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Evaluation of Routing Protocols for VANETS in different Mobility Scenarios

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Abstract—*Vehicular Ad-Hoc Network (VANET) is a type of ad-hoc network in which communication between vehicles on the road network occurs. Two types of communication are there: 1) Vehicle to Vehicle (V2V) and 2) Vehicle to Infrastructure (V2I).VANET has three major applications: 1) Road Safety 2) Internet Applications 3) Traffic Management. It's characteristics like high mobility , rapid changing topology and different network density make data dissemination difficult. In this paper, the performance of routing protocols AODV, AOMDV, DSDV,DSR and AntHocNet are examined for different performance metrics in different mobility scenarios at different node densities. The evaluations will be done in three different mobility scenarios that is Manhattan scenario, Jalandhar scenario and Random scenario. Also, the performance of these protocols will be analyzed by using various parameters like bandwidth, packet size, etc.*

Keywords*: VANET, Mobility, Routing Protocols.*

1. INTRODUCTION

VANETS are a kind of "computer network on wheels". There are many *casualties on the roads daily all across the globe. So, if timely and dynamic information about road traffic conditions are provided, there are chances to avoid the accidents and traffic jams. VANET has characteristics like short range of transmission, low bandwidth, omni-directional broadcast and no power constraint.*

Fast changing network topology and varying communication conditions pose a great challenge for routing protocols being used in VANETS [1].Routing protocols need to be robust need to be robust, reliable, minimize latency and network load for VANETS. For achieving more realistic results, different mobility scenarios has been developed and evaluation of the performance of the routing protocols has been done.

2. RELATED WORK

Some of the related work has been described below:

1) *Hannes Hartenstein et al.* [3] presented an overview of the field and provide motivations, challenges, and a snapshot of proposed solutions.

2) *Dharmendra Sutariya et al.* [1] evaluated the performance of routing protocols in city traffic scenarios , they developed a realistic city mobility model with use of MOVE. The performance of routing protocols AODV, AOMDV, DSDV and DSR are examined .Results are then analyzed based on the different Performance metrics to find their suitability of these protocols for vehicular area networks.

3) *Tajinder Kaur et al*. [11] studied the behavior of AODV in real world mobility model generated using MOVE. The performance of AODV is analyzed and compared in three different node density that is, 4, 10 and 25 nodes with respect to various parameters like Throughput, Packet size, Packet drops, End2End delay etc.

4) *Soumen Saha et al.* [8] presented a comparative test of various mobility scenarios of VANET in three Indian metros (Kolkata, Chennai and Mumbai) by using AODV protocol. The simulation tool used is NCTuns-6.0

5) *Syed A.Hussain et al.* [10] presented a comprehensive analysis of currently available networking and traffic simulators for VANETS including interaction between the two.

6) *Jagdeep Kaur et al*. [4] analyzed the performance comparison between unicast and multicast routing in VANETS.

7) *Soni Shaik et. al* [7] did the performance evaluation of AntHocNet, AODV and DSR by using the network simulator ns-2.34 at different pause times, different speeds, different number of nodes and also at different data rates. AntHocNet is based on the ant foraging behavior. It is based on Ant Colony Optimization (ACO) metaheuristic.

8) *Mary Valantina et al.* [13] evaluated the concept of introducing Mesh routers in the network thereby optimal route is selected which leads to a decrease in routing overhead, packet end-to-end delay and an increase in packet delivery ratio.

9) *Monica Patidar et al*. [6] evaluated the performance of the routing protocols Ad-Hoc On Demand Distance Vector

routing protocol (AODV), MAODV and Destination Sequence Distance Vector routing protocol (DSDV) in VANET. Their performance has been calculated on the basis of residual energy, packet delivery ratio, throughput, routing overhead and End2End delay.

