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# OMG's Third Software-Based Communications (SBC) Workshop: *Realizing the Vision*

Fairfax, VA USA – March 5-8, 2007

## **Workshop Program**

### **MONDAY – March 5, 2007 - Tutorials**

0900 - 1230 ***An Introduction to the OMG Systems Modeling Language (OMG SysML™)***

Sanford Friedenthal, Principal Systems Engineer, Lockheed Martin

The OMG Systems Modeling Language (SysML) is a general-purpose graphical modeling language for specifying, analyzing, designing, and verifying complex systems that may include hardware, software, information, personnel, procedures, and facilities. In particular, the language provides graphical representations with a semantic foundation for modeling system requirements, behavior, structure, and integration with a broad range of engineering analysis. SysML represents a subset of UML 2.0 with extensions needed to satisfy the requirements of the UML(tm) for Systems Engineering (SE) RFP. This presentation provides an introduction to how the SysML extension to UML can address the needs of the systems engineer. It includes background and motivation, and provides a summary of the different SysML diagram types and extensions to UML.

1030 - 1045 Morning Refreshments

1230 - 1315 Lunch

1330 – 1700 ***OMG Software Radio Specifications***

Gerald Lee Bickle, Chief Scientist-SDR Products, PrismTech

This tutorial presentation will discuss the concepts of the software radio specification based upon the current revisions soon to be adopted. The tutorial will touch upon each of the major areas of the specification: UML Profile for Component Framework, UML Profile for Communication Channels, Software Radio Facilities, Component Descriptors, and POSIX profiles. The tutorial will also discuss compliances against the specification and how this compares against the JTRS Software Communications Architecture specification.

1500 - 1515 Afternoon Refreshments

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### **TUESDAY – March 6, 2007**

0900 - 0905 ***Welcome & Opening Remarks – Program Committee Chair***

Fred Waskiewicz, Director of Standards, Object Management Group

0905 – 1000 ***Keynote - NASA's Vision for Space Exploration and the Role of SBC and Navigation Systems***

Robert Spearing, Deputy Administrator for Space Communications and Navigation, NASA Headquarters

1000 – 1015 Morning Refreshments

1015 – 1130 **Session 1: *Analysis and Design of Space Systems***

Chair: Roy Bell, Staff Software Engineer, Raytheon

The OMG SBC task force has developed a standard for software radio. This standard is defined in UML and it consists of a Platform Independent Model (PIM), and a Platform Specific Model (PSM). The PSM features are built on top of POSIX, XML, and CORBA. Radio communication systems can be developed using MDA that is compliant with these standards, but space communication systems offer unique challenges. This session will describe some of these challenges and it will provide a strategy for getting a second PSM to meet them.

**PIM/PSM For Space SDR RFP**

Mark Scoville, Software Architect, L-3 Communications

The OMG's PIM/PSM for Software Radio Components Specification is being assessed by the Space Telecommunications community as the basis for MDA-based standardization of the Space Software Defined Radio (SDR). Industry has teamed with NASA to issue a Request for Proposal (RFP) for a PIM/PSM for Space Software Radio Components. This presentation will address: RFP Scope, the relationship of the RFP to existing OMG specifications, the collaborative efforts of industry and various consortia (including the OMG, SDR Forum, and the IEEE P1900 groups) to the effort, and the candidate space missions that may include this technology.

**Applying MDA to SDR for Space to Model Real-time Issues**

Tammy M. Blaser, Sr. Computer Engineer, NASA John H. Glenn Research Center, Flight SW Engineering Organization

NASA space communications systems have the challenge of designing SDRs with highly constrained Size, Weight and Power (SWaP) resources. A study is being conducted to assess the effectiveness of applying the MDA Platform-Independent Model (PIM) and one or more Platform-Specific Models (PSM) specifically to address NASA space domain real-time issues. This paper will summarize our experiences with applying MDA to SDR for Space to model real-time issues. Real-time issues to be examined, measured, and analyzed are: meeting waveform timing requirements and efficiently applying Real-time Operating System (RTOS) scheduling algorithms, applying safety control measures, and SwaP verification. Real-time waveform algorithms benchmarked with the worst-case environment conditions under the heaviest workload will drive the SDR for Space real-time PSM design.

