shows that the various performance metrics are tightly related, and that TCP performance is tightly coupled with the stability and length of the routing path of each routing protocol.

A variety of routing protocols have been proposed for Mobile Ad-Hoc Networks. However, little attention has been paid to study the performance of TCP traffic over these protocols. Therefore the authors investigate the performance of TCP over multi hop routing protocols using simulations in *ns*-2 for a range of node mobility with a single traffic source. The performance metrics that they considered include TCP window size, throughput and packet delay. Based on numerical results, they show that TCP performance is tightly coupled with the stability and length of routing paths. Therefore they plan to investigate TCP performance of routing protocols with multiple traffic sources.

In the paper[6] the Authors shows that the Ad-hoc networks offer challenges to TCP's congestion control mechanism related to its inability of distinguishing between losses induced by congestion and others types of losses. There are numerous articles to deal with this issue that can be broadly categorized to either end-system based or network-assisted. In this paper the author present a summary of those articles with emphasis on their distinguishing characteristics. The author of the paper also present the performance study of an end-system based mechanism that performs precise detection of network states by measuring appropriate metrics. They evaluate its performance under variety of network conditions running different class of routing protocols DSR (reactive) and DSDV [5] (proactive). Their performance study shows the effect of different factors in isolation and in combination with each other on the TCP performance, and the impact of routing protocol design approaches in the TCP stability.

In the paper [7] the authors discussed the impact of AODV and DSDV routing protocols on the TCP through put, delay and drop rate performance. Their Extensive simulation results and analysis showed that TCP has better performance over AODV than over DSDV and has more stable performance in SN mobility than in RW mobility. Therefore they suggest using more mobility models, in particular, such as SN, in the evaluations of the transport layer or routing layer protocols because the mobility patterns have impacts on the protocol performance. In this work, they evaluate the TCP performance including the good put, delay and drop rate over AODV or DSDV routing protocol in Random Waypoint mobility model and in Social Network mobility model. Extensive simulation results and analysis showed that the TCP performance is better over AODV than over DSDV because of its higher good put, lower drop rate and is more stable in different mobile host speed scenarios, in the scenarios generated by both Social Network mobility model and Random Waypoint mobility model.

In the paper [8], the authors evaluate AODV and OLSR performance in realistic urban scenarios. They studied those protocols under varying metrics such as node mobility and vehicle density, and with varying traffic rates and show that clustering effects created by cars aggregating at intersections have remarkable impacts on evaluation and performance metrics. They provide a qualitative assessment of the applicability of the protocols in different vehicular scenarios. In this paper, they evaluated the performance of AODV and OLSR for vehicular ad hoc networks in urban environments.

3. IMPLEMENTATION

In previous section we covered background and general concepts required to understand our research study. We studied basics of NS-2 the simulation tool we are going to use for implementation of our scenario.

a. Transmission Control Protocol (TCP)

On left side of the Fig 1 in module 4 we use Transmission control protocol which further use File transfer protocol (FTP) on application layer to deliver the data from sender to receiver.

b. User Datagram protocol (UDP):

On Right Side of the Fig 1 in Module 4 we use user datagram Protocol which uses constant Bit Rate (CBR) to send data packets from source to destination.

Performance Metrics

This is the most important chapter in our thesis, since it deals with the performance evaluation of Ad-Hoc Network routing protocols (AODV, DSDV, DSR) with both TCP and UDP under variable nodes density. The performance metrics we used here are packets received, packets lost, Nodes velocity, Delay and Overload etc

a. Throughput The amount of data transferred from one place to another or processed in a specified amount of time. Data transfer rates for disk drives and networks are measured in terms of throughput. Typically, throughputs are measured in kbps, Mbps and Gbps

Percentage throughput = (No. of pkt received / No. of pkt sent)* 100

b. Packet Received

Packet received is equal to number of packets send form source minus number of packet loss in the path to destination.

No of Packets Received = No of pkt send – No of pkt Loss

c. Delay

The average time taken by the data packet to reach the intended destinations, here we considered Average End-to-End delay. This include delay occurred due to different reasons like queuing delay, propagation delay, processing delay etc. it is an important parameter for delay sensitive application like multimedia application. It is also very important for application where data is processed online.

Packet Delay = packets receive time – Packet send time

d. Overload:

Overload is the extra information which is needed to deliver the packet to its right destination. It depends on the routing protocol which you are using for communication.

Routing Overhead = Total packet size – payload size

4. RESULTS

In this section we present the results of different scenarios.