3. PROBLEM FORMULATION

As road safety is a major application of VANET, there is a need to improve the performance of routing protocols. There are various routing issues like drop in packets, increased delay, increased normalized routing load and low throughput. As topology of VANETS changes very fast, these issues are of major concern. Also, it is important to analyze the performance of VANETS for various mobility scenarios and performance of QoS parameters need to be improved. There is a need to increase the PDR and throughput. At the same time, there is need to decrease the NRL, Avg. End2End delay and no. of dropped packets. Also, there is need to correlate the concept of real life world into networks which may help to improve the routing performance for VANETS. In this paper, the performance of routing protocols (AODV, AOMDV, DSDV, DSR) has been improved by using various parameters like bandwidth, packet size, etc. At the same time, the performance of these protocols is compared with AntHocNet protocol which is based on Ant Colony Optimization (ACO) metaheuristic. The evaluations will be done in three different mobility scenarios that is Manhattan scenario, Jalandhar scenario and Random scenario. Also, their performance will be evaluated at different node densities.

3.1 Routing Protocols

Two main classes of protocols can be distinguished as: location-based (position-based) and topology-based protocols. These protocols enable the exchange of data between distinct pairs of nodes, using intermediate network participants for forwarding packets on their way to the destination. Location-based routing protocols use additional information on the nodes geographical positions to find suitable routes. These positions may be e.g. the nodes GPS coordinates. However, when using location-based protocols, there is always a need for location services and servers. Topology-based routing protocols can be further classified as proactive, reactive and hybrid approaches [1].

Following protocols are some chosen ones for the exploration of mobility scenarios:

- AODV: Ad-Hoc On Demand Distance Vector is an improved version of DSDV, as its name suggest, establishes the route only when demanded or required for the transmission of data. By this mean, it only updates the relevant neighboring node(s) instead of broadcasting every node of the network. Three main control messages are used by AODV. These are Routing Request, Routing Reply and Route Error [11].
- DSDV: Destination Sequence Distance Vector is a proactive routing protocol where every node maintains a table of information (which updates periodically or when change occurred in the network) of presence of every other node within the network. Any change in network is broadcasted to every node of the network.
- DSR: Dynamic Source Routing is an on demand routing protocol like AODV. It maintains the source routing, in which, every neighbor maintains the entire network route from source to the destination [1].
- AntHocNet: It is based on Ant Colony Optimization (ACO) metaheuristic. AntHocNet [7] is a multipath routing algorithm that combines both proactive and reactive components. The algorithm is reactive in the sense that it only gathers routing information about destinations that are involved in communication sessions. It is proactive in the sense that it tries to maintain and improve information about existing paths while the communication session is going on.

3.2 Simulation Tools

To carry out the experiments those simulations tools are used which can produce realistic mobility scenarios. The various tools used for simulation, simulation configuration, performance metrics used for making various comparisons are discussed in this section.

1) *Network Simualtor-2 (NS2):* NS2 is used for simulations of protocols. It consists of two simulation tools. The network simulator (ns) contains all commonly used IP protocols. The network animator (NAM) is use to visualize the simulations [11]. In this project, NS-2.35 is used.

2) *Simulation of Urban Mobility (SUMO):* It is an open source, highly portable, microscopic road traffic simulation package designed to handle large road networks. It allows the user to build a customized road topology, in addition to the import of different readymade map formats of many cities and towns of the world. In this project, SUMO-0.12.3 is used [11].

3) *Mobility model generator for Vehicular networks (MOVE):* It is used to facilitate users to rapidly generate realistic mobility models for VANET simulations. MOVE is currently implemented in java and is built on top of an open source micro-traffic simulator SUMO [11].

4) *OpenStreetMap (OSM):* It was created by Steve Coast in UK in 2004. It is a collaborative project to create a free editable map of the world. It is one of the supported input format by SUMO.

3.3 Network Performance Indicators

Following performance metrics are used to analyze the simulation results:

- Normalized Routing Load (NRL): Normalized Routing load is the numbers of routing packets transmitted per data packet send to the destination. Lower the value of metric, more privileged is routing protocol.

- Dropped packets: It defines a total number of packets dropped during transmission of packet from source end to destination end. Lesser the no. of dropped packets , better is the performance of the protocol.

