Data Dissemination for reliability using network encoding

[1]Arpita Patel ,[2] Asst.Prof Karishma Gandhi

[1,2]*Computer Department, Sliver oak collage of Engineering and Technology , Ahmedabad, Gujrat, India*

ABSTRACT

Vehicles in a highway are connected to form a vehicular adhoc networks. (VANET) A VANET turns every participating vehicle into a wireless router or node. 100 to 300 meter distance is allowed between vehicles to cover a wide network range. Multi-hop data dissemination in vehicular ad hoc networks (VANETs) is very important for the realization of conflict open systems and other many interesting applications. However, designing an efficient data dissemination protocol in VANETs has been a challenging issue due to vehicle movements, limited wireless resources and lossy characteristics of wireless communication. In this paper, we propose a protocol which employs intra-flow and inter-flow network coding to reduce the protocol overhead as compared to traditional protocols. The protocol also can improve the packet reception possibility at the receiver nodes by using the network coding. Therefore, the protocol can provide a lightweight and reliable solution for data dissemination in VANETs. We use theoretical analysis and computer simulations to show the advantage of the proposed protocol over other existing alternatives.

Keywords: *Roadside infrastructure, vehicle-to-vehicle relaying,VANET*

1.INTRODUCTION:

A vehicular ad hoc network (VANET) uses cars as mobile nodes in a MANET to create a mobile network. A VANET turns every separate car into a wireless router or node, allowing cars approximately 100 to 300 metres of each other to connect and, in turn, create a network with a wide range Vehicular ad hoc networks (VANETs) are an envision of the Intelligent Transportation System (ITS). In VANETs, basically vehicles communicate with each other by inter-vehicle communication or vehicle to roadside infrastructure communication. VANET promote vehicle drivers to communicate and to coordinate among themselves in order to avoid any critical situation through Vehicle to Vehicle (V2V) communication e.g. accidents, traffic jams, speed control, free passage of emergency vehicles and unseen obstacles etc [1]. Besides safety applications VANET also provide comfort applications to the road users. For example, information procedure, mobile ecommerce, Internet access and other multimedia applications. The optimal goal of VANETs is to provide safety information in timely information to drivers, passengers and concerned authorities. The specific characteristics of VANETs such as high mobility, variable density, and non-uniform distribution exhibit a challenging task for delivery of the data to the appropriate destination vehicle. There is a high degree of change in the number and distribution of the vehicles in the network at given time instant. So it is quite difficult for reliable data delivery in between source and destination vehicle with reduced delay and control overheads considering mobility as basic constraint.

This paper proposes the scheme for reliable data delivery in VANETs considering the mobility of the vehicles as a major concern. Proposed scheme identifies the forwarding zone and expected zone. The vehicles with maximum speed for carrying the data packet in the forwarding zone, with an expectation of minimizing the delay. Later in the expected zone of the destination vehicle.The data packets are broadcasted until they reach the destination vehicle. Forwarding zone and expected zones are circles, the radius for Forwarding circle is the distance between source and destination vehicle calculated using the Euclidean distance. The radius of the expected zone circle is twice of the forwarding zone circle radius The rest of the paper is organized as follows. Some of the relevant works are reported in section 2. Background of the work is reported in section 2. Section 3 presents the methods. In section 4, the method is evaluated in terms of accuracy & security. Finally, in section 5 conclusions is reported.

II. PROPOSED PROTOCOL

A. Assumptions

Each node knows its position information, velocity information and antenna height. Each node transmits this information by using hello messages. The road width is considered to be negligible as compared with the radio range. All vehicles have the same transceiver and transmit with the same power. The average transmission range is assumed to be known by all vehicles. Each sender node needs to know a packet should be delivered to whether the forward direction or backward direction (using the current node as the reference node).