I. Result of Packet Received Vs Velocity in UDP

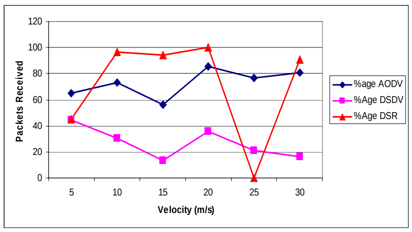

Fig .1 Pkt Received Vs Velocity in UDP with 50 Nodes

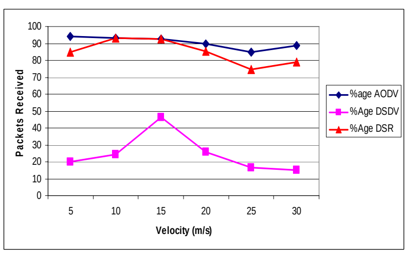

Fig .2 Pkt Received Vs Velocity in UDP with 75 Nodes

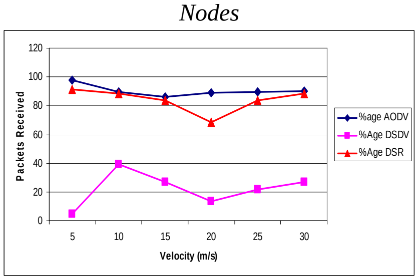

Fig 4. Pkt Received Vs Velocity in UDP with 100 Nodes

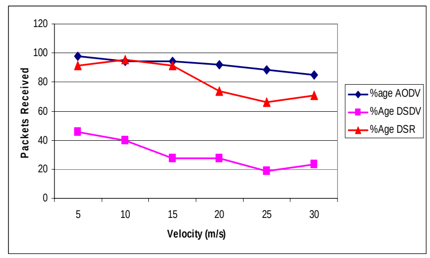

Fig 5 Pkt Received Vs Velocity in UDP with 125 Nodes

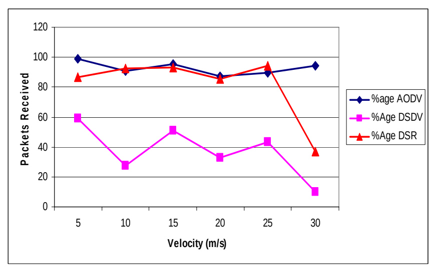

Fig .6 Pkt Received Vs Velocity in UDP with 150 Nodes

II. Result of Packet Received Vs Velocity in TCP

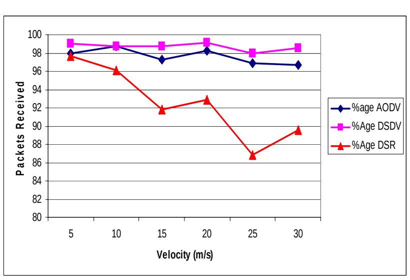

Fig 7. Pa Received Vs Velocity in TCP with 50 Nodes

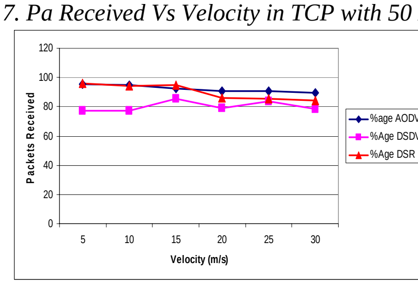

Fig 8.Pkt Received Vs Velocity in TCP with 75 Nodes

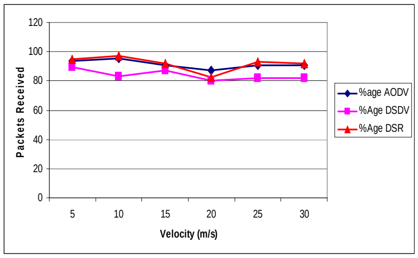

Fig 9 Packet Received Vs Velocity in TCP with 100 Nodes

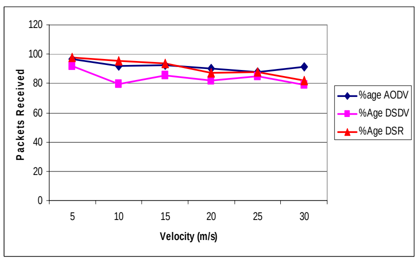

Fig 10.Packet Received Vs Velocity in TCP with 125 Nodes

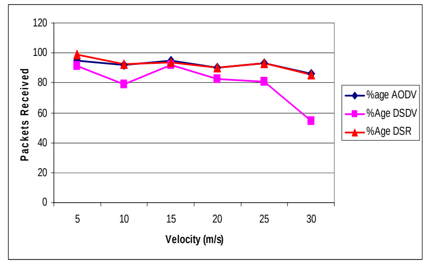

Fig 11.Packet Received Vs Velocity in TCP with 150 Nodes

III. Results of Overload Vs Velocity in UDP

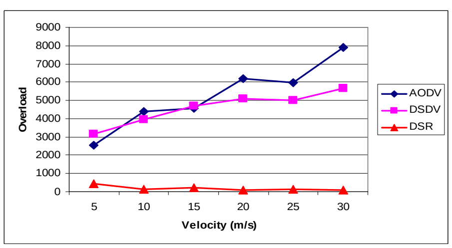

Fig 12.Overload Vs Velocity in UDP with 50 Nodes

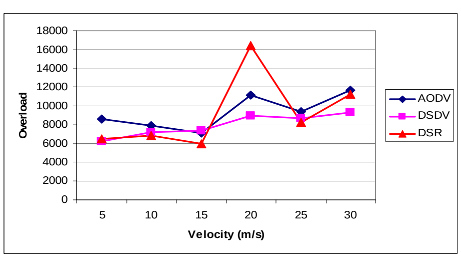

Fig 13. Overload Vs Velocity in UDP with 75 Nodes

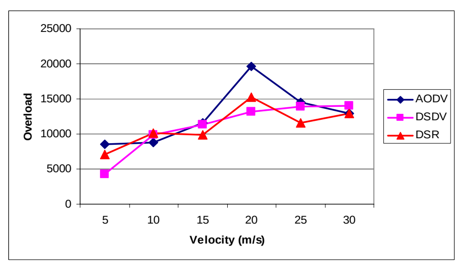

Fig 14. Overload Vs Velocity in UDP with 100 Nodes

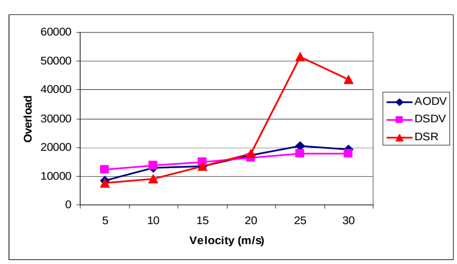

Fig 15. Overload Vs Velocity in UDP with 125 Nodes

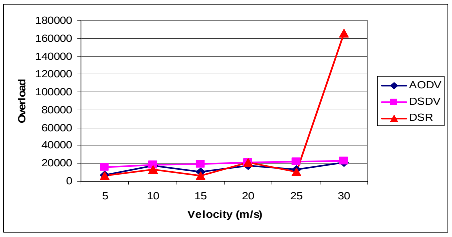

Fig 16. Overload Vs Velocity in UDP with 150 Nodes

IV. Results of Overload Vs Velocity in TCP

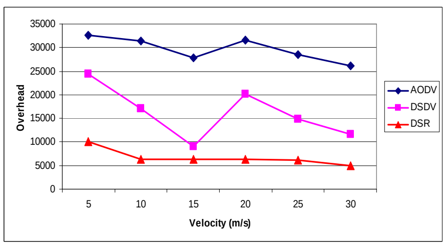

Fig 17. Overload Vs Velocity in TCP with 50 Nodes

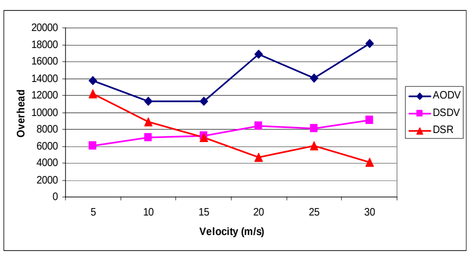

Fig 18. Overload Vs Velocity in TCP with 75 Nodes

