Collation of DSR, ZRP and FSR Routing Protocols in Sub Urban Environment of Vehicular Networks

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Abstract— **The increasing demand of wireless communication and the needs of new wireless devices have tend to research on self organizing, self healing networks without the interference of centralized or pre-established infrastructure/authority. Vehicular Ad hoc Networks (VANET) is the subclass of Mobile Ad Hoc Networks (MANETs). The communication may be of 3 types- 1.inter-vehicle communication 2.vehicle to roadside communication 3.inter-roadside communication i.e communication between roadside unit and the base station. Network connectivity is the key factor for frequent link breakage and high mobility of vehicles as it greatly affects the VANET performance. Performance of communication between vehicles depends on various routing protocols. In the following sections we compare DSR, ZRP and FSR in sub urban environment based on their performance metrics.**

Keywords— **connectivity, VANET, wireless, routing protocols**

I. INTRODUCTION

The topology based routing protocols are further divided into three different categories for vehicular ad-hoc data networks, according to [6]: Proactive, reactive and hybrid.The first is a proactive routing protocol, which relies on the periodic broadcast of data network topology. In these protocols the tables updating regularly and send the information from one node to another. Proactive routing protocols also called the table driven protocols due to its nature. There are two types of updating available in proactive protocol. They are periodic update and triggered update which are due to broadcast the update tables they waste power and bandwidth in the network[7]. In proactive protocols, table size is increase when nodes are added in networks due to this the load increase. Because of this, Fisheye State Routing (FSR) protocol is proposed. The second category, reactive routing protocols which are opposite to proactive protocols they cannot maintain tables when the topology changes. In these types of protocols, the query floods into the network when a source node want to transmit the data and discovered route is stored until other node is in accessible. They deal cache routes and how routes replies and led. One of the popular reactive protocols is Dynamic Source Routing (DSR). Third one is hybrid routing protocol which is combination of both proactive and reactive routing protocols. One of most popular example is ZRP(Zone Routing Protocol).

II. DESCRIPTION OF TOPOLOGICAL ROUTING PROTOCOLS IN VANET

In this section, we will give a brief description about the most common topological routing protocols implemented in Qualnet 5.0, namely, Dynamic Source Routing (DSR), Zone Routing Protocol (ZRP) and Fisheye State Routing Protocol (FSR).

A. *Dynamic Source Routing*

Dynamic Source Routing (DSR) is on-demand routing protocol that was specifically designed for use in multi-hop vehicular ad-hoc networks [8].and it is completely self organizing protocol. It has two mechanisms:

1) *Route Discovery*: Route discovery is the process that the DSR algorithm uses to find a route to send a packet from source to destination. When no route is present the source node transmits a route request (RREQ). Each node broadcasts the message until it reaches the destination. Each route request carries a sequence number which is used to prevent loop formations and to avoid multiple transmissions of the same route request by an intermediate node. Sequence number is generated by the source node based on the path it has traversed. Once the packets reached at the destination node, that node will send back a route reply (RREP) to the source. The

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source node selects the best path and use that for sending data packets.
2) *Route Maintenance:*Allows for the topology of the network to change and a nodes routing table to remain fresh. DSR does not use any type of periodic packets or messages at any level. When data packets traversed from source to destination an intermediate node learns about route breaks. DSR allows piggy backing of a data packet on the route request so that a data packet can be sent along with the route request. When an intermediate node in the path moves away, causing a wireless link to break. In this situation, a route error(RERR) message is generated from the node adjacent to the broken link to inform the source node. The source node again initiates the route establishment procedure.

B. Zone Routing Protocol

Zone Routing Protocol is a hybrid routing protocol which contains the best features of proactive and reactive routing protocols and it decreases the delay and high overhead for discovering the route. Further, the protocol divides into zone distinct and overlapping zones as a group of nodes and the nodes are in zone radius. The zones are creates on the base of hop distance and chosen through topological distribution of nodes. At the edge of zone, the nodes are called peripheral nodes. The size and radius of length is determined by the radius of length α where α is the number of hops to the perimeter of the zone. The function of peripheral nodes are route discovery outside zone and for this a reactive approach is used Intra-zone routing protocol (IERP). A proactive routing protocol is used in inside the zone that is called Intra-zone Routing Protocol (IARP).

