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Analysis the Performance of Vehicles Ad Hoc Network

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Abstract

VANET (Vehicular Ad-hoc Network) is an astute system innovation in remote correspondence where the vehicles go about as versatile hubs to share information with no focal passage for a wellbeing issue. The vehicles send some data about street status and traffic. Because of ongoing development of programming innovation, it gets important to make a stage toward utilizing programming to keep an eye on this system before the execution. Recreation devices give us a far-reaching investigation of the system before applying it in a genuine situation. There are many system test systems which has their own highlights to recognize it from other. We should concentrate on picking the best one that gives the best outcomes. NS2 is the most widely recognized test system device, right now utilized NS2 to plan the system, which made correspondence inside the system with various steering conventions. We think about a wide range of steering conventions (AODV, AOMDV, DSDV and DSR) in view of the different regular measurements, throughput, start to finish postponement, and bundle conveyance proportion by shifting the quantity of versatile vehicles while applying CBR traffic. The examination has been finished by utilizing reenactment device NS2. To construct the system situation progressively like a genuine domain, diverse portability models will be considered. Two kind of portability designs were utilized in our undertaking. Learning about various steering conventions give us a thought of utilizing the best convention in various cases under different parameters of a system. We composed a TCL Content on NS2 to assess the conduct of directing conventions that utilized in VANET arrange. In the wake of executing the recreation in various portability models, we understood that AODV has the best execution at both and ideal for the huge and little condition of system, yet it devours power during transmission. AOMDV gives center outcomes in all parameters. The enormous start to finish delay shows up in DSR convention. Be that as it may, DSDV has lower throughput and bundle conveyance proportion than other steering conventions with an alternate number of hubs. Then again, it acts well in E2E postpone when the system size is changed

Keywords: VANET, NS2, Network Performance

1. INTRODUCTION

In recent years, the roads have seen a large increase in the number of vehicles, which resulted in an increase in traffic accidents and congestion on the roads. So, it became necessary to provide safety and comfort for the driver on the road. Therefore, the need for a network VANET is appeared. VANET is a technology used car as nodes to establish a wireless connection between them without the need of any central base station or any controller. It allows the cars sending and receiving information between each other and the environment surrounding them. VANET can be used for a of safety and non-safety applications, like improved navigation, location-based services such as finding the closest fuel station or restaurant, infotainment applications such as providing access to the Internet, traffic management, and vehicle safety. The main purpose of VANET is providing information about safety, but because the network topology changes very fast and the network is self-organized, it leads to the problem of link breakages. If the connection failed or the package arrived too late someone is likely to be seriously injured. So, we need to build a network with high performance and high quality to make sure it has achieved the desired goal, and provide high level of safety for drivers. Fig. 1 shows the architecture of VANET.

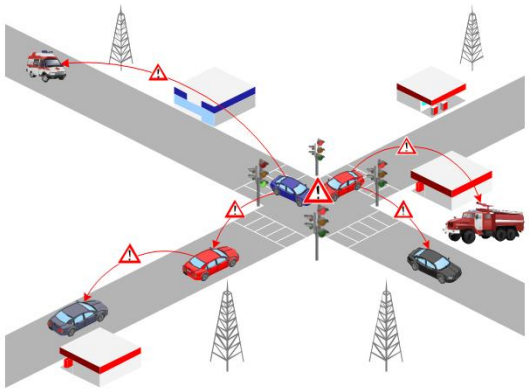

Fig.1. VANET architecture.

Testing actual VANET network is costly as it needs hard work and consumes a lot of time. Simulation is a useful alternative to

study the performance of the network under different conditions. Therefore, NS2 simulator is used to study the performance of VANET network using different routing protocols and under different scenarios of mobility model. The performance of routing protocols is compared based on different metrics such as throughput, end to end delay, and packet delivery ratio. To simulate a real road traffic, the work depends heavily on node mobility, so that results from the simulation correctly reflect the real-world performance of a VANET Network.

