

# An innovative real time environmental management system

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## Abstract

This paper describes the characteristics and capabilities of a real time, automated, environmental management service based on a “Digital Environmental Reporting” capability (DER) and designed to be compliant with the latest European environmental legislation and directives. The system supports easy adaptation to suit different national situations and cultures. We will briefly describe the functionality of the system, its technological structure, and the advantages it conveys, along with an application of the system that meets the 96/61/EC IPPC permit agreement. This system is based on technologies that close the Real Time gap that currently exists in the environmental information chain, by delivering fully up to date environmental information to all relevant stakeholders (e.g. the industrial sector, public environmental administrations and citizens) in formats suited to their individual information needs.

## Introduction

The Review of the 5th Environmental Programme noted that industrial companies are an important source of environmental pollution. It stressed that a number of environmental problems are still being caused and that small and medium-sized enterprises (SMEs) are a significant contributor. Emissions to air,

water and soil, non-efficient energy use and waste production are all highlighted as obvious problems.

The council directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control (IPPC) prescribed common rules on licensing of industrial installations to minimise pollution throughout the European Union [1]. All installations covered by the IPPC Directive are required to obtain an authorisation (permit) from the competent authority for their region. Without a permit, they are not allowed to operate. Detailed information on the percentage of total pollution originating from SMEs is very difficult for regional and national regulatory bodies and the relevant EU Commission services (DGs Environment & Enterprise) to acquire and collate, and yet it is an essential building block for effective policymaking with regard to SMEs and the environment.

Until now, the need for quantitative assessment of the environmental impact of SMEs has been severely hampered through lack of available and reliable up-to-date information. Through the use of the new digital system, which we describe, this will no longer be a concern, either in normal situations or in high-risk situations that trigger alarms.

This innovative new system is a “Digital Environmental Reporting” system (DER), amounting to nothing less than a real-time, automated, environmental management service. One of the main applications of the system enables compliance with the IPPC permit agreement, in a format in which all relevant stakeholders in the environmental impact chain conduct all phases of their ongoing inter-relationships instantaneously in real-time and electronically. This imparts instant and paperless ubiquity and immediacy to the environmental information chain, raising the vital role of environmental pollution control up to the kind of standards which other aspects of industry are expected to face today. The system can also work well with other national and international legislation and directives.

## **Operational aspects**

The Real Time Environmental Management System will provide built-in monitoring and reporting and, therefore, it will be possible to establish well-founded correlations between environmental improvements and the agreements that generate them, thus facilitating an atmosphere of continual improvement. It aims to deliver fully up to date environmental information to all relevant stakeholders, of which there are four levels, in real-time in formats suited to their needs:

- Industrial Sector (1st level of control: self-control);
- Technological institutes & Enterprise associations (2nd level: guardian control);
- Public administration (PA) (3rd Level: political control);
  - Environmental surveillance administration;

- Environmental funding administration;
- Citizens: (4th level: public environmental awareness).

The system can handle all the monitoring requirements, specified measurements, evaluation procedures, and also the SME's obligation to supply the competent authority with data required to check compliance with the environmental permit. The system is particularly suited to the prevention of emissions above acceptable levels. Thus, where there is a risk that this may occur (e.g. through leaks or malfunctions), the SME can be instantaneously alerted to take corrective action before the thresholds are exceeded. The competent authority can be informed of the monitoring results without delay and without risk of any incident or accident significantly affecting the environment.

The described system comprises a Real Time monitoring and alarm system, a data management system and a Digital Environmental Reporting unit.

For continuous monitoring, there is a direct synchronous contribution of information derived from measurement devices, which is updated without human intervention. This provides the most advanced and comprehensive, but also somewhat more expensive, system of collecting information and is not suitable for all kinds of pollution control (e.g. waste disposals). Manual monitoring and data-entry, which includes the indirect asynchronous contribution of information from manual stack sampling, portable equipment and data-loggers plus "factual human decisions" (by eco-auditors and operators), will still be an important component of the system in the IPPC context until devices become available for continuous monitoring, as the system will allow the results of this monitoring to be submitted on time. The Real Time Alerts System, with its four-level Real Time Information Warnings of actual contamination levels in industries, fosters all-round improvements. It raises environmental awareness, strengthening the ability of the public and civil society to contribute to future progress towards sustainable development.

