



COBOTTA - a ROS-Enabled Collaborative Robot



@ ROS-INDUSTRIAL CONFERENCE 2018

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Manager**

DENSO Robotics Europe

Datum: 13.12.2018

Ort: Stuttgart

DENSO Corporation

- 1949** –DENSO established as a separate entity of TOYOTA Motor Co. Ltd.
- 1967** – Start development of robots
- 2018** – One of the 500 world's biggest companies
- 1 of TOP 3 auto parts suppliers worldwide
 - Market leader in small industrial robots

US \$48.1 billion
in annual revenue



170,000
employees
in 200 group companies



9% of revenue
invested in R&D



38,000
active patents worldwide



DENSO
Inventor of QR Code

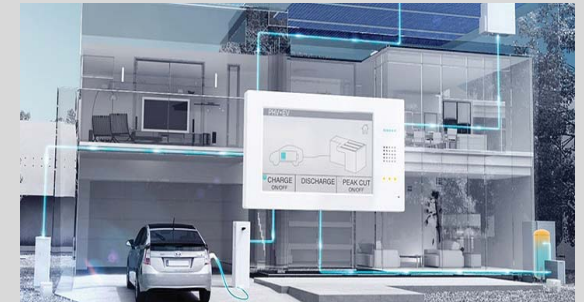


1) Automotive Industry

One of TOP3 auto parts suppliers



2) Consumer Products



3) New Business Fields

Energy Management , Electric Power assist, Security, Healthcare, Biotechnology, Agriculture technology(&Cold Chain).



4) Industrial Products



DENSO
Crafting the Core

Presentation venue / date / presenter name / department name
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ROS I-Conference: COBOTTA - a ROS-Enabled Collaborative Robot / 13.12.2018 / Arun Damodaran /
DENSO Robotics Europe

DENSO Robotics

Robotics Pioneer

50 Years

Over 50 Years (since 1967) of Industrial Robots Development for Industries.

100,000 Robots

Worldwide Market Leader in Small Segment Assembly Robots

OEM Supplier

Trusted OEM Supplier with world wide Trust to our Products even as OEM Supplier

20,000 Own Use

One of the World's Largest Robot Users and has Over 20,000 DENSO robots work in our own manufacturing facilities

Assembly



Packaging



Measurement



Pharma



Medical



Automotive parts



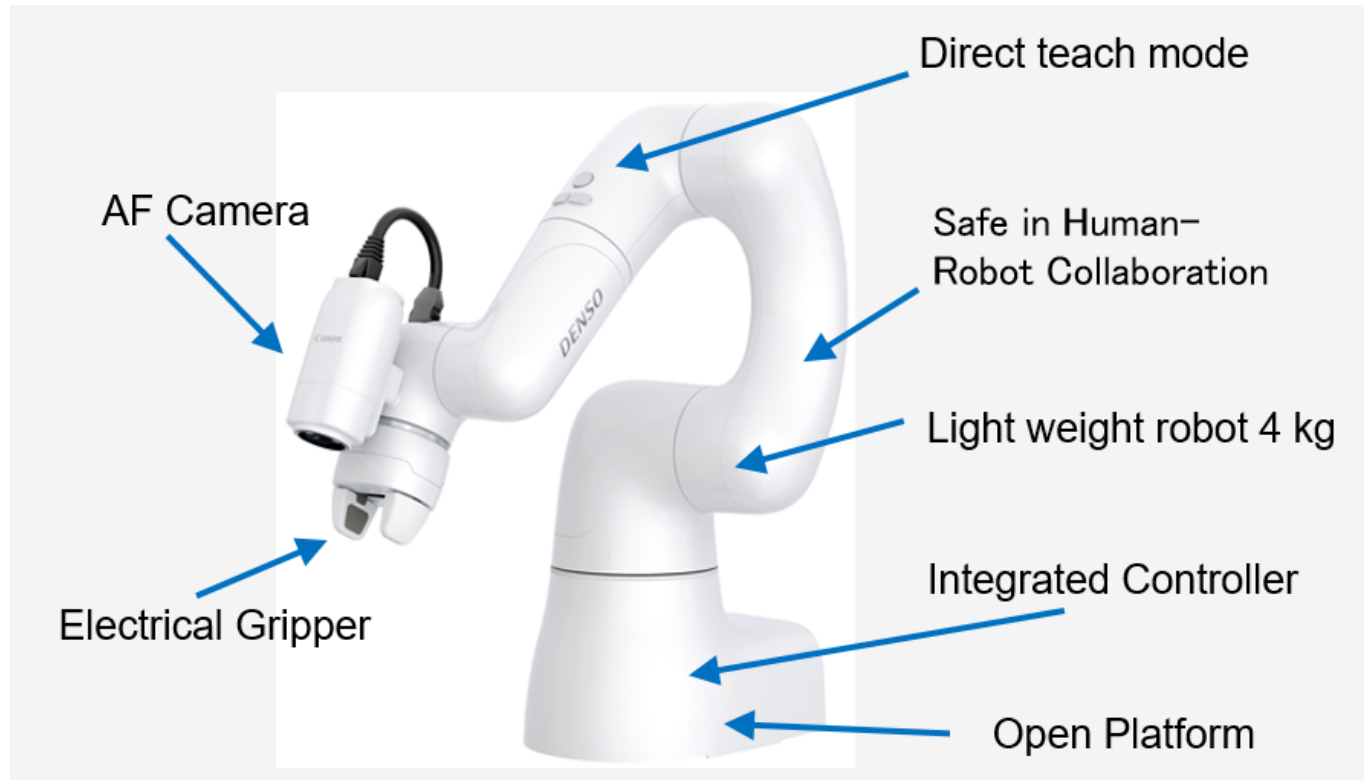
6-AXIS	VP SERIES		VS SERIES		NEW VS SERIES				VM SERIES	
	VP-5243G	VP-6242G	VS-6556G	VS-6577G	VS-050	VS-060	VS-068	VS-087	VM-6083G	VM-6081G
Max arm reach	430 mm	432 mm	653 mm	854 mm	505 mm	605 mm	710 mm	905 mm	1,021 mm	1,298 mm
Max payload	3kg	2.5 kg	7kg		4 kg		7kg		13 kg	
Repeatability	± 0.02 mm		± 0.02 mm	± 0.03 mm	± 0.02 mm		± 0.02 mm	± 0.03 mm	± 0.05 mm	± 0.07 mm
Cycle time	0.99 sec ¹		0.49 sec ²	0.59 sec ²	0.35 sec ²		0.31 sec ²	0.34 sec ²	0.89 sec ²	0.95 sec ²
Options	Standard (IP60)		• Standard (IP40) • Dust & splash-proof (IP65/54) • Cleanroom (ISO 5 & 8)		• Standard (IP40) • Dust & splash-proof (IP65/54) • Protected (IP67)		• Cleanroom (ISO 5 & 8) • UL specifications		• Standard (IP40) • Dust & splash-proof (IP65/54) • Cleanroom (ISO 5)	

