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Hybrid Approach for Routing in Vehicular Ad-hoc Network (VANET) Using Clustering Approach

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ABSTRACT: Interest in vehicular ad hoc networks (VANETs) has grown over the last few years, particularly in the context of emerging intelligent transportation systems (ITS). Vehicular ad hoc networks (VANETs) are highly mobile wireless networks that are designed to support vehicular safety, traffic monitoring, and other commercial applications. However, efficient routing in VANETs remains challenging for many reasons, e.g., the varying vehicle density over time, the size of VANETs (hundreds or thousands of vehicles), and wireless channel fading due to high motion and natural obstructions in urban environments (e.g., buildings, trees, and other vehicles). Within VANETs, vehicle mobility will cause the communication links between vehicles to frequently be broken. Routing becomes an important issue in VANET. If the network has very less vehicle then it becomes more challenging to send a packet from source to destination. In such scenarios efficient routing plays an important role. With efficient routing technique we can provide communication in network even if the density of vehicles in the network is low. We provide a routing algorithm which works on a hybrid scenario, i.e. it will have both static and dynamic infrastructure. The approach used is Cluster based routing which will help in transmitting packets even in a network with low vehicle density.

Keywords: Routing, VANET, Cluster Based Routing, Multipath flooding.

I. INTRODUCTION

The automotive industry is currently undergoing a phase of revolution. Today, a vehicle is not just a thermomechanical machine with few electronic devices; rather, recent advancement in wireless communication technologies has brought a major transition of vehicles from a simple moving engine to an intelligent system carrier. A wide spectrum of novel safety and entertainment services are being driven by a new class of communications that are broadly classified as vehicle-to-vehicle communication and vehicle-to-infrastructure communication.

Currently, intelligent transportation system components provide a wide range of services such as freeway management, crash prevention and safety, driver assistance, and infotainment of drivers and/or passengers [1]. Recent trends swing toward advertisement, marketing, and business of services and products on wheels. Consequently, these applications appear to be very lucrative and promising in terms of commerce and research. The significant use of vehicular communications in safety and infotainment applications has resulted in the development of a new class of media access control and network layer protocols.

The current domain of vehicular research includes routing, congestion control, collision avoidance, safety message broadcast, vehicular sensing, security, etc. Different terrains pose separate challenges to vehicular routing. The issues in a city network would not be exactly the same as in a highway or in a delay torrent network. The outskirts may have sparse vehicular density, whereas downtown has to deal with vehicular congestion. The evening may have the highest vehicular traffic, and midnight may be seen as the most silent period of the day. It is a most difficult job to predict the exact traffic density of a region. The structure of the road (i.e., straight or curved), number of intersections, number of lanes, length of the road (i.e., based on road ID), availability of public transport, and driver behaviour have a great impact on the node density and network connectivity of a vehicular network.

We worked on a network in which density of vehicle is very low i.e. the number of cars in the network is very less. A cluster based approach is used to solve the problem of communication. There is a hybrid network i.e. it has both kind of nodes static as well as dynamic. We propose a method to solve the issue of low communication in scarce network.

II. RELATED WORK

A lot of work has been done in the field of Vehicular Ad-hoc Network. Routing has been one of the main issues in VANET because of dynamic nature of the network. So many authors have worked on routing issue in VANET.

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Jamal Toutouh, José García-Nieto, and Enrique Alba have proposed in [5] that optimal parameter tuning of the OLSR routing protocol can be used in VANETs by using an automatic optimization tool. For this task, they defined an optimization strategy based on coupling optimization algorithms (PSO, DE, GA, and SA) and the $ns - 2$ network simulator. In addition, they have compared the optimized OLSR configurations with the standard one in RFC 3626 as well as with human expert configurations found in the current state of the art.

In [6] Mohammad Al-Rabayah and Robert Malaney combined the features of reactive routing with location-based geographic routing in a manner that efficiently uses all location information available. The protocol is designed to gracefully exit to reactive routing as the location information degrades. A significant reduction in the routing overhead was achieved in HLAR compared to standard reactive and geographic routing protocols. It effectively obtains optimal scalability performance.