1130 – 1200 **Sponsor Presentation** 

Deborah Wilson, Program Manager, Boeing

1200 - 1300 Lunch

1300 – 1415 **Session 2: *Security-Aware SBC***

Chair: Kevin Richardson, Software Systems Engineer, The MITRE Corporation

All complex, networked software based systems are potential targets for security breaches. The intrusions could be a result of random malicious attacks, unintentional actions or well-coordinated campaigns. Regardless of the rationale behind the attack, the consequences can be significant for those who use or depend on the integrity of information conveyed on those systems. This issue is especially germane to software intensive communication applications and platforms and this session explores techniques to design, develop and assess secure SBC systems.

**A Threat Model for Software Reconfigurable Communications Systems**

Bernard C. Eydt, Associate, Booz Allen Hamilton

Based on the SDR Forum's work on a threat model for software reconfigurable communications systems, this presentation will explore the general security controls that can be employed to counter those threats. It will focus on technical controls to authenticate the source and protect the integrity of software objects. Emphasized will be the SDR Forum's proposals for using digital signature technology to support the security objectives of diverse stakeholders, such as regulators, operators, manufacturers, and users. How trusted computing techniques can support digital signature controls will also be addressed.

## **Modeling and Implementation of Inter-Component Security for Effective Security Policy Enforcement and Channel/Process Separation**

Sebastian Staamann, Director for Security Products and Solutions, PrismTech

The security of a radio critically relies on the prevention of non-authorized and non-detected access to the software components. We discuss the enhancement of the CORBA infrastructure with security enforcement points that provide for reliable and evaluable access and security control for all component interactions based on formalized external and declarative security policies. We discuss two complementary implementation approaches. In detail, we present the access control and security audit functions of this security framework. Furthermore, we also discuss the decomposition of higher level security policies to component specific policies and the model driven automatic generation of the set of formalized component security policies for the whole radio and its applications.

### 1400 – 1900 ***Demonstration Area Open***

*(Demonstration Area will remain open though the end of the reception)*

1415 – 1445 Afternoon Refreshments in Demonstration Area

### 1445 – 1645 **Session 3: Tool Support for SBC Software Development**

Chair: Piya Bhaskar, Systems Engineer, Lockheed Martin

The three presentations in this session will explore tool support for SBC software development, covering the software lifecycle from design through implementation and on to simulation and verification. Examples are derived from industry as well as academia.

## **The Future of Software Radio MDD Tools**

Dominick Paniscotti, VP & General Manager & Fred Humcke, Director of Hardware, SDR Products, PrismTech

Like any new approach, it takes time for processes and tools to emerge to support MDA style approaches using Model Driven Development (MDD). This presentation will outline how current Model Driven tools support the rapid development of SDR products using MDA principles. In addition, the presentation will consider the possible future direction such tooling may take to further increase the productivity of SDR developers.

## **Integrating SBC Tools**

John Hogg, CTO, Zeligsoft

Software-based communication (SBC) software development teams bemoan the walls between their different activities. They perceive an inability to share artifacts between activities in an efficient, repeatable, reliable, automated way. Coincidentally, the most widely used tools in SBC development are the Microsoft Office suite. This presentation shows that SBC tool integrations exist today and the picture is steadily improving. It lays out the activities of SBC development and the tasks within them and gives examples of tools that automate each task. It is an existence proof for an integrated toolchain. Microsoft Word is not the last word.

## **Efficient Hardware in the Loop Functional Verification Methodology for Software Defined Radios**

Pascal Giard, J.F. Boland, Assistant Professor, J. Belzile, Professor, École de Technologie Supérieure

Complex circuit design is performed with various tools working at multiple levels of abstraction. The verification of these designs is challenging and may take more time and efforts than the design itself. Testbench duplication across abstraction levels is error prone and time consuming. We propose a multi abstraction level verification methodology that also includes hardware-in-the-loop. Our methodology is articulated around the SystemC modeling language and an ORB interface mechanism. Each component of the system can range in implementation detail from gate level to system level. The verification framework links the appropriate tool of each component together to create an efficient verification environment.

