Performance Comparison of CBR in MDVZRP with DSDV and AODV

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Abstract— **we have previously developed a new routing protocol for Ad hoc networks in name of multi-path distance vector zone routing protocol (MDVZRP). In this paper the new routing protocol MDVZRP is compared with DSDV and AODV standard protocols delivering CBR traffic. Simulation results show that MDVZRP gives better performance than DSDV and AODV when mobility is low.**

Keywords: MDVZRP, CBR and performance

Keeping the routing overhead minimal is the key to design an efficient routing protocol for mobile ad hoc network MANET [3]. This type of networks is a non infrastructure, self-configuring and decentralized set of mobile nodes. The node moves at different speeds in independent random form, connected by any number of wireless links, where each node is ready to pass or forward both data and control traffic unrelated to its own use ahead (*Routing*) to other nodes in a flexible interdependence of wireless communication in between. In contrast to infrastructure wireless networks, where the communication between network nodes is take place by a special node known as an access point . It is also, in contrast to wired networks in which the routing task is performed by special and specific devices called routers and switches.

In general, MANET topology is dynamic, because of node departure and new node arrival during the connectivity time among the nodes, and asymmetrical, because the nodes communicate over wireless links have a different transmission range. Hence this environment is dynamic, the primary challenge is to maintain up to date routing information at each node in The MANET.

Such environment can be used to establish a standalone, or a large network (*Internet*) connection.Therefore, there is a demand for efficient routing protocols to offer optimum routes during the network establishing time to allow the network nodes to communicate over multi hop paths. In the following section we give a brief overview about MDVZRP, then simulation models and the performance study.

Our goal in this paper is to carry out a performance study of two standard dynamic protocols DSDV [2], AODV [6] for ad hoc networks and compare their performance of CBR traffic with our new routing protocol MDVZRP[1,5].

I. MDVZRP PROTOCOL DESCRIPTION

A node in MDVZRP has a flat view over most the network nodes but not all of them, when it joins the network and broadcasts a beacon message for the first time. It is easy to save and get ready multipath to most of the destinations in the network by broadcasting and receiving *Beacons* and Routes Update Packets *RSUP* (*routing information*) to and from all its one hop neighbours to build and save its own routing table. In the event that a route to a node is not known, and transmission needs to take place immediately the protocol exhibits its reactive nature. This is through the use of broadcast Route Request *RREQ* and unicast Route Replay *RREP* messages.

Since all nodes proactively store local routing information, route requests can be efficiently performed without querying all the network nodes. For reducing the overhead in general, the node checks its routing table when it receives a *Beacon* for any significant changes. For an example, in case a node received a new routing information *new route / routes* or discovered an active broken link or non reachable node, instead of broadcasting an update packet regarding to the new routing information or an immediately error message regarding to that broken link or non reachable node as we proposed in an early versions of MDVZRP, the new version of MDVZRP which we are going to evaluate in this paper includes the routing information it got since the last beacon it has broadcasted in a *RSUP* packet instead of broadcasting an empty *Beacon*.

RSUP and *Beacon* have same format and purpose (*heart beats*) but the only difference between is that the *Beacon* is an empty heart beat packet, while *RSUP* is a heart beat packet includes any new routing information. Therefore, the node should broadcast either a *RSUP* or *Beacon* by the Beacon time. Also, we have used zones technique rather than the whole network flooding one during the route discovery by *RREQ* messages.

II. SIMULATION MODELS

In our study and evaluation for the three protocols DSDV, AODV and MDVZRP we have used the radio propagation simulation model based on ns-2 [4] (v2.30). The IEE802.11 protocol [7] (*DCF*) Distributed Coordination function is used as the MAC layer protocol.

The mobility mode is a Random Way Point *RWP* in a rectangular field. Two fields are used in this simulation study 550x500 and 750x600 m with 20, 60 and 100 nodes, where each node at the start of the simulation time remains fixed for an instance of time from 0-100 seconds (*Pause time*), then choose a random destination from its location and starts its journey towards it with a randomly selected speed, uniformly distributed between 0-20 m/sec, compared to the traffic speed inside the cities this is a fairly speed for an ad hoc network.

Once the node reaches that desired destination, it stops for a pause time interval, and then another random destination is targeted with same or different speed. The relative speeds of the mobiles are affected by varying the pause time, (which can be seen clearly in this paper graphs). The simulation time of each scenario is run for 100 seconds. The traffic sources used are Constant Bit Rate (*CBR*) with 512 byte data packets in 4 packets per second per source, where each pair of source and destination is randomly distributed over the network.

