ICT PHD

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

Tutor:
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Proposed Title of the research:
Edge computing platforms for the support of complex applications

Keywords – (5)
Distributed Systems, Cloud Computing, Edge Computing, Load Balancing, Optimization Problems

Research objectives: – (max 10 rows)
The research aims at proposing innovative techniques for the management of an Edge computing platform (also called Fog computing).
Edge computing is a new paradigm for the development, deployment and delivery of innovative applications processing huge amount of data in a scalable way. Application may involve the execution of IA algorithm (for example to process images from sensors) and can include the management of personal or sensitive information. The application fields range from industry plant monitoring and management to smart agriculture to smart cities to e-health.
In this research we consider that applications are composed of multiple micor-services organized as a Directed Acyclic Graph (DAG). Each application is subject to QoS constraints, for example in the form of a maximum response time. Additional elements of concern are the network characteristics, with latency and bandwidth limitation, security issues or specific hardware requirements (e.g., GPUs for IA applications).
The research aims at tackling the problems of managing such infrastructures considering multiple aspects ranging from computing load (including dynamic changed in the load) to network characteristics and up to power efficiency.

Proposed research activity – (max 10 rows)
The research activity concerns several main aspects of infrastructure management.
A first approach, operating at a coarse-grained time scale, is to formulate and solve an optimization problem for the deployment of the considered applications, including problems of service replication, cloud-based offloading etc, ...
The problem can be either considers static or stationary (i.e. slowly changing) or dynamic with periodic re-configuration of the infrastructure. This latter approach require the ability to evolve a deployment scheme to cope with changes in the incoming load, minimizing the change with respect to the original deployment.
A different approach that will be considered during the Ph.D. research is to focus on a fine-grained time scale, analyzing dynamic load balancing cooperative algorithms to distribute on-the-fly data across the platform and evaluating their performance.
At both time scales the solution can either be based on traditional algorithmic solution or can exploit unsupervised machine learning solution such as Reinforcement Learning
All these research topics should be analyzed combining multiple techniques ranging from mathematical models (e.g., performance models, energy models, optimization problems) to simulation-based performance evaluation and up to prototype development and testing.

Supporting research projects (and Department)
This project will be carried out at the Department of Engineering "Enzo Ferrari" and will be supported by research funds provided by Prof. R. Lancellotti.

Possible connections with research groups, companies, universities.
The research may involve the undergoing collaborations with research groups at:
- Roma "Tor Vergata" (Prof. Chiaraviglio)
- Roma "Tor Vergata" (Prof. Lo Presti)
- Politecnico di Milano (Prof. Ardagna)
- Roma "Sapienza" (Prof. Beraldi)
- King's College of London (Prof. Pierazzi)
- Unimore – DISMI (Prof. Iori)

Specific case studies may involve local enterprises active in data processing and facility management (e.g., Doxee, Coopservice). The research group can leverage several on-going projects that can provide realistic scenarios to test the research ideas.

Depending on the specific themes, the Ph.D. student can spend a period of up to 6 month at the King's college London university working under the supervision of prof. Pierazzi.