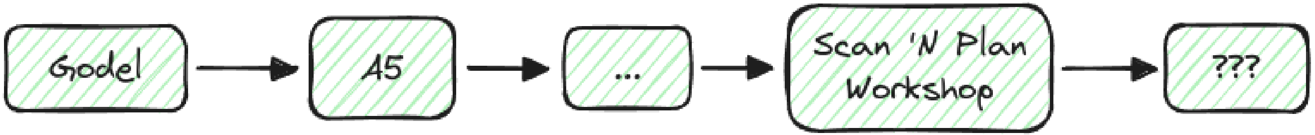
Providing Open-Source Solutions for Industry

2022 Annual Meeting

ROS-I Americas Tech Vision

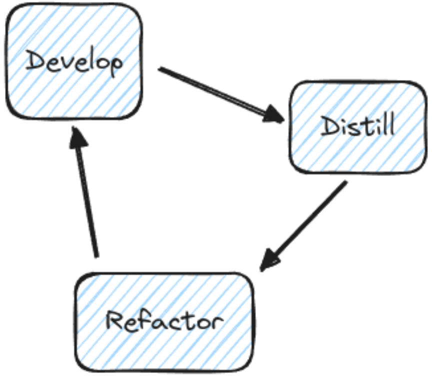
- The “killer” app?

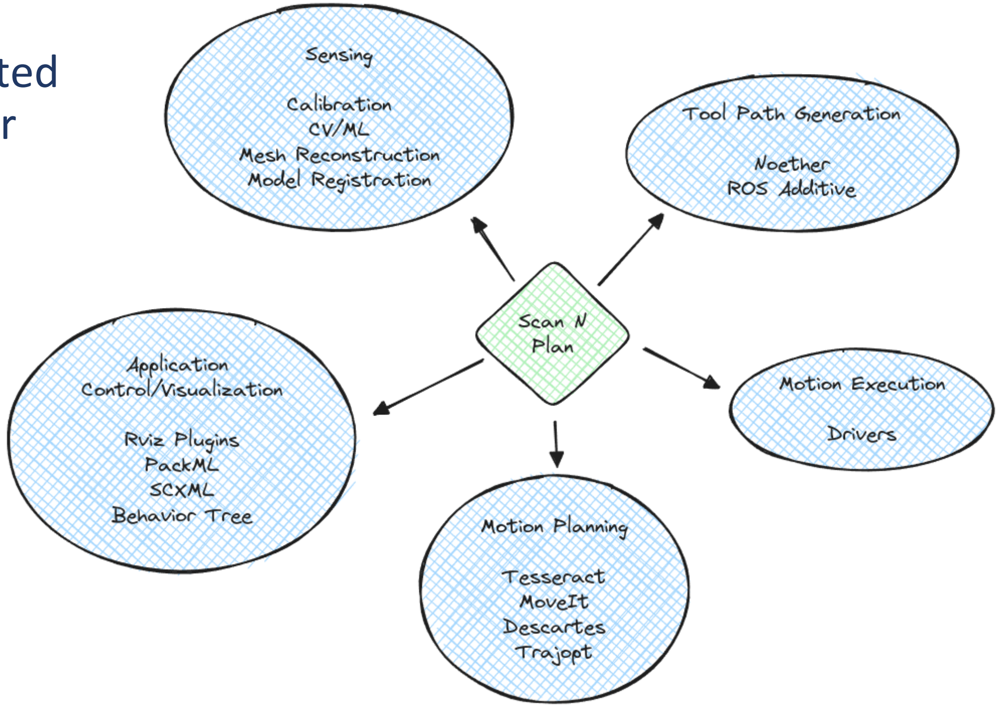


- Why so many apps that look the same?
  - Similar approach, similar components, different requirements
  - Focus on modularity
- Vision
  - Create a toolbox of intuitive and useful robotics modules that are easy to build into an application

