Weight-Based Clustering Algorithm for Military Vehicles Communication in VANET

Mayank Sharma, Pradeep Kumar, and Ranjeet Singh Tomar

Abstract— **In vehicular ad-hoc network (VANET), every vehicle node indicates a mobile node and it acts as a transmitter, receiver and router for the delivery of the information. VANET is a subgroup of mobile ad-hoc network (MANET) and is related to the dynamic topology. Dynamic network scenarios are more challenging issues as compared to MANET topologies, so finding a suitable algorithm for all VANET applications is the major challenge for the researchers. Routing protocols in VANET are divided into six parts i.e., cluster-based, geocast-based, topology-based, position-based, and broadcast-based. Autonomous robots and unmanned military vehicles (UMVs) become part of the advanced warfare strategy to execute dangerous war field operations and military combat missions. The military vehicles (MVs) transfer information to each other in order to achieve required military tasks collectively. In the proposed work, rhombus shaped area is divided into multiple clusters using a weight-based clustering algorithm for transmitting the event information to the vehicles. Intersection clustering with rhombus shaped area which are very effective for clustering. To choose cluster head (CH), the proposed method has used two weighted metrics, one is real time average speed and the other parameter is degree. This work is useful for choosing right CH in the network. Each vehicle in the same cluster transmits the data to the CH instead of broadcasting it. The simulation has been done in the SUMO and NETSIM simulator, which shows the network performance for the different protocols like Ad-hoc on-demand distance vector (AODV), dynamic source routing (DSR) in terms of packet delivery ratio, throughput, delay, overhead transmission, mean and standard deviation.**

Index Terms— **VANET, OBU, Routing Protocols, Manned and Unmanned Vehicles, Cluster Head, SUMO, NETSIM.**

I. Introduction

By using intelligent electronic tools known as on-board Units (OBUs), vehicles are now equipped with computers on wheels because micro hops and wireless communication technologies are constantly improving. The OBU consists of a microcontroller, a global positioning system (GPS), sensing devices, storage devices, and a wireless transceiver that enables in VANET.

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As long as vehicles are equipped with OBUs, they can currently connect to other vehicles and as they travel on the road with secure roadside structures when they go through series of interconnected network. In similar scenario to base stations, roadside units (RSUs) are revolutionary infrastructure elements that are connected to the internet backbone through transmit signals. The RSUs are intended to provide message dissemination, protection, and network constancy to vehicular networks by locating themselves at dangerous intersections of the road, such as nodes or construction sites. In order to accomplish this, 75 MHz of color band in the 5.9 GHz band has been allocated for the dedicated short-range communications (DSRC) standard, a set of protocols and measures for vehicular trade data throughout which real-time multimedia uses, including peer-to-peer (P2P) substance provisioning, can be deployed in the future and many facilities can be delivered. In Europe and Japan, a similar band has been distributed. VANETs are ad-hoc networks, but they differ significantly from other transmit signal networks, including sensor networks, MANETs, etc [1].

VANETs provide reliable communication services since they are infrastructure-based. As a result of the high mobility of vehicles, these networks have short connection time. For example, two vehicles moving in a similar direction and starting at the same position can only keep a reliable link for 25 seconds between them if one of them is faster by 10m/s and range of sending information to people by using communication range is 150-200m through technology. As a result of the limited motion and dependence on each other vehicles have to be viewed separately. As a result of a movement, it is possible for links to fail at times, so exchange multi-hop paths are useful for validating associates between vehicles for long period of time. The VANET is consist of applications including security, traffic control, commercial ad distribution, driver assistance, web surfing, voice, games, and infotainment. Multi-application units (AU) can be found in vehicles, that are built-in or portable communication devices that have numbers or collections of different applications and things to communicate with. These uses have dissimilar hold-up conditions, consistency, and security. It is well known fact the size of VANET competent enough to pass, express, achieve and show the safety warning on the road. As a result of this many countries has already adopted this methodology to countries the practices of unsafe vehicular application [1]. In VANETs vehicles equipped with wireless form a system of lines. Wires are connected with each other impulsively through travelling sideways the road.

The quality of node movement recognizes VANETs from different sorts of ad hoc networks. So, the structure of an effective routing protocol is very essential for VANETs. The bandwidth resources in VANETs are limited and the network topology can change frequently. Therefore, it is not required to keep routes to every node. The dynamic modification in topology reduces the effective routing time. Similarly, it decreases operation rate of routing information [2].

Thus, on-demand routing system of rules that explains the correct conduct and procedures to be followed in formal situations are better for VANETs. These protocols generally include two procedures- Route Maintenance and path innovation. When a source node that has no routing information within routing table desires to create a route to the target node, the route discovery process is activated. The source node transmits routing request packets through the group of people or organizations that are closely connected and work with each other by flooding. At the point when this packet achieves the target node, node transmits a route response packet to the source node. This system has a turnaround path among the origin node and end node. When the node changes and if some connection on the initial path can be discontinued, then the path keep on processing it will be activated. AODV routing arrangements is accurately used to carry on variations of figure or size in need of routing protocol for VANET [2].

