GEO Architecture Implementation Pilot Phase 2 (AIP-2)

Response prepared by ESA

Issue 1.0 - 1 September 2008

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 OVERVIEW

1.1 Introduction

As part of the long term strategy of the GEOSS to achieve comprehensive, coordinated and sustained observations of the Earth system, the European Space Agency (ESA), in coordination with other space agencies through the Ground Segment Coordination Body (GSCB), is participating in the activities of several tasks of the 2007-2009 GEO work-plan with major contributions focused on the implementation task AR-07-02. ESA's commitment is in line with and part of its work as Implementing Agency of the GMES Space Component Programme and the associated ground segment.

ESA participated to the Architecture Implementation Pilot Call For Participation 2007 developing the GEOPortal in collaboration with the Food and Agriculture Organization of the United Nations (FAO), and through the Federated Earth Observations (FedEO) Pilot conducted in collaboration with the Open Geospatial Consortium (OGC).

The GEOPortal and FedEO activities were aimed at improving access to satellite imagery, spatial databases and interactive maps, including the interfaces with standards based catalogues. The ESA/FAO collaboration focused on the improved accessibility of geospatial information resources through a GEOPortal, in support to the ESA and FAO mandates. The standardization process and testing for catalogue access from the Portal were complementary to the GEOportal contribution and performed in the framework of FedEO.

The FedEO Pilot was in fact conceived with the following main objectives: to permit the evolution and test of the interoperability protocols initially defined within the Heterogeneous Mission Accessibility (HMA) Project; to demonstrate using selected scenarios the interoperability which can be achieved with the protocols defined by means of available components and services; to permit the conformance testing of the adopted standards and protocols to support industry and institutions in the testing of their own products or developments. It is worth to highlight that the interoperability protocols and standards defined in HMA will be widely adopted in the framework of the GMES Program in Europe.

The GEOPortal, operational since July 2007, was successfully demonstrated at the 4th GEO Ministerial Summit in November 2007 and is now part of the GEOSS Common Infrastructure together with other portal and clearinghouse candidates. During the last year the GEOPortal has been routinely operated, further populated and improved to increase the number and the quality of the services offered to the users, and several tests were started to ensure the interoperability with the GEOSS Clearinghouses candidates. In May 2008 the GEOSS Common Infrastructure has entered in the Initial Operating Capability (IOC) phase with the aim to provide an opportunity for the entire GEO community to use, evaluate and improve the Common Infrastructure and also to enable Earth observation providers to populate GEOSS by registering their data sets, services, and other components.

With the response to the AIP CFP 2008, ESA is aiming, with the support of several partners, at augmenting the GEOSS Common Infrastructure (GCI) and at supporting the GCI IOC phase.

1.2 ESA Contribution to AIP Phase 2

ESA response to the AIP Phase 2, in coordination with other space agencies through the Ground Segment Coordination Body (GSCB) and in cooperation with several partners, aims at augmenting the GEOSS Common Infrastructure (GCI) and at supporting the current GCI IOC phase. To this end and to contribute to the increase of the GEOSS interoperability between the various and different components, the following contributions and activities are proposed:

1. **GEOPortal – www.geoportal.org :** This contribution is proposed in cooperation with FAO and is based on the GEOPortal developed in the framework of the AIP 2007 and actually part of the GCI. The contribution to the AIP 2008 consists in maintaining the current capabilities and functionalities of the GEOPortal (both operationally and in terms of content management), in adding new functionalities to the GEOPortal or improving the available ones, in upgrading the GEOPortal basing on received inputs (e.g. from User Community, Task Force, GEO Secretariat, etc…) and in the consolidation of its interoperability and interfaces with the other GCI components (e.g. GEOSS Clearinghouses and Registries).
   - The GEOPortal is currently operated, and will be continued to be, in the operational configuration as the other ESA Web portals and this is a guarantee of high stability and availability of service. Content management will be continuously carried out in order to guarantee the availability of up to date information in the GEOPortal and the identification of information resources, components and services to be made visible through the GEOportal.
   - New functionalities will be added or available ones will be improved (e.g. improvement of visualisation capabilities of geographical information, support of new scenarios or services through the integration of portlets developed by the service/scenarios developers, etc..).
   - Evolution of the GEOPortal basing on inputs coming from different sources (e.g User community, Task Force, GEO Secretariat): this will consist in the definition and collection of requirements, in the analysis of the feasibility and the assessment of the impacts on the GEOPortal, and possibly in the implementation of the required changes and test in alignment with GEO interoperability standards. The information content and the requirements from the user community will be coordinated through a dialogue with the SBAs to be established by GEO, e.g. through interaction with the UIC.
   - The consolidation of the interfaces towards GEOSS Registries and GEOSS Clearinghouse candidates could require some adaptations, to be evaluated, and a series of tests with the interfaces made available for such a purpose by the GCI component providers following the cooperation principles of GEOSS**.**
2. **FedEO EO Community Clearinghouse:** This contribution is proposed in cooperation with Eumetsat, OGC and the International Charter "Space and Major Disasters" (via CNES which supports the charter catalogue) and is aimed at improving and consolidating the FedEO EO Community Clearinghouse prototype developed in the 2007 FedEO pilot and already accessible through the GEOPortal, and at increasing the number of community catalogues accessible through it (and then through the GEOPortal) using the interoperability protocols defined within the HMA projects. The HMA interoperability protocols followed OGC procedures to become OGC best practises and standards and will be used in GMES, the European Contribution to GEOSS. The basic activities will consist in the:
   - Consolidation of FedEO Clearinghouse and evolution of the catalogue ebRIM EO profile.
   - Installation in an operational environment at ESA.
   - Addition of new catalogues (e.g. Disaster Charter, NASA, Jaxa, etc..).

3. **SSE – Workflow, Conformance Testing and Test Environment:** This contribution, proposed by ESA and based on the ESA's Service Support Environment (SSE), consists in a Workflow and Conformance Test Environment together with a number of Conformance Test Tools to test catalogues, orders, processing and access to the data. This component can be seen as a Workflow Management Engine and a service Test Facility for conformance/compliance test of data and models to ensure proper and interoperable use of GEOSS components and services in applications and interfaces. This environment will allow to:
    - support the creation of new services (e.g. through services chaining) and the development of scenarios relevant to the different SBAs through the workflow engine;
    - test interfaces for catalogues, orders, processing and access to the data through the Conformance Test Environment and tools.
    - carry out conformance/compliance testing to ensure proper and interoperable use of GEOSS components and services in applications and interfaces using the HMA standards consolidated in the framework of the AIP 2007 FedEO initiative and the OGC conformance testing.

The three contributions described above are twofold: from one side they can be seen individually representing the augmentation (in agreement with the Phase 2 of the AIP) of components already developed in Phase 1 or as new ones to allow a greater interoperability within GEOSS; from another side they can be seen as connected together representing an interoperable integrated environment where new SBA scenarios and GEOSS services can be built, GEOSS components can be tested with respect to a set of consolidated standards and accessibility can be provided to the GEOSS User community. In this integrated environment (shown in Figure 1):

- The GEOPortal provides an access point for GEOSS users to all the services/components made available to GEOSS (access to services/components is provided in cooperation with other Common Infrastructure elements, e.g. GEOSS Clearinghouses, and through the FedEO EO Community Clearinghouse).
- The FedEO EO Community Clearinghouse provides access and search capabilities towards EO community catalogues implementing the standard interfaces promoted in the FedEO 2007 pilot with the inherent advantages deriving from these standard interfaces that were specifically defined for EO data.
- New services and scenarios can be developed starting from the powerful test and development environment (SSE Workflow Engine) and integrating data from multiple domains. Services can be then made accessible through the GEOPortal, after registration in the GEOSS registries following the standard procedure, and available to the GEOSS user community.
- The catalogues and services based on the interoperability protocols and standards defined within the HMA projects and promoted through the AIP 2007 FedEO, will benefit of an environment and of test tools to perform conformance/compliance testing. They will be afterwards potentially accessible through the FedEO EO Community Clearinghouse and therefore available to the GEO user community through the GEOPortal with all the inherent advantages associated to their compatibility with the standard interfaces.

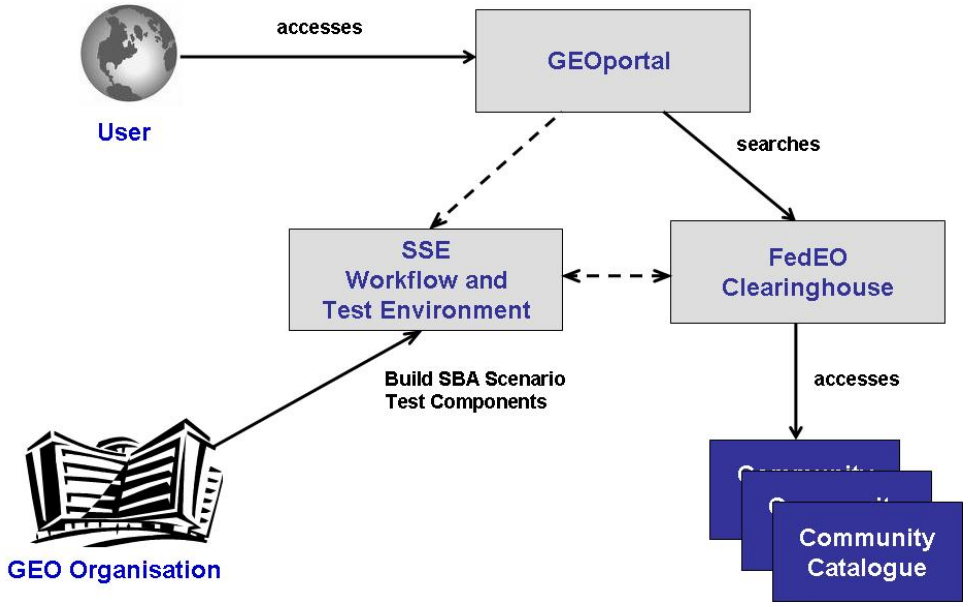

Figure 1: AIP 2008, ESA contributed components

The interfaces of the ESA provided components in response to the AIP CFP 2008 with the other GCI elements are shown in Figure 2.

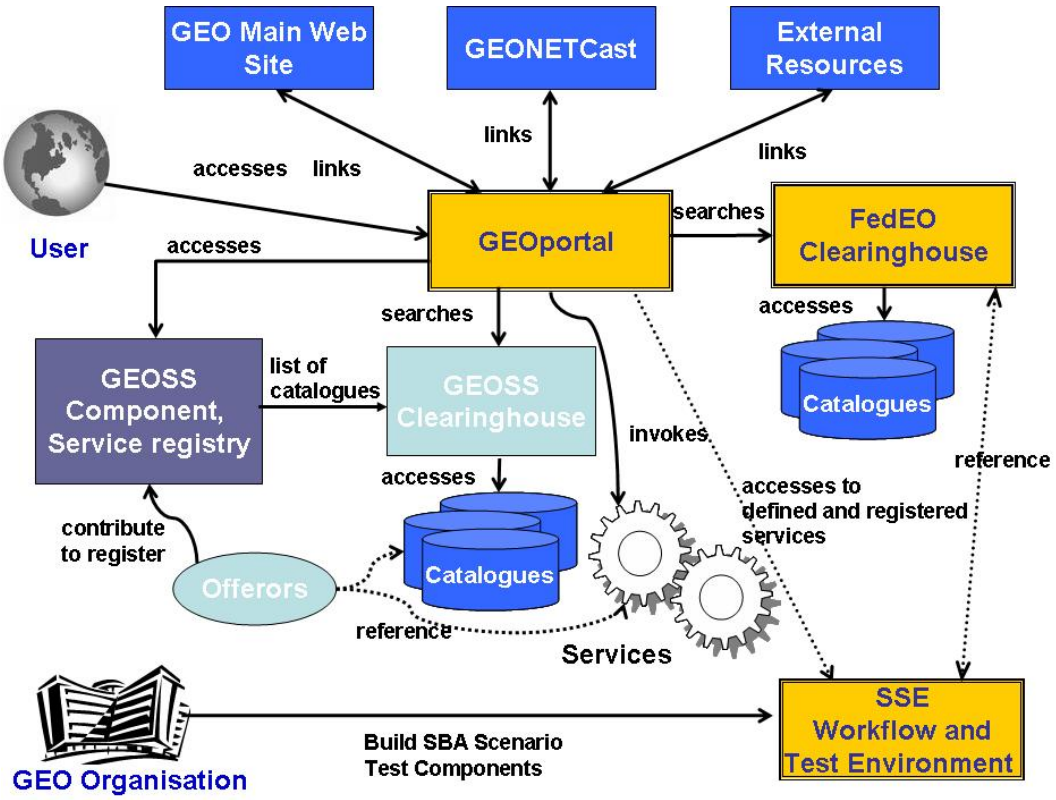

Figure 2: GEOSS Common Infrastructure and AIP 2008 ESA Components

The three different contributions briefly described above and composing the current proposal provided as response to the AIP CFP 2008 are described in detail in Sections 2.2.2, 2.2.3 and 2.2.4 respectively.

2 PROPOSED CONTRIBUTIONS

The contributions proposed by ESA in collaboration with its partners are mainly based on contributions developed in the framework of the 2007 AIP and improved and maintained during the last year. Further development of the contributions and testing activities will be performed and will consider as starting point the currently available versions of the proposed components.

Updated versions of the GEOPortal and FedEO Clearinghouse will be tested and then and then deployed on the same environment currently supporting the IOC. The GEOPortal will be operated by ESA as currently done for the several Web portals including the version of the GEOPortal supporting the GCI IOC phase. This guarantees high level of performances, flexibility and availability of service.

The SSE Workflow and Conformance Testing Environment will be operated by ESA and accessible from Internet.

2.1 Societal Benefit Area Alignment and Support

The three contributions proposed by ESA with its partners in the response to the 2008 AIP CFP support in principle all the nine Societal Benefit Areas.

The ESA/FAO GEOPortal, being part of the GEOSS Common Infrastructure, supports all the nine SBAs defined within GEOSS and is already structured according to them and to the sub-categories for each SBA defined in the GEOSS "10-Year Implementation Plan Reference Document". The GEOPortal is a gateway to Global Earth Observation data, information and services and already identifies a huge amount of services/information relevant to each SBA in support to user needs. Depending on the scenario, the GEOPortal may support local searches for data and services to assist new/non-experienced users to answer questions such as:

- Which services exist in the service segment that serves emergency response applications, e.g. disaster charter?

