

PhD Position - Geo-distributed Storage System for Multi-Cloud Infrastructure

About Inria

Inria, the French national institute for research in computer science and control, is dedicated to fundamental and applied research in information and communication science and technology (ICST). Inria has a workforce of 3,800 people working throughout its eight research centers established in seven regions of France.

The PhD student will be integrated into the Avalon Research Team localized in Lyon. The co-advisors will be Gilles Fedak (Lyon) and Shadi Ibrahim (Rennes), respectively for the Avalon and KerData Research Teams.

Mission and activities

This PhD position targets the design, development and experimental validation of the data management framework envisioned in the Discovery initiative [1].¹ This next-generation storage systems aims at offering the best solution for Virtual Machine Images (VMI) management in the context of a geographically distributed cloud.

While the Internet was built in a decentralized fashion, we are currently witnessing a strong re-centralization of computing facilities such as those run by Amazon, Google or Facebook. The intrinsic limitations to this model is increasingly visible, chiefly due to reliability, privacy, and energy issues, as is experienced recently by users.

The Discovery initiative is driven by the objective of proposing a *decentralized cloud architecture* composed by deploying IT resources within the core of the network. Indeed, the infrastructures set up by Internet providers are most of the time over-provisioned given the actual needs. It consequently appears that installing computing resources along the path of the backbone could reduce the costs related to the construction, maintenance, and energy supply of a computing center by capitalizing on the existing infrastructure. Also, it will lead to a natural distribution of resources while favoring the use of resources that are geographically close to the user.

The objective of this thesis is to propose a *new storage system* able to provide the best performances for geo-distributed Clouds with a focus on VMI management.

The first objective of the thesis is to conduct a state-of-the art analysis on : (i) VM Image repository solutions, (ii) existing VM formats and identification of alternative formats that facilitate deployment mechanisms, (iii) tools to manage VM Image characterization to allow block prioritization, deduplication, replication used on other tasks, (iv) storage systems related to multi-sites deployment.

A VM image repository is a storage and inventory system at which VM Images (VMIs) are stored and that provides functions to manage VMIs, essentially to query, track, copy, clone, and update, in a secure manner.

¹ <http://beyondtheclouds.github.io>

In particular, we will focus our research leveraging two technologies: OpenStack [2] for Cloud infrastructure management and Ceph [3], a distributed storage system with the goal of revisiting the current VM image repository in order to fit in the Discovery requirements (geo-distributed multi-Clouds).

We propose also to study placement/scheduling algorithms that can use the knowledge of content when searching hosts to deploy VMs; hosts close to or the same as those already holding pages of the VMI may be preferentially selected.

Finally, we plan to investigate advanced mechanisms to move a step forward the VM images management inside DISCOVERY. Three axes will be investigated:

- Improve and adapt the Ceph distributed storage to cope with VMI management : deduplication, block distribution prioritization, multi-sites setting, in-memory, latency-tolerant strategies (prefetching, localization, caching, overlapping, bursting etc...) and energy-efficiency globally and locally.
- Data scheduling strategies for VM images: Movements should be intelligent enough to reduce the overhead in terms of network congestion, latency and also energy footprint. Placement of VMI should allow to cope with user requirement (locality for instance), cross-site traffic minimization, load balancing between sites etc...
- Design relevant abstraction for locality-aware data management. As the infrastructure is distributed, it is necessary to represent the infrastructure in terms of costs and performances to move and store the data. Following this abstraction, the storage system will be able to handle efficiently different kinds of workload. In particular, we will consider the deployment of a content distribution network (CDN) on top of DISCOVERY.

The work will go through several phases. Firstly, the requirements will have to be formalized. Secondly, the initial experiences should allow building relevant scenarios, that will allow to design algorithms providing relevant optimizations. Thirdly, an experimental validation and tuning of the parameters of the algorithm, probably through their deployment on a large-scale platform such as Grid'5000 [4] will be planned.

References

[1] M. Bertier, F. Desprez, G. Fedak, A. Lebre, A.-C. Orgerie, J. Pastor, F. Quesnel, J. Rouzaud-Cornabas, and C. Tedeschi. Beyond the clouds: How should next generation utility computing infrastructures be designed? In Z. Mahmood, editor, *Cloud Computing: Challenges, Limitations and R&D Solutions*. Springer, Computer Communications and Networks, Springer, 2014.

[2] Sefraoui, O., Aissaoui, M., & Eleuldj, M. (2012). OpenStack: toward an open-source solution for cloud computing. *International Journal of Computer Applications*, 55(3).

[3] Weil, S. A., Brandt, S. A., Miller, E. L., Long, D. D., & Maltzahn, C. (2006, November). Ceph: A scalable, high-performance distributed file system. In *Proceedings of the 7th symposium on Operating systems design and implementation* (pp. 307-320). USENIX Association.

[4] <http://www.grid5000.fr>

Skills and profiles

Knowledge and/or experience in distributed systems

Experimentation skills (simulation and in-vivo experiments)
Autonomy / Curiosity
English or French mandatory

Additional information

The candidates are invited to contact Gilles Fedak and Shadi Ibrahim
(firstname.name@inria.fr).

Duration: 36 months

Location: Lyon, France

Monthly salary after taxes: around 1958 euros (medical insurance included).