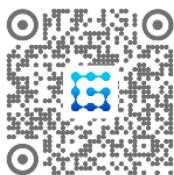


ROS机械臂开发：从入门到实战




—— 第10讲：针对工业应用的ROS-I又是什么



主讲人 胡春旭



机器人博客“古月居”博主
《ROS机器人开发实践》作者
武汉精锋微控科技有限公司 联合创始人
华中科技大学 自动化学院 硕士

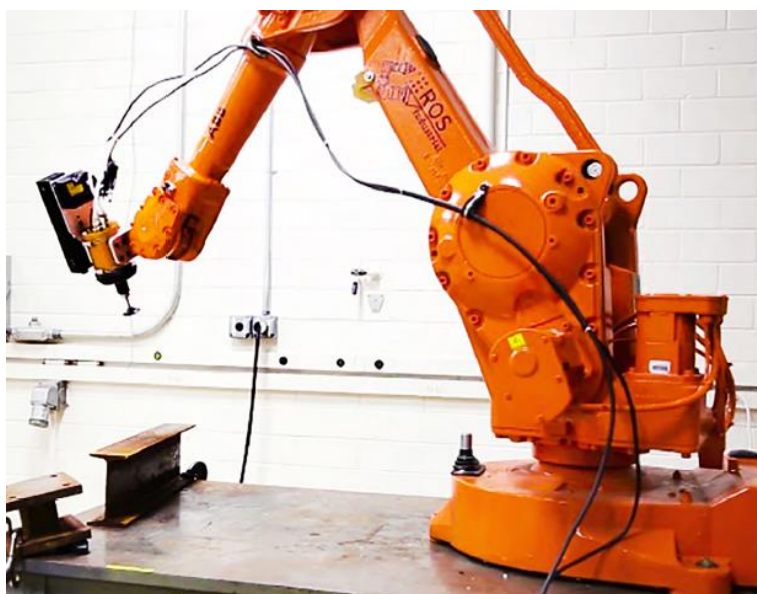
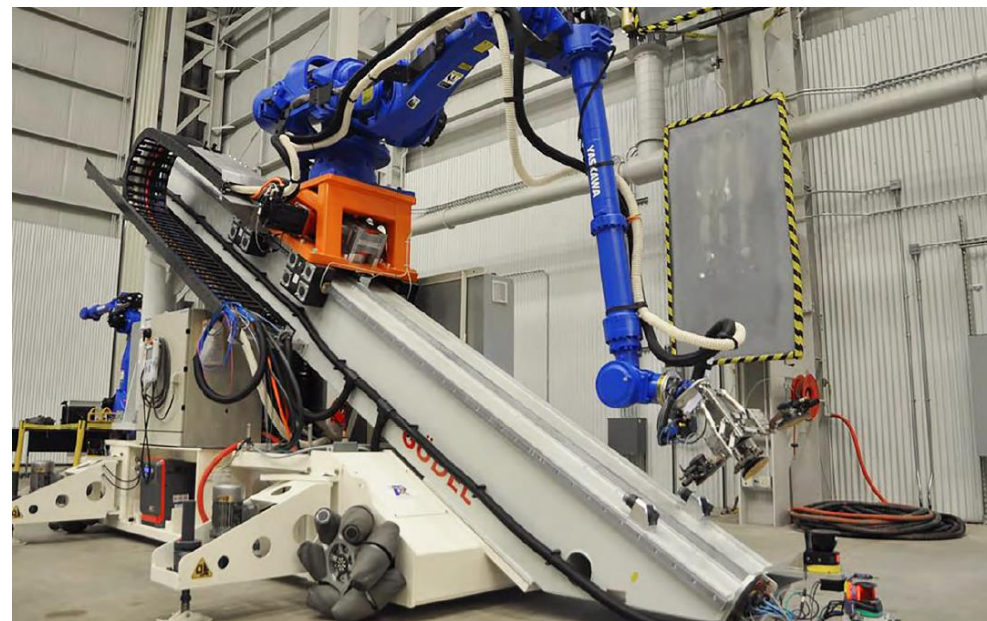
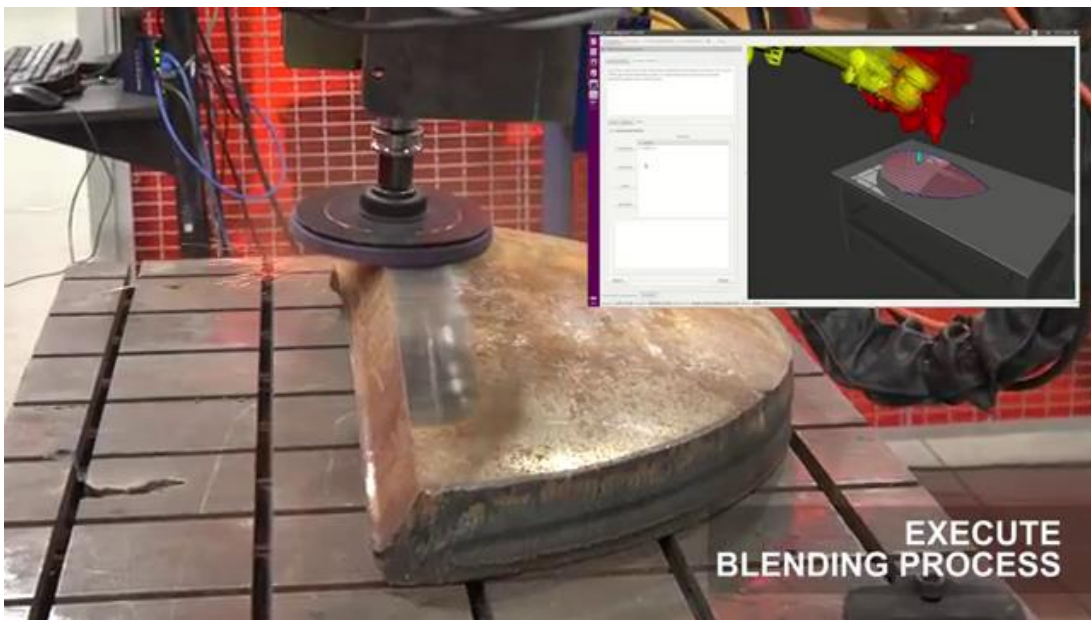
-  1. ROS-I框架介绍
-  2. ROS-I应用原理
-  3. ROS-I代码浅析



1. ROS-I框架介绍



1. ROS-I框架介绍



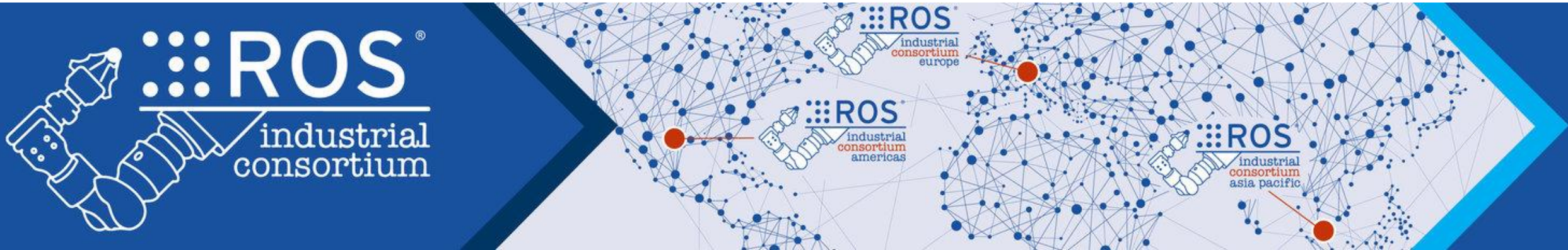


1. ROS-I 框架介绍



The ROS-Industrial Open Source project began as the collaborative endeavor of **Yaskawa Motoman Robotics**, **Southwest Research Institute**, and **Willow Garage** to support the use of ROS for manufacturing automation.

