Network Coding Based Reliable Anycast Routing Protocol for VANET

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Abstract – A vehicular Adhoc network or VANET is a technology that uses moving cars as nodes in a network to create a mobile network and communication typically over the DSRC at 5.9 GHZ frequency. MANET routing protocol fail in scenario in which no contemporaneous path exists between source and destination because they try to find end-to-end path before data transmission which is not possible in VANET also these increase delivery delay and decrease delivery ratio. So for these VANET uses 'store-carry-forward' paradigm. Network Coding is a tool for optimization in which node is allowed to combine and encode one or more input packet instead of directly forwarding them. In network coding source node or intermediate node allows to combine number of packet it has received or generated into one or several outgoing packets. Reliability is one of the issues. so we use network coding with multi generation mixing in which packet are grouped into generation and generation grouped into mixing set. In our work we have proposed network coding based reliable anycast routing protocol for VANETin which we observed improvement over reliability and also we found optimal mixing set size and generation size as a function of meeting rate, delivery delay and delivery ratio empirically and analytically. By using simulation we compare the performance of proposed protocol with the same protocol using network coding and conventional approach. Simulation result suggest, our protocol achieves less delay, higher delivery ratio and higher throughput compared to network coding based scheme and conventional scheme

Keywords- VANET, Network Coding, MGM, Anycasting, Routing.

I. INTRODUCTION

Vehicular adhoc network (VANET) is part of MANET, this means that every node can move freely within the network coverage and stay connected. VANET is a technology that uses mobile vehicular nodes in a network to create a mobile network. VANET turns each participating vehicle into a mobile node making a network with wide range by allowing vehicles nearby 100 to 300 meters of each other to connect. The main goal of VANET is to provide safety and comfort for traveller's drivers and other road users [1].

VANET will form the biggest adhoc network ever implemented, so therefore issues of stability, reliability and scalability are of concerns. VANET is not an architectural network and not an ad hoc network but a combination of both[2],this unique characteristics combined with high speed nodes complicates the design of the network .In these type of network have no fixed communication structure also due to which routing of data packet through VANET is very crucial. Due to dynamic network topologies, frequent disconnected network,varyingcommunication conditions and hard delay constraints VANETs can be distinguished from other kinds of adhoc networks.

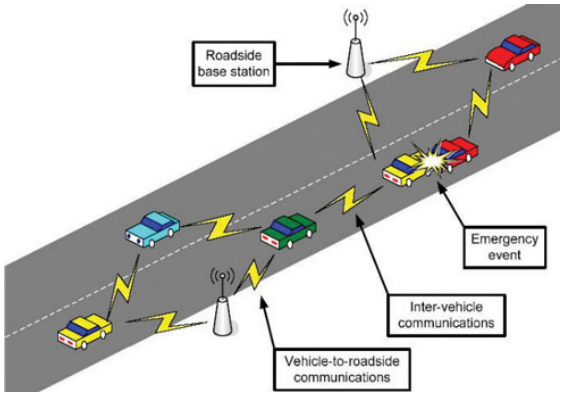

Figure.1 VANET Architecture [12]

There are number of different applications where the network is sparse and experiences frequent and long disconnection. For these we define one example, consider a traffic management system in a city where vehicles are network nodes which generate and forward vehicular traffic data through other vehicles. There may never be contemporaneous path exist between source and destination through other vehicles. Many type of VANET applications need anycast service .for example, vehicle on road may send the packet requiring optimal route to destination, traffic information, weather information, gas station or restaurant location to one of the server on road side, it is necessary to transmit information from server to a vehicle may transmit information packet regarding accident to one of the server like ambulance or emergency service providers. However, traditional anycast methods proposed for the internet or mobile adhoc networks are not suitable for VANET, due to the challenge of frequent network partitions. Data transmissions suffer from large end-to-end delays along the

tree because of the repeated partitions due to the frequent disconnections. Also the traditional approaches may fail to deliver to deliver a message when the possibility of link unavailability becomes high. To increase chance of delivery and to reduce delivery delay, routing approaches, VANET make multiple copies of a packet in the network. However communication overhead and buffer occupancy increases as we increase number of copies per packet without impacting the performance, this overhead can be reduced.

