Scientific Report: Short Term Scientific Mission

Action number COST Action CA15127: Resilient communication services protecting end-user applications from disaster-based failures (RECODIS)
STSM Title: Resilient networking among Fog, Edge and IoT devices
Start and End Date: 14.06.2018 to 26.06.2018
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1 Purpose of the STSM

The purpose of this STSM was related to preparation of chapter 4.3 of the RECODIS book entitled "Resilient cloud networking and fog computing for CPS and IoT" within WG4, and also to chapters 2.3 and 2.8 where the topics of edge, fog and dew computing are used for resilient networks.

The advances in Internet infrastructure has initiated inclusion of controllers, sensors, and other smaller devices into a more complex organization of interconnected devices, forming the world of the Internet of Things (IoT) and/or Cyber-Physical Systems (CPS). In addition, the architectural concepts of cloud-based solutions, including various edge computing implementations include extensive network communications and need special focus on analysis and network design in order to obtain resilient solutions.

The goal of this STSM was to define resilient implementations targeting the cloud, edge, fog and dew computing in the following book chapters:

- Chapter 2.3 - Resilient IoT eHealth solutions in case of disasters,

- Chapter 2.8 - Techniques of network design / update of characteristics of existing network architectures to improve their resilience against technology-related disruptions,

- Chapter 4.3 - Resilient cloud networking and fog computing for CPS and IoT.

2 Description of the work carried out during the STSM

2.1 Problem to solve

The identified problem was to define resiliency on networks for IoT systems and various cyber-physical systems, which complexity has increased both in user requirements and engineering solutions. The focus was set on solutions and communications including cloud-based servers, various interconnection networks or edge computing organizations, such as mobile edge computing, cloudlets, fog computing, dew computing, etc. with

During the STSM, we defined the structure and possible resilient solutions for each of identified chapters, concerning

- IoT and CPS (chapter 4.3),

- network design in a multilayered edge architecture (chapter 2.8), and

- post-disaster recovery and emergency network use case (chapter 2.3).

2.2 Work carried out

The realized research methods about a definition of specific architectures and resilient networking solutions included: literature overview, sharing of knowledge, discussion, and individual research. Especially, the research activities included the tools for cloud environment including their cloud and workflow manager simulator, that is proprietary of the University of Innsbruck.

The carried work addressed the following:

- Understanding the current research and development activities at the University of Innsbruck,

- Demonstration and experimentation with their proprietary simulator and workflow management system,

- Specification and drafting an overview of resilient solutions within the scope of the project and planned book chapters.

A typical working day in the STSM was carried by common discussion as method for collaboration and idea exchange; and individual research. At the end of each working day, through discussion we summarized and confirmed the realized research activities, and planned the next activities.

Work on these three chapters was divided into three phases: i) definition of a possible disaster and how it can impact the network design, ii) identifying a possible resilient solution and modeling new architectural design and constraints and iii) analysis of the proposed solution with details on possible implications and malfunctions.

I have also held a lunch-time seminar presentation on 21.06.2018 at 12h entitled: **On the borders of edge computing and IoT**, where I explained the edge computing concepts and possible resilient solutions. There were several interesting questions after the presentation.

The summary of our results for all three activities are described in the following section.

3 Description of the main research results obtained

The proposed contribution is drafting a book chapter structure and initial ideas about its content. It includes specification of corresponding architecture and solution organizations and compares resilient networking solutions including clouds, cloudlets, fog computing, dew computing or other forms of edge computing.

Initially, the resilient networking solutions were analyzed for their properties, advantages, and disadvantages. To summarize, by analyzing the cloud and edge computing solutions, we have defined concepts on:

- Resilient networks addressing Big data concepts for streaming IoT and CPS devices,

- Resilient solutions targeting network design in multilayered edge computing architecture; and

- Use-case of a emergency solution used after a disaster to save lives.

4 Future collaboration with the host institution

Since the defined resilient concepts included various architectural and network design approaches that need a follow up, and discussions will be organized remotely. The overall goal is finalization of the proposed book chapters.

Nevertheless, we tackled several ideas to design possible protocols to be used in edge computing architectures, especially in serverless approach.

The future plan is to finalize contribuitons in chapters 2.3, 2.8 and 4.3 of the RECODIS book chapter.

A joint article is also planned if relevant results are obtained in developing new protocols for serverless edge computing resilient solutions.