- ROS-Industrial Consortium Americas , Led by SwRI,
- ROS-I Consortium Europe, led by Fraunhofer IPA in Stuttgart, Germany
- ROS-Industrial Consortium Asia Pacific, led by ARTC and NTU in Singapore.

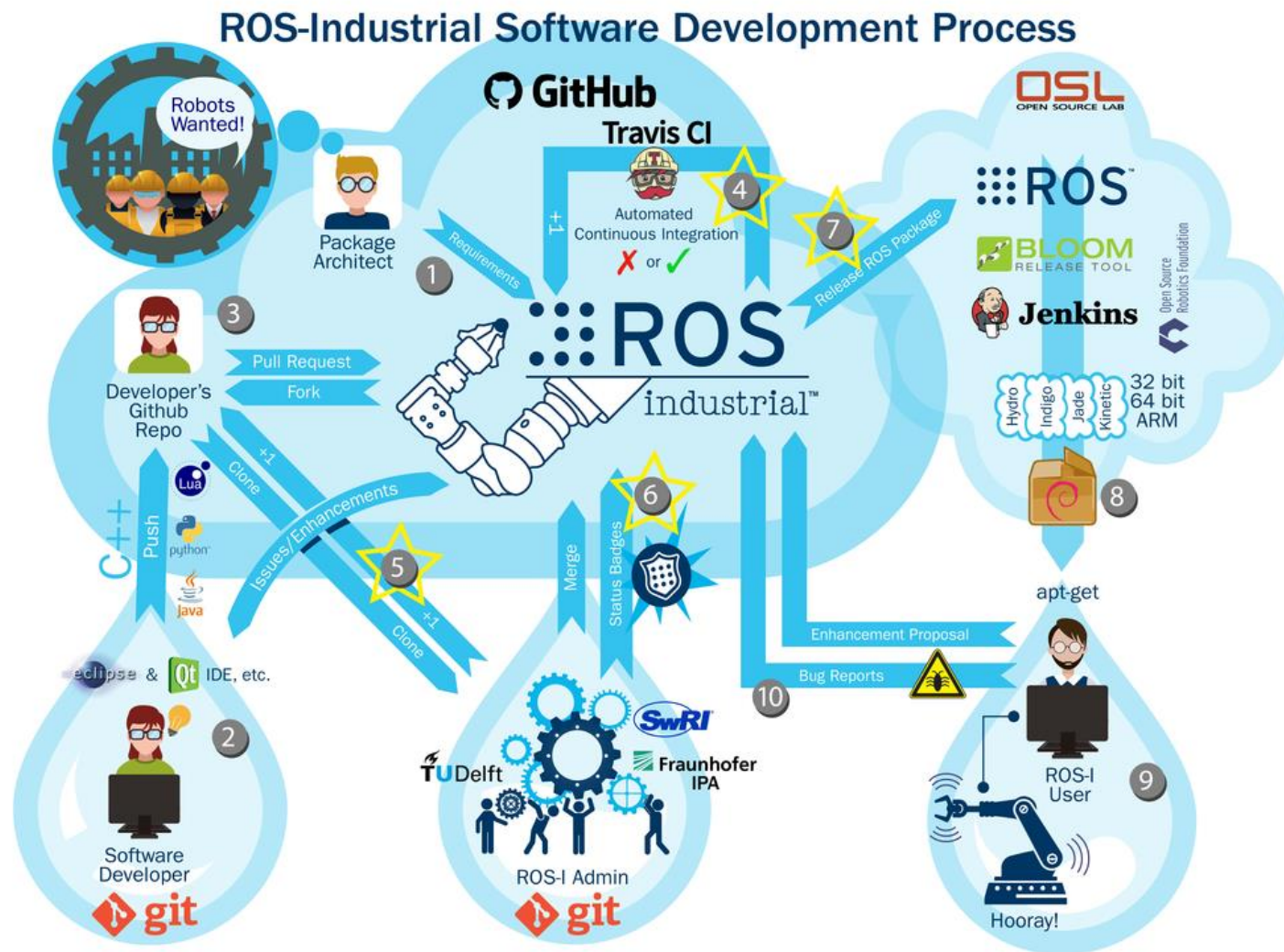




1. ROS-I框架介绍

➤ ROS-I的目标

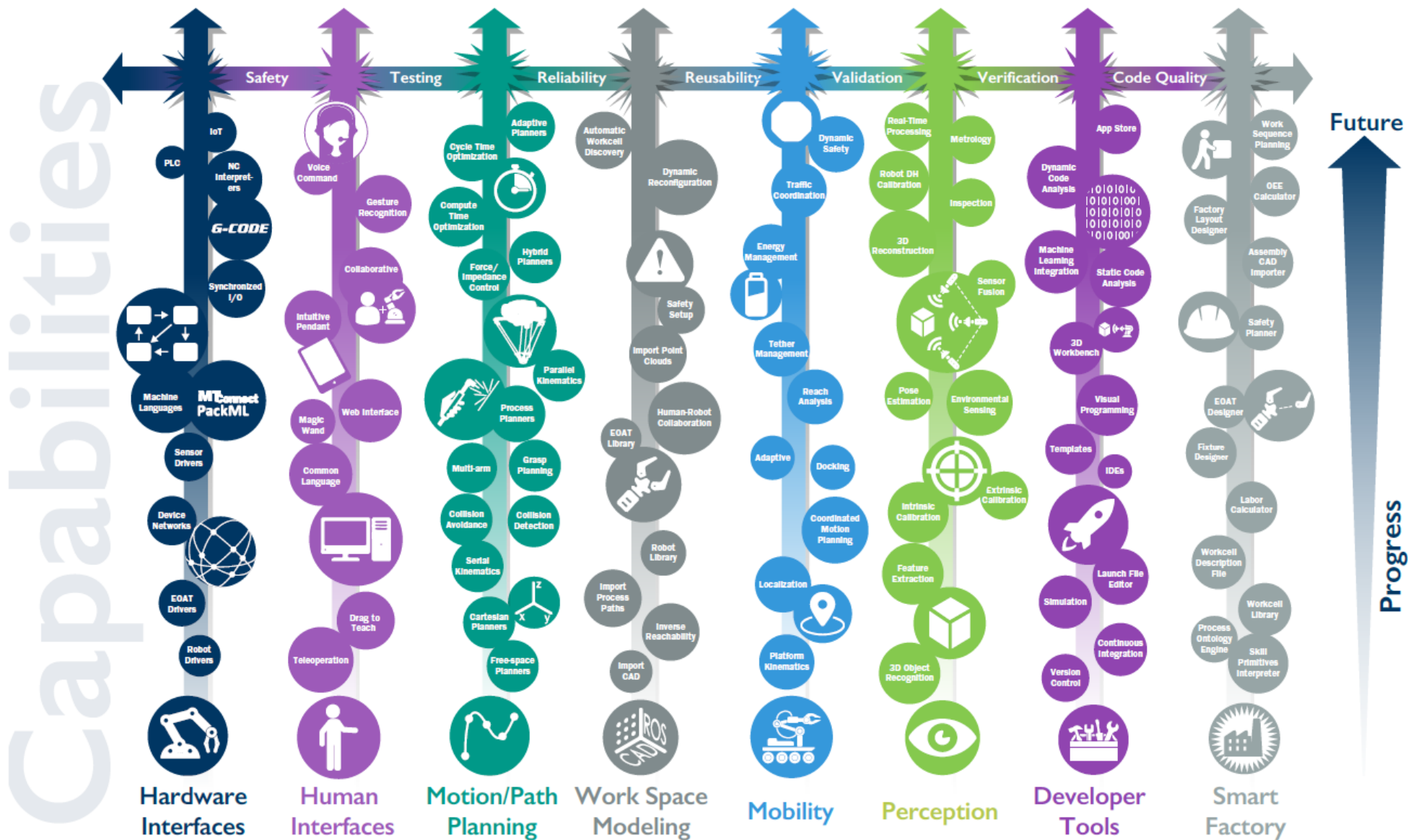
- 将ROS强大的功能应用到工业生产的过程中；
- 为工业机器人的研究与应用提供快捷有效的开发途径；
- 为工业机器人创建一个强大的社区支持；
- 为工业机器人提供一站式的工业级ROS应用开发支持。





