

H2IOSC Project: The Italian Federated Cluster for IoT-based Monitoring and Digital Twinning of Cultural Heritage

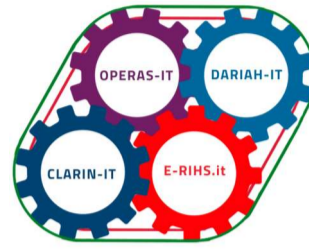
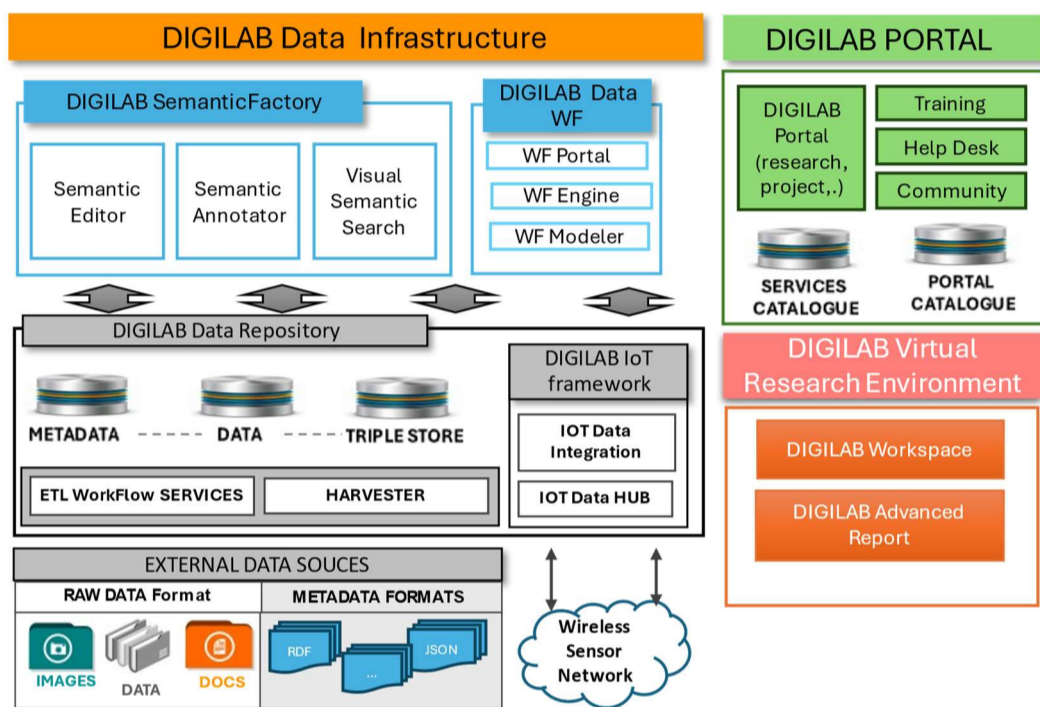
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Abstract

The H2IOSC project aims to create a federated cluster of research infrastructures (RIs) in the domain of Cultural Heritage at the national level in Italy. Through four key RIs — DARIAH-IT, CLARIN, OPERAS, and E-RIHS — the project enables collaboration among researchers with interdisciplinary expertise. Within this context, DIGILAB emerges as a digital access platform for the Italian node of E-RIHS, providing data management, digital tools, and services to boost cultural heritage preservation, fruition, and study. A significant aspect of DIGILAB architecture is its capability to support geo-localization and real-time monitoring of cultural heritage sites in terms of environmental conditions, structural integrity, and diagnostics, leveraging on novel Internet of Things (IoT) systems and large-scale Wireless Sensor Networks (WSNs). By integrating WSNs into DIGILAB framework, the project enhances remote monitoring and control of cultural sites. These networks facilitate the collection of real-time data on factors such as temperature, humidity, and air quality, providing crucial insights for the Cultural Heritage research community. Moreover, WSNs enable proactive measures to be taken in response to emerging threats, mitigating risks and minimizing damage to cultural assets at a national level.

