

ESF Strategic Workshop on  
**Correct Software in Web  
Applications**

Hagenberg (Austria), 25-28 September 2011

Convened by:

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## **Main Objectives of the Workshop:**

### **Problem Description**

Web applications have become one of the largest area for the application of software engineering methods. At the beginning web applications were only simple information services, which soon developed into large database-backed web information systems, i.e. data-intensive systems that are accessed and maintained via the world-wide web. More recently, the area of web services has emerged referring to software components on some web server that can be accessed by and integrated into other software systems. There is a tendency to extend web information systems and web services towards large-scale inter-operable systems. This marks a shift towards computation in the public domain using the internet as the medium for interaction of software components.

Despite the immense importance of web applications for software engineering there is a lack of well-founded development methods. Surprisingly, many web applications are created in an ad-hoc manner without use of sophisticated formal methods. Quality assurance is to a large extent ignored. This constitutes a barrier to productive software development; in other words, the envisioned and most likely technically possible shift to computation in the public domain will only become reality, if the resulting systems are trustworthy with respect to consistency, reliability, performance, and security. Thus, there is a need for development methods that lead to provably correct web application systems.

On the other hand, over the last decades many sophisticated formalized methods in software engineering have been developed and applied in various areas with many success stories to the date. The Theorema project at the Research Institute for Symbolic Computation (RISC) is a project and a software system that aims at supporting the entire process of mathematical theory exploration: invention of mathematical concepts, invention and verification (proof) of propositions about concepts, invention of problems formulated in terms of concepts, invention and verification of algorithms solving

problems, algorithm synthesis, and storage and retrieval of the formulae invented and verified during this process.

The Theorema system consists of a general higher-order predicate logic frame and a collection of special provers that call each other depending on the particular proof situations. The individual provers imitate the proof style of human mathematicians and produce human-readable proofs in natural language presented in nested cells. The special provers are intimately connected with the functors that build up the various mathematical domains.

Similarly, abstract state machines (ASMs) provide a general method to combine specifications on any desired level of abstraction, ground modeling (requirements capture) techniques and stepwise refinement to executable code providing the basis for experimental validation and mathematical verification. ASMs have been successfully applied to diverse areas such as specification and verification of the implementation of programming languages (e.g. Prolog2WAM, Occam2Transputer, Java2JVM, C#2CLR), of chip design, train control systems, the Mondex electronic purse, and many more. These success stories involve verification by mathematical proofs as well as proofs by theorem provers (e.g. KIV, PVS, ISABELLE) or model checking with justifiable effort.

The key problem addressed by the proposed ESF explorative workshop is that there is almost no connection between the research on these industrially successful formal methods in software engineering and the important area of web applications. Researchers in symbolic computation, abstract state machines, automated reasoning, and verification need input from researchers in web information systems, web services, interoperability and service-oriented architectures to tailor their research to the needs of the applications, and researchers in web applications engineering need support to address the challenging correctness problems.

### **Vision**

The vision behind the proposal is that bringing together different research communities in web applications engineering and formal software engineering methods will result in a clear picture of the research challenges in combining these two areas. Identifying the imminent research questions that have to be addressed in order to achieve correctness in web applications is the first step toward the realization of the dream of computation in the public domain across the internet, in which large portions of software can be integrated by means of services that are made available by others. Follow-on joint research efforts stimulated by the workshop will be the next step. This will end in solid, mathematically grounded software development methods for web applications together with provably correct verification techniques.

The global character of the web implies that imminent correctness problems in web applications cannot be addressed by a single research group nor by researchers in a single country. Instead, collaboration on a large scale will be necessary. The time has come to bundle European research efforts to a joint effort towards correct web application software, starting with a highly relevant and complex application area, to overcome the myth that different from other engineering disciplines correctness in software development is not achievable. The feasibility proof will foster research investment into globalised software systems with the benefit of reducing redundancy and costs in software development while at the same time increasing software quality.

### **Objectives**

The proposal aims at bringing together researchers in areas such as Theorema or Abstract State Machines with researchers in web services and web applications engineering in order to explore the potential of formal approaches to software development to develop correct web applications. More detailed, the objectives of the workshop are the following:

1. Obtain a common understanding of the challenging research questions in web applications comprising web information systems, web services, and web interoperability
2. Obtain a common understanding of verification needs in web applications
3. Achieve a common understanding of the available rigorous approaches to system development, and the cases, in which they succeeded

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4. Identify how rigorous software engineering methods can be exploited to develop correct web applications
  5. Develop a European scale research agenda comprising theory, methods and tools that would lead to correct web applications with the potential to realize systems for computation in the public domain

## **Workshop Agenda**

The workshop will approach the problems through a mixture of seminar presentations, open moderated discussions, and ad-hoc summaries. The seminars will be given by inventors of or key-researchers in the field, each time opposing presentations about the web application domain with presentations about potential formalized solutions such as Theorema and Abstract State Machines. Presentations are supposed to be focused on the correctness theme in order to provide the necessary basis for the follow-on discussions.

