A New Approach to Manage and Disseminate Data in Vehicular Ad hoc Networks

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ABSTRACT

Our work focuses on data dissemination in Vehicular Ad Hoc Networks (VANETs). Publish/Subscribe communication paradigm enables efficient method of information spreading in a VANET environment. In this paradigm, the broker is a mediator between the publisher and the subscriber. These brokers can be fixed on the roadside or mobile in a specified area.

In this paper, we propose an enhancement to an existing approach to improve its performance, this approach has used the mobile brokers, which are connected to Internet and form a Distributed Hash Table (DHT) based on broker overlay.

Categories and Subject Descriptors

C.2.1 [Computer-Communication Networks]: Network Protocols, Network Architecture and Design—*Wireless communication*.

General Terms

Algorithms, Performance, Reliability

Keywords

VANET, DHT, publish/subscribe.

1. INTRODUCTION

A vehicular ad hoc network (VANET) is an infrastructure less wireless network, which allows vehicles to connect while on the road. Vehicles may share safety information thus helping more safety on the road and driving more enjoyable. Therefore, VANETs are designed to provide primarily safety related services, road traffic management, and driving comfort services, such as infotainment service and Internet connectivity [1]. The main difference between simple Mobile ad hoc Networks (MANET) and VANET resides in the fact that vehicles in VANET move along roads and therefore their possible trajectories are known ahead of time are therefore well controlled.

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in VANET-like environment. This paradigm provides decoupling in time, space, and synchronization between information producers, referred to as publishers, and information consumers, referred to as subscribers. The role of the broker in this approach is to facilitate the interactions between the subscribers and the publishers by acting as a mediator between them, and helping the decoupling of the interactions by making them asynchronous and anonymous [2].

Publishers do not send messages to specific subscriber. Instead, the publisher issues a publication characterized into topics, without knowledge of what consumers there may be.

Subscribers declare their interest on a certain topic by issuing a subscription to that topic. As soon as information is published, it is forwarded to all corresponding subscribers. To this end, brokers manage subscriptions and forward information items.

Chord [3] is the most popular structured P2P protocols. It provides support for efficiently locating a peer, which stores desired contents. It utilizes SHA-1 [4], a consistent hashing mechanism, to assign m-bit identifier to each peer and content object. Chord is usually deployed on application layer as a P2P overlay. Chord acts elegantly because of the simplicity of the design and scalability to construct large-scale overlay networks with low complexity. In a N-node Chord overlay, each node have to keep contact with only O(log N) nodes, and a query can be performed within O(log N) steps. Furthermore, nodes only need to maintain few local information (the successor and the predecessor) in order to maintain the consistency of Chord.

In Chord, the identifiers space can be viewed as an identifiers circle where identifiers are represented from 0 to 2^m-1 where m is the number of bits in the identifier. This is called a chord ring. Each peer maintains links to its successor and predecessor peers in the identifier ring. Lookup requests are passed around the ring through successor links. This process terminates when a peer is found which is responsible for the desired identifier getting looked up. In order to improve the routing performance, each peer maintains additional routing information in form of *finger-table*. This finger-table is a routing table, which has a maximum of m entries. The i^{th} entry in the finger-table of any peer n contains identifier of a peer that succeeds n by at least 2^i-1 on the identifier circle, where $1 \leq i \leq m$ and all operations are modulo 2^m. As peers leave and join, the routing tables are updated accordingly through cooperative stabilization procedure performed at each peer. This is essential for keeping the structure of overlay intact. Each peer has to exchange messages periodically for refreshing the routing table to minimize the effect of churn (peer leaving and joining). The maintenance cost is proportional to the churn rate. The higher the churn rate, the shorter the interval of periodic maintenance and the higher the maintenance cost.

In this paper, we propose some modifications to enhance the performance of an existing approach (to be detailed in section III). This paper is structured as follows. Section II describes the related work and an overview of the existing approach. We present our contribution in Section III. Section IV describes the simulation environment and presents the obtained results. Finally, Section V concludes our work.

