SDO-DSIG Final Agenda ver.1.01 (sdo/2005-06-01)

OMG TC Meeting - Boston, MA, USA -- June 20-24 , 2005

		TF/SIG				
		Host	Joint (Invited)	Agenda Item	Purpose	Room
Monday (June 20)						
9:00	10:30	SDO	(Robotics)	RFP drafting WG	draft discussion	Federal2, Mezz Lvl
10:30	12:00	Robotics	(SDO)	RFI drafting WG	draft discussion	Federal2, Mezz Lvl
12:00	13:00			**LUNCH**		
13:00	13:30	C4I	robotics, SDO	C4I Pleanary (SDO for Robotics RFP)	Information Exchange	Cambridge, Harbor Lvl
16:00	17:00	MARS	Robotics, RTESS, SDO	MARS Pleanary (RFI: Initial survey for robotics)	hammer out RFI	Waterfront2, Harbor Lvl
Tuesday (June 21) SDO Plenary						
9:00	9:10	SDO	(Robotics)	Welcome and Review Robotics Agenda	SDO Meeting Kick-off	Congress, Mezz Lvl
9:10	9:40	SDO	(Robotics)	< *Special Talk* > "Biologically-inspired Adaptive Networking with Super Distributed Objects" - Jun Suzuki (Univ. of Massachusetts Boston)	Informative	
9:40	10:30	SDO	(Robotics)	SDO for robotics RFP (part 1)	RFP pre-review	
				Break		
11:00	11:50	SDO	(Robotics)	SDO for robotics RFP (part 2)	RFP pre-review	
11:50	12:00	SDO	(Robotics)	Next Meeting Agenda Discussion, etc	SDO Closing session	
12:00				Adjourn		
12:00	13:00			**LUNCH**		
16:00	17:00	MARS	Robotics, RTESS, SDO	MARS Pleanary (SDO for Robotics RFP)	RFP Review	Waterfront2, Harbor Lvl
Wednesday (June 22) Robotics Plenary						
9:00	9:15	Robotics	(SDO)	Welcome and Review Robotics Agenda	Robotics Meeting Kick-off	Federal, Mezz Lvl
9:15	10:15	Robotics	(SDO)	< *Special Talk* > Introduction to JAUS - Jeff Kotora (Chair, JAUS WG)	Informative	
				Break		
10:30	11:10	Robotics	(SDO)	< Presentation by participants > 1) "Robotics Needs of the Oilfield Industry" - Mike Barrett and Claude Baudoin (Schlumberger)		
11:10	12:00	Robotics	(SDO)	Initial Survey RFI (part 1)	RFI review	
12:00	14:00			**LUNCH and OMG Plenary**		
14:00	15:00	Robotics	(SDO)	Initial Survey RFI (part 2)	RFI review	Federal, Mezz Lvl
				Break		
15:30	16:40	Robotics	(SDO)	< *Presentation by participants* > 2) "Toward a Reference Model for Robotic Standards" - Hui Min Huang (NIST) 3) "Middleware Technology for Robotics: Robot Software Communications Architecture" - Jaesoo Lee (Seoul National Univ.)	Technology Exchanges	
16:40	17:00	Robotics	(SDO)	Voting RFI recommendation Next Meeting Agenda Discussion, etc	Robotics Closing session	
17:00				Adjourn		
18:00	20:00			**OMG Reception**		
Thursday						
9:00	10:00	MARS	Robotics, RTESS, SDO	MARS Pleanary (RFI: Initial survey for robotics)	RFI Review and voting?	Waterfront2, Harbor Lvl
10:30	11:00	ManTIS	Robotics, SDO	ManTIS Pleanary (RFP and RFI Report)	Informatin Exchange	Skyline, Plaza Lvl
12:00	13:00			**LUNCH**		
13:00	18:00			Architecture Board Plenary		
17:00	19:00	MARS	all	Agenda Coordination	cooperative activity	
Friday						
8:30	15:00			AB, DTC, PTC		
12:00	13:00			**LUNCH**		

Other Meetings of Interest

Monday						
8:00	8:45	OMG		New Attendee Orientation		
9:00	12:00	OMG		Tutorial - Introduction to UML 2.0		
13:00	17:00	OMG		Tutorial - Applying Model Driven Architecture(MDA), Value Chain Analysis(VCA), and Service-Oriented Architecture(SOA) to Enable the Agile Enterprise		
18:00	19:00	OMG		New Attendee Reception (by invitation only)		
Tuesday						
9:00	12:00	OMG		Tutorial - Introduction to the Data Distribution Service		
13:00	17:00	OMG		Tutorial - An Overview of MDA: Where It Came From and Where It's Going		
17:00	18:00	OMG		RTF/FTF Chairs' Roundtable		Waterfront 1C, Harbor Lvl
Wednesday						
9:00	12:00	OMG		Tutorial - Understanding and Extending the UML 2.0 Metamodel		
14:00	17:00	OMG		Tutorial - Survey of OMG Specifications		
17:00	18:00	OMG		Chairs' Roundtable		Cityview2, Plaza Lvl
Thursday						
9:00	12:00	OMG		Tutorial - Overview of the Software Communications Architecture (SCA)		
13:00	17:00	OMG		Industry Collaboratives: Leveraging Open-Sourece and Open-Standards Communities		

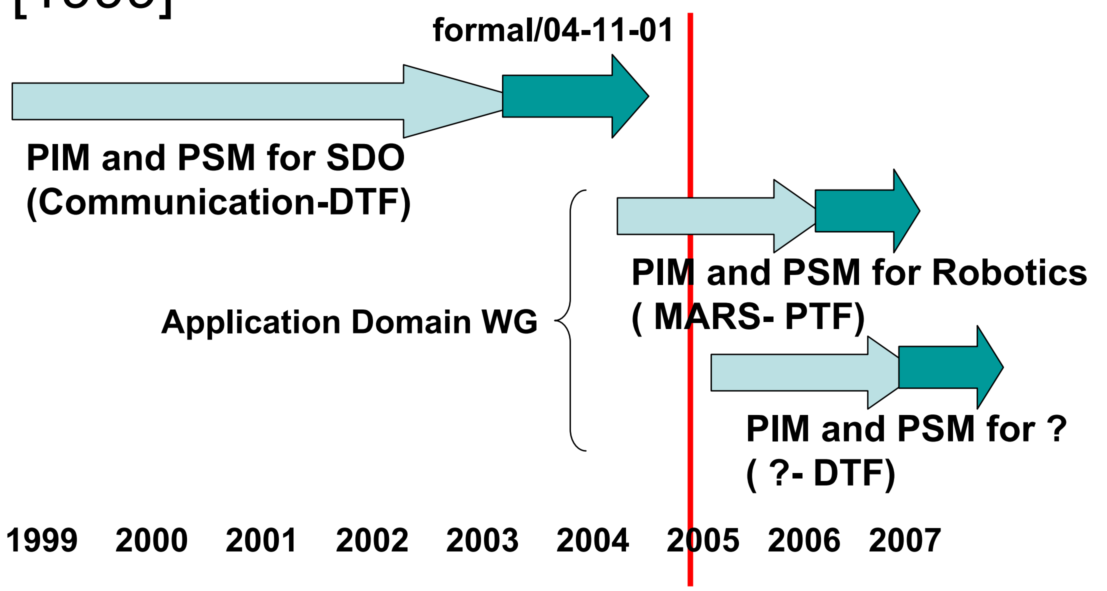
SDO (Super Distributed Objects) Plenary Meeting

June 21, 2005
Boston, MA, USA

Seaport World Trade Center
Congress, Mezzanine Level

SDO Roadmap

Chartering SDO (Super Distributed Object) SIG [1999]



NATIONAL INSTITUTE OF ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY (AIST)

