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An Efficient Route Maintenance Routing Algorithm for VANETS

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***Abstract:** Vehicular ad-hoc network is a sub class of mobile ad-hoc network (MANET) with a difference of having moving vehicles as nodes. Todays, it is growing very fast. ITS have two key components self-organized and key component for VANETs. In Vehicular ad hoc network (VANET) vehicles can share data and communicate without infrastructure with other vehicles and road side units (RSU). These networks are having highly dynamic topology with fast moving vehicles and frequent disconnection properties. It requires handover management and an efficient routing algorithm. This research paper contains a network which is the combination of vehicular nodes, road side unit (RSU), and WiMax. This paper also proposed an optimized routing algorithm for handover management in VANET. This algorithm is compared with RBRA. The paper results that the proposed algorithm has minimum transmission time and minimum request block rate.*

Keywords:

I. INTRODUCTION:

VANET could be a very fast growing technology that is a part of intelligent transportation system (ITS). It's a subclass of mobile ad-hoc network. MANET differs from MANETS with one property. VANETs have moving vehicles as mobile nodes. Vehicles and Road side Units (RSUs) will communicate through wireless medium. It's a most prominent analysis area that provides communication between vehicles and RSUs without using any infrastructure. These networks are self-organizing in nature. In VANET vehicles are moving along the road side and these moving vehicles are equipped with wireless facilities. A spontaneous network is created by these vehicles while moving along the roads [1].

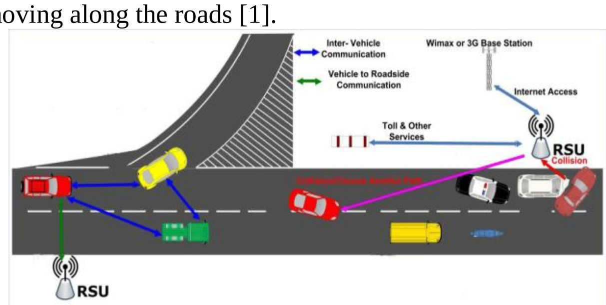

Figure 1: Creating a Vehicular ad hoc networks

VANETs are useful to provide safety and comfort related applications [2]. There are many applications to provide road safety while traveling and to avoid road accidents.

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Information related to safety related information, road traffic condition, collision avoidance, ITS, are some safety related applications. For example lane changing assistant applications, location based services, traffic information, traffic signal and road condition warning messages, electronic payment system, and electronic toll collection. VANETs are also used to increases the comfort of the passengers by providing traffic information, weather information, restaurant location, and internet access.

VANET has its unique characteristics [2]. VANET has dynamic topology because of highly mobile vehicles. Vehicles can form a network and leave the network very quickly which leads to frequent topology changes.VANETs have frequent disconnection property and mobility modelling feature. There is no power constraint in VANET. Vehicles have no limitation over power consumption and storage.

In VANETs communication between vehicles, RSU can be classified in the following categories: vehicle to infrastructure (V2I) communications and vehicle to vehicle (V2V). One vehicle can communicate directly with nearby vehicle in V2V Communication. This communication is cost effective and efficient. In V2V communication, vehicles that are near can communicate over short range wireless technologies. A vehicle, and RSU or infrastructure can communicate with each other in Vehicle-Infrastructure (V2I) Communication. Using hotspots, Wi-Fi or wide / long range wireless technologies, RSU can discover nearby vehicle. RSU can be used for internet access also [1].

Reactive and Proactive routing protocols are the two categories of Ad-hoc routing protocols. Routing overheads is increased in proactive routing protocols, as the are nodes continuously updated in the routing table, whereas route discovery is not required in Proactive routing. Hence proactive routing protocol are suitable for applications used for safety & security. More bandwidth is consumed in maintain **unusual paths which result in more consumption of bandwidth**. Initial high latency occurs in reactive routing protocols, due to initial route discovery. Routes are maintained in reactive routing protocol which are recently used which in turn reduces the network load. Dynamic MANTE on demand (DYMO) , Ad-hoc on demand distance vector (AODV), Dynamic source routing (DSR) are few examples of reactive routing protocols. Example of proactive routing protocols is Optimized link state routing [1].

In VANET Routing algorithms are required to find the path between two communicating nodes or vehicles. In VANET vehicles move on road with high speed and road side units (RSUs) are placed along road side. It is considered that vehicles moving in same direction have similar velocity in highway scenario. Vehicles moving in same direction remain connected with each other for more time than vehicles moving in opposite direction [4].

