

Movelt Land, Sea, & Space

ROS Industrial Asia Pacific 2021



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- **Background**
- **About MoveIt**
- **Land, Sea, Space**
- **MoveIt 2 Roadmap Update**
- **ROS 2 Hardware Support**
- **Future Outlook**



About PickNik Robotics



2015
Founded

32
Employees

251 years
Combined
Experience

13
Masters
In Robotics

7 PhDs
In Robotics

60
Client Partners
To Date



Headquartered in
Boulder, Colorado

We are your partners in strategically developing custom robotics software, while de-risking open source usage.

The Dream: A Multi Purpose Robot

Powered by MoveIt and ROS



Movelt: A Hardened Motion Planning Platform

arm_navigation

 **Movelt!**

 **Movelt!**

 **Movelt2**

Movelt3?



Version 1.0
2010



Beta
2013



Version 1.0
2019



Version 2.0
2020



Version 3.0
2022?

Global Planners

- OMPL
- SBPL
- TrajOpt
- STOMP
- CHOMP

Cartesian Planners

- RobotState
- Descartes
- JogArm
- PilzMotion

Inverse Kinematics

- KDL
- IKFast
- TracIK
- LMA
- BioIK

Grasping Libraries

- MoveIt Grasps
- Grasp Pose Detection (GPD)
- Intel OpenVino GPD

Collision Checking

- Fast Collision Library (FCL)
- Bullet

Perception / Octomap

- Depth Images
- Point Clouds



152 Robot types integrated to work with Movelt

29,843 Downloads per month of moveit_core

733 Academic citations of Movelt

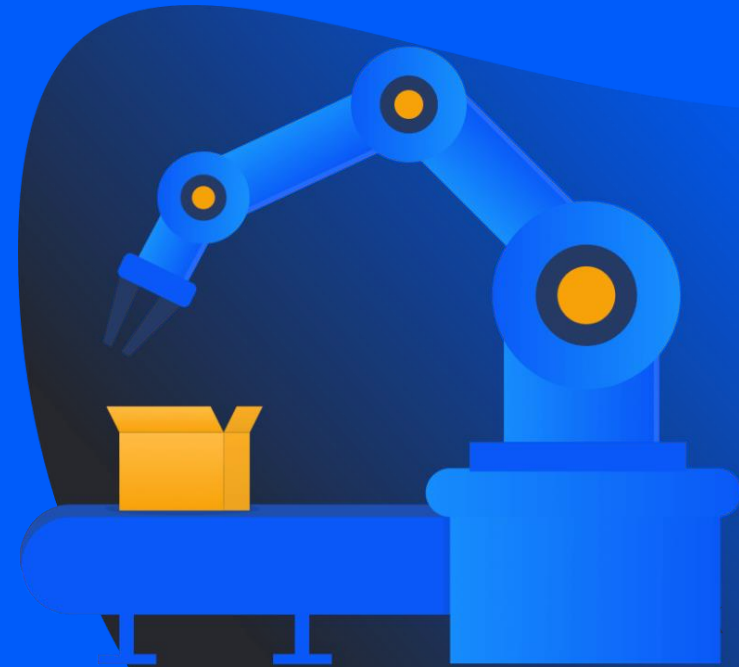
162,630 Unique users to moveit.ros.org in 2021

5,600 Members of Discourse, Movelt's Discussion Forum

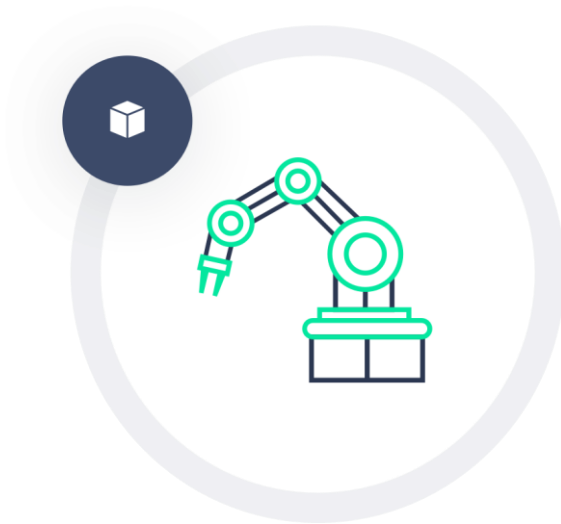
1,136 Github users have starred the Movelt project

