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Vehicular Ad Hoc Network Clustering Algorithm Based on Stable and Secure Methods For Data Dissemination on Hybrid Strategies

Prashant Kumar Shrivastava*[1], Mayank Sharma[2], Ranjeet Singh Tomar[3], Hemant Kumar Gupta[4]

[1]School of Advance Computing Department,
[1]SAGE University Bhopal M.P., India
[2,3,4]Department Electronics and Communication Engineering
[2,3,4]ITM University, Gwalior M.P. India
Email's: [1]drPrashantkumarshrivastava@gmail.com, [2]mayanksintal@gmail.com, [3]er.ranjeetsingh@gmail.com, [4]hkgupta132@gmail.com

Abstract
The objective of this paper is an ad-hoc vehicle network (VANET) is an ad-hoc mobile network (MANET) that has a network of cars usually on roads cars. Because of the semi conditions nature of the vehicle movement subject to road geometry and regulation restrictions as well as barriers to physical connection in urban settings, the VANETs offer a unique set of problems and possibilities for protocol routing. On specifically, research in large urban VANETs is presently being conducted on the issues of routing protocol reliability and scalability. Clustering may be utilized to enhance VANET scalability and reliability by combining vehicles based on associated geographical distribution and associated velocity, as it leads to the dispersed development of hierarchical network structures. These classifiers may serve as a basis for incident detection or congestion detection, info distribution, and entertaining apps in addition to the advantages of routing. This article examines the design options taken for the construction of VANET-targeted clustering algorithms. we aim to provide a novel research concept and develop an effective approach for data dissemination using different evaluation parameters like PDR, throughput, and E2E delay.

Keywords: Clustering, VANET, V2R, V2V, V2I, VADD, Multi-hop Clustering, Data dissemination, DSRC.

1. Introduction

Autonomous vehicle (AV) technologies have the potential to drastically change transportation. The level of automation of autonomous vehicles (AVs) has progressively increased recently, driving a desire for additional advancements (Wang et al., 2021). Vehicles are now outfitted with sensors, on-board units (OBUs), and many other processing and transmission capability, thanks to fast advancements in the automobile industry. The fast advancement of AVs has inspired new views and possible difficulties for traditional means of mobility (Anderson et al., 2016). From this advancement, Vehicular Ad-hoc Networks (VANET) have emerged, and providing the industry with new research avenues (Tomar et al., 2017). Within these developments, VANET has opened new opportunities for the usage of safety applications.

A particular kind of mobile ad hoc network (MANETs) that includes vehicle interaction adverse vehicles Ad hoc networks (VANETs) (Luckshetty et al., 2016). Different from cellular networks, VANETs conduct communication with no help from traditional infrastructure. The VANET is classified into two main types V2R and V2V vehicle-to-vehicle infrastructures. A V2X network provides access to the Internet for vehicles connected to road infrastructures such as traffic lights and road lighting. The vehicles coordinate the network in V2V service, sharing information without central control. VANET applications are categorized into two types: protection and infotainment(Shalini and Patil, 2019), according to the type of information received. Safety requirements provide traffic information, such as traffic collisions, congestion, vehicle emergency alerts, vehicle overtaking warnings, lane shifting assistance, or pre-accident warnings. VANETs architecture (Sharma and Jain, 2020) encompasses three principal categories: communication between vehicles; this is also called connectivity between vehicle and vehicle (V2V) or networking solely ad hoc.

