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This document defines the “Technology Watching” activities on Data Access and Processing of the GIGAS Project Loop 2
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Introduction

1.1 Purpose and Scope

The GEOSS INSPIRE and GMES Action in Support (GIGAS) project seeks to carry out a Support Action (SA) aiming at a rapid adoption of standards, protocols, and open architectures in support of INSPIRE, GMES, and GEOSS initiatives. GIGAS will identify and define what is needed to enable a full integration of the architectures of the three initiatives via a consensus.

This document defines the “Technology Watching” activities on Data Access and Processing of the GIGAS Project.

The watching activities are performed according to the methodology defined in [AD2] based on the RM-ODP approach, see also [RD2] and [RD4].

This document is part of GIGAS deliverable D2.2 “Technology watch reports” as defined by [RD3] and it is an input for D2.3 “Comparative Analysis” as per [AD1].

The document is part of the activities of GIGAS Work Package 2 “Requirements and Architecture Watch” as per [AD1].

1.2 Documents

1.2.1 Applicable Documents

AD 1. SEVENTH FRAMEWORK PROGRAMME THEME [FP7-ICT-2007-2] GEOSS, INSPIRE and GMES, an Action in Support – Annex I – "Description of Work" – 13/05/2008

AD 2. GIGAS Methodology for Technology Watch Issue 100 25/07/2008

AD 3. GIGAS Refine Scope and targets Issue 100

1.2.2 Reference documents

RD 1. GIGAS Technology watch reports Issue 1.0 30/09/2008

RD 2. Reference Model for the ORCHESTRA Architecture (RM-OA) V2 (Rev 2.1) OGC 07-097

RD 3. Report of GIGAS WP2 workshop: Refine scope and targets, Darmstadt, Germany , 11th June 2008

RD 4. ISO-IEC 10746-1/2/3 Information technology — Open Distributed Processing — Reference model

RD 5. GIGAS Technology Watch Report WPS, 30/06/2009

RD 6. SANY D2.3.4 Sensor Service Architecture V3

RD 7. GIGAS Technology Watch Report WPS, 22/06/2009

RD 8. GIGAS Technology Watch Report Sensor Planning

RD 9. GIGAS Technology Watch Report WPS, 23/01/2009

1.3 Acronyms

Acronym	Description
ATS	Abstract Test Suite
CAFE	Clean Air For Europe
CEN	Comité Européen de Normalisation or European Committee for Standardisation
CF	Climate and Forecast
CITE	Compliance & Interoperability Testing & Evaluation
CRS	Coordinates Reference System
DAIL	Data Access Integration Layer
DAP (2)	Data Access Protocol
DGIWG	Digital Geospatial Information Working Group
DiGIR	Distributed Generic Information Retrieval
EO	Earth Observation
ESA	European Space Agency
ESS	Earth Systems Science
ETS	Executable Test Suite
FE	Feature Expert
FIG	Fèdèration Internationale des Gèometres or International Federation of Surveyors
FP	Framework Program
GALEON	Geo-interface to Atmosphere, Land, Earth, Ocean, NetCDF
GEOSS	Global Earth Observation System of Systems
GeoTIFF	Geographic Tagged Image File Format
GIGAS	GEOSS INSPIRE and GMES Action in Support
GMES	Global Monitoring for Environment and Security
GML	Geography Markup Language
GRIB	GRIdded Binary
GSCDA	GMES Coordinated Data Access
HMA	Heterogeneous Missions Accessibility
HMA-FO	Heterogeneous Missions Accessibility – Follow On
HMA-I	Heterogeneous Missions Accessibility – Interoperability
HMA-T	Heterogeneous Missions Accessibility – Testbed
HDF	Hierarchical Data Format
ICT	Information and Communication Technology

Acronym	Description
IE	Initiative Expert
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IFP	Initiative Focal Point
INSPIRE	Infrastructure for Spatial Information in the European Community
ICD	Interface Control Document
ISO	International Standards Organization
IT WG	Interoperability Tools Working Group
KO	Kick-Off
M WG	Methodology Working Group
netCDF	network Common Data Form
OASIS	Organization for the Advancement of Structured Information Standards
O&M	Observations and Measurements
OGC	Open Geospatial Consortium
OPeNDAP	Open-source Project for a Network Data Access Protocol
RASDS	Reference Architecture for Space Data Systems
RM	Reference Model
RM-OA	Reference Model ORCHESTRA Architecture
RM-ODP	Reference Model Open Distributed Processing
RST WG	Refine Scope & Target Working Group
SANY	Sensor ANYwhere
SOA	Service Oriented Architecture
SOS	Sensor Observation Service
SWE	Sensor Web Enablement
TBC	To Be Confirmed
TBD	To Be Defined
TBV	To Be Verified
TDWG	Taxonomic Database Working Group
THREDDS	Thematic Realtime Environmental Distributed Data Services
UML	Unified Modeling Language
W3C	World Wide web consortium
WCS	Web Coverage Service
WCTS	Web Coordinate Transformation Service

Acronym	Description
WFS	Web Feature Service
WG	Working Group
WMS	Web Map Service
WMTS	Web Map Tiled Service
WP	Work Package
WPS	Web Processing Service
XML	eXtensible Markup Language

1.4 Document Overview

This document is based on the GIGAS methodology [AD.2]. Due to the fact that the document is mainly oriented to describe service, only the enterprise and Service Viewpoints are used in Chapter3, with the goal of focusing the attention on the most relevant aspects of the study.

This document consists of the following sections:

- Chapter 1 is an introduction
- Chapter 2 provides an overview of the feature/architecture aspect under analysis and lists the high level interoperability requirements
- Chapter 3 contains the RM-ODP based technology watch study
- Chapter 4 contains the conclusions of the study

2 Background

2.1 Context

2.1.1 Data Access and Processing Standards

This TN discusses the harmonization and interoperability of "Geographic model/information management services" for geographic data access and processing (ISO 19119). These services category is comprised of:

- *Feature access service. Service that provides a client access to and management of a feature store. An access service may include a query that filters the data returned to the client. ISO 19125-1 is relevant to feature access.*
- *Map access service. Service that provides a client access to a geographic graphics, i.e., pictures of geographic data. ISO 19128 is relevant to map access.*
- *Coverage access service. Service that provides a client access to and management of a coverage store. An access service may include a query that filters the data returned to the client. ISO 19123 and ISO 19111 are relevant to coverage access.*
- *Coverage Access Service – sensor. Service that provides access to a coverage where the source of the coverage data is a real-time sensor, i.e., not a persistent store.*
- *Product access service. Service that provides access to and management of a geographic product store. A product can be a predefined feature collection and metadata with known boundaries and content, corresponding to a paper map or report. A product can alternately be a previously defined set of coverages with associated metadata.*
  In the context of sensors the information derived from raw sensor data as well as processed data could also be seen as a "product" (e.g. in the EC SANY project the Sensor Observation Service is used as access method for both sensor and product).
- *Processing Service. Service that provides management of remote processing capabilities of geographic data and/or products. Processing could be a transformation of existing data until a production chain that deliver a product from raw data.*

Note

As to the "Processing Service" category, processing service access functionalities may be also included. For example, the new OGC specification for Web Processing Service (i.e. WPS 2.0, currently in draft version) adresses the access and processing services (including subsetting, download, transaction and execution functionalities) for:

- field-based geographic data (e.g. Imagery, Gridded and Coverage Data);
- geo-relational-based geographic data (e.g. General Feature Data);
- sensors and sensor collections and data derived from sensor data. Both in-situ and remote sensors are considered, in principle.

Interoperability Standards

Main related features include:

- International Standard protocols and data models; such as:
  - WMS
  - WCS
  - WFS
  - SWE SOS/SPS
  - WPS
  - ISO 19129, 19142, 19143, 19136, 19123, 19156/O&M.
  - netCDF- CF
  - SensorML, TransducerML.
- Extensions and Applications profiles; such as:
  - WCS CF-netCDF extension profile;
  - WCS GeoTIFF extension profile;
  - WCS-JPEG 2000 extension; profile
  - WMS EO extension profile.

2.1.2 OGC Service Viewpoint

The OGC Abstract Specification Topic 12 - The OpenGIS Service Architecture provides a framework for developers to create software that enables users to access and process geospatial data from a variety of sources across generic computing interfaces within an open information technology environment.

OGC standards are defined for multiple distributed computing platforms while maintaining common geospatial semantics across the underlying technology. OGC defines one conceptual specification as the basis for multiple platform-specific implementation specifications.

OGC services are defined using fundamental principles of service-oriented architecture:

A Service is a distinct part of the functionality that is provided by an entity through interfaces,

An Interface is a named set of operations that characterise the behaviour of an entity,

An Operation is a specification of a transformation or query that an object may be called to execute. Each operation has a name and a list of parameters.

Application and extension of the OGC Service Architecture is described in The Reference Model for the ORCHESTRA Architecture available as an OGC Best Practice.

OGC Web Services (OWS) are defined using open non-proprietary Internet standards; in particular the World Wide Web (WWW) standards of HTTP, Uniform Resource Locators (URLs), Multipurpose Internet Mail Extensions (MIME) types and the Extensible Markup Language (XML).

Recently, OWS services are becoming defined on the enterprise web service standards of WSDL (Web Services Description Language) and SOAP (this was originally an acronym for Simple Object Access Protocol but this was dropped in later versions of the standard). In parallel, OWS services are being defined for mass-market application using resource oriented or "RESTful" approaches including specifications such as geoRSS and KML. OGC Web Service standards have been established for geospatial data

The OGC Web Services Architecture Description Best Practice document summarises significant aspects of the OGC web services architecture. This architecture is a service-oriented architecture, with all components providing one or more services to other services or to clients.

Service Viewpoint

Aspect	**Description**
Service name	OGC Web Service Common Implementation Specification (OWS-Common)
Category	Geographic model/Information management services (ISO 19119) OA-InfoStructure (Orchestra)
Reference to specification	see standard reference
Standard reference	OGC Web Service Common Implementation Specification, version 1.1.0, OGC 06-121r3.
Description	The OGC Web Services Common (WS-Common) Interface Standard specifies parameters and data structures that are common to all OGC Web Service (OWS) Standards. The OpenGIS Web Service Common Implementation Specification provides specifics that are common to OWS interface Implementation Specifications. These common aspects are primarily some of the parameters and data structures used in operation requests and responses. For example, the standard normalizes the ways in which operation requests and responses handle such elements as bounding boxes, exception processing, URL requests, URN expressions, and key value encoding. Each Implementation Specification details additional aspects of that interface, including specifying all additional parameters and data structures needed in all operation requests and responses. Among its uses, this document serves as a normative reference for other OGC Web Service standards, including the OpenGIS Web Map Service (WMS), Web Feature Service (WFS), and Web Coverage Service (WCS). Rather than continuing to repeat this material in each such standard, each standard will normatively reference parts of this document.
Format	UML, XML, KVP, HTTP
Comment	The OWS Common 1.2 Standards Workgroup is focused on processing change requests to be included in OGC Web Services Common 1.2.

	The work of the SWG will be to consider at least the following Change Requests: • Add Flexible Metadata (OGC 07-042) • Add XML Elements and Types for Parameters (Section 3.1 of OGC 04-105) • Add Conformance Classes (Not yet drafted, analogous to OGC 07-058r2 for WCS) • Add General Reference System (OGC 07-059) • Add SOAP Encoding (OGC 06-094) • Add Time Zone Offset Request (Section 7.1 of OGC 06-022) • Define a URN to Identify Service Type (OGC 06-150) • Expand Multilingual Abilities (Not yet drafted, analogous to OGC 06-149r2 for WMS) • Improve Abstract Test Suite (Annex A) • Improve Schema Modularization (Section 2.1 of OGC 04-054r1) • Include remoteSchema attribute in Metadata Element (Section 3.4 of OGC 04-105) • Include Filter Capabilities (Section 2.2 of OGC 04-054r1) • Nested KVP Parameter Encoding • RESTful Additions and / or Changes • Support Rights Management (OGC 06-177) • WSDL Recommendations Annex (OWS-2 Architecture IPR OGC 04-060) • Split OWS Common document into parts (Drafted)

Table 1: OGC Web Service Common Implementation Specification (WS-Common)

2.1.3 INSPIRE Service Architecture

Download services

The INSPIRE Directive asks Member States in article 11(1) (c) to establish and operate a network of "download services, enabling copies of spatial data sets, or parts of such sets, to be downloaded and, where practicable, accessed directly". In addition, where public authorities levy charges for the download services, Member States shall ensure that e-commerce services (including rights management services) are available (article 14(4)). A download service supports:

- downloading of a complete dataset or datasets;
- downloading of a part of a dataset or datasets;
- direct access to complete datasets or parts of datasets.

In the context of INSPIRE, datasets are restricted to the categories defined by the Annexes I-III (see Article 4 of the Directive), and for which metadata exist and are updated according to Article 5, and that spatial datasets are interoperable and harmonized according to Article 7-10. However, the same type of services can be used much more general.

Transformation services

The INSPIRE Directive requires, in Article 11(1)(d), Member States to "establish and operate a network of … transformation services, enabling spatial data sets to be transformed with a view to achieving interoperability". This service may be seen as a spatial data processing service, capable of transforming the input dataset into another (e.g. from a Coordinate Reference System (CRT) to another).

Comparative analysis with OGC SOAP services framework

The recent "INSPIRE network services SOAP framework" issued by INSPIRE includes a comparative analysis between the INSPIRE service framework and the one proposed by OGC. The rest of the paragraph contains useful excerptions.

The *first consideration to be done is that the INSPIRE framework was born with the idea to be based on SOAP, while OGC web services infrastructure has been thought when SOAP was not a standard yet and so it layers mostly on HTTP GET and POST actions. This substantial divergence brings to a different choice also about the interoperability standard: OGC is not WS-I compliant, while the INSPIRE proposed framework follows WS-I Basic Profile 1.2 and could evolve in time, in order to follow WS-I profile 2.0 dictates.*

Under a more technical point of view, as demonstrated in [EUR 23452 EN - 2008], OGC does not take an univocal decision under the main aspects of a hypothetical SOAP framework. There is not a common choice for the data encoding topic, neither for the binary data transport and representation, while INSPIRE, with the proposed framework (described in the network document), *clearly defines the ways to be followed. Document/literal wrapped style and MTOM+XOP on MIME will be the used standards.*

Anyway these choices do not differ too much from the several ones proposed by OGC: OGC in some specifications left a free choice between Document/literal and RPC/literal, but the former is the most popular suggestion. Even for the binary data representation and transport mechanism MTOM+XOP solution was between the proposed choices by OGC.

OGC does not take over the SOAP header theme at all, while in INSPIRE the possibility to exploit this kind of extensions has been analysed and has been proposed as a solution for different kind of problems of the INSPIRE domain, like security, artefact signatures, download checksums and multilingualism.

The INSPIRE SOAP framework follows precisely the OGC specification about how to represent the raised exceptions in SOAP messages, approving the whole proposed XML message structure.

The following table summarizes all the protocol and standard used by the two different frameworks, together with the specific version.

INSPIRE SOAP FRAMEWORK	OGC WEB-SERVICES
XML 1.0	XML 1.0
HTTP 1.1	HTTP 1.1

SOAP 1.1	SOAP 1.2
WSDL 1.1	WSDL 1.1
MTOM 1.0 + XOP 1.0 + MIME 1.0	SwA or MTOM+XOP+MIME or FastInfoset
Document/literal wrapped	Mainly Document/literal
WS-I 1.2 *(next 2.0)* compliance	No WS-I compliance

Table 2: **INSPIRE service architecture vs OWS: Protocol and standard versions comparison**

Resource Oriented Architecture and REST

The INSPIRE document "Resource Oriented Architecture and REST" summarizes the analysis done for applying RESTFul to the INSPIRE SOA framework. This document concludes: *it emerges that no particular benefits have been identified when using REST and RESTFul platforms for offering SOA services. Moreover, concerning pure ROA infrastructure we can certainly claim that it is not straightforward rephrase INSPIRE architecture (and OGC services) implement the equivalent ROA and it is important take into account the INSPIRE time schedule constraints.*

2.1.4 GMES Service Architecture

The GMES initiative comprises a group of vertical services aimed at monitoring Earth sub-systems (land, ocean, and atmosphere) and horizontal services addressing emergency and security issues.