262 Github code contributors to Movelt

167 International attendees of 2020 MoveltWorld online event



- **Movelt Workshop @ ROSCon 2021**
- **World Movelt Day (annually)**
- **Monthly Movelt Manipulation Working Group meetings**



Land, Sea, Air



Agriculture

Plant Harvesting



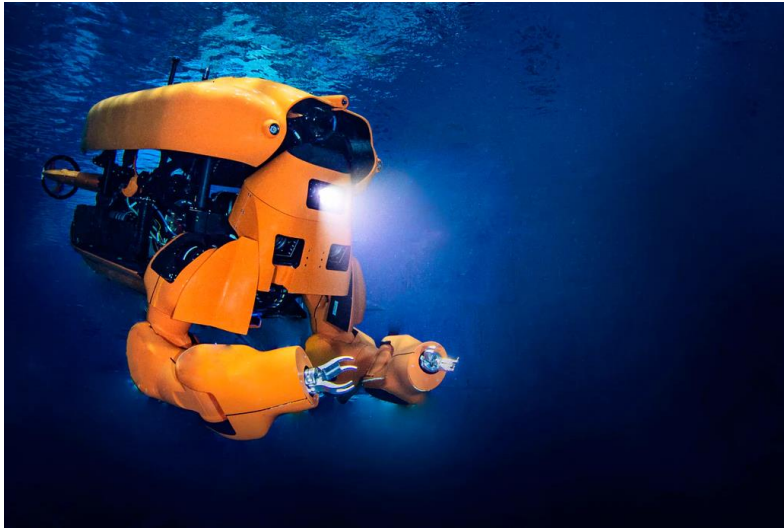
Food

Kitchen Assistant



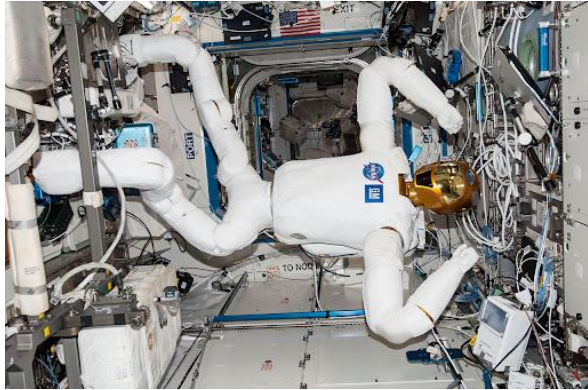
Logistics

Bin Picking



Subsea

Remotely Operated Underwater Vehicles (ROVs)



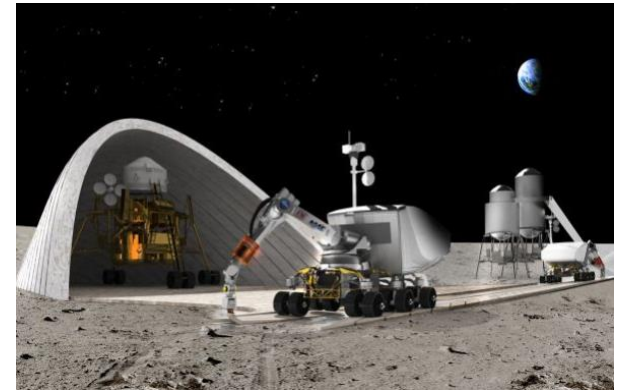
Space

Inter Vehicle Robotics



Space

In Orbit Satellite Servicing



Space

Lunar Base Construction

Supervised Autonomy

- Smarter than teleop, but not full automation
- Human in the loop



MoveIt Migration to ROS 2

Updates

Migration Progress: ~98.5%

All but MSA, Pilz, Python bindings!

MoveIt 2 Git Stats:

- 340 PRs, ~500 commits in MoveIt 2 out of 7.9k total
- MoveIt 1->2 diff: 828 files touched, 18688+, 31696-
- 2x GitHub stars since July 2020 (120 -> 243)

