

# Modbus Communication System with ESP32

## Overview

Develop a system that can send and receive Modbus requests and display the data on a web-based dashboard. The system uses an ESP32 microcontroller and can operate in two modes: master and slave.

## Components

- **ESP32:** The microcontroller responsible for Modbus communication and hosting the web server.
- **ESAM E2002:** Electrical component that communicates with the ESP32 in master mode.
- **ModScan Software:** Software that communicates with the ESP32 in slave mode.

## Modes of Operation

### 1. Master Mode

- The ESP32 sends Modbus requests to the ESAM E2002.
- It receives data from the holding registers
- It correctly converts the data (eg. from 2 words of 16bit to a float)
- It stores them in a local data structure

### 2. Slave Mode

- The ESP32 receives Modbus requests from ModScan software.
- It correctly converts back the data (eg. from a float to a 16bit word)
- It responds with data from the holding registers.

# Initial Configuration

## 1. WiFi Setup

- The ESP32 starts in configuration mode with the SSID "CONFIGURE ME".
- Connect to the "CONFIGURE ME" WiFi network.
- A captive portal opens for configuring the ESP32 to connect to a new network (e.g., "NEW WIFI").
- Once connected to "NEW WIFI", the ESP32 communicates its new IP address.

## 2. Web Interface

- **Configuration Page:** Accessible via the new IP address.
  - Displays a table of all measurements in the holding registers.
  - Allows users to create, edit, and delete measurements.
  - For each measurement, users can define:
    - Register address range (eg. "124-125")
    - Type (eg. "float")
    - Read/write (eg. "read only")
    - Label (eg. "V1")
    - Description (eg. "Voltage Phase 1")
    - Unit (eg "V")refer to the [E2002 Manual](#) pages 13-16 for more
  - Allows users to switch the ESP32 between master and slave modes.
  - Configure swap settings.
- **Analytics Page:** Accessible via the new IP address.
  - Displays selected real-time data in a textual format.
  - Includes a user-friendly GUI for better visualization (Bonus)

## Evaluation Criteria

Criteria Name	Criteria Description	Max score
ESP32 - Modbus Master - Data Reception	The ESP32's ability to send Modbus requests to the ESAM E2002 and accurately receive various data types, converting them correctly from holding registers.	4
ESP32 - Modbus Master - Local Data Storage	The ESP32's capability to save different data types from holding registers into local storage efficiently.	1
ESP32 - Modbus Slave	The ESP32's proficiency in responding to Modbus requests from ModScan software with accurate and reconverted data from holding registers.	4
WiFi Configuration	The ease and success of the initial WiFi setup via a captive portal, including the transition to a new network.	4
IP Address Communication	Accurate communication of the new IP address to the user after connecting to the new WiFi network.	1
Configuration Page	The completeness and usability of the configuration page, including the ability to create, edit, and delete measurements.	3
Analytics Page	The accuracy and clarity of real-time data display on the analytics page in textual format.	2
System Stability	The stability and reliability of the system during normal operation, including error handling and recovery processes.	2
Documentation Quality and Completeness	The quality and thoroughness of the documentation, providing step-by-step instructions, images, and relevant information for users to replicate or understand the product.	3
Presentation Quality and Completeness	The quality of the presentation, including well-structured content, clear visuals, and comprehensive coverage of all relevant aspects of the product such as functionality and architecture.	2
Demo Quality	The effectiveness of the product demonstration in showcasing its features, capabilities, and value proposition, being engaging, well-prepared, and leaving a positive impression on the audience.	3
User Interface Design - BONUS	The overall design and user experience of the web interface, including both the configuration and analytics pages.	3
<b>TOTAL</b>		<b>32</b>

## Evaluation Score Sheet

Available to the person who will score the project and for autonomous self-evaluation.

