# ROS-Industrial Consortium Americas – Year in Review

Matt Robinson, RIC Americas Program Manager

Levi Armstrong, RIC Americas Tech Lead

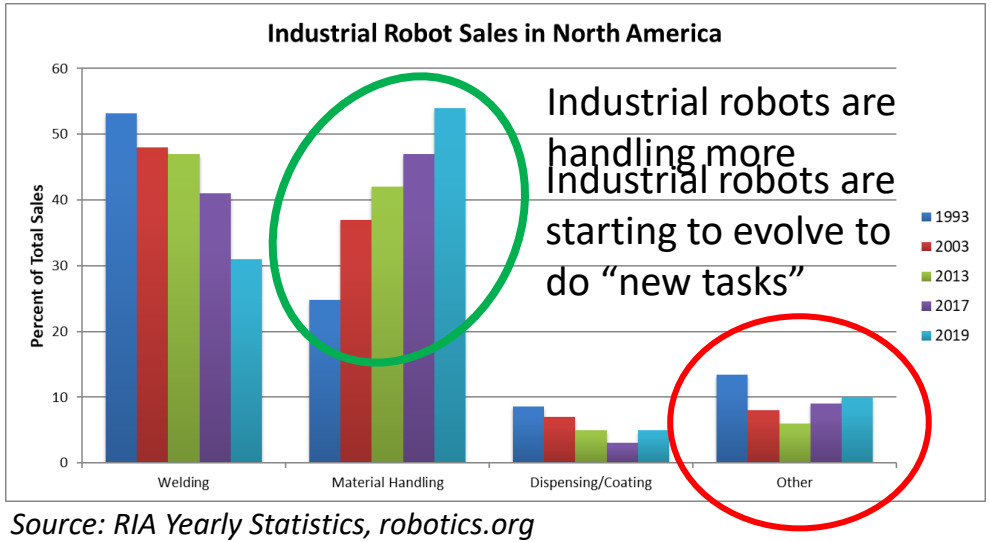
April 13, 2021

# Welcome!

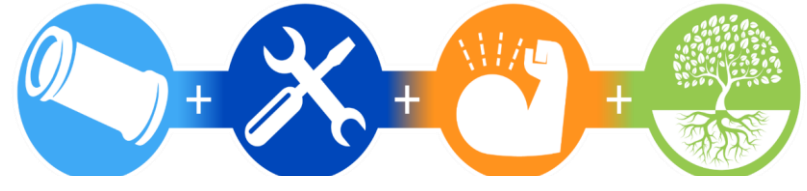
- Brief Intro
- What is ROS-I Refresher
- Objectives of the Consortium and Membership
- Tech Development Strategy
- Summary of Activities
- Technical Update

