Vehicular Communication Using Named Data Networking (V2VNDN)

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Abstract: Vehicular communication is the leading approach for many organizations and industries. In this paper, we deal with the new model of networking scenario to provide necessary contents between two or more vehicles. To make it effective, we coined the term Named Data Networking (NDN) which is the new internet architecture to replace the existing system called TCP/IP. Also, we proposed vehicle to vehicle communication using Named Data Networking (V2VNDN). V2VNDN is mainly designed to share road traffic information, safety messages on road condition and information about emergency vehicles. In V2VNDN, the routable prefix can be broadcasted to all nearby connected nodes where each of the vehicles acts as a node. Since the number of contents is fixed, so it's necessary to broadcast all three contents by each of the nodes. To make our proposal effective, we showed the simulation results and verified the experimental results of V2VNDN for vehicular communication.

Keywords Vehicular Communication, Named Data Networking, NDN contents.

1. INTRODUCTION

In recent years, vehicular communication is the important system to enhance the road safety and traffic management system. Similarly, Named Data Networking (NDN) [1] is the networking scenario which deals with the content retrieval instead of point to point communication. So, we proposed V2VNDN for the vehicular communication with the new internet architecture i.e. NDN. Named Data Networking (NDN) is mainly divided into three parts [1] i.e. Pending Interest Table (PIT), Forwarding Information Base (FIB) and Content Store (CS). Each protocol has a different function based on the interest from the consumer side to the producer.

Although TCP/IP is one of the widely accepted networking scenarios, it still has many issues of latency, security, and mobility. To overcome these issues, NDN is one of the best networking architecture which depends on "what" are the contents instead of "where" are the contents. For the vehicular communication, we prepared the three important contents which are necessary to reduce the road accident and to prevent from the emergency situation. The first is road traffic system, it will provide all the traffic information as well as the required time information for the requested user; and the second is safety message on the road condition like construction or damage on the road; and the last is information about emergency vehicles like ambulance, police car, fire truck, and disaster management vehicles.

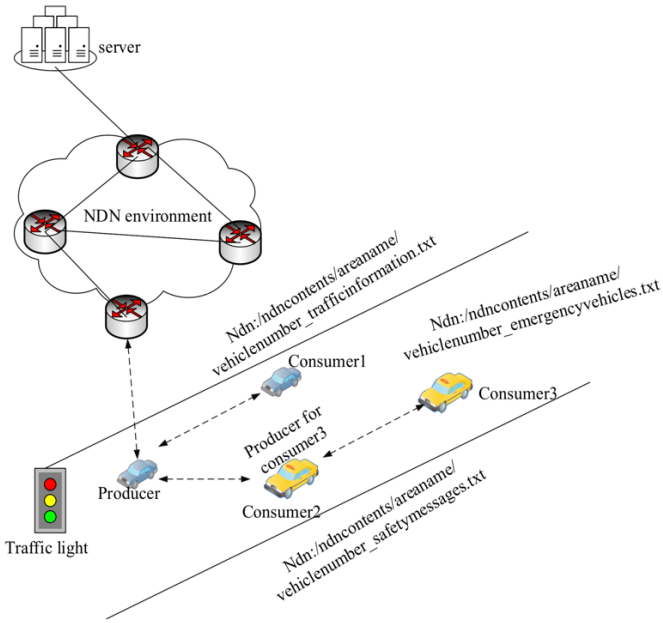

Fig. 1. Architecture of V2VNDN

Figure 1 shows the architecture of V2VNDN which shows the communication between vehicles with the necessary contents ID. To get the contents from a producer, the consumer can request with a content ID i.e. with vehicle number followed by a content name. If the content ID is matched in the content store (CS); data will be forwarded by CS otherwise it will look up at pending interest table (PIT); it will update an existing PIT entry if matching found otherwise it will look up at FIB; it will create a new PIT entry if matching found otherwise it will

discard the interest. This is the actual procedure to exchange the contents and interests between producer and consumer. In V2VNDN, the communication takes place between two or more vehicles where the vehicle which sends an interest is a consumer and another which provides the content is a producer.

