Analytical Study of AODV, DSR and DSDV Routing Protocols in VANET simulating City scenario using EstiNet Simulator

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***Abstract*—VANET is an emerging technology that will help in increasing road safety of commuters and comfort of passengers. In this paper, we compare various topology based routing protocols DSDV, AODV and DSR that are MANET protocols for their behavior in VANET networks, that is a sub-class of MANET based on few parameters. The real city scenario with vehicle traffic has been created using Estinet simulator and analyzed for behavior using different protocols. Finally, we conclude which protocol performs better in city scenario taken in our simulation.**

Keywords—AODV, DSR, DSDV, ITS, EstiNet, Throughput, Packet drop, Collision packets

I. Introduction

With the increase in traffic on roads, road traffic crashes are becoming a major hazard for the commuters. The estimates conducted by World Health Organization [1] show that more than a million people are killed and more than 50 million injured on roads around the world each year in traffic collisions [2]. This alarming situation has evolved a need of new technology for road safety of passengers known as VANET.

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VANET [3] stands for Vehicular Ad-hoc Network which is a new technology that has emerged during recent years with a view to increase road safety and comfort of road users. VANET is a sub-category of MANET that uses moving vehicles as nodes to form a mobile ad-hoc network. The networks formed in VANET are self-organizing, self-configuring and the vehicles are equipped with On Board Units (OBUs) that helps to form a wireless network that helps vehicles to communicate and exchange of information during their movement on roads. VANET provides Intelligent Transportation System (ITS) [4] whose main purpose is road safety applications like avoiding accidents by issuing warnings, signaling emergency recovery units like police, ambulance in case of a crash; manage city traffic, notifying road dangers ahead like sharp curves, narrow and low height bridges, road closed warning and speed limit warnings such as in case of school ahead. The other applications of VANET are convenience applications for the comfort of passengers such as parking space availability, weather updates, nearby gas station or restaurant and free route discovery; and commercial applications like downloading music, toll payment, web access, advertisement, etc.

The communication that takes place in VANET is Vehicle to vehicle communication that takes place using OBUs installed in vehicles and Vehicle to Infrastructure communication that takes place between OBUs in the vehicles and RSUs installed along road side.

VANET is a sub-class of MANET with different characteristics [5] such as high mobility of nodes, rapid changing network topology, has unlimited power source, high computational capability and has more delay constraints due to real time applications. However, since both are related to mobile communication. MANET protocols like DSDV, AODV and DSR can also be used in VANET. In this paper, we use these protocols for Vehicular communication in city scenarios and compare based on throughput, packet drop and number of collision packets during communication.

The paper is organized as follows. Section II presents literature survey and comparison parameters used. Section III describes simulation setup and

Section IV shows simulation results. Finally we conclude in Section V.

II. Literature Survey

As VANET is emerging as a critical area of research, there needs to be efficient routing protocols. Routing protocol governs the way in which communication takes place between various entities to exchange desired information in considerable amount of time.

In this paper we compare various topology based routing protocols AODV, DSR and DSDV. Topology based networks maintain link information about the nodes present in the network. This information is used in making routing decisions. The parameters used in this paper for analysis of the protocols are throughput, packet drop and the number of collision packets.

Throughput- It is defined as the packets received at the destination out of total number transmitted packets. The unit used is KB/s. The routing protocols with high throughput are more efficient.

Packet drop- It is the number packets that are not sent to the destination. These packets are lost during transmission from source to destination. The packet drop may be due to signal degradation, corrupted packets or congestion, etc. The lower is the packet drop the better is the routing protocol.

Number of collision packets- When two or more stations try to transmit packets across the network at the same time, a packet collision occurs. A protocol having less number of collisions is more reliable.

A. *DSDV*

DSDV [6] stands for Destination Sequenced Distance Vector. It is a Proactive routing protocol that use information stored in routing table to take routing decisions. In DSDV, each node maintains route to all known destinations in the form of table. The table has entries as destination node, next hop, and cost metric i.e. number of hops to destination, sequence number assigned by destination to avoid loops and install time i.e. time when entry was made that is used to remove stale entries. The topology changes are updated by immediate advertisements to the neighbors. The tables are updated by full update in which a node sends all information to other nodes, or incremental update in which a node sends only changed entries to other nodes.

Destination	Next hop	Cost metric	Sequence number	Install time

Figure 1. Fields in routing table of each node

The advantages of DSDV protocol are that it is simple, path is loop free due to the use of sequence numbers and no latency as the path is obtained from the routing table maintained by the nodes.

