Open Architecture for Smart and Interoperable Networks in Risk Management Based on In-Situ Sensors – OSIRIS –

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Abstract
This paper briefly describes the OSIRIS project, led under EC auspices in the GMES environment. The main objective of the OSIRIS project is to enhance the overall efficiency of the in-situ data processing chain by connecting the in-situ sensors via an intelligent and versatile network infrastructure that will enable the end-users to access multi-domain sensors information. OSIRIS will address the smart deployment, use and reconfiguration of network of sensors in the monitoring as well as in the crisis phase. It will develop architectures enabling the easy sharing of data and access to services, and will provide the required technologies to allow for the customisation of sensors or sensors network to fulfil end-users needs and define interoperability within an In-situ Monitoring sensor web. An experimental validation based on end-users requirements will be conducted to support the proposed concepts and investigate options to improve in-situ observations dissemination, addressing three themes in the natural resources domain: forest fires monitoring, air pollution monitoring and water resource monitoring (in quantity – dryness – and quality – pollution).

1. Introduction
GMES is an information system which covers all the necessary steps from data acquisition to service delivery to the end-users. Data acquisition requires in-situ observations as well as space-based observations. By in-situ observations, we mean observations captured locally, i.e. within a few kilometres of the object or phenomenon being observed, thus including measurements taken at ground station or by aircraft.

GMES services are all based on a three stage process:
- Observation, relying in space-based and in-situ capabilities,
- Modelling, dedicated to the processing of the data generated by the above mentioned observation systems,
- Service production and delivery.

Most of the required capabilities are today in the development process and some significant steps have already been achieved mostly for space-based observations. There is, therefore, a distinct need for co-ordinated in-situ observations as part of the GMES infrastructures. To address the requirements of in-situ monitoring systems, OSIRIS focuses on the state of the art technologies for smart sensors. The objectives of this project are to develop the technologies and necessary software for smart sensors networks deployments and operations.

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2. OSIRIS general objectives

OSIRIS addresses the monitoring, preparation and response phases of environmental risk / crisis management (mostly concerning the prevention and monitoring, preparedness, alert and response phases of the following diagram). It aims to improve the capacity of the following organizations to manage these phases:

- Civil authorities,
- Civil protection,
- Entities operating networks.

![Diagram of OSIRIS In-Situ Monitoring Enhancement](https://example.com/diagram.png)

3. OSIRIS key aspects addressed

OSIRIS project addresses key aspects of in-situ systems, described hereafter.

3.1 Accessibility

The in-situ sensors community is today quite fragmented: there is usually no real link between the different users. The objective is therefore to enable the end-users to access various in-situ data in order to benefit from an overall service (which could be much more profitable for them). Accessibility will be achieved by an infrastructure framework linking any type of in-situ sensors.
3.2 Interoperability

In-situ sensors and systems must be complementary to and interoperable with space-based observation; indeed, these two types of earth and environment observation systems are not competitive but complementary (for example, for space-based data calibration).

In environmental risk/crisis management, the space-based observations have some limitations which can be overcome by in-situ observations:
- they can hardly see under the ground (to measure level of ground water for example),
- they cannot measure chemicals (for air pollution for example) or bacteriology,
- even if they ensure a revisit of the same place after a (not insignificant) amount of time, they can hardly be mobilized rapidly to respond to a crisis and cannot provide continuous monitoring of the crisis theatre (except from a geostationary orbit at low resolution).

On the other hand, in-situ observations which can overcome these limits also have to date a series of limitations:
- they lack efficient communication standards and capabilities and, thus, cannot provide real time data access,
- they lack sensors network deployment flexibility,
- they lack data and sensors-oriented services sharing and interoperability.

The in-situ sensors and systems must also be interoperable between them, in order to gear up the observation capacity.

3.3 Flexibility

This will be achieved by developing smart sensors networks based on:
- new technologies for sensors network deployment and organization strategies (automatic reconfiguration, scaling, etc.),
- data and sensors-oriented services sharing and interoperability.

As space-based observations are limited in quantity and not very flexible, a large number of in-situ sensors need to be deployed that are very flexible and versatile and therefore can complement space observations.