For V2VNDN scenario, we used NDNx [2] codebase and OpenStack for the practical implementation and prepared NDN cache to store the necessary contents. The rest of this paper is divided into different sections. Section 2 summarizes the related work, section 3 summarizes the vehicular communication on NDN environment, section 4 discusses the simulation results and discussion, and finally, we conclude our proposal in section 5.

2. RELATED WORK

When we go through the past research papers [3][4], a lot of research has been done for vehicular communication based on existing networking system called TCP/IP but none of them are implemented practically and holds many issues of security, latency, and mobility. Most of the vehicular communication is based on host centric designed IP stacks [5] where the node mobility is complex and mobility issues in vehicular communication and it is hard to predict the movement of producer and consumer. To solve this kind of issues, NDN plays an important role since it is location independent network scenario and also provides the in-network caching system.

Similarly, emergency application for vehicle to vehicle has been proposed in [6] where the authors have adapted eVNDN into vehicle to vehicle communications. The main goal was to provide the emergency applications and changed the PIT, FIB and CS to support their system.

Until now, the research community focused mostly on forwarding strategy and pending contents on NDN and host centric networking. In this paper, we have focused towards the overall network scenario of NDN and new naming strategy. We found that interest packets and data packets can travel from each of the vehicles with the content ID which consist vehicle number to identify the prefix name. Also, we proposed the possible solution of broadcasting the routable prefix of one vehicle to the nearby vehicles. So, our proposal will clearly show the overall network scenario for vehicular communication using NDN.

3. VEHICULAR COMMUNICATION ON NDN ENVIRONMENT

NDN is the networking architecture for the future internet which is based on Information-Centric Networking (ICN) [7] architecture. In V2VNDN, we have created the separate cache storage and remotely connected to the NDN nodes. Following operations take place to transfer interests and receive data.

- The receiving node or the consumer will send an interest to the specific vehicle from which it wants the information. Since each content ID is assigned with the vehicle number, area name, and fixed contents name. so, it's easy to find out the content ID of a producer by the consumer.
- Once the interest is received by a producer, it will upload and publish the current information about traffic or safety messages immediately for the first user and first time.
- If the same information is requested by the other vehicles afterward, the data will be provided immediately.
- If the contents are not found in the CS, the PIT table will be updated based the received interest with the face ID.

Publishing the contents and the format of content ID is listed below.

- The published contents are saved into the repository.
- The producer will publish the content using "ndnpublish" command and consumer will receive the content using" ndnget".

TABLE 1
CONTENTS ID

Producer	Consumer
ndn:/ndncontents/Waseda/24**_trafficinfo.txt var/www/traffic.txt	ndn:/ndncontents/Waseda/24**_trafficinfo.txt received.txt
Status: Inserted file	Status: Retrieved file
Time: published time	Time: Received time

4. SIMULATION RESULTS AND DISCUSSION

In this section, we have shown the simulation results of V2VNDN by using ndnsim1.0 [8] and compared with TCP/IP. The simulated vehicular network consists of 4 vehicles where node 0 is a producer and other nodes are the consumer. Similarly, the delay for TCP/IP is calculated by using "Wireshark" [9].

TABLE 2

SIMULATION PARAMETERS

Parameters	value
Number of Nodes	4
Number of Interests	1-3
Data Rate	1 Mbps
Maximum packets	100
Forwarding strategy	BestRoute

