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An Access Point Based Routing Algorithm (APBR) using Greedy Method Towards Improving Quality of Service for VANET

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Abstract

The vehicular Ad-Hoc networks (VANET) is a main challenge in the high mobility of advanced wireless local area network technology. In a city environment, an intermediate intersection plays a crucial role in routing protocols. In contrast to highway scenarios, this research work deals with the crucial problems associated with routing in city environment due to obstacles and voids. Thus the Enhanced Greedy Back Bone routing technique(EBGM) is used in which some specialized nodes perform functions such as tracking the movement of end nodes, detecting voids regions on road segments, storing packets on unavailability of forwarding nodes and selecting the most suitable intersection node as the forwarding node. This paper introduces an Enhanced Backbone Greedy method, an Access point Based Routing Algorithm proposed specifically for a VANET scenario and evaluate the performance using the NS2 simulator. In this paper, we propose an Access point based routing algorithm (ABPR) for VANET that is used to enhance routing decision in packet delivery. The ABPR Algorithm supports efficient one-hop and multihop unicasting services by using Access point(Base station). This algorithm is used to send the packet from source node to the destination through the Access point.Simulation results show that ABPR outperforms EBGM in terms of the packet delivery ratio and end-to-end delay.

Keywords: Vehicular networks, unicasting, performance evaluation, ABPR,EBGM.

1. Introduction

VANET or Intelligent Vehicular Ad-Hoc Networking provides an intelligent way of using vehicular networking [1]. Besides the road safety enhancements that VANETs will bring, they also open doors to many applications to enhance the driving and travelling comfort, like Internet access from a car. In order to enable the effective Ad-Hoc networks on road, each vehicle is equipped with a wireless communication device called an on-board unit (OBU). Road-side units (RSUs) are installed at the roadside locations as access points for OBUs. VANET have different scenarios such as highway and city environment. The routing in a highway network is made effortless because it is one-dimensional. The routing in a highway network would not be same as in a city network because the city scenario faces many challenges in routing protocols such as two-dimensionality, obstacles, node density and low-mobility.

Many routing protocols [2] have been developed for both scenarios which is reliable in highway environment, but produces higher hop-count in a city environment. To reduce the hop count, the greedy routing and backbone mechanisms are used to solve the problem in a city environment.The Enhanced Back- bone greedy protocol is implemented based on the IEEE 802.11p with Unicast routing method. The enhanced Back Bone greedy method is a position based routing protocol in VANET.

The Challenges of Position based routing in City Environment are:

1. The sending node uses location service to know the position of the destination node.

2. Greedy position based forwarding - node forwards packets to direct neighbors closest to the destination [3].

The proposed work, Access Point Based routing Algorithm is implemented based on the IEEE 802.16p with the unicast routing method. This Algorithm is mainly developed to reduce the packet delivery ratio and end-to-end delay when compared to the enhanced back-bone greedy method.

In Enhanced back bone greedy method, the node can be communicated directly with another node through the reliable routing path,but in the Access Point Based Routing Algorithm, each node can communicate with each other node through the Base station i.e,access point. This algorithm reduces transmission collisions, produce a high packet delivery ratio and less end-end delay.

Related Works And Motivations

In this research work, papers related to various routing techniques for Vehicular Adhoc Networks are discussed. In contrast to highway scenarios, this Research work deals with the problems associated with routing in city environment due to obstacles (building) and voids. Several routing Protocols have been developed to overcome the problem of routing overhead and collision.

Greedy Traffic Aware Routing (GyTar)

The Existing protocols GyTar (Greedy Traffic Aware Routing) is an intersection based geographic routing protocol capable to find robust and optimal routes within an urban environment. The main principle of GyTar is the dynamic and in-sequence selection of intersections through which data packets are forwarded to the destination. The recovery strategy adopted by GyTar is 'carry- and-forward' technique: the forwarding, vehicle of the packet in a recovery mode will carry the packet until the next intersection or until another vehicle, closer to the destination intersection, reaches its transmission range. GyTar dynamically selects the intermediate intersections based on traffic density and curve metric distance, but it cannot avoid void and it depends on roadside units.

