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Evaluating the Impact of Routing Protocol on VANET

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ABSTRACT

Vehicular Ad Hoc Networks (VANETs) are self-organizing, self-healing networks that offer wireless communication among vehicles and roadside equipment. Providing safety and comfort for drivers and passengers is a promising goal of those networks. Designing an applicable routing protocol according to the network application is one among the essential necessities for implementing a victorious vehicular network. In this paper, we tend to report the results of a study on routing protocols associated with conveyance applications and their communication desires. The main aim of our study was to spot that routing technique has higher performance in extremely mobile environment of VANET. The thesis works is based on comparison between Ad hoc on demand Distance Vector routing protocol (AODV), Modified Ad hoc on demand distance vector routing (MAODV) and Destination sequenced distance vector routing (DSDV) in VANET on the basis of packet delivery ratio and end-to-end delay. The tool which we used for the work of performance is Network Simulator 2 (NS-2).

Keywords : MANET, VANET, Routing protocol, MAODV

I. INTRODUCTION

VANET might be a specific category of Mobile Ad-Hoc Network (MANET) that offers communication between the vehicles and the vehicles and roadside infrastructure. VANET differs from MANET because it provides advanced quality of nodes, bigger scale networks, geographically unnatural topology and frequent network fragmentation. There are no fixed infrastructure networks and have confidence the vehicles themselves for implementing any network practicality. A VANET may be a reorganized network as each node accomplishes the functions of host and router.

It is the technology [1] of building secure networks between vehicles, i.e., vehicles communicate to every alternative and pass information to another vehicle. The most favorable position of VANET communication is the enhanced driver's safety by virtue of exchanging warning messages among vehicles. VANET security is essential because of an inadequately planned VANET is vulnerable to organize to network attacks and this successively compromises the protection of drivers. Security systems have to make sure that transmission comes from an approved source and not interfered in the path by different sources. Security frameworks need to ensure that transmission originates from an approved source and not altered in the course by various sources.

Accidents can be avoided if the vehicles follow the traffic rules and road limit. The malicious node could spread out spam messages and send false messages to make matters like false data of collision and theft and heavy traffic. VANET has become a rising space of investigation. Researchers have put lots of efforts [2] in this field to create the robust plan and the implementation of VANET network environment. With the expanding amount of the vehicles, streets can most likely get more rushful. Therefore, it is exceptionally important to expand street protection and decrease movement blockage. In VANET, the communication is built up by exchanging the refreshed data about the street and movement conditions to avoid road accidents and efficient result of traffic. VANET is utilized to give the assurance and movement reports to the clients about congested driving conditions, earthquake, tsunami, etc. for lessening the road accidents, fuel consumption and provides safe driving atmosphere.

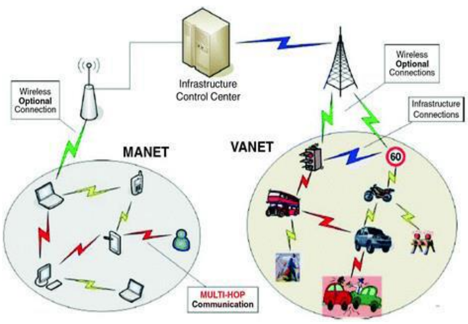

Figure 1 : Architecture of MANET and VANET.

II. METHODS AND MATERIAL

2.1 Wireless Ad-hoc Network

Wireless Ad-hoc network is defined as a network which doesn't have a pre-existing communication infrastructure. Network is created by some available nodes. In this type of network, determination of which nodes is to transfer data to which node is done dynamically, depending upon the connectivity of both devices. In routing, ad-hoc networks can use flooding for forwarding the data. An ad-hoc network refers to a temporary network connection created for a specific purpose. It is a set of networks where all devices are free to associate with any other ad-hoc network devices in link range. Very often, ad hoc network refers to a mode of operation of IEEE 802.11 wireless networks.