Comparison of MoveIt 1 and MoveIt 2

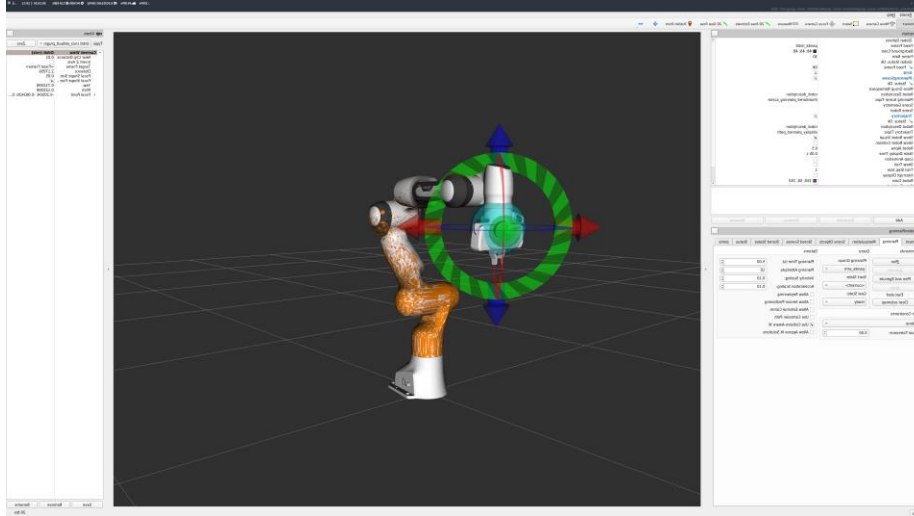


	MoveIt 1	MoveIt 2
ROS 1 Support	✓	via ros1_bridge
ROS 2 Support	✗	✓
Motion Planning	✓	✓
Inverse Kinematics	✓	✓
Perception	✓	✓
Grasping	✓	✓
Setup Assistant	✓	in development
MoveIt Task Constructor	✓	pending
Game Controller Integration for Servo	✓	✓

Industrial Trajectory Generator	✓	planned
Probabilistically complete Cartesian Planning	Stale Patch	✓
Composable Nodes	nodelet subsystem	✓
Planning for Differential Drive Bases	✗	✓
Hybrid Planning (global + local planners)	✗	pending
Based on Realtime Capable DDS Messaging	✗	✓
Native Windows Build	via RoboStack	✓
New Feature Development by PickNik	✗	✓
Development Coordinated with ROS 2 Technical Steering Committee	✗	✓
Built for Industrial Security	✗	✓

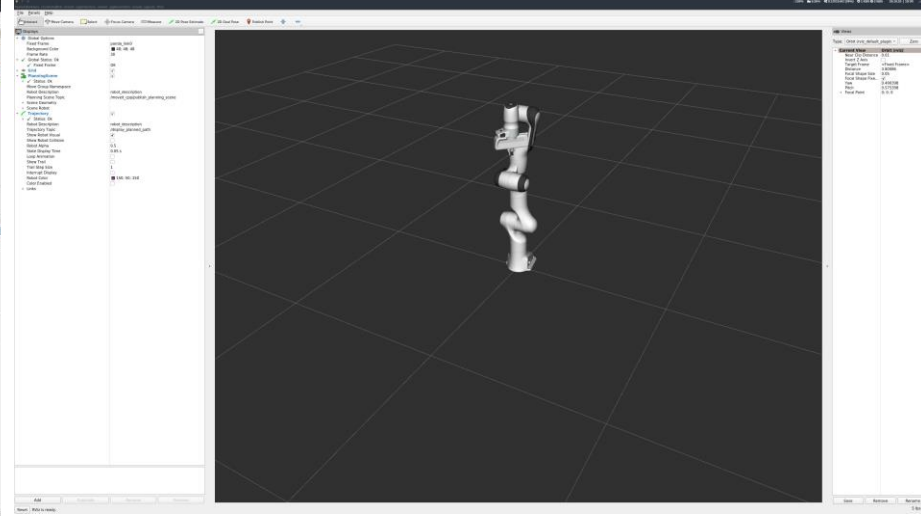
- **Ported MoveIt Task Constructor, MoveIt Visual Tools**
- **Fully switched to GitHub Actions CI**
- **Servo/PoseTracking redesign, Component Nodes**
- **OMPL Constrained Planning (partial support)**
- **ROS2-Control integration, “fake driver” mode**
- **Mobile base joint support, Ignition Gazebo**
- **Hybrid Planner**
- **Multi-planner support**

MoveGroup



Demo code: https://github.com/ros-planning/moveit2/tree/main/moveit_demo_nodes/run_move_group

MoveItCpp



Demo code: https://github.com/ros-planning/moveit2/tree/main/moveit_demo_nodes/run_moveit_cpp

1. Reactive Closed-loop control

- New pose tracking feature based on MovelT Servo
- 6-DOF PID controller for stable Cartesian motions
- Runs distance-based collision checking
- Supports dynamic scene updates