However, GyTAR appears to have a slightly higher delivery ratio and end to end delay than GPCR because of the enforcement of a local recovery strategy.When compared with GPCR ,GYTAR produces better performance. But,GYTAR cannot avoid void regions and produces higher hop count . Enhanced back bone greedy method is introduced to reduce the number of hopcount.

Enhanced Backbone Greedy method in City Environment

In a city network, finding the routing path is more crucial due to fleet of vehicles has crossed many intersections (junctions) [4]. So intermediate intersections, place an inimitable challenge to routing protocols. The problem occurred in the city environment is not alike as that of the highway environment. In highway may have a sparse vehicular density, but in city environment have dense vehicular density and also meet many numbers of intersection points. Thus the main objective of this research is to design a reliable routing protocol for VANET which provides connectivity at the intersection and avoid the number of intersections that are used to change the direction of the routing path. This is achieved by using enhanced back bone assisted hop greedy routing method and implemented using the NS2 simulator.

Enhanced Back Bone Mechanism

The enhanced backbone mechanism is used in which some specialized nodes perform functions such as tracking the movement of end nodes, detecting voids regions on road segments, storing packets on unavailability of forwarding nodes, and selecting the most suitable intersection node as the forwarding node[6].

The node turn blue indicates the moving vehicles and the red color node indicates the signals. When the vehicle reaches the intersection, it will wait to cross the intersections until the signal turns green. The node waiting at the signal is considered as a backbone node [7] as shown in figure 5..

Backbone nodes can be classified into three types. They are

1. Stable back bone nodes
2. Major back bone nodes
3. Minor back bone nodes

The vehicles waiting at the junction and nearest to the intersection node declares itself as the stable back bone. The major and minor backbones are selected from the fleet of vehicles crossing the intersection when the signal turns green. In the proposed method, when the vehicles cross the intersections it will change the node color to yellow for allusion and consider that a node is a major backbone node. After crossing the intersections, the major backbone nodes are to be changed as minor backbone nodes. The backbone nodes maintain the information of all its neighbor nodes with a speed of vehicles, the position of a particular vehicle and the moving direction. With the assist of this information, finding out the next forwarding node to be forwarded with the least number of hops[8].

Proposed Work

This research work highlights the implementation details and analysis of the system. To improve the packet delivery ratio, and End-to-End delay the proposed system is implemented using Access point Based Routing Algorithm. In this algorithm, the routing is performed with one base station(BS) and multiple Subscriber stations(SS)[14]. The MAC layer is used for the management of the message such as REQUEST/REPLY, DOWNLINK/UPLINK etc.

Enhanced Backbone Greedy Algorithm (EBGM)

Assumptions

It is assumed that two paths are available to reach from source node(SN1) to the destination node(DN1). For designing the network with enhanced backbone greedy method, the source node have x intermediate intersections and the destination node as y intermediate intersections

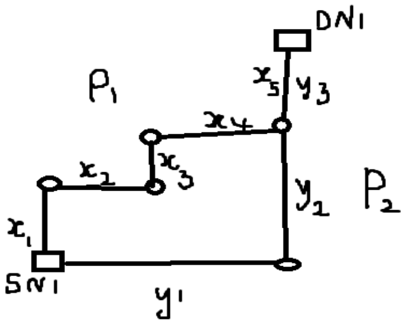


Figure 1. Routing path.

In the figure 1, the source node SN1 has two paths to reach the destination node DN1. The path (P1) from source to destination have X intermediate nodes such as

Length(P1)= $\sum_{r=1}^{n1} x_r$ equ(1)

And calculate the hop count for path (P1) as

Hopcount(P1) = n1

Transmission time taken from path P1 is

$$\text{Transmission time}(T1) = \frac{\text{Distance taken from Source to destination}}{\text{Speed}}$$

Distance taken from source to destination =weighted score(x1+x2+x3+……..+xn1)

The path (P2) from source to destination have Y intermediate nodes as

Length (P2)= $\sum_{r=1}^{n2} y_r$ equ(2)

And calculate the hop count for path (P2) as

Hop count (P2) = n2

Transmission time taken from path P2 is

$$\text{Transmission time (T2)} = \frac{\text{Distance taken from Source to destination}}{\text{Speed}}$$

Distance taken from source to destination =weighted score (y1+y2+y3+……..+y_{n1}).

