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OGC® FedEO Pilot Engineering Report

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Preface

This document was developed as part of the FedEO Pilot activity. This OGC Interoperability Program initiative was sponsored by the European Space Agency (ESA). The FedEO Pilot was conducted in conjunction with the GEOSS Architecture Implementation Pilot (AIP) initiative that started in June 2007 and finalized with a demonstration in November at the GEO Ministerial Summit of Cap Town, in South Africa. The demonstration videos results were presented at the OGC Boulder TC meeting in mid September.

Suggested additions, changes, and comments on this draft report are welcome and encouraged. Such suggestions may be submitted by email message to the authors or to the OGC.

Forward

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OGC® FedEO Pilot Engineering Report

1 Introduction

The OGC Interoperability Program (IP) is a global, innovative, collaborative, hands-on engineering and testing program designed to define, document, and test draft specifications or enhancements to existing OpenGIS specifications and to communicate the results of the initiative work to the OGC Technical Committee.

The primary purpose of OGC's IP is to bring Sponsors and Participants together in rapid, hands-on, collaborative engineering efforts to achieve one or more of the following objectives:

- Produce and test Candidate Implementation Specifications for geoprocessing interoperability;
- Perform research on the use of another IT information technology standard in terms of that standards relevance and ability to help solve geospatial interoperability problems;
- Develop and test prototype interoperable infrastructure based on those specifications;
- Demonstrate the work performed during a given initiative.

Interoperability initiatives are the primary programmatic vehicle of the OGC-IP. They are designed to be cooperative activities among sponsors, participants, and the IP Team, but most particularly among participants representing various member organizations. Such collaborative activities are composed of work items supported by designated work groups consisting of at least three to five participating organizations that are participating in the various relevant initiatives. This approach provides a means to rapidly develop and prototype specifications for the insertion into specification process in a way that considers various points of view, requirements, and objectives.

The Federated Earth Observations (FedEO) Pilot was conducted in conjunction with and support of the GEOSS Architecture Implementation Pilot (AIP). The FedEO pilot used and extended the GEOSS AIP Architecture with additional services, e.g, Product Programming, Service Orchestration, Processing Services, Orthorectification and Reprojection Services and Order Service.

The objectives of this Engineering Report, which is one of the two main outputs of the OGC IP Pilot with the demonstrative video (http://www.ogcnetwork.net/AIPdemos), are to address for consideration by the TC some requirements, Engineering Specifications, Testing Approach and Results, Compliance Test Design and obviously lessons learned and the next steps envisaged.

1.1 Scope

The Federated Earth Observation Missions (FedEO) Pilot provides a broad international venue for operational prototyping and demonstration of Earth Observation (EO) requirements and protocols as defined by the European Space Agency (ESA) , together with other space agencies (ASI, CNES, CSA, DLR) and users (EUSC) and by other OGC members. The FedEO Pilot applies and refines OGC specifications relevant to EO. The FedEO Pilot tests and validates OGC specifications in a business context, and provides feedback regarding their ability to improve access to and application of earth observation data and services. This Pilot is sponsored by ESA.

The FedEO Pilot will test and validate 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.

The FedEO pilot will offer a persistent service support and protocol demonstration and testing environment based on the ESA's Service Support Environment.

The FedEO Pilot will focus 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
- Sensor Planning Service for EO Sensors
- GML Application schema for Earth Observation products
- Improvements to Ordering Services for Earth Observation Products

Several of these documents have been developed within ESA's Heterogeneous Mission Accessibility (HMA) project which was started in the framework of the Global Monitoring for Environment and Security (GMES) Preparatory activities. The purpose of the HMA effort was to define the interoperability requirements across the ground segments of the European and Canadian missions which will contribute to the GMES initial phase. Consistent with HMA, the FedEO Pilot results will contribute to the Global Earth Observing System of Systems (GEOSS). Furthermore, the interoperability framework of the FedEO Pilot will allow harmonised access to the national and Eumetsat missions.

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1.2 Document contributor contact points

All questions regarding this document should be directed to the editor or the contributors:

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1.3 Revision history

Date	Release	Editor	Primary clauses modified	Description
April 07		Pier Giorgio Marchetti (ESA), Jolyon Martin (ESA), Corentin Guillo (EADS Astrium)		Original Contributors Annex B of the AIP Call For Participants
October 07	Version 0.1	Corentin Guillo (EADS Astrium)	Initial Draft	Initial version submitted for discussion to FedEO Pilot participants
07 November 07	Version 0.2	Corentin Guillo (EADS Astrium)	Draft	Initial draft version updated with : - ESA and OGC comments, - DATAMAT and INFOTERRA Ltd feedback
14 November 07	Version 0.3	Corentin Guillo (EADS Astrium)	Draft	Updated with : - FEDEO tests related to JAXA and GEO Clearinghouse candidates reported in ESIT-TN-0019-SPB and ESIT-TN-0020-SPB from SPACEBEL - General comments from OGC
16 November 07	Version 0.4	Corentin Guillo (EADS Astrium)	Draft	Conformance with ER template
Dec. 13 2007	Version 0.4	Carl Reed	DP	Get ready for posting as DP

1.4 Future work

Improvements in this document are desirable to the different RM-ODP view points from :

- The FedEO participants in order to post the IPR to the OGC Pending Document three weeks before the Stresa-Italy Technical Committee,
- The OGC members during the three-weeks rule in order to be adopted as an OGC Discussion Paper at the Stresa-Italy Technical Committee,
- The OGC members until the Saint-Louis-USA Technical Committee in order to be adopted as an OGC Best Practice for Earth Observation Resources Access.

2 References

The following documents are referenced in this document. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the normative document referred to applies.

- OGC 06-121r3, OpenGIS® Web Services Common Specification
- OGC Intellectual Property Rights Policy and Procedure http://www.opengeospatial.org/about/?page=ipr
- OGC Reference Model. http://orm.opengeospatial.org/
- OGC Interoperability Program, OGC Document 05-127-r1, 2005-03-20
- OGC Interoperability Pilot Policies and Procedures, OGC Document 05-131-r1, 2005-03-20
- Architecture Implementation Pilot - Call for Participation (CFP), GEO Task Team AR-07-02, CFP Issuance Date: 13 April 2007
- OGC Cataloguing of ISO Metadata (CIM) using the ebRIM profile of CSW, OGC Document 07-038 version 0.1.6
- OGC OpenGIS Sensor Planning Service Application Profile for Earth Observation Sensors, OGC Document 07-018 version 0.9.4
- OGC Ordering Services for Earth Observation Products, OGC Document 06-141 version 1.2.0
- OGC GML 3.1.1 Application Schema for Earth Observation products, OGC Document 06-080r2 version 0.9.1
- OGC OGC Catalogue Services Specification 2.0, Earth Observation Extension Package for ebRIM (ISO/TS 15000-3) Application Profile, OGC Document 06-131 version 0.1.4

- OGC Web Map Service – Application Profile for Earth Observation products, OGC Document 07-063 version 0.2.0
- OGC User Management Interfaces for Earth Observation Services, OGC Document 07-118r1 version 0.0.1
- GMES HMA – Architecture Design Technical Note (Proj. Ref. HMA-DD-DAT-EN-001)

3 Terms and definitions

3.1 Conventions

3.1.1 Symbols (and abbreviated terms)

3.1.2 UML notation

Most diagrams that appear in this specification are presented using the Unified Modeling Language (UML) static structure diagram, as described in Subclause 5.2 of the OGC Web Services Common Implementation Specification [OGC 04-016r2].

3.1.3 Document terms and definitions

This document uses the specification terms defined in Subclause 5.3 of [OGC 04-016r2].

4 FedEO overview

This document was developed during the FedEO - GEO AIP initiative of the OGC. It was contributed by the organizations involved in the Earth Observation and Natural Resources and Environment Domain Working Group (EO/NRE DWG) in the OGC Specification Program. The document describes recommendation for architecture and specification that enables interoperability between OGC services and clients in the Earth Observation domain.

The document is intended as a discussion paper. It does neither cancel nor replace other OGC documents in whole or in part.

Eight other documents are also planned as result of the FedEO Pilot:

- The OGC 07-038 Cataloguing of ISO Metadata (CIM) using the ebRIM profile of CSW
- The OGC 06-131 OGC Catalogue Services Specification 2.0, Earth Observation Extension Package for ebRIM (ISO/TS 15000-3) Application Profile
- The OGC 06-080r2 GML 3.1.1 Application Schema for Earth Observation products

- The OGC 06-141 Ordering Services for Earth Observation Products
- The OGC 07-018 OpenGIS Sensor Planning Service Application Profile for Earth Observation Sensors
- The OGC 07-063 Web Map Service – Application Profile for Earth Observation products
- The OGC 07-118r1 User Management Interfaces for Earth Observation Services

The model presented in this document is based on the Reference Model of Open Distributed Processing (ISO/IEC 10746-1:1998) which is an international standard for architecting open, distributed processing systems.

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5 Geospatial Architecture Implementation Pilot and FedEO

The OGC GEOSS AIP initiative was created in order to reach consensus on architectural elements that initiatives supporting geospatial information systems can carry forward into operations, thereby increasing the overall level of interoperability. It's objectives was to identify components with services (e.g. portals, catalogues…), to participate in conforming the interoperability of those identified services using standards and interoperability arrangements as identified in the architecture of the call for participants, and, participate in the collaborative development of societal benefit scenarios to guide testing and demonstrations of the identified interoperable services.

The OGC GEOSS AIP initiative was initiated to solicit response to the GEOSS Architecture Implementation Pilot, which aims to incorporate contributed components consistent with the GEOSS Architecture - using a GEOSS Web Portal and a GEOSS Clearinghouse search facility –to access services through GEOSS Interoperability Arrangements in support of the GEOSS Societal Benefit Areas. The GEO Task AR-07-02 will conduct this pilot consistent with the request of the GEO Plenary.

FedEO Pilot and the Tri-Lateral Interoperability PilotTwo have offered their collaboration with GEOSS by providing a broad assessment of capabilities and opportunities to address interoperability on a broad scale

5.1 GEOSS Architecture Implementation Pilot

The high-level objectives of this Pilot are:

1. To develop persistent demonstrations of end-user benefits of the contributed systems that interoperates using open standards.
2. To increase interoperability between the information systems and the associated services of the participating organizations, and
3. To advance the state of implementation of geospatial interoperability using open standards, in particular for Earth Observation data and information.

The GEOSS Architecture Implementation Pilot task aims to incorporate contributed components consistent with the GEOSS Architecture - using a GEOSS Web Portal and a GEOSS Clearinghouse search facility – or order to access services through GEOSS Interoperability Arrangements in support of the GEOSS Societal Benefit Areas. This pilot is GEO Task AR-07-02 conducted by the GEO Architecture and Data Committee.

5.2 Tri-Lateral Pilot (Section merges inputs from Doug and Ioannis)

The organizations responsible for national and regional "Spatial Data Infrastructures" in Europe (INSPIRE), Canada (GeoConnections), and the U.S. (FGDC) signed a tri-lateral arrangement document in January 2006 to formalize collaboration on applied geospatial standardization in an international context.

The Tri-Lateral Interoperability Pilot is a collaborative, open standards development, supporting collective requirements of governments with the knowledge and capabilities of academic, commercial, and non-commercial solutions providers. This pilot is sponsored by FGDC.

Participation in this Pilot invited the contribution of standards-based services that can be catalogued and accessed to support multiple international interests. The pilot builds on existing components addressing issues of desertification, land use and land cover change, deforestation, forest fires, hydrological resources and modelling, and resulting pressures on ecosystems and biodiversity made interoperable through the GEOSS architecture to provide support to decision-makers in Africa. Technical objectives of this pilot include tests of distributed access to catalogues' contents and protocols with particular interest into OGC Catalogue Service for the Web (CSW) catalogues i.e. ebRIM and ISO 19115/19119 and service registries i.e. UDDI and OASIS ebRS access. The WMS and WFS services will also be part of the Tri-Lateral Pilot.

5.3 Common Architectural Context

While each of the Pilots has its own objectives, there is a high degree of commonality of the architecture of the pilots. An aim of the collaborative Pilot is to reach consensus on architectural elements that initiatives in support of geospatial information systems can carry forward into operations, thereby increasing the overall level of interoperability.

The common architecture is based on the current "mainstream" approach to service oriented architecture (SOA) and was selected to provide the best opportunity for meeting the Pilot requirements. This architecture is not intended to determine the physical system configuration, but to identify the interfaces and protocols within the current mainstream SOA.

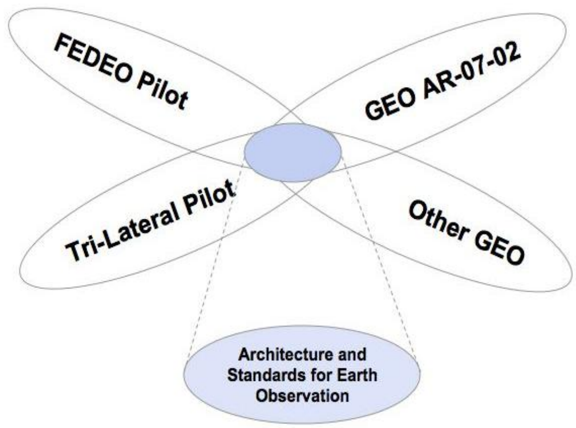


Figure 1 - Architecture for Coordinated Pilots

6 Process of the FedEO Architectural Design

The Reference Model of Open Distributed Processing (ISO/IEC 10746-1:1998) is an international standard for architecting open, distributed processing systems. It provides an overall conceptual framework for building distributed systems in an incremental manner. The RM-ODP standards have been widely adopted: they constitute the conceptual basis for the ISO 19100 series of geomatics standards (normative references in ISO 19119:2005), and they also have been employed in the OMG object management architecture.

The RM-ODP approach has been used in the design of the OpenGIS Reference Model (OGC 2003) with respect to the following two aspects:

- It constitutes a way of thinking about architectural issues in terms of fundamental patterns or organizing principles, and
- It provides a set of guiding concepts and terminology.

Systems resulting from the RM-ODP approach (called Open Distributed Processing systems, i.e.ODP systems) are composed of interacting objects whereby in RMODP an object is a representation of an entity in the real world. It contains information and offers services.

Based on this understanding of a system, ISO/IEC 10746 specifies an architectural framework for structuring the specification of ODP systems in terms of the concepts of viewpoints and viewpoint specifications, and distribution transparencies.

The viewpoints identify the top priorities for architectural specifications and provide a minimal set of requirements—plus an object model—to ensure system integrity. They address different aspects of the system and enable the 'separation of concerns'.

Five standard viewpoints are defined:

- The **enterprise viewpoint**: A viewpoint on the system and its environment that focuses of the purpose, scope and policies for the system.

- The **information viewpoint**: A viewpoint on the system and its environment that focuses on the semantics of the information and information processing performed.

- The **computational viewpoint**: A viewpoint on the system and its environment that enables distribution through functional decomposition of the system into objects which interact at interfaces.

- The **engineering viewpoint**: A viewpoint on the system and its environment that focuses on the mechanisms and functions required to support distributed interaction between objects in the system.

- The **technology viewpoint**: A viewpoint on the system and its environment that focuses on the choice of technology in that system.

The aspect of a distributed ODP system is handled by the concept of distribution transparency. Distribution transparency relates to the masking from applications of the details and the differences in mechanisms used to overcome problems caused by distribution. According to the RM-ODP, application designers simply select which distribution transparencies they wish to assume and where in the design they are to apply. The RM-ODP distinguishes between eight distribution transparency types. These distribution transparencies consider aspects of object access, failure of objects, location of objects, as well as replication, migration, relocation, persistence and transactional behaviour of objects.

An RM-ODP-based approach has been selected for the design of the FedEO Architecture as the primary objectives of RM-ODP like:

- support for aspects of distributed processing,

- provision of interoperability across heterogeneous systems, and

- hiding consequences of distribution to systems developers

are largely coherent with the FedEO objectives. However, as FedEO architectures have the characteristic of a loosely-coupled network of systems and services instead of a "distributed processing system based on interacting objects", the RM-ODP concepts are not followed literally.

The usage of RM-ODP for the FedEO Architectural design process focuses on the structuring of ideas and the documentation of the FedEO Architecture. Thus, a mapping of the RM-ODP viewpoints to the FedEO needs has been applied and summarised as follow:

- The enterprise viewpoint is concerned with the purpose, scope and policies governing the activities of the specified system within the organization of which it is a part. This viewpoint is intended to end users and stakeholder readership.

- The information viewpoint specifies the modelling of all categories of information the FedEO architecture deals with including their thematic, spatial, temporal characteristics as well as their metadata.

- The computational viewpoint referred to as "Service Viewpoint". It specifies the FedEO services that support the syntactical and semantic interoperability between ground systems, clients and FedEO components. These two last viewpoints are intended to analysts' readership.

- The technology viewpoint specifies the technological choices of the service infrastructure and the operational issues of the infrastructure.

- The engineering viewpoint specifies the mapping of the FedEO service specifications and information models to chosen service and information infrastructure. These two last viewpoints are intended to analyst and developers readerships.

7 Enterprise Viewpoint :

The enterprise viewpoint of FedEO is concerned with the business activities of the subject federated earth observation environment also known as SSE (Service Support Environment). These activities can be represented by two sets of use cases related to respectively the end-user of services and the service provider (or service owner).

