THINK INDIA JOURNAL

ISSN:0971-1260
Vol-22-Issue-37-December -2019

Clustering Algorithms In Vehicular Ad-Hoc Networks: A Review

Manoj Sindhwani*, Dr. Charanjeet Singh

Department of Electronics and Communication Engineering
Lovely Professional University
Phagwara, India

Abstract

By virtue of VANETs, vehicles can transmit attentive messages to the other vehicle drivers to avoid dangerous circumstances which can cause fatal accidents. But due to fast speed with frequent changes, the delivery of messages on time can be a challenging task.. Clustering may be the solution to rectify the routing schemes and reliability in VANETs because of the formation of hierarchical network structures. This study presents a review on various clustering techniques being researched in recent years with the description of algorithms being used for a better understanding of the reader. A comparative study of all the clustering algorithms can make it easy to understand and know about most efficient algorithm for clustering in a particular situation.

Keywords—Vehicular Ad Hoc Networks, clustering schemes for VANET, cluster head selection

I. INTRODUCTION

VANET is the popular technique used for exchanging information between vehicles to avoid collisions and devastating accidents. One vehicle converses with the other vehicle to avoid collision via exchange of information. Now days, vehicle is no more just a transport media instead it has been made as an intelligent system to easify the diurnal and nocturnal life on roads. The infrastructure based networks allow scheduling of channel access and network resources distribution throughout the coverage area as intended to be covered. Clustering may be the solution to rectify the routing schemes and reliability in VANETs. Since a number of clustering algorithms has been put forward for MANETs in general and VANETs in particular, some of them for VANETs utilize mobility based cluster formation. A kind of ad-hoc network is shown in figure 1.

ISSN:0971-1260
Vol-22-Issue-37-December -2019

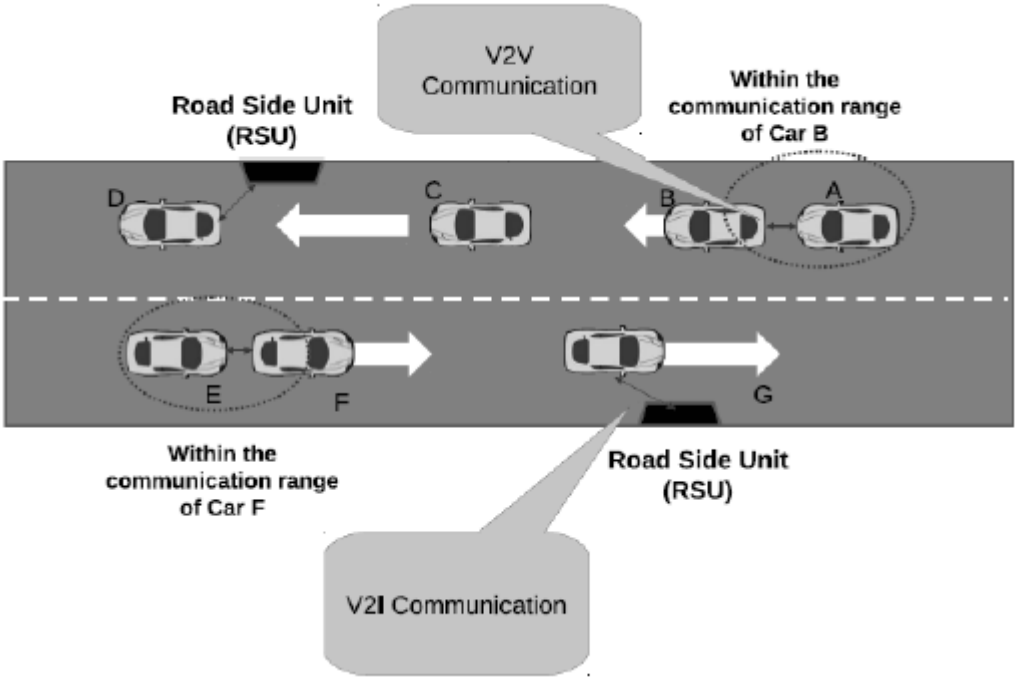

Figure 1: Creating Ad Hoc Network using Vehicles

Structure

A vital aspect of designing VANET is to develop efficient, reliable and secure routing protocols [5] and clustering algorithms. VANET provides a medium between vehicle and Roads Side Unit (RSU), On- Board Units (OBU) communicates with other OBUs to realize V2V communication having other functions such as providing radio Access, ad-hoc network and data reliability [1]. The Application Unit (AU) communicates with the network via OBU hence controlling the mobility and network functioning. RSU based network device provides network connectivity to On-Board Units. It is equipped on roadsides. The main application of clustering is described via application specific clustering algorithm and general purpose algorithms.

