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Research Article

A Framework for Providing Optimal QoS Routing Information in Vehicular Ad Hoc Network

Abubakar A. Mu'azu, A.H. Muhamad Amin, Halabi Hasbullah, Ibrahim A. Lawal and Sallam O. Fageeri
Computer and Information Sciences Department, Universiti Teknologi
Petronas 31750 Tronoh, Perak, Malaysia

Abstract: The unique characteristics of VANETs make numerous conventional ad hoc routing protocols unsuitable. One of the most challenging tasks in VANET is Quality of Service (QoS) which is determined by numerous parameters such as packet delivery ratio, end-to-end delay and connection duration. This paper introduces geographical QoS routing information capable of providing optimal paths between the source and all destinations that fulfill certain QoS requirements for packet forwarding. This is an efficient solution for communications and information delivery in VANET. Cluster-based method is to be employed to enhance the performance protocol as it incurs lower overhead throughout topology updates and has faster re-convergence.

Keywords: Cluster based routing, geographical routing, QoS, Restricted Directional Flooding (RDF), VANET

INTRODUCTION

The increasing demand for wireless communication and the needs of new wireless devices have a tendency to research on self-organizing, self-healing networks without the interference of centralized or pre-established infrastructure/authority. The networks with the absence of any centralized or pre-established infrastructure are known as Ad hoc networks and are collections of self-governing mobile nodes (Mauve *et al*., 2001).

Recently, a lot of research including Chen *et al*. (2001) and Yelemou *et al*. (2011) has suggested several methods to route data within VANETs and it can be grouped into two main categories:

Topology-based and position-based routing are the two techniques of forwarding data, generally adopted for multi-hop wireless systems. Topology-based techniques take advantage from the information of obtainable network links for packet transmission and each node should keep up-to-date with the routing table.

However, geographic routing generally referred to as position-based routing and it offers an adaptable routing elucidation for wireless networks. Ultimately, it is ordinarily a scalable routing technique intended for wireless networks, whereby the nodes will generate neighborhood routing selections that make the use of position information. With geographic routing, nearby neighbors within a region exchange position information acquired through GPS (Global Positioning System) or any other location perseverance mechanism (Xiao *et al*., 2011).

Geographic addressing and routing is a networking mechanism that distributes the information to nodes within a designated destination area. Therefore, a routing protocol is in charge of information dissemination over multiple hops until every vehicle has received this information within the destination area (Stojmenovic, 2002). Each vehicle examines whether re-transmission is needed and executes it with proper timing as needed. Within this concept, individual nodes' addresses are associated with their geographical position which is often used by sending algorithms to move data packets for the destination node. Geographic routing possesses the advantage that should be much more adaptable as a consequence of lesser desire for routing information. Thus its efficiency as well as adaptability makes a decent choice for routing within multi-hop wireless networks (Xiao *et al*., 2011).

Basically, position-based routing algorithms require information about the physical location of the participating nodes in the network. Thus, a sender can easily ask for the location of the receiver using a location service to forward the packet to the destination using different mechanisms. These however, include other related techniques such as greedy forwarding, hierarchical forwarding and Restricted Directional Flooding (RDF).

In RDF, a sending node has the ability to forward a particular packet to all nearby neighbor nodes which often lie in direction of the expected region of the

Corresponding Author: Abubakar A. Mu'azu, Computer and Information Sciences Department, Universiti Teknologi Petronas 31750 Tronoh, Perak, Malaysia
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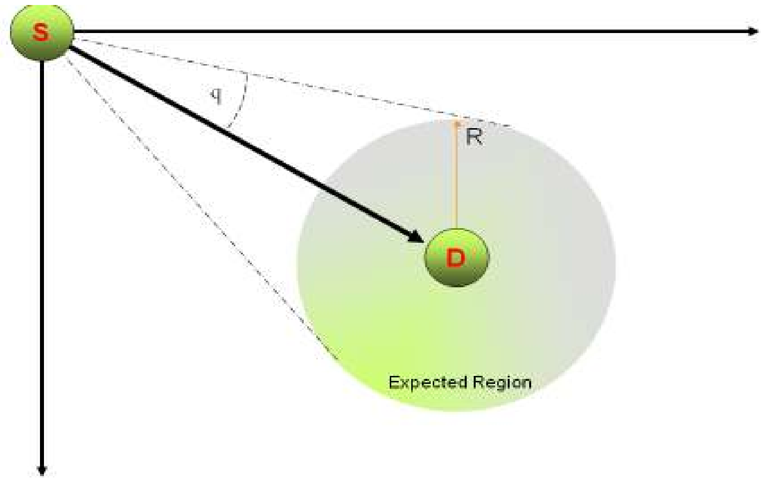

