Energy Efficient VANET using Data Rerouting.

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Abstract - This article proposes DIVERT, a distributed vehicular re-routing system for congestion avoidance. DIVERT offloads a large part of the rerouting computation at the vehicles, and thus, the re-routing process becomes practical in real-time. To take collaborative rerouting decisions, the vehicles exchange messages over vehicular ad hoc networks. DIVERT is a hybrid system because it still uses a server and Internet communication to determine an accurate global view of the traffic. In addition, DIVERT balances the user privacy with the re-routing effectiveness. The simulation results demonstrate that, compared with a centralized system, the proposed hybrid system increases the user privacy by 92% on average. In terms of average travel time, DIVERT's performance is slightly less than that of the centralized system, but it still achieves substantial gains compared to the no re-routing case. In addition, DIVERT reduces the CPU and network load on the server by 99.99% and 95%, respectively.

Keywords - VANET, Security, Energy Efficiency

I. INTRODUCTION

Vehicular ad hoc networks (VANETs) are a subgroup of mobile ad hoc networks (MANETs) with the distinguishing property that the nodes are vehicles like cars, trucks, buses and motorcycles. This implies that node movement is restricted by factors like road course, encompassing traffic and traffic regulations. Because of the restricted node movement it is a feasible assumption that the VANET will be supported by some fixed infrastructure that assists with some services and can provide access to stationary networks. The fixed infrastructure will be deployed at critical locations like slip roads, service stations, dangerous intersections or places well-known for hazardous weather conditions.

Nodes are expected to communicate by means of North American DSRC standard that employs the IEEE 802.11p standard for wireless communication. To allow communication with participants out of radio range, messages have to be forwarded by other nodes (multi-hop communication). Vehicles are not subject to the strict energy, space and computing capabilities restrictions normally adopted for MANETs. More challenging is the potentially very high speed of the nodes (up to 250 km/h) and the large dimensions of the VANET.

The primary VANET's goal is to increase road safety. To achieve this, the vehicles act as sensors and exchange warnings or – more generally – telematics information (like current speed, location or ESP activity) that enables the drivers to react early to abnormal and potentially dangerous situations like accidents, traffic jams or glaze. The information provided by other vehicles and stationary infrastructure might also be used for driver assistant systems like adaptive cruise control (ACC) or breaking assistants. In addition, authorized entities like police or firefighters should be able to send alarm signals and instructions e.g. to clear their way or stop other road users. Besides that, the VANET should increase comfort by means of value-added services like location based services or Internet on the road.

The recent adoption of the various 802.11 wireless standards has caused a dramatic increase in the number of wireless data networks. Today, wireless LANs are highly deployed and the cost for wireless equipment is continuing to drop in price. Currently, an 802.11 adapter or access point (AP) can be purchased for next to nothing. As a result of the high acceptance of the 802.11 standards, academia and the commercial sector are looking for other applicable solutions for these wireless technologies. Mobile ad hoc networks (MANET) are one area that has recently received considerable attention. One promising application of mobile ad hoc networks is the development of vehicular ad hoc networks (VANET).

A MANET is a self-forming network, which can function without the need of any centralized control. Each node in an ad hoc network acts as both a data terminal and a router. The nodes in the network then use the wireless medium to communicate with other nodes in their radio range. A VANET is effectively a subset of MANETs. The benefit of using ad hoc networks is it is possible to deploy these networks in areas where it isn't feasible to install the needed infrastructure. It would be expensive and unrealistic to install 802.11 access points to cover all of the roads in the United States. Another benefit of ad hoc networks is they can be quickly deployed with no administrator involvement. The administration of a large scale vehicular network would be a difficult task. These reasons contribute to the ad hoc networks being applied to vehicular environments. Traffic fatalities are one of the leading causes of death in the United States. The Federal Communications Commission (FCC), realizing the problem of traffic fatalities in the US dedicated 75 MHz of the frequency spectrum in the range 5.850 to 5.925 GHz to be used for vehicle to vehicle and vehicle to roadside communication. The 5.9 GHz spectrum was termed Dedicated Short Range Communication (DSRC) and is based on a variant of 802.11a. Seven channels of 10 MHz each make up DSRC, with six of the channels being used for services and one channel for control. The goal of the project is to enable the driver of a vehicle to receive information about their surrounding environment. The control channel is used to broadcast safety messages e.g. to alert the driver of potentially hazardous road conditions. The control channel is also used to announce the services that are available. If vehicle finds a service of interest on the control channel, it then switches to one of the service channels to use the service. A number of additional value added features are to be provided by the service channels such as the announcement of places of interest in the driver's locations e.g. restaurants in the area or gas prices.