Hanan Saleet, Rami Langar, Kshirasagar Naik, Raouf Boutaba, Amiya Nayak and Nishith Goel worked on Intersection-Based Geographical Routing Protocol for VANETs in order to improve Quality of service [7]. IGRP is based on an effective selection of road intersections through which a packet must pass to reach the gateway to the Internet. The selection is made in a way that guarantees, with high probability, network connectivity among the road intersections while satisfying quality-of-service (QoS). Geographical forwarding is used to transfer packets between any two intersections on the path, reducing the path's sensitivity to individual node movements.

In Back-Bone-Assisted Hop Greedy Routing for VANET's City Environments, Pratap Kumar Sahu, Eric Hsiao - Kuang Wu, Jagruti Sahoo, and Mario Gerla [9], choose hop count as the metric to find the routing paths. The hop greedy routing protocol exploits the transmission. It is ensured that the selected intersections have enough connectivity. BAHG adopt an indirect method to compute the connectivity parameter for each intersection. It introduces a back-bone mechanism in which some specialized nodes perform functions such as tracking the movement of end nodes.

In [10] D.Rajini Girinath , S.Selvan worked on Cluster based approach for VANET. Clustering was used for routing in the city scenario. Multipath flooding algorithm was proposed for Cluster formation. They tried to group vehicles with low mobility with respect to each other into the same cluster.

III. **PROPOSED WORK**

All The research on real-time communication in Vehicular Ad Hoc Networks enables distributed applications among vehicular nodes in infrastructure-less areas. Cluster based Routing in VANET is particularly useful for applications that require better routing and scalability to hundreds or thousands of vehicles. Location based clustering techniques can aid in improving the routing performance under different mobility scenarios. Vehicular Ad Hoc Network (VANET) is characterized by vehicles with relatively high mobility and has become a promising field of research paving way to safety of Traffic Management. VANET enables communication between the Vehicles (V2V communications) and the road-side infrastructure (V2I communications).

Static and dynamic cluster heads are responsible for coordination among the nodes within their clusters, and between the clusters. Periodic re-clustering can select nodes with longer travel time and more number of stops like buses act as cluster heads. Network lifetime is prolonged through (i) choosing the optimal path with minimal interference of nodes, (ii) periodic updation in clusterhead regarding the routing and cluster information, and (iii) routing through the nodes with average speed of nodes. A stand-alone cluster based approach that considers a hybrid and dynamic mobility model. Based on this approach, we present a Location based Multipath Flooding algorithm, which have three primary goals: (i) reducing delay, (ii) prolonging network lifetime and (iii) maximal data delivery ratio at high mobility. Stability in this context implies the need for load balancing and efficient resource utilization. Routing protocols can also employ clustering [2], [3].

In [4], clustering was proposed as a useful tool for locating the destinations. In a complete distributed system like VANET, every node can act as a source or a relay node, which motivates the need for efficient algorithms to select servers according to the outlined system goals. Each vehicle should store the information related to the cluster within the transmission range of source node. In our model, a fixed number of dynamic and static sources are known to every vehicle of the system, and a static source is always available for processing large amount of data.

In our integrated approach the information pertaining to traffic is maintained in both sources, lesser time in dynamic source and longer duration in static sources for future purpose. If the distance between two cluster head nodes is found to be less than the threshold, the cluster with fewer members is dismissed to reduce communication overheads and its members join other clusters [6]. During high mobility conditions the process of reclustering increases the communication cost. Locating the position of nodes, relative speed predictions and effective communication distance between nodes according to mobility are dealt in our approach.

Grouping the vehicles can be differentiated in different mobility models according to their spatial and temporal dependencies. For example, two nodes moving in same direction are having high spatial dependency [9]. Temporal dependency is a measure of the relationship between current and previous velocities. High temporal dependency would be spotted between the nodes having the same velocity. VANET's are characterized by high mobility communication in infrastructure-less environments and dynamic topology situations [8], which lead to frequent network partition. VANET's dependency on external parameters like type of the roads, driver's decision, timing, weekdays, and speed of the vehicle and location of the vehicles make it difficult to monitor and manage the entire network. Mobility aware ripple free clusters are used for maintaining stable vehicular infrastructure and inter cluster routing. Thus network can adaptively adjust its dominant routing mechanism based on its mobility features [13].