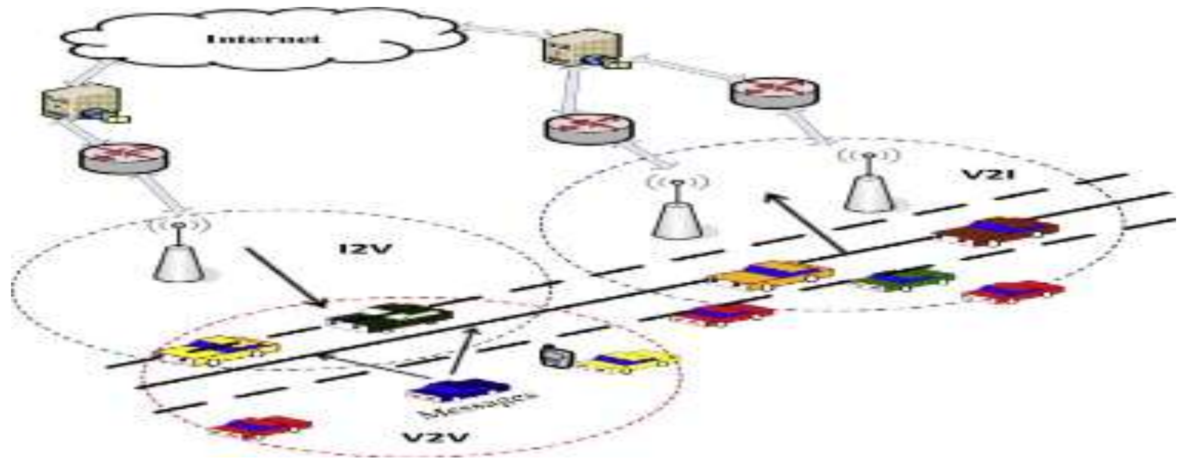

Figure 1. Architecture of VANET

In this category, vehicles communicate with each other without infrastructural assistance. Valuable information collected from car sensors may be provided to new vehicles. Communication from vehicle to road: this is also called communication from Vehicle to infrastructure (V2I). In this group, mobile gateways or wireless local network access points can be used by vehicles to connect to the Internet to make vehicle applications simpler. Communication between roads. It is also referred to as the contact between hybrid vehicles on road. Vehicles can connect via infrastructure or share the information received by ad-hoc communication from their infrastructure with other vehicles in a peer-to-peer model. This architecture provides V2V contact and offers more versatility for sharing content(Yeferny and Hamad, 2020).

The key goal of VANET is to give information & traffic management related to safety. Health and traffic control includes information in real-time and has a significant impact on the lives of passengers. The VANET mechanism's simplicity and protection ensure greater efficiency. Security is the primary feature of the VANET. The common VANET nodes are vehicles that, without previous knowledge, are up to form self-organizing networks. VANET is more vulnerable to frequent attacks at low levels of security. VANET is used in a variety of applications including commercial entertainment, customers, or protection to these networks so that risk to life &characteristics cannot transpire. There are also numerous applications(Ghori et al., 2018). VANET has a sufficient vehicle capacity to relay environmental hazards or poor road conditions warnings to other vehicles and regional information. VANETs' main objective is to ensure a safe but snug drive for the user on the road. Vehicles move so fast that seamless handoff and continuous internet connectivity are harder to maintain.

2. Literature Survey

(Yeferny and Yahia, 2021) A novel adaptive geocast data distribution technique referred to as the Markov Chain-based data Dissemination Protocol (MCDP), is introduced in this research. The forward-if-relevant concept is used by the MCDP to dynamically identify the Zone of Relevance (ZOR) of an event in a dynamic manner. Whenever there is a strong chance that the vehicle will arrive at the event site within a short period, researchers consider the event to be worthwhile for a vehicle. Researchers provide a mathematical model for managing vehicle mobility in the road network, which is described in detail below. Aside from that, we provide a novel technique for correctly determining the relevance of an event to the receiving vehicle. The findings of the simulation confirm In terms of efficacy and efficiency, the MCDP exceeds the pioneering baseline procedures used to develop it.