The main objective of any routing protocol is to find an optimal way of communication between nodes (vehicles). Researchers have proposed several routing protocols for ad hoc networks, these protocols perform differently in terms of efficiency, reliability and security. Therefore, it is important to study the behavior of different routing protocols in the context of VANET network.

This paper is organized as follows: section two present the standard that we use in our work, chapter three is literature review includes relevant works and their results, chapter four is the methodology which provides details on how the work works, chapter five results and analysis is summarizing our data and the results of our work, chapter six discussion of our results and finally we make some concluding remarks in chapter 7. In this chapter, we want to state what is the problems that we faced during this project and what we did to overcome them. In addition, the second part pointed to the standard supported by VANET network.

2. LITERATURE REVIEW

Many researchers have published several papers which represent the studying and analyzing the different VANET routing protocols according to many parameter metrics. Each one of them use a different type of network simulators, also under the different scenarios to do this aim. Khan et. al. [1] study and analysis the attitude of each VANET routing protocol (AODV and DSR), according to different parameters such as number of packets dropped and end to end delay by using network simulator NCTUns 4.0. Their results appear as following, about dropped packets, DSR and AODV act well when the number of node increases. AODV better than DSR and more efficient in more situation according to end to end delay at higher number of nodes. Singh et al [2] in this paper, two possible scenarios of traffic are chosen (urban and highway) to apply two different ad hoc routing protocols (AODV and DSR) for VANET network to learn how criteria affect to each case. Tools of simulation mainly Network Simulator (NS) and MOVE over SUMO were used. It was observed that AODV is very good in term of packet delivery ratio in both two scenarios. However, the DSR do well in both scenarios in average end to end delay.

Throughput and delay were tested and evaluated on AODV and DSR routing protocol on VANET network using NS-2 simulation tool [3] [11]. From this work, they obtained that DSR is better in throughput but as the number of node increase AODV protocol become suitable for routing. Also, DSR have low delay in comparison of AODV. As the previous study [4] used MOVE along with SUMO and NS-2 to check the same performance metric and packet delivery ratio on VANET routing protocol, they got the same results in addition to that AODV is preferred for packet delivery ratio against to DSR. By using two traffic connections CBR and TCP, Mustafa et. al. [5] discussed the attitude of AODV and DSR routing protocols under TCP and CBR traffic connections on VANET network in term of end to end delay and average throughput. As their observation, when using TCL traffic connection, DSR has a better performance than AODV. In addition, DSR has a minimum delay.

Every VANET simulators are differ in their feature and performance in different application environment. The proper selection of network simulation is our serious task. This section gives analysis and comparison study of different wireless network simulators (Glomosim, Qualnet, Omnet++, Ns-2, Opnet, and J-Sim) based on following parameters: language supported, license, GUI support, time taken to learn, platform, network visualization tool, create trace files, and fast simulation capabilities. Table 1 provides the analysis and comparison of different network simulators.

Table 1: Analysis and comparison of different network simulators.

Features	Qualnet	Omnet++	NS2	OPnet	J-Sim
Language Supported	C++	C++	C++ OTCL	C++/Java	Java
License	Commercial	Open source	Open source	Commercial	Open source
GUI support	Yes	Yes	Poor	Yes	Yes
Time taken to learn	Low	Moderate	Long	Long	Moderate
Platform	Linux	Unix and Windows	Unix, Microsoft Windows	Windows or/and Linux	Windows XP, and Linux
Network visualization tool	Yes	Yes	Yes	Yes	Yes
Create trace files	Yes	Yes	Yes	Yes	Yes
Fast simulation	Yes			Yes	
Distributed simulation	Yes		No	Yes	

3. OVERVIEW OF ROUTING PROTOCOLS UNDER STUDY

This paper studies the performance of wireless ad-hoc network considering different routing protocols; for the sake of simplicity, we mention them briefly.

