AIST SICE2011 2011.09.13

SICE SO
The Society of Instrument and Control Engineers since 1961

OMG
OBJECT MANAGEMENT GROUP

Part 1:
Introducing RT-Middleware

National Institute of Advanced Industrial Science and Technology (AIST)
Intelligence Systems Research Institute
Tetsuo KOTOKU, Noriaki ANDO

RT MIDDLEWARE

http://www.openrtm.org/

AIST

Outline:

- Self-Introduction
- RT-middleware Introduction
- System Examples

Objective:
to understand core concept of RT-Middleware

AIST

Technical Background

Robot Society in the 21st century

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.

Rapid progress:

Computer Technology

Network Technology

Robot Systems
- larger
- more complicated

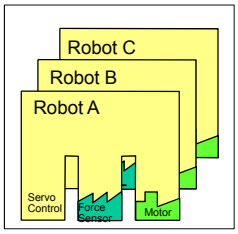
Single robot
Networked robot

Efficient Development

AIST

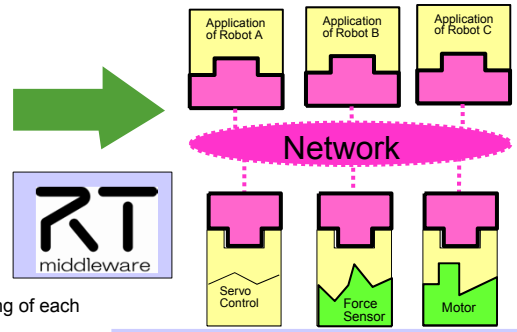
RT Middleware Project

Conventional Robot Systems



- Robot Maker makes Everything of each robot.
- Interfaces of modules in each robot are not defined well. So, it is difficult to re-use them in other robot systems.
- Cost of development is high.
- It is difficult to create a variety of robots

Component Based Robot Systems

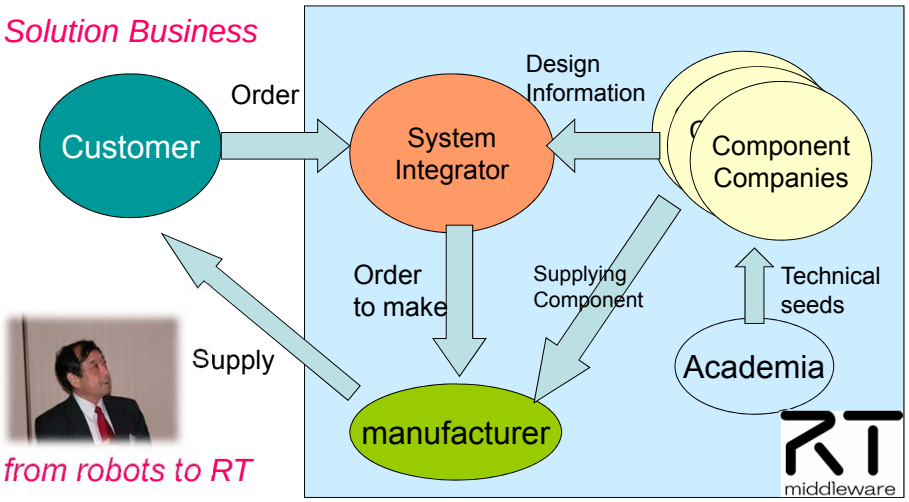


- It will be easy to create new robot by re-using existing modules.
- Cost of development of new robot will be low.
- Module suppliers, software module suppliers and system integrators can join the new robot business.
- It will be easy to develop a variety of robots.

AIST

Technology Strategy (JARA)

Solution Business



from robots to RT

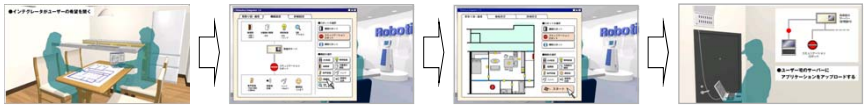
21st Century Business Model

Made-to-Order Business

AIST

Business Scenario of RT Space

Introduction of RT Space



Integrator interview customer and design RT Space for the customer.

Integrator develop service programs of RT Space with RT middleware.

Simulation and confirmation with RTM tools

Installation of RT components and service programs.

Addition of RT Component

Purchase of a new cleaner robot component.

Install the new RT component hardware.

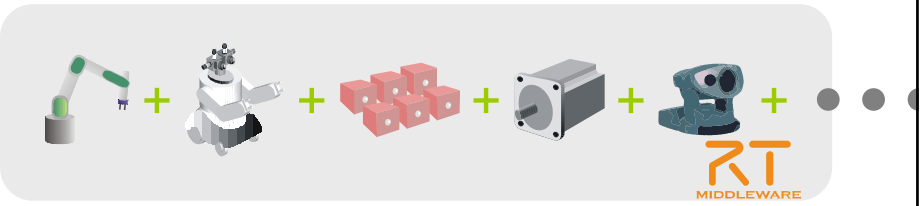
Install the new RT component software.

New component cooperates other components and provides new services.

AIST

What is RT?