End-users benefit from this environment as it brings together distributed EO products and EO data offered by multiple service providers. Via this access points (accessible from distributed Web Portals or from service registries or catalogues), the end-user can more easily discover services matching his exact requirements. This discovery is facilitated by the thematic and local distribution of FedEO Services. EO product, data collection and service catalogues for multiple missions of different satellite operators are offered within a distributed environment and are linked with data access, programming, ordering and processing services hereby offering a one-stop solution for users of EO services.

The environment empowers service providers by offering them the possibility to advertise and integrate their new and existing services within thus one stop Portals for EO data and EO products. Their simple or chained services would be promoted and provided to different level (local and thematic) Portals depending on the characteristic of the services. The distributed portals 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 products on EO imagery by distributing the processing steps over different specialists. Service providers can offer these services via the Portals pages or via a machine-to-machine “data access integration layer” allowing discovery of their services via a virtual service and data/products registry or catalogue.

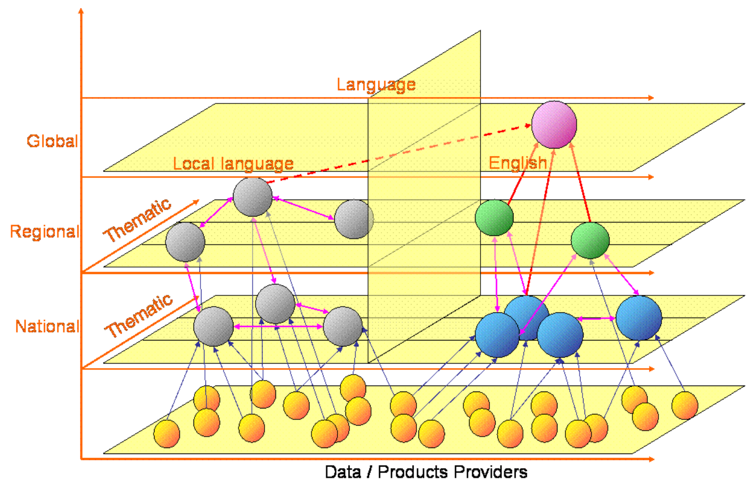


Figure 2 : Portals distributed network

The enterprise viewpoint thus addresses following high level objectives:

- provide a neutrally managed overarching distributed infrastructure enabling the interactions among products and data providers, service providers and with end-users,
- permit service interaction whilst avoiding the service de-localisation (i.e. services remain on the service provider infrastructure),
- allow easy publishing and orchestration of synchronous and asynchronous EO services for online and offline processes,
- allow chaining of services into more complex ones,
- 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,

- allow services/data providers to register, provide and promote their products to thematic or local portals,

- minimise service provider investments by building on open standards.

The objective of this FedEO architecture is to demonstrate the benefits of the protocols proposed in the technological viewpoint below with multiple scenarios. This will allow the services to be deployed as depicted in the bellowing

Figure 2 : global, regional and national with thematic scales.

The following services will be involved in the FedEO architecture:

- Collection and service catalogue discovery,

- Catalogue search service,

- Product Programming and Order,

- Online Data Access,

- Satellite Multicast Service,

- Orthorectification and re-projection services,

- Service Orchestration

Supported by a lower level services for:

- User Management

8 Information Viewpoint :

The information viewpoint describes the information that flows in a system and is processed by a system. It focuses on the structuring of semantic information, typically the information that are stored in a database and communicated between the components (services and clients) of a system. Hence this chapter deals with the modelling of the data FedEO has to manage, namely:

- Service & collection metadata (for Discovery services);

- Product metadata (for Catalogue service);

- Order, programming and subscription (for Order & Programming services);

- User Profile and authorization metadata (for User Management service);

- Web map, coverage and feature services (for Online Data Access)
- Workflow and Business Process (for Service Orchestration)

These data items are described in the following sub-sections.

8.1 Features, coverages, observations and maps

The starting point for modeling of geographic information is the geographic feature. A feature is an abstraction of a real world phenomenon. A geographic feature is a feature associated with a location relative to the Earth. A digital representation of the real world can be thought of as a set of features.

Any feature may have a number of properties that may be operations, attributes or associations. Any feature may have a number of attributes, some of which may be geometric and spatial. A feature is not defined in terms of a single geometry, but rather as a conceptually meaningful object within a particular domain of discourse, one or more of whose properties may be geometric.

Geographic phenomena fall into two broad categories, discrete and continuous. Discrete phenomena are recognizable objects that have relatively well-defined boundaries or spatial extent. Examples include buildings, streams, and measurement stations. Continuous phenomena vary over space and have no specific extent. Examples include temperature, soil composition, and elevation. A value or description of a continuous phenomenon is only meaningful at a particular position in space (and possibly time). Temperature, for example, takes on specific values only at defined locations, whether measured or interpolated from other locations.

These concepts are not mutually exclusive. In fact, many components of the landscape may be viewed alternatively as discrete or continuous. For example, a stream is a discrete entity, but its flow rate and water quality index vary from one position to another. Similarly, a highway can be thought of as a feature or as a collection of observations measuring accidents or traffic flow, and an agricultural field is both a spatial object and a set of measurements of crop yield through time.

Standardized conceptual schemas for spatial and temporal characteristics increase the ability to share geographic information among applications. These schemas are used by geographic information system and software developers and users of geographic information to provide consistently understandable spatial data structures.

A coverage is a feature that associates positions within a bounded space (its spatiotemporal domain) to feature attribute values (its range). Examples include a raster image, a polygon overlay, or a digital elevation matrix. Commonly used spatiotemporal domains include point sets, grids, collections of closed rectangles, and other collections of geometric objects. The range of a coverage is a set of feature attribute values. The attributes of a coverage, i.e., its range, are homogeneous across its domain. A Geographic imagery scene is a coverage whose range values quantitatively describe physical phenomena.

An observation is an event with a result which has a value describing some phenomenon. The observation event is modelled as a Feature within the context of the General Feature Model [ISO 19101, ISO 19109]. An observation feature binds a result to a feature of interest, upon which the observation was made. The observed property is a property of the feature of interest. An observation uses a procedure to determine the value of the result, which may involve a sensor or observer, analytical procedure, simulation or other numerical process.

A map is a portrayal of geographic information. While a map may be a digital image file suitable for display on a computer screen, a map is not the data itself.

GEOSS components utilize discrete features, coverages, observations and maps. Satellite imagery is a coverage and may be processed in to specific discrete features, e.g., hot spot points from a thermal-band image. Coverages and discrete Features are both need to support decision making by Societal Benefit Areas.

8.2 Spatial referencing

Spatial Referencing is accomplished is several ways including

- Terminology with spatial reference
- Coordinate reference systems

Many terms refer to locations near the surface of the earth, e.g., identifiers and place names. Spatial referencing with identifiers is when an identifier uniquely indicates a location, e.g., a postal code. Place names may be ambiguous, e.g, Springfield, requiring additional information to be resolved into a specific location. Gazetteers and geocoding are used to resolve the ambiguity.

Coordinates are unambiguous only when the coordinate reference system to which those coordinates are related has been fully defined. A coordinate reference system is a coordinate system that has a reference to the Earth. A coordinate reference system consists of a coordinate system and a datum. Types of coordinate reference systems include: geocentric, geographic (including an ellipsoid), projected, engineering, image, vertical, temporal. The datum defines the origin, orientation and scale of the coordinate system and ties it to the earth, ensuring that the abstract mathematical concept "coordinate system" can be applied to the practical problem of describing positions of features on or near the earth's surface by means of coordinates. Thousands of coordinate reference systems have been defined for various applications. The World Geodetic System (WGS) defines a coordinate reference system that is used with Earth Observation data. frame for the earth, for use in geodesy and navigation. The latest revision is WGS 84.

8.3 Collection Metadata

A dataset collection is a set of catalogue entries having a common set of characteristics. For the EO products, collections are generally associated to mission sensors and operation mode, e.g. a collection of all the TerraSAR-X spotlight mode data. The collection metadata describes these sets by providing the identifier, the description, the possible geographical and temporal extent, the common attributes, etc.

The metadata for collection has been modelled following the ISO 19115 standard.

8.4 Service Metadata

This is Human readable service metadata about available Earth Observation related services. It provides users sufficient information to assess and to access these services.

Whereas the metadata stored in the UDDI registry provides standard web-service discovery metadata used for example for service orchestration, this service discovery metadata is more tailored to the Earth Observation needs, e.g. it is in charge of answering questions like: finding an order service allowing ordering products of a specified collection; finding a Web Coverage Service returning products of a specific collection; etc.

This metadata is defined by identifying the minimum set of elements of the ISO 19119 Service Metadata which are sufficient for discovering the FedEO services.

The following concepts have to be represented in this Service Metadata:

- Services are defined by:
  - Identification info (e.g. contact information, usage restrictions, region/time period of applicability, etc.);
  - Operations and related parameters
  - Dependencies (i.e. how operations depend on results of other operations);
- Data metadata may be subject to restrictions and therefore
  - not visible for each user of the catalogue service
  - Access control not handled by the catalogue service natively

8.5 Product Metadata

This is the metadata used for describing the products derived by earth observation satellites that are managed by the Catalogue service of the FedEO architecture.

- Earth observation satellite products are mainly characterised by the following attributes:
- satellite and sensor acquiring the data;
- the time when the data has been acquired;

- the geographical coverage of the acquired data;
- the ground station receiving the satellite downlink;
- other attributes depending on the type of sensor:
    - for radar sensors possible relevant attributes are: polarization, Doppler frequency, swath identifier;
    - for optical sensors possible relevant attributes are: cloud coverage, the illumination angles;
    - for atmospheric sensors possible specific attributes are: vertical coverage, specy;

From user point of view the main characteristic of Earth Observation products is their geographical coverage and then, because GML provides a rich set of definitions for representing geographic objects, the representation of Earth Observation products is performed through GML application schemas.

Earth observation products are modelled with the EarthObservationProductType type which is an extension of GML AbstractFeatureType type. Because different product types derived by different type of sensors have different set of specific attributes, then the following approach has been followed:

- a namespace including definitions common to all sensors has been defined: eop
- a separated namespace for each class of sensor has been defined:
    - **sar** for radar sensors
    - **opt** for optical sensors
    - **atm** for atmospheric sensors
    - other namespaces can be defined for other classes of sensors
- additional specific namespaces can be defined on top of previous ones.

The EarthObservationProductType is defined in each namespace by extending the definition in the parent namespace leading to this hierarchy:

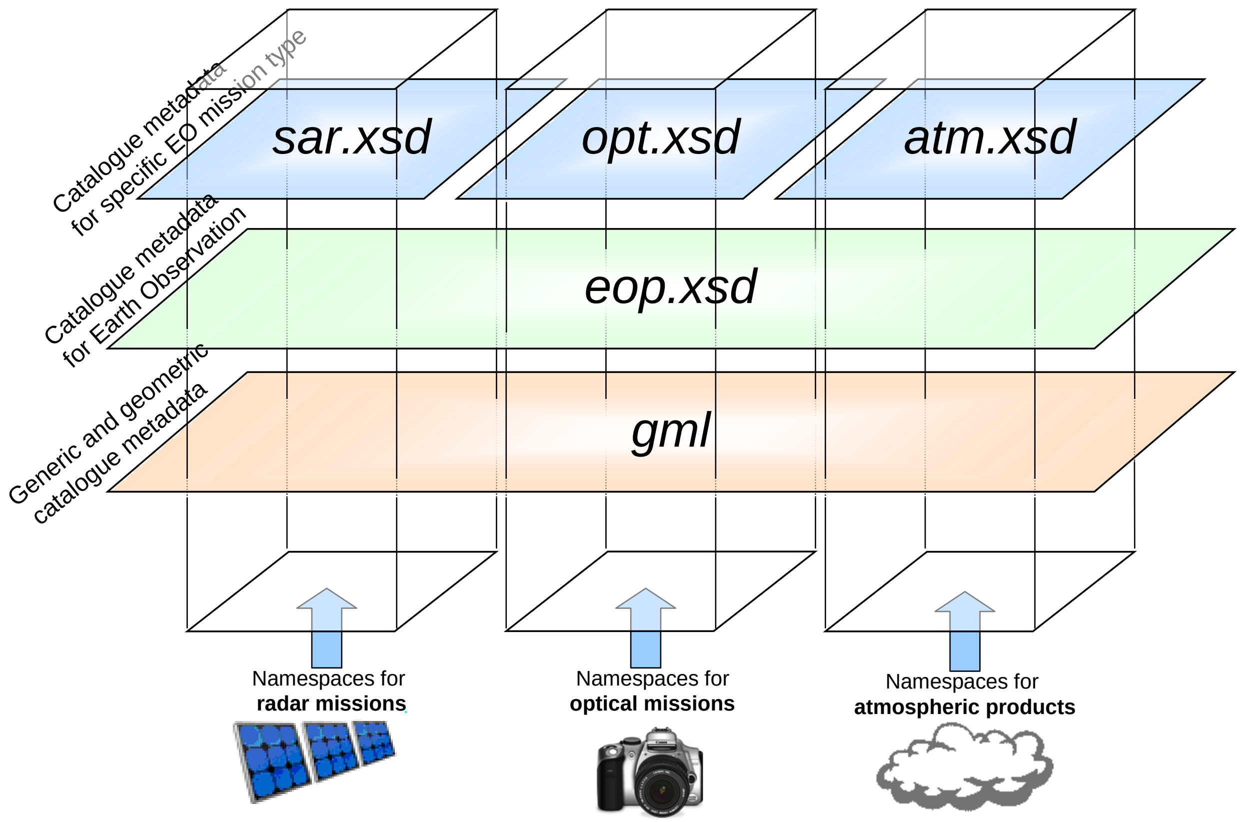


Figure 3 : EarthObservationProduct type hierarchy.

The "eop" metadata element names have been harmonized with ISO 19115 (ISO 19139 schemas) and ISO 19115 Part II draft as far as possible. The catalogue profile (and GML application schemas) allows extension of this layered structure in order to complement the optical layer for a specific "atmospheric" mission, which would require additional mission specific metadata or queryables.

Because a Catalogue compliant with this definition can return different EarthObservationProduct element format depending on the supported schema, then the catalogue allows the clients to get first the list of supported schemas (either eop, opt, sar, or other ones defined on them) and then access the metadata at the level in the hierarchy that best fit their needs when the data is retrieved.

8.6 User Management Data

This section deals with the FedEO information items needed for user authentication. FedEO user profile is a set of user attributes that describes a FedEO user, whether a human or a service entity. The user profile is composed of several attributes, each associated with an identity, a source and an authority. The identity is the entity (or principal) which is described by the profile.

The source is the entity that provides the information for the profile item and the authority is the entity that verifies and/or maintains the value.

Because the large support of COTS and because the usage from many user and organizations, the LDAP V3 has been selected as the mean for modelling and managing FedEO user profiles.

LDAP foresees a hierarchical representation of the stored objects and items and then FedEO user profile are represented by sub-trees of LDAP hierarchy.

The FedEO Clearinghouse stores all user information in an LDAP v3 registry and can link to external LDAP as far as the user information is stored according to IETF RFC 2256. Tests were performed with OpenLDAP as well as Oracle OID.

9 Computational Viewpoint :

The FedEO architecture uses a Service Oriented Architecture with Web Services to define an RM-ODP Computational Viewpoint. It specifies the services that support the syntactical and semantic interoperability between the high-level operational services waited for the FedEO pilot. The FedEO's service oriented architecture shall place no restrictions on the granularity of a geospatial (Web) services 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 provided by one or many 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 firstly in the scope of the GMES Program but are extended for the FedEO Pilot :

- Collection and service discovery
- Catalogue Service
- Product Programming and Order
- Online Data Access
- Processing Services
- Orthorectification and re-projection services
- Service Orchestration

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

9.1 Service Oriented Architecture

SOA architecture is popular and widespread because it allows exploitation and reusing of existing systems functionality by means of services and it provides interoperability among functionality provided by heterogeneous systems and technologies.

It's an architectural style of building software applications that promotes loose coupling between components so that they can be re-used in an easy and cost effective way. Thus, it's a new way of building applications with the following characteristics:

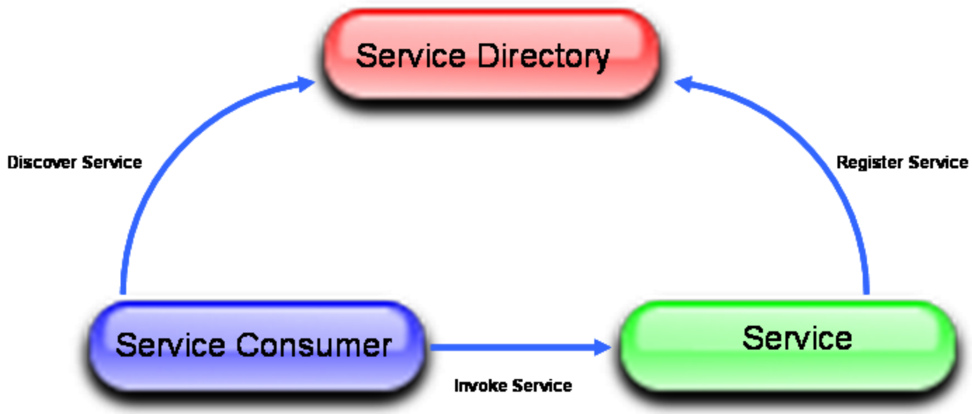
- Services are software components that have published contracts/interfaces; these contracts are platform-, language-, and operating-system-independent. XML and the Simple Object Access Protocol (SOAP) are the enabling technologies for SOA, since they are platform-independent standards.
- Consumers can dynamically discover services.
- Services are interoperable.

