EFFICIENT LEADER HEAD SELECTION IN VANET BY MINIMIZING MESSAGE OVERHEAD

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May , 2023

DECLARATION:

This is to certify that the work presented in this thesis, titled, **"EFFICIENT LEADER HEAD SELECTION IN VANET BY MINIMIZING MESSAGE OVERHEAD"**, is the outcome of the investigation and research carried out by Mouhammad Aboubakar, Abdoulaye Mamoudou and Aminata Nomoko, under the supervision of an Assistant Professor and a lecturer. It is also declared that neither this thesis nor any part thereof has been submitted anywhere else for the award of any degree, diploma, or other qualifications. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references is given.

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ACKNOWLEDGEMENT:

It is an auspicious moment for us to submit our thesis work by which we are eventually going to end our Bachelor of Science study. In the beginning, we want to express our heartfelt gratitude to Almighty Allah for his blessings to bestow upon us which made it possible to complete this thesis research successfully. Without the mercy of Allah, we wouldn’t be where we are right now. All thanks and praises be to Allah.

We would like to express our grateful appreciation to Faisal Hussain, Assistant Professor,Department of Computer Science and Engineering, Islamic University of Technology and S.M. Sabit Bananee,Lecturer ,Department of Computer Science and Engineering,Islamic University of Technology for being our advisors and mentors. Their motivation, suggestions, and insights for this thesis have been invaluable. Without their support and proper guidance, this thesis would not see the path of the proper itinerary of the research world. Their valuable opinion, time, and input provided throughout the thesis work, from the first phase of thesis topics introduction, research area selections, the proposition of algorithm, modification, and implementation helped us to do our thesis work properly.

We would also like to thanks Dr. Muhammad Mahbub Alam, Professor, Department of Computer Science and Engineering, Islamic University of Technology for his enormous help in directing us towards our goal and helping us in time of our need. We are grateful to him for his constant and energetic guidance, constructive criticism, and valuable advice.

ABSTRACT:

Vehicular Ad-hoc Networks (VANETs) require efficient leader head selection algorithms to optimize network management tasks and communication overhead In this paper, we offer a proactive approach technique to reduce message overhead while retaining effective network performance for leader head selection in VANETs. To create clusters and choose leader heads, the system makes use of predictive models of vehicle motion and communication patterns. The proposed technique achieves better scalability, decreased communication cost, and improved network performance by minimizing the number of messages exchanged and optimizing cluster formation. The algorithm's success in decreasing message overhead and ensuring effective leader head selection in VANETs is demonstrated by simulation results.

Vehicle-to-vehicle (V2V) communications have rapidly advanced in recent years, opening the door for new applications tackling concerns like autonomous driving, traffic efficiency, and vehicle safety. These applications may greatly enhance the driving experience, travel time, fuel efficiency, traffic safety, and other elements directly connected to automobiles. In many of these circumstances, a coordinator vehicle is necessary to coordinate the right-of-way among many cars. Such a coordinator or leader vehicle is essential in many situations where a cooperative aim is desired for all cars in the group.

Effective leader head selection algorithms are crucial in the context of Vehicular Ad-hoc Networks (VANETs) for optimizing network management activities and reducing communication overhead. The proactive approach strategy that is suggested in this study attempts to lower message overhead while maintaining efficient network performance in VANETs. To generate clusters and choose leader heads, the method makes use of predictive models of vehicle movements and communication patterns.

The suggested method delivers higher scalability, lower communication costs, and increased network performance by utilizing predictive models. This is accomplished by optimizing cluster formation and reducing the volume of

communications transferred during the leader-head selection process. To choose the best leader heads, the system considers a number of variables, including vehicle velocity, proximity, connection, and communication patterns. The algorithm can efficiently divide the leadership position among cars in a way that improves network performance and lowers communication costs by taking these aspects into account.

Results from simulations show how the suggested technique is successful in lowering message overhead and guaranteeing efficient leader head selection. The simulations illustrate how the algorithm can build effective clusters and choose appropriate leader heads, improving throughput, latency, and reliability across the network. The algorithm's proactive strategy and implementation of predictive models let it adapt to VANETs' dynamic nature, where cars are continually moving and entering/leaving the network, effectively.

The development of vehicle-to-vehicle (V2V) communications has created new possibilities for applications relating to autonomous driving, traffic efficiency, and vehicle safety in a more general sense. The existence of a coordinator or leader vehicle is essential in many of these scenarios in order to promote coordination and collaboration among several vehicles. In order to enable smooth coordination and collaboration inside VANETs, the suggested leader head selection algorithm solves this need by effectively recognizing and choosing leaders' heads.

Overall, the proactive strategy and technique based on predictive modeling described in this study provide solutions that have promise for lowering message overhead, improving cluster formation, and ensuring efficient leader head selection in VANETs. These developments have the potential to improve a number of directly linked features of vehicles and their interactions in V2V communication scenarios, including the driving experience, journey duration, fuel efficiency, traffic safety, and others.

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1. INTRODUCTION

VANET is a particular kind of wireless multi-hop network that must support fast topology changes due to high node mobility. As more vehicles are equipped with wireless communication devices and computer capabilities, inter-vehicle communication is evolving into a viable field for study, standardization, and development. Due to the exponential rise in the number of cars and the delay restrictions brought on by frequent disconnections, deploying such congestion detection and traffic analysis algorithms for the VANET on conventional architectures appears to be a challenging issue.

Our algorithm's main goal is to reduce message overhead while choosing leader heads in VANETs. We seek to increase network scalability, decrease resource usage, and improve overall network performance by lowering the volume of messages exchanged throughout the selection process. The system accomplishes this by using a clustering approach, in which vehicles are grouped together based on their proximity to one another and their communication habits. A leader head is chosen for each cluster according to established standards like network load, dependability, or mobility patterns.

An important factor in improving traveler comfort, traffic safety, and intelligent transportation systems is the vehicle ad-hoc network (VANET). In order to establish connection between automobiles and between cars and infrastructure, specialized short-range communications technology is developed for the VANET. The VANET may experience complex problems with scalability, resource scarcity, reliability, and hidden terminal concerns due to the absence of router equipment and flat vehicle-to-vehicle network structure. Vehicle clustering is used in the VANET to address all of these concerns and enhance network performance. According to their design goals, clustering protocols in VANET are comprehensively categorized in this study.

When examining clustering techniques in VANET, two fundamental categories—generalized and application dependent—are taken into consideration.Building a solid cluster with a long sustainable life is the main goal of the cluster design in the generalized clustering protocol. The goal of cluster design, as opposed to application-dependent clustering protocols, is to enhance the performance of certain applications (such as target tracking, traffic prediction, misbehavior detection, privacy preservation, certificate revocation, etc.) on a variety of performance criteria.Our objective is to assess the existing algorithms and provide a solution or improvement for the present problem. In this paper, we provide a broad introduction of the concept of vehicular ad hoc networks, as well as information on their uses, characteristics, and clustering. Additionally, we will talk about some of the cluster head selection that is the basis of our work.