3.4 Network Parameters

The choices of the simulator parameters are presented in the following table.

Table 1: Simulation Parameters

Parameter	Simulated Value
Simulator	NS-2.35
Simulation Time	400 second
Mobility Scenarios	Manhattan, Jalandhar, Random
Antenna Model	Omni Directional Antenna
Radio Propagation Model	Two Ray Ground
Transmission Range	250m
MAC Type	IEEE 802.11
Interface Queue Type	Priority Queue (50 Packets)
Routing Protocols	AODV, AOMDV, DSDV, DSR, AntHocNet
Simulation Area	50000 m X 50000 m(Jalandhar), 1552m X 1552m(Manhattan and Random)
No of Vehicles	24, 48, 120 ,400
No. of TCP Connections	10

4. SIMULATION ENVIRONMENT

In order to evaluate the performance metrics for each case different simulations are carried out and then average value is used for plotting graphs. There are two cases calculated for all the performance metrics in the three scenarios.In first case, value of bandwidth is taken as 1Mbps and packet size is taken as 512 bytes. In the second case, value of bandwidth is taken as 5 Mbps and packet size is taken as 1024 bytes.

4.1 Manhattan Mobility Scenario

A realistic vehicular mobility scenario for Manhattan City is generated using MOVE. MOVE is built on top of an open source microtraffic simulator SUMO .

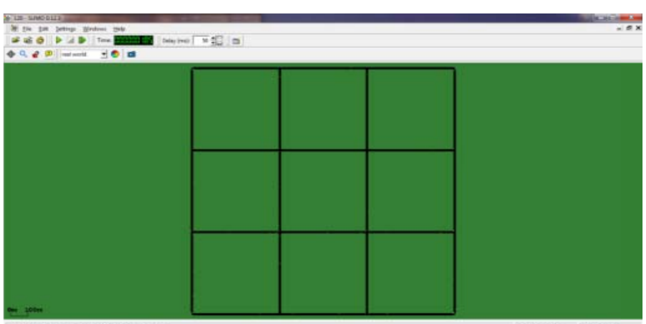

Fig. 1: Manhattan Mobility Scenario in SUMO

A vehicular mobility pattern defines vehicle motions within the road segment during a simulation time, which reflects, as close as possible, the real behavior of vehicular traffic such as traffic jams and stop at intersections [1].

City scene with Network Animator is shown in Fig. 2.

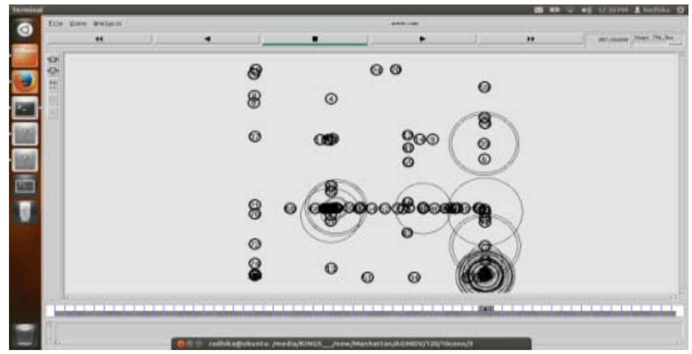

Fig. 2: Manhattan Mobility Scenario in NS-2

Fig. 3 and Fig. 4 shows the Normalized Routing Load for number of routing protocols vs. number of vehicles for 10 TCP connections for the two cases.

