Network Coding Based Multi-copy Protocol to Anycast Information in VANET

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***Abstract* -- A Vehicular Ad-Hoc Network, or VANET, is a technology that uses moving cars as nodes in a network to create a mobile network. Communication: typically over the Dedicated Short Range Communications (DSRC) (5.9 GHz) Example of protocol: IEEE 802.11p. Vehicular Ad-Hoc Network (VANET) is sparse ad hoc networks in which no contemporaneous path exists between source and destination most of the time. In VANET, connectivity graph of the network changes over time either due to mobility or sleep-wake up cycles of the nodes. So, routing protocols proposed for VANET follow `store-carry-forward' paradigm in which two nodes exchange messages with each other only when they come into contact. Vehicle connectivity can be fairly considered as future killer application which will add value to car industry. We will develop a multi copy routing protocol for anycasting in vanet which used network coding to reduce communication overhead.**

***Key Words* – VANET, Anycasting, Multi generation mixing**

I. INTRODUCTION

Basic of VANET

A Vehicular Ad-Hoc Network, or VANET , It is a form of Mobile ad-hoc network. It is used to provide communications nearby vehicles and between vehicles and nearby fixed stations, usually known as roadside equipment. So in other words, it is known as a combination of vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication. For this an electronic equipment will be placed inside each vehicle which will help as Ad-Hoc Network connectivity for the person who is travelling in a vehicle. This network can operate without any infra-structure client and server communication.

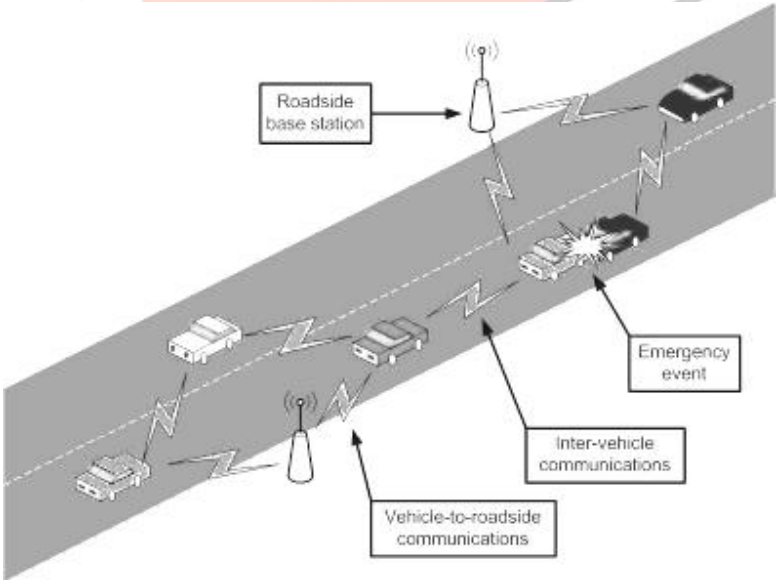

Figure I: A VANET consists of vehicles and roadside base stations that exchange primarily safety messages to give the drivers the time to react to life-endangering events.[2]

Dedicated Short Range Communication (DSRC) based Vehicular Ad Hoc Network (VANET) provides an opportunity to enable communication-based cooperative safety systems in order to decrease road traumas and improve traffic efficiency. VANET also offers a wide range of commercial and infotainment applications. Vehicular Ad-Hoc Network (VANET) provides a unique opportunity to establish communication-based cooperative safety systems. VANET comprises two modes of communication: Vehicle-to-Vehicle (V2V) communication and Vehicle-to-Infrastructure (V2I) communication. Dedicated Short Range Communication (DSRC) technology is envisioned as a key enabler technology for VANET. DSRC technology is based on a cost effective local area network technology.

Motivation of Project

The main motivating factors for selection of this topic for dissertation are: VANET is nowadays very popular research topic. As vehicles increasing day by day. The comfort and safty of passangers also become very important. So the data transmission is also one big issue as vehicles are with different speeds. Due to the inherent characteristics of the vehicular environment, traditional routing protocols for MANETs cannot be applied to VANETs. The main goal of routing in VANETs is to transmit data from a single source to a single destination or to a specific geographic region using an amalgamation of wireless multi-hop and carry-and-forward techniques. Therefor to find out such a routing protocol which become helpful to transmit the data to vehicle to vehicle or vehicle to infrastructure?

