GLOBAL FRONTRUNNER ROUTING ALGORITHM (GFRA) FOR V2V COMMUNICATION IN VANETS

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ABSTRACT

VANET (Vehicular Ad hoc NETwork) is the emerging research area that making the phrase "Network on Wheel" true. In this new age network the basic WLAN (IEEE 802.11) standard is used. As the necessity of such network increases the implementation challenges are being taken into account. They are broadcasting, routing, priority scheduling and security and privacy. In this paper the routing is considered as the research factor. A proposal for routing with frequently changing topology to avoid disconnection of network on road and for the routing among overlapping networks in flyovers with multiple ramps and stack to avoid wrong messaging is given.

KEY TERMS

VANET, DSRC, Network topology ,RSU, V2V Communication

I. INTRODUCTION

Driving means constantly changing position. In this case to provide communication between the vehicles is a challenging task. This is provided by a hybrid network of ad – hoc and infrastructure networks. In this network vehicles are treated as nodes. The typical VANET architecture [1] gives the connectivity of the moving nodes.

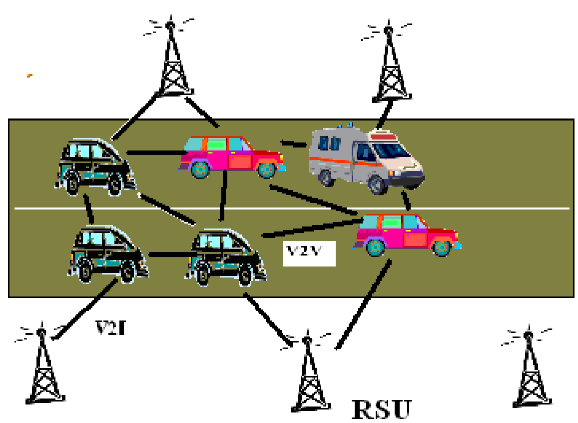

Figure 1. A VANET example

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In VANET two types of communications are vehicle to vehicle (V2V) and vehicle to infrastructure communication (V2I). The Road Side Unit (RSU) acts as an access point which provides internet connectivity. The external data are transmitted for both V2V and V2I communications are using Dedicated Short Range Communication (DSRC). VANET will support various applications for safety, driver assistance, and traffic efficiency and even for entertainment. Each vehicle equipped with different sensors and transceivers can sense the changes in environment and together they form a vehicular network.

The research and application development in VANETs are driven by the IEEE802.11p technology [2] which is intended to enhance the IEEE 802.11 to support the Intelligent Transportation System (ITS) applications where reliability and low latency are crucial. The IEEE 802.11p technology is aimed to support up to 1000m communication range between vehicles or vehicles and infrastructure. Although the standard is well defined, there are some implementation challenges [3]. They are:

1. Network Topology: VANETs may be made up of only vehicles as nodes or vehicles and RSUs as nodes.

2. Dynamicity of the Network: VANETs face an extremely dynamic network situation due to fast speeds of vehicles or nodes. This will see a constant change in the network topology

3. Network Connectivity: As the network is extremely dynamic and topology changes frequently, disconnections are likely in the network.

4. Communications Environments: Depending on the vehicle density, static obstructions such as trees or buildings, the communication environment will change. More vehicles will mean a better network due to increased number of nodes. The network will use both single-hop and multi-hop techniques depending on the vehicular environment.

5. *Node addressing*: The nodes in VANETs will mostly be limited to a particular area. This area might be very small with many nodes or few nodes. VANETs will address nodes based on their geographical position. Packets would be transferred to or within a particular area in case of emergency.

6. *Delay constraints:* Delay constraints for transmitting warning messages will hold top priority. Delay for other applications like entertainment may be higher.

In this paper the dynamically changing topology is taken as the origin which leads to another problem of disconnectivity.

II. RELATED WORKS

Inter-vehicle communication will play an important role in future automobiles and traffic management in general. Many different services have been proposed in the literature using vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication. These include safety applications like collision warning, up-to-date traffic information and active navigation, and infotainment. The main goal of using communication technology in vehicles is to improve passenger safety and reduce fatalities. However, a valid business case is needed to be able to finance the required technology.

