ROBIN FTP
The ROS-CODESYS Bridge

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Bringing academia, companies, public administration and society closer together

**Mission**

Research of excellence
International recognition
Social relevance

Economic and social fabric development
Contribute to the performance, competitiveness and internationalisation of Portuguese companies and institutions

**Vision**

To be an international player in the science and technology arena
To be perceived as an important world player, in the domains of Computer Science, Industry and Innovation, Networked Intelligent Systems, and Power and Energy
728 researchers (345 PhDs) dedicated to R&D and advanced consulting

<table>
<thead>
<tr>
<th>Role</th>
<th>Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senior Researchers</td>
<td>289</td>
<td>Hired staff (of which 66 have PhDs)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Professors (medium time allocation: 50%)</td>
</tr>
<tr>
<td>Support Services</td>
<td>86</td>
<td>Organisation &amp; Management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Business</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Technical-Administrative</td>
</tr>
<tr>
<td>Researchers</td>
<td>350</td>
<td>Postdoctoral researchers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Research assistants</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PhD students</td>
</tr>
<tr>
<td>Affiliated Researchers</td>
<td>73</td>
<td>(medium time allocation: 10%)</td>
</tr>
<tr>
<td>Other Collaborators</td>
<td>369</td>
<td>External researchers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Research trainees</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Special projects</td>
</tr>
</tbody>
</table>

October 2019
Platforms for developing global solutions with partners

Strong presence in regional/national Poles and Clusters

Cross-fertilisation

Supply chain 4.0
Intelligent power networks and mobility
Services/production, diagnosis
Digital Ports, underwater robotics
Contents, creative industries
Precision agriculture, integrated distribution chain
TEC4INDUSTRY: Some of our Projects

Moreover, it visually helps the operator set up the parts with a spatially optimized layout, improving overall productivity by increasing part density and reducing the movement trajectories of both the robot and operator.
ROBIN FTP: The ROS-CODESYS Bridge

**CHALLENGES**

Time consumed developing and maintaining drivers for industrial communication protocols and actuators;

Inability for automation technicians to program complex robotic systems.

**SOLUTION**

Shared memory interface between ROS and CODESYS softPLCs.
ROBIN FTP: High-level Architectural Overview

# ROBIN FTP: Messages Conversion

<table>
<thead>
<tr>
<th>Description</th>
<th>ROS Messages Primitive Type</th>
<th>C++</th>
<th>IEC 61131-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsigned 8-bit Integer</td>
<td>bool</td>
<td>uint8_t</td>
<td>USINT</td>
</tr>
<tr>
<td>Signed 8-bit Integer</td>
<td>int8</td>
<td>int8_t</td>
<td>SINT</td>
</tr>
<tr>
<td>Unsigned 8-bit Integer</td>
<td>uint8</td>
<td>uint8_t</td>
<td>USINT</td>
</tr>
<tr>
<td>Signed 16-bit Integer</td>
<td>int16</td>
<td>int16_t</td>
<td>INT</td>
</tr>
<tr>
<td>Unsigned 16-bit Integer</td>
<td>uint16</td>
<td>uint16_t</td>
<td>UDINT</td>
</tr>
<tr>
<td>Signed 32-bit Integer</td>
<td>int32</td>
<td>int32_t</td>
<td>DINT</td>
</tr>
<tr>
<td>Unsigned 32-bit Integer</td>
<td>uint32</td>
<td>uint32_t</td>
<td>UDINT</td>
</tr>
<tr>
<td>Signed 64-bit Integer</td>
<td>int64</td>
<td>int64_t</td>
<td>LINT</td>
</tr>
<tr>
<td>Unsigned 64-bit Integer</td>
<td>uint64</td>
<td>uint64_t</td>
<td>ULINT</td>
</tr>
<tr>
<td>32-bit IEEE Float</td>
<td>float32</td>
<td>float</td>
<td>REAL</td>
</tr>
<tr>
<td>64-bit IEEE Float</td>
<td>float64</td>
<td>double</td>
<td>LREAL</td>
</tr>
<tr>
<td>ASCII String</td>
<td>string</td>
<td>std::string</td>
<td>STRING</td>
</tr>
<tr>
<td>Time (secs/nsecs)</td>
<td>time</td>
<td>ros::Time</td>
<td>TIME</td>
</tr>
<tr>
<td>Time (secs/nsecs)</td>
<td>duration</td>
<td>ros::Duration</td>
<td>TIME</td>
</tr>
</tbody>
</table>

- **Fully Supported by Current Implementation**
- **WIP** Partial Support by Current Implementation

ROBIN FTP: ROS Implementation

- Topic-based implementation;
- Shared memory written automatically on subscriber callback;
- Shared memory read periodically and published to topic.

```cpp
1 class Robin
2 {
3   std::string name_;  
4   Semaphore semaphore_; 
5   SharedMemory shared_memory_; 
6   ros::NodeHandle nh_; 
7   ros::Publisher pub_; 
8   ros::Subscriber sub_;  
9   std_msgs::Bool msg_; 
10  const uint32_t queue_size_ = 100; 
11  const bool latch_ = true;
12  void write(const std_msgs::Bool::ConstPtr& msg);
13 public:
14  Robin(std::string name, bool mode=READ, bool open=true);
15  bool isOpen(); 
16  bool isClosed(); 
17  void read(); 
18  void open(bool mode=READ); 
19  void close(); 
20  ~Robin(); 
21 }; 
```

Public interface
ROBIN FTP: ROS Implementation

```c
#include "robin/robin.h"
#include <ros/ros.h>
int main(int argc, char **argv)
{
    ros::init(argc, argv, "robin");
    // Object creation
    Robin move_conveyor("move_conveyor", WRITE);
    Robin wait_conveyor("conveyor_finished", READ);
    ros::Rate read_rate(10);
    while (ros::ok())
    {
        // Periodic shared memory reading
        wait_conveyor.read();
        ros::spinOnce();
        read_rate.sleep();
    }
    return 0;
}
```
ROBIN FTP: CODESYS Implementation

Project structure

Main program

```
PROGRAM MAIN
VAR_INPUT
  msgFromRos : BOOL;
END_VAR
VAR_OUTPUT
  msgToRos : BOOL;
END_VAR

CONVEYOR_PRG.on := msgFromRos;
msgToRos := CONVEYOR_PRG.finished;
```

Variable mapping program

```
PROGRAM ROBIN_PRG
VAR
  msgFromRos : Robin('move_conveyor', RobinConstants.READ);
  msgToRos : Robin('conveyor_finished', RobinConstants.WRITE);
END_VAR

// read
MAIN.msgFromRos := msgFromRos.read();
// write
msgToRos.write(MAIN.msgToRos);
```
ROBIN/ScalABLE4.0 Demonstration at Simoldes

Diagram:

- ROS Master
- ROS Node
- CODESYS
- Embedded Device
- PLC
- I/O Module
- Sensors
- Motor controller

Connections:
- ROS topic (shared memory)
- Modbus
ROBIN FTP: Conclusion & Next Steps

• Ongoing:
  • Support for more data types and custom data structures;
  • Development of Automation Methodologies to Expedite Integration;
  • Milestone 1: Public Release in the scope of the ROSIN Project.

• Future:
  • Standard interfaces for commonly used components;
  • Easier reconfiguration of mapped variables;
  • Support for ROS services and actions.

Github.com/ScalABLE4.0/ROBIN