Bringing Theory to Practice:

Predictability and Performance in Embedded Systems

PPES'11, March 18, 2011, Grenoble, France

Edited by
Philipp Lucas
Lothar Thiele
Benoît Triquet
Theo Ungerer
Reinhard Wilhelm

Editors

Philipp Lucas, Universität des Saarlandes, Germany phlucas@cs.uni-saarland.de
Lothar Thiele, ETH Zürich, Switzerland thiele@ethz.ch
Benoît Triquet, Airbus, France benoit.triquet@airbus.com
Theo Ungerer, Augsburg University, Germany ungerer@informatik.uni-augsburg.de
Reinhard Wilhelm, Universität des Saarlandes, Germany wilhelm@cs.uni-saarland.de

ACM Classification 1998
C.3 [Special-purpose and application-based systems]: Real-time and embedded systems

ISBN 978-3-939897-28-6

Published online and open access by
Schloss Dagstuhl – Leibniz–Zentrum für Informatik gGmbH, Dagstuhl Publishing, Saarbrücken/Wadern, Germany.

Publication date
March, 2011.

Bibliographic information published by the Deutsche Nationalbibliothek
The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available in the Internet at http://dnb.d-nb.de.

License
All parts of this work are licensed either under a

- CC-BY-NC-ND: Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported license (http://creativecommons.org/licenses/by-nc-nd/3.0/legalcode), or a

- CC-BY-ND: Creative Commons Attribution-NoDerivs 3.0 Unported license (http://creativecommons.org/licenses/by-nd/3.0/legalcode).

In brief, this licenses authorizes each and everybody to share (to copy, distribute and transmit) the work under the following conditions, without impairing or restricting the author's moral rights:

- *(by-nc-nd, by-nd)* Attribution: The work must be attributed to its authors.
- *(by-nc-nd, by-nd)* No derivation: It is not allowed to alter or transform this work.
- *(by-nc-nd)* Noncommercial: The work may not be used for commercial purposes.

The copyright is retained by the corresponding authors.

Digital Object Identifier: 10.4230/OASIcs.PPES.2011.i

ISBN 978-3-939897-28-6 **ISSN 2190-6807** **www.dagstuhl.de/oasics**

OASIcs – OpenAccess Series in Informatics

OASIcs aims at a suitable publication venue to publish peer-reviewed collections of papers emerging from a scientific event. OASIcs volumes are published according to the principle of Open Access, i.e., they are available online and free of charge.

Editorial Board

- Dorothea Wagner (Karlsruhe Institute of Technology)

ISSN 2190-6807

www.dagstuhl.de/oasics

Contents

Software Structure and WCET Predictability
Gernot Gebhard, Christoph Cullmann, and Reinhold Heckmann 1

Towards a Time-predictable Dual-Issue Microprocessor: The Patmos Approach
Martin Schoeberl, Pascal Schleuniger, Wolfgang Puffitsch, Florian Brandner, Christian W. Probst, Sven Karlsson, and Tommy Thorn 11

A Template for Predictability Definitions with Supporting Evidence
Daniel Grund, Jan Reineke, and Reinhard Wilhelm 22

An Overview of Approaches Towards the Timing Analysability of Parallel Architectures
Christine Rochange 32

Towards the Implementation and Evaluation of Semi-Partitioned Multi-Core Scheduling
Yi Zhang, Nan Guan, and Wang Yi 42

An Automated Flow to Map Throughput Constrained Applications to a MPSoC
Roel Jordans, Firew Siyoum, Sander Stuijk, Akash Kumar, and Henk Corporaal .. 47

Towards Formally Verified Optimizing Compilation in Flight Control Software
Ricardo Bedin França, Denis Favre-Felix, Xavier Leroy, Marc Pantel, and Jean Souyris 59

Workshop on Bringing Theory to Practice: Predictability and Performance in Embedded Systems (PPES 2011).
Editors: Philipp Lucas, Lothar Thiele, Benoît Triquet, Theo Ungerer, Reinhard Wilhelm
OpenAccess Series in Informatics
OASICS Schloss Dagstuhl – Leibniz-Zentrum für Informatik, Dagstuhl Publishing, Germany

Preface

We are happy to present the proceedings of the 2011 Workshop on Predictability and Performance in Embedded Systems, held in March 2011 in Grenoble, France, as a satellite event of the Conference on Design, Automation & Test in Europe (DATE).

The PPES workshop is concerned with critical hard real-time systems that have to satisfy both efficiency and predictability requirements. For example, an electronic controller for a safety-critical system in an automobile needs to react not only correctly to external inputs such as rapid deceleration or loss of grip, but also provably within a given time-span. This topic of *reconciling predictability and performance* has received much interest in recent years, in particular considering its growing relevance and complexity with the advent of multi-core systems with shared resources.

The advancements in these fields, however, have been discussed mostly in the standard venues (general conferences, workshops, journals). The aim of this workshop is twofold:

- to present the results achieved and tools developed by various researchers, in particular to industrial end users;
- and to present the industrial viewpoint on needs and challenges which need to be tackled for applicability.

To this end, the workshop comprises an invited presentation by Ottmar Bender of Cassidian Electronics on *Predictability and Performance Requirements in Avionics Systems*, a panel discussion on *Predictability and Performance in Industrial Practice*, and a number of paper presentations. In this first instance of the workshop, we received 14 submissions. After a careful review, 7 submissions covering various aspects of predictability and performance have been selected to appear in these proceedings. We would like to thank all authors for submitting their work to this first instance of the workshop despite the tight deadlines.

PPES was supported by

- *ArtistDesign*, the European Network of Excellence on Embedded Systems Design
- the *PREDATOR* project (Design for Predictability and Efficiency)
- the*MERASA* project (Multi-Core Execution of Hard Real-Time Applications Supporting Analysability)

The workshop is organised by: Philipp Lucas (Universität des Saarlandes), Lothar Thiele (ETH Zürich), Benoît Triquet (Airbus), Theo Ungerer (Augsburg University) and Reinhard Wilhelm (Universität des Saarlandes; chair). We were supported in the Program Committee by Pascal Sainrat (University of Toulouse), Sami Yehia (Thales), Wang Yi (Uppsala University) and Rafael Zalman (Infineon). Additional reviews were provided by David Black-Schaffer, Unmesh Dutta Bordoloi, Christian Bradatsch, Giorgio Buttazzo, Mamoun Filali, Mike Gerdes, Claire Maiza, Jörg Mische, Eric Noulard, Christine Rochange and Sascha Uhrig. Our thanks also go to Nicola Nicolici, the workshop chair of DATE, and to Bashir M. Al-Hashimi, general chair of DATE, for making this event possible.

Philipp Lucas, Reinhard Wilhelm
Saarbrücken, March 2011

Workshop on Bringing Theory to Practice: Predictability and Performance in Embedded Systems (PPES 2011).
Editors: Philipp Lucas, Lothar Thiele, Benoît Triquet, Theo Ungerer, Reinhard Wilhelm
OpenAccess Series in Informatics
OASICS Schloss Dagstuhl – Leibniz-Zentrum für Informatik, Dagstuhl Publishing, Germany