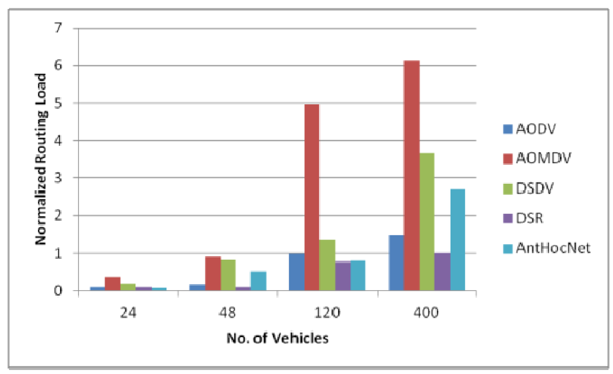

Fig. 3: NRL vs number of Vehicles

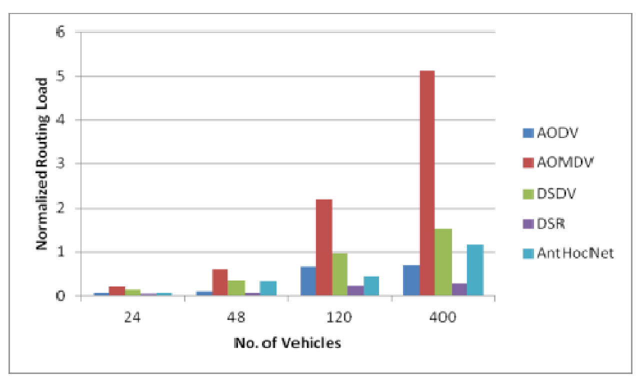

Fig. 4: NRL vs number of Vehicles

It shows that as no. of vehicles increases, NRL also increases. Also, AOMDV has higher NRL value than other protocols while DSR has the lowest value for NRL as compared to other protocols. Certainly, NRL is less in second case as compared to first case.

Fig. 5 and Fig. 6 shows the total dropped packets for number of routing protocols vs. number of vehicles for 10 TCP connections for the two cases .

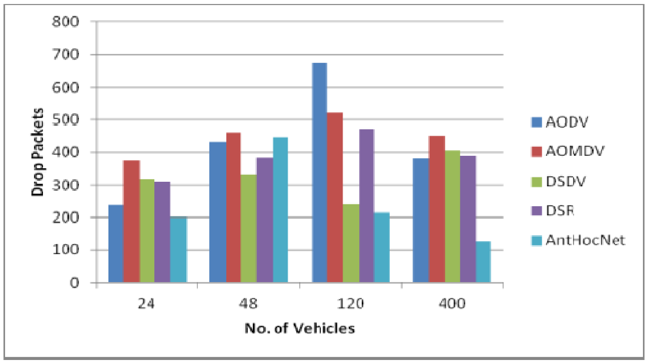

Fig. 5: Drop Packets vs number of Vehicles

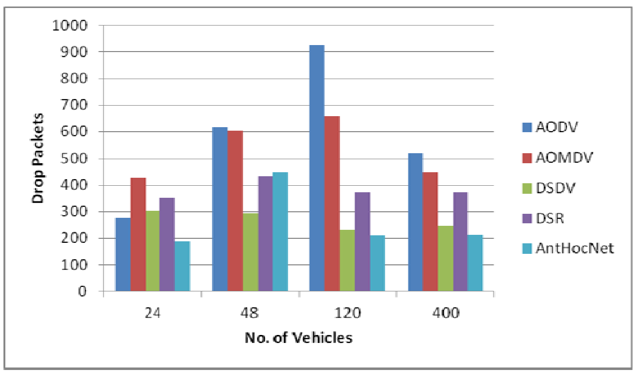

Fig. 6: Drop Packets vs number of Vehicles

The result shows that AODV has most no. of dropped packets than other protocols in most of the cases.

4.2 Jalandhar Mobility Scenario

In this, Jalandhar city mobility scenario is generated using SUMO and OpenStreetMap. A realistic vehicular mobility scenario for a City is generated using SUMO.

The Jalandhar city scenario is shown in the following figure:

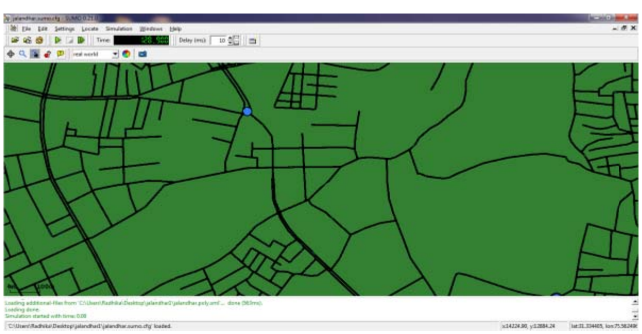

Fig. 7: Jalandhar Mobility Scenario in SUMO

City scene with Network Animator is shown in Fig. 8.

