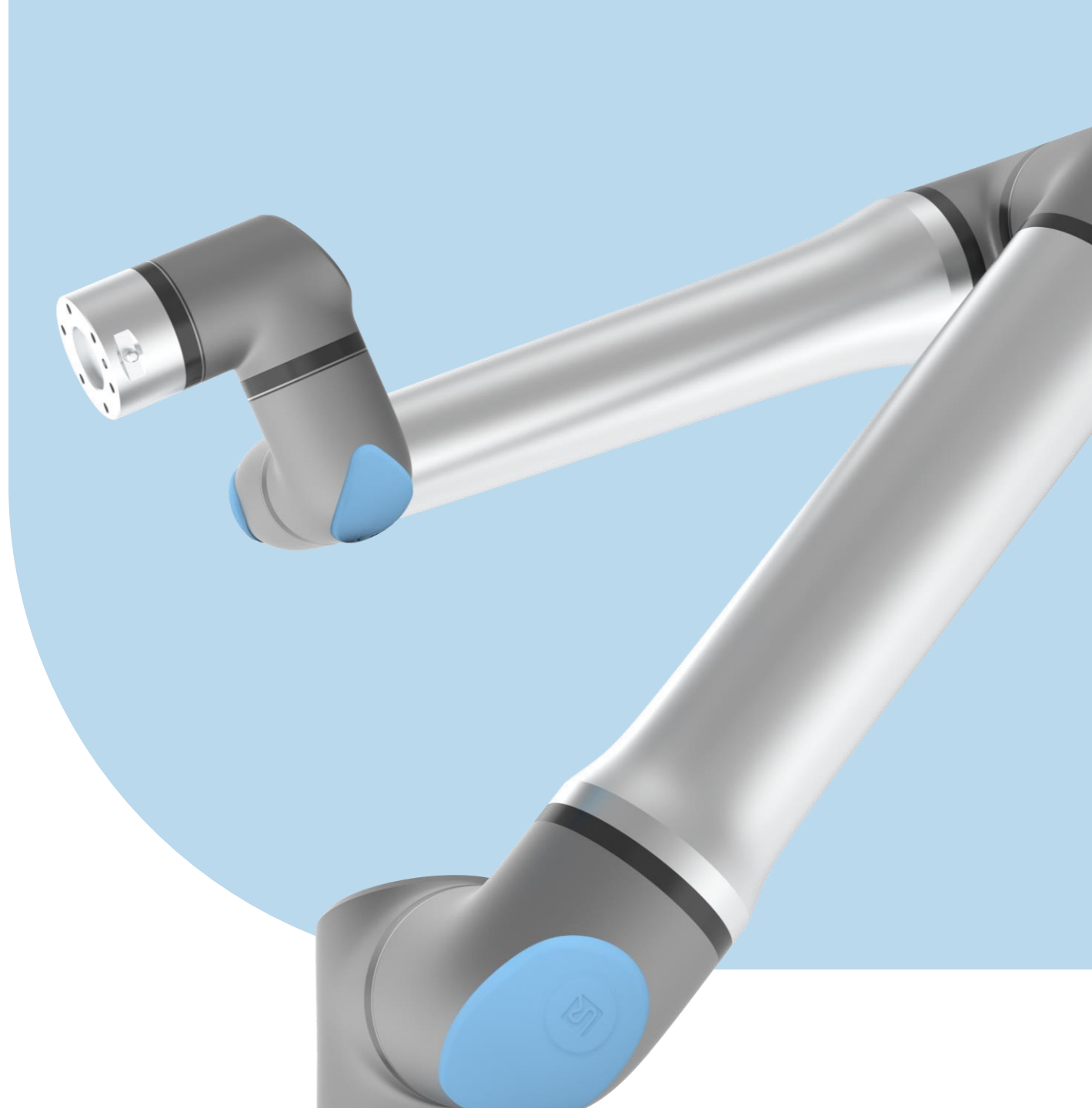# More than just an actuator

Better ROS support for a manipulator

Rune Søe-Knudsen

Felix Exner