- Ad Hoc On Demand Distance Vector (AODV) [6] where AODV is a reactive routing protocol so that rout from source to destination is established only when a node needs to send packet to specific destination. AODV routing protocol contain two processes: route discovery process and route maintenance process.

Where, Route discovery process begin when source node went to send a data and it has no information about the rout to destination, source node broadcasts a route request (RREQ) packet in order to find optimal path to destination, neighbor nodes receive the RREQ, when a RREQ is received a route to the source is created , if the receiving node not has a route to the destination if one of the neighbor nodes has a route to the destination or it is a destination, will rebroadcasts the RREQ , and this process is repeat until the rout to the destination node is founded otherwise, it generates a unicast route reply (RREP)message and sent it back to the source node hop by hop through the node that transmit the RREQ, When the source node receives the RREP, it save the route to the destination and start sending data. If multiple RREP is received the path with smallest hops will be chosen.

Moreover, at route maintenance process each node sends a Hello message periodically to its neighbors to till them the link between is still alive, if a node doesn't receive HELLO message from its neighbor within time period, then node it notes that a link to that neighbor node has broken, then it generates a route error message (RERR) to tell nodes of this link failed. RRER messages inform all sources using a link when a failure occurs.

- Ad hoc On-Demand Multipath Distance Vector protocol (AOMDV) [7], where AOMDV is type of reactive routing protocol as AODV, the route from source to destination is established only when a node needs to send packet to specific destination. AOMDV is an extension to the AODV protocol, which determine multiple paths to destination in RREQ procedure.

Moreover, AOMDV protocol contains two main procedures multiple loop-free and link disjoint paths. In the First technique based on advertised hop count this remain in all rout table of node addition to set of next hops in rout table of each node. The advertised hop count represents the maximum hop count for all the paths. If node received hop count is less than advertised hop count, it accepts the alternate path. The same sequence number gave to all the next hop. In the link disjoint paths method, route discovery route request is sent to all disjoint node to build the multiple path in all node

- Dynamic Source Routing Protocol (DSR) [8], where it is source routing protocol, so the sender can determine the route that a packet should take through the network, DSR network self-organization and self-configuration, and it is a reactive routing protocol. Moreover, The DSR always updates its route cache to check if a new easier rout is available. If a new easier one is an available, the node will direct the packet to this route. The packet ought to know the route direction. Information about the route set in the packet to reach to its destination and kept in it by this way, the packet find its route. The DSR protocol is contain two mechanisms: route discovery and route maintenance.

Route discovery , if node went to send packet to specific destination firs it check its cache memory if it has a rout to destination or not , if it has a route it forward the RREQ message only to the destination node , if the sender don't know the rout to destination it broadcasting RREQ massage in the network , the neighbour node in coverage range will receive the RREEQ message, add their own address and rebroadcast it again in the network this process is repeated until RREQ message reached to the destination, and the first message reached to the destination has full information about the route , destination will send a RREP packet to the sender having complete route information.

Route Maintenance: if network topology changed, and the route between sender and destination no longer work, the sender try to employ another route, which is known to destination, if sender cannot, the rout discovery will repeat to discover anew route.

- Destination-Sequenced Distance Vector routing protocol (DSDV [9] which is table driven routing scheme for ad-hoc mobile network based on Bellman Ford routing algorithm.

Moreover, DSDV routing protocol is table driven routing scheme for ad-hoc mobile network based on Bellman Ford routing algorithm. In DSDV nodes send periodically to its neighbor node about its routing table. DSDV routing table contains the cost of each path, all the possible destinations, the number of hops and the destination sequence number. each node updates its own routing table according to information of other routing tables. Each node advertises an increasing even sequence number for itself. When Node A determines that destination Node D is unreachable, it advertises the next odd sequence number for the route that has failed with an infinite metric count. Any node that receives this infinite metric count updates its table for the matching route and waits until a greater sequence number with non-infinite metric count is received. Every mobile host also calculates the weighted average of the time taken to receive a route with the best metric. This time is called the settling time.