1.2 Ad-hoc routing protocol

An ad-hoc routing protocol is a standard, that controls the nodes and decide which way to route packets between computing devices in a mobile ad hoc network. In ad-hoc networks, nodes are not intimate with the topology. The basic plan is that a brand new node could reveal its presence and should keep an eye on its neighbors for broadcast the message. Each node learns regarding nearby nodes and way to reach them. The following is a list of some ad hoc network routing protocols.

1.3 VANET Routing Protocols

All of the quality wireless protocol companies are experimenting with VANET. This includes all the IEEE protocols, Bluetooth, Integrated Resource Analyses (IRA) and Wi-Fi. There are also VANET experiments using cellular and satellite technologies. Dedicated Short Range Communications (DSRC) is a protocol that has been specifically to be use with VANET. DSRC has many advantages: it is already operating at 5.9 GHz, it is easy to individualize and it is oriented to the idea of transmitting along a street grid framework as against to the Omni-directional transmission, which is standard for wireless protocols. Vehicular ad-hoc networks boost to the complexness because the nodes are travelling at high rates of speed. Overall, VANETs should work in all style of traffic i.e. high and low vehicle density atmosphere in urban and rural environment respectively. This generates a challenge for the hardware design for VANETs. Because for example in low density vehicle atmosphere the number of vehicle will be less so some vehicles will be out of range for communication. In high density vehicle environment sharing of bandwidth is a challenge for VANET.

2.3.1. MAODV

Multicast protocol is a technique that advantages within the important reduction of network loads when packets have to be compelled to be transmitted to a bunch of nodes. Multicast protocol should guarantee the performance requirements: pliable to the dynamic amendments of network topology, timeliness, minimizing routing overhead and efficiency etc. Multicast is a communication approach for groups on information source using the single source address to send data to hosts with same group address. MAODV topology relies on multicast tree adopting broadcast routing discovery mechanism to search multicast routing, that sends information - packets to every cluster nodes from data source.

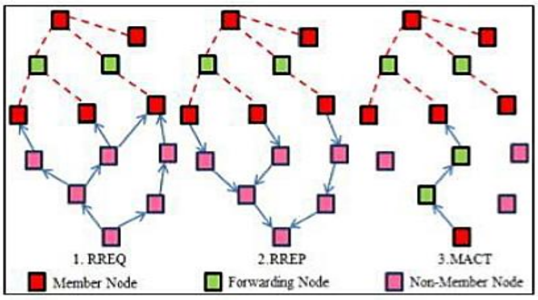

Figure 2 : MAODV Protocol

1) Route Discovery

MAODV use route request (RREQ) and route reply (RREP) that exist already in AODV. If a node needs to join in or send messages to a multicast group whereas there's no path to the multicast group, it'll broadcast a RREQ, any multicast group member can answer the request message if necessary. If RREQ isn't a Join Request, any node with updated (serial number is greater than RREQs) routing path will respond directly. If non-multicast node receives RREQ request, or the node isn't available to the target group, it will forward RREQ directly.

2) Route Maintenance

a) Multicast Tree Maintenance: Group leader maintains the multicast groups' serial number by broadcasting Group Hello periodically. Group Hello is extended from the Hello message in AODV, which is consisted of multicast address, multicast serial number, hop count and TTL (Time to live).

b) Node Leave: If the node isn't a tree leaf, it still can act as a router solely by setting multicast address zero, else it'll send Add and Prune (P marked MACT) to prune itself. When it is upstream node receives P-marked MACT, it will delete this node from its multicast routing table. If the node is a multicast member or not a tree leaf, the prune process ends, else send the P-Marked MACT to its upstream node continuously.

c) Disconnection Repair: When the link is disconnected due to node mobility or other reasons, it'll broadcast RREQ to re-join in the multicast group, only the member with latest serial number and its hop less than multicast group hop can respond. If the upstream node which has lost its node isn't a multicast group member, and becomes the tree leaf, then it will set the timer to rebuild and if in certain period, it is still not be activated, the Add and Prune will be sent to prune the node itself. If the network is divided due to the repair failure, the divided network needs new group leader. If the nodes initiating repair is a multicast group member, then it will become the group leader, or the new group leader will be selected by sending G-Marked MACT.

d) Tree Merge: When the node receives Hello message, if it is a multicast group member and contains group members of the lower address group leader, it will initiate tree-rebuild process.

