Real-time and Embedded Systems Workshop

Arlington, VA USA - July 10-13, 2006

Workshop Program

MONDAY - July 10, 2006 - Tutorials

0900 - 1230 ***Real-time Data Distribution Service Tutorial (Part 1)***
Track 1 Victor Giddings, Senior Scientist, Objective Interface Systems
Gerardo Pardo-Castellote, Chief Technology Officer, Real-Time Innovations, Inc.

The Data Distribution Service (DDS) is an adopted OMG specification that adds typed, multi-point data distribution between publishers and subscribers. This data-centric communications decouples publishers of information from subscribers in several dimensions. First, the need for identity of publishers and subscribers is moot; information to be shared is described by topic and type only. Second, the transfer of information from publishers to subscribers is asynchronous; subscribers decide whether to listen for changes or to use the currently available value. This decoupling of system components offers advantages for system design and evolution. System design is very flexible. For example, system components can decide to contribute or digest data based on a static system design or any number of dynamic attributes including role, capability, or physical location. Systems can also more easily evolve; data can be put to originally unanticipated uses without affecting the publishers of the data. The specification allows high-performance implementations that will scale well to very large numbers of publishers and subscribers. DDS also offers an easy to understand and use interface. This tutorial will cover the contents of the DDS specification, contrast it with other OMG specifications that offer data distribution capabilities, and discuss its possible application in different system architectures.

0900 - 1230 ***Real-time CORBA Tutorial***
Track 2 Kevin Buesing, Director of Technology Services, Objective Interface Systems

The OMG Real-time CORBA specification extends CORBA for use in real-time systems. Real-time CORBA provides a clean infrastructure for building distributed applications with time constraints. The addition of Real-time CORBA 2.0, Dynamic Scheduling, provides significant extensions that allow application engineers to "plug-in" alternative workload management and scheduling capabilities. In addition, the Minimum CORBA specification offers a feature-optimized version of the CORBA specification that allows application designers to depend on the reduced feature sets of lightweight ORB implementations. This tutorial will highlight the concepts and features of each of the specifications, along with examples of their use.

1030 - 1045 Morning Refreshments

1230 - 1315 Lunch

1330 – 1700 ***Real-time Data Distribution Service Tutorial (Part 2)***
Track 1 Gerardo Pardo-Castellote, Chief Technology Officer, Real-Time Innovations, Inc.
Victor Giddings, Senior Scientist, Objective Interface Systems

This is a continuation of the morning session and will also deal with advanced DDS concepts.

1330 – 1700 ***Using the Lightweight CORBA Component Model to Develop Distributed Real-time and Embedded Applications***
Track 2 Douglas C. Schmidt, Professor of Computer Science, Vanderbilt University
Frank Pilhofer, Software Engineer, Mercury Computer Systems

This tutorial will explain the key features and mechanisms in the Lightweight CORBA Component Model (CCM) specification, including in-depth examples of applying the OMG Deployment and Configuration

Specification for distributed real-time and embedded (DRE) applications. Several examples will be used to demonstrate how these features and mechanisms can simplify DRE application development and integration. These examples will show how to develop CORBA components, how to assemble these components into applications, and how to deploy these applications in the Lightweight CCM run-time environment. Other examples will show how real-time extensions to Lightweight CCM can enable the development of robust, adaptive, and complex DRE applications. By attending this tutorial, DRE system developers will get a comprehensive introduction to the Lightweight CORBA Component Model. Attendees will also learn how to use CCM features and extensions to develop CORBA applications that can meet stringent real-time QoS requirements. This tutorial will also refer to ongoing OMG standards activities to add QoS support to CCM and UML, as well as enhance CCM by integrating it with Model Driven Architecture (MDA) and Model Integration Computing (MIC) tools and techniques.

1500 - 1515 Afternoon Refreshments

1700 – 1800 **BOF: *Enhancing the High Confidence Software Infrastructure for DRE Systems***
Moderator: Helen Gill, Program Director, National Science Foundation

Significant effort is spent manually rediscovering and reinventing solutions to common requirements, which has led to the situation where the software for many mission- and safety-critical distributed real-time and embedded (DRE) systems is late, over budget, and defect ridden. This BoF session will be organized as a panel that will discuss promising technical approaches pertaining to developing a high confidence software infrastructure for DRE systems. In particular, the panelists will present promising strategies and tactics for enhancing the current real-time operating system, virtual machine, and distributed computing middleware platforms into a sound and assured technology base for DRE systems.

