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## **ENERGY SBA**

**Participation in the development of the scenario and  
provision of persistent operational services**

**in the**

**GEOSS Architecture Implementation Pilot – Phase 3  
(AIP-3)**

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## Mines ParisTech Response to the GEOSS AIP-3 CFP

### 1 Overview

This scenario intends to provide information on the environmental impact of the production, transportation and use of energy. The production and the use of energy are major contributors to Greenhouse Gases (GHG). Decision makers and policy planners need a better knowledge of the impacts on environment induced by the various technologies used for energy production, in order to select the most appropriate technologies. The scenario focuses on the assessment of such impacts by a proper exploitation of data available within GEOSS. This scenario will benefit from existing resources deployed within the AIP-2 pilot project. This is specially the case for energy related resources such as solar energy that have made available within AIP-2. One major outcome of this scenario will access to databases related to technologies and emissions for a given energy sector. Several energy domains are considered within this scenario such as solar, wind, biomass, fossil fuel and consequently the addition of environmental impact assessment parameters is of crucial importance.

This scenario is fully aligned with the Energy Societal Benefit Area. According to the horizontal nature of environmental impact assessment other SBA's such as Water, Biodiversity, Agriculture should benefit from access to such resources.

This scenario will benefit from two ongoing FP7 European projects: ENERGEIO and GENESIS. The consortiums of both projects agree to provide the GEOSS AIP-3 Pilot project with resources that will be part of their own achievements.

**ENERGEO** main objective is to develop a strategy for a global assessment of the current and future impact of the exploitation of energy resources on the environment and ecosystems and to demonstrate this strategy for a variety of energy resources worldwide.

Importantly, the EnerGEO project takes the testing and demonstration of the observing system and developed scenarios through the execution of dedicated pilots at heart. These pilots are focused on the most important issues at hand relating to atmospheric composition and land degradation through the use of **fossil fuels**, future impacts of the use and production of **biomass** on land ecosystems and food security, sustainable integration of **solar energy** in current grids as well as the visual impact of large arrays of solar systems and relating to the impact of **wind energy** on marine ecosystems.

A distributed system based developed on the recommendations of the GEO-Architecture and Data Committee (ADC), global collection and dissemination of data relating to the effect of energy use on the environment will be supported.

In the AIP-3 framework it is expected that resources related to solar energy, wind, biomass and fossil fuel as well as environmental parameters coming from ENERGEIO partners would be made available in a GEOSS compliant standard for the benefit of GEO.

## GENESIS

The **GENESIS** project has the objective of providing those involved in environment management and health services in Europe with an **efficient, web-based solution** for monitoring air quality, fresh and coastal water quality and their impacts on health. The advanced, ICT-based solution that will result from this research and development will combine open, **collaborative information networks** while integrating systems that already exist in Europe. Moreover, this solution will be generic, i.e. it will not only cover the thematic field covered in the project but can serve a **wide range of environment-related scenarios**. More information is available at: <http://genesis-fp7.eu/>.

There are already inside the GENESIS project a few validation pilots on Air Quality and Fresh Water Quality thematic domains. It is planned here that the GENESIS project supports the AIP-3 proposed pilot by providing the standard technology allowing to access and orchestrate the various Web services required by the pilot.

## 2 Proposed Contributions

The commitment of proposer and of the ENERGEO and GENESIS FP7 projects enables several possible contributions for the Energy community and for GEOSS as a whole.

Within the ENERGEO project it is planned to provide datasets in a GEOSS standard compatible format. Such datasets include Biomass, Wind, Fossil Fuel and Solar energy. The initial proposal describes solar energy photovoltaic scenario. Other energy-related datasets and scenarios coping with GEOSS recommendations coming from ENERGEO partners might be provided within the AIP-3 time frame.

In a similar way, efforts will be made towards providers of datasets such as IEA, NASA, DLR and meteorological offices so that they contribute to the registration of components and services. Several partners from the now-completed EC-project INTAMAP ([www.intamap.org](http://www.intamap.org)) agreed to contribute to the initial scenario by their expertise in interoperability of datasets and description of uncertainties (UncertML).

### **The environmental impact assessment of the photovoltaic sector scenario.**

As photovoltaic sector development is extensively growing, environmental concerns according to technologies and systems are not yet well assessed. Expert needs to provide answers to various questions like:

Regarding environmental impacts, what is the most favorable material for photovoltaic panel construction? What are the overall environmental performances of PV systems? What is the carbon footprint of a PV system according to its lifecycle?

