Institutional Repository - Research Portal
Dépôt Institutionnel - Portail de la Recherche

researchportal.unamur.be

University of Namur

RESEARCH OUTPUTS / RÉSULTATS DE RECHERCHE

STARS

Lima dos Santos, Edilton; Perrouin, Gilles; Schobbens, Pierre Yves

Published in:
Proceedings - VaMoS 2020

DOI:
10.1145/3377024.3377033

Publication date:
2020

Document Version
Peer reviewed version

Link to publication

Citation for pulished version (HARVARD):
Lima dos Santos, E, Perrouin, G & Schobbens, PY 2020, STARS: Software Technology for Adaptable and Reusable Systems PhD Research Project. in M Cordy, M Acher, D Beuche & G Saake (eds), *Proceedings - VaMoS 2020: 14th International Working Conference on Variability Modelling of Software-Intensive Systems.*, a15, PervasiveHealth: Pervasive Computing Technologies for Healthcare, ACM Press, pp. 1-2, 14th International Working Conference on Variability Modelling of Software-Intensive Systems, VaMoS 2020, Magdeburg, Germany, 5/02/20. https://doi.org/10.1145/3377024.3377033

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal ?

Take down policy
If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Download date: 19. Apr. 2024

STARS: Software Technology for Adaptable and Reusable Systems PhD Research Project

Edilton Lima dos Santos (PhD Student)
edilton.limados@unamur.be
University of Namur

Gilles Perrouin (Promoter)
gilles.perrouin@unamur.be
University of Namur

Pierre-Yves Schobbens (Co-Promoter)
pierre-yves.schobbens@unamur.be
University of Namur

ABSTRACT

Dynamically Adaptive Systems (DAS) modify their behaviours in response to (sometimes unpredictable) changes in their environment or to the evolution of their own abilities (sensors and actuators). To support adaptation, a reference architecture (such as the MAPE-K model) is paramount. Yet, this is not sufficient as challenges concerning the fine-grained variability management and testability remain. The STARS Ph.D. project aims at developing a variability and context-aware architectural model for DAS that particularly takes into account testability. In particular, we want to adapt tests at runtime in order to assess and prevent the impact of inappropriate adaptations.

KEYWORDS

Self-adapting, Software architecture, MAPE-K loop, Software test.

ACM Reference Format:
Edilton Lima dos Santos (PhD Student), Gilles Perrouin (Promoter), and Pierre-Yves Schobbens (Co-Promoter). 2020. STARS: Software Technology for Adaptable and Reusable Systems PhD Research Project. In *Proceedings of the 14th International Working Conference on Variability Modelling of Software-Intensive Systems (VaMoS '20), February 5–7, 2020, Magdeburg, Germany*. ACM, New York, NY, USA, 2 pages. https://doi.org/10.1145/3377024.3377033

1 CONTEXT

The advent of internet-of-things (IoT) and Smart Homes has led to an ever-increasing number of connected devices and sensors, which produce an enormous amount of data, that in turn fuel smarter software systems [12]. An important characteristic of such systems refers to their capability of dynamically self-adapting according to changes in their execution environment in a way that is transparent to their users [10]. Also, adaptations are difficult to define since they may take place at the early stages of the development process, but also at runtime where there are many situations to consider, e.g., limited connectivity, hardware heterogeneity, changes of user preferences, etc. Software architecture is paramount to support adaptation robustly and efficiently. As a result, the role of software architecture is gaining momentum in the research and practitioners communities [4].

VaMoS '20, February 5–7, 2020, Magdeburg, Germany

© 2020 Copyright held by the owner/author(s).
This is the author's version of the work. It is posted here for your personal use. Not for redistribution. The definitive Version of Record was published in *Proceedings of the 14th International Working Conference on Variability Modelling of Software-Intensive Systems (VaMoS '20), February 5–7, 2020, Magdeburg, Germany*, https://doi.org/10.1145/3377024.3377033.

Besides that, there are challenges to testing because the context is unpredictable and may change at any time [5]. In this scenario, is necessary to consider the dynamic context changes while testing a dynamically adaptive system (DAS). Some works [3] [5] [9], present solutions can help us to understand how to test DAS, taking into account its adaptability to context. These solutions can be used to develop more testable and adaptable architectures.