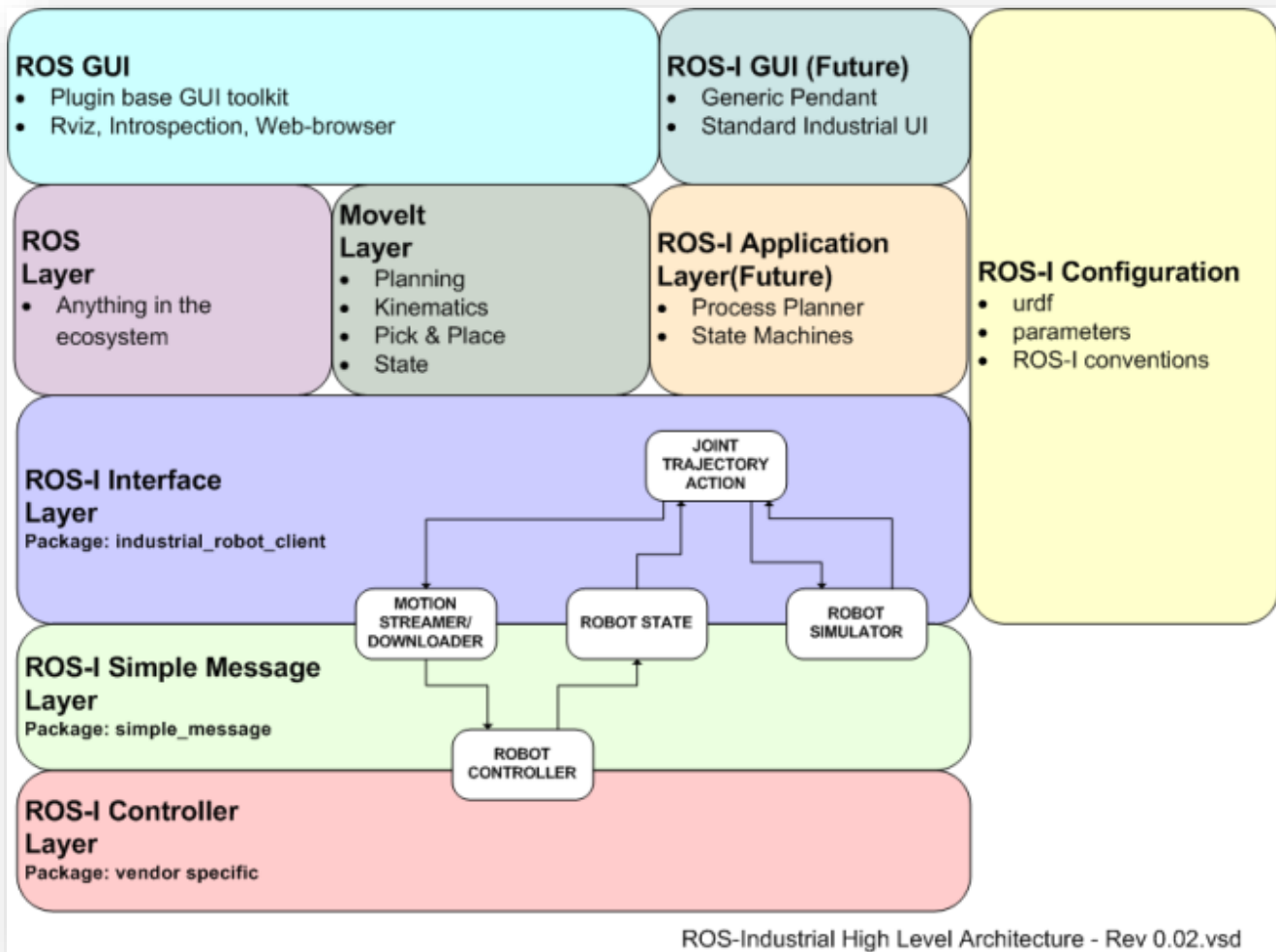
1. ROS-I框架介绍

ROS-Industrial Technical Vision

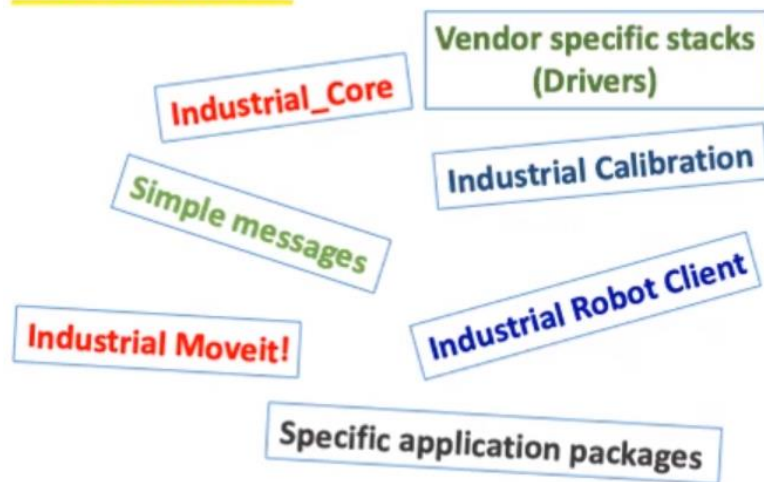




1. ROS-I框架介绍



ROS-I is a BSD (legacy) / Apache 2.0 (preferred) licensed program that contains libraries, tools and drivers for industrial hardware. It is supported and guided by the ROS-Industrial consortium.



ROS-I的总体架构



1. ROS-I框架介绍



Industrial Training
melodic

Search docs

- PC Setup
- MIT Introduction to C++
- Bruce Eckel Thinking in C++
- Exercise 0.1 - Intro to Ubuntu GUI
- Exercise 0.2 - The Linux File System
- Starting the Terminal
- Navigating Directories and Listing Files
- Altering Files
- Job management
- Exercise 1.0 - ROS Setup
- Exercise 1.1 - Create a Workspace
- Exercise 1.2 - Installing Packages
- Exercise 1.3 - Packages and Nodes
- Exercise 1.4 - Topics and Messages
- Exercise 2.0 - Services
- Exercise 2.1 - Actions
- Exercise 2.2 - Launch Files
- Exercise 2.3 - Parameters
- Exercise 3.0 - Intro to URDF
- Exercise 3.1 - Workcell XACRO

Read the Docs v: melodic



ROS-Industrial Website|Blog

Docs » ROS Industrial (Melodic) Training Exercises

Edit on GitHub

ROS Industrial (Melodic) Training Exercises

Setup PC

- [PC Setup](#)

Prerequisites

C++

- [MIT Introduction to C++](#)
- [Bruce Eckel Thinking in C++](#)

Linux Fundamentals

Slides

- [Exercise 0.1 - Intro to Ubuntu GUI](#)
- [Exercise 0.2 - The Linux File System](#)
- [Starting the Terminal](#)