The paper is organized as follows. Section II reviews the background and related works. Section III carries out framework of clustering algorithm. Section IV precedes the application part. Section V presents clustering techniques.

II. RELATED WORK

The mechanism groups various vehicular nodes on the basis of some predefined parameters like velocity, density, location of vehicle, etc. Craig Cooper [4] presents novel techniques of clustering highlighting a comparison among all. Bali [2] proposes learning automata based clustering algorithm using a backbone called cluster leadership to decide cluster head.

ISSN:0971-1260
Vol-22-Issue-37-December -2019

Rong Chai [17] works upon utility based clustering algorithm considering credit history and current state of the vehicle.

III. FRAMEWORK OF CLUSTERING ALGORITHM

In VANET, the connectivity of nodes is self organizing and dynamic which can result in hidden terminal issues to be resolved by clustering. Clustering hence, will organize the vehicular nodes on the bases of specific characteristics. Clustering algorithms and techniques will be bought up in use to coordinate the node. Prior to the implementation of clustering, some parameters are to be taken into consideration, which are as follows:

A. Neighborhood discovery and sensing

When the communication system is turned on and the nodes are willing to communicate then a node will broadcast the message of its existence periodically while gathering similar information like position information from its neighbors to be further stored with the help of clustering algorithm.

B. Cluster head selection

Cluster Head (CH) node is dependent upon clustering algorithms. A node will also consider itself to be a CH with specific parameters. There are various techniques to select appropriate cluster head like:

- Fuzzy logic based CH selection
- Dual CH selection
- Back up CH selection, etc.

C. Affiliation

The optimal CH will try to be a part of specified cluster where few algorithms can demand the member to assign the role of CH. Once a node has been designated as a member of the cluster, it will announce its existence.

D. Announcement

The most suitable CH is supposed to send an announcement message to the neighbors for the purpose of beginning of affiliation.

IV. APPLICATIONS

This section incorporates various surveyed algorithms with their principle applications as follows:

ISSN:0971-1260
Vol-22-Issue-37-December -2019

A. General Purpose Algorithms

These algorithms are not application specific and tend to stress upon the robustness of mobility of the vehicles. Many of the MANET algorithms have been modified to be deployed in vehicular environment for VANETs like Distributed Clustering Algorithm (DCA) which have stationary nodes during clustering. Distributed Mobility Awareness Clustering (DMAC) algorithm was also designed for the ad hoc networks having mobile nodes and was not particularly for vehicles on road [4].

B. Topology

VANETs having a dynamic topology can analyze by the virtue of multi clustering structures. The affiliated nodes provide the information to the CH for building a connectivity map in a network between the nodes.

C. Security

A security mechanism is provided by affiliating a CH. Multistate mechanisms can be provided by various surveyed algorithms.

D. Channel Access Management

Clustering divides a network in sub networks allowing the CH to manage various activities by scheduling channel access. A TDMA- based approach is used in the intended algorithms.

E. Routing

Clustering may lead to the development of a hierarchical structure for routing of the packets. Routing algorithms can form the structure in many types, also a dynamic backbone structure is formed, or the structure can be based upon the gateway nodes

F. Safety

Cluster Based Risk- Aware Cooperative Collision avoidance (C- RACCA) estimates the expected braking time of the vehicle and incorporates a potential to avoid collisions by disseminating a warning message through the cluster to the recipient to take an appropriate action in such emergency. Event type can be specified in the warning message.

V. VANET CLUSTERING TECHNIQUES

A. Cluster Head Selection

The following assessment mechanisms make the use of various assessment parameters for finding the most suitable CH. The methods are describes in this section.

1) Weighted metrics: This is one of the commonly used approaches to select a CH by calculating the fitness of a node eligible for CH. In a neighbor table, all the neighbor nodes will be ranked

ISSN:0971-1260
Vol-22-Issue-37-December -2019

wishing to be indulged with the highly ranked node. The degree of connectivity is the weighted sum of various network matrices. Adaptable Mobility Aware Clustering Algorithm based on Destination (AMACAD) highest score which means the least comparing all the neighbors. Alternatively, best score of Mean Time Clustering algorithm may indicate the highest among all. This approach is quite advantageous as it offers simplicity and the guarantee of the existence of a single CH. Critically based Clustering Algorithm (CCA) uses a threshold to prevent the cluster structure thrashing. Clusters can be prevented from merging using Prioritize clustering hence specifying a dismiss threshold.

