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Design and Analysis of AODV Routing Protocol in VANET Using NS-2

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Abstract: In last three decade ,tremendous improvement is made in research area of wireless adhoc network and now a days ,one of the most attractive research topic is inter vehicle communication i.e. realization of mobile adhoc network . AODV routing protocol is used to implement the Intelligent Transport Systems (ITS) concepts in VANET. A simulation is performed using AODV routing protocol in NS2 to study the hurdles involved in providing a secure and data transfer between the vehicular nodes. The data analysis is done based on the results collected from the simulation environment. The data's are traced out to find the absolute details of the network. Finally, the graphs are plotted for Throughput , E2EDelay and PDF.

Keywords: MANET, VANET, ITS ,AODV,NS2,etc.

I. INTRODUCTION

MANETs consist of mobile/semi mobile nodes with no existing pre-established infrastructure. They connect themselves in a decentralized, self-organizing manner and also establish multi hop routes. If the mobile nodes are vehicles then this type of network is called VANET(vehicular adhoc network). One important property that distinguishes MANET from VANET is that nodes move with higher avg. speed and number of nodes is assumed to be very large. Vehicular networks consist of vehicles and Road Side Units (RSU) equipped with radios. Plummeting cost of electronic components and permanent willingness of manufacturers to increase road safety and to differentiate themselves from their competitors vehicles are becoming “Computer on Wheels” rather than “Computer N/W on Wheels”. Convergence of forces from both the public and private sector implies that in not-too-distant future we are likely to see the total birth of vehicular n/w.

The wealth of information that could be obtained from vehicular networks is quite enormous, ranging from location and speed of emergency alerts and request for roadside assistance. In particular, many envisioned safety related applications require that the vehicles continuously broadcast their current position and speed in so called heart beat messages. This messaging increases the awareness of vehicles about their neighbors' whereabouts and warns drivers off dangerous situations.

The goal of most of these projects is to create new network algorithms or modify the existing for use in a vehicular environment. In the future vehicular ad hoc networks will assist the drivers of vehicles and help to create safer roads by reducing the number of automobile accidents. Vehicles equipped with wireless communication technologies and acting like computer nodes will be on the road soon and this will revolutionize the concept of travelling. VANETs bring lots of possibilities for new range of applications which will not only make the travel safer but fun as well. The VANET is a growing technology that is becoming a very interesting domain for research in computer science. The Vehicular Communication (VC) makes the steps in the research area to enhance the security and the effectiveness of the communication systems, for example, the traffic status in the road as shown in fig 1.

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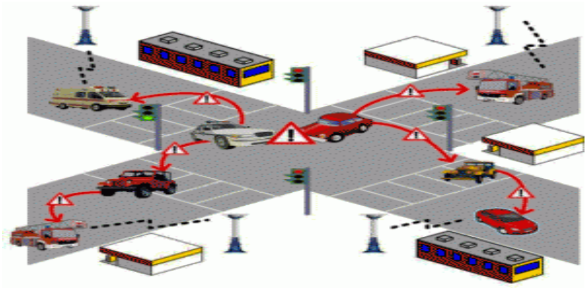

Fig.1 VANET Scenario

II. UNIQUE CHARACTRISTIC OF VANET

2.1 Unique VANET characteristics

Though Vehicular network share common characteristics with conventional ad-hoc sensor network such as self organized and lack of central control. VANET have unique challenges that impact the design of communication system and its protocol security[2]. These challenges include-

1. Potentially high number of nodes.

Regarding VANETs as the technical basis for envisioned Intelligent Transportation System (ITS) we expect that a large portion of vehicles will be equipped with communication capabilities for vehicular communication. Taking additionally potential road-side units into account, VANET needs to be scalable with a very high number of nodes.

2. High mobility and frequent topology changes.

Nodes potentially move with high speed. Hence in certain scenarios such as when vehicle pass each other, the duration of time that remains for exchange of data packets is rather small. Also, intermediate nodes in a wireless multi-hop chain of forwarding nodes can move quickly.

