Programming and Performance Modelling of Automotive ECU Networks (Half Day)

Samarjit Chakraborty, National University of Singapore
S. Ramesh, General Motors R&D, India Science Laboratory, Bangalore

Abstract

The last decade has seen a phenomenal increase in the use of electronic components in automotive systems, resulting in the replacement of purely mechanical or hydraulic-implementations of different functionalities. Today, in high-end cars, it is common to have around 70 electronic control units (ECUs), each consisting of programmable processors, one or more microcontrollers and a set of sensors and actuators. Different functionalities (e.g. adaptive cruise control or anti-lock braking) are then implemented in a distributed fashion with parts of a task being mapped onto one or more ECUs and these ECUs exchanging messages and signals via high-speed communication buses. The heterogeneity and the distributed nature of these implementations, coupled with the emergence of new standards and protocols for the automotive domain have given rise to new challenges – both in terms of programming large-scale ECU networks, as well as in evaluating their performance and timing properties. This tutorial will provide a comprehensive overview of the recent developments in this domain and also highlight some of the challenges facing embedded systems designers and programmers. The topics covered will include time-triggered architectures for implementing safety-critical applications, emerging protocols for the automotive domain such as FlexRay, techniques for performance and timing analysis of FlexRay-based ECU networks, and languages and tools for developing distributed implementations of automotive functionality around FlexRay and other related protocols. Apart from discussing the relevant protocols, languages and modelling/analysis techniques, the tutorial will also cover practical case studies and some commercially available tools and their functionality.

Speaker Biographies

Samarjit Chakraborty is an Assistant Professor of Computer Science at the National University of Singapore. He obtained his Ph.D. in Electrical and Computer Engineering from ETH Zurich in 2003. For his Ph.D. thesis, he received the ETH Medal and the European Design and Automation Association’s “Outstanding Doctoral Dissertation Award” in 2004. His work has also received Best Paper Award nominations at DAC 2005, CODES+ISSSS 2006 and ECRTS 2007. Samarjit’s research interests are primarily in the area of system-level design and analysis of real-time and embedded systems. He has extensively published in major research forums on this topic including DAC, DATE, CODES+ISSSS, ASP-DAC, RTSS and RTAS, and has also served on the technical program committees of many of these conferences. He is currently serving as the TPC Co-Chair of the Hardware/Software Co-design track of the 2007 IEEE Real-Time Systems Symposium (RTSS), TPC Chair of the Hardware/Software Co-design track of the 2007 International Conference of Embedded and Ubiquitous Computing (EUC) and the TPC Co-Chair of the 2007 IEEE Workshop on Embedded Systems for Real-Time Multimedia (ESTIMedia). Over the last few years he has been working on various problems related to performance modelling and analysis of real-time and embedded systems and teaches a graduate-level course on this topic at NUS. He is also interested in studying various models, protocols and architectures in the context of automotive systems and collaborates with General Motors R&D in this area. He has given invited talks on various topics related to design, modelling and analysis of embedded systems at various universities and industrial labs, including UC Berkeley, MIT, CMU, Philips, General Motors and Creative Technology Labs. His experience with conducting tutorials include (i) a tutorial at the IEEE International Conference on Multimedia & Expo (ICME) at Amsterdam in July 2005, entitled “Multimedia Processing on Multiprocessor SoC Platforms: What should Multimedia System Developers know about Architectural Design, Performance Analysis and Platform Management?” (jointly with Radu Marculescu from CMU and Paul Stravers from Philips
Research), (ii) a half-day solo tutorial at the ACM Multimedia Conference (MM) at Santa Barbara in October 2006 on “Flexible Modelling and Performance Debugging of Real-Time Embedded Multimedia Systems”, (iii) a tutorial at the VLSI Design Conference at Bangalore in January 2007 on “Performance Debugging of Complex Embedded Systems” (jointly with Abhik Roychoudhury from NUS), and (iv) a tutorial at the ARTIST2 Winter School on Modelling, Testing, and Verification for Embedded Systems (MOTIVES) at Trento, Italy in February 2007 on “Interactive Performance Debugging of Real-Time Systems”.

S. Ramesh is a Technical Fellow at the General Motors India Science Laboratory in Bangalore, India. As a technical fellow, he plays a key role in setting up a Centre of Excellence in rigorous control software engineering for automotive embedded systems. As part of this Centre, he is involved in directing a group of young researchers in devising and developing rigorous methods and tools for model-based development and verification of distributed embedded software. S. Ramesh has more than 20 years of research experience in the areas of high level language design, validation and verification of distributed systems, embedded software and hardware designs. Earlier, he was a Professor in the Dept of Computer Science and Engineering, Indian Institute of Technology, Bombay. At IIT Bombay, he was also the head of the Centre for Formal Design and Verification of Software which he co-founded. As part of the Center activities, he carried out many industry-sponsored projects on verification of hardware and embedded software. S. Ramesh has also been actively involved in many national and international collaborative research projects. He has published more than sixty papers in international conferences and journals, co-edited a few conference and workshop proceedings, special issues in international journals, been panelists and on the program committee for many international conferences, and refereed several papers for many international journals and conferences.