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Traffic Management in VANET Using Clustering

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***Abstract*— Moving vehicle is never free of traffic congestion especially in the cities. Every day commuters wastes hours in travelling just because of traffic congestion. This has led to the emergence of vehicular management which will be beneficial for Road Transport department to control and manage the traffic flow on congested roads. Thus to support above idea we have Vehicular Ad-Hoc Network, or VANET technology that turns every participating car into a node, allowing cars to connect with each other and in turn create a network. It ensures there is proper co-ordination amongst the vehicles on the road and this in turn reduces traffic congestion. This is also benefits the environment by reducing the pollution caused due to burning of fuel during traffic jams. In this paper cluster formation algorithm run on the vehicular environment so as to have a stable form of communication amongst the vehicles .The transmission range of mobile terminals being is fixed, results in a dynamically changing network topology: As stations move around, some network links are destroyed while the possibility of new links being established arises. Thus, new routing protocols are needed for the dynamically changing ad-hoc wireless environment. The different cluster formation and routing protocols which suits the ad-hoc environment are to be simulated using NS2 and SUMO and results can be analyzed to have the best one. Thus for our simulation, real aspects of vehicular traffic is very essential and scenarios play a very crucial role.**

***Index Terms*— commuters wastes, NS2, SUMO, VANET**

I. INTRODUCTION

The concept of leveraging wireless communications in vehicles has fascinated researchers since 1980’s [4]. In the last few years we have witnessed a large increase in research and development in this area because traffic congestion has become a major concern. This technology treats every car as a moving node and thus these moving nodes form the network. In VANET communication is also made possible between these nodes via the transmission of messages in the wireless environment.

Also the vehicles have different destinations and hence over a course of time they follow different routes which lead to the change in the network, as result the vehicle network has no fixed topology and keeps on changing with time. From this it is clear that vehicle movement reflects the ad-hoc nature because of dynamic networks and hence the name VANET- “**Vehicular Ad-Hoc Network**” is completely justified.

There are two units which connect the vehicles with one another :

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- RSU (Road Side Unit) **-** It is the stationary unit that connects the roaming vehicles to the access network.
- OBU (On Board Unit) **-** It is network device fixed in roaming vehicle and is connected to the wireless network.

A. *Objectives*

- Reduction of Traffic Congestion: Messages which are exchanged among the moving vehicles help in distribution of information amongst them and thus reduces traffic load, driver spend less time on the roads.

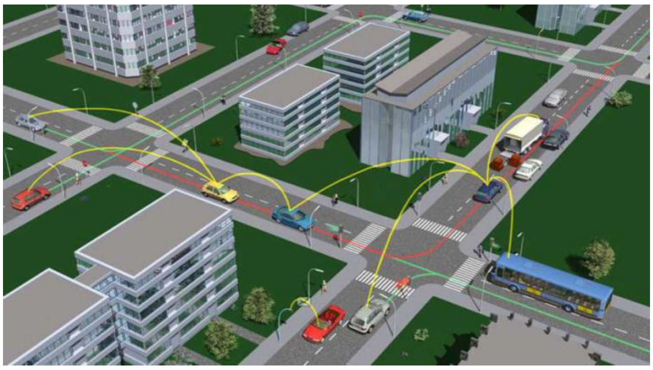


Fig. 1 VANET in a city scenario. Vehicles are warned of the truck blocking the road, and alternate routes [5]

- Reduction in the number of accidents: Safety messages are given to the vehicles, information is available about the vehicles, and this is turn helps the drivers to avoid accidents.

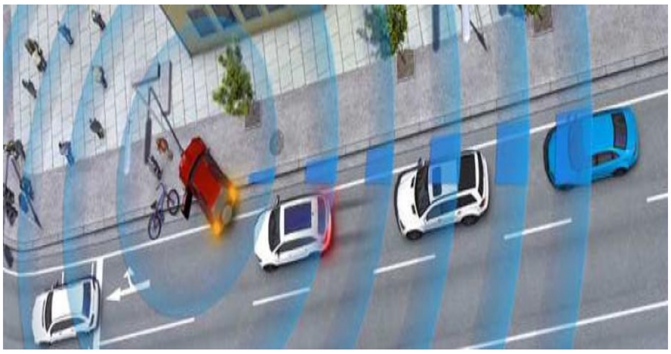


Fig. 2 VANET preventing a multi-vehicle collision [5]

To fulfil the above mentioned objectives of VANETs many complications must first be overcome. The dynamic VANET topology and harsh VANET environment results in many communication and networking challenges.