Cluster-based techniques divide vehicles into subgroups, clusters, for task subdivision to provide communication services with minimum network requirements. In VANET clustering, cluster heads (CHs) are an essential part of the cluster formation process. Input metrics can be used to develop a cluster in a variety of ways. The member vehicle of a cluster is called cluster member (CM) [3], [4]. Weight based cluster algorithm has been designed to identify CHs dynamically in vehicular ad-hoc network. Sensor network in general has several constraints as compared to traditional network scenario. Hence it is not appropriate to apply the weight cluster algorithm to the wireless sensor network because it does not take the transmission rate, power energy among others factors in-to consideration [3].

In [5], authors examined a dynamic open key framework for VANETs to transfer the part of the focal affirmation power among an arrangement of dynamically elect certificate authorities (CA)s. Decision of dynamic CAs based on a clustering algorithm where CHs plays out the part of testament experts. These certain nodes are expected to implement as the registration authority (RA). In [6], a dissimilar kind of clustering method was defined, that has two tier architectures called as mobility infrastructure based VANET (MI-VANET). Buses are utilized as communiqué backbone due to its larger overlapping radio range and they are at a fixed distance from each other (as they depart at interval of 15 minutes). Vehicles present in lower tier are needed to register first with the nearest vehicle for communication. Thus, when a vehicle (source car) wants to deliver information, it has to first deliver the information to its registered vehicle (source bus) via technique called mobile infrastructure registering (MIRG) MI-VANET has enhanced the availability amongst clusters and the simulation result indicates predominant data delivery ratio and increment in network throughput [6]. In [7], authors introduced that in the most recent couple of years VANETs have received expanded consideration as the potential technology to upgrade dynamic and preventive security out and about, and in addition travel comfort. In the event that vehicles can be given data about such occurrences or activity circumstance in continue, the class of driving can be enhanced essentially in states of time, distance, and safety. One of the main challenges in VANET is to investigate the effective route for transporting data information.

In this proposed work, the weight-based clustering technique is proposed using average speed of vehicle and degree of each vehicle for rhombus shaped network. In the existing technique vehicles move in uniform speed but due to lack in stability of CH. In proposed algorithm, we have used rhombus shaped clustering path with (150-200m) transmission range of its adjacent vehicles so it is very effective for stability of CH and reduce overhead transmission. Vehicle clustering has been improved by using a rhombus shape intersection path. A rhombus shape path has eight lanes and four central junctions. Each lane forms a cluster, and each cluster contains between four to ten vehicles. This clustering technique is more effective than other clustering methods so we can easily measure the relative speed and degree of the vehicles in rhombus shape path. We analyzed the results of the proposed work using SUMO interfacing with NETSIM environment. The development of technologies enables smart cities to optimize their traffic is in full swing around the world, industry 5.0 appears more and more often in this context. With Industry 5.0, various capabilities will be combined to create smart solutions. VANETs, Autonomous Vehicles and Industry 5.0 will form the basis for the smart city traffic concept of the future.

The rest of this paper is organized as follows. Description of routing protocol is presented in section II. Section III describes the connectivity concept of vehicles in cluster. Proposed work is presented in section IV. The rhombus shaped network simulation results and cluster based simulation results are given in Section V and VI, respectively. Finally, conclusion is given in section VII.

II. Routing Protocol in VANET

Topology based routing protocol link statics and it is set through the vehicle progression. Here, the progression of seeking or saving a path from sender to receiver is compulsory before sending information packets. This routing protocol is based on path matrix. In this routing technique, the option of a path from transmitter to destination depends on connected links statistics formerly collected through the vehicle (proactive/table-driven) or looked for while required (reactive/on-demand) [2], [8]. The progression of seeking or saving a path from transmitter to receiver is compulsory before delivery of information packets [2], [8].

Each vehicle identifies the geographical area and accurate position (as satellite system and global navigation). The expertise of the whole path makes no meaning to send the packet information. They are also known as geographic-based protocol [2], [10], [11]. We can measure vehicle geographical information inside the relay selection system and identify that each vehicle has the ability to identify its geographical position like Global Navigation Satellite System (GNSS). Here, the expertise of the entire route makes no sense to transfer the data information.

A cluster-based routing protocol can be used to group vehicles with similar characteristics, such as travelling in the same direction at about the same speed, and elect a cluster-head to manage the cluster and coordinate intercluster communications. Intra-cluster communications are connected via direct links without a cluster-head [11]. A geocast protocol provides multi-hop wireless communication over an autonomous mobile environment (no infrastructure is required). After being developed for MANETs, it was quickly adapted for other networks such as mesh networks, wireless sensor networks (WSNs) and VANETs. A simple flooding technique is used in broadcast routing protocols in order to reach all vehicles on the network. Message overhead can be reduced by using different relay selection techniques [11], [12].