TUESDAY – July 11, 2006

0900 - 0915 ***Welcome & Opening Remarks*** **– Program Committee Chair**
Andrew Watson, Vice President & Technical Director, Object Management Group

0915 – 1200 **Session 1: *Fault Tolerance***
Chair: Victor Giddings, Senior Scientist, Objective Interface Systems

Fault tolerance, the ability of a system to detect, analyze, and recover from failures that affect the system, is a critical attribute of most distributed real-time and embedded systems. It is an attribute that can be provided by certain types of middleware, such as those conforming to the Fault Tolerant CORBA specifications. But Fault Tolerance mechanisms in middleware do not operate independently of other mechanisms that provide equally important attributes of a system. Indeed, the needs of fault tolerance are often in conflict with other attributes, such as real-time predictability or constrained resources. The interactions of Fault Tolerance with component assembly, with resource management, and with Real-time are explored in this session. An implementation of the Fault Tolerant CORBA specification is also explored.

Investigating Lightweight Fault Tolerance Strategies in Enterprise Distributed Real-time Embedded Systems
Jaiganesh Balasubramanian, Aniruddha Gokhale & Douglas C. Schmidt, Dept. of EECS, Vanderbilt University
Nanbor Wang, Tech-X Corporation

This presentation will describe techniques we used to enhance/apply the Lightweight CCM and FT CORBA specifications to support high dependability in enterprise DRE systems, which are realized as groups of services deployed across multiple hosts. Our presentation will focus on explaining novel concepts to represent replicas for such systems, and discuss their failover possibilities, state synchronization and consistency needs, and fault detection and notification requirements. Finally, we demonstrate how standards based deployment and configuration metadata can be used to capture the dependability requirements of such systems, so that appropriate runtime support can be deployed and configured according to individual application requirements.

Providing Fault-Tolerant Management in a CCM DRE Environment
Paul Rubel, Joseph Loyall and Matthew Gillen, BBN Technologies
Aniruddha Gokhale and Jaiganesh Balasubramanian, Department of EECS, Vanderbilt University
Priya Narasimhan and Aaron M. Paulos, Carnegie Mellon University

This presentation will discuss our ongoing effort to develop a fault-tolerant Multi-Layer dynamic Resource Management (MLRM) system (a CORBA Component Model (CCM) infrastructure application used to deploy, and manage resources for, other CCM domain applications.) We will discuss some of the challenges we have encountered and the R&D we have undertaken, including providing rapid recovery, supporting fault-tolerance and characteristics of component middleware, and integrating replicated and non-replicated components.

1030 - 1045 Morning Refreshments

Analysis of Passive CORBA Fault Tolerance Options for RT Applications
Robert A. Kukura, Senior Principal Software Engineer, Raytheon and Paul V. Werme, Lead Scientist, NSWCDD

Within mission-critical systems, including US Navy combat systems, there is often a need for deterministic time-bounded fault detection and recovery. For CORBA-based systems, key aspects for achieving this involve fault detection and failover of connections and method invocations between clients and sets of replicated servers. We present an analysis of passive CORBA fault tolerance issues, options, and architectures that support real-time deterministic performance, effective fault tolerance, application level transparency, standards compliance, and interoperability with non-FT-enabled CORBA clients. Our analysis focuses primarily on standards-compliant solutions based on location forwarding.

CORBA Fault Tolerance for Mission and Safety Critical Systems
Hakim Souam, Technical Architect, THALES Air Traffic Management

This presentation will discuss the development of Fault Tolerant middleware for next generation mission and safety critical Command Control and Information Systems (CCIS) systems. CARDAMOM is an advanced middleware platform, which has been developed by a consortium of companies including THALES and SELEX-SI. It is currently used to support the development of Air Traffic Control centers and Airborne Command and Control Systems. CARDAMOM provides an implementation of the CORBA Fault Tolerance specification focused on Warm Passive replication of both CORBA objects and CORBA components.

1200 - 1245 Lunch

1300 – 1330 **Sponsor Presentation**
Meeting the Challenges of Ultra-Large-Scale Distributed Real-time and Embedded Systems
Douglas C. Schmidt, Professor of Computer Science, Vanderbilt University

Future network-centric operations will run on ultra-large-scale (ULS) systems characterized by thousands of platforms, sensors, decision nodes, actuators, and operators connected through heterogeneous networks to exploit information superiority and achieve strategic and tactical objectives. Given the limitations of today's technology base, how can we build systems of the future that will have hundreds of millions of of lines of code, unboundedness, continuous requirements evolution, and continuous operation? This talk will explore the characteristics of ULS systems and present some candidate middleware and model-driven technologies that can help us get to such a scale from our current technology base.

1330 – 1530 Session 2: *Performance and QoS Assurance*

Chair: Andrew Watson, Vice President & Technical Director, Object Management Group

The presentations in this session concern topics on determining the QoS and performance characteristics of real-time systems.