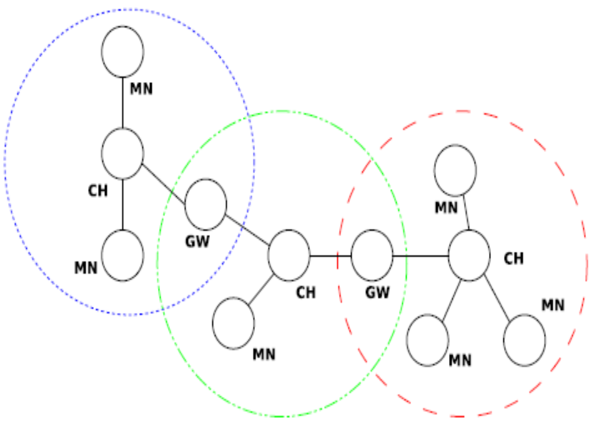
The extreme economic and social impacts of motor vehicle accidents have motivated the research and development of

Intelligent Transportation Systems (ITS). Intelligent transportation systems aim to improve the safety, security and efficiency of surface transportation systems, through the implementation of intelligent technologies. These intelligent systems encompass a variety of technologies; however most applications rely fundamentally on the ability for communication in the vehicular environment.

The rest of the paper is organised as follows. Section 2 describes the cluster formation process and selection of cluster head. We also propose a new cluster head selection algorithm. Section 3 describes the routing protocols used in the simulation and also 802.11p (DSRC). Section 4 describes the stepwise generation of realistic mobility model for VANET. The conclusion is presented in Section 5.

II. CLUSTERING

Clusters are conceptual structures where several nodes self organise into a group around their momentarily selected representative called the cluster head.



A configuration of clusters

The cluster head is a special node which assumes the role of coordinator for the remaining members of the cluster. Cluster gateway is responsible for communication between two different clusters.

A. Process of Clustering:

Clustering in VANET's requires selecting a cluster head that results in a stable cluster. The nodes which are present in a particular cluster select a cluster-head to coordinate the communication among them. The cluster head will be able to communicate directly to all other cluster members and may act as the relay node of communications to other cluster members and other nodes in different clusters. Significant time and channel bandwidth will be consumed to complete this process.

B. Advantages of Clustering:

VANET is the dynamic and dense network topology, resulting from the high mobility and high node-density of vehicles [6]. This dynamic topology causes routing difficulties as well as congestion from flooding, and the dense network leads to the hidden terminal problem. The hidden terminal problem is the main cause of collisions in a wireless network. The hidden terminal problem occurs when there are two nodes that are outside the transmission range of each other but will each transmit to a node that is shared between them[7].

In Fig. 3 below, nodes S1and S2 cannot sense each other's transmissions. If both S1 and S2 were to transmit to R1 at the same time a collision would occur.

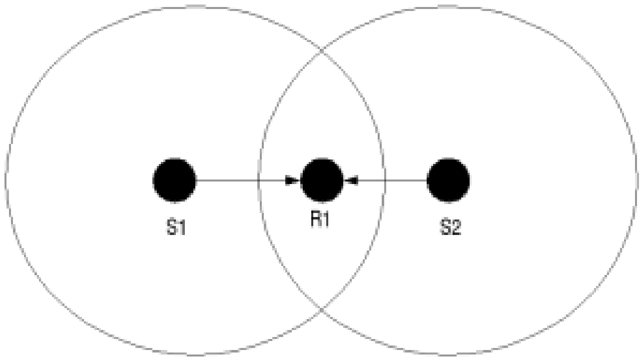


Fig. 3 Collision in transmission

A clustered structure can make the network appear smaller and more stable in the view of each node [8], [9]. By clustering the vehicles into groups of similar mobility, the relative mobility between communicating neighbour nodes will be reduced, leading to intra-cluster stability. In addition, the hidden terminal problem can be diminished by clustering [10].

The dynamic topology of VANETs demand a high frequency of broadcast messages to keep the surrounding vehicles updated on position and safety information. In addition, many routing algorithms necessitate flooding the network to find routes, which in a dynamic network needs to be done frequently to keep routes updated. All this flooding leads to severe congestion, which can be alleviated by a clustered topology [11] [12]. When the network is clustered, only the cluster-head participates in finding routes, which greatly reduces the number of necessary broadcasts.

An additional challenge for VANETs is Quality-of-Service (QoS) provisioning. In VANETs, many different types of data will need to be transmitted, and messages will be both delay-intolerant and delay-tolerant. For example, safety messages will demand high reliability and low delay, whereas non-vital road and weather information will be tolerant to longer delays. These different data types necessitate QoS provisioning, which can be achieved by a clustered network [13] [14].

C. Requisite for a clustering algorithm:

The main aim of clustering algorithm is to minimize cluster reconfiguration and cluster-head changes, which are unavoidable due to the dynamic nature of the network.