Section II explains overview of network coding, Section III explains network coding with multi generation mixing. Section IV explains Any casting, Section V explains Proposed protocol, Section VI explains experimental setup and Conclusion and future works is given in section VII.

II. NETWORK CODING

Network coding is a recent field in information theory in which, instead of simply forwarding data, nodes may recombine several input packets into one or several output packets. A simple example in a wireless context is a three node topology shown in figure.2 Linear network coding, in general, is similar to this example, with the difference that the xor operation is replaced by a linear combination of data. this allows for a much larger degree of flexibility in the way packet can be combined, network coding is a best suited for environment where only partial or uncertain information is available[3].

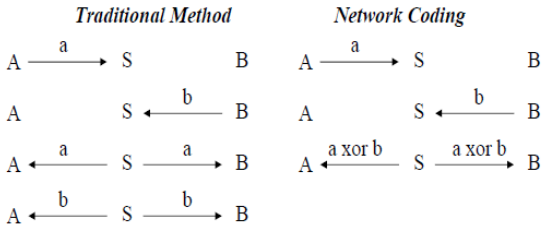

Figure.2 A simple network coding example [3]

Above example shows that Nodes A and B want to exchange packets via an intermediate node S(wireless base station).A[resp.B] will send a packet a[resp.b] to B. which then broadcasts a xor b instead of a and b in sequence. A and B both can recover the packet, while the number of transmission is reduced. Network coding is suited for environment where only undefined or incomplete or uncertain information is available [3].

Network coding need to use algebraic nature of data.These is three well known application of network coding in overlay networks: distributed storage system, content distribution and layered multicast. There are two types of network coding. Deterministic Linear Network Coding (LNC) and Random Linear Network Coding (RLNC).In traditional network, relay node or router simply forward the information packet destined to other node. In LNC, source node or intermediate node or router allows to combine number of packets it has received or generated into one or several outgoing packets, where addition and multiplication are performed over the field Galois field F_2^8[4].

Benefits of Network Coding

- Throughput Gain in Static Environment
- Robustness and Adaptability
- Applications of Network Coding
- P2P File Distribution
- Wireless Networks
- Ad-Hoc Sensor Networks
- Network Tomography
- Network Security

III. NETWORK CODING WITH MULTI GENERATION MIXING(MGM)

Network Coding with Multi-generation mixing (MGM) is a RLNC approach which improves the performance without increasing buffer size. In MGM mixing set of size m generations can be coded together. A new set of generation packet is mixed with previously transmitted generations. In MGM, N packets are grouped into generations where the size of each generation is k packets. Each generation is assigned sequence number from 0 to N/K.In G-by-G Network coding encoding is allowed amongst packet belonging to the one generation. Each mixing set has an index M.Generation i belongs to mixing set with index M=i/m.Each generation in mixing set has a position index. Position index (1) of generation i in a mixing set of size m is i mod m.G-by-G Network coding is a special case of MGM where m=1.In MGM packets of different generations are encoded together. when node send a packet belonging to generation i with position index 1on mixing set, that node encode all packet that are associated with the generation of same mixing set and have the position indices less than or equal to 1 as shown in Figure.3 [5].Size of encoding vector depend on the number of packets encoded together at sender node. Number of packets that are encoded together depends on the position index of the generation with which packet is associated. Packet in generation with position index 1 have the size of encoding vector is (1+1)k. So sender will generate (1+1)k independent packets. In Network coding with MGM goal is to enhance decidable rates in situation where losses prevents efficient propagation of sender packets.MGM allows the cooperatives decoding among the different generation of a mixing set which enhance decidability. Compare to G-by-G

