Master Internship — 5 to 6 months, starting between January and March 2026

ENACloud - Exploiting the dyNamic Adaptation plan space for improving the energy efficiency of CLOUD-based software applications

Denisse Muñante (1) and Sophie Chabridon (2)
(1) ensIIE, SAMOVAR Lab, Évry, France
(2) SAMOVAR Lab, Télécom SudParis, Institut Polytechnique de Paris, Évry, France
Contacts: denisse.munantearzapalo [at] ensiie.fr, Sophie.Chabridon [at] telecom-sudparis.eu

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Context. Dynamic adaptation of software is conceived as a way to avoid and correct, at runtime and under certain constraints, the degradation of quality of the software during its execution, which can be due to changes in environmental conditions. A substantial research effort has been done for defining methods and techniques to engineering self-adaptive software systems, SAS for brevity. And notably, research on model-driven approaches [2] and in particular on model@run.time methods have been proposed to specify how SAS should react in dynamically changing run-time environments [1].

Self-Adaptive Cloud Systems (SACS) dynamically adapt Cloud-based Software Applications with a specific adaptation goal, for instance, improving their energy efficiency to consequently reduce their overall greenhouse gas emissions. To do that, SACS are equipped with components that monitor, analyse, plan and execute the adaptation decisions at runtime. In particular, the `Planner` component is one of the cornerstone of SAS whose responsibility is to **decide how** the software system should be adapted **to achieve their adaptation goals**.

Challenges and Internship objectives. The objective of this internship is to **explore**, **formalise** and **exploit** the knowledge domain/space of **dynamic adaptation plans** for Cloud Software Applications, or part of them by considering **energy efficiency** as a primary adaptation goal.

To reach the objective of the internship, we should first explore which parts, from now on called variants, of the cloud software application can be adapted at run-time. Next, we should formalise these variants through, for instance the Planning Domain Definition Language (PDDL) [5]. This formalisation should facilitate the reasoning of the planner. Finally, we should build a tool-supported approach that exploits the previous formalisation to plan adaptations.

To reach the objective, we have to take into consideration the following challenges : (1) the first challenge (**Ch1**) is **to conceive variant models that conform to the architectures of cloud applications** or part of them without loosing important information, and (2) in order to not impact other QoS criteria, for instance *User Satisfaction*, the second challenge (**Ch2**) is **to consider the management of conflicts** when evaluating variants that can affect energy efficiency and other qualities, so a multi-criteria approach should be studied.

Notice that **Ch1** is related to the exploration and formalistation of the dynamic adaptation plan space, and **Ch2** is related to the exploitation of the previous formalisation for calculating, for instance through a problem solving approach, the new adaptation plans.

In this internship, we plan to validate our proposal on the TeaStore application [1]. Benchmarking will be performed using Grid'5000 infrastructure [2]. In addition, the entire process for the experiments must be reproducible, e.g. the benchmarking campaign is based on the construction of Jupyter NoteBooks [3].

Terms and conditions

- Production of open source documentation and code (licenses : GFDL and LGPL).
- Preference for using open source software.
- Version control with the GitLab platform of Télécom SudParis.

This subject is part of the research works of the DiSSEM group concerning Distributed Systems, Software Engineering and Middleware, in the ACMES team of the SAMOVAR lab.

1. https://github.com/DescartesResearch/TeaStore
2. https://www.grid5000.fr
3. https://www.fun-mooc.fr/en/courses/reproducible-research-methodological-principles-transparent-scie/

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