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SURVEY ON CLUSTERING ALGORITHM BASED MULTICAST ROUTING FOR VEHICULAR AD HOC NETWORKS

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Abstract:

Vehicular Ad Hoc network is a self-configurable and considered as a subset of mobile Ad Hoc networks (MANETs). VANET are developed for improving road safety and for providing best services of intelligent transport system. The communication in VANET is difficult because the messages are broadcasted and a wireless medium is used for propagation. To provide a secured communication among these vehicles clustering algorithms are used. The VANET protocols reduce the power consumption, transmission overhead and network portioning successfully by using multicasting/multicast routing schemes. In multicasting the messages are sent to multiple specified nodes from single source. Clustering of vehicles has been widely used for routing and data dissemination in VANETs. This paper focusses on the survey of clustering algorithms based on multicasting routing protocols for stable cluster formation and more secure communication. Formation of stable clusters withstanding the mobility patterns of the vehicles is important key factor for clustering algorithm in VANETs.

Keywords: Clustering in VANET, vehicular Ad Hoc networks.

I. Introduction

The fatalities and serious injuries which are caused mainly due to road crashes are increasing every year at a fast pace. According to the Department of Transport, Great Britain, the reported deaths in traffic accidents at United Kingdom during the year 2014 were 1775. In addition to this, the number of seriously injured people are reported as 22,807 in the same year. Besides this, according to the World Health Organization (WHO), every year 1.24 million people pass away due to this kind of vehicular accidents. MANETs are gaining a lot of attention due to its promising applications in different fields where development of infrastructure is not that feasible. It is possible to reduce the number of accidents by informing drivers in advance about the risk area by using the intelligent transport system

(ITS) which is one of the key applications in vehicular ad hoc network (VANET). In VANET, the vehicles communicate with each other by using vehicle to vehicle communication (V2V), vehicle to road side units (V2R), and vehicle to infrastructure (V2I). The vehicles are equipped with wireless sensing devices to develop inter vehicular communication (IVC) without deployment of infrastructure. Hence, VANET has got significant research attention since it develops wireless communication among vehicles in order to convey emergency messages. The main motivation of developing the VANET routing protocols is to reduce the human casualties and multicar collisions by managing topology of high speed vehicles at real time. The VANET develops the ITS based upon latest communication technologies to provide convenience, safety, and accuracy while driving. ITS has made the traffic system more efficient and secure when compared to the traditional traffic management system. The first generation of ITS was created in 1991 in the United States after considering severe loss of life in road accidents. The aim of developing the ITS was to bring the latest technology into the existing traffic system to reduce accidents and improve the road safety. As a result, first generation of Dedicated Short Range Communication (DSRC) system was developed for commercial vehicles which operate at 915MHz with transmission rate of 0.5 Mb/s. The commercial vehicles used DSRC system mainly to pay toll only. In 1997, the ITS at United States demanded bandwidth of 75MHz from Federal Communication Commission (FCC) to develop the advanced technology for traffic system[1,2]. In the Second Generation of Dedicated Short Range Communication (DSRC), the FCC has allocated the band of 5.9GHz (5.85GHz to 5.925GHz) with the bandwidth of 75MHz in the year 1999. The project aim is to develop reliable communication among vehicles to receive information regarding the weather, accidents, traffic, congestion, and so forth. Moreover, there are no charges to access the open standard DSRC 5.9GHz band which reduces its overall implementation cost. The aim of band allocation is to reduce the road accidents by using VANET. DSRC is also recognized as the Wireless Access in Vehicular Environments (WAVE)[1]