VANET can be considered as a special case of MANET. There are four kinds of routing protocols in MANET.

- Proactive routing

- Reactive routing
- Position based routing
- Topology based routing

For VANET specially designed routing protocols are being used. They are as follows:

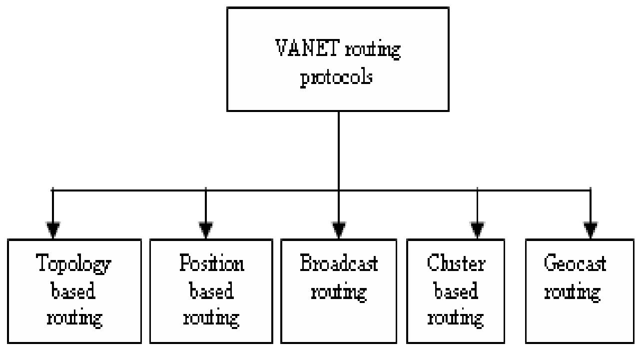

Figure 2. Types of VANET routing methods

Each of the protocol is further divided into several types.

Parameters	Topology based routing	Position based routing	Cluster based routing	Geocast routing	Broadcast routing
Packet forwarding method	Wireless multi hop forward	Heuristic method	Wireless multi hop forward	Wireless multi hop forward	Wireless multi hop forward
Necessity of digital map	No	No	Required	No	No
Necessity of virtual infrastructure	No	No	Required	No	No
Realistic traffic flow	Yes	Yes	No	Yes	Yes
Recovery from critical situation while transmission	Carry and forward	Carry and forward	Carry and Forward	Carry and Forward	Flooding
Real-time scenario	Urban	Urban	Urban	Highway	Highway

TABLE 1. COMPARISON OF PROTOCOLS BY PARAMETERS

The overall comparison is given based on the parameters packet forwarding method, necessity of digital mapping, necessity of virtual infrastructure, realistic traffic flow, recovery from critical situation while transmission and implementation scenario.

Most of the researches are going on about the MAC protocol. But the routing is a major problem in such a frequently changing network. A number of researchers concentrate on this problem. Inhyeok Jang [4] recommends a protocol with relay acknowledgement. This provides effective routing in the case of dynamically change of location. Here virtual location information is used. The node which is the neighbour to the destination node is given higher priority to access the wireless network. This node acts as relay node. It forwards the packets to the destination. The preceding node of the relay node maintains the details of received packets to prevent duplication.

The drawback of this method is that the destination node does not need to be a static node. So the relay node cannot be predicted until a transmission completes.

Routing by clustering using Euclidean distance [5] is another method. This considers the Euclidean distance between vehicles, direction of movement to form a cluster.

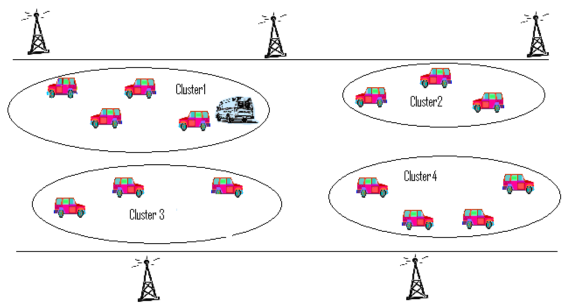

Figure 3. Euclidean distance based clustering

In position based directional vehicular routing [6] the position of the moving vehicle related to another moving vehicle is calculated with the values latitude, longitude and altitude and also using speed and timing information. The data forwarding method used is using store – carry – forward. In this scheme a node receiving a packet stores it in its buffer and carries it while moving. When the node finds another node which does not contain a copy of the packet, a copy will be forwarded to a new node. This broadcasting behaviour will continue until the destination node receives the packet. The drawback of this system is overhead in maintaining a large collection of received data and time consumption in checking the crossing vehicles for all buffered packets.

II MOTIVATION

In most of the emergency messaging broadcast is suggested. But this leads to unnecessary usage of bandwidth. As Global Positioning System (GPS) gives the details about the location and speed of a vehicle we can utilize it for sending a packet to a far away moving vehicle. As the position dynamically changes, the distance should be calculated with respect to the direction of the vehicle and the speed of the vehicle.