SOA promotes application assembly because services can be reused by numerous consumers. It allows automating of business-process management. Business processes may consume and orchestrate these services to achieve the desired functionality. Thus, new business processes can be constructed by using existing services.

SOA Architecture style offers several advantages:

- Adapt applications to changing technologies.
- Easily integrate applications with other systems.
- Leverage existing investments in legacy applications.
- Quickly and easily create new business processes from existing services.

What makes SOA so powerful is that it encompasses Web services. These modular, self-contained components are built on open standards, so they work together without custom coding. Since the services share a common protocol, they can communicate with each other even though they don’t share the same language or application platform. Web services make individual services available to other systems via a network.



To make services available to a wider audience, SOA uses the find-bind-execute paradigm. Service providers register their services in a public registry, the Service Directory. This registry is used by service consumers to find services matching certain criteria. The registry provides the service consumer with a contract (an interface) and an endpoint address for that service.

Each component (Web Service) provides a service through a clear and well known interface. The WSDL (Web Services Description Language) is the de facto standard for XML-based service description. WSDL defines the interface and mechanics of service interaction. The WSDL document can be complemented by other service description documents to describe these higher level aspects of the Web service. For example, business context is described using UDDI data structures in addition to the WSDL document. UDDI provides a mechanism for holding descriptions of Web Services. Although UDDI is often thought of as a directory mechanism, it also defines a data structure standard for representing service description information in XML. WSDLUDDI are the contracts to be respected by integrated service providers to join a SOA. Each component exposes offered services and is able to discover and exploit services provided by other infrastructures. These concepts are the basis to achieve an integrated, interoperable and extensible architecture.

Another advantage of using SOA architecture is the evolution of problematic regarding Security, Reliability and Authentication. The distributed nature of this architecture makes addressing security concerns a critical factor. New standards have been introduced to ensure reliable and secure communications over the network conceived to protect the environment based on the SOA architecture.

Each component is then an independent and de-coupled resource giving its contribution to reach the final result. Basic services will be composed in a work flow describing the sequence of actions to be taken contacting a number of service providers. Compound services are so characterized by a working flow composing basic services into an interoperability chain. A “Work-Flow Manager” agent is introduced to handle the basic services cooperation. Each “superservice” is related to a work flow describing the succession of invoked basic services in order to furnish the final result to the end user.

9.2 Collections discovery services

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 FedEO architecture.

This service is used for storing metadata of data set collections that can be accessed via catalogue/order or subscriptions.

9.3 Services discovery services

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 FedEO architecture.

9.4 Catalogue Services

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 FedEO 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 area of interest (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.
- Specific criteria (e.g. Cloud cover, snow cover, polarization etc.)

As explained within the information viewpoint, these product metadata vary depending on the type of mission: optical, radar or atmospheric.

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.

9.5 Product Programming services

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.

- 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 or are harvested by calling DescribeSensor operation implemented by GS Programming Services.

9.6 Order services

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 FedEO 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

9.7 Online Data Access services

Various on-line data access services provide access to ordered datasets via the Internet. Such services typically use the File Transfer Protocol (FTP) for allowing access to EO data, but also more advanced methods such as OGC Web Services for data delivery and visualization: Web Coverage Services (WCS), Web Map Services (WMS), Web Feature Services (WFS) and Sensor Observation Services (SOS).

9.7.1 Files Transfer Protocol

FTP or File Transfer Protocol from IETF is used to transfer data from one computer to another over the Internet, or through a network.

Specifically, FTP is a commonly used protocol for exchanging files over any network that supports the TCP/IP protocol (such as the Internet or an intranet).

9.7.2 OGC Web Map Service

An OGC Web Map Service (WMS) produces maps of spatially referenced data dynamically from geographic information. This international standard defines a "map" to be a portrayal of geographic information as a digital image file suitable for display on a computer screen.

A map is not the data itself. WMS-produced maps are generally rendered in a pictorial format such as PNG, GIF or JPEG, or occasionally as vector-based graphical elements in Scalable Vector Graphics (SVG) or Web Computer Graphics Metafile (WebCGM) formats. This is in contrast to a Web Coverage Service (WCS), which returns actual raster data.

WMS defines three operations:

- GetCapabilities, which returns service-level metadata.
- GetMap, which returns a map whose geographic and dimensional parameters are well-defined.
- GetFeatureInfo, which returns information about particular features shown on a map (optional).

9.7.3 OGC Web Coverage Service

The Web Coverage Service is an Open Geospatial Consortium standard web service for exchanging geospatial raster data.

WCS provides available data together with their detailed descriptions; allows complex queries against these data; and returns data with its original semantics (instead of pictures) which can be interpreted, extrapolated, etc. -- and not just portrayed. This is in contrast to a Web Map Service (WMS) which produces a digital image file.

WCS provides three operations:

- GetCapabilities, which returns XML document describing the data collections available via WCS.
- DescribeCoverage, which returns details about a specified data collection.
- GetCoverage, which returns the data in a well known format.

9.7.4 OGC Web Feature Service

The Web Feature Service is an Open Geospatial Consortium standard web service for defining interfaces for data access and manipulation operations on geographic features using HTTP as the distributed computing platform. Via these interfaces, a web user or service can combine, use and manage geodata – the feature information behind a map image – from different sources by invoking the following WFS operations on geographic features and elements :

- Create a new feature instance,
- Delete a feature instance,
- Update a feature instance,
- Lock a feature instance,
- Get or query features on spatial and non-spatial constraints.

9.7.5 OGC Sensor Observation Service

The Sensor Observation Service in an Open Geospatial Consortium standards web service for exchanging sensor observation data.

9.8 Processing Services

Earth Observation data will not always be well-suited to a specific purpose and will need processing specific to the users needs. This situation is typical in environments were data is acquired and archived for one application but this is accessed for by a user with a different application than the original application.

Extensive tests have been performed as well 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 Processing Service (WPS) defines a standardized interface that facilitates the publishing of geospatial processes, and the discovery of and binding to thse processes by clients. “Processes” include any algorithm, calculation or model that operates on spatially referenced data. “Publishing” means making available machine-readable binding information as well as human-readable metadata that allows service discovery and use.

9.9 Orthorectification and re-projection services

Ortho-rectification and re-projection of remote sensing images is an important issue for various applications. Indeed, the image orthorectification and re-projection process combines relief effects corrections and geo-referencing with high location accuracy.

The OGC Web Coordinate Transformation Service (WCTS) is another processing service that was experimented with, in combination with Spot Image Web Coverage Service as described within OWS-3 Imagery Workflow experiments.

9.10 Services Orchestration

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 services orchestration is implemented using BPEL (Business Process Execution Language) for most of the services which are part of the Clearinghouse.

The workflow engine is the component executing the workflows within a Service-Oriented Architecture. It executes business processes based on the Business Process

Execution Language for Web Services - BPEL standard. The workflow engine is implemented with the Oracle BPEL Process Manager.

Figure 4 : Service orchestration for distributed catalogue access.

The Service orchestration supports both synchronous and asynchronous services. An interesting example of a synchronous service is the product cross-catalogue search service. It allows simultaneous access to various (federated) catalogue services via a single "virtual" catalogue service.

The BPEL process implementing the GetRecords operation of the service accesses multiple catalogues in parallel and returns the combined search results to the Portal. The distributed catalogue search approach is to start a search from the Clearinghouse and to search federated catalogues with the same set of attributes. Federated catalogues are selected based on collection ID or ParentIdentifier.

Other applications of service orchestration implement access via composite services to ordering and programming services of multiple satellite ground segments.

10 Engineering Viewpoint :

This viewpoint specifies the mapping of the service specifications and information models to the chosen service and information infrastructure. The FedEO server at ESA is based on the Service Support Environment (SSE) ones which provide a reusable service oriented architecture for the integration of services in the Earth Observation (EO) and geospatial domains. More details are available at http://services.eoportal.org/portal/system/HelpUI.jsp

The FedEO Pilot augments and enhances the Engineering Viewpoint of the GEOSS AI Pilot. The figure below defines component types. The components implement the information and services described in the previous viewpoints.

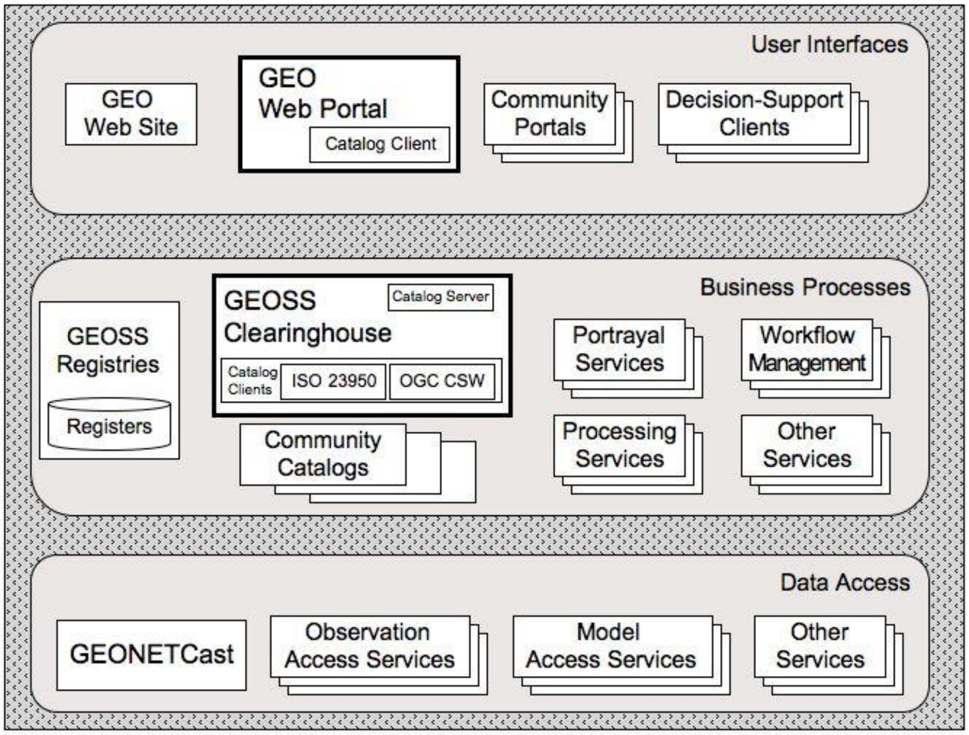


Figure 5 : Engineering Viewpoint.

The FedEO Pilot was the main provider of components to the AI Pilot for the component types of Workflow Management and Processing Services.

10.1 Collection and Services Discovery service

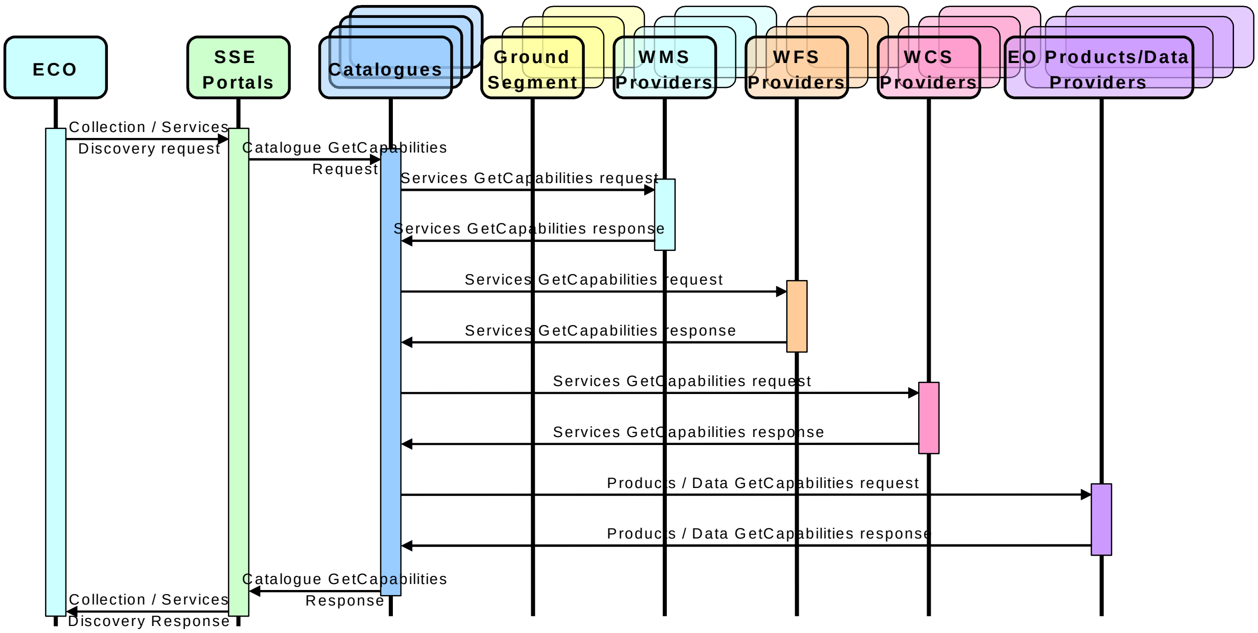


Figure 6 : Data and Services Discovery service diagram.

10.2 Catalogue Service

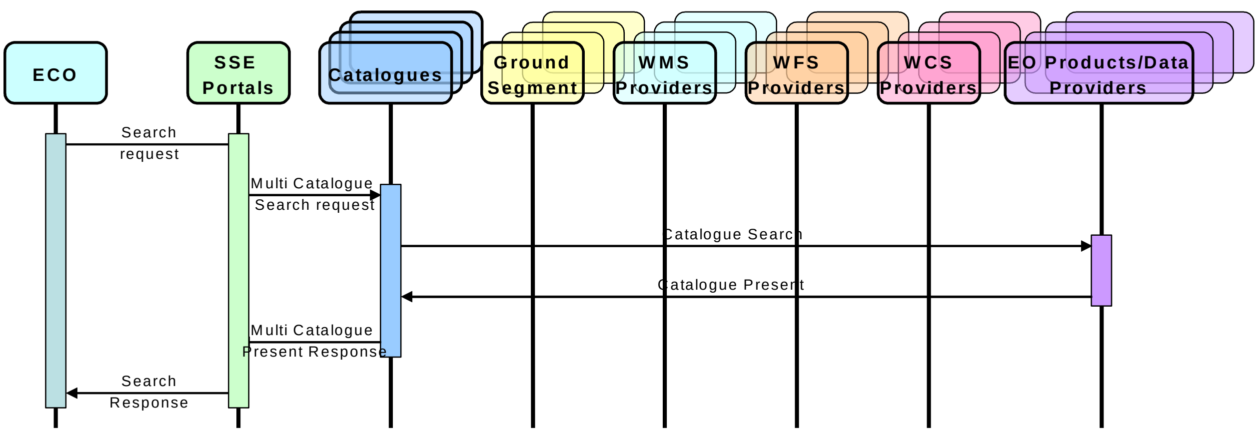


Figure 7 : Catalogue service diagram.

10.3 Order Service

This metadata covers the needs of EO products ordering and subscriptions. The main information items related to products are :

- Order Options
- Product Order

- Subscription

The structure of abov items is outlined in the UML models reported hereafter.

10.3.1 Order Options (to be update with inputs from the last HMA architecture TN)

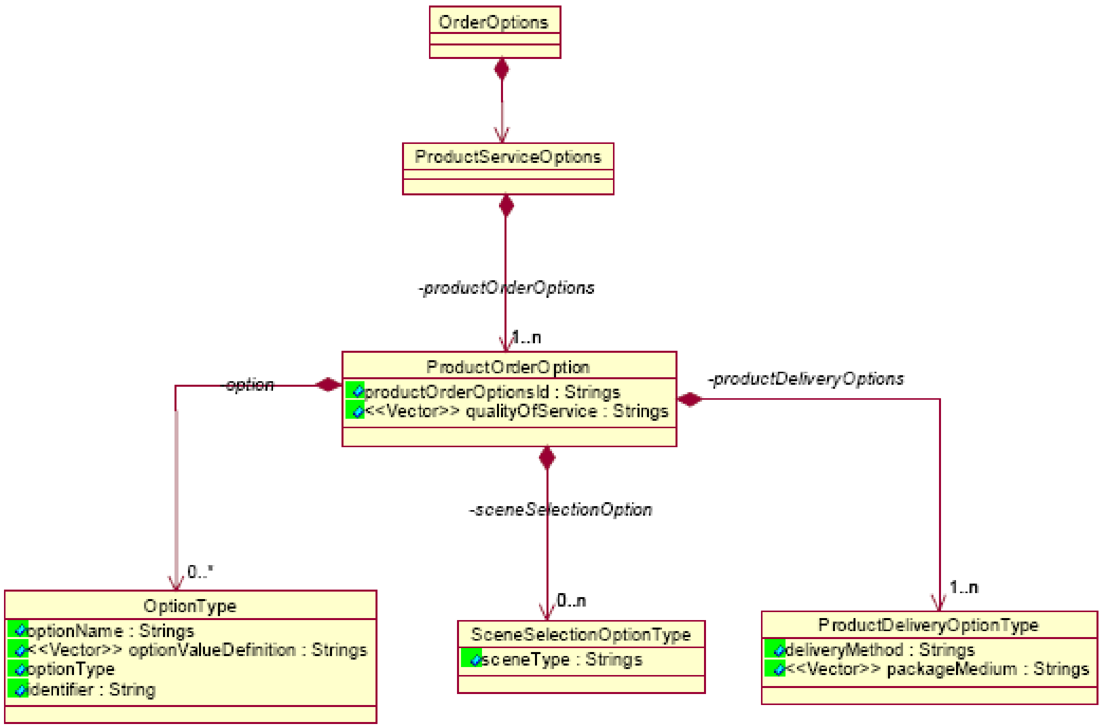


Figure 8 : Order Option structure.

