



A Comparative Study of DYMO, AODV, DSR & DSDV Routing Protocols in VANET

Alok Singh Thakur

Student M Tech, Computer Science,
Dept. of Computer Science,
Himachal Pradesh University, India

Anita Ganpati

Assistant Professor,
Dept. Of Computer Science,
Himachal Pradesh University, India

Abstract- *The need to have Intelligent Vehicle System has paved the way for the rapid emergence of Vehicular Adhoc Networks (VANET) which allows communication to take place between the vehicles. The effective implementation of VANET, a sub class of mobile adhoc networks, depends upon the routing protocols used which behave differently under different environments. This paper attempts to study the behaviour of Dynamic Manet on Demand Routing protocol, Adhoc on Demand Distance Vector Routing Protocol, Dynamic Source Routing Protocol and Destination Sequenced Distance Vector Routing protocol under different conditions for a highway scenario and compares their performance on different performance metrics using Network Simulator NS 2 and in the end identifies the protocol that gives best results.*

Keywords- VANET, DYMO, AODV, DSR, DSDV, ITS

I. INTRODUCTION

With the automobiles accidents increasing day by day, the need for Intelligent Transportation Systems (ITS) has been felt. The GLOBAL STATUS REPORT ON SAFETY of World Health Organisation puts that more than 1.2 million people die on world's roads every year and as much as more than 50 million are injured. WHO has predicted that going by the current rate of fatalities caused by road accidents, road traffic injuries will become the fifth leading cause of death by 2030. To improve safety and traffic efficiency in vehicles, there has been significant research efforts [1] made by government, academia and industry to integrate computing and communication technologies into vehicles, which has resulted in the development of intelligent transportation systems. Vehicular Ad HOC Networks (VANET) are a special class of Mobile Ad hoc Networks where the nodes are vehicles and roadside units, where each node takes the role of sender receives and router[2] to broadcast information to the vehicular network or transportation agency which is then used for ensuring safe and free flow of traffic. For communication to occur between the vehicles and the Roadside Units (RSUs) vehicles must be provided with On Board Unit (OBUs) that enables short-range wireless ad hoc networks to be formed, along with hardware that permits detailed position information such as Global Positioning System (GPS). For successful communication to take place, routing protocols have an important role to play in working of VANETs. A routing protocol governs how communication takes place between two entities. It defines the set of procedures useful in establishing, maintaining and discarding a route. VANET routing protocols can be categorized as Topology based and Geographic or Position based. Topology based routing protocols maintain link information about the nodes present in the network and then routing decisions are made using this information whereas in position based routing protocols, a node keeps track of its immediate neighbours only which keep on changing dynamically. Dynamic MANET on Demand Routing Protocol (DYMO) can be used both as pro-active and reactive routing protocol as in it routes can be discovered when needed. In DYMO [3], a special Route Request (RREQ) message is broadcast and each RREQ keeps on ordered list of all nodes it passed through. So every node receiving an RREQ message can immediately record a route back to the origin of the message, when a RREQ message arrive at its destination, a Routing Reply (RREP) message will be immediately routed back to the origin indicating that a route to the destination was found. As soon as the RREP message reaches its destination a two-way route is successfully recorded by all intermediate hosts and exchange of data packets can commence.

Adhoc on Demand Distance Vector Routing Protocol (AODV) is a reactive routing protocol for wireless adhoc networks. AODV [4] first introduced in 1999, uses a route discovery phase to find a route to the destination. The source sends a broadcast Route Request message to all its neighbour nodes. On receiving the message, each node records the previous hop called as backward learning and broadcasts it further. This continues till the destination is reached. The recorded nodes are used by the destination to send back Request Reply back to the source. This phase also involves recording the previous hops. The recording of previous hops in the first step helps destination to send data back to the source.

Dynamic Source Routing Protocol (DSR) is a topology based reactive routing protocol for wireless networks. In DSR [5] introduced in 1996, the source indicates the sequence of nodes to be followed to reach the destination in a data packet. Query packet records the sequence of the nodes, which are communicated to the source by the destination. Finally, the source uses this sequence to route packets to the destination.

Destination Sequenced Distance Vector Routing Protocol (DSDV) is a topology based proactive routing protocol. DSDV [6] introduced in 1994, uses a table driven routing scheme where each entry in the routing table contains a sequence number. The number is generated by the destination and the sender needs to send out the next update with this number. If a router receives new information, then it uses the latest sequence number. If the sequence number is the same as the one already in the table, the route with the better metric is used.

