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# A RELIABLE ROUTING PROTOCOL FOR VEHICULAR ADHOC NETWORK

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***Abstract: VANET and MANET both are wireless networks which are characterized as self-configured and autonomous ad-hoc networks. VANETs differ from MANETs in terms of dynamic topology and high mobility. Due to unstable connectivity, high mobility and network partitioning, information routing in VANETs becomes difficult and challenging, thus creating a need for efficient VANET routing protocols. In this paper we introduce a new protocol which is highly reliable. This routing protocol minimizes link breakage and increases throughput in VANET. And this paper also provides summary on VANET, wireless access methods in VANET, Characteristics of VANET and gives its routing protocols which focuses on vehicle to vehicle communication.***
***Keywords: VANET, DSDV, AODV, Proactive, Reactive, DTN, GPSR.***

## I. INTRODUCTION

Safe navigation support through wireless car-to-car and car-to-curb communications has become an important priority for car manufacturers as well as transportation authorities and communications standards organizations. New standards are emerging for car-to-car communications (DSRC and more recently IEEE 802.11p) [7]. There have been several well publicized testbeds aimed at demonstrating the feasibility and effectiveness of car-to-car communication safety; for instance, the ability to rapidly propagate accident reports to oncoming cars, the awareness of unsafe drivers in the proximity and the prevention of intersection crashes. While safe navigation has always been the prime motivation behind vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications, vehicular networks provide a promising platform for a much broader range of large scale, highly mobile applications. Since the automobile's role as a critical component in peoples' lives, embedding software-based intelligence into cars has the potential to drastically improve the user's quality of life. This, along with significant market demand for more reliability, safety and entertainment value in automobiles, has resulted in significant commercial development and support of vehicular networks and applications. Mobile ad hoc networks (MANETs) are autonomous systems which consist of a number of mobile nodes that communicate between themselves using wireless transmission. They are thus self-organized, self-configured and self- controlled infrastructure-less. Vehicular ad hoc networks (VANETs) are a subclass of mobile ad hoc networks in which the mobile nodes are vehicles; these vehicles are autonomous systems connected by wireless communication on a peer-to-peer basis. VANET has some special characteristics that distinguish it from other mobile ad hoc networks; the most important characteristics are: high mobility, self-organization, distributed communication, road pattern restrictions, and no restrictions of network size, all these characteristics made VANETs environment a challenging for developing efficient routing protocols. We have a number of ad hoc routing protocols for MANETs but when we have to deal with a VANET then we require ad hoc routing protocols that must adapt continuously to the unreliable conditions. MANET routing protocol is not suitable for VANET because MANET routing protocol has difficulties from finding stable routing paths in VANET environments. Many routing protocols have been developed for VANETs environment, which can be classified in many ways, according to different aspects; such as: protocols characteristics, techniques used, routing information, quality of services, network structures, routing algorithms, and so on. In this paper we are briefly explaining new routing protocol which is highly reliable in last section. Section ii is about various wireless access methods such as DSRC, 3G, and WiMAX. Section iii discusses the unique characteristics of vehicular communications and section iv briefly analyzes various VANET routing protocols that are essential to supporting applications.

## II. WIRELESS ACCESS METHODS IN VEHICULAR NETWORKS

We overview various wireless communication methods available in vehicular networks

DSRC/WAVE: Dedicated Short-Range Communication (DSRC) is a short to medium range communication technology operating in the 5.9 GHz range. DSRC supports vehicle speeds up to 120mph, transmission range of 300m (up to 1000m), and default data rate of 6Mbps (up to 27Mbps). This will enable operations related to the improvement of traffic flow, highway safety, and other Intelligent Transport System (ITS) applications in a variety of application environments called DSRC/WAVE (Wireless Access in a Vehicular Environment).

DSRC has two modes of operations:

(1) Ad hoc mode characterized by distributed multi-hop networking (vehicle-vehicle),

(2) Infrastructure mode characterized by a centralized mobile single hop network (vehicle-gateway).