4. OVERVIEW OF MOBILITY MODEL IN NS-2 SIMULATOR UNDER STUDY

Mobility plays a vital role in wireless networks including VANET network. The importance of mobility model lies on making more realistic scenarios as close as possible to real application. The Mobility pattern describe the physical movement of the mobile nodes in the range of network. within simulation the mobility pattern becomes one of the more important key to obtain more accuracy for simulation. it represents the initial random location of nodes, also how the nodes move based on the change of their direction, speed and

final position during the simulation time. Several models give different movement styles. Two types of mobility model were studied in our project which are Random-Based and Freeway Mobility Model.

- **Random-Based Mobility Model**

Random-Based model is a widely-used mobility model where a mobile node individually chooses its own initial position randomly in the defined topology area, then it moves freely without limitation. each of speed, direction and destination are all chosen independently over a specified period time. The node stays constant over a time called pause time after complete the movement toward final place, the speed of vehicles is determined randomly within the range speed and their location inside the limitation of the topology area.

- **Freeway Mobility Model(FM)**

Freeway mobility model is a way to build the movement of nodes using map. In a map, we can determine the number of freeway and number of lanes in each one in both directions. Vehicles are randomly distributed in various lanes. The nodes are restricted to move in lanes on the road. Also, node velocity is dependent on its previous velocity. Safety Distance (SD) should been between nodes that move on the same lane.

5. SIMULATION SETTINGS AND PERFORMANCE METRICS

The following parameters have been set to define the simulation scenario that is defined in Table 2.

Table 2. Simulation Parameters

Parameters	Value
Network Simulator	NS 2.35
Channel	Wireless
Propagation Model	Two Ray Ground
MAC Protocol	IEEE 802.11
Simulation Time	200sec.
Operating Frequency	2.4GHz
Packet Size	512byte
Transmitter Range	250m
Max Speed	100Km/h
Pause Time (sec)	2.0 sec
Packets Rate	5 Packets/s
Traffic Source	CBR
Number of nodes	10 ,20 ,30 ,40 ,50, 60, 70
Routing protocol	AODV, AOMDV, DSDV, DSR

Moreover, different performance metrics have been studied to compare and analyse the performance of different routing protocols under study in two different mobility models using the NS2 simulation tool in VANET network. Namely,

a. **Throughput** is simply the total packets that successfully reaches the destination node from the source node. By another word, the throughput is described as amount of data that actually arrived to receiver node divided by the time taken to this transmission. Throughput is measured in packets per second or bytes per second. Our simulation throughput result is displayed in Kbit /second

b. **Packet Delivery Ratio** is described as a ratio of Data packets received at the final destination to total packet generated by the source. A high value of packet delivery ratio represents a better performance of network.

c. **End to End Delay** End to End delay indicates the time that a packet takes to move during the path from one node to another. We remember to take into account all possible delays such as time that a packet stays in a queue, interval during route discovery, in addition to propagation times and retransmission delays. It measured in second.

d. **Energy Consumption**: describe the amount of energy that consume to send packet in the network; we assume that energy consumption based on number of packet send.

6. MOBILITY MODELS AND SIMULATION OUTPUTS

Two different mobility models have been considered namely Random Waypoint (RWP) model and Freeway mobility model [10]. RWP model is a random model for the movement of mobile users, and how their location, velocity and acceleration change over time. On the other hand, Freeway model, which is also called Manhattan model, was mainly proposed for the movement in urban area, where the streets are in an organized manner and mobile nodes move in horizontal or vertical direction on an urban map. Fig. 2 shows the simulation visualization of network topology where nodes=10, protocol=AODV, and Mobility= RWP. Subsequently, Fig. 3 shows the simulation visualization of network topology where nodes=20, protocol=AODV, and Mobility= Freeway.

