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DELAY AWARE AODV FOR GREENY VANETS

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Abstract— **One of the important QOS parameter in highly dynamic VANETs is minimum delay. There has been a continuing innovation in the area of routing for the VANETs to find the optimal path between source and destination. Many protocols have been proposed and deployed to realize the benefits of intelligent transportation systems (ITS) in VANETS. But still the question arises is how best, the protocol finds optimal path besides the rapidly changing environment? However no single protocol excels for VANETs. Due to high mobility and lossy characteristics of wireless medium, it's really a challenging question to find the optimal (shortest path) and at the same time, a lossless path which guarantees packet delivery. Guaranteeing packet delivery is the top most criteria in networks like VANETs. The importance of VANETS is better realized in the area of accident prevention and obviously, a safe driving. Link failures are frequent in VANETs and so the responses that arise from the protocol would degrade the performance, when the network size increases. So from our research study ,the issues that needs to be addressed for efficient routing are link failures , scalability, minimum delay and so a guaranteed transmission of real time data in accordance with the dynamic environments. In this paper, we propose a new algorithm to facilitate the reliable and efficient routing in VANET's. The new algorithm enhances the well-known ad hoc on-demand distance vector (AODV) routing protocol to propose the location-based scalable routing protocol AODV-r. Simulation results demonstrate that AODV-r outperforms significantly the AODV routing protocol in terms of better delivery ratio and small end-to-end delay while maintaining a reasonable routing control overhead. We had also proposed a new metric called Extended ETX which enhances the original ETX.**

Keywords— VANETS, Hybrid routing, AODV, Scalability, High throughput metric, Greedy-forwarding, Minimum delay.

I. INTRODUCTION

The motivations for our research are the deployments of VANETs for accidents prevention and obviously safe driving. And so the god-given lives are not lost carelessly. The necessity of Inter-vehicle communications (IVCs) [1] is better realized in the areas of traffic monitoring and issuing of warning messages to prevent vehicle accidents and so, safe driving. Each vehicle in the VANET has a wireless communication equipment to provide ad hoc network connectivity. It is realized that VANETs are a special class of mobile ad hoc networks (MANETs) with some of the key features distinguishing them. Vehicles in VANETs are highly mobile and so the network topology is ever-changing. Also, the communication link statuses between two vehicles are vulnerable due to high mobility and lossy wireless medium. Comparing VANETs with MANETs, the former have normally higher computational capability and higher transmission power.

Those key characteristics of VANETs should be addressed very seriously and resolved before deploying these networks effectively. Highly prioritized issue that is to be paid attention is the high mobility and the link failures of the network topology, due to strict radio range. Within VANETs, when the vehicles change their speed and/or lanes its topology varies.

These changes which depend on the drivers, road situations and traffic status are not scheduled in advance. The emerging new routing protocols for VANETs should adapt to the rapidly changing topology. Besides that, if they support and provide quality-of-service (QOS), it will be efficient to support to permit different transmission priorities according to the data traffic type especially for real time multimedia traffic.

In this paper, we propose a new location-based routing scheme to establish a more efficient route between the source and the destination nodes. Simulation experiments are performed to evaluate the performance of our proposed scheme in comparison to ad hoc on-demand distance vector (AODV) routing protocol. Some of the performance metrics that are considered in our evaluation process are packet delivery ratio, average number of link failures, end-to-end delay and routing control overhead.

The remaining sections of this paper are organized as follows: Related works summarizes the related works in this domain. Introduction to vehicular communications briefs the basic communication scenarios of vehicular communication technology. Algorithm for Location-based routing protocol AODV-L exhibits VANETs. And then the modified GA presents the proposed algorithm .Then, the Simulation setup and results presents the simulation scenario setup and results for AODV-r.. And finally, conclusion concludes the paper.

1.1. Our contributions

- We have proposed the hybrid routing algorithm that combines reactive routing and greedy strategy.
- The location based routing algorithm , AODV-r uses location information to forward data packets.
- We have proposed a new metric called Extended ETX, which enhances the original ETX metric. The new metric EETX incorporates a mobility metric, for the first time.
- The proposal for a modified GA, replacing the greedy forwarding strategy in AODV-r.

II. RELATED WORKS

The literature on location based routing protocol uses location information for packet forwarding. For example the authors of [2]-[10] differ in the way they choose the next forwarding vehicle in accordance with the problem encountered. In [5], the authors propose a routing protocol, **GPSR** ,wherein greedy strategy is used for packet forwarding .Its drawback is ,during void regions, backup procedure are called which leads to dead end. For example, in connectivity-aware routing (CAR) [8], data packets are forwarded toward to the destination but fail to find a high throughput path in wireless scenarios.

