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Latency-Sensitive Message Broadcasting Scheme Based on Vehicular Fog Computing for Connected Self-Driving Cars

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Abstract. Recently, fog computing based various researches related on connected self-driving cars have been studied to support enhanced service performance. In particular, fog computing based novel ITS technology, such as vehicular fog computing, is being developed for an vehicle application in vehicle networks. Vehicles are regarded as smart devices with mobile and have the computational capability to collect useful traffic information and road information. The information is collected not only from sensors in the vehicle but also from the environment external to the vehicle(s). In vehicular networks enabled to vehicular fog computing, fog nodes performing computing can be deployed at the edge of vehicular networks to collet, store, and process traffic data related on vehicle from urban/highway areas. Vehicular fog computing can provide a vehicle services to connected self-driving car with the providing driving information, smart traffic control and road safety improvement. Thus, in this paper, we propose latency-sensitive message broadcasting scheme based on vehicular fog computing to provide the connected self-driving cars with the enhanced vehicular services. The proposed scheme can provide a method of rapidly disseminating latency-sensitive message such as accident notification message and safety message.

Keywords: Fog Computing, Safety Message, Self-driving, Reliability

1 Introduction

Recently, fog computing technology is studied as potential solution to be able to be adapted at IoT environment[1]. Fog computing is still in its early stage, with operational challenges, ranging from architecture to clear use cases to processing and computing issues and so on. For example, in a recent report on connected vehicles by the IHS automotive company [2], it is estimated that there will be 152 million actively connected cars on the road by 2020, and an average car will produce up to 30 TB of data each day. This will result in a significant increase in bandwidth consumption and competition, in the sense that a connected vehicle would need to compete against other devices for finite bandwidth. In particular, fog computing based various researches related on connected self-driving cars have been studied to support enhanced service performance. Fog computing based novel ITS technology, such as vehicular fog computing, is being developed for an vehicle application in vehicle networks. One

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potential application of fog computing is the integration of fog computing with conventional vehicular network to form the Internet of Vehicles (IoV) or vehicular fog computing[3]. Vehicular fog computing extends the fog computing paradigm to conventional vehicular networks, which allows us to support more enhanced performance to driver, self-driving car and vehicles application, by overcoming the limitations in conventional vehicular networks in terms of latency, location awareness, and real-time process through vehicular for computing. From vehicular fog computing perspective, vehicles are regarded as smart devices with mobile and have the computational capability to collect useful traffic information and road information. The information is collected not only from sensors in the vehicle but also from the environment external to the vehicle. In vehicular networks enabled to vehicular fog computing, fog nodes performing computing can be deployed at the edge of vehicular networks to collet, store, and process traffic data related on vehicle from urban/highway areas. Vehicular fog computing can provide a vehicle-based services to connected self-driving car with driving related information service, smart traffic control and road safety improvement. In this paper, we present vehicular fog computing architecture and a typical use case using vehicular fog computing. Then we propose potential solution which is latency-sensitive message broadcasting scheme based on vehicular fog computing to provide connected self-driving cars with the improved vehicular services connected self-driving cars. In particular, the proposed scheme can provide a method of rapidly disseminating latency-sensitive message such as accident notification message and safety message. The remainder of the paper is structured as follows. Vehicular fog computing architecture and its benefits are presented in Section 2, In Section 3, we address the scenario of vehicular assumed in the paper and the proposed scheme. Finally, a conclusion is provided in Section 4.

2 Vehicular Fog Computing Architecture

A high-level system architecture of vehicular fog computing (VFC) is shown in Fig. 1[3]. VFC system architecture is composed of three types of layer which are the data generation layer, the fog layer, and the cloud layer. The function of three types of layer is shown in Figure 1.

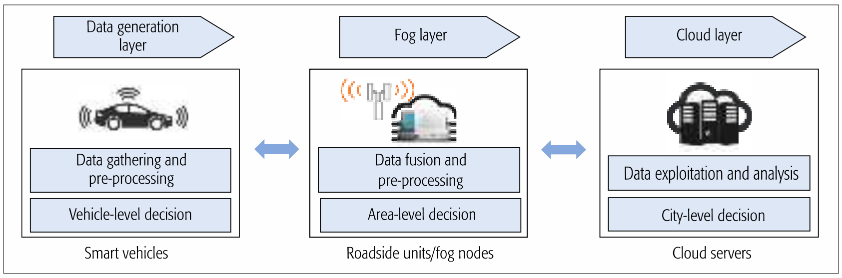

Fig. 1. System architecture of VFC[3]