The improvements and integrations planned in the AIP Phase 2 should help the users further to answer questions such as:

- Which types of data sets available through GEOSS support services for marine applications, e.g. SAR?
- Which data sets are available via subscription and dissemination via GEONetcast?
- Which data available through GEONetcast supports NRT delivery for iceberg monitoring?

In principle, the GEOPortal contribution is also capable of supporting additional scenarios or connecting the portal to new services/components as appropriate.

Similarly to the GEOPortal, also the FedEO EO Community Clearinghouse, allowing to search generic EO data catalogues that could be relevant to several SBAs and user communities, supports in principle all the nine SBAs.

The same applies also for what concerns the SSE – Workflow and Conformance Test Environment thanks to its capability to provide on one side a support environment for the creation of new services and the development of scenarios relevant to the different SBAs, and on the other side an environment to carry out conformance/compliance testing to ensure proper and interoperable use of GEOSS components and services that could be relevant to different SBAs. The SSE supports a generic set of technologies applicable to Earth Observation and can be tailored to support specific scenarios via ad-hoc workflows.

2.2 Component and Service Contributions

2.2.1 Context of ESA contributions

ESA proposes the following contributions in response to the AIP CFP 2008:

- GEOPortal;
- FedEO EO Community Clearinghouse;
- SSE – Workflow and Conformance Test Environment.

The following Figure 3 shows the context of the proposed contributions with respect to the GEOSS reference architecture. The components provided as response to the AIP CFP 2008 are circled in red and the interfaces with the other components are roughly sketched.

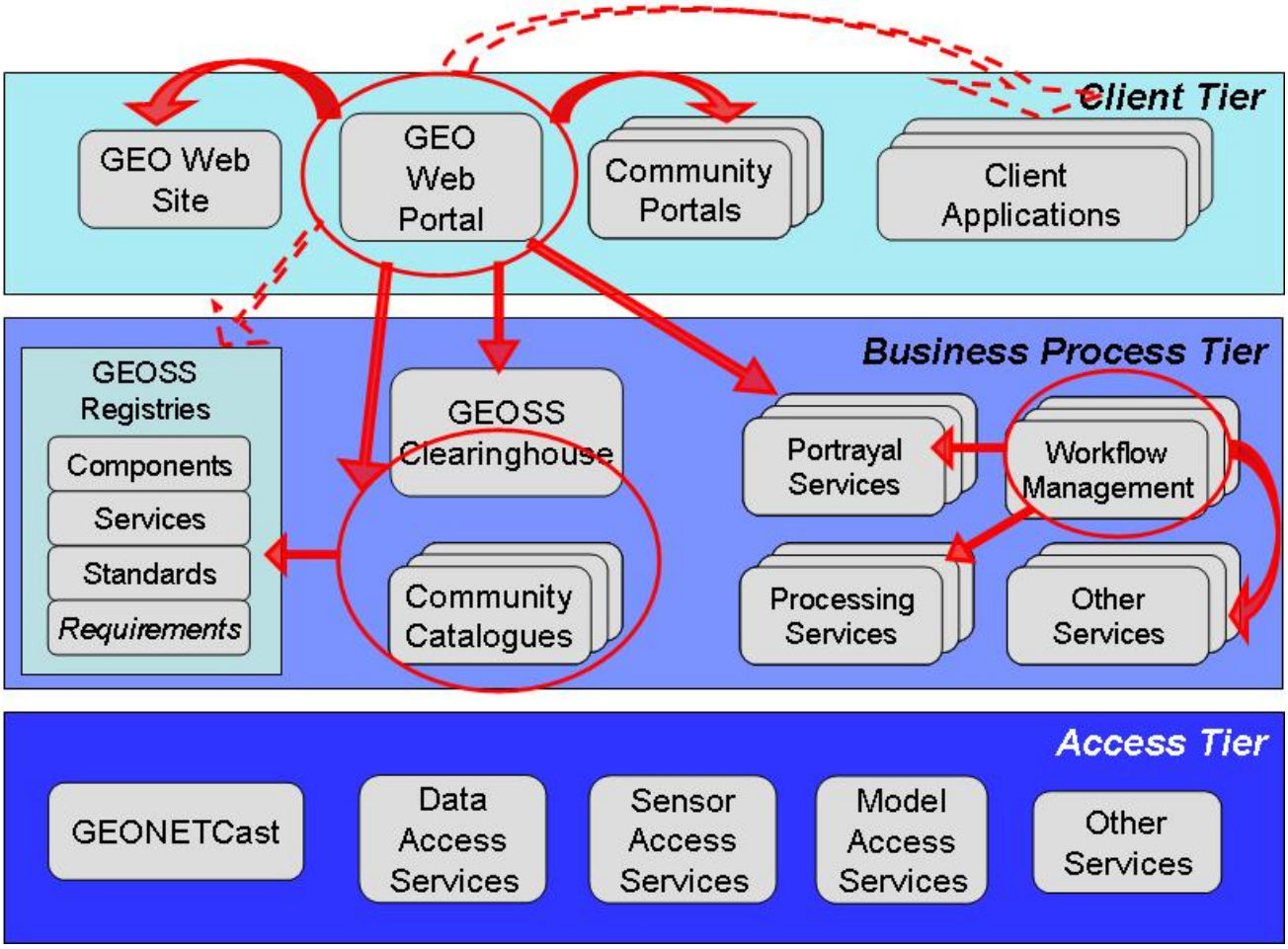

Figure 3: GEOSS components

The GEOPortal is one of the GEO Web Portal candidates currently part of the GEOSS Common Infrastructure.

The FedEO EO Clearinghouse can be considered as a community clearinghouse that integrates/accesses EO Community Catalogues through a specific set of standard interfaces and the position of the red circle in the figure has been set in order to reflect this peculiarity.

The SSE – Workflow and Conformance Test Environment contribution can on the other hand be identified as a Workflow Management and Test Facility.

2.2.2 GEOPortal

2.2.2.1 ESA/FAO GEOPortal introduction and current status

The ESA/FAO GEOPortal is a gateway to Global Earth Observation data, information and services developed by ESA in collaboration with FAO as contribution to GEOSS and actually operational and available on line at the link: http://www.geoportal.org.

ESA/FAO work on the GEOPortal contribution started in July 2006. A demonstrator was presented at the Third GEO Plenary Session and to the User Interface Committee in November 2006. Feedback was received and considered for a first release of a GEOportal demonstrator made available online in February 2007. The GEOPortal was further developed in cooperation with FAO in the framework of the AIP 2007 and was presented in November 2007 during the GEOSS Fourth Plenary & Ministerial Summit. Since then the GEOPortal has been constantly operated, maintained and improved.

From May 2008 the GEOPortal is entered in the Initial Operating Capability (IOC) period together with other portal candidates, registries and clearinghouses candidates. As part of the Initial Operational Capability phase of the GEOSS Common Infrastructure, the GEOPortal already constitutes a main access point to worldwide information on Earth Observation capabilities and services including the ones proposed and implemented in the framework of GEO activities (i.e. output of GEO Workplan tasks and pilot projects).

The GEOPortal includes a number of common functions and solutions to search and discover services and provides news and other relevant information to the GEOSS user community.

The Community concept is extended to a global community and across all GEOSS users providing an entry point to the resources no matter where the user is located and no matter the nature of usage within the GEOSS areas of application. The portal achieves this goal based on two key characteristics:

- A high-level structure of the information according to the nine GEO societal benefit areas, SBAs.
- A global coverage linking all resources contributed by the GEO members and participating organizations.

Figure 4 illustrates the GEOPortal as part of the GEOSS architecture with its interfaces towards the different resources of the GEOSS.

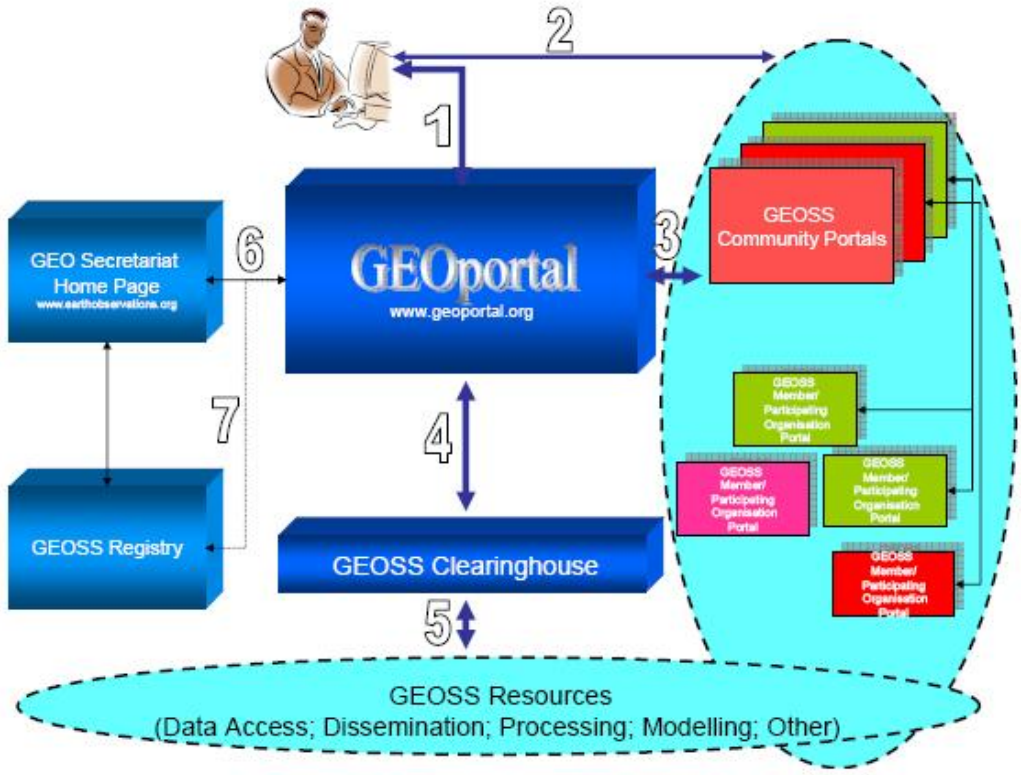

Figure 4: GEOPortal and interaction with other GEOSS components

Based on the GEO recommended standards and following the Geospatial Portal Reference Architecture of the OGC the GEOPortal provides a variety of services:

- Geospatial Portal Service providing the user interfaces for viewing, discovering data, information and services available in GEOSS.
- Portrayal Viewer Service allowing the display and handling of maps and context information from various sources, e.g. from different GEO Societal Benefit Areas through WMS services.
- Interfaces to Catalogue Services of the GEOSS Clearinghouse, allowing distributed catalogue search in an interoperable manner.
- Interfaces to the GEOSS Registries.
- Browse through a comprehensive directory of service providers e.g. related to GEO Members and Participating Organisations.
- Retrieval of Earth observation education, training and capacity building resources.

To access to different types of information, the GEOPortal allows navigation and access primary via Societal Benefit Area selection and Geographical selection. The SBA selection leads the user to a main SBA page providing relevant information on the services available within that SBA, the service providers, as well as a showcase of data sets.

From there, the user can have access to specific service pages, providing, among other, a user friendly description of the services, a point of contact, a direct link to the services, and access to the related details on the GEOSS Registry. A user can also refine his search by SBA subcategory and/or geographical area, in order to retrieve services more appropriate to satisfy his informational needs. The geographical selection allows the user, selecting regions and countries from the rotating globe, to access a variety of data, information resources and services available for that specific geographical area.

The GEOPortal is currently operated, and will be continued to be, in the operational configuration as the other ESA Web portals and this is a guarantee of high stability and availability of service. Content management will be continuously carried out in order to guarantee the availability of up to date information in the GEOPortal and the identification of information resources, components and services to be made visible through the GEOportal. With the number of components of GEOSS growing, there is in fact the constant need to ensure that any resource newly available to GEOSS can be discovered through the GEOPortal coupled to the GEOSS Clearinghouse and GEOSS Registries.

Despite the GEOPortal instance under IOC operated by ESA that will remain operational, it is important to underline that, as required in AIP CFP 2007, the GEOPortal is based on Open Source components and can be freely installed and configured at GEO members' premises.

Figure 5 shows the GEOPortal home page currently under IOC with the rotating globe and the SBA structure on the left side.

The homepage primarily allows access to information via:

- SBA selection, and
- Geographical selection

SBA selection guides the user to a main page per SBA with relevant information, e.g. services available within the SBA, sample data sets. From there, access to specific service pages local to the GEOportal is possible. This includes a link to the services portals outside the GEOportal. Geographical selection allows to select regions and countries from a rotating globe, giving access specific to that geographical area.

The Homepage furthermore provides access to

- The Clearinghouses;
- The GEOSEC Home page;
- To services horizontal to all SBAs, e.g. EO Tutorials, GEONetCast.