The authors of [11] did not specify any mobility metric for choosing the optimal path. GA when combined with the techniques like immigrants schemes [12], multi population [13] converges better than the location-based algorithm to find the optimal path.

III. INTRODUCTION TO VEHICULAR COMMUNICATIONS

Research in VANETs has grown more due to its deployments for accidents prevention and improving road safety. All data collected from the sensors on a vehicle can be displayed to the driver or sent to a road side unit (RSU) or be broadcasted to neighboring vehicles depending on certain requirements. For example, applications like car-to-home communication, travel and tourism information distribution, multimedia and game applications, and Internet connectivity. Our location based algorithm finds an optimal path despite wireless losses.

3.1. The architecture of vehicular networks

As shown in Fig 1, the architecture of VANETs is classified into three main categories

1. Vehicles-to-vehicle (V2V) communication, otherwise called as pure ad hoc networking, vehicles communicate with each other with no centralized controller. The information collected from the sensors is sent to the s neighboring vehicles for further preventive actions.

2. Vehicle-to-infrastructure (V21) communication, where vehicles use gateways and access points (AP) to connect to the Internet and further to enable vehicular applications.

3.Inter-roadside communication vehicles use infra structure to share the information received from infrastructure with other vehicles in a peer-to-peer mode through ad hoc communication. And also, vehicles communicate with the infrastructure either in single-hop or multi-hop fashion depending on their position.

3.2. The key distinguishing characteristics of VANETs As of MANETs, the network nodes in VANETs are self-organized and can self-manage information in a distributed fashion without a centralized authority that which controlling the communication. Here nodes operate as servers and/or clients at the same time and exchange information with each other. Furthermore, VANETs have unique attractive features over MANETs as follows

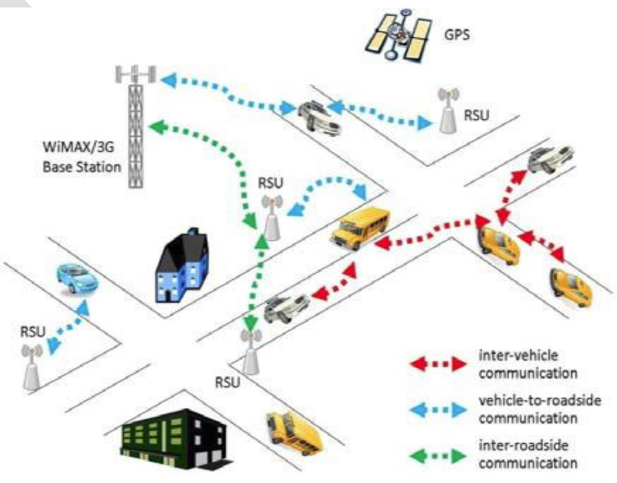

Fig 1: The architecture of vehicular networks [14].

Vehicles in VANETs are basically installed with higher power and storage than those in MANETs. Operating vehicles afford higher computing, communication and sensing capabilities than MANETs.

3.3. Routing issues of VANETs

Due to the key distinguishing features of VANETs, the routing procedure is an important issue that needs to be addressed seriously before these networks are deployed effectively.

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In accordance with [15],[18], the routing protocols for VANETs are classified into two categories: the topology-based routing protocols that uses the link status of the network topology to perform packet forwarding; the location information based routing protocols, where the location information of the vehicles are used for packet forwarding. AODV [19] is widely used, for it acquires routes on demand. HOPS metric of AODV does not guarantee high throughput path. The authors of [20] had proposed ETX metric for the discovery of high-throughput path. According to [21] the definition for scalability goes like this: Routing scalability is defined as the capacity of the routing protocol to maintain its routing overhead rate less than the MTL, network's minimum traffic load, as some parameter, say for e.g. network size increases.MTL is defined as the minimum amount of bandwidth required to forward packets over the shortest distance routes available.

IV. ALGORITHM FOR THE LOCATION BASED ROUTING PROTOCOL AODV-R

Step 1: Perform route discovery and route establishments using RREQ and RREP packets using the location information.
Step 2: Perform route discovery using the EETX metrics to find the minimum delay path, despite wireless medium losses.
Step 3: On encountering link failures the protocol finds the lossless path using the link quality metric.
Step 4: Repeat (1-3) till destination is reached.
Step 5: Perform data forwarding over the optimal path, when the destination is reached.
Step 6: Continue from Step 1 for further route establishments.

