GROUP ON EARTH OBSERVATIONS

Architecture Implementation Pilot (AIP) Phase 2: IOC Augmentation

Call for Participation (CFP)

Version: 20080626

CFP Issuance Date: 26 June 2008

Kickoff Response Due Date: 1 September 2008

Phase 2 Kickoff Workshop: 25-26 September 2008

Preface

This Call for Participation (CFP) seeks participants in the GEOSS Architecture Implementation Pilot (AIP). A Pilot is a collaborative effort that applies open standards for interoperability to achieve user objectives in an environment of operational use.

This 2nd Phase of AIP aims to establish "persistent operational exemplars" of services that support the GEOSS Societal Benefit Areas (SBAs) using a consistent architecture. This 2nd phase will augment the Initial Operating Capability of the GEOSS Core Infrastructure previously established by the 1st Phase of the AIP and other GEO Tasks.

Outcomes include best practices and interoperability arrangements suitable for an operational capability. An aim of the Pilot is to reach consensus on architectural elements that initiatives supporting geospatial information systems can carry forward into operations, thereby increasing the overall level of interoperability.

This Call for Participation invites GEO Members and Participating Organizations to:

- Participate in the collaborative development of SBA scenarios to guide testing, demonstrations and operations of the identified interoperable services. Initial scenarios have been developed, in close coordination with the User Interface Committee, relevant GEO Tasks, and GEO Secretariat Experts.
- Provide services relevant to SBAs; where those services are deployed consistent with the GEOSS architecture based on Interoperability Arrangements. Participate in interoperability testing to confirm the architecture and including use of the GEOSS Core Infrastructure Components; and,
- Contribute to the refinement of the architecture and interoperability arrangements. Including refinement of the CFP architecture and interactions with the GEOSS ADC Standards and Interoperability Forum (SIF)

To be most effective organizations responding to the CFP should plan to fully participate in the Pilot development activities beginning with the Kickoff Workshop. The CFP will remain open for the duration of 2nd Phase of AIP.

Geospatial Architecture Implementation Pilot
Call for Participation (CFP)

TABLE OF CONTENTS

Geospatial Architecture Implementation Pilot
Call for Participation (CFP)

1 Introduction

1.1 Purpose

This Call for Participation (CFP) seeks organizations to participate in the GEOSS Architecture Implementation Pilot (AIP). The 2^{nd} Phase of the AIP will augment the GEOSS Initial Operating Capability previously established. This CFP was created the GEO Task AR-07-02.

Responses to this CFP may come from governmental or non-governmental organizations that are either located in a GEO Member country or that are members of a GEO Participating Organization. Responses are encouraged to include or reference multiple parties that are collaborating on the offer of persistent services, data, and/or applications that benefit one or more GEO Societal Benefit Areas (SBAs).

Since the Pilot will address interoperability and user support in the broadest manner, broad participation is encouraged in order to achieve the Pilot's objectives on a voluntary basis. This benefits both the participant organizations and the GEO Architecture development.

All organizations interested in participating in the Pilot shall respond to this CFP. Instructions for responding are provided in Section 3. The CFP will remain open for organizations to respond any time during the 2^{nd} Phase of the AIP. To be most effective, responses are encouraged prior to the Kickoff Response Due Date.

1.2 The CFP Process

The CFP Process is part of a Development Process for Interoperability Initiatives. The first Phase of AIP included several Requests for Information (RFIs) that determined the interest and state of readiness for conducting the Pilot Execution Phase. The results of the RFIs and of the entire 1^{st} Phase were used as inputs for this CFP. This CFP seeks participants in the 2^{nd} Phase of the AIP.

The AIP Development Process is defined in Annex A of this CFP.

The AIP Architecture is defined in Annex B of this CFP.

The Process for the Pilot has been defined using the Open Geospatial Consortium's (OGC's) Interoperability Program process. The OGC Interoperability Program is a global, collaborative prototyping program designed for rapid development of implementations and specifications for geospatial interoperability.

1.3 Master Schedule

The following table details the major events associated with this CFP:

CFP Issued	26 June 2008
Clarification Teleconference	18 July 2008, 1300 UTC
Kickoff Response Due Date*	1 September 2008
Kickoff Workshop at NCAR, Boulder, CO, USA	25-26 September 2008
Status and Interim results to GEO Plenary, Beijing, China	19-20 November 2008
Final results of Phase 2 AIP	1st Quarter 2009

*Responses received by this date will be used to prepare for the Kickoff Workshop.

Additional information is available http://www.ogcnetwork.net/AIpilot

2 Context

The GEO Work Plan charges Task AR-07-02, “Architecture Implementation Pilot,” to:

> Lead the incorporation of contributed components consistent with the GEOSS Architecture using a GEO Web Portal and a Clearinghouse search facility to access services through GEOSS Interoperability Arrangements in support of the GEOSS Societal Benefit Areas.
>
> Incorporate GEOSS contributed components into a pilot implementation of the GEOSS Architecture in coordination with Task AR-07-01.

Participation in this Pilot anticipates

1) Refinement and augmentation of the GEOSS Common Infrastructure including GEO Web Portal, Clearinghouse and Registries solutions.
2) Registration of components and services hosted by the participating organization in the GEOSS Registry to support access by the Clearinghouse and Portal, and that to support demonstration of a set of user scenarios.
3) Participation in the development of a set of user scenarios that support the GEO Societal Benefit Areas.
4) Participation in the refinement of the initial architecture in Annex B based upon the pilot activities.

Collaboration with other GEO Tasks is anticipated, in particular with GEO Task AR-07-01 and its GEOSS Interoperability Process Pilot Project (IPPP). Other examples of coordination with GEO Tasks are shown in Table 1.

Table 1 – Examples of AIP Coordination with GEO Tasks

Session	**Task #**	**Task Short Title**
Disasters	DI-06-09	Use of Satellites for Risk Management
Biodiversity	BI-06-02	Biodiversity Requirements in Earth Observation
Biodiversity	EC-07-01	Global Ecosystem Observation and Monitoring Network
Biodiversity	BI-06-03	Capturing Historical Biodiversity Data
Energy	EN-06-04	Using New Observation Systems for Energy
Air Quality	HE-07-02	Environment and Health Monitoring and Modelling
Intercalibration	DA-06-02	Data Quality Assurance Framework
AG Mon	AG-07-03	Operational Agricultural Monitoring System
Sensors	DA-07-03	Virtual Constellations
Sensors	DA-07-04	Sensor Web Enablement for In-Situ
Registry	DA-06-04	Data, Metadata and Products Harmonisation
Overall	DA-06-01	Application of the Agreed GEOSS Data Sharing Principles
Overall	AR-07-01	Enabling Deployment of a GEOSS Architecture
Overall	AR-07-02	GEOSS Architecture Implementation Pilot

An aim of the Pilot is to reach consensus on architectural elements that initiatives in support of geospatial information systems can carry forward into operations, thereby increasing the overall level of interoperability.

Participants in this initiative will implement the services identified in the architecture provided in Annex B. Other than the architecture described in Annex B, participants will have flexibility in deploying interoperable interfaces and protocols for use in the demonstrations associated with the operational context.

The architecture presented in Annex B is based on the current "mainstream" approach and was selected to provide the best opportunity for meeting the GEOSS requirements. This architecture is not intended to determine the physical system configuration, but to identify the interfaces and protocols within the current mainstream. Participants are assumed to be providing any and all hardware, software, networks, personnel, etc., needed to make their services available to the Pilot.

In support of IOC and GCI, work will proceed toward full interoperability of the services contributed in AIP Phase 2 and the GCI services. This will be achieved by a common architecture that allows for services to support multiple SBAs.

3 CFP Response Terms and Conditions

Documentation submitted in response to this CFP will be distributed to many organizations and may be posted on a publicly accessible web site. Responders shall not include information in their responses for which you are not authorized to distribute. Proprietary and confidential information must not be submitted under this request. **It will be assumed that CFP responses do not contain confidential information.**

This CFP does not offer compensation to organizations preparing a response to the CFP. The CFP does not offer funds to any organizations for participation in the Pilot.

Submit an electronic copy of your CFP response to the OGC Technology Desk (techdesk@opengeospatial.org). Microsoft Word® 2000 for Windows, 2001 for Macintosh, or higher format is preferred; however, Portable Document Format or Rich Text Format are acceptable.

Proposals must be received no later than the date and time in Master Schedule (Section 1.3).

Questions and requests for clarification should be sent electronically to the OGC Technology Desk (techdesk@opengeospatial.org).

4 CFP Response Format and Content

4.1 Response Outline

Responses should follow the following outline:

- Cover page
- Overview
- Proposed Contributions
  - Societal Benefit Area Alignment and Support
  - Component and Service Contributions
  - Architecture and Interoperability Arrangement (Standards) Development
- Description of Responding Organization

4.2 Cover Page

Provide the name(s) of the responding organization(s). Teams of organizations should list the names of all organizations. It is encouraged that organizational logos are included on the cover page. .

4.3 Overview

Provide a one-page introduction to the contents of your proposal and its benefits.

4.4 Proposed Contributions

Describe your proposed contribution to the Pilot based on your desired role. Justify your approach.

4.4.1 Societal Benefit Area Alignment and Support

Document the one or more Societal Benefit Areas (SBA) that you are best aligned with and will be supporting.

If you are proposing to enhance the SBA descriptions and deployment, please include the following in your response:

- Comment on the SBA Sections of Annex B.
- Define your scenarios (e.g. web service-oriented use cases, workflows, decision support environments).
- Delineate aspects of the existing Annex B scenarios to which you propose to contribute.
- Provide comments on the Annex B architecture to increase the expectation that the results will support Societal Benefit Areas (SBAs).
- Describe participation and/or membership of the responding organization in SBA activities; list relevant experience for SBAs the organization is offering to participate in,
- Define plans for participating in the Pilot Activities regarding scenario development and the application of the scenarios to component integration and demonstration.

Do not assume a single participant development or demonstration; rather the developments will show how the various components can interoperate to produce results unique to coordinated activity of the participants.

4.4.2 Component and Service Contributions

If you plan to contribute components and services, please include the following in your response:

- Descriptions of components and services to be registered with GEOSS,

- Relationship of the components and services to the architecture in Annex B. Comments to support the refinement of the Annex B architecture are encouraged,
- Examples of which SBAs that the components and services support, e.g., relevant data, processing capabilities and/or client applications,
- Support of open standards by the services, with explanation of multiple-use potential outside of a single scenario within GEOSS,
- Identify how the proposed components and services will be used in the GEOSS Common Infrastructure (GCI) – baseline architecture of GEOSS Registries, Portal, and Clearinghouse. If you will provide client application capabilities, identify how this may also exploit the GCI in the proposed project.
- Performance capability of the components including typical traffic (hits per hour) that the components support, and
- Availability of the components for participation in the Pilot activities including persistence.

4.4.3 Architecture and Interoperability Arrangement Development

If you plan to contribute or support the refinement of the architecture and interoperability arrangements, please include the following in your response:

- Comments and contributions to the architecture in Annex B,
- Comments on the GEOSS Process for Reaching Interoperability Arrangements (produced by GEO Task AR-06-01), and specifically, plans on use of GEOSS open standards or interactions with the Standards and Interoperability Forum in making “special arrangements” for use of non-GEOSS standards.
- Describe participation and/or membership of the responding organization in standards developing organizations; list relevant experience for specific open standards,
- Plans to support refinement and elaboration of the currently defined architecture and interoperability arrangements during the Pilot activities.

4.5 Description of Responding Organization

Provide a brief description of responding organization including its relationship to the Pilot Initiative, e.g., GEO Member or Participation Organization.

Describe the Organizations approach to supporting the Pilot including identifying the human and system resources to be assigned to participate in the Pilot.

Provide contact information for both a Programmatic Contact and for a Technical Contact. The contact person may be the same for Programmatic and Technical contacts.

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Architecture Implementation Pilot (AIP) Phase 2: IOC Augmentation

Call for Participation (CFP) Annex A – Development Plan

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Phase 2 Kickoff Workshop: 25-26 September 2008

Architecture Implementation Pilot - Call for Participation
Annex A – Development Plan

TABLE OF CONTENTS

Architecture Implementation Pilot - Call for Participation
Annex A – Development Plan

1 Overview

This Annex to the Call for Participation (CFP) describes the development plan for the Pilot initiative.

The procedures in this annex are an application of the OGC Interoperability Program procedures for a Pilot Initiative. More information can be found here: http://www.opengeospatial.org/ogc/policies/ippp

2 Pilot development process

A Pilot Initiative is where open standards can be "stress tested" and perfected based on real-world application and experience. While some research may be done during a pilot in terms of refining, documenting, and distributing specifications and in terms of developing prototypical software that exercises the refined specification, this research is directed at improving existing specifications rather than in creating new specifications.

The general approach to performing one of phase of the pilot is to go through a five-step process (Figure 1). The details of these Tasks are explained below.

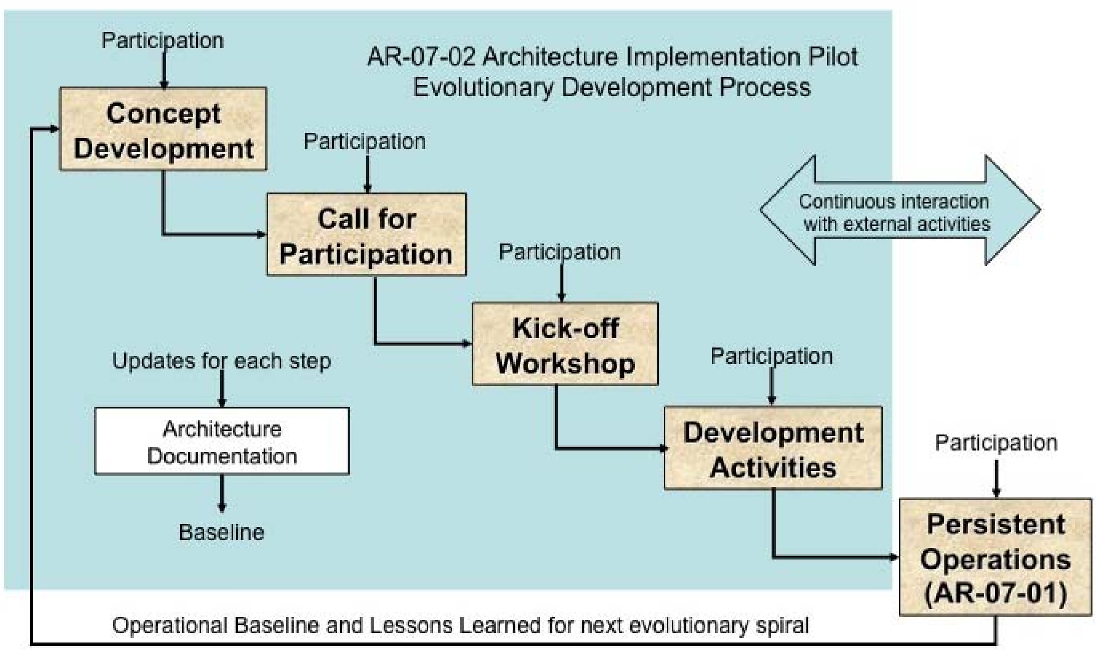

Figure 1 – Steps of a Pilot Phase

2.1 Concept development

The Concept Development phase results in an architecture, requirements and a plan sufficient to develop a Call for Participation in the Pilot Initiative.

The GEOSS ADC RFIs for Clearinghouse and Web Portal along with the GEOSS Ten-year Plan Reference Document, the GEO Work Plan and the efforts of the GEO ADC and the Task Team contributed to the concept development.

The Architecture is refined based upon the results of previous Phases of the Pilot. This feedback is a key to this form of evolutionary development process.

2.2 CFP development

Phase B of a Pilot is to release a Call for Participation (CFP) and to receive and evaluate responses to this CFP.

Once a draft CFP is developed by the GEO Task Team (AR-07-02) it is presented to the GEO Architecture and Data Committee for their review and comment. Comments are addressed and incorporated by IP Team into the final version of the CFP. Once the Task Team and ADC agreed to the release, the CFP is announced through several communication mechanisms. The desire is that multiple will submit proposals that explain the technical contribution they intend to make, how their contribution maps to the architecture, and the contributions they will make to the initiatives.

The following guidelines are provided to organizations for developing a CFP response:

- Annex B of this CFP is the initial baseline for the Pilot Initiative. The relationship between the content of the response and Annex B should be noted by the Responding organizations. Responses need not address the full spectrum of the architecture as outlined in Annex B. Responses can focus on specific portions of that architecture.
- Responding organizations should plan on performing all development work at their own facilities. These facilities should include a server (where applicable) that is accessible to other Pilot participants via the Internet. Testing will be carried out among the participants based on these Internet-accessible servers.
- Responding organizations should be prepared to build interoperable components and thus should be prepared to cooperate with all selected development teams, regardless of whether individual proposals covered the full pilot architecture or portions of it.
- Software components developed in the initiative should either be based upon currently operational components, or should be prototypes or pre-release versions of components that the responding organization intends to deploy.
- Responding organizations must participate in the full course of interface and component development, test and integration experiments, and other essential activities throughout the initiative in order to have access to and participate in demonstration exercises.

- Responding organizations shall respond using the outline for responses in the main body of the CFP.

Organizations should plan to send at least one technical representative to the Kickoff meeting. Dates for the Pilot events are provided in the Master Schedule (CFP Main Body)

2.3 Kickoff activities

On receipt of the responses, the AIP IP Team will review the responses, update the architecture and plan for the kickoff meeting.

All responding organizations should assume that their responses are accepted for participation in the Pilot unless they are notified otherwise.

The Pilot architecture, schedule, and development plan will be updated by the IP Team prior to the kickoff. The IP Team will work with the GEO Task Team and Initiative Sponsors to develop an agenda for the Kickoff Meeting.

One goal of the Pilot Kickoff meeting is to obtain consensus on the work plans for the Pilot by all stakeholders in the initiative.

The Kickoff meeting will address two development activities in the Pilot process: (1) component interface and protocol definitions, and (2) demonstration scenario development. The development activities will interact and affect each other, and the interaction will be iterative. During the Kickoff, both activities will be jump-started using the preliminary architecture and other assets that participants bring to pilot. Participants will be asked to volunteer to address any perceived shortfalls.

An additional product of the Kickoff meeting will be a development schedule that defines specific milestones. These milestones will include component-to-component interactions across the interfaces under development, and component insertion into demonstration scenarios. Among the milestones will be Technology Integration Experiments (TIEs). The TIEs will be conducted on a planned basis during the Execution Phase. Participants providing components shall participate in relevant TIEs.

At the Kickoff meeting, there will be technical breakouts to begin developing component interface solutions. The participants are expected to have systems and/or software engineers in attendance to assist in the initial assessment and interaction of the interfaces. This may include UML modeling of the interfaces. Use cases will be made available to the demonstration development team, and the interface definition team should incorporate in their own analysis use cases provided by the demonstration development team. As a way of validating the interfaces, they will be “exercised” against the demonstration scenarios.

Simultaneously, there will be technical breakouts at the Kickoff meeting to begin demonstration scenario design and creation. This activity will involve the development of use cases to explore the implications of the scenarios. These use cases should be made available to the interface development team, and demonstration developers should incorporate in their own analysis the use cases provided by the interface development team.

2.4 Execution

The completion of the Kickoff marks the beginning of the Execution phase of the initiative. Using the agreed upon work package as the governing documents for the conduct of the initiative, the stakeholders will begin the principal tasks of refining engineering specifications as needed, developing components, and testing those components. The key outcome of the pilot initiative will be persistent, operational exemplars and demonstrations of the exemplars.

To achieve the demonstrations, a series of design and testing activities will be needed. It is anticipated that TIEs will go through some number of iterations before the Components share information interoperably. A TIE is generally understood to minimally include a participant providing a client component and another participant providing a server component working in conjunction to test the implementation of a particular specification.

The primary goal of a pilot is to demonstrate the value of the interaction of a set of components that exercise a set of specifications in support of user defined scenarios. This capability will be instantiated in a persistent environment provided in part by the OGC Network. Therefore, participants will provide components and conduct TIEs to determine if these components can function in an interoperable environment. Typically there will be several "software builds" until interoperability in the environment is demonstrated via the TIEs.

If, during the course of Pilot Execution, modifications to existing open standards specification are found to be necessary, then a change proposal must be developed that documents the change. Change proposals not need be adopted during the pilot, rather it is intended to serve as documentation of both the change and the requirement that led to the change. The change proposal will be submitted to appropriate standards developing organization.

The design activities will be used by the participants to clearly demonstrate the capabilities of the components by exercising the scenarios. As a core requirement of the pilot effort, all demonstrations be made available via the Internet.

Participation in demonstration exercises is predicated upon full engagement with development, testing, and planning activities throughout the initiative.

To finalize the demonstrations, a Demonstration Event will be convened to conduct the final integration of the components and to refine the steps in the demonstrations. During the demonstration event, the demonstrations will be captured through techniques such as client screen capture software. The demonstrations will then be made available for distribution. The Date and location for the Demonstration Event is provided in the Master Schedule contained in the main body of the CFP.

2.5 Persistent operations and demonstration

Once the Execution phase is complete, the components and demonstrations developed during the Execution Phase will continue to be made available. This activity will result in configuration-controlled components that are considered stable enough to use in ongoing demonstrations. The components will be available for persistent operations and demonstration.

3 Roles in Pilot Initiative

The following roles are defined for the Pilot Initiative.

3.1 Participants

Participants are organizations that contribute to the definition of interfaces, prototypical implementations, scenario development and other support for an IP initiative. Participants are defined as organizations that have committed to contribute in a "substantial" amount. Participants are represented in an Initiative by business and technical representatives.

3.2 IP team

The Interoperability Program (IP) Team is an engineering and management team to oversee and coordinate an Interoperability Initiative. The IP Team facilitates architectural discussions, synopsizes technology threads, and supports the specification editorial process. The IP Team is comprised of OGC staff, representatives from organizations, and OGC consultants.

3.3 Observers

Observers are organizations that have been granted access to the initiative communication tools but are not contributing as participants. Observers are given full access to email lists, initiative web sites and regularly scheduled initiative wide teleconferences. Observers may make recommendations and comments to the participants via any of these fora. The Initiative Manager has the authority to table any comments, recommendations or other discussions raised by observers at any point without prior warning. Failure of an observer to comply may result in suspension of access.

4 Communications Plan

4.1 Distributed communication requirements

The communications plan supports development of the Initiative given the geographically distributed locations of the participants. Communication requirements include:

- The need to proactively and rapidly alert participants of events, deadlines, and decisions that affect them,
- The need to keep participants apprised of the status of all participants to ensure coordination and cross-communication,
- The need for participants to post items of interest, status reports, and software for distribution amongst the participants,
- The need for participants who are in remote locations to provide to IP Team or other participants with software for installation at various support sites, and
- The need for groups of participants to communicate/discuss and resolve ongoing definitional and development issues and related solutions.

The following sections describe communication to be used during the initiative

4.2 GEO Webex telecons

Telecons will be conducting using the combined webex and telecon facility provided by the GEO Secretariat. Details on the operations will be provided via the mailing lists.

4.3 AIP pages on OGC Network

OGC is providing a content management site for use by the AIP.

http://www.ogcnetwork.net/AIpilot

AIP Participants are encouraged to register for an account on OGC Network so as to contribute to the AIP pages.

Record of telecons and events of the AI Pilot are listed on OGC Network pages.

4.4 GEO task e-mail reflector

E-mail will be exchanged for the GEOSS Pilot using several e-mailing listservs. The AIP e-mail lists are summarized here:

http://www.ogcnetwork.net/AIPilotLists

4.5 GEO FTP site

The GEO FTP site allows uploading of documents as well as downloading them. The folder has its own account, which will allow those with the username/password combination to upload files

To set up ftp client (e.g. FileZilla) to the EXCHANGE folder:

host: ftp.wmo.int port: 21 login: normal

The username/password combination can be requested from:

- Osamu Ochiai, GEO Secretariat, oochiai@geosec.org
- Rik Baeyens, GEO Secretariat, HBaeyens@geosec.org
- George Percivall, Task AR-07-02 lead, gpercivall@opengeospatial.org

To download FileZilla:

http://filezilla-project.org/

5 Initiative Principles of Conduct

5.1 GEOSS references

The GEOSS approach to Governance is defined here:

http://www.earthobservations.org/about/about_GEO.html#governance

The GEO Rules of Procedure (GEO 0205-10) are available here

http://www.earthobservations.org/docs/GEO-II/GEO%200205-10%20GEO%20RULES%20OF%20PROCEDURE.pdf

5.2 Principles of Conduct

While non-binding, the following principles of conduct can support an effective pilot process:

1. Pilot participants extend respect and courtesy to their colleagues at all times.

Initiative participants come from diverse origins and backgrounds and are equipped with multiple capabilities and ideals. Regardless of these individual differences, participants treat their colleagues with respect as persons--especially when it is difficult to agree with them. Seeing from another's point of view is often revealing, even when it fails to be compelling.

English is the de facto language of the process, but it is not the native language of many process participants. Native English speakers attempt to speak clearly and a bit slowly and to limit the use of slang in order to accommodate the needs of all listeners.

2. Pilot participants develop and test ideas impartially, without finding fault with the colleague proposing the idea.

We dispute ideas by using reasoned argument, rather than through intimidation or ad homonym attack. Or, said in a somewhat more consensus-like way: "Reduce the heat and increase the light"

3. Pilot participants think globally, devising solutions that meet the needs of diverse technical and operational environments.

The goal of the initiative is to maintain and enhance a working, viable, scalable, global set of interfaces and protocols that provide a framework for interoperability in the geospatial domain. Many of the problems we encounter are genuinely very difficult. Participants use their best engineering judgment to find the best solution for the whole domain of geospatial interoperability, not just the best solution for any particular network, technology, vendor, or user.

Architecture Implementation Pilot (AIP)
Phase 2: IOC Augmentation

Call for Participation (CFP)
Annex B – Architecture

Version: 20080626

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TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

Foreword

The GEOSS Architecture in this Annex provides just an overview of the results of extensive development by hundreds of individuals from GEO Members and Participating Organizations.

The GEOSS AIP CFP Annex B was developed by the team listed here:

Name	**Organization**
George PERCIVALL, Editor	Open Geospatial Consortium (OGC)
Doug NEBERT, Co-editor	US FGDC
David ARCTUR	OGC and OGCii
Yuqi BAI	George Mason University
Steven BROWDY	IEEE and OMS Tech, Inc.
Petya Entcheva CAMPBELL	CEOS and NASA GSFC
Herve´ CAUMONT	ERDAS
Stephan FALKE	Northrop Grumman
Rudy HUSAR	Washington University, St. Louis
Terry KEATING	US EPA
Siri Jodh Singh KHALSA	CIRES
Josh LIEBERMAN	Traverse Technologies, Inc. and OGC
David MCCABE	US EPA
Larry MCGOVERN	Northrop Grumman
Lionel MENARD	Ecole des Mines de Paris
Douglas MUCHONEY	GEO Secretariat
Guy SEQUIN	Canada
Ingo SIMONIS	Geospatial Research
Stephen UNGAR	CEOS and NASA GSFC (emeritus)
John WHITE	US EPA
Genong (Eugene) YU	George Mason University

Architecture Implementation Pilot, Phase 2: Call for Participation – Annex B – Architecture

1 Overview

1.1 Common Architecture and Standards

This Annex B defines the architecture as part of a Call for Participation (CFP) in the GEOSS Architecture Implementation Pilot (AIP). This annex was developed based upon preparation, execution, and documentation of a prior AIP phase in 2007. The architectural requirements were assembled from the GEOSS Ten-Year Implementation Plan and from the more detailed GEO Tasks that are undertaken by GEO Members and Participating Organizations. This technical architecture for GEOSS is expressed the viewpoints of the RM-ODP International Standard (See Section 1.2).

1.2 RM-ODP Viewpoints

The architecture artifact in this CFP was developed using RM-ODP: ISO/IEC10746, Information technology — Open Distributed Processing — Reference model. The RM-ODP standards are used in multiple geospatial and earth observation architectures, e.g., the ISO 19100 series of geographic information standards, and the OGC Reference Model. Following the RM-ODP process is also in line with the existing efforts of numerous Spatial Data Infrastructure (SDI) efforts that work towards providing geospatial services[i].

RM-ODP defines five viewpoints that are useful to separate the various concerns in developing an architecture. A summary of the RM-ODP Viewpoints is provided in ISO/IEC 19793, Information technology -- Open Distributed Processing -- Use of UML for ODP system specifications, describes a specification of the different ODP viewpoints of a system, using Unified Modeling Language (UML). The AIP CFP for Phase 2 includes the use of ISO/IEC 19793 for modeling the Enterprise Viewpoint. Other viewpoints in the CFP use UML but with less adherence to ISO/IEC 19793.

Table 1.

ISO/IEC 19793, Information technology -- Open Distributed Processing -- Use of UML for ODP system specifications, describes a specification of the different ODP viewpoints of a system, using Unified Modeling Language (UML). The AIP CFP for Phase 2 includes the use of ISO/IEC 19793 for modeling the Enterprise Viewpoint. Other viewpoints in the CFP use UML but with less adherence to ISO/IEC 19793.

Table 1 – RM-ODP Viewpoints

Viewpoint Name	Description of RM-ODP Viewpoint as used herein
Enterprise	Articulates a "business model" that should be understandable by all stakeholders; focuses on **purpose, scope, and policies**.
Information	Focuses on the **semantics** of the information and information processing performed, by describing the structure and content types of supporting data.
Computational	**Service-oriented** viewpoint that enables distribution through functional decomposition of the system into objects that interact at interfaces.
Engineering	Identification of **component types** to support distributed interaction between the components.
Technology	Identification of **component instances** as physical deployed technology solutions, including network descriptions.

A key point of coordination between the viewpoints regards types of components. Components identified in the Enterprise Viewpoint are those that reflect the community and the purpose of the system while specifying as little as possible about the implementation. Components in the Engineering Viewpoint reflect design decisions that have been made for optimal implementation. It is an activity of the AIP Phase 2 to refine our collective approach to the Enterprise Components and the Engineering Components and the traceability between the two. For clarity, the context should be stated, e.g., Enterprise Component or Engineering Component.

