An Efficient Routing Protocol for Minimizing Multi-hop in VANET using WiMAX

Vaishak.P, T.Sivakumar

***Abstract*—**Vehicular Ad hoc Networks (VANET) are achieving a lot of attention due to the wide variety of services they provide. Which include applications and user services like games, web browsing, chat, providing safety, file sharing, delivering advertisements and finding available parking etc. For achieving the network connectivity it uses infrastructure module called RSU, which provide seamless connection to services. For sending a data or vital message to known destination in VANET, existing protocols lags because of dynamic nature of VANET. Each time it has to create a new path through different vehicles (nodes) if the intermediate node moves in different direction of either source or destination nodes. Interoperability between VANET module and WiMAX are possible for achieving reliable network connectivity and sending the data fast and acquiring high end to end ratio. This paper proposes a protocol which Embed the WiMAX technology to the Vehicular Ad hoc network. It sends the data through WiMAX or VANET module according to the distance between the source and destination. Here it assumes that each vehicle is capable of locating itself by location service like GPS and destination is known to the source.

Index Terms — VANET, WIMAX, Communication Range, RSU, MANET.

1 INTRODUCTION

TO allow inter-vehicle communication, vehicles must form some kind of network called Vehicular Ad hoc Network (VANET).It is also called Vehicle -to-Vehicle communication (V2V). VANET is a decentralized and self-organizing network consists of high speed moving vehicles. It can be used to establish communication between vehicles and by develop pervasive applications [1], [2] for road safety. VANET is different from MANET but it is a special case of MANET. VANET nodes are moves along the road segment, not like random movement of nodes in MANET. Processing power and storage efficiency are not an issue in VANETs as they are in MANETs. But topology of VANET changes because vehicles are moving very fastly. Characteristics of VANET includes High mobility, Rapid changing topology, No power constrain, interaction with on –Board sensors etc.

Routing is big issue in VANET because it is highly dynamic in nature. Two types of Ad hoc mobile routing protocol are there, Pro-active and Reactive. In pro-active protocols it finds the path in advance and periodically exchanges the routing information to maintain the path. For the reactive protocol, It discover the path when the packet or data needed to transmit and here there is no known path exist. When there is a routing failure occurs then it will try to alter the path. Among this VANET is using Reactive protocol because there is less control packet overhead is there and because of mobility of vehicle is not easy to maintain a path always. Basic Reactive routing protocol like AODV (Ad hoc On-Demand Distance Vector routing) [3] and DSR (Dynamic Source Routing) [4] are not efficient because this have more latency, so it takes more time to establish the path.

Three main constrain in which it decide the efficiency of the protocol are (1) Packet Delivery Ratio, (2) End –to-End delay and (3) Control Overhead. If any protocol having High End-to-End delay, Good Packet delivery Ratio and Less control overhead, then it is considers as efficient protocol. Recently, some routing protocols for VANETs have been proposed. Most important ones are: GSR, A-STAR, GyTAR. 'GSR' [5] (Geographic Source Routing) supports for vehicular ad hoc networks in city environments. It combined position-based routing with topological information. The simulation results with city environments shows that GSR outperforms topology-based approaches like DSR and AODV with respect to packet delivery ratio and latency.

A-STAR [6] (Anchor-based Street and Traffic Aware Routing) guaranteed an end-to-end connection even if we have low traffic density. A-STAR used information on city bus routes to identify an anchor path with high connectivity for packet delivery. It gives more performance than GPS and GPSR. But it has large delays because routing path may not be optimal and it is along the anchor path. GyTAR [7] (Improved Greedy Traffic Aware Routing protocol) is an intersection-based geographical routing protocol capable to find robust routes within city environments. GyTAR out perform all of the other routing protocols in terms of above mentioned three criteria i.e. overhead of the routing, delivery ratio of packet and end-to-end delay in routing.

The design and the implementation of efficient and scalable routing protocols constitute one main issue. There is chance of formation of Black hole in the network while transmitting the packet. The above factor degrades the end-to-end delivery ratio. In vehicular Ad hoc networking it is better to use RSU if there are many numbers of vehicles in between the source and destination. It reduces the Delay of the communication and thereby makes sure that end to end delay is high. RSU can bypass the packet if there is a Black hole in the network. We can provide more connectivity in VANET by interoperability with WiMAX. Worldwide Interoperability for Microwave Ac-

cess (WiMAX) [4] is a technique which is used basically for the wireless and broadband for allowing high speed internet access for long distances. It is based on standard IEEE802.16. It is more cost-effective and faster to set up. WiMAX is used for fixed and mobile accesses. Nowadays for fixed stations it can access up to the speed of 40 Mbit/s and research is going on to make it as 1Gbit/s in future.