Order options specify all possible valid combinations of options for ordering products of a specified collection and for adhering to a subscription.

A single order option instance includes the following attributes:

- Identifier of the order options group;
- scene selection options (e.g. possible options for ordering a scene on the product). These are not applicable to subscriptions.
- the list of possible product delivery options (e.g. CD, DVD, electronic, etc.);
- the list of other options (e.g. for product orders: product level, product format, etc; for subscriptions: expiration date, geographical area, etc.).

10.3.2 Product Order and Subscription

The order is the data structure sent by user / operator to order products and to adhere to subscriptions.

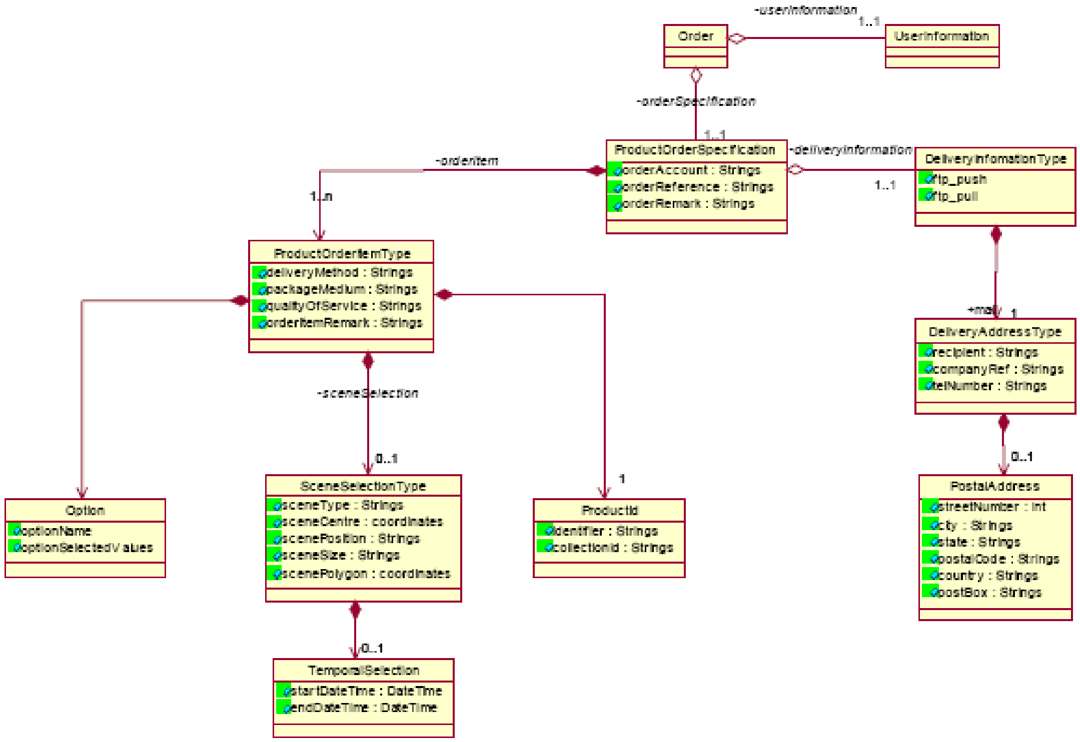


Figure 9 : Product Order strucutre.

An order contains the following information:

- userInformation, identifying the user who submitted the order;
- orderSpecification, which regroups the following attributes:
  - orderAccount, Account under which the user is authorised to order from the specific provider;
  - orderReference, user defined name of the order;
  - orderRemark, textual remark;
  - deliveryInformation, which include FTP / mail (with related deliver address);
  - list of orderItem, which include:
    - productId, which identifies the item to order;
    - option: list of user selected options. Several type of options can be specified: strings, numbers, enumerated strings, polygon, times.

- sceneSelection: in case of scene order it identifies the scene on the parent product;
- deliveryMethod, package, quality of service.

This structure is used for the 2 purposes: product ordering / subscription. The distinction is performed by the productId element: if the specified collection reference to a collection then the order implies the adhesion to the subscription; if it references an EO product, then it is a product order.

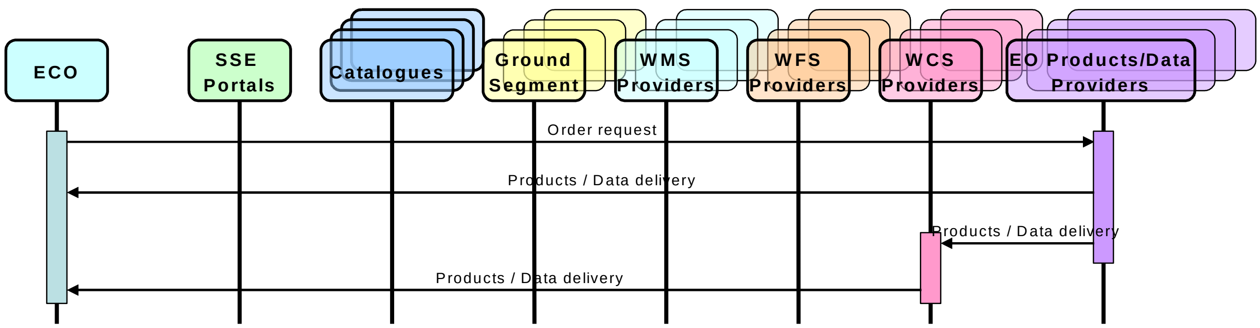


Figure 10 : Order Service diagram.

10.4 Programming Service

The FedEO Clearinghouse contains various clients which allow programming EO sensors via the OGC SPS (Sensor Planning Service) interface and in particular its profile for EO (OGC 07-018). Such clients were demonstrated as part of OWS-4 (see OGC 07-008), the ESA COPS-B project and CoMu. The SWE thread in OWS-5 is expected to build on this work and align it with the latest version of the specification 07-018.

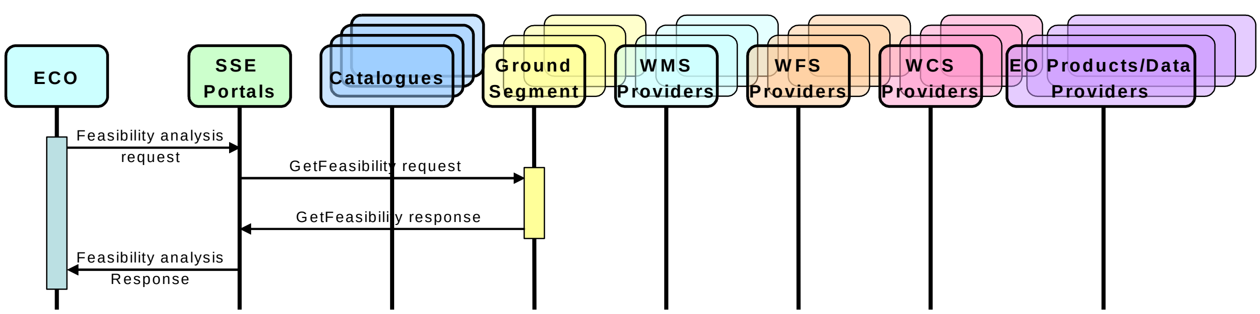


Figure 11 : Feasibility analysis diagram.

10.5 Online data access Services

Previous experiments with WCS in the framework of OWS-3 are accessible via the SSE as described in OGC 07-008. The FedEO Clearinghouse contains an WCS client supporting GEOTIFF.

Experiments have been performed in the framework of FedEO for on-line data access to EO data using OGC WCS and JPEG2000 in cooperation with SPOTIMAGE. An online demonstrator is being finalised which will allow on-line data access to EO data requested by a user via an EO Profile for SPS interface (OGC 07-018). The DescribeResultAccess may return the URL to the WCS/JP2 server and a client in the FedEO Clearinghouse will allow visualising and downloading part of the product.

The FedEO Clearinghouse also supports on-line access to data via the OGC SOS (Sensor Observation Service). Various experiments have been performed by the ESA COPS-B and EC FP6 SANY projects which have been integrated in the FedEO Clearinghouse built on SSE technology.

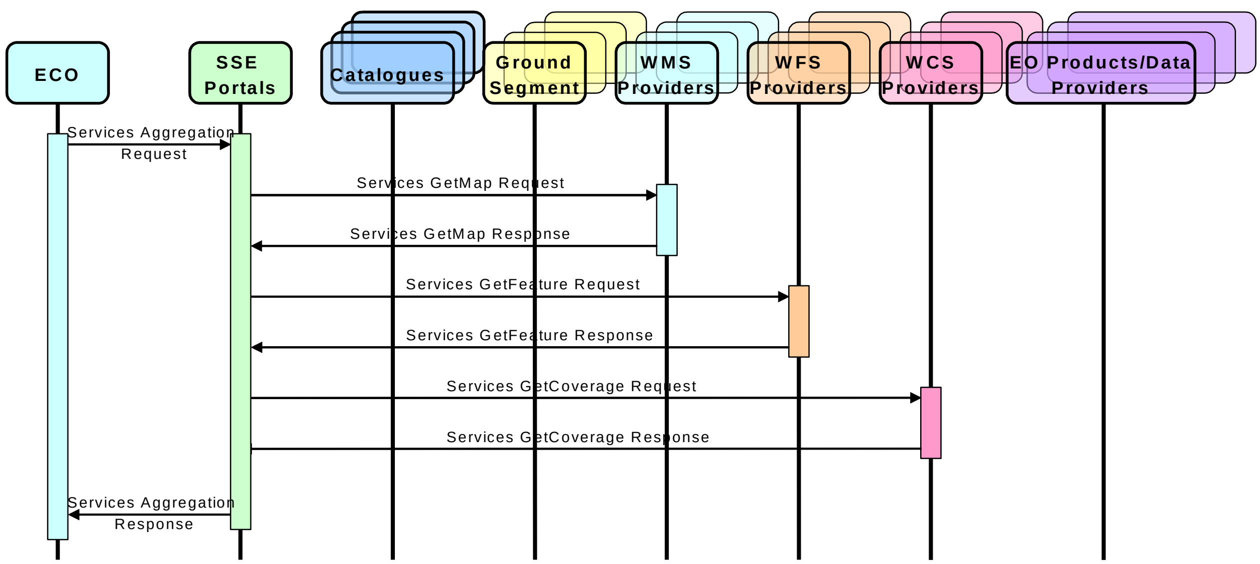


Figure 12 : Online data access Services diagram.

10.5.1 Processing Services

TBC

10.5.2 Orthorectification Services

TBC

10.6 Services orchestration

The service metadata describes the services provided by the SSE and the mission Ground Segments. The level of description is such that an application should be able to discover and then use the services (e.g. supported operations). For the management of this data the usage of a UDDI registry is envisaged.

The Universal Description, Discovery, and Integration (UDDI) specification describes an online electronic registry that serves as electronic Yellow Pages, providing an information structure where various business entities register themselves and the services they offer through their definitions (e.g. using WSDL).

The UDDI specification defines a 4-tier hierarchical XML schema that provides a model for publishing, validating, and invoking information about Web Services. XML was chosen because it offers a platform-neutral view of data and allows hierarchical relationships to be described in a natural way. UDDI uses standards-based technologies, such as common Internet protocols (TCP/IP and HTTP), XML, and SOAP (a specification for using XML in simple message-based exchanges).

UDDI is a standard Web Service description format and Web Service discovery protocol; a UDDI registry can contain metadata for any type of service, with best practices already defined for those described by Web Service Description Language (WSDL).

A UDDI registry consists of the following data structure types:

- businessEntity - The top-level XML element in a business UDDI entry, it captures the data partners require to find information about a business service, including its name, industry or product category, geographic location, and optional categorization and contact information. It includes support for "yellow pages" taxonomies to search for businesses byindustry, product, or geography.

- businessService - The logical child of a businessEntity data structure as well as the logical parent of a bindingTemplate structure, it contains descriptive business service information about a group of related technical services including the group name, a brief description, technical service description information, and category information. By organizing Web Services into groups assoociated with categories or business processes, UDDI allows more efficient search and discovery of Web Services.

- bindingTemplate - The logical child of a businessService data structure, it contains data that is relevant for applications that need to invoke or bind to a specific Web Service. This information includes the Web Service URL and other information describing hosted services, routing and load balancing facilities, and references to interface specifications.

- tModel - Descriptions of specifications for Web Services or taxonomies that form the basis for technical fingerprints; its role is to represent the technical specification of the Web Service, making it easier for Web Service consumers to find Web Services that are compatible with a particular technical specification. That is, based on the descriptions of the specifications for Web Services in the tModel structure, Web Service consumers can easily identify other compatible Web Services. For instance, to send a business partner's Web Service a purchase order, the invoking service must know not only the location/URL of the service, but what format the purchase order should be sent in, what protocols are appropriate, what security is required, an what form of a response will result after sending the purchase order.

The information hierarchy and the key XML element names that are used to describe and discover information about Web Services are shown in the figure below:

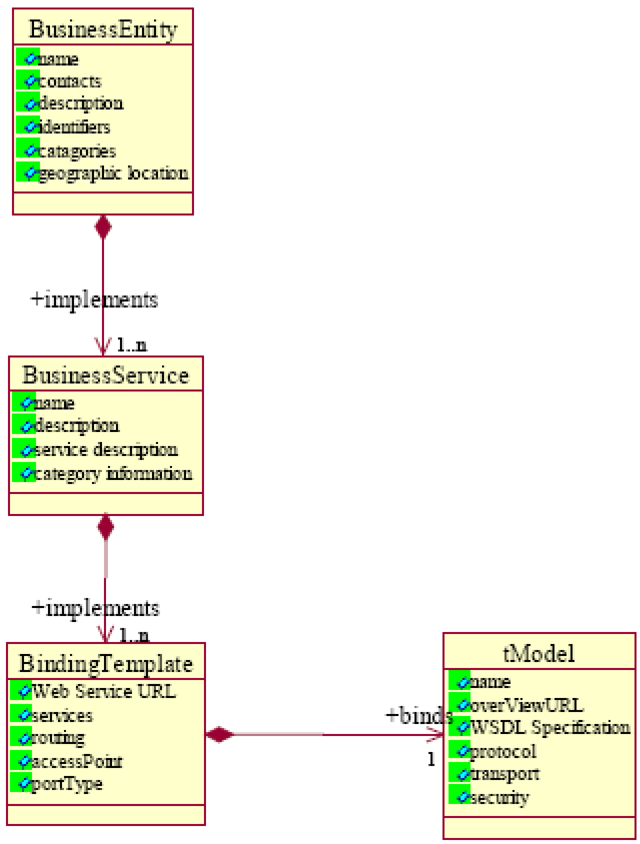


Figure 13 : Service Metadata UDDI model

Generic services are described via Web Services Description Language (WSDL) providing Service Interface Specification and Service Implementation information. A WSDL service description contains an abstract definition for a set of operations and messages, a concrete protocol binding for these operations and messages, and a network endpoint specification for the binding. This represents a reusable definition of a service.

In order to publish and find Services by means of their WSDL description using UDDI the following applies: the Service interface is published in a UDDI registry as a tModel.

The service implementation describes instances of a service. Each instance is defined using a WSDL service element. Each service element in a service implementation document is used to publish a UDDI businessService.

