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Analysis the Performance of Vehicles Ad Hoc Network

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Abstract

VANET (Vehicular Ad-hoc Network) is an intelligent network technology in wireless communication where the vehicles act as mobile nodes to share data without any central access point for a safety issue. The vehicles send some information about road status and traffic. Due to recent growth of software technology, it becomes necessary to make a step toward using software to check on this network before the implementation. Simulation tools give us a comprehensive study of the network before applying it in a real environment. There are many network simulators which has their own features to distinguish it from other. We should focus on choosing the best one that gives the best results. NS2 is the most common simulator tool, in this project we used NS2 to design the network, which made communication within the network with different routing protocols. We compare many different routing protocols (AODV, AOMDV, DSDV and DSR) based on the various common metrics, throughput, end to end delay, and packet delivery ratio by varying the number of mobile vehicles while applying CBR traffic. The comparison has been done by using simulation tool NS2. To build the network scenario more like a real environment, different mobility models will be considered. Two type of mobility patterns were used in our project. Studying about different routing protocols give us an idea of using the best protocol in different cases under various parameters of a network. We wrote a TCL Script on NS2 to evaluate the behavior of routing protocols that used in VANET network. After executing the simulation in different mobility models, we realized that AODV has the best performance at both and preferable for the large and small environment of network, but it consumes power during transmission. AOMDV gives middle results in all parameters. The large end to end delay appears in DSR protocol. However, DSDV has lower throughput and packet delivery ratio than other routing protocols with a different number of nodes. On the other hand, it acts well in E2E delay when the network size is changed.

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Keywords: VANET; NS2; Network Performance

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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.

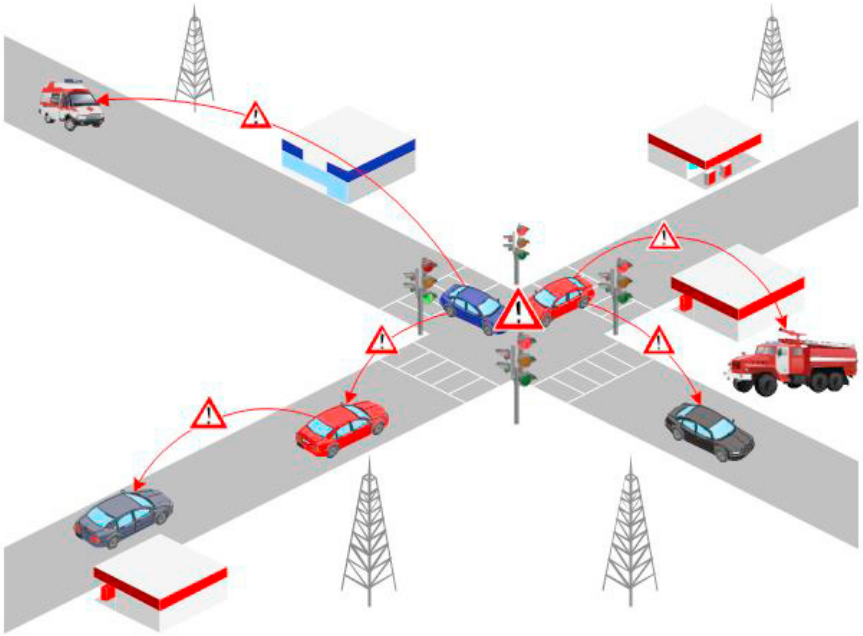

Fig.1. VANET architecture.

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]. 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

Features	Qualnet	Omnet++	NS2	OPnet	J-Sim
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.
- 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.
- 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. and iv) 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.

4. 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, i**) Throughput** which is the amount of data moved successfully from source node to the destination in each

period; ii) **Packet Delivery Ratio** which is described as a ratio of data packets received at the final destination to total packet generated by the source. iii**) End to End Delay** which indicates the time that a packet takes to move during the path from source node to the destination node. iv**) Energy Consumption**: describe the amount of energy consumed to send packet in the network; we assume that energy consumption based on number of transmitted packets in the scenario.