A. CLUSTER BASED ROUTING

Cluster based Routing combines the features of static and dynamic clustering together. Static clusters are formed around the static sources located at the road signals, street corners and congested places known as static clusterhead. However buses are chosen as dynamic sources in our algorithm, having the predefined path and time chart to handle the high mobility situations known as dynamic clusterhead. Hierarchical clustering creates a layering environment that poses some of the main challenges in such ad hoc networks. Top layer consists of static clusterhead, middle layer consists of dynamic clusterhead and lower layer consists of ordinary vehicles. Because of highly dynamic vehicles network topology also changes. This in turn affects the performance of the network and also invokes protocol mechanisms to react to such dynamics. Mobility awareness deals with sudden changes in topology by responding against malfunctions in routing. Some of mobility metrics are considered for cluster construction in order to form a stable cluster structure thereby decreasing its influence on cluster topology. Vehicles Mobility behaviour determines the architecture of the cluster. Vehicles are grouped in two different ways either by those vehicles which are in the communication ranges of dynamic sources or by those vehicles which are in the ranges of static sources mounted at traffic signals and road junctions.

Dynamic clustering attempts to partition a number of nodes into multi-hop clusters based on the following parameters (VID,LID,s,VLT) we defined in Algorithm 1. The(VID,LID,s,VLT) criteria indicate that every vehicle node in a cluster has it own unique VID and Location ID representing the road in a particular area of the city it belongs. The symbol 's' indicates the speed of the vehicle and VLT indicates the vehicles life time in a particular cluster.

Dynamic clustering scheme, our parameterized clustering scheme requires no periodic re-clustering. As soon as a vehicle enters into the clustering zone its unique VID is registered into the clusterhead and becomes a member of that cluster. Any unclustered vehicle joins a cluster by sending out CJReq message. Mobility also affects the size of the cluster, low mobility increases the size of the cluster compared to high mobility, leading to increase in the number of clusters. A Vehicle can join a cluster if it has a valid VID and its speed is also an important criterion, if any new vehicle other than ambulance or rescue vehicle enters into the cluster with the speed more than an average speed it is not necessary to update it everywhere. If a vehicle does not receive a response message after a certain period of time, it creates a new cluster and it will become the head for itself, even after that it will send and receive message to become a cluster member or it will continue as a cluster head.

In the algorithm CJM (Cluster Join Messages) for cluster formation is suitable for a network with high mobility, where mobility of vehicles affects the cluster topology. Cluster formation depends only on CJM and not by any other messages thereby overheads are avoided; similar to the idea proposed in [10]. Once the vehicle enters into a cluster region it periodically broadcasts CCM (Cluster Connect Messages) before passing the data, once it receives the response it will start data transmission. In our approach ripple effect of reclustering is reduced by choosing known and defined vehicles like buses as clusterheads and this effect has been reduced in some places by mounting static clusterheads, hence cluster structure and topology has to be maintained smoothly without any force alternations [12]. One advantage of Static clusterhead is gathering accurate neighbour information and cluster structure is promised with specific attributes. Another metric is the duration of each vehicle to become a member of the cluster. By sending a message to all neighbours (n), each vehicle can help each of its neighbours to decide the distance between them. Then each neighbour should send reply information(r), including the VID, CID, distance, speed and direction. Hence, each vehicle needs to send out (n+r) messages for cluster construction. During cluster construction phase, one should consider how to reduce the amount of clustering-related message exchanged for the cluster formation.

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From time to time each unclustered vehicle seeks a cluster to join after sending CJM messages periodically, and creates a singlenode cluster to cover itself when there is no proper cluster to join. A too-small cluster, however, may produce large number of clusters and thus increase the length of hierarchical routes, resulting in longer end-to-end delay. To avoid this, two clusters are integrated based on clusterhead speed and by choosing slow speed clusterhead as new head. In our non-overlapping multihop structure, data transmission is more flexible and do not have a hop limit between two neighbouring clusterheads.