AIST

Robotics Roadmap Review

- Robotics WG inside SDO-DSIG :
  discussions about the SDO model for robotic applications.
  <focus on SDO interoperability > **RFP**
- Robotics-DSIG :
  discussions about a wide variety of standardizations on robotics domain.
  <focus on its priority> **RFI => White Paper**

visible

Two activities in parallel

AIST

Review Agenda

Robotics DSIG
Wednesday, June 22, 2005
9:00 – 17:00

Tuesday, June 21, 2005

- **09:00- Welcome and Review Agenda**
- **09:10- Invited Talk: "Biologically-inspired Adaptive Networking with Super Distributed Objects" (Prof. Jun Suzuki)**
- **09:40- SDO model for Robotics Domain (1) (RFP pre-review, Dr. Suehiro, AIST)**
- **11:00- SDO model for Robotics Domain (2)**
- **11:50- Next meeting Agenda**
- **12:00- Adjourn**

Next Meeting Agenda

September 12-16, 2005 (Atlanta, GA, USA)

Tuesday:

RFP draft WG Meeting [Tue, Sept.13 AM]

- Robot Technology Components (RTCs) RFP [amending RFP]

SDO-DSIG Meeting [Tue, Sept.13 PM]

- Robot Technology Components (RTCs) RFP [review RFP draft]

Robotics-DSIG Plenary
Wed, Sept. 14

Roadmap for Robotics Activities

robotics/05-06-03 & sdo/05-06-03

Item	Status	Athens Apr-2005	Boston Jun-2005	Atlanta Sep-2005	Burlingame Nov-2005	TBD Feb-2006	TBD Apr-2006	TBD Jul-2006	POC / Comment
Charter on Robotics WG in SDO	done								Kotoku(AIST), Mizukawa(Shibaura-IT)
SDO model for Robotics Domain	Planned	discussion	draft RFP	RFP		Initial Submittion		Revised? Submittion	Suehiro(AIST), Sameshima(Hitachi), Kotoku(AIST)
SDO model for xxx Domain	no plan			discussion	draft RFP	RFP		Initial Submittion	TBD
Charter on Robotics SIG	done								Kotoku(AIST), Mizukawa(Shibaura-IT)
Robotics Information Day [Technology Showcase]	pending								Yokomachi(NEDO), Kotoku(AIST)
Robotics: Initial Survey [Clarification of Target Item]	Planned	discussion	RFI		RFI due Presentation	Presentation	review RFI response	review RFI response	Lemaire, Chung, Lee, Mizukawa, Kotoku
									,
(Robot Middleware for Controller)	Future			Official Start of WG	discussion	draft RFP	RFP		to be discussed
(Robot Middleware for Specific Applications)	Future								to be discussed
(Robot Middleware Common Services)	Future								to be discussed
(Robot Middleware for Common Data Structures)	Future								to be discussed
etc…	Future								to be discussed

Biologically-inspired Adaptive Networking with Super Distributed Objects

Jun Suzuki, Ph.D.
jxs@cs.umb.edu
http://dssg.cs.umb.edu/
Distributed Software Systems Group
Department of Computer Science
University of Massachusetts, Boston

Who am I?

- Academics
  - Assistant Professor, UMass Boston
  - Post-doc Research Fellow, UC Irvine
  - Lecturer, Keio University, Japan
  - Ph.D. from Keio University
- Industrial
  - Technical Director, Object Management Group Japan
  - Technical Director, Soken Planning Co., Ltd., Japan
  - Co-founder and CTO, TechAtlas Comm Corp, Austin, TX
- Professional
  - Member, ISO SC7/WG 19
  - OMG Super Distributed Objects SIG

UMass Boston

- One of the 5 UMass system universities

Distributed Software Systems Group

- A research groups at CS Dept, UMass Boston
  – PI: Jun Suzuki
  – 6 Ph.D. students
  – 5 master's students
  – 2 industrial visitors

- Research thrusts
  – Autonomous adaptive networks
  – Model-driven development frameworks

Research Goals

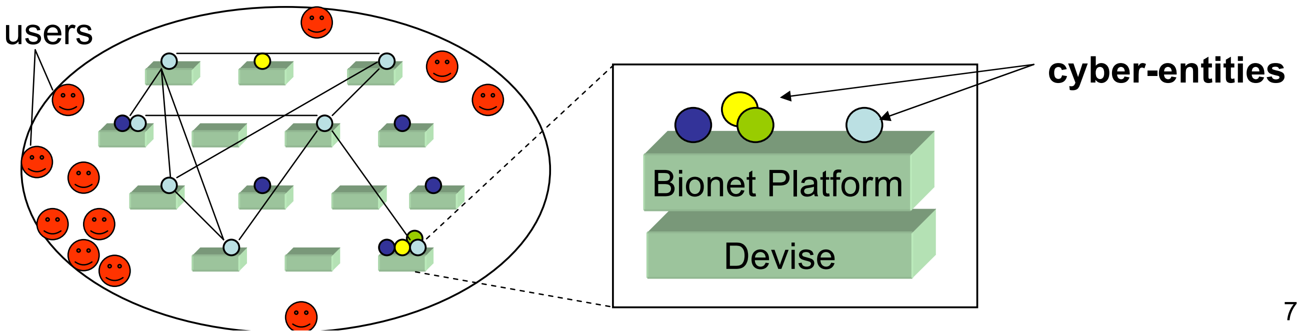
- To make network systems more autonomous, scalable and adaptive.
  - ***Autonomy***
    - e.g. to avoid interrupting users/administrators frequently
  - ***Scalability***
    - e.g. in terms of # of application objects and network nodes
  - ***Adaptability*** to dynamic changes in network conditions
    - e.g. workload, resource availability and user's location
  - ***Simplicity*** to develop and deploy
- Autonomic networks
  - Enormous technical and economic impacts

Observation and Approach

- Observation
  - The requirements for autonomic networks have already been realized by various biological systems.
    - e.g. bee colony, bird flock, fish school, etc.
- Approach
  - *Apply biological concepts and mechanisms to network (application) design*

The Bio-Networking Architecture

- The Bio-Networking Architecture
  - defines a network application as a set of software objects (agents).
  - models agents after biological concepts
    - so that they can support the identified requirements for autonomic networks
      - i.e. autonomy, scalability, adaptability and simplicity



Biological Concepts Applied (1)

- Decentralization
  - Biological systems
    - consist of autonomous entities (e.g. bees in a bee colony)
    - no centralized entity (e.g. a leader in a bird flock)
      - Decentralization increases scalability and survivability of biological systems.
  - The Bio-Networking Architecture
    - biological entities = cyber-entities (CEs)
      - autonomous with (biological) behaviors
        - » replication, reproduction, migration, death, etc.
        - » makes its own behavioral decision according to its own policy
    - no centralized entity among CEs

Biological Concepts Applied (2)

- Emergence
  - Biological systems
    - Useful group behavior (e.g. adaptability) emerges from autonomous local interaction of individuals.
      - i.e. no centralized entity
  - The Bio-Networking Architecture
    - Each CE autonomously
      - senses local/nearby environment
        - » e.g. existence of neighboring CEs, workload, etc.
      - invokes its behavior(s) according to the current environmental condition
      - interacts with each other

Biological Concepts Applied (3)

- Lifecycle
  - Biological systems
    - Each entity strives to seek and consume food for living.
    - Some entities replicate themselves and/or reproduce children with partners.
  - The Bio-Networking Architecture
    - Each CE stores and expends *energy* for living.
      - gains energy in exchange for providing its service to other CEs
      - expends energy for performing its behaviors, utilizing resources (e.g. memory), and invoking another CE's service.
    - Each CE replicates itself and reproduce a child with a partner.

