



Offer #2024-07598

PhD Position F/M Decentralised Market-based Application Orchestration in Fog and IoT Environments

Contract type : Fixed-term contract

Level of qualifications required : Graduate degree or equivalent

Other valued qualifications : Master's degree

Fonction : PhD Position

About the research centre or Inria department

The Inria Centre at Rennes University is one of Inria's nine centres and has more than thirty research teams. The Inria Centre is a major and recognized player in the field of digital sciences. It is at the heart of a rich R&D and innovation ecosystem: highly innovative PMEs, large industrial groups, competitiveness clusters, research and higher education players, laboratories of excellence, technological research institute, etc.

Context

In the context of the TARANIS project (PEPR Cloud), we are offering a PhD position to investigate flexible and decentralised application orchestration in fog environments.

The work will be carried out within the MAGELLAN team (Inria Centre at Rennes University, IRISA) at Rennes. Rennes is the capital city of Brittany, situated in the western part of France. Well-connected to Paris via a high-speed train line, Rennes is a lively city and a major center for higher education and research. The work will involve close collaboration with the STACK team (IMT Atlantique, Inria, LS2N) at Nantes.

PhD Advisors

- Nikos Parlavantzas (MAGELLAN team)
- Remous Aris Koutsiamanis (STACK team)

Assignment

Fog computing extends the traditional cloud computing model by distributing compute, storage, and network capabilities closer to users along a cloud-edge-IoT continuum [1]. The motivations for fog computing include supporting low latency, high bandwidth, data privacy, and energy efficiency [2]. Another significant motivation is democratising the network edge, enabling various actors such as individuals, companies, and communities to operate their own edge clouds, fostering sustained innovation and facilitating the emergence of new fog applications [3].

However, effectively delivering fog applications that optimally exploit fog capabilities poses significant challenges. First, fog applications are diverse and have varying requirements on QoS (Quality of Service) properties, such as latency, bandwidth usage, availability, and energy consumption [4]. Satisfying these requirements becomes even more challenging since the Fog/IoT infrastructure upon which these applications are deployed is often significantly constrained in the same axes. This makes it difficult for commonly-used, one-size-fits-all management approaches to optimise for application-specific QoS goals [5]. Second, fog applications must operate reliably despite dynamic and unpredictable changes in fog environments, resulting from user and device mobility, resource volatility, and topology changes. Coping with this dynamism requires making automated management decisions in a fast and scalable manner. Finally, fog applications must be able to use resources from multiple types of infrastructure providers, ranging from traditional cloud providers to small-scale edge cloud providers, which requires common interfaces and mechanisms for discovering and accessing these resources.

Main activities

To address these challenges, this thesis will explore flexible and decentralised application orchestration for fog environments. Specifically, the proposed approach is to equip each application with an automated application manager that produces an initial deployment for the application, potentially across resources from multiple infrastructure providers. The manager will then dynamically and autonomously adapt this deployment to react to environment changes in line with application-specific QoS goals [6,11]. The managers will negotiate and interact with infrastructure providers through a pricing

mechanism [7,10], incentivising providers to make their resources available [12] while enabling application owners to make flexible performance-cost trade-offs [8]. The implementation will support multiple application types and QoS goals [9] and build on standardised APIs and tools including the Kubernetes resource orchestrator. The solution will be evaluated on both emulated and real fog infrastructures using environmental monitoring and smart city applications.

References

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Skills

- Excellent communication and writing skills in English
- Strong programming and scripting skills in Linux environments
- Knowledge and experience in one or more of the following areas: distributed systems, IoT, cloud, edge, adaptive systems

Benefits package

- Subsidized meals
- Partial reimbursement of public transport costs
- Possibility of teleworking (90 days per year) and flexible organization of working hours
- Partial payment of insurance costs

Remuneration

Monthly gross salary amounting to 2100 euros for the first and second years and 2190 euros for the third year.

General Information

- **Theme/Domain** : Distributed Systems and middleware System & Networks (BAP E)
- **Town/city** : Rennes
- **Inria Center** : [Centre Inria de l'Université de Rennes](#)
- **Starting date** : 2024-09-01
- **Duration of contract** : 3 years
- **Deadline to apply** : 2024-06-23

Contacts

- **Inria Team** : [MAGELLAN](#)
- **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.

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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.