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Research paper



Parameter Based Efficient & Reliable Routing Technique to Enhance Network Lifetime for Vehicular Ad Hoc Networks

Asha K S[1*], Rajeshwari Hegde[2]

[1]*Research Scholar, Dept of ECE, SET-Jain University, Bangalore, India*
[2]*Associate professor and Head, Dept of TCE, BMSCE, Bangalore, India*
**Corresponding Author E-mail: [1]asha.kps@gmail.com, [2]rajeshwari.hegde@gmail.com*

Abstract

Some Inherent Vehicular Ad Hoc Networks (VANETs) characteristics such as intermittent connectivity, highly dynamic topology, and hard delay constraints, make data communication a challenging task in these networks. Due to such peculiarities, in this paper we study the impact of using vehicles predicted locations as a metric for data communication in VANETs. This paper deals with PBERR (Parameter Based Efficient Reliable Routing) for VANETs, which is a multilevel routing algorithm. The focus of this algorithm is 100% data transmission from end to end with no loss or drop of data packets by selecting the reliable path. The proposed algorithm will use the data of the digital maps to limit the scope of message exchanges in the shortest path for vehicles between source and destination. Our results clearly demonstrate the efficiency of the proposed solution in different scenarios, especially in terms of Network throughput, Energy consumption and Average delay.

Keywords: *Vehicular Adhoc Networks, PBERR (Parameter based efficient reliable routing), Routing.*

1. Introduction

The incorporation of communication technology in the vehicles has begun years ago. Some popular examples for the integration of mobile devices integration are Internet access and Car phones, based on Bluetooth adapters as well as cellular technologies. Inter-vehicle communication (IVC) deals with direct communication between vehicles using an Ad Hoc network, so called Vehicle Ad hoc Networks (VANETs), is a new approach. Thus, interconnected vehicles can collect and share information about themselves and surrounding environments in real time. Therefore, there is an extensive list of potential applications of VANETs, where we can highlight categories related to safety, transport efficiency and information/entertainment applications. Fine administration of versatility in VANET is vital with a specific end goal to guarantee routing efficiency. Common routing protocols based on topology have constrained exhibitions in such systems, on account of their expensive revelation and maintenance stages. Packet or Information routing is one of the significant issues in VANETs in view of previously mentioned qualities. In VANETs, routing protocols can be categorized into six classes:

1) Protocols based on Topology: They discover the routes amongst hubs and save them in routing table before forwarding information.

2) Protocols based on Position: This category of protocols use geographic positioning data with a specific end goal to locate the progressive sending hubs, hence there is no necessity to set up and save a route between sender and receiver.

3) Protocols based on Cluster: In this type of protocols, close vehicles attempt to make a group with each other. One among these vehicles is chosen as group-head who is responsible to broadcast and manage the inter/intra-group messages. In group based protocols, Scalability is the main advantage of group based protocols, and high overhead and delay are the main disadvantages in highly mobile systems like VANETs.

4) Protocols based on Geo-cast routing: In this type of protocols, nodes try to send information to a set of vehicles in a particular geographic zone. They resemble multicast routing. Partitioning and forwarding to a suitable node can be avoided by troublesome neighbor centers are the two drawbacks in Geo-cast routing protocols.

5) Protocols based on broadcast routing: These protocols are mainly used for different purposes in VANETs, such as: traffic information or data sharing, emergency news and advertisements news.

6) Protocols based on Infrastructure: In the routing process, these protocols use their infrastructure and hence the name.

Development of new attractive services can be done using particular properties of VANETs.

The most important and relevant areas are safety and comfort. Safety applications increase the wellbeing or safety of travelers by exchanging most important data by means of Inter vehicular communication. The data is either displayed to the driver or used to trigger safety system. Comfort Applications improve passenger traffic efficiency and comfort by optimizing the route to a destination. The paper is organized as follows. Section II deals with related work. Section III explains the localization prediction-based routing for VANETs. Section IV explains the proposed system. Section V deals with performance analysis. The paper is concluded in section VI.

