Exploration of VANET Mobility Models with New Cluster Based Routing Protocol

Kapil Bhagchandani, Yatendra Mohan Sharma

Abstract*— Vehicular ad-hoc network (VANET) is high dynamic wheeled networks in which moving vehicles that can move in any direction at varying speed are behave as network nodes and router for data exchange. The frequently changes in topology and mobility pattern in VANET pose many unique networking research challenges which make crucial the designing of an new suit of efficient routing protocol for VANET. Recently, several approaches proposed by some authors in order to overcome the problem of discovering and maintaining the efficient and effective route for the data transmission over the wireless network but still there is scope of modernization. In this paper we are presenting cluster based routing approach for VANET and compare their performances with existing routing protocols. This new routing approach will have an aim of increasing the overall network throughput and minimize end to end delay. This paper, considering the mobility models like: random way point mobility model and group mobility model. Simulation studies are conducted using NS2.

Keywords*— VANET, Clustering, Routing, Mobility, AODV, DSR.

I. INTRODUCTION

Vehicular ad-hoc network (VANET) is a subgroup of mobile ad-hoc network (MANET) with the key difference of frequently changes in mobility pattern and network topology [1,2,3,4]. At present, it is active research are of all major vehicle manufactures companies and industries for product development [5]. Due to high mobility of vehicle moving on the roads, protocols developed for general mobile ad hoc network are unsuitable for such an environment. In VANET network performance of routing protocol degrades with speed and size of network that poss research challenge to design efficient routing protocol for this high mobile environment. In recent years several of ad hoc routing protocols have been proposed, which can be classified into two categories: reactive (on-demand) and proactive protocols [6]. Because of less control overhead, reactive protocols such as DSR [7] and AODV [8] have gained more popularity. In AODV [8] each node maintains a routing table to keep the id of the next hop intermediate node. In DSR [7] the source determines the complete sequence of nodes to the destination based on the information of Route Reply message from the destination, and the route is listed in the header of each data packet transmitted. Both AODV and DSR try to find the shortest path in terms of the number of hops from the source to the destination. They both perform well in ad hoc networks without highly dynamic change of topology [6]. However, due to the characteristics of VANETs high mobility and frequent link disconnection, they perform poorly in VANETs.

Clustering is a method by which nodes are placed into groups, called clusters. A cluster head is elected for each cluster that maintains a list of the nodes belonging to the same cluster and path to each of these nodes that updated in a proactive manner. Similarly, a cluster head maintains a list of the gateways to the neighboring clusters. Cluster based Routing in VANET is particularly useful for applications that require better routing and scalability to hundreds or thousands of vehicles [4]. Vehicles Mobility behavior determines the architecture of the cluster. In cluster based routing a group of nodes identifies themselves to be a part of cluster and a node is designated as cluster head will broadcast the packet to cluster. Good scalability can be provided for large networks but network delays and overhead are incurred when forming clusters in highly mobile VANET.

In this paper we are presenting cluster based routing approach for VANET and compare their performances with existing routing protocols. This new routing approach will have an aim of increasing the overall network throughput and minimize end to end delay. The rest of paper is organized as follows. Section 2 presents the overview of different VANET routing protocol. The investigation of cluster based mobility model is discussed in section 3. The section 4 described routing protocol performance metric and simulation setup. The result is presented in section 5. Finally we summarize the paper and outline future research in section 6.

II. OVERVIEW OF VANET ROUTING PROTOCOLS

The routing protocols basically perform three main functionality route discovery, maintenance and selection of the efficient path from the various available paths. The routing protocols in the VANET environment are characterized on the basis of area / application where they are most suitable [9] and are classified into five categories can be seen in figure 1.

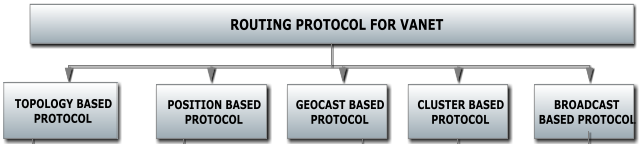

Fig. 1 VANET Routing Protocols

There are several papers [10, 11, 12] presents information about various VANET routing protocols. We have also described the categories of VANET routing protocol in our previous work [13]. In this paper we have investigate AODV, DSR and proposed cluster based routing protocol for our simulation purpose.