Descartes Use Case



• Robotic Routing

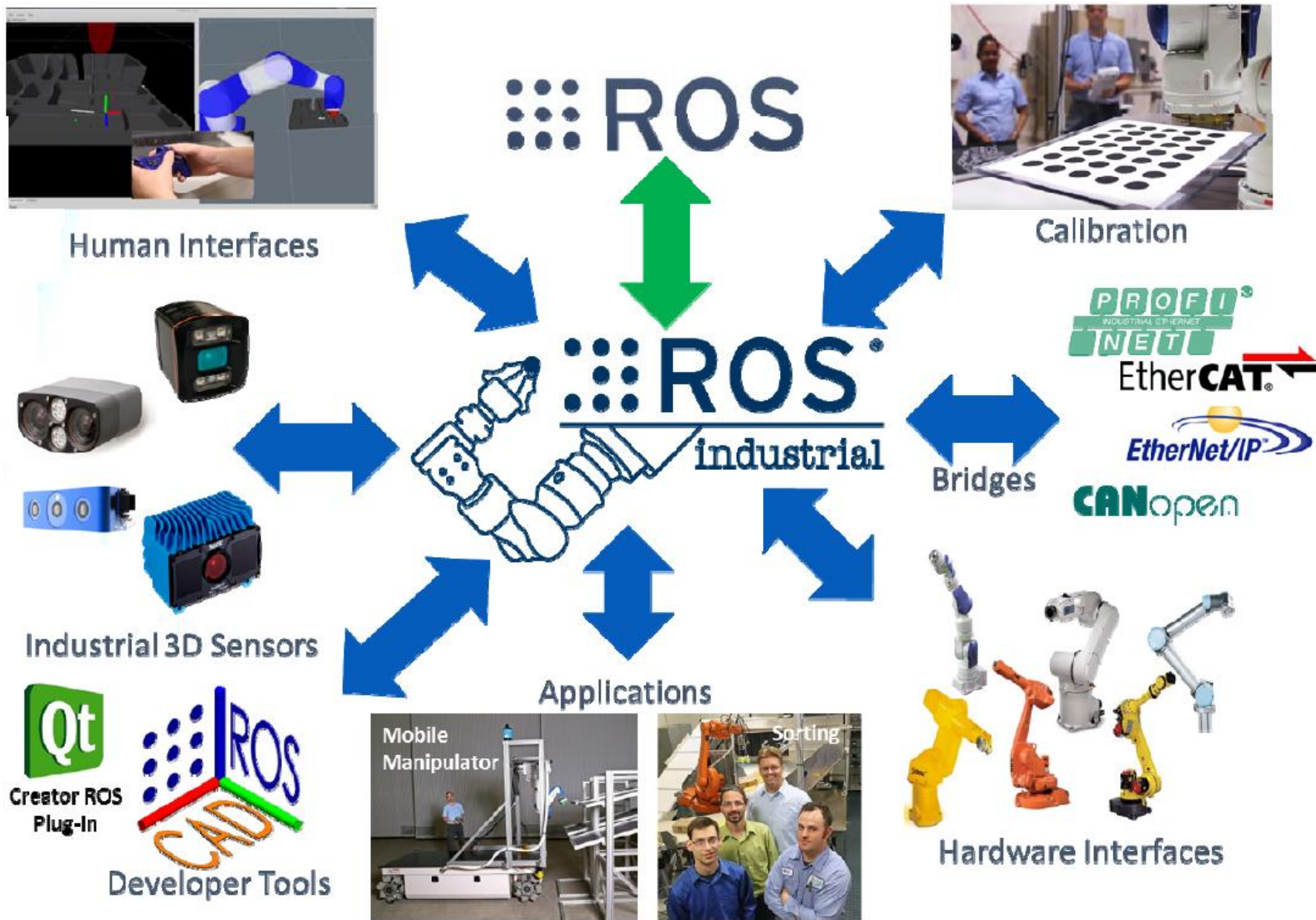
Path Points	Selected Point	Edit
point_2ec8868	Cartesian	Action Free Move
point_35d4148d		
point_3d238665		
point_37d8f9dc		
point_993913ba		
point_02a8d67		
point_cfd899fd		
point_0849d59		
point_4b75d6fa		
point_345e1dbb		
point_7065d8d7		
point_1fafece2		



<https://industrial-training-master.readthedocs.io/en/melodic/>



1. ROS-I 框架介绍



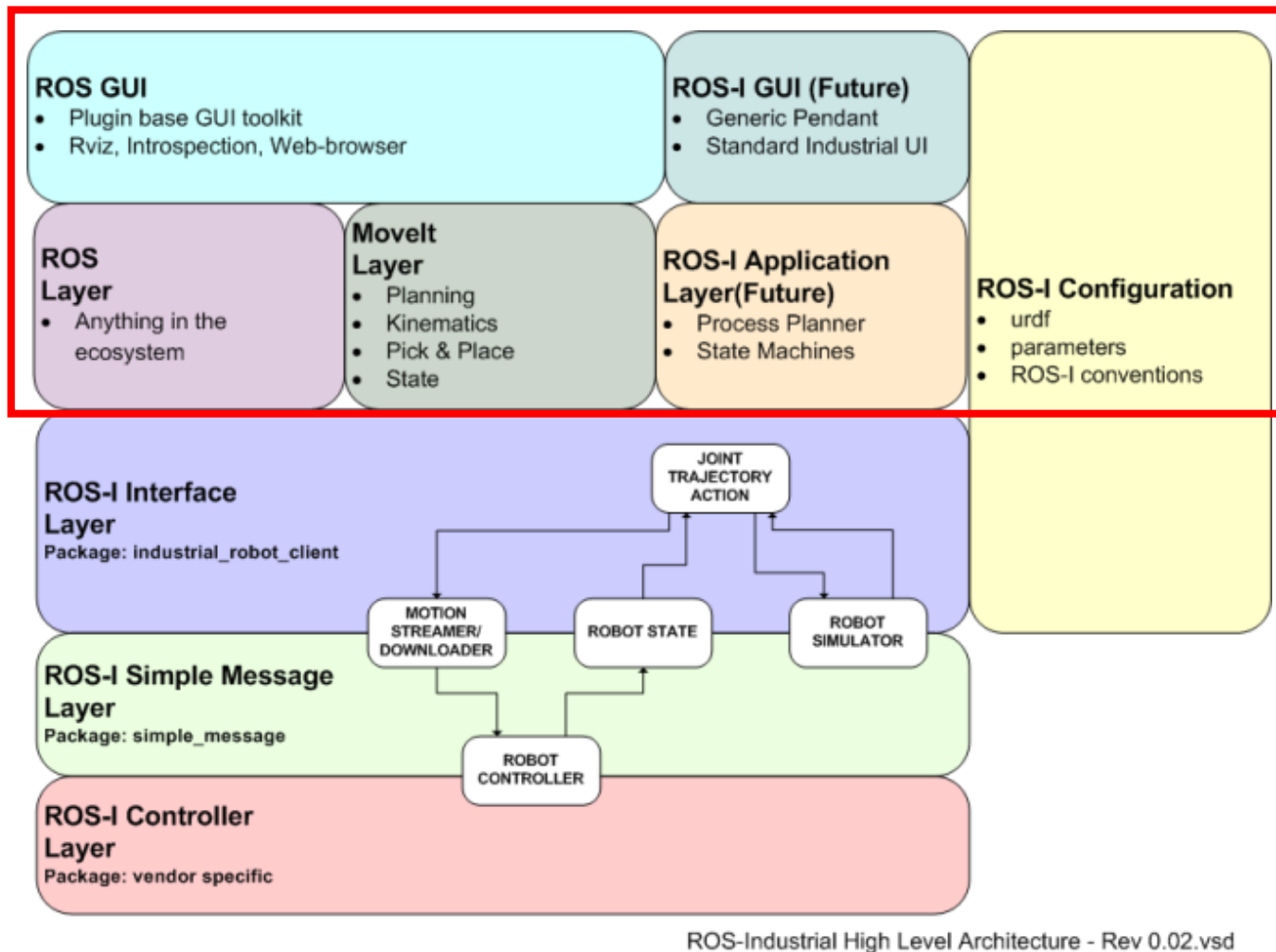


2. ROS-I应用原理



应用与规划

1. GUI: ROS中现在已有的UI工具和专门针对工业机器人通用的UI工具;
2. ROS Layer: ROS基础框架, 提供核心通信机制;
3. MoveIt! Layer: 为工业机器人提供规划、运动学等核心功能的解决方案;
4. ROS-I Application Layer: 处理工业生产的具体应用;