Our algorithm's main goal is to minimize message overhead while selecting leader heads in VANETs effectively in order to solve this problem. Our technique attempts to improve network efficiency, scalability, energy conservation, collision avoidance, and latency by decreasing the number of messages exchanged throughout the selection process. This improvement enhances VANETs' overall performance while also facilitating the smooth operation of numerous applications, such as traffic control, cooperative driving, and safety features.

Our program uses clever approaches and tactics to achieve the goal of lowering message overhead. It makes use of its knowledge of the neighborhood and communicates with the appropriate vehicles involved in the leader head selection process on a selective basis. The technique seeks to save bandwidth and increase network scalability, especially in heavily populated areas, by eliminating needless message distribution.

Periodic broadcast optimization, which transmits messages at optimal intervals while taking into account variables like vehicle density, mobility patterns, and the importance of the leader head selection process, complements selective communication. The algorithm also uses message aggregation strategies, which combine several messages into a single transmission to lower the total number of messages and further conserve resources.

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Additionally, our program automatically limits the amount of redundant or superfluous messages sent by only initiating message exchanges when necessary circumstances are met. The system introduces hybrid communication modes, employing combination infrastructure-to-vehicle (I2V) and vehicle-to-vehicle (V2V) communication, to maximize message delivery and relieve the communication burden from vehicles when infrastructure help is available.

Extensive simulations or real-world experiments will be performed to assess our algorithm's performance in terms of message overhead reduction, leader head selection accuracy, and overall network efficiency. Our method intends to increase the capabilities of VANETs by successfully lowering message overhead. This will allow for seamless communication, better resource usage, and effective coordination amongst cars, thereby boosting the security and effectiveness of vehicular networks.

The requirement to improve the efficiency and scalability of Vehicular Ad Hoc Networks (VANETs) is what drives effective leader head selection in VANET by minimizing message overhead. VANETs are dynamic networks made up of moving automobiles that interact with one another and roadside infrastructure to provide a variety of functions, including traffic control, collision avoidance, and information sharing. The choice of leader heads, who are in charge of organizing network operations and distributing information, is critical to the success of VANETs. Traditional leader head selection techniques, on the other hand, could have substantial message overhead, which might have a detrimental effect on communication dependability, network efficiency, and resource use. To reduce message overhead while preserving the needed network speed, an effective leader head selection system must be created.

The issue at hand is how to choose leader heads in VANETs while reducing message overhead. In order to ensure effective network operations and lower the quantity of messages needed for coordination and information dissemination, the goal is to choose a subset of vehicles as leader heads in the most effective way possible. The main issues and problems are as follows:

a) Reducing Message Overhead: The main issue is reducing the volume of messages sent and received by the vehicles during the leader head selection procedure. High message overhead can contribute to network congestion, decreased throughput, and energy waste. A leader head selection technique that minimizes messages while retaining efficient coordination and communication is the objective.

b) Criteria for Leader Head Selection: Establishing the standards for choosing leader heads is another issue. It is possible to take into account a number of variables, including vehicle proximity, connection, communication range, node degree, and particular application needs. The difficulty is in defining the right standards that support effective network operations and guarantee the choice of qualified and dependable leader heads.

c) Scalability and Dynamism: A huge number of vehicles that are continually moving as well as joining/leaving the network are what VANETs are known for. The network's dynamic character should be able to be accommodated by the leader head selection algorithm's scaling to a high number of cars. While retaining minimal message overhead, it should be able to adapt to changes in traffic circumstances, vehicle mobility, and network architecture.

The goal is to provide an effective leader head selection algorithm that reduces message overhead, enhances network performance, as well as enables effective communication and coordination in VANETs by solving these issue statements.

2. LITERATURE REVIEW:

We started with cluster analysis, which consist of understanding how cluster are form in Vanet.We began to study cluster , which involves classifying vehicles according to their proximity, communication patterns, and movement characteristics in order to comprehend how clusters arise in VANETs. This analysis aids in the discovery of clusters that can promote effective resource sharing, communication, and coordinated operations within the VANET.

We studied cluster head selection, which involves the process of identifying suitable vehicles within each cluster to act as cluster heads in VANETs The cluster head selection method takes into account a number of variables, including the vehicle's capabilities, communication range, connectivity, and leadership characteristics, to choose the best vehicles for the cluster head position. In VANET setups, choosing capable cluster heads is essential for controlling intra-cluster communication, coordinating network activities, and optimizing resource usage..

This paper proposes an algorithm that will ultimately pick a leader for each connected component of a dynamic network where nodes can relocate or crash is proposed in this study. A node retains topological knowledge, or a confined view of the network's communication graph and its dynamic evolution, and only interacts with other nodes within its transmission range[2].

Each time the network's topology or a node's membership is changed in this study, one or more nodes pick it up and broadcast it throughout the network, updating the nodes' topological knowledge in the process. Particularly on big components with little node movement, both Topology Aware techniques are more reliable than Flooding Degree, and the proximity variant has a shorter path to the leader.In comparison to Flooding Degree, the method increases leader stability up to 82%, transmits half as many messages, and reduces the distance that nodes must travel to the leader by 11%.

In addition, Nejood Faisal Abdulsattar[3] introduced a novel technique that forms usable clusters by employing the improved rider optimization algorithm (ROA) to choose the CH optimum. Using privacy-preserving mobility patterns during transmission, the network is shielded from all sorts of issues brought on by the blending and migration of new vehicles. The behavior of the bypass rider's CH is chosen by analysis, and thus creates the optimum clusters.

Vehicular Ad Hoc Networks are mobile wireless networks that enable communication and information sharing between cars and with infrastructure. In VANETs, the effective selection of cluster heads is essential since they are critical for resource allocation, routing, and data aggregation. The difficulties of privacy protection and ideal selection, however, might not be sufficiently addressed by conventional cluster head selection techniques.

The P2O-ACH technique, which merges a privacy-preserving mobility model alongside an optimization-based cluster head selection method, is the solution the paper suggests for these problems. The privacy-preserving mobility paradigm guarantees the security of vehicle location data, lowering the possibility of privacy violations. Based on factors including connection, stability, and availability, the optimization-based cluster head selection algorithm chooses cluster heads in the best possible way.

The efficacy of the suggested algorithm is assessed using simulations, and the outcomes show that it performs well in terms of network performance, energy efficiency, and privacy protection. By balancing the selection of cluster heads with the protection of privacy, the algorithm ensures effective and safe communication in VANETs.

By offering a fresh method for choosing cluster heads that tackles privacy issues and streamlines the selection procedure, the paper adds to the body of knowledge already available on VANETs. It emphasizes the need of protecting privacy in vehicle networks and offers details on how to build and deploy effective and secure VANET networks.

The "Privacy-Preserving Mobility Model and Optimization-Based Advanced Cluster Head Selection (P2O-ACH) for Vehicular Ad Hoc Networks" article offers insights and solutions for privacy-preserving cluster head selection in vehicular networks, making a significant contribution to the literature on VANETs.