2. RELATED WORK

As we mentioned above, this paper is an amendment of an existing method, so, for more information about the related work in this area is provided in [5]. In this approach, the authors have proposed an architecture, which is based on the publish/subscribe paradigm over structured P2P overlay for information dissemination in VANET environment. They have taken city buses to act as mobile brokers. The brokers send notifications about the publications to interested subscribers whereas other vehicles are considered to be in role of publishers and subscribers.

The buses are connected to the Internet and have underlying IP based communication channel among them. These city buses form DHT overlay among them using their Internet interfaces for gathering and disseminating publications and subscriptions.

3. OUR CONTRIBUTION

In this section, we provide the details of our contribution, and explain the modifications that we made on the proposed approach. The design of the existing protocol is divided into the following procedures.

- DHT formation of mobile brokers,
- Publication/subscription routing and storage,
- Locating the subscriber vehicle,
- Notification routing and delivery,
- Opportunistic delivery of notification.

In the following, we provide a brief explanation of these procedure, however, highlighting the improvement brought to the design. We will ignore the last two procedures, because no modification occurred on them.

3.1 DHT Formation of Mobile Brokers

The proposed P2P approach is based on the traditional Chord's DHT [3]. We assume that the presence of a bootstrap server for the initialization purpose only to help the new bus that are willing to join.

When a new bus want to become a part from the set of mobile brokers, it sends a join request to any existing mobile broker and acquires it as its successor, and this existing broker notifies its old predecessor about this new mobile without waiting for the next stabilization step. The process of the mobile broker joining the ring can be summarized in following steps:

(1) Newly arriving mobile broker (MBnew) sends a request to any existing mobile broker (MBexist).
(2) MBnew acquires MBexist as its successor
(3) MBnew notifies MBexist
(4) MBexist acquires MBnew as its predecessor
(5) MBexist notifies its old predecessor about the new predecessor
(6) Old predecessor's Mbexist acquires MBnew as a new successor
(7) Old predecessor's Mbexist notifies MBnew of its existence
(8) MBnew sets its predecessor to the old predecessor of MBexist.

MBnew builds its finger-table with the help of its successor and transfers the content objects to MBnew from their successor broker.

Note that the improved method doesn't need any bootstrap server like the authors proposed. Furthermore, contains an optimization witch allow a rapid stabilization.

3.2 Publication/Subscription Routing and Storage

In the existing approach, when a vehicles want to transfer their publications or subscriptions to the closest mobile broker. For this, vehicles utilize vehicle-to-vehicle forwarding mechanism over ad hoc communication links established among them until reaches the closest mobile broker.

Instead of this, in our proposition we don't use vehicle-to-vehicle forwarding, the vehicle just issues its publication or subscription in one hop, the mobile broker confirm its reception by sending ACK message to the vehicle in order to avoid the resending which causes more duplicated message in the overlay. Every city bus periodically broadcasts a control message in its proximity to inform vehicles of its presence. Once the publications or subscriptions reach any mobile broker they are routed to their respective rendezvous broker through the Internet level DHT formed among them.

3.3 Locating the Subscriber Vehicle

For successful reception of notification it is essential to locate the subscriber at any given time. The authors of [5] proposed that if the stored ID of a bus does not match the broadcasted ID, but this does not necessary mean that the bus location has changed. Thus, the location update is required on two conditions: first, the stored city-bus ID does not correspond to the broadcasted one and, second, the link between the subscriber and its mobile broker is lost.
The following steps are performed by each subscriber to update its location:

(1) Extract TTL value from subscription specification;
(2) Repeat until TTL expires OR notification received;
(3) Repeat until TTL expires OR notification received;
(4) If (Last-mobile broker == broadcasted identifier of city-bus (CBID));
(5) Then (No Location update);
(6) Else if (Last-mobile broker is connected)
(7) Then (No Location update);
(8) Else (trigger location update):
(9) Last-mobile broker = broadcasted identifier of city-bus (CBID),
(10) k = hash(Subscriber – VehicleIP),
(11) Send k and location update request to the city bus (CBID),

City bus uses DHT routing to update location in the Location-Table at the immediate successor of k.

