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Robot Middleware Standard “RT-Middleware”

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What is RT?

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

RT-Middleware developed by AIST

OpenRTM-aist

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

Conventional systems



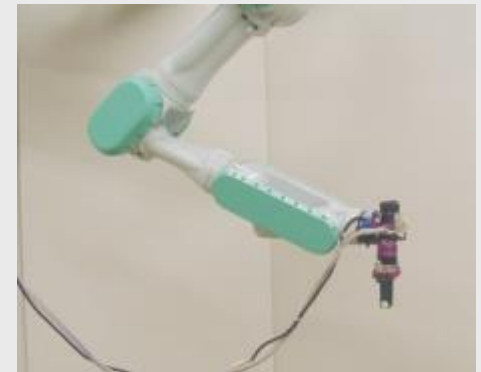
Joystick



Joystick
software



Robot Arm
Control software



Robot Arm

Compatible interfaces are connectable

Conventional systems



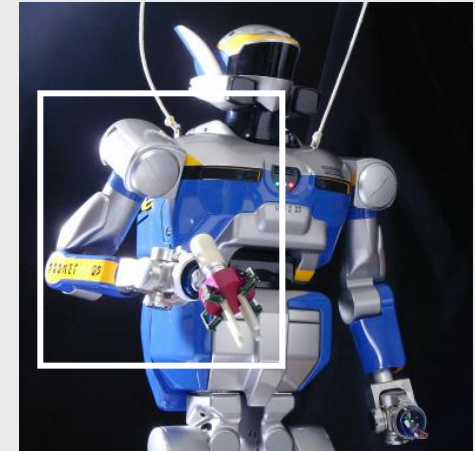
Joystick



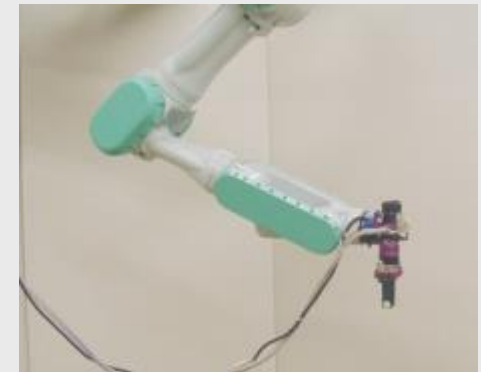
Joystick
software



Humanoid's Arm
Control software



Humanoid's Arm



Robot Arm

Various interfaces depends on robots.
They are not interoperable.

Robot Arm
Control software

By using RT-Middleware

RT-Middleware provides common interface sets to connect modules of various type of robots



Joystick



Joystick software

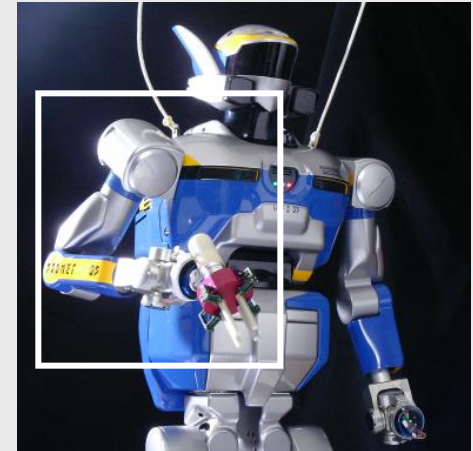
Arm A
Control software



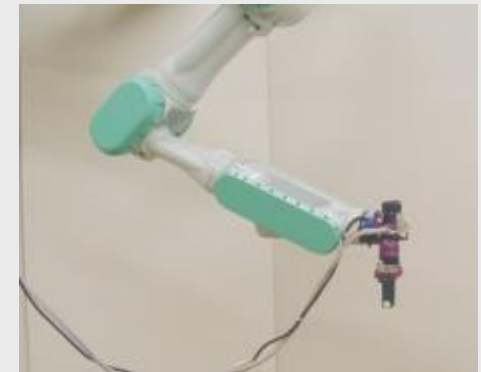
compatible
arm interfaces



Arm B
Control software



Humanoid's Arm



Robot Arm

Reusability of software will increase.
It helps easy RT-systems development.