Three fast track services (FTS) proceed into the implementation of the pilot operational phase. It has established a process for confirming these and defining their exact scope and modalities. The three services already proposed to the EU and ESA Member States in the GMES Advisory Council are: Emergency Response, Land Monitoring, and Marine Services.

Three Implementation Groups (IG) with representatives of the various user communities, were set up for these three FTS in 2006. Each IG analyzed the main issues related to FTS implementation, including the scope of the service and its potential evolution, its functionality and architecture, its main structure and governance principles, as well as its requirements regarding observation infrastructure and data needs, data integration and information management issues.

The GMES services are structured around 'Core' and 'Downstream' service layers. 'Core services' are pan-European in scope and generic in nature. More specialised 'downstream services' to meet the needs of a range of different users (e.g. national, regional or local) can be derived from them by further value-adding and customisation. As a user-driven initiative, GMES should ensure a continuous user uptake through constant consultation with users and integration of their changing needs in an iterative process.

2.1.5 GEOSS Common Infrastructure

The GEOSS infrastructure is based on a System of Systems approach. The infrastructure that coordinates access to the systems, applications, services, models, and products by the Societal Benefit Areas (SBAs) users is the ***GEOSS Common Infrastructure*** (GCI).

The infrastructure consists of four main elements: the GEOPortal, the GEOSS Clearinghouse, the GEOSS Components and Services Registry and the GEOSS Standards and Interoperability Registry.

Two key resources available through the GCI are “Components” and “Services.” A "GEOSS Component" is one of many earth observation resources that are contributed by a GEO Member or Participating organization. A "GEOSS Service" describes a service interface to a component resource. Typically implemented as an Internet-accessible resource, these service interfaces promote the exchange of structured messages for the selection or processing of information.

In order to augment the GCI Initial Operating Capacity, GEOSS conduces the Architecture Implementation Pilot (AIP) task. The second phase of this task (AIP-2) was conducted from June 2008 to August 2009. The Working Groups which participated documented their activity with Engineering Reports[1]. Several services were implemented in order to support the different needs of SBA users and interoperability was addressed by the use of international standards.

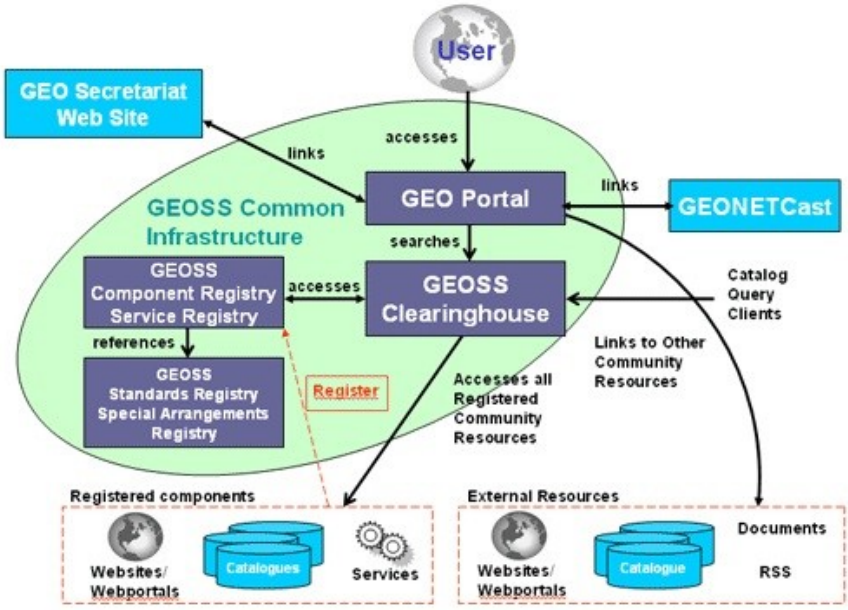


Figure 1 - GEOSS Common Infrastructure Diagram, credits: GEOSS Web Site

2.2 Results from Previous TN

This TN deepens some recommendations introduced by a previous survey [RD5]. They are:

2.2.1 WMS

The previous technology watch report [RD.7] was completed on the result that some interoperability issues would exist between INSPIRE and GEOSS or GMES projects that strictly implement ISO 19128 WMS Standard. Identified issues are:

- SOAP Binding

[1] http://www.ogcnetwork.net/AIP2ERs

- Multilingualism
- Linked data in GetCapabilities response.

These issues were subjects to draft recommendations in the process of consensus building. Poling results show an agreement about the subject of each issues but request to push one step deeper the analysis and concrete solution to recommend.

2.2.2 SPS

The results from the previous technology watch [RD.8] state that for the SPS there is a need for harmonization only between GMES and GEOSS; in fact, SPS is not applicable to INSPIRE at the present stage.

2.2.3 Ordering Service

The results from the previous technology watch [RD.9] put in evidence that Ordering Service is not at the same level of maturity on each of the three initiatives GMES, INSPIRE and GEOSS.

3 Architectural Analysis

3.1 Coverage Access services

3.1.1 Context

Following the GEOSS Standard & Interoperability Forum (SIF) approach, we may distinguish between international standards and interoperability arrangements implementing coverage access services –as defined by 19119.

International standards for coverage data access:

- OGC Web Coverage Sservice (WCS);
- OGC SOS (Sensor Observation Service).

Well-accepted Interoperability Arrangements for coverage data access:

- OPeNDAP/DAP2 (Data Access Protocol);
- OBIS/DiGIR (Ocean Biogeographic Information System/Distributed Generic Information Retrieval);

According to the OGC SOS 1.0.0 specification, “used in conjunction with other OGC specifications, the SOS provides a broad range of interoperable capability for discovering, binding to and interrogating individual sensors, sensor platforms, or networked constellations of sensors in real-time, archived or simulated environments”. In addition, The EC SANY project recently demonstrated the usability of the SOS service interface for retrieval various types of data fusion and modeling services, as well as for retrieval of the raw CAFE (Clean Air For Europe) reporting data. The SOS should be thus seen as a general purpose service front-end for all processes that deliver “sensor-like” output consisting of at least value(s), unit(s), temporal, and spatial context. In addition, the SOS allows rich description of process and data uncertainty by mean of embedded UncertML (see http://www.uncertml.org/).

SOS has three mandatory “core” operations: GetObservation, DescribeSensor, and GetCapabilities. The GetObservation operation provides access to sensor observations and measurements, as well as data derived from sensor data, via a spatio-temporal query that can be filtered by “observed properties“ (e.g. physical phenomena) as well as by other additional filtering possibilities –e.g. Offering, Procedure, and Result value.

The DescribeSensor operation retrieves detailed information about the sensors and processes generating those observations. Process description is important. In fact, process is described in SensorML in a generic way does not have to start from the sensor The GetCapabilities operation provides the means to access SOS service metadata. Several optional, non-mandatory operations have also been defined.

According to the current OGC WCS standard specification, "the Web Coverage Service supports electronic retrieval 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 Web Coverage Service provides three operations: GetCapabilities, DescribeCoverage, and GetCoverage. The DescribeCoverage operation lets clients request a full description of one or more

coverages served by a particular WCS server. The server responds with an XML document that fully describes the identified coverages. The GetCoverage operation returns a coverage (that is, values or properties of a set of geographic locations), encoded in a well-known coverage format.

OPeNDAP and DiGIR are usable with any data type. However, DAP2 is much more widely used than DiGIR and it is based on a discipline neutral model. OPeNDAP is a widespread implementation of DAP. Although the OPeNDAP information elements schema has some similarity with the WCS one, there are some important differences. In fact, OPeNDAP is explicitly based on HTTP and it uses the semantics of GET verb to express the action of retrieving resources representations. This conforms to a more RESTful architecture; however, important REST characteristics are missing –e.g. the constraint expression may hide processing functions, main resources have not any hypermedia representations.

Besides, of particular concern with regard to DAP2 servers was the lack of a semantic framework to order data as well as one for the returned data objects. This does not mean that semantic information is unavailable from DAP2 data objects, only that there is no imposed consistency on these semantics. By contrast WCS requires semantic consistency of the returned data objects.

The THREDDS (Thematic Realtime Environmental Distributed Data Services) technology from Unidata/UCAR may be used as an OPeNDAP-WCS gateway. In fact, it can operate as an OGC WCS server and as an OPeNDAP client (see the OGC GALEON network: http://www.ogcnetwork.net/galeon).

In a SOA approach, services are mainly characterized by specifying a common interface as well as a common payload data model. The latter is worked out considering the ongoing standardization effort in data, metadata and encoding models for coverages. This is comprised of the following international standards:

- OGC/ISO 19123 (Geographic information—Schema for coverage geometry and functions);
- OGC/ISO 19111 (Geographic information—Spatial referencing by coordinates);
- ISO 19111-2 (Geographic information – Spatial referencing by coordinates – Part 2: Extension for parametric values);
- ISO 19115 (Geographic information – Metadata);
- ISO 19115-2 (Geographic information – Metadata – Part2 - Metadata for imagery and gridded data)
- OGC/ISO 19136 (Geographic information – Geography Markup Language (GML))
- OGC/ISO 19156 (Geographic information – Observations and measurements)
- OGC SensorML and UncertML.

Actually, ISO19119 outlines that “ISO 19123 and ISO 19111 are relevant to coverage access”; in turn, ISO 19115 and ISO 19115-2 are relevant for the previous couple of specifications. OGC and ISO service payload encoding (e.g. OGC WCS, ISO 19128) utilize GML. Eventually, the Observation & Measurements specification introduces an harmonization data model solution for the field and geo-relational based approaches (i.e. feature-boundary and coverage datasets).

Challenges and limitations of current standards

There are a number of known limitations with the existing standards that include:

- Current WCS implementation specifications are only applicable to “grid coverages”. The term "grid coverages" typically refers to content such as satellite images, digital aerial photos, digital elevation data, and other phenomena represented by values at each measurement point. Actually, there are other important coverage data types including: swath, vertical profiles, trajectories, non-regularly spaced grids, point station observations, etc. More generally, there is a clear need to harmonize the Feature (ISO GFM) and Field (ISO Coverage) views of Geoinformation and consequently introduce advanced coverage data types and access functionalities.
- Coverages are acquired, managed and used using different granularity levels and, therefore, semantics. These heterogeneity aspects must be considered in an advanced specification. The development of middleware services capable of “bridging the gap” must be considered –e.g. mediation, brokering and transformation services.
- Access services may be conceived to address inter-community interoperability challenges (e.g. GIS accessing EO datasets to “understand” and use them) providing extended semantics content in a very explicit way. On the contrary, access services may privilege intra-community interoperability needs, such as: simple bulk transport of data across a range of coverage types, streaming functionalities, etc.
- Implementation simplicity vs effective functionalities.
- To support well-accepted output coverage formats which are able to encode aggregated data, as well as return subsets of the actual, unmodified data in the native CRS (e.g. 4-D) and data type −e.g. floating point. GeoTIFF proved not to be able to implement these requirements.
- CRS (Coordinates Reference System) support limitations –e.g. parametric dimensionalities support.
- Multidimensional domain support –e.g. 5-D(imensions) coverage support.

Consequently, the priority problems to deal with are [Nativi and Domenico, 2008]:

- P1: To control Complexity using Simple implementations;
- P2: Inter-community Vs Intra-community service scope;
- P3: Simple Vs Advanced service scope;
- P3: Scalability & Extensibility Vs Reliability & Stability of service specification scope;
- P4: Existing Capacity Vs Software Environment Interoperability building approach.

The recognized problems may be addressed by making precise (and strategic) implementation choices. We conceived a specific approach which is comprised of the following principles:

- Adopt different application levels of interoperability in order to control complexity. Examples include: a) core plus extensions for accommodating specific community requirements/needs; b) internal (advanced service functionalities along with implicit semantics of content) versus external −simple service functionalities along with explicit semantics of content. This contributes to address P1, P2 and P3.

- Follow a strict Model-Driven Approach (MDA), recognizing and specifying interoperability at different hierarchical levels which must be as de-coupled as possible. In addition, specifications must be as neutral as possible. This contributes to addressing P4 and P5.
- Follow an incremental approach for the specification of implementations; this is important to enable the development from existing capacity towards the new distributed computing platforms/environments; examples include: the specification and implementation of mediation solutions as well as middleware services for achieving transparencies. This contributes to addressing P4 and P5.
- Adopt a service specification approach more focused on user requirements –instead of technology developers needs, to keep specification stable, build on existing capacities and control implementation complexity. This contributes to addressing P1, P4 and P5.

3.1.2 OGC WCS

3.1.2.1 Enterprise Viewpoint

The Web Coverage Service (WCS) supports electronic retrieval 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 Service (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 the WMS, which portrays spatial data to return static maps (rendered as pictures by the server), the Web Coverage Service provide s available data together with their detailed descriptions; defines a rich syntax for requests against these data; and returns data with its original semantics (instead of pictures) which may be interpreted, extrapolated, etc. – and not just portrayed.

Unlike WFS, which returns discrete geospatial features, the Web Coverage Service returns coverages representing space-varying phenomena that relate a spatio-temporal domain to a (possibly multidimensional) range of properties

The Web Coverage Service provides three operations: *GetCapabilities*, *DescribeCoverage,* and *GetCoverage*.

- The *GetCapabilities* operation returns an XML document describing the service and brief descriptions of the coverages that clients may request. Clients would generally run the *GetCapabilities* operation and cache its result for use throughout a session, or reuse it for multiple sessions. When the *GetCapabilities* operation does not return such descriptions, then equivalent information must be available from a separate source, such as an image catalog.
- The *DescribeCoverage* operation lets clients request a full description of one or more coverages served by a particular WCS server. The server responds with an XML document that fully describes the identified coverages.

- The *GetCoverage* operation is normally run after *GetCapabilities* and *DescribeCoverage* operation responses have shown what requests are allowed and what data are available. The *GetCoverage* operation returns a coverage (that is, values or properties of a set of geographic locations), encoded in a well-known coverage format. Its syntax and semantics bear some resemblance to the WMS *GetMap* and WFS *GetFeature* requests, but several extensions support the retrieval of coverages rather than static maps or discrete features.

3.1.2.2 Service Viewpoint

Aspect	**Description**
Service name	OGC Web Coverage Service (WCS)
Category	Geographic model/Information management services (ISO 19119) OA-InfoStructure (Orchestra)
Reference to specification	see standard reference
Standard reference	OGC Web Coverage Service Implementation Specification, Version: 1.1.2, OGC Doc 07-067r5 Corrigendum 2 for the OGC Standard Web Coverage Service 1.1 (1.1.2), OGC 07-067r5 Web Coverage Service (WCS) 1.1 extension for CF-netCDF 3.0 encoding (0.2.2), Discussion Paper, 09-018 OGC Web Coverage Processing Service (WCPS) Language Interface Standard Implementation Specification, version 1.0.0, OGC 08-068r2 OGC Web Coverage Service (WCS) - Processing Extension (WCPS), Implementation Specification, version 1.0.0, OGC 08-059r3 OGC Web Coverage Service (WCS) - Transaction operation extension, Implementation standard, version 1.1.4, OGC 7-068r4

Description	The Web Coverage Service (WCS) supports electronic retrieval 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 Service (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 the WMS, which portrays spatial data to return static maps (rendered as pictures by the server), the Web Coverage Service provide s available data together with their detailed descriptions; defines a rich syntax for requests against these data; and returns data with its original semantics (instead of pictures) which may be interpreted, extrapolated, etc. – and not just portrayed. Unlike WFS, which returns discrete geospatial features, the Web Coverage Service returns coverages representing space-varying phenomena that relate a spatio-temporal domain to a (possibly multidimensional) range of properties The Web Coverage Service provides three operations: *GetCapabilities*, *DescribeCoverage,* and *GetCoverage*. • The *GetCapabilities* operation returns an XML document describing the service and brief descriptions of the coverages that clients may request. Clients would generally run the *GetCapabilities* operation and cache its result for use throughout a session, or reuse it for multiple sessions. When the *GetCapabilities* operation does not return such descriptions, then equivalent information must be available from a separate source, such as an image catalog. • The *DescribeCoverage* operation lets clients request a full description of one or more coverages served by a particular WCS server. The server responds with an XML document that fully describes the identified coverages. • The *GetCoverage* operation is normally run after *GetCapabilities* and *DescribeCoverage* operation responses have shown what requests are allowed and what data are available. The *GetCoverage* operation returns a coverage (that is, values or properties of a set of geographic locations), encoded in a well-known coverage format. Its syntax and semantics bear some resemblance to the WMS *GetMap* and WFS *GetFeature* requests, but several extensions support the retrieval of coverages rather than static maps or discrete features. **Web Coverage Processing** Web Coverage Services implementing *Web Coverage Processing Service (WCPS) Language* provide access to original or derived sets of geospatial coverage information, in forms that are useful for client-side rendering, input into scientific models, and other client applications.