Having a good clustering algorithm requires selecting the cluster-head that will serve most of the vehicles for the longest possible time. Knowing the traffic flow and the general information of a vehicle, such as speed, direction, location and lane, should lead to better cluster-head selection.

D. Clustering algorithm

Lowest-id clustering algorithm is having the lowest overhead [15]. In Lowest-ID, each node is assigned a unique ID, and the node with the lowest ID in its two-hop neighbourhood is elected to be the cluster-head. The algorithm works as follows: (1) Each node periodically broadcasts its unique ID, along with the ID of its neighbours. (2) If a node has the lowest ID of all ID's it hears, it becomes a cluster-head.(3) The lowest-ID a node hears is its cluster-head, unless that node gives up cluster-head status to another lower ID node. In this case, the node will re evaluate lowest ID status amongst undetermined nodes. (4) A node that hears from more than one cluster-head is a gateway node.

In an effort to reduce the frequent re-clustering involved in maintaining the lowest-ID status of all cluster-heads, the Least Cluster Change (LCC) algorithm was suggested [16].In LCC, re-clustering is only performed when two cluster-heads come within range of one another. At this point, the cluster-head with the lower ID remains the cluster-head.

In highest degree based clustering algorithm each node in the network is assigned a degree based on the number of neighbours in the defined range. The node with the highest degree is selected as the cluster head [17].
These algorithms do not exhibit cluster stability because they make no attempt to select a stable cluster-head during initial cluster-head election. For highly-mobile networks, mobility must be considered during the clustering process in order to ensure cluster stability.

The proposed algorithm is a distributed clustering algorithm, which possesses excellent cluster stability, where stability is defined by long cluster-head duration, long cluster member duration, and low rate of cluster-head change.

The relative mobility between node [15] X and node Y is then approximated by taking the ratio of time T taken at node Y for two successive "hello" messages to arrive from node X. The relative mobility metric, $M^{rel}{}_{Y}(X)$, at node Y with respect to X, is as follows:

$$M^{rel}{}_{Y}(X) = (T^{new}{}_{X\rightarrow Y} / T^{old}{}_{X\rightarrow Y})$$

In the above metric, if $T^{new}{}_{X\rightarrow Y} < T^{old}{}_{X\rightarrow Y}$,then $M^{rel}{}_{Y}(X)<0$, which implies the nodes are moving towards one another.On the other hand, if $T^{new}{}_{X\rightarrow Y} > T^{old}{}_{X\rightarrow Y}$,then $M^{rel}{}_{Y}(X) > 0$, which indicates that the nodes are moving away one another. Therefore, the closer $M^{rel}{}_{Y}(X)$is to one, the lower the relative mobility. Node Y calculates an aggregate mobility metric by considering the $M^{rel}{}_{Y}(X_i)$for each neighbour, Xi. The aggregate mobility metric is found by finding the variance, with respect to zero, for the set of relative mobility values, $M^{rel}{}_{Y}(X)$. This aggregate mobility metric, M_Y, is computed by: $M_Y= var\{M^{rel}{}_{Y}(X)\}^{m}{}_{j=1}$
Proposed algorithm is based on the mobility of the vehicles on the roads and hence it ensures formation of a stable cluster.

III. ROUTING PROTOCOLS:

In wireless ad hoc networks, stations are free to move around. This, together with the fact that the transmission range of mobile terminals is fixed, results in a dynamically changing network topology: As stations move around, some network links are destroyed while the possibility of new links being established arises. Thus, new routing protocols are needed for the dynamically changing ad-hoc wireless environment. There are two types of ad hoc routing protocols-table-driven and on-demand.
In this paper we will be focusing on DSDV, DSR and AODV protocols.

In DSDV, each node maintains a routing table that contains information regarding all possible routes within the network, the number of hops of each route and the sequence number of each route. Network nodes periodically broadcast their routing tables in order to propagate topology knowledge throughout the network.

The DSR protocol allows nodes to dynamically discover a *source route* across multiple network hops to any destination in the ad hoc network. The protocol is composed of the two main mechanisms of "Route Discovery" and "Route Maintenance", which work together to allow nodes to discover and maintain routes to arbitrary destinations in the ad hoc network. In order to limit the overhead of this control messaging, each node maintains a cache comprising routes that were either used by this node or overheard. As a result of route request by a certain node, all the possible routes that are learned are stored in the cache. Storing in the cache of alternative routes means that route discovery can be avoided when alternative routes for the broken one exist in the cache. Therefore route recovery in DSR can be faster than in other on-demand protocols.