Ravi Shanker Shukla et.al [3] proposed a Position Based Routing Algorithm termed as VTARA, Vehicular Traffic Aware Routing Algorithm for VANETs. In his algorithm he suggested three modes of communication are possible in VANET: vehicle to vehicle (V2V), RSU to RSU (R2R), vehicle to RSU (V2R). According to this algorithm, sometimes RSU can communicate with another RSU by using fixed network. In VTARA, if ad-hoc region is not maintained or destination vehicle is not found in any ad-hoc region, then sender will route packet through the RSU in which the sender is registered.RSU checks the registered vehicles in its range. If destination vehicle is not registered in next RSU, then it sends packet to next RSU by using fixed network. This process continues till any RSU will find at least one vehicle registered in it or finds the destination under it. If destination find out then it will deliver packet to destination vehicle. But in this process, the delay will occur due to RSU to RSU communication. VTARA is useful routing algorithm but it is necessary to have a route optimization flow decision mechanism. We have proposed a routing algorithm that is an extension to the VTARA.
Efficient routing scheme s purposed in this paper. The working of the routing scheme is elaborated in section 2. In section three simulation result and analysis is presented. Finally in section 4 conclusion is drawn.

II. PROPOSED ROUTING ALGORITHM:

This section discussed Proposed Position Based Routing Algorithm. Proposed Routing Algorithm is a based on reactive routing algorithm for VANETs. When a vehicle wants to communicate with another vehicle it finds road based paths between vehicles. Best route can be find using purposed algorithm dependent on availability of destination host in real time traffic information. Proposed Routing Algorithm is an optimized version of VTARA [3] routing algorithm.
In VANET vehicles are equipped with data sharing and wireless capabilities. Each on board unit (OBU) is installed on vehicular node (VN). Vehicles and RSUs can communicate by using wireless technologies. In VANET each vehicle moves on the road and road side units (RSUs) are placed along the road side. It is assumed that GPS, navigation system, and digital map are installed in each vehicle. Routes are created by using moving vehicles, fixed RSUs, and WiMax.
Since it is assumed that GPS system is installed in each vehicle hence vehicles can find the position of other vehicles using GPS. When a vehicle has a route i.e the sequence of nodes for the destination, then it stores the complete route is stored if the header of data packet. This sequence of nodes in the header is used by intermediate nodes to forward the data packet and deliver the packet to destination. With the help of GPS system vehicles a list of all the vehicles are in its range by using GPS system a list is maintained by the source vehicle. Each vehicle maintains a list of neighbours with the help of GPS system. Each vehicle has a unique IP address as ID. This list of neighbours has IDs of all neighbours that are in its ad hoc region.
The following assumptions are used while designing the proposed routing algorithm.

1. The speed limits of each vehicle is within the range of 60-100 Km/hr.
2. Let maximum transmission range be r1, r2, and r3 of vehicle, RSU, and WiMax respectively.
    - Transmission range of RSU is 500 m
    - Transmission range of WiMax is 5 km
3. All vehicles will follow the road traffic topology and should be in single administrative control.
4. Highway scenario is considered for the movement of vehicular nodes.
5. TTL value assign the limit of broadcasting by any vehicle. It is assumed that vehicles broadcast the packet up to only single hop. Thus, TTL is set to 1. On rebroadcasting of packet by intermediate vehicle, the value of TTL is incremented by 1.

A network architecture is used to provide effective routing and handover process. In this architecture vehicles are mobile nodes and a network is used which is the combination of vehicularnodes, RSUs and WiMax. Vehicles are equipped with mobile routers (MR) and GPS. This architecture is shown in figure 2.1. Some assumptions are made for the network which are:

- RSUs are fixed and have fixed transmission range (500 m)
- Distance between two access routers is 1000 m
- Maximum Overlapping region: 250m
- Minimum Overlapping region: 50 m
- Sufficient traffic on the road to provide communication between two vehicles

