

Pre-Implementation Analysis of Distributed Control Systems - PICADOR

Ola Redell, Martin Törngren
Division of Mechatronics
Department of Machine Design
Royal Institute of Technology
ola@md.kth.se

June 28, 2001

Introduction

This is the first year report for the project Picador at Damek, KTH. The Picador project focuses on analysis of implementation effects of distributed control systems. One goal has been to develop an analysis method for distributed real-time systems and connecting it to the analysis of control system performance. The analysis method is to give tight estimations of timing performance important for the control behaviour, including response times and jitter (variations) in the release and response periods. Another goal is to provide a tool-set for evaluation of control system performance, connecting the analysis method to a control simulation environment in which control related effects can (and are normally) studied by control engineers. Another very important part of the project is the further development of the models for describing distributed real-time implementations of control systems. An initial set of models were defined in Ola Redell's licentiate thesis and these are now subject to further development and implementation in the above mentioned tool-set.

Project plan and achieved results

Summary of project plan

In the project plan four major parts of the research were pointed out:

- Further development and refinement of the models that constitute the base on which the AIDA tool-set is being built. Suggested model refinements should be available for inclusion in the second version of the AIDA tool-set in November 2001.
- The development of analysis methods that produce the desired timing estimates that are fed back to the control system analysis. These methods include jitter, synchronisation and response time analysis of distributed real-time transactions (i.e. chains of precedence related tasks within the system). An initial version of the method was scheduled due November 2000, and a further extension allowing analysis of more general system descriptions to November 2001.
- The development of the AIDA tool-set. The tool-set will be used for: (1) the evaluation of further generalized and refined models, (2) as a test-bed for improved analysis methods and (3) demonstration of the impact of the research within the projects AIDA and Picador primarily. The AIDA tool-set was to be developed in a first version until December 2000, and in a more complete version including model refinements by November 2001.

- A case study using the AIDA tool-set was to be performed in cooperation with some industrial partner. The case study was to be finished by April 2001.

Achieved results

The current status of the project is that the development of the first close-to-complete version of the AIDA tool-set is to be finished by the end of July this year. Most parts of the tool-set are completed but final fixes and some integration with Matlab/Simulink remain. The tool-set includes an analysis method based on other researchers work. The method has been tailored for the models used in AIDA and will be further developed to produce tighter bounds on the timing. The development of the envisioned analysis method has shown to be difficult and has proceeded a bit slower than expected. A paper on this issue is expected to be submitted for publication this year. The development of the tool-set is on track with the plan, and there was indeed an early version available in the end of last year. A paper describing the tool-set will be submitted to a special journal issue on “design methodologies and tools for real-time embedded systems” early September this year.

The models are being further developed and refined as the development of the tool-set proceeds, as expected. No case study has been performed yet however. Neither has one been initiated. The case study is now planned to start during the fall this year, and will hopefully be finished early next year. Possible industrial partners for this study include Volvo Wheel Loaders, ABB Robotics, Bombardier Transportation (formerly Adtranz) and Saab Automobile, of which the two first have stated their interest this far.

Industrial cooperation

The industrial contacts in the Picador project include:

Saab Automobile, contact person Kenneth Lind. Several initial contacts were made including a one week visit to Saab by the ARTES graduate students Ola Redell and Jad El-Khoury who spent a week at Saab in Trollhättan. The visit was rewarding and there is an unofficial report documenting the impressions. We are currently discussing with Saab how to continue the cooperation.

We have established an industrial reference group for the projects Picador and AIDA including representatives of the companies Volvo Wheel Loaders, Bombardier Transportation, Arcticus Systems, Saab and Combitech.

Publications

Törngren Martin, El-Khoury Jad, Sanfridson Martin and Redell Ola. Modelling and Simulation of Distributed Real-time Control Systems. Technical report, Mechatronics Lab, Department of Machine Design, Royal Inst. of Technology, Stockholm. TRITA-MMK 2001:3, ISSN 1400-1179, ISRN KTH/MMK--01/3--SE.

Törngren Martin and Redell Ola. A Modelling Framework to support the design and analysis of distributed real-time control systems. Invited Paper. Journal of Microprocessors and Microsystems, Vol. 24 No. 2, 17 April 2000, Elsevier, ISSN 0141-9331.

Redell Ola and El-Khoury Jad. Summary of Meetings at SAAB Automobile in Trollhättan. Internal report. Damek, KTH, July 2000