4-AXIS	HS-A1 SERIES			HSR SERIES			HM SERIES			
	HS-035A1	HS-045A1	HS-055A1	HSR-048	HSR-055	HSR-065	HM-6060*G	HM-6070*G	HM-6085*G	HM-60A0*G
Max arm reach	350 mm	450 mm	550 mm	480 mm	550 mm	650 mm	600 mm	700 mm	850 mm	1,000 mm
Vertical Stroke		100, 150, 200 and 320 mm								
Max payload		5 kg								
Repeatability	± 0.015 mm	± 0.02 mm	± 0.02 mm	± 0.01 mm	± 0.012 mm	± 0.012 mm	± 0.02 mm			± 0.025 mm
Cycle time		0.29 sec ²		0.28 sec ²			0.31 sec ²			0.31 sec ²
Options	• Standard type (IP40) • Bellows on 3rd axis • Dust & splash-proof (IP65) • Cleanroom (ISO 5) • UL specifications ¹			• Standard type (IP40) • Dust & splash-proof (IP65) • Cleanroom (ISO 5 & 8)			• Standard type (IP40) • Bellows on 3rd axis • Dust & splash-proof (IP65) • UL specifications ¹			

Cobotta Overview - a ROS Enabled Collaborative Robot

COBOTTA

- Arm: 6 axis (+1 for electric Gripper)
- Reach: 342,5 mm
- Repeatability: 0,05 mm
- Payload: 500g (700g)
- Extended-joint motors



COBOTTA = COllaboration **roBOT** Technology for **Arm**

Cobotta Key features & concepts

1. Safe Design



Inherently safe design

- No sharp parts
- Designs to prevent pinching and rolling-in.

Safety Standards

- ISO 10218-1:2011
- ISO/TS 15066
- ISO 13849-1:2015
PL d/Cat 3



Compliance with functional safety

- Safety-rated monitored function (all axis)

2. Easy to use



Easy to set-up & Use

- 1st set up takes only few minutes
- Few minutes Start-up time for a new application



3. Portability

Efficiency & Flexibility through Easy Portability of Cobotta




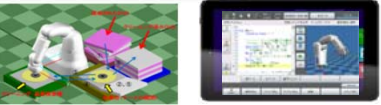

Pick & place on trolley or **ROS Enabled** - Mobile Platforms (AGV)



4. Open Platform – Advantages of COBOTTA

Wide possibilities to use COBOTTA - *from first time user to robot expert*

Programming Advantages

1. Cobotta World

2. RC8A compatible (PacScript)

3. PC Control (ORiN / b-CAP)

4. COBOTTA (OSS type)


Vision Connectivity

1. Vision via COBOTTA World

2. EVP Easy Vision Picking

3. CANON Vision Edition

4. External Vision Systems


External Control possibilities



Use of ROS with DENSO Industrial Robots



- DENSO has initiated the use of ROS internally and develop ROS packages and libraries actively from 2012 onwards.
- First Demonstration was made at IREX Fair 2013
- Steady development w.r.t additional functions, improvement of our Controllers focussing ROS usage

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denso indigo kinetic Show EOL distros: ☐

Documentation Status

denso: [denso_launch](#) | [denso_ros_control](#) | [vs060](#) | [vs060_gazebo](#) | [vs060_moveit_config](#)

Package Summary

✓ Released ✓ Continuous Integration ✓ Documented

Packages in the denso suite provide controller functionality for Denso's industrial manipulators.

ORiN (Open Robot interface for the Network) is a unified network interface for industrial robot applications and has been stably utilized in Denso's manipulators for years. Controllers in this package suite uses b-CAP, UDP-based control protocol defined in ORiN. It also has mechanism to detect faulty commands. Using b-CAP, ROS communicates to the embedded controller computer that has been achieving industry-proven reliability. The computer also has mechanism to detect faulty commands. That said as a whole the system maintains the same level of safeness with their commercial product setting.

Also, as a genuine ROS package, it enables robot application developers to access full ROS features. MoveIt! configuration package is also included for some of Denso's robots.

