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Object Management Group

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Robotic Systems Request For Information

OMG Document: *mars/2005-06-12*

Responses due: November 14, 2005

1.0 Introduction

1.1 The Object Management Group (OMG)

With well-established standards covering software from design and development, through deployment and maintenance, and extending to evolution to future platforms, the Object Management Group (OMG) supports a full-lifecycle approach to enterprise integration which maximizes ROI, the key to successful IT. OMG's Modeling standards, the basis for the MDA, include the Unified Modeling Language (UML) and Common Warehouse Metamodel (CWM). CORBA, the Common Object Request Broker Architecture, is OMG's standard open platform with hundreds of millions of deployments running today. Headquartered in Needham, MA, USA, the Object Management Group is an international, open membership, not-for-profit computer industry specifications consortium. More information about OMG can be found at www.omg.org.

1.2 *The Robotics Domain Special Interest Group (robotics DSIG)*

The purpose of the Robotics DSIG is to foster the integration of robotic systems from modular components through the adoption of OMG standards. To realize this purpose, we will:

- Adapt and extend OMG technologies that apply to the specific domain of robotics systems where no current baseline specifications exist, such as MDA for Robotics. The object technology is not solely limited to software but is extended to real objects. This effort promotes the use of OMG technologies in various markets.
- Promote mutual understanding between the robotics community and the OMG community.
- Endeavor to collaborate with other organizations for standardization, such as the one for home information appliances, and make an open effort to increase interoperability in the field of robotics.
- Coordinate with the appropriate OMG subgroups and the Architecture Board, for technology areas that overlap with other OMG Task Forces, to determine where the work will be accomplished.

Our overall goal is to adopt vendor-neutral common semantics, metamodel and abstract syntax for robotic systems, with the following objectives :

- To enable developers to better understand how to develop applications (including large-scale distributed systems) using robotic technology, thereby growing the market.
- To recommend technology for adoption to enable interoperability across the different products developed for use in service robotic systems.
- To recommend technology that enables robotic system design tool interoperability.
- To recommend technology for adoption of common semantics, metamodel, and abstract syntax for service robotics technologies representing reusable, interoperable, portable application components.

1.3 RFI Objectives

1.3.1 What is an OMG RFI?

The intent of an OMG Request for Information (RFI) is to gather information for the purpose of guiding a subgroup in its efforts to provide solutions to industry problems. The RFI process is used by a subgroup to canvass a targeted industry segment for one or more of the following purposes:

- ?? Acquiring general or specific information about industry requirements.
- ?? Soliciting assistance in identifying potential technology sources.
- ?? Soliciting input to validate a subgroup's roadmap.

Generally speaking, the RFI process determines which Request For Proposals (RFPs) will be issued (and, based on negative feedback, which won't) or influences the way a particular RFP is constructed.

2.0 Information Being Requested

2.1 Summary of this RFI

Robotic systems can be roughly defined as “systems that provide intelligent services and information by interacting with their environment, including human beings, via the use of various sensors, actuators and human interfaces”. The physical characteristics of a robotic system can have a large variation that includes mobile robots, humanoid robots, pet robots, manipulator robots, autonomous vehicles, robot house, etc. In the same way, the span of robotic system applications can be very broad, including but not limited to communication and entertainment robots, lifestyle support robots, rescue robots, transportation robots, medical robots, etc. Finally, robotic systems must deal

with technological fields and issues of various complexities such as hardware control, intelligent algorithms, information processing and dispatching, safety, reliability, etc.

All these aspects make it difficult to develop cost-effective yet functionally attractive robotic systems that will appeal to potential end-users and ensure the growth of the robotic market. We believe that modularization of robotic systems and standardization of robotic technology components will greatly help reduce the development and integration cost of robotic systems.