2 OBJECTIVE

The main objective of the Software Technology for Adaptable and Reusable Systems (STARS) project is to develop an architecture model for DSPL construction that allows the analysis of context based on sensors or data produced by other systems and in the sequence initialize the reconfiguration process. For this purpose, it must take into account the models of Variability and Context [6]. Moreover, the STARS project is based on the Smart Home Environment (SHE) Architecture and SHE Framework [12], aimed to support Dynamic Software Product Lines (DSPL). The SHE project is based on the MAPE-K architecture, capable to support Monitoring, Analysis, Planning and Execution activities, required to handle self-adaptive systems [7],[2]. Besides, the SHE project also handles Knowledge, as a means to provide the necessary data to support the system reconfiguration process and interact with all the other activities.

Also, we want to understand how these architectures can be tested at runtime to minimize the impacts of inappropriate adaptations to unpredictable contexts. To such purpose, the research will explore the links between DAS and testability, e.g., how to adapt the test methodology and tools to dynamically evolving features.

3 RESEARCH QUESTIONS

The STARS project is articulated with respect to the following research questions:

RQ1. What are suitable models and mechanisms to handle variability in a DSPL architecture? To address this research question, we will survey the existing architectural proposals, notably those based on MAPE-k loops, and investigate how existing variability mechanisms (*e.g.*, feature models [8]) can be related to the model. As a result, a new architectural model will be proposed. This architectural model will particularly take into account testability.

RQ2. How does the architecture support the identification of a specific context to foster the requested system adaptation? In particular, we will assess the identification capabilities of the proposed architectural model on the SHE platform.

RQ3. What are the appropriate adaptation mechanisms and how can they be tested? As we have seen, two adaptation strategies exist: ECA and goal-based. The goal of this research question is to explore which strategies are the most appropriate and how can they be efficiently tested.

4 BRIEF WORK PLAN

To investigate the proposed research questions, we will generally follow an empirical approach, using the SHE implementation as validation platform. The first step is to investigate about the testing of the DAS because the context is unpredictable and may change at any time. Then a literature survey will be conducted to cover the test techniques, methods, and tools necessary to perform the assessment in RQ3. We expect that this step will take six months and the outputs will be the literature survey (a journal publication is envisioned) and a technical report describing the test strategies for DAS.

The second step is to investigate the areas of SPL engineering, DSPL engineering, Context-Aware Systems, MAPE-K model, model-driven engineering (MDE), Event-Condition-Action (ECA) rules and goal optimization. Understanding these underlying concepts is of utmost importance to follow up on this research. Then a literature survey will be conducted to cover the models necessary to perform the assessment in RQ1. We expect that this step will take six months and the outputs will be the literature survey (a journal publication is envisioned) and a technical report describing the proposed architectural model.

The third step is to perform an exploratory study to assess the SHE platform. The study aims to understand *when* and *how* the SHE platform is capable to identify the specific context and, based on it, finding the appropriate sequence of actions and the software mechanisms that enable adaptation. A follow-up study will be conducted to identify *when* and *how* the SHE to adapt to perform the assessment in RQ2 in relation with the architectural model proposed. This step will require to extend the platform to support the requirements of the architectural model. We estimate that one year and half is necessary to carry out this step and that it will result in three conference publications.

The fourth step consists in investigating the adaptation mechanisms identified during the first step with respect to the SHE platform. In particular, we will implement and test them on the SHE platform with respect to various application scenarios: incident management (fire, health issue) or efficient energy management. This step will last one year and result in one journal publication.

Finally, the last year will be dedicated to the dissertation writing and the thesis defense.

5 RELATED WORK

Perrouin et al. [11] presented an approach, which allows dynamically adapting not only the system but also both its adaptation mechanisms and its adaptation policies. This work exploits the ECA-based and Goal-based techniques to define a dynamically reconfigurable adaptation loop. The adaptation loop allows evolving *Dynamically Adaptive Systems* (DAS) in a much more flexible manner. Moreover, the authors, pointed out the synchronization issue when evolving the variability model at runtime and highlighted the need for a runtime checker ensuring the validity of dynamically adaptive systems. Both works consider the MAPE loop as the basis for adaptive systems. However, STARS does not combine reasoning strategies (goals or ECA) to cope with new requirements, optimize DAS to use the most adapted reasoner or easily integrate new dimensions of the environment, it uses the MAPE-K loop. That is, we use the data produced by the system as a strategy for decision making.