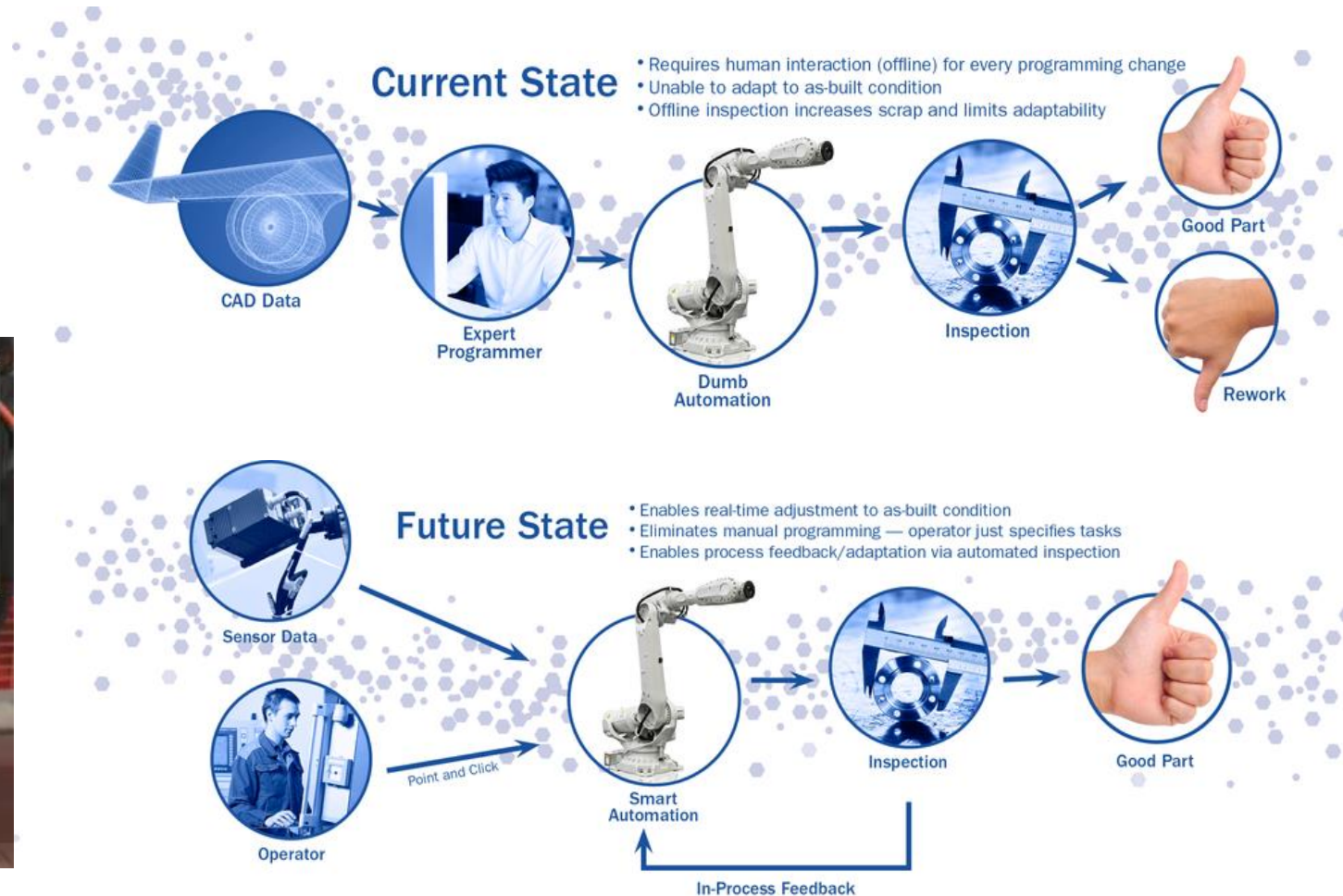
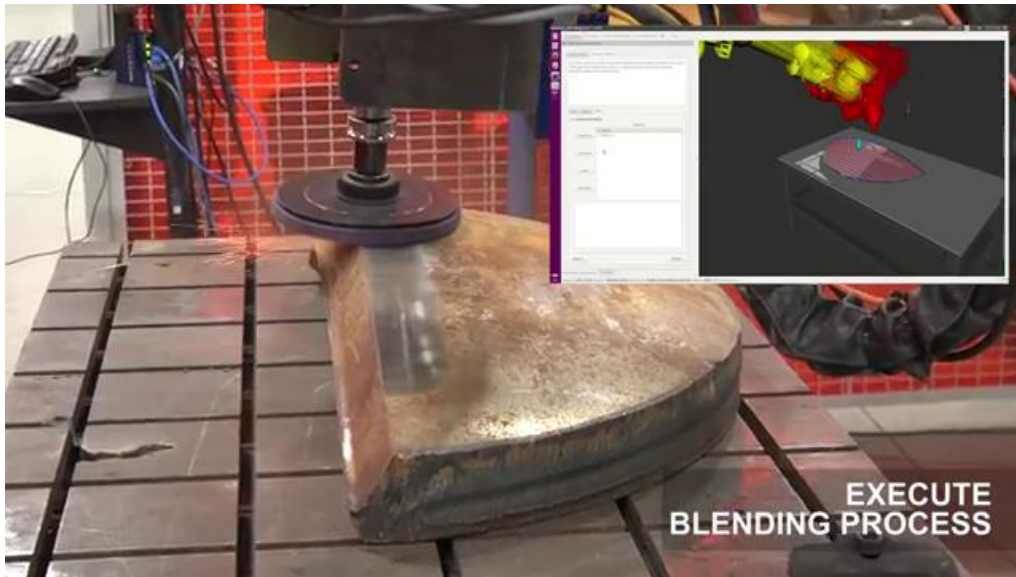
ROS-I的总体架构



2. ROS-I应用原理

Scan-N-Plan™

Scan-N-Plan technologies are a suite of tools that enable real-time robot trajectory planning from 3-D scan data.