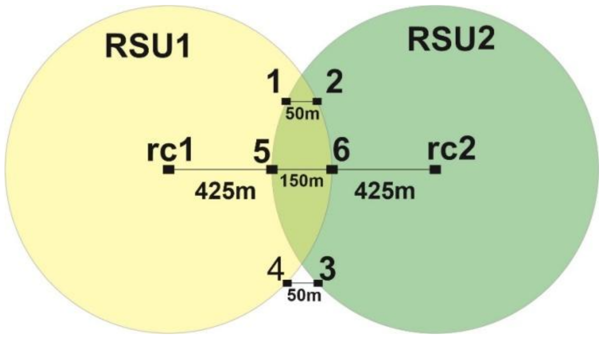

Fig: 2.1 Distance between two RSUs

RSUs are fixed along the road side and vehicles are moving on the road. So, the position of a vehicle is determined by using latitudes and longitudes position of a vehicle. These latitudes and longitudes of the vehicles are changed into spherical coordinates. Let earth of radius(r) is 3960 miles / 6378 Km. Let (ϕ1, ϴ1) and (ϕ2, ϴ2) be latitudes and longitudes of point rc1 and rc2 respectively. The values of ϕ and ϴ are in degrees. ϕ and ϴ angles are converted by multiplying 2ϕ/360. The distance between two points rc1(r, ϕ1, ϴ1) and rc2(r, ϕ2, ϴ2) in spherical coordinate system d is [3]:

$$d = 2r \arcsin \sqrt{\left[\sin^2 \frac{(\phi 1 - \phi 2)}{2} + \cos \phi 1 \cos \phi 2 \sin^2 \frac{(\theta 1 - \theta 2)}{2}\right]}$$

$$\phi = arccos(sin\,\phi 1, sin\,\phi 2\; cos(\theta 1\; -\; \theta 2)\; +\; cos\,\phi 1\; cos\,\phi 2)$$

$$arccos(rc1) = \; cos - 1(rc2)$$

Description:

In this algorithm WiMax is used which contains the information of each vehicular node under different RSUs. When a vehicle comes into the range of a RSU, it registers itself with that RSU and update this information in the RSU.

Vehicles follow this process when they leave and enter in the range of any RSU. The transmission range of RSU is more than the transmission range of vehicle and the transmission range of WiMax is more than the transmission range of RSU.

In this algorithm, it is assumed that GPS system is installed in each vehicle. Each mobile node (vehicle) maintains a list of mobile nodes (vehicles) that are in its range. Vehicles maintain the list with the help of GPS. This list consists unique identification number of each vehicle referenced to as IDs (or IP address). In the proposed routing algorithm three types of communications are possible: vehicle to vehicle, vehicle to RSU, and RSU to WiMax.

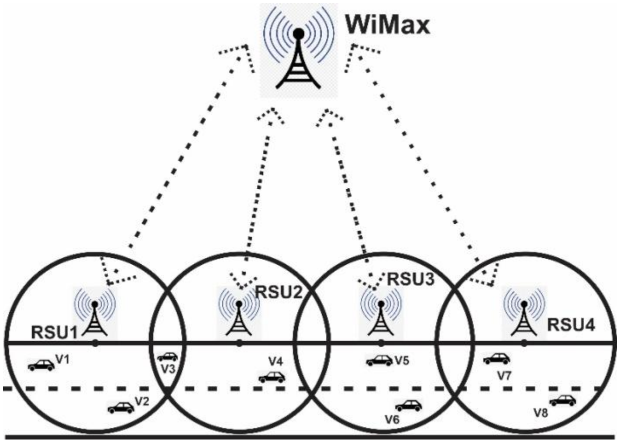

Fig: Movement of the vehicles

Vs and Vd are source and destination vehicles respectively. When a source vehicle Vs wants to communicate with destination vehicle Vd, source starts to send packets to destination. The process of proposed routing algorithm is described with following cases:

Case 1: Let source vehicle V1 has V2 vehicle in its ad hoc region. These vehicle V1 and V2 have IDs as ID1 and ID2 respectively. Source vehicle GPS system maintains a list of IDs of its neighbours that are in its range and form an ad-hoc region. Similarly, each vehicle maintains a list of vehicles.

If destination node V2 is found in the ad-hoc region of source vehicle V1, then data packet is delivered to it. In this case Vehicle to vehicle (V2V) communication will take place.