For fairness, across the three protocols, identical scenarios in mobility and traffic are used and repeated for 10 times. Therefore, each data point in this paper graphs represents an average of 10 iterations. Also, in this simulation model we assume that each node has sufficient power to function properly throughout the simulation time.

III. SIMULATION MODELS SUMMARY

- Area: 500x550 meters
- Number of nodes: 20,60 and 100
- Simulation duration: 100 seconds
- Number of iteration: 10
- Confidence interval : 95%
- Physical/Mac layer: IEEE 802.11
- Transmission range:250 meter
- Mobility model: RWP
- Pause time : 0-100 seconds, with 20 second increment
- Traffic source: CBR

IV. PERFORMANCE METRICS

The primary metrics we carried out to evaluate the performance of the three protocols were Packet Delivery Fraction (PDF), Average End to End Delay (AEED), Throughput, Normalized Routing Load (NRL) and Overhead (OH), but in this paper we are only presented the following metrics:

Packet Delivery Fraction: is the ratio of received packets by CBR sink at destination over sent packets by constant bit rate source (CBR,"application layer"). This metric actually tells us how much reliable the protocol is. It describes the loss rate that will be seen by the transport protocol, which in turn affects the maximum throughput the ad hoc network can support.

$$\text{PDF} = \frac{\sum CBR\ \text{Re}ceived\ Packets\ by\ CBR\ destination}{\sum CBR\ Sent\ Packets\ by\ CBR\ sources} x100$$

Normalized Routing Load: It is the number of routing packets transmitted per data packet delivered at the destination. Each hop –wise transmission of a routing packet is counted as one transmission.

$$\text{NRL} = \frac{Routing\ Control\ Packets}{Data\ Packets\ Delivered}$$

Average End-to-End Delay: is the delay that could be caused by buffering during route discovery, queuing delays at interface queues, retransmission delays at the MAC, and propagation and transfer times.

$$\text{EED} = \frac{1}{N}\sum_{n=1}^{N}(r_n - s_n)$$

s_n = Time that data packet n was sent

r_n = Time that data packet n was received

N = Total number of data packets received

Routing Overhead: It is the sum of all the routing control packets sent during the simulation time. The control packets include all MDVZRP's routing packet such as Beacon, FRIP, RSUP, RREQ, and RREP. For all the forwarded packets over multiple hops, each packet transmitted over multi hops counts as one transmission.

$$\text{OH} = \sum \mathit{Transmissions\ Of\ Routing\ Packets}$$

This metric is important to compare the performance of routing protocols over scalability and power consumption (*less routing packets sending is less power consumption*). Also, the probability of packet collision is increased with increasing of sending routing packets where that may increases the delay data packets to be send or waiting in the queues.

V. SIMULATION CONFIDENCE INTERVALS

Each point on the graph is an average of the results obtained from the 10 iterations performed. This study shows the spread in the data collected. 95% a sample of confidence intervals for PDF are given in Table 1, and shown in Figure 1. Confidence intervals for the other metrics are of similar magnitude, but are omitted from the graphs for clarity.

Table 1: A sample of 95% PDF confidence intervals

Parameters	DSDV		AODV		MDVZRP	
Num. of Nods	PDF %	Confidence Interval	PDF %	Confidence Interval	PDF %	Confidence Interval
20	85.31	2.48	99.6	2.48	98.9	2.49
60	86.23	4.36	98.85	4.40	98.87	4.43
100	83.97	6.14	92.87	6.81	97.09	6.85

