IJCSMS International Journal of Computer Science & Management Studies, Special Issue of Vol. 12, June 2012
ISSN: 2231-5268
www.ijcsms.com

COMPARATIVE STUDY OF VARIOUS VANET ROUTING PROTOCOLS

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Abstract

Vehicular Ad-hoc Network (VANET) represents a challenging class of mobile ad-hoc networks that enables vehicles to intelligently communicate with each other and with roadside infrastructure. Routing of data in a vehicular ad hoc network is a challenging task due to the changing topology of such a network. In case of highway traffic position-based routing approaches can very well deal with the high mobility of network nodes. In this paper we analyze a position-based routing approach, a map-based routing approach and topology-based adhoc routing strategies. A comparison is made between these protocols strategies on the basis of type and sub type of protocol type, overhead, mobility model and propagation model.

Keywords: *VANET, Challenges in Communication Protocols, Different Routing Techniques.*

1. INTRODUCTION

Communication between vehicles by means of wireless technology has a large potential to improve traffic safety and travel comfort of drivers and passengers [1]. Vehicular Ad Hoc Network shares some common characteristics with general Mobile Ad Hoc Network (MANET). Both VANET and MANET are characterized by the movement and self-organization of the nodes. They are also different in some ways.

MANET can contain many nodes that cannot recharge their power and have uncontrolled moving patterns. Vehicles in VANET can recharge frequently, however can be constrained by the road and traffic pattern [2].The characteristics of the network can affect the routing strategy. There are existing protocols designed for the characteristics of MANET, but further studies are required to evaluate the suitability of existing protocols for VANET. Existing routing protocols are generally categorized in *topological-based* and *position-based* routing. Topological based routing makes use of global path information and link information to forward packets. Position-based routing does not keep global network information but requires information on physical locations of the node.

There are two variations of mobile wireless networks. The first is known as infra-structured networks, i.e., those networks with fixed and wired gateways. The bridges for these networks are known as base stations. A mobile unit within these networks connects to, and communicates with, the nearest base station that is within its communication radius. The second type of mobile wireless network is the infrastructure less mobile network, commonly known as an ad-hoc network. Infrastructures less networks have no fixed routers; all nodes are capable of movement and can be connected dynamically in an arbitrary manner. Nodes of these networks function as routers which discover and maintain routes to other nodes in the network. Example applications of ad-hoc networks are emergency search-and-rescue operations, meetings or conventions in which persons wish to quickly share information, and data acquisition operations in inhospitable terrains.
Since the service discovery in the first type of mobile wireless network is simple, we will focus on the second type of mobile wireless network, especially the ad-hoc network. An ad-hoc mobile network is a collection of mobile nodes that are dynamically and arbitrarily located in such a manner that the

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interconnections between nodes are capable of changing on a continual basis. During the service finding process in ad hoc network, it needs many ad hoc routing protocols; the table driven type protocols and the source-initiated on-demand driven type protocols. And we will discuss them respectively [3].

2. CHALLENGES OF VANET COMMUNICATION

A. Security

Besides the introduction and management of trust also the security of message content is a big issue for vehicle to vehicle communication. The content of a received message has to be verified within a short time to be able to use the information as soon as possible.

B. Authentication

The authentication service is concerned with assuring that the communication is authentic in its entities. Vehicle should react to events only with disseminating messages generated by legal senders. Therefore we need to authenticate the senders of these messages.

C. Integrity

The integrity service deals with the stability of a stream of messages. It assures that messages are received as sent, without modification, insertion, reordering, or replays.

D. Confidentiality

This service provides the confidentiality to the communication content. It guarantees the privacy of drivers against unauthorized observers.

E. Accessibility

A kind of attacks can result in the loss in the accessibility. Even a robust communication channel can still suffer some attacks which can bring down the network. Therefore, availability should be also supported by alternative means.
An important feature of VANET security is the digital signature.

F. Scalability

The term scalability means that the number of users and/or the traffic volume can be increased with reasonably small performance degradation or even network outage and without changing the system components and protocols.