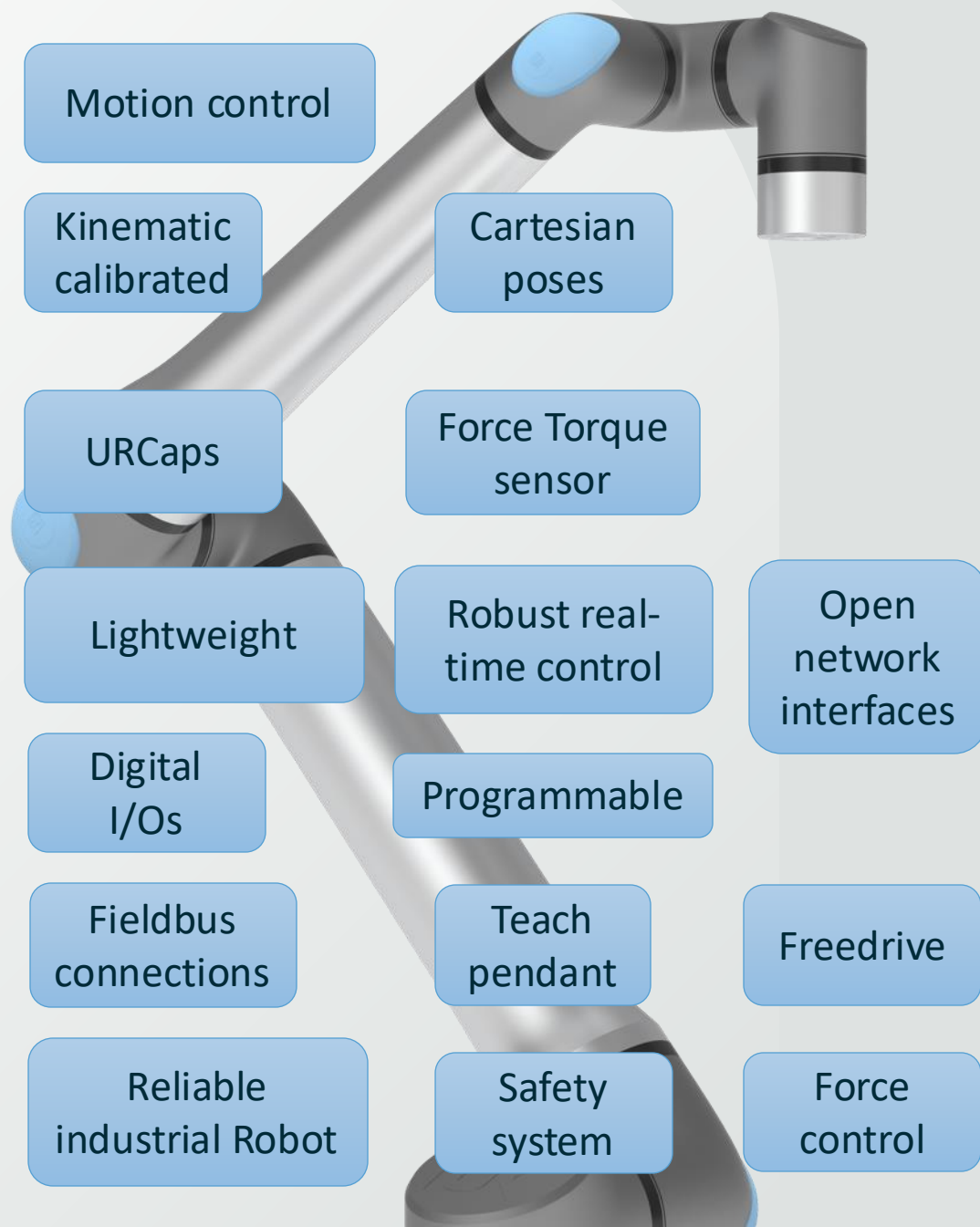
October 22, 2024, ROSCon Odense
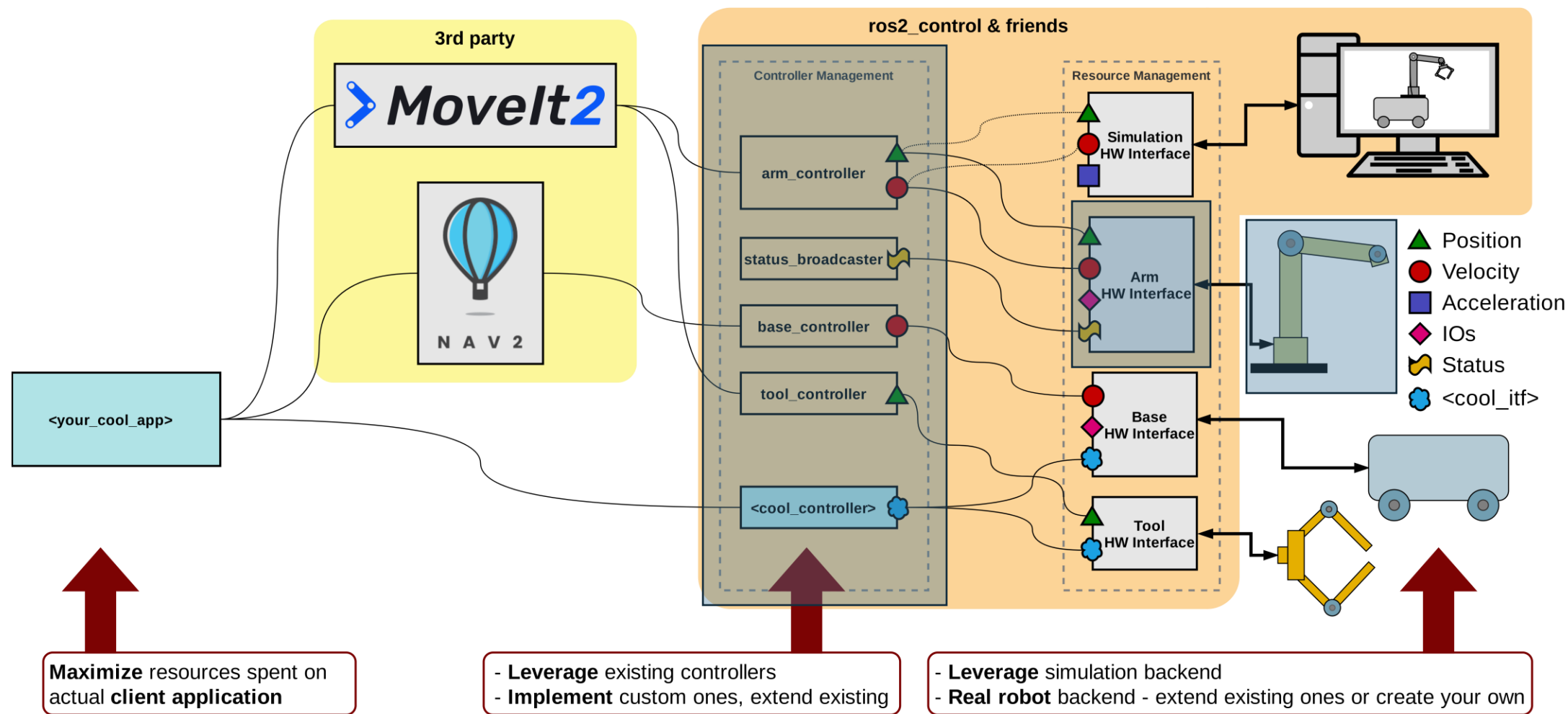
Introduction