The drawbacks of the protocol are overhead as some of the information is never used and tables need to be updated regularly that consume a significant amount of bandwidth.

B. *AODV*

AODV stands for Adhoc On Demand Distance Vector Routing. AODV [7] is a reactive protocol in which route is discovered when it is needed. It is based on discovery of route as and when needed. Control packets are used to discover routes. The source node sends broadcast query RREQ (Route Request) packet to all its neighboring nodes.

Source IP address	Source Sequence number	Destination IP address	Destination Sequence number	Broadcast Id

Figure 2. RREQ Query packet

On arrival of RREQ, each node sets up a reverse route entry for source node in its routing table. It consists of address of the previous hop from which the packet is sent, number of hops to source node and life time field in its routing table. This is known as Backward learning that is used to create path. The RREQ packets are broadcasted until it reaches destination. Once destination is reached is sends RREP Route reply packet to the source node through the path found by Backward learning mechanism.

Destination IP address	Destination sequence number	Source IP address	Hop count	Lifetime

Figure 3. RREP packet

When RREP packet is sent to the source, each intermediate node sets up a forward path entry to destination in its routing table, containing Destination IP address, IP address from which entry arrived, hop count and lifetime. Now when the packet receives the destination, the data can be sent using the routing table entries. In case a link fails, the node sends RERR (Route Error message) to the destination. Then again, new route discovery process is started.

The advantage of this protocol is that overhead is reduced as only the routes that are active and needed are discovered. It also has mechanism for route failure. An up to date path is found as destination sequence numbers are used.

The drawback of the protocol is that route finding latency is high and the old entries in the routing table of intermediate node can lead to inconsistency in path.

C. DSR

DSR stands for Dynamic Source Routing [8]. It is also reactive routing protocol in which path is created on demand i.e. when it is needed. DSR use source routing in which the source node indicates the sequence of intermediate nodes to reach the destination. The route discovery and route maintenance is same in DSR as in AODV except that it does not use backward learning. The source node sends RREQ (Route Request) as broadcast node to its neighboring nodes. The header of the query packet carries the Ids of intermediate nodes through which it travels. The destination on receiving RREQ packet sends with RREP (Request reply) packet to the destination. It uses the reverse of path that was stored in the RREQ packet. The source node receives the path to the destination from the RREP message. The source may receive more than one route that it stores in cache. Now, the source node copies the path to the destination in each data packet to be sent to destination. The packets follow the path mentioned by the source. In case the route fails. The intermediate node sends RERR (Route Error) message to the source. The source then uses another path stored in the cache if it has multiple routes stored. Otherwise the route discovery is done again.

The advantages of the DSR protocol are that use of cache decreases the latency, speeds up route discovery and decreases overhead as multiple routes are stored in cache.

The drawback of this protocol is that as the data packet contains the full routing information that increases overhead. The outdated routes in the cache also affect the performance as they may be no longer valid paths.

D. EstiNet

Estinet [9] is a simulation tool that is easy to use and is GUI based. Estinet is capable of drawing network topologies, configuring protocol modules in a node, movement of mobile nodes, plotting network performance graphs, constructing road structure and animation view of the data transmission during simulation. It allows constructing roads, roads have traffic light controllers at the intersections, place vehicles with OBUs IEEE 802.11p that can move at different speeds and also allows us to use different protocols for communication by making changes in the protocol stack of the node. It also allows installing RSUs along the road. The real road scenarios with vehicles can be created using the simulator. In this paper, we have used Estinet 7.0 [10] as the simulator as a platform to implement the routing protocols in VANET.

III. Simulation Tool and Experimental Setup

In order to create a city traffic scenario with moving cars having OBU (On Board Unit) to communicate with each other and distribute data, EstiNet 7.0 has been used as Simulation tool.

The experimental setup is a city scenario with an area of 4000 m X 1500 m with 20 cars moving on 2 lane roads.

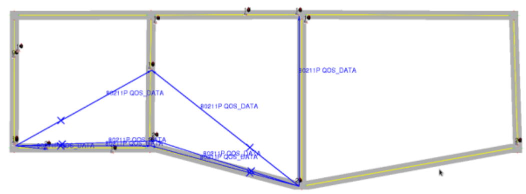


Figure 4. City scenario with 20 vehicles V2V communication

The same city scenario has been installed with 4 RSUs (Road side units) to analyze for various parameters using Road side infrastructure. This shows V2V and V2I communication to distribute data.