AODV based on business needs to establish and maintain routing is a combination of DSR and DSDV which is known as a typical on-demand routing protocol. It uses the base of route discovery and route maintenance in DSR protocol and uses hop-by-hop routing, sequence order number and the cycle update mechanism in route maintenance phase.
For setting up DSDV/DSR/AODV we set following line in tcl script:

setval (rp) DSDV/DSR/AODV;

IEEE 802.11p

IEEE 802.11p/DSRC is a wireless communication protocol designed for vehicular ad hoc networks in order to support safety and commercial non-safety applications. The conventional 802.11 protocols are not suitable for these types of networks because of high vehicular mobility, faster topological changes and requirements of high reliability and low latency for safety applications.

The above needs and requirements have been addressed by the Dedicated Short Range Communication (DSRC) technology, which was adopted by ASTM and IEEE to provide a secure, reliable, and timely wireless communication component as an integral part for the intelligent transportation system (ITS). DSRC operates in the 75 MHz licensed spectrum at 5.9 GHz bandwidth. WAVE (Wireless Access in Vehicular Environments) or, 802.11p, is an IEEE standard which provides enhancements to the physical (PHY) and medium access control (MAC) layers for the DSRC protocol.

IV. SIMULATION

There are many open source and commercial tools and softwares available in the market for generating traffic simulation model.

In the proposed paper we are using OpenStreetMap (www.openstreetmap.org) to get the road network in the form of .osm file.

The .osm file is converted to sumo XML files by eWorld and then TraNS

1. Open www.openstreetmap.org. Enter the location and select appropriate road for which simulation is to be done. After selecting road map go to export and select OpenStreetMap XML data and export the .osm file and save it.
2. The OSM file will be imported in eWorld which is an open source project that converts the map data from .osm file to the format used dfor traffic simulators like SUMO. The result is files containing information about routes, nodes, etc. in XML format for SUMO.
3. The network and route file generated by eWorld is given to TraNS which is a GUI based tool which integrates traffic and network simulators (SUMO and ns2) for generating realistic scenarios of Vehicular Ad hoc NETworks. TraNS allows the information exchanged in a VANET to influence the vehicle behavior in the mobility model. It generates the .tcl files.

