VANET BASED SIMULATION USING CLUSTER BASED TECHNIQUE

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Abstract - The goal of this study is to develop an algorithm to construct stable multi-hop cluster with minimum number of cluster head in VANET. The original contributions of this paper are three. First we propose a novel mobility metric that is periodically exchanged and used for similarity calculation among scenario. Third to the best of our knowledge, the proposed approach VMaSC is the first work to simulate SUMO. Several vehicular ad hoc network (VANET) studies have focused on the communication methods based on IEEE802.11p, which forms the standard for Wireless Access for vehicular environments (WAVE). In the network employing IEEE 802.11p only, the broadcast storm and disconnected network problems at high and low vehicle densities respectively degrade the delay and delivery ratio of safety message dissemination.

Keywords – VANET, RSU, MANET, VMACS, DSRC

I. INTRODUCTION

Sensor networks refers to a heterogeneous channel consisting of multiple detection stations called sensor nodes with a communications infrastructure studied to monitor and record conditions at diverse locations. Sensor nodes also known as point are small, lightweight and portable devices equipped with a transducer, microcomputer, transceiver, and power source. The transducer generates electrical signals based on the sensed physical phenomena. The microcomputer processes and stores the sensed information. The transceiver gets instructions from the base station/central computing system and dispatch data to it. Each sensor node derives its energy usually from a battery or any other embedded form of energy harvesting. The size of the sensor nodes change from that of a shoe box to that of a minute sand particle. Similarly their expense also varies from hundreds of dollars to a few pennies. Size and cost impaction result in corresponding constraints on energy, memory, computational speed and communications bandwidth.

Vehicular Ad-hoc Networks (VANETs) represent a rapidly emerging, particularly challenging class of Mobile Ad Hoc Networks (MANETs). VANETs are distributed, self organizing communication networks built up from traveling vehicles, and are thus characterized by very high speed and limited degrees of freedom in nodes movement patterns. Such particular features often make standard networking protocols inefficient or unusable in VANETs, and this, combined with the huge impact that the deployment of VANET technologies could have on the automotive market, explains the growing effort in the development of communication protocols which are specific to vehicular networks. Whereas it is crucial to test and evaluate protocol implementation in real test bed environments, logistic difficulties, economic issues and technology limitations make simulation the mean of choice in the validation of networking protocols for VANETs, and a widely adopted first step in development of real world technologies. A critical aspect in a simulation study of VANETS is the need for a mobility model which reflects, as close as possible, the real behavior of vehicular traffic. When dealing with vehicular mobility modeling, we distinguish between macro-mobility and micro-mobility descriptions. For macro-mobility, we intend all the macroscopic aspects which influence vehicular traffic: the road topology, constraining cars movement, the per-road characterization defining speed limits, number of lanes, overtaking and safety rules over each street of the aforementioned topology, or the traffic signs description establishing the intersections crossing rules. Micro-mobility instead refers to the drivers’ individual behavior, when interacting with other drivers or with the road infrastructure: traveling speed in different traffic conditions; acceleration, deceleration and overtaking criteria, behavior in presence of road intersections and traffic signs, general driving attitude related to driver’s age, sex or mood, etc.
would be desirable for a trustworthy VANETs simulation that both macro-mobility and micro-mobility descriptions be jointly considered in modeling vehicular movements. Indeed, many non-specific mobility models employed in VANETs simulations ignore these guidelines, and thus fail to reproduce peculiar aspects of vehicular motion, such as car acceleration and deceleration in presence of nearby vehicles, queuing at road intersections, clustering caused by semaphores, vehicular congestion and traffic jams.

II. COMMUNICATION MODES IN VANET

Vehicular communications in on-road traffic environments have been realized through VANETs. In this network, vehicles termed as nodes share information through wireless communication. Dedicated short range communications (DSRC) technology is used for wireless. DSRC is an enhanced version of Wi-Fi technology specially designed for VANETs environment and this is known as wireless access in vehicular environment (WAVE). During the communication, when a sender node does not find any neighboring nodes, it forwards the information using road side units (RSUs) available along the road. However, the availability of RSUs is not strictly considered in VANETs. Thus, the communications in VANETs can be categorized in the following two modes: (1) vehicle-to-vehicle (V2V) communication and (2) vehicle-to-roadside (V2R) communication.

1. V2V Communication: V2V communication is the basic and primary aim in VANETs. It is pure ad hoc communication between two vehicles. V2V communication can be through direct link or through multihop links. If the destination node is present within the transmission range of the source node then the direct link is established for communication and this type of communication is known as single-hop communication. If the destination node is present outside the transmission range of the source node then the intermediate nodes are used to deliver the message up to the destination and this type of communication is known as multihop communications. V2V communication is mainly used for the safety applications such as road blockade alarm, electronic brake warning, incoming traffic warning, vehicle stability warning, lane change warning, and collision warning. This type of communication is also used for the different types of the protocol operations. To set up RSUs such as fixed infrastructure access points, internet gateways, and base station on the road side is expensive. Therefore, VANETs should use V2V communication as much as possible for communication purpose.