4.1 Extended ETX Metric

The ETX (Estimated Transmission count) metric is calculated from the beacons that a node receives from its neighbors. The formula for ETX is, ETX = $1/D_f * D_r$. D_f and D_r forward and reverse delivery ratios respectively. The mobility metric, say, speed is assigned as a weight to a link and along with the ETX value it is coded.

Greedy, when replaced with the Genetic algorithm finds optimal path better and quicker.

4.2 Modified Genetic Algorithm

GA for VANETs is modeled as a connected topology graph with vertices and links (radio). Chromosomes are encoded under the delay constraint. If the delay constraint is not-agreeing then the encoding process is repeated to satisfy the delay condition. Modified GA contains the usual steps of GA. Genetic algorithms for VANETs must adapt to the dynamic environment changes. The standard GA works well for the static environments. Quick convergence to the optimal solution is expected from modified GA. The memory and elitism-based schemes, multi-population approach is the techniques that are incorporated into standard GA. In multi-population approach, the search space is divided into several small parts and those small populations are used to search them separately. One small population, acting as parent continuously searches for new optimum. The remaining child populations exploit the old promising ones. The diversity level of the population is kept by substituting random individuals either to the parent or to the child.

The modified algorithm finds a sequence of paths {P_i Є i ׀ {0,1,…}} over a series of graphs {G_i gniyfsitas {{…,1,0} Є i ׀ the delay constraint as shown in (a) and with the least cost path as shown in (b).

$$\Delta P_i = \Sigma\, d_l <= \Delta \quad \text{\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_}(a)$$

l Є belongs to Pi(s,r) where ΔPi is the total transmission delay on path P_i and Δ is the delay upper bound.

$$C(P_i) = \min_{P \in G_i} \{ \Sigma_{l \in P(s,r)}\, C\, l\, \} \quad \text{\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_} (b)$$

The main part of any GA is the fitness function which here finds the least cost path between the source node ,s and the destination node, The fitness value of chromosome (here, routing path, P) is given as :

$$F(Chi) = [\, \Sigma_{l\, \varepsilon\, P(s,r)}\, cl]^{-1}$$

V. PROPOSED ALGORITHM FOR CONSTRUCTING DELAY AWARE AODV

Step 1: Randomly generate a large single population.
Step 2: For each given change interval INV do the following for [INV/2] generations:

- **Step 2.1:** Single population is split into 3 small Populations.
- **Step 2.2 :** Choose parent and child populations.
- **Step 2.3 :** These 3 small popultations keep evolving independently till the change interval finishes.
- **Step 2.4:** When the toplogy change is detected,each small population processed separetly and then merged together to form a single population again.
- **Step 2.5:** For each generation ,a small number of random immigrants are added into the parent because it does exploring.

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Step 2.6: If new chromosomes produce infeasible solution then repair functions are called.

Step 3: Mark the best offspring in the generation as Best-off.

VI. SIMULATION SETUP AND RESULTS

VANET communication network is created using these tools NS2 [22], MOVE [23] and SUMO [24]. Simulation experiments are evaluated in IEEE 802.11p.Table 1 shows the simulation parameters. The discrete event network simulator, NS-2 simulator is used along with MOVE and SUMO tools. The MOVE (Mobility model generator for Vehicular networks) tool allows users to rapidly generate realistic mobility models for VANET simulations. Move consists of two main components:-Map Editor and vehicle editor. The map editor is used to create the road topology. The vehicle movement editor allows us to specify the trips of each vehicles and the route that each vehicle will take for one particular trip. SUMO (Simulation of Urban Mobility) is helpful for building realistic mobility model especially to handle large road network By clicking on the “Visualization” button of MOVE main menu, the generated mobility trace is seen on the monitor, as shown in figure 2.

NS2 is integrated to SUMO using MOVE. We compare the simulation results of AODV routing protocol with our proposed routing protocol AODV-L.

6.1 Performance metrics

Some of the performance metrics that are considered in our simulation experiments are:

• Packet delivery ratio (PDR) represents the average

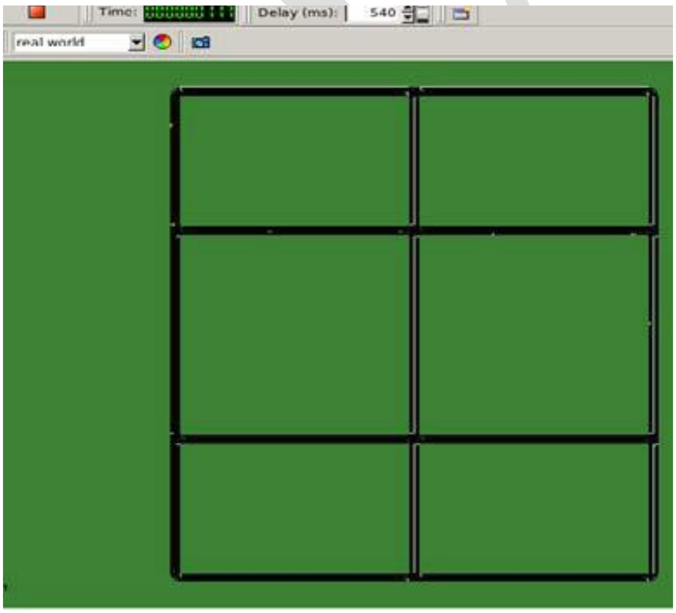

Fig 2: Real world simulation

TABLE I
SIMULATION PARAMETERS

Parameter	Value
Number of vehicles	40-240 vehicles
Transmission range	150-240 m
Data rate	8 kbps
Beacon sampling period	1 sec
MAC layer	802.11p
Bandwidth	2 Mbps
Average velocity	40-100 km/h
Speed distribution	Two-ray Ground

Ratio of the number of successfully received data packets at the destination node to the number of data packets supposed to be delivered.

• Routing control overhead expresses the ratio of the total generated routing control message to the total number of data messages supposed to be received.

• End-to-end delay represents the average time between the sending the receiving times for packets received.

6.2 Simulation Results

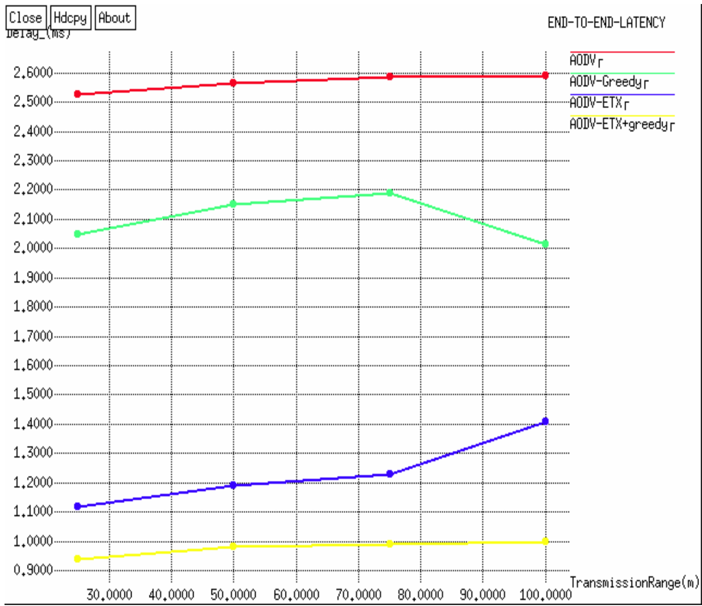

Fig 3 : End-to-End delay analysis

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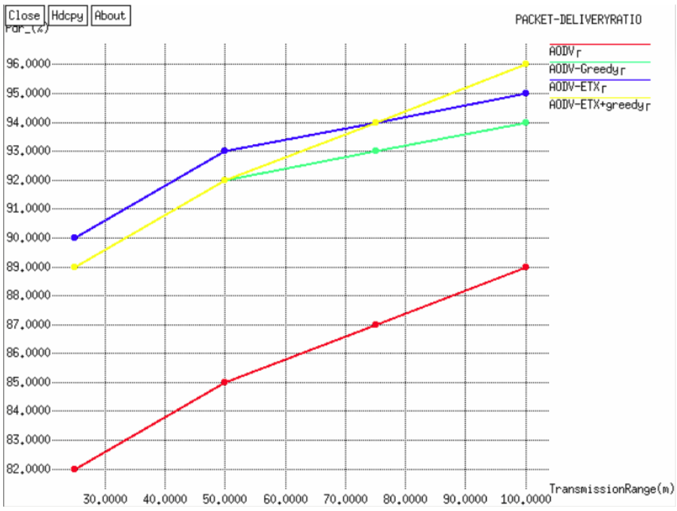

Fig 4: PDF analysis

VII. CONCLUSIONS AND FUTURE WORK

The Simulation results have shown that the proposed protocol AODV-R outperforms AODV. The optimality can be achieved by using a Meta heuristic algorithm like genetic algorithm. The proposed routing algorithm considered the vehicular movements as the main cause for link breakages. The other possible causes for link breakage could be wireless channel congestion and/or noise errors [25] as well. The impact of wireless channel congestion/noise errors and considering QOS requirements to support real time applications while maintaining scalability in our developed routing protocol will be future extensions. We are working on these issues.

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