Robotics DSIG Final Agenda ver.1.01 (robotics/2005-06-01)

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

		TF/SIG Host	TF/SIG 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		

Robotics DSIG Plenary Meeting

June 22, 2005

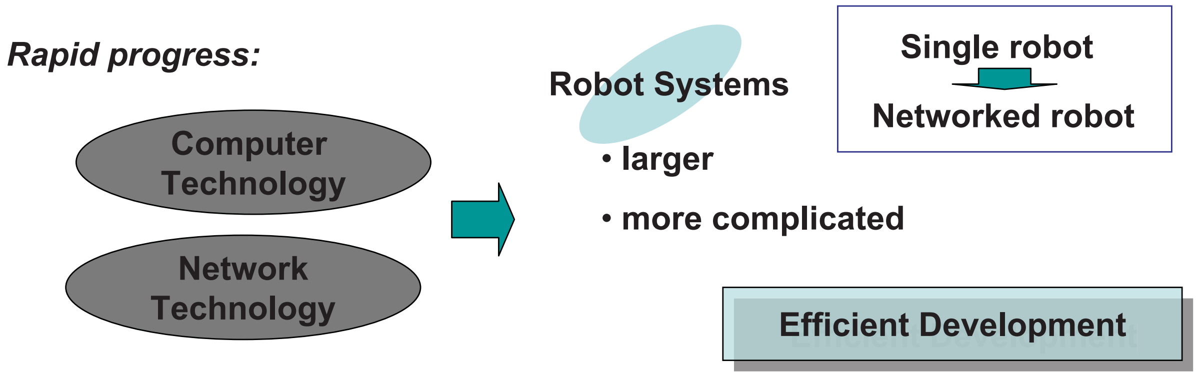
Boston, MA USA

Seaport World Trade Center

Federal, Mezzanine Level

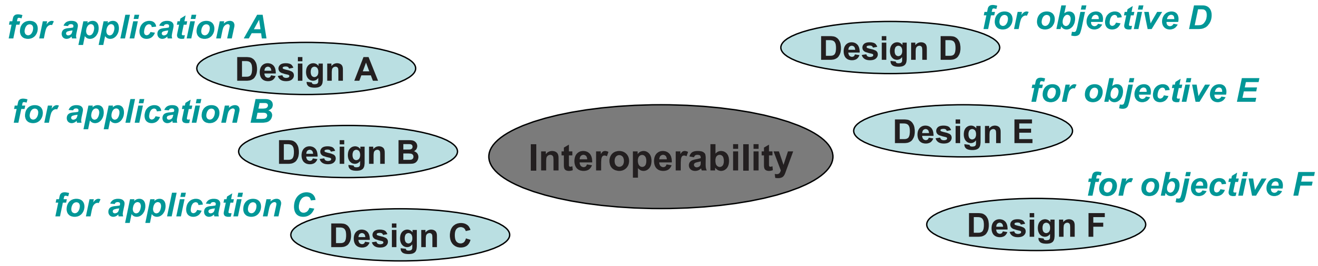
Robotics Standards at OMG

With the rapid progress in computer and communication technology, the robot systems are fast becoming larger and more complicated. Therefore, there is a real need for the software technologies for efficient developments. Now various software technologies are proposed and implemented respectively.



Robotics Standards at OMG

Unfortunately, most of these pioneering initiatives are developed independently of the others, driven by specific applications and objectives. In order to settle this state of chaos, we would like to contribute to the promotion of standardization in the field of robotics based on the mutual understanding between the relevant parties.



Integration of robot systems based on modular components

Robotics standards based on the MDA

Charter

The purpose of the Robotics Domain SIG is to foster the integration of robotics 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.

Roadmap Review

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

Two activities in parallel

Review Agenda

Wednesday, June 22, 2005

SDO DSIG
Tue, June 21, 2005
09:00 – 12:00

- **09:00- Welcome and Review Agenda**
- **09:15- Special Talk: Introduction to JAUS**
  Jeff Kotora (Chair, JAUS WG)

<break>

- **10:25- Robotics needs of the oilfield industry**
  Mike Barrett and Claude Baudoin (Schlumberger)
- **11:15- Robotics: initial survey (RFI discussion)**
  Olivier Lemaire (WG chair)

<lunch>

<break>

- **15:20- Towards a reference model for robotic standards**
  Hui Min Huang (NIST)
- **16:00- Middleware technology for robotics**
  Jaesoo Lee (Seoul National Univ., Korea)
- **16:30- Voting, Next Meeting Agenda Discussion**
- **17:00- Adjourn**

Joint Meeting with MARS/RTESS
Thursday, June 23, 2005
09:00-16:30 (Waterfront2)

Organization

- RFI drafting WG [completed]
- Public Relations WG (Web, Info-Day)
- Liaisons between OMG TF/SIGs
  - ManTIS, MARS, RTESS, etc.
- Liaisons between related organizations
  - JAUS, AUTOSAR, URC, etc.

We needs volunteers

Next Meeting Agenda

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

Wednesday [Sept.14]

Robotics-DSIG Plenary Meeting

- **SDO-DSIG joint meeting** (tentative):
  Robotics Technology Components RFP review

- **Participants Talk:**
  - **Bruce Boyes** (Systronix) “Implementing and Teaching Emerging Robotics Standards at the University Level”
  - **Joseph M. Jacob** (OTI) “Security in Robotics” (tentative)
  - etc

Roadmap for Robotics Activities

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

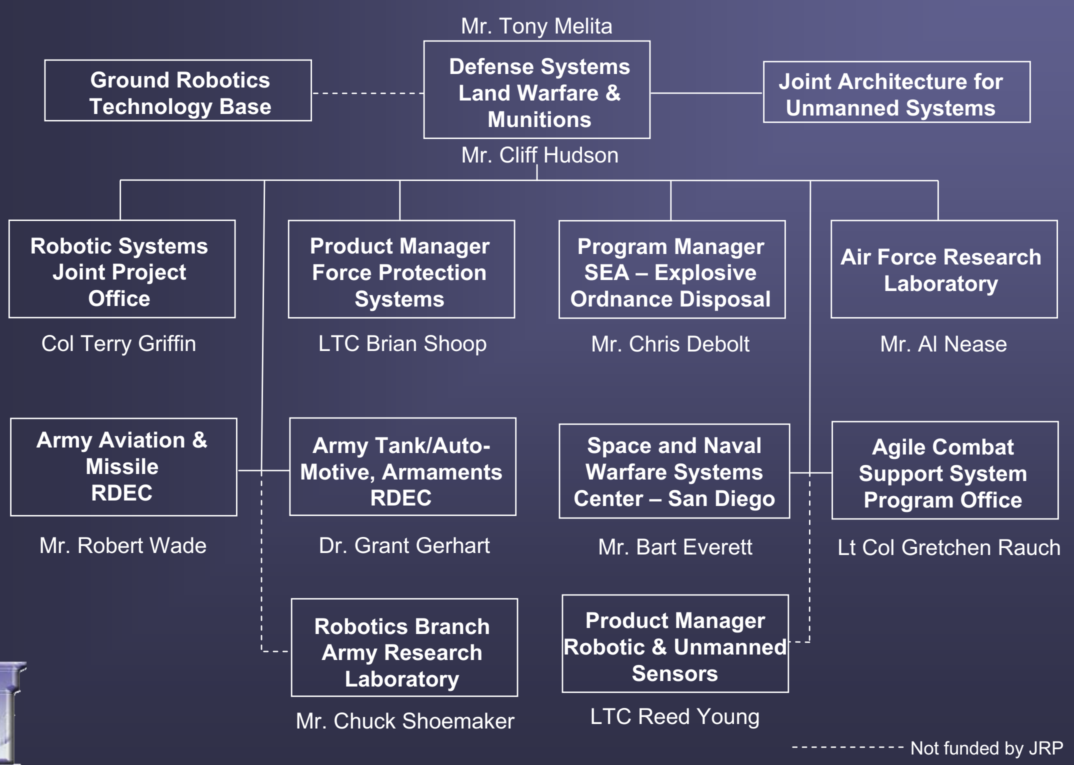
Item	Status	Athens Apr-2005	Boston Jun-2005	Atlanta Sep-2005	Burlingame Nov-2005	TBD Feb-2006	TBD Apr-2006	TBD Jul-2006	POC / Comment
Charter on Robotics WG in SDO	done								Kotoku(AIST), Mizukawa(Shibaura-IT)
SDO model for Robotics Domain	Planned	discussion	draft RFP	RFP		Initial Submittion		Revised? 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

JAUS *Overview*

Joint Architecture for Unmanned Systems

Jeff Kotora
OSD Support Staff
Chair, JAUS Working Group
(256) 722-5555
jkotora@titan.com

Joint Robotics Program (JRP)



JRP SYSTEMS

Future Combat Systems (FCS)

Gladiator

Remote Ordnance Neutralization System (RONS)

All-purpose Remote Transport System (ARTS)

JRP SYSTEMS

Omni-Directional Inspection System (ODIS)

Experimental Unmanned Vehicle (XUV)

COUGAR

Introduction

Initiated by the UGV/S JPO in 1996 to address cost reduction for its 2 on-going UGV acquisitions. Adopted by the OSD Joint Robotics Program in 1999 for all of its efforts.

Originally authored by a single individual, JAUS is now authored by a Working Group including industry and academia.

The Joint Architecture for Unmanned Systems addresses interoperability with an emphasis on the logical communications between heterogeneous computing systems used for Unmanned Systems command and control.

JAUS = { Messages }

Message = Control + Addressing + Data

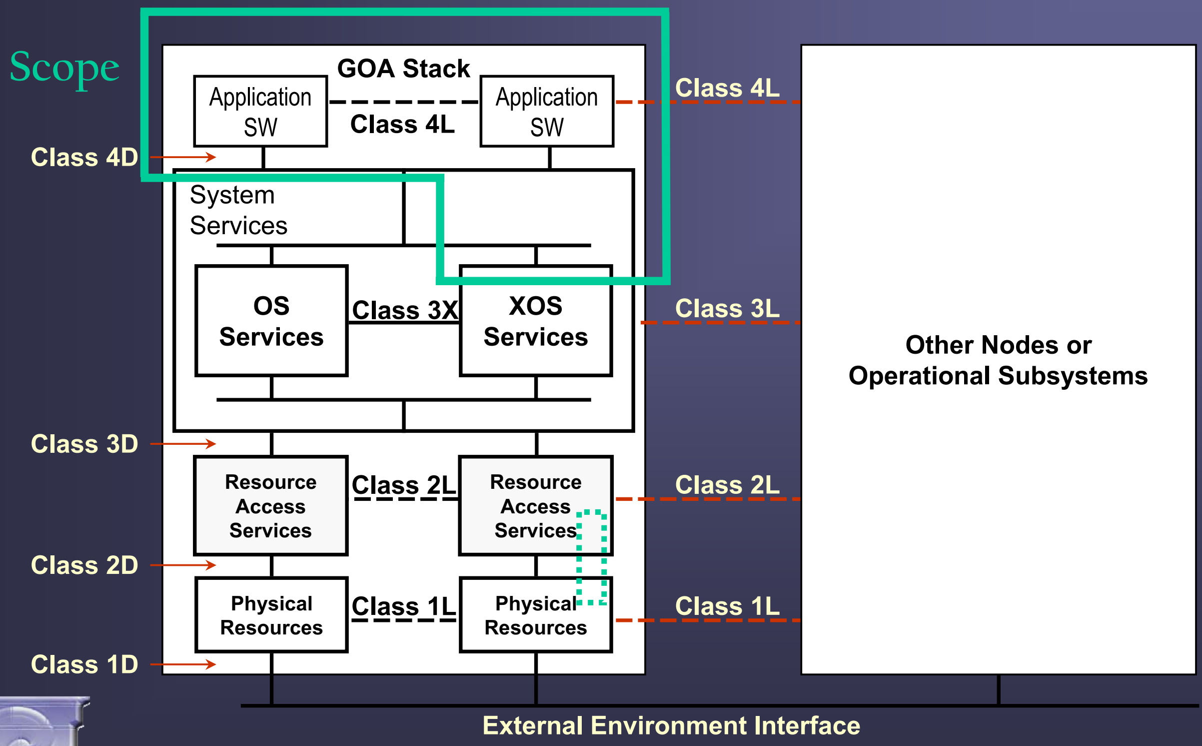
JAUS is an Open Systems Specification

Objectives of JAUS

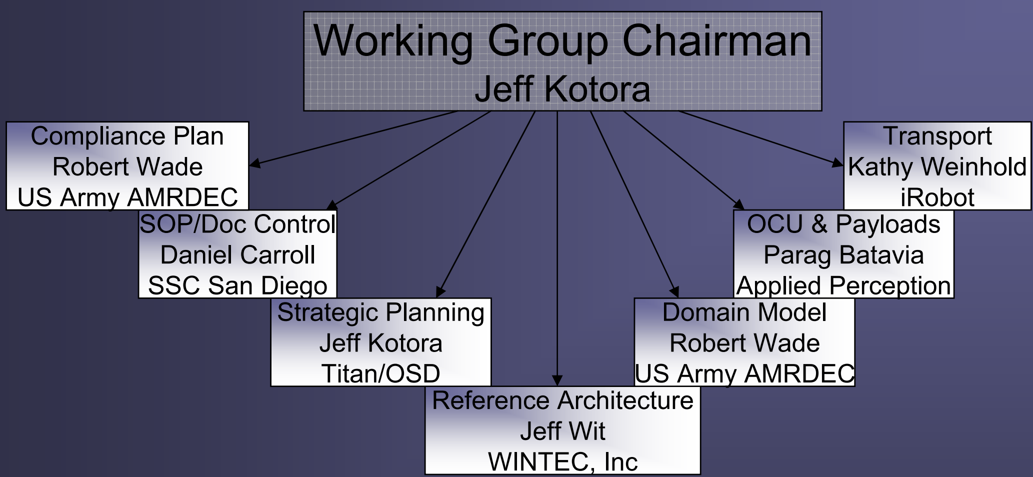
- Hardware Platform Independence
  - Supports interoperability on any platform
- Mission Isolation
  - Supports configurable payloads
- Computer Hardware Independence
  - Not based on dated technology
- Technology Independence
  - Supports technology insertion
- Operation Independence
  - Allows the warfighter to determine tactics

JAUS is designed to exploit existing and future technologies while simultaneously supporting systems evolution to autonomy

JAUS Architecture Framework (Generic Open Architecture)



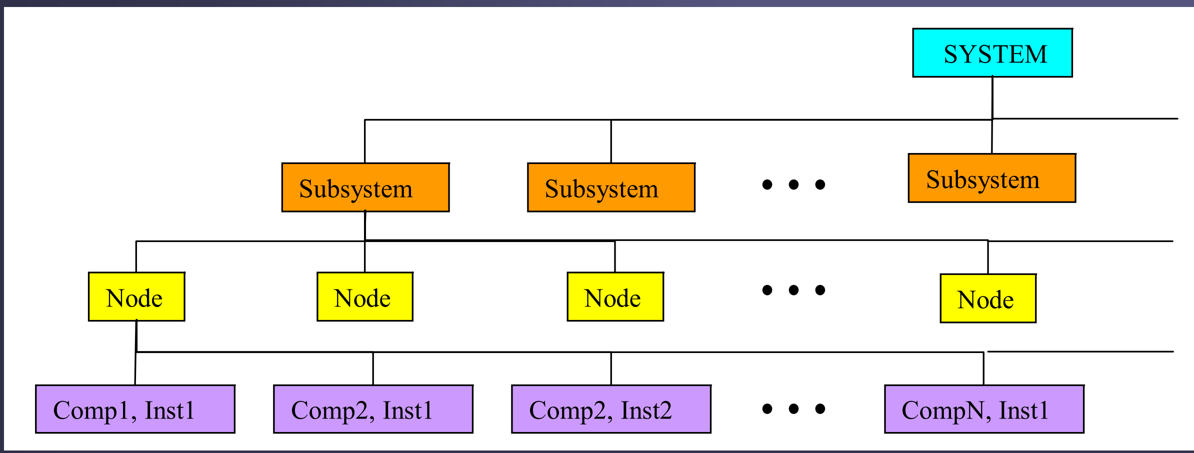
JAUS Working Group



- Web Page: www.jauswg.org
- FTP Site: ftp.jauswg.org
  - Username: jauswgftp
  - Password: jauswgftp

JAUS Reference Architecture Topology

- Defines a system topology consisting of Operational Subsystems, Nodes, and Components.