Note that this modification can minimize the traffic in the network, which leads to several benefits in such sort of network

4. SIMULATION ENVIRONMENT AND RESULTS

We have simulated our approach by using Oversim [6] over OMNeT++ [7] and Traffic control Interface (TraCI) client for OMNeT++/MiXiM [8,9] framework. OMNeT++ is an open-source, component-based, discrete event simulation environment coded in C++. OverSim is an open-source simulation framework for peer-to-peer overlay networks to be used over OMNeT++ simulation environment. The simulator contains several modules for structured p2p systems e.g. Chord, Kademlia and Pastry. We have used its Chord module for simulating DHT infrastructure of info-stations. To generate realistic Vehicle movements we have utilized MOVE (Mobility model generator for VEhicular networks) [10]. MOVE is built on top of microtraffic simulator SUMO (Simulation of Urban MObility) [11]

We have used the same parameters used in the simulation of the existing approach [5] to show the benefit of the proposed enhancement. The simulation parameters are summarized in Table 1

Table 1: Simulation parameters

Traffic type		
Vehicle density	**Time of the day**	**No. of vehicles**
Peak traffic	07:00–10:00 and 17:00–19:00	800 to 1000
Moderate traffic	10:00–17:00 and 19:00–00:00	300 to 500
Low traffic	00:00–7:00	100 to 300
Vehicle properties		
Maximum speed of ordinary vehicle = 65 km/hour Maximum speed of city buses = 45 km/hour City bus pause time at bus stops = 3 minutes No. of city buses = 15% of total vehicles Maximum number of publishers at a time: 20% of total vehicles Maximum number of subscribers at a time: 40% of total vehicles		
Ad hoc communication properties		
Protocol used: 802.11p Transmission range of vehicles: 200 meters Identification broadcast period of city bus: 5 seconds		
DHT communication properties		
Protocol used: chord, underlying protocol: TCP/IP Fix-finger period: 3s Stabilization period: 3s		

The goal of the enhancement cited above is to decrease the notification delay in the existing approach [5] as much as possible, so we focused in our results just on the notification delay which is the time required to deliver a notification successfully to intended subscriber.

Figures 1 describes a set of simulation results where the enhanced approach is compared with the existing approach with respect to delay in notification delivery.

Figure 1 shows that, the enhanced approach performs better than the existing approach.

Further, it may be observed that to reduce the notification delay, in the enhanced approach requires more info-stations. Because the Chord protocol is just between them.

5. CONCLUSIONS AND FUTURE WORK

We have proposed an improvement for an existing approach to manage and disseminate data in vehicular network based on publish/subscribe paradigm and peer-to-peer communication. We are working on the simulation of these amendments under several scenarios, using OverSim [6] over OMNeT++ [7]. As a future work in this area, we will include more improvements and its feasibilities in highway environment.

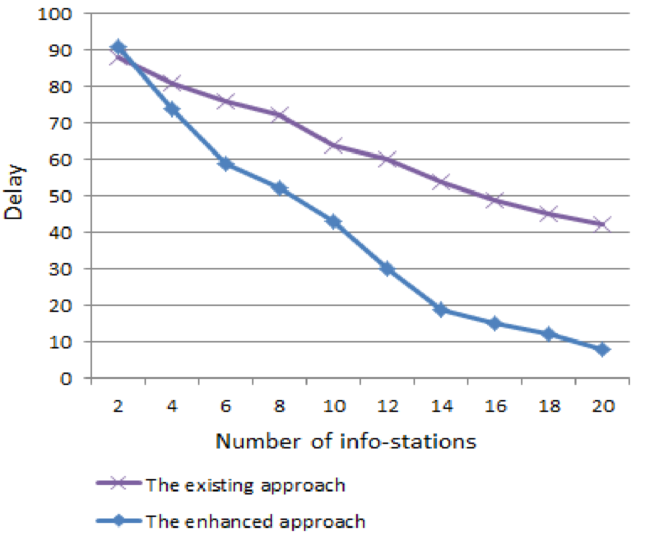

Figure 1. Notification delay: the enhanced approach versus the existing approach.

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