

Luís Caires
Vasco T. Vasconcelos (Eds.)

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CONCUR 2007 – Concurrency Theory

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Lisbon, Portugal, September 2007
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Preface

This volume contains the proceedings of the 18th International Conference on Concurrency Theory, held at the Gulbenkian Foundation, Lisbon, Portugal, September 3–8, 2007. Since its first edition back in 1990, Concur has been a leading conference in concurrency theory, attracting researchers, graduate students, and practitioners, to exchange ideas, progresses, and challenges.

The Concur conference has traditionally covered a large spectrum of the field, including invited lecturers and tutorials by prominent researchers, contributed technical papers, and several associated workshops. Main topics include basic models and logics of concurrent and distributed computation (such as process algebras, Petri nets, domain theoretic or game theoretic models, modal and temporal logics), specialized models or classes of systems (such as synchronous systems, real time and hybrid systems, stochastic systems, databases, mobile and migrating systems, protocols, biologically inspired systems), related verification techniques and tools (including state-space exploration, model-checking, synthesis, abstraction, automated deduction, testing), and concurrent programming (such as distributed, constraint or object-oriented, graph rewriting, as well as associated type systems, static analyses, and abstract machines).

This year, the Program Committee, after a careful and thorough reviewing process, selected for inclusion in the programme 30 papers out of 112 submissions. Each submission was evaluated by at least three referees, and the accepted papers were selected during a one-and-a-half-week electronic discussion.

The volume opens with the invited contributions by Luca Aceto (Reykjavík), Vincent Danos (Paris 7), and Fred B. Schneider (Cornell). The program also included an additional invited lecture by Peter O’Hearn (QMU London) and an additional tutorial by José Luiz Fiadeiro (Leicester), all of which, we believe, complimented the technical papers rather well.

Co-located with Concur 2007, eight workshops took place: Expressiveness in Concurrency (EXPRESS), Graph Transformation for Verification and Concurrency (GT-VC), Security Issues in Concurrency (SECCO), Verification and Analysis of Multi-threaded Java-like Programs (VAMP), Applying Concurrency Research in Industry (IFIP WG 1.8), Foundations of Coordination Languages and Software Architectures (FOCLASA), From Biology to Concurrency and Back (FBTC), and International Workshop on Verification of Infinite-State Systems (INFINITY).

Concur 2007 was made possible by the contribution and dedication of many people. First of all, we would like to thank all the authors who submitted papers for consideration. Secondly we would like to thank our invited and tutorial speakers. We would also like to thank the members of the Program Committee for their hard work, careful reviews, and the thorough and balanced discussions during the selection process. Finally, we acknowledge the Gulbenkian Foundation

for hosting Concur 2007, and Easychair and Andrei Voronkov for providing software support for the Program Committee meeting.

June 2007

Luís Caires
Vasco T. Vasconcelos

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Mapping the Security Landscape: A Role for Language Techniques

Abstract of Invited Lecture

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Over the last decade, programming language techniques have been applied in non-obvious ways to building secure systems. This talk will not only survey that work in *language based security* but show that the theoretical underpinnings of programming languages are a good place to start for developing a much needed foundation for software system security.

Research developments in language design, compilers, program analysis, type checking, and program rewriting have brought increased assurance in what a software system does and does not do. This was needed, welcome, but not surprising. What is surprising are the new approaches to engineering secure systems that have emerged from language-based security research. Inline reference monitors, for example, enable enforcement of a broad class of authorization policies specified separately from the components they concern; and proof carrying code provides a way to relocate trust from one system component to another, providing designers with flexibility in setting the trusted computing base.

Our sophistication in the engineering of secure systems has improved without the benefit of a rigorous mathematical foundation. This is probably a matter of luck and certainly a matter for concern. Too much of security engineering is based on anecdotes, driven by past attacks, and directed by a few familiar kinds of security policies. We have still to identify abstract classes of enforcement mechanisms, attacks, or policies, much less understand connections between them. In short, we have made little progress in mapping the security landscape.

Yet some features of the security landscape do start to become apparent if the abstractions and metaphors of programming language semantics are applied to software system security. And there is reason to believe the approach will yield more fruit, too. We will discuss what is known, what we might strive to know, and the role that programming language semantics can play.