Organization of the Paper

The work of this phase is presented in eight sections. Section 2 talks about the existing systems and the literature survey done. It gives an overview of the different protocol used for routing. Section 3 present basic and importance of network coding. Section 4 will give detail about anycasting and its basics and usefulness in VANET routing protocol. Section 5 gives detail about existing protocol and its limitation and overview. Section 6 will gives detail about proposed work and how protocol works. Section 7 represents the conclusion and future work for improving the algorithms developed in this work.

II. EXISTING SYSTEMS AND THE LITERATURE SURVEY

Network coding uses computational power to increase network efficacy. With the help of network coding, the mediater nodes will send packets that are linear combinations of previously received information. We get two benefits of this approach: high potential throughput and a high degree of robustness. Here , nodes may recombine several input packets into one or several output packets.[1]

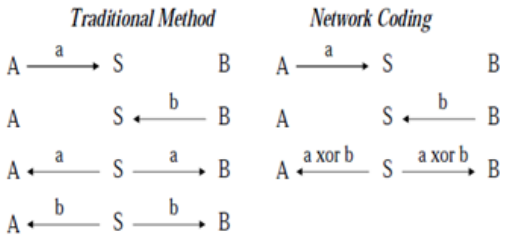

Figure 2. Example of Network Coding [1]

Benefits of network coding

- Throughput Gain in Static Environment
- Robustness and Adaptability
- Application
- Wireless Networks
- P2P file sharing

Reliable multicast is an example where the existing solutions need to be re-though. Emerging areas such as ad-hoc networks overlay infrastructures and sensor networks are starting to benefit of network coding.[1]

Propose a new network coding approach where they employ Multi-Generation Mixing (MGM). MGM eliminates the need to increasing buffer sizes while improving the performance of network coding. Under MGM, They define a mixing set of size m generations that can be network coded (mixed) together. Within each MGM mixing set, a new set of generation packets are mixed with previously transmitted (network coded) generations. This generalized approach provides a great deal of resilience against losses when compared with traditional generation-based network coding. MGM allows encoding among generations. Within each MGM mixing set, a new set of generation packets are mixed (i.e., encoded) with previously transmitted (encoded) generations. This approach improves the reliability of recovering sender data that may not be decoded in situations of high loss rates and sparse connectivity.[11]

An opportunistic routing strategy is a strategy where there is no predefined rule for choosing the next node to destination. Here the main goal has clearly been to improve the overall safety of vehicular traffic, traffic management solutions and entertainment application are also expected by the different bodies.[5]

The main two categories of routing protocols are 1.topology-based 2.geographic routing. Topology-based routing learns about links that exist in the network and creates a local "map" (the routing table) that is used to perform packet forwarding. Geographic routing uses only instantaneous neighboring location information to perform packet forwarding. A node forwards a packet in "opportunistic" mode if it does not have a predefined strategy to choose the next node for guaranteed delivery to destination. It is proved to be well suited for highly dynamic environments such as Vehicular Ad Hoc Networks. As because of its simplicity.[5]

Virtual Navigation Interface (VNI) providing this types of data:

1. Route info that includes detailed path, the destination, or simply the direction of the vehicle, depending on the types of underlying data sources.
2. Confidence that indicates the probability that the vehicle's movement would abide by the given route information. More specifically,

confidence = 0% means that the vehicle moves completely randomly;

confidence = 100% means that the vehicle moves strictly according to advertised route information

In a wireless ad hoc network, an opportunistic routing strategy is a strategy where there is no predefined rule for choosing the next node to destination.[5]

Anycast refers to the transmission of data from a source node to (any) one member in the group of designed recipients in a network, which has been defined a standard communication model of IP version 6. In order to implement multi-destination and multi-path anycast routing on the heavy load network, Anycast refers to the transmission of data from a source node to (any) one member in the group of designed recipients in a network. Anycasting provides best delivery of an anycast datagram to at least one host, and preferably only one host, which serves the anycast address. One host initiates an update of a router table for a group of hosts, sending the data to the nearest host.[7]

