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PLC & IOT BASED MULTI-PROTOCAL TRAINER

Integration of S7-1500, S7-1200, IoT 2050, Opta PLC, and Arduino via Modbus TCP IP AND OPC UA for Industrial IoT Applications

Our advanced integration solution seamlessly connects Siemens S7-1500 and S7-1200 PLCs, IoT 2050, Opta PLC, and Arduino via Modbus TCP/IP and OPC UA protocols. Designed for industrial IoT applications, this multi-protocol system ensures robust communication and interoperability among diverse devices, enabling streamlined data exchange and enhanced operational efficiency in complex industrial environments.

Hardware Requirements

- Siemens S7-1500 PLC
- Siemens S7-1200 PLC
- Siemens IoT 2050 Gateway
- Opta PLC
- Arduino Board
- 8 port switch
- Raspberry Pi 5

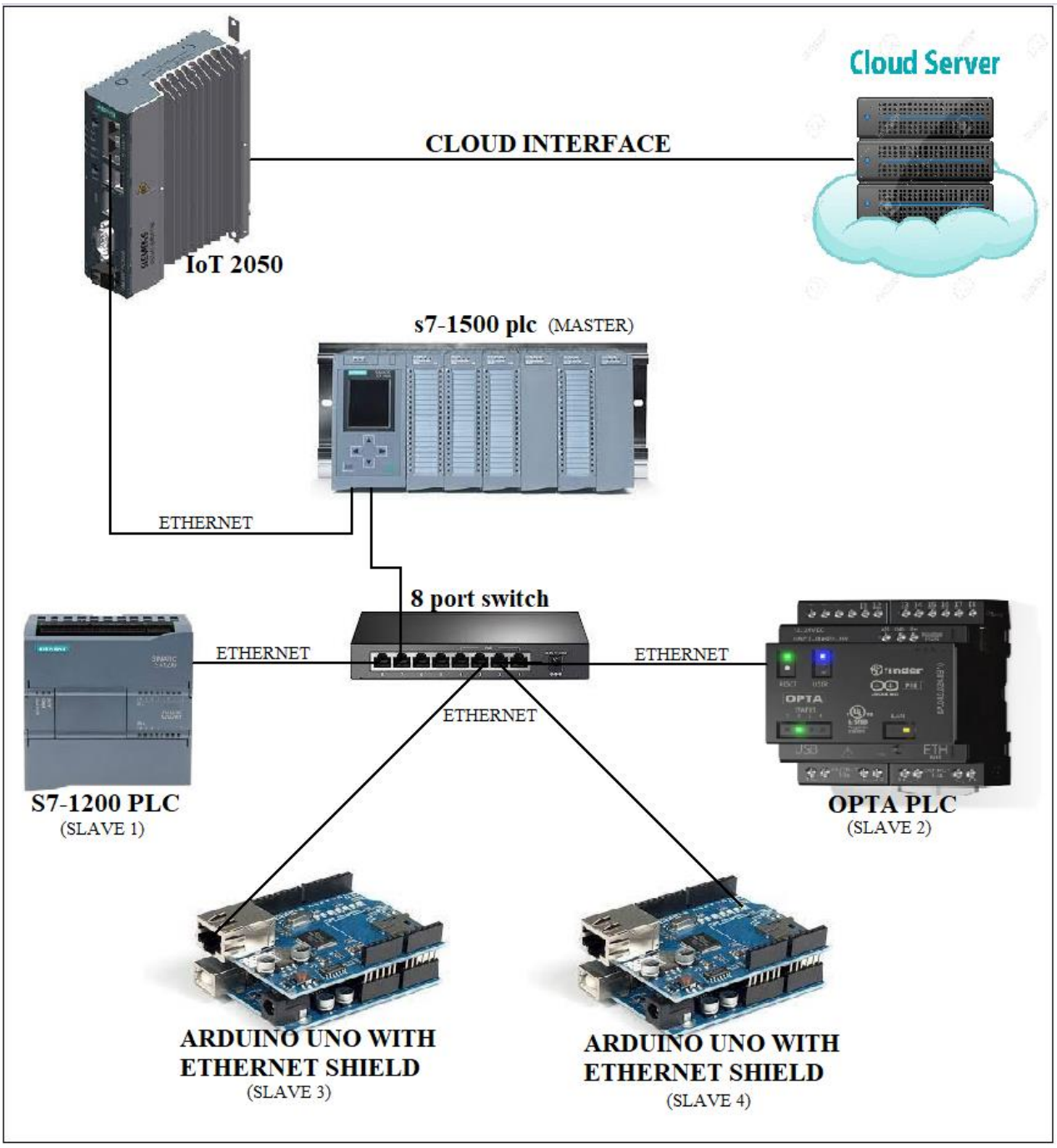
Software Requirements

- Siemens TIA Portal
- OptaPLC IDE
- Arduino IDE
- Node-red
- Mendix

Description:

- This project focuses on integrating the Siemens S7-1500 PLC ,Siemens S7-1200 PLC, Siemens IoT 2050 Gateway, Opta PLC, and Arduino board using the Modbus TCP protocol for Industrial IoT applications.

- The integration enables seamless communication between these devices, allowing for efficient data exchange and control.


Cloud Server
CLOUD INTERFACE
IoT 2050
s7-1500 plc (MASTER)
ETHERNET
8 port switch
ETHERNET
ETHERNET
ETHERNET
S7-1200 PLC
(SLAVE 1)
OPTA PLC
(SLAVE 2)
ARDUINO UNO WITH
ETHERNET SHIELD
(SLAVE 3)
ARDUINO UNO WITH
ETHERNET SHIELD
(SLAVE 4)

- The S7-1500 PLC will handle core automation tasks, the IoT 2050 Gateway will facilitate cloud connectivity and edge computing,theS7-1200 PLC and Opta PLC will manage specialized control functions, and the Arduino will serve as a flexible, low-cost sensor interface.

- The system will utilize Ethernet networking for robust and reliable communication. By leveraging Modbus TCP, a widely adopted open communication protocol, this project ensures interoperability and scalability, making it suitable for modern industrial environments.