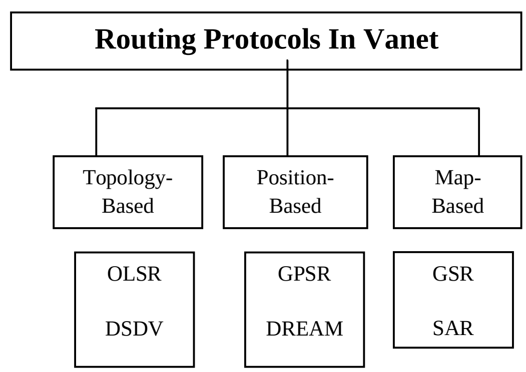
G. Reliability

Due to the brief communication time, it is difficult to assure the reliable message reception and acknowledgement between communication vehicles on opposite directions. In vehicular ad hoc networks a majority of the messages that are transmitted will be periodic broadcast messages that announce the state of a vehicle to it neighbors. So in case of broadcast messages it needs more reliability.

3. VANET Protocol Description

There exist various classes of Vehicular Adhoc routing protocols, the topology-based and the position-based routing protocols and map-based routing protocol which are distinguished by the

kind of information used to make their routing decisions in Fig. 1. Topology-based routing uses information about the existing links in the network, whereas the position-based routing mainly relies on information about the geographic positions of the nodes in the network.



3.1. Topology based routing

These routing protocols use links' information that exists in the network to perform packet forwarding. They can further be divided into proactive (table-driven) and reactive (on-demand) routing [4]. Protocols belonging to this class always use the information about existing links in the network to forward packets.

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3.1.1. Proactive Protocol

The proactive protocols, such as Optimized Link State Routing (OLSR) [5] and Destination-Sequenced Distance-Vector Routing (DSDV) [6] compute and maintain routing information about all available paths in the networks even if no data traffic is exchanged. In DSDV, every node maintains a vector of distances to every known destination. Therefore, frequent broadcast messages are issued by all nodes to learn periodically about their neighbors or to advertise topology changes (e.g. link breakages). Similarly, OLSR floods the network by the topology control messages in order to disseminate the link states information.

Throughout the entire network showing which nodes are connected to which other nodes. This additional traffic used in proactive approaches for the maintenance of unused paths has several drawbacks. First, it consumes the networks resources and wastes a part of the bandwidth for control messages that increase with rapid changes. Moreover, the use of flooding increases the network congestion and leads to the loss of messages because of collision. So proactive solutions do not scale well in very large networks with a high number of nodes joining and leaving the network over a short time, which is the case for VANETs.

3.1.2. Reactive Protocol

On the contrary, reactive protocols such as AODV [7] and DSR [8] determine a route to a given destination only on-demand. They reduce the overhead by restricting the route maintenance only between nodes that need to communicate. In other words, route discovery is only initiated when a sending node has to set up a valid path towards a given destination. Also most of reactive protocols use the flooding technique to establish the communication between the source and destination and consume a lot of the available bandwidth. Because of the high mobility of vehicles, the topology-based algorithms fail to handle frequent broken routes usually constructed as a succession of vehicles between the source and the destination. Moreover, the route instability and frequent topology changes increase the overhead for path repairs and thus, degrade the routing performances.

3.2. Position-based routing

Position-based protocols perform the routing decisions based on the geographic information of the nodes. This class offers an alternative approach known to be more robust to face the mobility issues[9]. Indeed, no global knowledge of the network topology is required; a purely local decision is made by each node to make a better progress towards the destination. Therefore, they require all nodes to be aware of their physical positions as well as their neighbours' positions. They also assume that the sending node knows the position of the destination. Typically, a location management service is responsible for querying this information [10].

3.2.1 Greedy perimeter stateless routing

As a representative example of the position-based algorithms, Greedy Perimeter Stateless Routing (GPSR) seems to be the most popular candidate for dynamic networks. Typically, there are several requirements on the availability of position information: GPSR requires that each node is able to obtain its current location e.g., through a GPS receiver as it is becoming standard equipment in vehicles. Furthermore, it assumes that each node learns about the existence of its direct neighbors and their current positions through the exchange of periodic HELLO messages. To make the routing decisions, a source node needs to know the position of the destination. The source node forwards the packets toits neighbor which is geographically closest to the destination. This procedure, known as Greedy Forwarding, is recursively applied by intermediate nodes until the final destination is reached. However, packets can reach node that has no neighbor which is closer to the destination than itself. This problem known as local maximum is likely to happen in case of sparse networks. In such a case, GPSR switches to a recovery strategy called Perimeter Mode using the right hand rule algorithm of planer graph traversal to route the packets out of the local maximum region. Being expensive this recovery procedure is abandoned as soon as possible to go back to the

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greedy strategy since it can decrease the performance when used often.