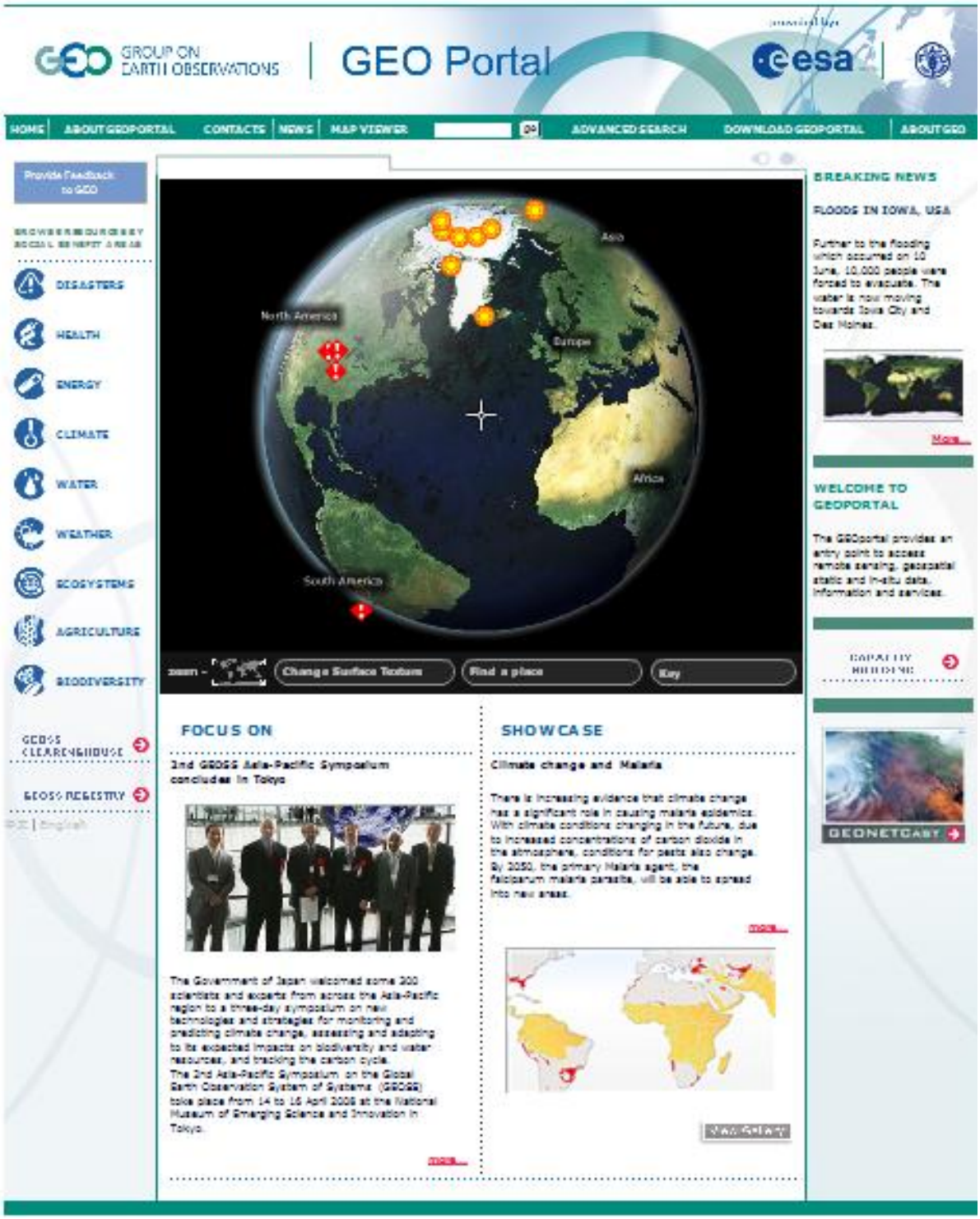

Figure 5: Sample GEOPortal Home Page

2.2.2.2 Improvement of the GEOPortal

GEOPortal will participate in the augmentation of the GEOSS Common Infrastructure. In order to augment its interoperability the following activities have been foreseen for the Phase 2:

- Functional improvement for 2008 – 2009
- Support to various SBA scenarios
- Testing activities

The following ***functional improvement*** for the Phase 2 of the ESA Contribution are planned:

- Consolidation and further integration of communities portals, information systems, datasets and services in support to GEO Secretariat and to respond to GEO Societal Benefit Areas needs;
- Consolidation of the interfaces to the GEOSS Registries and to GEONetcast;
- Consolidation of the interfaces to FedEO Clearinghouse and to the GEOSS Clearinghouse candidates;
- Introduction of new communication and collaboration capabilities;
- Consolidation of the GEOPortal download capability to allow some GEO organisations to download GEOPortal structure and contents and to deploy/customise GEOPortal on their own server (in line with the principle of Open Source development applied to GEO portal);
- Possible further extension with Google Earth capabilities;
- Possible further enhancements of the visualization of geographical information, maps and imagery.

Moreover the GEO portal will be enhanced also for other ESA internal purposes, in order to support ESA policy for what regards interoperability and development of applications in the field of the Earth Observation:

- Continuous improvements to open-source components and/or COTS to be integrated into the portal, in particular JSR 168 compliant portlets with due consideration of reusability and maintenance for possible other installations of the Portal.

Considering the augmentation foreseen in the AIP CFP 2008 where new services and scenarios related to different SBAs are being developed with a strict interaction with the users in order to allow users to discover, order and receive data and products, the GEOPortal will take into account the ***possibility to support new scenarios*** through the:

- Search and Discover services providing relevant information to the user community;
- Further integrate portlets provided by scenario developers that will representing specific visualization and processing application, in order to display scenario data;
- Improvement of the information to the user how to download/order data from a particular organisation.

Starting from these bases, in order to support a new developing scenario, resources will be allocated to cooperate with scenario developers to:

- collect scenario information;
- evaluate user requirements related to the scenario and per consequence in respect to the GEOPortal;
- make an impacts assessment of new requirements on existing operational GEOPortal in terms of implementation efforts and performances requested;

- Possibly implementation of the requested changes to the GEOPortal to support the new scenario;
- test of the updated GEOPortal.

Testing activities towards the three GEOSS Clearinghouse candidates will be continued in order to check the interoperability between the ESA GEOPortal and the GEOSS Clearinghouses to pave the way towards an operational scenario.

Interfaces from the different GCI components providers will have to be made available for such a purpose following the cooperation principles of GEOSS

After update of the GEOPortal interfaces, the three GEOSS Clearinghouse candidates will be fully integrated and tested within the GEOPortal using OGC CSW 2.0.2 – HTTP bindings. For the integration of GEOSS Clearinghouse candidates information existing in the GEOSS Registry will be used.

The following figure shows relationships between the GEOPortal and other GEOSS components as foreseen in the AIP CFP 2008:

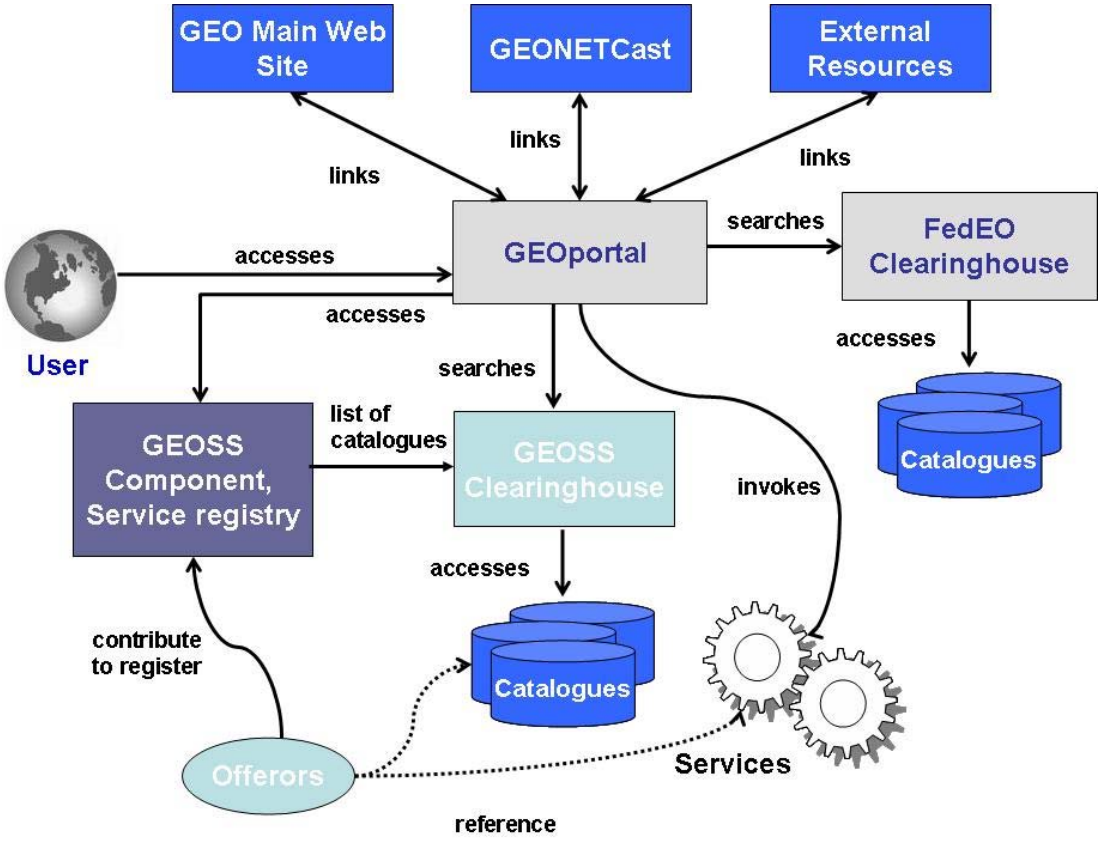

Figure 6: GEOPortal interfaces

2.2.2.3 Relevant Data

The information provided by GEOPortal is targeted to meet the needs of the nine GEO Societal Benefit Areas.

For each Societal Benefit Area and/or location the user will be provided with search capabilities to retrieve information on the overall services and data. An example of organisations and/or projects providing information on services and data is given in the table below.

Type of data	Categories	Examples
Information Services	Early warning services	EUMETNET-Meteoalarm, RISK-EOS, World Weather Information Service, FEWS NET - Famine Early Warning Systems Network, GIEWS - Global Information and Early Warning System on Food and Agriculture
	Monitoring Services	LMCS - Land Monitoring Core Service, GCOS - Global Climate Observing System, GEONetCast, RESPOND, SERVIR, MIC - Monitoring and Information Centre, GAW - Global Atmosphere Watch , ITIC - International Tsunami Information Centre
	Analysing Services	ATSR Fire Atlas, FAO-AQUASTAT, GTOS - Global Terrestrial Observing System, DataFed, GLipha: Global Livestock Production and Health Atlas
	Mapping Services	RESPOND, UNOSAT, AFRICOVER, GlobCover
	Assessment Services	INSCRIT, FAOMET, UNEP- Global Environment Outlook Data Portal, DISFLOOD, ECA&D - European Climate Assessment & Dataset
	Alert Systems	RSOE HAVARIA - Emergency and Disaster Information Services, GEAS - Global Environmental Alert Service, AlertNet
	Geospatial web services	FAO GeoNetwork, ORCHESTRA,
	Data processing	WOCAT, EO G-POD - Earth Observation Grid Processing on Demand
	Data provision	World Data Centers
Service Providers	UN Organizations and Agencies	FAO, WMO, UNEP, UNITAR, UNESCO, UNOOSA,
	Coordination Bodies	CEOS, IGOS, EUMETNET, POGO, EuroGeoSurveys
	Space agencies	ESA, DLR, CNES, CSA, NASA, ISRO, JAXA
	International organizations	EUMETSAT, EC, OECD, CATHALAC
	National Organizations	USGS, NOAA, EPA, ACRES, CMA
	Research Centers	Helmholtz Research Network – EOS, ICSU, CIRES, École Mines Paris
International Initiatives	-	International Charter - Space and Major Disasters, GMES, TIGER, IPCC, IPY, EGY, UNCBD
Showcases of Datasets	-	Maps of flooded areas / wild fire maps in support to disaster management, Land use - Land cover map, World cities, World rivers, Hydrological basins in Africa, population etc.

Table 1: Sample Information

From GEOPortal some showcases of datasets will be retrievable, while full access to comprehensive catalogues of datasets will be granted through the access to the GEO Clearinghouse.

2.2.2.4 Support of open standards

GEOPortal contains a local instance of the GeoNetwork opensource catalogue, which is used to maintain a local copy of selected resource descriptions either harvested from external sources or entered by the GEOPortal administrator. A local copy is required to ensure the overall performance and reliability of the GEOPortal. The GeoNetwork catalogue contains " EO collection level" metadata and other resource (Web Map Servers, etc) descriptions. Work is ongoing to empower the open source catalogue with support to the ISO profile, in order to ensure wider interoperability.

The GEOPortal is based on an open-source platform and web portal application; natively it supports the following standards:

- JSR168 interface for access to portlet applications (including GeoNetwork);
- RSS (GEO-RSS) client access to alerts and news feeds;
- OGC WMS client for access to web map services;
- OGC CSW ISO API profile (through use of GeoNetwork Open Source software) for publishing local metadata;
- OGC CSW base interoperability (via the GEOSS clearinghouses);
- OGC CSW ebRIM EO extension package access via FEDEO clearinghouse.

The GEOPortal software is based on a number of Open Source modules which could be made available and be configured to create for example a Portal for a specific SBA. GEO organisations wishing to install/operate an instance should be able to customise the portal according to their SBA, considering that the GEOPortal software is based on Open Source components.

2.2.2.5 Performance

The deployed GEOPortal for the IOC is compliant with the requirements of the AIP CFP 2007. In the AIP CFP 2008, *services are expected to be available at least 99% of the time, except when otherwise required by the nature of the service*. As already specified in the response to the AIP CFP 2007, the ESA GEOPortal is compliant to this requirement.

ESA has in fact secured the operations, maintenance and content management of the GEOPortal until the end of 2009 accordingly to ESA standard service levels. The GEOPortal infrastructure is operated by the industrial consortium responsible for the operation and maintenance of ESAs' EO user services and the GEOportal is operated with the same service level of the other EO web portals hosted and operated at ESA/ESRIN.

The GEOPortal operations are not actually limited to the operations of the technical infrastructure of the underlying GEOPortal system, but include the maintenance of the information contained locally within the GEOPortal and ensure the consistency of the links and interfaces to GEOSS. Local information may include up to date sample data sets representative of the different SBAs and the GEOPortal provides also value-adding in that its operators proactively identify and highlight specific data and information.

2.2.3 FEDEO Clearinghouse

2.2.3.1 FedEO introduction and current status

Whereas scope of the GEOSS clearinghouse is to provide access and search capabilities towards all catalogues, FedEO can be considered as an EO community clearinghouse focusing on a specific set of protocols and data models applicable to satellite based Earth observations. This specific set of interoperability protocols, defined through the HMA project and consolidated during the FedEO 2007 pilot, followed the standard procedures to become OGC standards and will be adopted in GMES, which is the European Contribution to GEOSS.

Starting from the Heterogeneous Mission Accessibility - Interoperability (HMA-I) Project started in 2005 in the framework of the GMES Preparatory activities with the purpose of defining the interoperability concept across the ground segments of the European, Canadian and third party missions which will contribute to the Global Monitoring for Environment and Security – GMES Programme initial phase, ESA answered to the AIP CFP 2007 with the Federated Earth Observations (FedEO) Pilot.

