Performance Evaluation of CBR and AODV Protocols in VANET

Tejal Patil[1], Imdad Rizvi[2]

[1]*Electronics and Telecommunication Engineering, Terna Engineering, College, Navi Mumbai, India*.
[2]*Electronics and Telecommunication Engineering, Terna Engineering, College, Navi Mumbai, India*.

***Abstract*—Inter-vehicular communication is a predominant part of the Intelligent Transportation Systems (ITS). Vehicular Ad-hoc Networks (VANET) is a variant of Mobile Ad Hoc Networks (MANET) and which provide wireless communication among vehicles and vehicle to Road Side Units (RSU). Ad-Hoc, Position-based, broadcast based, Geo-cast based and Cluster based are routing algorithms for VANET. In this paper, we propose mechanism of cluster based routing algorithm which is used to increase the route stability and average throughput by selecting cluster head to broadcast the data packets from source to destination. Simulation results show comparison between Cluster Based Routing (CBR) Protocol and Ad-hoc On Demand Distance Vector (AODV) routing protocol in the metrics of packet delivery ratio and End-to-End delay. Cluster Based Routing (CBR) Protocol have small average end to end delay jitter with higher packet delivery ratio to meets the real-time application needs.**

***Keywords*—Intelligent Transportation Systems (ITS); Vehicular Ad-hoc Networks; Mobile Ad Hoc Networks (MANET); Road Side Units (RSU); Cluster Based Routing Protocol (CBRP); NS2 software.**

I. INTRODUCTION

VANET is based on short range wireless communication between vehicles which is used to improve safety and comforts for vehicles, passengers and drivers. Signals range in VANET is up to 300 meters but in some implementations this range is restricted up to 1000 meters. VANET is a heterogeneous network which provide wireless communication among vehicles and vehicle to Road Side Units (RSU). In VANET Vehicle can communicate with each other by using On-Board Units (OBUs) that are fitted on it, called Vehicle-to-Vehicle (V2V) communication or it can communicate with stationary road infrastructure units called Vehicle-to-Infrastructure (V2I) communication. The Vehicle-to-Vehicle communication is more flexible and less expensive than Vehicle-to-Infrastructure communication, since it does not need expensive equipment. It also avoids high frequent hand-offs which is caused by fast-moving vehicles and road-side stations. The countries where proper roadside infrastructures are unavailable, the V2V communication become more attractive and more appropriate for vehicle-related applications in which neighboring vehicles exchange messages [1]. Cluster Based Routing Protocol (CBRP) received more attention by researchers because in this algorithm, the header of a cluster is selected according to the moving direction of vehicles to forward packets from source to destination.

We gave background for VANET and advantages for Vehicle-to-Vehicle communication over Vehicle-to-Infrastructure communication in Section I. In Section II existing routing protocols for VANET is reviewed. The Cluster based routing algorithm is explained in Section III. Section IV includes the simulation results. Finally, Section V conclude the paper.

II. EXISTING ROUTING PROTOCOLS

Due to high vehicles mobility routing the packets in the vehicular network is one of the challenging tasks. The main objective behind routing protocols in VANET is to create a path to transfer the data packets between source to destination at prescribed time. Several routing protocols performed routing to improve the Packet Delivery Ratio (PDR) and other network performance metrics.

A. Ad-Hoc

Ad-hoc routing protocols is AODV [2]. AODV broadcast route discovery mechanism when source node needs to communicate with another node. The route discovery process in AODV is depends on position, speed, acceleration, direction of the vehicle and the link quality between the communicating vehicles [3].

B. Position Based

To provide efficient routing in vehicular networks the position based routing protocol used destination position to find out route and transfer the data. This position information of destination node is get by using GPS system or by using periodic beacon messages. In this protocol previous route discovery is not required to send the message from source to destination because every node knows its own position and neighbor's position and destination node position [4]. In highway environment this protocol does good Performance because of high mobility of vehicles and less number of obstacles. Routing tables and network topology are not needed, therefore overall overhead is minimum [5].