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The Saga of the Axiomatization of Parallel Composition^{*}

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Abstract. This paper surveys some classic and recent results on the finite axiomatizability of bisimilarity over CCS-like languages. It focuses, in particular, on non-finite axiomatizability results stemming from the semantic interplay between parallel composition and nondeterministic choice. The paper also highlights the role that auxiliary operators, such as Bergstra and Klop’s left and communication merge and Hennessy’s merge operator, play in the search for a finite, equational axiomatization of parallel composition both for classic process algebras and for their real-time extensions.

1 The Problem and Its History

Process algebras are prototype description languages for reactive systems that arose from the pioneering work of figures like Bergstra, Hoare, Klop and Milner. Well-known examples of such languages are ACP [18], CCS [44], CSP [40] and Meije [13]. These algebraic description languages for processes differ in the basic collection of operators that they offer for building new process descriptions from existing ones. However, since they are designed to allow for the description and analysis of systems of interacting processes, all these languages contain some form of *parallel composition* (also known as *merge*) operator allowing one to put two process terms in parallel with one another. These operators usually interleave the behaviours of their arguments, and support some form of synchronization between them.

For example, Milner’s CCS offers the binary operator \parallel , whose intended semantics is described by the following classic rules in the style of Plotkin [49].

$$\frac{x \xrightarrow{\mu} x'}{x \parallel y \xrightarrow{\mu} x' \parallel y} \quad \frac{y \xrightarrow{\mu} y'}{x \parallel y \xrightarrow{\mu} x \parallel y'} \quad \frac{x \xrightarrow{\alpha} x', y \xrightarrow{\bar{\alpha}} y'}{x \parallel y \xrightarrow{\tau} x' \parallel y'} \quad (1)$$

(In the above rules, the symbol μ stands for an action that a process may perform, α and $\bar{\alpha}$ are two observable actions that may synchronize, and τ is a symbol denoting the result of their synchronization.)

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Although the above rules describe the behaviour of the parallel composition operator in very intuitive fashion, the equational characterization of this operator is not straightforward. In their seminal paper [39], Hennessy and Milner offered, amongst a wealth of other classic results, a complete equational axiomatization of bisimulation equivalence [48] over the recursion-free fragment of CCS. (See the paper [14] for a more detailed historical account highlighting, e.g., Hans Bekić’s early contributions to this field of research.) The axiomatization proposed by Hennessy and Milner in [39] dealt with parallel composition using the so-called *expansion law*—a law that, intuitively, allows one to obtain a term describing explicitly the initial transitions of the parallel composition of two terms whose initial transitions are known. This law can be expressed as the following equation schema

$$\left(\sum_{i \in I} \mu_i x_i \right) \parallel \left(\sum_{j \in J} \gamma_j y_j \right) = \sum_{i \in I} \mu_i (x_i \parallel y) + \sum_{j \in J} \gamma_j (x \parallel y_j) + \sum_{\substack{i \in I, j \in J \\ \mu_i = \gamma_j}} \tau (x_i \parallel y_j) \quad (2)$$

(where I and J are two finite index sets, and the μ_i and γ_j are actions), and is nothing but an equational formulation of the aforementioned rules describing the operational semantics of parallel composition.

Despite its natural and simple formulation, the expansion law, however, is an equation schema with a countably infinite number of instances. This raised the question of whether the parallel composition operator could be axiomatized in bisimulation semantics by means of a finite collection of equations. This question was answered positively by Bergstra and Klop, who gave in [20] a finite equational axiomatization of the merge operator in terms of the auxiliary left merge and communication merge operators. Moller showed in [46,47] that bisimulation equivalence is not finitely based over CCS and PA without the left merge operator. (The process algebra PA [20] contains a parallel composition operator based on pure interleaving without communication—viz. an operator described by the first two rules in (1)—and the left merge operator.) These results, which we survey in Section 2, indicate that auxiliary operators are necessary to obtain a finite axiomatization of parallel composition.

Moller’s results clarified the role played by the expansion law in the equational axiomatization of parallel composition over CCS and, to the best of our knowledge, were the first negative results on the existence of finite equational axiomatizations for algebras of processes that were presented in the literature. To our mind, the negative results achieved by Moller in his doctoral dissertation removed a psychological barrier by showing that non-finite axiomatizability results could indeed be achieved also in the study of process algebras, and paved the way to the further developments we describe henceforth in this paper.

The contributions our collaborators and we have offered so far to the saga of the axiomatization of parallel composition have been mostly motivated by an attempt to answer the following questions.

1. Are there other “natural” auxiliary operators that can be used, in lieu of Bergstra and Klop’s left and communication merge, to achieve a finite equational axiomatization of parallel composition?