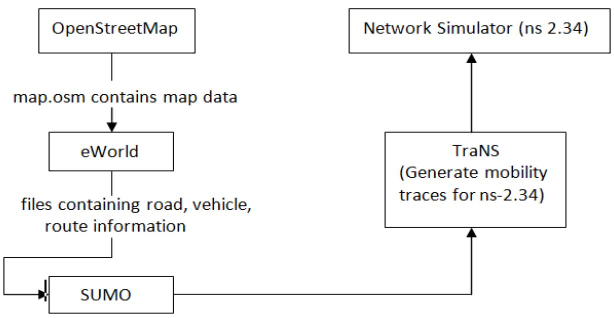


Fig 4. Generation of files used for Simulation

V. IMPLEMENTATION:

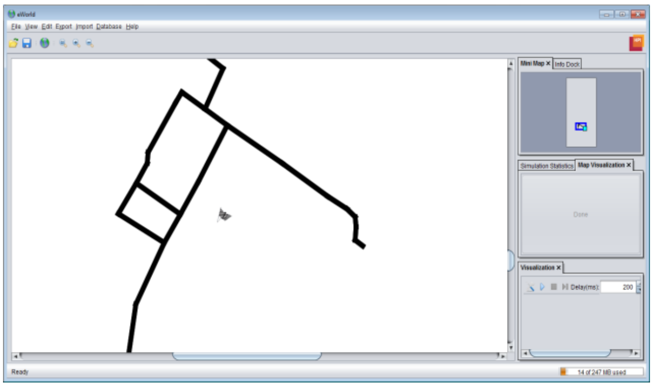


Fig 5. eWorld

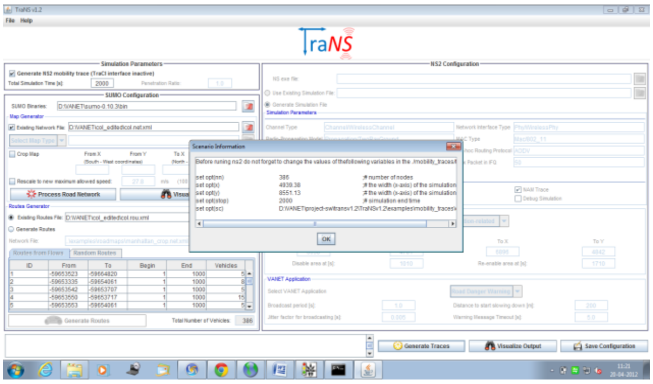


Fig 6. TraNSV

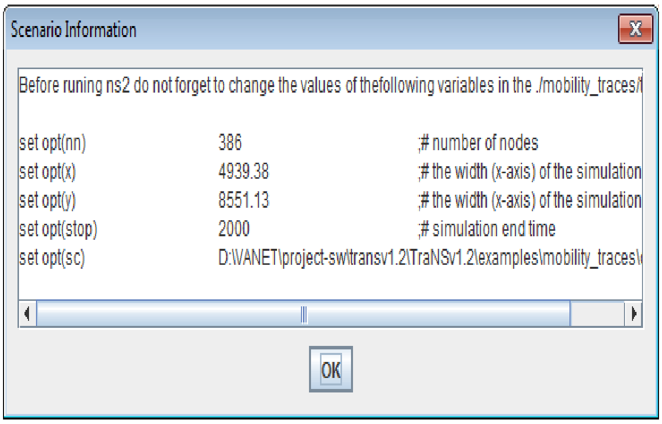


Fig 7. Scenario information by TraNS

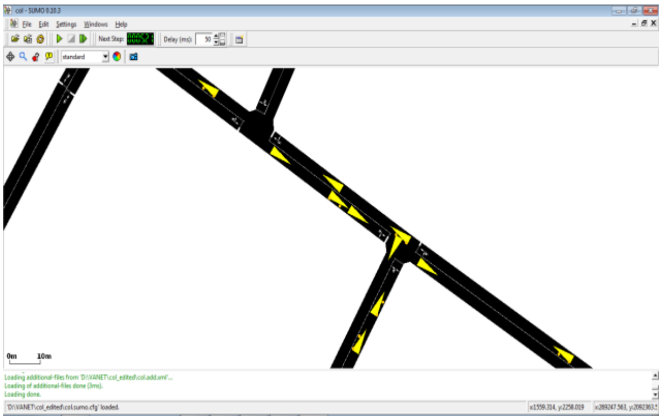


Fig 8. Scenario in SUMO

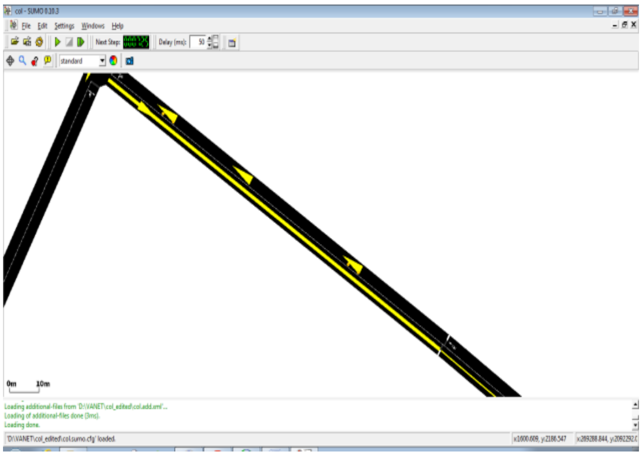
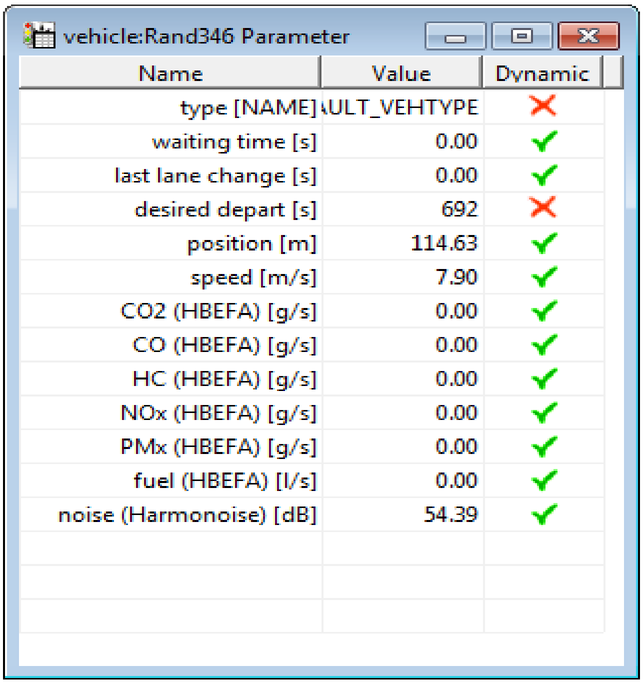