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2. Related Work

K. Prasanth et.al [1] has worked on "Efficient Packet Forwarding Approach in Vehicular Ad Hoc Networks Using EBGR Algorithm":
VANETs are highly mobile. Taking care of safety measures is very important in this case. Since the vehicle speed and topology are changing very rapidly it is a challenging task to design a routing algorithm which meets all the requirements. EBGR (Edge node Based Greedy Routing) is a position based reliable routing algorithm used for unicast or multicast routing. This algorithm first identify the neighboring node, next it will calculate the distance to the next node using GP information, then identify the moving direction of the neighboring node, establish a link between the source and the neighboring node, calculate the energy of the neighboring node for further forwarding and finally select the edge node with higher potential within the transmission range for forwarding. Simulation results explain that packet delivery ratio has been improved.
Marwane Ayaida et.al [2] developed "A Movement-Prediction-based Joint Routing and Hierarchical Location Service for VANETs". Location-based protocols maintain (and provide) location information which is used by geographic routing protocols. Location and Routing are generally related, but they are separately handled by VANETs. In this paper, Prediction-based Hybrid Routing and Hierarchical Location Service (PHRHLS), they predicted the mobility of the nodes. For this they used, Greedy Perimeter Stateless Routing (GPSR), and the Hierarchical Location Service (HLS) algorithms. According to PHRHLS, there is a reduction in localization overhead and the routing performance is enhanced. Some of the simulation results reveal that this approach yields a great result in terms of packet delivery ratio, end-to-end latency and controls message overhead.
Elias C. Eze et.al [3] described about "Vehicular Ad Hoc Networks (VANETs): Current State, Challenges, Potentials and Way Forward".
Over the past few years, automobile industry and advancements in wireless communication technology have triggered a lot in the research field of VANETs. Wireless technology 802.11P supports both vehicle to vehicle communication as well as vehicle to infrastructure communication. The main aim is to improve motor traffic efficiency and road safety in near future by developing intelligent transportation system. In order to achieve this automobile industries, government and academia have joined their hands to establish standards and they are working on several ongoing projects for VANETs. Some more applications of VANET are traffic information dissemination and vehicle collision warning have made VANET an attracted field of wireless communication. This paper deals with challenges, current state of the research and potentials of VANETs to go forward to achieve the best and long awaited ITS.
Mohammad Reza Jabbarpour et.al [4] developed "The Comparative Analysis of Velocity and Density in VANET Using Prediction-Based Intelligent Routing Algorithms":
Both industry and academia are attracted towards research on VANET. Designing the best routing algorithm is one of the main challenging issue in VANET. Another challenging task in VANET is predicting the best suitable node to forward the packets within the network for reliable communication. There are many factors which influences VANET are location, density, distance and velocity. In this paper impact of velocity and density on the precision of routing algorithm has been discussed. They investigated how velocity along with density affects the routing algorithms in VANETs. They divided algorithm into density-based and velocity-based groups. Using NS2 special scenarios have been shown by considering density and velocity at the same time and how these parameters affect each category of algorithms. Graphs are shown for the obtained results based on packet delivery ratio and delay as routing performance indicators.
Saleh Yousefi et.al [5] described about "Vehicular Ad Hoc Networks (VANETs) challenges and perspectives". VANET is a subclass of MANET, main aim here is to design intelligent transportation system. Network functionality mainly rely on the vehicles itself as there is no fixed infrastructure. Characteristics of VANET are different from MANETs due to high mobility, driver behavior and other mobility constraints. Challenges and problems of VANET have been discussed here; solutions are provided for few problems. Current state of the research and future perspectives are discussed in this paper. Good explanation is done on vehicular adhoc network and research trends in vehicular network area.

