Routing Protocol in Urban Environment for V2V communication Vanet

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Abstract
The vehicle-to-vehicle communication is a very actual and challenging topic. Vehicles equipped with devices capable of short-range wireless connectivity can form a particular mobile ad-hoc network, VANET − Vehicular Ad-hoc Network. The existence of such networks opens the way for a wide range of applications. Two of the most important classes of such applications are those related to route planning and traffic safety. Route planning aims to provide drivers with real-time traffic information, which, in the absence of a VANET, would require an expensive infrastructure.
In this work we evaluate our VANET routing protocol that is especially designed for city environments. This protocol is based on the localization of the node, the cost assigned to the section and score for each vehicle.
Keywords: *VANET, routing, simulation, Dijkstra, urban environment, Delivery Ratio, end to end delay, IDM.*

1. Introduction

A critical aspect in a simulation study of VANET is the need for a mobility model that would reflect the real behavior of vehicular traffic, as vehicular mobility significantly impacts the networking shape of VANET.

The majority of the VANET convenience applications are more or less directly related to a navigation system. Prime examples are again a distributed traffic information system for finding routes with short travel times based on the current traffic situation and a system for finding free parking places. From the perspective of information generation in VANETs, the fact that more and more vehicles are equipped with a navigation system means that more and more vehicles have a particularly powerful and sophisticated kind of ‘sensor’ at their disposal: a navigation system not only has quite accurate position and speed information available, but also detailed map data and information about the intended driving direction.

2. Communication requirements

We are interested to the Vehicle to vehicle communication. One way to propagate information between vehicles very fast is to use flooding. In a naive implementation every node that receives this information will simply rebroadcast it. To avoid infinite packet duplication, each node will broadcast a given packet at most once. In addition a time to live (TTL) counter may be used to limit the area where the packet is distributed. This naive approach will transmit a large amount of redundant packets, potentially leading to severe congestion. This is known as the ‘broadcast storm problem’ [1]. Many approaches have been proposed to deal with this problem.
We begin at first by description of the V2V communication with the diagram figure 1:

- A vehicular system is composed of one or more area.
- An area consists of several junctions and cells.
- A junction may be source or candidate.
- A vehicle can be elected and belongs to one or more cells

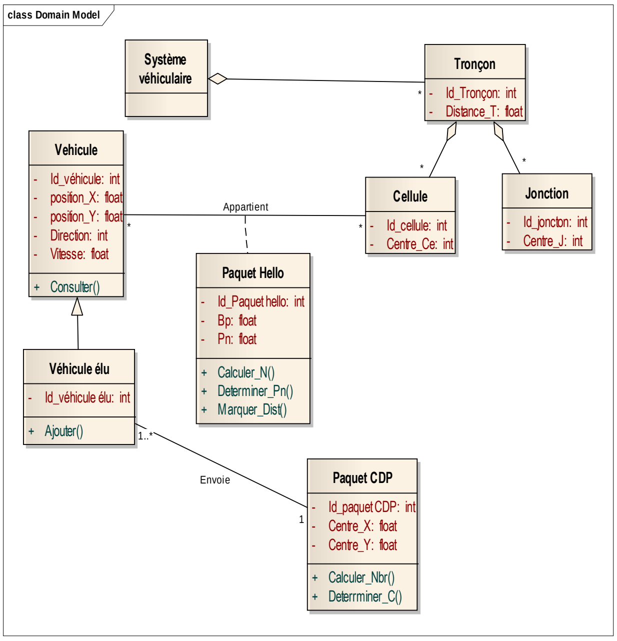

Figure 1: UML class diagram for the vehicular system

3. Routing performance requirements

In Ad-hoc vehicle-to-vehicle communication, where no supporting infrastructure is required, vehicles communicate when they are within the radio range of each other, or when multiple hop relay via other vehicles are available. Messages need to be routed from the source to one or several destinations. Desirable characteristics of routing protocols include [3] :

- Minimal control overhead
- Loop-free routing paths
- Low complexity
- Multicast capabilities

Beside the above requirements, the vehicular environment poses new challenging requirements to vehicle-to-vehicle routing protocol design, including [4]:

- Adapting routing information in highly mobile topologies
- Short convergence time of the routing algorithms
- Short delay for neighbor discovery
- Scalability

In this work, we present a new geographic routing protocol VANET called "Intelligent Routing protocol in Urban environment for Vanet "(IRUV). To evaluate the performances of this protocol, we compare it with GyTAR and LAR in terms of: End to End Delay, Delivery Ratio and efficacy. GyTAR and LAR are efficient in comparison with GSR [2].