1645 – 1800 **Panel: *Convergence of Military & Commercial SDR Requirements & Standards***

Moderator: Fred Waskiewicz, Director of Standards, Object Management Group

This panel explores the need for complete industry participation and integration of the commercial SBC standards with military SDR standards. The audience is invited to join the panel in discussing the relevant set of SDR specifications and charting a course to establish an objective standards baseline that applies to both the commercial and military domains. Specific discussion topics will address how well existing standards meet domain requirements and what areas should be improved; whether or not existing tools meet the functional, performance and time to market needs of the marketplace; and what strategies may be employed to fold the use of such tools and standards into tactical as well as commercial software-based communications development programs.

Panelists: Gunter Brunhart, Chief Engineer, DoD PM NED  
John Chapin, CTO, Vanu, Inc.  
John Hogg, CTO, Zeligsoft  
Dominick Paniscotti, VP Engineering SDR, PrismTech  
Deborah Wilson, Program Manager, Boeing

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



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**WEDNESDAY, March 7, 2007**

0900 – 0945 ***Keynote - Future Mobile Devices Based on Software Based Platform***

Soon Joon Park, Chief Research Engineer, LG Electronics

In the commercial mobile cellular industry, fragmented markets are demanding now the development of multi-mode, multi-band portable devices. Software-based radio platforms are poised to be the key technical solution over multi-chip, hardware-based solutions due to many compelling advantages of employing those software platforms. However, despite these advantages, it has been very challenging to develop practical and, at the same time, power- and cost-efficient platform solutions when faced with significant improvements in many technology areas of the semiconductor industry. Dr. Choi's presentation will address the issues surrounding the development of software-based radio platforms; offer ideas on how to solve those problems; and will share some real development experiences at LG Electronics.

0945 – 1000 AM Refreshments in Demonstration Area

0945 – 1600 ***Demonstration Area Open***

1000 – 1200 ***Session 4: Evolving Standards Realizing the Extended, Higher Performance, Lower Cost SDR Vision***

Chair: Fred Waskiewicz, Director of Standards, Object Management Group

Complexities of existing SCA-compliant SBC Systems warrant a re-examination and evolution of in-place standards addressing further flexibility and extensions in the existing architectures, as well as the need for higher performance and smaller foot-prints. This evolution path is required to address the current and future needs of SBCs systems in the military sector, such as tactical communication systems under the supervision and guidance of the JTRS JPEO, as well as those in the commercial SDR industry. This session examines in detail 3 mechanisms to bring about such flexibility and extensions through examining CORBA/e and its benefits for replacing Minimum CORBA for SDR development to support smaller sizes, greater speeds and higher performance for SBC systems in the defense as well as the telecommunications industries, the relationship between the SCA and the OMG SDR specification and the improvements brought about by this specification to enhance performance and reduce development costs for SCA-compliant communication systems, and finally, a new framework for reconfigurable SDR commercial equipment.

### **CORBA/e - New CORBA Profiles for SDR**

Victor Giddings, Senior Scientist, Objective Interface Systems

The CORBA/e (CORBA for embedded) profiles offer architectural solutions to keep up with the rapid pace of technological change – in processors, models, and particularly communications bus types. 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 the SDR community. CORBA/e systems deliver high-performance, reduced footprint communications while supporting the OMG’s mature interoperability standards: General Inter-ORB Protocol and Internet Inter-ORB Protocol.

### **Evolution And Standardization Of the SCA**

Gerald Lee Bickle, Chief Scientist-SDR Products, PrismTech

An effort to commercially standardize the Joint Tactical Radio System's (JTRS) Software Communications Architecture (SCA) specification was undertaken by the Object Management Group (OMG) several years ago. In December 2005, a new standard known as the Platform Independent Model (PIM) and Platform Specific Model (PSM) for Software Radio Components was adopted by the OMG to serve as an open, commercial standard for the development of Software Defined Radios (SDR) such as the JTRS. This presentation discusses how this new commercial specification relates to the existing JTRS SCA specification, details the extensions available as part of this specification and focuses on specification conformance.

### **A Framework For SDR Commercial Equipment: THE Reconfigurable Equipment PIM (REP)**

Eric Nicollet, Embedded Software Architect, THALES Communications

Considerable research effort has been conducted about applying the internal architecture of SDR to commercial equipment. Following an MDA® approach, we present a reference UML PIM (Platform Independent Model) of an architecture framework for such equipment. The first level breakdown of this PIM is composed of three architecture areas that need to be taken into account in any SDR equipment design: Reconfiguration Management, Reconfiguration Infrastructure and Reconfigurable Elements. For each architecture area, exhaustive and coherent coverage will define classes (entities, controllers, meta-data tables) with particular attention paid in defining the APIs (interfaces + sequences + associated data or meta-data) that rule the main interactions.