# Industrial Robotics

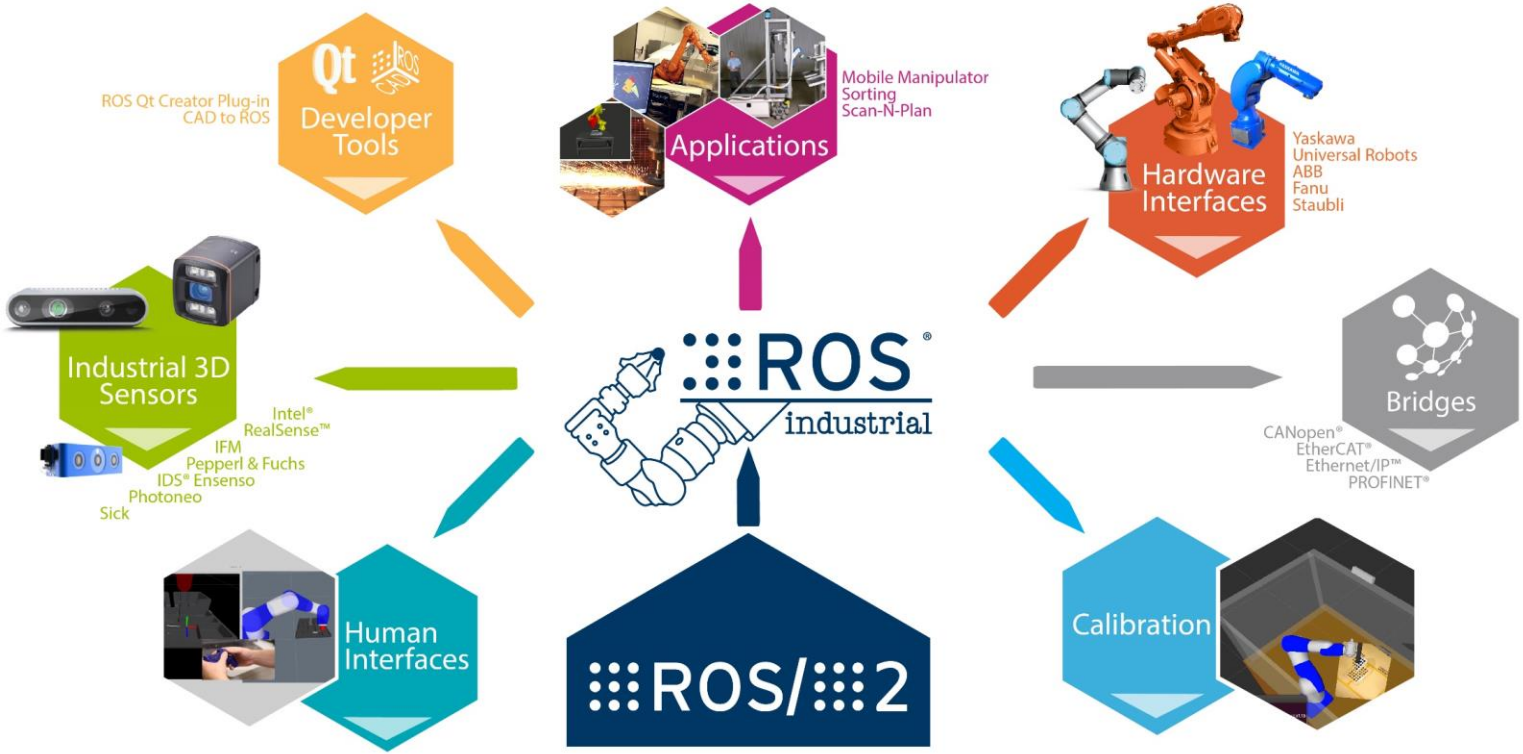
- Silos/Vendor Lock
- Historical reliance on large-scale end-users




*Source: RIA Yearly Statistics, robotics.org*

# What is ROS-I?


ROS Qt Creator Plug-in
CAD to ROS
Qt
Developer Tools
Applications
Mobile Manipulator
Sorting
Scan-N-Plan
Hardware Interfaces
Yaskawa
Universal Robots
ABB
Fanu
Staubli
Industrial 3D Sensors
Intel® RealSense™
IFM
Pepperl & Fuchs
IDS® Ensenso
Photoneo
Sick
ROS industrial
Bridges
CANopen®
EtherCAT®
Ethernet/IP™
PROFINET®
Human Interfaces
ROS/2
Calibration

# ROS-Industrial Timeline

2010 SwRI Adopts ROS

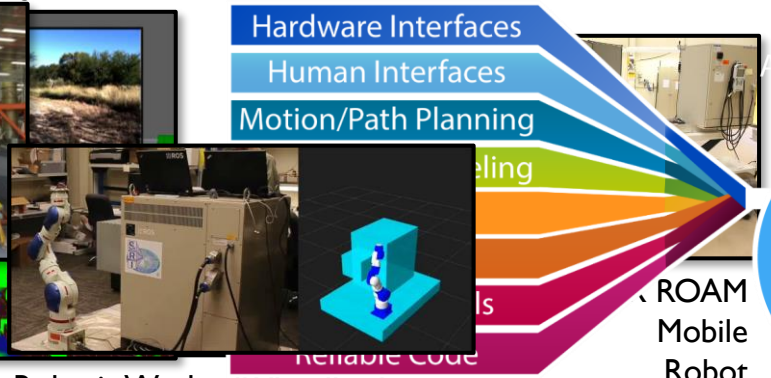
2011 ROS-I Inception

2012 ROS-I Launch

2013-2016 ROS-I Consortium

SwRI Unmanned Ground Systems

Robotics Coating Removal System




Robotic Workcell Visualization

ROAM Mobile Robot

Enable Global Leverage of Regional Development

# Tech Vision Supported by Industry

- **ROS-Industrial Consortium** acts as an ecosystem where different players – end-users, equipment providers, system integrators, institutes of research and training partners **come together to advance and proliferate Open Source robotics**

