

# NATIONAL UNIVERSITY OF SINGAPORE

School of Computing

## C S S E M I N A R

**Title: Code Generation for Hard Real-Time Systems - Current State and Future Challenges**

Speaker: Prof. Dr. Heiko Falk  
Institute of Embedded Systems/Real-Time Systems  
Ulm University

Date/Time: 9 September 2014, Tuesday, 03:00 PM to 05:00 PM

Venue: Executive Classroom, COM2-04-02

Chaired by: Dr Roychoudhury, Abhik, Professor, School of Computing  
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### Abstract:

When designing software for hard real-time systems, compilers play a central role since the binary code generated by them has a direct influence on criteria like, e.g., execution time. Furthermore, compilers can apply optimizations in order to improve such criteria systematically. In the domain of real-time systems, the key metric is the worst-case execution time (WCET), instead of the average-case execution time (ACET) which is usually optimized by standard compilers.

The first part of this talk thus introduces the current industrial development practice for real-time software, with the focus on code generation and optimizing compilers. It will be motivated why this current state of the art in the area of compiler construction is highly unsatisfying.

The second part of this talk presents the WCET-aware C Compiler WCC. By coupling the compiler with a tool for static WCET analysis, a formal WCET timing model has been integrated into a compiler for the very first time. This timing model provides valuable data about an application's worst-case behaviour to the compiler. The WCET timing model is afterwards exploited by novel optimizations systematically minimizing WCETs. One of WCC's optimizations is presented, and its effectiveness is illustrated by means of an on-line demonstration where WCC is applied to an industrial automotive engine control system.

The limitations of WCC's current compilation flow regarding multi-task and multi-core systems are outlined in the third part of this talk. A brief overview about the most recent efforts on worst-case analysis for such parallel systems is given. The talk ends with an outlook on our future challenges and research agenda in the domain of WCET-aware compilation.

Biodata:

Heiko Falk received his Ph.D. in Computer Science from the University of Dortmund (Germany) in 2004. From 2004 until 2011, he worked as assistant professor in the embedded systems group at the Technical University of Dortmund. Since 2011, he is full professor for embedded systems and real-time systems at Ulm University (Germany).

His Ph.D. focused on high-level source code optimizations. Typical embedded multimedia applications only use a small fraction of their execution time to compute audio or video data. Most of the execution time is used to evaluate complex control flow. Motivated by this observation, Dr. Falk developed novel techniques for control flow optimization at the source code level.

In the last years, the focus of his work is on code generation and optimization for performance and predictability of safety-critical real-time systems. The WCC compiler initially established by him and developed by the research teams led by Dr. Falk is the currently only known compiler which is able to systematically reduce the worst-case execution time (WCET) of programs by tightly integrating static timing analyses into the code generation and optimization stage.