# Safety Certified ROS-native Industrial Manipulator

https://wiki.ros.org/pilz_robots

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Product Management


PILZ

# Service Robotic Modules

# Manipulator Module PRBT 6

- **Number of axes: 6**
- Max. load capacity: 6 kg
- Repetition accuracy: +/- 0.1 mm
- Mounting direction: any
- Weight: 19 kg
- Max. operating range: 741 mm

- **Power supply: 24 V DC**
- Interface: CANopen
- Safety functions:
  - STO (safe torque off)
  - SBC (safe brake control)


**No proprietary controller needed**

# Why using ROS?

Because it is the answer to Service Robotic in industrial and non-industrial environment!


# Previous work in ROS

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THE SPIRIT OF SAFETY

## Driver

- based on `ros_canopen`
- safety functions

## Industrial planners

- using MoveIt!
- industrial requirements
- deterministic behavior
- basic movements: Linear, Point-to-Point, Circular
- blending of the above

## Python API

- easy to use interface to aforementioned planners
- no extensive training required

## Example: Moving a Robot with Python API

```
r = Robot()

# Simple ptp movement in joint space
r.move(Ptp(goal=[0, 0.5, 0.5, 0, 0, 0],
           vel_scale=0.4))
start_joint_values = r.get_current_joint_states()

# Relative ptp movement
r.move(Ptp(goal=[0.1, 0, 0, 0, 0, 0],
           relative=True,
           vel_scale=0.2))

# Simple cartesian Lin movement
r.move(Lin(goal=Pose(position=Point(0.2, 0, 0.8)),
           vel_scale=0.1,
           acc_scale=0.1))

# Circ movement
r.move(Circ(goal=Pose(position=Point(0.2, -0.2, 0.8)),
            center=Point(0.1, -0.1, 0.8),
            acc_scale=0.4))

# Move robot with stored pose
r.move(Ptp(goal=pose_after_relative,
           vel_scale=0.2))
```

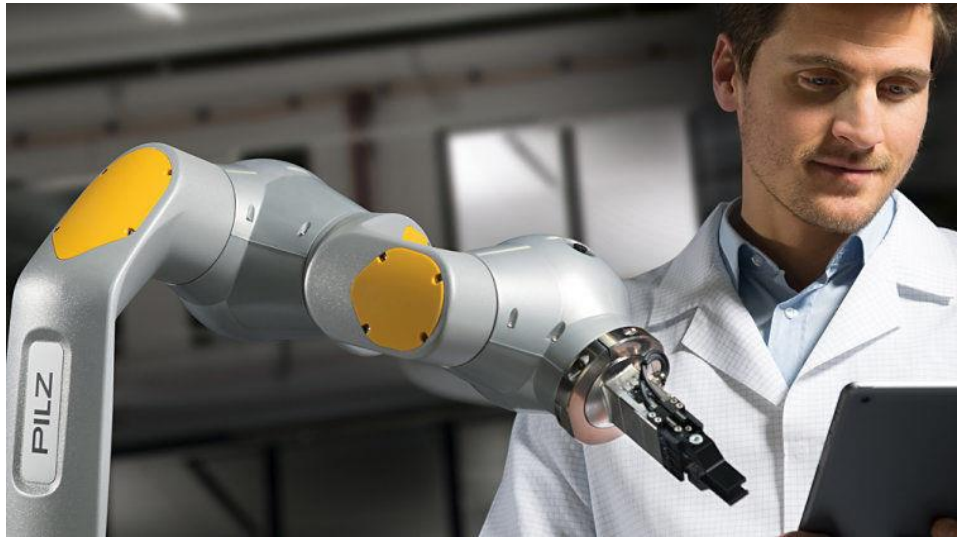
ROSin

Supported by ROSIN - ROS-Industrial Quality-Assured Robot Software Components. More information: rosin-project.eu

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 732287.