# Strategy for Capability Development

Environment Layer (MoveIt, Tesseract, Dart, etc.)

Messages, Topics

ROS 1 / ROS 2 / Middleware Layer

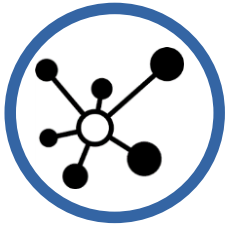
Build ROS1 or ROS2, these are independent

Independent of ROS

Collision Detection


Motion Planners

Kinematic Solvers

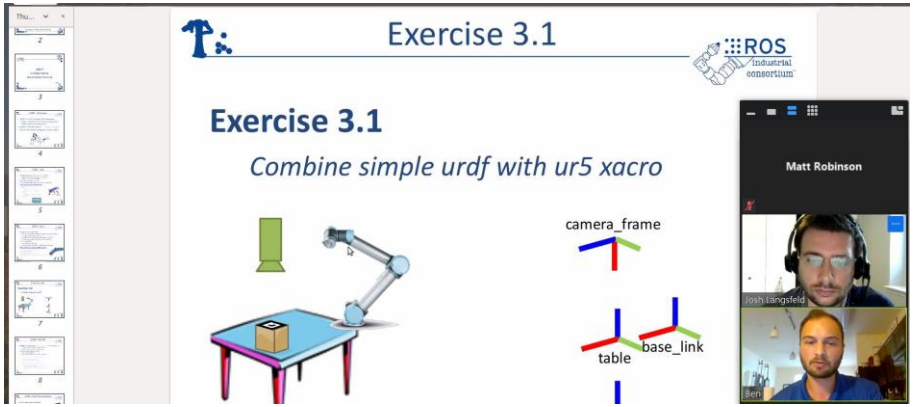


Connectivity Structure

Continue to support deployed end-user ROS1 systems with new capabilities as they are developed even if for a ROS2 solution

# Getting to ROS2

- Rolled out ROS2 ROS-Industrial Training
  - Porting practices
  - Use of the bridge
  - Basic training Feb 2021
- First Virtual Training
  - Leverage the AWS EC2 Instance
  - Zoom & Slack/IRC