II. LITERATURE SURVEY

Gayathri [7] introduced the concept of VANET, its applications, infrastructure & requirements & challenges.

Kevin C. Lee et al. [8] presented taxonomy of routing protocols in VANET.

Monika et al. [9] described the importance of VANET for road accidents by making its importance realize for drivers as the knowledge from VANETS can help reduce road accidents. In this paper author compared the position-based routing protocols which work in high traffic density using average end to end delay, packet delivery ratio and throughput as the performance metrics.

Rakesh Kumar et al. [10] described VANET as a subclass of Mobile AdHoc Networks that provided a distinguished approach for ITS, and describes the needs of survey of routing protocol in VANET, its importance and necessity for ITS.

Yasser Toor et al. [11] discuss about the possible applications that can be used in VANETs and stresses more on the application of VANETs in providing safety to the vehicles by preventing accidents through the use of communication in wireless networks. They explore the various implementation issues to provide quality services in wireless environment.

Sun Xi et al. [12] studied the application of VANET to city road traffic control. In their study, city section mobility model was appended in NS2 and the feasibility of VANET to the city road traffic control was justified.

D. Geeta et al. [13] Compared TORA and DSR routing protocols. In the case of mobile adhoc networks on parameters of throughput delay, packer delivery ratio and routing load & found the performance of TORA better than DSR protocol.

Shaikhul Islam Chowdhuer et al. [14] compared performances of reactive routing protocols namely Ad Hoc Demand distance Victor (AODV), Dynamic source Routing (DSR) and Ad Hoc on Demand Multipath Distance Vector (AOMDV) in VANET using different mobility models. They concluded by taking the tradeoff between performance metrics that in VANET, AOMDV is more appropriate than DSR & AODV. Niangsheng Liu et al. [15] presented the results of simulation model of three mobile adhoc routing protocols viz. DSDV, DSR and AODV for the freeway scenario and concluded that AODV is more suitable for the freeway VANET.

III. NEED AND SCOPE OF STUDY

Road Safety is an issue of national and global concern, considering its magnitude and gravity and consequent negative impacts on the economy, public health and the general welfare of the people, some efforts need to be taken on all front. The Intelligent Transportation System is one of the action plan for tackling the issue. The vehicular Adhoc Networks presents a scheme to provide for the ITS. The implementation of VANET depends upon the various set of routing protocols. Hence the need to study these protocols arises so as to analyse how the protocols behaves under different set of conditions and to find which protocol is best to a particular situation. There are many topology based and position based routing protocols, but the preset study has been restricted to four protocols DYMO, AODV, DSR and DSDV. The performance of these protocols can be compared on various performance metrics, but the present study has been restricted to three parameters of End to End delay, Packet Delivery Ratio and Throughput as these are the most important parameters for judging the network quality and more so in time critical vehicular communications.

IV. OBJECTIVES

The objective of the study are:

- i) To have a general understanding of vehicular Ad Hoc Network protocols DYMO, AODV, DSR and DSDV.
- ii) To perform the quantitative comparative evaluation of protocols DYMO, AODV, DSR and DSDV under different traffic scenarios using simulator to emulate the real world scenario.

V. RESEARCH METHODOLOGY

The theoretical study of VANET and its associated protocols is studied by consulting various sources such as research journals, books and internet. The empirical study to compare and analyze the routing protocols has been done using network simulator NS-2 for simulating the real world environment and then the behaviour of the protocols is analysed from the results obtained from the simulation.

VI. RESULTS AND ANALYSIS

A. Simulation Setup

Network Simulator NS-2 has been used for performing simulation. It is an open source discrete event simulator targeting at networking research and provides substantial support for simulation of TCP, UDP, routing and multicast protocols over wired and wireless network. The set up used for doing simulation is shown in table below:

TABLE 1: Simulation Setup

Simulation Scenario	Highway
Topology Dimension	1000m × 500m
Number of Vehicles	20,40,60

Vehicle Speeds	6m/s to 30m/s
Protocols Simulated	DYMO,AODV,DSR,DSDV
Simulation Time	200 Seconds
Communication Time	Ad-Hoc
Traffic Type	TCP
Simulator	NS-2.35

A Straight highway scenario has been simulated for 20, 40 and 60 vehicles i.e. for low, medium and high traffic densities, moving at a speed of 6 to 30 m/s within 1 kilometre and 500 meter wide space. The simulation was carried out for 200 seconds. Ad Hoc mode, in which the communication takes only between vehicles and no road side units were used. Topology Designer NSG-2.1 was used for designing topology. NSG 2.1 can be used to generate TCL scripts automatically using a GUI. It is a free Java based software and can be run on Windows. The Topology design used is shown in following figure. It shows the scenario when the number of nodes considered are 20.