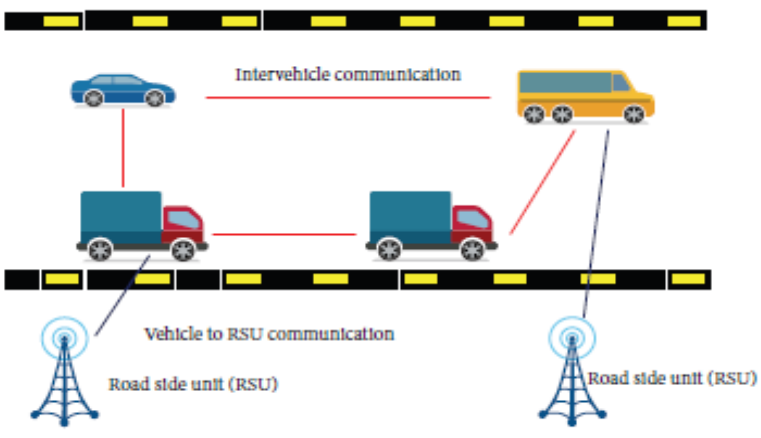

FIGURE 1: VANET applications and transmission strategies.

The Comparison between the different wireless technologies shows that DSRC is more appropriate for this VANET environment. There are two types of DSRC devices which are being used for the VANET communication. These devices are road side unit(RSU) and the On Board Unit(OBU).OBUs are installed in the vehicles along with omnidirectional antennas to access wireless channel, while these RSUs are the stationary devices installed along the roads and highways with functionality similar to OBUs. The general architecture of RSUs consists of a antenna, a processor, and multiple sensors to facilitate communication among vehicles. When vehicles are in the network, they send messages regarding their personal information, road information, unnatural activities on road, etc to the other components of the network. These communications are done through wireless medium provided by the WiF's. Communication in VANET includes Inter-vehicle communication (IVC), Inter-roadside unit communication (IRC) and Roadside unit to the vehicle communication (RVC). In IVC, vehicles communicate among themselves. Roadside units communicate among themselves in the IRC. In RVC, vehicles communicate with fixed devices installed on the either sides of roads, called as Road Side Units (RSU)s. This technology was initially developed for the police, fire and emergency departments. As the vehicles pose dynamic nature, vehicular network is likely to face stable entries and congestion. In order to avoid this kind of problems many solutions are been proposed, of which clustering is one of the solution technique. Clustering reduces the messages count and increases connectivity in the network. The remainder of this paper is structured as follows. Section II provides a discussion of the recent literature on the clustering techniques in VANET and brief classification of protocols using clustering techniques in the VANET. The last Section III concludes the discussion.

A) Abbreviations

WHO-world health organization, WAVE-wireless access in vehicular environments, DSRC- dedicated short rage communication, FCC-federal communication commission, CBLR- cluster based location routing.

II. Overview: Researchers all across globe proposed many clustering schemes for VANET. These clustering techniques focus on various topics and even use clustering schemes proposed for MANET for the cluster formation. Hence in this paper, we attempt to classify these schemes according to parameters used in this respective technique. Classification of the clustering schemes in vehicular network is summarized below in deatil.

A. Mobility Based Clustering Schemes

Protocols under this category consider mobility characteristic of vehicles as one of the parameters for selecting the clusters and the cluster heads in the network. The other characteristics of a vehicle are position, direction, speed etc.

The mobility based clustering techniques can be further classified into two types depending on the direction considered by the vehicles on road. They can be namely direction based clustering schemes and non-direction based clustering schemes.

1) Direction Based Clustering Schemes

Some of the direction based clustering schemes focus on the direction of vehicle for selecting effective clusters for a vehicular network. However, some of these schemes focus on direction of the vehicle or lane for selecting clusters or cluster heads for a respective network. So based on these differences the direction based clustering schemes can be further classified into two types namely Lane based clustering schemes and Vehicle based clustering schemes.

a) Lane Based Clustering Schemes

The lane based clustering schemes consider direction of traffic on road as one of the parameters for calculating efficiency and comparatively stable clusters in VANET. The advantages of stable clustering scheme is that it reduces the overhead of re clustering which results in an efficient network topology. Cluster head changes and cluster reconfigurations cannot be avoided in the various networks like VANET. This affects stability of the network. For more stable clusters in the network there needs to be fewer cluster head changes. To achieve less number of cluster head changes, the cluster members should select a node among the cluster members which can meet all these requirements of being a cluster head for relatively long period of time when compared with the rest of them. Mohammad S.Almalag et al. [3] discussed a technique where cluster head is selected depending on lane having the maximum traffic flow. Vehicles have knowledge of the lane of traffic on the road and they broadcast this information to nearby vehicles. This helps in determining efficient cluster head.