network coding with MGM extra encoded packets associated with generation protects more than one generation. Computational overhead is incurred at intermediate node to check the usefulness of received packets and at receiver node to decode received packet [6].In G-by-G Network coding computation are performed on packets within the generation so it is fixed due to fixed generation size. But in MGM encoding/Decoding is performed on packets belonging to at least one generation in mixing set and so computational overhead is not fixed. In MGM in case generation is unrecoverable due to the reception of insufficient encoding ,it is still possible to recover that generation collectively as a subset of mixing set generations. Packets received with generation of higher position indices have information from generation of lower position indices in the same mixing set. Redundant encoded packets enhance the reliability of communication. With MGM extra packets protects all generations with lower position indices. While in G-by-G network coding extra packets that generation only.

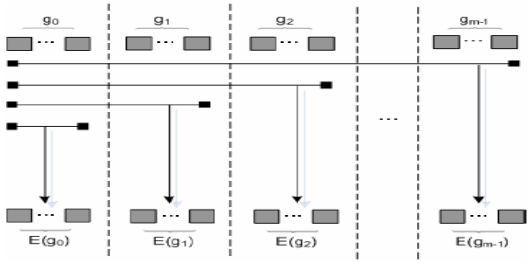

Figure.3 Network Coding with MGM, each generation is encoded with previous generations in mixing set [5]

In MGM there are different options for sending extra packets. One option is distribute the packets over all generations of mixing set. Another option is to send extra encodings with the last generation of mixing set. So, extra encodings protects all mixing set generations.

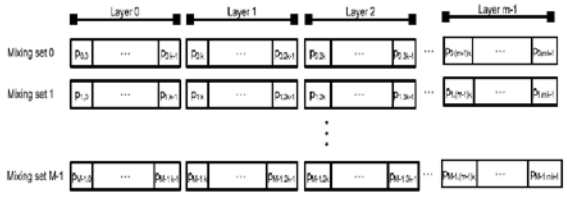

Figure.4 Generation's partitioning with MGM into different layers of priority. Mixing set size is m, generation size is k [7]

IV. ANYCASTING

Anycast is a network addressing and routing methodology in which datagram from a single sender are routed to the topologically nearest node in a group of potential receivers, though it may be sent to several nodes, all identified by the same destination address.[8].

There are four kinds [10] of datacasting schemes: unicast, multicast, broadcast, and anycast. Besides the one-to-one, one-to-many, and one-to-all modes of packet delivery,

Anycast provides one-to-any service. In the anycast mechanism, service providers are assigned a single anycast address within an anycast group. When a client sends packets to an anycast server by an anycast address, routers will attempt to deliver the packets to a server which matches the anycast address. The source node does not need to care about how to pick the closest destination node.

Anycast [9] is a service that allows a node to send a message to at least one, and preferably only one, of the members in a group. The idea behind anycast is that a client wants to send packets to any one of several possible servers offering a particular service or application but does not really care any specific one. Anycast can be used to implement resource discovery mechanisms which are powerful buildings block for many distributed systems, including file sharing etc.

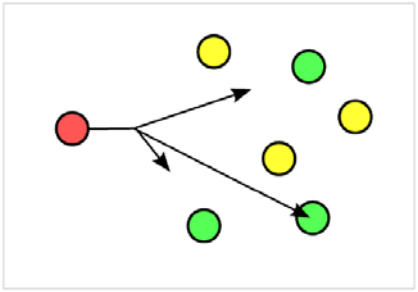

Figure.5 Anycast Network Topology[10]

Anycast in DTNs means that a node wants to send a message to any one of a destination group and intermediate nodes help to deliver the message by leveraging their mobility when no contemporaneous path exists between the sender node and any node of the destination group. A typical scenario, shown in Fig.5, is in a park, people cluster to watch some musical performances and they want to share and search music files at the same time. People in different clusters may be disconnected while people or cars moving between clusters can act as carriers to deliver messages. Anycast can be used to find a person who owns a certain file. Moreover, DTN anycast can be used in a disaster rescue field, in which people may want to find a doctor or a fireman without knowing their IDs or accurate locations. In anycast, the destination can be any one of a group of nodes. Thus during the routing, both the path to a destination group member and the destination of the anycast message can be changed dynamically according to current vehicle movement situation[9].