# Collaboration

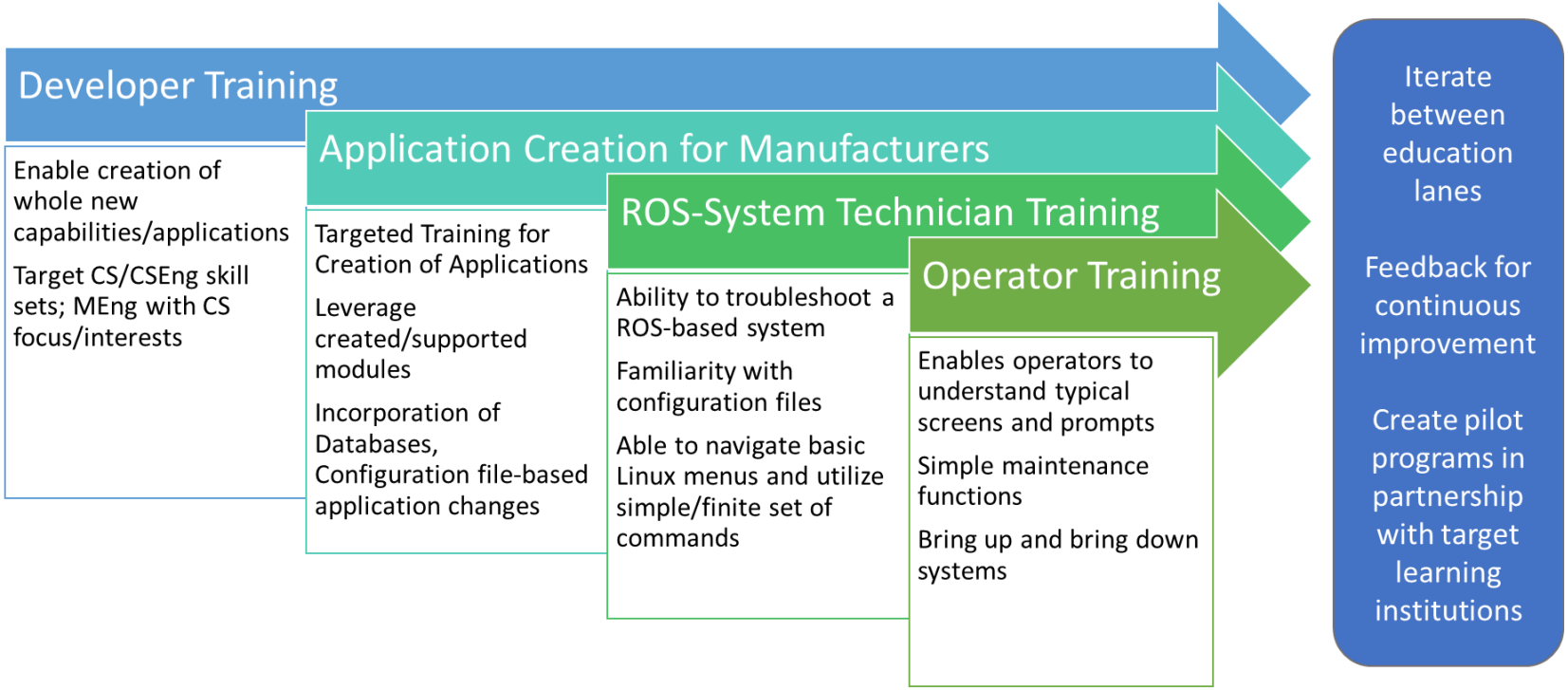
- Members working together
  - PickNik working with UR and FZI Research to create UR RO2 Driver
  - MathWorks and Delft University of Technology on Simulink + ros_control
- ROS-I Members working with the ARM Institute
  - Spirit AeroSystems with NIAR at Wichita State
    - Collaborative Robotic Sanding
  - Siemens, Yaskawa, Keba, and SwRI along with ARM Institute members RTI & Schlumberger
    - Multi-Machine Multi-Robot Interoperability
  - Microsoft supporting ROS+HoloLens2 Projects
  - Boeing, Siemens, Aerobotix, and SwRI supporting coating sustainment projects – extending applications of the A5 repo


Human Drawn Boundary Region Detection

# ROS2 Collaborative Development

- In collaboration with Spirit AeroSystems, NIAR at Wichita State University and the ARM Institute
- Collaborative sanding application for composite parts
- Full open-source development of a Scan-N-Plan system
  - Force-commanded constant velocity trajectory controller
  - Human marking detection and replanning
  - https://github.com/swri-robotics/collaborative-robotic-sanding