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A. *Ad-hoc On-Demand Distance Vector (AODV)*

With some significant difference Ad Hoc on Demand Distance Vector (AODV) have combine functionality of DSDV and DSR routing protocol. It is reactive routing protocol that establishes route on-demand in source to destination node and does not require maintaining routes to node that are not communicating. It has the ability of unicast & multicast routing and use routing tables for maintaining route information. In this algorithm the sender node send a Route Request (RREQ) message to its neighbors for route discovery and after establishing route if any link failure occur than node send information to its upstream neighbor in form of Route Error (RRER) message. This process execute till sender node not receive the information of failure link, after receiving message sender node resend another RREQ message to find new route [14].

Advantage of this protocol is establishing on-demand route in between source and destination node with the lower delay in connection setup and does not require much memory for communication but there are several disadvantage with this protocol like if the source node sequence number is very old than the intermediate nodes can lead to route inconsistency. Heavy control overhead if there has multiple route reply packets for a single route request packet. It consumes extra bandwidth because of periodic beaconing.

B. *Dynamic Source Routing (DSR)*

Dynamic Source Routing (DSR) is designed specifically for multi-hop wireless ad-hoc network. Unlike other ad-hoc network protocol DSR not require any periodic routing message in network. This algorithm provides the route on-demand and the sender node knows the complete hop by hop route to the destination. The routes are store in route cache. Route discovery and maintenance are two major phases of this protocol. At the time when node wants to send message, it check its route cache for searching the availability of unexpired route up to the destination from that node. If route is found than node start transmission of packet else start the route discovery process for searching new route in between source and destination node. Each route request packet carries the source node address, a new sequence number and the destination node id. The entire node that receiving route request packet checks the sequence number and rebroadcast that packet to it neighbors if it has not forwarded it already or that node is not the destination node after adding its address information in packet.

The advantage of this protocol is that it provide on-demand routing path and does not require periodic packet that are used by a node to inform its presence to its neighbors. The control overhead is reduced by using the information efficiently from route cache by node to access the route for packet transmission that are already discovered but in this protocol path length effect the routing overhead and broken links in network does not repair locally at route maintenance process. This is the main limitation of this protocol that makes it unsuitable for large high mobility network [15,16].

C. *Cluster Based Protocols*

It's a routing protocol which based on position and clusters. Each cluster has one cluster-head, which is responsible for intra and inter-cluster management functions. Intra-cluster nodes communicate each other using direct links, whereas inter-cluster communication is performed via cluster headers. In cluster based routing protocols the formation of clusters and the selection of the cluster-head is an important issue. In this protocol, the geographic area is divided into some foursquare grids. Only if there is a vehicle in a grid will a vehicle be elected to the cluster header, and the data packet is routed by cluster header across some grids one by one. In VANET due to high mobility dynamic cluster formation is a towering process. The various cluster based routing protocol are COIN[17], LORA-CBF[18], CBDRP[19].

D. *Shortcoming of Existing Protocol*

The existing routing protocols are effective only when the node population is small. The Reactive routing schemes will fail to discover a complete path due to frequent network partition. The proactive routing protocols will be overwhelmed by the rapid topology changes and even fail to converge during the routing information exchange stage. The Position-based routing schemes generally require additional node physical position information during the routing decision process. A location service is needed as well to provide the position information of nodes. Due to the high node mobility and the movement constraints of mobile nodes the conventional topology-based routing schemes are not suitable for VANETs.

III. INVESTIGATED MOBILITY MODEL

Cluster is a subgroup of interconnected network. In VANET network the vehicle moving at road take form of cluster. In last few decades many researchers propose several cluster based routing approaches for improving communication pitfalls in between high speed moving vehicle. In this cluster based approach cars that move on roads are selected as dynamic node that behave as source or intermediate node and on the bases of these nodes communication range the network are divided as groups of nodes that are directly in the communication range of them or another nodes group that are in the road side unit communication range to reduce reclustering rate. Every node that are in clusters have a different identification mark from another one and all the danger messages propagate in network by only head of the cluster known as cluster head in the sub-network. Whenever a node goes out from the communication range of cluster heads than that join another one or a new cluster is formed. Some low speed vehicles in cluster with high speed vehicle make reason of high end to end delay and losses of data packets. We are trying to reduce delay and improve throughput of the network.

IV. PERFORMANCE METRICS & SIMULATION SETUP

A. *Simulation Tool & Parameters*

There are many network simulators available in the market but the most frequently used are OPNET, Qualnet, and NS2. OPNET and Qualnet both also best network simulators, but these are not opens source tools and having the more cost for purchasing for such kinds of education studies. Hence the best choice is to use the NS2 simulator which is completely free and open source tool for all kinds of network simulations and researches. There are many versions of NS2 available ranging from ns-2.26 to ns-2.34.