- "There are three sides to every story: your side, my side, and the truth"
  by Robert Evans

- Each User and Manufacturer have they own needs, views and values

- Research / Industry

- ROS / Classic robot programming

- Low level control / High level programming

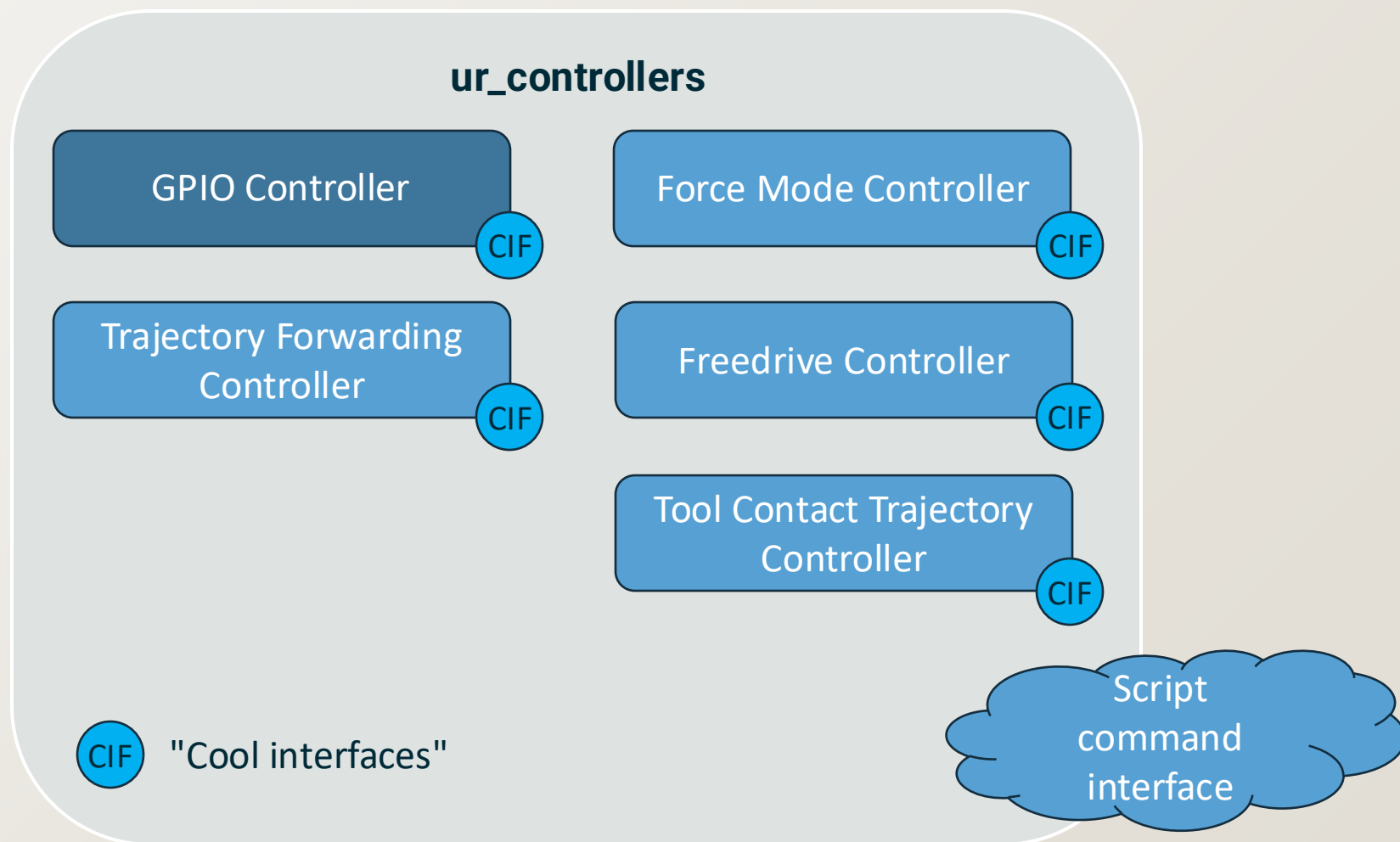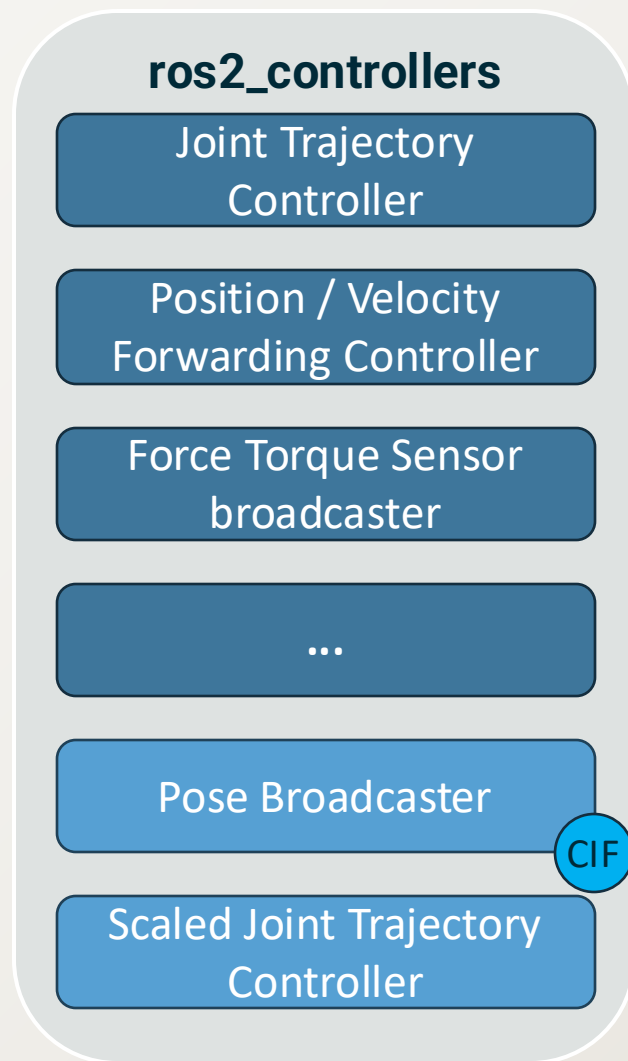- Many years ROS developer / Robot manufacturer developer

