

Application Development with ROS

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Technology Seminar – ROS in Industrial Applications



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Application Development with ROS Goals

- Learn about how to develop an application in ROS
 - System integration
 - Application setup
 - Task specific configuration
 - Application execution monitoring
- Learn about the hardware independence in ROS
 - Hardware independent application development
 - Developing an application in simulation
 - Transfer application from simulation to real hardware
 - Running same application on different hardware setups

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Application Development with ROS

A pick and place application

- Task: Pick an object from a pre-defined source location and place it on a pre-defined target location
- For creating such an application we need:
 - An manipulator with attached gripper (real hardware or equivalent in simulation)
 - Software interfaces to move the manipulator and open and close the gripper
 - Configuration to specify source and target locations
 - Coordinator component defining task execution

Application Development with ROS

A hardware independent pick and place application with ROS components

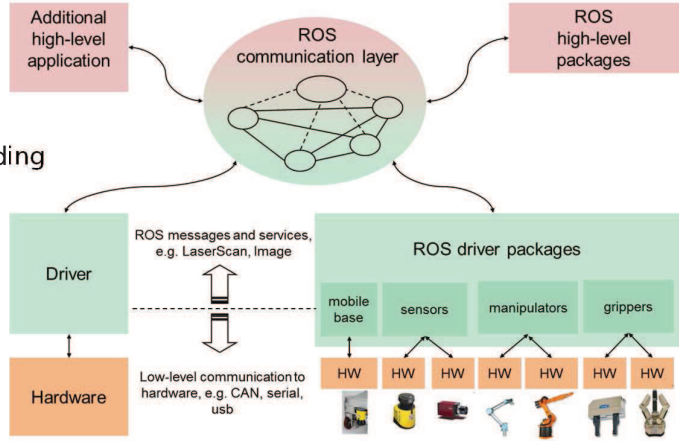
- ROS provides an hardware abstraction level through standardized ROS APIs (topics, services and actions)
- ROS provides a state-machine based task-level architecture for creating complex robot applications called SMACH
 - StateMachine, concurrent, sequence and iterator containers
 - Wrapper container for any ROS action
 - Configuration of states through ROS parameters
 - Runtime execution monitoring
 - Implemented in Python
- Process for using SMACH for task coordination:



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Hardware abstraction

- Creating a system launch file including
 - All drivers (manipulator, gripper)
 - All high-level components (MoveIt!)
 - Offers standardized ROS interfaces (Topics, Services, Actions)
- Creating an application launch file including
 - Uploading parameters
 - Starting up application



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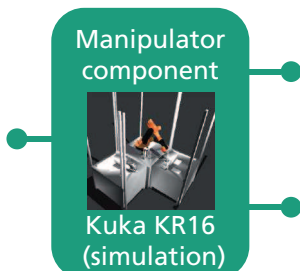
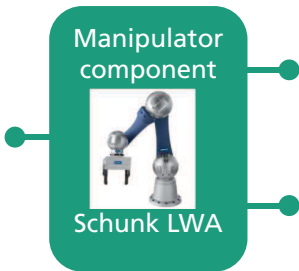
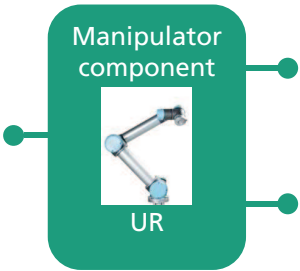
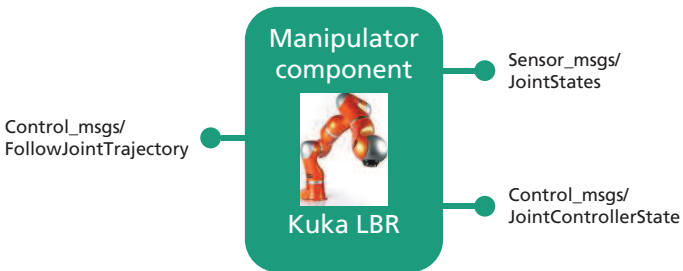
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Hardware abstraction

- Standard interfaces, e.g. for manipulator component (real and simulation)