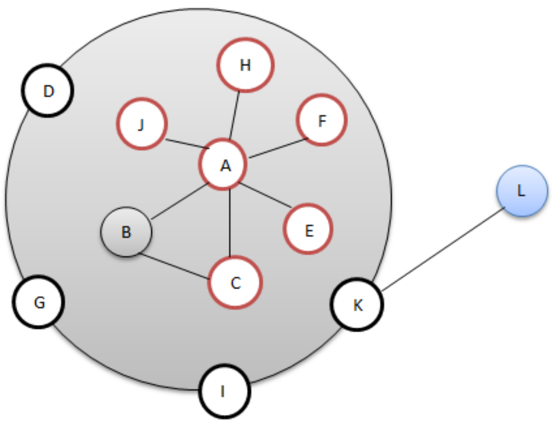

Figure 1 ZRP having Zone radius α =2

In the above diagram ZRP, protocol having Zone radius 2 therefore the zone communication done in proactive way and outside the zone it has been done in reactive way.A, E, F, H, J, C are present inside the zone and D, G, I, k are border nodes. The communication between B and K is done through proactive way and L is located outside the zone.ZRP consist of [2] two parts IARP proactive part,IERP reactive part.

1) IARP (INTRA ZONE ROUTING PROTOCOL):

The Intra zone Routing Protocol (IARP) [3] is a limited scope of proactive routing protocol. The routing zone radius shows the scope of the proactive part, the distance in hops that IARP route updates relayed. IARP's proactive tracking of local network connectivity provides support for route acquiring and route maintenance. First,routes to local nodes are immediately available which avoids the traffic overhead and latency of a route discovery. Traditional proactive link state protocols are modified in order to serve as an IARP by limiting link state updates to the scope of the link source's routing zone.

*2) IERP (INTER ZONE ROUTING PROTOCOL)***:**

The Interzone Routing Protocol (IERP) is the global reactive routing component of the Zone Routing Protocol(ZRP). It is responsible for finding the route to the destination node which is present outside the zone. IERP effectively uses the available information produced by each node involved in zone routing protocol. Routing protocol initially checks the zone whether the destination node is present within the zone or not. If the destination node is present inside the zone, then the source node will deliver the packets directly to that node by using IARP. Otherwise the source node will rebroadcast the route request message to its peripheral nodes and find the destination node which is present outside the zone by using IERP.

C. Fisheye state routing protocol

FSR is a type of proactive routing protocol. It uses the fisheye technique to reduce information required to represent graphical data, to reduce routing overhead. The basic principle behind this technique is the property of a fish's eye that can capture pixel information with greater accuracy near its eye's focal point.

Algorithm:
There are 3 main procedure in the routing protocol:
Neighbor Discovery: It is responsible for establishing and maintaining neighbor relationships.
Information Dissemination: It is responsible for disseminating Link State Packets(LSP), which contain neighbor link information, to other nodes in the network.
Route Computation: It is responsible for computing routes to each destination using the information of the LSPs.

Each node initially starts with an empty neighbor list and an empty topology table.After its local variables are initialized, the Neighbor Discovery

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mechanism is takes place toacquire neighbors and maintain current neighbor relationships. LSPs in the network aredistributed using the mechanism called Information Dissemination. Each node has a databaseconsisting of the collection of LSPs originated by each node in the network. From thisdatabase, the node uses the Route Computation mechanism and thus yield a routing table for theprotocol. This process is periodically repeated.

1) Neighbor discovery:

This mechanism is responsible for establishing and maintaining neighborrelationships. Neighbors can meet each other simply by transmitting a special packetover the broadcast medium. In the wireless network, packetsare periodically broadcasted and nodes within the transmission range of the sending node will hear these special packets and record them as neighbors. Each node associates a TIMEOUT value in the node's database for each neighbor. When it does not hear apacket from a particular neighbor within the TIMEOUT period, it will removethat neighbor from the neighbor list. TIMEOUT values are reset when a message is heard. Packets also contain the list of routers whose packets have beenseen recently. Nodes can use this information to detect the presence of uni-directional orbi-directional links by checking if it sees itself listed in the neighbor's Packets.

2) Information Dissemination:

This mechanism is responsible for distributing LSPs to the nodes in the network.It has two main functions are to handle the LSP integrity and updating interval.