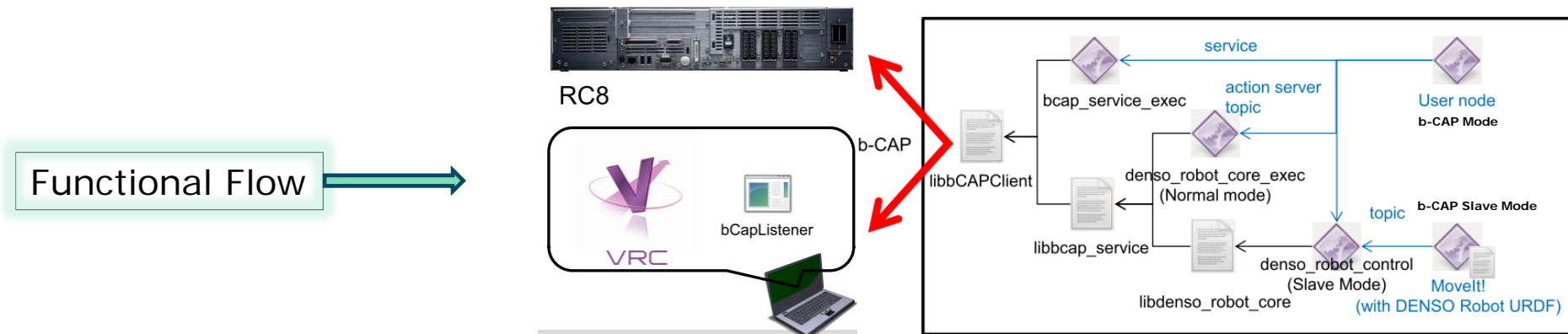
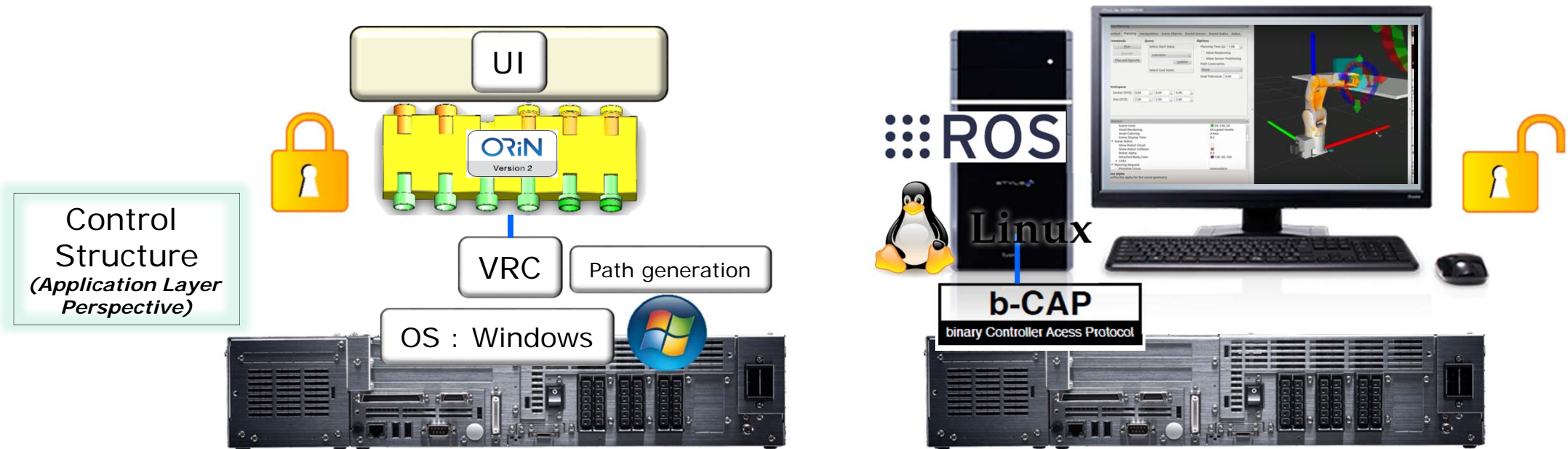
Core functionality

- Maintainer status: developed
- Maintainer: Ryohei Ueda <ueda AT jsk.t.u-tokyo.ac DOT jp>, TORK <dev AT opensource-robotics.tokyo DOT jp>
- Author: Ryohei Ueda, Kei Okada <k-okada AT jsk.t.u-tokyo.ac DOT jp>
- License: BSD
- Bug / feature tracker: <https://github.com/start-jsk/denso/issues>
- Source: git <https://github.com/start-jsk/denso.git> (branch: kinetic-devel)

Package Links
[Tutorials](#)
[FAQ](#)
[Changelog](#)
[Change List](#)
[Reviews](#)

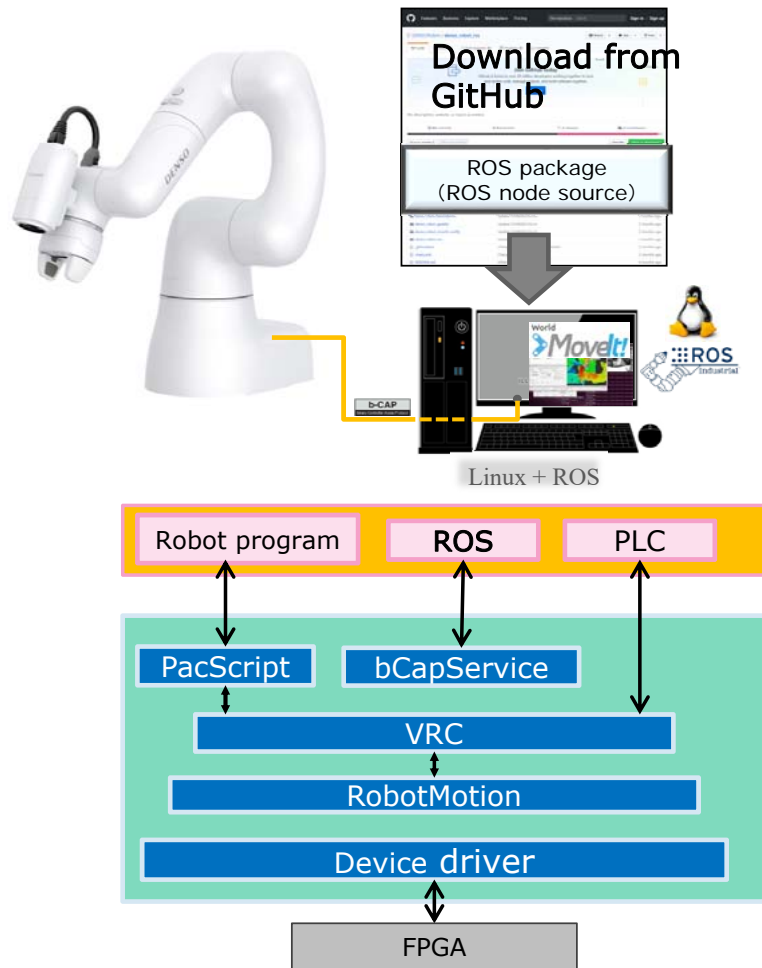
Dependencies (6)
Jenkins jobs (10)



Open Platform – Control Methodologies & Functional Overview



Open Platform - ROS based control of COBOTTA

1st Method - Using DENSO basic OS version



 : Customer Development
 : offered by DENSO

Basic OS: Control from external PC which has installed ROS (same as RC8A)

- Utilising the existing facilities - PC control.