Fig 9. Best lane for a vehicle in SUMO



Name	Value	Dynamic
type [NAME]	ULT_VEHTYPE	✗
waiting time [s]	0.00	✓
last lane change [s]	0.00	✓
desired depart [s]	692	✗
position [m]	114.63	✓
speed [m/s]	7.90	✓
CO2 (HBEFA) [g/s]	0.00	✓
CO (HBEFA) [g/s]	0.00	✓
HC (HBEFA) [g/s]	0.00	✓
NOx (HBEFA) [g/s]	0.00	✓
PMx (HBEFA) [g/s]	0.00	✓
fuel (HBEFA) [l/s]	0.00	✓
noise (Harmonoise) [dB]	54.39	✓

Fig 10. Vehicle parameters in SUMO

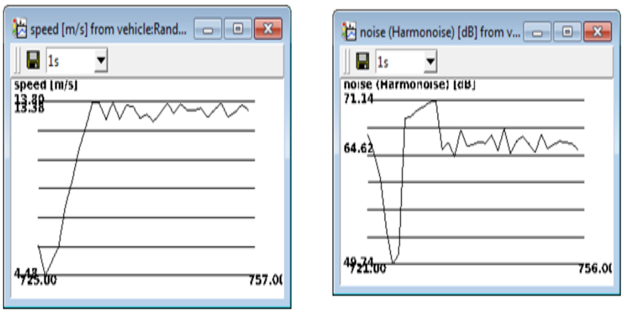


Fig 11. Vehicle graph in SUMO

VI. SIMULATION IN NS2:

1] In the first executed tcl file(message.tcl), all the nodes in the cluster will send messages to others. This will help to capture their speed which will be used for finding the clusterhead for that particular cluster.

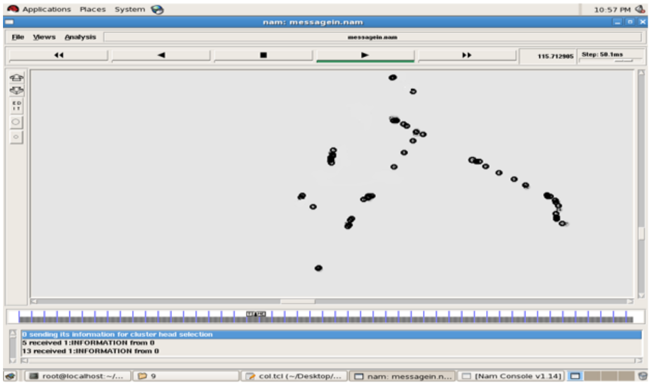


Fig.12(a) Nodes sending messages

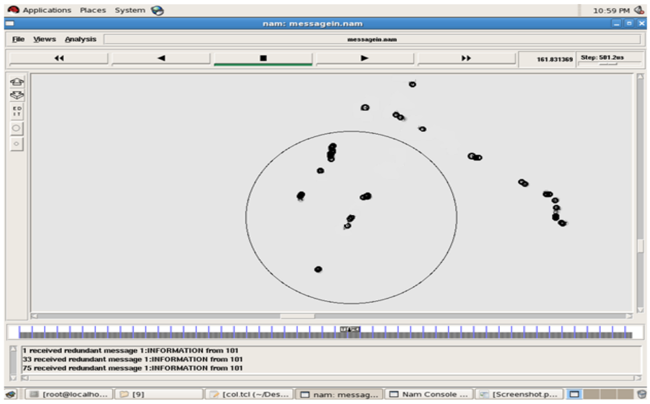
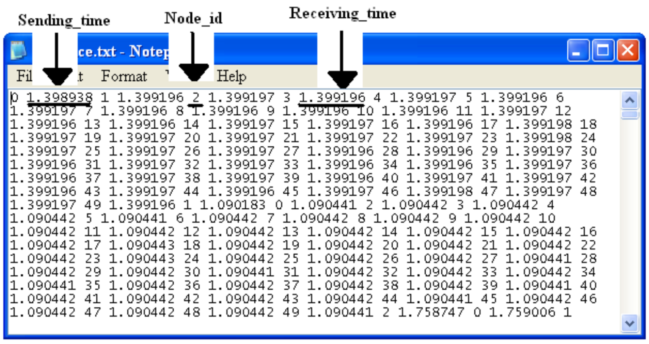