DIGILAB-IT

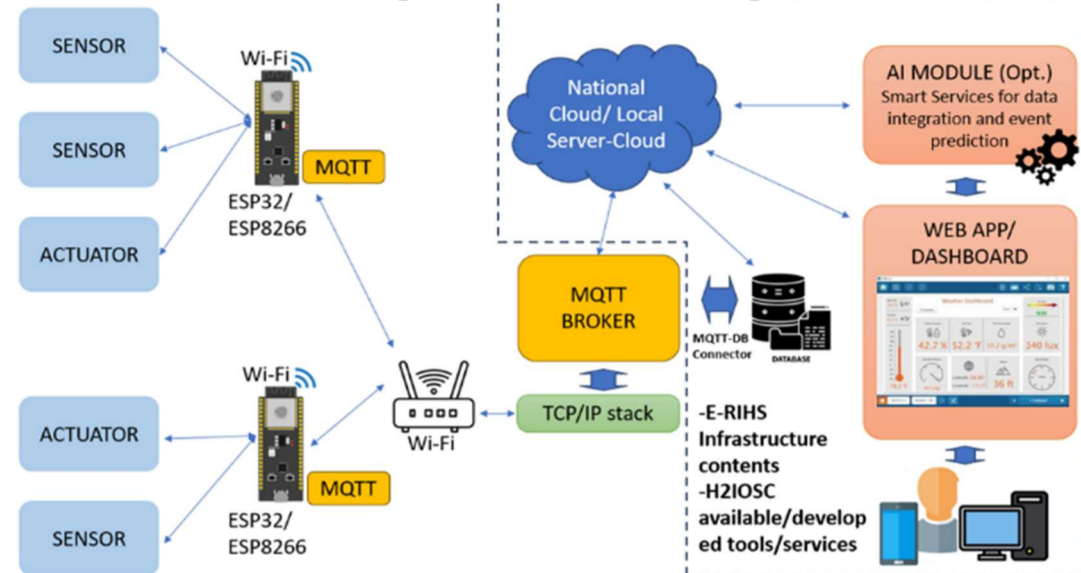
A socio-technical system for the HS research community



Semantic Knowledge base
Interoperable Linked Open Data
Services
Tools/Instruments
Digital Twin
Federated data, services and tools
Scientific Data Life Cycle
FAIR Data
Data Preservation
Community systems

WIRELESS SENSOR NETWORK

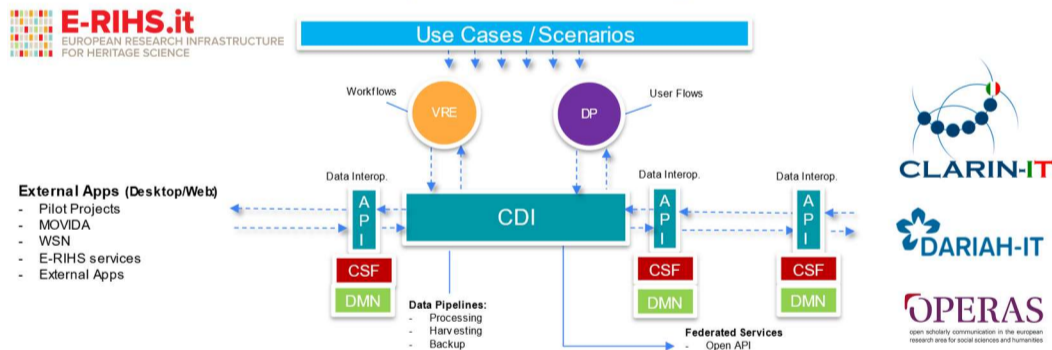
IoT-based Monitoring of Cultural Heritage



Architecture of the large-scale WSN proposed at both the physical and software levels.

Each node within the hardware subsystem collects data from various sensors. The sensor node performs preliminary data processing on board and subsequently transmits the results to the MQTT broker using appropriate wireless technologies.