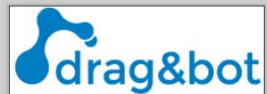
COBOTTA with 'drag&bot' Software

drag&bot adds options to control DENSO Robots

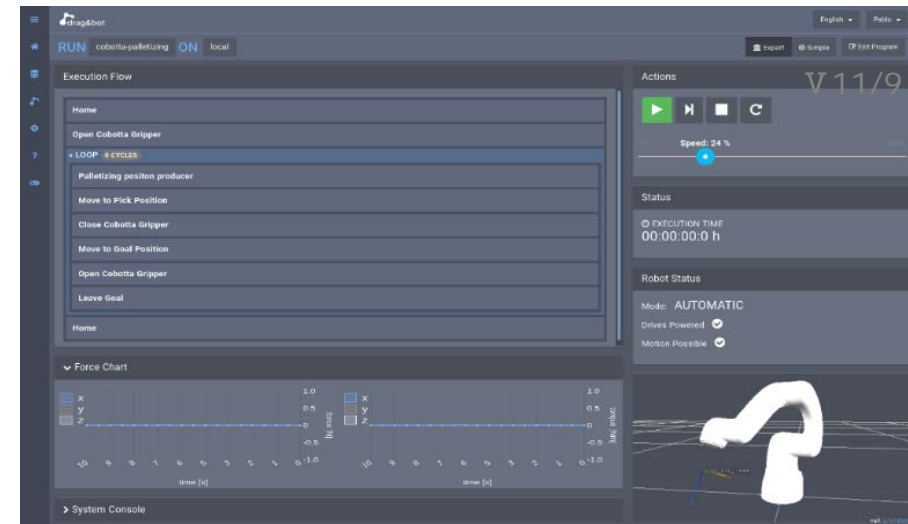
drag&bot is a software developed over ROS platform for a simple, graphical setup and programming of robotic applications. drag&bot works perfect with COBOTTA and other Denso robots.

Benefits:

- Everyone can operate and program robots
- No IT/robot skills or expensive training required
- 5x faster programming of robots in comparison to normal robot programming
- Enables cost-efficient automation by flexible change of robot tasks



www.dragandbot.com



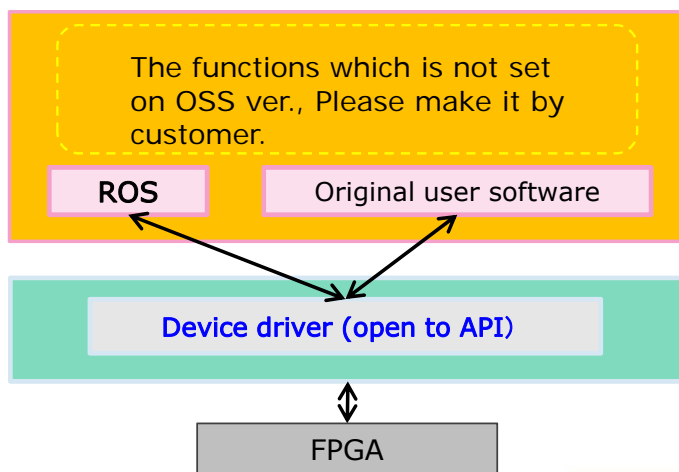
Open Platform - ROS based control of COBOTTA

2nd Method – OSS Type (Open Source Software)

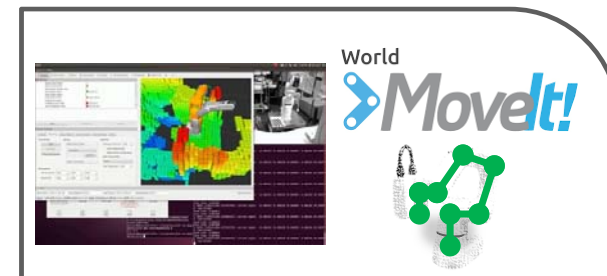
OSS: Control of COBOTTA with ROS

Built-in controller and API for controls

- Individual development environment (Linux+ROS)
- Suitable for Development, Investigation and education (Linux + ROS)



Especially thought for ROS Enthusiasts !!!



ROS
(Installed by the customer)

- (1) DENSO ROS package
For COBOTTA
(ROS Node, source)



OS : Linux Ubuntu
(Installed by the customer)

- (2) Dedicated driver for
COBOTTA
(Source)



Provided as open source software
(1) DENSO ROS package
(2) Dedicated driver for COBOTTA

Open Platform - ROS Access Links for COBOTTA

Supporting ROS with Cobotta

- Links to access the ROS Packages for DENSO -



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denso_robot_ros

indigo kinetic Documentation Status

Package Summary

The denso_robot_ros stack contains libraries, configuration files controlling a DENSO robot from ROS.

- Maintainer status: developed
- Maintainer: DENSO WAVE INCORPORATED <denso_robot_software@denso-wave.co>
- Author: DENSO WAVE INCORPORATED <denso_robot_software@denso-wave.co>
- License: MIT
- Source: git https://github.com/DENSORobot/denso_robot_ros (branch: kinetic-devel)
- Latest build: [View build logs](#)

1. Status

DEVEL The stack is ready to be built

2. Overview

This stack contains packages that ROSIA. It currently supports ROS 1 and an associated MoveIt configuration ROSConverter page for creating 1

Download files from GitHub

43 commits 4 branches 2 releases 2 contributors

Commit	Message	Time
YoshihiroMYAKOSHIE	Add send_format and recv_format parameters	27 Dec 2017
bcap_core	Update CHANGELOG.rst	2 months ago
bcap_service	Update CHANGELOG.rst	2 months ago
bcap_service_test	Update CHANGELOG.rst	2 months ago
denso_robot_bringup	Add send_format and recv_format parameters	a month ago
denso_robot_control	Change check_robot function	2 months ago
denso_robot_core	Update CHANGELOG.rst	2 months ago
denso_robot_core_test	Update CHANGELOG.rst	2 months ago
denso_robot_descriptions	Update CHANGELOG.rst	2 months ago
denso_robot_gazebo	Update CHANGELOG.rst	2 months ago
gitmodules	Change bcap_core to none submodule	2 months ago
travis.yml	Change to industrial_core's one	2 months ago
README.md	Initial commit	4 months ago

http://wiki.ros.org/denso_robot_ros

https://github.com/DENSORobot/denso_robot_ros

ROS packages for DENSO Robots

We provide 7 ROS Packages as DENSO ROBOT ROS

- 2 Packages for Simulation of DENSO Robot
- 4 Packages for Controlling Real DENSO Robot
- 1 Package for creating Path Trajectory easily