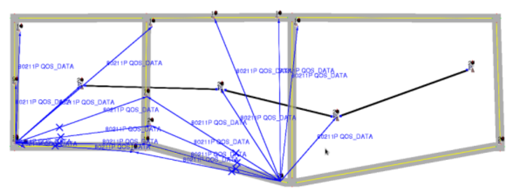


Figure 5. City scenario with 20 vehicles and 4 RSUs showing V2V and V2I communication

The node editor enables us to modify the protocol stack of any node. The simulation has been done using different protocols in the protocol stack.

TABLE I. Simulation Details

Simulator used	EstiNet 7.0
Simulation Time	100 s
Area	4000 m X 1500 m
No. of Vehicles	20
Speed of Vehicles	0 – 30 m/s
Vehicle Type	802.11p (Agent controlled)
No. of RSUs	4
Road Type	2 Lane
No. of Traffic Light controllers	8

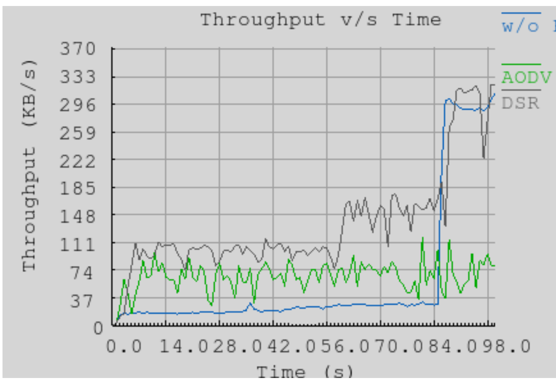
IV. Simulation Results

We have simulated the DSDV, DSR and AODV routing protocols to compare how they behave in Vehicular Networks. To analyze their behavior two cases have been taken. The first case simulates the city scenario with 20 vehicles in which Vehicle to Vehicle communication takes place. The second case also has city scenario with 20 vehicles along with 4 RSUs installed along roadside. The communication takes place in this case is Vehicle to Vehicle, Vehicle to Infrastructure and infrastructure to infrastructure communication.

A. *Simulation of Vehicle to Vehicle communication in City scenario*

1) Throughput

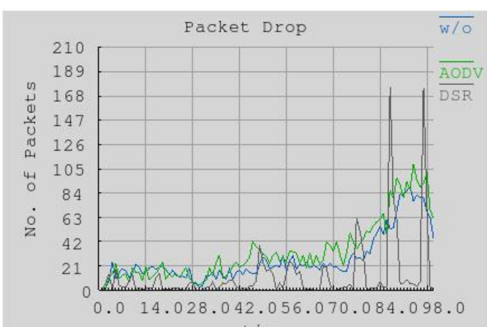
The throughput of DSR protocol is better than the AODV protocol. The throughput is worst in case we do not use a MANET routing protocol.



Graph 1. Throughput v/s Time

2) Packet Drop

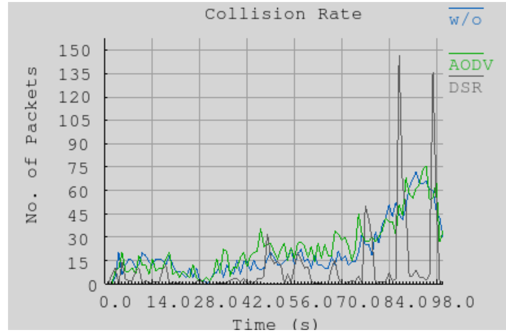
The packet drop in case of AODV protocol is higher and least for DSR protocol. The protocol with lower packet drop is more reliable and efficient.



Graph 2. Number of packets dropped v/s Time

3) Number of Collisions

The packets that have been lost due to collisions are more in when we use AODV protocol rather than DSR protocol.



Graph 3. Number of collision packets v/s Time

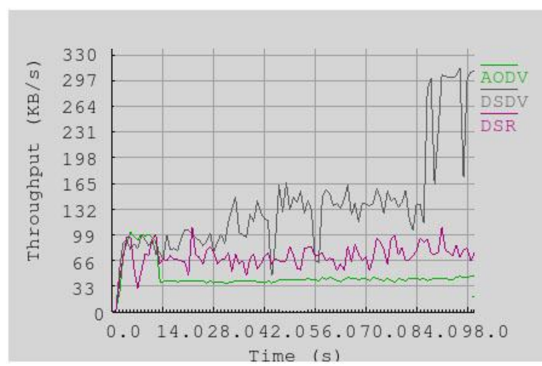
TABLE II. Simulation without using RSUs

Protocol	Throughput (KB/s)	Packets dropped	Packet collisions
AODV	66	3354	2325
DSR	134	1203	940
w/o	61	2684	2046