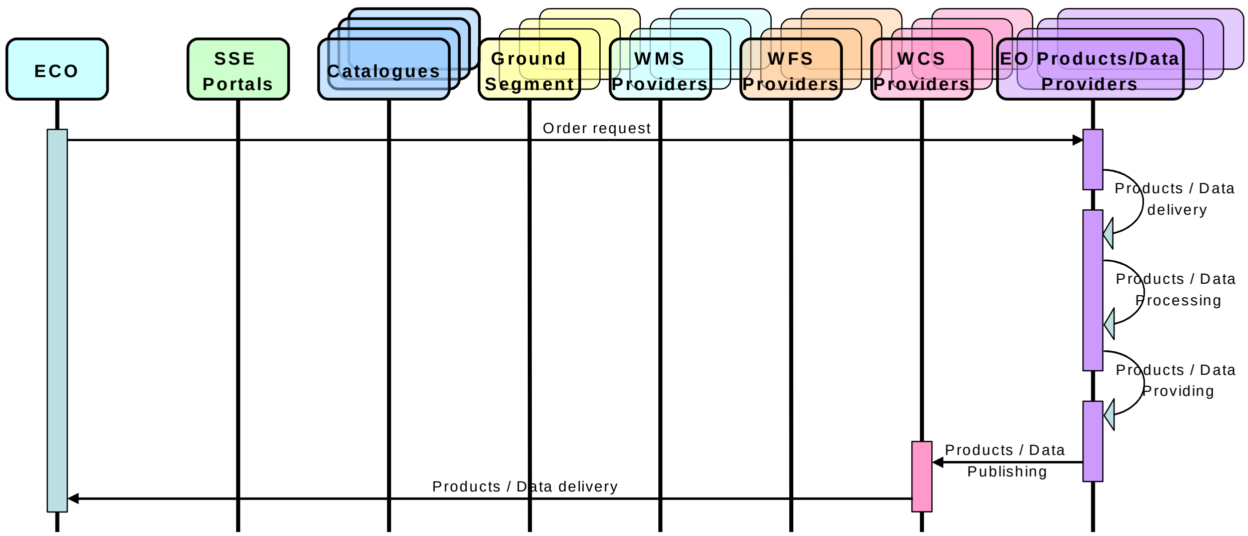


Figure 14 : Services orchestration diagram.

11 Technology Viewpoint and Standards :

This viewpoint describes the components that have been deployed and still are operational in the scope of FedEO Pilot.

For more details on the different components instance deployed for the FedEO scenario, please refer to the §13 : Disaster Management / Emergency Response Scenario – Oil Spill Tanker.

11.1 Application of Standards

In the FedEO architecture a large set of open standards have been used:

- Service Oriented Design. Due to the SOA approach, the following standards have been adopted:
    - XML Schemas express shared vocabularies and allow machines to carry out rules made by people. They provide a means for defining the structure, content and semantics of XML documents in more detail. XML Schema is used together WSDL for defining the interfaces of FedEO Services.
    - Message-based SOAP (Simple Object Access Protocol) over HTTP or HTTPS for secure communication is used as protocol between the FedEO architecture clients and remote GS services.

  - WSDL (Web Services Description Language) is used to define the operations, the SOAP messages, the protocol bindings of the FedEO services in a formal way. It is equivalent to a CORBA IDL.

  - The Business Process Execution Language (BPEL) from OASIS provides a vendor-independent XML-based format to model service workflows. The FedEO workflow engine uses this open standard. Software (i.e. workflows) developed using this language is thus reusable and the workflow engine or workflow editing tool would be replaced.

  - Universal Description, Discovery and Integration (UDDI). This standard allows for service discovery and is an essential part of a SOA. It defines the external interfaces of a Web service registry. Competing standards (with less vendor support) are WS-inspection (IBM) and OGC Catalogue specification CSW 2.0.

  - Ws-addressing is used to correlate asynchronous message exchanges in a standard way instead of an ad-hoc content-based mechanism. Ws-addressing is standardized by the W3C Consortium.

- Geospatial, Inspire related and recommended by CEN:

For the analysis of the spatial data model the following standards have been considered

  - ISO 19109, which contains the general feature model for ISO/TC 211. It guides the use of classes, relationships, interfaces, and properties in designing feature schemas for data transfers or transactions.

  - ISO/TS 19103 provides rules and guidelines for the use of a conceptual schema language within the ISO geographic information standards. It also provides a profile of UML (Unified Modelling Language) for use with geographic information. UML is the chosen conceptual schema language within ISO/TC 211.

The definition of spatial data encoding has been done following the:

  - ISO 19136 Geography Markup Language (GML). It is an XML grammar written in XML Schema for the modelling, transport, and storage of geographic information. The key concepts used by GML to model the world are drawn from the OpenGIS® Abstract Specification and the ISO 19100 series. GML provides a variety of kinds of objects for describing geography including features, coordinate reference systems, geometry, topology, time, units of measure and generalized values.

For the definition of features spatial data services:

  - The Web Feature Service (WFS) allows a client to retrieve and update geospatial data encoded in Geography Markup Language (GML) from multiple Web Feature Services. The requirements for a Web Feature Service are:

- The interfaces must be defined in XML.
- GML must be used to express features within the interface.
- At a minimum a WFS must be able to present features using GML.
- The predicate or filter language will be defined in XML and be derived from CQL as defined in the OpenGIS Catalogue Interface Implementation Specification.
- The datastore used to store geographic features should be opaque to client applications and their only view of the data should be through the WFS interface.
- The use of a subset of XPath expressions for referencing properties.

This standard is relevant for the on-line data access interface.

For the definition of raster spatial data services:

- Web Map Service (WMS) standard specifies the behaviour of a service that produces spatially referenced maps dynamically from geographic information. It specifies operations to retrieve a description of the maps offered by a server, to retrieve a map, and to query a server about features displayed on a map. This International Standard is applicable to pictorial renderings of maps in a graphical format; it is not applicable to retrieval of actual feature data or coverage data values.

This standard is relevant for the on-line data access interface.

- The Web Coverage Service (WCS) supports electronic interchange of geospatial data as "coverages" – that is, digital geospatial information representing space-varying phenomena. A WCS provides access to potentially detailed and rich sets of geospatial information, in forms that are useful for client-side rendering, multi-valued coverages, and input into scientific models and other clients. The WCS may be compared to the OGC Web Map Ser-vice (WMS) and the Web Feature Service (WFS); like them it allows clients to choose portions of a server's information holdings based on spatial constraints and other criteria. Unlike WMS, which filters and portrays spatial data to return static maps (rendered as pictures by the server), the Web Coverage Service provides available data together with their detailed descriptions; allows complex queries against these data; and returns data with its original semantics (instead of pictures) which can be interpreted, extrapolated, etc. -- and not just portrayed. Unlike WFS, which returns discrete geospatial features, the Web

Coverage Service returns representations of space-varying phenomena that relate a spatio-temporal domain to a (possibly multidimensional) range of properties.

This standard is relevant for the on-line data access interface.

For the definition of spatial data catalogue services:

- ISO 19119 Services identifies and defines the architecture patterns for service interfaces used for geographic information and defines its relationship to the Open Systems Environment model. It also presents a geographic services taxonomy and a list of example geographic services placed in the services taxonomy.

- ISO 19115 Dataset Series (collection) metadata

- ISO 19139 XML encoding for ISO 19115/19119

- OGC CSW2.0 Application Profile ISO19115/19119. This application profile specifies the interfaces, bindings, and encodings required to publish and access digital catalogues of metadata for geospatial data, services, and applications that comply with the given profile. Metadata act as generalized properties that can be queried and returned through catalogue services for resource evaluation and, in many cases, invocation or retrieval of the referenced resources.

This application profile was selected as an initial candidate for the collections discovery specification.

- Security/Identity management: for the management of user identity, user profile, to have secure exchange of information between the EO DAIL and the GSs, the following protocols have been considered:

  - Security Assertion Markup Language (SAML), developed by the Security Services Technical Committee of OASIS, is an XML-based framework for communicating user authentication, entitlement, and attribute information. As its name suggests, SAML allows business entities to make assertions regarding the identity, attributes, and entitlements of a subject (an entity that is often a human user) to other entities, such as a partner company or another enterprise application.

  - Lightweight Directory Access Protocol (LDAP) is a set of protocols for accessing information directories. LDAP is based on the standards contained within the X.500 standard, but is significantly simpler. And unlike X.500, LDAP supports TCP/IP, which is necessary for any type of Internet access. Because it's a simpler version of X.500, LDAP is sometimes called X.500-lite. It has been selected as the protocol for the management of user profiles.

- WS-Security describes enhancements to SOAP messaging to provide quality of protection through message integrity, message confidentiality, and single message authentication. These mechanisms can be used to accommodate a wide variety of security models and encryption technologies.

- WS-Security also provides a general-purpose mechanism for associating security tokens with messages. However, no specific type of security token is required by WS-Security. It is designed to be extensible (e.g. support multiple security token formats) to accommodate a variety of authentication and authorization mechanisms. For example, a requestor might provide proof of identity and a signed claim that they have a particular business certification. A Web service, receiving such a message could then determine what kind of trust they place in the claim. Additionally, WS-Security describes how to encode binary security tokens and attach them to SOAP messages. Specifically, the WS-Security profile specifications describes how to encode Username Tokens, X.509 Tokens, SAML Tokens , REL Tokens and Kerberos Tokens as well as how to include opaque encrypted keys as a sample of different binary token types. With WS-Security, the domain of these mechanisms can be extended by carrying authentication information in Web services requests.

- WS-Policy provides a flexible and extensible grammar for expressing the capabilities, requirements, and general characteristics of entities in an XML Web services-based system. WS-Policy defines a framework and a model for the expression of these properties as policies. WS-Policy defines a policy to be a collection of policy alternatives, where each policy alternative is a collection of policy assertions. Some policy assertions specify traditional requirements and capabilities that will ultimately manifest on the wire (e.g., authentication scheme, transport protocol selection). Other policy assertions have no wire manifestation yet are critical to proper service selection and usage (e.g., privacy policy, QoS characteristics). WS-Policy provides a single policy grammar to allow both kinds of assertions to be reasoned about in a consistent manner. WS-Policy does not specify how policies are discovered or attached to a Web service.

11.2 Application of Protocols

In the frame of FedEO Pilot activities the following new protocols have been proposed for standardization:

- "**OGC Cataloguing of ISO Metadata (CIM) using the ebRIM profile of CS-W**" (OGC 07-038 version 0.1.6), which is the ICD for the Collection & Service Discovery Services.

The OGC 07-038 document complements the ebRIM application profile of CS-W for the cataloguing of ISO 19115 and ISO 19119 compliant metadata record. It defines for this purpose a Core ISO Metadata extension package of ebRIM.

- "**OGC Catalogue Services Specification 2.0 - EO Products Extension Package for ebRIM (ISO/TS 15000-3) Profile of CSW 2.0**" (OGC 06-131 version 0.1.6), which is the ICD for the Catalogue Service.

The OGC 06-131 document describes the mapping of Earth Observation Products – defined in the OGC GML 3.1.1 Application schema for Earth Observation products [OGC 06-080r1] to an ebRIM structure within an OGC™ Catalogue 2.0.0 (with Corrigendum) [OGC 04-021r3] implementing the OGC™ ebRIM (ISO/TS 15000-3) Profile [OGC 05-025r3].

- **GML Application Schema for EO products** (OGC 06-080 version 1.0.0), which is used for modelling the Earth Observation Product metadata.

The OGC 06-080 defines an application schema of the Geography Markup Language (GML) version 3.1.1 for describing Earth Observation products (EO products) within the OGC 06-131.

- **Ordering Services for Earth Observation Products** (OGC-06-141 version 1.2.0), which is the ICD for Ordering service.
- **Sensor Planning Service Profile for Earth Observation Sensors** (OGC-07-018 version 0.9.4), which is the ICD for Programming ICD.
- **Earth Observation Application Profile for CSW 2.0** (OGC-06-079 version 0.2.0)
- **Web Map Service – Application Profile for Earth Observation products** (OGC-07-063 version 0.2.0)
- User Management Interfaces for Earth Observation Services (OGC-07-118 version0.0.1)

11.3 Collection and Service Discovery Service

For the discovery of collections and services, Open source tools as FAO's "GeoNetwork Opensource" catalogue solution could be used for storing and discovering dataset collection metadata as well as the associated services. The following dataset collections metadata were made accessible from the FedEO Clearinghouse via this protocol:

- ESA's MUIS collection descriptions,
- Eumetsat's UMARF collection descriptions,
- GSE GMFS (Global Monitoring for Food Security),

- An NGI Belgium catalogue (NSI project).

Figure 15 : ESA collection discovery from GeoNetwork.

The document-style SOAP bindings of the CSW to discover service and dataset collection metadata using the CSW ISO Profile was initially used. However, the Cataloguing of ISO Metadata(CIM) using the ebRIM profile of CSW was adopted to ensure coherence across the supported protocol stacks. A collection discovery service according to this specification was provided by both IONIC and EUMETSAT according to this specification.

Also the integration of the three GEO Clearinghouse candidates was tested. Three Clearinghouse Candidates are currently being considered which allow for allow for service and collection discovery:

- Geonetwork Clearinghouse Candidate 1.
- Compusult Clearinghouse Candidate 2.
- ESRI Clearinghouse Candidate 3.

For cross-platform testing GEO hopes to see that each of the GEO Web Portal candidates can demonstrate use of their integrated clients to query all three of the following instances of the GEOSS Clearinghouse:

- GeoNetwork Clearinghouse Candidate: http://65.123.203.156:9090/GeoNetworkClearinghouse/discovery?Service=CSW&Request=GetCapabilities
- Compusult Clearinghouse Candidate: http://gaia.compusult.net/wes/serviceManagerCSW/csw?request=GetCapabilities
- ESRI Clearinghouse Candidate: http://keel.esri.com/catalog/csw202?Service=CSW&Request=GetCapabilities

The GEO Geonetwork Clearinghouse Candidate supports OGC CSW 2.0.2 (HTTP bindings) was successfully integrated as shown below. The main problems experienced were problems with default namespaces, invalid character sets and the fact the clearinghouse was not deployed on port 80.

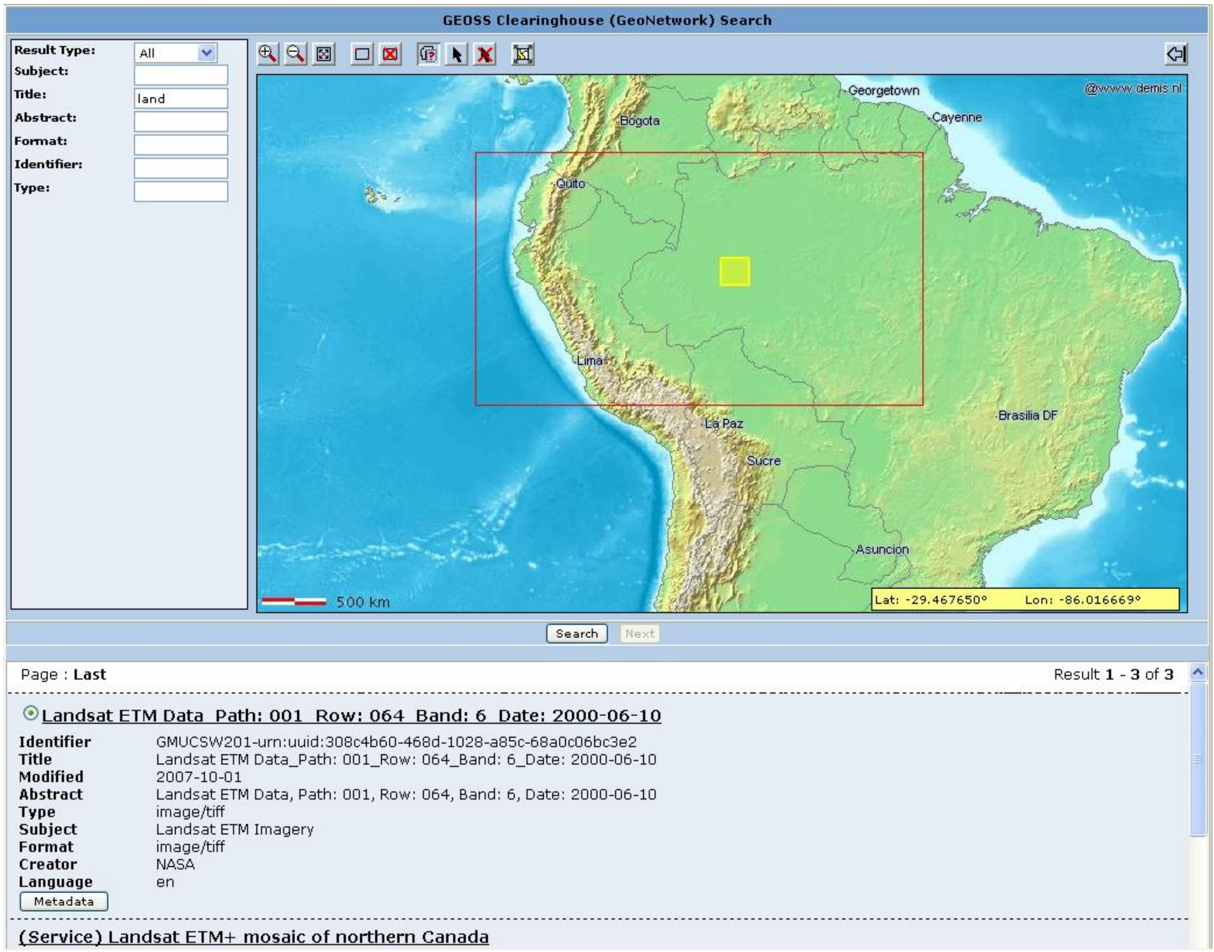


Figure 16: Collection and service discovery via GEO Clearinghouse (GeoNetwork)

The GEO Compusult Clearinghouse Candidate supports OGC CSW 2.0.2 (HTTP bindings) and CSW ebRIM Application Profile was partly integrated as shown below. The main remaining problem is the MIME type returned by the catalogue. The official

OGC position in the CSW 2.0.2 specification (OGC 07-006) is that the catalogue should support "application/xml". The Oracle BPEL Process manager 10.1.3 used as catalogue client currently does not support this MIME type.

