



micro-ROS - ROS 2 into microcontrollers

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Agenda



- **What is OFERA?**
- **What is Micro-ROS?**
- **Success. How we did it?**
- **Impact**
- **Future**



What is OFERA?

The EU Project behind Micro-ROS:

ROS 2 for Microcontrollers



OFERA -> Micro-ROS

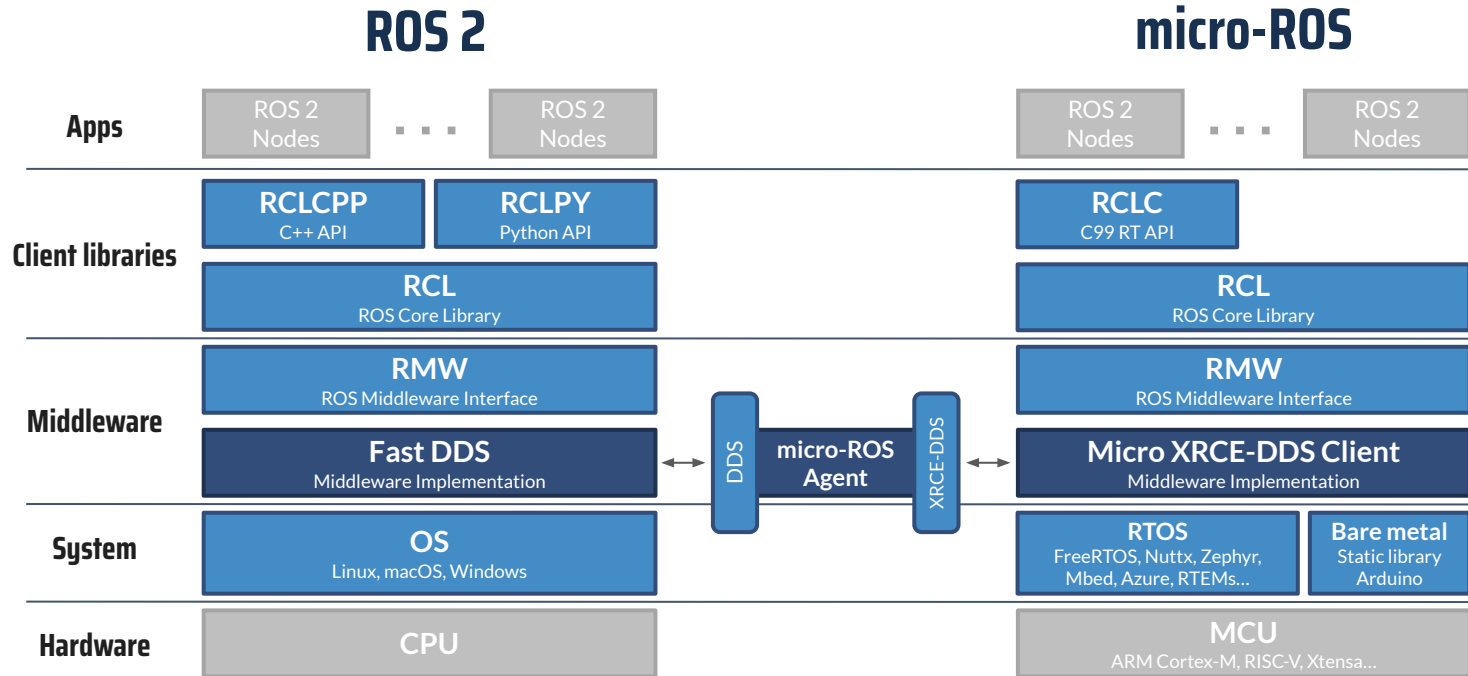


- **The EU project Ends, BUT**
- **Micro-ROS continues!**
 - **Open Source community**
 - **Business Ecosystem**
 - **eProsima already supporting commercial customers.**

What is micro-ROS?



ROS 2 in Microcontrollers. Same API, Same Messages.



Reasons for success

1.- It Works!

2.- Adoption:

Repo clones in 2022

262.770!

What?

How is this possible?

262.770!

**Well, we use some
Jedi Tricks**



1 Post per week

1 Tutorial per month

Monthly Embedded Working Group

Twitter, linkedin,

ROS Discourse, Press Releases

Events: ROSCON, ROS World, ERF

Community Success Cases



CANONICAL

LUXonjs



SONY

luos_

ROBOTIS

WINDRVR



ROS 2 Embedded Working Group (EWG):

monthly meeting: users and partners

- Presentation about embedded & micro-ROS topics
- Presentation or discussion about new features and bugs
- Miscelanea section, community questions...

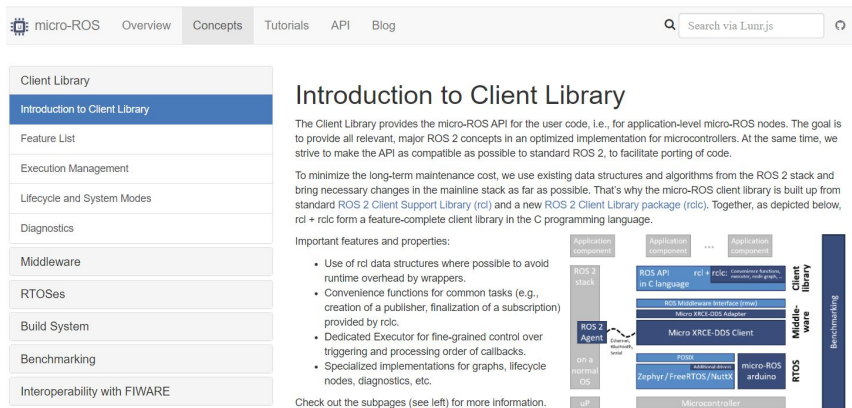
They are recorded and published on ROS Discourse #embedded

**Developers, Developers, Developers,
Developers, DEVELOPERS!,
Developers, Developers, Developers,
DEVELOPERS!!**

Micro-ROS Dev Support



- Easy to use.
- Really good Documentation
 - Tutorials, videos, use cases
- Always updated.
 - Same ROS 2 release cycle.