Additional considerations for cross-viewpoint consistency are:

- Viewpoints should not make mutually contradictory statements
- All roles, activities, and policies of the Enterprise Viewpoint are correctly reflected in other viewpoints.
- Computational view services are mapped into Engineering Components
- Computational interfaces correspond to engineering interfaces.
- Information View types correspond to information exchanged and/or addressed by engineering / computational interfaces.
- Basic engineering objects correspond to computational objects.

1.3 GEO Architecture Data and Committee References

Task Teams of the GEO Architecture and Data Committee (ADC) have developed several documents that support the goals of the AIP. The architecture incorporates – directly or by reference – the following ADC documents[ii]:

- A Process for Reaching GEOSS Interoperability Arrangements (Developed by Task Team AR-06-01)
- GEOSS Interoperability Strategic Guidance (Developed by Task Team AR-06-02).
- GEOSS Interoperability Tactical Guidance (Developed by Task Team AR-06-02)
- GEOSS Components Registration (Developed by Task Team AR-06-04)
- GEOSS Clearinghouse: Demonstration of Existing Capability, Statement of Work, proposed, developed by Eliot Christian as an action of the ADC.

Also included in this document is a set of definitions developed by the ADC.

1.4 New in AIP Phase 2

The results of the 2nd phase of the AIP will augment the Initial Operating Capability of the GEOSS Common Infrastructure (GCI), which was previously established by the 1st Phase of the AIP and other GEO Tasks, and was announced as of June 2nd asking GEO community to evaluate and register their component and services. The 1st Phase of the AIP focused on demonstrating GEO Portal and Clearinghouse solutions; The 2nd Phase will establish a broad set of “persistent operational, research and technical exemplars” services that support the GEOSS Societal Benefit Areas (SBAs) using a consistent architecture.

- Support GEOSS Common Infrastructure (GCI) IOC evaluation Process
- Augment GCI beyond IOC baseline, for example, increase the number of services that are discoverable in GCI and can be invoked for useful functions.
- Focus on four SBA Communities of Interest identified in coordination with the GEOSS User Interface Committee.
- Emphasize Enterprise Modeling of the SBAs in accordance with to ISO/IEC 19793, Use of UML for ODP system specifications,
- Address distributed search across heterogeneous community catalogues
- Develop common core metadata for EO resources
- Portals and application clients access services based upon registry search results.
- Add Sensor Web to the AIP architecture for observations information types and sensors services
- Introduce calibration and validation of EO data as defined by CEOSS WGCV
- Begin development of community-agreed application schemas for EO products
- Increase the role of event handling, e.g., CAP alerts
- Emphasize operational persistence with emphasis on availability of services;
- Initiate a distributed Test Facility in support of the service registration process.
- Build on work done in the 1st Phase of AIP and other GEO Tasks.
- AIP results to be contributed to the GEOSS Best Practices Registry

2 Enterprise Viewpoint – Value of Earth Observations

2.1 GEO community objective

The enterprise viewpoint focuses on the purpose, scope and policies for that system and its environment. It describes the business requirements and how to meet them, without regard to system considerations such as the details of its software architecture, computational processes or the technology to be used to implement the system.

The other viewpoints of this architecture provide the detailed technology, components and interactions that collectively support the GEO community objectives as an emergent behavior of the systems of systems.

As a "system of systems", GEOSS is composed of contributed Earth Observation systems, ranging from primary data collection systems to systems concerned with the creation and distribution of information products. Although all GEOSS systems continue to operate within their own mandates, GEOSS systems can leverage each other so that the overall GEOSS becomes much more than the sum of its component systems. This synergy develops as each contributor supports common arrangements designed to make shared observations and products more accessible, comparable, and understandable.[iii]

For elaboration of the objectives of the GEO Community refer to the GEOSS 10 Year Plan; the GEOSS 10 Year Plan Reference Document; and to GEOSS Interoperability Strategic Guidance Document.

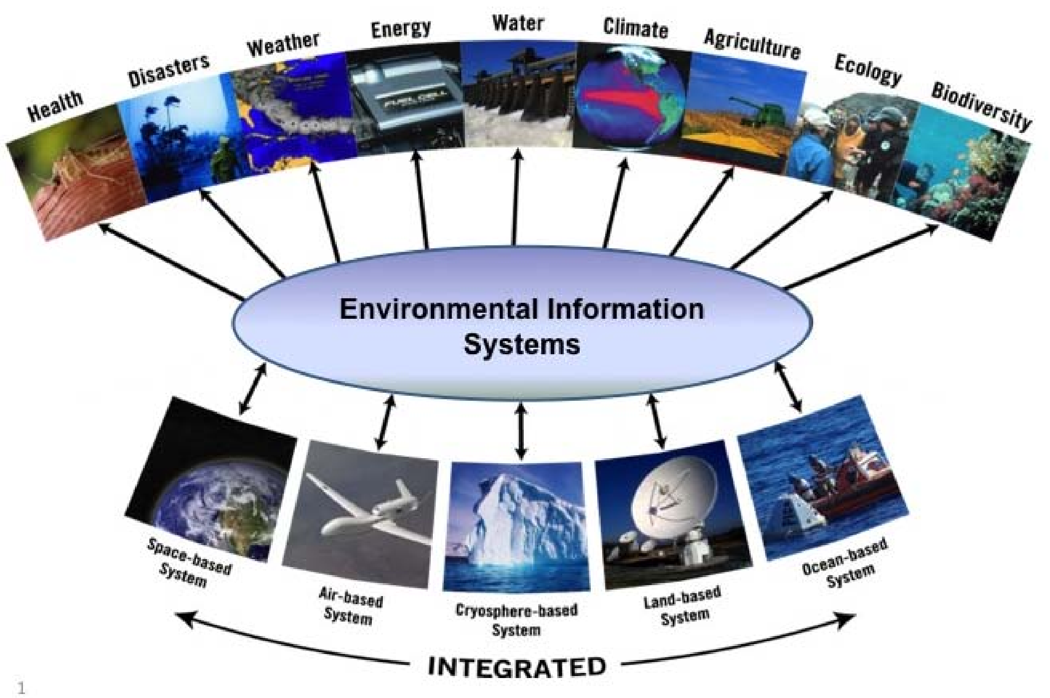


Figure 1 – A Global Earth Observation System of Systems GEOSS

2.2 Societal benefits

GEOSS will be primarily focused on issues of regional and global scale and on cross-sector applications, while also facilitating the operation and enhancement of Earth observing systems that are focused on national, local, and sector-specific needs. In this context, investments in Earth observations worldwide certainly exceed tens of billions of dollars per year. Those investments already yield substantial societal benefits, but those benefits will be increased through the collective actions enabled by GEOSS.[iv]

At present, GEOSS Implementation is concentrating on nine areas of societal benefits:

Reduction and Prevention of Disasters

Human Health and Epidemiology

Energy Management

Climate Change

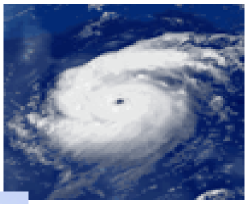
Water Management

Weather Forecasting

Ecosystems

Agriculture

Biodiversity



2.3 Data sharing principles

The GEOSS 10 Year Implementation Plan defines the GEOSS Data Sharing Principles:

> "There will be full and open exchange of data, metadata, and products shared within GEOSS, while recognizing relevant international instruments and national policies and legislation. All shared data, metadata, and products will be made available with minimum time delay and at minimum cost. All shared data, metadata, and products for use in education and research will be encouraged to be made available free of charge or at no more than the cost of reproduction."[v]

Since the 10 Year Plan was issued, a team of experts has worked on GEOSS Data Sharing Principles as GEO Task DA-06-01 under of the International Council for Science (ICSU). Over the past two years, the team has drafted a White Paper that provides an overview of international data sharing laws, principles, and policies and recommends a draft set of implementation guidelines for the GEOSS Data Sharing Principles as outlined in the GEOSS 10-Year Implementation Plan. It is foreseen to present the White Paper to the 5th GEO Plenary meeting in Beijing in November 2008 for discussion.

2.4 Interoperability arrangements

The success of GEOSS will depend on data and information providers accepting and implementing a set of interoperability arrangements, including technical specifications for collecting, processing, storing, and disseminating shared data, metadata, and products. GEOSS interoperability will be based on non-proprietary standards, with preference to formal international standards. Interoperability will be focused on interfaces, defining only how system components interface with each other and thereby minimizing any impact on affected systems other than where such affected systems have interfaces to the shared architecture.[vi]

At minimum, all GEOSS Components are bound by the requirements on contributed systems as stated in The GEOSS 10 Year Implementation Plan and its companion Reference Document. These stated requirements, referenced in GEOSS documents as "interoperability arrangements", are expected to be further expanded, clarified, or otherwise modified over time. Any new GEOSS Component is understood to be bound by the GEOSS interoperability arrangements as documented at the time it was contributed[vii].

Following are excerpts of interoperability requirements on contributed systems as stated in the GEOSS 10-Year Implementation Plan (Section 5.3 pg 7):

> The success of GEOSS will depend on data and information providers accepting and implementing a set of interoperability arrangements, including technical specifications for collecting, processing, storing, and disseminating shared data, metadata, and products. GEOSS interoperability will be based on non-proprietary standards, with preference to formal international standards. Interoperability will be focused on interfaces, defining only how system components interface with each other and thereby minimizing any impact on affected systems other than where such affected systems have interfaces to the shared architecture.
>
> For those observations and products contributed and shared, GEOSS implementation will facilitate their recording and storage in clearly defined formats, with metadata and quality indications to enable search, retrieval, and archiving as accessible data sets. [...]
>
> To enable implementation of the GEOSS architecture, GEOSS will draw on existing Spatial Data Infrastructure (SDI) components as institutional and technical precedents in areas such as geodetic reference frames, common geographic data, and standard protocols. GEO Members and Participating Organizations and their contributions will be catalogued in a publicly accessible, network-distributed clearinghouse maintained collectively under GEOSS. The catalogue will itself be subject to GEOSS interoperability specifications, including the standard search service and geospatial services.

The Process for Reaching GEOSS Interoperability Arrangements document defines the steps by which an interoperability arrangement is determined including the activities of the Standards and Interoperability Forum (SIF).

2.5 Enterprise components

The overall GEOSS is a federated system that grows ever more useful over time as its constituent GEO Members and Participating Organizations link their contributed GEOSS components together. The components already contributed by GEO Members and Participating Organizations can be grouped in the following broad categories:[viii]

- **Components to acquire observations:** based on existing local, national, regional and global systems to be augmented as required by new observing systems;
- **Components to process data into useful information:** recognizing the value of modeling, integration and assimilation techniques as input to the decision support systems required in response to societal needs; and
- **Components required to exchange and disseminate observational data and information:** including data management, access to data, and archiving of data and other resources.

Focusing on the data exchange and dissemination components, the types of components fall into the seven key component categories[ix]:

- Catalogues and registries aiding discovery
- Applications interfacing to the internet and providing the user experience to web clients
- Means for identifying and accounting for users, and where necessary authenticating and authorizing their use of services
- Means for actually accessing and extracting required data
- Means for generating portrayals of data, such as maps
- Means for performing geographic processing on data

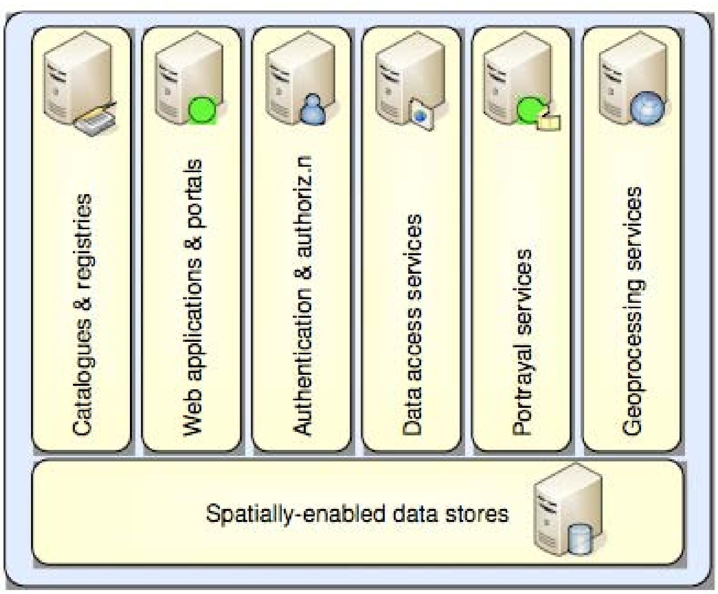


Figure 2 – GEOSS data exchange and dissemination services

A successful GEOSS architecture will reduce the clients' view of the current complex of inconsistent and disconnected set of services to one. This harmonisation will provide a consistent experience within which the user will be able to discover and access a variety of services offered by numerous disparate providers. At the same time the content and behaviour of these services will be predictable allowing the user to anticipate the results and use the services through a normal Internet connection. This idealized approach is represented as an "Internet bus" approach. [x].

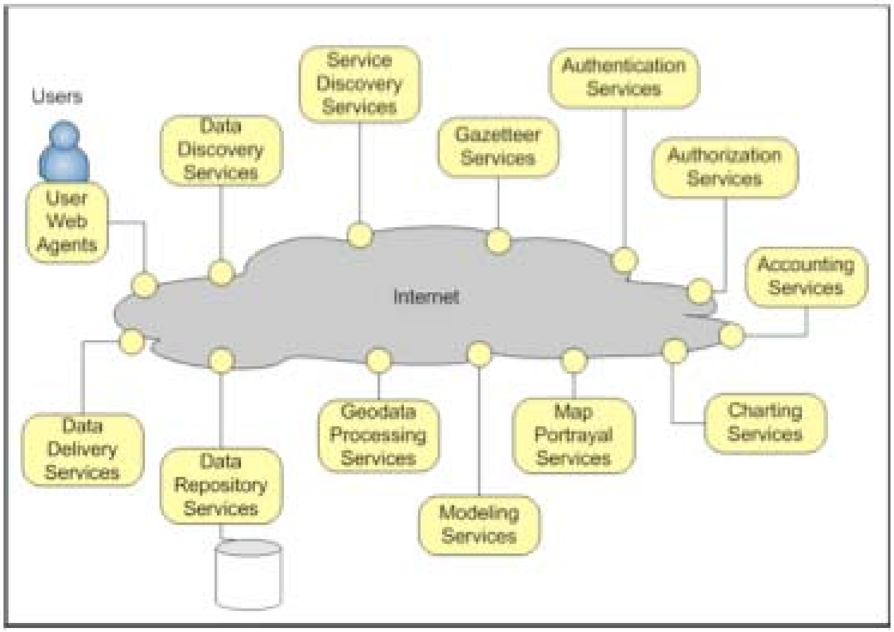


Figure 3 –The Internet Bus model

GEOSS Components may be designated at any time by any GEO Member or Participating Organization. These are in addition to those GEOSS components listed in the "Table of Initially Identified Systems" given as Annex 1 of the agreed GEOSS 10-Year Implementation Plan Reference Document. The procedure for designating additional contributed GEOSS components is defined in the GEOSS Components Registration document.[xi]

2.6 SBAs for the 2nd Phase of AIP

The SBAs in this section provide a narrative description of functionality to be supported by the 2nd Phase of AIP. The SBAs in the CFP have initially been developed, in close coordination with the User Interface Committee, relevant GEO Tasks, and Secretariat Experts. The SBA sections aim to be written from an end-users point of view, e.g., policy maker, decision-maker, researcher, etc.

An objective of the AI Pilot is to develop enterprise models capturing the components and interactions among the diverse set of users/actors. The enterprise model diagrams in each SBA focus on a subset of the overall scenario and represent a starting point that is expected to evolve based on the implementation of components and interoperability agreements among Pilot participants

2.6.1 Disaster Response SBA

2.6.1.1 Community

In recent decades, both the frequency and impact of great natural disasters has been increasing. Great disasters are those that overtax the ability of regional authorities to respond, requiring international assistance. The increase in the world's population, increased development in coastal areas and increased vulnerability of modern societies have all contributed to the greater impact of disasters, particularly hydrological events such as typhoons and hurricanes, which are the most frequent hazards and, after earthquakes, the most costly in terms of loss of life.

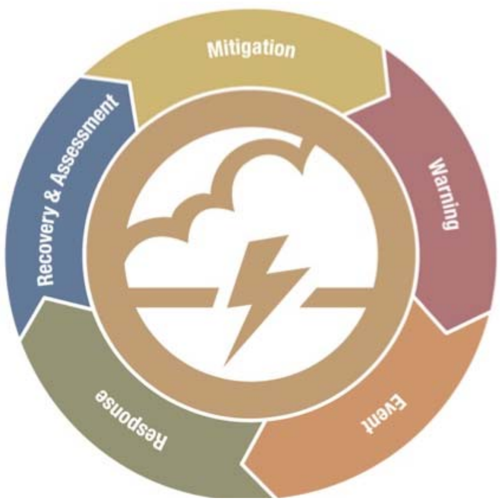


Figure 4 – Disaster Cycle

A cycle of activities pertaining to disasters and disaster response in general is shown in Figure 4. It is an objective of the GEO Tasks to use this cycle in the application of GEOSS to disaster response:

- For *Response*, broaden International Charter by inviting GEO Member states to designate authorized users; encourage new Charter membership
- For *Mitigation/Warning/Recovery*, use pilot project approach with selection of regional champions that can integrate satellite data; organize volunteer contributions on mission-by-mission basis; define global "baseline" imaging scenario

2.6.1.2 SBA Scenario

These scenarios aim to be user driven and use existing space assets with targeted acquisition programs to specifically address problems of concern. The scenarios will address the need of the following users.

1. The decision maker who needs to affect resources
2. Regional civil protection preparing to face a natural disaster or looking for information on a daily basis to react.
3. The public looking for information either to face the situation or to find out what can be done to help

Weather satellites have for many years made well-recognized contributions to disaster warning and prevention, particularly hydrological disasters. More recently, other Earth observation satellites are being used to improve the management of a broader range of natural disasters. This can be achieved through better assessment of risk before events take place, providing accurate warnings of where disasters will occur, assessing the situation of critical infrastructure after an event or supporting the recovery process long after the disaster is over. Dozens of Earth observation satellites orbit the world collecting imagery in the visible, near-infrared and even microwave spectrum. The images provide information about the effects of hazards derived from low and high-resolution data. The data from these satellites can be integrated into disaster warning systems to improve their utility, and may be used to generate maps and products that assist responders in determining the most affected areas and the status of infrastructure.

The GEO portal and clearinghouse aim to improve access to these unique data sets for disaster managers. GEOSS ensures that critical observations are sustained over the long term. In the context of GEO, member states are also examining how to ensure operational integration of data into disaster management decision support systems and develop capacity for improved use of satellite imagery.

Note that this scenario is consistent with GEO tasks DI-06-09 “Use of Satellites for Risk management”, DI-07-01 “Risk management for flood” and DI-06-13 “Implementation of a Wildland Fire Warning System at Global Level”.

To provide an example of Disaster Response the following sections focus on an Flooding example. This example is used for the CFP. Depending upon the response to the CFP, other disasters scenarios may become the focus of the 2nd Phase of AIP.

2.6.1.3 Enterprise Model

This section defines an Enterprise Model for a specific disaster scenario of flooding caused by a hurricane. The models defined in these sections are illustrative and will be developed further based upon responses to the CFP and throughout 2nd Phase of AIP.

The Flooding scenario context diagram in Figure 5 depicts the external interactions of external classes and actors to the GEOSS Class and all external inputs, outputs and ports.

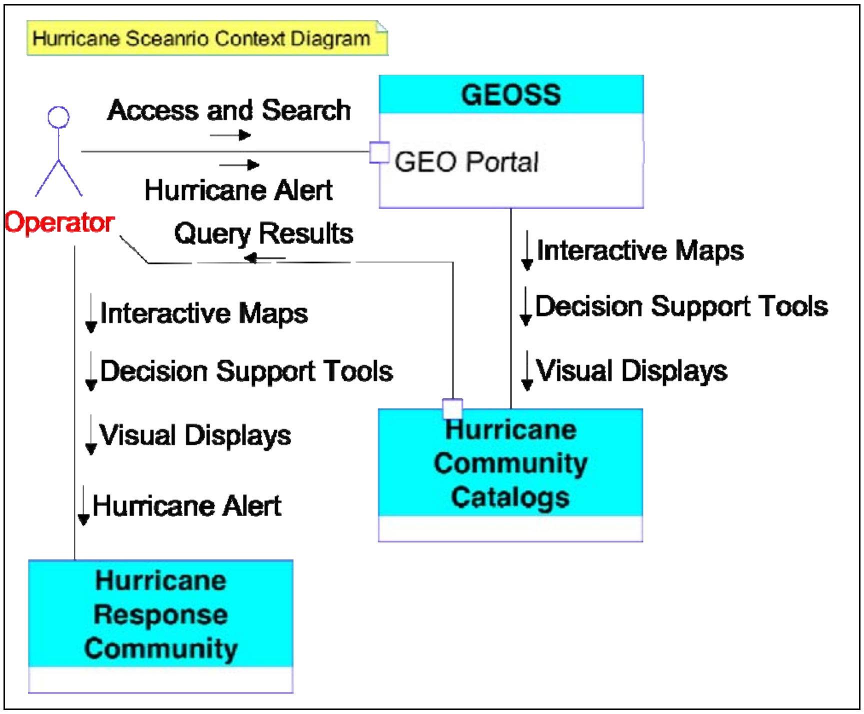


Figure 5 – Flooding Scenario Context Diagram

The Enterprise Specification (Figure 6) describes the properties that the environment of the ODP system must have for the specification to be used. A community is a collection of entities e.g. human beings, information processing systems, resources of various kinds, and collections of these. Community objects are included in the package names as Enterprise Global objects. Here the entities are whose scope is wider than the GEOSS itself.

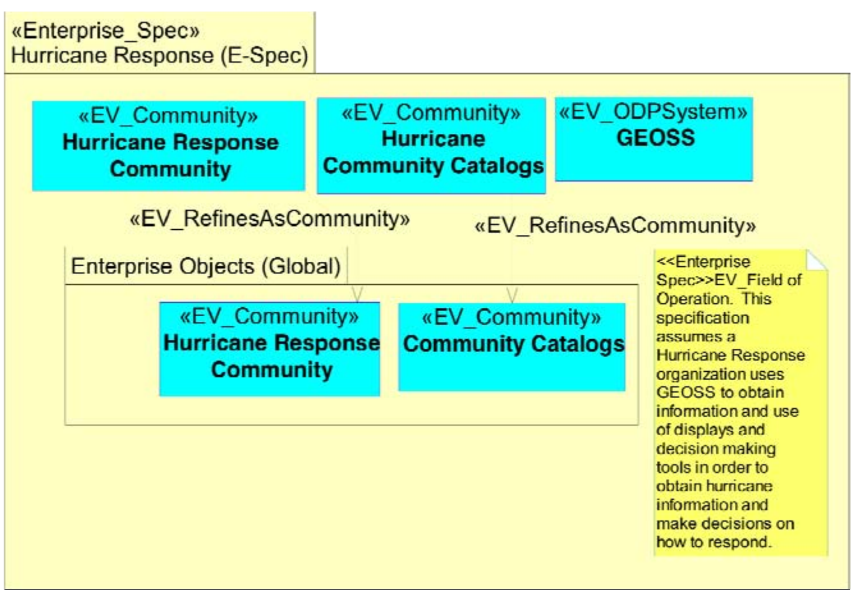


Figure 6 – Flooding Scenario Enterprise Specification

Figure 7 shows the processes of the Flooding Scenario.

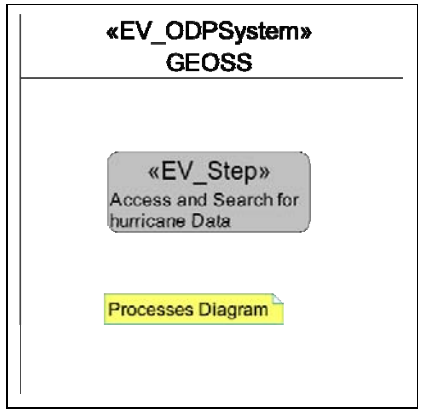


Figure 7 – Flooding Process Diagram

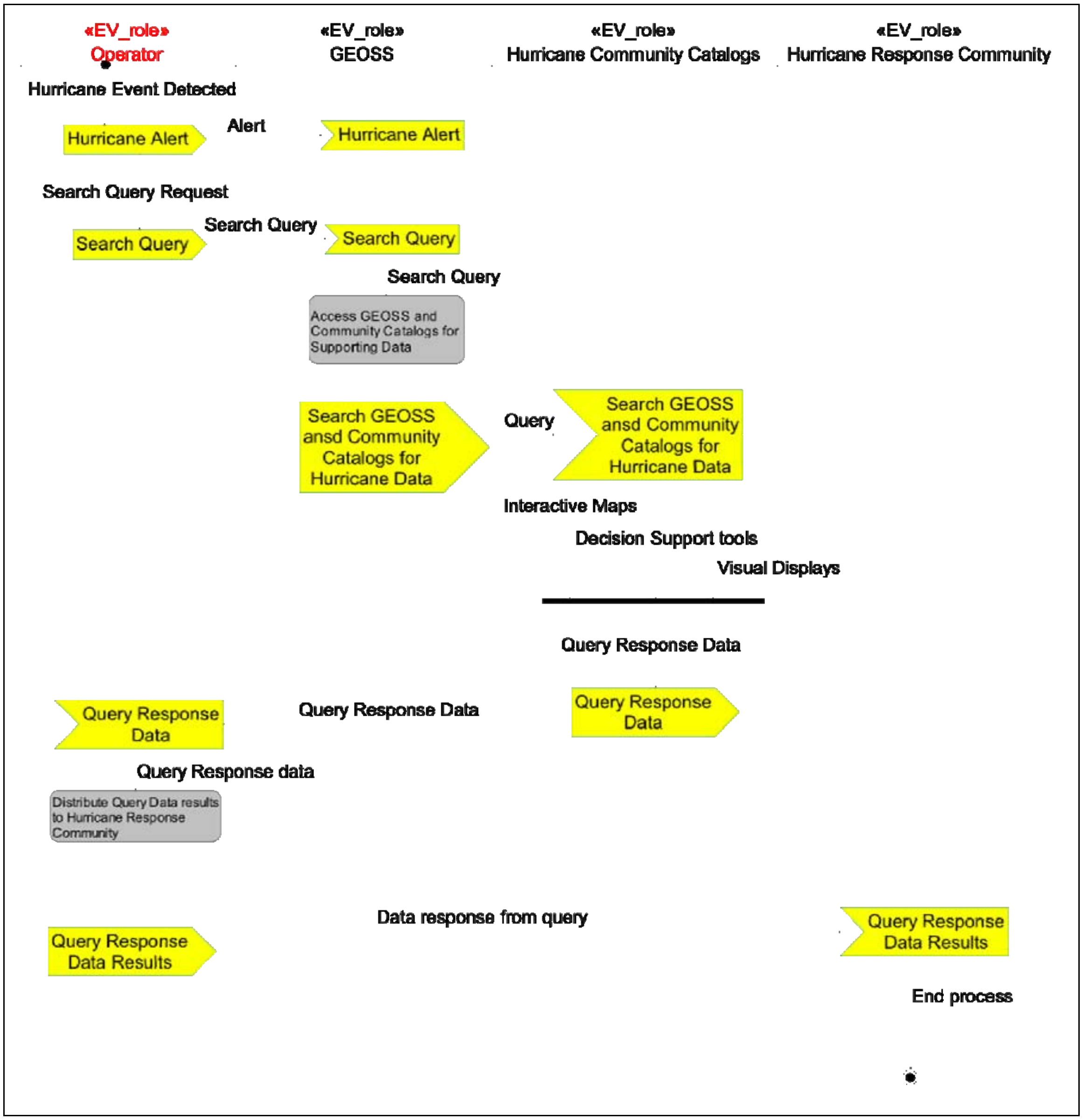


Figure 8 – Flooding Activity Diagram

2.6.2 Health SBA: Air Quality

2.6.2.1 Summary

The air quality scenario envisions GEOSS facilitating two broad goals: building connections to facilitate movement of data between actors, and developing interoperable tools for intercomparison and fusion of a wide variety of atmospheric data. Readers are referred to the full version of the scenario for more details:

http://wiki.esipfed.org/index.php/AIP_AQ_Unified_Scenario

The scenario is focused on three end users:

- A policy-maker, needing synthesized information on the importance of intercontinental pollutant transport
- An air quality manager, who needs to assess whether a regional pollution event was caused by an “exceptional event"
- The public, needing information about air quality now and in the near future to make activity decisions

While the scenario describes three distinct sets of end users, each depends upon common upstream actors and synthesized Earth observations. In fact, the common need for these synthesized atmospheric observations is a primary motivation for the structure of this scenario.

Given the wide variety of atmospheric processes at many scales, each of the above decisions needs an array of observations and models (listed below). Each type of data is significantly limited and not able to broadly document the state of the atmosphere. Synthetic fusion and intercomparison of the data will allow analysts to produce a far more complete and accurate description of the atmosphere than obtainable from any one type of data. There are a number of scientific approaches to this challenge, but technical tools for intercomparison, fusion, and processing of air quality data are not operationally available.

This scenario is consistent with GEO project HE-07-03: Integrated Atmospheric Pollution Monitoring, Modeling, and Forecasting in the GEO 2007-2009 Work Plan, and with the efforts of the CEOS Atmospheric Composition Constellation, the development of the GMES Atmospheric Service, and other major international collaboration efforts.

2.6.2.2 Context and pre-conditions

A number of actors process earth observations information upstream of the decision makers, who base their decisions on highly synthesized data. They are described in more detail in the full scenario.

Actors Processing and Using Data: Intercontinental Pollutant Transport Example

For illustration, a “value chain” of actors involved in the Intercontinental Pollutant Transport events is listed here; similar chains for the other events are described in the full scenario.