Greedy Perimeter Stateless Routing (GPSR) is one of the position-based routing protocol, which works with both greedy forwarding mode and perimeter mode. In greedy forwarding node data packet forward to the nearest neighbor of destination node within network range while in perimeter mode data packets forward to destination node which is not in its geographical area [6].

C. Broadcast Based

Broadcast based routing protocol plays a major role in almost all the safety applications. The main advantage of this protocol is that a vehicle does not need to know a destination address and a route to a specific destination. This eliminates the complexity of route discovery, address resolution and topology management, which are difficulties in dynamic networks such as VANET [7].

Protocol send a packet to all nodes in the network, typically using flooding. This ensures the delivery of the packet but bandwidth is wasted and nodes receive duplicates. Broadcasting is used when message needs to be disseminated to the vehicle beyond the transmission range i.e. multi hops are used. BROADCOMM, UMB are examples of broadcast routing protocols [8].

D. Geocast/ Multicast

The main aim of geocast or Multicast routing protocols is to transmit data from a unique source node to a set of destination nodes and satisfying a set of geographic criteria called zone of relevance (ZOR). It defines specific geographic region where the packets are forward to other vehicles to reduce message overhead and network congestion caused by simply flooding packets everywhere. To avoid unnecessary hasty reaction, the vehicles outside the ZOR are not warned by geo-casting routing. In this, packet is delivered via many nodes so the packet transmission is reliable and it minimize overhead by occurrence of broadcast storms. IVG, ROVER, DTSG are some geocast based routing protocols [9].

III. CLUSTER BASED ROUTING (CBR) PROTOCOL

Clustered-Based Routing (CBR) protocol is a hybrid routing protocol that divides the large network into small areas called clusters and main objective of CBR protocol is to increase packet delivery ratio and to reduce end-to-end delay [10]- [11]. In this communication between source and destination is perform through the medium of intermediate node called cluster Head. Member node is an ordinary node which belong to cluster and depends on cluster head for communication. To form a cluster each node, maintain neighbor table, which stored information such as, neighbor's IDs, role of node in a cluster (CH or member node).

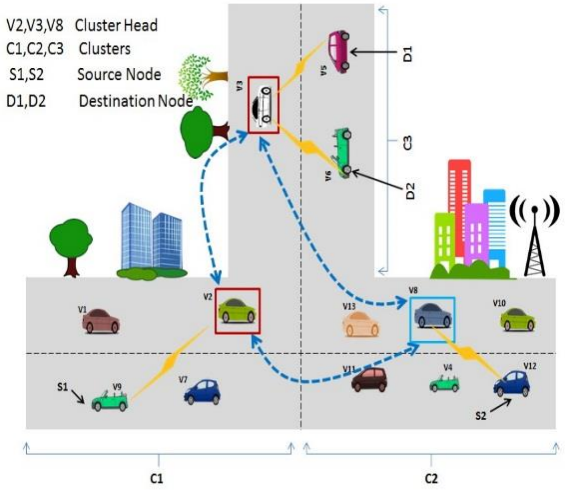

Fig 1. VANET using CBR protocol [12].

Fig 1. Shows a VANET using the CBR protocol. The VANET consists of source vehicles, clusters, cluster heads and destination vehicles [12]. The figure shows three clusters and data transmissions from the source 1 (S1) to the destination 1 (D1) and from the source 2 (S2) to the destination 2 (D2) takes place. The vehicle 2 (V2) is selected as the cluster head when data is transmitted from source1 (s1) to destination1 (d1) because it is the closest vehicle to the grid center. The V2 forwards the data packets to the V3 that is the cluster head of Cluster 3(C3) because D1 is located in the (C3). Similarly, in the second transmission from the S2 to D2 nodes, vehicle (V8) is cluster head, which selects the optimal neighboring cluster head (V3) and forwards the packets to the destination (D2). In this protocol, the cluster head keeps on moving, it needs to be re-selected and the next subsection repeat the cluster head selection procedure.