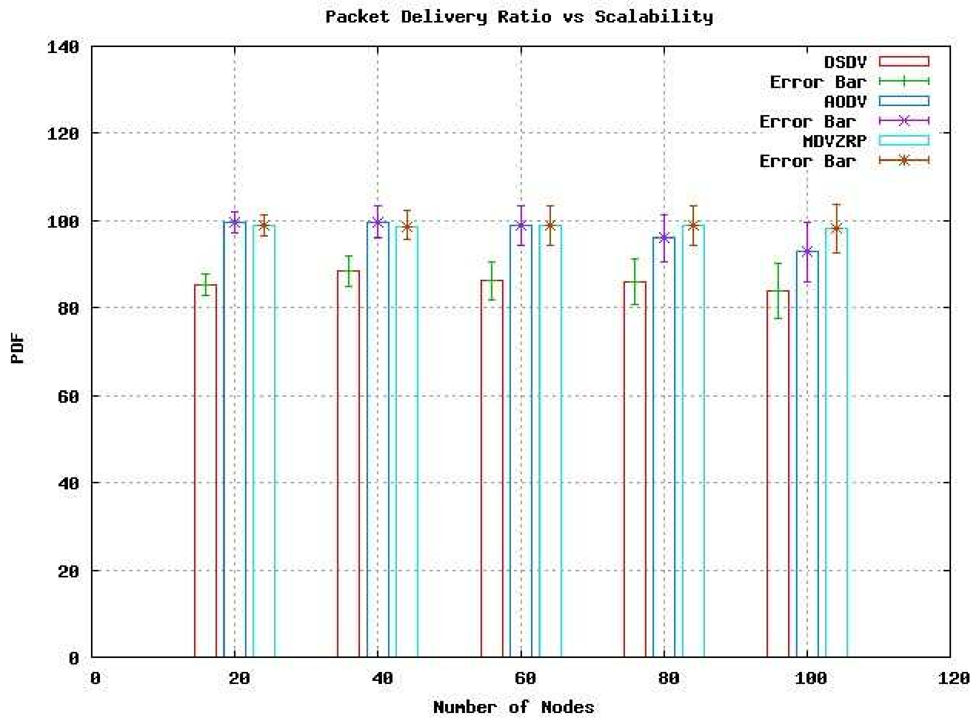

Figure 1: PDF 95% confidence interval and error bars

VI. PERFORMANCE RESULTS

We have divided our study into three sets of experiments; the first set studies the performance of the three protocols over a small number of nodes (*20 nodes*) with 10, 15 and 20 traffic sources, while the second and third are 60 and 100 nodes respectively with 20, 30 and 40 traffic sources and a packet rate of 4 packets/s. By the way, for 40 sources we kept the same packet rate (*4 packets/s*) because we would like to see the affect of the congestion on the three protocols performance as well.

In this paper, we are going to demonstrate only the performance of the three protocols regarding to 20, and 60 nodes only, because of space and pages number.

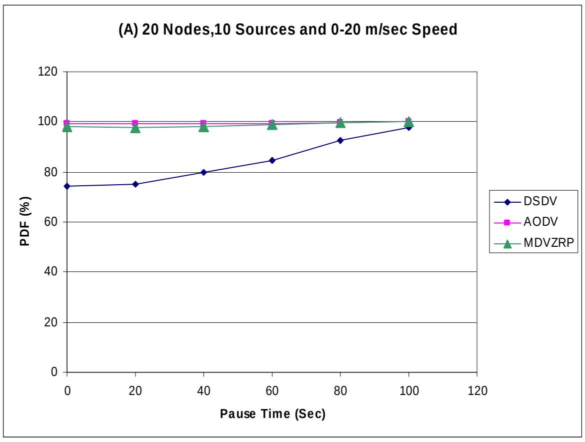

Fig (2A): PDF for the 20 nodes model with 10 sources and various speeds

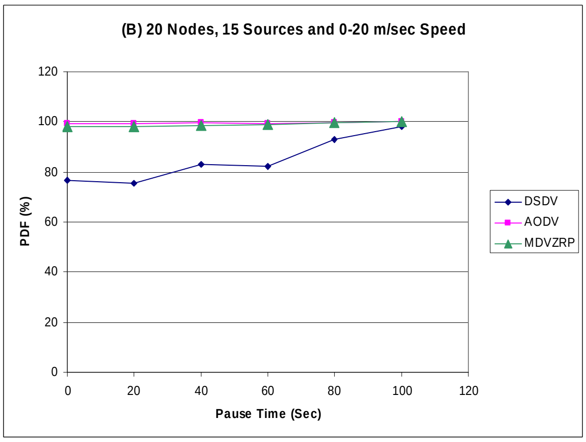

Fig (2B): PDF for the 20 nodes model with 15 sources and various speeds

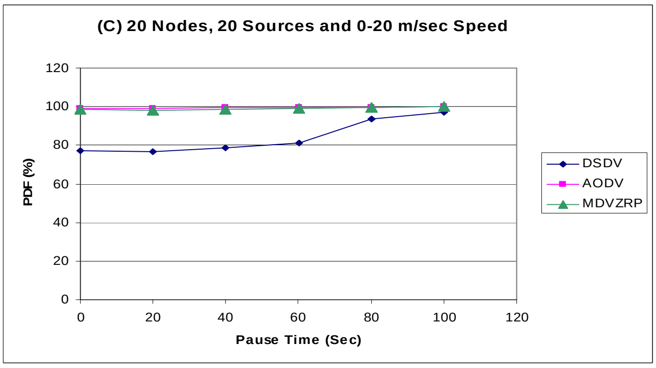

Fig (2C): PDF for the 20 nodes model with 20 sources and various speeds

The Packet Delivery Fractions for both AODV and MDVZRP are very similar with 10, 15 and 20 sources in the first set of 20 nodes network as shown in Figures (2A-2C), while DSDV has a less performance at lower pause times *higher mobility*. MDVZRP shows a best NRL in all cases, while AODV show highest NRL at the high mobility times, where decreases gradually as the network tends to be a stationary as shown in Figures (3A-3C), that because both AODV and DSDV compared to MDVZRP generates more packets per data packet, which made both AODV and DSDV have produced higher overhead than MDVZRP in all scenarios as shown in Figures (5A-5C).

