Software-Defined Cloud-based Vehicular Networks with Task Computation Management

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ABSTRACT

Cloud vehicular networks are a promising paradigm to improve vehicular through distributing computation tasks between remote clouds and local vehicular terminals. Software-Defined Network(SDN) can bring advantages to Intelligent Transportation System(ITS) through its ability to provide flexibility and programmability through a logically centralized controlled cluster that has a full comprehension of view of the network. However, as the SDN paradigm is currently studied in vehicular ad hoc networks(VANETs), adapting it to work on cloud-based vehicular network requires some changes to address particular computation features such as task computation of applications of cloud-based vehicular networks. There has been initial work on briging SDN concepts to vehicular networks to reduce the latency by using the fog computing technology, but most of these studies do not directly tackle the issue of task computation. This paper proposes a Software-Defined Cloud-based vehicular Network called SDCVN framework. In this framework, we study the effectiveness of task computation of applications of cloud-based vehicular networks with vehicular cloud and roadside edge cloud. Considering the edge cloud service migration due to the vehicle mobility, we present an efficient roadside cloud based controller entity scheme where the tasks are adaptively computed through vehicular cloud mode or roadside computing predictive trajectory decision mode. Simulation results show that our proposal demonstrates a stable and low route setup time in case of installing the forwarding rules of the routing applications because the source node needs to contact the controller once to setup the route.

Key Word

Vehicular Networks, Software-Defined Networks, Task computation, routing forwarding application, cloud-based application

I. Introduction

Nowadays, the field of Intelligent transportation systems (ITS) is a challenging research area due to the potential of new vehicular applications. Research efforts in vehicular ad hoc networks (VANETs) are in fact split between industrial consertia and the academic community. Unfortunately, there is no general consensus with respect to fundamental service models and the universal platform architecture.

The cloud architecture for vehicular [1] is in the progress of merging with the Internet as a fundamental platform for Intelligent Transportation System (ITS). The cloud architecture for vehicular networks consists of three interacting layers: vehicular cloud, Roadside Unit (RSU) cloud and central Cloud. The RSU is accessible only by the nearby vehicles. RSU components are described as a highly virtualized platform that provides the computation, storage. Similar system typical known as edge computing [2] such as Cloudlets [3] are emerging at the RSU as a small-scale operational site that offers cloud services to bypassing vehicles.

Software-Defined Network(SDN) can bring advantages to Intelligent Transportation System ITS) through its ability to provide flexibility and programmability through a logically centralized controlled cluster that has a full comprehension of view of the network. However, as the SDN paradigm is currently studied in vehicular ad hoc networks(VANETs), adapting it to work on cloud-based vehicular network requires some changes to address particular computation features such as task computation of applications of cloud-based vehicular networks.

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a Software-Defined Cloud-based vehicular Network called SDCVN framework. In this framework, we study the effectiveness of task computation of applications of cloud-based vehicular networks with vehicular cloud and roadside edge cloud. Considering the edge cloud service migration due to the vehicle mobility, we present an efficient roadside cloud based controller entity scheme where the tasks are adaptively computed through vehicular cloud mode or roadside computing predictive trajectory decision mode.

II. Software-Defined Cloud-based Vehicular network (SDCVN)

The architecture of the proposed Software-Defined cloud-based vehicular network is shown in Figure 1. This SDCVN framework enables SDN in VANETs assume the existence of Road Side Unit Controller(RSUC) that can communicate with elements in the data plane and educate vehicles and RSUs about the forwarding rules to apply and which resources to allocate for different traffic, related to distinct aspects(safety, management, etc). Modules of the proposed architecture included a local backup controller and heterogeneous wireless technologies such as LTE for control plane and Wi-Fi for data plane RSU cloud and a RSU micro data center as a storage, computation and communication infrastructure as shown of Figure 2.