2 RELATED WORKS

Bijan Paul, Md. Ibrahim and Md. Abu Naser Bikas give an Idea about VANET Application [8].There the Pros and cons of the VANET have been discussed. It has given that it is possible to have Technology like WiMAX and CELLULAR in existing VANET for providing more applications. Interoperability between WiMAX and VANET are possible.

IEEE802.16 standard, WiMAX is worldwide interoperability for microwave access is a technique which is used for the wireless and broadband for high speed access with long coverage. In the paper [10], they are discussed about the properties of WiMAX. Here difference between fixed and mobile WiMAX has been discussed. It has been saying that interoperability of WiMAX is possible. WiMAX supports high coverage with high data speed. Nowadays vehicles are equipped with mechanism of communicating directly to WiMAX also.

In paper [13] Cost effective way to place RSU in VANET has been discussed. It gives a proper idea about the handover mechanism in Vehicular Ad-hoc networking. It uses multi hope relaying if the vehicles are not in the communication range of RSU. In this similar manner our algorithm also forwards the packet through vehicles if the RSU is not available in any area. This RSU is placed according to the traffic density and considering the cost also. Paper [12] shows how RSU is communicating to vehicles in peak time. This RSU is acting as both active and passive depending upon the traffic. When there is more number of vehicles it act as passive and only communication among vehicle is occurring. When there is less number of vehicles, it works in active mode.

3 PROBLEM DEFINITIONS

I**n** VANET vehicles or nodes are exhibit high mobility. Because of this each time topology changes and makes routing difficult. VANET Uses Topology based Reactive routing algorithm or Geographical routing algorithm for routing. Each algorithm lags in many cases which include geographical area, Network connectivity, speed and direction of vehicles etc. One protocol may be good in one scenario like city but if we Consider highway and other rural area it shows low performance. So for sending any important data to known destination, which is located far way from source it takes time to reach because of many intermediate nodes. Data is forwards through multiple hopes and get delay because of dynamic nature of the network. In VANET there is no mechanism to send important data quickly to a known destination without going through multiple nodes.

In current scenario when source needs to send the data to the destination, it sends to an intermediate node which can forward the data to destination. When the data is forwarding to the new node, it apply the best routing algorithm which is available. Existing algorithms forwards data through many nodes without considering the traffic in the network. In real time scenario it is difficult to achieve 100% forwarding and delivery due to the nature of the vehicles. When there is case to send the data to a longer distance it follows the same steps. Only exception is through RSU we can send the data to a longer distance. But there can be many issues related to RSU and it is need not necessary to have RSU everywhere.

4 PROPOSED SYSTEM

It uses location services like GPS or Hierarchical Location Service (HLS) [9] to locate the position of both source and destination. GPS receivers like G-mouse give latitude and longitude of the vehicle. It is shown in the figure 1. So co-ordinates of both sender and receiver can obtain. From this distance between source and destination can be calculated. We took this value to "x". According to this value, our protocol decides which strategy is going to choose. We assume that Range of RSU is 500-600meter and communication range of vehicles is 200-250 meter. For the fixed stations WiMAX [10] provide broadband wireless access up to 30miles or 50kilometers, and for the mobile stations it provides 3-10miles or 5 to 15 kilometres.

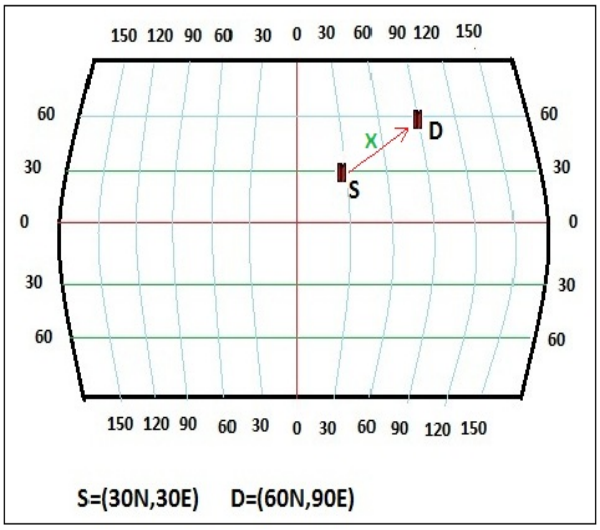

Fig 1. Latitude and Longitude specification.