# ISO 10218-2

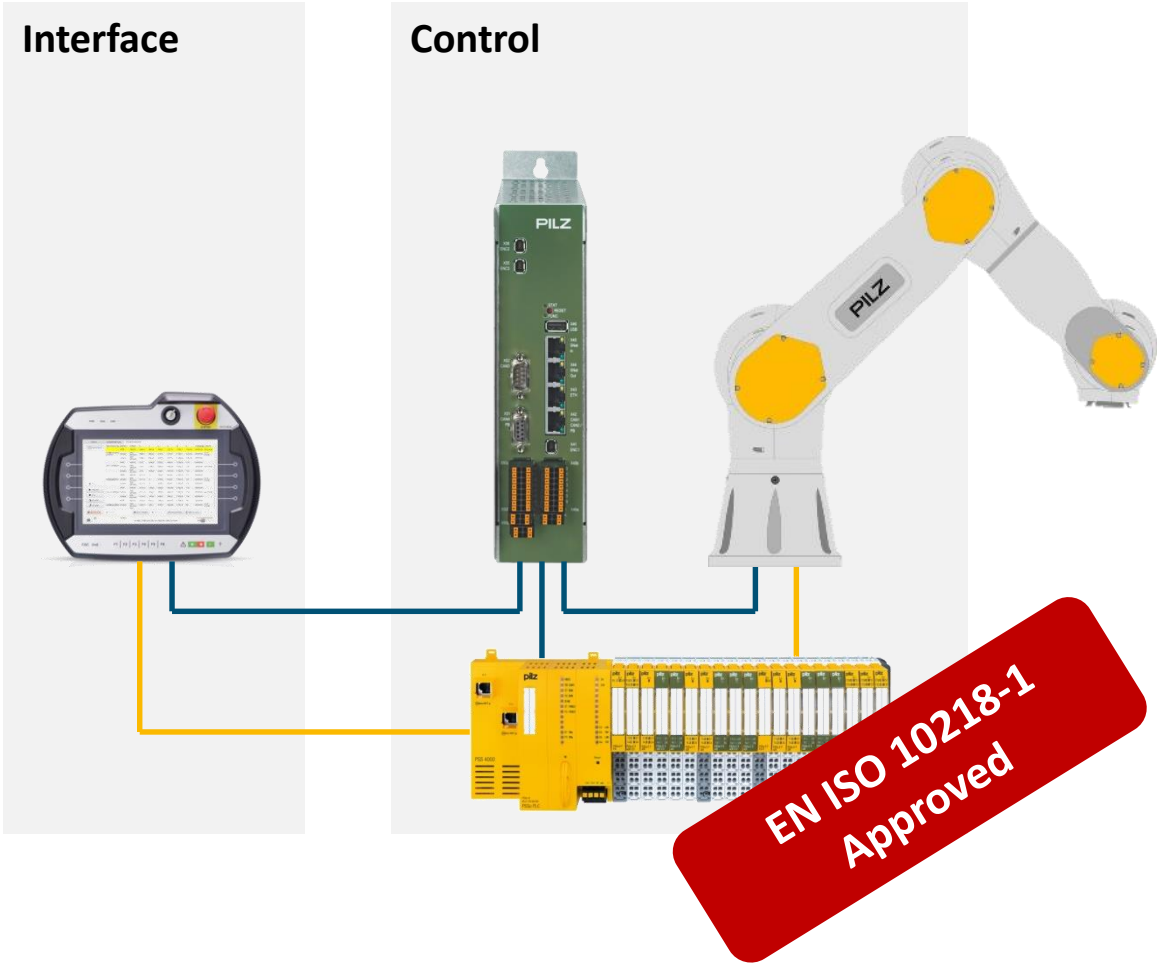

# Goals for a safe Robot-Application in ROS



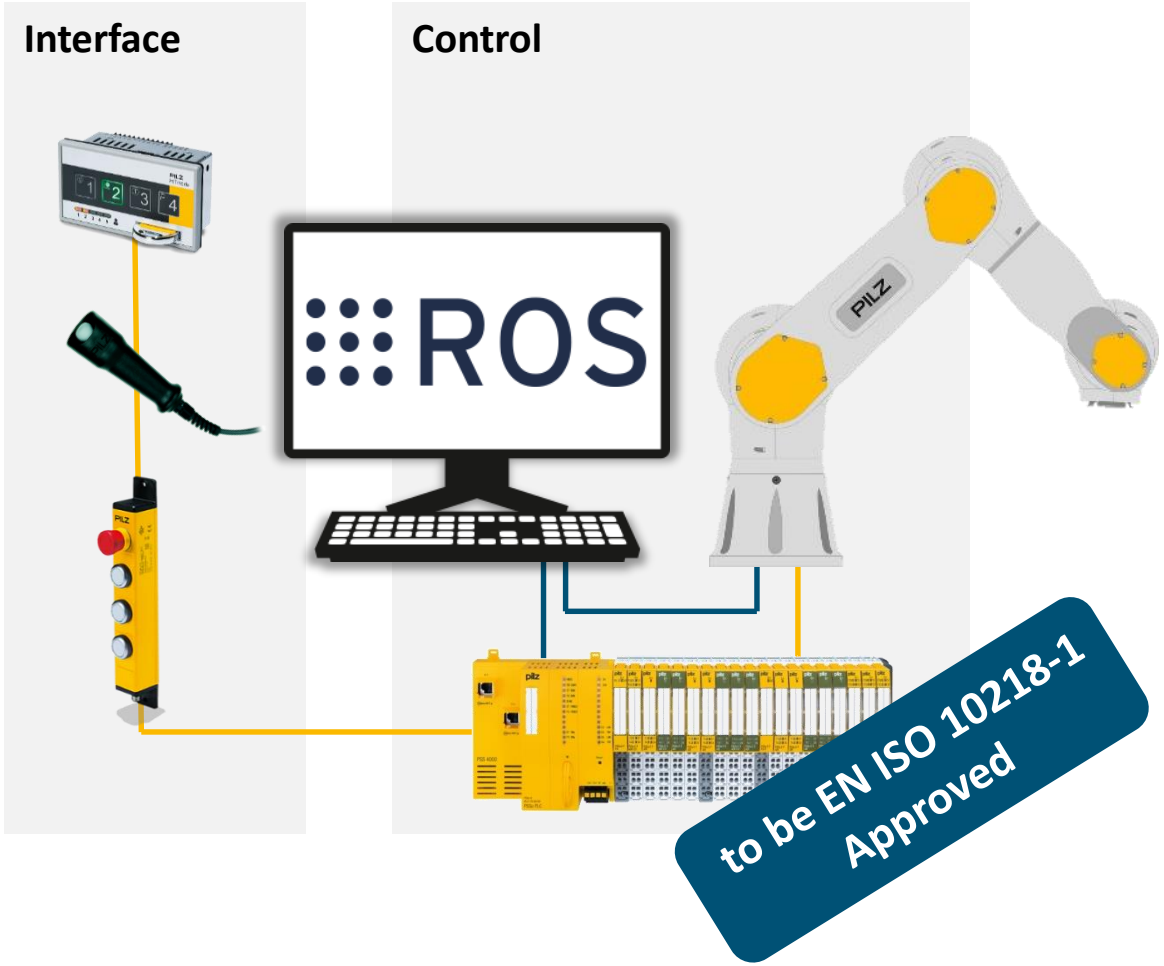

## Establish ROS in Industrial Applications

- *Robot can be used with ROS*
  - no Proprietary Controller
  - no Proprietary Teach-Pendant
- As much functionality as possible implemented in ROS
  - Safety Controller for Safety Functionality
- *Robot is certifiable under EN ISO 10218-1*
  - Applications are build purely in ROS
- *Integrator can focus on application*
  - Safety is provided “with the Robot”

# How do we do this?




## Traditional Setup – the industrial way




## Intended Setup – the Future

# ISO 10218-1:2011 Robots and robotic devices
# Safety requirements for industrial robots - Part 1: Robots

Exemplary Aspects of the Standard:


Operational modes

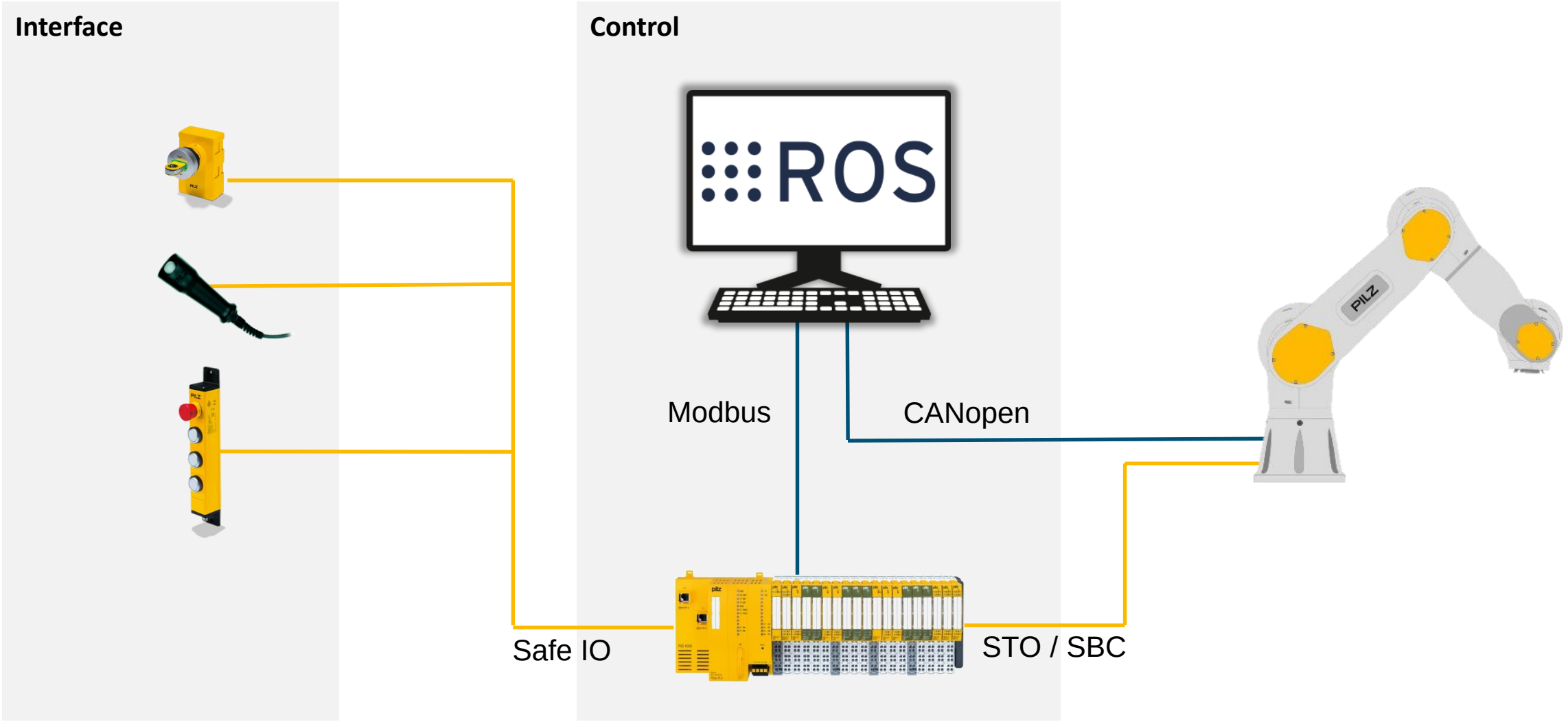
- Automatic / Manual Reduced Speed
  - display of Mode
  - monitoring of reduced speed

Robot stopping functions

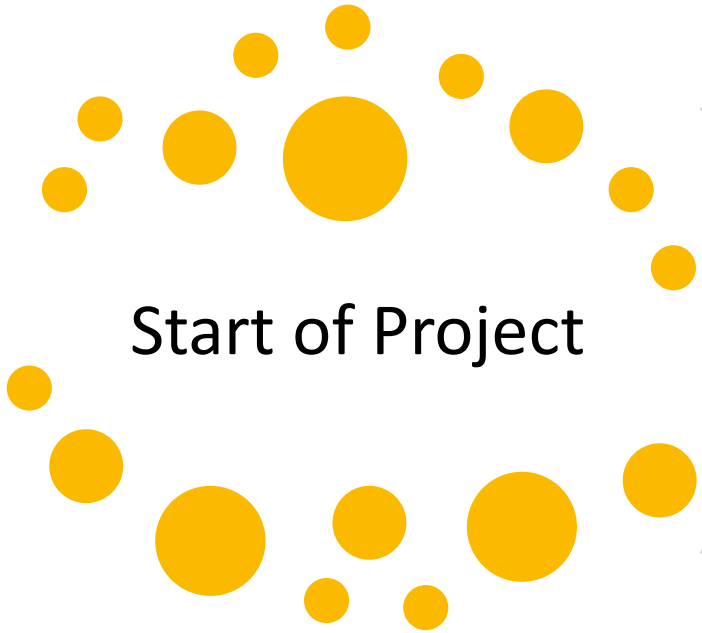
- Emergency stop
  - smoothly stopping
  - brakes in emergency
  - brake Test
  - within time limit
  - triggered from external device