Panimalar Kathiroli[11] suggested that in wireless sensor networks, a sizable number of nodes with low battery life are employed to collect and transmit data to the base station. Here, data transport uses up the greatest energy.

Therefore, one of the main issues is maximizing network longevity while minimizing node energy use. The clustering approach is used to address this problem and produce energy-efficient data transfer. The network lifespan is increased by electing a cluster head who employs an energy distribution technique to save the remaining power. Different modern approaches are used, however each algorithm has significant limitations on its own.

Through cluster head selection, this study suggests a hybrid Sparrow Search approach with a Differential Evolution method to solve the issue of energy efficiency in Wireless Sensor Networks. The suggested method uses the very efficient Sparrow Search method with the dynamic capability of Differential Evolution, which expands node lives. Utilizing throughput, remaining energy, and the proportion of live and dead nodes, this hybrid model seems to function effectively. The recommended Improved Sparrow search algorithm uses the Differential evolution model to choose the best cluster head and outperforms earlier comparable techniques in terms of residual power and throughput.

Finally, Rusheng Zhang[1] said that Rapid developments in vehicle-to-vehicle (V2V) communications in recent years have made it possible for new applications to solve issues with vehicle safety, traffic efficiency, autonomous driving, and other issues.

Proactive approaches to leader selection in VANETs have been proposed. These approaches aim to enhance network performance, reduce communication overhead, and improve coordination and management within the network.

This paper initially introduces a novel proactive leader selection method. The algorithm's desirable qualities are then demonstrated through simulation results, which reveal that they include:

The procedure is straightforward and only calls for a small quantity of data to be provided. However, in terms of quick convergence time, it is quite effective. The algorithm also quickly returns to stability when uncontrollable errors occur.

The algorithm is simple to implement and may be quickly incorporated into vehicular network protocols by simply adding a special field or header to the Basic Safety Message (BSM).

The method holds up well in extremely dynamic settings. It does not necessitate a rigid topology, dependable channels for communication, or even constant network connectivity.

This paper considered a typical VANET scenario for a small, moving group of cars, often no more than 40 cars. While V2V communication is possible between all of the vehicles under consideration, the channel may be noisy and unreliable, making it possible for any packet to be lost. The i-th vehicle is referred to as vehicle. An order function (veh1, veh2) that returns 1 or 0 depending on the relationship between the two automobiles provides a rigorous binary relationship for any two vehicles.

The order function determines which vehicle will be the leader; they should all agree on the leader and be aware of him or her. The ideal vehicle should be the leader. It's important to maintain the leadership position: When the current leader departs, the search for a replacement starts; as new vehicles join the club, they make the same choice. Because switching leaders will result in a time gap, which is undesirable for most applications, the leader status should continue even if the node order changes or a better vehicle joins.

The leader should be able to provide the same information to all of the group's vehicles. These communications are known as leader messages.All of the vehicles in the group should be able to get the same information from the leader. These messages are referred to as leader messages.

However, this involves sending a lot of messages, especially in proactive models where nodes must often interact and reassess their leadership positions. There is an inherent communication overhead to ensure that each node is aware of the present network leadership structure.

3. VANET (Vehicular ad-hoc network)

Vehicle-to-vehicle communication is made achievable via a unique class of dynamic wireless networks called the VANET (Vehicular Ad-hoc Network).Wireless communication between nodes and their various mobility nodes occurs in VANET. The two distinguished communication instances that have been established for transportation networks are vehicle-to-vehicle communication (V2V), in which cars exchange messages directly, and vehicle-to-infrastructure communication (V2I), in which exchange of information is made through the RSU in addition to tolls and Internet access points.

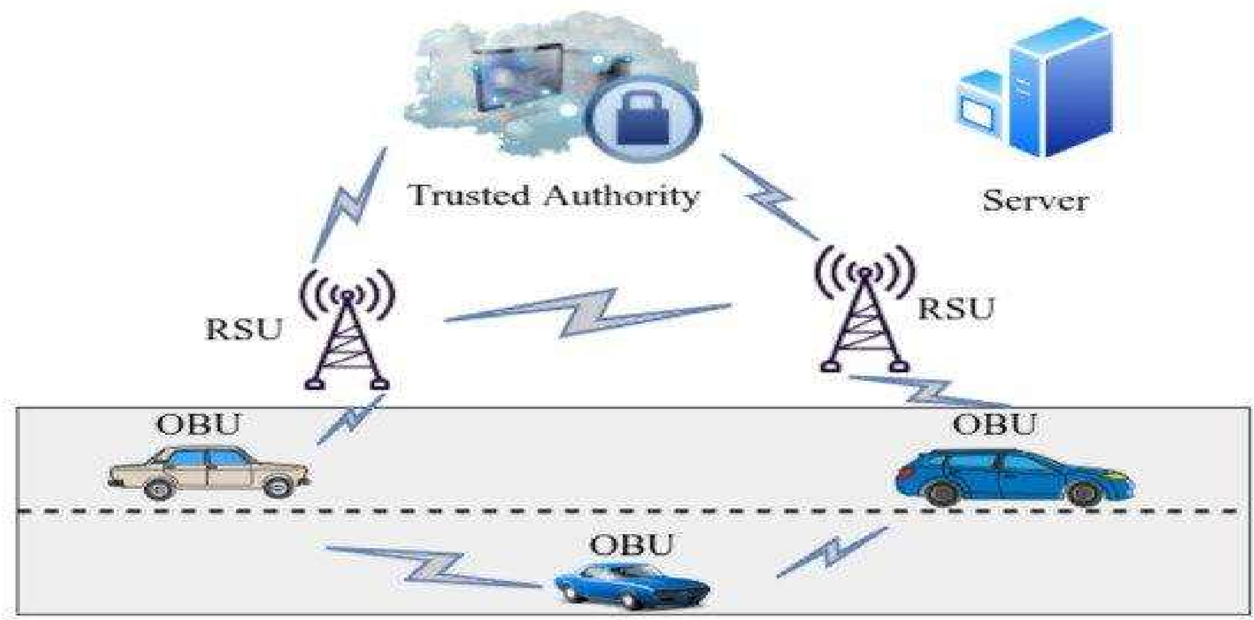

Figure 1 : Vanet Generic Architecture[10]

When the VANET network components work together, they form domains, which are collections of logical and physical elements that work together to generate links among nodes and RSU. The following criteria are used to classify these domains:

• **Domain in the car**: These can be wired or wirelessly linked domains that provide a bidirectional communication network within the vehicle.

• **Ad hoc domain**: This domain refers to wireless connections made between nodes or between nodes and the RSU.

• The **domain of infrastructure** was established by the access networks, the RSU, and the back-end infrastructure that supported the nodes' requests for Internet access. It is possible to communicate through wired and/or wireless technologies.

3.1 Vanet application

Through collaborative systems built on v2x communications, the VANETs present a possibility for the creation of applications that improve travel and traffic situations.