II. RELATED WORK

This paper looks into the possibility of using the regular traffic patterns provided by public buses to improve the performance of Mobile Ad-hoc Networks (MANET) for Inter-vehicular communications systems (IVCS). MANET is an adhoc network with mobile nodes that are random and unpredictable. IVCS provide drivers and passengers with a range of services, and implementation of IVCS is possible using MANET. However, certain differences in the properties of nodes affect the performance. This performance degradation would be discussed in this paper through the results that are obtained from NS-2 simulations in a suggested Metropolitan GRID (M-GRID) scenario that attempts to simulate the physical traffic situation in a small part of any typical metropolitan environment. In view of this, a novel approach named BUSNet is introduced. This approach utilizes the deterministic nature of bus routes or any other public transport system to incorporate a mobile backbone infrastructure that improves the performance of IVCS using MANET.[1]

The vehicular ad hoc network (VANET) has attracted a lot of interest recently. However, traditional VANET is just an instantiation of MANET in which nodes are treated equally for data delivery. We first analyze the unique features of urban VANET that vehicles have different types, and move as clusters due to the influence of traffic lights. Then a two tier architecture called Mobile Infrastructure Based VANET (MIVANET) is proposed. In this architecture, the buses constitute a mobile backbone for data delivery while the low tier is composed of ordinary cars and passengers. MI-VANET will not only bring the benefit that ordinary cars do not have to forward packets for other nodes, but also improve the network connectivity. The corresponding Mobile Infrastructure Registering (MIRG) and Mobile Infrastructure Routing (MIRT) algorithms are also presented. The bus line information is made full use in MIRT. Simulation results show that there is a 40-55% improvement in delivery ratio while the throughput is even doubled compared to GPSR in traditional VANET.[2]

Due to recent development in wireless communication networks, researches in Vehicular Ad-hoc Networks (VANETs) have been getting much attention on information sharing and service discovery. However, due to the ever-shifting mobility of vehicle topology, vehicles moving in non-fixed routes may not find suitable next-hop vehicles to pass the data. This paper proposes schemes to effectively circulate and discover service information with the aid of public transportation systems. Bus routes can be used to create a backbone structure and data can be posted and circulated on the structure to avoid the broadcast storm problem. Moreover, by adopting the proposed architecture, the required data can be effectively disseminated and discovered through the traffic infrastructure and mobile vehicles. The experiment results demonstrate that our scheme outperforms other schemes in terms of packet delivery ratio and end-to-end delay. Moreover, the overhead of our scheme outperforms other scheme with an increasing of number of service requests.[3]

III. PROPOSED SYSTEM

This paper proposes DIVERT, a distributed vehicular re-routing system for congestion avoidance, which leverages both cellular Internet and VANET communication. DIVERT is a hybrid system because it still uses a server, reachable over the Internet, to determine an accurate global view of the traffic.

The centralized server acts as a coordinator that collects location reports, detects traffic congestion and distributes re-routing notifications (i.e., updated travel times in the road network) to the vehicles. However, the system offloads a large part of the re-routing computation at the vehicles and thus the re-routing process becomes practical in real-time.

To take collaborative re-routing decisions, the vehicles situated in the same region exchange messages over VANETs. Also, DIVERT implements a privacy enhancement protocol to protect the users' privacy, where each vehicle detects the road density locally using VANET and anonymously reports data with a certain probability only from high traffic density roads.

When signs of congestion are detected, the server sends the traffic map only to the vehicles that sent the latest updates. Subsequently, these vehicles disseminate the traffic data received from the server in their region. User privacy is greatly improved since this protocol reduces dramatically the number of vehicle location updates to the server and, thus, the driver exposure and identification risks. Moreover, in this hybrid architecture, the server does not know the OD pairs of the users.

