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A Review on Cluster Based Routing Protocols in Vehicular Adhoc Networks

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Abstract—Vehicular Adhoc Networks is an emerging technology for the communication of vehicles with the support of Intelligent Transportation Systems(ITS) to avoid fatal collisions and crashes on road and to ensure the road safety among the vehicles. The vehicles can be communicated through a wireless medium. Due to the rapid movement of vehicles and change in the topology leads to some message overheads with delays. Hence connectivity among the vehicles disappears and there is a need to identify an optimal path to be identified from source to destination for effective routing. A cluster will be formed to achieve a better link stability between the nodes and able to forward data to other members in case of any emergency situation. The safety message will be disseminated to other nodes in a limited short span of time. This paper gives a review on Vehicular Adhoc Networks(VANET) with its architecture, applications and various strategies which can be applied to form a cluster that yields high performance and evaluated with Quality of Service parameters.

Keywords-VANET, ITS, Cluster, Routing Protocols, DSR

I. INTRODUCTION

Now a days the usage of vehicles is multi folded that leads to increase in collisions. VANET is to promote road safety between the vehicles on the road. The vehicles are moving dynamically in nature and its topology might change. There may involve certain issues like routing, security, obstacles in a road, traffic congestion and collision are identified. The vehicles are communicated to each other through a short range wireless medium initiated by Dedicated Short Range Communication (DSRC) and IEEE 802.11p standard as Wireless Access for Vehicular Environment(WAVE). VANET provides seven 10MHz channels for promoting transmissions at 5.9GHz and ranges from 250m-1000m. The communication between the vehicles achieved directly through Inter Vehicle Communication(IVC)[1].

This paper contains the Architecture and Applications of VANET discussed in section 2. Section 3 involves the categories of routing protocols with merits and demerits. Under section4 and 5 the study of various cluster based routing protocols are discussed in the former and conclusion is defined in the latter respectively.

II. ARCHITECTURE AND APPLICATIONS

The communication between Vehicle to Vehicle (V2V) and Vehicle to Infrastructure (V2I)[1] supported by two entities such as On Board Unit (OBU) and other by Roadside Unit (RSU). The V2V communication takes place between the vehicles through OBU in which comprises of sensors, actuators, computing and processing capability, Global Positioning System(GPS), Event Data Recorder(EDR), Transceivers, front and rear camera and radars which a integrated into vehicles for high speed internet connectivity that helps to locate the vehicles easily. The V2I transmits message between vehicles and the infrastructure built on the road through RSU. The architecture of VANET is specified in Figure1.

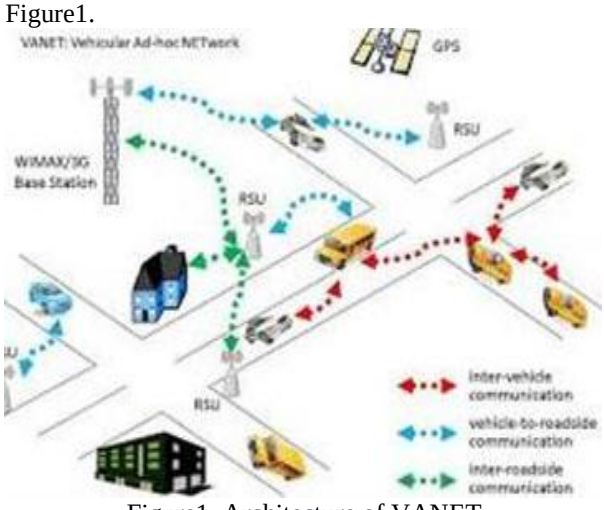

Figure1. Architecture of VANET

The characteristics of VANET is of high mobility due to the rapid movement of vehicles and its topology changes automatically. Each node possess unlimited battery power within itself. The nodes are specified as self organized in which they act according to the scenario. Since dynamic in nature it possess several issues like routing in which the messages are not delivered to destination, the packet delivery ratio, packet loss, security as well as connectivity.

