

# Cluster and Cluster Head Selection And Formation Scenario In VANET: A Comparative Study

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**Abstract :** *Vehicle Ad-hoc Network (VANET), enables the communication between groups of vehicles to offer data exchange, entertainment, traffic updates, and driver safety. By using local coordination, clustering is an effective way to address the frequent changes in the topology of the VANET. In this paper, we address various clustering techniques implemented in VANET for vehicle clusters. These techniques use various parameters of the vehicle's mobility, which include position, velocity, packet-forwarding capacity, speed, direction, no of vehicles, etc. the various schemes proposed establishes stable and consistent clusters based on these parameters. For cluster head (CH) selection, RSU agent, size of the cluster, and distance are used in these approaches. However, security, stability, communication, and consistency are some major issues that wireless VANET networks must deal with. We use MATLAB simulators to find the results of these schemes for their comparison. We formed a VANET on Matlab and compared them to various parameters.*

**Keywords:** *Cluster, Cluster-Head, Security, RSU, Vehicle Mobility, Vehicle-to-Vehicle Communication, Vehicle-to-Infrastructure Communication.*

## I. INTRODUCTION

Vehicular ad hoc networks (VANETs) have the potential to be practical for Intelligent transportation system (ITS) real-world applications. The increased mobility of vehicles and the scalability of real-world applications are some of the major issues in this network environment. Specifically, moving cars that can interact with each other constitute a vehicular ad hoc network (VANET)[6]. By grouping cars in the network that shares features, it is possible to use different mobility-based characteristics. In VANET environments, clustering is a strategy that divides the network into groups of vehicles, or clusters, to change the network's flat structure into a hierarchical one. Given the dynamic nature of the environment, stability is one of the key prerequisites for efficient VANET clustering. In order to create clusters in a vehicular network, this research provides a scenario of various clustering technique and their cluster head (CH) selection procedure. Rapid network topology change and unpredictable network connectivity are the major problems for VANET. With the clustering topology incorporated into the VANET, the aforementioned problems are handled. During the clustering process, every node came together in a single group. There are some key components of a cluster: the cluster member (CM), cluster head (CH), and cluster gateway (CG). The cluster gateway deals with one particular cluster member, the cluster head coordinates with all of the cluster's members. The primary difficulty in the clustering strategy is the choice of cluster heads.

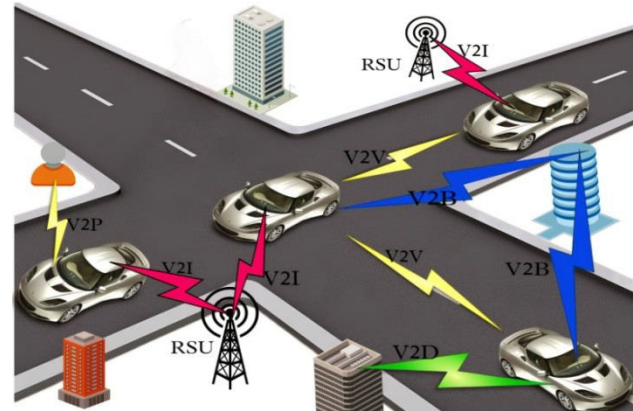


Fig 1: VANET Schematic

The vehicle that receives data from all vehicles traveling in a VANET is known as the cluster head (CH). The CH vehicle of the VANET should be reliable, dynamic, and move at a steady pace. The cluster head is chosen using a variety of techniques.

By exchanging the raw or processed sensor data from the vehicle's sensors and status map, vehicles may create a collaborative environment for cognition [6]. Clustering is essential for improving the stability of the collaborative environment in the vehicular ad-hoc network (VANET).

## II. VANET CLUSTERING

A. Ali et. al. in their research "VANET Clustering Using Whale Optimization Algorithm" explained that the Whale Optimization Approach (WOA) [13] is a cutting-edge methodology that draws inspiration from humpback whales' feeding behavior. Whales have a unique eating strategy known as spiral bubble-net attacking. In order to fool the prey from 12 meters below the surface and swiftly approach the surface to chase the prey, the attacking procedure of the whale begins by forming spiral-shaped bubbles around the prey. There are three phases in a whale's hunting activity: a) an encircling habit around the prey b) exploitation to attack the prey in the vicinity of the prey, and c) behavior of exploration to look for the prey. Each search agent in this method has knowledge of potential vehicles that might be cluster heads or cluster members. The suggested strategy first identifies the cluster head and then chooses the cluster head's neighbors. Here 1) A car can only serve as the cluster head for one cluster at a time. In other words, it is essential that the cluster head is in a single cluster. 2) If a vehicle is in the transmission of another cluster head, it cannot become a cluster head. The problem space is made up of search agents that are randomly filled to look for the best solution in order to maximize the creation of vehicular clusters. Each search agent's solution is assessed in light of the objective function.

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The two objective functions are distance neighbour and delta difference.

X. Ge et. al. suggested, “A Novel Clustering Algorithm Based on Mobility for VANET”. They suggested, Based on the vehicle's mobility, which includes position, velocity, and packet-forwarding capacity, the cluster head is chosen [2]. When the quantity and density of cars fluctuate significantly, it may result in a high number of clusters, increasing the cost of signaling. As a result, safety-related emergency messages and entertainment-related messages cannot be transmitted in a timely manner, which negatively impacts performance. In the clustering procedure, communication between vehicle nodes and adjacent cars is a crucial requirement. In order to calculate the normalized node degree, it is required to know the node degree of the  $i$ th car, the maximum number of CMs permitted in each cluster, and, the set of vehicles within the communication.