4. Description of the IRUV protocol

The IRUV protocol uses Multipoint Relays (elected vehicle) in each zone. The elected vehicle sends information to the neighbor's vehicles and updates the CDP packet where only the links that lead to the elected vehicle are authorized to enriching CDP [4]. The frequency of control packets increased with mobility.
IRUV adopts Dijkstra's algorithm to choice the optimal way for destination. So, we calculate the cost of junction instead of the score in GyTAR
The approach adopted by IRUV protocol is given in three parts:

- Collecting information on traffic segment "between source and candidate junctions".
- Calculating the score for the candidate junction which represents the cost of the section of road.
- Apply Dijkstra's algorithm to choose the best path to the destination

The UML sequence diagram below describes the purpose of electing vehicle to vehicle V2V communication that can enrich the CDP package.

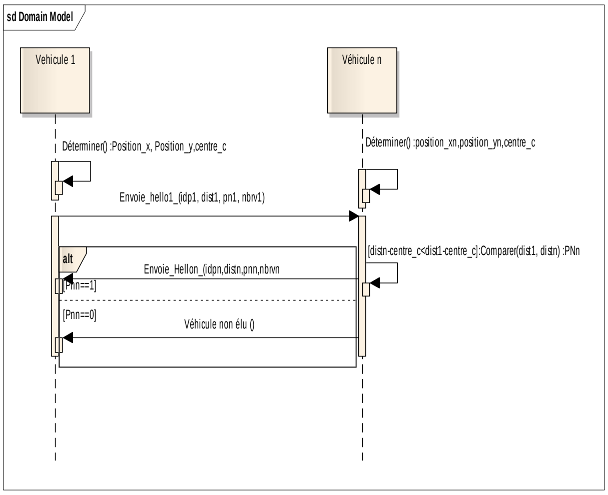

Figure 2: UML sequence diagram for V2V communications

The process of communication is composed of the following steps:

- Election of the vehicle which is near to the candidate junction to send the message
- Electing the vehicle closest to the center of the cell

Enrichment of the CDP package elected by the vehicle, by adding information about: traffic density, the position of the center, the identifier of the cell i, and send the packet to the CDP vehicle closest to the cell i+1. So, it can quickly reach the range of the vehicle so as to arrive faster to elected vehicle in the cell i-1 (repeat the procedure until getting the vehicle to a cell 1 which is the source junction)

The procedure is composed of following step:

- Take into consideration the distance between the vehicle, the next cell, the speed of candidate nodes and the geographical position of these nodes
- The notion of score will also be assigned to the node according to time:

tp=(xp-xi)/vi+ti **(1)**

The node will be selected is the node with the minimal score (figure 2)

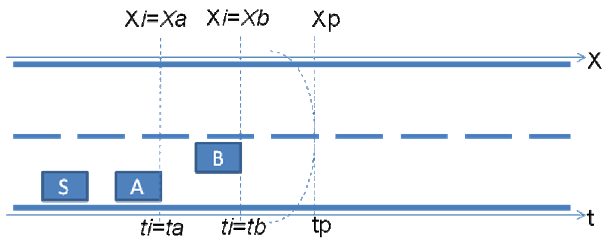

Figure 3 : sending the packet to the node closest to the next zone

With:

- tp: time needed to reach the limited scope of the vehicle S
- ti: Vhi moment the vehicle and the position xi
- Xi: Vhi position of the car at time t
- Xp: scope of the vehicle S
- Vi: Car speed Vhi

To send data between two junctions, we consider:

✓ The direction of the next vehicle
✓ The speed of this vehicle

Each vehicle maintains a neighbor table where all information mentioned above is registered.

