

# Timing Verification of Real-Time Systems

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## Abstract

Hard real-time systems are subject to stringent timing constraints which are dictated by the surrounding physical environment. A schedulability analysis has to be performed in order to guarantee that the timing constraints of all co-executed tasks on a given platform will be met ("timing validation"). Schedulability analysis requires upper bounds for the execution times of all the system's tasks to be known. These upper bounds are commonly called worst-case execution times (WCETs). The WCET-determination problem has become non-trivial due to the advent of processor features such as caches, pipelines, and all kinds of speculation, which make the execution time of an individual instruction dependent on the execution state, e.g. the contents of the caches. Such execution times may vary between a few cycles and several hundred cycles.

A combination of Abstract Interpretation (AI) with Integer Linear Programming (ILP) has been successfully used to determine precise upper bounds on the execution times of real-time programs. The task solved by abstract interpretation is to compute invariants about the processor's execution states at all program points. These invariants describe the contents of caches, of the pipeline, of prediction units etc. They allow to verify local safety properties, safety properties that correspond to the absence of "timing accidents". Timing accidents, e.g. cache misses, pipeline stalls are reasons for the increase of the execution time of an individual instruction in an execution state.

The technology and tools have been used in the certification of several time-critical subsystems of the Airbus A380, the Airbus A350, and the M400. The tool aiT, developed by our spin-off company AbsInt, is the only tool worldwide, validated for these avionics applications.

# Time Verification of Real-Time Systems

Radionica

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**Saarland University, Germany**

Schloss Dagstuhl – Leibniz Center for Informatics

Vrijeme i mjesto održavanja:

19.09.2018. od 18-20h

Odjel za matematiku, Sveučilište u Osijeku

Trg Lj. Gaja 6, dvorana 1

Radionica će se održati na engleskom jeziku.

Sudjelovanje je besplatno za sve zainteresirane istraživače i studente.

## Program radionice:

- 18:00 – 18:10 - Uvodna riječ (prof.dr.sc. Domagoj Matijević)
- 18:10 – 19:10 - Reinhard Wilhelm: Time Verification of Real-Time Systems – predavanje uz prikaz slučajeva primjene algoritama
- 19:10 – 20:00 – Diskusija o mogućnostima daljnjeg razvoja i primjene algoritama za predviđanje trajanja procesa u stvarnom vremenu

## O voditelju radionice:



Prof. em. Dr. Dr. h.c. Reinhard Wilhelm je umirovljeni profesor na Fachbereich Informatik, Universität des Saarlandes. Bio je voditelj Katedre Programming Languages and Compiler Construction at Saarland University (od 1978-2014), Scientific Director of Schloss Dagstuhl – Leibniz Center for Informatics (od 1990-2014), Associate of AbsInt Angewandte Informatik GmbH, Associate Editor of the Communications of the ACM. Osnivač je spin-off tvrtke AbsInt i dobitnik brojnih prestižnih nagrada, kao što su Konrad Zuse Medal (2009), Merit Cross on Ribbon (2010), ACM Distinguished Service Award (2011). Objavio je osam knjiga iz područja računalne znanosti te više od stotinu radova u časopisima i na konferencijama. Bio je pozvani predavač na više konferencija, među kojima i na 7th International Conference on Operational Research KOI 1998, Rovinj, Croatia. Njegovi istraživački interesi uključuju područja: Timing Analysis for Real-Time Systems, Static Program Analysis, Compiler Construction, Algorithm Explanation i drugo iz područja računalne znanosti. Više informacija na stranici: <http://www.rw.cdl.uni-saarland.de/people/wilhelm.shtml>.