Construction of Data Streams Applications from Functional, Non-Functional and Resource Requirements for Electric Vehicle Aggregators. The COSMOS Vision

J.A. Bañares, R. Tolosana-Calasanz, F. Tricas, U. Arronategui, J. Celaya, and J.M. Colom

Depto de Informática e Ingeniería de Sistemas - Universidad de Zaragoza
banares@unizar.es

Abstract. COSMOS, Computer Science for Complex System Modeling, is a research team that has the *mission* of bridging the gap between formal methods and real problems. The goal is twofold: (1) a better management of the growing complexity of current systems; (2) a high quality of the implementation reducing the time to market. The COSMOS *vision* is to prove this approach in non-trivial industrial problems leveraging technologies such as software engineering, cloud computing, or workflows. In particular, we are interested in the technological challenges arising from the Electric Vehicle (EV) industry, around the EV-charging and control IT infrastructure.

Keywords: Continuous Data Streams, Executable High-Level Specification, Scheduling, Non-functional specifications, Distributed Systems, Resource Allocation Systems, Cloud Computing, Smart Grid, Electric Vehicle

1 Introduction

Electric Vehicles (EVs) give rise to computational challenging problems. EVs will be plugged into the electric infrastructure (distribution networks) for the re-charging of their batteries, and they will share capacity with other users of electricity. On other hand, electricity distribution and generation infrastructures are currently turning into Smart Grids for more efficient management. From a computational point of view, this involves demand forecast methods, state estimation techniques, and real-time monitoring, leading to communication and control of residential and commercial areas taking place at a fine granularity. Critical characteristics of the involved computational problems are related to large volumes of data being generated in a distributed, stream fashion, and real-time –which is often agnostic of demand variation in a given geographical area. The main scientific and technical objectives are: 1) The development of a methodology for the construction of applications for Continuous Data Streams Processing. It must cover all Software Engineering phases of the life cycle, and

must be able to address functional and non-functional requirements together with the specification of the execution infrastructure and the involved resources. 2) The previous methodology requires the definition of an executable specification language across all the software architectural levels. It will support modular and hierarchical specification of these types of applications, together with the associated tools, analysis, verification, simulation, implementation, execution and monitoring. A set of mechanisms, taking into account different architectural configurations that can be used in the implementation, will be designed to support the studied policies and mechanisms. 3) Analysis, design and development of a proof of concept Autonomic Smart Energy Management System for Electric Vehicles infrastructure management.

2 Expected Scientific Impact

Recent studies estimate that uncontrolled re-charging processes of EV batteries can lead to significant increase in the electricity demand peaks. Moreover, they anticipate that EVs will impact the local level, where hotspots will be created depending on how EVs cluster within a particular geographical location. These hotspots may eventually overload the low voltage distribution networks. The re-charging of EV batteries will generate large-scale volumes of information, in a distributed fashion, that need to be processed. This project looks for computational solutions to manage the large amounts of re-charging information coming from the EVs. It uses a single computational infrastructure that enforces an established Service Level Agreement, while adapting the computational power for the processing of the information. From a socioeconomic point of view, the expected impact is: (1) The computational solutions can be exploited for the managing of EVs in the electric infrastructure. Large-amounts of information streamed by smart meters can be required to be processed in real-time when EVs re-charge their batteries. (2) As a result, there will be a substantial reduction of computational resources and, as a consequence, of energy in their management as well. Additionally, a substantial reduction of human intervention is expected, saving costs to companies. (3) The project falls within the social challenge 4 of the Horizon 2020 program of the European Union: "Smart, Green and Integrated Transport." (4) The results of the research shall also apply to decision-making systems of healthcare systems. (5) The results of the research may also apply to different data processing applications with real-time needs, that can be of interest for highly qualified SMEs, enabling them to become a media company to data process.

3 Collaboration

In this endeavour, we are looking for partners that can help us to construct solid collaboration structures in order to apply for an European project proposal within the EU Horizon 2020 framework.