How do we see our robots?

- Robust

- Safe

- Lightweight

- Easy-to-use

- Extendable

- Integrable

- Automation for anyone. Anywhere

What is a robot to ROS (ros2_control)?


Maximize resources spent on actual **client application**

- **Leverage** existing controllers
- **Implement** custom ones, extend existing

- **Leverage** simulation backend
- **Real robot** backend - extend existing ones or create your own

The world of controllers

ros2_controllers

- Joint Trajectory Controller
- Position / Velocity Forwarding Controller
- Force Torque Sensor broadcaster
- ...
- Pose Broadcaster **CIF**
- Scaled Joint Trajectory Controller

ur_controllers

- GPIO Controller **CIF**
- Trajectory Forwarding Controller **CIF**
- Force Mode Controller **CIF**
- Freedrive Controller **CIF**
- Tool Contact Trajectory Controller **CIF**

CIF "Cool interfaces"

Script command interface

Pose broadcaster

- Poses published from the robot controller

- Reveals kinematic errors due to missing calibration

- Uses tool settings on the teach pendant
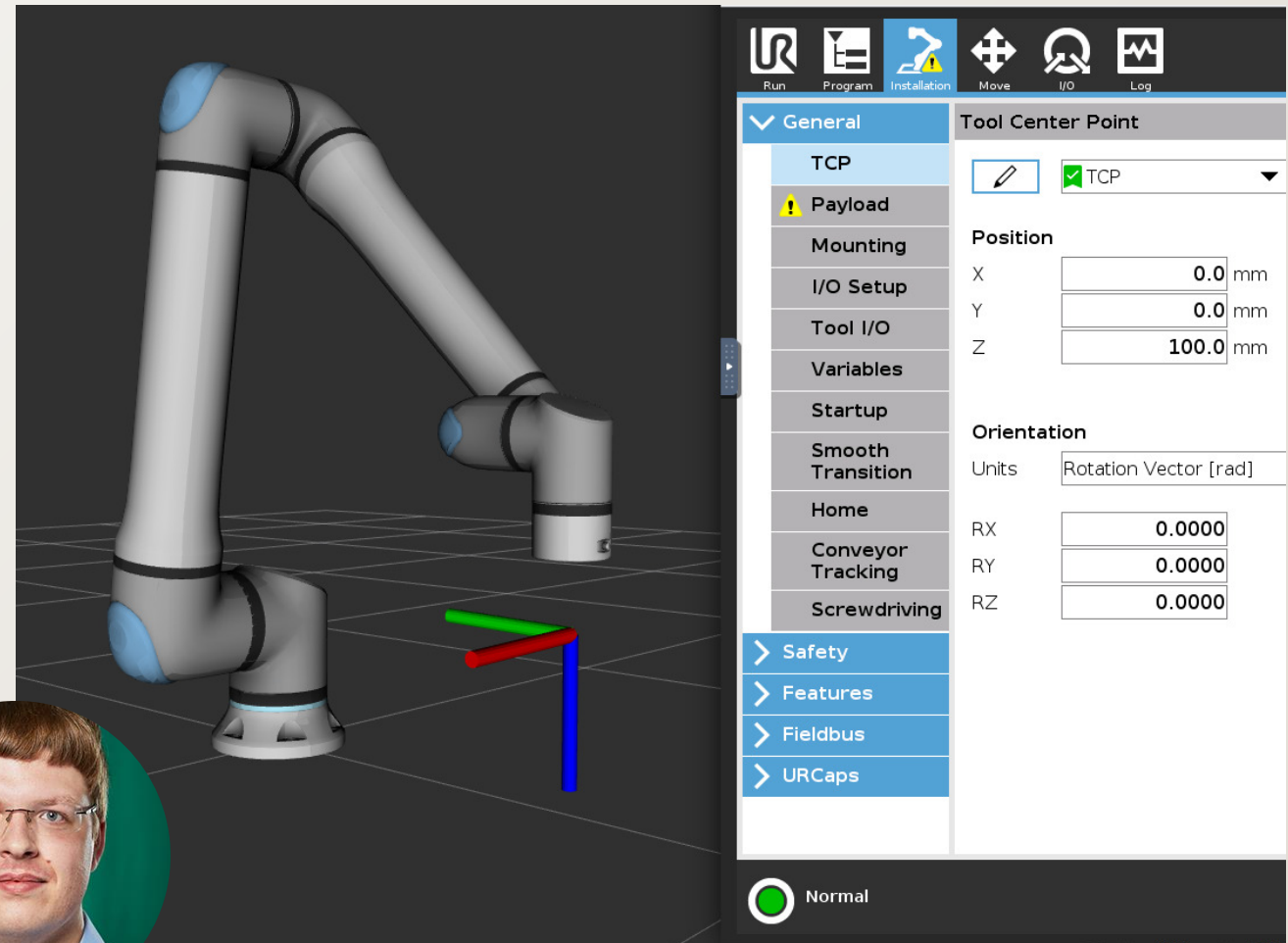
PR: https://github.com/UniversalRobots/Universal_Robots_ROS2_Driver/pull/1108