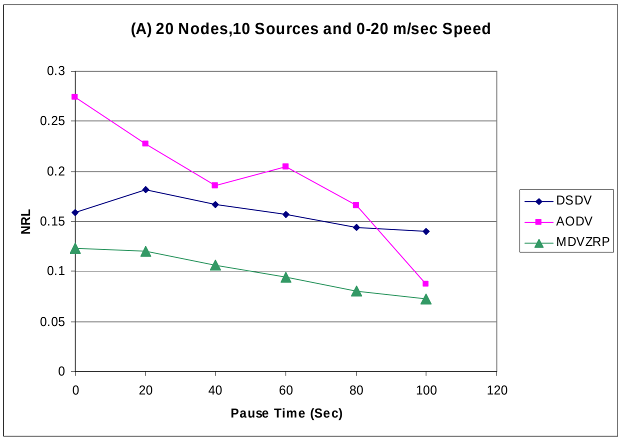

Fig (3A): NRL for the 20 nodes model with 10 sources and various speeds

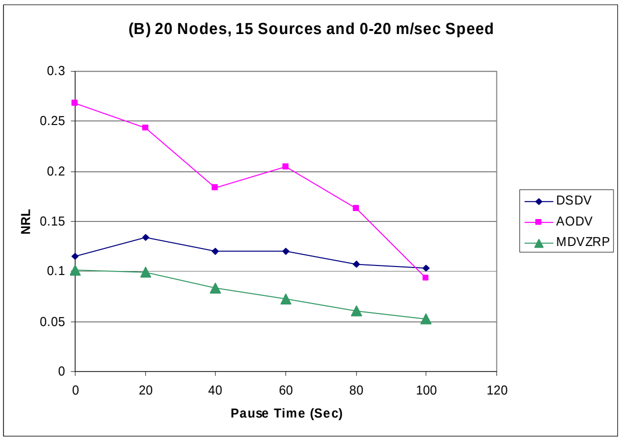

Fig (3B): NRL for the 20 nodes model with 15 sources and various speeds

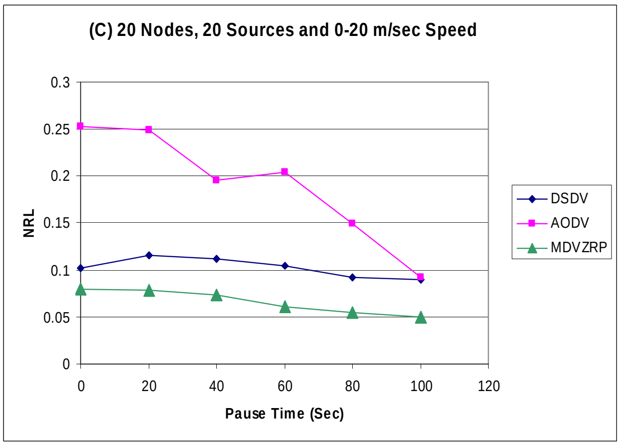

Fig (3C): NRL for the 20 nodes model with 20 sources and various speeds

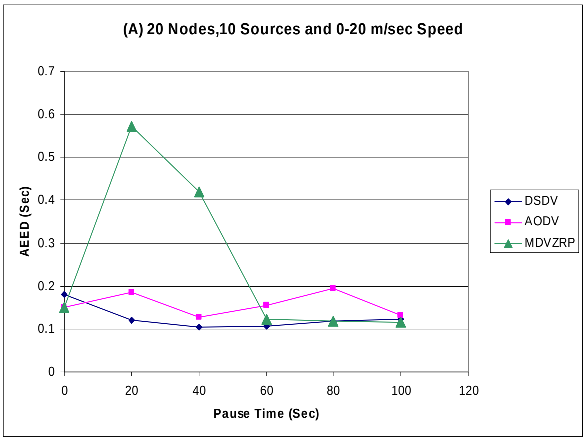

Fig (4A): AEED for the 20 nodes model with 10 sources and various speeds

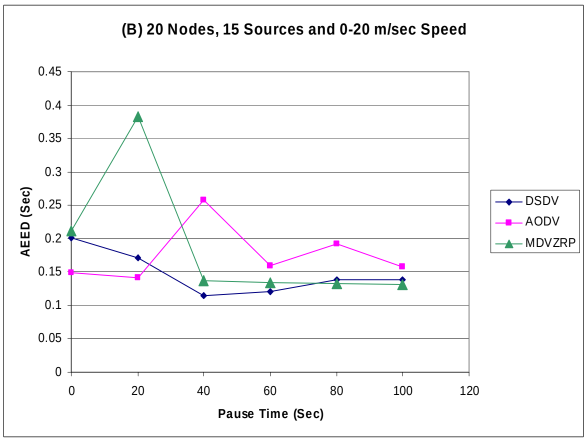

Fig (4B): AEED for the 20 nodes model with 15 sources and various speeds

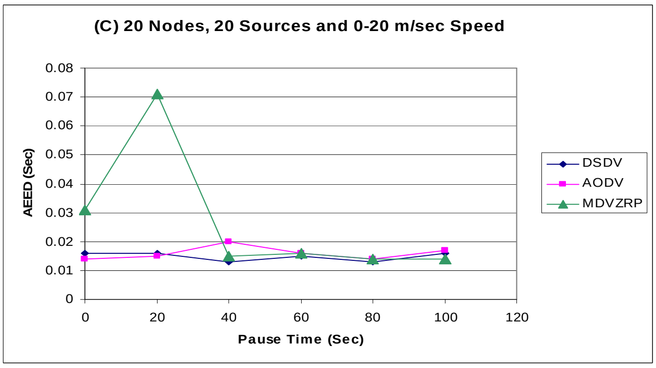

Fig (4C): AEED for the 20 nodes model with 20 sources and various speeds

The relative performance of the three protocols with respect to AEED is similar as the network size increases and tends to low mobility where that can be seen clearly in figure (4C). However, AODV shows a better AEED than MDVZRP at high mobility as shown in Figures (4A-4C). That