The GMES Contributing Missions which have participated in previous interoperability work in the context of the HMA Project are (the list is indicative):

- Cosmo Skymed first constellation (ASI)
- Radarsat-2 (CSA)
- Pleiades (CNES)
- TerraSAR-X (DLR)
- Meteorological Missions (Eumetsat)
- Envisat, ERS, PROBA, Sentinels (ESA)

In 2007, in the frame of the OGC Interoperability Program (IP), the FedEO Pilot was conducted in conjunction and support of the GEOSS Architecture Implementation Pilot (AIP). The FedEO pilot used and extended the 2007 GEOSS AIP Architecture with additional services, e.g.: Product, Programming, Service Orchestration, Processing Services, Orthorectification and Reprojection Services and Order Services. The objectives of the FedEO Pilot 2007 have been:

- To permit the evolution and test of the interoperability protocols which have been initially defined within the HMA Project.
- To permit the conformance testing of selected HMA adopted standards and protocols to support industry and institutions in the testing of their own products or developments. Reference for conformance testing shall be considered the TEAM environment developed by Open Geospatial Consortium (OGC).
- To demonstrate using selected scenarios the interoperability which can be achieved with the protocols defined by means of available components and services.

The FedEO 2007 Pilot provided the following benefits:

- broad international venue for operational prototyping and demonstration of Earth Observation (EO) requirements and protocols as defined by ESA, together with other space agencies (ASI, CNES, CSA, DLR) and users (EUSC) and by other OGC members;
- application and refinement of OGC specifications relevant to EO;
- test and validation of OGC specifications in a business context, and provision of feedback regarding their ability to improve access to and application of Earth observation data and services;
- test and validation of OGC specifications and profiles proposed in the context of ESA's Heterogeneous Missions Accessibility project to improve access to and application of Earth Observation data and services.

Based on ESA's Service Support Environment (SSE) the FedEO Pilot offered a persistent service support and protocol demonstration and testing environment focusing on refining the following Implementation Specifications and other OGC documents:

- Catalogue Service for the Web (CSW) for EO Collection and Service Discovery;
- Catalogue Service CSW ebRIM Earth Observation and ISO extension packages;
- Web Map Services – Application Profile for EO Products;
- GML Application schema for Earth Observation products;
- The FedEO pilot architecture model is described in Annex A.

In the frame of FedEO 2007 the following activities have been performed on the FedEO Clearinghouse:

- implementation of "Service Discovery" via an UDDI[1] registry.
- population of an instance of the registry for the registration of new services within the FedEO Clearinghouse (built on SSE technology).
- The following dataset collections metadata have been made accessible from the FedEO Clearinghouse:
    - ESA's MUIS collection descriptions,
    - Eumetsat's UMARF collection descriptions,
    - GSE GMFS (Global Monitoring for Food Security),
    - An NGI Belgium catalogue (NSI project).
- The ebRIM information model for EO data has been defined in the EO extension package for ebRIM Profile of CSW 2.0. The following catalogues have been made accessible from the Clearinghouse via this protocol:
    - ESA MUIS,
    - Spot Image Dali,
    - Eumetsat UMARF,
    - NASA ECHO (as a prototype),
    - EC FP6 WIN catalogue (demonstrated in April 2007).

[1] Universal Description, Discovery and Integration – UDDI registry standard defined by OASIS

- The integration of the three GEOSS Clearinghouse candidates with the GEOPortal has been tested.

The FedEO Clearinghouse is currently available as a prototype and accessible through the GEOPortal.

2.2.3.2 Improvements of the FedEO Clearinghouse

FedEO will participate in the augmentation of the GEOSS Common Infrastructure through the improvement of its capabilities and interoperability. An architectural description of the FedEO Clearinghouse is available in Annex A.

Augmentation will mean mainly the evolution of the ESA's Service Support Environment (SSE) clients and interfaces in order to integrate the maximum number of catalogues possible responding to the international standards used and/or defined from the HMA project. The SW engineering processes for evolution will be carried out following European Cooperation for Space Standardization (ECSS) directives.

All the activities planned for the period 2008 – 2009 and listed hereafter will be performed with this aim in mind: extend the collaboration between FedEO and Earth Observation catalogues:

- Evolution of the FedEO Clearinghouse:
  - Evolution of ebRIM EO Profile:

    The FedeO Clearinghouse developed in 2007 will be updated to be aligned with the *OGC Catalogue Services Specification 2.0 Extension Package for ebRIM (ISO/TS 15000-3) Application Profile: Earth Observation Products.*
  - Support of asynchronous Catalogue responses:

    The FedEO Clearinghouse, developed basing on the Data Access Integration Layer (DAIL) prototype developed in the frame of HMA project, will be improved in order to support input and output asynchronous notification for the catalogue as already done for the orders.
  - Support of version negotiation:

    The FedEO Clearinghouse will be improved in order to support input and output version negotiation of the catalogue interoperability protocols.
- Evolution of the Clearinghouse clients to support testing by GEOPortal of the interoperability with the GEOSS Clearinghouse candidates:
  - Support for WMS EO profile following standard specifications.
  - Improve linkage between collection and product level information improving SSE metadata in order to implement a collection discovery function.
  - Support collection name harvesting through GetCapabilities request.
  - Support collection name hierarchies in GetCapabilities request.
- Integration of new catalogues which implement the HMA standard interfaces. The following additional collection catalogues should be integrated with the support and active participation of the catalogue owners (eventually other catalogues will be added):
  - Disasters Charter catalogue (supported by CNES),
  - Nasa,

  - Jaxa,
  - Spot,
  - Gcat.
  - Others…
- Impacts on the developed and used standards will be analysed and feedbacks will be reported into the standardisation process.
- The updated FedEO Clearinghouse will be installed in an operational environment at ESA premises and will be available through Internet operated and maintained by ESA.

The updating of the FeEO Clearinghouse will benefit from the parallel execution of other ESA projects (e.g. HMA-T (Testbed) implementation, EO-DAIL implementation, ERGO EbRim Implementation with Geonetwork and OMAR project).

Concerning the input documentation about the ebRIM application profile, it shall be noted here that the AIP CFP 2008 contains a recent and an old (deprecated) reference in the footnotes (latest two pages). The evolution of FedEO for the ebRIM application profile will use as input reference only the most recent one.

The right one is: *"OGC 06-131, EO Products Extension Package for ebRIM (ISO/TS 15000-3) Profile of CSW 2.0, Renato Primavera, Open Geospatial Consortium discussion paper, August 2006"*,

The old (deprecated) one is: *"OGC 06-079r1, EO Application Profile for CSW 2.0.0, M. Gilles, Open Geospatial Consortium candidate implementation specification, June 2006"*.

2.2.4 SSE – Workflow, Conformance Testing and Test Environment

2.2.4.1 Overview

The ESA Service Support Environment (SSE), accessible at the following link http://services.eoportal.org/, is an open, interoperable system based on widely accepted standards from W3C, OASIS, WSI and OGC. It implements a Service Oriented Architecture (SOA) facilitating access to and deployment of services and combining services using workflow technology. Services can be Ground Segment related modules such as catalogues, ordering but also external services for oil spill monitoring, fire risk, algae bloom, coordinate transformation, classification, etc.

The SSE permits to integrate a wide range of heterogeneous EO and geospatial information services, supports the service prototyping and demonstration processes, allowing designing workflows automatically executed. This avoids the manual replication of the same task, with a valuable decrease of the overall development effort.

The SSE allows to:

- Orchestrate synchronous and asynchronous Web Services for online and offline processes;
- Provide an overarching platform, neutrally managed by ESA;
- Integrate the access to EO data within the prototyping and delivering of the services;
- Empower service providers through a business process management platform;
- Minimize service providers' upfront investments;
- Use of Open standards to facilitate adoption and evolution;
- Integrate data from multiple domains, e.g. geospatial, meteorological, in-situ, EO, within the processing and exploitation chains;
- Advertise and integrate new and existing services; support their evolution and maintenance.

The SSE Portal provides an area to share ideas and competencies with other professionals and companies of the sector. It permits to find colleagues and partners to boost the development process and to find new opportunities to improve technologies, standards and services.

The services available in this area are:

- Forums: mutual support for the developers, share resources & expertise and search partners.
- Wikis: a way to consolidate the experience.
- Blogs: lead by professionals of the sector to give support in every phase of the development process

An architectural description of the SSE is available in Annex A.

2.2.4.2 Provided Tools

Tools are made publicly available to develop and test operations and interfaces. The following list provides a brief description of this equipment:

Scenario and service prototyping support tools

SSE Toolbox

The SSE Toolbox facilitates integration of existing service with the SSE; it converts any legacy service in a SOA based one, dramatically reducing the coding problems. In progress the update with OMAR EbRim software.

Workflow Editor

The Workflow Editor allows the creation of complex workflows, chaining services available on the portal. This process is supported by an orchestration engine that provides a Standard workflow definition language.

Test and conformance testing Tools

Dedicated test clients

The ICD's developed during the course of the HMA project can be tested and demonstrated through the SSE. Dedicated test clients are made available for the catalogue, ordering and programming interfaces.

The following figures represent an example of a dedicated test client for catalogue. The catalogue services registered in the Portal are listed on the right hand side of the "organisation page". Selecting a catalogue service from the (e.g. PHR Catalogue), item (2) on Figure 7, will open the catalogue client depicted in Figure 8.

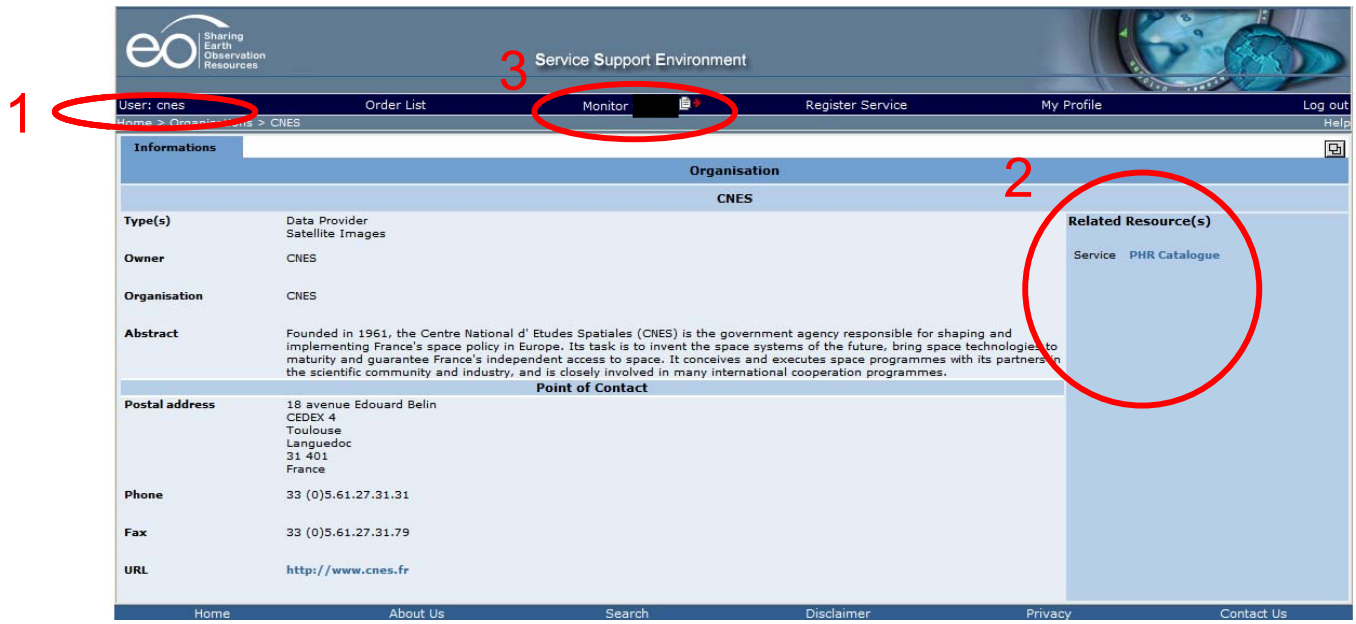

Figure 7: Dedicated Test Client – e.g. CNES PHR Product Catalogue Service

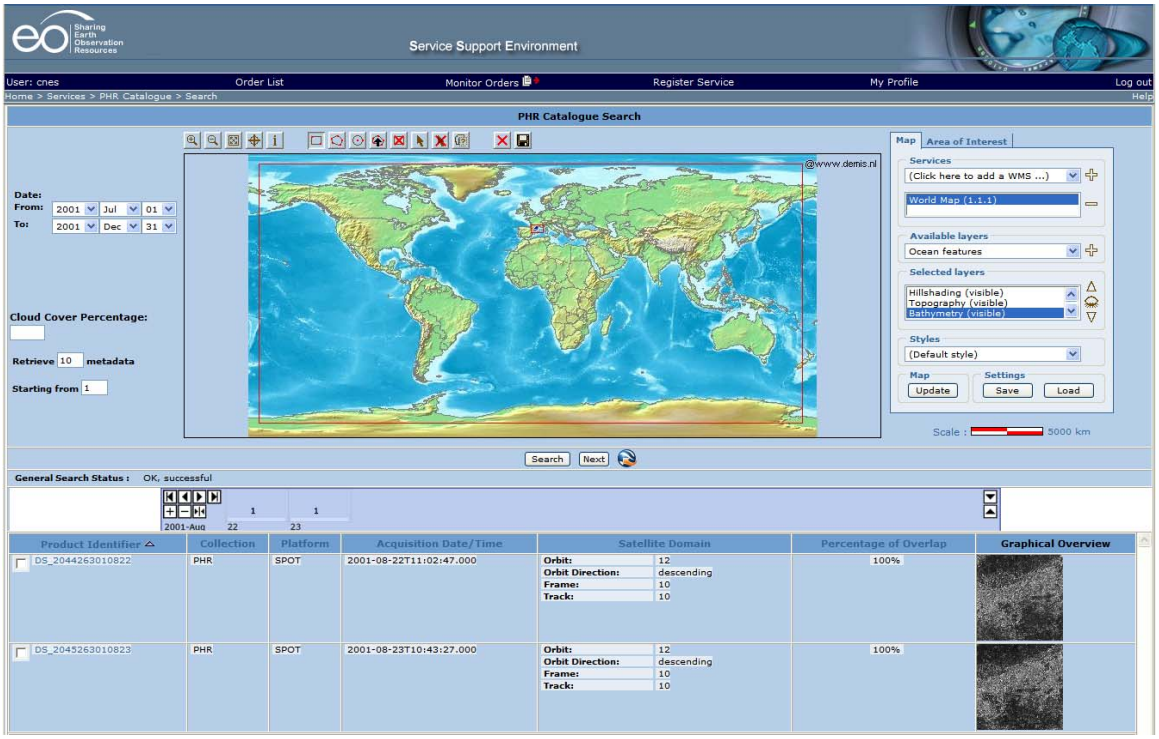

Figure 8: Dedicated Catalogue Test Client

Generic SOAP Test Client

This software is a generic client that allows a low level testing of the SOAP requests and responses for the specific service. It is made available through the "Monitor" link on the SSE as shown as (3) in Figure 7. This generic SOAP test client supports a login/domain per Service Provider and provides access to the intermediate messages sent and received by the client. It facilitates low level testing of SOAP interfaces by allowing the user to submit SOAP requests and visualise the responses. Performances can be measured through this tool and interfaces can be stress tested.