1200 - 1300      Lunch

1300 – 1330    ***Sponsor Presentation***    

### ***Transitioning to COTS-Based SDR Solutions***

Gary Putlock, Director, Sales, SDR Products, PrismTech Corp.

The US DoD has invested significant funding to date in the development of standards-based Software Defined Radios. While this investment has proven the feasibility of building such radios, the development approach taken by the defense industry has resulted in handcrafted SDR solutions that are costly to develop and maintain, difficult to optimize across a family of radios with varying form factors and intolerant of changes to the underlying standards. As a result, a COTS SDR industry is emerging to address these issues by delivering small, reusable SDR operating environments suitable for deployment across a wide range of form factors and radio device technologies and by delivering SDR tools that boost developer productivity, readily incorporate modifications to the underlying standards, and increase quality of delivered systems. A COTS SDR approach is the key to ultimately lowering the cost of fielding robust SDRs. This presentation will illustrate how PrismTech's COTS SDR solution is delivering on this promise today.

1330 – 1600    ***Session 5: New Directions for SBC***

Chair: Victor Giddings, Senior Scientist, Objective Interface Systems

Pioneers are building on the success and acceptance of the technologies on which Software-Based Communication is based and pushing these technologies into new realms. In particular, one trend is to continue efforts to increase system flexibility and adaptability by pushing technologies that were previously perceived as “software only” into domains that were previously perceived as “hardware”. The presentations in this session will describe four of these new different directions: in extensions of existing operating environment technologies, in conformance testing, into Field Programmable Gate Arrays, and into autonomously reconfigurable equipment.

### **Next Generation SCA Operating Environments**

Gerald Lee Bickle, Chief Scientist-SDR Products, PrismTech

Today's embedded CORBA middleware, designed and standardized for use in real-time, resource constrained, distributed systems, makes the building of small and fast SCA implementations viable across General Purpose Processors (GPPs), Digital Signal Processors (DSPs) and Field Programmable Gate Arrays (FPGAs). This presentation begins with a brief discussion about SCA perceptions and technologies that offset these perceptions. The presentation additionally discusses SCA distributive communication approaches: adapters along with their shortcomings and new alternatives that are architecturally consistent and use CORBA throughout the radio set. Finally, the presentation discusses the capability of SCA operating environments on DSPs and FPGAs.

1410 – 1440 Afternoon Refreshments in Demonstration Area

### **Making FPGAs "First Class" SCA Citizens**

Fred Humcke, Hardware Director-SDR Products, PrismTech Corp.

This presentation will discuss an Integrated Circuit ORB (ICO) that supports a drop-in SCA compatible interface between distributed software objects running on processors and waveform objects residing in silicon. Using techniques discussed in this presentation, the connection between Software and Hardware clients and servant is made seamless, fast and uses fewer system resources. It will be shown that waveform designers can use ICOs to make their FPGA designs first class SCA citizens without the time consuming task of becoming experts in the minutia of the SCA specification.

### **A Platform-Independent Model for Autonomously Reconfigurable User Equipment and Network Elements**

Zachos Boufidis, Nancy Alonistioti, Eleni Patouni, Makis Stamatelatos, Communication Networks Laboratory, Department of Informatics & Telecommunications, University of Athens  
Markus Muck and Didier Bourse, Motorola Labs

The autonomic computing concept has revolutionised the IT research community envisaging self-configuration and self-management capabilities of computing systems in order to fight their increasingly complex nature. This presentation applies the self-ware rationale in the context of reconfigurable mobile systems and networks beyond 3G. The contribution exploits the autonomy approach in the form of the Reconfiguration Management Plane (RMP), which comprises a platform-independent model that offers control and management operations in autonomic software/cognitive radio environments. The presentation will describe the RMP modules as well as the RMP UML model with emphasis on autonomic decision-making and reconfiguration management, policy-based context management, and self-configuration and management.

