Master Internship — 5 to 6 months, starting between Feb. and Apr. 2023

AMICO - About the energy consumption of MIcroservices COntainers in cloud environments

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Context. Cloud computing and its many variations offer users considerable computing and storage capacities. The maturity of virtualization techniques has enabled the emergence of complex virtualized infrastructures, capable of rapidly deploying and reconfiguring virtual and elastic resources in increasingly distributed infrastructures. This resource management, transparent to users, gives the illusion of access to flexible, unlimited and almost immaterial resources.

However, the power consumption of these clouds is significant, as are the environmental impacts associated with their global emissions and their consumption of critical raw materials used to manufacture IT equipments. In a context where climate change is becoming more visible and impressive every year, with serious consequences for people and the planet, all sectors (transport, construction, agriculture, industry, etc.) must contribute to the effort to reduce greenhouse gas emissions. Despite their ability to optimize processes in other sectors (transport, energy, agriculture), clouds are not immune to this observation: the increasing slope of their greenhouse gas emissions must be reversed, or else their potential benefits in other sectors will be erased.

At the scale of a data center or a computer, it is now common that Cloud providers present electrical consumption to their customers. However at the scale of a software service, this remains a challenge that cloud providers have to face. Indeed, the increasing software stack between the hardware and the user's application (operating system, virtual machines, containers, orchestrators, microservices, etc.) as well as the interweaving between service calls makes it difficult to attribute a consumption to a service.

Internship roadmap. This project aims to address the problem of measuring the consumption of a computing microservice hosted in a container and using other microservices hosted in other containers. The ultimate goal is that this consumption can be evaluated by a cloud provider for each hosted microservice.

The cloud elasticity enables to acquire computing resources on demand, but this is usually driven by a CPU metric. There are only a few research works addressing both performance and energy dimensions to support the execution of microservices applications in the cloud ([2, 3]). The internship will therefore start with a state of the art regarding the available mechanisms (e.g. [1]) to measure the energy-consumption of microservices running in a cloud. The objective will then be to define solutions to monitor both performance and power consumption and apply reconfiguration actions when power consumption exceeds some budget.

Different application profiles will be defined and a prototype will be setup in order to evaluate the proposed solutions on representative microservices applications.

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.

References

[1] Aurelien Bourdon, Adel Noureddine, Romain Rouvoy, and Lionel Seinturier. Powerapi: A software library to monitor the energy consumed at the process-level. *ERCIM News*, 2013(92), 2013.

[2] Igor Fontana de Nardin, Rodrigo da Rosa Righi, Thiago Roberto Lima Lopes, Cristiano André da Costa, Heon Young Yeom, and Harald Köstler. On revisiting energy and performance in microservices applications: A cloud elasticity-driven approach. *Parallel Computing*, 108:102858, 2021.

[3] Foutse Khomh and S. Amirhossein Abtahizadeh. Understanding the impact of cloud patterns on performance and energy consumption. *Journal of Systems and Software*, 141:151–170, 2018.