B. Backbone-based data dissemination

The proposed protocol, selects backbone vehicles to relay data using the same method as Ref. [10]. Backbone nodes use network coding to encode the packets before transmissions (this will be explained in the next Subsection). As shown in Fig. 1, upon reception of a data message, a node forwards the message if the node is a backbone vehicle. The backbone vehicles are updated periodically (with the same interval as hello messages) based on the topology information acquired from the received hello messages. Backbone vehicles are selected in a distributed manner from the neighborhood. The vehicle velocity, vehicle density on the driving direction and antenna height are considered in the backbone node selection by using a fuzzy logic algorithm [11] to combine these constraints. The backbone selection algorithm ensures the generation of a reliably connected vehicle backbone.

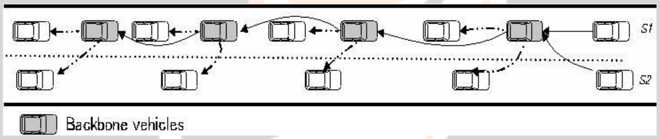

Fig. 1. Data dissemination using backbone vehicles.

C. Inter-flow network coding

The backbone-based forwarding makes the inter-flow network coding possible. Now we explain how to encode two packets coming from two different directions (inter-flow network coding). As show in Fig. 2, upon reception of ai from S1 and bj from B2, node B1 encodes ai and bj, and transmits ai + bj. Upon reception of ai + bj, node S1 and B2 can successfully decode the packet and retrieve the original packets bj and ai respectively. For traditional protocols, node B1 has to send two packets ai and bj. By using the network coding, the proposed protocol can save one transmission for each 4 transmissions.

D. Intra-flow network coding

Since there is no MAC layer acknowledgment for broadcast frames, packet losses at the relay node could happen. Therefore, we have to consider a lightweight retransmission mechanism. Since there are multiple intended receivers for broadcast applications, the aim of the protocol is to disseminate data packets to all these receivers.

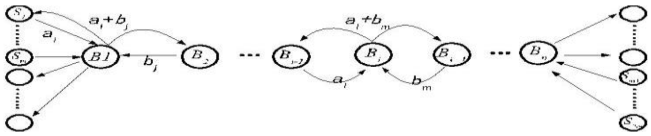

Fig. 2. Inter-flow network coding at backbone vehicles.

However, different nodes could experience different channel conditions. If we use a simple retransmission mechanism, the retransmission overhead could be very large. This is because different nodes could lose different packets and therefore the sender node has to retransmit all these lost packets. In order to handle this problem, we use network coding to reduce the number of transmissions when a packet loss occurs. In the proposed protocol, the sender node processes network coding-based on a batch of two packets (we say these two packets belong to the same generation). The source node uses network coding to encode 2 consecutive native packets (which bound for the same direction) to get 2 encoded packets, and transmits the encoded packets. As shown in Fig. 3, Bi−1 encodes al and al+1 to get two encoded packets, al + al+1 and al +2al+1. When al + al+1 is lost at the next relay node Bi, and al +2al+1 is lost at node M, the proposed protocol only needs to retransmit one packet which is 2al +3al+1. After reception of the packet, Bi and M can retrieve the original packet al and al+1. For the traditional approach (without network coding), two retransmissions (al and al+1) are required. Therefore, the proposed protocol can significantly reduce the number of retransmissions.

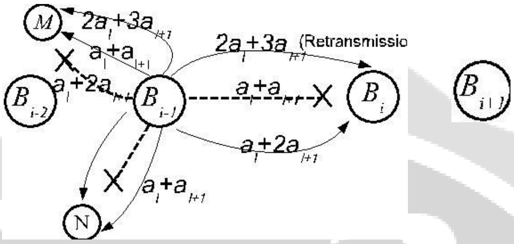

Fig. 3. Inter-network coding at backbone vehicles.