3. Clustering Concepts

A. Development of VANET technology

In the early 1990s, serious interest in VANET tech began to create growth in recent years. After electronic road tolling schemes are created on a range of proprietary active RFID transponder schemes, required standards will become evident in this field. Numerous big architectures of electronic toll collecting schemes formed a Dedicated Short-Range (DSRC) company Consortium, which was working to a popular standard for the physical layer of short-range vehicle interaction, realizing that this basic idea might be extended in aid of several vehicle communications applications. This work led to an introduction of a physical layer based totally on IEEE 802.11 Ad-hoc mode running in five-nine GHz band referred to as is (WAVE) Wireless Access in Vehicular Environments/ Dedicated Short Range Communications Standards (DSRC) and formally described through IEEE as an 802.11 (Noussaiba and Rahal, 2017)(Mukhtaruzzaman and Atiquzzaman, 2020). The IEEE, ISO, ETSI, &other bodies are presently in a process of creating a variety of standards for many additional elements of the network stack especially the IEEE 1609 working cluster, which is creating on 802.11, to create security standards and applications for VANET. Projects like the Keystone Architecture for Europe Networks (KAREN) (ERIKSSON and AXELSSON, 2000) have been trying, over the past years, to create a framework through which vehicle technology strategies and plans may be converted into system specifications. Concerning roll-outs and public use of technology, the project of Cooperative Vehicle Infrastructure Systems (CVIS) CO-Funded by the EU aimed to build the VANET Structure for the delivery of certain services. The project Cooperative Schemes for Intelligent Road Safety (COOPERS) (Benaissa et al.,2021) seeks to create telemetric apps for car communications schemes and to build collaborative vehicleinfrastructure traffic management. SAFESPOT is also working to create reloading systems and vehicle security systems. Meanwhile, the NSF is aimed at creating vehicle network safety-specific apps.

In terms of traffic safety and road network performance, VANETs provide exciting opportunities. Vehicles can prevent accidents using simple communication systems like turning signals by talking and sharing driver intention information at a level that is not feasible. Emergency cars may be warning cars, which may be well beyond human sight or auditory range, to clear the way in front of the vehicle and therefore decrease ambulance and police car response times. Traffic conditions may be monitored to allow vehicle flows to be redirected to obstacles by issuing congestion warnings in real-time. If combined with developing driver awareness technology, cars could alert a central agency to the tired or poisoned drivers or if another vehicle seems to be driving strangely; most significantly, VANETs provide real-time accountability if accidents happen. The environmental effect of vehicle emissions may, too, be decreased via VANET technology by choosing routes leading to reduced fuel use and smaller emissions. There are also a no. of technological and ethical problems if contemplating such apps, like driver safety and privacy, the capacity, like alteration, jamming, or the fraudulent production of vehicle traffic data, to avoid hostile agents interfering with network functioning. These problems are much more important in the roll-out, particularly when autonomous navigation systems fail, of autonomous or semi-autonomous cars like Google Car. In the literature,much comprehensive research has been provided on these problems already (Elsagheer Mohamed and Alshalfan 2021).

B. Development of Clustering

By connecting mobile nodes into a cluster, a VANET clustering algorithm is operated following certain rules and choosing a node called the cluster head (CH) to mediate in much asimilar manner as a wireless access point between a cluster & network. Based on application, the functions of the cluster head vary as does the mechanism by which the head is chosen. The method used for cluster-associating nodes should perfectly be resilient to node movements & sudden shifts innetwork & cluster topology & could offer credible VANET connectivity in end-to-end mode. The first major task of clustering was initiated with the DARPA packet-radio network (Yurtsever et al., 2020), to buildan autonomous sub-network for the distribution of network sources inside the MANET.

The methods of clustering have been adapted to these specific characteristics because of the outcomes of channel circumstances and mobility of VANET which differentiate them from MANET situations. Techniques for creating clustering, detection and cluster affiliation, and the preservation of current clusters in the VANET range include monitoring of channel, mobility, machine learning and forecasting, safety evaluation.