- End use decision maker: Policy maker negotiating an agreement on intercontinental pollutant transport
  - Information needed: Synthetic assessment reports quantifying the impact of long-range pollutant transport
- Upstream information processor: Scientific advisory group
  - Information needed: Technical assessments of model experiments and synthesized datasets to assess transport

- Upstream information processor: Scientific task force assessing long-range transport
    - Information needed: Synthetic description of the atmosphere, using multiple observations and models
- Upstream information processor: Air quality data analysts
    - Information needed: Wide variety of atmospheric observations, *synthetic integrations of this data*

Other Actors: Earth Observations Providers

The earth observations required are generally needed for each set of scenario events.

- Government agencies (National, State/Provincial/Tribal, and/or Local):
    - Environmental, Meteorological, Land management, Space agencies
- Industry, Consultants
- Academic and Other Research Institutes
- International cooperative fora (e.g. WMO, CEOS, EEA)

Information Already Available for Scenario Events

- Meteorological data, such as observations from ground-based networks, satellites, radiosondes, and forecasts from numerical models at various scales
- Geographical data (land use, demographics, emissions-related activity, etc.)
- Atmospheric composition (air quality) observations such as surface monitoring networks, satellite observations, radiosondes, ground-based remote sensors, and aircraft measurements
- Numerical air quality chemical transport models (at regional to global scales)

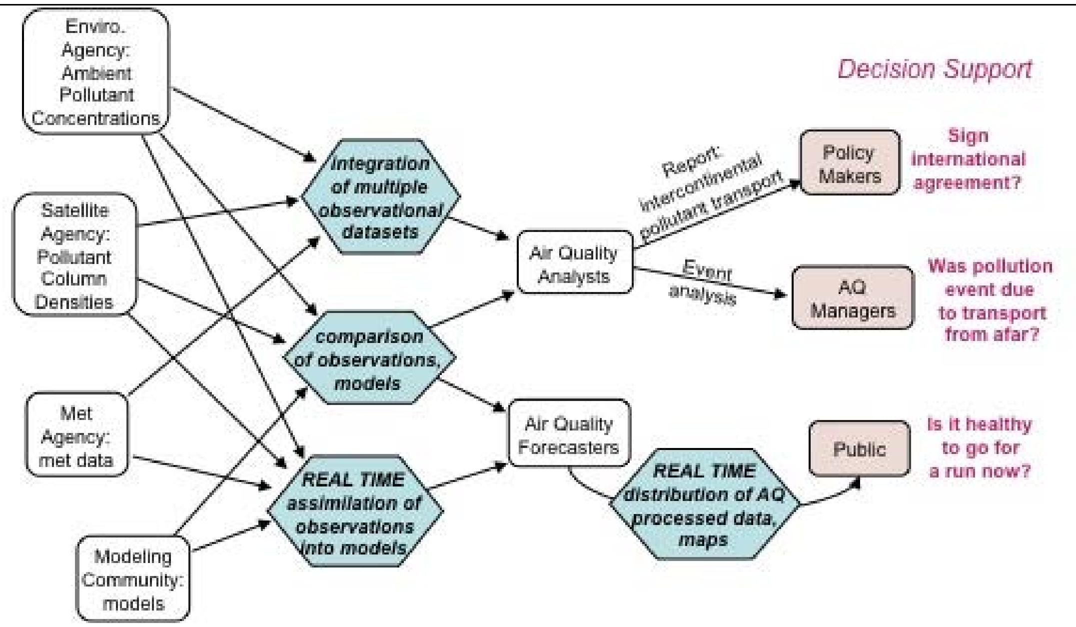
Specific processing and collaboration functionality needed

- Community Catalog(s) for registering data and services to be harvested by the GEOSS Clearinghouse
- Community Portal(s) for finding, accessing the data and services needed for the execution of the scenario,
- Functionality for standard-based access to spatio-temporal data and metadata, and workflow software for service orchestration
- Community of Practice Workspace(s) where the actors in the scenario can communicate and coordinate their activities.

Additional functionality and facilities specific to the Air Quality Scenario should include tools for visualizing, and processing observational and modeling data for near real time and for historical analysis. These tools should facilitate:

- Integration of multiple observational data sets to create rich n-dimensional descriptions of the atmosphere to improve understanding of atmospheric processes;

- Comparison of observational data to numerical model estimates to improve numerical model descriptions of historical conditions (events or long-term trends);
- Real-time assimilation of observational data into numerical models to improve numerical forecasts;
- Effective mechanisms for distributing (in near real time) maps/images, descriptive information, and processed data to health, emergency response, and air quality management authorities; to mass media; other research and assessment communities (e.g., health); and the general public.



An illustration of the information processing chain described in the Air Quality Scenario. GEOSS Core functionality (catalogs, portals, standards) allow analysts ready low barrier access to the required input data. The additional functionality described in the scenario is shown in blue hexagons.

Figure 9 – Value Chain of the Air Quality Scenario

2.6.2.3 Scenario Events

The cyberinfrastructure envisioned by this scenario will enable analysts to combine wide range of air quality observations, models, and other information, which will ultimately be used to produce a broad range of decision support products for a number of different audiences. Current projects (see full version of the scenario) are significant building blocks along with the evolving data mediators of the needed networks and tools.

Assessment of International and Intercontinental Transport of Air Pollution

Assessment of this phenomenon is currently underway by several bodies. GEOSS can assist these efforts by constructing linkages between the various databases and other existing air quality-related data hubs and by developing and linking tools to facilitate comparison of models, observations, and emissions data.

These capabilities are used to form a more complete and accurate description of the atmosphere than currently available from any one type of atmospheric observation. Researchers will use these datasets and models to quantitatively assess the importance of long-range pollutant transport. Research efforts will then be compiled into a detailed report of the task force. This report is then used as the basis for an synthesis report and executive summary which will finally be delivered to policymakers to inform their decision making process, as international conventions consider initiatives to address long range pollutant transport.

The connectivity and tools developed as part of this effort will be applicable to model evaluation and analysis at the regional scale as well, ultimately benefiting a large community of air quality managers and researchers.

Exceptional Event Analysis

Air quality is periodically influenced by natural and anthropogenic events, such as wildfires and dust storms. For regulatory purposes in several countries, pollution episodes can be flagged as 'exceptional events' if an area would not have exceeded the pollution standard without the occurrence of an uncontrollable and unusual natural or anthropogenic event.

An event might be obvious or subtle, so the impetus to examine a given event could come air quality managers or the wider community. Analysts at air management agencies or elsewhere would use models and ambient and satellite observations to identify potential events. Once an event is proposed, relevant data is compiled from those data sources to explore the origin and evolution of the pollution, with data and developing analysis shared in a virtual workspace. Synthesizing data from the various sources, analysts quantify the effect of the event on the receptor regions, and then compile this information into a report submitted to air quality managers.

Providing Near Real-Time Air Quality Reports and Forecasts to the Public

Real-time and forecasted air quality information plays a very important role in informing the public about potentially harmful conditions. This information allows individuals to take precautionary measures to avoid or limit their exposure to predicted unhealthy levels of air quality. Information is needed in a central, accessible, and understandable format. While air quality report and forecast systems exist in many countries, they depend on ambient monitors. Such an approach does not utilize many types of Earth observations, and will be less fruitful in many parts of the world due to geography and the expense of a network of real-time monitors.

These systems depend on continuous air quality and metrological monitoring network, including data and information from other jurisdictions (other regions or nations). Capabilities for fast assimilation of satellite observations and products are needed. These observations must be automatically ingested, formatted, and processed (for example, quality assurance) into a database. Forecasts and reporting are produced from the integration of these datasets. Current conditions and forecasts are then disseminated to give the public high spatial and temporal information about the location and duration of unhealthy air. Information is tailored, in some cases, to particular audiences such as emergency managers and health providers.

The continuous monitoring and high frequency reporting, distribution, and forecasting in this scenario event facilitate frequent evaluation of the entire system. Insights from these checks will not only improve forecasting techniques, but are also useful for improving understanding of the input data and models.

2.6.2.4 Enterprise Model

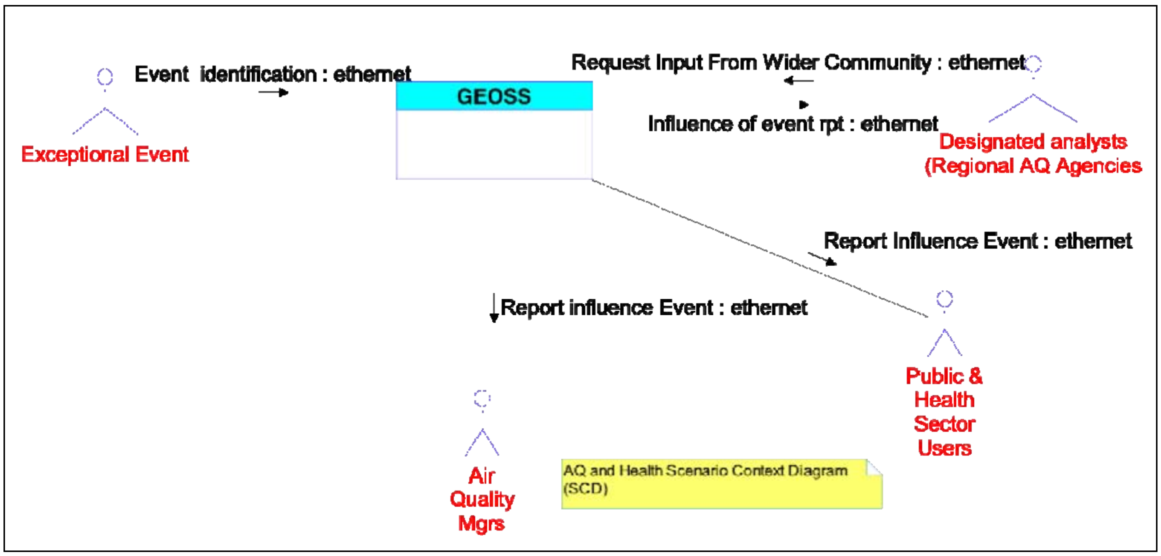


Figure 10 – Air Quality Scenario Context Diagram – Draft

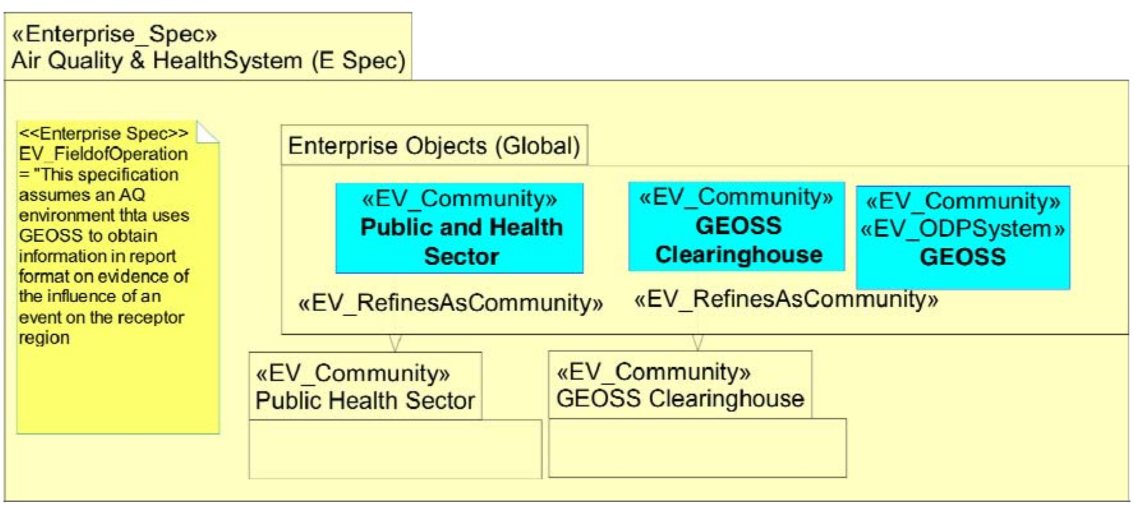


Figure 11 – Air Quality Scenario Enterprise Specification – Draft

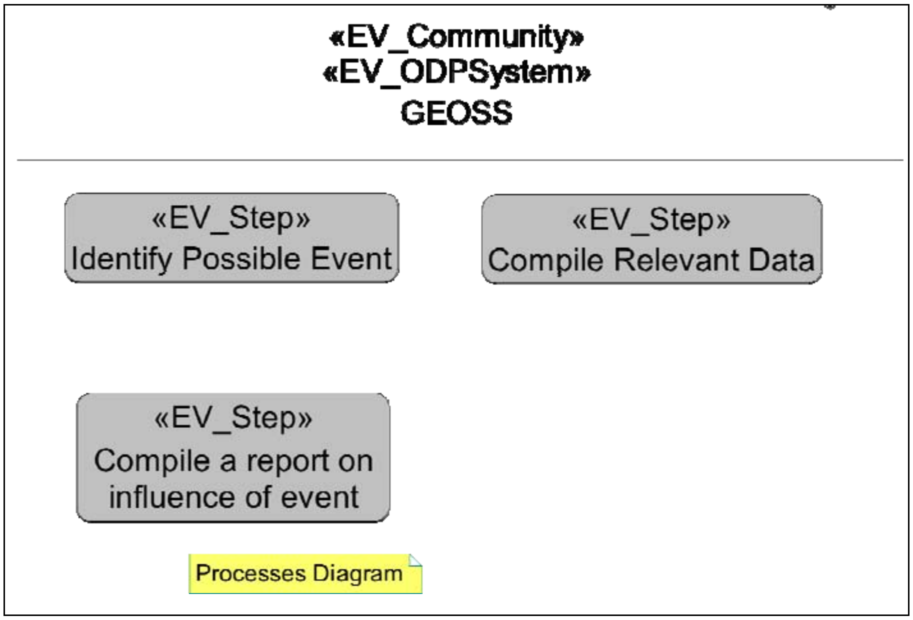


Figure 12 – Air Quality Scenario Process Diagram

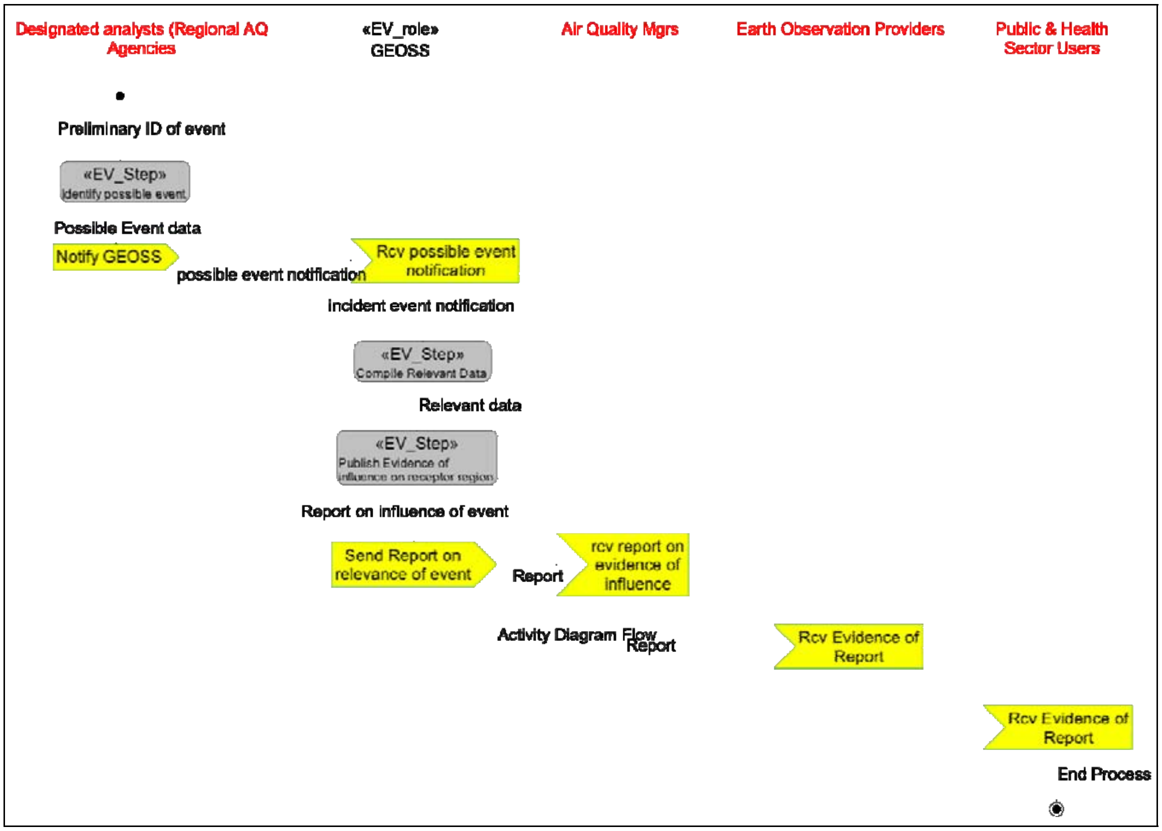


Figure 13 – Air Quality Event Activity Diagram

2.6.3 Biodiversity SBA: Protected Areas

2.6.3.1 Summary of the scenario and the community supported

Protected Areas (PAs) and Protected Area Systems are designed to conserve natural and cultural resources, to maintain biodiversity (ecosystems, species and genes) and ecosystem services. This scenario will aid protected area system designers and protected area managers to understand the representativeness of the system or PA, and to quantify its status, trends and threats. The scenario will make use of a species distribution modelling component whereby a variety of geospatial data is integrated with species presence/absence and/or abundance data and processed using one or more modelling algorithms to predict species distribution.

Specific decisions to be made:

1. Determine what data are available for any protected area (discovery).
2. Determine how to access data and tools.
3. Determine if the PA boundary is valid (correctly delineated) and update the boundary as necessary.
4. Determine if the national, regional, continental and global protected areas system is adequate for capturing the representatives of ecosystems, species and genes,

especially for endemic, keystone and threatened and endangered species. This is, in effect, a protected areas gap analysis.

5. Determine the effectiveness of protected area systems and individual protected areas.
6. Determine the System and PA effectiveness related to climate and land use change.

References for additional information

- IP3 Biodiversity and Climate Change Demonstration project (http://www.earthobservations.org/documents/the_full_picture.pdf; Predicting the impact of climate change on biodiversity - a GEOSS scenario; pp. 262-264)
- European Commission Joint Research Centre project (http://www-tem.jrc.it/PA/intro.html.), Evaluating Protected Areas in Africa.

2.6.3.2 Context and pre-conditions

The actors in the scenario include:

- Protected Area managers
- National park agencies
- International protected area institutions (UNESCO, UNEP-WCMC, The Nature Conservancy, IABIN, Ramsar)

The specific information assumed to be available before the scenario begins is:

- Time series climate data
- Time series phenology data
- Multi-date land cover data
- Transportation data
- Protected areas data (WDPA and other)
- Human population data
- Primary species occurrence data (IUCN Red List, GBIF)

The specific processing and collaboration functionality assumed needed in the scenario

1. **Data Discovery**: Data awareness is a limiting factor. Inventory and discovery of datasets should be mediated via a distributed metadata catalogue system. Data discovery should be integrated into applications, with the discovery process transparent to users.
2. **Data Bundles**: Datasets should be grouped into thematic “data bundles” based on user profiles and other filters to make relevant data directly discoverable by PA

managers and researchers. This service would be usable, not only for the GEOSS Societal Benefit Area (SBA) of Biodiversity, but also others, including natural and human-induced disasters, environment and health, energy, climate change, ecosystems, agriculture and desertification.

Automated catalogue update service: Currently, PA managers, and researchers, must spend an inordinate amount of time searching various sites for available data. Cataloguing data, even if data itself is not digitised, is important as well. This service would, for each PA in the World Database on Protected Areas (WDPA), automatically generate a catalogue of available data on a regular basis (10-30 day intervals). A client would provide basic mapping/visualisation functionality, e.g., listing an auto-updated set of layers that can be displayed/overlaid.

Note: No/null data are important to indicate where data gaps exist, especially the lack of a PA boundary.

3. **Data Access**: Data should be made accessible via a range of web services, e.g., OGC web services.
4. **Applications**: Data catalogue searches should be integrated within applications (e.g. a web-enabled community). The scenario would couple the IP3 species modelling activity with the JRC Africa Protected Areas analysis, allowing users to conduct JRC-like analyses for their region, nation or specific protected area. The scenario thus builds upon previous investment, promotes continuity of analysis, provides modelling capability and expands geographic scope and usership. Components include:
    a. A transactional web feature service to support community data entry of, e.g., Protected Area boundaries and threats.
    b. A tool based on the functionality of the JRC Protected Areas web site (http://www-tem.jrc.it/PA/intro.html), to perform the same analysis for any of the 110,000 protected areas.
    c. Provision of the Rapid Land Cover Mapper (RLCM; http://edcintl.cr.usgs.gov/rlcm/) as a service to PA managers to develop vegetation and land cover maps based on selected data bundles.
    d. A tool for online change detection of multi-temporal image data (e.g. image differencing, PCA etc).
    e. A tool for stratifying sampling (systematic and stratified).
    f. A generic Exploratory Data Analysis Tool

       Functionality:

       1. Assemble and / or link to geospatial data

       2. A stock set of analytical and reporting units: country, watershed, ecosystem, protected area boundaries

       3. Flexible analytical and reporting units (per country, PA, species, etc.)

5. **Modelling**: Modelling is an adjunct to expert opinion, informing experts on the distribution and status of species, populations and ecosystems, and their impact/sensitivity to climate change and other threats.
    a. Ecological niche modelling, as demonstrated in the IP3 pilot is an effective tool for predicting species distribution and changes in those distributions

under climate change scenarios. This User Scenario would include a species modelling package whereby one could assimilate geospatial data, overlay with species presence/ absence and or abundance data, and choose from a set of models to predict distribution.

2.6.3.3 Scenario Events

Table 2 – Biodiversity Decision Scenario

Step	Description
0	Reduce uncertainty in species distribution using niche modeling; decide on species or taxon group and check for availability of datasets and services; decide on geospatial/environmental parameters to be used and check for available services; locate modeling service and download required datasets; run model using various algorithms; output report, maps, etc. for decision makers.
1.	Determine the effectiveness of a protected areas system and individual PAs in protecting species
2.	Conduct PA assessment using indicators (status, vulnerabilities, threats) developed by JRC
3.	Evaluate effectiveness of system and PA(s) in climate and land use change scenarios.
4.	Conduct a gap analyses and make decisions to revise the system and or individual PAs; gap analysis should include primary species occurrence data and could be used to alert potential data providers to make hitherto undigitised datasets available.

2.6.3.4 Enterprise Model

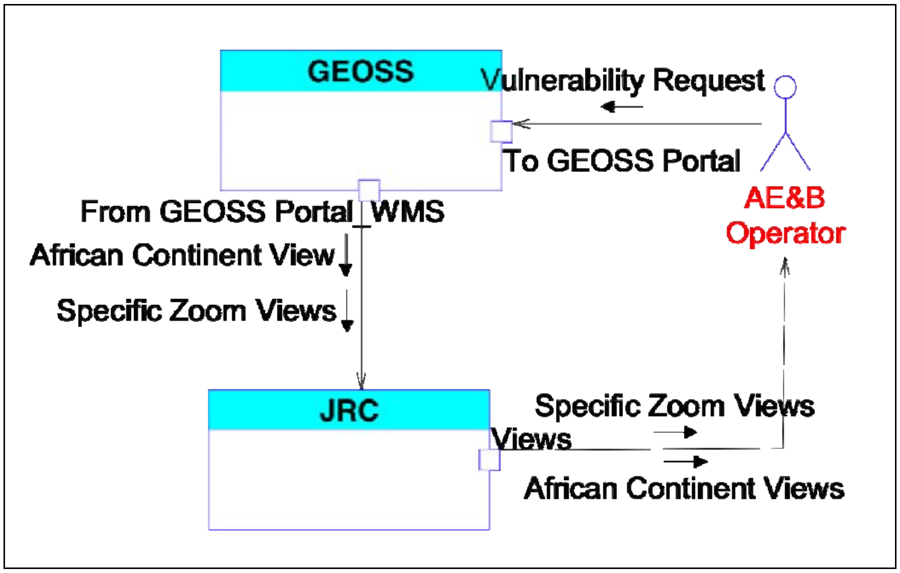


Figure 14 – Biodiversity Context Diagram

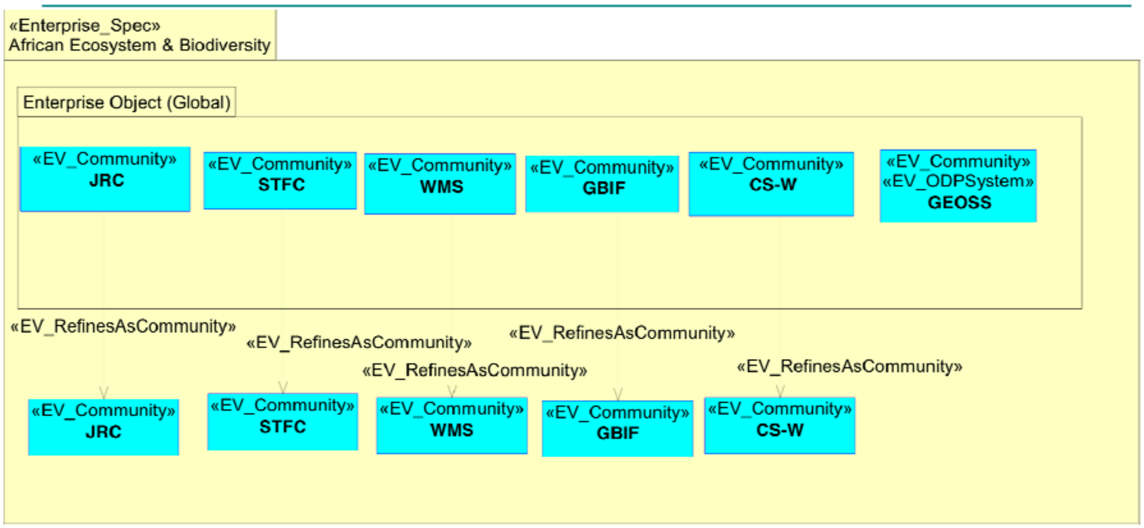


Figure 15 – Biodiversity Enterprise Diagram

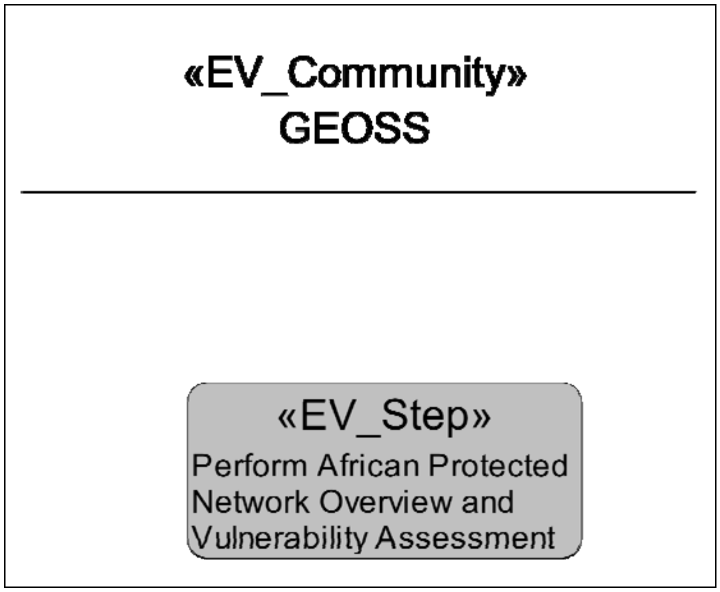


Figure 16 – Biodiversity Process Diagram

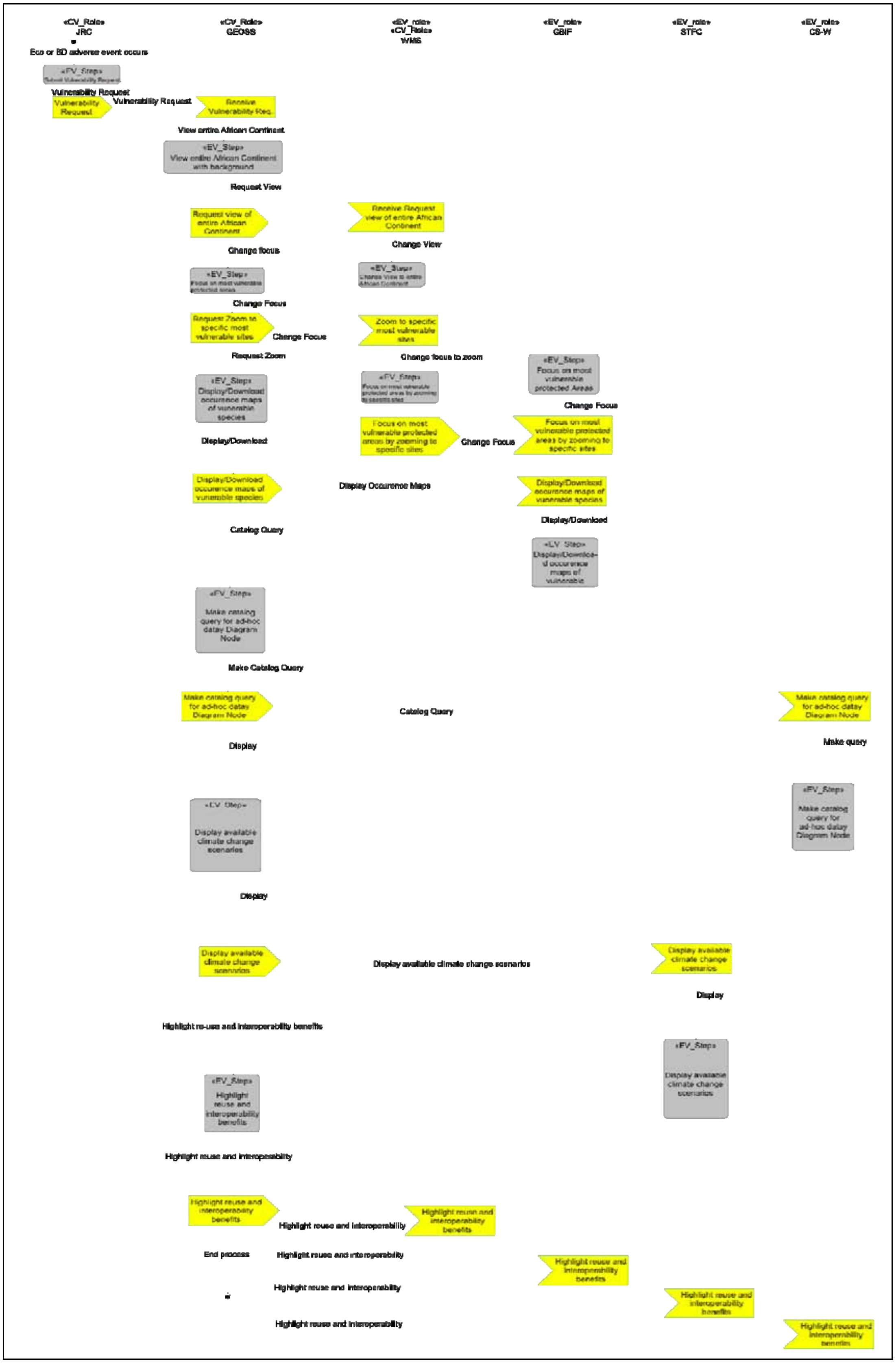


Figure 17 – Biodiversity Activity Diagram

2.6.4 Energy SBA: Electricity - Renewable Energy Production

2.6.4.1 Community Objectives

Renewable energy sources (RES) such as solar and wind energy offer a large untapped potential for electricity production The exploitation of these energies requires accurate knowledge of the resources and of their availability (in space and time) as well as accurate forecasts in the different phases of an energy system life cycle**.** For instance, the site selection process for development of large solar systems, such as photovoltaic (PV) on open land, require data on time-averaged values of solar irradiance from which basic economic assessments of a plant concept can be made. Accurate, easy accessible and affordable wind information is needed at different levels of detail before deciding the sitting of a wind park as well as during the life- cycle of a wind farm. An error of a few percent in wind resource evaluation may drastically affect the profitability of an offshore wind park.[1]

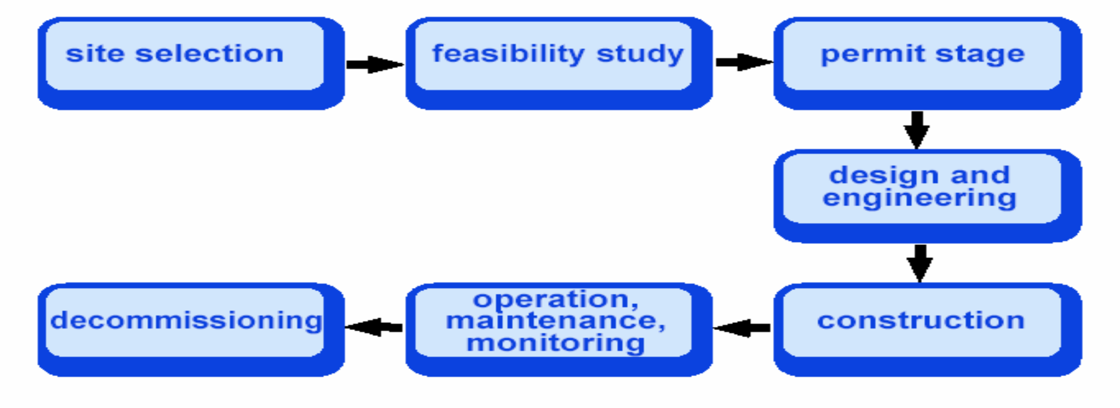


Figure 18 – Life-cycle of an energy system

To better harness renewable energy sources, consultants need an easy and unified access to data sets. Such data sets include meteorological, geographical and environmental parameters.

