Zone Routing Protocol (ZRP) - A Novel Routing Protocol for Vehicular Ad-hoc Networks

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This Paper discusses the capability of the current routing protocols for Mobile ad hoc networks for Vehicular ad hoc networks. VANET is derived from MANET and it is a network consisting of vehicles which can communicate wirelessly. In high traffic conditions the message should be delivered correctly between the vehicles and the communication using Road Side Units. VANETs are characterized by a dynamic topology with patterned mobility consisting on mobile nodes with sufficient resources and varied time channel behavior. The network traffic requirements differ for VANET. There are many routing protocols for mobile ad hoc networks which can be used for vehicular ad hoc networks. In this paper, we are introducing Zone Routing Protocol which can improve the parameters of VANET i.e. less communication delay and delivering the messages on time compared to AODV and DSR protocols while the vehicles are moving at high speeds. WE have used a simulation to demonstrate those improvements.

Keywords—*MANET, VANET, AODV, DSR, ZRP.*

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I. INTRODUCTION

Wireless Sensor Networks give an extension between real world and virtual systems. They have played an important role in communication purposes in the recent years. Wireless systems are grouped into many categories based on the communication and network type. Sensors use batteries to operate and consume less power. They are comprehensively divided into two classes, one is infrastructure-aided and other is infrastructure less.

Mobile ad hoc systems (MANET) are self-sorting systems of versatile nodes with no foundation; it is an infrastructure less system. Transitional or sending nodes are utilized to build up a correspondence between nodes. The routing protocols are required on the grounds that the nodes need to move in the usual way and the routing strategy plays an essential part in ad hoc systems. The nodes can communicate inside of the system at whatever time. Along these lines the connection can be set up between each node to different nodes in the system. MANET differs from VANET by traffic requirements. In MANET the communication is mobile-to-mobile, has a smaller mobility network, and is infrastructure less.

VANET goes under infrastructure-aided systems. A system utilizing the infrastructure point interfaces the vehicles on the road. Those points are Roadside Units. They are similar to the Access Point (AP) in a PC system, which acts a state of communication between the system and the vehicles. Vehicular ad hoc networks consist of nodes, which the association between them and the mobility of the nodes are well maintained. Vehicular ad hoc systems are utilized in Intelligent Transport Systems (ITS). This framework utilizes GPS for tracking the accurate position of the car and other inbuilt frameworks for parking assistance and while emergency purposes to send information. Vehicles can continue on the road quickly with nodes interaction.

In VANET, the system topology is changeable as a result of high convenience of vehicles. Nodes can connect and leave a bit of the system at tiny intervals of time. Thusly, vehicles may remain for small time intervals in the interaction extent of roadside units. In the middle of vehicles and RSUs, the communication links are set up and broken rapidly. The system among center points can be exceptionally vaporized due to constrained interaction link and more flexibility. The vehicles in VANET interchange basic and fundamental information, so false data in a message

makes a vehicle go in the incorrect direction with edgy results.

In this framework, the communication process should be completed in a brief timeframe to provide enough time to a vehicle to catch up on the data (which contains safety advised message). The routing procedure is an imperative step for the nodes combination in the system. There are many routing protocols in MANET; they are ordered into two sorts fundamentally proactive and reactive, which is table and on demand driven. Many routing protocol conventions are suggested for Ad Hoc systems. Number Ad hoc On-Demand Distance Vector(AODV) and Dynamic Source Routing(DSR) have been used on the MANETs to be utilized as a part of VANET in the previous couple of years [1].

Zone Routing Protocol (ZRP) is a correlation of proactive and on-demand protocols (i.e.it is both table driven and demand driven). A nodes local neighborhood is called routing zone. In a node set, routing zone for the node is the least hop distance and it should not be greater than the zone radius. [2] A node keeps routes to all the destinations in the routing zone in its routing table. To establish a routing zone, first the node must identify all its nearby members which are away from a reaching distance. The two protocols within ZRP are intra-zone Routing Protocol (IARP) which uses routing table the other is Inter-Zone Routing Protocol (IERP). IARP is in charge of keeping nodes inside the routing area and IERP is in charge of finding and maintaining the routes to the nodes outside the routing zone. A major point of preference of this protocol is that a single route request can result in multiple route replies.