	The *OGC Web Coverage Service Processing Extension* specifies the service interface encoding to an additional Web Coverage Processing Service (WCPS), the ProcessCoverages operation, that may optionally be implemented by WCS servers.. This extension allows retrieval and processing of geospatial coverage data based on the coverage model of the WCS. WCPS provides access to original or derived sets of geospatial coverage information, in forms that are useful for client-side rendering, input into scientific models, and other client applications. As such, WCPS includes WCS functionality and extends it with an expression language to form requests of arbitrary complexity allowing, e.g., multi-valued coverage results. To this end, this extension defines an additional request type ProcessCoverages beyond the request types GetCapabilities, DescribeCoverage, and GetCoverage, which are man-datorily required by WCS. This operation, the ProcessCoverages request type, allows a client to request processing of multi-dimensional grid coverage data on a WCS server by means of the Web Coverage Processing Service (WCPS) language and to retrieve the results over the World Wide Web. Result coverages can be transmitted directly or made available for download by URLs communicated to the client. **Transactional operations** The OGC *Web Coverage Service (WCS) - Transaction operation extension* of the WCS standard specifies an additional Transaction operation that may optionally be implemented by WCS servers. This Transaction operation allows clients to add, modify, and delete grid coverages that are available from a WCS server. The Transaction operation request references or includes the new or modified coverage data, including all needed coverage metadata.
Format	HTTP, XML, image binary
Comment	The Web Coverage Service 2.0 Standards Working Group (WS 2.0 SWG) has the aim to finish the Web Coverage Service (WCS) Version 2.0 Standard. This SWG will consider at least the following Change Request Proposals: • Separate Grid Coverages Common • Generalized Domain / axis concept - allowing axes of not just spatio-temporal semantics. • https://portal.opengeospatial.org/twiki/bin/view/WCSrwg/UpdateToGML321Update to GML 3.2.1 • Add Abstract Test Suite • Add Conformance Classes Annex • Provide WSDL description of SOAP encoding • Reduce Implementation Options

	• Support JPEG 2000 and JPIP Output Formats • Support GeoTIFF Output Format • Support Asynchronous GetCoverage Responses • Allow Multiple Temporal Domain Axes • Harmonization with related OGC standards (SWE, WPS, etc) • Integrate and harmonize with OWS Common 1.2

Table 3: OGC Web Coverage Service

3.1.3 INSPIRE

INSPIRE Implementing Rules (IRs) on Download services include coverage as one of the downloadable spatial objects (see D3.9 Draft Implementing Rules for Download Services).

For a description of the INSPIRE abstract Download service, see 3.2.3.

In the “Draft Technical Guidance for INSPIRE Download Services” document, the following documents are candidate normative references if the functionality of the web coverage service is required for a given INSPIRE theme:

- OGC 07-067r5 OGC WCS OpenGIS Web Coverage Service (WCS) Implementation Standard 1.1.2
- OGC 07-066r5 Corrigendum 2 for the OGC Standard Web Coverage Service 1.1 (1.1.2).

The present draft document covers WFS implementation. *“If later data specifications relating to Annex II or Annex III themes should require additional functionality, like those covered by the OGC Web coverage service (WCS), this Technical Guidance document will be extended accordingly”*.

Note

The “Draft Technical Guidance for INSPIRE Download Services” document is a first draft that provides only a rudimentary description of the recommended way to implement INSPIRE Download Services. It is meant as minimum description to accompany the draft Implementing Rules for Download Services during Communities review phase. This document will evolve during the implementation and experience phases of the INSPIRE programme.

3.1.4 GMES

The "Forum GMES 2008" (Lille, France, September 2008) marked the launch of the first GMES services in pre-operational mode. The following domains are addressed:

- Land Environmental Services
- Marine Environmental Services

- Support to Emergencies and Humanitarian Aid
- Atmospheric Environmental Services
- Support to security-related activities

Coverage Access is foreseen in all the above domains, although there seems not to be a unifying approach to the issue. At the current state of implementation, access is generally provided by means of ad-hoc web interfaces integrating discovery functionalities (cf. the MyOcean interactive catalogue, the ECMWF Meteorological Archival and Retrieval System, etc.)

In particular, the Marine Environmental Services are implemented by the MyOcean service, which, in its V1 version (end 2010) will offer direct, INSPIRE-compliant access to products.

MyOcean, currently in its V0 version, allows access to worldwide and European regional Ocean Products (real time observations, analysis and forecast) that have been made available under previous projects such as MERSEA, MARCOAST, POLARVIEW, ECOOP, GLOBCOLOR.

Most products are accessible via FTP of through a mail order. Some products (including those published within the MERSEA project) are made available on THREDDS catalogs and accessible via HTTP or OPeNDAP endpoints. OPeNDAP is described in the following sections.

3.1.4.1 Enterprise Viewpoint

The OPeNDAP Data Access Protocol (DAP) is a data transmission protocol designed specifically for science data. The protocol relies on the widely used and stable HTTP and MIME standards, and provides data types to accommodate gridded data, relational data, and time series, as well as allowing users to define their own data types.

The DAP is a protocol for access to data organized as name-datatype-value tuples. It is particularly suited to accesses by a client computer to data stored on remote (server) computers which are networked to the client computer. The protocol has been used by the Distributed Oceanographic Data System since 1995 and subsequently by many other projects and groups.

The DAP 2.0 uses HyperText Transfer Protocol (HTTP) as a transport protocol.

The DAP uses three responses to represent a data source. Two of these responses, the Dataset Descriptor Structure (DDS) and Dataset Attribute Structure (DAS), characterize the variables, their datatypes, names and attributes. The third response, the Data Dataset Descriptor Structure (DataDDS), holds data values along with name and datatype information.

The DAP returns error information using an Error response. If a request for any of the three basic responses cannot be returned, an Error response is returned in its place.

The three responses (DAS, DDS and DataDDS) are complete in and of themselves so that, for example, the data response can be used by a client without ever requesting either of the two other responses. In many cases, client programs will request the DAS and DDS before requesting the DataDDS, but there is no requirement they do so and no server shall require that behavior on the part of clients.

Operationally, a DAP client sends a request to a server using HTTP. The request consists of a HTTP GET request method, a Uniform Resource Identifier (URI) that encodes information specific to the DAP and an HTTP protocol version number followed by a MIME-like message containing various headers that further describe the request.

In practice, DAP clients typically use a third-party library implementation of HTTP/1.1 so the GET request, URI and HTTP version information are hidden from the client; it sees only the DAP Uniform Resource Locator (URL) and some of the request headers. The DAP server responds with a status line that includes the HTTP protocol version and an error or success code, followed by a MIME-like message containing information about the response and the response itself. The DAP response is the payload of the MIME-like HTTP response.

3.1.4.2 Service Viewpoint

Aspect	Description
Service name	Open-source Project for a Network Data Access Protocol
Category	Geographic model/Information management services (ISO 19119)
Reference to specification	http://www.opendap.org/pdf/ESE-RFC-004v1.1.pdf
Standard reference	Gallagher, Potter, Sgouros, Hankin, Flierl. The Data Access Protocol — DAP 2.0. ESE-RFC-004.1.1. NASA, October 2007.
Format	Text for DAS and DDS; binary (Sun Microsystems' XDR protocol[) for DataDDS
Comment	In addition to the above data representations, a DAP server may provide additional "services" which clients may find useful. For example, many DAP-compliant servers provide an HTML-formatted representations of a data source's structure and a way to get data represented in CSV-style ASCII tables.

Table 4 - The OPeNDAP Protocol

Note

An OGC discussion paper introduced a WCS extension package for accessing CF-netCDF datasets, including the OPeNDAP support (see 09-018r1 Web Coverage Service (WCS) 1.1.2 extension for CF-netCDF 3.0 encoding).

The OGC standardization process for CF-netCDF is ongoing (see 09-122 CF-netCDF Encoding Specification)

3.1.5 GEOSS

3.1.5.1 Enterprise Viewpoint

3.1.5.1.1 Web Coverage Service

The Web Coverage Service (WCS) defines an interface for retrieving rasters/coverages through the Web using platform-independent calls. The requests are in XML however, the retrieved coverages can be in a variety of formats including GeoTIFF, ArcGRID etc.

WCS is intended for providing archived/stored data in contrast to portrayals of data, normally provided through WMS. Therefore, although both WCS and WMS can return raster images, they have very distinct purposes. Images returned by a WMS are rendered according to a pre-defined 'style' or one defined at the time of request.

3.1.5.1.2 Physical Media Transfer

GEOSS recognizes that there may be situations where electronic transfer of data is not possible, thereby requiring transfer through physical means in the form of magnetic or optical media.

3.1.5.2 Service Viewpoint

3.1.5.2.1 Web Coverage Service

Aspect	Description
Service name	OGC Web Coverage Service (WCS)
Category	Geographic model/Information management services (ISO 19119)
Reference to specification	GEOSS AIP-2 Engineering Reports for: • "The Impact of Climate Change on Pikas Regional Distribution" Climate Change and Biodiversity WG Use Case Scenario
Standard reference	OGC Web Coverage Service Implementation Specification, Version: 1.1.2, OGC Doc 07-067r5
Format	XML, GeoTIFF, ArcGRID ASCII, GML
Comment	Extensions of the WCS standard have been proposed for adding a Transaction operation that may optionally be implemented by WCS servers. A WCS offering the Transaction operation is named a WCS-T. The Transaction operation will allow clients to add, modify, and delete grid coverages that are available from a WCS server. *GEOSS AIP-2 Pika Climate Change and Biodiversity* scenario included use of WCS and also WCS-T.

Table 5: Web Coverage Service

3.1.5.2.2 Physical Media Transfer

Aspect	Description
Platform name	Physical Media Transfer
Reference Model	Annex B of GEOSS AIP-2 CFP
Interface Language	Magnetic data tapes, CDs, DVDs, etc
Schema Language	Not applicable
Schema Mapping	Not applicable

Table 6: Physical Media Transfer

3.2 Feature Access services

3.2.1 Context

Service that provides a client access to and management of a feature store. An access service may include a query that filters the data returned to the client. ISO 19125-1 is relevant to feature access.

3.2.2 OGC WFS

3.2.2.1 Enterprise Viewpoint

The OGC Web Feature Service (WFS) Implementation Specification defines the 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:

- Return service-level metadata (GetCapabilities);
- Describe the structure of any feature type it can service (DescribeFeatureType)
- Get or query features based on spatial and non-spatial constraints (GetFeature)
- Create a new feature instance (Transaction)
- Delete a feature instance (Transaction)
- Update a feature instance (Transaction)
- Lock a feature instance (LockFeature)
- Service a request to retrieve element instances by traversing XLinks that refer to their XML IDs. (GetGMLObject)

A basic WFS implements the GetCapabilities, DescribeFeatureType and GetFeature operations. This would be considered a read-only web feature service.

An XLink WFS supports in addition the GetGmlObject operation for local and/or remote XLinks, and offer the option for the GetGmlObject operation to be performed during GetFeature operations.

A transaction web feature service support all the operations of a basic web feature service and in addition it implements the Transaction operation. Optionally, a transaction WFS could implement the GetGmlObject and/or LockFeature operations.

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 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
- The use of a subset of XPath expressions for referencing properties.

The *Filter Encoding Implementation Specification* defines a common component that can be used by a number of OGC web services. Any service that can query objects from a web-accessible repository can make use of the Filter Encoding. For example, WFS may use Filter Encoding in a GetFeature operation.

The *OGC Gazetteer Service Best Practices Document* defines an Application Profile of the WFS Implementation Specification by specifying a minimum set of Feature Types and operations required to support an instance of a gazetteer service. The information model of the specification is a GML application schema that defines a general feature type to be served by a Gazetteer Service.

3.2.2.2 Service Viewpoint

Aspect	Description
Service name	OGC Web Feature Service (WFS)
Category	Geographic model/Information management services (ISO 19119) OA-InfoStructure (Orchestra)
Reference to specification	see standard reference
Standard reference	OGC Web Feature Service Implementation Specification, Version: 1.1.0, OGC 04-094 OpenGIS Web Feature Service (WFS) Implementation Specification (Corrigendum) (1.0.0), OGC 06-027r1 OGC Web Feature Service (WFS) Implementation Specification with XLinks, version

	1.1.0, OGC 04-094 OGC Filter Encoding Implementation Specification, Version 1.1, OGC 04-095 OGC Gazetteer Service - Application Profile of the Web Feature Service Implementation Specification, Best Practice Paper, version 0.9.3, OGC 05-035r2
Format	HTTP, GML (XML), other data formats, XPath
Comment	Further work is desirable in the next version of the specification, on the following work items. • Determine whether WFS should optionally offer operations beyond generic get/lock/update operations on elements of GML version 3 types that are not feature types, to provide specialized capabilities for such types, for example, topological types. • Support an update/merge operation that allow features to be updated without having to fetch the entire feature. For example adding vertices to a geometry without having to specify the whole geometry in the update request. The WFS Gazetteer Profile 1.0 Standards Working Group has the aim to define the existing Best Practice paper "Gazetteer Service - Application Profile of the Web Feature Service Implementation Specification" and publish it as a Version 1.0 implementation standard.

Table 7: OGC Web Feature Service (WFS)

3.2.3 INSPIRE View

3.2.3.1 Enterprise Viewpoint

The “Draft Technical Guidance for INSPIRE Download Services” document gives guidelines for the technical service interfaces for the INSPIRE Download Services. The guidelines are based on the abstract model established in the INSPIRE Implementing Rule (IR) for Download Services –i.e. “D3.9 Draft Implementing Rules for Download Services”. The draft Implementing Rules for Download Services define the INSPIRE Download Services divided into two main types – download services for pre-defined datasets or pre-defined parts of datasets, and direct access download services including a query capability. In addition, the concept of a query to identify a part of the dataset plays a major role in download services. This draft guidance document describes how the different download service types can be implemented using ISO standards and draft standards and OGC specifications. It also describes how the query mechanism can be implemented using a draft ISO standard.

