DENSO
Crafting the Core

COBOTTA - a ROS-Enabled Collaborative Robot

@ ROS-INDUSTRIAL CONFERENCE 2018

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DENSO Robotics Europe

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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

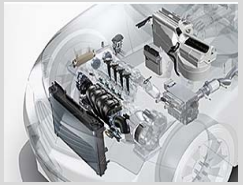
9% of revenue
invested in R&D

38,000
active patents worldwide

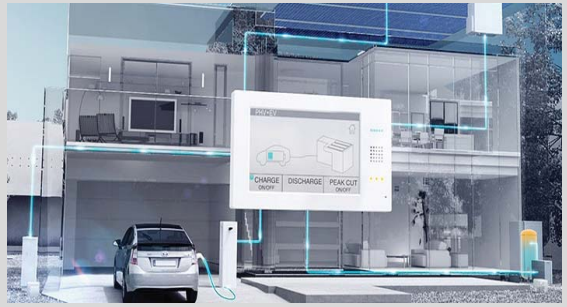
DENSO
Inventor of QR Code

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 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

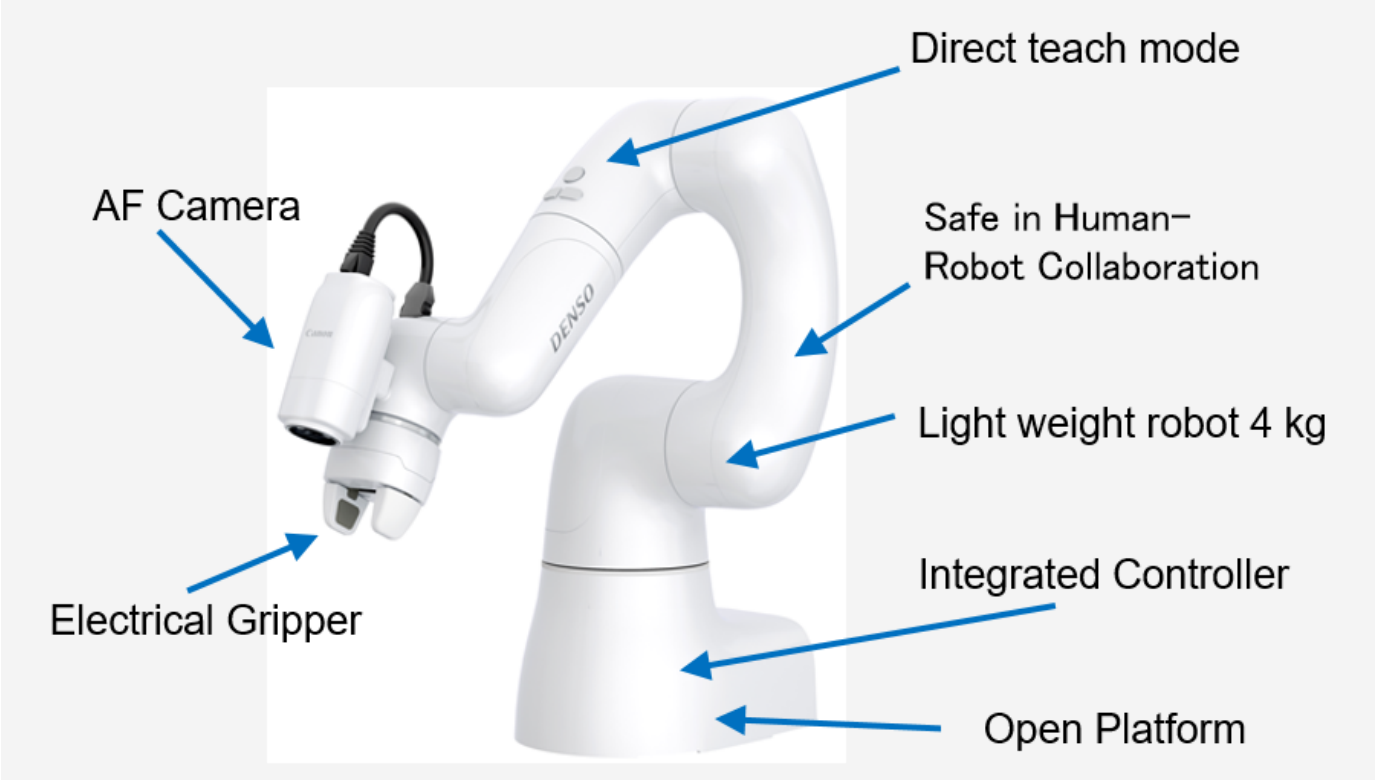
Medical

Automotive parts

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 ro**BOT T**echnology for **A**rm

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 Plattforms (AGV)

4. Open Platform – Advantages of COBOTTA

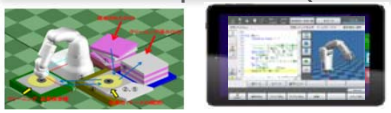
Wide possibilities to use COBOTTA - *from first time user to robot expert*

Programming Advantages

1. Cobotta World

RC8A compatible (PacScript)

2.



PC Control (ORiN / b-CAP)

3.

COBOTTA(OSS type)

4.