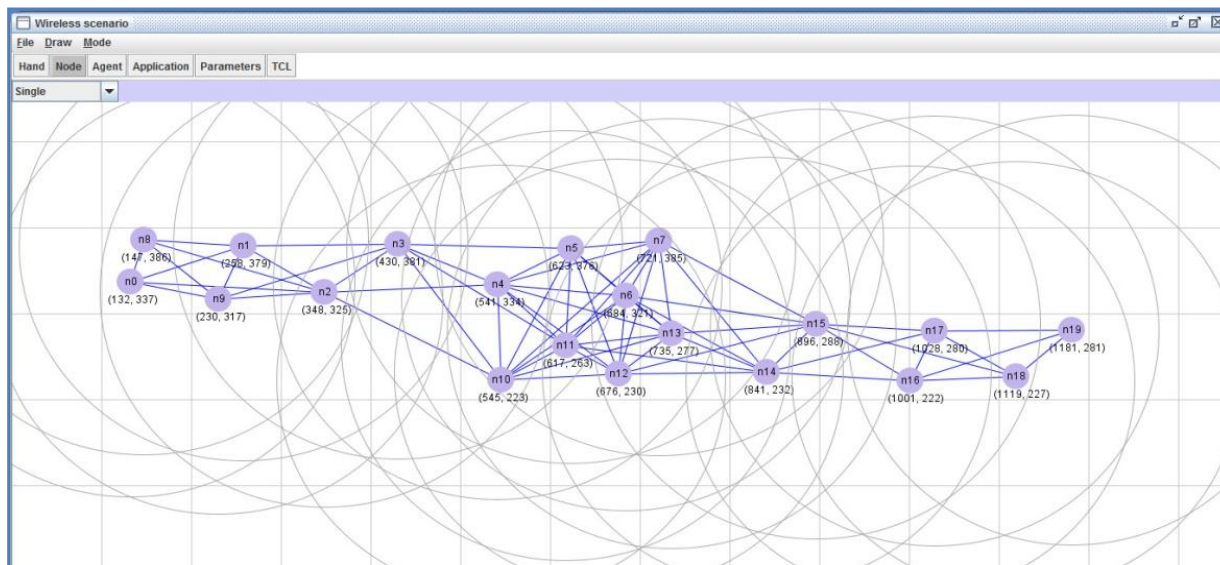


Figure 1: Topology Design Used

B. Parameters for Simulation

1) *End to End delay*: End to End delay refers to the time taken by a packet to reach the destination from the source. This includes the delay such as transmission delay, propagation delay, processing delay and queuing delay that occurs during transmission. Since, these delays occur at each router, so mathematically it can be written as:

$$E = N(T + P + PR + Q), \text{ where}$$

E= End to End Delay.

N= Number of links.

T= Transmission delay.

P= Propagation delay.

PR= Processing delay.

Q= Queuing delay.

Lower the value of end to end delay, better the protocol.

2) *Packet Delivery Ratio*: Packet Delivery Ratio is the ratio of packets delivered to the number of packets sent by a source. Mathematically,

$$\text{Packet Delivery Ratio} = (\text{DATA}_R / \text{DATA}_S) \times 100$$

Where

DATA_R is the number of packets received

DATA_S is the number of packets sent.

A higher Packet Delivery Ratio means a better protocol.

3) *Throughput*: Throughput is the ratio of packets received to the time over which the transmission takes place.

Mathematically,

Throughput = Number of bits (or data Packets) successfully received/Time for transmission.

Throughput is generally measured in bits per second (bps) or kilo bits per second (kbps).

Higher the throughput better is the performance of the protocol.

C. Analysis

To analyse the performance of DYMO, AODV, DSR and DSDV routing protocols in VANETs, a total of 12 simulations were carried out and 36 readings were taken for making comparisons on the above mentioned parameters for 20, 40 and 60 vehicles for a highway scenario. The results of which in graphical form are shown below.