2. V2R Communication: V2R communication is the combination of ad hoc network and fixed infrastructure networks. This mode of communication involves on-road vehicles as well as RSUs. Only single-hop communication between a vehicle and RSU is used in V2R communication. Further, vehicle sends the message to the road side unit which broadcasts the message to all the vehicles in the neighborhood. Generally, RSUs use links of higher bandwidth for communication and broadcasting. RSUs may be placed at every one kilometer or less to enable and maintain high data rate in highly dense traffic environment.

III. PROPOSED WORK

The nodes in VANET aim to form clusters such that each has one cluster head and all nodes in a cluster can communicate with the cluster heads in a number of hops that is less than a maximum pre-determined value. Three example clusters, namely 1-hop, 2-hop and 3-hop, where in each case middle vehicle is the cluster head (CH), and vehicles that are n-hop far away, are n-hop cluster members (CM). The cluster formation algorithm should be designed with the goals of minimizing the number of cluster heads in the network to decrease the cost of communication over cellular network, maximizing the duration of cluster head and cluster member to provide the stability and minimizing the overhead of forming the clusters. In this section, we describe the states of the vehicles, the algorithm for cluster formation and maintenance, and multi-hop clustering mechanism.

States of Vehicles:
Each vehicle can operate under one of the five states as described below.

- **INITIAL is the starting state of the vehicle. Vehicles stay in this state and start to receive and send HELLO PACKETS with clustering related attributes.**
- **STATE ELECTION is the state where the vehicle makes decision about the next state based on state election algorithm (Algorithm-1) by using LOCAL KNOW which is constructed upon reception of packets.**
- **CLUSTER HEAD is the state of the vehicle which is less mobile with respect to its neighbours.**
- **CLUSTER MEMBER is the state where the vehicle is connected to a constructed cluster.**
- **CLUSTER GUEST is the state which is enabled only in unnecessary cluster head election in case when a vehicle cannot hear head related message, it declares itself as new cluster head. Vehicle in this state is regarded as a cluster member who accesses to cluster with the help of a cluster member.**

Algorithm Detail

1. Start Vtimer;  
2. while Vtimer is not expired do  
3. if LOCAL KNOW contains CH then  
4. for each CH in LOCAL KNOW do  
5. Control AV GRELspeed and MEMBERch;  
6. if AV GRELspeed and MEMBERch are satisfied then  
7. Send JOIN REQ and set Vtimer for reply;  
8. Wait for JOIN RESP;  
9. if JOIN RESP is received then  
10. Connect to CH;  
11. Change state to CLUSTER MEMBER;  
12. else  
13. Set Vtimer;  
14. Change state to STATE ELECTION;  
15. if MAX HOP > 1 then  
16. if no CH found in LOCAL KNOW then
17: if LOCAL KNOW contains CM then
18: for each CM in LOCAL KNOW do
19: Control AV GRELSpeed, GUESTcm and MAX HOP;
20: if AV GRELSpeed, GUESTcm and MAX HOP are satisfied then
21: Send JOIN REQ packet and set a Vtimer;
22: Wait for JOIN RESP;
23: if JOIN RESP is received then
24: Connect to CM;
25: Change state to CLUSTER GUEST;
26: else
27: Set Vtimer;
28: Change state to STATE ELECTION;
29: if MAX HOP _ 2 then
30: Apply MultiHop Clustering;
31: if Vstate is not determined then
32: if AV GRELSpeed is smallest in LOCAL KNOW then
33: Broadcast CH ADV packet;
34: Change state to CLUSTER HEAD;
35: else
36: Set Vtimer, wait for CH ADV PACKET;
37: if Vtimer is expired and CH ADV is not received then
38: Set Vtimer;
39: Change state to STATE ELECTION;
40: Trigger cluster forming process again;

In STATE ELECTION, the decision to become cluster head, cluster member and cluster guest is made as described in Algorithm-1. Since the main goal of clustering scheme is electing minimum number of cluster heads, Algorithm-1 first tries to set up a connection between existing cluster heads (Lines 3 to 11). Via using LOCAL KNOW, vehicle checks CH existence and its MEMBER ch. After CH control, CHs are ordered based on AV GRELS speed and comparison of AV GRELS speed is done between CH and current vehicle (Line 5 to 6). To extend the CM lifetime, CH whose relative mobility resembles current vehicle the most is elected from the CH about the connection request (Line 7). If vehicle receives JOIN RESP from cluster head, vehicle changes state to CLUSTER MEMBER (Lines 10, 11). Response waiting is controlled via timer where if vehicle does not receive JOIN RESP in given amount of time, it sets the timer and waits in the STATE ELECTION (Lines 13, 14) and apply clustering process again. If clustering scheme is 1-hop, where the MAX HOP is 1 (Line 15), second step of Algorithm-1 tries to set up a connection with cluster member to be a cluster guest (Lines 16, 26). To prevent system from unnecessary cluster head in 1-hop, cluster guest state is initiated. Like in the first step, vehicles check the LOCAL KNOW for CM and control GUESTcm, MAX HOP and form ordered list by comparing.