Vehicular Ad hoc Networks supports a range of applications that falls into the two categories[2] :
i. Comfort Applications: The location of a restaurant through GPS, weather information, traffic information, downloading music and mail are examples of infotainment messages.
ii. Safety Applications: The notification of emergency vehicles, varying limits of speed, enforcement of roads automatically are some of the safety applications. The prioritization will be given to safety messages like providing an alternate path, any obstacles on the road, traffic areas as well as collisions rather than the infotainment messages.

III. CATEGORIES OF ROUTING PROTOCOLS IN VANET

Routing is a process in which the message gets forwarded from one node to other using certain parameters like number of hops, shortest path and so on. The forwarding of messages to the destination is a challenging task due to the rapid movement of vehicles. A number of routing protocols are used to achieve optimal paths from source to destination but with some limitations. Routing protocols in VANET[3] are classified as in the Figure 2.

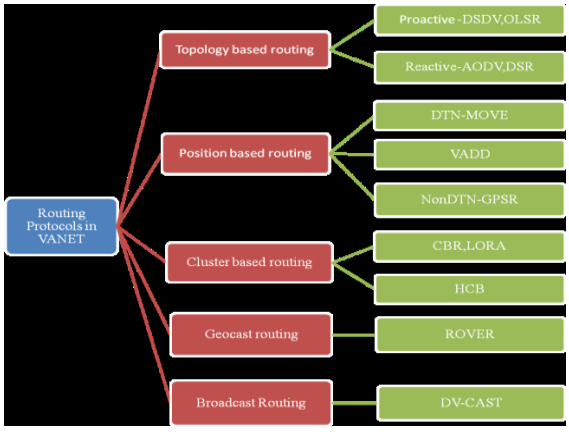

Figure 2. Categories of routing protocols in VANET

Topology based routing
It maintains link states and routing tables about the neighbors. It is further divided into proactive and reactive protocols.

Proactive[4] maintains the next neighbourhood in the background. No route discovery involved with low latency for real world applications such as audio and video. Destination Sequence Distance Vector (DSDV),Optimized Link State Routing(OLSR) are some proactive routing protocols.

Reactive specifies on demand routing to be included when there is a demand hence called as on demand routing protocols saves bandwidth, no updation of routing tables with excessive flooding causes disruption of nodes. Ad hoc On demand Distance Vector (AODV), Dynamic Source Routing(DSR) are reactive routing protocols. Position based routing.

The position of vehicles with their neighbour nodes are identified through Global Positioning System(GPS) yields high performance, low processing overhead, suited for high speed vehicles but does not works in high building structures, bridges and narrow streets .It is further subdivided into Delay Tolerant(DTN) and Non Delay Tolerant(Non DTN).

Delay Tolerant(DTN)[4]
It helps to forward packets from one node to the other node so they reach their transmission range using store and forward strategy by consider the disconnection between the nodes. Motion Vector Routing Algorithm (MOVE),Vehicle Assisted Data Delivery(VADD) are examples of DTN protocols.

Non Delay Tolerant(Non DTN)
It works in high density network. The packets are forwarded to the closest neighbour to the destination. Greedy Perimeter Stateless Routing (GPSR) will be used.

Geocast Routing
Geocast Routing forward packets in the geographical region by ZOR(Zone of Relevance)or outside by ZOF(Zone of Forwarding).The packets are sent from a single source to a group of nodes. Robust Vehicular Routing(ROVER)is an example for Geocast Routing.
Broadcast Routing

Broadcast initiates the message to be sent from the source to all destinations through flooding to share emergency information, alert messages about road obstacles with minimum overheads and high bandwidth. Distributed Vehicular Broadcast protocol(DV-CAST)is a broadcast routing protocol.

Cluster based routing
The network is partitioned into a group of nodes called clusters. The group of nodes having similar characteristics like travelling in the same speed, direction and also their

vicinity are to form the clusters as they have limited time to communicate with other nodes. It is used to aggregate the received messages to other nodes in case of emergency situation.