III. Connectivity in Clusters

If the distance between two vehicles i and j is less than the transmission range i.e. the DSRC communication range, they are considered as neighbors. A vehicle's connectivity level is determined by the number of vehicles directly connected to it. As shown in Eq (1), the number of neighbors of node i at time t is calculated as follows [3].

$$\sum_{j=1}^{n} \mathrm{dist}(i,j,t) < \text{Transmission range } (node\ i) \tag{1}$$

The value of dist (i, j, t) exists if a connection is established between the vehicles i and j at time t, otherwise it does not exist. Speed is one of the important mobility characteristics involving vehicles moving on the road. In a free flow traffic state, the velocity of a vehicle is assumed to follow a normal distribution. The probability density function (pdf) is given in Eq (2) [3].

$$pdf = \frac{1}{\sqrt{2*\pi*\sigma^2}} e^{\frac{-(V-\mu)^2}{2\sigma^2}} \tag{2}$$

Where, σ represents the standard deviation of the vehicles' speeds and μ represents the mean speed. Therefore, the vehicle with the closest speed to its neighbours will be given the highest priority for becoming a CH. Eq (3) expresses the mean speed of all the neighboring vehicles speed as follows [3].

$$\mu_{neighboring} = \sum_{i=0}^{n} \frac{distance}{time} \tag{3}$$

The node position N_T is given in Eq (4).

$$N_T = (x_t, y_t) \tag{4}$$

where, x_t and y_t represent the position coordinates of the vehicles. The average speed (AS) of all the vehicles is given in Eq (5) [3].

$$\text{AS} = \frac{1}{T}\sum_{t=1}^{T} \sqrt{(x_t - x_{t-1})^2 + (y_t - y_{t-1})^2} \tag{5}$$

where, T and t represent the total real time and instant real time, respectively. The normalized speed (μ_n) of all the vehicles is given in Eq (6)[3].

$$\mu_n = \frac{v_{i-AS}}{\sigma} \tag{6}$$

Where, v_i represent the vehicle speed. Each node determines its weight value (WT(i)) using Eq (7) for suitability of becoming a CH [3].

$$\text{WT(i)} = w_1 \deg(i) + w_2 \mu_n \tag{7}$$

i=1,2,3……30; w_1=0.4, w_2=0.6; w_1+ w_2=1

deg(i) = Sum of the adjacent vehicles where vehicles are different. The weight factors associated with each parameter are w_1 and w_2. The vehicle with the highest weight value is selected as a CH.

IV. Proposed Algorithm

In this work, vehicles are divided into a rhombus shape area with intersection clusters for communication. Whenever a vehicle detects an information, it sends a message to all other vehicles, hence reducing their energy consumption. In the existing technique of vehicle communication, a group of neighboring nodes is maintained, which consumes area and adds overhead to the network. Therefore, sending the message to neighboring vehicles is not an effective technique. In the proposed work, multiple clusters are used to broadcast event information from each cluster to the vehicles. Instead of broadcasting, each vehicle provides data to the CH. We have measured the vehicle speed, the average speed and the degree of vehicles with respect to real time for selecting the CH. When a military vehicle detects a particular information, it forwards the data to the CH, and the CH transmits the data to the other CHs, hence allowing all vehicle nodes to receive the information. This reduces the network overhead and increases the efficiency of the network. Fig. 1 shows the flowchart of the proposed work.

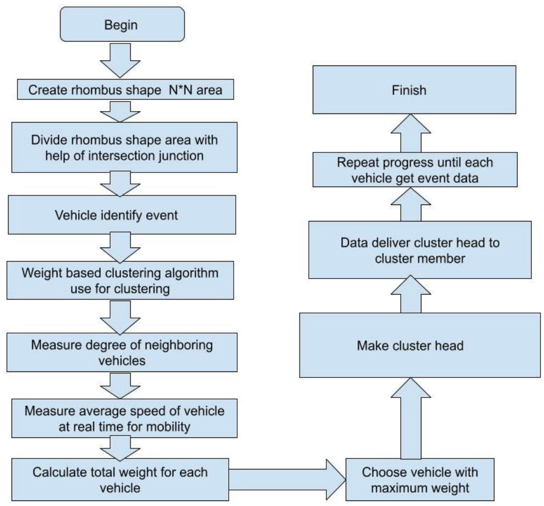

Fig. 1. Flow chart of the proposed work.

A. Proposed algorithm steps

Begin

Start-1 Rhombus shaped N*N area

Start-2 Area divide into lane cluster

1. 7-8 Intracluster with MV and UMV
2. 1 Intercluster with MV and UMV

Start -3 Each intracluster consist of 4-10 vehicles

Start -4 Junction create in area, where each junction consists one traffic light

Start-5 Vehicle range is 150-200m, where vehicles periodically transfer information, and each vehicle knows about neighbour nodes. If vehicle predict information, then start clustering of the vehicle using weight-based clustering protocol.

Step-6 Discover the neighbours of every vehicle within the range which classified as degree.

Step -7 Degree of nodes (deg(i)) can be calculated as: deg(i)=Sum of adjacent vehicles, where vehicles are different.

Step-8 Compute the average speed and normalized speed of vehicles in real time t, which can be considered as mobility of vehicles which follows as:

$$AS = = \frac{1}{T}\sum_{t=1}^{T}\sqrt{(x_t - x_{t-1})^2 + (y_t - y_{t-1})^2}$$

$$\mu_{n=} \frac{v_{i-}AS}{\sigma}$$

Where (x_t, y_t) and (x_{t-1}, y_{t-1}) are the coordinates of vehicles at real time, AS is ratio of total distance and total time

Step-9 Calculate the total weight WT(i) for each vehicle,

$WT(i) = w_1 deg(i) + w_2\mu_n$

where w_1 and w_2 are weighting factors, w_1=0.4 and w_2=0.6.

Step-10 Select the vehicle with maximum WT(i) as the CH, when difference is minimum between average speed and vehicle speed then assign CH.