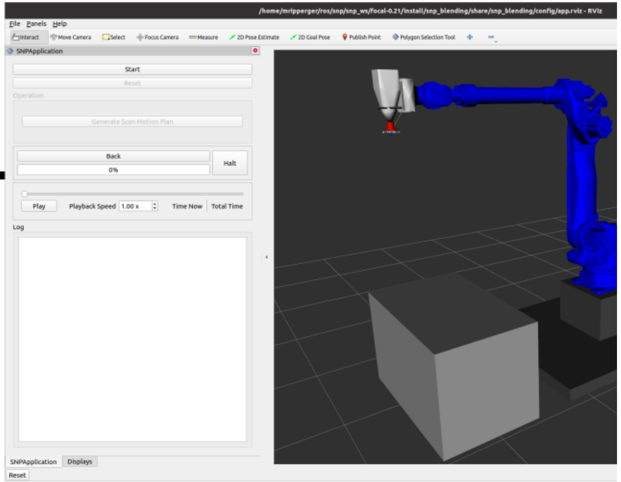
Modularity at the Application Level

- Scan 'N Plan capabilities curated into more modular repos over time
- Greater flexibility/reusability
- Greater cohesion

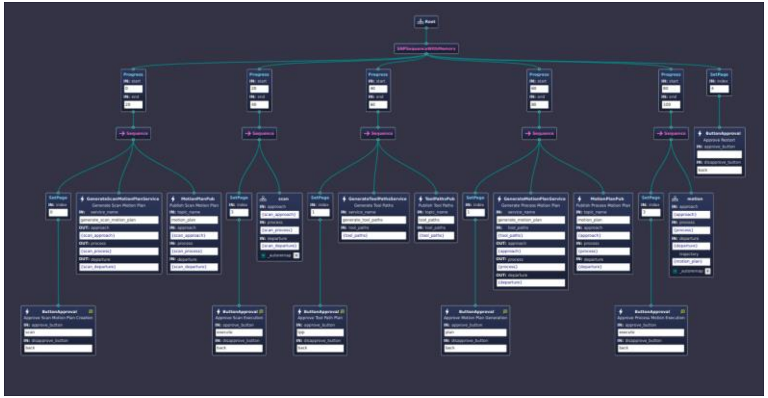




Modularity at the Repository

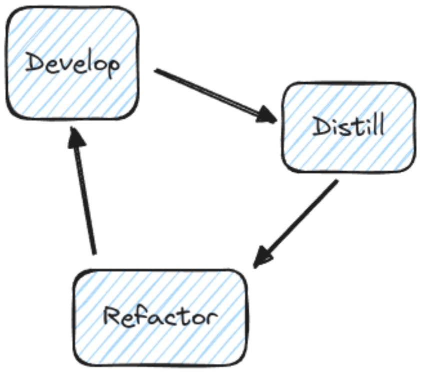


- Scan ‘N Plan Workshop/Blending M5
  - Revised architecture
  - How to create a richer, more customizable workflow?
    - 10000+ line case statement?
    - State machine?
    - Behavior Tree?
  - BT
    - 17 Custom nodes, 4 sub-trees
    - Blackboard for data transfer
    - Virtually unlimited expression capability
  - Modularity unlocks easy customization
    - Blending M5: 150 lines of new application code



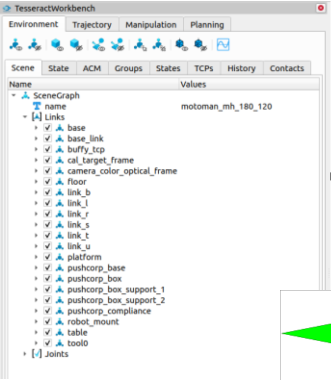
Modularity at the Repository Level

- Experience with BT
  - Clear and cohesive concepts/interfaces
  - Easy to build and customize
  - Decent documentation
  - My application did not exist out of the box with BT, but it was not difficult to create
- Similar experience with several other robotics projects (Open3D, Drake, ROS2 control)
- Let’s do the same for our ROS-I tools

