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Energy Efficient Routing Protocols in Vanets

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Abstract

Modernization in field of technology is characterized by usage of wireless gadgets, and is no far from transportation field through the deployment of VANET (Vehicular Ad Hoc Network) permitting modern users for better coverage of their travelling distance. VANET is valuable approach that allows for accomplishment of better performance and assuring safe transportation system in prospect. VANET, encircle vehicles, as mobile nodes connecting and communicating among themselves and with access points (roadside units) establishing a network. Amplification in use of VANET stimulates voluminous applications such as road topology, emergency information, electronic toll collection and many more. Expansion and advancement in VANET, engenders numerous applications as real-time traffic, electronic toll collection and surrounding road conditions. In this paper, R-optimal paths technique have been undertaken to ensue real-time communication between nodes. When any node wants to establish path to destination, the path must be selected through root node. This minimizes chances of link failure in the network. The algorithm is implemented in ns2 and it has been identified proposed technique outstands in terms of delay, throughput, packet delivery ratio and energy consumption.

Keywords: VANET, RSU, OLSR, AODV, ERBA, VORI,PDR.

I. INTRODUCTION

Advancement in field of Science and Technology has also spread its fleet in transportation and communication industry via development and deployment of VANET (Vehicular Ad Hoc Network) technology. Implementation of Internet of Vehicles through VANET has attracted both transportation and operator services. Right away, transportation industry is flourishing at a rapid rate due to increasing human

needs. Alarming increase in use of transportation facilities, whether private or public transport, causes roads to become nasty. Hence, advancement and disposition of VANET technology has turn out to be both essential and amenable for assuring one's journey safe and sound.

VANET, a significant and appealing application of MANET, has fascinated interest of both transportation industry and academia. VANET encompasses vehicles, substituted as mobile nodes, equipped with on-board units

(OBU) providing wireless technology. Also, road segments are employed with roadside units (RSU) providing real-time information about traffic and road topology[1].

VANET allows large number of vehicles to be linked to few hundreds of meters, by employing OBUs & RBUs, forming a network. VANET addresses two types of communication: V2V (VEHICLE to VEHICLE), each vehicle sends messages to other vehicles either directly or through multi-hop mechanism.V2I (VEHICLE to INFRASTRUCTURE), vehicles establishes a connection with RSU and communicates through formed routes to disseminate required information as shown in figure [1].

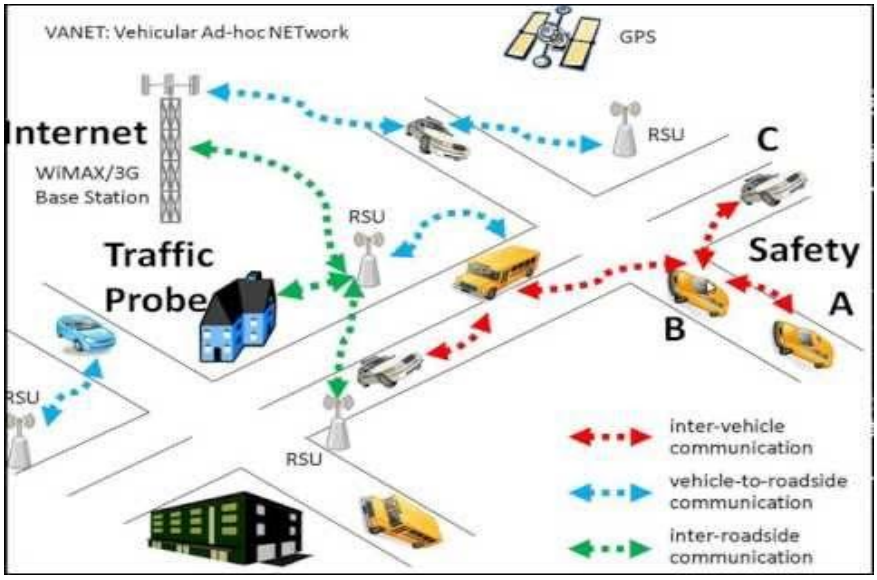


Fig1: Communication Types[27]

VANET can be deployed in one of flowing architectural way: Pure Cellular/WLAN, where access points (RSU) at junctions or cellular gateways to provide access to network and gather information.[3] Ad-hoc network, a self-organized network permitting vehicle-to-vehicle communication, no need for infrastructure. Hybrid network, featuring services provided by both V2I and V2V communication. [16] as shown in figure 2.

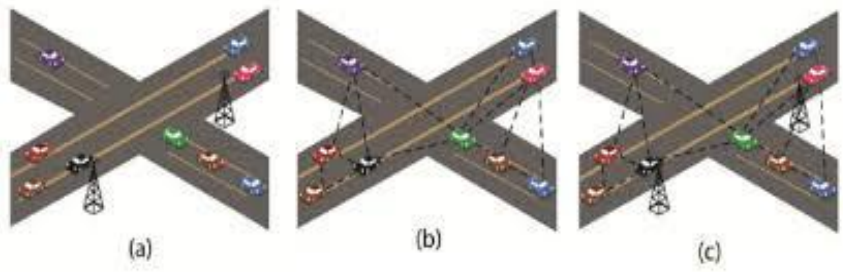


Fig 2: Architecture of networks[26]

1.1 VANET CHARCTERISTICS

A) Abundant Energy: VANETs ensues uninterrupted dissemination of messages by allowing considerable amount of power and storage, whence eradicating major challenge of other ad hoc networks. However, Hand-handle devices like mobiles in other ad hoc networks yields limited energy, thus depleting their utilization[28].