SPACEBEL has developed a workaround to cope with the MIME problem and the Compusult Clearinghouse Candidate has now successfully been integrated.

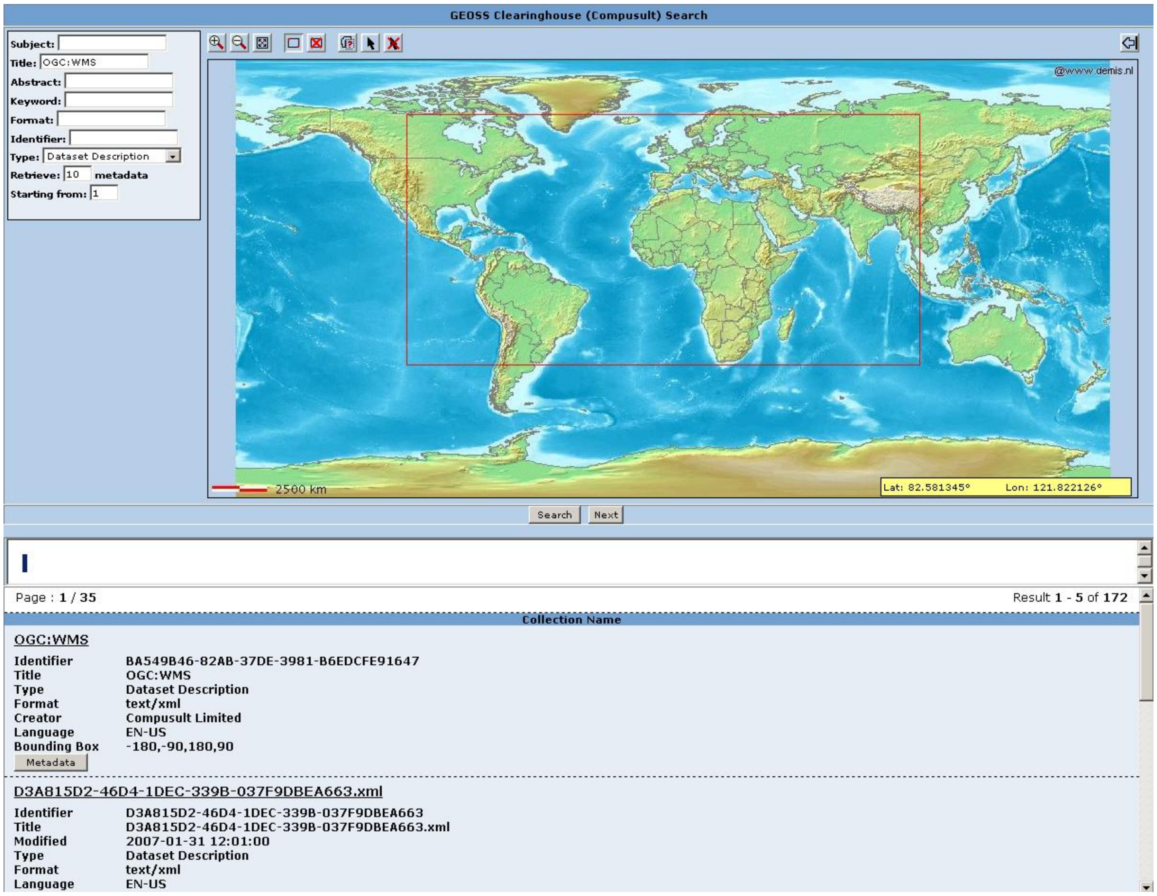


Figure 17: Collection and service discovery via GEO Clearinghouse (Compusult).

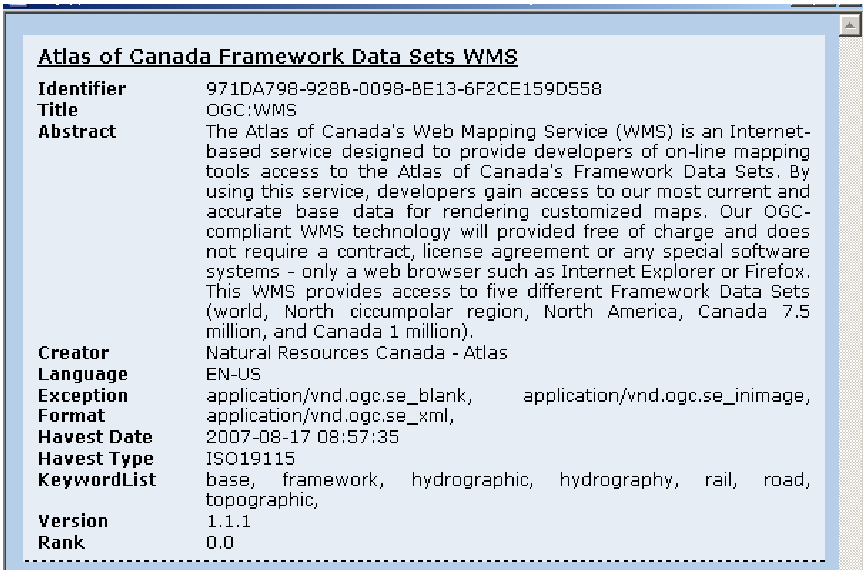


Figure 18: GEOSS Clearinghouse (Compusult) GetRecordsByID.

The third GEO Clearinghouse Candidate "ESRI" supports OGC CSW 2.0.2. It could not be integrated as it does not return a MIME type in its GetRecords response but SPACEBEL managed to integrate it successfully.

11.4 Service Discovery Services

The FedEO Clearinghouse supports service discovery via Universal Description, Discovery and Integration – UDDI from OASIS population of an instance of the UDDI is core of the registration of new services within the FedEO Clearinghouse built on SSE technilogy.

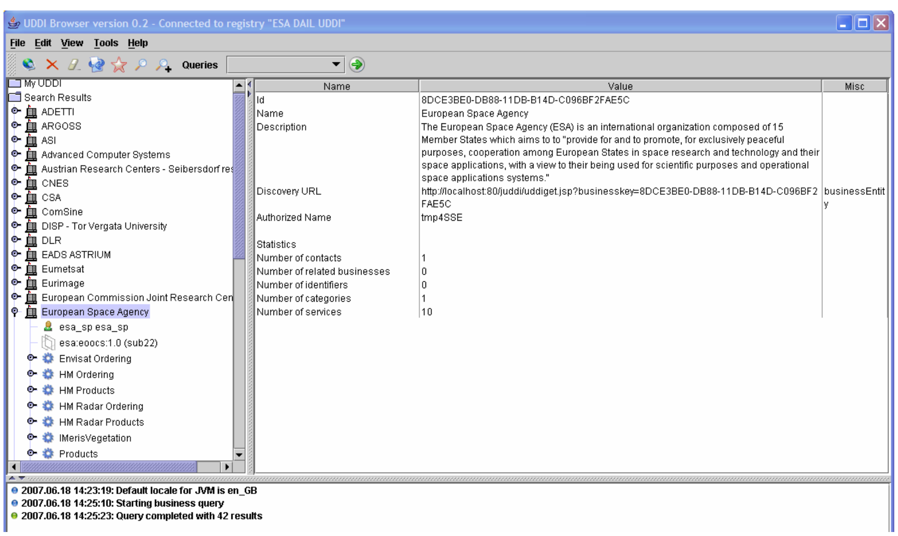


Figure 19 : Discovering Services via UDDI.

11.5 Catalogue Service

The ebRIM Application Profile of CSW has been selected for the « dataset » (product) catalogue service. It is an OGC CSW Application Profile that is also in use outside of the specific EO domain. This strategy is in-line with the recent OGC decision to recommend the use of the ebRIM model as information model for future catalogue specifications.

The ebRIM information model for EO data is defined in the EO extension package for ebRIM Profile of CSW2.0. The following catalogues are currently 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).

The ebRIM information model for EO data is defined in the EO extension package for ebRIM Profile of CSW 2.0 has also been extended by CNES to support the International Charter "Space and Major Disasters", and is currently being tested within the FedEO Clearinghouse.

In CSW EO extension package for ebRIM (as well as in the CSW EO Application Profile) the metadata are specified as a GML application schema defined within OGC 06-080.

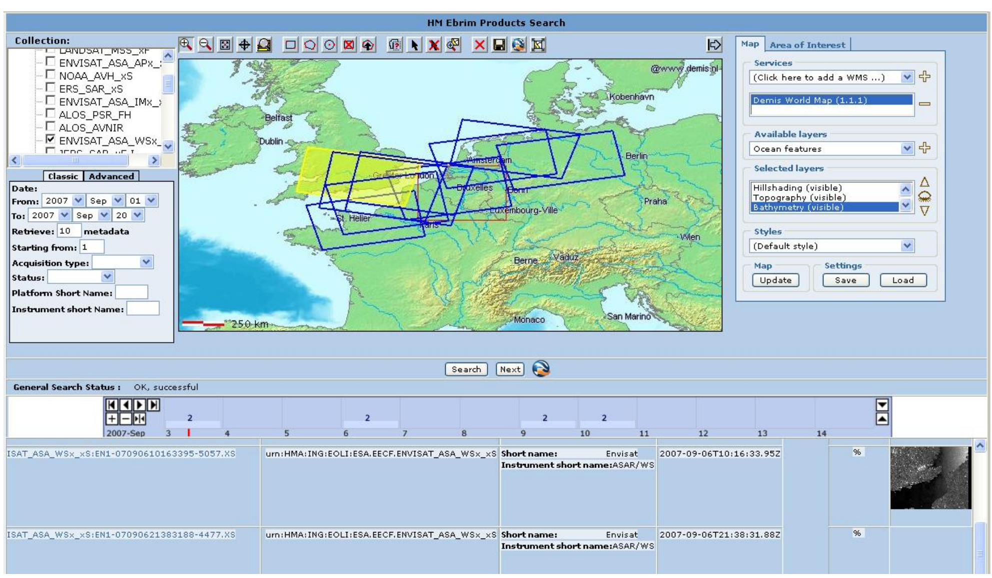


Figure 20 : Access to ESA MUIS catalogue.

The above catalogues were combined using service orchestration to allow for distributed searches. The resulting HM service called "FedEO clearinghouse for satellite based EO data" was made available on the FEDEO Clearinghouse Portal. In addition, the same client and clearinghouse was integrated in the ESA-FAO GEO Portal candidate as depicted below.

Figure 21 : Catalogue client integrated in GEO Portal Candidate.

The relationship between the various catalogues specifications mentioned above is depicted below:

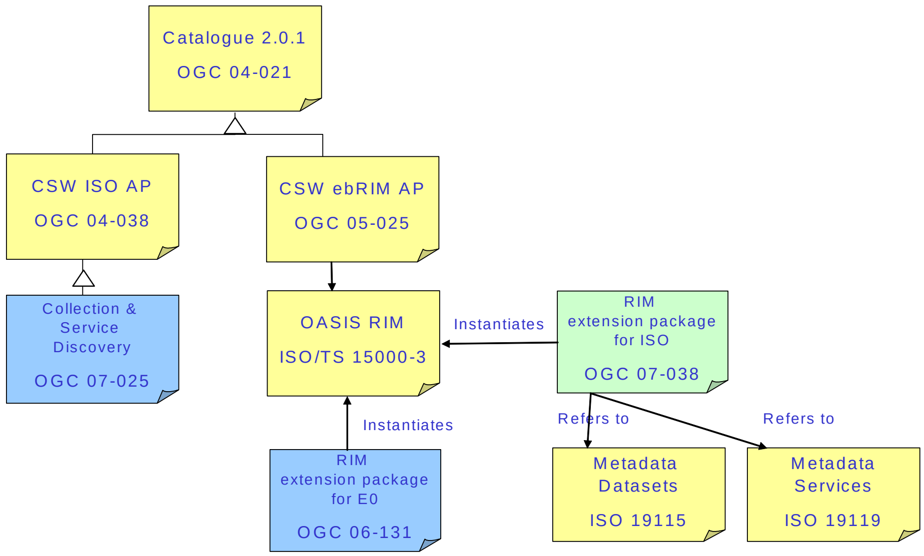


Figure 22 : Relationship catalogue specifications.

The specification tree will have to be updated soon to take into account the migration from OGC 05-025 to OGC 07-110 and OGC 07-144 which is expected to be formalized by the end of 2007 by OGC. OGC 07-110 is the update of the CSW ebRIM Application Profile to take into account the Catalogue specification 2.0.2 (OGC 07-006). The specification tree that will be supported soon is depicted below:

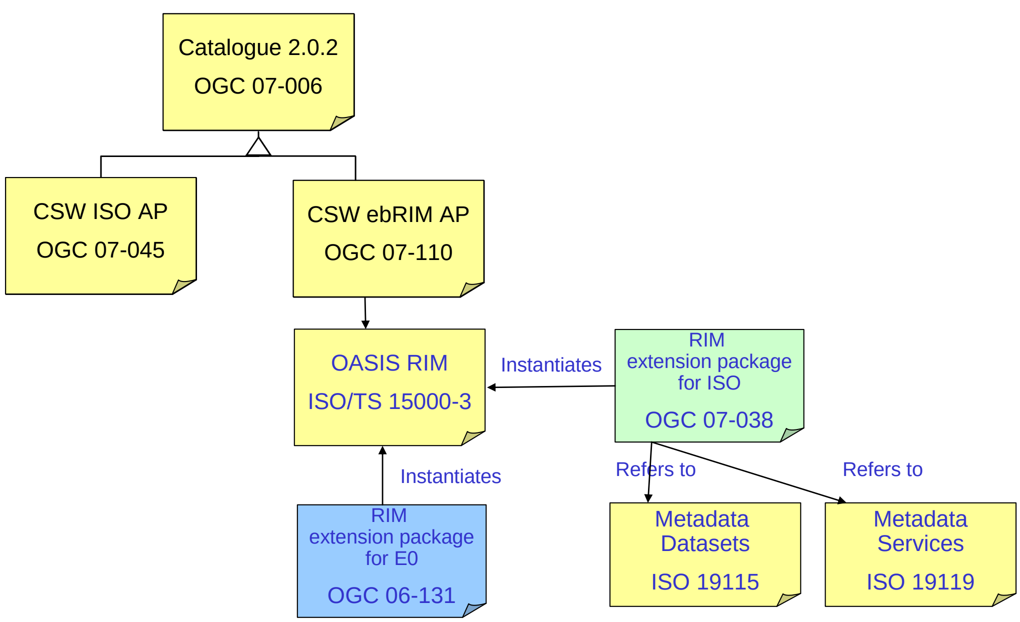


Figure 23 : Expected relationship catalogue specifications.

The first EO catalogue supporting the above specification stack for ebRIM required by OGC 06-131 issue 0.1.7 is the Spot Image DALI catalogue which was integrated in the

FedEO Clearinghouse in November 2007. The main impact on the catalogue client was the different syntax inside the filter expressions

In the course of the FedEO pilot activities, other ebRIM catalogue services have been integrated with ebRIM based profiles:

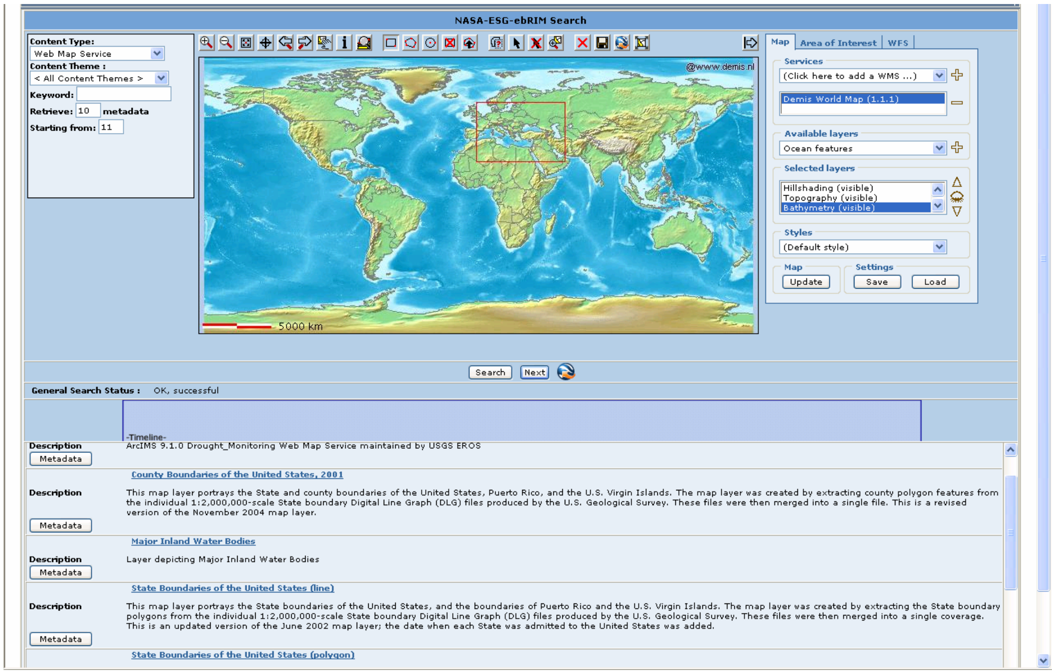


Figure 24: Access to NASA ESG catalogue.