refers to data queued for longer in MDVZRP because of *RREQ* and *RREP* mechanism, which takes longer in MDVZRP than AODV, that because each intermediate node checks the whole its routing table to see if it has a route to the required destination during the *RREQ* receive mechanism, and some of the intermediate nodes do the same thing again to get routing information during the *RREP* receive mechanism.

Increasing of speed with short pause time increases the possibility of links breakage, and hence that increases the possibility of using routes on demand where that requests from MDVZRP to call RREQ/RREP many times, which effects negatively in AEED. We can see that clearly in Figures (4A-4C) at pause time 20 sec.

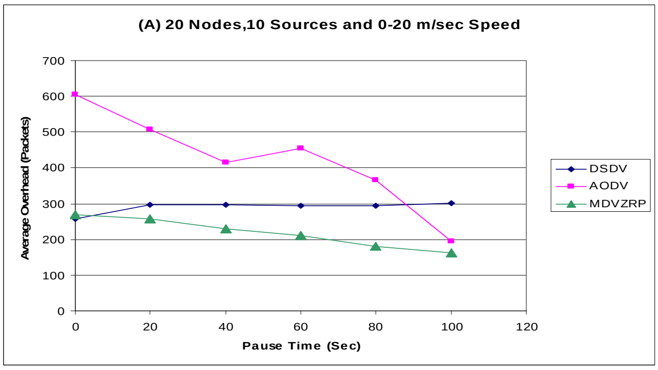

Fig (5A): Average Overhead for the 20 nodes model with 10 sources and various speeds

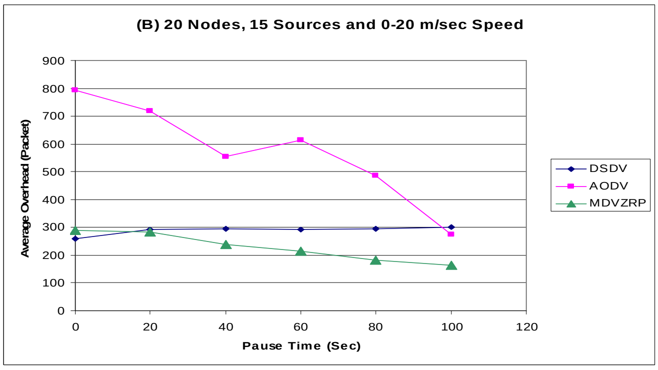

Fig (5B): Average Overhead for the 20 nodes model with 15 sources and various speeds

