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RESEARCH ARTICLE

A Study and Analysis of DADCQ Protocol for VANET

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***Abstract*- The DADCQ protocol utilizes the distance method to select forwarding nodes. The performance of this method Depends heavily on the value of the decision threshold, but it is difficult to choose a value that results in good performance across all Scenarios. Node density, spatial distribution pattern, and wireless channel quality all affect the optimal value. Broadcast protocols Tailored to vehicular networking must be adaptive to variation in these factors. The aim of this work is to give better VANETs routing mechanisms, this research gives an overview of Vehicular ad hoc networks (VANETs) and the existing VANET routing protocols; mainly it focused on vehicle to vehicle (V2V) communication and protocols. Broadcast protocols tailored to vehicular networking must be adaptive to variation in these factors. The proposed approach facilitates impact analysis of distance dependent DSRC fading channel and application-level analysis.**

Keywords: **DADCQ; DSRC; RSU; VANET**

I.INTRODUCTION

Vehicular Ad hoc networks (VANETs) are a special type of mobile ad hoc networks; where vehicles are simulated as mobile nodes. VANET contains two entities: access points and vehicles, the access points are fixed and usually connected to the internet, and they could participate as a distribution point for vehicles. VANET addresses the wireless communication between vehicles (V2V), and between vehicles and infrastructure access point (V2I). Vehicle to vehicle communication (V2V) has two types of communication: one hop communication (direct vehicle to vehicle communication), and multi hop communication (vehicle relies on other vehicles to retransmit). VANET also has 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. VANETs applications types are classified into safety and efficiency. There are many difficulties facing VANETs systems design and implementation, including: security, privacy, routing, connectivity, and quality of services. This research will focus on routing problem in vehicle to vehicle communication (V2V); discusses some proposed routing solutions, routing protocols classifications, and illustrates some challenges and open issues in VANET routing. The main goal for routing protocol is to provide optimal paths between network nodes via minimum overhead. 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. Some research researches classified VANETs routing protocols into five classes: topology-based, position-based, geocast-based, broadcast, and cluster-based routing protocols, this classification is based on the routing protocols characteristics and techniques .As well, other researches classified VANETs routing protocols according to the network structures, into three classes: hierarchical routing, flat routing, and position-base routing. Moreover, they can be categorized into two classes according to routing strategies: proactive and reactive. On the other hand other researches classified them into two categories: geographic-based and topology-based, according to the routing information used in packet forwarding. Also based on quality of services classification, there are three types of protocols that dealing with network topology (hierarchical, flat, and position aware), concerning with route discovery (reactive, proactive, hybrid and predictive), or based on the MAC layer interaction. However all previous classifications did not concern by transmission strategies classification (such as unicast, broadcast, and multicast). This research will address two types of classifications as shown in Fig. 1; the first one is the routing information which used in packet forwarding, it mainly focuses on topology-based and graphic-based routing. And the other class is the transmission strategies, which is we thought it has a significant impact in protocol design and network performance (in case of network overhead, delay, and packet loss).

II.DADCQ PROTOCOL

Wireless communications generally and VANET in particular is loss of packets as they traverse the medium. Multipath fading causes a signal to interfere with itself as it splits into multiple paths due to being reflected off objects in the environment. Packets can also be lost when different transmitted signals interfere with each other, a phenomenon called a collision. These effects vary in intensity across space and time and can work against the design of multihop broadcast protocols. If a broadcast protocol is designed and tested in an environment that assumes perfectly reliable communications, it could break down when fading and collisions are introduced.

Often, broadcast protocols must accommodate packet communication failures by increasing the number of nodes that are rebroadcasting source messages. Ideally, this increased usage of bandwidth is the minimum necessary to retain the level of connectivity required by the application. Practical VANET broadcast protocols should accommodate fading and collisions while minimizing redundant source message retransmissions.