JAUS Reference Architecture (RA)

- Defines specific components and their interfaces (messages), based on the services and capabilities specified in the domain model.
- Defines methods for message passing, and standards to support component integration.
- Written in the language of the scientist/engineer.

JAUS RA Documentation

- Part 1: Architecture Framework
  - provides explanation of components
- Part 2: Message Definition
  - provides details about message formats and headers
- Part 3: Message Set
  - provides detailed description of messages

Messages

- Messages between components are categorized as
  1. command class
  2. query class
  3. inform class

Types of Components

1. Command and control components
2. Communications components
3. Platform components
4. Manipulator components
5. Environmental sensor components

Types of Components

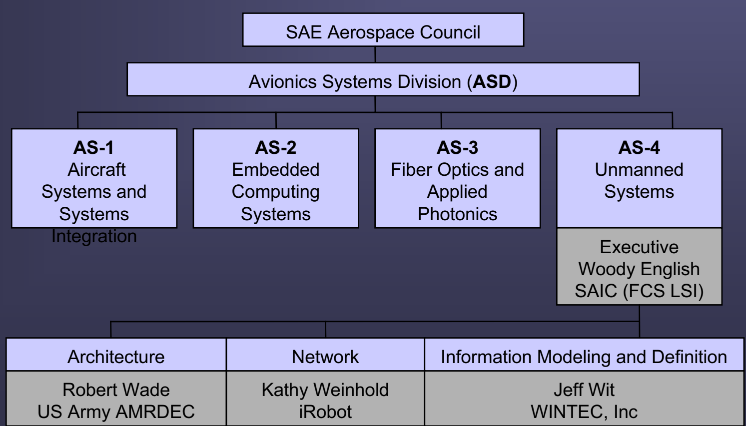
1. Command and control components
   a) System Commander
   b) Subsystem Commander
2. Communications components
   a) Communicator
3. Platform components
   a) Global / Local Pose Sensor
   b) Velocity State Sensor
   c) Primitive Driver
   d) Reflexive Driver
   e) Global / Local Vector Driver
   f) Global / Local Waypoint Driver
   g) Global / Local Path Segment Driver
4. Manipulator components
   a) Primitive Manipulator
   b) Manipulator Joint Position Sensor
   c) M. Joint Velocity Sensor
   d) M. Joint Force/Torque Sensor Component
   e) M. Joint Positions Driver Component
   f) M. End-Effector Pose Driver
   g) M. Joint Velocities Driver
   h) M. End-Effector Velocity State Driver
   i) M. Joint Move Driver
   j) M. End-Effector Discrete Pose Driver
5. Environmental sensor components
   a) Visual Sensor
   b) Range Sensor

Coordinate Systems

- Global coordinate system
  - geo referenced ; latitude/longitude in accordance with the WGS 84 standard
- Vehicle coordinate system
  - attached to vehicle; x forward, z down
- Local coordinate system
  - user defined ; for example, within a building

Transition to an Industry Standard

- Society of Automotive Engineers October 2004
- Aerospace Council
- Avionics Systems Division (ASD)
- Unmanned Systems Committee (AS-4)



JAUS and AS-4 will execute in parallel until further notice

JAUS—SAE Migration

JAUS Documents	Technical Content	Proposed SAE Documents
Domain Model	Requirements Baseline/Background	Architecture Framework
Reference Architecture	System Composition/Nomenclature Component Level Architecture	Architecture Framework
Reference Architecture	Message Headers UMS Specific Protocol (Dynamic Registration) (Service Connections) (Ack/Nak) (Large Data Sets)	Network –Session
Reference Architecture	Message Definitions (sans header)	Unmanned Systems Message Set
Transport Specification	TCP/IP Assignments Point to Point Protocols	Network –Transport

Current JAUS Document Set will be compatible with the first set of SAE Documents

Current Systems & Developments

- Air Force ARTS
- USMC Gladiator
- Air Force REDCAR
- Navy JUSC2 ACTD
- Army FCS Mule
- Army FCS UAVs
- Army FCS ARV
- Army FCS SUGV
- State Department NGEODRCV
- iRobot PackBot
- Remotec Andros
- Navy MTRS
- Army MDARS-E
- Army CRS
- Army RCSS
- Navy Spartan ACTD

The JAUS Working Group has over 29 member organizations

Service, Industry & Academic Participants

- Boeing
- Lockheed Martin
- Titan Corporation
- Autonomous Solutions
- Applied Perception
- John Deere
- Caterpillar
- OSD JRP
- DoC NIST
- Navy EODTECHDIV
- Navy SPAWAR SC
- Army UAMBL
- Army MANSCEN
- Air Force AAC
- General Dynamics
- Northrop Grumman
- Carnegie Mellon
- Univ. of Florida
- iRobot
- Army AMRDEC
- Army TARDEC
- Army CERDEC
- Army STRI
- PM Soldier
- Marine/Army RS JPO
- Navy Crane SC
- Air Force Research Laboratory

And over 50 active individual members

Product vs. Interface

- Product
  - Owned by single agency/organization
  - Incur Obsolescence
  - Expensive
  - Difficult to Adapt
- Interface
  - Broad Market appeal
  - Adaptable
  - Support Technology Insertion

Interface Standardization is superior to Product Standardization

What's Next

- Continue Transition to SAE
- Dynamic Registration/Configuration
- Mission Planning and Execution
- World Modeling Components
- Transport Specification
- Weapons/Fire Control
- Component Definition Changes
- Products
  - Validation Tool Suite
  - JAUS Communicator

Robotics for Oil and Gas Exploration and Production

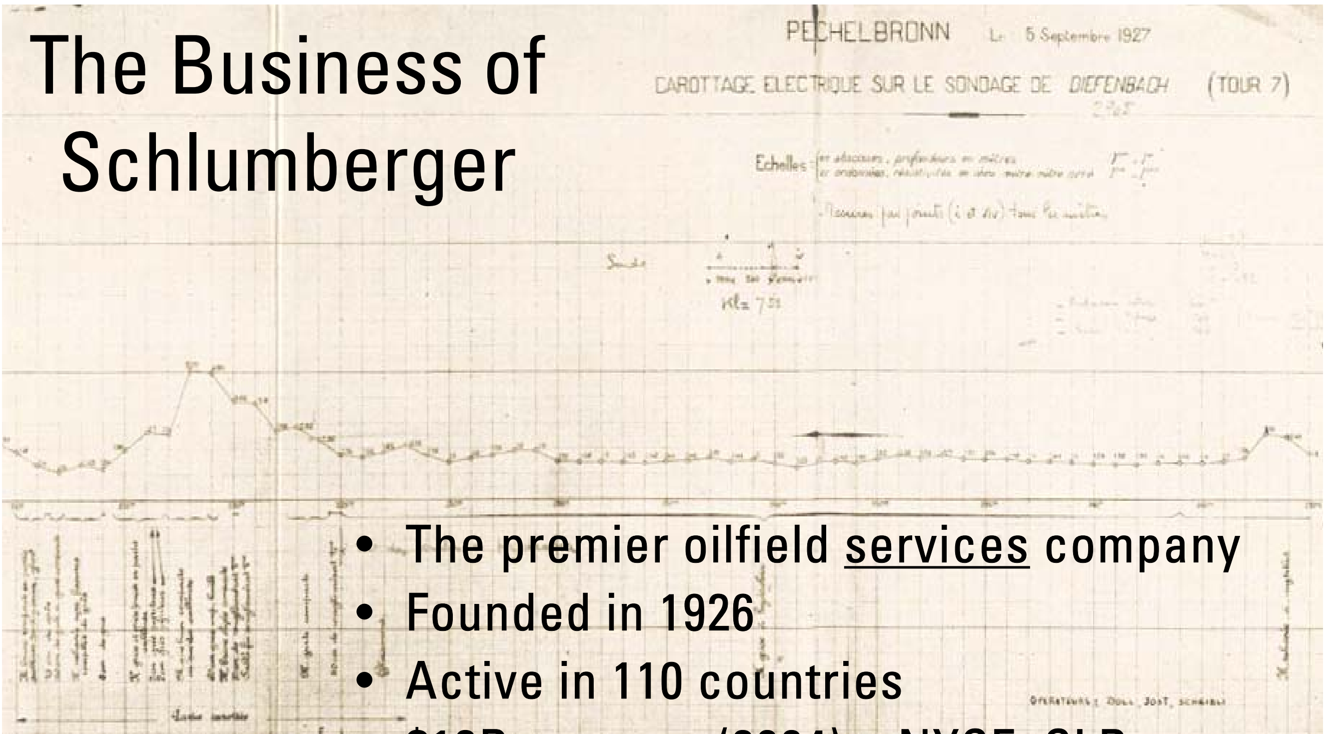
Presentation to the OMG Robotics DSIG – Prepared by

Schlumberger

Mike Barrett, Claude R. Baudoin

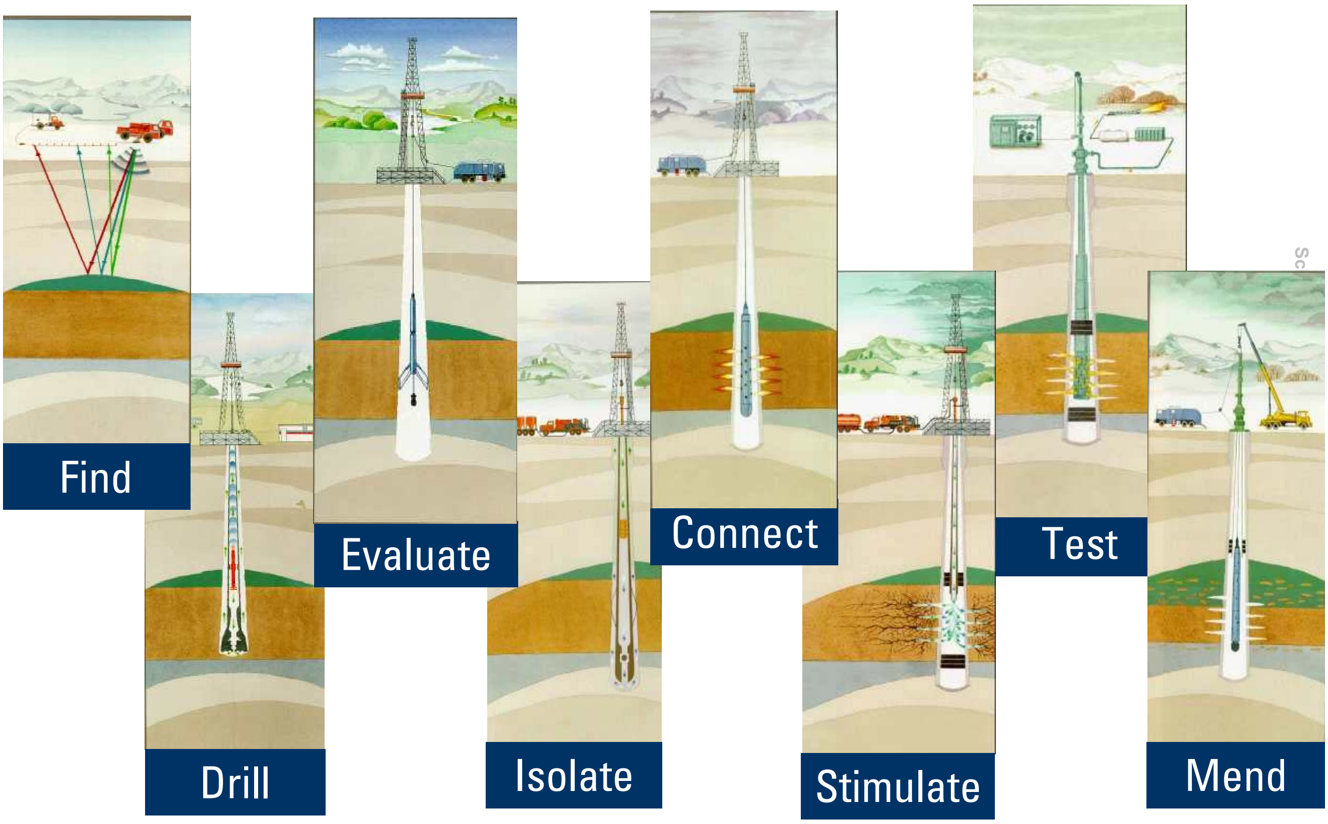
22 June 2005

The Business of Schlumberger

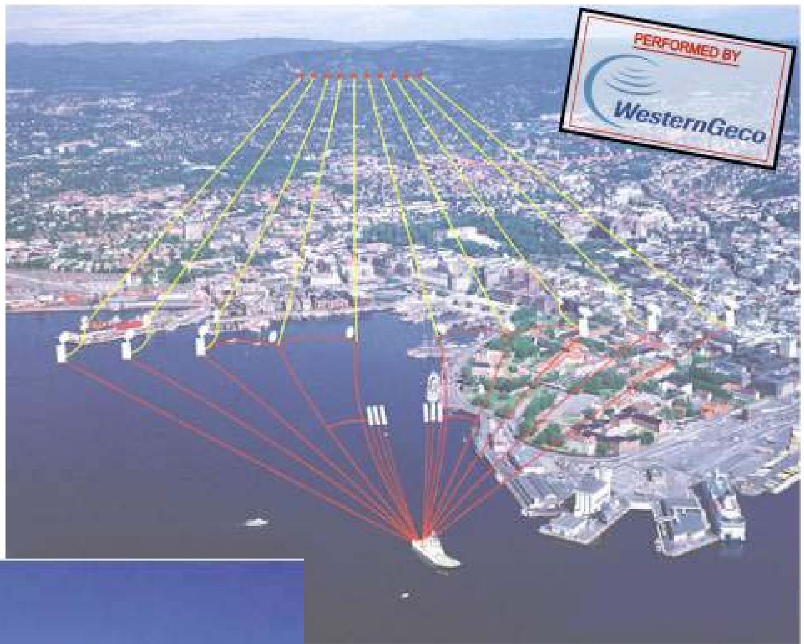


- The premier oilfield <u>services</u> company
- Founded in 1926
- Active in 110 countries
- $12B revenue (2004) – NYSE: SLB
- 55,000 employees
- 2 business groups: Oilfield Services, WesternGeco (30% Baker Hughes)