Depending on the deployment scenarios, gateways can be connected to one another or to the Internet, and they can be equipped with computing and storage devices.

Cellular Networks: Cellular systems have been evolving rapidly to support the ever increasing demands of mobile networking. 2G systems such as IS-95 and GSM support data communications at the maximum rate of 9.6kbps. To provide higher rate data communications, GSM-based systems use GPRS (<171kbps) and EDGE (<384kbps), and IS-95-based CDMA systems use 1xRTT (<141kbps). Now 3G systems support much higher data rate. UMTS/HSDPA provides maximum rates of 144kbps, 384kbps, and 2Mbps under high mobility, low mobility, and stationary environments respectively. CDMA2000 1xEvDO (Rev. A) provides 3Mbps and 1.8Mbps for down and up links respectively. The average data rate perceived by users is much lower in practice: <128kbps for GSM/EDGE and <512kbps for 3G technologies.

WiMAX/802.16e: 802.16e or WiMAX (Worldwide Interoperability for Microwave Access) aims at enabling the wireless broadband access (<40Mbps) providing wireless data over long distances. This will fill the gap between 3G and WLAN standards, providing the data rate (tens of Mbps), mobility (<60Km/h), and coverage (<10Km) required to deliver the Internet access to mobile clients

WLAN: WiFi or WLAN can also support broadband wireless services. 802.11a/g provides 54Mbps and has nominal transmission range of 38m (indoor) and 140m (outdoor). Despite its short radio range, its ubiquitous deployment makes WLAN an attractive method to support broadband wireless services. It has long been used as a means of Internet access in vehicles.

## III. CHARACTERISTICS OF VANET ENVIRONMENTS

In designing protocols for the next generation vehicular network, we recognize that nodes in these networks have significantly different characteristics and demands from those in traditional wireless ad hoc networks deployed in infrastructure less environments (e.g. sensor field, battlefield, etc.). These differences have a significant impact on application infrastructures.

1. Vehicles have much higher power reserves than a typical mobile computer. Power can be drawn from on-board batteries and recharged as needed from a gasoline or alternative fuel engine.
2. Vehicles are orders of magnitude larger in size and weight compared to traditional wireless clients and can therefore support significantly heavier computing (and sensorial) components. This combined with plentiful power means vehicular computers can be larger, more powerful, and equipped with extremely large storage (up to Terabytes of data), as well as powerful wireless transceivers capable of delivering wire-line data rates.
3. Vehicles travel at speeds up to one hundred miles per hour, making sustained, consistent vehicle-to-vehicle communication difficult to maintain. However, existing statistics of vehicular motion such as tendencies to travel together or traffic patterns during commute hours, can help maintain connectivity across mobile vehicular groups.
4. Vehicles in a grid are always a few hops away from the Infrastructure (WiFi, cellular, satellite, etc.). Thus, network protocol and application design must account for easy access to the Internet during “normal” operations.

## IV. VANET ROUTING PROTOCOLS

Based on routing information, routing protocols are broadly categorized as topology-based and position-based routing protocols. In topology-based routing mechanism, we deal with the network layout/architecture of the nodes such that packet forwarding is possible using the information that is available about the nodes and links within the network whereas, location of nodes should be known in position based routing mechanism for packet forwarding.

### *A. Topology-based Routing Protocols*

Topology-based routing protocols make use of routing tables for storing the link information as a basis of packet forwarding from source node to destination node. These protocols are further categorized into two types based on the network architecture [1]: Proactive and Reactive routing protocols.

