ISSN: 2319-5967
ISO 9001:2008 Certified
International Journal of Engineering Science and Innovative Technology (IJESIT)
Volume 2, Issue 1, January 2013

GHOST - Geo Cache Hybrid On-Demand Scheme For Tracking VANET

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Abstract— ***several medium access control protocols have been proposed in the recent past for the vehicles for accessing radio channels and for distributing timely active safety messages for inter-vehicle communication in Vehicular Ad-hoc Networks (VANETs). As contention period is high in Medium Access Control (MAC) for channel access, MAC in unable to distribute timely safety messages. To reduce the contention period, Region based Clustering Mechanism (RCM) is applied in MAC protocols. In this RCM, data is forwarded to vehicles using a multi-hop networks. This resolves the competition among vehicles to get radio channels for inter-vehicle communication. This also involves the effective, efficient and traceable communication during high mobility of vehicles. The design of hybrid mobility model for traffic regulation reduces the re-clustering process and creates more stable clusters than the other existing models. It caters to the better performance in cluster construction, data transmission and vehicular traffic regulation. This scheme groups vehicle nodes with low relative mobility into the same cluster. In this way, more regions are formed with mobile node communication. When a mobile node (vehicle) moves from one region to another region, radio channel of current region with low latency is accessed. Ad Hoc On- Demand Distance Vector (AODV) routing protocol is used for providing shortest path between source and destination so as to make the communication occur with high throughput. Geo cache is implemented in VANET in order to solve the tower problem. When a node has no tower, the information about that node would be accessed from the previous region. In this former region, the node information is sent to the sink nodes and would be multicast to all nodes of that region. When a sink node fails, the node information would be taken from the other nodes.***

Index Terms— **Ad Hoc On-Demand Distance Vector (AODV), Medium Access Control (MAC), Safety-Critical Application (SCA), Region based Clustering Mechanism (RCM), Vehicular Ad-hoc Network (VANET).**

I. INTRODUCTION

Vehicular Ad Hoc Network (VANET) consists of wireless routers or wireless nodes. Normally, the transmission range of VANET is 100 to 300 meters range. Inter-vehicle communication takes place with ad-hoc networks. Information such as speed and position of each vehicle is known by other vehicles. VANET is an important mode of inter-vehicle communication for Intelligent Transportation Systems (ITS) [1], [2]. In such a network, each vehicle is equipped with a wireless communication and an on-board GPS device. Data forwarding is then performed collaboratively among vehicles in a multi-hop relaying manner. One of the most important applications for VANET is the distribution of active safety messages to improve driver safety, namely Safety-Critical Application (SCA) that requires timely and reliable message dissemination. Information about SCA is exchanged so as to notify the drivers about the car accident and to perform control actions in coordinated systems [3]. Other applications are also permitted for shortening the deployment cost of VANET and for speeding up its adoption period. Medium Access Control (MAC) protocols of VANET resolve contentions among vehicles for channel access. The dominant standard for vehicular networks is IEEE 802.11p based Dedicated Short Range Communications (DSRC) [4], [5]. Its random access mechanism is based on IEEE 802.11 Distributed Coordination Function (DCF) relying on the Carrier Sense Multiple Access/Collision Avoidance (CSMA/CA) mechanism. Other important MAC protocols include ADHOC, MAC [6], [7] that are designed for an European project. These protocols depend upon a Time Division Multiple Access (TDMA) based protocol called Reliable R-ALOHA (RR-ALOHA) for radio access control; Space Division Multiple Access (SDMA) [8], [9] wherein the geographical area is divided into multiple space division units and one radio channel is dedicated to serve the vehicle in a space division unit. Important issues related to MAC for VANET include mobility (i.e., the MAC protocol should support vehicles to leave and join inter-vehicle communications at high speed), delay bounded (i.e., the communication must be delay bounded and real-time), scalability (i.e., VANET should scale itself according to the number of vehicles present), bandwidth efficiency (i.e., the radio resource should be utilized in an efficient and fair manner), cost (i.e., for cost-efficient and reliable communications, VANET should be fully