Conceptual Model - Digilab-IT



DATA VISUALIZATION DASHBOARDS

Main features of the IoT platform are the customizable dashboards based on the scenario and information to be represented. Users can share and manage the dashboards. For the component's implementation, ThingsBoard (in the figure below) has been decided upon. This open-source IoT platform includes tools for collecting, presenting, and processing data. Moreover, it allows the implementation of custom tools.

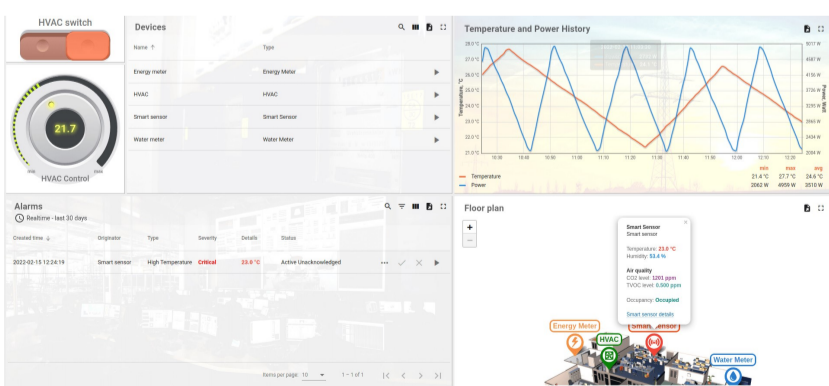


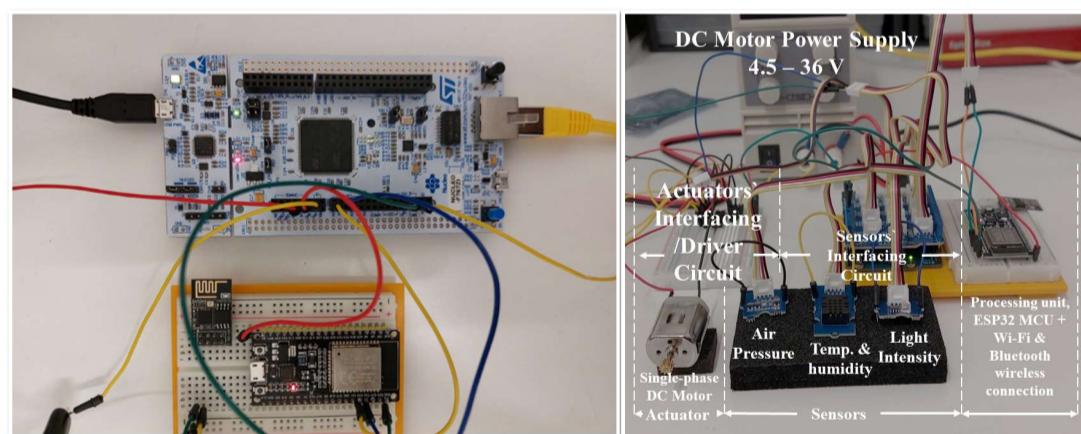
Image from Thingsboard.org about the monitoring of environmental parameters

Acknowledgement

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PHYSICAL IMPLEMENTATION

IoT Sensor Node



IoT multi-sensor measurement node for microclimate monitoring for the preservation of Cultural Heritage

A prototype of an IoT node that is based on ESP32 and STMicroelectronics Nucleo-144 dev. Boards. This configuration can communicate with the external world through various wired and wireless communication protocols and standards: USB, I2C, SPI, CANbus, Ethernet, Wi-Fi, and Bluetooth.

CASE STUDY

Grotta degli Animali (Florence - Italy)



The use case examines the choreographed water feature that wet the inside of the cave for 15 minutes every two hours and analyses the possible problems that may arise due to the water and subsequent drying. The aim is to create a wireless sensors network (WSN) to measure the factors that can cause damage to the structure.

IoT

Cultural Heritage

Wireless Sensor Network

Data Processing

Digital Twin

Data Visualization



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