However, topological protocols have disadvantages. The density and speed of vehicles in VANET means that the network topology will be highly variable. Consider the rather modest scenario of a single two-lane street in isolation with vehicles traveling in both directions at a speed of 50 kph (32 mph) and separated by 20m. Half of each node's neighbors (the ones traveling in the same direction) are roughly constant. However, the set of neighbors traveling in the opposite direction changes every 715 ms. If a protocol needs accurate neighborhood information to operate properly, messages used to discover the topological data will need to be sent at a high rate to keep the local neighborhood information up-to-date. Statistical broadcast protocols typically do not use this rapidly changing neighborhood information. Statistical protocols measure the value of one or more locally available variables and make a decision to rebroadcast based on the measured value and a cutoff threshold. For example, the statistical method used in this work, the distance method, measures the distance to the nearest neighbor from which a node has received the broadcast message. If that distance is greater than a threshold value, then the node rebroadcasts the message. The threshold value is calculated as a function of more slowly changing topological factors such as node density and spatial distribution pattern[4].

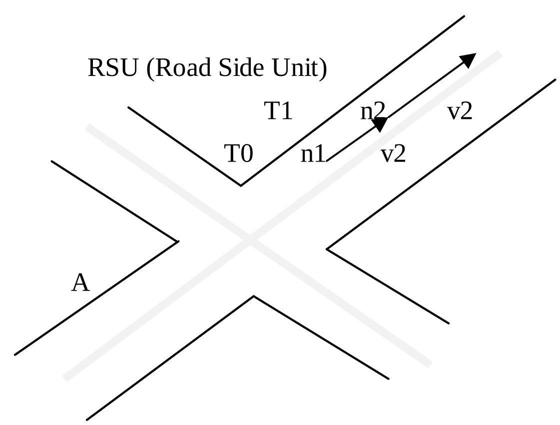


Fig 1. Calculation of intervehicular distance.

Vehicle identification number
Source X-coordinates
Source Y-coordinates
Destination X-coordinates
Destination Y-coordinates
Speed of the neighboring vehicle
Intervehicle distance

Table I: Routing Table

$$d2= v2 * (T1-T0) \quad (2)$$

$$d1=v1 * (T1-T0) \quad (3)$$

$$inter\_vehicular\_distance=d2-d1 \quad (4)$$

In this approach every vehicle makes use of digital map. We suppose that digital map provides entire detail of the road network such as coordinates of intersection. All the vehicles determine its initial position using GPS technology or from users and identifies its location in the digital map. Table I represents routing table maintained by all the vehicles. The vehicles keep track of velocity and direction information. Whenever there is a change in these parameters, the vehicle will broadcast a hello message. The neighboring node which receives the hello message will updates its routing table accordingly and recomputed inter-vehicular distance analogous to change in velocity and also updates the vehicle ID, velocity, position information and coordinates of destination in the routing table. The size of the table depends on the traffic congestion of the road. When there is huge traffic congestion, maintaining all the vehicle information will increase the computational load. So the delay of updating and searching while forwarding the data is minimized with the help of varying table size. Then DBR forwards the data packet using both location information and vehicle ID present in the routing table [5].

Packet sequence number
Destination vehicle id
Next hop
Previous hop
Number hops

Table II: Data Forwarding Table

In ordered to forward the data packet, a vehicle selects the next hop based on the direction if the location of destination is known. Table II represents data forwarding table maintained by every vehicle. Before forwarding any data packet the parameters of data forwarding table associated with the data packet are stored in the table. The vehicle searches for necessary information in data forwarding table to select the next hop whenever a data packet is received.