5. 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.

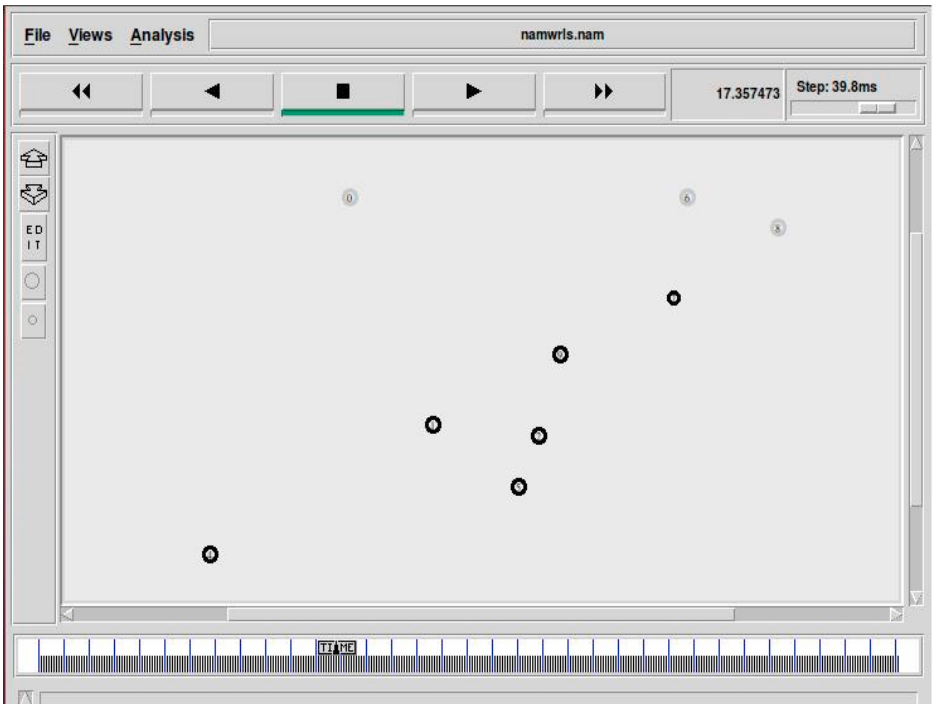

Fig. 2. NAM Showing Topology Graph during the Simulation working at Random Model

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

6. 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.

6.1. Random Waypoint Mobility model

6.1.1. 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.

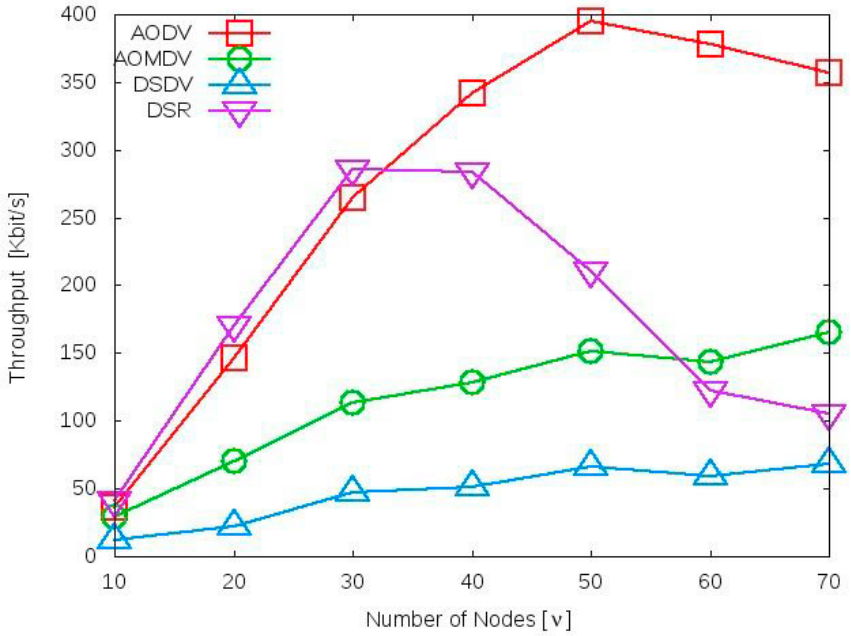

Fig.4.Throughput vs number of vehicles at random way point model

6.1.2. 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.