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So the protocol has the following steps:

Step 1: Calculate "X" value from the latitude and longitude of source and destination.

Step 2:

If the value(X>2km)
Then Source will send the data through RSU to WiMAX
If ("S" is not in the Range of any RSU)
Send to next node which is in the Range of any to RSU
Else
Send to RSU, Then to the WiMAX.

For both of the cases, WiMAX broadcast to the all the RSU in which possibly the Destination can have.
(End of main-if)

Else if (800m<X<2km)
Then Source will send the data through RSU
If(S is not in the range of RSU)
Send to next node which is in the Range of any to RSU
Else
Send to RSU

For both of the case RSU is forwards the data.Here there is no usage of WiMAX module.
(End of Else-if)

Else
Use any efficient routing algorithm for sending through vehicles.

This protocol uses three ways to send the vital data. If the value of "X" is more than a 2km (which can be assigned according to the traffic density) then it uses technology of WiMAX to send the data. This data can also be termed as message. For this Source "S" sends the data to nearest RSU. If RSU is not in the communication range of it, it sends to the next vehicle which is in the range of nearest RSU. This RSU forward this data to WiMAX. When it reaches WiMAX, It knows the RSU in which who is possibly gives the communication range for destination node. If the destination node is not in the range of RSU because of movement, it sends to a vehicle which is in contact with the Destination "D".

Our protocol uses only RSU if the distance is between 2km and 800meter.Here possibly, through 3-4 RSU message has to travel. This module is used in this protocol because to reduce the traffic to the WiMAX because WiMAX is also uses for other commercial purposes. Here if the "X" is in the above specified range, Source sends Message to the next RSU which is in the range of the source. Here the above step will repeat if the source is not directly in the range of any RSU. RSU forwards the message from one to other and it reaches the RSU in which who communication ranges, the Destination node have present. Third medium of communication is through vehicles, i.e. if the "X" value is less than 800meter. Here it uses only vehicles and thereby reducing traffic in RSU. It can use the Best protocol which is use in the routing for vehicle. The most important protocols are GSR, A-STAR and GyTAR. This protocol can be explained by using the figures.

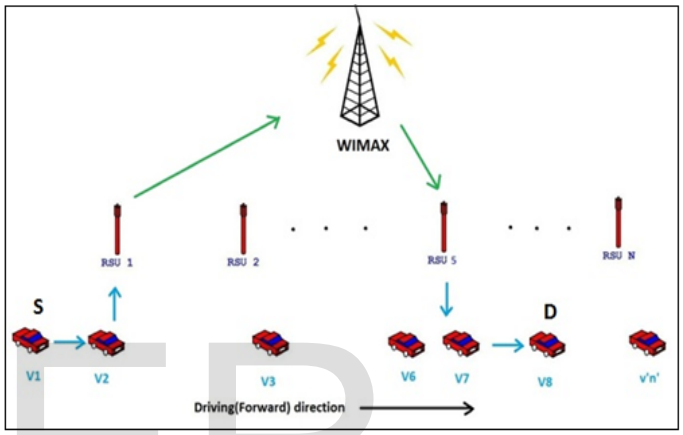

Fig 2.Send message through WiMAX.

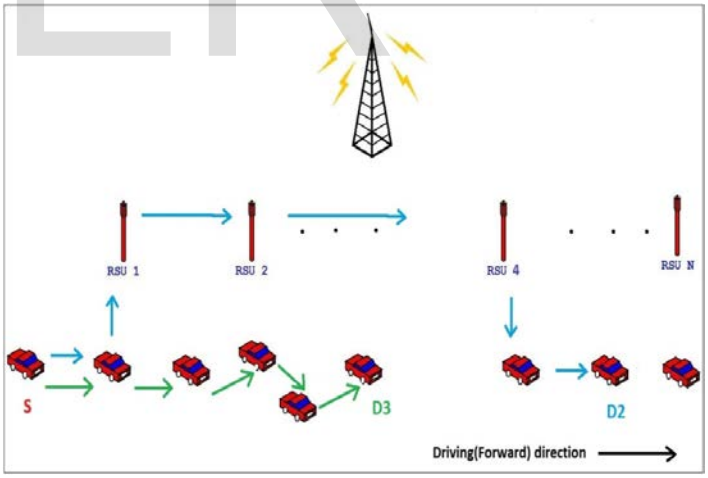

Fig 3.Send message through RSU and Vehicle.