Fig. 1: Example of expected region (Basagni *et al*., 1998)

destination. The idea is to put a reason for probability of reliable data sharing and communication amongst extremely mobile nodes. The expected region can be a circle within the position of destination mainly because it is known to the source. However, the radius r of the expected region is scheduled to $(t_1-t_0)*V_{max}$; where t_1 = current time, t_0 = timestamp of the position information, a source has related to destination, and V_{max} = the optimum velocity that a node might travel within the ad hoc network. The actual direction of destination is determined through the line between the source and the destination and the angle ϕ as shown in Fig. 1.

In this study, we provide a framework for achieving an optimal, reliable and stable route capable of providing most favorable link between the source and all destinations. The optimal QoS is on a non mutual communication link that directly connects two or more nodes in a network; these perhaps will fulfill certain QoS requirements forward packet.

Therefore, the main objective of this paper is to provide a framework of achieving optimal QoS routing using RDF for packet forwarding technique. Nodes would be divided in virtual group according to some rules whereby nodes belonging in a group can execute different functions from other nodes. During broadcast implementation, a virtual infrastructure is to be created through geographically clustering of nodes in order to provide scalability. Each cluster can have a cluster head which will be responsible for secure communication, allows aggregation and limits data transmissions.

LITRATURE REVIEW

The most common method of geographic routing is through greedy forwarding packets for the neighbors that are geographically nearest to the destination. Despite the fact that the greedy technique is almost effective, packets might get routed to where no neighbor node is closer to the destination from the current node and avoid circumstance arise. Thus, the void problem occurs when there is no any node in the direction of the destination.

Ultimately, several position-based routing techniques (Frey, 2005; Kihl, *et al*., 2007; Li, *et al*., 2009) are recommended with assorted forwarding techniques to select neighbors as the next-hop node. For instance, some protocol like Greedy Perimeter Stateless Routing (GPSR) (Karp and Kung, 2000) uses the position information to obtain the next-hop node. Therefore, the performance of GPSR protocol is affected by the next-hop selection mechanism. Even though, the geographic routing makes routing decision with various distance-based metric which imprison the extended-term performance of wireless links (Xiao *et al*., 2011).

Furthermore, protocols, such as, Context-aware Adaptive Routing (CAR) (Naumov and Gross, 2007), GVGrid (Sun *et al*., 2006), and DeReQ (Niu *et al*., 2007a) apply the probability to build the routing protocol in the selected region or cluster. The probability theory is often used in dynamical systems to describe the likelihood of certain events, for example the probability of link breakage with a certain transmission power or a certain mobility parameter.

However, in Cluster head Gateway Switch Routing (CGSR) (Chiang *et al*., 1997) the CGSR protocol uses a distributed algorithm called the Least Cluster Change (LCC). By combining nodes directly into clusters control by the cluster heads, there is a need for support regarding the developing capabilities for channel accessibility, bandwidth allocated and routing. Nodes subsequently communicate with the cluster head which always communicates with some other cluster heads that are in direction of the expected region throughout

Table 1: DSRC applications and requirements

Application	Allowable latency (ms)	Priority
Intersection collision warning/avoidance	100	Safety
Emergency braking warning/avoidance	100	Safety
Cooperative collision warning	100	Safety
Toll collection	50	Non-safety
Service announcements	100	Non-safety

the network. Restricted Directional Flooding protocols, such as Location-Aided Routing (LAR) (Ko and Vaidya, 2000) and the Distance Routing Effect Algorithm for Mobility (DREAM) (Basagni *et al.*, 1998) are actually meant for mobile ad-hoc networks where the latest location within the destination node is unknown. These protocols use flooding techniques of packets forwarding to discover a route to the desired destination. And by so doing utilize location information so that packet broadcasts are restricted to a subset of nodes rather than the whole network.