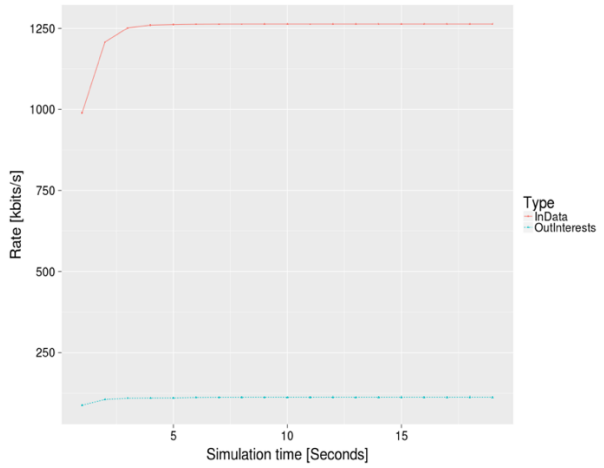

Fig. 2. Simulation time vs. Data rate

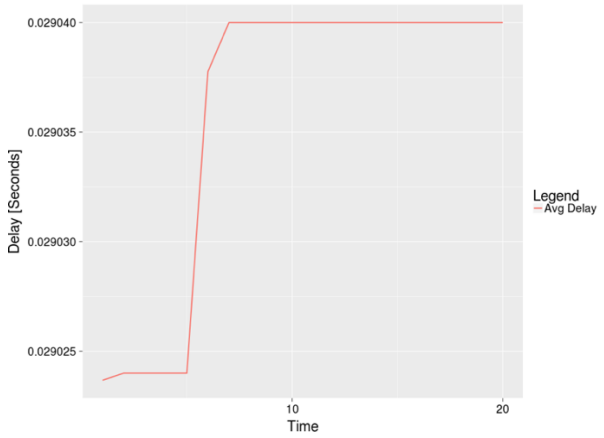

Fig. 3. Time vs. Delay in seconds

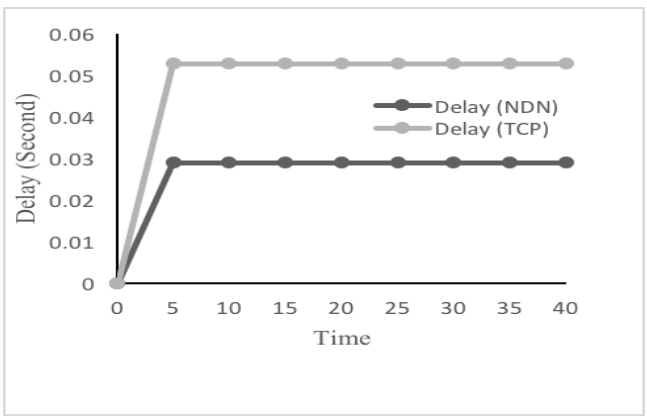

Fig. 4. Time vs. delay in NDN and TCP

Fig. 2 and 3 shows the average data rate and delay in NDN respectively. And, the fig. 4 shows the comparison of delay between TCP/IP and NDN. We can clearly analyze that the delay of NDN is almost half of TCP/IP. Similarly, fig. 2 shows the average incoming interest and outgoing data in NDN environment. When we analyze the figure 3 and 4, the initial delay and final delay of NDN is very less. The above simulation results were also verified by using NDNx. Since the average speed during the obstacles or emergency conditions is very low. So, the mobility and handover for vehicular communication will be almost same as the normal communication between nodes using NDN environment. From this scenario, we can conclude that there will be no mobility and handover problem in V2VNDN. So, it is worth to mention that, the V2VNDN can become one of the best proposals for vehicular communication and is easy to conclude that NDN is the best networking scenario for vehicular communication.

5. CONCLUSION

In this paper, we have proposed the vehicular communication using named data networking (V2VNDN) and shown the naming, publishing and retrieving strategy of NDN environment. Through the simulation, we found that the delay of NDN is almost half of TCP/IP. Since the number of contents is fixed and assigned with vehicle number and area name, it's very easy to know the content ID of nearby vehicles and received the required information. It is also worth to say from the data-rate graph that the data drop rate is null. We can conclude by stating that the V2VNDN is easy, accurate, highly efficient, cost-effective, and strong security networking system which can be implemented in the near future to make the transportation system intelligent and accident-free. Our future work includes the mobility and handover for high-speed vehicles.

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