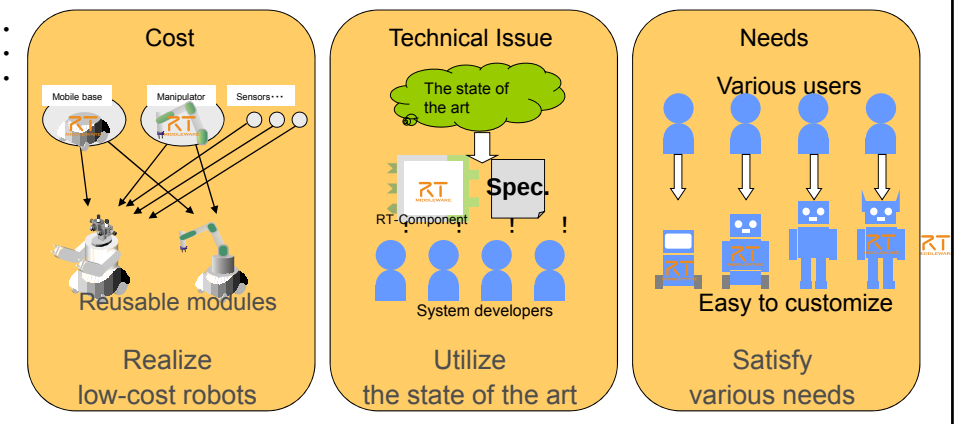
- RT = Robot Technology cf. IT
  - not only standalone robots, but also robotic elements (sensors, actuators, etc….)



- RT-Middleware
  - middleware and platform for RT-element integration
- RT-Component
  - Basic software unit in RT-Middleware

AIST

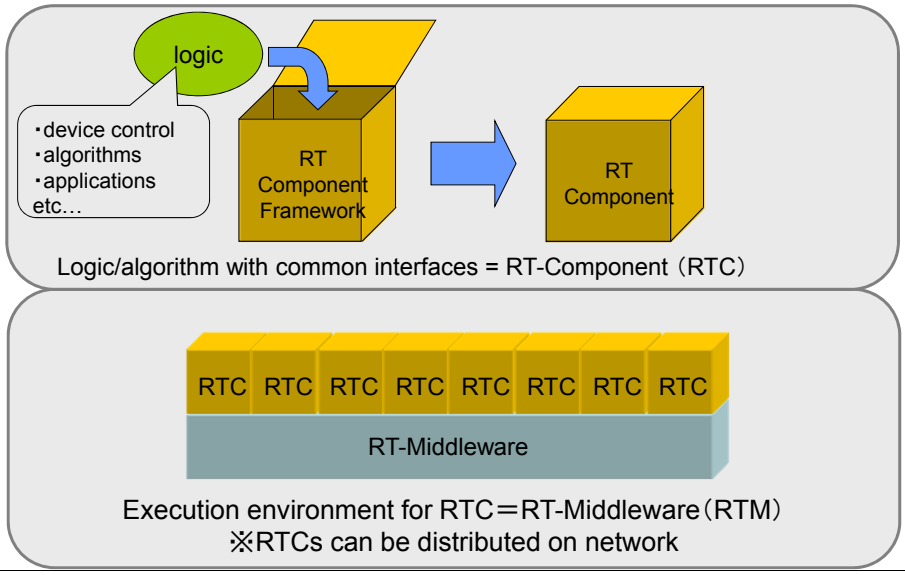
Problem Solving by Modularization



Robot System Integration Innovation

AIST

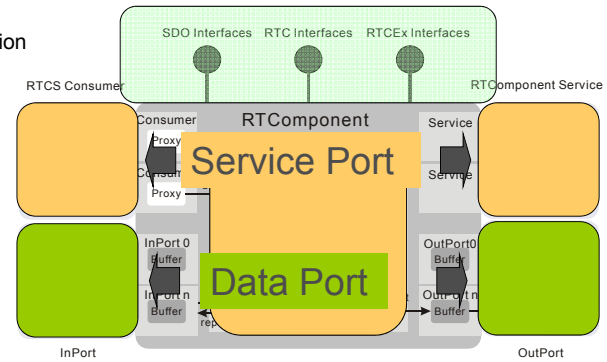
RT-Middleware & RT-Component



AIST

RT-Component Architecture

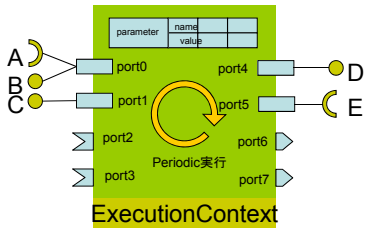
- Meta-data acquisition
  - Profile
  - What kind of component?
- Activity
  - Logic execution
- Data Port
  - Data Centric interaction
- Service Port
  - Request/response interaction
- Configuration
  - Parameter management



AIST

RT-Component's Meta-data

- Meta-data
  - RTC's specification
- Introspection
  - Name, type
  - Port (number, kind)
  - Interface information
  - Properties
  - Parameter
  - Execution context
- For dynamic reconfiguration of systems