A. Cluster Header Election and Selection of the Optimal Cluster Header

Cluster head election process is rely on angle between the cluster center and destination node and moving direction of vehicles, so that without any delay packets are transfer from source to destination. To forward the data efficiently the CBR protocol select the optimal neighbor cluster header based on the location of the destination node by measuring the angles enclosed by two rays to the destination and neighboring clusters emanating from the source cluster header [11]. After selecting the Optimal Cluster Header by using the minimum angle criterion, Source cluster header forward the data packets towards it but at the same time it caches the data packet until it has a neighbor cluster header whose priority is higher than header A or the caching time expires.

B. Routing Protocols

In Routing process, packets are forwarded after finding the route from source to destination.CH receives the packets from source and transfer it to destination if its neighbor of it

else broadcast it to the neighboring cluster header. When destination receives the request packet, it replies back with the route that had been recorded in the request packet. While forwarding the reply message, destination find broken link, it sends an error message to the source. Routing process is shown by using Route Discovery between source to destination [13].

C. Route Discovery

Route discovery between source (S) to destination (D) in CBRP is shown in fig.2

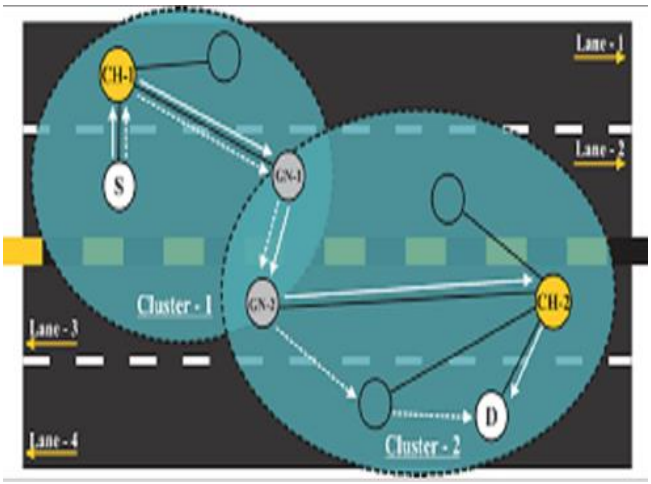

Fig.2 Route Discovery between Source to Destination in CBRP [13].

In this mechanism source node broadcast route request package (RREQ) with unique ID containing destination's address to CH1 of cluster-1. After receiving the request from source node CH-1 check whether destination node is a neighbor or is two-hop away from it. It then transfers (RREQ) to destination else broadcast it to the neighboring cluster head i.e. CH-2. The (RREQ) contains loose source route [S, C1, C2….Ck , D].If the RREQ reaches the destination 'D' ,it contains the path called as loose source route,[S,C1,C2….Ck , D].Destination node sends Route Reply message [RREP] back to source node using the reversal loose source route [D, Ck…C2,C1,S], i.e. RREP is sent back to source along reversed loose source route of cluster heads. Every time a cluster head receives this RREP it computes a strict source route, which contain the nodes that form the shortest path within each cluster. A loose source route is shown by non-dashed white arrows, while strict source route is shown by dashed white arrows.

IV. RESULTS

In this section, we evaluate the proposed routing protocol and compare it with existing routing protocol i.e. AODV via simulation. For this purpose, we implemented the proposed algorithm on the NS-2 [14] simulator. The simulation carried out for 20 vehicles.

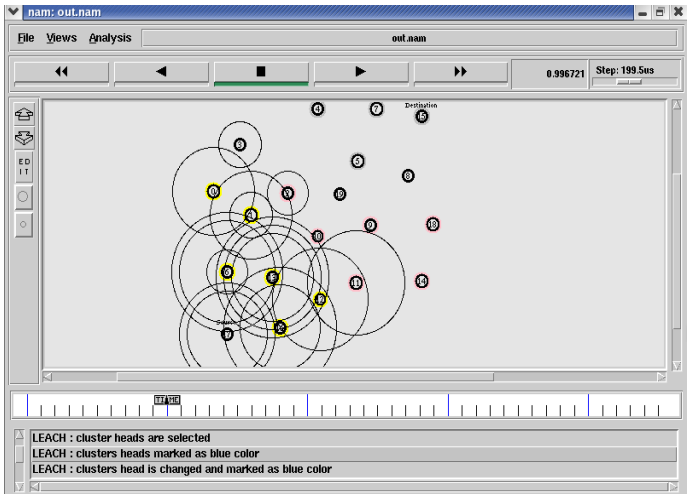

Fig.3 Snapshot of NAM file

Fig.3 shows Snapshot of NAM file in which cluster heads are selected and marked as blue color. The Performance of the CBRP and AODV protocol is evaluated in terms of packet delivery ratio and average end-to-end delay.