Computing the score of the section of the road between the source junction and candidate ones is based on the collected information in the first step.

$$score(Ni) = \alpha(1 - D_p) + \beta(1 - D) + \gamma N_d \quad (2)$$

$$\alpha + \beta + \gamma = 1 \quad (3)$$

With:

- DJ (Di respectively): the curvilinear distance between J (respectively I) and the destination
- Dp = Dj / Di: Dp determines the proximity of the intersection relative to the candidate destination
- D = Dij / Sun: The distance between the source and the branch candidate from the source junction
- α, β, γ are constants

After this step, we calculate the cost of the candidate junction, to identify the section between source and candidate junctions using the following equation:

$$\cos t(Ni) = \frac{1}{score(Ni)} \quad (4)$$

This parameter will be used later to identify the best path using Dijkstra's algorithm implemented in the IRUV protocol. IRUV protocol selects the junctions based on the cost.

5. Simulation

5.1 Present simulation plan

In present study, we work on a VANET simulation using VanetMobiSim / NS-2 application. In VanetMobiSim, we use a micro-mobility model belonging to Intelligent Driver Model (IDM), using lane Changing scenario (IDM-IM) in mobility model building.

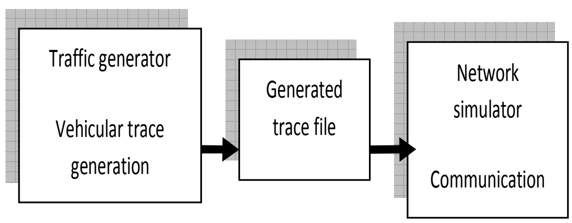

Figure 4: Simulation basic architecture

This diagram describes the simulation steps:

- Traffic simulation tool that generates a vehicular mobility traces (using VanetMobiSim).
- Network simulator that generates the communication environment (using NS2).

5.1.1. The network simulator NS2

NS2 is a discrete event simulator targeted at networking research. NS2 provides substantial support for simulation of TCP routing and multicast protocols over wired and wireless (local and satellite) networks.

5.1.2 The Traffic simulator

To generate realistic motion, we use a mobility emulator well known: VanetMobiSim.

VanetMobiSim is an extension of CanuMobiSim, which focuses on road mobility, offering more realistic mobility models at microscopic and macroscopic
VanetMobiSim Processes:
Input:

- Defining xml file with VANET parameters such as nodes, area, speed, Time etc.
- Output:
- Generate mobility model (Traffic generator) trace file in formats of Ns-2 file
- Provides visualization of the mobility scenario.
- A screen shot of the model in an xfig figure (figure5).

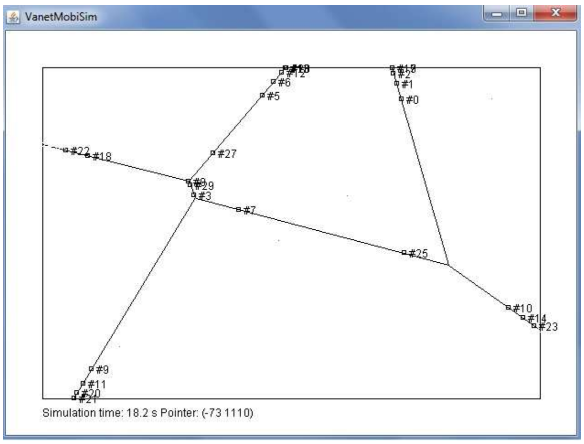

Figure 5: IDM_IM VanetMobiSim model

5.2 Simulation results

To evaluate our proposition, we implement IRUV, GyTAR and LAR protocols in NS2 and we compared those protocols by applying them on a real traffic generated by VanetMobisim.
For measuring performance of routing protocols we chose metrics that we considered most significant to measure the performance of a routing protocol: Packet Delivery Fraction (PDF), Average End to End Delay (AVG), and efficiency.
All the key parameters of our simulation are summarized in the following table:

Table 1: Simulation parameters

Parameter	**Setting**
Traffic model	IDM_IM.xml
Vehicle velocity	30 to 60 Km/H
Transmission range	250m
Map size	1000x1000 m^2
Number of vehicle	50 to 400
Packet sending rate	0.2 s
MAC protocol	IEEE 802.11
Simulation time	200s

For Displaying Results, We use awk to extract information to display from trace file generated by NS2.