3. High application requirement on data delivery.

Important VANET applications are for traffic safety to avoid road accidents; potentially including safety-of-life. These applications have high requirements with respect to real time and reliability. An end-to-end delay of seconds can render a safety information meaningless.

4. No confidentiality of safety information.

For safety application the information contained in a message is of interest for all road users and hence not confidential.

5. Privacy.

Communication capabilities in vehicles might reveal information about the driver/user, such as identifier, speed, position and mobility pattern. Despite the need of message authentication and non-repudiation of safety messages, privacy of users and drivers should be respected in particular location privacy and anonymity.

III. ROUTING PROTOCOLS FOR VANET

A routing protocol governs the way of exchanging information in two communication entities; it includes the procedure in establishing a route, decision in forwarding, and action in maintaining the route or recovering from routing failure. Fig. 2 illustrates the taxonomy of these VANET routing protocols which can be classified as topology-based and geographic (position-based) in VANET

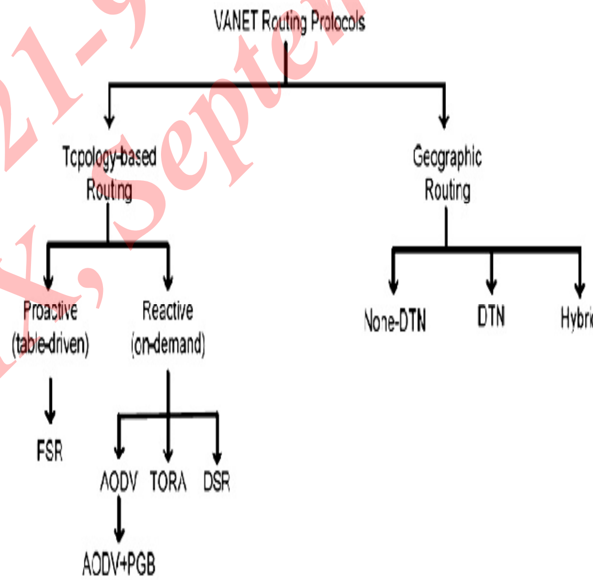

Fig. 2: Taxonomy of Various Routing Protocols in VANET

The routing protocols can be divided into topology based routing and geographic routing [2]. Topology based routing protocols use links information to forward the packet whereas geographic routing uses the information about the location of destination to forward the packet. Topology based routing can again be reactive or proactive. Proactive routing uses the routing table for propagation of message whereas reactive routing builds the route only when it is required. We have used AODV protocol for the analysis which is reactive routing protocol.

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3.1 AODV

As in VANET, nodes (vehicles) have high mobility and moves with high speed. Proactive based routing is not suitable for it. Proactive based routing protocols may fail in VANET due to consumption of more bandwidth and large table information. AODV is a reactive routing protocol, which operates on hop-by-hop pattern. The Ad hoc On-Demand Distance Vector (AODV) [3] algorithm enables dynamic, self-starting, multihop routing between participating mobile nodes wishing to establish and maintain an ad hoc network. AODV allows mobile nodes to obtain routes quickly for new destinations, and does not require nodes to maintain routes to destinations that are not in active communication. Route Requests (RREQs), Route Replies (RREPs), and Route Errors (RERRs) are the message types defined by AODV. In AODV routing, upon receipt of a broadcast query (RREQ), nodes record the address of the node sending the query in their routing table. This procedure of recording its previous hop is called *backward learning*. Upon arriving at the destination, a reply packet (RREP) is then sent through the complete path obtained from backward learning to the source . At each stop of the path, the node would record its previous hop, thus establishing the *forward path* from the source. The flooding of query and sending of reply establish a full duplex path. After the path has been established, it is maintained as long as the source uses it. A link failure will be reported recursively to the source and will in turn trigger another query-response procedure to find a new route.