E. Integration of intra-flow and inter-flow network coding:

Dissemination direction-aware network coding In the proposed protocol, data packets are forwarded by the backbone vehicles. We use an approach which conducts different network coding processing depending on dissemination directions of the packets. In the proposed protocol, network coding is conducted based on a batch of two packets. If the two packets come from different directions (which means the dissemination directions are different), the proposed protocol uses the inter-flow network coding approach as described in Subsection II-C. When two packets are required to transmit to the same direction, the proposed protocol encodes these two packets in order to improve the packet dissemination ratio. As shown in Fig. 4, upon reception of al + al+1, al +2al+1, bl + bl+1 and bl +2 bl+1, Bi can retrieve the original packets al, al+1, bl and bl+1. Node Bi first encodes al and bl to get X = al + bl, and encodes al+1 and bl+1 to get Y = al+1 + bl+1. After that node Bi transmits X + Y and X +2Y which can be used to retrieve the original packets, al, al+1, bl and bl+1.

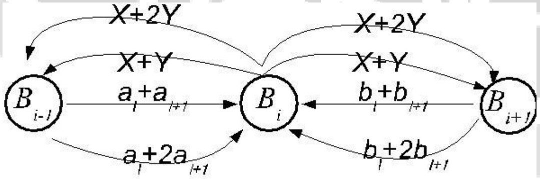

Fig. 4. Integratioin of intra-flow and inter-flow network coding.

F. Data encoding and forwarding algorithm

Each node maintains two different send buffers, the forward direction buffer and the backward direction buffer. The forward direction buffer is used to maintain the packets which are required to disseminate to the forward direction (using the current node as the reference node). The backward direction buffer is used to maintain the packets which are required to disseminate to the backward direction. When there are packets to send, a node does the actions as shown in Algorithm.

III. THEORETICAL ANALYSIS

By using inter-flow network coding, the proposed protocol can significantly reduce the number of transmissions. As shown in Fig. 5, we assume packets {a1 ...az} are broadcasted from the left to right (Bi−1 → Bi+1), and packets {b1 ...bz} are broadcasted from the right to left (Bi+1 → Bi−1). In order to transmit a1 (from Bi−1) toBi+1, the traditional approach (without network coding) requires 4 transmissions. However, by using inter-flow network coding, the proposed protocol can do it in 3 transmissions. Therefore,