Figure 2 shows a scenario in which it contains vehicles, Road Side Unit (RSU) and WiMAX. Vehicle direction is taken from left to right which is considering as forward direction. These vehicles are given names from V1, V2, and V3 etc Vn. There are many RSU present in roadside RSU1, RSU2.....RSUn, which are connected by using wired medium like optical fibre cable. We can also make Wireless connection but it is less reliable and having less communication range compare to connected RSU. In the above figure some of the vehicles are not in the range of RSU's, they send the data through other vehicles

that are connected to RSU.

For example here Vehicles V1 and V8 are not in the range of any RSU's, they are connected to RSU1 and RSU5 through V2 and V7 respectively. So if the value between source and destination exceed 2km then it uses WiMAX to transmit the message. In the figure 2, source "S" send the message to next vehicle V2 because there is no RSU in its communication range. Then the RSU1 forwards the message to WiMAX. When the message reaches at WiMAX it knows that Destination is in the range of RSU5, so it sends the data to RSU5. When message reaches at RSU5, now Destination "D" is moved some distance forward. It forwards to vehicle V7 and through it reaches to destination "D".

Figure 3 explains about the second and third module of our protocol. I.e. when the distance is in between the range of 800meter to 2km then source send the data through RSU. Suppose source "S" need to send data to D2 which is just 1600meter apart from it. It sends the message to RSU1 first, and then it forwards through many RSU and finally reaches RSU4. Lastly RSU4 sends the data to the Destination "D2".If the value is less than 800 meters it uses the third module. For example source wants to send the message to the Destination D3. Then it sends the message through many intermediate nodes or vehicle and reaches destination D3.

Here we can use any routing algorithm which is mentioned earlier, I.e. GSR, A-STAR or GyTAR. In terms of packet delivery ratio, routing overhead and end-to-end delay GyTAR shows more performance in simulation. It is an intersection-based [7] geographical routing protocol capable to find robust routes within city environments. It has two modules: (i) Selection of the junctions through which a packet must pass to reach its destination, and (ii) an improved greedy forwarding mechanism between two junctions. By using GyTAR, a packet can move successively closer towards the destination along streets or roads where there are enough vehicles to provide connectivity.

5 INTEROPERABILITY OF WiMAX AND VANET

WiMAX is technology supports mainly three factors, which are mobility of nodes, high data rate and long coverage. WiMAX can use for fixed and mobile accesses. For the fixed access it provides coverage up to 50 kilometres with the speed of 40 Mbps. It is possible to embed WiMAX technology in existing VANET for attaining high packet delivery ratio and end-to end ratio. In existing VANET scenario Road side Unit is uses in it to provide connectivity and packet delivery ratio.RSU is used according to the traffic pattern [12]. According to the availability of vehicles, this RSU act as carrier or forwarder of packet to next RSU/vehicle. Interoperability of RSU and VANET is possible. When we need to send the packet to a longer distance it has to go through many RSU and it is not necessary to have RSU all over the city. If we have to send vital data to long distance it is better to send through less Number of intermediate nodes, at this time we can use the WiMAX technology. WiMAX can send the data to a longer distance (up to 50 kilometres) with high speed long coverage. It is possible to operate cellular network with VANET, but it makes traffic more congested and not having more coverage like WiMAX. WiMAX is having many advantages over cellular and other type of networks. From the table it is clear that WiMAX is the most cost effective approach for providing high data rate, which can fulfil the needs of VANET, mobile multimedia users. WiMAX has other properties of low latency and high coverage with high data rate.

Parameters	WIMAX	DSRC	GSM	CDMA
Max Range km	<50	< 1	<10	<10
Data Rate mbps	70	10	0.1	2
Average Latency	Low	Very Low	Low	Low
Connectivity	High	Low	High	Very High
Sustain km/hr	180	80	140	110

Fig 4. wimax comparison with other technologies.

6 CONCLUSION

This work proposes an efficient and intelligent way of routing the vital data to a longer distance. Since this work introduces new method of Embedding WiMAX with VANET, we can make the Routing of vital data more efficient. This algorithm works according to the distance between source and destination. It routes data through Vehicles, Road side unit and uses WiMAX to send data to longer distance. This algorithm is efficient and reliable because it uses WiMAX and provides End-to-End and Packet delivery ratio. Qualnet [11] is a network simulation tool that simulates wireless and wired packet mode communication networks. As a future work we will implement above model in Qualnet and assess its performance.

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