Master Internship — 5 to 6 months, starting between Nov. and Dec. 2024

RENEW: Requirements engineering for mastering the interplay between ENergy Efficiency and other qualities of softWare

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Keywords Energy awareness, Energy-efficiency, Requirement Analysis, Goal-oriented Modelling

Context and motivation In the last years, software systems' energy-efficiency has been investigated by the Software Engineering research community along different aspects. For instance, conceptual frameworks and guidelines have been proposed to help increase stakeholders' awareness about energy efficiency, and more generally about sustainability requirements of software systems. Moreover, specific design patterns or code refactoring have been proposed to guide software system architects when evaluating possible alternative solutions.

Problem Taking a requirements engineering perspective, we can observe that requirements for software energy-efficiency often interplay with other functional and quality requirements thus requesting an early analysis and characterisation of alternative design solutions, which may coexist in the resulting software product [6].

Principal idea We revisit requirements engineering methods such as goal-oriented model-driven approaches, and use them to generate usage scenarios from requirements in a systematic, semi-automated way, with the purpose to evaluate software energy-efficiency requirements (see our previous work [4]).

Internship objectives. To give continuity to our previous work [4], we aim at answer the following research question: How can we analyse the interplay between energy efficiency and other qualities of software?

To answer this question, concretely the tasks that will be carried by the selected candidate are:

1. Study the software-based power meters that can be used for monitoring energy consumption [2].
2. Study goal-oriented modelling that proved to be effective in analysing conflicting requirements, e.g. [3].
3. Study the applicability of goal-oriented modelling for representing and analysing sustainability requirements, *e.g.,* [1, 5].
4. Define how to integrate energy consumption measurements, which are collected at run-time, into goal-oriented requirements models.
5. Design a method that analyses the interplay of energy efficiency and other qualities.

References

[1] Jordi Cabot, Steve Easterbrook, Jennifer Horkoff, Lysanne Lessard, Sotirios Liaskos, and Jose-Norberto Mazon. Integrating sustainability in decision-making processes: A modelling strategy. In *2009 31st International Conference on Software Engineering - Companion Volume*, pages 207–210, 2009.

[2] Mathilde Jay, Vladimir Ostapenco, Laurent Lefèvre, Denis Trystram, Anne-Cécile Orgerie, and Benjamin Fichel. An experimental comparison of software-based power meters: focus on CPU and GPU. In Yogesh Simmhan, Ilkay Altintas, Ana Lucia Varbanescu, Pavan Balaji, Abhinandan S. Prasad, and Lorenzo Carnevale, editors, *23rd IEEE/ACM International Symposium on Cluster, Cloud and Internet Computing, CCGrid 2023, Bangalore, India, May 1-4, 2023*, pages 106–118. IEEE, 2023.

[3] Sotirios Liaskos, Rina Jalman, and Jorge Aranda. On eliciting contribution measures in goal models. In Mats Per Erik Heimdahl and Pete Sawyer, editors, *2012 20th IEEE International Requirements Engineering Conference (RE), Chicago, IL, USA, September 24-28, 2012*, pages 221–230. IEEE Computer Society, 2012.

[4] Denisse Muñante, Anna Perini, and Angelo Susi. Exploiting goal-oriented requirements models for increasing energy awareness: A research preview. In *Proceedings of the 16th International iStar Workshop co-located with the 31st International Requirements Engineering Conference (RE 2023), Hannover, Germany*. CEUR-WS.org, 2023.

[5] Gunter Mussbacher and Douglas Nuttall. Goal modeling for sustainability: The case of time. In *IEEE 4th International Model-Driven Requirements Engineering Workshop, MoDRE 2014, 25 August, 2014, Karlskrona, Sweden*, pages 7–16. IEEE Computer Society, 2014.

[6] Shola Oyedeji, Bilal Naqvi, Birgit Penzenstadler, Mikhail O Adisa, Mariam Abdulkareem, and Ahmed Seffah. The interplay between usability, sustainability and green aspects: A design case study from a developing country. In *ICT4S*, 2019.