VANETS RELATED ISSUES AND CHALLENGES

Typically the inter-vehicle communication configuration makes use of multi-hop multicast/broadcast to transmit traffic information through multiple hops the receivers. There are many standards that are often relevant to wireless access in vehicular environments. These standards range between protocols that are applied to transponder equipment protocols to security protocols, routing, addressing solutions, and interoperability protocols.

Quality of Service (QOS): The term Quality of Service (QoS) is the measure of service used to express the level of performance provided to the users (Ledy *et al*., 2009; Zeadally *et al*., 2010). Excessive levels of QoS in standard networked settings are often attained by means of resource reservation together and sufficient infrastructure. These however, should not be guaranteed in dynamic, ad-hoc network such as in VANETs; due to the inherent deficiency of dependable infrastructure and rapidly changing topology.

Conversely, at present, there exists an enforced latency requirement for QoS applications as well as services. Data sent over VANETS could be considered as safety or non-safety data. Therefore QoS applications are often time-sensitive and latency intolerant. Safety messages should be forwarded within a particular upper tolerance (delay bound) or will be considered useless. An effective medium access strategy guarantees the actual prioritization of transmission simply by granting safety messages the highest priority. Table 1 gives examples of DSRC applications and requirements with allowable latency (Mak *et al*., 2009).

The increasing popularity of using VANET safety and real time applications in different potential commercial scenarios, make it logical step to support Quality of Service (QoS) over wireless networks. QoS support is tightly associated with resource allocation and reservation (Qabajeh *et al*., 2010). QoS provisioning pose a challenge in VANETs as network topology changes due to the nodes rapid movement. This involves negotiation between nodes, in order to determine the path in addition to secure the required resources to supply QoS.

The MAC sub-layer functions as a possible interface between the Logical Link Control (LLC) sub layer and the network's physical layer. The MAC offers addressing and channel access control mechanisms to coordinate the transmission between users sharing the medium. The MAC sub layer enables several nodes to communicate within a multiple access network which often incorporates a shared medium. In general, at the MAC level users should be able to transmit with equal probability of transmission.

Routing: In multi-hop regime the data could be disseminated in two ways: to everyone in the surrounding nodes (multicast) or to individual nodes inside a specific area (geocast). Nodes compute the best quality path by means of exchanging details about network links that able to route messages with other nodes.

Routing for mobile ad-hoc networks has the ability to conserve massage consistency within the network and to reduce the number of propagations of each message. Various factors have an impact on the message consistency, e.g., routing algorithm, environmental circumstances that is the physical layer and also network attacks (security). Since VANETs are a specific class of ad hoc networks, the commonly used ad hoc routing protocols initially implemented for MANETs have been tested and evaluated for use in a VANET environment.

QoS position-based routing: QoS routing protocol as suggested in (Ko and Vaidya, 2000) is a situation whereby the region is partitioned into equal-size square groupings. The nearest node towards the center is chosen as cluster-mind for every cluster. Next, a gateway node is chosen to forward the packet once the headers from the adjacent groupings are from the effective transmission range. The sender node begins the multicast session by packet probing (Packet probing is an important Internet measurement technique, supporting the investigation of packet delay, path, and loss) within cluster region. And therefore forward the packet towards the proper neighbor cluster before the destination or intermediate node with valid path to the destination is arrived at. The destination or even the intermediate node chooses the perfect route using best predecessor alternative strategy (Popescu *et al*., 2010), in which the node selects the following best predecessor that satisfies the QoS constrains (delay, bandwidth, cost and link reliability) by greedy technique.

There are also several works that consider routing protocols in VANETs that espouse greedy forwarding (Lochert *et al*., 2003; Sun *et al*., 2006). In greedy forwarding, a node forwards a packet towards neighboring nodes which is positioned nearer to the destination. This type of forwarding strategy may fails, because there might be circumstances by which no any node is closer to the destination from the forwarding node. In this situation, there is need for a recovery strategy which is to be used in recovering from adverse situations. A recovery strategy is the criteria, which is used to evaluate the performance of protocol.

Cluster-based routing: As in (Chiang *et al*., 1997), the Cluster Based Routing Protocol which is on demand source routing protocol; partition clusters into nodes to reduce control overhead in route discovery. K-Hop Cluster Based Routing Protocol (Chunhua and Cheng, 2009) improves CBRP in (Chiang *et al*., 1997) with improvement in a number of nodes as well as its mobility. This idea changes the prevailing Weighted Clustering Algorithm (WCA) to the selection of Cluster Head.