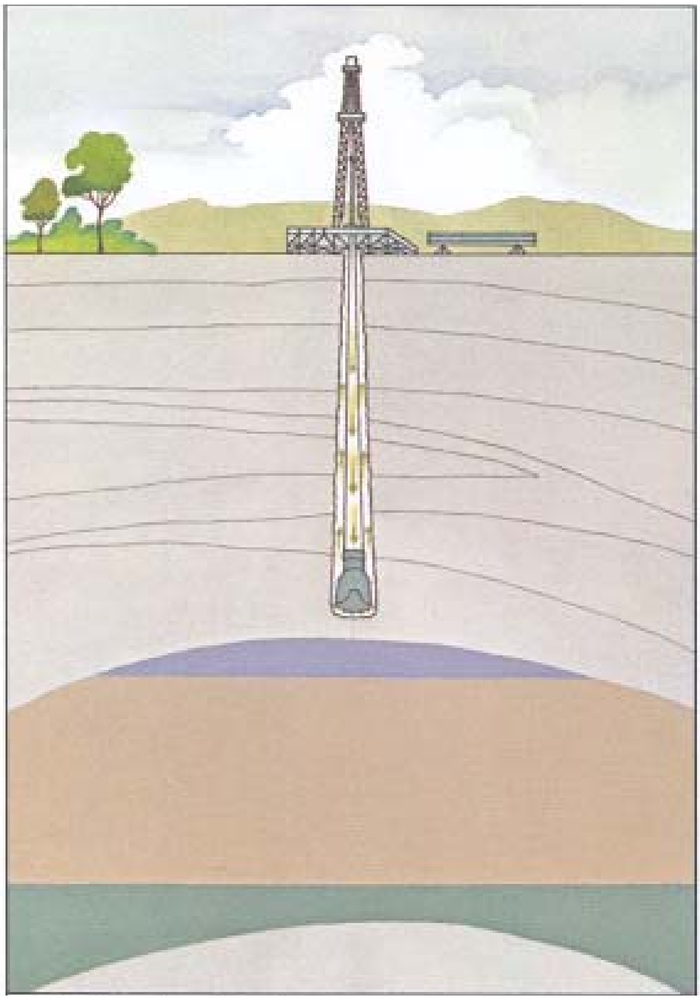
The Life of an Oil Well

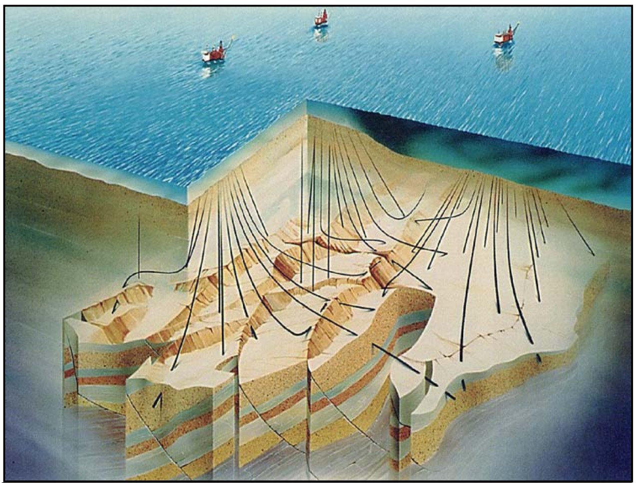


Seismic Exploration

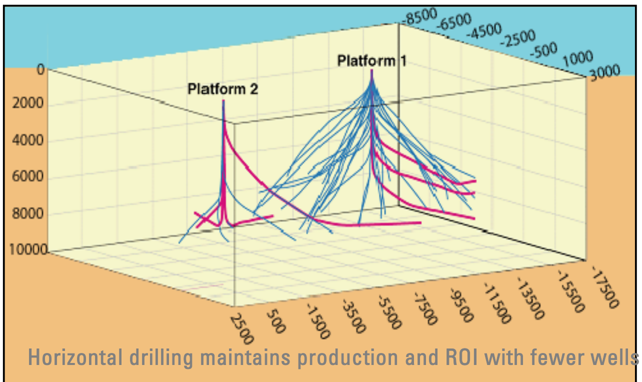


Drilling



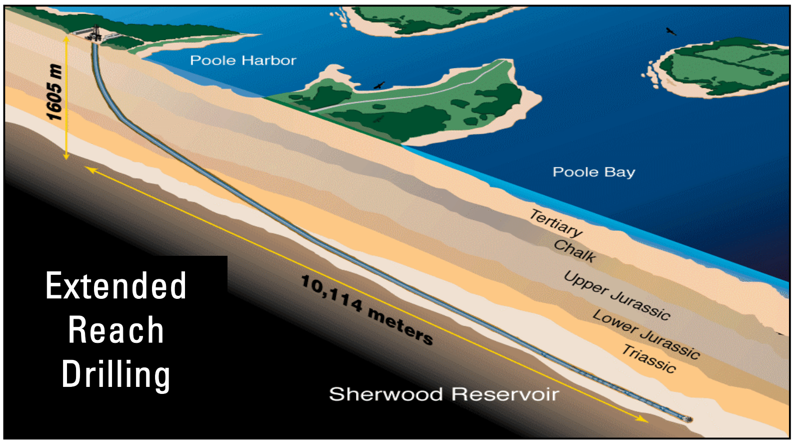


Access to each reservoir pocket

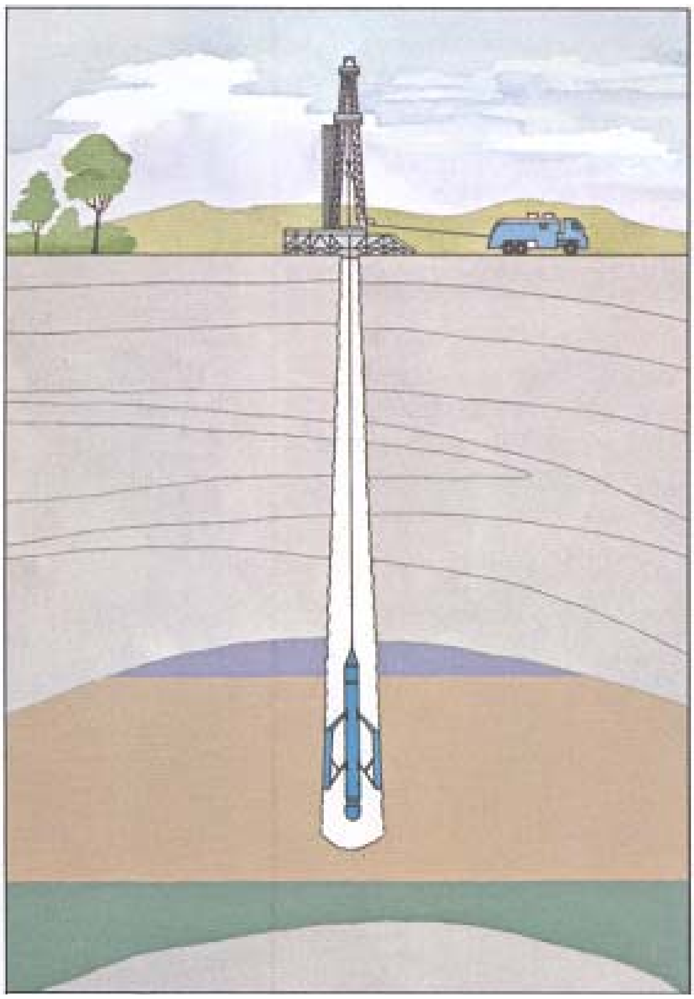


Minimum number of wells

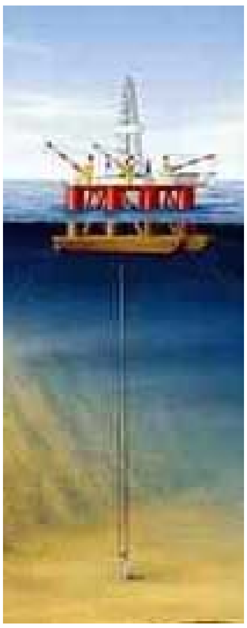
Directional Drilling



Wireline Logging



Vision for Autonomous Wellbore Robotics

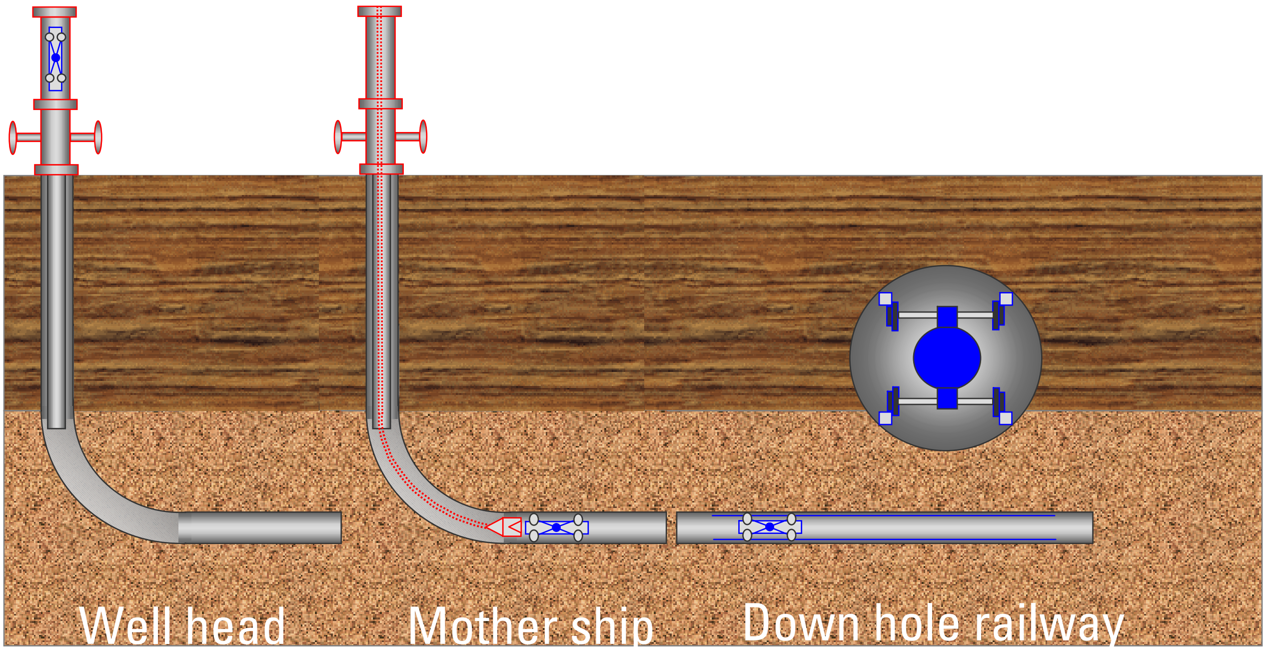


- Robotics give access where it is limited today
  - Subsea wells
    - Part of a Complete Monitoring and Control System
      - Place and replace fixed sensors and actuators
      - Perform well maintenance: water control, valve operation
      - Operate from boat instead of rig
      - Considerable reduction in cost of intervention
  - Extended reach / long horizontal wells
    - Beyond the range of tractors
  - Multi-lateral wells
    - Flexibility to access individual legs

Vision for Autonomous Wellbore Robotics

- Low-cost Well Logging
  - Easy deployment
    - Reduced logistics
    - One-man operation, no hookup costs
  - Simple operation
    - Drop robot into well head
    - Robot performs preprogrammed tasks
    - Robot retrieved later and data downloaded

Horizontal Well Deployment Method



Key Challenges

- POWER !
  - Particularly acute due to our environment and geometry
  - Limited space, long and thin form factor
  - High temperature, pressure, shock and vibration
  - Must always have enough power to trip out of the hole
- Navigation (no GPS)
- Control and reliability
  - Software: fail-safe, intelligent control software
  - Hardware: high-reliability electronic and mechanical system
  - Sensor: high-reliability sensing and unmanned data processing
- Industry acceptance
  - How do you persuade a client to let you “put that thing down the hole”?

An Example: *MicroRig*

MICRORIG

- Well workover tractor
  - 10 m long, 70 kg
  - Spec’d for 3000 m depth
  - Modular design
  - “Chain caterpillar drive”
- MIT / IS Robotics spinoff
- Consortium with Statoil, BP-Amoco, Marathon, Halliburton
- Started in 1999, tests done in 2002… development ended in 2003 (?)

For Further Information

Mike Barrett
Principal Research Engineer

Schlumberger Cambridge Research
High Cross
Cambridge, CB3 0EL, United Kingdom
Tel. 44 1223 325200
Fax 44 1223 467004
mbarrett @slb.com

Schlumberger

Hitoshi Tashiro
Sonic Product Line Manager

Schlumberger K.K.
2-2-1 Fuchinobe, Sagamihara
Kanagawa 229-0006, Japan
Tel. 81 42 759 5270
Fax 81 42 759 4016
tashiro1@slb.com

Schlumberger

Claude R. Baudoin
Information Technology Advisor

Schlumberger-Doll Research
320 Bent Street
Cambridge, MA 02141-2025, USA
Tel. 1 617 252 4702
Fax 1 617 252 4780
claude.baudoin@slb.com

Schlumberger

Object Management Group

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

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

Robotic Systems

Request For Information

OMG Document: *robotics/2005-06-06*

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 roughly be 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 outlook of a robotic system can be various such as mobile robots, humanoid robots, pet robots, manipulator robots, autonomous vehicles, robot house… 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… Finally, robotic systems deal with various technological fields and issues of various complexities such as hardware control, intelligent algorithms, information processing and dispatching, safety, reliability…

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

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

- ?? Determine where the need for standardization lays and set the 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 each potential RFPs

We are seeking information in the area of :

- ?? Identification of usage the Robotics Technology
- ?? Needs for standardization for the Robotics Technology
- ?? Technical information like existing implementations, standards, requirements, models, 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 might include but are not limited to :

2.2.1 Identification of usage of the Robotics Technology

1 – Give a brief explanation of your vision of the use of a robotic system
2 – What is your vision of the future trends of Robotics Technology

2.2.2 Needs for standardization for the Robotics Technology

1 – Provide one or several business use-cases in which the standardization of robotic components would be profitable
2 – Explain which part of a robotic system you wish 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, how would you like it to evolve to best match you 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. Also requirements related to software-based control technologies (compatibility, platforms, etc) are of interest as responses to this RFI.

2.2.4.4 Models

Of special interest for the purposes of this RFI is the reception of 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, theoretical analyses of object-based, distributed robotics systems performance are of major interest as potential responses to the RFI.

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 might include but are not limited to the following points. It is also 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 be 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 exchange data ?

2.3.1.3 Command Flow

What invocation method (RPC, message…) 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 with a block diagram of the entities found in you robotic system.

2.3.2.2 *Common Data Structures (like Images, Laser scan, 3D position…)*

What data structures are you commonly using ?
What are the meta-rules for defining data structures exchanged between entities in the system ?
How do you convert data of different formats ?

What is your unit system ?

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 well defined custom interface or minimal interface with differentiation only by the type ingoing/outgoing data) ?
What are the meta-rules for defining sensors, actuators, 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 an 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 they are capable of ? 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 capababilites of several components in order to create novel capabilities ?

2.3.2.4.4 Monitoring

To which 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 you manage conflicting requests on physical resources ?

2.3.2.4.8 Safety Management

Did you define any safety procedure 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 detects 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 RT Services

We call an RT Service a centralized functionality offered by a unique component in the system and that will help other components work together. We provide the list below to give the reader examples of some of the main RT services. Respondent to this RFI shall feel free to address any/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 an 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 being main capabilities. Respondent to this RFI shall feel free to address any/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 as for the time being, we do not intend to issue any standard concerning them. However, any input 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 OMG issues a subsequent Request 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. Explain your usage of the Robotics Technology.

Part 2. Explain your needs for standardization for the Robotics Technology

Part 3. Address the technical topics related to Robotics Technology

While all respondents do not have to address all three topics, this is the order that the Robotics DSIG expects them to be addressed.

Also, this effort is geared toward future standardization in the area of reusability and interoperability for robotics technology and is by no mean 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_iiop.htm*.

Data Acquisition form 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 form 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,

Comments form AB buddy Stephen Mellor

17 June 2005

Robotics-DSIG

Comment 1:

In the following: "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." What does the second sentence mean? How can your specific Robot work promote use in other markets?

Comment 2:

"If the need arises, write a white paper summarizing the state-of-the-art in the field of robotics technology" takes away from the first three bullets, which are very strong. (Top of page 4)

Comment 3:

An RFI, by it's nature, is open-ended. However, this RFI seems to me to ***very*** broad. Are there any specific areas that you wish to emphasize? For me, the key elements are the bullets (except the last one) on pg 4 just above section 2.2. But for every area of Robotics?

Comment 4:

Under sec 2.2, Detail, I think item (1) is not necessary.

Comment 5:

Many of the detailed topics in Sec 2.2 are not specific to Robotics. I think the RFI would be stronger if you deleted as many as you can.

From my point of view

Comments 3 and 5 go together and are the most important. If you do not focus the RFI a bit more, you will get responses that vary so widely you will not be able to make them coherent.

