SHORT TERM SCIENTIFIC MISSION (STSM)
SCIENTIFIC REPORT

This report is submitted for approval by the STSM applicant to the STSM coordinator

Action number: CA15127
STSM title: Delay Constrained Offloading in Vehicular Edge Computing Networks
STSM start and end date: 02/06/2017 to 11/06/2017
Grantee name: Alexey Vinel

PURPOSE OF THE STSM:

The STSM aimed at facilitating of the long-term research relationship between Halmstad University (Sweden) and Simula Research Lab/University of Oslo (Norway). Mobile Edge Computing (MEC) is a promising solution to improve vehicular services through offloading computation to cloud servers in close proximity to mobile vehicles. However, the high mobility characteristic of the vehicles make the design of the computation offloading scheme a significant challenge from the resilience perspective. In this STSM we focused on a new Vehicular Edge Computing (VEC) framework to model the computation offloading process of the mobile vehicles running on a bidirectional road both in normal operation as well as in the disaster scenarios. The STSM was carried under the framework of WG3: Technology-related disasters.

DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS

The advancements in IoT bring us pervasive smart devices such as vehicles that can facilitate realizing many novel and powerful mobile applications. Some of such applications include interactive infotainment, traffic cognition and automatic driving. However, with the drastically increasing needs for resources along with stricter requirements on performance for advanced vehicular applications, supporting large computing intensive applications is a big challenge for the resource constrained vehicles. To cope with the explosive application demands of the vehicular terminals, cloud-based vehicular networking is widely considered as a promising approach to improve the performance of the services. In cloud-enabled networks, computation processing and storage for vehicular applications are provided as services on the cloud. Thus, the complicated computing tasks can either run locally on the vehicular terminals or be offloaded to the remote computation cloud. By leveraging rich computational resources from cloud, both the performance of the vehicular applications as well as the resource utilization of the cloud can be improved. However, the long distance between mobile vehicles and remote cloud servers may incur significant network transmission delay as well as considerable overhead. This latency and overhead seriously impairs the performance of delay-sensitive mobile applications and the computation offloading efficiency. A new architecture and technology known as MEC has emerged to address the above challenges, which pushes cloud services to the edge of the radio network, and provides a cloud-based computation offloading in close proximity to the mobile vehicular terminals. Due to proximity to mobile vehicles, the network latency accessing to cloud computing services can be greatly reduced, which enables MEC to provide fast interactive response in the computation offloading service. However, compared to the traditional cloud servers located in the backbone network with powerful computation platforms, MEC servers may suffer from resource limitation. Furthermore, unlike handheld mobile devices that always move slowly within a relatively small range, smart vehicles have a unique feature in terms of their high mobility. Considering the limited coverage area of each RoadSide Unit (RSU), a vehicle may pass by several RSUs within the delay tolerance time of its

applications. In MEC systems, servers are always equipped with the RSUs. Thus, in order to improve the computation offloading efficiency while ensuring the performance constraints, it is imperative to jointly investigate MEC server selection strategies for offloading data transmission as well as the MEC cloud resource allocation schemes. Intuitively, mobile computations can be migrated effectively in MEC systems with well-designed offloading mechanisms, but then the resilience aspect should be taken into account since the system becomes heavily dependent on the RSU backbone infrastructure. In case of disasters both the MEC servers as well as the network of RSUs might get damaged and the computation/communication disturbance with vehicles might take few hours. Different vehicular applications might have different requirements to handle these disaster cases, which should be taken into account at the design stage. For example, the disturbance with the interactive infotainment might be acceptable, while automatic driving applications should guarantee safe operation even under such a long-term disaster cases.

DESCRIPTION OF THE MAIN RESULTS OBTAINED

We proposed a new Vehicular Edge Computing (VEC) offloading framework, where both the computing resource capacity of the VEC servers and the high-speed mobility of vehicles are considered.

We modeled the VEC offloading process with a contract theoretic approach, and designed a contract-based offloading scheme.

To further improve the computing resource utilization of the VEC servers while also ensuring the delay constraints of the vehicular applications, we proposed an efficient algorithm for VEC server selection and computing resource assignment.

Respective research paper is under submission to Mobile Networks and Applications (Springer) Journal.

FUTURE COLLABORATIONS (if applicable)

Joint research efforts are continued during the STSM “Platoon-based Vehicular Networks towards Smart Grid Resilience” 05/07/2017 - 12/07/2017 by Sabita Maharjan, Simula Research Laboratory, Norway to Halmstad University, Sweden (Host: Alexey Vinel).