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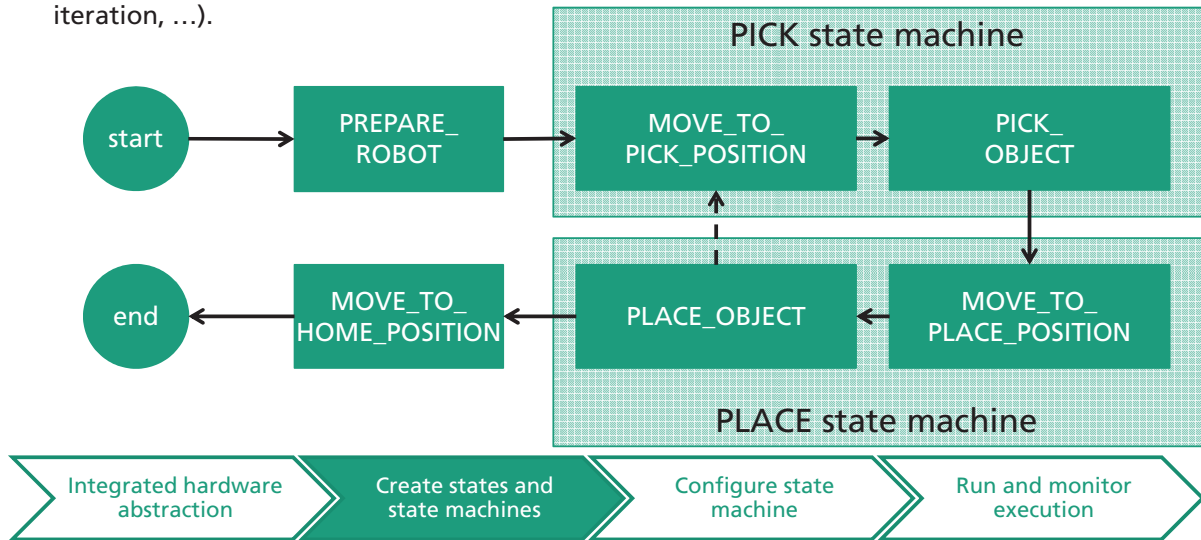
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Creating states and state machines

- Each state has transitions to link to following states .
- States are executed in containers. Containers define the execution behavior (e.g. concurrency, iteration, ...).



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Configuration

- Configuration needed for
 - Source location (Pose6D)
 - Target location (Pose6D)
- Configuration can be done through ROS parameter server
 - Uploading parameters in launch file
 - Uploading parameters through yaml file



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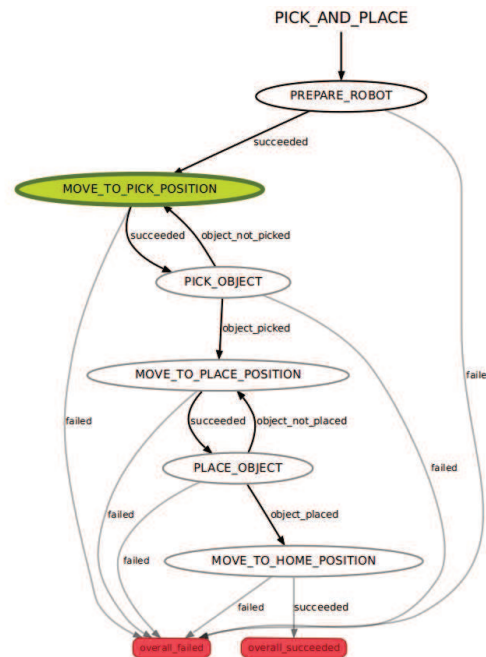
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Execution monitoring

- Running the application by starting the Python script for the state machine
- SMACH offers a graphical tool for
 - Visualizing states and transitions
 - Monitor current state of execution



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Summary

- ROS includes state-machine based task-level programming
 - SMACH: <http://wiki.ros.org/smach>
 - SMACH_viewer: http://wiki.ros.org/smach_viewer
- Separation of hardware driver layer, capability layer and application layer with hardware abstraction through standardized ROS interfaces
- More detailed documentation about standard interfaces can be found at
 - Sensor_msgs: http://wiki.ros.org/sensor_msgs
 - Geometry_msgs: http://wiki.ros.org/geometry_msgs
 - Trajectory_msgs: http://wiki.ros.org/trajectory_msgs
 - Control_msgs: http://wiki.ros.org/control_msgs

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Application Development with ROS

Your ROS application expert



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ROS IN DER INDUSTRIELLEN ANWENDUNG

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