<https://rosindustrial.org/scan-n-plan>



2. ROS-I应用原理



godel	Resolved dependencies
godel_msgs	Merge pull request #201 from Jmeyer1292/feature/z_offsets
godel_param_helpers	Make all package.xml files the format 2 convention.
godel_path_execution	Make all package.xml files the format 2 convention.
godel_plugins	Changed BlendProcessExecution.action to ProcessExecution.acti
godel_polygon_offset	Make all package.xml files the format 2 convention.
godel_process_execution	Changed BlendProcessExecution.action to ProcessExecution.acti
godel_process_path_generation	Removing more unused launch files - some of which reference f
godel_process_planning	Got my process planning re-write nominally working and added
godel_robots	Rotated cage to match the new work cell configuration.
godel_scan_analysis	Using a std_srvs::Trigger type, added the ability to remotely clea
godel_simple_gui	scan state will not progress to select surface if scan fails.
godel_surface_detection	static_cast from MoveItErrorCode to bool
godel_utils	Removed dead references, added helper function to simplify En
industrial_robot_simulator_service	Make all package.xml files the format 2 convention.
meshing_plugins	Make all package.xml files the format 2 convention.
meshing_plugins_base	Make all package.xml files the format 2 convention.
path_planning_plugins	Moved keyence approach paths into process planning. Moved s
path_planning_plugins_base	Make all package.xml files the format 2 convention.

<https://github.com/ros-industrial-consortium/godel>

1. SCAN

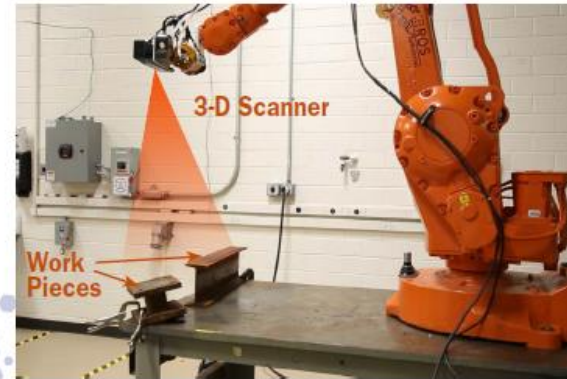


Figure 1: In seconds, Scan-N-Plan software enables CAD-free recognition of flat surfaces that are eligible to blend.

Milestone 3 Sponsors



2. PLAN

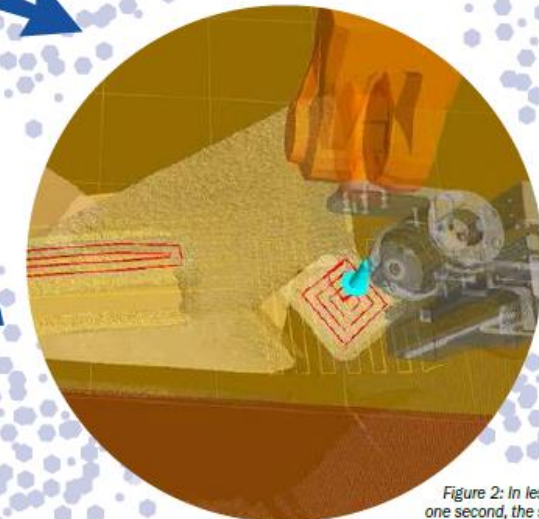


Figure 2: In less than one second, the software computes collision-free paths to blend each of the selected surfaces.

3. EXECUTE



Figure 3: The robot blends the surface of each work piece.

4. INSPECT



Figure 4: After blending, the system executes a quality assurance scan with a high resolution laser line scan sensor.

Software Development Team



ROSIndustrial.org/ric-americas/
Paul.Hvass@swri.org
+1 210.522.5823



Automated Painting for Aerospace

- Automated spray paint processes
 - Reduce emissions (regulation)
 - Reduce exposure (personnel)
 - Reduce cost (materials)
 - Increase quality (consistency)
- Challenges
 - Unconstrained location
 - “Random” part order
 - Real time processing
 - Moving parts





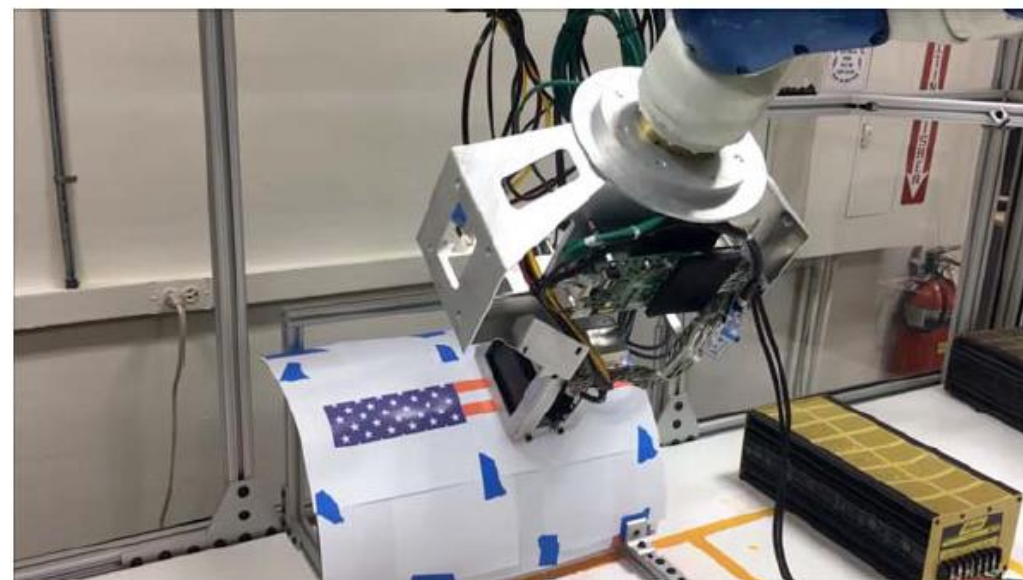
Solution: Automated Painting

- 3D Sensing (ROS/OpenNI)
- 3D Processing (ROS/PCL)
- Process based path planning (SwRI)
- Robot IK solvers (ROS/MoveIt!)
- Robot workcell visualization (ROS/Rviz)
- Distributed system (ROS/Core)
- Data acquisition/playback (ROS/bag)





2. ROS-I应用原理



- Develop and Test Unique Inkjet Technology For Large Complex Surfaces
- Demonstrate Inkjet Technology on Aircraft Application Using Large Scale Robots
- Simulated Demonstration Rotary Bell Painting on LR System Robot leveraging ROS-based path planning