B) Mobility: Mobility in nodes is one of the main appealing feature provided by VANETs. Fluctuating and immense speed of mobile nodes helps in curtailing mesh in network, a usual drawback in other ad-hoc network.

C) Kind of Communication: In contrast to other ad-hoc networks that uses unicast and multicast approach for communication, VANET, additionally provides geocast communication, that permits packet dissemination to specific geographical area.

D) Communication Environments: VANET operates in two communicational environments: sparse networks such as highway and rural network and dense network such as urban area. In former, traffic is low and communication uncomplicated, whereas, in latter, communication is copious and hurdles such as buildings, trees and other vehicles inhibit direct communication among nodes.

E) Delay Constraint: Most of applications needs real-time delivery of information so as to be useful In particular, in emergencies, it becomes mandatory to deliver information quickly, making it possible for driver's to take alternate routes or desired actions. Maximal delay in such situations would be sacristan.

F) Patterned Mobility: Mobility is foreseen as vehicles moves accordingly with road topology and acts according to traffic rules. Moreover, it demands that nodes to correlate with other nodes.

G) On-Board Units: Vehicles are employed with sensor on-board units that enable dissemination of packets for communication purposes. Speedometer in vehicles and availability of Global Positioning System (GPS) supplies position information. Moreover, roadside units are equipped alongside roads[28].What's more GPS and GPS-

based navigation system gives information concerning traffic, road topology enabling selection of absolute routes by driver.

H) Dynamic Topology: High mobility of nodes causes topology to transit many times. Also, behaviour of driver behaviour based on message content results in changing topology.

*I) Network Fragmentation***:** Frequent transit in topology results in frequent disconnection from network[30]. For instance, if two nodes are travelling in opposite direct at relatively high speed of about 70km/hr, they are in associate for short time interval. Thus, it necessitates that chosen routing protocol be robust such that recurrent disconnections can be diminished, to ensure proper communication due to varying density[29].

II. RELATED RESEARCHES: A REVIEW

4.1 A Secure Routing Protocol for Vehicular Ad Hoc Network: A Survey [13]

Mukesh Tripathi and Sandeep Rai (2015): Vehicular communication involves participating nodes to communicate with other mobile nodes in range of 100 -300 meters and creates a system with wide range. This increases chances of malicious attacks by adversaries. The paper proposes security and protection characteristics by employing distributed computing environment where trusted cloud environment is accomplished, that is regulated together by customer and cloud environment administrator. Furthermore, adequacy is analyzed with increasing number of hubs and amount of replication using absolute world movement conditions. It also focuses on impact of encryption and unscrambling of verifiers and analyzes its effect on calculation.

4.2 A Review: Position Based Routing Protocol in VANET [11]

Kirti R. Rathod and K.H. Wandra(2015): Research concludes compares different routing protocols such as GPSR,GSR,GPCR,B-MFR,RBTV,Geo DTN+Nav. The paper specifies VANET routing network can operate in two modes: vehicle to vehicle and vehicle to roadside infrastructure transmission. It also limelight various protocols and contrast them based upon several parameters as forwarding strategy, street maps, simulation scenarios and delivery rate performance It concludes that a protocol such as GSR needs street maps. B-MFR and Geo DTN+Nav protocols are apt for less dense areas like highways whereas RVBT and IGPR suits highly dense areas such as city.

4.3 Energy-Efficient Min Delay-based Geocast Routing Protocol for Internet of Things [18]

Li-Der CHOU et al.(2015): EEMD-based protocol is laid out that advances packets via selected relay nodes with considerable boost in energy-efficiency and minify power

exhaustion, and whence resulting in increased performance of network. The protocol is designed by nominating minimum number of relay nodes that either features high energy efficiency or minimum delay. Carry-n-forward approach is utilized and comparing energy efficiency of packet forwarding of a node with nearby nodes respectively. Initially, energy efficiency is compared and if nodes exhibits identical energy efficiency then same are contrasted based on packet delivery delay.

Simulation reports performance of EEMD-based protocol in contrast with GRUV(Geocast Routing in Urban Vehicular Ad Hoc Network) and Geocache protocols. As number of nodes multiplies EEMD-based protocol accomplish lowest power expenditure. Research winds up that EEMD-based protocol is convenient to lessen energy expenditure for distributing packets. Also, methodology wraps up that EEMD-based protocol attains less packet delivery delay, maximal delivery ratio inattentive of number of vehicles and lesser packet delivery as to other two protocols.