OVERVIEW

Vehicular Ad hoc networks (VANETs) are a special type of mobile ad hoc networks; where vehicles are simulated as mobile nodes. VANET contains two entities: access points and vehicles, the access points are fixed and usually connected to the internet, and they could participate as a distribution point for vehicles. VANET addresses the wireless communication between vehicles (V2V), and between vehicles and infrastructure access point (V2I). Vehicle to vehicle communication (V2V) has two types of communication: one hop communication (direct vehicle to vehicle communication), and multi hop communication (vehicle relies on other vehicles to retransmit). VANET also has 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. VANETs applications types are classified into safety and efficiency. There are many difficulties facing VANETs systems design and implementation, including: security, privacy, routing, connectivity, and quality of services. This research will focus on routing problem in vehicle to vehicle communication (V2V); discusses some proposed routing solutions, routing protocols classifications, and illustrates some challenges and open issues in VANET routing. The main goal for routing protocol is to provide optimal paths between network nodes via minimum overhead. 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. Some research researches classified VANETs routing protocols into five classes: topology-based, position-based, geocast-based, broadcast, and cluster-based routing protocols, this classification is based on the routing protocols characteristics and techniques .As well, other researches classified VANETs routing protocols according to the network structures, into three classes: hierarchical routing, flat routing, and position-base routing. Moreover, they can be categorized into two classes according to routing strategies: proactive and reactive. On the other hand other researches classified them into two categories: geographic-based and topology-based, according to the routing information used in packet forwarding. Also based on quality of services classification, there are three types of protocols that dealing with network topology (hierarchical, flat, and position aware), concerning with route discovery (reactive, proactive, hybrid and predictive), or based on the MAC layer interaction. However all previous classifications did not concern by transmission strategies classification (such as unicast, broadcast, and multicast). This research will address two types of classifications as shown in Fig. 1; the first one is the routing information which used in packet forwarding, it mainly focuses on topology-based and graphic-based routing. And the other class is the transmission strategies, which is we thought it has a significant impact in protocol design and network performance (in case of network overhead, delay, and packet loss) [5].

III.CONTRIBUTION OF DADCQ

The contributions of this work are summarized as follows:

DADCQ protocol: The primary contribution of this work is the proposed multihop broadcast protocol DADCQ. DADCQ combines local spatial distribution information and other factors with the distance method heuristic to select rebroadcasting nodes. Previous broadcast protocols proposed for ad hoc that make use of the distance method use less comprehensive supplemental information. A key insight proposed here is a methodology for incorporating more information into the protocol. This extra information is used to make the protocols adaptive to more networking scenarios than many previous proposals.

Adaptive threshold function design: This paper gives a novel design strategy for a decision threshold function. Threshold functions are a critical component of many multihop broadcasting methods, such as stochastic broadcast (gossiping), the counter method, the distance method, and the location method [4]. The proposed design scheme builds a threshold function using three independent input variables chosen to allow the threshold to be adaptive to the environmental conditions of primary interest. These variables measure local node density, the distribution pattern of nearby nodes, and the wireless channel quality. Thus, the resulting threshold function of these three inputs causes the protocol to operate efficiently across a broad range of conditions.

Quadrat method for spatial distribution characterization: One of the factors used to compute the rebroadcasting decision threshold in DADCQ is local node distribution pattern. This work is the first to propose that the quadrat method of spatial statistics be used to characterize the spatial distribution of nodes for use in a multihop broadcast protocol. Because distribution pattern may affect the behavior of many multihop broadcast methods, this contribution may be applicable in a wider context as well.

Analysis of behavior with respect to threshold value: This paper presents original results addressing the nature of the threshold value used in the distance method. We show that system performance exhibits a phase transition with respect to the threshold value and suggest that an optimal threshold value should cause the system to operate in the supercritical region of performance as close to the transition region as possible.

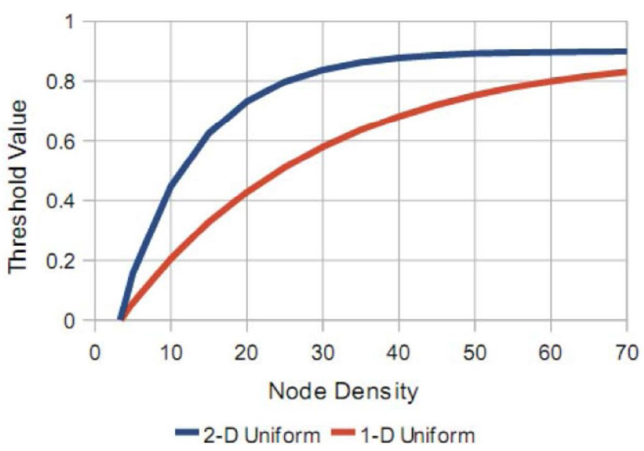
IV DISTANCE METHOD IN DADCQ

At its core, the proposed DADCQ protocol utilizes the distance method to select forwarding nodes. The distance method uses the minimum distance from sender to receiver (one-hop distance) as the variable of discrimination between rebroadcasters and nonrebroadcasters. The method appeals to the intuition that if a node has received a message from another node very close to it, there is little benefit in terms of additional coverage achieved by rebroadcasting. Nodes then should favor rebroadcasting when this distance is large. The algorithm is simple and is given here.