However, in order to focus on the basic characteristics of the service we present here a single reference scenario:

First of all an agreement is signed for the use of the system by industry or the public authorities, specifying essential environmental parameters for measurement based on directives and legislation and non-essential parameters such as information that might be only sent to the industry itself and not the regulatory agency.

The next stage is the connection of a continuous data-logging and instrumentation pack, as well as communication mechanisms, at the industry site. Measurements can be taken directly of air, water, soil, chemical quality or other industrial factors and/or indirectly by linking into existing measurements of the industrial process. Industry will receive its own constant feedback of the data produced in the facility. The data, which will be provided to the system in raw format and/or processed format, will be collected and returned using a variety of leading-edge tools, as befits the situation in the industry (Web presentation as basic, but radio mechanisms for special situations, including alerts). Communications will flow from measurement using the special IP sensors

(indicators) [2] and will be displayed on Web, Wap and UMTS (also with SMS text and GPRS).

The information is also sent to the regulatory agency, with which a further agreement will be concluded. Ordinary regulatory personnel will process this data in a manner that makes it immediately amenable to use. These personnel will also have access to archived data, which will be presented in a form that allows trends to be readily ascertained and oncoming dangers detected. It will then be up to the agency to decide what action to take with the industry.

Aggregated data will be provided to the third category of stakeholder, which is the local administration of the region in which a group of co-operating SMEs reside. This will allow local staff to evaluate general environmental performance in the area and to use this as citizen's information – which can be widely published (e.g. used for tourism or other purposes). Furthermore, these administrations will be provided with relevant (pre-agreed) warnings and alerts to key personnel - in emergency services or elsewhere – so that regional protective measures can be undertaken immediately upon the occurrence of hazardous situations (figure 1).

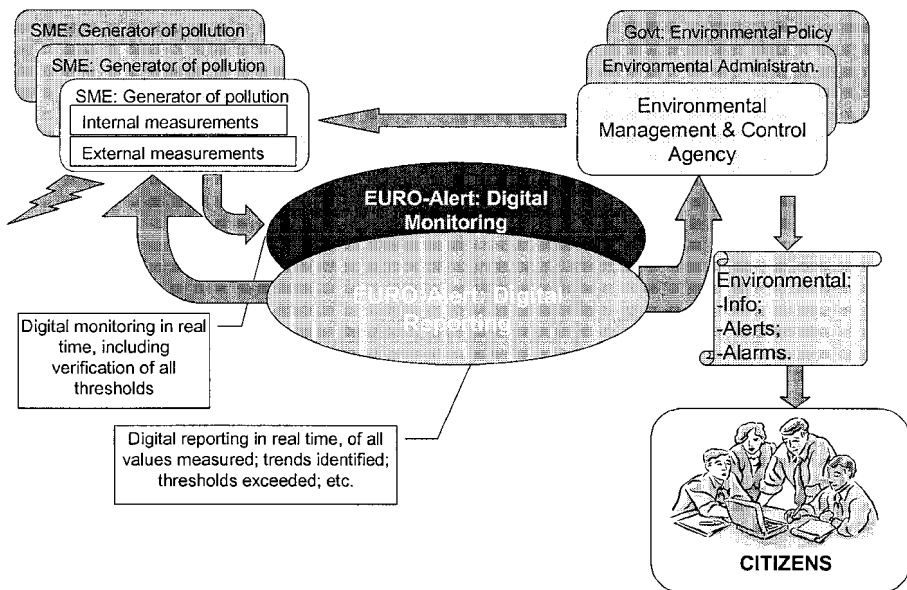


Figure 1: Overall architecture and relationships within the system

## Technology used

The detailed Real Time Environmental Management System, illustrated in more detail in figure 2, is both advanced and innovative and yet it is fully proven. It consists of:

- Special IP (Internet Protocol) sensors, which vary in the parameters they measure but use a common type of interface to the IP network. These do their work within the industry facility or (when necessary) externally, using land-link or mobile data contribution channels. They can even measure local rivers, lakes or air samples when this is necessary.
- A common database and data processing facility accepts and stores the information received and analyses it for trends, over-threshold alerts and extreme alarm situations. Use of XML and Java ensure interoperability across the many platforms that must co-operate with the system.
- The Data Pump Server then transmits the results to the various recipients, respecting various levels of authorisation, using standard web technologies with Real Time and other extensions/enhancements. The output will display using specially designed GUIs on a standard user web browser to which a small plug-in client is added.