A node with high power can be elected as cluster head (CH) communicates with other members as member nodes (MN). Communication between clusterheads carried over by gateway as intercluster whereas a message from clusterhead to member is initiated by intracluster. The benefits of using cluster are good scalability, high end to end delay, minimum overhead and proper utilization of bandwidth which are high than any other routing protocols. Also link stability and connectivity are much improved.

Cluster Based Routing(CBR),Hierarchical Cluster Based Routing(HCB),Location Routing Algorithm(LORA) are some of the cluster routing protocols.
Table1 gives the comparison of various routing protocols with its merits and limitations.

IV. RELATED WORKS

A Novel optimized routing scheme for VANETs designed by Samira Harrabi et.al[5] proposed a multiagent approach and PSO(Particle Swarm Optimization) algorithm to solve the route instability. An optimal cluster head is selected by PSO . PSO-C-MADSDV reduces the average number of dropped packets , decreases the unused paths and throughput higher than MADSDV.

Three parameters such as packet drop ratio, throughput and average routing overhead are considered as parameters and implemented in MATLAB,JADE tools. End to End Delay, Packet Delivery Ratio are to be considered in future.

Table 1 VANET Routing Protocols Merits and Limitations

Routing Protocol	**Topology Based Routing**	**Position based routing protocol**	**Cluster based routing protocol**	**Geocast routing**	**Broadcast routing**
Merits	Routes are defined in the backgro und No delay	No routing table maintaine d Suited for high speed vehicles Minimizes bandwidth	Promote s scalabili ty Applica ble for large size network s Utilizes bandwid th	Collisio n will be avoided	Reliable data transmiss ion Easy to use
Limitations	Update the routing table High bandwid th	Needs GPS to track vehicle's position since it is expensive Not works in high building structures, bridges and narrow streets	More overhea ds Delay in forming clusters	Needs GPS Consum es bandwid th	Consume s bandwidt h Congesti on occurs Unnecess ary flooding Duplicati on of packets

Jaskaran Preet Singh et.al[6] devised A Hybrid Backbone based Clustering Algorithm for Vehicular Adhoc Networks that uses a backbone called cluster leadership to select cluster head.Number of leader nodes is considered as cluster leadership instead of one cluster head. A node acts as a leader if its degree of connectivity is greater than its threshold value.CH is selected among the leaders in leadership.

By specifying vehicular mobility CH is selected. Communication Cost gets reduced and increases the stability of network. The protocol Aggregate Relative Velocity(ARV) is compared with Aggregate Local Mobility(ALM) using NS2 and yields good performance through parameters such as average Cluster Head lifetime, status change and Cluster Head density.

The cluster head duration is high to form a stable cluster. It outperforms average cluster head lifetime, percentage of cluster heads and status change than ALM. Parameters like location, distance, density are considered in future to form stable clusters.

Sourav Chhabra et.al[7] developed Dynamic Vehicle Ontology Based Routing for VANETs. A RSU can be installed at the junctions where traffic is high. An activity file table is maintained to gather the information. Evaluates the existing traffic condition and dynamically adjusts the route information.

Emergency response messages forwarded quickly and divert an alternate path to the drivers. A entire area will be focused instead of congested areas in future. Waiting time minimised. Resources such as cost, petrol be minimised with the most appropriate route is found.

DVOR protocol compared with Destination Sequence Distance Vector (DSDV), Optimized Link State Routing (OLSR). PDR, MD, trip duration are considered for the evaluation of performance using ns3. The importance will be

given to security related intrusion detection and to prevent attacks for the further work.

Ahmad Abuashour et.al[8] devised Performance Improvement of Cluster-Based Routing Protocol in VANET. Proposed three algorithms namely

i) Cluster-Based life-time Routing(CBLTR) increases the route stability and average throughput in a bidirectional segment
ii) Intersection Dynamic VANET Routing(IDVR) achieves minimum end to end delay
iii) Control Overhead Reduction Algorithm(CORA)reduces control overheads between the clusterhead and member The overall performance is much improved .