To find out the least hop count with the help of an equation equ1 and equ2 as

1 initialize

2 tempp=select paths to forward message through 802.11;pi=number of paths;

Ti=time taken to send messages from source to destination

3 Tempp=p1

4 For each path pi=1 to pn-1

5 if(hop count(pi)<hop count(pi+1)

and Time(Ti)<Time(Ti+1) then

6 Tempp=pi

7 end if

8 loop

Alg 1. Procedure for finding a path with less hop count with less transmission time.

The number of hop count and transmission time_in the path(P1) is lesser when compared to the hop count and transmission time in the path(P2)….(pn). Thus the path (P1) is the routing path with the least number of hop count.

Simulation Setup

The simulation is performed in a simulation area 5500x5500m with 10 nodes [9]. The results are produced under the simulation study of the network using the NS2 simulator. The vehicles waiting for a red signal is considered as a stable backbone node. Stable backbone nodes change to major backbone nodes when the signal turns green[10].

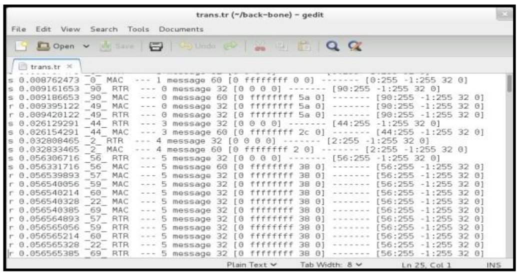


Figure 2. Trace File

Figure 2 , indicates the trace file generated after running the simulation that indicates the events of the nodes and time taken from the node to send the data to the destination .The trace file is used to find out the performance measures[11][12].

Simulation Parameters

Parameters	Values
NS Version	NS_2.35
Topology size	5500m X 5500m
No of vehicles	15
Data packet size	1000
Routing protocol	DSDV
Traffic type	CBR
Packet type	UDP
IEEE	802.11p
Radio Propagation model	Two ways Ground

Performance Measure
Performance analysis entails the balancing of response time(or delay)and throughput[13].

Access Point Based Routing algorithm(APBR)
Pseudo code of APBR is given in Algorithm 1.Upon the Vehicle V1 can check whether or not the node is currently is in the range of networks. In this algorithm, BS denotes the Base Stations and SS denotes the Subcriber Station (nodes). Before sending the message to the destination,the Subscriber Station(node) Establishes the connection with the Base Station. Through the Base station the node can communicate messages with the other node.

Algorithm 2.Pseudocode of APBR Algorithm

1. Event Vehicle V1 is in the range of networks
2. Initialize node setup(SS)
3. BASE=f1←BASE
4. SS←Timing=f1←Timing
5. SS←Power Parameter = f1←Power parameter
6. SS.Send(Bandwidth)←BASE
7. SS.Bandwidth←BASE.Response(Bandwidth)
8. SS←Base.Response(Request)
9. Connection Establishment between the BASE and SS.

Fig 3 : Initialization procedure

For the BS to communicate with the SS, the following processes are to be performed. They are Initial ranging process, Bandwidth allocation,. Registration request.

In the initial ranging process, the SS synchronizes with the DL channel and receives the DL-MAP and UL-MAP for a frame. Then the BS and SS need to adjust its timing offset and power parameter(4-5). After the initial ranging process is completed, the bandwidth request is sent by the SS to the BS on a per-connection basis. The BS grants the request and sends the allocated bandwidth to the SS(6-7). After the bandwidth allocation, the SS sends the registration request to the BS by REG_REQ and REG_RSP messages(8). Finally, after successful registration, messages can be sent between the BS and SS for communication(9)[18].

1. SETUP(SS)
2. f1=Fail
3. Scan frequency of BASE(f1) is in a range
4. While(f1 != Fail)
5. {
6. Scan(f1)
7. Next
8. }
9. Return f1

Fig 4: Procedure to evaluate a node range

1. Event message copy received from SS
2. BS_FINDPATH(G,SS)
3. If(DN ≤ range)
4. Dist(BS)←0
5. Q←V[G]
6. While Q≠null
7. ADD V[G] to Q
8. U=mindist(Q in V[G])
9. BS←BSU{U}
10. For each BS of U
11. Sr=dist[U]+length(U,BS])