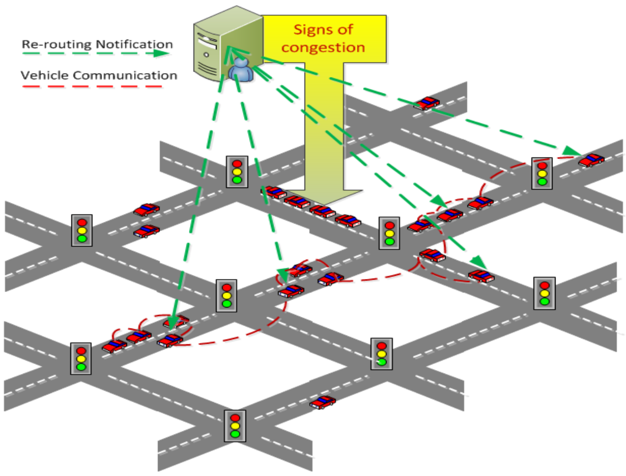

Figure 1: System Architecture

Privacy - Aware Traffic Reporting - DIVERT's goal is to protect driver's location privacy against attackers at the server side, who could link traffic reports (which include locations) to driver identities. The traffic reports need to be frequent to compute a global traffic view and detect congestion accurately.

In order to measure the privacy loss due to each location update, each location report is associated with a weight. The weight of a location report depends on the popularity of the location road segment. That is, the more popular a spatial region is, the more difficult it is for an adversary to single out the report sender. However, the number of vehicles along the segment is not sufficient to quantify its popularity, because some vehicles may have a dominant presence in that space. Instead, a metric is applied that is based on the entropy of the road segment.

Density Reporting - Our privacy-aware reporting is based on the observation that in dense areas, vehicles naturally experience a higher degree of anonymity similar to a person walking through an inner-city crowd. Therefore, a density-based traffic reporting mechanism is proposed wherein vehicles report to the server only if the road density is higher than a predefined threshold. The server computes the smoothed average of the traffic density on each road segment as it receives new traffic reports. Computing the smoothed average of the traffic density at each vehicle (using a moving time window) is of little use in our case because the vehicles do not report often due to our privacy-aware reporting protocol (e.g., a vehicle rarely reports twice from the same road segment). This mechanism is beneficial for both the rerouting effectiveness and the vehicle privacy, since the server can still accurately detect the congestion signs at the cost of lower user privacy exposure.

Our goal is to minimize the number of vehicle reports, i.e., only a fraction of the vehicles situated on a road segment will send traffic reports. Specifically, density reports sent to the server conform to the following rules: (1) cars submit reports only when they perceive that the density on the road segments is above a threshold that would signal a chance of congestion, (2) cars decide probabilistically when to submit data as function of the density - i.e., the more cars there are, the fewer reports each car submits as the reports are distributed among the cars on the segment, (3) cars send their messages through anonymizers to protect their identities.

IV. RESULT ANALYSIS

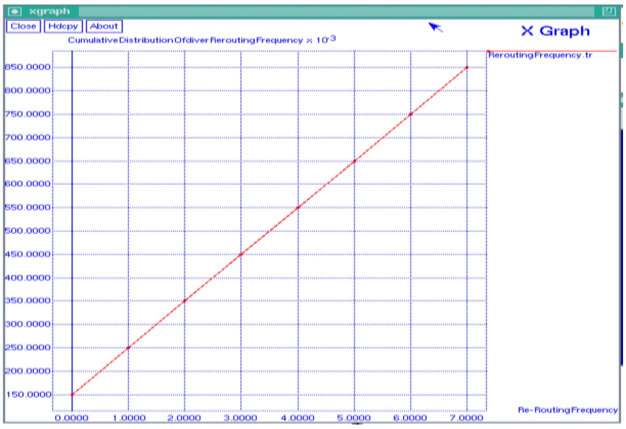

Figure 2: Cummalitive Distribution of Driver Rerouting Frequency with time

V. CONCLUSION

The central server has to perform intensive computation (to re-assign vehicles to new paths) and communication with the vehicles (to send the paths and to receive location updates) in real-time. This can make centralized solutions infeasible for large regions with many vehicles. Second, in a centralized architecture, the server requires the real-time locations as well as the origins and destinations of the vehicles to estimate the traffic conditions and provide effective individual re-routing guidance. This leads to major privacy concerns for the drivers and may prevent the adoption of such solutions due to “big brother” fears.

VI. REFERENCES

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