Realtime Support

Reactive, closed-loop control to sensor input
Visual servoing, faster octomap updates
Preempt motion if new collision detected

Separate global and local planner (hybrid planning)

Global planner (full collision checking): ~10hz

Local planner (IK-based, field-based): ~300hz

Zero-memory copy integration to controllers (ros_control)

Tighter integration to ros_control

Integrate pilz_industrial_motion

2. Separate Global/Local Planner (Hybrid Planning)

Project Status

- Initial research completed
- Working on architecture design
- Selecting & Testing Planner Candidates

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3. ROS 2 Controllers - Zero-memory Copy Integration

- Demos running on simulated ROS 2 controllers
- Integration was paused due to breaking API changes
- Part of “Hardware Integration” efforts
- Possibly supporting ROS 2 Controllers as “Local Planner”

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4. Integrate Pilz Industrial Motion Planner

- Computes standard robot motions: PTP, LIN, CIRC
- Supports motion sequences via trajectory blending
- Integration and tutorials are **feature complete**

TODO: Port to ROS 2

Realtime Support

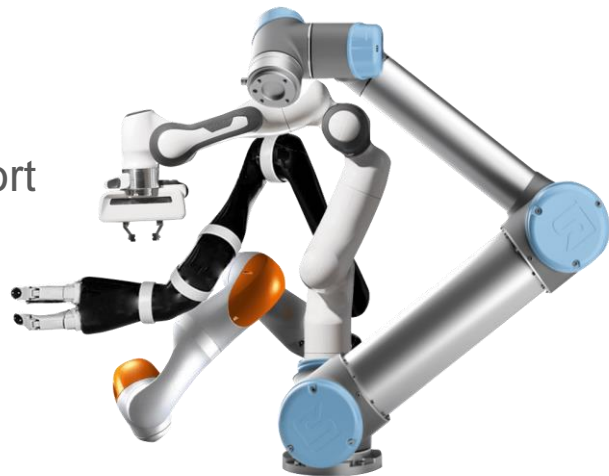
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Hardware Support

Hardware Integration Challenges

“Chicken and Egg” Problem:

- ROS 2 user adoption is driven by hardware support
- Broad hardware support requires user adoption

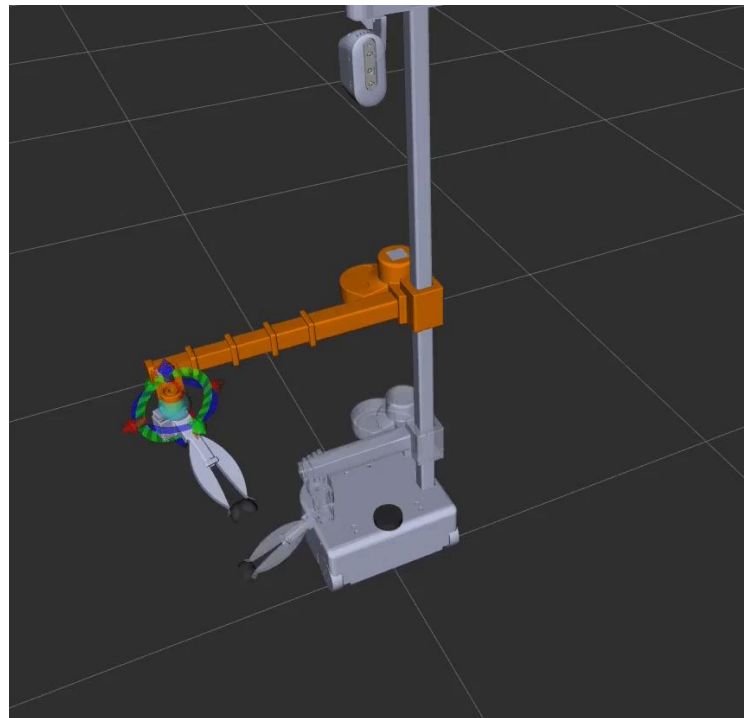


PickNik is working on multiple hardware integration efforts...