B. ALGORITHMS

1. LOCATION BASED MULTIPATH FLOODING:

```
    At source
 a) flood (CJReq) all Immediate Neighbours(NVID)
 b) VC = # (NV)
        for each relay node
        {
                for each CJReq received
                {
                    if new NVID =old NVID
                    drop(RREQ) to avoid repeation
                    if (current node(CVID = DVID)
                    then DVID is set to nodes id
                  else
                 {
                 i)CJReq to IMVID add(CVID)
                 ii)Find  VC1 = # (NV)
                     }
At Destination
         For each CJReq received, send (CJRep) to source
        If (speed>thresholdspeed)
                update only VID in Clusterhead
        else
                sort(CJRep IMVID)
                update details of vehicle to all nodes
At source {
                till(timestamp< threshold time)
                {
                        link = SORT(CJRep IMVID)
                        for each link
                        { find SP= MIN(CJRep VC)
                        send (data) to DV through SP
                }
SORT(CJRep IMVID)
```

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```
for each IMVID in CJRRep
{
        calculate VD
        SORT( IMVID) in ascending order of VD
        calculate SP  # elements whose VD
        store all VID in an array in each cluster
}
```

2. CLUSTER HEAD SELECTION ALGORITHM:

```
        For a new vehicle
                if valid CID
receive past information  and  make entry into the list register its CID in existing CH choose the CH
                new vehicle is either source or relay node
                if  source calculate speed
                if CID speed< old CH speed
                        assign(new vechile=CH)
                        start flood(ns,nd,tpath)
                 Upon receiving flood(ns,nd,tpath) from source
                Check if (ni==nd) and
                if ( tpath length > best path )
                {       set newpath =tpath
                        send newroute(nd,ns,newpath) }
                        end if
        if no RouteReq then
           {    wait until threshold time
                endif
                if any RouteRep received
                find # of (interference nodes)
                    choose minpath(interference nodes)
          }
                end if
                end if
                endif

        else
                flood (RouteReq)
                until new route
                {
                hold existing route information upto threshold time t
```

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```
            receiving flood(ns, nd, tpath) from neighbour node
    if (ni= source)
    {
            store the path information
            forward(data)
    }
    else
    {        forward newroute(nd, ns, path)}
    end if
    end if
```

C) ENVIRONMENT GENERATION

For environment generation we have used OMNET++ simulator. The environment was generated for different scenarios with each scenario having different number of static and dynamic nodes. The area considered is of 4 km by 4 km. The speed and the direction of the vehicles are kept random.

