

# Response-Time Analysis of ROS 2 Processing Chains Under Reservation-Based Scheduling (Artifact)

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## Abstract

This artifact provides the means to validate and reproduce the results of the associated paper “Response-Time Analysis of ROS 2 Processing Chains under Reservation-Based Scheduling.” It consists of two independent components. First, it contains a model validation component that vali-

dates the paper’s claims about the ROS 2 executor’s callback scheduling. Second, it contains the source code for the paper’s case study, i.e., an implementation of the proposed response-time analysis and a model of the `move_base` navigation stack.

**2012 ACM Subject Classification** Software and its engineering → Real-time schedulability

**Keywords and phrases** ROS, real-time systems, response-time analysis, robotics, resource reservation

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## 1 Scope

This artifact consists of two independent parts: the model validation experiment described in Section 3<sup>1</sup>, and the response-time analysis used in the case study reported on in Section 6. The model validation test validates the paper’s claims about the ROS executor scheduling policies. It sends a predefined sequence of messages to a dedicated ROS node and records the execution order. The output uniquely determines the execution order shown in Figure 3.

The response-time analysis component implements the analysis described in Section 5, contains the model of the `move_base` system shown in Figure 7, and generates the graphs in Figure 8. It

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<sup>1</sup> All references to figures and sections refer to the related paper.



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thereby supports our claim, that the proposed analysis is practical, in particular that Subsection 5.3 sufficiently limits the otherwise infinite search space to obtain practical analysis runtimes. Furthermore, it can be used to reproduce the case study.

### 2 Content

The artifact package consists of two independent parts, which are separated into the `case_study` directory and the `model_validation` directory. The `case_study` directory contains:

- `ros.py`: the implementation of the ROS-specific response-time analysis in Section 5
- `move_base.py`: the model of `move_base` and the graph plotting functions
- `ros_test.py`: unit tests

The `model_validation` directory contains:

- `package.xml`: the ROS package metadata
- `CMakeLists.txt`: the *CMake* build file (for use with the *colcon* build tool)
- `bin/send_cb_sequence`: the sending component of the model validation
- `src/arbitrary_cb_time.cpp`: the receiving component of the model validation
- `msg, srv`: definition of message datatypes

Furthermore, each directory contains a `README.md` file with installation and usage instructions.

### 3 Getting the artifact

The artifact endorsed by the Artifact Evaluation Committee is available free of charge on the Dagstuhl Research Online Publication Server (DROPS). In addition, the artifact is also available at [https://github.com/boschresearch/ros2\\_response\\_time\\_analysis](https://github.com/boschresearch/ros2_response_time_analysis).

### 4 Tested platforms

The artifact was tested on a Desktop computer using 64-bit Linux Ubuntu 16.04 LTS; it does not assume or require any particular hardware configuration. The artifact should work on any system that supports:

- Python 3.7
- ROS 2 “Crystal Clemmys”
- matplotlib 3.0
- pyCPA 1.2

### 5 License

The artifact is available under the 3-Clause BSD license.

### 6 MD5 sum of the artifact

5689ca131a1c42c93dcfb952923874c9

### 7 Size of the artifact

20 KiB