1) Proactive Routing Protocols: Proactive routing protocols, also known as table-driven protocols, allow every network node to maintain a routing table for storing the route information to all other nodes, every next hop node is maintained in the table entry that comes in the path towards the destination from the source. The routing table of every node gets updated whenever a change in network topology occurs as a result of which more overhead cost is incurred. These protocols provide actual data to the network availability [1]. The shortest path algorithms are used by these protocols to find out which route has to be chosen. Destination Sequenced Distance Vector (DSDV) and Fisheye State Routing (FSR) protocols are examples of proactive routing protocols.

a) Destination Sequenced Distance Vector (DSDV) Routing Protocol: Based on the distance vector strategy using shortest path algorithm, DSDV [1] routing protocol implements a single route from source to destination which has been maintained in the routing table. A routing table is maintained for each node containing information of every accessible node in the network and total number of hops needed to succeed those nodes. The destination node initiates a sequence number to every entry in the table. Each node maintains the route reliability by broadcasting their routing table to the neighbouring nodes. DSDV protocol does not allow cyclic routes, reduces control message overhead and excludes extra traffic caused by frequent update. The total size of routing table is reduced as DSDV keeps solely the best possible path to each node instead of multi paths. DSDV is not able to control the networks congestion that decreases the routing efficiency.

b) Fisheye State Routing (FSR) Protocol: FSR [1] is a table-driven routing protocol that maintains a topology map for each node and updates its routing table by collecting the latest information from its neighbouring nodes. The updated data is broadcasted with different frequencies with higher frequencies rather than the farther ones to various different destination nodes based on the hop distance from the forwarding node. Since FSR helps every node in network to exchange the updated routing information with its immediate neighbouring nodes partially, it reduces the consumed

  

bandwidth and provides reduction of routing overhead. The drawbacks with the FSR are the increasing network size the number of routing tables that leads to complexity of storage and process overhead of routing table. Route establishment becomes difficult if destination node goes outside the range of source node. Even if there is any link failure, changes in routing table do not occur because FSR does not trigger any message for link failure. FSR works on basis of link state routing and Global State routing.
Thus the proactive routing protocol advantages can be abbreviated as follows, namely,

- Since route from source node to destination node is maintained via routing table, there is no need of route discovery process.
- Performance of proactive routing protocols is good in low mobility networks whereas reactive routing protocols have high mobility and density than the proactive routing protocols.
- In proactive protocols, increase in network overhead occurs when unused routes consume available bandwidth.

2) Reactive Routing Protocols: Reactive routing protocols, also known as on-demand routing protocols. They are called so because on requirement of a route that does not exist from source node to destination node, the route discovery starts. This reduces the network traffic and saves bandwidth. Flooding of the network helps in route discovery mechanism by sending a route request message. Any node existing on the route towards the destination on receipt of the request message, sends back a route response message to the source node using unicast communication. These routing protocols have high route finding latency and are suitable for large sized mobile ad-hoc networks which are highly mobile and have frequently changing topology. The following sections illustrate few existing reactive routing protocols.

a) Ad-hoc On-demand Distance Vector (AODV) Protocol: AODV [2] protocol reduces flooding in the network and gives low network overhead comparing to the proactive protocols. This routing protocol minimizes the routing table by creating a route when a node needs to send information data packets to other nodes in the network, hence reducing the memory size required. The routing table keeps the entries of the recent active nodes and the next hop node of the route instead of keeping the whole route. AODV uses destination sequence numbers for route discovery which eliminates looping in routes and provides dynamic updates for adapting the route conditions.
AODV is more suitable for large networks and network having high dynamic topology. This protocol causes delay in route discovery process. When route failures occur, new route discovery is required causing additional delays thus decreasing the data transmission rate and increasing the network traffic. This causes more bandwidth consumption that is increased due to increasing number of nodes in the network which causes collision leading to packet loss problem.
Ad-hoc On-demand Distance Vector Preferred Group Broadcasting (AODV+PGB) Routing Protocol: AODV routing protocol with PGB (Preferred Group Broadcasting) algorithm [5] reduces control message overhead and provides route availability in VANET environment which reduces the routing overhead in networks is considered to be an important issue and also achieving the routes consistency which is a desirable issue today. The performance of adhoc networks decreases with various upcoming issues such as the network throughput decreases when there are a large number of errors in the network and when the signals are weak from source node to destination node, the hidden terminals can easily interrupt the communication between the two nodes. PGB algorithm makes it possible for some nodes to again broadcast a route request data message. If even after rebroadcasting the message, no nearest node to destination is found, delay in route discovery process occurs. This protocol may cause packet duplication if at the same time, two nodes broadcast same data packet.