RTC's meta-data example

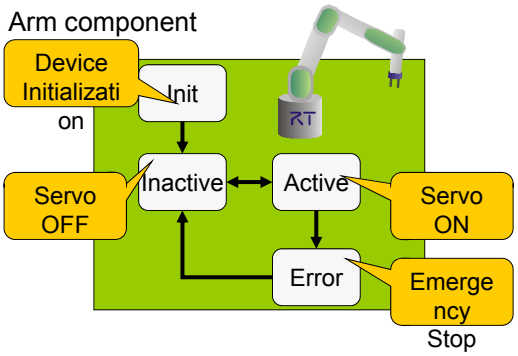
Name	MyManipulator0
Type	Periodic execution type
port0	Provide: A, Required: B
port1	Provide: C
Port2	DataPort: InPort, velocity, float x6
Port3	DataPort: InPort, position, float x6
Port4	Provide: D
Port5	Required: E
Port6	DataPort: OutPort, status int x1
Port7	DataPort: OutPort, velocity, float x6
ExecutionContext	Period: 10ms
Parameter	gain0(float x6), flag(int x1), dev_file(string)

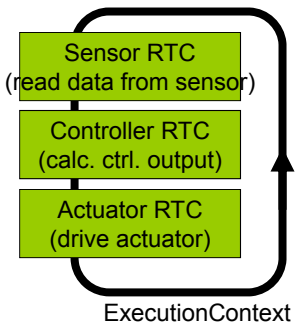
NATIONAL INSTITUTE OF ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY (AIST)

AIST

Activity

- Logic Execution
- Common State Machine
  - Initialize
  - Inactive（OFF）
  - Active（ON）
  - Error





Execute independent components sequentially in real-time thread
→Composite Component

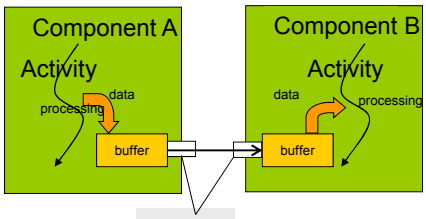
NATIONAL INSTITUTE OF ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY (AIST)

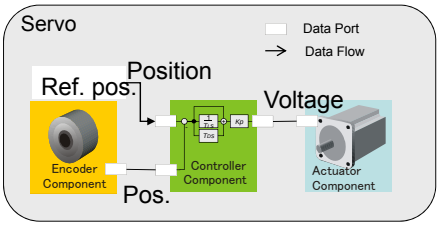
43

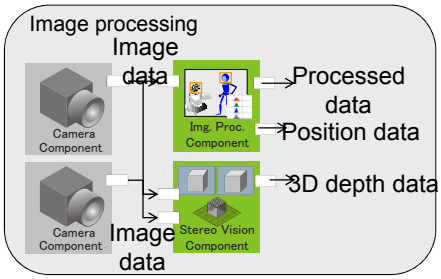
AIST

Data Port

- Port for data centric interaction
- Data stream
  - Position control
    - Ex. position, voltage
  - Image processing
    - Ex. image data
- For lower level processing for robot systems
- Same data-typed ports are connectable
- Dynamic connection/disconnection



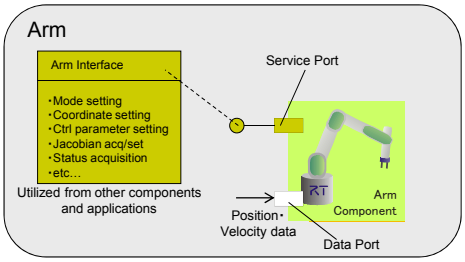


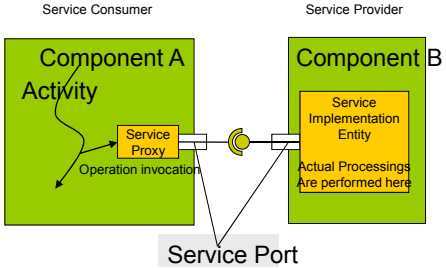


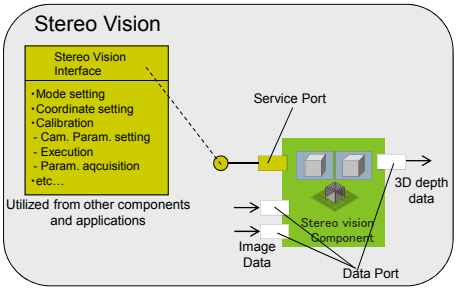
AIST

Service Port

- The Port which has any kind of interfaces
  - Developer defined interface
  - Provider Interface
    - Provides services to other components
  - Consumer Interface
    - Consume services of other components
- Service to provide accessibility to
  - Parameter setting,
  - Mode change,
  - Service request and response
  - etc…







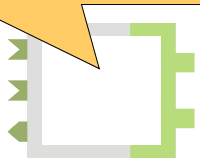
AIST

Configuration

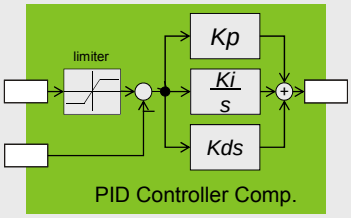
- Configuration
  - Parameter management
  - Configuration Set
    - Set's name、list of name value
    - Two or more sets
    - Sets can be switched