Fig.12(b) Nodes sending messages in VANET

2] From the trace file(messageout.tr) generated, node id and speed of vehicles are obtained and stored in variance.txt using ClusterHead.awk file.




```
0 1.398938 1 1.399196 2 1.399197 3 1.399196 4 1.399197 5 1.399196 6
1.399197 7 1.399196 8 1.399196 9 1.399196 10 1.399196 11 1.399197 12
1.399196 13 1.399196 14 1.399197 15 1.399197 16 1.399196 17 1.399198 18
1.399197 19 1.399197 20 1.399197 21 1.399197 22 1.399197 23 1.399198 24
1.399197 25 1.399197 26 1.399197 27 1.399196 28 1.399196 29 1.399197 30
1.399196 31 1.399197 32 1.399197 33 1.399196 34 1.399196 35 1.399197 36
1.399196 37 1.399197 38 1.399197 39 1.399196 40 1.399197 41 1.399197 42
1.399196 43 1.399197 44 1.399196 45 1.399197 46 1.399198 47 1.399197 48
1.399197 49 1.399196 1 1.090183 0 1.090441 2 1.090442 3 1.090442 4
1.090442 5 1.090441 6 1.090442 7 1.090442 8 1.090442 9 1.090442 10
1.090442 11 1.090442 12 1.090442 13 1.090442 14 1.090442 15 1.090442 16
1.090442 17 1.090443 18 1.090442 19 1.090442 20 1.090442 21 1.090442 22
1.090442 23 1.090443 24 1.090442 25 1.090442 26 1.090442 27 1.090441 28
1.090442 29 1.090442 30 1.090441 31 1.090442 32 1.090442 33 1.090442 34
1.090441 35 1.090442 36 1.090442 37 1.090442 38 1.090442 39 1.090441 40
1.090442 41 1.090442 42 1.090442 43 1.090442 44 1.090441 45 1.090442 46
1.090442 47 1.090442 48 1.090442 49 1.090441 2 1.758747 0 1.759006 1
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Fig 13. Variance.txt

3] The second executed tcl file(chselection.tcl) will calculate the cluster head.

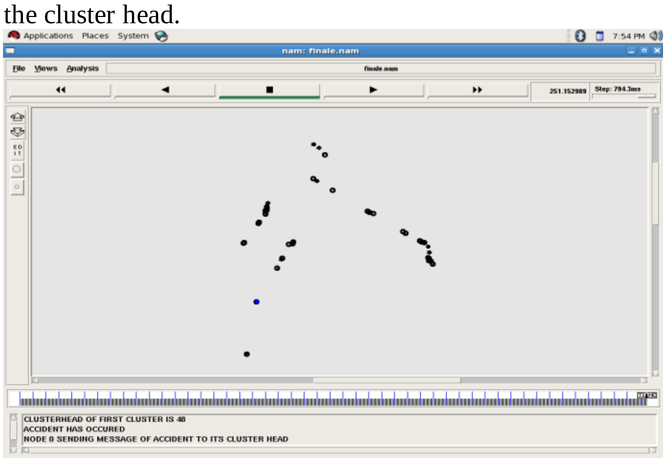

Fig.14 Cluster Head in VANET

VII. RESULT AND ANALYSIS:

To do analysis of DSDV, AODV and DSR routing protocol, five main and very important performance parameters are considered:

1. Number of packets sent
2. Number of packets received
3. Packet delivery ratio
4. End to end delay
5. Throughput

End to end delay: Average end to end delay is calculated and analyzed at Fig.15 by varying routing protocol under parameters of 802.11p. It is clear from results that DSDV has the lowest end-to-end delay among all the three routing protocols.

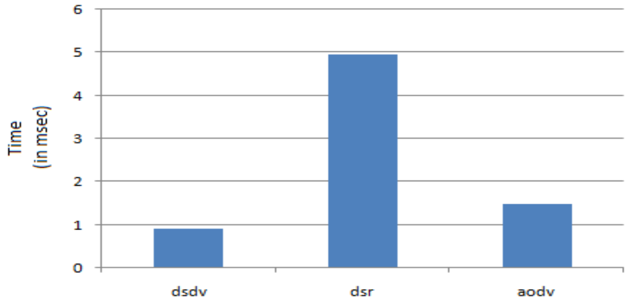

Fig. 15 End-to-end delay

Throughput: Throughput is calculated and analyzed at Fig.16 by varying routing protocol under parameters of 802.11p. It is clear from results that DSDV has the highest throughput among all the three routing protocols.

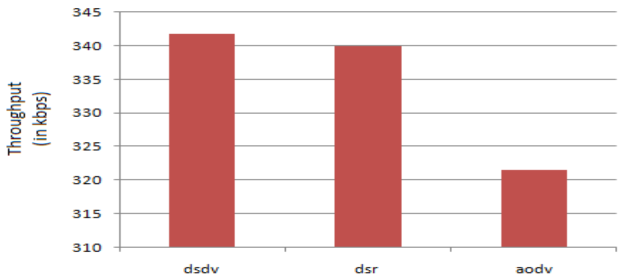

Fig. 16 Throughput

Packet delivery ratio: Packet delivery ratio is calculated and analyzed at Table.5.4 and Fig.5.3 by varying routing protocol under parameters of 802.11p. It is clear from results that DSDV has the highest throughput among all the three routing protocols.

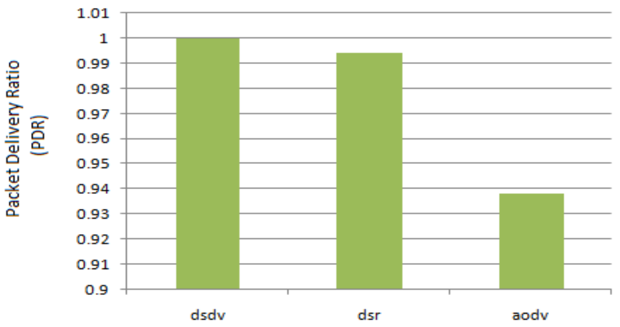

Fig.17 Packet delivery ratio

CONCLUSION: As per the simulation results obtained from the above scenario, we can conclude that DSDV (Destination Sequenced Distance Vector) Routing Protocol is the best suited routing protocol for the mentioned clustering algorithm. It gives the highest throughput and PDR (Packet Delivery Ratio) while giving the minimum end-to-end delay.