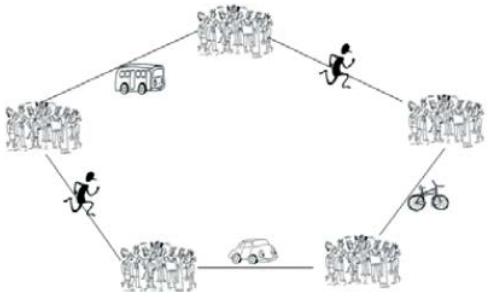

Figure.6. A typical scenario of DTNs. People clusters and cars, buses or other people moving among the clusters can act as carriers to deliver messages[9]

Various methods have been proposed for anycasting communication. These techniques can be classified mainly into two groups:

1.Anycasting in the application-layer

2.Anycasting in the network layer

Application-layer anycasting include research on the model of anycast communications and selection strategy of the target site. Network-layer anycasting is mainly composed of the routing table and routing algorithm in communication [11].

Application of Anycasting

- Domain Name System
- IPv6 transition
- Content delivery networks
- Security

V PROPOSED PROTOCOL

In this section, we describe working of our protocol. Data packets are grouped into generations and generations are grouped into mixing set. Nodes store independent packets along with their coefficients according to RLNC scheme.

Below is the Algorithm of Proposed Protocol

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-generation mixing concept for each mixing set.

Step 3: Send the packets

2). if Id = Intermediate_node then

Step 1: Calculate the rank of received packets for each 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.

Receiver Side

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 neighbouring nodes

End Procedure

VI. EXPERIMENTAL SETUP

We evaluated the performance of our scheme by NS2 simulation. Network Simulator with 2.34 versions is used on fedora 17 operating system for the simulations. In our simulations, the transmission range is set to 250 m. The evaluations are conducted with a total of 100 nodes that are randomly distributed in an area of 500m x 500m. We use cross way modelfor node mobility. In each test, the simulation lasts for 200 seconds while the minimum speed of 5 and maximum speed of 20 m/s were chosen. The size of each Constant Bit Rate (CBR) packet is 512 bye.Table. defined the parameter defined in TCL files.

Also we need to predefine initial positions of all nodes and their movements for the time period we have predefined in TCL file.

Here the main thing is we need to define routing protocol as an WFRP. So that we will run our TCL file with the WFRP protocol to which we have enhanced our proposed solution

and it will give us two files as an output, one is trace (.tr) file and another file is .nam file. Trace file is used to generate comparison graphs and .nam file is used to visualize the traffic scenario that we have generated through this TCL file.

we need to predefine initial positions of all nodes and their movements for the time period we have predefined in TCL file.

Parameter	Value
Number of nodes	100
Channel type	Wireless Channel
Routing protocol	WFRP
Mac type	802.11p
Simulation time	100 sec
Environment size	500x500
Transmission range	250m
Traffic Type	UDP
Packet Size	512 bytes
Simulator	NS-2.34
Mobility model	Cross way
Antenna type	Omni directional

Table 1: Some Parameters defined in TCL file

We compare packet delivery ratio, delivery delay and throughput of conventional scheme, protocol using network coding and our protocol with different meeting rate.

Figures 7,8,9 and 10 shows graphs of Block delivery delay, packet delivery ratio, Reliability, and Throughput.