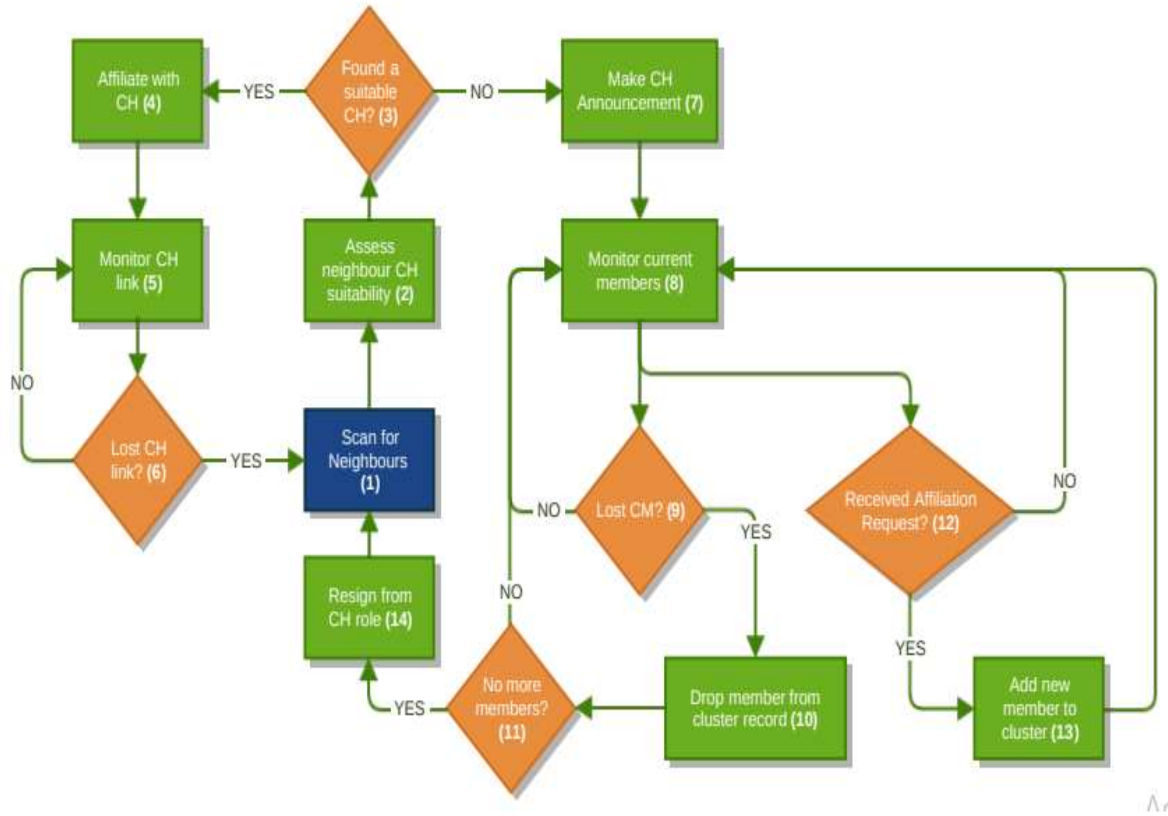

Figure 2: A clustering algorithm's fundamental flow diagram. This technique has many variants, but each algorithm in this survey follows this basic pattern.

C. Clustering Algorithm Anatomy

The creation and maintenance of the cluster is including with a set of fundamental processes which may need to be repeated according to the algorithm rules & movement dynamics of the network. The process overall flow of the method of the cluster is shown in figure 2. Nodes that participate in a cluster or want to take part are normally involved in any or following processes concerning figure 2.

1) **Neighborhood Discovery:** If a car firstly connections the road network and chooses to be willing to take part in a VANET, its communications system is activated and all the nodes are considered to be in a network firstly just useit as a member node. A node will start with a regular broadcast of its existence to its neighbors while simultaneously collecting comparable data from its neighbors either by listening passively to radio broadcasts or via actively requests for applications by a neighbor (1). This info usually contains the location information of the neighboring nodes and is kept for use in the clustering process in a neighbor table. The pseudocode for the discovery of neighbors is illustrated in Algorithm1.

Algorithm 1: The neighborhood discoveryprocess

Requires: M_{rate} (mobile rate), SHN set (Single-hop Neighbors), Identifier (ID)

Struct MHR_j {}
Set N_j = {};
    Neighbors broadcasting the BEACON msg (j, v_j, T_j, P_j)
    Acknowledge BEACON msg (ID, v, T, P)
    For each acknowledged BEACON msg (k)
        check **if** speed $(j,k)<\min(T_j, T_k)$ then
            $N_j \rightarrow N_j \cup k$
        end of if condition
    end of for loop
    $Deg_j \rightarrow |N_j|$
Calculate M_{ratej} based on node connectivity, avg. relative velocity, avg. speed and link stability
MHR_j[ID] ->j
$MHR_j[M_{rate}] \rightarrow M_{ratej}$
MHR_j[SHN] ->Nj
Sends SHARE msg (MHR) to the RSU-Gateway

2) Cluster Head Selection: After collecting environmental information, a node examines the neighboring table to identify a proper node that acts as a CH (2). The part of the cluster head may vary based on the method of clustering - routing or relaying functions could be included and cluster membership is also responsible for determination. A node will also evaluate its eligibility for becoming a CH throughout this method. If selected CH is located in aneighboring the node will continue to stage 3 otherwise it will go to step 4 if it is better suited to becoming CH.In this workmaster cluster head election has been done using Depth-first search (DFS) The pseudocode for the DFS is illustrated in Algorithm 2.