The proposal intends to develop the exploitation of Earth observation data in this context, to set-up a series of Web Services that implement key features in Earth observation data exploitation and to illustrate their use through a complex application in the sitting of a solar power plant. In general, the scenario builds on GEOSS facilities to achieve connections to facilitate movement of data, applications and information between actors and development of interoperable tools towards persistent exploitation.

2.6.4.1.1 Targeted end user:

- Investors and electricity producers, needing high level integrated information reports for decision making

[1]According to studies funded by ESA and the Energy Community of Practices of the GEOSS initiative, meteorological data are mandatory for each step of energy system life-cycle. Other types of data are also needed depending on the step.

- Consulting companies, needing an easy and unified access to various data sets to design and sit the power plant
- Researchers, needing large and various data sets to benchmark and improve assessment methodologies, improve uncertainties measurements providing guidance and best practices to the community
- Policy makers, needing high level integrated information reports for planning and shaping emergent technologies use involving renewable energy.

2.6.4.1.2 Links with other activities

Effort for providing integrated information in renewable energy within the GEOSS framework will benefit to other communities where this information is needed in various areas:

- Health: provide accurate data about solar radiation to fight skin cancer (melanoma);
- Biodiversity: photosynthesis process that power the ecosystem is driven by solar radiation. This parameter is therefore of high interest to biodiversity researchers;
- Environmental impact of energy use: several recent projects aim at assessing the current and future impact of the exploitation of energy resources on the environment and ecosystems. Among other data solar radiation and wind power resource assessment are key factors.

All those activities will provide downstream test cases for the planned GMES (Global Monitoring for Environment and Security) core service on atmosphere composition and climate (MACC), which will have a component related to solar energy.

2.6.4.1.3 Context and pre-conditions

To allow a final decision from investor and electricity producer a large number of actors handle, process and shape earth observation data. From the most aggregated form of product to the fine grained data set the list of actors in the process chain is listed below.

2.6.4.1.4 Actors:

- *Investors and electricity producers*: Taking final decision to bank the project
  - Information needed: Synthetic assessment report on sites selection
- *Consulting companies*: Performing the complete studies from technical, environmental, economical and policy respect point of views
  - Information needed: Energy, geographical and environmental related data sets in a standard format allowing easy access and integration
- *Energy Community Portal integrator*: Providing the high end applications needed by the consulting companies
  - Information needed: Description and localization of the various data sets and interoperable services, including specific applications, in a GEOSS compliant format
- *Providers of specific applications*: Develop and deploy persistent applications needed for the scenario

    - Information needed: Access to energy, geographical and environmental GEOSS catalog to build interoperable applications
- *Data providers*: Provide GEOSS compliant raw or transformed earth application data needed for the scenario
    - Information needed: Wide variety of earth observation data

2.6.4.1.5 Information available before scenario begins

- Meteorological data
    - Time-series of irradiance: daily values
    - Time-series of wind speeds and directions: 3-hourly values or better
    - Time-series of air temperature: 3-hourly values or better
    - Sun position every three minutes over a year
- Geographical data
    - Digital Terrain Model (DTM)
        - ASTER (Advanced Spaceborne Thermal Emission and Reflectance Radiometer)
        - SRTM (Shuttle Radar Topography Mission)
    - Hydrological features
    - Gazetteer and locations: built-up areas
    - Land use
- Environmental data
    - Protected areas
    - Maps of risks and hazards

2.6.4.2 Specific scenario: sitting of a solar power plant

The proposed scenario is general and applies to all steps of the life-cycle of an energy-production system. For the purpose of the demonstration, an instantiation of the general scenario is proposed and deals with a complex application in the sitting of a solar power plant. This instantiation has been selected partly because it involves a large number of actors and partly because it calls upon several data sets that are available in other areas (cross-SBA aspect).

2.6.4.2.1 Specific processing

- Preparing integrating archives of energy-related data, that includes meteorological and climate parameters for a limited number of sites and also policy-relevant data (energy consumption, consumer-product data etc.)
- Assessment of irradiance on inclined surface
- Slope and exposition of the terrain
- Shadowing due to terrain

The developed applications will be Web Services compliant with GEOSS and W3C standards that could be invoked as such through the GEOSS portal.

This interoperable approach will permit their re-use in other contexts and other domains (health, agriculture, biodiversity…) and will ensure their persistence. Intellectual

Properties Rights (IPR) will be dealt with, taking into account the GEOSS document on Data Sharing Principles.

2.6.4.2.2 Graphical User Interface (GUI) development and GEOSS portal integration

Additional development should be made in order to provide specific visualization and processing for the Energy Scenario. This includes:

- Capacity of exploiting energy developed application provided as Web services
- Building graphical tool for visualizing and processing the energy scenario
- Ease the integration of multiple earth observation dataset

2.6.4.3 Enterprise Model

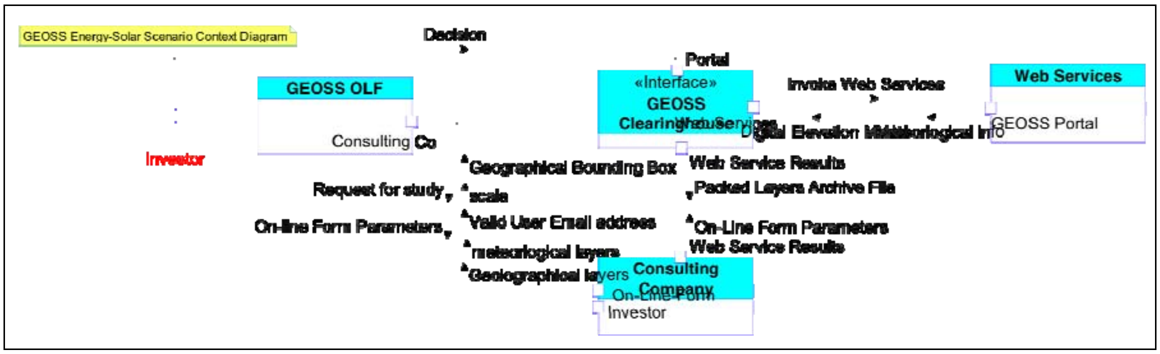


Figure 19 – Energy Context Diagram

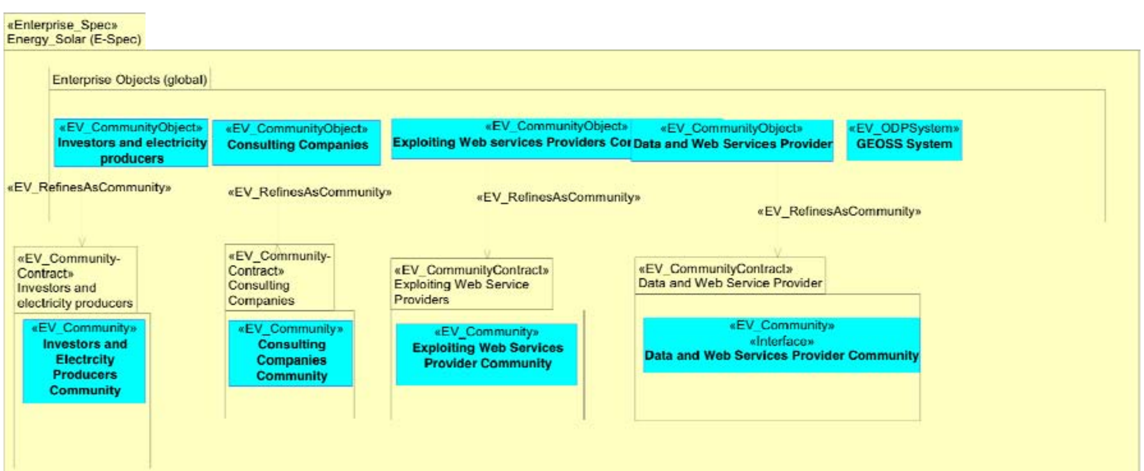


Figure 20 – Energy Community Enterprise Specification

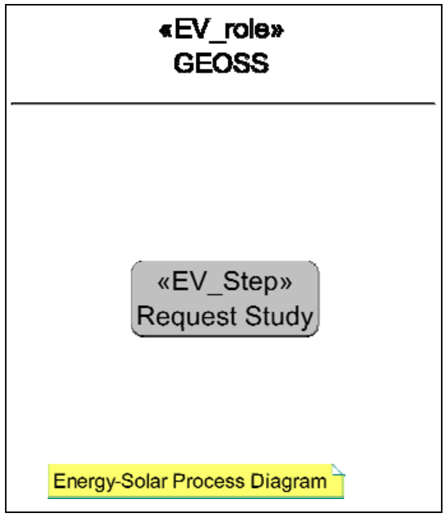


Figure 21 – Energy Community Process Diagram

2.6.4.3.1 Typical sequence of user actions

According to the above lifecycle of an energy system diagram a typical sequence of user action is listed below.

Step	Description
Step 0	The investor asks a consulting company for a study for a given geographical area
Step 1	The consulting company wants to obtain the necessary information and puts requests to the GEOSS portal
Step 2	The specific application is invoked
Step 3	The specific application invokes various web services and resources to retrieve needed information. It then invokes the specific processing web services.
Step 4	The specific application packs the layers as an archive file and deliver it to the consulting company
Step 5	The consulting company retrieves the archive, performs the study by exploiting the retrieved information and its own models and reports to the investor
Step 6	The investor takes a decision

2.6.4.4 References for the Energy Scenario:

References for the Energy Scenario are provided in the endnotes[xii]

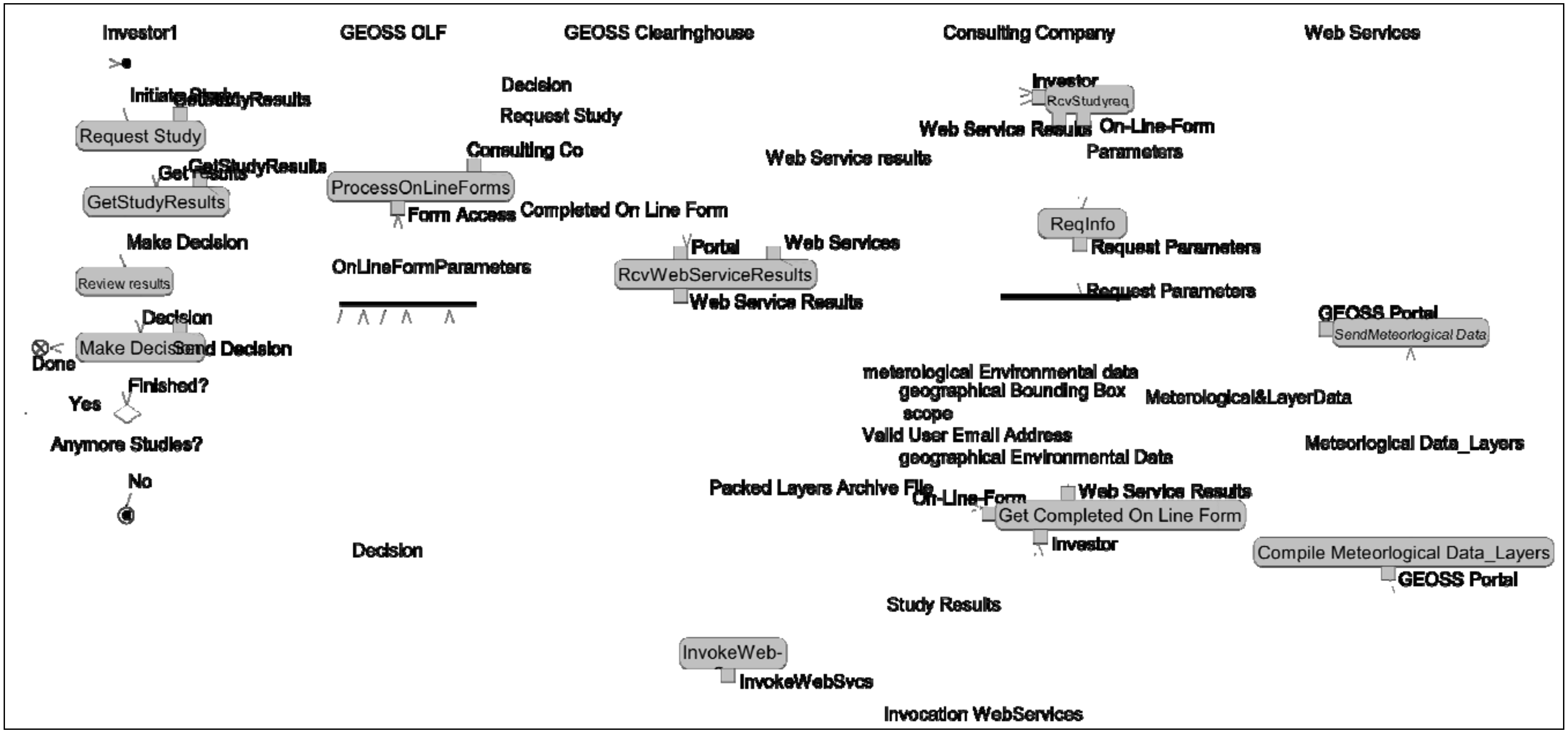


Figure 22 – Electricity Production Activity Diagram

3 Information Viewpoint – Earth Observations

3.1 Earth observation information model

There is little debate about the critical role of data standards in enabling SDI components to be effectively shared, and in particular to allow decomposition of responsibilities within a hierarchy of global to local jurisdictions[xiii].

"The Cookbook authors recommend that Core and non-Core data be modeled and shared in the designs of national SDI's using emerging ISO standards by following the rules for application schema, publishing a feature catalogue, and standardizing the encoding of the data." [GSDI Cookbook]

Information that is core to GEOSS includes common semantics though information models, data that is exchanged between services, and metadata placing the information in context–geospatial, temporal, domain, and community–for effective utilization across the system of systems.

3.2 Maps, features, coverages, and observations

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

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

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

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

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

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

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

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

GEOSS components utilize discrete features, coverages, observations and maps. Satellite imagery is an observation and maybe processed into coverage and specific discrete features, e.g., hot spot polygons processed from a thermal-band image. Observations, coverage's, discrete features and maps are all needed to support decision making by Societal Benefit Areas.

3.3 Spatial referencing

Spatial Referencing is accomplished in several ways including

- Terminology with spatial reference
- Coordinate reference systems

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

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

An International Standard for defining the information model of CRSs is provided by ISO 19111, Geographic information — Spatial referencing by coordinates, also available as OGC Abstract Specification Topic 2 - Spatial Referencing by Coordinates. In order to achieve interoperability of data, it is anticipated that example CRSs that are relevant to GEOSS should be identified and discussed as common. Descriptions of CRSs can be exchanged using the OGC Geography Markup Language (GML). For on-line interoperability, identifiers for CRSs need to be agreed and used, e.g., "urn:ogc:def:datum:EPSG:6.3:6326" identifies the WGS 1984 datum defined in the EPSG v6.3 database. GEOSS should consider its interactions with registries and registers for CRSs that are being established consistent with ISO 19135. For example ISO TC211 is working with the Geodesy community, e.g., IAG, to establish a Geodetic CRS register.

An element of the 2nd Phase of AIP will be to increase the coordination of AIP with the GEO Task on coordinate reference systems. For example the developments of GGOS have been identified as relevant to this coordination. This CFP seeks responses to increase this coordination.

3.4 Geographic information types

3.4.1 Basic Geographic Information Types [xv]

Definition: basic geographic data is such data as commonly used when geographic data are dealt, and is defined as one of following in the guideline developed by GEO Task DA-06-05:

- Topography: data on undulation of earth surface such as contour lines and DEM.
- Bathymetry: data on topography of sea bottom.
- River systems: data on rivers and lakes
- Infrastructure: data on infrastructure such as roads and railroads
- Land Use / Cover: land use is to classify land by the function of land from human activity point of view. Land cover is to classify land by physical coverage of earth surface.
- Administrative Boundaries: spatial extent of administrative unit and its boundary. Coastline is included in this category.
- Residential Areas: areas where humans collectively settle

3.4.2 Community Specific Information Types

Several existing community application schemas are relevant to GEOSS

The community specific information types in Table 3 are currently listed in the GEOSS Standards Registry.

Table 3 – Community Specific Information Types

WMO Manual on Codes	WMO
ANSI Framework Data Content Standard	US ANSI
ANSI N42.42: Data format standard for radiation detectors used for Homeland Security	US ANSI
EM 1110-2-1003: National Hydrography Data Content Standard for Coastal	USA Government
IHO S-100: Geospatial Standard for Hydrographic Data	IHO
TDWG LSID Vocabularies (Life Sciences)	TDWG

GML Application Schemas have been developed for several communities:

- GML Application schema for Earth Observation products
- GeoSciML

For additional GML Application Schemas: http://www.ogcnetwork.net/node/210

3.4.3 Application Schemas Development Methodology

GEOSS might consider developing a methodology for development of application schemas. For consideration, an INSPIRE Drafting Team has developed "Data Specifications" Methodology for the development of data specifications http://www.ec-gis.org/inspire/reports/ImplementingRules/inspireDataspecD2_6v2.0.pdf

3.5 Observations, Sensor Information and Inter-calibration

3.5.1 Observation and Measurements

The Observations and Measurements (O&M) Engineering Specification describes a conceptual model that allows the depiction of spatial and temporal variant readings. The values of those readings are the results of the estimation of some natural phenomenon. The representation is based on the specified XML encoding. In O&M, measurement usually refers to the measuring device and procedure used to determine the value, such as a sensor or observer, analytical procedures, simulations or other numerical processes. The carrying out of the procedure to estimate the value of the phenomenon is called observation.

3.5.2 Sensor Model Language

Based on common understanding among Earth observation scientists that data from space-borne sensors is neither adequately nor easily georeferenced to meet processing requirements, a markup language has been developed that allows the description of the dynamic, geometric, observational characteristics of sensors. Sensor Model Language (SensorML) defines models and XML Schema for describing any process, including measurement by a sensor system, as well as post-measurement processing. SensorML supports a variety of needs within the sensor community, including discovery of sensor, sensor systems, and processes, on-demand processing of observations, lineage of observations as well as plug-and-play, auto-configuration, autonomous sensor networks, and archiving of sensor parameters.

3.5.3 Intercalibration

GEOSS aims to deliver comprehensive, global knowledge/information products in a timely manner to meet the needs of the nine societal themes. The GEOSS 10-year implementation plan identifies that "The success of GEOSS will depend on data and information providers accepting and implementing a set of interoperability arrangements". However, data accessible does not necessarily mean that the data is usable, or fit for the specific purpose. Although data of high accuracy is desirable, accurate assessment and reporting of the data and/or information products uncertainty is essential. Calibration and Validation (Cal/Val) are two essential steps for the correct use and understanding of the EO data, which are critical for data quality assurance and data usability.

Definitions*:

Calibration:	The process of quantitatively defining the system responses to known, controlled signal inputs.
Intercalibration:	The activity by which a group of instruments or measurement systems produce and maintain compatible data and information outputs.
Validation:	The process of assessing, by independent means, the quality of the data products derived from the system outputs.

(http://wgcv.ceos.org/wgcv/wgcv.htm)*

A significant challenge for GEOSS's interoperability is the lack of consistency in calibration of EO from satellites developed and operated by different space agencies worldwide. Many EO satellite instruments are calibrated independently using different methodologies and calibration/validation sites. The potential for significant discrepancies exists across satellites and programs.

Goals: Promote accurate assessment and reporting of the data and/or products uncertainty, throughout the use of common Cal/Val practices and the intercalibration of sensors over community endorsed Cal/Val sites, with the ultimate goal to produce and maintain compatible EO data and information products.

Efficient use of EO data relies on multi source data access, interoperability, long-term data preservation, and common definition standards. To effectively exploit information derived from disparate data sources, certain consistency of content among data providers is required, which could be achieved through guidelines for the appropriate characterization of the observing systems and their derived products. Ultimately, consistency can be achieved through identified best practices registered with GEOSS to be used across data providers.

As the space segment of the GEO, the Committee on Earth Observation Satellites (CEOS) Working Group on Calibration and Validation (WGCV) is providing information, tools and data for calibration and validation of EO data through the GEO/CEOS Cal/Val Portal (http://calvalportal.ceos.org). The Cal/Val Portal is dedicated to ease and strengthen the calibration process and facilitate the comparability of data from similar instruments. Over the past three years CEOS/WGCV, in conjunction with participants in GEO task DA-06-02, has developed a Data Quality Framework (DQF) for GEO. The current version of this framework, entitled “Quality Assurance Framework for Earth Observations” (QA4EO), will be available through the GEO/CEOS Cal/Val Portal. CEOS endorsed Cal/Val sites and/or data types are currently being identified and key guidelines for data quality assurance have been established, which should be used by space agencies and value-added data providers to perform consistency checks at their own discretion. While the specific procedures for intercalibration and Cal/Val would differ for various sensors and applications, common key guidelines and some suggested procedures are already available trough the Cal/Val Portal.

To test the key Cal/Val concepts, promote the implementation of QA4EO, and to further develop the Cal/Val Portal a number of prototype studies have been initiated, including:

- Harmonization of coincident satellite measurements from MODIS, AVHRR, and ATSR by using Hyperion to resolve spectral differences.
- Collaborate on the on-orbit SI traceable benchmark missions TRUTHS and CLARREO.
- A cross comparison of satellite measurements, using Dome Concordia Cal/Val site at the Antarctic Plateau. Major advantages of this site include long-term stability, relative uniformity, low aerosol loading, dry atmosphere, low cloud cover, more frequent satellite overpass, and unique geographic location.
- Characterization of BRDF (bidirectional reflectance distribution function) effects on satellite observations with inter-comparisons to ground measurements.

The results and methodology from the prototype investigations will be made available over the next few years through the Cal/Val portal. A CEOS standards handbook will be developed to document CEOS standards and recommendations.

3.6 Alerts and Feeds

3.6.1 Alerts and Public Warning - CAP

The Common Alerting protocol (CAP) is a format for exchanging all-hazard emergency alerts and public warnings requirements presented in ASN.1 and XML.

CAP is a simple but general format for exchanging all- hazard emergency alerts and public warnings over all kinds of networks. CAP allows a consistent warning message to be disseminated simultaneously over many different warning systems, thus increasing warning effectiveness while simplifying the warning task. CAP also facilitates the detection of emerging patterns in local warnings of various kinds, such as might indicate an undetected hazard or hostile act. And CAP provides a template for effective warning messages based on best practices identified in academic research and real-world experience.

CAP is specified in the ITU-T Recommendation X.1303, which is technically equivalent and compatible with the OASIS Common Alerting Protocol, v1.1 standard. The OASIS

CAP specification includes and XML Schema. ITU-T X.1303 provides an ASN.1 specification that permits a compact binary encoding of CAP messages.

3.6.2 GeoRSS

GeoRSS (http://www.georss.org) is a hybrid content type that is proving extraordinarily useful as a means of exchanging and propagating information in a lightweight but rapid fashion across the Web or any Web-enabled federation. It consists of standard Web feed content in, for example, the IETF standard Atom format (http://www.ietf.org/rfc/rfc4287.txt) which has been extended with GML and derivative elements to precisely but simply describes location or other geographic representation.

Each Web feed member, an Atom entry for example, combines a reference to a resource which is addressable on the Internet (most commonly on the Web), with a concise set of metadata elements such as title, summary, time of update, and so on. A GeoRSS entry adds a geometric property to this list.

GeoRSS often serves a dual role. In one role it provides a summary of information already associated with a resource (e.g. an observation feature of interest) which can be searched, subscribed to, aggregated, and exchanged over the Web through a variety of channels. In the other role, it can serve to augment the information available from the original resource. For example, a GeoRSS entry can add a searchable geometric property, a classification, or other properties to resources which do not provide them directly. This "featurization" of source information in particular can be valuable for enhancing the discovery in space and time of information otherwise difficult to access in this fashion.

GeoRSS[xvi] is available in two GeoRSS serializations: 1) GeoRSS GML and 2) GeoRSS Simple. GeoRSS GML is a formal GML Profile, and supports a greater range of features than GeoRSS Simple, notably coordinate reference systems other than WGS84 latitude/longitude.

3.7 Registry Information Models

3.7.1 GEOSS Registry Model

The GEOSS Registry Model is portrayed by the Use Case in Figure 23 and Class Diagram in Figure 24

It is also important to register the semantics of shared data elements so that any system designer can determine in a precise way the exact meaning of data occurring at service interfaces between components. The standard ISO/IEC 11179, Information Technology--Metadata Registries, provides guidance on representing data semantics in a common registry[xvii].

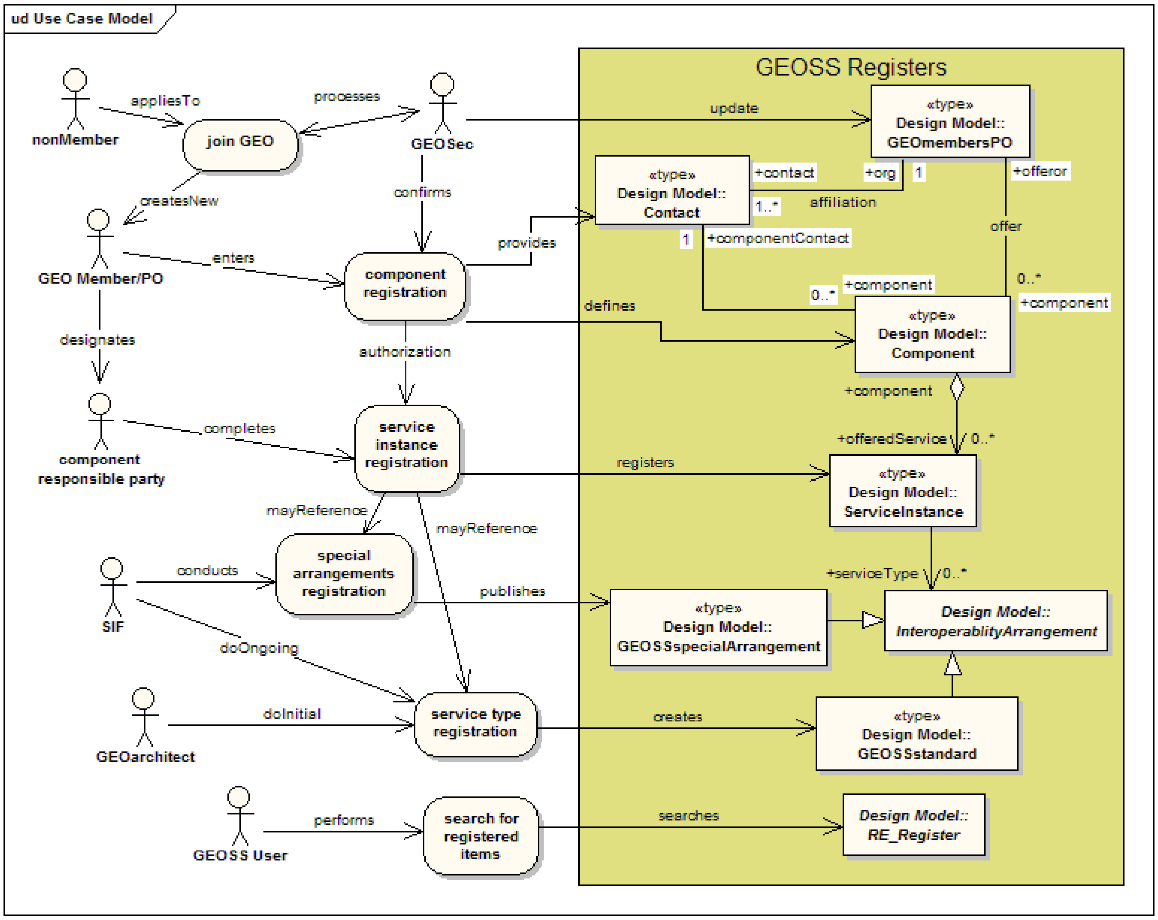


Figure 23 – GEOSS Registers Use Case Model

The standard for geospatial metadata is ISO 19115: Geographic Information--Metadata. This standard facilitates the exchange and integration of data and information by giving a standard description of the identification, extent, quality, spatial and temporal scheme, spatial reference and distribution specifics of geospatial data[xviii].