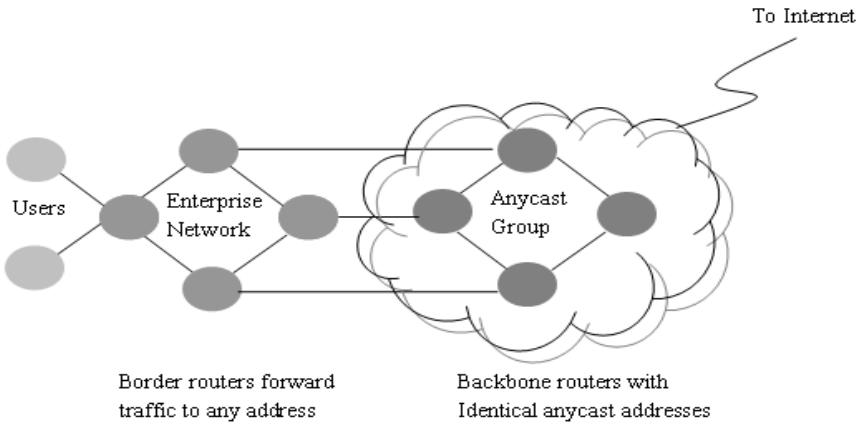

Figure III. Anycast Illustration[7]

Node movement feature of Vehicular ad hoc network (VANET) closely resembles with that of mobile ad hoc network (MANET) but its high speed mobility and unpredictable movement characteristics are the key contrasting feature from that of MANET. The simulations have shown that AOMDV performs comparatively better than DSR and AODV in different mobility models in terms of end to end delay as performance metric. VANET is one type of ad hoc networks in which topology frequently changes.

Reactive Routing Protocols :[10]

Reactive protocols on demand routing algorithms makes a route to a given destination when a node requests it by starting a route discovery process. When a route has been established, the node keeps it until the destination is no longer accessible. Examples of reactive routing protocols are AOMDV, AODV, and DSR.

III. NETWORK CODING

Linear Algebra[11]

Linear algebra provides the formal setting for the linear combination of equations used in the Gaussian method. Assume the goal is to search out and describe the solution.

$$\begin{aligned} 2x + y - z &= 8 \quad (L_1) \\ -3x - y + 2z &= -11 \quad (L_2) \\ -2x + y + 2z &= -3 \quad (L_3) \end{aligned}$$

The Gaussian-elimination algorithm is shown as below: eliminate x from equations below L1, and then eliminate y from equations below L2. It will put the system into triangular form. After this using back-substitution, each unknown can be solved for. In this, x is eliminated from L2 by adding (3/2)L1 to L2. x is then eliminated from L3 by adding L1 to L3. Formally:

$$\begin{aligned} L_2 + \tfrac{3}{2}L_1 &\rightarrow L_2 \\ L_3 + L_1 &\rightarrow L_3 \end{aligned}$$

The result is:

$$\begin{aligned} 2x + y - z &= 8 \\ \frac{1}{2}y + \frac{1}{2}z &= 1 \\ 2y + z &= 5 \end{aligned}$$

Now y is eliminated from L3 by adding −4L2 to L3:

$$L_3 + -4L_2 \rightarrow L_3$$

The result is:

$$\begin{aligned} 2x + \ y - \ \ z &= 8 \\ \frac{1}{2}y + \frac{1}{2}z &= 1 \\ -z &= 1 \end{aligned}$$

This solution is a system of linear equations in triangular form, and thus the first part of the algorithm is finish. The end part, back-substitution, is mix of solving for the knows in reverse order. So It can thus be seen that

$$z = -1 \quad (L_3)$$

Then, z can be substituted into L2, which can then be solved to obtain

$$y = 3 \quad (L_2)$$

Now, y and z can be substituted into L1, which will help be solved

$$x = 2 \quad (L_1)$$

So We can, in, write any system of linear equations as a matrix equation:

$$Ax = b.$$

Which we can utilize to encode the packets in network coding. Network coding is become useful as with NC, mediator nodes may send out packets which are linear combinations of previously received information. The advantages are of using this approach: It potential throughput improves and a high degree of robustness. Here we don't simply forwarding data, nodes may recombine some input packets into one or some output packets. Network Coding provides advantages in Network by decreasing the Bandwidth required for achieving the desired. It can also increase the throughput of the Network.

Here it is an example in a wireless context is a three node topology, as shown in Figure 1. Linear network coding, It is similar to this example, with the difference that the xor operation is replaced by a linear combination of the data, interpreted as numbers over some finite field.

