Using ROS2 for Vision-Based Manipulation with Industrial Robots

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BOSCH

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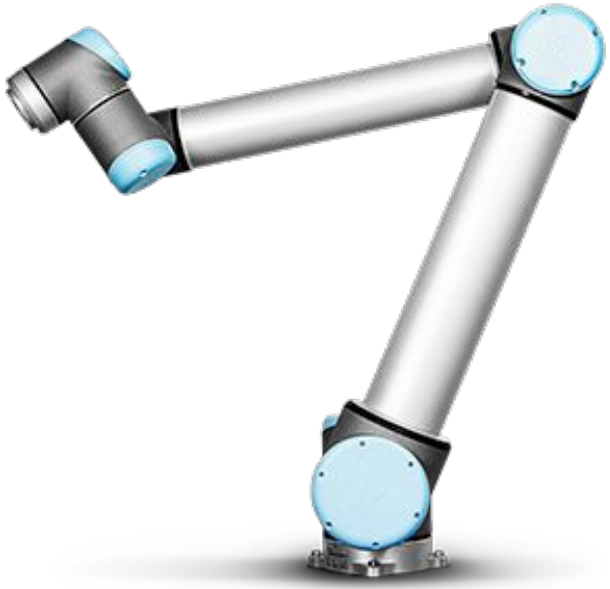
ABB



DDS
Auto-Discovery

Cross Platform

QoS

ament_resource_index

Multi-Node
Processes

Composition

Namespacing

Security

ROS1 Bridge

Parameters

Lifecycle Nodes

Intra Process
Communication

Cross Language

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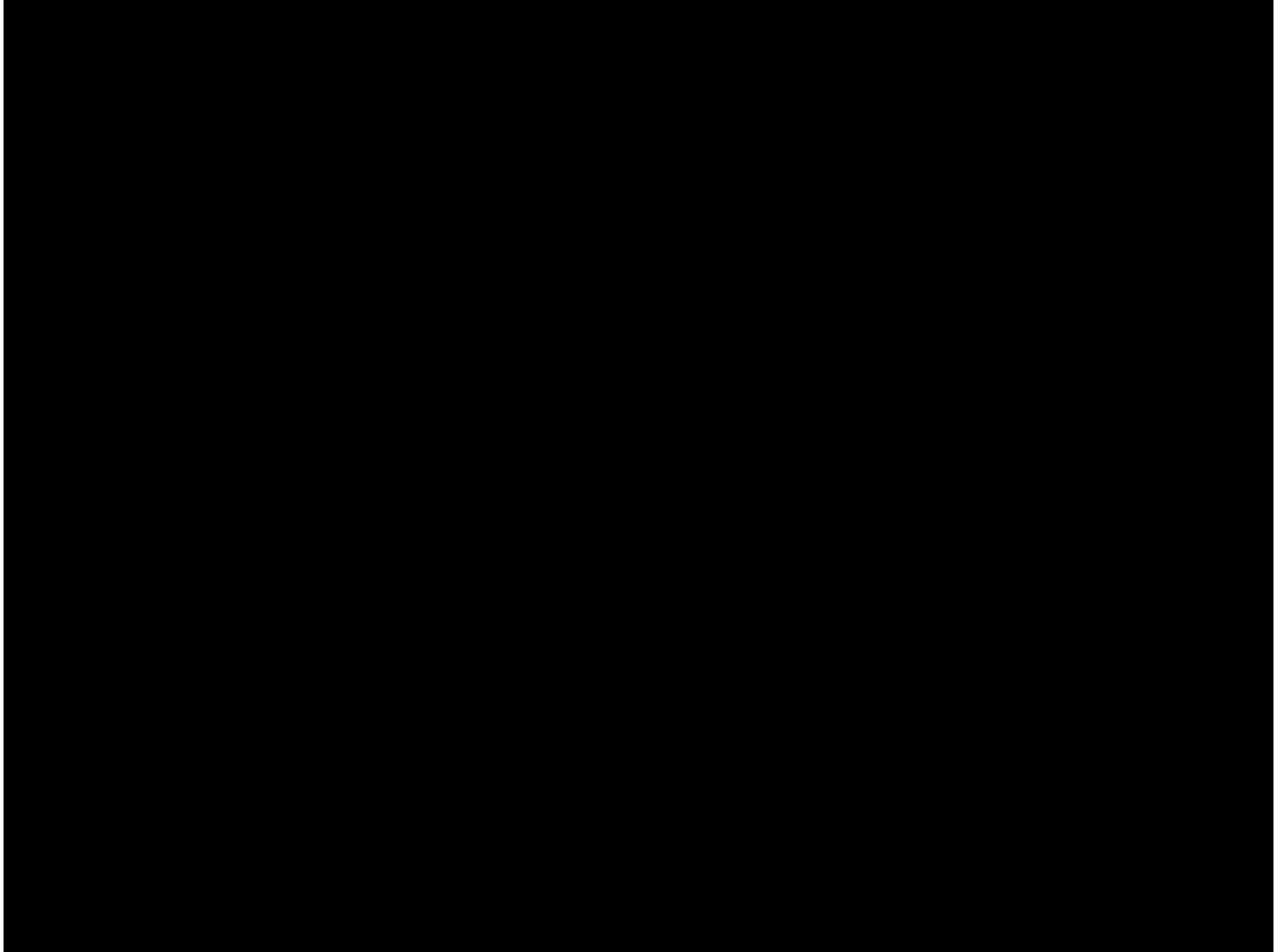
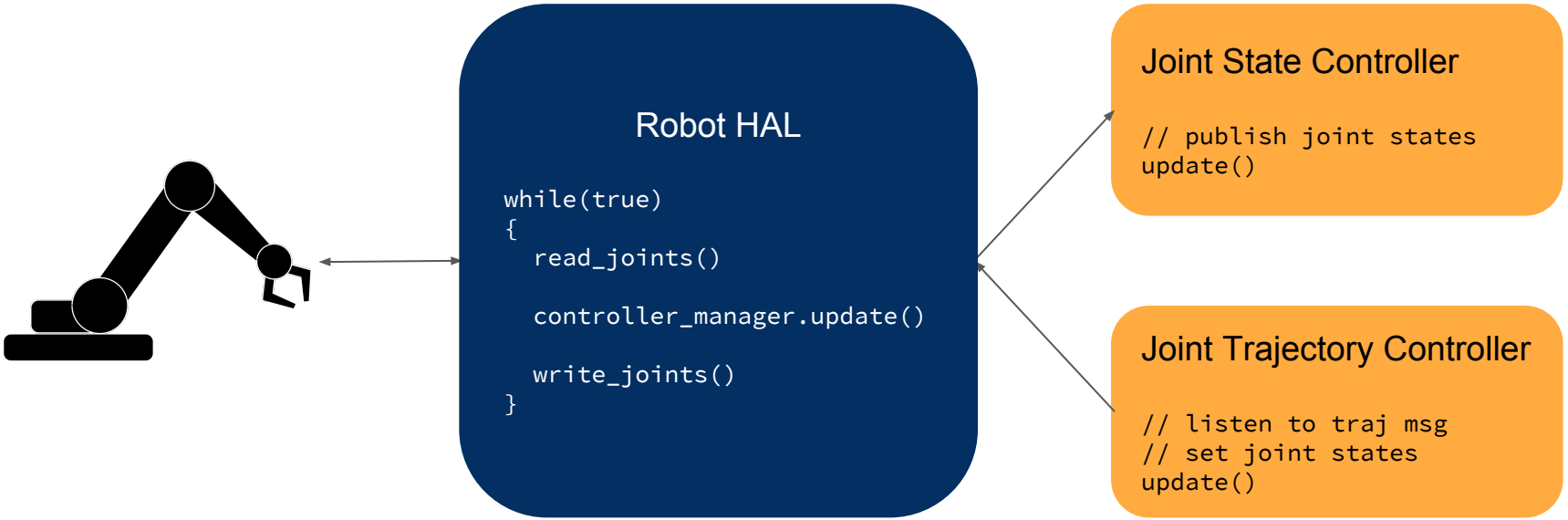