Vision Connectivity

1. Vision via COBOTTA World

2. EVP Easy Vision Picking

3. CANON Vision Edition

4. External Vision Systems

External Control possibilities

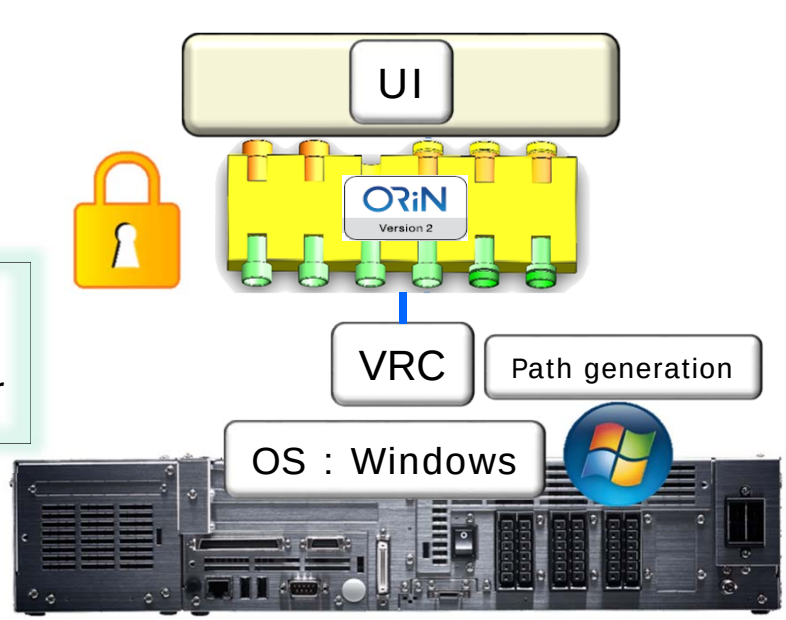
Use of ROS with DENSO Industrial Robots

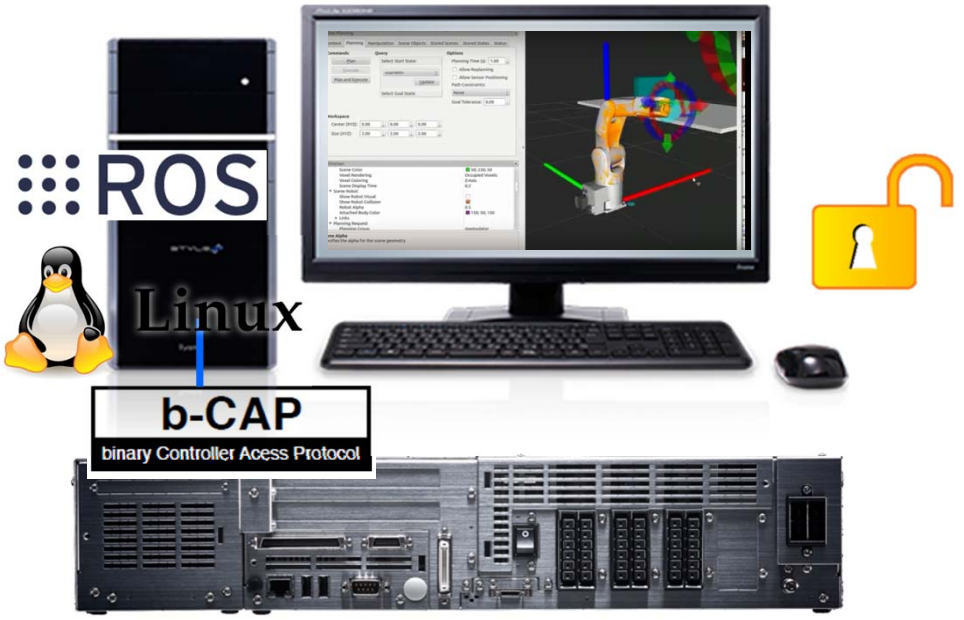
ROS.org + DENSO

- 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

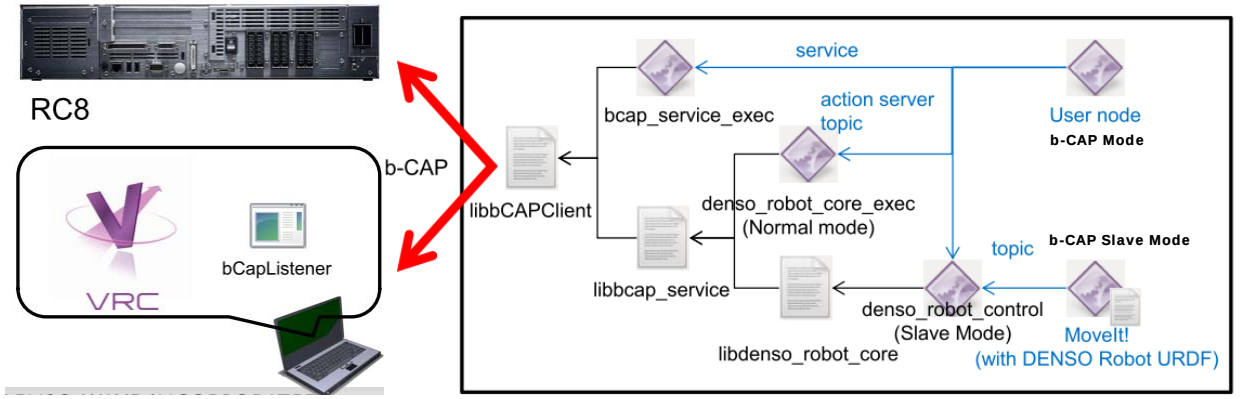
Open Platform – Control Methodologies & Functional Overiew

Control Structure
(Application Layer Perspective)