Being able to assess scientific, technical parameters will allow to characterize the environmental impact of the photovoltaic sector.

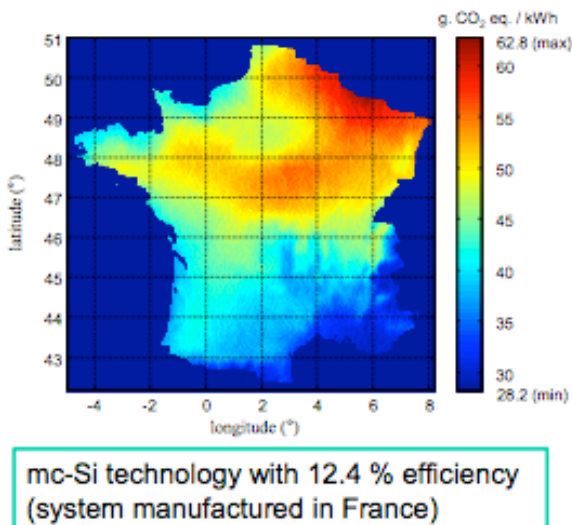
The assessment of the carbon footprint of a PV system according to its lifecycle implies to deal with various data sets that perfectly fit into the GEOSS interoperable approach:

- Solar radiation (kWh/m<sup>2</sup>) is a key parameter with a significant impact of PV electricity production

- Geo-localization (lat. long. or Area Of Interest AOI) where such PV systems will be installed is consequently of major importance.
- The type of material and technology of the PV system (a-si, multi-Si, mono-Si)
- The total primary energy that has been needed for the PV system construction depending on the electricity mix used for its production

As a final result a map of carbon footprint according to PV life-cycle assessment will be produced. An example of a recent study performed for the French territory (ESPACE Project <http://www.espace-pv.eu/resultats.html>) illustrates this scenario.

### Carbon footprint of mc-Si PV installation electricity over France



### Observations

- **High variation of carbon footprint with the level of irradiation over France**
- **Valid trend for any technology**

**Figure 1 Example map of carbon footprint selection**

The functionality to generate such maps will be made available from a Web Portal that via a workflow engine steers specific processing services hereby instantiating the GEOSS interoperability approach of chaining and combining distributed Web Services having access to the required data sets.

According to the description made in the section 1.1.1.2.1 of the AIP-3 CFP, actors have been identified in the solar energy scenario.

- **Community Resource Providers:** for the energy scenario they include data providers in energy and environmental impact assessment. They will provide the raw or transformed Earth observation components (data, metadata, catalogue, model, services, tools...) in a GEOSS interoperable compliant form for the realization of the scenario. Mines ParisTech will provide access to solar energy datasets. Ecoinvent will provide access to environmental impact assessment parameters for the photovoltaic sector. The GENESIS consortium will help the community resource providers to set-up proper catalogue and metadata for enabling GEOSS compatible search & discovery

- **GEOSS Integrators:** The scenario aims at providing value-added indicators of the environmental impact of the use of energy by combining the distributed needed resources coming from GEOSS members. Based on the use of the GCI and Community Resources, the GEOSS Integrators will develop and deploy persistent application needed to achieve the scenario goals. Within the GENESIS consortium, Thales will coordinates the development of rich clients for geo visualization and data retrieval
- **GEOSS Users:** from high end-users like **policy planners**, who need synthetic assessment and report, **energy operators**, who conduct top level studies and **installers of renewable energy systems**, for large dissemination activities, the scenario will tackle a wide range of different users and needs. Dissemination through a large set of users will be eased by strong connection of ENERGEO members and Mines ParisTech to the Energy community. Various networks, consortium, project, associations, groups of interest will be aware of the AIP-3 Energy scenario achievements. This include of course the GEOSS Energy Community of Practice, International Energy Agency members, ...

## **2.1 Societal Benefit Area Alignment and Support**

The overall scenario is directly linked to the Energy SBA. It fully contributes to the Energy GEO 2009-2011 Work Plan goals and to the GEOSS 10-Years Implementation Plan that declares: “GEOSS outcomes in the energy area will support: environmentally responsible and equitable energy management; better matching of energy supply and demand; reduction of risks to energy infrastructure; more accurate inventories of greenhouse gases and pollutants; and a better understanding of renewable energy potential.”