Furthermore, depending on the user-selected profiles, certain data is also transmitted by radio mechanisms to individuals (e.g. remotely located individuals or those to be alerted in certain situations). WAP or other browsers will show the results in an optimal way.

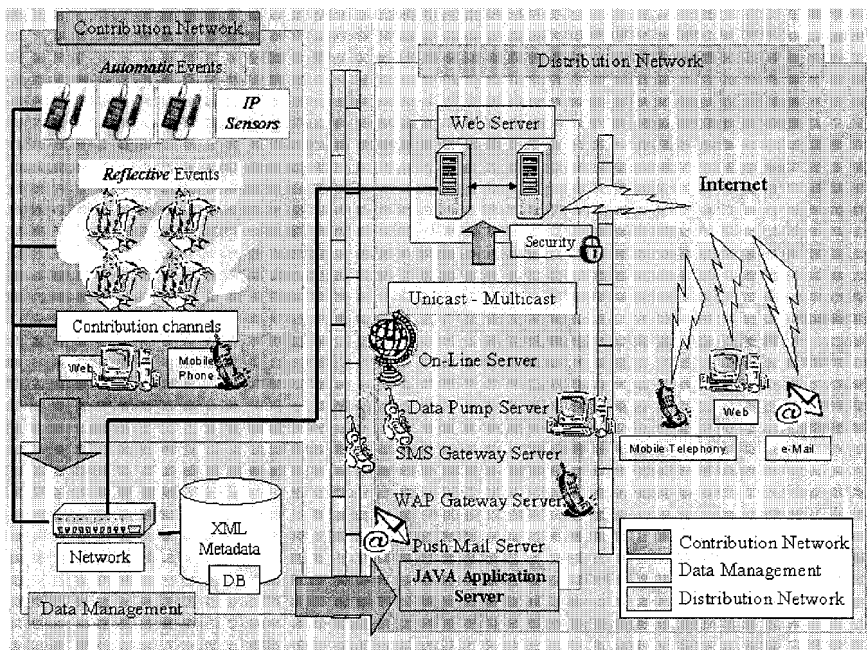


Figure 2: Technology structure of the system

The RT-EKN Servers © Framework is a multi-platform high-tech product, deployed for a broad range of available Internet servers and fully developed in pure Java. The main target of this innovative solution is to deliver Real Time data in an automatic and continuous flow instantaneously (IMMEDIACY) and to the appropriate place (UBIQUITY) using any available Internet channel.

It is a Data Event Driven (DED) Internet System Framework, founded on IP Internet Protocol, for transferring real-time data from one side of an IP Network to another, taking advantage of secure and controlled unicast connections and multicast “open” approaches.

The model can also be deployed as an ASP (Application Service Provision) service (i.e. the application is rented - usually on a monthly-based fee). In this case no investment in infrastructure is required, there is no need for in-house expertise and there is rapid deployment. This ASP model can facilitate SMEs, providing a non-traumatic implementation of environmental directives.

## **The challenging aspect**

For regulatory agencies, the regulatory process includes all activities that are covered directly or indirectly by the legislation. This means:

- promotion of voluntary compliance by providing information and supervision;
- measuring the degree of compliance, by controls and inspections;
- consulting further and threatening sanctions if situations of non-compliance occur;
- ensuring compliance by using sanctions under criminal and/or civil law.

It is therefore a challenging aspect of compliance and enforcement programmes to develop strategies to make the most effective use of (often limited) resources available to inspectorates. This system is a service product with a goal to expand the use of compliance audits and environmental management systems and thereby improve protection of the environment, increase public understanding of a company's environmental performance, and achieve more efficient use of public and private resources. Regulatory agencies throughout Europe need a tool like it to minimise the big economic and organisational impact on them involved in implementation of the IPPC Directive - and the new directives, which will emerge. It will be demanded by users because it is a tool that can help them to greatly mitigate the administrations lack of human and economic resources to carry out the titanic task of getting small companies (90% of total in Spain) to comply with the environmental directives.

