SHORT TERM SCIENTIFIC MISSION (STSM) – SCIENTIFIC REPORT

The STSM applicant submits this report for approval to the STSM coordinator

Action number: CA15127
STSM title: Controller Assignment and Fast Failure Recovery for Software-Defined Networks
STSM start and end date: 01/09/2018 to 09/09/2018
Grantee name: Gürkan Gür

PURPOSE OF THE STSM/

Current data networks suffer from complex control plane protocols, difficulties in deployment of new technologies, vendor-specific configuration interfaces, and expensive equipment. However, network-resident applications and services have become indispensable with ever-increasing traffic volumes and bitrates. Therefore, network infrastructure is supposed to adapt and evolve to address this stringent level of requirements in a sufficient and flexible manner. In that regard, the concept of Software Defined Networking (SDN) and Future Internet concepts such as Network Function Virtualization (NFV) and Information-Centric Networking (ICN) are instrumental and emerge as integral parts of future networks. Although SDN paradigm facilitates new degrees of freedom in data networks, it also brings forth profound issues related to network performance and resilience.

In that regard, the key objectives of this STSM can be summarized as follows:

- **Initiate project proposal for joint Future Internet projects:** The visiting researcher Dr. Gür aimed to pursue potential joint Future Internet project proposals, especially regarding Horizon 2020 programme.
- **Discuss/proceed on co-authored technical papers:** Another purpose of the STSM for Dr. Gür and Dr. Liyanage was to discuss and make headway on collaborated papers on Future Internet including SDN, Mobile Edge Computing (MEC) and 5G topics from a resilience and security perspective. This objective also focuses on the research question of controller assignment and placement to improve the reliability and failure recovery of the software-defined networks in the runtime. The purpose here was to investigate if any joint work is possible on this topic.
- **Investigate new channels to improve collaboration:** The researchers would like to continue collaborating and carry out new STSMs to deepen collaboration listed in this list of objectives.
- **Learn about the properties and capabilities of 5G test network at Uni. Oulu:** CWC has an operational 5G test network with various testbed components, which will be vastly extended with 6Genesis project. This infrastructure is beneficial for any Future Internet research work. Dr. Gür wanted to learn the capabilities and properties of this system via this STSM.

DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS

During the week-long visit, various activities were performed to serve the listed objectives in the previous section. Those can be summarized as follows:

- **Various meetings with Dr. Liyanage to work on these topics:** Dr. Gür and Dr. Liyanage held various meetings during the week to work towards the STSM objectives. Potential project calls were examined and discussed. Technical work on joint academic papers was done. The researchers exchanged information on ZHAW projects and capabilities, and CWC 5G testbed and projects, specifically 6Genesis project for future collaborations.

- **A meeting with PhD candidate Pawani Porambage** was held to search for and discuss suitable open calls in H2020 program for future collaboration. In that work meeting, Dr. Gür and Mrs. Porambage went through the project calls in 2018 and 2019, and identified the suitable ones to work on for joint proposals. The key strands and expected impact for those calls were extracted and discussed.

- **Dr. Gür attended the "test-run" of PhD thesis presentation of Mrs. Porambage** (which will be defended by the end of September 2018) in order to meet with the network security group at CWC and familiarize with their research further.

- **Dr. Gür held two meetings with Dr. Zaheer** (researcher and adjunct faculty at CWC, Uni. Oulu) to elaborate on dynamic spectrum access for resilient 5G communications. That collaboration was an unplanned by-product of this STSM since it was not decided beforehand. During those meetings, Dr. Khan described his recent work on this topic from the open research problems perspective. Accordingly, Dr. Gür and Dr. Khan formulated a channel bonding optimization problem for unlicensed spectrum access in 5G networks.

DESCRIPTION OF THE MAIN RESULTS OBTAINED

During the scientific mission visit, the following main results were obtained via the work carried out during that period:

- **Kickoff for a joint project proposal for H2020 5G call in March 2019:** A project call on 5G Long Term Evolution (ICT-20-2019-2020) for March 2019 was selected and studied (http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/ict-20-2019-2020.html). Joint work to prepare and submit a proposal for that call was commenced. The key research concepts and potential partners were discussed.

- **Initiation of an article on integration of MEC, Information-Centric Computing and SDN/NFV:** Work on a magazine article on MEC, ICN and SDN/NFV was started. The current author list includes Dr. Liyanage, Dr. Gür and PhD candidate Porambage.

- **Initiation of an article on channel bonding in dynamic spectrum access for resilient 5G communications:** Work on a journal article on channel bonding in dynamic spectrum access for resilient 5G communications was started with Dr. Khan. The work will extend Dr. Khan's current work for unlicensed spectrum access.

- **Information exchange on current activities and capabilities through presentations:** For facilitating collaboration between the ZHAW and CWC teams, mutual presentations were given. This information exchange focused on two major dimensions:

- **ZHAW projects and capabilities:** Dr. Gür presented ongoing research projects at ZHAW and gave information on the security group's activities.

- **CWC 5G testbed and projects, specifically *6Genesis*:** The properties and capabilities of 5G testbed at Uni. of Oulu were presented by Dr. Liyanage. This infrastructure is crucial considering any possible utilization for demonstrations and test-bed based evaluations in prospective projects. Moreover, the scope and objectives of recently-awarded *6Genesis* project were described.

Since this was a very short-term visit, the tangible outcomes of these results are expected to materialize in the medium and long term. Moreover, more STSMs may be utilized to bring these outcomes to maturity and enable future collaborations.

FUTURE COLLABORATIONS (if applicable)

For the medium term, Dr. Liyanage and Dr. Gür is already pursuing an international project collaboration as described in the purpose and results sections. Such a project will yield a long-term collaboration for future research in secure and resilient networking in future networks, if successfully executed. Moreover, there is also the academic research and paper initiatives which have already been established during that scientific mission as described in previous sections. These efforts themselves are expected to go on in the future and may lead to additional new joint works. Therefore, it is planned to continue collaboration in order to realize those outcomes. In that regard, communication instruments such as telcos and further research visits through COST will also be utilized. Another key future collaboration is to look for a possible chapter to contribute in the RECODIS book.