Algorithm 2: DFS algorithm

Require: Graph Gr (v, e), Stack (S), neighboring node (p)

```
DFS(Gr,v)   (start the search from vertex v which is initial)
      S = ();  ( set stack=nil)
 For each u, set visited[u] = flag 0;
       push the S, v;
       while (S ≠ nil) do
         u = pop S;
         if (not visited[u]) then
           visited[u] = flag 1;
For each not visited neighbour p of u
             push the S, p;
         end of if condition
       end of while loop
     END of DFS ()
```

3) Affiliation: The node contacts its neighbor from his point of view, and tries to enter that cluster the best CH from its viewpoint (4). Certain methods may demand that the addressee be already a defined cluster head, while others might enable the addressor for becoming a normal or unclusteredmember node in the cluster. Another step could be taken if a +ve/-ve acknowledgment of the membership application is given back to the attachment node, which could then be followed by an authentication stage in an instance of security-sensitive apps method. When a node becomes a member of the cluster (12, 13), step 5b is entered.

4) Announcement: After a node is identified to be the greatest appropriate CH, it may then send a notice to its neighbors to start the development & affiliation procedure (7). If a node has been accumulated cluster members, step 5a will be taken.

5) Maintenance: This is a separate step depending on the node is a member of CH:

a) As a Head Node: The node will do pooling of its cluster member nodes& evaluate the status of a cluster (8). Multi-step preservation is possible in many algorithms which enable clusters to alter heads, integrate byneighboring clusters, &capture lost connections to members, ex by a transient disconnect (9, 10). There may be a no. of events that alter the state of the cluster: if a cluster head node has lost every one of the member nodes of that cluster (11) then the cluster is called a died cluster (14) & node returns to step 1, A cluster may alternatively combine with another, and a lower cluster CH may become a normal member of a novel, bigger cluster. In popular methods that highlight the development of large clusters for enhanced security, this is common. The node goes to step 5b in this situation.

b) As a Member node: The node assesses its connection to its cluster head (5) from time to time, either in waiting mode for a polling frame of the cluster-head or transferring the messages "alive". If CH connection with other node getsfails (6), it goes back to step one. If a node accepts an affiliate demand from a non clustered node, this can withdraw itfrom becoming a CH from its parent cluster and proceed to Step 5a, or it can transfer to a combined state when the node heads a nested cluster in the event of hierarchical algorithms. In this situation, it can simultaneously take steps 5b and 5a.

In this article, we contrasted the K-Mean-based method (KMB) and SCAlE techniques with our three clustering algorithms, Center-Stable Clustering Algorithm (CBSC). The method K-means is widely used in the clustering of VANET.

Algorithm: HSDDS

Require: number of RSU, forwarded information, cluster member counter, forwarding probability, Threshold, data transmission interval

Procedure:

Step 1. Start
Step 2. Deployed the RSU in the network
Step 3. Perform registration of all RSUs
  a. Send "hello" message to all vehicles
  b. send register request to TA
Step 4. Perform authentication to RSU registration
Step 5. Perform cluster formation and master cluster head election
  a. perform neighbor discovery by broadcasting the beacon message
  b. elect the MCH using the DFS algorithm to traverse its multi-hop neighbors based on its Multi-hop records and the other records
  c. The cluster is started by designating a master CH to one of the nodes that meet the requirements.
  d. if the unclustered node (UN) receives a cluster head announcement (CHA) message from MCH then the UN join the cluster by sending one CMR (cluster member request) to MCH
  e. if MCH receives the CMR message from UN then It will check if they are driving in the same the direction
  f. if yes then MCH send one confirmation message to the UN
  g. if no then Discard the message
  h. if UN receives a confirmation message from MCH then UNchangesit's status to CM
  i. if CM does not receive any data from MCH with a one-time interval then find a new MCH
  j. Now CM changes its status to UN.
Step 6. Send the packet to its MCH by receiver-based forwarding scheme from Gateway
Step 7. check if SINR> threshold and set expiration timer, set counter = 0
Step 8. In the previous forwarder, the message winner declaration adds the winner ID
Step 9. Now Compare the nodes ID with the winner ID
Step 10. If node ID matches, the node inserts its location information and transmits a packet go to step 6
Step 11. If not, the node must cancel or reject the packet
Step 12. Stop