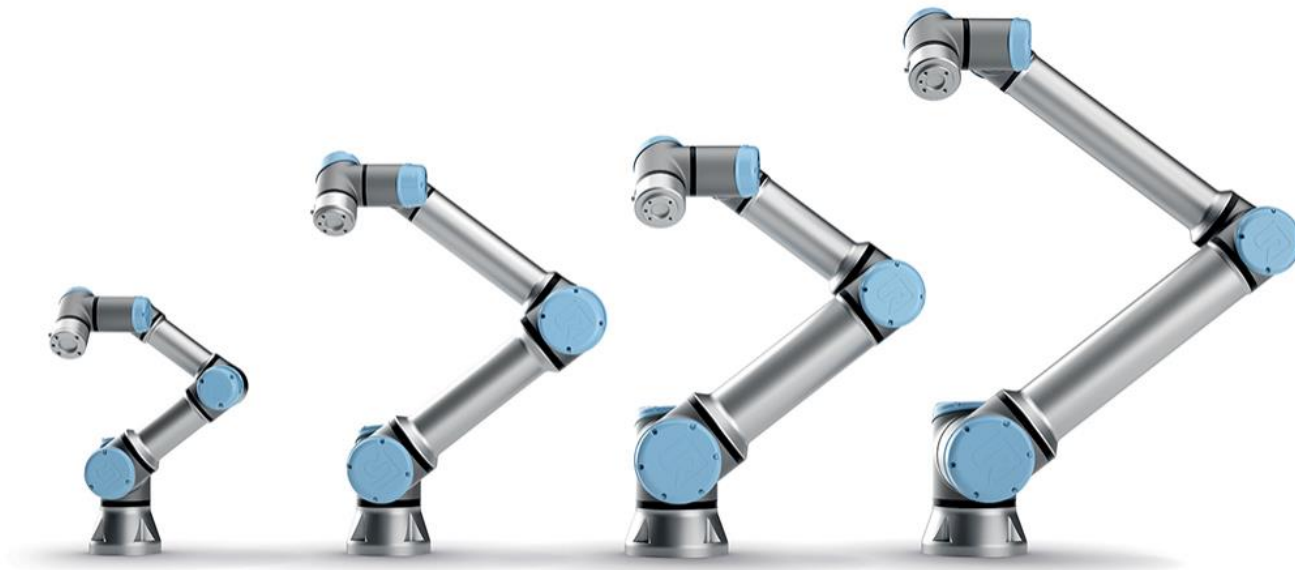
Major contributions to ros2_control

- Admittance controller (PR in review)
 - Currently used for streamed waypoints
 - Trajectory controller in progress
- Dynamic loading, starting, stopping and unloading of HW interfaces
- Port of gripper action controller
- Extensive testing on industrial and cobot hardware

Hello Robot - "Stretch"



Universal Robots UR5



Kinova Gen3



Future Outlook



Movelt3?

Version 3.0
2022?

- End effector switching at runtime
- Lifecycle Management of Movelt Nodes
- Leverage ROS2 component nodes

Seeking funding sources!

Movelt Roadmap



FEATURE	ESTIMATED DATE	FEATURE LEAD	
Hybrid Planning View issue	June 2021	Sebastian Jahr PickNik	Henning Kayser PickNik
Migrate Pilz Industrial Motion Planner to ROS 2 View issue	July 2021	Henning Kayser PickNik	
Movelt Config Redesign - Migrate MSA to ROS 2 View issue	October 2021	Henning Kayser PickNik	Tyler Weaver PickNik
Scene Graph Support View issue	December 2021	Felix von Drigalski OMRON SINIC X	
OMPL Orientation Constraints View issue	December 2021	TBD	
Add ability to attach and detach end-effector links View issue	December 2021	TBD	

WIP: Will be completed with Fraunhofer collaboration

WIP: Almost completed

WIP: Just recently got support from third-party company, might require to be broken up into multiple goals

Inactive

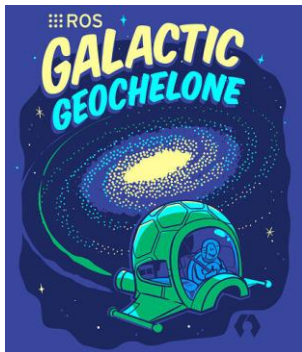
WIP: lots of work on this

WIP: initial investigations

Versions & Release Cycle

Supported on all three primary ROS 2 Distros:

- ROS 2 Foxy, Galactic, Rolling
- Focusing only on Galactic and Rolling
- Active development on Windows



Get Involved

https://moveit.ros.org/about/get_involved/

Enhance Documentation

Expand and improve upon our tutorials and example code.

Answer User Questions

You probably know more than you realize, share that knowledge!

Fix Bugs

Any active and growing project inevitably has regressions that need cleanup.

Add New Features

MoveIt is actively developed: help improve the #1 ROS manipulation





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Thanks!

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