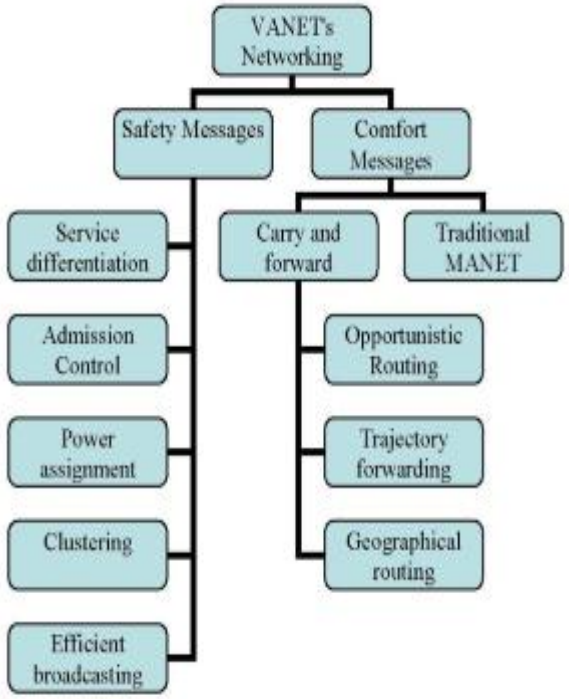

Fig. 1: Networking challenges in VANET's

3. Localization Prediction-Based Routing For Vanets – LPRV

This is the existing routing algorithm, i.e., the routing algorithm for data communication in VANETs:
The main idea of the existing LPRV algorithm is to predict the future locations of the node to forward the packets. Since prediction about the node is done, packets carry trajectories along with them without the need for any extra control message. To avoid the broadcast storm problem, the LPRV algorithm also takes advantage of a digital map to limit the scope of message exchanges in the shortest path for vehicles between source and destination, thus avoiding unnecessary transmissions. Since predicted locations are encoded in the packets, only nodes with future computed positions closer to the destination are chosen as next hop of a forwarding a packet. To ensure the election of best trajectories in the packet forwarding, this algorithm computes a contention time in which the farthest nodes in a given path segment wait more time than the closer nodes, thus ensuring better greedy forwarding decisions.

4. Proposed System

Parameter Based Efficient Reliable Routing Algorithm (PBERR) algorithm is proposed to choose reliable path between sending node and the receiving node based on the distance between two successive nodes, hop count, energy level and free buffer space. The alternate path will be selected if malicious nodes are detected.

The main objective of this algorithm is to reduce the number of hop count and to reduce packet loss. Packet loss happens when energy at the node is less than the threshold level, such that it cannot forward the packet. Which results in dropping of packets at intermediate stage and it may happen because of insufficient buffer space at nodes to store the packets.
By choosing a node with sufficient energy level and sufficient memory to store and forward the packet hop count will be reduced. Reduction in hop count will reduce number of nodes in a reliable path. Algorithm selects the best quality path of the network for highly reliable data transfer.
It is a multilevel routing algorithm, as the main objective of this algorithm is to reduce packet loss or drop of packet, which will choose the best quality path of the network for highly reliable data transfer.
In this algorithm, following parameters are considered for the selection of reliable path from the source node to destination node.
1. Min Hop count.
2. Min Energy Level.
3. Check for Free Buffer Space.
4. Distance between source and destination.

Algorithm

[OPR] = algorithm (N, S, D)
OPR=Optimal routing path, N=Node, S=Source and D=Destination
Step 1: Input N, S, D
Step 2: Define Initial Energy & Transmission Range
Step 3: Calculate the distance using Euclidian formula by greedy Method
Dist = In the Euclidian plane, if p = (p1, p2) and q = (q1, q2) then the distance is given by