- This setup will enhance operational efficiency, enable real-time monitoring and control, and support advanced data analytics for improved decision-making.

HARDWARES:

I. IOT 2050 GATEWAY

- Design : IoT Gateway, built-in unit
- Type of supply voltage : 12/24 V DC
- Processor type: ARM TI AM6528 GP(2 CORE)
- Graphics controller: Integrated
- Slot for drives: 1x microSD card slot

- Type of memory: DDR4
- Main memory: 1 GB RAM
- Capacity of main memory, max.:1 Gbyte
- free slots: 1x Arduino, 1x mPCIe
- Number of digital inputs: 20
- Type of input voltage: DC
- Number of digital outputs: 20
- Output voltage
- Type of output voltage:DC
- permissible voltage at output, min.: 3.3 V
- permissible voltage at output, max.: 5 V
- PROFIBUS/MPI can be implemented with plug-in card
- Number of industrial Ethernet interfaces : 2
- Number of PROFINET interfaces: 2
- USB port: 2x USB 2.0
- Connection for keyboard/mouse: USB
- serial interface: 1x COM (1x RS 232 / 422 / 485)
- Graphics interface: 1x DisplayPort
- Industrial Ethernet interface : 2x Ethernet (RJ45)

II.S7-1500 PLC:

CPU Module Specifications

- **Make:** Siemens, Simatic S7 Family
- **Model:** CPU 1511C-1 PN

General Specifications:

- **Timers & Counters:** 512 Nos Each
- **Digital Inputs:** 16 Nos (24V DC)

- **Digital Outputs:** 16 Nos (24V DC)
- **Input Supply:** 24V DC
- **Analog Inputs:** 4 Nos (0-10V DC, 4-20mA)
- **Analog Outputs:** 2 Nos (0-10V DC, 4-20mA)
- **Program Memory:** 1 MB
- **Data Memory:** 5 MB
- **High-Speed Counters:** 6 Nos [3 at 1MHz, 3 at 100KHz]
- **PWM Outputs:** 2 Channels at 1MHz
- **PID Controller:** Up to 64 PID control loops with Auto-tuning facility
- **Profinet Communication Interface:** Yes (Integrated)
- **Instruction Set:** Includes PID controller, Floating Point, Timer, Counters, Math, Logical operations, etc.