II. BACKGROUND

The AODV protocol is superior over Destination Sequenced Distance Vector(DSDV) routing [3].The two steps in ADOV are finding the routes and maintaining the route. Suppose if a node needs to send a data to the other node but do not have a proper route to deliver to the other node, the source starts a process of route discovery. Source sends a RREQ to all its neighboring nodes. The initiator node includes in the RREQ are its own sequence number; the broadcasting ID, in which the latest number of sequence the initiator has for the destination. The nodes between the source and the destination replies if it finds the destination route utilizing the sequence number, which is higher than or less to that mentioned in the Route Reply. For enhancing route performance, in between nodes documents the nearby node address from which they get the first broadcast packet. Now the return path is initiated. Other replies received are discarded. Once the RREQ finds its destination or an intermediate node with the new route to the destination, the destination node delivers a Unicast Route-Reply (RREP) message back to the neighbor from which it received the first copy of the RREQ. A timer for the route is kept with every route entry. This timer triggers the removal of the unused route entry in a particular lifetime. Another protocol followed in the route maintenance is the employment of hello messages. Frequent local interaction by a node tells its presence to other nodes. These messages ensure local connectivity. One of the methods used for recouping the path is the reception of hello messages to check whether the next hop is within reach. The limitation in AODV is the route discovery latency, which is very high and lacks efficient route maintenance technique.

The improvement of AODV protocol is that routes are fixed on destination and demand sequence numbers which are used to identify the current route to the destination. It also aids Unicast and Multicast packet data transmissions. It replies to the changes in the network topology and updates the nodes that might be affected, utilizing the RRER message. In a network, hello message is important for maintenance of the route, which is restricted so that they do not produce unneeded overhead[4].

In order to analyze the characteristics of MANET protocols (ADOV, DSR), several metrics need to be considered. In epidemic routing, multiple copies may be delivered to the destination [5].

Challenges in routing occur due to large number of nodes in the VANET environment. As the network goes from less to dense in a small amount of time, a scalability problem occurs. In DSR, the objective is reducing the bandwidth, which is used by the packets that controls the wireless network. In DSR there are two phases, discovery of route and maintaining the route. In the route discovery process, the source node sends the packet to destination by obtaining the source route. It is mainly used when the source needs to send the packets to the destination. When there is a change in topology of the network, the protocol has the ability to detect. In this case, it no longer use this exact route

to the destination because of the broken link. The maintenance is only required for this route when the source node is transmitting the packets to destination. The source includes the path for routing in its information packet and it is conveying to nearby nodes. If no proper routing path is found for the source to send the data, it then performs the recovery of the route by giving away more request to the network (RREQ). The demerits of this protocol are the performance decreases with a rise in mobility and cannot be used in larger networks [6].

III. PROBLEM IDENTIFICATION

Research has been done on MANET protocols, which can be utilized for VANET. In the study of AODV and Dynamic Source Routing (DSR), protocols were employed as the routing protocol and it was good for less mobility network. The delay and the routing load were less, and packet delivery ratio was high. The problem occurred in high mobile ad hoc network, which is Vehicular Network where the route discovery process is complex and so the delay and the routing load is increased. It requires high latency time in finding the routes, and also network clogging occurs due to excessive flooding. A better routing protocol is needed to reduce delay and routing load in VANET. It should also reduce the latency time.

IV. METHODOLOGY

In high traffic networks, the process for route discovery employing AODV Protocol becomes complex. This increases the communication delay and routing load. If the route discovery process consists of both pro-active and reactive techniques, the timing can be relaxed and the flooding process can be avoided. Flooding process makes the network unreliable and results in loss of the packet. In order to overcome the above problems, the route discovery process should be completed in a minimal time. The only way to complete the route discovery process with less control packets and time is to use a protocol that uses zones to find the routes and send the packet. So we use zone routing protocol, [7] which is both on-demand and table driven. For routing the packets within the zone it utilizes Intra-Zone routing, which is table driven while nodes outside the routing zone utilizes Inter-zone routing process, which is on-demand. By using this protocol in high mobile ad hoc network the parameters like communication delay and the routing load can be compromised.