4. Result Analysis

In the trial, four measurements of the three techniques are compared with various numbers of cars, transmission ranges, or road speed restrictions. An overall number of the vehicle (N) and various transmission ranges (R) presents the results achieved when the speed limit for motor vehicles (v) is 100 km/h, as shown in Figures 3, 5, and 7. Figures 4 and 6 indicate the outcome to the transmission delay.

Table 2. Simulation Table

PARAMETER	**VALUE**
Traffic applications	CBR
Rate of transmissions	512 bytes/0.002sec
range of Radios	250m
Size of packets	512 bytes
Max speeds	50m/s
Time of simulations	100s
Wired nodes	4
Node of wireless	60
RSU No.	2
Area	1300x800
Routing	AODV
Routing techniques	EH-GPSR, CLACO, RSUDP, GPCR, GYTAR, RDDO, PBCSR, GPSR

Technique	Number of Nodes									
	10	20	30	40	50	60	70	80	90	100
Existing	737	659	703	709	739	703	672	667	645	714
Proposed (HSDDS)	684	694	703	704	695	705	700	712	693	715

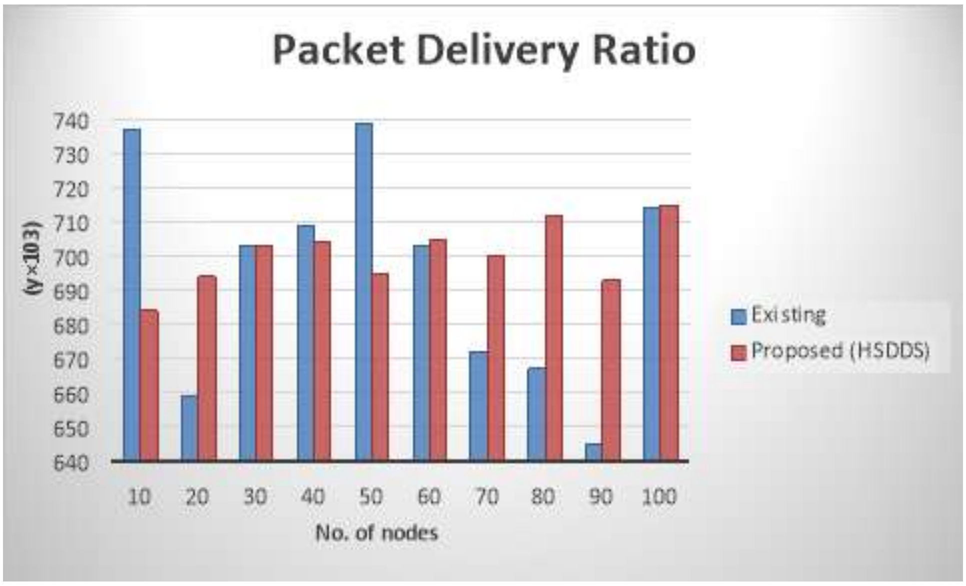

Figure 3: Packet Delivery Ratio

Technique	Time (Seconds)										
	10	20	40	60	80	100	120	140	16 0	180	200
Existing	4.2	4.4	4.2 7	3.6	3.7	4.01	4.2 2	4.0 5	3.7	3.4	3
Proposed (HSDDS)	4.3	4.6	4.5 5	3.8 1	3.8 5	4.21	4.4 1	4.2	3.8	3.4 7	3.08