1. Initialize D ¼ 1.
2. When a message is received, set d to the distance to the sender, D ¼ minfD; d=rg, and set a random backoff timer.
3. If a message is received during the backoff, repeat 2.
4. When the backoff expires, rebroadcast if D > Dc.

The key to any statistical broadcast protocol is the decision cutoff, in this case Dc. If the value is set too high, reachability will be degraded. If the value is set too low, the protocol will not prevent many nodes from rebroadcasting. Thus, protocol behavior exhibits a phase transition relative to Dc [26]. In the supercritical phase, when Dc is less than the critical value, reachability is nearly one in all simulation runs. Around the critical value, the reachability quickly transitions from one to zero and the variance of the reachability spikes, indicating the reachability is highly variable from run to run. In the subcritical phase, message propagation is suppressed so that only nodes near the source will receive the message. The design tradeoff is with bandwidth consumption. When Dc is set deep into supercritical phase, the protocol will propagate messages to the entire network with high reliability, but it comes at a cost of decreased broadcast efficiency. Our goal then is to set Dc as high as possible while maintaining acceptable reachability. This optimal value for Dc varies with node density (among several factors). At low densities, Dc must be lower to allow the message to propagate to the entire network. When the node density is high, we can set Dc more aggressively to eliminate excess transmissions. Therefore, we use the following procedure to find Dc as a function of N, the number of neighbors of the node (also referred to as local density) If transmission may fail due to loss of CTSs or ACKs. According to the number of received ACKs, a source can decide whether the transmission is successful or not, and re-initiate the MRTS procedure. If no CTS is received, then the source will directly re-initiate the MRTS procedure [7].

1. Find the optimal value of Dc at many values of the global density _. The optimal value of Dc is the maximum value for which the reachability remains acceptable.
2. Plot the measured optimal values and find suitable approximation function Dcð_Þ.
3. Substitute local density N for global density _ to get DcðNÞ.
4. Test DcðNÞ to ensure reachability is acceptable.
5. Adjust DcðNÞ as necessary



Threshold value versus density for 1D and 2D uniform distributions [11].

ADAPTATION TO CHANNEL QUALITY in DADCQ

Finally, this section incorporates adaptability to channel quality into the proposed protocol. The design described in the previous section assumes that the wireless channel and the medium access control protocol deliver messages between nodes located within transmission range of each other with perfect reliability. In practice, wireless signals in the system interfere with themselves and with each other in unpredictable ways, leading to apparently non-deterministic message reception. When two nodes transmit messages at the same time, the wireless signals may interfere and cause one or both of the messages to be lost at a destination node. Fading, the phenomenon where multiple parts of the same signal traveling along different paths interfere with each other, degrades communications even when only a single node is transmitting.

Multihop wireless broadcast protocols must be able to operate effectively even when communication reliability is poor. What follows in this section is the design of a decision threshold function that is adaptive to both node distribution pattern and channel quality, culminating in the Distribution-Adaptive Distance with Channel Quality (DADCQ) protocol [6].

C. Adaptive Beacon Control

In urban areas, there could be thousands of vehicles moving across intersections in short period of time. If each vehicle keeps sending beacons, it will cause many collisions and failures. So, this protocol uses a beacon control mechanism to adjust beacon generation rate. The main function of beacons in this approach is to find the farthest neighbor in each direction for greedy forwarding. It is not necessary to let all nodes send beacons. There should be a proper number of nodes sending beacons.