Packages for Simulation:

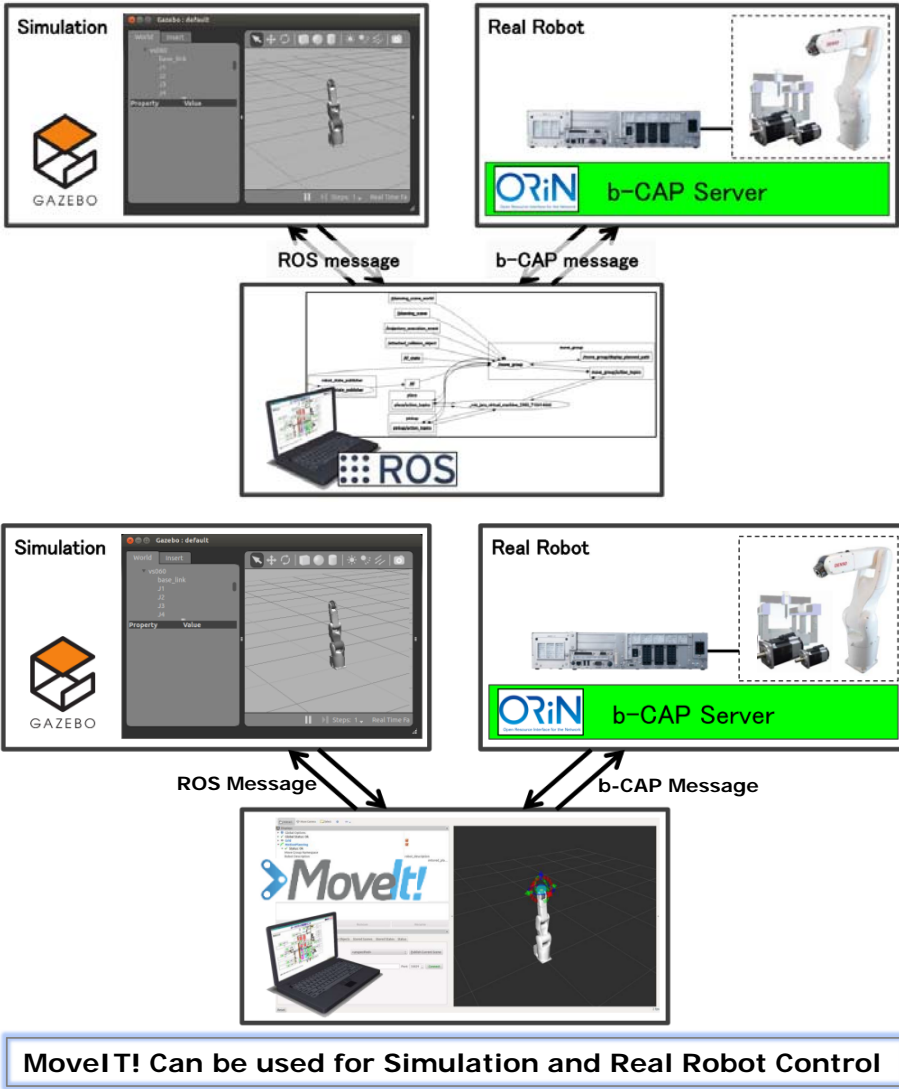
Package	Description
denso_robot_gazebo	ROS package for starting DENSO robot simulation by Gazebo.
denso_robot_descriptions	ROS package containing some DENSO robot's URDF files.

Packages to control Real Robot:

Package	Build Output	Description
bcap_core	Lib: libbCAPClient.so	ANSI-C library for sending and receiving b-CAP packets.
bcap_service	Lib: libbcap_service.so Node: bcap_service_exec	ROS node containing all of b-CAP methods. Provide 1 ROS service for sending and receiving b-CAP packets.
denso_robot_core	Lib: libdenso_robot_core.so Node: denso_robot_core_exec	ROS node containing general DENSO robot's functions, such as move or variable read and write. Provide some ROS action and message.
denso_robot_control	Node: denso_robot_control	ROS node for controlling DENSO robot by your original motion planning.

Packages for Path Generation:

Package	Description
denso_robot_moveit_config	ROS package for starting MoveIt! with DENSO robot.



ROS Integration with 6-Axis Industrial Robot

Steps to use DENSO Robot in ROS => MoveIT!'s ROS Plugin

Install DENSO ROS Package as Pre-requisite

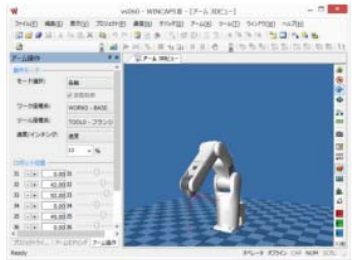
```
$ rosdep install vs060  
$ ros-$YOUR_ROSDISTRO$-moveit-ros-visualization
```

Execute MoveIT! Launch => Rviz Plugin

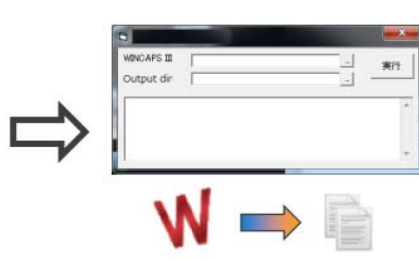
```
$ roslaunch denso_launch denso_vs060_moveit_demo_simulation.launch
```

ROS Converter - Tool for any further DENSO Robots

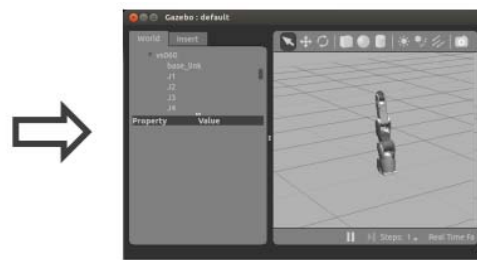
Easily generate DENSO Robot URDF Model from WINCAPS Software !!