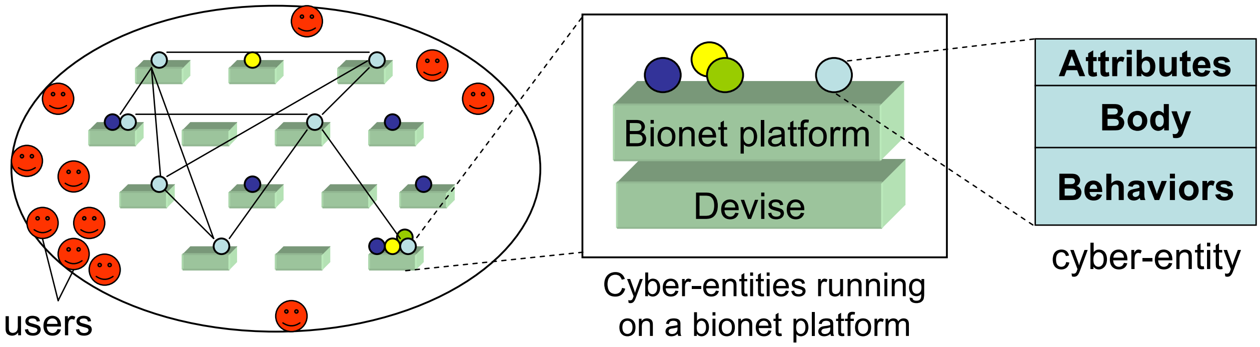
Biological Concepts Applied (4)

- Evolution
  - Biological system
    - adjusts itself for environmental changes through species diversity and natural selection.
  - The Bio-Networking Architecture
    - CEs evolve by
      - generating behavioral diversity among them, and
        - » manually by human developers
        - » through mutation and crossover (in replication/reproduction)
      - executing natural selection.
        - » death from energy starvation
        - » tendency to replicate/reproduce from energy abundance

Biological Concepts Applied (5)

- Social networking
  - Biological systems (social systems)
    - Any two entities can be linked in a short path through relationships among entities.
      - six decrees of separation ("small world!" phenomenon)
  - The Bio-Networking Architecture
    - CEs are linked with each other using *relationships*.
      - Each relationship contains the attributes of a relationship partner.
    - Relationships are used for a CE to search other CEs.
      - Search queries travel thru relationships among CEs.

CE's Structure and Behaviors



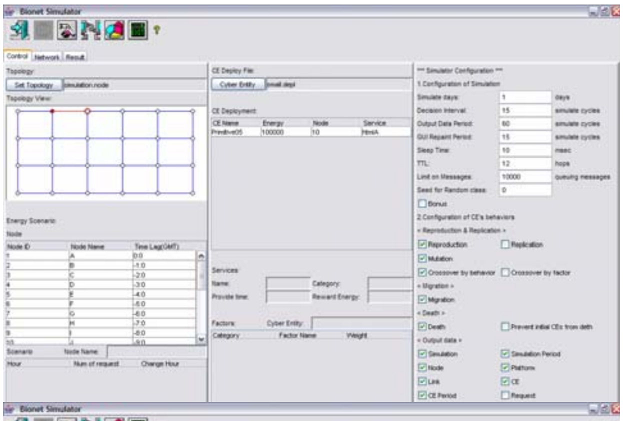
- Attributes
  - ID
  - Relationship list
  - Owner
  - …etc.
- Body
  - functional service
    - hotel room reservation
    - temperature sensing, etc.
- Behaviors
  - Energy exchange and storage
  - Migration
  - Replication
  - Reproduction
  - Death
  - Relationship maintenance
  - Social networking (discovery)
  - Resource sensing

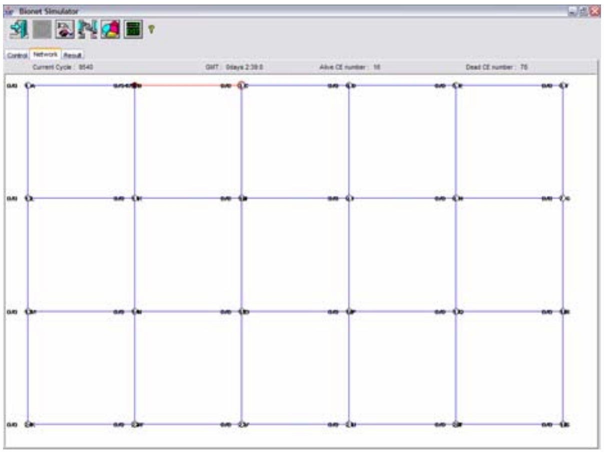
Research Methods

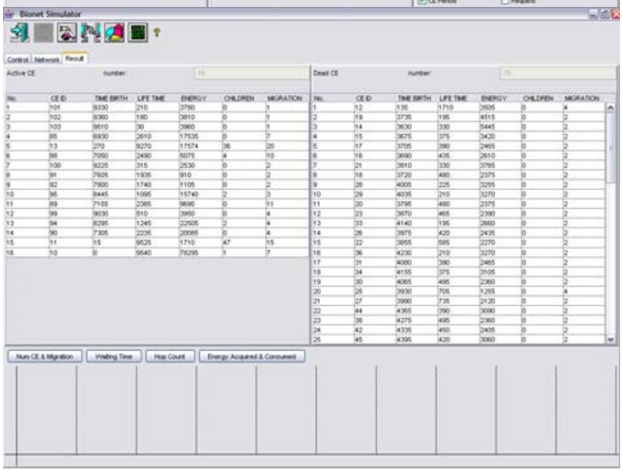
- Simulations
  - Implementing various biological mechanisms on simulator
  - Understanding the characteristics of those biological mechanisms
- Empirical evaluation
  - Porting simulation implementations on the real network
  - Evaluating how biological mechanisms impact on network systems

Bionet Simulator

- Java based simulator
  - Contains over 14,000 lines of Java code
- Simulates
  - Network topology
  - Network traffic
  - Users (request rate and location)
  - CEs
  - Platforms
  - resources







Simulation Work

- Evolutionary adaptation (long-term adaptation)
  - A genetic algorithm designed for CEs.
  - Behavioral policies modeled as genes.
  - Cyber-entities dynamically adjust their population and location against demands, net traffic and resource availability.

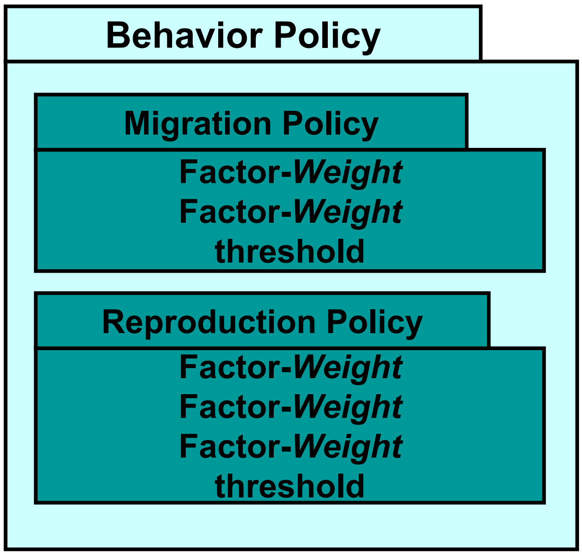
- Immunological adaptation (short-term adaptation)
  - An immunological algorithm designed for CEs.
  - Environmental conditions modeled as antigens.
  - Behavioral policies modeled as antibodies.
  - Cyber-entities dynamically adjust their population and location against demands, net traffic and resource availability.

Bionet Genetic Algorithm

Each CE has its own policy for each behavior.

A behavior policy consists of *factors* (F), *weights* (W), and a *threshold*.

– If $\sum_i F_i \cdot W_i$ > threshold, then migrate.