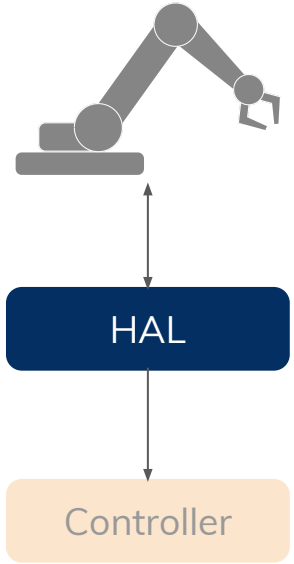
The big picture



More details from Jackie Kay and Adolfo Rodriguez Tsouroukdissian at ROScon 2015
https://roscon.ros.org/2015/presentations/RealtimeROS2.pdf

Controller Manager

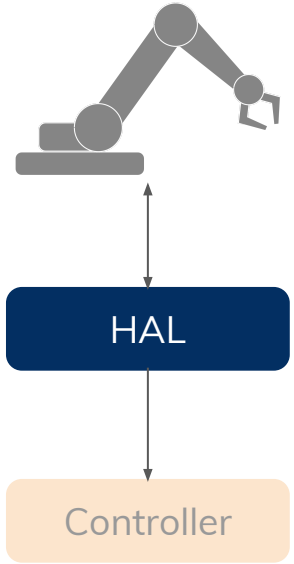
```
ControllerManager::load_controller(package_name, class_name, controller_name)
{
  auto library_path = get_ament_resource(package_name, class_name);

  auto loader = std::make_shared<class_loader::ClassLoader>(library_path);
  auto controller =
    loader->createInstance<controller_interface::ControllerInterface>(class_name);
  controller->init(controller_name);
  executor_->add_node(controller->get_node_base_interface());
}


int main(int argc, char ** argv)
{
  cm.load_controller(
    “ros_controllers”, “ros_controllers::JointTrajectoryController”, “trajectory_controller/left”);

  cm.load_controller(
    “ros_controllers”, “ros_controllers::JointTrajectoryController”, “trajectory_controller/right”);

}
```



https://github.com/ros2/ros2/wiki/Composition

Ament Resource Index

```
<ros2_ws/install>
    `-- share
        |   `-- ...  # Other, non-plugin related, stuff
        |-- ament_index
            |-- resource_index
                |-- packages
                |   `-- controller_manager
                |   `-- ...
                |-- controllers
                |   `-- ros_controllers  # containing controller info
```