The system should present no compatibility problems with existing IT systems because its technology consists of generic building blocks and open platforms and it is ready for the adoption of open source software for distributed

systems and for embedded systems. It can continue to improve the effectiveness of environmental data usage, strengthen regulatory agencies' capacity to use information effectively to manage environmental programmes, and enhance public access to essential information for decisions about health and the environment. The data, processed differently in each case, will also be supplied to the responsible regulatory agency and the local administration, giving them instant access to up-to-the-moment complete records of the environmental performance of each participating SME, regardless of the location of the agency/administration (or even of the individual officer concerned). The regulatory agency will be able to interact with the SME, via this system or directly, if any immediate parameters or longer-term trends need a reaction. Emergency messages will also be sent to selected individuals when necessary (extreme results or certain pre-programmed situations). This is especially important for out-of-hours situations. Finally, a set of data can be offered to administrations, showing aggregated data for whole areas or sectors, suitable for presentation to the public (e.g. via Web/WAP/TV-Text, etc.). This will also make use of measurements from public facilities, if required. An example would be the collection of data from water reservoirs, lakes or rivers that might be subject to industrial pollution, aggregated data from SMEs, and/or the collection of air quality measurements in industrial regions.

### **Socio-economic effects**

The described system can provide significant and directly measurable environmental benefits to the regions in which its services are implemented. These benefits can affect a range of people/organisations at various levels in a way that is disproportionately beneficial compared to the costs involved. The following table describes this:

Table 1: Socio-economic effects

<b>Benefit</b>	<b>Target</b>	<b>Explanation</b>	<b>Comment</b>
Instantaneous and ubiquitous information on environmental performance, using selected key parameters. Data is pre-processed so the target readily understands Information	Regulatory agencies	All essential parameters plus some voluntary ones are measured. Failures are instantly detected.	Parameters decided by regulatory bodies. Participating SMEs in the region are monitored.
Reduced wastage	Participating SMEs	Unusual / over-threshold values are reported to SMEs (and to agencies) as they occur. They can be corrected by the SME.	This could mean pollution is occurring or simply that there is excess usage of materials.
Reduced monitoring visits	Regulatory agencies & SMEs	As all key data is available to the agencies, there is little need for visits.	—
Alarms, alerts and emergencies handled ultra effectively	Administrations and emergency services	Hazardous situations instantly shown by processed data. Alerts are flashed to all relevant personnel	SMS text, WAP, basic web, and GSM (GPRS or UMTS) voicemail, as required.
Regional environmental status constantly available in real time	Citizens (via administrations)	Aggregated data passed to administrations is shown on web sites in real time – but including trends.	Water and air quality can be monitored for regions as well as directly for SMEs.
Contribution to EU-US environmental agencies work	European Environment Agency (EEA)	See below*	Affects harmonisation of information access

\* The system contribute to the Programme “Towards Distributed Data Sharing: a cooperation effort of the European Environment Agency (EEA) and the U.S. Environmental Protection Agency (EPA)” [3]. There is broad motivation for this cooperation in facilitating access to environmental information. The international political environment is quickly forcing public sector regional and national environmental institutions to integrate their ideas, approaches, data archives, and strategic visions. The Kyoto Conference in December 1997 on



global climate change launched a debate over terms, vocabulary, language, and syntax as well as interfaces with a common language.

## Conclusions

This system is based on technologies that close the Real Time gap that currently exists in the environmental information chain, by delivering fully up to date environmental information to all relevant stakeholders (e.g. the industrial sector, public environmental administrations and citizens) in formats suited to their individual information needs. The described system supports a real time, automated, environmental management services based on a "Digital Environmental Reporting" capability (DER) and designed to be compliant with the latest European environmental legislation and directives. It is suitable for use in a vast array of industrial situations and, with modification, even outside the industrial sphere. It is applicable to industries, especially heavy industry, in all parts of the European Union but will be especially useful in Mediterranean or Eastern countries where strict enforcement of standards has not been so commonplace as in Northern European countries.

## Acknowledgements

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## References

- [1] European Commission, *The IPPC Directive*, Pollution from industrial installations, last updated 30/08/01, <http://europa.eu.int/comm/environment/ippc/>
- [2] Panorama of the European Union, Environment & Energy, *Environmental pressure indicators for the EU*, 2001
- [3] EPD and EEA, The National Environmental Information Network, an integrated information system, [http://nfp-gr.eionet.eu.int/epd\\_eop\\_en/edpp\\_en/edpp\\_en.html](http://nfp-gr.eionet.eu.int/epd_eop_en/edpp_en/edpp_en.html)
- [4] EURO-Alert Consortium, The EURO-Alert project, official Web site, <http://www.idieikon.com/euroalert/>