The metadata standard to use should primarily be ISO 19115/19119/19139. Dublin Core is also an international standard; it should be fully supported as appropriate and not just "be considered". Following the two international standards, National standards, such as FGDC, may then be considered.[xix]

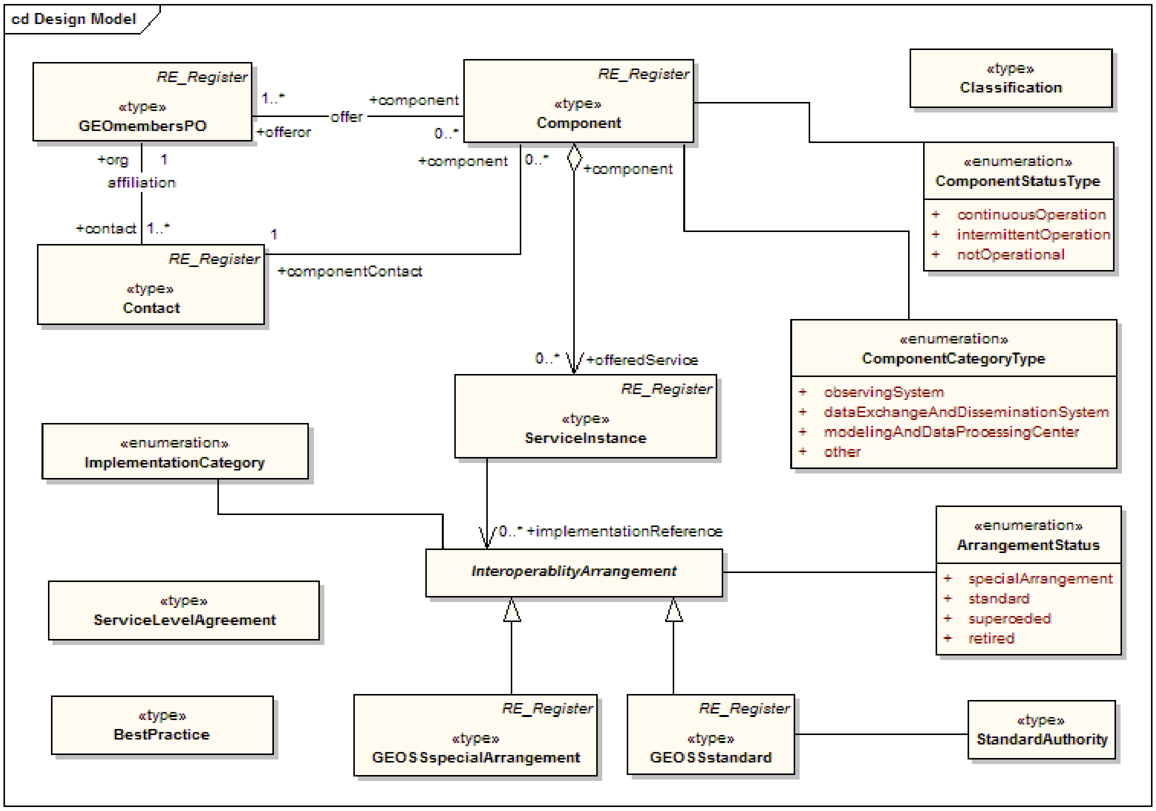


Figure 24 – GEOSS Registers Design Model

3.7.2 Registry Information Model (ebRIM)

According to ISO 19135, a registry is an information system on which a register is maintained. A register is a controlled list (a store or a database) of information. A registry system acts as a hub within a distributed data & services infrastructure, and ultimately provides an aggregated view of content from numerous, heterogeneous information resources. In this approach, standards for describing, registering and querying resources are essential.

An ebXML Registry is an information system that securely manages the standardized metadata describing any content type, and provides a set of services that enable sharing of content and metadata between organizational entities in a federated environment.

The OASIS Consortium standard "ebXML Registry Information Model (regrep-rim-3.0)" defines the types of objects and items that can be stored in an ebXML Registry to describe a registered content artifact.

A separate document "ebXML Registry: Service and Protocols" defines how to expose registry request and response messages and lifecycle management functions. These standards together describe a combination of registry and repository functionality in which content artifacts may be separately installed in an online repository and described in the associated register.

Those two documents are parts 3 and 4 of the ISO 15000 Electronic business eXtensible Markup Language ebXML series of standards. They do not support geospatial or temporal operations per se, as defined by geospatial communities' standards bodies like ISO TC211 or the Open Geospatial Consortium. For those purposes, one can consider the OGC-published set of profiles which include ebRIM within its standard specification stack for geospatial catalogs, and offer spatio-temporal discovery capability.

The main benefits of ebRIM in OGC catalogue profiles are the versatility and extensibility of the RIM (Registry Information Model). These are benefits to the GEOSS community where a great variety of content and service resources are shared across many diverse organizations and users.

At the root of this model are the two main ebRIM object types – RepositoryItems and RegistryObjects. An ebXML Registry is capable of storing any type of electronic content such as XML documents, text documents, images, sound and video. Instances of such content are referred to as a RepositorytItems. RepositorytItems are stored in a content repository provided by the ebXML Registry. In addition to the RepositoryItems, an ebXML Registry is also capable of storing **standardized metadata** that may be used to further describe RepositoryItems. Instances of such metadata are referred to as **RegistryObjects** (or one of its sub-types). Important subtypes include the 'association', 'classification', and 'slot' ebRIM objects.

3.7.3 Dataset metadata – searching

The GEOSS 10 Year Implementation Plan Reference Document identifies ISO 19115 as "the" standard for geospatial metadata, and certainly it will be listed in the GEOSS Standards Registry as a fairly comprehensive model for description of geospatial data, although its limitations for description of earth observation data in particular require further work. For the foreseeable future, however, some variety of metadata specifications both "standard" and "special" will continue in use to describe the diverse resources offered by the many communities of GEOSS.

For the purposes of resource discovery, fortunately, a few common elements (e.g. title, author, subject, date, and place) often suffice and are generally accessible through a variety of catalog search interfaces, including widely used ones such as ISO 23950, (one of the GEOSS recommended standards for discovery interfaces). For this reason, search interoperability for discovery may not be much impacted by the variety in structures of metadata nor their particular elements. The hundreds of additional / specialized metadata elements found in different disciplines are primarily used for evaluating the suitability of data rather than for discovering its existence. The content of these other metadata elements needs to be displayable, but rarely needs to be searchable on a large scale. The various metadata schemas don't need to be fully mapped each to each other at least for purposes of discovery. Only a small number of "queryable" elements have to be mapped to a common syntactic and semantic type.

That said, experience so far with implementation of discovery within GEOSS indicates that there are additional "queryable" metadata elements particular to earth observation data, which often figure in successful large-scale data discovery as well as in data evaluation. Precisely what elements should be defined and included is an appropriate goal for the upcoming work; they include at a minimum the temporal and spatial extent of an observation (collection) feature of interest and the phenomenon (phenomena) being observed.

3.7.4 Profile for GEOSS metadata

The initial focus for common metadata (core queryables and common responses) in the 2nd Phase of AIP is recommended to be the OGC CSW:Record which in turn is based on the Dublin Core metadata with a handful of extension elements. Dublin Core defines a minimal set of metadata elements that can be supported by almost all communities. As described above, additional metadata elements should be defined (parsimoniously) as needed to support more expressive searching and retrieval specific to the needs of the GEOSS communities.

Consideration of a profile for GEOSS metadata will also build on the experiences of searching GEOSS community catalogues. This experience can be informed by previously developed metadata profiles that are relevant to the GEOSS communities. These profiles have been previously developed for CSW[2]:

- **ebRIM Application Profile of CSW**: defines a profile on the use of the OASIS ebXML Registry Information Model (ebRIM) for CSW part (Clause 10) of the OGC Catalogue Services 2.0.2 specification. It makes use of the OASIS ebXML Registry Information Model (ebRIM) as the building blocks for modelling needs of diverse communities of practice within the geospatial domain, by defining an extensible catalogue service, that can encompass multiple domain-specific extension packages, some of which are described below as offered by ebRIM (see Bibliography item[xx])

- **BASIC package**: defines a general utility extension package that shall be supported by all conforming catalog services, with a focus on service-oriented metadata management, for the cataloguing of OGC Web Services (OWS Common), WSDL Service descriptions, and some basic ISO 19139 (XML encoding) data descriptions (see Bibliography item[xxi])

- **CIM package**: defines a Core ISO Metadata (CIM) extension package of the ebRIM Profile of CSW, for the cataloguing of ISO 19115 and ISO 19119 compliant metadata record, including templates for interoperability with ISO Application Profile (see Bibliography item [xxii])

- **EO (Earth Observation) package**: defines an Earth Observation Products extension package of the ebRIM Profile of CSW, based on HMA EO product metadata (see Bibliography item[xxiii])

Note: work is ongoing at OGC technical committees for providing other extensions package specifications (portrayal rules, units and measures…) and in particular a CRS extension package.

- **ISO Metadata Application Profile of CSW**: defines a profile of CSW 2.0.2 based on ISO 19115 and 19119 with support for XML encoding per ISO/TS19139. This profile does not use the ebRIM CSW Profile (see Bibliography item[xxiv]).

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[2] Complete citations for the profiles is provided in the Bibliography

- **Earth Observation Application Profile of CSW** (see Bibliography item[xxv])

For widest interoperability, the initial focus should be on supplementing the concrete record in CSW 2.0.2 (CSW-Record, see OGC Catalog specification Section 10.2.5.3 Core queryable and returnable realization). Additional analysis will be required in light of GEOSS needs and the CSW profiles: ebRIM profile with CIM and EO packages, ISO Application profile, and how these may factor into or accommodate GEOSS requirements.

3.8 EO Metadata

This section describes an approach for metadata used to describe products of earth observation satellites.[xxvi] This metadata specification is a potential source or inspiration for metadata elements useful in both discovery and evaluation of earth observation data.

From a user's point of view, the main characteristic of Earth Observation products is their geographical coverage; since GML provides a rich set of definitions for representing geographic objects; Earth Observation product descriptions are modeled here by means of GML application schemas.

Earth observation products are derived from an EarthObservationProductType (Figure 25) which is itself an extension of GML AbstractFeatureType type. The eop metadata element names have been harmonized as much as possible with ISO 19115 (ISO 19139 schemas) and the ISO 19115 Part II draft for remote sensing data. Since different EarthObservationProduct element formats will be returned from a catalog search depending on the supported schema, the catalogue profile for this metadata schema allows clients to first retrieve the list of supported schemas (either eop, opt, sar, or other ones defined on them) and then access the metadata at the level in the hierarchy that best fits their needs.

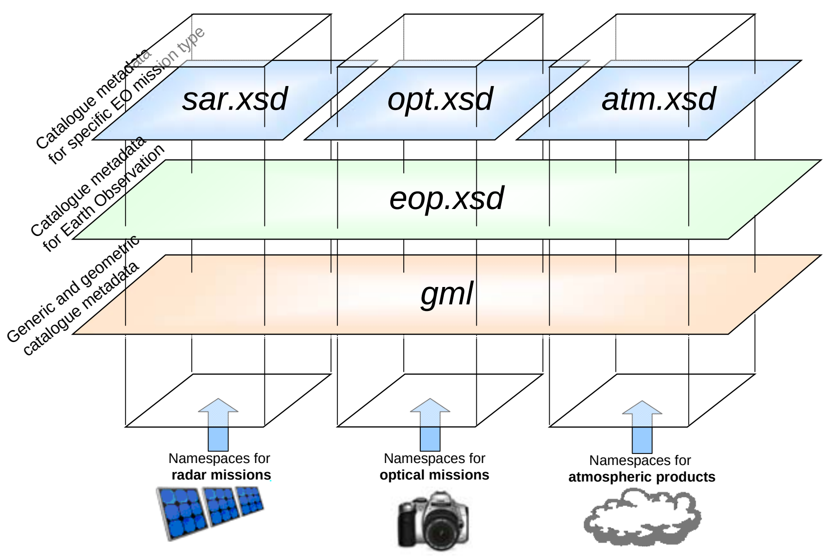

Figure 25 – EarthObservationProduct type hierarchy

3.9 Information Encoding Formats

Systems interoperating in GEOSS agree to avoid non-standard data syntaxes in favor of well-known and precisely defined syntaxes for data traversing system interfaces. The international standard ASN.1 (Abstract Syntax Notation) and the industry standard XML (Extensible Markup Language) are examples of robust and generalized data syntaxes, and these are themselves inter-convertible[xxvii].

One encoding format interoperability issue arises from current XML implementations and their patchy support for text encoding as needed for languages that use character sets other than Latin-1. It appears that many application tool chains involving XML continue to have varying levels of support for text encoding options. Consequently, only a handful of encodings are actually supported when interoperating across a range of systems. For example, many software systems use the "expat" XML parser engine internally (a BSD licensed open source library), but that engine only supports ASCII, ISO Latin encodings, and Unicode (UTF-8 and UTF-16). When systems encounter XML with a standard Asian text encoding, software faults can occur at successive points in the chain of processing. At the "standards policy" level, GEOSS certainly embraces Unicode standardization of text encoding. But, the reality today is that there is still no guarantee that actually deployable systems are capable of the necessary conversions.

The GEOSS Standards registry lists these data encoding formats: GeoTIFF, OGC GML, NetCDF, ESRI shapefile. It is anticipated that additional formats will be registered, e.g. KML.

4 Computational Viewpoint – Systems of Systems

4.1 Service oriented architecture (SOA)

The Computation Viewpoint defines mainly a Service-oriented approach to enable distribution through functional decomposition of the system into objects that interact at interfaces. There are GEOSS elements beyond the services approach, e.g., direct satellite broadcast, delivery of data on media, but the predominant discussion in this viewpoint concerns a Service-Oriented Architecture (SOA).

GEOSS interoperability arrangements are to be based on the view of complex systems as assemblies of components that interoperate primarily by passing structured messages over network communication services. By expressing interface interoperability specifications as standard service definitions, GEOSS system interfaces assure verifiable and scalable interoperability, whether among components within a complex system or among discrete systems in a federated "system of systems"[xxviii].

The OASIS Reference Model for Service Oriented Architecture[xxix] defines SOA as a paradigm for organizing and utilizing distributed **capabilities** that may be under the control of different ownership domains. The value of SOA is that it provides a powerful framework for matching needs and capabilities. Visibility, interaction, and effect are key concepts for describing the SOA paradigm. **Visibility** refers to the capacity for those with needs and those with capabilities to be able to see each other. Whereas visibility introduces the possibilities for matching needs to capabilities (and vice versa), **interaction** is the activity of using a capability. The purpose of using a capability is to realize one or more **real world effects**. At its core, an interaction is "an act" as opposed to "an object" and the result of an interaction is an effect (or a set/series of effects). This effect may be the return of information or the change in the state of entities (known or unknown) that are involved in the interaction. **Service** combines the following related ideas:

- The capability to perform work for another
- The specification of the work offered for another
- The offer to perform work for another

Visibility is promoted through the **service description** which contains the information necessary to interact with the service and describes this in such terms as the service inputs, outputs, and associated semantics. In general, entities (people and organizations) offer capabilities and act as **service providers**. Those with needs who make use of services are referred to as **service consumers**. The service description allows prospective consumers to decide if the service is suitable for their current needs and establishes whether a consumer satisfies any requirements of the service provider.

The Publish-Find-Bind use case (Figure 26) is a basic building block of a service-oriented architecture.

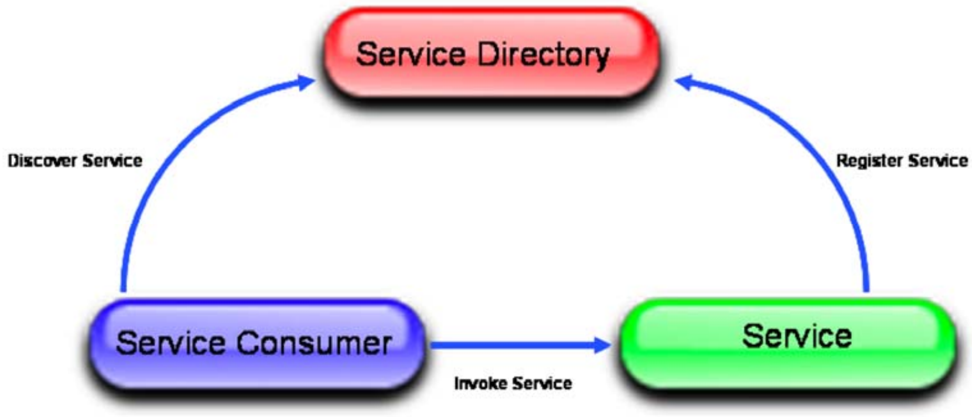

Figure 26 – Publish-Find-Bind Sequence

The archetypal SOA “triad” does presume that a direct connection between a service and client (service consumer) is feasible; that the components share both a distributed computing protocol and a knowledge community / domain. In heterogeneous or federated systems, this is may not be the case, and a fourth component role needs to be invoked, that of broker or mediator:

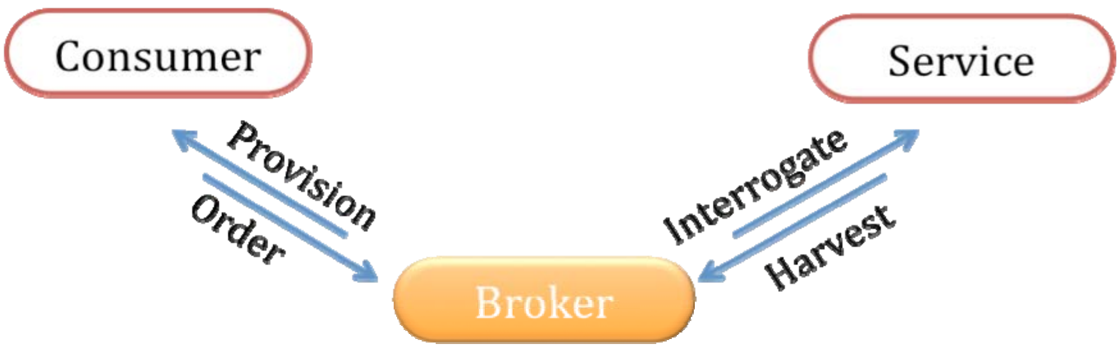

Figure 27 – Broker Role in SOA

A broker implements one or more mediation functions (protocol, interaction style interface type, information model) through the same service interfaces which would be invoked in its absence, or may support extended interfaces such as ordering or harvesting.

Experience with initial implementations of the GEOSS Clearinghouse has demonstrated the importance of this broker role in facilitating discovery across the GEOSS Federation. The mediation role filled by the Clearinghouse applies particularly to interoperability across catalog services provided by the various GEOSS communities and is described in more detail in following sections.

4.2 GEOSS Functions via SOA

4.2.1 Discover and register services

4.2.1.1 Overview

Interoperability arrangements for catalog search are key to service oriented architectures. The GEOSS 10 Year Plan Reference Document identified ISO 23950 as one standard needed for use in GEOSS to search catalogs of interest. Responses to a Request for Information in the 1st Phase of AIP identified several catalog standards that are essential to GEOSS. The RFI responses primarily recommended use of the OGC Catalogue Service - Catalog Service for the Web (CSW). The catalog roles depicted above require at least discovery and harvesting / publishing arrangements, and probably other arrangements for managing registry information and component behavior. This section describes several catalog service standards that support one or more of the required catalog functions. The engineering viewpoint then goes into more detail as to how components implementing these services are to carry out their roles in the GEOSS architecture.

Many Earth Observation catalogues have adopted the ISO 23950 Protocol for Information Search and Retrieval. This search service is interoperable with a broad range of information resources and services, including libraries and information services worldwide as well as the Clearinghouse catalogues supported across the Global Spatial Data Infrastructure now implemented in more than 50 countries.[xxx].

Profiles of the OGC CSW specification namely the ebRIM, ISO 19115/19119, and Earth Observation application profiles were identified as areas to be investigated and tested in the Proof of Concept Phase, i.e., before the Call for Participation in the Architecture Implementation Pilot was released.

The GEOSS Clearinghouse will need to be a client to community catalogue servers implemented in accordance with multiple catalog service standards; at a minimum these include ISO 23950 and OGC CSW.

(It has been suggested to refer only to the OGC Catalog specification as the Catalog service spec supported by the GEOSS Clearinghouse. Then this includes SRW, OGCCORE and the two application profiles, ISO and ebRIM.[xxxi])

With respect to the metadata supported by the clearinghouse, it is expected that additional classification schemes may be needed. Additional catalog service interfaces have proved useful in the initial phase of the AIP and elsewhere (e.g. NASA ESG). One example is the manager interface of the OGC CSW ebRIM profile. This interface provides the capability to support search by societal benefit area, type of resource, etc. This approach has been successfully implemented in ESG such that when a resource is registered (or harvested) in the catalog, the publisher has the option of also entering additional classification information such as the type of resource, the supported NASA national application, the applicable ISO categories, etc. This approach allows users to leverage precise categories in their searches and narrow them down quickly, especially important in a distributed global environment.

Another important catalog interface is one supporting distributed search. Clearly this is a critical function for the GEOSS Clearinghouse to be able to extend searches to remote community catalogues. A combination of distributed search and metadata harvest functions appears to be optimal based on Clearinghouse experiences in the AIP. Where remote metadata holdings are relatively static and not too voluminous, search of previously harvested holdings provides the best performance as well as the greatest opportunity to mediate between metadata formats and schemas.

Where remote holdings are either large or dynamic or both, distributed searches are more fruitful. Even in this case, however, it is recommended for better performance that the distributed search interface allow users to be able to specify (or select) the remote catalogs that they wish to search for a given query. Supporting this functionality may also improve performance, as the clearinghouse won't have to issue queries to all its underlying catalogs if the user is only interested in a couple at a time. . It also is recommended that harvesting interfaces allow high-level collections metadata be harvested from all catalogs so that the Clearinghouse itself can prioritize where to distribute a particular query.

4.2.1.2 Catalog service – ISO 23950[xxxii]

The ISO 23950 standard defines a network client-server service whereby a client can precisely specify a search request and preferences for the response that retrieves search results. The standard includes a definition for search request/response using TCP/IP protocol, also defined as a Protocol Binding in OGC Catalog Services, and using HTTP (Hypertext Transfer Protocol) known as SRW (Search and Retrieve for the Web) or SRU (Search and Retrieve via URL, see http://www.loc.gov/standards/sru/). SRW and SRU are designed for both the HTTP GET and HTTP POST interfaces, and for both Web Services using SOAP (Simple Object Access Protocol) as well as CGI (Common Gateway Interface, formally specified in RFC 1738). The vast majority of ISO 23950 implementations are served via TCP/IP rather than over HTTP. HTTP access to ISO 23950 over TCP/IP may be provided through an SRU-to-Z39.50 protocol gateway (see indexdata.dk).

For example, the following ISO 23950 SRU search request finds Library of Congress catalog entries containing the word "fruit":

http://z3950.loc.gov:7090/voyager?operation=searchRetrieve&version=1.1&maximumRecords=20&recordSchema=dc&query=fruit

As required by RFC 1738, the request has two component parts: a "base URL" and a "searchpart", separated by a question mark ("?"). The base URL identifies the server host and port (here, "z3950.loc.gov:7090") and the ISO 23950 service (here, "voyager"). The searchpart consists of parameters separated by "&", each with the structure "key= value". The names of the parameters in this ISO 23950 service description are the "key" strings within the URL, here: "operation", "version", "maximumRecords", "recordSchema", and "query".

Here is an example of an ISO 23950 SRU search request using a geospatial index:

http://www.search.gov/gsdi/sru2kml.php?operation=searchRetrieve&version=1.1&maxi

mumRecords=100&recordSchema=XML&query=geo.bounds within/partial/nwse "43.772 -101.411 31.7723 -77.7499"

This example specifies that the search targets the "geo.bounds" index, an index for bounding coordinates defined for the geospatial search community. This kind of search is not a text matching operation, but a search for points of overlap between available geographic "footprints" and the area being searched. The concept of overlap is given here by the search qualifier: "within/partial". The query also specifies, through the "nwse" qualifier, that the bounding box is given in decimal degrees of latitude and longitude, with coordinates in the order of northernmost, southernmost, westernmost, easternmost.

4.2.1.3 Catalog service – OGC CSW

The OpenGIS Catalogue Services Specification[xxxiii] specifies the interfaces between clients and catalogue services, through the presentation of abstract and implementation-specific models. Catalogue services support the ability to publish and search collections of descriptive information (metadata) for data, services, and related information objects. Metadata in catalogues represent resource characteristics that can be queried and presented for evaluation and further processing by both humans and software. Catalogue services are required to support the discovery and binding to registered information resources within an information community.

The OGC Catalogue specification contains bindings of the abstract catalog model to specific transport protocols. The Catalogue Services for the Web (CSW) binding applies the abstract model to the HTTP protocol.

With CSW the interaction between a client and a server is accomplished using a standard request-response model of the HTTP protocol. That is, a client sends a request to a server using HTTP, and expects to receive a response to the request or an exception message.

Request and response messages are encoded as keyword-value pairs within a request URI or using an XML entity-body. Requests may also be embedded in a messaging framework such as SOAP, although the CSW binding only properly applies to SOAP messages that are exchanged over HTTP request-response sessions.

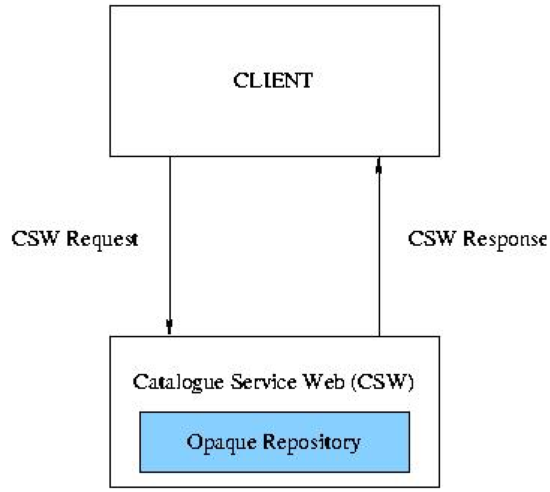

Figure 28 — Catalogue service web

The CSW binding has been implemented with profiles for specific information models for the content of the repository accessible using the CSW.

4.2.1.4 OASIS UDDI

The focus of Universal Description Discovery & Integration (UDDI)[xxxiv] is the definition of a set of services supporting the description and discovery of (1) businesses, organizations, and other Web services providers, (2) the Web services they make available, and (3) the technical interfaces which may be used to access those services. Based on a common set of industry standards, including HTTP, XML, XML Schema, and SOAP, UDDI provides an interoperable, foundational infrastructure for a Web services-based software environment for both publicly available services and services only exposed internally within an organization.

UDDI is primarily intended for businesses and organizations to support discovery of their products and services through standard key and keyword descriptions. It is most often used to support discovery of services within an enterprise environment, but is also utilized by a number of integrated development environments to generate Web service client software code components semi-automatically.

4.2.2 Visualization services

4.2.2.1 Web Map Service

Web Map Service specifies the behaviour of a service that produces spatially referenced maps dynamically from geographic information. It specifies operations to retrieve a description of the maps offered by a server, to retrieve a map, and to query a server about features displayed on a map.

In particular Web Map Service defines:

1. How to get and provide information about what types of maps a server can deliver (GetCapabilities)
2. How to request and provide a map as a picture or set of features (GetMap)
3. How to get and provide information about the content of a map such as the value of a feature at a location (GetFeatureInfo)

Web Map Service may provides a choice of “style” options that can be used in rendering the selected “Layers”, but there is only the name of each style is available. To provide a general definition of map styling, and to even enable style customization in WMS, a Symbology Encoding language is defined in the *Styled Layer Descriptor profile of the Web Map Service Implementation Specification* (OGC 05-078r4). Depending on how style customization is implemented, this specification also defines integrated-WMS and component-WMS respectively. The difference between them is that component -WMS can interact with any standard WFS and/or WCS in runtime, while integrated-WMS can only symbolize feature data from its own feature or coverage data source.

OGC Web Map Service (WMS) version 1.3 (OGC06-042) is identical with ISO 19128:2005, Geographic information – Web map server interface.

Please note that Web Map Service is applicable to pictorial renderings of maps in a graphical format; it is not applicable to retrieval of actual feature data or coverage data values. These can be done through Web Feature Service and Web Coverage Service respectively.

4.2.2.2 OGC Web Map Context Documents

OGC Web Map Context (WMC) Documents (OGC 05-005) is a companion specification to the aforementioned Web Map Service (WMS) specification. It states how a specific grouping of one or more maps from one or more Web Map Services can be described in a portable, platform-independent format.