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ISO 9001:2008 Certified
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decentralized), and fairness (i.e., every vehicle should get a fair chance to get the radio channel). The challenge of successfully deploying VANET services lies in ensuring timely and reliable data delivery for mobile vehicles.[14]

The MAC protocols for radio channel access among vehicles are effective under light traffic load. However, when the number of vehicles in the vicinity is large, the protocols may not be able to ensure the desired service due to lack of radio resource (e.g., more contentions among vehicles for random access based protocols like CSMA/CA, and less chance to be allocated a time slot for TDMA based protocols like RRALOHA) and cause a longer contention period to obtain radio resource. Fig. 1 shows the Vehicular Ad Hoc Network.

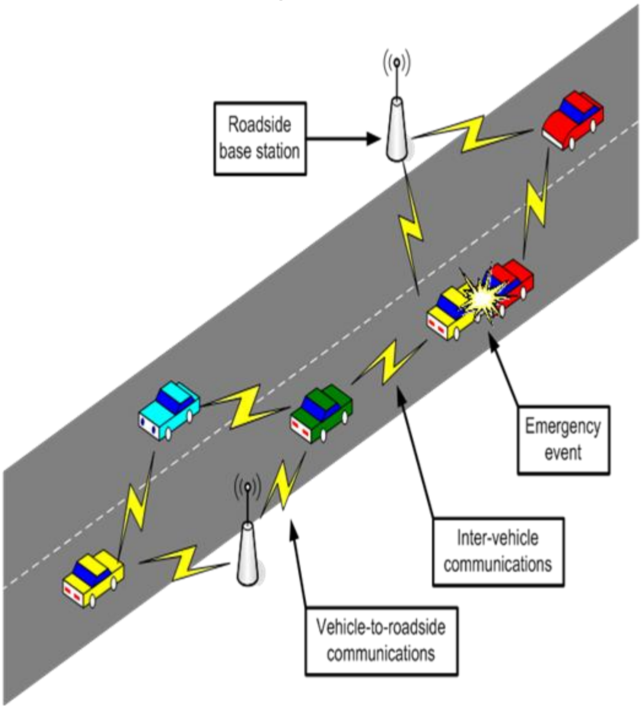

Fig. 1Vehicular Ad-hoc Network

In the literature, several methods (e.g., [10], [11], [12]) have been proposed to reduce the contention period. DUCHA [10] utilizes dual-channel to separate control packets and data packets. Request To Send (RTS) and Clear To Send (CTS) are transmitted on a separate control channel to avoid the collisions with data packets. Fast Collision Resolution (FCR) algorithm [11] redistributes the back off counters to speed up the collision resolution. The FCR algorithm uses a smaller contention window for each station with successful packet transmission and reduces the back off counter exponentially when a station detects a number of consecutive idle slots. MAC-SCC [12] schedules data transmissions to reduce the back off time. The control channel is used to schedule data transmissions by using two different Network Allocation Vectors (NAVs) for the data channel and the control channel, respectively.

Region-based Clustering Mechanism (RCM) is used to improve the performance of MAC operations for VANET [13]. In RCM, the service area is divided into a set of region units and the number of vehicles is limited in each region unit for the contention of radio channels. Each region unit is then associated with a non-overlapping radio channel pool. Since the number of vehicles in each region unit is limited, the contention period is reduced and the throughput is increased. Note that this proposed idea can be applied on top of existing methods (e.g., [10], [11], [12] to improve the contention period performance of MAC protocols for VAENT). RCM is formed with the limited number of vehicles in [13]. In RCM, there is no central controller for channel access. The contention resolution is required to obtain a channel. In the proposed system, Ad- Hoc On-Demand Distance Vector (AODV) protocol is used to maintain shortest path between vehicles.

II. Proposed System

Fig. 2 shows the block diagram of the proposed system. In the proposed system, mobile nodes are self-configured into an integrated network with distributed control. The connection between nodes in the network is in such a way that it has peer-to-peer communication links. NS-2 tool is used for network creation. Wireless channel is used with Omni antenna. The topological dimension and number of nodes are set according to the requirements.