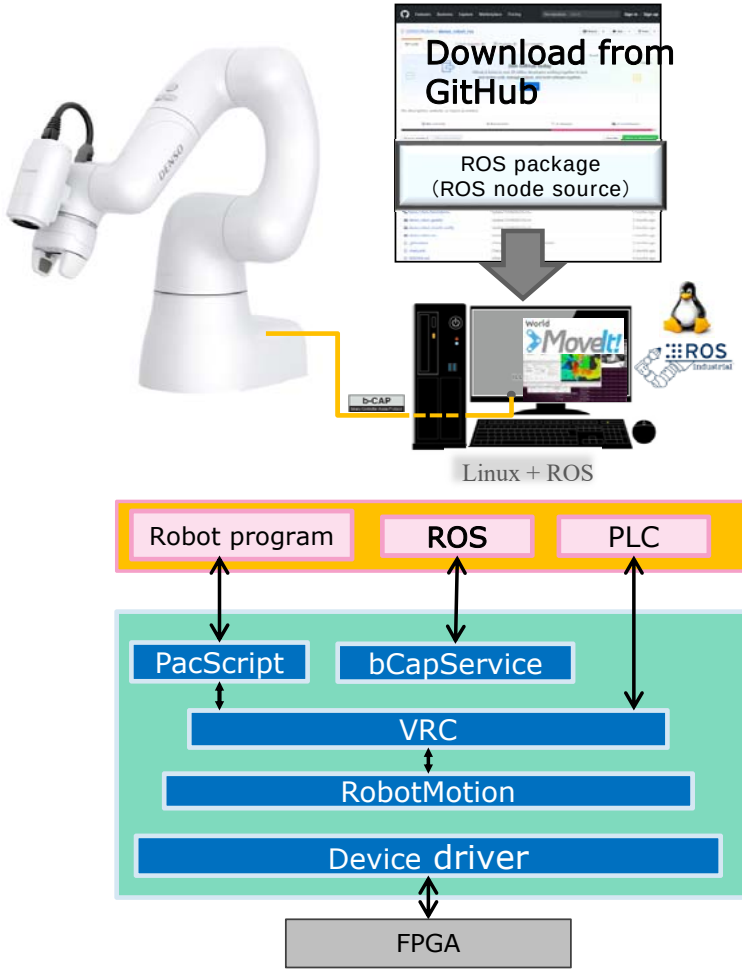


Functional Flow



Open Platform - ROS based control of COBOTTA

1 st 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

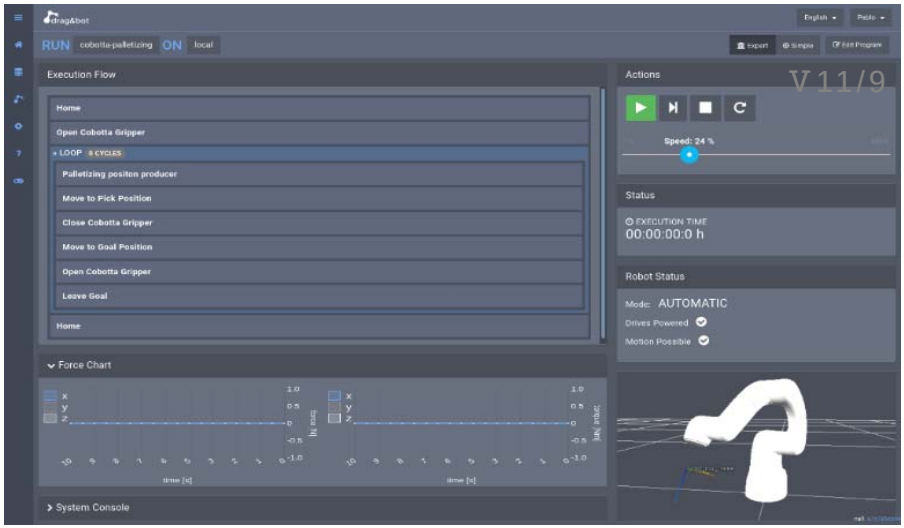
drag&bot is a software developed over ROS platform for a simple, graphical setup and programming of robotic applications. drag&bot works perfect with COBOTTA and other Denso robots.

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

drag&bot

www.dragandbot.com



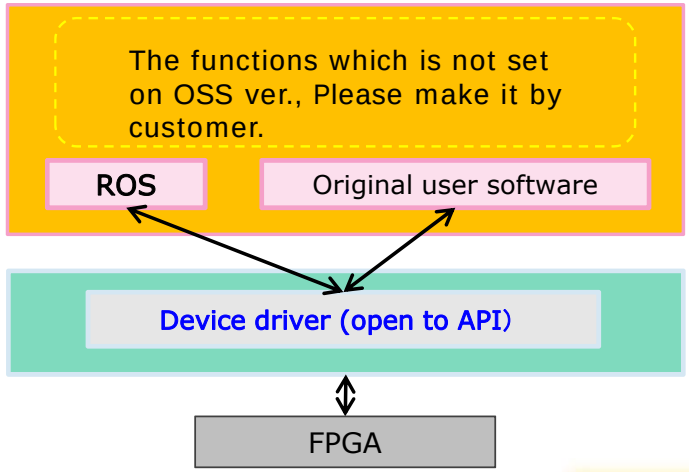
Open Platform - ROS based control of COBOTTA

2nd Method – OSS Type (Open Source Software)

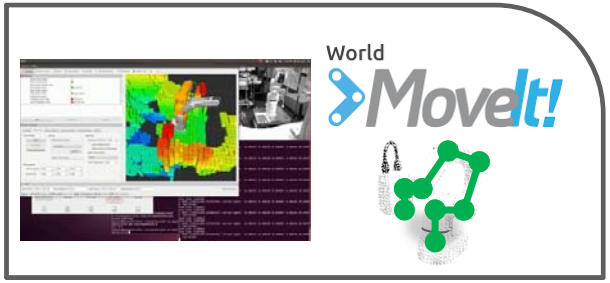
OSS: Control of COBOTTA with ROS

Built-in controller and API for controls

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



: Customer Development
: offered by DENSO



ROS
(Installed by the customer)

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

ROS

OS : Linux Ubuntu
(Installed by the customer)

