# MUSCLE Device Implementation on Microcontrollers

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To enhance the MUSCLE project, a system to simplify controlling of laboratory equipment, we have integrated microcontrollers, thereby offering more versatility. Given the necessity for real-time capabilities, the handling of a real-time operating system is desirable, a feat previously unachievable. The objective of this thesis is to design and implement a microcontroller-based MUSCLE device.

## MUSCLE (MUSCLE Unified System for Controlling Laboratory Environment)

the system represents a versatile, self-hosted environment designed to control and monitor nearly every aspect of a laboratory setup. As a soon open source platform, MUSCLE opens up countless possibilities for controlling various technical equipment, given they have a communication interface. Additionally, this project provides the opportunity to reduce complicated devices and user interfaces (UIs) to an easy-to-use UI that can be developed for the industry, schools, research facilities and all other users. A brief system overview is shown in the figure 1.

## Motivation

Previously MUSCLE exclusively supported Embedded Linux devices, the scope of its use remained limited due to certain underlying challenges such as higher costs, increased power consumption, and the inability to provide real-time responses. By integrating microcontrollers into the MUSLCE system, we aim to address these challenges and thereby unlock new potential. Microcontrollers are known for their cost-effectiveness, low power consumption, and real-time capabilities. These features can extend the reach of MUSCLE to a broader range of applications, especially those requiring real-time operation and energy efficiency.

## Goal

The primary objective of this thesis is the implementation of a microcontroller-based MUSCLE device using a Real-Time Operating System (RTOS) to manage network communication, frontend device API requests, and user programming. In achieving these goals, we aim to extend the capabilities of the MUSCLE system, expand its applicability, and improve its utility in various laboratory environments. Ultimately, this work demonstrates the potential for integrating microcontrollers with an RTOS into the MUSCLE system and open the door for future development and innovation in this area.

## Software Component Tasks

**Network Communication**: The implementation is responsible for handling the network communication. Thereby facilitating seamless interactions within the laboratory environment.
**Frontend Device API Requests**: By coordinating these requests from the MUSCLE frontend, the implementation ensures that all device function requests are handled properly, providing functionality between the MUSCLE system and the user program.
**User Programming**: Finally, the implementation takes over the user programming tasks. This gives users the ability to create custom controls and functions, further increasing the versatility and customizability of the MUSCLE system.

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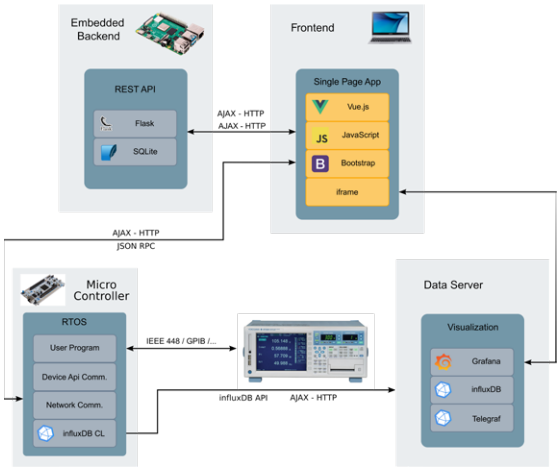


Fig. 1: MUSCLE Microcontroller Overview Concept

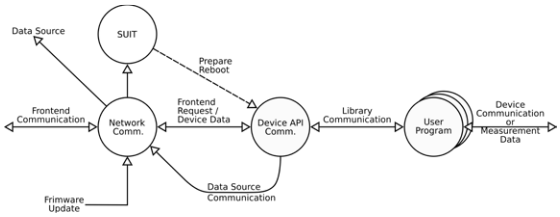


Fig 2: MUSCLE Microcontroller Device Software Concept