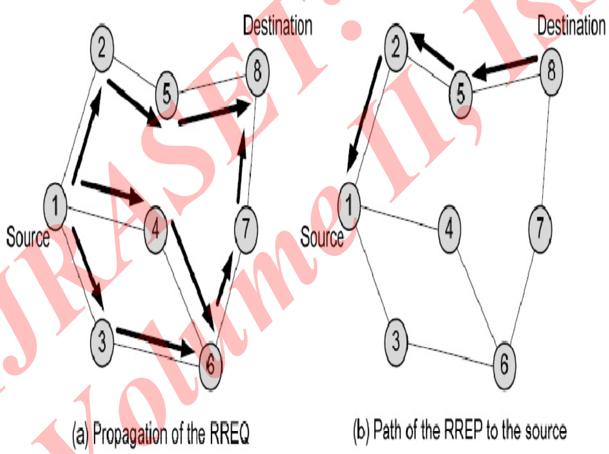

Fig. 3: AODV route discovery

3.2. AODV Route Discovery

AODV [25] uses route discovery by broadcasting RREQ to all its neighboring nodes. The broadcasted RREQ contains addresses of source and destination, their sequence numbers, broadcast ID and a counter, which counts how many times RREQ has been generated from a specific node. When a source node broadcast a RREQ to its neighbors it acquires RREP either from its neighbors or that neighbor(s) rebroadcasts RREQ to their neighbors by increment in the hop counter. If node receives multiple route requests from same broadcast ID, it drops repeated route requests to make the communication loop free.

3. 3 AODV Route Table Management

Routing table management in AODV is needed to avoid those entries of nodes that do not exist in the route from source to destination. In AODV Managing routing table information handled with the destination sequence numbers.

3.4 AODV Route Maintenance

When nodes in the network detects that a route is not valid anymore for communication it delete all the related entries from the routing table for those invalid routes. And sends the RREP to current active neighboring nodes that route is not valid anymore for communication. AODV maintains only the loop free routes.

IV. SIMULATION ENVIRONMENT

The ns-2 simulator is used for the experiments. It is a discrete event simulator developed by theUniversity of California at Berkeley. We are using Network Simulator NS2 for simulations of protocols. It provides substantial support for simulation of TCP, routing and multicast protocols over wired and wireless networks. Ns-2 code is written either in C++ and OTCL and is kept in a separate file that is executed by OTCL interpreter, thus generating an output file for NAM (Network animator) [8]. It then plots the nodes in a position defined by the code script and exhibits the output of the nodes communicating with each other. It consists of two simulation tools. The network simulator (ns) contains all commonly used IP protocols. The network animator (NAM) is use to visualize the simulations. It generates trace file for the same scenario by using which we simulated various simulation parameter.

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4.1 Simulation Parameters

Various parameters used for performance evaluation are:

1) Throughput: It is the amount of data per time unit that is delivered from one node to another via a communication link. The throughput is measured in Packets per unit TIL or bits per TIL. TIL is Time Interval Length. More is the throughput of sending and receiving packets better is the performance. Lesser is the throughput of dropping packets better is the performance.

2) Average throughput: It is the average of total throughput. It is also measured in Packets per unit TIL or bits per TIL.

3) Packet Drop: It shows total number of data packets that could not reach destination successfully. The reason for packet drop may arise due to congestion, faulty hardware and queueoverflow etc. Lower packet drop rate shows higher protocol performance.

4) Packet size: Size of packets in bytes.

5) Average simulation End to End delay (End2End delay): This metric gives the overall delay, from packet transmission by the application agent at the source node till packet reception by the application agent at the destination node. Lower delay shows higher protocol performance. The following equation is used to calculate the average end-to-end delay, Average End to End Delay = (T_DataR – T_DataS), Where T_DataR = Time data packets received at destination node T_DataS = Time data packets sent from source node. The end to end delay is important metrics because VANET needs a small latency to deliver quick messages. It shows the suitability of the protocol for the VANET.