2.3.2 Link Repair Mechanism of MAODV

In MAODV, once a link breakage is detected, the downstream node is responsible for initiating the repair procedure. In order to repair the tree, downstream node broadcasts RREQ-J message with multicast group leader extension included. The multicast group hop count field in multicast group leader extension is ready to adequate node's current distance to multicast group leader, only nodes no further to the group leader can respond. A node receiving the RREQ-J respond by unicasting a RREP-J on condition that it satisfy the subsequent constraints: It's a member of the multicast tree, its record of the multicast group sequence number is at least as great as that contained in RREQ-J and its hop count to the multicast group leader is smaller or an adequate to the contained within the multicast group hop count extension field. After waiting for RREP-J wait time, the source node selects the best path from the RREP-J messages received and subsequent route activation is performed by a MACT-J message. Once the repair is finished, it is likely that the node which initiated the repair is now at a different distance to the group leader. In this case, it must inform its downstream nodes about their new distance to the group leader. The node performs this task by broadcasting a MACT-J message with the new hop count to leader contained. When a downstream node receives the MACT-J message and determines that this packet arrived from its upstream node, it increments the hop count value contained in the MACT-J and updates its distance to the group leader. The problem associated with this link repair mechanism is that the shortest path to the group leader is not ensured and it can lead to tree partitioning.

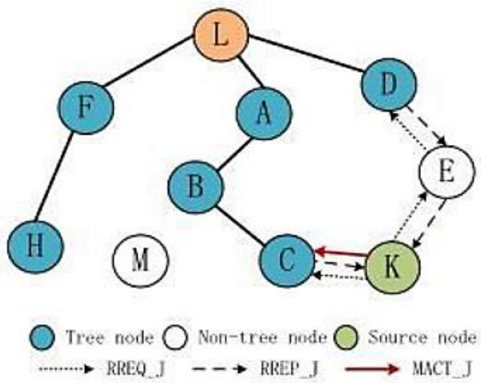

Figure 3 : Link Repair Mechanism of MAODV

III. RESULT AND DISCUSSION

In an ad-hoc network to evaluate the performance of a protocol, it's necessary to check the protocol under realistic conditions, particularly as well as the movement of the mobile nodes. Surveys of different mobility models have been done. This includes the Random Waypoint Mobility Model that's utilized in our work.

1. **Packet Delivery Ratio**: The packet delivery ratio is the ratio of successfully delivered packets at the destination to the packets sent by the sender. It represents the success rate of packets transmission that is in a given interval of time, how many packets are able to reach the destination out of the whole packets which were transmitted. It is a function of packet drops or lost packets because of router congestion, routing algorithm efficiency and queuing delays at the routers. An efficient routing protocol with ensure a high packet delivery ratio. It describes the success rate of the protocol from source to destination and is given by the formula:

$$PDF = \frac{No. of\ received\ packets}{No. of\ sent\ packets} * 100$$

2. **End to end Delay:** The end-to-end delay represents the total time taken by the data to reach from sender to receiver's side and comprises of all the various delays experienced by the packets throughout their journey from source to destination. For average end-to-end delays each delay is added for successively packet and is divided by the number of successively received packet. A lower value of end-to-end delay in a routing protocol represents efficient routing protocol, quick routes convergence and packets traversing the best routes. The end-to-end delays are significant for video and voice data transmissions. The formula for end-to-end delay is as follows:

$$End - to - End\ delay = \frac{1}{N}\sum_{n=1}^{N}(\mathrm{Rn} - \mathrm{Sn})$$

Where

Sn = Time at which nth data packet is sent

Rn = Time at which nth data packet is received

N = Number of data packets received

For better understanding of our work i.e. evaluation of routing protocol under VANET environment we have framed our work in three scenarios which consist of some energy efficient protocol for now we have taken AODV, DSDV, MAODV in consideration and performed a comparative study by implementing respective protocols on a custom generated topography. Then we've analyzed the results on the premise of various performance matrices such as Packet Delivery fraction and End to End Delay. In our work we have performed 3 simulations First scenario is with a normalized AODV protocol. Second is for DSDV Protocol then with the MAODV Protocol on a standard VANET environment. The simulation is done using NS-2 simulator, to analyze the performance of the network by applying various types of data flow following parameters has used to evaluate the performance of the work done which are as given below:

1. **Packet Delivery Ratio:** Figure shows the PDR under varying mobility of nodes i.e. 15, 25, 35 and 45 nodes under AODV, DSDV and MAODV Protocols.

Table 1: Packet Delivery Ratio

PDR	AODV	DSDV	MAODV
15 NODES	98.98	97.81	99.03
25 NODES	98.43	96.76	99.53
35 NODES	98.18	95.71	99.15
45 NODES	98.37	93.92	99.28

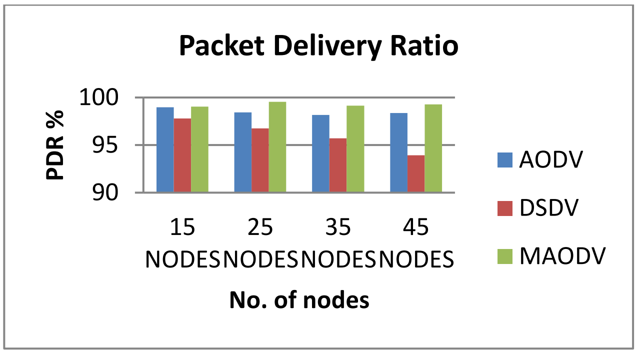

Figure 4 : Packet Delivery Ratio

2. **End to End Delay:** Figure shows the average End to End Delay in milliseconds under varying mobility of nodes i.e. 15, 25, 35 and 45 nodes under AODV, DSDV and MAODV protocols.

Table 2 : End-to-End delay

E-2-E DELAY	AODV	DSDV	MAODV
15 NODES	222.597	196.704	202.633
25 NODES	142.818	261.295	124.504
35 NODES	210.927	188.467	193.458
45 NODES	234.85	174.538	210.979

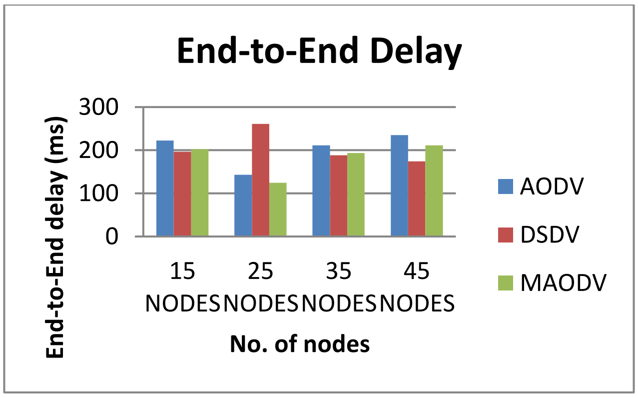

Figure 5: End–to-End Delay

IV. CONCLUSION

VANET provides the communication within the network and there are various methods which are used to deliver the messages among the vehicles. In this paper our simulation work illustrates the performance of three routing protocols AODV, DSDV and MAODV. The paper presents a study of the performance of routing protocols, used in VANETs, in high mobility case under low, medium and high density scenario. We vary the number of nodes from 15 (low density) to 45 (high density). From all the tabulations and graphs as far as Throughput is concerned, AODV perform better than the DSDV even when the network has a large number of nodes, it is clear that AODV and DSDV are performing their best at their less number of nodes. Average End-to-End Delay MAODV routing protocol shows constant performance if the numbers of nodes are increased. In this paper, we have done complete analysis of the three VANET's routing protocols. Our future plan is to evaluate security issues in VANET.

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