The screenshot shows the documentation page for the micro-ROS Client Library. The navigation bar includes links for 'micro-ROS', 'Overview', 'Concepts', 'Tutorials', 'API', and 'Blog'. A search bar is located on the right. The left sidebar contains a table of contents with 'Introduction to Client Library' highlighted. The main content area is titled 'Introduction to Client Library' and contains text explaining the library's purpose and features. A diagram on the right illustrates the system architecture, showing the flow from ROS 2 stack through various layers to the microcontroller.

Client Library

- Introduction to Client Library
- Feature List
- Execution Management
- Lifecycle and System Modes
- Diagnostics
- Middleware
- RTOSes
- Build System
- Benchmarking
- Interoperability with FIWARE

Introduction to Client Library

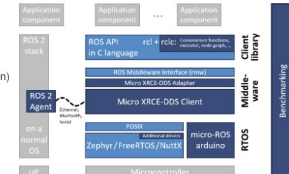
The Client Library provides the micro-ROS API for the user code, i.e., for application-level micro-ROS nodes. The goal is to provide all relevant, major ROS 2 concepts in an optimized implementation for microcontrollers. At the same time, we strive to make the API as compatible as possible to standard ROS 2, to facilitate porting of code.

To minimize the long-term maintenance cost, we use existing data structures and algorithms from the ROS 2 stack and bring necessary changes in the mainline stack as far as possible. That's why the micro-ROS client library is built up from standard ROS 2 Client Support Library (rci) and a new ROS 2 Client Library package (rcic). Together, as depicted below, rci + rcic form a feature-complete client library in the C programming language.

Important features and properties:

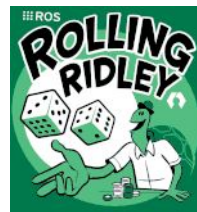
- Use of rci data structures where possible to avoid runtime overhead by wrappers.
- Convenience functions for common tasks (e.g., creation of a publisher, finalization of a subscription) provided by rcic.
- Dedicated Executor for fine-grained control over triggering and processing order of callbacks.
- Specialized implementations for graphs, lifecycle nodes, diagnostics, etc.

Check out the subpages (see left) for more information.



The diagram illustrates the system architecture. It shows the ROS 2 stack (Application Component, ROS API in C language, ROS Middleware Interface (rmw), Micro XRC-DDS executor) interacting with the Client Library (rci + rcic: common system, Micro XRC-DDS Client). This client library runs on a normal OS and interfaces with ROS 2 Agent. The ROS 2 Agent connects to the ROS 2 stack. The Client Library also interfaces with the Micro-ROS Middleware (rmw) and the Micro-ROS hardware (Zephyr / FreeRTOS / NuttX). The hardware runs on a microcontroller. A Benchmarking layer is shown on the right side of the diagram.

For the interested reader: The rationales for the decision to use a combination of rci + rcic are explained in our decision paper (PDF) from 2019.





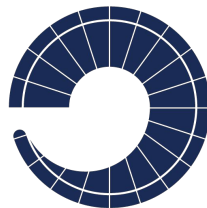
And yes, we make money with this!

Commercial Success Cases

CAPRA ROBOTICS - UK Agritech

Mobile platforms - Capra Hircus

Usage of micro-ROS for the real time controllers.



CAPRA ROBOTICS®



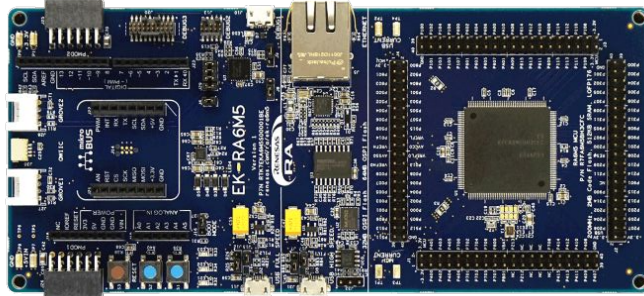
**You can see it in action [HERE](#)
today!**

Commercial Success Cases



RENESAS - Japan silicon

Global leader in microcontrollers, analog, power and SoC products.
Official reference board provider for micro-ROS: RA Family



Commercial Success Cases



**RENESAS - Today at Embedded world
(March 14-16)**

Commercial Success Cases



GARDIN - UK Agritech

Farm optimization via image recognition.

Usage of micro-ROS for the low level controlling of their sensors.



GARDIN



EU Impact:

micro-ROS now is a key component of ROS 2: Huge impact!

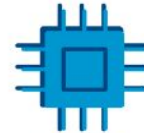
**Europe has a leading role in the
de facto standard for Robotics.**

Future: Fully European ROS Distro



CLOUD

Cloud/edge communication
of ROS 2 entities



MICRO

Seamless integration
of MCUs to ROS 2



SIMULATION

Model, program and
Simulate ROS 2 robots



TOOLS

Test and improve ROS 2
Network performance