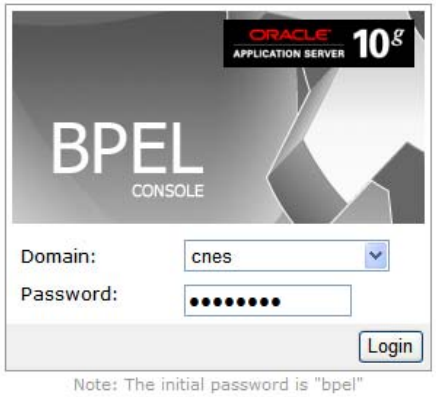

Figure 9: Generic Test Client - login

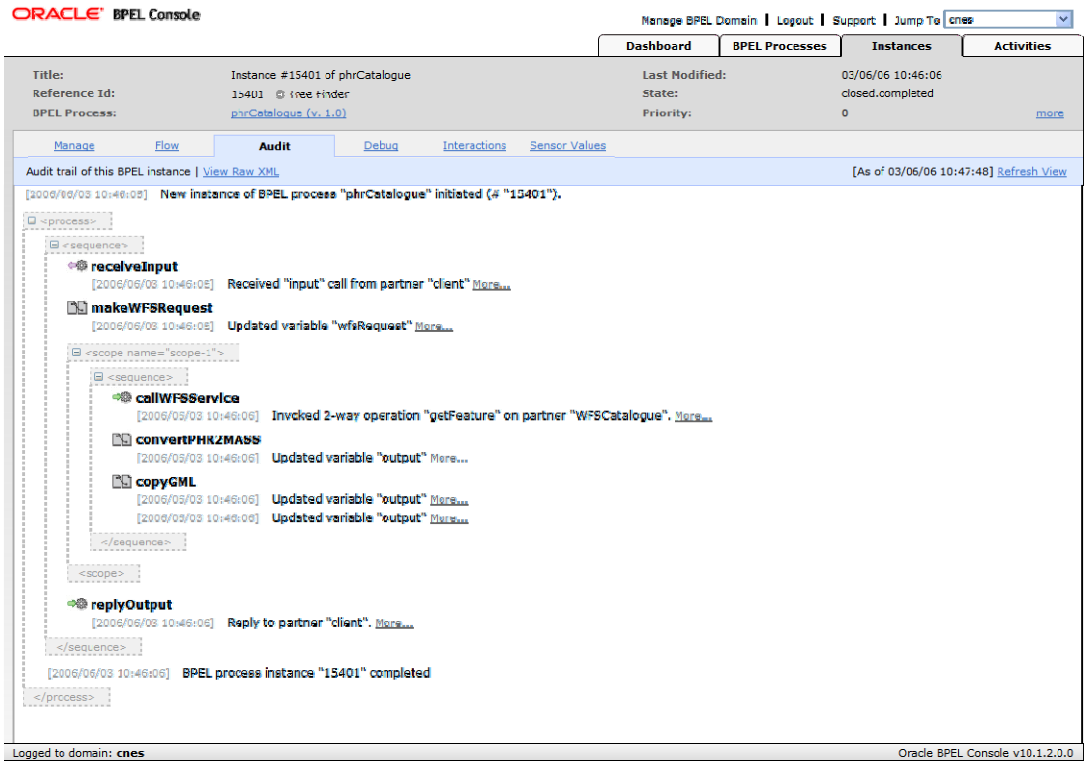

Figure 10: Audit - Low Level Access to Intermediate Messages

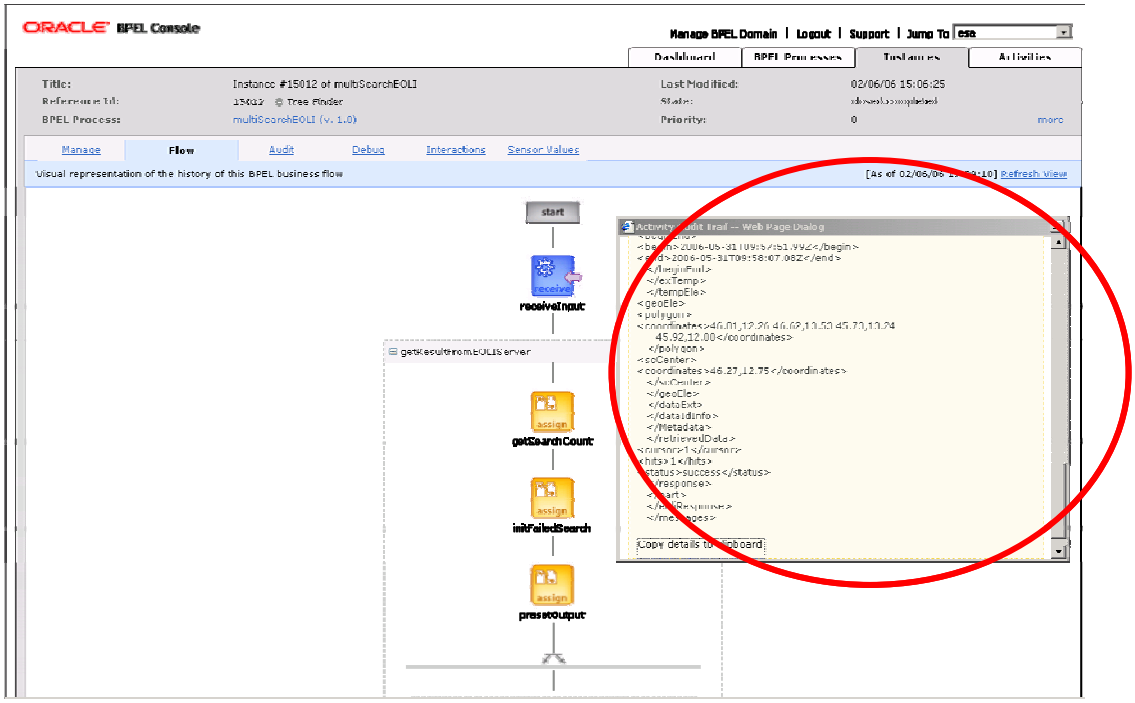

Figure 11: Workflow - Low Level Access to Intermediate Messages

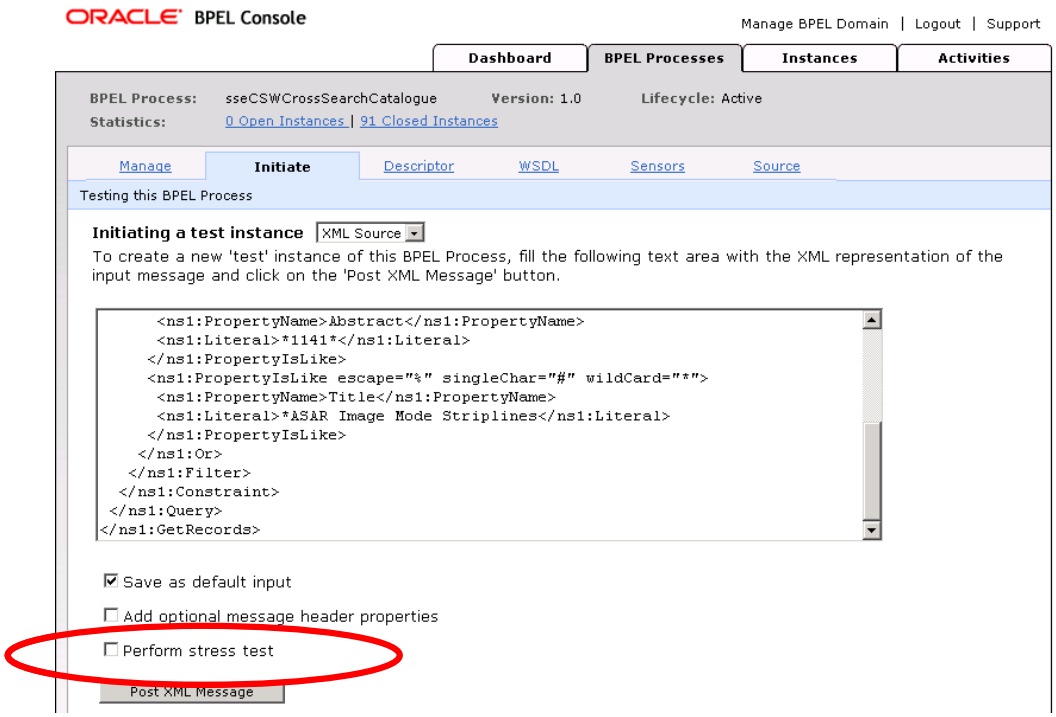

Figure 12: Stress Test SOAP interface

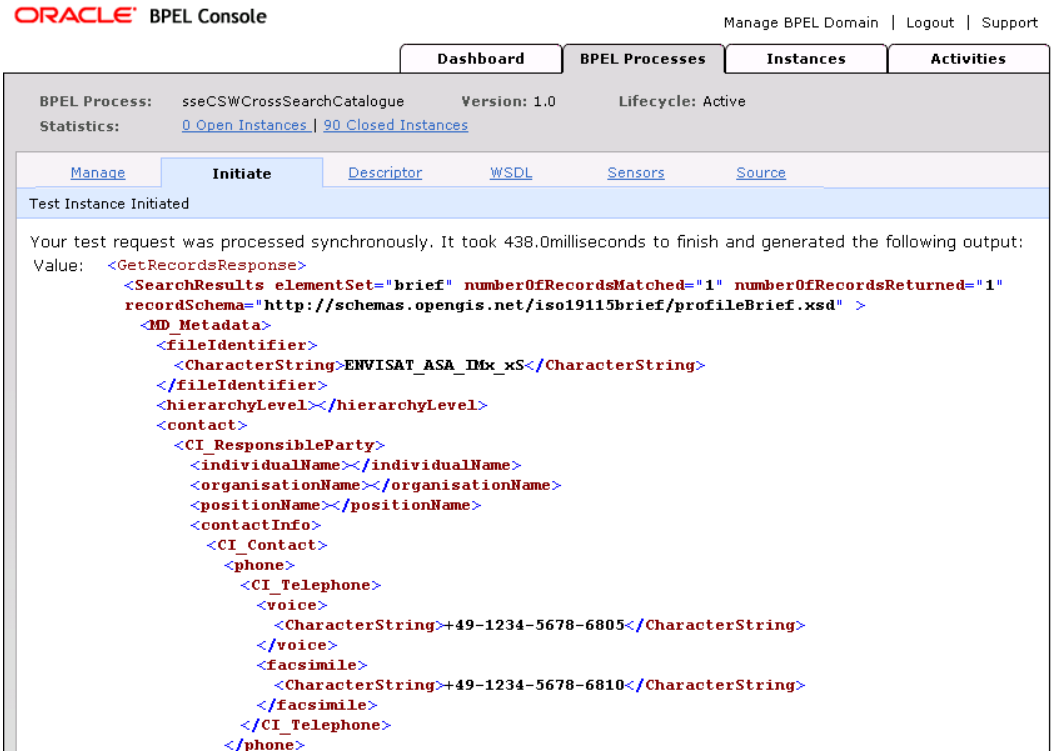

Figure 13: Test Response

Test Skeleton Client

A test skeleton can be used to validate the prototype before full integration with the service back end.

It allows simulating the interfaces for each of the following ICDs:

- Collection Catalogue - OGC 07-038, ISO Extension Package for ebRIM Application Profile, Version 0.1.8, 21/11/2007.
- (Product) Catalogue - OGC 06-131, Catalogue Specification 2.0.2, EO Extension Package for ebRIM Application Profile, 0.1.9, 14/05/2008.
- Ordering - OGC 06-141, Ordering Services for Earth Observation Products, Version 0.9.2, 27/09/2007.
- Programming - OGC 07-018, Sensor Planning Service Application Profile for EO Sensors, Version 0.9.5, 19/11/2007.
- User Management - OGC 07-118, User management Interfaces for Earth Observation Services, Version 0.0.2, 23/04/2008.

Service providers can simulate a service with synchronous operations that support any requests and their corresponding responses by configuring a test-case file for each operation. It is delivered with source code and could thus possibly also be used as starting point for the service interfaces implementation by the Partners.

The HMA Test Skeleton contains a server part as well as a Test Client. They can be used in a variety of combinations as explained in the use cases below:

SSE Client communicating with Test Skeleton.

The SSE Client can be used with the test services implemented by the configured Test Skeleton as shown in the figure below.

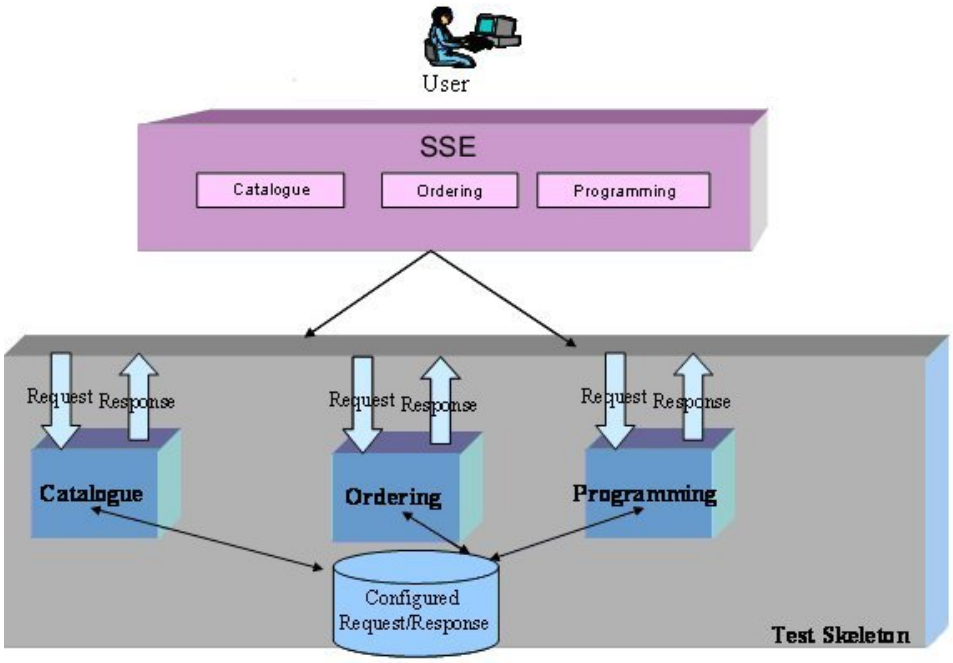

Figure 14: SSE Client communicating with Test Skeleton

This configuration allows testing the SSE client with dummy services until the actual services have been developed.