3.2.3.2 Service Viewpoint

Aspect	Description
Service name	Download Service

<table>
<tr><td>Category</td><td>Access and download service</td></tr>
<tr><td>Reference to specification</td><td>INSPIRE „D3.9 Draft IR Download Services v2.0.doc“
INSPIRE “Draft Technical Guidance for INSPIRE
Download Services“</td></tr>
<tr><td>Standard reference</td><td>It is recommended to implement the direct access services using the Web feature service, WFS, as
specified in ISO/DIS 19142, and with the query facility of Filter encoding, FE, as specified in ISO/DIS
19143. These versions of WFS and FE are jointly developed by OGC and ISO/TC 211, and represent
the latest versions of the specifications</td></tr>
<tr><td>Description</td><td>An implementation of Download services using WFS, shall conform to WFS conformance classes according to the following table:
<table>
<tr><th>Conformance class name</th><th>Operation or behaviour</th><th>M/O</th></tr>
<tr><td>Simple WFS</td><td>The server shall implement the following operations: GetCapabilties, DescribeFeatureType, ListStoredQueries, DescribeStoredQueries, GetFeature operation with the StoredQuery action only. One stored query, that fetches a feature by id, shall be available.
Additionally the server shall conform to at least one of the HTTP GET, HTTP POST or SOAP conformance classes.</td><td>M</td></tr>
<tr><td>Basic WFS</td><td>The server shall implement the Simple WFS conformance class and shall also implement the Query action for the GetFeature operation and the GetPropertyValue operation.
Servers that implement this conformance class shall also implement the Minimum Spatial Filter conformance class from ISO 19143.</td><td>M</td></tr>
</table></td></tr>
</table>

Transactional WFS	The server shall implement the Basic WFS conformance class and also implemented the Transaction operation.	O
Locking WFS	The server shall implement the Transactional WFS conformance class and shall implement at least one of the GetFeatureWithLock or LockFeature operations.	O
HTTP GET	The server shall implement the Key-value pair encoding for the operations that the server offers.	O
HTTP POST	The server shall implement the XML encoding for the operations that the server implements.	O
SOAP	The server shall implement XML encoded requests and results within SOAP Envelopes.	M
Inheritance	The server shall implement the schema-element() function in Xpath expressions.	O
Remote resolve	The server shall implement the ablity to resolve remote resource references.	O
Response paging	The server shall implement the ability to page through the response features or values.	M
Standard joins	The server shall implement join predicates using all Filter operators except the spatial and temporal operators.	O
Spatial joins	The server shall implement join predicates using spatial operators.	O
Temporal joins	The server shall implement join predicates using temporal operators.	
Feature versions	The server shall implement the ability to navigate feature versions.	M
Manage stored queries	The server shall implement the CreateStoredQuery and the DropStoredQuery operations.	M

It is not required that the Download service shall conform to the Transactional WFS or Locking WFS conformance classes.

WFS and FE will have the capability of serving all download service requirements for Annex I themes.

The functions of the draft IR shall in the case of direct access download service be implemented in the following way:

Function	**Description in IR**	**M/O/C**	**Recommended implementation in WFS and FE**
Get Download Service Metadata	Provides all necessary information about the service to a user (service provider, spatial objects available, access constraints ...) and describes service capabilities to enable a client application to use the service (list of supported operations).	M	GetCapabilities operation of WFS
Get Spatial	The Get Spatial Objects operation allows spatial object		GetFeature operation of WFS

		Objects	instances to be retrieved. In the case of direct access, the retrieval can be based on an optional query defined by the Define Query operation. In the case of non-direct access, the operation will retrieve a pre-defined data set or a pre-defined part of a data set. The operation shall support user requested CRS belonging to the INSPIRE defined CRSs.	M	Any query shall be submitted to the service by a CreateStoredQuery operation and the query name passed as a parameter to the GetFeature operation, or submitted directly as a parameter to the GetFeatures operation (adhoc query). In both cases, the query shall conform to FE.
		Describe Spatial Object Types	The Describe Spatial object Type operation generates a description that defines zero or more of the spatial object types that the service offers. In the case of download service of a pre-defined data set or pre-defined part of data set, the function shall return the description of the complete set of spatial object types contained in the data set or part of data set. In the case of a direct access download service, the function can have as parameter a set named spatial object types for which the description is requested.	C, M in case of direct access	DescribeFeatureType operation of WFS. Optionally an Adhocquery of WFS conforming to FE can be passed as a parameter to DescribeFeatureType in order to select a subset of feature types to be selected.

Define Query	Defines a query to be used in the Get Spatial Objects operation. The query predicates, encoded using a query expression, can include spatial, temporal and non-spatial constraints. The predicates shall express characteristics based upon the model of the data set as defined by an INSPIRE Implementing Rule on the interoperability of spatial data sets. The general characteristics are defined by the generic conceptual model. This function is applicable only in the case of direct access download service. The capability to define a query is mandatory, but a query can be omitted in a concrete Get Spatial Objects request.	C, M in case of direct access	CreateStoredQuery operation of WFS, with query expression conforming to FE, alternatively as an Adhocquery of WFS conforming to FE and passed as a parameter to GetFeature or DescribeFeatureType
Link Download Service	Allows the declaration of a Download Service for downloading of its resources through the Member State Download Service while maintaining the downloading capability at the Public Authority or the Third party location.	M	To be implemented by uploading the appropriate metadata to the INSPIRE network using PublishMetadata function of an INSPIRE compliant discovery service.

Additional operations of WFS that not required by the Implementing rule for download services, some will anyway be mandatory according to this Technical Guidance as they belong to a mandatory conformance class			
		M	GetPropertyValue
		O	GetFeatureWithLock
		O	LockFeature
		O	Transaction
		M	DropStoredQuery
		M	ListStoredQueries
		M	DescribeStoredQueries

M/O/C : Mandatory / Optional/Conditional

Format	
Comment	

Table 8 - INSPIRE Download Service

3.2.4 GMES View

The SANY project implemented a service which corresponds to the OGC WFS but is extensible by schema mapping.

3.2.5 GEOSS View

3.2.5.1 Enterprise Viewpoint

3.2.5.1.1 Web Feature Service

The Web Feature Service (WFS) defines an HTTP interface for retrieveing geographic features from spatial databases using platform-idenpendent calls. Retrieved geographic features are generally encoded in GML.

WFS allows a client to retrieve, access or manage geographic features using HTTP as the distributed computing platform. Through a WFS interface, a client is able to:

- Create a new feature instance
- Delete a feature instance
- Update a feature instance
- Lock a feature instance
- Query features based on spatial and non-spatial constraints retrieve features in Geographic Markup Language (GML).

3.2.5.1.2 Sensor Observation Service

SOS provides an interface for managing deployed sensors and retrieving observation data. The interface supports both in-situ and dynamic sensors.

It is one of the specifications under the umbrella of the OGC Sensor Web Enablement(SWE) activity. Related SWE specifications include Sensor Model Language (SensorML), Observations and Measurements (O&M), Sensor Planning Service (SPS), Transducer Markup Language (TML), Sensor Alert Service (SAS), and Web Notification Service (WNS).

3.2.5.1.3 Physical Media Transfer

GEOSS recognizes that there may be situations where electronic transfer of data is not possible, thereby requiring transfer through physical means in the form of magnetic or optical media

3.2.5.1.4 GBIF

The GBIF portal offers a range of services to support the use of biodiversity data in other applications and analyses. Web services which are available are based on a RESTFull approach. In the GEOSS AIP-2 such services were used in order to access animal species data presence (see AIP-2 Engineering Report for “The Impact of Climate Change on Pikas Regional Distribution”);

3.2.5.2 Service Viewpoint

3.2.5.2.1 Web Feature Service

Aspect	Description
Service name	OGC Web Feature Service (WFS)
Category	Geographic model/Information management services (ISO 19119)
Reference to specification	GEOSS AIP-2 Engineering Reports for: • "Arctic Food Chain" Climate Change and Biodiversity WG Use Case Scenario
Standard reference	OGC Web Feature Service Implementation Specification, Version: 1.1.0, OGC Doc 04-094
Format	XML, GML
Comment	

Table 9: Web Feature Service

3.2.5.2.2 Sensor Observation Service

Aspect	Description
Service name	OGC Sensor Observation Service (SOS)
Category	Geographic model/Information management services (ISO 19119)
Reference to specification	GEOSS AIP-2 Engineering Reports for: • Floods Disaster Response
Standard reference	OGC Sensor Observation Service Implementation Specification, Version: 1.0.0, OGC Doc 06-009r6
Format	XML
Comment	The *Floods Disaster Response scenario of GEOSS AIP-2* included use of an SOS for

	accessing in-situ NOAA sensors. This standard is dual listed as both a coverage and feature access service because it may be used to access observations at a point location(e.g. from in situ sensors) or over a geographic extent (e.g. from a satellite-based sensor).

Table 10: Sensor Observation Service

3.2.5.2.3 Physical Media Transfer

Aspect	Description
Platform name	Physical Media Transfer
Reference Model	Annex B of GEOSS AIP-2 CFP
Interface Language	Magnetic data tapes, CDs, DVDs, etc
Execution Context	GEOSS recognises that there may be situations where electronic transfer of data is not possible, thereby requiring transfer through physical means in the form of magnetic or optical media. This note is repeated because physical media transfer can be used to transport both coverage and feature data.
Schema Language	Not applicable
Schema Mapping	Not applicable

Table 11: Physical Media Transfer

3.3 Map Access Services

3.3.1 Context

Service that provides a client access to a geographic graphics, i.e., pictures of geographic data. ISO 19128 is relevant to map access.

3.3.2 OGC WMS

3.3.2.1 Enterprise Viewpoint

A 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.

The WMS Implementation Specification defines three operations:

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

A *basic WMS* supports the basic service elements "GetCapabilities operation" and the "GetMap operation". A queryable WMS also supports the "GetFeatureInfo operation".

Web Map Service operations can be invoked using a standard web browser by submitting requests in the form of Uniform Resource Locators (URLs). The content of such URLs depends on which operation is requested. In particular, when requesting a map the URL indicates what information is to be shown on the map, what portion of the Earth is to be mapped, the desired coordinate reference system, and the output image width and height. When two or more maps are produced with the same geographic parameters and output size, the results can be accurately overlaid to produce a composite map. The use of image formats that support transparent backgrounds (e.g. GIF or PNG) allows underlying maps to be visible. Furthermore, individual maps can be requested from different servers.

The Web Map Service thus enables the creation of a network of distributed map servers from which clients can build customized maps.

The *Web Map Context Implementation Specification* defines how a specific grouping of one or more maps from one or more WMS servers can be described in a portable, platform-independent format for storage in a repository or for transmission between clients. A Context Document contains sufficient information for Client software to reproduce the map, and ancillary metadata used to annotate or describe the maps and their provenance for the benefit of human viewers.

The *OGC Symbology Encoding Implementation Specification* defines an XML language for styling information used to portray Feature and Coverage data.

The *OGC Styled Layer Descriptor Profile* of the Web Map Service Implementation Specification explains how WMS can be extended to allow user-defined symbolisation of feature and coverage data. This profile defines how the Symbology Encoding specification can be used with WMS.

The *WMS Application Profile for EO Products* (Best Practice Paper) is intended to support the interactive visualisation and evaluation of Earth Observation (EO) data products. The profile sets out to describe a consistent Web Map Server (WMS) configuration that can be supported by many data providers (satellite operators, data distributors …), most of whom have existing (and relatively complex) facilities for the management of these data. In addition, this profile is intended to compliment the OGC Catalogue Services Application Profile for EO products by showing how WMS servers may be used to evaluate products identified through catalogue discovery prior to their ordering.

The *Tiled WMS Discussion Paper* explains how the Web Map Service specification can be extended to allow fast response to a predefined set of tiled maps.

3.3.2.2 Service Viewpoint

Aspect	Description
Service name	OGC Web Map Service (WMS)
Category	Geographic model/Information management services (ISO 19119)

	OA-InfoStructure (Orchestra)
Reference to specification	see standard reference
Standard reference	OGC Web Map Server Implementation Specification, Version 1.3.0, OGC Doc. 06-042 OGC Web Map Context Implementation Specification, version 1.1, OGC 05-005 OGC Symbology Encoding Implementation Specification, version 1.1.0, OGC 05-077r4 OGC Styled Layer Descriptor Profile of the Web Map Service Implementation Specification, version 1.1.0, OGC 05-078r4 OpenGIS Tiled WMS Discussion Paper, version 0.3.0, OGC 07-057r2 OGC Web Map Services - Application Profile for EO Products, Best Practice Paper, version 0.2.0, OGC 07-063
Format	XML, HTTP, image binary
Comment	The Web Mapping Service 1.4 Standards Working Group (WMS 1.4 SWG) has the aim to finish the Web mapping Service (WMS) Version 1.4 Standard. A number of Change Requests and Proposals that are considered within the SWG: OGC 07-108 - Change request to Move DescribeLayer from SLD Profile to WMS. OGC 07-116 - WMS Change request to Add AcceptVersions and AcceptFormats Mechanisms Enforce URN notation for the CRS as recommended by OWS common. There is still considerable debate on the axes order issue, which need to be revisited before enforcing CRS URN notations for the next version of the WMS specification. Add Abstract Test Suite. OGC 06-149r1 - WMS change request to add multilingual support OGC 05-138 - WMS change request to Specify all KVP names OGC 02-017r1 proposal - proposal for XML encoding of GetMap request Align the version of the specification with the latest approved OWS Common specification. If OWS version 1.2 is on track to become an IS prior to WMS 1.4 release, it would be best to align this version of wms 1.4 with OWS 1.2. Align the version of the specification with the latest approved Styled layer descriptor Implementation Specification (05-078r4) Advance the discussions on the two papers dealing with Tiled Mapping Services : OGC 07-057r2 and 07-057r3. The "07-057r3" version is uncoupled from the OGC WMS specification, but will be dealt within this specifications group which will work towards creating an implementation specification. The SWG will discuss and decide on the possibility of retiring the "07-057r2" version. Possible Further Considerations

	Discuss and decide on the need for aligning the WMS specification document with the Core-Extension model(Sept 07 motion, OGC 07-056r2). Align any recommendations for SOAP WSDL based on - SOAP OGC Discussion Paper 07-158 (Dec 07 motion) and OWS 5 SOAP/WSDL Common ER Harmonization with related OGC standards (SLD, Filter Encoding) (Not yet drafted)

Table 12: OGC Web Map Service (WMS)

3.3.3 INSPIRE View

3.3.3.1 Enterprise Viewpoint

In the context of spatial data services, the European standard EN ISO 19128 :2005(E) – (WMS 1.3.0) has been identified as the most relevant standard to implement INSPIRE View Services on the grounds of its stability and widespread use. Other standards may also be used as long as they conform with the Implementing Rules.

Two other OGC standards to portray geographic information are associated with the EN ISO 19128 :2005(E) (see paragraph about Styling):

- OGC Styled Layer Descriptor Profile of the Web Map Service Implementation Specification (05-078r4) and its corrigendum1 for OGC Implementation Specification SLD 1.1.0 (07-123r1) ;
- OGC Symbology Encoding Implementation Specification (05-077r4), which is a language used for styling feature and coverage data, and independent of any service interface
- specification.

The “Draft Technical Guidance to implement INSPIRE View services” document aims to explain how this standard must be used to setup an INSPIRE View Service according to the View Services Implementing Rules defined in the document “Draft Implementing Rules for View Services”.

Note

The “Draft Technical Guidance to implement INSPIRE View services” document is an initial version that will be developed further in collaboration with the stakeholder community and relevant standardization organizations.

3.3.3.2 Service Viewpoint

Aspect	**Description**
Service name	View Service (INSPIRE Profile of ISO 19128:2005(E))
Category	Web Map Service
Reference to specification	INSPIRE IR “Draft Technical Guidance to implement INSPIRE View services”

<table>
<tr><td>Standard reference</td><td>

OGC 05-077r4-Version:1.1.0 (revision 4) - Symbology Encoding Implementation Specification ;
OGC 05-078r4 Version: 1.1.0 (revision 4) - Styled Layer Descriptor profile of the Web Map Service Implementation Specification
OpenGIS® Catalogue Services Specification 2.0.2 -ISO Metadata Application Profile ;
ISO 19128:2005(E) : Geographic information — Web map server interface ;
Technical Guidance Document for INSPIRE Discovery Services.
EUR 20120 – Map projection for Europe – Institute for environment and sustainability, JRC, Eurogeographics – 2001

</td></tr>
<tr><td>Description</td><td>
This specification lays down the basic behavior of an INSPIRE View Service. In fact, some aspects need to be extend or profiled with respect to the requirements of the INSPIRE Directive and the Implementing Rules for View services.