Therefore, this RFI seeks information which will be used to direct future standardization efforts in the area of reusability and interoperability of robotics technology. Sharing your experiences will be particularly helpful in this effort, especially to:

- ?? Determine the areas that need standardization and their respective priorities
- ?? Identify recurrent functional / architectural patterns in existing robotic systems so as to propose common platform independent models
- ?? Help define working groups to work on potential RFPs

We are seeking information with regards to::

- ?? Identification of areas where Robotics Technology is used
- ?? Needs for standardization of Robotics Technology
- ?? Technical information such as existing implementations, standards, requirements, models, and theoretical studies on Robotics Systems

2.2 Detail

This RFI is seeking information in the categories described below. Respondents are asked to address areas in which they have expertise and/or interest. Therefore, it is not necessary that a single response to this RFI addresses all the topics. Conversely, respondents may consider areas not explicitly asked for if they feel the information provides useful guidance.

Topics of interest for this RFI include but are not limited to:

2.2.1 Identification of areas where Robotics Technology is used

- 1 – Provide a brief explanation of your vision of the use of a robotic system
- 2 – Describe your vision of the future trends of Robotics Technology

2.2.2 Needs for standardization of Robotics Technology

- 1 – Provide one or more business use-cases in which the standardization of robotic components would be profitable
- 2 – Explain which part of a robotic system you would like to have standardized

- 3 – If you are already using a standard related to robotics technology, explain which standard you are using.
- 4 – What are the features that made you select this standard
- 5 – If you are already using a standard related to robotics technology, what are the shortcomings of this standard, and how would you like it to evolve to best match your needs?

2.2.3 Motivation to respond to this RFI

- 1 – How do you think the OMG Robotics DSIG can help you solve your robotic system integration problems?
- 2 – How do you think you could help the Robotics DSIG achieve its standardization process?

2.2.4 Technical Information

To help the Robotics DSIG make useful and efficient decisions in its technology adoption process, we invite respondents to provide us with information in the categories described below and on the topics described in section 2.3:

2.2.4.1 *Existing Implementations*

OMG requests information on availability, maturity, and importance of any existing models, products, methodologies, etc. which support the distributed robotic system concept.

2.2.4.2 *Standards*

OMG requests information on relevant standards, both *de facto* and *de jure*. Where multiple standards exist, respondents are asked to compare significant differences among them. It is also important to identify problems with current standards that prevent their acceptance or cause problems in their implementation.

2.2.4.3 *Requirements*

OMG requests information on user requirements on robotic systems implementation, architecture and/or performance. This RFI is also interested in requirements related to software-based control technologies (compatibility, platforms, etc).

2.2.4.4 *Models*

Of special interest for the purposes of this RFI is information regarding available object-oriented models of distributed robotics systems.

2.2.4.5 *Theoretical studies*

Due to the nature of the domain targeted in this RFI, responses that include theoretical analyses of object-based, distributed robotic systems performance are of major interest.

2.2.4.6 *Other Information*

OMG requests that respondents furnish any other information they think may be relevant.

2.3 **Technical Topics**

Technical topics of interest for this RFI include but are not limited to the points below. It is not necessary to address all of them in a single response. For each topic, we mention one or more particular issues that we would like to have addressed.

2.3.1 Robotic System Software Infrastructure

What is the software infrastructure supporting your robotic system?

2.3.1.1 *Transport / Protocol*

What are the protocols used for inter-components communication? If these are custom protocols, describe them and the reason you selected them.

2.3.1.2 *Data Flow*

How do you handle data flow between entities in the system?

What formatting do you apply to the data exchanged?

2.3.1.3 *Command Flow*

What invocation method (RPC, message, etc.) do you use and why?

2.3.1.4 *Middleware*

Are you using a middleware/communication framework to facilitate inter-components communication? If so, which one and why?

2.3.1.5 *Use of component model*

Do you make use of a specific component model? Which one and why?

How do you apply it?

2.3.1.6 Security

How does your robotic system deal with security issues?

2.3.1.7 Deployment

How do you deploy components in your robotic system?