The clustering problem is creatively converted into a cutting graph problem as suggested by G. Liu et.al.[6] in “Enhancing Clustering Stability in VANET: A Spectral Clustering Based Approach”. The Spectral Clustering method and the enhanced force-directed algorithm serve as the foundation for a brand-new clustering algorithm. To increase the stability of the overall system, it uses the average lifetime of all clusters as an optimization target. The Simulation of Urban Mobility (SUMO) produces a number of scenarios that are eerily similar to being real-world. They presented some numerical outcomes using SUMO to show that their strategy performs better in preserving full cluster stability.

A. Bavalatti and A. V. Sutagundar in their research developed a reliable clustering method for VANET based on multiple agents [7]. RSU agents and vehicle agents are employed in this programme. RSU agent changes the cluster size in accordance with relative mobility, which is calculated using the average speed of all nearby cars.

When choosing the CH, several restrictions, such as vehicle separation distance and velocity, must be taken into account for stable cluster formation in VANET [12]. G. Khayat et. all proposes a new clustering technique in their research, which is based on a weighted formula for determining the likelihood of choosing the cluster head. Trust, distance, and velocity are the three factors that make up the weighted formula. The trust is a recently introduced statistic that each vehicle calculates and broadcasts to all of its neighbours.

### III. RESULTS AND OUTCOMES

Comparing several algorithms fairly is challenging. Existing clustering techniques are not fairly compared, as appears from the observations of these algorithms. The majority of clustering strategies try to boost cluster stability. Many of them, meanwhile, omitted to define "cluster stability" and the associated performance measures. In this paper's, a few of the performance indicators presented are summarised in Table 1 for simulation.

Table 1

Parameters Values	Parameters Values
Max number of nodes	150
Vehicle speed	40-120kmph

Communication range	0-1000 meters
Simulation time	300s
Bandwidth	10 mbps

Here, four algorithms are compared on the basis of the No of nodes and their End-to-End delay in transmission. On comparing these algorithms, we found the following observation.

Table 2

No of Nodes	WTCHS	SOCDV	NCA	AODV
25	0.073	0.121	0.101	0.078
50	0.177	0.141	0.108	0.081
75	0.212	0.151	0.122	0.091
100	0.211	0.162	0.128	0.100
125	0.244	0.200	0.161	0.123
150	0.278	0.251	0.209	0.150

Below is the comparison chart of these algorithms on the number of nodes and their End-to-End delay. Here we found that more or less these algorithms are somewhat similar and give an almost equal performance. But we found that WTCHS is marginally better than others.

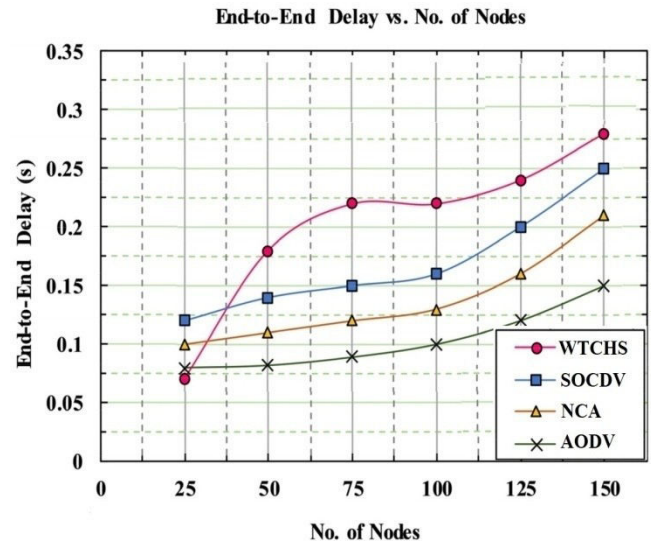


Fig 2: Comparison of End-to-End delay vs No of Nodes

In the graph shown in fig 3, we are comparing their throughput with the number of nodes. Here we can see as the number of nodes increases average throughput is also increasing. Again, we can see that differences in the throughputs are marginal. All algorithms are very impactful. Here we found that WTCHS is marginally better than others.

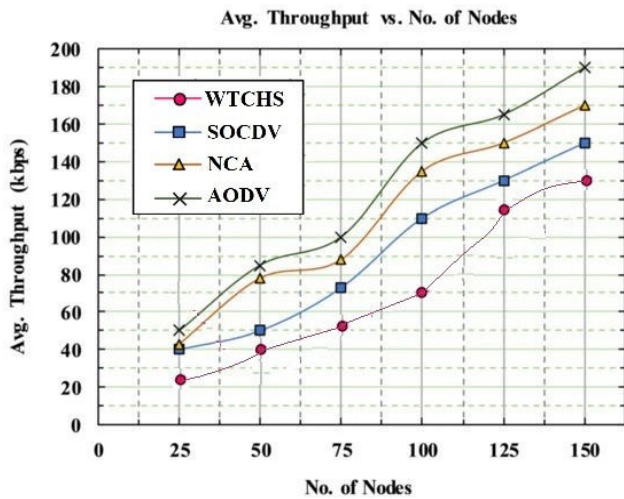


Fig 3: Comparison of throughput vs No of Nodes

#### IV. CONCLUSION

Due to the direct and essential roles of distance and velocity in cluster head selection, they are frequently employed in a number of earlier techniques. Some approaches use single-head and some use double-head concepts for clustering similarly various clustering uses different parameters to form clusters like velocity, distance, size, diameter, etc. we found that there are benefits of these clustering and cluster head selection approaches in different scenarios, like the small size and bigger size clusters. The MATLAB simulation confirmed our anticipated outcomes of various clustering approaches, providing insight into them. We found WTCHS is somewhat better than other clustering techniques employed for the clustering vehicles in VANET.

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