Scaled trajectory controller

- Transparently forward speed reductions to ROS

- Speed changes during trajectory execution

- Currently integrated into ros2_controllers JTC

- Safety system integration

- Usable for other robots

PR: https://github.com/ros-controls/ros2_controllers/pull/1191
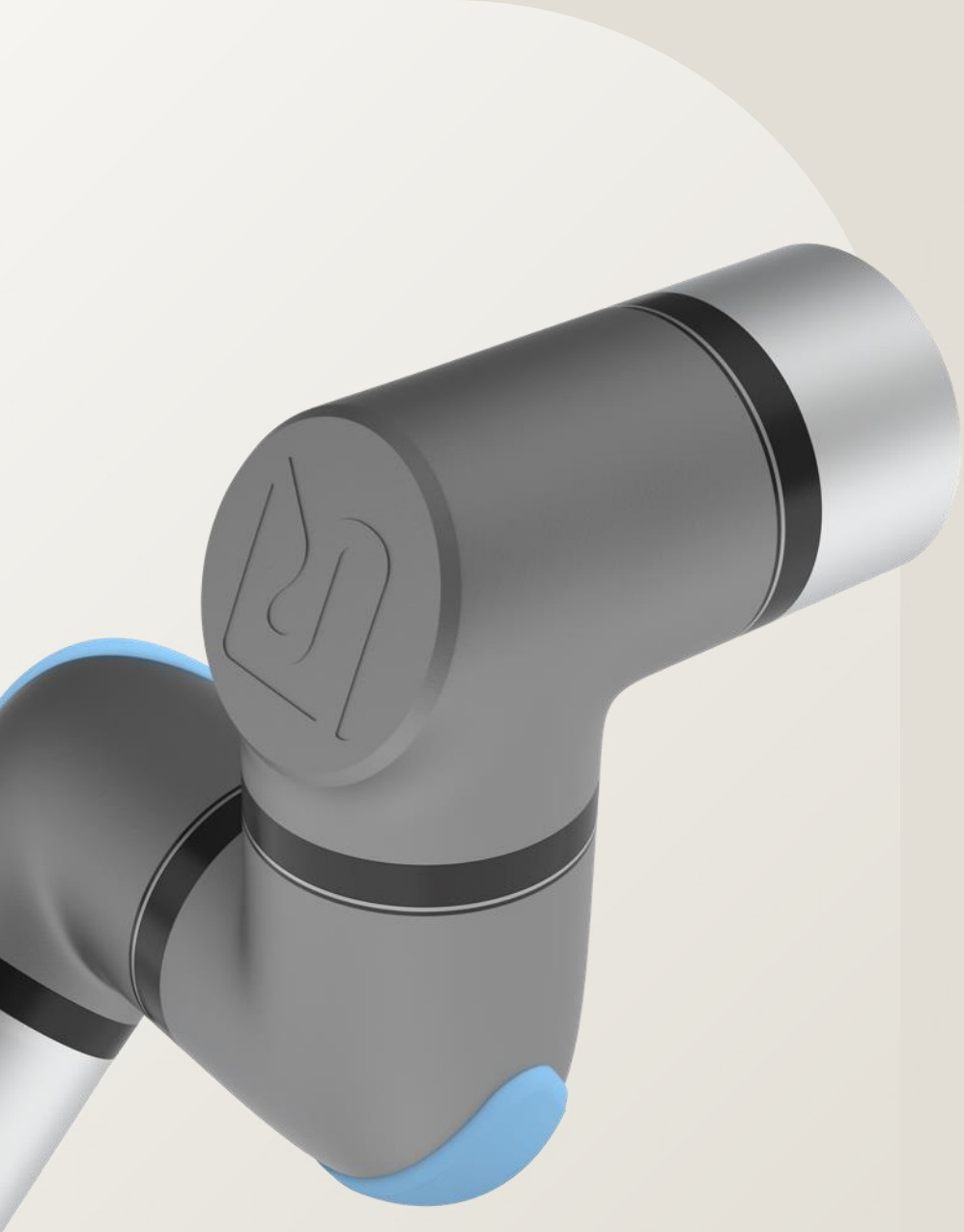
Trajectory forwarding