b) Dynamic Source Routing (DSR) Protocol: DSR [3] routing protocol is a reactive protocol which implements routing process using low overhead and quick reaction to frequently changing topology to ensure successful packet delivery even if change in network happens. DSR is a multi-hop routing protocol decreases the network traffic by decreasing periodic messages. DSR provides two processes that are the route discovery mechanism and route maintenance process. During the discovery mechanism, when the source node requires to search a non-existing route, a route request message is send by it to all its neighbours. All nodes in- between that receive the request message broadcast it again except to the destination or if there is a direct route from the forwarding node towards the destination node. After which the source node receives back route reply message and that route is stored in the routing table of the source node for future use. If any failure in route occurs, the source is informed by sending a route error message back to the source node. In this protocol routing, each information packet consists of a list of nodes that exist in the path so that source node deletes the nodes on the route which have failed from its cache and stores another successful route to that destination and exchanges it with a correct route. If no such route exists, DSR again starts a new route discovery process. The benefits/advantages provided by DSR routing are best visible in networks with less mobility as it makes use of alternate routes before a new route discovery mechanism is initiated. Although multi- route discovery could cause further routing overhead/traffic due to addition of whole route information to each information packet of routing table, besides, as the network discovers large routes as well as additional nodes, the routing overhead increases quickly resulting in degradation of network performance.

c) Temporally Ordered Routing Algorithm (TORA) Protocol: TORA [1] is a distributed routing protocol. TORA uses multi-hop routes during routing mechanism. This protocol reduces the communication overhead to adapt with frequent network changes and does not include implementation of shortest path algorithm and therefore, routing doesn't represent a distance. This protocol creates a directed graph which has the source node as its tree root node. This protocol consists of tree structure in which packets should run from higher nodes to lower nodes. As a node broadcasts data packets to its destination node, its neighbours send back a route reply message if its packets run from higher levels to lower level to the destination, otherwise it only rejects the data. The protocol follows loop free routing and multi path routing as the information moves down to the destination node and does not move back upward to the forwarding node. TORA provides a route towards each node of the network topology, also reducing control message broadcast which are the main advantages of TORA. In this routing mechanism, routing overhead/traffic is caused during route maintenance among network nodes in high dynamic VANETs.

Topology-based routing protocols are not much suitable in case of vehicular ad-hoc networks since:

- Topology routing protocols are not very scalable.
- Route finding latency for topology routing protocols is high.
- The unused paths stored in routing tables occupy available bandwidth unnecessarily.
- AODV consumes extra bandwidth due to periodic beaconing.
- Topology routing protocols do not perform good for high mobility networks.
- Topology routing protocols give worse performance in small networks.

*B. Position-based Routing Protocols*

Position-based routing protocol [6] depends on the position/location data during the routing mechanism. The source node sends information data packet to the destination making use of the packets location instead of utilizing the network address. During this protocol mechanism, every node decides its position and that of their neighbouring nodes through help of Geographic Position System (GPS) which is a position determining service. The node determines the location of its neighbour inside the radio range of the current node. Once the source node sends its data packet, it saves the location of the destination in the header of the packet that aids in sending the data packet to the destination node with no need of route discovery, route maintenance or any awareness of topology. Hence, position-based routing protocols are considered to be appropriate and stable for highly mobile VANET environments with topology-based routing protocols. Position-based protocols are categorized as namely, DTN i.e. Delay Tolerant Network, Non-DTN i.e. Non Delay Tolerant Network and Hybrid protocols.