1600 – 1615 Afternoon Refreshments

### **1615 – 1745 *Panel: Alternative Architectures for Software Based Communications***

Moderator: Roy Bell, Staff Software Engineer, Raytheon

The SBC and the SCA endorse CORBA, but some people don't like it and some devices don't (yet) support it. Is CORBA the only approach, or are there other approaches that should be standardized? This panel will show that software radios have been well served by CORBA and it will also show that DDS and SOA are worthy alternatives that have considerable merits.

Panelists: Cory Casanave, CEO/President, Model Driven Solutions  
Victor Giddings, Senior Scientist, Objective Interface Systems  
Dominick Paniscotti, VP Engineering SDR, PrismTech  
Gerardo Pardo-Castellote, CTO, Real-Time Innovations, Inc.  
Additional Panelists TBA

1800 - 2000 ***Workshop Reception*** hosted by



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## THURSDAY, March 8, 2007

### 0830 – 1000 **Session 6: *Integration***

Chair: John Hogg, CTO, Zeligsoft

The theme of this session is bringing together the pieces. The first two presentations explain how standards and standards bodies interwork and interrelate to provide a basis for software-based communication. The third presentation presents the results, experiences and lessons learned of an SBC project from the integrator's point of view.

#### **The Software-Defined Radio & Cognitive Radio Inter-Consortia Affiliation**

Mark Scoville, Software Architect, L-3 Communications

The evolution of the Software Communications Architecture (SCA) has sprung from a vision for the SDR/CR community to maximize the value of radio interoperability, reusability, and portability. The SDR/CR community is diverging from the vision for varied reasons: use case differences, competing standards, heavyweightness, scoping, cost and profitability, conflicting technological views, misperception, or not being aware of other similar activity. This paper cannot address all these issues, but does seek to address the developing inter-consortia affiliation of consortia that are aiming to collectively review and address standards development pertinent to the SDR/CR community.

#### **Digital IF Revised Submission: A Concrete Example of Collaboration between an Industrial Forum and a Standardization Body**

Eric Nicollet, Embedded Software Architect, THALES Communications

Focusing on the context and process perspective, this presentation will aim to explain the benefits of OMG SBC DTF and SDRF existence in the standardization effort relative to Digital IF. How the technical domain concertation is carried on in SDRF will be explained, and how it translates into the solid MDA framework of OMG will follow, stressing the benefit in terms of overall SDR standardization credibility and consistency. Technical illustrations will follow to illustrate the conclusions with concrete examples of what the radio experts discuss at the SDRF level and of standardization matters taking place at the OMG.

1000 – 1015 Morning Refreshments

### 1015 – 1215 **Session 7: *Developing Communication Systems Using MDA***

Chair: Piya Bhaskar, Systems Engineer, Lockheed Martin

This session explores the development processes of communication systems using the MDA methodology. The rigors of the communication system development pose specific challenges and demand domain-enhanced solutions to the generic MDA approach. In this session, a number of very unique and diverse solutions will be presented. The first presentation highlights an SBC software development approach fulfilling diametrically opposite goals. The second presentation brings to the forefront a standardized methodology for the design of RF front end functionality. The third presentation shows HC3 architecture development for a family of next – generation military communication platforms. This session is sure to energize the design/development methodologies for future Software Based Communication systems.

#### **Delivering Optimized Portable SBC Software**

John Hogg, CTO, Zeligsoft

Software-based communication (SBC) development is driven by conflicting goals. Software must be portable and reusable, yet SBC environments have demanding performance requirements. Optimization and portability are usually diametrically opposed: increasing one decreases the other. How can the development team have both? This presentation describes innovative, automated techniques for generating efficient code while maintaining portability. Automated optimization at the detailed level frees the user to experiment and explore at an architectural level, leading to global optimization as well. Special attention will be paid to iterative development. Optimized and portable: choose any two.

### **A Methodology for Coherent Functional Description and Hardware Abstraction in RF Front Ends**

Sabeur Lafi, A. B. Kouki & J. Belzile, École de Technologie Supérieure  
A. Ghazel, Ecole Supérieure de Communication de Tunis

Despite the fact that the OMG has specified both platform independent and specific models for radio platforms and also developed an interface definition language (IDL) that specifies interfaces and associated data structures, there is still a big gap between the hardware implementation and verification and the user specification of the desired functionalities. Our objective is to address some of the key issues that need to be resolved in bridging this gap, particularly with regard to RF Front Ends. We propose to develop a coherent methodology that offers to the designer a set of flexible design tools as well as optimal technology mapping strategies. Such a methodology should provide several abstraction levels with different granularity degrees and have the possibility to define the underlying hardware with the required performance, using an intelligent automated synthesis process. We illustrate the proposed methodology by considering a case study and detailing the process flow as well as the tools and interfaces required at various levels.

