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Towards Usage Reduction of Infrastructure Resource for Regional Content Distribution

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1. Introduction

The application of vehicle communication, which is focus on real-time traffic message, is currently extending to contents access and vehicle file sharing. The heterogeneous sort of information, not only traffic jam, car accident and alert messages for road safety, local parking availability, geography, shopping and entertainments etc., also have been concerted to improve the traffic management and enjoyment [1].

The current vehicle information and communication system shown in Fig.1 can support the local contents download as soon as possible via content-server and road side unit (RSU). However this architecture extremely relies on RSU and content server. In order to improve the vehicle resource availability and decrease the access to server via backbone with the consideration of energy efficient and network bandwidth, the new content distribution architecture shown in Fig.2 is proposed in this paper. The vehicle resource could be available sufficiently by setting up cache as on board facility. Depending on the proposed cache-based architecture, every vehicle can store file and distribute it to other vehicles as well as processing it by its device. All of vehicles constitute a storage system to supply other vehicle's demands and therefrom rapidly share in the same information. Additionally the proposed architecture can alleviate relying on the network access to RSU and content server.

Thereby, a scenario of download requested file is simulated by OMNeT++ & Veins framework in a real urban area. The communication times are evaluated in both content-server and cache-based architecture. The simulation results indicate that the proposed architecture could reduce the accessing times to RSU as well as communication times in the traffic system.

2. Content distribution scheme

The current vehicle communication architecture shown in Fig. 1 is to use access points, such as road side unit (RSU), to request data from content-server. However, when all of vehicles download file from content-server, it cause a crowded accessing to RSU and content server. If vehicles are much, the access might not successful for a portion of vehicles. On the other hand, when a vehicle is quickly passing by an access point, it might not have sufficient time to download requested data. The same direction parading vehicles could have enough time to download requested file from neighbor vehicles [2].

Thereby, the proposed architecture shown in Fig. 2 is an on-board-cache based content distribution that is equipped with cache in a vehicle to serve as a content storage and distribute file to other vehicles. When a vehicle has the same file request, the on-board-cache in which the file is stored, serves as a responder to provide the request. Videlicet, once a vehicle download a file from content server, other vehicles can request this vehicle directly to share in this file without accessing content server. As a result, the vehicle resource is sufficiently utilized because vehicles themselves constitute a storage system to share in information each other.

Cache-based content distribution opens up a possibility for content access and vehicle file sharing in vehicle-to-vehicle communication.