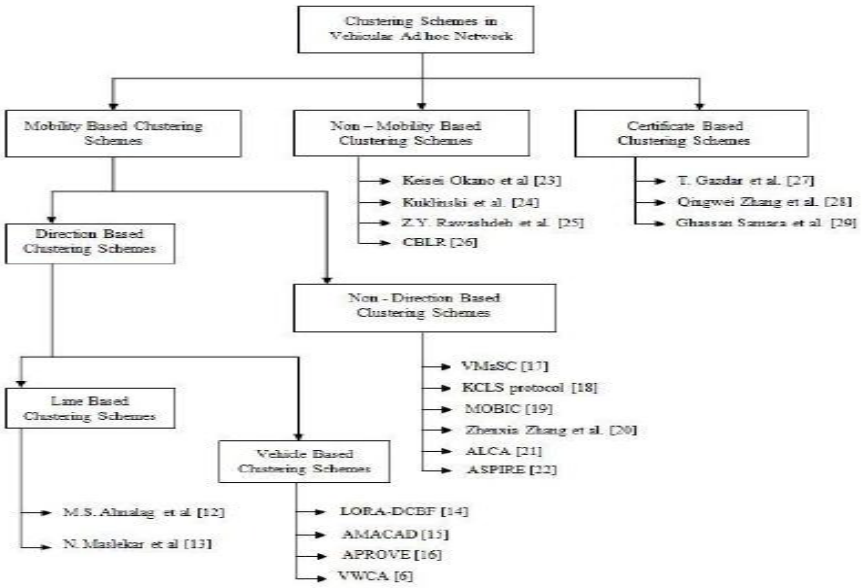

Figure-2: Clustering flowchart.

As Vehicles are highly mobile on road, it is quite difficult to find the exact route in VANETs. In ALCA, agents communicate with each other and calculate mobility of the vehicles depending on learning Vehicle clustering. Agents are deployed on moving vehicles, and they also have sensing capabilities. Agents are used to decide the itinerary of the vehicles and share this information with the other agents. The agents decide path and are also useful in calculating the density of vehicle on the road in an interactive manner which they share with other agents for taking the decision about this routing. The reason for selecting the agent technology is that they are autonomous and adaptive in taking decisions.

b) Vehicle Based Clustering Schemes

Protocols using the direction of vehicles for the selection of clusters and cluster heads are classified under vehicle based clustering schemes. LORA-DCBF [4] is a routing algorithm based on position of vehicle. It uses both GPS and direction of vehicles for the cluster formation. This scheme enables two or more cluster heads for a cluster, provided that cluster heads are in opposite directions. It enhances traditional routing techniques by using this local information. Routing of packets is done in hop-to-hop fashion. Nodes use the most recent location information of the neighbouring nodes for packet routing in network. Thus the system can sustain some packet loss. As vehicles are highly mobile in network, transmission of data is prone to stale entries and loss of data. This can be avoided since all intermediate nodes transmitting information are using most recent information. The control traffic is reduced due to the usage of only the selected nodes, which are also called as gateway nodes, for message dissemination. This strategy is more effective and results in the more stable clusters as different direction nodes have different cluster heads.