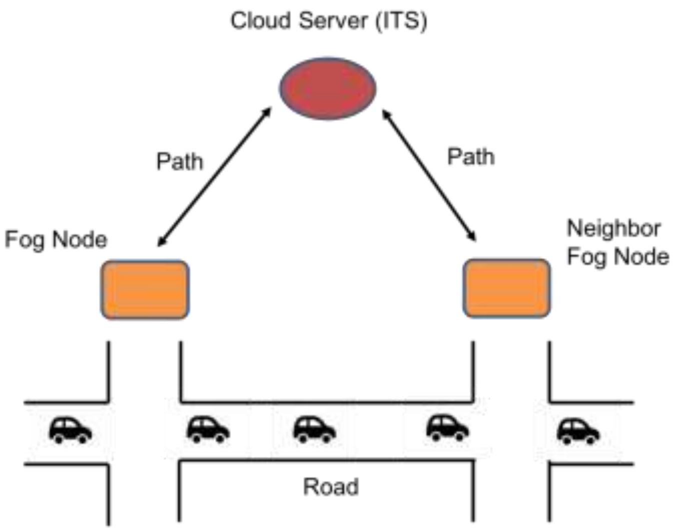

Fig. 2. The assumed network model

3 Latency-sensitive Message Broadcasting Scheme

In this section, latency-sensitive message broadcasting scheme based on vehicular fog computing is proposed to provide connected self-driving cars with the improved vehicular services connected self-driving cars. First at all, the assumed network is shown in Figure 2. We use a fog-computing based traffic control system as a use case to assume vehicular network using the vehicular fog computing. In the assumed network, latency-sensitive message related on road traffic congestion and car accidents is generated, and then fog node performs procedure which is to broadcast the latency-sensitive message to neighbor all cars. For that, we propose latency-sensitive message broadcasting(LSMB) scheme based on vehicular fog computing. The LSMB scheme is described in Figure 3. Fog node in VFC monitors and manage local traffic flow. Also, a fog node has communication range to be able to covers a region of intersection as shown in Figure 2. If a connected vehicle is physically located within the communication range of a fog node, it is able to send and receive traffic messages to and from the fog nodes. Especially, when there are a self-driving vehicles within the coverage of a fog node, it will frequently report traffic conditions and road conditions of its current location. Based on the traffic information received from a self-driving vehicles, the fog node can perform the following. For example, while the fog node will monitor and control the local traffic flow of the intersection, if car accidents occurs in the region, the fog node should quickly send safety messages to nearby vehicles. In order to perform this, in the proposed LSMB scheme, the procedure is performed as shown in Figure 3. Thus, the proposed scheme should operate safety message in real time and low latency. Also, the fog node will pre-process and aggregate the received data as the statistical traffic information, and report such information to the cloud servers.

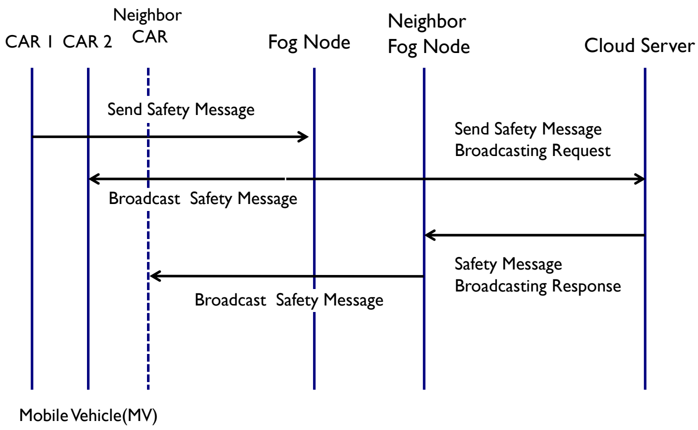

Fig. 3. the procedure of the proposed scheme

3 Conclusion

In this paper, latency-sensitive message broadcasting scheme is proposed to broadcast latency-sensitive message broadcasting in vehicular fog computing based vehicular network environments. As explained up, vehicular fog computing is the one of the best solution to support more enhanced vehicular performance to driver, self-driving car and vehicles application. Thus, the vehicular fog computing based LSMB scheme can operate safety message in real time and have low latency.

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