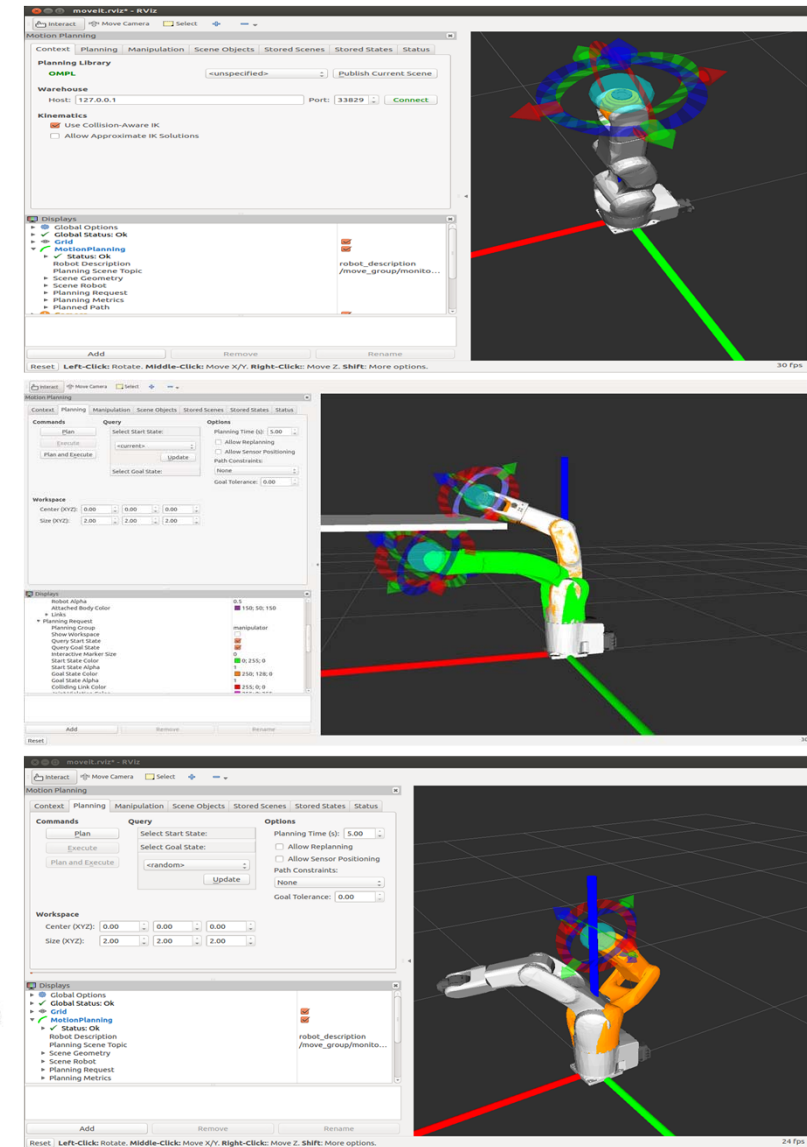
Create WINCAPS III Project



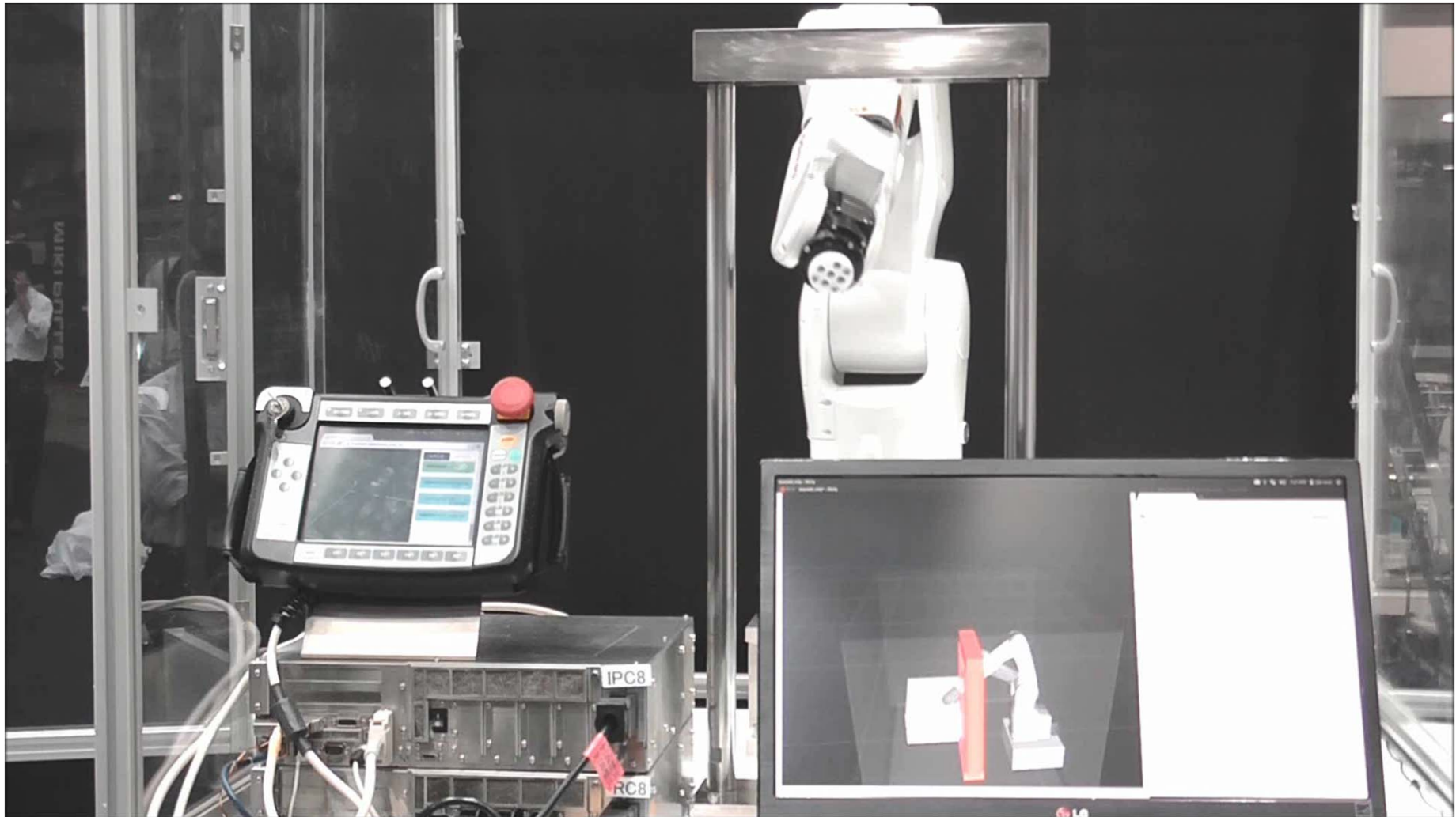
Convert WPJ to URDF



Copy URDF to Linux, and Start Simulation

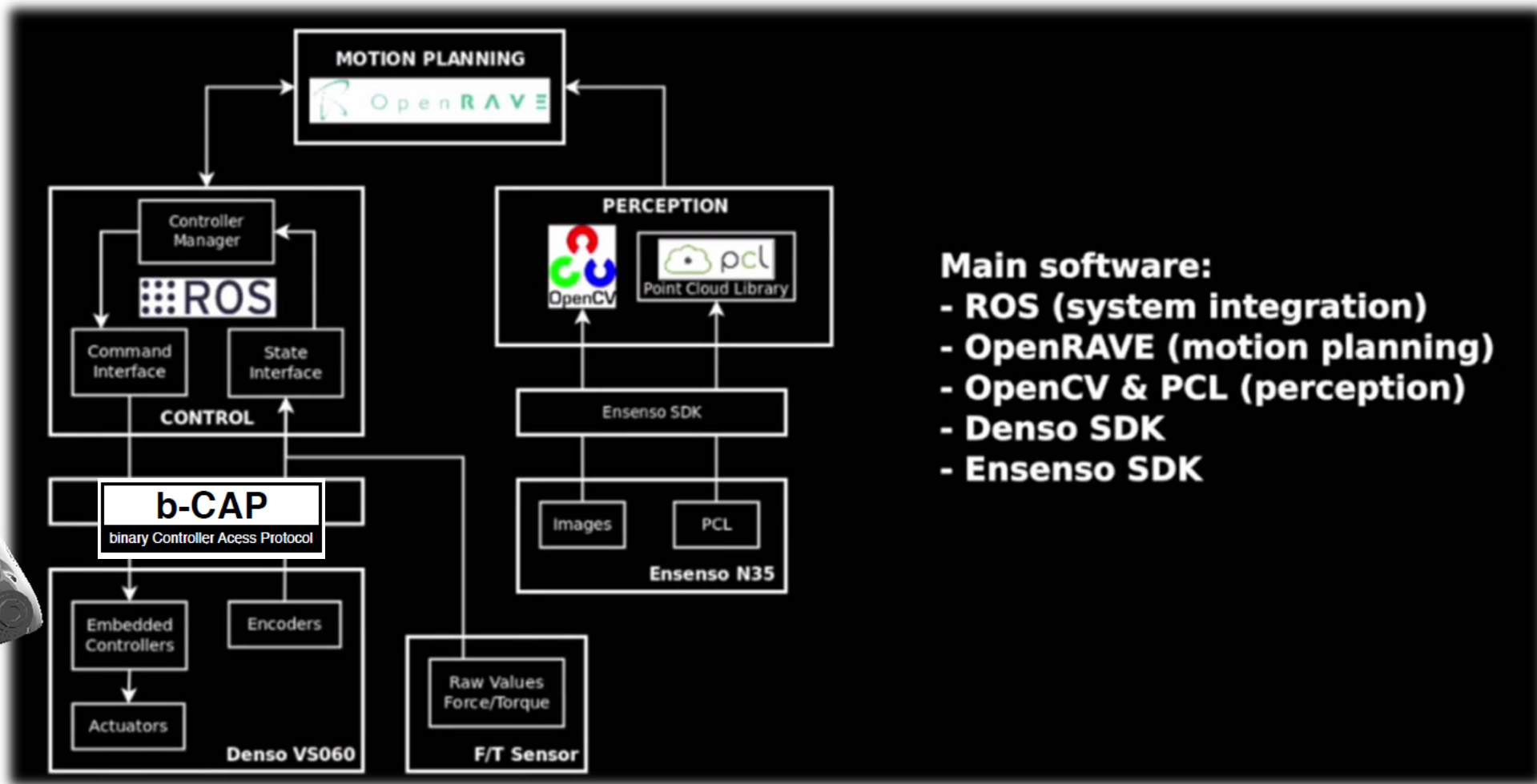


DENSO VS-060 with ROS



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DENSO VS-060 with ROS – Practical Example



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DENSO VS-060 with ROS – Practical Example