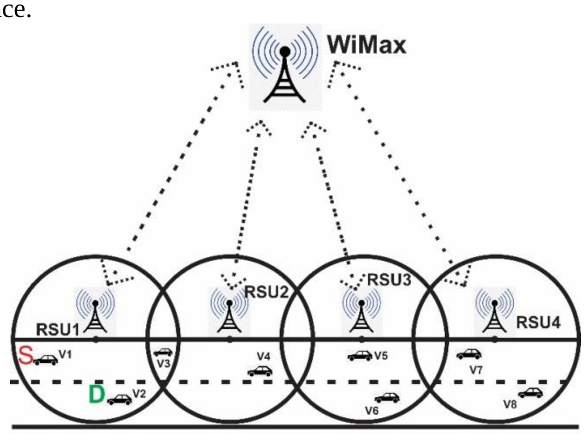

Fig: Case 1 of Proposed Routing Algorithm

Case 2: If destination node is not discovered in the ad-hoc region of source vehicle but both the vehicles are under the same RSU, then source vehicle send the packet to the RSU in which it is registered. And then RSU delivers the data packet to the destination node.

For example V1 wants to communicate with the V3 vehicular node. The V3 node is not in the ad hoc region of V1 node, then V1 send the data packet to the RSU1 and RSU1 will deliver the data packet to the V3 vehicular node.

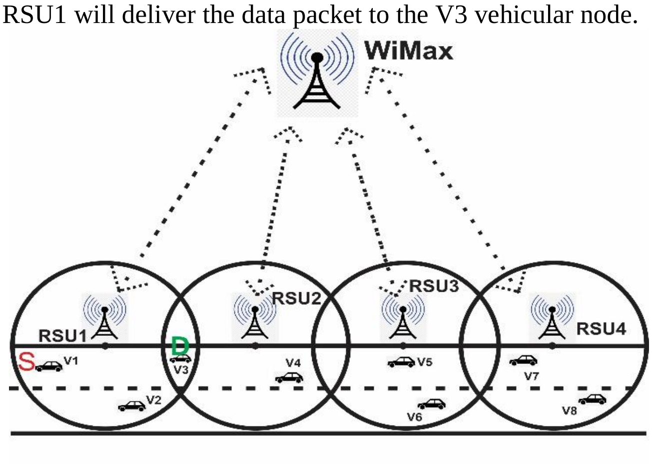

Fig: Case 2 of Proposed Routing Algorithm

Case 3: If the source node does not have the destination node in its ad hoc region and they both are in different RSU, then the source node uses the WiMax for the communication. The source node sends the data packet to the RSU in which it is registered. Then the RSU sends the data packet to the WiMax and then the WiMax sends the packet to the RSU in which destination vehicle is registered. Finally the data packet is delivered to the destination vehicle using RSU.

For example, V1 node wants to communicate with the V7 node. V1 and V7 are in different RSU. V1 and V7 are registered under the RSU1 and RSU4 respectively. The V1 vehicle sends the data packet to the RSU1 and RSU1 send it to the WiMax. Then the WiMax sends this data packet to the RSU4. Finally RSU4 delivers the data packet to the destination vehicle V7.

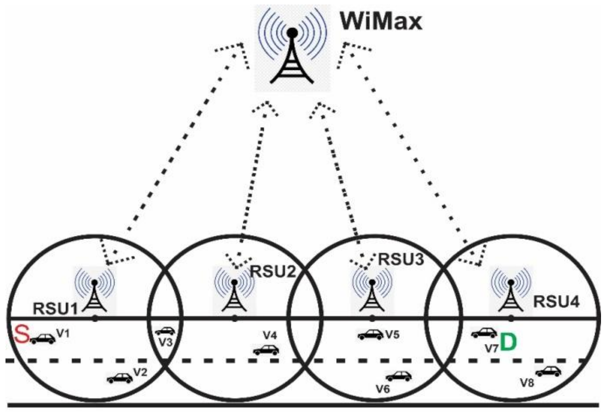

Fig: Case 3 of Proposed Routing Algorithm

The flow chart of the proposed routing algorithm is shown in figure:

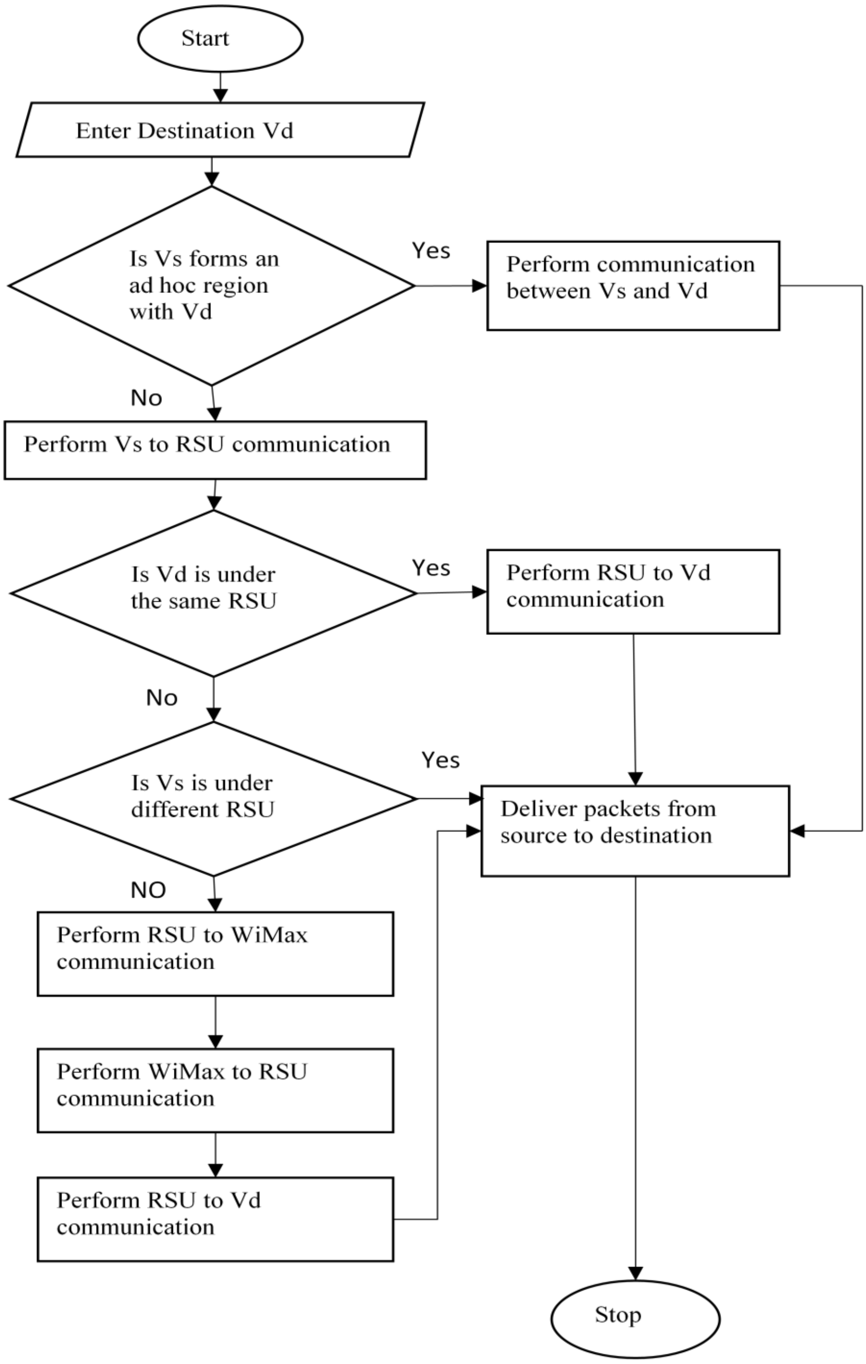

Fig: Proposed Routing Algorithm

III. PERFORMANCE EVALUATION OF PROPOSED ROUTING ALGORITHM:

In this section performance evaluation of proposed routing algorithm is done. Network simulator NS-2.34 and SUMO are used for the performance evaluation of the proposed routing algorithm. To evaluate the performance, highway scenario is considered. The proposed algorithm is compared with dynamic source routing (DSR) and Route based routing algorithm (RBRA). Proposed routing algorithm is analysed by using block rate and transmission time.

Figure 4 shows the comparison between proposed routing algorithm (PRA) and RBRA routing algorithm. The result shows that request block rate of RBRA is very high as compared to the PRA. Request block rate for proposed algorithm is reduced.