Baresi et al. [1] proposed a reference architecture for dynamically evolving DSPLs, which manages the validation, rebinding and adaptation stages of the DSPL evolution process. For each stage, the authors propose the reasoning operations to avoid consistency and correctness issues, which cannot be properly handled manually by the DSPL maintainer due to their complexity. In addition, explained how this architecture supports the evolution of DSPLs based on Feature Models extended with cardinality and attributes. Our work uses the MAPE-K loop to bind and unbind new features according to DSPL reconfiguration rules and context.

Acknowledgments. Gilles Perrouin is a FNRS Research Associate.

REFERENCES

[1] Luciano Baresi and Clément Quinton. 2015. Dynamically evolving the structural variability of dynamic software product lines. In *Proceedings of the 10th International Symposium on Software Engineering for Adaptive and Self-Managing Systems*. IEEE Press, 57–63.
[2] Nelly Bencomo, Jaejoon Lee, and Svein Hallsteinsen. 2010. How dynamic is your Dynamic Software Product Line?. In *4th Int. Workshop on Dynamic Software Product Lines (DSPL)*.
[3] Jiang Bo, Long Xiang, and Gao Xiaopeng. 2007. MobileTest: A tool supporting automatic black box test for software on smart mobile devices. In *Proceedings of the Second International Workshop on Automation of Software Test*. IEEE Computer Society, 8.
[4] Rafael Capilla, Jan Bosch, Pablo Trinidad, Antonio Ruiz-Cortés, and Mike Hinchey. 2014. An overview of Dynamic Software Product Line architectures and techniques: Observations from research and industry. *Journal of Systems and Software* 91 (2014), 3–23.
[5] Ismayle de Sousa Santos, Rossana Maria de Castro Andrade, Lincoln Souza Rocha, Santiago Matalonga, Kathia Marcal de Oliveira, and Guilherme Horta Travassos. 2017. Test case design for context-aware applications: Are we there yet? *Information and Software Technology* 88 (2017), 1–16.
[6] Matthias Galster, Uwe Zdun, Danny Weyns, Rick Rabiser, Bo Zhang, Michael Goedicke, and Gilles Perrouin. 2016. Variability and Complexity in Software Design: Towards a Research Agenda. *ACM SIGSOFT Software Engineering Notes* 41, 6 (11 2016), 27–30. https://doi.org/10.1145/3011286.3011291
[7] IBM. 2006. An architectural blueprint for autonomic computing. *IBM White Paper* 31 (2006), 1–6.
[8] Kyo C Kang, Sholom G Cohen, James A Hess, William E Novak, and A Spencer Peterson. 1990. *Feature-oriented domain analysis (FODA) feasibility study*. Technical Report. Carnegie-Mellon Univ Pittsburgh Pa Software Engineering Inst.
[9] S. Matalonga and G.H. Travassos. 2017. Testing context-aware software systems: Unchain the context, set it free! *ACM International Conference Proceeding Series* (2017), 250–254. https://doi.org/10.1145/3131151.3131190 cited By 0.
[10] Jacopo Mauro, Michael Nieke, Christoph Seidl, and Ingrid Chieh Yu. 2016. Context Aware Reconfiguration in Software Product Lines. In *Proceedings of the 10th International Workshop on Variability Modelling of Software-intensive Systems (VaMoS)*. 41–48.
[11] G. Perrouin, B. Morin, F. Chauvel, F. Fleurey, J. Klein, Y. Le Traon, O. Barais, and J.M Jézéquel. 2012. Towards flexible evolution of Dynamically Adaptive Systems. In *2012 34th International Conference on Software Engineering (ICSE)*. 1353–1356. https://doi.org/10.1109/ICSE.2012.6227081
[12] Edilton Santos and Ivan Machado. 2018. Towards an Architecture Model for Dynamic Software Product Lines Engineering. In *2018 IEEE International Conference on Information Reuse and Integration (IRI)*. IEEE, 31–38.