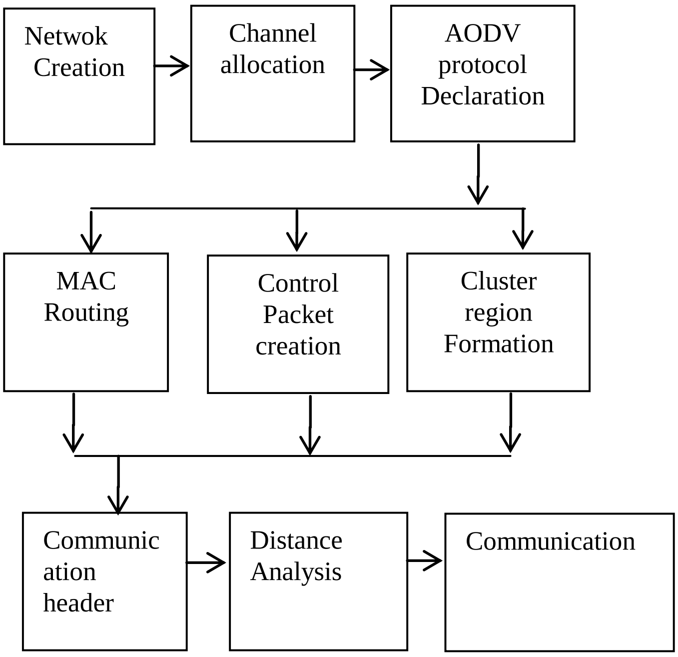

Fig. 2 Block Diagram of the Proposed System

After creating network, channel is allocated for each region without any overlap for avoiding congestion. Different radio channels are allocated to every region. A vehicle in each region has access to separate radio channel from the corresponding region. AODV protocol is used for selecting the shortest path between source and destination. It does not need any central administrative system to control the routing process. Source node and the intermediate nodes store the next-hop information corresponding to each flow for data packet transmission.

The connection link between source and destination is established by Transmission Control Protocol (TCP) or User Datagram Protocol (UDP). After creating mobile nodes, region is formed with limited number of mobile nodes. This would reduce the contention period for channel access. Here, more regions are formed. Through Ad-Hoc, vehicles inter-communicate. When a vehicle moves beyond a particular region, it would automatically switch over to the new radio channel.

Cluster head, which has the knowledge of all vehicles under its jurisdiction, is identified for each region. If a cluster head fails, then the other highest priority mobile node acts as the cluster head. Here, vehicles are moving with different speed. When a mobile node moves out of the region, it may fail to receive the information from previous region but through neighboring mobile nodes, it would get the update of that previous region/unit.

A. Protocol Description

In [13], the R-ALOHA-based protocol is used as an example to show the ways to achieve contention resolution in RCM whereas in proposed system AODV protocol is used for achieving the shortest path among vehicles. Fig. 3 shows the AODV Protocol operation.

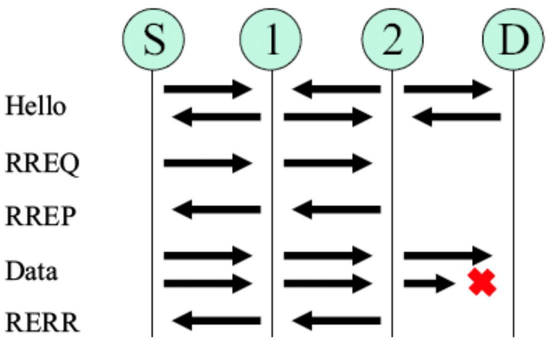

Fig. 3 AODV Protocol operation

ISSN: 2319-5967
ISO 9001:2008 Certified
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AODV routing protocol is designed for use in ad-hoc mobile networks. AODV is a reactive protocol: the routes are created only when it is necessary. It uses traditional routing tables, one entry per destination, and sequence numbers to determine whether routing information is up-to-date and to prevent routing loops.