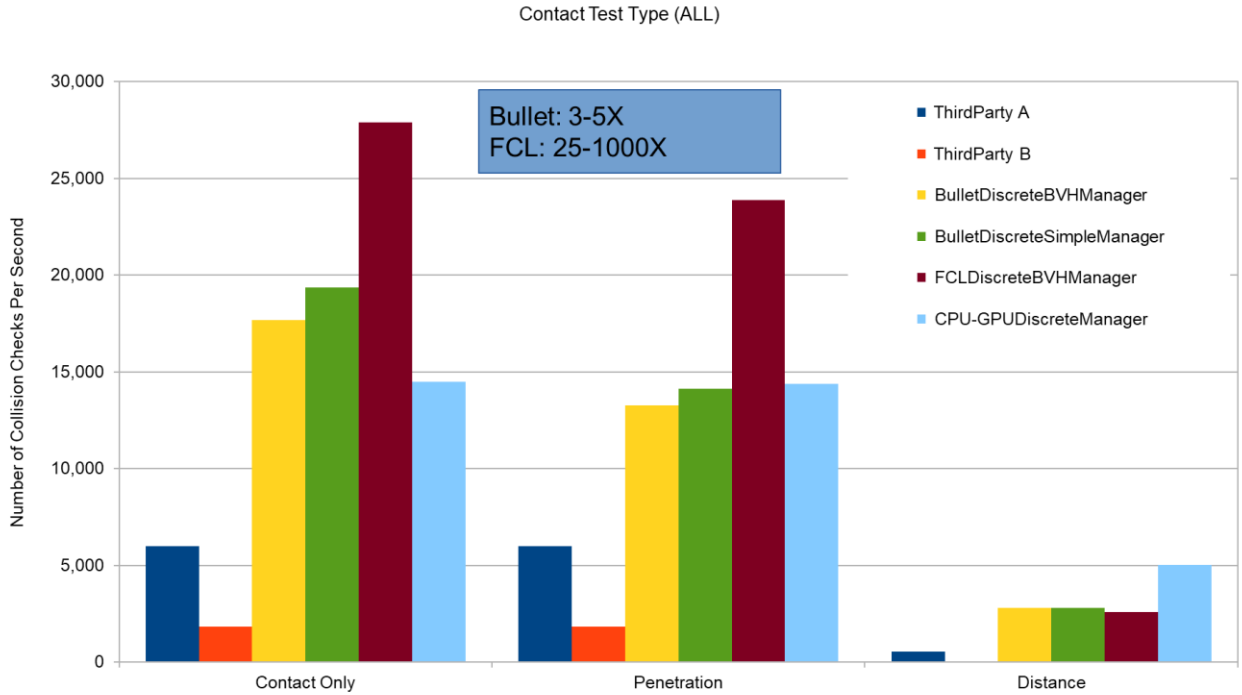
# Continued understanding of areas of need



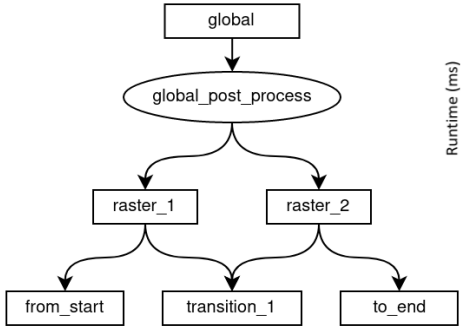
# Tech Update Overview

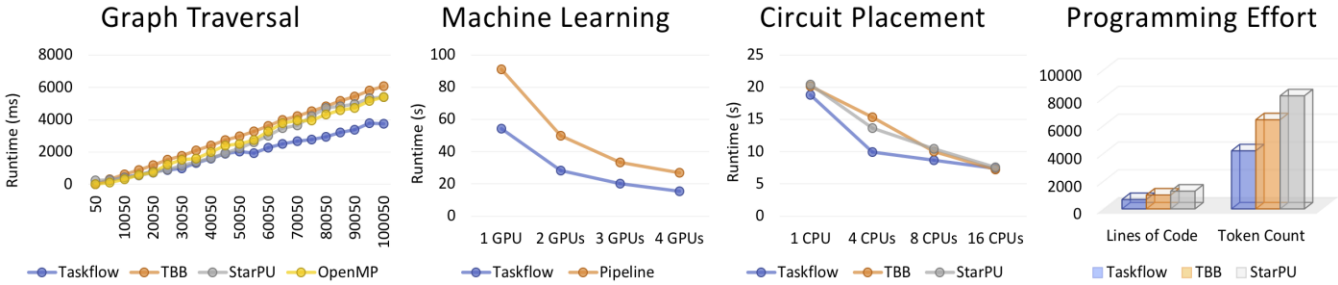
- Collision Checking Improvements
- Parallel Process Planners
- Example Application
- Kinematic Calibration
- Offline Toolpath Planner Updates
- Adaptive Force Control