$$d(p,q) = \sqrt{(q_1 - p_1)^2 + (q_2 - p_2)^2}$$

Step 4: Calculate node's initial energy
Step 5: By considering node states as highest parameter
Step 6: Evaluate if the destination lies within the transmission range or not, If yes update source and destination location
Step 7: Evaluate if the destination distance <= transmission range then update the source node and routers
Step 8: Select the node within transmission range based on the threshold value and which is near to destination node
If distance is < threshold
then threshold = distance
Source = Next Source
Goto step5
End
Step 10: Check the availability of buffer size and calculate the energy levels for each nodes, based on these values select the node as a router to forward the packets.
Step 11: Select the router node as parent node and construct the tree structure for all the deployed nodes.
Algorithm tries to find the reliable and shortest path by selecting the nodes carefully by considering the parameters- energy level of nodes and available buffer size, by selecting nodes which are present at boundary of transmission range and which are at most near to the destination.
Algorithm determines the energy level of nodes to make sure that node that is involved in routing is capable of routing all the packets to the next hop without failure due to insufficient energy.
Buffer size is used to determine, whether node is having sufficient buffer size to store all the incoming packets and forward it to the next hop. This prevents the drop of packets due to insufficient buffer size or loss of memory.
Algorithm selects the nodes which are at boundary levels of transmission range of nodes so that packets can reach the destination at the earliest. It also increases the lifetime of network because number of nodes involved in transmission is comparatively less when compared to other algorithms.
Algorithm selects the nodes which are closer to destination by determining the distance between the node and destination nodes before involving the node for transmission. This procedure is used to reduce the number of hops involved in transmission of packets to destination.
Based on the above parameters a node is selected as parent node between the source and destination and a tree is constructed to transmit the packets. All other nodes will be in sleep state where as parent node will be in active state.
Advantages of selecting the nodes by taking into account the above parameters are 1) Increases Packet delivery ratio and 2) Decrease in delay of Packet delivery 3) Increases network lifetime.

RSA Algorithm

In order to secure data transmission in VANET, messages are encrypted at the sender node and decrypted at the receiver node. Encryption and decryption is done using RSA algorithm. RSA is an asymmetric cryptographic algorithm. Two different keys are used in this algorithm. This is also called public key cryptosystem, where encryption is made using public key which is known to everyone and decryption is made using private key which is a secret key maintained at each individual. The RSA calculation involves four stages: generation of the key, dissemination of key, encryption and decryption.

The public key as the name implies is shared with everyone, whereas the private key is for individual and must be kept secret. In RSA cryptography, either public key or private key can be used to encrypt/decrypt a message. If public key is used for encryption then private key is used for decryption and vice versa.

Data Transmission and Alternative Path Selection

After encrypting the packets or messages using RSA algorithm, reliable path is selected to transmit packets. While transmitting the information, take should be taken about malicious node attackers in the system which will leak the data to different nodes. If malicious nodes are discovered, further transmission of data through that node will be stopped and locate the best way using PBERR algorithm. The best path between the source hub 11 and sink hub 16 is shown in fig.2.

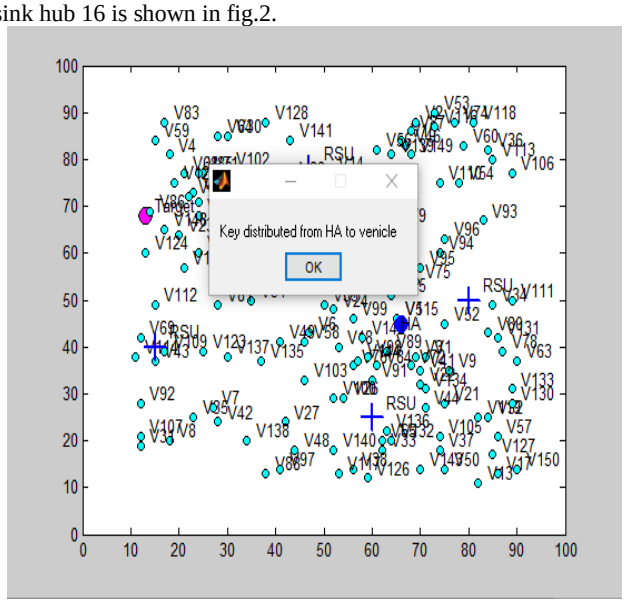

Fig. 2: Reliable path between source node 11 and destination node 16

Once the alternative route is found, the packet/information is retransmitted to the destination node.

5. Performance Analysis

Simulation was done using MATLAB. The parameters energy consumption, network throughput, average delay was considered for simulation and the results were compared with LPRV algorithm. There was a significant improvement in the parameters compared to LPRV algorithm.

1. Energy consumption

Simulation result for energy consumption is shown in fig. 3. PBERR algorithm is compared with LPRV algorithm. It was found that the energy consumption is 40% less as compare to LPRV algorithm.