The benefits of modularization

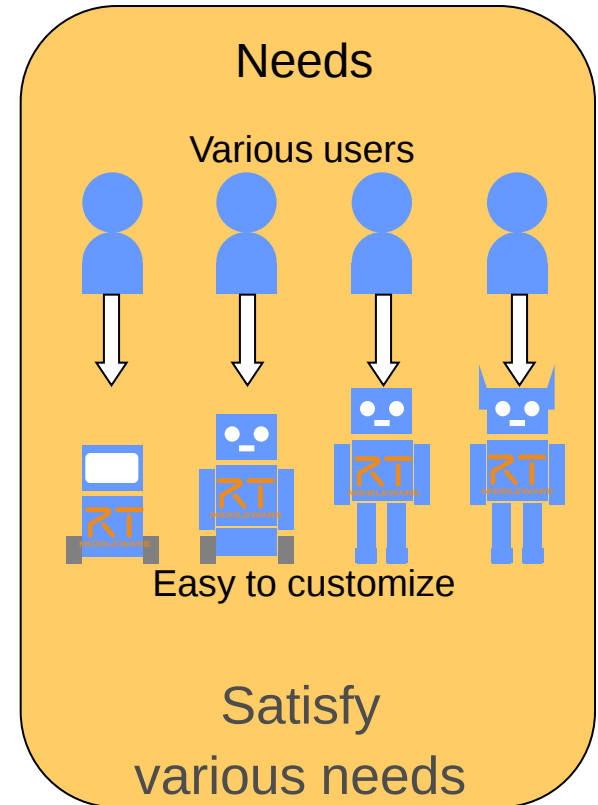
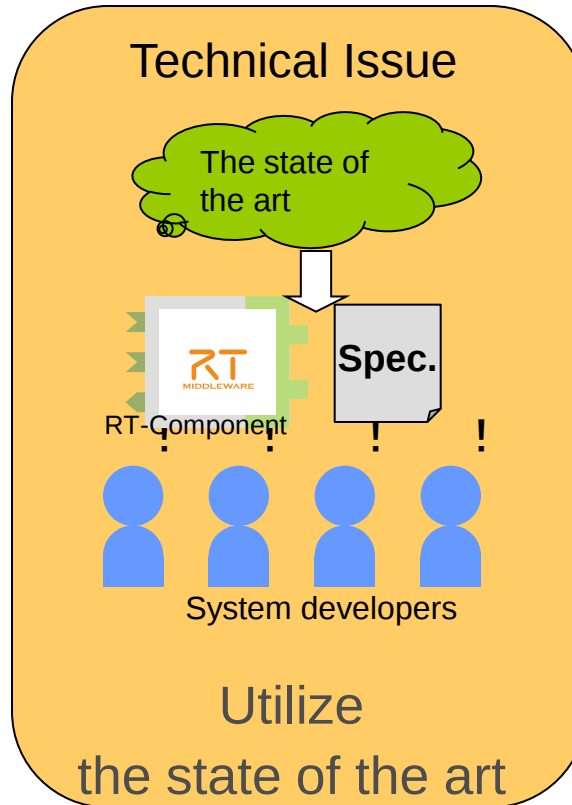
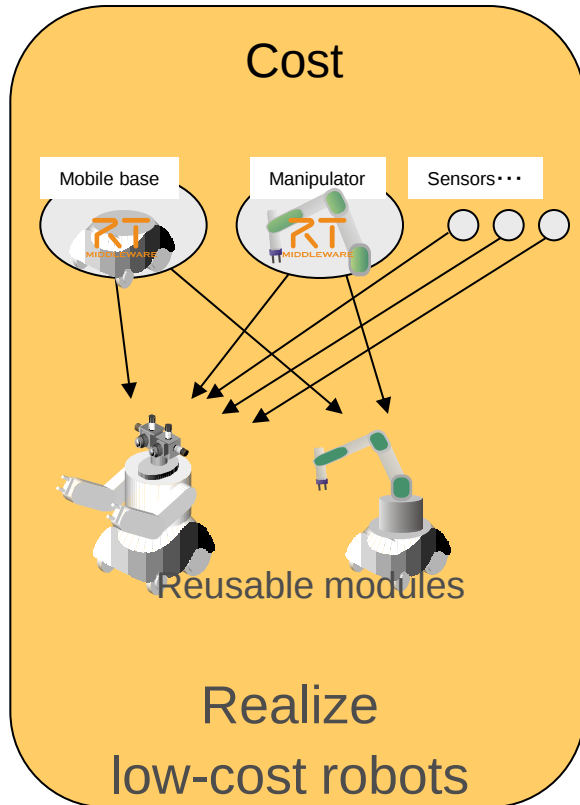
- Reusability
 - A component can be reused in various systems.
- Diversification
 - Various type of same functional modules can be tried in systems.
- Flexibility
 - System structure can be changed easily.
- Reliability
 - Easy to test a module and well tested modules are reliable.
- Durability
 - Well divided and independent module error does not affect too much to whole systems.