5.2.1 Delivery Ratio

In this part, we calculate the delivery ratio for IRUV and LAR. We obtained the following graph (figure 6). It is the amount (total size) of packet received to the amount of packets sent by all nodes. The estimation is made by using UNIX 'awk'.
In figure 6, we have demonstrate that the IRUV protocol provides a delivery ratio better than LAR and GyTAR, especially in the case of a mobility less than 200 vehicles, and significantly higher than LAR and GyTAR protocols in the case of a denser mobility. This is due to the implementation of Dijkstra's algorithm, which has good convergence, and improved delivery because of using to the Dijkstra algorithm used to choose the path with the lowest cost.

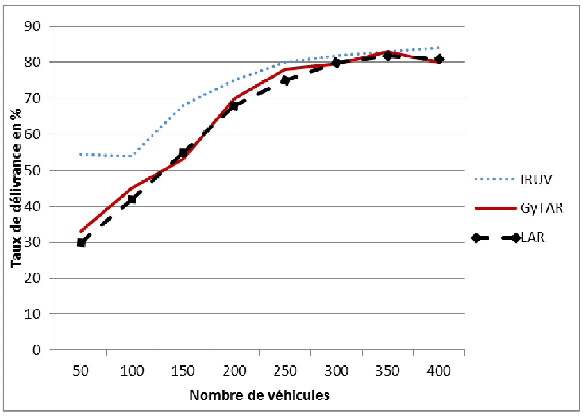

Figure 6: Delivery ratio in terms of vehicles number

5.2.2 End to End Delay

The delay of end to end latency includes the discovery of roads, transit time in the queues for intermediate nodes and the transmission time of a jump to another. We measure the average time from start to finish over all packets received during the simulation and then compute the average. This metric represents the efficiency of the protocol in terms of response time and in terms of choice for optimal paths.
We extract information to calculate the end to end delay by using UNIX 'awk'.

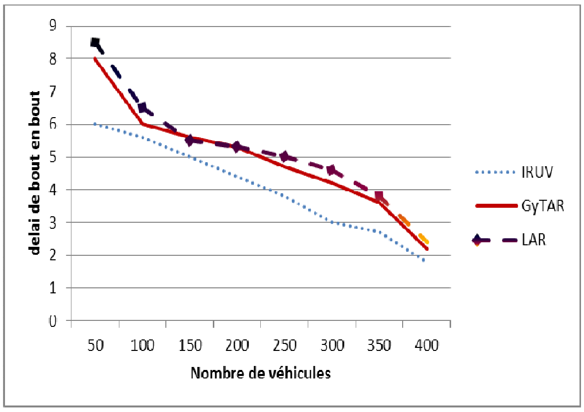

Figure 7: End to end delay in term of vehicle number

Note that IRUV protocol gives end to end delay much lower than the Protocol LAR and GyTAR where traffic is less than 250 vehicles, and significantly lower in the case of a denser mobility. This can be explained by the addition of the concept of score for vehicles to choose the vehicle closest to the next zone for forwarding the packet as soon as possible to the elected vehicle in the next zone, which improves the greedy forwarding algorithm [Lakshimi12] adopted by protocol GyTAR and LAR, hence the fast exchanging CDP packet for IRUV protocol to collect information specific to the zone and choose the best section to transfer data.

6. Conclusion:

In this work, we proposed a new geographic protocol (IRUV), and we compare this protocol with LAR and GyTAR protocols, all of them uses real time traffic density information and movement prediction to route data in VANET.
Our protocol selects the junctions by comparing the cost, more traffic is high, and more the cost given to the candidate junction of the link is low.

It was demonstrated that our proposition has a best delivery ratio and end to end delay. So our protocol IRUV selects the fastest and shortest route in the road network as the best way

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