Locality-aware and lazy overlay networks for WANs

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 recruited will be directed by Christine Morin from the Myriads team and co-advised by Marin Bertier from the ASAP team and Cédric Tedeschi from the Myriads research team, located at the Inria Rennes center.

Mission and activities

This PhD position targets the design, development and experimental validation of the overlay network envisioned in the Discovery initiative [1].[1] *This next-generation overlay aims at offering the best trade-off between maintenance cost and efficiency, while being built according to physical locality between nodes.*

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 [5].

The DISCOVERY initiative [2] is driven by the objective of proposing a decentralized cloud architecture composed by leveraging on the resources within the network's backbone. Telecom operator's infrastructure appears to be highly over-provisioned. In other terms, the backbone links and routers are highly underutilized most of the time. This suggests that this infrastructure could be exploited to underlie a utility computing platform. By adding computing resources on Point-of-presence (PoPs), a distributed utility computing platform could be deployed inside the telecom operator's core network. Doing so, a significant economy of scale can be achieved, with cost savings related to the construction, maintenance and energy supply of such 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.

Exploiting such a utility computing platforms calls for mechanisms to place applications, under the shape of virtual environments (made of multiple cooperating virtual machines), efficiently. The different problems to address are the following.

Firstly, the need is to locate close nodes. Indeed, deploying a set of cooperating virtual machines on a set of physically close nodes will avoid increasing latencies and uselessly burdening the network. Secondly, we need to provide a data management layer allowing to retrieve data efficiently while minimizing transfers when concurrent geographically-distributed accesses are made on these data. For instance, creating a data can always lead to a local storage of this data. Then, data migrations due to subsequent read and write operations can be minimized, by using indirection mechanisms for subsequent data retrieval operations. Thirdly, ensuring data availability will require devising a replication scheme. The replication

[1] http://beyondtheclouds.github.io

mechanisms designed must, again, account for a minimization of the data transfers required.

The work in this thesis will consist in proposing the building blocks for the design and implementation of reliable service and data placement mechanisms to be used in the DISCOVERY initiative. On the conceptual side, this will call for building proximity-aware overlay networks [3], large data (key value stores) management [7] and lazy data maintenance schemes [6].

The work will go through several phases. Firstly, the requirements will have to be formalized. Secondly, the algorithms will be developed and validated through analysis and simulation. 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] http://beyondtheclouds.github.io

[3] Frank Dabek, Russ Cox, M. Frans Kaashoek, Robert Morris: Vivaldi: a decentralized network coordinate system. SIGCOMM 2004: 15-26

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

[5] http://gigaom.com/2012/07/12/amazon-outages-lessons-learned/

[6] Sergey Legtchenko, Sébastien Monnet, Pierre Sens, Gilles Muller: RelaxDHT: A churn-resilient replication strategy for peer-to-peer distributed hash-tables. TAAS 7(2): 28 (2012)

[7] Cassandra: Principles and Application. Dietrich Featherston. Department of Computer Science University of Illinois at Urbana-Champaign.

Skills and profiles

Knowledge and/or experience in distributed systems
Experimentation skills (simulation and in-vivo experiments)
Highly motivated, autonomous and curious
English mandatory (French is a plus)

Additional information

The candidates are invited to contact Marin Bertier and Cédric Tedeschi (firstname.name@inria.fr).

Duration: 36 months
Location: Rennes, France
Monthly salary before taxes: 1958 euros (medical insurance included).