The benefits of RT-Component model

- Provides rich component lifecycle to enforce state coherency among components
- Defines data structures for describing components and other elements
- Supports fundamental design patterns
 - Collaboration of fine-grained components tightly coupled in time (*e.g.* Simulink)
 - Stimulus response with finite state machines
 - Dynamic composition of components collaborating synchronously or asynchronously

The aim of RT-Middleware

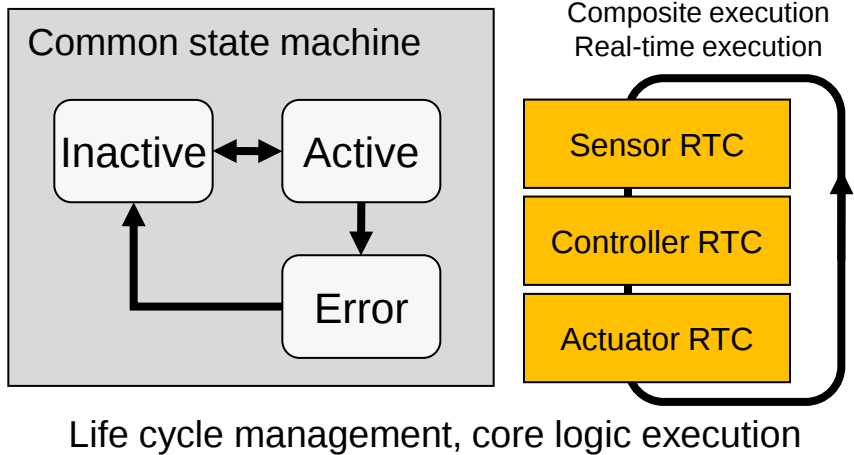
Problem Solving by Modularization



Robot System Integration Innovation

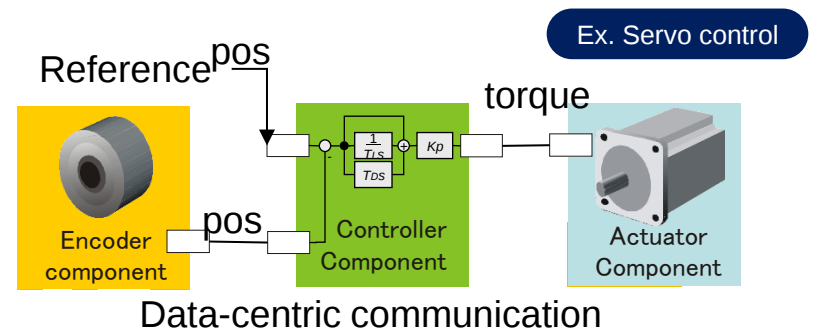
Main features of RT-Component

Activity, Execution context



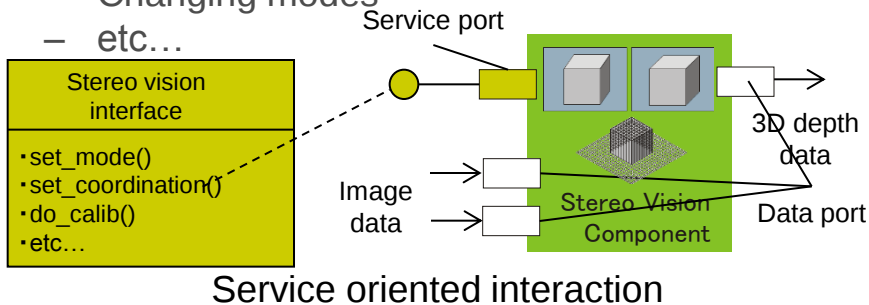
Data Port

- Data centric communication
- Continuous data transfer
- Dynamic connection/disconnection



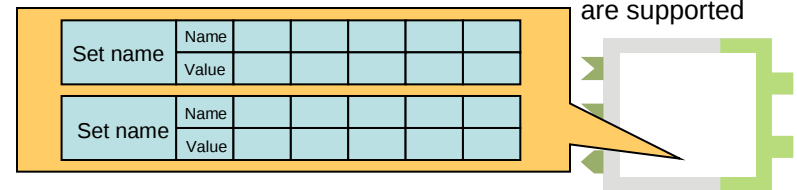
Service Port

- User defined interface
- Access to detailed functionality of RTC
 - Getting/setting parameters
 - Changing modes
 - etc...