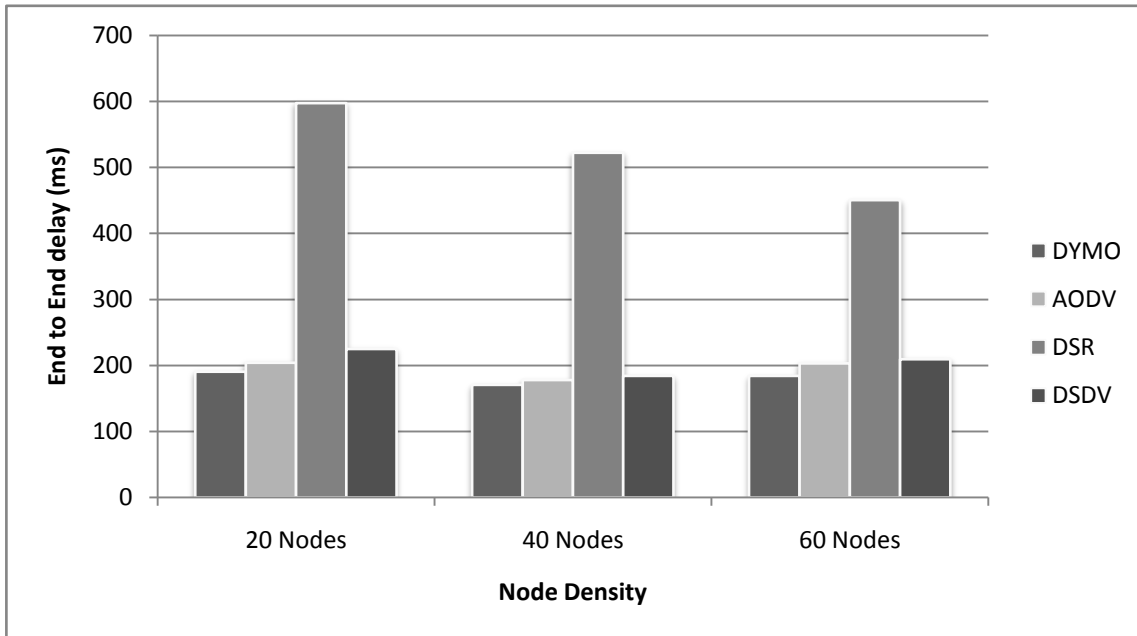


Figure 2: Node Density Vs End to End Delay

From Figure 2, it is evident that for 20 nodes DSR has the highest delay, then DSDV and AODV whereas DYMO has the lowest End to End delay. For 40 nodes traffic density, again DYMO has the lowest delay and DSR the highest and for AODV and DSDV it lies between DYMO and DSR. When the traffic density is increased to 60 nodes, DSR again gives the highest End to End delay, whereas DYMO gives the lowest. It is also evident from the above that whereas the DSR has quite high end to end delay, it is comparable in others and remains quite stable even when the node density increases.

