

# BERT – BUDGETING FOR EMBEDDED REAL TIME SYSTEMS

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The BERT (Budgeting for Embedded Real-Time Systems) project is focusing on how to, primarily in early design, cope with the growing system complexity. To increase engineering efficiency, we develop scheduling, allocation and analysis methods that can be integrated into a tool to help in the design of distributed embedded computer systems.

## 1. Background and Motivation

The aim of the BERT (Budgeting for Embedded Real Time Systems) project is to make and evaluate a method for early design evaluation. This is needed since, as system complexity grows, engineering efficiency does not. As a result of the research so far we have implemented a systematic method for derivation of non functional constraints available at design time which made it possible to verify the implementability of a certain design and also make implementation a much clearer task. This is not only needed since systems of increasing complexity have to be developed but also since the cost for failing has proven to be too high. So, the problem has been to develop a method that will 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.

## 2. Basic Implementation Constraint Derivation (BICD) method

Based on available resources, performance restrictions and the task set with its constraints, a budget containing intermediate constraints for all tasks is generated. This procedure is repeated and the most promising budgets are stored in a set of implementation budgets.

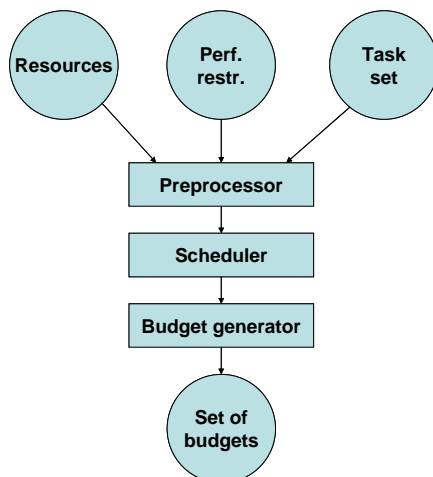


Figure 1. Basic Implementation Constraint Derivation (BICD) method.

To get the basic method as generally applicable as possible, a number of extensions are needed. One example of extension is to support the combination of task graphs with different periods of execution. Another important issue is to develop methods to analyze communication performance of complex interconnection networks. This is in order to include communication delays in the budgeting of complex networked embedded systems and to be able to find good mappings of the network traffic, or even to adapt the network architecture to the traffic.

## 3. Results

We have implemented a systematic method for derivation of non functional constraints available at design time which made it possible to verify the implementability of a certain design and also make implementation a much clearer task. Moreover, we have developed a method to simulate the implementation process, making it possible to evaluate design and implementation methods in a cheap and repeatable way. Each implemented task results in a cost and a worst-case execution time.

To support switched interconnection networks in our targeted distributed systems, we have developed a method to choose topology. The method can even be used to choose different topologies to reconfigure between during run-time when having several working modes to switch between. We have also developed a preliminary solution to analyze a switched network using the knowledge about the task graph properties, in order to increase the amount of possible guaranteed real-time traffic.

## PARTNERS AND STATUS

The project is coupled to other CERES projects, primarily ERTCENS with the following industrial partners: Combitech AB, Ericsson AB, and Saab Microwave Systems.

Project leader: Magnus Jonsson.

PhD candidate: Mattias Weckstén.

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