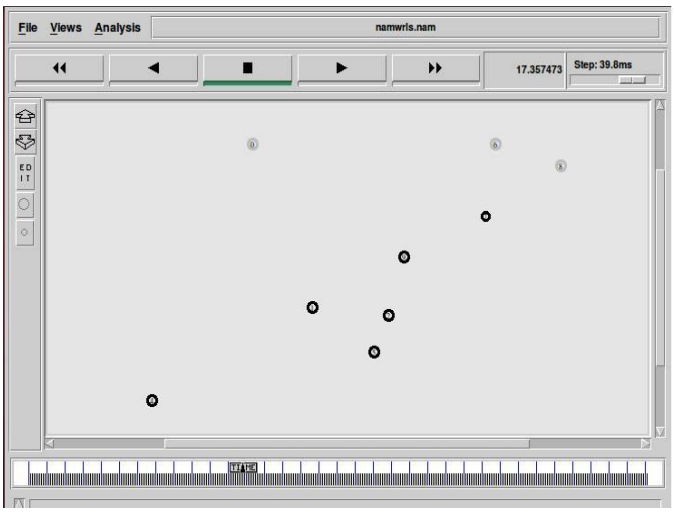

Fig. 2. NAM Showing Topology Graph during the Simulation working at Random Model

Fig. 3. NAM Showing Topology Graph during the Simulation working at Freeway Model

7. SIMULATION RESULTS

The simulation is aimed to analyze the impact of increasing the size of network on each of throughput, End to End delay, Packet Delivery Ratio on different routing protocol (AODV, DSR, DSDV, AOMDV) VANET environment using NS2 simulator. We apply the same simulation parameters to both routing protocol at different number of nodes (10,20 ,30,40,50,70), first on Random Waypoint Mobility model and second time on Free Way Mobility model.

7.1. Random Waypoint Mobility model

7.1.1. Throughput

From Fig. 4 we noticed the AODV has higher throughput, DSDV has lower throughput, and. both of AODV and DSR act the same performance in the small cluster of nodes, but when the size of network increases the AODV become more suitable in large number of nodes compared to DSR.

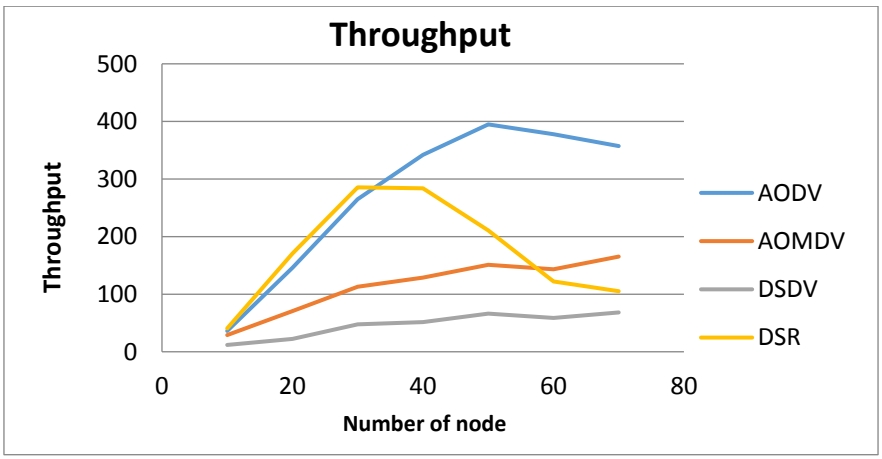

Fig.4. Throughput vs number of vehicles at random way point model

7.1.2. End to End Delay

Fig. 5 shows end to end delay outcomes of our simulation of routing protocol. it indicates that DSR has higher delay and the delay is decrease until 40 nodes then the delay starts increase, DSDV and AOMDV have the same performance with respect to delay, they have lower delay.