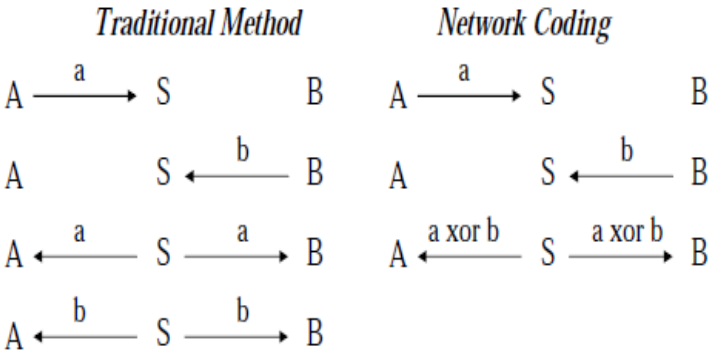

Figure 4. A simple network coding example.[1]

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 of interest, while the number of transmissions is reduced. NC is suited for environments where only half or uncertain or incomplete information is available for decision making. Every time a client needs to send a packet to another client, the source client generates and sends a linear combination of all the information available to it (similarity to XOR ing multiple packets). After a client receives enough linearly independent combinations of packets, the client can reconstruct the original information. Successful getting of message is not depending on receiving specific packet content but rather on receiving a sufficient number of independent packets. A node stores the encoded vectors it receives as well as its own original packets, row by row, in a so-called decoding matrix. When an encoded packet is received, it is inserted as last row into the decoding matrix. The matrix is transformed to triangular matrix using Gaussian elimination. The packets need to be decoded has a little impact on delay. Here it is not compulsory or necessary to receive every encoded packets before some of the packets can be decoded. Together with a reduction in the number of required transmissions, generally totally overall end-to-end delay in network coding is generally not larger than the normal end-to-end delay in realistic format.

IV. ANYCASTING

Anycast refers to the transmission of data from a source node to (any) one member in the group of designed recipients in a network. In anycasting, it is a one-to-many association in between network addresses and network endpoints: each and every destination address identifies and get to know a set of receiver endpoints, but it choose any one of them at given time to receive data from any given sender. In Internet Protocol Version 6, anycast is make communication possible between a single sender and the several receivers which are near in a group. In multicast, communication take place between a single sender and multiple receivers, and in unicast, communication take place between a single sender and a single receiver in a network. We can say Anycast means the transmission of information from a source node to one member in the group of recipients in a network. Anycasting provides a best effort delivery of an anycast datagram to one host, and only one host, which serves as the anycast address. Anycast is communication between a single sender and several receivers topologically nearest in a group.

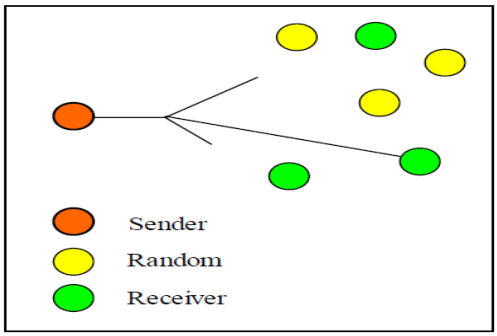

Figure 5. Anycast Network Topology [7]

V. VARIOUS ROUTING PROTOCOLS

A popular example of opportunistic routing is the "delay tolerant" forwarding to "data mules" when a direct path to destination does not exist. Conventional routing in this case would just "drop" the packet. With opportunistic routing, a node acts upon the available information: it seeks the neighbor best qualified to "carry" the packet to destination. If none is available, it will await the right opportunity. This procedure is also known as "data muling" or Delay Tolerant Network (DTN) routing.