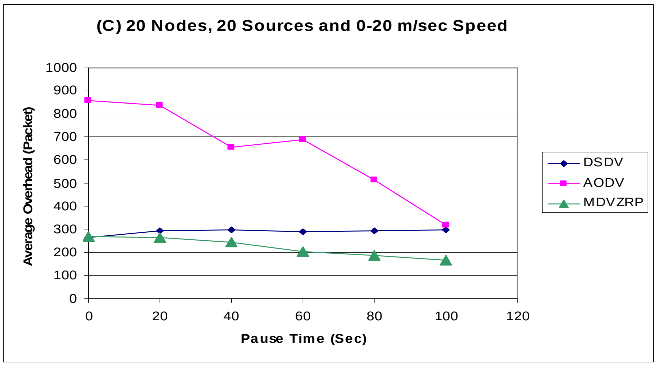

Fig (5C): Average Overhead for the 20 nodes model with 20 sources and various speeds

For the 60 and 100 nodes experiments as well, we have used 20, 30 and 40 sources, with same and fixed data rate 4 packets/sec. In Figure (6A), note that MDVZRP has similar PDF to AODV for 20 sources. While AODV shows a little bit better performance as the mobility increased with 30 and 40 sources as shown in Figures (6B, 6C).

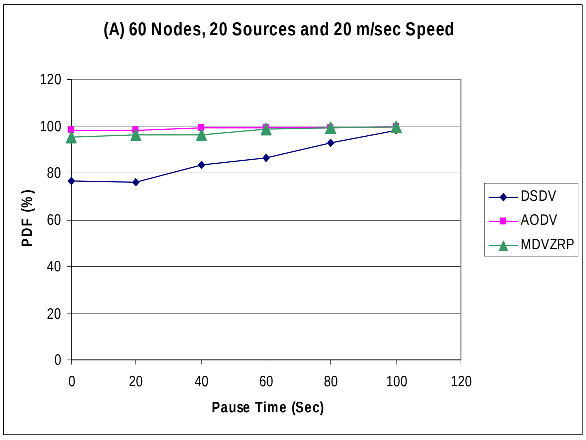

Fig (6A): PDF for the 60 nodes with 20 sources and various speeds

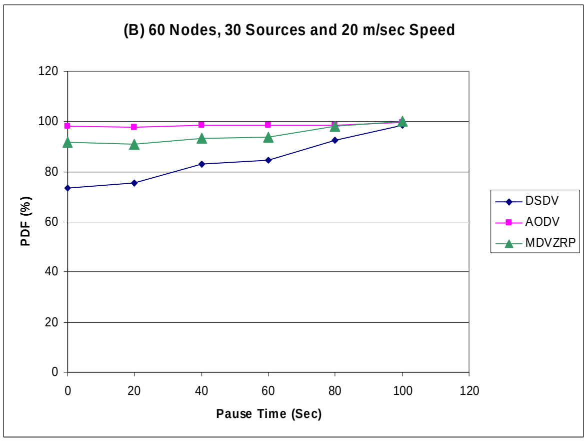

Fig (6B): PDF for the 60 nodes with 30 sources and various speeds

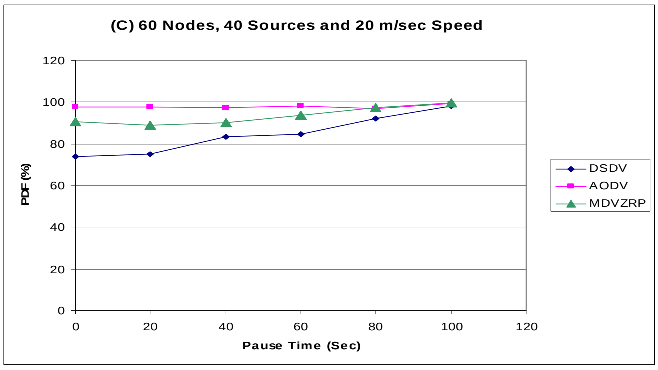

Fig (6C): PDF for the 60 nodes with 40 sources and various speeds

Because fewer control packets broadcast for each data packet, MDVZRP still achieves better NRL and overhead in all scenarios, specially in high mobility network scenarios. The difference in both NRL and overhead control packets are 5 times more in AODV for 60 nodes than in 20 nodes network as shown in Figures (7A-7C) and (9A-9C).