V. ANALYSIS

At first this research considers a Vehicular ad hoc network environment where the routing protocol has to be deployed. In the VANET environment the Vehicles in roads move with usual road rules. They are inhibited to drive straight in a high traffic condition on a linear road. The speed limit is 40 miles per hour to 90 miles per hour. Vehicles i.e. nodes, are placed randomly on the road at a 2000 feet distance. We take a highway, which has two lanes, and 40 vehicles travelling in it. In which, 20 vehicles move in one direction and 20 in opposite direction. Road Side Units (RSUs) are used to establish communication between the vehicles. All the units will be connected to the WiMAX network, also known as the base station. The communication will be via internet and the active server is the cloud. Location of the vehicles is obtained by the GPS, which will be useful for vehicle-to-vehicle communication. There are many parameters in this scenario, the communication delay and the routing load are specifically used in this research. Delay is the amount of period taken by packets between the receiving node from the sending node. Routing load means the number of control packets which has been transmitted to deliver the data at the destination. In the Figure a VANET scenario is shown to understand the proposed mechanism.

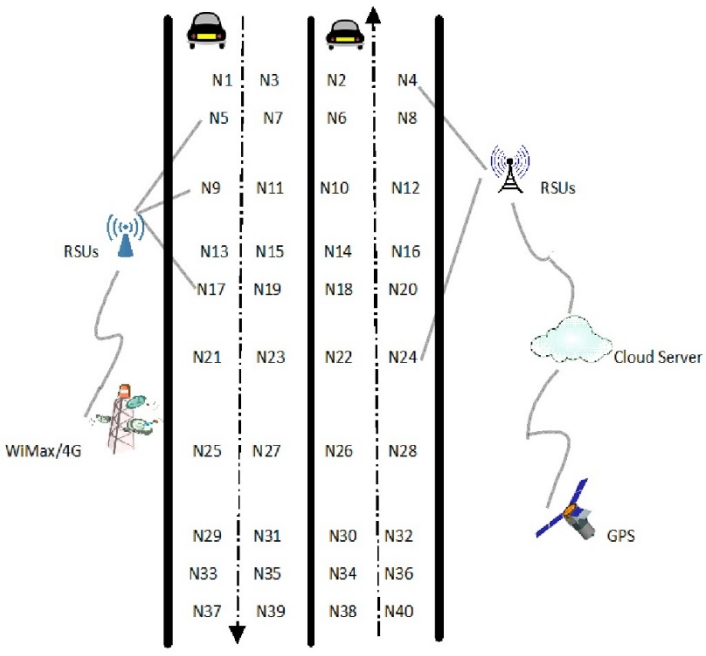

Fig 1: Vanet Environment

Vehicles are represented as nodes from N1 to N40. Zone Routing Protocol is employed for delivering the data efficiently from one node to the destination node. The routing zone for node 1 and node 11 is shown in fig2. Suppose if the nodes from 1 to 10 want to communicate i.e. in its routing zone it uses Intra-Zone Routing Protocol in which it uses the routing table to find the destination node. In other case if N1 wants to send a data packet outside the routing zone, Inter-zone Routing Protocol is utilized which is On-Demand.

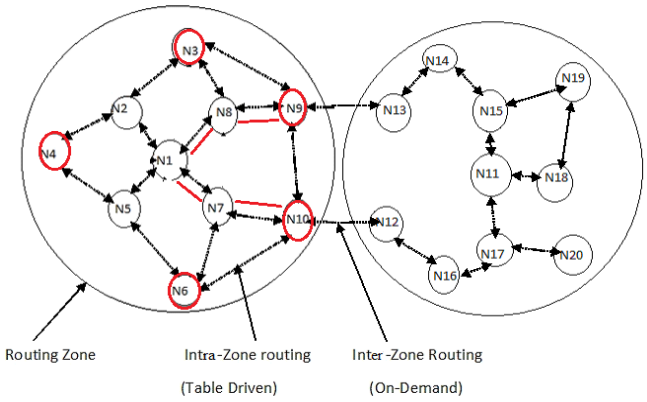

Fig 2: Finding the path

Consider a situation where node 1 wants to send data packet to node19. Here Source node is N1 and destination node is N19. To send the packet to the destination node it has to find the path first. Node goes through its routing table for N19 utilizing Intra-Zone Routing Protocol. Since the node (N19) is not in its own routing zone it initiates the route requests utilizing Inter-Zone Routing protocol. The requests are border casted to the peripheral nodes. Here the peripheral nodes for N1 are N9 and N10. Now N9 and N 10 goes through its own routing table for the node N19.