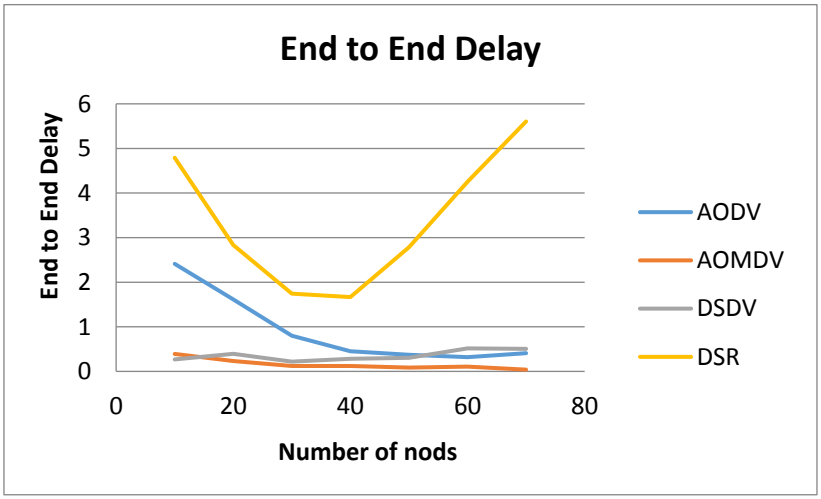

Fig.5. End to End Delay vs number of vehicles at random way point model

7.1.3. Packets Delivery Ratio

From Fig. 6 we know that DSR has higher PDR for small number of node, at high number of node AODV has higher PDR, and DSDV has lower PDR at all number of node.