Configuration

- Function for internal parameter
 - Multiple parameter sets
 - They can be changed from remote in run-time
- RTC can have several configuration sets. Runtime reconfiguration and dynamic switching are supported



RTM as a International Standard

OMG Standard

Standardized by OMG process

- It can not be modified by just one company
- Various compatible implementation
- It promoted competition and interoperability

Ten or more RT-Middleware implementation exist

Implementation	Vendor	Features	Compatibility
OpenRTM-aist	AIST	Reference implementation by AIST	---
HRTM	Honda R&D	ASIMO is now moving to HRTM	◎
OpenRTM.NET	SEC	.NET(C#,VB,C++/CLI, F#, etc..)	◎
RTM on Android	SEC	RTM implementation for Android	◎
RTC-Lite	AIST	Tiny implementation on PIC and dsPIC	○
Mini/MicorRTC	SEC	RTM/RTC for CAN and Zigbee	○
RTMSafety	SEC/AIST	Functional safety standard capable RTM implementation	○
RTC CANOpen	SIT, CiA	RTM for CANOpen standard	○
PALRO	Fujisoft	Yet another C++ PSM implementation	×
OPRoS	ETRI	Implementation of Korean national project	×
GostaiRTC	GOSTAI, THALES	C++ PSM implementation on a robot language	×

Users can chose and continue to use on of the RTM implementations

Date: September 2012



Robotic Technology Component (RTC)

Version 1.1

Normative reference: <http://www.omg.org/spec/RTC/1.1>
Machine consumable files: <http://www.omg.org/spec/RTC/20111205/>
Normative:
<http://www.omg.org/spec/RTC/20111205/rtc.xml>
<http://www.omg.org/spec/RTC/20111205/rtc.h>
<http://www.omg.org/spec/RTC/20111205/rtc.idl>
Non-normative:
<http://www.omg.org/spec/RTC/20111205/rtc.eap>

History

- September, 2005
Request for Proposal issued (starting standardization)
- September, 2006
Specification approved by OMG
- April, 2008
OMG RTC ver.1.0 released
- September, 2012
Updated to ver. 1.1
- September, 2015
FSM4RTC (FSM based RTC standard) adopted

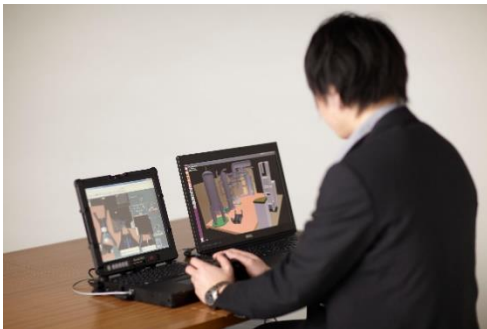
Application examples



HRP series: KAWADA industry Inc. and AIST S-ONE: SCHAFT



DAQ-Middleware: KEK/J-PARC
KEK: High Energy Accelerator Research Organization
J-PARC: Japan Proton Accelerator Research Complex



Disaster response robot simulator:
NEDO/Chiba Institute of Technology



HIRO, NEXTAGE open: Kawada Robotics



RAPUDA: Life Robotics



BeautoRover RTC/RTC-BT(VSTONE)



OROCHI (RT)



Mobile SEM

RT-Middleware Summer Camp

- 1 week camp every summer
- This year: Aug. 3rd ~ 7th
- Number of participants: 20
- Venue: AIST Tsukuba center (Tsukuba city, Ibaraki pref.)
- Lectures, practical work and presentation by five teams.
- Staying in the AIST's accommodation and coding endlessly every night :-P.



RT-Middleware Contest

- Held as an organized session in SICE SI conference
 - Various prizes
 - Entry deadline: Aug. 21st
 - Software registration: Oct.
 - Paper submission due: Sep. 25th
 - Online examination: from end of Nov.
 - Presentation and award ceremony: Dec.
- Record of year 2014
 - Number of applications : 20
 - SICE RT-Middleware award x1
 - Product supporting award x2
 - Company supporting award x11
 - Personal supporting award x7
- See more details: openrtm.org
 - Menu: community -> events



RTM Tutorial

- Regular tutorials
 - ROBOMECH (One of division on JSME)
Tutorial: June
 - Boot camp: just before on summer camp, 3 or 4 times in Tokyo, Nagoya, Osaka
- Other
 - International Robot Exhibition (iRex)



RTM Tutorials

iRex RTM Tutorial

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Date: Dec. 2nd, 2015 10:00-17:00
Venue: TOKYO Bigsight
Capacity: 30 for training
 (First-come-first-served basis)
Admission: Free
Web site <http://openrtm.org>

Thank you for your kind attention!!