The specific environmental impact assessment of the photovoltaic sector scenario directly addresses the Task Number: EN-07-02-Energy Environmental Impact Monitoring. This task objective is defined as follow: “Promote the development of Earth observation systems for the monitoring and prediction of environmental impact from energy resource exploration, extraction, transportation and/or exploitation. Build upon the contribution of the European project EnerGEO (Earth observation for monitoring and assessment of the environmental impact of energy use).”

The scenario objectives are also empowering the contribution made in the GEO Task Number: EN-07-01-Management of Energy Sources, where the key contributions to the management of energy sources include have been on the one hand development of a prototype web portal (<http://project.mesor.org>) and a GEOSS Community Portal ([www.webservice-energy.org](http://www.webservice-energy.org)) to assess different surface solar irradiance databases and on the other hand the publication of a study on solar energy resource assessment using remote sensing as a basis for investment decisions. The Energy scenario response will enrich the existing web services already deployed on the energy Community Portal in the following manner. New Web Services will be provided in the field of environmental impact assessment. Existing Web Services will be analyzed in order to evaluate potential enhancement towards data quality and IPR (Intellectual Property Rights) management.

As a whole the expected achievements of the AIP-3 Energy scenario will enhance the assets of the Energy policy planners and therefore copes with the Task Number: EN-07-0-Energy Policy Planning, which has benefits from the Energy AIP-2 scenario outcomes. In this AIP-2 scenario, a service for siting solar plants was developed. This service helps foster the use of Earth observations for informed energy-policy planning in developing and developed countries.

## 2.2 Component and Service Contributions

The AIP-3 “environmental impact assessment of the photovoltaic sector” scenario will contribute several components and services. The contribution of components and services varies according to the role of each actor as defined above. It will follow the GEOSS Transverse Technology Use Cases that have been defined in the GEOSS AIP-2 final engineering report shown below.



Figure 1

Figure 2 GEOSS Transverse Technology Use Cases

### Community or GEOSS Resource Provider:

Mines ParisTech will provide OGC compliant Web Services enabling access to solar radiation parameters. This includes a world coverage dataset of monthly means of solar

irradiance coming from data fusion techniques applied to satellite data, meteorological re-analyses from NCEP /NCAR (USA) and orography for the period 1990-2004.

OGC WMS (Web Map Services) and OGC WPS (Web Processing Services) will be made available to achieve the scenario goals. Those resources will be deployed on the existing Energy Community Portal [www.webservice-energy.org](http://www.webservice-energy.org). Web Services will be registered in the GEOSS registry for harvesting purpose by GEOSS crawlers. This will enable GEOSS search & discovery mechanism by the GEOSS users through GEOSS portal. It is not yet defined which standard will be used in order to provide metadata and catalogue components. Mines ParisTech successfully implement the approach of INSPIRE ISO 19119 Metadata and the WAF (Web Accessible Folder) in the AIP-2. The other possibility of having a dedicated or hosted OGC compliant CSW (Catalogue Service Web) will be investigated during the AIP-3 time frame.

Ecoinvent with the help of Mines ParisTech will provide OGC compliant Web Services enabling access to environmental parameters for the photovoltaic sectors. The deployment, registration, metadata and catalogue actions will be similar to Mines ParisTech approach.

An effort will be made on the metadata describing the quantities specific to energy. As much as possible, existing metadata will be used. Of particular interest, are those related to IPR (Intellectual Property Rights) and uncertainties/quality. Various data providers and data users will be solicited in order to assess the performance of such description for both categories of stakeholders.

### **GEOSS Integrators:**

Beside each granular Web Service made available by GEOSS resource providers, the added value of the scenario is achieved by combining several resources into a web based easy to use GUI (graphical user interface). Using this customizable Web Portal that interacts with a workflow controller, the scenario will demonstrate web service chaining. A good example of such GUI and web chaining has been developed in the AIP-2 Energy Scenario ([http://project.mesor.net/web/guest/geoss\\_re\\_scenario](http://project.mesor.net/web/guest/geoss_re_scenario)) and fully implemented in the prototype of the IEA SHC36 information system.