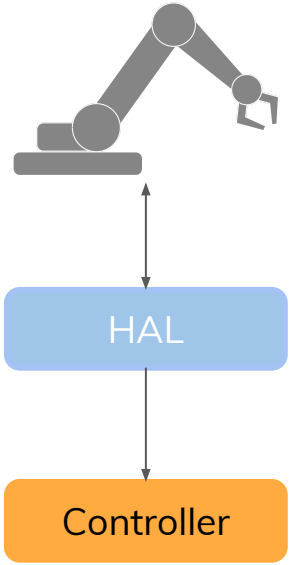



```
$ cat /ros2_ws/install/share/ament_index/resource_index/controllers/ros_controllers
ros_controllers::JointStateController;bin/default_controllers.dll
ros_controllers::JointTrajectoryController;bin/libdefault_controllers.dll
```

https://github.com/ament/ament_cmake/blob/master/ament_cmake_core/doc/resource_index.md

Lifecycle Controller Nodes

```
class ControllerInterface : public LifecycleNodeInterface
{
  virtual rcl_lifecycle_transition_key_t
  on_configure(const State & previous_state);

  virtual rcl_lifecycle_transition_key_t
  on_activate(const State & previous_state);

  virtual rcl_lifecycle_transition_key_t
  on_deactivate(const State & previous_state);

  virtual rcl_lifecycle_transition_key_t
  on_cleanup(const State & previous_state);

  virtual rcl_lifecycle_transition_key_t
  on_shutdown(const State & previous_state);

  virtual rcl_lifecycle_transition_key_t
  on_error(const State & previous_state);
};
```

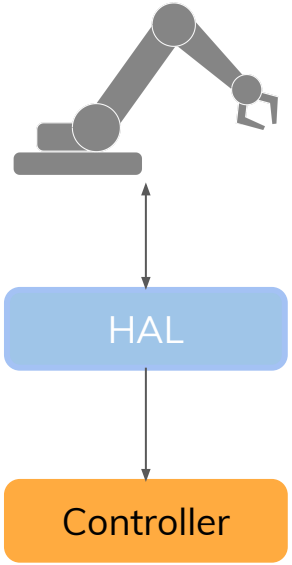


http://design.ros2.org/articles/node_lifecycle.html

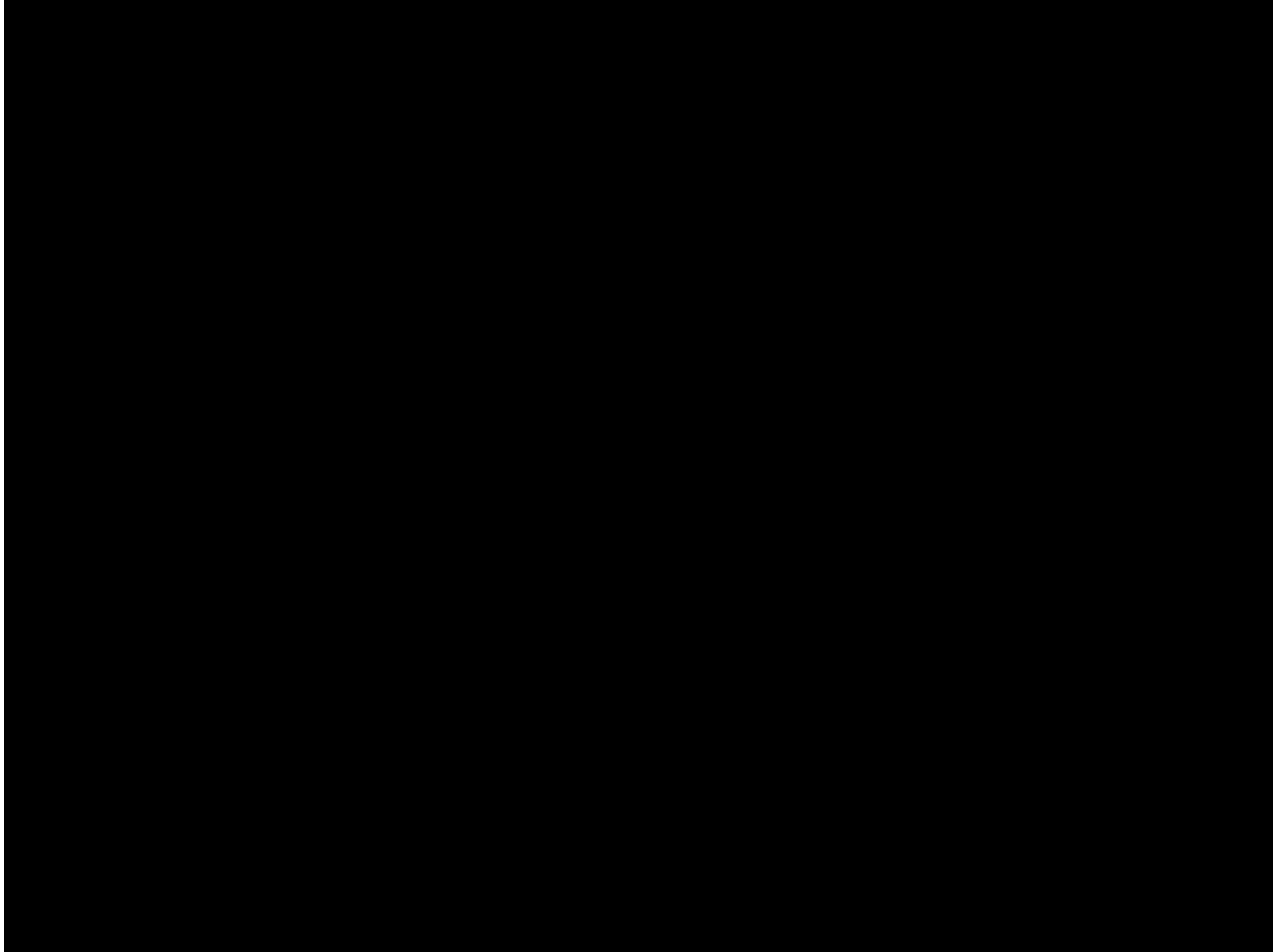
Lifecycle Controller Nodes

```
class MyController : public ControllerInterface
{
  // do lifecycle controller stuff
  on_activate()...
};
```

```
$ ros2 service list
/my_controller/change_state
/my_controller/get_available_states
/my_controller/get_available_transitions
/my_controller/get_state

$ ros2 service call /my_controller/get_state lifecycle_msgs/GetState
lifecycle_msgs.srv.GetState_Response(
current_state=lifecycle_msgs.msg.State(id=1, label='unconfigured'))
```