Evaluating the Performance of Pub/Sub Platforms for Tactical Information Management
Jeff Parsons, Senior Staff Engineer and Ming Xiong, Vanderbilt University
Gautam Thaker, Project Leader, Lockheed Martin Advanced Technology Labs

Standards-based platforms have recently emerged that enable tactical information management systems to communicate by publishing the information they have and subscribing to the information they need. For example, the OMG Data Distribution Service (DDS) specification supports a plethora of diverse real-time computing environments ranging from small-networked embedded systems to system of systems. Various DDS implementations are now available. This presentation describes the results of studies that measure the QoS of various Pub/Sub platforms. Our results show that while there is some variability in DDS implementation QoS, all DDS implementations performed consistently better than implementations of other pub/sub platforms.

Network QoS Assurance in the Presence of Faults
Balakrishnan Dasarathy, Chief Scientist, S. Gadgil, F. Porter, K. Parmeswaran, R. Vaidyanathan, Telcordia Technologies

We present a network Quality of Service (QoS) solution that adapts to major catastrophes such as multiple subnet failures and partitions. The key component of our QoS solution is a Bandwidth Broker (BB) that provides admission control of applications into various service classes ensuring that admitted flows of a given class will have needed capacity or bounded delay. The talk will focus both on the software and network fault recovery aspects of the BB, specifically its state restoration using a COTS database cluster technology, and the impact of a fault on QoS of previously admitted flows and their QoS restoration.

Open Architecture Computing Environment: DDS Middleware Benchmarking
Bruce McCormick, Engineer, EG&G Inc.

This presentation will discuss the results of a standalone benchmarking effort involving several DDS implementations; Splice, NDDS, and the TAO Data Distribution Service that OCI is developing. The purpose of the effort was to characterize the performance of different products, for multiple configurations. This project provided insight and data on key implementation issues, and performance, and is a follow up to last year's presentation on pre-DDS compliant products. This effort provided insight into some of the issues of porting from pre-standard publish/subscribe middleware to DDS-compliant middleware.

1500 – 1900 *Demonstration Area Open*

1530 – 1600 Afternoon Refreshments

1600 – 1800 Session 3: *Software Defined Radio Implementation Experiences*

Chair: Andrew Foster, Product Manager, PrismTech

Software Defined Radio (SDR) has been a key goal of the signal and communications as well as the intelligence and defense community for some time now as it offers significant advantages over traditional hardware radios. Presentations in this session will examine some of the key issues facing SDR community today including, improving the performance of SDR middleware operating environments, provision of a standardized communication infrastructure across different processor sets (GPP, DSP & FPGA) in the radio and addressing the issue of Real-time component composability in the SCA.

Performance of Middleware for HBHT Radios
Piya Bhaskar, Systems Engineer, Lockheed Martin

Latency and throughput performance of control and data transport through the radio software chain become extremely critical, as SDR technologies are increasingly used in high-bandwidth, high-throughput military radios. Today the signal processing required for the high-bandwidth, high-throughput terminals precludes the ultimate expression of SDR technologies. For the future, it is imperative that middleware operating environments allow operations at increasingly higher rates. This work evaluates the performance of middleware infrastructure on a number of real-time operating systems with IPv6 network stacks and analyses the factors that would lead to higher performance.

Next Generation Operating Environment
Bruce Trask, Director of S/W Engineering, SDR Products, PrismTech

CORBA has been branded by many as being slow or large as a result of its use in enterprise systems. However today's CORBA middleware, designed and standardized for use in real-time, resource constrained, distributed systems makes its use viable in the signal processing domain. The presentation will discuss CORBA's application in DSPs and FPGAs along with size and performance metrics. These approaches discussed will describe an environment that accommodates component frameworks such as the SCA and the OMG Software Radio Component Framework with further discussion of optimized, architecturally consistent SCA implementations.

Composability Problems and Mitigation in Real-time Software Defined Radio (SCA) Systems
David Carlson, President, Chronolytics, Inc. & Raymond Lindenmayer, Sr. Engineering Manager, Harris Corporation

This presentation will discuss design issues within the CORBA/POSIX/SCA framework that lead to software radio designs where global parameters, such as thread priority, decrease composability of the operating environment and the waveforms. We will present an alternative model for a POSIX-based application framework which, in part, addresses real-time composability in component design. It will include a justification for building software radios with design-for-latency, asynchronous method invocation (AMI) and Deadline Monotonic Analysis (DMA). We will examine state-of-the-art practice in designing large real-time systems. We claim by adopting and adapting these practices, software radio components can be built with greater composability, which will decrease the risk and cost to the integrator of multi-vendor software radios.

