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E2SP. The business case of an Environmental Information System in ASP mode.

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Abstract: According to PSR (OECD) and DPSIR (EEA) models, environmental agencies are in charge of measuring the State and Pressure and evaluate the Impact in order to define the most suitable Responses; this implies data analysis and reporting activities, as one of their core responsibilities. Environmental Information Systems support these activities by combining the advantages of first-rate consolidated technology (such as Business Intelligence and Data Warehouses) to specific technical architectures tailored to environmental management tasks. E2SP (Environmental Enterprise Service Provider) is a online reporting and forecasting platform, providing a cost effective, Internet based Environmental Information System and Decision Support System in ASP (Application Service Provider) mode. Tasks such as data integration, data analysis through OLAP, impact analysis and forecasts through mathematical models, emission inventories, indices/indicators calculation, reporting, are supplied in an integrated environment as on line services to public authorities and private industries. E2SP project, funded by the eTEN program of the European Commission, allowed to develop a as the business case study, described in this paper, to verify the viability of the ASP approach to Environmental Information System (EIS) in a trans-national context, starting from the air quality theme.

Keywords: Environmental Information Systems; Application Service Provider; data analysis; forecasts.

1. INTRODUCTION

An ASP is a third-party entity that manages and distributes software-based services and solutions to customers across a wide area network from central data centres and it is a way for companies to outsource their information technology needs. E2SP is a Value Added, Vertical Market ASP, providing services to environmental actors both in terms of Information technology and domain related applications. Target users are the Environmental Agencies and other public bodies engaged in environmental governance, chemical and petrochemical industry, educational and research centres, private firms acting in the environmental assessment sector. E2SP provides them online services for environmental management, through two pilot service centres running since July 2005 in Italy and Poland.

While ASP success relies in affordable services with a 1:10 typical cost ratio with respect to system implementation by the users (no need for infrastructure, no maintenance costs, only a periodic fee), as underlined by the existing business literature, this is only partly true in environmental domain, in particular when approaching "core business areas". TCO (Total Cost of Owneship) and data integration are not attractive enough to ensure a successful services deployment. Situation is much more complex and several critical factors have to be faced. First, how to transfer to customers the vision of ASP strategic benefits: Public Administrations managers are intrigued by, but confused about the ASP business model and its potential to bring greater efficiencies to government information processing. This paper describes how the ASP approach to EISs deployment has been developed by the authors, which services have been implemented and supplied, which have been the technical and not technical challenges, which are the achievements and the still open points.

2. THE BUSINESS MODEL.

E2SP relies on a "Basic Hosting" model. Environmental applications run on the Service

Centre ASP's infrastructure, and services are delivered to clients via the Internet. The E2SP Service Centres remotely host and deliver a packaged applications to the client from an off-site, centralized location. The client does not claim ownership of the applications but instead "rents" them. Environmental data are only hosted by the ASP, but they are owned by the data supplier.

The service foresees the rent of a virtual space and data processing applications on the sharing server which remains of Service Provider's property. In this case the customers pay for the use of the platform and of the packaged applications, developed by the provider that, consequently, is also a domain expertise. The customers pay a periodic licence fee, increased with the cost of the service management (ASP licence fee) but they save themselves the expense of the HW products, SW developments and maintenance.

3. THE APPROACH AND THE ARCHITECTURE.

3.1 From the prototype to service deployment: a complex approach.

E2SP started in 2001 as a research prototype, further developed in 2002-2004 in Apulia region (Italy) as the core part of an industrial accident early warning system. This experience validated the integration between models and monitoring networks, while the ASP business model in the environmental field was still to be exploited. There was the need to run a validation phase with Environmental Agencies, in order to understand how to give them the right vision about the ASP strategic benefits, added to the pure reduction of the TCO (Seltsikas [2002]). The shared experience under the institutional umbrella of the eTEN program of the European Commission, created the needed cooperation frame between institutions, scientific world, industries and business consultants, otherwise difficult to build. Figure 1 summarises E2SP path to deployment. The E2SP project, a trans-national market validation phase, started in March 2005, with the objective to validate the ASP approach to EIS and to start the pilot deployment of on-line environmental services.