2) Precedence: To be a CH, the nodes advertise their own fitness and seek themselves potential enough. It can also selfishly choose the CH suiting its own requirements rather than considering the other nodes. Multi Channel Cooperative. Clustering based MAC (MCC- MAC) choose the CH having lower relative velocity than its own. Higher cluster member stability is ensured with the help the algorithms based on this parameter of Precedence shown in Table 1.

TABLE I: Algorithms in Precedence approach

Algorithm	Selection Metric(s)	Neighbour discov-ery	Affilation Hand-shake	CLuster Head Handoff
C-Drive	Front of Platoon, Direction of travel	Hello	No	Yes
MCC-MAC	Relative Velocity	Hello	Yes	No
VMaSC	Relative Velovity	Hello	Yes	No
CPTD	ID,Degree,Link expiration time	Hello	Yes	No
RMAC	Cluster head sta-tus, Distance, Ve-locity, Size	Inquiry	Yes	No
CMGM	Relative Velocity, Deceleration capability, infront or behind	Inquiry	yes	No
C-RACCA	Relative Velocity, Deceleration capability, infront or behind	Inquiry	yes	No

3) Timers: In this approach, the un-clustered nodes waits for a period of time to announce itself and affiliates with it if a node detects the presence of a CH within the time period. The node will declare itself as a CH if the time expires. This algorithm offers the advantage of speed and simplicity. Also, the cluster head will use channel bandwidth when necessary, like while

ISSN:0971-1260
Vol-22-Issue-37-December -2019

announcement broadcasts. Hidden nodes can be a challenge in this scheme wherein high node density situation occurs.

B. Passive Clustering

The three approaches weighted network metrics, precedence and timers are the active approaches because a common channel is used for the maintenance and formation of a cluster.

In passive clustering techniques, there is no contention between the traffic and clustering as in case of active clustering, hence allowing to achieve success. No extra traffic is required in passive clustering because it exploits the synergy between two systems to achieve cluster formation. Piggy backing the cluster controlled data on the routing traffic does not made it mandatory to have separate broadcast phase for clustering. By virtue of this technique, packet ratio is improved hence reducing end to end delay for a given node density. However clustering mechanism is shown with help of Figure 2, 3 and 4.

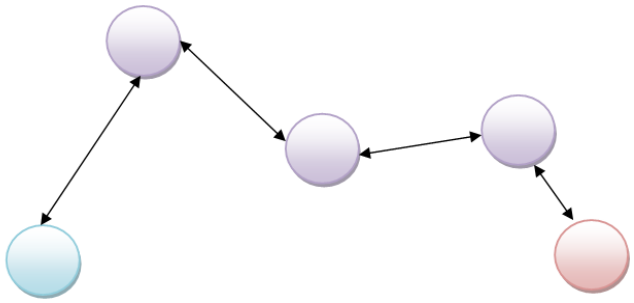

Figure 2: Snaking CH Chain

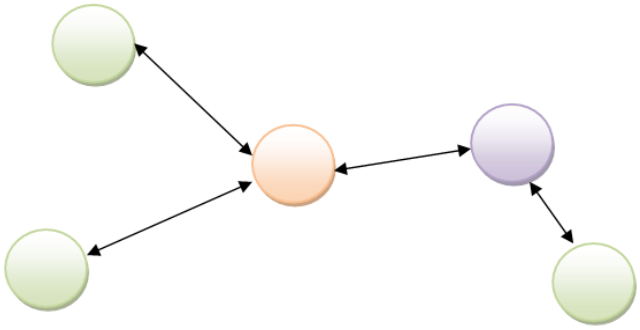

Figure 3 : Hierarchical Approach

Figure 4: Illustration of CH chain

Practically, the network traffic is irregular, resulting in the irregularity of cluster formation and cluster maintenance. So the system becomes vulnerable to the high node mobility. This problem

ISSN:0971-1260
Vol-22-Issue-37-December -2019

can be resolved by the usage of dynamically switched active- passive system but there is no such proposal till the time though research work is going in this field. CH selection is based on channel quality measurements hence VANET PC delivers a better performance than the only PC. Moreover, the vehicles with active data gathering can be chosen as CH.

C. Criteria for Cluster Head Selection

As a CH selection parameter, former two uses some unique code identification numbers like the MAC addresses whereas the latter models the node mobility. The VANET channel is subjected to the high fading behavior.