1800 – 1900 ***Demonstration Area Reception*** ***hosted by***

PRISMTECH & VANDERBILT

1900 – 2000 **BOF: *CORBA/e - Future Profiles***
Moderator: Andrew Foster, Product Manager, PrismTech

CORBA/e is the OMG's latest flagship initiative that aims to address the needs of the Real-Time Embedded CORBA community. A key aspect of CORBA/e is its endorsement for the idea of domain specific profiles. Profiles define subsets of CORBA functionality targeted at meeting the specific requirements of different end user communities and enabling highly optimized CORBA implementations. With the initial launch of CORBA/e two new profiles were defined (Micro and Compact). We will discuss these new profiles and their suitability for different application domains. The session will also include a discussion of the requirements for future profiles that may be embraced by CORBA/e.

WEDNESDAY, July 12, 2006

0900 – 1200 Session 4: *Applications of Model Driven Development*

Chair: Ben Watson, Research Program Manager, Lockheed Martin Aeronautics Company

Model Driven Development (MDD) has matured into a viable technological approach for a variety of systems development disciplines. This session highlights four diverse applications of MDD to the development of real-time, embedded systems. The applications include development process methodology, analysis methods for QoS and fault tolerance, and optimizations for component middleware.

Model-Driven Agile Development of High Assurance Distributed Systems
James Kirby, Jr., Center for High Assurance Computer Systems, Naval Research Laboratory

The Sage development method and its associated tool set support an agile, model-driven process to build and maintain high assurance reactive distributed systems. A Sage application model comprises a set of interconnected models that provide documentation supporting high assurance certification efforts, that tools can analyze for important classes of errors, that support maintenance and reuse of the models, and from which tools can generate a complete distributed system. We have used a prototype tool chain incorporating Sage to construct, automatically check for consistency and completeness, and execute several example distributed systems, including a subsystem on a deployed weapon platform.

Applying Model-Driving Engineering to Evaluate the QoS of Distributed, Real-time, Embedded Systems
John M Slaby, Software Architect, Raytheon -James H. Hill, Sumant Tambe, Douglas C. Schmidt, Vanderbilt University

This presentation shows how CUTS (Component Workload Emulator {CoWorkEr} Utilization Test Suite) MDE tools have been used to evaluate DRE system QoS. This presentation will show the use of CUTS to capture the structure of the SLICE scenario, rapidly define multiple deployments for performance testing, capture the behavior and resource consumption of each individual component in the SLICE scenario, and visually locate problematic aspects of particular D &Cs to help improve subsequent compositions. Our results show that MDE tools help improve performance analysis of DRE systems and can help discover, measure, and solve integration and performance problems early in the system's lifecycle.

1015 - 1045 Morning Refreshments

1000 – 1600 ***Demonstration Area Open***

Model-Driven Engineering of Fault Tolerance in Enterprise DRE Systems
Sumant Tambe, Aniruddha Gokhale, Jaiganesh Balasubramanian, Krishnakumar Balasubramanian, Douglas C. Schmidt ISIS, Vanderbilt University

The presentation will motivate the audience by showing the challenges involved in development of component-based, large scale enterprise DRE systems, which have stringent, simultaneous dependability requirements. This presentation will focus on the following three contributions of applying Model-Driven Engineering (MDE) to design fault-tolerant enterprise DRE systems: (a) demonstrating how modeling FT elements at different granularities can help in separation of concerns, and (b) how generative technologies can be used to rapidly and reliably enhance the system with FT capabilities, and (c) how system deployment concerns can be alleviated applying placement decision algorithms on the models.

Model-Driven Optimizations of Component-Based Systems
Krishnakumar Balasubramanian, Research Assistant and Douglas C. Schmidt, Professor of Computer Science, Vanderbilt University

This presentation describes optimizations for component-based enterprise DRE systems. First, we identify key sources of overhead, including run-time checks for collocation, inefficient middleware glue-code generated per component, and creation of redundant infrastructure elements. Second, we show how component models can help build optimization frameworks that combine application information with the knowledge of underlying middleware implementation and customize middleware implementations depending upon application needs/requirements. Finally, we describe model-driven optimization techniques that can automatically optimize overhead in Lightweight CCM using use of context supplied (or deduced) from application models and a novel scheme for providing a physical mapping of a component assembly.

1200 - 1245 Lunch

1300 – 1330 **Sponsor Presentation**
RTE Standards-based Middleware and Model Driven Design – Trends and Challenges
Keith Steele, CEO, PrismTech Corporation

This presentation examines and discusses emerging trends in standards-based middleware, the application of Model Driven Design (MDD) techniques to support these standards, new OMG RTE standards, the evolution of existing OMG standards, and the COTS implementations that will support and ease development to these standards.

