

Research internship (Master 2)

Contribution to the adaptation of urgent applications in the IoT-to-Cloud continuum

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1 Introduction

With the advent of distributed infrastructures, the Cloud computing paradigm is progressively moving towards a full continuum from IoT devices and sensors to the centralized Cloud, with Edge (edge of the network) and Fog computing (core network) in between [1]. Simultaneously, distributed applications also evolve. Urgent computing tackles services that require time-critical decisions that improve quality of life, monitor civil infrastructures, respond to natural disasters and extreme events, and accelerate science (e.g., autonomous cars, disaster response, precision medicine, etc.). These services are typically sensitive to latency and response time and are among the best candidate for the IoT to Cloud computing continuum [2].

In this internship, we consider a new breed of urgent intelligent services using the IoT-to-Cloud Continuum, combined with the recent advances in Artificial Intelligence and Big Data Analytics. First, these services and applications require a large computing capacity to perform well, while often being under the constraints to move data from the edge of the network to the Cloud [5]. Second, these services and applications require system support to program reactions that occur at runtime, especially when the target infrastructure capacities and capabilities are unknown during the design [9].

It is challenging to run such services with guaranteed performance on the continuum. From the application perspective, different types of events associated with the data to be transformed drive its configuration (i.e., what should run?) [4, 6]. From the infrastructure perspective, objectives associated with the urgency of the results or the resources usages impacts the placement of function across the IoT-to-Cloud Continuum (i.e., where should it run?) [3].

2 Expected work

We expect the successful candidate to contribute to a comprehensive architecture that enables the composition of services from different providers across a highly heterogeneous infrastructure with geographically distributed resources. This work specifically targets end-to-end applications that are implemented as a workflow of services spanning data producers located at the edges, and data consumers requesting time-critical decisions from anywhere in the network.

The objectives of this internship are :

- to model and integrate the variability of the computing continuum ;

- to model and integrate the variability of the services involved in urgent applications ;
- to leverage machine learning techniques to dynamically take advantage of this variability to adapt both the application features [7, 8] and services placed on the continuum [3].

In this modeling and integration tasks, two important aspects will have to be studied :

- make a separation of concerns between domain scientists (familiar with the applications) and devops (familiar with the platforms) in the modeling ;
- consideration of metrics relative to latency, quality of service, and throughput during the lifecycle of an urgent application.

We expect the successful candidate to create repeatable processes and artifacts that will be used at scale to develop and evolve edge computing designs. Experiments and validation will occur on Grid'5000, the biggest share network dedicated to research in Computer Science.

Note that if satisfactory, the successful candidate will probably have an opportunity to start a Ph.D. thesis after the internship.

3 Skills

The following skills are expected from the successful candidate :

- a student in the last year of a Master's degree in Computer Science (or in the last year of an engineering school with a computer science option) ;
- modeling skills to be able to abstract the properties of the computing continuum and the urgent applications ;
- knowledge of the Python programming language, and ideally an experience in using Machine Learning libraries (SciKit-Learn, TensorFlow, Keras etc.) ;
- ideally some background in formal methods to provide formal modeling ;
- a good level of English to contribute to the writing of a research paper ;
- an ability to collaborate and communicate ;
- curiosity and an appetite for learning new things.

4 Additional information

Advisors

- [Hélène Coullon](mailto:helene.coullon@imt-atlantique.fr), IMT Atlantique & Inria équipe Stack, helene.coullon@imt-atlantique.fr
- [Daniel Balouek-Thomert](mailto:daniel.balouek@utah.edu), SCI Institute, University of Utah, daniel.balouek@utah.edu

Duration 6 months

Salary legal amount of 3,90€ / hour, full time

Location IMT Atlantique, équipe Inria Stack, laboratoire LS2N à Nantes

Références

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