View service operations
<table>
<tr><th>Function (from IR)</th><th>WMS Operation</th><th>M/O [1]</th></tr>
<tr><td>Get Service Metadata</td><td>GetCapabilities</td><td>M</td></tr>
<tr><td>Get Map</td><td>GetMap</td><td>M</td></tr>
<tr><td>Get Feature Information</td><td>GetFeatureInfo</td><td>O</td></tr>
</table>
These three operations shall use parameters defined in the ISO 19128 WMS standard, but the profiling document specifies the role of some parameters in the INSPIRE context.

INSPIRE extension/profile to ISO 19128:2005(E): General Service Metadata
LANGUAGE
The mandatory parameter LANGUAGE defines the client’s preferred language. The language values are based on ISO 639-2, alpha 3 codes as used in the INSPIRE Metadata Implementing Rules.
The response documents are returned in this preferred language if it is supported. If there is no support for the requested language, the documents are returned in the service default language (generally the Member State language being one of the official 23 European languages).
However, following the European Interoperability Framework (EIF) services should at least support parts of the service responses to be provided in English. To identify the different languages a language code list is provided.
Motivation:
There is not yet a standard way to deal with multilingualism when using ISO or OGC public standards specification to implement INSPIRE Network Services. The View Service must provide a way for a client application to request results according to the
</td></tr>
</table>

	specified language. Several elements are language dependent : • the service capabilities (result of the GetCapabilities operation) and managed by the service provider. These capabilities describe the service itself but also layers provided by the service (with several elements language dependent: title, abstract, keywords…) ; • the map if it contains texts language dependent, and managed by the data provider ; • the dataset metadata provided for each layer, and managed by the metadata provider ; • the legend attached to each layer, and managed by the data provider; • the information returned by the GetFeatureInfo operation, and managed by the data provider ; • the service exceptions, managed by the service provider. The return documents are not multilingual, but hold only one language: either the specified language given by the LANGUAGE parameter or the service default language. CONTACT INFORMATION Contact information shall be mandatory: • Contact address ; • Email ; • Phone, fax. RESPONSE LANGUAGE Language of the current capabilities response. SUPPORTED LANGUAGES Supported languages for the service operations. **INSPIRE extension/profile to ISO 19128:2005(E): Layer Properties** STYLE There is no requirement in the Directive about portrayal, but to guarantee that maps are presented consistently from the different Member States some rules are necessary. For the styling for features, the thematic working group set-up by the European Commission to draft the Implementing Rules for laying down technical arrangements for the interoperability and,

	where practicable, harmonization of spatial data sets and services, are also in charge of the provision of feature styling whenever a European/International solution exist for the specific spatial data theme and is assessed as fit for purpose.
	
	When the STYLE parameter is left blank in the GetMap request, the INSPIRE default styling applies in the GetMap response.
	
	COORDINATES REFERENCE SYSTEM
	• ETRS89 : pan-European CRS with datum ETRS89 in geographic coordinates shall be supported for continental Europe. CRS:84 is recommended outside continental Europe; Wherever relevant in these horizontal CRSs may be supported :
	  • ETRS-LAEA : pan-European CRS with datum ETRS89 in European Lambert azimuthal equal area projection ;
	  • ETRS-LCC : pan-European CRS with datum ETRS89 in European Lambert conformal conic projection ;
	  • ETRS-TM26 to ETRS-TM39 : pan-European CRS with datum ETRS89 in European transverse Mercator projection ;
	  • ETRS89/(X,Y,Z) : pan-European CRS with datum ETRS89 in Cartesian coordinates ;
	  • ETRS89 ellipsoidal heights ;
	  • World Geodetic System 1984 (ITRF91, at epoch 1994.0) CRSs-based (geographic, projection or Cartesian coordinates) for the non-continental European areas that are maintained by legal authorities ;
	  • Thematic and parametric CRSs covering e.g. Meteorology or Oceanography (see ISO19111-2) ;
	  • Universal Polar Stereographic (UPS) (used in Meteorology).
	For some cases, there is a link between CRSs and scale range. However, the choice of the most relevant projection may not only be linked to the scale. Wherever relevant in these vertical CRSs may be supported :
	  • EVRF_AMST/NH : normal heights of the United European Levelling Network in relation to the tide gauge in Amsterdam ;
	  • EVRF_AMST/CP: geopotential numbers of the United European Levelling Network in relation to the tide gauge in Amsterdam ;
	  • Height systems for the non-continental European areas that are maintained by legal authorities.
	
	SERVICE EXCEPTIONS

	The error messages (exceptions) are either expressed in the service's default language (suppose that the request is wrong and the LANGUAGE parameter has not been interpreted before issuing the error/exception text) or in the preferred (requested) language in other cases.
Format	
Comment	

Table 13 - INSPIRE View Service

3.3.4 GMES View

From the previous technology watch [RD.7] it emerged that for this kind of service in GMES there is a clear reference to OGC WMS standard. It was also noted that, since INSPIRE Directive entered into force on the 15th May 2007 and future GMES projects are subject to it, interoperability issues concerning INSPIRE will "propagate" to new GMES projects too.

ORCHESTRA/SANY proposed an extension of this service. Map and Diagram Service (see http://www.sany-ip.eu/publications/3253).

FP6 InterRisk proposed WMS application profiles to support Data Fusion (see Table 24).

3.3.5 GEOSS View

3.3.5.1 Enterprise Viewpoint

WMS provides an HTTP interface for retrieving earth-referenced maps from spatial databases. A WMS client can specify the layers to render on the map, the bounding coordinates of the map, a style/legend to apply and the image format to retrieve the map as.

WMS is closely related to the OGC Web Map Context standard which states how a specific grouping of one or more maps from one or more WMS can be described in a portable, platform-independent format for storage or dissemination.

3.3.5.2 Service Viewpoint

Aspect	**Description**
Service name	Web Map Service (WMS)
Category	Geographic model/information management service (ISO 19119)
Reference to specification	• *GEOSS AIP-2 Polar Ecosystems Biodiversity Scenario* • *GEOSS AIP-2 Floods Disaster Response Scenario*
Standard reference	OGC Document 06-042 that is identical to ISO 19128 WMS
Format	HTTP, image binary
Comment	The *GEOSS AIP-2 Polar Ecosystems Biodiversity Scenario* used the GeoBrain WCS and WMS services to provide standards-compliant access interfaces for the generated Polar Area Vegetation Change products.

	The GEOSS AIP-2 Flood scenario also uses WMS.

Table 14: OGC Web Map Service

3.4 Tiled Map Access Services

3.4.1 Context

For information about OGC 06-042 Web Map Service, please refers to Technological Watch Loop 1. This section focuses on Tiled version of Web Map Service.

3.4.2 OGC WMTS

At the time being no IS level document is available for Tiled mechanism of the Web Map Service. This section is based on the working version of a *candidate* IS Web Map Tiled Service (WMTS) document.

This standardization effort is currently supported by the WMS 1.4 SWG that groups discussions on the two papers dealing with Tiled Mapping Services : OGC 07-057r2 and 07-057r3. The "07-057r3" version is uncoupled from the OGC WMS specification, but will be dealt within this specifications group which will work towards creating an implementation specification. Currently the WMS 1.4 SWG is working on the release 7 version 12 of the OGC 07-057 WMTS IS candidate document. Considerations bellows are based on this document.

As a general trends, strong discussion about advantages and disadvantages of building a Web Map Tiled Services as a extension of the original WMS service or as a separated and uncoupled service. No final answer is available at the time being.

Since the document is a candidate IS and is subject to a significant activity, we would focus here on key principals only that is expected to be stable over the IS adoption process.

3.4.2.1 Enterprise Viewpoint

The purpose of a WMTS service is to serve maps divided in individual tiles. The WMTS service aim is to be performance oriented and scalable. Therefore, servers must be able to return tiles quickly. The chosen way to achieve that is to use locally stored pre-rendered tiles that will not require any image manipulation or geo-processing. Decision if pre-rendered tiles will be generated in a previous tile-preparation process or generated on the fly utilizing a caching mechanism is left up to the implentation level.

3.4.2.2 Service Viewpoint

WMTS provides two additional operations comparing to the OGC WMS operations:

- GetTile – It allows a client to request a tile of a map (mandatory)
- FeatureInfo– It allows a client to request information about a particular pixel of a tile map in a similar way to the WMS GetFeatureInfo operation (optional)

3.4.2.2.1 Get Tile operation

GetTile allows WMTS clients to request a particular tile of a particular tile matrix set in a predefined format. Only one layer can be retrieved at a time. If you want to allow a combination of layers to be served and requested, you have to give this combination an identifier and add it as a new layer in the service metadata document. Nevertheless, clients are expected to easily overlay layers themselves. A tile image is the typical answer to a GetTile request.

Table below shows an extract of specific GetTile request parameters. Other parameters are common to the typical GetMap operation as defined in WMS standard.

Names	Definition	Data type and values	Multiplicity and use
TileMatrixSet tileMatrixSet	TileMatrixSet identifier	Character String type, not empty identifier that is defined in the capabilities document	One (mandatory)
TileMatrix tileMatrix	TileMatrix identifier	Character String type, not empty value that is defined in the capabilities document	One (mandatory)
TileRow tileRow	Row index of tile matrix	Non negative integer type value between 0 and MatrixHeight-1 of this tile matrix defined in the capabilities document	One (mandatory)
TileCol tileCol	Column index of tile matrix	Non negative integer type value between 0 and MatrixWidth-1 of this tile matrix defined in the capabilities document	One (mandatory)

Table 15 -Specifics Parameters in GetTile operation request

3.4.2.2.2 GetFeatureInfo operation

The GetFeatureInfo allows WMTS clients to request information of a particular position of a particular tile of a particular queryable layer. GetFeatureInfo is the tiled version of the original GetFeatureInfo operation described in the WMS standard. In the same way, GetFeatureInfo has to duplicate parameters of the previous GetTile request.

3.4.2.3 Tile matrix set – the geometry of the tiled space

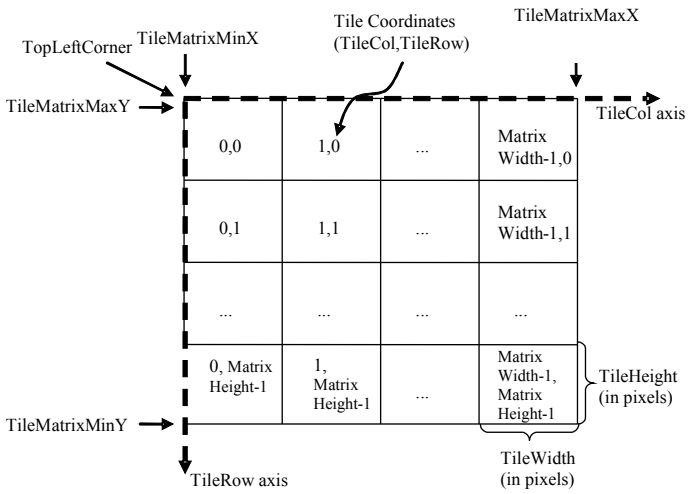
In a tiled layer the representation of the space is constrained in a discrete set of parameters. These parameters are defined by a tile matrix set. Each tile matrix set contains one or more "tile matrices" defining the tiles that are available for that coordinate system. Each tile matrix specifies:

a) The scale of the tiles as a scale denominator.

b) The width and height of each tile in pixels.

c) The top left (minimum x, maximum y) corner of the bounding box of the tile matrix (*i.e.*, the real-world co-ordinate of the top left corner of the top left pixel of the top left tile).

d) The width and height of the tile matrix in tile units (*i.e.*, number of tiles).



3.4.3 INSPIRE View

At the time being, D3.5 INSPIRE Network Services Architecture and Draft Technical Guidance View Services v 2.0 only refers as View Service to a typical GetMap based Web Map Service as defined in OGC 06-042 WMS Implementation Specification.

Tiled version of an INSPIRE View Service is not addressed by the Drafting Team.

3.4.4 GMES View

For Service GMES refers to OGC standards. For Portrayal service reference is made to 06-042 WMS Implementation Specification without any additional mention of a tiled version of the service.

3.4.5 GEOSS View

In Architecture Implementation Pilot (AIP) - Phase 2 document, Visualization Services are defined on the basis of a typical GetMap based Web Map Service as defined in OGC 06-042 WMS Implementation Specification.

Tiled version of an GEOSS Visualization Service is not addressed by GEOSS.

3.5 Coverage Access Services – Sensors

3.5.1 Context

Service that provides access to a coverage where the source of the coverage data is a real-time sensor, i.e., not a persistent store.

3.5.2 OGC SOS

3.5.2.1 Enterprise Viewpoint

The OGC Sensor Observation Service (SOS) Implementation Specification defines a web service interface for requesting, filtering, and retrieving observations and sensor system information. Observations may be from in-situ sensors (e.g., water monitoring devices) or dynamic sensors (e.g., imagers on Earth-observation satellites).

SOS has three mandatory “core” operations: GetCapabilities, DescribeSensor, GetObservation.

- The *GetCapabilities* operation provides the means to access SOS service metadata. Several optional, non-mandatory operations have also been defined.
- The *DescribeSensor* operation retrieves detailed information about the sensors and processes generating those measurements.
- The *GetObservation* operation provides access to sensor observations and measurement data via a spatio-temporal query that can be filtered by phenomena.

There are two operations to support transactions, RegisterSensor and InsertObservation, and six enhanced operations, including GetResult,GetFeatureOfInterest, GetFeatureOfInterestTime, DescribeFeatureOfInterest, DescribeObservationType, and DescribeResultModel.

Used in conjunction with other OGC specifications, the SOS provides a broad range of interoperable capability for discovering, binding to and interrogating individual sensors, sensor platforms, or networked constellations of sensors in real-time, archived or simulated environments.

3.5.2.2 Service Viewpoint

Aspect	**Description**
Service name	OGC Sensor Observation Service (SOS)
Category	Geographic model/Information management services (ISO 19119) OA-InfoStructure (Orchestra)
Reference to specification	see standard reference
Standard reference	OGC Sensor Observation Service, version 1.0.0, OGC 06-009r6
Format	HTTP, XML
Comment	The Sensor Observation Service 2.0 Standards Working Group (SOS 2.0 SWG) aims at updating the SOS Version 1.0 Standard and to develop Version 2.0. The primary aim of this SWG is to redesign the existing service model and to improve and facilitate its usage from a client's perspective. This will be done by analyzing the current specification and by clearly identifying end user requirements to a refactored SOS interface. The following items are considered: • Combined CRs from OWS-5 CITE

	Observation offering and procedure consistency Guarantee match between procedure IDs and ID contained in sensor description document Indication of responseMode in GetObservation response Clarification of outputFormat parameter in DescribeSensor operation • Enhance GetFeatureOfInterestTime • Add UpdateSensor • KVP Encoding for Core Operations • Introducing SensorOffering Concept • Addition of the InsertResult Operation • Consistency of inserting updating and removing observation offerings and procedures • Observation Offering and Default Response when event time is not provided • Observation offering and procedure consistency • Obligation of observedProperty parameter in GetObservation request • srsName multiplicity • Clarification of observedProperty in SOS with respect to SensorML description • Add Time To DescribeSensor

Table 16: OGC Sensor Observation Service (SOS)

3.5.3 INSPIRE View

Presently, there is no application profile or extension package promoted by the INSPIRE IR Drafting Teams.

3.5.4 GMES View

Within GMES the SANY IP has extended application of SOS to a processing service. See section 3.6.3.2.

3.5.5 GEOSS View

3.5.5.1 Enterprise Viewpoint

3.5.5.1.1 Sensor Observation Service

SOS provides an interface for managing deployed sensors and retrieving observation data. The interface supports both in-situ and dynamic sensors.