Market validation approach was based on:

- inputs from Public and Private Users, essential in order to validate both market assumptions and services;
- inputs from *data* providers, *to* define the feasibility of the proposed business model towards this community;
- inputs from peer reviewers, to validate E2SP business and services model in a wider context.

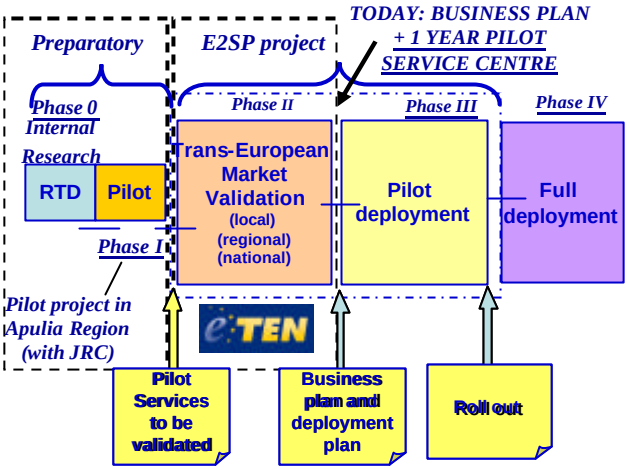

Figure 1. The business case story.

Institutional participation is a crucial point, because Public Administration have a moderate attitude to changes, in particular if changes are industry driven.

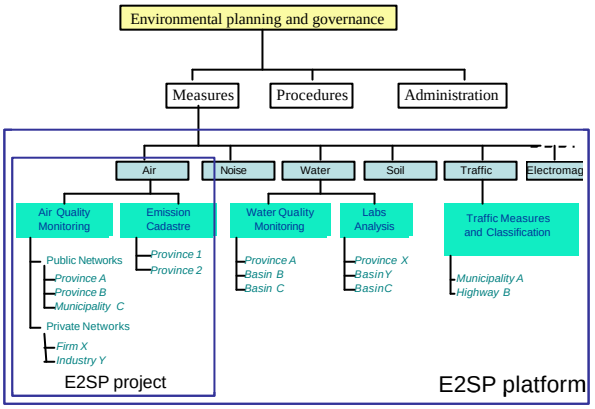

Figure 2. The application areas

E2SP project focused on air quality as the case study, and involved partners representing a relevant "panel" of environmental operators:

- Environmental Agencies: Regional Inspectorate of Upper Silesia, WIOS (Poland), Municipality of Bari (Italy);
- research and educational: University of Bari, (Italy), the Polish Academy of Science, IPIS-PAN (Poland);
- industrial partners: Project Automation (Italy), ESAPROJEKT (Poland), Aria Technologies (France);

- business partners: Sineura (Italy), GL2006 (UK).

clustered in working groups: the users, composed by the institutional users and the scientific advisors (one group in Italy, one in Poland) and supported by the service provider; the business group, composed by the industries and the business consultants, with the objective to define the business and deployment plan; the service providers technical group.

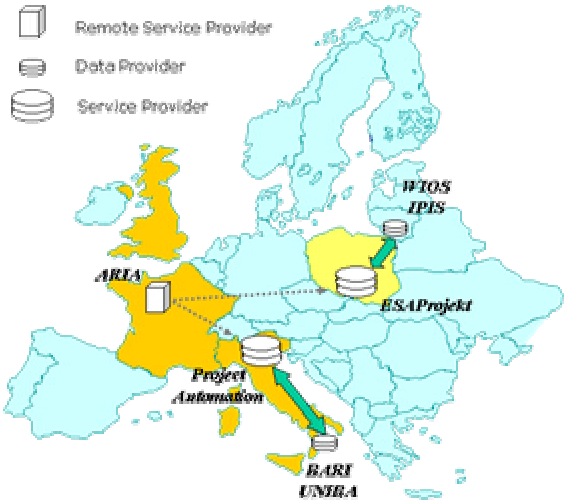

Figure 3. The partners and the service centres.

