# Recent Trend of Edge Caching in Vehicular Networks

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***Abstract*—As the vehicles are connected to the Internet, various services can be provided in the vehicles. In particular, entertainment such as video streaming and navigation systems using VR require the large-sized content. To deliver content within time constraints, strategies for caching near the vehicles have emerged. In this paper, we will explore the edge caching techniques in the vehicular networks**

***Keywords*—caching, edge caching, vehicular networks**

## I. Introduction

As vehicles are connected to the Internet, vehicles can provide lots of services to users. In particular, in order to provide the entertainment using video streaming and the navigation system with the virtual reality (VR), the large-sized content download is required. However, it takes a lot of time to download large content from a cloud. To solve the problem, the mobile edge computing (MEC) server on the network and on-board unit (OBU) on the vehicle are used as a caching node. They are located closer to the vehicles compared to the cloud and help to reduce transmission latency. However, they have the limited capacity, so efficient caching methods for MEC and OBU need to be studied.

## II. Key Technologies For Edge Caching in Vehicular Networks

When a vehicls receives content from the cloud, the distance between the vehicle and the cloud is far, so the latency time becomes long. Fig. 1 shows an illustration of edge caching frames in an urban area. Caching content near vehicles helps to reduce the latency time. The strategies for content caching in the vehicular environment are divided into caching in MEC servers (MECSs), caching in OBUs of vehicles, and caching in both MECSs and OBUs for content request of vehicles.The MECS is usually installed with base station or road side unit (RSU), and OBU is in the vehicles.

### *A. Caching to RSUs*

MECS in RSU has a relatively larger storage space than OBU and a wider communication range. But the resident time of vehicles is short because the vehicles continue to move. The short resident time makes links between vehicles and RSUs change quickly. There are methods of caching to the RSUs in places such as intersections where vehicles stay for a long time [1] or caching in advance by predicting the mobility [2] are studied.

### *B. Cahing to Vehicles*

When caching in OBUs, an ad hoc network is used for communication between vehicles. Since the content is delivered from a personal vehicle, it is sensitive to the private information. Therefore, there are techniques that apply a named data networking (NDN) to vehicles for the scalability and the security benefits [3]. Because vehicles with the same direction have a long connection time, clustering methods for grouping similar vehicles are proposed.

### *C. Caching to RSUs and Vehicles.*

Although there is the benefit of increasing the space to cache through content caching to RSUs and vehicles, the network becomes more complicated. It is necessary that the vehicle to request content decides whether to receive the requested content from the other vehicle or RSU. It is usually chosen the one that can obtain the content within a shorter time. Some methods are proposed that adopt the reinforcement learning to determine where to cache content in the dynamic environments [4].

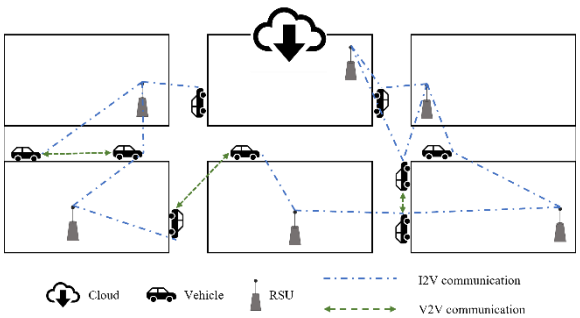


**Fig . 1.** Illustration of the edge caching framework in a vehicular network

## III. Future Research Directions

In this paper, we have introduced the edge caching problem to efficiently handle content requests from vehicles by using MEC and OBU as caching nodes. Technologies such as vehicle trajectory prediction, clustering, and reinforcement learning are used to solve the problem.

In the near future, networks will be more complex and dynamic, and robustness of environments and resource management need to be considered. Thus, improving energy

efficiency helps to save the batteries of vehicles where OBU is and to reduce the power consumption of RSUs.

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