1330 – 1530 **Session 5:** ***Exploiting the Potential of DDS: Application-Design Patterns and Model-Driven Development***

Chair: Gerardo Pardo-Castellote, Chief Technology Officer, Real-Time Innovations, Inc.

The OMG Data-Distribution Service for Real-Time Systems specification (DDS) has enjoyed rapid acceptance within the real-time community as a basis for building information-centric systems. Projects are attracted to DDS by its flexibility and features: (1) the richness of quality of service (QoS), (2) the high-level data-centric distributed-programming abstraction, (3) the performance and modularity afforded by its publish-subscribe model, (4) the built-in fault-tolerance, filtering, etc. However, good system-design is not about using every feature in the book, rather it is more about applying the proper techniques to the right problem. It is therefore critical to move beyond "what DDS provides" towards "how to use DDS" best. The session presentations provide insight on the effective and efficient use of DDS for building information-centric systems. Effectiveness comes from an understanding of the capabilities of DDS and how they can be applied to solving practical application use-cases. Efficiency comes from the use of graphical MDA tools to define the information model and automate programming steps via code-generation. The practical information presented in the session will help architects, integrators and developers of distributed-systems who are using or considering DDS.

DDS Use Cases: Effective Application of DDS Patterns, and QoS
Gordon A. Hunt, Principal Engineer, Real-Time Innovations, Inc.

The Data Distribution Service (DDS) standard is seeing rapid adoption across many application domains. Each application domain leverages DDS's rich set of Quality of Service (QoS) parameters to address and solve unique requirements. Understanding the QoS parameters is the first step to utilizing the full capabilities of DDS. Applying and combining these QoS together with appropriate settings is the second. QoS settings affect all aspects of an application design; fail-over and redundancy, system startup and discovery, reliability and synchronization, to even data and Topic design. This talk will provide examples and design patterns that show how to leverage the full set of DDS QoS. Additionally, these patterns and examples will be applied to real world application problems.

Model Driven Development and DDS
John Russell, Product Manager, PrismTech

The 'information centric' approach proposed by OMG's Data Distribution Service (DDS) offers developers of distributed real-time mission critical systems enormous potential to address the challenges of architectures which are typically complex, highly dynamic, loosely coupled and asynchronous. The presentation will describe how Model Driven Development / Architecture (MDD/MDA) with Generative Programming (GP) techniques can be applied to the DDS in order to leverage the sophisticated capabilities and services provided by the middleware. The presentation will focus on how graphical MDD tools for DDS can significantly reduce application complexity, shorten application development time, improve quality and ensure standards compliance.

Realizing Data Distribution Services through MDA
Sam Mancarella, CTO, Sparx Systems and
Davis Ford, Chief Consultant, Zeno Consulting, Inc.

DDS is a middleware specification for delivering data-centric information among communicating nodes with predictability needs. The principle of Model Driven Architecture (MDA) is to abstract technology-specific details of system architecture, allowing developers to focus centrally on the system's form and function. This presentation demonstrates the realization of DDS-capable systems using MDA. It involves modeling the system's "platform-independent" architecture and automatically transforming that model into an implementation for a given language and platform. DDS provides a powerful middleware infrastructure with adjustable Quality of Service parameters. Enabling DDS system development using MDA provides developers with an easier way to harness that power.

1530 – 1600 Afternoon Refreshments

1600 – 1800 Session 6: *Real-time CORBA: The New Paradigm*

Chair: Joseph M. Jacob, Senior Vice President, Objective Interface Systems, Inc.

As CORBA evolves, developers are continually finding new and remarkable ways to use CORBA to solve a variety of different programming challenges. To further this evolution, new specifications are being adopted to enhance further the desirability of CORBA. This session will present how CORBA is being used successfully in two entirely different types of systems. In addition, this session will also present the new CORBA/e standard, designed specifically for real-time and embedded systems to enable CORBA to be used from large, mission-critical processing systems to ultra-small form factors.

Using CORBA for Automated Stock Trading
Carlos O'Ryan, CTO, Automated Trading Desk, LLC

ATD uses CORBA in its order management system (OMS.) Such systems are typically responsible for receiving, recording and monitoring customer and proprietary orders. The OMS is also expected to perform pre-trade compliance, i.e., verify that all applicable regulations are followed before an execution takes place. The system is also responsible for providing basic risk management controls. ATD's OMS is implemented using CORBA as its primary distribution mechanism. In this talk we will describe how ATD has used CORBA to provide load balancing, persistent message passing, and failover. The talk will also describe how some aspects of CORBA Messaging are used to improve parallelism in the system without requiring multi-threading.