Multiple sets can be replace in runtime

Set's name	name					
	value					
Set's name	name					
	value					



PID Controller



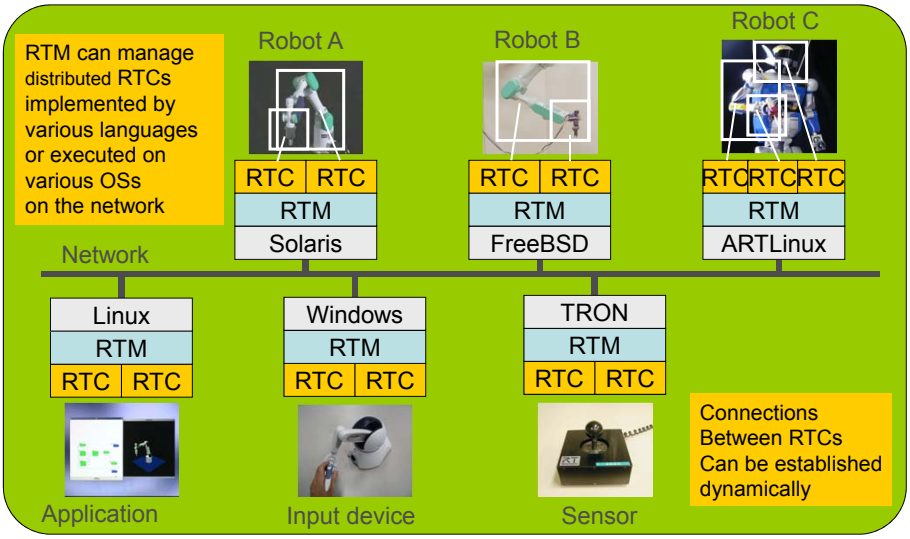
		Kp	Ki	Kd	In_{max}	In_{min}
modeA	name					
	value	0.6	0.01	0.4	5.0	-5.0
modeB	name					
	value	0.8	0.0	0.01	10.0	-10.0
modeC	name					
	value	0.3	0.1	0.31	1.0	-1.0

PID gains and limiter parameter can be switched according to controlled plants or modes. Parameter can be switched any time.

AIST

RTM based Distributed Systems

RTM can manage distributed RTCs implemented by various languages or executed on various OSs on the network



AIST

Related Robot Projects in Japan

Inter-Ministry Project

- from 2005FY to 2007FY,
- Framework for Robot Simulator (OpenHRP3)
- RT middleware (OpenRTM-aist-0.4.1)

NEDO Project for common components

- from 2005FY to 2007FY,
- Hardware module (voice recognition, vision, motion control)

Intelligent Robot Technology Software Project

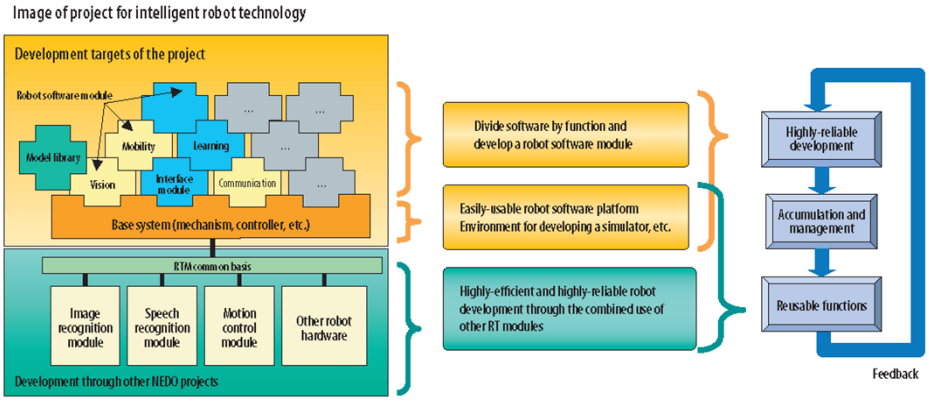
- from 2007FY to 2011FY
- Software module and architecture for intelligence
- Software development Tools

AIST

Intelligent Robot Technology Software Project (FY2007-FY2011)

Project Leader: Tomomasa SATO (The University of Tokyo)

Image of project for intelligent robot technology



AIST

Intelligent Robot Technology Software Project

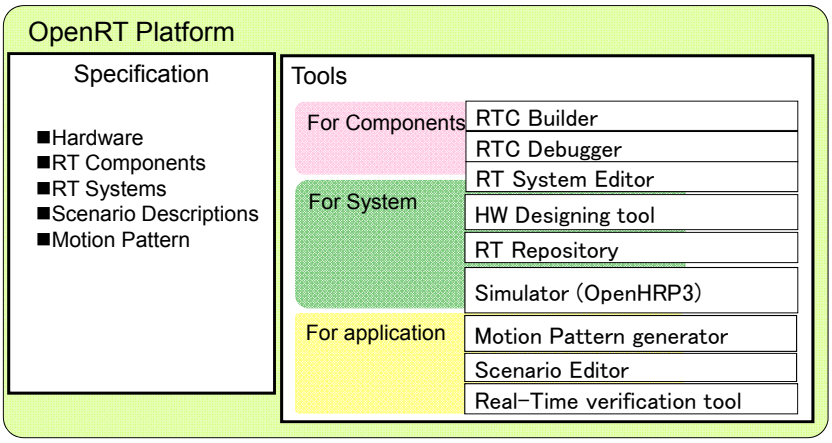
次世代ロボット知能化技術開発プロジェクト (FY2007-FY2011)

- Supported by METI and NEDO
  - 1,500Million yens (2008)
  - 15 consortiums , 38 organizations
    (19 Companies, 15 Universities, 4 Research institutes)
- OpenRT Platform
- Applications
  - Manipulation
    - Factory automation, Try service & cleanup in a cafeteria etc.
  - Mobility
    - Mobile Robot, Intelligent Vehicle, GIS etc.
  - Communication
    - Home Robot, Guide Robot etc.

