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Reliable Multicast Routing Protocol For DTN Based Vehicular Ad Hoc Networks

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Abstract:*Vehicular Ad Hoc Networks (VANET) are unique in their characteristics. Most of the VANET applications request one-to-many (group) communications. In this paper we discuss routing in DTN based VANET application. In our study we consider only the non-safety applications in the VANET environment. These applications request multicast routing. However the existing routing approaches which are mainly designed for safety application are not suitable. The basic routing paradigm store-carry-forward approach and DTN custodial responsibility will over overcome the limitations of the VANET application. Therefore we propose a Reliable Multicast Routing Protocol (RMRP) for non-safety applications that increases packet delivery ratio and reduces end-to-end delay. The simulation results are provided to verify the effectiveness of RMRP.*

Keywords*: Vehicular ad hoc networks, multicasting, DTN*

I. Introduction

The VANET has been proposed to implement the transient networks for the benefit of the developing communities. These networks are applied for various applications. VANET has introduced many challenging issues. With the advancement in technology VANET has been used for non-safety applications like business and entertainment applications such as video conferences and file sharing [1][4]. Most of these applications operate in a group based manner and require an efficient network support for good communication. In this category of networks frequent partitions and long delays are common. Due to this well known routing schemes fails to work properly in a frequent disconnections and long delays. In such a network Delay Tolerant Network will enable the non-safety applications to multicast the data with reliability. It enable communication where connectivity issues like sparse and intermittent connectivity, long and variable delay, high latency, high error rates, highly asymmetric data rate, and even no end-to-end connectivity exists [3].

In this paper we propose a multicast routing protocol to ensure end to end delivery of the packets and for increasing the message delivery ratio and lowering down the latency. In the proposed model multicast tree is constructed at each source node and the multicast data is forwarded with custodial responsibility. The multicast tree is constructed by selecting shortest path to the farthest destination and increases the reliable delivery of messages by using the DTN's custodial responsibility. The rest of the paper is organized as follows: Section II introduces the related works in the field of VANET. Section III presents multicast routing problem and formal definition, the method to obtain input values from the context information and multicast scheme. In Section IV the Performance evaluations are given. The conclusion and future research direction are given in Section V.

II. Related Work

The proposed multicast routing is designed for non-safety applications in business and entertainment applications such as video conferences and file sharing. There are several number of multicast routing protocols that has been proposed for VANET. However in CMED protocol [4] minimum delay multicast tree is used in the Contention-based relaying and implicit acknowledgment strategies. The MO-RP [5] focused on the new multi-objective metric, which combines co-channel interference, link duration probability, and End-to-End delay. In The Motion Vector Algorithm (MOVE) [7] for V2R VANET considers sparse network where prior prediction must be made for rare opportunistic routing. In Scalable Knowledge based Vehicular Routing (SKVR) [8] predictable routes and vehicle schedules were made use. The Routing protocol [6] exploits the well-known multicast tree construction algorithms such as Shortest Path Tree (SPT) and Minimum Spanning Tree (MST) to efficiently forward data from a source to destinations. Another algorithm called Prediction Based Routing (PBR) [9], focused on providing Internet connectivity to vehicles. This algorithm assumes that each vehicle has knowledge of its own position. The performance of routing protocol in VANET depends significantly on the mobility models and the density of nodes. Therefore it is essential to design routing protocols specific to the mobility models.

III. Proposed Protocol

We consider a large-scale VANET where a number of vehicles move on roads. Each vehicle is aware of the road map with RSU information and its location and speed information in the network by using onboard navigation system. Every vehicle is aware of the location information of its neighbor vehicles by periodically exchanging beacon signals. Source vehicles are predefined in the network initialization phase, and know the ID and location information of their own destination vehicles. The method to know a destination vehicle's location is supported by location service schemes.

In VANET we consider V is the set of vehicles and every vehicle $v \in V$ is located on the road. sv is the source vehicle such that $sv \in V$ and Dv is the set of destination vehicle such that every $dv \in Dv \subset V$. The location information of every destination vehicle dv is known to sv. R is the set of RSU on the roads. By using the navigation system every vehicle knows that every RSU $r \in R$. McasT is the tree generated by the algorithm, multicast data is forwarded by exploiting the DTN mode and vehicle mobility is also supported. The entire methodology proposed is illustrated in Fig.1.