12. If(sr<dist[U]and hopcount(dist)≤hopcount(previous)
13. Dist[u]=sr
14. Previous[U]=BS
15. Endif
16. EndFor
17. EndWhile

Figure 5. Procedure for APBR

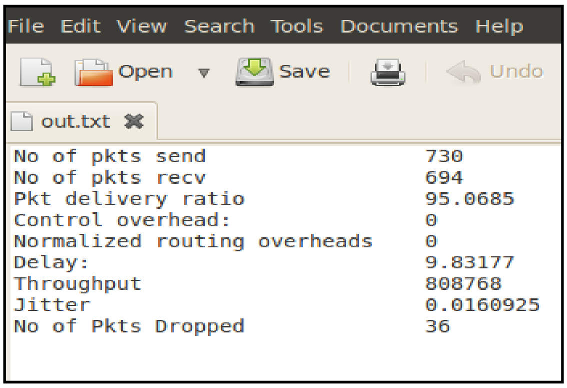
In the fig 4, set up the procedure of Subscriber Station and to identify the Base Station by scanning the frequency(F1) in the available range.As in the fig 5,after receiving the message from SS(source node), the Base Station is computed shortest path from a single BS to all of the other nodes in a range of network. This algorithm is used to calculate the best path to the destination by using minimum distance and lesser hop count. For example, if there are two links between a node and a destination, the base station chooses the link with the minimum distance and lesser hop count node(8-14). This algorithm reduces transmission collisions, produce a high packet delivery ratio,throughput and less end-to-end delay.

1 Intialize
2 Event receive message from ss
3 if(Add(D)≤range)then
4 BS_FINDPATH(G,BS)
5 else
6 BS←send msg to nearest BS
7 endif
8 dist←send msg through dist

Figure 6 Finding range of Base station.

In the figure 6,the BS find the range of destination(D).if it is in the range,send the message to the destination(3-4). Otherwise, send the message to the nearest Base station (6) and the process is to be continued as in fig 4.

Performance Measure



No of pkts send	730
No of pkts recv	694
Pkt delivery ratio	95.0685
Control overhead:	0
Normalized routing overheads	0
Delay:	9.83177
Throughput	808768
Jitter	0.0160925
No of Pkts Dropped	36

Simulation Parameters

Parameters	Values
NS Version	NS_2.35
Topology size	2500m X 2500m
No of vehicles	21
Data packet size	1500
Routing protocol	DSDV
Traffic type	CBR
Packet type	UDP
IEEE	802.16p
Radio Propagation model	Two way ground

Results and Analysis

APBR is an appropriate solution for VANET.Analysis and simulation results in city scenarios are presented to evaluate the performance of APBR and compare it with EBGM, an existing protocol for VANETs. It is shown that the APBR can provide significantly decreases the delay and increases packet delivery ratio.

Performance Evaluation

In this section, we evaluate the performance of the Enhanced backbone greedy method and Access Point Based Routing Algorithm. A city scenario with obstacles is considered to demonstrate the protocol performance.

Simulation Results and Analysis

In this section, the packet delivery ratio and end to end delay of Enhanced backbone greedy method and Access Point based Routing Algorithm are evaluated with respect to certain factors such as packet delivery rate and average time.

Packet Delivery Ratio:

The packet delivery ratio is the ratio between the numbers of packets received at the destination to the number of packets sent from the source. The greater value of the packet delivery ratio means better performance of the protocol [19].

Packet Delivery Ratio = Σ Number of packets received / Σ Number of packets send

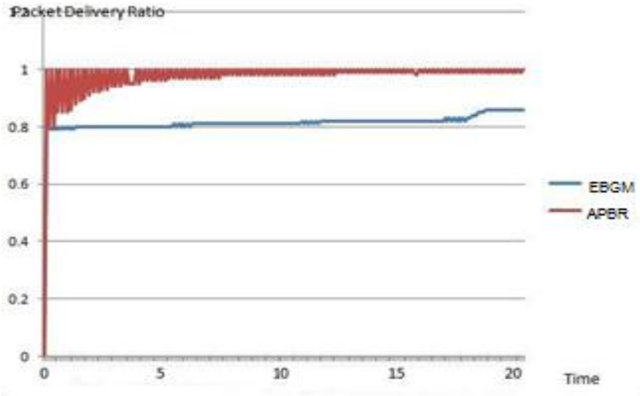


Figure 7. Packet Delivery Ratio

The figure 7, shows the graph plotted for packet delivery ratio using Enhanced back-bone greedy method(EBGM) and Access point based routing method(APBR). The graph shows that the packet delivery ratio of an access point based routing method is better when compared to the packet delivery ratio of Enhanced back-bone greedy method(EBGM). This is because Access Point Based Routing Algorithm offers large radio coverage and higher data rates.