The discussion rounds are intended as real working group sessions. These discussions will be moderated by two experts, one from the area of web applications, the other one from the area of formalized software engineering methods. Preferably these discussion session convenors should also be knowledgeable in the other area. The approach is to identify the correctness problems in web applications and oppose them to possible solutions by formalized methods. Ideally this should lead to a list of open research problems.

Following the discussion rounds it is intended to have brief summary sessions, in which the results of the discussion rounds will be presented back to the workshop participants. In order to run these summary sessions two participants will be given the task to write up structured minutes from the discussion rounds. Preferably, these participants should be experts in either web applications or formalized software engineering methods, and knowledgeable in the other area.

With respect to the complexity of the application area it is intended to structure presentations and follow-on discussions in three parts covering web information systems, web services, and interoperability on the web, respectively. Likewise, the presentations and discussions on formalized methods will first cover ASMs and Theorema separately.

The expected outcomes are as follows:

1. An identification of correctness problems in web applications and sketches, how these can be solved by formalized software engineering methods, in particular Theorema and ASMs.
2. An identification of open problems regarding correctness of web applications, and corresponding research questions that have to be addressed in the context of Theorema and ASMs to solve these problems.
3. A common understanding among the workshop participants regarding the need for assuring correctness, and the potential of formalized methods with this regard.
4. An agreed research agenda, preferably grouped into project topics, to address the open problems regarding correctness of web applications.
5. A plan how to continue with the research agenda.

## **Report publication and dissemination**

The convenors of the workshop will prepare post-workshop proceedings containing

- the presentations given at the workshop, which will be written by the presenters,
- the results of the discussion sessions, which will be written jointly by the discussion moderators and those participants who took minutes and prepared the summary sessions,
- a general summary by the workshop convenors identifying the problems, solutions, and emphasizing the research agenda to solve open problems.

It is intended to publish the post-workshop proceedings, e.g. as a volume of Springer LNCS.

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## PRELIMINARY PROGRAMME

### Sunday, September 25, 2011

Afternoon                      *Arrival*

### Monday, September 26, 2011

- 08.30-08.40                      **Welcome by Host and Convenors**  
**Bruno Buchberger** (RISC, Hagenberg, Austria)  
**Klaus-Dieter Schewe** (SCCH, Hagenberg, Austria)
- 08.40-09.00                      **Presentation of the European Science Foundation (ESF)**  
**Stefan Jähnichen** (ESF Standing Committee for Physical and Engineering Sciences (PESC) and Technical University of Berlin, Germany)
- 09.00-10.40                      Session I: Web Information Systems**
- 09.00-10.00                      **Presentation 1 "Foundations and Modelling of Web Information Systems"**  
**Bernhard Thalheim** (Christian-Albrechts-University Kiel, Kiel, Germany)
- 10.00-10.40                      **Presentation 2 "tbd "**  
**Vincenzo Gervasi** (University of Pisa, Pisa, Italy)
- 10.40-11.00                      *Coffee / Tea Break*
- 11.00-13.00                      Session II: Theorema**
- 11.00-11.20                      **Presentation 3 "Introduction to the Theorema Project"**  
**Bruno Buchberger** (RISC, Hagenberg, Austria)
- 11.20-12.10                      **Presentation 4 "A Logical Approach to Total Correctness"**  
**Tudor Jebelean** (RISC, Hagenberg, Austria)
- 12.10-13.00                      **Presentation 5 "Symbolic Computation Techniques for XML"**  
**Temur Kutsia** (RISC, Hagenberg, Austria)
- 13.00-14.00                      *Lunch*
- 14.00-15.30                      Session III: Discussion**
- 14.00-15.30                      **Moderated Discussion 1: Verification & Web Information Systems**  
**Andreas Prinz** (University of Agder, Grimstad, Norway)  
**Gerhard Schellhorn** (University of Augsburg, Augsburg, Germany)
- 15.30-16.00                      *Coffee / tea break*
- 16.00-17.00                      Session IV: Summary**
- 16.00-17.00                      **Summary of Discussion 1: Verification & Web Information Systems**  
**Andreas Prinz** (University of Agder, Grimstad, Norway)  
**Gerhard Schellhorn** (University of Augsburg, Augsburg, Germany)
- 19.00                                      *Dinner*

### Tuesday, September 27, 2011

- 08.30-10.30                      Session V: Web Services**
- 08.30-09.20                      **Presentation 6 "Using Recommender Technology for Designing Applications"**  
**Meike Klettke** (University of Rostock, Rostock, Germany)