In the AIP-3 the GENESIS team will provide a state of the art platform where clients for specific services can be instantiated. For each service or service chain deployed on the platform, a GUI can be configured that allows the end user to select various parameters before executing the request to the various web services. Among the parameters a geo-localization map allowing single point as well as AOI (Area Of Interest) selection are needed as well as various input forms (text, menu, combo and check box) for application specific parameters selection. After executing the Web Services provided by GEOSS resource providers, maps of environmental impacts of PV life-cycle assessment (as describe above) will be provided. The Geo visualization application will allow the resulting maps and corresponding legend to be viewed on the platform. Moreover as the GEOSS resource providers not only provide WMS but also WPS (and optionally WFS, and WCS) a mechanism for retrieving the data corresponding to the visualization will be provided. Environmental impacts could be evaluated with different methodologies and consequently the output format will vary. This graphical type of information will be

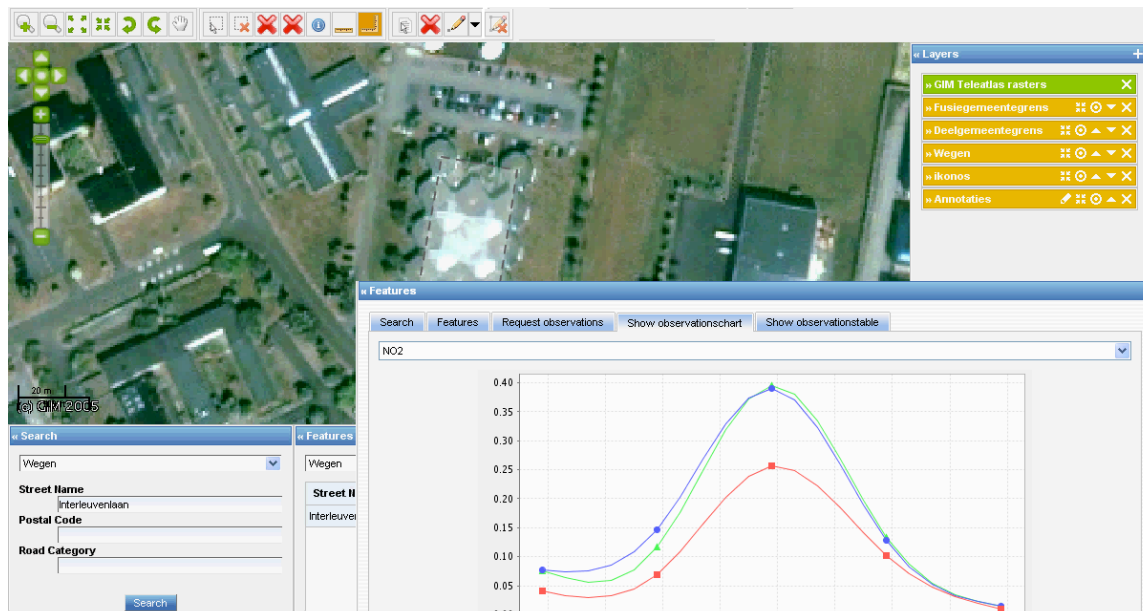


useful to understand the possible variability of results over the European territory. On a second level, pinpoint information on impacts of a PV installation could be given for a particular scenario. In this case the results should be presented through a table of data. The format of this table will vary depending on the type of analysis method used. In this table, critical information would be: the PV electricity impacts, the electricity production of the installation and a comparison of the PV electricity impacts with the impacts of the country electricity mix. Graphical representation of those data would be useful for end-users and the development of such feature will be considered.

The Web Services will be registered in the GEOSS registry and deployed at the Energy Community Portal that already runs for two years on a nominal operational basis. The client application will be made available with persistence in mind.

The GENESIS portal is a redesign of the ESA Service Support Environment Portal based on Portlet/JSF/AJAX technology. It is built on the Liferay/JBOSS platform and is connected to a BPEL workflow engine to orchestrate requests to remote web services. The portal allows Service Providers to register user interface to connect the portal to their remote web services based on latest versions of OGC standard protocols for catalogue (OGC 06-131, OGC 07-038...) and processing (WPS 05-007) services. Once registered on the GENESIS portal, these user interface clients can be discovered and used to invoke the remote services.

The portal includes several portlets among them a geodata visualisation portlet that allows to define areas and points of interest to be used as input into catalogue and processing services and to display (time series) of vector and/or raster data results of catalogue and processing on the map. The geodata visualization portlet is a “thin” Web client for OGC WMS (including support for Temporal Dimensions and SLD-WMS), WFS (including WFS transactional and gazetteer), SOS and WCS services. It also supports the display and exports of geographical data in various geographical data formats including but not limited to OGC GML and KML. The portlet is entirely configurable by the service provider using a GUI that allows for instance to easily compose WFS query forms and feature tables.