Step-11 Repeat the process until each vehicle gets the event information.

Stop

Algorithm: Select CH and Broadcast information

I/p: Number of vehicle nodes(N), vehicle speed, avg speed, time, edge
O/P: Connectivity in cluster
For i=1 to N do
If (dist(i, j, t) < Transmission range) *(intracluster)*then
$N_i = N_{j=i+1}$ (Message transfer)
deg(v)-> $sum\ of\ N_i\ connected\ N_{j=i+1}$ vehicles in edge
calculate Average speed with formula Eq… (5)
else
$N_i \neq N_{j=i+1}$ (Message not transfer)
end if
If (v_i ≈AS) ($v_i = vehicle\ speed, AS = Average\ speed$)
$v_{nearest\ speed} = CH(cluster\ head)$ *(First condition)*
else
Not become CH
end if
calculate weight with formula……Eq (6)
WT= [wt1, wt2, wt3….]
If (WT=max value) *(Second Condition)* then
$N_i = cluster\ head$
else
Not become CH
end if
end for
Broadcast information in each cluster and calculate all parameters

V. Rhombus Shaped Network Simulation Results

Proposed clustering algorithm was implemented on SUMO interfacing with NETSIM using 802.11p medium access control technique. The simulations were carried with 30 vehicles over the manned and unmanned vehicles in intercluster and intracluster rhombus shaped path. Fig. 2 consists 8 nodes and 16 edges, pair of edges make cluster which is separated with four junctions(jneE16-19). Four traffic lights are used with central junction in rhombus shaped area (0.32km). Rhombus shaped area with intersection gives better clustering path. VANET simulation parameters and vehicles node parameters are given in Table I and Table II, respectively.

The rhombus shaped network scenario on NETSIM is shown in Fig. 3. Fig. 4 shows that how close a vehicle's mean speed is to its neighbor's mean speed. Therefore, the vehicle with the closest speed to its neighbours mean speed will have the highest priority of becoming a CH. In Fig. 4, CH broadcast information to all vehicle nodes is depicted.

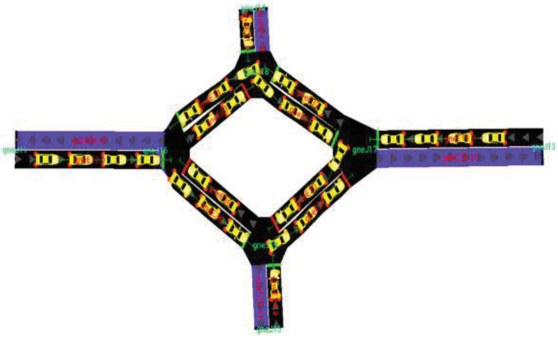

Fig. 2. Rhombus shaped area with intersection clustering on SUMO.

TABLE- I
VANET SIMULATION PARAMETERS

Symbol	Parameter	Value/Type
	Simulation tool	SUMO, NETSIM
N	Number of moving vehicles	30
	Network size	Rhombus shaped two-way lane
	Network Protocols	DSR, AODV
		IEEE80.211, IEEE802.11b
T	Time	100s
AS	Average Speed	
deg	Sum of nearest vehicles	
	Vehicle speed	10 m/s
	Communication range	250-300 m
	Message type	Unicast, Broadcast
	Packet size	1420
	Transmitted power	100mW
	Lane length	0.32km
Cl-1	lane-1	gneE17-gnE17
Cl-2	Lane2	gnE33-gnE3.4
Cl-3	Lane-3	gnE22.13-gnE21
Cl-4	Lane-4	gnE31-gnE32
Cl-5	Lane-5	gnE20.23-gnE19
Cl-6	Lane-6	gnE3.0-gnE29
Cl-7	Lane-7	gnE35-gnE36

TABLE -II
VEHICLES NODE PARAMETERS

Edge	Vehicle ID	Cluster head
gnE18.23-gnE17.0 (Cl-1)	16,26,22.30,15,21,25	22
gnE3.3 gnE3.4 (Cl-2)	1,7.15,19,25,10,14,18, 22,23,24,28,30	22
gnE22.13-gnE21 (Cl-3)	8,12,20,22,1	22
gnE31-gnE32 (Cl-4)	1,8,10,12,17,18,20,22, 23,27	22
gnE20.23-gnE19 (Cl-5)	7,12,14,13,15,18,24	15
gnE3.0 -gnE29 (Cl-6)	1,4,1013,27,7,19,14,21 ,16,17,18,23,24	18
gnE35-gnE36 (Cl-7)	1,4,10,13,14,17,18,21, 23,24,28,7,16,19	18

Cl- Cluster in Network, gnE=Edge in Network

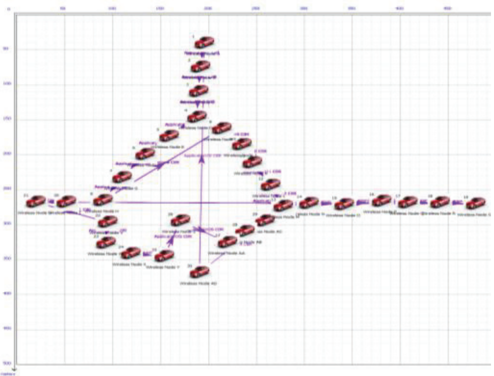

Fig. 3. Rhombus shaped network scenario on NETSIM.