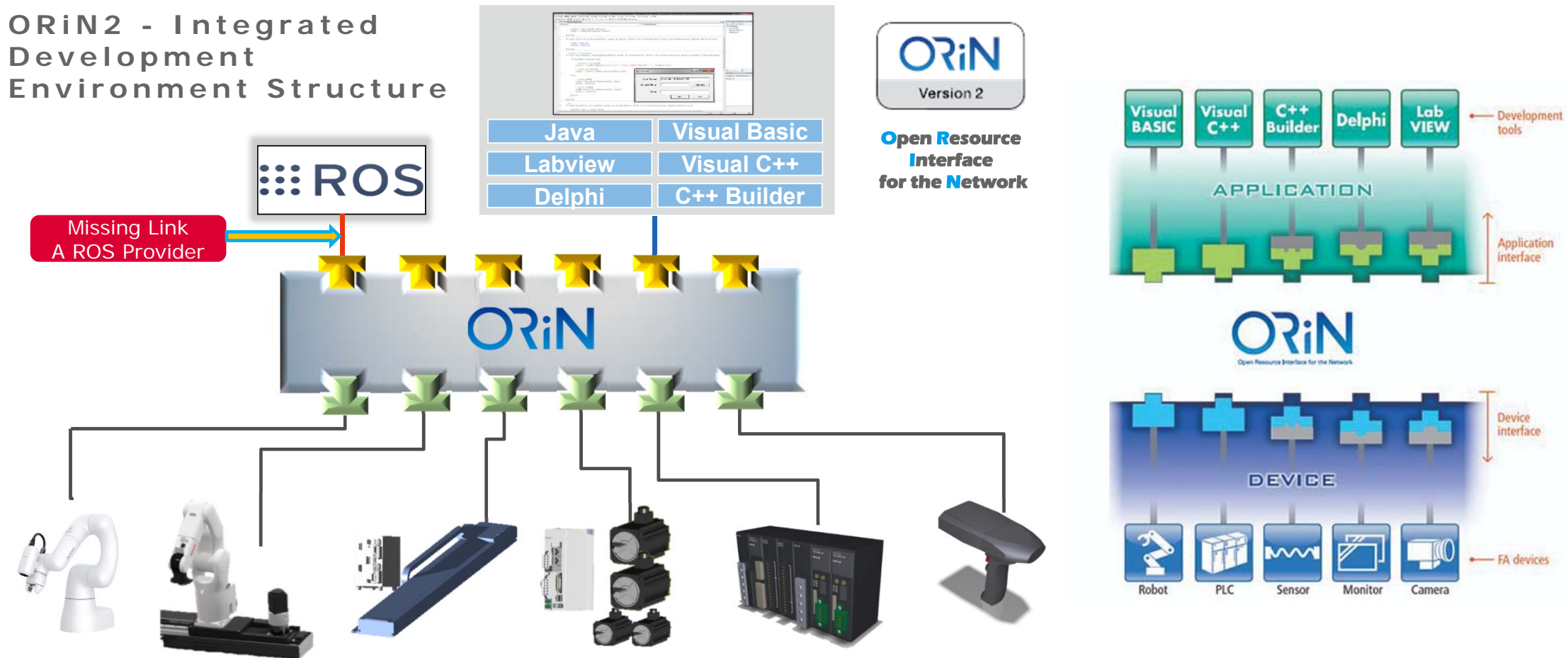


Courtesy: NTU, Singapore

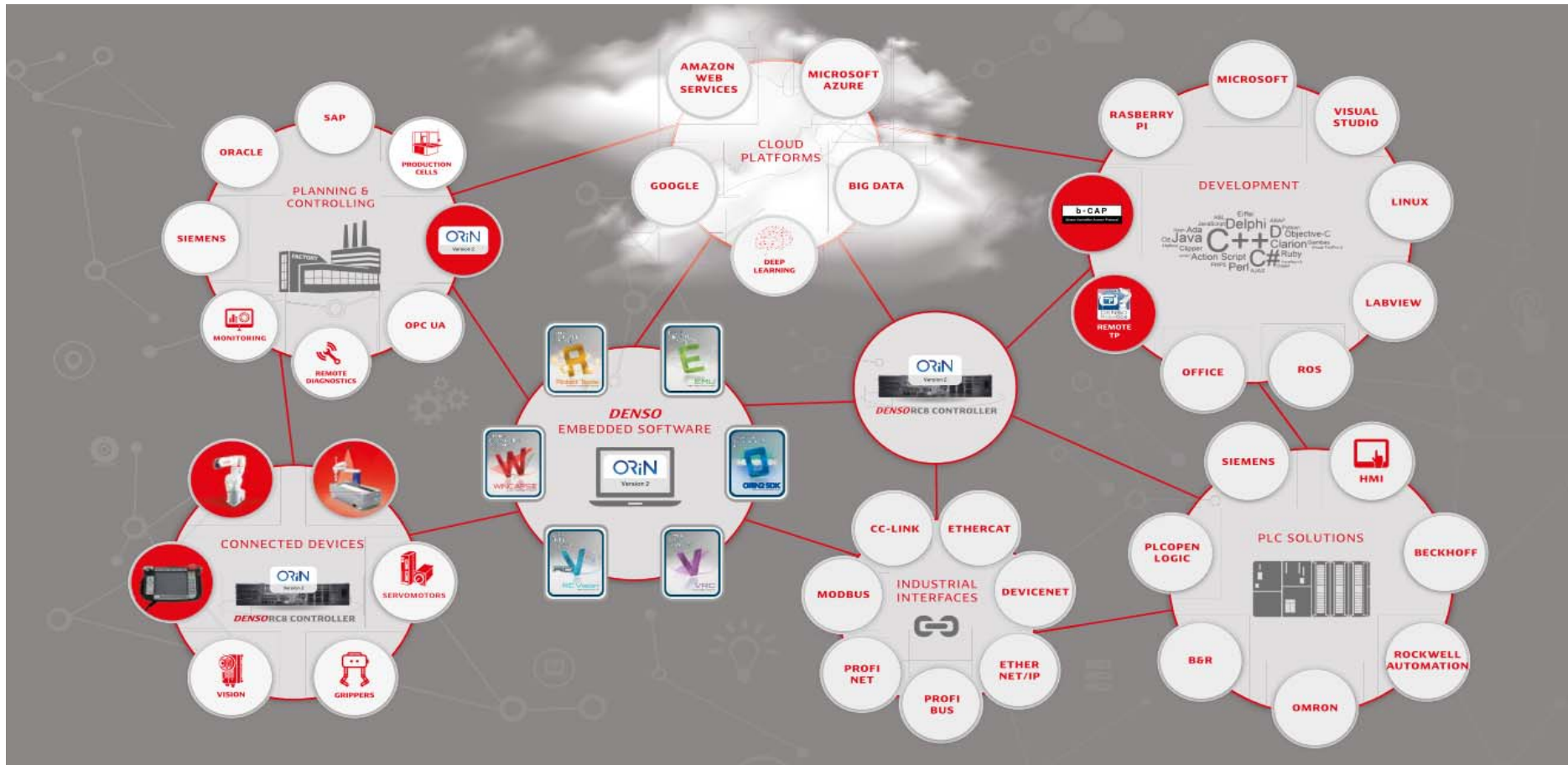
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ORiN2 – IDE for Applications and Industry 4.0

ORiN2 - Integrated Development Environment Structure



ORiN/DENSO – IIoT Solution Overview



Summary

- ✓ DENSO Robots and Cobotta provides wide possibilities to ROS users
- ✓ Cobotta laying special focus on ROS Users, has an option of OSS Version for customers to install the OS and User software directly
- ✓ DENSO is steadily supporting development of ROS drivers and Libraries

DENSO

Crafting the Core

Thank You