An important feature of AODV is the maintenance of time-based states in each node: a routing entry not recently used is expired. In case of a route that gets broken, the neighbors can be notified of any unnecessary happening. Route discovery is based on query and reply cycles. The route information is stored in all intermediate nodes along the route in the form of route table entries. The following control packets are used: Routing Request (RREQ) message is broadcasted by a node requiring a route to another node, Routing Reply (RREP) message is unicast back to the source of RREQ and Route Error (RERR) message is sent to notify other nodes of the loss of the link. HELLO messages are used for detecting and monitoring links to neighbors. Routing protocols in mobile networks are subdivided into two basic classes:

- Proactive routing protocols and
- Reactive routing protocols

The proactive routing protocols (e.g. OLSR) are table-driven. They usually use link-state routing algorithms for flooding the link information. Link-state algorithms maintain a full or partial copy of the network topology and costs for all known links. The reactive routing protocols (e.g. AODV) create and maintain routes only on demand. They usually use distance-vector routing algorithms that keep information only about next hops to adjacent neighbors and costs for paths to all known destinations. Thus, link-state routing algorithms are more reliable, less bandwidth-intensive, but also more complex and compute- and memory-intensive. In on-demand routing protocols, a fundamental requirement for connectivity is discovering routes to a node via flooding of request messages. The AODV routing protocol does not need any central administrative system to control the routing process. AODV, a reactive protocol, tends to reduce the control traffic messages overhead at the cost of increased latency in finding new routes. AODV reacts relatively fast to the topological changes in the network and updates only the nodes affected by these changes. The HELLO messages supporting the routes maintenance are range-limited for preventing unnecessary traffic overhead in the network. The AODV routing protocol saves storage place as well as energy. The destination node replies only once to the first request and ignores the rest. The routing table maintains at most one entry per destination. When a node has to choose between two routes, the up-to-date route with a greater destination sequence number is always chosen. If a routing table entry is not used recently, the entry gets expired. When a not- valid route is deleted, the error packets reach all nodes through a failed link on its route to any destination which supports both unicasting and multicasting.

III. Network Simulation

Simulation is done by NS-2 tool. In simulation, 66 nodes are created which would form networks. During simulation, the nodes are in moving condition. Regions are formed with the mobile nodes. When a node leaves one region, then it would automatically go to another region. AODV protocol selects the shortest path between the mobile nodes (vehicles). The packets are transferred from source mobile node to destination mobile node.

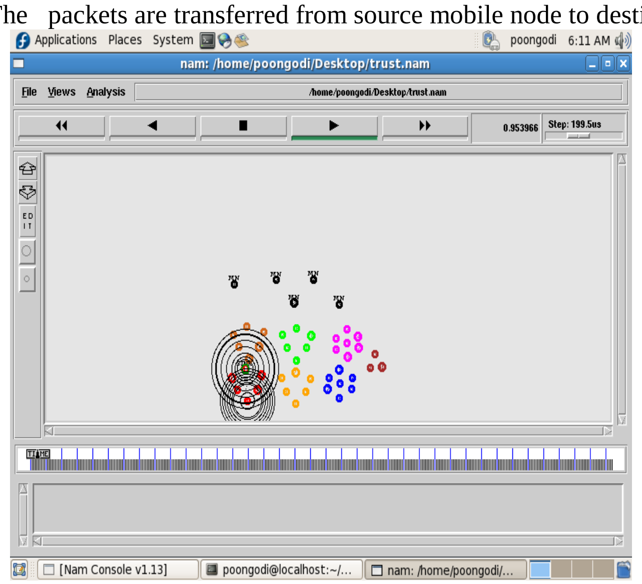

Fig. 4 Region Formation with Mobile Nodes

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ISO 9001:2008 Certified
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Fig. 4 shows the regions that are formed with mobile nodes. Here, sink node is formed for each cluster. Sink maintains the information about all nodes of the region. When mobile nodes enter the region, the node that has been in existence for a long time would act as the sink node. Sink node is otherwise known as cluster header.