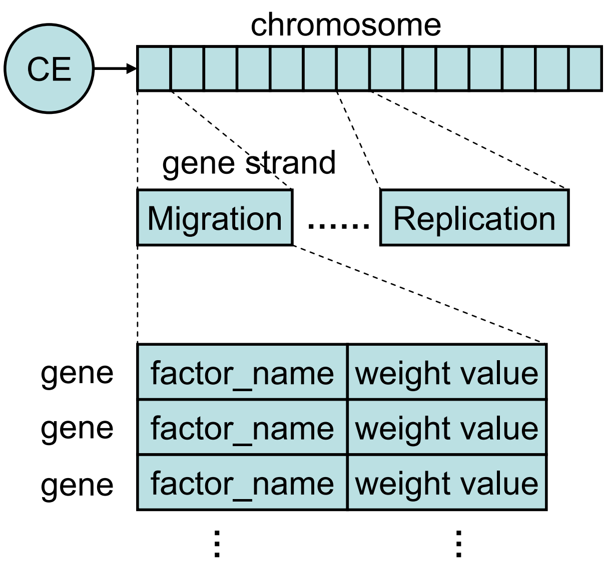


Example migration factors:

– *Migration Cost*
  - A higher migration cost (energy consumption) may discourage migration.

– *Distance to Energy Sources*
  - encourages CEs to migrate toward energy sources (e.g. users).

– *Resource Cost*
  - encourages CEs to migrate to a network node whose resource cost is cheaper.

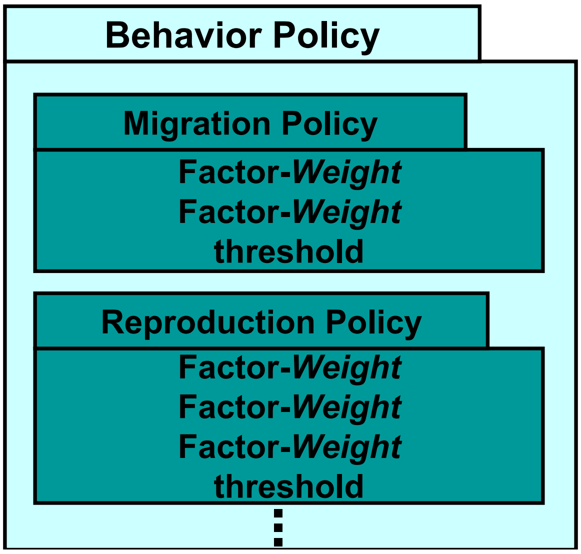


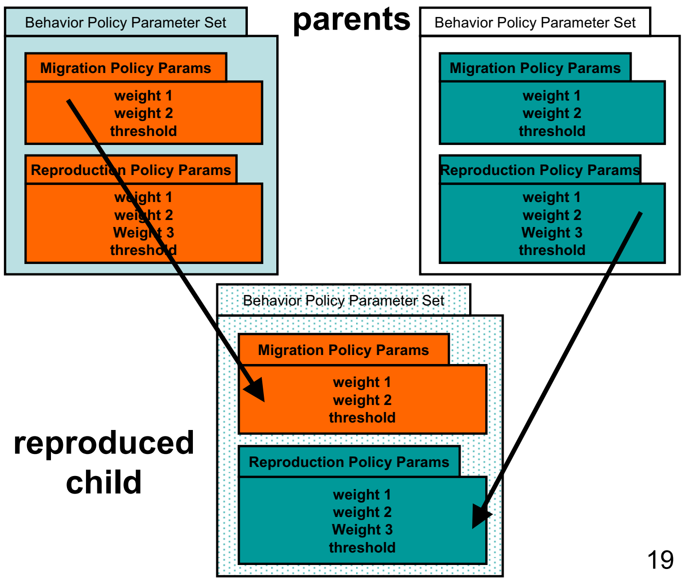
Each CE has its own chromosome. It is given by a human developer or contributed by its parent(s).

A chromosome consists of gene strands. Each gene strand corresponds to a behavior.

A gene strand consists of genes. Each gene encodes factor name, and weight value. Weight values are mutable.

- Weight values in each behavior policy change dynamically through mutation.
- Mutation occurs during replication and reproduction.
- Crossover occurs during reproduction.
- A child CE inherits different behaviors from different parents through crossover.





Bionet Immune Algorithm

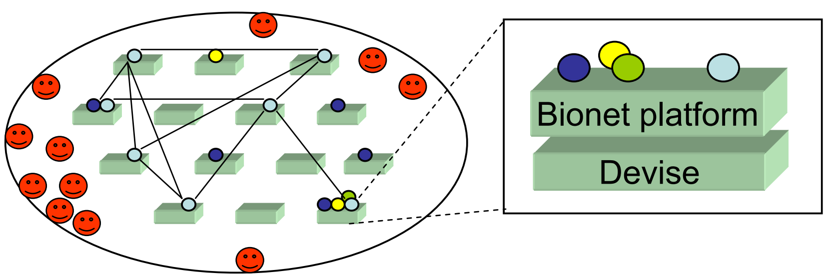
- The immune system
  - detects antigens (e.g. viruses) and produces a specific type of antibodies that kill them.
- The Bionet artificial immune system
  - detects environmental changes (antigens) and selects a behavior (antibody) suitable to the current environmental condition.

On-going Work

- Combining short-term and long-term adaptation mechanisms
  - – Genetic + immunological algorithms
  - – Synergistic effect?
- Symbiosis between CEs and platforms
  - – Models both CEs and platforms as biological entities

The Bio-Networking Platform

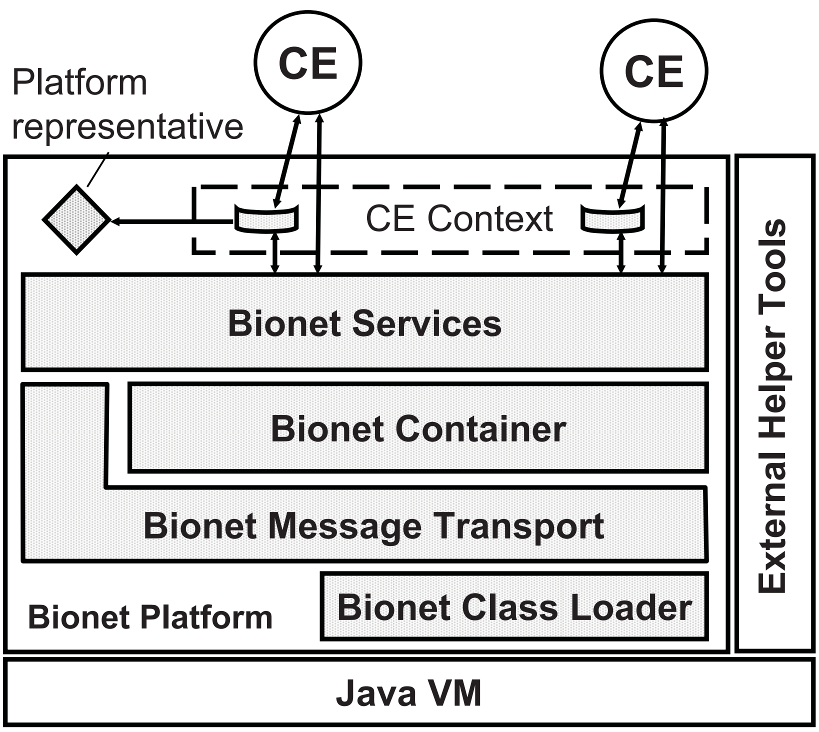
- The bionet platform is a middleware that
  - – deploys the Bio-Networking Architecture on the network.
  - – aids developing, deploying and executing CEs by
    - abstracting low-level networking and operating details.
    - providing high-level runtime services
      - – designed based on several biological mechanisms.
  - – Contains 34,000 lines of Java code



Design Strategy

- Identify a set of functional requirements derived from the features of cyber-entities
  - e.g. energy mgt., relationship maintenance, discovery, environment sensing, migration, lifecycle mgt., etc.
- Identify a set of common networking and operating functionalities required to deploy and execute CEs.
  - e.g. I/O, concurrency, messaging, network connection management, reference management, etc.
- Design and implement the bionet platform based on identified functionalities.