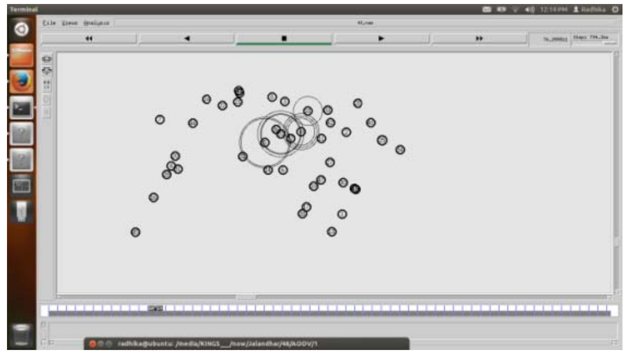

Fig. 8: Jalandhar Mobility Scenario in NS-2

Fig. 9 and Fig. 10 shows the Normalized Routing Load for number of routing protocols vs. number of vehicles for 10 TCP connections for the two cases .

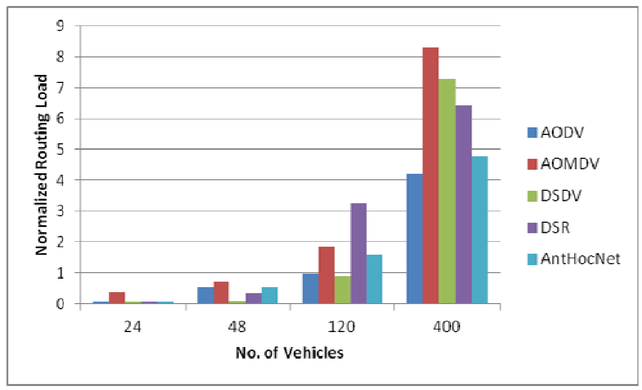

Fig. 9: NRL vs number of Vehicles

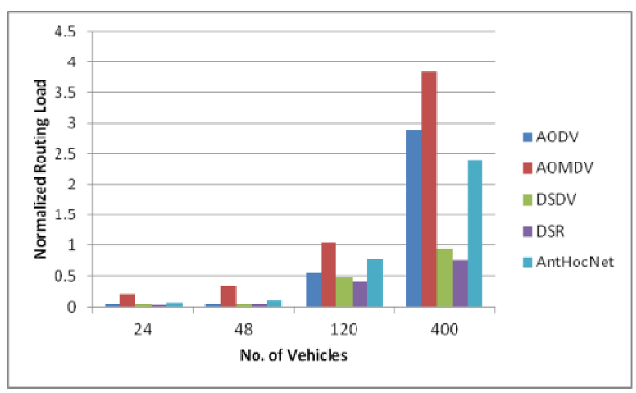

Fig. 10: NRL vs number of Vehicles

It shows as no. of vehicles increases, NRL also increases. Also, AOMDV has higher NRL value than other protocols in most of the cases. NRL is less in second case as compared to first one.

Fig. 11 and Fig. 12 shows the total dropped packets for number of routing protocols vs. number of vehicles for 10 TCP connections for the two cases.