4.4 AN ENERGY-EFFICIENT ROUTING FOR VEHICULAR AD HOC NETWORKING USING REAL-TIME PERCEPTION OF NODE INFORMATION [14]

Zhongwei CUI et al(2015): It designed Vehicular opportunity route based on real time information(VORI) is proposed. Under pressed work nodes gather real time area information and establish hot-area for best inter-area selection for message delivery. Simulation results of proposed VORI algorithm are then compared with classical routing algorithm such as Epidemic algorithm, Prophet algorithm, Spray and Wait algorithm in terms of message delivery rate, cumulative delay probability, average buffer time, average number of hops and average overhead ratio. Message delivery rate of VORI is near to Spray and Wait algorithm from 0 to 12,000.Delay rate is lower than Epidemic algorithm and near to Spray and Wait algorithm from 4,000 to 9,000.Refrence to average buffer time and average number of hops VORI algorithm is near to Epidemic and Prophet algorithm respectively. What's more, VORI algorithm can maintain status of neighbour node by using HELLO packets. Research concludes VORI algorithm is comparatively more energy efficient than classical routing algorithm.

4.5 Priority Based Congestion Control for VANET: Review [9]

Meenal Pannase(2014): It proposed Priority Based Congestion Control Protocol (PBCCP) to enhance network throughput besides packet delivery ratio and curtail delay. Information dissemination from too many sources with constraint of timely and delivery of message causes congestion problem in vehicular communication, thus ensuring packet dropping, low energy efficiency and extended delay. Designed scheme vanquish congestion problem in real time application by curtailing delay, congestion avoidance and reduces packet loss. Proposed work includes Congestion Detection Unit (CDU) and Congestion Notification Unit(CNU) such that both packet drop and time delay ratio are minimized. The notion of parent and child nodes is employed where progeny nodes of parent node listen in congestion information warning. Delay is

computed using current time as the parameter and random priority is enrolled to messages. Performance of proposed work is estimated in terms of throughput, delivery ratio and delay making it decisive for real time applications and minimize packet drop ratio as well as lengthen delay.

4.6 Improving Energy and Efficiency in cluster based VANETS through AODV protocol [12]

Prerana Deshmukh et al(2014): It proposed an enhanced AODV(Ad hoc On Demand Distance Vector) protocol that enhances performance by employing location based clustering mechanism. Research methodology is carried out in stages as: Network formation, Specification of Modes of transmission. Then LB-VANET(Location Based-VANET) algorithm is employed. What's more, it refines rote discovery phase and downplay energy utilization during message dissemination by engaging two tier procedure. Employed enhanced protocol also leads to reduction in overhead for each route and is capable of dealing with diverse traffic circumstances.

4.7 An Energy-Efficient Routing Protocol Using Movement Trends in Vehicular Ad-Hoc Networks[8]

Daqiang Zhang et al (2013): schemed ERBA, an energy efficient routing protocol uses movement trends considering driver's behaviour and vehicle categorization. Movement tendency is deployed by taking into account current and future directions. ERBA enables packet dissemination by employing proactive, prediction-based routing protocol for opting sustainable routes for application where delay is critical. Chosen methodology ensues that small and efficient route is selected with no loops. ERBA analyzes real urban scenario from Shanghai project undertaken and correlates with AODV and ROMGSP considering performance metrics such as throughput, probability density function, neighbourhood reliable links and end-to-end delay. It concludes that ERBA outperforms others in achieving better performance and least energy utilization by selecting conceives routes.

4.8 Fast Energy-aware OLSR routing in VANETs by means of parallel evolutionary algorithm[20]

Alba Enrique et al(2013): Modification of OLSR (Optimized Link State Routing) by applying parallel evolutionary algorithm decreasing power utilization, without any loss in Quality of Service. Proposed protocol attains efficiency rectification via appliance of automatic configuration of OLSR framework exercising parallel Genetic algorithm. Additionally, it points to curtail time required to carry out automatic configuration.

Pervasive Simulation concludes that pressed protocol diminish the execution time and obtains computational efficiency protocol curtails the execution time and achieves computational efficiency more than 80%.A significant reduction in power utilization of approximately 40.2% is attained. What's more, diminishing network overload resulted

in curtailing of packet delivery delay. However, the technique endure reduction of about <8% in QoS at time of communication.

4.8 Design and Implementing PGP Algorithm in Vehicular Ad Hoc Network [5]

Navdeep Kaur Randhawa(2012): It proposed Pretty Good Privacy(PGP) algorithm that permits secure end to end communication past interception. The proposed algorithm is more agile and secure in contrast with existing algorithms.PGP relies on compression technique and session key using encryption and decryption algorithm. Paper also limelight scope, diverse applications and risks involved in VANET.PGP renders Compatibility, Digital Signatures, Confidentiality and Certificates.

4.9 A VANET-Based A* Route Planning Algorithm for Travelling Time- and Energy- Efficient GPS Navigation App [25]

Inn-Chau Chang et al.(2013): VANET based A* route planning algorithm is preferred that targets to determine and select the route with lowest fuel consumption or shortest travelling time. The algorithm obtains needed real-time traffic information from two sources and updates the vehicle route's in accordance with real-time traffic and road conditions. An application is developed and implement on Android platform. One of information source is on-board units equipped in vehicles that reports traffic information such as whether vehicle has crossed an intersection or its velocity. This information is disseminated among nodes through IEEE 802.11p wireless link. Second source of information is Google maps. This information from both sources is aggregated so to provide drivers with precise and adequate route for travelling.