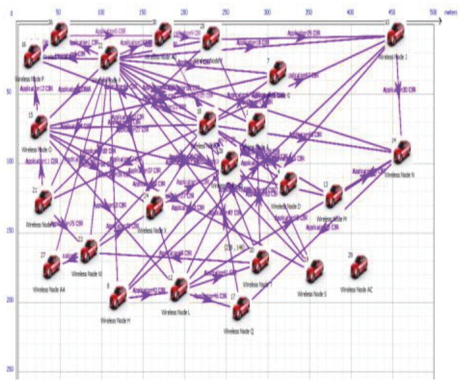

Fig. 4. Broadcast information through CH on NETSIM.

The throughput (Mbps) is calculated as given below:

$$\text{Throughput (Mbps)} = \frac{\text{Receive packets} \times \text{size}}{\text{stop time} - \text{start time}}$$

Fig. 5 and Fig. 6 indicate that initially in rhombus shaped network throughput is increased drastically and after some duration throughput is drastically decreased, so it is clearly indicated that after some time traffic is higher and collision is more in the network. At 1-10 sec the maximum throughput is 23.15 Mbps in DSR and 15.53 Mbps in AODV. It is clearly indicated maximum link throughput is higher in DSR as compared to AODV. DSR protocol takes less time to achieve maximum throughput as compared to AODV.

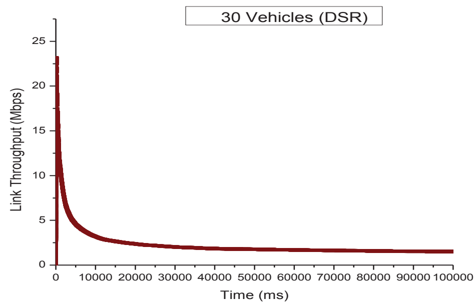

Fig. 5. Overall link throughput of the network in DSR protocol.

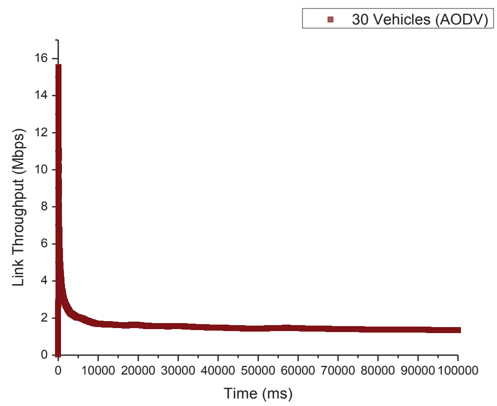

Fig. 6. Overall link throughput of the network in AODV protocol.

The packet delivery ratio (PDR) is calculated using the following:

$$PDR = \frac{number\ of\ packets\ received}{number\ of\ packets\ sent}$$

Fig. 7 and Fig. 8 represent the average link throughput and the packet delivery ratio, respectively. The average throughput is higher in DSR and the packet delivery ratio is higher in AODV protocol. The higher values of the throughput and packet delivery ratio indicate the better performance of the network. In the DSR protocol, we can observe lower PDR value and higher link throughput. In less dense network AODV gives better PDR value as compared to the DSR. Fig. 9 represents the average end-to-end delay. The delay is more in AODV protocol as compared to the DSR protocol. This indicates that the packets travelled shorter path.

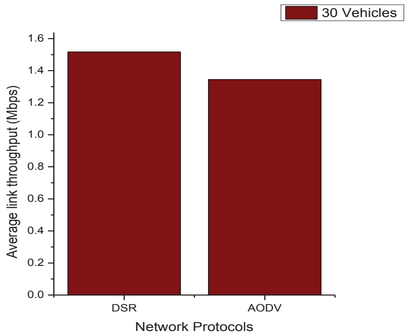

Fig.7. Overall link average throughput for the different protocols.

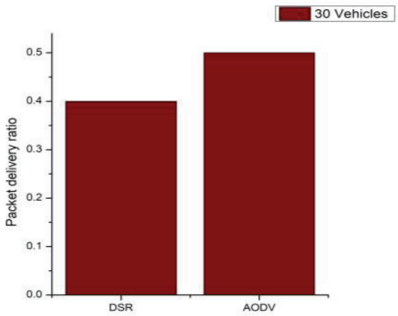

Fig. 8. Packet delivery ratio of the network.

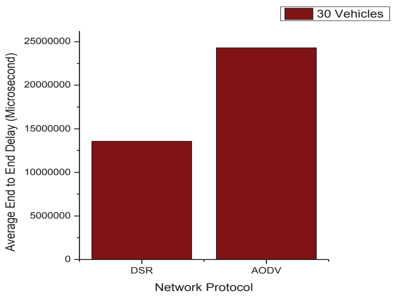

Fig. 9. Delay graph of overall network.

The overhead transmission refers to the variety of control packets transmitted between the sources and the destinations inside the network. It is the ratio of total overhead bytes transmitted to the total packets transmitted in the network. Fig. 10 shows that the overall overhead is higher for the AODV protocol as compared to the DSR protocol. This indicates that the AODV is not suitable for higher mobility as it gives higher overhead as compared to the DSR. Overhead transmission should be minimum for better reliability of the network.