V.NOTES ON FINDING K

DADCQ calculates the rebroadcasting threshold value as a function of N (the number of neighbors), Q (the distribution clustering metric), and the Rician fading parameter K. N and Q can be easily calculated using overhead messages exchanged between nodes (see also Section 7). K, however, cannot be easily calculated by nodes dynamically. For dynamically measuring K, nodes in practice will have several options. First, designers may be aware of a worst case (minimum) value of K that nodes can use in all circumstances. Results in [31] and [33], for example, show K is almost always greater than 5. Statically employing this value of K, reachability should always exceed the application requirements, provided the true value of K is not less than the assumed minimum. However, since the value of K may often be higher than the minimum, this method may result in excessive rebroadcasts and thus inefficient use of wireless bandwidth. Since vehicles equipped with VANET capabilities will likely also have extensive mapping data used by on-board navigation systems, it may be possible to improve on this static value of K by encoding minimum values of K at different geographic locations. For example, fading will likely be worse in urban areas with tall buildings than in flat open areas. These geographic influences on K can be measured and encoded in mapping data for use by the broadcast protocol.

Finally, although nodes probably cannot accurately measure K dynamically, they may be able to use the measured node distribution to provide some feedback to the value of K. For a given value of N, Q, and K, nodes will know about how many overhead messages (beacons) can be expected from neighbors at various distances away. So if, for example, the number of beacons received from neighbors at the edge of the transmission range is much different than expected, the node can adjust its assumed value of K to reflect this observation. In the evaluations in later sections, we assume nodes know K and can use it to calculate the rebroadcast threshold for DADCQ [12].

VI.PROTOCOL ADAPTABILITY RATE

Another important issue when considering the choice of Tb is the rate at which the protocol can adapt to sudden changes in node density and distribution pattern. Nodes continue to use collected topological information that is up to Tb seconds old, so in the worst case a node will not be fully aware of a sudden change in topology for Tb seconds. However, beacon reception is randomly staggered between all nodes, so if a vehicle transitions into an area with a dramatically different node distribution pattern, it will begin to receive updated information immediately. Its internal aggregate measurements of topology will slowly be updated and improve in accuracy until after Tb seconds the topological information is up-to-date. In our experimental results, using simulated vehicular traffic patterns on both real and contrived road maps, we find that both node density and node distribution pattern change slowly relative to value Tb ¼ 30 s used for DADCQ. However, it is easy to imagine a scenario where a vehicle moves suddenly from an area with sustained topology A to an area with sustained topology B, where A and B are very different. (Note that nodes do experience dramatic temporary changes in density and distribution pattern in the simulation scenarios presented below, but these tend to average out and do not have significant impact on broadcast protocol performance.) In cases of rapid change between long-term average topology, it can be expected that protocol performance will be negatively impacted for a period of Tb, with performance slowly improving from when the change occurs until topological information is entirely updated. We suggest that sudden dramatic changes in sustained topology are likely to be rare in practical vehicular scenarios, so we defer the issue to future study [14].

VII.CONCLUSION

DADCQ provides high reachability and efficient use of bandwidth in both urban and highway scenarios with varying node density and fading intensity. DADCQ achieves better than 95 percent reachability across all network scenarios while showing efficient use of bandwidth. In most cases, protocols used for comparison either fail to match this level of reachability or do so using a higher level of bandwidth consumption. There are some scenarios where DADCQ performance could be improved, notably in very poor channel quality, and its use requires positional information, but overall it is shown to be highly adaptable and efficient. The performance of protocols such as DADCQ that use statistical broadcasting methods like the distance method is highly dependent on the rebroadcasting decision threshold function. In the past, this dependency has been a key disadvantage of statistical protocols, as it is difficult to choose a value for the decision threshold that works well across a wide range of network scenarios. In this work, we addressed this challenge directly and proposed a methodology to design a decision threshold surface dependent on several external factors so the resulting protocol is adaptive to many scenarios. Bridging this statistical broadcast protocol design gap is important for VANET as it now opens up a new class of multihop broadcast protocols that are well suited to the challenges of VANET [13].

We present DADCQ protocol for multihop Broadcast the warning messages in VANETs. DADCQ provides high reachability and efficient use of bandwidth in both urban and highway scenarios with varying node density and fading intensity. The simulation results shows that our system out performs than previously used methods. DADCQ protocol has proved that extremely effective when the density of vehicles is high, especially in maps with low density of streets and junctions. Our proposed method also performs well in all the scenarios like urban, sub-urban and highway updated. We suggest that sudden dramatic changes in sustained topology are likely to be rare in practical vehicular scenarios, so we defer the issue to future study [14].

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