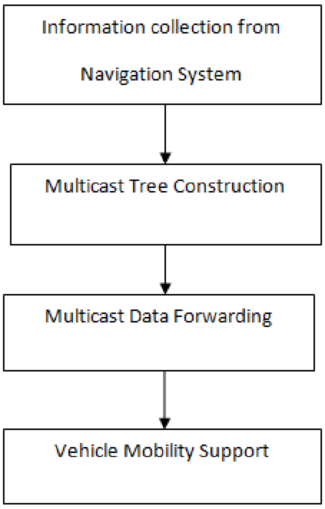

Fig. 1. Overall Block Diagram of the Proposed System

3.1 Multicast Tree Construction

A multicast tree is constructed whenever a source vehicle sv wants to send data to the Dv destination. Initially McasT has only one node that is sv. When there are one or more destinations in Dv, the shortest path to the destination is determined. It first finds farthest destination from sv in Dv and finds the shortest path from sv to Dv. Then the algorithm checks whether the point locates on an RSU of an edge e(n,m) connected between two vertices n and m are source vehicle and destination vehicle. Then the edge is divided in to two edges as (n,r) and (r, m) and remove dv from DV and r will become custody of the multicast data in the relying path. If any destination vehicle is on the edge then remove dv from DV. This procedure is repeated for all dv in DV then the tree is constructed.

Multicast Tree Construction Algorithm

Input: sv, Dv, R

Output: McasT

1. While ($Dv \neq$Null) {
2. Find the Farthest Destination Vehicle (Fdv) from McasT in Dv
3. Find a point on McasT to provide the shortest path between Fdv and McasT
4. If (the point is r of an edge (n, m) in McasT)
5. Add an edge (r, Fdv) in McasT
6. Divide the edge (n, m) into two edges (n, r) and (r, m)
7. Remove the Fdv in set DV
8. Else if (the point is on a vertex v in McasT)
9. Add an edge (v, Fdv) in McasT
10. Remove the Fdv from DV
11. If (there is any other destination vehicle dv on the edge (r, Fdv)/(v, Fdv))
12. Divide the edge (r, Fdv)/(v, Fdv) into edge (r, dv)/(v, dv) and (dv, Fdv)
13. Remove dv from DV
14.} Return McasT

3.2 Multicast Data Forwarding

After generating the multicast tree, it is used to send multicast data to the destination vehicle. Initially it checks whether the sv divide in to branches if so it sends the multicast data to the opposite vertex of the edge in each branch. In other words it sends data to RSU or the vehicle which may be a one of the dv or not a dv in the path which is destined to the DV. One of the geographical routing protocols is used in the VANET to multicast data to the locations [10] in our simulation. When vertex is the dv it receives the data otherwise it forwards to the next vertex. If the vertex is RSU, it will take the custodial responsibility for delivery of the messages. When there is no RSU to take the custodial responsibility in the path sv will be custodian of the message. When RSU holds the responsibility it saves a copy of messages and forward it to enable a reliable delivery of message by switching to the DTN mode when connectivity is lost. Thus reliable delivery of message is achieved.

3.3 Vehicle Mobility Support

The proposed protocol supports the multicast data forwarding to a moving vehicle in a multicast tree. The destination can be any one of the two mobility, they are1.The movement on the line of the tree 2.The movement on the out of the line of the tree. On the line of the multicast tree the mobility of the vehicle may be in the direction of the source vehicle or in the direction of the opposite to that of source vehicle. When the destination vehicle moves it construct the relaying path from the location where it register to the moving location in order to receive the data that is any RSU within the transmission range receives , it multicast the data to the new location of the dv . Thus if any of the dv moves opposite direction of the sv or out of the tree it receives the data from the register location to the moved location by the relaying path with the help of RSU which has the current custodial responsibility.

