Executive Summary

Army Open System Demonstration Project

Aviation and Missile Command (AMCOM)

PNUM 5B

Background: AMCOM/Honeywell is assessing the suitability of the Portable Operating Standard Interface (POSIX) Ada Language Interface and proposed POSIX standards for advanced missile and aircraft avionics software. It evaluates these requirements through porting the MetaH real-time Computer Aided Software Engineering (CASE) toolset developed for building such applications to operate on top of POSIX. The evaluation includes a requirements study and a prototyping study using a commercially available cross-development toolset and a POSIX compliant real-time operating system. The intent of the project is to both define unsupported but needed interfaces and to evaluate how current interfaces can be used to support advanced avionics systems. By pushing these capabilities through to acceptance in the standards processes it becomes much more likely that advanced systems such as the Joint Strike Fighter, the Comanche Helicopter, or the THAAD Air Defense System can effectively build on POSIX, an Open Systems and Army Technical Architecture standard.

POSIX is a set of standards that define the interface between application software and an underlying operating system. The desire is for multiple operating system vendors to provide this interface to their products, thereby increasing the portability of application software. This study focuses in particular on the POSIX Ada language interface, including real-time extensions. Relevant proposed POSIX standards are also being evaluated.

MetaH is a high-level design language for specifying software and hardware architectures for real-time systems (including flight control and vehicle management software) and was developed to meet requirements in the missile and avionics domains. MetaH has semantics to deal with real time, faults and errors, partitioning/security, and multi-processor systems and the software/hardware interface. The associated toolset performs real-time schedulability, reliability, and partition impact modeling and analysis. The toolset also automatically generates glue code or “middleware” to integrate all the software and hardware components. In a hardware analogy, glue code furnishes the wiring harness between standardized components and provides the sockets with built-in protection between the components to provide safety and fault containment. The interface between this glue code and the underlying Real-Time Operating System (RTOS) is a major focus of this evaluation. Through this interface, MetaH reflects a wide range of domain requirements for O/S services. Since MetaH supplies an Extended Operating System (XOS), under the Generic Open Architecture (GOA) model, it also provides evaluation for POSIX XOS API support (4D, 3X, 3L). MetaH also supplies the Resource Access Services (RAS) layer with 3D, 2D interfaces which are not involved in the current analysis of POSIX.

POSIX standards need to be suitable for advanced avionics systems. MetaH includes features to address anticipated needs for future functionally integrated, physically distributed, evolvable integrated modular avionics systems. An assessment of POSIX as an interface between MetaH-composed software and the RTOS provides an assessment of the suitability of POSIX for a broad class of anticipated avionics systems.

The MetaH/POSIX project is synergistic to DARPA, other OS-JTF work, and SEI efforts. MetaH is the Architecture Description Language to be used by the SEI to describe and generate Simplex architecture under the INSERT program with DARPA. Since OS-JTF is extending the Simplex approach for safe insertion of COTS software, MetaH complements the OS-JTF work as well. MetaH also provides additional protection mechanisms and generation capability to the Simplex approach. MetaH/POSIX findings will be directly applicable to the SAE Avionics O/S interface and the GOA XOS definition. MetaH, supplying an XOS and RAS provides an excellent integration point for the Uniform Driver Interface (UDI).

Evaluations will be performed by collecting and analyzing documentation and program information, and also by prototyping using an existing MetaH toolset and an existing commercial RTOS that supports POSIX interfaces. There are two primary evaluation criteria with respect to using POSIX interfaces with MetaH: 1) portability enhancement and 2) ability to meet performance requirements. From the evaluation will come suggested changes to MetaH or POSIX to improve these two key areas.

The technical report delivered at the conclusion of this project will describe missile and helicopter requirements to be met by a MetaH/POSIX toolset; present the technical approach used for prototyping (outline of how the services needed by MetaH-generated glue code could be implemented using a POSIX interface); and present the evaluation results, which will include consideration of draft POSIX standards and the Society of Automotive Engineers (SAE) Avionics O/S and (GOA) draft standards.

The results of the work will be directly used to support the standardization process. The report will be presented at the appropriate POSIX/SAE meeting(s). Reports will be sent to the appropriate subcommittees and to the SAE avionics working group.

FY98 Tasks:

AMCOM/Honeywell will do an initial investigation of each of the tasks below and recommend for OS-JTF selection one of the first three tasks to execute in conjunction with the fourth task. AMCOM/Honeywell will also investigate and make recommendations on the advisability of executing a reduced level of effort on multiple tasks, based on readiness of the technologies for demonstration and their value in implementing Open Systems.

1. Extend work with LynxO/S to prototype more of the features required for the MetaH/Avionics domain, seeking additional features in Lynx needed in POSIX and demonstrating with flight software. Examples of areas where work is required are improved execution time monitoring (for adaptive real-time scheduling methods and for time partitioning), the ability to enforce restrictions on calls made by application processes (for partitioned and secure systems), and passive process or other methods for including efficient secure servers or executives in a system. This task provides an Architecture Description Language based, high productivity, hard-real time POSIX solution with performance data. It also extends the Lynx POSIX capabilities for features needed in the aviation domain.

2. Port to the Hughes AOS POSIX interface, and demo with flight software, track costs as a measure of POSIX portability impact, demonstrate performance. This task provides a very capable avionics solution for advanced aircraft which would be evaluated by primes and possibly impact with reduced costs some major developments like JSF. Since the Hughes AOS was a starting point for the SAE Avionics architecture, this may provide an experimental vehicle for evaluation of the SAE API. This task would also assess and demonstrate the degree of portability and platform upgradeability that is achieved through the use of these standardized interfaces.

3. Develop a UDI interface capability in MetaH. Experiment with available devices and drivers. Compare to MetaH's current Resource Access Layer. Provide performance and API analysis. This task promotes a new and very needed hardware interface capability. An open standard here attacks an area of significant cost in embedded systems development, since avionics systems do an inordinate amount of I/O and sensor, actuator and communications device interfaces where technologies change rapidly. Demonstrate performance with aviation code. Attend UDI meetings as well as POSIX/SAE. This task provides a platform for rapid development of demonstrations for UDI, matures the UDI specification, and assesses its readiness for application.

4. In addition to a task area selected from the above set, AMCOM/Honeywell will establish and publish a specification suitable for standardization of the MetaH language. This initial specification will then be used to approach and select a standardization body. An open standardization effort will be started and supported within the accepting body. This task puts the MetaH language in the public domain with a specification that can be used by multiple vendors to build toolsets. It also makes it available for use in the ATA/JTA as an emerging standard. An Architecture Description Language (ADL) standard for the hard real-time domain will bring, in a portable and revolutionary way: bring powerful analysis, generation, and evolvability capabilities; extend the power of reuse; and raise the level of abstraction for complex system development. It will also significantly reduce the time to develop and upgrade systems, while building on open system standards.

5. Generate a functional requirements specification, as part of the Virtual Joint Technical Architecture (JTA) efforts, for using the JTA for the Army missile and aviation domain.