In Fig. 7, the packet delivery ratio is measured with varying source- destination distance. The routing Algorithm EBGM experience a decrease in delivery ratio with an increase in the initial source to destination distance. One common factor responsible for this drop is the dependence on intersection node for packet forwarding i.e, node probing problem. As a result, the delivery ratio of APBR is highest among the EBGM. Because the APBR choose the route path with the access point method. Each node can send the packet to the destination node through the Base station(BS)i.e Access point.The base station can find the routing path to the destination with low weight and less number of hopcount. However, the update mechanism of the APBR protocol with the help of Access points enables the source to be connected with the destination through a reliable path. Therefore, the packet delivery ratio of APBR is maintained high, irrespective of the destination dislocation distance.

End-to-End Delay

End to End delay is the average time taken by a data packet to arrive at the destination. The lower value of end-to-end delay indicates better performance of the protocol [20].

End-to-End delay = Σ (arrive time – send time) / Σ Number of connections

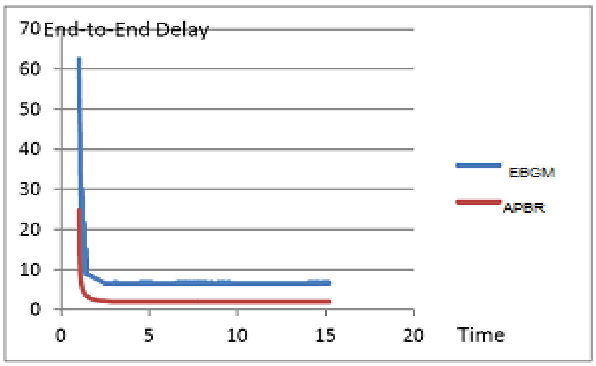


Figure 8. End-to-End delay

The figure 8, shows the graph plotted for End-to-End delay using Enhanced back-bone greedy method(EBGM) and Access point based routing method(APBR).The graph shows that the End-to-End delay of APBR is less when compared to the End-to-End delay of Enhanced back bone greedy method.

It is observed that the end-to-end delay in APBR experiences the highest variation, whereas EBGM shows the least variation. Unlike EBGM [3], APBR is not affected by the delay as it is designed to send packets only through less weight and less hopcount.

As far as APBR is concerned, the routing path is selected considering the minimum number of hopcount. It directly follows that fewer number of intersections are involved to forward a packet from the source to the destination, keeping the end-to-end delay as low as possible. As shown in Fig. 8, it achieves the lowest delay among EBGM.

Conclusion And Future Scope of Research

Several routing protocols are used for VANET routing in a city environment. The position based routing protocols outperforms the traditional ad hoc routing protocols in VANET. In city environments, intersections play crucial roles in data communications. Thus unicast routing is preferred over the broadcast as the packets are vulnerable to collision at the intersections. As the intersection region is comparatively small and the probability of change of direction is very high, it will be risky to choose an Unstable node as the forwarding node from this region, because the node may cross the intersection before receiving a data packet. Thus the Enhanced Back Bone Greedy method is used where the concept of back bone nodes avoids the connectivity issues such as void regions and unavailability of forwarders. The EBGM algorithm finds the best possible path in terms of both hop count and connectivity. To improve the performance of routing, the proposed system is implemented using access point based routing method which offers large radio coverage and higher data rates. The simulation results show that the proposed system outperforms the existing system in terms of the packet delivery ratio and end to end delay.

The proposed work is compared with the conventional enhanced back bone greedy Algorithm [3] and access point based routing Algorithm.

From the simulation results it is clear that the Access-point Based Routing algorithm attains high packet delivery ratio, throughput and reduced packet drop.In future work, this method will be implemented by using Broadcasting method.

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