WMC Documents are encoded in XML language. They may consist of the following components: information about the server(s) providing layer(s) in the overall map, the bounding box and map projection shared by all the maps, sufficient operational metadata 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.

WMC Documents provide a practical way to reconstruct the web mapping context in the same WMS clients where they were generated or the other WMS clients that support this WMC Documents specification.

4.2.2.3 KML

KML is an XML grammar used to encode and transport representations of geographic data for display in an earth browser, such as a 3D virtual globe, 2D web browser application, or 2D mobile application. It is an XML language focused on geographic visualization, including annotation of maps and images. Please note that, geographic visualization includes not only the presentation of graphical data on the globe, but also the control of the user's navigation in the sense of where to go and where to look.

Though KML is not a visualization service itself, it promotes the interoperable geospatial data visualization by defining how the visualization of geospatial data in 2D or 3D environments could be formally described. KML documents authorized by one person can be directly shown up in others' KML browsers. From this perspective, KML is complementary to the key existing OGC/ISO Web Map Service standard and OGC Web Map Context Documents, where only 2D geospatial data visualization is considered.

KML (formerly Keyhole Markup Language) was submitted by Google to the OGC. It has been evolved within the OGC consensus process, and finally results in two approved OGC standards, KML version 2.2 (OGC 07-147r2) and KML 2.2 – Abstract Test Suite (OGC 07-134r2).

4.2.3 Dataset access services

4.2.3.1 Web Feature Service

The OpenGIS Web Feature Service (WFS) allows a client to retrieve and update geospatial data encoded in Geography Markup Language (GML) from multiple Web Feature Services. The specification defines 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.

The following WFS operations are available to manage and query geographic features and elements:

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

4.2.3.2 Web Coverage Service

The OGC 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.

4.2.4 Service Chaining and Workflow

ISO 19119:2003, Geographic information — Services, defines service chaining as the combining services in a dependent series to achieve larger tasks.   ISO 19119 enables users to combine data and services in ways that are not pre-defined by the data or service providers.   This level of data/service interoperability will be achieved in stages. Currently users can discover data that is provided by a service, i.e., “tight” data/service binding. We are beginning to see processing services offered that could bind to remote services that offer data.   Processing services acting as clients to data services is an example of “loosely” coupled services.

There are many options for achieving service chaining.   Several GEO Members have implemented workflow approaches using a workflow engine and a scripting language.[xxxv] [xxxvi] Much of the workflow management for controlling the execution of a chain of web services has been done using OASIS Business Process Execution Language (BPEL). Other scripting languages are available.

A description of Service Chaining as applied to Earth Observations can be found in an HMA Architectural Design Technical Note.[xxxvii]

A description of workflow applied to Earth Observations in combination with sensor web developments is provided in a recent NASA paper[xxxviii].

4.2.5 Processing services

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

Processing services are network accessible services that can process data provided by a separate service. Typically a processing service does not include capabilities for providing persistent storage of data.

The OGC Web Processing Service (WPS) defines a standardized interface that facilitates the publishing of geospatial processes, and the discovery of and binding to those processes by clients. Processes may include any algorithm, calculation or model that operates on spatially referenced data. A WPS can be configured to offer any sort of geospatial functionality to clients across a network, including access to pre-programmed calculations and/or computation models that operate 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 OGC Web Coordinate Transformation Service (WCTS), which can be used by geospatial applications and other services for the transformation of geospatial data from one coordinate reference system (CRS) to another. This is frequently required when using data from different sources in one application. To use together data stored in different CRSs, such data must be transformed into the same CRS.

Recent efforts are underway to provide Grid Computing as defined by the Open Grid Forum through a WPS interface. Extensive tests have been performed as well within the ESA Grid infrastructure leading to a preliminary definition of a Grid-based Processing Service. This with the objective of reducing the burden caused by the transfer of large EO coverages by transferring instead the processing algorithms on the Grid that hosts within its storage element the coverages to be processed.

An objective is the GEOSS SOA supported by Grid processing, protected by GSI (Grid Security Infrastructure) and VOs (VirtualOrganization). Retaining owners' data/resource/service policy, OGC and OGF need to introduce a finer granular Security Framework including WPS so that each request for the OWS must be protected appropriately.

4.2.6 Product programming service

The programming service provides a set of functionalities for the user/operator to:

- Perform feasibility analysis of EO future products i.e. to check whether the request can be fulfilled considering the satellite and sensor characteristic, meteorological conditions and mission workload. The analysis can be performed at different level of accuracy.
- Issue future EO products requests

The programming service supports the following 3 types of requests:

- Order of precisely identified future products. This type of orders are referenced as Acquisition Orders;
- Order asking the coverage of specified area in a specified time window. This type of orders are referenced as Coverage Orders;

- Same as the previous one, but the coverage is repeated several times with a defined periodicity.

A request to the Programming Service is generally referred to “Programming Request”.

An order for future products is referred to “task”.

In order to autonomously accomplish the feasibility analysis, the service has to receive / harvest satellite/sensor characteristics. The parameters are received via files or are harvested by calling DescribeSensor operation implemented by GS Programming Services.

4.2.7 Ordering Services for Earth Observation Products

This service provides a set of functionalities for the user/operator to place orders for the catalogued EO products and for adhere to subscriptions from the missions being part of the FedEO infrastructure.

This service allows the clients to perform the following activities:

- Get the service capabilities: retrieval of the supported version, the supported operations, etc.
- Order options retrieval (scene selection options, processing options, media definition, subscription sub-setting, etc.).
- Order Quotation: for getting a quotation of the order going to be submitted.
- Order submission
- Order monitor: to check the status of submitted orders.
- Order Cancellation: to cancel an on-going order.
- Retrieval of on-line available products.

During the order execution the user can query the status of his / her orders or also cancel the orders. The services should verify any constraints that may be imposed on users, and report status and relevant information back to the user

4.2.8 Sensor Web services

4.2.8.1 Introduction to Sensor Web

The Sensor Web is a revolutionary concept of achieving a collaborative, coherent, consistent, and consolidated sensor data collection, fusion and distribution system. It can be viewed as a new breed of Internet for monitoring spatio-temporal phenomena appearing in the physical environment in real time. Any kind of sensor, from a thermometer located at a fixed position to a highly complex hyper spectral sensor on board of an earth-orbiting satellite, will be made available on a global level. The services and encodings of the Sensor Web fit into the 3-tiers ISO model described above and populate mainly the two lower layers. The Sensor Web is discussed in a separate section due to particular characteristics of its corresponding services and encodings: The use of a common model to describe observation processes and results, which is shared among components that access sensor data, task sensors, or subscribe to sensor events.

Although the initial focus of Sensor Web has been to investigate standardised interfaces for physical sensors operating in near-real-time, rather than the conventional static data stores, Sensor Web addresses models and simulators either way. Note, that a simulator resembles a sensor regarding the provision of spatio-temporal data (it only differs in the way how it estimates the requested value and in being temporally independent).

Sensor Web addresses information gathering from distributed, heterogeneous, dynamic information sensors and sources of different structure and aims at

- Describing sensors in a standardized way,
- Describing sensor data processing in a standardized way,
- Standardizing access to sensor data,
- Standardizing the process of what is commonly known as sensor planning, but in fact is consisting of the different stages planning, scheduling, tasking, collection, and processing,
- Building a framework and encoding for measurements and observations.

Information concepts for Sensor Web are described in Section 0. Sensor Web services are described next.

4.2.8.2 Sensor Observation Service

The Sensor Observation Service (SOS) provides access to observations from sensors and sensor systems in a standard way that is consistent for all sensor systems including remote, in-situ, fixed and mobile sensors. SOS provides information about the sensor itself encoded in SensorML and observation data encoded in Observation and Measurement (O&M).

4.2.8.3 Sensor Planning Service

The Sensor Planning Service (SPS) provides a standard interface to collection assets (i.e., sensors, and other information gathering assets) and to support systems that surrounds them. SPS supports different kinds of assets with differing capabilities, as well as different kinds of request processing systems, which may provide access to the different stages of planning, scheduling, tasking, collection, processing, archiving, and distribution of resulting observation data.

4.2.8.4 Sensor Alert Service

The Sensor Alert Service (SAS) provides a standard interface to subscribe to events generated on the basis of observations. The interface allows clients to subscribe to pre-defined events as well as to define specific event-criteria.

- Sensor Planning Service (SPS) for commanding EO Sensors
- Sensor Observation Service (SOS) for access data from web accessible sensors.

4.2.9 Event Handling

4.2.9.1 Event handling defined

Basically, an event-based interaction model relies on two concepts (Muehl/Fiege/Pietzuch, 2006):

- An *event*, that describes any happening of interest that can be observed from within a computer, and
- A *notification*, that reifies an event as a datum, i.e., it contains data describing the event.

The "happening of interest" in the event definition indicates that an event requires an event condition that has to be stated before an event may occur. This is a more restricted definition than provided by (Muehl/Fiege/Pietzuch, 2006), who further define an event as "an arbitrary detectable state change in a computer system". Notification as defined by (Muehl/Fiege/Pietzuch, 2006) is sometimes referred to as "alert" (OMG, 2008). The terms notification and alert are used synonymously.

In the event-based interaction model the initiator is the provider of the data, i.e. the producer of notifications. The addressing scheme is indirect, which means that the notifications are not addressed to any specific set of recipients but mediated by a broker component, which offers a notification service. A consumer may express its interest to notifications by subscribing to the notification service. The essential characteristic of this interaction model is that producers do not know any consumers.

Notifications are conveyed via messages on the network transport level. Figure 29 illustrates the distinction between events, notifications, and messages. The model clearly separates the underlying communication technique from the model of interaction.

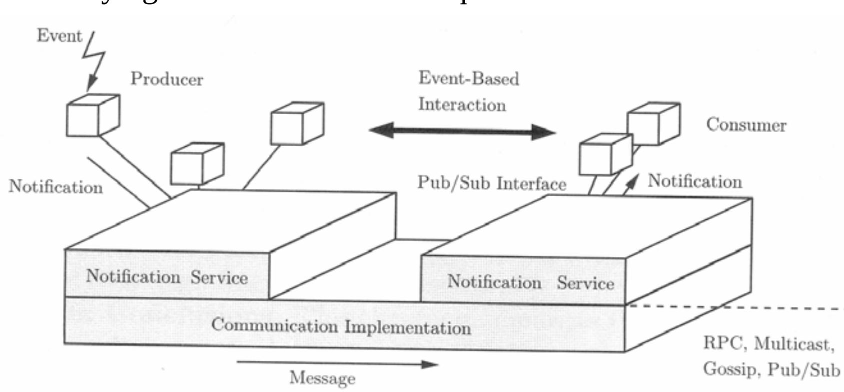

Figure 29 – Event-based System (Muehl/Fiege/Pietzuch, 2006)

Earth Observation System architectures in general require means and mechanisms to define, generate, distribute, receive, and process events. Three types of events are observed most frequently:

1. Events based on observations made by sensors or models,
2. Events based on aggregated observations made by one or multiple sensors or models, and
3. Events related to the operation of the sensor network or the sensor services.

The first type of events occurs if a sensor detects something that matches a previously defined event condition. The occurrence may take place in the environment of the sensor (externally) or internally. Examples of both event types are temperature values that exceed a threshold, the detection of hotspot pixels in a remote sensing image (both externally), or low battery power of a sensor (internally).

The second type of events occurs if non-atomic conditions occur, e.g. temperature and wind speed observation result values exceed thresholds in the case of a multiple sensor event. Additionally, events may be based on conditions that remain for a well-defined number of time intervals, e.g. temperature exceeds a threshold for n time intervals continuously (also known as time series analysis based events).

The third type of events occurs when some state has changed in the sensor or service network configuration (e.g. addition of a new sensor device or sensor service instance) or some unforeseen behaviour has been detected. The latter situation usually results in an exception on programmatic level. If deemed essential by the programmer, such exceptions may be escalated to other components in form of events.

Often all event types are handled equally and the event type is transparent to the receiver of an event notification. It is created by the event observer and published or transferred to notification consumers.

4.2.9.2 Event handling in GEOSS

To implement a flexible and extendable event handling in GEOSS, the following aspects have to be considered:

- Event generation and notification handling: Event observers generate events and publish notifications. The event generation and publication mechanism shall support resource-constrained devices. Such devices will not have to implement all the features of the event handling specifications, but still participate in the notification pattern. If necessary, security patterns have to be applied.
- Event definition language: Observers cross check the current situation and generate events if the event condition is matched. The event definition language formalizes those conditions. Ideally, the event condition language uses a similar approach as other data request filters.
- Event notification transport mechanism: GEOSS shall define an abstract event and notification system and provide concrete implementations based on a single or a number of different transport systems. The transport system must ensure the delivery of messages across various business processes interconnected by some form of bus. To allow message transport across different protocols, the definition of mediation services will be discussed. Mediation services ensure communication by taking care of the transformation form one protocol to another. If necessary, the transport services have to be secured.
- Event notification data model: GEOSS shall define the format of the notification message payload. This is of overall importance as only the definition of a proper data model allows content augmentation to enrich a message with any additional information. The content model shall be harmonized with other GEOSS service definitions in order to optimize interoperability.

4.2.9.3 Web feed protocols

Web feeds are services in which XML documents in RSS or Atom format are exchanged via standard HTTP methods. The XML documents themselves are collections of elements (items or entries) which summarize, describe, and reference other addressable resources on the Internet.

An elaboration of the basic HTTP GET method utilized by Web feeds are useful. Atom Publishing Protocol (APP) (http://www.ietf.org/rfc/rfc5023.txt) utilizes other HTTP methods such as PUT, POST, and DELETE to facilitate distributed management of Web feed entries.

The IETF standard Atom format (http://www.ietf.org/rfc/rfc4287.txt) specifies an Internet standards track Web feed information model and encoding for the Internet community, and requests discussion and suggestions for improvements.

Each Web feed member, an Atom entry for example, combines a reference to a resource which is addressable on the Internet (most commonly on the Web), with a concise set of metadata elements such as title, summary, time of update, and so on

Feeds are a particularly useful means of discovery when the particular search query of interest is relatively constant (oil slicks in the Mediterranean, for example) and even registered as an ongoing information subscription, but there is a need to discover new resources matching the query as quickly as possible in a lightweight and loosely coupled fashion. Feeds are also useful as browsing or alerting content in portal applications. They may represent personalized subscriptions for each viewer and/or consist of entries chosen by the portal operator or the community which the portal represents.

4.2.9.4 Web Services Notification

The purpose of the OASIS Web Services Notification is to define a set of specifications that standardise the way Web services interact using "Notifications" or "Events". They form the foundation for Event Driven Architectures built using Web services.

These specifications provide a standardized way for a Web service, or other entity, to disseminate information to a set of other Web services, without having to have prior knowledge of these other Web Services. They can be thought of as defining "Publish/Subscribe for Web services".

The WS-Notification family of specifications defines a standard Web services approach to notification. This document is the base specification on which all the other specifications in the family depend. It defines the normative Web services interfaces for two of the important roles in the notification pattern, namely the NotificationProducer and NotificationConsumer roles. This specification includes standard message exchanges to be implemented by service providers that wish to act in these roles, along with operational requirements expected of them.

4.2.9.5 Web Notification Service

The Web Notification Service (WNS) supports asynchronous service handling. WNS instances forward incoming messages on various transport protocols (e.g. email, HTTP, Instant Messaging protocols, phone, etc.) to clients. The service interface allows clients to register a target address and protocol which will be used to deliver messages from calling services that need to inform clients about specific events, e.g. that requested data is now available or that planned sensor missions are completed. The asynchronous communication pattern plays a crucial role in GEOSS, as request/response pairs may not be handled synchronously due to delays in sensor data acquisition or provision.

4.3 GEOSS functions via broadcast

The GEONETCast concept is to use the multicast capability of a global network of communications satellites to transmit environmental satellite and in situ data and products from providers to users within GEO. Commercially available technology provides cost-efficient solutions with easy to implement terminals, which are widely used for direct to home digital television. The multicast capability allows different datasets to be handled in parallel, regardless of the source. The use of a key access capability enables the data policy of each data provider to be respected and the distribution at individuals or groups of users, as appropriate, to be targeted within the footprint of each satellite.

All data types (not the instances) that are disseminated on GEONETCast (regional and global) should be described with standardised Meta data information. The current standards are the series of ISO 19100 standards and WMO Core Metadata Profile of the ISO Metadata Standard.

The concept of GEONETCast is to use bandwidth on commercial satellites for the data broadcast using standard DVB-S broadcast.

The GEONETCast Implementation Plan[xxxix] lists a number of standards have emerged as forming the baseline for dissemination systems which contribute to the GEONETCast infrastructure:

- Contributing dissemination systems should be generic, multi-service dissemination systems, based on standard Digital Video Broadcast (DVB) technology;
- Using commercial broadcast channels on television, direct-to-home (DTH) telecommunication satellites;
- Utilising commercial, off-the-shelf, commonly available reception equipment;
- Using Internet Protocol (IP) over DVB standard coding;
- Systems should support transparent transfer of files – files should be received exactly as sent;
- Use of standard, openly described file formats is encouraged – examples currently in use are L/HRIT, BUFR, GRIB, HDF, netCDF;
- Contributing systems should provide secure access control at individual file and User level;
- The systems should be open, flexible, and scalable at both the Network Centre and User Terminal level;
- Quality of service should be ensured and regularly monitored;

- Catalogues of transmitted data should be maintained and made available for consultation by Users in order to facilitate data discovery and subscription;
- Dissemination should be organised in multiple multicast channels corresponding to product categories, which are associated with Programme Identifiers (PID). User level;

4.4 GEOSS Functions via Media

There may be instances where digital transport either via Internet or broadcast is not possible. It is possible that a data provider does not have satellite or Internet access in order to disseminate data. Similarly, it is possible that a data consumer does not have satellite or Internet access in order to receive data. When either of these situations is true, the only means available for data transfer between data provider and data consumer will include mechanisms such as data disks, data tapes, CDs, DVDs, etc. that are sent via physical transfer. It will be assumed that there is local computing support to be able to use the media that is necessary for disseminating or receiving data.

4.4.1 Media Types

The media choices that are available for data encoding and data transfer are broad. Since GEOSS is based upon the utilization of open standards, the media choices discussed will be those that are widely available and compatible between various computing systems.

4.4.2 Magnetic Tape Storage

Although the format is proprietary, the Digital Linear Tape (DLT) format is widely used and supported by multiple companies. Many capacities are available, and Super DLT (SDLT) supports higher capacities and transfer rates than DLT.

An open standard alternative to DLT is Linear Tape-Open (LTO). LTO supports various capacities and transfer rates, as well. The open nature of the format means that any company can support it. The most widely used form factor for LTO Ultrium, a ½" tape format specified by the standard ECMA-319.

Regardless of the format chosen to be used by a data provider, the appropriate tape reader device must be used by the data consumer. These devices are proprietary and must be purchased specifically for DLT or LTO media.

4.4.3 Disk Storage

Disk storage is a very common way to transfer data between parties, especially since the advent of very small footprint, but high capacity, drives. Since file system specifications are associated with their operating systems, each disk drive will typically have its contents written in a way that will only be able to be read by the operating system which wrote the files.

There are portable disks that employ data transfer standards that are widely used and supported by all major operating systems currently being used; e.g. Microsoft Windows, Apple MAC OS, and Linux. These data transfer standards are Universal Serial Bus (USB) and FireWire (IEEE 1394). Disk drives manufactured to support either of these standards will work seamlessly with all major computing platforms.

There have been version upgrades to both of these standards. There are different cabling requirements for each, however most computers today support both. USB is more widespread. Portable drives are manufactured that support one or both of these transport standards.

4.4.4 Optical Storage

Optical storage is a very common way to transfer data between parties, but the storage capacity is not as great as with the other media discussed. The media can be Compact Disc (CD) and Digital Video Disc (DVD).

CDs and DVDs typically use different encoding standards. CDs use CD-ROM, CD-R, or CD-RW, while DVDs use DVD-R/DVD-RW, DVD+R/DVD+RW, or DVD-RAM.

DVD drives can read CDs, but CD drives cannot read DVDs. The drives used for reading must be compatible with the recording standard that was used for the media. An encoding standard that is widespread and works for both CDs and DVDs is Universal Disk Format (UDF). It is the ISO/IEC 13346 standard, which is also known as ECMA-167. Because of the possible confusion and compatibility issues surrounding the various CD and DVD encoding formats, GEOSS encourages use of the UDF standard for encoding of optical media for data transfer.

4.4.5 Registering Media Services

If a data provider wishes to disseminate data within GEOSS via physical media, the appropriate component, service, and standard or special arrangement must still be registered in the GEOSS registries so that data consumers can discover information about the data available and the service needed to consume it. In order to register, the data provider must have access to the GEOSS registries via the Internet. If the data provider has no Internet access, then all registration must take place via a proxy that does have Internet access. The proxy can be a GEO Member representative or a GEO Participating Organization representative.

The service registered, that provides data on physical media, must have an Information URL that points to a document available online that describes how to request data, and how to access the data on the media (this includes file names and standards used for the data). This document will contain a form that can be used online or printed out. The form should include the following sets of fields:

1. Data consumer contact information (postal, phone, fax)
2. Data requested
3. Date of request
4. Media choice

If the data provider is not on the Internet, then the request form should specify where to send it or fax it.

4.4.6 Utilizing Media Services

If a data consumer wishes to receive data within GEOSS via physical media, the search for the service must take place over the Internet using the Clearinghouse or registries. If the data consumer has no Internet access, then this search and discovery process must take place via a proxy that does have Internet access. The proxy can be a GEO Member representative or a GEO Participating Organization representative.

Once the service has been identified, the Information URL of that service can be accessed, and the form for requesting data can be filled out or printed out.

4.4.7 Use Case Diagrams

To be developed in the AIP execution phase.

5 Engineering Viewpoint – Components Types

5.1 Engineering Components and Tiers

The Engineering Viewpoint identifies component types in order to support distributed interaction between the components. The component types are to be consistent with the Enterprise viewpoint, e.g., GEOSS as a system of systems.

The components are best characterized as part of a service layer in the ISO 3-tier model (Figure 30):

- The top tier is the only one with which clients (people or systems) deal directly. It provides the interfaces to describe and use the services offered;
- The middle tier embodies all the business processes required to respond to requests issued by clients. The services in general embody everything from authentication to complex geoprocessing on sets of data from various repositories and from generation of map views to statistical charts that the client gets back at the end of the process;
- The lower tier provides read and/or write access to data, whether its geospatial data, accounting records, or catalogue entries stored in any of a dozen different types of registries.

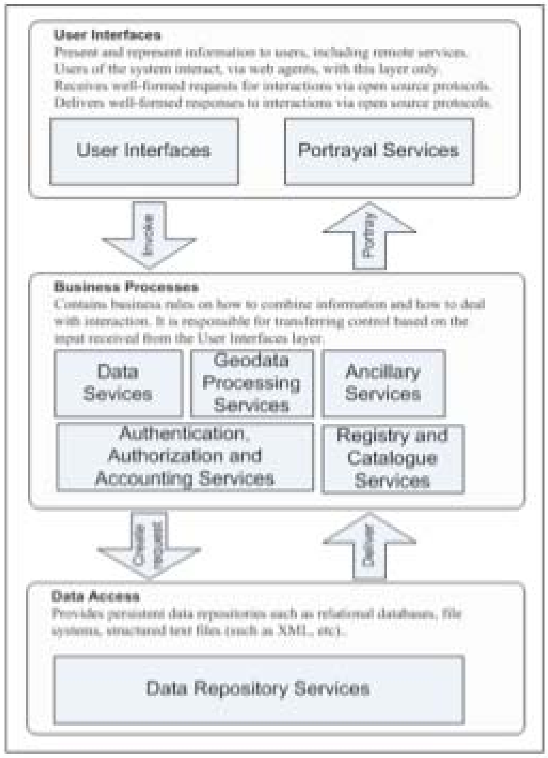

Figure 30 – Service Tiers: User, Business and Data[xl]

The component types interact based upon the services identified in the Computational Viewpoint. Figure 31 provides a summary of the component types organized consistent with the Service Tiers identified in the Computational Viewpoint. To limit the complexity of the diagram, interactions between components is not made explicit in Figure 31. Services supported by specific component types are described in the section for the specific component types.

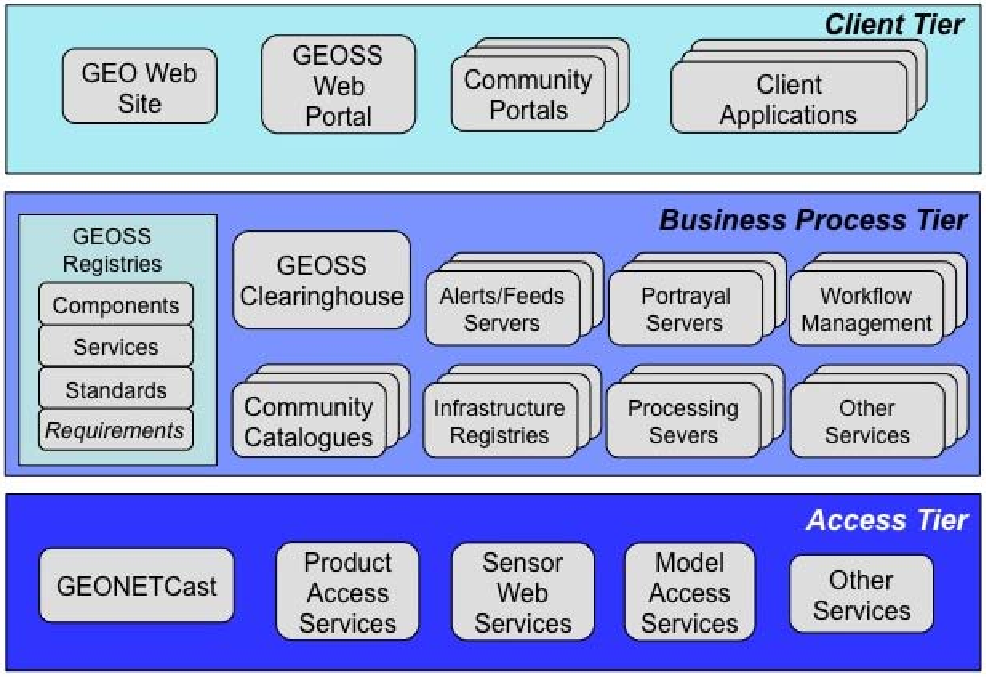

Figure 31 – Engineering Viewpoint Components

5.2 GEOSS Common Infrastructure

Phase 1 of the AIP focused on GEO Web Portal and the GEOSS Clearinghouse in conjunction with the development of registries developed by Task AR-07-01. These components are collectively referred to as the GEOSS Common Infrastructure (GCI) as shown in Figure 32. The Initial Operating Capability (IOC) of GCI was declared established as of 1 May 2008. The GCI IOC baseline represents a significant milestone in the development of GEOSS. The Executive Committee and GEO Secretariat have now declared that GEOSS is "Open for Business".

A Task Force has been formed to evaluate the IOC baseline as established in AIP Phase 1. The task team is charged with evaluating how the IOC meets the users needs and how it can move toward institutional persistence. The Task Force will evaluate the GCI as generally defined as of 1 May 2008, i.e., the IOC Baseline. The AIP will augment the GCI internally and externally during Phase 2.

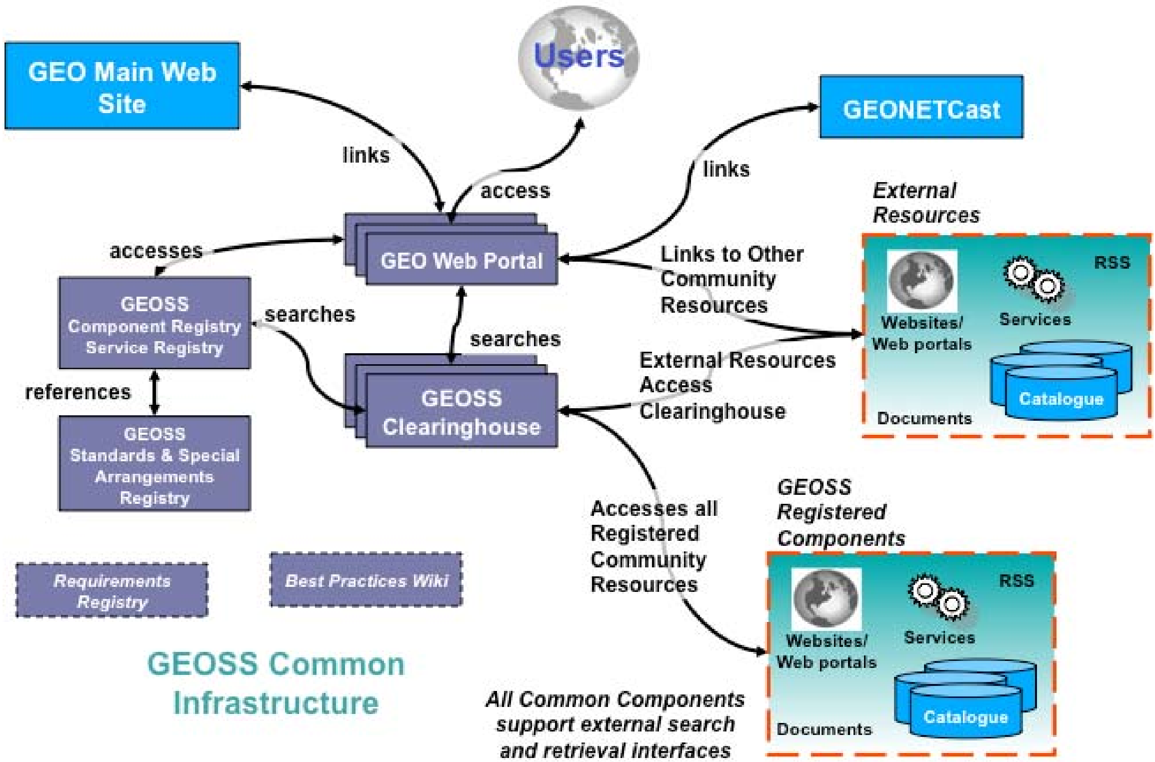

Figure 32 – GEOSS Common Infrastructure

5.3 User Interface Components

5.3.1 GEO Web Portal

A Web portal is a single point of access to information, which is linked from various logically related Internet based applications and is of interest to various types of users. The GEOSS architecture defines two types of portals: a GEO Web Portal and GEOSS Community Portals. Additionally the development of reusable portlets is envisioned.