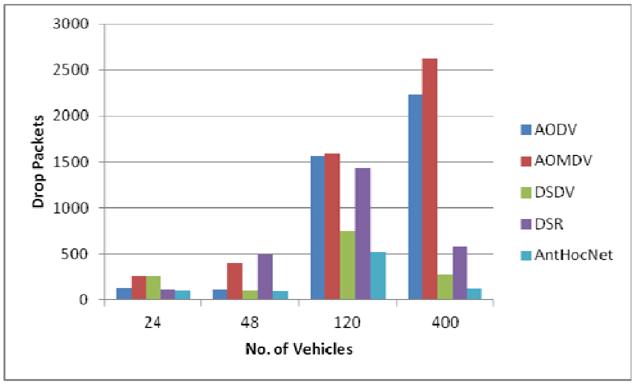

Fig. 11: Drop Packets vs number of Vehicles

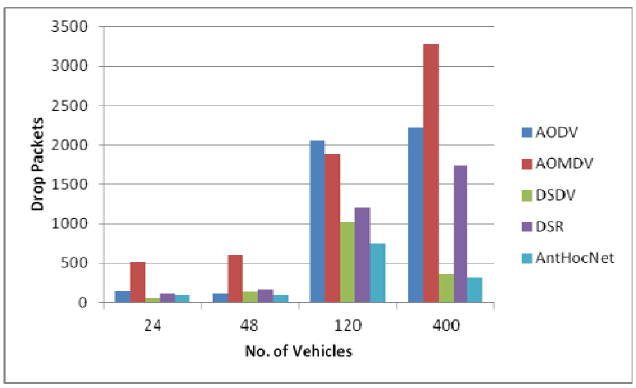

Fig. 12: Drop Packets vs number of Vehicles

The result shows that AODV has most no. of dropped packets than other protocols.

4.3 Random Mobility Scenario

In this, Random mobility scenario is generated using NS-2.The NAM output for Random scenario is shown in the following figure:

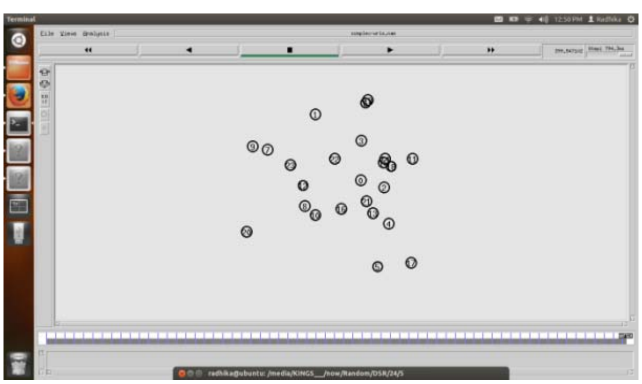

Fig. 13: Random Mobility Scenario in NS-2

Fig. 14 and Fig. 15 shows the Normalized Routing Load for number of routing protocols vs. number of vehicles for 10 TCP connections for the two cases.

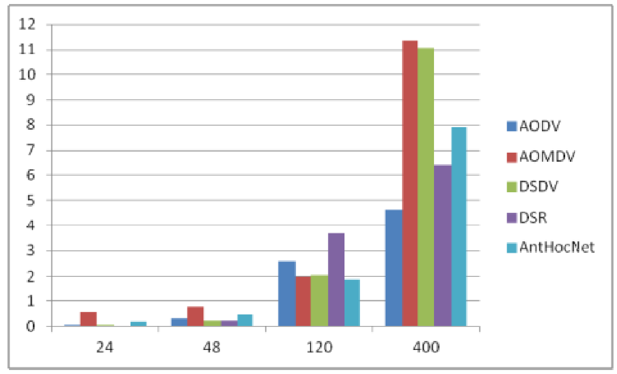

Fig. 14: NRL vs number of Vehicles

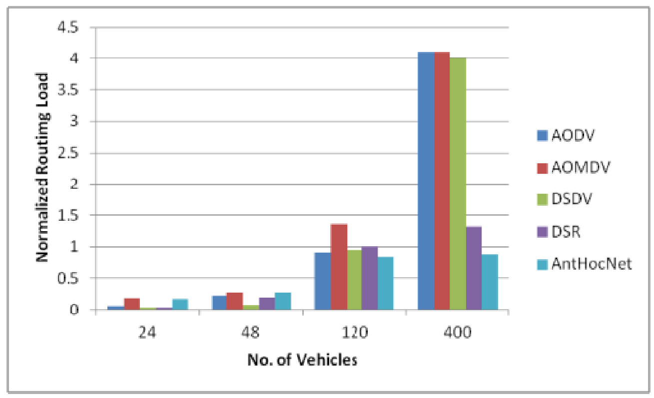

Fig. 15: NRL vs number of Vehicles

It shows as no. of vehicles increases, NRL also increases. Also, AOMDV has higher NRL value than other protocols in most of the cases. It is less in second case than the first one.