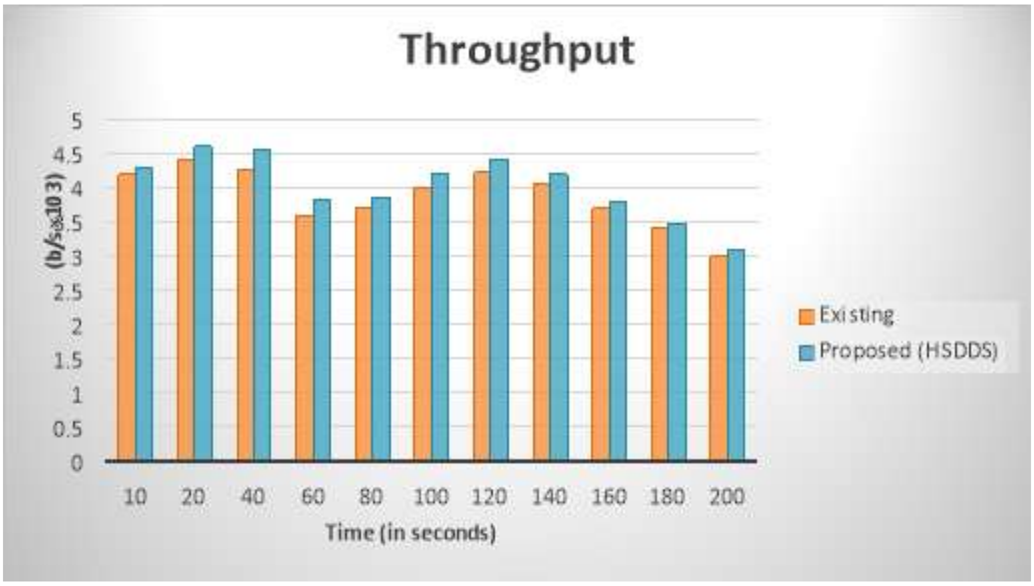

Figure 4: Throughput

Technique	Number of Nodes									
	10	20	30	40	50	60	70	80	90	100
Existing	0.02	1	1.28	2.06	3.66	6.15	12.40	15	20	35.20

Proposed (HSDDS)	0.01	0.02	0.025	0.05	1.2	1.6	1.75	1.8	1.85	1.89

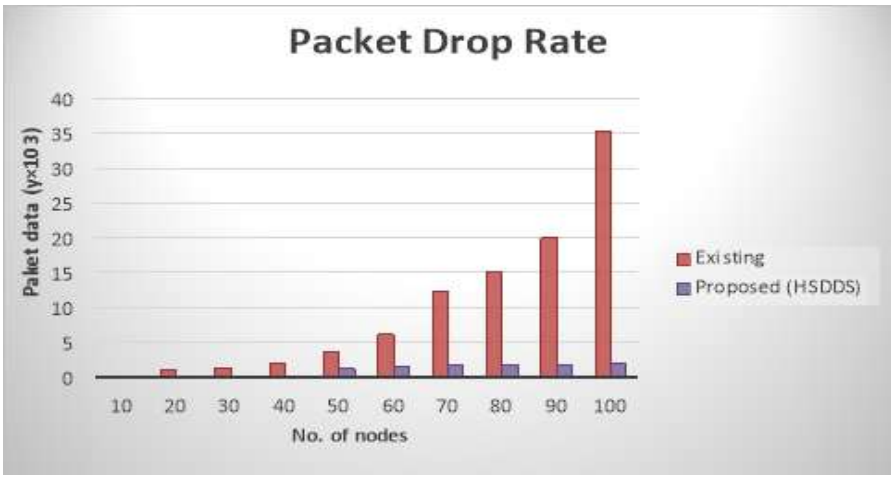

Figure 5: Comparative bar graph of packet drop rate (packet loss)

Technique	Number of Nodes									
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Existing	0.01	110	141	52	71	0.01	26	9	0.001	0.01
Proposed (HSDDS)	0.0	0.01	0.001	0.001	0.01	0.0	0.002	0.0012	0.002	0.003