Portals present information from diverse sources in a unified way; they provide a consistent look and feel with access control and procedures for multiple applications, which otherwise would have been different entities altogether. Since all the applications share information through portals, there is better communication between various types of users. Another advantage of portals is that they can make event-driven campaigns. Generally, a portal provides:

- Intelligent integration and access to enterprise content, applications and processes
- Improved communication and collaboration among customers, partners, and employees
- Unified, real-time access to information held in disparate systems
- Personalized user interactions
- Rapid, easy modification and maintenance of the website presentation

The following are the properties of portals:

- Look and feel
- Consistent headers and footers, color schemes, icons and logos which gives the user a feel and sense of consistency, uniformity, and ease of navigation

The GEO Web Portal will be a main application for accessing GEOSS services. It will include a number of common functions and solutions, including functions and solutions to search and discover services and provide news and other relevant information to the user community. It should also take into account integration and interoperability with non-geospatial portal environments and associated standards.

The GEO Web Portal is called GEO Web Portal rather than GEOSS Web Portal. The rationale behind this naming is as follows: The GEO Web Portal will provide access to services of GEOSS and also coordinate access to additional information from the GEO community as a whole. The GEO Web Portal is also a brand. It indicates that this is the primary Web Portal for GEO, the Group on Earth Observation.

The GEO Portal interacts with other components using GEOSS Interoperability Arrangements. The Portal section of the "GEOSS Core Architecture Implementation Report" from November 2007 has the set of requirements for the IOC level of Portal. Phase 2 of the AIP will consider augmentations to the IOC requirements for the GEO Portal.

GEO Portal will enable discovery of many types of services. The GEO Portal will be a client to only some of the discovered services. For example, all the GEO Portal must be a WMS client and so capable to execute a ServiceRequest of GetMap and process the response. It is not anticipated that the GEO Portal will be a client to every service type in the GEOSS registry. The AIP Architecture anticipates that "Application Client" components will serve as helper clients to services not supported by the Portal.

5.3.2 Community Portals

Community portals provide a user interface for a specific community. The user interface including the accessible information is tuned to the needs of the user community. User communities can be for a specific research interest, societal benefit area, etc.

The Pilot is anticipates two types of responses regarding Community Portals:

1. Existing community portals that currently provide web access to a community of users. Participation in the Pilots will enable the participating organization to expand their portal by interoperating with additional web services. The Community Portals will also play a significant role in the demonstration of user scenarios.
2. Portal solutions are available for hosting by other organizations. Solutions will need to be freely distributed to any organization for hosting and populating by the receiving organization. Proposals should for portal solutions should not only describe what the portal can do but the methods by which other organizations can obtain and configure the portal solution at their sites.

Community Portals may provide a list of functionalities, either as direct components of the portal itself or linked from physically remote locations. All services seem to be part of the portal itself.

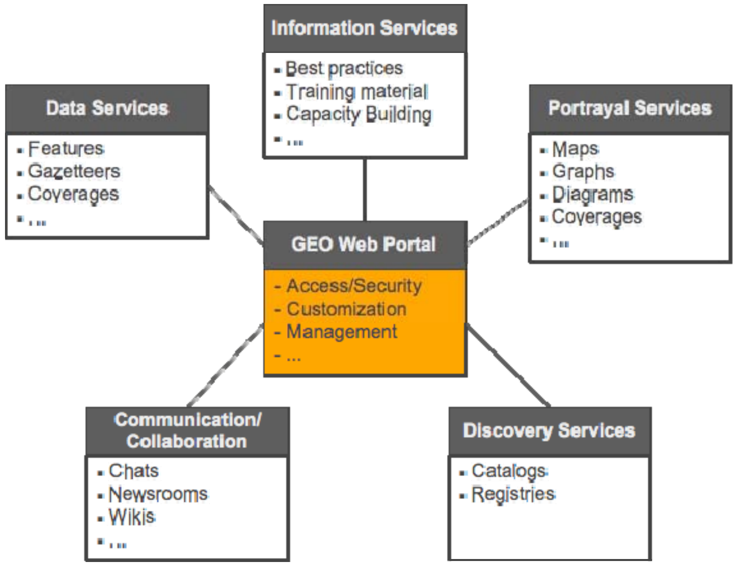

Figure 33 – Web Portal and integrated or linked services

5.3.3 Client Applications

Decision support client application components access remote data from one or more Web services and provide manipulation of the data in the client application. Decision support functionality may include filtering, aggregation, analysis, visualization, presentation, and interpretation of multiple sources of data. Decision support clients may be specific to a user community or may be more generic geospatial data applications. Client applications which can be distributed free of charge are desired, note that this does not necessarily require that the code be open source.

While this type of application is generally understood to be a user-facing component, this does not restrict the computing platform by which it is implemented. The application may be implemented in software running “standalone” on the user’s desktop, or it may be generated by software running on a remote server and “delivered” through a Web browser.

It should be note that the “thin” versus “thick” client distinction is becoming increasingly blurred by rich client technologies. Many analytical procedures previously thought of as desktop functions are also now being incorporated into services, composed into workflows, and then accessed by lightweight user-facing clients.

Despite the range of technological and architectural possibilities, GEOSS client applications should facilitate consumption of GEOSS services by a wide range of users and support decisions needed for the societal benefit area scenarios detailed in this document.

The Decision Support Client component type includes not only Web client applications but also GEONETCast clients.

5.3.4 Client Portlets

Client application generator components supporting the Portlet (JSR 168 specification) and/or WSRP (Web Service Remote Portlet, OASIS-approved network protocol) specifications facilitate both consumption of GEOSS services and incorporation of decision support / visualization functionality into the GEO portal as well as some community portals and should be considered.

5.4 Business Process Components

5.4.1 GEOSS registries

A registry is an information system on which a register is maintained; whereas, a register is a set of files containing identifiers assigned to items with descriptions of the associated items (definitions from ISO 19135). A registry provides access to the registers that it maintains.

The GEOSS registries and their current owners are:

1. GEO Member & PO Register - managed as web page resources by GEOSecretariat
2. GEOSS Components and Services Registry - approved by GEOSecretariat, managed by GMU[3]
3. GEOSS Standards and Interoperability Registry - IEEE[4]
4. GEOSS Best Practices Wiki – IEEE[4]
5. GEOSS Reusable Components Register – currently not owned, open to be offered

The GEOSS Clearinghouse, exposed by the GEO Portal, will directly access all these registers, and provide search and discovery for all catalogue records stored therein. Some registers, such as the Components and Services Register, the Standards and Interoperability Register, and the Best Practices Wiki have their own user interface for the entry and searching of the register contents, but can still be accessed via the GEO Portal. The GEO Secretariat provides a public web page with the official list of GEO Members and Participating Organizations.

As shown in the figure below, the Components and Services Registers interoperate via UDDI, ebRS, CSW and a Web user interface, while the Standards and Special Arrangements Registers interoperate via SRU (Z39.50) and a Web user interface. There is also a special interoperability arrangement between the Special Arrangements Registry and the Services Registry. This interoperability arrangement facilitates the registration of special interoperability arrangements with the Special Arrangements Registry seamlessly while registering the services they support at the Services Registry.

[3] GMU: George Mason University

[4] IEEE, now a formal acronym, it previously stood for the Institute of Electrical and Electronic Engineers.

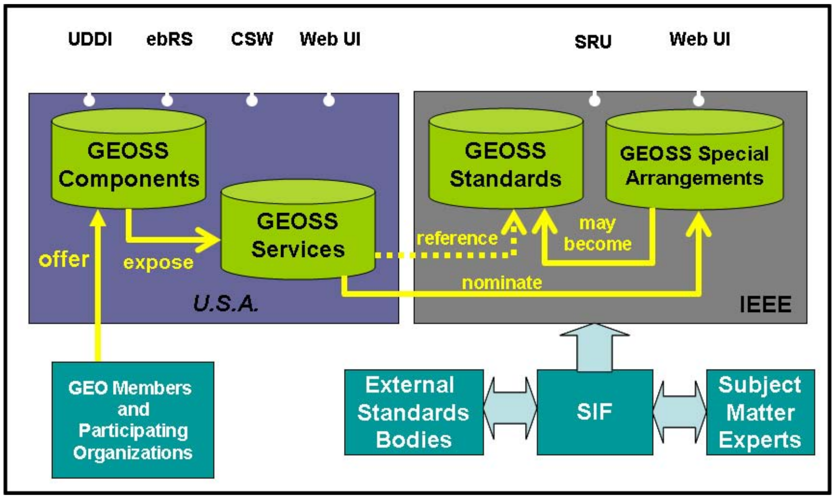

Figure 34 – GEOSS Components and Service Registries

5.4.2 GEOSS Clearinghouse

The GEOSS Clearinghouse provides access to a distributed network of catalogue services that support the interoperability arrangements of GEO. Member and participating organizations may nominate catalogues containing structured, standards-based metadata and other web services for access by the GEOSS Clearinghouse. The Clearinghouse provides search capability across the catalogues and their registered resources. The GEO Web Portal will search the GEOSS Clearinghouse in addition to other nominated GEOSS resources (e.g. other websites and documents). Through the use of interoperability standards, additional portals may be established for national or professional communities to access the GEOSS Clearinghouse. The Global Spatial Data Infrastructure (GSDI), for example, offers a similar clearinghouse capacity.

The GEOSS Clearinghouse will provide access to cached catalogue records from catalogue service instances registered with GEOSS in the Service Registry. This provides one-stop access to metadata on data, services, documents, ontologies, coordinate reference systems, and other resource types nominated within GEOSS. The GEOSS Clearinghouse context is defined in Figure 35

The GEOSS Clearinghouse anticipates access to a federation of catalogues. Each catalog shall maintain its own metadata registry. The Clearinghouse is not a central metadata registry, although it may cache a significant amount of metadata from external, registered catalogues. The Clearinghouse enables discovering communities.

A key consideration is that GEOSS catalogues data and services with sufficient metadata information so that users can find what they need and gain access as appropriate. The interoperable GEOSS catalogues form the basis of a virtual GEOSS catalogue, known as Clearinghouse. GEOSS data resources can be fully described in context, and data access can be facilitated through descriptions of other useful analysis tools, user guides, data policies, and services. Many examples of such clearinghouse facilities already exist in the realm of Earth Observation and networked information systems generally, and many of these already employ interoperable interfaces. [...][xli]

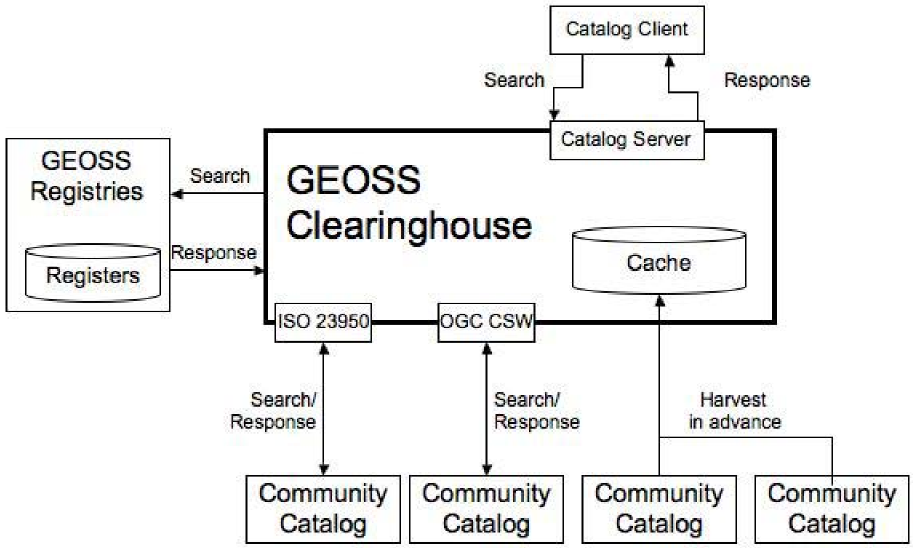

Figure 35 – GEOSS Clearinghouse Architecture - Engineering Viewpoint

Specific interoperability arrangements (standards and practices) are required by catalogues participating in the GEOSS Clearinghouse to maximize interoperability. For catalogue services, the ISO 23950 (ANSI Z39.50) standard using the Geospatial Profile (GEO) may be offered. The OGC Catalogue Services Specification 2.0.1 includes references to the Z39.50 protocol binding as well as the Catalogue Services for the Web (CS-W) protocol binding, which may also be offered for search through the GEOSS Clearinghouse. Both ISO 23950 and CS-W catalogues are offerings registered and supported for search by the GEOSS Clearinghouse. Current and anticipated metadata standards in use include the ISO 19115 and 19139 (XML) standards and the Federal Geographic Data Committee (FGDC) Content Standard for Digital Geospatial Metadata (CSDGM, 1998). ISO 15836:2003 (Dublin Core) metadata also provides a minimum, cross-disciplinary set of metadata elements that can be correlated with more complex metadata standards, and forms the basis of a 'common' result record for summary metadata in both CS-W and Clearinghouse record responses. Additional metadata standards may be anticipated although they will require specialized programming to process the results of the distributed search.[xlii]

The GEOSS Clearinghouse must anticipate the ability a) to perform distributed search of remote disparate catalogues and b) the ability to harvest and cache metadata from certain distributed collections. Some metadata collections may be highly static or of a small number of records and are more amenable to direct caching and search within the Clearinghouse. Other typically large or frequently updated metadata collections that are searchable through catalogue interfaces may be accessed via distributed search through the GEOSS Clearinghouse interface. Both methodologies have been identified as requirements on existing catalogues within GEOSS. The metadata to be held by the

Clearinghouse is dependent upon the approach used for searching. These two anticipated capabilities for access to remote catalogues include:

- Distributed search approach: search requests are sent in parallel to registered distributed catalogues. For these catalogues the only 'local' Clearinghouse metadata is the registered address for the distributed catalogue stored in the Service Registry.
- Harvested approach: The clearinghouse periodically harvests (caches) all metadata from registered distributed catalogues. A user search request is executed against the metadata harvested from the remote catalogues and the results are managed and portrayed in the Clearinghouse.

The GEOSS Clearinghouse itself is searchable via API from external clients such as the GEO Web Portal and embedded application clients. The separation of the Web Portal and Clearinghouse functionality is desirable to allow for optimization and specialization of the search and harvesting capability on a separate machine, to permit plug-and-play substitution of Web Portal and Clearinghouse implementations, and to allow fail-over of one Clearinghouse instance to another. This separation is achieved through the adoption of common interoperability arrangements for search – the Web Portal acting as the client, and the Clearinghouse acting as the federated catalogue service façade. The primary standard for the search capability is achieved through the CS-W version 2.0.2 "baseline."

Table 4 – GEOSS Clearinghouse Requirements

Requirement
Shall provide a catalog *service* interface conformant with OGC Catalogue Service for the Web CS-W Version 2.0.2 "baseline"
Shall provide catalog *client* interfaces conformant with: • ISO 23950 Geospatial ("GEO") Profile Version 2.2 • OGC Catalog Services for the Web (CSW) – Version 2.0.1 and 2.0.2 "baseline," anticipating the following OGC Community Profiles for Catalogue Services: ISO 19115, ebRIM, Earth Observation (EO) Profile, and FGDC
Shall access the GEOSS Service Registry for: • Catalog Service instances whose contents are to be harvested or searched • All other service instance descriptions (metadata) to be made searchable as Clearinghouse resources
The clearinghouse shall be available at least 99% of the time, i.e., approximately 7 hours of down time a month.
Requirements for the future: Shall be hosted on a computer hosted at, or though contract to, the GEO Secretariat. Host shall provide adequate access to the Internet.
Requirements for the future: Maintenance of the software of Clearinghouse shall be performed by the contributing organization.

The ability to perform search using the recently developed OpenSearch protocol would simplify the development of client-side queries and handling of results and make the

Clearinghouse appear like a geo-enabled search engine, since OpenSearch is already adopted as an industry-wide API by Google, Yahoo, and A9 (Amazon). OpenSearch as a "GET"-style query protocol supports both simple (text) and advanced (term) search and returns result sets as "feeds" in the RSS 2.0 or Atom 1.0 XML formats, recognized natively by most browsers.

5.4.3 Community catalogues

Each distributed community catalogue will hold metadata records that describe geospatial information and the means to access them. The metadata records shall be structured in accordance to standards agreed to by GEO. For maximum interoperability, catalogues should support metadata standards and structures adopted widely in the community, such as ISO 19115 (with 19139 to define a common XML encoding). A given metadata record may represent a collection of imagery, an individual image, a vector data set or collection of features, a scanned map or other georeferenced information. Additional resource types that may be described in metadata include documents (e.g. spreadsheets, text files, HTML files), schemas, ontologies, lists of coordinate reference systems, feature catalogues or data dictionaries, or other resource types of interest. Each metadata record should include a web-accessible link to the resource being described, though it may simply include instructions for other means of access. Where standards-based web access methods are available to visualize or access a data set, these should be expressed and included in the metadata record.

5.4.4 Infrastructure Registries

The previous sections have addressed registries for discovery. Other registries are needed for resources that allow the interoperable infrastructure to operate. Examples include registries for Coordinate Reference Systems, Application Schemas, and Symbol Sets.

During the 1st Phase of AIP the Standard Archive Format for Europe (SAFE) registry was registered in the GEOSS Component Registry. SAFE is a long-term preservation data format definition for Earth Observation data based on the XML Formatted Data Units (XFDU) CCSDS (and future ISO) standard. SAFE is also conformant with the CCSDS 650.0-B-1 / ISO 14721:2003 (Open Archival Information System Reference Model) Although it has been primarily developed for archives based on the so-called L0 data, SAFE is not limited to them and detailed implementations exists already for L1 and l2 data.

5.4.5 Portrayal servers

Portrayal is for the "presentation of information to humans" (ISO 19117 (2004)) for human visualization. For example, map portrayal is concerned with the shape and color of symbols representing features or is concerned with rules for displaying text labels or for showing or not showing symbols.

A Portrayal Service produces visual pictures from geographic data. Portrayal Services are components that, given one or more inputs, produce rendered outputs such as cartographically portrayed maps or perspective views of terrain.

Example Portrayal Service implementations include: Web Map Service (WMS), Coverage Portrayal Services (CPS) and Feature Portrayal Services (FPS). An FPS is a specialised component-WMS able to portray GML data from WFS services. A CPS is a specialised component-WMS able to portray coverage data from WCS services.

These services usually generate maps in pictorial formats like JPEG, PNG or GIF. Besides these 2D maps as a direct visualization of geospatial data, OGC Web Map Context Documents and OGC KML, as an in-direct visualization of geospatial data, is also valuable in terms of promoting global sharing of geospatial data visualization among different GEOSS practitioners.

5.4.6 Processing components

Processing Server components are both clients and servers. They provide a service interface such as OGC WPS that accepts requests to process data. The process achieved by algorithms and data handlers provided by the Processing Server. The data is accessed from a remote service, i.e., the client role of a Processing Server. Processing Servers may be used individually or as part of a workflow.

5.4.7 Workflow management engine

A workflow, in general sense, is a sequence of operations composed of work of a person, work of a simple or complex mechanism, work of a group of persons, work of an organization. In the context of GEOSS, we focus on workflows combining algorithms, models, and systems in the Web environment. A workflow management engine should be capable of managing workflows, services, activities, and workflow execution instances. Figure 36 shows the overall architecture. It has two groups of functions. One is the portal that supports human interactions, such as administrative function, manual deployment/undeployment, interactive execution, and debugging. Another set is the suite of services that are consumed by programs or Web services, such as management services for deploying, undeploying, and executing workflows. Each deployed workflow should be accessible as standard Web services by other software programs.

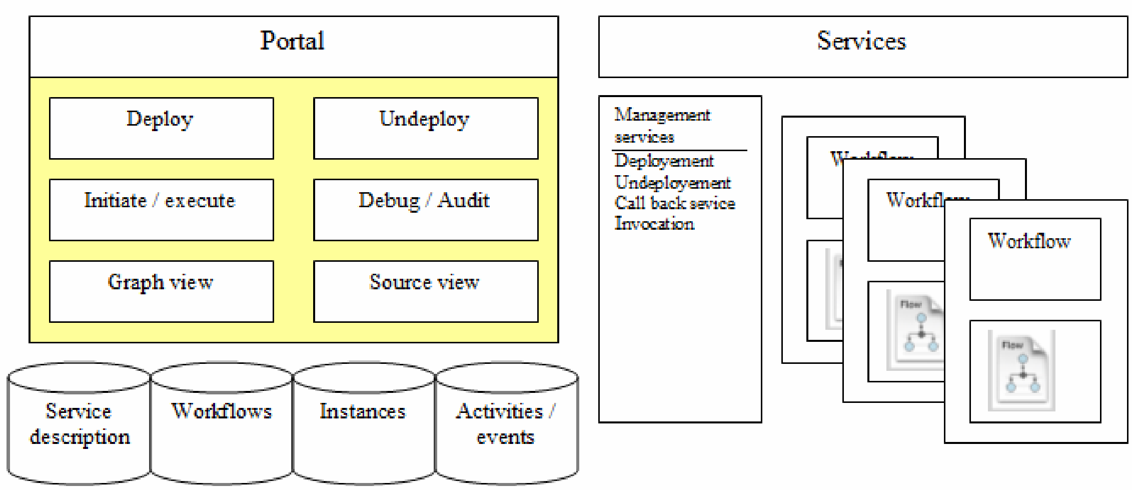

Figure 36 – Architecture for a workflow management engine

To support workflow development, workflow designers aid in the development of workflow scripts. Such designers aid the automatic checking of data types and support the user in evaluation of the semantic correctness of the products derived by a workflow. Workflow designers are available either desktop version or Web version.

5.4.8 Alerts and Feeds

These components provide RSS feeds and CAP Alerts. It is also anticipated that the work on events in this phase of AIP will result in further development of this component.

5.4.9 Other business components

The "other service" component type is included in the architecture to accommodate extensibility. Services that are contributed by members that do not match the previous types are placed in this category. At the beginning of the next phase of AIP, the existing other services will be considered for refinement of the component type architecture.

5.5 Access Components

5.5.1 GEONETCast

GEONETCast is a near real time, global network of satellite-based data dissemination systems designed to distribute space-based, air-borne and in situ data, metadata and products to diverse communities.

The concept of GEONETCast is to use bandwidth on commercial satellites for the data broadcast using standard DVB-S broadcast. Each regional system GEONETCast-Americas, EUMETCast and FENGJUNCast make use of this concept by having procured bandwidth on commercial satellites to which the data is uplinked and then broadcast within the footprint of this satellite. The result of the cooperation of the partners is a nearly global coverage.

GEONETCast Global Design Document[xliii] describes the conceptual idea of a global GEONETCast implementation is that several regional centres take on the responsibilities for establishing a satellite based regional dissemination system and provide the same services to the common user community. The concept of interconnected regional GEONETCast Network Centres (GNC) would allow such an implementation.

A fundamental premise in the design of a GEONETCast capability for interoperability is that the regional systems are as loosely coupled as possible to maximize each region's flexibility to implement optimal solutions based on its own unique regional challenges. However they must possess common interfaces standards and processes and service level based business-to- business relationships that facilitate exchange of data in both directions in a way that minimizes (but not necessarily eliminates) burden on participants, including providers, data providers, and end users.

Each User accesses in the first instance a central GEONETCast portal on http://www.geonetcast.org (one stop shop). Based on the input of geographical information, the user is then re-directed to the responsible regional GNC, which hosts the regional implementation of the portal. There the user can access services for:

- Data discovery (searchable) on global and regional products and services;
- Links to the regional service performance indicator and news messages;
- Links to the help-desk services;
- Links to the GEONETCast subscription service;
- Web links to the regional archives of the various data providers

Implementations of such distributed portals are widely available. It is pre-mature to discuss now the actual portal technology to be used for GEONETCast; the only important aspect for now is the requirement that the portal technology and implementation of its services should follow recognized international standards.

5.5.2 Product Access Component

These components provide services to access Earth Observation data. The components are typically hosted by an archive data center or other facility that provides redundant resources for both high availability and high performance. Product access components provide access to information of value to the GEOSS community: features, coverages, and observations and maps. The services may be of several types, e.g., WMS, WFS, WCS, SOS, other. It is typical to see a catalogue associated with one or several product access server nodes that provides metadata for the products hosted by the facility.

Product Access Servers are similar to the Imagery Archive Nodes as identified in ISO/TS 19101-2, Geographic information – Reference model – Part 2: Imagery (Figure 37).

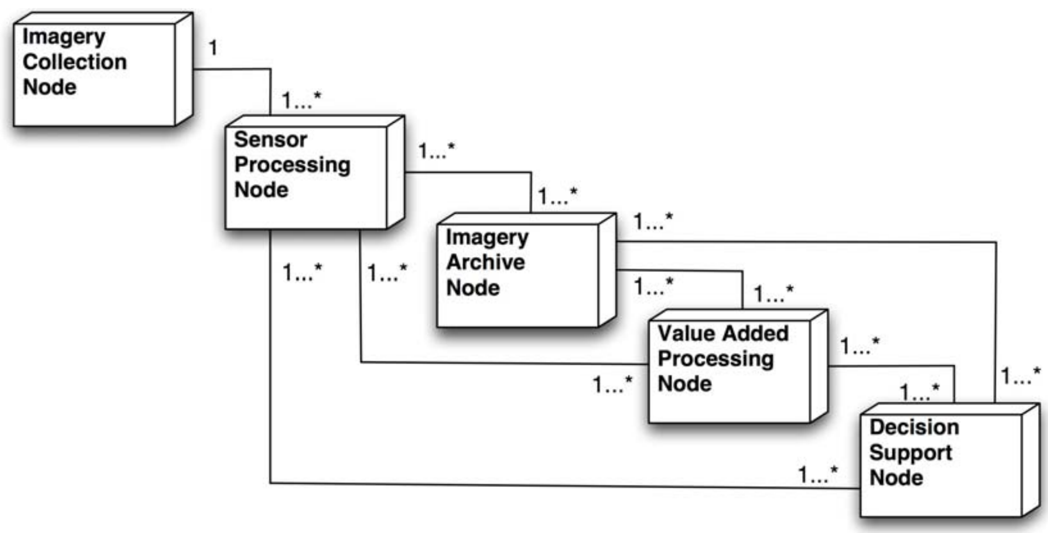

Figure 37 – Imagery reference model nodes

5.5.3 Model Access Component

These components provide services to access outputs of predictive models of geospatial information. The components are typically hosted by a simulation and modeling center or other facility that provides redundant resources for both high availability and high performance. Model Access Components provide access to information of value to the

GEOSS community: features, coverages, and observations and maps. The information may be through several types of services, e.g., WMS, WFS, WCS, SOS, other. It is typical to see a catalogue associated with one or several product access server nodes that provides metadata for the products hosted by the facility.

5.5.4 Sensor web components

These components provide services to sensors networks. Examples include: 1) a ground station and associated satellites and 2) in-situ networks of sensors available through sensor web.

The components are typically hosted by a facility that provides redundant resources for both high availability and high performance. Sensor components provide access to information of value to the GEOSS community: features, coverages, and observations and maps. The information may be through several types of services, e.g., WMS, WFS, WCS, SOS, other. It is typical to see a catalogue associated with one or several product access server nodes that provides metadata for the products hosted by the facility.

The Sensor Web represents a meta-platform that integrates arbitrary sensors and sensor networks; each maintained and operated by individual institutions. This reflects the existing legal, organizational and technical situation. Sensors and sensor systems are operated by various organizations with varying access constraints, security, and data quality and performance requirements. The architectural design of the Sensor Web allows the integration of individual sensors as much as the integration of complete sensor systems without the need of fundamental changes to the constituent systems.

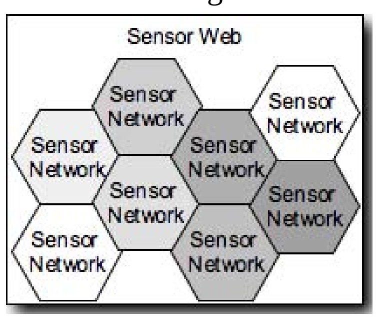

Figure 38 – Sensor Web: Aggregation of Sensor Networks

5.5.5 Other access components

The "other service" component type is included in the architecture to accommodate extensibility. Services that are contributed by members that do not match the previous types are placed in this category. At the beginning of the next phase of AIP, the existing other services will be considered for refinement of the component type architecture.

5.6 Test Facility for Service Registration

5.6.1 Purpose

The Service Test Facility is intended to ensure proper and interoperable use of GEOSS components and services in applications and interfaces. The Test Facility is intended to promote predictable and reliable access to services registered with the GEOSS Service Registry. The facility will support service providers, service operators, technology providers, integrators, and other users. It will provide a means for service operators and technology providers to get feedback on the efficacy of their interfaces and applications in implementing and using GEOSS Interoperability Arrangements. The Test Facility should enable web services developers to test their data and model prototypes for GEOSS SBA scenarios and demonstrations. In this way, the facility can foster improved collaboration for interoperability It will allow service operators to test their service interfaces at the operation level to determine nominal conformance/compliance with published interface specifications, where they exist. This will promote interoperability between compatible client and service instances of the same version and allow integration of diverse resources across GEOSS. The facility will also enable periodic checking as to the availability and reliability of registered components and services, encourage cross-community implementations, and shorten prototyping cycles. To these ends, the Test Facility needs to be a permanent, sustainable resource.

5.6.2 Processes and Procedures

The Test Facility will be particularly important for the testing of data and models for use within specified domain communities. Since a given community would know best how to describe and identify "proper and interoperable use" of data and models within its domain, it makes sense that there would not be a single, centralized Test Facility, but rather a federation of Test Facilities, each managed by a particular community of interest.

The GEOSS Components Registry, Services Registry, and Standards Registry together provide a centralized resource, which can be utilized by the Test Facilities. Where tests are developed having common functionality that is of use in other domains, these should not be duplicated, but should be linked for shared use among the Test Facilities.