LSP Integrity

After the router generates a new LSP, the new LSP must be transmitted to all theother routers. A simple scheme is flooding, in which each packet received is transmittedto each neighbor except the one from which the packet was received. Because eachrouter retains the most recently generated LSP from other nodes, the router can recognizewhen it is receiving a duplicate LSP and refrain from flooding the packet more than once.The problem with this flooding is that a router cannot assume that the LSP mostrecently received is the one most recently generated by that node. Two LSPs could travelalong different paths and might not be received in the order in which they weregenerated. A solution to this is to use a scheme involving a combination of a sequencenumber and an estimated age for each LSP.A sequence number is a counter. Each router keeps track of the sequence numberit used the last time it generated an LSP and uses the next sequence number when it needsto generate a new LSP. When a router receives a LSP, it compares the sequence numberof the received LSP with the one stored in memory (for that originating node) and onlyaccepts the LSP if it has a higher sequence number. The higher the sequence number, the more recently generated. However, a sequence number alone is not sufficient. The sequence numberapproach has various problems:

1.The sequence number field is of finite size. A problem arises when a node creates a LSP to case the field to reach the maximum value. Making the sequence numberfield wrap around is not a good idea because it causes ambiguity on the relation of thesequence numbers.

2.Sequence number on an LSP becomes corrupt. If the sequence field is corrupted to avery large sequence number, it will prevent valid, newer LSPs (with smaller sequencenumbers) to be accepted.

3.Sequence number is reset. When a router goes down or forgets the sequence numberit was using, newer LSPs cannot be distinguished from older LSPs. To solve the preceding problems, an age field is added to each LSP. It starts at somevalue and is decremented by routers as it is held in memory. When an LSP's age reaches 0, the LSP can be considered too old and an LSP with a nonzero age is accepted as new,regardless of its sequence number.

Update Interval

The key difference between fisheye and traditional Link-state is the interval inwhich the routing information is disseminated. In Link State, the link state packets aregenerated and flooded into the network whenever a node detects topology changes.Fisheye uses a new approach to reduce the number of LSP messages. In [1], Kleinroch and Stevens proposed the fisheye technique to reduce the size of information required to represent graphical data. The original idea of fisheye wasto maintain high resolution information within a range of a certain point of interest andlower resolution further away from the point of interest. For routing, this fisheyeapproach can be interpreted as maintaining a highly accurate network information aboutthe immediate neighborhood of a node and becomes progressively less detailed as itmoves away from the node.

The reduction of routing messages is achieved by updating the network information for nearby nodes at a higher frequency and remote nodes at a lowerfrequency. As a result, considerable amount of LSPs are suppressed. When a nodereceives a LSP, it calculates a time to wait before sending out the LSP from the followingequation:

Update Interval = Constant Time * hop count^alpha

Constant Timeis the user defined default refresh period to send out LSPs,hopcountis the number of hops the LSP has traversed, alpha is a parameter thatdetermines how much effect each scope has on the UpdateInterval. Values for alpha arezeroand greater than or equal to one(fisheye). A maximum

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value of Update Interval is established to prevent an effective complete suppression of LSPmessages(when calculated UpdateIntervalis too large).

When a router accepts a LSP from a faraway node, and has not yet sent out theLSP in memory, the next time it will send out the LSP will be the minimum of the timeleft to wait in memory and the new calculated Update Interval based on the new LSP:

Update Interval(new) = MIN(Update Interval(memory), Update Interval(LSP))

This is to prevent a router from waiting indefinitely to send out a LSP when a new LSParrives before the one in memory is sent out for that node.

3) Route Computation:

Once the router has a database of LSPs, it computes the routes based on the Djikstra's algorithm which computes all shortest paths from a single vertex. The linkmetric used for path cost is the hop count. The algorithm uses 2 databases:

1.Link State Database- Contains the LSPs the node received.

2.PATH- contains ID, path cost, forwarding direction tuples. Holds the best path found.

III. METRICS FOR PERFORMANCE EVALUATION

A. *Packet Delivery Ratio:* The ratio between the number of packets received by a destination node to the number of packets transmitted by a source node.

B. *Average End to End Delay*:The end-to-end delay is defined as the average amount of time spent by the transmission of a packet that is successfully delivered from the source to the destination.

C. *Jitter*:The time difference in packet inter-arrival time to their destination or simply defined as variation in the delay of received packets.

IV. SIMULATION RESULTS AND EVALUATION

In this section , we study the performance of DSR,ZRP and FSR by using Qualnet version 5.0. DSR,ZRP and FSR are the most fundamental types of on-demand, hybrid and table-driven routing protocols which are most widely used in VANET scenario. To analyse the connectivity of network, some parameters are measured such as packet delivery ratio, jitter and average end-end delay based on varying number of vehicles.