It is one of the specifications under the umbrella of the OGC Sensor Web Enablement(SWE) activity. Related SWE specifications include Sensor Model Language (SensorML), Observations and Measurements (O&M), Sensor Planning Service (SPS), Transducer Markup Language (TML), Sensor Alert Service (SAS), and Web Notification Service (WNS).

3.5.5.2 Service Viewpoint

Aspect	Description
Service name	OGC Sensor Observation Service (SOS)
Category	Geographic model/Information management services (ISO 19119)
Reference to specification	GEOSS AIP-2 Engineering Reports for: • Floods Disaster Response
Standard reference	OGC Sensor Observation Service Implementation Specification, Version: 1.0.0, OGC Doc 06-009r6
Format	XML
Comment	The *Floods Disaster Response scenario of GEOSS AIP-2* included use of an SOS for accessing in-situ NOAA sensors. This standard is dual listed as both a coverage and feature access service because it may be used to access observations at a point location(e.g. from in situ sensors) or over a geographic extent (e.g. from a satellite-based sensor).

Table 17: Sensor Observation Service

Aspect	Description
Platform name	GEONETCast
Reference Model	Annex B of GEOSS AIP-2 CFP http://www.earthobservations.org/geonetcast.shtml Wolf L. & Williams M. (2008) IEEE SYSTEMS JOURNAL, VOL. 2, NO. 3, pp.401-405

Interface Language	Digital Video Broadcast (DVB), and others
Execution Context	The GEONETCast multicasting allows different datasets or EO products to be transmitted in parallel from satellites or in-situ sensors. Access to data is controlled and targeted to specific groups of users through a key access capability. The multicast capability uses a global network of communications satellites that includes direct-to-home (DTH) telecommunication satellites and Digital Video Broadcast (DVB). „The usage of DVB-S multicast for dissemination makes the system independent to a growing user community and the schema of commercial service provision with regards to the dissemination bandwidth makes the system also very scalable towards growing data needs.“ Wolf L. & Williams M. (2008)
Schema Language	Not applicable
Schema Mapping	Not applicable

Table 18: GEONETCast

3.6 Processing Services

3.6.1 OGC WPS

Processing services are addressed by the OGC with the Web Processing Service (WPS) standard version 1.0.0 [OGC 05-007-r7] (WPS 1.0.0).

WPS is a generic interface, in the sense no specific processes, data input or outputs are defined. Standard defines “*generic mechanism that can be used to describe and web-enable any sort of geospatial process*”, including general mechanism for describing input data and outputs. Such mechanism supports direct input data providing or an indirect reference of a data source, enabling collaboration with other OGC standards dedicated to data delivery.

Scope of the WPS standard is summarized as an interface that provides “*client access across a network to pre-programmed calculations and/or computation models that operate on spatially referenced data. The calculation can be extremely simple or highly complex, with any number of data inputs and outputs*”

WPS 1.0.0 standard is in line with OGC Web Service models, and, consequently refer to Web Services Common Implementation Specification 1.1.0 [OGC 06-121r3] for any commonalities.

Referring to OWS-Common, WPS follows the capabilities model. However *WPS does more than just describe the service interface, in that it specifies a request/response interface that defines how to*:

- *encode requests for process execution*
- *encode responses from process execution*
- *embed data and metadata in process execution inputs/outputs*
- *reference web-accessible data inputs/outputs*

- *support long-running processes*
- *return process status information*
- *return processing errors*
- *request storage of process outputs*

As a result *WPS can be thought of as an abstract model of a web service, for which profiles need to be developed to support use, and standardized to support interoperability. As with the other OGC specifications GML and CAT, it is the development, publication, and adoption of profiles which define the specific uses of this specification.*

Generic aspect of the standard enables to easily integrate a WPS into a service chain:

- as an atomic operation managed by a distinct workflow engine (for instance a BPEL workflow engine),
- as the starter of an encoded workflow inside a single process,
- by being invoked with a cascade of service encoded into the execute request.

Service Viewpoint

Aspect	**Description**
Service name	Web Processing Service (WPS)
Category	Geographic processing services /spatial,thematic, temporal (ISO 19119)
Reference to specification	see standard reference
Standard reference	OGC Web Processing Service, Implementation specification, version 1.0, OGC 05-007r7
Description	The OGC Web Processing Service (WPS) Implementation Specification defines an interface that facilitates the publishing of geospatial processes, and the discovery of and binding to those processes by clients. Processes include any algorithm, calculation or model that operates on spatially referenced data. A WPS may offer calculations as simple as subtracting one set of spatially referenced numbers from another (e.g., determining the difference in influenza cases between two different seasons), or as complicated as a global climate change model. The data required by the WPS can be delivered across a network using OGC Web Services. A WPS process may be an atomic function that performs a specific geospatial calculation. Chaining of WPS processes facilitates the creation of repeatable workflows. WPS processes can be incorporated into service chains in a number of ways: A BPEL engine can be used to orchestrate a service chain that includes one or more WPS processes. Business Processing Execution Language is a standard

	issued by OASIS. A WPS process can be designed to call a sequence of web services including other WPS processes, thus acting as the service chaining engine. Simple service chains can be encoded as part of the execute query. Such cascading service chains can be executed via the GET interface.
Format	HTTP, WSDL, XML
Comment	OGC Abstract Specification Topic 12: OpenGIS Service Architecture defines service chaining as the combination of services in a dependent series to achieve larger tasks. Topic 12 addresses the syntactic concepts of service chaining, e.g., data structure of a chain, and the semantic concepts, e.g., does a specific chain produce a valid result? Service chaining enables users to combine data and services in ways that are not pre-defined by the data or service providers. The Web Processing Service 2.0 Standard Working Group (WPS 2.0 SWG) has the aim to to evaluate and work the proposed change requests assigned to the Web Processing Service 2.0. The work of the SWG will be to consider at least the following Change Requests: • Include a Cancel request • Align with proposed OGC version numbering conventions • Make all elementFormDefault = qualified • Format should include a human readable description • Correct references to Format • Implement Corrigendum #1 (08-091) • Avoiding timeouts • Merge SPS and WPS (08-037) • Application profiles • Better support for asynchronous services via SOAP • Use of ";" in HTTP GET • Add ability to determine processing capacity • Add ability to reserve a server • Simplify HTTP Get Execute encoding The *OWS-6 WPS Grid Processing Profile Engineering Report (OGC 09-041r3)* describes and reviews the Grid Computing related activity completed during the OGC OWS-6 Interoperability testbed. The document describes the WPS

	processes deployed in the different demonstration scenarios and offers recommendations to the OGC community as to how to better harmonize the standards work of the OGC with Grid Computing platforms and related concepts and technologies. The original goal of the OWS GRID activity was to investigate, define and implement an OGC WPS Grid Processing Profile that is integrated with a grid computing infrastructure using relevant specifications. As such, this document the participants should record the findings and recommendations resulting from the effort to implement the WPS Grid Processing Profile service. Due to the nature of the WPS standard, in the majority of cases it is not necessary to create specific profiles. The team found that it is mostly sufficient to use the existing capabilities described in the WPS standard for accessing distributed Grid resources. Thus, instead of developing several candidate profiles for the WPS, this document reviews the Grid Computing related WPS processes that were implemented in the OWS-6 GPW thread.

Table 19: OGC Web Processing Service (WPS)

WPS 1.0.0 operations

WPS 1.0.0 describes three operations all mandatory: GetCapabilities, DescribeProcess and Execute.

- **GetCapabilities** provides typical discovery and binding mechanism following the OGC model. In addition of the traditional service description, the list of supported process, including identifier and brief description, is provided.
- **DescribeProcess** returns, for a given *process identifier*, a detail process description (*ProcessDescription)* in term of data input description (*InputDescription*), output results description (*ProcessOutputs*) and process capabilities, that are, at the time being, ability to provide a status and/or store processing results.
- **Execute** enable to request execution of a given process on data defined in the *DataInput* request parameter. Optionally, a *ResponseForm* could be provided to describe whished type of response. By default, service return all responses described in the *ProcessDescription*.

In term of data flow model, both direct data specification embedded in the request and indirect mechanisms is provided. Consequently Execute request could specify a location where the WPS service will find needed input date to perform its processing.

Symmetrically, outputs could be directly delivered inside the response or store at server location to be retrieved asynchronously. In this latter fashion, response includes the location to retrieve outputs.

Protocol Binding

In addition of OWS Common 1.1.0 HTTP GET/POST binding, WPS support the SOAP and WSDL binding. SOAP binding is provided by packaging the request into a SOAP envelop body.

WPS supports the use of WSDL for an individual WPS process, as well as for the entire WPS instance that may include several processes. It is not possible to generate a single generic WSDL document that

describes all WPS implementations, since WSDL requires specific binding information that is only found in WPS profiles

WPS 2.0 SWG Activity

Web Processing Standard 2.0 Working Group is currently working on the next version of the standard. At the time being, 23 Change Requests has been submitted in the field of

- Asynchronous management of execution instance
- Unification effort with other standards such as SPS or SensorML
- Makes distinction between core part and extension of the standard. Core part focuses on control flow description than extension part are dedicated to specifics data input and outputs description.
- Tentative to define a REST approach of the interface.

The WPS 2.0 SWG is reviewing these change requests (CR) trough the mailing list and bi-weekly teleconferences.

As for the “Controlling Asynchronous Processes” topic is concerned, CRs are motivated by the integration of WPS in Grid computing environments. The WG is discussing whether to introduce different operations, suc as:

1. pauseProcess
2. resumeProcess
3. cancelProcess

Besides, the following will be considered:

4. use URL as identifiers
5. the possibility of making clear that instances of process should be paused, resumed or cancelled (e.g. by naming the operations pauseProcessInstance, resumeProcessInstance, cancelProcessInstance).

As been discussed the integration of a restartProcess operation. This would be especially helpful in Grid Computing environments.

The possibility to promote extensions was also discussed: there are different options:

1. Asynchronous part as an extension
2. Asynchronous part + existing pull mechanism as an extension
3. Abstract Core (GetCapabilities + Describe Process) + Asynchronous + synchronous extension

As for KVP-Encoding, the following is under discussion:

- Eliminate the Service, Version, Request, and Identifier request parameters.

- Eliminate the double URL encoding required for DataInputs, ResponseDocument, and RawDataOutput.
- Merge the DescribeProcess with the Execute operation.
- Repeat selected contents of the Capabilities response with the DescribeProcess response.

There seems to be some overlap on asynchronous communication pattern with the SPS 2.0 SWG, especially for the reservation of tasks/jobs.

3.6.2 INSPIRE View

The “Draft Implementing Rules for Transformation Services” document identifies the implementing rules for Transformation Services to fulfill the INSPIRE directive.

The INSPIRE Transformation Services address the following articles from the Directive (PECONS3685/2006):

Article 11

Member States shall establish and operate a network of the following services for the spatial datasets and services for which metadata have been created in accordance with this Directive:

…

- *(d) transformation services, enabling spatial data sets to be transformed with a view to achieving interoperability;*

… those services shall take into account relevant user requirements and shall be easy to use, available to the public and accessible via the Internet or any other appropriate means of telecommunication.

The role of the Transformation Services is to help the other types of services to work in conformance with the related IRs. Consequently, a Transformation Service could potentially be combined with all the INSPIRE content access service types: Discovery, View and Download, to make them interoperable according to the established IRs.

The Directive suggests the use of a Transformation Service as an alternative for a permanent adaptation of the existing spatial data sets to the theme-specific INSPIRE data specifications. This implies that Transformation Service has an especially important role in the context of the Download Service, as a tool for achieving data conformity on the service level through transformed virtual data sets.

Transformation Service has a particularly important role as a possible value-adding functionality a portal may offer, because Transformation Service is seen as an intermediary function facilitating the communication between a service requestor and a data service provider.

The main transformation types that a Transformation Service could perform in the INSPIRE service context include file format transformations, language translations, geometric transformations and schema

translations. In future, concrete Technical Guidance documents will be compiled for different transformation types, as seen appropriate.

<table>
<tr><th>Aspect</th><th>Description</th></tr>
<tr><td>Service name</td><td>INSPIRE Transformation Service</td></tr>
<tr><td>Category</td><td>Web Processing Service</td></tr>
<tr><td>Reference to specification</td><td>INSPIRE IR: Draft Implementing Rules for INSPIRE Transformation Services.</td></tr>
<tr><td>Standard reference</td><td>ISO 19118</td></tr>
<tr><td>Description</td><td>An INSPIRE Transformation Service is a Web service for carrying out data content transformations from native data forms to the INSPIRE-compliant form and vice versa.

The operations of the Transformation Service are given in the following table.
<table>
<tr><td>Operation</td><td>Description</td><td></td></tr>
<tr><td>GET SERVICE METADATA</td><td>Provides access to service metadata, like information about the supported transformation category, supported transformations, accepted input data types, supported model definition and mapping languages etc.</td><td>Mandatory</td></tr>
<tr><td>TRANSFORM</td><td>Carries out the actual transformation process. The parameters of this operation are detailed in the following table.</td><td>Mandatory</td></tr>
<tr><td>IS TRANSFORMABLE</td><td>By this request the calling application can ascertain, if the given transformation can be performed by the transformation service. Used to avoid unnecessary effort in the case of an impossible transformation.</td><td>Mandatory</td></tr>
<tr><td>GET TRANSFORMATION</td><td>Enables the calling application to retrieve the definition of a specific transformation. This definition can be used as input parameter in a subsequent TRANSFORM –operation.</td><td>Optional</td></tr>
<tr><td>PUT TRANSFORMATION</td><td>Enables the calling application to store a transformation definition into the service. This transformation can be referenced later on in a TRANSFORM -operation.</td><td>Optional</td></tr>
</table>
GET SERVICE METADATA operation

Request parameters
<table>
<tr><td>Parameter</td><td>Description</td><td></td></tr>
<tr><td>LANGUAGE</td><td>Indicates the natural language requested for the metadata content. Has to be one of the advertised languages.</td><td>Optional</td></tr>
</table>
Response parameters</td></tr>
</table>

	<table><tr><td>Parameter</td><td>Description</td><td></td></tr><tr><td>SERVICE</td><td>General service metadata as defined by INSPIRE metadata IR.</td><td>Mandatory</td></tr><tr><td>OPERATIONS</td><td>Operations supported by the service together with theirs address information.</td><td>Mandatory</td></tr><tr><td>LANGUAGES</td><td>Natural languages supported by the service.</td><td>Optional</td></tr></table> TRANSFORM operation Request parameters <table><tr><td>Parameter</td><td>Description</td><td></td></tr><tr><td>INPUT DATA</td><td>Indicates the data set to be transformed. Can be given inline or as a reference to an outside resource, like a content access service.</td><td>Mandatory</td></tr><tr><td>SOURCE MODEL</td><td>Specifies the model in which the input data is provided. This is given as an identifier or as a definition.</td><td>Conditional, not required if can be determined from the input data.</td></tr><tr><td>TARGET MODEL</td><td>Specifies the model in which the results are expected. This is given as an identifier or as a definition.</td><td>Mandatory</td></tr><tr><td>MODEL MAPPING</td><td>Enables the calling application to control in detailed level, how the transformation is to be carried out.</td><td>Optional, if a default exists (e.g. a well-known map projection formula).</td></tr></table> Response parameters <table><tr><td>Parameter</td><td>Description</td><td></td></tr><tr><td>TRANSFORMED DATA</td><td>The result of the transformation.</td><td>Mandatory</td></tr></table>
Format	
Comment	

Table 20 - INSPIRE Transformation Service

The „Draft Technical Guidance for INSPIRE Coordinate Transformation Services“ document defines technical guidance for INSPIRE Coordinate Transformation Services according to the Transformation Services IR.