**Figure 3 GENESIS Geodata visualization portlet**

The overall components and services contribution overview by proposal responders can be summarized using the following task breakdown.

- Mines Paristech and EnerGEO will develop the user scenario, design the functional requirements for the pilot, and coordinate activities;
- Mines Paristech and EnerGEO will provide relevant datasets and host software components to serve such data as web services;
- ECOINVENT will provide relevant datasets for the photovoltaic sector;
- TASF would be the front-end to question / support from Mines ParisTech regarding the use of the GENESIS platform. TASF would also host the GENESIS platform;
- GENESIS (4CT) will support the transition of W3C services to OGC services using software from the GENESIS solution;
- GENESIS (Intecs and GIM) will provide appropriate web processing capabilities (WPS) using software from the GENESIS solution. A set of WPS services performing typical GIS operations like clipping, reprojection, generalization, format conversion on vector and raster data as well as overlay, contouring, spatial interpolation, ... are provided. In addition to these general purpose services, a Toolbox for exposing legacy applications with specific functionality as OGC Web Processing Services is available.

- GENESIS (Spacebel and GIM) will provide the Web Portal and Geodata Visualisation portlet, using software from the GENESIS solution.
- Spacebel will provide support to register the remote web services on the GENESIS portal.

### ***2.3 Architecture and Interoperability Arrangement Development***

According to the AIP-3 Call For Participation a particular interest among GEOSS users is the access to information about how data quality and uncertainties has been assessed, what standard have been used and, if any, how IPR (Intellectual Property Rights) apply to datasets. Among the Energy community and particularly in the solar energy sector, efforts have been made to assess such information. It's worth mentioning that Mines ParisTech is leading on going 5-years actions in the International Energy Agency (IEA) Solar & Heating Program Task-36 "Solar Resource Knowledge Management" program. Such actions include the development of methods that improve the quality and the spatial and temporal coverage, with customized solar resource products, including reliable solar radiation forecasts. The European Commission FP-6 Project MESoR, where Mines ParisTech was also partner, has conduct a benchmarking exercise to establish a coherent set of benchmarking rules and reference data sets to enable a transparent and comparable evaluation of the different solar radiation data sources. We think that such efforts worth to be promoted at a GEOSS information system level for metadata, catalogue and datasets with respect to standard procedure in order to allows this quality and IPR information to be part of the final user delivery. It would be consequently being transported all along the GEOSS interoperable chain and as an output be part of both the search & discovery results and accessible into any top-end application based on those dataset.

The AIP-3 Energy scenario partners, as GEOSS resource providers, are keen to participate to any initiative that will promote such approach.

## **3 Description of Responding Organization**

**Mines ParisTech** is a French engineer school that takes part to GEOSS activities since 2005. Mines ParisTech (Lionel Menard) was the leader of Renewable Energy Scenario Pilot in the Architecture Implementation Pilot Phase 2 AIP-2. Mines ParisTech through its representative Dr Thierry Ranchin is co-chairing of the User Interface Committee (UIC) for France. Mines ParisTech (Dr. Thierry Ranchin) with DLR (Marion Schroedter-Homscheidt) and University of Waterloo (Prof. Ellsworth LeDrew), are leading the Energy Community of Practice.

Within the AIP-2 framework, Mines ParisTech has built a community portal ([www.webservice-energy.org](http://www.webservice-energy.org)) in order to access energy related data via web services. This information system has been recognized by the GEO consortium has a persistent

resource. Several energy related GEOSS compatible web services are deployed as well as catalogue and metadata. This fully copes with the GEOSS resources search and discovery standard approach. The AIP-3 components will fully exploit this existing community portal. Based on this community portal providing access to resources via web services, dedicated client will be developed to implement the scenario.

Mines ParisTech key persons:

**Lionel Menard, Isabelle Blanc, Philippe Blanc, Benoît Gschwind, Lucien Wald**

**ECOINVENT**, originally called the Swiss Centre for Life Cycle Inventories, is a joint initiative of institutes and departments of the Swiss Federal Institute of Technology Zürich (ETH Zürich), of the Paul Scherrer Institute (PSI), of the Swiss Federal Laboratories for Materials Testing and Research (Empa), and of the Swiss Federal Research Station Agroscope Reckenholz-Tänikon (ART). The mission of ECOINVENT is to provide the most relevant, reliable, transparent and accessible LCI data for users all over the world. Therefore, ECOINVENT provides the database **ecoinvent data v2** with more than 4000 industrial life cycle inventory (LCI) datasets to assist every-day work related (but not limited) to Integrated Product Policy (IPP), Design for Environment (DfE), Environmental Management Systems (EMS) and Product Stewardship.