AIST

Overview of OpenRT Platform

- Integrated development tools for developing RT components, RT systems and application scenarios



AIST

Open RT PLATFORM

Demonstration in iREX2009

http://www.nikkan.co.jp/eve/irex/english/index.html/

NATIONAL INSTITUTE OF ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY (AIST)

AIST

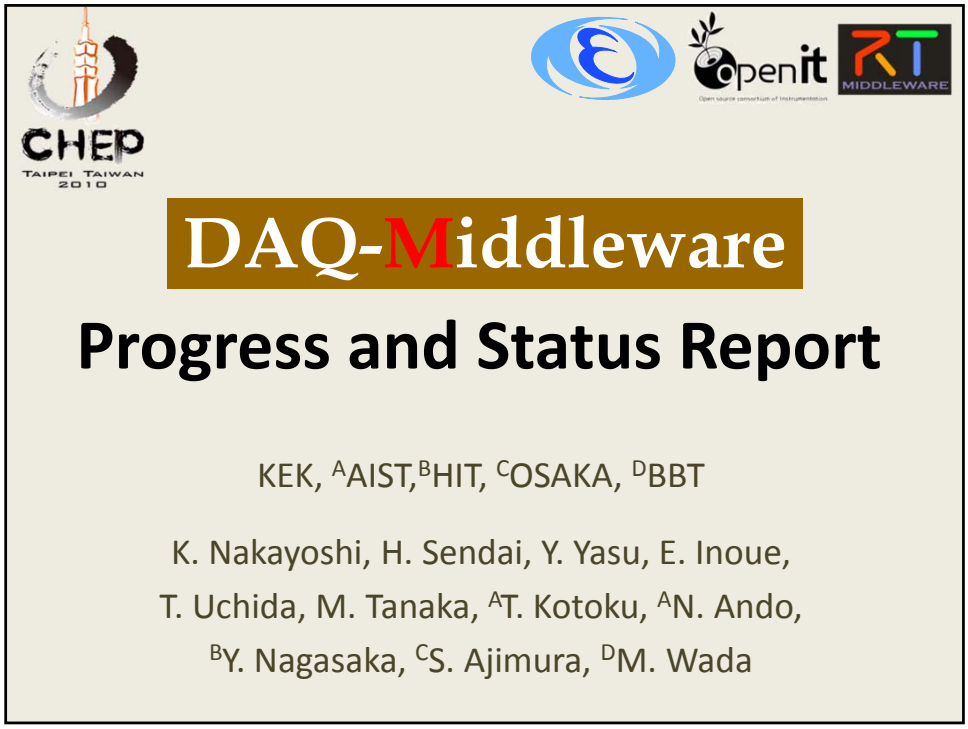
Open RT PLATFORM

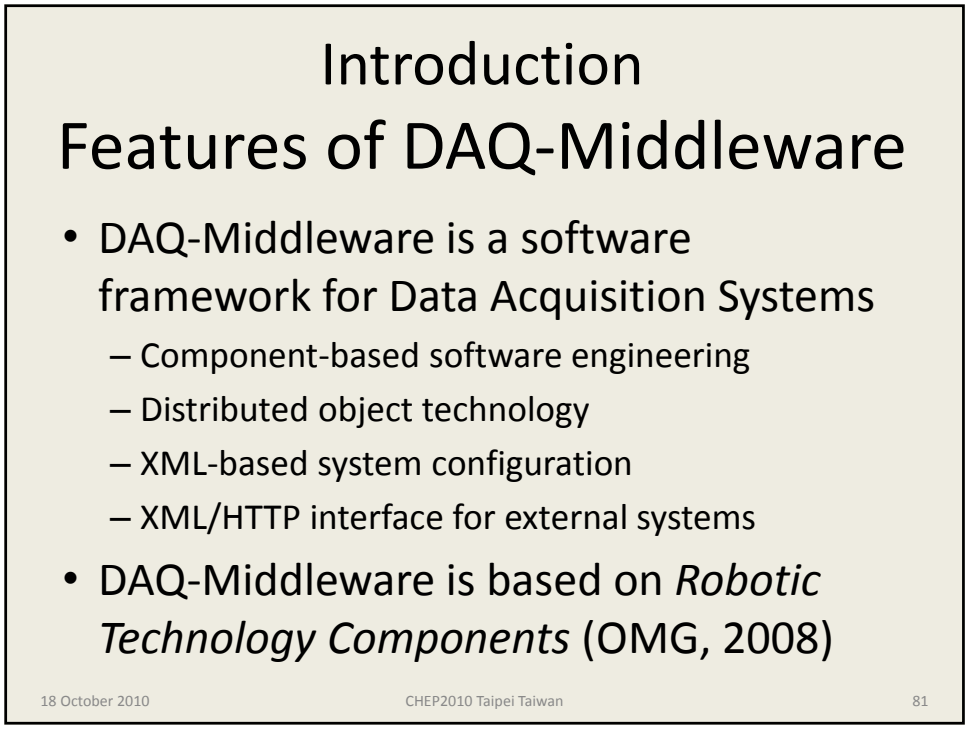
Demonstration in iREX2011

- RT-System Demonstration
- Tutorial Session on Development ToolChain
- Press Release