Platform Architecture



A *Cyber-entity (CE)* is an autonomous mobile object. CEs communicate with each other using FIPA ACL.

A *platform rep* keeps references to bionet services and container.

A *CE context* provides references to available bionet services.

***Bionet services* are runtime services that CEs use frequently.**

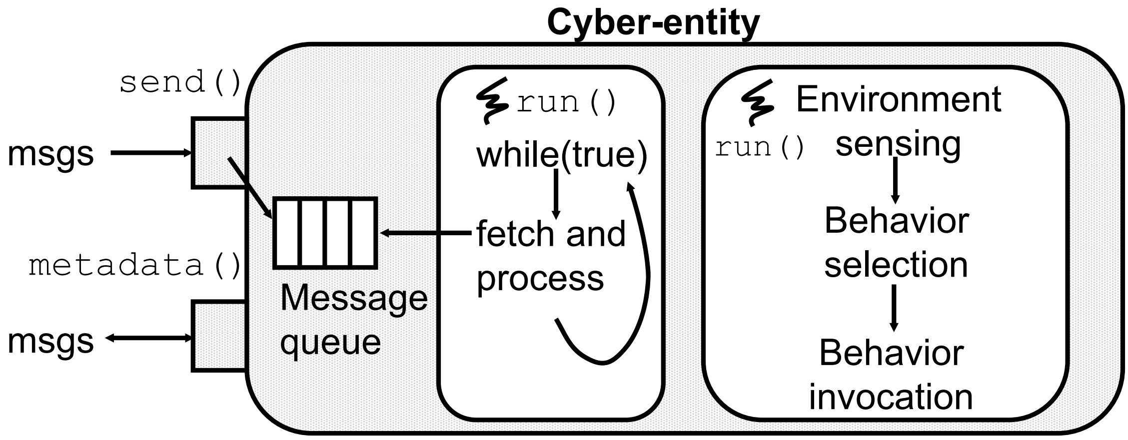
***Bionet container* dispatches incoming messages to target CEs.**

***Bionet message transport* takes care of I/O, low-level messaging and concurrency.**

***Bionet class loader* loads byte code of CEs to Java VM.**

CE's Internals

- Each CE is implemented as a Java object.
- Each CE uses 2 threads to
  - (1) fetch and process incoming messages
  - (2) sense nearby env conditions and invoke behaviors
- Each message is formatted in FIPA ACL and encoded with XML.



Bionet Services

- 8 services defined and implemented.
- Each service works on per-platform basis.
- Bionet Lifecycle Service
  - used to initialize and install a CE.
  - allows a CE to
    - activate, inactivate and replicate itself.
    - reproduce a child CE with a partner.
- Bionet Energy Management Service
  - keeps track of energy level of the CEs running on a local platform.
  - allows a CE to pay energy amounts for
    - invoking another CE's service
    - using resources (e.g. memory)
    - performing behaviors (e.g. for replicating).

- Bionet Relationship Management Service
  - allows a CE to establish, examine and eliminate its relationships.
- Bionet Resource Sensing Service
  - allows a CE to sense the type, amount and unit cost of available resources.
- Bionet CE Sensing Service
  - allows a CE to locate others CEs on the same platform.
- Bionet Migration Service
  - allows a CE to migrate to another bionet platform.

- Bionet Pheromone Emission/Sensing Service
  - allows a CE to leave its pheromone (or trace) on a local platform when it migrates to another platform
    - so that other CEs can find the CE at a destination platform
- Bionet Social Networking Service
  - allows a CE to search other CEs through their relationships.

Bionet Message Transport

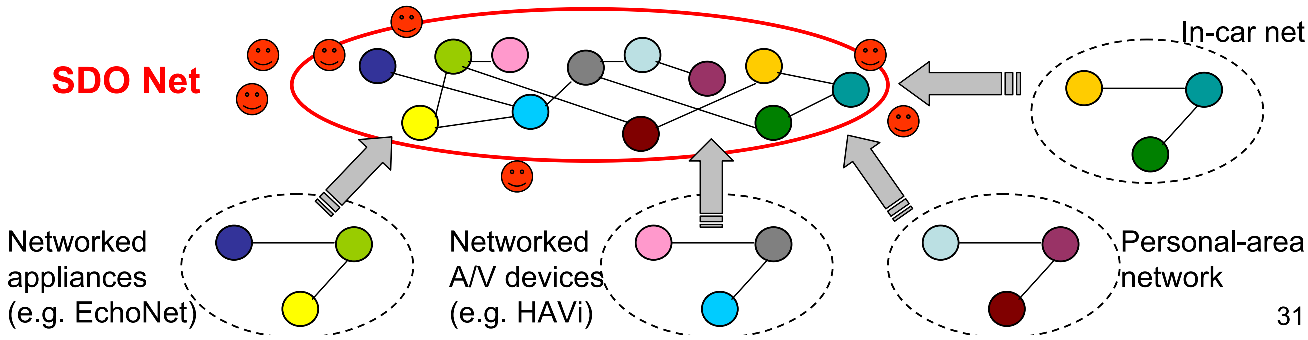
- abstracts low-level networking details
  - such as I/O, concurrency, messaging, network connection management.
  - Marshaling/unmarshaling messages issued by a CE
    - A string message (string data) written in the FIPA ACL is transformed to an IIOP binary representation.
  - TCP connection setup and management
    - “keep alive” policy (connection pooling) on connection management
      - A connection between platforms keeps alive (not destroyed) after it is established so that it is reused for future communication.
  - Threading (thread pooling) to accept incoming messages
- uses the interfaces of the CORBA ORB specification.

Bionet Container

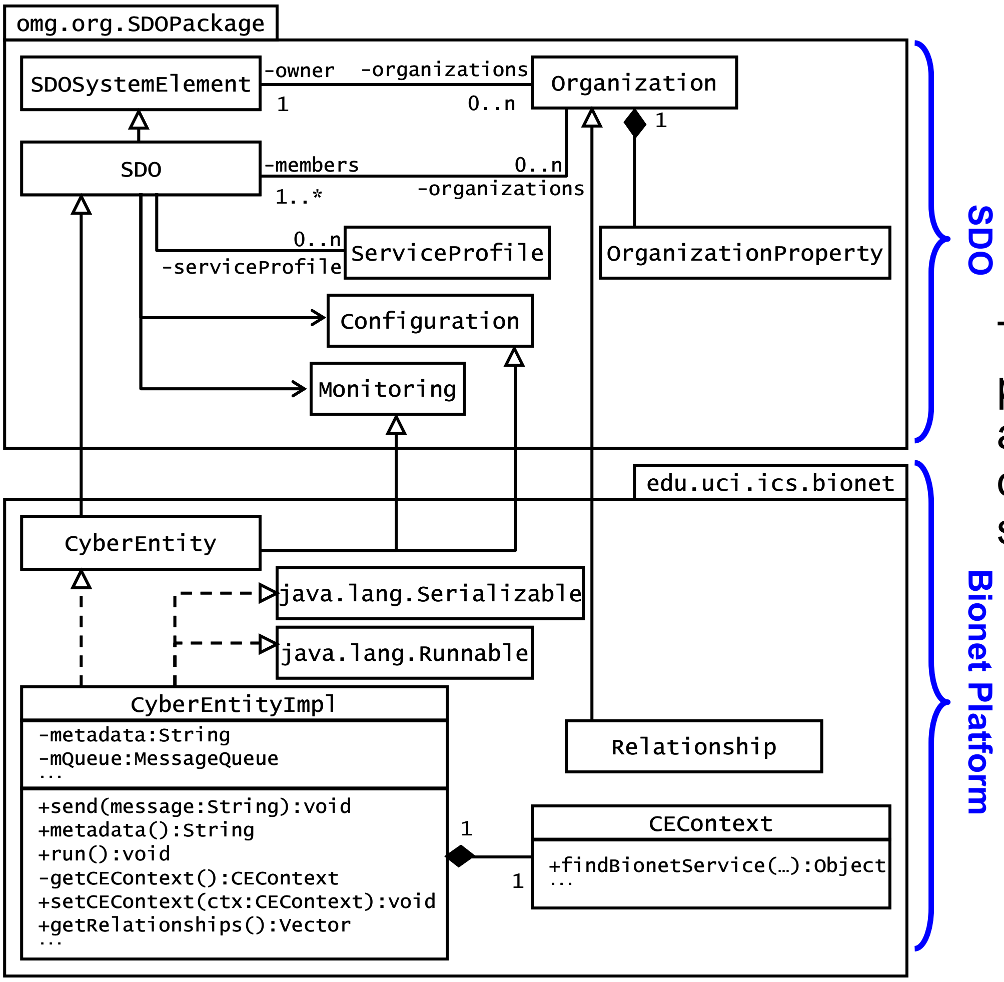
- contains a table listing all the CEs running on the same platform.
  - pairs of CE’s GUID and pointer to the CE
- uses the table to dispatch incoming msgs to target CEs.
- creates a CE references.
- keeps track of the current traffic load by counting
  - the size of incoming IIOP messages
  - the number of method dispatches.
- uses the interfaces of the CORBA POA (Portable Object Adaptor) specification.