Users groups performed service evaluation, providing feedbacks for their refinement; the technical group analysed the technical elements (bandwidth, data transfer, data storage, demand for processing resources) connected to service delivery. These activities supplied the guidelines for infrastructure dimensioning and scalability parameters. Forecasts, running since September 2005, have been chosen according to the environmental most critical issues of each site:

- **Bari.** It is a sunny area, delimited by the Adriatic sea coast, with traffic pollution, production of secondary pollutants, and limited industrial settlements. O_3, NO_2, CO, PM_{10}, wind fields and temperatures, forecasts are supplied on daily basis.
- **Upper Silesia agglomeration**. It has one of the highest industrial settlements density in Europe, with a relevant number of industrial point sources emissions. SO_2 and NO_x deposition forecasts due to point sources, wind fields and temperatures, are daily supplied.

3. 2 The services architecture.

Two service centres (figure 3) have been started in July 2005, one in Italy, the second in Poland, and a remote "back office" modelling service centre has been started in France. The pilot service centres offer Internet-based user interfaces (figure 4) for:

- Configurable query & reporting.
- Air quality, traffic and noise data analysis and validation.
- Data export in XML format.
- Modelling, meteorological and air pollution forecasts.
- Geo-referenced and thematic representation.
- Environmental portal.

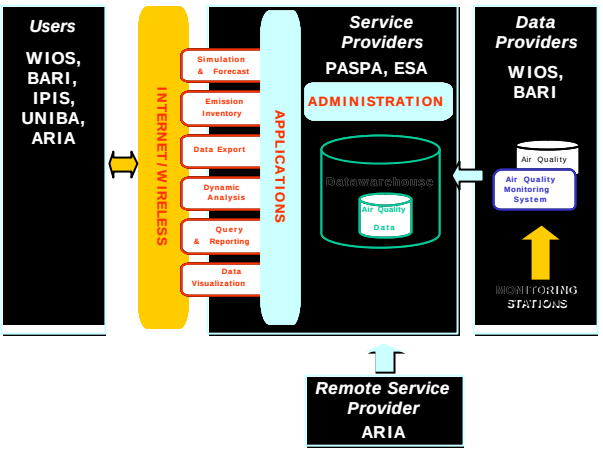

Figure 4. The services architecture

Through ETL (Extract, Transform and Load) procedures, data from Bari and Upper Silesia air pollution monitoring networks and laboratories are extracted and stored on daily basis in the service centres datawarehouses and made available for online data analysis. Collected data are typically hourly average values. These data are sent in XML format to the remote service provider in Paris (Aria), that uses them with meteorological inputs from MM5 model, to generate pollution and deposition forecasts for the next 48 hours, through dispersion models (CHIMERE, SPRAY, FARM). Simulation results are sent to E2SP systems via Internet, and integrated in their datawarehouses and presentation layers. The environmental operators remotely access E2SP portal and related environmental decision support functions via Internet, using a common modem/ADSL data connection.

4. THE SERVICES.

4.1. Air quality online reporting and data analysis.

Reporting and data analysis services on collected data (Cislaghi et al. [2005]), including the virtual sensors from the models, are based on Business Intelligence applications on top of thematic datamarts. They are accessible via Internet through the online OLAP (On Line Analytical Processing) module, capable to supply tools for fulfilling the legislative frameworks and to perform advanced environmental data analyses for:

- creation new combinations of environmental indicators and indices, according to various space-time aggregation criteria,
- investigation data according to "free" and personalized analytical paths,
- dynamically view, build and consult reports in graphic and/or table format.

The OLAP module generates "standard" reports, required by the regulations, and "ad hoc" reports created according to users' specific needs, with simple drag and drop operations. There is no need for programming, only environmental expertise is needed, and the standard and customised analysis are stored in the ASP systems.