Pervasive simulations has been done by comparing implemented algorithm with other protocols such as Dijkstra, A*, TTU-A*(angle),TTU-A*(angle + speed),VBA*(fuel) and VBA*(time) considering time, distance and fuel as performance metric. It achieves down turning of average travelling time and fuel consumption by deploying it in both congested and non-congested time interval.

4.10 Routing Protocols in Vehicular Ad Hoc Network: A Survey and Future Perspectives[3]

Yun-Wei Lin et al(2010): The paper winds up diverse routing protocols highlight three major categorization: Unicast routing, multicast and geocast routing and broadcast routing protocols. It also interprets challenges and perspectives for each. It concludes that routing protocols must be designed such that there is low communication overhead, low time cost and flexibility for adjusting according to traffic density.

4.11 VANET Routing on City Roads using Real-Time Vehicular Traffic Information [24]

Josiane Nzouonta et al (2008): In this paper a RBVT named routing protocol is proposed which is a road based protocols. This protocol is proposed with the help of vehicular traffic information routing that is based on the already existing routing protocols within the VANETs. The geographical forwarding technique is used in this paper for sending the packets in between the intersection path for the reduction of sensitivity within the paths for individual node movements. Here, a reactive RBVT-R protocol as well as proactive RBVT-P protocol is proposed and further compared with the MANET protocols such as AODV, OLSR etc. The RBVT-R protocol is proven to the best protocol through the simulation results. The parameters developed after the results were the delivery rate and the average delay.

4.12 A Fixed Sensor-Based Intersection Collision Warning System in Vulnerable Line-of-Sight and/or Traffic-Violation-Prone Environment [23]

Jeong-Ah Jang(2006): In this paper, for the purpose of detecting and localizing the Sybil nodes in VANETs, a new security method is proposed. This method is based on the statistic analysis of the signal strength distribution. Through this method, each vehicle present on the road is able to detect the Sybil vehicles closer to them with the help of this distributed and localized mechanism. This is done through verification of the claimed positions. A basic signal strength based position verification scheme is first introduced. Here, the traffic patterns as well as the assistance from the roadside base stations are used up to their benefits. Here, two statistical algorithms are used for enhancing the accuracy of the positional verification. The verification error rate is lowered with the help of the statistic nature of these algorithms. For the detection of Sybil nodes in GPS as well as RSSI, the signal measurements are used. The reported positions of the vehicles are confirmed with the help of Vehicle-to-Vehicles communication used within this scheme. The RSSI measurements are used for reference purposes. The parameters such as vehicle mobility, traffic patterns and supports from the roadside are used for correcting the errors identified in the RSSSI measurements

III. LAR PROTOCOL

LAR is on demand routing protocol like AODV and DSR. It utilizes location information of mobile nodes to decrease the routing overhead. LAR scheme only forward the packets in the request zone. It uses position information to send a route request packet (RREQ) to destination in given request zone. Consider a node S (sender) has to find a route to node D (destination). The node can only transmit the data to the other node if it belongs to the request zone. If node wants to send the packet to others, then area should be the expected zone. Otherwise packet will only transmit in the request zone. In LAR, there are two zones present: expected zone and request zone. LAR uses flooding like DSR to discover the route but flooding is restricted to a certain

area called "request zone". It uses location information to flood a route request packet for destination in request zone instead of in the entire ad hoc network.

It is possible that the destination will not receive a route request message (for instance, when it is unreachable from the sender or route requests are lost due to transmission errors). In such cases, the sender needs to be able to re-initiate route discovery. Therefore, when a sender initiates route discovery, it sets a timeout. If during the timeout interval, a route reply is not received, then a new route discovery is initiated (the route request messages for this route discovery will use a different sequence number than the previous route discovery – recall that sequence numbers are useful to detect multiple receptions of the same route request). Timeout may occur if the destination does not receive a route request, or if the route reply message from the destination is lost. Route discovery is initiated either when the sender S detects that a previously determined route to node D is broken, or if S does not know a route to the destination.

IV. RESEARCH METHODOLOGY

4.1PROBLEM DEFINATION

VANETs has established its roots and attracted interest of transportation industry. Communication between vehicles via roadside units(RSUs) and on-board units employed in vehicles has fascinated transportation and academia. However, an insecureable environment leads to transparency of vehicle(vehicle/driver) related information vulnerable. Simultaneously achieving higher throughput and minimizing delay, while retaining lower energy depletion is mandatory.

Our proposed work attains these benchmark by implementing the concept of root and leaf nodes, where root nodes maintain a routing table, that assist in selecting apt route for transmission from source to destination, while preserving vehicle's energy.