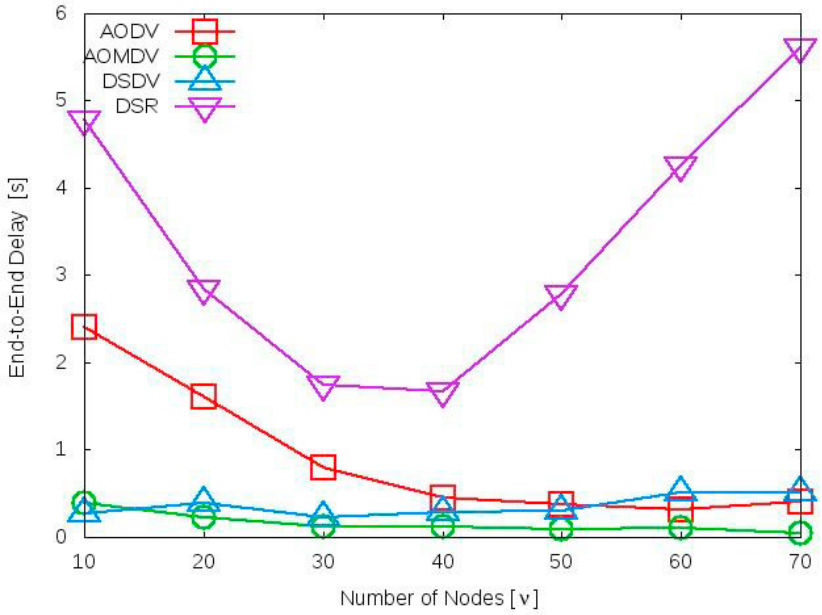

Fig.5. End to End Delay vs number of vehicles at random way point model

6.1.3. 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.

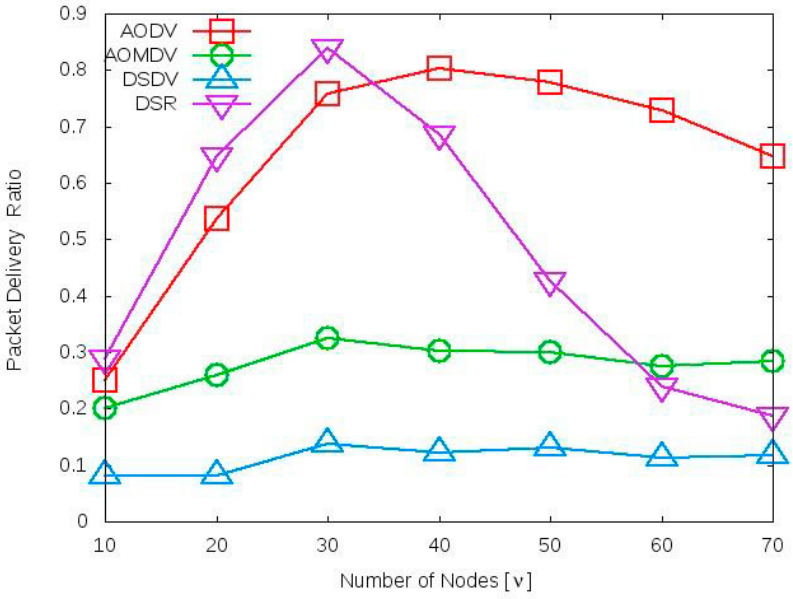

Fig.6. PDR Vs number of vehicles at random way point model

7. 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++.

8. 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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