2.3.2 Robotic System Architecture

2.3.2.1 Functional Layering / Block Decomposition

How do you functionally break up your robotic system? Provide a block diagram of the entities found in your robotic system.

2.3.2.2 Common Data Structures (such as Images, Laser scan, 3D position, etc.)

What data structures do you commonly use?

What meta-rules do you use to define the data structures exchanged between entities in the system?

How do you convert data between different formats?

What is your system of units?

2.3.2.3 Hardware Abstraction

How do you deal with hardware abstraction?

What artifact do you use for realizing hardware abstraction (device exposed through a complete and well defined custom interface or minimal interface with differentiation only by the type of ingoing and outgoing data)?

What are the meta-rules for defining sensors, actuators, and human interfaces?

2.3.2.4 Supporting mechanisms

2.3.2.4.1 Configuration, Dynamic Reconfiguration

How do you configure unit components in the system and dynamically re-configure them?

How do you configure your system topology and dynamically reconfigure it?

2.3.2.4.2 Component capabilities modeling and advertisement

A component capability is a functionality offered by a component in the Robotic System, specific to the robotics technology, and accessible via the component's interface.

How can your components advertise to the system and other components what their capabilities are? How can components in the system find other components with the necessary capabilities to accomplish a task?

2.3.2.4.3 Capability Composition

How do you combine capabilities of several components in order to create novel capabilities?

2.3.2.4.4 Monitoring

To what extent do you require system monitoring?

How do you accomplish monitoring?

2.3.2.4.5 Physical Space / Time Management

How do you ensure consistency of time and physical space representation in your robotic system?

How do you manage them?

2.3.2.4.6 Task Synchronization / Prioritization

How do you synchronize tasks executed by different components in the robotic system?

How do you eventually prioritize these tasks?

2.3.2.4.7 Physical Resource Management

How do you manage physical resources?

How do you manage conflicting requests for physical resources?

2.3.2.4.8 Safety Management

Did you define any safety procedures in case of failure?

How do you ensure the execution of the safety procedures?

2.3.2.4.9 Error Detection / Propagation / Management

How does your robotic system detect faults occurring in components?

How do you handle error propagation in a chain of components?

Do you have any special way to generically manage errors?

2.3.2.4.10 Fault Tolerance / Recovery Strategies

How do you recover from system failures?

2.3.2.4.11 Security

What kind of security policies did you apply at the application level? Why?

2.3.3 Robotic System Applications

2.3.3.1 *Robotics Technology (RT) Services*

We use the term RT Service to mean a centralized functionality offered by a unique component in the system, which will help other components work together. We provide the list below to give the reader examples of some of these RT services. Respondents to this RFI should feel free to address any or all of these topics, as well as, services not listed but deemed of interest.

- ?? World model repository
- ?? Behavior composition and sequencing
- ?? Integration with IT Systems

2.3.3.2 *Capabilities*

A Capability is a functionality offered by a component in the Robotic System, specific to the robotics technology, and accessible via the component's interface. The capabilities are highly application dependent although some are recurrent in many applications. We provide the list below to give the reader an overview of some of what we consider main capabilities. Respondents to this RFI should feel free to address any or all of these topics, as well as, topics that are not listed but deemed of interest.

- ?? World modeling
- ?? Navigation
- ?? Path-Planning
- ?? Localization
- ?? Motion Control
- ?? Manipulation
- ?? Kinematics
- ?? Behavior/State Management
- ?? Task planning / synchronization
- ?? Visual Processing
- ?? Sound Processing
- ?? Human interface
- ?? Sensor fusion

2.3.4 Robotic System design

The following points are requested for informational purposes. For the time being, we do not intend to develop standards in those areas. Nevertheless, any input provided in these areas will be very valuable to gauge trends in robotic system design.

