PhD Position in Computer Science

Capture and propagate contextual green software data in cyber-physical environments

Laboratory : Laboratoire Informatique de l'Université de Pau et des Pays de l'Adour (LIUPPA)
Location : Anglet, France
Funding : PhD thesis funded by the E2S scientific challenges project
Supervisor : Adel Noureddine
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1 Introduction

The computer science laboratory of the University of Pau and Adour Countries (LIUPPA : Laboratoire Informatique de l'Université de Pau et des Pays de l'Adour), offers a 3-year PhD position designed for outstanding and motivated candidates.

2 Scientific Context

Energy demands in information systems, ranging from computers and servers to devices in Internet of Things (IoT) and data centers, have grown subsequently in the last decade. Information and Communication Technologies' (ICT) greenhouse gas emissions (GHGE) could exceed 14% of global GHGE by 2040 from around 1-1.6% in 2007. In particular, computers and data centers account for the majority of ICT energy consumption. These findings show the necessity to reduce and optimize energy consumption in computers and servers and in ICT. These issues in ICT have a broader impact on society : ICT is responsible for 4% of European CO2 emissions, and up to 10% of electricity consumption. In addition, there is a wider shift in computing economics as more services and applications are moving into cloud services. The energy strains, due to this shift, on user devices (smartphones, computers), but also on industrial actors (servers, industry 4.0) is therefore higher and the need for ICT energy optimizations is an important social and economic issue.

There have been many efforts to address energy consumption in computing systems, with approaches and results covering, 1) measuring energy consumption, 2) optimizing the energy consumption of software, 3) optimizing the energy footprint of servers and equipment in data centers, and 4) optimizing the workload in servers and in virtual machines. However, these approaches address energy in individual and separate layers or "silos" : energy is managed and optimized for a particular layer in the system (software, servers, equipment, OS, VM, middleware, etc.) or a particular workload. The next big leap in energy efficiency requires more than addressing each layer individually. Instead, energy should be managed by looking beyond each "silo" to address energy in a holistic way.

Our hypothesis is therefore to address energy consumption in computer systems in a holistic approach. We aim to understand the effects of the different layers of the system and contribute an approach to efficiently communicate energy and performance data between these layers. This knowledge-sharing is the key step to have a better understanding of the entire system and comprehend the interactions, effects and dependencies for better energy efficient systems.

3 PhD Project

The PhD project aims to better understand the factors affecting energy consumption across different layers in a computing environment, and use this knowledge to apply autonomous adaptations and reconfigurations. The context of the work combine software engineering and cyber-physical systems as we aim to address energy across software, computers, virtual environments and servers, equipment and physical devices and objects. The expected PhD project contributions are :

3.1 Understand and capture the factors affecting energy consumption

As current smart environments generate huge quantity of heterogeneous data (devices, software, living, interactions, IoT), there is a need to capture the useful and relevant data for energy optimizations. We aim to identify and capture relevant software and contextual data that can be used in energy adaptations. In particular, much information can be learned from software environments besides the energy and power consumption values. Therefore, the project aims to create a semantic green model for software using static and dynamic information from source code and software environment.

3.2 Propagate and share this knowledge across the system and the environment

Contextual data are rarely used in software runtime adaptations, with a few specific use cases. These data are heterogeneous, with different formats and standards. Most importantly, there is no common transportation vessel to share this data between software, operating systems, middleware and virtual machines, equipment, and connected devices and IoT.

Sharing contextual green data requires a standardized messaging format, and a transportation protocol. The energy-aware interface is expected to address challenges in computer systems, data centers and cyber-physical environments. The interface might be used in autonomic management of data centers. The interface will allow sharing of components' contextual and energy data through the layers of a data center environment, and thus allowing an energy-efficient management for sensors and effectors, and helps in building energy-aware autonomic data center systems in the different stages of monitoring, analyzing, planning and execution of software and hardware reconfigurations.

3.3 Use this shared knowledge to autonomously apply adaptations on the systems

These real-time and offline knowledge will be used to apply, autonomously, energy reconfigurations and adaptations to the environment. The collected contextual data, shared with the built interface and protocol, are used to reduce and optimize the energy consumption of software environments and cyber-physical systems. This will be achieved through runtime adaptations using the autonomic computing paradigm.

4 Candidates Requirements

We are looking for outstanding and motivated candidates for this 3-year position. The candidates must hold (or about to receive) a Master's degree in computer science, computer engineering, software engineering, or related areas. The candidate must have good English skills. Knowledge of French is not required but recommended as the thesis will take place in a French university.

Salary : This thesis has its own funding (from the E2S project), with a gross salary around 1878 € per month (which include extra gratification for teaching duties, 32 hours per year).

5 Applications

Applications must be sent to Dr. Adel Noureddine by email adel.noureddine@univ-pau.fr, with the following documents :

— A curriculum vitae,
— A motivation/cover letter explaining the interest in the scientific aspect of the PhD,
— Master's grades or equivalent,
— Examples of your scientific writing (publications, internship report, project reports),
— Any other documents the candidate seems fit to enrich his application,
— Contact details of at least two references.

Applications must be received before **5 July 2019**. Applications will be reviewed and selected candidates will be invited for interviews (in person for local candidates or by videoconference) that will take place all along the application period and up a week after the deadline.