B. Non-Mobility Based Schemes

The non-mobility based schemes are the vehicular ad hoc network schemes which uses the clustering technique but don’t use mobility as one of the metrics. The following are few of the non-mobility based schemes. Keisei Okano et al. [5] proposed an autonomous clustering scheme which selects network gateway nodes dynamically according to the network topology change in heterogeneous mobile ad hoc network environment. When a network gateway node is to be selected, a cluster head takes a decision on whether to select the network gateway node or to wait for a specified amount of time. In order to avoid oscillation of network gateway nodes between two adjacent clusters, the waiting period is calculated by comparing its own network address with the network address of neighbouring network. If the network address of the cluster head is more than that of the neighbouring network, it waits for a specified period until the gateway nodes of the neighbouring network are elected by the cluster head. The goal of clustering algorithm

discussed by Slawomir Kuklinski et al. [6] is to form long living and stable clusters for the reliable communication. This technique can also be referred to as density based clustering in VANET. This is a clustering scheme with complex metric which is a function of the density of connection graph, traffic conditions and link quality. Prerequisite of the scheme is that a node having knowledge about its current position, position of a node connected by the link being evaluated and velocity vectors of itself and the other node. Cluster formation in this technique is based on several factors like connectivity level, link quality (SNR), relative node position and the prediction of this position in future, node reputation.

Zaydoun Y Rawashdeh et al. [7] discuss a scheme which aims for the stable network topology. It considers speed difference among the neighbouring nodes as a parameter for a stable clustering structure. Vehicles moving in a same direction always form clusters. In this technique, vehicles having higher mobility, group in to one cluster whereas vehicles having lower mobility group in to another cluster. The challenge in this technique is to divide the network into minimum number of clusters. This is based on their mobility patterns and is achieved with higher probability. Therefore, all neighbouring nodes used for speed difference calculation are limited to those vehicles travelling in same direction. A CBLR (Cluster based location routing) is discussed by R. A. Santos et al. [9]. CBLR implements clustering technique in evaluating the inter-vehicular traffic of data on a motorway using a multi-hop network. The nodes in vehicular network uses HELLO message to distribute states. A new node entering the network can either join an existing cluster or create a new cluster by acting as the cluster head. It is assumed that all the nodes know location and position of other nodes in a cluster. In this technique each cluster head maintains a cluster table which contains the address and geographic locations of its own member nodes. A cluster neighbour table is also maintained by cluster head which contains information about its neighbouring clusters.

C. Certificate Based Schemes

The protocols which use clustering scheme for the certificate generation or revocation approach are classified under certificate based schemes. The following are the few protocols which fall under this category. Tahani Gazdar et al. [10] discuss the dynamic public key infrastructure for VANETs that aims to distribute role of the central certification authority among a set of dynamic chosen Certificate Authorities (CA) s. Election of dynamic CAs is based on clustering Algorithm where cluster heads perform the role of certificate authorities. The dynamic demilitarized zone (DDMZ) formed by confident nodes which are located at the 1-hop distance from cluster head of the same cluster. These confident nodes are intended to perform as the registration authorities (RA).

In [11], Qingwei Zhang et al. discuss a certificate revocation status validation scheme. It uses the concept of clustering in the realm of data mining. In VANET, certificate validation is more time sensitive as every vehicle is prone to receive a large number of messages in a minimum amount of time. The discussed scheme employs the k-means clustering technique to boost up the efficiency of certificate validation. There by, this enhances security of vehicular ad hoc network. Credibility and the issued date are added to certificates to improve the security of the system.

VANET Multicast Routing

Multicast routing protocols are most active research Area due to their efficiency and mobility within dynamic Environment like VANET. Multicasting reduces the power consumption, transmission overhead, and control overhead by sending the multiple copies of messages to various vehicles simultaneously. In multicast routing protocols, messages travel from a single sender to multiple destinations or towards a group of the interested nodes. In case of VANET multicast routing protocols, messages are transmitted to group of intended vehicles. Multicast routing methods are classified as *Flooding*, *proactive*, and *reactive approach [11]*. In *flooding*, the messages are broadcasted across network like a chain reaction. Every node sends the message to all its neighbours except to the sender.

The messages broadcasting can be limited within the desired geographical area. Therefore, the nodes rebroadcast the message only when they lie within a specified geographical area. The flooding algorithm is simple to implement which delivers the messages reliably. Flooding consumes a lot of bandwidth and power due to these redundant messages which increase the network load and the traffic congestion. The message redundancy causes collision in a network which results in packet loss. In *Proactive Approach*, the routing information is stored in routing tables by pre computation of routing paths. These routing tables are maintained and updated periodically for the distribution of routing information across the network. In this approach, the shortest path is adopted for routing without any route discovery.

