Offer #2025-08850

PhD Position F/M Coordinating multiple autonomic feedback loop managers in the Cloud/Edge computing

Contract type : Fixed-term contract

Level of qualifications required : Graduate degree or equivalent

Fonction : PhD Position

About the research centre or Inria department

The Centre Inria de l'Université de Grenoble groups together almost 600 people in 24 research teams and 9 research support departments.

Staff is present on three campuses in Grenoble, in close collaboration with other research and higher education institutions (Université Grenoble Alpes, CNRS, CEA, INRAE, …), but also with key economic players in the area.

The Centre Inria de l'Université Grenoble Alpes is active in the fields of high-performance computing, verification and embedded systems, modeling of the environment at multiple levels, and data science and artificial intelligence. The center is a top-level scientific institute with an extensive network of international collaborations in Europe and the rest of the world.

Context

co-advised by Eric Rutten (Ctrl-A, Grenoble), INRIA, and Thomas Ledoux (Stack, Nantes), IMT Atlantique

Within the framework of a partnership of collaboration between 2 Inria teams: Ctrl-A and Stack, funded by the Taranis project in the PEPR Cloud.

Assignment

Orchestration is a process that consists of managing dynamically and automatically computing resources in the Cloud/Edge, applications and services in order to satisfy final users.

Autonomic management and orchestration of distributed systems use feedback control loops [IBM03] that react to perceived variations (events or values in the system and its environment) by deciding upon reconfigurations (hardware and/or software). These reconfigurations are then implemented through basic actions in the system's API.

Feedback loops can manage a variety of objectives, of different natures (e.g., self-optimization, self-configuration, self-protection, etc.). They deal with different dimensions: quantitative, temporal, logical, etc. and rely upon diverse decision techniques (control theory, scheduling, constraints resolution, learning, etc.). The general challenge is the design of autonomic managers that can handle this complexity.

This research topic considers the necessity to coordinate multiple autonomic loops, interdependent or in parallel, to face the co-existence of multiple problems in real-world complex architectures.

Main activities

The approach consists of exploring novel compositions of controllers and decision techniques, exploiting their complementarities, and applying them to concrete resource management problems that can benefit from them.

Compositions of loops will be studied at the level of software architectures of autonomic managers, exploring coordination mechanisms with a "black box" vision via mechanisms of vote or consensus, or "white box" with more internal integration (e.g., control and constraints), or "grey box" at intermediary levels of integration.

Particularly interesting compositions concern:

- the coordination of infrastructure and application managers, specified separately, for reasons of separation of concerns, and considering that

development teams are distinct. Typically, applications can have running modes that sollicit resources in different ways, and which can be exploited when reconfiguration is required ([Alvares13], [Serrano16], [Mokhtari24], [Moghaddam22]).

- the composition of managers for deployment (typically based on constraints resolution), taking into account the dynamic aspects of the variations they are reacting to (typically speed or acceleration of evolutions).
- beyond the previous point, the composition and coordination of deployment managers (or even scheduling) with managers using Control Theory [Rutten18] for the regulation of system values such as the number of servers or power consumption.

For scheduling-related topics, the work can be done in cooperation with another topic in the Taranis project, on control and scheduling.

Experimental validation "in vivo" will concentrate on the SLICES-FR (https://slices-fr.eu/) platform, a research infrastructure covering the whole continuum IoT/networks/edge/cloud, with a particular attention for reproducibility. Another path of experimentation will consider simulation, like the Batsim environment
(https://batsim.frama.io/).

Références

[IBM03] J. O. Kephart and D. M. Chess, "The vision of autonomic computing" in Computer, vol. 36, no. 1, pp. 41-50, Jan. 2003

[Alvares13] F. Alvares de Oliveira, T. Ledoux and R. Sharrock, "A Framework for the Coordination of Multiple Autonomic Managers in Cloud Environments" in IEEE 7th International Conference on Self-Adaptive and Self-Organizing Systems, Philadelphia, PA, USA, 2013

[Moghaddam22] Mahyar Tourchi Moghaddam, Eric Rutten, Guillaume Giraud, "Hierarchical Control for Self-adaptive IoT Systems A Constraint Programming-Based Adaptation Approach" in HICSS 2022 – Hawaii International Conference on System Sciences, Jan 2022, Hawaii, United States.

[Serrano16] Damián Serrano, Sara Bouchenak, Yousri Kouki, Frederico Alvares de Oliveira Jr., Thomas Ledoux, Jonathan Lejeune, Julien Sopena, Luciana Arantes, and Pierre Sens. "SLA guarantees for cloud services", Future Generation Computer Systems, Pages 233-246, Volume 54, 2016.

[Mokhtari24] Anas Mokhtari, Baptiste Jonglez, Thomas Ledoux. Towards Digital Sustainability: Involving Cloud Users as Key Players. IC2E 2024 - 12th IEEE International Conference on Cloud Engineering, Sep. 2024, Paphos, Cyprus.

[Rutten18] Eric Rutten, Nicolas Marchand, Daniel Simon. Feedback Control as MAPE-K loop in Autonomic Computing. Software Engineering for Self-Adaptive Systems III. Assurances., 9640, Springer, pp.349-373, 2018, LNCS.

Skills

The PhD candidate must have:

- a MSc degree in Computer science.
- Excellent skills in programming languages, software engineering
- Knowledge in the domains of Cloud infrastructures, autonomic computing, control techniques.
- Good organizational and communication skills.
- Relational skills: curiosity, autonomy and social capabilities.

Benefits package

- **Subsidized meals**
- **Partial reimbursement of public transport costs**
- **Leave: 7 weeks of annual leave + 10 extra days off due to RTT (statutory reduction in working hours) + possibility of exceptional leave (sick children, moving home, etc.)**
- **Possibility of teleworking (90 days / year) and flexible organization of working hours**
- **Social, cultural and sports events and activities**
- **Access to vocational training**
- **Social security coverage under conditions**

Remuneration

2200 euros gross salary /month

General Information

- **Theme/Domain :** Distributed Systems and middleware Software engineering (BAP E)
- **Town/city :** Grenoble
- **Inria Center :** Centre Inria de l'Université Grenoble Alpes
- **Starting date :** 2025-10-01
- **Duration of contract :** 3 years

- **Deadline to apply :** 2025-07-11

Contacts

- **Inria Team :** CTRL-A
- **PhD Supervisor :**
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About Inria

Inria is the French national research institute dedicated to digital science and technology. It employs 2,600 people. Its 200 agile project teams, generally run jointly with academic partners, include more than 3,500 scientists and engineers working to meet the challenges of digital technology, often at the interface with other disciplines. The Institute also employs numerous talents in over forty different professions. 900 research support staff contribute to the preparation and development of scientific and entrepreneurial projects that have a worldwide impact.

> **Warning** : you must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website. Processing of applications sent from other channels is not guaranteed.

Instruction to apply

Defence Security :
This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST).Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

Recruitment Policy :
As part of its diversity policy, all Inria positions are accessible to people with disabilities.