?? Tool Support

- ☒ Component Code Generation
- ☒ Application Generation
- ☒ Visualization / Analyzer
- ☒ Design rules checking
- ☒ Language Profiles
- ☒ Scheduling support
- ☒ Development APIs

?? Verification Techniques

- ☒ Unit Testing
- ☒ System Testing
- ☒ Simulation
- ☒ Evaluation Metrics

2.3.5 Related Standards and Reference Documents

2.3.5.1.1 *Within the OMG*

2.3.5.1.2 *From other organizations*

2.3.5.1.3 *Possible collaborations with other organization*

3.0 Instructions for Responding to this RFI

3.1 Who May Respond

Responses from *anyone* in industry, government, or academia with practical knowledge of robotic systems are welcome.

When and if the OMG issues Requests for Proposals (RFP) in this area, OMG members at the appropriate membership level will be eligible to respond with detailed specifications.

3.2 How to Respond

One electronic copy in machine-readable format (typically ASCII, MS Word, or WordPerfect format) should be sent to omg-documents@omg.org. One confirming paper copy of all documents should be sent to the OMG postal address below.

Object Management Group, Inc.

First Needham Place

250 First Avenue, Suite 201

Needham, MA 02494

USA

Attn: Robotic Systems RFI

Responses to this RFI must be received at OMG no later than 5:00 PM US Eastern Time (22:00 GMT) November 14, 2005.

Other communication regarding this RFI should be sent to the contacts listed in paragraph 3.8.

3.3 RFI Response Contact

Companies responding to this RFI shall designate a single contact within that company for receipt of all subsequent information regarding this RFI and the forthcoming series of RFPs. The name of this contact will be made available to all OMG members.

3.4 Format of RFI Responses

The following outline is offered to assist in the development of your response. You should include:

?? A cover letter -- the cover letter should include a brief summary of your response, such as indicating to which areas you are responding and must also indicate if supporting documentation is included in your response.

?? The response itself, covering any or all of the areas of information requested by this RFI.

?? If required, a glossary that maps terminology used in your response to OMG standard terminology. (See OMG specifications [CORBA, UML, MOF, XMI] and a description of OMG's Model Driven Architecture [MDA] for OMG's standard terminology.)

Although the OMG does not limit the size of responses, you are asked to consider that the OMG will rely upon volunteer resources with limited time availability to review these responses. In order to assure that your response receives the attention it deserves, you are asked to consider limiting the size of your response (not counting any supporting documentation) to approximately 25 pages. If you consider supporting documentation to be necessary, please indicate which portions of the supporting documentation are relevant to this RFI.

3.5 Specific Requirements for this RFI

There are three specific topics that the Robotics DSIG would like respondents to cover:

- Part 1. Your usage of Robotics Technology.
- Part 2. Your needs for standardization of Robotics Technology
- Part 3. Technical topics related to Robotics Technology

Respondents do not have to address all three topics above. In the case of a partial response, the relative preference between topics is indicated by the order above.

Note that this effort is geared towards future standardization in the area of reusability and interoperability for robotics technology and is by no means a marketing study. Therefore, respondents shall refrain from including marketing material unless it is relevant to support the information provided.

3.6 Distribution of RFI Responses

Copies of all documentation submitted in response to this RFI will be available to all OMG members for review purposes.

3.7 Copyrighted Material

According to OMG Policies and Procedures, proprietary and confidential material shall not be included in any response to the OMG. Any material received is treated as a public document. If copyrighted material is sent in response to this RFI then a statement waiving that copyright for use by the OMG is required and a limited waiver of copyright that allows OMG members to make up to twenty-five (25) copies for

review purposes is required. Consult Appendix B for a template for this copyright waiver.

3.8 Reimbursement

The OMG will not reimburse submitters for any costs in conjunction with their responses to this RFI.

3.9 Questions Regarding this RFI

Any technical questions regarding this RFI should be sent to:

Matoko MIZUKAWA mizukawa@sic.shibaura-it.ac.jp

and/or

Tetsuo KOTOKU t.kotoku@aist.go.jp

Questions regarding the response process should be forwarded to:

Object Management Group, Inc.