There isn’t any official, internationally agreed service interface specification available for coordinate transformations. The approach adopted in this document is to incorporate the only mandatory operation “Transform” defined in of the OGC Discussion Paper ‘Web Coordinate Transformation Service’ (WCTS) as an Application Profile of the OGC Implementation Specification ‘Web Processing Service’ (WPS). The “IsTransformable“ operation of the WCTS is implemented as an optional parameter of the main transformation operation. All other optional operations of the WCTS interface are omitted.

This specification defines a WPS Application Profile.

<table>
<tr><th>Aspect</th><th>Description</th></tr>
<tr><td>Service name</td><td>INSPIRE Coordinate Transformation Services</td></tr>
<tr><td>Category</td><td>Web Processing Service</td></tr>
<tr><td>Reference to specification</td><td>Draft Technical Guidance for INSPIRE Coordinate Transformation Services</td></tr>
<tr><td>Standard reference</td><td>OGC WPS, OGC WCTS, INSPIRE Transformation Service</td></tr>
<tr><td>Description</td><td>The specified Coordinate Transformation Service interface conforms to the abstract service definition established in the INSPIRE Implementing Rules (IR) for Transformation Services. In the following tables the mapping is presented from the abstract operations introduced in the IR to the service interface elements described in the speficication.

Mapping from the operations defined in the Transformation Service IR to the concrete operations defined in the Technical Guidance:

<table>
<tr><td>Abstract operation</td><td>WPS operation</td></tr>
<tr><td>GET SERVICE METADATA</td><td><code>GetCapabilities</code> and <code>DescribeProcess(TransformCoordinates)</code></td></tr>
<tr><td>TRANSFORM</td><td><code>Execute(TransformCoordinates)</code></td></tr>
<tr><td>IS TRANSFORMABLE</td><td><code>TestTransformation</code> parameter of the <code>Execute(TransformCoordinates)</code> operation</td></tr>
<tr><td>GET TRANSFORMATION</td><td>Not implemented (optional)</td></tr>
<tr><td>PUT TRANSFORMATION</td><td>Not Implemented (optional)</td></tr>
</table>

Mapping from the parameters of the TRANSFORM –operation defined in the Transformation Service IR to the elements defined in the Technical Guidance:</td></tr>
</table>

Abstract parameter	WPS element
INPUT DATA	`Execute/DataInputs/Input/ComplexData`, or `Execute/DataInputs/Input/Reference`, where `Input/Identifier = 'InputData'`
SOURCE MODEL	`Execute/DataInputs/Input/Data/LiteralData`, where `Input/Identifier = 'SourceCRS'`
TARGET MODEL	`Execute/DataInputs/Input/Data/LiteralData`, where `Input/Identifier = 'TargetCRS'`
MODEL MAPPING	`Execute/DataInputs/Input/Data/LiteralData`, where `Input/Identifier = 'Transformation'`

The value of the INPUT DATA –parameter shall be given to the process either as an inline XMLstructure (ComplexData) or as a reference (URL) to a Web-accessible resource (Reference, typically a WFS GetFeature –query). The service is required to support all INSPIRE-defined GML APs as an input and output data schema. The input and output shall always reference to the same schema.

The GML input might also contain coverage data, encoded in the form of a GML feature. In this case the desired interpolation method can be indicated by an optional input parameter InterpolationMethod (LiteralData).

The value of the SOURCE MODEL and TARGET MODEL –parameters shall be given to the process as a well-known CRS identifier (LiteralData, URN) The CRS identifier shall be given in the following form, as specified in the OGC Best Practice document 'Definition identifier URNs in OGC namespace' [4]:

urn:ogc:def:crs:[AUTHORITY]:[DB-VERSION]:[CODE]

The database version can be omitted, in which case the latest available CRS definition is assumed.

The value of the MODEL MAPPING –parameter shall be given to the process as a well-known transformation identifier (LiteralData, URN),. The transformation identifier shall be given in the same form as the identifier for CRS, with 'crs' replaced by 'coordinateOperation'.

The abstract IS TRANSFORMABLE operation is implemented as a boolean parameter TestTransformation of the Execute(TransformCoordinates) operation. If the value of the parameter is 'false' or it is missing from the request the service is supposed to perform an ordinary coordinate transformation. If the value is 'true' the service is expected to only test if it is possible to carry out the transformation. The result of the testing is returned in an exception message with the ExceptionCode having the value of 'Transformable' in the case of a successful transformation and value 'NotTransformable' in the case transformation is not possible. When returning the value 'NotTransformable' the service

	can indicate the reason for the failure in the ExceptionText element. **WPS Application Profile for INSPIRE Coordinate Transformation Service** According to the WPS specification, the Application Profile (AP) of the standard is defined by: a) an OGC URN that uniquely identifies the process b) a reference response message to the DescribeProcess request for that process. A human-readable documentation that describes the process may also be provided. The OGC URN of the coordinate transformation process of the WPS-based INSPIRE Coordinate Transformation Service is: urn:ogc:wps:1.0.0:INSPIRE:TransformCoordinates:1.0 A reference DescribeProcess response is given in the Appendix A of the specification. An exemplary Execute query can be found in the document Appendix B. The exception codes introduced in this Application Profile are listed in document Appendix C.
Format	
Comment	

Table 21 - INSPIRE Coordinate Transformation Service

3.6.3 GMES View

3.6.3.1 FP6 InterRisk WPS

Aspect	Description
Context	The lack of a pan-European infrastructure for uniform access and distribution of environmental data is a severe problem in all types of risk and crisis management. In marine and coastal areas, environmental risk and crisis situations such as oil spills and harmful algal blooms usually have an international dimension. Thus, users in several countries and organizations need access to the same data, including observations, derived parameters and predictions of future conditions. While many national monitoring and forecasting services are well developed, they are customized to their country's territorial waters, and often based on proprietary or non-standard solutions that hinder efficient data exchange. Today advances in the fields of sensor technology, data fusion methods, numerical modeling, ontologies and web services, provide better building blocks for GMES services. However, the challenge of bringing such components together to support smooth and efficient cross-country cooperation in crisis situations remains. Therefore, the InterRisk project aims to develop a pilot system for interoperable GMES monitoring and forecasting services for environmental risk management in marine and

Aspect	Description
	coastal areas.
Start and End Date	September 2006 to August 2009
Home Page	http://interrisk.nersc.no/
Summary	The InterRisk pilot consists of an open system architecture based on noted GIS and web standards, and integrates services for several European regional seas. The network of InterRisk services is embedded in the European Space Agency's Service Support Environment (SSE), which provides the underlying infrastructure for the InterRisk system. The SSE implements an open service-oriented and distributed environment among both service users and service providers, and enables integration of remote sensing, in situ, meteorological, oceanographic and GIS data. The InterRisk services include basic services such as satellite data processing, in situ data delivery, model simulations and metadata catalogues, as well as complex services such as oil drift prediction and ecosystem modeling. The services will be based on satellite and aircraft data, in situ data and numerical models needed to monitor and forecast marine environmental degradation and crisis events. The purpose of this “InterRisk WPS” section is to give details of the InterRisk complex services implemented in the ESA SSE by InterRisk partners. Complex services combine multiple “simple” services or apply additional processing to a simple service. Web Processing Service (WPS) was found to be the best candidate of the current OGC standards for InterRisk partners implementing simple services. Hence, the demonstration complex services developed by the InterRisk project use WPS as the building block (i.e. simple service) with the SSE controlling the flow of data between services.
Reference to architecture specification	InterRisk D5-2 Complex products and services for Norwegian, UK-Irish, French, German & Polish, Italian waters
Source of Requirements	End users responsible for crisis management and Service providers GMES users
Business rules (model),	The InterRisk pilot system and services are validated by users responsible for crisis management in case of oil spills, harmful algal blooms and other marine pollution events, in Norwegian, UK/Irish, French, German, Polish and Italian coastal waters.
Security rules	N/A
Authority rules for privileges and permissions	none
Resource usage rules	Pilot specific

Aspect	Description
Transfer rules,	public specifications re-use of software components depending on partner
Domain rules	Closed consortium; advisory board with selected users
Important use cases	Four complex services implemented in the ESA SSE by InterRisk partners: ° Demarcation of waters exceeding a chl-a threshold level ° Extraction of map data at locations of in situ sampling ° Highlighting of thresholded data ° Automatic oil spill detection

Table 22: Enterprise Viewpoint of the FP6 InterRisk Project

Aspect	Description
Service name	Image Thresholding (PML)
Category	Geographic processing services
Reference to specification	InterRisk D5-2 Complex products and services for Norwegian, UK-Irish, French, German & Polish, Italian waters
Standard reference	OGC Web Processing Service (WPS), Implementation specification, version 1.0.0, OGC 05-007r7
Description	This service aims to perform the thresholding of an image. It is part of the complex service “Demarcation of waters exceeds a chl-a threshold level”, which takes satellite images or model outputs of chlorophyll-a concentration and masks value greater than a user defined threshold. A typical threshold value would be 10 mg m^{-3} a commonly used threshold for reporting on areas of eutrophication, for example for OSPAR. However, the user can select their own threshold to meet local requirements or reflect changes to European reporting. The service, therefore, clearly shows areas that may be problematic by presenting as a red/green image and speeds up interpretation of satellite or model data by coastal zone managers.
Format	WSDL
Comment	The inputs are the URL of chl-a image and the threshold value. Those input parameters will be included directly in the WPS Execute request.

Table 23: InterRisk Image Thresholding Service

Aspect	Description
Service name	WFS and WMS data merging (PML)
Category	Geographic processing services
Reference to	InterRisk D5-2 Complex products and services for Norwegian, UK-Irish, French, German &

specification	Polish, Italian waters
Standard reference	OGC Web Processing Service (WPS), Implementation specification, version 1.0.0, OGC 05-007r7
Description	This service combines WFS feature data with the actual values of the WMS layer at the same points and times as the feature data. It is part of the complex service “Extraction of map data at locations of in situ sampling”, which takes a satellite image or model output served from a Web Map Server supporting GetFeatureInfo and extracts values at specific geographic locations corresponding to sampling stations. The WMS could, in principle, be any InterRisk or other SSE data supplier while the point locations could come from any in situ data supplier. This service has been suggested by the UK Environment Agency to provide inputs to their water quality spreadsheets. It also speeds up the scientific evaluation of a model or satellite image in comparison to in situ measurements.
Format	WSDL
Comment	Inputs are WFS URL, WFS feature name, WMS URL, WMS layer name, bounding box and time bounds. These parameters will be included in an XML WPS Execute request.

Table 24: InterRisk WFS and WMS Data Merging Service

Aspect	**Description**
Service name	Image highlighting (GKSS)
Category	Geographic processing services
Reference to specification	InterRisk D5-2 Complex products and services for Norwegian, UK-Irish, French, German & Polish, Italian waters
Standard reference	OGC Web Processing Service (WPS), Implementation specification, version 1.0.0, OGC 05-007r7
Description	This service is based on an algorithm which calculates wind fields from ASAR. Regions where the roughness of the sea shows deviations from the roughness of the surrounding sea might be a potential oil spill. If a few other conditions are fulfilled these regions are marked with a special colour (magenta) which is not part of the colour scale for the deduced wind. However, most of the marked regions are not potential oil spills. The exclusion of these false positives can be done by visual inspection in most cases; for instance, the marked region may be close inshore in a fjord. As the regions can be very small sometimes it is hard to find the marked regions for this visual inspection. The highlighting service has been modified so that instead of highlighting a special colour (magenta) the colour to be highlighted is given as an input parameter to the WPS web-service. This service is chained with the previous “Image Thresholding” WPS to build the complex service “Highlighting of thresholded data”, which applies a threshold value to the data resulting in 2 images. The first is a thresholded image; the second is an image which highlights only the regions where the exact threshold value matches. The visual comparison between regions above the threshold and regions with the exact threshold

	value provides information about the selected threshold. Many highlighted pixels mean that the chosen threshold value is within a maximum of the frequency distribution.
Format	WSDL
Comment	Inputs are URL of the thresholded chl-a image and the colour (RGB) to highlight. These parameters will be included in an XML WPS Execute request.

Table 25: InterRisk Image Highlighting Service

Aspect	**Description**
Service name	Image Pre-processing (NERSC)
Category	Geographic processing services
Reference to specification	InterRisk D5-2 Complex products and services for Norwegian, UK-Irish, French, German & Polish, Italian waters
Standard reference	OGC Web Processing Service (WPS), Implementation specification, version 1.0.0, OGC 05-007r7
Description	This service processes the calibration, the normalization and the geo-coding of an ASAR.N1 image and saves the resulting image in a GeoTiff file format and png file format. It is the first service included in the chain of the complex service “Automatic oil spill detection”, which provides algorithms for detection of oil spills in satellite SAR images.
Format	WSDL
Comment	Input is the number of selected ENVISAT ASAR N1 satellite scene or fragment (amongst a predefined list of number). This parameter will be included in an XML WPS Execute request. Output is the URL of pre-processed PNG image file.

Table 26: InterRisk Image Pre-processing Service

Aspect	**Description**
Service name	Adaptive Image Thresholding (INI)
Category	Geographic processing services
Reference to specification	InterRisk D5-2 Complex products and services for Norwegian, UK-Irish, French, German & Polish, Italian waters
Standard reference	OGC Web Processing Service (WPS), Implementation specification, version 1.0.0, OGC 05-007r7
Description	This service thresholds an input gray scale image to black [pix.val=1] and white [pix.val=255] according to a threshold defined as Mean [image brightness]*scaling_factor. It is the second service included in the chain of the complex service “Automatic oil spill detection”, which provides algorithms for detection of oil spills in satellite SAR images.
Format	WSDL

Comment	Inputs are the URL of ASAR image in PNG format and three optional parameters: scaling factor and two skip values. Input will be in the form of an XML WPS Execute request. Output is the URL of thresholded image file.

Table 27: InterRisk Adaptive Image Thresholding Service

Aspect	**Description**
Service name	Segment Labelling (INI)
Category	Geographic processing services
Reference to specification	InterRisk D5-2 Complex products and services for Norwegian, UK-Irish, French, German & Polish, Italian waters
Standard reference	OGC Web Processing Service (WPS), Implementation specification, version 1.0.0, OGC 05-007r7
Description	This service labels segments in a thresholded image by unique numbers and produces a segmented colour image. It is the third service included in the chain of the complex service “Automatic oil spill detection”, which provides algorithms for detection of oil spills in satellite SAR images.
Format	WSDL
Comment	Inputs are the URL of thresholded image in PNG format and four optional parameters: image background, image foreground and two skip values. Input will be in the form of an XML WPS Execute request. Output is the URL of labelled (segmented) image file.

Table 28: InterRisk Segment Labelling Service

Aspect	**Description**
Service name	Oil Spills Detection (INI)
Category	Geographic processing services
Reference to specification	InterRisk D5-2 Complex products and services for Norwegian, UK-Irish, French, German & Polish, Italian waters
Standard reference	OGC Web Processing Service (WPS), Implementation specification, version 1.0.0, OGC 05-007r7
Description	“Oil Spills Detection” service is used for the detection of oil spills in SAR image using a Support Vector Machine (SVM) algorithm. Image segment features are computed using segmented image provided by the previous “Segment Labelling” service. It is the last service included in the chain of the complex service “Automatic oil spill detection”, which provides algorithms for detection of oil spills in satellite SAR images.
Format	WSDL

Comment	Inputs are the URL of pre-processed ASAR image in PNG format, URL of labelled (segmented) image in PNG format, and two optional parameters: image background and skip value. Input will be in the form of an XML WPS Execute request. Output is the URL of of oil spill map file.

Table 29: InterRisk Oil Spills Detection Service

Applicable component types are listed below. A component type can be considered as a combination of service interface and information content.

- PyWPS Web Processing Service: is a Python program which implements the OGC WPS 1.0.0 standard (with a few omissions). PyWPS was chosen as it is up to date with the WPS standard and has a low footprint, making it easy to install on most Linux systems. Python was considered a good choice of implementation language as it is a very easy language to develop in and allows partners to easily integrate existing processing which may have been written in other languages. PyWPS documentation may be found at http://pywps.wald.intevation.org/documentation/index.html
- Orchestration engine: component type is used to orchestrate a service chain (i.e. InterRisk "complex" service) that includes one or more InterRisk "simple" WPS processes.
- Complex services: are services which combine multiple "simple" services or apply additional processing to a "simple" service.