Applications for road safety

With the aid of these applications, traffic accidents tend to occur less frequently and result in fewer injuries and fatalities. Drivers are in this instance issued alert messages about unexpected road incidents, information about nearby vehicles, and incident management.

i. **Crash avoidance** Here, the RSU alerts the driver when there is a potential collision between two vehicles.There are

• a collision alert for intersections.

• a pre-collision alert.

• a line change alert.

• an alarm for risky areas.

ii.**The purpose of traffic sign notification** (RSN) is to alert drivers to road signs and offer help while they are on the road. Several RSN applications include:

• Speed Warning for Curves.

• Violation of a traffic signal warning

Road Efficiency Applications: The goal is to manage and monitor vehicle traffic and road conditions in order to improve traffic conditions.It is separated into two parts:

i.Traffic management: processes information from the RSU components of the transportation network on traffic flow and management. Applications of this kind include:

- intelligent traffic control;
- traffic-free tolls.
- Controlling speed.
- Better navigation and route recommendations.

ii. Traffic monitoring: Keep an eye on the state of the roads and the vehicles on them, and alert drivers and traffic officials to any abnormalities. Some of these uses include:

• Traffic congestion monitoring.
• Tracking agents and vehicle tracking.

Applications for commerce and information (infotainment)

These kinds of applications concentrate on offering drivers and passengers entertainment and information offerings.

I. Entertainment: Users may do a variety of tasks, including as browsing the internet, playing online games, and viewing multimedia content, using wifi access points installed on the road or over the cellular phone data network. The use of the VANET resources for leisure activities is made possible for the passengers of the cars via these applications.

II. Background data: These applications advise drivers about interesting places, nearby landmarks, and location-based services. Here are a few instances:

- Download and update maps.
- Location and Parking Reservation.
- Information on Sites of Interest

3.2 **Vanet characteristics**

MANET application, it has unique qualities that can be summed up as follows:

i.**High Mobility**: The nodes in VANETs typically move quickly. As a result, it is more difficult to forecast a node's position and node privacy is less protected.

ii. **Network topology**: Because of high node mobility and erratic vehicle speeds, node positions regularly change.

iii-**Unrestricted network size**: VANET can be developed for a single city, a group of cities, or an entire country.

iv.**Regular information exchange**: The ad hoc nature of VANET encourages the nodes to collect data from other vehicles and roadside equipment.

v. **Wireless Communication**: The VANET is developed for wireless environments. Wireless connections allow nodes to communicate and exchange information.

3.3 **Clustering**

A method for organizing logical groups of automobiles nearby is called clustering. A cluster is the name given to the created logical groups. In a cluster, the vehicles may play any of the following roles:

• **Cluster head** (CH): A vehicle that manages data transmission between other cluster heads and its own members.

• A **cluster member** (CM) is any additional regular vehicle within a cluster that is not connected to another cluster.

• A **cluster-gateway** (CG) is a device that connects two or more clusters together.

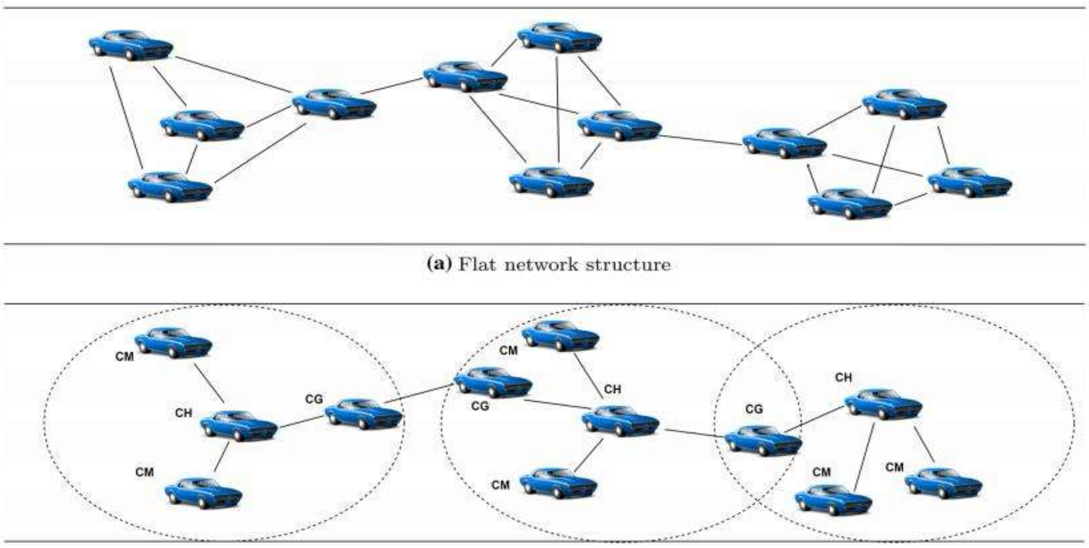

Figure 2 : General flat and cluster based network structure in Vanet[3]

Some of the cars that make up the cluster member are within the transmission range of several clusters or CHs that are used to connect clusters. Gateways are the name given to these vehicles. The gateway vehicles, cluster members, and cluster head's status are monitored on a regular basis.

By applying an effective cluster head selection technique, the stability of a cluster may be considerably increased, and many applications, like routing and MAC, can perform better as a result. When creating clusters and selecting a cluster leader, a number of important factors must be taken into consideration.