III GLOBAL FRONTRUNNER ROUTING PROTOCOL

A main difference between VANET and conventional ad-hoc network is a variable network density caused by the rapid changes of network topology. In highway, the density of vehicles may be lower than that in urban. Traffic may become serious during the rush hours, while a sparse vehicles scenario are expected to appear at night or other idle daytime. In a high density environment, a large number of vehicles with wireless transceivers are "co-exist" in a communication zone, and the channel access contention problem is a crucial challenge for reliable transmissions with low delay

In the above situations to send emergency messages, multi hop forwarding methods will take more time. Here the parameter of coverage area of DSRC (1000m) is taken as a key factor. If the destination is in this coverage area (<1000m) the packet can be sent directly as given in figure 4.

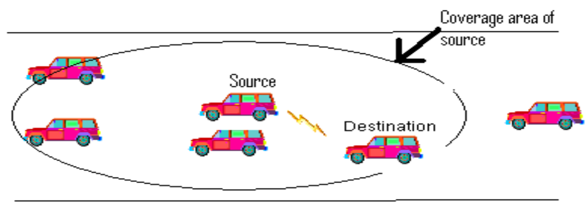

Figure 4. Single hop routing

If the destination is beyond the coverage area (>1000m) the global frontrunner method is used. The scenario is given in Figure 5

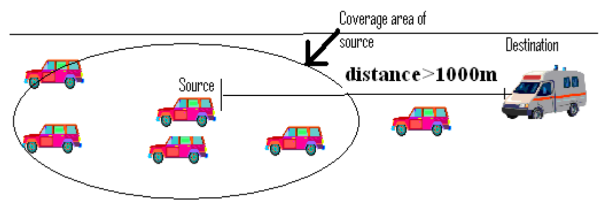

Figure 5. Problem scenario

In both the scenarios the distance of the destination is obtained from the GPS. Then the distance relative to the direction of the destination is defined. If the distance is greater than 1000m the source should find the frontrunner in the direction of the destination. Frontrunner is the farthest vehicle within the coverage area of source vehicle. Now routing can be performed through the frontrunner. At this stage the frontrunner estimates the distance between itself and the destination node. If it is <1000m, the frontrunner forwards the packet to the destination. Otherwise the frontrunner will find the next possible front runner within its coverage area and forwards the packet to the new frontrunner. This will be repeated until the destination receives the packet. In each stage the sending node will keep the packet in its buffer until it receives the ACK from the corresponding receiver. The algorithm for this proposed routing method is given below.

VARIABLES

- $Dist_{rel}$: Direction based Distance between two nodes
- FR: Frontrunner node
- T: ACK timer
- T_{th}: Timer threshold

INPUT

- S: Source;
- D: Destination;

BEGIN

1) Calculate $Dist_{rel}$ between S and D

2) If $Dist_{rel}$ <=1000

   2.1 Forward the packet to D Reset T=0. Start T wait for ACK.

   2.2 While($T<T_{th}$)

      If ACK received
      Goto step 4
      Else goto step 2.1

3) elseIf $Dist_{rel}$>1000

   3.1 Find the FR

   3.2 Forward packet to FR Reset T=0. Start T wait for ACK.

   3.3 While(T==T_{th})
   If ACK not received
   goto step 3.2

   3.4 Set FR as S

   3.5 Goto step 1

4) *If ACK received from D*

5) Terminate

IV SIMULATION OPTIONS

To simulate behaviour of this algorithm the simulator NS2 is suggested. The simulation is in progress. In our simulations a 5000 meters length highway scenario, with 200 vehicles moving in two opponent directions are considered. Speed ranges starting from a minimum speed value of 60 km/h and a maximum speed value which we increase from 100 to 180 km/h. In each direction we have a density of 5 vehicles every 150 m. The other factors can be decided at the time of designing the simulation.

V CONCLUSION AND FUTURE WORK

VANET is becoming the key research area. The proposal given in this paper is expected that a good transmission result can be achieved. As number of hops is reduced the transmission delay can be minimized hence the traffic in the networks can be reduced. In this system unicast messaging is suggested. As the immediate Frontrunner has the data, this method can be used to avoid unnecessary usage of bandwidth and the RSUs. In future along with the simulation the security will be provided for this transmission.

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