The Test Facilities should provide feedback to the relevant standards authorities when interoperable use among registered components and services is not achieved. Such outcomes could be the result of immature standards and practices, and may inform the standards authorities of issues needing discussion that could potentially influence their standards process and products.

The Test Facility will be available for service interfaces that have registered a test profile for a given standard or special arrangement. This testing framework will be based on a web service oriented test ‘harness’ that supports basic testing of service interfaces using the range of available standard protocol environments, including “GET”, “POST”, and SOAP-based solutions, where they are called for in the referenced standard. Web service testing environments such as “WebInject” or the OGC “TEAM” Engine will be evaluated to host the test facility. The test facility will not test models or message/response content, except where the syntax of a message or response is published within the standard and is easily configured for testing. The CFP seeks participation and collaboration in the development, testing, and operation of a test facility for GEOSS.

The GEOSS Components Registry, Services Registry, and Standards Registry together provide a centralized resource, which can be cross-referenced with the Test Facility. Tests will be associated with registered standards or special arrangements, registered service instances are already associated with standards and by implication the tests that apply to them. Where tests are developed having common functionality that is of use in other domains, these should not be duplicated, but should be linked for shared use among the Test Facilities.

The Test Facility should provide feedback to the relevant standards authorities when interoperable use among registered components and services is not achieved. Such outcomes could be the result of immature standards and practices, and may inform the standards authorities of issues needing discussion that could potentially influence their standards process and products.

The Capabilities of the Test Facility does not enforce compliance or availability but rather is a resource to aid those services that are being contributed to GEOSS to be most effective. The GEOSS Test Facility is not a certifying body. Tests performed on the GEOSS Test Facility do not replace the certification tests for a standard as defined by the organization that maintains the standard. Passing a test in the GEOSS Test Facility is only normative to the GEOSS operating environment.

5.6.3 Test Facility Processes and Procedures:

- Register and link to tests for standards and special arrangements
- Collect and forward feedback to standardisation organisations
- Testing Facility in line with GEO principles
  - Federation
  - Avoid duplication of efforts, link to resources offered to GEO
- Scenario development, link to use case from UIC
  - Involve users of specific communities
  - Prioritize the components of the testing facility based on use case
- In particularly important for testing of models
- Test Facility should provide feedback to standardisation organisations
- Permanent character of Testing Facility is important

5.6.4 Functions of the Test Facility:

- User Interface “Portal-like” function: identify appropriate testing resources
- Collect feedback to standardisation organisations
- Testing Facility should provide feedback on

  - Syntactic interoperability (service interfaces, message syntax)
  - Semantic interoperability based on GEOSS data (content, where practical)
  - Availability and reliability through periodic test polling (based on periodic service checks)
- Provides feedback to technology and service providers
- Aspects of quality of service should be taken into account
  - Tools that monitor behaviour of services, aspects of quality
  - Where is service propagated from, authoritative service provider

5.7 Engineering Use Cases

5.7.1 Register and Distributed Search

Distributed search is a primary function of the GEOSS Clearinghouse. Distributed searching assumes that multiple catalogs will be accessible. While harvesting some portion of the metadata from some catalogues will occur in advance, it is not practical in a system-of systems-to centralize all metadata from all catalogs.

Figure 7 is a UML interaction or sequence diagram that depicts the processes involved in the operation of the GEOSS Clearinghouse and Registries. This viewpoint is primarily that of a GEOSS publisher; end user interactions are not documented in this figure. Four activities are shown in the figure to highlight the publishing, registration, clearinghouse configuration, and Web Portal interactions, labeled A, B, C, and D, respectively.

In the publishing activity, “A,” a GEOSS publisher activates an online service and documents its existence or its data sources in a catalog. Activity “B” details the transactions taking place between a publisher who is registering a Component and a service and the Service and Standards registries. Activity “C” shows the GEOSS Clearinghouse discovering eligible services including catalog services in the GEOSS Service Registry and then accessing the found services directly. In some cases, the remote catalogs are set up for real-time distributed query – in others for harvesting or processing the results into a local cache. Activity “D” shows the expected interaction between a Web Portal and the clearinghouse and Component and Service registry.

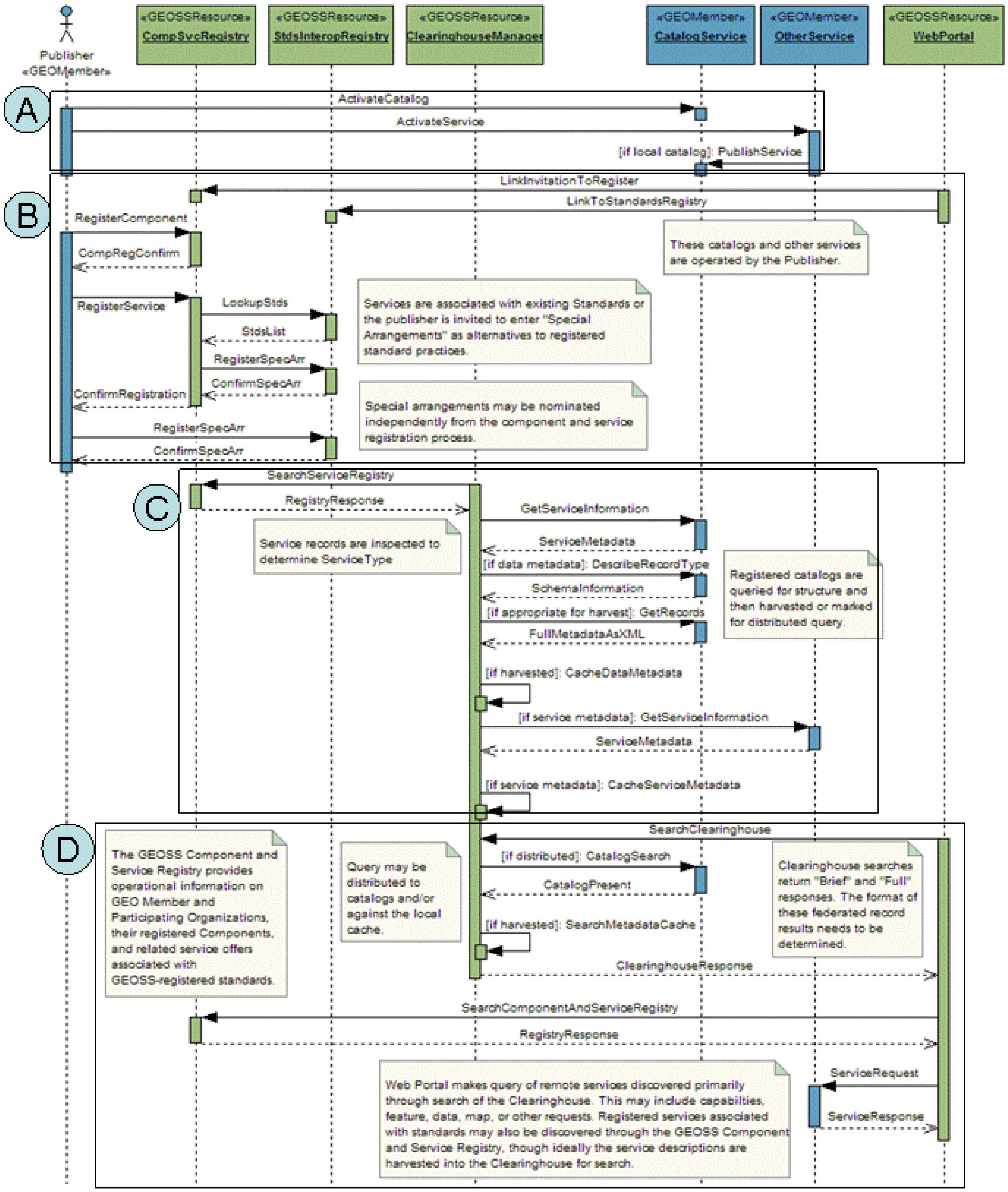

Figure 39 – Distributed Search Sequence

Figure 35 shows that the Clearinghouse has two ways to interact with the Community Catalogues: Harvest or Distributed Search. The following criteria are used to evaluate the options.

- User response time. The performance in terms of time to respond to a user search placed against the Clearinghouse. The User's search is assumed to trigger distributed searching. The duration is from the time the search is received by the clearinghouse until the operation has fully completed and the clearinghouse has replied to the user with results.
- Results ranking. Users desire that the results of a search be ranked in a fashion that provides the result of most interest at the top of the list. Ranking of results requires that the entire result set can be evaluated in a uniform fashion.
- Metadata accuracy. The consistency of the metadata received by the user in comparison to the most accurate metadata available at any location at the time of the search.
- Metadata ownership. Compatibility of the alternative to stewardship of metadata by the organization that is charged with maintaining the metadata.
- Robustness. Ability of alternative to gracefully handle unanticipated changes of the distributed catalogues, e.g., catalogue off-line, catalogue schema changed.
- Adaptive Modularity. Ability to accommodate the addition and deletions of Community Catalogues from the GEOSS architecture
- Clearinghouse Cost. Cost for creating and maintaining the GEOSS Clearinghouse – not including the costs of the Community Catalogues.

The consensus of the Clearinghouse WG in the 1st Phase of AIP was that the most important criteria are: 1) User Response Time and 2) Results Ranking. Therefore, the Harvest option should be selected for as many Community Catalogues as possible.

Given the nature of GEOSS, i.e., a system of systems, there will be catalogues that cannot or will not be harvested. Where a Community Catalogue distinguishes between collection and granule metadata, only the collection metadata should be harvested. Some catalogues will object to being harvested, i.e., criteria 4) Metadata ownership. Therefore, the Clearinghouse should provide a distributed Search functionality but its use should be minimized.

To meet this hybrid recommendation, further analysis of the Clearinghouse server interface is required. Currently there is not a widely implemented catalog interface standard that blends a full response from the local harvested cache with stateful distributed queries. What is needed is a stateless catalog interface for hybrid search: immediate response to user while distributed searches are continuing.

A previous trade study with alternatives similar to this study came to the following conclusion:

"There is no 'one size fits all' geospatial enterprise or server architecture that is appropriate for all organizations. Organizations will develop their architectures and systems to best fit the data quality, security, accessibility and related factors associated with their business environment and processes. [Fisher]

5.7.2 Visualization of EO Data

Visualization of Earth Observation data is a primary mode of interaction for human users with the EO data. Portrayal Services created pictures of data, e.g., maps. The map visualization of EO data can then be combined with other geographic data accessible from WMS services.

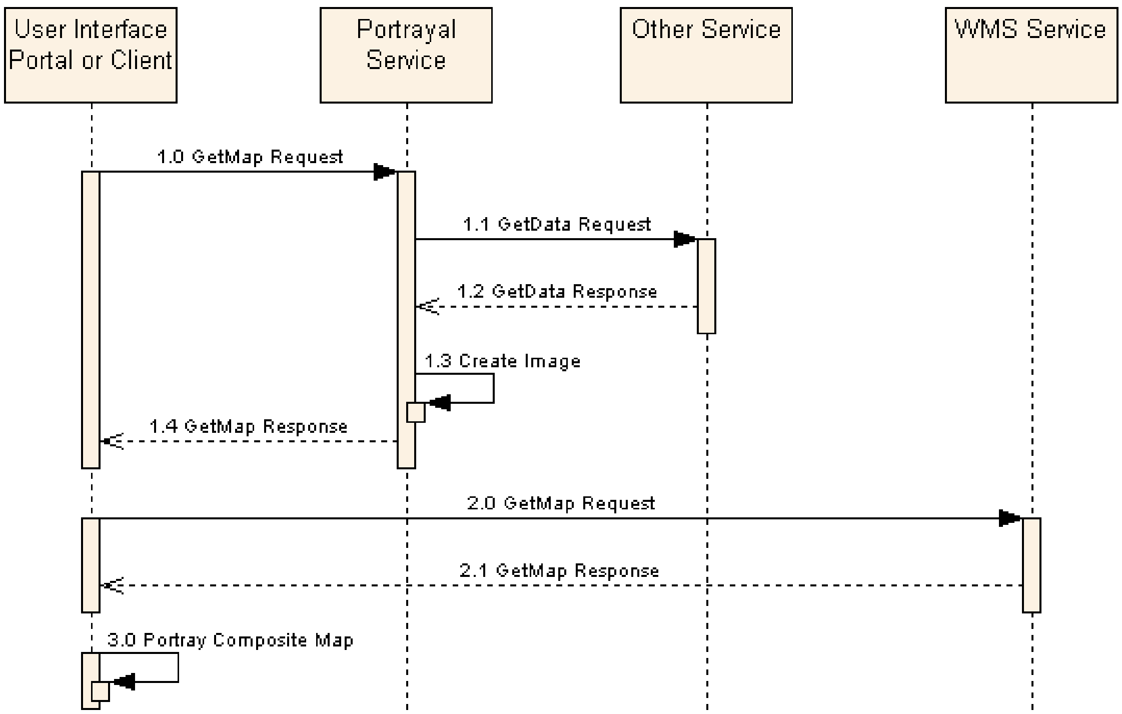

Figure 40 – Visualization of EO Sequence

Table 5 – Visualization of EO Steps

Step Label	Description
Initial Conditions	• Components and services have been registered in GEOSS Component Registry • User Interface Portal or Client has knowledge of a data source and a suitable portrayal service. • Examples of Other Services include WFS, WCS, and CSW.
1.0 GetMap Request	User Interface Portal or Client creates a getMap request including the URL of the Other Service and styling information.
1.1 GetData Request	Portrayal Service accesses data from Other Service using the URL in the GetMap Request of step 1.

1.2 GetData Response	Other Service responds with data.
1.3 Create Image	Portrayal Service creates an image from data by applying the styling information from step 1.
1.4 GetMap Response	Picture of the data is sent to the User Interface
2.0 GetMap Request	User Interface requests additional maps of the same geographic extent from WMS services.
2.1 GetMap Response	WMS service responds with map picture
3.0 Display Composite Map	User Interface creates a composite map by overlaying the maps.

5.7.3 Processing of Service Responses

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

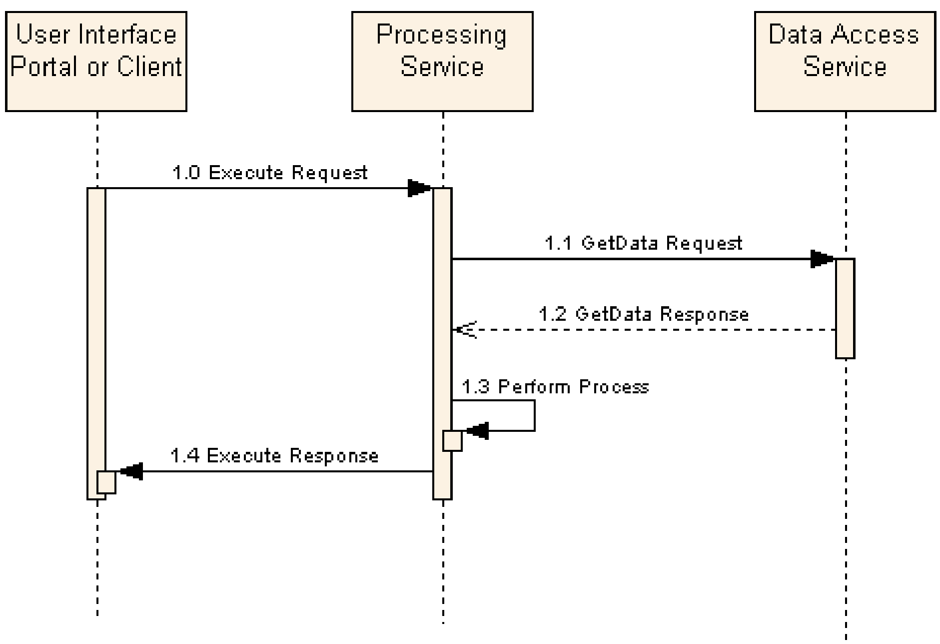

Figure 41 – Processing of Service Response Sequence

Table 6 – Processing of Service Response Steps

Step Label	Description
Initial Conditions	• Components and services have been registered in GEOSS Component Registry • User Interface Portal or Client has knowledge of a data source and a suitable processing service, e.g., WPS. • Examples of Data Services include WFS and WCS.
1.0 Execute Request	User Interface Portal or Client creates an Execute request including the URL of the Data Service and processing parameters.
1.1 GetData Request	Processing Service accesses data from Other Service using the URL in the Execute Request of step 1.
1.2 GetData Response	Data Service responds with data.
1.3 Perform Process	Processing Service creates value-added data by applying the performing the processing using the parameters from step 1.
1.4 Execute Response	Value-added data is sent to the User Interface

5.7.4 Workflow orchestration

The previous use cases can be combined in a multitude of ways in order that the user receives the information suited to their decision, research, etc. As multiple services are combined into a chain of services a workflow is defined. The workflow can be stored in a scripting language, e.g., BPEL. Control of a service chain can be automatically controlled by a workflow management service. The workflow shown here is one example of many.

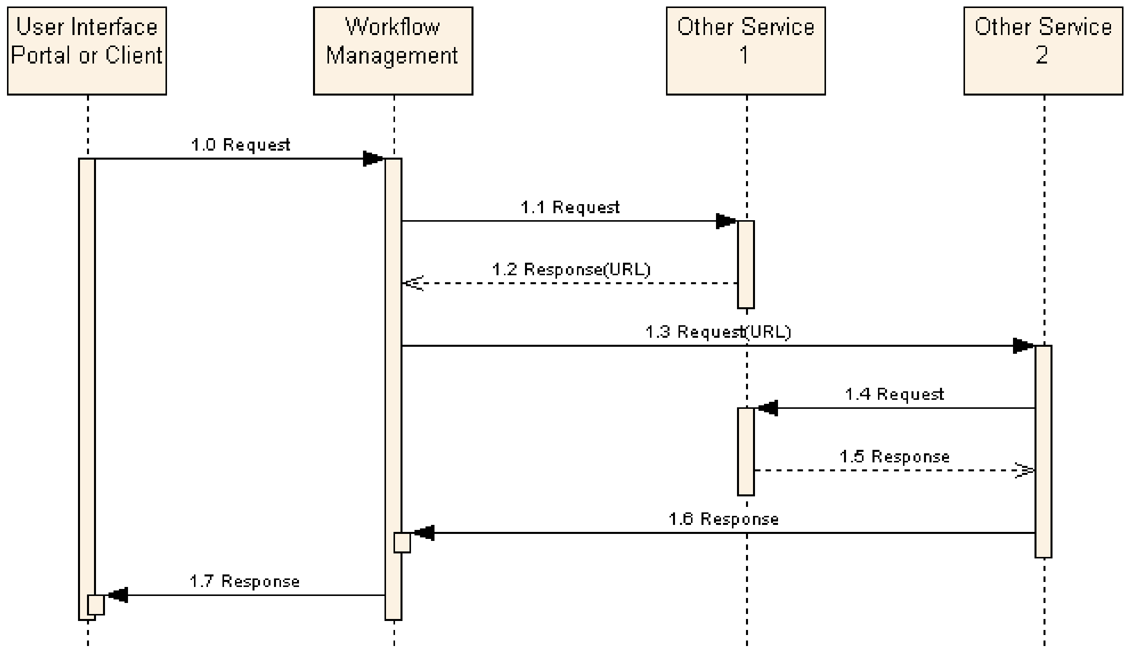

Figure 42 – Workflow Execution Sequence

Table 7 – Workflow Execution Steps

Step Label	Description
Initial Conditions	• Components and services have been registered in GEOSS Component Registry • A workflow script has been created previously and exists in the workflow engine. • Examples of Others Services include Portrayal Services, Processing Services and Data Access Services and Catalogues.
1.0 Request	User Interface Portal or Client creates a request on the Workflow Management service.
1.1 Request	Workflow Management service initiates the service chain by sending a request to an Other Service.
1.2 Response (URL)	Other Service responds typically with a response that the data is available at a URL that is provided in the response.
1.3 Request (URL)	Workflow Management service reviews the script to determine the next step in the chain and sends a request to an Other Service. The request includes the URL of the intermediate product in step 3.
1.4 Request	Other Service requests intermediate product from Other

	Service.
1.5 Response	Other Service responds with intermediate product from Other Service.
1.6 Response	Other Service performs additional processing on intermediate product and produces a final product to the Workflow Management service.
1.7 Response	Workflow Management service sends final product to User Interface.
Alternative for 1.6 and 1.7	Instead of the final product being sent to the Workflow Management service, the Other Service returns a URL of the final product that is sent on to the User Interface. User Interface then uses URL to acquire final product directly from the Other Service.

5.7.5 Ordering products

(To be developed: Use case for on-line ordering of EO products which are delivered asynchronously either by network or media)

5.7.6 Product Delivery via GEONETCast

(To be developed: use case for discovering an metadata record for a product that is subsequently accessed using the a client that can receive GEONETCast broadcasts.)

5.7.7 Integration of Sensors

The following use case illustrates the integration of taskable sensors into GEOSS. Based on the assumption that a catalogue search for observation data was didn’t produce any results, the client searches for sensors that could be used to produce the required data.

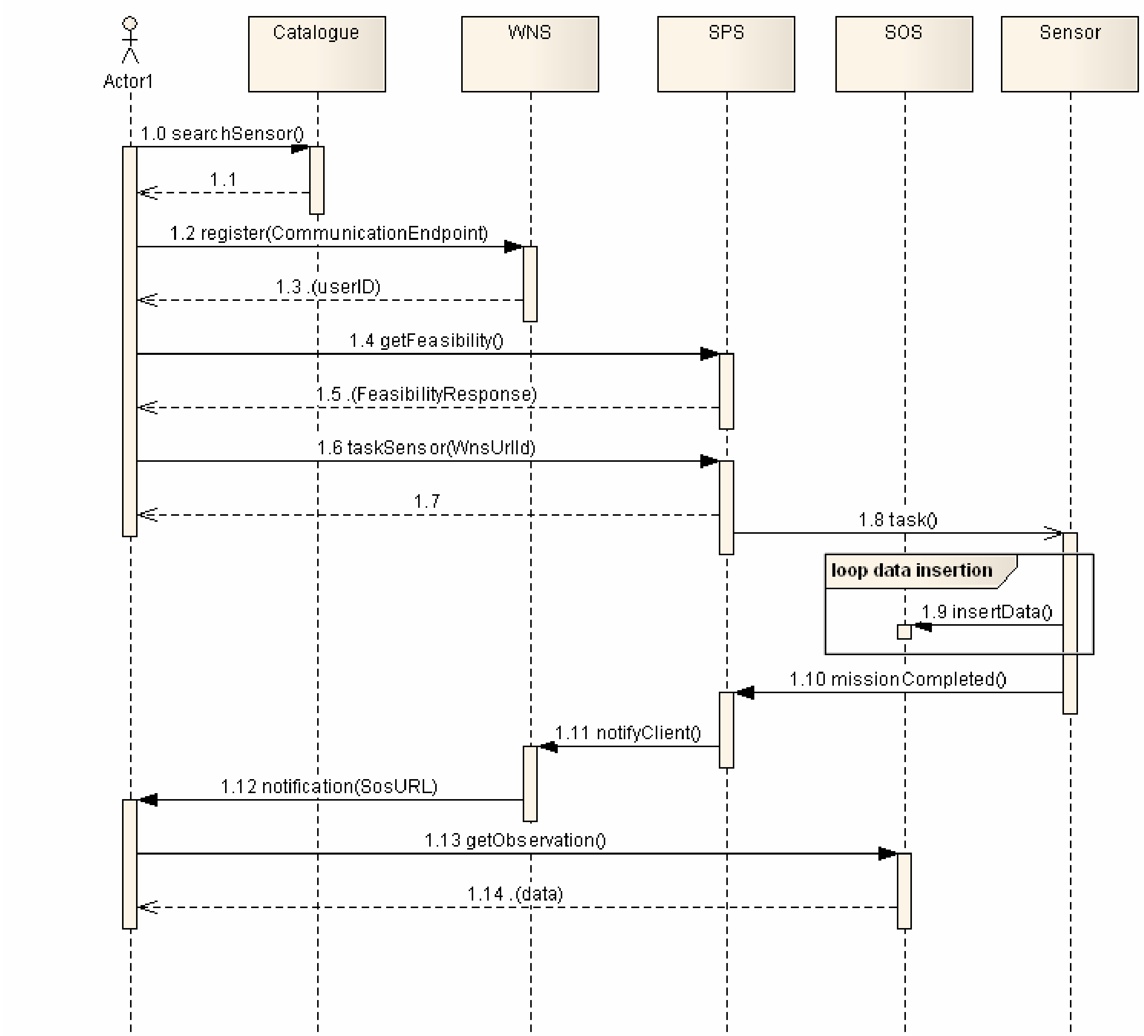

Figure 43 – Sensor Tasking Sequence

Table 8 – Sensor Tasking Steps

Step Label	Description
Initial Conditions	• Sensor and observable types have been registered in GEOSS registries • All services types have been registered in GEOSS component registry • All service instances have been catalogued
1.0 SearchSensor	Client searches for taskable sensors that can produce the required data sets
1.1 Response	Catalogue provides list of services interfaces facading appropriate sensors
1.2 Register(CommunicationEndpoint)	The client registers at a Web Notification Service to allow asynchronous communication
1.3 message (UserID)	WNS provides UserID that can be used to identify the user at this WNS
1.4 getFeasibility	Client tests feasibility of intended tasking request
1.5 FeasibilityResponse	SPS provides feasibility response that allows the client to formulate the tasking request.
1.6 taskSensors (WnsUrlId)	Client submits the tasking request and provides its WNS ID to allow asynchronous communication (SPS has to inform the client once the sensor has been tasked and data is available)
1.7 Response	SPS acknowledges
1.8 task	SPS tasks the sensor
1.9 insertData	Sensor performs observation and pushes data to transactional SOS until mission is completed (loop)
1.10 missionCompleted	Sensor informs SPS about completion of mission
1.11 notifyClient	SPS sends notification request to WNS. Access information to data is piggybacked.
1.12 notification (SosURL)	WNS forwards the message to the client. Message contains all information to retrieve the data from SOS
1.13 getObservation	Client requests data from Sensor Observation Service
1.14	Data is delivered to the client.

Further Sensor Web Use Cases have to be developed during the 2nd Phase of AIP.

6 Technology Viewpoint – Component Instances

6.1 Component Registry

The Technology Viewpoint identified the component and service instances that comprise the "as-built" system. The GEOSS Registries are the definitive source for this information (http://geossregistries.info/). A purpose of the Pilot Development process is to augment the component and service instances.

6.2 Operational persistence

Deployed servers that seek be consider as "persistent operational exemplars" must meeting the following criteria:

1. Length of commitment
    1. Upon registering a service, a service provider must specify the length of time for which the service will be offered (preferably 'unlimited').
    2. Experimental services will be registered and exempt from the level of service requirements.
    3. Consider multiple years
2. Level of service
    1. Services are expected to be available at least 99% of the time, except when otherwise required by the nature of the service.
    2. This allows for approximately 7 hours of down time a month
    3. Adequate network service must be utilized in order to provide this level of availability.
3. •Termination
    1. GEO may "de-list" a server
    2. Non-functioning components of the Network will diminish the operational and marketing value of the Network in general for all participating organizations.

7 GEO ADC Definitions

The following Candidate GEOSS Architecture-related Definitions were compiled during GEO ADC meeting, December 2006.

GEO (Group on Earth Observations): GEO is an intergovernmental partnership among GEO Member countries and Participating Organizations: see http://earthobservations.org/

GEO Member: Any member State of the United Nations may become a GEO Member on request and after having endorsed the GEOSS 10-Year Implementation Plan.

GEO Participating Organization: Subject to approval by GEO Members, any intergovernmental, international, or regional organization with a mandate in Earth observation or related activities may become a GEO Participating Organization on request and after having endorsed the GEOSS 10-Year Implementation Plan.

GEOSS (Global Earth Observation System of Systems): The collection of collaborating earth observation systems that are registered with the GEO to provide access to diverse, multi-disciplinary data and services associated with earth observation. GEOSS reflects a global scientific and political consensus that information vital for societies requires comprehensive, coordinated, and sustained Earth observations.

GEOSS 10 Year Implementation Plan: The GEOSS 10 Year Implementation Plan is directed by GEO (Group on Earth Observations) to achieve the vision of comprehensive, coordinated, and sustained Earth observations for the benefit of societies worldwide.

component: a part of GEOSS contributed by a GEO Member or Participating organization. Example types of components include observing systems, data processing systems, dissemination systems, educational programmes, or other initiatives. Components may expose *service* interfaces to provide access to earth observation-related functions and/or data. Components are described in the *GEOSS Component Registry*.

service: Functionality provided by a component through component system interfaces. Services communicate primarily using structured messages, based on the Services Oriented Architecture view of complex systems. Services are described, along with information about their operating organizations, in the *GEOSS Service Registry*.

Services Oriented Architecture [get official website] OASIS, W3C

interoperability: the ability to link two or more components/services to execute a particular task that spans those components without knowledge of underlying implementation. Interoperability may be addressed at the component level and/or defined at the service interface level through the adoption of common standards.

interoperability arrangement: a registered declaration by one or more GEO Members or Participating Organizations to provide access to *services* and data through identified non-proprietary standards. Formal international standards are documented and referenced in the Standards Registry. Interoperability arrangements that document informal standards are referenced in the Special Arrangements Registry. Special arrangements are not required when referencing formal international standards starting from those in the Standards Registry.

standard: documented approach for conducting an activity or task. Standards may be de jure (formally recognized) or de facto (informally adopted) within a community of application. De jure standards are typically managed by a standards development organization. Formal international standards are documented and referenced in the *Standards Registry*. Interoperability arrangements that document informal standards are referenced in the *Special Arrangements Registry*.

GEOSS Clearinghouse: a component that provides access to a network of catalogues and registries that conform to identified catalogue service and metadata standards. The Clearinghouse supports access to data, documents, services, and other resources through the search of descriptive properties (metadata) offered by GEO Members and Participating Organizations.

GEO Web Portal: a website that provides access through *standard* interfaces to the *GEOSS Clearinghouse*, GEOSS registries, and related information.

register: set of files containing identifiers assigned to items with descriptions of the associated items (ISO 19135)

registry: information system on which a register is maintained [and accessed] (ISO 19135)

Footnotes

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