II. S7-1200 PLC:

***CPU Module**

- Make : Siemens, Simatic S7 Family
- Model : CPU 1214C
- Timers & Counters : 256 Nos Each
- Digital Inputs : 14 Nos (24V DC)
- Digital Outputs : 10 Nos (24V DC)
- Input Supply : 24V DC
- Analog Inputs : 2 Nos (0-10)V DC
- Program Memory : 50KB
- Data Memory : 1MB
- High speed counters : 1 No [3 at 100KHz, 3 at 30KHz]
- PWM outputs : 1 channel at 100KHz
- PID controller up to 16 PID control loops with Auto tuning facility
- Profinet Communication Interface
- PID controller, Floating, Timer, Counters etc instructions are available

III. OPTA PLC:

Input	8x configurable digital / analog (0-10V) input
Processor	STM32H747XI Dual ARM® Cortex®: • Cortex -M7 core up to 480 MHz • Cortex -M4 core up to 240 MHz
Connectivity	Support 10/100 Ethernet (TCP/IP or Modbus TCP) USB-C Wi-Fi + Bluetooth® Low Energy RS485 half duplex
Memory	1MB RAM (programming) 2MB internal + 16MB Flash QSPI
RTC	Typical 10 days power retention at 25°C NTP sync available through ethernet
IP protection	IP20
Output	4x relays (250 V AC - 10 A)

Programming languages	• Arduino programming language via IDE
	• IEC-61131-3:
	  ○ Ladder Diagram (LD)
	  ○ Function Block Diagram (FBD)
	  ○ Sequential Function Chart (SFC)
	  ○ Structured Text (ST)
	  ○ Instruction List (IL)

Security	ATECC608B Secure element
Supply voltage	12…24 V DC

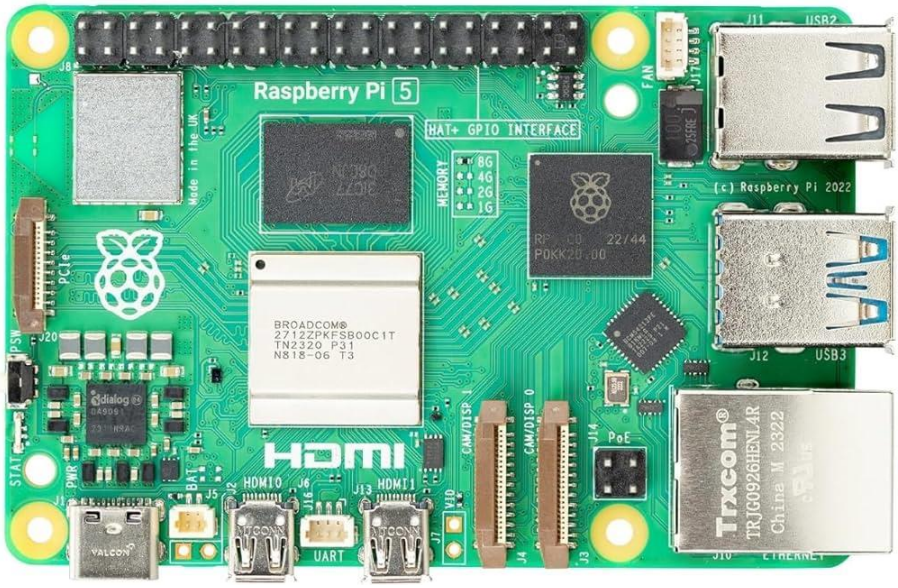
V .Arduino UNO board with Ethernet shield

Features:

- Microcontroller: ATmega328P
- Operating Voltage: 5V
- Input Voltage (recommended): 7-12V
- Inout Voltage (limit): 6-20V
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- PWM Digital I/O Pins: 6
- Analog Input Pins: 6
- DC Current per I/O Pin: 20 mA
- DC current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB (ATmega328P) of which 0.5 KB used by bootloader
- SRAM: 2 KB (ATmega328P)
- EEPROM: 1 KB (ATmega328P)
- Clock Speed: 16 MHz
- LED_BUILTIN: 13
- IEEE802.3af compliant
- Based on the W5100Based on the Wiznet W5100 allows an Arduino board to connect to the internet.
- Stackable Design, can directly be supported by for Arduino official Ethernet Library.
- Supports up to four simultaneous socket connections
- Can be used to store files for serving over the network.
- Can be accessed using the Mini SD TF library.
- IEEE802.3af compliant
- Low output ripple and noise (100mVpp)
- Overload and short-circuit protection

VI .Raspberry Pi 5

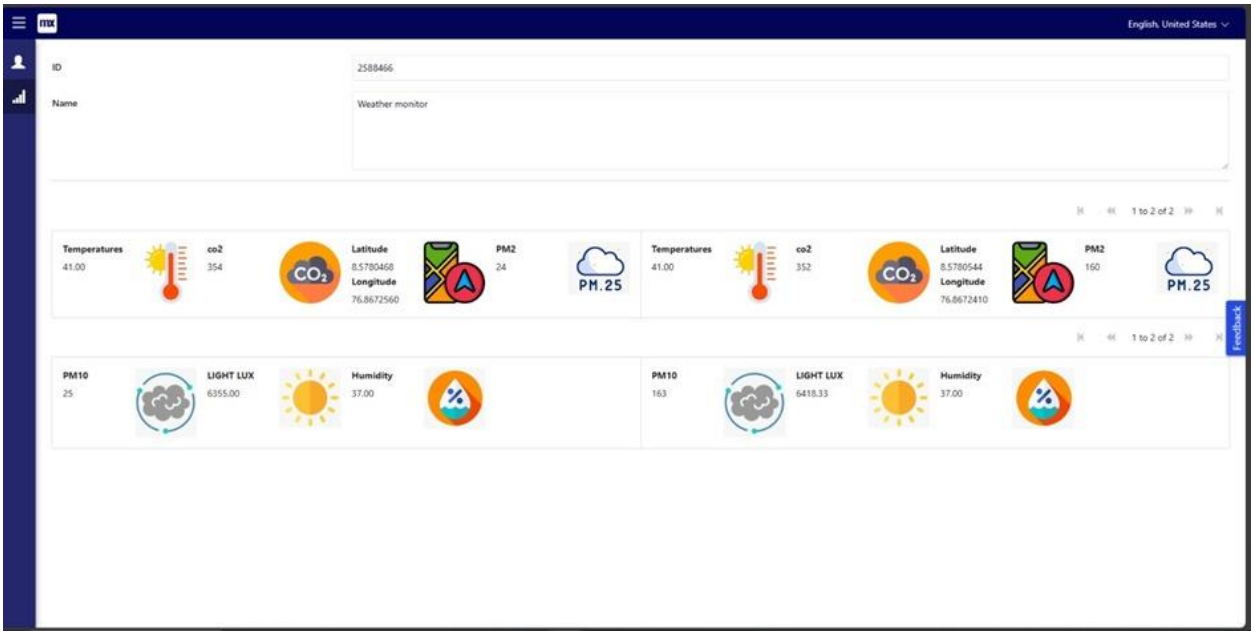
Features:



- Broadcom BCM2712 2.4GHz quad-core 64-bit Arm Cortex-A76 CPU, with cryptography extensions, 512KB per-core L2 caches and a 2MB shared L3 cache
- VideoCore VII GPU, supporting OpenGL ES 3.1, Vulkan 1.2
- Dual 4Kp60 HDMI® display output with HDR support
- 4Kp60 HEVC decoder
- LPDDR4X-4267 SDRAM (2GB, 4GB, and 8GB)
- Dual-band 802.11ac Wi-Fi®
- Bluetooth 5.0 / Bluetooth Low Energy (BLE)
- microSD card slot, with support for high-speed SDR104 mode
- 2 × USB 3.0 ports, supporting simultaneous 5Gbps operation
- 2 × USB 2.0 ports
- Gigabit Ethernet, with PoE+ support (requires separate PoE+ HAT)
- 2 × 4-lane MIPI camera/display transceivers
- PCIe 2.0 x1 interface for fast peripherals (requires separate M.2 HAT or other adapter)
- 5V/5A DC power via USB-C, with Power Delivery support
- Raspberry Pi standard 40-pin header
- Real-time clock (RTC), powered from external battery
- Power button