Fig. 16 and Fig. 17 shows the total dropped packets for number of routing protocols vs. number of vehicles for 10 TCP connections for the two cases.

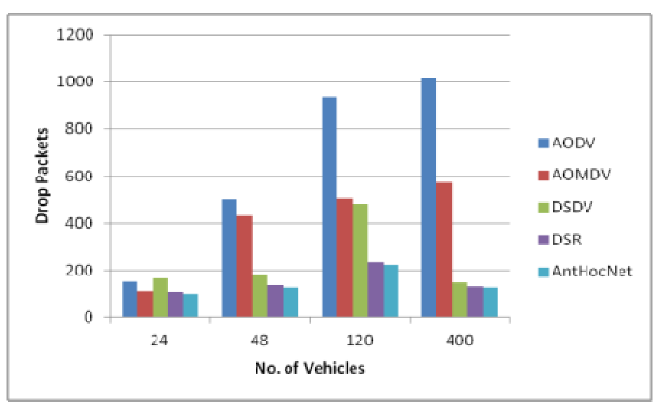

Fig. 16: Drop Packets *vs number of Vehicles*

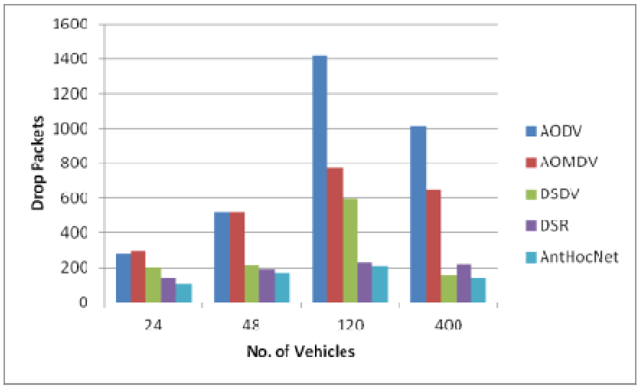

Fig. 17: Drop Packets vs number of Vehicles

The result shows that AODV has most no. of dropped packets than other protocols. Also for AODV, as no. of vehicles increases, total dropped packets also increases.

5. CONCLUSION AND FUTURE SCOPE

Simulation results show that AOMDV has more NRL as compared to other protocols. AODV has higher no. of dropped packets as compared to other routing protocols. Through simulation results, it is found that AntHocNet performs efficiently in all the three scenarios and at higher node density also.

The performance of all the protocols for the three scenarios is discussed below:

AODV has high Drop Packets in Jalandhar scenario. In random scenario, it has high NRL.

AOMDV has higher NRL in all the three scenarios. Drop Packets are greater in Jalandhar scenario.

DSDV has more NRL in Manhattan scenario. Drop Packets is less in Random scenario.

In DSR, as no. of nodes increases, NRL also increases. When no. of nodes is less, DSR has higher NRL in Manhattan scenario. When no. of nodes is more, DSR has higher NRL in Jalandhar scenario. When no. of nodes is less, DSR has high Drop Packets in Random scenario. When no. of nodes increases, DSR gives high Drop Packets in Jalandhar scenario.

It has high NRL in Random scenario. When no. of nodes is less, AntHocNet has high Drop Packets in Manhattan scenario. When no. of nodes increases, AntHocNet gives high Drop Packets in Jalandhar scenario.

So, it is summarized as:

In terms of NRL, different protocols give different NRL values for all the three scenarios.

In terms of Drop Packets, it is higher in Jalandhar scenario as compared to other scenarios.

In future, the performance can be analyzed for other swarm intelligence techniques in wireless networks. Also, these protocols can be extended in order to improve the performance metrics for VANETS.

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