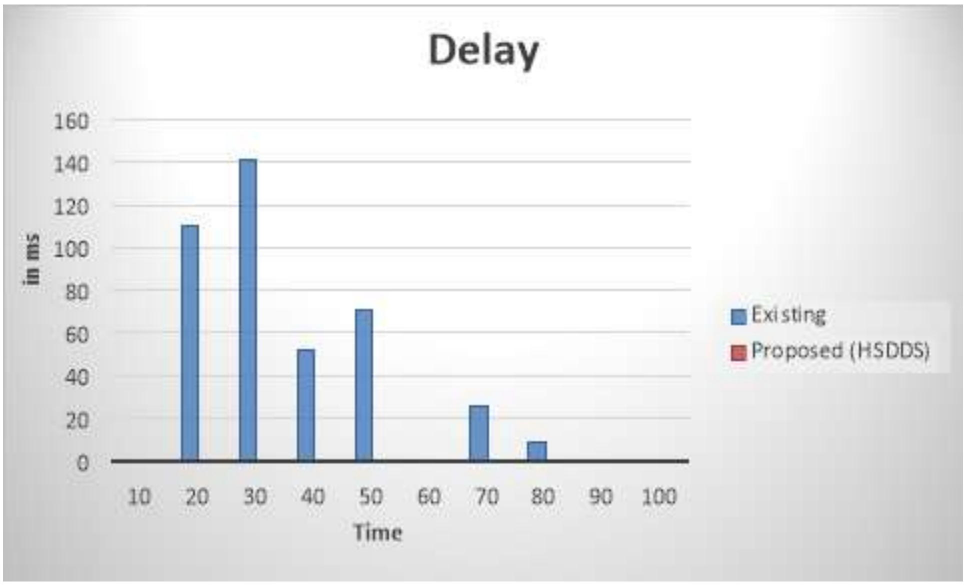

Figure 6: Comparative bar graph of Delay

Simulation findings show that the CBSC clusters are the most stable among the three methods. It also has the long average CM life and the smallest average reassignment times per vehicle. Although Scales does perform in CH lifespan experiments slightly well than CBSC, the average CM lifetime is much shorter. Moreover, the quantity of CMs in one system is much greater than the CHs. We believe thus that CBSC is more stable than Scales.

Table 3. Comparison results of three different data dissemination methods

Methods	Features	Efficiency / Detectionrate
KMB	● Similarity groups: coarsening and refining ● Converge to some such relative	● Average CH Lifetime=52 sec. (N=150, R=200) ● Average CH Lifetime=48 sec. (R=200, v=70)

	position ● Expected on intuitive grounds ● Degree of stability	● Average CM Lifetime=60 sec. (N=450, R=400) ● Average CM Lifetime=58 sec. (R=400, v=100) ● Packet Loss Rate= 0.018% (N=300, R=400) ● Packet Loss Rate= 0.018% (R=400, v=70)
SCalE	● Knowledge of the vehicles behaviour for efficient selection of CHs ● The employment of a backup CH to maintain the stability of cluster structures	● Average CH Lifetime=58 sec. (N=150, R=200) ● Average CH Lifetime=59.9 sec. (R=200, v=100) ● Average CM Lifetime=40 sec. (N=300, R=400) ● Average CM Lifetime=48 sec. (R=400, R=70) ● Packet Loss Rate= 0.018% (N=450, R=300) ● Packet Loss Rate= 0.019% (R=400, v=100)
CBSC	● Self-organized VANETs forming stable clusters ● Impact of vehicle motion differences ● Two metrics ● Status change frequency of vehicles on highway	● Average CH Lifetime=58 sec. (N=150, R=200) ● Average CH Lifetime=56 sec. (R=200, v=100) ● Average CM Lifetime=89.4 sec. (N=450, R=400) ● Average CM Lifetime=82 sec. (R=400, R=70) ● Packet Loss Rate= 0.013% (N=450, R=400) ● Packet Loss Rate= 0.015% (R=400, v=70)

5. Conclusion

Numerous earlier surveys and clustering taxonomies in VANETs, including having indicated that more single features of the VANET atmosphere should be used to address structure and preservation problems in VANETs best. The guidelines proposed include the greater use of machine learning technology, the use of bidirectional flows in the forming of the cluster, and enhanced participation of stationary units on the road. Although these possibilities are important, valuable advances the VANET clustering is a state of the art technology is hindered of important basic weaknesses in the literature presented below and that need to be addressed adequately, to change beyond simulations and into broad practical implementation in robust and reliable VANET .We attempt to create VANET clusters as reliable as feasible while maintaining the network efficiency, to reduce administration overhead and improve communication quality. An enhancement in the VANET technique and analysis will speed up the implementation of this technology and significantly boost the advantages that it is expected to offer.

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