Haigang Gong et.al[9] proposed an Efficient Data Dissemination Protocol (EDP) with road side parked vehicles assistance in Vehicular Networks. EDP use the resources of the parked vehicle to forward data to other nodes since the parked vehicles are static for many hours. The vehicles that are parked on the roadside are grouped and a cluster is formed for the delivery of data.

Also handles the duplicated packets easily. Data delivery ratio and data delivery delay are the performance metrics compared with Buffer and Switch (BAS), Traffic Aware data Delivery Scheme (TADS) and Epidemic routing.

EDP achieve better delivery ratio than BAS and TADS. Its performance is high in the light traffic scenario. A parking model is to be initiated in future and integrated with the mobile model for the vehicles that are parked on the streets. The tools used are Vanet MobiSim 1.1 and NS2.33.

Eduardo Cambruzzi et.al[10] formulated a Cluster Management System for VANETs.CMS are better in collecting data from the vehicles on the road. It is more effective as well as robust whenever there is a change in the traffic and environment.It is compared with Mobility Based Metric for Clustering(MOBIC)and Weighted Utility Function(WUF).The tools used are SUMO and OMNeT++. The performance metrics such as number of reaffiliations, cluster's duration and number of reconfigurations are considered for evaluation. The cluster's duration and accuracy of data is high than MOBIC and WUF.

An Adaptive Clustering Scheme for improving the scalability in Intelligent Transportation Systems developed by Yen-Wen Lin et.al[11]. A gateway acts as a medium to access the internet for ITS applications. A two-way architecture of cluster is profounded for gateway management to achieve scalability. In level 1, there are four fixed road side Access points(AP) are set to act like a Stationary Gateway(SG).

A client vehicle can be connected to any one of the four access points to get the internet services. It moves to the level 2 if the capacity for Qos requirements is not met. This algorithm uses signalling overhead, rewarding index, various communication range and traffic load are considered for the performance evaluation. Compared with Mobile Gateway Routing Protocol(MGRP) and Adhoc On Demand Vector (AODV). Due to adaptive cluster, traffic collision is reduced. Also the deployment cost is less. It outperforms in signalling overhead, rewarding index, different traffic load as well as communication range than AODV and MGRP using NS2.

Raghavendra Pal et.al[12] suggested Adaptive Mobility and Range Based Clustering. A high stability is maintained and size of the cluster is limited for the members to exchange beacons within the interval of finite time.

The priority will be given to safety messages than the infotainment messages. To form a stable CH selection the relative position and velocity are considered. The reliability is achieved by the algorithm Cluster Partitioning and Combining Algorithm(CPCA). AMRBC is compared with Distributed Multichannel MAC protocol(DMMAC) by specifying the metrics as average CH time, safety message delay, infotainment message delay,PDR,reliability,packet loss ratio and throughput.

The performance evaluation is high for all metrics in AMRBC than DMMAC. It is not suited for dense scenario. The average cluster head time is decreased when the clusters are partitioned and combined.

An Efficient clustering algorithm for VANET is proposed by A.Malathi et.al[13]. Cluster stability is enhanced when the vehicles change their speed and distance. A super Cluster Head is discovered by Cuckoo Search (CS) algorithm for optimization. Affinity Propagation (AP) is for the clustering. It gives high performance in reliability, average cluster head duration, cluster life time and average number of cluster member duration. Suited for the dynamic environment yields a stable, secured and reliable solution using NS2 than MOBIC.