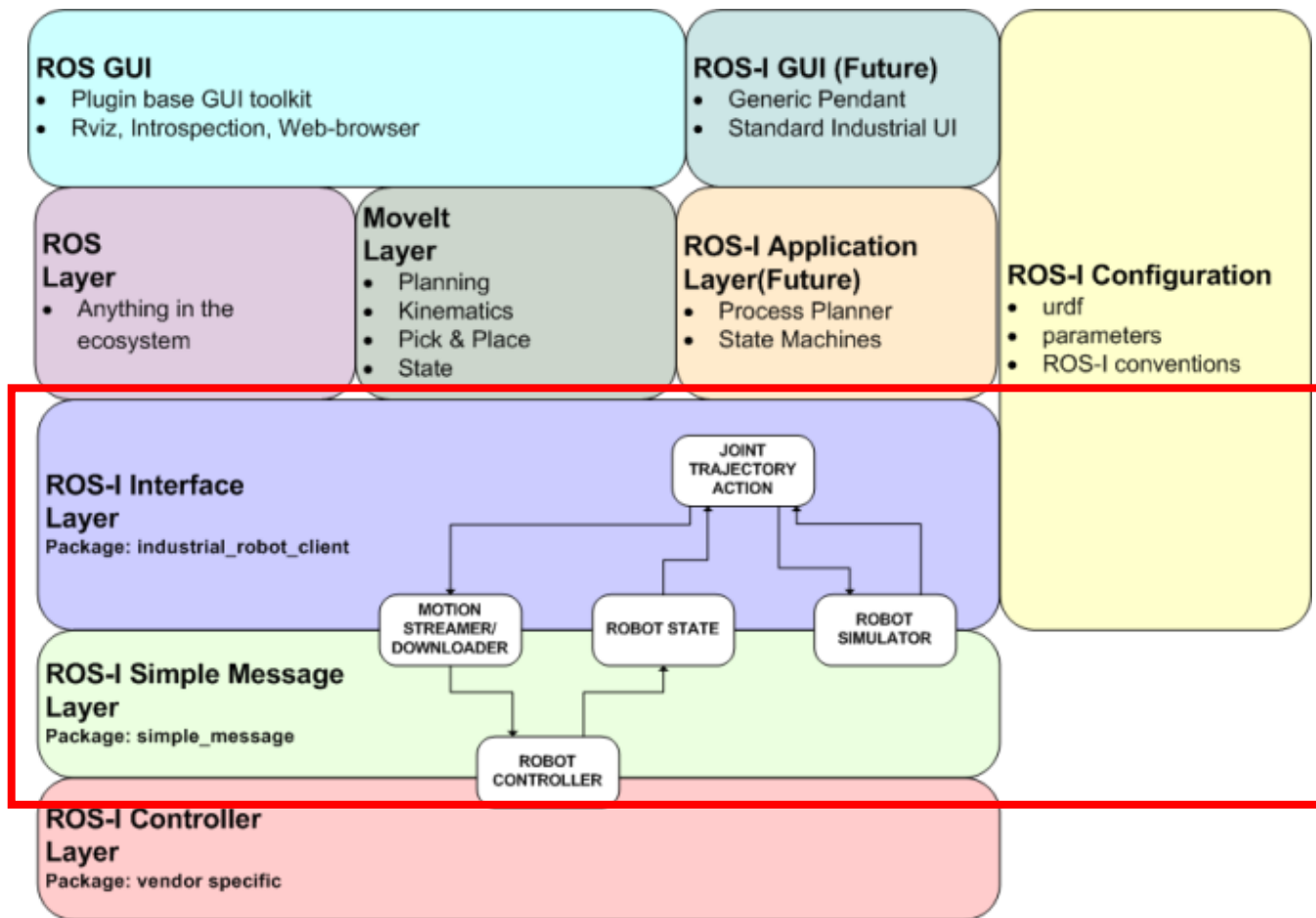


3. ROS-I代码浅析



接口与协议

1. ROS-I Interface Layer: 接口层，工业机器人的客户端，通过 simple message协议与机器人的控制器通信；
2. ROS-I Simple Message Layer: 通信层，定义了通信的协议，打包和解析通信数据；
3. ROS-I Controller Layer: 机器人厂商开发的工业机器人控制器。

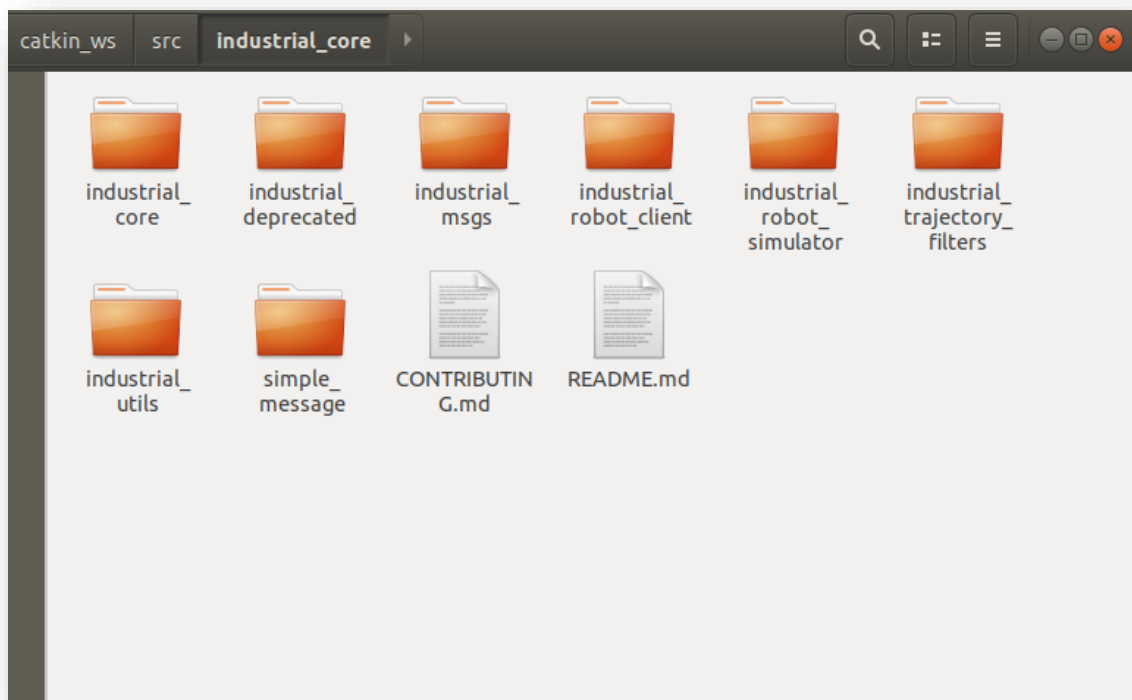


ROS-Industrial High Level Architecture - Rev 0.02.vsd

ROS-I的总体架构



3. ROS-I代码浅析



jrgnicho Merge pull request #223 from gavanderhoorn/remove_genmsg ...

industrial_core	all: update maintainer email addresses.
industrial_deprecated	all: update maintainer email addresses.
industrial_msgs	msgs: remove unneeded genmsg dependency.
industrial_robot_client	all: update maintainer email addresses.
industrial_robot_simulator	all: update maintainer email addresses.
industrial_trajectory_filters	all: update maintainer email addresses.
industrial_utils	all: update maintainer email addresses.
simple_message	all: update maintainer email addresses.
.gitignore	Ignore some more project management related files.
.travis.yml	travis: catch up with industrial_ci improvements.
CONTRIBUTING.md	Create CONTRIBUTING.md
README.md	add docker instructions to README. (#201)