IV. SIMULATION RESULT

Simulation of the VANET based cluster algorithm was carried out using MATLAB language (matrix laboratory) which is a numerical computing environment developed by Math Works. MATLAB allows matrix multiplication, showing graphs of functions and data, implementation of algorithms. The experiments were conducted for the network of different sizes of 8, 16, 32, 64,128 nodes. Tests were scheduled for each node at each 30 ± 6 units of time, where σ is a random number in the range of 0 to 3. During each test, the status of nodes are checked and if the node is fault free, diagnosis information concerning the cluster is copied to testing node. If the tested node is faulty, the testing nodes proceed testing as described in the algorithm. Network is clustered using the algorithm described above. The parameters from diagnosis literature are assumed for executing the diagnosis tasks, send initiation time and propagation time of the messages in the VANET.

<table>
<thead>
<tr>
<th>SI NO.</th>
<th>Parameter</th>
<th>Value (units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Diagnosis task execution time</td>
<td>0.01 to 0.05</td>
</tr>
<tr>
<td>2</td>
<td>Send initiation time</td>
<td>0.002</td>
</tr>
<tr>
<td>3</td>
<td>Request heartbeat/response heartbeat delay</td>
<td>0.008 to 0.08</td>
</tr>
<tr>
<td>4</td>
<td>Local diagnostic message/Global diagnostic message</td>
<td>0.012 to 0.12</td>
</tr>
</tbody>
</table>

Table: Values of Different Parameters Used in the Simulation

MODEL 1: VANET NODES AT INTERSECTION OF ROADS

In the code built for this model, one inherent problem with MATLAB sequential nature was encountered. As the MATLAB allows only 8 parallel threads to be run simultaneously, it was difficult to develop a near accurate depiction of two independent nodes on two separate courses of locomotion. The code was developed exploiting the fact that the computational speed of the each nodal location calculation will be much lower compared to the distance traveled by each node during the encounter. The typical differences was in the order of 10s (nodal encounter window size) to 0.1ms (computational window for each nodal location calculation and update). Thus the sequential nature of the MATLAB code does not affect the accuracy of the model. The simulators used for calculation of nodal locations in mobile networks (VANETS and MANETS) generally use C++ threads in parallel. Though these threads provide accurate location update, the plotting on GUI with given simulators is not as easy as with MATLAB. This marks the interaction of Vehicle-to-Vehicle type. This type of interactions is needed to test for DSRC based direct exchange of messages between mobile nodes of close vicinity. The goal was to demonstrate the utility of sequential MATLAB operation to recreate near real time coordinates despite the lack of parallel computing. The results can be seen below.
MODEL 2: VANET NODES AT SINGLE ROAD-SIDE UNIT

This model is similar to a cellular base station trying to provide range for traveling mobile node. The model allows user to configure the range of the RSU. The communication platform facilitated by this model can be used to test the connection mechanisms between mobile VANET nodes and the stationary RSU which will act as hub or central controller for the given region. This also marks the second type of interconnection in the VANET system which is Vehicle-to-Infrastructure unit.

Simulation Parameters

We have used different type of parameters in our Purposed Work. These parameters are usually used to evaluate the proposed fault diagnosis algorithm.

1. Diagnostic Latency: It is the time elapsed by the initiator node to determine the status of the node in the network.
2. Message Complexity: It is the number of messages exchanged among nodes in the network to determine the status of nodes.
3. Hop Count Ratio: It is the ratio of the Euclidian distance between the source and destination node to the number of nodes in between the source and destination node.

V. CONCLUSION

Since most applications in VANETs favor broadcast transmission as opposed to point-to-point routing, routing protocols should be designed to address the broadcast storm problem to avoid unnecessary loss of important safety related packets during a broadcast storm. In this article we have proposed three techniques that depend only on the local positions of the receiver and transmitter nodes. The algorithms are completely distributed and computationally efficient in that they require only minor computations. In the absence of the GPS signal, the proposed algorithms can also be modified to use the RSS of the packet received to determine whether or not the packet should be retransmitted, although this approach is not as efficient as the GPS approach. The proposed schemes are tested against single-lane and multilane topologies as opposed to generic two-dimensional square or torus topologies. The results show that the proposed slotted 1-persistence and slotted p-persistence schemes can reduce broadcast redundancy and packet loss ratio by up to 70 percent while still offering acceptable end-to-end delay for most multi hop VANET applications (e.g., using a roadside unit to inform drivers about detours, construction)

REFERENCES