OMG SDO Specification

- Contributed several designs in the bionet platform to the OMG's Super Distributed Objects (SDO) SIG
- SDO SIG aims to
  - incorporate massive numbers of heterogeneous hardware devices and software services
  - model them as objects (SDOs) in a uniform object model
  - operate SDOs on higher-level overlay network in a decentralized manner



- The current SDO standard defines
  - common *resource data model* for SDOs
    - used to describe SDO's properties (e.g. ID)
  - common *interfaces* to access and manipulate the resource data
  - PIM and CORBA PSM for
    - Resource data model and interfaces



The bionet platform as a specialization of the SDO standard

Current Status

- Measurements done to evaluate the bionet platform
  – Overhead of platform functionalities
  – Memory footprint of CEs and platforms
- Deploying and evaluation adaptation mechanisms on the bionet platform

Object Management Group

First Needham Place
250 First Avenue, Suite 100
Needham, MA 02494

Telephone: +1-781-444-0404
Facsimile: +1-781-444-0320

Request For Proposal

Robot Technology Components (RTCs)

OMG Document: sdo/2005-05-01

Letters of Intent due: <month> <day>, <year>
Submissions due: <month> <day>, <year>

Objective of this RFP

This RFP solicits proposals for a Platform Independent Model (PIM) and at least a CORBA Platform Specific Model (PSM) of RTCs that specifies

- interfaces for RTCs to transfer data and commands,
- a resource data model for RTCs,
- internal state transitions of RTCs,
- interfaces that are common to RTCs to monitor the state of RTCs,

as a extension to the specification of SDOs.

For further details see Chapter 6 of this document.

< Notes to RFP Editors. (1) When actual RFP is in draft form, a truncated document comprising of this cover pag, Chapter 6 and Appendix A suffice for

review purposes. The sections that RFP writers are not allowed to change are elided in this template. However, all chapters and appendices must be present in the published version. (2) Don't forget to replace the running header and footer with the name of the RFP, date, and so on, and remove or hide these notes. (3) If additional chapters beyond Chapter 6 and appendices beyond Appendix B are added to the RFP, make sure to include them for the truncated review document, and make sure to insert a brief description of each additional chapter and Appendix in section 1.2. (4) Do not change the contents of any sections other than those mentioned in item (1) above. >

1.0 Introduction

1.1 Goals of OMG

The Object Management Group (OMG) is the world's largest software consortium with an international membership of vendors, developers, and end users. Established in 1989, its mission is to help computer users solve enterprise integration problems by supplying open, vendor-neutral portability, interoperability and reusability specifications based on Model Driven Architecture (MDA). MDA defines an approach to IT system specification that separates the specification of system functionality from the specification of the implementation of that functionality on a specific technology platform, and provides a set of guidelines for structuring specifications expressed as models. OMG has established numerous widely used standards such as OMG IDL[IDL], CORBA[CORBA], Realtime CORBA [CORBA], GIOP/IIOP[CORBA], UML[UML], MOF[MOF], XMI[XMI] and CWM[CWM] to name a few significant ones.

1.2 Organization of this document

The remainder of this document is organized as follows:

Chapter 2 - *Architectural Context* - background information on OMG's Model Driven Architecture.

Chapter 3 - *Adoption Process* - background information on the OMG specification adoption process.

Chapter 4 - *Instructions for Submitters* - explanation of how to make a submission to this RFP.

Chapter 5 - *General Requirements on Proposals* - requirements and evaluation criteria that apply to all proposals submitted to OMG.

Chapter 6 - *Specific Requirements on Proposals* - problem statement, scope of proposals sought, requirements and optional features, issues to be discussed, evaluation criteria, and timetable that apply specifically to this RFP.

< Note to RFP Editors: Additional RFP-specific chapters may also be included following Chapter 6. If additional chapters are included, please insert brief description of each such chapter here. Insert the additional chapters immediately following Chapter 6, and preceding Appendix A. >

Appendix A – *References and Glossary Specific to this RFP*

< Note to RFP Editors: Please insert any references that are specific to this RFP in section A.1 as per the instructions that appear in that section.

Note to RFP Editors: Please insert any glossary items that are specific to this RFP in section A.2 as per the instructions that appear in that section. >

Appendix B – General References and Glossary

< Note to RFP Editors: Additional RFP-specific appendices may also be included following Appendix B. If additional appendices are included, please insert brief description of each such appendix here. Insert the additional appendices immediately following Appendix B. >

1.3 Conventions

The key words "**must**", "**must not**", "**required**", "**shall**", "**shall not**", "**should**", "**should not**", "**recommended**", "**may**", and "**optional**" in this document are to be interpreted as described in RFC 2119 [RFC2119].

1.4 Contact Information

Questions related to the OMG's technology adoption process may be directed to omg-process@omg.org. General questions about this RFP may be sent to responses@omg.org.

OMG documents (and information about the OMG in general) can be obtained from the OMG's web site (http://www.omg.org/). OMG documents may also be obtained by contacting OMG at documents@omg.org. Templates for RFPs (this document) and other standard OMG documents can be found at the OMG *Template Downloads Page* at http://www.omg.org/technology/template_download.htm

2.0 Architectural Context

<RFP writers shall not change this section>

3.0 Adoption Process

<RFP writers shall not change this section>

4.0 Instructions for Submitters

<RFP writers shall not change this section>

5.0 General Requirements on Proposals

<RFP writers shall not change this section>

6.0 Specific Requirements on Proposals

6.1 Problem Statement

Large numbers of robots are used for repetitive tasks in factories. These conventional industrial robots are designed for simple common tasks.

Conventional industrial robots were designed once, and sold their copies. Therefore, even if money and time were spent in the development of the robot, the profit was able to be taken.

In the other hand, the service robot in the future is expected to support our daily life in various scenes. Such a robot includes the cleaning robot and the mowing robot and also a robotic space in which functional modules are distributed – for example, where life support and nursing for individuals are achieved by cooperation of these functional modules.

In order to provide such robot system which supports our daily life, it is necessary to create custom-made robot systems into which various robotic functions are integrated to satisfy the needs of each customer. To open such a new robot industry, such custom-made robot systems should be developed easily.

Generally, robot systems are integrations of a lot of robot technology functions, such as actuators, sensors, controllers and so on, some of which include hardware and some are pure software.