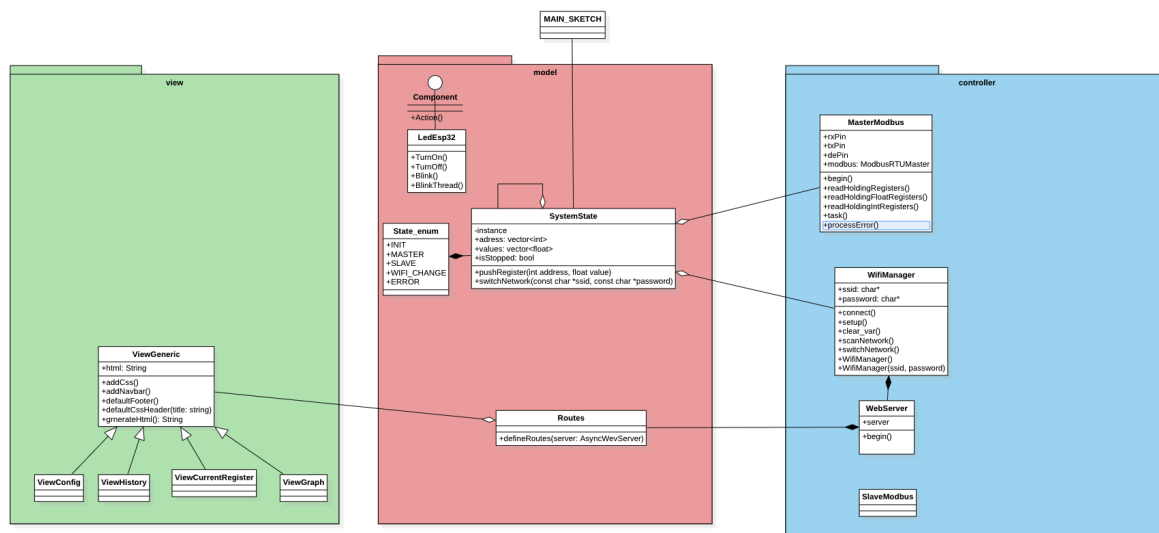
Questions	Score
<b>ESP32 - Modbus Master - Data Reception</b>	Max 4
Does the ESP32 successfully send Modbus requests to the ESAM E2002?	2
Does the ESP32 correctly receive various data types from holding registers?	1
Does the ESP32 correctly convert various data types from holding registers?	1
<b>ESP32 - Modbus Master - Local Data Storage</b>	Max 1
Does the ESP32 save received data correctly in local storage?	1
<b>ESP32 - Modbus Slave</b>	Max 4
Does the ESP32 accurately respond to Modbus requests from ModScan?	2
Is the data reconverted correctly when responding to requests?	2
<b>WiFi Configuration</b>	Max 4
Is the initial WiFi setup via the captive portal easy and successful?	2
Does the ESP32 correctly switch to the new network?	2
<b>IP Address Communication</b>	Max 1
Does the ESP32 communicate the new IP address correctly after connecting to the new network?	1
<b>Configuration Page</b>	Max 3
Are all necessary measurement details (address range, type, label, etc.) available for configuration?	2
Can the user add/edit/delete new measurements	1
<b>Analytics Page</b>	Max 2
Is the real-time data received and displayed?	1
Is the data presented clearly in a textual format?	1
<b>System Stability</b>	Max 2
Does the system operate stably under normal conditions?	1
Is error handling and recovery implemented effectively? (eg. modbus communication error)	1
<b>Documentation Quality and Completeness</b>	Max 3
Is the documentation detailed and well-structured?	1
Does the documentation include step-by-step instructions?	1
Are images and relevant information provided to guide users?	1
<b>Presentation Quality and Completeness</b>	Max 2
Is the presentation well-structured and visually clear?	1
Does the presentation comprehensively cover the product's functionality and architecture?	1
<b>Demo Quality</b>	Max 3
Is the product demonstration engaging and well-prepared?	1
Does the demo effectively showcase the product's features and capabilities?	1
Does the demo leave a positive impression on the audience?	1
<b>User Interface Design - BONUS</b>	Max 3
Is the web interface well-designed and user-friendly?	1
Does the configuration page have a good user experience?	1
Does the analytics page have a good user experience?	1

## Frequently Asked Questions

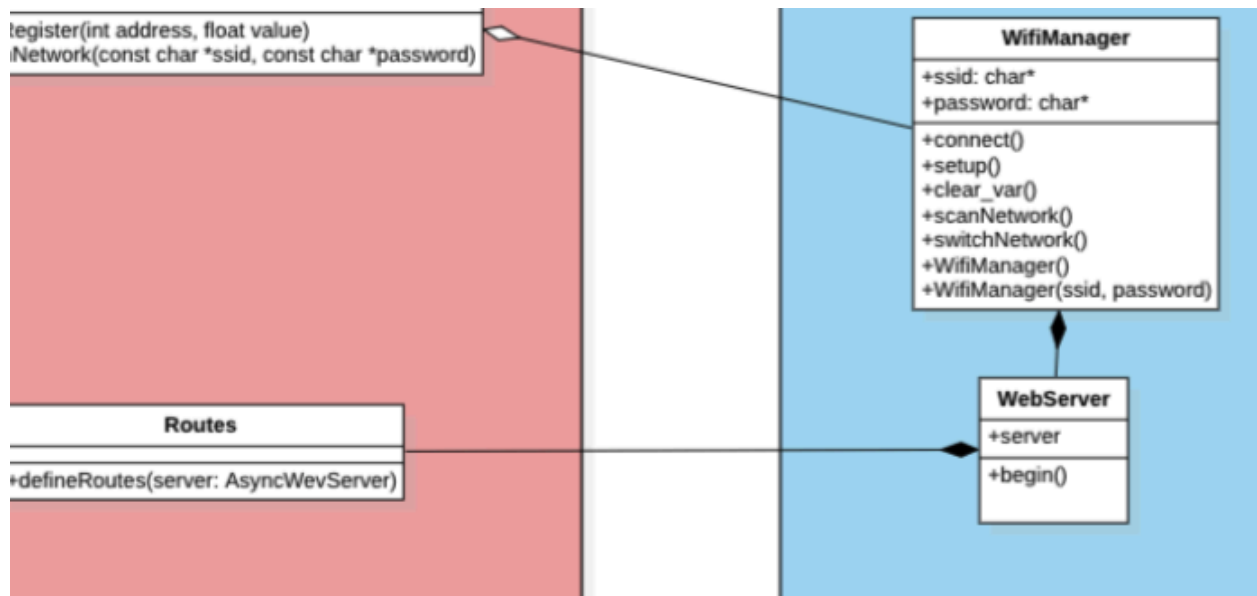
- When ESP is in slave mode, and I'm using MODSCAN, should the data I'm collecting be in real time? Yes, retrieved from the E2002
- Why do we need a configuration table? this enables the system to be flexible without changing the actual code if a modbus-compatible device replaces the E2002
- What should be the graphical representation of the system? I'm not interested in this, I'm more interested in the logic. To be flexible, a user should be able to view, add, edit, delete the information. How this is actually implemented visually is not really interesting.
- Why are you asking us to do this project? I'm expecting you to autonomously make the links with real life examples but this is already a real life example. In any IoT device nowadays there is a connection part (generally setup), a configuration part and a cloud part. I'm sure that if you practice on the first two, doing the third will be quite trivial.
- Can I develop part of the software outside the ESP and have the ESP just to be the server sharing the data? Yes but not required. I asked to do everything inside the EPS for ease of testing but I understand you would like to "separate the concerns" so you can do it in any way.

