Internet of Sensors

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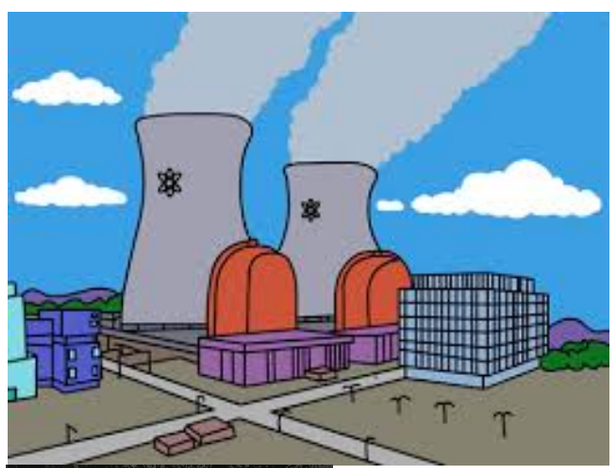
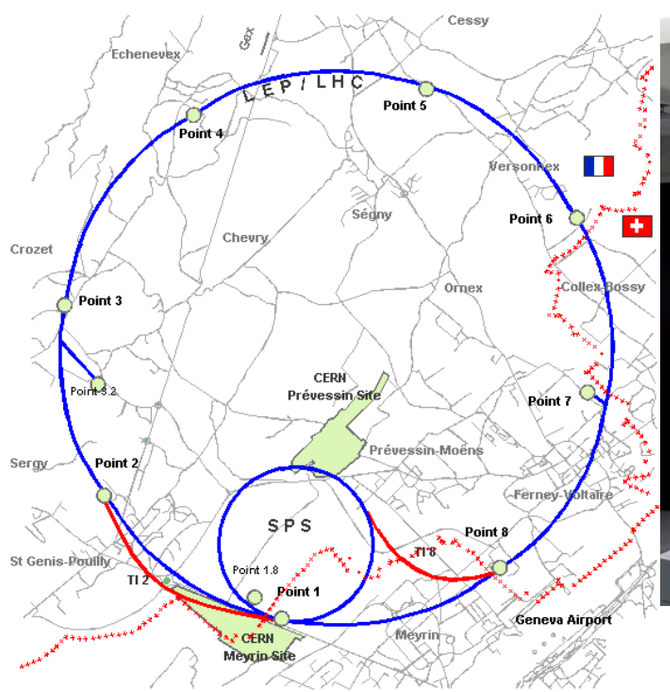
INTRODUCTION

A huge amount of **radiation monitoring** is performed, on a daily basis, in and around research centers, nuclear installations, university laboratories, hospitals, industrial facilities and military sites.

Part of it relies heavily on measurements performed by trained **operators**.





Map of CERN sites and LHC access points

Shortcomings of the operator driven approach:

1. Human operator introduces variability
2. Monitoring difficult to access locations
3. Automated data logging/alarm system?
4. Data merging
5. System blind between controls [lack of continuos sensitivity]
6. Short exposures: long exposures hard to achieve
7. Personnel requirements

UPGRADE TO AN AUTOMATED SYSTEM?

Requirements for an automated system:

1. Sensor optimized for the specific radiation field (alpha, beta, gamma, neutrons...; energy spectrum; intensity)
2. **Sensitivity down to background level**
3. Needs a **robust** device: resistant to adverse weather, temperature variations, vibrations and mechanical shock
4. **Operate unattended** and with **minimal maintenance**
5. **Low power consumption** (battery powered)
6. Integrated **data transmission** facilities (e.g. GSM, WiFi, RF)
7. **Acceptable cost**

IoS concept

IoT: 6 billion connected things by the end of 2016, 20 billions by 2020. 5 million new things get connected every day.

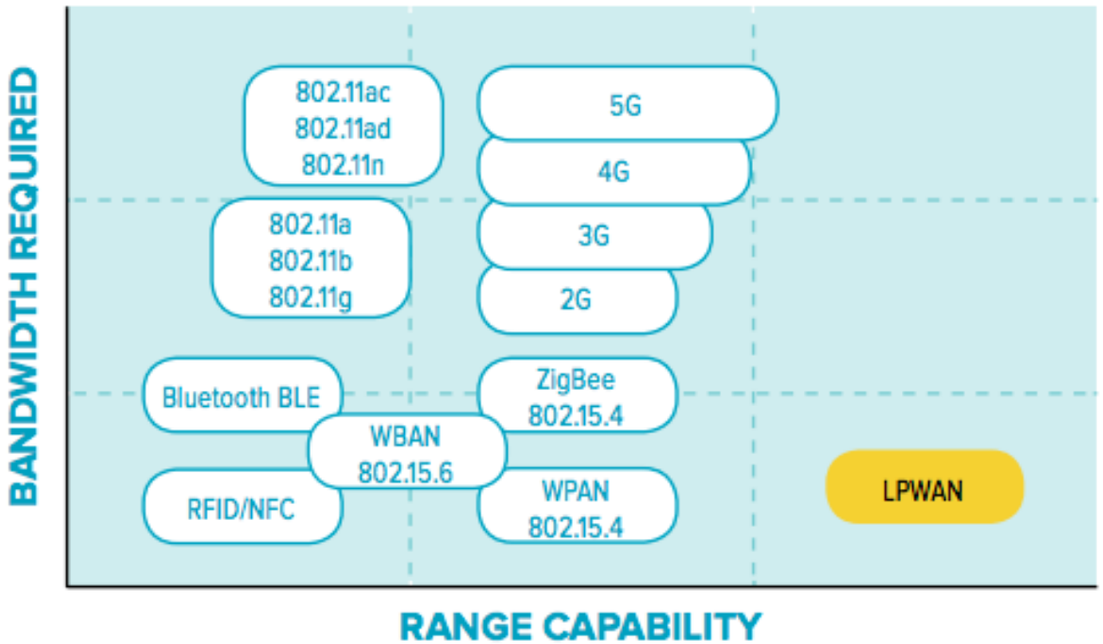
Recent availability of:

- affordable solid-state radiation sensors
- reliable and cheap micro-controllers and memories
- new developments in wireless communication (i.e. LPWAN)
- low power microelectronics
- efficient batteries

The development of a network of smart radiation sensors perfectly aligned with powerful trends in the contemporary technological landscape, e.g. "Internet of Things" (IoT).

The goal of the Internet of radiation Sensors (IoS) project is to design, build, test and operate a network of smart radiation sensors.

IoS concept



Low Power Wide Area Networks (LPWAN) as LoRa and Sigfox provide a practical way to transfer a limited amount of data over long distances with minimal power consumption.

CERN offers a unique environment for the development of IoS:

- unique infrastructure
- distributed over a large geographical area
- variety of skills and expertise
- highly diversified testing ground for radiation applications

Pilot project at CERN: automated monitoring of radioactivity in ordinary waste (W-MON)

Applications

- **Distributed network of sensors**: environmental monitoring of large areas, providing the environmental gamma dose in real time with high granularity
- **Personal dosimetry**, with wireless data transmission and centralized data handling
- **Automatic tracking of radioactive sources** in laboratories: provide continuous real time information of the location of the source (useful also for protection of first responders)
- **Transport of radioactive materials**: continuous data recording allows to reconstruct with great accuracy the status of the source, and offers a very effective, documentable way to establish that the source has not been tampered with.
- Direct integration in consumer electronics
- Homeland Security
- **A generalized IoT platform dedicated to environmental risk**