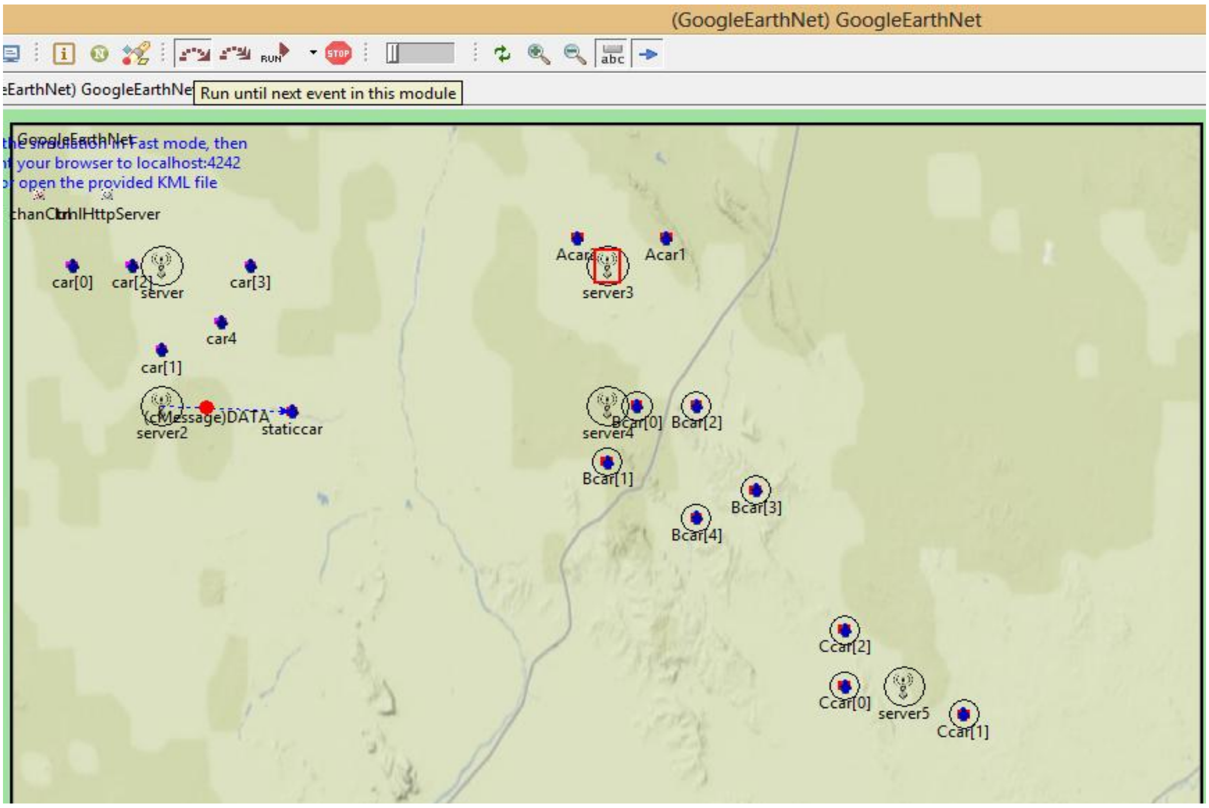

Figure 1 : A scenario with 5 Road side Units and 16 cars

IV. EXPERIMENTS AND RESULTS

A) 100 messages were sent in each and every scenario so as to calculate number of successful messages reaching the destination.

The result of the test is shown below:

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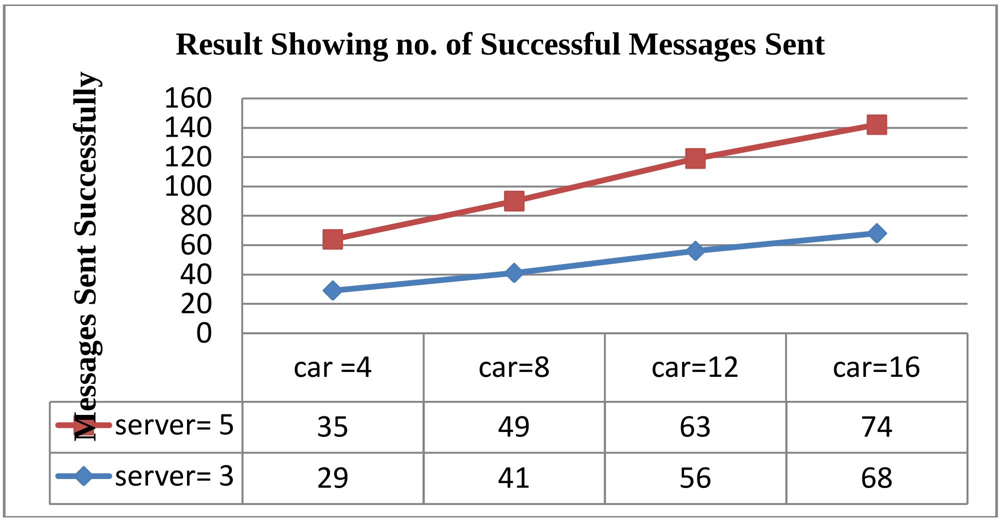

a. For 3 server and 4 cars no. of successful messages sent was 29 out of 100
b. For 3 server and 8 cars no. of successful messages sent was 41 out of 100
c. For 3 server and 12 cars no. of successful messages sent was 56 out of 100
d. For 3 server and 16 cars no. of successful messages sent was 68 out of 100
e. For 5 server and 4 cars no. of successful messages sent was 35 out of 100
f. For 5 server and 8 cars no. of successful messages sent was 49 out of 100
g. For 5 server and 12 cars no. of successful messages sent was 63 out of 100
h. For 5 server and 16 cars no. of successful messages sent was 74 out of 100

B) The time was checked for 100 successful messages in each and every scenario. Using this data the time analysis was done.