A Multihoming clustering algorithm for Vehicular Ad hoc Networks proposed by Samo Vodopivec et.al[14] suggested a new metric and a clustering algorithm with multihoming support. The vehicle's relationship can be identified by sending and receiving wireless packets to the vehicles. Reliability is increased by specifying redundant cluster connections if there is a topological change. It promotes connectivity of nodes and stability of clusters than MOBIC. It was implemented in NS2.It also handles the signal propagation model, wireless medium congestions and unwanted obstacles. The parameters used in

this algorithm are number of CH, vehicles, metric threshold and switch probability.

Mazen Alowish et.al[15] analysed the performance evaluation of a Cluster Based Routing protocol for VANETs. The performance of CBR is developed using OMNeT++ and compared with AODV,GPSR and DSR routing protocols. It outperforms in packet delivery ratio and message overheads than the above mentioned three routing protocols.

The source can efficiently send packets to the destination by optimal series of cluster heads. The destination's node is identified by the minimum angle criterion from source node. In future deployment cost should be minimal and the PDR performance will be improved by selecting the minimum CH selection.

A Mobility-based Scheme for Dynamic Clustering in Vehicular Ad hoc Networks(VANETs) developed by Mengying Ren et.al[16]. A mobility and stability based, dynamic in nature is suggested for the urban environment. The relative position, moving direction and link lifetime estimation are considered. The metrics considered are cluster head duration, cluster member duration, number of clusters and number of state changes and compared with protocols Lowest Id and VMaSc.

The number of vehicles can be limited by a safe threshold in which cluster head and cluster member moves geographically in the same direction. The cluster head communicates to the cluster member by its range.

Waqar Farooq et.al[17] devised a Novel Real Time Framework for Cluster Based Multicast Communication in Vehicular Ad Hoc Networks(RTVC). It can be used for urban and highway environments using multicast communication. It consists of VANET Cluster Scheme(VCS) and VANET Multicast Routing(VMR)for the effective communication between the vehicles. The protocols compared are Multicast Ad hoc On Demand Vector (MAODV) and Dynamic Source Routing (DSR) using the metrics such as mobility ,number of CMs, number of clusters. High PDR, throughput, cluster stability with less overhead are achieved by this protocol.Table 2 discuss the various cluster based routing protocol with its issues.

Table 2. Various cluster based routing protocol with its issues

Author	Developed Protocol	Compared Protocol	Parameters	Mechanism and Tools	Results
Samira Harrabi, Ines Ben Jaffar, Khaled Ghedira, 2016[5]	PSO-CMADSDV	MADSDV	Packet Drop ratio, throughput, average routing overhead	a multiagent approach and PSO algorithm to solve the route instability and to select optimal cluster head MATLABJADE	Promotes link stability between nodes,reduces number of routing packets and unused path number
Jaskaran Preet Singh, Rasmeet S.Bali, 2015[6]	ARV	ALM	ClusterHead density, status change, average ClusterHead lifetime	Number of links and mobility is for the cluster formation,NS2	Stability improved,reduced cost for communication and overheads
Sourav Chhabra, Rasmeet Singh Bali, Neeraj Kumar, 2015[7]	DVOR	DSDV OLSR	Mean Delay,Trip Duration Packet Delivery Ratio	RSU based scheme and activity file table is maintained for traffic areas	Resources,waiting time minimised, minimum delay,high packet delivery ratio
Ahmad Abuashour,Michel Kadoch, 2017[8]	CBLTR IDVR CORA	CBR	Maximum lifetime	ClusterHeads are selected by the lifetime that are located in each cluster MATLAB SUMO	increases the route stability and average throughput, Minimum end to end delay,reduces control overhead, performance improved
Haigang Gong, Nianbo Liu, Lingfei Yu, Chao Song, 2013[9]	EDP	BAS TADS	Data delivery ratio, data delivery delay	The parked vehicles are grouped to form cluster VanetMobiSim 1.1 and NS2.33	Less delay, better packet delivery ratio Works well when traffic is light
Eduardo Cambruzzi, Jean- Marie Farines, Werner Kraus, Raimundo Macedo, 2016[10]	CMS	MOBIC WUF	Number of reaffiliations,reconfig urations, cluster's duration, data accuracy	Two levels are maintained hierarichically SUMO OMNeT++	Robustness and effectiveness when there is a change in traffic, data accuracy is high
Yen-Wen Lin, Hao-Chun Weng, Tsung-Han Lee, Shan-Yin Hou, 2013[11]	An adaptive Clustering scheme for improve the scalability	MGRP AODV	signalling overhead rewarding index, various communication range and traffic load	Two level gateway is supported for the scalability of gateway NS2	reduces the traffic collisions when traffic is high. Deployment cost is less. reduces