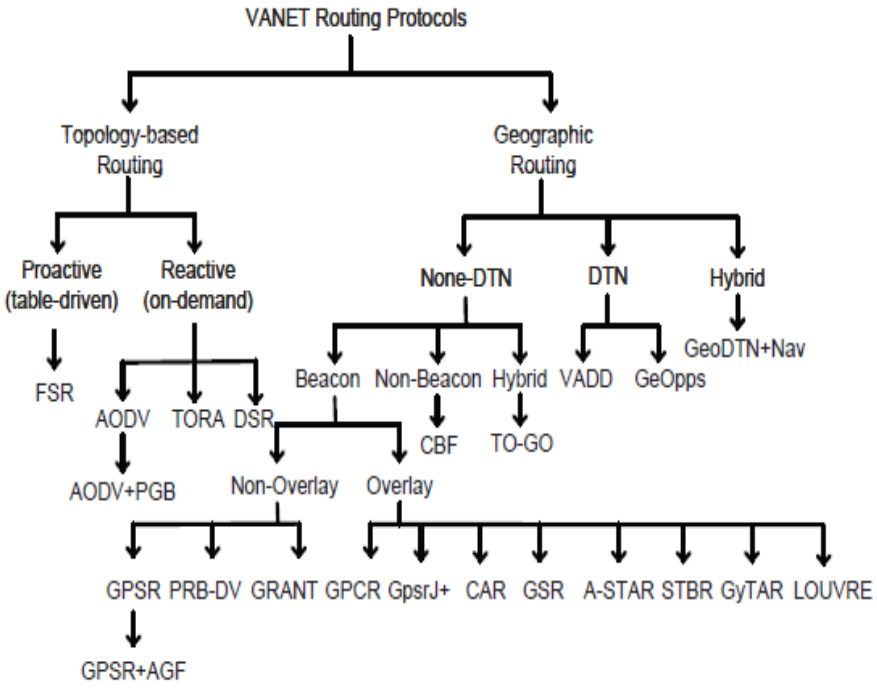

Figure 5.VANET Routing Protocol[10]

Reactive Routing Protocols

Reactive protocols are on demand routing algorithms. They establish a route to a given destination when a node requests it by initiating a route discovery process. Once a route has been established, the node keeps it until the destination is no longer accessible. Examples of reactive routing protocols are DSR, AODV, and AOMDV etc.

1. DSR - The DSR protocol determines the complete route to the destination node, expressed as a list of nodes of the routing path, and embeds it in the data packet. Once a node received a packet, it simply forwards the packet to the next node in the path. DSR keeps a cache structure to store source routes learned by the node. The source only initiates Route discovery whenever it does not have a needed and valid route to a given destination node in its route cache.
2. AODV - This AODV protocol keeps a route table to store and save next node routing information for given destination nodes. Each routing table can be used for a period of time. If a route is not requested within that period, it expires. Each time a route is used, its lifetime is updated. When a source node has a packet to be sent to a given destination, it looks for a route in its route table. It initiates a route discovery procedure to find a route by broadcasting a route request (RREQ) message to its neighbors. Upon receiving a RREQ message, a node performs the following actions: checks for duplicate messages and discards the duplicate ones, creates a reverse route to the source node, and checks whether it has an unexpired and more recent route to the destination. Node replies to the source node with a route response message which contain the last known route to the destination. Otherwise it retransmits the RREQ message.

3. AOMDV - The AOMDV routing protocol is an enhancement of AODV. AOMDV allows multipath between source and destination to provide efficient fault tolerance with faster and more efficient recovery from route failures in dynamic network.

VI. PROPOSED WORK

Algorithm for protocol

Here we will generate multicopy of encoded packets for more reliability. So we can get packet if it loss by any reason. If node get the encoded packet it will reject to another same copy. So it will be discarded. And overhead will be reduced.

Algorithm :

```
Sender( )
{
        Divide Message into N packets [ Where No. of packets = message / n ]
        For each No. of packets
                Generate Random Co-efficient m * n ,
                Apply NC on No_of_Packets
        Send ( Network_coded_packets  )
}

Intermediate_node( )
{
        Call forward ( )
}


Destination ( )
{
        Buffer m Packets of same group [ where m = 4 ]
        For all m packets of a particular group
                Apply decoding by using Random co-efficient from packet header
        Receive ( Packets )
}
```

In encoded packet in header we will put the size of matrix for example 4*4. So we can get idea. Matrix its own complexity is O(n3).So if we are sending more copies or taking large size of matrix its complexity will be increase. And which will reduce the performance.Thats why we have taken here this assumption of 2 multicopy and group of 4 packets. Because of applying NC the reliability will be increase and also delivery rate will be good so we can get higher throughput. Here we will also consider the buffer management. As each node has limited buffer storage.so we have also manage buffer overflow. But as we are using NC we have encoded pakets. So by adding them we can get space in buffer. And reduce the buffer overflow. So By applying this approach we will try to do buffer management.

VII. CONCLUSION AND FUTURE WORK

By learning and reading the recent researches we come to know that in VANET still we have to work more on routing protocols. Despite of many protocols existing but they have some cons like overhead, delay less reliability. And existing protocols are for specially for MANET So they are not exactly fit for VANET. Some protocols are not supporting high mobility. And in VANET it is there.

So by using various aspects like linear algebra ,network coding , anycast in routing protocol for VANET we can get more efficiency ,reliability ,increased throughput ,buffer management. And we can Work smoothly in VANET.I have learned basics of Network coding .And also linear algebra which is useful in network coding. For simulation we use NS2.Which is installed and learned basic of it.

We will use multi-copy scheme for developing anycasting based routing protocol using network coding which will give us better reliability and throughput. So we will be able to overcome the above issues. Now We will configure the C++ implemented coding in NS2 simulator and make working our new protocol.

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