4.2 PROPOSED WORK

In *t*he proposed technique, in the whole network we define some nodes which are root nodes, under these root nodes we will defines the leaf nodes. The leaf node comes under which root that will be decided by prediction based technique for multicasting. The Root nodes are responsible to maintain the tree on the basis of distance between the nodes. The root nodes can maintain routing table and in this routing table information about their leaf nodes are stored. The root nodes can send the stored information to RSU's and before requesting for the path to destination. The source node communicates with the RSU and RSU give information about the leaf node for path establishment by using R-optimal paths algorithm. The source node send route request packets to only those root nodes, which have access to desired leaf node.

4.3 OBJECTIVES

The proposed research work finds reliable and stable route for packet transmission from source to destination by using real-time traffic information such as energy utilized during transmission is less than previous existing algorithm. Objectives are lime lighted below:

a. To propose routing protocol that minimizes energy consumption and ensures apt information delivery in real-time.
b. To implement and analyze algorithm on vehicles moving at different speed and in different environments(urban and rural).
c. To validate result using ns2 simulator.

4.4 PSUDO CODE FOR PROPOSED ALGORITHM:

Step1:- Install Ubuntu 12.5 using VMWARE.

Step2:- Update Ubuntu by entering command Sudo- apt.

Step3:- Install ns-2 version NS-2.35, Install xgraph, Install Network Animator.

Step4:- Designing Topology for wireless communication.

Step5:- Nodes are then configured in network.

Step6:- Design algorithm and integrate in C++ and TCl.

Step7:- Analyze the results by computing several parameters as energy consumption, delay, and throughput and packet delivery ratio.

Step8:- Obtain graphs and contrast with existing algorithms.

4.5 PROPOSED ALGORITHM

Traffic, comprising vehicles, moving at different velocities in both urban and rural areas are subjected to propound algorithm:

❖ **R-optimal path algorithm**

Set M mobile node's

Set S sender and R receiver

Node Routing=AODV

Set Route

{If(route found(from S to R))

{Checking resistance of route;

If (route>=1) //alternative route exist in the network

{

Search nearest neighbouring nodes

Establish path through root nodes

Root node is transmitting acknowledgement

}}

Else {destination root unreachable}

{ Creation of new node(root);

{

Source node start sending data to destination through root node

{ Q++;

Store incoming data;