(2) Dedicated driver for
COBOTTA
(Source)

ubuntu

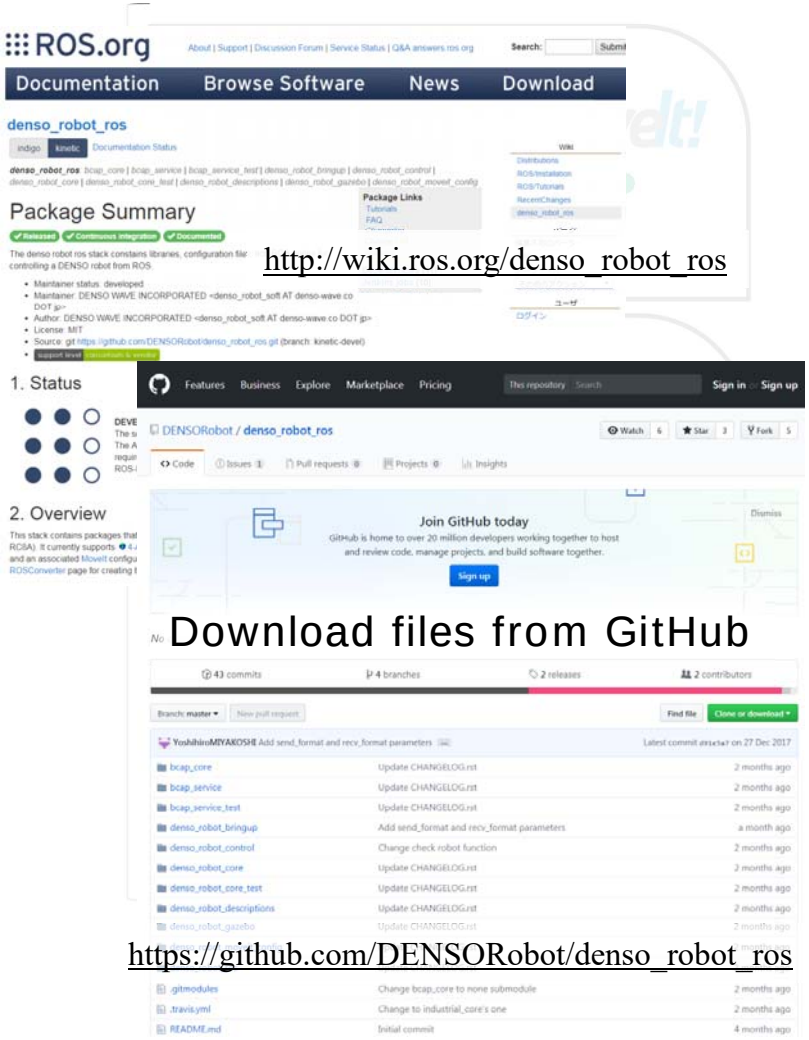
Provided as open source software
(1) DENSO ROS package
(2) Dedicated driver for COBOTTA

Especially thought for ROS Enthusiasts !!!

Open Platform - ROS Access Links for COBOTTA

Supporting ROS with Cobotta

- Links to access the ROS Packages for DENSO -



http://wiki.ros.org/denso_robot_ros

Download files from GitHub

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 Trajetory easily

Packages for Simulation:

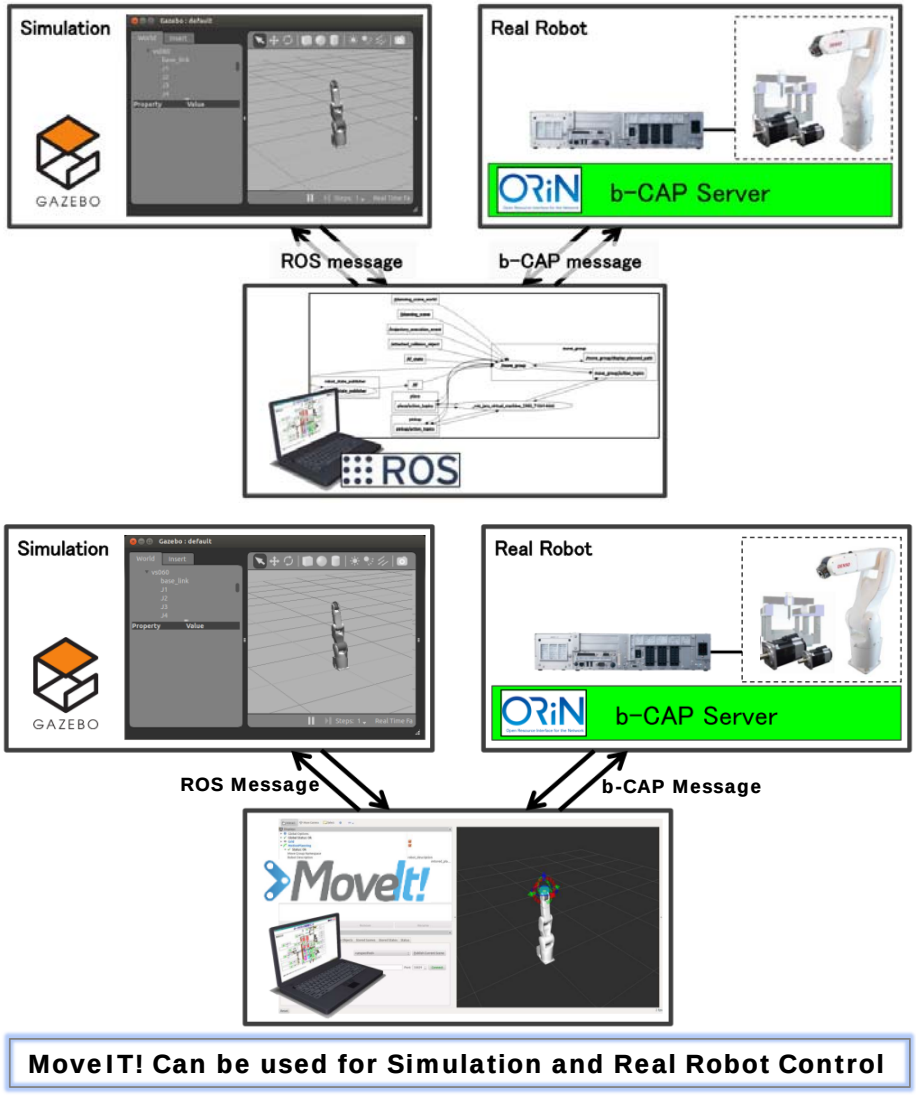
Package	Description
denso_robot_gazebo	ROS package for starting DENSO robot simulation by Gazebo.
denso_robot_descriptions	ROS package containing some DENSO robot's URDF files.