Real-Time CORBA for Mission Critical Systems - Space Vehicle Static Testing
Felicia Pravina J.T., Senior Software Engineer, Technical Lead, Sankhya Technologies

In this presentation we discuss the application of OMG's Real Time CORBA in a mission critical system, viz. space vehicle static testing. The presentation will cover the development of a CORBA based real-time system for monitoring and controlling various critical parameters like engine chamber pressure, thrust, propellant flow, various temperatures, valve status for static rocket engine test. Monitoring systems in turn dispatch the parameters to various digital media for online real-time display.

CORBA/e: The New CORBA for Embedded Systems
Victor Giddings, Senior Scientist, Objective Interface Systems

The OMG has merged the interoperability of standard CORBA with the reliability and deterministic execution of Real-time CORBA into a pair of specification profiles – Compact CORBA/e and Micro CORBA/e – that meet the middleware needs of Distributed Real-time and Embedded (DRE) computing. Compact CORBA/e fits easily on a typical 32-bit microprocessor, running a standard Real-Time Operating System (RTOS); these systems may run such applications as signal or image processing with real-time dependability. Micro CORBA/e, even smaller, fits on the kind of low-powered microprocessor or high-end DSP found on mobile or hand-held equipment.

1800 - 2000 *Workshop Reception* *hosted by* PRISMTECH & VANDERBILT

2000 – 2100+ BOF: *Open-source Middleware for Distributed Real-time and Embedded Systems*

Moderator: Douglas C. Schmidt, Professor of Computer Science, Vanderbilt University

Many research and production projects are using open-source middleware to build distributed, real-time, and embedded (DRE) and/or general-purpose distributed computing applications in a wide variety of domains, including telecom, aerospace, process control, financial services, and medical systems. This BoF session is intended to provide a forum for research, engineering, and business segments of the open-source middleware community for a discussion on: Interesting research and product development being done with open-source middleware; Where the primary needs of the community lie; and What the future plans are for various open-source middleware efforts.
The BoF session will be highly interactive and driven largely by the interests of the attendees. To spur discussions on concrete topics, we may include presentations on current and future plans of open-source middleware by developers and users who are actively involved in these projects. We plan to circulate a synopsis of the BoF session to solicit presentations from relevant open-source projects that focus on developing middleware for DRE systems.

THURSDAY, July 13, 2006

0900 – 1145 Session 7: *Components*

Chair: Douglas C. Schmidt, Professor of Computer Science, Vanderbilt University

Component middleware platforms are becoming popular for distributed real-time and embedded (DRE) systems because they provide effective reuse of (1) the core intellectual property (i.e., the "business logic") of applications and (2) the infrastructure for deploying and configuring DRE system components. This session highlights a range of enhancements and applications of components to the development of DRE systems. The enhancements and applications include support for dynamic component configuration and deployment, integrating AI planners with component middleware, using containers and other declarative techniques to enforce QoS constraints and minimize footprint in DRE systems.

Provisioning Dynamic Reconfiguration and Redeployment Capabilities for Enterprise DRE Systems
Gan Deng, Douglas C. Schmidt, and Aniruddha Gokhale, ISIS, Vanderbilt University

Enterprise Distributed Real-time Embedded (DRE) systems must often be prepared to accommodate changing operating conditions, therefore the ability to dynamically reconfigure and redeploy components is essential for enterprise DRE systems. This presentation will describe the techniques we used to enhance OMG Lightweight CCM and the D&C model to support dynamic component reconfiguration and redeployment. We will also describe the results of experiments that quantify the costs and benefits of our techniques. These results show how our enhancements provide powerful mechanisms to enable CCM-based enterprise DRE systems to become more flexible and adaptable without changes to existing component source code.

A Decision-Theoretic Planner for DRE Systems
John S. Kinnebrew, Nishanth Shankaran, Gautam Biswas, Dept. of EECS, Vanderbilt University
Dipa Suri & Adam S. Howell, Lockheed Martin Advanced Technology Center

This presentation describes a decision-theoretic mission planner that supports autonomous operation of distributed real-time and embedded systems in dynamic environments. This planner operates on a spreading activation network, which captures relationships between tasks (implemented as components) and system conditions. Goal utilities and task success probabilities are used to generate expected utility values that guide planning. Incorporating resource constraints and scheduling allows the generation of robust plans for Lightweight CORBA Component Model (CCM) applications. We also include efficient re-planning for dynamic changes in goals, conditions, and runtime resource usage. CCM uses the generated plans to (re)deploy components and provide runtime control.