In the research field, VANET cluster head selection is a hot research topic because it is a self organizing network which does not have a fixed arrangement of its nodes and changes frequently. Certain parameters like mobility, link expiration time, vehicle class, trust factors etc. utilize the nodes.

1. Mobility: Nodes that are moving together having a small relative velocity will be able to maintain a stable communication link hence, potential CH is a logical choice. A reliable link is supported by potential CHs in close proximity. RMAC favors potential CH with more members, low speed relative to the joining nodes. This methodology is quite successful in identifying the CH which a properly connected to the group.

A passive Clustering Algorithm known as cluster formation for IVC uses a speed based grouping which affiliates a CH. Here, a speed threshold is used when a vehicle changes its speed group. Codes are assigned to the cluster members using CDMA to identify them and also to avoid packet collision.

2. Link expiration time: The LID/HD scheme is extended by Modified Distributed Mobility Aware Clustering (MDMAC) where there exists link expiration time between a potential CH and a CH seeking a node. Clustering Protocol for Topology Discovery (CPTD) estimates an expected link time for the avoidance of unnecessary re- clustering. Algorithms include DBA- MAC, MCTC.

3. Quality of the signal: Urban canyon effect can be seen due to the inaccuracies introduced by GPS by virtue of poor satellite reception. Clustering metric algorithms can be used to solve this problem. As the channels possess time varying nature- fast and deep fades can occurs due to the reflection of the signal. Relative weights are adjusted to compute overall CH metric. Channel metric can use SNR or K-hop clustering to calculate CH selection using propagation delay.

4. Platoon leadership: Here the front most car is chosen as a CH in a platoon where the CH selection is triggered when the traffic stops [24] as shown in Figure 5.

ISSN:0971-1260
Vol-22-Issue-37-December -2019

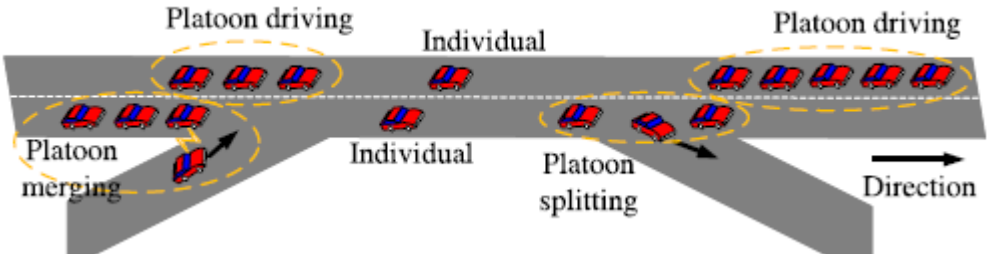

Figure 5: Platoon mechanisms with various driving patterns

The C-RACCA algorithm performs a check to know that from where the announcement has arrived, whether from back or front. Also, it access that should it use the cluster responding to it or should declare itself a CH. Also many clustering algorithms name are mentioned in Table II.

TABLE II: Algorithms Reviewed

Acronym	Algorithm Name
DMAC	Distributed Mobile Aware Clustering
GDMAC	Generalized Distributed Mobile Aware Clustering
MDMAC	Modified Distributed Mobile Aware Clustering
DBC	Density Based Clustering
CCA	Criticality- based Clustering Algorithm
PPC	Position- based Prioritized Clustering
UF	Utility Function
TBC	Threshold Based Clustering
FLBA	Fuzzy Logic based Algorithm
UOFC	User Oriented Fuzzy- logic based Clustering
MCTC	Mean Connection Time Clustering
NMCS	Neighbor Mobility- based Clustering Scheme
DMCNF	Distributed Multi- hop Clustering using Neighborhood Follow
CBLR	CBLR
RMAC	Robust Mobility Adaptive Clustering
PC	Passive Clustering
VPC	Vehicular Passive Clustering
TACR	Trust-dependent Ant Colony Routing
DBA- MAC	Dynamic Backbone Assisted - MAC
AMACAD	Adaptable Mobility Aware Clustering Algorithm on Destination
MCA- VANET	Multi- homing Clustering Algorithm for VANETs
CAC	Cellular Automata Clustering
CSBP	Clustering with Scalability Broadcast Performance
HCA	Hierarchical Clustering Algorithm
TC- MAC	TDMA Cluster based MAC
CCP	Cluster Configuration Protocol
SBCA	Stability Based Clustering Algorithm
MCC- MAC	Multi- channel Cooperative Clustering MAC
C-RACCA	Cluster based- Risk Aware Cooperative Collision Avoidance
CPTD	Clustering Protocol for Topology Discovery
FQGWS	Fuzzy QoS balancing Gateway Selection
CMGM	Cluster based Multimetric adaptive Gateway Management