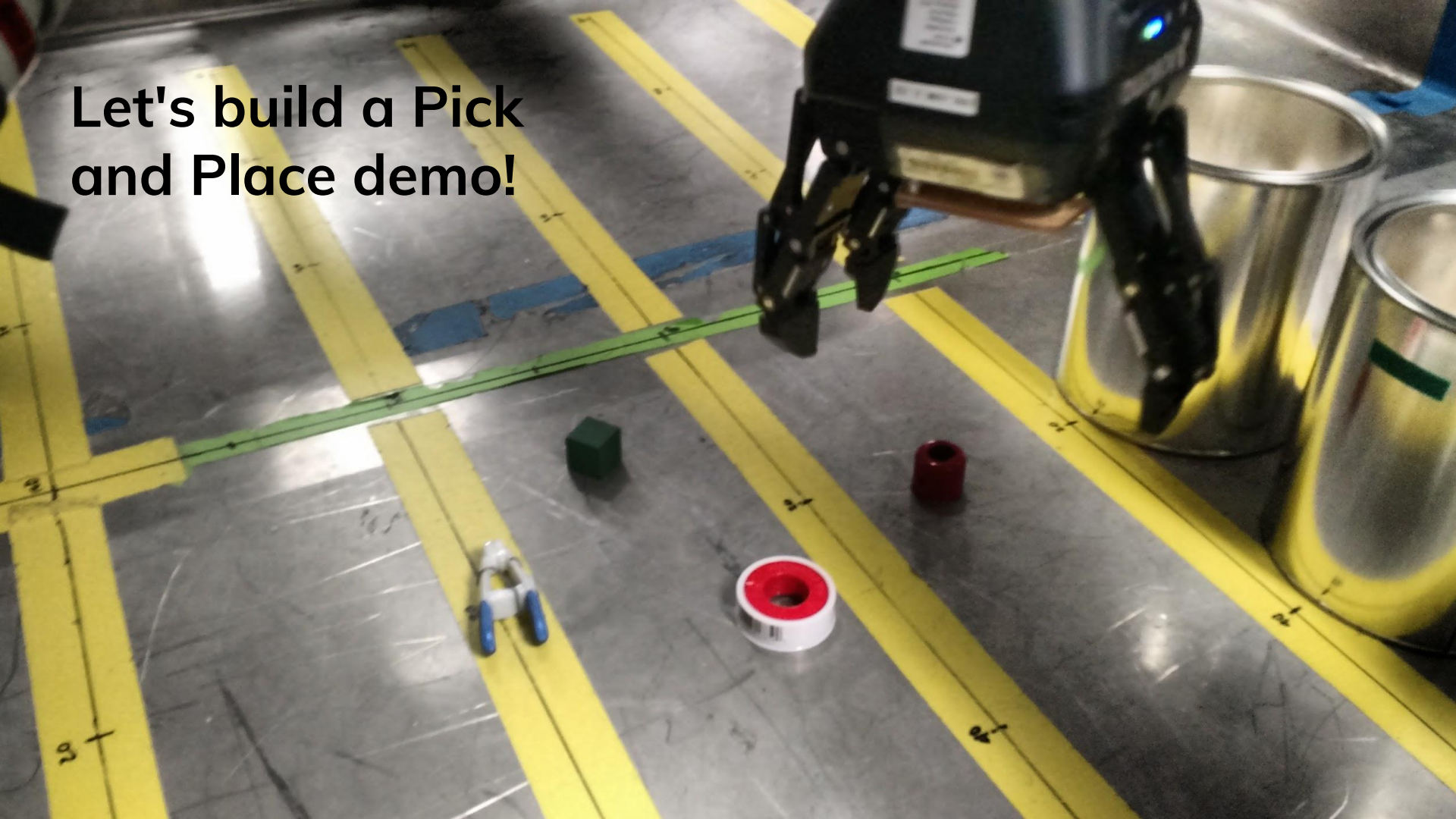


https://github.com/ros2/ros2/wiki/Managed-Nodes



The Picky Robot: Motivation

- Show that ROS2's core features are in place
- Do some integration but also add some new functionality


Let's build a Pick
and Place demo!

