CoSMIC: An MDA Tool Suite for Distributed Real-time and Embedded Systems

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Research Synopsis

Model Driven Approach for Distributed Real-time & Embedded Middleware

Develop, validate, & help to standardize technologies that:

(1) Model
(2) Analyze
(3) Synthesize &
(4) Provision

multiple layers of middleware for distributed real-time and embedded (DRE) systems that require simultaneous control of multiple quality of service properties end-to-end
Distributed Real-time & Embedded Systems

The Past

• Stringent simultaneous quality of service (QoS) demands
• Part of larger systems
• Resource constrained

The Future

• Network-centric & large-scale
• Dynamic context
• Stringent simultaneous quality of service (QoS) demands
• Part of larger systems
• Resource constrained
DRE Systems: The Challenges Ahead (1/2)

- There is a limit to how much application functionality can be factored into broadly reusable COTS middleware.
- Middleware has become extremely complicated to use, configure, & provision statically & dynamically.
- There are now multiple middleware technologies to choose from.
DRE Systems Challenges: Emergence of Component Middleware (2/2)

Context
• Component middleware gaining importance (CCM, J2EE, .NET)
• Components encapsulate application core logic
• Components possess
  • Event sinks & sources
  • Connection points e.g., receptacles
  • Interfaces e.g., facets
  • attributes
• Containers provide execution environment for components with common operating requirements
• Containers communicate via a middleware bus

Challenges
• Accidental complexities configuring the middleware
• Accidental complexities deploying semantically compatible components
Our Solution: *Model-Driven* Middleware for DRE Systems

**Key Benefits**

- Preserves DRE application functional & systemic QoS properties as high level models
- Domain-specific languages & analysis/synthesis tools transform models to customize underlying multi-layered middleware platforms
- Leverages & shapes standards for wider applicability

**Related Work:**

- MIC, Vanderbilt (Sztipanovits, Karsai, et al)
- Ptolemy, UC Berkeley (Lee et al)
- Cadena, KSU (John Hatcliff et al)
- Quality Connector, LMCO (Joe Cross et. al)
MDA-Component Middleware Integration

- Our tool suite is called CoSMIC
- CoSMIC = Component Synthesis using Model Integrated Computing

Goals
- Configuring and deploying application services end-to-end
- Composing components into component servers
- Configuring application component containers
- Synthesizing application component implementations
- Synthesizing dynamic QoS provisioning and adaptation logic
- Synthesizing middleware-specific configurations
- Synthesizing middleware implementations
Current Target Middleware: CIAO CORBA Component Model

Focus on infrastructure support for composition of the following aspects
- CIDL compiler to synthesize component descriptor metadata & stubs/skeletons
- RT event channel integration with CIAO containers
- Assembly & deployment framework
- Collaboration with Washington University
Boeing Bold Stroke: Current Target Domain

- Avionics Product Line Component Model
- DRE system with 3,000+ domain-specific software components, 3-5 million lines of C++ code
- 100+ developers
- Mission-control software for Boeing military aircraft, e.g., F-18 E/F, Harrier, UCAV
- Leverages the ACE+TAO middleware
- Used as Avionics Open Experimental Platform (OEP) for DARPA/IXO PCES & MoBIES programs
- Moving towards using CIAO CCM
Concluding Remarks

CoSMIC Tools Applying MDA to address
1. the end-to-end deployment aspect of DRE applications
2. the component container configuration aspect
3. the middleware configuration aspect
4. the dynamic QoS provisioning & adaptation aspect

Current Status:
• Modeling paradigm and generators developed for CCM component assembly & deployment
• Modeling paradigm and constraint checker to determine semantic compatibility of ORB configuration options
Downloading the Middleware & Tools

- Beta and Stable release can be accessed from [http://www.dre.vanderbilt.edu/Download.html](http://www.dre.vanderbilt.edu/Download.html)

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