In this work we have implemented the investigated VANET new routing algorithm for the efficient network performance. We carried our simulation studies with NS2, and simulated

this approach with the aim of higher throughput and minimized end to end delay. We used the new hybrid mobility model and compare its performance as well. In this simulation the main parameter which is varied during the simulation is the number of nodes, number of connections and size of the network. Here we are considering the simulation for the 10, 20 30, 40, 50 nodes for the different protocols with the increased network size and number of connections.

Table 1: Simulation Parameters

Number of Nodes	10/20/30/40/50
Traffic Patterns	CBR (Constant Bit Rate)
Network Size	500 x 500 (X x Y)
Max Speed	10 m/s
Simulation Time	600s
Transmission Packet Rate Time	10 m/s
Pause Time	2.0s
Routing Protocol	DSR / AODV / Proposed Cluster Based Algorithm

B. Performance Metric

There are several performances metric at which routing protocols can be evaluated for network simulation [20]. We use the performance metrics in our simulation purpose are: Network Throughput and End to End delay.

Throughput: The throughput of the protocols can be defined as percentage of the packets received by the destination among the packets sent by the source. It is the amount of data per time unit that is delivered from one node to another via a communication link. The throughput is measured in bits per second.

End to End delay: The total time for transmitting a packet from source to the destination node is known as end to end delay. The delay performance metric include the delays due to route discovery, packet propagation and sending time and the time of packet in queue [21].

V. RESULTS

Following graphs showing the performance comparison between AODV, DSR and New cluster based routing protocol in terms of throughput and end to end delay.

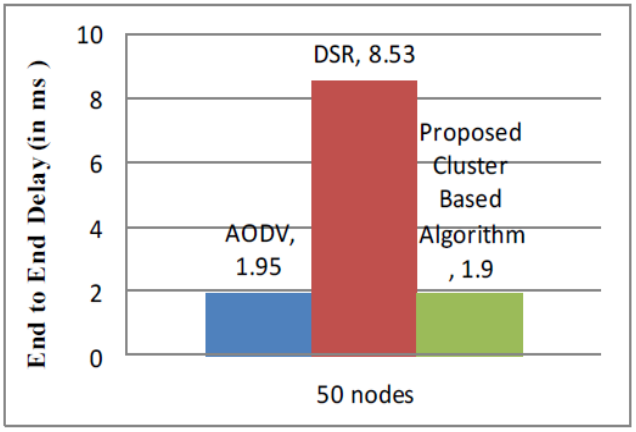

Fig. 2 End to End Delay Analysis for 50 nodes

Above figure 1 showing that performance of new cluster based approach having more improved performance as compared to both AODV and DSR for end to end delay. Similarly in next figure 2, its having higher throughput for 10 and 50 nodes network of VANET of proposed cluster based routing protocol.

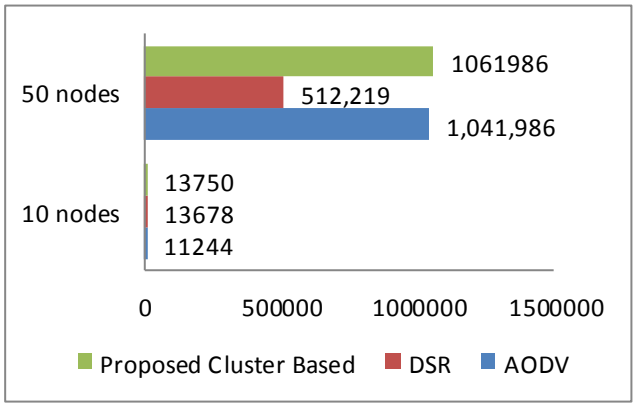

Fig. 3: Throughput Analysis (in kbps)

VI. CONCLUSION & FUTURE WORK

In this paper, we discussed the new approach presented for VANET routing as well as new mobility model used. We compared the new protocol with existing protocols like AODV and DSR for VANET networks and observed their results. From the results we can say that cluster based approach having better performance in terms of throughput and end to end delay. Regarding to mobility model, hybrid mobility model is having the better mobility support for VANET networks. From above results we can claim that proposed new cluster based routing protocol having more improved performance as compared to existing AODV and DSR for VANET.

In the area of VANET research, there is always scope for further works; here we can suggest that energy aware cluster based approach for routing. For wireless networks, energy is always vital resource, so we have to add mechanism to minimize the energy consumption as well to present study.