6) Simulation time: Total time taken for simulation. It is measured in seconds.

Parameter	Value	Description
Simulator	NS2	Simulator tool
Simulation time	300s	Maximum execution time
Simulation area	500mx500m	Physical boundary of the network
Number of nodes	20	Nodes participating in the nodes
Transmission range	100m	Frequency of the node
Max speed	0,5,10,15,20 m/s	Speed of nodes
CBR flows	20	Constant Bit Rate link used
Data payload	512 bytes	Packet size
Movement model	Random waypoint	Network connection

Table 1. Data Analysis Based on simulation setup

V. RESULTS AND ANALYSIS

Simulations were conducted as per the table shown above by keeping the number of nodes constant and varying the maximum velocity of the nodes. After the simulation we used the trace file and awk file to calculate the various parameters. The throughput obtained for nodes are shown in fig .The PDR obtained for nodes are depicted in fig. and finally we calculated the end2end delay parameter with the help of trace file and awk file. As we can observe, AODV performs consistently better for increasing number of nodes. Another set of simulations were performed by varying the number of nodes, keeping the maximum velocity of the nodes constant.. We can notice that, again, AODV provides a better PDR in most cases. Thus, reactive routing can be trusted to provide reliable delivery of packets for varying number of node.

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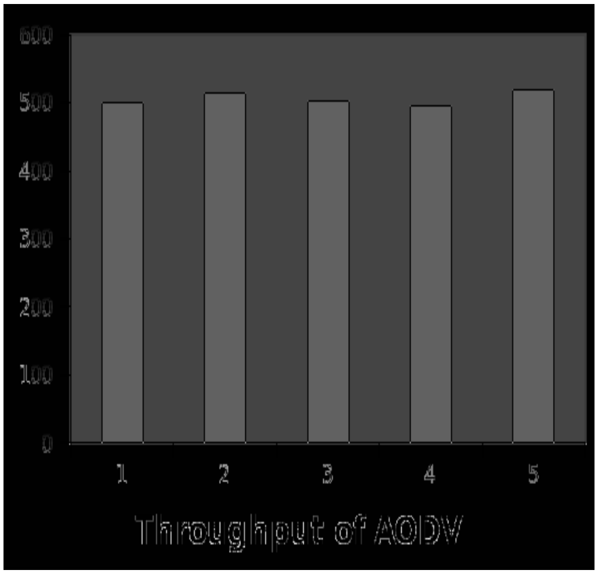