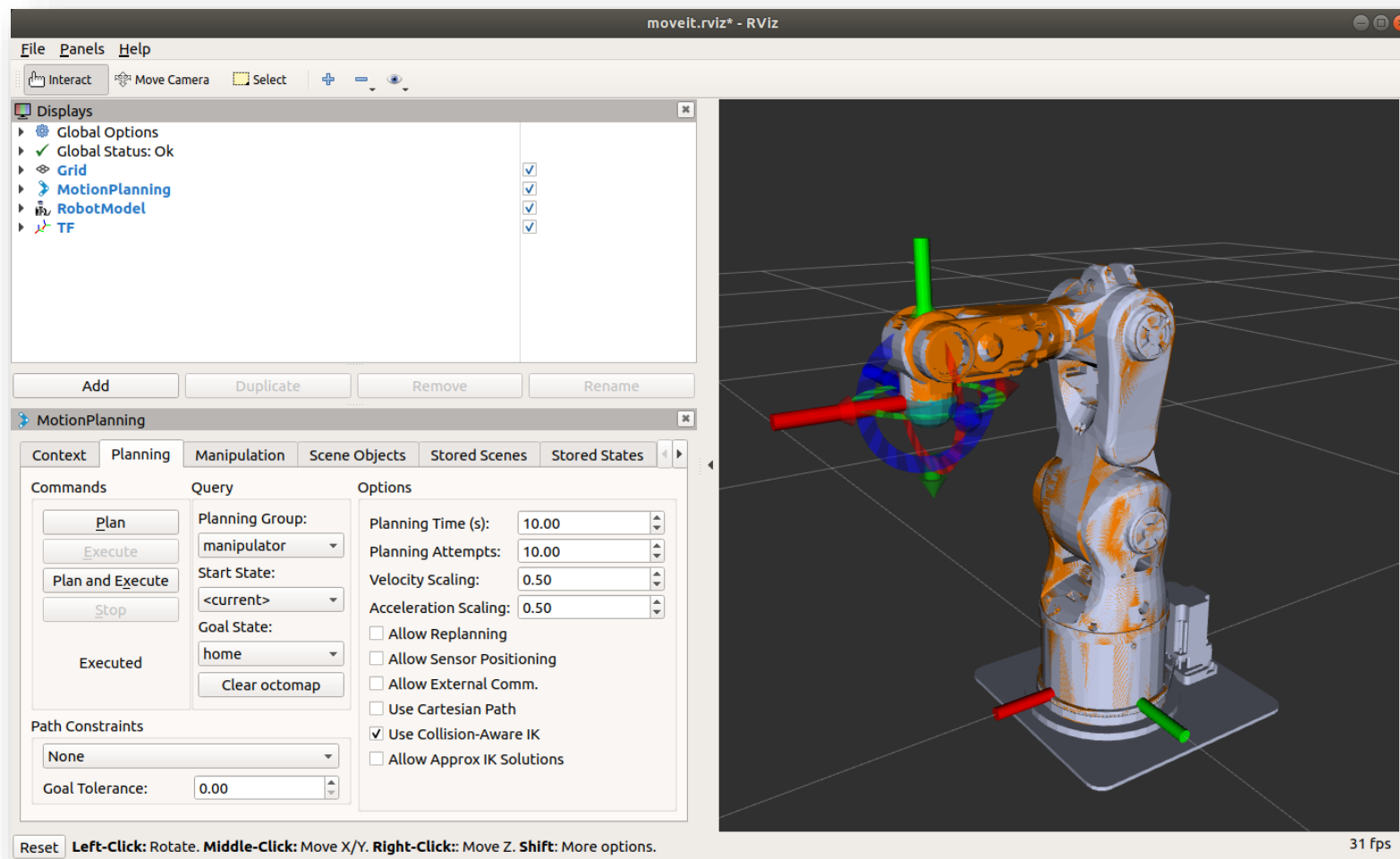
https://github.com/ros-industrial/industrial_core



核心代码浅析



3. ROS-I代码浅析

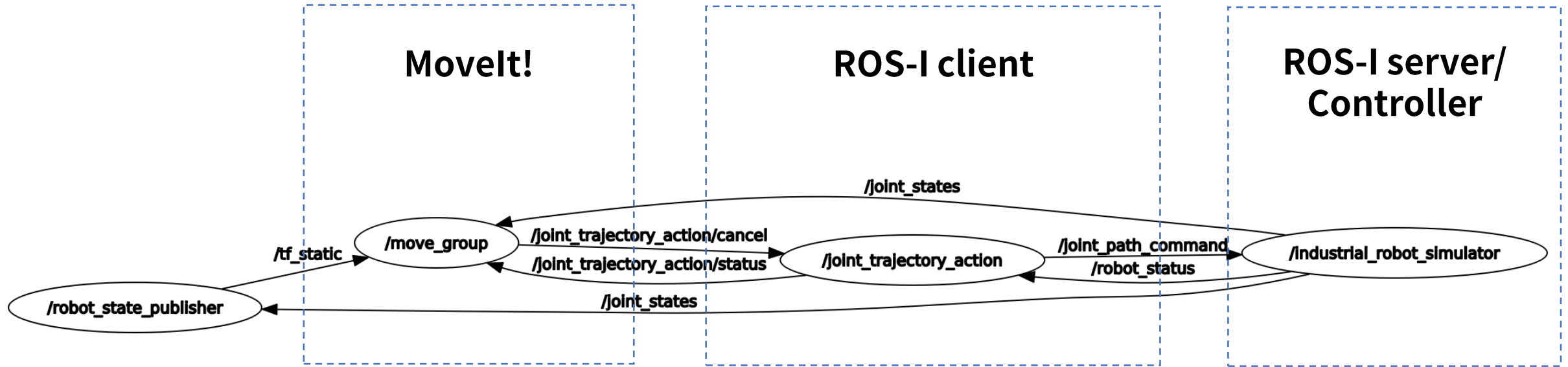


启动PROBOT Anno
ROS-I仿真

```
$ roslaunch probot_bringup probot_anno_bringup.launch sim:=true
```



3. ROS-I代码浅析

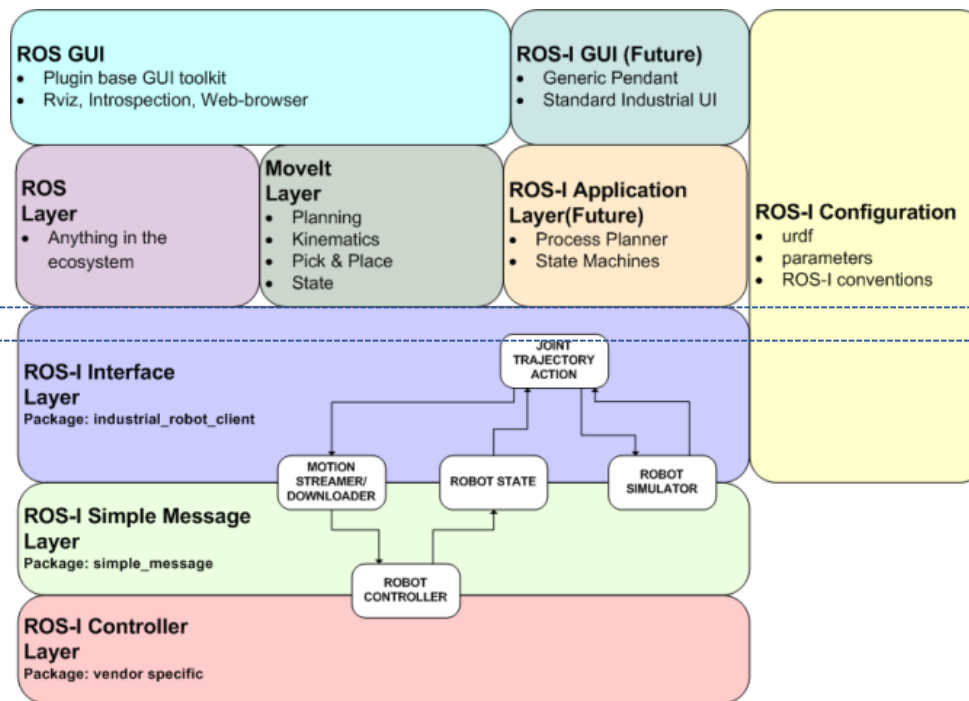




ROS-I框架介绍

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- 为工业机器人提供一站式的工业级ROS应用开发支持。

ROS-I应用原理



ROS-Industrial High Level Architecture - Rev 0.02.vsd

ROS-I代码浅析

1. 对照例程代码和运行效果，理解ROS-I框架；
2. 使用任意机械臂模型完成ROS-I仿真器环境下的配置，并控制模型运动。

- ROS Industrial Tutorials

<http://wiki.ros.org/Industrial/Tutorials>

<https://industrial-training-master.readthedocs.io/en/melodic>

- ROS Industrial

<https://rosindustrial.org/>

- ROS-Industrial Github

<https://github.com/ros-industrial>

- ROS 在工业机器人上有哪些应用？

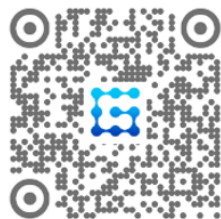
https://mp.weixin.qq.com/s/O-k3GQGqB0Ia_XgzLUCM-Q



Thank You

怕什么真理无穷，进一寸有一寸的欢喜

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 古月居



 古月春旭