Technical Roadmap for Robotic Standards

An Architectural Approach

Hui-Min Huang
hui-min.huang @nist.gov

OMG Technical Meeting
June 22, 2005

Outline

1. Objectives
2. Robotic Standards Technical Framework
   A. Existent Generic Frameworks/Infrastructures
   B. Proposed Robotic Standards Framework
3. Existent Standards Efforts Potentially Supporting Framework
4. Recommendations/Summary

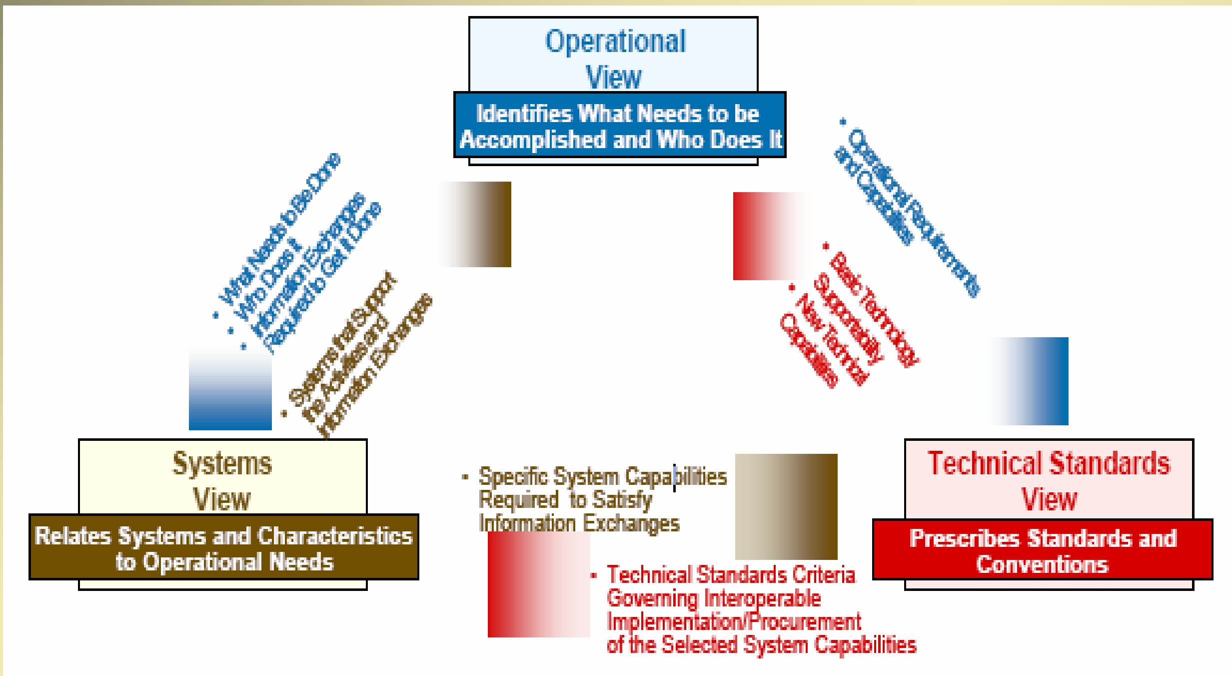
1. Objectives

- A reference technical framework to serve as a basis for Robotic Standards Technical Roadmap
- Systemaically identify robotic standards technical areas and types--adopt existent work as feasible

2.A. Generic Architectural Infrastructures

- DODAF/MODAF
- SAE GOA/DOD TRM
- ISO OSI
- JTA/DISR
- …

2.A. Department of Defense Architecture Framework (DODAF) and UK's Ministry of Defense Architecture Framework (MODAF)



2.A. DODAF Operational View (OV)

Description of the tasks and activities, operational elements, and information exchanges required to accomplish missions.

2.A. DODAF Operational View (OV)

- High-Level Operational Concept
- Operational Node Connectivity
- Operational Information Exchange Matrix
- Organizational Relationships
- Operational Activity Model, Rules Model, State Transitions, and Event-Traces
- Logical Data Model

2.A. DODAF Technical View (TV)

Provides the technical systems implementation **guidelines** for:

- developing engineering specifications
- establishing common building blocks
- developing product lines

Includes a collection of the technical **standards** / options and implementation conventions, rules, and criteria.

2.A. DODAF Systems View (SV)

Describes systems and interconnections supporting the operational activities.

2.A. DODAF Systems View (SV)

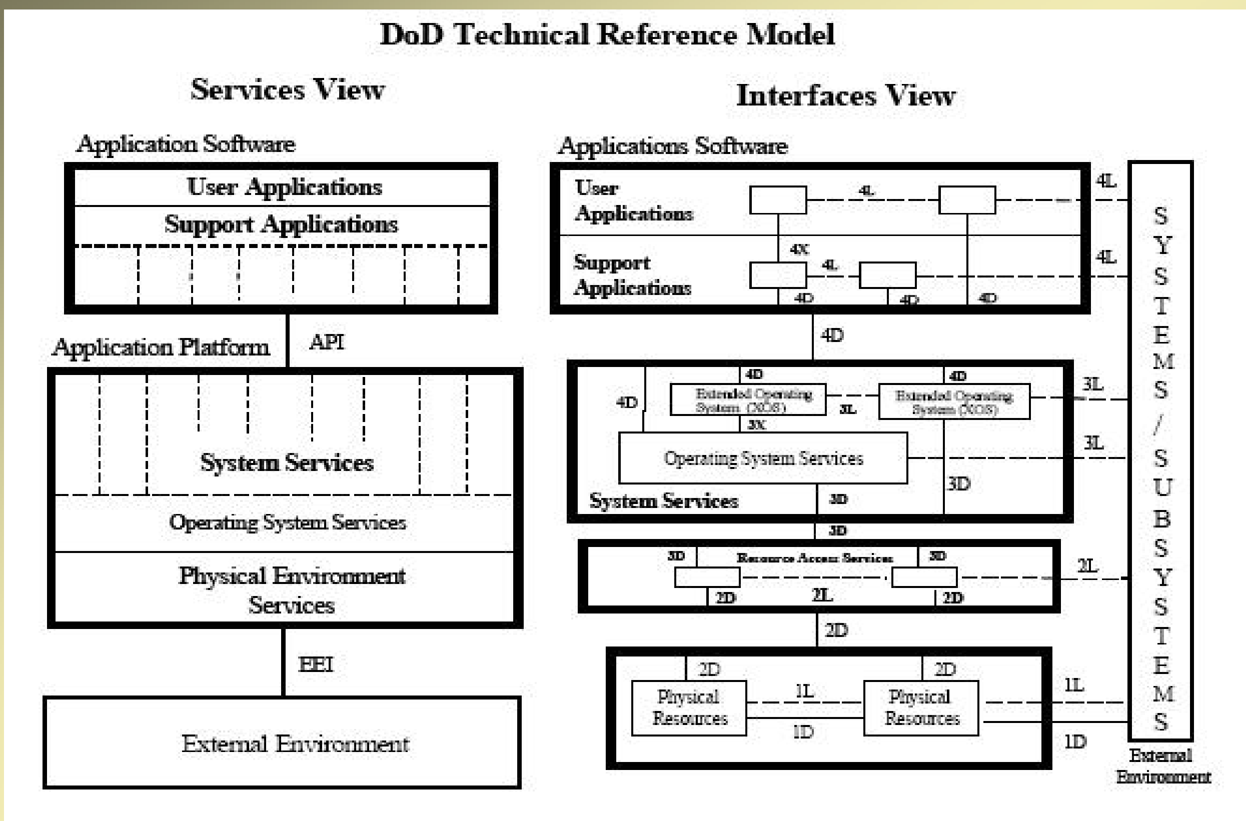
- Systems Interface and Communications, Systems-Systems Matrix
- Systems Functionality
- Mapping Operational Activities to Systems Functions
- Systems Data Exchange Matrix
- Systems Performance Parameters
- Systems Evolutions and Technology Forecast
- Systems Rules, State Transitions, and Event-Traces
- Physical Schema

2.A. DODAF All View (AV)

For perspectives concerning all views:

- Overview and Summary
- Dictionary

2. A. Standard Architectural Layers: GOA/TRM



2.A. Standard Architectural Layers

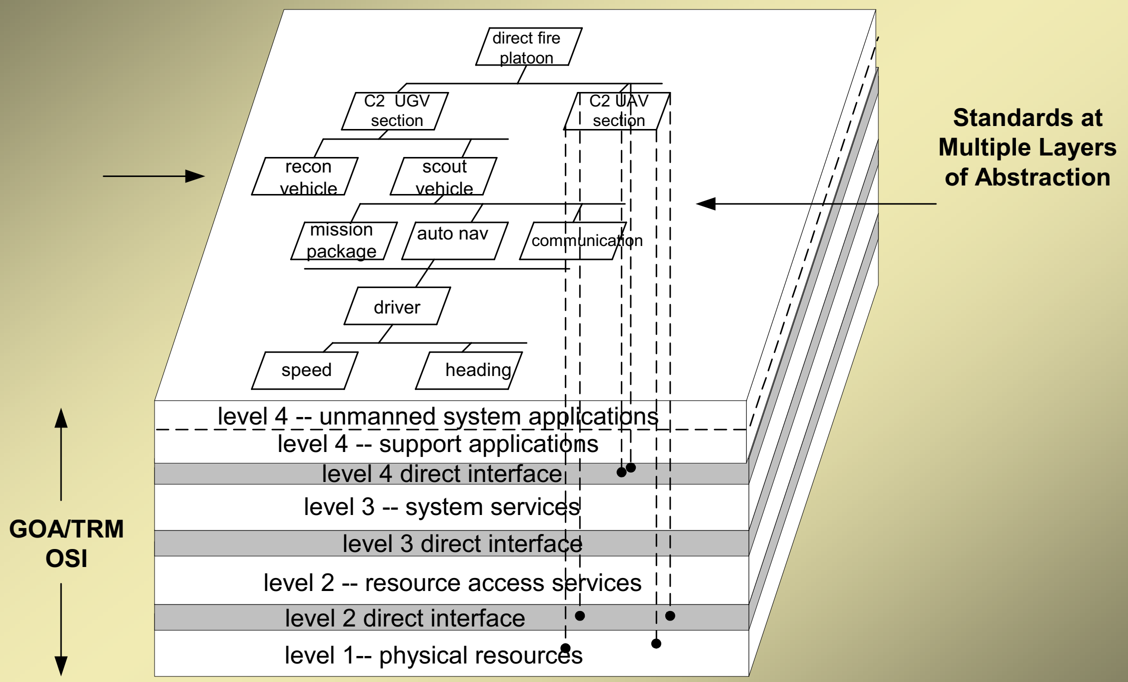
```
OSI                                  TCP/IP
----                                 -------

Application -----¥
                  ¥
Presentation ------+-------------   Application
                  /
Session  --------/


Transport -----------------------   Transport

Network -------------------------   Network

Datalink ---------¥
                   +-------------   Link
Physical  --------/
```

Ref: JAUS Transport Spec.

2.B. Proposed Robotic Standards Framework

- Terminology
- Architectural elements
- Performance metrics

2.B. Proposed Robotic Standards Framework



Standards Based Unmanned System Architecture

3. Existent Standards Efforts Potentially Supporting Standards Framework

A. Terminology

B. Architectural elements

C. Performance metrics

3.A. Toward Robotic Standards:

Terminology/Taxonomy/Ontology

- Terms
- Definitions
- Characteristics
- Categorization

3.A. Robotic Standards Taxonomy

Categorization

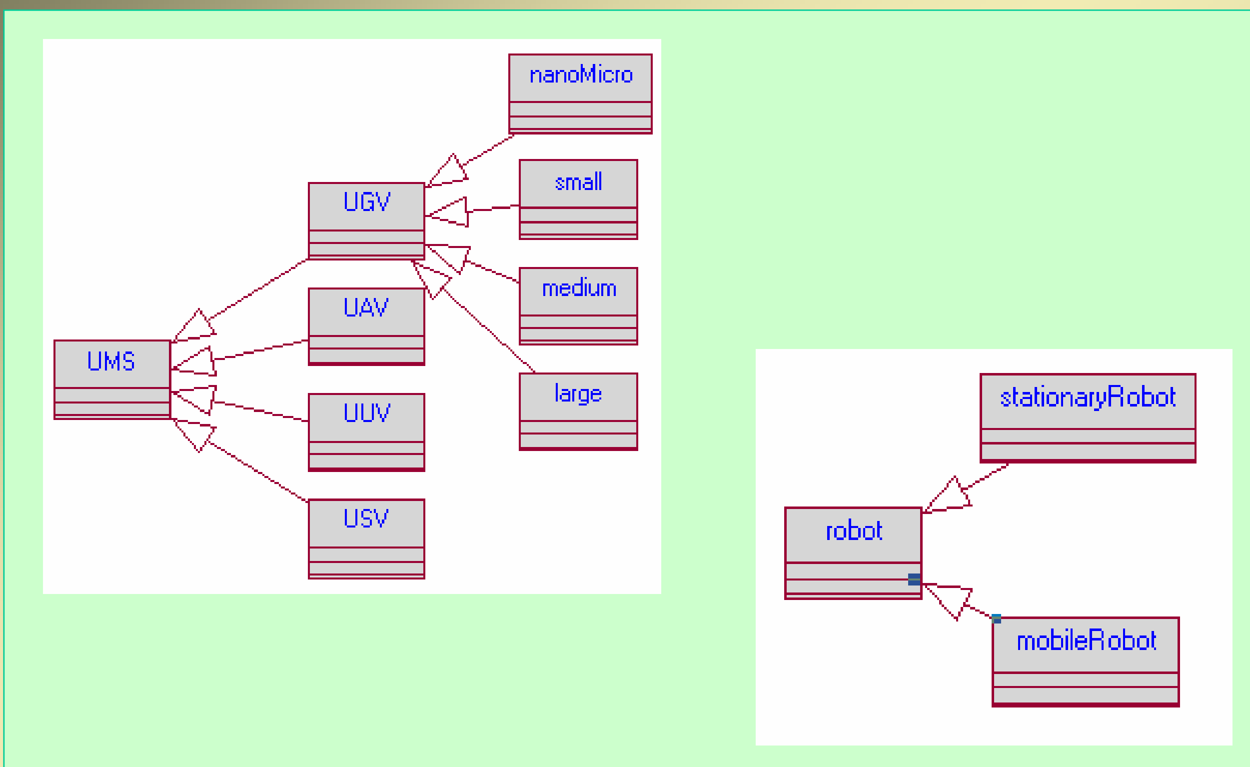
- Industrial robot
- Service robot
- Unmanned systems
  - Military
  - Urban search and rescue
  - Transporation
  - …

3.A. Robotic Categorization

Industrial robots (ASTM F1034-86)

- types of power sources or control,
- payload,
- mechanical configuration,
- DOF,
- application,

3.A. TOWARD UMS TAXONOMY Categorization



TAXONOMY/ONTOLOGY? TERMS AND DEFINITIONS

ROBOT: An electro-mechanical system that can react to sensory input and carry out predetermined missions. … equipped with … tools or certain capabilities (and knowledge) … react to different situations …

UNMANNED SYSTEM (UMS): A electro-mechanical system, with no human operator aboard, that is able to exert its power to perform designed missions. May be mobile or stationary

NIST Special Pub 1011:

http://www.isd.mel.nist.gov/projects/autonomy_levels/publications/NISTSP_1011_ver_1.1.pdf

INDUSTRIAL ROBOT: **An automatically controlled, reprogrammable multipurpose manipulator, programmable in three or more axes which may be either fixed in place or mobile for use in industrial automation applications. ANSI/RIA R15.06-1999**

3.A. Robotic Standards Framework: Terminology References

- Autonomy Levels for Unmanned Systems Framework, Volume I: Terminology, Version 1.1, NIST Special Publication 1011
- SAE Aerospace Information Report: JAUS Transport Specification (SAE AIR5645)
- …

3.B. Framework Architectural Elements:

UML Profile for DODAF/MODAF (UPDM) RFP

RFP is for a UPDM that satisfies the representations for the DODAF/MODAF views and products for modeling of the systems architecture (Systems View) along with their associated standards (Technical View) within the context of the business or enterprise architecture (Operational View).

3.B. Architectural Elements for Standardization

- Technical systems implementation guidelines for establishing common building blocks (DODAF TV).
- Tasks and activities, operational elements, and information exchanges. Information flows/frequency between nodes (DODAF OV).
- Systems and interconnections supporting the operational activities and facilitating the exchange of information among operational nodes (DODAF SV).