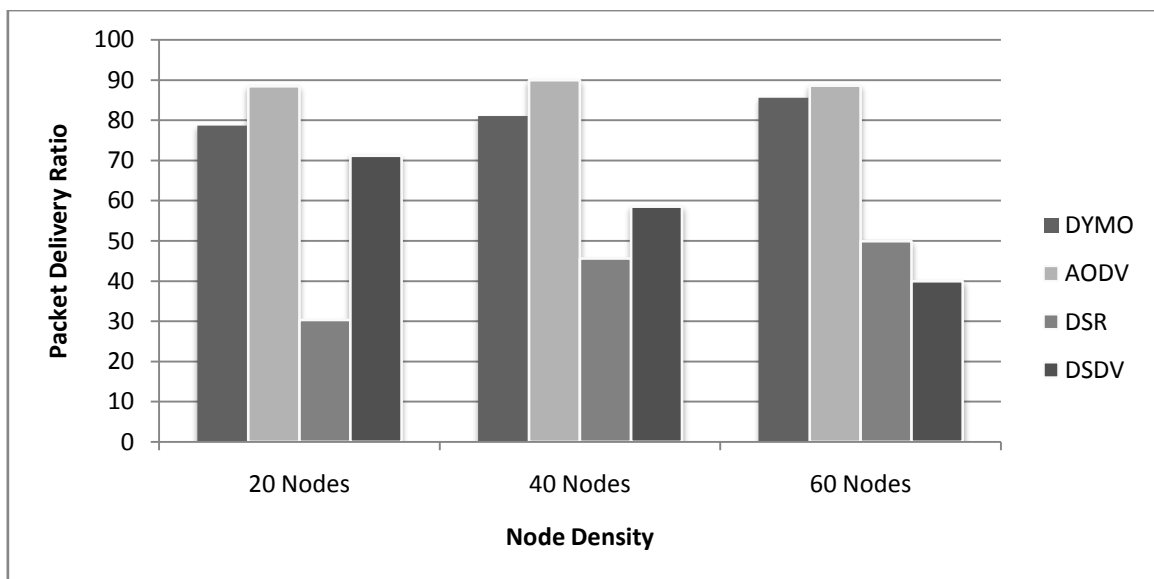


Figure 3: Node Density Vs Packet Delivery Ratio

It is evident from Figure 3, that for 20 nodes the Packet Delivery Ratio is highest for AODV then DYMO, DSDV and DSR. There is big difference between DSR and AODV, whereas in AODV the Packet Delivery Ratio is close to 90, in case of DSR it is close to 30 and as such DSR is the worst performer. When the number of nodes is increased to 40, the Packet Delivery Ratio in case of DSDV decreases but for others it increases and AODV still performs better than the

others. When the node density is further increased to 60, AODV again has the highest Packet Delivery Ratio and DSDV has the lowest. It is also important to note that whereas the PDR is increasing for DSR with the increase in node density but for DSDV it is decreasing and at high density it performs even worse than DSR which was having lowest PDR for 20 and 40 nodes scenario. The variation in the PDR for DYMO and AODV is quite stable even when the node density is increased.

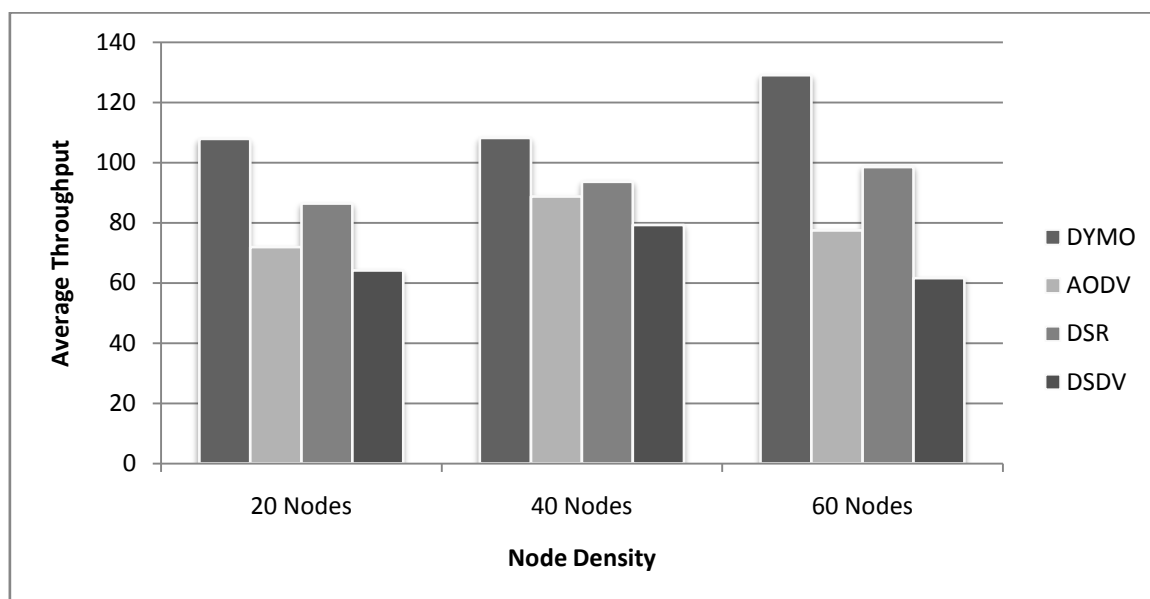


Figure 4: Node Density Vs Average Throughput

From Figure 4, it is evident that for 20 nodes the average throughput for DYMO is highest and for DSDV lowest. The throughput for DSR is more than AODV but less than DYMO. When the number of nodes are increased to 40, the throughput for all the protocols increase as compared to what it was when the number of nodes was 20 but DYMO still performs better than the other protocols. When the number of nodes are further increased to 60, DYMO again as the highest throughput and DSDV again the lowest. It is also evident that in case of DYMO and DSR the average throughput increases with the increase in node density but for AODV and DSDV it first increases as the node density increases from 20 to 40 but it decreases when further increase in node density is made.