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.



MoveIT! Can be used for Simulation and Real Robot Control

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

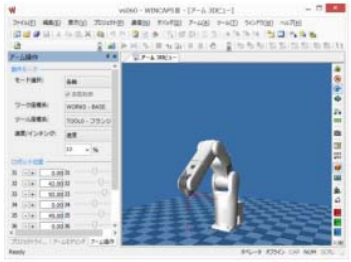
```
$ rosdep install vs060
$ ros-$YOUR_ROSDISTRO$-moveit-ros-visualization
```

Execute MoveIT! Launch => Rviz Plugin

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

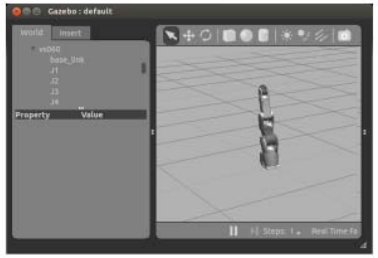
ROS Converter - Tool for any further DENSO Robots

Easily generate DENSO Robot URDF Model from WINCAPS Software !!

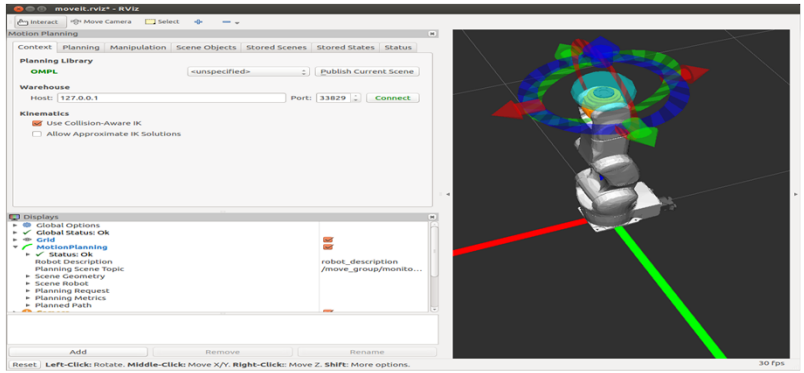


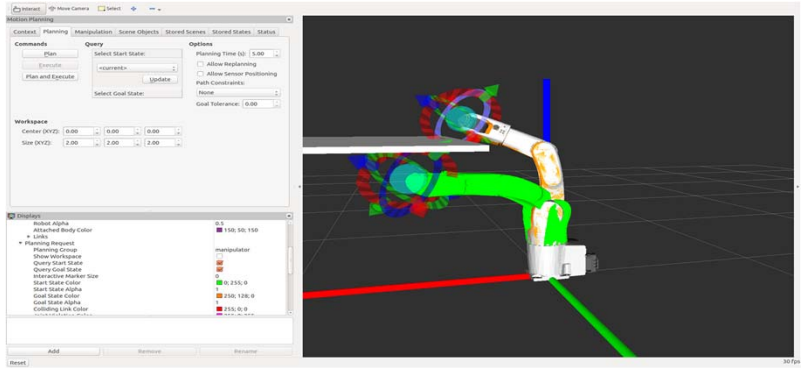
Create WINCAPS III Project

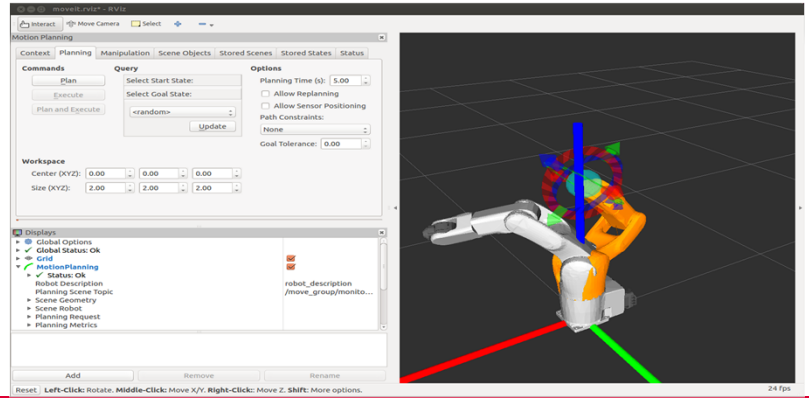
Convert WPJ to URDF



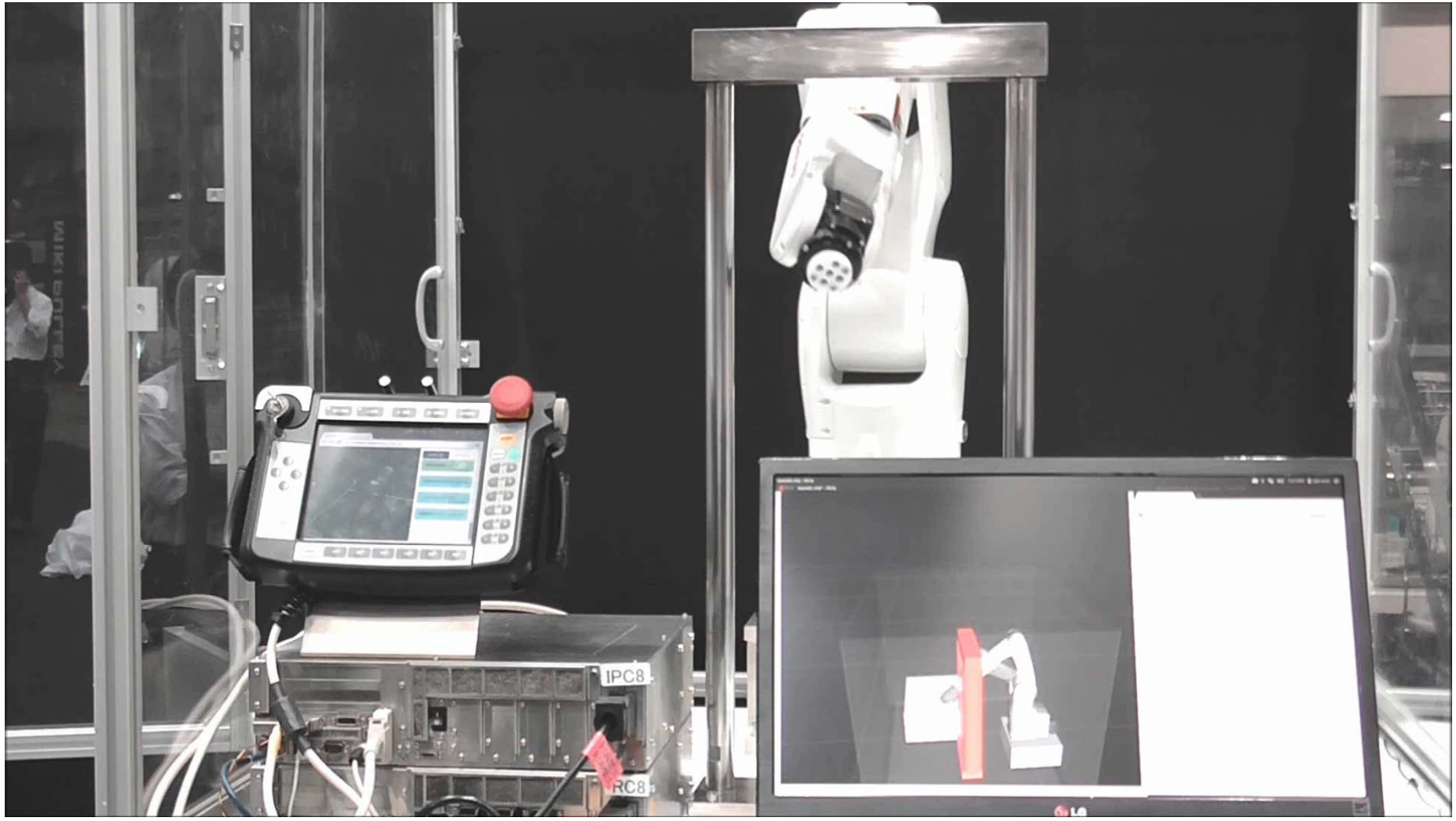
Copy URDF to Linux, and Start Simulation