The result of the test is shown below:

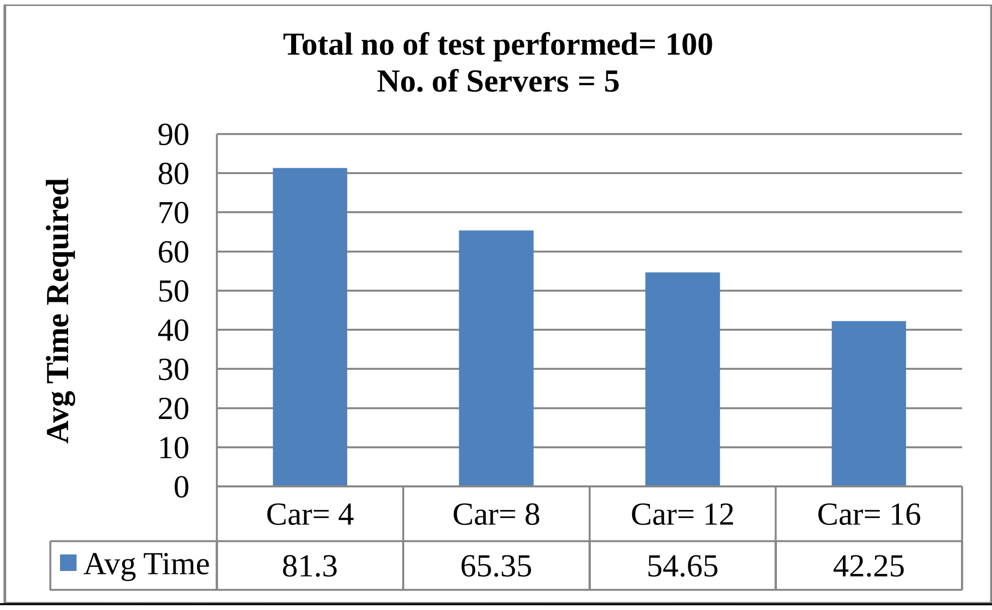

Figure 2: Average Time Required for Delivering Successful Message

a. For 4 cars the average amount of time required to deliver a successful message is 81.3ms
b. For 8 cars the average amount of time required to deliver a successful message is 65.35ms

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c. For 12 cars the average amount of time required to deliver a successful message is 54.65ms
d. For 16 cars the average amount of time required to deliver a successful message is 42.25 ms

C) The time required for first 20 successful message delivery is shown below:

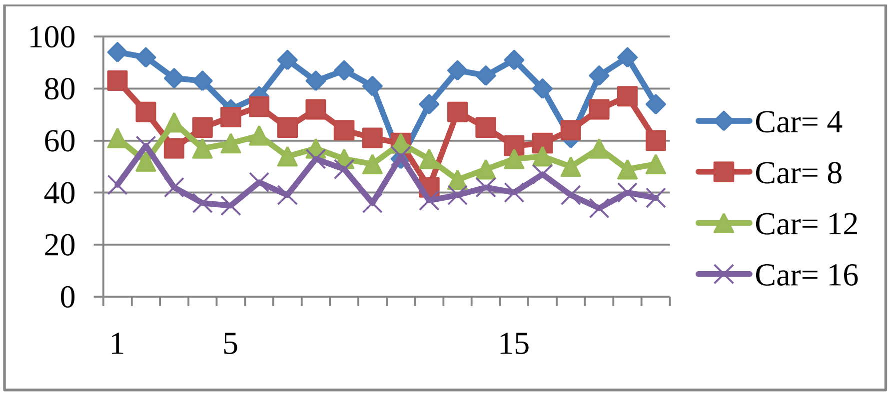

Figure 3: Time Required for Successful Message Delivery

V. CONCLUSION AND FUTURE SCOPE

The Clustering based system was used for routing in VANET. The technique has worked efficiently on scarce network in VANET. Different scenarios were generated using OMNET++ simulator and messages were send for testing and analysis purpose. The analysis showed that with increase in number of cars and Road Side Units probability of message reaching the destination increases. Also the average time required for successful message transmission reduces with increase in number of cars.

In future different technique for selection of cluster head can be used. There are many ways in which clusterheads can be selected. Different criteria can be used for head selection. The analysis of these techniques can be done. Also the network can be expanded with respect to area, number of cars, and number of Road Side Units. The testing and analysis for the same can be done.

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BIOGRAPHY

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