3.B. Existent Candidates

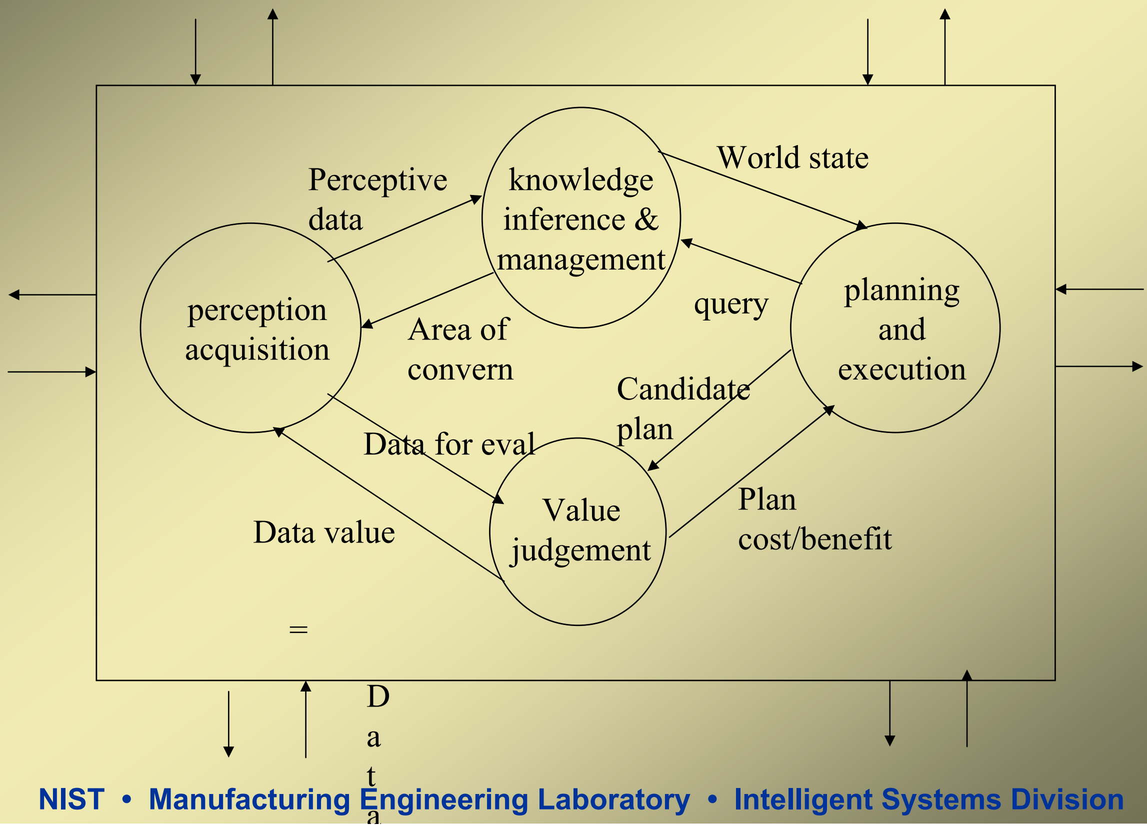
- NIST 4D/RCS Reference Architecture
- JAUS
- …

3.B. Standard candidate: NIST 4D/RCS Reference Architecture

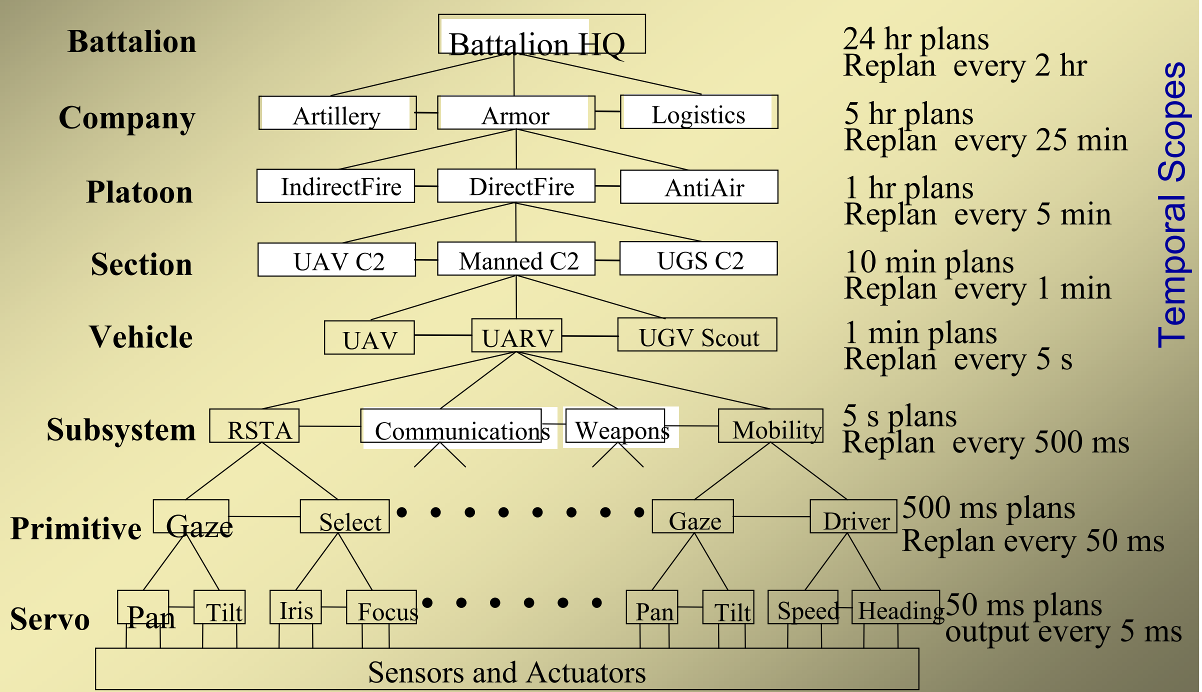
- Generic building block (DODAF TV).
- Generic interface (DODAF OV).
- Generic information flow model (DODAF OV).
- Guidelines for implementation (DODAF TV, SV).

NIST • Manufacturing Engineering Laboratory • Intelligent Systems Division

3.B. Standard candidate: Generic Building Block



Large Robotic Unmanned System Example based on 4D/RCS



4D/RCS Implementation Reference Model

Part I: Controllers

Complement MDA

Product/Company Disclaimer:
Certain commercial products or company names are identified in this document to describe our study adequately. In no case does such identification imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the products or names identified are necessarily the best available for the purpose.

3.B. Standard candidate: 4D/RCS Implementation Guidelines

Process/Methodology :

- Operation analysis and scenario identification
- Task analysis and decomposition
- Behavior analysis and specification for the tasks
- Actuator specification in support of the tasks
- Knowledge analysis in support of the tasks and behaviors
- Perception processing analysis in support of the knowledge requirements
- Sensory specification in support of the perception requirements

http://www.isd.mel.nist.gov/projects/rcs/

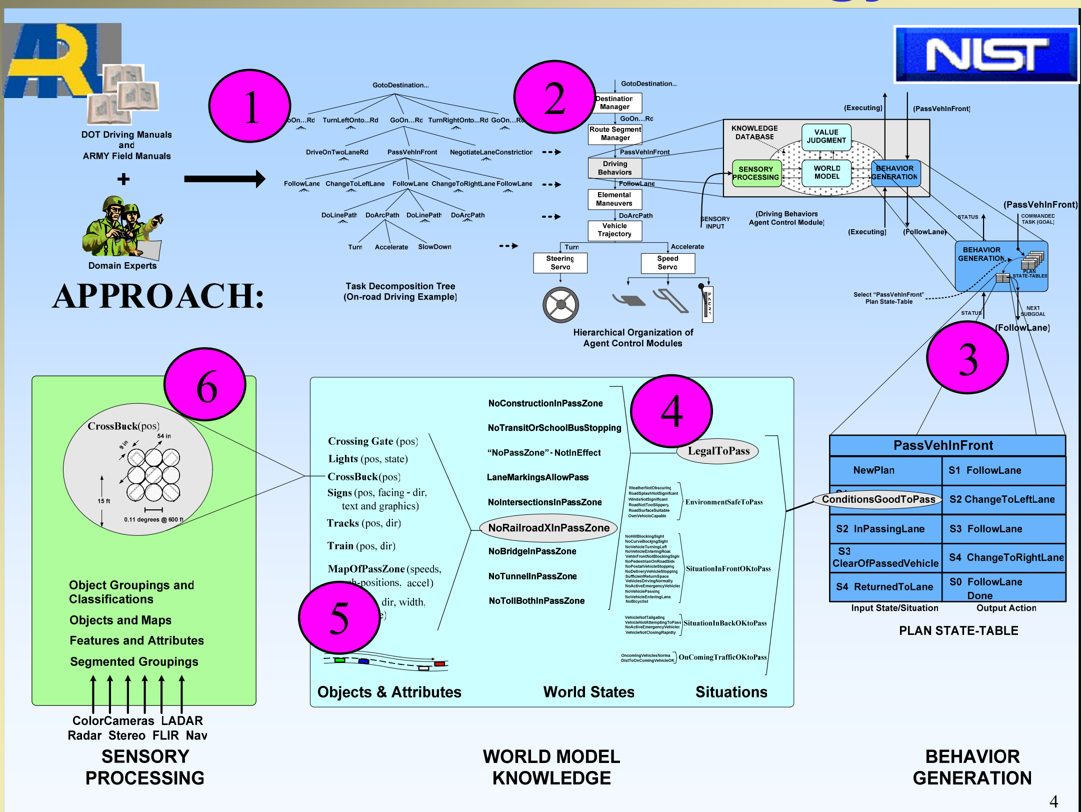
3.B. Standard candidate: 4D/RCS Implementation Guidelines

Characteristics:

- Hierarchical, task-based system design & control
- Manages complexity through multiple spatial, temporal resolutions
- Software engineering benefits
  - Templates, classes, interfaces, reuse, interoperability

http://www.isd.mel.nist.gov/projects/rcs/

4D/RCS Methodology



4D/RCS

Provides an integrated framework that supports intelligent robotic standards in the areas of: architecture, interoperability, communication, software reuse, performance,

3.B. Standard candidate: JAUS

```
    OSI                    TCP/IP             JAUS
     ---                   ------             ----

Application -----¥
                  ¥
Presentation ------+--- Application ------- Messages
                  /
Session  --------/
                                              /---- Network
                                             /      Environment
Transport ------------ Transport ------+¥
                                        ¥---- Transport
Network -------------- Network -------------/
                                           /
Datalink ---------¥                       /
                   +--- Link ------------/
Physical  --------/
```

3.C. Performance Metrics and Testing Methods Standards

- ALFUS/PermFUS
- Performance Standards for Robots

3.C. Performance Metrics Standards

Autonomy Levels for Unmanned Systems (ALFUS)

⇓

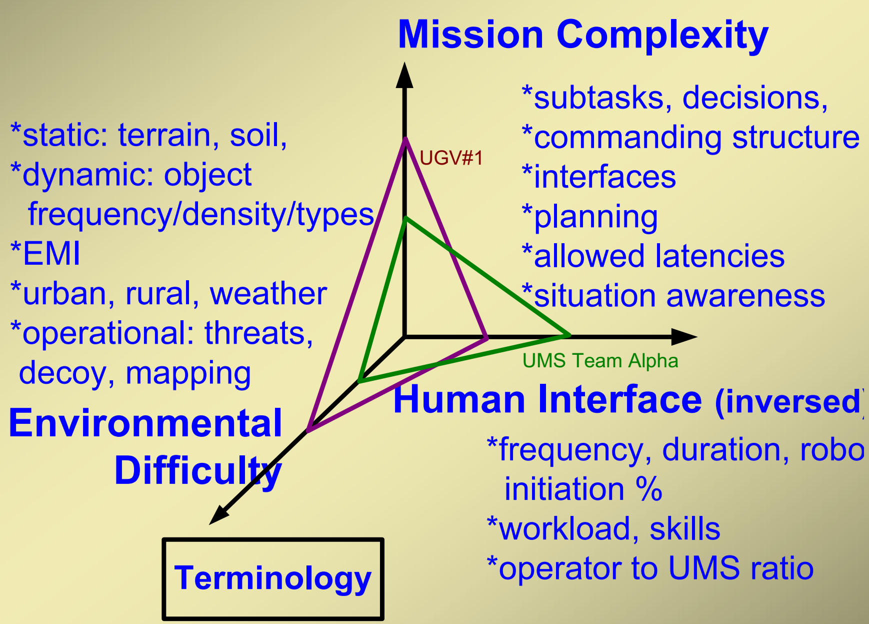
Performance Metrics Framework for Unmanned Systems (PerMFUS)

http://www.isd.mel.nist.gov/projects/autonomy_levels/

ALFUS OBJECTIVE / USER NEEDS

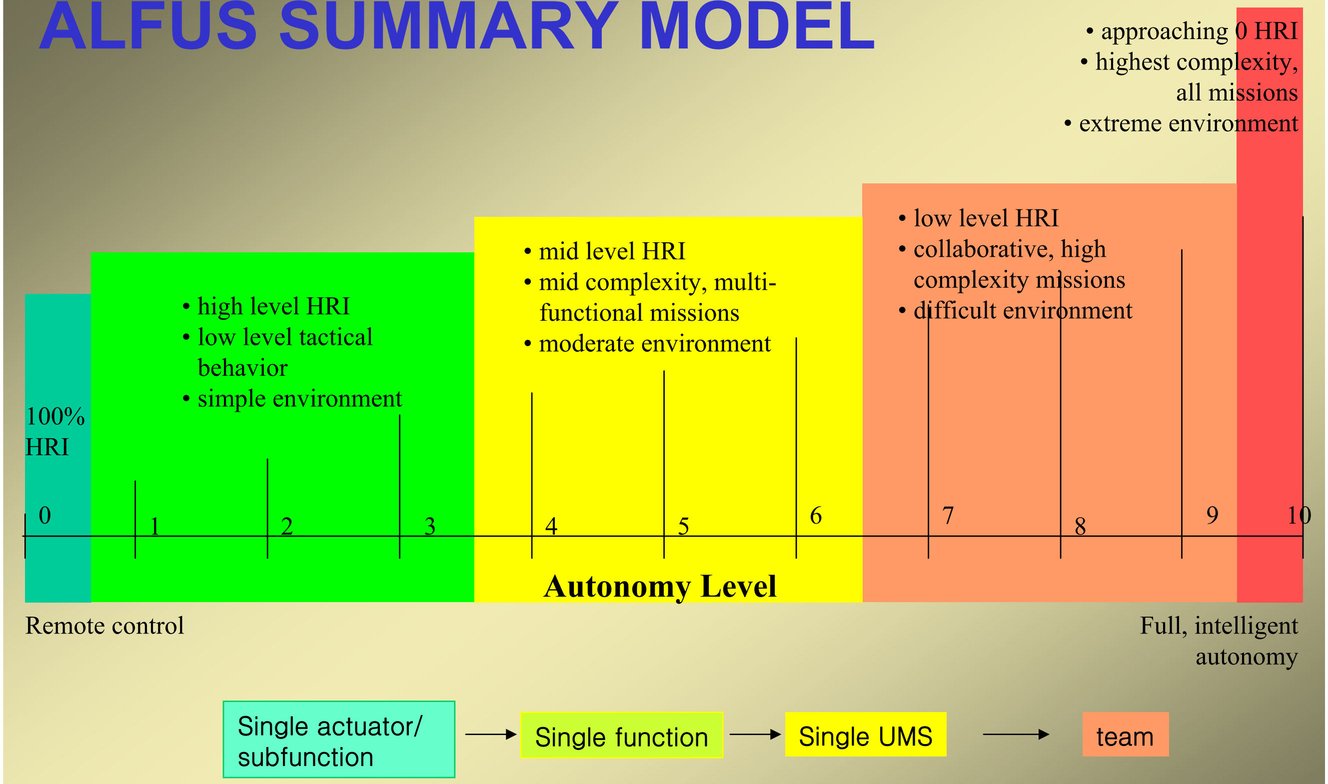
- Standard terms and definitions for characterizing the levels of autonomy *and performance requirements* for unmanned systems.
- Metrics, methods, and processes for measuring autonomy *and performance* of unmanned systems.

