Distributed software reconfiguration in the presence of intermittent IoT nodes

December 8, 2023

1 Context

This internship focuses on autonomous IoT nodes built around an ambient energy harvesting mechanism (solar, RF, etc.), one or more sensors, a microcontroller and a wireless network interface. For a number of reasons, it makes sense to build these nodes without a battery [GY22] and simply integrate a (super)capacitor to act as an energy buffer, easing the transition between periods of activity and periods of sleep. As a result, the node inherits the intermittent nature of the energy source that powers it. Special compilation and execution techniques are used to ensure that the computations executed on the node progress despite the intermittent availability of the input energy [LBC+17].

The work envisaged for this internship consists of proposing and prototyping a solution to enable the integration of intermittent IoT nodes into a distributed software reconfiguration process (e.g., software update, changes in the distributed topology). The main challenge is to take into account the specific constraints of these nodes: very limited resources (memory, bandwidth) and intermittent operation.

Several aspects will be addressed:

- Modelling intermittent nodes for the problem of distributed software reconfiguration;

- Adapting reconfiguration computation and orchestration algorithms to the presence of intermittent nodes;

- Extending RESURRECT [Ber23] (a runtime for intermittent nodes) and Concerto [CCP20, CJL19] (a reconfiguration tool) to support distributed software reconfiguration.

2 Profile

We are looking for a student in the 2nd year of a Master's degree in Computer Science or Computer Engineering, or in the 3rd year of an engineering school in Computer Science, with solid knowledge in one or more of the following subjects:

- Software engineering (modelling and verification);

- Distributed systems (distributed algorithms, distributed reconfiguration);

- IoT (microcontroller programming, LPWAN networks).

3   Internship conditions

- Duration: 6 months;

- Period: 1 March to 31 August 2024;

- Compensation: €4.05 per hour, or approximately €590 per month;

- Address: see below.

The internship will take place at LS2N (Laboratoire des Sciences du Numérique de Nantes), between the STACK and STR teams. The intern will be hosted at one of the two sites of the laboratory: École Centrale Nantes or the Nantes campus of the Institut Mines Télécom Atlantique.

4   Contacts

Please send your questions and applications to `helene.coullon-at-imt-atlantique.fr` and `sebastien.faucou-at-ls2n.fr`.

References

[Ber23]   Antoine Bernabeu. *Support d'exécution pour les systèmes intermittents.* PhD thesis, École Centrale Nantes, 2023.

[CCP20]   Maverick Chardet, Hélène Coullon, and Christian Pérez. Predictable Efficiency for Reconfiguration of Service-Oriented Systems with Concerto. In *CCGrid 2020 : 20th IEEE/ACM International Symposium on Cluster, Cloud and Internet Computing*, Melbourne, Australia, 2020. IEEE.

[CJL19]   Hélène Coullon, Claude Jard, and Didier Lime. Integrated Model-checking for the Design of Safe and Efficient Distributed Software Commissioning. In *IFM 2019 : 15th International Conference on integrated Formal Methods*, Integrated Formal Methods, pages 120–137, Bergen, Norway, 2019.

[GY22]   A. Goknil and K. S. Yildirim. Toward sustainable iot applications: Unique challenges for programming the batteryless edge. *IEEE Software*, 39(5):92–100, 2022.

[LBC+17]   B. Lucia, V. Balaji, A. Colin, K. Maeng, and E. Ruppel. Intermittent Computing: Challenges and Opportunities. In *2nd Summit on Advances in Programming Languages (SNAPL 2017)*, pages 8:1–8:14, 2017.