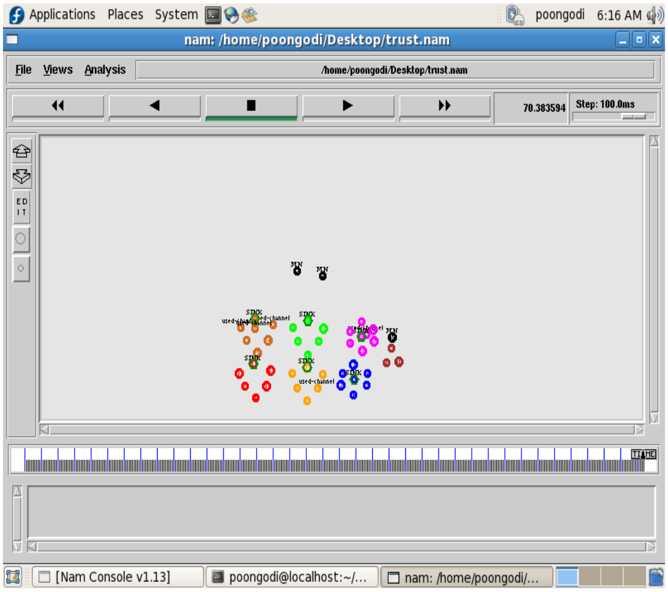

Fig. 5 Formed Sink Nodes

Sink nodes are shown in fig. 5. When a sink node of a region fails, another long-life node of that region would act as the cluster header.

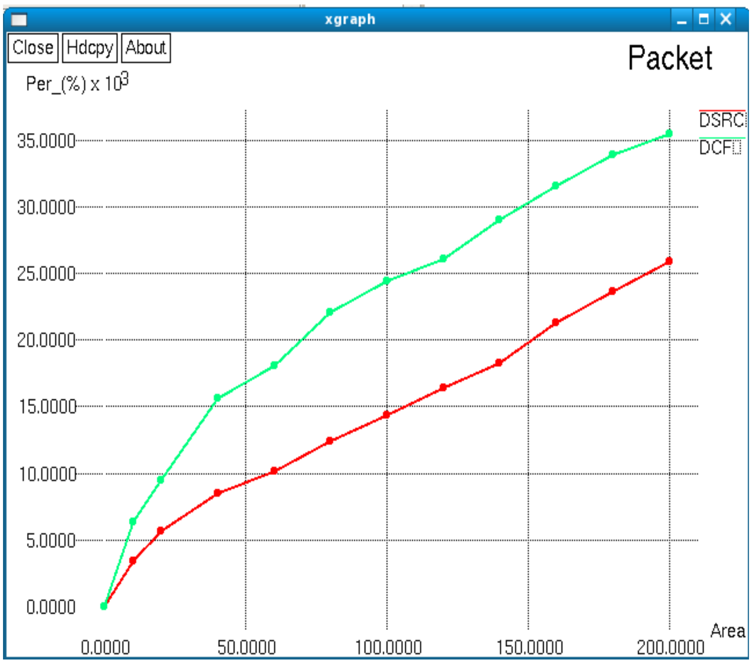

Fig. 6 Packet Transformation

Fig. 6 shows the packet transformation. Distributed Co-ordination Function (DCF) is the basic format of AODV protocol. From the above graph, it is found that DSRC takes more time for bigger areas than the DCF. Time is given on the y-axis.

IV. CONCLUSION

Thus, region based clustering mechanism is applied with MAC protocol to reduce the contention period for channel access. Mobile nodes are created. More regions in which vehicles are limited are included. Each region is allocated with non-overlapping channel for facilitating efficient communication among mobile nodes. Route is established with AODV protocol for facilitating shortest path among the mobile nodes. Sink node that has the information about all nodes of a region is formed for each region. In the next phase of our project, Geo caching, nearest region, distance bounding and long life vehicle sensing would be included. In addition, comparison of previous and proposed method in terms of throughput would also be shown. Distance bounding would be considered for exchange of information such as position, speed and traffic among the mobile nodes. Cluster head would be formed for maintaining the knowledge of other mobile nodes of that region. By including nearest region, traffic information would be shared among the mobile nodes.

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