In order to make those robot systems, especially non-industrial custom-made robot systems, easier and more effective, it is necessary to compose robot systems as integrations of robot technology function modules.

Figure 1 shows layered structure of robot system.

As for the hardware dependent layer, developer of robot system use various kinds of platforms, computer hardware, OS, computer language, communication method and so on. Those are dependent on implementations and it is difficult to standardize those implementations.

To achieve reusability and interoperability of robot modules, it is important to standardize in the distributed object layer. We call the robot modules in this level “Robot Technology Components (RTCs)”.

RTCs are autonomous modules of robot technology functions which include hardware devices. They can be considered as a kind of SDOs. So, We would like to make a specification of RTCs as application of SDOs to the robotics domain.

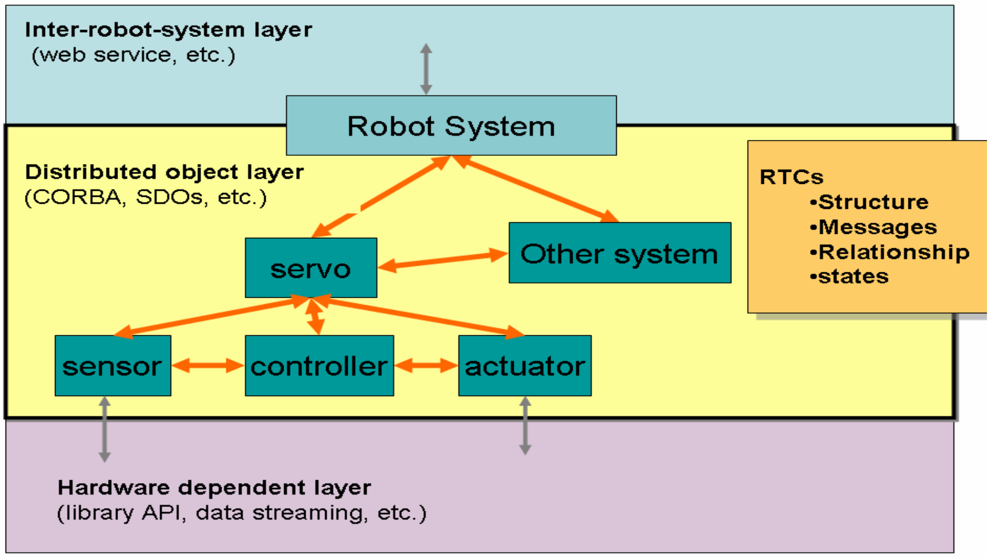


Figure 1 Layered Structure of Robot System and RTCs

6.2 Scope of Proposals Sought

The scope of the proposal sought with this RFP is the following:

(1) Specification of RTCs as a framework of modularization of robot technology functions in the distributed object layer.

Proposed RTC should give the framework of modularization of robot technology functions that covers robotic domain widely to achieve interoperability and flexibility.

Functions provided by RTCs and environment in which RTCs are used are different according to each robot system. So, the grain size of RTCs can be chosen by its developers freely. And, a large RTC can be composed of some small RTCs.

RTCs shall communicate with other RTCs directly, and cooperate to realize their tasks. RTCs should provide both the command and data communication interfaces.

(2) Specification RTCs based on SDOs.

RTCs can be considered as application of SDOs to the robotics domain as described before. Therefore, RTC should be specialization of the specification of existing SDOs.

It is necessary to clarify the following:

- Mapping of necessary interface and data structure,
- Extension and modification of the specification of SDOs,
- Classification mandatory and optional feature for robotics domain.

6.3 Relationship to Existing OMG Specifications

The following list provides some of the existing OMG specifications that need to be analyzed to examine whether the CORBA PSM for RTC being proposed by submitter can benefit from them:

- PIM and PSM for Super Distributed Objects, ver.1.0 [formal/2004-11-01]
- Meta-Object Facility(MOF), ver.1.4 [formal/2002-04-03]
- UML2.0 Infrastructure Final Adopted Specification [ptc/03-09-15]
- UML2.0 Superstructure Final Adopted Specification [ptc/04-10-02]
- UML2.- OCL Final Adopted Specification [ptc/03-10-14]
- PIM and PSM for SWRADIO Components Final Adopted Specification [dtc/2004-05-04]
- Data Distribution Service for Real-time Systems, ver.1.0 [formal/2004-12-02]
- Data Acquisition form Industrial Systems (DAIS) ver.1.0 [formal/2002-11-07]
- Histrical Data Aquisition form Industrial Systems (HDAIS) [dtc/2003-02-01]
- Smart Transducers Interface, ver.1.0 [formal/2003-01-01]
- Distributed Simulation System, ver.2.0 [formal/2002-11-11]

6.4 Related Activities, Documents and Standards

Proposals may include existing systems, documents, URLs, and standards that are relebant to the problems discussed in this RFP. They can be used as background information for the proposal.

Examples:

- AUTOSAR (Automotive Open System Architecture)
  http://www.autosar.org/

- CARMEN: Carnegie Mellon Robot Navigation Toolkit
  http://www-2.cs.cmu.edu/~carmen/

- CLARAty: Coupled Layer Architecture for Robotic Autonomy
  http://robotics.jpl.nasa.gov/tasks/claraty/homepage.html

- CLAWAR : CLimbing And WAlking Robots Project
  http://www.clawar.com/home.htm

- IEEE1451 (Smart Sensor and Actuator Interface Standard)
  http://ieee1451.nist.gov/

- IEEE Robotics and Automation Society, Technical Committee on Network Robot

- IEEE Robotics and Automation Society, Technical Committee on Programming Environments in Robotics and Automation

- JAUS: Joint Aerchitecture for Unmanned Systems
  http://www.jauswg.org/

- LAAS Open Software for Autonomous Systems:
  http://softs.laas.fr/openrobots/index.php

- MARIE : Mobile and Autonomous Robotics Integration Environment
  http://marie.sourceforge.net/en/HomePage.html

- MIRO: Middleware for mobile robot applications
  http://smart.informatik.uni-ulm.de/MIRO/

- Network Robots Forum
  http://www.scat.or.jp/nrf/

- OPC Foundation
  http://www.opcfoundation.org/

- OROCOS: Open Robot Control Software, Open Realtime Control Service
  http://www.orocos.org/

- Orca:
  http://orca-robotics.sourceforge.net/

- ORiN :Open Robot/Resource Interface for the Network
  http://www.orin.jp/

- Player/Stage
  http://playerstage.sourceforge.net/

- Ptolemy Project
  http://ptolemy.eecs.berkeley.edu/

- RCS (Realtime Control Systems Architechture)
  http://www.isd.mel.nist.gov/projects/rcs/

- RSi: Robot Service Initiative
  http://www.robotservice.org/

- RT middleware Project
  http://www.is.aist.go.jp/rt

- SAE AADL (Society for Automotive Engineers, Architecture Analysis and Design Language)
  http://www.aadl.info/

- RETF (Robotics Engineering Task Force)
  http://www.robo-etf.org/

- URC(Ubiquitous Robotic Companion)Project

- Yaorozu Project
  http://www.8mg.jp/

6.5 Mandatory Requirements

For all the mandatory requirements, proposals shall provide a platform independent model and at least one CORBA specific model.

(1) Proposals shall specify interfaces for RTCs to transfer data and commands.

(2) Proposals shall specify a resource data model for RTCs, which describes their capabilities and properties. This model shall identify all the necessary and relevant data to describe them and contain the corresponding data structures and relationships.

(3) Proposals shall specify a set of internal RTC states and transitions among them.

(4) Proposals shall specify interfaces for RTCs to monitor the state of RTCs.

6.6 Optional Requirements

Proposals may specify optional features below without ruining the interoperability and independency from platform.

(1) Proposals may specify a simple discovery method of RTCs.