http://www.nikkan.co.jp/eve/irex/

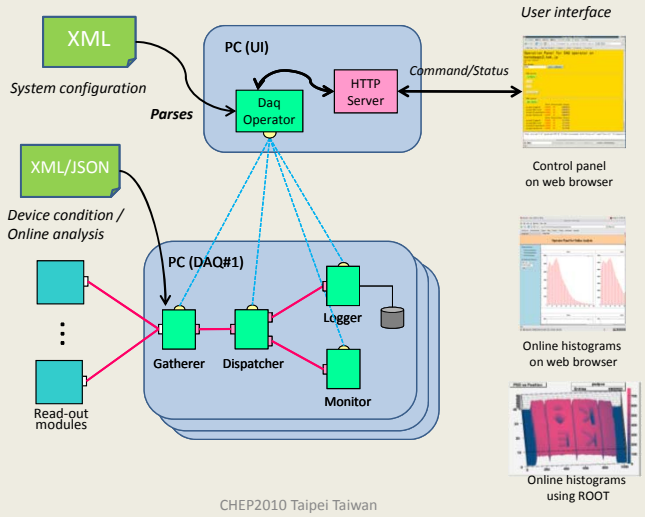
NATIONAL INSTITUTE OF ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY (AIST)


CHEP
TAIPEI TAIWAN
2010
openit
RT
MIDDLEWARE
DAQ-Middleware
Progress and Status Report
KEK, AAIST,BHIT, COSAKA, DBBT
K. Nakayoshi, H. Sendai, Y. Yasu, E. Inoue,
T. Uchida, M. Tanaka, AT. Kotoku, AN. Ando,
BY. Nagasaka, CS. Ajimura, DM. Wada


Introduction
Features of DAQ-Middleware
• DAQ-Middleware is a software framework for Data Acquisition Systems
– Component-based software engineering
– Distributed object technology
– XML-based system configuration
– XML/HTTP interface for external systems
• DAQ-Middleware is based on *Robotic Technology Components* (OMG, 2008)
18 October 2010
CHEP2010 Taipei Taiwan
81

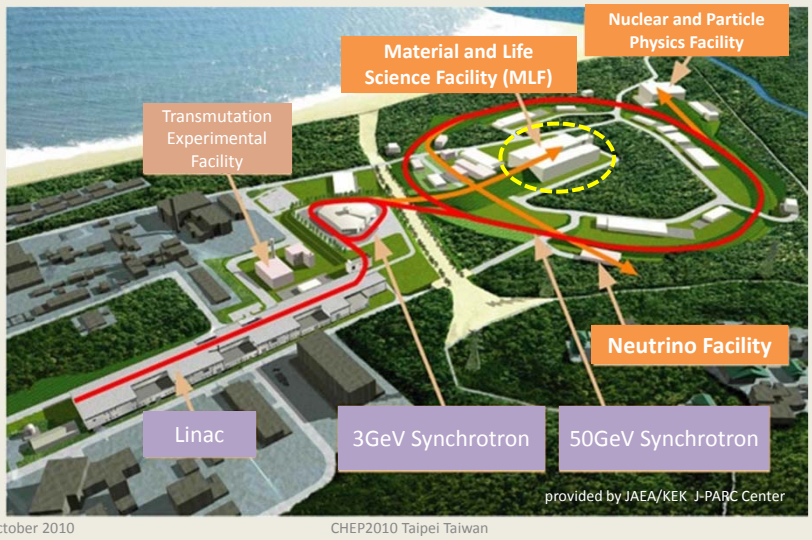
Introduction

Basic configuration

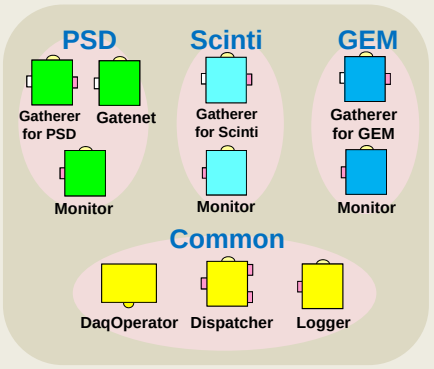


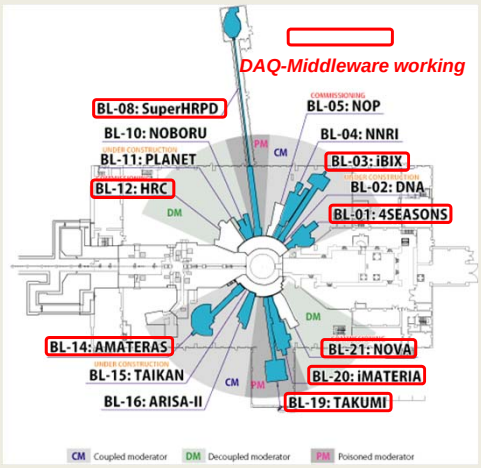
Current status of DAQ-Middleware in MLF J-PARC