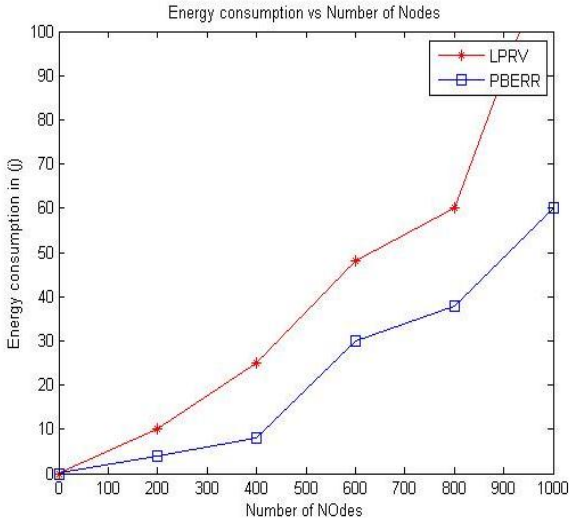

Fig. 3: PBERR energy consumption Vs. LPRV energy Consumption

2. Average delay

Simulation result for Average delay is shown in fig. 4. PBERR algorithm is compared with LPRV algorithm, the average delay is 75% less as compare to LPRV algorithm.

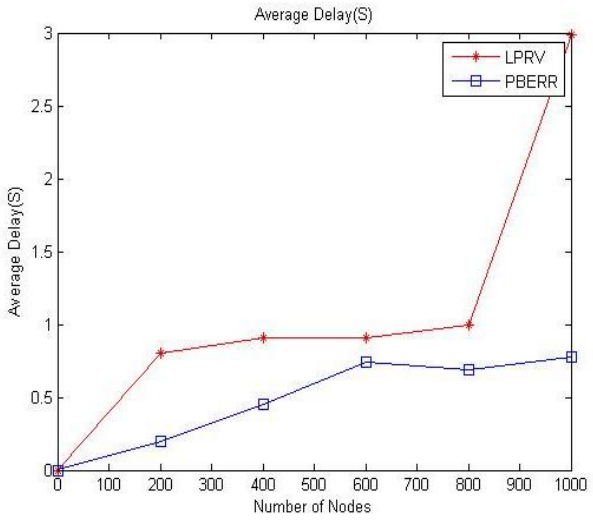

Fig. 4: PBERR average delay Vs. LPRV average delay

3. Network Throughput

Simulation result for Network throughput is shown in fig.5. . PBERR algorithm is compared with LPRV algorithm, the network throughput is 8% more as compare to LPRV algorithm.

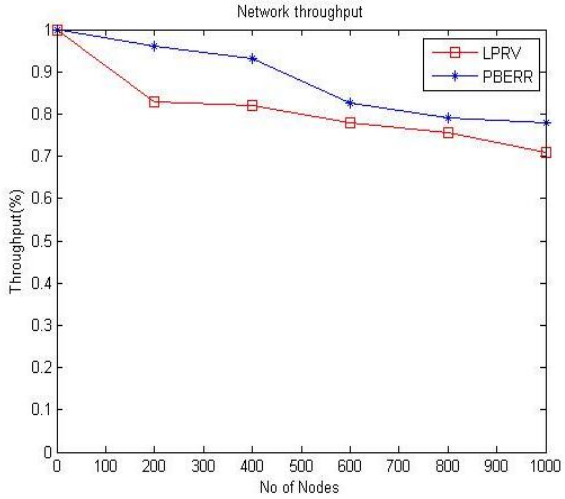

Fig. 5: PBERR network throughput Vs. LPRV network throughput

6. Conclusion and Future Work

In this paper, PBERR algorithm has been proposed for the reliable path selection between source and destination with minimum packet loss. This algorithm is useful to find the alternative route when malicious nodes are encountered during message transmission. In order to provide better security, the information is encrypted and decrypted using RSA algorithm. Finally simulation results are compared with LPRV algorithm and improvements in the system performance could be seen. As future work, we extend our simulation to increase packet delivery ratio and reduce network overhead. Which intern increases the system performance.

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