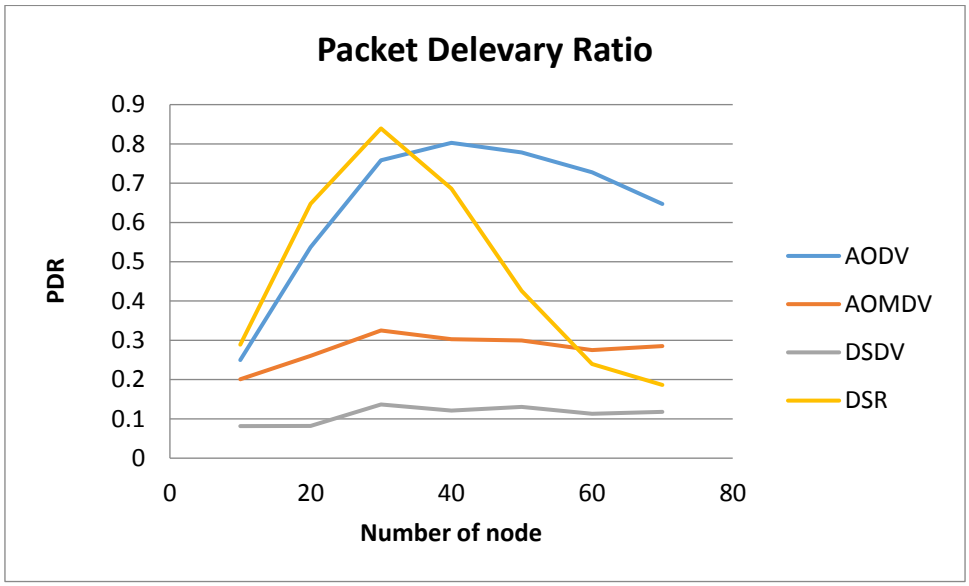

Fig.6. PDR Vs number of vehicles at random way point model

7.1.4. Energy Consumption

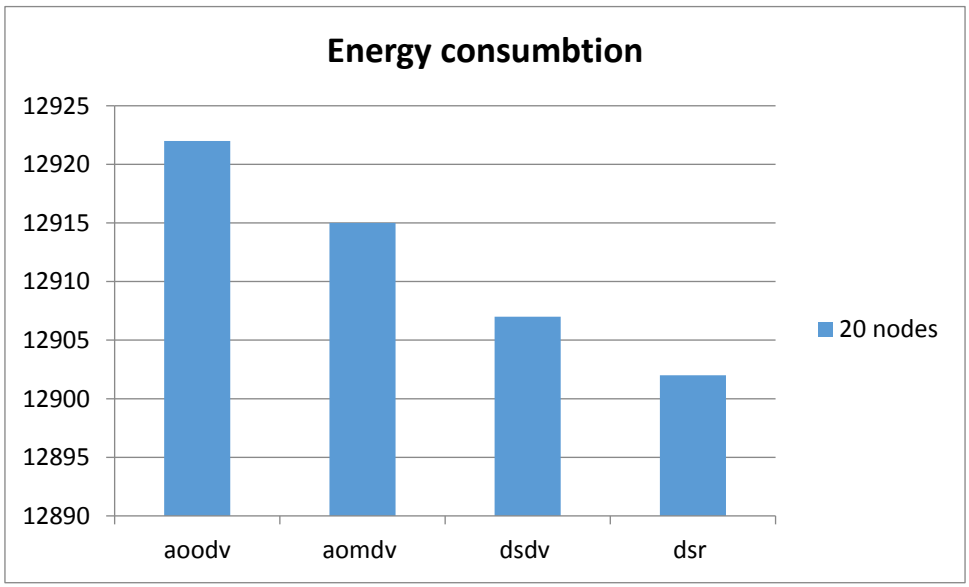

Fig.7. Energy consumption for different routing protocol at 20 node

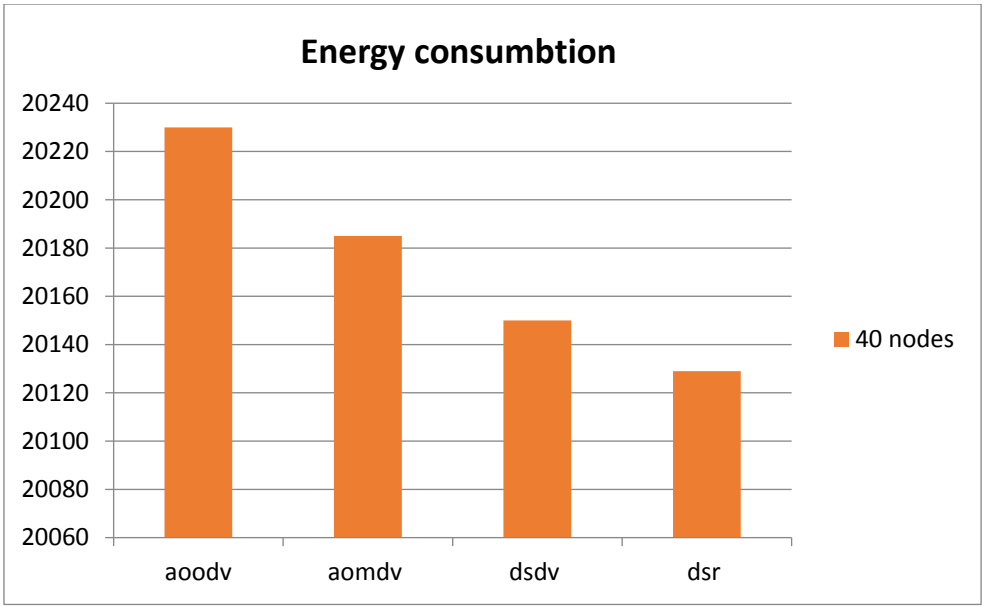

Fig.8. Energy consumption for different routing protocol at 40 node

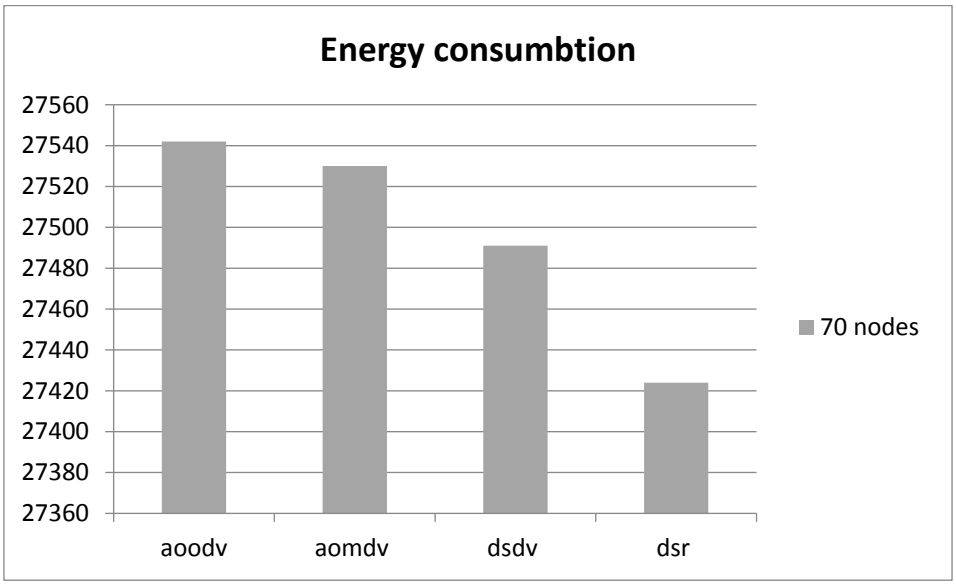

Fig.9. Energy consumption for different routing protocol at 70 node

From Fig. 7,8,9 we note that AODV routing protocol consume high energy, and the DSR routing protocol consume less energy at same number of nodes.

8. DISCUSSION

In vehicles ad hoc network, we studied the attitude of network under varying the size of network with respect to many factors, throughput, End to End delay, and packet delivery ratio of AODV and DSR routing protocols using CBR traffic connection. From our work, we observe in both mobility model that DSDV has shown the lowest in throughput, but AODV gives the best pattern. The throughput of all protocol improved due to increase in the network size until 60 nodes, after this point, the diagram starts to decline except DSDV. According to packet delivery ratio, AODV and DSR gives almost the same diagram in small density, but in large number of nodes AODV overcomes of DSR which represents bad pattern. DSDV also performs bad in PDR. In End to End delay metric, DSR gives worst form comparing with another protocol. Also, AODV has a highest energy consumption in different number of nodes.

We suggest applying other condition to other routing protocol to study more parameter about them such as jitter, average routing overhead. from other hand, we need to evaluate these parameters over change the speed, packet size also at different Pause time. Moreover, apply this simulation at different mobility scenarios using several network simulators like OMNET++.

9. CONCLUSION AND RECOMMENDATION

Study the performance of VANET network is necessary before implementing it in real world that it's expensive and difficult to analyze the faults and design the VANET network more applicable. In our project, we used NS-2 simulator to make comparison in term of many metrics between AODV, AOMDV, DSDV and DSR routing protocols, and how these protocols behave by increasing number of vehicles in cluster. we find that not a one routing protocol is better and more efficient in all condition and in different environments. DSDV represent worst packet delivery ratio through increasing nodes while AODV is suitable in throughput for small and large environment. On the other hand, it consumes more power to transmission. AOMDV gives the middle pattern in all metrics. DSR has the highest average End to End delay. The same graph appears in both Random and Freeway models with small variation of their values. The mixing of these protocols become better solution fit to the changing scenarios. If we knew about the behavior of routing protocol this give you the ability to choose the best one in different environments.

We recommend AODV in VANET network communication, but we encourage also AOMDV with low E2E delay. Moreover, we recommend making many studies using different simulators instead of NS2 simulator and compare between the results in each of them. The main task is to choose the best one. There are always fields for further works in wireless networks we suggest adding technique to reduce the energy consumption this is a wide field of study.

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