New Horizons for European Open Source Robotics
Fraunhofer IPA
The organisation

- Fraunhofer Gesellschaft: the largest applied research organization in Europe
- Non-profit, network of 80+ institutes, 28k+ employees, €2.8B annual budget
- Fraunhofer IPA: focus on Manufacturing Engineering and Automation, €70M+ annual budget, located in Stuttgart – Germany, the “silicon valley of mechatronics”
Fraunhofer IPA
Adapting ROS internally

• Early ROS adopters in Europe (since the late 2000s)
• Developers of service robotics platforms (Care-O-bot)
• Piloting with SwRI the ROS-Industrial concept (2012)
• Managing RIC-EU starting in 2014
Fraunhofer IPA
Bringing ROS into the Industry

ROS-Industrial Consortium - Harsh Deshpande - hsd@ipa.fraunhofer.de
Recent achievements and new horizons

Recent Achievements

New Horizons

ROS-Industrial Consortium - Harsh Deshpande - hsd@ipa.fraunhofer.de
ROSIN
Making ROS better, business friendlier and more accessible

better
Software Quality
ROS-I best practices and tools: continuous integration, unit testing, code reviews
ROSIN further improves on them with code scanning, automated test generation, model-in-the-loop testing

business friendlier
New components
ROSIN FTPs: 3.5 Million € to third parties for ROS-Industrial development. Develop missing components or improve existing ones.
Commercial release template (licensing, etc)

more accessible
Education
ROSIN summer schools: Educate students
ROS-I academy: Educate professionals
Education projects: Fund your ROS education initiative

rosin-project.eu/software-quality-assurance
rosin-project.eu/ftps
rosin-project.eu/education

ROS-Industrial Consortium · Harsh Deshpande · hsd@ipa.fraunhofer.de
ROSIN FTP highlights
Universal robots

- Cooperation between UR & FZI
  - Driver with official OEM support
  - Integration of ROS into UR Caps
  - External control
  - Many more

<table>
<thead>
<tr>
<th>KPI (github)</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contributers</td>
<td>23</td>
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<tr>
<td>Forks</td>
<td>173</td>
</tr>
<tr>
<td>Stars</td>
<td>291</td>
</tr>
</tbody>
</table>

- Follow-up activities:
  https://github.com/PickNikRobotics/Universal_Robots_ROS2_Driver
ROSIN FTP highlights
Pilz GmbH & Co. KG

- Project executed by Pilz GmbH & Co. KG
  - Generating LIN, PTP and CIRC trajectories
  - Industrial accuracy and performance

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<thead>
<tr>
<th>KPI (github)</th>
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<tbody>
<tr>
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<td>26</td>
</tr>
<tr>
<td>Stars</td>
<td>81</td>
</tr>
</tbody>
</table>

- Follow-up activities:
  https://github.com/ros-planning/moveit/tree/master/moveit_planners/pilz_industrial_motion_planner
Project executed by Cyberbotics
- Porting of the epuck robot to ROS 2
- Real and simulated e-puck interfaces in webots
- ROS2 support for the webots interface

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<tr>
<td>Stars</td>
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- One of the first robots supporting ROS2
- Webots is now part of ROS core packages (https://www.ros.org/reps/rep-2005.html)
Recent achievements and new horizons

Recent Achievements

New Horizons
Cognitive Robotics & AI Innovation Center
ROS-I lighthouse in Baden-Württemberg - Germany

- Pre-funding of 2 M€ acquired in 2019 from regional government
  - Until now 41 transfer projects with companies from BW executed by center (Sick, Pilz, Siemens, ...)