The routes are updated and maintained at the regular intervals irrespective of their usage. Therefore, only partial information is required to maintain the routes which reduce the bandwidth consumption and latency. It is suitable for the real time applications due to its low latency. On the other side, the overhead increases due to the maintenance of unused routing paths which occupies a lot of bandwidth. The complexity of maintaining routing tables continues to rise in larger networks. This approach does not respond to any kind of link failure within the network. The third main

category is *Reactive Approach* in which the paths are calculated on demand. It is based on the query response mechanism. The connection is established between sender and desired receiver only when the query reaches to that receiver. In this approach, the routes do not need to be updated after regular intervals because these are established on demand. Therefore, there is no need to maintain routing tables which reduce network traffic, overhead, and complexity. Similarly, the bandwidth consumption also reduces because reactive approach is beaconless.

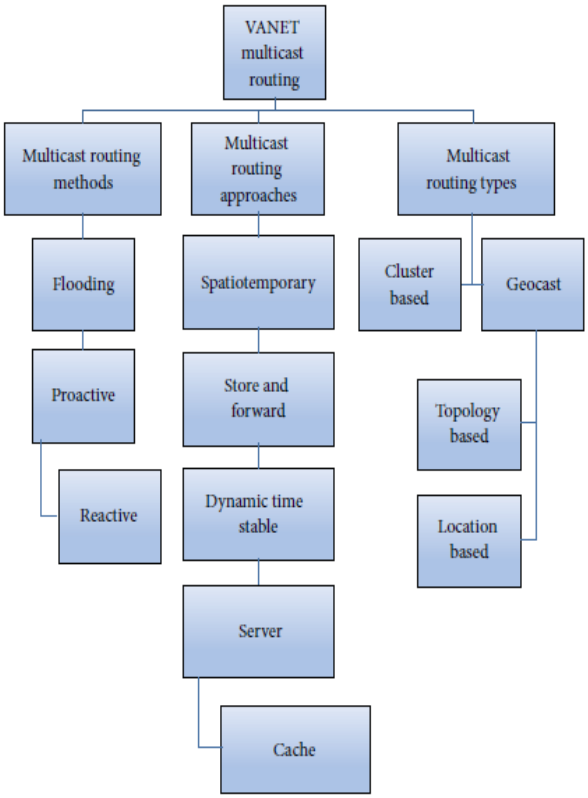

FIGURE 2: VANET multicast routing classification.

This approach responds to any kind of link failure within the network. It has high latency because the routes are discovered on demand. MANET multicast routing protocols are unable to execute well in the VANET because topology changes continuously as the vehicles move unpredictably. Therefore, it is also difficult to reduce bandwidth and power consumption due to high mobility in VANET. All these issues have made VANET multicast routing extremely challenging. The aim of developing multicast routing methods in VANET is reducing the transmission overhead, maintenance of adaptable topology, avoidance of loop formation, and reducing the processing load [12].

III. Conclusion

In VANET, the topology is highly dynamic in nature due to unpredictable mobility of the vehicles. Therefore, there is a need to develop such a framework which is capable of handling high mobility of vehicles within any kind of scenario whether that is urban or highway. VANET multicast routing protocols are received according to their various routing selection techniques and principles. The performance of protocols affects badly in VANET due to the

dynamic movement of the nodes which results in network fragmentation, delay, transmission overhead, and low throughput. Therefore, multicasting is used to improve performance of VANET routing protocols. Multicasting in VANET routing protocols reduces the power consumption, fragmentation, transmission, and control overhead by sending the multiple copies of messages from a single source to multiple specified vehicles. Furthermore, the network throughput results can be ordered from higher throughput to lower throughput such as highway > urban > rural areas. Certainly, there are many important open research issues on V2V communications and applications. The design of the VANET routing protocol is based on the application area and the environment for which it is developed. Hence, it is not possible to design a single protocol, which is suitable for all the VANET environments. Therefore, all the VANET multicast routing protocols are reviewed along with their functionality, advantages, disadvantages, applications, and performance in various environments.