ALFUS DETAILED MODEL



NIST • Manufacturing Engineering Laboratory • Intelligent Systems Division

ALFUS SUMMARY MODEL



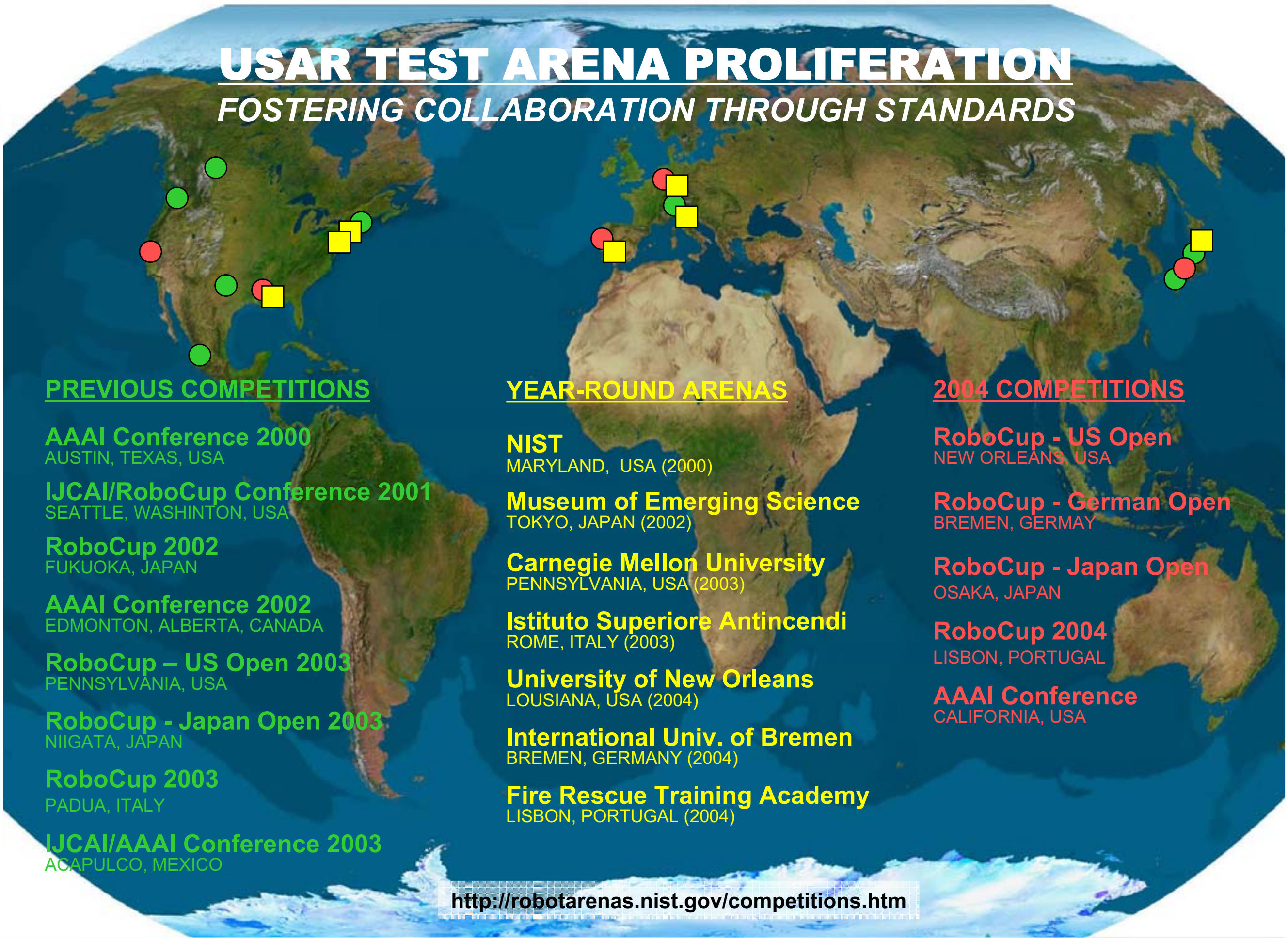
Performance Metrics and Standards for DHS Urban Search and Rescue Robots

FY04-FY10 NIST-Led National Program

Goal:

Develop comprehensive standards for the development, testing, and certification of effective technologies for sensing, mobility, navigation, planning, integration, operator interaction within search and rescue robot systems . . .

enabling DHS to provide guidance to local/state/federal homeland security entities regarding purchase, deployment, and use of these emerging tools



Initial access categories: 2 inch bore hole, 24 inch triangular hole, doorway, and aerial



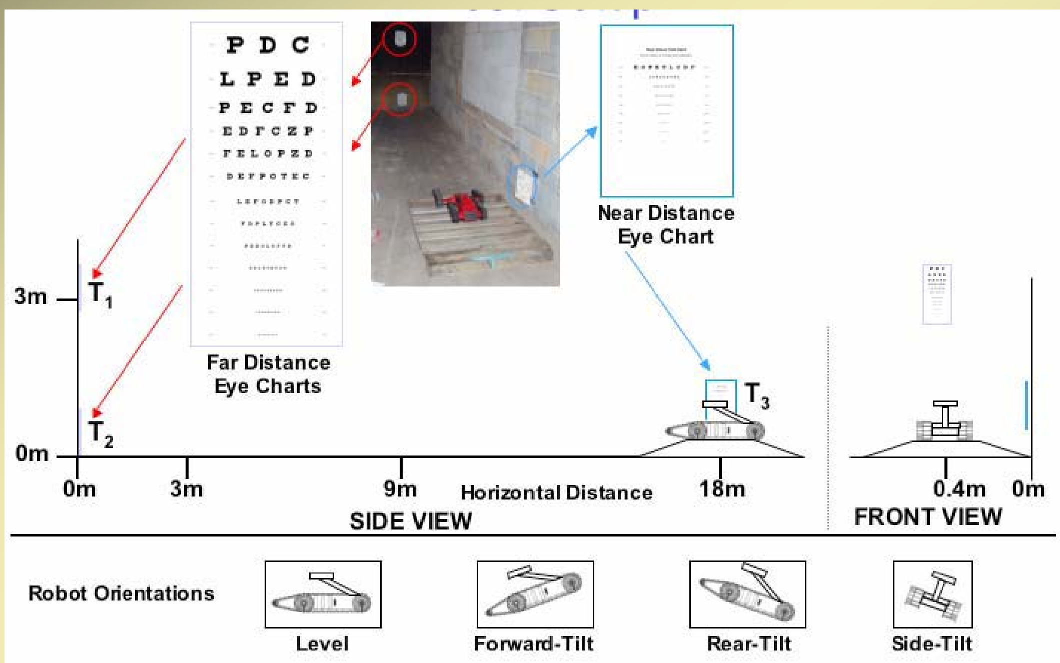
US&R Performance Metrics Standards

performance requirements and test methods

category	element	requirements
Chassis	Illumination	Adjustable
Communications		Security
Communications		Range: Beyond Line of Sight
Communications		Range: Line of Sight
Sensing	Real-Time Video	Real time remote video system (near/far)
Sensing	Real-Time Video	Field of View

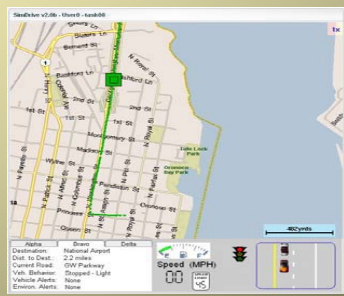
US&R Performance Metrics Standards

performance requirements and test methods



Human robot interaction (HRI) at NIST

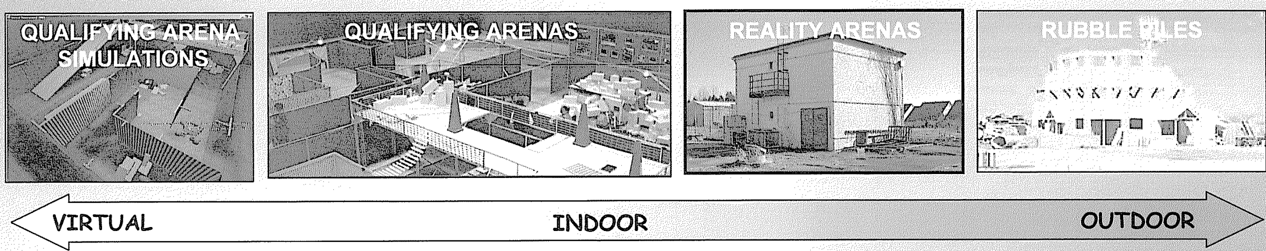
- Goal: develop standards for HRI, metrics and evaluation methodologies in order to save developmental costs, training costs, and promote more effective use of robots
- Methodology:
  - investigate effective and efficient user interactions in domains of:
    - USAR
    - EOD
    - On-road driving
    - Off-road driving
  - Collect and analyze data at USAR competitions, technical readiness level assessments
  - Develop prototype user interfaces and conduct laboratory studies



Both the USAR and EOD Projects Leverage the Existing Reference Test Arenas for Urban Search and Rescue Robots

DARPA

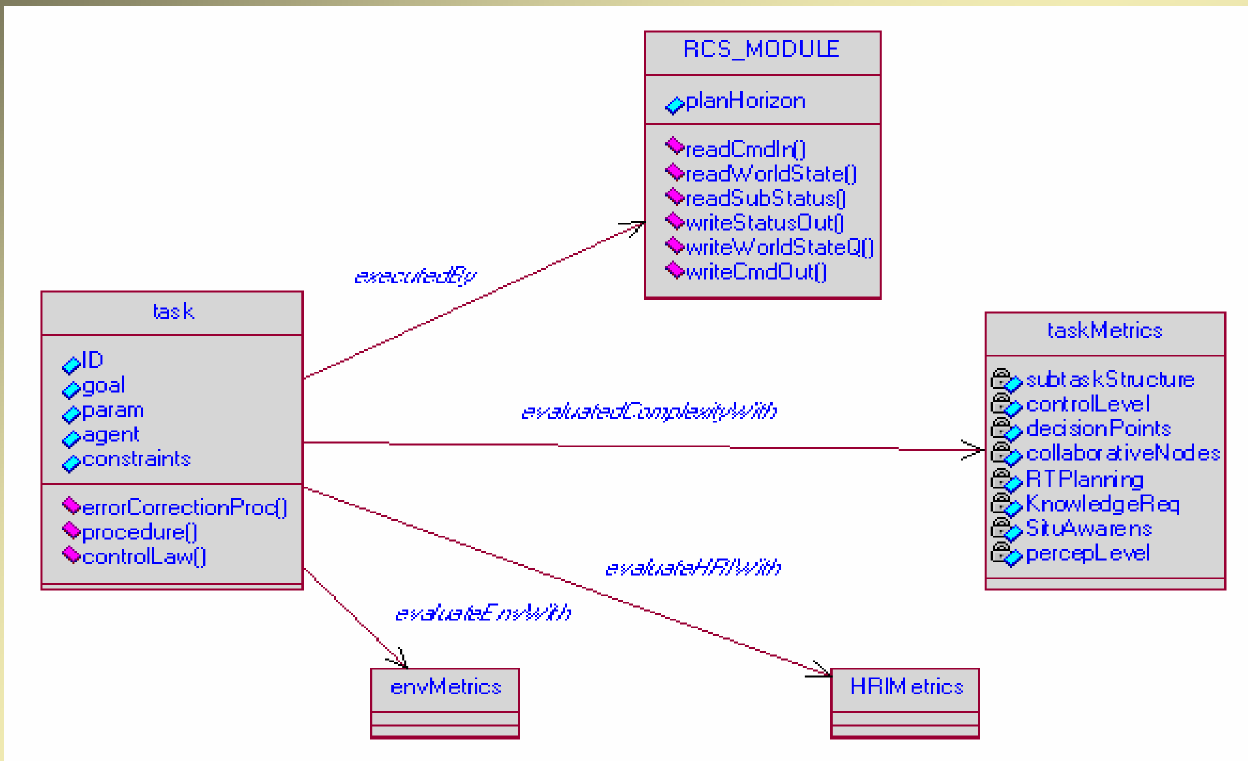
A facility to accelerate the advancement of mobile robot capabilities and provide a stepping stone from research to deployment



Allowing…

- *Objective evaluation of robotic components and methods*
- *Development of performance metrics and standards*
- *Collaboration among robotics researchers*

3. TOWARD UMS TAXONOMY/ONTOLOGY
Integrated Relationships



4. Summary/Recommendations
Standards Benefits

- Interoperability
- Component reuse
- Plug-and-play

NIST • Manufacturing Engineering Laboratory • Intelligent Systems Division

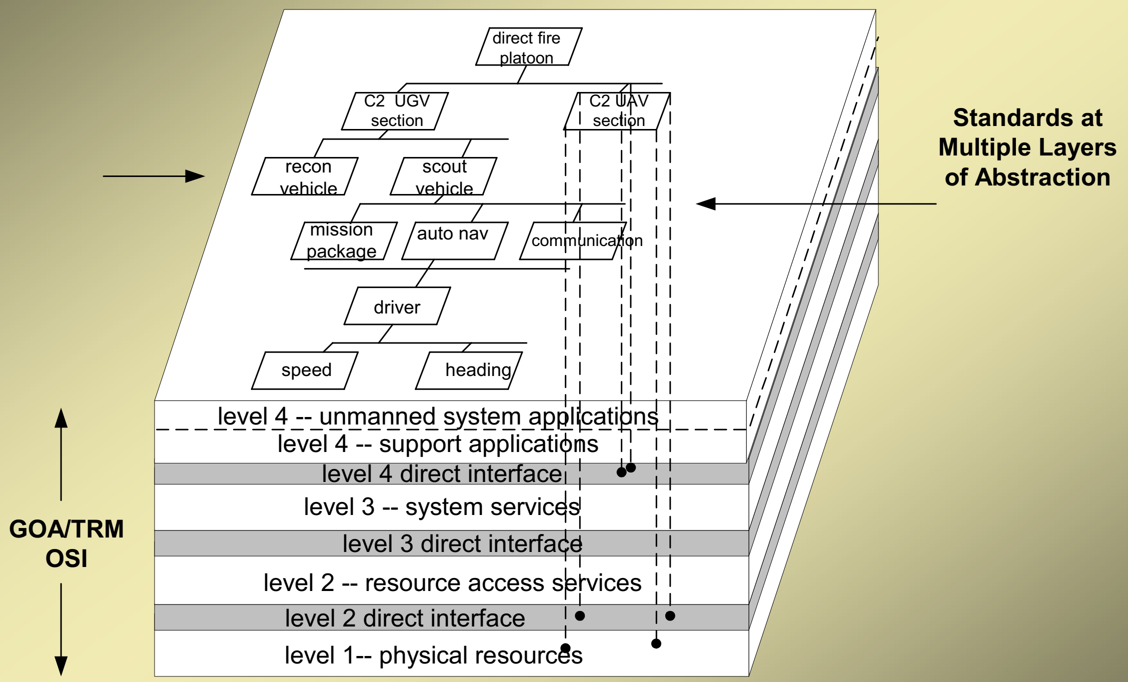
4. Summary/Recommendations standards areas

- Industrial robot
- Service robot
- Unmanned systems
  - Military
  - Urban search and rescue
  - Transporation

4. Summary/Recommendations standards areas

- Reference archietctures
- Performance metrics

4. Proposed Robotic Standards Framework



Standards Based Unmanned System Architecture

4. Summary/Recommendations

- Generic Framework for Identifying Robotic Standards Areas
- Standards Candidate Identification
- Performance Metrics and Standards are important.

Would be glad to participate, contribute, and collaborate!

Thank You!

http://www.isd.mel.nist.gov

hui-min.huang@nist.gov

2.B. Approach

Generic Frameworks:

A. Reference Architecture

B. Performance Metrics

Supporting Standards and Metrics for Intelligent Robotic Systems

Raw material

ALFUS TERMINOLOGY

Autonomy Levels for Unmanned Systems (ALFUS) Framework

Volume I: Terminology

Version 1.1

NIST Special Publication 1011

http://www.isd.mel.nist.gov/projects/autonomy_levels/publications/NISTSP_1011_ver_1.1.pdf