B. *Simulation of Vehicle to Vehicle and Vehicle to Infrastructure communication using Road Side Units*

1) Throughput

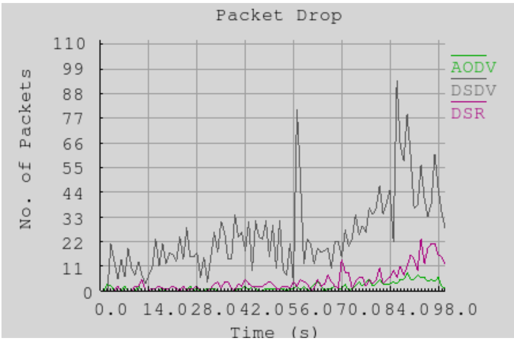
The throughput of DSDV protocol is better than DSR and AODV protocol when roadside infrastructure is used. DSDV protocol works better in terms of throughput in our scenario.



Graph 4. Throughput v/s Time

2) Packet Drop

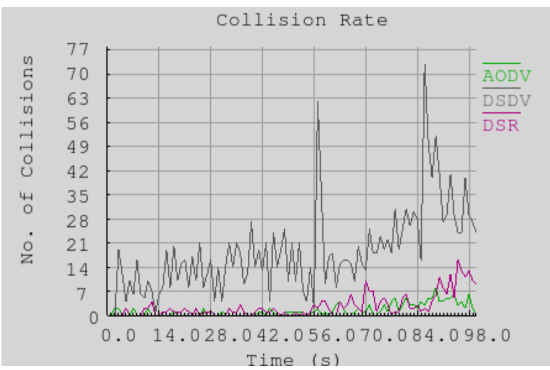
The DSDV protocol shows a high packet drop as compared to other protocols DSR and AODV.



Graph 5. Number of Packets dropped v/s Time

3) Number of Collisions

The number of collision packets is highest in DSDV protocol and lower in DSR and AODV protocol.



Graph 6. Number of collision packets v/s Time

TABLE III. Simulation using RSUs

Protocol	Throughput (KB/s)	Packets dropped	Packet collisions
AODV	40	167	143
DSR	71	442	270
DSDV	134	2550	1894

V. *Conclusion*

The above results show that when no RSUs are used, DSR protocol performs better than AODV protocol and when no MANET protocol is used. DSR protocol has higher throughput that makes it more efficient. It has lower packet drop and number of collisions that make it more reliable.

In other case when RSUs are used, DSDV has higher throughput but it also has higher packet drop and packet collisions that makes it unstable, unreliable and increases channel overhead as compared to AODV and DSR. So, DSR is more efficient and reliable in this scenario.

Thus, we conclude that DSR protocol outperforms than AODV and DSDV protocol in real city scenario while using in Vehicular Networks. However, we need more efficient, reliable and stable protocols that are designed keeping in view the characteristics and requirements of VANET that differs from MANET.

References

[1] "World report on road traffic injury prevention". World Health Organisation.

[2] Road Traffic Safety, available online at http://en.wikipedia.org/wiki/Road_traffic_safety

[3] VANET, available online at www.wikipedia.org/wiki/Vehicular_ad-hoc_network

[4] Yi Qian; Nader Moayeri, "Design of Secure and Application-Oriented VANETs", Proceedings of IEEE VTC'2008-Spring, Singapore, May 11-14, 2008

[5] Bijan Paul; Md. Ibrahim; Md. Abu Naser Bikas, "VANET Routing Protocols: Pros and Cons", International Journal of Computer Applications (0975 – 8887), Volume 20– No.3, April 2011

[6] Guoyou He., Destination-sequenced distance vector (DSDV) protocol. Technical report, Helsinki University of Technology, Finland.

[7] C. Perkins, E. Belding-Royer; S. Das, "Ad hoc On Demand Distance Vector (AODV) Routing", IETF RFC 3561, Jul. 2003.

[8] David B. Johnson; David A. Maltz., "Dynamic Source Routing in Ad Hoc Wireless Networks. In Mobile Computing", edited by Tomasz Imielinski and Hank Korth, chapter 5, pages 153–181. Kluwer Academic Publishers, 1996.

[9] ESTINET, available online at www.estinet.com/

[10] Estinet Technologies University Program, http://www.estinet.com/university03_show.php

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