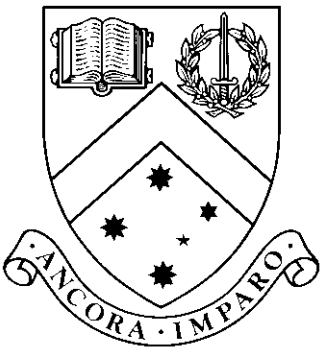
# Pervasive Services Engineering for SOAs

by

**Dhaminda Buddhika Abeywickrama, BComp (Hons)**




**Thesis**

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Supervisor: Dr. Sita Ramakrishnan

**Clayton School of Information Technology**
**Monash University**

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Dhaminda Buddhika Abeywickrama, BComp (Hons)
Dhaminda.Abeywickrama@gmail.com
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## Abstract

Context information is of great importance for pervasive services to enhance their flexibility and adaptability to changing conditions and dynamic environments. However, context information is characterized by several qualities that make pervasive services challenging compared to conventional Web services. These are: a highly dynamic nature, real-time requirements, quality of context information and automation. Most existing approaches to representing pervasive services focus on the detailed design or implementation phases of the software life-cycle such as pervasive Web services. Little attention has been given to the early phase of design, such as architecture design, which is of a higher level and abstract in design. Building software architectural models of pervasive services provides service engineers with a better understanding of how these complex services interoperate and help uncover any errors during the early stages of the software life-cycle.

This thesis proposes a novel approach based on behavioral modeling and analysis techniques for modeling pervasive software services and their compositions and verifying the process behavior of these models against specified system properties. This systematic, architecture-centric approach for engineering pervasive services integrates the benefits of principles such as model-driven architecture, aspect-oriented modeling, and formal behavioral modeling and analysis techniques using model checking. The approach of this thesis is explored using a real-world case study in intelligent transport.

The research methodology of this thesis consists of three main stages. First, using the case study the use cases are extracted and a service specification for the system under consideration is defined using message sequence charts. Second, the architecture for the system is defined using a component configuration and an architecture model in Finite State Processes (FSP). Third, the architecture model synthesized is modularized by using aspect-oriented models in UML, and is automatically transformed into behavioral FSP. A custom tool - Aspectual FSP Generation - applying an effective pipeline of model-to-model and model-to-text transformations has been built to automate the correct separation of concerns of the crosscutting context-dependent functionality at both UML modeling and formal behavioral specification levels. The generated context-dependent adaptable behavior and the core service behavior for the pervasive services are rigorously verified using the LTSA model checker against specified system properties. An evaluation framework is presented to validate the custom tool developed, the context and adaptation dimensions of the customization approach, and the formal methods employed in this study. In summary, the primary contribution of this thesis is a novel, systematic architecture-centric approach for engineering pervasive services at the software architectural level.