Algorithm

Sender Side

```
1).if  Id = Source_node then
        Step 1: Create n generations of k packets in to each mixing  set m
        Step 2: Encode the generation using multi-generationmixing  concept for each mixing  set.
        Step 3: Send the packets
2). if Id = Intermediate_node then
        Step 1: Calculate the rank of received packets foreach generation of particular mixing  set
        Step 2: Do collectively decoding if the rank of received packets is sufficient
                (i.e. generation size*generation ID)
        else
        "decoding not possible" and wait for new to become neighbor
        Step 2: Do re-encoding of the received packets.
        Step 3: Send the encoded packets with their respective effective co-efficient vector to its neighbour nodes.
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Receiver Side

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3). if Id = Destination_node then
      Step 1:Calculate  the rank of received packets for
        each generation of particular mixing  set
        Step 2: Decode it if rank is sufficient
        i.e. rank>=gen_size * gen_ID
        Step 3: Send anti-packets to its neighboring nodes
  End Procedure
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sent packet for a short period of time for future use.when the traffic flows are evenly distributed in the network, we can reduce the number of transmissions by 25%. For the proposed protocol, after exchanging data messages for a while, each backbone node would have one packet to send from right to left (bm), and one packet from left to right (al). In this case, the backbone node only needs to send al + bm. After convergence, every backbone node (excluding the source node) only needs to send the encoded packet. As a result, the proposed protocol can reduce the number of transmissions by near 50%

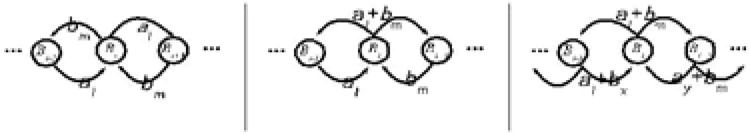

Fig. 5. Data forwarding schemes (left: Traditional, middle: proposed protocol at the beginning, right: proposed protocol after convergence)

IV.SIMMULATION RESULT

The proposed scheme has been simulated in various network scenarios using "C" programming language with a confidence interval of 95%.

A. Performance Metrics

Some of performance metrics evaluated are as follows:

• Delay: It is the time taken to setup the data forwarding path in between the source and destination. It is expressed in terms of milli seconds.

• Packet Delivery Ratio: It is the ratio of the total number of packets received to the total number of packets sent. It is expressed in terms of percentage.

• Route Life Time: It is the existence route time in between the source vehicle and the destination vehicle. It is expressed in terms of seconds.

• Control overhead: It is defined as the total number of control packets utilized for the data delivery process. It is expressed in terms of percentage.

B. Result Analysis