J-PARC Overview



Current status of DAQ-Middleware in MLF J-PARC



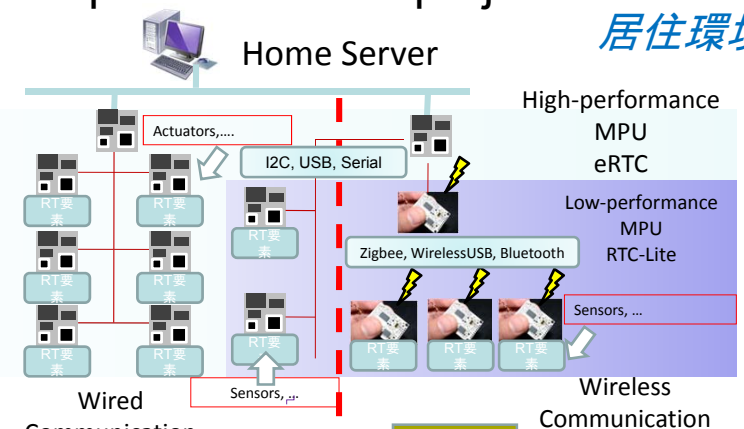


18 October 2010 CHEP2010 Taipei Taiwan 88

AIST

Open innovation project

居住環境のRT化



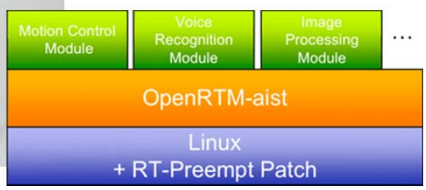
Damage detection Power assist window/door Energy Savings Security

NATIONAL INSTITUTE OF ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY (AIST)

AIST

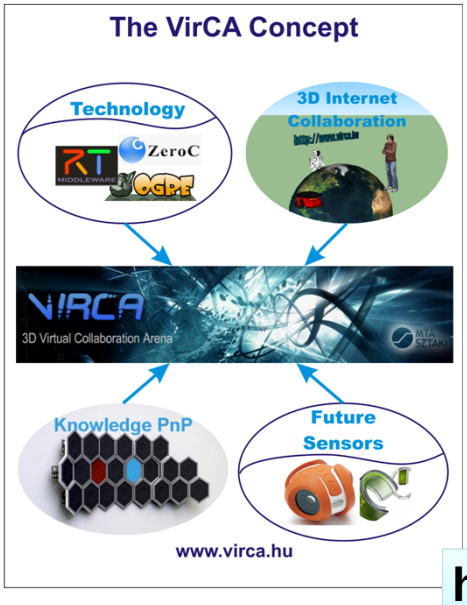
Development of HRP-4, a Research and Development Platform for Working Humanoid Robots

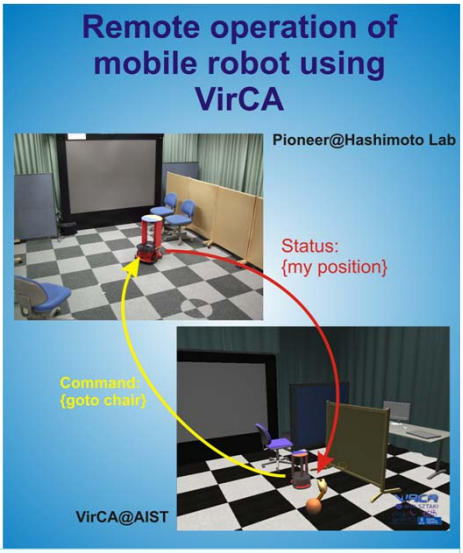
- Supply to external research organizations from January 2011 -



http://www.aist.go.jp/aist_e/latest_research/2010/20101108/20101108.html

AIST





http://www.virca.hu/

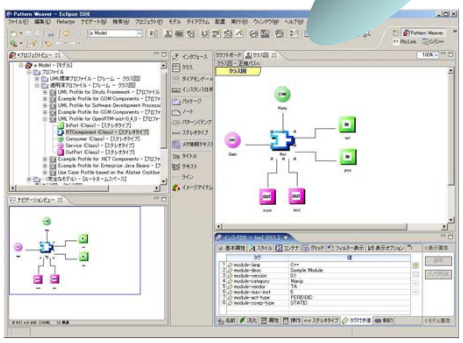
AIST

Technologic-Arts

株式会社テクノロジックアート
TECHNOLOGIC ARTS INCORPORATED

(one of supporters of RTC Specification)

New Business



UML Modeling Tool + RTC-Template (plug-in)

http://pw.tech-arts.co.jp/pw/rt_middleware/index.html

AIST

Standardization Activity in OMG

Object Management Group

OBJECT MANAGEMENT GROUP

- **Worldwide software consortium**
  - Distributed Object Middleware (CORBA)
  - Object Model Language (UML)
  - Model Driven Architecture (MDA)
- **Application Fields Specific Standardization**
  (Business Enterprise Integration, C4I, Finance, Healthcare, Life Science Research, Manufacture, Software-based Communication, Space, **Robotics**)
  -> **Domain Technology Committee**