Figure 2 displays the standard procedures that each clustering algorithm follows

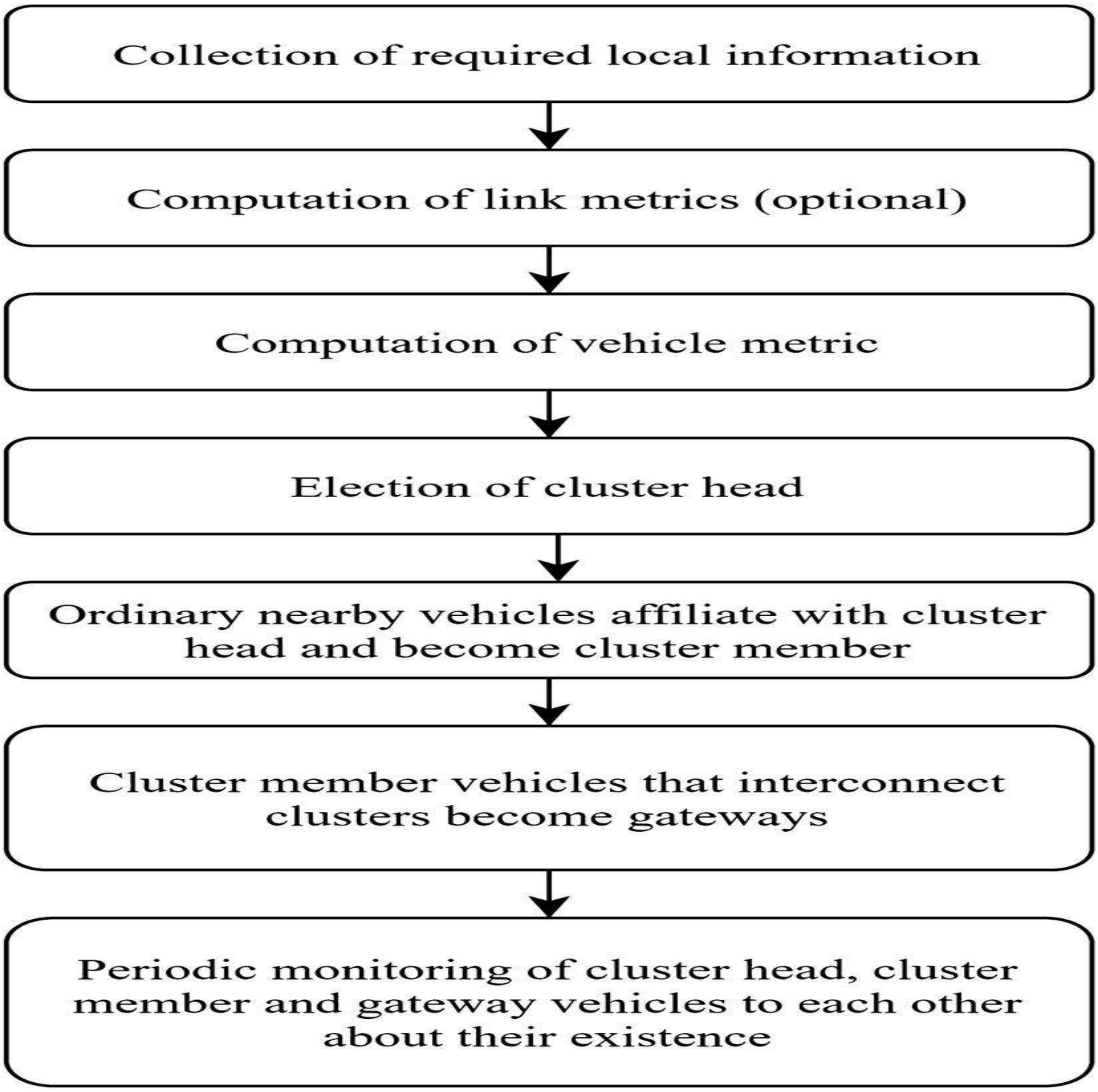

Figure 3 : General steps of clustering algorithm[2]

3.4.1 **Role of cluster in Vanet**

The vehicle-to-vehicle communication protocol has two methods for data dissemination in the network: flooding and relaying. A flooding strategy was used by all nearby cars that received the broadcasted data packet from the source node to rebroadcast it to their neighbor. The data packet's destination was the main focus of the procedure's multiple rounds. In a flat, dense network, flooding may lead to the broadcast storm problem [40].

Only a select few vehicles designated as forwarder vehicles are permitted to transmit new data packets, while all surrounding vehicles in relaying approaches receive the data packets broadcast from the source vehicle.

The flooding strategy is used in multi-hop flat dense vehicular ad hoc networks to reduce the likelihood of successful data transmission to the destination [40].

Using a relaying strategy enhanced the likelihood of effective data delivery at the same time, but with significant overhead and delay. Clustering in VANET is, to a large extent, a popular approach to address such issues.

Due to the limitations of proactive, reactive, and spatial routing protocols in VANET, such routing approaches that improve routing scalability and dependability, efficient bandwidth use, and lowered data transmission time are required. Cluster-based routing systems largely satisfy these constraints. In cluster-based routing systems, the large network is divided into distinct entities known as clusters. The routing protocols used within a cluster and between clusters are referred to as intra-cluster and inter-cluster, respectively. In both scenarios, CH takes complete ownership of all routing duties in place of cluster's entire fleet of vehicles.

Using the clustering technique, the VANET is divided into manageable portions, and the cluster head effectively arranges channel access for the cluster members. In order to increase throughput, it maintains the network topology in addition to lowering channel contention. The cluster-based MAC protocol makes the network more scalable and reliable.

Clustering protocols are necessary for MAC and routing applications. The main purpose of the MAC protocol is to provide infrastructure and automobiles with fair channel access. The VANET's dynamic topology causes an increase in the overhead of control messages used for channel access. The constrained bandwidth of a vehicle network in a crowded area exacerbates channel congestion. The exposed terminal problem and the hidden terminal problem with channel access are major problems in Vanet.

3.4.2 **Challenges of cluster in vanet**

Due to the dynamic nature of the network and the distinctive features of vehicular communication, clusters in Vehicular Ad Hoc Networks (VANETs) may encounter a variety of difficulties. The following are some difficulties with clustering in VANETs:

Dynamic Network Topology: Because vehicles are mobile, VANETs are very dynamic networks that frequently change their topology. The maintenance of stable and durable clusters is difficult due to its dynamic character. Cluster creation, upkeep, and management must change to accommodate the evolving network topology.

Resource Constraints: Resources are limited for vehicles in VANETs, including processing speed, memory, and battery life. To increase the lifespan of the network, cluster formation and maintenance should consume as little resources as possible. For stable clusters to be kept while minimizing overhead, resource efficiency is essential.

Interference and Channel Access: Because VANETs use shared wireless channels, cluster performance may be impacted by interference. It's possible for vehicles in adjacent clusters to compete for the same channel resources, increasing packet collisions and decreasing communication dependability. To enable efficient cluster communication, effective channel access methods and interference management techniques are required.

Security and Privacy: Clustering creates issues for VANETs in terms of security and privacy. Cluster leaders might be given more responsibility and access to private data.

Important factors in VANET clustering include defending against assaults on cluster heads, securing cluster communication, and guaranteeing privacy protection.

Heterogeneity: Vehicles with varying capacities, communication ranges, and transmission powers may be a part of VANETs. To accommodate different vehicle features and promote effective cluster formation and operation, clustering algorithms should take heterogeneity into account.

The creation of reliable and flexible clustering algorithms, effective cluster management protocols, and efficient resource utilization techniques are necessary to meet these problems. Researchers are still looking into novel ways to improve the functionality and scalability of clusters in VANETs while taking into account the particulars of vehicular communication.

4. METHODOLOGIES:

In this section, we describe our working process of selecting candidate for leader selection The concept uses candidate evaluation and predictive modelling to make proactive selections of effective leader heads. The algorithm predicts future vehicle behaviour and enhances cluster formation using predictive models. By limiting communication to pertinent cars within clusters, this reduces message overhead. The selection process for candidates makes sure that the chosen leader heads have the attributes needed for effective network management.