SSE Client communicating with deployed Services

The SSE Client can be used with the real Services. These services can take the delivered test skeleton source code as an implementation starting point as shown below.

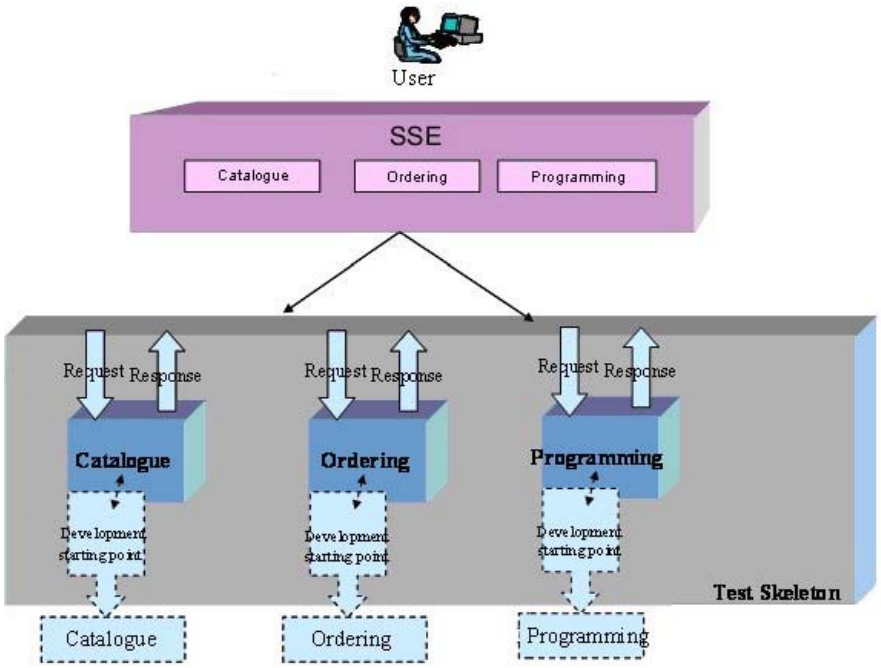

Figure 15: SSE Client communicating with deployed Services

- **Skeleton Client communicating with Test Skeleton as server**

A skeleton test client is delivered through which the user can issue requests and receive the configured corresponding reply from the test skeleton used as server.

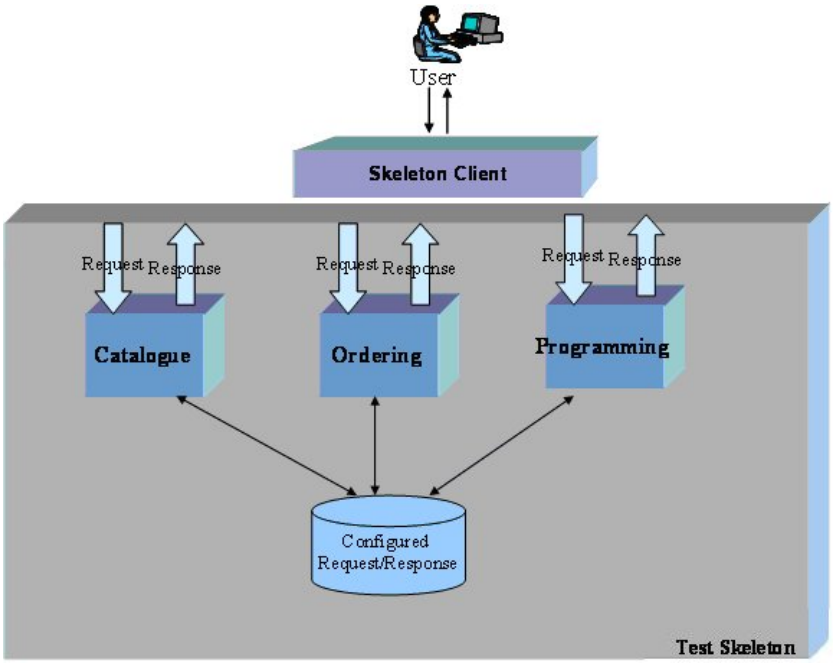

Figure 16: Skeleton Client communicating with Test Skeleton (server)

- **Skeleton Client communicating with deployed Services**

The test skeleton client can also be used to directly test the deployed services.

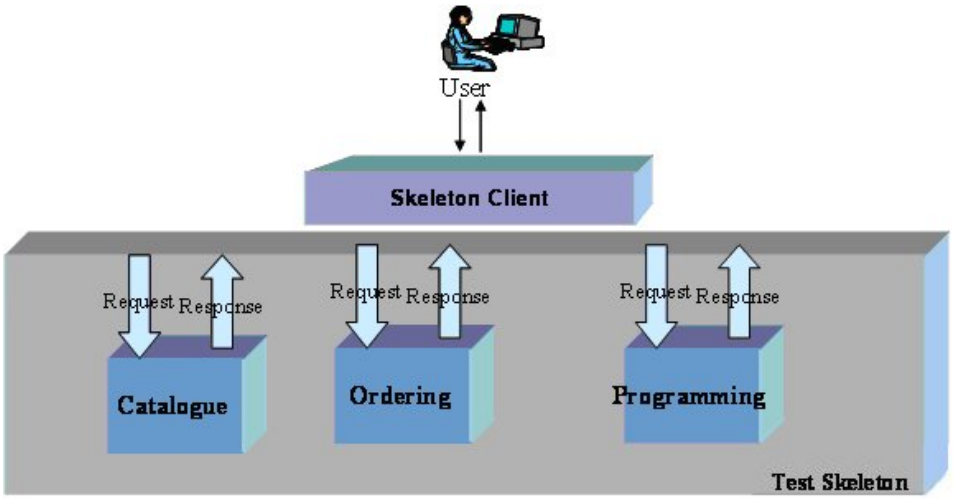

Figure 17: Skeleton Client communicating with deployed Services

This configuration allows to test his service interfaces before integrating the services in the target environment. Instead of pointing to the (local) Skeleton server, the skeleton client sends in this use case its requests to an external server.

WFS StyleSheet Wizard

The WFS StyleSheet Wizard allows you to generate the stylesheet files that configure the Web Feature Service client within the SSE Webmapviewer.

WMS Request Tester

The WMS Request Tester allows you to test the accessibility of your Web Map Service.

WFS Request Tester

The WFS Request Tester allows you to test the accessibility of your Web Feature Service.

WCS Request Tester

The WCS Request Tester allows you to test the accessibility of your Web Coverage Service.

GML/SLD Tester

The GML/SLD Tester allows you to test your GML and OGC Styled Layer Descriptor files (SLD).

OGC Compliance Tests

The HMA Compliance & Interoperability Testing & Evaluation (CITE) is a test engine for HMA standard services. The OGC compliance testing initiative (OGC/CITE) is currently using TEAM Engine software to assess conformance to OGC specifications

The Test, Evaluation, And Measurement (TEAM) Engine is a test script interpreter. It executes test scripts written in Compliance Test Language (CTL) to verify that an implementation of a specification complies with the specification. It provides a framework for performing automated functional testing of web services.

OGC Compliance Testing Portal currently provides a set of test scripts for a number of specifications.

HMA-T project schedules to provide reference implementations for the following HMA interfaces:

- HMA Catalogue Protocol OGC 06-131
- HMA Catalogue protocol OGC 07-038
- HMA User Management protocols OGC 07-118
- HMA Ordering protocols OGC 06-141
- HMA Programming protocols OGC 07-018
- OGC 07-063 WMS Profile for Earth Observation

while currently works to supply CITE conformance test scripts for the following HMA interfaces:

- HMA Catalogue Protocol OGC 06-131
- HMA Catalogue protocol OGC 07-038
- HMA User Management protocols OGC 07-118

2.3 Support to Outreach

ESA contribution includes also the support for a number of GEOSS related events at which presentations and demonstrations of the components proposed in the framework of the current AIP 2008 could be provided. The major identified events are:

- AIP Phase 2 Kick-Off Workshop on 25 and 26 September 2008 in Boulder (USA).
- GEO Plenary V to be held in November 2008 in Bucharest (Romania).
- Conclusion of Phase 2 AIP on 1st Quarter 2009.
- GEO Plenary VI (end 2009).

3 DESCRIPTION OF RESPONDING ORGANIZATIONS

ESA's contribution defined in the current proposal as answer to the AIP CFP 2008 is managed as part of the responsibilities of the ESA Earth Observation Programmes Directorate, Ground Segment Department. It is proposed in cooperation with several partners and coordinated with the Ground Segment Coordination Body and with the Ground Segment and Data Access activities under the GMES Space Component Programme. The contribution is coordinated by Mirko Albani (Mirko.Albani@esa.int).

3.1 GEOPORTAL

The GEOPortal is a contribution from ESA and FAO. Both organisations are GEO Participating Organisations and known to GEO. For general information please refer to www.esa.int and www.fao.org.

The GEOPortal Project Manager at ESA is Jolyon Martin (Jolyon.Martin@esa.int).

The FAO contribution is coordinated by John Latham (John.Latham@fao.org).

3.2 FedEO and SSE – Workflow, Conformance Testing and Test Environment

The organisations involved in FedEO (ESA, Eumetsat, OGC and the Disasters Charter represented by ESA and CNES) are known to GEO. SSE is a contribution from ESA.

For general information please refer to the following websites.

- European Space Agency – ESA : www.esa.int
- EUMETSAT: www.eumetsat.int
- Open Geospatial Consortium – OGC : www.opengeospatial.org
- Disasters Charter : www.disasterscharter.org
- French Space Agency – CNES : www.cnes.fr

The ESA Project Manager for FedEO and SSE is Pier Giorgio Marchetti (Pier.Giorgio.Marchetti@esa.int)

The EUMETSAT contribution is coordinated by Rafael Zarza (Rafael.Zarza@eumetsat.de).

The OGC contribution is coordinated by Ray Singh (rsingh@opengeospatial.org).

The Disasters Charter contribution is coordinated via CNES and ESA by Jerome Gasperi (Jerome.Gasperi@cnes.fr) and Jolyon Martin (Jolyon.Martin@esa.int).

ANNEX A

4 ARCHITECTURE DESCRIPTION OF THE PROPOSAL

4.1 The Methodology for Architecture Design

The proposed Service Oriented Architecture is designed and described making use of the RM-ODP model (Reference Model of Open Distributed Processing - RM-ODP - SO/IEC 10746-1:1998) [6]. The RM-ODP model has been modified to take into account the objective of addressing a digital library of distributed services rather than a distributed processing system for which the RM-ODP was originally defined.

The RM-ODP model analyses open distributed systems through 5 different views of the system and its environment:

- The enterprise viewpoint: focuses on the purpose, scope and policies for the system.
- The information viewpoint: focuses on the semantics of the information and information processing performed.
- The computational viewpoint: enables distribution through functional decomposition of the system into objects which interact at interfaces.
- The engineering viewpoint: focuses on the mechanisms and functions required to support distributed interaction between objects in the system.
- The technology viewpoint: focuses on the choice of technology in that system.

In the design of the proposed architecture, the RM-ODP was tailored by replacing the computational viewpoint with a service viewpoint as detailed in the following paragraphs. For the sake of this CFP response we'll limit our description to the enterprise, information and computational viewpoints, leaving the engineering and technology ones chapters for the CFP reports.

The following paragraphs have been written on the basis of information available in the documents:

- Architecture and Services for Computational Intelligence in Remote Sensing in Computational Intelligence for Remote Sensing Series: Studies in Computational Intelligence , Vol. 133 Grana, Manuel; Duro, Richard J. (Eds.) 2008, X, 394 p. 184 illus., Hardcover ISBN: 978-3-540-79352-6
- HMA Architectural Design Technical Note Version 1.7
- Service Support Environment Interface Control Document ME-ICD-0001-SPB http://services.eoportal.org/massRef/documentation/icd.pdf

4.2 Enterprise Viewpoint

4.2.1 Geoportal Enterprise Viewpoint

The GEOPortal provides an access point for GEOSS users to all the services/components made available to GEOSS (access to services/components is provided in cooperation with other Common Infrastructure elements, e.g. GEOSS Clearinghouses, and through the FedEO EO Community Clearinghouse). It provides a discovery and entry point towards the information relevant to SBAs.

4.2.2 FedEO Clearinghouse Enterprise Viewpoint

The FedEO EO Community Clearinghouse provides access and search capabilities towards EO catalogues implementing the OGC interfaces coming out of the HMA and HMA-T projects. Users can discover the collections and search within the collections for EO products (metadata).

4.2.3 SSE Enterprise Viewpoint

The Service Support Environment supports several use cases related to the prototyping, test and definition of data provision and data exploitation services and the support to community building via the "join and share" area which makes available a wiki, forums and blogs.

The environment empowers data owners and service providers by offering them the possibility to **prototype, test and conformance test,** advertise and integrate new and existing services. They are provided with cost-effective tools based on open standards allowing them to publish and manage their services as well as monitor their use whilst keeping control over the services backend on their local infrastructure. These services can be combined with other services that may possibly be provided by third parties hereby facilitating the definition of advanced value-adding services on EO imagery by distributing the processing steps over different specialists. Service providers can offer these services via the Portal pages allowing discovery of their services via a virtual service and data registry or catalogue.

SBAs benefit from this environment as it brings together distributed EO services and EO products offered by multiple service providers. Via this common access point (accessible from the Web Portal or from a service registry or catalogue), the end-user can more easily discover services and products matching his exact requirements. EO product, collection and service catalogues for multiple missions of different satellite operators are offered within a single environment and are linked with data access, programming (planning of sensors' acquisitions), ordering and processing services hereby offering a one-stop solution for users of EO data and services.