1) Delay Tolerant Network (DTN) Routing Protocol: DTN [1] routing protocol is an efficient protocol for networks with characteristics such as rapid disconnectivity during communication, massive/huge scalability, large unavoidable delays, restricted bandwidth, high fault tolerance rates and power constraints. DTN protocol uses a store, carry and forward strategy within the network where all the nodes help each other in forwarding the data packets. Each node features restricted transmission range, thus packet transmission takes long delays. DTN may be a mobile node that creates routes towards other nodes in the network once they are in the current nodes' transmission range. In DTN protocol, we cannot ensure that disconnectivity will not occur, so the data packets are cached for some time duration with other nodes on the route i.e. intermediate nodes. To form a routing protocol for DTN network having such characteristics is an important issue.

2) Non Delay Tolerant Network (Non DTN) Protocols: The Non-DTN [1] protocols are a type of position-based routing protocols that do not take into account the disconnectivity problem instead assume that a large amount of nodes exist to attain successful communication, which implies that the protocol is more appropriate for dense networks. The source node forwards the message to the closest neighbouring node to the destination node. This strategy can also fail, if no such nearest neighbouring node exists but only the current/forwarding node. This failure is handled by using different strategies of Non-DTN routing protocols such as:

a) Greedy Perimeter Stateless Routing (GPSR): GPSR [5] follows greedy routing mechanism for routing in VANETs. During this protocol routing, every node sends a data packet to different intermediate nodes that are close to destination node, until the data reaches the destination. If there are not any neighbouring nodes nearer to message's destination, it makes use of perimeter forwarding technique to come to a decision to which node the message should be delivered. GPCR is a stateless routing protocol which keeps information about its first hop neighbours' position that increases scalability of protocol over the shortest path ad hoc routing protocols. A benefit of GPSR routing protocol is the dynamic forwarding packet decision it takes. This routing protocol comes across link failures that occur because of frequently changing topology of network and high mobility of the network. This drawback is handled via perimeter forwarding which causes huge data loss and because a large number of hops that is caused in perimeter forwarding technique, more latency time is taken. The information that is embedded in the packet header does not get updated, if destination node acquires a new position.

b) Reliability Improving Position-based Routing (RIPR): RIPR [1], a position-based routing algorithm, was created to be used in vehicular ad hoc network routing. RIPR algorithm tries to solve the problem of link failures which are found during routing process. This protocol determines the vehicle speed and direction in which it moves on the roads. Here, the source selects a nearby node to send the data determining the mobility for the intermediate nodes. The source node creates a routing table storing positions with mobility speeds of neighbouring nodes. This algorithm is used to select the forwarding node that aids in choice of next intermediate node, is done using characteristics of the route and therefore the position of node after the exchange of message [1] is done. The protocol therefore, helps in avoiding the problem that does not allow a node to select its neighbour node as intermediate node which arises when no nearer node to the destination exists. Two types of techniques are used by RIPR protocol: greedy technique and perimeter technique similar to GPSR protocol. RIPR also uses characteristics of the route and considers the position of the nodes. The advantages of the RIPR protocol are that it reduces link failure drawback that occurs due to storage of the data of wrong intermediate node.

3) Hybrid Position-based Routing: Hybrid routing is the position-based routing that reduces control overhead/traffic and do not want to maintain the table since they make use of the location information about the neighbouring nodes and destination node which makes position-based routing more scalable. Some limitations are as follows that restrict the use of position-based routing [1]:

- According to the positional accuracy, the position routing protocol performance may decrease as the precise location information is a factor to have a better performance in the position routing.
- If no nearest neighbouring node to the destination exists, position routing may lead to link failures.

Researchers developed hybrid schemes merging the characteristics of more than one routing protocols, such as merging of two position-based routing protocols: DTN and Non-DTN routing protocols; or merging of position-based routing protocols along with one or more topology-based routing protocols. The hybrid positional routing protocols make use of advantages of two or more schemes.