- Send complete trajectory to robot

- Interpolation on robot controller

- Execution mode can be chosen (in future)

  o Spline interpolation as JTC

  o Linear in joint space

  o Linear in Cartesian space

  o UR-specific optimization
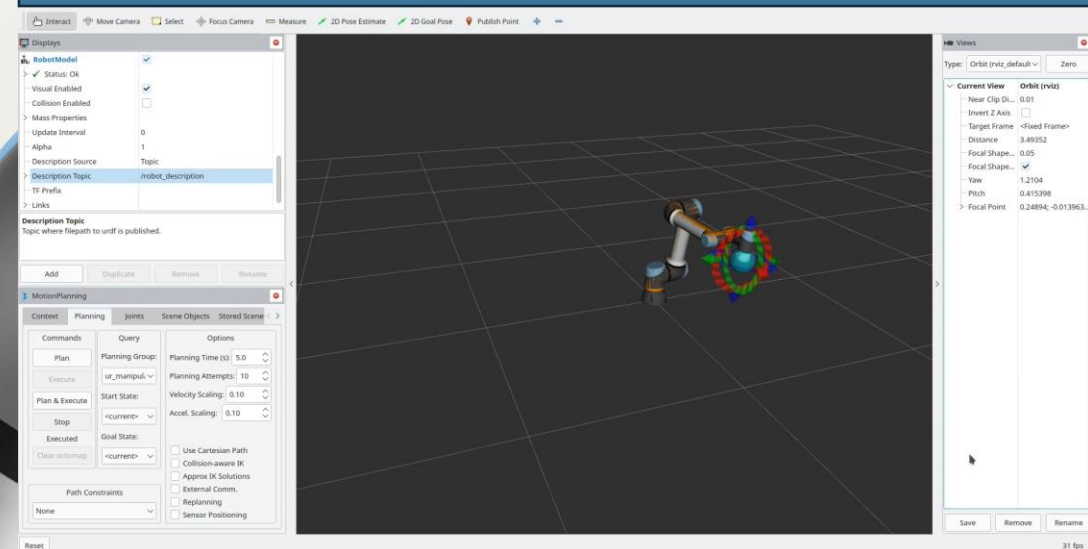
- Potentially decreased real-time requirements

PR: https://github.com/UniversalRobots/Universal_Robots_ROS2_Driver/pull/944

Reducing real-time requirements

Driver running at 2 Hz
Passthrough controller

- Consistent update rate required for command streaming

- Connection is cut if commands are missed

- Special thread scheduling and kernel recommended

- With trajectory forwarding we

  o Can increase communication timeout on the robot

  o Can drop real-time requirements on driver threads

  o Don't need special scheduling / kernel

PR: https://github.com/UniversalRobots/Universal_Robots_Client_Library/pull/218

Freedrive mode

- Move the robot around freely for Human interaction

- Usually being used with the "deadman" button on the Teach Pendant

- Implemented as ros2_control controller

PR: https://github.com/UniversalRobots/Universal_Robots_ROS2_Driver/pull/1114

Force mode

- Execute motions under force constraints

- Runs on the robot controller

- Combine with passthrough trajectory controller
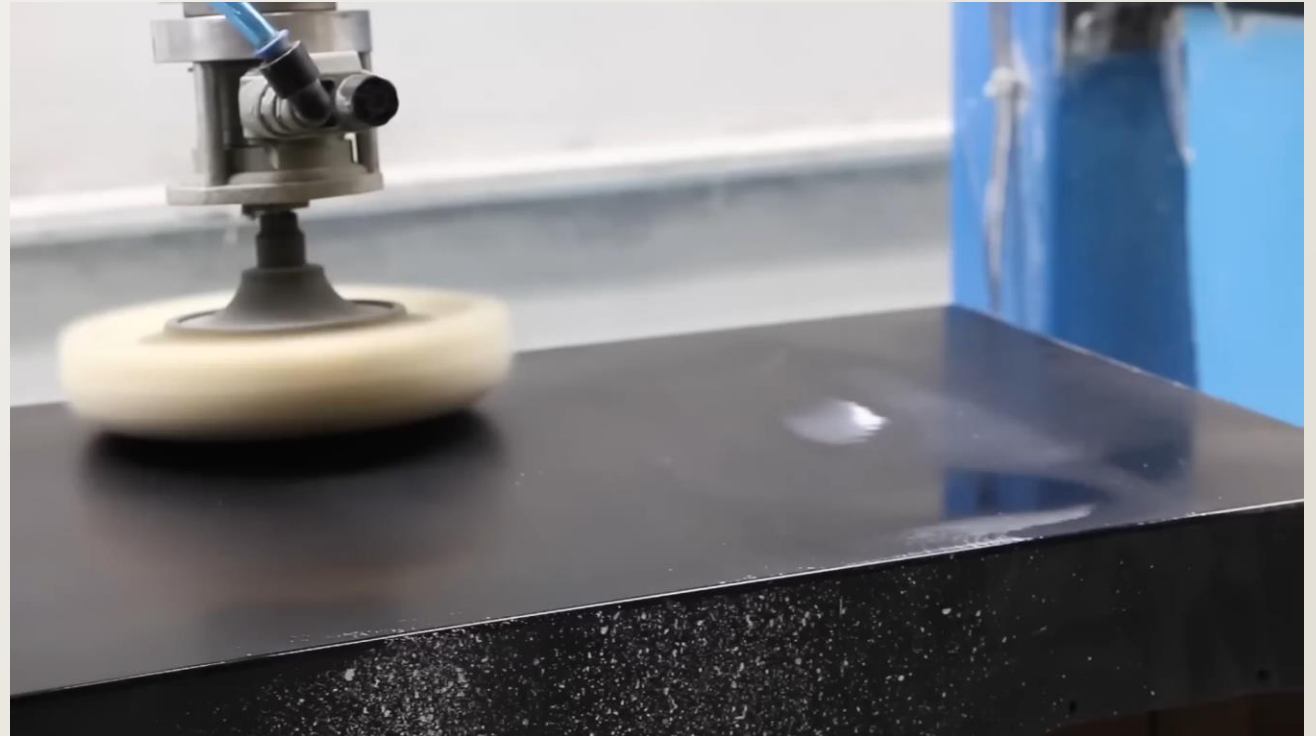
PR: https://github.com/UniversalRobots/Universal_Robots_ROS2_Driver/pull/1049

