Evaluating Interest Broadcast in Vehicular Named Data Networking

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***Abstract*—Vehicular Ad-hoc Networks (VANETs) are expected to provide assistance to various applications, such as accident notification and emergency announcement. Named Data Networking (NDN) has been recognized as a more suitable architecture than TCP/IP for application in VANETs due to its ability to handle high mobility and intermittent connectivity. The Vehicular NDN (V-NDN) has further made special architectural modifications for VANETs. However, V-NDN can be challenged in its extensive use of broadcast in dense network situations. For example, broadcasting of interest packets could lead to more collisions.**

In this study, we explore the broadcast performance of V-NDN using the ORBIT testbed. Our experimental results show that V-NDN suffers an increased loss ratio in dense network scenarios because of Wifi broadcast collision, and it is important to find a suitable range of values to be distributed by the collision-avoidance timer before transmission.

I. Introduction

During the last several years, Vehicular Ad-hoc Networks (VANETs) have attracted much attention from academic researchers to automotive manufactures. The varieties of Intelligent Transportation Systems applications include safe driving, traffic flow controllers and navigation assistance.

All these applications require an efficient method to exchange data between nodes in VANETs, which is either a moving vehicle or a static Road Side Unit (RSU). Named Data Networking (NDN), or Content Centric Networking (CCN), has been proposed [1], which has become a candidate architecture for the next generation of networking. In NDN, all communications are based on data name, instead of host-to-host connections. To request data, consumers should send an interest packet with a data name to the network. Any provider who has the name-matching data will send the data back along the same path as the interest packet. Due to its connection-free feature, NDN has been recognized as an attractive solution for mobile ad hoc networks [2].

Since then some research has been done to enhance NDN in MANETs, and new developments are devoted to Vehicle Ad Hoc Networks (VANETs) too. A name structure for vehicle-to-vehicle (V2V) traffic information exchanges has been proposed using the strawman approach [3]. The name structure includes geographical and temporal scope in traffic data names and uses nonce to prevent duplication.

The searching-data feature of NDN and the broadcasting nature of wireless communication will flood the interest request packets to potential provider(s). Research has been done to reduce packet flooding in vehicular NDN. A set of timers has been used to minimize collision for packet transmission, which will be introduced in following section [4].

It is common for many cars to be present in the wireless transmission range on highways or in an urban environment during rush hours or congestions. These cars may rebroadcast interest packets after they receive them. Though V-NDN has the aforementioned timers to tackle the collisions issue, we'd like to obtain a further understanding of the broadcasting performances of vehicular NDN in dense networking. Our study is performed using the ORBIT testbed. In this work-in-progress paper, we are able to run real V-NDN code on all the active nodes while we change the range of the random numbers for the collision-avoidance timer to draw from. The observation we obtained is simple but reflects the importance of collision-avoidance timer to broadcast performance. The rest of the paper will give a brief overview of V-NDN, then the details of the configurations of the experiments, followed by the results.

II. Background

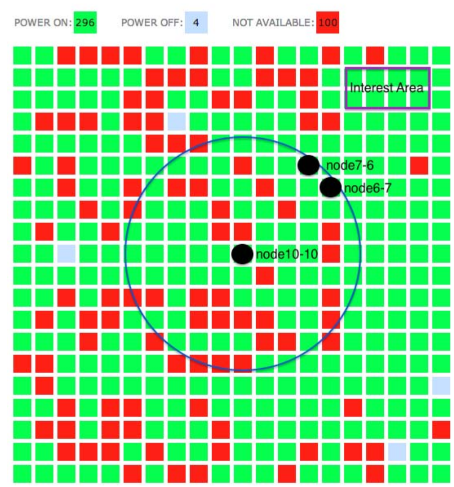

Fig. 1. Experiment Topology

The V-NDN architecture modified several features of traditional NDN for vehicular environment [5]. In the V-NDN architecture: geolocation information is included in name

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structures, all nodes cache the received data no matter whether there is a matching PIT entry, no FIB table is needed because of the wireless broadcast nature and a special design of timers is introduced to combat the collision issue when broadcasting messages.

V-NDN uses the following timers to determine the waiting time before retransmitting an interest packet. The collision-avoidance timer is set to distribute a random variable from a given range for collision avoidance. The pushing timer is for transmitting priority based on the distance from the previous hop. A node with further distance from the previous hop will wait for shorter time, which can push data far away from its generator. Those two timers are used to determine the total waiting time before retransmission.

As Figure 1 shows, for example, when node10-10 needs to know the traffic information of the interested area, it will broadcast one interest packet. All its neighboring nodes inside the transmission range receive the interest packet and retransmit it after a waiting time. In our case, assuming node10-10 has the transmission range shown in Figure 1, node7-6 and node6-7 will receive the interest packet at the same time. Since they have the same distance to node10-10, the pusher time will be same. Therefore, the collision-avoidance timer will play an important role in avoiding collision of the next rebroadcast from each of them.

III. Experiment Evaluation

A. Experiment Setup

In our experiments, we use all active nodes from the main grid in the ORBIT testbed [6]. We use *baseline-ubuntu-12-04-32bit.ndz* image with MadWifi installed to drive the Wifi devices. Each node is equipped with at least one wireless card, and the transmittable signal power can be adjusted. Since our goal is to evaluate the broadcasting performance in dense network scenarios, and the signal speed is much faster than vehicles' moving speed, it is reasonable to emulate a static environment. Figure 1 gives the grid availability and the topology of our experiment.

The V-NDN code we were running has been tested [7][5]. It contains three main programs that run on each node. The NDN daemon works as a router and defines the network faces required by NDN. It is responsible for maintaining both CS and PIT tables as well as sending and receiving network packets. If a consumer application requests the road traffic information about a given desired location (in our example, it is the top-right corner in the figure), it sends the interest packets and waits to receive the data. In vehicular NDN architecture, each node is supposed to be equipped with a GPS device. Since there are no GPS devices on ORBIT nodes, we use a fakeGPS software to provide continual GPS data during the experiment.

The broadcasting performance is measured as the success ratio, the ratio of the total received number of interest packets over the total transmitted number of interest packets. We will measure how it changes when the value from the collision-avoidance timer changes.

B. Performance Results

Figure 2 presents our initial result from the experiment. It shows that small timer range values will lead to low success ratio, which suggests packet losses. When the range increases, the success ratio increases. After a certain value, the success ratio stays at a relatively consistent level. Considering that a larger timer value will result in a prolonged delivery delay, for the network density we studied, the best random number range from the collision-avoidance timer is around 1500 microseconds. We are continuing to work on testing different Wi-Fi transmission ranges and network density using the ORBIT grid. We expect the results to reveal a certain relationship between the density and the success ratio.

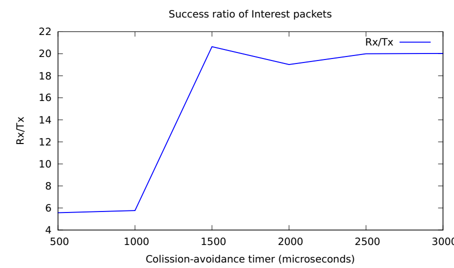

Fig. 2. Experimental Result

IV. Conclusion and Future work

In this study, we explored broadcast performance of V-NDN in dense networks. The results are as expected and can be used to guide the configuration of the default range of the collision-avoidance timer. Our final purpose is to make collision-avoidance timer self-adapted to the network density. In future work, broadcast performance can be measured in different densities and more realistic scenarios. In addition, we will explore the relationship between the pushing timer and the network density.

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