SOFTWARE

I .**Siemens Mendix Dashboard Software**

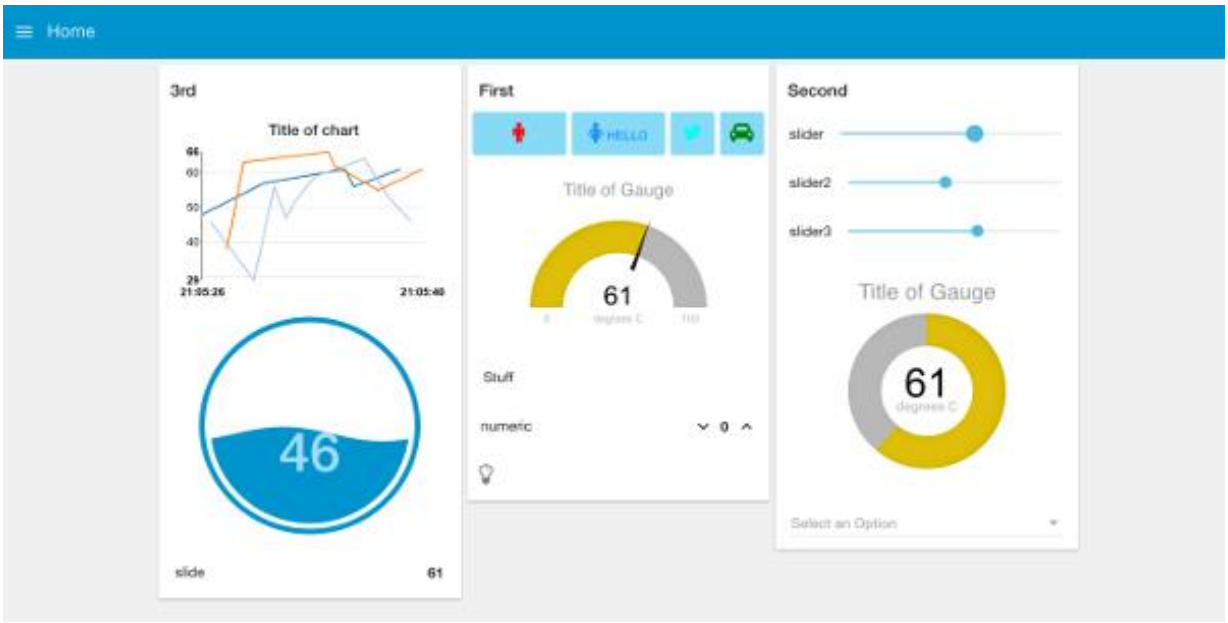


Features:

- **Low-Code Platform**: Enables rapid development of dashboards with minimal coding, accelerating deployment and customization.

- **Real-Time Data Visualization**: Provides interactive dashboards for live data monitoring from industrial systems.
- **Seamless Integration**: Easily integrates with Siemens industrial software and hardware for smooth data flow.
- **Customizable and Scalable**: Offers flexible, customizable templates and supports scaling to accommodate growing needs.
- **Mobile and Web Access**: Dashboards are accessible on both mobile and web platforms for convenient, on-the-go monitoring.

II . Node Red and Rode Red dashboard



- **Low-Code Interface**: Node-RED Dashboard provides a visual, low-code interface for building custom dashboards, allowing users to create and configure widgets without extensive coding.
- **Real-Time Data Visualization**: It enables real-time monitoring and visualization of data through interactive charts, gauges, and other widgets, making it suitable for live data displays.
- **Seamless Integration**: Integrates effortlessly with various data sources and systems through Node-RED's flow-based programming, supporting a wide range of IoT devices and APIs.
- **Customizable Widgets**: Offers a variety of customizable widgets and layout options to tailor dashboards to specific needs and preferences.
- **Web-Based Access**: Dashboards are accessible via web browsers, making them available from any device with internet access for remote monitoring and control.