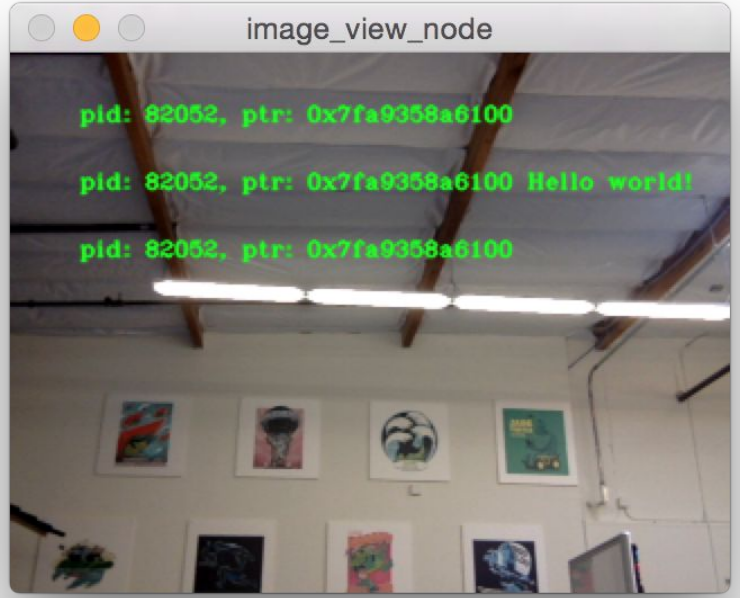
Architecture

Astra Depth Camera

Astra Camera Driver

Object Detector
(LINEMOD)

Shared Memory for Intraprocess Communication



https://github.com/ros2/ros2/wiki/Intra-Process-Communication

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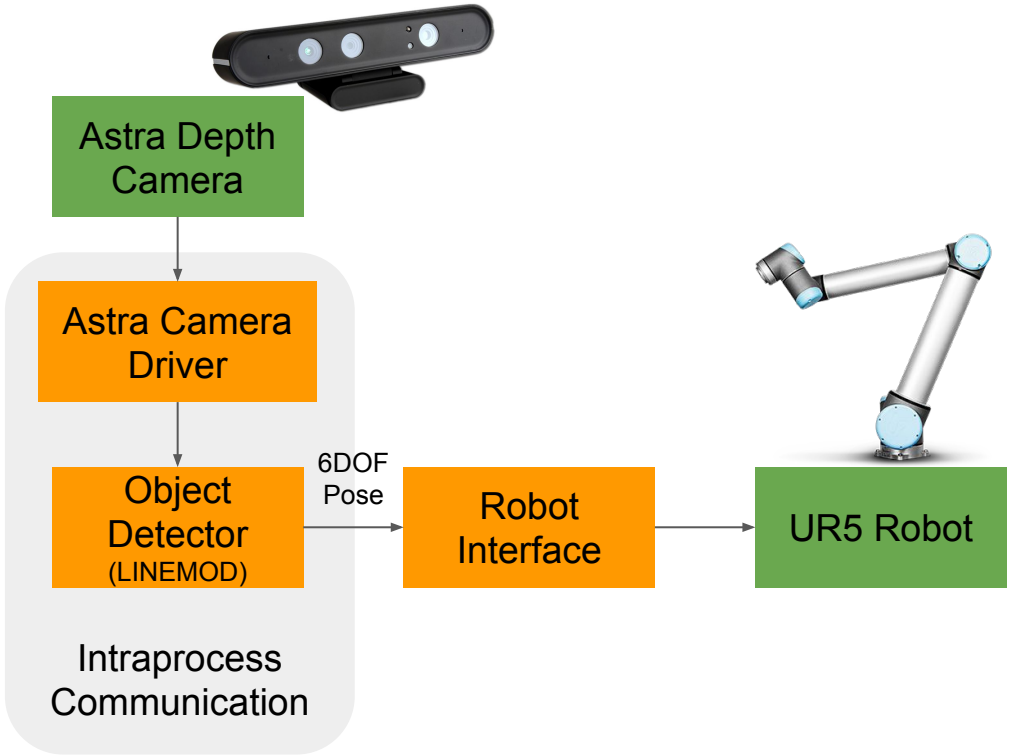

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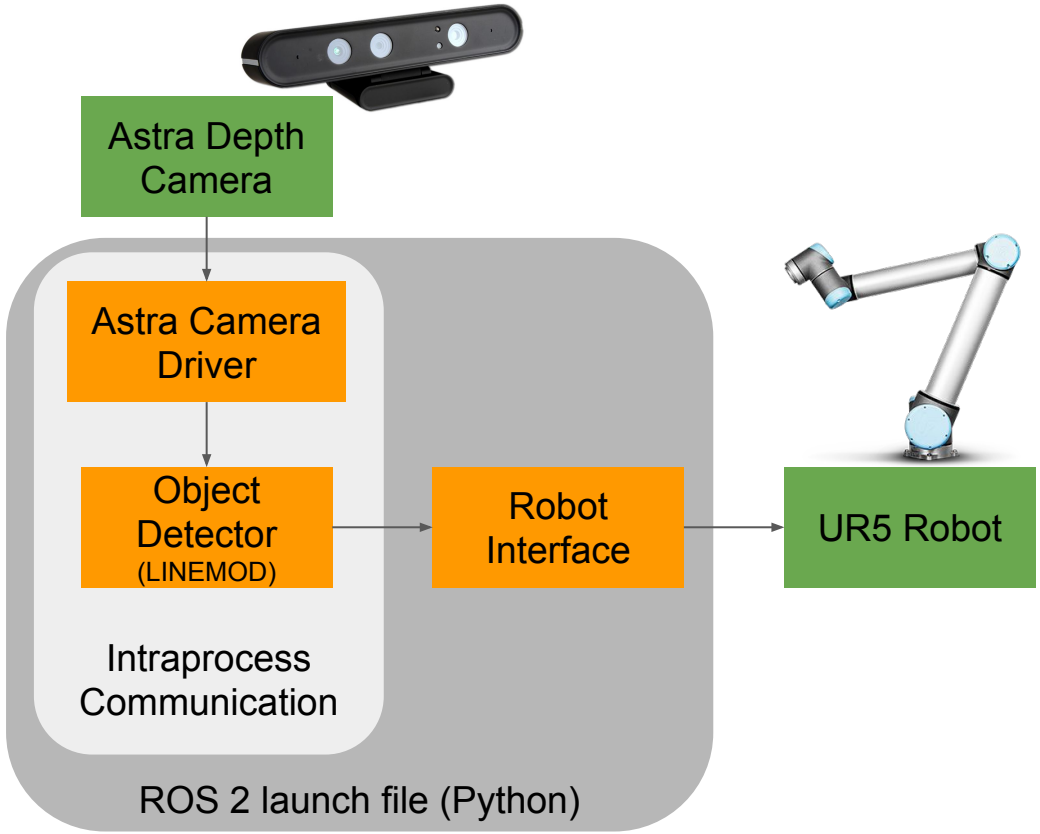