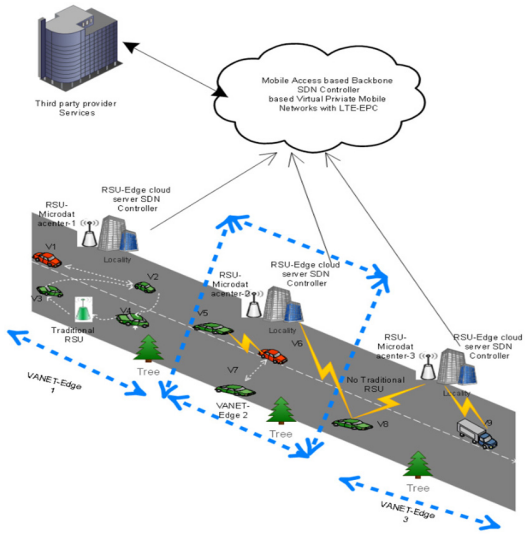

그림 1. Overview of SDCVN framework.

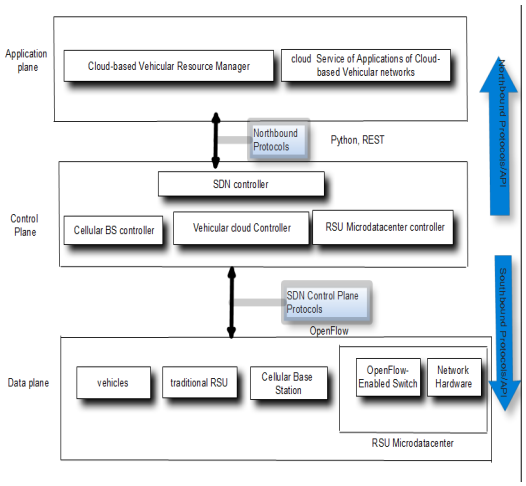

그림 2. Logical structures of the SDCVN includes data and control planes.

III. Computation task with vehicle-roadside cloudlet and roadside cloud

There are two methods of computation of cloud service from central cloud to the vehicle or to the RSU-cloudlet. The first is direct Vehicular cloud mode and the other is roadside- cloudlet predictive trajectory decision mode. The over-view of the two approaches is shown on the Figure 3.

A. Computation task based vehicular cloud mode

If the vehicle adopts the direct Vehicular cloud mode to compute its task to a group of vehicles candidates to a vehicular cloud, it delivers the request of application to the directly. As the vehicle runs at a high speed, it may be outside the coverage range of at the end of time. The ouput of the computation task needs to be re-assembled the output segments into one segments from to the located on the road segment where the vehicle arrives. The transmission of output data between theses passes through V2V communications.

B. Roadside-cloudlet predictive trajectory decision mode

In the case that a vehicle chooses to compute its task in the roadside-cloudlet predictive trajectory decision mode. The computation request is transmitted to a central cloud SDN controller through BS. Since the SDN controller is deployed on the BS, the BS is responsible for delivery of

control information to OpenFlow switches and providing responses to different events such as topology establishment and trajectory decision, records of the mapping of IP and MAC addresses of devices in the roadside-cloudlets by the vehicle at the final hop of the transmission relay.

IV. Conclusions and Future Works

We presented a new architecture in the vehicular network called Software-Defined cloud-based Vehicular network. Applying SDN to the roadside cloudlet enable the centralized system to have a better consistency since the controller has a global view of the network. we also present an efficient roadside cloud based controller entity scheme where the tasks are adaptively computed through vehicular cloud mode or roadside computing predictive trajectory decision mode.

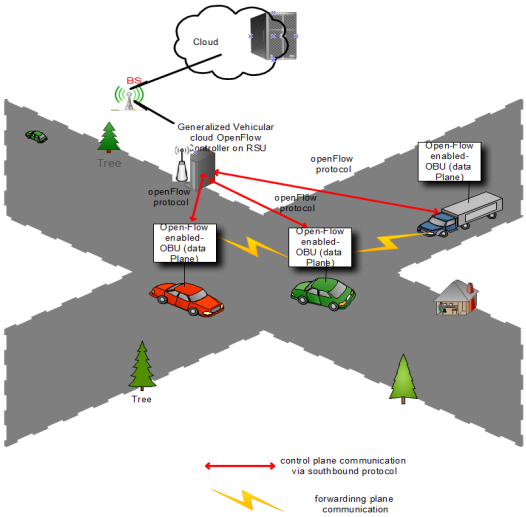

그림 3. Overview of the computation based vehicular mode and roadside-cloudlet predictive trajectory decision mode.

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