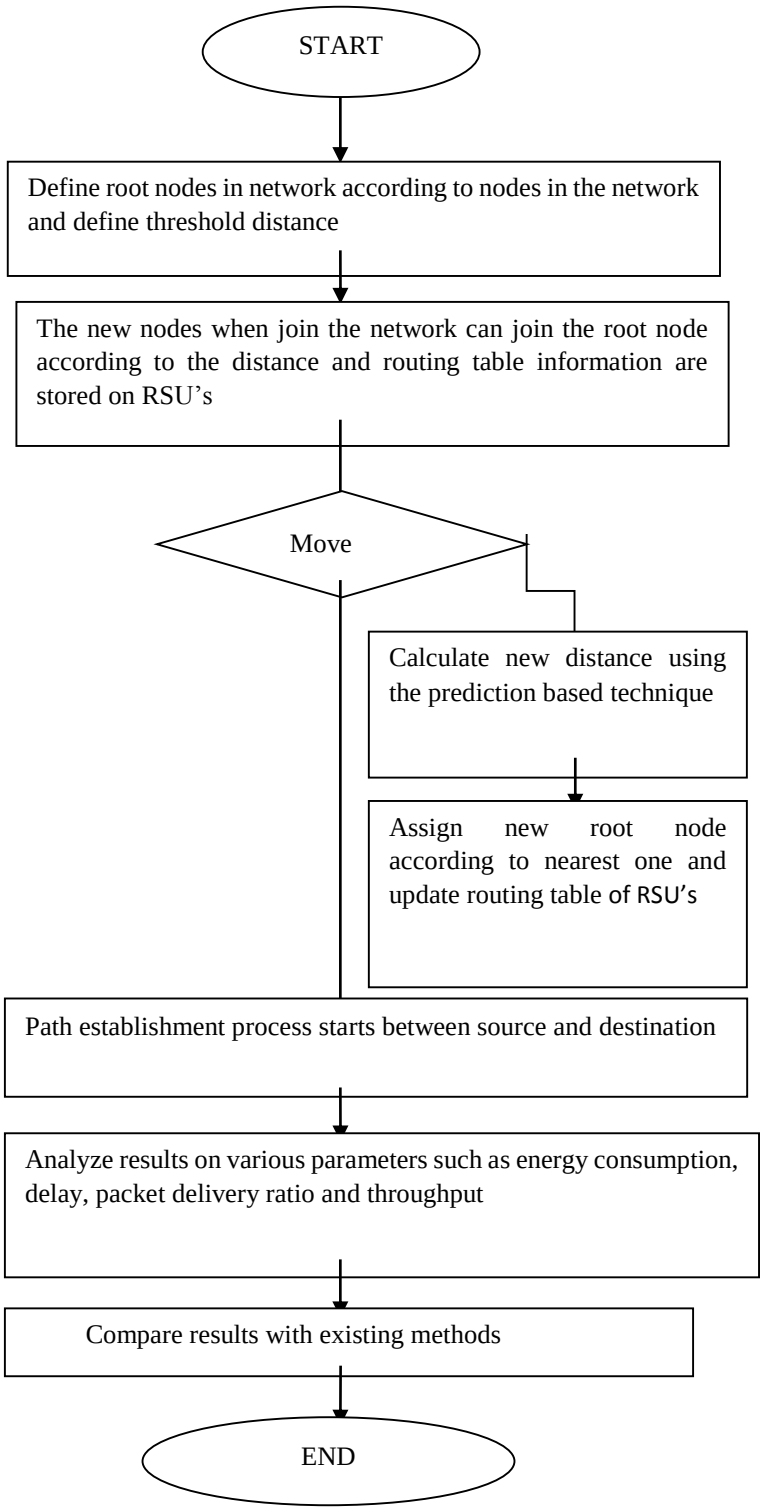
}

Receiver receives data from I node;

Send ACK to sender S;

}}}

4.6 FLOWCHART



V. EXPERIMENTAL RESULTS AND COMPARISON

We execute immense demonstrations to figure out the performance of designed algorithm. We use previous protocol AODV as baseline strategy. It is apparent from the parameters described and graphs concluded that our algorithm surpass existing algorithms. To justify the performance, we chose a sequence of parameters, which are discussed below:

- **Throughput:** Network throughput can be defined as accomplishment of acknowledged packets over a communication channel. The rate of acknowledged packet delivered from one node to another is considered as throughput. It is measured in bits per second(bps),megabits/gigabits per second(mbps/gbps).

Table1: Throughput Comparison

Time (in sec)	Existing Algorithm	Proposed Algorithm
2	8.5	8.8
8	58.8	66.3

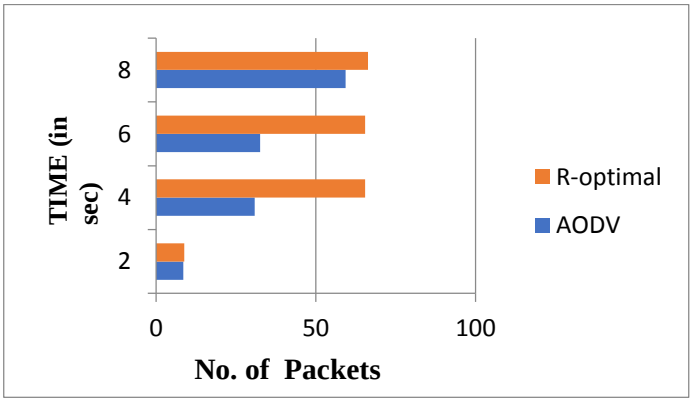


Fig 3: Throughput Comparison

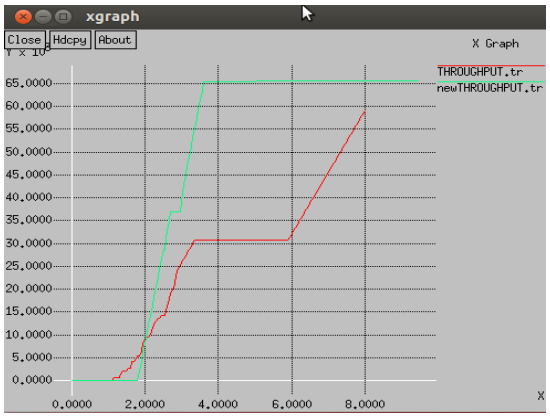


Fig4: Comparison of AODV and R-optimal algorithm

Table 1 summarizes comparison and improvisation in throughput by implementing R-optimal algorithm.Also as shown in figure 3, the technique of broadcasting is applied for the path establishment which is existing algorithm and technique of multicasting is applied which is the proposed algorithm for the path establishment in the network. This leads to increase the network throughput which is illustrated in the figure 4.

- **Packet Delivery Ratio:** It can be described as number of packets delivered successfully and correctly to number of packets delivered over communication channel. It signifies whether proposed algorithm works or not.