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09.20-10.10	<b>Presentation 7 "Security and Privacy Issues in Web Service Composition"</b> <b>Elena Ferrari</b> (University of Insubria, Insubria, Italy)
10.10-10.40	<i>Coffee / Tea Break</i>
<b>10.40-13.00</b>	<b>Session VI: Abstract State Machines</b>
10.40-11.20	<b>Presentation 8 "Using ASMs for Modelling and Analysis of Web Services"</b> <b>Egon Börger</b> (University of Pisa, Pisa, Italy)
11.20-12.10	<b>Presentation 9 "Experiences with ASMs by Defining UML Semantics and Possible Applications in Modelling Web Services"</b> <b>Alexander Raschke</b> (University of Ulm, Ulm, Germany)
12.10-13.00	<b>Presentation 10 "MDD, ASMs, Refinement: Some Ideas for a Development and Verification Approach for Web Applications"</b> <b>Gerhard Schellhorn</b> (University of Augsburg, Augsburg, Germany)
13.00-14.00	<i>Lunch</i>
<b>14.00-15.30</b>	<b>Session VII: Discussion</b>
14.00-15.30	<b>Moderated Discussion 2: ASMs, Verification &amp; Web Applications</b> <b>Anne Brüggemann-Klein</b> (Technical University of Munich, Munich, Germany) <b>Vincenzo Gervasi</b> (University of Pisa, Pisa, Italy)
15.30-16.00	<i>Coffee / tea break</i>
<b>16.00-17.00</b>	<b>Session VIII: Summary</b>
16.00-17.00	<b>Summary of Discussion 2: ASMs, Verification &amp; Web Applications</b> <b>Anne Brüggemann-Klein</b> (Technical University of Munich, Munich, Germany) <b>Vincenzo Gervasi</b> (University of Pisa, Pisa, Italy)
19.00	<i>Dinner</i>

## Wednesday, September 28, 2011

<b>08.30-10.30</b>	<b>Session IX: Web Interoperability</b>
08.30-09.10	<b>Presentation 11 "Formal Modelling of BPEL Web Services Compositions within the Event-B Method"</b> <b>Yamine Ait-Ameur</b> (Ecole Normale Supérieure de Mécanique et d'Aérotechnique, Poitiers, France)
09.10-09.50	<b>Presentation 12 "An ASM-Based Modelling and Execution Language for Service-Oriented Applications"</b> <b>Elvinia Riccobene</b> (Polytechnico di Milano, Milan, Italy)
09.50-10.10	<b>Presentation 13 "An ASM-Based Framework for Coordinated Simulation of Heterogeneous Service-Oriented Applications"</b> <b>Patrizia Scandurra</b> (University of Bologna, Bologna, Italy)
10.10-10.30	<b>Presentation 14 "Analysis and Run-Time Monitoring of Software Components by ASMs"</b> <b>Paolo Arcaini</b> (University of Bologna, Bologna, Italy)
10.30-11.00	<i>Coffee / Tea Break</i>
<b>11.00-12.30</b>	<b>Session X: Discussion</b>
11.00-12.30	<b>Moderated Discussion 3: ASMs, Verification &amp; Web Interoperability</b> <b>Klaus-Dieter Schewe</b> (SCCH, Hagenberg, Austria) <b>Elvinia Riccobene</b> (Polytechnico di Milano, Milan, Italy)

12.30-13.30	<i>Lunch</i>
<b>13.30-14.30</b>	<b>Session XI: Summary</b>
13.30-14.30	<b>Summary of Discussion 3: ASMs, Verification &amp; Web Interoperability</b> <b>Klaus-Dieter Schewe</b> (SCCH, Hagenberg, Austria) <b>Elvinia Riccobene</b> (Polytechnico di Milano, Milan, Italy)
14.30-15.00	<i>Coffee / tea break</i>
<b>15.00-16.30</b>	<b>Session XII: Final Summary</b>
15.00-16.30	<b>Discussion of Results and Further Steps</b> <b>Bruno Buchberger</b> (RISC, Hagenberg, Austria) <b>Temur Kutsia</b> (RISC, Hagenberg, Austria)
16.30	<i>end of workshop and departure</i>



## European Science Foundation

### **Objectives of the ESF Standing Committee for Physical and Engineering Sciences (PESC)**

The **ESF Standing Committee for Physical and Engineering Sciences (PESC)** covers a broad number of fields from physics, chemistry, mathematics, informatics and computer sciences, to engineering, material and technical sciences. PESC has the following responsibilities and tasks:

- to develop scientific initiatives within the ESF operational framework;
- to make proposals for 'a la carte' scientific initiatives;
- to undertake studies on large research facilities and assist in the evaluations and assessments and other special reviews requested by Member Organisations;
- to provide specialist advice and input on a wide range of ESF actions and contribute to the development of the ESF science policy agenda and take a strategic view of the scientific area for which it has responsibility; and
- where appropriate, to work with other Committees and groups in promoting multidisciplinary and interdisciplinary activities.

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