1015 - 1030 Morning Refreshments

Using Containers to Enforce Smart Constraints on Real-time Systems
Gabriel Moreno and Scott Hissam, Senior Members of the Technical Staff,
Software Engineering Institute, Carnegie Mellon University

The goal of the Predictable Assembly from Certifiable Components (PACC) Initiative at the Software Engineering Institute (SEI) is to enable the construction of software systems from software components in a manner that allows for automatic prediction of system behavior. This presentation briefly introduces the PACC concepts and then describes the use of component containers as a mechanism to impose constraints required by a performance reasoning framework. A robot controller model problem is used to motivate a solution to the requirement of allowing third-party extensions to a real-time system while preventing the extension from hindering the predictability of the system's performance.

Component Approach to Real-time and Embedded Systems
Vincent Seignole, Embedded Software Architect, THALES,
Ansgar Radermacher, Embedded Software Researcher, CEA and Colin Wigham, Consultant, PrismTech

This presentation will deal with recent embedded software component technology developments and achievements obtained as part of the COMPARE European project efforts. We will report on the design and implementation strategies applied to obtain a real-time and very low footprint CORBA component model for very different embedded platforms. We will emphasize how the portability issue is dealt with in our approach, addressed via focus on the automated integration of Lightweight-CCM compliant components on the selected target platforms, via fit-for-purpose containers for the targets. We will report on how this technology is being applied on a SDR (software defined radio) demonstrator, and also on a deeply embedded software electrical breaker system.

1145 - 1230 Lunch

1245 – 1400 Session 8: *Certification and Security*

Chair: Gordon Uchenick, Mentor/Principal Engineer, Objective Interface Systems

Ensuring security in mission critical distributed systems is becoming as important as ensuring proper functionality. This session probes two issues: implicit authorization for access control and certification of adaptive distributed systems. The presentations start by exploring the ramifications of implicitly controlling authorization. Adaptive systems have traditionally been viewed as dangerously thin ice by certification authorities because analysis is so difficult. Presentations continue by describing an overall approach to certification for systems with dynamic behavior.

Using CORBA Object References as Authorization Tokens – A Good Idea or Not?
Sebastian Staamann, Director of Security Products, PrismTech

Many CORBA based systems use object references as tokens for implicit authorization. This means that handing over a reference to a client not only provides the necessary addressing and context information but also authorizes the client entity to access the object. It is assumed that other entities, which have not legally received an object reference, cannot access the object. However, external attackers or rogue software can still illegally obtain object references and access objects, thus undermining implicit authorization. This significantly raises the degree of necessary assurance of all software used in embedded systems where implicit authorization is used.

Toward Certification of Adaptive Distributed Systems
Lonnie Welch, Professor, Ohio University; John M. Slaby, SW Architect Paul R. Work, Engineering Fellow, Raytheon

This presentation will describe an overall approach to certification of adaptive systems. The objectives of the approach include the following: evidence generation, reproducibility, increase confidence in adaptive technology, provide assurances about system performance, guarantee that good resource allocations will be found, insure prompt detection and response for changes in resource status and resource demands, guarantee that adaptive middleware components perform correctly, show that requirements and characteristics of adaptive systems can be specified easily and completely. The presentation will also discuss metrics and a process for assessing adaptive middleware. The metrics include timeliness of middleware functions, accuracy of event detection, and quality of resource allocation solutions.

1400 – 1515 Session 9: *The Real-Time Specification for Java: ORB and Case Study*

Chair: E. Douglas Jensen, Chief Scientist, Information Technologies Directorate, MITRE

This session begins with a presentation on the development of a "Real-Time Java" (Real-Time Specification for Java) CORBA ORB that is intended to support both hard real-time systems and enterprise level business applications. The second presentation documents the authors' experience porting a prototype U.S. Surface Navy real-time combat system software application to "Real-Time Java" (Real-Time Specification for Java).

Java for Real-time Enterprise Systems
Andrew Foster, Product Manager, PrismTech

The Java platform is ideally suited to many of the needs of the enterprise community, but until recently, has offered no support for Real-time functionality. The new Real-time Specification for Java (RTSJ) extends the benefits of Java to the real-time community, creating an architecture in which hard Real-time, soft Real-time and non-real-time processes can coexist and share data. This presentation describes the development of a Java ORB that can support the Real-Time Specification for Java (RTSJ). It highlights the issues faced when designing and implementing a Java ORB based on RTSJ and its extensions to the Java programming model.