REFERENCES

[1] Hang Dok, Huirong Fu, Ruben Echevarria, and Hesiri Weerasinghe, "Privacy Issues of Vehicular Ad-Hoc Networks", International Journal of Future Generation Communication and Networking Vol. 3, No. 1, March , 2010

[2] Yun-Wei Lin, Yuh-Shyan Chen, And Sing-Ling Lee, " Routing Protocols in Vehicular Ad Hoc Networks: A Survey and Future Perspectives", JISE-2009-1

[3] Xiong Wei , Li Qing-Quan, "Performance Evaluation Of Data Disseminations For Vehicular Ad Hoc Networks In Highway Scenarios", The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences. Vol. XXXVII. Part B1. Beijing 2008

[4] D.Rajini Girinath, S.Selvan, "A Novel Cluster based Routing Algorithm for Hybrid Mobility Model in VANET" International Journal of Computer Applications (0975 - 8887) Volume 1 – No. 15, 2010

[5] Martin Koubek, Olivia Brickley, Susan Rea, Dirk Pesch, " Application Driven Routing for Vehicular Ad Hoc Networks – A Necessity", ISVCS 2008, July 22 - 24, 2008, Dublin, Ireland. ISBN 978-963-9799-27-1

[6] J. Broch, D.A. Maltz, D.B. Johnson, Y-C Hu, and J.Jetcheva, "A Performance Comparison of multi-hop wireless ad hoc network routing protocols," in ACM MOBICOM'98, Oct. 1998.

[7] D. Johnson and D. Maltz, "Dynamic source routing in ad hoc wireless networks," Mobile Computing, 1996.

[8] C.E. Perkins and E.M. Royer, "Ad hoc on demand distance vector (AODV) routing," in 2nd IEEE Workshop on Mobile Computing Systems and Applications, Feb. 1999.
[9] James Bernsen, D. Mnivannan, "Unicast routing protocols for vehicular ad hoc networks: A critical comparison and classification", in journal of Pervasive and Mobile Computing 5 (2009) 1-18
[10] Jagadeesh Kakarla, S Siva Sathya, B Govinda Laxmi, Ramesh Babu B." A Survey on Routing Protocols and its Issues in VANET" International Journal of Computer Applications (0975 – 8887) Volume 28– No.4, August 2011
[11] Uma Nagaraj, Dr. M. U. Kharat, Poonam Dhamal "Study of Various Routing Protocols in VANET" IJCST Vol. 2, Issue 4, Oct . - Dec. 2011
[12] Rakesh Kumar, Mayank Dave " A Comparative Study of Various Routing Protocols in VANET" IJCSI International Journal of Computer Science Issues, Vol. 8, Issue 4, No 1, July 2011
[13] Yatendra Mohan Sharma, Dr. Saurabh Mukherjee " A Contemporary Proportional Exploration of Numerous Routing Protocol in VANET" International Journal of Computer Applications (0975 – 8887) Volume 50– No.21, July 2012
[14] Zhan Haawei and Zhou Yun.Comparison and analysis AODV and OLSR Routing Protocols in Ad Hoc Network, 2008, IEEE.
[15] D. Johnson, B.D.A. Maltz, and Y.C.Hu, "The Dynamic Source Routing Protocol for Mobile Ad Hoc Networks (DSR)", draft-ietf-manet-dsr-10.txt, 2004.
[16] C.E.Perkins and E. M. Royer. Ad-Hoc On Demand Distance Vector Routing, Proceedings of the 2nd IEEE Workshop on Mobile Computing Systems and Applications (WMCSA), pp. 90-100, 1999.
[17] J. Blum,"Mobility management in IVC networks," 2003.
[18] R. A. Santos, "Performance evaluation of routing protocols in vehicular ad hoc networks," 2005.
[19] Tao Song," A Cluster-Based Directional Routing Protocol in VANET".
[20] Ajay Kumar, Ashwani Kumar Singla "Performance evaluation of Manet routing protocols on the basis of tcp traffic pattern" International Journal of Information Technology Convergence and Services (IJITCS) Vol.1, No.5, October 2011
[21] S H Manjula, C N Abhilash, Shaila K, K R Venugopal, L M Patnaik, "Performance of AODV Routing Protocol using group and entity Mobility Models in Wireless Sensor Networks," Proceedings of the International Multi Conference of Engineers and Computer Scientists (IMECS 2008), vol. 2, 19-21 March 2008, Hong Kong, pp. 1212-1217

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