IV. Performance Evaluations

We simulate the RMRP multicast routing protocol proposed in this paper, and compared its performance with GeoDTN+Nav and GPSR/GPCR by using network simulator ns2. We have used a grid topology in an urban area size 2500m X 2500m where the side length of a single grid is 500m. 250 vehicles are distributed on grid lines and move with an average of 50km/h along the lines. IEEE802.11 DCF used as a MAC with a transmission rate of 2Mbps and a transmission range of 250m.One source vehicle and 10 destination vehicles are selected randomly for multicasting every 10 seconds. From the known information source vehicle constructs a multicast tree and sends the multicast data to the destination vehicle on the multicast tree and forwarded by a geographical routing protocol TO-GO [10] in VANETS.

The simulations are performed 10 times for 100 seconds. The metrics used in our simulation to evaluate the performance are

1. Packet Delivery Ratio, The ratio of packets that are successfully delivered to a destination compared to the number of packets that have been sent.
2. End-to-End Delay, The average time in use by a packet to broadcast from source to target across the set-up is renowned as End to End delay.
3. Reliability is concerned with the ability of a network to carry out a desired operation such as "communication". If the system has higher reliability then the network has more security.

The Fig.2, Fig.3 and Fig.4 show the Packet Delivery Ratio, End-to-End Delay and Reliability respectively. In Fig.1GPSR/GPCR have lowest delivery ratio and GeoDTN+Nav have lower delivery ratio than RMRP. In Fig.2 the proposed RMRP has least delay and in Fig.3 the Reliability in RMRP is comparatively higher than GeoDTN+Nav and GPSR/GPCR.

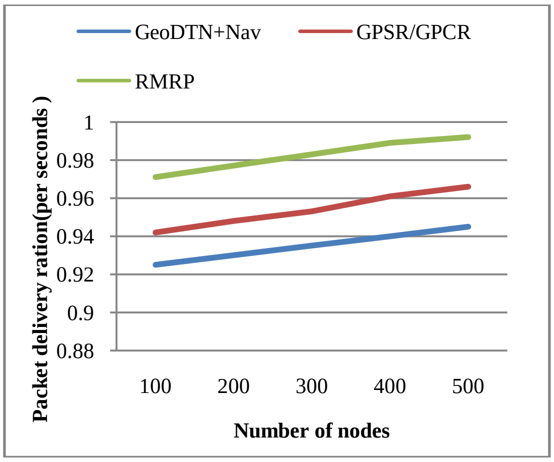

Fig.2 Packet Delivery Ratio

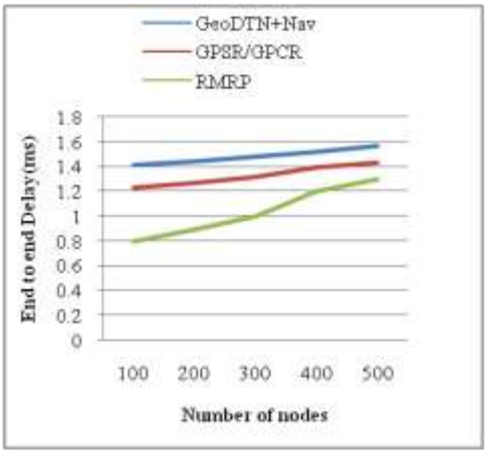

Fig.3: End to End Delay

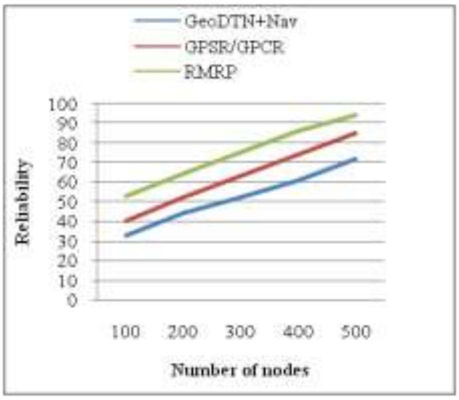

Fig.4. Reliability

V. Conclusion

In this paper we proposed a reliable multicast routing protocol in VANET. McasT is constructed by using a navigation system and reliability is achieved by exploiting RSU. Thus the simulation results shows that the proposed protocol RMRP has better performance than GeoDTN+Nav and GPSR/GPCR in terms Packet Delivery Ratio, End-to-End Delay and Reliability. We have evaluated its efficacy and suitability for the very challenging non-safety application in VANET scenario. Future work will investigate the application of network coding for a broader range of vehicle scenarios

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