IV. Observations/Position for Robotic Standards

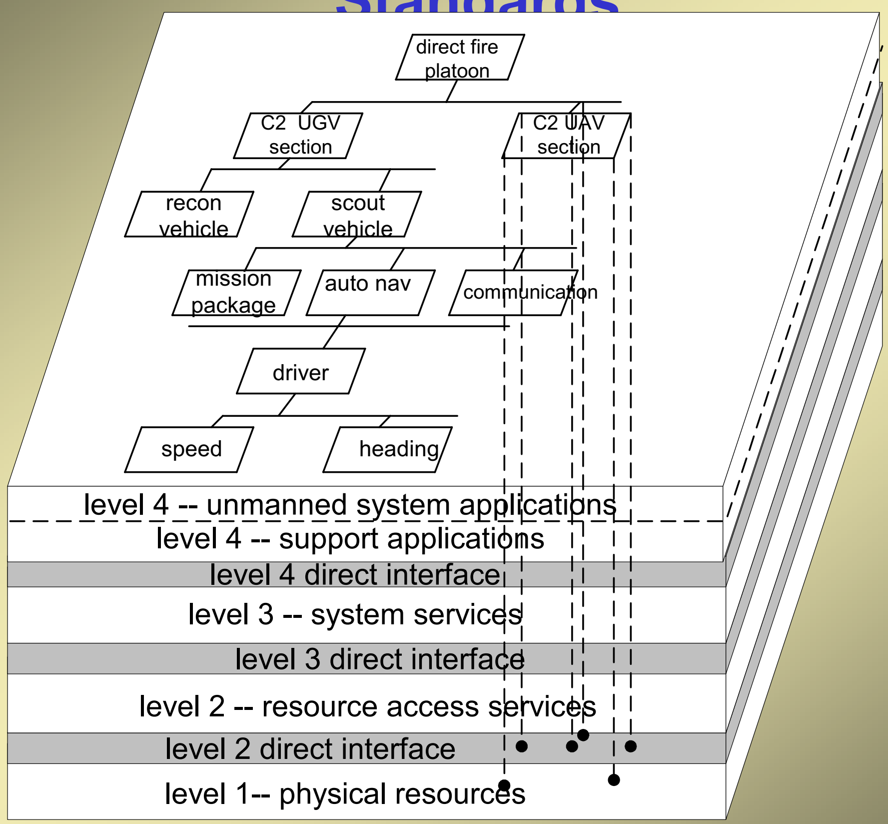
A. Generic Architectural Frameworks

B. Performance Metrics Framework

C. Taxonomy/Ontology

Standards Framework

4D/RCS Architecture Facilitating Standards

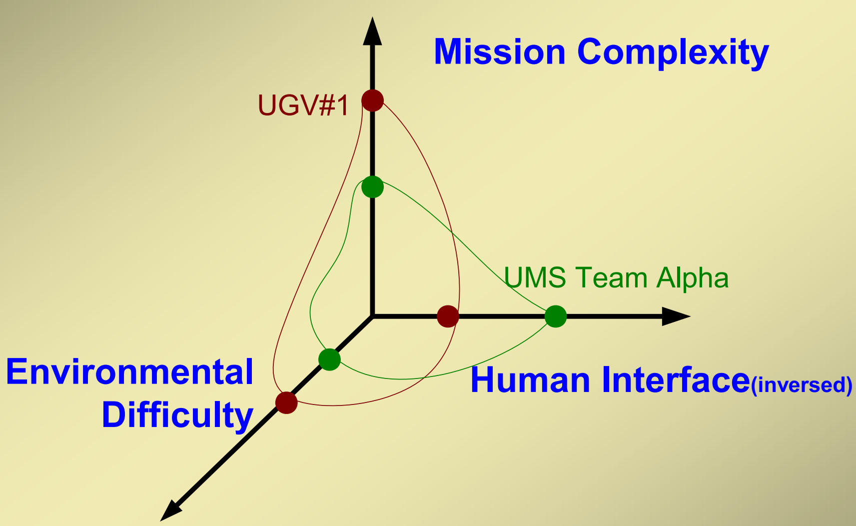


SAE GOA/ DOD TRM

Reference Model

- Systems, functions, entities, events, relationships
- Interaction and information flow between systems and subsystems
- Representations for knowledge, goals, plans, tasks, schedules, intentions, beliefs, values
- Housing for methods of perception, attention, cognition, reasoning, modeling, and learning

PERFORMANCE METRIC FRAMEWORK FOR UNMANNED SYSTEMS



Technical View (TV)

- TV-1 Technical Standards Profile
- TV-2 Technical Standards Forecast

2.A. DODAF Operational View (OV)

Description of the tasks and activities, operational elements, and information exchanges required to accomplish missions.

Identification of the operational nodes and elements, assigned tasks and activities, and information flows required between nodes. The frequency of information exchange, which tasks and activities are supported by the information exchanges, and the nature of information exchanges.

Middleware Technology for Robotics: Robot Software Communications Architecture (RSCA)

June 22. 2005

Jaesoo Lee

Real-Time Operating Systems Lab
Seoul National University

Http://redwood.snu.ac.kr

Outline

- Introduction
- Experiences with Robotics Middleware Technology
  - What is RSCA's Deployment Middleware ?
  - RSCA vs. Legacy Robot SW Architecture
  - Implementation and Performance Evaluation of RSCA
- Conclusion

Introduction: Challenges and Our Approach

- Robot development is facing SW crisis.
- Challenges of robot SW stem from 'complexity'.

interoperability
reusability
reconfigurability

- Systematic robot SW development with "Reuse & Abstraction" principles
  - Platform-based development
  - Model-based development
  - Component-based development
- Standardized robot SW architecture

Introduction: Challenges and Our Approach

- Standards for robot SW architecture
  - Operating environment
    - Standard real-time operating system
    - Standard distribution middleware
    - Standard deployment middleware
  - Application component interfaces
    - Standard robot component types
    - Standard robot service components
  - Standard layering method

Experiences with Middleware Technologies Applied to Robotics

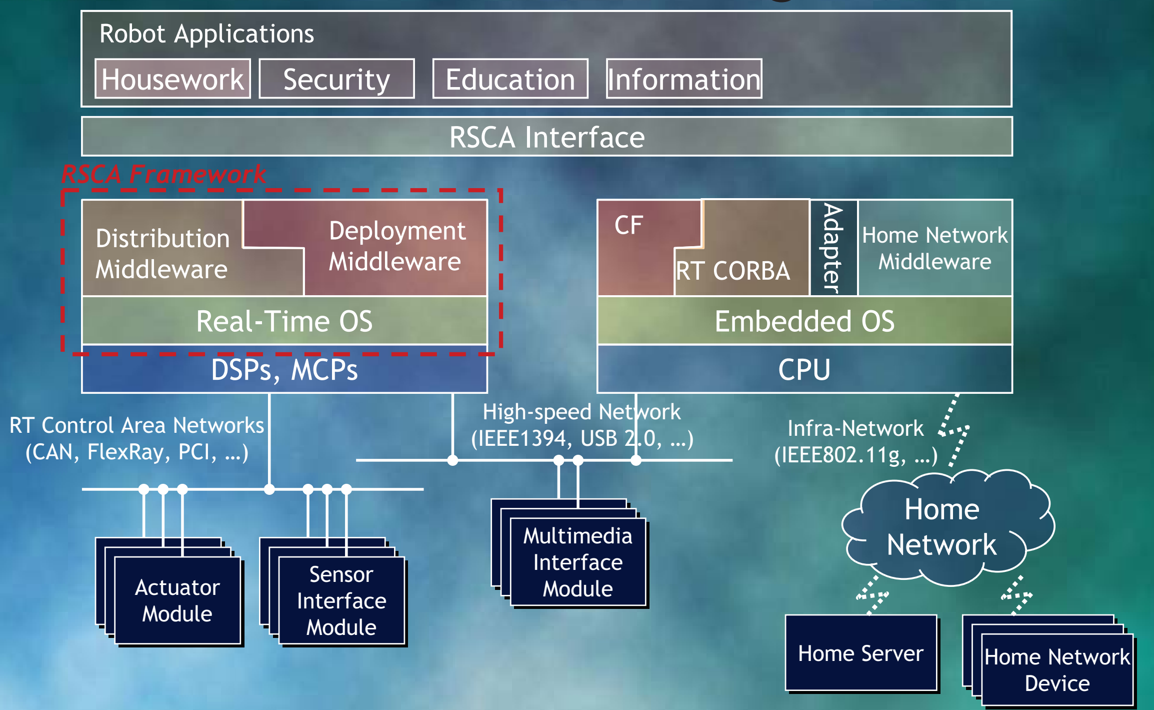
Seoul National University
RTOS Lab

RSCA Framework for Robot Software

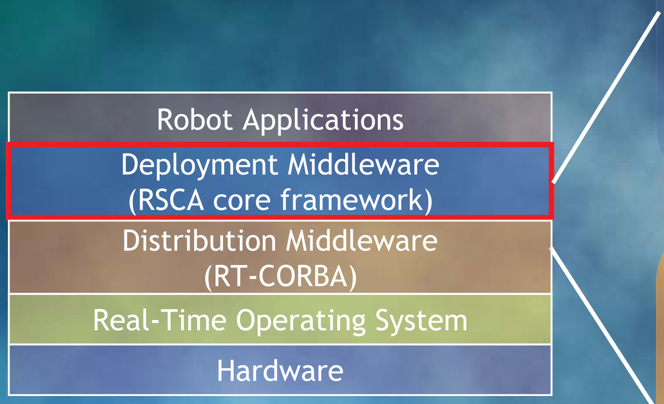
- We are developing standards for a robot middleware based on existing distributed object technologies
  - SCA
    - Defined by Joint Tactical Radio Systems (JTRS)
    - De facto standard middleware adopted by Software Defined Radio (SDR) forum
    - OMG also adopted it and is making the Software Based Communications standard
    - Basis for our standard
  - CORBA
    - Adopted as standard distribution middleware in SCA
    - Useful in heterogeneous distributed systems
    - Widely used. There are many full-featured and high-performance CORBA ORBs on the market

Seoul National University
RTOS Lab

Overview of Software/Hardware Architecture of a Robot using RSCA



What does Middleware Provide ?



Enable dynamic reconfiguration

- Dynamic installation/uninstallation
- Dynamic instantiation/tear-down
- Dynamic start/stop
- Dynamic configuration

Hide heterogeneity

- Heterogeneous HW platform
- Diverse OSes
- Diverse network topologies
- Diverse communication protocols
- Diverse implementation languages

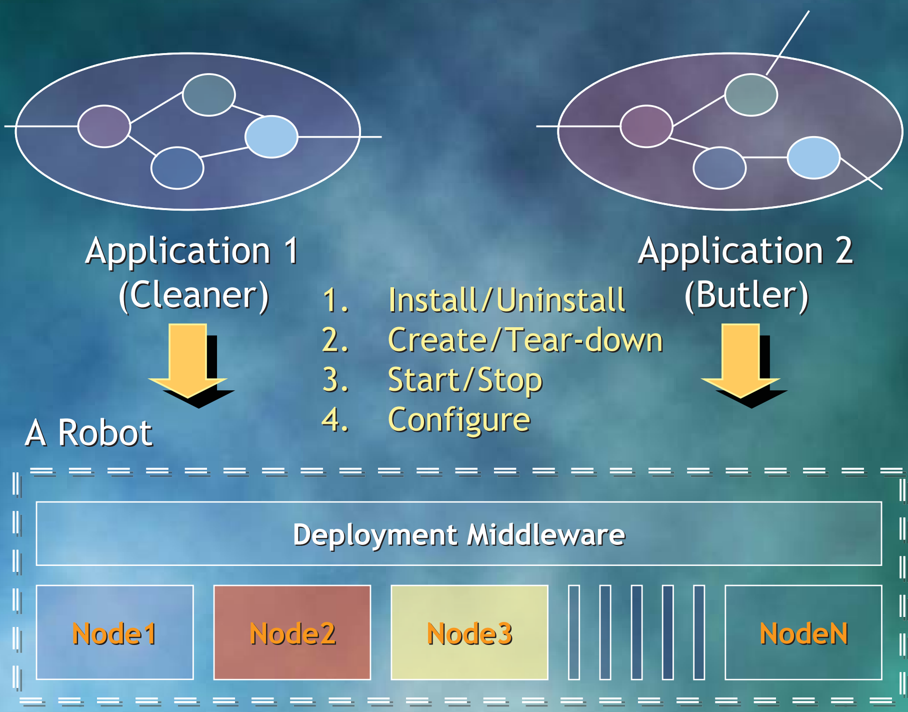
RSCA: Standardized Operating Environment for Robot Software

- Operating System
  - Compliant with at least PSE52 (IEEE POSIX.13 Real-time Controller System Profile)
- Distribution Middleware & Services
  - Minimum CORBA and Real-Time CORBA v1.1
  - CORBA Services (Naming, Log, and Event)
- Core Framework
  - CF Interfaces (IDL)
    - Base component interfaces
    - CF control interfaces
    - CF service interfaces
  - Domain Profile (XML descriptors)

Deployment Middleware

What is RSCA's Deployment Middleware?

RSCA: How does it help ? (1)



Seoul National University
RTOS Lab

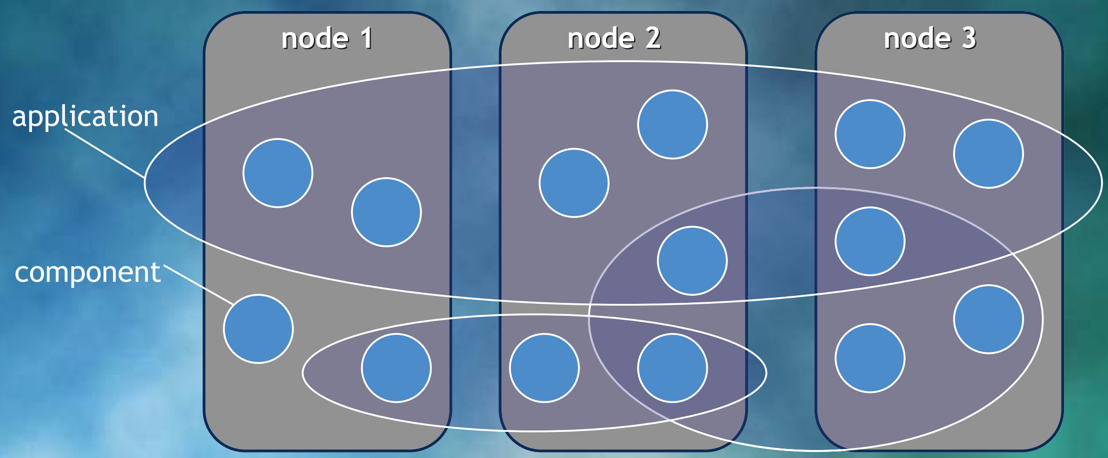
RSCA: How does it help ? (2)

- Easy to dynamically install and uninstall applications
  - Provide standard meta information descriptors for applications
    - Which components exist
    - How components are connected
    - Which pre-installed components are required
    - What kind of operating environment is required (operating system, CPU type) i386-Linux JVM
    - How much resources should be allocated (MIPS, memory, storage) 4kB 20kB

Seoul National University
RTOS Lab

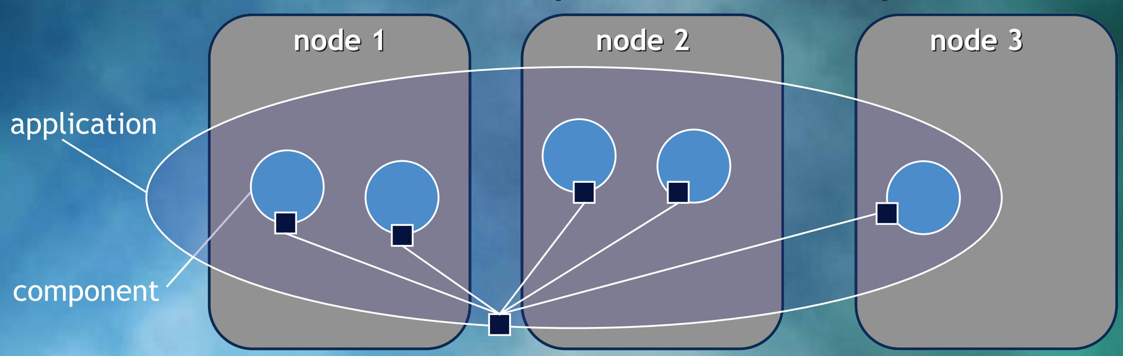
RSCA: How does it help ? (3)

- Easy to dynamically instantiate and tear down applications



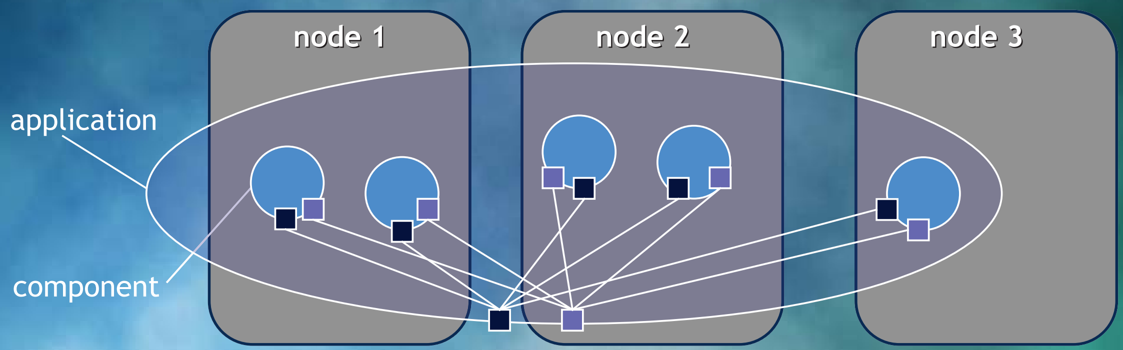
RSCA: How does it help ? (4)

- Easy to dynamically start and stop applications
  - Provide a standardized common interface for start and stop of each component



RSCA: How does it help ? (5)

- Easy to dynamically configure applications
  - Provide a standardized common interface for configuration



Seoul National University
RTOS Lab

RSCA: More than Deployment Middleware

- Component model
  - Similar to CCM
- Components substrate to encourage the reusability and portability of robot software
  - the standard operating environment
- Standard application component interfaces to maximize the interoperability (on-going)

Seoul National University
RTOS Lab

What Does RSCA Specify for Dynamic Deployment? (1)

- Core Framework Interfaces
  - Interfaces between applications and RSCA's deployment middleware
- Domain Profile (standard descriptors)
  - Configuration information for hardware devices and software components

What Does RSCA Specify for Dynamic Deployment? (2)

- CF Interfaces (defined in IDL) composed of
  - Base Component Interfaces — **Application**
    - For exchanging information between software application components
  - CF Control Interfaces — **Deployment Middleware**
    - For the start-up, control, and tear-down of software application components, and the allocation and control of hardware assets.
  - CF Service Interfaces
    - For distributed file access service, event logging service, and QoS service for software application components.