Examining the Use of RT Garbage Collection in a Prototype U.S. Surface Navy Combat System Application
Fred Weindelmayer and Tim Childress, Naval Surface Warfare Center Dahlgren Division

While standard Java is a powerful and versatile programming language, historically it has not proven suitable for creating real-time applications. One technology that has arisen to address this problem is real-time garbage collection. We will present the design of an experiment where a prototype real-time weapon system application was ported to standard Java, and will examine the results of using a real-time garbage collector as compared with conventional garbage collectors. In conclusion, we will discuss the possible implications for the use of Java in U.S. Navy Open Architecture applications.

1515 – 1530 Afternoon Refreshments

1530 – 1730 Session 10: *Integrating Heterogeneous Middleware Technologies: Bridging Real-Time, Enterprise, and Domain-Specific Systems*

Chair: Carlo Cloet, Senior Applications Engineer, Real-Time Innovations, Inc

System integration is driven by the promise of improved efficiencies, the potential of new and enhanced services and transparent access to system wide data. The need to integrate has resulted in a myriad of technologies in both the enterprise community (SOAP, JMS, SQL, etc), real-time systems community (DDS, RT-CORBA), and in other more specialized domains, such as distributed simulation (HLA, DIS, etc). As these technologies mature and establish themselves within their respective application domains, a new integration challenge has recently presented itself to people developing systems that must bring together these different technologies. No clear solution exists for how to bridge the gap from real-time into enterprise and non-realtime and back. The presenters in this session describe practical approaches to solving the integration problem, including the definition of general-purpose connectors and bridges between several popular middleware standards. The session presentations cover the integration of JMS, SOAP, HLA, SQL-Databases, and DDS based systems. Many of the approaches presented make use of the DDS standard, illustrating the potential of this specification as an integration tool.

Unifying the Global Data Space using DDS and SQL
Gerardo Pardo-Castellote, Chief Technology Officer, Real-Time Innovations, Inc.

The DDS distributed global data-space is organized around an underlying table data model, which can be mapped to the SQL data model. This talk explores how the DDS operations can be mapped to SQL operations, and how this mapping can be used to automatically store the data at each node in an SQL database. Furthermore, we explore how changes made to an SQL database can be distributed to local database caches at other nodes via DDS. The result is a global data space that can be uniformly accessed via DDS or SQL. We discuss how this can be used to implement replicated databases.

Interoperability between DDS and HLA Simulations
Bruno Calvo Chevillat, Nextel Engineering Systems

The presentation will start with an introduction of state of the art in simulation and Network Embedded Capabilities. We will cover the main features of the standards, the interface, how a user develops a simple application, etc. The standards will be compared, in order to know how they could be mapped. A case study: The SimWare-Kernel Middleware, will detail, with a single API, connection to both standards, how the mapping between the standards has been done, and what are the main problems in a real implementation. We will also cover the SimWare-Gateway application and it's objective of joining two simulations, which can be DDS, HLA or one of each.

Using DDS to enable the Real-Time Enterprise Service Bus
Gerardo Pardo-Castellote, Chief Technology Officer, Real-Time Innovations, Inc.
Gordon Hunt, Principal Applications Engineer, Real-Time Innovations, Inc.

By including DDS as a new service in the enterprise service bus backbone applications can benefit from the QoS-aware low-latency data distribution capabilities of DDS to connect enterprise and real-time systems. This talk will start with a discussion of the architectural approaches for integrating DDS into an enterprise service bus and bridge the DDS services to popular enterprise technologies such as JMS, SQL, and Web Services. The main focus of the talk will be the introduction of a formal semantic mapping between DDS and each of the popular enterprise middleware technologies: JMS, SQL, and Web Services. These mappings could be used as the basis of an MDA-driven approach to the integration of these technologies.

Program Committee

Dock Allen	MITRE
Bill Beckwith	Objective Interface Systems
Andrew Foster	PrismTech
Victor Giddings	Objective Interface Systems
Helen Gill	National Science Foundation
Andy Gokhale	Vanderbilt University
Joe Jacob	Objective Interface Systems
Doug Jensen	MITRE
Vana Kalogeraki	University of California Riverside
Hermann Kopetz	TTTech
James Kulp	Mercury Computer Systems
Jean-Claude Mahieux	PrismTech
Stephen Mellor	Mentor Graphics
Jishnu Mukerji	Hewlett Packard
Priya Narasimhan	Carnegie Mellon University
Steve Osselton	PrismTech
Gerardo Pardo-Castellote	Real-Time Innovations
Irfan Pyarali	OOMWorks
Doug Schmidt	Vanderbilt University
Bran Selic	IBM Rational Software
Jon Siegel	Object Management Group
Richard Soley	Object Management Group
Dave Stringer	Borland
Virginie Watine	Thales
Andrew Watson	Object Management Group (Chair)
Ben Watson	Lockheed Martin Aeronautics