					signalling overhead,rewarding index, different traffic load as well as communication range
Raghavendra Pal, Nishu Gupta Arun Prakash ,Rajeev Tripathi, 2017[12]	AMRBC	DMMAC	Number of nodes message delay, average ClusterHead time, Throughput, PDR,PLR, reliability	By the position of vehicle and its relative velocity CH selection is made. CPCA is to partition and combine into clusters NS2	Stability is increased Exchange beacons in a finite interval of time Throughput,PDR ,reliability,average cluster head time are high Message delay is less
A.Malathi, N.Sreenath,2017[13]	An Efficient Clustering Algorithm for VANET	MOBIC	Average ClusterHead duration, Reliability Cluster lifetime average number of cluster member duration	Affinity Propagation(AP) is to form clustering and Cuckoo Search(CS) is to identify super ClusterHead Broadcasts a hello beacon by the id of vehicle,position,velocity periodically NS2	Reliability,duration of ClusterHead and members are high Used for dynamic scenario Achieves better stable,reliable solution
Samo Vodopivec,Janez Bester, Andrej Kos,2014 [14]	A multihoming Clustering algorithm	MOBIC	Average number of ClusterHead, Vehicles	A metric called multihoming is dependent of the vehicles to send and receive packets NS3	Better cluster stability High node connectivity Handles signal propagation problem,obstacles and congestion
Mazen Alowish,Yasuhiro Takano,Yoshiaki Shiraishi,Masakatu Morii, 2017[15]	Performance Evaluation of Cluster Based Routing	AODV DSR GPSR	PDR, overheads	Selection of ClusterHead by minimum angle criterion CH broadcasts a initate(INI) comprises of coordinate of grid(G), Location(loc)is to find out neighboring nodes OMNeT++	High packet delivery ratio, less overheads
Mengying Ren ,Khoukhi Labiod, Jun Zhang, Veronique Veque, 2016[16]	Mobility based Scheme for Dynamic clustering	VMaSC Lowest-Id	Average number of clusters,CH duration, member duration, CH change rate, average state change	A safe distance threshold is used for cluster of vehicles by a single hop A cluster formation is promoted by specifying additionally a temporary	Better stability in a dynamic environment which is high
Waqar Farooq, Muazzam Ali Khan, Saad Rehman, 2016[17]	RTVC	MAODV DSR	Mobility, overhead related to members, number of clusters	Stability achieved by Cluster Speed Limit(CSL),similar direction,cluster threshold Value(CTV) NS2.34,SUMO	High efficiency and throughput Low overhead and delay

V. CONCLUSION

This paper provides a comprehensive view of Vehicular Ad hoc Networks, different types of routing protocols with limitations. The importance of cluster based routing protocol is also discussed. Some of the issues like routing, stability of nodes, interconnectivity, data dissemination and security are considered for the reliability of messages between the nodes. The experimental results of various routing protocols are studied and analysed by their parameters. The issues are identified for further direction of work.A new routing protocol is to be developed using cluster based routing that will yield a high performance QoS avoiding the pitfalls.

REFERENCES

[1]. Advanced Technologies for Intelligent Transportation Systems-Marco Picone,Stefano Busanelli,Michelle Amoretti,Francesco Zanichelli,Gianluigi Ferrari.

