Title: MDE4DRE: Model-Driven Engineering for Distributed Real-time and Embedded Systems

Tutorial Objectives

Reusable software components and standards-based component models are increasingly being used to develop large-scale distributed real-time and embedded (DRE) systems. This trend, however, also introduces new complexities associated with composing and deploying DRE systems using components, including the need to (1) design consistent component interface definitions, (2) validate interactions between components and generate valid component deployment descriptors, (3) configure application components and the underlying middleware and platform correctly, (4) ensure that requirements of components are met by target nodes where components are deployed, and (5) validate the selected configuration and deployment satisfies end-to-end QoS requirements. The lack of simplification and automation in resolving these challenges can significantly hinder the effective transition to—and adoption of—component middleware technology to develop DRE systems.

Model-Driven Engineering (MDE) has emerged as a promising means to address these issues by combining domain-specific modeling languages (DSMLs) with generators that analyze certain aspects of the models and then synthesize various artifacts, such as source code, simulation inputs, XML deployment descriptions, or alternative model representations. This tutorial provides an overview of MDE for DRE systems, focusing on

- Fundamental concepts of MDE including DSMLs, system execution modeling (SEM) and generative programming.
- How MDE tools and metamodeling are applicable to DRE systems.
- Role of code generation and model-to-model transformation in meeting QoS requirements of DRE systems.
- Role of MDE in design-time analysis of DRE system properties.
- Deploying and configuring middleware and DRE applications using MDE tools.

Many of the topics mentioned above will be introduced using examples and case studies from production DRE systems. Wherever possible, we'll show live demos of using MDE tools in the tutorial.

Relevance to RTAS 2007 participants.

By using real-world scenarios and application lifecycle challenges drawn from different DRE domains, such as avionics, shipboard computing and space missions, RTAS 07 participants will find the session interesting and useful. Upon completing this tutorial, attendees will be able to:

1. Recognize the inherent and accidental complexities involved with developing software for DRE systems.
2. Understand precisely how MDE techniques and tools can and cannot help to alleviate this complexity.
3. Apply key MDE design techniques (such as metamodeling, system execution modeling, constraints, and model interpreters) to develop domain-specific modeling languages and modeling artifacts that resolve key challenges faced by DRE system developers.
4. Utilize popular MDE tools to create efficient, robust, and reusable software for DRE systems.
5. Know where to find additional sources of information on how to successfully apply MDE techniques to DRE systems.

Organizers

Douglas C. Schmidt is a Professor of Computer Science at Vanderbilt University. His research covers a range of research topics, including patterns, optimization techniques, and empirical analyses of software frameworks and domain-specific modeling environments that facilitate the development of distributed real-time and embedded (DRE) middleware and applications running over high-speed networks and embedded system interconnects. In addition to his academic research, Dr. Schmidt has over fifteen years of experience leading the development of ACE, TAO, CIAO, and CoSMIC, which are widely used, open-source DRE middleware frameworks and model-driven engineering tools that contain a rich set of components and domain-specific languages that implement patterns and product-line architectures for high-performance DRE systems.

Email: schmidt@dre.vanderbilt.edu
Institute for Software Integrated Systems, Dept of EECS
Vanderbilt University
2015 Terrace Place
Nashville, TN 37203
(615) 343-8197

Aniruddha Gokhale is an Assistant Professor of Computer Science and Engineering at Vanderbilt University. His research focuses on the development of innovative model driven engineering techniques including domain specific modelling languages and generative technologies to specify, analyze, configure, optimize and deploy component-middleware systems used to build distributed real-time and embedded systems. As the Principal Investigator for the DARPA PCES and ARMS program, he led a team of researchers to build the open source CoSMIC MDE tool suite. His MDE research focus is complemented by his work in developing highly optimized middleware platforms to support adaptive, fault tolerant and real-time distributed systems.

Email: gokhale@dre.vanderbilt.edu
Institute for Software Integrated Systems, Dept of EECS
Vanderbilt University
2015 Terrace Place
Nashville, TN 37203
(615) 322-8754

Relevant Past Publications and Presentations

1. Douglas C. Schmidt, Model-Driven Development of Distributed Systems, Tutorial, OOPSLA 2006, Portland, OR, October, 2006.
2. Douglas C. Schmidt, Model-Driven Engineering of Distributed Systems, Tutorial, MODELS 2006, Genova, Italy, October, 2006.
3. Douglas C. Schmidt, Model Driven Engineering for Distributed Real-time and Embedded Systems, Distinguished Lecturer Series talk at Colorado State University, Ft. Collins, CO, April 10, 2006.
4. Aniruddha Gokhale, “Model Driven Engineering”, Invited Talk at Avaya Research Labs, Basking Ridge, NJ, April 14, 2006.

5. Aniruddha Gokhale, ``CoSMIC: Addressing Crosscutting Deployment and Configuration Concerns of Distributed Real-time and Embedded Systems via Aspect-oriented and Model-driven Software Development," Demonstration presentation, Fourth International Conference on Aspect-oriented Software Development (AOSD), Chicago, IL, Mar 2005.
6. Krishnakumar Balasubramanian, Jaiganesh Balasubramanian, Jeff Parsons, Aniruddha Gokhale, and Douglas C. Schmidt, A Platform-Independent Component Modeling Language for Distributed Real-time and Embedded Systems, Elsevier Journal of Computer and System Sciences, Volume 73, Number 2, March 2007, pages 171 - 185.
7. Aniruddha Gokhale, Douglas C. Schmidt, Balachandran Natarajan, Jeff Gray, and Nanbor Wang, Model Driven Middleware, in *Middleware for Communications*, edited by Qusay Mahmoud, Wiley and Sons, New York, 2003.

Publicity Plan

We will advertise our tutorial via SEWORLD, RTAS/RTSS mailing lists, as well as the mailing lists we use for ACE/TAO, CIAO and CoSMIC software we have developed. These mailing lists have in the past been successfully used to convey information on past tutorials given by Doug Schmidt, which had a healthy response.

Tutorial Website

Information on the tutorial will be made available at www.dre.vanderbilt.edu/cosmic as well as the presenters' home pages and the ISIS main web page.