IV. Future Work

Although there are various VANET multicast routing protocols developed for the effective and efficient communication, still there are many areas in which these kind of protocols are to be implemented. The performance of the VANET multicast routing protocols can be improved by increasing throughput and reducing end to end delay.

References

1. J. B. Kenney, "Dedicated short-range communications (DSRC) standards in the United States," *Proceedings of the IEEE*, vol. 99, no. 7, pp. 1162–1182, 2011.
2. S. P. Saraswat and W. T. Schiano, "Emerging issues in United States telecommunications policy: an analysis of federal communications commission activity," in *Proceedings of the 39th Annual Hawaii International Conference on System Sciences (HICSS '06)*, vol. 4, January 2006.
3. Mohammad S. Almalag and Michele C. Weigle, "Using Traffic Flow for Cluster Formation in Vehicular Ad-hoc Networks", IEEE 35th Conference on Local Computer Networks (LCN), 631-636, 2010.
4. Sadaf Momeni, Mahmood Fathy and Nasser Mozayani, "Vehicular Ad-Hoc Networks Clustering", In: proc. Of Advanced Satellite Mobile Systems, 299-304, 2009.
5. Keisei Okano, Tomoyuki Ohta and Yoshiaki Kakuda, "ADynamic Network Gateway Selection Scheme Based on Autonomous Clustering for Heterogeneous Mobile Ad Hoc Network Environment", In: proceedings of IEEE Globecom Workshops (GC Wkshps), 513-517, 2012.

6. Slawomir Kuklinski and Grzegorz Wolny, "Density Based Clustering Algorithm for VANETs", 5th International Conference on Testbeds and Research Infrastructures for the Development of Networks and Communities and Workshops, 1-6, 2009.
7. Zaydoun Y Rawashdeh and Syed Masud Mahmud, "A novel algorithm to form stable clusters in vehicular ad hoc networks on highways", EURASIP Journal on Wireless Communications and Networking, 2012.
8. Valantina. G.Mary and S.Jayashri."Trajectory based multicasting in vehicular ad hoc networks". International journal of Pharmacy and technology, ISSN 0975-766X,volume-6 Issue-4 Jan-April 2015.
9. R. E. R. A. Santos and N. Seed, "Inter vehicular data exchange between fast moving road traffic using ad-hoc cluster based location algorithm and 802.11b direct sequence spread spectrum radio", PostGraduate Networking Conference, 2003.
10. Tahani Gazdar, Abdelfettah Belghith and Abderrahim Benslimane, "A cluster based secure architecture for vehicular ad hoc networks", IEEE/ACS International Conference on Computer Systems and Applications (AICCSA), 1-8, 2010.
11. Qingwei Zhang, Mohammed Almulla, Yonglin Ren, and Azzedine Boukerche, "An Efficient Certificate Revocation Validation Scheme with k-Means Clustering for Vehicular Ad hoc Networks", IEEE Symposium on Computers and Communications (ISCC), 862-867, 2012.
12. L. Junhai, Y. Danxia, X. Liu, and F. Mingyu, "A survey of multicast routing protocols formobile Ad-Hoc networks," *IEEE Communications Surveys and Tutorials*, vol. 11, no. 1, pp. 78–91, 2009.
13. Valantina. G.Mary and S.Jayashri."A novel approach to efficient and reliable routing in VANETs".Applications of digital information and web technologies(ICADIWT),2014 Fifth information conference on the IEEE,2014.
14. Valantina. G.Mary and S.Jayashri."Detection of Reliable path for congession free traffic in Vanets". International journal of Applied Engineering Research,ISSN 0973-4562,volume-9 No.21,2014.
15. Valantina. G.Mary and S.Jayashri." A Systematic survey of VANET routing protocols based on transmission strategies." Indian journal of science and technology 9.22(2016).