Presentazione:

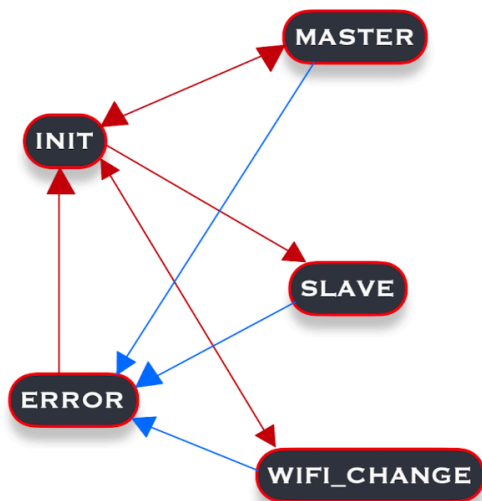
Alessio: panoramica generale:



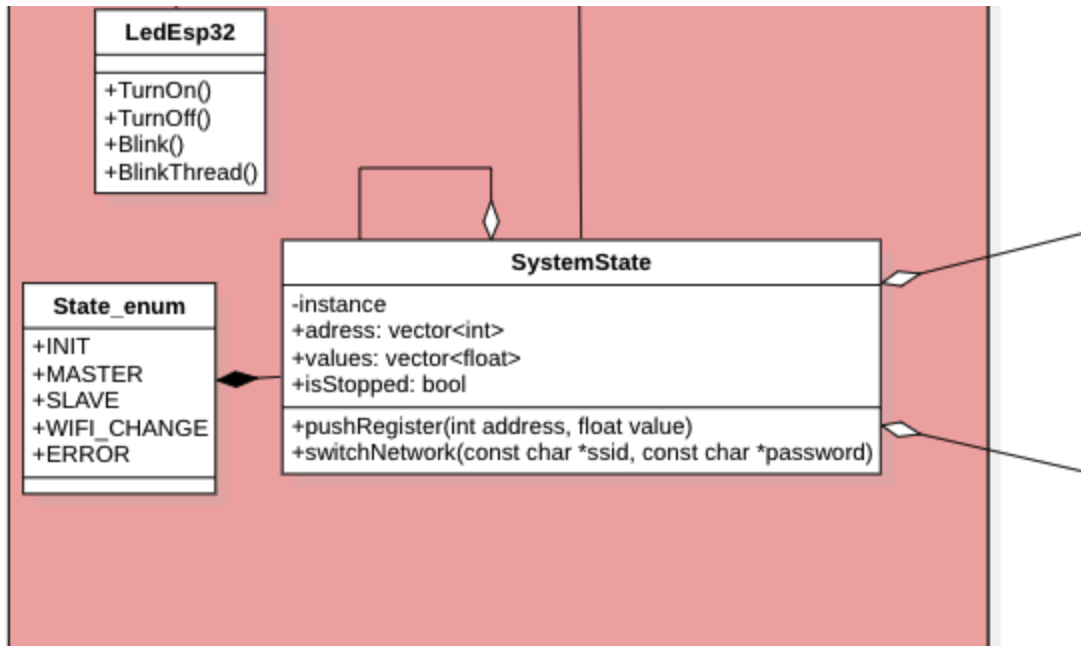
Enrico:



Simone



Il nostro sistema e pensato per funzionare esattamente come una macchina a stati..



System State segue pattern singleton.