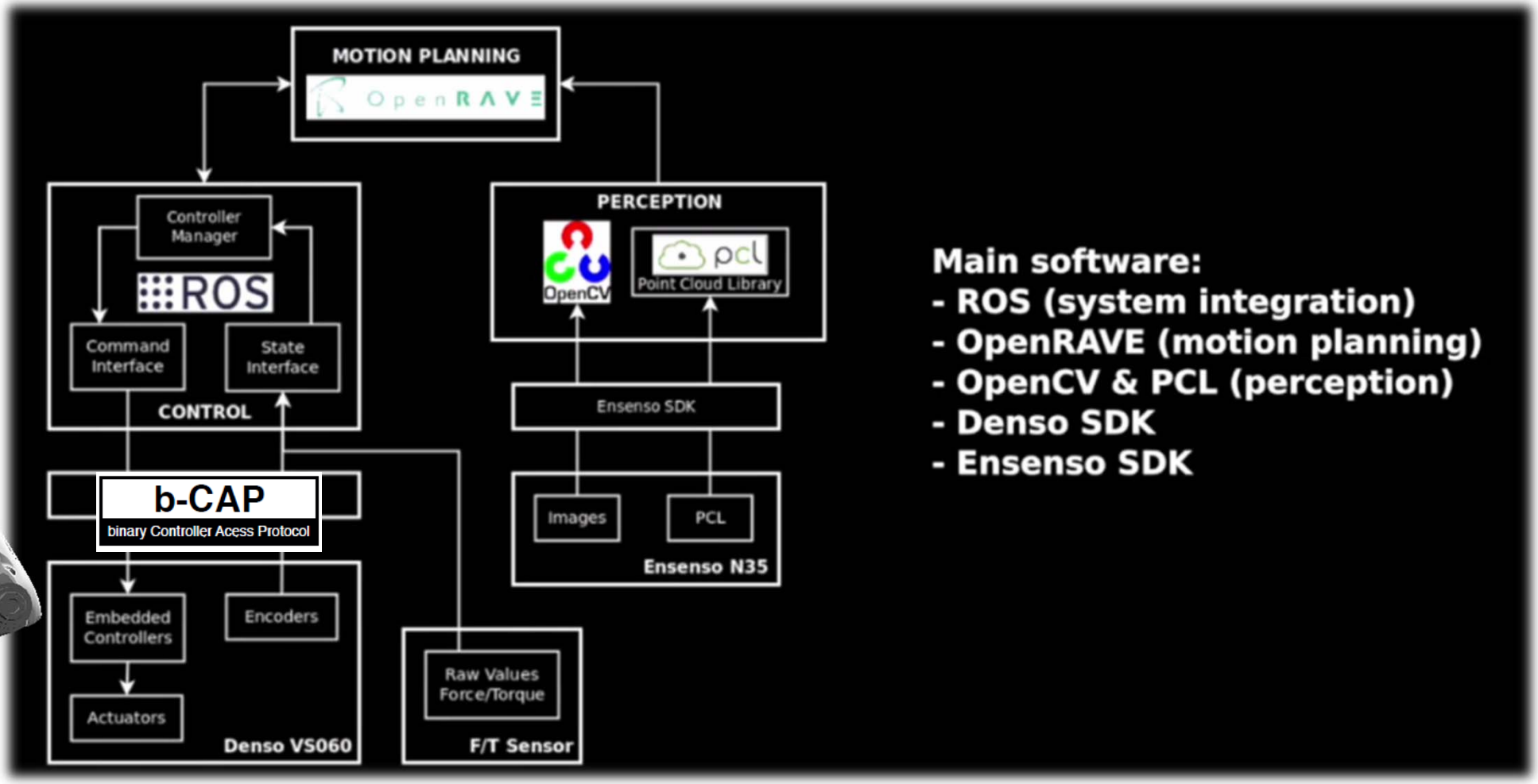




DENSO VS-060 with ROS



DENSO VS-060 with ROS – Practical Example

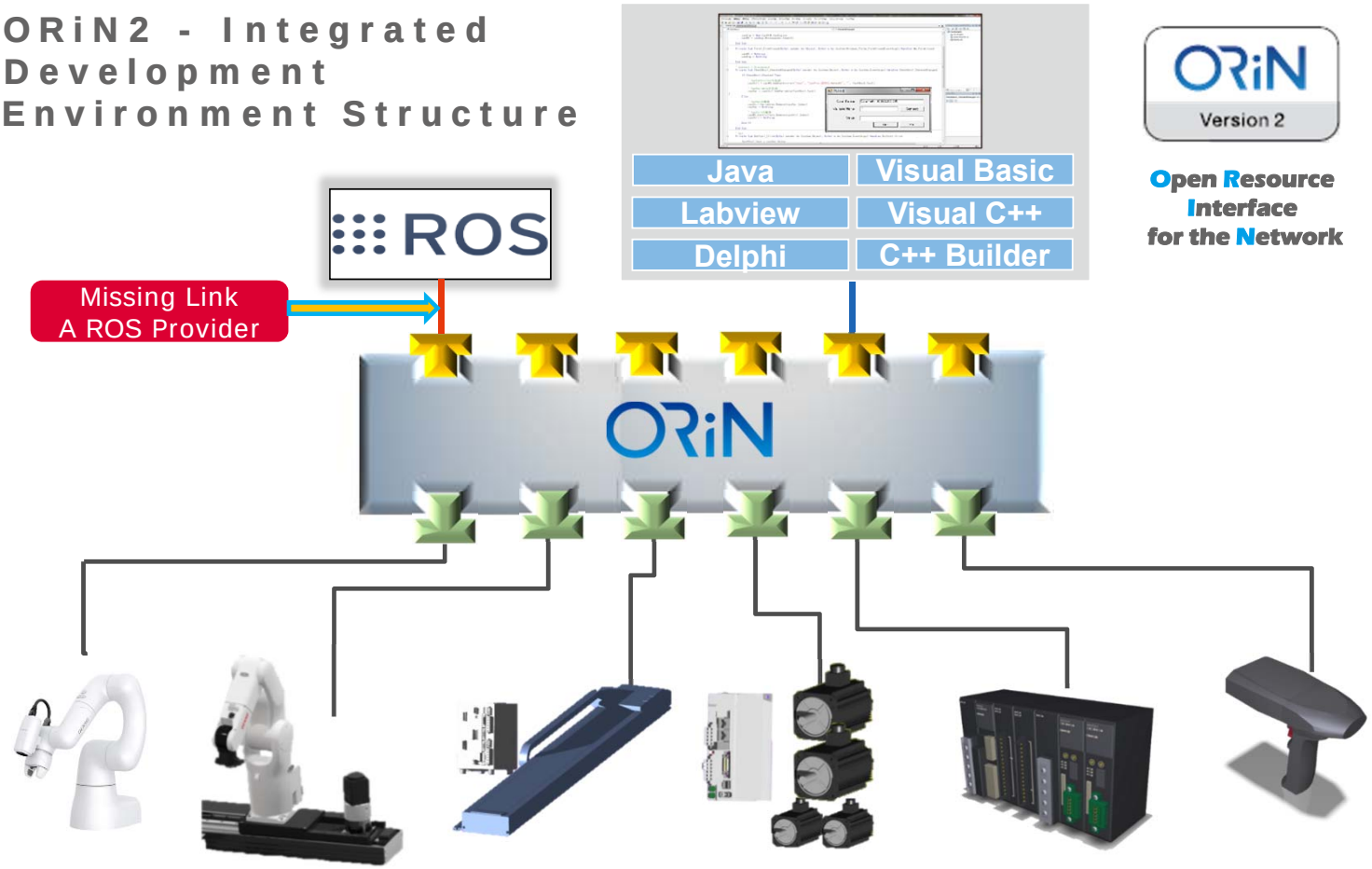


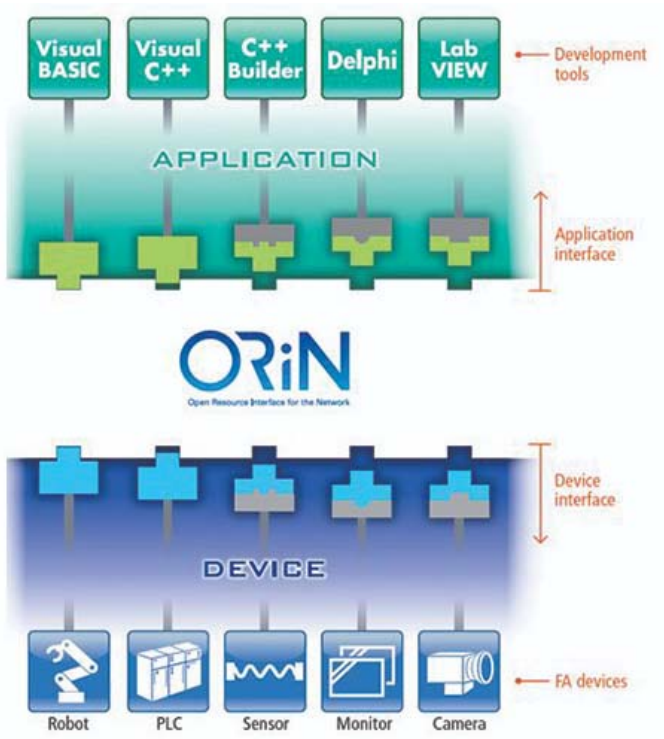