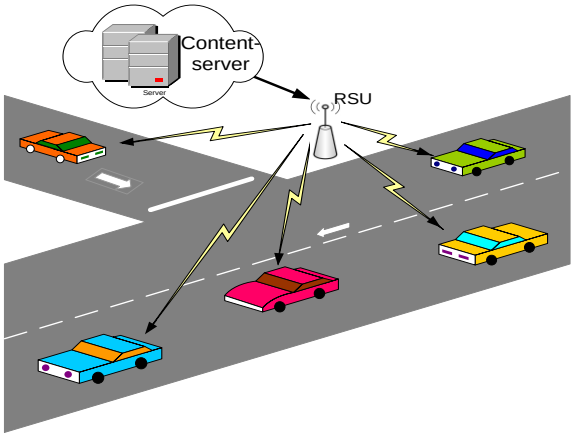

Fig.1 Content-server based content distribution

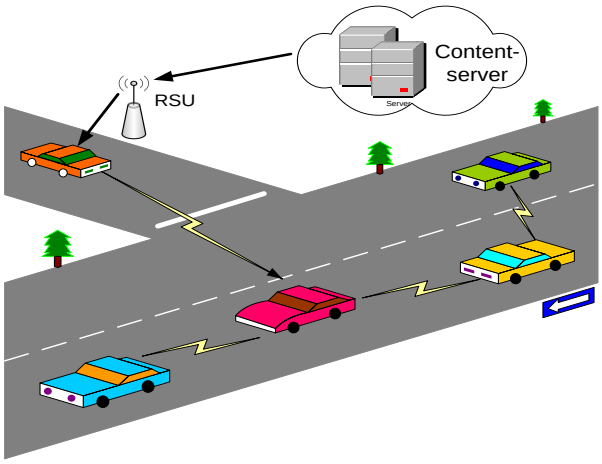

Fig.2 On-board-cache based content distribution

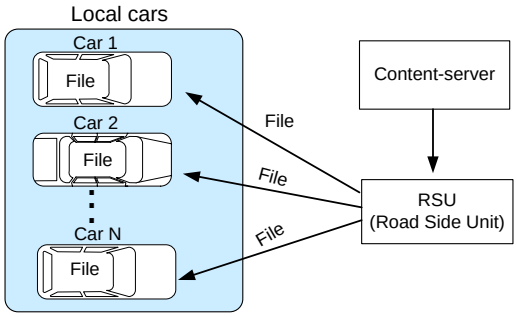

Fig. 3 Content-server based file download

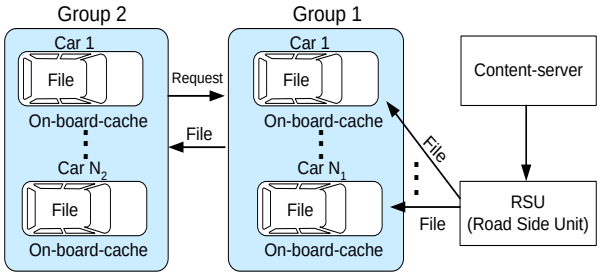

Fig.4 On-board-cache based file download

3. Application description

The times of transmitting data will be counted to evaluate which is regarded as the resource usage such as power consumption or network bandwidth in simulation. For the case of contents-server based content distribution, the flow is shown in Fig.3. When the cars request a file, they sent a request message to RSU. RSU answers every request, and then downloads the file via content-server and forwards to the car who requests the file. Every car obtains the same file by accessing content-server via RSU.

For the case of on-board-cache based content distribution, the flow is shown in Fig.4. A car in the first group has file by accessing content server and RSU. When a car in the second group wants to acquire the file, it sent a request to its neighbor cars by broadcast. If the car in the first group stores the file in cache, it forwards this file to the car that is in the second group. (If the neighbors do not have this file, this car will request RSU to send it this file.) The same operation is repeated for other cars that request the same file, so that the times of accessing RSU and content server will be decreased effectively.

In the case of Fig. 3, 50 cars request content to RSU, and RSU answers every requests. Consequently all of cars download file via content-server respectively. In the case of Fig.4, RSU only answer 1 times among 10 times requests. As a result, only a small part could get file from RSU, most of cars have to hunt the file from vehicle-to-vehicle communication.

Fig. 5 Map of simulation (Sannomiya, Kobe)

Table 1 Simulation parameters

Location	Attitude: 34.*6882~6978*, Longitude: 135.*1864~2017*
Nodes	50 cars and 1RSU
Files	Size: 1KB, Number: 10
Time	Simulation: 40 sec, Request interval: 0.1sec

Table 2 Simulation results

Communication quantities	On-board-Cache based	Content-server based
Request from car	62	315
Sending file from RSU	40	398
Sending file from car	259	-
Total :	361	703

4. Simulation parameters and results

The simulation is implemented by OMNeT++ 4.4.1 (network simulator), and Veins 3.0 framework (vehicular network simulator). A real urban traffic map is shown in Fig.5 produced by SUMO 0.21.0 (road traffic simulator). The simulation parameters and results are shown in Table 1 and 2, respectively.

5. Conclusion

In order to share in the regional information, such as coupon, hot-selling and festival events etc., the approaches of contents access and vehicle file sharing are reviewed and proposed. OMNeT++ and a series of its framework simulates a real scenario in an urban traffic to valid the proposed scheme. Comparing with current architecture of content-server based content distribution, the proposed on-board-cache based content distribution reduced the communication quantities as well as decreasing the access to RSU and content-server. The vehicular resource could be efficiently available to improve the vehicular system robust.

References

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[2] M. Sathiamoorthy, A. G. Dimakis, B. Krishnamachari, and F. Bai, “Distributed Storage Codes Reduce Latency in Vehicular Networks,” IEEE Trans. on Mobile Computing, vol.13, no.9, pp.2016–2027, Sep. 2014.