# Collision Checking Improvements

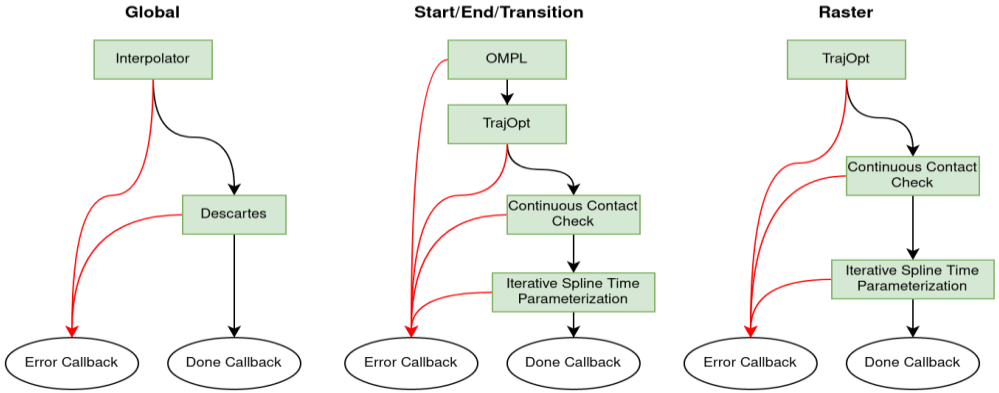


# Parallel Process Planners




Taskflow lets you quickly implement task decomposition strategies that incorporate both regular and irregular compute patterns, together with an efficient work-stealing scheduler to optimize your multithreaded performance.