The enterprise viewpoint thus addresses following high level objectives:

- provide a neutrally managed overarching infrastructure enabling the interactions among service providers and with end-users;
- permit service prototyping, test and interaction whilst avoiding the service de-localisation (i.e. services remain on the service provider infrastructure);
- allow easy publishing and orchestration (i.e.: chaining of services into more complex ones) of synchronous and asynchronous EO services for online and offline processes;
- support "subscription" type services and standing orders (e.g. fires active monitoring and alerting);
- support the evolution and maintenance of services;
- allow easy identification of, and access to requested services and products, with progress follow-up until completion;
- integrate services from multiple domains, e.g. geospatial, meteorological, in-situ, to exploit multi-domain synergies;
- minimise service provider investments by building on open standards.

4.3 Information viewpoint

The information viewpoint specifies the modelling of all categories of information that the proposed architecture deals with, including their thematic and spatio-temporal characteristics as well as their metadata. The following information viewpoint description is valid for the Geoportal, FedEO Clearinghouse and Service Support Environment.

4.3.1 Service Metadata Information Model

This service metadata needs to provide the details to allow for machine-to-machine communications but also contain descriptive information targeted at human readers. This service metadata can be modelled according to ISO 19119.

In addition this ISO 19119 information model offers the possibility to couple services to data metadata. This is required for services that are considered to be tightly coupled with datasets or datasets collections, as for instance EO product catalogue or ordering services that allow respectively the discovery and ordering of products pertaining to specific collections.

This ISO 19119 standard defines the model for geographic services metadata; it however does not specify the exact XML grammar to be employed. This is dealt with in the draft ISO 19139 standard [9] that describes the transformation of the abstract UML models into XML schema.

4.3.2 EO Collection Metadata Model

EO collections are collections of datasets sharing the same product specification. An EO collection can be mapped to "dataset series" in ISO terminology. In the Earth Observation context, a collection typically corresponds to the series of datasets (i.e. products) derived from data acquired by a single sensor onboard a satellite or series of satellites and having the same mode of operation. Examples of EO collections are for instance "TerraSAR-X spotlight mode" or "ESA ENVISAT MERIS Full Resolution L1+2".

The metadata of EO collections can be described by employing the ISO 19115 standard for Geographic Metadata.

As for the services information model, this ISO 191115 standard does not specify the exact XML encoding of metadata documents, this is dealt with in the ISO 19139 standard that was referenced above.

4.3.3 EO Product Metadata Model

The most important information model in the EO-related Service Support Environment is the EO product metadata which has been based on the Open GeoSpatial Consortium - OGC Geography Mark-Up Language - GML. GML is a modelling language and XML encoding for the transport and storage of geographic information, including both the geometry and properties of geographic features.

4.4 Computational (Service) Viewpoint

The computational viewpoint in the RM-ODP is replaced within the proposed architecture by the service viewpoint: It specifies the services that support the syntactical and semantic interoperability between the services. Service oriented architectures like the one proposed shall place no restrictions on the granularity of a (Web) service that can be integrated. The grain size can range from small (for example a component that must be combined with others to create a complete business process) to large (for example an application). It is envisaged to support two main categories of services:

Basic services are limited services running on the service providers' local infrastructure. Basic services may be requested (ordered) via the Portal's user interface, or from within a composite service (or workflow).

Composite services are services consisting of a combination of basic services or other composite services. A service provider using the graphical workflow definition tools provided by SSE can model composite services. Composite services can comprise services provided by different service providers.

Another way of dividing services into categories relates to the specific functions performed by the service. The following set of specific EO data access services has been defined to specifically support the GMES Programme:

- Collection and service discovery;
- Catalogue Service;
- Sensor Planning Service (Product Programming)
- Order;
- Orchestration Service;
- Processing Services.

This Service Viewpoint defines these different services from a functional point of view. The interfaces with which all of these services are implemented form the subject of the Technology Viewpoint that is described below.

4.4.1 Collection and Service Discovery

An end-user typically uses collection discovery to locate dataset collections meeting the needs of his application domain e.g. urban planning, precision farming etc.

The service discovery service then provides access to the services that operate on these dataset collections, e.g. catalogue, ordering, data access or programming services.

Name	Collection Discovery Service	
Taxonomy	Model/Information management services	
Category	Application Service	
Standard Specifications	OGC™ 07-038 Cataloguing of ISO Metadata (CIM) using the ebRIM profile of CS-W	
Extension of		
Description	This service provides a set of functionalities for the user/operator or for applications to insert, search and retrieve structured information on the collections offered as part of the HMA architecture. This service is used for storing metadata of data set collections and subscriptions.	
Service Operations		

GetCapabilities	Description	The mandatory GetCapabilities operation allows a client to retrieve collection metadata from a server. The response to a GetCapabilities request is an XML document containing service metadata about the server.
	Input	
	Output	Collection metadata.
GetRecords	Description	This mandatory operation allows querying the list of available collections.
	Input	Required results format, sorting criteria, filtering criteria.
	Output	Metadata of the collections matching the input parameters.
GetRecordById	Description	The GetRecordById operation provides a simple means of retrieving one or more records by identifier; the identifier may be that of some registry object (rim:RegistryObject/ @id) or an external identifier (rim:ExternalIdentifier/ @value) assigned to a registry object.
	Input	Identifier of the item to retrieve
	Output	The record having the required identifier.
DescribeRecord	Description	The DescribeRecord operation allows a client to discover the information model(s) supported by the service and to retrieve record type definitions.
	Input	List of type names that are to be described by the catalogue.
	Output	Description of the requested types.
GetDomain	Description	The optional GetDomain operation produces a description of the value domain of a given data element or request parameter, where the value domain is the set of actual or permissible values. The value domain may be enumerated or non-enumerated. One use of this operation is to discover 'active' terms in taxonomy that are currently used to classify registry objects.
	Input	Name of property or interface parameter for which value domain information is desired
	Output	Allowed values

GetRepositoryItem	Description	The GetRepositoryItem operation is used to retrieve the repository item corresponding to some extrinsic object. If available, the item is included in the body of the response; it must be an instance of a MIME media type, as indicated by the value of the Content-Type header field. An extrinsic object may also be used to catalogue an external repository item that is managed by another party. In this case, the ExtrinsicObject must be associated (using the "RepositoryItemFor" association) with an ExternalLink that specifies an absolute URL for retrieving the item.
	Input	Absolute URI that refers to some extrinsic object.
	Output	If the request is processed successfully and a repository item is accessible, the body of the response message shall include the repository item as a MIME entity. If any additional encodings have been applied to the resource (e.g., compression using gzip), these must be specified by the Content-Encoding header field.
Transaction	Description	This operation allows to insert / delete / update single metadata records already loaded in the server.
	Input	Collection metadata to be inserted / updated / deleted
	Output	The transaction response message conveys two pieces of information. First of all, it reports a summary of the transaction by indicating the number of records created, updated or deleted by the transaction. Secondly, the transaction response message indicates the results of each insert operation found in the transaction.

Harvest	Description	The Harvest operation allows a user to request that the catalogue attempt to harvest a repository item from a specified network location, thereby realizing a 'pull' model for publishing registry content. If the catalogue successfully retrieves the resource and successfully processes it, then one or more corresponding registry objects are created or updated. Brief representations of all modified records are returned to the client when processing is complete. The Harvest operation has two modes of operation, controlled by a flag in the request. The first mode of operation is a synchronous mode in which the service receives a Harvest request from the client, processes it immediately, and sends the results to the client while the client waits. The second mode is asynchronous in that the server receives a Harvest request from the client, and sends the client an immediate acknowledgement that the request has been successfully received.
	Input	URI of the remote catalogue to be harvested; the type and the format of data to harvest; the sync / async flag.
	Output	In sync mode it returns the summary of the data retrieved by the remote catalogue; in async mode it returns immediately an acknowledge and later, at the address specified in the request, it returns the summary of harvested data.
Example usage		
Comments		

Table 2: Collection Discovery Service

Name	Service Discovery Service	
Taxonomy	Model/Information management services	
Category	Application Service	
Standard Specifications	OGC™ 07-038 Cataloguing of ISO Metadata (CIM) using the ebRIM profile of CS-W	
Extension of		
Description	This service provides a set of functionalities for the user/operator or for applications to search and retrieve structured information on the "Human Readable Services" offered as part of the HMA architecture.	
Service Operations		

GetCapabilities	Description	The mandatory GetCapabilities operation allows a client to retrieve service metadata from a server. The response to a GetCapabilities request is an XML document containing service metadata about the server.
	Input	
	Output	Service metadata.
GetRecords	Description	This mandatory operation allows querying the list of available services.
	Input	Required results format, sorting criteria, filtering criteria.
	Output	Metadata of the service matching the input parameters.
GetRecordById	Description	The GetRecordById operation provides a simple means of retrieving one or more records by identifier; the identifier may be that of some registry object (rim:RegistryObject/@id) or an external identifier (rim:ExternalIdentifier/@value) assigned to a registry object.
	Input	Identifier of the item to retrieve
	Output	The record having the required identifier.
DescribeRecord	Description	The DescribeRecord operation allows a client to discover the information model(s) supported by the service and to retrieve record type definitions.
	Input	List of type names that are to be described by the catalogue.
	Output	Description of the requested types.
GetDomain	Description	The optional GetDomain operation produces a description of the value domain of a given data element or request parameter, where the value domain is the set of actual or permissible values. The value domain may be enumerated or nonenumerated. One use of this operation is to discover 'active' terms in taxonomy that are currently used to classify registry objects.
	Input	Name of property or interface parameter for which value domain information is desired
	Output	Allowed values

GetRepositoryItem	Description	The GetRepositoryItem operation is used to retrieve the repository item corresponding to some extrinsic object. If available, the item is included in the body of the response; it must be an instance of a MIME media type, as indicated by the value of the Content-Type header field. An extrinsic object may also be used to catalogue an external repository item that is managed by another party. In this case, the ExtrinsicObject must be associated (using the "RepositoryItemFor" association) with an ExternalLink that specifies an absolute URL for retrieving the item.
	Input	Absolute URI that refers to some extrinsic object.
	Output	If the request is processed successfully and a repository item is accessible, the body of the response message shall include the repository item as a MIME entity. If any additional encodings have been applied to the resource (e.g., compression using gzip), these must be specified by the Content- Encoding header field.
Transaction	Description	This operation allows to insert / delete / update single service metadata records already loaded in the server.
	Input	Service metadata to be inserted / updated / deleted
	Output	The transaction response message conveys two pieces of information. First of all, it reports a summary of the transaction by indicating the number of records created, updated or deleted by the transaction. Secondly, the transaction response message indicates the results of each insert operation found in the transaction.

Harvest	Description	The Harvest operation allows a user to request that the catalogue attempt to harvest a repository item from a specified network location, thereby realizing a 'pull' model for publishing registry content. If the catalogue successfully retrieves the resource and successfully processes it, then one or more corresponding registry objects are created or updated. Brief representations of all modified records are returned to the client when processing is complete. The Harvest operation has two modes of operation, controlled by a flag in the request. The first mode of operation is a synchronous mode in which the service receives a Harvest request from the client, processes it immediately, and sends the results to the client while the client waits. The second mode is asynchronous in that the server receives a Harvest request from the client, and sends the client an immediate acknowledgement that the request has been successfully received.
	Input	URI of the remote catalogue of services to be harvested; the type and the format of data to harvest; the sync / async flag.
	Output	In sync mode it returns the summary of the data retrieved by the remote catalogue; in async mode it returns immediately an acknowledge and later, at the address specified in the request, it returns the summary of harvested data.
Example usage		
Comments		

Table 3: Service Discovery Service

4.4.2 Catalogue Service

The catalogue service allows a user to find datasets or products within a discovered dataset collection that meet specific search criteria such as time, geographic extent, cloud cover, snow cover, polarisation etc. and gives access to all dataset metadata available in a catalogue. As explained within the information viewpoint, these product metadata vary depending on the type of mission: optical, radar or atmospheric.

Name	Catalogue Service
Taxonomy	Model/Information management services
Category	Application Services

Standard Specifications	OGC 06-131 OGC Catalogue Services Specification 2.0, EO Extension Package for ebRIM (ISO/TS 15000-3) Application Profile	
Extension of		
Description	The Catalogue service provides a set of functionalities for the user/operator to search and retrieve metadata and browse images for the catalogued EO products from the missions being part of the HMA infrastructure. This service allows user/operator to find the EO products matching their needs. Catalogue searches can specify: The collection (e.g. Envisat_ASAR, ERS_SAR, etc) The ROI (e.g. one or more rectangles / circles / polygons) The time windows of interest Mission specific parameters e.g. orbit, pass direction, swath, track number, frame number, etc. Note that some EO catalogues contain entries for future planned and potential (i.e. products predictable through orbit swath propagation) products. The access to a catalogue service is subject to user authorization.	
Service Operations		
GetCapabilities	Description	The mandatory GetCapabilities operation allows clients to retrieve service metadata from a server. The response to a GetCapabilities request is an XML document containing service metadata about the server. In particular it returns also the list of supported schemas (e.g. hma, ohr, sar, ..), the queryable attributes and the supported type names.
	Input	
	Output	Service metadata.
GetRecords	Description	This operation allows querying the catalogued EO product records.

	Input	Filtering criteria: Region of interest Time window Sensor Specific attributes e.g. orbit, track, pass, etc. Desired results format (e.g. hits, records with brief format, record identifier, etc.)
	Output	Depending on specified results format: Number of hits or Product metadata records
GetRecordById	Description	This operation allows retrieving the details of product metadata items. In order to support the ordering, the returned items have to be provided with sufficient information to order them. Several types of record composition are supported (summary, full).
	Input	The identifiers of the products to get detailed information.
	Output	Metadata for each identified record containing the attributes corresponding to the required level of presentation (Brief, Full, Browse, Summary)
DescribeRecord	Description	The mandatory DescribeRecord operation allows a client to discover elements of the information model supported by the target catalogue service.
	Input	List of type names that are to be described by the catalogue.
	Output	Description of the requested types.
Example usage		
Comments		

Table 4: Catalogue Service

4.4.3 Order Service

A user accesses the ordering service to order datasets referenced from within the (distributed) catalogue service. He can also order future products, not yet in the catalogue by using the programming service.

