THE UNIVERSITY OF ADELAIDE

South Australia

Formal Verification of Transactional and Configurable Service-Oriented Processes

A dissertation submitted for the degree

Doctor of Philosophy in the School of Computer Science

by

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2016

ABSTRACT OF THE DISSERTATION

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The industrial rise of Web services and cloud services provides ample opportunities for business processes to be implemented with third-party components in a way that is rapid to develop, low-cost, and with reduced start-up risk. *Service-oriented processes* are business processes implemented by remotely provisioning third-party services: autonomous black box implementations of common software or hardware requirements. However, executing a workflow structure of these distributed and heterogeneous components creates several transactional concerns. These include ensuring an acceptable level of atomicity over long-running executions, handling a diverse range of potential fault types, and considering the various transactional properties of component services.

In this thesis, we present three related approaches towards ensuring well-formed transactional behavior in service-oriented processes. We address the problem of identifying issues in the transactional behavior of service-oriented processes at design-time, to prevent costly issues or redevelopment at later stages. We adapt an expressive service-oriented process modeling approach that allows for developers to specify detailed transactional behavior. A set of rules can be applied to this model in order to identify transactional issues such as deadlock and invalid termination. Furthermore, developers can elicit complex and varied transactional requirements for the process with ease using our set of *temporal logic templates*. Model checking is used to ensure that process designs satisfy these rules and requirements.

Recent innovations in *cloud services* have led to the proposal of *Business Process as a Service* (BPaaS). BPaaS offers common business processes as configurable cloud services, enabling clients

to perform complex or resource expensive business operations in a simple pay-be-use manner. Both service providers and clients have concerns to be satisfied during BPaaS configuration. Providers must enforce *domain constraints* to restrict the service to valid configurations, while the client has their own application-dependent requirements for the service to meet. Using *Binary Decision Diagram* (BDD) analysis and model checking as formal methods, we devise a multi-step process that identifies a BPaaS configuration satisfying the requirements of both parties.

These verification and configuration techniques have been implemented in a prototype tool called TL-VIEWS. We include six validation scenarios to demonstrate the effectiveness of our methods, using real Web and cloud services. An extensive performance analysis is performed for each model checking feature used by TL-VIEWS and the results indicate that our state-space reduction measures can decrease verification time for complex models by up to 98.63%.

ORIGINALITY STATEMENT

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SELECTED PUBLICATIONS GENERATED FROM THIS THESIS

1. S. Bourne, C. Szabo, and Q.Z. Sheng. Managing Configurable Business Process as a Service to Satisfy Client Transactional Requirements. In *Proceedings of the 11th International Conference on Services Computing*, IEEE, 2015.

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7. S. Bourne, C. Szabo, and Q.Z. Sheng. Verification and Assurance of Transactional Requirements in Service-Oriented Processes: A Survey. *(Under review for Computing Surveys, ACM).*

ACKNOWLEDGMENTS

I have been extremely fortunate during my candidature to have the backing of a great support network, both inside and outside my work environment. This thesis simply could not have been completed without all of their presence, input, and encouragement.

I am deeply grateful to my co-supervisor Dr. Claudia Szabo for the time, guidance, effort, input, and knowledge she has dedicated to me over the last few years. Under her encouraging, ambitious, and understanding supervision, I felt I could really produce my best work and grow as a researcher. Her role in improving my ability to *analyze* research work, rather than simply absorb it, cannot be understated.

From day one of my candidature, my principal supervisor Associate Professor Michael Sheng has given me valuable insight into conducting and writing research, while instilling me with the confidence to aim high. I am very appreciative for everything he has done for me over the years, and for the tremendous impact he has had on my professional development.

During my time at the School of Computer Science in The University of Adelaide, there have been many other students that have provided me with support, help, encouragement, and friendship. For all this, I want to thank Yihong, Ali, Javier, Lu, Lachlan, Kewen, Sujith, and Lijuan.

Away from academic life, I am very thankful to my parents for the unwavering support that has been behind every accomplishment I have made. Regular camaraderie from my interstate brother delivered to my inbox has been appreciated, masked in dry humour though it was. I also want to thank my friends Michael, Daniel, Nathan, Diana, Tom, Candice, Angela, and Heather. All the fun we have had together allowed me to keep going.

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