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# Towards the Systematic Analysis of Non-Functional Properties in Model-Based Engineering for Real-Time Embedded Systems

Guillaume Brau<sup>a,b</sup>, Jérôme Hugues<sup>b</sup>, Nicolas Navet<sup>a</sup>

<sup>a</sup>University of Luxembourg, CSC Research Unit,  
6 rue R. Coudenhove-Kalergi, L-1359 Luxembourg, Luxembourg.  
{guillaume.brau, nicolas.navet}@uni.lu

<sup>b</sup>Université Fédérale Toulouse Midi-Pyrénées, ISAE-SUPAERO,  
10 avenue E. Belin, 31055 Toulouse, France.  
jerome.hugues@isae-supaero.fr

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## Abstract

The real-time scheduling theory provides analytical methods to assess the temporal predictability of embedded systems. Nevertheless, their use is limited in a Model-Based Systems Engineering approach. In fact, the large number of applicability conditions makes the use of real-time scheduling analysis tedious and error-prone. Key issues are left to the engineers: *when to apply a real-time scheduling analysis? What to do with the analysis results?* This article presents an approach to systematize and then automate the analysis of non-functional properties in Model-Based Systems Engineering. First, *preconditions* and *postconditions* define the applicability of an analysis. In addition, *contracts* specify the analysis interfaces, thereby enabling to reason about the analysis process. We present a proof-of-concept implementation of our approach using a combination of constraint languages (REAL for run-time analysis) and specification languages (Alloy for describing interfaces and reasoning about them). This approach is experimented on architectural models written with the Architecture Analysis and Design Language (AADL).

*Keywords:* Model-Based Systems Engineering; Non-Functional Properties; Analysis; Contracts; Real-Time Scheduling; Architecture Description Languages

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## 1. Introduction

*Context.* Embedded systems have become an integral part of our daily life. We can find them in cars, aircrafts, trains, robots, healthcare equipments, mobile phones, consumer electronics, etc. In particular, a major issue related to embedded systems is to fulfill the non-functional requirements dictated by their environment, expressed for example in terms of timing, dependability, security, or other performance criteria. In safety-critical applications for instance (e.g. in an airplane), missing a non-functional requirement can have severe consequences, e.g. loss of life, personal injury, equipment damage, environmental disaster, etc.

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