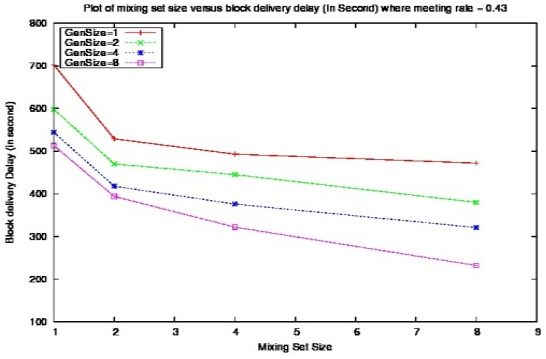

Figure.7 Block Delivery Delay

Above graph shows that as MSS increases block delivery delay will also increases but our protocol with compared to others has lesser delay for the different generation sizes.

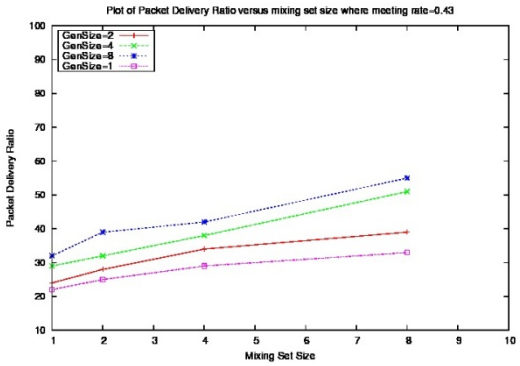

Figure.8 Packet Delivery Ratio

Above graph shows PDR versus MSS for different Generation size. In that as MSS increases PDR correspondingly increases. Whereas Gen size =1 means no network coding i.e conventional approach.

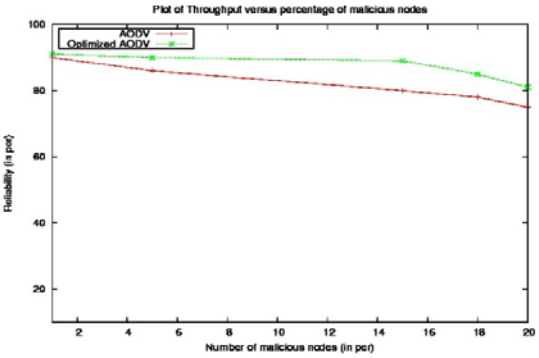

Figure.9 Reliability

As in the graph, it is clear that as no, of malicious node increase Reliability also decrease but with compare to traditional approach to our approach outperform in reduced Reliability. It shows that Conventional Increase Reliability average by 10%.

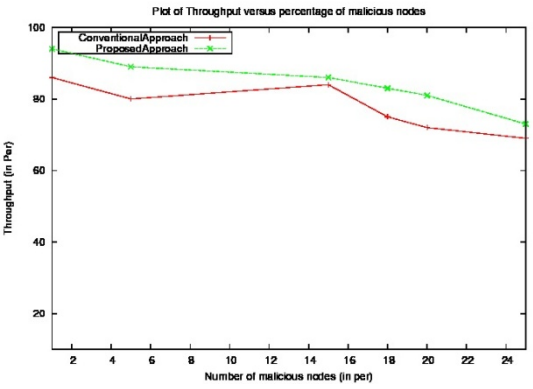

Figure.10 Throughput

As in the graph, it is clear that as number of malicious node increase Throughput also decrease but with compare to

traditional approach to our approach outperform in reduced throughput.It shows that Conventional reduce by 8% more with compare to our approach..

VII CONCLUSION AND FUTURE WORK

Due to dynamic network topology and frequent disconnected networks, VANET requires different routing strategy than other Ad-Hoc networks. Many VANET applications need anycast service. To improving reliability without impacting performance, network coding with multi generation mixing is used [5] in that there is a problem of overhead of packets in terms of generation size and mixing set size. So we found protocol using network coding with MGM outperforms over traditional skims i terms of delay & throughput and also we have found optimal mixing set size and generation size as a function of meeting rate, delivery delay to control number of copies and improve efficiency in terms of buffer and bandwidth usage.

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