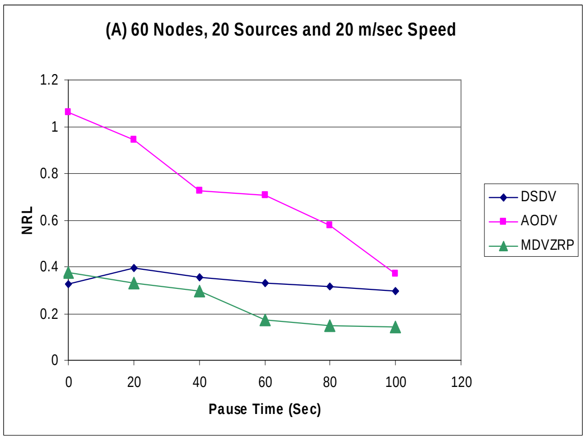

Fig (7A): NRL for the 60 nodes with 20 sources and various speeds

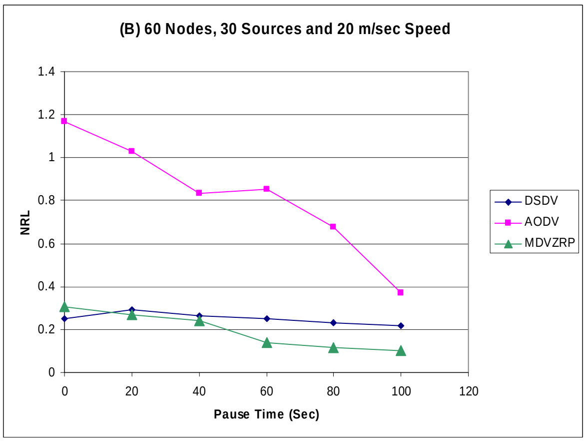

Fig (7B): NRL for the 60 nodes with 30 sources and various speeds

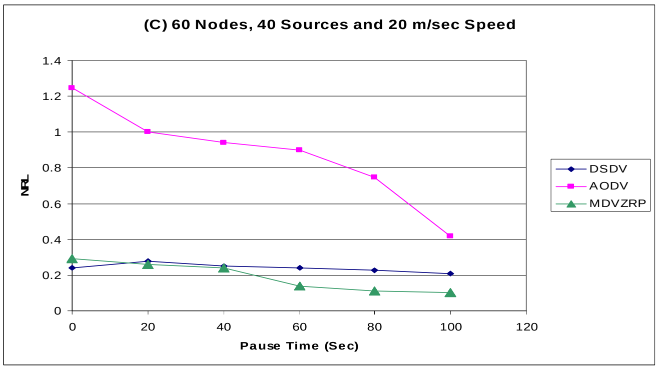

Fig (7C): NRL for the 60 nodes with 40 sources and various speeds

However, MDVZRP's delay is still higher than both AODV and DSDV at high mobility, but shows better delay performance at low mobility than the other two protocols as shown in the following figures (8A-8C).