**THALES ALENIA SPACE (TAS)** is a joint venture from Thales (67%) and Finmeccanica (33%) created in April 2007. TAS focuses its activities on the design, development, and manufacturing of space systems, satellites, payloads, orbital infrastructures and space transportation, instruments and associated ground systems for civilian and military applications.

TASF leads the GENESIS project, leads the cross cutting activities between thematic and technologic tasks, and is in charge of the global architecture of GENESIS and of its validation

**SPACEBEL** is a Belgian SME specializing in the development of software solutions for the European Space Infrastructure, i.e. for satellite on-board control, satellite mission control centre, and dissemination of data from space-borne sensors. SPACEBEL is also active in the development and marketing of Earth Observation based Applications dedicated to natural resource monitoring and risk management

SPACEBEL leads the development of the GENESIS solution using its experience related to SOA architecture and interoperability solutions from ESA SSE and HMA related activities.

The **Joint Research Centre** is one of the Directorates Generals of the European Commission, engaged in direct research. The mission of the JRC is to provide customer-driven scientific and technical support for the conception, development, implementation and monitoring of EU policies. The Institute for Environment and Sustainability (IES) is one of the JRC Institutes, the mission of which is to provide scientific and technical support to EU policies for the protection of the global environment contributing to sustainable development. Within the Institute, the Spatial Data Infrastructures (SDI)

includes a highly competent and motivated technical team of about 30 scientists working on Spatial Data Infrastructures, the largest group in Europe in this field.

The **JRC-IES** is in charge of the synergy between GENESIS and European or worldwide initiatives (INSPIRE, GEOSS,...)

**4CT** is one of the oldest members of the Cronos Group, as it was founded in 1996. It currently employs about 50 FTE's and various external independent consultants. 4CT is organized in 5 departments who are specialized in Project Management, Architecture, Business Analysis, Business Integration and R&D.

4C Technologies' kZen department contributes in GENESIS to various work packages related to Data modelling, Data Fusion and Metadata Management (in WP600).

**GIM** (Geographic Information Management nv) is an independent provider of information management, system integration and consultancy services in the selected areas of Geographic Information Systems (GIS), Earth Observation (EO) and Geo Information Technologies (Geo-ICT). As a software independent system integrator, GIM has got extensive experience with both COTS and Open Source tools for releasing scalable and interoperable WebGIS systems. GIM is actively participating to ESAs SSE and HMA related activities.

Within the GENESIS project, GIM is responsible for the GIS and EO Data Access services, the Geo Information Services and the Geodata visualisation.

**Intecs S.p.A.**, an SME, is a private company operating in the IT field related to transport, space and defence. It provides big national and international organisations with consultancy services on high-tech systems, prototype, product and "turn-key" software systems development. During more than 30 years of activity, Intecs has achieved extensive experience in the production of Earth Observation/GIS software systems, acquired through a well-established co-operation with most of the major Italian and European electronic industries and the development of proprietary products.

Within the GENESIS project, Intecs is mainly involved in the development activities related to the service integration (SSE, ORCHESTRA), EO Dataset and GIS dataset (Collection) Catalogue services (EOLI and HMA\_P, SIAT ARPa Lazio), user registration (Cosmo-SkyMed) and the design and implementation of OGC Web Processing Services (ORCHESTRA).

### **3.1 System resources assigned:**

The current configuration includes a Dell PowerEdge 1955 blade server with 10 blades.

Two disks of 146 Gb, running on Red Hat Enterprise 5 Operating System.

Each blade is loaded with two Quad Core Xeon 2.66 GHz processors with 4 modules of 2 Go RAM.

A 27 Tb storing capacity server (Dell PowerEdge 2900) consisting of 3 MD1000 bays including 15 disks of 750 Gb each is associated to the blades server.

Each server can be backed-up using rSync on a remote Quad Core Dell PowerEdge 1850 server containing 10 disks of 500 Gb each for a total of 3.6 Tb backup capacities.

All this system is lean to a Continuous Power Supply (CPS) for proving a continuous supply of electric power to all the connected equipments.

All the existing components and Web Services are running since the AIP-2 and are provided by Mines ParisTech with full persistence in mind.