However, in Location Aided Routing (LAR) (Ko and Vaidya, 2000) protocol, the overhead of route discovery is decreased through the use of location information of the moving nodes. Using GPS navigation, as in (Niu *et al*., 2007b) for location information, LAR protocol reduces the search space for any preferred route. Through communication with a location service provider which usually holds the information on actual positions of all the so-called nodes, the source node ought to first obtain the position of the destination mobile node in the event it desires to deliver data packets with a destination.

Geographic cluster based routing: Majority of geographic routing algorithms considers a proactive beaconing approach to be able to decide the latest information regarding all one-hop nearby neighbors. Each node in the cluster transmits a shorter beacon message with optimum transmission including its address, information regarding its present geographic location, along with a constant quantity of extra bits. Therefore the node receiving the actual beacon message will include the particular sending node inside a list stockpile with almost all available one-hop nearby neighbors. This perhaps updates the received information if the sending node is already contained in list. Therefore, whenever a beacon that is transmitted from one particular neighbor is neglected for a specified stretch of time, the neighbor and its particular located information could be removed from the one-hop neighbor list again (Zeadally *et al*., 2010).

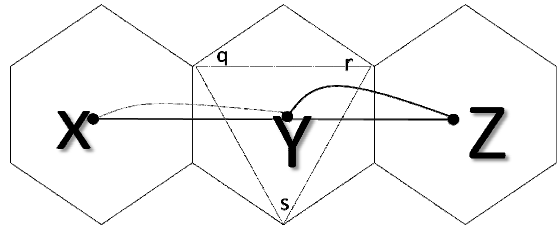

Fig. 2: Connecting clusters with all nodes located inside

However, the geographical cluster based routing mechanism further necessitates that delivering a message from cluster X towards the adjacent cluster Y as shown in the Figure 2 for example, will certainly be achievable by sending it along some restricted quantity of intermediate network nodes.

Figure 2 show a regular hexagon of symmetry in nature and it's noted that *qrs* formed an isosceles triangle with the sides equal. Therefore we can observe that node Z is to be connected with any node situated in the right side of cluster Y.

Assume that there is a message that has to be forwarded to a node U positioned in cluster X with a cluster Y that is alongside X. If cluster XY is an explicit boundary on the node velocity, there will be one or more node V in cluster X that could obtain a node W, located in cluster Y. More so, if node U is a node in cluster X, it could directly pass the information into cluster Y by delivering it towards the neighbor node W. Else, the information may be sent into cluster Y over the path UVW.

Let XY be considered the short edge that suffices the condition for an implied edge. Message forwarded by cluster X to Y might be acquired with the same mechanism as defined for explicit edges, when there exists one or more interconnected node set V and W that might be located within cluster X and Y, respectively. Suppose for the next massage forwarding, there is no available node to deliver a message at the edge of cluster X into cluster Y directly, then an edge with this property is denoted as a pure implicit.

Conversely, an implicit edge XY is introduced because of a collinear long edge developing an irregular intersection and among both edge finishing points of X or Y. this perhaps is type of intersection might be because of an extended edge intersecting with cluster Y or because of a long edge YZ intersecting with cluster X.

In general, the VANETs related issues guarantee useful and meaningful applications to improve both driving safety and driving comfort. It provides essential services by disseminating information regarding weather, road conditions, traffic accidents, etc., for the vehicles within these areas. With the connectivity simulation for highway and dense areas, the ad hoc networks could be well useful for inter vehicle communication. However it appears appropriate to employ a intelligent broadcasting system and routing protocol which take into consideration driving directions for fast moving vehicles for minimizing frequent disconnection. This could however result in developing a protocol that provides optimal and high reliability with low propagation delay.