Name	Order Service	
Taxonomy	Model/Information management services	
Category	Application Services	
Standard Specifications	OGC 06-141 Ordering Services for Earth Observation Products	
INSPIRE	No corresponding service found.	
Extension of	OpenGIS Catalogue Services – Best Practices for EO Products OGC-05-057r4	
Description	This service provides a set of functionalities for the user/operator to place orders for the catalogued EO products and for adhere to subscriptions from the missions being part of the HMA infrastructure. This service allows the clients to perform the following activities: Get the service capabilities: retrieval of the supported version, the supported operations, etc. Order options retrieval (scene selection options, processing options, media definition, subscription sub-setting, etc.). Order Quotation: for getting a quotation of the order going to be submitted. Order submission Order monitor: to check the status of submitted orders. Order Cancellation: to cancel an on-going order. Retrieval of on-line available products. During the order execution the user can query the status of his / her orders or also cancel the orders. The services should verify any constraints that may be imposed on users, and report status and relevant information back to the user The full specification of operations and input and output parameters are provided in [AD05]. In the following the operations, input and output parameters are briefly summarized.	
Service Operations		
GetCapabilities	Description	The mandatory GetCapabilities operation allows clients to retrieve service metadata from a server.

		The response to a GetCapabilities request shall be an XML document containing service metadata about the server, including specific information about a Order Service.
	Input	
	Output	Service and operation metadata.
GetOptions	Description	This operation allows the retrieval of the options for ordering products of a specific collection or for customizing the parameters of a subscription.
	Input	CollectionId: it is the identifier of the collection to issue requests. Optional identifier of the product to order (for getting product specific options). userInformation: identification information about the user who issues the request.
	Output	Array of all possible combinations of ordering options.
GetQuotation	Description	This operation allows the client to get a quotation of the order that is going to be submitted. This operation has to be supported by HM and GS Services instances. This operation can be used in synchronous and asynchronous mode: it depends on the client and server capabilities. If the server is able to provide a quotation in real time, the quotation can be included in the output message of GetQuotation; otherwise the quotation is sent to the client by calling the GetQuotationResponse operation provided by the client it self.
	Input	userInformation: identification information about the user who issues the request. Order specification: it is the order going to be submitted (see Submit operation).
	Output	Completion result of the quotation request. Either the quotationId, in case of asynchronous usage; Or the quotation itself in case asynchronous usage.
Submit	Description	This operation allows submitting an order of precisely identified non-future products or for subscribing to EO products. This operation is asynchronous: it returns only an

		acknowledgement on the request including the orderId and the completion result of the submission. Depending on the required status notification, the progress of the order can be notified to the client by calling its SubmitResponse operation.
	Input	userInformation: identification information about the user who issues the request. Order specification: Delivery information: method for disseminating products to the user (FTP push, FTP pull, mail) Invoice address; List of order items: Product identifier: it is the identifier of the item to order. In case of product orders it has to specify a pair of strings: the first identifies the product, the second, optional, identifies the collection the product is related to. In case of subscription only the collection id has to be specified. options: list of selected processing options (e.g. NRT / OFFLINE, level of processing, etc.) or subscription parameters (e.g. expiration date, sub-area of interest, etc.) Scene selection options: specification of the scene to be extracted from the parent product. The scene can be defined either providing the scene centre coordinates, or the start and stop time or some provider specific parameters (e.g. frame number). Not applicable to subscriptions. Delivery method and medium of the single item. Additional user added item info (orderITemRemark). Payment information: Either Order account: Account under which the user is authorised to order from the specific provider. Or credit card info. Alternatively the order can be specified providing the identifier of the quotation, in case the quotation has been provided and accepted by the client.
	Output	This operation returns: The completion result of the order submission;

		The identifier of the submitted order. The operation is asynchronous: it returns quickly the result of the order submission without waiting for the completion of the order.
GetStatus	Description	This operation allows retrieving the status of submitted product orders. This operation allows two different type of requests: Retrieval of the status of an order providing its identifier. Retrieval the status of all orders which have been updated (i.e. which have done some progress) after a specified date.
	Input	userInformation: identification information about the user who issues the request. lastUpdate: it is alternative to the next one. It is used for issuing the second of type of requests described above. OrderId: it is the identifier of the order to retrieve the status (first type of requests described above).
	Output	List of product order status. For each item the following information is returned: The whole submitted product order including also the status for each ordered item. The product order identifier. The status at order level: order state (e.g. BeingProcessed, Completed, Cancelled) and a textual description.
Cancel	Description	This operation allows asking the cancellation of an already submitted order.
	Input	userInformation: identification information about the user who issues the request. orderId: it is the identifier of the product order to be cancelled.
	Output	This operation returns: The completion result of the cancellation request; The operation is asynchronous: it returns quickly the result of the cancellation request without waiting for the completion of the cancellation. The progress of the cancellation of the order can be monitored with GetStatus operation.

DescribeResultAccess	Description	This operation is in charge of returning the URLs of products ordered specifying on-line delivery.
	Input	userInformation orderId flag specifying whether the URLs of all ready products have to be delivered or only the new one with respect the previous call.
	Output	URLs of the products ready for being accessed.
Example usage		
Comments		

Table 5: Ordering Service

4.4.4 Sensor Planning Service for EO products (Programming Service)

Name	Programming Service
Taxonomy	Model/Information management services
Category	Application Services
Standard Specifications	OGC 07-018 Opengis Sensor Planning Service Application Profile for EO Sensors
INSPIRE	No corresponding service found.
Extension of	
Description	The programming service provides a set of functionalities for the user/operator to: • Perform feasibility analysis of EO future products i.e. to check whether the request can be fulfilled considering the satellite and sensor characteristic, meteorological conditions and mission workload. The analysis can be performed at different level of accuracy: light, the check takes into account physical characteristic of the satellite / sensor; estimate, with respect the previous one it adds also possible meteorological data and the estimated workload of the satellite; full, with respect the previous it takes into account the work load of the satellite. • The lower levels are performed at HMA level, the highest level is performed at ground segment level (the mission

	workload is not normally made available at HMA level). Issue future EO products requests The programming service supports the following 3 types of requests: Order of precisely identified future products. This type of orders are referenced as Acquisition Orders; Order asking the coverage of specified area in a specified time window. This type of orders are referenced as Coverage Orders; Same as the previous one, but the coverage is repeated several times with a defined periodicity. A request to the Programming Service is generally referred to "Programming Request". An order for future products is referred to "task". This service allows the clients to perform the following activities: Retrieval of the programming parameters related to the specified product / sensor; Definition of the programming request and checking the feasibility; Submission of the programming request; Programming request status monitoring; Possible cancellation of the submitted request; Issuing of status notification. Retrieval of acquired data. In order to autonomously accomplish the feasibility analysis, the service has to receive / harvest satellite/sensor characteristics. The parameters are received via files (ROP files) or are harvested by calling DescribeSensor operation implemented by GS Programming Services. In the following the operations, input and output parameters are briefly summarized.	
Service Operations		
GetCapabilities	Description	The mandatory GetCapabilities operation allows clients to retrieve service metadata

		from a server. The response to a GetCapabilities request shall be an XML document containing service metadata about the server, including specific information about the Programming Service.
	Input	
	Output	Service and operation metadata.
DescribeSensor	Description	This operation provides detailed information about the specified sensor e.g.: average orbit period, orbit inclination, WRS information, incidence angle, reference swaths, etc.
	Input	sensor identifier.
	Output	Satellite and sensor parameters.
EstimateSensorWorkload	Description	The EstimateSensorWorkload provides information about the estimated workload of the requested sensor. This information is under the responsibility of each mission and must be accessible on demand by the SPS server. The SPS service has to maintain up to date information of such workload by harvesting the information to the mission on regular basis (weekly, or monthly) The minimal information provided by the mission is as follows: Temporal domain: begin date, end date, Temporal resolution: number of days (i.e. how many days between two consecutive values in a mesh), Spatial domain: lat min, lat max, long min, long max (somewhat similar to "Area of service"), Spatial resolution: size of the meshes, expressed in degrees, minutes or in km Further on, the following information has to be provided for each mesh: mesh location: lat-long coordinates of the mesh centre, mesh date or range of dates workload value: percentage of the resource already booked on this mesh at

		this date
	Input	sensorId
	Output	Description of the estimated workload
DescribeGetFeasibility	Description	This operation describes the list of input and output parameters of GetFeasibility operation.
	Input	sensor identifier
	Output	Array of input parameters required for the feasibility analysis of the specified sensor Array of parameters returned by the feasibility analysis of the specified sensor.
DescribeSubmit	Description	This operation describes the list of input and output parameters of Submit operation.
	Input	sensor identifier
	Output	Array of input parameters required for issuing a tasking request for the specified sensor. Array of parameters returned by the Submit operation.
GetFeasibility	Description	This operation allows asking the system to verify the feasibility of the specified programming requests. This operation is asynchronous: it returns only an acknowledgement on the request including the feasibilityID. The actual result is sent to the client by calling the GetFeasibilityResponse client's operation.
	Input	Notification: the method for notifying the caller of this operation about the result of the feasibility analysis. List of sensor parameters: one sensor task can be specified within the GetFeasibility specifying the parameters described by DescribeGetFeasibility.
	Output	Completion result specifying the feasibility of the programming request with the feasibilityID, which identifies the analysed request.
Submit	Description	This operation allows submitting a programming request.

		It allows to submit a previously analysed request (i.e. checked by GetFeasibility operation), in this case the request can be submitted specifying only the feasibilityID returned by the GetFeasibility; it allows also to submit a new request not previously checked, in this case all parameters have to be provided. This operation is asynchronous: it returns only an acknowledgement on the request including the taskID. The actual result is sent to the client by calling the SubmitResponse client's operation.
	Input	Notification: the method for notifying the client about the result of this operation. One task can be specified within the Submit operation providing either: feasibilityID: in case of sensor task already checked it is sufficient to send the identifier returned by GetFeasibility In case of non checked sensor task, the full set of sensor parameters have to be provided. Delivery information: method for disseminating products to the user (FTP push, FTP pull, mail)
	Output	The taskID The status of the submitted task Possible alternatives in case the requested task in not feasible. The operation is asynchronous: it returns quickly the result of the submission without waiting for the completion of the programming activity.
GetStatus	Description	This operation allows retrieving the status of submitted programming requests.
	Input	taskID: it is the identifier of the programming request task to retrieve the status.
	Output	Status of the specified task. It can include also the list of acquired scenes.

Update	Description	This operation allows a client to update a previously submitted task.
	Input	taskID: it is the identifier of the programming request task to retrieve the status. Tasking parameters
	Output	Completion result of the update operation.
Cancel	Description	The Cancel operation cancels a previously requested task.
	Input	taskID: it is the identifier of the sensor task to cancel.
	Output	This operation returns: The completion result of the cancellation request; The operation is asynchronous: it returns quickly the result of the cancellation request without waiting for the completion of the cancellation. The progress of the cancellation of the order can be monitored with GetStatus operation.
DescribeResultAccess	Description	This operation, in case no delivery information has been specified in the Submit operation, allows Programming Service clients to retrieve information about where the observed data can be accessed from. This access source may be a SOS, WMS, WFS or any other OGC Web Service that provides data.
	Input	taskID: it is the identifier of the sensor task to retrieve the data.
	Output	URL of the service to get the observed data. The identifier of the products resulting from the tasking request.
Example usage		
Comments		

Table 6: Programming Service

4.4.5 Orchestration Service

Service orchestration, based on the OASIS Business Process Execution Language – BPEL [21], allows for composition of Web services, typically from multiple service providers or ground segments which themselves become then available as Web services. The orchestration engine is the service used to execute the resulting composite services. The resulting workflows can also contain interactive steps, e.g. to model a service provider's internal authorisation processes.

Name	Orchestration Service	
Taxonomy	Workflow/ Task Management Service	
Category	Architecture Service	
Standard Specifications	OASIS BPEL XLANG, WSFL, WSDL W3C ws-addressing W3C ws-choreography	
INSPIRE	Invoke Spatial Data Services	
Extension of		
Description	This service allows designing and executing compound services. A compound service is defined by a workflow describing it in term of interactions among simple and / or compound services already defined. This is similar to defining a normal service. It means that you need to define the interface and to provide the definitions to implement that interface. The workflow is implemented based on the BPEL (Business Process Execution Language) technology.	
Service Operations		
CreateWorkflow	Desription	A workflow can be defined by an authorised user using a workflow (BPEL) editor. Supported workflows can be synchronous or asynchronous. The SSE will execute the workflows by using specific system APIs. Therefore, to make the workflow executable via the APIs, the workflow's definition must match the following constraints: For asynchronous interaction workflow: The workflow interface must have a start-up operation (be invoked to provide the workflow input) and an end operation (be invoked to return the workflow output). The xml messages assigned to the two operations must have part named "parameters". The start-up operation, which is implemented by

		using the BPEL receive function, must be named "initiate". In the workflow bpel.xml file, the callbackBindings must be set to "jms". This is to direct the workflow engine to deliver the workflow output into a JMS queue, in which the HMA portal application is listening for the workflow output. For synchronous interaction workflow: The workflow interface (the wsdl file) must be compliant to the SSE ICD. The workflow interface must have one and only one operation, named "main". The main operation is similar to an RPC style operation. The workflow input is stored in the operation's argument message and the workflow output is stored in the operation's return message. The xml messages (containing the workflow input and output), which are assigned to the operation "main", must have the part named "parameters".
	Input	
	Output	BPEL description of the Workflow ready to for packaging (.jar file)
PackageWorkflow	Description	Validate the workflow and package it ready for deployment
	Input	BPEL description of the Workflow ready to be deployed
	Output	Pockaged Workflow
DeployWorkflow	Description	Deploy a Packaged workflow within SSE. Once the workflow has been validated and packaged as a .jar file, you have to deploy it using the workflow console.
	Input	Workflow Package (.jar), Domain (Service Provider name)
	Output	
Example usage		
Comments	New Workflow definition is an activity restricted only to authorised users, e.g. Service Providers.	

Table 7: Orchestration Service

4.4.6 Processing Services

Extensive tests have been performed within the ESA Grid infrastructure leading to a preliminary definition of a Grid-based Processing Service. This with the objective of reducing the burden caused by the transfer of large EO coverages by transferring instead the processing algorithms on the Grid that hosts within its storage element the coverages to be processed.

The OGC Web Coordinate Transformation Service (WCTS) is another processing service that was experimented with, in combination with a Spot Image Web Coverage Service as described in the OGC OWS-3 Imagery Workflow Experiments and OWS-4 EO Sensor Planning Service experiments.