Fig. 11 and Fig. 12 show the mean and standard deviation analysis of the network for DSR and AODV protocols. The mean and standard deviation are important parameters of vehicle speed. Each vehicle can determine how close its current speed is to the mean speed of its neighbors. As a result, the vehicle with the closest speed to its neighbor's average speed will be given the highest priority for becoming a CH.

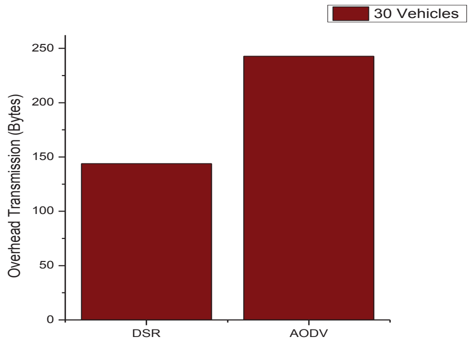

Fig. 10. Overhead transmission of network.

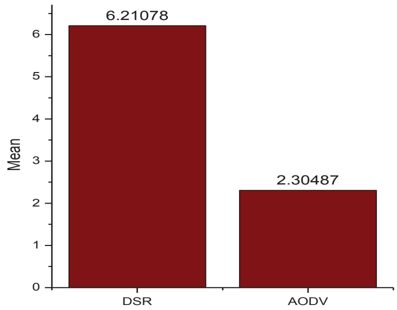

Fig. 11. Mean analysis of overall network.

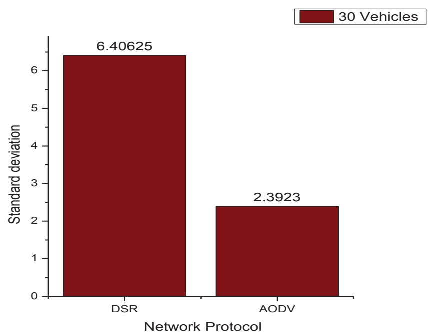

Fig. 12. Standard deviation of overall network.

VI. Cluster Based Simulation Results

Proposed intracluster algorithm was executed on NETSIM using the 802.11p MAC technology. The simulations were carried out with 30 vehicles over the intercluster and intracluster vehicles. Rhombus shaped area was divided into 7 intracluster. Each cluster consists of 4-10 vehicles. The two vehicles within the transmission range of each another are considered as stable neighbors. Vehicles with the same road ID and moving in the same direction is considered to form a cluster group within a road segment on the highway. Each vehicle can identify how near its real time speed is to the average speed of its neighbors. As a result, the vehicle with the nearest speed to its neighbors' average speed is given the highest priority for becoming a CH. In Fig. 13, cluster-1 consists of vehicle ids-16, 26, 22, 30, 15, 21, 25 and elects vehicle id-22 as CH based on the average speed and the degree. In Fig. 14, cluster-2 consists of vehicle ids- 1, 7, 15, 19, 25, 10, 14, 18, 22, 23, 24, 28, 30 and elects vehicle id-22 as CH. In Fig. 15, cluster-3 consists of vehicle ids- 8, 12, 20, 22, 1 and elects CH to vehicle id-22. In Fig. 16, cluster-4 consists of vehicle ids-1, 8, 10, 12, 17, 18, 20, 22, 23, 27 and elects CH to vehicle id-22. In Fig. 17, cluster-5 consists of vehicle ids-7, 12, 14, 13, 15, 18, 24 and elects CH to vehicle id-15. In Fig. 18, cluster-6 consists of vehicle ids- 1, 4, 10, 13, 27, 7, 19, 14, 21, 16, 17,18, 23, 24 and elects CH to vehicle id-18. In Fig. 19, Cluster-7 consists of vehicle ids- 1, 4, 10, 13, 14, 17, 18, 21, 23, 24, 28, 7, 16, 19 and elects CH to vehicle id-18.

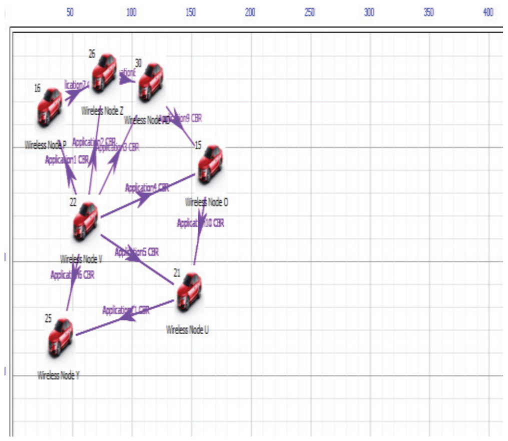

Fig. 13. Network scenario of cluster-1 on NETSIM.

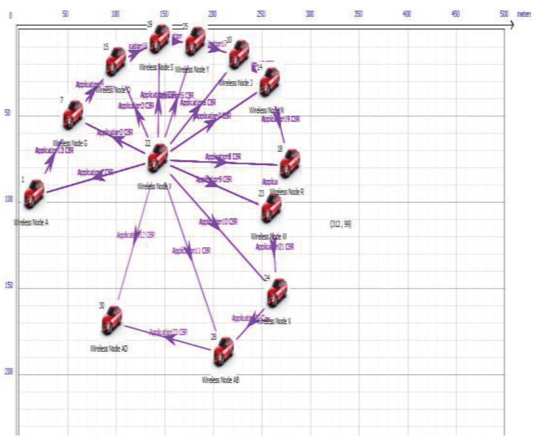

Fig. 14. Network scenario of cluster-2 on NETSIM.