- Follow-up funding of 23 M€ acquired in 2021 for coming four years
  - Approximately 10 M€ are invested in new and improved ROS based technologies
  - 30% of the developments are foreseen for open source release

ROS-Industrial Consortium - Harsh Deshpande - hsd@ipa.fraunhofer.de
## ROS-Industrial Research Activities

**Hybrid model-driven engineering for ROS**

<table>
<thead>
<tr>
<th>Problem</th>
<th>ROS-Industrial Solution</th>
</tr>
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<tbody>
<tr>
<td>No integrated development solution available</td>
<td>Graphical ROS development toolchain</td>
</tr>
<tr>
<td>ROS-based robot systems are complex to understand</td>
<td>Graphical modeling of ROS-systems and components</td>
</tr>
<tr>
<td>Ecosystem packages not modeled</td>
<td>Model-extraction using static and dynamic analysis approaches</td>
</tr>
<tr>
<td>MBSE is not common in the ROS community</td>
<td>Generation of boilerplate code for hand-written nodes</td>
</tr>
<tr>
<td>Testing by trial-and-error method</td>
<td>Validation of the composition and autogeneration of deployment artifacts</td>
</tr>
</tbody>
</table>

### Contact:

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hg@ipa.fraunhofer.de

### Technology readiness:

ROS1: Tested  
ROS2: Under development

### Sources:

https://github.com/ipa320/ros-model
 ROS-Industrial Research Activities
Hybrid model-driven engineering for ROS

Step 1: Model-extraction
Step 2: Graphical ROS system design
Step 3: Generating ROS files

Launchfiles
Python boilerplate code
C++ boilerplate code
ROS workspace structure

Folder
.launch
.py
.cpp

Step 1: Model-extraction
Step 2: Graphical ROS system design
Step 3: Generating ROS files

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Python boilerplate code
C++ boilerplate code
ROS workspace structure

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ROS-Industrial Research Activities
Model-based observer generation

Goal:
- Model-based diagnosis and monitoring framework for running ROS systems

Features:
- **ROS Graph Observer:** Continuous evaluation of ROS components and interfaces
- **Property Observer:** Design-time application-independent generation of property observers (ranges or complex functions)
- **Integration** with common ROS diagnostics tools

Contact:
Harshavardhan Deshpande
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hsd@ipa.fraunhofer.de

Technology readiness:
ROS1: Tested – Documentation in progress
ROS2: Under development

Sources:
https://github.com/rosin-project/rosgraph_monitor
ROS-Industrial Research Activities
Model-based observer generation

ROS Graph Observer

 ROS Graph Observer

 Property Observer

 ROS-Industrial Consortium - Harsh Deshpande - hsd@ipa.fraunhofer.de
Cognitive Robotics & AI Innovation Center

ROS development roadmap

ROS2 Model-Driven Development:
- Component model extraction
- Interface Documentation generation
- Launchfile generation
- Runtime checkers

ROS2 Runtime Reliability:
- Automated redundant deployment
- Gluecode and monitors generation

ROS2 Model-Driven Development:
- Modeling Hardware characteristics
- Kinematic model generation (URDF)
- Deployment artifact generation
Cognitive Robotics & AI Innovation Center

ROS application development

- Easy programming for welding robots
  - Seam detection
  - Collision-free, optimal path planning
  - Work piece pose detection
  - Easy programming through ROS integration in UR caps

- Want to test?
  - Contact: Johannes.Stoll@ipa.fraunhofer.de
# Description

The ROS 2 Industrial Training teaches the basics of ROS 2 and how to use ROS 2 for manipulation and for navigation. The class is completed by a session of best practices, which teaches how ROS 2 development is done best. The goal of the training is to get all the information needed to start developing with ROS.

Attendees should have basic knowledge:
- Linux and Terminal
- Python

Cost:
- 800€ (Remote), 1200€ (Presence), 0€ (ROS-I Members)

Planned trainings in 2021:
- 09. – 12.03.2021 (Remote)
- 18. – 21.05.2021 (Remote)
- 21. – 24.09.2021 (Remote)
- 16. – 19.11.2021 (TBD)

# Agenda

<table>
<thead>
<tr>
<th>Day</th>
<th>Courses</th>
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<tbody>
<tr>
<td>Day 1</td>
<td>ROS 2 basic concepts</td>
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<tr>
<td></td>
<td>ROS 2 file system</td>
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<td>ROS 2 terminal</td>
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<td>Day 2</td>
<td>ROS 2 extended concepts</td>
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<td>ROS 2 handling coordinates with tf2</td>
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<td>ROS 2 manipulation basics</td>
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<td>Day 3</td>
<td>ROS 2 navigation basics and localization</td>
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<td>ROS 2 navigation</td>
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<td>Day 4</td>
<td>ROS 2 Best practices</td>
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Questions?