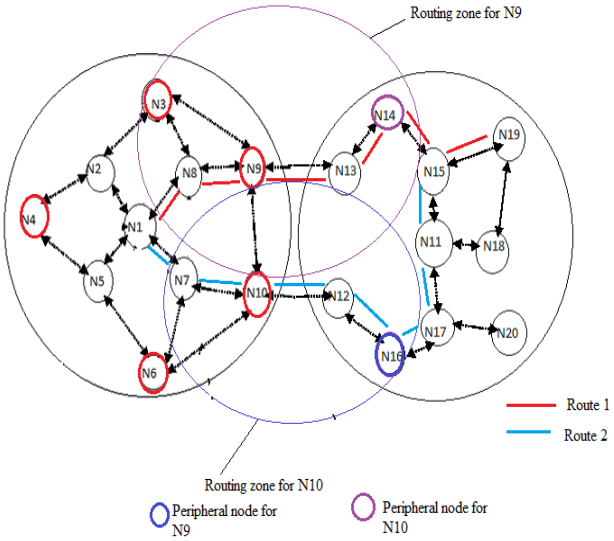

Fig3: Flow of Data Packet

The routing zone for N 9 and N10 is shown in Fig 3. Since the nodes cannot find the destination N19 in its routing tables it needs to send to peripheral nodes utilizing border casting. The peripheral node for N9 is N14 and for N10 its N16. Now the nodes examine their routing table for N19. Since N19 is in the zone of N14 it adds the path from itself to N1 using the route request path. Finally, it sends the generated reply route back to the N1. Another path is also generated by the node N16 and sent to N1. Now N1 gets multiple route replies. Among the replies it uses the shortest path to the N19 and sends the data packet. The shortest path is N1-N8-N9-N13-N14-N15-N19.In this way, the route discovery process is done and it reduces the delay for N1 and N19 to communicate. Also less control packets are sent compared to AODV to find the path to the destination, which reduces the Routing Load.

VI. CONCLUSION

In this paper, we considered a high mobile ad hoc network scenario and the route discovery process time is relaxed using Zone Routing Protocol. This protocol provides a better communication delay and routing load in high mobility environments compared to AODV and DSR protocols.

VII. REFERENCES

1. Chaurasia, B.K., et al. *Suitability of MANET routing protocols for vehicular ad hoc networks*. in *Communication Systems and Network Technologies (CSNT), 2012 International Conference on*. 2012. IEEE.
2. Zhang, X. and L. Jacob. *Adapting zone routing protocol for heterogeneous scenarios in ad hoc networks*. in *Parallel Processing, 2003. Proceedings. 2003 International Conference on*. 2003. IEEE.
3. Khiavi, M.V., S. Jamali, and S.J. Gudakahriz, *Performance comparison of AODV, DSDV, DSR and TORA routing protocols in MANETs.* International Research Journal of Applied and Basic Sciences, 2012. **3**(7): p. 1429-1436.
4. Paul, H. and P. Sarkar, *A study and comparison of OLSR, AODV and ZRP routing protocols in ad hoc networks.* International Journal of Research in Engineering and Technology, 2013. **2**(8).
5. Adam, N., M. Ismail, and J. Abdullah. *Effect of Node density on performances of three MANET Routing Protocols*. in *Electronic Devices, Systems and Applications (ICEDSA), 2010 Intl Conf on*. 2010. IEEE.
6. Royer, E.M. and C.E. Perkins. *An implementation study of the AODV routing protocol*. in *Wireless Communications and Networking Confernce, 2000. WCNC. 2000 IEEE*. 2000. IEEE.
7. Haas, Z.J., M.R. Pearlman, and P. Samar, *The zone routing protocol (ZRP) for ad hoc networks.* draft-ietf-manet-zone-zrp-04. txt, 2002.