SHORT TERM SCIENTIFIC MISSION (STSM) – SCIENTIFIC REPORT

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

Action number: CA15127
STSM title: Evaluation of upper bounds to FC performance in multi-content scenarios
STSM start and end date: 02/04/2019 to 05/04/2019
Grantee name: Gianluca Rizzo

PURPOSE OF THE STSM

In post disaster communications, a key role is played by opportunistic communications. This STSM focuses on a specific communication service based on opportunistic message replications, which goes under the name of Floating Content. When it comes to applying FC in order to support message exchanges in realistic setups, one of the key open issues is how to appropriately tune the utilization of resources such as bandwidth and user memory in order to ensure a satisfactory FC performance while accommodating for a large number of floating contents. The goal of the STSM is to address this issue, starting from a first model formulation elaborated jointly by the two research groups. More generally, the aim of this STSM is to reinforce the collaboration between the two research groups which are already active in the field of FC and of opportunistic communications.

DESCRIPTION OF WORK CARRIED OUT DURING THE STSM

The starting point of the work of this STSM has been a set of results developed by the requester, in collaboration with Prof. Mancuso. Those existing results allow estimating, in a given setup and for a given amount of available resources, the maximum performance achievable by the FC scheme in terms of the number of contents which can float in the given scenario. This is crucial in a disaster scenario, when resources such as bandwidth, energy and memory are necessarily scarce and likely to be contended among several different services and applications. These existing approaches however suffer from a set of drawbacks, which do not allow them to scale, nor to apply to more realistic scenarios. For instance, configurations in which, in a same region, several different contents are made available via FC cannot be optimally dimensioned with the currently available framework. Nor it is possible to account for contents with different performance targets and reference performance zone (called Zone of Interest or ZOI). All these aspects are critical for the practical viability of the FC paradigm in realistic scenarios, and

particularly in those in which coordination from infrastructure cannot be assumed to be available, such as in locations struck by some form of natural or man-made disaster.

In order to address this issue, the work in this STSM has focused on the outlining of a new modeling approach, based on the application of the fluid limit approximation (also known as mean field limit approach). The first phase has been the elaboration of a Markov chain model of the system, which is anyway characterized by a large dimensionality which makes it difficult to handle, and hard to deliver insights even on the most basic aspects of performance of the system.

The second step has been the application of the mean field approach, which has resulted in the derivation of set of simple differential equations. Finally, based on such equations, a set of simulations setups have been designed, in order to assess the accuracy of the model and the impact of the approximations introduced.

DESCRIPTION OF THE MAIN RESULTS OBTAINED

The overall outcome of the STSM is the elaboration of a new model, and of the first steps of its numerical assessment. Out new approach holds the potential to enable the estimation, in a multi- content scenario with heterogeneous performance targets, of the maximum performance achievable by the FC scheme with a given amount of available resources. The new approach has the nice property of being applicable to either the study of the evolution of the diffusion of several contents over short time intervals, such as for contents and messages of relatively short validity (of the order of a few tenths of minutes, e.g. for safety warnings, such as warnings about possible explosions, fires, or collapsing buildings, in a disaster struck area), as well as for contents of longer validity (a few hours or more). Our new model will enable the elaboration of a set of engineering rules for the joint dimensioning of a set of FC schemes in a realistic scenario. The results are planned to be submitted for publication to INFOCOM 2020.

FUTURE COLLABORATIONS (if applicable)

The research work performed in the STSM will contribute to further strengthening of the collaboration between Institute IMDEA Networks and HES SO Valais, and it laid the basis for future joint work on the topics of the STSM.