### **Considerations of the Waveform/Platform Boundary in the HC3 Architecture**

Jerry Kazin, Senior Principle Software Engineer, David Hendry, Engineering Fellow,  
George Vachula, Engineering Fellow, Paulo Barroso, Senior Systems Engineer,  
Raytheon-Network Centric Systems

This presentation discusses the partitioning of Waveform components from platform components and how that boundary contributes to the goals of the HC3 architecture. In order to perform the partitioning a Commonality/Variability Analysis technique is used. The commonality - variability analysis addresses a multidimensional problem that depends heavily on the correct selection of the problem dimensions. The assignment of waveform and platform responsibilities is critical to realizing portability, evolvability, modifiability, etc. in the HC3 architecture. The discussion also includes how various SATCOM waveforms differ with respect to their types of requirements and dynamic behavior.

1215 - 1315      Lunch

## **1315 – 1515      *Session 8: Case Studies for The Software Defined Radio***

Chair: Mark Scoville, Software Architect, L-3 Communications

Open architecture for a WiBro Smart Antenna Base Station providing SDR: What's it look like under the hood?  
Waveforms on limited capacity platforms: Can SCA play here?

Multi-National Interoperability: Is the technical language barrier coming down?

In this session we review three examples of where SDR principles are being applied.

### **Implementation of WIBRO Smart Antenna Base Station System With Open Architecture for SDR Functionality**

Taeyoul Oh, Namkyu Ryu, Yusuk Yun and Seungwon Choi

HY-SDR Research Center, School of Electrical and Computer Engineering, Hanyang University  
Jinsung Choi, Mobile Communication Tech Research Lab., CTO, LG Electronics

In this session, we present an open architecture for a smart antenna base station system providing SDR functionality. In order to define interfaces among modules of the smart antenna system, we also present API's for the proposed system. The proposed architecture is applied to hardware implementation of WiBro (Wireless Broadband) smart antenna base station system in order to validate the performance of required functionalities. Finally, the operation of each API is shown through a use case that is prepared for the proposed WiBro smart antenna base station system.

### **Software Defined Radio on Small Form Factor Systems**

Philip Balister, Tom Tsou, Graduate Research Assistants, Virginia Tech  
Jeffrey H. Reed, Director of Wireless@Virginia Tech

This presentation addresses limiting factors for a small form factor Software Defined Radio (SDR). A small form factor SDR has limited processing power and memory available to perform signal processing functions. These limiting factors determine the maximum data rate and the Central Processing Unit (CPU) cycles available for processing complex waveforms. For this session Wireless@VT will present results measured on SCA based waveforms running on the OSSIE core framework. Measurements will include waveform component profiling showing what portions of the component (signal processing versus framework overhead), component memory usage, and measures of inter-component data transfer latency.

## **Software Radio Cooperative Research Program (SRCRP)**

Jimmie Marks & Roy Bell, Staff Software Engineers, Raytheon

The SRCRP is a proof of concept bilateral project that has successfully demonstrated that two nations can interoperate using Software Defined Radio technologies including the Software Communications Architecture (SCA). This presentation focuses on the technology and achievements of the SRCRP. The developed software defined radios were tested for SCA compliance by SPAWAR Waveform Test & Evaluation elements, and were successful in communicating using multiple waveforms in the VHF and UHF frequency bands. Two waveforms were separately developed software packages and each contains approximately 10,000 single lines of code (SLOC) each. To ease porting of the waveforms Japan and the U.S combined their efforts to design a specification for a Common Application Program Interface (API) to maximize application portability.

## ***Program Committee***

Roy Bell - *Raytheon*

Piya Bhaskar - *Lockheed Martin*

Jerry Bickle - *PrismTech*

Tansu Demirbilek - *Mercury Computer Systems*

Victor Giddings - *Objective Interface Systems*

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Fred Waskiewicz - *OMG (PC Chair)*