In addition, access to JAXA catalogue using CSW 2.0.1 (HTTP bindings) has been successfully implemented despite a remaining problem related to the MIME type which is not supported by the Oracle orchestration engine:

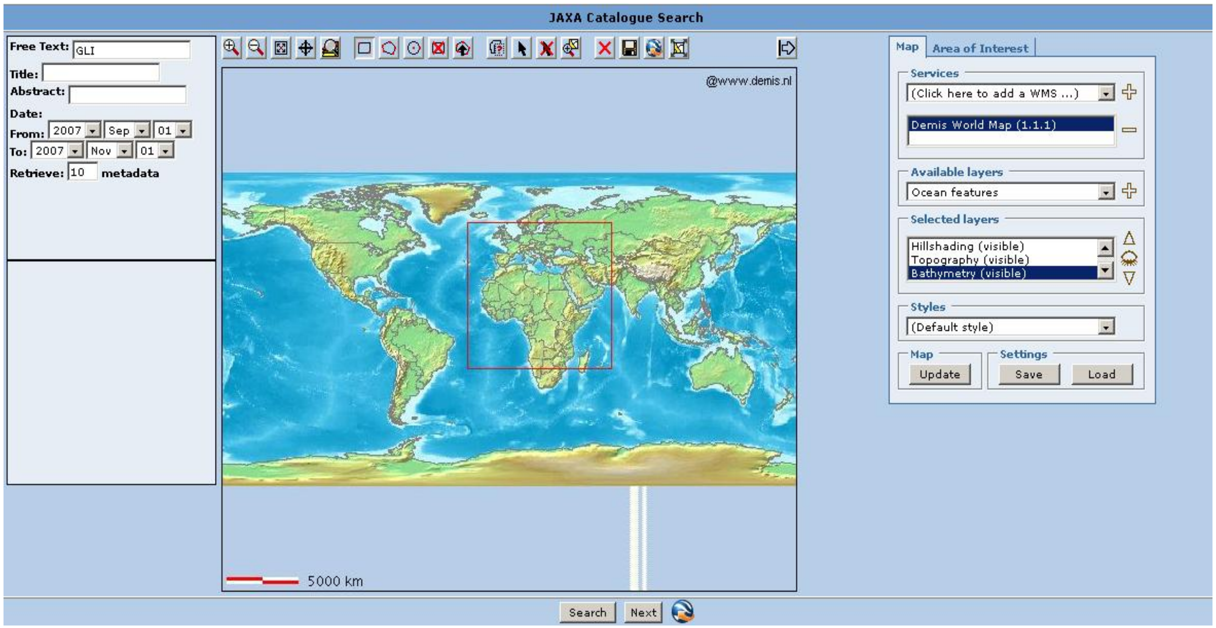


Figure 25: Access to JAXA catalogue.

For completeness, we can also mention that other catalogues are accessible from the SSE Portal (FedEO Clearinghouse) which do not use the recommended FedEO protocols but are based on EOLI-XML (OGC 05-057), CSW Profile for EO (OGC 06-079) and the EC FP6 ORCHESTRA catalogue specification.

The EO products catalogue services based on OGC 06-131 are combined as HM (heterogeneous mission) catalogues using BPEL service orchestration as explained in the next section.

11.6 Programming service

In the scope of FedEO, the programming service has been proposed by EADS Astrium based on the CoMu (Mission Planning for Constellations and Multi-Use) project prototype. This CoMu prototype is a system which helps a user to reach suitable mission GS in order to cover a product requirement. It transforms a requirement of imaging on an area of interest (multi mission programming request) into one or more request for programming (mission programming request) to affiliated missions GS.

The Sensor Planning Service Profile for Earth Observation Sensors (OGC-07-018) is the ICD for the programming service.

CoMu prototype is based on an imaging requirement on an area of interest, this one is taken in account in order to make a simulation on the capacity of the affiliated mission GS. This is a theoretical feasibility analysis. Then the missions GS are involved in order to perform a detailed feasibility analysis by taking into account the constraints of the mission planning of each mission GS.

On the basis of result of feasibility by the mission GS, CoMu is in charge to compute an optimal solution of acquisition on the area of interest by combining several missions in addition to the solutions of acquisition by single mission GS.

The user then has the choice between the acquisition by a single mission and the acquisition achieved by several mission.

In parallel of the submission of an imaging requirement, CoMu must also take into account the requests for programming cancellation and the request for programming status.

CoMu is thus interfaced toward the final user for the requirement specification and the choice of the programming and is also directly interfaced with the mission GS which achieve the mission plan of each satellite by taking into account in particular the mission programming requests emitted within the framework of CoMu.

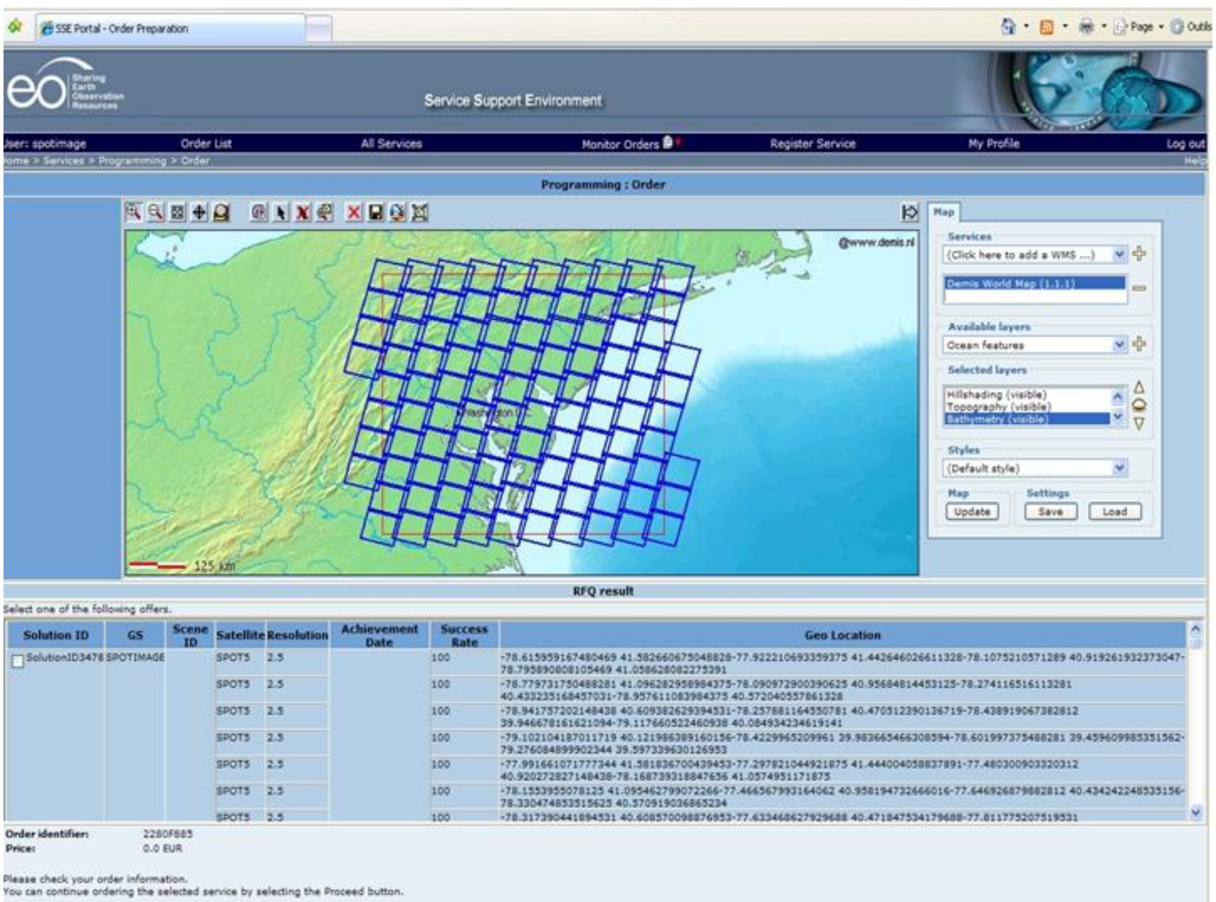


Figure 26 : Feasibility Analysis results.

11.7 Order service

11.8 Online Data Access service

The EADS Astrium's MeTiS product has been used in the scope of FedEO for accessing WMS through web2.0 technologies.

MeTiS is a virtual earth information environment integrating both benefits of Web 2.0 wave technologies together with OGC interoperability standards (WMS). MeTiS offers to end user an ergonomic and user friendly interface for geospatial data discovery and aggregation. Dedicated to users' needs for environmental monitoring purpose, MeTiS manages and records user-context allowing persistent remote access to various distributed data sources. It provides access to remote interoperable servers such as background "streaming" web map APIs like Googlemap, YahooMap, Windows Live Local, etc… and environmental WMS offering access to data and value added products at different scales relevant to different user communities.

MeTiS offers many functional and operational capabilities such as navigation into a web on-line "Google Map Like" application, subscription to a certain number of WMS and dynamically aggregates the related layers, definition and management of different thematic working environments and saving/restoring users' context for further connections.

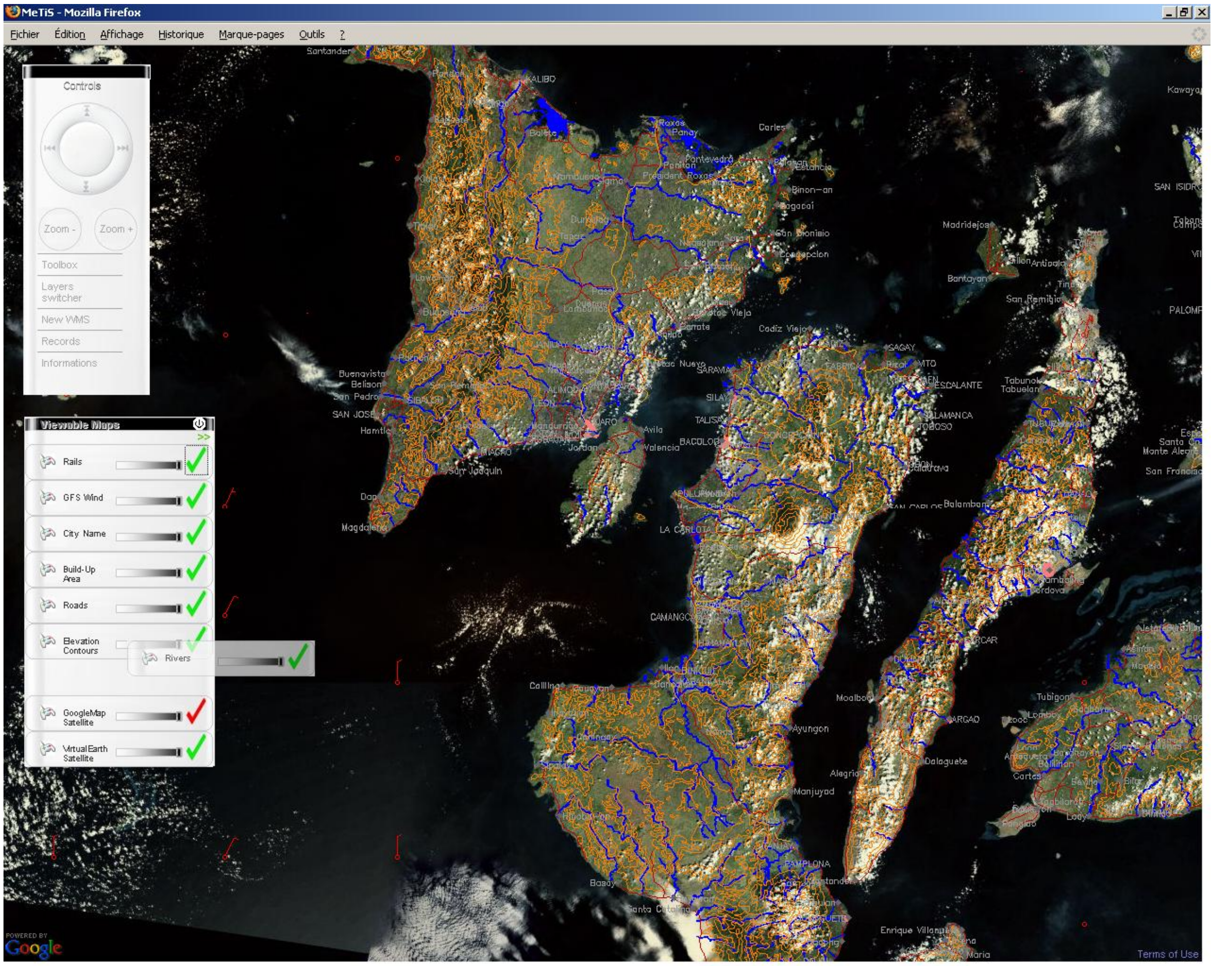


Figure 27 : WMS aggregation through web2.0 technologies.

11.9 Processing Service

11.10 Orthorectification Service

11.11 Reprojection Service

11.12 Service Orchestration

12 Operational issues

12.1 Collection Discovery Service

As for the discovery of services, the OGC CS-W 2.0.1 ISO Metadata Application Profile was used for the discovery of EO product collections of which the metadata is encoded within an ISO 19115 and ISO 19139 based model and encoding. As a consequence existing COTS and Open Source tools as FAO's "GeoNetwork Opensource" catalogue solution can for instance be used for storing and discovering dataset collection metadata as well as the associated services.

In the meanwhile, we are migrating to the OGC CS-W 2.0 ebRIM Application profile and more in particular the ISO 19115/19119 extension package for ebRIM (OGC 07-038). In the framework of FEDEO, a first such catalogue was published by Ionic Software.

12.2 Service Discovery Service

The OGC CS-W 2.0.1 ISO Metadata Application Profile (OGC 04-038) was used for service discovery. This application profile of the Catalog Services for the Web - CS-W specification provides ISO 19139 compatible XML Schema for Catalog Search Result sets for ISO 19115 (data) and ISO 19119 (service) metadata. In addition, it defines the available operations and the supported query criteria (queryables) that catalog clients can use for interacting with the catalog service. It enables users to discover and retrieve metadata about available Earth Observation related services hereby providing sufficient information to assess the usefulness of a service for the task at hand. Furthermore, it offers the binding information for accessing this service (e.g. HTTP binding together with a hyperlink composed of a GetCapabilities request of an OGC Web Service - OWS (WMS, WCS, WFS). In addition, FedEO can support service discovery via Universal Description, Discovery and Integration – UDDI from OASIS with the advantage of allowing mainstream IT tools from large vendors (Oracle, IBM, Microsoft) to discover the exposed services.

We are currently migrating from the ISO 19115/19119 Application Profile to the OGC CS-W 2.0 ebRIM Application profile and more in particular the ISO 19115/19119 extension package for ebRIM (OGC 07-038). In the framework of FedEO, a first such catalogue was published by IONIC-LEICA.

12.3 Catalogue Service

For the « dataset » (product) catalogue service the CS-W Application Profile for Earth Observation (OGC 06-079) was initially proposed to take into account the EO specific product metadata.

Since then, we have migrated to the ebRIM Application Profile of CS-W as this allows using an application profile that is also in use outside the EO domain. This is in-line with the recent OGC decision to recommend the use of the ebRIM model as information model for future catalogue specifications. The ebRIM information model for EO data is defined in the EO extension package for ebRIM Profile of CSW2.0 (OGC 06-131). In both cases, the metadata are specified as a GML application schema defined within OGC 06-080.

A first version of CITE TEAM tests for the specification OGC 06-131 is being finalised for the moment under ESA contract. It is expected that these conformance tests which are based on the same engine used by the OGC will be on-line early 2008.

12.4 Programming Services

12.4.1 Comments on Programming ICD

Hereafter the list issues related to the Programming ICD:

- Confusion on document and schema versions
  Schemas refer to 0.9.4, while the document does not provide its version number.

- Error handling
  The reference to the exception specification of OGC Web Service Specification is wrong: the correct section is §8 and not §7.4 (e.g. see §13.6, §14.6, 15.3.1, etc.)

- GetCapabilities response
  Not clear the meaning of the following fields:

  - sps:RequiresNotificationTarget
  - sps:SubsequentGetFeasibilitySupported
  - wns:SupportedCommunicationProtocols
  - wns:SupportedCommunicationFormats

  Additionally seems missing a parameter specifying the support of WS-Addressing for asynchronous requests.

- Tasking Parameters
  The section §8.2 describes the preliminary list of tasking parameters providing a short description and type for each of them. It is missing the specification of which sps:definition to use i.e. what element of the following ones has to be used for each the parameters:

  - sps:commonData element, which implies SWECommon;
  - sps:TaskMessageDefinition, which is not clear how does it work;
  - sps:GeometryDefinition
  - sps:ParameterDescriptor for nested parameters

  Additionally for each of above elements further information is needed:

  - in case of sps:commonData element, it is necessary to specify which SWECommon type has to be used e.g.: Count, Quantity, Text, Category, TimeRange, DataRecord, etc.
  - in case of sps:GeometryDefinition, it is necessary to specify whether it is a gml:Polygon or gml:Point etc..
  - in case of nested parameters it is necessary to specify whether swe:DataRecord or nested sps:ParameterDescriptor have to be used.

To be noted that SWECommon types allow defining complex and nested structures without the need of using nested sps:ParameterDescriptor. In fact for example, the swe:DataRecord allows specifying elements that can be simple or complex type as well; array are also supported.