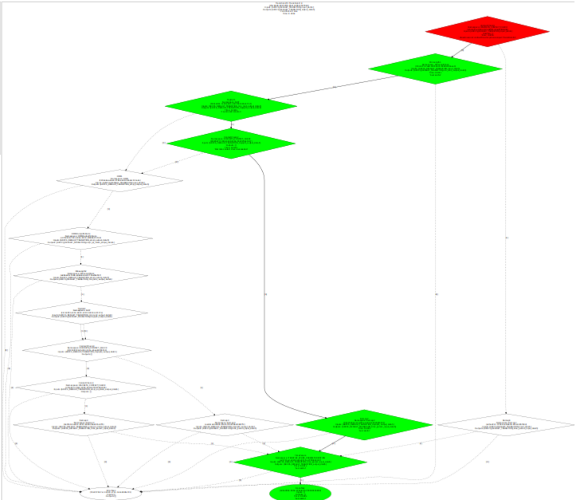


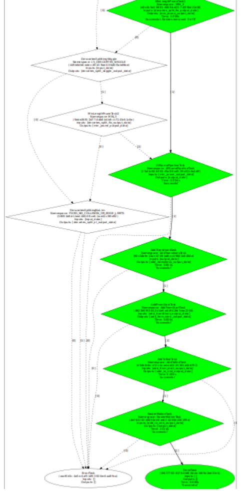
Modularity at the Repository

- Tesseract (Motion Planning)
  - Abstract interfaces for core capabilities (collision checking, IK, visualization, planning)
  - Planning Pipelines
    - Planning capabilities as modules with inputs/outputs
    - Plugins for customization
    - Construct complex pipelines for complex tasks
    - Meta-planning
  - Visualization of results after each pipeline stage



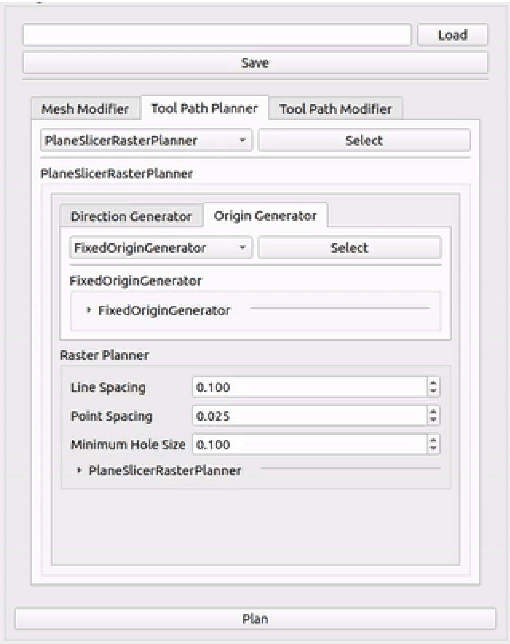
Name	Values
SceneGraph	
name	motoman_mh_180_120
Links	
☑ base	
☑ base_link	
☑ buffy_tcp	
☑ cal_target_frame	
☑ camera_color_optical_frame	
☑ floor	
☑ link_b	
☑ link_l	
☑ link_r	
☑ link_s	
☑ link_t	
☑ link_u	
☑ platform	
☑ pushcorp_base	
☑ pushcorp_box	
☑ pushcorp_box_support_1	
☑ pushcorp_box_support_2	
☑ pushcorp_compliance	
☑ robot_mount	
☑ table	
☑ tool0	
Joints	





Modularity at the Repository

- Noether (Tool Path Planning)
  - Clear and cohesive interfaces
  - Many out-of-the-box capability modules
    - Mesh modification (primitive fitting, ROI selection)
    - Tool path planners
    - Tool path modifiers (approaches, departures, smoothing, organization)
  - GUI
    - Quick pipeline configuration
    - Plugins for customization
    - Present custom front-ends to specific users