(2) Proposals may specify a model and interface for time management or real-time support.

6.7 Issues to be discussed

These issues will be considered during submission evaluation. They should not be part of the proposed normative specification. (Place them in Part I of the submission.)

- Mapping to the model of SDOs.
- Examples applied to some robot systems
- Level of guarantee of interoperability

6.8 Evaluation Criteria

The proposed PIMs should be compliant with the OMG UML standard. The proposed CORBA-specific PSMs should be compliant with the CORBA standard. Any metadata described by the proposed model should be compliant with the XMI standard.

Proposals should show an example of RTCs for a specific application robot system (manipulator control, mobile robot system, robotic space, and so on) using specified model and interface.

Proposals will be evaluated in terms of consistency in their specifications, versatility across different robot applications, and extensibility.

6.9 Other information unique to this RFP

None.

6.10 RFP Timetable

The timetable for this RFP is given below. Note that the TF or its parent TC may, in certain circumstances, extend deadlines while the RFP is running, or may elect to have more than one Revised Submission step. The latest timetable can always be found at the OMG *Work In Progress* page at http://www.omg.org/public_schedule/ under the item identified by the name of this RFP.

Approx Day	Event or Activity	Actual Date
	Preparation of RFP by SIG	*May 30, 2005*
	RFP placed on OMG document server	*May 31, 2005*
	Review by TF	*June 21, 2005*
	Preparation of RFP by TF	*August 1, 2001*
	RFP placed on OMG document server	*August 22, 2005*
	Approval of RFP by Architecture Board *Review by TC*	*September 15, 2005*
0	*TC votes to issue RFP*	*September 16, 2005*
90	*LOI to submit to RFP due*	*December 15, 2005*
129	*Initial Submissions due and placed on OMG document server ("Three week rule")*	*January 23, 2006* *(at least 12 weeks form issue)*
143	*Voter registration closes*	*February 6, 2006* *(one week before TM)*
150	*Initial submission presentations*	*February 13, 2006*
	Preliminary evaluation by TF	

199 (240)[262]	*Revised Submissions due and placed on OMG document server ("Three week rule")*	*April 3, 2006*
220 (261)[283]	*Revised submission presentations*	*April 24 , 2006*
	Final evaluation and selection by TF Recommendation to AB and TC	*June 26,2006*
	Approval by Architecture Board Review by TC	*June 29, 2006*
287 (330)[357]	*TC votes to recommend specifications*	*June 30, 2006*
360	*BOD votes to adopt specifications*	*September, 2006*

Appendix A References and Glossary Specific to this RFP

A.1 References Specific to this RFP

< Note to RFP Editors: Insert any references specific to this RFP that are referred to in the Objective Section, Section 6 and any additional sections in the same format as in Section B.1 and in alphabetical order in this section. >

A.2 Glossary Specific to this RFP

< Note to RFP Editors: Insert any glossary items specific to this RFP that are used in Section 6 and any additional sections in the same format as in Section B.2 and in alphabetical order in this section. >

Appendix B General Reference and Glossary

< Note to RFP Editors: Append additional appendices if needed here and update the list and brief description of appendices in Chapter 1. >

SDO

Super Distributed Objects

Date: Friday, 24th June, 2005
Reporting: Tetsuo Kotoku
Group email: sdo@omg.org

➢Highlights from this Meeting:

SDO Plenary (Tue.):

– Special Talk (Prof. Jun Suzuki, Univ. of Mass.) [sdo/05-06-04]

– RFP 1st review (Dr. Suehiro, AIST) [sdo/05-06-05]

Joint Meeting with C4I (Mon.):

Joint Meeting with MARS/RTESS (Tue.):

Joint Meeting with ManTIS (Thu.):

SDO

Super Distributed Objects

Date: Friday, 24th June, 2005
Reporting: Tetsuo Kotoku
Group email: sdo@omg.org

➢Future Deliverables (In-Process):

– **RFP (Robot Technology Components)**

➢Next Meeting (Atlanta, GA, USA) :

– **RFP draft 2nd review**
(Robot Technology Components)

SDO Meeting Minutes – Boston, MA, USA (sdo/2005-06-07)

Overview and votes

We worked on the Robot Technology Components RFP, planned for issuance in Atlanta.

OMG Documents Generated

sdo/2005-06-01 Final Agenda (Tetsuo Kotoku)
sdo/2005-06-02 Opening presentation (Tetsuo Kotoku)
sdo/2005-06-03 SDO-DSIG and Robotics-DSIG Roadmap (Tetsuo Kotoku)
sdo/2005-06-04 Presentation: "Biologically-inspired Adaptive Networking with Super Distributed Objects" (Jun Suzuki)
sdo/2005-06-05 Revised RFP draft for RTC (Robot Technology Components) (Takashi Suehiro)
sdo/2005-06-06 DTC Report Presentation (Tetsuo Kotoku)
sdo/2005-06-07 Meeting Minutes (Tetsuo Kotoku)

Agenda

09:00-09:10 Welcome and Review Agenda
09:10-10:00 Special Talk: "Biologically-inspired Adaptive Networking with Super Distributed Objects" (Prof. Jun Suzuki, UMass Boston)
10:20- 11:50 RFP pre-review: "Robot Technology Components" (Dr. Takashi Suehiro, AIST)
11:50- Next meeting Agenda
12:00- Adjourn

Minutes

21 June, Tuesday

Tetsuo KOTOKU, presiding co-chair
Meeting Week – Kick-off

- Meeting was called to order at 09:00
- Tetsuo Kotoku provided a brief guidance about SDO-DSIG and our roadmap updated for the Boston meeting.
  - ✓ sdo/2005-06-02 Opening presentation
  - ✓ sdo/2005-06-03 Roadmap for Robotics Activities

Invited Talk "History of SDO DSIG and Overview of PIM and PSM for SDO"

- Jun Suzuki (UMass Boston) made a brief introduction of UMass Boston, and presented his research on Bio-Networking Architecture. The Bio-Networking platform is going to implement as a specialization of the SDO standard. He is one of SDO-DSIG founders, so he gave us an initial stage story. He recommended us sending our draft RFP to two or three AB members and asking for their comments.
  - ✓ sdo/2005-06-04 Special Talk "Biologically-inspired Adaptive Networking with Super Distributed Objects"

RFP discussion "SDO and RTC (Robot Technology Components)"

- Takashi Suehiro (AIST) presented the draft RFP. The main target is to keep the interoperability of robot components.
- To make more impressive title, "PIM and PSM" was cut out from the title.
- YunKoo Chung (ETRI) asked for making clear the boundary of Robotic Systems.
- The definition of Robotic systems was also discussed.
- There are a lot of discussions about the requirement of specification of states and their transitions.
- ***Action:*** Continue the working group activity (to draft RFP by 3 weeks before the Atlanta meeting).
  - ✓ sdo/2005-06-05 RFP discussion "SDO and RTC (Robot Technology Components)"

Meeting Wrap-up, Plan for Boston

- Tetsuo Kotoku presented the Draft Agenda for the next Atlanta meeting.
- SDO plenary meeting will be held on Tuesday Afternoon.
  - ✓ sdo/2005-06-02 Opening presentation

ADJOURNED @ 12:00

Meeting Attendees (sign-in)

- Makoto Mizukawa (Shibaura Institute of Technology)
- Olivier Lemaire (JARA)
- Jeff Kotora (Dept. of deffence / TITAN)
- Yokomachi Masayoshi (NEDO)
- YunKoo Chung (ETRI)
- Hiroshi Miyazaki (Fujitsu)
- Akira Tanaka (Hitachi)
- Kumar Subramanian (Raytheon)
- Takashi Suehiro (AIST)
- Jun Suzuki (Umass Boston)
- Hiroki Kamata (OTI)
- Tetsuo KOTOKU (AIST)

Prepared and submitted by Tetsuo Kotoku