3.2.2. Greedy Perimeter Coordinator Routing

Because nodes are highly mobile in VANETs, node planarization can become a inaccurate, and continuous process. In their work of Greedy Perimeter Coordinator Routing (GPCR), [14] have observed that urban street map naturally forms a planar graph such that node planarization can be completely eliminated. In this new representation of the planar graph using the underlying roads, nodes would forward as far as they can along roads in both greedy and perimeter mode and stop at junctions where decision about which next road segment to turn into can be determined. GPCR not only eliminates the inaccuracy of node planarization, but also improves routing performance as packets travel shorter hops in the perimeter mode. Furthermore, the improved routing decision keeps packets from being routed to the wrong direction that often leads to higher delay. GPCR does not rely on a map to determine whether a node is located at a junction, but rather provides two heuristics to determine whether a node is a junction. The first heuristic uses beacon messages and determines a node x is located at a junction if it has two neighbors y and z that are within the range of each other but do not list each other as neighbors. The second heuristic is derived from a *correlation coefficient* that relates a node to its neighbors. A correlation coefficient close to 0 shows there is no linear relationship between the positions of the neighbors. This indicates the node is located at a junction.

3.3. Map-based routing protocols

The Map-based routing protocols combine the position information with topological knowledge about the road and the surroundings. The idea is to build a spatial model representing the underlying road topology and select a routing path that overlaps with the streets. For this purpose, the road maps are represented by graphs where vertices are cross roads and edges are road segments. Accordingly, the routing path is selected based on the new constructed graph and the data packets are only forwarded respecting the particular mobility pattern restricted by the road topology. These approaches vary from source routing approaches, where the entire path towards the destination is pre-computed by the data source, to the dynamic routing where decisions are made only at road intersections based on various parameters.

3.3.1 Geographic source routing

The first protocol to use the knowledge of the underlying map of the streets was Geographic Source Routing (GSR) which is mainly proposed for urban environments[12]. Assuming the availability of such information through a navigation system, a given source computes the shortest path to an intended destination using Dijkstra’s algorithm based on the distance metric. The computed path consists of a sequence of junctions IDs known as Anchor Points (AP), along which packets should be forwarded to reach the destination. These anchors, obtained from the streets map, reflect the underlying road topology and usually represent the road intersections where decisions are made. The list of junctions is then inserted into the header of each data packet sent by the source. The packets are forwarded over the selected path successively from one AP to the next AP using the greedy forwarding scheme. the insertion of the entire path in the packet’s header cannot be preferred in case of a long route between the source and the destination since it causes an additional packet overhead.

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3.3.2 Spatially aware packet routing

Spatially-Aware Packet Routing (SAR) protocol to improve the basic GSR with a recovery procedure to avoid a local maximum, as the greedy routing used to forward packets along the shortest path may fail if there are no vehicles ensuring connectivity to the next intersection. In such situations, GSR drops the packets although a valid path may exist. On the contrary, SAR suggests finding an alternative path from the current location where the local maximum occurs and then replaces the original route with the new one. The new path is computed again using Dijkstra algorithm after removing the current road segment where the local maximum is detected. In this another option would be to store the packet in a suspension buffer and wait for an incoming neighbor that provides positive progress towards the next intersection. The suspended packets will be dropped if the buffer is full or if they cannot be forwarded during a predefined interval depending on the application requirements. The performances evaluation has shown that SAR is more robust to the mobility than topology-based routing protocols (DSR) since the routing path is computed independently of specific mobile nodes. Although knowing the road topology represents a big advantage, this approach fails in the case where the algorithm tries to forward packets over streets where no vehicles are moving.[13]

4. Conclusion

We have analyzed the routing problem in vehicular ad hoc networks and presented a taxonomy of existing protocols in table 1. Several routing protocols have been proposed or adapted for the vehicular applications. Nevertheless, the geographic routing has become the trends taking advantages of the availability of navigation system that makes the vehicle aware of its own location as well as its surrounding. Many studies showed that the exploitation of the road-topology improves the routing performances especially with complex mobility patterns of vehicular environments. Also the use of traffic information is proved to be of a great importance and demonstrated better performances. Different ways are used to model this traffic awareness through the historical density data or the real-time traffic information. On the basis of above study I found Geographic Based Protocols is best in finding the best alternate path in case of road congestion. So in our proposed work we will implement Geographic Based Approach on Vehicular Ad-hoc Networks by using the NS-2 simulator tool.

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ISSN: 2231-5268
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