Hybrid Location-based Ad-hoc Routing (HLAR) Protocol
HLAR [1] is an efficient position-based routing protocol is a scalable protocol that uses the positional information and helps in reduction of the routing control overhead in comparison to on-demand routing. HLAR protocol can act as on-demand routing protocol when either information of position is limited or is not sufficient enough and can overcome the problem where no nearer neighbouring nodes to the destination node exist. HLAR also works as reactive routing protocol and helps in route discovery process. When we do not get a route to the destination node, then the source node adds the data packet of its position and position of destination node to route request message to search for the nearest node existing to the destination. If any such node exists, then a route request message is further forwarded to it and if a closest node to the destination is found, then the source node broadcasts a request message to all of its neighbouring nodes. The mechanism is then repeated by the source node until the destination node is reached. Since the intermediate node does not have backward link to the source node, HLAR does not ensure if a reliable route exists.

## V. RELIABLE ROUTING PROTOCOL

The MANET routing protocols are not effective in VANET environment. The occurrence of link breakage is very frequent in VANET when compared to MANET due to the swift movement of the vehicles . Hence, this highly dynamic behaviour of VANETs demands a reliable routing strategy. As of now, not much attention is laid on routing reliability of VANETs in highway environment. In [8] they proposed a reliable routing protocol that minimizes link breakage and thereby increasing the throughput in VANET- variable velocity environment. The mechanism is based on the mathematical model of normal (Gaussian) distribution, which is a continuous probability distribution function. This function is used to estimate the link reliability between the vehicular nodes in the road. Based on the computed link reliability values between the nodes, the system constructs an evolving graph in a dynamic fashion and the route reliability value is estimated from the graph. This route forms the Most Reliable Journey for the data transmission. The proposed algorithm[8] takes into account the variable velocity parameter and computes the link reliability and route reliability value between the nodes. An evolving graph is constructed based on the estimated link reliability value. Our aim is to make this routing protocol still more reliable so we are computing link expiration time based on direction of the vehicle then the route reliability value and route expiration time can be given as an input to fuzzy controller system to find most reliable journey from source to destination considering both the velocity parameter and the direction parameter. This sequence of nodes in the Most Reliable Journey is added as an extension to the AOMDV protocol header.

## VI. SUMMARY

In this paper we are given the basic idea in designing a reliable routing protocol. We mainly surveyed the available routing protocols in VANET and also discussed various wireless protocols and access methods such as DSRC, 3G and WiMAX and discussed the unique characteristics of vehicular communications.

## REFERENCES


[1] Altayeb, M., and Mahgoub, I., "A Survey of Vehicular Ad-hoc Networks Routing Protocols", International Journal of Innovation and Applied Studies, Vol.3, pp.829-846, 2013.

[2] Lal, A., Dubey S., and Presswani, B., "Reliability of MANET through the Performance Evaluation of AODV, DSDV, DSR", International Journal of Advanced Research in Computer Science and Software Engineering, Vol.2, Issue 5, 2012.

[3] Johnson, D. B., and Maltz, D. A., "Dynamic source routing in wireless ad hoc networks", Mobile Computing, Vol.353, 1996.

[4] Kumar, Y., Kumar, P., and Kadian, A., "A Survey on Routing Mechanism and Techniques in vehicle to vehicle communication (VANET)", International Journal of Computer Science & Engineering Survey, Vol.2, No.1, Feb 2011.

[5] Ranjan, P., and Ahirwar, K., "Comparative study of VANET and MANET routing protocols",


  

International Conference on Advanced Computing and Communication Technologies, ACCT 2011.

[6] Ryu, M. W., Jha, S. H., Koh, J. G., and Cho, K. H., “Position-based routing algorithm improving reliability of inter-vehicle communication”, Transaction on Internet and Information Systems (TIIS), August 2011.

[7] Standard Specification for Telecommunications and Information Exchange Between Roadside and Vehicle Systems - 5 GHz Band Dedicated Short Range Communications (DSRC) Medium Access Control (MAC) and Physical Layer (PHY) Specifications, Sept. 2003.

[8] R. Kirtiga, GnanaPrakasi O.S, D. Kavipriya, R. Anita, Varalakshmi.P, “Reliable graph based routing in vanet Environment” presented at 2014Interference Conference on Recent Trends in Information Technology, Chennai.

  