

ICT PHD

Research project for a PhD curriculum in ICT – Computer Engineering and Science

Tutor:

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Proposed Title of the research:

CE4D Cloud and Edge computing for the digitization of communication process

Keywords – (5)

Distributed Systems, Cloud Computing, Edge Computing, Load Balancing, Optimization Problems

Research objectives:

The project tackles the green economy problem of document flows management. In this area, CO2 production can be reduced by dematerializing the document flow relying on ICT. However, this process opens two new challenges. The first challenge is how to reduce the environmental and economic costs associated with the computing platforms used for document management. The second concerns security problems in data management. The PhD project aims to investigate the use of edge and cloud computing technologies with high efficiency, performance and security for the management of document flows.

Proposed research activity:

The management of document processes based on physical documents presents several critical issues: document archiving requires space and time; information retrieval is slow; the risk of losing documents (with economic and legal consequences) is a common problem. Even worse, the management of physical documents is deeply inefficient and requires a huge consumption of raw materials and energy (with consequent production of CO2).

One approach to address these issues, with a major impact in terms of the environmental sustainability of the processes, is dematerializing documents, using ICT systems for their management and storage. This technology is an enabler for additional value-added services by enriching the use of documents from a digital user experience perspective.

However, this approach introduces complex challenges for the supporting ICT infrastructure. A common practice is to outsource part of the processing to cloud data centers managed by third parties. This use of data centers has pointed out the environmental impact of ICT, to the point that the production of CO2 attributable to cloud computing worldwide is comparable to that of nations such as France or Italy. It is therefore fundamental to identify green solutions that can improve the efficiency of cloud systems, both from the point of view of reducing the demand for computing power (at the level of the computing platform users), and at the level of efficiency in data center management. A further element of interest is the adoption of techniques that push some processing towards the end user of the document process. To this aim the project will evaluate the adoption of paradigms such as edge computing, that relies on multiple small data centers to distribute the processing towards the edge of the network. Research in the area of cloud computing systems will benefit from existing collaborations with prof. Ardagna at the Polytechnic University of Milano.

A second aspect of the problem concerns the security of operations. From this point of view, there are legal requirements such as the GDPR that impose very strict rules on data management in order to preserve its confidentiality and integrity. In the project, the problems of secure data processing will be addressed in collaboration with prof. Fabio Pierazzi at King's College in London.

Specifically, the doctorate will include the following areas of activity:

- Development of mathematical performance models for cloud and edge computing systems
- Definition of optimization techniques, also exploiting meta-heuristics (genetic algorithms, ant colony optimization, particle swarm optimization) to improve the efficiency of cloud and edge computing systems

- Scaling, migration and load balancing solutions in multi-cloud contexts, also considering problems of uncertainty in the load estimation
- Simulation of complex calculation systems for the validation of the proposed solutions
- Creation of prototypes of document management systems on the cloud platform
- Definition of solutions for secure data processing
- Countermeasures in the context of secure data processing in the presence of smart adversaries

During the doctorate there is a period of at least 6 months in Doxee (a Modena-based company) company and 6 months at King's college in London.

Supporting research projects (and Department)

This project will be carried out at the Department of Engineering “Enzo Ferrari” and research activities will be carried out together with Doxee, King’s College London.

Possible connections with research groups, companies, universities.

The research may involve the undergoing collaborations with research groups at:

- King’s College London (Prof. Pierazzi)
- Polytechnic University of Milano (Prof. Ardagna)
- Doxee Inc.