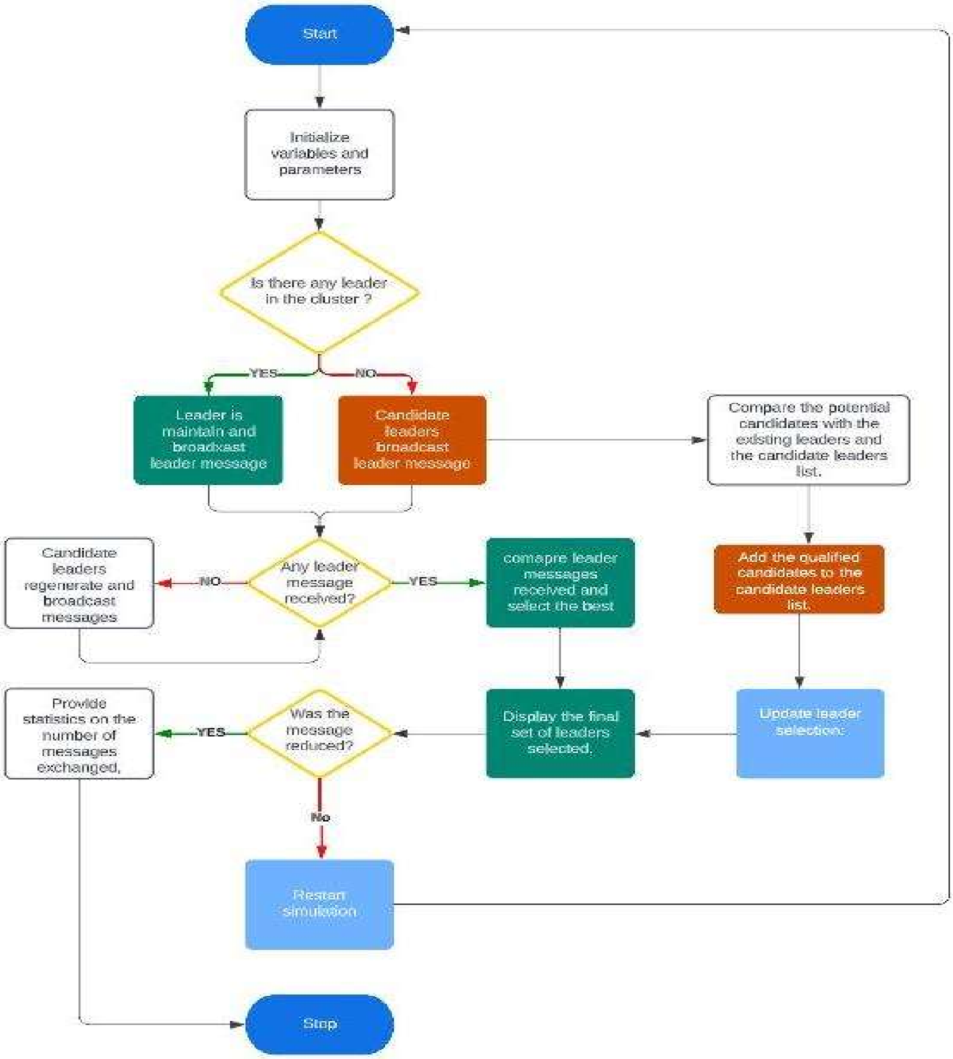

Figure 4: Workflow of the algorithm

The following stages make up the method for effective leader head selection in VANET with an emphasis on reducing message overhead. First, the network's maximum number of leaders and cars is determined. The leaders and candidate leaders are then added to empty lists. The next step is to arrange a fleet of cars at random, and the initial leaders are selected using criteria like proximity, connection, or node degree. The leaders list now includes these early leaders.

Each leader sends a message to the nearby cars containing pertinent information, such as the leader's ID and job. The nearby cars analyze the received leader messages and extract data such as the leader ID and position. Leading candidates are chosen from the received messages based on variables such as distance, signal strength, or node characteristics. The qualifying candidates are added to the candidate leaders list after comparison with the probable candidates, the candidate leaders list, and the present leaders.

In accordance with a selection criterion like the greatest priority, enhanced connection, or best coverage, the leaders are updated by choosing them out of the candidate leaders list. The leaders are then compared to the present leaders to update the leader list. The least qualified leaders are eliminated using a specified criterion if the number of leaders is more than the maximum permitted. The data forwarding system is updated utilizing optimizations like selective forwarding, temporal filtering, or clustering to reduce message propagation and redundancy.

Checking for leader selection stabilization, which means that the leader list has not experienced major changes, is how convergence analysis is carried out. The process of message swapping, candidate selection, and leader update resumes at step 4 if convergence is not attained. The algorithm then produces the final selection of leaders and offers data on the quantity of messages exchanged, the speed of convergence, and other pertinent parameters.

Overall, by minimizing messages overhead and taking into account variables like proximity, connection, and node characteristics, this method seeks to effectively choose leader heads in VANET.

4.1 Candidate selection

The methodology for the efficient leader head selection algorithm in VANETs, based on a proactive approach to minimize message overhead, involves two main steps: candidate selection and leader selection. Here is an overview of the methodology

a) Candidate Evaluation Criteria:

i. **Reliability:** Evaluate a candidate vehicle's dependability based on elements like its previous performance, stability, and consistency in communication.

ii. **Communication Capabilities:**communication capability, taking into account their bandwidth availability, transmission range, and signal strength.

iii. **Available Resources**: To make sure the candidate can handle the increased obligations of being a leader head, take into account the applicant's available resources, such as computational power, storage capacity, and battery life.

iv. **Connectivity**: Assess the candidate's connectivity to other cars in its cluster and to the wider VANET network. Enhanced connectivity and more communication links

b) Rating and Scoring of Candidates:

Establish a scoring system or a set of guidelines to award scores to each candidate in accordance with the evaluation criteria. This can be a weighted average of the results for each individual criterion or a more intricate scoring formula.

Candidates are ranked: Put the best candidate at the top of the list by ranking the candidates according to their scores. The candidate selection order is influenced by this ranking.

b) Select leader heads:

Choose the candidate with the highest score among all vehicle as leader head for a particular small group of clusters. The selection of the leader head comes after the selection of the candidate leader. The best candidates are chosen as leader heads after the candidate leaders have been assessed based on a set of criteria. The leader head selection procedure makes sure that the selected leaders possess the needed abilities and traits necessary for effective functioning in the VANET.

4.2 Leader selction

Candidate Evaluation: Vehicle candidates for the selection of the leader head are located within each cluster. The system assesses each candidate's appropriateness based on predetermined standards such vehicle dependability, communication abilities, resource availability, or mobility patterns. Considerations for factors such vehicle speed, stability, connectivity, and past performance may be made during the appraisal process.

Leader Head Selection: The algorithm chooses a leader head for each cluster based on the candidate evaluation. Routing, data aggregation, and job scheduling are just a few of the network operations that the leader head is in charge of managing and organizing. Criteria like leadership experience, network load balancing, or dynamic adjustment depending on shifting circumstances could be considered during the selection process.