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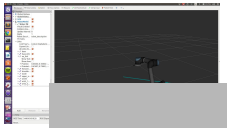
Intraprocess Communication

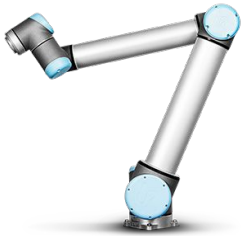
ROS 2 launch file (Python)



RViz

ROS2 bridge

Robot Interface



UR5 Robot

Architecture

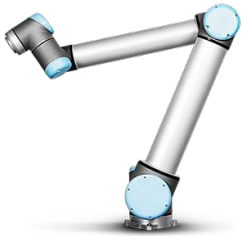
Astra Depth Camera

Astra Camera Driver

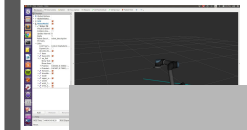
Object Detector (LINEMOD)

Intraprocess Communication

Robot Interface



UR5 Robot

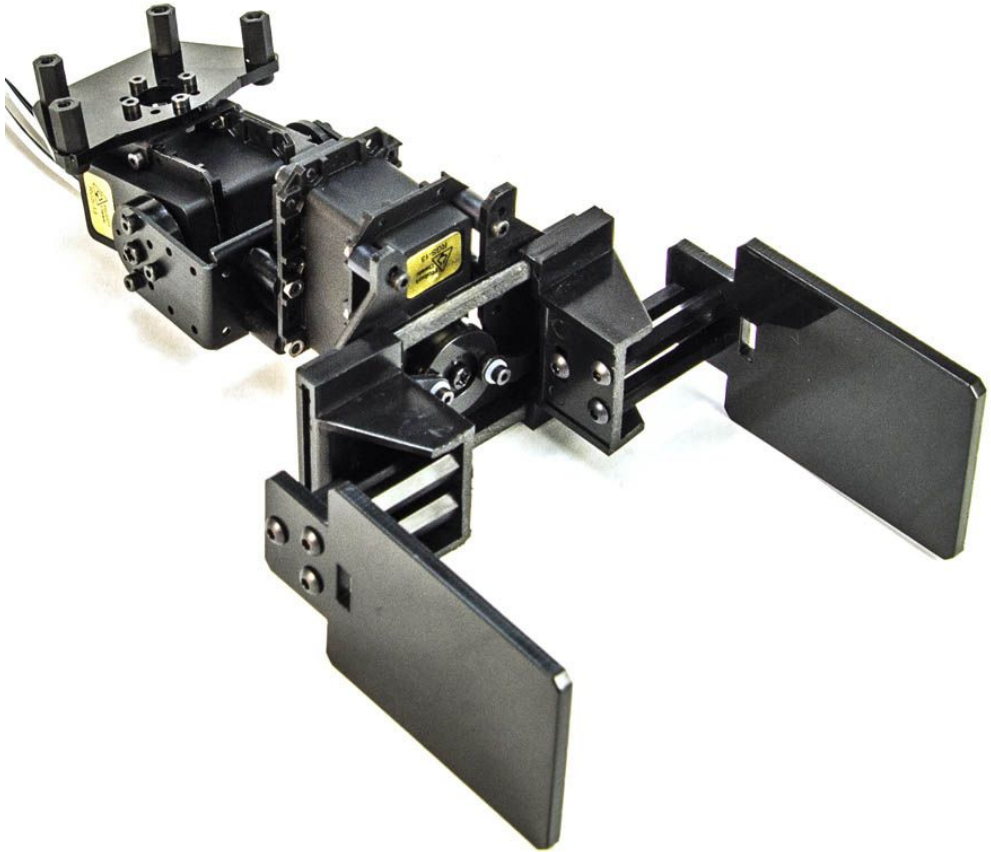


RViz

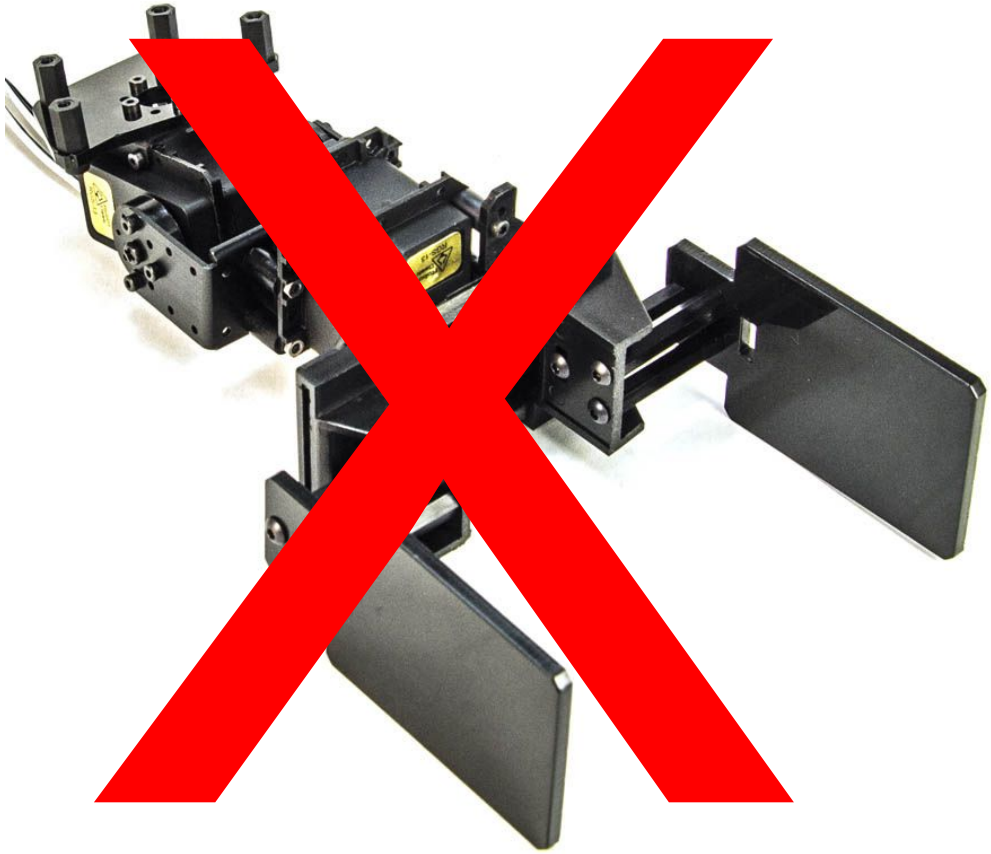
ROS2 bridge

ROS 2 launch file (Python)

Docker Container



http://www.trossenrobotics.com/Shared/images/PImages/widegripper/rg-wide-gripper-a.jpg



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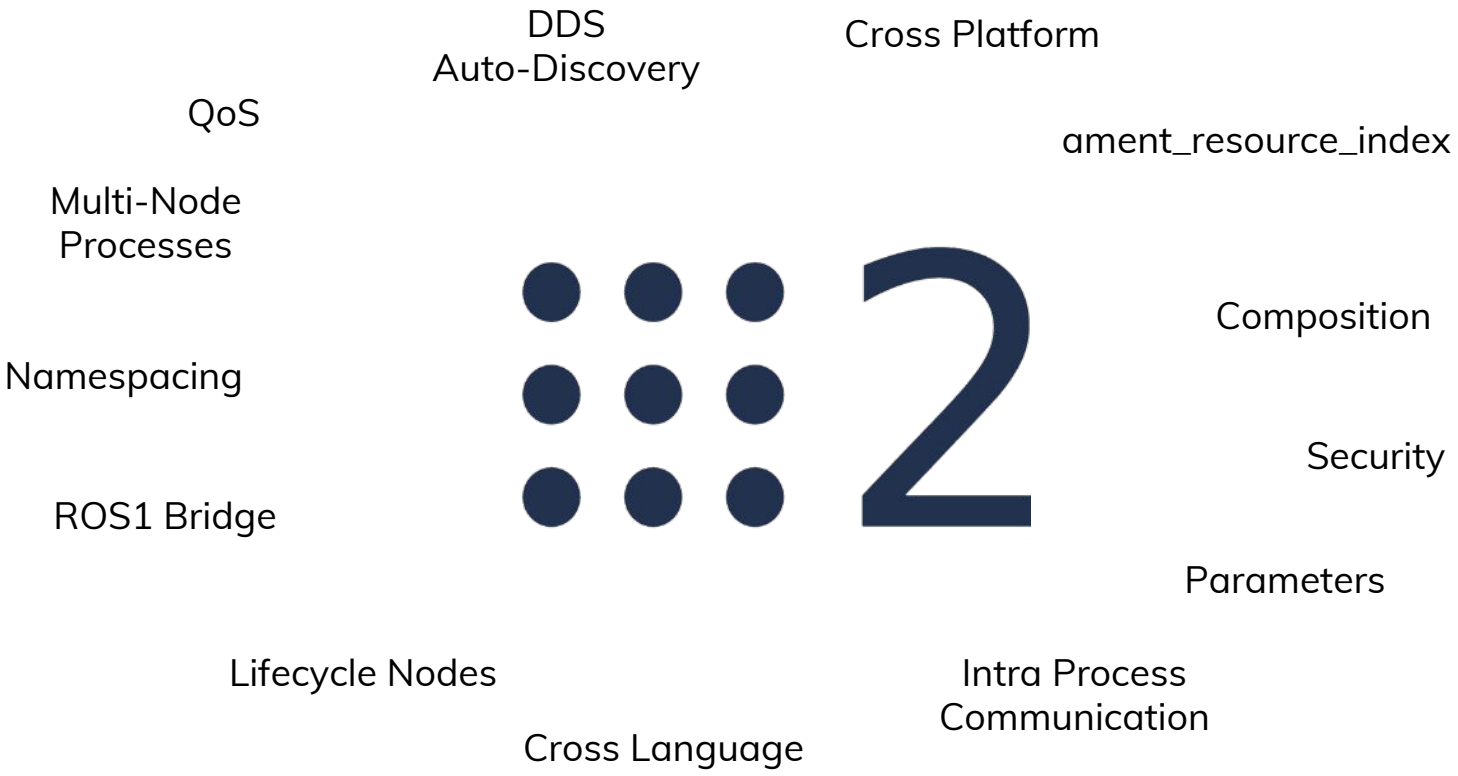
Video