ISSN:0971-1260
Vol-22-Issue-37-December -2019

VI. CONCLUSION

Many authors are showcasing their work and presenting novel clustering algorithms for the illustration of performance and the enhancement of the traffic safety and management via choosing an appropriate cluster head. Numerous algorithms have been reviewed in order to justify the factors at which they are dependent to choose an algorithm to cluster the vehicles in VANETs. As VANET is a persistently changing network with dynamic topology have distinct requirements from solving various challenges that come across the way as a barrier in CH selection. The new protocols and algorithms can be designed around the obstacles for making it convenient to communicate in a network. Though, there are a number of challenges in VANETs as, more VANET specificity in the clustering algorithms is direly needed.

REFERENCES

[1] Mayank Dixit, Rajesh Kumar, Anil Kumar Sagar, "VANET Architecture, research issues, routing protocols and its applications", 2016 ICCA, pages- 555-561

[2] Rasmeet Singh Bali, Neeraj Kumar, Joel J.P.C. Rodrigues, "An Intelligent Clustering Algorithm for VANETs", IEEE "International Conference on Connected Vehicles and Expo", 2014, page- 974-979.

[3] Farhan Ahmed, Abir Awad, "Vehicular cloud networks", IEEE, 14th March, 2016, p.571-576.

[4] Craig Cooper, Daniel Franklin, Farzad Safaei, Montserrat Ros, Mehran Abolhasan, " A comparative study of Vanet Clustering Techniques", Year- 2017, vol. 19, issue-1, p.657-681.

[5] Lihong Zheng, Tanveer A. Zia, "VANETs- an overview", journals of wireless communications and systems, year, 2013, p.20-38

[6] Parul Chaudhary, Umang, "literature review on VANET for intelligent transport", IEEE, 2nd international conference on computing for sustainable global development, p.2209-2213,. year- 2015

[7] Arohi Gupta, Raghuraj Singh, Danish Ather, Ravi Shankar Shukla, "Comparison of various routing algorithms", IEEE, p.153-157,2016

[8] Saleha Mubarak AlMheiri, hHend Saeed AlQamzi, "MANETs and VANETs Clustering Algorithms", 8th IEEE GCC conference and exibition, year- 2015

[9] Herve Boeglen, Jonathan Ledy, "V2V channel modelling for VANET simulations", IEEE international conference on wireless on demand network systems and services, year- 2011.

[10] Rongb Chai, Xianle Ge, Xun Hu, Bin Yang, "Utility Based Clustering Algorithm",IEEE International conference on communication and networking, 2014

[11] Emna Daknou, Mareim Thaalbi, Nabbil Tabbane, "clustering enhancement for VANETS in highway scenario", p.1-5, year- 2015

ISSN:0971-1260
Vol-22-Issue-37-December -2019

[12] Dhagga, Meenakshi, anshu sharma, "an algorithm for static geographical clustering in VANET",p. 420-426, year-2015
[13] Zhang, Liu,"VANETS: state, challenges, potential and way forward", international conference on computing and conference, 2014
[14] Hadded, Zagrouba, "Multi objective genetic algorithm based adaptive clustering protocol in VANET", IEEE, p.994-1002, year- 2015.
[15] Humayun Kabir, "research issues on VANET", vol.6, no.4, dec.2013
[16] Jia, lu, wang, "platoon based vehicular cyberphysical systems", IEEE computer surveys and tutorials, year- 2014
[17] Jerry, kuang, zhang, "VANET cluster on demand minimum spanning tree prim clustering algorithm" , IEEE, p 101- 104, year- 2013
[18] Louazani, "Petri net model for connectivity maintenance in VANET clustering algorithm", IEEE, p.92-97,year- 2016.
[19] Malik, komal "VANET challenges and solutions", IEEE conference on emerging trends in engineering, year 2013
[20] Sachdev, komal mehta, "design of protocol for cluster based routing in VANET using fire fly algorithm", IEEE conference on engineering and technology , year 2016
[21] Surmukh, "vanet routing protocols", IEEE, uiet, chandigarh, year 2014
[22] Sutagundhar, hubbabali "stability oriented clusterdynamism in vanet", IEEE international conference on computational systems, year- 2016
[23] Seyhan,"Multi hop cluster based arc hitecture for vanet", IEEE, 2017
[24] Xu, shen, le, "clustering algorithms in vanets", IEEE, year 2012