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Semantic Integration of Heterogeneous Software Specifications

With 78 Figures

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Preface

In October 1998 the German Research Council (Deutsche Forschungsgemeinschaft, DFG) launched a Priority Program on the Integration of Software Specification Techniques for Applications in Engineering. Thirteen research projects were coordinated in this program, working in an interdisciplinary fashion on the different aspects of integration of software specifications. From the engineering point of view the systematic development of control software for technical systems was addressed, and computer scientists investigated the corresponding specification languages and techniques from the methodological, pragmatic, and semantic points of view. The overall concern within the program has been the multiparadigm approach to software development, which is inherently related to the subject of the program: working in different disciplines, with different backgrounds, aims, and languages. But multiparadigmatic views occur in industrial practice too, when teams of engineers and computer scientists work together on a common product and thus need to communicate with each other. The benefit of covering such a wide range of views in a research program, in spite of the communication problems each interdisciplinary project starts with, is that it corresponds with actual practice and thus enhances significantly the usability of the research results.

The main precondition for the definition of the Priority Program was that the multiparadigm approach to software development should not be avoided, but rather be supported. Instead of searching for the one language that serves all purposes, lets everyone understand each other, and makes everything unique, the use of established and tailor-made languages for the different concerns was supported as the only realistic and practicable way. This view is also broadly accepted elsewhere, and developments like the standardised Reference Model of Open Distributed Processing (RM-ODP) and the Unified Modeling Language (UML) realise these principles in different ways. The issue that arises immediately with the use of different languages, however, is the integration of these languages. Are the various specifications consistent with each other? Do some of their elements correspond to each other and, if so, in which way? Can specifications be translated from one language to another one

or are there paradigmatic differences that prevent this? Questions like these have to be addressed in such projects, and, from a more fundamental point of view, it must be clarified whether these are the relevant questions at all.

The aim of this book is to provide a framework for the integration of heterogeneous software specifications and in this way to support the multiparadigm approach. The book addresses in the first line the fundamental issues of what integration in this context means and how it can be achieved in general. Following the old slogan *Semantics first!*, the starting point has been to make precise the semantic concepts of specification languages, which also provide the fundamental concepts for integration. Separating semantics from both syntactic and methodological aspects in this way has led to a general semantic integration framework that is now independent of specification languages and methods, and can be universally applied. The instantiation of the integration framework with concrete languages will still require significant application-specific effort, depending on the syntactic and semantic complexity of the languages: the more features a language has and the less clear their semantics are, the more difficult and complex the instantiation will be. But, having a guideline that tells one what to do obviously makes such an endeavour much easier than trying to achieve an integration without an explicit integration concept and guideline. Moreover, many smaller examples for instantiations of the integration framework are worked out in detail in the book. They cover a wide spectrum of specification approaches, showing how their different concepts can all be embedded into the conceptual framework and how an integration can be achieved. According to the meta-level approach of the integration framework, the envisaged readers of this book are researchers in the areas of rigorous software systems development methods and modelling, integrated formal methods, and the semantics of specification languages, and theoretical computer scientists working in the area of specification and semantics.

While developing the integration framework I was working in different situations. Most of the time I worked at the Technische Universität Berlin on various research projects, including the above-mentioned Priority Program. In between I had the pleasure of working at the Università di Roma *La Sapienza*, the Università di Pisa, and the Universitat de les Illes Balears, Palma de Mallorca. These research visits gave me the opportunity to discuss the topic with people from very different backgrounds and consider its problems from many different points of view. I am very grateful to all my colleagues who accompanied me along this way and gave me the opportunity to pursue my work over the whole period. I would also like to thank the two anonymous referees who made many helpful comments on the initial version of this book.

Berlin, August 2003 *Martin Große-Rhode*

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