Tool contact mode

- Detect tool contacting something

- Stop motion on tool contact

- Wrapped into own controller

- Chainable with trajectory passthrough controller

PR: https://github.com/UniversalRobots/Universal_Robots_ROS2_Driver/pull/940

Safety improvements

- Controller stopper: Motion controllers only active when program is running
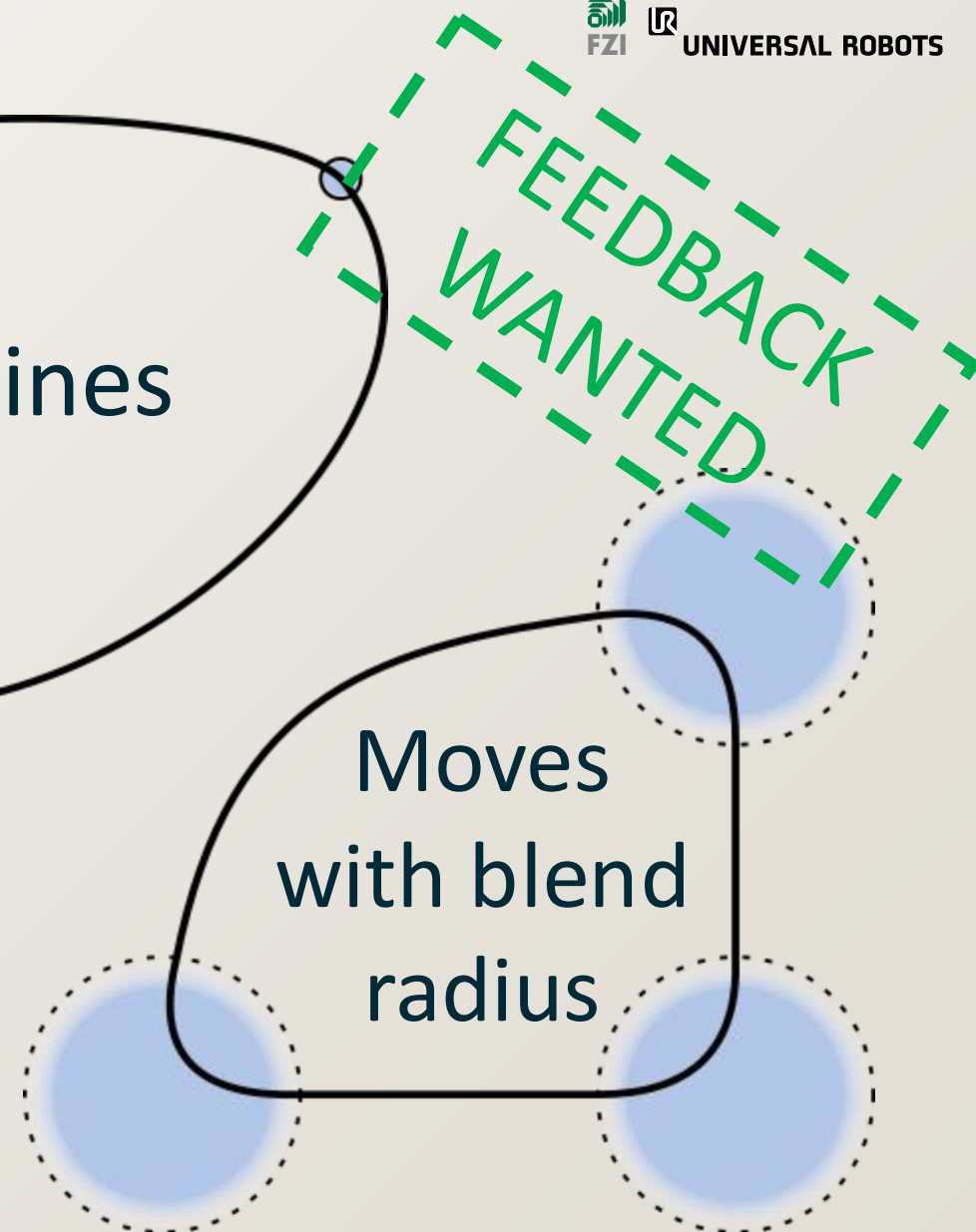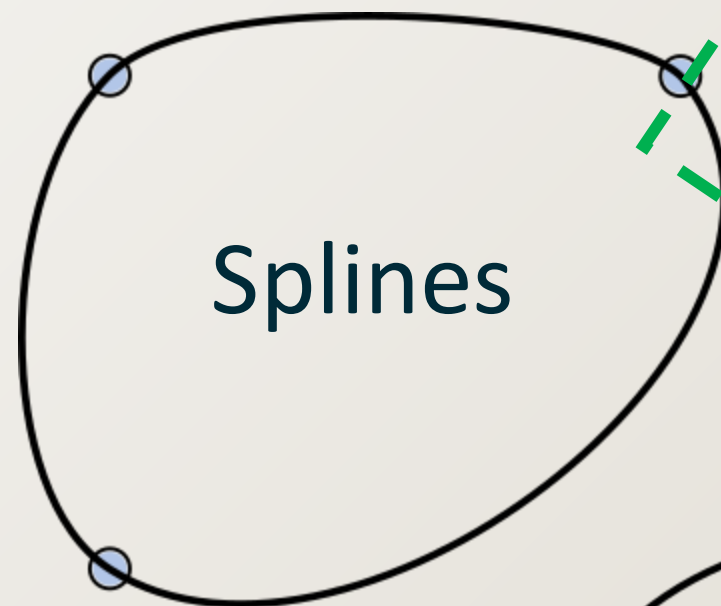
- Avoid sudden motions due to illegal input
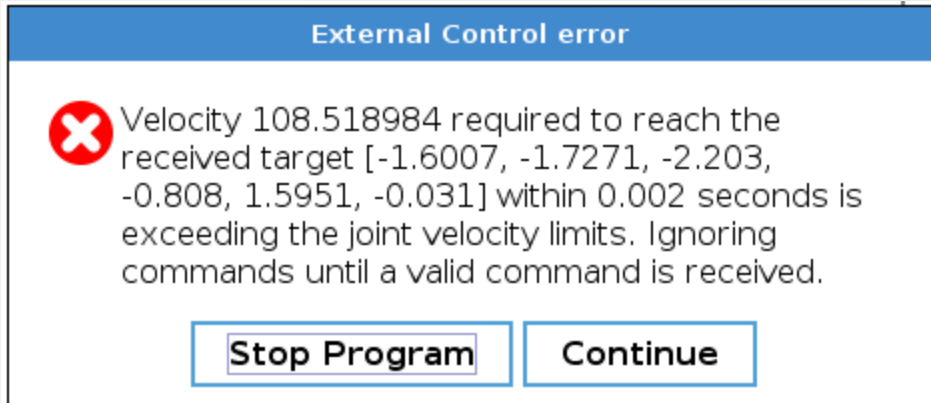
- Ongoing / Future work: Improve lifecycle management in ros2_control