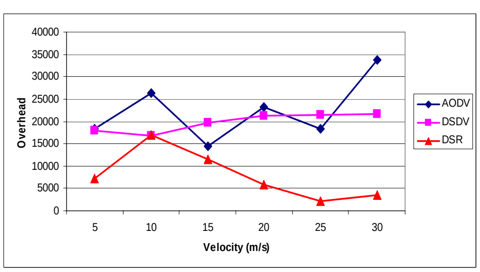

Fig 21. Overload Vs Velocity in TCP with 150 Nodes

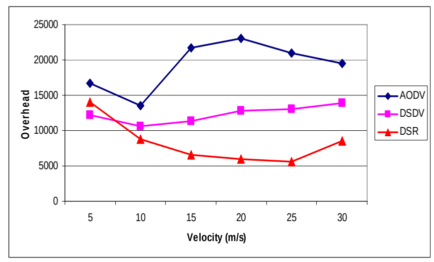

Fig 19. Overload Vs Velocity in TCP with 100 Nodes

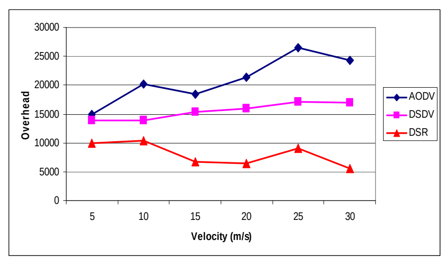

Fig 20. Overload Vs Velocity in TCP with 125 Nodes

5. Results of Delay Vs Velocity in UDP

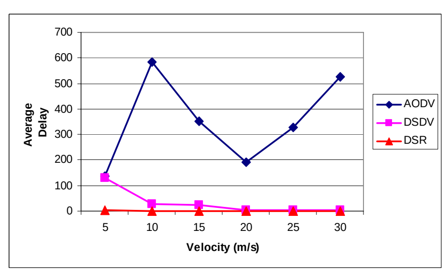

Fig 22. Avg. Delay (in seconds) Vs. Velocity in UDP with 50 Nodes

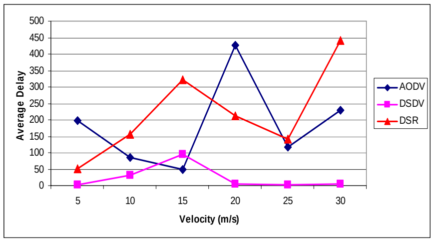

Fig 23. Avg. Delay (in seconds) Vs. Velocity in UDP with 75 Nodes

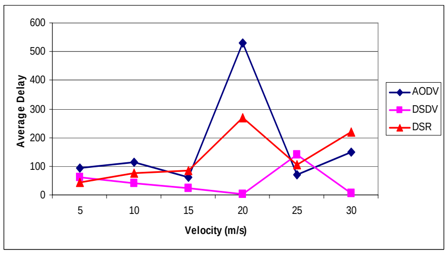

Fig 24. Avg. Delay (in seconds) Vs. Velocity in UDP with 100 Nodes

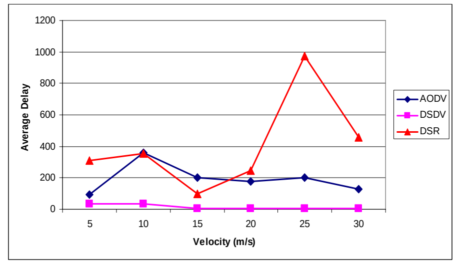

Fig 25. Avg. Delay (in seconds) Vs. Velocity in UDP with 125 Nodes

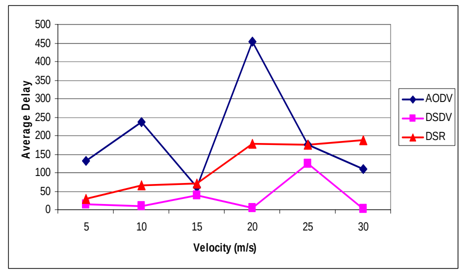

Fig 26. Avg. Delay (in seconds) Vs. Velocity in UDP with 150 Nodes

6. Results of Delay Vs Velocity in TCP

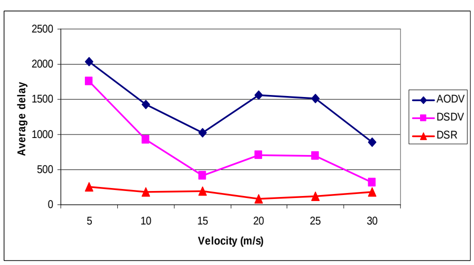

Fig 27. Avg. Delay (in seconds) Vs. Velocity in TCP with 50 Nodes

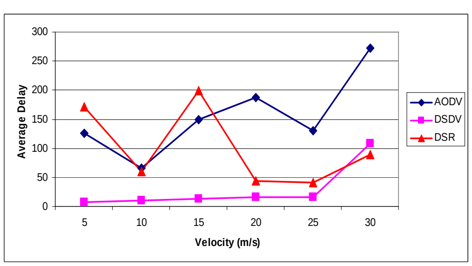

Fig 28. Avg. Delay (in seconds) Vs. Velocity in TCP with 75 Nodes

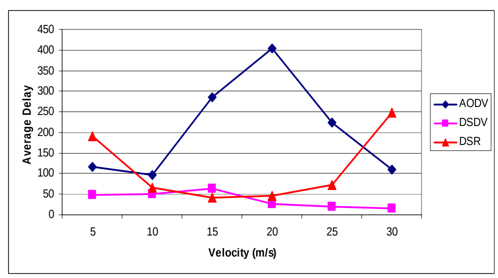

Fig 29. Avg. Delay (in seconds) Vs. Velocity in TCP with 100 Nodes

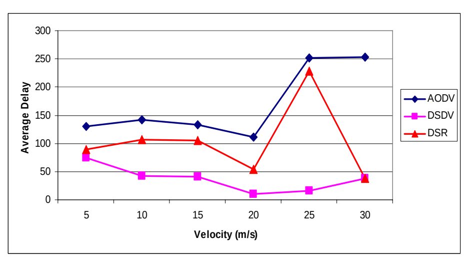

Fig 30. Avg. Delay (in seconds) Vs. Velocity in TCP with 125 Nodes

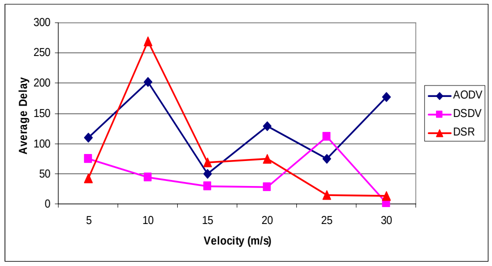

Fig 31. Avg. Delay (in seconds) Vs. Velocity in TCP with 150 Nodes

5. CONCLUSIONS

In our implementation the protocols are performing in an unpredictable fashion in most of the cases with varying nodes mobility and density. From Fig 2 to 31, it is clear that that node density plays an important role in the performance of Ad-hoc networks. Keeping all other parameters same and changing only node density effect performance of an ad hoc network routing protocol.