Table 2: Packet Delivery Ratio

Time (in sec)	Existing Algorithm	Proposed Algorithm
2	16	5
8	23.3	15

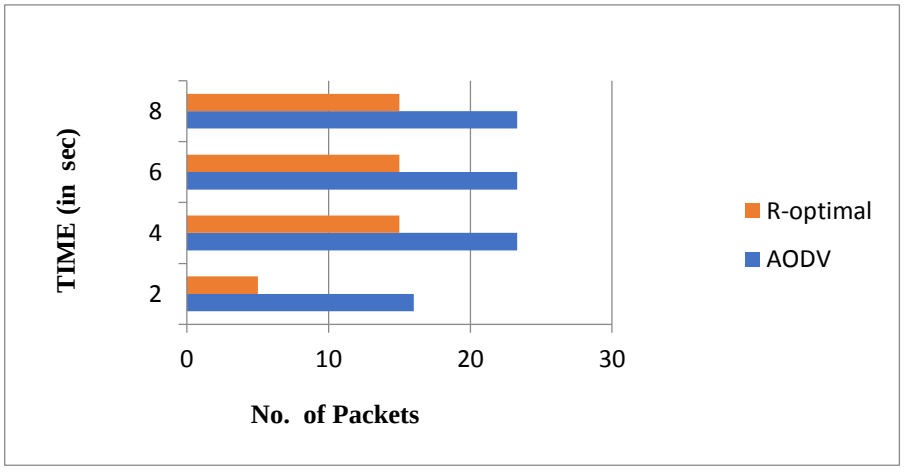


Fig5: Packet Delivery Ratio

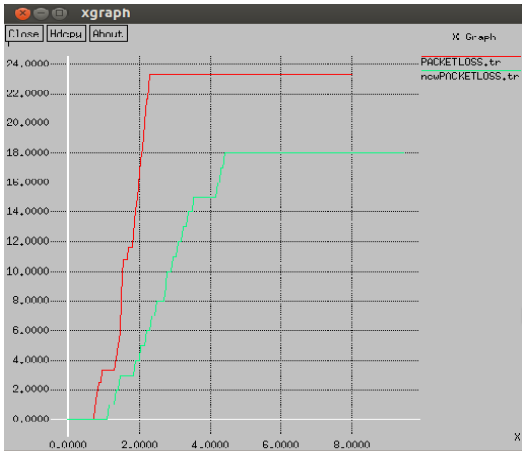


Fig 6: Comparison of AODV and R-optimal algorithm

Table 2 outlines packet delivery ratio is lesser in improved algorithm than existing algorithm. As shown in the figure 5, the proposed and existing techniques are compared in terms of packet delivered successfully. From figure 6, it is been analyzed that packet delivery ratio of the proposed is less and compared to existing technique.

- **Delay:** End-to-End delay specifies amount of time needed for packet to be delivered accurately from the source to destination. It points out how long it takes for packets to travel across a network. It is measured in fraction of seconds. It indicates latency that proposed algorithm might provoke. Generally, to achieve low end-to-end delay requires lower energy consumption.

Table 3: Network Delay

Time (in sec)	Existing Algorithm	Proposed Algorithm
2	15	12
8	108	97

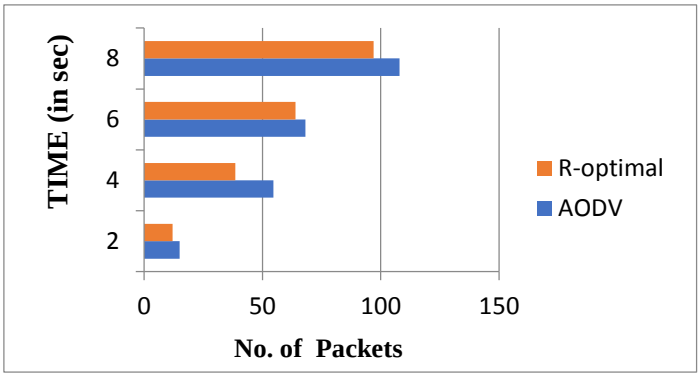


Fig 7: Network Delay

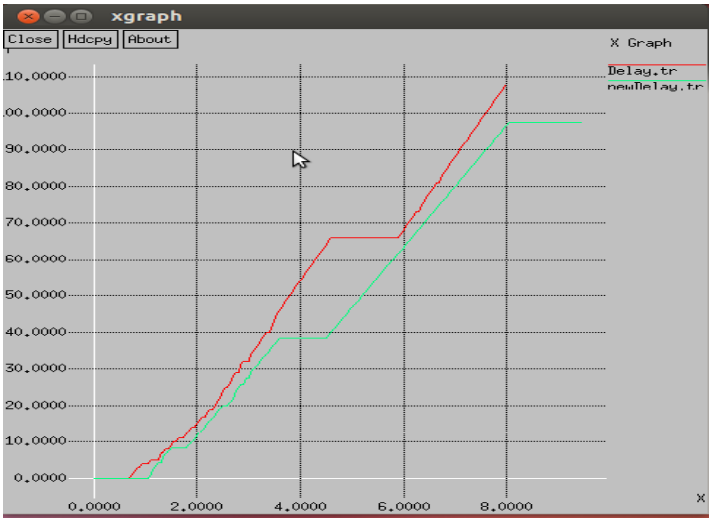


Fig 8: Comparison of AODV and R-optimal algorithm

Table 3 briefly estimates reduction in delay by implying R-optimal algorithm in comparison to existing algorithm. As shown in figure 7, the proposed and existing techniques are compared in terms of delay. The delay in the proposed technique is less than the existing scheme due to multicasting approach is used for the path establishment which can be concluded from figure [8].

- **Energy Consumed**: It is referred to as total energy depleted during transmission of packets from source to destination.