Then it is suggested:

- either to complement that paragraph with a table specifying all above information for each identified parameter
- or provide a rule and a template XML file showing how the different parameters have to be declared and set.

- Detailed comments on sps:ParameterDescriptor:
  - sps:restriction can be removed because constraints can be defined directly within SWE Common types.
  - sps:cardinality is not described in the document.
  - Parameter names are case sensitive?
- Detailed comments on preliminary identified tasking parameters:
  - "Urgence" to be corrected to "Urgency". It is defined as Quality of service but the values are not aligned with the OS EO [AD-02].
  - Polarization Mode to be clarified: what's the meaning of these values? D, Q, S, T, UNDEFINED.
    This is a comment for GML Application schema rather than SPS EO.
  - Clarification on SurveyPeriods:
    - If a sensor can be tasked by scenes and by coverage, how it can be encoded?
      How the choice specified in §8.2.6 can be encoded when declaring the parameter?
  - TemporalSeries: there is only the periodicity and not also the repetition (then the standing order will never finish).
  - The tasking parameters for coverage orders are too few: in fact it is not possible to filter also by orbit, pass, track, frame (which are currently supported by the ESA Catalogue when computing future potential products).
- "Estimate" Feasibility Level
  This level of feasibility analysis takes into account also meteorological data. It looks not necessary because it is implicit when specifying the "Validation Parameters". In fact when the tasking parameters include the accepted level of snow or cloud coverage it implies automatically to use meteorological data. Then it is suggested to use only 2 levels e.g. "Standard" and "Full" (when the mission planning is also considered).
- GetFeasibility input parameters
  It is not clear the purpose of **ID** element in the get feasibility **request**.
- Get Feasibility Output Parameters
  In the current release of the Programming ICD it is not yet defined how scenes / strips calculated by the feasibility analysis are represented i.e. which parameters (EO Product Metadata attributes) have to be returned.

- Quotation

  In case of stand alone usage of Programming ICD it is suggested to add GetQuotation operation, similar to that of Ordering ICD, for getting a cost estimation of the tasking request going to be submitted.

12.4.2 Further details on encoding of Tasking Parameters / ordering options

The choice of using dynamic extensible lists for modelling tasking parameters and ordering options has the advantage of allowing each SPS / OS server to specify all the parameters that are deemed necessary (as already said, sps:ParameterDescriptor allows modelling every data type), but it has the following drawbacks:

- This flexibility is achieved practically leaving part of the messages without a schema type, which implies:
  - The correctness of messages cannot be easily verified.
  - Misunderstandings on message format are very probable because there is not a formalized definition.
  - Tools generating automatically XML readers / writers according an XML schema cannot manage the unspecified section;
- Because there is not a schema, then another XML file describing in some way the expected content of the tasking parameters / order options is needed (GetOptionsResponse, DescribeGetFeasibilityResponse, DescribeSubmitResponse).

12.5 Ordering Services

The FedEO Clearinghouse built on SSE technology, provides interfaces to access programming and ordering services for EO products. The programming interface constitutes an EO profile of the OGC Sensor Planning Service - SPS. The ordering service interfaces are defined in the Ordering Services for Earth Observation Products specification.

12.6 Online Data Access

The following set of geospatial services defined by the OGC will be used for user interaction and/or data access and information visualization:

Web Map Service – WMS : This OGC implementation specification (and ISO standard) defines the interactions between client and server applications for the delivery of maps, rendered geographic information, over HTTP. Within the proposed architecture, this standard is employed for both supplying background maps and for visualizing outputs of services. For example, browse images of EO products can be visualised during catalog searches by employing this protocol.

The handling of EO data within WMS is, however, problematic as:

1. the flexibility of the WMS specification leads to non-interoperable implementations;

2. EO data is often reacquired repeatedly, necessitating the handling of hundreds to tens of thousands of unique maps.

An EO specific application profile of the WMS specification was defined as an OGC Discussion Paper in 2006. As part of the FedEO Pilot Project, this draft specification was updated and a reference implementation created. As well a providing a well-constrained, consistent handling for the visualisation of EO products, this specification and implementation also enables the interactive browse of spatial quality metadata. In other words, the EO products discovered by a catalogue search can be evaluated to see if they are fit for purpose before the full data product is ordered or downloaded.

Web Coverage Service – WCS: The OGC implementation specification related to the delivery of coverage, in casu raster data files, across the Internet. It is used as the interface by which clients can download and visualize EO products.

12.7 Processing Service

The FedEO Clearinghouse provides already access to a number of processing services. The IMERIS processor running on the ESA G-POD infrastructure was made accessible via SSE in 2006. Recently a number of "fusion" services developed under the EC FP6 project SANY were integrated with an OGC WPS (Web Processing Service) interface.

In past OGC testbeds OWS-3 and OWS-4, also coordinate conversion services were made available through the SSE by Spot Image and other organisations as OGC WCTS (Web Coordinate Transformation) services. This was documented in the IPR documents OGC 05-140 and OGC 07-008. These services are still accessible via the FedEO Clearinghouse Portal.

12.8 Orthorectification and Reprojection Service

12.9 Service Orchestration

13 Disaster Management / Emergency Response Scenario – Oil Spill Tanker

13.1 Participants, contacts and responsibilities

Organisation Project	Contact(s)	Responsibility
ESONET Network	Roland PERSON	Mobile observatory and Services provider

Organisation Project	Contact(s)	Responsibility
IONIC LEICA	Emmanuel MONDON Frederic HOUBIE	Provide RedSpider catalogue for service discovery metadata (ebRIM extension for ISO profile)
EADS ASTRIUM	Corentin GUILLO	Provide Metis WMS viewer product Provide Feasibility Analysis server to respond to GetFeasibility generated from SSE
SPOTIMAGE	Didier GIACOBBO Philippe MERIGOT	SPOT data WMS server SPOT EO Profile compatible catalogue service SPS EO profile compliant programming service for SPOT (responds to GetFeasibility requests)
JAXA	Satoko MIURA Kengo AIZAWA	WCS server containing ALOS data over the ROI WMS service to access oil slick characteristics extracted from ALOS PALSAR data Catalogue service (TBD)
COMPUSULT	Craig COFFIN Larry BOUZANE Robert THOMAS	Support and Service provider
INFOTERRA UK	Thomas LANKESTER	WMS server (EO profile compliant) containing ASAR data over the ROI
GIM	Steven SMOLDERS	WMS, WFS and WCS viewer integrated in the SSE portal
SPACEBEL	Yves COENE	SSE product for EO services access. Integration into SSE of JAXA, NASA ESG, Spot Image, Dali, Eumetsat and other catalogues. Integration of GEO Clearinghouse catalogues and service orchestration with BPEL.

Organisation Project	Contact(s)	Responsibility
ESA	Jolyon MARTIN	EO Profile compatible catalogue service (ebRIM) to MUIS and NASA (TBC) ASAR data to be used for populating the ITUK WMS server SPS EO profile compliant programming service for ENVISAT MERIS instrument (responds to GetFeasibility requests)
ESA-FAO	Francesca CASALE	GEO Portal
KSAT	S. Jøkulsson GUDMUNDUR	Post processing of ASAR data for extraction of oil slick characteristics Oil slick characteristic data in WMS format
USGS	Eliot CHRISTIAN	CAP RSS feed
EUMETSAT	Franck CADE Michael SCHICK	EO profile compatible catalogue service
UNIDATA	Ben Domenico	WCS servers of global forecast data (TBD)

13.2 Area of Interest:

ESA and JAXA have chosen together the GUIMARAS ISLAND (PHILIPPINES) with the SOLAR I Catastrophe.

Figure 28 : Demonstration scenario AOI

Some links :

http://www.disasterscharter.org/disasters/CALLID_129_e.html

http://www.eorc.jaxa.jp/ALOS/img_up/dis_060825.htm

http://www.eorc.jaxa.jp/ALOS/img_up/pal_oil200608.htm

http://www.panda.org/news_facts/newsroom/index.cfm?uNewsID=78300

http://www.ligtasguimaras.com.ph/

13.3 Scenario Script:

As this scenario differs in several ways from the standard operational concept of the Disaster Charter, it is preferable not to refer to Charter specific vocabulary such as ECO (Emergency on Call Officer).

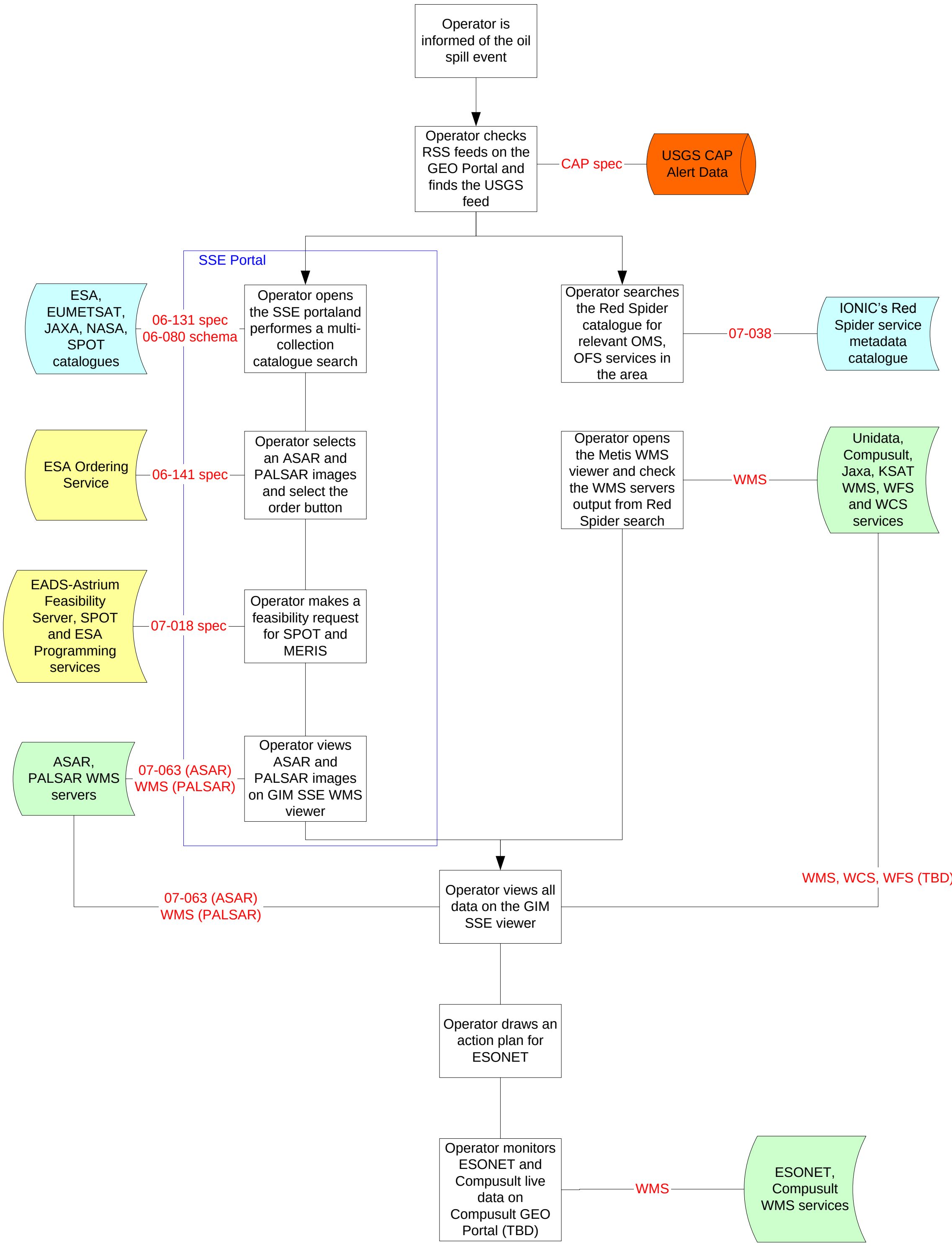
It is planned to combine filming and screen captures.

VISION	ACTIONS/AUDIO (to be expanded)	Comments
Film sequence of an operator is facing 2 screens Zoom on the 1st screen showing the GEO Portal with the maps of Alert services Screen capture of GEO Portal Zoom on the 2nd screen where the details of the USGS alert (through RSS feed) are shown in (e.g.) the google interface Screen capture of the USGS alert	Introduction on the disaster (scene, date, etc) An operator has 2 screens in front of him. On the opening shot, he is looking at the GEO Portal on screen 1 His attention is drawn to screen 2 where the USGS RSS Feed generates an alert corresponding to the oil spill in the Philippines region	Ideally the GEO portal would integrate the USGS RSS feed but it seems that the CAP format used by USGS is not read by the GEO Portal As a 2nd choice, a GEO Portal compatible RSS feed should be created to show the alert sign on the GEO Portal map before moving to the 2nd screen to see the details of the alert from the USGS feed
Film sequence of the operator accessing the SSE portal on screen 1 Screen captures from the manipulation of the SSE portal	The operator logs onto the SSE portal He performs a multi-catalogue search selecting collections from ESA, SPOT Image, EUMETSAT and JAXA (TBD) catalogues He analyses the results, which includes an ASAR data	Should we rename the SSE portal (e.g. FedEO portal) for the film? Meteosat collections will obviously not return any products on the ROI
Capture of the SSE operations	The operator clicks on the thumbnail of the ASAR data The GIM WMS viewer displays the ASAR image The operator selects the order option for the ASAR data and proceed to the Ordering page	ASAR only as we want to then show him looking at SPOT and MERIS future acquisitions (next step)

VISION	ACTIONS/AUDIO (to be expanded)	Comments
Captures of the KSAT processing s/w	The ASAR data is processed by KSAT to extract oil slick characteristics The results are shown on the KSAT viewer The report is briefly shown on the screen	This is a slight adaptation of the KSAT oil spill service as KSAT service tends to be used for monitoring and detection rather than post event analysis
Capture of the SSE operations	The operator selects the multi-mission programming service He performs an SPS EO Profile compatible GetFeasibility requests for SPOT and MERIS instruments The result of the search is shown on the SSE GUI The operator selects one or more of the SPOT scenes and submit the programming request (TBD if the GUI will allow)	Availability of the MERIS interface is TBD Can we obtain MERIS data?
Capture of the SSE operations (possibly fast forward for the catalogue operations)	Narration to explain the acquisition process The operator access the acquired data through the catalogue (quick execution) The operator visualize the SPOT data on the SSE WMS	The SPOT data viewed may not be the one selected in the programming step, however it should not be noticeable
Film sequence of the operator turning to screen 2 Screen capture of RedSpider catalogue actions	On screen 2, the operator makes a search for available services in the areas on the RedSpider service catalogue Analyses the results Select services View those services on the Metis viewer over the Google Earth map	For the moment, we only have one WMS service The results include the KSAT WMS server containing the data Ideally the Metis viewer would allow viewing the ASAR and SPOT data as background

VISION	ACTIONS/AUDIO (to be expanded)	Comments
Film sequence of the operator turns towards screen 1 Capture of SSE operations Film sequence of the operator preparing an action plan on the basis of the image on the screen	The operator is now looking the GIM viewer of the SSE which displays both the EO images and the layers from the services discovered in the RedSpider catalogue The operator makes several manipulations with layers The operator draws an action plan	
Screen capture of the ESONET interface	The operator uses the interface to the ESONET to convey his action plan To be continued….	Need more details about the ESONET interface

13.4 Scenario Diagram:



13.5 Logistics

The test SSE environment of ESA will be used for the purpose of this scenario (services-test.eoportal.org). Please use the ESA help facilities for issues related to the use of SSE.

13.6 Service Lists

(Interface Specification used with issue number to be completed by participants ASAP)

Services accessible through SSE only

These services do not need to be registered in the Red Spider Catalogue. For the registration of the catalogue services following the ebRIM 06-131 specifications, please send server details to SPACEBEL who will register the services in the test SSE environment of ESA.

Service	Provider	Interface Document
SPOT catalogue service	SPOT Image	TBC
MUIS Catalogue service	ESA/Siemens Austria	TBC
NASA Catalogue service	NASA/ESA/Siemens Austria	TBC
EUMETSAT Catalogue service	EUMETSAT	TBC
JAXA Catalogue service	JAXA	TBC
SPOT Programming service	SPOTIMAGE	TBC
MERIS Programming service	ESA/Datamat	TBC
MUIS Ordering service	ESA/Datamat	TBC

Services registered in the Red Spider Catalogue

The Red Spider catalogue will be made available online by the 20th August. Details of the Red Spider catalogue to be posted as soon as available. Server URL's to also be sent to GIM for integration in SSE viewer.

Service	Provider	Interface Document
WMS service containing ASAR data over the ROI	ITUK	TBC
WMS service to access oil slick characteristics extracted from ASAR data	KSAT	TBC
Oil Spill CAP RSS feed	USGS	TBC
WCS services of global forecast data (TBD)	UNIDATA	WCS
WMS Live Sensor data	Compusult	WMS
WCS server of ALOS/PALSAR data	JAXA	WCS
WMS server of oil slick characteristics extracted from ALOS/PALSAR data	JAXA	WMS

13.7 Demonstration

http://www.ogcnetwork.net/pub/ogcnetwork/GEOSS/AI_Pilot_Demo/index.html