Platform Name	W3C Web Services Platform
Reference Model	W3C Web Services Architecture
Interface Language	The discovery service interfaces can be expressed in two ways: ▪ WSDL 1.1: This is the version actually used by the InterRisk development and run-time environment and the software development tools. ▪ WSDL 2.0: this is the "official" interface as included in the OGC catalogue specification 2.0.2.
Execution Context	▪ Bindings: SOAP 1.1 bindings over HTTP 1.1. The message style is "document". ▪ The "simple" service interfaces are described in OGC Web Processing Service (WPS), Implementation specification, version 1.0.0, OGC 05-007r7 ▪ The complex service is implemented using the OASIS Business Process Execution Language WS-BPEL.
Schema Language	The schema language to define information models is:

	▪ W3C XML Schema for the definition of input/output messages of the OGC Web Processing Service operations.
Schema Mapping	N/A

Table 30: The specification of the platform conformant with OASIS RM-SOA

The mandatory Execute operation allows WPS clients to run a specified process implemented by a server, using the input parameter values provided and returning the output values produced. Inputs can be included directly in the Execute request, or reference web accessible resources. The outputs can be returned in the form of an XML response document, either embedded within the response document or stored as web accessible resources.

If the outputs are stored, the Execute response shall consist of a XML document that includes a URL for each stored output, which the client can use to retrieve those outputs. Alternatively, for a single output, the server can be directed to return that output in its raw form without being wrapped in an XML response document.

Normally, the response document is returned only after process execution is completed. However, a client can instruct the server to return the Execute response document immediately following acceptance by the server of the Execute request. In this case, the Execute response includes a URL from which the response document can later be retrieved during and after process execution. The server can be instructed to provide regular updates to a measure of the amount of processing remaining if the process is not complete. This allows the client to determine the process status by polling this URL.

The orchestration of a complex service that includes a chain of one or more simple WPS processes is implemented by using the OASIS Business Process Execution Language WS-BPEL.

This section gives implementation details on the component types identified in the engineering viewpoint, e.g. the products that provide the implementation of the component types:

- Complex service client: http://interrisk.spacebel.be providing access to the InterRisk complex services.
- InterRisk Portal Environment including
  - Orchestration engine: Oracle BPEL Process Manager 10.1.2
- Simple WPS Services

Service name	Provider
Image Thresholding	PML (UK)
WFS and WMS data merging	PML (UK)
Image highlighting	GKSS (DE)
Image Pre-processing	NERSC (NO)
Adaptive Image Thresholding	INI (DE)

Segment Labelling	INI (DE)
Oil Spills Detection	INI (DE)

This paragraph provides preliminary information about the software components that will eventually be used as run-time environment for the above services. Only the components directly relevant to the complex services are listed:

- RedHat 4 Linux as operating system.
- JBoss Java EE Application Server 3.2.6
- Oracle BPEL Process Manager 10.1.2.

The list of components deployed at the Production Centers is not yet available as these implementations are on-going.

The InterRisk processing service interfaces are based on OGC Web Processing Service (WPS), Implementation specification, version 1.0.0, OGC 05-007r7.

3.6.3.2 SANY Sensors Anywhere

SANY aims to improve the interoperability of in-situ sensors and sensor networks, allowing quick and cost-efficient reuse of data and services from currently incompatible sources in future environmental risk management applications. By addressing the access to and interoperability between in-situ sensors, SANY complements the INSPIRE (concentrates on access to static geospatial data) and the Heterogeneous Mission Accessibility (HMA) initiative of the European Space Agency, which addresses earth observation data. Main project results include:

1. Sensor Service Architecture (SensorSA) specification
2. Prototype implementation of the SensorSA services
3. a framework for integration of fusion- and modelling- engines into SensorSA networks
4. a security framework for access control & policy enforcement
5. a web based platform for decision support applications based on ESA SSE
6. three prototype applications illustrating the use of SANY in air quality, marine risks and geo hazards domains.
7. a collection of educational material for decision makers and technicians interested in developing their own SensorSA compliant networks

SensorSA belongs to the family of service-oriented architectures (SOA) but has a particular focus on the access, the management and the processing of information provided by sensors and sensor networks. As such, it contains sensor-specific services, however, in order to provide a higher-level, functionally and semantically richer interface to environmental risk management applications it also has to abstract from the peculiarities of sensors and to encompass generic information processing functionality. Thus, there is a sliding passage to the functionality of a generic service infrastructure. The SensorSA foresees mechanisms

to generate events and distributes them as notifications to interested consumers. This enables spontaneous distribution of information about changing configurations in underlying sensor networks, e.g. the dynamic addition or removal of sensor devices, which is a pre-requisite for the support of the “plug-and-measure” type of operation. Furthermore, the SensorSA relates the basic concepts of a resource-oriented architecture (ROA) such as resources and their representations to the SOA concepts in order to gain flexibility in discovery tasks and the mapping to underlying mainstream Web service environments.

The foundation for the conceptual architectural work for SANY has been taken from the OGC Best Practices Document 07-097 which corresponds to the Reference Model for the ORCHESTRA Architecture (RM-OA) as specified by the European Integrated Project FP6-511678 ORCHESTRA (Open Architecture and Spatial Data Infrastructure for Risk Management). The RM-OA provides a platform-neutral abstract specification of a geospatial service-oriented architecture that responds to the requirements of environmental risk management applications. It comprises generic architecture services and information models based on and extending existing specifications of the Open Geospatial Consortium (OGC).

Some highlights of SANY and SensorSA:

- SANY SensorSA builds on the architectural basis of ORCHESTRA RM-OA
- SANY embraced the ORCHESTRA idea of “technology independence” , and experimented with three service bindings in-parallel: classical OGC web services, W3C web services (SOAP) and RESTfull services.
- SensorSA extends the RM-OA interaction models: in addition to the classical request/reply interaction pattern, SensorSA also supports event-driven interaction pattern.
- the use of OGC Sensor Web Enablement services (in particular SOS and SPS) is advocated not only in the sensor domain, but also as front ends for general processing services.
- SANY recommends the use of UncertML for descriobing of process and data uncertainity

SensorSA allows to use both SPS and WPS. SANY IP recently compared and contrasted the use of both SPS and WPS as front-ends for various data fusion and modelling services and came to following conclusions (see SANY Deliverable D3.3.2.3 „Fusion and Modelling Architectural Design V2“)

- „The WPS standard is simpler for a service provider, with much flexibility of implementation available to easily handle most processing use cases; this comes at the expense of the client who must potentially support each WPS provider's domain specific input and output formats.
- The SPS standard is more structured, and provides a pre-defined mechanism to support client notification of progress and result availability. The GetFeasibility operation in the SPS standard allows a client some feedback on the viability of a processing operation before committing to execution.
- In addition to functionality already offered by WPS, the SPS standard defines notification and steering protocols and s thus a good choice if this is important.

Both standards are easily extended and can support, for example, uncertainty (e.g. using UncertML) and provenance metadata (e.g. using SensorML process descriptions).The final bullet is very important from the point of view of result reproducibility [SANY Deliverable D3.3.2.3 „Fusion and Modelling Architectural Design V2“: „After a fusion process run has finished, it is important, that the fusion result contains all necessary information to be able to reproduce the process. SensorML encoding of this information plays an essential

role in the Fusion workflow. In both Fusion SPS and WPS it is used for fusion process description. They describe the expected inputs, parameters, outputs, the algorithm itself and the implementation module of the fusion process. This is also useful for fusion service discovery. For each fusion workflow execution a unique SensorML file is created, one per successful executed fusion run, that describes the fusion algorithm executed and the input parameters provided. It contains essentially a copy of the fusion-process description which includes the supplied values (inputs, parameters) for that specific fusion run. The purpose of this SensorML description file is to provide a provenance record to allow a fusion experiment to be reproduced.

3.6.4 GEOSS View

Aspect	Description
Service name	OGC Web Processing Service (WPS)
Category	Geographic processing services (ISO 19119)
Reference to specification	GEOSS AIP-2 Engineering Reports for: • "The Impact of Climate Change on Pikas Regional Distribution" Climate Change and Biodiversity WG Use Case Scenario • "Arctic Food Chain" Climate Change and Biodiversity WG Use Case Scenario • Floods Disaster Response
Standard reference	OGC Web Processing Service Implementation Specification, Version: 1.0.0, OGC Doc 05-007r7
Description	The WPS provides an interface that standardises inputs and outputs of geospatial processing services, such as schematization services. The standard defines how the execution of a process can be requested and how the output from the process is handled. WPS facilitates the publishing, discovering and binding of geographic processes. The results of a WPS process can either be accessed synchronously or asynchronously by callback(for long running processes).
Format	XML
Comment	*GEOSS AIP-2* scenarios included use of WPS in Climate Change,

Table 31: Web Processing Service

3.7 SPS

At the present stage the standard solution for Sensor Planning service is OGC Sensor Planning Service (SPS) described in the following section. SPS is not applicable to INSPIRE at the moment.

See also the previous GIGAS TN [RD. 8]

3.7.1 OGC SPS

3.7.1.1 Enterprise Viewpoint

The Sensor Planning Service (SPS) provides a standard interface to collection assets (i.e., sensors, and other information gathering assets) and to the support systems that surround them. Not only must different kinds of assets with differing capabilities be supported, but also different kinds of request processing systems, which may or may not provide access to the different stages of planning, scheduling, tasking, collection, processing, archiving, and distribution of requests and the resulting observation data and information that is the result of the requests. The SPS is designed to be flexible enough to handle such a wide variety of configurations.

The *Sensor Planning Service Application Profile for EO Sensors*, published as a Best Practice Paper, is intended to support the programming process of Earth Observation (EO) sensors system. This profile describes a consistent SPS configuration that can be supported by many satellite data providers, most of whom have existing facilities for the management of these programming requests.

It specifies the interfaces and parameters for requesting information describing the capabilities of a Sensor Planning Service dedicated to the EO Sensor domain, for determining the feasibility of an intended sensor planning request, for submitting such a request, for inquiring about the status of such a request, for updating or cancelling such a request, and for requesting information about further OGC Web services that provide access to the data collected by the requested task.

In particular, the application profile defines operations for:

- Getting the list of parameters that can be specified for programming a specified sensor;
- Verify the feasibility of the request that is going to be submitted
- Submit the request and then check its progress
- If necessary to cancel the submitted request
- Retrieve the sensor's acquired data.

3.7.1.2 Service Viewpoint

Aspect	**Description**
Service name	OGC Sensor Planning Service (SPS)
Category	Geographic workflow/task management services (ISO 19119)
Reference to specification	see standard reference

Standard reference	OGC Sensor Planning Service Implementation Specification, version 1.0.0, OGC 07-014r3 OGC Sensor Planning Service Application Profile for EO Sensors, Best Practice Paper, version 0.9.5, OGC 07-018r2
Format	HTTP, XML
Comment	The Sensor Planning Service 1.1 Standard Working Group (SPS 1.1 SWG) aims at updating the Sensor Planning Service (SPS) Version 1.0 Standard and to develop Version 1.1. At least the following Change Request Proposals and discussion items are discussed: • Integration of the SOAP on HTTP binding to facilitate the usage of OASIS specifications WS-Notification, WS-Addressing, WS-Topics • Change of the communication patterns: Future versions of the SPS shall make use of WS-Notification in combination with WS-Addressing and WS-Topics in order to inform the client about status changes of the request. • Harmonization with SWE Common: The parameter settings in both requests and responses shall use SWE Common instead of the proprietary SPS approach. • SPS shall inform more detailed about the status of individual tasking requests.

Table 32: OGC Sensor Planning Service (SPS)

SPS 1.0.0 operations

The SPS interface (currently) specifies eight operations that can be requested by a client and performed by a SPS server. Those operations are:

- **getCapabilities** informs the client about both common and specific capabilities of a Service Planning Service instance.
- **describeTasking** requests the information needed in order to prepare an assignment request targeted at the assets that are supported by the SPS and selected by the client. The server will return information about all parameters that have to be set by the client to perform a submit operation.
- **getFeasibility** (optional) provides feedback to a client about the feasibility of a tasking request. Dependent on the asset type covered by the SPS, the SPS server action may be as simple as checking that the request parameters are valid and are consistent with certain business rules, or it may be a complex operation that calculates the availability of the asset to perform a specific task at the defined location, time, orientation, calibration etc.
- **submit** submits the assignment request. Depending on the covered asset, it may perform a simple modification of the asset or start a complex mission.
- **getStatus** (optional) requests information about the current status of the requested task.
- **update** (optional) Updates a previously submitted task.
- **cancel** (optional) cancels a previously submitted task.

- **describeResultAccess** retrieves information about how and where data that were produced by the asset can be accessed. The server response may contain links to any kind of data accessing OGC Web services such as SOS, WMS or WFS.

3.7.2 GMES View

Within GMES the SANY IP implemented SPS 1.0. See section 3.6.3.2.

3.7.3 GEOSS View

3.7.3.1 Enterprise Viewpoint

SPS defines interfaces for querying the capabilities of sensors and also tasking sensors. SPS operations are designed to submit, enquire, update or cancel a tasking request. It is also possible to request information about other OGC web services that disseminate data collected by a requested task.

One of the specification under the umbrella of the OGC Sensor Web Enablement(SWE) activity. Related SWE specifications include Sensor Model Language (SensorML), Observations and Measurements (O&M), Sensor Observation Service (SOS), Transducer Markup Language (TML), Sensor Alert Service (SAS), and Web Notification Service (WNS).

3.7.3.2 Service Viewpoint

Aspect	Description
Service name	OGC Sensor Planning Service (SPS)
Category	Geographic workflow/task services (ISO 19119)
Reference to specification	GEOSS AIP-2 Engineering Reports for: • Floods Disaster Response
Standard reference	OGC Sensor Planning Service Implementation Specification, Version: 1.0.0, OGC Doc 07-014r3
Format	XML
Comment	The *Floods Disaster Response scenario of GEOSS AIP-2* included use of an SPS for tasking SPOT5 assets.

Table 33: Sensor Planning Service

3.8 Ordering Services

Ordering Services were described and analyzed in the previous GIGAS TN document [RD.9]. Conclusions from that document state that Ordering Service standardization is not at the same level of maturity on each of the three initiatives GMES, INSPIRE and GEOSS.

In particular from the previous technology watch it is important to cite the following results for each of the three initiatives:

GMES has already implemented some interoperable system including EO Ordering based on a proven ICD.

INSPIRE is working on the implementing rules for the specification of the network services. The download service is within the INSPIRE offer the service that shares the scopes with the Ordering domain. Download services, including user access management, are scheduled in the period 2009-2011.

GEOSS Ordering definition has been started within the AIP-2 of GEOSS. The pilot project includes the definition of the Ordering use case, cross-related with the needs of the main Societal Benefit Areas. Unfortunately the Ordering use case has now a low priority within GEOSS AIP-2, so that it is likely that a further AIP phase would be needed before seeing the Ordering service definition in GEOSS.

4 Conclusions

The following conclusions can be drawn:

- *The INSPIRE, GMES and GEOSS initiatives agree on the choice of International Standard protocols and data models to implement Data Access and Processing service; such as: OGC WMS, WCS, WFS, WPS; ISO 19129, 19142, 19143, 19136.*
- *Interoperability arrangements are also considered by GEOSS (and by several GMES projects). Valuable examples are: THREDDS/OPeNDAP, CF-netCDF, and GBIF RESTFull standards.*
- *The three initiatives applied international standards for different applications, developing specific Application Profiles, Extension packages, Implementation Guidelines and Best Practices. That mainly stems from their specific Enterprise Viewpoints and user communities.*

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