[2]. Saleh Yousefi,Mahmoud Siadat Mousavi and Mahmood Fathy,"Vehicular Ad Hoc Networks(VANETs):Challenges and

Perspectives", IEEE ITS Telecommunication Proceedings, pp.761-766, 2006.
[3]. Poonam Dhamal,Uma Nagaraj and Disha Devotale,"Study of various routing protocols in VANET",Elixir Adoc Network,Vol.37A, pp.4033- 4039,2011.
[4]. Vehicular Networks-From Theory to Practices-.Stephen Olariu,Michele C.Weigle.
[5]. Samira Harrabi,Ines Ben Jaffar and Khaled Ghedira,"Novel Optimized Routing Scheme for VANETs",Elsevier ScienceDirect Procedia Computer Science,Vol.98, pp.32-39,2016.
[6]. Jaskaran Preet Singh and Rasmeet S.Bali,"A Hybrid Backbone based Clustering Algorithm for Vehicular Adhoc Networks", Elsevier ScienceDirect Procedia Computer Science,Vol.46,pp.1005-1013,2015.
[7]. Sourav Chhabra,Rasmeet Singh Bali and Neeraj Kumar,"Dynamic Vehicle Ontology Based Routing for VANETs",Elsevier ScienceDirect Procedia Computer Science,Vol.57,pp.789-797,2015.
[8]. Ahmad Abuashour and Michel Kadoch,"Performance Improvement of Cluster-Based Routing Protocol in VANET",IEEEAccess,Vol:5,2017,pp:15354-15368.
[9]. Haigang Gong,Nianbo Liu,Lingfei Yu and Chao Song,"An Efficient Data Dissemination Protocol with Roadside Parked Vehicles'Assistance in Vehicular Networks",Hindawi Publishing Corporation International Journal of Distributed Sensor Networks,Vol.2013,pp. 1- 12,2013.
[10]. Eduardo Cambruzzi,Jean-Marie Farines,Werner Kraus and Raimundo Macedo,"A Cluster Management System for VANETs",Springer Science+Business Media,Vol.14,pp.115-126,2016.
[11]. Yen-Wen Lin,Hao-Chun Weng,Tsung-Han Lee and Shan-Yin Hou,"An Adaptive Clustering Scheme for Improving the Scalability in Intelligent Transportation Systems, Hindawi Publishing Corporation International Journal of Distributed Sensor Networks,Vol.2013,pp.1-18,2013.
[12]. Raghavendra Pal,Nishu Gupta,Arun Prakash and Rajeev Tripathi,"Adaptive Mobility and Range Based Clustering Dependent MAC Protcol for Vehicular Ad Hoc Networks",Springer Science+Business Media,2017.
[13]. A.Malathi and Dr.N.Sreenath,"An Efficient Clustering Algorithm for VANET",International Journal of Applied Engineering Research,Vol.12,pp.2000-2005,2017.
[14]. Samo Vodopivec,Janez Bester and Andrej Kos,"A Multihoming Clustering Algorithm for Vehicular Ad Hoc Networks", Hindawi Publishing Corporation International Journal of Distributed Sensor Networks,Vol.2014,pp. 1-8,2014.
[15]. Mazen Alowish,Yasuhiro Takano,Yoshiaki Shiraishi and Masakatu Morii,"Performance Evaluation of Cluster Based Routing Protocol for VANETs",Journal of Communications,Vol.12,pp.137-144,2017.
[16]. Mengying Ren,Lyes Khoukhi,Houda Labiod,Jun Zhang and Veronique Veque,"A Mobility based Scheme for Dynamic Clustering in Vehicular Ad-hoc Networks(VANETs)",Vehicular Communications,2016.
[17]. Waqar Farooq,Muazzam Ali Khan and Saad Rehman,"A Novel Real Time Framework for Cluster Based Multicast Communication in Vehicular Ad Hoc Networks", Hindawi Publishing Corporation International Journal of Distributed Sensor Networks,Vol.2016,pp. 1-18,2016.

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