In the figure 3, we can see that the delay is sensitive to mobility. It decreases with increasing mobility, since we have considered the vehicle with maximum speed for carrying data packet in forwarding zone, the data packet will be transmitted immediately thereby minimizing the delay. As the number of vehicles increases the network becomes more congested and it takes longer time for the data packet to reach destination vehicle. Hence the delay increases with increase in number of vehicles.

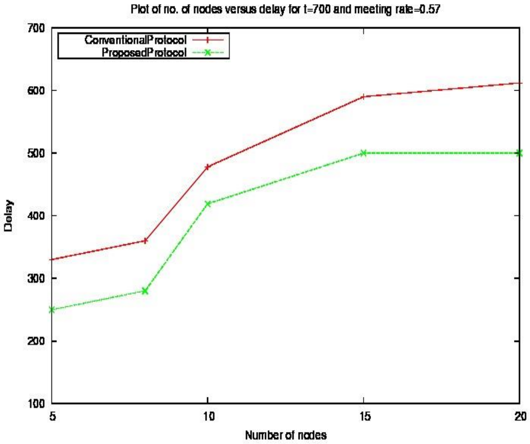

fig 5 Delay vs. no of nodes

In the figure 4, no. of packets increase with increasing time because with increase in mobility, the possibility of vehicle going out of network increases thereby reducing the route lifetime. Hence the packet delivery ratio decreases with the increase in mobility. Also packet delivery ratio decreases with increasing number of vehicles as the number of vehicles increases ,the network becomes more dense resulting in packet loss due to queuing and buffering.

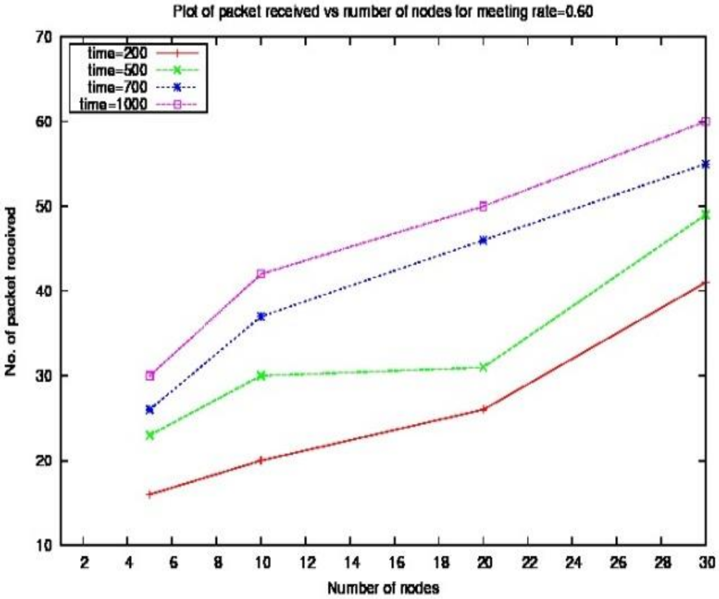

fig 6 Packet received versus number of nodes for meeting rate 0.60

In the figure 5, the route lifetime of the route between source and destination decreases with increase in mobility of vehicles. As the mobility of the vehicles increases, the the encoded packet size is increases as well as packet delivery ratio increases. As the number of vehicles increases the network gets congested and it becomes difficult to maintain the route from source to destination, therefore route lifetime decreases with increase in number of vehicles.

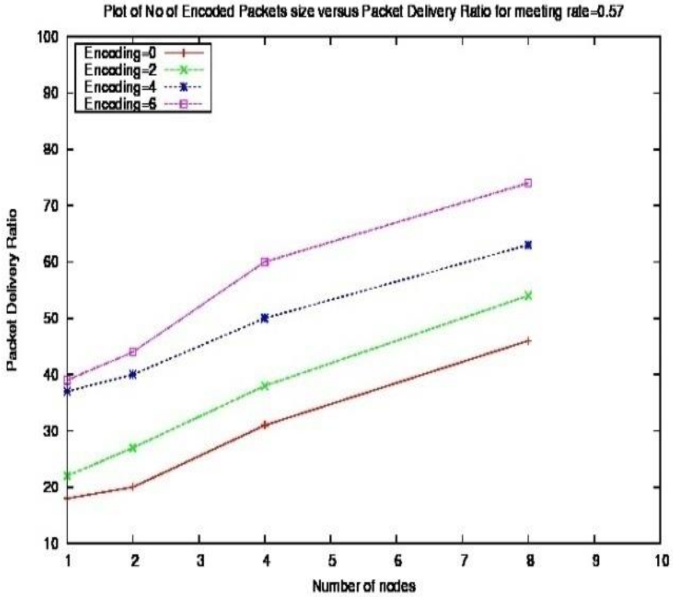

fig 7 Encoded packet size versus packet delivery ratio for meeting rate 0.57

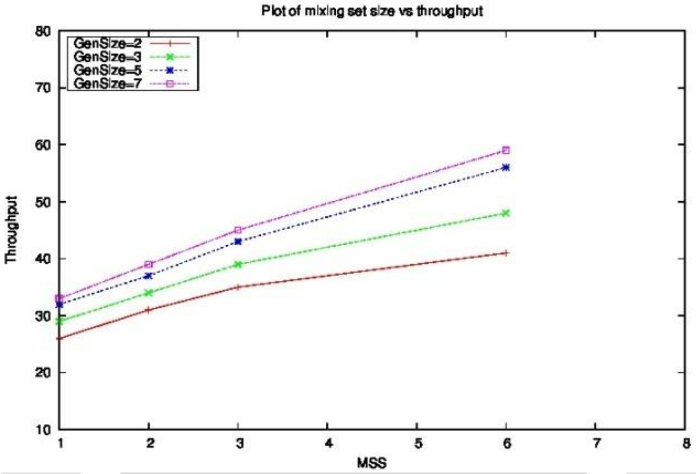

fig 8 mixing set size versus throughput

In fig 8 the maxing set size is increase with increase in throuput, as the set size is increases throughput is increases This is mainly because the proposed protocol can reduce the number of transmissions significantly by using the inter-flow network coding. As shown in Fig.8, the advantage is very significant when the number of source nodes is large. This is because that protocol overhead has a significant effect on the end-to-end delay when the packet rate is high.

CONCLUSION:

A network coding-based broadcast protocol for vehicular ad hoc networks. The protocol employs a joint inter-flow and intra-flow network coding approach. By using the inter-flow network coding, the protocol can significantly reduce the number of transmissions. The intra-flow network coding can improve the packet dissemination ratio. Therefore, the proposed protocol can provide a lightweight and reliable solution for data dissemination in VANETs. We used theoretical analysis and simulation results to show the advantage of the proposed protocol over existing alternatives.

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