Fig 4 Throughput of AODV

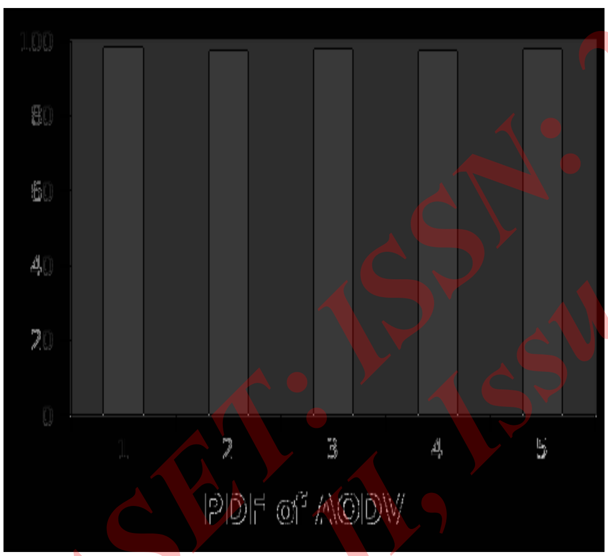

Fig 5 PDF of AODV

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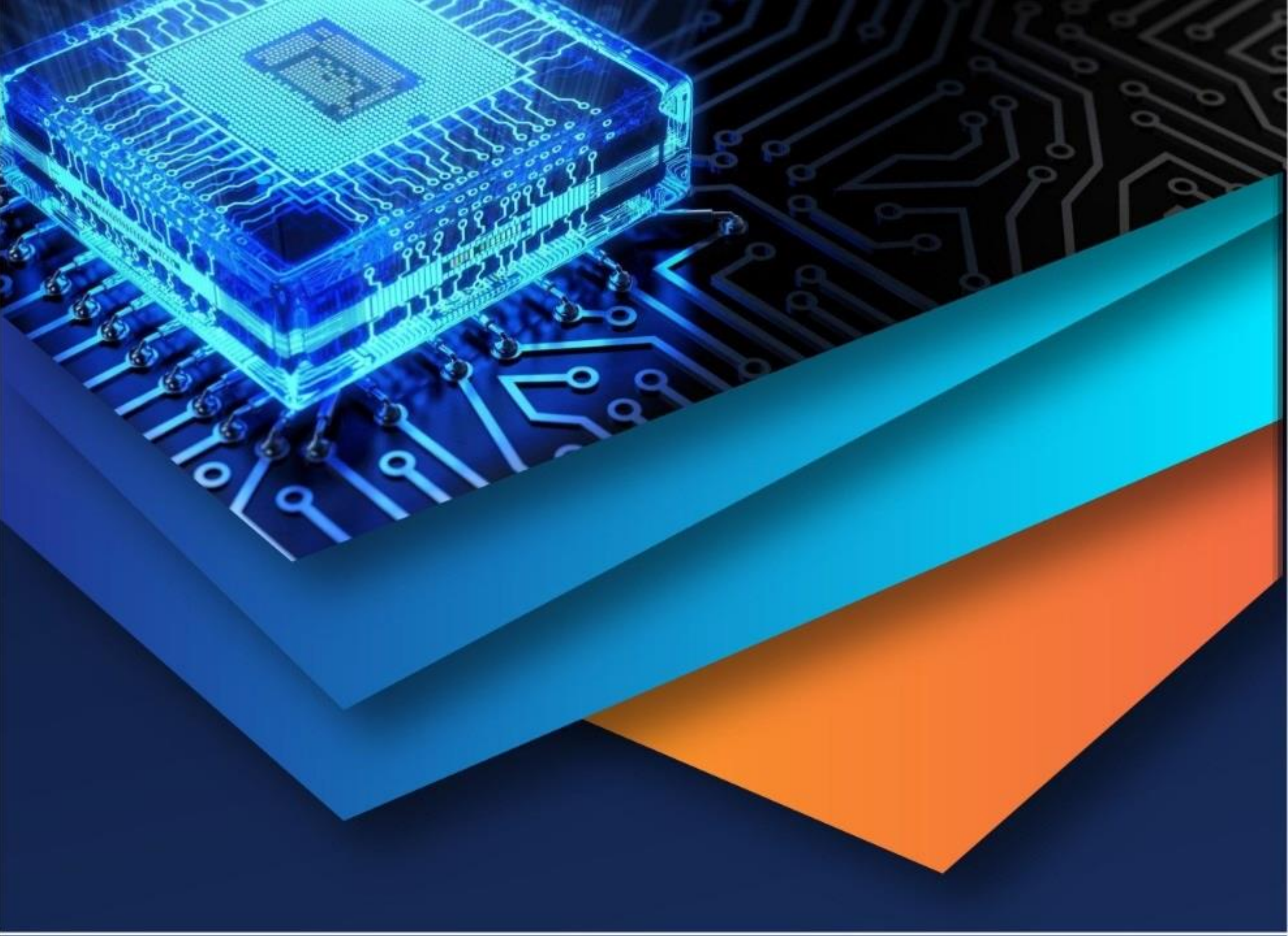

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