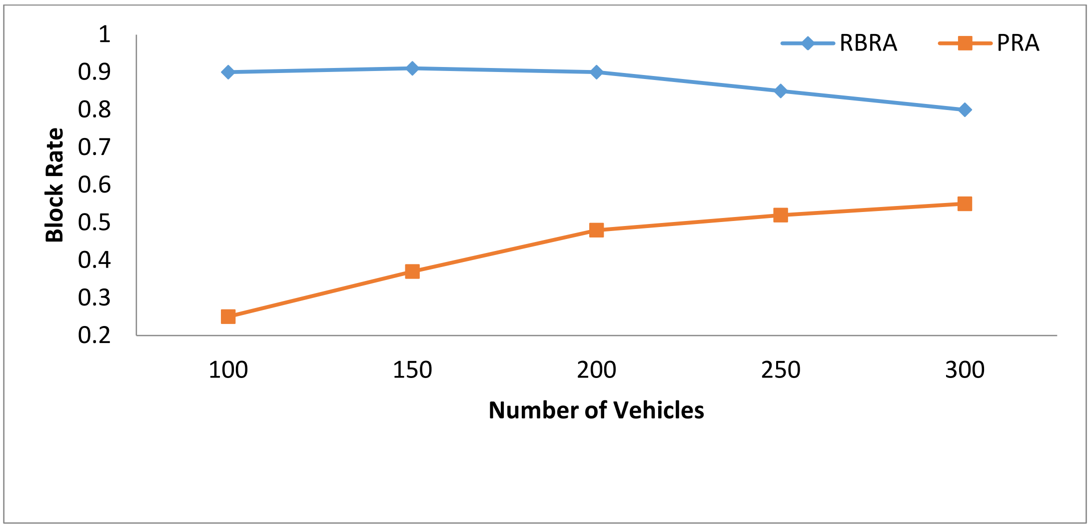

Figure 4 :Performance evaluation of DSR, RBRA and proposed routing algorithm using Request Block Rate

Figure 5 shows the comparison between proposed routing algorithms (PRA), DSR, and RBRA. The result shows that transmission time of RBRA is very high as compared to proposed algorithm PRA. Transmission time of proposed algorithm is reduced.

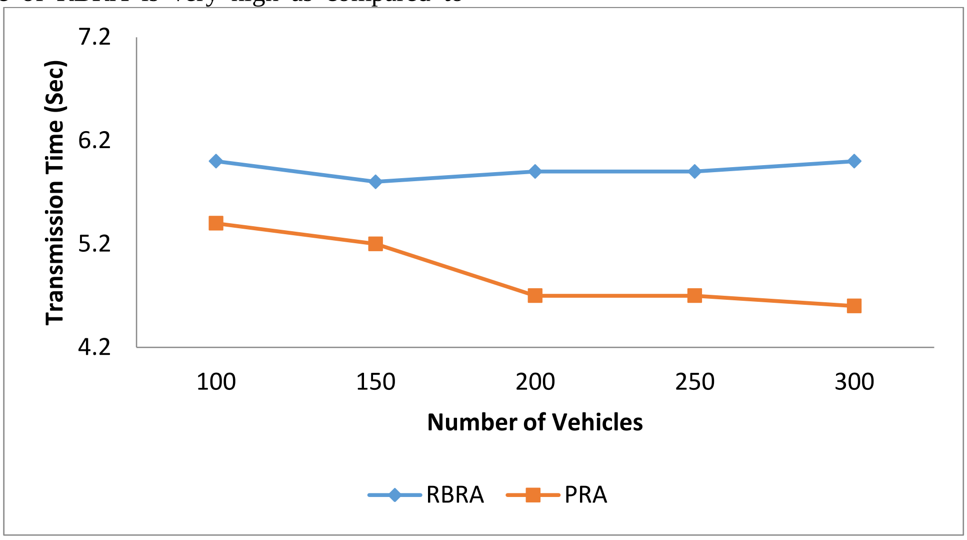

Figure 5: Performance evaluation of DSR, RBRA and proposed routing algorithm using Transmission Time

IV. CONCLUSION:

In this paper an optimized routing algorithm is proposed for VANETs. This algorithm is implemented and analyzed with existing routing algorithms RBRA. The highway scenario is used for the movement of vehicles. The proposed algorithm takes the advantage of the network which is the combination of vehicular nodes, RSUs and WiMax. It results with the improved request block rate and improved transmission time. Request block rate and transmission time of the proposed routing algorithm are reduced. This algorithm is compared with the RBRA. It gives better results in terms of both performance parameters. It means request block rate of RBRA is higher than the proposed algorithm. Transmission time of RBRA is also more than the proposed routing algorithm.

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