First Needham Place

250 First Avenue, Suite 100

Needham, MA 02494

USA

Attn: Mr. Juergen Boldt, Director of Member Services

Phone: +1-781-444 0404

Fax: +1-781-444 0320

Email: juergen@omg.org

4.0 Response Review Process and Schedule

4.1 Review Process

OMG RFIs are issued with the intent to survey industry to obtain information that provides guidance, which will be used in the preparation of RFPs. The OMG membership, specifically the robotics Domain Special Interest Group, will review responses to this RFI. Based on those responses, the Robotics DSIG will augment its roadmap and prepare one or more RFPs.

4.2 Clarification

To fully comprehend the information contained within a response to this RFI, the reviewing group may seek further clarification on that response. This clarification may

be requested in the form of brief verbal communication by telephone; written communication; electronic communication; or a presentation of the response to a meeting of the Robotics DSIG.

4.3 RFI Response Presentations and Demonstrations

RFI Respondents may be invited to present their response to the Robotics DSIG. The purpose of this presentation would be to seek clarification of information contained within the response (as noted above); to further explore issues raised; or to further meet the goals of the RFI.

In addition, a technology demonstration to the Robotics DSIG may prove useful to support the RFI response. If desired, please coordinate with the Contact cited in paragraph 3.8.

4.4 Schedule

The schedule for responding to this RFI is as follows. Please note that early responses are encouraged.

RFI issued: June 24, 2005

RFI responses due: November 14, 2005

Review of RFI responses: December 05, 2005

(Note that this schedule is subject to change based on the number of RFI responses received.)

Appendix A References and Glossary Specific to this RFI

A.1 References Specific to this RFI

[CORBA] http://www.omg.org/technology/documents/formal/corba_iip.htm.

Data Acquisition from Industrial Systems (DAIS) ver.1.0 [formal/2002-11-07]

Data Distribution Service for Real-time Systems, ver.1.0 [formal/2004-12-02]

Distributed Simulation System, ver.2.0 [formal/2002-11-11]

Historical Data Acquisition from Industrial Systems (HDAIS) [dtc/2003-02-01]

[MDA] MDA Technical Perspective, <http://doc.omg.org/ab/2001-02-01>.

[MOF] Meta-Object Facility (MOF),
<http://www.omg.org/technology/documents/formal/mof.htm>.

PIM and PSM for Super Distributed Objects, ver.1.0 [formal/2004-11-01]

PIM and PSM for SWRADIO Components Final Adopted Specification [dtc/2004-05-04]

Smart Transducers Interface, ver.1.0 [formal/2003-01-01]

[UML] Unified Modeling Language (UML),
http://www.omg.org/technology/documents/formal/unified_modeling_language.htm.

[XMI] XML Metadata Interchange (XMI),
http://www.omg.org/technology/documents/formal/xml_metadata_interchange.htm.

A.2 Glossary Specific to this RFI

Appendix B Template for Copyright Waiver for RFI Responses

[Date]

Object Management Group, Inc.
250 First Ave.
Suite 100
Needham, MA 02494
Attn: James Nemiah, General Counsel

Fax: 781-444-0320

Dear Mr. Nemiah:

This letter constitutes a limited license to use certain materials copyrighted by the undersigned. We understand that the Object Management Group, Inc. ("OMG") is a not-for-profit consortium that produces and maintains computer industry specifications for interoperable enterprise applications.

We understand that the Copyrighted Material identified below is being submitted to OMG as part of a response to the identified Request for Information (RFI), for use in connection with an OMG process that may result in the adoption of an OMG specification.

Source of Copyrighted Material:

Copyrighted Material to be submitted to OMG:

Submitter(s):

RFI Doc.-Title & No.

We hereby grant OMG the right to make an unlimited number of copies of the Copyrighted Material as part of the OMG adoption process.

We hereby grant each OMG member the limited right to make up to twenty-five (25) copies of the Copyrighted Material for review purposes only as part of the OMG adoption process.

Regards,