https://vimeo.com/228848126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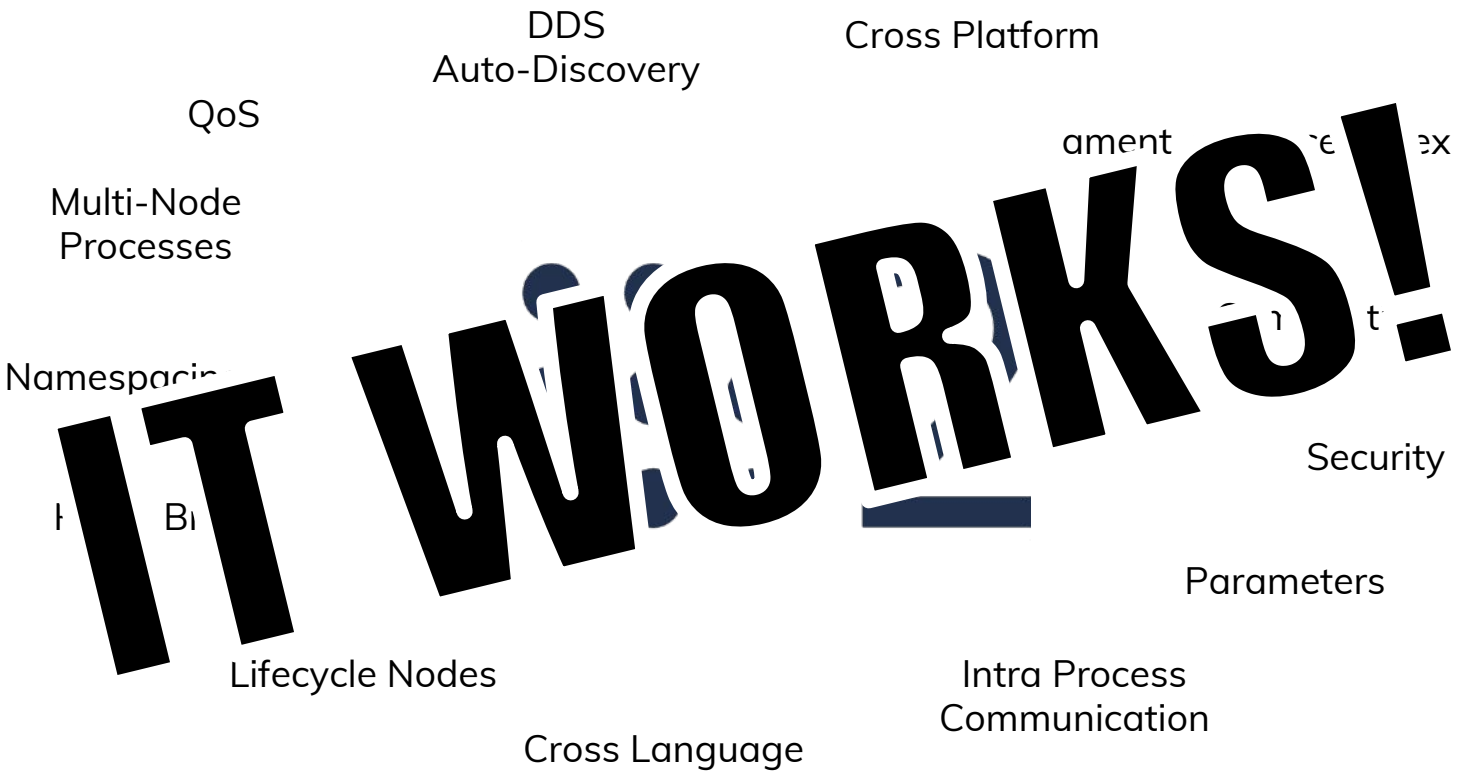
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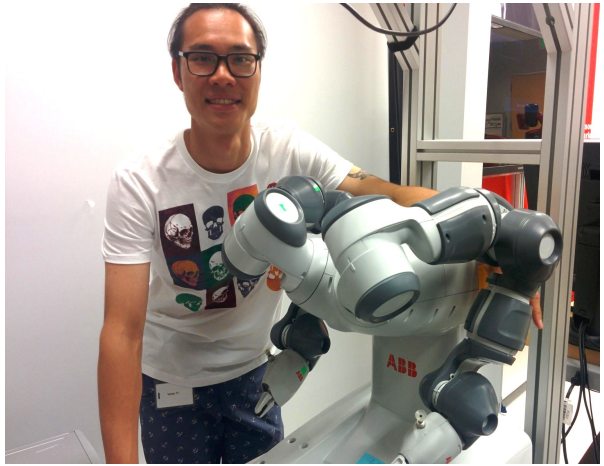
IT WORKS!

Special Thanks to ...



Calvin Ngan - Karsten's Bosch summer intern

ABB

ROS industrial

Mikael Arguedas - Adam's Open Robotics summer mentor

Thank you!

Code available:

- https://github.com/kukanani/picky_robot
- https://github.com/ros-controls/ros2_control
- https://github.com/ros-controls/ros2_controllers

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