DENSO VS-060 with ROS – Practical Example

Courtesy: NTU, Singapore

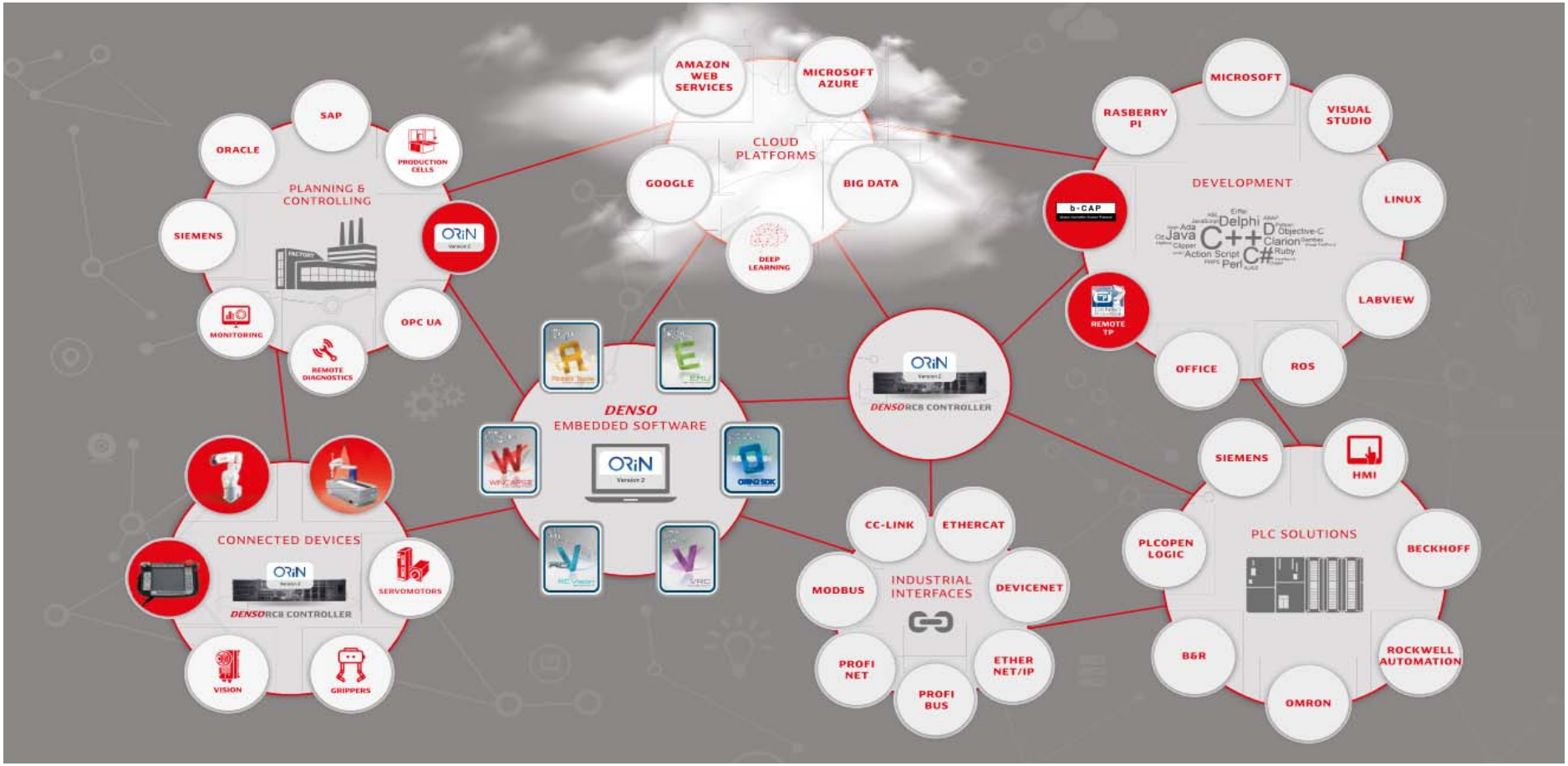
ORiN2 – IDE for Applications and Industry 4.0

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