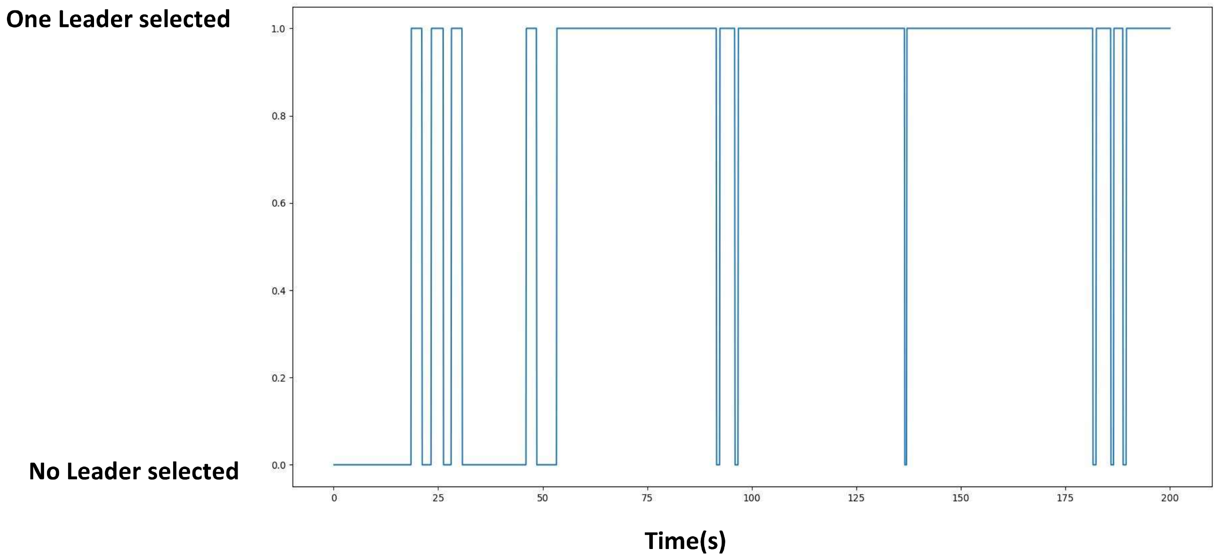

Figure 5: Leader selection process

4.3 Reduction of message

The leader messages generated will be reduced by reducing the threshold frequency between the message broadcast intervals thereby increasing the time and vice versa.

5. EXPERIMENTS AND RESULTS:

5.1 Experiment : This experiment is been conducted on Sumo.The version is 1.8.0 for windows 64bit compatible together with veins versions 5.2 and inet 4.2.5 installed correctly in the platform. In windows as well as in Ubuntu to be able to execute the simulations smoothly without any interruptions and results given respectively.

A. Dateset Description:

In this scenario we use 40 vehicles .We ran extensive packet-level simulations to assess how the developed algorithm worked in various scenarios [22].

In order to obtain reliable and precise results, we developed a hybrid simulator that mimics both the mobility of autos and the probabilistic DSRC channel. The mobility is simulated using SUMO, a popular open-source mobility simulator

i. Number of message generated:

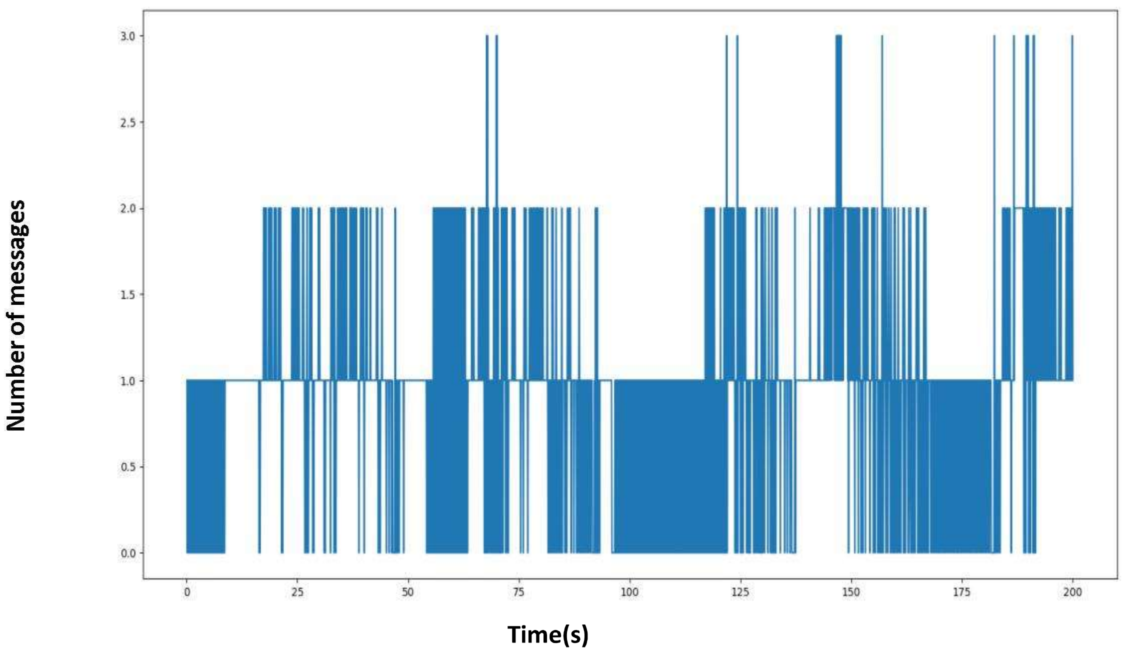

Figure 6: Message generated

From the above figure, we can see that at the setting from 0 to 20 the number of message is not relevant.But when they are new vehicle coming inside the cluster the number of message increase as there is many candidate vehicle .from 100-125 we can see a flux of un-stop message generate by candidate and leader

ii. Convergence time:

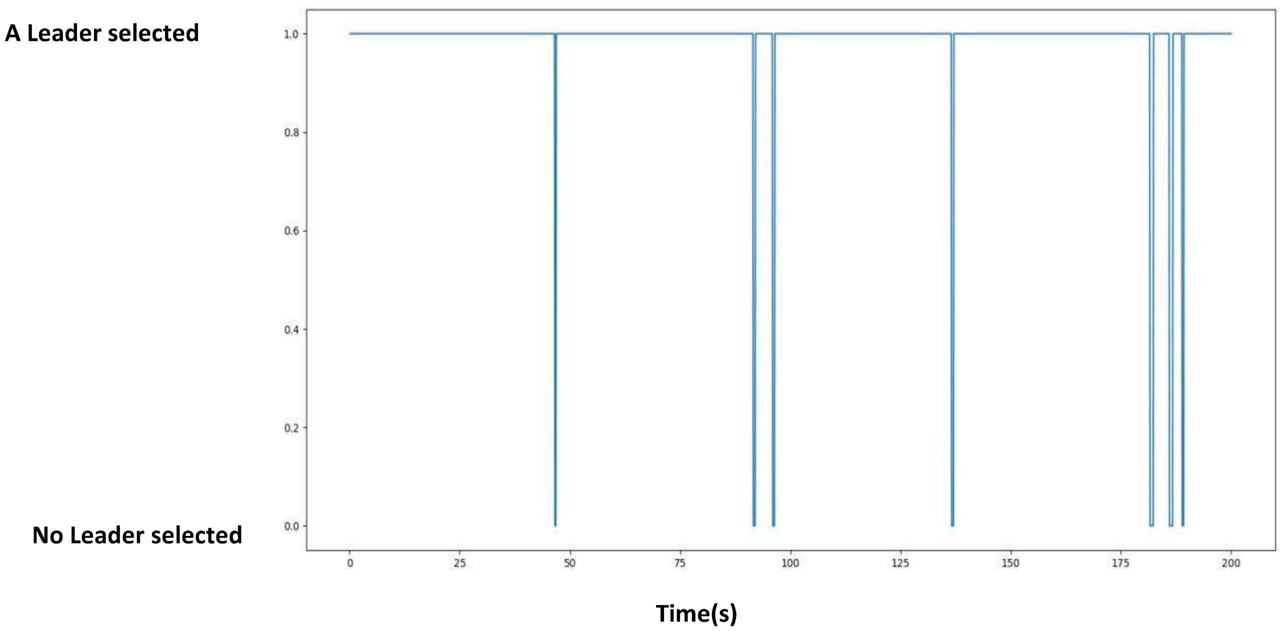

Figure 7: Convergence time

The leader will wait for the red light at the intersection for some time before moving on when it turns green. We see that as the leader vehicle exits the intersection, the other vehicles immediately recognize this as an event and begin choosing a new leader. This new leader selection time is quite brief—less than one second. The basic leader selection algorithm performs nearly identically to the optimized leader and improved version selection method in terms of maintaining leader status.

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B. Results:

i. **Comparison model:**

algorithm	**Basic**	**Optimized**	**Improved_version**
Stable percentage	98%	98%	97.5%
Average Convergence time(s)	0.6	0.39	0.52
Maximum convergence time(s)	0.83	0.64	0.7
Number of message	54743	8829	2481

Table 1: comparison of model

As we can see from this table that,the number of message for the basic message has been reduce by 85% by the optimized version in dense traffic,these message has also been reduce by 79%.also we can see that the average converge time of the improved version is higher this is due to the candidate selection

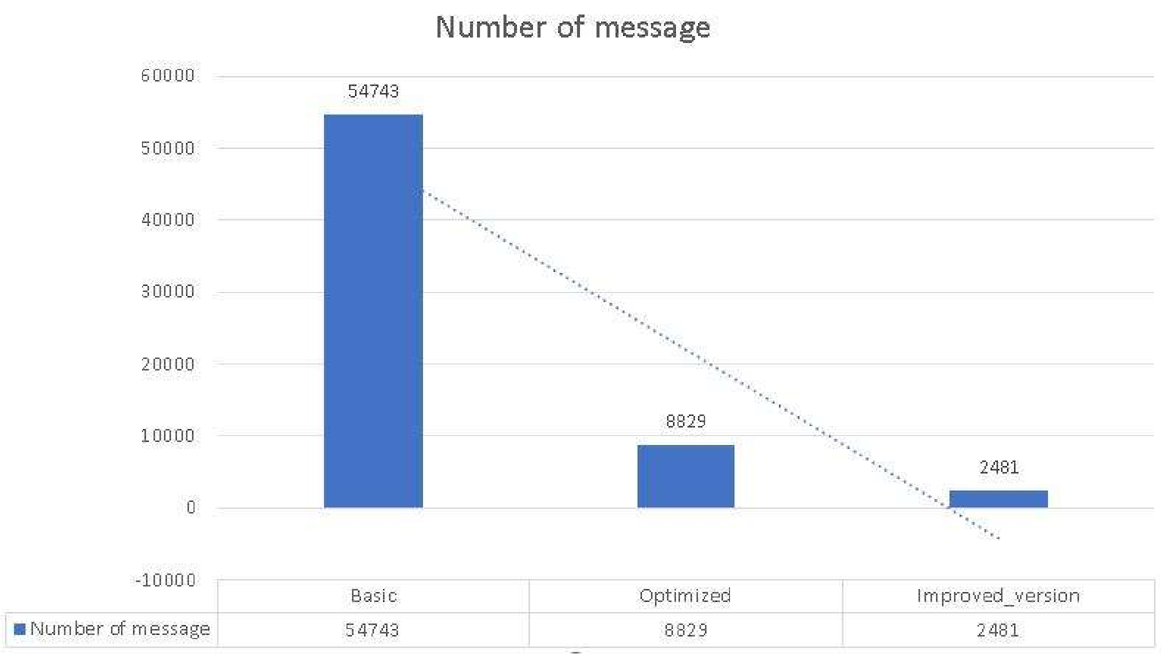

Figure 8 : algorithm comparison

i. **Conclusion on experiment :**

These methods efficiently reduce the amount of messages sent by either limiting communication to representative nodes within clusters, sending updates only when certain criteria are met, synchronizing communication based on predictive models, aggregating information to provide a summary, or scheduling message exchanges during specific time slots. Researchers have successfully used these techniques to lessen the overall message load on the network while ensuring that essential leadership information is quickly communicated.

It's crucial to remember that there is still room for improvement in terms of lowering message overhead. Work that is currently being done and that will be done in the future may concentrate on optimizing algorithms, dynamically modifying thresholds, creating adaptive communication plans, including fault-tolerant mechanisms, utilizing machine learning, and creating thorough assessment frameworks. The quantity of messages sent during leader selection in VANETs can be further decreased by continued improvement and innovation in these areas, resulting in increased scalability, improved network performance, and more effective resource usage.

6. CONCLUSION:

In conclusion, the research on choosing leaders in vehicular ad-hoc networks (VANETs) and the investigation of proactive strategies have brought to light the significance of creating a reliable and effective leadership structure in dynamic network environments. The goal of the proactive strategy is to shorten response times and ensure prompt coordination throughout the network by anticipating the need for leaders in advance.

By limiting communication to representative nodes inside each cluster, cluster-based techniques can minimize the volume of communications. Threshold-based updates reduce pointless message exchanges by allowing nodes to provide updates only in certain circumstances. By predicting future network conditions and leader stability, predictive algorithms enable synchronization and decrease message overhead.

The reduction in message overhead achieved through these approaches contributes to improved scalability, network performance, and resource utilization. By minimizing communication delays and computational complexity, proactive leader selection approaches can enhance the overall efficiency and effectiveness of VANETs.

The performance of vehicular networks can be significantly improved by minimizing message overhead while choosing leader heads in VANETs, which is the main goal of our technique. We seek to improve network efficiency, scalability, energy conservation, collision avoidance, and latency by decreasing the number of messages sent during the leader head selection procedure.

Our approach solves the issues related to message overhead in VANETs by using intelligent techniques such neighborhood awareness, selective communication, periodic broadcast optimization, message aggregation, intelligent triggering, and hybrid communication modes. These methods help to select the best leader candidate for a particular group of clusters with better resource management, less traffic, longer battery life, quicker decision-making, and more dependable communication.

7. FUTURE WORK:

We are still working forward to improve the the convergence time and the stability of the leader. We can research more methods to increase the stability of leader selection and concentrate on further enhancing the convergence time and stability of choosing a single leader in order to reduce the time needed to choose a leader while maintaining stability and dependability in the selection process.

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