All the three protocols show mixed response to varying nodes density. Here the Performance of AODV and DSR in term of packet delivery is far better than DSDV.

Comparing results for both UDP and TCP, we conclude that all the protocols perform well under TCP as far as packets received are concerned. This is because in TCP, lost packets are retransmitted, unlike UDP. In UDP no mechanism for lost packets exists therefore packet delivery ratio is lower than TCP.

It has been noted that there is a trend of increase in packet delivery ratio of different protocols with increase in mobility (velocity) and node density. At small node density few data packets are delivered due to lack of routes. But when node density and connectivity increases the packet delivery ratio also increases. Due to faster node movement the link breakage will be more frequent. Even though the effective bandwidth seen at individual nodes suffer due to increased transmission power and collision. The delivery ratio still keeps on increasing compare to node density. It happens so because link breakages are less frequent and routes are maintained for relatively longer period of time. [25]

From Fig 22 to Fig 31 we conclude that there is trend of increasing end to end delay with increasing speed (velocity) and node density.

When nodes keep on moving more frequently there will be more topology changes and more link breakages. This will cause activation of routes discovery process to find additional links. Thus packets have to wait in buffers until new routes are discovered. This results in larger average delay.

We observed DSDV as poor protocol for mobile environment. This is because DSDV is a distance vector protocol, dependent on periodic broadcast. Therefore it needs some time to converge before a route can be used. This converge time can probably be considered negligible in a static wired network, where the topology is not changing so frequently. In an Ad-hoc network on the other hand, where the topology is expected to be very dynamic, this convergence time will probably mean a lot of dropped packets before a valid route is deleted.

In the last we must say that behavior of each protocol is different, in each scenario a protocol may perform better with low node density and velocity but with the increase in node density and velocity give poor performance. Similarly we should also keep in mind about our scenario parameters both constants and variable.

6. FUTURE WORK

Ad-hoc wireless is the hot area of research now-a-days. This resulted in the development of large number of protocols for Adhoc networks. Therefore plenty of work is required to be done to evaluate the performance of these protocols in different real world scenarios. Therefore we also have some other parameters such as nodes pause time, transmission range, simulation time and node density which may affects the performance of protocols in term of its packet delivery ratio, overload, and delay. Therefore my plan of work is to move this Research work forward and change other parameters one by one and observe the performance of each protocol in each particular scenario in term of

its packet delivery ratio, delay overload, throughput, and out-of-order delivery etc.
We have observed that different protocol perform differently in different scenario. There is no single protocol that performs well in all scenarios with all perspectives. Therefore there is a need to design such protocols which perform efficiently in every scenario.

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