CORBA

UNIFIED MODELING LANGUAGE

http://www.omg.org/

NATIONAL INSTITUTE OF ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY (AIST)

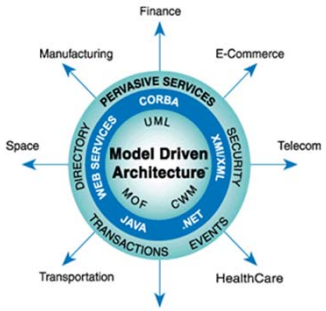
AIST

Robotics DTF

(Since Dec. 9, 2005)

- Robotics Domain Task Force (DTF)
  - Is one of nine task forces within the OMG that is addressing the needs of a particular problem domain.
  - Is defining software standards for integration and interoperability in the field of robotics.
  - Is composed of industry, government and research organizations from countries in Asia, Europe and North America.
  - Maintains active outreach to robotics community, *e.g.*, ISO TC184 , KIRSF, JARA, ORiN, *etc.*

OMG OBJECT MANAGEMENT GROUP



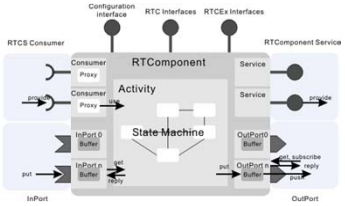
Robotics

http://robotics.omg.org/

AIST

Robotic Technology Component (RTC)

- Issued as public specification
  http://www.omg.org/spec/RTC/1.0/
- Component model for robotics
  - Basis for software modularization and integration at infrastructure/ middleware level in this domain
  - Builds on – does not replace – general-purpose component models

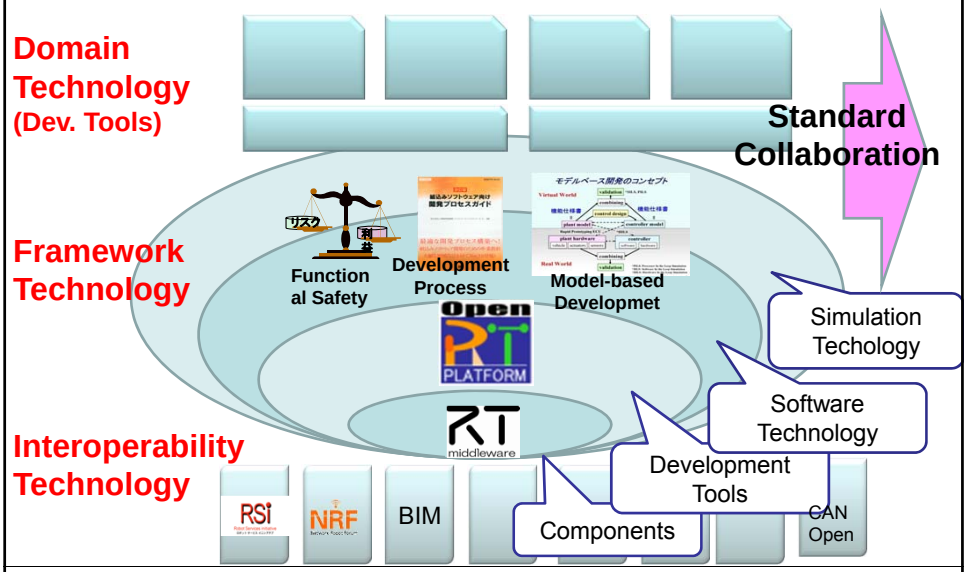


National Institute of Advanced Industrial Science and Technology
AIST
National Institute of Advanced Science & Technology (AIST)

RTI Real-Time Innovations
Real-Time Innovations (RTI)

AIST

Future RT-Middleware Technology



AIST

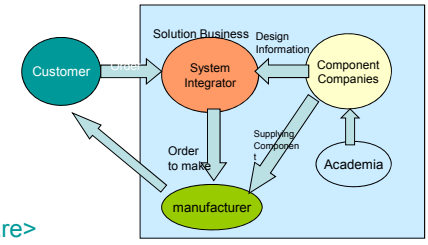
Conclusions

< Key Technology of RT >

Module-base Open Architecture

- Inter operability
- reusability
- portability
- development tool

RT middleware



<Development and diffusion of RT middleware>

Standardization OMG

< meet the market needs >
New RT Industry

AIST

RT-Middleware tutorial

10:00 - 10:45	**Part 1: Introducing RT-Middleware**
	Tetsuo Kotoku (AIST)
	An introduction to RT-Middleware, RT-Systems and RT-Components.
11:00 - 12:30	**Part 2: Building RT-Systems using RT-Middleware**
	Geoffrey Biggs (AIST)
	Hands-on practice using small samples to construct complete RT-Systems.

13:30 - 15:00	**Part 3: Creating RT-Components**
	Geoffrey Biggs (AIST)
	Hands-on practice creating RT-Components.
15:15 - 16:00	**Part 4: Human interaction with OpenHRI**
	Yosuke Matsusaka (AIST)
	A demonstration of RT-Components for human-robot interaction.
16:00 - 16:30	**Part 5: Discussion**

AIST

Thank you…

- Our Official Site:
  - http://www.openrtp.org/
  - http://www.openrtm.org/
  - http://robotics.omg.org/