

# CHALMERS

## Resource Budgeting as a Tool for Reduced Development Cost for Embedded Real-time Computer Systems

MATTIAS WECKSTÉN

Licentiate seminar will be held in Wigforssalen at Halmstad University  
on the 20<sup>th</sup> April, 2004 at 13:30.

The discussions will be conducted by Dr. Jakob Axelsson, Volvo Car Corporation.

The thesis is available at the School of Information Science, Computer and Electrical  
Engineering, Halmstad University and the School of Computer Science and Engineering,  
Chalmers University of Technology.



School of Computer Science  
and Engineering

CHALMERS UNIVERSITY  
OF TECHNOLOGY

412 96 Göteborg  
Tel: 031-772 10 00



School of information Science,  
Computer and Electrical Engineering

HALMSTAD UNIVERSITY

301 18 Halmstad  
Tel: 035-16 71 00

# Resource Budgeting as a Tool for Reduced Development Cost for Embedded Real-time Computer Systems

MATTIAS WECKSTÉN

*School of Information Science, Computer and Electrical Engineering,  
Halmstad University  
School of Computer Science and Engineering,  
Chalmers University of Technology*

Thesis for the degree of Licentiate of Engineering, a Swedish degree between M.Sc. and Ph.D.

## Abstract

Wouldn't it be great if there were a systematic method for derivation of non functional constraints available at design time that made it possible to verify design and make implementation a much clearer task? This kind of methods are needed since systems of increasing complexity has to be developed, and the cost for failing has proven to be too high. The problem is how to derive the design time constraints into implementation time constraints, maintaining the traceability for the individual constraints, and early on get indications whether a project is about to fail or not.

A method for implementation time constraint derivation has been developed and is presented in this thesis. Along with the basic method, several extensions are proposed. Evaluations of the practical usefulness of the method and the method's scalability have been done. To prove the method's importance in real development projects, a method for evaluation of the usability of this kind of methods has also been developed. The evaluation of the practicality shows that it is possible to find close to optimal solutions (within percent) in short time (within minutes). The evaluation of the scalability shows that the run time for finding implementable solutions scales polynomial with the size of the task graph. The evaluation of the usability shows that using the proposed method always leads to lower development cost than using an ad hoc method, in the case that the implementation is about to fail.

**Keywords:** Real-time systems, embedded, resource budgeting, design tool, tightness optimization, guarantees.