IoT Monitoring System for Shelters and Protective Structures

Degree programme: BSc in Electrical Engineering and Information Technology | Specialisation: Communication Technologies
Thesis advisor: Prof. Dr. Andrea Ridolfi
Expert: Ing. civ. dipl. EPF Cédric Vuilleumier (Federal Office for Civil Protection FOCP)

We have developed an IoT system / sensor network for the remote monitoring of environmental parameters and operating statuses of Swiss protective structures (shelters / protected premises). Its key features are: Modularity / Expandability; Low Power Consumption; Use of Opensource Technologies; Robustness. Measures parameters and alarms can be displayed locally as well as sent via the internet to a cloud computing service or to a dedicated server.

Motivation

Swiss protective structures aims at protect the population (shelters) and at ensuring the readiness of civil protection resources (protected premises), in case of armed conflicts as well as in case of disasters and emergencies (e.g., increased radioactivity, earthquake, acute risk of an avalanche). They are periodically controlled under the supervision of the Federal Office for Civil Protection FOCP in order to ensure their readiness to be used. An IoT / Sensor Network based system enabling the remote monitoring of environmental parameters (e.g., humidity, temperature, water leakages. CO2), and operating statuses (e.g., water reservoir and fecal pits level) can significantly reduce the costs of maintenance (periodic in-situ controls, late detection of damages).

Monitoring System Concept

The monitoring system has been designed, developed, and implemented based on four key criteria

- Modularity / Expandability (addition or elimination of sensors / monitored parameters);
- Low Power Consumption (coherently with the Swiss Energy Strategy 2050 and with the deployment of the monitoring system in a large number of protective structures) ;
- Use of Opensource Technologies (compatibility with other open system, future further expansions);
- Robustness (low maintenance / long term durability).

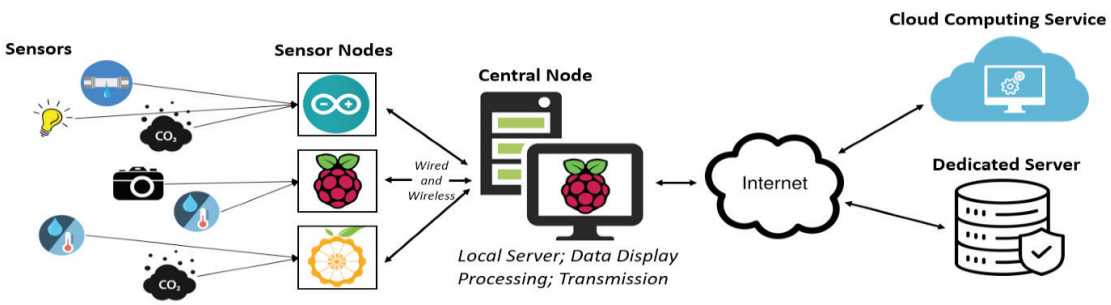
It accounts for the peculiarity of protective structures, namely: Mostly underground / basement; Rooms with extremely thick walls; Cable trays connecting each room; Absence of windows; Internet (existing or planned) and telephone connection. The monitoring system has been implemented into two prototypes: A prototype targeting fixed installation for long term monitoring, based on wired connections; A prototype aiming at short term monitoring campaigns for specific issues (e.g., water damages), which is meant to be easily and temporarily installed and it combines both wired and wireless connections. Both systems use an embedded linux node (raspberry-pi) acting as a central node for data processing / transmission / display, and several low power sensor nodes for data measurement and alarm generation (Arduino / orange-pi / raspberry-pi 0).

Results and Outlook

The two prototypes has gone through laboratory testings. A particular attention has been given to the programming and reliability testing of sleep / wake up features. These features are crucial for power consumption minimisation and trustable alarm generation. Measurement intervals are configurable according to the type of measurement. The system will be extensively tested in the protected structure in Lyss.

Mauro Carcano
078 846 36 29
maurocarcano64@gmail.com

Jonathan Giudice
079 948 25 19
jonathan.giudice10@gmail.com



Prototype IoT Monitoring System