PlaneSlicerRasterPlanner

PlaneSlicerRasterPlanner

FixedOriginGenerator

FixedOriginGenerator

▸ FixedOriginGenerator

Raster Planner

Line Spacing 0.100

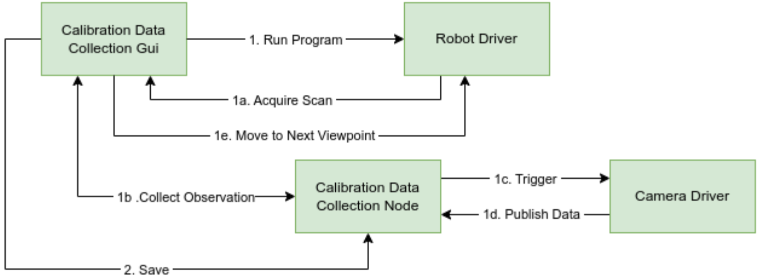
Point Spacing 0.025

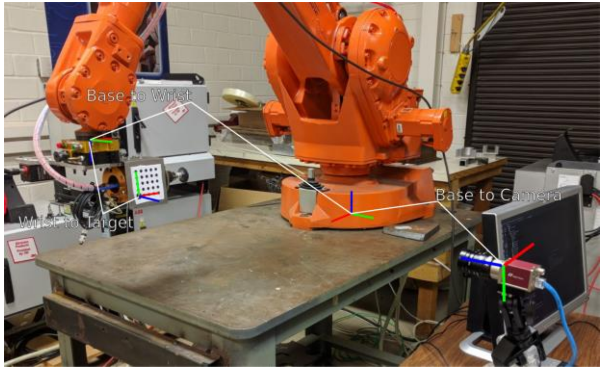
Minimum Hole Size 0.100

▸ PlaneSlicerRasterPlanner

Modularity at the Repository

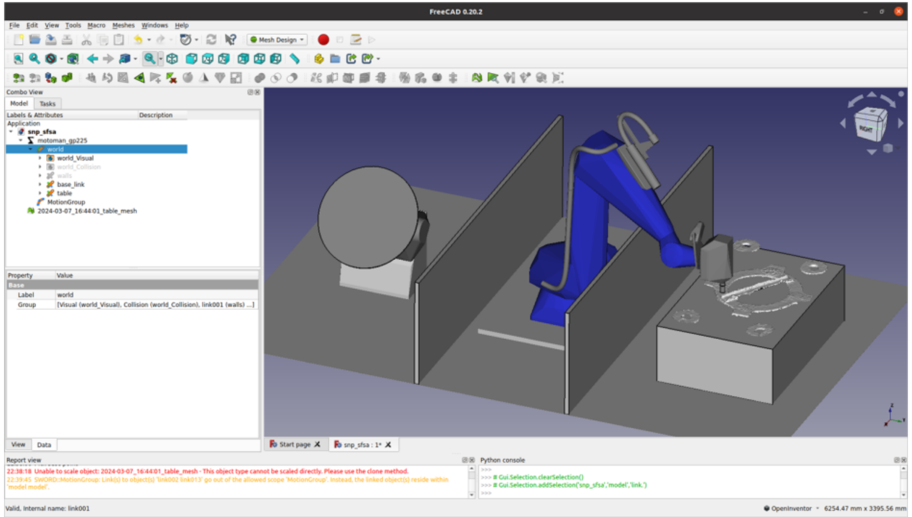
- Calibration
  - Improved reorganization
  - Provided utilities for
    - Common sensor calibration types
    - Validation and accuracy checks
    - Detecting targets
  - Hooks for customizability
  - GUI (in progress)
  - Example data collection pipeline applications





Modularity at the Repository Level

- SWORD
  - CAD-based sandbox for experimenting with ROS-I tools
  - GUI front-end for reduced development iteration time



```
Application
  snp_sfsa
    motoman_gp225
      world
        world_Visual
        world_Collision
        walls
        base_link
        table
      MotionGroup
    2024-03-07_16:44:01_table_mesh
```

Property	Value
Base	
Label	world
Group	[Visual (world_Visual), Collision (world_Collision), link001 (walls) ...]

```
22:38:18  Unable to scale object: 2024-03-07_16:44:01_table_mesh - This object type cannot be scaled directly. Please use the clone method.
22:39:45  SWORD::MotionGroup: Link(s) to object(s) 'link002 link013' go out of the allowed scope 'MotionGroup'. Instead, the linked object(s) reside within
'model model'.
```

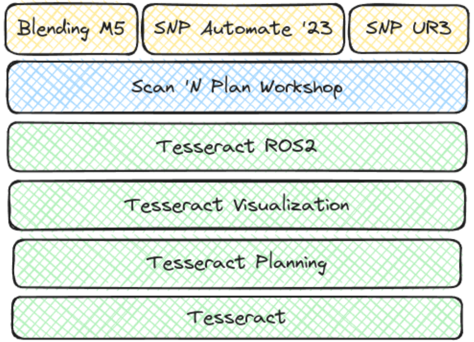
```
>>>
>>> # Gui.Selection.clearSelection()
>>> # Gui.Selection.addSelection('snp_sfsa','model','link.')
>>>
```

Valid, Internal name: link001

OpenInventor · 6254.47 mm x 3395.56 mm

Modularity for Deployment

- Build on multiple platforms (Ubuntu, Windows)
- Common CI practices across repositories
- Containerization
  - Build containers per repository
    - Host-agnostic
    - Configured for network and device connection via docker compose
  - Layer containers
  - Full system bring-up for applications with docker-compose



Takeaways

- Maybe we don’t have one “killer app” but many killer* building blocks
- *Still much work to be done
  - Clear and cohesive concepts/interfaces
  - Easy to build and customize
  - Decent documentation
- Contributions always welcome
  - Code, feedback, testing, etc
  - Consortium input needed for design effort

Thank You

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