A. Simulation Setup

Simulation environment has taken as suburban area with 1500m x1500m and the environment has various obstacles. Therefore, two-ray model has been chosen with frequency range of 2.4GHz. Flag shows the mobility of vehicles in the constructed area. VANET scenario for sub-urban environment has been shown for 10 vehicles with Wi-Fi connectivity and protocols has been chosen as DSR, ZRP and FSR. Simulation parameters has been shown in Table 1.

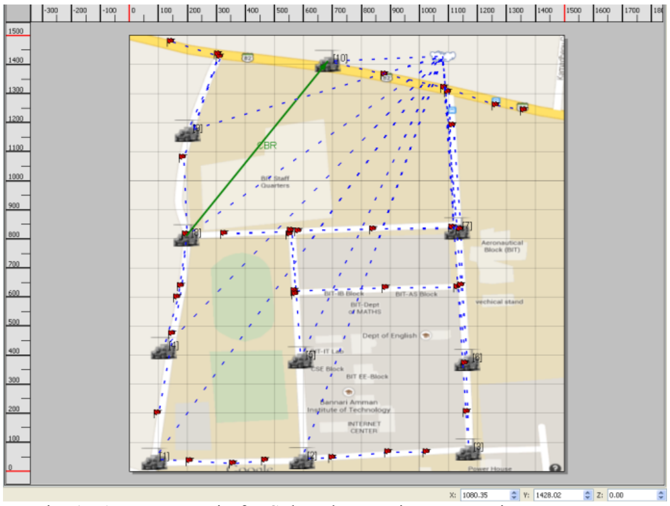

Fig. 1VANET scenario for Sub-Urban environment using QUALNET 5.0

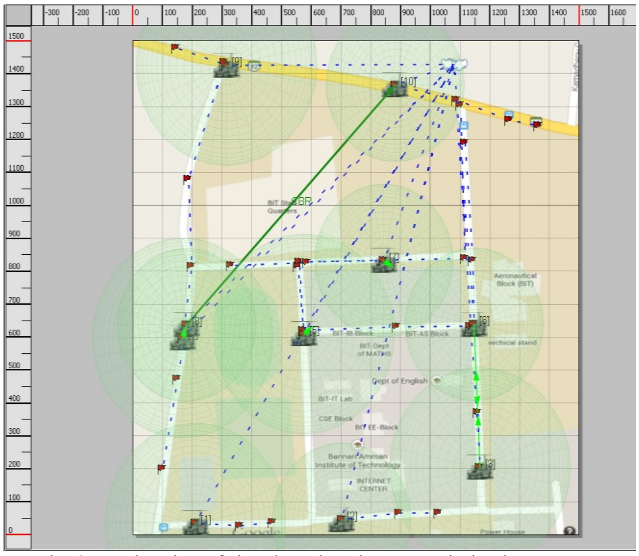

Fig. 2Broadcasting of signals and packet transmission by DSR,ZRP and FSR

Simulation Parameters

Parameters	Setting
Simulation Area	1500m x 1500m
Transmission Range	250m
MAC Protocol	802.11
Traffic Type	CBR
Path Loss Model	Two-Ray
Data Rate	2Mbps
Number of Vehicles	5-25
Simulation Time	300s

Table 1

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B. Result and Analysis

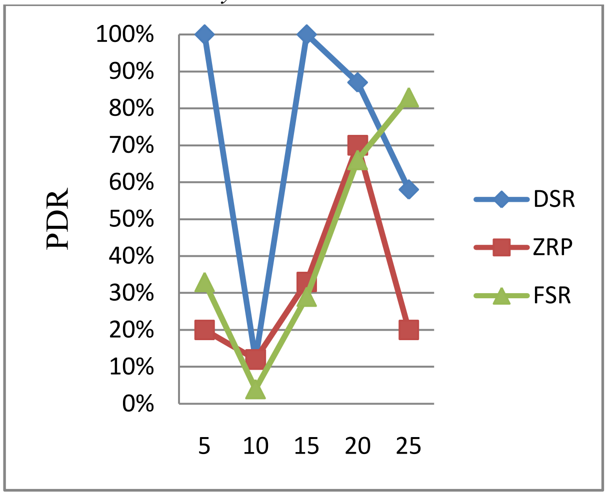

Fig. 3 Number of Nodes Vs PDR

As shown in Figure 3, we compare the performance of the three protocols in terms of packet delivery ratio. We find DSR and ZRP has low level of packet delivery ratio when increases the number of vehicles compared to FSR. To indicate the better connectivity of network, FSR achieves 85% of packet delivery ratio when number of vehicles has increased by 25 and also increases the speed of the vehicles. Hence, FSR is suitable for large and highly vehicular ad hoc wireless networks compared to DSR and ZRP.