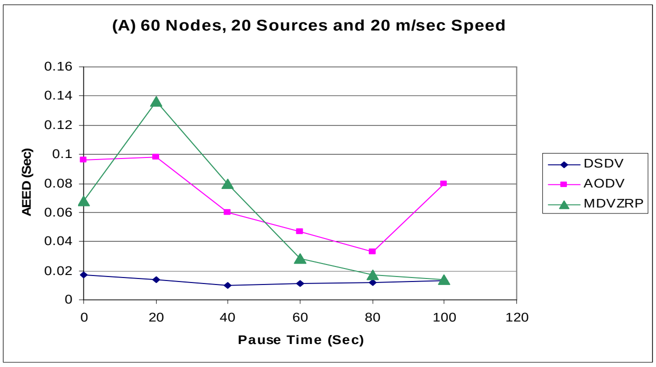

Fig (8A): AEED for the 60 nodes model with 20 sources and various speeds

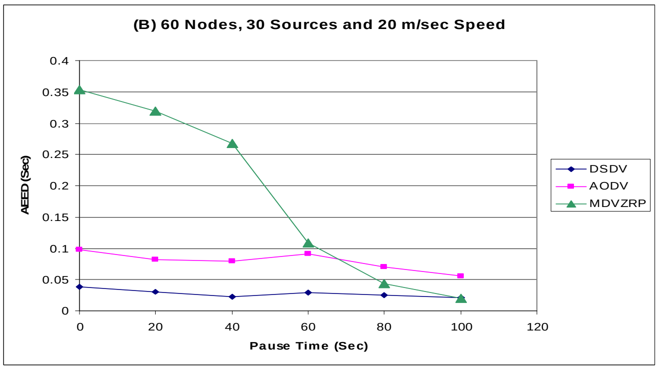

Fig (8B): AEED for the 60 nodes model with 30 sources and various speeds

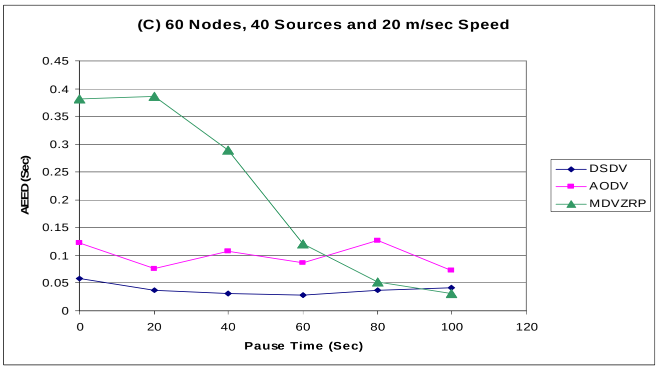

Fig (8C): AEED for the 60 nodes model with 40 sources and various speeds

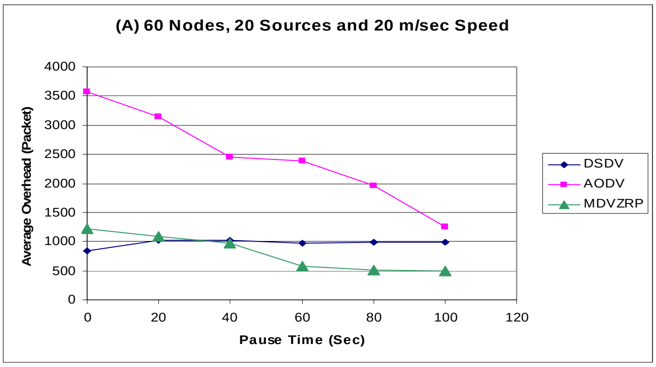

Fig (9A): Average Overhead for the 60 nodes model with 20 sources and various speeds

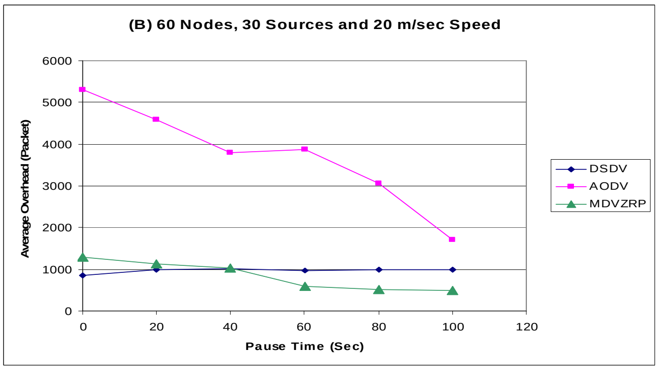

Fig (9B): Average Overhead for the 60 nodes model with 30 sources and various speeds

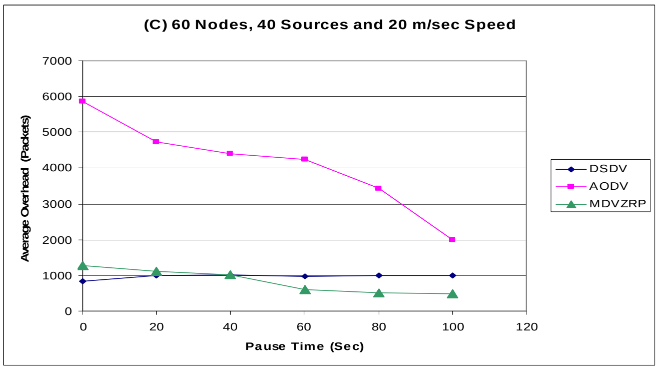

Fig (9C): Average Overhead for the 60 nodes model with 40 sources and various speeds

VII. CONCLUSION AND FUTURE WORK:

We have compared the performance of our hybrid dynamic routing protocol MDVZRP with two standard routing protocols DSDV and AODV. Both are single path routing protocols, where DSDV is a proactive while AODV is a reactive on demand routing protocol, moreover, both are using routing tables to save one route per destination and destination sequence number to refresh that routing tables. The general observation in all cases, from all scenarios and network sizes, we found that MDVZRP has outperformance DSDV, but compared to AODV it has outperformance only in low mobility networks despite stressful situations, such as number of nodes, mobility and load.

The interesting observation is that MDVZRP has less NRL and overhead than AODV by 25%. However, the MDVZRP performance regarding to the end to end delay at high mobility scenarios and large size networks is due to three reasons:

The first one is routing table size for keeping all the active routes to each destination due to multipath mechanism. Increasing of speed with short pause time increases the possibility of links breakage. Moreover, nodes carrying Semi-sequential search where that delays route replay *RREP*, and *RREQ* rebroadcasting in case of no route available to the required destination, the second reason is the lack of any mechanism determines routes freshness when multipath choices are available, and the last is gathering any routing information pass through the intermediate nodes especially during route replay mechanism *RREP*.

Hence, our protocol MDVZRP achieved a good performance for low mobility networks, we plan to investigate and develop the mechanism of *RREQ* and *RREP* to be more reliable and efficient for reducing AEED in high mobility networks as a continuation to this research.

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