What Does RSCA Specify for Dynamic Deployment? (3)

- Domain Profile (defined in XML)
  - Describes (1) the individual components of a SW application, (2) their interconnection, (3) the properties
    - Identity
    - Inter-dependency
    - Property
    - Capability
    - Location

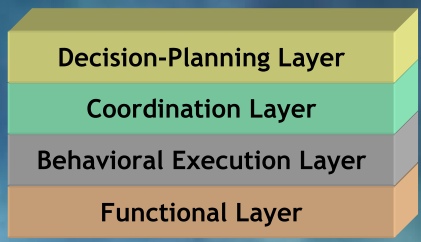
5 Key Ingredients

RSCA vs. Legacy Robot Software Architecture

"RSCA does NOT REPLACE legacy robot software architecture, BUT SUPPORTS it"

Legacy Software Architecture for Robots

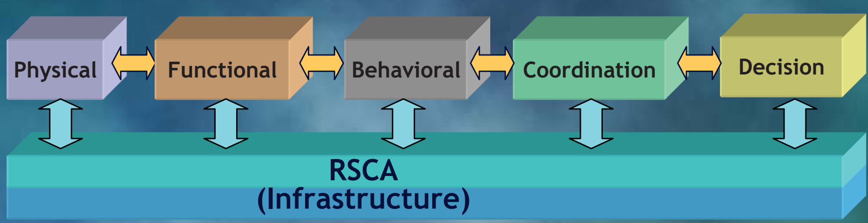
- Ex. hybrid layering architecture



- Legacy software architecture provides guidelines on how to decompose and build applications into CORBA components to maximize:
  - Modularity, reusability, interoperability

Roles of RSCA

1. Software bus



2. Standardized control

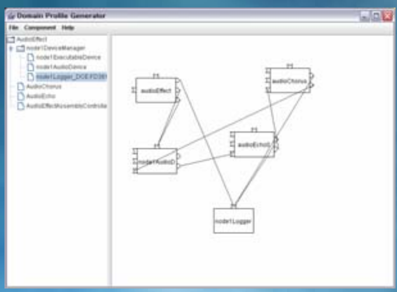
Implementation and Performance Evaluation of RSCA

Implementation (1)

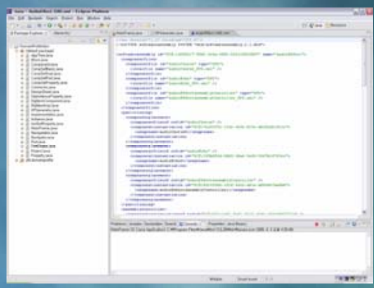
- We have fully developed the RSCA
  - Full-featured C++ implementation of the RSCA specification
  - Linux v. 2.4.20
  - TAO RT-ORB v. 1.3.1 and omniORB v. 4.0.5
- We have a plan to develop it as an open source project
  - http://rsca.snu.ac.kr

Implementation (2)

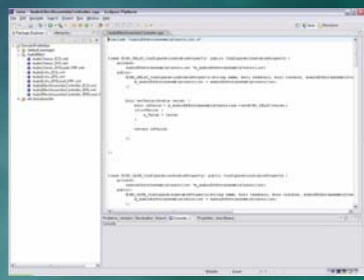
- We are developing tools for supporting the proposed RSCA framework to show its utility for robot software



Model-based design tool



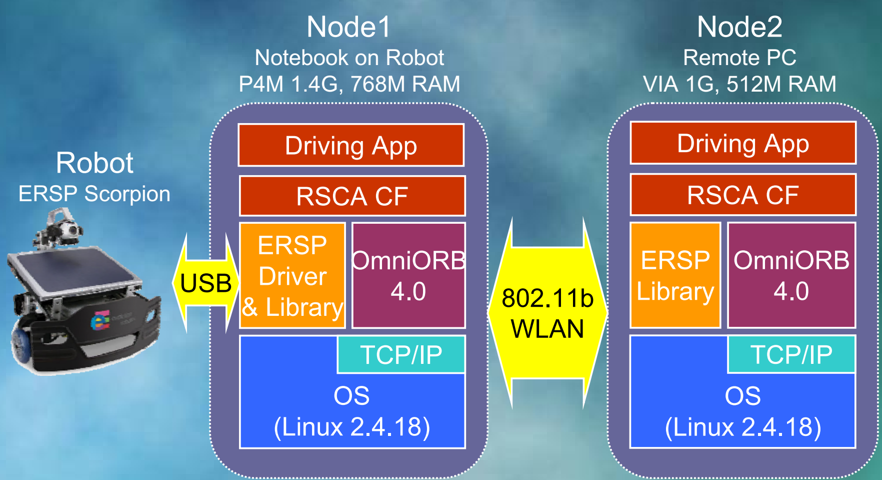
generated domain profile (XML)



CORBA stub code (C++)

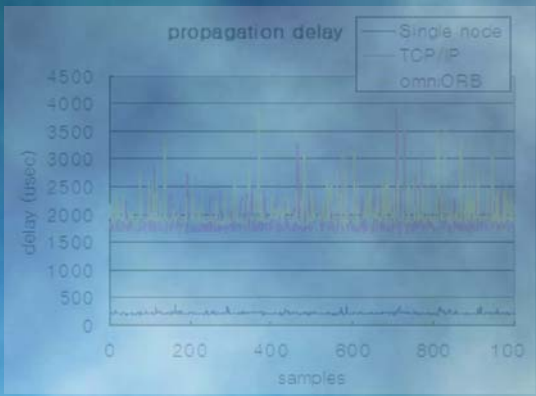
Performance Evaluation of RSCA with ERSP SDK (1)

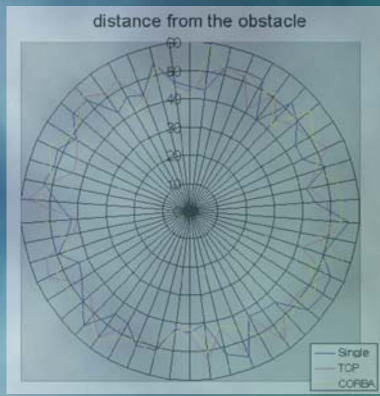
- Implemented driving prototype system
  - Target platform: Scorpion robot from evolution robotics with ERSP^{TM} SDK



Performance Evaluation of RSCA with ERSP SDK (2)

- Scenario 1
  - Robot stops moving if an obstacle is detected within 60 cm from the robot



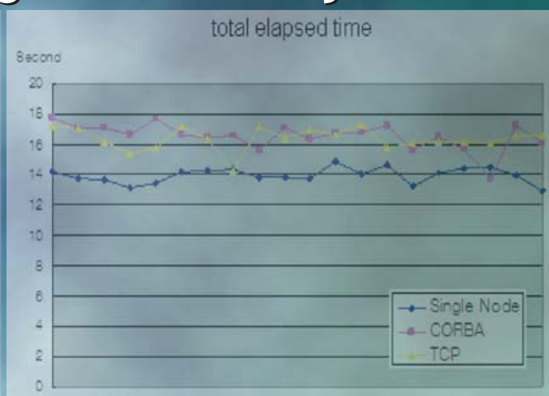


Single Node	TCP/IP	CORBA
222.2 us	1872.6 us	2045.9 us

Single Node	TCP/IP	CORBA
48.35 cm	48.67 cm	49.97 cm

Performance Evaluation of RSCA with ERSP SDK (3)

- Scenario 2
  - Robot detects the targeted object while rotating, and then goes to the object



Single Node	TCP/IP	CORBA
25 ms	251 ms	280 ms

Single Node	TCP/IP	CORBA
13.9 s	16.3 s	16.5 s

Conclusion

RSCA: Common Operating Environment for Robot Software

- Component substrate for robot software
  - Act as a software bus
- RSCA's deployment middleware
  - Provides standard ways of building, packaging, deploying, reconfiguring, and managing applications
- CORBA used as distribution middleware in RSCA does not incur significant overhead
  - Even better, its effect on the behavior of robots is not significant
    - E.g. a less than 4 % reduction in accuracy and a less than 20 % increase in response time

Future Directions

- Defining standard interfaces for application components
- Applying MDA techniques
  - UML profile for RSCA

Thank You !!

For more information, please visit our website at
http://rsca.snu.ac.kr

Real-Time Operating Systems Lab
Seoul National University
Http://redwood.snu.ac.kr

Object Management Group

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

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

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?

<mars/2005-06-12>

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?

<mars/2005-06-12>

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 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.

<mars/2005-06-12>

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_iiop.htm*.

Data Acquisition form 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 form 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

<mars/2005-06-12>

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,

Robotics

Date: Friday, 24th June, 2005
Reporting: Tetsuo Kotoku
Group URL: http://robotics.omg.org/
Group email: robotics@omg.org

➢Highlights from this Meeting:

Drafting RFI WG (Mon.):
Plenary Meeting (Wed.):

- Invited Talk : JAUS (Mr. Jeff Kotora) [robotics/05-06-04]
- RFI review (Mr. Olivier Lemaire) [robotics/05-06-06]
- Participant's Talk
  - Dr. Claude Baudoin (Schlumberger) [robotics/05-06-05]
  - Dr. Hui Min Huang (NIST) [robotics/05-06-08]
  - Mr. Jaesoo Lee (Seoul National Univ., Korea) [robotics/05-06-09]

Joint Meeting with MARS/RTESS (Mon. and Thu.):

Joint Meeting with ManTIS (Thu.):

Robotics

Date: Friday, 24th June, 2005
Reporting: Tetsuo Kotoku
Group URL: http://robotics.omg.org/
Group email: robotics@omg.org

➢Deliverables from this Meeting:

- **RFI Recommendation**
  Robotic Systems RFI [mars/2005-06-12]

➢Next Meeting (Atlanta, GA, USA):

- **RFI promotion**
- **Presentation** [tentative]
  - **Bruce Boyes** (Systronix)
  - **Joseph M. Jacob** (OTI)
  - etc

Robotics-DSIG Meeting Minutes – Boston, MA, USA (robotics/2005-06-12)

Overview and votes

We completed the Robotic Systems RFI and voted to issue the RFI. It was approved to issue in PTC sponsored by MARS.

OMG Documents Generated

robotics/2005-06-01 Final Agenda (Tetsuo Kotoku)
robotics/2005-06-02 Opening Presentation (Tetsuo Kotoku)
robotics/2005-06-03 SDO-DSIG and Robotics-DSIG Roadmap (Tetsuo Kotoku)
robotics/2005-06-04 Presentation: "Special Talk: Introduction to JAUS" (Jeff Kotora)
robotics/2005-06-05 Presentation: "Robotics Needs of the Oilfield Industry" (Mike Barret and Claude Baudoin)
robotics/2005-06-06 Revised RFI draft (Olivier Lemaire)
robotics/2005-06-07 Comments from AB buddy (Tetsuo Kotoku)
robotics/2005-06-08 Presentation: "Toward a Reference Model for Robotic Standards" (Hui Min Huang)
robotics/2005-06-09 Presentation: "Middleware Technology for Robotics: Robot Software Communications Architecture (RSCA)" (Jaesoo Lee)
robotics/2005-06-10 Robotic Systems RFI [mars/2005-06-12] (Olivier Lemaire)
robotics/2005-06-11 DTC Plenary presentation (Tetsuo Kotoku)
robotics/2005-06-12 Meeting Minutes (Tetsuo Kotoku)

Agenda

09:00-09:15 Welcome and Review SDO Agenda
09:15-10:15 Special Talk: "Introduction to JAUS" (Jeff Kotora, JAUS Chair)
10:30-11:10 "Robotics Needs of the Oilfield Industry" (Claude Baudoin, Schlumberger)
11:10-12:00 RFI discussion (part 1): Robotic Systems RFI (Olivier Lemaire, JARA)
14:00-15:00 RFI discussion (part 2): Robotic Systems RFI (Olivier Lemaire, JARA)
15:30-16:00 "Toward a Reference Model for Robotics Standards" (Hui Min Huang, NIST)
16:00-16:30 "Middleware Technology for Robotics: Robot Software Communications Architecture" (Jaesoo Lee, Seoul National Univ.)
16:45-17:00 Next meeting agenda discussion

Minutes

22 June, Wednesday

Tetsuo KOTOKU, presiding co-chair

Meeting Week – Kick-off

- Meeting was called to order at 9:00
- Tetsuo Kotoku provided a brief guidance about Robotics-DSIG.
  - ✓ robotics/2005-06-02 Opening presentation
- Tetsuo Kotoku presented the Draft Roadmap.
  - ✓ robotics/2005-06-03 Roadmap for Robotics Activities

Special Talk "Introduction to JAUS"

- Jeff Kotora (Dept. of Defense / TITAN), JAUS Chair, introduced us the activity of JAUS.
  - ✓ robotics/2005-06-04 "Special Talk: Introduction to JAUS"

Presentation: "Robotics Needs of the Oilfield Industry"

- Claude Baudoin (Schlumberger) presented current status of robotics technology in the Oilfield Industry.
  - ✓ robotics/2005-06-05 "Robotics Needs of the Oilfield Industry"

RFI discussion "Robotic Systems RFI"

- Olivier Lemaire (JARA) presented the revised RFI draft.
- There were some changes in the technical wording.
  - ✓ robotics/2005-06-06 Revised RFI draft

- ✓ robotics/2005-06-07 Comments from AB buddy
- ***Action:*** The motion of recommendation to issue "Robotic Systems RFI" allowing minor amendments in MARS

Presentation: "Toward a Reference Model for Robotics Standards"

- Hui Min Huang (NIST) presented the brief review of Generic Framework for robot architecture and made points about the importance of performance metrics and standards.
  - ✓ robotics/2005-06-08 "Toward a Reference Model for Robotics Standards"

Presentation: "Middleware Technology for Robotics: Robot Software Communications Architecture"

- Jaesoo Lee (Seoul National Univ.) presented Korea's national project, Ubiquitous Robotic Companion. About 20 million dollars a year is funded by the government.
  - ✓ robotics/2005-06-09 "Middleware Technology for Robotics: Robot Software Communications Architecture (RSCA)"

Meeting Wrap-up, Plan for Atlanta

- There is a small discussion about the organization of our Robotics-DSIG.
- Tetsuo Kotoku proposed that we should ask for volunteers as liaisons between the related organizations for active information exchanges.
- There were some volunteers as below;
  - JAUS: Hui Min Huang
  - ORiN: Makoto Mizukawa
  - URC: YunKoo Chung
  - RTmiddleware: Tetsuo Kotoku
- Tetsuo Kotoku presented the draft Agenda for the next meeting.
- Robotics Plenary meeting will be held on Wednesday in Boston.
  - ✓ robotics/2005-04-02 Opening presentation
- ***Action:*** Keep up finding liaisons between related organizations.

ADJOURNED @ 17:00 pm

Participants (Sign-in)

- Yun Koo Chung (ETRI)
- Tom Hein (Deere)
- Takashi Suehiro (AIST)
- Masayoshi Yokomachi (NEDO)
- Stephanie (OMG)
- Dana Morris (OMG)
- Duane Clarkson (Deere)
- Hideo Shindo (NEDO)
- Brad Kizzort (Harris)
- Hui-Ming Huang (NIST)
- Jeff Kotora (Dept. of Defense / TITAN)
- Olivier Lemaire (JARA)
- Claude Baudoin (Schlumberger)
- Jaesoo Lee (Seoul Natioanl Univ.)
- Back Michael (Seoul National Univ.)
- Hung Pham (RTI)
- Makkoto Mizukawa (Shibaura Institute of Technology)
- Gerardo Pardo (RTI)
- Hiroki Kamata (OTI / OMG)
- Joe Jacob (Objective Interface)
- Tetsuo Kotoku (AIST)

Prepared and submitted by Tetsuo Kotoku