REFERENCES

[1] P. L. Ramage-Morin, \Motor vehicle accident deaths, 1979 to 2004," *Health Reports*,July 2008.

[2] \The economic impact of motor vehicle crashes 2000," *National Highway Tra±cSafety Administration*, May 2002.

[3] \Car 2 car communication consortium."[Online]. Available: www.car-2-car.org

[4] H. Kawashima, "Japanese Perspective of Driver Information Systems," *Transportation*, vol. 17, no. 3, Sept.1990, pp. 263–84.

[5] Car 2 car communication consortium." [Online]. Available: www.car-2-car.org

[6] M. Torrent-Moreno, M. Killat, and H. Hartenstein, \The challenges of robust inter-vehicle communications," in *Vehicular Technology Conference, 2005. VTC-2005-Fall. 2005 IEEE 62nd*, vol. 1, Sept., 2005, pp. 319{323.

[7] http://www.csie.ntpu.edu.tw/~yschen/course/96-2/Wireless/papers/broadcast-5.pdf

[8] A. McDonald and T. Znati, \A mobility-based framework for adaptive clustering in wireless ad hoc networks," *Selected Areas in Communications, IEEE Journal on*, vol. 17, no. 8, pp. 1466{1487, Aug 1999.

[9] J. Yu and P. Chong, \A survey of clustering schemes for mobile ad hoc networks,"*Communications Surveys & Tutorials, IEEE*, vol. 7, no. 1, pp. 32{48, Qtr. 2005.

[10]Y. Gunter, B. Wiegel, and H. Grossmann, \Cluster-based medium access scheme for vanets," *Intelligent Transportation Systems Conference, 2007. ITSC 2007. IEEE*, pp. 343{348, 30 2007-Oct. 3 2007.

[11] S.-Y. Ni, Y.-C.Tseng, Y.-S.Chen, and J.-P. Sheu, \The broadcast storm prob-lem in a mobile ad hoc network," in *MobiCom '99: Proceedings of the 5th annualACM/IEEE international conference on Mobile computing and networking*. New York, NY, USA: ACM, 1999, pp. 151{162.

[12] W. Chen and S. Cai, \Ad hoc peer-to-peer network architecture for vehicle safety communications," *Communications Magazine, IEEE*, vol. 43, no. 4, pp. 100{107,April 2005.

[13] R. Ramanathan and M. Steenstrup, \Hierarchically-organized, multihop mobile wireless networks for quality-of-service support," *Mobile Networks and Applications*, vol. 3, no. 1, pp. 101{119, 1998.

[14]H. Su and X. Zhang, \Clustering-based multichannel mac protocols for qosprovisionings over vehicular ad hoc networks," *Vehicular Technology, IEEE Transactionson*, vol. 56, no. 6, pp. 3309{3323, Nov. 2007.

[15]C. Lin and M. Gerla, \Adaptive clustering for mobile wireless networks," *SelectedAreas in Communications, IEEE Journal on*, vol. 15, no. 7, pp. 1265{1275, Sep1997.

[16] C.-C. C. Hsiao-Kuang, C. chuan Chiang, H. kuang Wu, W. Liu, and M. Gerla,\Routing in clustered multihop, mobile wireless networks with fading channel," in*The IEEE Singapore International Conference on Networks*, 1997.

[17] Gerla, M. and Tsai, J., "Multicluster, mobile, multimedia radio network, wireless networks", 1(3) 1995, pp. 255-265.

[18]https://tspace.library.utoronto.ca/bitstream/1807/18879/6/Shea_Christine_K_200911_MASc_thesis.pdf