Table 4: Energy Consumption

No. Of Nodes	Existing Algorithm	Proposed Algorithm
35	90	39
50	144.3	89.44

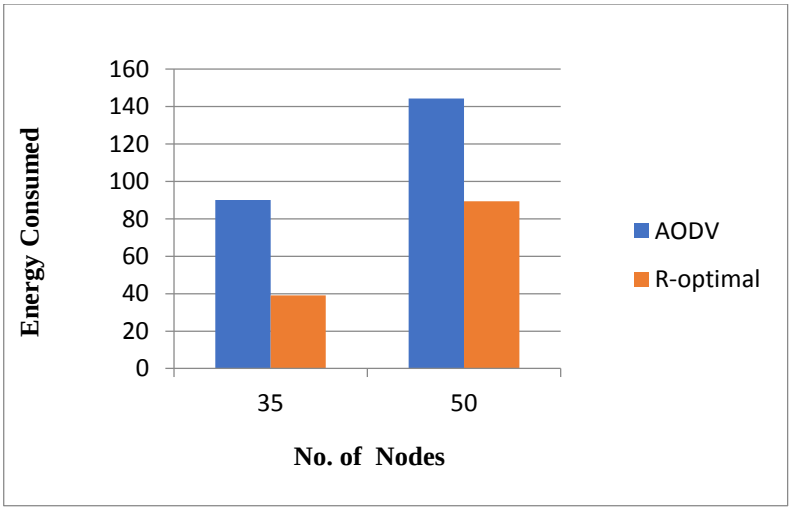


Fig 9: Comparison of Energy Depletion

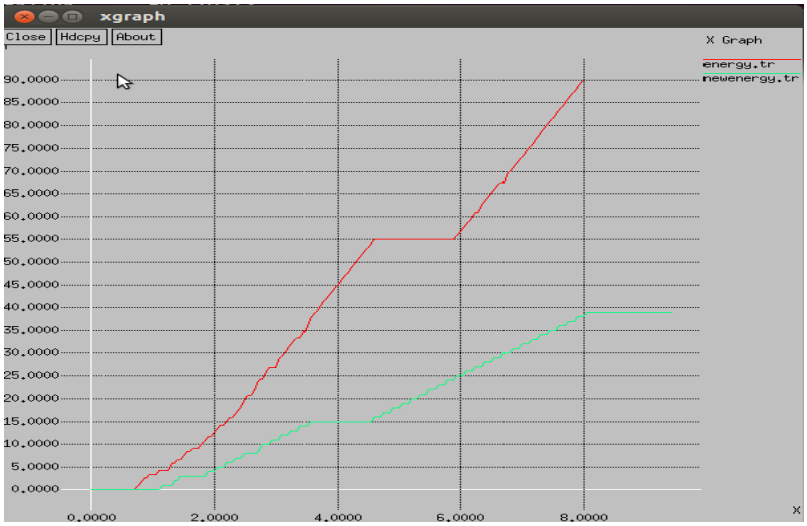


Fig10: Comparison of energy consumption for AODV and R-optimal algorithm in highway scenario

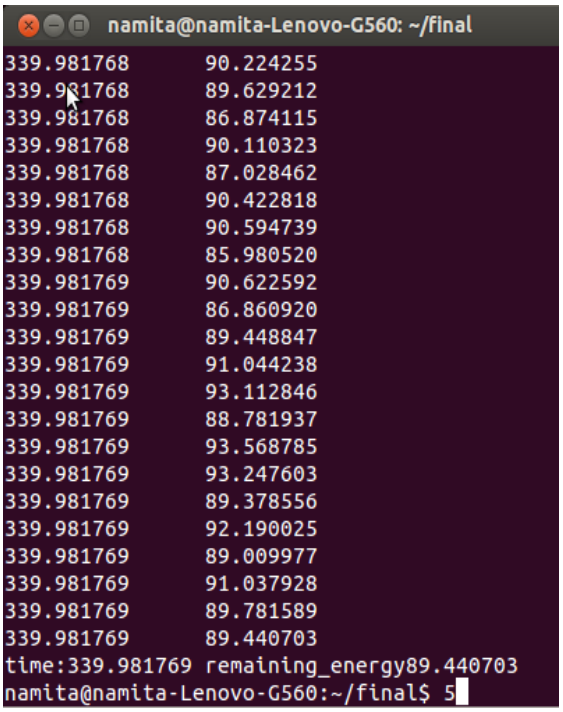


Fig11: Energy Consumed using R-optimal algorithm in urban scenario

Table 4 concludes remaining energy under different scenarios by employing improved algorithm in comparison to existing algorithm. Also it can be concluded from figure 9 & 10, energy depletion by using multicasting technique and hence R-optimal algorithm is lesser than existing algorithm. Also in urban scenario, energy consumed is less whence remaining energy is more as concluded in figure 11.

VI. CONCLUSION

This research is based on routing issue in which two type of communication is possible; the first type of communication is V2V and second type of communication of V2I. In this work, multicasting technique is proposed in which source node flood the route request packets to the node which has maximum possibility to establish path to destination. The proposed technique improves leads to reduction in packet loss, delay and increase in network throughput. The proposed algorithm is the multicasting algorithm which can be tested on the different scenarios to analyze network performance by deploying lesser energy. The technique assists drivers to utilize VANET facility in efficient manner in different scenarios (urban areas and highways) by retaining vehicle's battery energy.

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