A. Packet delivery ratio

The packet delivery ratio is the ratio of packets successfully received to the total sent. Higher PDR implies that the packet loss rate is lower and protocol is more efficient from the perspective of data delivery.

PDR= Total number of packet received at destination/ Total number of packet transmitted by sender.

B. End-to-End delay

End-to-End delay is the amount of time it takes for packets to travel from the sender to the receiver. It can be computed as the ratio between the link length and the propagation speed over the specific medium. The average end to end delay is the ratio of sum of delay experienced by each packet transmitted across the network from source to destination to the total number of packet transmitted.

Average End to End Delay = Sum of delay experienced by each packet/ Total number of packets transmitted.

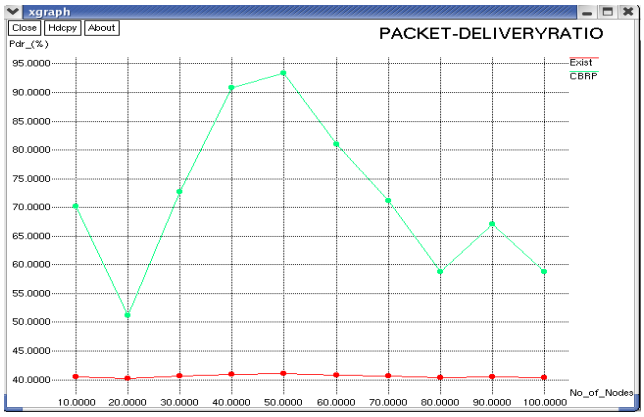

Fig. 4 Packet Delivery Ratio analysis

Fig. 4 shows graph of percentage packet delivery ratio vs number of node. Above figures shows that the packet Delivery ratio more in our new approach than AODV. However, the average throughput of AODV is less as it consumes more bandwidth due to periodic beaconing.

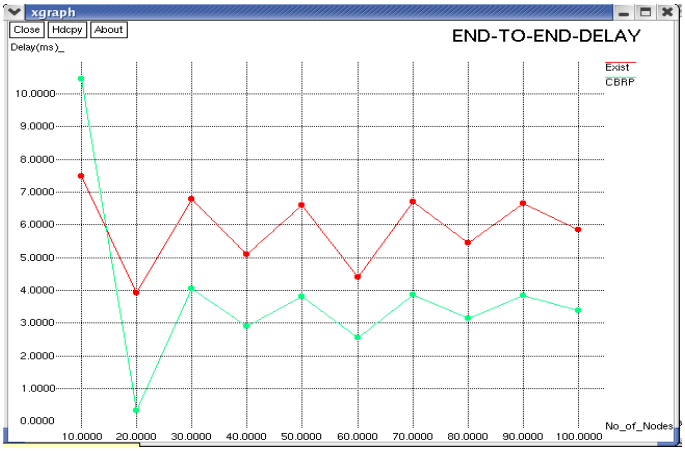

Fig.5 End-to-End delay analysis

Fig.5 shows the graph for end-to-end delay vs. number of nodes. It can also be concluded from this study (Fig. 5) that the average end-to-end delay for CBR protocol lower than existing AODV protocol.

V. CONCLUSION

This paper present different categories of routing protocols in VANET networks and proposed mechanism of cluster based routing protocol and it compared with existing routing protocol i.e. AODV via simulation.CBR have low packet delivery delay with higher packet delivery ratio than AODV protocol to transfer the data packets between source to destination at prescribed time.

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