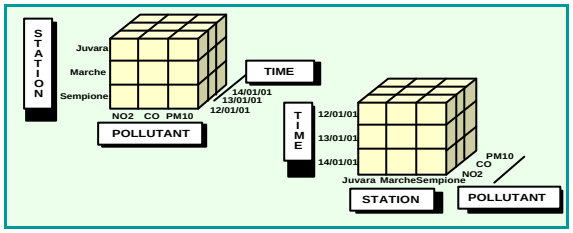

Figure 5. Multidimensional data analysis

Compared with usual reporting tools, E2SP-OLAP supports the capability of viewing data according to analytical paths which may follow different aggregation criteria (geography, time, type of pollutant, name of monitoring station etc.). The user can choose free analytical paths by changing the analysis dimension at every step (for example, starting from geographical aggregations and after focusing on time dimension etc.).
The module supports dynamic exploration of the information through "drill down" and "roll up" capabilities, that support fast data aggregations and disaggregations. By intuitively interacting with report objects (tables, graphs, etc.), it is possible to perform detailed analysis or new groupings and correlations, such as analytical "zooms" to display detailed data (e.g. average monthly or daily concentration of a pollutant) starting from extremely synthetic data (e.g. average yearly concentration).

4. 2 Online forecasts.

E2SP provides model services (De Gennaro [2006], C.Derognat et al. [2005]) for:

- evaluation of traffic pollutants concentration (CO, PM, benzene) in urban areas;
- evaluation of photochemical pollution on relatively wide areas;
- evaluation of pollutant concentrations due to industrial settlements or large combustion plants such as energy production plants and incinerators (area and point sources).

Figure 6. The integrated user interface.

The models chain runs in Paris. The simulation results include daily supply of 48 hours meteo and pollution forecasts, with 2D/3D graphic presentations, time series, altitude profiles, virtual sensors and scenarios. They are available to users within 7 a.m. and, consequently, data collection from E2SP datawarehouses takes place during night time. The results are available at E2SP portal at 4 a.m., thanks to an accurate dimensioning of data acquisition and processing times. The data transferred to E2SP systems are about 30 Mbytes and data exchange is ftp based. The steps performed to produce daily forecasts are:

- reception of global scale meteorological forecasts (NCEP);
- reception of air pollution and meteorology data from the E2SP servers;
- daily operation of a refined regional scale weather forecast for the sites in Italy and Poland, based on the MM5 model;
- daily forecasts, based on the CHIMERE, SPRAY and FARM dispersion models;
- Transfer via ftp to the E2SP servers of tabular and graphical results.

Evaluations are performed considering the emission scenario supplied by the users (point source cadastre, regional scale emission inventory with CORINAIR methodology). The system uses DTM territorial data and land-use data. The MM5 meteorological model drives different dispersion models: the multi-scale chemistry-transport models CHIMERE (Derognat et al. [2005]) and FARM (Silibello [2003]) gridded Eulerian model, and the Lagrangian Particle model SPRAY. The CHIMERE dispersion model runs over the three nested following domains:

- Large Scale domain (LaS_EU);
- Poland Regional Scale domain (RS_PL);
- Italian Regional Scale domain (RS_IT).

The Large Scale domain takes into account, over the two regional areas, of European emissions and main continental meteorological features (e.g. West to East main flow, etc.), while the two regional scale domains (RS_PL/RS_IT, 600x600 Km) take into account the recirculation of air masses (e.g. link to the sea/land breezes) and the ratio of 3 between large and regional MM5 nested grids. FARM and SPRAY models run on the target Local Scale domain that cover an area of 150x150 km^2 centred on the target city of Bari (LcS_BA) and Katowice (LcS_KA). CHIMERE and MM5 runs over the Regional Scale domains (RS_xx) are used to provide to local scale domains, initial/boundary conditions and meteorological fields (wind, temperature, humidity, pressure, precipitation, clouds data). SURFPRO micrometeorological postprocessor derives, from MM5 2D/3D fields, further information needed by FARM (horizontal/vertical diffusivities, dry deposition velocities, etc.).

4.3. Traffic and noise online reporting and data analysis.

Monitoring networks may include a number of traffic and noise measurements. Traffic parameters are geo-localised traffic flows (vehicle countings, classification, vehicle average speeds, lanes occupancy) and noise measures (LEQ, LNA). These data, normalised to hourly data by the ETL procedures, can be processed through the online OLAP module, so allowing cross-theme analysis with air quality and emissions.

5. FUNCTIONAL AND NON FUNCTIONAL REQUIREMENTS.

Data security and privacy, accessibility, useability, interoperability are key issues of e-Government guidelines, that complement the environmental regulations with non-functional requirements (Larsen [2004]). E2SP "business group" developed a qualitative reticular model (figure 7) in order to assess the positioning on the market vs. users' requirements and potential competitors. This model was used in developing the service catalogue and defining the Service Level Agreements (SLA)., the "core part" of an ASP contract.