# Example Application

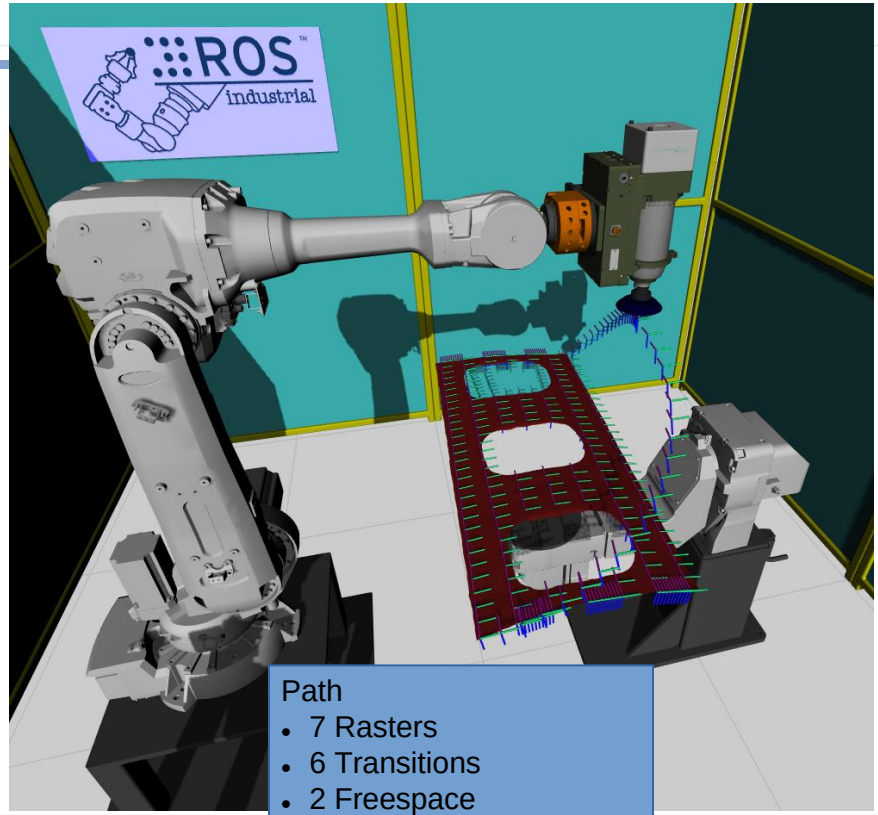
ABB 6DOF Manipulator

ABB 3DOF Positioner

Fuselage section with windows

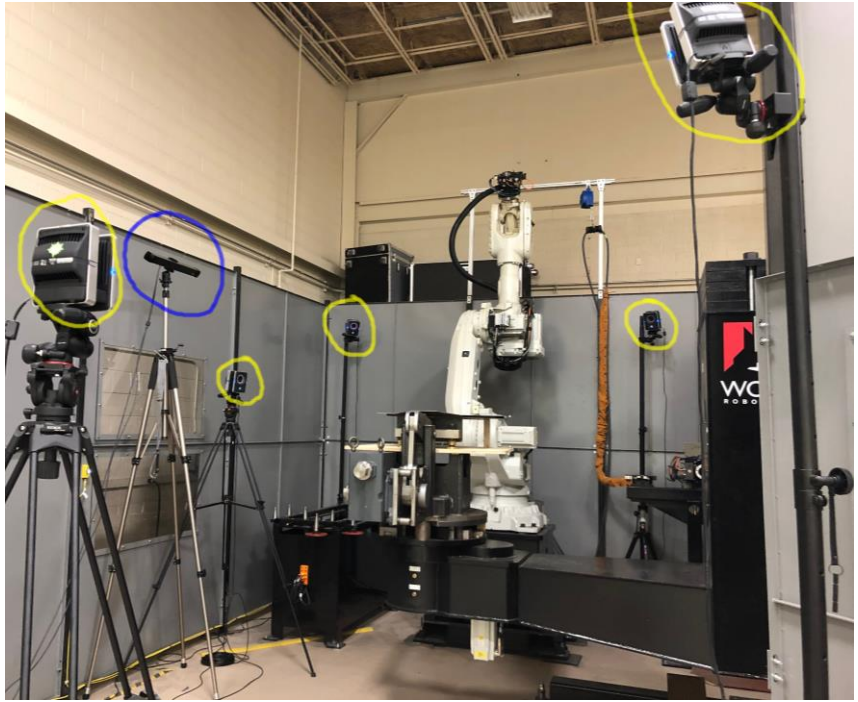
Generate a process trajectory

- Single Threaded
  - 7.286156 seconds
    - 19.274 ms per instruction
  - 6.862507 seconds (with seed)
    - 18.059 ms per instruction
- Multi-Threaded
  - 3.236508 seconds
    - 8.517 ms per instruction
  - 2.300784 seconds (with seed)
    - 6.054 ms per instruction



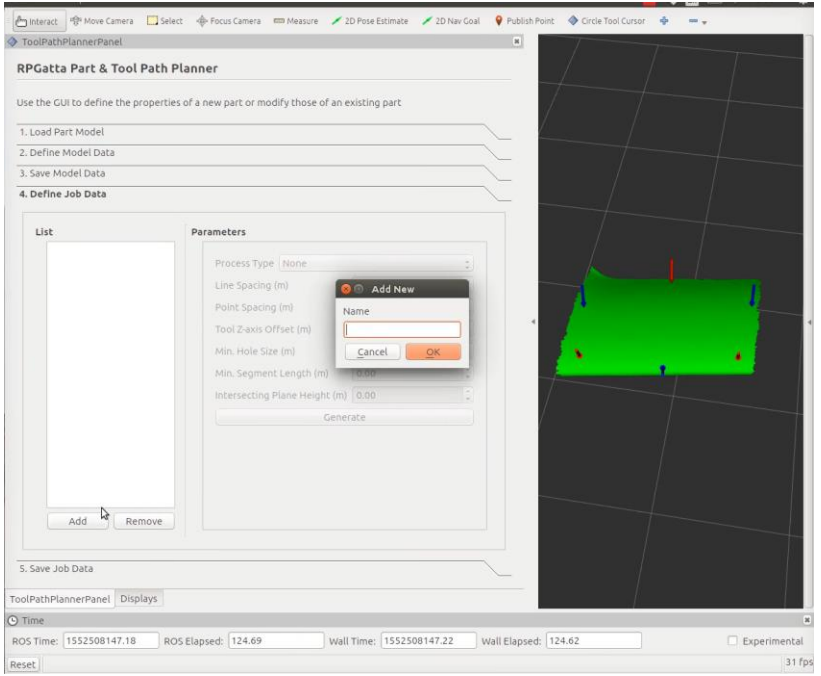
# Kinematic Calibration

- Tested using the following Systems
  - Photoneo
  - Vicon
- Calibration Approaches
  - DH Parameters
  - Full Kinematic Calibration
- POC
  - Michael Ripperger
  - Michael.ripperger@swri.org
- Repository
  - https://github.com/Jmeyer1292/robot_cal_tools