Full Standard ➔ https://www.iso.org/standard/51330.html

# Technical Overview



# Development Progress




Implementation
Functional Modules

Certification

04/2019

06/2019

06/2020

# Brake Test

- Robot must be able to brake safely
  - when emergency stop is pressed
  - when speed limit is violated
  - when other safety sensors are trigger
- Equipped with brakes
  - regular testing is required
  - Safety Controller ensures test is preformed
- ROS can
  - ask when test is required
  - execute test at any point before time limit
- Safety Controller
  - disables drives if test is not performed within limit
  - ensures Safety

Example: Performing a brake test with Python API

```
r = Robot()

if r.is_brake_test_required():
# Move robot to the pose where the brake test should be executed
r.move(Ptp(goal=_BRAKE_TEST_POSE))
try:
    # Execute brake test
    r.execute_brake_test()
except RobotBrakeTestException as e:
    # Handle error
    rospy.logerr(e)
```

# Operation Modes

- Automatic
  - automatic execution of predefined program
  - e.g. Script written in our API

- Manual reduced speed
  - limit of speed to 250 mm/s
  - for teaching
  - ROS will monitor any TF frame
  - Robot can be controlled by any method in ROS

- Manual high speed
  - limit start at 250 mm/s but can be increased
  - control from ROS
  - for testing

# Example Application: Visual Inspection

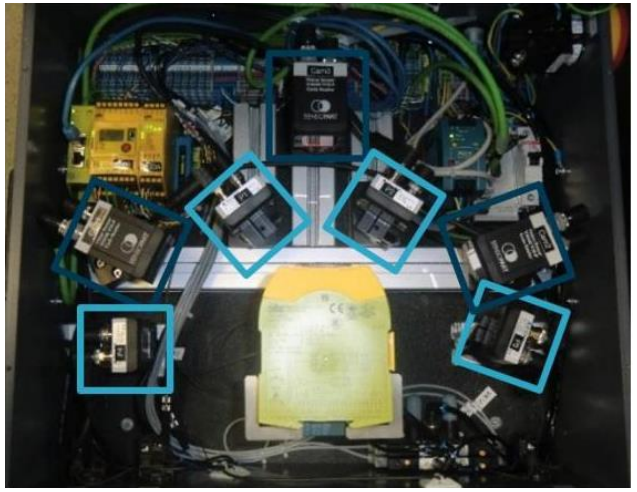
**Task:** Inspect part features for large number of product variants

**Approach:** Robot on-board camera supported on database to lookup poses and save results

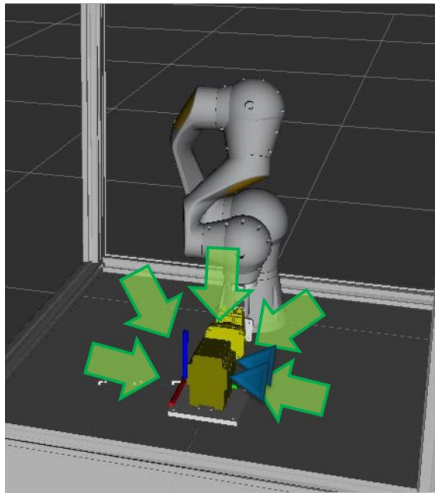
**Strengths of ROS:**

- high-level control based on the adaption of State-Machine packages
- interface with other software components
- use of workspace based (OMPL) and deterministic (pilz_industrial_motion) motion planners

*Current Setup*



*Inspection Poses*



*Demo Setup*

*Machine setup*

# Summary


We want to help establish ROS in industrial applications

Our robot RPBT6 supports ROS natively

We provide the safety, so you can focus on the application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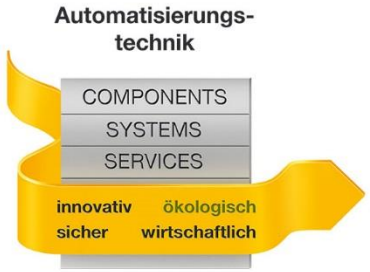
Let me answer your questions!

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**Please visit**
**https://github.com/pilzde/pilz_robots**

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