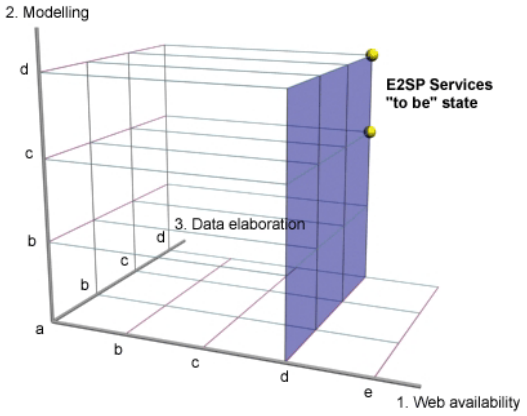

Figure 7. Environmental services positioning model.

The 3D model represents the real value added of environmental ASP services, with the following metrics:

- SLA as Web availability (from no web interface, up to high security, full support for interoperability, high availability "24x7").
- Data elaboration (from standard Reporting to User configurable Data Analysis).
- Models (no models, simple Gaussian, up to a full set of models).

Guidelines from ISO27001, EEA and National Agencies have been used to define the qualitative scale on the axis. Very high availability (>99,99%, 24x7) brings to unsustainable service costs.

Table 1. Availability and data security.

Needs	Solutions
Identification and authentication	Identity management
	Strong authentication
Max data protection	*Sensitive data cryptography*
	Accesses accountability
Authorisation and access control	Physical access control
	Three tier architecture
	Firewall
	User and group management
Confidentiality	Secure communication
	Cryptography
Integrity	*Cryptography and digital signature*
	Antivirus policies
	Backup policies
Accountability	Log mechanism
Availability and dependability of services	Systems in Cluster configuration
	Three tier architecture
Continuity and fault tolerance	Data distribution on Raid disks
	Disaster recovery

An availability adapted to prevailing user demand (average 98,5%, peak 99,5%), joint with the data security operations (table 1) compliant with ISO 27001:2005, is the basis for a viable environmental ASP model. Service centres architecture has been accordingly defined: three tiers levels architecture, with Quad-processors Intel DB and application servers in cluster, Storage Area Network, web servers with Network Load Balance and broadband connection with Internet provider.

SLA must cover system technical availability and:

- Operational availability of services through local support via call centre.
- Time to recover in case of ETL procedure failure on remote data source. This introduces the need for a technical assistance network.
- Activation time for new and extended services.
- Time to compliance with new European and National regulations.

On the functional point of view, E2SP showed that:

- Integration between monitoring networks and widely accepted models (such as MM5, CHIMERE, FARM, SPRAY) is a key point.
- Monitoring networks are "living" infrastructures; instruments and stations are added, moved and removed, campaigns are performed. ASP provider must dynamically follow networks evolution.
- Data analysis must be cross-thematic.
- Services have to be gradually extended to water, noise, traffic.

6. CONCLUSIONS

An EIS in ASP mode must supply high quality, cost effective services, fully compliant with environmental regulations and e-Government guidelines, starting from a joint initiative between Institutions and industries. Customers will evaluate Environmental ASP on the basis of their partnerships with the key players; the provided SLA; the range and the quality of the web enabled applications; and their financial soundness. Cost reduction is just one challenge. The service centres must offer support for interoperability, multi-lingual interfaces, data security. Moreover, high quality contents and cross-theme elaboration capability, domain expertise, customer support, must be available. The offered services must integrate simulations and monitoring networks, be modular, complementary to already running software at customer premises (ERP software, models, etc.), and capable to integrate software from different ISVs (Independent Software Vendors), in particular models. Datawarehouse organisation into datamarts (such as air, traffic, noise) and the consequent possibility to offer scalable service packages is a starting point to reach high end customers (regions, large agencies, large industries), middle and low end market. Services must target the full range of environmental actors, and be deployed in a trans-national context, in order to reach the critical mass needed for their economical viability.

7. ACKNOWLEDGEMENTS

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