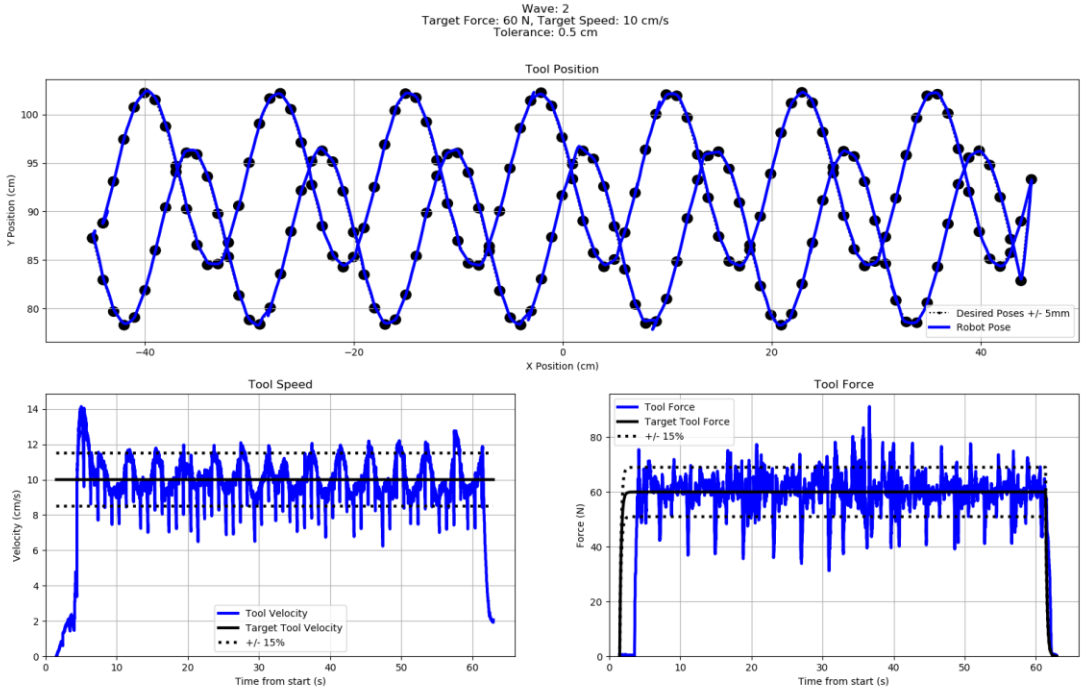
# Offline Toolpath Planner Updates

- Integrated Heat Raster
  - Upgraded to the latest version in geometry central.
  - Improving extraction of the toolpath from the distance data.
- Draw paths on meshes
- POC
  - Dr. Chris Lewis
  - christopher.lewis@swri.org
- Repository:
  - https://github.com/swri-robotics/toolpath_offline_planning



# Adaptive Force Control

- Leveraging
  - ROS2, ROS1, UR10e
  - ROS Control, Cartesian Controller
- POC
  - Tyler Marr
  - tyler.marr@swri.org
- Repository
  - https://github.com/swri-robotics/collaborative-robotic-sanding
  - https://github.com/fzi-forschungszentrum-informatik/cartesian_controllers



# Resources for the Community

- ROS-Industrial
  - Home: rosindustrial.org
  - Documentation: wiki.ros.org/industrial
  - Code: https://github.com/ros-industrial; https://github.com/ros-industrial-consortium
  - Training: http://ros-industrial.github.io/industrial_training/
  - ROSin: http://rosin-project.eu/
  - Upcoming Events (https://rosindustrial.org/events-summary/)