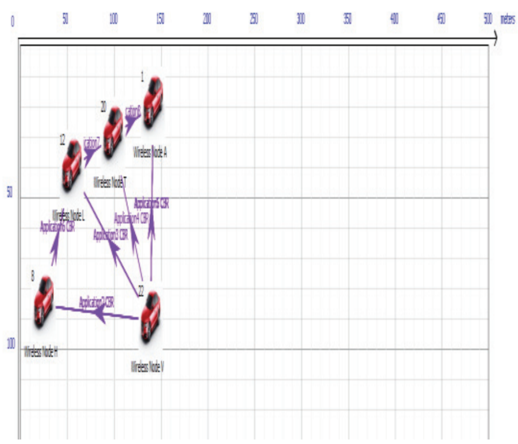

Fig. 15. Network scenario of cluster-3 on NETSIM.

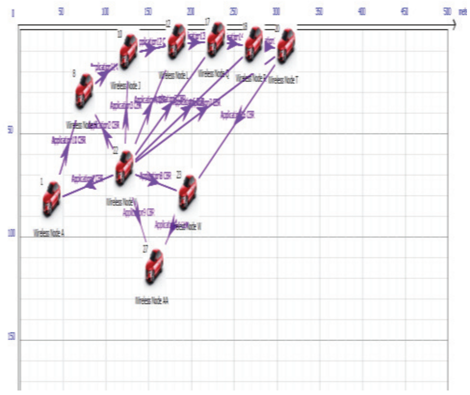

Fig. 16. Network scenario of cluster-4 on NETSIM.

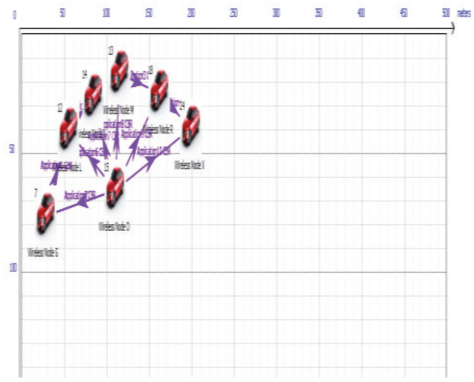

Fig. 17. Network scenario of cluster-5 on NETSIM.

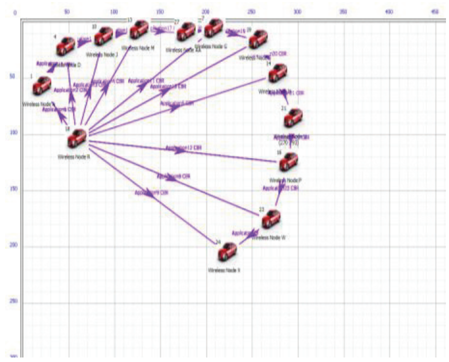

Fig. 18. Network scenario of cluster-6 on NETSIM.

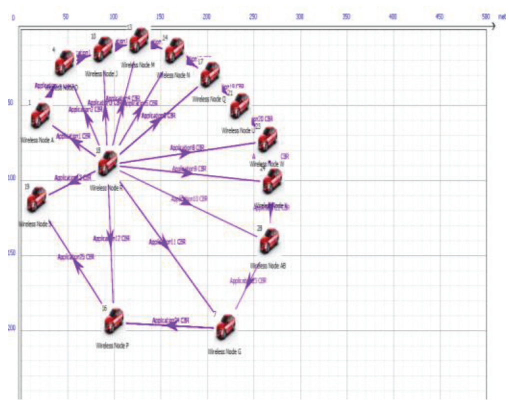

Fig. 19. Network scenario of cluster-7 on NETSIM.

Fig. 20 and Fig. 21 present the throughput analysis of all clusters. In DSR protocol, maximum throughput is higher and application throughput is lower, it indicates that AODV is more effective as compared to the DSR in one-to-one vehicle communication. Fig. 22 shows that the packet delivery ratio is higher in AODV as compared to DSR in all clusters.

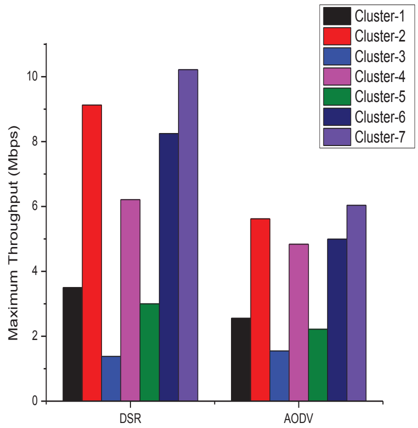

Fig. 20. Throughput analysis of the all clusters.

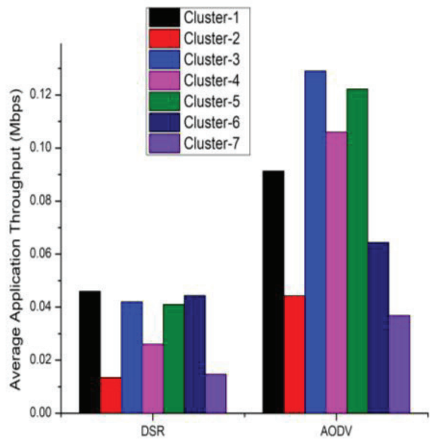

Fig. 21. Average throughput analysis of all clusters.