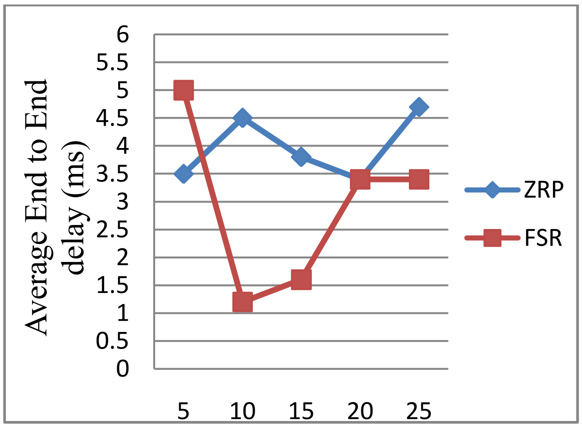

Fig. 4No of Nodes Vs Average End to End delay

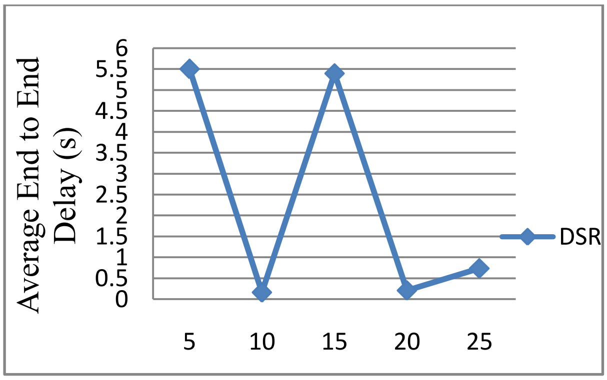

Fig. 5Number of Nodes Vs Average End-End Delay

Figure 4 and Figure 5 shows the performance of the average end-to-end delay. We can learn that the average delay of ZRP is nearly 4.9ms when there are 25 vehicles in the network. For DSR, the delay reaches to 0.7s when there are 25 vehicles in the network. The delay of FSR achieves 3.5ms average gain compared with ZRP. This is due to the reason that FSR significantly reduces the bandwidth consumed by link sate update packet and achieves network transmission reliability.

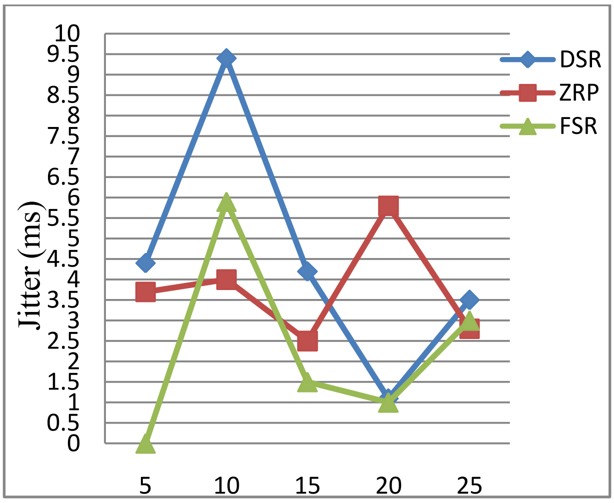

Fig. 6No of Nodes Vs Jitter

Figure 6 shows the performance of jitter with the number of nodes for DSR, ZRP and FSR. For DSR, the minimum value of jitter is 1ms and the maximum value is 9.5ms. For ZRP, the jitter value for 25 nodes is 2.7ms. For FSR, the jitter value is 3ms for 25 nodes present in the network. This can be achieved due to FSR maintains the topology of the network at every node, but does not flood the entire network with the information. Instead of flooding, a node exchanges topology information only with its neighbors.

V. CONCLUSIONS

In this paper we are discuss the different topological routing protocols which are usedin v2v communication. Routing is the backbone of the network. So the major challenge is todesign protocol in VANET is to improve reliability of Protocols and to reduce delivery delaytime. Based on performance of DSR, ZRP and FSR, FSR gives lower latency when the number of nodes are increased by using the fisheye technique. Also it produce high packet delivery ratio which sates that the connectivity of VANET during communication has also improved.

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