3.4 Autonomy

In-situ observations are organised in networks and its success relies on the capacity of this network to work autonomously, in a self organising manner. The purpose here is to build sensor networks that can change their configuration, notably when needs change. For example, when the situation changes from monitoring to crisis management, the characteristics of the observations required may change in quantity (increased sampling frequency, spatial distribution and measurement dynamics) and even in nature.

3.5 Standardization

OSIRIS addresses various types of sensors, which can deliver various types of information, such as vegetation analysis, soil measurements, telemetry, chemical and biological analyses of gases, liquids, solids, atmosphere, video, weather monitoring, etc. This information is basically heterogeneous (as it is required by totally different users).

In order to reach the best interoperability and flexibility, there is therefore a strong need to standardise the type of information that will be delivered (e.g. ancillary data, but also localisation and communication).
These overall objectives cover scientific and technological objectives:

- sensors network dynamic organization through space and time: the sensor network shall be adaptable in order to integrate new sensors, either to provide new information or to replace sensors that are no longer part of the system (failure, redeployment, etc.);
- sensors deployment and use strategies (hierarchical, focusing on a point when crisis, …): the project will describe the several possibilities of deploying a sensor network depending on the criteria that are chosen;
- data and sensors-oriented services sharing and interoperability;
- customisation of state-of-the-art or emerging sensors or network of sensors to fulfill the crisis management: evaluation of the added-value of new types of sensors, such as micro-sensors or wireless sensors;
- implementation of the sensor web: web service-based interoperability framework integrating geolocalised sensors into a Spatial Data Infrastructure;
- easy plug-in of sensors: implementation of an abstraction layer enabling each type of sensors to interface the sensor network.

4. OSIRIS description of work

Overall, OSIRIS will focus on enhancing the monitoring of risks leading to environmental crises such as natural hazards or industrial accidents (e.g., water pollution, urban air pollution, forest fires etc.) and the overall GMES value chain. More specifically the project has the following objectives to:

- Design and develop environmental sensor networks capable of evolving, in particular with the different phases of environmental risk/crisis management (mainly monitoring, preparation and response) and taking into account existing sensor or existing networks;
- Define strategies for sensor management, sensor deployment, sensor use, sensor cooperation;
- Enable the integration of those sensors or networks of sensors into a web services architecture, enabling an easy access and a wide share of information.

OSIRIS intends to support decision making processes by providing tailor-made information for different end-user organisations. The information provided is characterised as follows:

- on time, predictive, and proactive;
- inter-sectoral provided in order to allow joint actions co-ordinated by different public authorities,
- explanatory to the environmental damages with identification routines and impact assessments,
- comprehensive in addressing major policy issues and geographic areas of concern,
- scientifically credible based upon scientific evidence, accuracy, and robustness.

The next figure shows an innovative sensors network enabling architecture.
In order to fulfill the objectives mentioned above in a end-user driven environment, there will be a large survey of the common and specific needs, practices, etc, in various in-situ monitoring communities mainly focusing in three areas: water management, health city management, forest fires.

The project development is thus based on the following:

- end-user requirements survey leading to systems requirements (WP 2000),
- study of the various possible (and ad hoc) strategies for sensors deployment or sensor use (WP 3000),
- design and development of sensors networks with various sensors configurations: existing communications infrastructure or none, connection of stand-alone sensors, use of local wireless network sensors, etc (WP 4000, WP 5000),
- definition of the overall architecture enabling the integration of those sensors and allowing users to reach-out, access and use any sensor (WP 6000),
- demonstration via an experimental validation of the viability of an in-situ monitoring network (WP 7000),
- dissemination via a website, conference/workshop for professional dissemination, leaflet/demos for public dissemination, as well as a freely downloaded software allowing the connection of everybody’s own home weather station to a monitoring network (WP 8000).
5. OSIRIS Consortium

The OSIRIS consortium is coordinated by THALES Communications France. It is a comprehensive consortium with a well balanced set of representative end-users and Companies and Research Institutes for the coverage of technical developments as shown below:

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<th>Technical activities</th>
<th>Company/Institute</th>
<th>Country</th>
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<td>THALES Communications SA</td>
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<td>Germany</td>
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<td>APS GmbH</td>
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<td>Applications (end-users)</td>
<td>Réseau Euro-Méditerranéen d’Information et de l’Education à la gestion des risques</td>
<td>France</td>
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<td></td>
<td>Stadt Aachen (Firebrigade Aachen)</td>
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