SHORT TERM SCIENTIFIC MISSION (STSM) – SCIENTIFIC REPORT

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

Action number: CA15127
STSM title: "Redaction of chapter 3.9"
STSM start and end date: 06.01.2019 to 12.01.2019
Grantee name: Gianluca Rizzo

PURPOSE OF THE STSM/

Event notification is an extremely popular communication pattern in the current information systems, such as Wireless Sensor Networks, Internet of Things, critical control systems and services and so on. Due to their key role in critical applications, such as rescue management for exchanging emergency-related information, it is crucial to achieving resilience in post-disaster scenarios where the overall network infrastructure has been partially compromised, or the increase of the traffic is causing congestion phenomena. An important approach to the implementation of reliable event notifications is through redundancy techniques, in order to recover from losses (and coping with temporary crashes). Among the approach being proposed, the breadcrumb strategy, derived from the Floating Content paradigm, allows coping with scenarios with low density of users, and high mobility.

The main goal of the proposed STSM is to foster the collaboration on this topic between HES SO and the group in Federico II University in the person of Christian Esposito, and to contribute to the redaction of chapter 3.9 of the RECODIS book.

DESCRIPTION OF WORK CARRIED OUT DURING THE STSM

The work has focused on scenarios where the messages exchanged are not time-critical, and where there is a low likelihood to find an end-to-end path between two peers, due to node sparsity in space and to their highly dynamicity. In a disaster scenario, a peer might search for a person or a service without knowing exactly the identity of the other peer providing the information or the service, nor its exact geographical location, but only having an approximate knowledge of the area where the person (or the information about him/her) could be located.

The traditional approach to this problem is geocasting, and it consists in sending a query into a destination area. The query is typically forwarded to the area via one of the many techniques available of DTN routing. Once the message reaches the area, it is replicated locally in order to have the query reach the intended recipient with a sufficiently high level of likelihood. The reply is assumed to be routed again via some form of DTN routing strategy, based on the spatial coordinates of the sender and of the originator. Indeed, as the originator is able to indicate his position in space, this information can be used to route back the reply.

Funded by the Horizon 2020 Framework Programme
of the European Union

However, in highly dynamic environments such as those which characterize the aftermath of a disaster and in which store, carry and forward is the main way to spread a message, a significant delay might incur between the time in which the query is issued, the time at which it finally reaches the intended recipient (s), and the time at which the reply to the query reaches the query originator. The mobility of the originator and the delay between the query origination and the delivery of the reply might make delivery of the reply a challenging task, as the originator might not be anymore at the position in which he was at the time of issuing the query.

A possible way to tackle this issue is through some form of geographically constrained flooding. That is, once the query reaches the target area, or when the reply reaches the location of the originator, content could be replicated opportunistically in a region around the target location or area. Such region should be of such size and shape as to strike a compromise between likelihood of having the message reach the intended recipient (or mean time required by the message to be delivered to its intended recipient), and amount of resources involved (e.g., mean number of message replications, or mean number of agents possessing a copy of the message).

Such geographically constrained flooding, which in the literature is also denoted as Floating Content (FC), has been recently well studied, and a set of analytical tools can be employed in order to address the issue of the optimal dimensioning of the replication area, both at the destination site of the query, and at the location of the originator. Hence, a first goal of the STSM work has been to perform a first crude evaluation of the applicability the existing analytical approaches to FC dimensioning to the considered problem.

However, for what concerns the issue of having the reply message efficiently reach the query originator, the FC approach alone might be highly inefficient, possibly requiring a large floating content area and hence employ a significant amount of resources. In order to deliver the reply to the originator in a more resource efficient manner, the Breadcrumbs Geocasting Routing (BGR) has been proposed.

In BGR, the originator periodically spreads around him (via FC) a message (the "breadcrumb") containing information about his current position. The goal of this information is to support a location based DTN routing protocol to route the reply to the originator. As a result, once reached the location in which the originator was at the time at which it issued the query, the reply follows the originator by collecting the information in his breadcrumbs. The effectiveness of the BGR approach in decreasing the resources required to deliver the reply to the originator depends on several parameters, among which are the radius of the FC of the breadcrumbs, the frequency at which they are produced, as a function of the mobility patterns of the agents and of their density.

In the STSM, we have analysed the available literature on BGR performance and integrated it into chapter 3.9 of the RECODIS book.

DESCRIPTION OF THE MAIN RESULTS OBTAINED

The main outcome of this work has been the definition of the role of the Floating Content approach in breadcrumb-based strategies for notification delivery in disaster environments with sparse agents. These elaborations will be included in the content of Chapter 3.9.

FUTURE COLLABORATIONS (if applicable)

In addition to collaborating to the redaction of chapter 3.9, the two research groups plan to continue interact and collaborate in the near future, possibly through further exchanges of researchers, in order to fully explore the potential of the approach individuated. Possibly, this might lead to a technical paper outlining an analytical model for the performance of the BGR approach in disaster scenarios, to be published at reputable conference venues.