VII. CONCLUSIONS

In this paper, the study of four routing protocols DYMO, AODV, DSR and DSDV was done on Network Simulator NS-2 and the topology designed using topology designer NSG-2.1. The protocols were compared for low, medium and high traffic densities for a highway traffic scenario using 20, 40, and 60 nodes in the simulation on three performance metrics of End to End Delay, Packet Delivery Ratio and the Average Throughput. From the results, it is evident that no protocol performs best on all the three parameters. Considering the critical requirements of the real world scenario, it is desirable to have a protocol that performs best for all the traffic scenarios, DSR and DSDV can be rejected as for DSR the delay is too much for a real world situation and also its reliability is low as its PDR is low, similarly for DSDV average throughput is low as its PDR continue to decrease with the increase in node density. Now the choice remains between AODV and DYMO as AODV has more PDR than DYMO and the difference in End to End delay is not too low than DYMO but when Throughput is concerned it is low than DYMO, DYMO on the other hand has low End to End delay and its PDR although less than AODV but the difference in PDR between the two continue to decrease as node density increases, its Throughput is high than AODV and continues to increase with the increase in the node density. Hence considering all these variations DYMO is the recommended protocol for a highway scenario.

REFERENCES

- [1] Panos Papadimitratos and Jean Pierre Hubaux, "Secure Vehicular Communications: Results and Challenges Ahead", ACM SIGMOBILE, 2008.
- [2] Jinyuan S., Chi Z. and Yuguang F. , "An ID-based Framework Achieving Privacy and Non-Repudiation", IEEE, MILCOM, 2007.
- [3] I. Chakers, E. Belding Royer, UC Santa Barbara and C. Perkins, "Dynamic MANET on-demand Routing Protocol(DYMO)", IETF, 2006.
- [4] C. Perkins, E. Belding-Royer and S. Das, "Adhoc On-Demand Distance Vector (AODV) Routing", ACM DL, 2003.
- [5] David B. Johnson and David A. Maltz, "Dynamic Source Routing in Ad hoc Wireless Networks ", CiteSeer, 1996.

- [6] Charles E. Perkins and Pravin Bhagwat, "Highly Dynamic Destination-Sequenced Distance-Vector Routing (DSDV) for Mobile Computers", Proceedings of the conference on Communications architectures, protocols and applications SIGCOMM, 1994.
- [7] Gayathri Chandrasekaran, "VANETs: The Networking Platform for Future Vehicular Applications", springer, 2006.
- [8] Kevin C. Lee, Uichin Lee and Mario Gerla, "Survey of Routing Protocols in Vehicular Ad Hoc Networks", IGI Global, 2010.
- [9] Monika, S. Batish and A. Dhiman, "Analytical Study of Position based Routing Protocols in VANET", International Journal of Computer Application, 2012.
- [10] Rakesh Kumar and Mayank Dave, "A Comparative Study of Various Routing Protocols in VANET", IJCS, 2011.
- [11] Yasser Toor and Paul Muhlethaler, Inria Anis Laouiti, GET/INT Arnaud Dela Fortelle, Ecole Des Mines "Vehicle Ad Hoc Network: Application and Related Technical Issues" IEEE communication Surveys, 2008.
- [12] Sun Xi and Li Xia- miao, "Study of Feasibility of VANET and its Routing Protocols", IEEE. 4th International Conference on Wireless Communications, Networking and Mobile Computing, 2008.
- [13] D.Geetha and T. Sarika, "Performance Analysis of TORA and DSR Routing Protocols in Mobile Ad-Hoc networks", IJECSE, 2013.
- [14] Shaikhul Islam Chowdhury, W. lee, Youn-Sang Choi, Guen-Young Kee and Jae-Young Pyun, "Performance evaluation of Reactive Routing protocols in VANET", 17th APCC, Malaysia, 2011.
- [15] Niangsheng Liu, Huihuan Quin, jingyu Yan and Yangsheng Xu, "Performance Analysis of Routing Protocols for Vehicle Safety Communication on the freeway", 3rd international conference on Anti-Counterfeiting, security and identification in communication (ASID), 2009.