Industrial robot motion interface

- Meet traditional automation programming

- Trajectory interface as PTP, LIN, CIRC motions

- Forwarding controller planned

Splines

Moves with blend radius

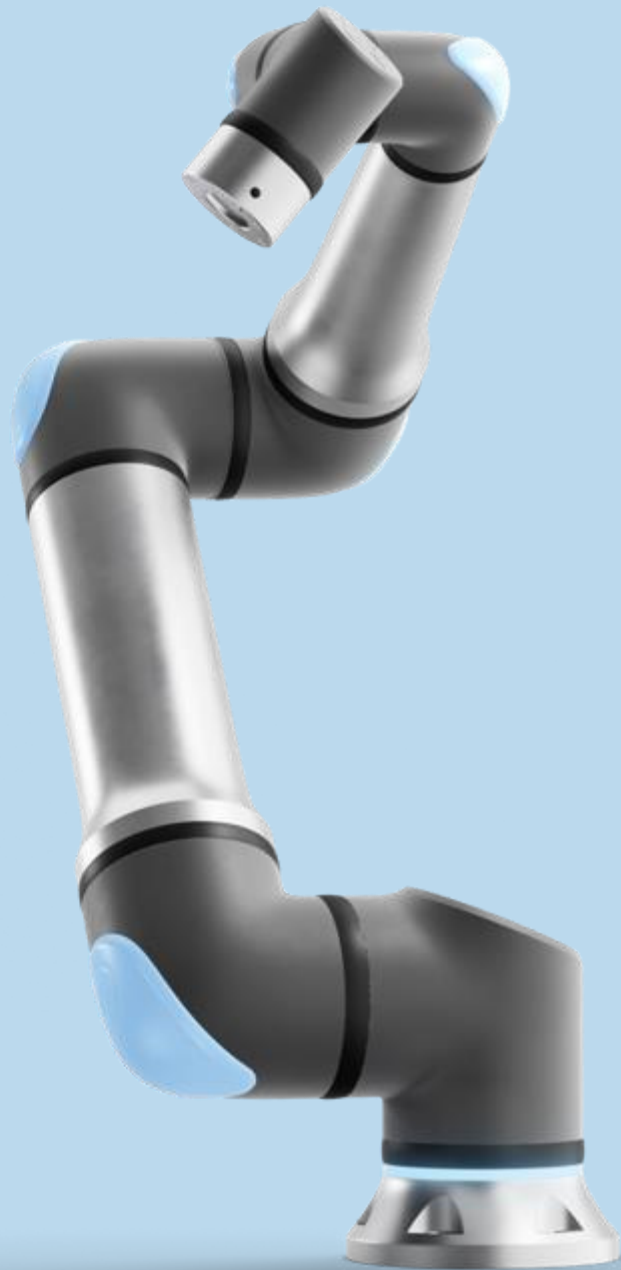https://github.com/UniversalRobots/industrial_robot_motion_interfaces

We want to

- Meet and be accelerated by each other

- Provide more value, for faster success

- Keep being a flexible and robust platform

- Expose more built-in functionality through the ROS Driver

- **News** - PolyScopeX will have ROS2 msg support

"While we are all different, we are also the same in many ways."
by Stephen R. Covey

Thank you
Let's change the world!