BASIC IDEA FOR PROVIDING OPTIMAL QOS ROUTING

Cluster based geographical routing would certainly provide QoS for timely distribution of real-time information dissemination as an improvement for the throughput in safety applications. This might guarantee QoS routing information by discovering obsolete source nodes and avoiding the transmission of redundant information and thus restricting redundant broadcasts to limit the application's bandwidth usage and in so doing improves the latency of messages. Consequently making the routing a position based multicast routing. Its objective is to find an optimal QoS route with minimal delay to deliver the packet from source node to all other nodes within a specified geographical region. As in geocast routing (Kihl *et al*., 2007), vehicles outside the relevant region are not alerted to avoid unnecessary hasty reaction.

In addition, the geographical cluster based routing scheme will also enhance the efficiency and effectiveness for performance in dense scenario. In this scheme, the network area is to be partitioned into a number of equalized cells (clusters). During broadcast implementing, virtual infrastructure is created through clustering of nodes in order to provide scalability. Each cluster can have a cluster head, which is responsible for secure communication between inter-cluster and intra cluster coordination in the network. However, only the cluster heads will rebroadcast the messages, which minimizes broadcast flooding by using only head nodes to rebroadcast (Kuhn *et al*., 2008).

In each cluster, a selection algorithm will be executed to determine the Cluster Head (CH). The node coordinator will be responsible for maintaining the positions of the nodes within its region. When a source node wants to send data to a group of destinations, the source communicates with the CH and provides all the nodes interested in forming multicast session and their positions. Therefore the source will divide the group members into sub-groups and choose a coordinator for each subgroup to start the multicast session. The selection algorithm is to be developed to elect the nodes in order to keep the leader role to serve the cluster as much as possible. Each CH keeps information about the identity and position of the nodes in the cluster it is responsible for. The membership of these nodes in different cluster groups and information about the neighboring clusters. The forwarding of route request packet to each destination is to be done using RDF for packet forwarding technique to achieve optimal QoS routing. In RDF, the node resends the packet only if it is closer to the destination than its previous hop.

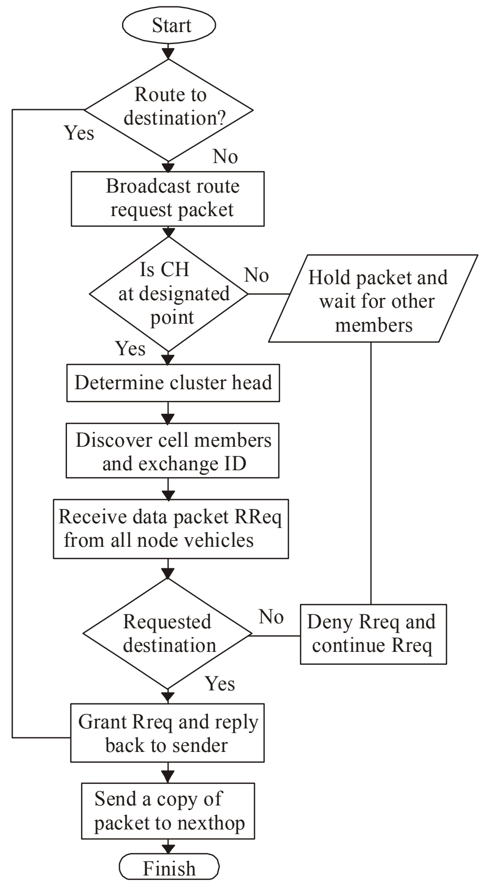

Fig. 3: Flowchart for the providing optimal QoS routing

In the event the clusters are formulated and also the Time Division Multiple Access (TDMA) schedule will be guaranteed and the actual data transmission starts. The assumption is that the nodes generally have data to send out, and they send the packet to the cluster-head over the designated time slot. The overall scenario of the activities is shown in the Fig. 3.

CONCLUSION AND RECOMMENDATIONS

VANET has some special nodes, the road side units which are static nodes that may provide access to the Internet for the rest of VANET nodes. These nodes may have access to a more complete view of the network topology and to additional information that may also improve not only routing but also the construction of the multicast network topology. Additionally, this research is undergoing it early stage which could use geographic routing to provide additional information that allows opportunistic routing which may improve the robustness and the reliability of the multicast networks and reduce the end-to-end delay.

There are still quite few characteristics in routing decision that has not been instigated in this research. Focus on future work is how to effectively select the best path to route packet taking into considerations on some constraints (link reliability and bandwidth) using Veins patch of OMNET++ simulator. However, VANET impose challenges to its features to research communities which upon real implementation will support vehicular communication.

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