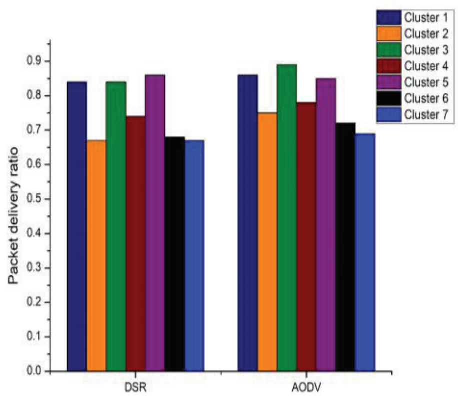

Fig. 22. Packet Deliver Ratio of all cluster.

From Fig 23, it can be observed that the routing overhead transmission is higher in AODV in some clusters. In Fig. 24, it can be observed that average delay is more in AODV as compared to the DSR protocol. In Fig. 25 and Fig. 26, it can be observed that the mean and the standard deviation are higher in DSR as compared to the AODV protocol. The higher values of the mean and standard deviation indicate the better performance of the network. According to all simulation results, we can analyze that DSR protocol is more reliable than AODV in rhombus shaped clustering. It is an effective solution for enhancing the safety of the vehicles and provides more reliable network. Comparative analysis of the proposed method with the existing methods is given in Table III. It can be observed that the proposed algorithm provides better performance.

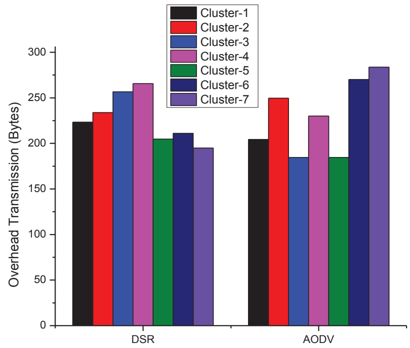

Fig. 23. Overhead transmission of all clusters.

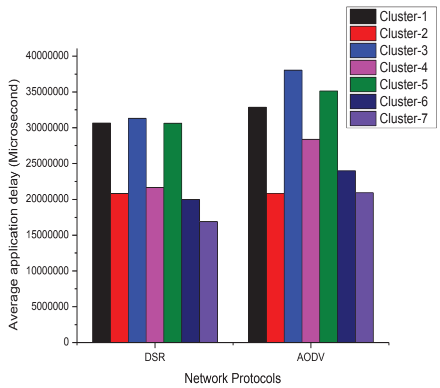

Fig. 24. Application delay of all clusters.

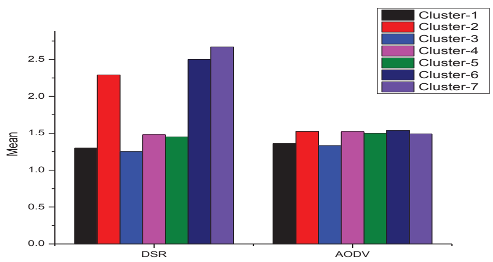

Fig. 25. Mean of all clusters.

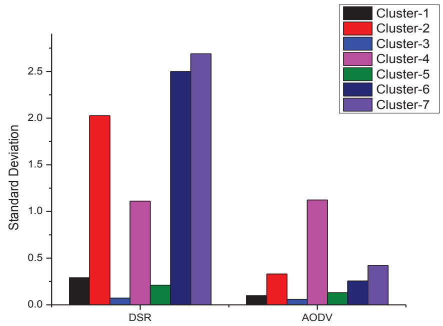

Fig. 26. Standard deviation of all clusters.

TABLE III
COMPARATIVE ANALYSIS

Method	Th (Mbps)	PDR	OH(B)
Existing Clustering [23]	0.161	0.53	200
Existing Clustering [24]	0.064	0.8	295
Existing Clustering [25]	0.018	0.30	---
Existing Clustering [26]	0.016	0.8	500
Proposed Clustering (Overall Network)	23 (Maximum) 1.5 (Average)	0.5	145
Proposed Clustering (Clusters)	10 (Maximum) 0.14 (Average)	0.9	180

Th = Throughput (Mbps), PDR =Packet delivery ratio, OH=Overhead Transmission, B=Byte

VIII. Conclusion

The weight-based clustering algorithm for dividing the rhombus shaped area into multiple clusters has been presented. The proposed algorithm has been applied on vehicles in the network. Rhombus shaped network is divided into 7 clusters and each cluster consists of 5-10 vehicles. Each vehicle of cluster transmits the data to the cluster head instead of broadcasting. The cluster head election is performed by calculating the average speed and degree of each vehicle with the weight value. When a military vehicle detects certain event then it forwards the data to the cluster head. The presented method is more reliable as compared to the existing techniques. The cluster formation in the rhombus shaped network using presented method provides less network overhead and delay in different protocols whereas high throughput packet delivery ratio, mean and standard deviation while transmitting the data through the cluster heads in different protocols.

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